

PLYMOUTH, INDIANA

STORM WATER AND COMBINED SEWER OVERFLOW MONITORING

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The City of Plymouth (population 10,000) is located in Marshall County in northern Indiana. Yellow River is the most prominent waterbody in the city. Smaller watersheds within Plymouth's city limits include Schuh Ditch and Elmer Seltenwright Ditch.

Like many other Indiana cities, Plymouth has a storm water permit which requires a "baseline characterization" of the quality of surface water within the city's jurisdiction. The original baseline characterization was carried out in 2004 by Commonwealth Biomonitoring. This study was done using a bioassessment technique, which quantifies the number and kinds of aquatic life present in area streams to measure their ecological health. The technique results in a biological quality value (biotic index) that is expressed as a percentage of the maximum possible value.

In addition to its storm water program, the City of Plymouth is also carrying out a combined sewer overflow (CSO) operational plan. The CSO plan is designed to reduce the number of times combined sewers (those with both a sanitary and storm water component) overflow directly into Yellow River. Additional monitoring sites were chosen to determine whether water quality improvements associated with implementing the CSO plan have been achieved.

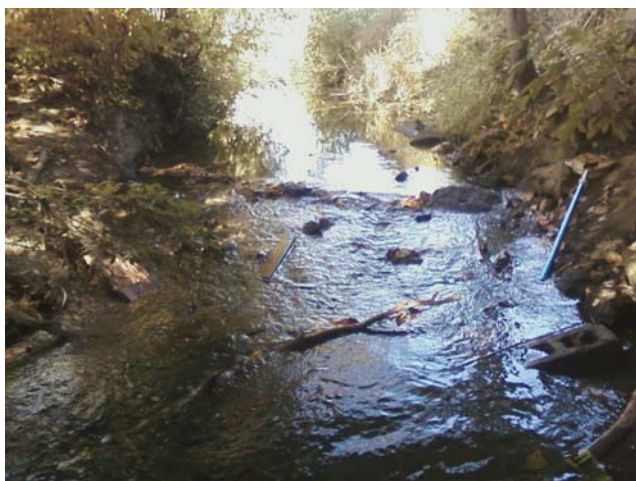
The first storm water monitoring study in 2004 showed that all three sites examined were ecologically degraded, compared to biological values from "reference" streams in the same ecoregion. The degraded conditions were related to lower water quality from urban storm water runoff. Water quality in Schuh Ditch was especially degraded. This stream supported few forms of aquatic life and those which were able to colonize these streams are known to be highly tolerant to toxic chemicals such as polycyclic aromatic compounds (PAHs). CSO-related sampling in 1997 showed similar degraded conditions as the Yellow River flowed through the city.

During the next nine years, the City of Plymouth storm water program began to implement "best management practices" to reduce or eliminate water pollution caused by storm water runoff. The City began

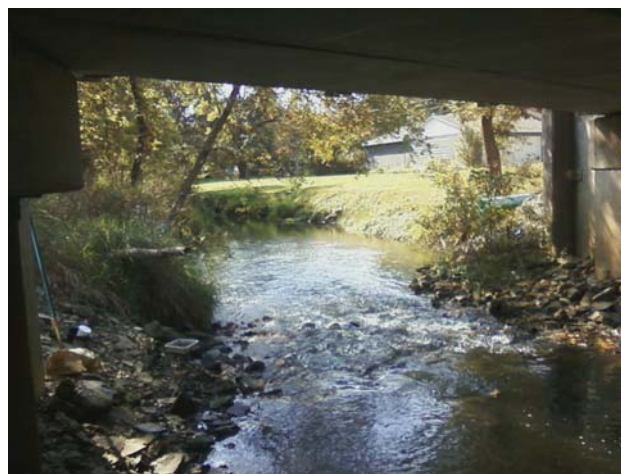
implementation of the Indiana storm water regulation (Rule 13). Regular street sweeping continued to be performed. Storm water was directed to detention ponds and vegetated swales. In addition, the CSO operational plan was carried out. Several CSOs discharging to Yellow River were eliminated and the frequency of overflows was reduced significantly.

Each site was then re-examined in October 2013 using the same bioassessment technique previously employed. Sampling was also done on at two additional sites on Yellow River that had been analyzed similarly in 1998 as part of the CSO operational plan. Photographs of each study stream are shown below.

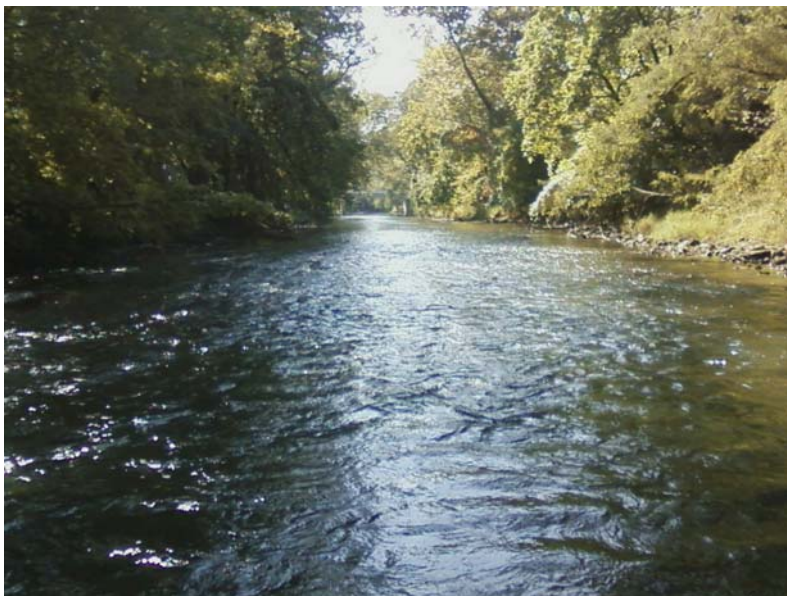
Schuh Ditch



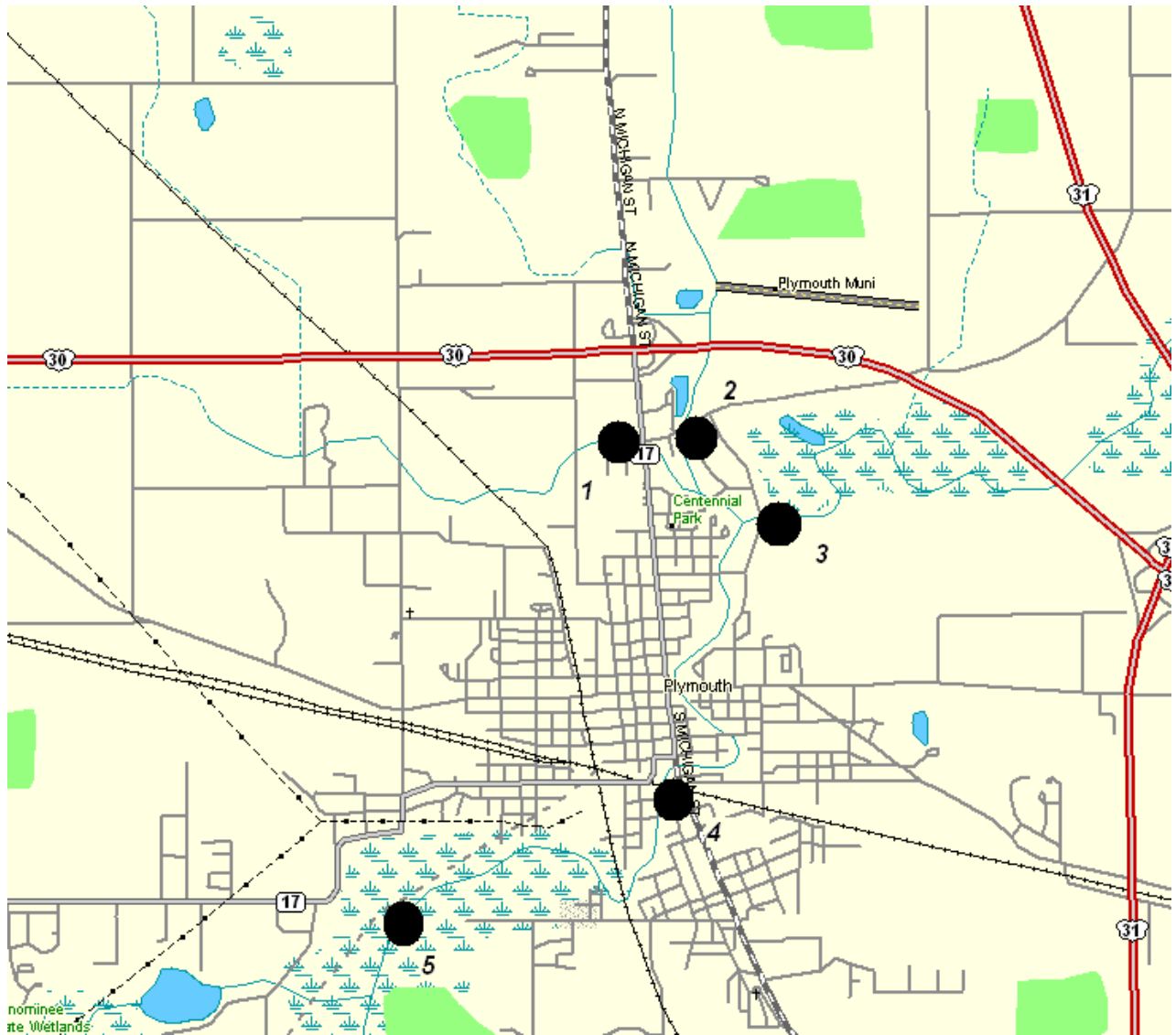
Elmer Seltenwright Ditch



Yellow River



Location of the Study Sites



Results

Macroinvertebrate sampling data are shown in the Appendix. The dominant animals at most of these sites were mayflies and caddisflies (groups intolerant to environmental degradation). Two species (*Ceratopsyche sparna* and *Brachycentrus numerosus*) are known to occur only in the cleanest streams of Indiana and one or both of these caddisflies were present at four of the five sites sampled. The IBI scores of the Yellow River increase at each downstream site, indicating that the river becomes increasingly healthy as it flows through the City of Plymouth.

Comparison to Previous Results

The IBI scores for each sampling site for each year that sampling has occurred are shown in the table below. The potential IBI scores range from 0 (worst biological health) to 48 (highest possible biological health). All three streams showed increasing biological health compared to previous sampling. This was especially true in Schuh Ditch, whose index of biotic integrity score rose from 2 in 2004 (an essentially lifeless stream) to 28 in 2013. The Yellow River in the downtown Plymouth has also seen significant increases in ecological health.

	Schuh Ditch Site 1	Elmer Seltenwright Site 2	Yellow River Site 3	Yellow River Site 4	Yellow River Site 5
1997			38	18	24
2003	2	18		16	
2013	28	32	36	40	42

Conclusion

The 2013 sampling showed that since the storm water and CSO programs began, the ecological health of the three streams (as measured by their biotic index values) has significantly improved. These two water quality improvement programs in the city of Plymouth have resulted in significant improvements to water quality in city streams.

Biological Indicators of Improving Water Quality



Caddisfly larva, an animal requiring good water quality.

They have increased in abundance since 2004.



Mayfly nymphs also require good water quality.

They have also increased in abundance.



Midge larvae are considered to be tolerant of poor water quality.

They were the most common animal found during the 2004 survey, but have decreased in abundance since the stormwater program has been carried out.

SCORING VALUES FOR METRICS
 Adapted from Ohio EPA and U.S. EPA RBA Protocol III.

	6 points	4 points	2 points	0 points
# of Genera	>20	14 - 20	7 - 13	<7
# Mayfly Taxa	> 6	4 - 6	2 - 4	<2
# Caddisfly Taxa	> 4	3 - 4	1 - 2	0
# Diptera Taxa	>12	8 - 12	4 - 7	<4
% Tanytarsini	>25	11 - 25	1 - 10	0
% Mayflies	>25	11 - 25	1 - 10	0
% Caddisflies	>20	11 - 19	1 - 10	0
% Tolerant Species	0-10	11 - 20	21 - 30	>30
% non-Tanytarsids & non-insects	<25	25 - 45	46 - 65	>65
% Dominant Taxon	<20	21-29	30-39	>40

Raw Data

Site	1	2	3	4	5
Number of Genera	12	10	15	13	19
EPT Taxa	5	6	6	8	10
# EPT	85	57	73	63	81
% Dominant	67	35	41	22	38
Mayfly Taxa	1	1	4	3	3
Caddisfly Taxa	4	5	2	5	7
% Mayflies	1	5	26	27	4
% Caddisflies	84	52	47	36	77
% Tolerant	1	0	3	0	0
% Non-Insects	9	9	16	7	10
# Diptera Taxa	5	4	7	4	8
% Tanytarsini	0	0	0	0	22

METRIC SCORES

Site	1	2	3	4	5
Number of Genera	2	2	4	2	4
% Dominant	0	2	0	4	2
Mayfly Taxa	0	0	4	2	2
Caddisfly Taxa	4	6	2	6	6
% Mayflies	2	2	6	6	2
% Caddisflies	6	6	6	6	6
% Tolerant	6	6	6	6	6
% Non-Insects	6	6	6	6	6
# Diptera Taxa	2	2	2	2	4
% Tanytarsini	0	0	0	0	4
TOTAL IBI Score	28	32	36	40	42

Site	1	2	3	4	5
Orthocladus obumbratus	2				1
Eukiefferiella pseudomontana		6	3		
Cricotopus bicinctus			3		
Brillia flavifrons		1	1		
Rheocricotopus robacki	2	2	2	7	3
Thienemanniella xena	1				
Dicrotendipes nervosus					1
Polypedilum convictum	2				
Stenochironomus spp.			6		
Rheotanytarsus spp.					1
Tanytarsus spp.					1
Thienemannimyia spp.			1		2
Tipula				1	1
Antocha				2	
Simulium	3	33	3	11	3
Ameletus		5			
Stenacron			1		1
Stenonema pulchellum					1
S. terminatum			17	4	
Baetis fkavistriga					2
B. intercalaris	1		8	22	
Heterocloeon				1	
Tricorythodes			1		
Ceratopsyche bifida	2	4	5	15	26
C. sparna	4	6		3	3
Hydropsyche betteni	12	6		2	3
H. simulans					1
Cheumatopsyche	67	35	41	15	38
Polycentropus					1
Brachycentrus		1		1	5
Macronychus		1		5	1
Stenelmis			7	11	4
Argia			1		
Hetaerina	2				
Ferrissia	1				
Sphaerium	1				
Dugesia					1
Total	100	100	100	100	100