RAPID BIOASSESSMENT OF THE HOG RUN AND MIDDLE FORK OF WILDCAT CREEK WATERSHEDS USING BENTHIC MACROINVERTEBRATES

for the Soil and Water Conservation Districts of
Tippecanoe and Clinton Counties

Study conducted during
August and October 1994

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EXECUTIVE SUMMARY

Rapid bioassessments of the benthic communities of Hog Run and the Middle Fork of Wildcat Creek in central Indiana were conducted in August and October 1994. The purpose of the assessments was to document the degree of biological impairment present in the waterbodies prior to initiation of various land treatments.

The study showed that all four sites examined were "slightly" to "moderately" impacted, compared to a nearby "reference" stream. Although lower aquatic habitat values contributed to observed biological impacts at each site, degraded water quality also appeared to be a problem as well. The most likely cause of lower water quality at these sites was nutrient enrichment and/or sediment deposition. Two sites on the Middle Fork of Wildcat Creek were probably more impacted by lower water quality than sites on Hog Run.

The biological index scores of all four study sites were lower in October than in August. The dry summer of 1994 may have contributed to the somewhat lower index values observed during October. The site with the lowest biological index score occurred on the Middle Fork of Wildcat Creek upstream from Hog Run. Additional work on land treatments in this watershed is recommended.

INTRODUCTION

This study was conducted to measure the "biological integrity" of the Middle Fork of Wildcat Creek and one of its tributaries (Hog Run) in central Indiana. Wildcat Creek has been identified by the Soil and Water Conservation Districts of Tippecanoe and Clinton Counties and the Indiana Department of Environmental Management (IDEM) as having seriously degraded water quality due to nonpoint sources of pollution [1]. Soil conservation measures were planned by the Indiana Department of Natural Resources (IDNR) and local Soil and Water Conservation Districts to improve the water quality of these streams. By commissioning studies of the biological communities of the streams before and after application of land treatments in the watersheds, IDNR and the Districts hoped to determine whether treatments resulted in improved water quality, as reflected by an improved biological community.

Land treatments in the watershed were initiated in October 1993 and continued through the summer of 1994. The first study of the biological communities of these streams was conducted in August 1994. The second study was conducted in October 1994, shortly after completion of all land treatments planned for the watershed.

Local Setting

Hog Run and the Middle Fork of Wildcat Creek are located in the "Eastern Corn Belt Plain" ecoregion of the Central U.S. This area is composed of a glacial till plain broken by various glacial features, including glacial lakes. The natural vegetation consists of a diverse beech/maple and oak/hickory forest. Soils are composed of loamy glacial till. About 75% of the ecoregion is in cropland, primarily for corn and soybeans [2].

Hog Run is a small "second order" stream with a total watershed area of about 30 square kilometers. It originates in northern Clinton County and flows northwestward, joining the Middle Fork of Wildcat Creek in eastern Tippecanoe County. Although draining a watershed which is intensively farmed, most of the stream retains its natural channel characteristics. However, only a thin strip of riparian vegetation is present in most locations along the stream's length.

The Middle Fork of Wildcat Creek is a much larger "fourth order" stream and at its juncture with Hog Run has a watershed area of about 250 square kilometers. Like Hog Run, most of the Middle Fork's watershed is agricultural. U.S. Geological Survey records [3] indicate that this stream has a small but permanent flow throughout the year (7Q10 = 2.5 cfs).

Four sites were chosen for study in these watersheds (Fig. 1). The sites on Hog Run were chosen to represent the two primary tributaries where land treatment are being planned. The sites on the Middle Fork were chosen to represent the watershed upstream and downstream from Hog Run. Site 4 is also upstream from several other smaller tributaries. A summary of each site and its watershed area is shown below:

Site 2	Hog Run @ CR 850 W	13 km^2
Site 3	Unnamed Tributary of Hog Run @ CR 550 N	8 km^2
Site 4	Middle Fork of Wildcat Creek @ CR 680 W	150 km^2
Site 5	Middle Fork of Wildcat Creek (20 m downstream from Hog Run)	275 km^2

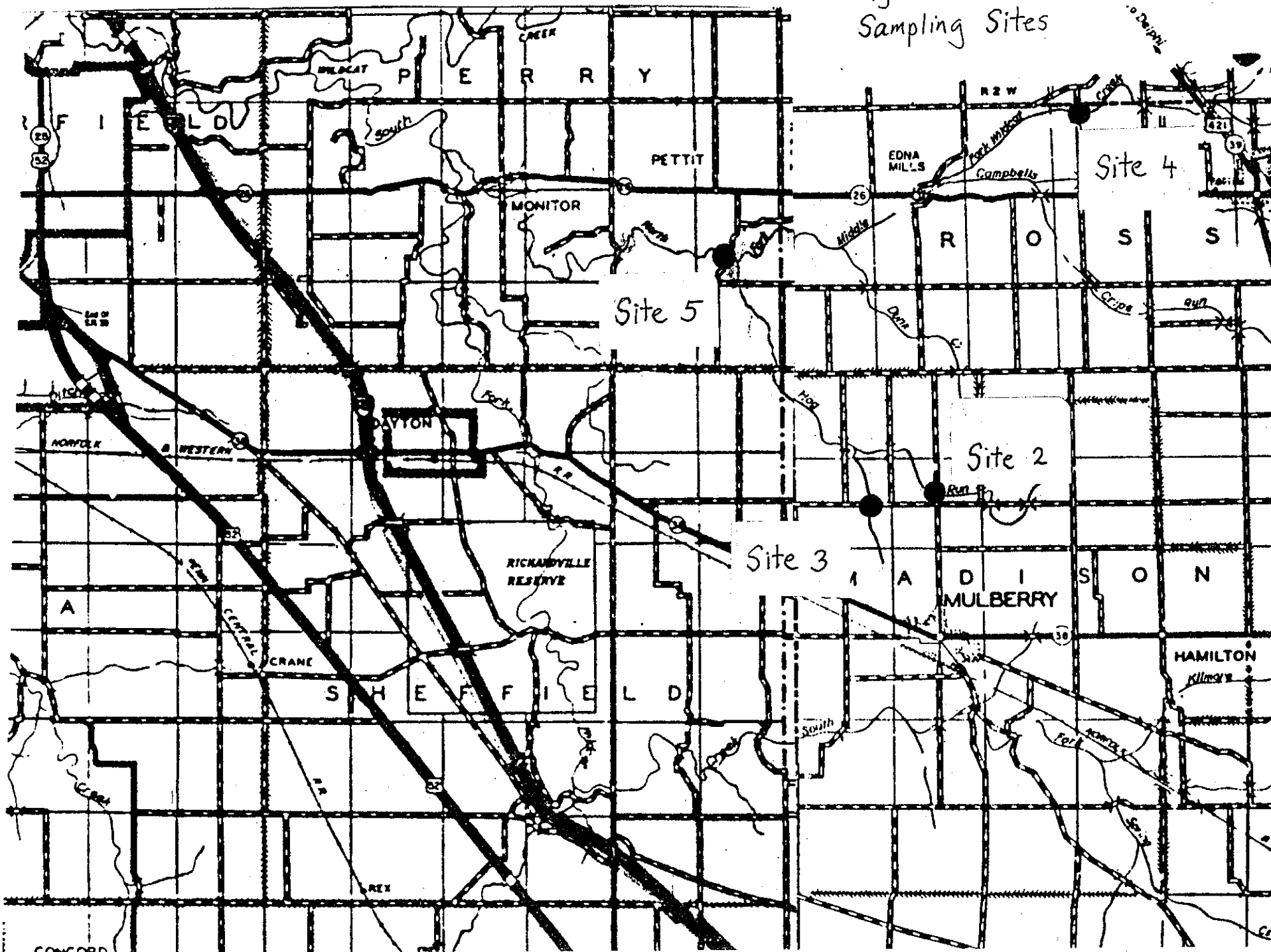
METHODS

Because they are considered to be more sensitive to local conditions and respond relatively rapidly to change [4], benthic (bottom-dwelling) organisms were used to document the biological condition of both Hog Run and the Middle Fork of Wildcat Creek. The U.S. Environmental Protection Agency (EPA) has recently developed a "rapid bioassessment" protocol [5] which has been shown to produce highly reproducible results that accurately reflect changes in water quality. We used EPA's Protocol III to conduct this study. Protocol III requires a standardized collection technique, a standardized subsampling technique, and identification of at least 100 animals from each site to the genus or species level from both "study sites" and a "reference site."

Reference Site

A reference site is required for comparison of its aquatic community to that of each study site. The reference site should be in the same "ecoregion" as the study sites and be approximately the same size. It should be as pristine as possible, representing the best conditions possible for that area. Flint Creek in western Tippecanoe County was chosen as the reference site for this study. Much of the Flint Creek watershed is wooded and the stream remains mostly unchannelized. Its watershed area is about 75 square kilometers, which is similar to that of Hog Run and the Middle Fork of Wildcat Creek. A fisheries study done in 1974-77 [6] showed that Flint Creek supported a diverse fish community (20 species at two sites), including 5 darter species, known to be susceptible to environmental degradation [7].

Figure 1.
Sampling Sites



Sample Collection

Samples in this study were collected by kicknet from riffle habitat where current speed was 30 cm/sec. Riffles were used because they were the most important benthic habitat present at all study sites. The kicknet was placed immediately downstream from a riffle while the sampler used a hand to dislodge all benthic organisms attached to rocks within the riffle. The organisms were swept by the current into the kicknet and subsequently transferred to a white pan. Each sample was examined in the field to assure that at least 100 organisms were collected at each site. In addition, each site was sampled for organisms in CPOM (coarse particulate organic matter, usually consisting of leaf packs from fast-current areas). All samples were preserved in the field with 70% isopropanol.

Laboratory Analysis

In the laboratory, a 100 organism subsample was prepared from each site by evenly distributing the whole sample in a white, gridded pan. Grids were randomly selected and all organisms within grids were removed until 100 organisms had been selected from the entire sample.

Each animal was identified to the lowest practical taxon (usually genus or species). As each new taxon was identified, a representative specimen was preserved as a "voucher." All voucher specimens will ultimately be deposited in the Purdue University Department of Entomology collection.

Data Analysis

Following identification of the animals in the sample, eight "metrics" are calculated for each site. These metrics are based on knowledge about the sensitivity of each species to changes in environmental conditions and how the benthic communities of unimpacted streams are usually organized. For example, EPT animals consist of those in the insect orders Ephemeroptera, Plecoptera, and Trichoptera, which are known to be more sensitive than most other benthic animals to degradation of environmental conditions. Feeding behaviors such as "scapers", "filterers", and "shredders" change predictably under different conditions. The sum of all eight metrics provides an individual "biotic score" for each site.

Quality Assurance

To help assure the quality of the results, a duplicate sample was collected at Site 1 during October. The biological scores of each sample were measured to determine the amount of variability associated with the technique. Ideally, the individual scores of duplicate samples should be within about 10% of the mean score to assure that reproducible results are obtained.

RESULTS

Quality Assurance

The biotic index scores of site 1, as determined by duplicate benthic samples, were 38 and 42, respectively, during the October sampling period (see Appendix). These values were within 10% of the mean and the use impairment categories obtained by both samples were identical. This indicates that the bioassessment technique produced reliable results during this study period.

Aquatic Habitat Analysis

When the EPA habitat scoring technique was used, the following aquatic habitat values were obtained for each site in the study:

	Score	% of Reference
Flint Creek (reference, Site 1)	117	100
Hog Run (Site 2)	88	75
Unnamed Tributary (Site 3)	84	72
Upstream Middle Fork (Site 4)	87	74
Downstream Middle Fork (Site 5)	117	100

The maximum value obtainable by this scoring technique is 135, with higher values indicating better habitat. Sites with lower habitat values normally have lower biotic index values as well. These scores indicate that 3 of the 4 study sites had habitat values which were somewhat lower than that present at the reference site. The habitat at site 4 was hampered primarily by an abundance of sand, which embedded the spaces around larger gravel and cobble substrates. However, the habitat at site 5 on the Middle Fork was very good and appeared to similar to that of the reference site.

Water Quality Measurements

	D.O mg/l	pH SU	Cond. uS	Temp (C)
Reference Site 1 9:45 a.m. (8/15/94)	9.2	8.1	440	17
Site 2 11:30 a.m. (8/15/94)	9.8	8.2	460	18
Site 3 12:15 p.m. (8/15/94)	9.4	8.1	490	18
Site 4 2:45 p.m. (8/15/94)	8.8	8.1	380	20
Site 5 1:30 p.m. (8/15/94)	9.0	8.2	390	21

Table 1.
Rapid Bioassessment Results - Hog Run and Middle Fork - August 1994

	Site # 1	2	3	4	5
Chironomidae					
Cricotopus bicinctus	1				1
Brillia flavifrons				2	
Cardiocladius sp.			1		1
Synorthocladius sp.		1			
Dicrotendipes sp.				10	
Chironomus sp.					1
Polypedilum convictum	5		1		5
Microtendipes caelum			7		3
Tanytarsini				7	
Thienemannymia gr.	2		1		1
Simuliidae				5	1
Tipulidae	1			3	
Empididae					
Athericidae (Atherix)		2			1
Ephemeroptera					
Stenacron interpunctatum		1	2		2
Stenonema pulchellum				1	
Stenonema vicarium	4				
Stenonema immatures				4	
Baetis flavistriga	6	4	2	2	11
B. brunneicolor	1		2		
B. intercalaris				5	11
Baetis immatures	1			14	
Isonychia sayi	16	2	1	3	3
Caenis sp.				2	
Tricorythodes sp.	1			1	
Trichoptera					
Ceraclea				1	
Cheumatopsyche	21	30	24	5	14
Hydropsyche betteni	4	17	27	3	
H. simulans					3
Ceratopsyche bifida	28	21	13	2	35
C. sparna	4		6		
Chimarra obscura	1				

Table 1 (continued)
Rapid Bioassessment Results - Hog Run and Middle Fork - August 1994

	Site # 1	2	3	4	5
Coleoptera					
Stenelmis	2	19	11	16	7
Dubiraphia	1				
Gastropoda					
Fossaria sp.				1	
Helisoma sp.				2	
Pleurocera sp.				2	
Ferrissia			1		
Decapoda (Astacidae)	1	1	1		
Pelecypoda					
Pisidium		1		1	
Oligochaeta					
Tubificidae		1		8	
Total	100	100	100	100	100

Table 2. Data Analysis for August Results

METRICS

	Site # 1	2	3	4	5
# of Genera	15	12	15	19	15
Biotic Index	4.2	5.3	5.6	6.4	4.2
Scrapers/Filterers	0.05	0.01	0.04	0.5	0.02
EPT/Chironomids	11	75	7.8	0.6	6.0
% Dominant Taxon	28	30	27	20	35
EPT Index	8	6	6	8	6
Community Loss Index	0.0	0.7	0.4	0.4	0.4
% Shredders (CPOM)	+	-	-	+	-

SCORING

	Site # 1	2	3	4	5
# of Genera	6	4	6	6	6
Biotic Index	6	4	4	2	6
Scrapers/Filterers	6	4	6	6	4
EPT/Chironomids	6	6	4	0	4
% Dominant Taxon	4	4	4	4	2
EPT Index	6	4	4	6	4
Community Loss Index	6	4	6	6	6
% Shredders (CPOM)	6	3	3	6	3
TOTAL	46	33	37	30	35
% of Reference	100	72	80	65	76
Impairment Category	N	S	S	S	S

N = NONE S = SLIGHT M = MODERATE

Table 3.
Rapid Bioassessment Results - Hog Run & Middle Fork - October 1994

	Site # 1	2	3	4	5
Chironomidae					
Cricotopus trifascia	1	3			3
Brillia flavifrons		1	1		
Cardiocladius sp.			1		
Eukiefferiella pseudomontana			5		
E. potthasti				4	
Orthocladius obumbratus	1	2	2	3	
Glyptotendipes lobiferus				4	
Corynoneura sp.	2				
Parametriocnemus lundbecki		1		1	1
Polypedilum convictum		1	6		
Microtendipes caelum				1	
Tanytarsus sp.	2				
Rheotanytarsus sp.					1
Thienemannymia gr.	1	15	2	1	
Simuliidae			1	6	1
Tipulidae					
Antocha sp.		1			2
Tipula sp.		1			
Ephemeroptera					
Stenacron interpunctatum		2	3		
Stenonema terminatum					1
Stenonema vicarium	7				
Baetis flavistriga	2		1		1
Isonychia sayi	7	2		2	6
Trichoptera					
Helicopsyche borealis	2				
Cheumatopsyche spp.	27	35	46	50	30
Hydropsyche betteni	3	13	19	4	9
H. frisoni					1
H. dicantha					1
Ceratopsyche bifida	34	3	1	19	40
C. sparna	5	2		3	1
Chimarra obscura	5			1	1

Table 3 (continued)
Rapid Bioassessment Results - Hog Run & Middle Fork - October 1994

	Site # 1	2	3	4	5
Coleoptera					
Stenelmis spp.		14	8		1
Macronychus glabratus	1			1	
Odonata					
Calopteryx sp.		1			
Gastropoda					
Ferrissia sp.		2	3		
Pelecypoda					
Sphaerium sp.		1			
Hirudinea			1		
Total	100	100	100	100	100

Table 4. Data Analysis for October Results

METRICS

	Site # 1	2	3	4	5
# of Genera	14	15	15	13	13
Biotic Index	3.7	6.4	6.5	5.2	4.1
Scrapers/Filterers	0.10	0.07	0.09	0.0	0.01
EPT/Chironomids	13	2.5	4.1	5.6	18
% Dominant Taxon	34	35	46	50	40
EPT Index	8	5	5	5	7
Community Loss Index	0.0	0.4	0.5	0.5	0.5
% Shredders (CPOM)	22	1	0	0	4

SCORING

	Site # 1	2	3	4	5
# of Genera	6	6	6	6	6
Biotic Index	6	2	2	4	6
Scrapers/Filterers	6	6	6	0	0
EPT/Chironomids	6	0	2	2	6
% Dominant Taxon	2	2	0	0	2
EPT Index	6	4	4	4	6
Community Loss Index	6	6	6	6	6
% Shredders (CPOM)	6	0	0	0	2
TOTAL	44	26	26	22	34
% of Reference	100	60	60	50	77
Impairment Category	N	S	S	M	S

N = NONE S = SLIGHT M = MODERATE

DISCUSSION

Chemical measurements taken during the study show that dissolved oxygen and pH fell within the range acceptable to most aquatic organisms. Cooler water temperatures and permanent flow at the two Hog Run watershed sites indicate this stream may have a substantial groundwater input.

A total of 34 macroinvertebrate genera were collected at the five sites during August, while 31 genera were collected during October. The most commonly collected animals at most study sites were one of the "EPT" taxa, especially the caddisflies Ceratopsyche bifida, Hydropsyche betteni and Cheumatopsyche sp.

Figure 2 shows the normal relationship of biotic index scores to habitat values (a linear relationship according to [5]). The figure also shows a range of plus or minus 10% to account for a certain amount of measurement variability. When biotic index values fall outside this range, the site typically has degraded water quality. Figure 2 indicates that, during the October sampling period, all study sites had biotic index values lower than expected from their measured habitat values. Therefore, these sites were probably affected by both degraded habitat and degraded water quality. Sites 4 and 5 on the Middle Fork of Wildcat Creek had index values consistently lower than predicted by habitat and were probably more negatively affected by water quality than Sites 2 and 3 on Hog Run.

An examination of those metrics showing the greatest difference from the reference stream may provide an important clue about causes of biological impairment. Most study sites had an increased abundance of Chironomidae (midges) at the expense of more environmentally intolerant forms such as caddisflies, mayflies, and stoneflies ("EPT" taxa). The two Wildcat Creek sites supported very few "scraper" animals in comparison to the much larger number of "filtering" animals. In addition, the HBI index value at most study sites was significantly higher than the reference values. All of these metrics are indicative of nutrient enrichment.

Sedimentation also seems to be responsible for some of the observed water quality degradation. Tables 5 and 6 list macroinvertebrates known to be tolerant and intolerant to sediment deposition. The reference site usually had more intolerant and fewer tolerant animals than any of the study sites. This difference was especially large in the October samples, indicating that sediment deposition may have increased from August to October. Low streamflow during the dry summer of 1994 may also have contributed to this effect. Both sites on Hog Run were near areas where the stream was used for livestock watering. This use contributes to both increased sedimentation and nutrient enrichment in streams.

Figure 2

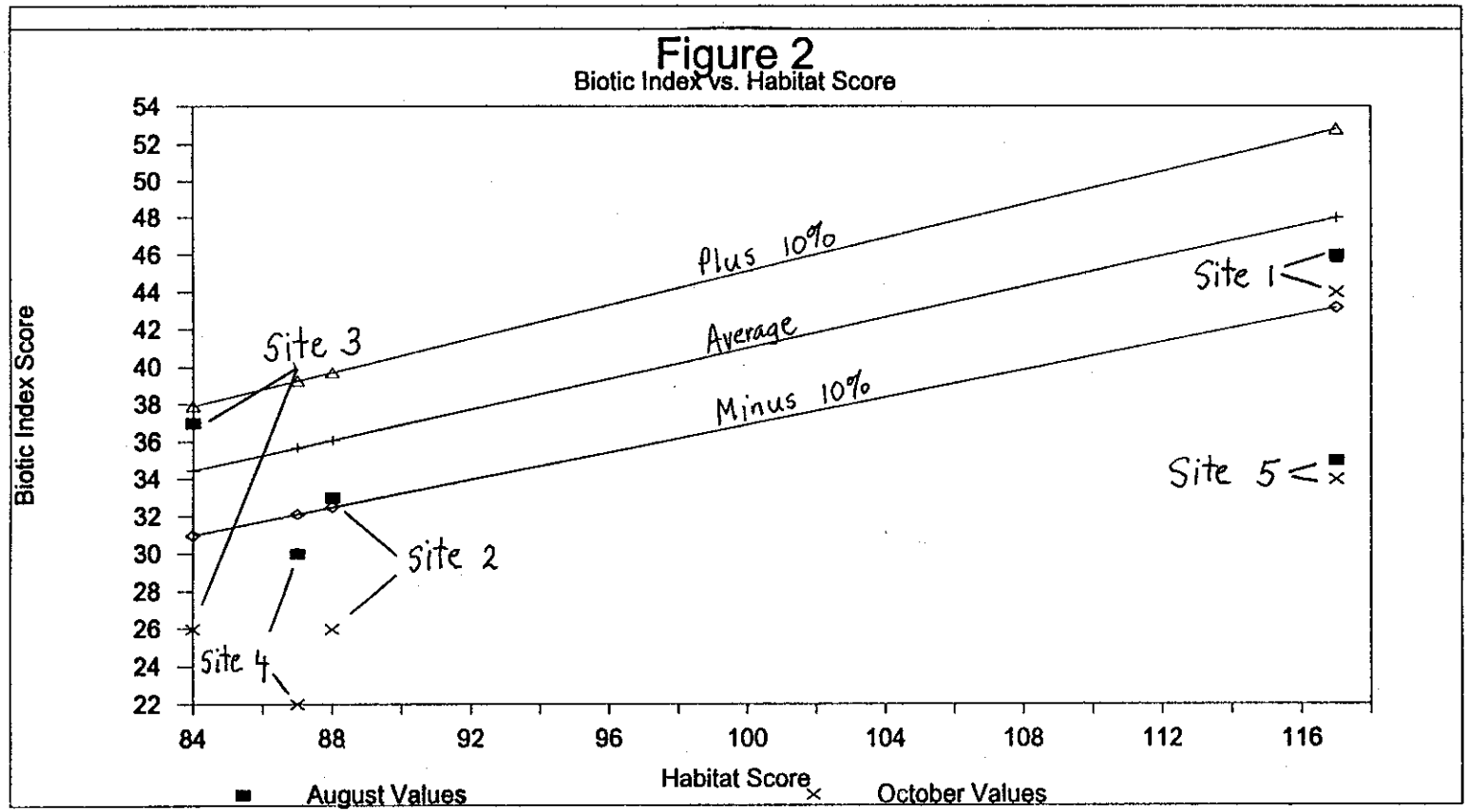

Biotic Index vs. Habitat Score
Biotic Index Score
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
84
88
92
96
100
104
108
112
116
Habitat Score
Plus 10%
Average
Minus 10%
Site 1
Site 2
Site 3
Site 4
Site 5
August Values
October Values

Table 5. Sediment-Tolerant Species Observed
(References shown in brackets)

Cheumatopsyche sp.	[10]	[9]
Hydropsyche betteni	[10]	
Baetis intercalaris (close to B. flavistriga)	[10]	
Caenis sp.	[9]	[11]
Tricorythodes	[9]	[12]
Polypedilum convictum	[9]	
Chironomus sp.	[6]	
Thienemannymia group	[9]	
Calopteryx spp.	[9]	
Macronychus glabratus	[9]	
Tubificidae	[11]	

SEDIMENT-TOLERANT ORGANISMS

August Samples

% of All Organisms at the Reference Site	39%
% of All Organisms at the Study Sites	
Site 2	52%
Site 3	55%
Site 4	39%
Site 5	43%

October Samples

% of All Organisms at the Reference Site	34%
% of All Organisms at the Study Sites	
Site 2	64%
Site 3	74%
Site 4	61%
Site 5	40%

Table 6. Sediment-Intolerant Species Observed
(References shown in brackets)

Plecoptera	[9]
Microtendipes sp.	[9]
Brillia sp.	[9]
Tipula sp.	[9]
Stenonema vicarum	[9]
Ceraclea sp.	[9]
Helicopsyche borealis	[9]

SEDIMENT-INTOLERANT ORGANISMS

June Samples

% of All Organisms at the Reference Site	5%
% of All Organisms at the Study Sites	
Site 2	0%
Site 3	7%
Site 4	6%
Site 5	3%

October Samples

% of All Organisms at the Reference Site	9%
% of All Organisms at the Study Sites	
Site 2	2%
Site 3	1%
Site 4	1%
Site 5	0%

Comparison to Other Studies

There have been no previous studies of the fish or macroinvertebrate communities of Hog Run. An IDNR study done in 1974 [8] showed that the fish community of the Middle Fork of Wildcat Creek near its confluence with Hog Run was not very diverse (only 9 species were collected at a site near Highway 26, while "healthy" stream sites typically support 15-20 species.) In addition, the fish community was dominated by tolerant "minnow" species, able to survive in conditions of poor water quality and degraded habitat. "Intolerant" fish were virtually absent from the two sites studied in the watershed. It appears that the Middle Fork had at least mildly degraded water quality and/or habitat during the recent past.

RECOMMENDATIONS

1. Continue to monitor these five sites during 1995 to determine whether a trend toward improvement in biolgical conditions has occurred after completion of land treatments.

2. Consider monitoring each site during April, rather than August, to more closely determine whether agricultural runoff during spring planting is affecting water quality.

3. Despite their very small watershed areas, the two sites on Hog Run have more-or-less permanent flow and appear to be spring-fed. During August, both sites seemed to have excellent water quality. Restricting access of livestock to Hog Run may help improve some of the "slight" water quality degradation observed during October.

4. Consider expanding land treatment efforts in the upper Middle Fork of Wildcat Creek watershed, where biotic index scores are lowest. Additional monitoring sites on affected tributaries may be useful to gauge program effectiveness.

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Site 1

PHYSICAL CHARACTERISATION/WATER QUALITY
FIELD DATA SHEET

Flint Creek
CR 700 W
8/15/94

PHYSICAL CHARACTERISATION

RIPARIAN ZONE/INSTREAM FEATURES

Predominant Surrounding Land Use:

Forest Field/Pasture (Agricultural) Residential Commercial Industrial Other _____

Local Watershed Erosion: None (Moderate) Heavy

Local Watershed NPS Pollution: No evidence (Some Potential Sources) Obvious Sources

Estimated Stream Width 4 m Estimated Stream Depth: Riffle ____ m Run ____ m Pool ____ m

High Water Mark ____ m Velocity >30 Dam Present: Yes __ No ✓ Channelized: Yes __ No ✓

Canopy Cover: Open Partly Open (Partly Shaded) Shaded

SEDIMENT/SUBSTRATE:

Sediment Odors: (Normal) Sewage Petroleum Chemical Anaerobic None Other _____

Sediment Oils: (Absent) Slight Moderate Profuse

Sediment Deposits: Sludge Sawdust Paper Fiber Sand Relict Shells Other _____

Are the undersides of sto..es which are not deeply embedded black? Yes No

Inorganic Substrate Components

Substrate Type	Diameter	Percent Composition in Sampling Area
Bedrock		
Boulder	>256-mm (10 in.)	
Cobble	64-256-mm (2.5-10 in.)	50
Gravel	2-64-mm (0.1-2.5 in.)	30
Sand	0.06-2.00-mm (gritty)	10
Silt	.004-.06-mm	10
Clay	<.004-mm (slick)	

Organic Substrate Components

Substrate Type	Characteristic	Percent Composition in Sampling Area
Detritus	Sticks, Wood, Coarse Plant Materials (CPOM)	
Muck-Mud	Black, Very Fine Organic (FPOM)	
Marl	Gray, Shell Fragments	

WATER QUALITY

Temperature ____ C Dissolved Oxygen ____ pH ____ Conductivity ____ Other _____

Instrument(s) Used _____

Stream Type: Coldwater (Warmwater)

Water Odors: (Normal) Sewage Petroleum Chemical None Other _____

Water Surface Oils: Slick Sheen Globs Flecks (None)

Turbidity: (Clear) Slightly Turbid Turbid Opaque Water Color _____

WEATHER CONDITIONS

PHOTOGRAPH NUMBER

OBSERVATIONS AND/OR SKETCH