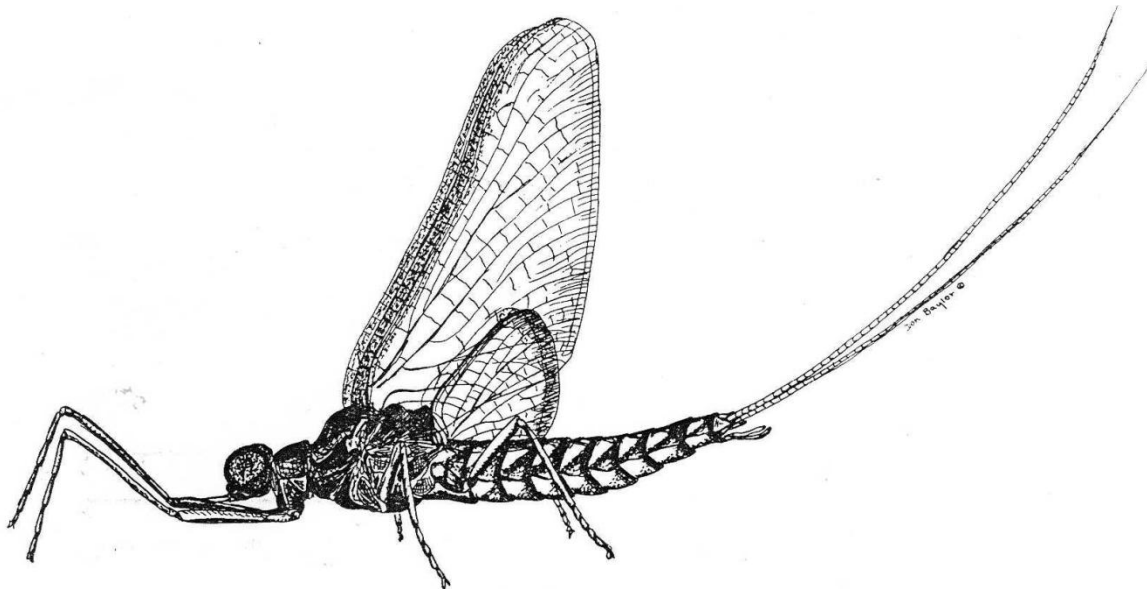


ENVIRONMENTAL QUALITY OF PIKE COUNTY STREAMS



DECEMBER 2015

ENVIRONMENTAL QUALITY OF
PIKE COUNTY STREAMS

Prepared For

Pike County Conservation District
Hawley, PA 18428

Prepared by

Kenneth Ersbak
Aquatic Biologist
Aquatic Resource Consulting

December 2015

TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	METHODS.....	2
III.	RESULTS AND DISCUSSION.....	9
IV.	RECOMMENDATIONS	23
IV.	REFERENCES.....	23

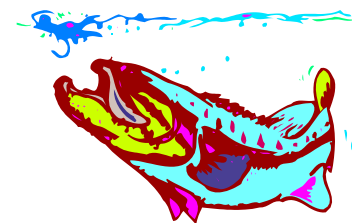
LIST OF TABLES AND APPENDICES

Table	Page
1. Evaluation of water quality using biotic index values (Hilsenhoff, 1987).....	3
2. Sample metric standardization and index of biotic integrity calculations for a benthic macroinvertebrate sample	4
3. Index of biotic integrity (IBI) metrics and the scoring criteria used for each to calculate the IBI scores for Pike County fish populations.....	6
4. Physical and chemical field data from twenty-five Pike County stream sites (April-May, 2015) – PA Dept. Environ. Protection, 2009)	10
5. Habitat assessment of 25 sampling stations on Pike County Streams (April-May, 2015) – PA Dept. Environ. Protection, 2009)	12
6. Metric scores for 25 benthic macroinvertebrate samples from Pike County stream sites (April-May, 2015).....	17
7. Metric scores for 1 benthic macroinvertebrate sample from Pike County stream sites (November, 2015).....	19
8. Stream fish communities sampled for width category, impoundments in watershed and game fish present in Pike County, PA (August-October, 2015).....	19
9. Fish species collected from five stream sites in Pike County, PA (August, and October, 2015).....	21

10.	Index of biotic integrity (IBI) test scores at 5 stream sites in Pike County, Pennsylvania (August and October, 2015).....	22
-----	--	----

Appendix		Page
A.	Taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from the 25 stream sites in Pike County for 2015.....	25
B.	Taxa, numbers, and site description for the 5 electrofishing stream sites in Pike County for 2015.....	32

AQUATIC RESOURCE CONSULTING



Route 715 - Saylorsburg, PA 18353 – (570) 992-6443; 992-3558; 685-7171

INTRODUCTION

Biological monitoring of surface waters serves several purposes. It provides an early warning of hazardous changes in water quality, detects episodic events such as pollution spills, evaluates recovery from disturbed conditions, and reveals environmental trends and cycles.

Aquatic macroinvertebrates (primarily insects) and fish are important biological components of freshwater systems. They are the fundamental sensors of any stress that occurs within a stream ecosystem. This stress, which manifests itself in the health of aquatic organisms, can cause subtle or dramatic changes in overall community structure.

Work in bio-monitoring of stream communities has emphasized cost-effective “protocols” that attempt to extract maximum information with the least possible expenditure of time and money. Some of these methods have become standards in the field of bio-monitoring.

The United States Environmental Protection Agency (USEPA) provides several rapid bioassessment procedures for macroinvertebrate and fish populations (Plafkin et al, 1989). The Pennsylvania Department of Environmental Protection (PADEP) has developed its own assessment and listing methodology for integrated water quality monitoring (PADEP, 2007, 2009). Besides providing a means for monitoring temporal trends in aquatic life communities, it also provides a means for evaluating effects among stations.

Pike County has numerous freshwater streams ranging from small headwaters to large rivers. Nearly all of these waterways are classified by the PADEP as “High-Quality” or “Exceptional Value” (PADEP, 1996). The aquatic life communities in these riverine ecosystems have similar characteristics that allow for regional comparisons. However, subtle but recognizable differences do occur between streams of varying size and gradient, and between those waters located above and below impoundments. Consequently, these differences must be noted and considered in any stream comparison or evaluation using the PADEP “Assessment Methodology”.

METHODS

Pike County Conservation District (PCCD) personnel sampled fish and benthic macroinvertebrates at baseline and non-point stream sites in Pike County with the assistance of Aquatic Resource Consulting biologists. These sites were established in 1995 as part of the Pike County Water Quality Program network (PCCD, 1995). Additional sites have subsequently been added. In 2012 and 2013 eleven special study sites were surveyed to obtain baseline information. The study was to monitor water quality and determine how sites compared to designated use criteria established for Pennsylvania streams by the Pennsylvania Department of Environmental Protection (PA DEP, 2007, 2009).

Stream Habitat and Water Quality

The Pennsylvania Department of Environmental Protection (PADEP) Flowing Waterbody Field Data and Water Quality Habitat Assessment Forms were filled out for each station (Appendix B). Field measurements included stream temperature, dissolved oxygen, pH, alkalinity and conductivity. Land use and canopy cover at each site were also assessed. Habitat was evaluated at each station using PADEP's Water Quality Network Habitat Assessment forms for streams with a riffle/run prevalence. Twelve habitat parameters were ranked on a scale of 1-20 and combined for a total habitat score. Scores put habitat into categories of "optimal", "sub-optimal", "marginal", and "poor". According to protocols, scores that fall between these category ranges are left to the decision of the investigator for classification.

Macroinvertebrate Communities

Macroinvertebrate sampling methods followed those recommended by the US Environmental Protection Agency Protocol III (Plafkin, et al., 1989) with the latest modifications adopted by the PA Department of Environmental Protection (PADEP, 2009). At each station, six samples were taken from a riffle/run area with a dip net of 500µm nitex. Samples were taken by placing the net against the substrate and disturbing approximately one square meter above the net by foot. Organisms and debris were composited for each station in a plastic container and preserved in alcohol for transport to the laboratory. In the laboratory, organisms were removed from the debris and placed in a white pan marked with a grid to delineate 21 squares measuring two inches on a side. Organisms were then picked from randomly selected grids until 200 (± 40) organisms were obtained. Organisms were identified to genera or the lowest taxonomic level practicable, enumerated, and assigned a pollution tolerance value (PADEP, 2007) – Appendix A. Metrics for riffle/run freestone streams were calculated for each sub-sample, including Modified Beck's Index (MBI), Ephemeroptera + Plecoptera + Trichoptera taxa richness (EPT), total taxa richness, Shannon diversity index (DI), Hilsenhoff biotic index (BI), percent dominant taxon, and percent intolerant individuals. A description and brief rationale for each of the metrics follow:

1. **Modified Beck's Index** is a weighted count of taxa with pollution tolerance values of 0, 1, or 2. This metric is expected to decrease in value with increasing anthropogenic

stress to a stream ecosystem, reflecting the loss of pollution sensitive taxa. It is calculated by multiplying by 3 the number of taxa with a pollution tolerance value of 0, multiplying by 2 the number of taxa with a pollution tolerance value of 1, and multiplying by 1 the number of taxa with a pollution tolerance value of 2. The three values are added to yield the Modified Beck's Index score.

2. **Ephemeroptera, Plecoptera, and Trichoptera** (mayflies, stoneflies, and caddisflies), collectively referred to as EPT, are generally considered pollution sensitive (Plafkin et al. 1989). Thus, the total number of taxa within the EPT insect groups is used to evaluate community balance. Healthy biotic conditions are reflected when these taxa are well represented in the benthic community.

3. **Total Taxa Richness** – is an index of diversity. The number of taxa (kinds) of invertebrates indicates the health of the benthic community through measurement of the variety of species present. Generally, number of species increases with increased water quality. However, variability in natural habitat (stream order and size, substrate composition, current velocity) also affects this number.

4. **Shannon Diversity Index** measures taxonomic richness and evenness of numbers of individuals across the taxa of a subsample. This metric is expected to decrease in value with increased anthropogenic stress to a stream ecosystem, reflecting loss of pollution-sensitive taxa and predominance of a few pollution-tolerant taxa.

5. **Hilsenhoff Biotic Index** – is a direct measure of organic pollution in streams. The biotic index value is the mean tolerance value of all organisms in a sample (Table 1). Tolerance values range from 0.00 to 10.00; the higher the value, the greater the level of pollution indicated.

Table 1. Evaluation of water quality using biotic index values (Hilsenhoff, 1987)

BIOTIC INDEX	WATER QUALITY	DEGREE OF ORGANIC POLLUTION
0.00-3.50	Excellent	None Apparent
3.51-4.50	Very Good	Possible Slight
4.51-5.50	Good	Some
5.51-6.50	Fair	Fairly Significant
6.51-7.50	Fairly Poor	Significant
7.51-8.50	Poor	Very Significant
8.51-10.00	Very Poor	Severe

6. **Percent Intolerant Individuals** is the percentage of individuals in the subsample with pollution tolerance values of five or less. It is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

Index of Biotic Integrity Calculation

An overall index is used to integrate information from these various metrics and standardize them into one score for a subsample. The values for any standardized core metric are set to a maximum value of 1.00, with values closer to zero corresponding to increasing deviation from the expected reference condition and progressively higher values corresponding more closely to the biological reference condition. The adjusted standardized metric values for the six core metrics are averaged and multiplied by 100 to produce an index score ranging from 0-100. This number represents the index of biotic integrity (IBI) score for a sample. Table 2 shows a sample of metric standardization equations and index calculations for a freestone stream site:

Table 2. Sample metric standardization and index of biotic integrity calculations for a benthic macroinvertebrate sample				
Metric	Standardization Equation	Observed Metric Value	Standardized Metric Score	Adjusted Standardized Metric Score Maximum =100
Modified Beck's Index	Observed value/39	34	0.87	0.87
EPT Taxa Richness	Observed Value/23	21	0.91	0.91
Total Taxa Richness	Observed value/35	32	0.91	0.91
Shannon Diversity Index	Observed Value/2.90	2.76	0.95	0.95
Hilsenhoff Biotic Index	10-observed value/ (10-1.78)	3.65	0.77	0.77
Percent Intolerant Individuals	Observed value/92.5	51.9	0.56	0.56
Average of adjusted standardized core metric scores x 100 = IBI score				83.1

Pennsylvania DEP Index of Biotic Integrity scoring benchmarks require a score of 80.0 or better to qualify for High Quality (HQ) and Exceptional Value (EV) waters. Scores greater than 62 qualify for Cold Water Fishery (CWF), Trout Stocked Fishery (TSF), and Warm Water Fishery (WWF) use.

Fish Communities

Fish communities were sampled in August and October, 2015 at five baseline sites identified by the Pike County Conservation District and Aquatic Resource Consulting (ARC) – Appendix B. Each stream site was sampled with a battery-powered, variable voltage, Smith-Root backpack electrofisher with 6-foot anode probe. Direct-pulsed current at 45 Hz was used to cause electronarcosis in the fish being collected.

Sampling effort was standardized at each site by sampling for a period of 20 minutes or until 300 linear feet of stream had been traversed. As recommended by the PADEP 2007 protocols for sampling fish, the sample reach was at least 10 times the mean width, or a minimum of 300 feet. All fish were collected on the first pass through the sampling area and stored in a 50 gallon live well.

All fish were identified to species and enumerated. Species that could not be identified in the field were preserved in 10% formalin and returned to the laboratory for positive identification. Fish were checked for anomalies, such as discoloration, deformities, eroded fins, excessive mucous, fungus, parasites, poor condition, reddening, tumors and/or ulcers. Exotic or introduced species were noted. Following collection of data, fish were returned to the stream unharmed.

Fish habitat was assessed at each station by measuring stream widths (wetted perimeter) at 50-foot intervals and estimating mean width (Appendix B). Each station was then placed in a standard stream width category for future comparison to other streams in the Pocono region. The categories were as follows: <10 ft. = 1, 10-20 ft. = 2, 21-40 ft. = 3, 41-60 ft. = 4, and >60 ft. = 5.

For this study, 10 biological characteristics (metrics) were used to assess the fish communities (Lyons et al., 1996 and Karr et al., 1986). They were based on the fish community's taxonomic and trophic (food guild) composition, and the abundance and thermal tolerance of fish (Table 3). These metrics attempt to quantify the quality of the fish community. Comparing values with those expected for the region scores each of these evaluations. Scoring criteria were based on historical data collected from numerous stream sites in Pike County between 1995 and 2015 by Aquatic Resource Consulting. Metric values approximating, deviating slightly from, or deviating greatly from values expected in high quality streams are scored as 5, 3, or 1, respectively. The scores for each metric are tabulated to give a sum ranging from 50 (excellent) to 10 (very poor). This score is known as the index of biotic integrity (IBI).

The IBI serves as an integrated analysis because individual components may differ in their relative sensitivity to various levels of biological condition. A description and brief rationale for each of the 10 IBI metrics used for this study is outlined below.

TABLE 3. Index of biotic integrity (IBI) metrics and the scoring criteria used for each to calculate the IBI scores for Pike County fish populations.

<u>IBI Metrics</u>	<u>Scoring Criteria</u>		
	<u>5</u>	<u>3</u>	<u>1</u>
1. Number of Intolerant Species	>2	1-2	0
2. Percent of Individuals that are Tolerant	<11%	11-35%	>35%
3. Percent of Individuals that are Top Carnivores	>19%	8-19%	<8%
4. Percent of Individuals that are Coolwater or Coldwater	>83%	43-83%	<43%
5. Percent of Salmonid Individuals that are Brook Trout	>2%	1-2%	<1%
6. Percent of Individuals that are Insectivores	>56%	44-56%	<44%
7. Percent of Individuals that are Pioneering Species	<21%	21-56%	>56%
8. Catch per 20 Minute Effort	>142	96-142	<96
9. Percent of Individuals that are Lithophilic Spawners	>89%	72-89%	<72%
10. Number of YOY Trout Caught Per 20 Minute Effort	>11	1-11	<1

1. Number intolerant species - recognizes those fish that are sensitive to degradation resulting from siltation and oxygen depletion because they feed and reproduce in benthic (stream bottom) habitats.

2. Percent of individuals that are tolerant species - measures those fish species present that are tolerant to a variety of chemical and physical pollutants, and which tend to dominate a fish community that is degraded.

3. Percent of individuals that are top carnivore species - measures that portion of the fish community that feed on other fish. The dominant carnivores in coldwater streams are pollution sensitive adult salmonids (trout).

4. Percent of individuals that are stenothermal coolwater and coldwater species - measures that portion of the fish community that is intolerant to warm water conditions. Stenothermal fish species are often associated with high water quality.

5. Percent of salmonid individuals that are brook trout - Brook trout are often associated with high-quality, cold water streams. They are pollution sensitive to chemicals, elevated water temperatures, and siltation.

6. Percent of individuals that are insectivores - measures that portion of the fish community that feed on insects. The percent of insectivores, which are the dominant trophic guild in clean waters, increases as the physical and chemical habitat improves.

7. Percent of individuals as pioneering species - measures the proportion of the fish community represented by species which dominate in fluctuating environments such as variable flow regimes, chronic shifts in stream temperature, shifting habitats, and pulses of chemical pollutants.
8. Catch per 20 minute effort - measures the density of the fish community, which varies with region and stream size. Generally, the number of fish increases with improving stream conditions.
9. Percent lithophilic spawners - is an estimate of the suitability of the habitat for reproduction by fish species that build nests in sand, gravel and cobble substrates. These fish provide no parental care of their young after the eggs are laid and fertilized. Generally, as environmental degradation increases the number of lithophils decreases.
10. Catch of young-of-year trout per 20 minute effort – measures the capacity of a stream to reproduce trout species. Generally, the number of young-of-year trout increases with improving stream conditions.

Sampling Stations

Twelve baseline, 5 non-point, and 8 special study stations were sampled for benthic macroinvertebrates in April and May, 2015. One special study site (Dimmick Meadows) was sampled again in November, 2015 (Appendix A). Five baseline stations were sampled for fish in August and October, 2015 (Appendix B). Following are descriptions and co-ordinates for the macroinvertebrate and fish stations:

Macroinvertebrates

Station 01 – Saw Creek, Lehman Township; 41.089659⁰, -75.038688⁰

Station 02 – Big Bushkill Creek, Lehman Township; 41.090662⁰, -75.004328⁰

Station 03 – Little Bushkill Creek, Lehman Township; 41.091364⁰, -75.003598⁰

Station 04 – Toms Creek, Lehman Township; 41.152075⁰, -74.954147⁰

Station 07 – Adams Creek, Delaware Township; 41.261335⁰, -74.890436⁰

Station 09 – Sawkill Creek, Milford Township; 41.317207⁰, -74.799562⁰

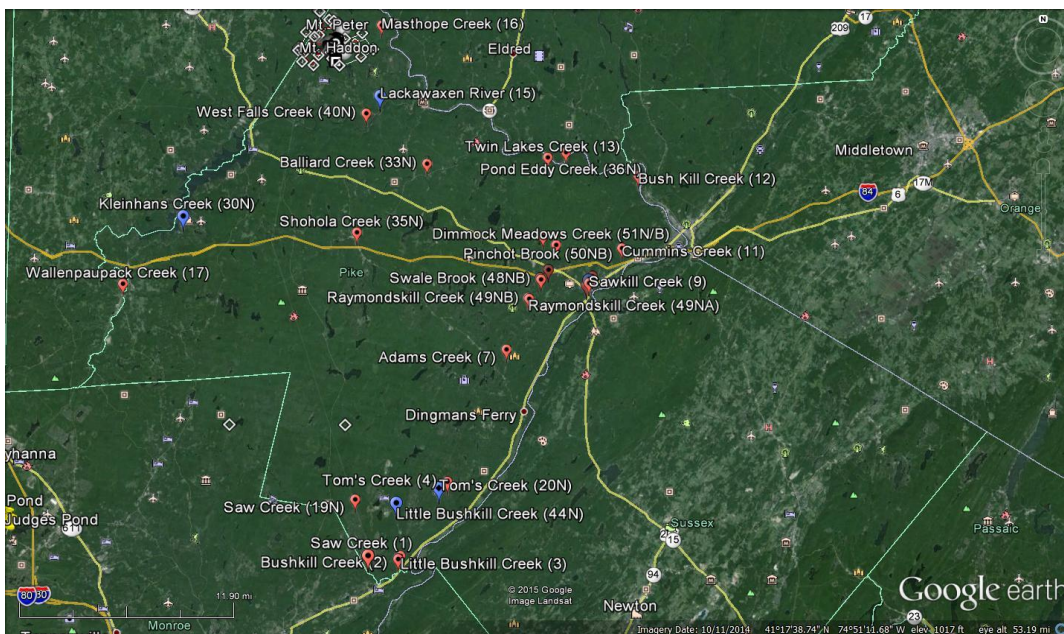
Station 10 – Vandermark Creek, Milford Township; 41.323286⁰, -74.795256⁰

Station 11 – Cummins Creek, Milford Township; 41.345091⁰, -75.761230⁰

Station 12 – Bush Kill Creek, Westfall Township, 41.409343⁰, -74.743587⁰
Station 13 – Twin Lakes Creek, Shohola Township, 41.321327⁰, -75.308891⁰
Station 16 – Masthope Creek, Lackawaxen Township, 41.545425⁰, -75.039145⁰
Station 17 – Wallenpaupack Creek, Greene Township, 41.315489⁰, -75.315825⁰
Station 19N – Saw Creek, Lehman Township; 41.137486⁰, -75.053638⁰
Station 33N – Balliard Creek, Shohola Township; 41.419379⁰, -74.980858⁰
Station 35N – Shohola Creek, Shohola Township; 41.359891⁰, -75.057742⁰
Station 36N – Pond Eddy Creek, Shohola Township; 41.429517⁰, -74.824731⁰
Station 40N – West Falls Creek, Blooming Grove Township; 41.463428⁰, -75.050390⁰
Station 47N/A – Sloat Brook, Dingman Township; 41.329212⁰, -74.845133⁰
Station 47N/B – Sloat Brook, Dingman Township; 41.328575⁰, -74.844403⁰
Station 48N/A – Swale Brook, Dingman Township; 41.321310⁰, -74.853300⁰
Station 48N/B – Swale Brook, Dingman Township; 41.320478⁰, -74.852664⁰
Station 49N/A – Raymondskill Creek, Dingman Township, 41.303913⁰, -74.867259⁰
Station 49N/B – Raymondskill Creek, Dingman Township, 41.303845⁰, -74.866505⁰
Station 50N/B – Pinchot Creek, Milford Township, 41.369160⁰, -74.842247⁰
Station 51N/B – Dimmick Meadows Creek, Milford Township, 41.349500⁰, -74.835900⁰

Fish

Station 9 – Sawkill Creek, Milford Township; 41.19°02.6'N/74.47°59.6'W
Station 15 – Lackawaxen River, Lackawaxen Township; 41.28°34.0'N/74.02°07.0'W.
Station 20N – Toms Creek, Lehman Township; 41.08°46.5'N/74.57°55.1'W.
Station 30N – Kleinhans Creek, Palmyra Township; 41.22°15.58'N/75.15°07.02'W.
Station 44N – Little Bushkill Creek, Lehman Township; 41.07°56.6'N/75.00°32.4'W.



RESULTS AND DISCUSSION

Physical – Chemical Field Data

Physical and chemical parameters measured were similar at both baseline and non-point stream sites surveyed (Table 4, Appendix B). Temperature and dissolved oxygen levels were considered adequate for stream life at the time of sampling. All streams were considered slightly acidic to slightly alkaline with low buffering capability (alkalinity). In the fall, Dimmock Meadows had an elevated pH from that seen in the spring. Meter error may have been the cause for this discrepancy.

Conductivity readings at each site were generally low suggesting limited concentrations of dissolved or filterable solids such as minerals, metals, or man-made wastes. They were highest on Sloat and Swale Brook. The mean value of the world's rivers contain an average of 120 parts per million (ppm) of total dissolved solids (Cole, 1983). A comparable conductivity would equal 240 $\mu\text{mhos/cm}$.

Habitat

Twenty-one of the twenty-five stream sites scored in the optimal range for habitat (Table 5, Appendix B). Stations that exceeded the PADEP scoring benchmark of 192 for optimal habitat are shown in green and those that fell in the suboptimal or marginal category are shown in blue (PA DEP, 2007). The sites with sub-optimal habitat were Station 10 on Vandermark Creek, 40N on West Falls Creek, 48NA on Swale Brook, and 49N/B on Raymondskill Creek. Diverse habitat is considered a necessary component to healthy stream conditions. Habitat can be degraded by human activities within a watershed. However, natural events may also degrade habitat at certain times (i.e. floods, dewatering due to drought, pest infestations, etc.).

Table 4. Physical and chemical field data from twenty-five Pike County stream sites (April-May, 2015) – Pennsylvania Department of Environmental Protection 2009.

PARAMETER	STA. 1 Saw	STA. 2 Bushkill	STA. 3 Little Bushkill	STA.4 Toms	STA. 7 Adams	STA. 9 Sawkill
Sample Date	5/13/15	5/29/15	5/29/15	5/29/15	5/13/15	5/25/15
Temperature (°C)	16.6	19.1	16.8	16.8	15.0	8.3
Dissolved Oxygen (mg/l)	9.63	9.53	9.39	9.33	8.96	11.15
pH	7.25	7.22	6.94	7.20	6.71	7.11
Conductivity (µmhos/cm)	109.9	66.0	65.0	162.2	131.4	67.8
Alkalinity (mg/l)	15	15	20	10	10	10
PARAMETER	STA.10 Vandermark	STA. 11 Cummins	STA. 12 Bush Kill	STA.13 Twin Lakes	STA.16 Masthope	STA.17 Wallenpaupack
Sample Date	5/15/15	5/27/15	5/27/15	5/20/15	5/1/15	5/15/15
Temperature (°C)	11.9	14.6	17.2	12.3	11.7	12.8
Dissolved Oxygen (mg/l)	11.14	9.37	8.90	10.54	11.33	10.85
pH	7.02	6.98	6.97	7.24	7.33	7.35
Conductivity (µmhos/cm)	135.9	83.6	61.5	74.5	44.5	82.7
Alkalinity (mg/l)	15	15	15	10	10	20
PARAMETER	STA.19N Saw	STA.33N Balliard	STA.35N Shohola	STA.36N Pond Eddy	STA.40N West Fall	ST.47NA Sloat (above)
Sample Date	5/13/15	5/1/15	5/20/15	5/19/15	5/27/15	4/29/15
Temperature (°C)	17.9	12.9	15.5	14.5	15.4	11.7
Dissolved Oxygen (mg/l)	9.47	10.24	9.05	9.60	8.80	10.58
pH	7.08	6.83	6.41	7.11	7.18	6.22
Conductivity (µmhos/cm)	49.5	84.8	78.3	38.8	131.4	401
Alkalinity (mg/l)	10	10	15	10	20	5

Table 4. (cont.).						
PARAMETER	ST.47NB Sloat (below)	STA.48NA Swale (above)	STA.48NB Swale (below)	ST.49NA Raymondskill (above)	ST.49NB Raymondskill (below)	ST.50NB Pinchot
Sample Date	4/29/15	4/29/15	4/29/15	5/13/15	5/13/15	5/15/15
Temperature (°C)	10.2	12.5	12.8	15.5	15.5	11.9
Dissolved Oxygen (mg/l)	10.04	9.83	10.72	9.23	9.52	10.46
pH	6.26	7.02	7.07	7.07	7.13	6.84
Conductivity (µmhos/cm)	373.4	259.5	270.5	166.3	166.2	26.2
Alkalinity (mg/l)	5	20	20	15	15	10
PARAMETER	ST.51NB Dimmick Meadows	ST.51NB Dimmick Meadows				
Sample Date	5/15/15	11/6/15				
Temperature (°C)	12.7	12.1				
Dissolved Oxygen (mg/l)	10.06	10.29				
pH	6.94	8.10				
Conductivity (µmhos/cm)	30.1	25.1				
Alkalinity (mg/l)	15	10				

Table 5. Habitat assessment of twenty-two sampling stations on Pike County streams (2015) - Pennsylvania Department of Environmental Protection. 2009.

HABITAT PARAMETER	STA. 1 Saw	STA. 2 Big Bushkill	STA. 3 Little Bushkill	STA. 4 Tom's	STA. 7 Adams	STA. 9 Sawkill
1. Instream Cover	18	18	18	17	19	18
2. Epifaunal Substrate	19	14	18	11	17	19
3. Embeddedness	16	17	19	17	19	17
4. Velocity/Depth Regimes	19	19	20	17	16	19
5. Channel Alteration	18	11	19	15	19	16
6. Sediment Deposition	17	15	18	18	18	18
7. Frequency of Riffles	16	15	18	15	20	18
8. Channel Flow Status	19	17	17	18	11	16
9. Condition of Banks	12	19	18	15	14	12
10. Bank Vegetative Protection	15	19	19	19	15	14
11. Grazing or Other Disruptive Pressure	17	17	20	17	18	17
12. Riparian Vegetative Zone Width	15	10	20	17	15	15
TOTAL SCORE	201	191	224	196	201	199
Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60						

Table 5. (cont.).

HABITAT PARAMETER	STA.10 Vandermark	STA 11 Cummins	STA 12 Bush Kill	STA. 13 Twin Lakes	STA.16 Masthope	STA.17 Wallenpaupack
1. Instream Cover	17	18	19	20	19	18
2. Epifaunal Substrate	17	20	19	17	19	16
3. Embeddedness	18	19	17	19	18	16
4. Velocity/Depth Regimes	13	19	18	19	19	19
5. Channel Alteration	10	19	14	20	19	15
6. Sediment Deposition	17	16	16	18	17	15
7. Frequency of Riffles	18	18	19	19	20	20
8. Channel Flow Status	15	17	17	19	19	19
9. Condition of Banks	11	16	18	20	18	18
10. Bank Vegetative Protection	12	19	15	19	19	20
11. Grazing or Other Disruptive Pressure	9	20	17	20	20	19
12. Riparian Vegetative Zone Width	11	19	15	15	15	20
TOTAL SCORE	168	220	204	225	222	215

Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60

Table 5. (cont.).

HABITAT PARAMETER	STA.19N Saw	STA.33N Balliard	ST.35N Shohola	ST.36N Pond Eddy	STA.40N West Falls	ST.47NA Sloat (above)
1. Instream Cover	20	18	18	20	13	12
2. Epifaunal Substrate	19	19	19	18	17	20
3. Embeddedness	19	18	17	20	14	19
4. Velocity/Depth Regimes	20	17	18	19	18	14
5. Channel Alteration	19	18	20	20	15	20
6. Sediment Deposition	20	19	20	20	12	13
7. Frequency of Riffles	19	19	18	19	19	20
8. Channel Flow Status	20	19	20	16	16	18
9. Condition of Banks	20	15	20	18	10	20
10. Bank Vegetative Protection	18	15	20	18	14	20
11. Grazing or Other Disruptive Pressure	19	16	19	20	17	20
12. Riparian Vegetative Zone Width	17	17	15	20	17	20
TOTAL SCORE	230	210	224	228	182	216

Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60

Table 5. (cont.).

HABITAT PARAMETER	ST.47NB Sloat (below)	STA.48NA Swale (above)	STA.48NB Swale (below)	STA.49NA Raymondskill (above)	ST.49NB Raymondskill (below)
1. Instream Cover	15	13	16	14	17
2. Epifaunal Substrate	19	6	19	16	14
3. Embeddedness	19	11	13	17	14
4. Velocity/Depth Regimes	12	14	16	15	15
5. Channel Alteration	12	20	13	19	16
6. Sediment Deposition	12	9	11	11	14
7. Frequency of Riffles	20	7	19	16	7
8. Channel Flow Status	17	19	19	15	15
9. Condition of Banks	20	17	19	15	4
10. Bank Vegetative Protection	20	20	20	16	12
11. Grazing or Other Disruptive Pressure	20	20	20	18	12
12. Riparian Vegetative Zone Width	20	20	20	19	13
TOTAL SCORE	206	176	205	191	153

Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60

Table 5. (cont.).

HABITAT PARAMETER	ST.50NB Pinchot (below)	STA.51NB Dimmick Meadow (spring-below)	STA.51NB Dimmick Meadow (fall-below)		
1. Instream Cover	17	16	18		
2. Epifaunal Substrate	17	18	20		
3. Embeddedness	18	13	20		
4. Velocity/Depth Regimes	16	11	14		
5. Channel Alteration	19	14	20		
6. Sediment Deposition	18	12	20		
7. Frequency of Riffles	19	18	20		
8. Channel Flow Status	16	11	19		
9. Condition of Banks	19	20	16		
10. Bank Vegetative Protection	19	19	17		
11. Grazing or Other Disruptive Pressure	20	16	20		
12. Riparian Vegetative Zone Width	18	19	20		
TOTAL SCORE	216	187	224		

Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60

There was a notable difference in the total score of habitat for the Dimmick Meadows site (51NB) from spring to fall. Subjective scoring criteria by two different field teams may have been the cause for this difference.

Benthic Macroinvertebrates

Appendix A shows the taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from 12 baseline 5 non-point, and 8 special study stream sites in Pike County for 2015. Table 6 shows the raw metric values and the adjusted standardized index of biotic integrity (IBI) score for each sample. Stations that exceeded the PADEP scoring benchmark of ≥ 80 for EV (exceptional value), HQ (high quality) protected use are highlighted in blue, those exceeding the benchmark of ≥ 63 for CWF (cold water fishery), TSF (trout stocked fishery), and WWF (warm water fishery) protected use are

highlighted in green. Stations that failed to meet either of the two benchmarks are highlighted in red.

Of the twenty-five stations sampled in 2015, sixteen had IBI scores high enough to qualify for special protection HQ and EV waters (Tables 6 and 7). Eight met the PADEP benchmark for the supporting use categories of CWF, TSF, and WWF and one failed to meet either of the two use categories. Stations 4 and 16 on Tom's Creek and Masthope Creek, respectively, had the highest IBI score of 93.3. Sloat Brook (47N/A), had the lowest score of 53.4. Comparison of upstream and downstream stations at the special study sites revealed some difference in biotic integrity with lower values seen above versus below on Sloat and Swale Brook.

Most of the stations surveyed in 2015 showed higher IBI scores than the past 8 to 10 year average for each stream. Only 3 of the baseline and non-point sites had lower than average scores including Saw Creek, Adams Creek and Shohola Creek.

In 2015 some special study sites showed noticeable change in their biotic integrity from that seen over the past three years. Noticeable improvement in the IBI occurred at two of

Table 6. Metric scores for twenty-five benthic macroinvertebrate samples from Pike County stream sites (April-May, 2015).

METRIC	STA. 1 Saw	STA. 2 Big Bushkill	STA. 3 Little Bushkill	STA. 4 Tom's	STA 7 Adams	STA. 9 Sawkill
Total Taxa Richness	29	27	30	29	27	33
Diversity Index	2.76	2.40	2.87	2.78	2.48	2.48
EPT Taxa Richness	16	18	19	20	13	21
Hilsenhoff Biotic Index	3.7	3.3	2.7	2.3	3.3	3.7
Percent Intolerant Individuals	55%	45%	61%	68%	47%	38%
Modified Beck's Index	11	26	39	39	23	35
Index of Biotic Integrity	73.3	77.5	92.2	93.3	72.3	82.7

METRIC	STA.10 Vandermark	STA.11 Cummins	STA 12 Bush Kill	STA. 13 Twin Lakes	STA.16 Masthope	STA.17 Wallenpaupack
Total Taxa Richness	23	26	20	26	34	22
Diversity Index	2.38	2.78	2.42	2.77	2.33	2.35
EPT Taxa Richness	16	18	16	17	25	18
Hilsenhoff Biotic Index	2.1	1.9	1.9	2.0	2.1	3.0
Percent Intolerant Individuals	71%	75%	77%	81%	77%	63%
Modified Beck's Index	32	38	25	35	41	16
Index of Biotic Integrity	84.4	91.4	81.4	91.6	93.3	74.1

Table 6. (cont.)

METRIC	STA.19N Saw	STA.33N Balliard	ST.35N Shohola	ST.36N Pond Eddy	STA.40N West Falls	ST.47NA Sloat Above
Total Taxa Richness	29	32	24	26	26	13
Diversity Index	2.73	2.95	2.79	2.42	2.68	1.75
EPT Taxa Richness	19	16	16	19	17	8
Hilsenhoff Biotic Index	2.4	3.26	3.57	1.44	2.36	3.84
Percent Intolerant Individuals	73%	54%	5%	87%	64%	44%
Modified Beck's Index	29	28	15	42	31	18
Index of Biotic Integrity	89.8	83.3	71.0	92.2	85.9	53.4

METRIC	ST.47NB Sloat Below	ST.48NA Swale Above	STA.48NB Swale Below	ST.49NA Raymondskill Above	ST.49NB Raymondskill Below	ST.50NB Pinchot
Total Taxa Richness	19	21	28	31	34	25
Diversity Index	1.82	1.85	2.59	2.86	3.10	2.57
EPT Taxa Richness	13	11	18	20	22	14
Hilsenhoff Biotic Index	3.22	3.18	3.12	2.65	3.60	2.16
Percent Intolerant Individuals	55%	54%	66%	63%	46%	78%
Modified Beck's Index	17	18	27	25	26	37
Index of Biotic Integrity	63.7	63.3	83.9	87.0	83.6	86.3

METRIC	STA.51NB Dimmick Meadows Below					
Total Taxa Richness	21					
Diversity Index	2.16					
EPT Taxa Richness	15					
Hilsenhoff Biotic Index	3.05					
Percent Intolerant Individuals	63%					
Modified Beck's Index	17					
Index of Biotic Integrity	70.3					

Table 7. Metric scores for one benthic macroinvertebrate sample from Pike County stream site (November, 2015).

METRIC	STA.51NB Dimmick Meadows Below					
Total Taxa Richness	24					
Diversity Index	2.81					
EPT Taxa Richness	17					
Hilsenhoff Biotic Index	2.15					
Percent Intolerant Individuals	75%					
Modified Beck's Index	33					
Index of Biotic Integrity	89.4					

the five special study sites, including Sloat below (47N/B) and Raymondskill below (49N/B), where scores rose 4-5 points from the average. However, the IBI dropped 20 points from the average at the upstream station on Swale Brook (48N/A) and at the downstream station on Dimmick Meadows (51N/B).

FISH

Five stream fish communities in Pike County were assessed by electrofishing techniques. Each survey site was categorized into habitat categories based on stream width (wetted perimeter) to allow for comparative assessments of biotic integrity among streams (Table 8 – Appendix B). The streams surveyed fell into one of five width categories ranging from 1 (<10 feet) to 5 (>60 feet). Of the 5 stream stations, three had one upstream impoundment and two had more than three (Table 8).

Table 8. Stream fish communities sampled for width category, impoundments in watershed, and game fish present in Pike County, PA (August, 2015)

STREAM SAMPLED	SITE ID	WIDTH CATEGORY	IMPOUNDMENTS ABOVE SAMPLE SITE	GAME FISH PRESENT
Sawkill Creek	09	3	1	Rainbow & Brown trout
Lackawaxen River	15	6	>3	Brook trout
Tom's Creek	20N	3	1	Brown trout
Kleinhans Creek	30N	2	1	Brook & Brown trout
Little Bushkill Creek	44N	4	>3	

Trout species were present at four of the five stream sites surveyed. Brook and brown trout were collected from Kleinhans Creek, brown and rainbow trout from Sawkill Creek, brook trout from the Lackawaxen River and brown trout from Tom's Creek (Table 8).

Trout are an important sport fish in the region, are temperature sensitive and prefer streams where thermal conditions seldom exceed 65 degrees Fahrenheit (Scott and Crossman, 1979). Impoundments with surface water releases tend to discharge warm water during the summer months, which is considered detrimental to the natural survival and production of trout. Sedimentation of streams is also detrimental to the survival of trout, as they require a clean substrate to incubate their eggs. Brook trout can tolerate less thermal stress and sedimentation than brown trout and are usually associated with springs and headwater regions of watersheds. They also require high concentrations of dissolved oxygen to survive. Therefore, they are usually associated with clean water conditions and are fairly intolerant to organic pollutants.

Trout reproduction was evident by the presence of young-of-year (YOY) fish at Tom's Creek, Lackawaxen River, and Kleinhans Creek. Nine YOY brown trout were collected in Tom's Creek and two in Kleinhans Creek. Seven YOY brook trout were also found in Kleinhans Creek and one in the Lackawaxen River.

A total of 14 species of fish were collected from the five streams surveyed in August and October of 2015 (Table 9). Dace and common shiners were the dominant forage fish. The American eel (*Anguilla rostrata*), which is a catadromous fish (living in fresh water and spawning in salt water), was found at 3 stream sites. The Sawkill and Lackawaxen River had the most diversity of fish with 8 and 9 species present, respectively.

Fish species were classified for calculation of an index of biotic integrity at each station surveyed (Table 10). These categories included pollution tolerance, trophic position (carnivore, omnivore or insectivore), thermal tolerance (stenothermal vs. eurythermal), adaptability to changing conditions (pioneer), spawning requirements (lithophil), and salmonid reproductive capacity (presence of young-of-year) – Lyons et al., 1996, Scott and Crossman, 1979; Plafkin et al., 1989; and Cooper, 1983.

The index of biotic integrity for the 5 stream sites surveyed ranged from 24 at Tom's Creek to 38 at Kleinhans Creek – Table 10. All of the sites had IBI indices that are considered good (≥ 24) and scores approximating those found in high quality streams of the region. All of these stream sites have consistently rated high in their fish population's biotic integrity (Ersbak, 1995-2015).

Stream flows at the Little Bushkill site were high and the water tea colored (dystrophic) making sample collection difficult. These conditions may have influenced the IBI.

It is noteworthy, that of the 152 individual fish sampled, no external deformities (tumors, ulcers, etc.) indicative of stress resulting from chemical or physical pollutants was observed.

Table 9. Fish species collected from five stream sites in Pike County, PA (August and October, 2015).

		8/24/15	10/9/15	8/24/15	8/9/15	10/9/15
Scientific Name	Common Name	Sawkill 9	Lackawaxen 15	Tom's 20N	Kleinhaus 30N	Little Bushkill 44N
<i>Anguilla rostrata</i>	American eel	11	21	40		
<i>Catostomus commersoni</i>	white sucker	1	4			
<i>Rhinichthys atratulus</i>	blacknose dace			40	3	2
<i>Rhinichthys cataractae</i>	longnose dace	1	31		4	
<i>Salmo trutta</i>	brown trout	12		33	7	
<i>Salvelinus fontinalis</i>	brook trout		1		10	
<i>Oncorhynchus mykiss</i>	Rainbow trout	1				
<i>Exoglossum maxillingua</i>	cutlips minnow	1	1			
<i>Semotilus atromaculatus</i>	creek chub					6
<i>Luxilus cornutus</i>	common shiner	18	26			1
<i>Etheostoma olmstedii</i>	tessellated darter	2				
<i>Lepomis macrochirus</i>	Bluegill		2	1		
<i>Noturus insignis</i>	marginated madtom		1		2	3
<i>Etheostoma olmstedii</i>	Tessellated darter		4		3	
TOTAL		47	91	114	29	12

TABLE 10. Index of biotic integrity (IBI) test scores at 6 stream sites in Pike County, Pennsylvania (August and October, 2015).

IS	Number of intolerant species
TOL	% of individuals that are tolerant species
CARN	% of individuals that are top carnivore species
STENO	% of individuals that are stenothermal coolwater & coldwater species
ST	% of salmonid individuals that are brook trout
I	% of individuals that are insectivores
P	% of individuals that are pioneering species
CPE	Catch per 20 minute effort
L	% of individuals that are lithophilic spawners
YOY	Number of young-of-year trout

INDEX OF BIOTIC INTEGRITY

STATION 09

SAWKILL CREEK

IBI Metrics	Metric Value	Test Score
IS	1	3
TOL	2	5
CARN	51	5
STENO	75	3
ST	0	1
I	89	5
P	23	3
CPE	45	1
L	72	3
YOY	0	1

IBI Score = 30

STATION 15 LACKAWAXEN RIVER

Metric Value	Test Score
2	3
4	5
24	5
74	3
100	5
93	5
28	3
91	1
69	1
1	3

34

STATION 20N

TOM'S CREEK

Metric Value	Test Score
0	1
35	3
64	5
29	1
0	1
65	5
70	1
109	3
64	1
9	3

24

STATION 30N

KLEINHANS CREEK

IBI Metrics	Metric Value	Test Score
IS	2	3
TOL	10	5
CARN	59	5
STENO	100	5
ST	59	5
I	90	5
P	21	3
CPE	29	1
L	83	3
YOY	9	3

IBI Score = 38

STATION 44N LITTLE BUSHKILL CREEK

Metric Value	Test Score
1	3
92	5
59	5
100	5
0	1
33	1
67	1
12	1
75	3
0	1

26

RECOMMENDATIONS

It is recommended that the PCCD continue its monitoring program of streams and rivers in the county. The cyclical rotation schedule of sites to be surveyed should be reviewed and a new schedule of sampling established, if necessary.

The special study stream sites of Swale Brook and Dimmick Meadows where the IBI has declined should be monitored for one more year to determine what, if any, impacts are occurring to the stream macroinvertebrate community and water quality.

The special study stream site at Pinchot Brook (50N) was scheduled to be monitored for fish in 2014. It was not completed. It is recommended that this site be monitored in 2016 to determine what, if any, impacts are occurring to the stream fish community and water quality.

Further testing should be considered for other new or existing stream sites threatened or reportedly impaired from environmental impacts. Future large development projects should be considered in scheduling additional special study sites in the County's water quality monitoring program.

REFERENCES

Cole, Gerald A. 1983. Textbook of Limnology 3rd edition. The C. V. Mosby Company, London. 401 pp.

Cooper, E. L. 1983. Fishes of Pennsylvania. Pennsylvania State University Press, University Park, PA. 243 pp.

Ersbak, Kenneth 1995-2014. Environmental Quality of Pike County Streams using Bioassessment Techniques. Pike County Conservation District, Hawley, PA.

Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist 20:31-39.

Karr, J. R., et al. 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Natural History Survey Special Publication 5. 28 pp.

Lyons, J. L., Wang, L. and T. D. Simonson. 1996. Development and validation of an Index of Biotic Integrity for coldwater streams in Wisconsin. North American Journal of Fisheries Management 16:241-256.

Pennsylvania Department of Environmental Protection. 2007. 2007 Assessment Methodology. Index of biological integrity for wadeable, freestone streams in Pennsylvania, and Appendix B: Taxa tolerance and trophic classification table. (draft).

Pennsylvania Department of Environmental Protection. 2009. Assessment Methodology. Index of biological integrity for wadeable, freestone streams in Pennsylvania, and Appendix B: taxa tolerance and trophic classification table. (391-3200-001/draft/March 19, 2009)

Pennsylvania Department of Environmental Resources. 1996. Title 25. Rules and Regulations. Part I. Department of Environmental Resources. Subpart C. Protection of Natural Resources. Article II. Water Resources. Pp. 93.1-93.144.

Pike County Conservation District. 1995. 1995 Annual Report: Surface Water Quality Monitoring Program. P.C.C.D., Hawley, PA. 117 pp.

Plafkin, J. L. et al. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/440/4-98/001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C. 20460.

Scott, W. B. and E. J. Crossman. 1973. Freshwater Fishes of Canada. Bull. 184. Fisheries Research Board of Canada, Ottawa. 966 pp.
Cole, Gerald A. 1983. Textbook of Limnology 3rd edition. The C. V. Mosby Company, London. 401 pp.

Appendix A.

Taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from twenty-five stream sites in Pike County for 2015.

**2015 PIKE COUNTY MACROINVERTEBRATE
DATA**

TAXON															
ORDER	POL.														
GENERA/SPECIES	TOL.	01	02	03	04	07	09	10	11	12	13	16	17	19N	
BIVALVIA (clams)															
<i>Pisidium spp.</i>	8		1			1									
COLEOPTERA (beetles)															
<i>Stenelmis spp.</i>	5	9	14	5	1	2	1							1	
<i>Promoresia spp.</i>	2					14			1	1	12			4	
<i>Oulimnius spp.</i>	5								8						
<i>Optioservus spp.</i>	4	1	1	1	3	1	1	1		1	2	1		2	
<i>Psephenus herricki</i>	4	5	15	4	23	52	26			4		3		1	
DECAPODA (crayfish)															
<i>Cambarus spp.</i>	6								1		3	1			
DIPTERA (true flies)															
Chironomidae	8	47	56	18	29	15	47	50	20		11	24	12	23	
<i>Blepharicera spp.</i>	0	2	2	5			1	14	3		4	2			
<i>Chrysops spp.</i>	7	2													
<i>Tipula spp.</i>	4	1	1	1				2			2			1	
<i>Hexatoma spp.</i>	2			4	6	1	3	8	6		4	2	1		
<i>Dicranota spp.</i>	3				3										
Empididae	6						1					1	1		
Dolichopodidae	4						1								
<i>Atherix spp.</i>	2	1	1				2								
<i>Antocha spp.</i>	3	7		2	4	2	9						17		
<i>Dixa spp.</i>	1	1													
<i>Prosimulium spp.</i>	2							2				1			
<i>Simulium spp.</i>	6							4	1					1	
EPHEMEROPTERA (mayflies)															
<i>Epeorus spp.</i>	0	13	4	11	5		6	49	5	9	23	22	9	6	
<i>Mccaffertium spp.</i>	3	1			3	9	4	1				9	2	3	
<i>Ephemerella spp.</i>	1	26		4	47	37	31		10	9	29	75	61	39	
<i>Eurylophella spp.</i>	4						1					1	2		
<i>Drunella spp.</i>	1		1	3	3		5		18		2		11	17	
<i>Seratella spp.</i>	2	22	15	21	7		6			25					
<i>Habrophlebiodes spp.</i>	6									1					
<i>Leucrocuta spp.</i>	1								1	4	1				
<i>Paraleptophlebia spp.</i>	1				22	4	2	9	20	14	3	7			
<i>Heterocloen spp.</i>	2							2							
<i>Cinygmula spp.</i>	1							2							
<i>Nixe spp.</i>	2				6										
<i>Rithrogena spp.</i>	3						1					9			
<i>Isonychia spp.</i>	3		1				2				3	7	1	1	

2015 PIKE COUNTY MACROINVERTEBRATE DATA

TAXON														
ORDER	POL.													
GENERA/SPECIES	TOL.	01	02	03	04	07	09	10	11	12	13	16	17	19N
EPHEMEROPTERA (mayflies)														
<i>Ameletus spp.</i>	0										2			
<i>Baetis spp.</i>	6		5	28	8	27	22	1	7	22	17	4	22	6
Baetidae	6									2				
<i>Acerpenna spp.</i>	6													1
<i>Acentrella spp.</i>	4	3					17							
GASTROPODA (snails)														
<i>Ferrissia spp.</i>	7					3								
Physinae	8									1				
MEGALOPTERA (hellgramites)														
<i>Sialis spp.</i>	6					1								
<i>Corydalus spp.</i>	4													1
<i>Nigronia spp.</i>	2	2		1	1	3	4		4		1			1
ODONATA (dragon flies)														
<i>Boyeria spp.</i>	2					1								
<i>Stylogomphus spp.</i>	4					1	2							
<i>Ophiogomphus spp.</i>	1			2								1		
<i>Lanthus spp.</i>	5					1								
Gomphidae	4	1			2						1			1
OLIGOCHAETA (worms)	10	3	1	5										
PLECOPTERA (stoneflies)														
<i>Leuctra spp.</i>	0	4		5	3	5			17			2		1
<i>Taenionema spp.</i>	3											6		
<i>Amphinemura spp.</i>	3		1					12	16	1	22			23
<i>Pteronarcys spp.</i>	0	2						2	3		2	1		3
<i>Acroneuria spp.</i>	0	13	22	23	4	7	3	2	8	5	11	6		10
<i>Paragnetina spp.</i>	1	5	4	14	3		2					2		1
<i>Agneta spp.</i>	1	1	1						13				2	
<i>Perlinella spp.</i>	2												4	
<i>Perlesta spp.</i>	4		1				6							
<i>Suwallia/Sweltsa spp.</i>	0							27	6	1	3	1		1
<i>Remenus spp.</i>	2							1						
<i>Tallaperla spp.</i>	0				1								1	
<i>Diploperla spp.</i>	2										4	1	1	
<i>Clasperla spp.</i>	2													17
<i>Diura spp.</i>	2											1		
<i>Isoperla spp.</i>	2					8	1		6		9	10	5	

2015 PIKE COUNTY MACROINVERTEBRATE DATA

TAXON														
ORDER	POL.													
GENERA/SPECIES	TOL.	01	02	03	04	07	09	10	11	12	13	16	17	19N
TRICHOPTERA (caddisflies)														
<i>Chimarra spp.</i>	4		2	2		1						6		5
<i>Dolophilodes spp.</i>	0	4	35	32	7	2	5		1	13		2		4
<i>Neophylax spp.</i>	3							1				1	4	
<i>Hydropsyche spp.</i>	5												1	
<i>Ceratopsyche spp.</i>	5	15	10	14	6	2	22	4	1			8	6	12
<i>Cheumatopsyche spp.</i>	6	13	4	7								2	19	
<i>Diplectrona spp.</i>	0	2		1	7	1		10	36	29	23			13
<i>Rhyacophila spp.</i>	1	4	1	2	3	2	1	5	3	3	2	6	1	3
<i>Lepidostoma spp.</i>	1	6	1	2			1	4			3	2		
<i>Glossosoma spp.</i>	0		1	1										
<i>Psilotreta spp.</i>	0				1		1							
<i>Lype spp.</i>	2				1									
<i>Agapetus spp.</i>	5			3	15									
<i>Micrasema spp.</i>	2		1											
<i>Polycentropus spp.</i>	6			1			1		3	2				
<i>Pycnopsyche spp.</i>	4			2	1	3				1	2	1	4	
TOTAL		260	256	288	265	214	268	237	259	193	229	255	218	239

METRICS	01	02	03	04	07	09	10	11	12	13	16	17	19N
Total Taxa Richness	29	27	30	29	27	33	23	26	20	26	34	22	29
Shannon Diversity Index	2.76	2.40	2.87	2.78	2.48	2.48	2.38	2.78	2.42	2.77	2.33	2.35	2.73
EPT Taxa Richness	16	18	19	20	13	21	16	18	16	17	25	18	19
Hilsenhoff Biotic Index	3.7	3.3	2.7	2.3	3.3	3.7	2.1	1.9	1.9	2.0	2.1	3.0	2.4
Percent Intolerant Individuals	55%	45%	61%	68%	47%	38%	71%	75%	77%	81%	77%	63%	73%
Modified Beck's Index	11	26	39	39	23	35	32	38	25	35	41	16	29
Index of Biotic Integrity	73.3	77.5	92.2	93.3	72.3	82.7	84.4	91.4	81.4	91.6	93.3	74.1	89.8

**2015 PIKE COUNTY
MACROINVERTEBRATE
DATA**

TAXON	P O L L U T I O N
ORDER	
GENERA/SPECIES	
AMPHIPODA (shrimp)	
<i>Gammarus spp.</i>	4
BIVALVIA (clams)	
<i>Pisidium spp.</i>	
COLEOPTERA (beetles)	
<i>Agabus spp.</i>	5
<i>Celina spp.</i>	5
<i>Gyrinus spp.</i>	4
<i>Lutrochus spp.</i>	6
<i>Microcylloepus spp.</i>	2
<i>Stenelmis spp.</i>	5
<i>Promoresia spp.</i>	2
<i>Stenelmis spp.</i>	5
<i>Optioservus spp.</i>	4
<i>Psephenus herricki</i>	4
COLLEMBOLA (snow fleas)	
<i>Podura spp.</i>	9
DECAPODA (crayfish)	
<i>Cambarus spp.</i>	6
DIPTERA (true flies)	
Chironomidae	8
Empididae	6
<i>Tipula spp.</i>	4
<i>Hexatoma spp.</i>	2
<i>Dicranota spp.</i>	3
<i>Atherix spp.</i>	2
<i>Antocha spp.</i>	3
<i>Tabanus spp.</i>	5
<i>Dixa spp.</i>	1
<i>Proimulium spp.</i>	0
<i>Simulium spp.</i>	6
EPHEMEROPTERA (mayflies)	
<i>Epeorus spp.</i>	0
<i>Mccaffertium spp.</i>	3
<i>Hexagenia spp.</i>	6
<i>Cinygmula spp.</i>	1
<i>Ephemerella spp.</i>	1

FALL												SPR
33 N	35 N	36 N	40 N	47 N/A	47 N/B	48 N/A	48 N/B	49 N/A	49 N/B	50 N/B	51 N/B	51 N/B

3												
---	--	--	--	--	--	--	--	--	--	--	--	--

3	3								7			
---	---	--	--	--	--	--	--	--	---	--	--	--

					2							
						1	4					
				1	1							
							1					
						1						
18												
	22	7							9	15	21	14
	1		3					1	9			
1	3		2						3		3	
1	1	2	6					15	8	22	3	4

							2					1
--	--	--	--	--	--	--	---	--	--	--	--	---

			1			1	2			1		
--	--	--	---	--	--	---	---	--	--	---	--	--

35	21	15	19	38	33	44		33	35	16	2	38
					1							
1							4	1				
			4	4								
		2	6							2		
3								2	1			
	5	2						7	1		2	
						3						
										1		
22				23	4		6			1		
5	4			75	70		34		11			5

18		7	8		18		4	11	7	4	1	
1	4				1	2	2	9	6		10	4
									1			
		1										
10	20	58	11		8	61	30	38	20	48		43

**2015 PIKE COUNTY
MACROINVERTEBRATE DATA**

TAXON	
ORDER	POL.
GENERA/SPECIES	TOL.
EPHEMEROPTERA (mayflies)	
<i>Eurylophella</i> spp.	4
<i>Serratella</i> spp.	2
<i>Drunella</i> spp.	1
<i>Paraleptophlebia</i> spp.	1
<i>Habrophlebiodes</i> spp.	6
<i>Isonychia</i> spp.	3
<i>Ameletus</i> spp.	0
<i>Baetis</i> spp.	6
<i>Plauditus</i> spp.	4
<i>Acerpenna</i> spp.	6
<i>Acentrella</i> spp.	4
GASTROPODA (snails)	
<i>Ferrissia</i> spp.	7
<i>Physinae</i>	8
ISOPODA (scuds)	
<i>Caecidotea</i> spp.	6
MEGALOPTERA (hellgramites)	
<i>Sialis</i> spp.	6
<i>Nigronia</i> spp.	2
<i>Corydalus</i> spp.	4
ODONATA (dragon/damsel flies)	
<i>Boyeria</i> spp.	2
<i>Cordulegaster</i> spp.	3
<i>Ophiogomphus</i> spp.	1
<i>Hagenius</i> spp.	3
<i>Gomphidae</i>	4
<i>Lanthus</i> spp.	5
<i>Stylogomphus</i> spp.	4
OLIGOCHAETA (worms)	10
PLECOPTERA (stoneflies)	
<i>Leuctra</i> spp.	0
<i>Amphinemura</i> spp.	3
<i>Pteronarcys</i> spp.	0
<i>Acroneuria</i> spp.	0
<i>Paragnetina</i> spp.	1
<i>Suwallia/Sweltsa</i> spp.	0
<i>Perlesta</i> spp.	4
<i>Nemoura</i> spp.	1

											FALL	SPRI
33N	35N	36N	40N	47 N/A	47 N/B	48 N/A	48 N/B	49 N/A	49 N/B	50 N/B	51 N/B	51 N/B

1					1	4		1			10	1
	18		3						2			
4		1	5		4			9	4			
		2				2	1	1	2	5	7	6
			1			1			1			
							1	6	7			
			2	1						1		
	30	6	38				1	2	8	4		1
	17											
	3										13	
									4			

								2	1			
			1									

1												
---	--	--	--	--	--	--	--	--	--	--	--	--

						3						
4		6	1			4	2	15	10	2		
1								1				

		2						3		1	1	
						2						
4												
											1	
							2					
						2	3	4	5			1
5						2				1		
7										1		

2		9	24	2	3		1	15	5	9	6	6
		10	3		1		28			28		10
		2					1			12	5	
12	8	4	11			1	2	17	6	4	2	1
		1										1
		1	5							3	22	
	5											
				53	85							

**2015 PIKE COUNTY
MACROINVERTEBRATE
DATA**

TAXON	
ORDER	POL.
GENERA/SPECIES	TOL.
<i>Tallaperla spp.</i>	0
<i>Strophopteryx spp.</i>	3
<i>Diploperla spp.</i>	2
<i>Taenionema spp.</i>	3
<i>Isoperla spp.</i>	2
TRICHOPTERA (caddisflies)	
<i>Chimarra spp.</i>	4
<i>Dolophilodes spp.</i>	0
<i>Hydropsyche spp.</i>	5
<i>Cheumatopsyche spp.</i>	6
<i>Ceratopsyche spp.</i>	5
<i>Diplectrona spp.</i>	0
<i>Wormaldia spp.</i>	0
<i>Rhyacophila spp.</i>	1
<i>Oecetis spp.</i>	8
<i>Lepidostoma spp.</i>	1
<i>Micrasema spp.</i>	2
<i>Neophylax spp.</i>	3
<i>Nyctiophylax spp.</i>	5
<i>Brachycentrus spp.</i>	1
<i>Isonychia spp.</i>	3
<i>Psilotreta spp.</i>	0
Homoptera spp.	5
Limnephilidae	4
Phryganeidae	4
<i>Polycentropus spp.</i>	6
<i>Pycnopsyche spp.</i>	4

TOTAL

											FALL	SPR
33N	35N	36N	40N	47N/A	47N/B	48N/A	48N/B	49N/A	49N/B	50N/B	51NB	51N/B
		4					3			5	7	
											2	
		5	3					1	2			7
							15					
9	4				1	1	11	1		12		1

7	4							3	3			
	2	2	40	1				3	4	2	2	
	5								1			2
1	3						2	1	1		12	
3	9	4	5					15	13			
		50	10			1	7				1	1
				1	1							
5	2	4	2	8		2	2	5	8	2	17	1
1		3									12	
	8								1		11	
5				3	1			1				
									1			
7												
					5							
1						1						
					1							
												1
			1				1	1				
				6		6	5	6	1			

231 301 291 324 230 249 156 220 279 259 233 254 169

METRICS

Total Taxa Richness
Shannon Diversity Index
EPT Taxa Richness
Hilsenhoff Biotic Index
Percent Intolerant Individuals
Modified Beck's Index

Index of Biotic Integrity

											FALL	SPR
33N	35N	36N	40N	47N/A	47N/B	48N/A	48N/B	49N/A	49N/B	50N/B	51NB	51N/B
32	24	26	26	13	19	21	28	31	34	25	24	21
3	2.78	2.42	2.68	1.75	1.82	1.85	2.59	2.86	3.10	2.57	2.81	2.16
16	16	19	17	8	13	11	18	20	22	14	17	15
3.26	3.57	1.44	2.36	3.84	3.22	3.18	3.12	2.65	3.60	2.16	2.15	3.05
54%	5%	87%	64%	44%	55%	54%	66%	63%	46%	78%	75%	63%
28	15	42	31	18	17	18	27	25	26	37	33	17
83.3	71.0	92.2	85.9	53.4	63.7	63.3	83.9	87.0	83.6	86.3	89.4	70.3

Appendix B

Taxa, numbers, and site description for the five electrofishing stream sites in Pike County for 2015.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY

Stream/River - Sawkill Creek

Township - Milford

DEP Water Use
Classification

Site I.D. #09

Date - 24 August 2015

HQ_CWF

Location - Starting below Route 209 Bridge

Sampling duration - 21 minutes

Sampling Distance - 195 feet

Sampling area (ft2) - 4,582

Mean Stream Width - 23.5 feet

Weather /Comments - two 13" and one 17.5" brown trout

Gear used - Backpack Electroshocker

Habitat complexity/quality rating - Excellent

Voltage - 350 V DC

Stream Width Category - 3 (20-30 ft)

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (juvenile/adult)	12	0
<i>Oncorhynchus mykiss</i>	Rainbow trout (juvenile/adult)	1	0
<i>Anguilla rostrata</i>	American eel	11	0
<i>Rhinichthys cataractae</i>	Longnose dace	1	0
<i>Catostomus commersoni</i>	White sucker	1	0
<i>Luxilus cornutus</i>	Common shiner	18	0
<i>Etheostoma olmstedii</i>	Tesselated darter	2	0
<i>Exoglossum maxillingua</i>	Cutlips minnow	1	0

TOTAL

47

Anomalies = deformities, eroded fins, excessive mucous, fungus, reddening, tumors, and ulcers.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River - Lackawaxan River

Township - Lackawaxan

DEP Water Use Classification

Site I.D. #15

Date - 9 October 2015

HQ-CWF

Location - Starting 150 yards below Rowland Bridge

Sampling duration - 20 minutes

Sampling Distance - 145 feet

Sampling area (ft2) - 20,977

Mean Stream Width - 144.5 feet

Weather /Comments - Clear

Gear used - Backpack Electroshocker

Habitat complexity/quality rating - Fair

Voltage - 350V DC

Stream Width Category - 2 (10-20 ft)

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (young-of-year)	28	0
<i>Salmo trutta</i>	Brown trout (juvenile/adult)	5	0
<i>Anguilla rostrata</i>	American eel	6	0
<i>Catostomus commersoni</i>	White sucker	2	0
<i>Rhinichthys atratulus</i>	Blacknose dace	15	0
<i>Luxilus cornutus</i>	Common shiner	1	0

TOTAL 91

Anomalies = deformities, eroded fins, excessive mucous, fungus, reddening, tumors, and ulcers.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY
SURVEY

Stream/River - Tom's Creek

Township - Lehman

DEP Water Use Classification

Site I.D. #20N

Date - 24 August 2015

HQ-CWF

Location - starting 0.5 miles downstream from Raccoon Court

Sampling duration - 21 minutes

Sampling Distance - 150 feet

Sampling area (ft²) - 3,045

Mean Stream Width - 20.3 feet

Weather /Comments -

Gear used - Backpack Electroshocker

Habitat complexity/quality rating - Excellent

Voltage - 350 volts DC

Stream Width Category - 2 (10-20 ft)

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (juvenile/adult)	24	0
<i>Salmo trutta</i>	Brown trout (young-of-year)	9	0
<i>Anguilla rostrata</i>	American eel	40	0
<i>Rhinichthys atratulus</i>	Blacknose dace	43	0
<i>Lepomis macrochirus</i>	Bluegill	1	0

TOTAL 114

Anomalies = deformities, eroded fins, excessive mucous, fungus, reddening, tumors, and ulcers.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River - Kleinhans Creek

Township - Greene

DEP Water Use Classification

Site I.D. #30N

Date - 9 August 2015

HQ-CWF

Location - Starting 100 feet above Route 507 bridge

Sampling duration - 20 minutes

Sampling Distance - 273 feet

Sampling area (ft2) - 5,414

Mean Stream Width - 19.8 feet

Weather /Comments -

Gear used - Backpack Electroshocker

Habitat complexity/quality rating - Excellent

Voltage - 350V DC

Stream Width Category - 2 (10-20 ft)

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salvelinus fontinalis</i>	Brook trout (young-of-year)	7	0
<i>Salvelinus fontinalis</i>	Brook trout (juvenile/adult)	3	0
<i>Salmo trutta</i>	Brown trout (juvenile/adult)	5	0
<i>Salmo trutta</i>	Brown trout (young-of-year)	2	0
<i>Rhinichthys atratulus</i>	Blacknose dace	3	0
<i>Rhinichthys cataractae</i>	Longnose dace	4	0
<i>Etheostoma olmstedii</i>	Tessellated darter	3	0
<i>Noturus insignis</i>	Margined madtom	2	0

TOTAL 29

Anomalies = deformities, eroded fins, excessive mucous, fungus, reddening, tumors, and ulcers.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River - Little Bushkill Creek

Township - Lehman

DEP Water Use Classification

Site I.D. #44N

Date – 9 October 2015

HQ-CWF

Location - starting at Little Bushkill Rod & Gun Club property line above Bushkill Falls Road

Sampling duration - 22 minutes

Sampling Distance - 185 feet

Sampling area (ft2) - 7,104

Mean Stream Width - 38.4 feet

Weather /Comments - High water and very dystrophic

Gear used - Backpack Electroshocker

Habitat complexity/quality rating - Excellent

Voltage - 350V DC

Stream Width Category - 4 (30-40 ft)

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Rhinichthys atratulus</i>	Blacknose dace	2	0
<i>Noturus insignis</i>	Margined madtom	3	0
<i>Luxilus cornutus</i>	Common shiner	1	0
<i>Semotilus atromaculatus</i>	Creek chub	6	0

TOTAL 12

Anomalies = deformities, eroded fins, excessive mucous, fungus, reddening, tumors, and ulcers.