

*Impact of Dam Removal on Fish and  
Macroinvertebrate Populations:  
Pennsylvania's Observations*



R. Scott Carney, Chief  
Division of Habitat Management

# *Dams in Pennsylvania*



- Approximately 3,000 regulated dams in PA
- Only 1% provide hydropower
- Only 5% provide flood control
- **Over 75% are small, less than 25 feet high with short hydraulic residence time**
- 74% are privately owned
- 24% are publicly owned
- 2% are orphaned
- Hundreds are 75 + years old, many are 100 to 150 years old
- An estimated 4,000 unregulated dams exist

# *PFBC Consultation and Grant Program for Fish Passage and Habitat Restoration*

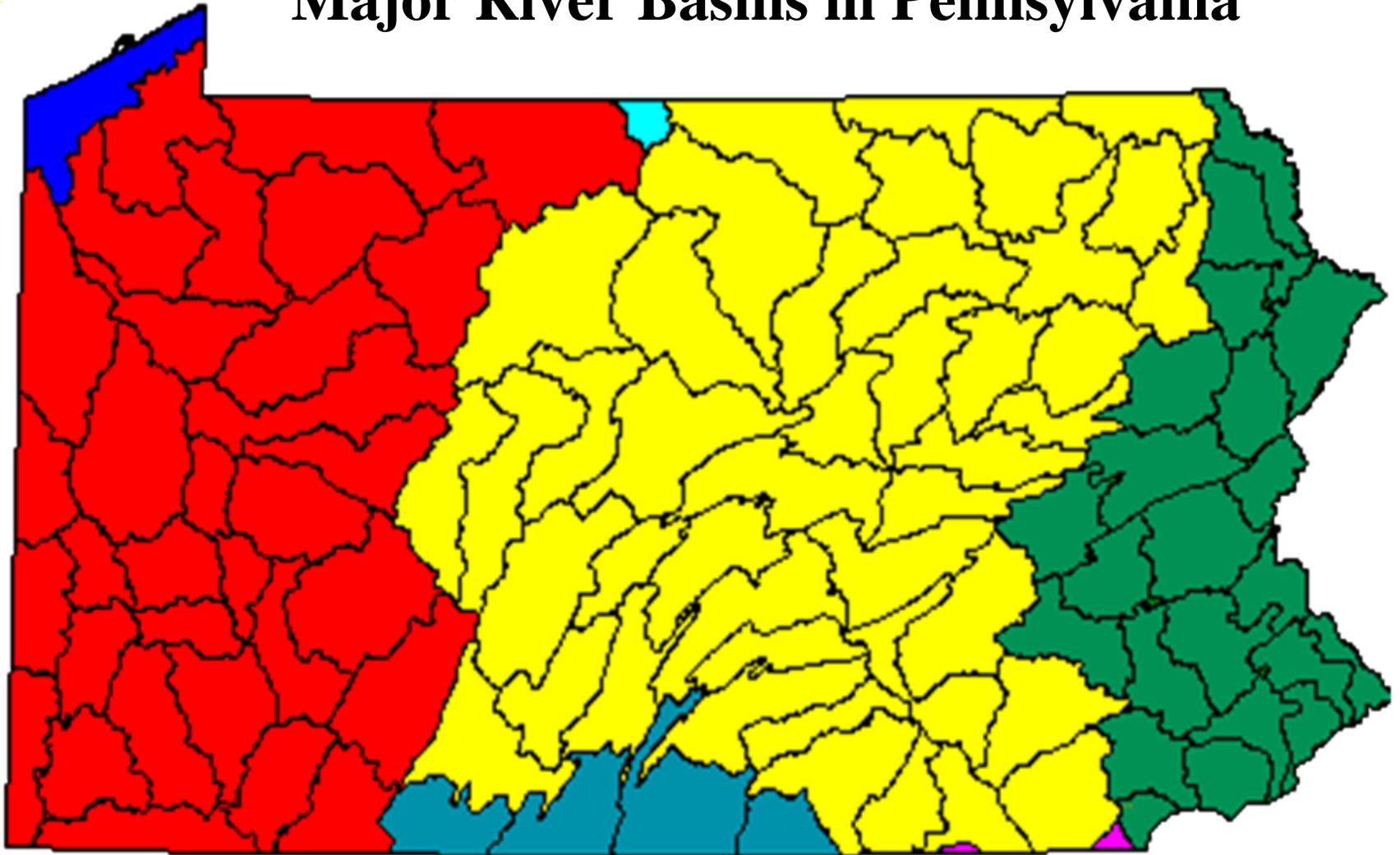


Supports dam removal by.....

- Providing engineering and technical assistance
- Providing financial support and consultation
- Providing education and outreach services
- Advocating and soliciting projects throughout PA



# Major River Basins in Pennsylvania



- |  |   |
|--|---|
|  Lake Erie                    |  Susquehanna River Basin           |
|  Ohio River Basin             |  Elk & Northeast /Gunpowder Rivers |
|  Genesee River (Lake Ontario) |  Delaware River Basin              |
|  Potomac River Basin          |   |

# *PFBC's Dam Removal Projects*

<i>Completed</i>	
<b>Basin</b>	<b>Number</b>
<b>Susquehanna</b>	<b>67</b>
<b>Delaware</b>	<b>13</b>
<b>Ohio</b>	<b>8</b>
<b>Potomac</b>	<b>3</b>
<b>Erie</b>	<b>0</b>
<b>Total</b>	<b>91</b>

<i>Ongoing</i>	
<b>Basin</b>	<b>Number</b>
<b>Susquehanna</b>	<b>41</b>
<b>Delaware</b>	<b>41</b>
<b>Ohio</b>	<b>20</b>
<b>Potomac</b>	<b>0</b>
<b>Erie</b>	<b>2</b>
<b>Total</b>	<b>106</b>

Over 120 dams removed statewide

# *Impacts of Impounding Rivers*

- Alter flow regimes and hydrologic processes

Habitat Modifications  Changes in the Structure and Function of Biotic Communities

- Fragment the continuity of rivers and the connectivity between aquatic and terrestrial habitats

# *Factor's Influencing the Rate, Magnitude, Duration, and Spatial Extent of Changes to Aquatic Communities Following Dam Removal*

- Height and length of dam

## Impacts to, and Recovery of, Fish and Macroinvertebrate Populations and Aquatic Ecosystems Functions are Highly Variable

- Presence of additional dams and other characteristics of the watershed
- Volume and physical characteristics of deposited sediment
- Removal approach and mitigation actions

# *Pennsylvania Dam Removal Studies*

- Pennsylvania Fish and Boat Commission
- Pennsylvania Department of Environmental Protection
- The Pennsylvania State University
- The Academy of Natural Sciences, Patrick Center for Environmental Research
- U.S.G.S.
- Normandeau and Associates, Inc.
- Western Pennsylvania Conservancy
- Beran Environmental
- Mifflin County Conservation District
- Worked with non-profit partners to establish a citizen monitoring program to evaluate pre- and post-dam removal impacts

# *Dam Removal Monitoring Activities*

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Parameters Monitored	Projects Monitored
Sediment Characterization	40
Fish	15
Sediment Contaminants	12
Macroinvertebrates (excluding mussels)	11
Water Quality	8
Sediment Transport	4
Mussels	3
Ground Water	2
Algae	1
Vegetative Succession	Multiple

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*Rock Hill Dam,  
Lancaster Co., PA*

Removed 1996



# *Rock Hill Dam*

One year following removal



# *Rock Hill Dam, Lancaster Co., PA*



**Before Removal**

Removed 1996



**After Removal**

**American shad return  
to the Conestoga River  
after 100 year absence.**



# *Lititz Run Watershed Restoration Project*

- EPA Chesapeake Bay Program
- LandStudies, Inc.
- Donegal Chapter T.U.
- Lititz Run Watershed Assn.
- PA DEP
- PA F&BC
- Center for Chesapeake Communities
- Lancaster County
- Lancaster County Conservation District
- Millport Conservancy
- Octoraro Native Plant Nursery



*Millport Roller Mills Dam,  
Lititz Run, Lancaster Co.*



**Impoundment  
prior to dam  
removal**

# *Millport Roller Mills Dam*

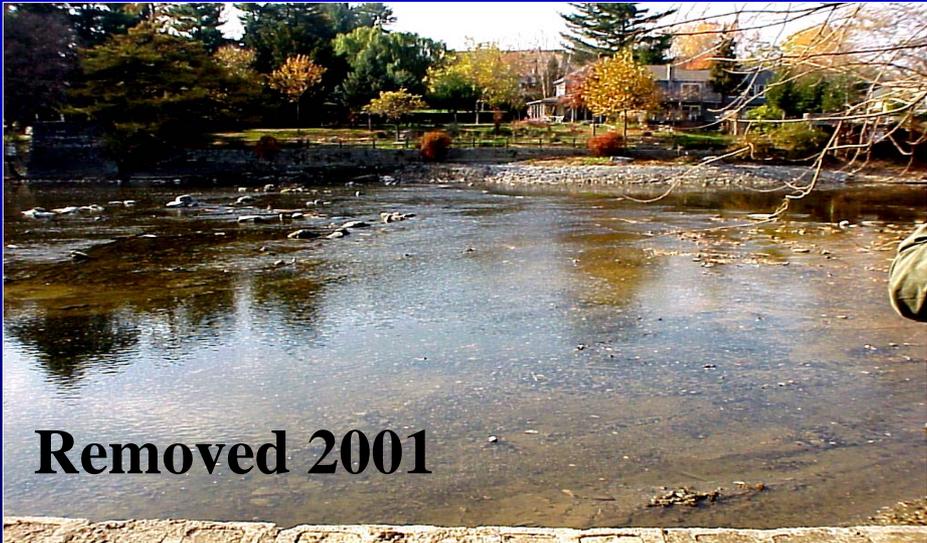
Removed 1999



### Summary

- Downstream water temperature decreased 12°F following removal of the dam
- Increased turbidity and mobilization of sediment occurred as a result of dam removal
- Macroinvertebrates located downstream were negatively impacted by mobilized sediment after removal, but increased in diversity and abundance in the long-term
- Habitat has improved, and Lititz Run currently supports a sustainable put-and-grow, stocked trout fishery

# *Good Hope Dam, Conodoguinet Creek, Cumberland Co.*



**Removed 2001**

### Summary

- Good Hope Dam was not an effective barrier to sediment transport
- Removal of the dam had no impact on water-quality characteristics
- Downstream macroinvertebrate communities were not impacted by the removal of the dam
- EPT taxa increased in diversity and abundance in former impoundment
- No changes in fish communities were observed
- Removal of the dam reopened 12 miles of historic habitat for migratory Alosines

# *Pennsylvania's Trout Water Classification System*

Class	Subprogram	Criteria
A	Wild Trout	(See Wild Trout Subprogram)
B	Hatchery Trout- Wild Trout	a. Total brook trout biomass of at least 20 kg/ha (17.8 lbs/acre) and less than 30 kg/ha (26.7 lbs/ acre). b. Total brown trout or brown and brook trout combined biomass of at least 20 kg/ha (17.8 lbs/ acre) and less than 40 kg/ha (35.6 lbs/acre).
C	Hatchery Trout	Total Trout biomass of at least 10 kg/ha (8.9 lbs/ acre) and less than 20 kg/ha (17.8 lbs/acre).
D	Hatchery Trout	Total trout biomass less than 10 kg/ha (8.9 lbs/ acre).

Sub-subprogram	Criteria
1. Wild brook trout fisheries	a. Total brook trout biomass of at least 30 kg/ha (26.7 lbs/acre)
	b. Total biomass of brook trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
	c. Brook trout biomass must comprise at least 75% of total trout biomass
2. Wild brown trout fisheries	a. Total brown trout biomass of at least 40 kg/ha (35.6 lbs/acre)
	b. Total biomass of brown trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
	c. Total brown trout biomass must comprise at least 75% of total trout biomass
3. Mixed wild brook/brown fisheries	a. Combined brook and brown fisheries trout biomass of at least 40 kg/ha (35.6 lbs/acre)
	b. Brook trout biomass must comprise less than 75% of total trout biomass
	c. Brown trout biomass must comprise less than 75% of total trout biomass
	d. Total biomass of brook trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
	e. Total biomass of brown trout less than 15 cm (5.9 in.) total length of at least 0.1 kg/ha
4. Wild rainbow trout	a. Total biomass of rainbow trout less than 15 cm (5.9 in.) total length of at least 2.0 kg/ha

# *Reedsville Mill Dam, Tea Creek, Mifflin Co.*



**Removed Fall 2004**  
**Total Cost: \$75,000**



# *Reedsville Mill Dam*



# *Reedsville Mill Dam*



# *Brown Trout Colonization in the Newly Established Channel Upstream of the Former Reedsville Mill Pond*

## Summary

- Trout biomass in the former impoundment area was significantly higher post removal
- Abundance of trout larger than the fingerlings (young-of-year) was limited by the present lack of adult fish habitat in former impoundment
- Overall, outstanding wild brown trout population by statewide standards especially when considering the level of disturbance associated with removal of the dams
- Fish habitat enhancement structures were installed in 2005 and riparian plantings completed in 2006
  - A modified Petersen population estimate of 1407 wild brown trout/km with a biomass of 1000 kg/km and 250 02 eggs/m<sup>2</sup> in the control reach of the channel
- Additional fish sampling planned, macroinvertebrate sampling ongoing but results not reportable  
Sampling conducted prior to installation of fish habitat enhancement structures

*Mirror Lakes, Reading  
Public Museum, Wyomissing  
Creek, Berks County,*

*Removed Summer 2004*



# *Sediment Management and Stream Diversion at Reading Museum, Wyomissing Creek*



# *Channel Grading at Reading Museum*



# *Channel Grading at Reading Museum*



# *Final Channel and Floodplain Grading at Reading Museum*



# *Streambank Stabilization and Seeding*



# *Reading Public Museum*

Removed 2004



# *Reading Public Museum – Before & After*



September 2002



October 2004

# Brown Trout Population Assessment, Wyomissing Creek, Berks Co, PA – Control and Former Impoundment Sites

Table 1. Estimated Abundance and Biomass of brown trout from WYOMISSING CK using a Petersen estimator. Site located at river mile 0.96, survey date: 07/25/05.

Size Group	Population Estimate	Low 95% CI	High 5% CI	Estimated Number/Ha	Estimated Kg/Ha	Estimated Number/Km
50	14			95	0.28	82
75	166	103	282	1122	8.98	976
100	19			128	1.67	112
150	43	25	84	291	14.83	253
175	62	37	110	419	28.51	365
200	8	4	18	54	5.25	47
225	18	11	33	122	16.8	106
250	10	4	24	68	10.89	59
275	4			27	5.38	24
300	2			14	3.72	12
325	1			7	2.62	6
450	1			7	7.45	6
Totals:	348			2354	106.38	2048

Table 2. Estimated abundance and biomass of brown trout from WYOMISSING CK using a Petersen estimator. Site located at river mile 0.75, survey date: 07/22/05.

Size Group	Population Estimate	Low 95% CI	High 95% CI	Estimated Number/Ha	Estimated Kg/Ha	Estimated Number/Km
50	1			8	0.02	6
75	110	76	167	901	7.21	621
100	38	25	61	311	4.05	215
150	9	4	23	74	3.76	51
175	13	7	27	106	7.24	73
200	11	6	23	90	8.74	62
225	2			16	2.26	11
250	2			16	2.64	11
275	4	2	10	33	6.52	23
Totals:	190			1555	42.44	1073

- A modified Petersen population estimate of 2048 wild brown trout/km and a biomass estimate of 106.4 kg/ha (Class A – 90<sup>th</sup> percentile) was observed at the control site
- A modified Petersen population estimate of 1073 wild brown trout/km with a biomass of 42.4 kg/ha (Class A) was observed in former impoundment.

# *Brown Trout Population Assessment Wyomissing Creek, Berks Co, PA – Downstream of Dam*

## Summary

- Trout biomass in the former impoundment area was significantly higher post dam removal
- Abundance of trout larger than the fingerlings (young-of-year) was limited by the present lack of adult fish habitat in former impoundment
- Overall, outstanding wild brown trout population by statewide standards especially when considering the level of disturbance associated with removal of the dams
- Continued habitat improvement in the former impoundment would likely create a wild brown trout population density and biomass worthy of aspiration  
A modified Peterson population estimate of 14.35 wild brown trout/km and a biomass estimate of 26.5 kg/ha was observed in the downstream site (high Class C) post dam.
- Impact of dam removal to downstream reaches unclear; stormwater runoff erosion and channel scouring effects from a storm sewer that serves a large geographical area may be contributing to reduced biomass.  
Trout densities were significantly higher at the downstream site in 2005 compared to 1996.

# *Hellburg Dam, Conestoga River, Lancaster Co.*

Removed Winter 1999



# *Hellberg Dam*

Immediately after removal



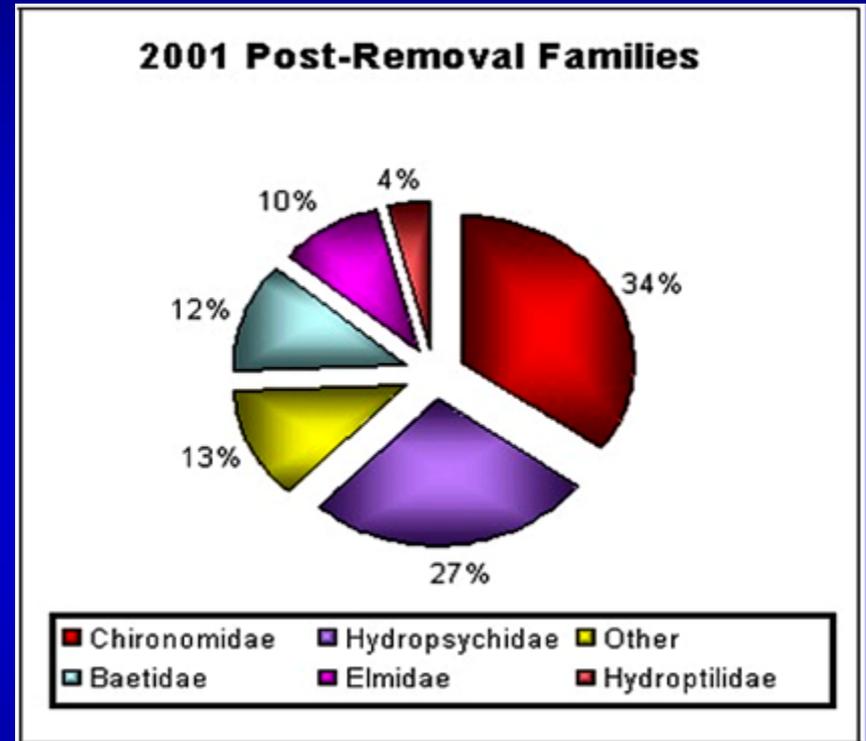
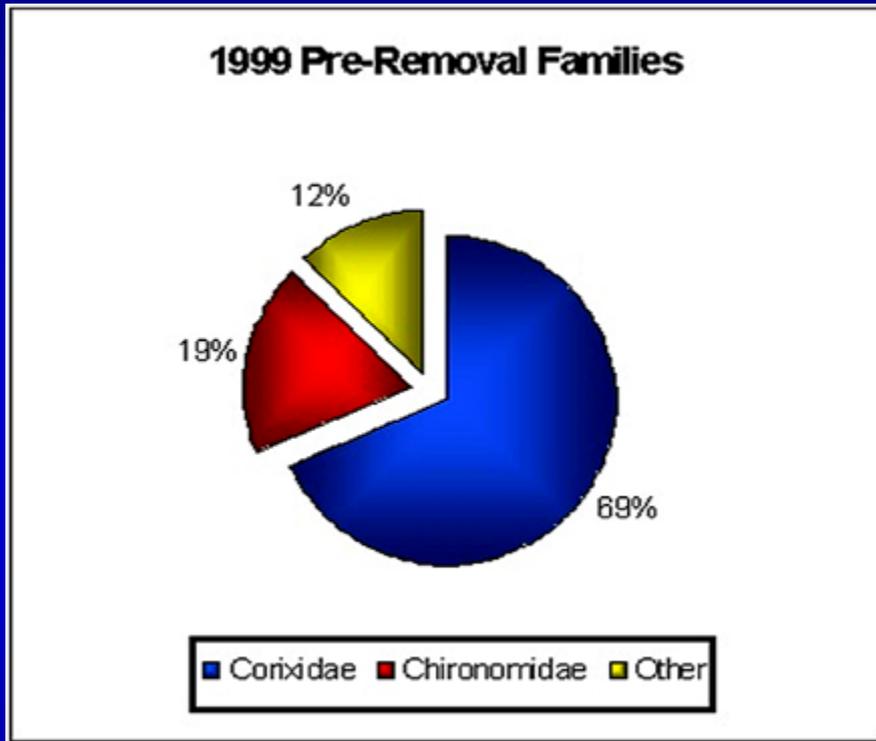
# *Hellburg Dam*

Two years after removal

**Just after removal**



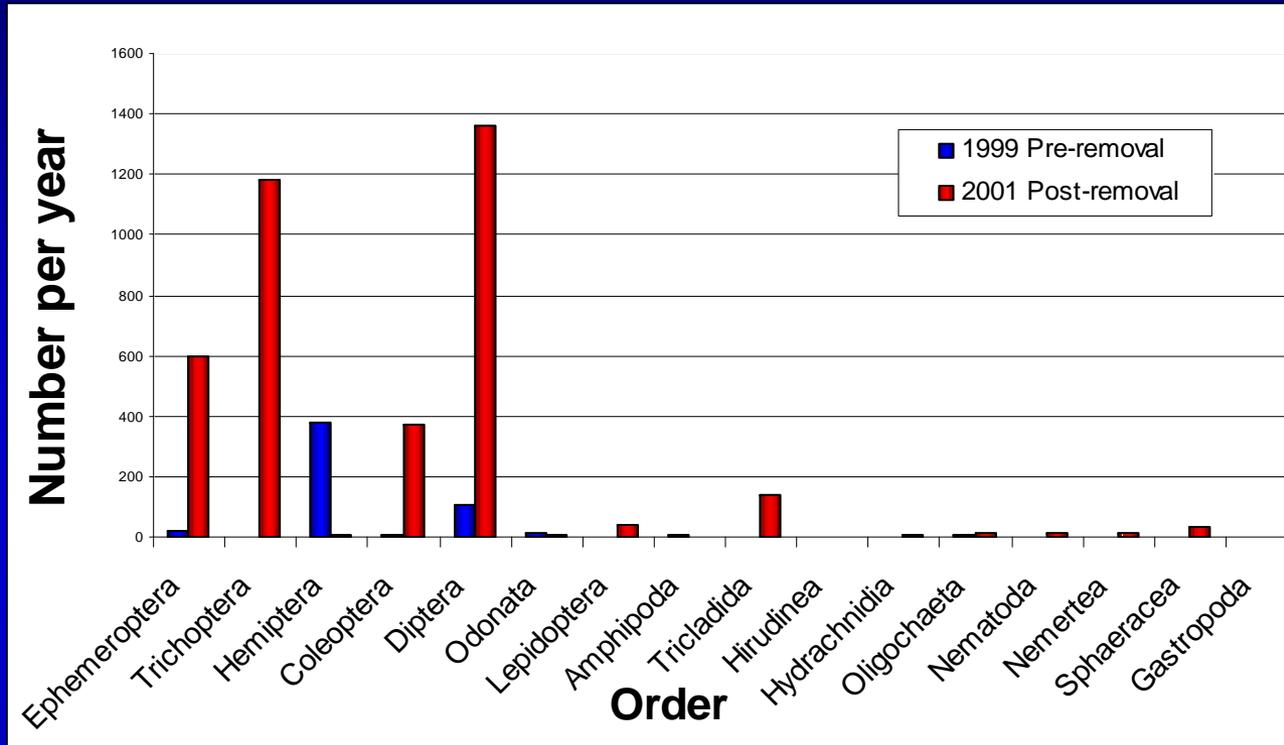
# *Macroinvertebrate Response to Dam Removal, Conestoga River, Lancaster County, PA*



- The 1999 pre-removal samples were dominated by two major families: Corixidae and Chironomidae.
- The 2001 post-removal samples were more evenly distributed among several families: Chironomidae, Hydropsychidae, Baetidae, Elmidae, and Hydroptilidae.

Provided by Pennsylvania State University

# Macroinvertebrate Response to Dam Removal



- ❖ In general, the 2001 post-dam removal samples had more taxa (30 families from 18 orders) represented than pre-removal samples (16 families from 10 orders). The 2001 samples had a combined 3,783 total macroinvertebrates present in 10 kick samples, while the 1999 samples only had 554 macroinvertebrates in 10 kick samples.
- ❖ Overall, the 2001 post-dam removal samples had higher numbers of individuals per taxon compared to the 1999 pre-removal samples, with the only exception being the dominance of Hemiptera in the 1999 pre-removal samples

*Franklin Mill Dam,  
Middle Creek,  
Snyder Co., PA*

Removed 1999



# *Fish Response to Dam Removal, Middle Creek, Snyder Co., PA*

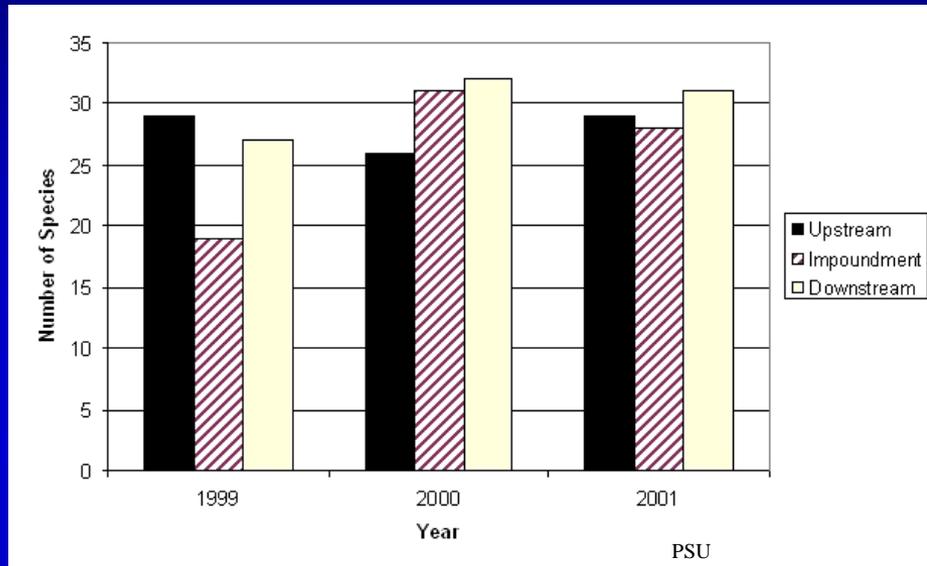


Figure 1. Total number of fish species collected in the upstream, impoundment, and downstream study sections of Middle Creek, Middleburg, PA.

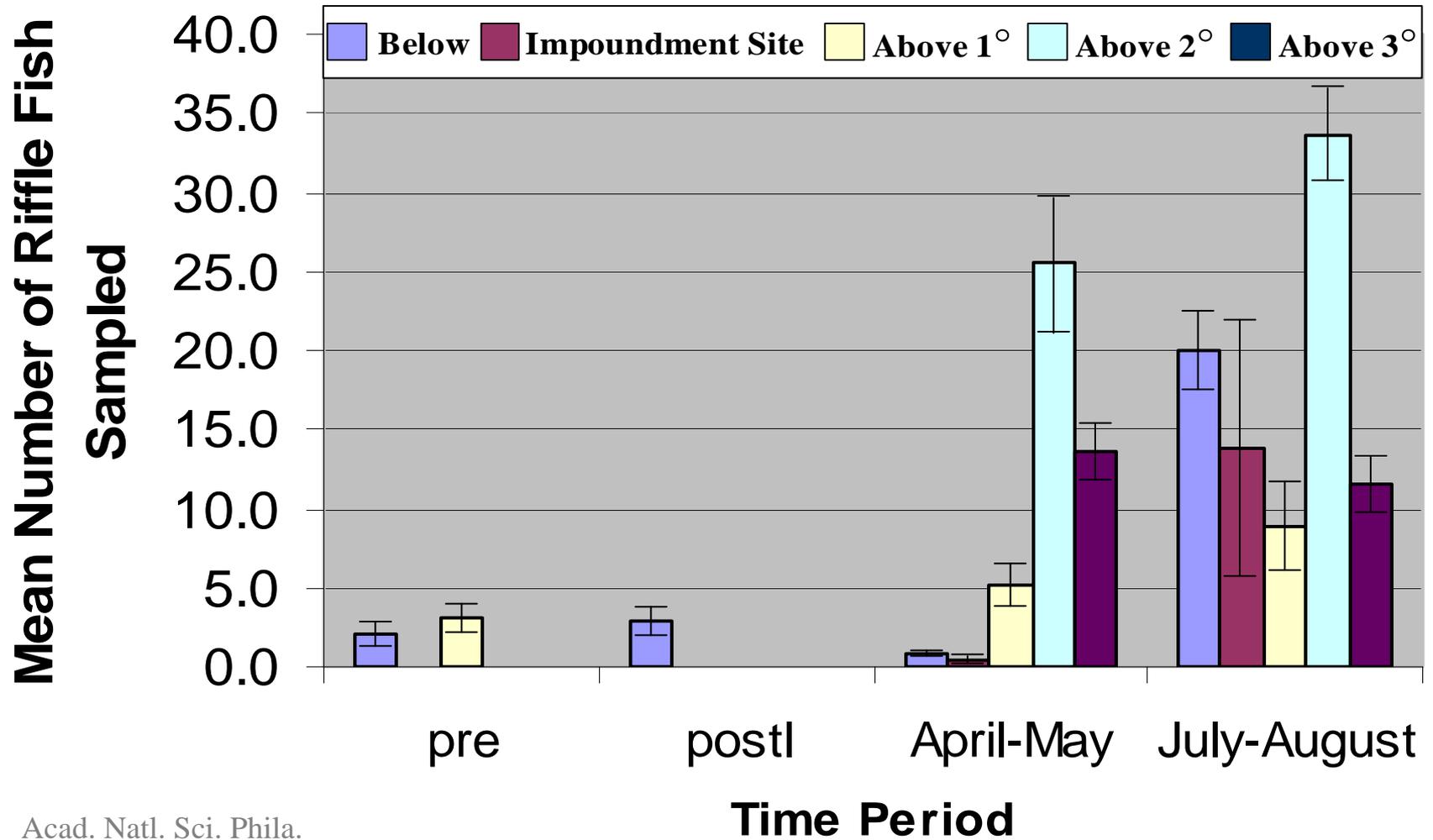
Attribute	Middle Creek		
	1999	2000	2001
Number of species	19	31	28
Number of individuals	247	1935	2349
Number of benthic species	3	11	10

Table 1. Total number of fish species, total number of individuals, and total number of benthic species sampled in the impoundment before (1999) and in the previously impounded area after (2000 and 2001) dam removal in Middle Creek, Middleburg, PA.

- ❖ Prior to dam removal (1999), 247 individuals distributed among 19 species were collected in the impoundment region. After the dam was removed (in 2000 and 2001), both the total number of species and the number of individuals sampled increased dramatically in the area that was previously impounded; 1,935 individuals distributed among 31 species, and 2,349 individuals representing 28 species in 2000 and 2001, respectively, were collected.

# *Fish Response to Dam Removal, Manatawny Creek, Montgomery Co., PA (25 m<sup>2</sup> Riffle Samples: Riffle Species)*

*(Etheostoma olmstedii, Hypentelium nigricans, Noturus insignis,  
Percina peltata, and Rhinichthys cataractae)*



# *Carter's Dam Mussel Survey, Conewango Creek, Warren County, PA*

Report on the Freshwater Mussels in the Immediate Vicinity of Carter's Dam,

Conewango Creek, River Miles 0.3 and 0.4

Warren County, Pennsylvania



A report to the Pennsylvania Fish and Boat Commission and American Rivers



Pennsylvania Natural Heritage Program

Ryan Evans and Tamara Smith

Pennsylvania Natural Heritage Program – Pittsburgh office

The Pennsylvania Natural Heritage Program is a partnership between The Western Pennsylvania Conservancy (Pittsburgh office), The Nature Conservancy Pennsylvania science office (Middletown office), and The Pennsylvania Department of Conservation and Natural Resources (Harrisburg office).

- Carter's Dam is 5 feet high and 400 feet long, orphaned and in advance disrepair
- **Dam removal is being advanced to mitigate impact for a nearby bridge replacement**
- Mussel survey was conducted due to suspected presence of state and federally listed species
- **Survey inventoried mussel population, marked and relocated selected species, and provided recommendations to minimize project impacts**

# *Carter's Dam Mussel Survey*

## Summary

- Inundation of mussel beds unlikely due to lack of fine sediment above the dam
- Dam to be removed incrementally to minimize scouring by anticipated increases water velocities and to afford opportunity to relocate individuals stranded by dewatering of impoundment
- Removal should be conducted (if possible) during periods of mussel dormancy and sparse aquatic vegetation in the impoundment (BOD concerns)
- Heavy equipment to utilize dam surface as causeway to minimize working on the stream bottom while dismantling the dam
- Net benefits (enhanced riverine habitat and passage for host fish species) thought to mitigate short-term negative impacts of dam removal

Source: PA Natural Heritage Program, PFBC, PA DEP

***Impacts of Small Dam Removal on Fish and Macroinvertebrate Communities -A Summary of Observations from Pennsylvania***

Location	Action	Short-Term Impacts	Long -Term Impacts
Upstream	Removal of migratory barrier	Reestablishment of connectivity among habitats and biota	Recolonization of native species  Introduction of invasive and/or nonnative species?
Impoundment	Dewatering of impoundment  Restoration of natural flow regime and channel form  Enhanced sediment and nutrient transport	Mortality associated with habitat desiccation and stranding of biota  Displacement of lentic species	Change in species diversity and abundance  Shift from lentic to lotic assemblages in response to changes in physical habitat, water temperature, dissolved oxygen?
Downstream	Restoration of natural flow regime and channel form  Enhanced sediment and nutrient transport	Increased stress, mortality, or displacement resulting from high turbidity, habitat inundation from mobilized sediment, abrupt changes in water temperature, dissolved oxygen?	Change in species diversity and abundance (decrease then gradual to rapid recovery)  Potential shift in biotic communities in response to changes in water temperature, dissolved oxygen?

# *Additional Observations and Trends*

- Change in flow regime and mobilization of sediment are the primary causative factors impacting stream biota
- **Short-term impacts to fish and macroinvertebrates are unavoidable, but gradual to rapid recovery observed depending on character and volume of sediment, and periodicity of flooding/flushing events**
- Recovery of fish and macroinvertebrate populations are highly variable among individual dam removal projects (months to decades)
- **Impacts to biotic communities comparable to natural high flow events**
- Small dams and dam removal has little impact on water quality with the exception of water temperature which could be dramatic
- **Benefits of dam removal may be masked by other anthropogenic stressors**
- River systems tend to be highly resilient and have great ability to recover in due time
- **More long-term monitoring needed**

# *Spring Creek, Centre Co., PA*



Courtesy of Todd Giddings

# *Cabin Hill Dam, Centre Co., PA*

Removed Summer 1997



# *Cabin Hill Dam*

One year after removal



# *Brown Trout Abundance and Biomass Post-Dam Removal, Spring Creek, Centre Co., PA*

Table 1. Time series abundance data from SPRING CK at site rivermile 0.37. Species selected: brown trout

SizeGroup	NumHa 7/5/2000	KgHa 7/5/2000	NumKm 7/5/2000	NumHa 8/2/1988	KgHa 8/2/1988	NumKm 8/2/1988
50	38	0.09	86	11	0.05	23
75	68	0.54	151	495	3.47	1070
100	5	0.05	11	54	0.65	117
125	3	0.08	6			
150	11	0.56	26	11	0.5	23
175	80	7.96	180	77	5.63	167
200	226	24.16	506	145	14.51	313
225	360	51.44	806	86	11.93	187
250	472	87.78	1057	96	17.32	207
275	199	46.16	446	74	17.41	160
300	91	25.81	203	110	33.31	237
325	32	11.1	71	54	20.04	117
350	10	4.48	23	39	17.17	83
375	5	2.56	11	26	14.64	57
400	4	2.45	9	15	10.17	33
425	3	1.88	6	9	7.94	20
450	3	2.34	6			
500				2	1.85	3
<b>Totals:</b>	1610	269.44	3604	1304	176.59	2817

- Brown trout abundance and biomass increased post dam removal (3604 trout/ha, 269.4kg/ha from 2817 trout/ha, 176.59kg/ha)
- Not clear if dam removal impacted trout populations, changes observed may be associated with natural variability
- Dam removal did no long-term harm
- Density of common carp decreased dramatically

# *McCoy's Dam, Spring Creek, Centre County*



# ***Goldsboro Dam Removal, Fishing Creek, York Co.***



# Detter's Mill Dam Removal, W. Conewago Creek, York County

Removed 2004



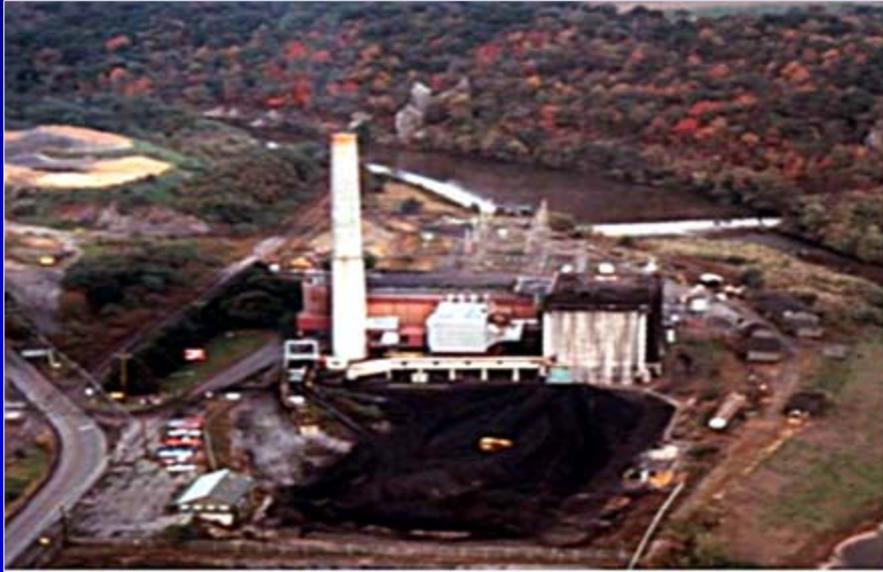
# Stream Clean-Up and Riparian Planting

Detter's Mill Dam, York County



# Williamsburg Station, Fr. Br. Juniata River, Huntingdon Co.

Removed 1996



# Williamsburg Station

Two years after removal



# *Irving Mill Dam, Ridley Creek, Montgomery Co.*



**Removed 2004**  
**Total Cost: \$95,000**



# *Irving Mill Dam*



# Irving Mill Dam



# *Black Dam, Conodoguinet Creek, York Co.*



**Removed 2003**  
**Total Cost: \$65,000**



# *Black Dam*



# *Black Dam*



# *Trindle Spring Run Dam Removal, Cumberland County*



# *Trindle Spring Run Dam Removal Temporary Diversion Channel*



# *Trindle Spring Run Dam Removal*



# *Trindle Spring Run Dam Removal Diversion Channel*



# *Trindle Spring Run Dam Removal Impacted Sediment Management*



# *Trindle Spring Run Dam Removal Sediment Disposal*



# *Spring Dam Removal Before & After, Pennypack Creek*



# *Sharpless Dam Removal Before & After, Ridley Creek*



# *Siloam Dam Before & After, Conococheague Creek*

