

## Introduction

The City of Kokomo, Indiana has a combined sewer system, with contributions from both sanitary sewage and storm water. Combined sewer overflows (CSOs) occur on three streams in the city: Little Wildcat Creek, Kokomo Creek, and Wildcat Creek. During 2001 and 2008, the City commissioned biologists to conduct studies to measure potential effects of combined sewer overflow CSOs on aquatic communities of these three streams. Data on these studies are reported by Strand Associates (2008).

During the past 10 years, Kokomo has implemented a combined sewer overflow operations plan and reduced the frequency and duration of CSOs. To measure potential improvements in water quality associated with implementation of the CSO operations plan, biologists sampled the same sites in 2013 using the same sampling methods used in the previous studies.

## Study Sites

Site 1. Little Wildcat Creek (EFW-1)	Highway 31
Site 2. Little Wildcat Creek (EFW-2)	CR 100 W
Site 3. Kokomo Creek (K-1)	Highway 31
Site 4. Kokomo Creek (K-2A)	Highland Park, upstream from dam
Site 5. Kokomo Creek (K-2B)	Highland Park, downstream from dam
Site 6. Wildcat Creek (W-1)	Waterworks Park
Site 7. Wildcat Creek (W-2)	Foster Park
Site 8. Wildcat Creek (W-3A)	Upstream from WWTP
Site 9. Wildcat Creek (W-3B)	Downstream from WWTP
Site 10. Wildcat Creek (W-4)	YMCA Camp at CR 300 W

# Sampling Sites



## Methods

Fish were collected by DC electrofishing for a minimum collection time of 1800 seconds at each site. Fish were identified on site before being released, except for representative specimens that were kept as vouchers. Small minnows were preserved for laboratory analysis. Any anomalies present on the fish were noted. Preserved fish were identified using the taxonomic references of Eddy and Underhill (1978) and Page and Burr (1991). Index of Biotic Integrity (IBI) scores were calculated according to the method of Karr et al. (1986) and Simon and Dufour (1997). This method evaluates 12 metrics for a total possible score of 60. Metrics include categories for community richness, species tolerance, community composition, and trophic status.

Macroinvertebrates were collected by dipnet at each site using the riffle kick-sample method and the multi-habitat methods employed by the Indiana Department of Environmental Management (2010). Samples are collected in the field, then returned to the laboratory where they are sorted and identified to the family level and later to the species level. The macroinvertebrate family-level IBI uses 10 metrics and produces a total possible score of 8. Metrics include categories for community richness, species tolerance, and abundance. The multi-habitat methods uses 12 metrics and a total possible score of 60. This scoring technique uses additional measurements such as trophic levels and habitat use. The data were also evaluated by a technique used by local Hoosier Riverwatch volunteers (1997).

## Results

Thirty-five species of fish were collected from the ten sampling sites in 2013. The fish community was dominated by Centrarchids (sunfish and bass) and Cyprinids (minnows) at most sites. Together, six species from these two groups made up 79% of all fish collected. Longear sunfish were the most common species collected. Also present in smaller numbers were various sucker, perch, and catfish species. A list of species collected at each site is shown in the Appendix.

Macroinvertebrate sampling found 30 families at the ten sampling sites. The macroinvertebrate community at most sites was dominated by mayflies, caddisflies, and riffle beetles. A list of each family collected at each site is shown in the Appendix.

## Discussion

### *FISH COMMUNITIES*

For fish, the index of biotic integrity or IBI, a measure of ecological health, has clearly improved at most sites since sampling began in 2001. Comparisons of IBI results for each stream during the 3 sampling periods are shown below:

Site	1	2	3	4	5	6	7	8	9	10
	EFW-1	EFW-2	K-1	K-2A	K-2B	W-1	W-2	W-3A	W-3B	W-4
2001	24	32	46	30	44	42	36	36	40	36
2008	34	44	42	30	50	38	40	48	46	52
2013	28	22	18	44	50	42	44	48	46	54

Notable exceptions to improving conditions were noted at site 2 (East Fork of Wildcat Creek) and site 3 (Kokomo Creek upstream from all CSO influence). The decline in Kokomo Creek was especially sharp and may have been associated with highway construction (a new Highway 31) east of Kokomo and upstream from the sampling site.

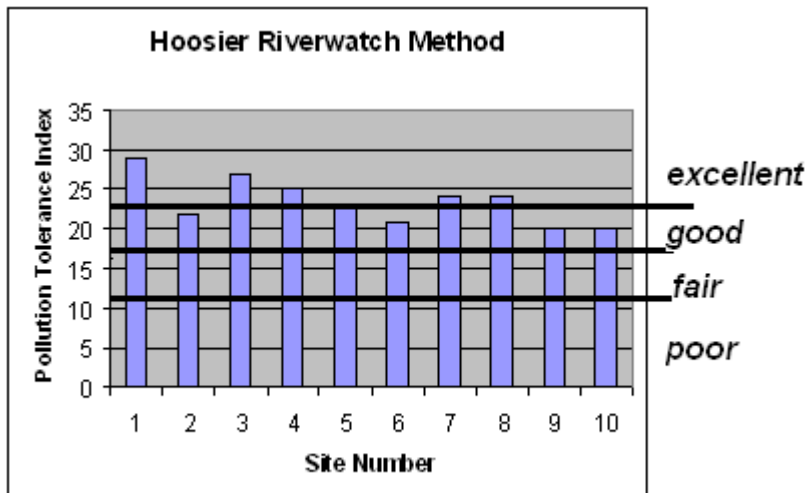
The average IBI score for the ten sites has ranged from 37 in 2001 (fair ecological condition) to 42 in 2008 (good ecological condition) to 40 (good ecological condition) in 2013. The greatest improvement has occurred in Wildcat Creek at site 10, downstream from the city at the YMCA camp. The IBI score here has improved 18 points, from “fair” to “excellent” (among the best fish communities in Indiana).

“Metrics” showing the greatest degree of improvement for fish communities since the previous study are (1) the number of sunfish species [the number has increased], (2) the percentage of tolerant individuals [the percentage has decreased], and (3) the percentage of omnivore individuals [the percentage has decreased]. Improved metric scores are associated with improved water quality (e.g. higher dissolved oxygen, lower ammonia and suspended solids, and fewer toxic substances).

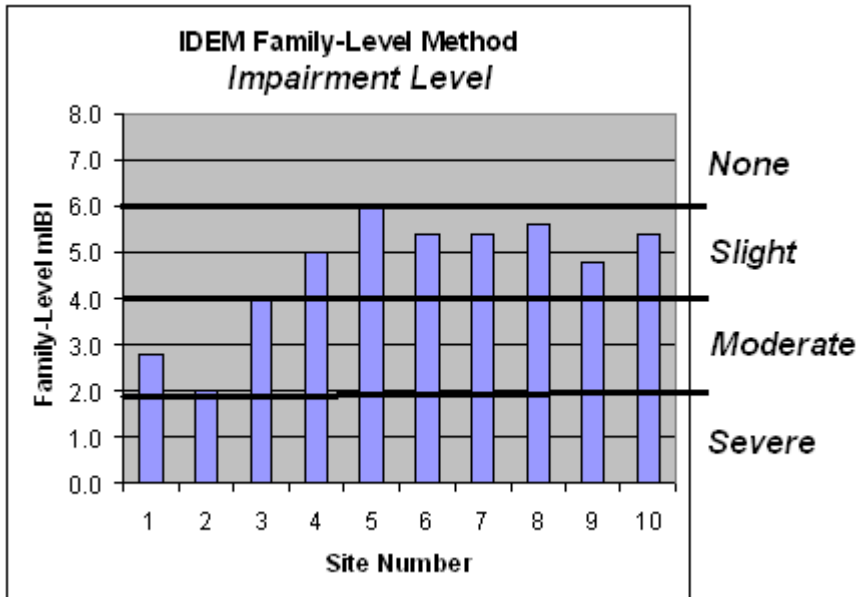
## MACROINVERTEBRATE COMMUNITIES

Significant improvements in the macroinvertebrate communities were also observed. In 2008 oligochaetes and midges (two highly tolerant groups) made up about half of all animals collected at the 10 sample sites. In 2013, this proportion dropped to only 16% of the total benthic community. Replacing these groups which are tolerant to pollution and environmental degradation in 2008 were intolerant forms such as mayflies, caddisflies, and riffle beetles in 2013. In 2008 only two species of mayflies (an intolerant group) were present and these made up less than 1% of the benthic communities of the 10 sample sites. In contrast, four species of mayflies were present in 2013 and they made up more than 25% of the benthic community. Caddisflies (another intolerant group) were completely absent in 2008 but four species contributed more than 25% of the total benthic community in 2013.

Results obtained by the Hoosier Riverwatch methods are shown below. Half the sites received an “excellent” rating, the remaining sites received a “good” rating.



Because it uses more precise taxonomic measurements, the IDEM family-level IBI produces a somewhat better measurement of ecological health. Results based on the IDEM family-level IBI are shown below.



## **Conclusion**

Improved aquatic communities observed in Kokomo area streams since sampling began in 2001 show that combined sewer overflow operations plan carried out by the City of Kokomo has been effective in improving water quality in local streams.

Wildcat Creek at Site 10. Excellent Habitat and Aquatic Communities Present



## References

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## Fish Community Data

	Site	1	2	3	4	5	6	7	8	9	10	Total
		EFW-1	EFW-2	K-1	K-2A	K-2B	W-1	W-2	W-3A	W-3B	W-4	
rockbass		2			1	4	1	5	11	18	13	55
longear sunfish				4	4	15	5	37	24	48	29	166
bluegill						5	42	7	2	3		59
pumpkinseed					1	7	3	1	5	9	10	36
green sunfish		2	5	14		2	9	3	2	2	1	40
largemouth bass				5			7			1		13
smallmouth bass		1				2	5		3	4	2	17
carp						1						1
sand shiner		1								7		8
silverjaw minnow		1	7									8
suckermouth minnow											3	3
central stoneroller		15	3			7	16				31	72
creek chub		38	52		3	5	38		3			139
hornyhead chub						2			13	2	4	21
silver chub											1	1
common shiner						1			16			17
bigeye shiner										7	35	42
emerald shiner					34					1		35
mimic shiner						26		1		2	20	49
bluntnose minnow		14	31			14	15		1	9	5	89
logperch										1		1
blackside darter					1		1		1			3
orangethroat darter					12	6		8	7	7	3	43
greenside darter					3	2		6	8	7	8	34
johnny darter		5	12			2	5	2	1		1	28
fantail darter					1							1
northern hogsucker		1				9			12	1	13	36
white sucker		1				1	1				1	4
spotted sucker							2		2			4
golden redhorse											3	3
blackstripe topminnow		15					15	9	12			51
yellow bullhead			1	2					4		1	8
stonecat									1		1	2
brook silverside							1					1
gizzard shad							2	22				24
TOTAL		96	111	25	60	111	168	101	128	129	185	1114

INDEX OF BIOTIC INTEGRITY  
CALCULATIONS

Wildcat Creek - YMCA Camp  
W-4

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	5	20	
Number of Darter Species	5	4	
Number of Sunfish Species	5	5	
Number of Sucker Species	3	3	
Number of Sensitive Species	5	8	
% Tolerant Individuals	5	8	4%
% Omnivore Individuals	5	6	3%
% Insectivore Individuals	5	128	69%
% Carnivore Individuals	3	14	8%
Catch per Unit Effort	5	372	
% Simple Lithophil Individuals	3	58	31%
% DELT Individuals	5	9	0%
Total IBI Score	54		

Wildcat Creek - D/S WWTP  
W-3B

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	3	17	
Number of Darter Species	3	3	
Number of Sunfish Species	5	5	
Number of Sucker Species	1	1	
Number of Sensitive Species	5	8	
% Tolerant Individuals	5	11	10%
% Omnivore Individuals	5	9	8%
% Insectivore Individuals	5	77	71%
% Carnivore Individuals	5	14	13%
Catch per Unit Effort	3	218	
% Simple Lithophil Individuals	1	15	14%
% DELT Individuals	5	0	0%
Total IBI Score	46		

Wildcat Creek - U/S WWTP  
W-3A

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	5	19	
Number of Darter Species	3	3	
Number of Sunfish Species	5	5	
Number of Sucker Species	3	2	
Number of Sensitive Species	3	7	
% Tolerant Individuals	5	10	8%
% Omnivore Individuals	5	1	1%
% Insectivore Individuals	5	94	73%
% Carnivore Individuals	5	14	11%
Catch per Unit Effort	3	258	
% Simple Lithophil Individuals	1	21	16%
% DELT Individuals	5	0	0%
Total IBI Score	48		

Wildcat Creek - Foster Park  
W-2

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	3	12	
Number of Darter Species	3	3	
Number of Sunfish Species	5	5	
Number of Sucker Species	1	0	
Number of Sensitive Species	3	5	
% Tolerant Individuals	5	25	25%
% Omnivore Individuals	5	0	0%
% Insectivore Individuals	5	62	61%
% Carnivore Individuals	5	14	14%
Catch per Unit Effort	3	204	
% Simple Lithophil Individuals	1	8	8%
% DELT Individuals	5	0	0%
Total IBI Score	44		

Wildcat Creek - Waterworks Park  
W-1

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	3	17	
Number of Darter Species	3	2	
Number of Sunfish Species	5	5	
Number of Sucker Species	3	2	
Number of Sensitive Species	3	4	
% Tolerant Individuals	3	65	39%
% Omnivore Individuals	5	16	10%
% Insectivore Individuals	3	57	34%
% Carnivore Individuals	3	14	8%
Catch per Unit Effort	5	336	
% Simple Lithophil Individuals	1	3	2%
% DELT Individuals	5	0	0%
Total IBI Score	42		

**INDEX OF BIOTIC INTERGRITY (IBI) - FISH**

Kokomo Creek - Hwy 31  
K-1

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	1	4	
Number of Darter Species	1	0	
Number of Sunfish Species	3	3	
Number of Sucker Species	1	0	
Number of Sensitive Species	1	1	
% Tolerant Individuals	1	16	64%
% Omnivore Individuals	1	0	0%
% Insectivore Individuals	1	6	24%
% Carnivore Individuals	5	5	20%
Catch per Unit Effort	1	50	
% Simple Lithophil Individuals	1	0	0%
% DELT Individuals	1	0	0%
Total IBI Score	18		

Kokomo Creek - LaFountain Street  
K-2A

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	3	9	
Number of Darter Species	5	3	
Number of Sunfish Species	3	3	
Number of Sucker Species	1	1	
Number of Sensitive Species	5	5	
% Tolerant Individuals	5	4	7%
% Omnivore Individuals	5	0	0%
% Insectivore Individuals	5	55	92%
% Carnivore Individuals	1	1	2%
Catch per Unit Effort	3	120	
% Simple Lithophil Individuals	3	14	23%
% DELT Individuals	5	0	0%
Total IBI Score	44		

Kokomo Creek – Downstream  
K-2B

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	5	18	
Number of Darter Species	5	3	
Number of Sunfish Species	5	4	
Number of Sucker Species	3	2	
Number of Sensitive Species	5	8	
% Tolerant Individuals	3	29	26%
% Omnivore Individuals	5	17	15%
% Insectivore Individuals	5	67	60%
% Carnivore Individuals	3	6	5%
Catch per Unit Effort	5	222	
% Simple Lithophil Individuals	1	17	15%
% DELT Individuals	5	0	0%
Total IBI Score	50		

Little Wildcat Creek - Hwy 31  
EFW-1

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	3	11	
Number of Darter Species	1	1	
Number of Sunfish Species	3	3	
Number of Sucker Species	1	1	
Number of Sensitive Species	3	2	
% Tolerant Individuals	1	55	58%
% Omnivore Individuals	5	15	16%
% Insectivore Individuals	1	22	23%
% Carnivore Individuals	1	3	3%
Catch per Unit Effort	3	190	
% Simple Lithophil Individuals	1	1	1%
% DELT Individuals	5	0	0%
Total IBI Score	28		

Little Wildcat Creek - Downstream  
EFW-2

	<u>Score</u>	<u>Raw Data</u>	
Total Number of Species	1	7	
Number of Darter Species	1	1	
Number of Sunfish Species	1	1	
Number of Sucker Species	1	0	
Number of Sensitive Species	1	0	
% Tolerant Individuals	1	89	80%
% Omnivore Individuals	3	31	28%
% Insectivore Individuals	1	20	18%
% Carnivore Individuals	1	0	0%
Catch per Unit Effort	5	222	
% Simple Lithophil Individuals	1	0	0%
% DELT Individuals	5	0	0%
Total IBI Score	22		

mIBI (Family Level)  
 IDEM Methodology  
 Macroinvertebrate Sampling Results  
 13-Sep-13

Site Number	1 EFW-1	2 EFW-2	3 K-1	4 K-2A	5 K-2B	6 W-1	7 W-2	8 W-3A	9 W-3B	10 W-4
Hydropsychidae	1		20	72	25	58	8	16	10	20
Hydroptilidae							1			
Philopotamidae			1			19	4	11		
Limnephilidae								1		
Tricorythidae					8		7	40	33	34
Caenidae										5
Baetidae	13			10	30	3	15	7	17	24
Heptageniidae		1	4				12		1	
Ephydriidae	4									
Chironomidae	8	42	29	10	4	11	30	10	21	9
Tipulidae	4	3	3	1						
Simuliidae				1	1	1		1		
Empididae					1					
Ceratopogonidae	1									
Calopterygidae			3		1					
Coenagrionidae	17	3	1	1	2		5	1	3	2
Aeschnidae			1							
Elmidae	26	39	25	5	26	10	10	7	11	5
Psephenidae			6							
Hydrophylidae	1						1			
Helodidae		3					2			
Dugesia spp.	7	7			6	3		6		
Physa spp.		2								
Helisoma spp.										
Sphaeriidae	14					1	1	2		
Corbicula fluminea										1
Amphipoda	2						3		4	
Decapoda		1								
Tubificidae	2		5				1			
Hirudinidae			2		1					

## Data Summary

Site Number	1	2	3	4	5	6	7	8	9	10
	EFW-1	EFW-2	K-1	K-2A	K-2B	W-1	W-2	W-3A	W-3B	W-4
Number of taxa	13	9	12	7	11	8	14	11	8	8
Number of individuals	100	100	450	450	450	450	450	450	450	450
Number of EPT taxa	2	1	3	2	3	3	6	5	4	4
Percent Dominant Taxa	26	42	29	72	30	58	30	40	33	34
EPT Count	14	1	75	328	254	320	188	300	244	332
# EPT/#Chironomids	1.8	0.02	0.9	8.2	16	7.3	1.6	7.5	2.9	9.2
% EPT	14	1	25	82	63	80	47	75	61	83
# of individuals/# squares	100	100	450	450	450	450	450	450	450	450
# Chironomids	8	42	116	40	16	44	120	40	84	36
HBI	5.8	5.5	4.9	4.3	4.6	4.4	5	4.7	4.7	4.7

## Metric Scores

Site Number	1	2	3	4	5	6	7	8	9	10
	EFW-1	EFW-2	K-1	K-2A	K-2B	W-1	W-2	W-3A	W-3B	W-4
Number of taxa	4	2	4	0	4	2	4	4	2	2
Number of individuals	4	4	8	8	8	8	8	8	8	8
Number of EPT taxa	0	0	2	0	2	2	6	4	4	4
Percent Dominant Taxa	6	4	6	0	6	2	6	4	4	4
EPT Count	0	0	2	8	8	8	6	6	6	6
# EPT/#Chironomids	2	0	2	8	8	6	2	6	4	6
% EPT	2	0	2	8	6	8	6	8	6	8
# of individuals/# squares	4	4	8	8	8	8	8	8	8	8
# Chironomids	6	4	2	4	6	4	2	4	2	4
HBI	0	2	4	6	4	6	4	4	4	4
Average	2.8	2.0	4.0	5.0	6.0	5.4	5.4	5.6	4.8	5.4