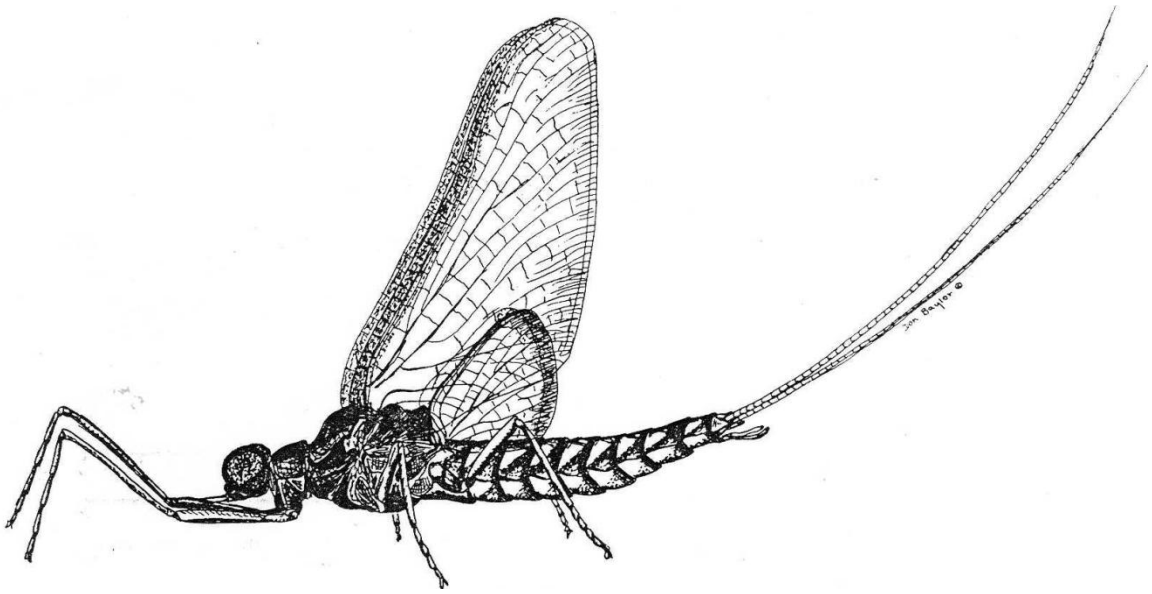
ENVIRONMENTAL QUALITY
OF
PIKE COUNTY STREAMS



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ENVIRONMENTAL QUALITY OF PIKE COUNTY STREAMS

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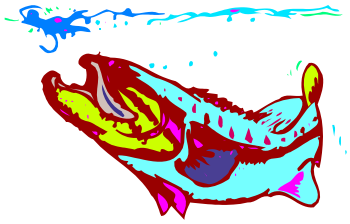

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INTRODUCTION

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, 2016 at one baseline stream site and six non-point 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, 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 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.

IBI Metrics	Scoring Criteria 5	3	1
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

Seven baseline and 10 non-point study stations were sampled for benthic macroinvertebrates in May, 2016 (Appendix A). One baseline and six non-point stations were sampled for fish in August, 2016 (Appendix B). Following are descriptions and co-ordinates for the macroinvertebrate and fish stations:

<u>Macroinvertebrates</u>

Station 01 – Saw Creek, Lehman Township; $41^0$05’22.78”N-$75^0$02’19.28”W

Station 02 – Big Bushkill Creek, Lehman Township; $41^0$05’26.43”N-$75^0$00’15.59”W

Station 03 – Little Bushkill Creek, Lehman Township; $41^0$05’29.35”N-$75^0$00’15.26”W

Station 04 – Toms Creek, Lehman Township; $41^0$09’07.37”N-$74^0$57’14.91”W

Station 07 – Adams Creek, Delaware Township; $41^0$15’40.86”N-$74^0$53’23.59”W

Station 09 – Sawkill Creek, Milford Township; $41^0$19’01.27”N-$74^0$47’58.17”W

Station 15 – Lackawaxen River, Lackawaxen Township; $41^0$28’32.85”N-$75^0$02’08.88”W

Station 20N – Toms Creek, Lehman Township, $41^0$08’33.25”N-$74^0$57’44.76”W

Station 22N – Dingmans Creek, Delaware Township, $41^0$14'16.61"N-$74^0$55'08.07"W

Station 23N – Dwarfskill Creek, Dingman Township, $41^0$17'49.70"N-$74^0$54'26.65"W

Station 27N – Walker Lake Creek, Shohola Township, $41^0$25'40.68"N-$74^0$54'37.86"W

Station 28N – Westcolang Creek, Lackawaxen Township,$41^0$30'39.97"N-$75^0$00'22.13"W

Station 29N – Teedyuskung Creek, Lackawaxen Township; $41^0$29'15.21"N-$75^0$06'20.71"W

Station 30N – Kleinhans Creek, Palmyra Township; $41^0$22'15.81"N-$75^0$15'07.50"W

Station 38N – Rattlesnake Creek, Lackawaxen Township; $41^0$33'02.88"N-$75^0$05'39.67"W

Station 43N – Lackawaxen Creek, Lackawaxen Township; $41^0$28'12.44"N-$75^0$07'52.88"W

Station 44N – Little Bushkill Creek, Lehman Township; $41^0$07'57.77"N-$75^0$00'31.01"W

Fish

Station 01 – Saw Creek, Lehman Township; 41.05'20.20"N/75.02'22.40"W

Station 19N – Saw Creek, Lehman Township; 41.08'9.48"N/75.03'16.37"W

Station 22N – Dingman Creek, Dingman Township; 41.13'54.9"N/74.54'38.7"W

Station 23N – Dwarfskill Creek, Shohola Township; 41.17'48.92"N/74.54'24.30"W.

Station 35N – Shohola Creek, Blooming Grove Township; 41.21'35.4"N/75.03'21.3"W.

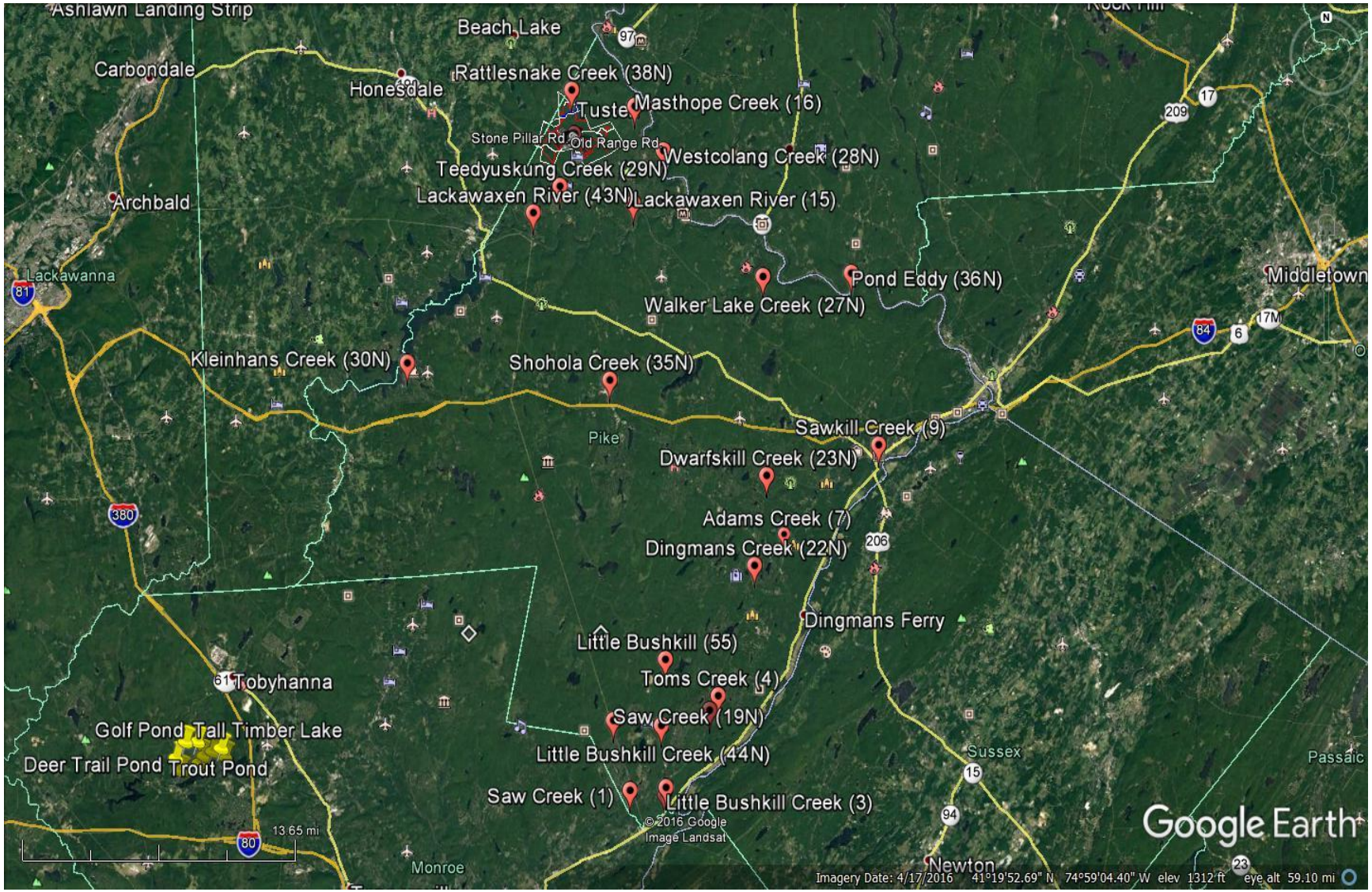
Station 36N – Pond Eddy Creek, Shohola Township; 41.17'47.6"N/75.54'22.1"W.

Station 55 – Little Bushkill Creek, Lehman Township; 41.10'34.58"N/75.0.0'16.58"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). pH readings were notably high at nine of the seventeen sites (>7.9 units) and not comparable to previous studies (Ersbak, 1995-2015). Meter error may have been the cause for this discrepancy. Conductivity readings at each site were generally low


Ashlawn Landing Strip
Beach Lake
Carbondale
Honesdale
Rattlesnake Creek (38N)
Masthope Creek (16)
Stone Pillar Rd
Old Range Rd
Westcolang Creek (28N)
Teedyuskung Creek (29N)
Lackawaxen River (43N)
Lackawaxen River (15)
Archbald
Lackawanna
Pond Eddy (36N)
Middletown
Walker Lake Creek (27N)
Kleinhans Creek (30N)
Shohola Creek (35N)
Pike
Sawkill Creek (9)
Dwarfskill Creek (23N)
Adams Creek (7)
Dingmans Creek (22N)
Dingmans Ferry
Little Bushkill (55)
Toms Creek (4)
Tobyhanna
Saw Creek (19N)
Golf Pond
Tall Timber Lake
Deer Trail Pond
Trout Pond
Little Bushkill Creek (44N)
Sussex
Passaic
Saw Creek (1)
Little Bushkill Creek (3)
13.65 mi
© 2016 Google
Image Landsat
Monroe
Newton
Google Earth
Imagery Date: 4/17/2016 41°19'52.69" N 74°59'04.40" W elev 1312 ft eye alt 59.10 mi

suggesting limited concentrations of dissolved or filterable solids such as minerals, metals, or man-made wastes. 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 µmhos/cm.

Habitat

All but one of the 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 and the one that fell in the suboptimal or marginal category is shown in blue (PA DEP, 2007). The site with sub-optimal habitat was Station 55 on the Little Bushkill 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.).

Habitat scores for Pike County streams over the past six years have averaged 215 and the average has ranged from 201 to 229 units (Ersbak, 2010-2015). Subjective scoring criteria by different field teams have been fairly consistent.

Benthic Macroinvertebrates

Appendix A shows the taxa, numbers, and pollution tolerance values for the benthic macroinvertebrates from 7 baseline and 10 non-point stream sites in Pike County for 2016. 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 $\geq$80 for EV (exceptional value), HQ (high quality) protected use are highlighted in blue, those exceeding the benchmark of $\geq$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 seventeen stations sampled in 2016, sixteen had IBI scores high enough to qualify for special protection HQ and EV waters (Table 6). One 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. Station 7, Adams Creek and Station 9, Sawkill Creek had the highest IBI scores of 91.2 and 93.6, respectively. Teedyuskung Creek (29N) had the lowest score of 54.9.

Nine of the 17 stations surveyed in 2016 showed significantly higher IBI scores than over the past 10 years. They included Saw Creek (01), Big Bushkill Creek (02), Adams Creek (07), Sawkill Creek (09), Lackawaxen River (15), Tom's Creek (20N), Dingman's Creek (22N), Westcolang Creek (28N), and Kleinhans Creek (30N). Only Teedyuskung Creek (29N) had a significantly lower than average score. The remaining sites showed no significant change or had too few years sampled to make a statistical analysis.

Table 4. Physical and chemical field data from seventeen Pike County stream sites (May, 2016) – Pennsylvania Department of Environmental Protection 2009.

PARAMETER	STA. 01 Saw Creek	STA. 02 Bushkill	STA. 03 Little Bushkill	STA. 04 Toms	STA. 07 Adams	STA. 09 Sawkill
Sample Date	5/12/16	5/19/16	5/12/16	5/11/16	5/6/16	5/6/16
Temperature (°C)	12.9	15.0	13.6	10.2	11.0	10.7
Dissolved Oxygen (mg/l)	10.84	9.96	10.66	11.77	10.24	10.84
pH	8.36	7.96	7.85	7.91	8.67	7.49
Conductivity (µmhos/cm)	70.8	68.0	48.1	112.2	76.2	108.5
Alkalinity (mg/l)	25	20	20	20	15	20
PARAMETER	STA. 15 Lackawaxen	STA 20N Toms	STA. 22N Dingmans	STA.23N Dwarfskill	STA.27N Walker Lake	STA.28N Westcolang
Sample Date	5/18/16	5/11/16	5/11/16	5/6/16	5/6/16	5/19/16
Temperature (°C)	13.4	10.9	13.2	10.8	11.9	12.4
Dissolved Oxygen (mg/l)	11.16	10.92	10.05	10.39	9.75	10.33
pH	8.68	7.75	7.69	7.66	7.18	7.65
Conductivity (µmhos/cm)	81.0	120.1	69.6	126.8	58.7	106.1
Alkalinity (mg/l)	25	20	20	20	15	15
PARAMETER	STA.29N Teedyuskung	STA.30N Kleinhans	STA.38N Rattlesnake	STA.43N Lackawaxen	STA.44N Little Bushkill	
Sample Date	5/18/16	5/11/16	5/19/16	5/26/16	5/12/16	
Temperature (°C)	12.5	11.8	12.3	17.8	16.6	
Dissolved Oxygen (mg/l)	10.57	15.30	10.12	8.45	10.36	
pH	8.15	8.30	7.94	8.07	8.01	
Conductivity (µmhos/cm)	162.6	93.4	33.1	107.3	41.4	
Alkalinity (mg/l)	20	20	15	40	10	

Table 5. Habitat assessment of twenty-four sampling stations on Pike County streams (2016) - Pennsylvania Department of Environmental Protection. 2009.						
HABITAT PARAMETER	STA. 01 Saw Creek 5/12/16	STA. 02 Big Bushkill 5/19/16	STA. 03 Little Bushkill 5/12/16	STA. 04 Tom's 5/11/16	STA. 07 Adams 5/6/16	STA. 09 Sawkill 5/6/16
1. Instream Cover	18	20	18	15	14	18
2. Epifaunal Substrate	20	20	20	16	19	18
3. Embeddedness	20	20	18	16	18	17
4. Velocity/Depth Regimes	19	20	19	17	15	13
5. Channel Alteration	19	18	19	16	19	14
6. Sediment Deposition	20	20	20	14	19	19
7. Frequency of Riffles	20	20	20	18	19	18
8. Channel Flow Status	20	20	17	19	19	18
9. Condition of Banks	17	20	19	19	15	17
10. Bank Vegetative Protection	16	20	19	20	19	15
11. Grazing or Other Disruptive Pressure	20	20	20	20	20	20
12. Riparian Vegetative Zone Width	19	18	19	17	20	14
TOTAL SCORE	228	236	228	207	216	201
Score ranges: Optimal 240-192, Suboptimal 180-132, Marginal 120-72, Poor <60						

Table 5. (cont.).

HABITAT PARAMETER	STA.15 Lackawaxen 5/18/16	STA 20N Toms 5/11/16	STA 22N Dingmans 5/11/16	STA. 23N Dwarfskill 5/6/16	STA.27N Walker Lake 5/6/16	STA. 28N Westcolang 5/19/16
1. Instream Cover	19	19	18	18	17	20
2. Epifaunal Substrate	18	18	19	18	17	20
3. Embeddedness	19	18	19	16	13	20
4. Velocity/Depth Regimes	18	20	19	17	15	20
5. Channel Alteration	20	19	16	20	20	19
6. Sediment Deposition	17	20	19	16	19	20
7. Frequency of Riffles	18	19	19	18	19	20
8. Channel Flow Status	19	20	19	19	19	20
9. Condition of Banks	20	19	20	18	19	20
10. Bank Vegetative Protection	20	17	18	19	15	20
11. Grazing or Other Disruptive Pressure	20	20	20	20	20	20
12. Riparian Vegetative Zone Width	18	19	18	15	14	20
TOTAL SCORE	226	228	224	214	207	239

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

Table 5. (cont.).

HABITAT PARAMETER	STA.29N Teedyuskung 5/18/16	STA.30N Kleinhans 5/11/16	ST.38N Rattlesnake 5/19/16	STA 43N Lackawaxen 5/26/16	STA 44N Little Bushkill 5/12/16
1. Instream Cover	20	19	20	20	20
2. Epifaunal Substrate	19	20	20	20	20
3. Embeddedness	20	20	19	19	19
4. Velocity/Depth Regimes	18	19	19	20	20
5. Channel Alteration	16	19	20	20	20
6. Sediment Deposition	20	20	19	20	20
7. Frequency of Riffles	20	20	20	20	20
8. Channel Flow Status	18	19	20	19	20
9. Condition of Banks	17	19	20	20	20
10. Bank Vegetative Protection	17	18	20	20	20
11. Grazing or Other Disruptive Pressure	20	20	20	20	20
12. Riparian Vegetative Zone Width	18	20	20	20	20
TOTAL SCORE	223	233	237	238	239

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

Table 5. (cont.).

HABITAT PARAMETER	STA. 01 Saw Creek 8/31/16	STA.19N Saw Creek 8/31/16	STA.22N Dingmans 8/24/16	STA. 23N Dwarfskill 8/24/16	STA. 35N Shohola 8/24/16
1. Instream Cover	20	18	20	16	18
2. Epifaunal Substrate	18	20	19	16	18
3. Embeddedness	19	18	20	19	18
4. Velocity/Depth Regimes	20	19	19	17	19
5. Channel Alteration	20	20	20	20	20
6. Sediment Deposition	20	20	20	19	20
7. Frequency of Riffles	20	19	18	19	17
8. Channel Flow Status	20	20	19	20	20
9. Condition of Banks	20	20	18	20	18
10. Bank Vegetative Protection	20	20	20	20	19
11. Grazing or Other Disruptive Pressure	20	20	20	20	20
12. Riparian Vegetative Zone Width	20	18	20	18	16
TOTAL SCORE	237	232	233	224	223

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

Table 5. (cont.).

HABITAT PARAMETER	STA. 36N Pond Eddy 8/24/16	STA.55 Little Bushkill 8/31/16
1. Instream Cover	19	18
2. Epifaunal Substrate	18	10
3. Embeddedness	18	12
4. Velocity/Depth Regimes	19	11
5. Channel Alteration	20	13
6. Sediment Deposition	20	13
7. Frequency of Riffles	19	11
8. Channel Flow Status	20	18
9. Condition of Banks	18	20
10. Bank Vegetative Protection	20	20
11. Grazing or Other Disruptive Pressure	20	20
12. Riparian Vegetative Zone Width	20	20
TOTAL SCORE	231	186

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, 2016).

METRIC	STA. 01 Saw Creek	STA. 02 Big Bushkill	STA. 03 Little Bushkill	STA. 04 Tom's	STA 07 Adams	STA. 09 Sawkill
Total Taxa Richness	29	34	30	29	27	32
Diversity Index	2.85	2.84	2.66	2.77	2.68	2.98
EPT Taxa Richness	24	22	22	22	18	22
Hilsenhoff Biotic Index	3.56	40.3	2.97	3.06	1.83	2.45
Percent Intolerant Individuals	40.1	34.6	50.9	54.3	80.5	60.5
Modified Beck's Index	28	32	37	40	31	40
Index of Biotic Integrity	81.3	83.0	88.1	89.1	91.2	93.6

METRIC	STA.15 Lackawaxen	STA.20N Tom's	STA 22N Dingmans	STA. 23N Dwarfskill	STA.27N Walker Lake	STA.28N Westcolang
Total Taxa Richness	28	29	25	27	17	22
Diversity Index	2.70	2.58	1.93	3.24	2.30	2.32
EPT Taxa Richness	16	20	18	19	11	15
Hilsenhoff Biotic Index	2.85	2.67	2.34	2.59	2.10	1.33
Percent Intolerant Individuals	61.3	59.8	61.9	45.6	74.8	81.8
Modified Beck's Index	24	38	19	30	16	28
Index of Biotic Integrity	81.2	89.9	75.9	81.4	68.0	83.3

METRIC	STA.29N Teedyuskung	STA.30N Kleinhans	ST.38N Rattlesnake	ST. 43N Lackawaxen	STA.44N Little Bushkill
Total Taxa Richness	15	24	31	36	29
Diversity Index	1.69	2.60	2.75	2.79	2.88
EPT Taxa Richness	11	15	18	26	17
Hilsenhoff Biotic Index	4.26	2.43	3.55	4.03	2.77
Percent Intolerant Individuals	32.3	64.5	51.2	32.2	61.7
Modified Beck's Index	21	35	30	26	34
Index of Biotic Integrity	54.9	83.8	83.9	80.5	88.0

FISH

Seven 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 seven (7) stream stations, one had one upstream impoundment, two had two impoundments, and four had more than three.

Trout species were present at six of the seven stream sites surveyed. Brook and brown trout were collected from Pond Eddy Creek (36N), brook trout from Saw Creek (19N), Dwarfskill Creek (23N), and Shohola Creek (35N), and brown trout from Saw Creek (01) and Dingman's Creek (22N) - Table 7.

Table 7. Stream fish communities sampled for width category, impoundments in watershed, and game fish present in Pike County, PA (August, 2016)

STREAM SAMPLED	SITE ID	WIDTH CATEGORY	IMPOUNDMENTS ABOVE SAMPLE SITE	GAME FISH PRESENT
Saw Creek	01	3	>3	Brown trout
Saw Creek	19N	3	>3	Brook trout
Dingmans Creek	22N	3	>3	Brown trout
Dwarfskill Creek	23N	2	>3	Brook trout
Shohola Creek	35N	3	1	Brook trout
Pond Eddy Creek	36N	2	2	Brook & brown trout
Little Bushkill Creek	55	3	2	

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 Saw Creek, Dwarfskill Creek, and Pond Eddy Creek. Five YOY brown trout were collected in Saw Creek and seventeen in Pond Eddy Creek (Appendix B). One YOY brook trout was found in Saw Creek, two in Dwarfskill Creek, and three in Pond Eddy Creek.

A total of 22 species of fish were collected from the seven streams surveyed in August of 2016 (Table 8). Blacknose dace 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 Saw Creek (01) and Dingman's Creek (22N). Saw Creek, at both station 01 and 19N, had the greatest diversity of fish with 11 species present.

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 seven (7) stream sites surveyed ranged from eighteen (18) at Dingman's Creek to thirty-six (36) at Pond Eddy Creek – Table 9. All of the sites except Dingman's Creek had IBI indices considered good ($\geq$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 biotic integrity and have changed little (Ersbak, 1995-2015). Only Shohola Creek Station 35N) had an IBI which deviated significantly from previous years sampled. It was slightly lower than the average.

It is noteworthy, that of the 520 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 seven stream sites in Pike County, PA (August, 2016).

		8/31/16	8/31/16	8/24/16	8/24/16	8/24/16	8/24/16	8/31/16
Scientific Name	Common Name	Saw Creek 01	Saw Creek 19N	Dingman 22N	Dwarfskill 23N	Shohola 35N	Pond Eddy 36N	Little Bushkill 55
Anguilla rostrata	American eel	44		1				
Catostomus commersoni	white sucker	12	3	3		9		
Erimyzon oblongus	creek chubsucker							2
Ameiurus nebulosus	brown bullhead							2
Rhinichthys atratulus	blacknose dace	24	14	22	50	1	16	
Rhinichthys cataractae	longnose dace	1	7	3				
Salmo trutta	brown trout	3		2			20	
Salvelinus fontinalis	brook trout		6		13	2	5	
Esox niger	chain pickerel				2	2		
Micropterus dolomieu	smallmouth bass	4						
Micropterus salmoides	largemouth bass		2	1	3			13
Pomoxis nigromaculatus	black crappie							1
Perca flavescens	Yellow perch				2			
Exoglossum maxillingua	cutlips minnow	26	20			1		
Semotilus atromaculatus	creek chub		6					
Luxilus cornutus	common shiner	2				35		
Notemigonus crysoleucas	golden shiner					1		2
Etheostoma olmstedi	tessellated darter	16	3			3		
Lepomis macrochirus	bluegill		1					8
Lepomis gibbosus	pumpkinseed			1				
Noturus insignis	margined madtom	2	7	20		19		26
Semotilus corporalis	fallfish	16	5					5
	TOTAL	**150**	**74**	**53**	**70**	**73**	**41**	**59**

TABLE 9. Index of biotic integrity (IBI) test scores at 7 stream sites in Pike County, Pennsylvania (August, 2016).

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 01

SAW CREEK

IBI Metrics	Metric Value	Test Score
IS	4	5
TOL	24%	3
CARN	34%	5
STENO	2%	1
ST	0%	1
I	56%	3
P	56%	3
CPE	131	3
L	56%	1
YOY	0	1
IBI Score =		**26**

STATION 19N

SAW CREEK

Metric Value	Test Score
2	3
23%	3
11%	3
9%	1
100%	5
40%	1
23%	3
74	1
75%	3
1	3
	26

STATION 22N

DINGMAN CREEK

Metric Value	Test Score
1	3
59%	1
8%	3
4%	1
0%	1
49%	3
55%	3
53	1
68%	1
0	1
	18

STATION 23N

DWARFSKILL CREEK

IBI Metrics	Metric Value	Test Score
IS	1	3
TOL	70%	1
CARN	25%	5
STENO	18%	1
ST	100%	5
I	18%	1
P	70%	1
CPE	72	1
L	88%	3
YOY	2	3
IBI Score =		**24**

STATION 35N

SHOHOLA CREEK

Metric Value	Test Score
3	5
15%	3
3%	1
3%	1
100%	5
81%	5
6%	5
73	1
66%	1
0	1
	28

STATION 36N

POND EDDY CREEK

Metric Value	Test Score
1	3
39%	1
61%	5
61%	3
20%	5
61%	5
39%	3
32	1
100%	5
19	5
	36

STATION 55
LITTLE
BUSHKILL
CREEK

IBI Metrics	Metric Value	Test Score				
IS	1	3				
TOL	7%	5				
CARN	22%	5				
STENO	0%	1				
ST	0%	1				
I	65%	5				
P	0%	5				
CPE	59	1				
L	12%	1				
YOY	0	1				
IBI Score =		**28**				

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 new schedule of sampling established if necessary.

The significantly lower IBI score for the macroinvertebrate population on Teedyuskung Creek (29N) is concerning. Another sample should be taken in 2017 to see if this low score was an anomaly or represents a decline in water quality.

The YSI meter for testing water quality should be calibrated to ensure accuracy in the field for all parameters tested. A factory certified calibration may be required.

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 2016.

2016 PIKE COUNTY MACROINVERTEBRATE DATA

TAXON ORDER *GENERA/SPECIES*	POL. TOL.	01	02	03	04	07	09	15	20N	22N	23N	27N	28N
AMPHIPODA (shrimp)													
Gammarus spp.	4							4					1
BIVALVIA (clams)													
Pisidium spp.	8							5				8	
COLEOPTERA (beetles)													
Stenelmis spp.	5	4	35	3		1	5			5			
Promoresia spp.	2			1		26	1	5			3		
Microcylloepus spp.	2			12				29				5	
Optioservus spp.	4		1					15	1		1		2
Psephenus herricki	4	3	9	14	15	9	20	2	20		14		1
Ectopria spp.	2						1				3		
DIPTERA (true flies)													
Chironomidae	8	43	17	55	44	13	26	20	36	23	23	36	20
Blepharicera spp.	0		1	1									
												1	
Tipula spp.	4	1					1						
Hexatoma spp.	2	1			4	2	2		4	1			
Dicranota spp.	3					1		1	1				2
Hemerodromia spp.	6											1	
Atherix spp.	2							2					
Antocha spp.	3	2	4			1	2	1	2				
Simulium spp.	6				1			2					
EPHEMEROPTERA (mayflies)													
Epeorus spp.	0	7	3	5	14	7	14		8	1	1		7
Mccaffertium spp.	3	5	14	1		5		2					
Ephemerella spp.	1	13	9	11	21	26	17	114	29		30	50	1
Eurylophella spp.	4	1	1										
Drunella spp.	1	2	5	8			2	42	10				
Seratella spp.	2	8	11	11	1		2	5	1				
Leucrocuta spp.	1		4	1									
Paraleptophlebia spp.	1	5	1	2	18	7	14		15				1
Cinygmula spp.	1				19		3		3				
Rithrogena spp.	3						2						
Isonychia spp.	3	1	3	1	9	1	3	1		1	1		
Plauditus spp.	4	4	5	4									
Diphetor spp.	6					1			1				

2016 PIKE COUNTY MACROINVERTEBRATE DATA

TAXON ORDER *GENERA/SPECIES*	POL. TOL.	01	02	03	04	07	09	15	20N	22N	23N	27N	28N
EPHEMEROPTERA (mayflies)													
Baetis spp.	6				34	6	10	10	14	28	4	2	9
Baetidae	6		3										
Acentrella spp.	4	24		16			7		3	3	1		
GASTROPODA (snails)													
Ferrissia spp.	7										5		
HIRUDINEA (leeches))													
Myzobdella spp.	7		3										
MEGALOPTERA (hellgramites)													
Chauliodes spp.	4		1					1					
Nigronia spp.	2		1	1	2	4	4		2	1	3	7	1
NEMATOMORPHA (horsehair worms)			1							1			
ODONATA (dragon flies)													
Boyeria spp.	2								1				
Lanthus spp.	5				6	1	2		2		5		
Argia spp.			1		1					1			
OLIGOCHAETA (worms)	10	9	1	1						1			1
PLECOPTERA (stoneflies)													
Leuctra spp.	0	3	3	7	1	26			9	75	14	53	50
Taenionema spp.	3												6
Amphinemura spp.	3	3		1	3	2	1			3	9	24	
Pteronarcys spp.	0		2			4			1		9	3	2
Acroneuria spp.	0	13	7	10	13	10	12	8	13	26	12	7	18
Paragnetina spp.	1	2		2	3		2		6		2		
Agnetina spp.	4	3					2						
Perlesta spp.	4	2						5					2
Suwallia/Sweltsa spp.	0			1	7		17						
Tallaperla spp.	0					1							1
Paranemoura spp.	2				1								
Diploperla spp.	2						2				5		7
Diura spp.	2										1		
Cultus spp.	2					12	1		4				
Isoperla spp.	2	1			2				1		2	5	8
TRICHOPTERA (caddisflies)													
Chimarra spp.	4			1		4				2	7		
Dolophilodes spp.	0	8	1	29	5	12	9	1		1	1		10
Hydropsyche spp.	5		1			2		3		1	1	2	
Ceratopsyche spp.	5	12	17	9	11	1	4	7	3	2	56		

2016 PIKE COUNTY MACROINVERTEBRATE DATA

TAXON ORDER *GENERA/SPECIES*	POL. TOL.	01	02	03	04	07	09	15	20N	22N	23N	27N	28N
TRICHOPTERA (caddisflies)													
Cheumatopsyche spp.	6	21	41	1				1		3		1	
Diplectrona spp.	0			3	4	1	1	2	2				50
Ceraclea spp.	3									1			
Rhyacophila spp.	1	1	2		2	5	4	3	2	4	1	3	4
Neophlax spp.	3									1		2	1
Lepidostoma spp.	1	3	3	1				1		1			
Brachycentrus spp.	1				1								
Hydatophylax spp.	2				1								
Glossosoma spp.	0										1		
Protoptila spp.	1	8							4				
Micrasema spp.	2				1								
Psilotreta spp.	0				1		2	2	1				
Psychomyia spp.	2									2			
Nyctiophylax spp	5		2										
Polycentropus spp.	6		1	1						1			
Pycnopsyche spp.	4	1											
TOTAL		212	214	214	245	190	195						

METRICS	01	02	03	04	07	09	15	20N	22N	23N	27N	28N
Total Taxa Richness	29	34	30	29	27	32	28	29	25	27	17	22
Shannon Diversity Index	2.85	2.84	2.66	2.77	2.68	2.98	2.70	2.58	1.93	3.24	2.30	2.32
EPT Taxa Richness	24	22	22	22	18	22	16	20	18	19	11	15
Hilsenhoff Biotic Index	3.56	4.03	2.97	3.06	1.83	2.45	2.85	2.67	2.34	2.59	2.10	1.33
Percent Intolerant Individuals	40.1	34.6	50.9	54.3	80.5	60.5	61.3	59.8	61.9	45.6	74.8	81.8
Modified Beck's Index	28	32	37	40	31	40	24	38	19	30	16	28
Index of Biotic Integrity	81.3	83.0	88.1	89.1	91.2	93.6	81.2	89.9	75.9	81.4	68.0	83.3

2016 PIKE COUNTY
MACROINVERTEBRATE DATA

TAXON ORDER *GENERA/SPECIES*	POL TOL.	29N	30N	38N	43N	44N
AMPHIPODA (shrimp)						
Gammarus spp.	4				3	
BIVALVIA (clams)						
Pisidium spp.	8			6		20
COLEOPTERA (beetles)						
Macronychus spp.	2					7
Stenelmis spp.	5			1	21	
Promoresia spp.	2			13	2	4
Stenelmis spp.	5					
Optioservus spp.	4		27	1	6	2
Psephenus herricki	4		1		26	
DECAPODA (crayfish)						
Cambarus spp.	6		1			
DIPTERA (true flies)						
Chironomidae	8	92	15	48	55	31
Hexatoma spp.	2		7			
Dicranota spp.	3	1				
Atherix spp.	2			2		
Antocha spp.	3		2		1	1
Blepharicera spp.	0		15			
Simulium spp.	6		1	2		1
EPHEMEROPTERA (mayflies)						
Epeorus spp.	0	6	40	1	4	6
Mccaffertium spp.	3	1		4	10	
Ephemerella spp.	1	10	3	11	14	12
Serratella spp.	2			1	3	2
Drunella spp.	1			1	10	12
Leucrocuta spp.	1				3	
Paraleptophlebia spp.	1			1		
Isonychia spp.	3			1	3	
Ameletus spp.	0	1				
Baetis spp.	6	44	24	20	21	6

2016 PIKE COUNTY
MACROINVERTEBRATE DATA

TAXON ORDER *GENERA/SPECIES*	POL. TOL.	29N	30N	38N	43N	44N
EPHEMEROPTERA (mayflies)						
Plauditus spp.	4				1	
Acerpenna spp.	6			2		
Acentrella spp.	4				7	
GASTROPODA (snails)						
Ferrissia spp.	7			10		
HIRUDINEA (leeches)						
Myzobdellaspp.	7					2
ISOPODA (scuds)						
Caecidotea spp.	6				1	
MEGALOPTERA (hellgramites)						
Nigronia spp.	2			5		7
Corydalus spp.	4					
ODONATA (dragon/damsel flies)						
Boyeria spp.	2	1				1
Argia spp.	6				1	
Ophiogomphus spp.	1			1		
Gomphidae	4			2		3
Lanthus spp.	5		2	2		
OLIGOCHAETA (worms)	10	1		1	5	1
PLECOPTERA (stoneflies)						
Leuctra spp.	0	7	2	24		21
Amphinemura spp.	3	7	28	7		1
Pteronarcys spp.	0		4	3		2
Acroneuria spp.	0	1	4	12	5	17
Paragnetina spp.	1				10	
Suwallia/Sweltsa spp.	0	28	11			
Agnetina spp.	4				1	
Paranemoura spp.	2		6			
Tallaperla spp.	0		2			
Cultus spp.	2				1	

2016 PIKE COUNTY
MACROINVERTEBRATE DATA

TAXON ORDER *GENERA/SPECIES*	POL. TOL.	29N	30N	38N	43N	44N
TRICHOPTERA (caddisflies)						
Chimarra spp.	4				6	5
Dolophilodes spp.	0		1	6	1	22
Hydropsyche spp.	5				1	
Cheumatopsyche spp.	6			1	2	3
Ceratopsyche spp.	5		4	2	3	5
Diplectrona spp.	0	3	6			6
Agapetus spp.	0					2
Rhyacophila spp.	1		4	2	1	1
Macrostemum spp.	6				1	
Lepidostoma spp.	1		1			3
Micrasema spp.	2			8		
Neophylax spp.	3				1	
Brachycentrus spp.	1				6	
Protoptila spp.	1				4	
Polycentropus spp.	6				1	
Pycnopsyche spp.	4	1			1	
TOTAL						

METRICS	29N	30N	38N	43N	44N
Total Taxa Richness	15	24	31	36	29
Shannon Diversity Index	1.69	2060	2.75	2.79	2.88
EPT Taxa Richness	11	15	18	26	17
Hilsenhoff Biotic Index	4.26	2.43	3.55	4.03	2.77
Percent Intolerant Individuals	32.3	64.5	51.2	32.2	61.7
Modified Beck's Index	21	35	30	26	34
Index of Biotic Integrity	54.9	83.8	83.9	80.5	88.0

Appendix B

Taxa, numbers, and site description for the seven electrofishing stream sites in Pike County for 2016.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY

Stream/River - Saw Creek

Township - Lehman

DEP Water Use Classification

Site I.D. #01

Date - 31 August 2016

EV

Location - Starting below Route Bridge

Sampling duration - 23 minutes

Sampling Distance - 200 feet

Sampling area (ft2) - 4,739

Mean Stream Width - 23.5 feet

Weather /Comments -

Gear used - Backpack Electroshocker

Habitat complexity/quality rating - Good

Voltage - 400 V DC

Stream Width Category - 3 (20-30 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Salmo trutta	Brown trout (juvenile/adult)	3	0
Semotilus dolomieu	Smallmouth bass	4	0
Anguilla rostrata	American eel	44	0
Rhinichthys cataractae	Longnose dace	1	0
Rhinichthys atratulus	Blacknose dace	24	0
Catostomus commersoni	White sucker	12	0
Luxilus cornutus	Common shiner	2	0
Semotilus corporalis	Fallfish	16	0
Noturus insignis	Margined madtom	2	0
Etheostoma olmstedi	Tesselated darter	16	0
Exoglossum maxillingua	Cutlips minnow	26	0
	TOTAL	**150**	

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Saw Creek | Township - Lehman | DEP Water Use Classification

Site I.D. #19N | Date - 31 August 2016 | EV

Location - Starting upstream of bridge

Sampling duration - 20 minutes | Sampling Distance - 145 feet

Sampling area (ft2) – 3,253 | Mean Stream Width – 22.1 feet

Weather /Comments -

Gear used - Backpack Electroshocker | Habitat complexity/quality rating - Good

Voltage - 400V DC | Stream Width Category - 3 (21-30 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Salvelinus fontinalis	Brook trout (young-of-year)	1	0
Salvelinus fontinalis	Brook trout (juvenile/adult)	5	0
Catostomus commersoni	White sucker	3	0
Rhinichthys atratulus	Blacknose dace	14	0
Rhinichthys cataractae	Longnose dace	7	0
Exoglossum maxillingua	Cutlips minnow	20	0
Noturus insignis	Margined madtom	7	0
Semotilus corporalis	Fallfish	5	0
Etheostoma olmstedi	Tesselated darter	3	0
Micropterus salmoides	Largemouth bass	2	0
Lepomis macrochirus	Bluegill	1	0
	TOTAL	**74**	

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY
SURVEY

Stream/River - Dingman Creek | Township - Dingman | DEP Water Use Classification

Site I.D. #22N | Date - 24 August 2016 | HQ-CWF

Location - starting upstream of bridge

Sampling duration - 20 minutes | Sampling Distance - 240 feet

Sampling area (ft2) – 5,333 | Mean Stream Width – 22.1 feet

Weather /Comments -

Gear used - Backpack Electroshocker | Habitat complexity/quality rating - Good

Voltage - 460 volts DC | Stream Width Category - 3 (21-30 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Salmo trutta	Brown trout (juvenile/adult)	2	0
Noturus insignis	Margined madtom	20	0
Anguilla rostrata	American eel	1	0
Rhinichthys atratulus	Blacknose dace	22	0
Rhinichthys cataractae	Longnose dace	3	0
Lepomis gibbosus	Pumpkinseed	1	0
Micropterus salmoides	Largemouth bass	1	0
Catostomus commersoni	White sucker	3	0
Semotilus atromacualtus	Creek chub	6	0

TOTAL 53

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River - Dwarfskill Creek | Township - Shohola | DEP Water Use Classification

Site I.D. #23N | Date - 24 August 2016 | HQ-CWF

Location -

Sampling duration - 20 minutes | Sampling Distance - 350 feet

Sampling area (ft2) - 5,635 | Mean Stream Width – 16.1 feet

Weather /Comments -

Gear used - Backpack Electroshocker | Habitat complexity/quality rating - Excellent

Voltage – 240 V DC | Stream Width Category - 2 (10-20 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Salvelinus fontinalis	Brook trout (young-of-year)	2	0
Salvelinus fontinalis	Brook trout (juvenile/adult)	11	0
Esox niger	Chain pickerel	2	0
Micropterus salmoides	Largemouth bass	3	0
Rhinichthys atratulus	Blacknose dace	50	0
Perca flavescens	Yellow perch	2	0
	TOTAL	**72**	

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Shohola Creek | Township – Blooming Grove | DEP Water Use Classification

Site I.D. #35N | Date – 24 August 2016 | HQ-CWF

Location -

Sampling duration - 20 minutes | Sampling Distance - 300 feet

Sampling area (ft2) - 7,467 | Mean Stream Width – 24.9 feet

Weather /Comments -

Gear used - Backpack Electroshocker | Habitat complexity/quality rating - Fair

Voltage - 460V DC | Stream Width Category - 3 (20-30 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Salvelinus fontinalis	Brook trout (juvenile/adult)	2	0
Noturus insignis	Margined madtom	19	0
Luxilus cornutus	Common shiner	35	0
Esox niger	Chain pickerel	2	0
Exoglossum maxillingua	Cutlips minnow	1	0
Etheostoma olmstedi	Tesselated darter	3	0
Catostomus commersoni	White sucker	9	0
Notemigonus crysoleucas	Golden shiner	1	0
Rhinichthys atratulus	Blacknose dace	1	0
	TOTAL	**73**	

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Pond Eddy Creek | Township – Shohola | DEP Water Use Classification

Site I.D. #36N | Date – 24 August 2016 | HQ-CWF

Location -

Sampling duration - 26 minutes | Sampling Distance - 180 feet

Sampling area (ft2) – 2,447 | Mean Stream Width – 13.7 feet

Weather /Comments – low water

Gear used - Backpack Electroshocker | Habitat complexity/quality rating - Good

Voltage - 460V DC | Stream Width Category - 2 (10-20 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Salvelinus fontinalis	Brook trout (juvenile/adult)	2	0
Salvelinus fontinalis	Brook trout (young-of-year)	3	0
Salmo trutta	Brown trout (young-of-year)	17	0
Salmo trutta	Brown trout (juvenile/adult)	3	0
Rhinichthys atratulus	Blacknose dace	16	0
	TOTAL	**41**	

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. #55 | Date – 31 August 2016 | HQ-CWF

Location -

Sampling duration - 20 minutes | Sampling Distance - 125 feet

Sampling area (ft2) – 3,094 | Mean Stream Width – 24.8 feet

Weather /Comments – low water

Gear used - Backpack Electroshocker | Habitat complexity/quality rating - Fair

Voltage - 400V DC | Stream Width Category - 3 (20-30 ft)

Scientific Name Genus/Species	Common Name	Number Collected	Number of Anomalies
Semotilus corporalis	Fallfish	5	0
Noturus insignis	Margined madtom	26	0
Ameiurus nebulosus	Brown bullhead	2	0
Lepomis macrochirus	Bluegill	8	0
Pomoxis nigromaculatus	Black crappie	1	0
Micropterus salmoides	Largemouth bass	13	0
Notemigonus crysoleucas	Golden shiner	2	0
Erimyzon oblongus	Creek chubsucker	2	0
	TOTAL	**59**	

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