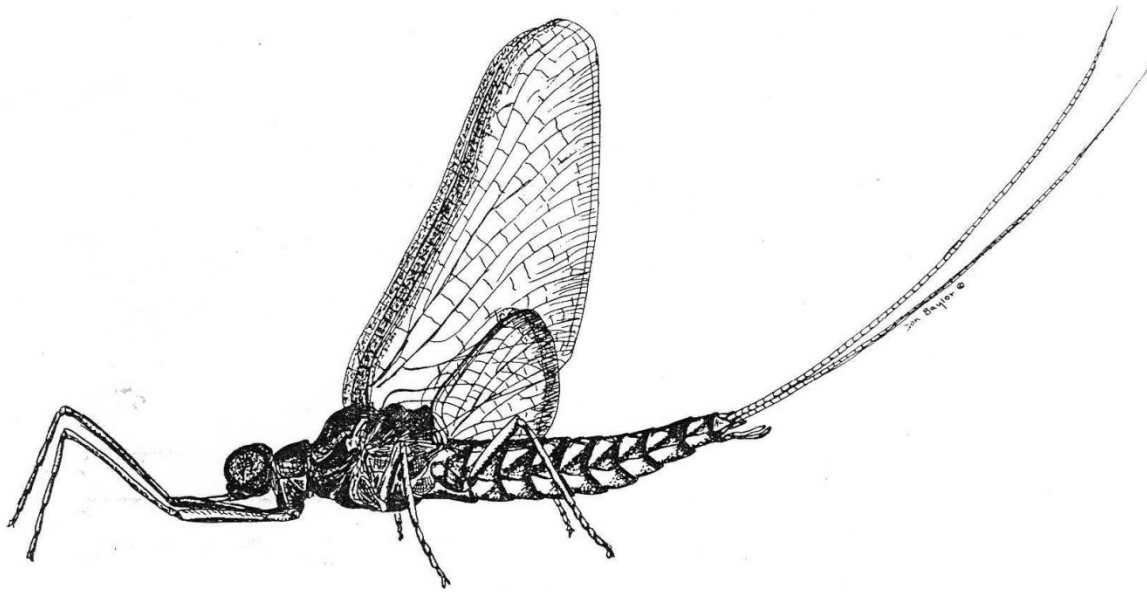


ENVIRONMENTAL QUALITY OF PIKE COUNTY STREAMS



DECEMBER 2018

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PIKE COUNTY STREAMS

Prepared For

Pike County Conservation District
Hawley, PA 18428

Prepared by

Kenneth Ersbak
Aquatic Biologist
Aquatic Resource Consulting

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TABLE OF CONTENTS

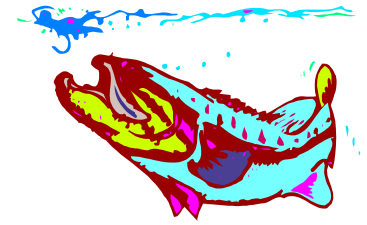
I.	INTRODUCTION.....	1
II.	METHODS.....	2
III.	RESULTS AND DISCUSSION.....	9
IV.	RECOMMENDATIONS	18
IV.	REFERENCES.....	19

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 eleven Pike County stream sites (May, 2018) – PA Dept. Environ. Protection, 2009.	10
5. Habitat assessment of 23 sampling stations on Pike County Streams (May/August, 2018) – PA Dept. Environ. Protection, 2009.	11
6. Metric scores for 17 benthic macroinvertebrate samples from Pike County stream sites (May, 2018).....	13
7. Stream fish communities sampled for width category, impoundments in watershed, drainage area (square miles), % storage area (ponds, lakes, wetlands), and game fish present in Pike County, PA (August/September, 2018).....	14
8. Fish species collected from six stream sites in Pike County, PA (August/September, 2018)	16
9. Index of biotic integrity (IBI) test scores at 6 stream sites in Pike County, Pennsylvania (August/September, 2018)	17

Appendix	Page
A. Taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from 11 stream sites in Pike County for 2018.....	21
B. Taxa, numbers, and site description for the 6 electrofishing stream sites in Pike County for 2018.....	25

AQUATIC RESOURCE CONSULTING



521 Quail Ridge Lane - Stroudsburg, PA 18360 – (570) 992-3558; 685-7171; 983-7606

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, 2012, 2015). 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 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. 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, 2012, 2015).

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, 2015). 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 for one minute. Organisms and debris were composited for each station in a plastic container and preserved in 90% ethyl 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. **EPT Taxa Richness** (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 with 0-4 tolerance values are 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, the 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 three 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 large freestone stream site (>50 square miles):

Table 2. Sample metric standardization and index of biotic integrity calculations for a benthic macroinvertebrate sample for a large freestone stream.				
Metric	Standardization Equation	Observed Metric Value	Standardized Metric Score	Adjusted Standardized Metric Score Maximum =100
Modified Beck's Index	Observed value/22*100	40	181.8	100
EPT Taxa Richness	Observed Value/16*100	22	137.5	100
Total Taxa Richness	Observed value/31*100	33	106.5	100
Shannon Diversity Index	Observed Value/2.90	2.67	93.4	93.4
Hilsenhoff Biotic Index	10-observed value/(10-3.05)*100	3.47	94.0	94.0
Percent Intolerant Individuals	Observed value/66.7*100	48.8	73.2	73.2
Average of adjusted standardized core metric scores x 100 = IBI score				93.4

Smaller streams (<25 square miles) have different standardization values. Streams between 25 and 50 square miles may have either standardization value applied to them. Pennsylvania DEP Index of Biotic Integrity scoring benchmarks require analysis through a multi-tiered flow chart. This decision process should act only as a guide for assessment as certain situations may not apply exactly as outlined.

Fish Communities

Fish communities were sampled in August and September, 2018 at five baseline stream sites and one non-point site 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 electrofishing unit with 6-foot anode probe. Direct-pulsed current at 45 Hz was used to cause electronarcosis in the fish

being collected.

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 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 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, ten (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 2017 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>	Scoring Criteria		
	<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 of 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 cold water 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. Generally, the number of pioneering species increases as water quality declines.
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

Eight baseline and three non-point study stations were sampled for benthic macroinvertebrates in May and June, 2018 (Appendix A). Five baseline and one non-point station were sampled for fish in August and September, 2018 (Appendix B). Following are descriptions and co-ordinates for the macroinvertebrate and fish stations:

Macroinvertebrates

Station 01 – Saw Creek, Lehman Township; 41°05'22.61"N-75°02'19.28"W

Station 04 – Toms Creek, Lehman Township; 41°09'07.37"N-74°57'14.91"W

Station 06 – Dingmans Creek, Delaware Township; 41°13'54.10"N-74°54'37.97"W

Station 08 – Raymondskill Creek, Dingman Township; 41°19'00"N/74°51'18.3"W

Station 10 – Vandermark Creek, Milford Township; 41°19'23.83"N/74°47'42.92"W

Station 11 – Cummins Creek, Westfall Township; 41°20'42.33"N/74°45'40.43"W

Station 12 – Bush Kill Creek, Westfall Township; 41°24'33.63"N/74°44'36.91"W

Station 16 – Masthope Creek, Lackawaxen Township, 41°32'26.2"W/75°02'01.2"W

Station 19N – Saw Creek, Lehman Township; 41°08'14.95"N/75°03'13.10"W

Station 25N – Vandermark Creek, Milford Township; 41°19'42.82"N/74°47'55.69"W

Station 26N – Rosetown Creek, Westfall Township; 41°21'16.54"N/74°43'44.58"W

Station 33N – Balliard Creek, Shohola Township; 41°25'9.77"N/74°58'51.09"W

Station 35N – Shohola Creek, Blooming Grove Township; 41°21'35.61"N/75°3'27.87"W

Station 36N – Pond Eddy Creek, Shohola, Township; 41°25'46.26"N/74°49'29.03"W

Station 38N – Rattlesnake Creek, Lackawaxen Township; 41°33'2.97"N/75°5'39.71"W

Station 40N – West Falls Creek, Lackawaxen Township; 41°27'48.34"N/75°3'1.40"W

Station 56P – UNT to Masthope Creek, Lackawaxen Township; 41°32'36.30"N/75°02'48.76"W

Fish

Station 04 – Tom's Creek, Lehman Township; 41°09'7.37"N/74°57'14.91"W

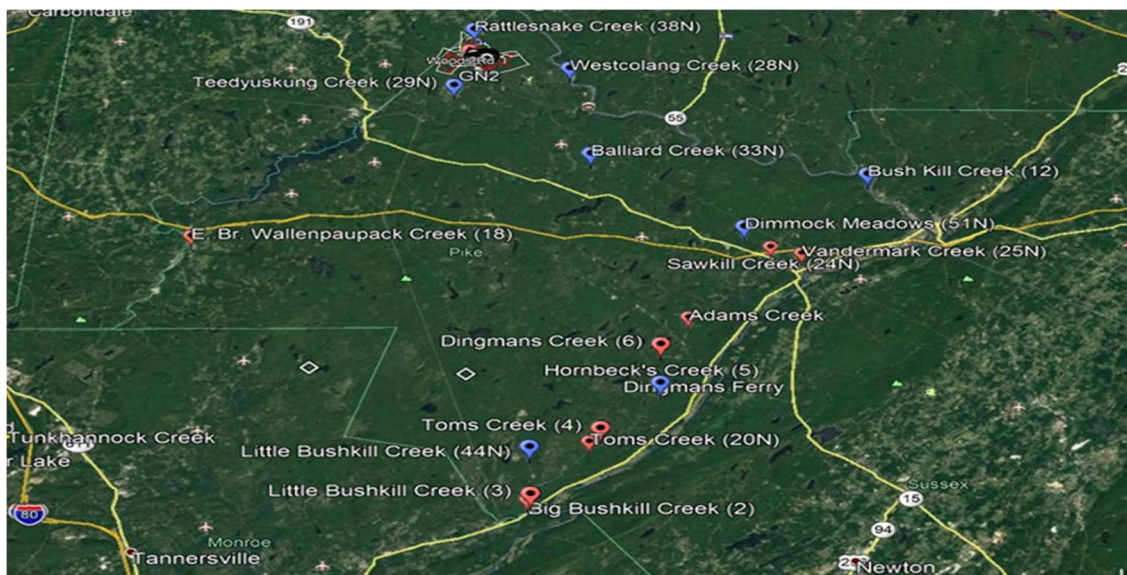
Station 06 – Dingmans Creek, Delaware Township; 41°13'54.4"N/74°54'39.4"W

Station 07 – Adams Creek, Delaware Township; 41°15'40.86"N/74°53'22.59"W

Station 08 – Raymondskill Creek, Dingman Township; 41°18'13.3:N/74°51'18.3"W

Station 16 – Masthope Creek, Lackawaxen Township; 41°32'26.2"W/75°02'01.2"W

Station 40N – West Falls Creek, Lackawaxen Township; 41°27'48.34"N/75°3'1.40"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 alkaline with low buffering capability (alkalinity). pH readings at most sites were higher than typical for the Pocono region and differed from the historical data base for these sites. This anomaly may have been due to meter error or inadequate calibration. Conductivity readings at each site were generally low suggesting limited concentrations of dissolved or filterable solids such as minerals, metals, or man-made wastes. The mean value of the world's rivers contains an average of 120 parts per million (ppm) of total dissolved solids (Cole, 1983). A comparable conductivity would equal 240 μ mhos/cm.

Habitat

All stream sites sampled 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 (PA DEP, 2007). 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.).

Habitat scores for Pike County streams over the past seven years have averaged 216 and this average has ranged from 200 to 232 units (Ersbak, 2010-2017). Subjective scoring criteria by different field teams has been fairly consistent.

Benthic Macroinvertebrates

Appendix A shows the taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from 8 baseline, 8 non-point, and 1 special study stream site in Pike County for 2018. Table 6 shows the raw metric values and the adjusted standardized index of biotic integrity (IBI) score for each sample. At two of the 17 sites fewer than 160 organisms were collected. Therefore, the IBI should be interpreted cautiously at these sites due to the smaller sample size used for the analysis.

All stations exceeded the PADEP scoring benchmark of ≥ 63 for EV (exceptional value) and HQ (high quality) protected use. Cummins Creek (11), Tom's Creek (4) Vandermark Creek (25N), Saw Creek (19N), and Westfalls Creek (40N) had the highest IBI scores of 93.0, 92.6, 91.9, 90.8, and 90.3 respectively. Raymondskill Creek (8), Rosetown Creek (26N), Shohola Creek (35N), and Dingmans Creek (6) had the lowest scores of 73.4, 75.3, 78.0, and 78.8, respectively.

Table 4. Physical and chemical field data from eleven Pike County stream sites (May, 2018) Pennsylvania Department of Environmental Protection 2009.

PARAMETER	STA. 01 Saw	STA. 04 Toms	STA. 06 Dingmans	STA. 08 Raymondskill	STA. 10 Vandermark	STA. 011 Cummins
Sample Date	5/8/18	5/8/18	5/30/18	5/25/18	5/25/18	5/1/18
Temperature (°C)	14.0	14.1	22.0	16.2	14.3	6.1
Dissolved Oxygen (mg/l)	9.30	9.56	7.54	8.15	10.07	11.93
pH	9.23	9.23	7.10	6.91	6.93	9.61
Conductivity (µmhos/cm)	77.7	12.0	79.7	107.5	82.8	44
Alkalinity (mg/l)	15	20	15		20	10
PARAMETER	STA. 12 Bush Kill	STA. 16 Masthope	STA. 19N Saw	STA.25N Vandermark	STA.26N Rosetown	STA.33N Balliard
Sample Date	5/1/18	6/5/18	5/8/18	5/25/18	5/1/18	5/23/18
Temperature (°C)	9.8	15.4	14.3	13.2	8.2	15.9
Dissolved Oxygen (mg/l)	10.86	9.07	9.54	9.7	11.0	9.19
pH	8.90	7.30	9.43	6.68	8.97	8.54
Conductivity (µmhos/cm)	30.7	46.7	35.7	64.9	25.9	0.6
Alkalinity (mg/l)	10		10	15	10	

PARAMETER	STA. 35N Shohola	STA. 36N Pond Eddy	STA. 38N Rattlesnake	STA. 40N West Falls	STA. 56P UNT Masthope	
Sample Date	5/23/18	5/30/18	6/5/18	4/30/18	4/27/18	
Temperature (°C)	12.8	15.6	15.0	7.2	9.1	
Dissolved Oxygen (mg/l)	9.30	8.67	8.5	11.9	10.92	
pH	8.80	7.15	6.96	9.38	10.09	
Conductivity (µmhos/cm)	0.5	28.9	31.4	92.8	22.8	
Alkalinity (mg/l)		15	20	15	15	

Table 5. Habitat assessment of twenty-three sampling stations on Pike County streams (2018) - Pennsylvania Department of Environmental Protection. 2009.

HABITAT PARAMETER	STA 01 Saw 5/8/18	STA 04 Toms 5/8/18	STA 06 Dingmans 5/30/18	STA 08 Raymondskill 5/25/18	STA 10 Vandermark 5/25/18	STA 11 Cummins 5/1/18
1. Instream Cover	18	18	18	18	19	17
2. Epifaunal Substrate	19	16	18	16	18	18
3. Embeddedness	18	15	18	18	17	16
4. Velocity/Depth Regimes	17	19	19	15	16	18
5. Channel Alteration	19	20	20	15	15	20
6. Sediment Deposition	18	16	18	19	17	18
7. Frequency of Riffles	19	16	19	16	17	18
8. Channel Flow Status	18	19	18	18	17	16
9. Condition of Banks	16	18	19	19	15	16
10. Bank Vegetative Protection	18	19	18	20	15	17
11. Grazing or Other Disruptive Pressure	20	20	20	20	20	20
12. Riparian Vegetative Zone Width	17	15	20	17	15	20
TOTAL SCORE	217	211	225	211	201	214
Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60						

HABITAT PARAMETER	STA 12 Bush Kill 5/1/18	STA 16 Masthope 6/5/18	STA 19N Saw 5/8/18	STA 25N Vandermark 5/25/18	STA 26N Rosetown 5/1/18	STA 33N Baliard 5/23/18
1. Instream Cover	18	17	18	16	18	19
2. Epifaunal Substrate	18	19	19	17	19	16
3. Embeddedness	18	16	17	15	18	18
4. Velocity/Depth Regimes	17	16	19	16	19	18
5. Channel Alteration	17	19	18	15	17	19
6. Sediment Deposition	18	15	19	15	19	19
7. Frequency of Riffles	19	19	19	17	19	16
8. Channel Flow Status	18	20	18	18	16	19
9. Condition of Banks	18	19	18	16	15	20
10. Bank Vegetative Protection	17	20	18	15	15	20
11. Grazing or Other Disruptive Pressure	20	20	20	20	20	20
12. Riparian Vegetative Zone Width	19	19	20	14	14	20
TOTAL SCORE	218	219	223	194	209	224

Table 5. (cont.).

HABITAT PARAMETER	STA 35N Shohola 5/23/18	STA 36N Pond Eddy 5/30/18	STA 38N Rattlesnake 8/23/17	STA 40N West Falls 4/30/18	STA 56P UNT Masthope 4/27/18
1. Instream Cover	18	19	19	16	16
2. Epifaunal Substrate	18	18	17	18	17
3. Embeddedness	18	17	16	18	18
4. Velocity/Depth Regimes	17	20	18	16	17
4. Channel Alteration	19	20	16	17	20
5. Sediment Deposition	18	18	17	18	20
6. Frequency of Riffles	19	19	17	18	19
7. Channel Flow Status	20	19	18	17	20
8. Condition of Banks	20	19	15	17	20
10. Bank Vegetative Protection	20	20	18	17	20
11. Grazing or Other Disruptive Pressure	20	20	20	20	20
12. Riparian Vegetative Zone Width	19	20	20	18	20
TOTAL SCORE	226	229	211	210	227

HABITAT PARAMETER	STA 4 Toms 9/24/18	STA 6 Dingmans 9/24/18	STA 7 Adams 8/8/18	STA 8 Raymondskill 9/24/18	STA 16 Masthope 9/24/18	STA 40N West Falls 8/8/18
9. Instream Cover	18	18	17	17	18	16
10. Epifaunal Substrate	19	19	18	16	18	18
11. Embeddedness	18	18	17	18	17	18
4. Velocity/Depth Regimes	18	19	18	17	19	16
12. Channel Alteration	17	20	19	17	20	17
13. Sediment Deposition	18	19	17	18	17	18
14. Frequency of Riffles	18	19	18	16	19	18
15. Channel Flow Status	19	19	18	18	19	17
16. Condition of Banks	19	18	19	19	20	17
10. Bank Vegetative Protection	19	18	19	20	20	17
11. Grazing or Other Disruptive Pressure	20	20	20	20	20	20
12. Riparian Vegetative Zone Width	16	20	18	17	20	18
TOTAL SCORE	219	227	218	213	227	210

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

Table 6. Metric scores for seventeen benthic macroinvertebrate samples from Pike County stream sites (May/June, 2018).

METRIC	STA. 01 Saw	STA. 04 Toms	STA. 06 Dingmans	STA. 08 Raymondskill	STA. 10 Vandermark	STA. 11 Cummins
Total Taxa Richness	27	30	27	33	23	27
Diversity Index	2.30	2.81	2.46	2.90	2.14	2.64
EPT Taxa Richness	15	19	15	18	15	18
Hilsenhoff Biotic Index	3.12	2.05	2.42	4.64	2.04	1.62
Percent Intolerant	54.9	68.1	62.3	29.8	72.1	87.0
Modified Beck's Index	33	45	23	19	32	40
Index of Biotic Integrity	80.0	92.6	78.8	73.4	82.4	93.0

METRIC	STA. 12 Bush Kill	STA. 16 Masthope	STA. 19N Saw	STA. 25N Vandermark	STA. 26N Rosetown	STA. 33N Balliard
Total Taxa Richness	24	31	29	31	16	25
Diversity Index	2.52	2.99	2.83	2.93	2.01	2.74
EPT Taxa Richness	15	20	17	20	11	19
Hilsenhoff Biotic Index	1.87	2.56	2.52	2.63	1.15	2.50
Percent Intolerant	76.1	61.8	76.8	66.7	93.2	63.9
Modified Beck's Index	34	28	32	39	27	33
Index of Biotic Integrity	86.7	88.5	90.8	91.9	75.3	88.3

METRIC	STA. 35N Shohola	STA. 36N Pond Eddy	STA. 38N Rattlesnake	STA. 40N WestFalls	STA. 56P UNP Westfalls	
Total Taxa Richness	28	25	28	27	25	
Diversity Index	2.22	2.53	2.56	2.32	2.74	
EPT Taxa Richness	16	16	19	18	19	
Hilsenhoff Biotic Index	2.86	1.47	2.46	1.30	2.50	
Percent Intolerant	66.7	62.9	66.5	80.5	63.9	
Modified Beck's Index	22	33	27	38	33	
Index of Biotic Integrity	78.0	89.4	86.1	90.3	88.3	

Six of the 17 stations surveyed in 2018 showed significantly higher IBI scores than over the past 10 years. They included Cummins Creek (11), Saw Creek (19N), Vandermark Creek (25N), Rosetown Creek (26N), Balliard Creek (33N), and Westfalls Creek (40N). The remaining sites showed no significant change or had too few years sampled to make a statistical analysis.

FISH

Six 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 7 – Appendix B). The streams surveyed fell into one of five width categories ranging from 1 (<10 feet) to 5 (>60 feet). Of the six (6) stream stations, one (Tom’s Creek) had no upstream impoundments and the remainder had more than three. The watershed for each site ranged from 1.2 to 31.5 square miles.

Trout species were present at three of the six stream sites surveyed. Brook and brown trout were collected from Tom’s Creek (04) while brown trout were collected from Dingmans Creek (06) and Westfalls Creek (40N) - Table 7. Largemouth bass were collected from Adams Creek (07). They were probably migrants from an upstream impoundment. No game fish were collected from Raymondskill Creek (08) or Masthope Creek (16).

Table 7. Stream fish communities sampled for width category, impoundments in watershed, drainage area (square miles), % storage area (ponds, lakes, wetlands) and game fish present in Pike County, PA (August/September, 2018).

STREAM SAMPLED	SITE ID	WIDTH CATEGORY	IMPOUNDMENTS ABOVE SAMPLE SITE	DRAINAGE BASIN AREA	% STORAGE AREA	GAME FISH PRESENT
Tom’s Creek	04	2	0	1.2	4%	Brook trout and brown trout
Dingmans Creek	06	3	>3	13.1	12%	Brown trout
Adams Creek	07	2	>3	4.6	5%	Largemouth bass
Raymondskill Creek	08	3	>3	30.0	13%	
Masthope Creek	16	3	>3	31.5	8%	
Westfalls Creek	40N	2	>3	6.9	6%	Brown trout

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 are less tolerant to thermal stress and sedimentation than brown trout and are usually associated with springs and headwater regions of watersheds. Brook trout also require high concentrations of dissolved oxygen to survive. Therefore, brook trout 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, Westfalls Creek and Dingmans Creek. Twenty-four YOY brown trout were

collected in Tom's Creek, nine in Westfalls Creek and one in Dingmans Creek (Appendix B).

A total of 15 species of fish were collected from the six streams surveyed in August and September of 2018 (Table 8). Blacknose dace were the dominant forage fish and found at all six sites. The American eel (*Anguilla rostrata*), which is a catadromous fish (living in fresh water and spawning in salt water), was found at Masthope Creek (16) and Westfalls Creek (40N). Sea lamprey, which is an anadromous fish (living in salt water and spawning in freshwater) was also collected in Masthope Creek. Masthope Creek and Raymondskill Creek (08) had the greatest diversity of fish with 8 and 7 species present, respectively.

Fish species were classified for calculation of an index of biotic integrity at each station surveyed (Table 9). 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 six (6) stream sites surveyed ranged from fourteen at Adams Creek to twenty-four at Tom's Creek – Table 9. Only Tom's Creek had an IBI index considered good (≥ 23) and approximating that found in high quality streams of the region. All but one of the stream sites had IBI scores that were significantly lower than previous years sampled (Ersbak, 1995-2017). Raymondskill Creek showed no significant deviation from the historical average. Elevated water levels from a season with much precipitation may have affected the IBI as sampling conditions were not ideal.

It is noteworthy, that of the 240 individual fish sampled, no external deformities (tumors, ulcers, etc.) indicative of stress resulting from chemical or physical pollutants were observed.

Table 8. Fish species collected from six stream sites in Pike County, PA (August/September, 2018).

		9/24/18	9/24/18	8/8/18	9/24/18	9/24/18	8/8/18
Scientific Name	Common Name	Toms 04	Dingmans 06	Adams 07	Raymondskill 08	Masthope 16	West Falls 40N
<i>Anguilla rostrata</i>	American eel					1	8
<i>Catostomus commersoni</i>	white sucker		1		1		
<i>Petromyzon marinus</i>	sea lamprey					1	
<i>Rhinichthys atratulus</i>	blacknose dace	50	5	28	3	15	25
<i>Rhinichthys cataractae</i>	longnose dace				4	4	
<i>Salmo trutta</i>	brown trout	34	1				13
<i>Salvelinus fontinalis</i>	brook trout	1					
<i>Micropterus salmoides</i>	largemouth bass			2			
<i>Exoglossum maxillingua</i>	cutlips minnow					3	
<i>Semotilus atromaculatus</i>	creek chub	4		4			
<i>Luxilus cornutus</i>	common shiner					3	
<i>Etheostoma olmstedii</i>	tessellated darter				2		
<i>Lepomis macrochirus</i>	bluegill	2			3		7
<i>Noturus insignis</i>	marginated madtom		1		4	2	
<i>Semotilus corporalis</i>	fallfish				2	6	
TOTAL		91	8	34	19	34	54

TABLE 9. Index of biotic integrity (IBI) test scores at 6 stream sites in Pike County, Pennsylvania (August/September, 2018).

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 04

Tom's Creek

IBI Metrics	Metric Value	Test Score
IS	1	3
TOL	59	1
CARN	38	5
STENO	38	1
ST	0	1
I	41	1
P	59	1
CPE	91	1
L	98	5
YOY	24	5

IBI Score = 24

STATION 06

Dingmans Creek

Metric Value	Test Score
1	3
13	3
13	3
13	1
0	1
25	1
63	1
8	1
88	3
0	1

IBI Score = 18

STATION 07

Adams Creek

Metric Value	Test Score
0	1
94	1
0	1
0	1
0	1
0	1
94	1
34	1
94	5
0	1

IBI Score = 14

STATION 08

Raymondskill Creek

IBI Metrics	Metric Value	Test Score
IS	1	3
TOL	21	3
CARN	0	1
STENO	16	1
ST	0	1
I	63	5
P	26	3
CPE	19	1
L	52	1
YOY	0	1

IBI Score = 20

STATION 16

Masthope Creek

Metric Value	Test Score
2	3
41	1
0	1
12	1
0	1
35	1
44	3
34	1
88	3
0	1

IBI Score = 16

STATION 40N

West Falls Creek

Metric Value	Test Score
0	1
46	1
39	5
52	3
0	1
52	3
61	1
54	1
70	1
9	3

IBI Score = 20

RECOMMENDATIONS

PCCD should 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 revised schedule of sampling established, if necessary. It is important that all macroinvertebrate samples be collected between mid-April and the end of May as per PADEP protocols. Fish should be collected at the season low water mark, typically in August or September. This sampling schedule will maintain consistency with previous years of study and allow for better comparative analysis.

Based on historical data it is suggested the following be included in the 2019 sampling rotation for macroinvertebrate and fish populations:

Macroinvertebrates

- | | | |
|--------------------|-----------------|---------------------|
| • Sawkill 09 | Toms 20N | Westcolang 28N |
| • Twin Lakes 13 | Dingmans 22N | Teeduskung 29N |
| • Shohola 14 | Dwarfskill 23N | Kleinhans 30N |
| • Lackawaxen 15 | Walker Lake 27N | Big Bushkill 39N |
| • Wallenpaupack 17 | Lakawaxen 43N | Little Bushkill 44N |

Fish

- | | | |
|----------------------|------------------|------------------------------|
| • Big Bushkill 02 | Cummins 11 | East Branch Wallenpaupack 18 |
| • Little Bushkill 03 | Twin Lakes 13 | Vandermark 25N |
| • Vandermark 10 | Wallenpaupack 17 | Sawkill 24N |

The watershed of each sampling site should be mapped and further delineated by basin characteristics for both fish and macroinvertebrates. These data will assist in the interpretation of water quality indices. The USGS Streamstats Program (<http://streamstats.usgs.gov/ss/>) is an available software tool for this purpose.

Further testing should be considered for other new or existing stream sites threatened by environmental impacts or significant land use changes. Proposed large development projects should be considered in scheduling additional special study sites in the County's water quality monitoring program.

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Appendix A.

Taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from seventeen stream sites in Pike County for 2018.

TAXON												
ORDER	POL.											
GENERA/SPECIES	TOL.	01	04	06	08	10	11	12	16	19N	25N	26N
AMPHIPODA (freshwater shrimp)												
<i>Gammarus spp.</i>	4										1	
BIVALVIA (clams)												
<i>Pisidium spp.</i>	8				23				1			
<i>Sphaerium spp.</i>	8				6							
Unionidae	4				1							
COLEOPTERA (beetles)												
<i>Stenelmis spp.</i>	5				3			1	22			
<i>Promoresia spp.</i>	2		1	1	2	2	21			1	1	
<i>Microcyloepus spp.</i>	2	4		12	15					3		
<i>Optioservus spp.</i>	4	1	1		4		5					
<i>Ancyronyx spp.</i>	2				1							
<i>Donacia spp.</i>	5										1	
<i>Psephenus herricki</i>	4	3	18	18	3	1		6	9	1	3	
<i>Ectopria spp.</i>	2							1				
DECAPODA (crayfish)												
<i>Cambarus spp.</i>	6	1	1	1								
DIPTERA (true flies)												
Chironomidae	8	25	17	32	20	25	5	30	11	8	23	2
<i>Blepharicera spp.</i>	0	2	7	4		18	25	7			11	6
<i>Tipula spp.</i>	4	1		1				1				2
<i>Hexatoma spp.</i>	2		8			1	1	2			5	
<i>Dicranota spp.</i>	3									2		
<i>Atherix spp.</i>	2								1			
<i>Hemerodromia spp.</i>	6	1	1									
<i>Antocha spp.</i>	3	1			1	3	1			4	2	
<i>Prosimulium spp.</i>	2	45	3				48	8		4		63
<i>Simulium spp.</i>	6			1			7			5		
EPHEMEROPTERA (mayflies)												
<i>Epeorus spp.</i>	0	15	32		2	59	17	30	16	5	14	58
<i>Mccaffertium spp.</i>	3	3		1	6			1		25		
<i>Ephemerella spp.</i>	1	9	23		3	4	12	49	12	38	21	14
<i>Eurylophella spp.</i>	4										1	
<i>Drunella spp.</i>	1	1			2				1	2	4	
<i>Seratella spp.</i>	2	1		1	1	2			6		1	
<i>Paraleptophlebia spp.</i>	1		1	1		3	4	3			10	3
<i>Cinygmula spp.</i>	1		5			1	3				1	10
<i>Isonychia spp.</i>	3		2	1	5			1	8	10		
<i>Ameletus spp.</i>	0		1									
<i>Baetis spp.</i>	6		16	1	3	2	4		1	2	1	6
<i>Acerpenna spp.</i>	6									9		

TAXON												
ORDER	POL.	01	04	06	08	10	11	12	16	19N	25N	26N
GENERA/SPECIES	TOL.											
EPHEMEROPTERA (mayflies)												
<i>Diphetor spp.</i>	6										2	
<i>Acentrella spp.</i>	4	21			2							
GASTROPODA (snails)												
Planorbidae	6								1			
Ferrissia spp.	7			2					1			
HIRUDINEA (leeches)												
Hirudinea cocoon	8					10					13	
MEGALOPTERA (hellgramites)												
<i>Sialis spp.</i>	6								1			
<i>Corydalus spp.</i>	4				4				1	1		
<i>Nigronia spp.</i>	2	2	2	1	5		1	5	6	2	3	
ODONATA (dragon flies)												
<i>Argia spp.</i>	6			3								
<i>Gomphidae</i>	4				1							
<i>Ophiogomphus spp.</i>	1								3	1		
<i>Lanthus spp.</i>	5	1	2									
OLIGOCHAETA (worms)	10	1		10	2	2				2	4	1
PLECOPTERA (stoneflies)												
<i>Leuctra spp.</i>	0		2	54	1	1	2	3	3	1	3	
<i>Amphinemura spp.</i>	3					1	1		3	6	1	
<i>Pteronarcys spp.</i>	0	1	2				6	4		4		
<i>Acroneuria spp.</i>	0	11	28	30	4		4	8	7	5	7	2
<i>Paragnetina spp.</i>	1	2	4						5		1	
<i>Agnetina spp.</i>	1					2	2	2			1	
<i>Tallaperla spp.</i>	0		3				2	3				3
<i>Suwallia/Sweltsa spp.</i>	0		1				2	13			3	26
<i>Isoperla spp.</i>	2		2			2	3		4	14		
TRICHOPTERA (caddisflies)												
<i>Chimarra spp.</i>	4			7	28				1			
<i>Dolophilodes spp.</i>	0	1	1	3		1	1		23	3	1	
<i>Neophylax spp.</i>	3			2		2		3	1			
<i>Hydropsyche spp.</i>	5		2	1								
<i>Ceratopsyche spp.</i>	5	4	8	3		1	1		13	11	3	3
<i>Cheumatopsyche spp.</i>	6	25			3		1	7	5	3		
<i>Diplectrona spp.</i>	0	1	5	18		9	9	2		1	8	3
<i>Macrostemum spp.</i>	6				12							
<i>Rhyacophila spp.</i>	1	1	8	5		3	5		9	9	7	5
<i>Lepidostoma spp.</i>	1							7	6		2	
<i>Psilotreta spp.</i>	0	1				1						
<i>Ceraclea spp.</i>	3				1							

TAXON												
ORDER	POL.	01	04	06	08	10	11	12	16	19N	25N	26N
GENERA/SPECIES	TOL.											
TRICHOPTERA (caddisflies)												
<i>Oecetis spp.</i>	8				1							
<i>Micrasema spp.</i>	2				1					1		
<i>Polycentropus spp.</i>	6			1	1				2			
<i>Pycnopsyche spp.</i>	4				1				1			
TOTAL		184	207	215	168	154	193	197	183	181	159	207

METRICS		01	04	06	08	10	11	12	16	19N	25N	26N
Total Taxa Richness		27	30	27	33	23	27	24	31	29	31	16
Shannon Diversity Index		2.30	2.81	2.46	2.90	2.14	2.64	2.52	2.99	2.83	2.93	2.01
EPT Taxa Richness		15	19	15	18	15	18	15	20	17	20	11
Hilsenhoff Biotic Index		3.12	2.05	2.42	4.64	2.04	1.62	1.87	2.56	2.52	2.63	1.15
Percent Intolerant Individuals		54.9	68.1	62.3	29.8	72.1	87.0	76.1	61.8	76.8	66.7	93.2
Modified Beck's Index		33	45	23	19	32	40	34	28	32	39	27
Index of Biotic Integrity		80.0	92.6	78.4	73.4	82.4	93.0	86.7	88.5	90.8	91.9	75.3

TAXON									
ORDER									
GENERA/SPECIES	POL TOL.	35N	36N	38N	40N	56P	33N		
BIVALVIA (clams)									
<i>Pisidium spp.</i>	8	12		1			1		
COLEOPTERA (beetles)									
<i>Stenelmis spp.</i>	5	4		2					
<i>Promoesia spp.</i>	2	6	5	16		3			
<i>Microcylloepus spp.</i>	2						11		
<i>Optioservus spp.</i>	4	3				1			
<i>Psephenus herricki</i>	4		7		11		8		
<i>Ectopria spp.</i>	2		1			1			
DIPTERA (true flies)									
Chironomidae	8	24	10	40	3	12	37		
<i>Blepharicera spp.</i>	0	1			2				
<i>Bezzia spp.</i>	6					1			
<i>Tipula spp.</i>	4				9				
<i>Hexatoma spp.</i>	2				3				
<i>Dicranota spp.</i>	3	1	1	1	1	2			
<i>Atherix spp.</i>	2			2					
<i>Antocha spp.</i>	3					1			
<i>Prosimulium spp.</i>	2				1	50			
<i>Simulium spp.</i>	6	5	10						
EPHEMEROPTERA (mayflies)									
<i>Epeorus spp.</i>	0		15	1	71	26	3		
<i>Mccaffertium spp.</i>	3	4		5					
<i>Ephemerella spp.</i>	1	84	37	4	22	53	15		
<i>Eurylophella spp.</i>	4					1			
<i>Drunella spp.</i>	1		1	1			5		
<i>Serratella spp.</i>	2						2		
<i>Paraleptophlebia spp.</i>	1	1	9		1				
<i>Isonychia spp.</i>	3				3	1			
<i>Baetis spp.</i>	6		2	6	9	5	3		
<i>Acerpenna spp.</i>	6	2							
GASTROPODA (snails)									
<i>Planorbella spp.</i>	6	1							
HIRUDINEA (leeches)									
Hirudinea (cocoon)	8		3						
LEPIDOPTERA (butterflies)									
Lepidoptera	5						1		
MEGALOPTERA (hellgrammites)									
<i>Sialis spp.</i>	6			1					
<i>Nigronia spp.</i>	2	2	2	6	1		2		

TAXON											
ORDER	POL.										
GENERA/SPECIES	TOL.	35N	36N	38N	40N	56P	33N				
ODONATA (dragon flies)											
<i>Boyeria spp.</i>	2	2									
<i>Gomphidae</i>	4				1						
<i>Stylogomphus spp.</i>	4					2					
<i>Ophiogomphus spp.</i>	1			1							
<i>Lanthus spp.</i>	5					1					
OLIGOCHAETA (worms)	10	2	1								
PLECOPTERA (stoneflies)											
<i>Leuctra spp.</i>	0	6	4	46		2	16				
<i>Amphinemura spp.</i>	3	2	3	5	1	7					
<i>Pteronarcys spp.</i>	0		5	6	6	1					
<i>Acroneuria spp.</i>	0	2	6	20	6		21				
<i>Paragnetina spp.</i>	1				7		1				
<i>Tallaperla spp.</i>	0				10	16					
<i>Suwallia/Sweltsa spp.</i>	0				2						
<i>Cultus spp.</i>	2				3						
<i>Diploperla spp.</i>	2	1									
<i>Isoperla spp.</i>	2	3	3	1	1	2	1				
TRICHOPTERA (caddisflies)											
<i>Chimarra spp.</i>	4	4		3			4				
<i>Dolophilodes spp.</i>	0		7	5	1		10				
<i>Neophylax spp.</i>	3					1	9				
<i>Hydropsyche spp.</i>	5	3		2							
<i>Ceratomyza spp.</i>	5	1		3	12	3					
<i>Cheumatopsyche spp.</i>	6			1			8				
<i>Diplectrona spp.</i>	0		54		3	7	1				
<i>Rhyacophila spp.</i>	1	2	10	9	3	6	5				
<i>Lepidostoma spp.</i>	1		1								
<i>Psilotreta spp.</i>	0						6				
<i>Psychomyia spp.</i>	2	1									
<i>Agapatus spp.</i>	5						7				
<i>Ceraclea spp.</i>	3	1									
<i>Oecetis spp.</i>	8			1							
<i>Micrasema spp.</i>	2	3	1								
<i>Polycentropus spp.</i>	6			4			2				
<i>Pycnopsyche spp.</i>	4		1	1	2	2	1				

TOTAL

183 199 194 195 207 180

METRICS

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

Index of Biotic Integrity

35N	36N	38N	40N	56P	33N					
28	25	28	27	25	25					
2.22	2.53	2.56	2.32	2.32	2.74					
16	16	19	18	15	19					
2.86	1.47	2.46	1.30	1.72	2.50					
66.7	82.9	66.5	80.5	86.5	63.9					
22	33	27	38	23	33					
78.0	89.4	86.1	90.3	82.6	88.3					

Appendix B

Taxa, numbers, and site description for the six electrofishing stream sites in Pike County for 2018.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY

Stream/River – Tom's Creek Township - Lehman DEP Water Use Classification EV

Site I.D. #04 Date – 9/24/2018

Location – starting downstream of Milford Road bridge

Sampling duration – 20 minutes Sampling Distance – 140 feet

Sampling area (ft2) – 2,800 Mean Stream Width – 20 feet

Weather /Comments – partly cloudy, high water

Temperature -14.2 Celsius Dissolved Oxygen – 12.37 ppm pH - 7.5 Alkalinity- 20

Gear used - Backpack Electroshocker Habitat rating – 219 Conductivity- 118 uS/cm

Voltage - 300 Stream Width Category - 2

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (young of year)	24	0
<i>Salmo trutta</i>	Brown trout (adult)	10	0
<i>Salvelinus fontinalis</i>	Brook Trout (adult)	1	0
<i>Lepomis macrochirus</i>	Bluegill	2	0
<i>Semotilus atromaculatus</i>	Creek chub	4	0
<i>Rhinichthys atratulus</i>	Blacknose dace	50	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 – Dingmans Creek Township - Delaware DEP Water Use Classification HQCWF

Site I.D. #6 Date – 9/24/2018

Location – upstream of Milford Road bridge, down hill from Silver Lake Road

Sampling duration – 20 minutes Sampling Distance – 203 feet

Sampling area (ft²) – 4,791 Mean Stream Width – 23.6 feet

Weather /Comments – high water

Temperature – 15.8 Celsius Dissolved oxygen – 11.87 ppm pH – 7.15 Alkalinity - 15

Gear used - Backpack Electroshocker Habitat rating – 227 Conductivity- 64.0 uS/cm

Voltage - 350 Stream Width Category - 2

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (young-of-year)	1	0
<i>Noturus insignis</i>	Margined madtom	1	0
<i>Catostomus commersonii</i>	White sucker	1	0
<i>Rhinichthys atratulus</i>	Blacknose dace	5	0
			0

TOTAL 8

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

FISH FIELD COLLECTION DATA SHEET
PIKE COUNTY WATER QUALITY
SURVEY

Stream/River - Adams Creek Township - Delaware DEP Water Use Classification EV

Site I.D. #07 Date – 8/8/2018

Location – 200 feet upstream of 2001 road bridge

Sampling duration – 20 minutes Sampling Distance – 203 feet

Sampling area (ft²) – 3,553 Mean Stream Width – 17.5 feet

Weather /Comments – high water

Temperature – 22.5 Celsius Dissolved oxygen – 9.30 mg/l pH – 6.96 Alkalinity - 20

Gear used - Backpack Electroshocker Habitat rating – 218 Conductivity- 100.8 uS/cm

Voltage - ? Stream Width Category - 2

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Micropterus salmoides</i>	Largemouth bass (young of year)	2	0
<i>Semotilus atromaculatus</i>	Creek chub	4	0
<i>Rhinichthys atratulus</i>	Blacknose dace	28	0

TOTAL 34

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Raymondskill Creek Township - Dingman DEP Water Use Classification HQCWF

Site I.D. #08 Date – 9/24/2018

Location – starting upstream of Milford Road bridge

Sampling duration – 20 minutes Sampling Distance – 320 feet

Sampling area (ft2) – 10,976 Mean Stream Width – 34.3 feet

Weather /Comments - high water

Temperature – 14.7 Celsius Dissolved oxygen – 10.97 ppm pH – 6.91 Alkalinity - 15

Gear used - Backpack Electroshocker Habitat rating – 213 Conductivity- 123 uS/cm

Voltage – 350 Stream Width Category - 3

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Lepomis macrochirus</i>	Bluegill	3	0
<i>Etheostoma olmstedii</i>	Tessellated darter	2	0
<i>Noturus insignis</i>	Margined madtom	4	0
<i>Salvelinus fontinalis</i>	Fallfish	2	0
<i>Rhinichthys atratulus</i>	Blacknose dace	3	0
<i>Rhinichthys cataractae</i>	Longnose dace	4	0
<i>Catostomus comersonii</i>	White sucker	1	0

TOTAL 19

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Masthope Creek Township – Lackawaxen DEP Water Use
 Site I.D. #16 Date – 9/24/2018 Classification HQCWF

Location – Starting upstream of McKay driveway on Masthope Plank Road

Sampling duration – 20 minutes Sampling Distance - 159

Sampling area (ft²) – 5,676 Mean Stream Width – 35.7 feet

Weather /Comments – high water

Temperature – 13.8 Celsius Dissolved oxygen – 12.7 ppm pH – 7.41 Alkalinity - 20

Gear used - Backpack Electroshocker Habitat rating – 227 Conductivity- 91 uS/cm

Voltage - 300 Stream Width Category - 3

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Semotilus corporalis</i>	Fallfish	6	
<i>Luxilus cornutus</i>	Common shiner	3	
<i>Noturus insignis</i>	Margined madtom	2	
<i>Anguilla rostrata</i>	American eel	1	
<i>Rhinichthys atratulus</i>	Blacknose dace	14	
<i>Exoglossum maxillingua</i>	Cutlips minnow	3	
<i>Petromyzon marinus</i>	Sea lamprey	1	
<i>Rhinichthys cataractae</i>	Longnose dace	4	

TOTAL 34

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Westfalls Creek Township – Lackawaxen DEP Water Use Classification HQCWF

Site I.D. #40N Date – 8/8/2018

Location – starting upstream of Church Road bridge

Sampling duration – 20 minutes Sampling Distance – 180 feet

Sampling area (ft²) – 3,582 Mean Stream Width – 19.9 feet

Weather /Comments – high water

Temperature – 20.1 Celsius Dissolved oxygen – 10.05 pH - 7.07 Alkalinity - 20

Gear used - Backpack Electroshocker Habitat rating – 210 Conductivity- 152 uS/cm

Voltage - 250 Stream Width Category - 2

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (juvenile/adult)	9	0
<i>Salmo trutta</i>	Brown trout (young-of-year)	4	0
<i>Anguilla rostrata</i>	American eel	8	0
<i>Lepomis macrochirus</i>	Bluegill	7	0
<i>Rhinichthys atratulus</i>	Blacknose dace	25	0

TOTAL 54

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