Sand Creek Water Quality Monitoring- 2003

A water quality study 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.

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. 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.

Fig. 1

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)
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

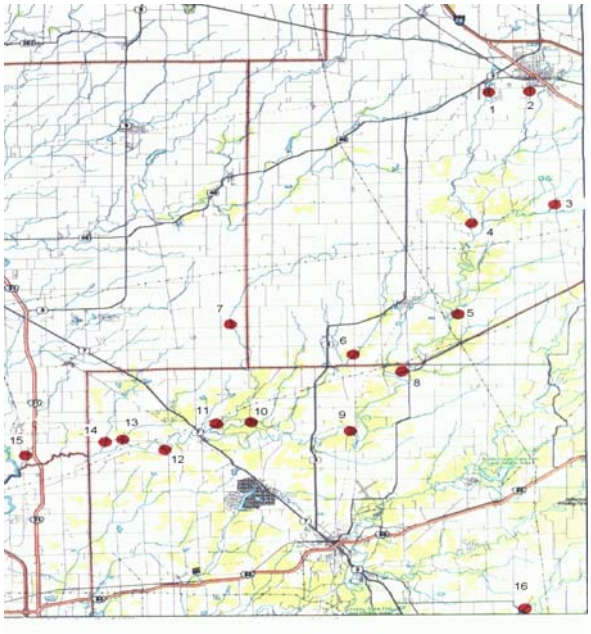


Fig. 2. Study Sites

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.

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 which has been shown to produce highly reproducible results that accurately reflect changes in water quality.

The aquatic habitat at each study site was evaluated according to the method described by Ohio EPA. 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.

RESULTS

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)

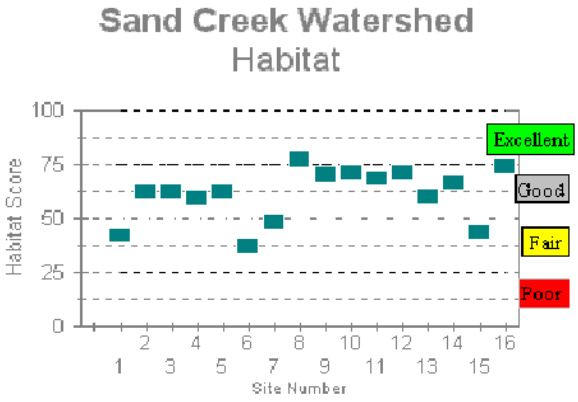
DISCUSSION

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 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.

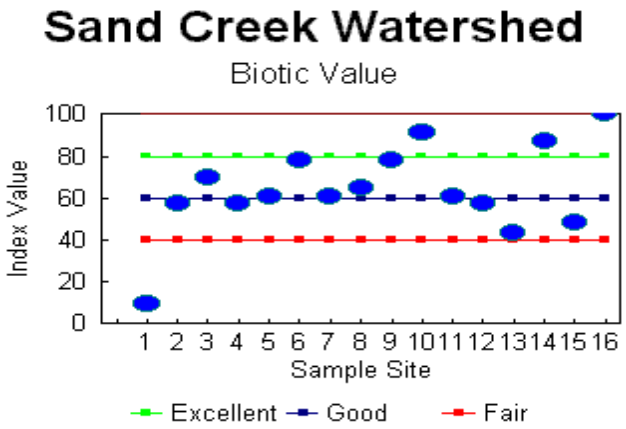


Macroinvertebrate Communities

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.

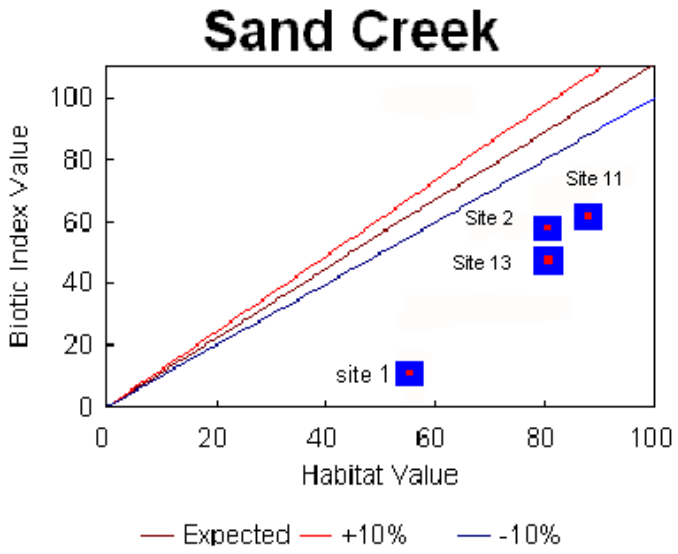
Figure 4



Diagnosis

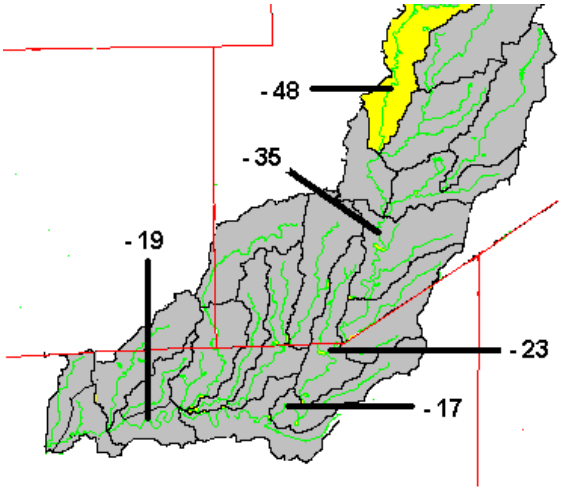
One of the most useful aspects of biological monitoring is the ability to use information on the way aquatic animals respond to different types of stress to diagnose a problem. For example, when aquatic habitat and biotic integrity are graphed in relation to each other, they form a straight line unless 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



The detrimental affect of low water quality in Muddy Fork on the remainder of the Sand Creek watershed can be seen in Figure 6. 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. 6



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

3. **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