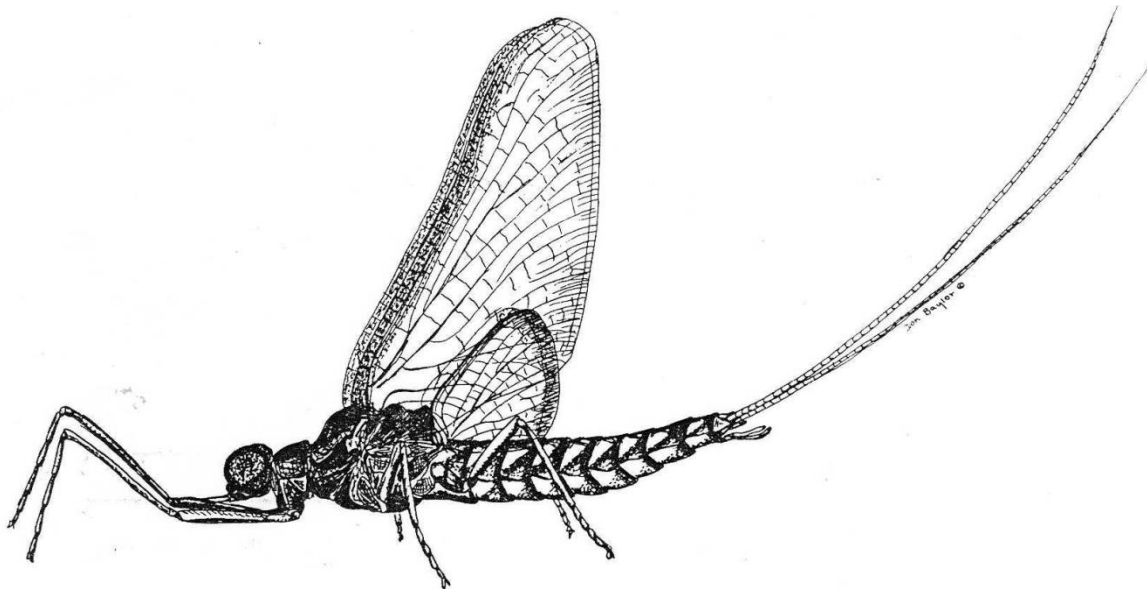


ENVIRONMENTAL QUALITY OF PIKE COUNTY STREAMS



DECEMBER 2019

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PIKE COUNTY STREAMS

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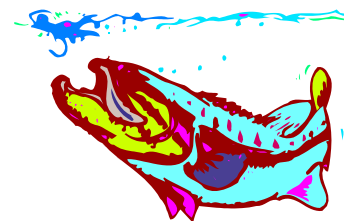
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AQUATIC RESOURCE CONSULTING



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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, 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. 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% isopropyl 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 (PADEP, 2009). 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 July and August, 2019 at five baseline stream sites and two 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 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.

After sedation with tricaine methane sulfonate 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 and after being revived from sedation, 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 (Table 7). 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 2018 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 lithophilic spawners declines.
10. Catch of young-of-year trout per 20 minute effort – measures the capacity of a stream to reproduce trout species. The number of young-of-year trout increases with improving stream conditions.

Sampling Stations

Five baseline and eight non-point study stations were sampled for benthic macroinvertebrates in April and May, 2019 (Appendix A). Five baseline and two non-point stations were sampled for fish in July and August, 2019 (Appendix B). Following are descriptions and co-ordinates for the macroinvertebrate and fish stations:

Macroinvertebrates

Station 09 – Sawkill Creek, Milford Township; 41.317207/-74.799562

Station 14 – Shohola Creek, Shohola Township; 41.455904/-74.923305

Station 15 – Lackawaxen River, Lackawaxen Township; 41.475779/-75.035083

Station 17 – Wallenpaupack Creek, Greene Township; 41.315489/-75.315825

Station 18 – East Branch Wallenpaupack Creek, Greene Township; 41.32327/-75.308891

Station 22N – Dingmans Creek, Delaware Township; 41.237985/-74.918941

Station 23N – Dwarfskill Creek, Dingman Township; 41.297113/-74.907403

Station 27N – Walker Lake Creek, Shohola Township, 41.427961/-74.910521

Station 28N – Westcolang Creek, Lackawaxen Township; 41.51115/-75.006029

Station 29N – Teedyuskung Creek, Lackawaxen Township, 41.487961/-75.105802

Station 30N – Kleinhans Creek, Palmyra Township; 41.371037/-75.252085

Station 43N – Lackawaxen River, Lackawaxen Township; 41.470209/-75.131452

Station 44N – Little Bushkill Creek, Lehman Township; 41.132621/-75.008715

Fish

Station 02 – Big Bushkill Creek, Lehman Township; 41.090662/-75.004328

Station 03 – Little Bushkill Creek, Lehman Township; 41.091364/-75.003598

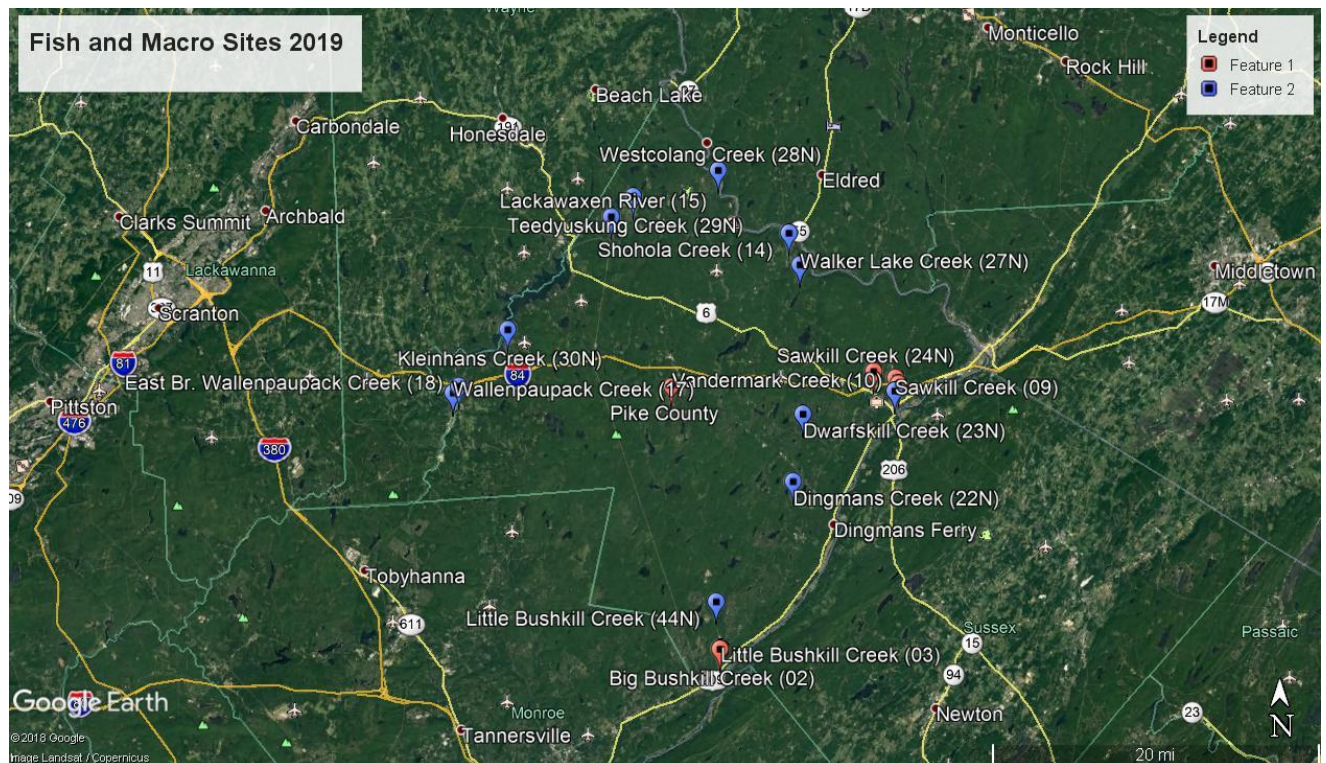
Station 10 – Vandermark Creek, Milford Township; 41.323286/-74.795256

Station 17 – Wallenpaupack Creek, Greene Township; 41.315489/-75.315825

Station 18 – East Branch Wallenpaupack Creek, Greene Township; 41.321327/75.308891

Station 24N – Sawkill Creek, Milford Township; 41.334251/-74.824545

Station 25N – Vandermark Creek, Milford Township; 41.328562/-74.798802



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). 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 typical for the Pocono region. 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). All stations exceeded the PADEP scoring benchmark of 192 for optimal habitat (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 have averaged 216 and this average has ranged from 196 to 232 units (Ersbak, 2010-2019). 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 5 baseline and 8 non-point stream site in Pike County for 2019. Table 6 shows the raw metric values and the adjusted standardized index of biotic integrity (IBI) score for each sample. At one of the 13 sites (Lackawaxen River, 43N) fewer than 160 organisms were collected. Therefore, the IBI should be interpreted cautiously at this site due to the less than recommended sample size of 160 organisms used for the analysis (PADEP, 2009).

All stations exceeded the scoring IBI benchmark of ≥ 43 (<51 square miles drainage area) and ≥ 50 (>50 square miles drainage area) for attaining aquatic life use and impairment for the cold water fishes (CWF), warm water fishes (WWF), and trout stocking (TSF) protected uses (PADEP, 2009). Sawkill Creek (09), Little Bushkill Creek (44N), Shohola Creek (14), and East Branch Wallenpaupack Creek (18) had the highest IBI scores of 89.6, 85.6, 85.0, and 80.5 respectively. Lackawaxen River (43N), Walker Lake Creek (27N), and Dingmans Creek (22N) had the lowest scores of 50.1, 54.7, and 62.3, respectively.

Table 4. Physical and chemical field data from 13 Pike County stream sites
(April/May, 2019) Pennsylvania Department of Environmental Protection
2009.

PARAMETER	STA. 09 Sawkill	STA. 14 Shohola	STA. 15 Lackawaxen	STA. 17 Wallenpaupack	STA. 18 E. Branch Wallenpaupack	STA. 22N Dingmans
Sample Date	4/24/19	5/23/19	4/8/19	4/18/19	4/18/19	4/24/19
Temperature (°C)	14.3	17.0	9.7	8.3	10.0	14.0
Dissolved Oxygen (mg/l)	10.03	9.02	12.83	11.17	11.00	9.60
pH	7.12	6.34	9.12	6.57	6.54	6.46
Conductivity (µmhos/cm)	87.0	53.4	58.6	46.8	28.4	49.4
Alkalinity (mg/l)	15	15	20	22.5	20	15
PARAMETER	STA. 23N Dwarfskill	STA 27N Walker Lake	STA. 28N Westcolang	STA.29N Teedyuskung	STA.30N Kleinhans	STA 43N Lackawaxen
Sample Date	4/24/19	4/30/19	4/30/19	4/30/19	4/18/19	4/8/19
Temperature (°C)	14.7	14.0	10.7	8.9	9.4	8.5
Dissolved Oxygen (mg/l)	9.09	9.24	10.52	11.16	10.90	12.17
pH	6.88	6.64	6.80	7.07	6.87	7.89
Conductivity (µmhos/cm)	109.4	52.6	88.3	109.4	92.6	55.8
Alkalinity (mg/l)	20	25	15	25	23	Not recorded

PARAMETER	STA. 44N Little Bushkill					
Sample Date	5/23/19					
Temperature (°C)	17.0					
Dissolved Oxygen (mg/l)	8.95					
pH	6.35					
Conductivity (µmhos/cm)	29.7					
Alkalinity (mg/l)	20					

Table 5. Habitat assessment of 13 sampling stations on Pike County streams (April/May, 2019) – Pennsylvania Department of Environmental Protection, 2009.

HABITAT PARAMETER	STA 09 Sawkill 4/24/19	STA 14 Shohola 5/23/19	STA 15 Lackawaxen 4/8/19	STA 17 Wallenpaupack 4/18/19	STA 18 E. Branch Wallenpaupack 4/18/19
1. Instream Cover	18	17	18	18	19
2. Epifaunal Substrate	20	17	20	19	19
3. Embeddedness	19	20	19	14	18
4. Velocity/Depth Regimes	15	10	16	16	15
5. Channel Alteration	20	20	17	17	16
6. Sediment Deposition	18	19	17	13	19
7. Frequency of Riffles	20	20	20	18	20
8. Channel Flow Status	19	20	17	20	20
9. Condition of Banks	16	19	19	16	19
10. Bank Vegetative Protection	15	19	18	16	18
11. Grazing or Other Disruptive Pressure	20	19	17	18	20
12. Riparian Vegetative Zone Width	17	18	15	15	15
TOTAL SCORE	217	218	213	200	218

HABITAT PARAMETER	STA 22N Dingmans 4/24/19	STA 23N Dwarfskill 4/24/19	STA 27N Walker Lake 4/30/19	STA 28N Westcolang 4/30/19	STA 29N Teedyuskung 4/30/19
1. Instream Cover	19	19	18	18	18
2. Epifaunal Substrate	20	20	17	20	19
3. Embeddedness	19	18	16	19	17
4. Velocity/Depth Regimes	19	20	18	19	15
5. Channel Alteration	20	19	15	20	19
6. Sediment Deposition	18	17	17	20	13
7. Frequency of Riffles	20	19	19	20	20
8. Channel Flow Status	19	19	20	20	19
9. Condition of Banks	15	16	15	18	5
10. Bank Vegetative Protection	15	18	15	13	12
11. Grazing or Other Disruptive Pressure	20	19	20	20	20
12. Riparian Vegetative Zone Width	20	16	19	18	19
TOTAL SCORE	224	220	209	225	196

Table 5. (cont.).

HABITAT PARAMETER	STA 30N Kleinhans 4/18/19	STA 43N Lackawaxen 4/8/19	STA 44N Little Bushkill 5/23/19		
1. Instream Cover	19	19	19		
2. Epifaunal Substrate	20	20	17		
3. Embeddedness	15	18	18		
4. Velocity/Depth Regimes	15	16	20		
5. Channel Alteration	20	20	20		
6. Sediment Deposition	15	18	18		
7. Frequency of Riffles	20	19	20		
8. Channel Flow Status	20	19	19		
9. Condition of Banks	20	18	19		
10. Bank Vegetative Protection	20	17	17		
11. Grazing or Other Disruptive Pressure	20	20	20		
12. Riparian Vegetative Zone Width	20	19	20		
TOTAL SCORE	224	223	227		

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

Table 6. Metric scores for 13 benthic macroinvertebrate samples from Pike County stream sites (April/May, 2019).

METRIC	STA. 09 Sawkill	STA. 14 Shohola	STA. 15 Lackawaxen	STA. 17 Wallenpaupack	STA. 18 East Branch Wallenpaupack
Total Taxa Richness	35	28	23	22	28
Diversity Index	2.79	2.66	1.97	1.94	2.90
EPT Taxa Richness	23	18	12	14	16
Hilsenhoff Biotic Index	3.00	2.81	4.50	3.75	3.48
Percent Intolerant	52.3	65.7	25.9	45.2	55.9
Modified Beck's Index	43	27	18	22	26
Index of Biotic Integrity	89.6	85.0	70.0	66.1	80.5

METRIC	STA. 22N Dingmans	STA 23N Dwarfskill	STA. 27N Walker Lake	STA.28N Westcolang	STA.29N Teedyuskung
Total Taxa Richness	30	22	13	15	19
Diversity Index	2.52	1.89	1.77	2.04	2.35
EPT Taxa Richness	15	12	6	11	14
Hilsenhoff Biotic Index	4.65	2.50	2.90	1.46	3.31
Percent Intolerant	28.9	78.4	69.8	85.4	63.5
Modified Beck's Index	19	17	10	20	29
Index of Biotic Integrity	62.3	70.7	54.7	71.5	75.2

METRIC	STA. 30N Kleinhans	STA 43N Lackawaxen	STA. 44N Little Bushkill		
Total Taxa Richness	23	15	31		
Diversity Index	2.28	1.36	2.95		
EPT Taxa Richness	12	7	17		
Hilsenhoff Biotic Index	3.40	4.82	3.31		
Percent Intolerant	46.2	27.0	53.2		
Modified Beck's Index	37	8	32		
Index of Biotic Integrity	73.3	50.1	85.6		

Three of the 13 stations surveyed in 2019 showed significantly higher IBI scores than over the past 10+ years sampled. They included Sawkill Creek (09), Shohola Creek (14), and East Branch Wallenpaupack Creek (18). Three of the sites showed significantly lower IBI scores than over the last 4+ years sampled. They included Lackawaxen River (43N), Wallenpaupack Creek (17), and Walker Lake Creek (27N). The remaining sites showed no significant deviation from their historical IBI average.

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). 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, two on Vandermark Creek had two upstream impoundments and the remainder had more than three. The watershed for each site ranged from 5.1 to 123 square miles.

Trout species were present at five of the seven stream sites surveyed. Native brook trout were collected from one section of Vandermark Creek (25N) while native brook and wild brown trout were collected from the other section of Vandermark Creek (10) - Table 7. Wild brown trout were collected from Wallenpaupack Creek (17), East branch of the Wallenpaupack Creek (18), and Sawkill Creek (24N). One stocked brook trout was collected from Wallenpaupack Creek (17). One young-of-year largemouth bass was collected from Wallenpaupack Creek (17). No game fish were collected from Big Bushkill Creek (02) or Little Bushkill Creek (03).

Table 7. Stream fish communities sampled for width category, impoundments in watershed, drainage area (square miles), and game fish present in Pike County, PA (July/August, 2019).

STREAM SAMPLED	SITE ID	WIDTH CATEGORY	IMPOUNDMENTS ABOVE SAMPLE SITE	DRAINAGE BASIN AREA (square miles)	GAME FISH PRESENT
Big Bushkill	02	4	>3	123	
Little Bushkill	03	3	>3	33	
Vandermark	10	2	2	5.2	Brown trout Brook trout
Wallenpaupack	17	3	>3	29.7	Brown trout, Brook trout Largemouth bass
East Branch Wallenpaupack	18	3	>3	34	Brown trout
Sawkill	24N	3	>3	19	Brown trout
Vandermark	25N	2	2	5.1	Brook 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 Vandermark Creek, Wallenpaupack Creek and Sawkill Creek. Forty YOY brown trout and twenty YOY brook trout were collected in Vandermark Creek, twelve YOY brown trout in Wallenpaupack Creek and twenty-one in Sawkill Creek (Appendix B).

A total of 15 species of fish were collected from the seven streams surveyed in July/August of 2019 (Table 8). Blacknose dace were the dominant forage fish and found at five of the seven sites. The American eel (*Anguilla rostrata*), which is a catadromous fish (living in fresh water and spawning in salt water), was found at Big Bushkill Creek (02), Little Bushkill Creek (03) and Vandermark Creek (10). All three sites were proximal to the Delaware River. Wallenpaupack Creek (17) and the East branch of Wallenpaupack Creek (18) 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 seven (7) stream sites surveyed ranged from eighteen at Big Bushkill Creek (02) to forty-two at Vandermark Creek (10) – Table 9. All but two sites had IBI indices considered good (≥ 23) and approximating that found in high quality streams of the region. Big Bushkill Creek (02) and Little Bushkill Creek (03) sites had IBI scores that were significantly lower than previous years sampled (Ersbak, 1995-2005).

It is noteworthy, that of the 448 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 7 stream sites in Pike County, PA (July/August, 2019).

		7/30/19	7/30/19	8/1/19	7/30/19	7/30/19	8/1/19	8/1/19
Scientific Name	Common Name	Big Bushkill 02	Little Bushkill 03	Vandermark 10	Wallenpaupack 17	East Branch Wallenpaupack 18	Sawkill 24N	Vandermark 25N
<i>Anguilla rostrata</i>	American eel	32	14	13				
<i>Catostomus commersoni</i>	white sucker				3		2	
<i>Rhinichthys atratulus</i>	blacknose dace	10	1		2		30	7
<i>Rhinichthys cataractae</i>	longnose dace	2	4	6		6		
<i>Salmo trutta</i>	brown trout			50	14	5	54	
<i>Salvelinus fontinalis</i>	brook trout			3	1		2	33
<i>Micropterus salmoides</i>	largemouth bass				1			
<i>Exoglossum maxillingua</i>	cutlips minnow		3			3		
<i>Semotilus atromaculatus</i>	creek chub	3				3		
<i>Etheostoma olmstedii</i>	tessellated darter	2	1		6	1		
<i>Lepomis gibbosus</i>	pumpkinseed			1				
<i>Lepomis macrochirus</i>	bluegill				1			
<i>Umbra pygmaea</i>	Eastern mudminnow				2	5		
<i>Noturus insignis</i>	marginated madtom	2				10	4	
<i>Cottus cognatus</i>	Slimy sculpin			2				116
TOTAL		51	23	75	30	33	92	156

Table 9. Index of biotic integrity (IBI) test scores at 7 stream sites in Pike County, Pennsylvania (July/August, 2019).

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 02

Big Bushkill Creek

IBI Metrics	Metric Value	Test Score
IS	1	3
TOL	25.5	3
CARN	62.7	5
STENO	0	1
ST	0	1
I	27.4	1
P	92.1	1
CPE	51	1
L	29.4	1
YOY	0	1

IBI Score = 18

STATION 03

Little Bushkill Creek

Metric Value	Test Score
2	3
4.3	5
60.9	5
4.3	1
0	1
21.7	1
69.6	1
19	1
34.8	1
0	1

20

STATION 10

Vandermark Creek

Metric Value	Test Score
2	3
0	5
88.0	5
74.7	5
5.6	5
82.7	5
17.3	5
75	1
78.7	3
43	5

42

STATION 17

Wallenpaupack Creek

IBI Metrics	Metric Value	Test Score
IS	1	3
TOL	16.7	3
CARN	53.3	5
STENO	70.0	3
ST	0	1
I	73.3	5
P	53.3	3
CPE	27	1
L	66.7	1
YOY	12	5

IBI Score = 30

STATION 18

East Branch Wallenpaupack Creek

Metric Value	Test Score
2	3
9.4	5
15.6	3
15.6	1
0	1
65.6	5
9.4	5
32	1
53.1	1
0	1

26

STATION 24N

Sawkill Creek

Metric Value	Test Score
2	3
34.8	1
60.9	5
60.9	3
0	1
65.2	5
32.6	3
92	1
95.6	5
21	5

32

STATION 25N

Vandermark Creek

IBI Metrics	Metric Value	Test Score
IS	2	3
TOL	1.9	5
CARN	21.1	5
STENO	95.5	5
ST	100	5
I	95.5	5
P	4.	5
CPE	93	1
L	25.6	1
YOY	17	5

IBI Score = 40

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 schedule of sampling established. Consideration should be given to re-sampling the Lackawaxen River site 43N in 2020 to obtain enough organisms to do a reliable analysis for historical comparison. It is important that all macroinvertebrate samples be collected between mid-April and the end of May as per PADEP protocols. Samples should be collected when conditions permit. High water or spate conditions should be avoided whenever possible. 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 2020 sampling rotation for macroinvertebrate and fish populations:

Macroinvertebrates

- Big Bushkill 09
- Adams 07
- Toms 20N
- Walker Lake Creek (new)
- Little Bushkill 03
- Sawkill 24N
- Lackawaxen 43N
- Hornbecks 05
- Twin Lakes 13N
- Dwarfskill DDMS

Fish

- Twin Lakes 13N
- Cummins 11
- Walker Lake 27N
- Little Bushkill 44N
- Toms 20N
- Shohola 14
- Kleinhans 30N
- Dingmans 22N
- Sawkill 09
- Lackawaxen 15
- Lackawaxen 43N

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 2019.

TAXON												
ORDER	POL.											
GENERA/SPECIES	TOL.	09	14	15	17	18	22N	23N	27N	28N	29N	30N
AMPHIPODA (shrimp)												
<i>Gammarus spp.</i>	4			1								
BIVALVIA (clams)												
<i>Pisidium spp.</i>	8		5			2						
COLEOPTERA (beetles)												
<i>Stenelmis spp.</i>	5	4		8		1			1			
<i>Promoresia spp.</i>	2		2			2	2	3				
<i>Microcylloepus spp.</i>	2		38				6					
<i>Optioservus spp.</i>	4	1		8		1						12
<i>Lutrochus spp.</i>	6	1						1				
<i>Psephenus herricki</i>	4	15	5		2	6	2	20		2		
<i>Ectopria spp.</i>	2											1
DIPTERA (true flies)												
Chironomidae	8	55	10	95	98	29	76	15	10	9	25	81
<i>Blepharicera spp.</i>	0	19										2
<i>Tipula spp.</i>	4						1		2	3		
<i>Hexatoma spp.</i>	2	1										1
<i>Atherix spp.</i>	2	1			1	1						
<i>Hemerodromia spp.</i>	6						7					
<i>Antocha spp.</i>	3			2	1	7	1	1			1	
<i>Prosimulium spp.</i>	2	3		1	2		12	1			42	12
<i>Simulium spp.</i>	6	1									5	
EPHEMEROPTERA (mayflies)												
<i>Epeorus spp.</i>	0	12	2	1	16	6				37	8	23
<i>Mccaffertium spp.</i>	3	2	1	3		7	2	5	21	7	15	
<i>Ephemerella spp.</i>	1	24	52	14	46	22	4	113	92	73	1	18
<i>Eurylophella spp.</i>	4	2					2					
<i>Drunella spp.</i>	1	5	5		3	18						
<i>Seratella spp.</i>	2	1	13									
<i>Heterocloen spp.</i>	2	1					6	6				
<i>Paraleptophlebia spp.</i>	1	5		2	2	11						
<i>Rithrogena spp.</i>	0	2			1							
<i>Isonychia spp.</i>	3	1	1	2	1	8	5	4				
<i>Ameletus spp.</i>	0					2				2	2	
<i>Baetis spp.</i>	6	12	9	1	15	11	1			9	27	25
<i>Acerpenna spp.</i>	6	3			1							
<i>Diphetera spp.</i>	6										1	
<i>Acentrella spp.</i>	4		4									

TAXON												
ORDER	POL.											
GENERA/SPECIES	TOL.	09	14	15	17	18	22N	23N	27N	28N	29N	30N
GASTROPODA (snails)												
Physidae	8						2					
Ferrissia spp.	7							2	1			
MEGALOPTERA (hellgramites)												
Corydalus spp.				1				1				
Nigronia spp.	2		1	1			1	6	6			
ODONATA (dragon flies)												
Argia spp.	6		1				1					
Gomphidae	4											
Ophiogomphus spp.	1											1
Lanthus spp.	5		2			1						
Boyeria spp	2											1
OLIGOCHAETA (worms)	10				1	9	5	1		6	5	1
PLECOPTERA (stoneflies)												
Leuctra spp.	0		1			1	1	2			4	7
Amphinemura spp.	3						4	1	24	1		
Paranemoura spp.	2					1						
Pteronarcys spp.	0	1									1	3
Acroneuria spp.	0	9	5	11	1		7	14	2	12	5	13
Paragnetina spp.	1	5	5		2	2						
Agnetina spp.	1				1							
Perlesta spp.	4		8				1					
Suwallia/Sweltsa spp.	0	9								9	7	7
Diploperla spp.	2	2									1	
Yugus spp.	2		7									
Capnia spp.	1											2
Isoperla spp.	2	2		1	20	18	2	2	2		15	2
TRICHOPTERA (caddisflies)												
Chimarra spp.	4		3	1		10	10	6				
Dolophilodes spp.	0		4			1		1			3	1
Neophylax spp.	3				1	2	1				2	
Hydropsyche spp.	5						8		15			
Ceratopsyche spp.	5	7	4	16	6	7	9					1
Cheumatopsyche spp.	6	1	24	8	2	13	15		38			
Diplectrona spp.	0	2					2			24	1	6
Macrostemum spp.	6											
Rhyacophila spp.	1	1	2	9	7	5	1	7	1	4		4
Lepidostoma spp.	1	1	3	1								
Psilotreta spp.	0	1										
Ceraclea spp.	3		2						1			

TAXON	
ORDER	POL.
GENERA/SPECIES	TOL.
TRICHOPTERA (caddisflies)	
<i>Oecetis spp.</i>	8
<i>Micrasema spp.</i>	2
<i>Neophylax spp.</i>	3
<i>Polycentropus spp.</i>	6

TOTAL

09	14	15	17	18	22N	23N	27N	28N	29N	30N
		1								
		1						1		
2						1				
										1
214	219	189	230	204	197	213	215	199	170	225

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

Index of Biotic Integrity

09	14	15	17	18	22N	23N	27N	28N	29N	30N
35	28	23	22	28	30	22	13	15	19	23
2.79	2.66	1.97	1.94	2.90	2.52	1.89	1.77	2.04	2.35	2.28
23	18	12	14	16	15	12	6	11	14	12
3.0	2.81	4.50	3.75	3.48	4.65	2.50	2.90	1.46	3.31	3.40
52.3	65.7	25.9	45.2	55.9	28.9	78.4	69.8	85.4	63.5	46.2
43	27	18	22	26	19	17	10	20	29	37
89.6	85.0	70.0	66.1	80.5	62.3	70.7	54.7	71.5	75.2	73.3

TAXON									
ORDER	POL								
GENERA/SPECIES	TOL.	43N	44N						
BIVALVIA (clams)									
<i>Pisidium spp.</i>	8		22						
COLEOPTERA (beetles)									
<i>Microcylloepus spp.</i>	2		19						
<i>Optioservus spp.</i>	4	1	3						
<i>Psephenus herricki</i>	4		3						
DIPTERA (true flies)									
Chironomidae	8	74	11						
<i>Antocha spp.</i>	3	1							
<i>Prosimulium spp.</i>	2	3							
<i>Simulium spp.</i>	6		2						
EPHEMEROPTERA (mayflies)									
<i>Epeorus spp.</i>	0		10						
<i>Mccaffertium spp.</i>	3	1							
<i>Ephemerella spp.</i>	1	12	9						
<i>Drunella spp.</i>	1		3						
<i>Heterocloen spp.</i>	2		7						
<i>Paraleptophlebia spp.</i>	1	1							
<i>Plautitus spp.</i>	4		2						
<i>Isonychia spp.</i>	3	7							
<i>Baetis spp.</i>	6		6						
GASTROPODA (snails)									
<i>Ferrissia spp.</i>	7		1						
HEMIPTERA (true bugs)									
<i>Mesovelis spp.</i>	9		1						
MEGALOPTERA (hellgrammites)									
<i>Sialis spp.</i>	6		1						
ODONATA (dragonflies)									
Gomphidae	4		1						
OLIGOCHAETA (worms)	10		4						
PLECOPTERA (stoneflies)									
<i>Leuctra spp.</i>	0		4						
<i>Pteronarcys spp.</i>	0		1						
<i>Agnetina spp.</i>	4	1							
<i>Taenionema spp.</i>	3	3							
<i>Acroneuria spp.</i>	0	2	10						

TAXON											
ORDER	POL.										
GENERA/SPECIES	TOL.	43N	44N								
TRICHOPTERA (caddisflies)											
<i>Chimarra spp.</i>	4		11								
<i>Dolophilodes spp.</i>	0		25								
<i>Hydropsyche spp.</i>	5	1									
<i>Ceratopsyche spp.</i>	5	1	2								
<i>Cheumatopsyche spp.</i>	6	2	14								
<i>Diplectrona spp.</i>	0		2								
<i>Macrostemum spp.</i>	6	1									
<i>Micrasema spp.</i>	2		3								
<i>Rhyacophila spp.</i>	1		1								
<i>Lepidostoma spp.</i>	1		2								
<i>Agapatus spp.</i>	5		2								
<i>Polycentropus spp.</i>	6		1								
<i>Pycnopsyche spp.</i>	4		1								

TOTAL 111 184

METRICS	43N	44N									
Total Taxa Richness	15	31									
Shannon Diversity Index	1.36	2.95									
EPT Taxa Richness	7	17									
Hilsenhoff Biotic Index	4.82	3.31									
Percent Intolerant Individuals	27.0	53.2									
Modified Beck's Index	8	32									
Index of Biotic Integrity	50.1	85.6									

Appendix B

Taxa, numbers, and site description for the seven electrofishing stream sites in Pike County for 2019.

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY

Stream/River – Big Bushkill Creek Township - Lehman DEP Water Use Classification HQ

Site I.D. #02 Date – 7/30/19

Location – W 41 05 21.5/N 75 00 20.1

Sampling duration – 20 minutes Sampling Distance – 200 feet

Sampling area (ft2) – 11,133 Mean Stream Width – 56 feet

Weather /Comments – sunny, warm

Temperature – 25.6 Celsius Dissolved Oxygen – 8.21 ppm pH – 7.64

Gear used - DC Electroshocker Habitat rating – fair Conductivity- 81.8 uS/cm

Voltage – 250 Stream Width Category - 4

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Anguilla rostrate</i>	American eel	32	0
<i>Noturus insignis</i>	Margined madtom	2	0
<i>Etheostoma olmsted</i>	Tessellated darter	2	0
<i>Rhinichthys cataractae</i>	Longnose dace	2	0
<i>Semotilus atromaculatus</i>	Creek chub	3	0
<i>Rhinichthys atratulus</i>	Blacknose dace	10	0

TOTAL 51

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 - Delaware DEP Water Use Classification EV

Site I.D. #3 Date – 7/30/19

Location – N 41 05 31.5/W 75 00 13.3

Sampling duration – 22 minutes Sampling Distance – 178 feet

Sampling area (ft2) – 5,035 Mean Stream Width – 28.3 feet

Weather /Comments – sunny/warm

Temperature – 24.4 Celsius Dissolved oxygen – 7.95 ppm pH – 7.3

Gear used - Backpack Electroshocker Habitat rating – good Conductivity- 57.4 uS/cm

Voltage – 250 Stream Width Category - 3

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Anguilla rostrate</i>	American eel	14	0
<i>Exoglossum maxillingua</i>	Cutlips minnow	3	0
<i>Rhinichthys cataractae</i>	Longnose dace	4	0
<i>Rhinichthys atratulus</i>	Blacknose dace	1	0
<i>Etheostoma olmstedii</i>	Tesselated darter	1	0

TOTAL 23

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

FISH FIELD COLLECTION DATA SHEET
PIKE COUNTY WATER QUALITY
SURVEY

Stream/River – Vandermark Creek Township - Milford DEP Water Use Classification HQCWF

Site I.D. #10 Date – 8/1/2019

Location – N 41 19 22.5/W74 47 44.2

Sampling duration – 20 minutes Sampling Distance – 250 feet

Sampling area (ft2) – 3,958 Mean Stream Width – 15.8 feet

Weather /Comments – sunny

Temperature – 15.6 Celsius Dissolved oxygen – 9.56 mg/l pH – 6.46

Gear used - Backpack Electroshocker Habitat rating – good Conductivity- 148.4 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 (young of year)	40	0
<i>Salmo trutta</i>	Brown trout (adult)	10	0
<i>Salvelinus fontinalis</i>	Brook trout (young of year)	3	0
<i>Anguilla rostrata</i>	American eel	13	0
<i>Rhinichthys cataractae</i>	Longnose dace	6	0
<i>Cottus cognatus</i>	Slimy sculpin	2	0
<i>Lepomis gibbosus</i>	Pumpkinseed	1	0

TOTAL 75

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Wallenpaupack Creek Township - Greene DEP Water Use Classification HQCWF

Site I.D. #17 Date – 7/30/19

Location – N 41 18 52.9/W 75 18 54.6

Sampling duration – 22 minutes Sampling Distance – 239 feet

Sampling area (ft2) – 6,732 Mean Stream Width – 28.2 feet

Weather /Comments - sunny/warm

Temperature – 18.0 Celsius Dissolved oxygen – 8.89 ppm pH – 7.04

Gear used - Backpack Electroshocker Habitat rating – good Conductivity- 80.8 uS/cm

Voltage – 250 Stream Width Category - 3

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (young of year)	12	0
<i>Salmo trutta</i>	Brown trout (adult)	2	0
<i>Salvelinus fontinalis</i>	Brook trout (stocked)	1	0
<i>Umbra pygmaea</i>	Eastern mudminnow	2	0
<i>Rhinichthys atratulus</i>	Blacknose dace	2	0
<i>Micropterus salmoides</i>	Largemouth bass (young of year)	1	0
<i>Catostomus commersoni</i>	White sucker	3	0
<i>Etheostoma olmstedii</i>	Tessellated darter	6	0
<i>Lepomis macrochirus</i>	Bluegill	1	0

TOTAL 30

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – E. Br. Wallenpaupack Creek Township – Greene DEP Water Use Classification HQCWF

Site I.D. #18 Date – 7/30/2019

Location – Starting upstream of McKay driveway on Masthope Plank Road

Sampling duration – 20 minutes Sampling Distance - 177

Sampling area (ft2) – 6,520 Mean Stream Width – 36.8 feet

Weather /Comments – sunny/warm

Temperature – 22.5 Celsius Dissolved oxygen – 7.79 ppm pH – 7.20

Gear used - Backpack Electroshocker Habitat rating – fair Conductivity- 46.5 uS/cm

Voltage - 250 Stream Width Category - 3

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Semotilus corporalis</i>	Creek chub	3	0
<i>Salmo trutta</i>	Brown trout (adult)	5	0
<i>Noturus insignis</i>	Margined madtom	10	0
<i>Etheostoma olmsted</i>	Tesselated darter	1	0
<i>Umbra pygmaea</i>	Eastern mudminnow	5	0
<i>Exoglossum maxilllingua</i>	Cutlips minnow	3	0
<i>Rhynchithys cataractae</i>	Longnose dace	6	0

TOTAL 33

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Sawkill Creek Township – Milford DEP Water Use Classification EV

Site I.D. #24N Date – 8/1/2019

Location – N 41 19 59.8/W 74 49 28.9

Sampling duration – 20 minutes Sampling Distance – 163 feet

Sampling area (ft²) – 3,803 Mean Stream Width – 23.3 feet

Weather /Comments – sunny

Temperature – 20.9 Celsius Dissolved oxygen – 8.63 pH - 7.16

Gear used - Backpack Electroshocker Habitat rating – fair Conductivity- 143.7 uS/cm

Voltage - 250 Stream Width Category - 3

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salmo trutta</i>	Brown trout (adult)	33	0
<i>Salmo trutta</i>	Brown trout (young-of-year)	21	0
<i>Salvelinus fontinalis</i>	Brook trout (adult)	2	0
<i>Catostomus commersoni</i>	White sucker	2	0
<i>Rhinichthys atratulus</i>	Blacknose dace	30	0
<i>Noturus insignis</i>	Margined madtom	4	0

TOTAL 92

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

FISH FIELD COLLECTION DATA SHEET

PIKE COUNTY WATER QUALITY SURVEY

Stream/River – Vandermark Creek Township – Milford DEP Water Use Classification HQCWF

Site I.D. #25N Date – 8/1/19

Location – N 41 19 43.3/W 74 47 55.8

Sampling duration – 25 minutes Sampling Distance – 238 feet

Sampling area (ft²) – 2,584 Mean Stream Width – 10.8 feet

Weather /Comments – sunny

Temperature – 16.5 Celsius Dissolved oxygen – 8.70 pH – 6.31

Gear used - Backpack Electroshocker Habitat rating – fair Conductivity- 128.8 uS/cm

Voltage - 250 Stream Width Category - 2

Scientific Name	Common Name	Number	Number of
Genus/Species		Collected	Anomalies
<i>Salvelinus fontinalis</i>	Brook trout (young of year)	17	0
<i>Salvelinus fontinalis</i>	Brook trout (adult)	16	0
<i>Cottus cognatus</i>	Slimy sculpin	116	0
<i>Rhinichthys atratulus</i>	Blacknose dace	7	0

TOTAL 156

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