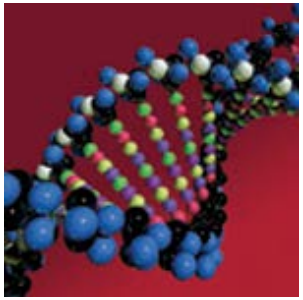
Stream Recovery After Reconstruction of Reclaimed Coal Strip Mine


West Fork Busseron Creek

Peabody Midwest Mining LLC

Farmersburg, (Sullivan County) Indiana

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Overview

- Busseron Creek Mitigation Site Short History
- 2003 Survey and Summary of Findings
- 2010 Survey and Summary of Findings
- Status
- Important/Supporting Features
- Implications

Busseron Creek Mitigation Area

1998 - 2003

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Busseron Creek Mitigation Area

March and September 2005

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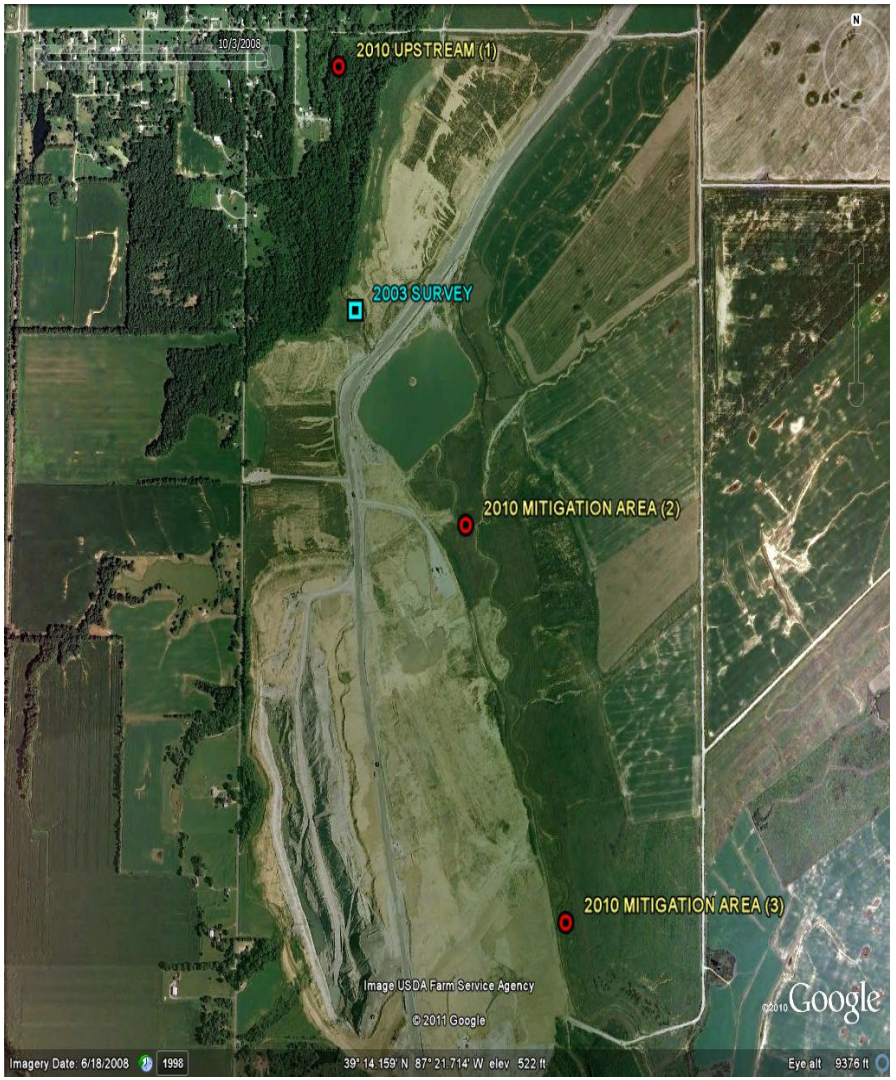
Busseron Creek Mitigation Area

2007 - 2008



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2003 Busseron Creek Survey Overview

- Studies conducted in Sept. 2002 and April 2003
- Quantitative and qualitative for fish and Unionid mussels. Fish IBI calculated
- Qualitative for amphibians/reptiles and small mammals.
- Habitat QHIE and general descriptive for substrates.
- No water quality reported.
- No benthic macroinvertebrates collected.

2003 Busseron Creek Survey
General Findings

Survey	Species	Summer/Fall	Spring	Total
Item	Richness	2002	2003	Individuals
Herpeto-faunal	19			276
Small mammals	6	(3) 257	(6) 259	0
Unionid mussels	0	0	0	0
Fish Upstream	17	17	NA	1,090
Fish Downstream	15 - 16	(15) 1,662	(16) 549	2,211

2003 Busseron Creek Survey
Fish Structure/IBI

Survey	Upstream	Downstream	Downstream
Item	**Summer/Fall 2002**	**Summer/Fall 2002**	**Spring 2003**
	Creek chub (28%)	Fathead minnow (32%)	Green sunfish (22%)
Dominant	Green sunfish (17%)	Silverjaw minnow (25%)	Fathead minnow (22%)
Species	Silverjaw minnow (15%)	Creek chub (11%)	Bluegill (18%)
	Fathead minnow (14%)	Green sunfish (10%)	Creek chub (12%)
Fish IBI	44	42	46
IBI Class	Fair	Fair	Good-Fair

2003 Busseron Creek Survey

Habitat

Habitat	Glide	Pool	Riffle	Run
Percent	48	37	13	2
Substrate	sand	sand	gravel	sand
	gravel	silt	sand	gravel
	Upstream		Downstream	
QHEI (100)	51.8		57.2	
QHEI (100)	54.7			

2010 Busseron Creek Survey Overview

- Studies conducted June 29-July 1, 2010
- Quantitative and qualitative for fish. Fish IBI calculated.
- Qualitative for benthic macroinvertebrates. Benthic MIBI calculated.
- Habitat QHIE and general descriptive for substrates.
- General water quality and selected water chemistry analyses.

2010 Busseron Creek Survey
Fish Community Structure/IBI

Fish Survey	2010		2003
Item	**Upper Reach**	**Lower Reach**	**Range**
Density (f/M^2)	0.34	0.23	0.68 - 0.70
Biomass (g/M^2)	8.7	1.6	2.7 - 3.7
Richness	12	13	15 - 17
Diversity (H')	1.94	2.17	1.89 - 2.00
Fish IBI	44	40	42 - 46
IBI Category	Fair	Fair	Fair - Good

2010 Busseron Creek Survey
Fish Community Shifts

	2010		2003
Fish	**Mass (g/f)**	**Shift (+/-)**	**Mass (g/f)**
Largemouth bass	13.1	mass, + 52 fish	3 (1)
Bluegill	43	mass, + 107 fish	3.5
Yellow bullhead	31	+ 48 fish	40
Longear sunfish	25	mass, + 53 fish	6.5
Suckermouth minnow	3.6	+133 fish	NA
Green sunfish	10	mass, - 319 fish	2.3
Creek chub	1.9	mass - 492 fish	10.8
Silverjaw minnow	3.2	- 565 fish	1.1
Bluntnose minnow	1.2	mass - 560 fish	0.7
Central stoneroller	NA	-106 fish	4.4
Johnny darter	NA	- 170 fish	0.9

2010 Busseron Creek Survey
Dominant Benthos

Upstream		Upper Reach		Lower Reach	
Reference	%	**Remediation**	%	**Remediation**	%
Riffle					
Caddisfly	47.5	Midge	34.1	Beetle-*Berusus*	14.5
Mollusk	13.3	Midge	15.9	Snail-*Physa*	13.5
Midge-*Polypedilum*	7	Midge	12.6	Damselfly	13.5
Multi-Habitat					
Snail-*Helisoma*	19.3	Midge	29.3	Caddisfly	37.5
Clam-*Pisidium*	14.3	Midge	14.1	Midge-*Polypedilum*	11
Snail-*Physa*	13.5	Damselfly	9.4	Midge	10.1

2010 Busseron Creek Survey
Benthos Community/MIBI

	Upstream	Upper Reach	Lower Reach
Metric	**Reference**	**Remediation**	**Remediation**
Riffle			
Richness	23	23	38
EPT Richness	2	3	6
EPT:Chironomid	2.2	0.06	0.79
H' Diveristy	2.9	3.1	4
MIBI	40	30 (Slight)	42 (None)
Multi-Habitat			
Richness	35	28	22
EPT Richness	3	4	4
EPT:Chironomid	0.51	0.13	1
H' Diveristy	4.1	3.6	3.3
MIBI	44	32 (Slight)	34 (Slight)

2010 Busseron Creek Survey
Stream Reach Habitat

	Upstream	Upper Reach	Lower Reach
Habitat Method	**Reference**	**Remediation**	**Remediation**
2003 QHEI	55	N/A	N/A
(Rankin 1989 - Ohio)			
2010 QHEI	53	52	50
(IDEM 2006)			
2010 USEPA	135	127	123
(RBP 1999)			
USEPA (1999) Category	Sub-Optimal	Sub-Optimal	Sub-Optimal

2010 Busseron Creek Survey
Water Chemistry

	Upstream	Upper Reach	Lower Reach
Parameter	**Reference**	**Remediation**	**Remediation**
Flow (cfs)	5.2	9.9	9.9
pH (average s.u.)	8	8.6	8.5
Conductivity (average uS)	685	498	477
Sulfate (mg/L)	217	147	136
SO_4 Criteria mg/L (37 IAC 2-1-6)	1,485	1,119	1,050
TDS (mg/L)	435	312	288
Alkalinity ($CaCO_3$ mg/L)	120	97	96
Calcium (mg/L)	57.9	41.1	40.5
Magnesium (mg/L)	28.2	20.4	19.3
Potassium (mg/L)	3.6	3.3	3.4
Sodium (mg/L)	35	26.1	22.6
Hardness (calculated mg/L)	259	186	180

Busseron Creek Mitigation Area
Key Findings - Status

- Physical morphology: pattern reduces flow velocity, promoting stable and enhanced localized hydrologic patterns
- Improved water quality: slight decrease in concentration of sulfate, conductivity and all major ions except potassium
- Equivalent in-stream habitat quality: assessment scores by two methods imply negligible difference

Busseron Creek Mitigation Area
Key Findings - Status

- Benthos reduced quality: Diptera-Chironomid (flies and midges) based benthic assemblage in entire Busseron Creek - more prevalent in mitigation area. MIBI values indicate multi-habitat (vegetation) important in Busseron Creek.
- Freshwater mussels: observation of relic and new individuals, sensitive to water quality conditions, imply a stable fish assemblage necessary for reproduction.

Busseron Creek Mitigation Area
Key Findings - Status

- Bioassessment scores of 2003 and 2010 indicate no change in fish assemblage quality.
- Indications of enhanced fishery:
  - Minnow-based to centrarchid/minnow assemblage
  - Increased diversity of sunfish species, age structure
  - Higher biomass, range in age structure of all fish
  - Expanded trophic level, age structure of bass

Busseron Creek Mitigation Area

Key Mitigation Factors

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Busseron Creek Mitigation Area
Key Mitigation Factors

Busseron Creek Mitigation Area Implications

- Demonstrates effectiveness of the stream design approach and program implemented by Peabody Midwest Mining (Peabody Energy)
- West Fork Busseron Creek Mitigation Area has attained pre-disturbance status and conditions.
- Some improvements in biological structure have water quality and functional implications (mussels, diversity, age structure of fish)
- Mitigation within 5 years with expectations of additional improvements through maturity/stability.

Busseron Creek Mitigation Area
Acknowledgements

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Busseron Creek Mitigation Area

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