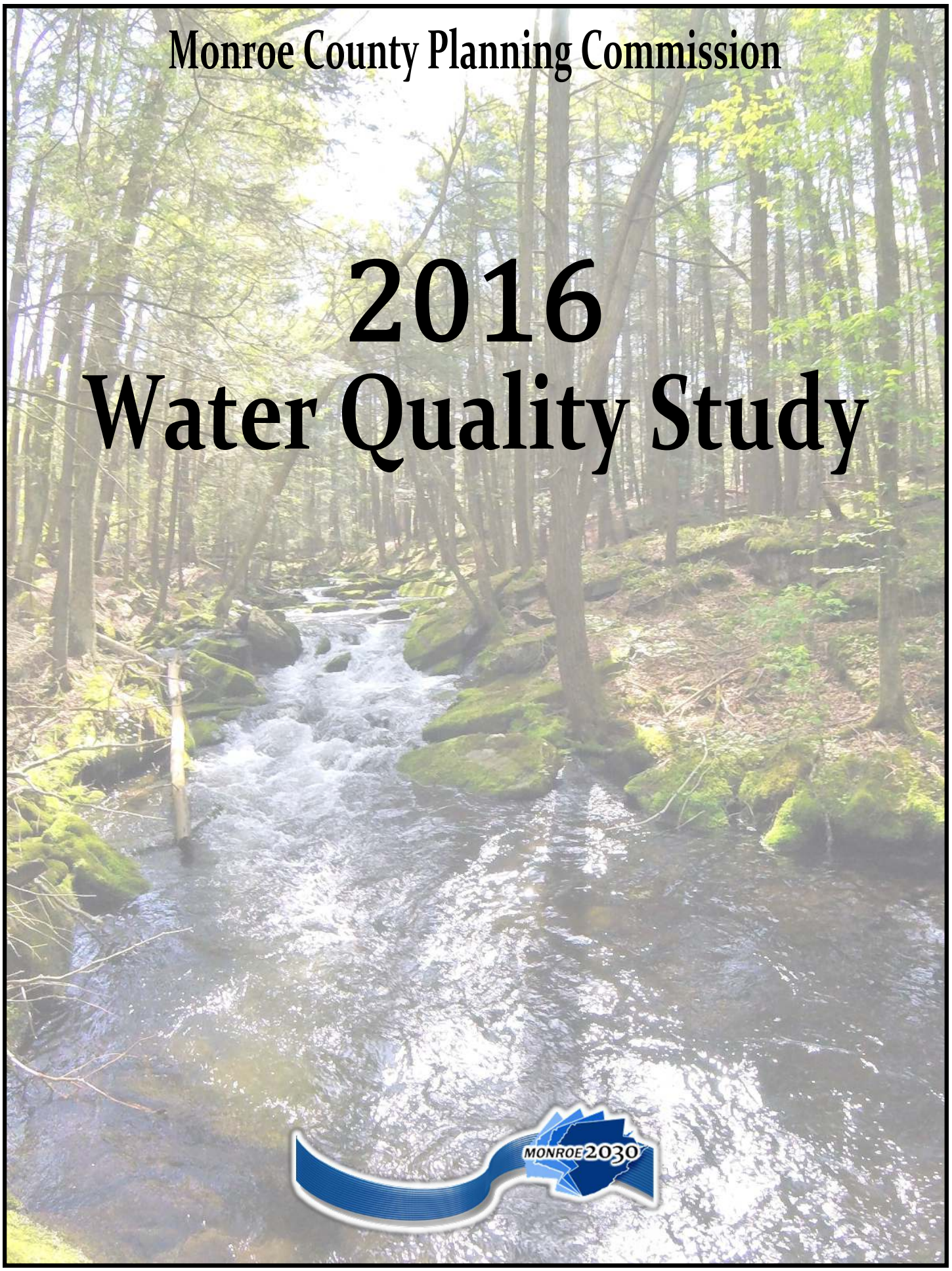
Monroe County Planning Commission

2016
Water Quality Study



ABSTRACT

The Monroe County Planning Commission along with the Monroe County Conservation District studied 38 stream sites throughout Monroe County in the spring of 2016. The sites were studied based on four parameters, field surface water measurements, laboratory chemistry analysis, macro-invertebrate identification, and habitat assessment.

Monroe County Planning Commission
1 Quaker Plaza, Room #106
Stroudsburg, Pa. 18360-2169
(570) 517-3100
Fax (570) 517-3858
www.monroecountypa.gov

Table of Contents

PREPARED BY MONROE COUNTY

BOARD OF COMMISSIONERS

John R. Moyer, Chairman
Charles A. Garris, Vice-Chairman
John D. Christy**,** Commissioner
Greg Christine, Chief Clerk/Administrator
John B. Dunn, Solicitor

MONROE COUNTY PLANNING COMMISSION BOARD

Rich Schlameuss, Chairman
Brian Barrett, Vice-Chairman
JoEllen Chadwick
Meg Dilger
Annie Lamberton
Roger McFadden
Sharon Solt
Alan Price Young

MONROE COUNTY PLANNING COMMISSION STAFF

Christine Meinhart – Fritz, Director
Ryan Baldwin, Vector Control
George Basila, GIS Analyst
Kim Borger, Planner/E-911 Addressing Coordinator
Fallon Horan, Community Planner
Eric Koopman, Senior Lead Planner
Evan Makuvek, Environmental Planner
Steven Rinker, GIS Coordinator/Manager
Nathaniel Staruch, Senior Planner

PROJECT PARTICIPANTS

Lead Agencies:

Monroe County Planning Commission
Program Director: Christine Meinhart - Fritz
Program Coordinator: Evan Makuvek

Monroe County Conservation District
District Manager: Craig Todd
Project Associate: Steven Baade
Project Associate: Matt Giambra
Project Associate: Andrea Mikol

Cooperating Agencies:

Pennsylvania Department of Environmental Protection
United States Environmental Protection Agency
Pinchot Institute for Conservation
Brodhead Watershed Association

Entomology Consultants:

Donald Baylor & Ken Ersbak
Aquatic Resource Consulting (ARC)
RR 715, Saylorsburg, PA 18353

Professional Laboratory Consultant:

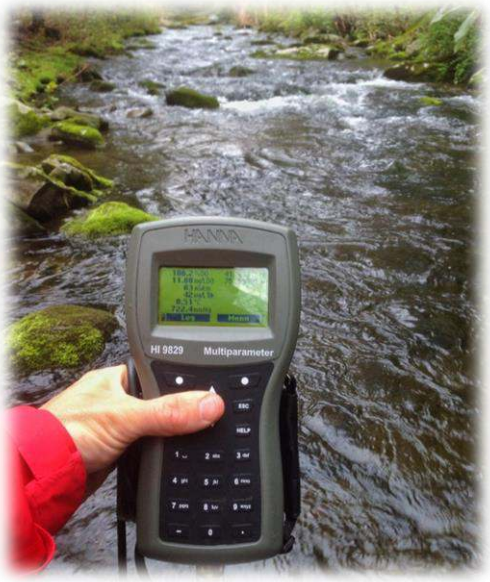
Microbac Laboratories
3355 Route 611 Unit 4
Bartonsville, Pennsylvania 18321

Materials & Methods

1. *Field Chemistry Sampling* *(Appendix A)*

The following parameters were measured and stored using HANNA Instruments- Multiparameter HI 9829 with a Multiparameter Probe 7609829 field meter and recorded on standard data forms:

-pH
-Temperature
-D.O. Concentration
-D.O. %
-Conductivity



2. *Lab Chemistry Sampling* *(Appendix A)*

The following table shows water chemistry parameters that were tested by Microbac. Laboratories in the analysis of the stream samples.

Test	**Units**	**Method**	**PQL**
Total Organic Carbon (TOC)	mg/L	SM5310 C-2000	0.500
Aluminum, Total	mg/L	E200.7	0.200
Calcium, Total	mg/L	E200.7	0.500
Iron, Total	mg/L	E200.7	0.100
Magnesium, Total	mg/L	E200.7	0.500
Harness	mg/L	SM2340-B-1997	5.00
Chloride	mg/L	EPA 300.0, Rv 2.1	0.250
pH	pH Units	SM4500 H+ B-2000	0.100
Nitrogen, Total as N (Calc)	mg/L	Calculation	0.500
Ammonia as N	mg/L	EPA 350.1, Rv 2	0.0500
Total Kjeldahl Nitrogen (TKN)	mg/L	EPA 351.2, Rv 2	0.500
Nitrate-Nitrate as N	mg/L	EPA 353.2, Rv 2.0	0.0200
Alkalinity to pH 4.5	mg $CaCO_3$/L	SM2320 B-1997	20.0
Total Dissolved Solids (TDS)	mg/L	SM2540 C-1997	20.0
Phosphorus - Total as P	mg/L	SM4500 P E-1999	0.0500
Biochemical Oxygen Demand	mg/L	SM5210 B-2001	3.00

Materials & Methods

3. Macroinvertibrate Sampling *(Appendix B)*

At each site, macroinvertebrates were collected using 12" D-frame nets that were held on the stream bottom. The collector thoroughly disturbed the stream bottom to dislodge any macroinvertebrates from the substrate. This process was repeated 6 times for Riffle/Run streams and 10 times for Multihabitat streams.

Riffle/Run 6 Samples (At least one of each)

-Fast & Shallow
-Fast & Deep
-Slow & Shallow
-Slow & Deep

Multihabitat 10 Samples (Based on abundance)

-Cobble/Gravel
-Snag
-CPOM (Course Particulate Organic Matter)
-Submerged Aquatic Vegetation
-Sand/Fine Sediment

4. Habitat Analysis *(Appendix C)*

The following tables show Habitat Assessment parameters for Riffle/Run and Low Gradient Streams. Each parameter is rated on a score from 1 to 20. 20 being the highest and 1 being the lowest

Riffle Run Streams

1	Instream Fish Cover
2	Epifaunal Substrate
3	Embeddedness
4	Velocity/Depth Regimes
5	Channel Alteration
6	Sediment Deposition
7	Frequency of Riffles
8	Channel Flow Statues
9	Condition of Banks
10	Bank Vegetative Protection
11	Grazing or Other Disruptive Pressures
12	Riparian Vegetative Zone Width

Multihabitat/Low Gradient Streams

1	Epifaunal Substrate/ Available Cover
2	Pool Substrate Characterization
3	Pool Variability
4	Sediment Deposition
5	Channel Flow Status
6	Channel Alteration
7	Bank Stability (score each bank)
8	Vegetative Protection (score each bank)
9	Riparian Vegetative Zone Width (score each bank)

Appendix A:

SURFACE WATER PARAMETERS

The chemical characterization of waterways is important for the general description of water quality conditions. The following parameters were measured in the field, water samples were also analyzed by Microbac Laboratories.

Field Measurements

pH

The pH of a solution refers to its hydrogen ion concentration. Measurement of pH is one of the most important and frequently used tests in water chemistry. The pH value of most natural waters falls within the range of 4 to 9. The pH scale ranges from 0 (acid) to 14 (base). The majority of waters are slightly basic because of the presence of carbonates and bicarbonates (generally, salts within the geology). Most fish can tolerate pH values from 5.0 to 9.0, however optimum fishing habitats fall within the range 6.5 to 8.2.

Temperature

Temperature is essential in determining if acceptable standards exist for a particular stream classification. Elevated temperatures from heated water discharges may have a significant ecological effect. Temperature also affects dissolved oxygen levels.

Dissolved Oxygen

D.O. is a measure of oxygen that is dissolved in water. Different levels of D.O. are necessary to support various types of aquatic life. These levels in natural and waste waters are dependent on the physical, chemical, and biochemical activities prevailing in the water body. The minimum D.O. levels are as follows: HQ-CWF 7.0mg / L CWF 5.0. mg/L TSF (February 15th – July 31st) 6.0 mg/L; Remainder of year 5.0

Specific Conductance

Conductivity is a numerical expression of the ability of water to carry an electrical current. It is an indication of the dissolved inorganic solids in the water. The higher the specific conductance, the more impurities are in the water. Freshly distilled w0ater has a conductivity of 0.5 to 2.0 microsiemens/cm. The conductivity of the drinking water in the U.S. generally ranges from 50 to 500 microseimens/cm (µS). It is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron.

Laboratory Analysis

TOTAL ORGANIC CARBON

TOC is a measurement of the amount of carbon containing compounds in a sample that can be quantified. This measurement is significant because the amount identified in a stream can be an indicator of the organic character of a stream. The larger the carbon or organic content, the more oxygen is consumed, thus a high content equates to an increase in of microorganisms that could contribute to the depletion of oxygen levels. Samples are preserved in the field by the addition of 1 ml of Sulfuric Acid (H2SO4). There is no numeric standard for TOC.

ALUMINUM

Aluminum is found naturally in the environment and is found in water in a dissolved form. Its concentration is influenced by multiple factors including pH, surface water flow over soil and bedrock, and groundwater flow through soil horizons and underlying geologic material. The Aluminum concentrations of water in healthy streams and rivers usually range from 0.001 to 0.05 mg/L.

CALCIUM

Calcium occurs most commonly in sedimentary rocks in the minerals calcite, dolomite and gypsum. Calcium is an important determinant of water harness, and it also functions as a pH stabilizer, because of its buffering qualities. Rivers generally contain 1-2 mg/L calcium, in limestone areas; rivers may contain calcium concentrations as high as 100 mg/L. There is no numeric standard for calcium.

IRON

Surface and groundwater naturally contain iron along with metals. Rainwater infiltrates soil horizons and iron bearing rocks and dissolves the iron into the water solution. There are two kinds of iron that occur in water. The first kind is called ferrous which is soluble in the water, this results in clear colorless water. The other state is called ferric, which results in a reddish-brown color because the iron is not completely dissolved in the water. Iron can also be combined with naturally-occurring acids (tannins) which will stain the water a tea color.

MAGNESIUM

This element is essential to chlorophyll and red blood cells. Magnesium commonly occurs in the minerals of magnesite ($MgCO_3$) and dolomite. It contributes to water hardness and is used in alloys, fertilizers, pharmaceuticals, and foods.

Laboratory Analysis (continued)

TOTAL HARDNESS

Hardness is defined as the total amount of calcium and magnesium salts that are present in the water. Hard water aids buffering capacity. Water can be defined by its total hardness as follows:

Soft Water	0 - 60 mg/L
Moderately Hard Water	60 - 120 mg/L
Hard Water	120 - 180 mg/L
Very Hard Water	180 mg/L and up

CHLORIDES

Chlorides are salts that contain chlorine and metal. Common Chlorides are sodium chloride, calcium chloride and magnesium Chloride. Most productive fish habitats have a chloride concentration of less than 170 mg/L. The recommended maximum chloride levels are 250 mg/L for water supply.

NITROGEN

Nitrate plus nitrite as nitrogen. The maximum recommended level for water supply is 10 mg/L as Nitrogen.

AMMONIA (NH3)

Ammonia is naturally present in surface and ground water and in wastewater. Pure ammonia is strong smelling and colorless. In nature, ammonia is formed by the action of bacteria on proteins and urea. Ammonia concentrations of 0.06 mg/L can cause gill damage in fish; 0.1 mg/L may indicate domestic or agricultural wastes and 0.2 mg/L and above is lethal to trout.

NITRITE (NO2)

Nitrite is the intermediate stage between nitrate and ammonia. It is relatively short-lived because it is quickly converted to nitrates by bacteria. Nitrite concentrations in drinking water seldom exceed 0.1 mg/L. There is no numeric standard for nitrite.

NITRATE (NO3)

Nitrate is found only in small amounts in domestic wastewater and is a major ingredient in farm fertilizer. During precipitation events, varying amounts of this chemical wash into nearby waterways. Nitrates stimulate the growth of phytoplankton and algae. When these photosynthetic organisms die, bacteria consume the dead organic material. This process also requires oxygen which depletes dissolved oxygen levels in the water and the fish may not be able to respire. Because Nitrate can be the limiting nutrient for plant growth in many ecosystems, the discharge from a septic tank into the aquatic environment can trigger prolific plant growth including algal blooms. There is no numeric standard for nitrate.

Laboratory Analysis (continued)

Total Kjeldahl Nitrogen

T.K.N. is the sum of organic nitrogen and ammonia nitrogen. Samples are preserved in the field by the addition of 1 ml of Sulfuric Acid (H_2SO_4). There is no numeric standard for TKN.

Total Alkalinity

Alkalinity measures the water's ability to buffer acid or acid neutralizing capacity. It indicates the water's ability to protect fish and other aquatic life against sudden changes in pH. The best fishing waters are those with alkalinity of 100 - 120 mg/L. The minimum level of total alkalinity for aquatic life buffering capacity is 20 mg/L, except where natural conditions are less. Stream alkalinity can be influenced by geologic material, soil horizons, salts, plant activities and certain industrial wastewater discharges. Water flowing through Carbonate rich limestone generally has high alkalinity – hence good buffering capacity. Conversely, areas rich in granites and some conglomerates and sandstones may have low alkalinity and therefore poor buffering capacity.

T.D.S.

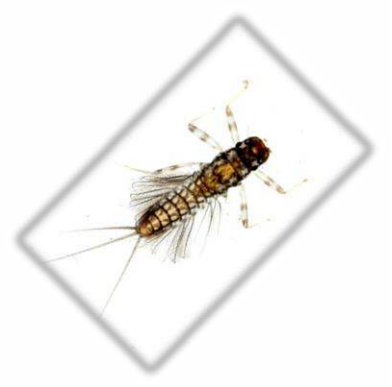
Total dissolved solids (T.D.S.), also termed total filterable residue, refers to the portion of residue that passes through a filter of a particular size. The DEP, as well as the EPA, have established secondary maximum contaminant levels of 500 mg/L of TDS for the Commonwealth's drinking water and waterways. The maximum recommended value for T.D.S. is 750 mg/L.

Total Phosphorus

Total Phosphorus is a measure of all the forms of phosphorus (dissolved or particulate) that are found in a sample. It occurs in natural waters and wastewaters almost solely in the form of phosphates. Phosphates enter waterways from animal wastes, phosphate rich rocks, fertilizers, and from the detritus of aquatic organisms. Phosphorus is essential to the growth of organisms and can be the limiting nutrient to plant growth. If high concentrations are present in streams the algae can grow more rapidly. This increase in algae is eventually consumed by bacteria which require oxygen. This process reduces dissolved oxygen in the water which can impact fish populations. Phosphate levels below 0.03 mg/L are generally considered to be unpolluted. The recommended maximum level is 0.01 mg/L for rivers and streams.

Biological Oxygen Demand

BOD is a measure of the dissolved oxygen required for the complete breakdown of organic matter, by aerobic bacteria over a five-day period. It is a key criterion used where organic loading must be restricted to maintain desired levels of dissolved oxygen in water. Sources of BOD, in addition to direct loading from STPs, include decaying algae, macrophytes and other biota. In streams that are polluted with sewage or high levels of other nutrients, the oxygen use or demand by microorganisms will be high, leaving little oxygen for other aquatic organisms. Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L.



Appendix B:

Benthic Macroinvertebrates

What is a Macroinvertebrate?

A macroinvertebrate is an organism that is large enough to see with the naked eye (macro) and lacks a vertebrate (invertebrate). The organisms that are collected for this study are called benthic macroinvertebrates. Benthic refers to the bottom layer of an aquatic ecosystem including underneath stream sediment. These organisms include mayflies, caddisflies, stoneflies, snails, clams, crayfish, freshwater shrimp, beetle larvae, midges, leeches, dragonflies, and more.

Why collect Macroinvertebrates?

- They are relatively easy to collect.
- They play a key role in the ecosystem's food web.
- They are used as bio indicators for environmental stress and can show varying responses to water chemistry and physical habitat.
- Due to their relative immobility (unlike fish) they cannot move upstream or downstream to avoid poor water conditions.
- They are extremely diverse. Different macroinvertebrates will live in different water bodies due to water conditions, available food, and absence or abundance of sediment, nutrients, and detritus (dead organic matter).

Source of Photos: http://kentschools.net thebeachschool.eq.edu.au www.fly-fishing-discounters.com

Macroinvertebrate Analysis

The protocols used in the development for the riffle/run Index of Biotic Integrity (IBI) were conducted from small first through third order riffle/run type streams, which totaled a drainage area of less than 50 square miles. The second protocol type is the multi-habitat assessment for low-gradient streams, which involved sampling a variety of habitat types. The difference between the two assessment protocols involved sampling different micro-habitats for macroinvertebrate collections and different habitat evaluation categories. These bio assessments were employed to cumulatively evaluate the ecological conditions of streams that are present within Monroe County.

Metric Calculations

The following are the riffle/run metrics used for the benthic macroinvertebrate analysis. Metrics are the various counts, indexes, and ratios computed from the results of the subsamples.

Different metrics convey different types of information about the macroinvertebrate community. For example, taxa richness is an index of diversity and the Hilsenhoff Biotic Index measures an organism's pollution tolerance. By using a set of metrics that measures multiple aspects of the macroinvertebrate community, a complete picture of a community can be attained. This enables the reader to understand the importance of measuring the relative stability of the aquatic community.

The following is a list of metric calculations utilized during the 2016 study:

Freestone Riffle/Run (6 D Frame):

Modified Beck's Index (**version 3**)
MBI metric is projected to decline in assessment score when anthropogenic stress to a stream ecosystem increases, therefore representing the loss of pollution-sensitive taxa. It should be noted that this index metric for this project, while similar in name and concept, differs slightly from the Beck's Index used in DEP's multihabitat protocol for assessing biological condition of low gradient pool-glide type streams.

EPT Taxa Richness
EPT Taxa Richness metric is a count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a sub-sample that represents community structure. These orders are commonly referred to as mayflies, stoneflies, and caddisflies, respectively. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of taxa from these largely pollution-sensitive orders.

Total Taxa Richness
Total Taxa Richness is a community structure metric, which is a count of taxa in the sub sample. Generally, this metric is expected to decrease with increasing anthropogenic stress to the ecosystem, reflecting loss of taxa and increasing dominance of a few pollution tolerant taxa.

Shannon Diversity Index
SDI is a taxonomic composition metric that measures taxonomic richness and evenness of individuals across taxa of a sub-sample. This metric is expected to decrease in values with increasing anthropogenic stress to a stream ecosystem.

Hilsenhoff Biotic Index
HBI is a taxonomic composition metric and is calculated as an average pollution tolerance value weighted by the number of individuals of each taxa in the sub-sample. The Hilsenhoff Biotic Index generally increases with increasing ecosystem stress.

Percent Sensitive Individuals
Percent Sensitive Individuals is a taxonomic composition metric which is the percentage of individuals with pollution tolerance values of three or less in a sub-sample and is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

Index Calculation-Riffle/Run:

Through the combination of these various metrics noted previously, standardization is needed. Table 1 depicts the standardization table with the associated standardized and adjusted metric scores with the total producing the IBI score. This index is a way to integrate data that is collected from the above equations. The sum of these specific metric equations constructs an IBI, which then can be related to reflect the ecology and impacts to the aquatic community being studied. There are six metrics involved, the Hilsenhoff Biotic Index (HBI) is the only one predicted to increase in value if the community is stressed. The other five IBI metrics are predicted to decrease in value if the community is exposed to increased stress. The index calculation and standardization is as follows.

Table 1. Metric Standardization Equations and Index calculations for sub-sampled sites.

Metric	**Standardized Equation**	**Observed Metric Value**	**Standardized Metric Score**	**Adjusted Standardized Metric Score** Maximum = 1.000
Modified Beck's Index	Observed value / 33			
EPT Taxa Richness	Observed value / 19			
Total Taxa Richness	Observed value / 38			
Shannon Diversity Index	Observed value / 2.86			
Hilsenhoff Biotic Index	(10 - Observed value) / (10 – 1.89)			
Percent Intolerant Individuals	Observed value / 84.5			
Average of adjusted standardized core metric scores * 100 = **IBI Score**				

Aquatic Life Use Attainment Benchmarks

Table 2 depicts the Aquatic Life Use (ALU) IBI scoring benchmarks utilized by DEP for assessment purposes. DEP implements a multi-tiered benchmark decision process for small wadeable freestone riffle/run streams in Pennsylvania that incorporates sampling season as a factor for determining ALU attainment and impairment; this process is outlined in the diagram below (PADEP 2009). Title 25, Chapter 93 of the Pennsylvania Code provides further information on these uses.

Table 2. Aquatic Life Use (ALU) IBI scoring benchmarks for Instream Comprehensive Evaluation (ICE) assessment purposes.

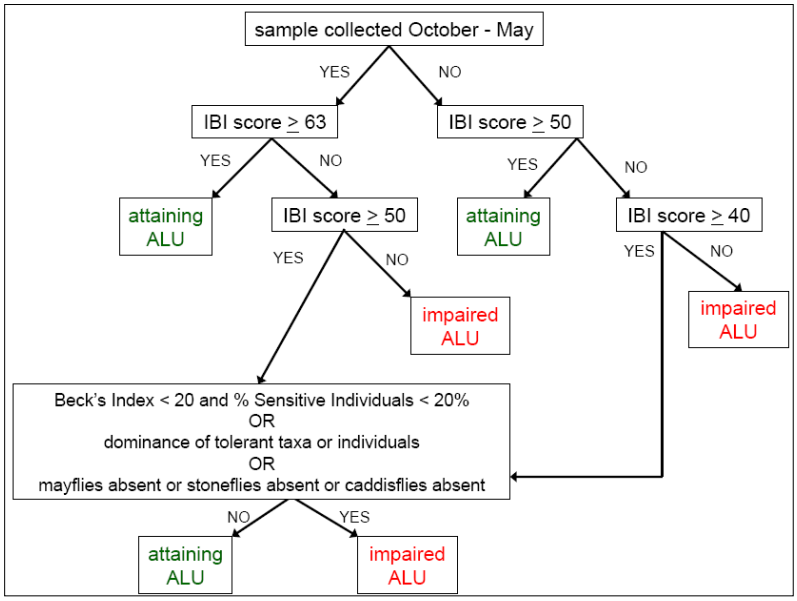


Table 2 depicts the adjusted and standardized Aquatic Life Use (ALU) IBI scoring benchmarks for ICE assessment purposes. For samples collected from smaller streams between October and May, an IBI score > 63 results in ALU attainment and an IBI score < 50 results in ALU impairment; an IBI score between 50 and 63 requires further evaluation to determine ALU impairment – three guidelines may be used:

(1) If the Beck's Index score is < 20 and the % Sensitive Individuals in the sub-sample is < 20%, the ALU should be impaired without compelling reason otherwise;

(**2**) If the sample is dominated by tolerant taxa or individuals, the ALU should be impaired without compelling reason otherwise; or

(**3**) If mayflies, stoneflies or caddisflies are absent from the sub-sample the ALU should be impaired. For samples collected between June and September from smaller streams, an IBI score > 50 results in ALU attainment and an IBI score < 40 results in ALU impairment; an IBI score between 40 and 50 requires further evaluation to determine ALU impairment, guided by the same three guidelines outlined above for October to May samples scoring between 50-63.

Multi-habitat - Low Gradient (10 D Frame):

EPT Taxa Richness - Refer to riffle/run definition.
Total Taxa Richness - Refer to riffle/run definition.

Modified Beck's Index (version 4) - This is a pollution weighted taxa richness measure that is based on the Hilsenhoff Biotic Index Score. It is a modified Beck's Index giving organisms with a Hilsenhoff score of 0 or 1 two points and Hilsenhoff scores of 2, 3, or 4 are given 1 point. This metric differs slightly from the Beck's Index used in DEP's riffle/run protocol for assessing the biological condition of freestone type streams.

Shannon Diversity Index - Refer to riffle/run definition.
#Caddisfly Taxa - Total number of Caddisflies (Trichoptera) in the sub-sample
#Mayfly Taxa - Total number of Mayflies (Ephemeroptera) in the sub-sample

Index Calculation-multihabitat:

Through the combination of the various metrics noted above, normalization is needed. This index is a way to integrate data that is collected from the above equations. Table 3 depicts the standardization table with the associated normalized and adjusted metric scores with the total generating an IBI score. The sum of these specific metric equations builds an IBI, which then can be related to reflect the ecology & impacts to the aquatic community being studied. Of the six metrics utilized, all are predicted to decrease in value if the community is stressed. The normalized scores above 100 are adjusted to a score of 100. The index calculation and normalization is as follows:

Table 3. Normalization of Metric and Total Biological Score Calculation.

Metric	Standardized Equation	Observed Value	Normalized Metric Score	Adjusted Metric Score Maximum = 100
EPT	(Observed value / 17) x 100			
Taxa Richness	(Observed value / 31) x 100			
Beck4	(Observed value / 22) x 100			
Shannon Diversity	(Observed value / 2.43) x 100			
% Caddisfly Taxa	(Observed value / 11) x 100			
% Mayfly Taxa	(Observed value / 6) x 100			
Total Biological Score				

Aquatic Life Use Attainment Benchmarks

The following depicts the aquatic life use (ALU) IBI scoring benchmarks utilized by DEP for assessment purposes. This multimetric approach simplifies management decisions, being presented as a single index score (PADEP 2007). If the total benchmark score of 55 is not reached, then the stream reach is not attaining the threshold for aquatic life. Title 25, Chapter 93 of the Pennsylvania Code provides further information on these uses.

The following summaries are presented in the sequence they were sampled. They depict the macroinvertebrate community per site, specifically genus level taxonomy, water pollution tolerances values (0 intolerant to 10 tolerant), trophic codes and the statistics that comprise the total standardized biological score. The trophic code is a general classification system, which is based on what type of feeding mechanism the macroinvertebrate utilized or how the food is acquired. These categories are presented to facilitate the descriptions on the following pages:

SC - **Scrapers**: graze or scrape materials from mineral and organic substrates

SH - Shredders: chew on plant and some animal material, breaking it down into smaller particles feeding directly on living vascular hydrophytes, or gouge decomposing wood submerged in streams

CG - Collector/Gatherers: feed primarily on fine pieces of decomposing particulate organic matter (< 1 mm diameter) deposited in streams;

FC - Filterer/Collector: remove particulate matter from suspension

PR - Predators: Organisms that feed on animal tissue by either engulfing or piercing and sucking body contents of prey (Merritt & Cummins 1984).

Monroe County executed two progressive stream evaluation surveys, the riffle-run and the multihabitat protocols, which are conducted within a 100 meter stream reach. These biological screening protocols were modified from the United States Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBPs), for assessing stream macroinvertebrate communities (PADEP 2009). These biological screening protocols are specifically designed per stream type, to provide intensive field surveys and water quality assessment approaches. The riffle-run Index of Biological Integrity (IBI) applies to benthic macroinvertebrate samples collected using a handheld 500-micron mesh D-frame net, which employed the semi-quantitative (PADEP-RBP) method, applied for each Instream Comprehensive Evaluation (ICE). Staff conducted six swipes from shallow, fast and slow riffle areas within a 100-meter stream reach. Each swipe disturbed approximately one square meter, immediately upstream of the net for approximately one minute, to an approximate depth of 10 cm, as substrate permits (PADEP 2009). The second sampling protocol is the multihabitat approach for low gradient streams, which required 10 jabs utilizing a 500-micron mesh D-frame net distributed between

five possible habitat types: Cobble/Gravel Substrate; Snag; Coarse Particulate Organic Matter (CPOM); Submerged Aquatic Vegetation (SAV); Sand/Fine Sediment) (PADEP 2007).

For the riffle-run dominated streams, each sample is composited into one container preserved with 95% ethanol in the field and transported to the contracted entomologist for enumeration and identification and placed into a pan marked with 28 four square inch grids. Debris from four grids is randomly selected and extracted using a four-square inch circular "cookie cutter," then placed into another identical empty pan. From this second pan, organisms are randomly selected from the grids until a 200-organism sub-sample (+/- 40 organisms) is obtained. Organisms in the sub-sample are identified according to taxonomic groupings and enumerated. Midges are identified to the family level of Chironomidae. Roundworms and proboscis worms are identified to the phylum level, flatworms and segmented worms, aquatic earthworms, and tubificids are identified to class. Water mites are identified as Hydracarina, and all other macroinvertebrates are identified to genus level (PADEP 2009).

For low gradient dominated streams, each sample is composited into one container preserved with 95% ethanol in the field and transported to the contracted entomologist for enumeration and identification and placed into a pan marked with 28 2” x 2” grids. Debris from four grids is randomly selected and extracted until a 200-organism sub-sample (+/- 20 %) is obtained. Organisms in the sub-sample are identified according to taxonomic groupings. Midges are identified to the family level of Chironomidae. Roundworms and proboscis worms are identified to the phylum level; flatworms are identified to Phylum Turbellaria; segmented worms, aquatic earthworms and tubificids are identified to Class Oligochaeta. Water mites are identified as Hydracarina, weevils to family, sand flies to family Ceratopogonidae, Decapoda, Gastropoda, and Pelecypoda to family, and all other macroinvertebrates are identified to genus level (PADEP 2007). The specifics of the macroinvertebrate analyses are discussed in Appendix B of this report.

Precision Quantification

To quantify precision methods, two of the biological samples were replicated and collected by the same investigator to minimize variability, and complies with the PADEP’s quality assurance manual to verify identification work performed on macroinvertebrates. The Field data sheets are available for review at the MCPC office.

Quality Assurance

Accuracy was determined through the use of routine laboratory protocols that required random spiking of samples as per *consistency with the Quality Assurance Manual for* PADEP. Data quality requirements were maintained in the field throughout the collections. Calibration of field equipment was performed daily.

During the field sampling, water samples were collected at mid-depth and mid-channel. These water samples were stored in coolers with ice packs in order for stabilization and then transported to Microbac Laboratories, which is EPA certified for analysis. The specifics of the chemical parameters are discussed in Appendix A of this report.

2016 MONROE COUNTY MACROINVERTEBRATE DATA

TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION												
ORDER *GENERA/SPECIES*		01	02	03	04	05	06	07	08	09	10	11	12	13
AMPHIPODA (shrimp)														
Gammarus spp.	4					2	1							
BIVALVIA (clams)														
Pisidium spp.	8	2												
COLEOPTERA (beetles)														
Berosus spp.	5													
Stenelmis spp.	5		7	6	18	3	1						4	
Promoresia spp.	2	1												
Dubiraphia spp.	6											2		
Optioservus spp.	4	6	4			3			1	5	63	7	13	
Ectopria spp.	5													
Psephenus herricki	4	2	1	2		10	2		8				17	
Microcylloepus spp.	2	1							22	3				
Hydrochus spp.	5		1											
Oulimnius spp.								5						
DIPTERA (true flies)														
Chironomidae	6	24	98	103	70	68	50	42	35	28	1	23	18	115
Blepharicera spp.	0													
Tipula spp.	4													
Hexatoma spp.	2						3	10					1	
Pericoma spp.	4													
Hemerodromia spp.	6													
Tabanus spp.	5													
Atherix spp.	2												2	
Antocha spp.	3	3		5	2	4		3	2	7			9	9
Simulium spp.	6		1	4	4			6		2	2	2		
Dicranota spp.	3						19							
Empididae spp.	6								1			1		
EPHEMEROPTERA (mayflies)														
Epeorus spp.	0		9	3	6		2	22	13					1
Mccaffertium spp.	3	15	4	4	1	13	12	4	1	4	6		3	
Stenacron spp.	4													
Ephemerella spp.	1	55	31	8	26	16	23	36	38	23	69	76	69	
Eurylophella spp.	4	3			2	1	2		1	1				
Drunella spp.	1	1	9	2	21	10	24	11	5	7			4	1
Danella spp.	2	3												
Attenuatella spp	2								1					
Seratella spp.	2		4			1	1			2	1	4		
Leucrocuta spp.	1													
Paraleptophlebia spp.	1							7	3					
Leptophlebia spp.	4													
Heterocloen spp.	2													
Cinygmula spp.	1							29				10		
Heptageniidae	3								1					
Isonychia spp.	3	3	5	1	5	1	5		1	12		4	14	
Ameletus spp.	0							3	1		1	2		
Baetidae	6									3				
Baetis spp.	6	1	1		3			11		4	2			20
Acerpenna spp.	6							1				5		
Plauditus spp.	6	2	4			1	4		1					
Acentrella spp.	4		30	8	21		46		12			1		
GASTROPODA (snails)														
Physinae	8													
HEMIPTERA (true bugs)														
Dasycorixa spp.	8													
HIRUDINEA (leeches)	8													
Myzobdella spp.														
ISOPODA (sowbugs)														
Caecidotea spp.	6													
MEGALOPTERA (hellgramites)														
Sialis spp.	6													
Corydalus spp.	4				2				1	2			3	
Nigronia spp.	2				1		2	1	1	2			5	2
NEMERTEA	6	1												
NEMATOPHORA (horsehair wo	9				1									

TAXON (continued)	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION (continued)												
ORDER *GENERA/SPECIES*		01	02	03	04	05	06	07	08	09	10	11	12	13
ODONATA (dragon flies)														
Libellula spp.	8													
Calopteryx spp.	6											1		
Boyeria spp.	2													
Ophiogomphus spp.	1						2							
Lanthus spp.	5													
Gomphidae	4											1		
Argia spp.	6									1				
OLIGOCHAETA (worms)	10	11												
PLECOPTERA (stoneflies)														
Leuctra spp.	0	1						7			1			
Taeniopteryx spp.	2													
Amphinemura spp.	3									1	23	13		2
Pteronarcys spp.	0			1				4	1					
Acroneuria spp.	0		2		4		1		9	2			2	
Paragnetina spp.	1				2		1							
Agnetina spp.	1				1			4	5			2		
Perlesta spp.	4		1						3			1		
Suwallia/Sweltsa spp.	0						1	14						8
Shipsa spp.	2													
Tallaperla spp.	0							6						
Diploperla spp.	2						1		1					
Clioperla spp.	2													
Diura spp.	2							3						
Cultus spp.	2											12		1
Isoperla spp.	2							2	2	1				
TURBELLARIA (flatworms)														
Macrostemum spp.	8													
TRICHOPTERA (caddisflies)														
Chimarra spp.	4						1		1			9		7
Dolophilodes spp.	0		9	43	18			1	3					43
Neophylax spp.	3										1			
Hydropsyche spp.	5	1				2				2	3	3	2	7
Ceratopsyche spp.	5	16	9	3	17	17	15	2	14	39	12	5	20	8
Cheumatopsyche spp.	6	10	6	8	14	41	14		29	65	31	23	37	
Diplectrona spp.	0							3						1
Rhyacophila spp.	1			1		1	1	3	4	3	1	1	1	2
Lepidostoma spp.	1	4	4	2		8	2				1	2		
Psilotreta spp.	0						1							
Glossossoma spp.	0												1	
Agapetus spp.	0								1			1		
Protoptila spp.	1													
Psychomyia spp.	2													
Lype spp.	2								1					
Micrasema spp.	2									5			1	
Polycentropus spp.	6	1					2	1			1			5
Nectopsyche spp.	3													
Pycnopsyche spp.	4	3									3	4		
TOTAL		170	240	204	239	202	239	241	223	224	222	215	226	232
METRICS														
Total Taxa Richness		24	21	17	21	18	28	27	33	24	18	26	20	16
Shannon Diversity Index		2.38	2.11	1.74	2.38	2.13	2.51	2.75	2.72	2.37	1.88	2.41	2.30	1.74
EPT Taxa Richness		8	11	10	11	8	16	17	22	11	9	14	8	9
Hilsenhoff Biotic Index		3.73	4.11	4.01	3.79	4.57	3.69	2.26	3.14	4.40	3.26	3.01	3.37	4.25
Percent Intolerant Individuals		51%	33%	34%	36%	27%	43%	72%	52%	32%	46%	60%	50%	30%
Modified Beck's Index		12	16	17	18	9	28	39	34	14	13	18	16	18
Index of Biotic Integrity (New)		**61.2**	**69.5**	**65.4**	**74.1**	**57.0**	**88.9**	**91.3**	**95.3**	**70.2**	**56.6**	**73.6**	**61.0**	**51.7**

2016 MONROE COUNTY MACROINVERTEBRATE DATA

TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION												
ORDER *GENERA/SPECIES*		**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
AMPHIPODA (shrimp)														
Gammarus spp.	4						17	21					2	
BIVALVIA (clams)														
Pisidium spp.	8													
COLEOPTERA (beetles)														
Berosus spp.	5													
Lutrochus spp.	6													
Microcylloepus spp.	2				1									
Stenelmis spp.	5													
Dubiraphia spp.	6													
Promoresia spp.	2				10	10				3			6	
Stenelmis spp.	5		6	1							9	2		
Ectopria spp.	5								1					
Optioservus spp.	4						15	8	3		1			
Agabus spp.	5		1											
Micronychus spp.	2					1								
Psephenus herricki	4				8	5	15	16		6	1	5	6	
DIPTERA (true flies)														
Chironomidae	6	60	110	76	21	7	14	14	66	17	83	125	63	90
Bezzia spp.	6													
Hemerodromia spp.	6													
Blepharicera spp.	0			3										
Limnophora spp.	6													
Muscidae	6													
Tipula spp.	4								1					
Hexatoma spp.	2	7	1	3					15	3	1			4
Atherix spp.	2				1		1				3		2	
Antocha spp.	3	9		2	2		1				10		5	1
Tabanus spp.	5													
Empedidae spp.	6							1		1				
Dicranota spp.	3		1					2	1	1				
Prosimulium spp.	0			9										
Pedecia spp.	6			2										
Simulium spp.	6	5	27		4	1		3		1				3
EPHEMEROPTERA (mayflies)														
Epeorus spp.	0	3		7	2				19	49			1	18
Mccaffertium spp.	3	6		1	3		15	25			9	5		
Stenacron spp.	4													
Ephemerella spp.	1	35		6	49	15	77	34	48	32	18	17	13	18
Eurylophella spp.	4	4				5	1				5			
Serratella spp.	2				3		1				1			
Leucrocuta spp.	1					2								
Dannella spp.	2						6							
Drunella spp.	1	6			4		24	4	1		21	22	16	2
Heterocloen spp.	2													
Paraleptophlebia spp.	1				9	15			1	4				1
Isonychia spp.	3	2			4		1	3			5	1		
Ameletus spp.	0													
Caenis spp.	7				2									
Baetis spp.	6	6		61	17	26	7	2	20	9	1		15	39
Acerpenna spp.	6													
Acentrella spp.	4	13			4	2	4	7	1		9	7	21	4
Ephemera spp.	2				1									
Caenis spp.	7						3							
Plauditus spp.	6						4							
Diphetor spp.	6								2					
Cinygmula spp.	1									9				3
GASTROPODA (snails)														
Gyraulus spp.	6													
Valvata spp.	2													
HEMIPTERA (true bugs)														
HIRUDINEA (leeches)														
ISOPODA (Sowbugs)														
Caecidotea spp.	6		5											
MEGALOPTERA (hellgramites)														
Sialis spp.	6													
Nigronia spp.	2							1	3		3			
Corydalus spp.	4	5	17											

TAXON (continued)	Pollution Tolerance													
ORDER *GENERA/SPECIES*		14	15	16	17	18	19	20	21	22	23	24	25	26
ODONATA (dragon/damsel flies	4													
Gomphidae	5													
Lanthus spp.	4	1			2					1				
Stylogomphus spp.	10		2											
Bayeria spp.	2		1											
Ophiogomphus spp.	1										1			
OLIGOCHAETA (worms)	10						1						1	
PLECOPTERA (stoneflies)														
Paraleuctra spp.	0												1	
Leuctra spp.	0	4	12	1					2	25	1	1		
Amphinemura spp.	3		15	8	4	5				15				
Pteronarcys spp.	0			1	7	3	1	1	10	11				
Acroneuria spp.	0	4			14	3		2	2	9	3	4	9	
Paragnetina spp.	1			1								4		
Agnetina spp.	2								5		1	1	2	2
Suwallia/Sweltsa spp.	0	1		8					12	18	3			9
Perlesta spp.	4						4							
Tallaperla spp.	0			2	1	1				1				
Diploperla spp.	2	2												
Isoperla spp.	2	1							2					1
Isogenoides spp.	0													2
Diura spp.	2								5					
Clioperla spp.	2			3										
Remenus spp.	2					1								
TURBELLARIA (flatworms)														
TRICHOPTERA (caddisflies)														
Chimarra spp.	4		3		1						3	1	7	
Dolophilodes spp.	0	11	1	21	15		2	4	1	11	5	22	25	26
Hydropsyche spp.	5		13					1						
Cheumatopsyche spp.	6	10	7		14		13	58			17	6	11	
Ceratopsyche spp.	5	17		13	21		2	13	12	1	17	7	30	12
Diplectrona spp.	0	14			12	16			1	9			1	
Rhyacophila spp.	1	4	13	4	4		1	3	4	2	3	2	3	3
Glossosoma spp.	0													
Psychomyia spp.	2					1								
Nyctiophylax spp.	6					1								
Lepidostoma spp.	1		2	1	1	2	1	6	2		4	2	1	2
Leucotrichia spp.	6													
Micrasema spp.	2					1								
Neophylax spp.	3							2						
Brachycentrus spp.	1	1												
Pycnopsyche spp.	4		1											
Molanna spp.	6		1											
TOTAL		231	239	234	241	123	231	231	240	238	238	234	241	240
METRICS														
Total Taxa Richness		25	20	22	30	21	25	23	26	23	27	18	23	19
Shannon Diversity Index		2.64	2.00	2.15	2.87	2.52	2.42	2.49	2.41	2.62	2.49	1.79	2.50	2.09
EPT Taxa Richness		16	8	13	18	14	13	11	16	13	15	13	12	13
Hilsenhoff Biotic Index		3.38	4.90	4.11	2.71	2.72	2.87	3.87	3.03	1.29	3.99	4.06	3.10	3.81
Percent Intolerant Individuals		48%	19%	35%	61%	62%	57%	38%	56%	85%	38%	35%	35%	38%
Modified Beck's Index		29	12	34	33	25	17	18	38	34	31	21	26	27
		77.8	**48.3**	**69.0**	**89.1**	**75.7**	**84.9**	**76.2**	**83.2**	**86.5**	**85.2**	**72.5**	**81.4**	**65.2**

2016 MONROE COUNTY MACROINVERTEBRATE DATA

TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION											
ORDER *GENERA/SPECIES*		27	28	29	30	31	32	33	34	35	36	37	38
AMPHIPODA (shrimp)													
Gammarus spp.	4				1								
BIVALVIA (clams)													
COLEOPTERA (beetles)													
Lutrochus spp.	6												
Microcylloepus spp.	2				89								
Macronychus spp.	2												
Stenelmis spp.	5										18		
Promoresia spp.	2		3	25				1		1	1		
Stenelmis spp.	5		26	9		1						6	2
Optioservus spp.	4		13	7			1		2			2	7
Psephenus herricki	4		25	5	1								8
DIPTERA (true flies)													
Chironomidae	6	110	22	10	47	14	31	5	71	118	28	6	61
Blepharicera spp.	0	2											
Hemerodromia spp.	6												
Empididae	6										1		
Muscidae	6												
Tipula spp.	4	1		1					1			1	
Hexatoma spp.	2	13					1	1	5			2	
Atherix spp.	2												
Antocha spp.	3	1	13	2	1		3		4		11		
Proimulium spp.	0								1				
Simulium spp.	6	1	3	6	1		7		1	2			
Dicranota spp.	3	3						1	4				
Probezzia spp.	6								1				
EPHEMEROPTERA (mayflies)													
Epeorus spp.	0	13						2	12		1		
Mccaffertium spp.	3		1	7	12	2					10	2	21
Stenacron spp.	4												
Cinygmula spp.	1												
Ephemerella spp.	1	9	19	73	1		5	25	30	17	3	2	26
Eurylophella spp.	4		2		2								13
Caenis spp.	7										1		
Serratella spp.	2			1									1
Drunella spp.	1		7	3						1	38		
Paraleptophlebia spp.	1							1	5				
Leptophlebia spp.	4												
Habrophlebiodes spp.	6												3
Isonychia spp.	3			7	2						40		
Ameletus spp.	0												
Baetis spp.	6	34		19	9	71	8	18	22	10			
Diphetor spp.	6								2				
Acerpenna spp.	6									2			5
Acentrella spp.	4	1	4						5				
Cynigmula spp.	1	2							15	1			
GASTROPODA (snails)													
HEMIPTERA (true bugs)													
Microvelia spp.	9											1	
HIRUDINEA (leeches)													
ISOPODA (sowbugs)													
Caecidotea spp.	6		5										2
MEGALOPTERA (hellgramites)													
Sialis spp.	6												1
Nigronia spp.	2	1	3							4		5	3
Corydalus spp.	4				2								

TAXON (continued)	Pollution Tolerance												
ORDER *GENERA/SPECIES*		27	28	29	30	31	32	33	34	35	36	37	38
ODONATA (dragon/damsel flies)													
Boyeria spp.	2										1		
Cordulegaster spp.	3												4
Lanthus spp.	5										1		
Argia spp.	6				1								
OLIGOCHAETA (worms)	10												
PLECOPTERA (stoneflies)													
Leuctra spp.	0	2					29	101	2			7	
Amphinemura spp.	3	2	2			1	124	25	1			5	
Pteronarcys spp.	0	3		1					2		1		
Perlidae	3									3			
Acroneuria spp.	0	1	3			3					10		
Paragnetina spp.	1		3										
Agnetina spp.	1	3		2		1							
Suwallia/Sweltsa spp.	0	9	1				10		11				
Paranemoura spp.	2												
Tallaperla spp.	0						2		4				
Diploperla spp.	2	2											
Diura spp.	2						3	1	1				
Perlesta spp.	4										1		1
Isoperla spp.	2	1		4		1			4				
TURBELLARIA (flatworms)													
TRICHOPTERA (caddisflies)													
Chimarra spp.	4		21	6	21	9				9			1
Wormaldia spp.	0						1					3	
Dolophilodes spp.	0	13	17	9		87	1		8	4			
Hydropsyche spp.	5				17	1			9	4		1	37
Cheumatopsyche spp.	6		29	2	20	2				1	45		36
Ceratopsyche spp.	5	9	8	36		25			10	14	14		
Diplectrona spp.	0												
Wormaldia spp.	0												
Rhyacophila spp.	1	1	7	2		3	8	2	4	2	7	2	
Neureclipsis spp.	7												
Parapsyche spp.	0						2						
Agapetus spp.	0								1				
Ceraclea spp.	3												1
Lepidostoma spp.	1	1	1	1			3	8	1	1	1	1	1
Micrasema spp.	2												5
Polycentropus spp.	6		2					1					
Pycnopsyche spp.	4			1								2	1
Cyrnellus spp.	8										1		
TOTAL		238	240	239	227	221	239	192	239	194	234	48	240
METRICS													
Total Taxa Richness		25	25	24	16	14	17	14	29	17	21	16	22
Shannon Diversity Index		2.06	2.80	2.44	1.87	1.61	1.74	1.58	2.61	1.58	2.34	3.70	2.33
EPT Taxa Richness		16	13	13	5	8	11	8	16	8	10	8	10
Hilsenhoff Biotic Index		4.16	3.88	2.99	3.90	3.20	1.61	1.39	3.38	4.97	3.67	2.92	4.54
Percent Intolerant Individuals		34%	33%	57%	46%	43%	80%	88%	48%	18%	53%	60%	26%
Modified Beck's Index		35	21	19	3	11	26	17	37	15	19	14	6
		72.2	**82.1**	**86.0**	**46.3**	**50.8**	**72.2**	**64.1**	**83.2**	**45.3**	**64.8**	**64.3**	**52.4**

Appendix C:

Habitat Assessment

Both the quality and quantity of available habitat affects the macroinvertebrate community. A healthy biological community not only requires good water quality, but also a supporting habitat. There are two types of rating systems for 2016. One is for a Riffle/Run prevalent stream, like most of the streams in Monroe County, which incorporates three categories for a total of 12 parameters. The second is the Multihabitat Low-Gradient stream for the low gradient streams that utilize 9 parameters. The following is an explanation of the habitat parameters:

Habitat Parameter Descriptions *Riffle/Run Streams*

1. **Instream Cover:**
   This is a measure of quantity and variety of natural structures in the stream that will provide a habitat for fish. (fallen trees, branches, logs, undercut banks, and large rocks)

2. **Substrate for Benthic Macroinvertebrates:**
   This measures the amount of hard substrate available for insects and snail habitat. Many insect larvae attach themselves to submerged substrate. Areas with rocky bottoms are critical for maintaining a healthy variety of insects.

3. **Embeddedness:**
   This refers to the degree to which rocks are covered or sunken into the silt, sand or mud. As substrates become embedded in the stream bottom, the amount of adequate surface space for insects to attach themselves decreases and the quantity and quality of the macroinvertebrate community is predicted to decrease.

4. **Velocity/Depth Regime:**
   There are four basic velocity/depth combinations:
   Shallow/Fast, Shallow/Slow, Deep/Fast, and Deep/Slow

5. **Channel Alteration:**
   This parameter is a measure of changes to the shape of the stream channel. When streams have been altered in any way (i.e., straightened, deepened, diverted, concrete channelized, artificial embankments or stabilization, dams or bridges), it can affect the macroinvertebrate community.

6. **Sediment Deposition:**
This parameter measures the sediment, which has accumulated on the stream bottom as a result of deposition. Deposition occurs as a result of large-scale movement of sediment caused by watershed erosion. This deposition may cause the formation of islands or point bars in the stream, which decreases the available habitat for macroinvertebrates.

7. **Frequency of Riffles:**
This parameter assumes that a stream with riffles or bends provides more diverse habitat than any straight or uniform depth stream. The ratio is calculated by dividing the average distance between riffles or bends by the average depth. The smaller ratio is an indicator of good habitat.

8. **Channel Flow Status:**
This is a measure of the degree to which the channel is filled with water. When the water reaches the base of both banks and a minimal amount of channel substrate is exposed, optimal conditions exist.

9. **Condition of Banks:**
This parameter addresses stream bank erosion (or potential for erosion). Steep banks are generally more susceptible to erosion and failure. Signs of erosion include crumbling banks, unvegetated banks, and exposed tree roots and soil.

10. **Bank Vegetative Protection:**
This measures the amount of stream bank covered by vegetation. Plant root systems on stream banks facilitate soil stability which reduces erosion. This parameter also provides information such as stream shading and nutrient uptake. Banks that support natural plant growth are indicative for supporting a healthier habitat for macroinvertebrates and fish.

11. **Grazing Disruptive Pressure:**
This parameter measures the impact to the riparian zone due to livestock grazing or human activities such as urbanization, golf courses, and residential developments.

12. **Riparian Zone Width:**
This is a measure of the width of the natural vegetation from the edge of the stream bank. This zone serves as a buffer to pollutants entering the stream from surface runoff.

Habitat Parameter Descriptions Multihabitat Low-Gradient Streams

1. **Epifaunal Substrate for Macroinvertebrate:**
   The substrate in muddy bottom streams consists mostly of submerged logs, snags and aquatic vegetation.

2. **Pool Substrate Characterization:**
   This is an evaluation of the type and condition of bottom substrates found in pools. Firm sediment types such as gravel and sand as well as rooted aquatic plants support a wider variety of organisms. A pool substrate dominated by mud or bedrock will not support a diverse community.

3. **Pool Variability:**
   This parameter rates the overall mixture of pool types found in the streams. The four basic types of pools are: Large-shallow, Small-deep, Small-shallow, Large-deep. General guidelines are as follows: greater than one half the cross-section to separate large from small and one meter separating shallow and deep.

4. **Sediment Deposition:**
   This parameter measures the sediment, which has accumulated on the bottom as a result of deposition.

5. **Channel Flow Status:**
   This is a determination of the percent of the channel that is filled with water. The flow status changes as the channel enlarges or as flow is decreased as a result of dams or obstructions, diversions for irrigation, or drought. When water does not cover as much of the streambed the available habitat is decreased.

6. **Channel Alteration:**
   This parameter is a measure of changes to the shape of the stream channel. Streams that run through agricultural or urban areas may have been altered many times. When streams have been changed in any way (i.e., straightened, deepened, diverted, concrete channelized, artificial embankments or stabilization, dams or bridges) it can affect the macroinvertebrate community. Streams that have been altered have fewer natural habitats for fish, macroinvertebrates and plants.

7. **Bank Stability:**
   This parameter addresses stream bank erosion (or potential for erosion). Steep banks are generally more susceptible to erosion and failure. Signs of erosion include crumbling and unvegetated banks and exposed tree roots and soil.

8. **Vegetative Protection:**
   This measures the amount of stream bank, which is covered by vegetation. Plant root systems on stream banks facilitate soil stability, which reduces the stream bank erosion. Banks that support full natural plant growth are indicative for supporting a healthier habitat for macroinvertebrates and fish.

9. **Riparian Vegetative Zone Width:**
   Refer to riffle/run definition.

Site Map

Site Chart

AQUACR14

Location	100 yards upstream of Lower Smith Gap Road Bridge		
Site #	2016-1	Date	5/9/2016
Stream Name	Aquashicola Creek	Time	10:57:37 AM
Township	Eldred Township	Latitude	40.82956
Habitat Asmt.	152	Longitude	-75.44618

Field Measurements	
Temp C	12.83
pH	7.99
Press inHg	29.54
DO Percent	103.1
DO mg/L	10.75
Cond (uS/cm)	129

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.38
EPT Taxa Richness	8
Hilsenhoff Biotic Index	3.73
Intolerant individuals (%)	51
Modified Becks Index	12
Index of Biotic Integrity	**61.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

BRODCR17

Location	Above East Stroudsburg STP Discharge (above McMichael Confluence)		
Site #	2016-2	Date	5/10/2016
Stream Name	Brodhead Creek	Time	10:26:29 AM
Township	East Stroudsburg Borough	Latitude	40.99019
Habitat Asmt.	110	Longitude	-75.1857

Field Measurements	
Temp C	11.97
pH	7.93
Press inHg	29.89
DO Percent	105.1
DO mg/L	11.31
Cond (uS/cm)	145

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.11
EPT Taxa Richness	11
Hilsenhoff Biotic Index	4.11
Intolerant individuals (%)	33
Modified Becks Index	16
Index of Biotic Integrity	**69.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.98
Aluminum mg/L	<0.200
Calcium mg/L	8.81
Iron mg/L	<0.100
Magnesium mg/L	1.94
Hardness CaCO3	30
Chloride mg/L	19.5
pH	7.33
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.18
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	60
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

BRODCR19

Location	Below Rock-Tenn / Below Marshalls Creek		
Site #	2016-3	Date	5/12/2016
Stream Name	Brodhead Creek	Time	7:31:10 AM
Township	Smithfield Township	Latitude	40.9941
Habitat Asmt.	160	Longitude	-75.13836

Field Measurements	
Temp C	12.9
pH	7.98
Press inHg	29.85
DO Percent	92.8
DO mg/L	9.77
Cond (uS/cm)	190

Macroinvertebrate Metrics	
Total Taxa	17
Shannon Diversity Index	1.74
EPT Taxa Richness	10
Hilsenhoff Biotic Index	4.01
Intolerant individuals (%)	34
Modified Becks Index	17
Index of Biotic Integrity	**65.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.1
Aluminum mg/L	<0.200
Calcium mg/L	12.6
Iron mg/L	<0.100
Magnesium mg/L	2.38
Hardness CaCO3	41.2
Chloride mg/L	25.2
pH	6.25
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.305
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	111
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

BRODCR22

Location	Just upstream of confluence with Paradise Creek		
Site #	2016-4	Date	5/5/2016
Stream Name	Brodhead Creek	Time	11:41:48 AM
Township	Stroud Township	Latitude	41.06639
Habitat Asmt.	184	Longitude	-75.22042

Field Measurements	
Temp C	10.19
pH	7.21
Press inHg	29
DO Percent	110
DO mg/L	11.97
Cond (uS/cm)	76

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.38
EPT Taxa Richness	11
Hilsenhoff Biotic Index	3.79
Intolerant individuals (%)	36
Modified Becks Index	18
Index of Biotic Integrity	**74.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

BRODCR24

Location	Above Rock-Tenn and below East Stroudsburg STP at Glenn Park		
Site #	2016-5	Date	5/13/2016
Stream Name	Brodhead Creek	Time	8:24:48 AM
Township	East Stroudsburg Borough	Latitude	40.98585
Habitat Asmt.	161	Longitude	-75.17551

Field Measurements	
Temp C	15.06
pH	7.19
Press inHg	29.43
DO Percent	95.3
DO mg/L	9.42
Cond (uS/cm)	315

Macroinvertebrate Metrics	
Total Taxa	18
Shannon Diversity Index	2.13
EPT Taxa Richness	8
Hilsenhoff Biotic Index	4.57
Intolerant individuals (%)	27
Modified Becks Index	9
Index of Biotic Integrity	**57**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.04
Aluminum mg/L	<0.200
Calcium mg/L	11.3
Iron mg/L	<0.100
Magnesium mg/L	2.22
Hardness CaCO3	37.4
Chloride mg/L	25.3
pH	6.54
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.282
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	112
Phosphorus as P mg/L	0.04
Biochemical Oxygen Demand mg/L	<3.00

BRODCR25

Location	Just above Forever Green Preserve		
Site #	2016-6	Date	5/5/2016
Stream Name	Brodhead Creek	Time	12:40:23 PM
Township	Stroud Township	Latitude	41.06484
Habitat Asmt.	204	Longitude	-75.22018

Field Measurements	
Temp C	10.43
pH	7.4
Press inHg	28.98
DO Percent	111.8
DO mg/L	12.09
Cond (uS/cm)	77

Macroinvertebrate Metrics	
Total Taxa	28
Shannon Diversity Index	2.51
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.69
Intolerant individuals (%)	43
Modified Becks Index	28
Index of Biotic Integrity	**88.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

BUHICR07

Location	Just up stream of golf course fairway at clubhouse, above falls		
Site #	2016-7	Date	5/5/2016
Stream Name	Buck Hill Creek	Time	9:17:33 AM
Township	Barrett Township	Latitude	41.1943
Habitat Asmt.	213	Longitude	-75.28142

Field Measurements	
Temp C	8.19
pH	6.92
Press inHg	28.11
DO Percent	103.6
DO mg/L	11.47
Cond (uS/cm)	61

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.75
EPT Taxa Richness	17
Hilsenhoff Biotic Index	2.26
Intolerant individuals (%)	72
Modified Becks Index	39
Index of Biotic Integrity	**91.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.86
Aluminum mg/L	<0.200
Calcium mg/L	2.77
Iron mg/L	<0.100
Magnesium mg/L	0.763
Hardness CaCO3	10
Chloride mg/L	4.45
pH	6.08
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.108
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	14
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

BUSHCR07

Location	Approximately 100 yards d/s of Fernwood/Middle Smithfield STP discharge, DWGNRA boundary		
Site #	2016-8	Date	5/12/2016
Stream Name	Bushkill Creek	Time	9:58:01 AM
Township	Middle Smithfield Township	Latitude	41.08468
Habitat Asmt.	202	Longitude	-75.02075

Field Measurements	
Temp C	13.68
pH	7.54
Press inHg	29.77
DO Percent	95.2
DO mg/L	9.82
Cond (uS/cm)	70

Macroinvertebrate Metrics	
Total Taxa	33
Shannon Diversity Index	2.72
EPT Taxa Richness	22
Hilsenhoff Biotic Index	3.14
Intolerant individuals (%)	52
Modified Becks Index	34
Index of Biotic Integrity	**95.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.37
Aluminum mg/L	<0.200
Calcium mg/L	4.97
Iron mg/L	<0.100
Magnesium mg/L	1.23
Hardness CaCO3	17.5
Chloride mg/L	7.39
pH	5.91
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	46
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

BUSHCR11

Location	100 yards U/S of wooden bridge on Anglers Rd. off Snowhill Rd.		
Site #	2016-9	Date	5/5/2016
Stream Name	Bushkill Creek	Time	10:34:06 AM
Township	Barrett Township	Latitude	41.18338
Habitat Asmt.	172	Longitude	-75.16

Field Measurements	
Temp C	10.43
pH	6.73
Press inHg	28.44
DO Percent	105.9
DO mg/L	11.24
Cond (uS/cm)	48

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.37
EPT Taxa Richness	11
Hilsenhoff Biotic Index	4.4
Intolerant individuals (%)	32
Modified Becks Index	14
Index of Biotic Integrity	**70.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	5.91
Aluminum mg/L	<0.200
Calcium mg/L	1.99
Iron mg/L	0.138
Magnesium mg/L	0.811
Hardness CaCO3	8.3
Chloride mg/L	3.06
pH	5.98
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	21
Phosphorus as P mg/L	0.03
Biochemical Oxygen Demand mg/L	<3.00

CHERCR06

Location	Immediately downstream Kemmertown Bridge		
Site #	2016-10	Date	5/10/2016
Stream Name	Cherry Creek	Time	7:57:36 AM
Township	Stroud Township	Latitude	40.93673
Habitat Asmt.	153	Longitude	-75.25281

Field Measurements	
Temp C	10
pH	8.17
Press inHg	29.81
DO Percent	103
DO mg/L	11.58
Cond (uS/cm)	199

Macroinvertebrate Metrics	
Total Taxa	18
Shannon Diversity Index	1.88
EPT Taxa Richness	9
Hilsenhoff Biotic Index	3.26
Intolerant individuals (%)	46
Modified Becks Index	13
Index of Biotic Integrity	**56.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.03
Aluminum mg/L	<0.200
Calcium mg/L	24.6
Iron mg/L	<0.100
Magnesium mg/L	5.56
Hardness CaCO3	84.2
Chloride mg/L	5.04
pH	7.47
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.271
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	63
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

CHERCR06

Location	Immediately downstream Kemmertown Bridge (Replicate)		
Site #	2016-11	Date	5/10/2016
Stream Name	Cherry Creek	Time	7:59:25 AM
Township	Stroud Township	Latitude	40.93671
Habitat Asmt.	153	Longitude	-75.25281

Field Measurements	
Temp C	10.01
pH	8.17
Press inHg	29.82
DO Percent	103.3
DO mg/L	11.61
Cond (uS/cm)	198

Macroinvertebrate Metrics	
Total Taxa	26
Shannon Diversity Index	2.41
EPT Taxa Richness	14
Hilsenhoff Biotic Index	3.01
Intolerant individuals (%)	60
Modified Becks Index	18
Index of Biotic Integrity	**73.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.86
Aluminum mg/L	<0.200
Calcium mg/L	24.2
Iron mg/L	<0.100
Magnesium mg/L	5.42
Hardness CaCO3	82.8
Chloride mg/L	5.02
pH	7.46
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.271
Alkalinity to pH 4.5 mg CaCO3/L	68.000
Total Dissolved Solids mg/L	82
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

CHERCR16

Location	Below Cherry Valley Golf Course		
Site #	2016-12	Date	5/10/2016
Stream Name	Cherry Creek	Time	9:47:26 AM
Township	Smithfield Township	Latitude	40.97306
Habitat Asmt.	159	Longitude	-75.16893

Field Measurements	
Temp C	12.33
pH	8.4
Press inHg	29.88
DO Percent	106.1
DO mg/L	11.32
Cond (uS/cm)	233

Macroinvertebrate Metrics	
Total Taxa	20
Shannon Diversity Index	2.3
EPT Taxa Richness	8
Hilsenhoff Biotic Index	3.37
Intolerant individuals (%)	50
Modified Becks Index	16
Index of Biotic Integrity	**61**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.98
Aluminum mg/L	<0.200
Calcium mg/L	27.4
Iron mg/L	<0.100
Magnesium mg/L	5.84
Hardness CaCO3	92.4
Chloride mg/L	9.3
pH	7.7
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.158
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	99
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

COOLCR01

Location	Just above confluence with Pocono		
Site #	2016-13	Date	5/11/2016
Stream Name	Coolmoor Creek	Time	12:52:41 PM
Township	Pocono Township	Latitude	41.05148
Habitat Asmt.	172	Longitude	-75.33935

Field Measurements	
Temp C	12.53
pH	7.25
Press inHg	29.01
DO Percent	90
DO mg/L	9.27
Cond (uS/cm)	380

Macroinvertebrate Metrics	
Total Taxa	16
Shannon Diversity Index	1.74
EPT Taxa Richness	9
Hilsenhoff Biotic Index	4.25
Intolerant individuals (%)	30
Modified Becks Index	18
Index of Biotic Integrity	**51.7**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.84
Aluminum mg/L	<0.200
Calcium mg/L	20.7
Iron mg/L	<0.100
Magnesium mg/L	4.64
Hardness CaCO3	70.9
Chloride mg/L	86.5
pH	6.38
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.237
Alkalinity to pH 4.5 mg CaCO3/L	24.000
Total Dissolved Solids mg/L	239
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	4

CRCRPA02

Location	Approximately 25 yards upstream of Cranberry Creek Road.		
Site #	2016-14	Date	5/5/2016
Stream Name	Cranberry Creek	Time	7:39:17 AM
Township	Mount Pocono Borough	Latitude	41.12085
Habitat Asmt.	181	Longitude	-75.26208

Field Measurements	
Temp C	9.11
pH	6.49
Press inHg	28.59
DO Percent	99.4
DO mg/L	10.94
Cond (uS/cm)	97

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.64
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.38
Intolerant individuals (%)	48
Modified Becks Index	29
Index of Biotic Integrity	**77.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.53
Aluminum mg/L	<0.200
Calcium mg/L	5.11
Iron mg/L	<0.100
Magnesium mg/L	1.59
Hardness CaCO3	19.3
Chloride mg/L	10.5
pH	5.97
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.174
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	60
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

DRSARU02

Location	North of I-380 in State Game Lands		
Site #	2016-15	Date	5/11/2016
Stream Name	Dry Sawmill Creek	Time	11:06:05 AM
Township	Pocono Township	Latitude	41.08101
Habitat Asmt.	168	Longitude	-75.37338

Field Measurements	
Temp C	15.29
pH	6.1
Press inHg	28.34
DO Percent	95.5
DO mg/L	9.06
Cond (uS/cm)	44

Macroinvertebrate Metrics	
Total Taxa	20
Shannon Diversity Index	2
EPT Taxa Richness	8
Hilsenhoff Biotic Index	4.9
Intolerant individuals (%)	19
Modified Becks Index	12
Index of Biotic Integrity	**48.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.73
Aluminum mg/L	<0.200
Calcium mg/L	1.46
Iron mg/L	0.495
Magnesium mg/L	0.595
Hardness CaCO3	6.11
Chloride mg/L	5.51
pH	5.97
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	46
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

DRSARU03

Location	South of I-380 in State Game Lands below confluence of Sand Springs Run		
Site #	2016-16	Date	5/11/2016
Stream Name	Dry Sawmill Creek	Time	12:07:11 PM
Township	Pocono Township	Latitude	41.06124
Habitat Asmt.	175	Longitude	-75.37114

Field Measurements	
Temp C	11.38
pH	6.8
Press inHg	28.64
DO Percent	97.9
DO mg/L	10.23
Cond (uS/cm)	177

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.15
EPT Taxa Richness	13
Hilsenhoff Biotic Index	4.11
Intolerant individuals (%)	35
Modified Becks Index	34
Index of Biotic Integrity	**69**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.07
Aluminum mg/L	<0.200
Calcium mg/L	5.4
Iron mg/L	0.109
Magnesium mg/L	1.07
Hardness CaCO3	17.9
Chloride mg/L	30.6
pH	6.13
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.103
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	111
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

MARSCR11

Location	Approximately 100 yards u/s of Newton Run and White Heron Lake		
Site #	2016-17	Date	5/12/2016
Stream Name	Marshalls Creek	Time	8:34:38 AM
Township	Middle Smithfield Township	Latitude	41.05458
Habitat Asmt.	207	Longitude	-75.13674

Field Measurements	
Temp C	11.03
pH	7.46
Press inHg	29.51
DO Percent	92.3
DO mg/L	10.02
Cond (uS/cm)	104

Macroinvertebrate Metrics	
Total Taxa	30
Shannon Diversity Index	2.87
EPT Taxa Richness	18
Hilsenhoff Biotic Index	2.71
Intolerant individuals (%)	61
Modified Becks Index	33
Index of Biotic Integrity	**89.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	4.18
Aluminum mg/L	<0.200
Calcium mg/L	7.16
Iron mg/L	<0.100
Magnesium mg/L	1.64
Hardness CaCO3	24.6
Chloride mg/L	9.44
pH	5.87
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.126
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	105
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

MARSCR15

Location	Near Ridge Rd II		
Site #	2016-18	Date	5/12/2016
Stream Name	Marshalls Creek	Time	9:01:29 AM
Township	Middle Smithfield Township	Latitude	41.0822
Habitat Asmt.	207	Longitude	-75.1428

Field Measurements	
Temp C	11.21
pH	7.5
Press inHg	29.35
DO Percent	91
DO mg/L	9.79
Cond (uS/cm)	103

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.52
EPT Taxa Richness	14
Hilsenhoff Biotic Index	2.72
Intolerant individuals (%)	62
Modified Becks Index	25
Index of Biotic Integrity	**75.7**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

MCMICR20

Location	Approximately 30 yards upstream of its confluence with Pocono Creek (above long slow pool)		
Site #	2016-19	Date	5/13/2016
Stream Name	McMichael Creek	Time	9:13:45 AM
Township	Stroudsburg Borough	Latitude	40.97934
Habitat Asmt.	131	Longitude	-75.19976

Field Measurements	
Temp C	15.77
pH	7.26
Press inHg	29.38
DO Percent	89.9
DO mg/L	8.74
Cond (uS/cm)	181

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.42
EPT Taxa Richness	13
Hilsenhoff Biotic Index	2.87
Intolerant individuals (%)	57
Modified Becks Index	17
Index of Biotic Integrity	**84.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.14
Aluminum mg/L	<0.200
Calcium mg/L	13.9
Iron mg/L	0.134
Magnesium mg/L	2.39
Hardness CaCO3	44.6
Chloride mg/L	16.9
pH	6.51
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.638
Alkalinity to pH 4.5 mg CaCO3/L	30.000
Total Dissolved Solids mg/L	286
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

MCMICR37

Location	Hickory Valley Park, 50 yds. Upstream of parking lot		
Site #	2016-20	Date	5/10/2016
Stream Name	McMichael Creek	Time	7:31:41 AM
Township	Hamilton Township	Latitude	40.96215
Habitat Asmt.	185	Longitude	-75.23681

Field Measurements	
Temp C	11.31
pH	7.6
Press inHg	29.79
DO Percent	95.6
DO mg/L	10.41
Cond (uS/cm)	167

Macroinvertebrate Metrics	
Total Taxa	23
Shannon Diversity Index	2.49
EPT Taxa Richness	11
Hilsenhoff Biotic Index	3.87
Intolerant individuals (%)	38
Modified Becks Index	18
Index of Biotic Integrity	**76.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.19
Aluminum mg/L	<0.200
Calcium mg/L	13.3
Iron mg/L	0.102
Magnesium mg/L	2.44
Hardness CaCO3	43.1
Chloride mg/L	16.2
pH	7.03
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.368
Alkalinity to pH 4.5 mg CaCO3/L	30.000
Total Dissolved Solids mg/L	60
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

MILLCR03

Location	Along Mill Creek Rd. above confluence with Brodhead Creek		
Site #	2016-21	Date	5/5/2016
Stream Name	Mill Creek	Time	8:18:16 AM
Township	Barrett Township	Latitude	41.16334
Habitat Asmt.	205	Longitude	-75.25315

Field Measurements	
Temp C	8.51
pH	6.97
Press inHg	28.45
DO Percent	106.2
DO mg/L	11.79
Cond (uS/cm)	85

Macroinvertebrate Metrics	
Total Taxa	26
Shannon Diversity Index	2.41
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.03
Intolerant individuals (%)	56
Modified Becks Index	38
Index of Biotic Integrity	**83.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

MOUNRN01

Location	Above Cherry Creek Confluence		
Site #	2016-22	Date	5/10/2016
Stream Name	Mountain Run	Time	9:19:36 AM
Township	Stroud Township	Latitude	40.95441
Habitat Asmt.	183	Longitude	-75.19669

Field Measurements	
Temp C	10.4
pH	7.75
Press inHg	29.63
DO Percent	92.2
DO mg/L	10.21
Cond (uS/cm)	144

Macroinvertebrate Metrics	
Total Taxa	23
Shannon Diversity Index	2.62
EPT Taxa Richness	13
Hilsenhoff Biotic Index	1.29
Intolerant individuals (%)	85
Modified Becks Index	34
Index of Biotic Integrity	**86.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.65
Aluminum mg/L	<0.200
Calcium mg/L	11.4
Iron mg/L	0.1.3
Magnesium mg/L	1.9
Hardness CaCO3	36.3
Chloride mg/L	13.9
pH	6.71
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.115
Alkalinity to pH 4.5 mg CaCO3/L	30.000
Total Dissolved Solids mg/L	39
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

PARACR08

Location	Just upstream of confluence with Brodhead Creek		
Site #	2016-23	Date	5/5/2016
Stream Name	Paradise Creek	Time	12:11:42 PM
Township	Pocono Township	Latitude	41.06642
Habitat Asmt.	176	Longitude	-75.22142

Field Measurements	
Temp C	10.54
pH	7.55
Press inHg	29.02
DO Percent	110.3
DO mg/L	11.9
Cond (uS/cm)	179

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.49
EPT Taxa Richness	15
Hilsenhoff Biotic Index	3.99
Intolerant individuals (%)	38
Modified Becks Index	31
Index of Biotic Integrity	**85.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

POCOCR14

Location	(MOUTH) Above McMichael confluence		
Site #	2016-24	Date	5/13/2016
Stream Name	Pocono Creek	Time	9:42:11 AM
Township	Stroudsburg Borough	Latitude	40.9811
Habitat Asmt.	154	Longitude	-75.19686

Field Measurements	
Temp C	15.26
pH	7.3
Press inHg	29.36
DO Percent	95.2
DO mg/L	9.35
Cond (uS/cm)	302

Macroinvertebrate Metrics	
Total Taxa	18
Shannon Diversity Index	1.79
EPT Taxa Richness	13
Hilsenhoff Biotic Index	4.06
Intolerant individuals (%)	35
Modified Becks Index	21
Index of Biotic Integrity	**72.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

POCOCR18

Location	Schaeffer Schoolhouse Road (above Wigwam Run)		
Site #	2016-25	Date	5/13/2016
Stream Name	Pocono Creek	Time	7:22:33 AM
Township	Stroud Township	Latitude	40.99082
Habitat Asmt.	189	Longitude	-75.25477

Field Measurements	
Temp C	14.91
pH	7.32
Press inHg	29.17
DO Percent	95.7
DO mg/L	9.41
Cond (uS/cm)	223

Macroinvertebrate Metrics	
Total Taxa	23
Shannon Diversity Index	2.5
EPT Taxa Richness	12
Hilsenhoff Biotic Index	3.1
Intolerant individuals (%)	35
Modified Becks Index	26
Index of Biotic Integrity	**81.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.14
Aluminum mg/L	<0.200
Calcium mg/L	13.9
Iron mg/L	<0.100
Magnesium mg/L	2.39
Hardness CaCO3	44.6
Chloride mg/L	36
pH	6.38
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.307
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	112
Phosphorus as P mg/L	0.03
Biochemical Oxygen Demand mg/L	<3.00

POCOCR27

Location	Just above confluence with Coolmoor Creek		
Site #	2016-26	Date	5/11/2016
Stream Name	Pocono Creek	Time	1:02:14 PM
Township	Pocono Township	Latitude	41.05205
Habitat Asmt.	151	Longitude	-75.33908

Field Measurements	
Temp C	12.86
pH	7.42
Press inHg	29.03
DO Percent	98.9
DO mg/L	10.13
Cond (uS/cm)	147

Macroinvertebrate Metrics	
Total Taxa	19
Shannon Diversity Index	2.09
EPT Taxa Richness	13
Hilsenhoff Biotic Index	3.81
Intolerant individuals (%)	38
Modified Becks Index	27
Index of Biotic Integrity	**65.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.42
Aluminum mg/L	<0.200
Calcium mg/L	5.45
Iron mg/L	<0.100
Magnesium mg/L	1.45
Hardness CaCO3	19.6
Chloride mg/L	25.9
pH	6.13
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.146
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	85
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

POCOCR27

Location	Just above confluence with Coolmoor Creek (Replicate)		
Site #	2016-27	Date	5/11/2016
Stream Name	Pocono Creek	Time	1:02:56 PM
Township	Pocono Township	Latitude	41.05201
Habitat Asmt.	151	Longitude	-75.33912

Field Measurements	
Temp C	12.87
pH	7.42
Press inHg	29.03
DO Percent	98.6
DO mg/L	10.09
Cond (uS/cm)	142

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.06
EPT Taxa Richness	16
Hilsenhoff Biotic Index	4.16
Intolerant individuals (%)	34
Modified Becks Index	35
Index of Biotic Integrity	**72.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.35
Aluminum mg/L	<0.200
Calcium mg/L	5.59
Iron mg/L	<0.100
Magnesium mg/L	1.42
Hardness CaCO3	19.8
Chloride mg/L	25.9
pH	6.39
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.159
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	110
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

POHOCR02

Location	50 yards upstream of US 209 near Beechwood Café		
Site #	2016-28	Date	5/9/2016
Stream Name	Pohopoco Creek	Time	11:59:40 AM
Township	Chestnuthill Township	Latitude	40.91569
Habitat Asmt.	124	Longitude	-75.43476

Field Measurements	
Temp C	13.22
pH	8.03
Press inHg	29.34
DO Percent	104.6
DO mg/L	10.74
Cond (uS/cm)	107

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.8
EPT Taxa Richness	13
Hilsenhoff Biotic Index	3.88
Intolerant individuals (%)	33
Modified Becks Index	21
Index of Biotic Integrity	**82.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

POHOCR06

Location	Whitey B. Drive where stream bends to west and parallels road		
Site #	2016-29	Date	5/9/2016
Stream Name	Pohopoco Creek	Time	10:00:38 AM
Township	Polk Township	Latitude	40.89955
Habitat Asmt.	196	Longitude	-75.50653

Field Measurements	
Temp C	10.99
pH	7.03
Press inHg	29.31
DO Percent	101
DO mg/L	10.9
Cond (uS/cm)	89

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.44
EPT Taxa Richness	13
Hilsenhoff Biotic Index	2.99
Intolerant individuals (%)	57
Modified Becks Index	19
Index of Biotic Integrity	**86**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

PONDCR04

Location	Immediately downstream of Primrose Lane.		
Site #	2016-30	Date	5/12/2016
Stream Name	Pond Creek	Time	8:09:23 AM
Township	Middle Smithfield Township	Latitude	41.05655
Habitat Asmt.	141	Longitude	-75.10325

Field Measurements	
Temp C	14.7
pH	6.96
Press inHg	29.59
DO Percent	76.8
DO mg/L	7.7
Cond (uS/cm)	228

Macroinvertebrate Metrics	
Total Taxa	16
Shannon Diversity Index	1.87
EPT Taxa Richness	5
Hilsenhoff Biotic Index	3.9
Intolerant individuals (%)	46
Modified Becks Index	3
Index of Biotic Integrity	**46.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

SASPRN01

Location	Above confluence with Dry Sawmill Creek		
Site #	2016-31	Date	5/11/2016
Stream Name	Sand Springs Run	Time	12:20:20 PM
Township	Jackson Township	Latitude	41.06179
Habitat Asmt.	187	Longitude	-75.37183

Field Measurements	
Temp C	13.87
pH	6.86
Press inHg	28.67
DO Percent	98.9
DO mg/L	9.78
Cond (uS/cm)	84

Macroinvertebrate Metrics	
Total Taxa	14
Shannon Diversity Index	1.61
EPT Taxa Richness	8
Hilsenhoff Biotic Index	3.2
Intolerant individuals (%)	46
Modified Becks Index	11
Index of Biotic Integrity	**50.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.4
Aluminum mg/L	<0.200
Calcium mg/L	1.57
Iron mg/L	<0.100
Magnesium mg/L	
Hardness CaCO3	5.35
Chloride mg/L	8.33
pH	6.16
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.0891
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	13
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	16

SWIFCR08

Location	At the westerly boundary of Pocono Manor Property. U/S 380 Culvert pipes		
Site #	2016-32	Date	5/11/2016
Stream Name	Swiftwater Creek	Time	8:05:52 AM
Township	Tobyhanna Township	Latitude	41.0967
Habitat Asmt.	189	Longitude	-75.39896

Field Measurements	
Temp C	8.63
pH	6.16
Press inHg	28.12
DO Percent	94.1
DO mg/L	10.3
Cond (uS/cm)	232

Macroinvertebrate Metrics	
Total Taxa	17
Shannon Diversity Index	1.74
EPT Taxa Richness	11
Hilsenhoff Biotic Index	1.61
Intolerant individuals (%)	80
Modified Becks Index	26
Index of Biotic Integrity	**72.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.52
Aluminum mg/L	<0.200
Calcium mg/L	5.78
Iron mg/L	<0.100
Magnesium mg/L	1.82
Hardness CaCO3	21.9
Chloride mg/L	53.9
pH	5.99
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.647
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	129
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

SWIFCR09

Location	Just below culvert pipes under 380 upstream of Kalahari		
Site #	2016-33	Date	5/11/2016
Stream Name	Swiftwater Creek	Time	8:53:05 AM
Township	Tobyhanna Township	Latitude	41.09564
Habitat Asmt.	169	Longitude	-75.39579

Field Measurements	
Temp C	9.49
pH	6.4
Press inHg	28.28
DO Percent	97.3
DO mg/L	10.49
Cond (uS/cm)	212

Macroinvertebrate Metrics	
Total Taxa	14
Shannon Diversity Index	1.58
EPT Taxa Richness	8
Hilsenhoff Biotic Index	1.39
Intolerant individuals (%)	88
Modified Becks Index	17
Index of Biotic Integrity	**64.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.97
Aluminum mg/L	<0.200
Calcium mg/L	5.9
Iron mg/L	<0.100
Magnesium mg/L	1.81
Hardness CaCO3	22.2
Chloride mg/L	55.5
pH	6.69
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.639
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	147
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

SWIFCR10

Location	Immediately downstream of Route 314		
Site #	2016-34	Date	5/11/2016
Stream Name	Swiftwater Creek	Time	9:39:09 AM
Township	Pocono Township	Latitude	41.10085
Habitat Asmt.	179	Longitude	-75.34648

Field Measurements	
Temp C	8.87
pH	6.5
Press inHg	28.84
DO Percent	93.8
DO mg/L	10.47
Cond (uS/cm)	155

Macroinvertebrate Metrics	
Total Taxa	29
Shannon Diversity Index	2.61
EPT Taxa Richness	16
Hilsenhoff Biotic Index	3.38
Intolerant individuals (%)	48
Modified Becks Index	37
Index of Biotic Integrity	**83.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.5
Aluminum mg/L	<0.200
Calcium mg/L	5.99
Iron mg/L	<0.100
Magnesium mg/L	1.63
Hardness CaCO3	21.7
Chloride mg/L	25.3
pH	6.16
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.466
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	93
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

SWIFCR11

Location	Below Swiftwater Lake at Hulbert Hill Rd Bridge		
Site #	2016-35	Date	5/11/2016
Stream Name	Swiftwater Creek	Time	10:13:52 AM
Township	Mount Pocono Borough	Latitude	41.09868
Habitat Asmt.	195	Longitude	-75.27398

Field Measurements	
Temp C	11.74
pH	6.73
Press inHg	29.33
DO Percent	94.2
DO mg/L	10
Cond (uS/cm)	276

Macroinvertebrate Metrics	
Total Taxa	17
Shannon Diversity Index	1.58
EPT Taxa Richness	8
Hilsenhoff Biotic Index	4.97
Intolerant individuals (%)	18
Modified Becks Index	15
Index of Biotic Integrity	**45.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.86
Aluminum mg/L	<0.200
Calcium mg/L	10.8
Iron mg/L	0.180
Magnesium mg/L	2.98
Hardness CaCO3	39.3
Chloride mg/L	54.3
pH	6.22
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.343
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	176
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

TOBYCR14

Location	Immediately upstream of the Route 115 bridge, downstream of the STP		
Site #	2016-36	Date	5/9/2016
Stream Name	Tobyhanna Creek	Time	7:45:54 AM
Township	Tobyhanna Township	Latitude	41.08275
Habitat Asmt.	194	Longitude	-75.58338

Field Measurements	
Temp C	10.86
pH	6.73
Press inHg	28.22
DO Percent	92.7
DO mg/L	9.66
Cond (uS/cm)	101

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.34
EPT Taxa Richness	10
Hilsenhoff Biotic Index	3.67
Intolerant individuals (%)	53
Modified Becks Index	19
Index of Biotic Integrity	**64.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	5.24
Aluminum mg/L	<0.200
Calcium mg/L	5.62
Iron mg/L	0.207
Magnesium mg/L	1.29
Hardness CaCO3	19.3
Chloride mg/L	23.6
pH	5.89
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.115
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	98
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

TUNKTR01

Location	Just U/S cilvert pipes on Schochs Mill Rd. across 903 from Pocono Raceway in SGL		
Site #	2016-37	Date	5/9/2016
Stream Name	Keiper Run	Time	8:56:59 AM
Township	Tunkhannock Township	Latitude	41.05036
Habitat Asmt.	182	Longitude	-75.53221

Field Measurements	
Temp C	8.09
pH	6.4
Press inHg	27.89
DO Percent	87.4
DO mg/L	9.61
Cond (uS/cm)	128

Macroinvertebrate Metrics	
Total Taxa	16
Shannon Diversity Index	3.7
EPT Taxa Richness	8
Hilsenhoff Biotic Index	2.92
Intolerant individuals (%)	60
Modified Becks Index	14
Index of Biotic Integrity	**64.3**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	3.74
Aluminum mg/L	<0.200
Calcium mg/L	4.41
Iron mg/L	<0.100
Magnesium mg/L	0.786
Hardness CaCO3	14.2
Chloride mg/L	35.5
pH	5.98
Nitrogen as N mg/L	<1.00
Ammonia as N mg/L	<0.100
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.0979
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	92
Phosphorus as P mg/L	<0.0250
Biochemical Oxygen Demand mg/L	<3.00

WEIRCR01

Location	Just downstream of County Park Rd.		
Site #	2016-38	Date	5/9/2016
Stream Name	Weir Creek	Time	11:39:42 AM
Township	Chestnuthill Township	Latitude	40.90788
Habitat Asmt.	180	Longitude	-75.43075

Field Measurements	
Temp C	15.6
pH	6.4
Press inHg	29.34
DO Percent	97.9
DO mg/L	9.54
Cond (uS/cm)	147

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.33
EPT Taxa Richness	10
Hilsenhoff Biotic Index	4.54
Intolerant individuals (%)	26
Modified Becks Index	6
Index of Biotic Integrity	**52.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

Conclusions and Recommendations

Macroinvertebrates

The potentially impaired sites are indicated below.
IBI Scores did not reach the recommended Aquatic Life Use Attainment Benchmarks

Site 15 (DRSARU02) IBI Score 48.3
Dry Sawmill Run– North of I-380 in State Game Lands

This site is in a small stream that was roughly 100 yards downstream of a lake. The low IBI score could be influenced by the proximity to the lake which would produce warmer water temperatures and lack of oxygen. This site had the second lowest dissolved oxygen measurement in the study.

Site 30 (PONDCR04) IBI Score 46.3
Pond Creek– Immediately downstream of Primrose Lane

Similar to Dry Sawmill Run, the low IBI score could be influenced by the proximity to the Pond Creek impoundments which would produce warmer water temperatures and lack of oxygen. This site had the lowest dissolved oxygen measurement in the study.

Site 35 (SWIFCR11) IBI Score 45.3
Swiftwater Creek – Below Swiftwater Lake at Hulbert Hill Rd Bridge

Although this site had higher oxygen levels, the IBI scores were surprisingly low. These scores could be low due Swiftwater Lake which is approximately 500 feet from the middle of the reach.

Site 38 (WEIRCR01) IBI Score 52.4
Weir Creek – Just downstream of County Park Road

This stream reach had a large abundance of aquatic vegetation and resembled a spring creek. The low IBI score found could be influenced by Weir Lake, which is a eutrophic lake upstream of the study site. This lake has multiple homes around it and experiences algal blooms during the summer months.

Chemistry Analysis

Low Alkalinity throughout Monroe County

Most of the sites showed low alkalinity scores. Low alkalinity is not harmful to a stream, however, low alkalinity decreases the water's ability to buffer acids and protect aquatic life against sudden changes in pH. These values are normal when considering the geology of Monroe County. Most of the streams that were studied in this report flow within areas of silica rich sandstone and quartzite conglomerates, as well as red and grey sandstone and shales. These rocks generally have low carbonate values which would be responsible for low surface and ground water alkalinity values. Cherry Creek, the lower half of Marshalls Creek, and the mouth of Brodhead Creek flows through carbonate rich shales and siltstones which may be the reason for higher alkalinity values when compared to the rest of the county.

Recommendations

After reviewing the data from the 2016 Water Quality Study, the lead and cooperating agencies recommend the following:

- All of the sites listed as impaired should be retested the following year to continue with data trend collection.
- 34 of 38 sites in the county are healthy attaining streams.
- Overall, much of the data that was collected during the study represents many miles of quality streams.
- Continued monitoring and increased trend data are essential tools to stream quality protection.

Bibliography

Clesceri, L.S., A. E. Greenberg, and A. D. Eaton., 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association. Washington DC.

Commonwealth of Pennsylvania., 2000. Title 25, Pennsylvania Code, Section 93. Specific Water Quality Criteria.

Environmental Protection Agency., 2001. Ambient Water Quality Criteria Recommendations. Rivers and Streams in Nutrient Ecoregion VIII. Doc. ID: EPA 822-B-01-015. Office of Water. Washington, DC.

Karr, J. R., and E. W. Chu., 1999. Restoring Life in Running Waters Better Biological Monitoring. Island Press, Washington, DC. 206p.

Merritt, R., and K. Cummins., 1984. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Company, Dubuque Iowa. 31p.

Monroe County Planning Commission., 2008. Monroe County Water Quality Study 2008, Vol. I & II., Stroudsburg, Pennsylvania. 182pp.

Pennsylvania Department of Environmental Protection., 2009. Draft-Instream Comprehensive Evaluation Surveys. Doc. ID: 391-3200-001. Bureau of Water Standards and Facility Regulation. Harrisburg, Pennsylvania. 56pp.

Pennsylvania Department of Environmental Protection., 2007. Multi-habitat Stream Assessment Protocol. Bureau of Water Standards and Facility Regulation. Harrisburg, Pennsylvania. 44pp.

United States Environmental Protection Agency. (2007). Ecoregions of North America. Retrieved February 9, 2009, Web site: http://www.epa.gov/wed/pages/ecoregions.htm.

Vølstad, J.H, N.E. Roth, M.T. Southerland and G. Mercurio. 2003. Pilot Study for Montgomery County and Maryland DNR Data Integration: Comparison of Benthic Macroinvertebrate Sampling Protocols for Freshwater Streams. Prepared by Versar, Inc., Columbia, Maryland for U.S. Environmental Protection Agency, Office of Environmental Information and Mid-Atlantic Integrated Assessment Program, Region 3, Ft. Meade, MD. 30pp.