WATERSHED BIOASSESSMENT REPORT

SAND CREEK WATERSHED

Decatur, Jennings, and Bartholomew Counties

2003

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TABLE OF CONTENTS

		PAGE NUMBER
I.	EXECUTIVE SUMMARY	1
II.	INTRODUCTION	2
III.	METHODS	6
IV.	RESULTS	9
V.	DISCUSSION	12
VI.	RECOMMENDATIONS	19
VII.	LITERATURE CITED	20

APPENDICES

Bioassessment Summary

EXECUTIVE SUMMARY

A rapid bioassessment of the benthic macroinvertebrate communities of Sand Creek and its tributaries in Decatur, Jennings, and Bartholomew Counties of Indiana was conducted in 2003. The purpose of the assessment was to document the biological condition of the streams as part of a watershed management program.

Fifteen sites were examined in the Sand Creek watershed, as well as a “reference" stream (Graham Creek) in the same ecoregion. The study showed that turbidity, nutrient concentrations, and E.coli levels are relatively low at most sites in the watershed during "base flow" (dry weather) conditions. However, these parameters are much higher during "storm flow" conditions at most sites. Some of the water chemistry results indicate the potential for high algal productivity in the watershed.

Aquatic habitat in the watershed is generally good. Few of the study streams are channelized and a zone of riparian vegetation is still in place along most streams.

The biological community of Muddy Fork near Greensburg was severely impacted by degraded water quality. The effects of this degradation can be measured in Sand Creek as far as 20 miles downstream.

Bear Creek, Nettle Creek and Gas Creek were moderately impacted. In contrast, one site on Wyaloosing Creek had habitat and a biological community among the best in Indiana. The Sand Creek watershed still supports a few species of live mussels, which are indicators of good water quality.

Causes of water quality degradation, as indicated by biological indicators, probably included low dissolved oxygen concentrations (2 sites), excessive nutrient concentrations (1 sites), and excessive sediment inputs (3 sites).

Recommendations to improve conditions in the watershed include (1) concentrating restoration efforts on Muddy Fork, (2) seeking a Lake and River Enhancement grant for a lake diagnostic study of Greensburg Reservoir and the Muddy Fork watershed, (3) targeting additional management efforts on Gas Creek, Bear Creek, and Nettle Creek, and (4) using appropriate best management practices to solve the unique problems identified in each sub-watershed.

INTRODUCTION

A 319 nonpoint source grant was awarded to the Decatur County Soil and Water Conservation District to prepare a watershed management plan for the Sand Creek watershed of southern Indiana. Sand Creek is on the Indiana Department of Environmental Management's list of "impaired waterbodies" [1] and the preparation of a management plan is part of the process of restoring water quality. One important component of the grant was to conduct a series of bioassessments in these streams. Bioassessments are recognized as a valuable tool in identifying water quality problems and helping diagnose their causes [2]. Certain animals are sensitive to different types of stresses. Comparison of the numbers and kinds of animals present can give important clues about the presence of toxic substances, excessive sedimentation, excessive nutrient inputs, or low dissolved oxygen concentrations.

This project was designed to characterize the chemical, biological and physical (aquatic habitat) integrity of the Sand Creek watershed. Questions to be answered include:

What is the overall ecological health of these watersheds?

Are unhealthy streams affected primarily by degraded water quality or by degraded habitat?

Are water quality parameters within normal ranges for aquatic life?

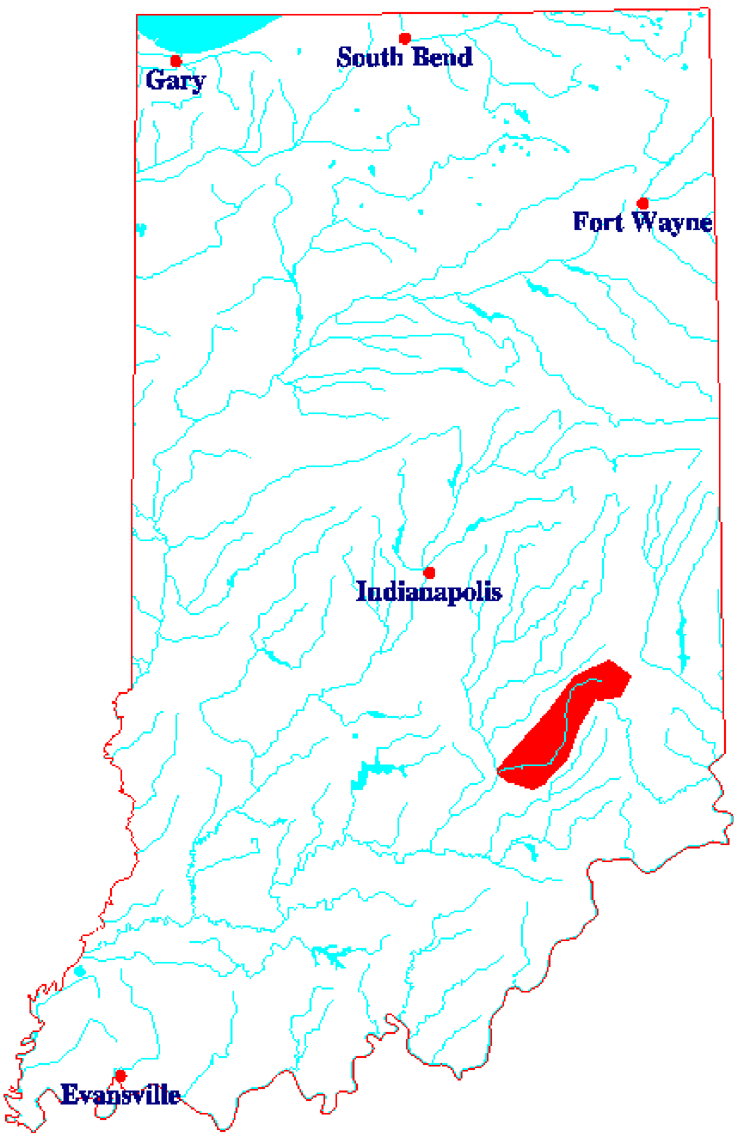
Where are water quality problems present?

What can be done to make the identified problems better?

Local Setting

The Sand Creek watershed (Fig. 1) lies in the southernmost part of the "Eastern Corn Belt Plain" ecoregion of the East-central United States [3]. This area is composed of a glacial till plain manteled in many places with loess. Stream valleys are generally shallow with narrow valley floors. Constructed ditches and channelized streams are common because much of the ecoregion has poorly drained soils. The natural vegetation consists of a mosaic of bluestem prairie and oak/hickory forest. However, a great majority of the land in this ecoregion is used for agriculture, primarily for corn and soybeans [3].

Figure 1.

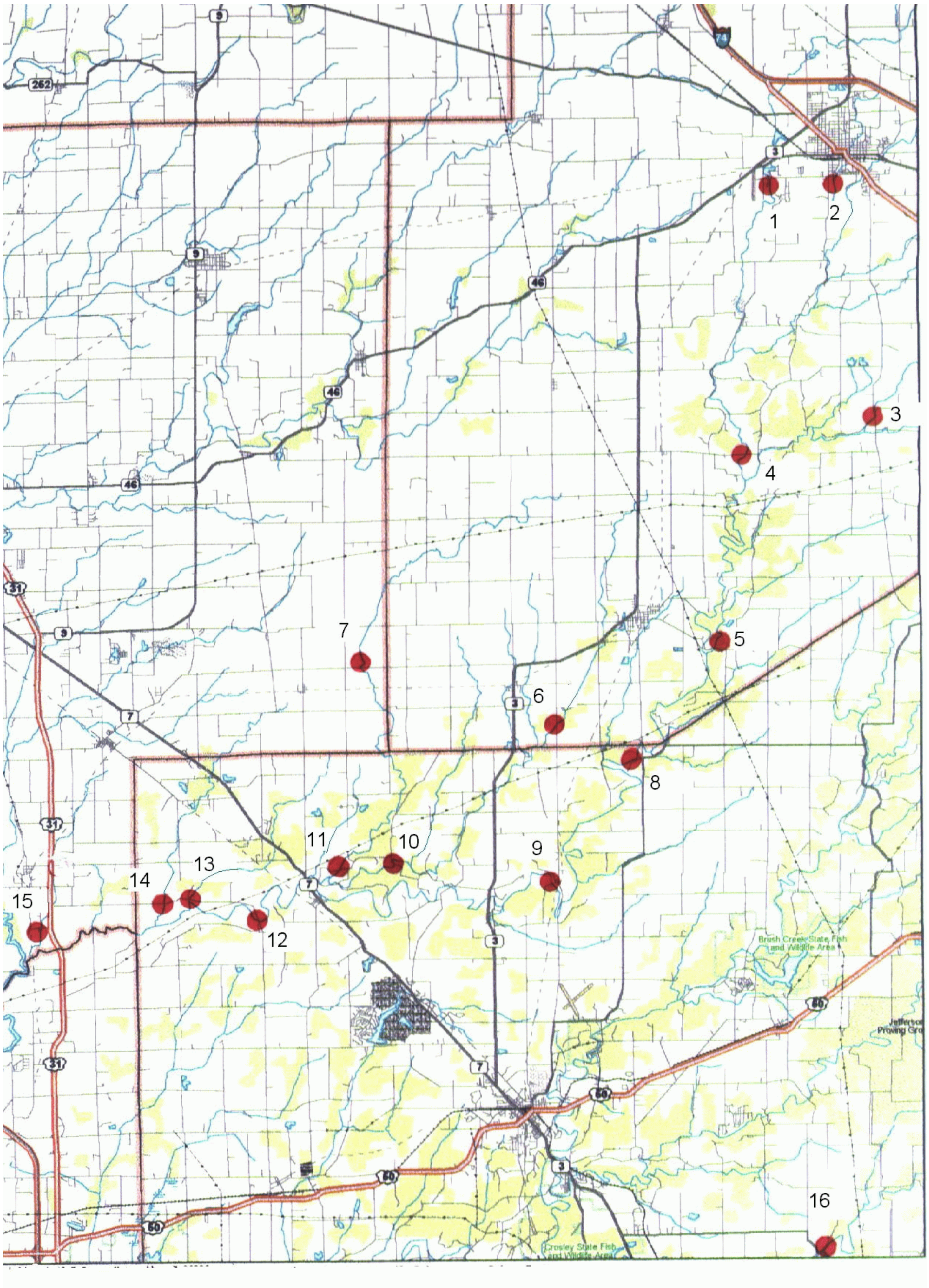


The Present Study

To document the biological integrity of the watershed, fifteen sites were chosen for study (Fig. 2). A sixteenth site outside the watershed (Graham Creek) was used as a "reference." Site locations were as follows:

	Stream	Latitude	Longitude	Drainage Area (mi^2) [10]
Site 1	Muddy Fork CR 50 S	39.19.71	85.30.92	17
Site 2	Gas Creek SW CR 60	39.19.69	85.29.20	4
Site 3	Cobb's Fork CR 60 E	39.13.84	85.31.25	19
Site 4	Sand Creek CR 700 S	39.13.99	85.31.61	61
Site 5	Panther Creek CR 1100 S	39.09.89	85.32.66	9
Site 6	Wyaloosing Creek CR 1300 S	39.08.71	85.36.74	11
Site 7	Bear Creek CR 300 S	39.09.60	85.41.85	15
Site 8	Sand Creek CR 500 W	39.08.00	85.34.46	122
Site 9	Sand Creek CR 250 W	39.05.09	85.39.48	146
Site 10	Wyaloosing Creek CR 360 W	39.05.55	85.41.05	36
Site 11	Bear Creek CR 500 W	39.04.72	85.42.29	23
Site 12	Sand Creek CR 650 N	39.04.71	85.45.24	224
Site 13	Nettle Creek CR 650 N	39.04.80	85.46.54	6
Site 14	Rock Creek CR 650 N	39.04.71	85.47.17	14
Site 15	Sand Branch CR 900 S	39.04.23	85.50.45	5
Site 16	Graham Creek CR 600 E	38.56.85	85.30.11	46

Fig. 2. Location of Study Sites



METHODS

WATER CHEMISTRY

Water chemistry measurements were made twice at each site. One set of measurements was made at "base flow" when no storm water runoff had occurred during the previous week. A second set of measurements was made at "storm flow" immediately following a storm event.

Dissolved oxygen was measured by the membrane electrode method. The pH measurements were made with a Cole-Parmer pH probe. Conductivity and temperature were measured with a Hanna Instruments meter. All instruments were calibrated in the field prior to measurements.

Samples for nutrient and bacteria analysis were collected as grabs and returned to the lab for analysis. E.coli were measured by the membrane filtration method, using m-coliblue as the growth medium. Nitrate and phosphorus were measured by spectrophotometry. Ammonia was measured by the ion-specific probe method.

AQUATIC COMMUNITY

Because they are considered to be more sensitive to local conditions and respond relatively rapidly to change, benthic (bottom-dwelling) organisms were chosen to document the biological condition of the streams. The U.S. Environmental Protection Agency (EPA) has recently developed a "rapid bioassessment" protocol [4] which has been shown to produce highly reproducible results that accurately reflect changes in water quality. The bioassessment technique relies upon comparison of the aquatic community to a “reference” condition (streams of similar size in the same geographic area which are least impacted by human changes in the watershed). Graham Creek in Jennings County was used as the reference in this study, since previous sampling has shown this stream to support a very diverse and pollution-sensitive aquatic community [9].

Habitat Evaluation

The aquatic habitat at each study site was evaluated according to the method described by Ohio EPA [8]. This method’s results assigns values to various habitat parameters (e.g. substrate quality, riparian vegetation, channel morphology, etc.) and results in a numerical score for each site. Higher scores indicate higher aquatic habitat value. The maximum value for habitat using this assessment technique is 100.

Sample Collection

Macroinvertebrate samples in this study were collected by dipnet in riffle areas where current speed approached 30 cm/sec. All samples were preserved in the field with 70% ethanol and returned to the lab for sorting and analysis. Mussels were identified in the field and returned to the river.

Laboratory Analysis

In the laboratory, a 100 organism subsample was prepared from each site by evenly distributing the animals collected 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, ten "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 ("reference") streams are usually organized. For example, mayflies and caddisflies are aquatic insects which are known to be more sensitive than most other benthic animals to degradation of environmental conditions. A larger proportion of these animals in a sample receives a higher score. The sum of all ten metrics provides an individual "biotic score" for each site.

The metrics used in this study were those recommended by U.S. EPA Protocol III. Individual metrics are shown below:

SCORING VALUES FOR METRICS
U.S. EPA RBA Protocol III.

	6 points	4 points	2 points	0 points	
# of Genera	>80	60-80	40-60	<40	*
Hilsenhoff Biotic Index	<5	5 - 6	6 - 7	>7	
Scaper/Filterer Ratio	>50	35-50	20-35	<20	*
EPT/Chironomid Ratio	>75	50-75	25-50	<25	*
% Dominant Taxon	<20	20-30	30-40	>40	
EPT Index	>90	80-90	70-80	<70	*
Community Loss Index	<0.5	0.5-1.5	1.5-4	>4	
% Shredders	>50	35-50	20-35	<20	*

* = study site score / reference site score x 100

Because the index scores for macroinvertebrates and habitat result in different maximum values, they are difficult to relate to each other. Therefore, both indices were eventually converted to a normalized score of 0 to 100 using the following formula:

Normalized Score = Actual Score / Maximum Possible Score x 100

RESULTS

Water Chemistry

Tables 1 and 2 show a summary of all the water chemistry data collected at the 16 sites examined in this study:

Table 1
Water Quality Measurements (Base Flow) - 200 cfs on Clifty Creek at St. Paul
May 27, 2003

Site	D.O. mg/l	pH SU	Cond uS	Temp C	ChlA ug/l	Turb NTU	NO3 mg/l	NH3 mg/l	PO4 mg/l Total	PO4 mg/l Ortho	E.coli /100 ml
Muddy Fork Site 1	9.8	8.4	500	23.6	286	9.4	12.0	<0.1	0.20	0.16	52
Gas Creek Site 2	9.4	8.0	1070	22.4	38	3.5	13.0	0.6	0.98	0.90	412
Cobb's Fork Site 3	10.0	8.7	410	20.0	41	3.1	5.0	<0.1	0.09	0.06	57
Sand Creek. Site 4	10.1	8.8	520	21.1	36	2.4	10.0	0.1	0.11	0.09	31
Panther Cr. Site 5	10.1	8.7	340	19.4	17	1.8	2.2	<0.1	0.07	0.05	140
Wyaloosing Cr. Site 6	9.2	7.9	400	22.8	76	13.6	13.0	0.1	0.25	0.22	201
Bear Creek Site 7	10.0	8.5	400	21.1	136	3.9	14.0	0.1	0.20	0.17	324
Sand Creek Site 8	10.2	8.6	470	20.6	28	3.5	10.0	<0.1	0.09	0.07	51
Sand Creek Site 9	10.2	8.6	490	20.0	35	3.8	8.5	<0.1	0.11	0.08	14
Wyaloosing Cr. Site 10	9.7	8.2	470	18.3	20	5.6	7.0	<0.1	0.12	0.08	81
Bear Creek . Site 11	9.9	8.4	480	17.8	18	5.0	10.5	<0.1	0.10	0.08	126
Sand Creek. Site 12	9.7	8.3	490	18.3	32	5.5	11.0	<0.1	0.19	0.15	33
Nettle Creek Site 13	9.2	8.2	470	17.8	14	3.5	2.8	<0.1	0.18	0.14	148
Rock Creek Site 14	9.0	8.0	470	17.2	22	3.6	6.0	<0.1	0.10	0.08	62
Sand Branch Site 15	9.1	8.1	440	16.6	16	8.2	9.0	0.2	0.08	0.05	245
Graham Creek Site 16	9.1	8.3	320	18.8	23	3.7	2.1	<0.1	0.10	0.07	7

Table 2
Water Quality Measurements (Storm Flow)
3000 cfs on Clifty Creek at St. Paul
June 13, 2003

Site	D.O. mg/l	pH SU	Cond uS	Temp C	ChlA ug/l	Turb NTU	NO3 mg/l	NH3 mg/l	PO4 mg/l Total	PO4 mg/l Ortho	E.coli /100 ml
Muddy Fork Site 1	8.6	7.1	390	19.7	249	635	6.3	1.2	0.44	0.34	4220
Gas Creek Site 2	9.5	7.3	420	19.0	30	5.0	9.8	0.2	0.48	0.35	83
Cobb's Fork Site 3	10.0	7.5	420	18.9	97	55.3	8.3	0.2	0.45	0.38	4800
Sand Creek Site 4	9.7	7.5	390	20.3	210	295	9.8	0.2	0.40	0.34	2560
Panther Cr. Site 5	10.0	7.7	370	19.6	78	11.6	8.6	0.5	0.58	0.49	529
Wyaloosing Cr. Site 6	9.1	7.7	400	19.8	43	16.4	13.0	0.1	0.56	0.44	152
Bear Creek Site 7	8.5	7.8	400	17.4	64	21.1	20.0	0.1	0.21	0.18	233
Sand Creek Site 8	9.5	7.8	420	19.5	225	213	9.8	0.4	0.46	0.35	540
Sand Creek Site 9	8.5	7.8	410	20.5	248	310	5.4	0.5	0.72	0.63	640
Wyaloosing Cr. Site 10	8.6	7.8	500	19.3	72	24.0	16.5	0.1	0.40	0.32	129
Bear Creek Site 11	8.7	7.8	370	18.4	77	32.7	16.5	0.3	0.18	0.15	238
Sand Creek. Site 12	8.1	7.9	400	20.0	191	221	4.9	0.4	0.16	0.10	440
Nettle Creek Site 13	9.4	7.8	400	20.7	58	16.6	3.8	1.2	0.61	0.52	192
Rock Creek Site 14	9.7	7.9	420	21.2	68	16.1	7.7	0.2	0.46	0.42	337
Sand Branch Site 15	8.7	7.9	410	23.7	32	8.4	14.0	0.7	0.32	0.23	226
Graham Creek Site 16	7.9	7.9	500	20.0	86	21.1	2.0	1.3	0.49	0.42	831

D.O. = Dissolved Oxygen
Cond. = Conductivity
ChlA = Chlorophyl a
Turb. = Turbidity
NH3 = Ammonia (as Nitrogen)
NO3 = Nitrite + nitrate (as Nitrogen)
PO4 = Phosphate (as Phosphorus)

Table 3. Additional Water Quality Measurements

August 4-5, 2003

	D.O. mg/l	pH SU	Cond. uS	Temp. (C)
Site 1 (Muddy Fork) 8/4, 4:50 p.m.	12.4	7.9	440	25.0
Site 2 (Gas Creek) 8/4, 4:30 p.m.	10.7	7.9	990	23.0
Site 3 (Cobbs Fork) 8/4, 3:30 p.m.	10.0	8.2	440	22.5
Site 4 (Sand Cr.) 8/4, 4:00 p.m.	10.6	8.3	770	23.0
Site 5 (Panther Cr.) 8/4, 2:30 p.m.	9.2	8.1	360	21.0
Site 6 (Wyaloosing Cr.) 8/4, 1:10 p.m.	7.8	7.9	500	23.5
Site 7 (Bear Cr.) 8/5, 2:30 p.m.	10.6	8.1	530	23.5
Site 8 (Sand Cr.) 8/4, 12:30 p.m.	9.0	8.0	400	23.0
Site 9 (Sand Cr.) 8/5, 1:30 p.m.	9.9	8.4	460	24.0
Site 10 (Wyaloosing Cr.) 8/5, 12:45 p.m.	7.5	7.8	340	22.0
Site 11 (Bear Cr.) 8/5, 12:00 noon	8.4	7.8	370	24.5
Site 12 (Sand Cr.) 8/5, 11:20 a.m.	8.7	7.9	460	22.5
Site 13 (Nettle Cr.) 8/5, 11:00 a.m.	8.9	8.0	490	20.5
Site 14 (Rock Cr.) 8/5, 10:00 a.m.	8.2	7.8	480	22.0
Site 15 (Sand Branch) 8/5, 9:30 a.m.	8.3	7.6	500	19.5
Site 16 (Graham Cr.) 8/4, 10:30 a.m.	8.7	7.7	390	23.0

D.O. = Dissolved Oxygen
Cond. = Conductivity
Temp. = Temperature in Degrees Centigrade

Aquatic Habitat Analysis

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

Table 4. Aquatic Habitat

		QHEI Score	Normalized Score
Site 1	Muddy Fork	42	57
Site 2	Gas Creek	62	84
Site 3	Cobb's Fork	62	84
Site 4	Sand Creek upstream	59	80
Site 5	Panther Creek	62	84
Site 6	Wyaloosing Creek upstream	67	91
Site 7	Bear Creek upstream	48	65
Site 8	Sand Creek middle	77	104
Site 9	Sand Creek middle	70	95
Site 10	Wyaloosing Creek downstream	71	96
Site 11	Bear Creek downstream	68	92
Site 12	Sand Creek downstream	71	96
Site 13	Nettle Creek	60	81
Site 14	Rock Creek	66	89
Site 15	Sand Branch	43	58
Site 16	Graham Creek	74	100

Quality assurance duplicate evaluation done at site 16 resulted in identical habitat scores. This indicates that the bioassessment technique was producing reliable, reproducible results during the study period.

DISCUSSION

Water Chemistry

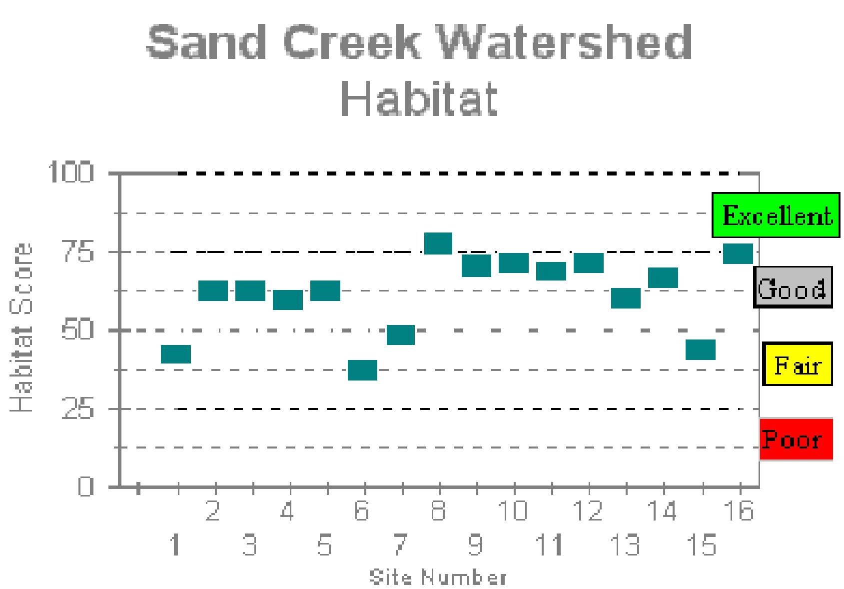
During "base flow" conditions, phosphorus and E.coli levels were relatively low at most sites. Only three sites had E.coli levels exceeding the Indiana water quality standard. Nitrate concentrations exceeded the proposed nitrogen criterion of 2 mg/l at all sites. Chlorophyl concentrations were somewhat elevated at site 1 (Muddy Fork) and site 7 (upper Bear Creek), indicating high algal productivity. Another indication of high algal productivity during base flow was the high number of sites with pH exceeding 8.5. High pH often occurs when photosynthesis rates are high on warm, sunny days.

"Storm flow" conditions were associated with much higher phosphorus and E.coli concentrations in the watershed. During storm flow, all sites exceeded the proposed nutrient phosphorus criterion of 0.1 mg/l and 10 sites exceeded the Indiana water quality standard for E.coli. Turbidity was very high at site 1 (Muddy Fork) during storm flow conditions.

Aquatic Habitat

Aquatic habitat index values ranged from 42 to 77 at the 16 study sites. According to this scoring scheme, most sites in the watershed have generally "good" aquatic habitat. Two sites were "excellent," eleven were "good," and three were "fair." The site with worst aquatic habitat (site 1 on Muddy Fork) was artificially channelized and had no shading canopy. Only three sites had artificially altered channels. Unchannelized headwater streams are rather rare in Indiana and should be protected wherever possible.

Figure 3.



Sand Creek Watershed Mussels

Species represented by live or "fresh dead" (fd) specimens

Lampsilis siliquoidea
Amblema plicata
Lampsilis cardium
Toxolasma parvus
Utterbackia imbecillis
Fusconia flava

Other species present, represented by weathered dead (wd) shells

Actinonaias ligamentina
Anodontoides ferussacianus
Elliptio dilatata
Lasmigona complanata
Lasmigona compressa
Lasmigona costata
Pyganodon grandis

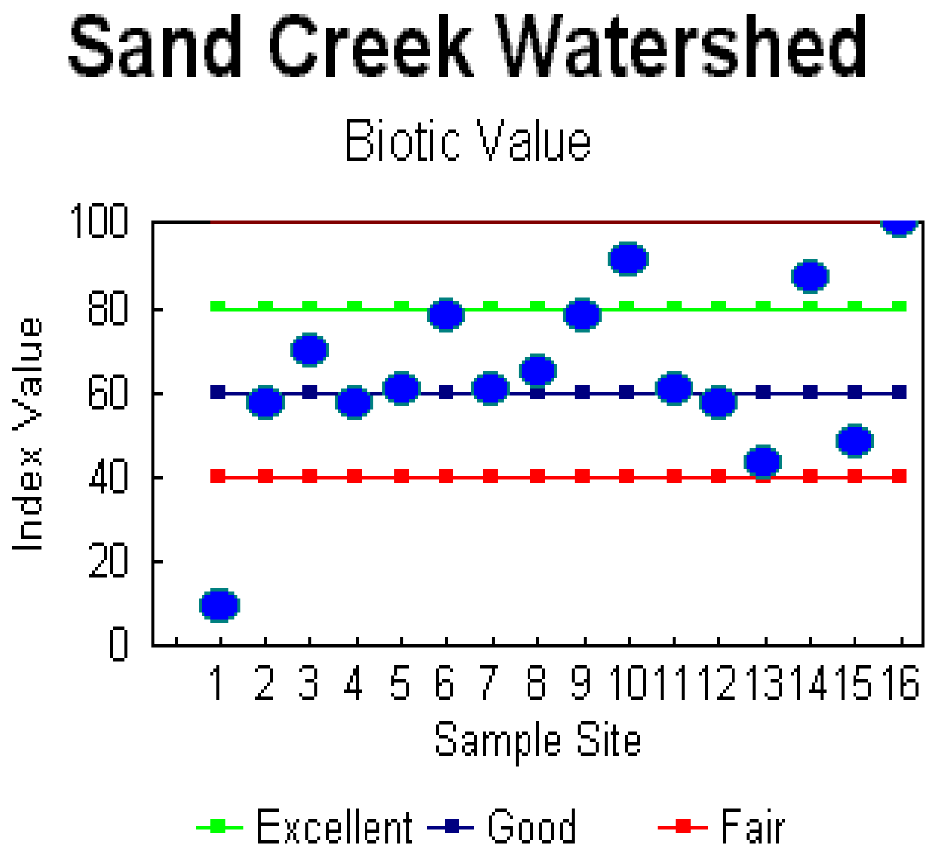
Site 1. Muddy Fork-*U. imbecillis* 1 fd
Site 2 Gas Creek-no mussels
Site 3 Cobbs Fork-*L. siliquoidea* wd valves
Site 4 Sand Creek-*L. cardium* 1 fd *L. siliquoidea* and *A. ferussacianus*-wd valves
Site 5 Panther Creek-1 valve fragment; probably *A. ferussacianus*
Site 6 Wyaloosing Creek-no mussels
Site 7 Bear Creek- *T. parvus*-1 fd *P. grandis*-wd 1 valve
Site 8 Sand Creek-*A. plicata* 2 fd and 2 valves fd
L. siliquoidea numerous wd valves
L. costata, A. ligamentina, , L. cardium, F. flava-1 wd valve each
Site 9. Sand Creek-*A plicata* 1 fd
L. costata, E. dilatata, L. cardium, P. grandis, L. siliquoidea, A. ligamentina, F. flava, L. complanata wd valves only
Site 10 Wyaloosing Creek-*L. siliquoidea* wd valves
Site 11 Bear Creek-no mussels
Site 12 Sand Creek-not surveyed for mussels due to high and turbid water conditions
Site 13 Nettle Creek-no mussels
Site 14 Rock Creek- *L. siliquoidea* 1 live; 1 fd; 2 wd valves
Site 15 Sand Branch-no mussels
Site 16 Graham Creek (reference site)-*F. flava* 1 fd ; 1 wd valve
L. cardium 1 fd and fd valve (juvenile)
L. siliquoidea 1 fd and wd valves
L. compressa 1 wd valve; *A. ligamentina* wd valves

Macroinvertebrate Communities

The most commonly collected species were riffle beetles, caddisflies (Hydropsychidae), mayflies (Baetidae and Heptageniidae), and midge larvae. Flatworms or blackflies were dominant at two sites.

The normalized biotic index scores ranged from 9 to 87. Four sites fell in the “excellent” category, eight sites were "good," two sites were “fair,” and one site had "poor" biotic integrity.

Figure 4

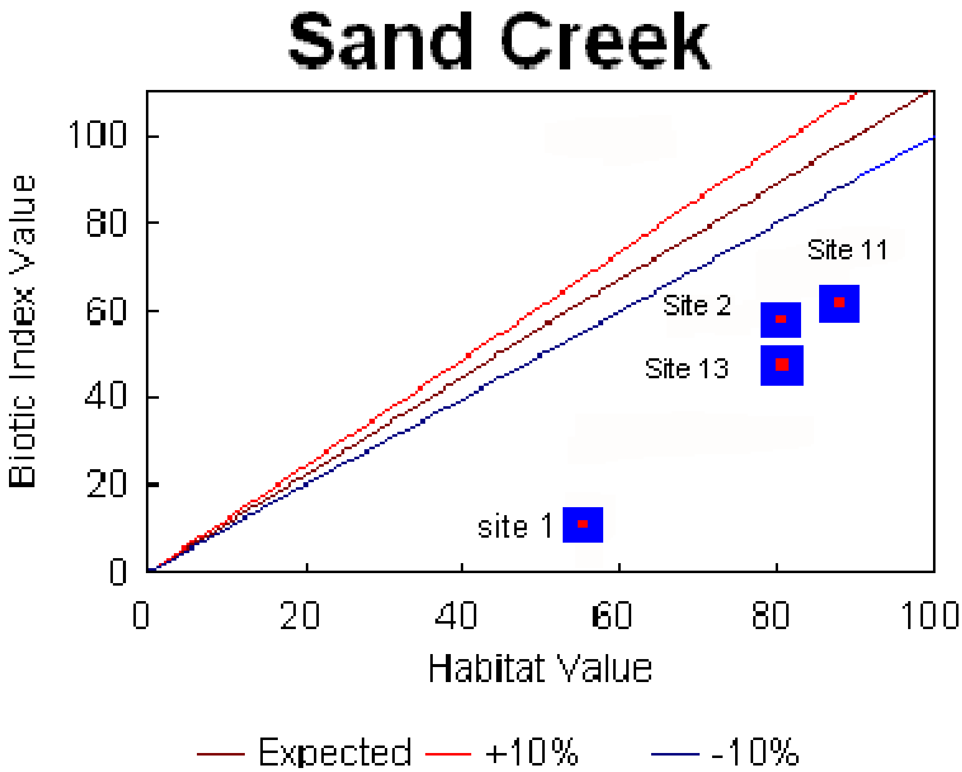


D iagnosis

One of the most useful aspects of biological monitoring is the ability to use information on the way aquatic animals respond to different types of stress to diagnose a problem. For example, when aquatic habitat and biotic integrity are graphed in relation to each other, they form a straight line unless water quality is degraded [4]. Plus or minus 10% can be added to the graph to allow for a certain degree of measurement error. When values fall outside this range, water quality problems are suspected. A comparison of biotic integrity to habitat is shown in

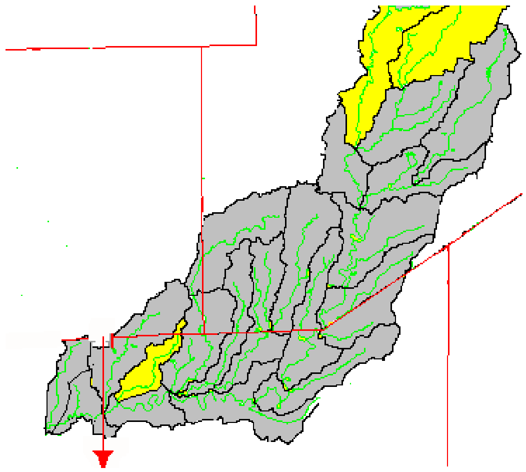
Figure 5. This figure suggests that five study sites had degraded water quality. Site 1 (Muddy Fork) deviated most highly from the expected relationship and therefore had the worst water quality. Others with moderately degraded water quality were site 2 (Gas Creek), site 11 (Bear Creek), and site 13 (Nettle Creek).

Figure 5



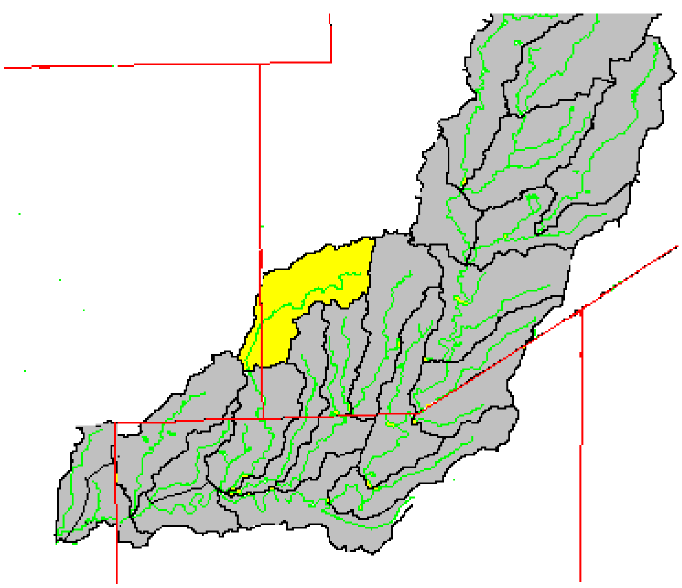
Three sub-watersheds were dominated by species known to be tolerant to sediment deposition. These are shown in yellow in Fig. 6. Best management practices in these areas should focus on sediment control.

Fig. 6



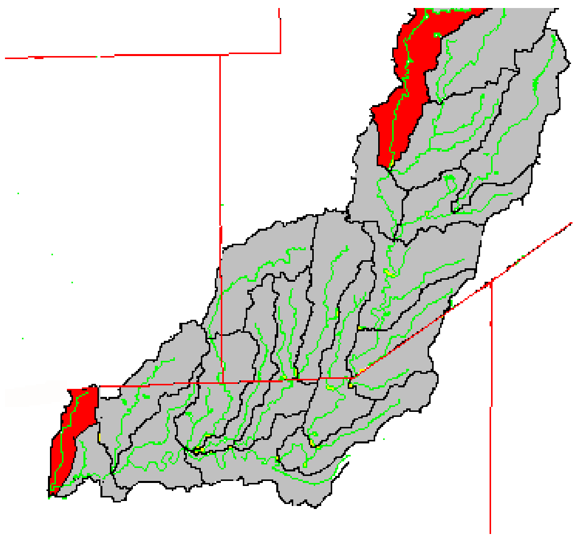
Excessive nutrient inputs are often indicated by a dominance of animals which eat algae ("scrapers"). Dominance by riffle beetles, snails, and certain kinds of mayflies are especially good indicators of this type of impairment [4]. Site 7 (upper Bear Creek) was dominated by scrapers and had the highest nitrate concentrations during both base flow and storm flow conditions. The sub-watershed represented by this site is shown in Figure 7. Best management practices in the Bear Creek area should focus on nitrogen and phosphorus reduction.

Figure 7



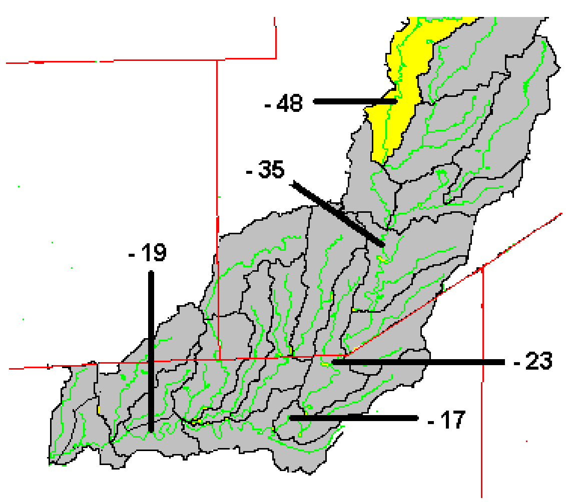
Low dissolved oxygen concentrations can often be determined by examining the Hilsenhoff Biotic Index for a particular site. This index, which ranges between 0 and 10, is especially suitable for the diagnosis of sewage-related pollution [6]. Sites with values greater than 7 frequently have dissolved oxygen concentrations below 4 mg/l (the minimum Indiana water quality standard). Sub-watersheds which may be affected by low dissolved oxygen are shown in red in Figure 8. Best management practices in these areas should focus on sewage or manure handling.

Figure 8



The detrimental affect of low water quality in Muddy Fork on the remainder of the Sand Creek watershed can be seen in Figure 9. Muddy Fork's biotic index value was 48 points lower than it's value predicted by the aquatic habitat available there. This water quality depression was also observed in Sand Creek for at least 20 miles downstream, as measured by similarly low "observed vs. predicted" biotic index values in Sand Creek.

Fig. 9



RECOMMENDATIONS

1. Concentrate restoration efforts on Muddy Fork. It has severe water quality problems (sediment runoff, high organic load) that can affect the remainder of Sand Creek downstream.

2. Team with the City of Greensburg and apply for an IDNR Lake and River Enhancement grant for Greensburg Reservoir. A lake diagnostic study would help find sources of impairment in the watershed upstream from the lake and would eventually result in water quality improvements to the lake itself.

3. Other tributaries requiring a lesser degree of attention include Gas Creek, Bear Creek, and Nettle Creek.

4. Focus appropriate best management practices to solve the unique problems identified in each watershed:

   Muddy Fork - Sediment control, nutrient control, organic inputs, habitat restorations
   Gas Creek - Sediment control
   Bear Creek - Nutrient control, habitat restorations (upper watershed)
   Nettle Creek - Sediment control
   Sand Branch - Organic inputs, habitat restorations

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Sand Creek Watershed Benthos - 2003																	
								SITE									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Chironomidae		37	19	26	17	12	11	18	15	9	9	9	10	12	11	78	5
Simuliidae			8	2	2	32	11	4		1	2	6		63	12		
Tipulidae			4								3						3
Empididae			1	2							2					1	
Tabanidae						1											
Ephydridae																	
Elmidae		3	3	8	5	2	9	20	21	21	26	24	20	2	9	2	7
Psphenidae						1											
Tricorythodidae									1	8			4				
Caenidae				3												1	
Heptageniidae				1	1	3	2		12	10	2	2	30	1	7	1	6
Baetidae			7	23	45	29	38	31	12	7	2	18	10	12	9	6	8
Isonychia					1						1						5
Ephemeridae																	1
Hydropsychidae			55	34	29	19	27	22	38	43	52	41	25	9	42	11	59
Hydroptilidae										1							
Philopotamidae							1				1			1	7		5
Perlidae																	
Megaloptera				1									1				1
Anisoptera																	
Zygoptera									1								
Sphaeridae								2									
Physidae																	
Ferrissia																	
Lymnaeidae																	
Amphipoda																	
Isopoda								1									
Decapoda						1	1								3		
Nematoda																	
Hirudinea			3					2									
Oligochaeta																	
Turbellaria		60															
TOTAL		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Data Analysis for Macroinvertebrates

METRICS

	Site # 1	2	3	4	5
# of Genera	3	8	9	7	9
Hilsenhoff Biotic Index	8.0	5.7	6.0	5.8	5.3
Scraper/Filterer Ratio	0.0	0.0	0.3	0.2	0.1
EPT/Chironomid Ratio	0.0	3.3	2.3	4.5	4.3
% Dominant Taxon	60	55	34	45	32
EPT Index	0	2	5	4	3
Community Loss Index	2.7	0.6	0.3	0.6	0.6
% Shredders	0	4	0	0	1

SCORING

	Site # 1	2	3	4	5
# of Genera	0	6	6	4	6
Hilsenhoff Biotic Index	0	4	4	4	4
Scraper/Filterer Ratio	0	0	6	6	4
EPT/Chironomid Ratio	0	2	0	2	2
% Dominant Taxon	2	4	6	4	6
EPT Index	0	0	4	2	0
Community Loss Index	2	4	6	4	4
% Shredders	0	6	0	0	2
SCORE	4	26	32	26	28
NORMALIZED SCORE	9	57	70	57	61

Data Analysis for Macroinvertebrates

METRICS

	Site # 6	7	8	9	10
# of Genera	8	8	7	8	10
Hilsenhoff Biotic Index	5.5	5.9	5.6	5.5	5.4
Scraper/Filterer Ratio	0.3	0.7	0.9	0.7	0.5
EPT/Chironomid Ratio	6.2	2.9	4.2	7.7	6.4
% Dominant Taxon	38	31	38	43	52
EPT Index	4	2	4	5	5
Community Loss Index	0.5	0.8	0.7	0.6	0.4
% Shredders	1	0	0	0	3

SCORING

	Site # 6	7	8	9	10
# of Genera	6	6	4	6	6
Hilsenhoff Biotic Index	4	4	4	4	4
Scraper/Filterer Ratio	6	6	6	6	6
EPT/Chironomid Ratio	4	2	2	6	4
% Dominant Taxon	6	6	6	4	4
EPT Index	4	0	4	6	6
Community Loss Index	4	4	4	4	6
% Shredders	2	0	0	0	6
SCORE	36	28	30	36	42
NORMALIZED SCORE	78	61	65	78	91

Data Analysis for Macroinvertebrates

METRICS

	Site # 11	12	13	14	15	16
# of Genera	6	7	7	8	7	10
Hilsenhoff Biotic Index	5.4	5.6	5.0	5.2	7.0	5.0
Scraper/Filterer Ratio	0.6	2.0	0.0	0.3	0.3	0.2
EPT/Chironomid Ratio	6.8	6.9	1.9	5.9	0.2	17
% Dominant Taxon	41	31	63	42	78	59
EPT Index	4	4	4	4	4	6
Community Loss Index	0.8	0.7	0.6	0.5	0.7	0.0
% Shredders	0	0	0	3	0	3

SCORING

	Site # 11	12	13	14	15	16
# of Genera	2	4	4	6	4	6
Hilsenhoff Biotic Index	4	4	6	4	2	6
Scraper/Filterer Ratio	6	0	0	6	6	6
EPT/Chironomid Ratio	4	4	0	4	0	6
% Dominant Taxon	4	6	2	4	2	2
EPT Index	4	4	4	4	4	6
Community Loss Index	4	4	4	6	4	6
% Shredders	0	0	0	6	0	6
SCORE	28	26	20	40	22	44
NORMALIZED SCORE	61	57	43	87	48	100

Habitat Evaluation Breakdown

	Site Number							
	1	2	3	4	5	6	7	8
SUBSTRATE	7	12	10	8	10	12	7	12
COVER	2	7	6	7	8	8	7	11
CHANNEL	7	12	12	13	14	13	10	13
RIPARIAN	5	8	6	5	7	8	4	10
POOL/RIFFLE	7	9	11	9	8	10	8	11
GRADIENT	6	8	8	6	8	8	4	8
DRAINAGE AREA	8	6	9	11	7	8	8	12
TOTAL	42	62	62	59	62	67	48	77

	Site Number							
	9	10	11	12	13	14	15	16
SUBSTRATE	10	9	10	10	10	11	7	10
COVER	10	10	10	11	8	8	5	11
CHANNEL	13	13	11	13	12	14	5	13
RIPARIAN	7	9	7	9	11	8	6	11
POOL/RIFFLE	10	12	11	9	6	9	7	11
GRADIENT	8	8	10	6	6	8	8	8
DRAINAGE AREA	12	10	9	13	7	8	6	10
TOTAL	70	71	68	71	60	66	43	74

BIOASSESSMENT SUMMARY
Sand Creek Watershed

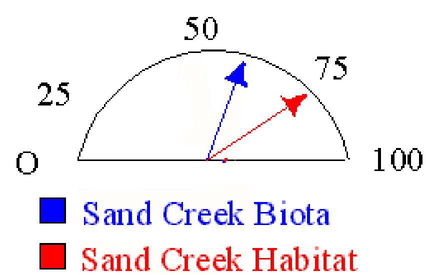
Purpose

To measure the ecological integrity of of the Sand Creek watershed. Both chemical and biological techniques were employed. Bioassessment uses knowledge of the biology of stream-dwelling animals to measure stream health.

Watershed Characteristics

The watershed is more heavily forested than most others in Indiana. The City of Greensburg is in the upper part of the watershed.

Results



Water quality and habitat are among the best in Indiana at one site. Other sites are affected by degraded water quality or habitat. Greatest impairment is in Muddy Fork. Water quality problems include excessive nutrients, sedimentation, and low dissolved oxygen.

Watershed Gauge
A score of 100 is our goal

Recommendations

Concentrate restoration efforts on Muddy Fork.

Date: 2003