ASSESSMENT OF INTERSTATE STREAMS IN THE SUSQUEHANNA RIVER BASIN

Monitoring Report No. 27
January 1, 2013 Through December 31, 2013

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Table of Contents

Introduction

The Susquehanna River Basin is the largest river basin on the Atlantic Coast of the United States, draining 27,510 square miles. The Susquehanna River originates at the outlet of Otsego Lake near Cooperstown, N.Y. From there the river flows 444 miles through New York, Pennsylvania, and Maryland before emptying into the Chesapeake Bay at Havre de Grace, Md. Eighty-three streams cross state lines in the basin. Several streams traverse the state borders at multiple points, contributing to 91 total crossings. Of those 91 crossings, 45 streams flow from New York into Pennsylvania, 22 from Pennsylvania into New York, 15 from Pennsylvania into Maryland, and nine from Maryland into Pennsylvania. Many streams are small, and 32 are unnamed.

The Susquehanna River Basin Commission (SRBC) reviews projects that may have interstate impacts on water resources in the Susquehanna River Basin. Established in 1986, SRBC's Interstate Streams Monitoring Program provides data from border streams that are not routinely assessed by state agencies in New York, Maryland, and Pennsylvania. Currently, the state agencies do not monitor all of the interstate streams and do not produce comparable data needed to determine potential impacts on the water quality of interstate streams. SRBC's ongoing interstate monitoring program is partially funded through a grant from the U.S. Environmental Protection Agency (USEPA).

The interstate water quality monitoring program includes periodic collection of water and biological samples from interstate streams, as well as assessments of physical habitat. Water quality data are used to: (1) assess compliance with water quality standards, (2) characterize stream quality and seasonal variations, (3) build a database for assessment of water quality trends, (4) identify streams for reporting to USEPA under Section 305(b) of the Clean Water Act, (5) provide information to signatory states for Integrated List purposes and possible Total Maximum Daily Load (TMDL) development, and (6) identify areas for restoration and protection. Biological conditions are assessed using representative benthic macroinvertebrate and fish populations, which provide an indication of the biological health of a stream and serve as indicators of water quality.

SRBC's interstate monitoring program began in April 1986. For the first five years, results were reported based on water-year (from October to the following September). In 1991, SRBC changed the reporting periods to correspond with the agency's fiscal year (from July to the following June). In 2009, SRBC transitioned to a reporting period based on the calendar year (from January to that December). Reports are typically completed the summer of the year following the collection period. Therefore, this report includes data collected between January 1 and December 31, 2013. Beginning in 2007, a web-based format was initiated to provide a more user-friendly product that is easily accessible to government agencies as well as any individuals or groups that may be interested in the condition of these streams and rivers. Recent reports are available on SRBC's web site at www.srbc.net/programs/monitoringprotection.htm.

Methods

Field and Laboratory Methods

Sampling Frequency

In 1989, SRBC divided the interstate streams into three groups according to the degree of water quality impairment, historical water quality impacts, and potential for degradation. These groupings were determined based on historical water quality and land use. To date, these groups remain consistent and are described below. Beginning in 2012, the sampling schedule of the interstate streams project was modified according to geographic location. Streams along the New York-Pennsylvania border were sampled in 2012, and streams along the Pennsylvania-Maryland border were sampled in 2013. At this time, no definitive timeframe has been established for additional sampling rounds. Monitoring frequency within the sampling year followed the existing schedule of quarterly Group 1 sampling and annual sampling of Group 2 and 3 streams. Details for each group are as follows:

Group 1

Streams with impaired water quality or those judged to have a high potential for degradation due to large drainage areas or historical pollution have been assigned to Group 1, which includes 13 sites along the Pennsylvania-New York border and eight sites along the Pennsylvania-Maryland border. Group 1 streams were sampled four times per year, once in each of the following months: February, May, July/August, and October. Water quality samples and field chemistry measurements were taken at each Group 1 site during these months. Macroinvertebrate collections were taken, and habitat assessments were made during the July/August sampling period. From 2009-2013, SRBC sampled the fish community at select Group 1 and 2 sites during the summer sampling period. The large river sites CHEM 12.0, COWN 1.0, SUSQ 289.1, SUSQ 365.0, and TIOG 10.8 were excluded from fish sampling due to sampling difficulties associated with the large sizes of these streams.

Group 2

Streams judged to have a moderate potential for impacts have been assigned to Group 2, which includes eight sites along the Pennsylvania-New York border and three sites along the Pennsylvania-Maryland border. Water quality samples, field chemistry parameters, benthic macroinvertebrate samples, and physical habitat information were obtained from Group 2 sites once per year, during base flow conditions in the summer months of July or August. As previously mentioned, SRBC sampled the fish community at select Group 2 sites from 2009-2013.

Group 3

Streams judged to have a low potential for impacts have been assigned to Group 3, which includes 21 sites along the Pennsylvania-New York border. No Group 3 sites are located along

the Pennsylvania-Maryland border. Macroinvertebrates, water quality parameters, and habitat conditions were assessed at Group 3 sites in May.

Stream Discharge

Several sites are located near U.S. Geological Survey (USGS) stream gages, including: the Susquehanna River at Windsor, N.Y. (SUSQ 365.0), the Susquehanna River at Sayre, Pa. (SUSQ 289.1), the Susquehanna River at Conowingo, Md. (SUSQ 10.0), the Chemung River at Chemung, N.Y. (CHEM 12.0), the Tioga River near Lindley, N.Y. (TIOG 10.8), the Cowanesque River at Lawrenceville, Pa. (COWN 1.0), and Octoraro Creek near Richardsmere, Md. (OCTO 6.6). For these sites, recorded stages from USGS gaging stations and ratings curves were used to determine instantaneous discharges measured in cubic feet per second (cfs). Instantaneous discharge was measured at all sites not located near USGS gaging stations at the time of sampling, using standard USGS procedures (Buchanan and Somers, 1969) and a FlowTracker. Discharge was not measured if high streamflows made access hazardous or impossible.

Water Samples

Water samples were collected at each of the Group 1, Group 2, and Group 3 streams to measure nutrient and metal concentrations. Water samples were collected using a depth-integrated sampler. Composite samples were obtained by collecting several depth-integrated samples across the stream channel and combining the samples in a churn splitter that was previously rinsed with stream water. Water samples were mixed thoroughly in the churn splitter and collected in one 500-ml bottle, two 250-ml bottles, and two 40-ml vials. The 500-ml sample bottle was used for a raw sample. Each of the 250-ml bottles consisted of a whole water sample, one fixed with 10-percent nitric acid (HNO_3) for metal analysis, and one fixed with 10-percent sulfuric acid (H_2SO_4) for nutrient analysis. The two 40-ml vials were pre-cleaned and fixed with sulfuric acid (H_2SO_4). The vials were filled with sample water and were used to measure total organic carbon (TOC). The samples were chilled on ice and sent to ALS Environmental in Middletown, Pa., within 24 hours of collection.

Field Chemistry

Temperature, dissolved oxygen, conductivity, and pH were measured in the field for all stations. Temperature, dissolved oxygen, conductivity, and pH were measured using a YSI model 6820 V2 multiparameter water quality sonde. Dissolved oxygen and pH probes were calibrated each day prior to sampling. The conductivity probe was calibrated at the beginning of each week.

Macroinvertebrate and Physical Habitat Sampling

Macroinvertebrate samples were collected from Group 1 and Group 2 stations in July and August, while Group 3 stations were sampled in May. The benthic macroinvertebrate community was sampled and assessed to provide an indication of the biological condition of the stream. Macroinvertebrates were defined as aquatic insects and other invertebrates too large to pass through a No. 30 sieve.

Benthic macroinvertebrate samples were analyzed according to field and laboratory methods described in An Index of Biotic Integrity for Benthic Macroinvertebrate Communities in Pennsylvania's Wadeable, Freestone, Riffle-Run Streams (PADEP, 2013). Sampling was performed using a D-frame dipnet with 500-micron mesh in the best available habitat in the stream reach. Samples consisted of a composite of six D-frame kicks from riffle areas in the stream reach, with each kick disturbing approximately one square meter immediately upstream of the D-frame net for approximately one minute. The six samples were composited and preserved in 95-percent ethyl alcohol for later laboratory identification and analysis.

In the laboratory, composite samples were sorted into 200-organism subsamples using a gridded pan and a random numbers table. Organisms within the subsample were identified to genus (except Chironomidae and Oligochaeta) and enumerated using taxonomic keys developed by Merrit and Cummins (1996), Peckarsky and others (1990), and Pennak (1989). Each taxon was assigned an organic pollution tolerance value and a functional feeding category (Chalfant, 2007).

Physical habitat conditions at each station were assessed using a slightly modified version of the habitat assessment procedure outlined by Barbour et al. (1999). Eleven habitat parameters were field-evaluated at each site and used to calculate a site-specific habitat assessment score. Habitat parameters were evaluated on a scale of 0 to 20 and were based on instream composition, channel morphology, and riparian zone and bank conditions. Some of the parameters to be evaluated varied based on whether the stream was characterized by riffles and runs or by glides and pools.

Fish Sampling

Fish community assessments are adapted from the RBP manual (Barbour and others, 1999) and from the Maryland Biological Stream Survey (Roth and others, 1998). Electrofishing at wadeable Group 1 and 2 interstate stream stations occurred according to the schedule outlined in Section VIII. Conditions at the time of sampling had to be conducive to electrofishing operations. Specifically, flows had to be manageable and allow the electrofishing team to traverse the entire width of the stream. Water clarity also had to be suitable to allow visual detection of immobilized fish at all depths. Every possible effort was made regarding trip reconnaissance prior to departure to sampling stations to ensure that ideal conditions are realized.

Electrofishing at all wadeable interstate streams stations consisted of three passes along a stream section equivalent to ten times the average wetted width of the stream channel. The downstream point was a natural cutoff (e.g., impassable riffles, falls, head of a pool) that could

deter fish from migrating out of the sample reach. If a natural cutoff was not present, then block nets were deployed to keep fish within the reach. After placing a piece of flagging tape in a visible location at the downstream point, staff measured five wetted channel widths, in meters, with a tape or rangefinder while walking to the upstream limit of the reach. Sample reach distance was adjusted if a natural cutoff occurs within ± 5 meter of the measured end point. If there was no natural cutoff at the upstream margin of the reach, block nets were be used. Reach lengths were a minimum of 100 meters if the stream was less than 10 meters in average width and a maximum of 400 meters if the average width was greater than 40 meters.

GPS coordinates for the upstream and downstream limits of the sample reach were recorded on the data sheet (Appendix). Sampling teams consisted of three or four members. Backpack electrofishing units (battery-powered or electrical-generated) with two handheld probes or a Smith Root towed barge with two or three anodes were used depending on stream size and depth. Electrofishing consisted of two or three passes (based on stream location) of the entire width and length of the stream segment selected. Beginning at the downstream limit of the sample reach, the sampling team proceeded upstream covering the entire stream width, using a sinuous pattern when necessary. A concerted effort was made by each team member to capture every fish sighted over 25mm in length, so that a representative sample was collected. Clock start and stop time, as well as accumulated electrofishing time (shock time), was recorded on the data sheet.

Nets and holding cages with 0.25-inch mesh netting were used to prevent escape. All fish were collected and identified to species in the field, when possible. The first 50 individuals of game fish species were measured to the nearest millimeter. All fish were weighed, in aggregate by species, to the nearest tenth of a gram. Fish that could not be identified in the field were preserved in formalin and returned to the laboratory for identification. Digital photographs were taken of all unknown specimens, as well as voucher (reference) photographs of each species. After processing fish from each pass, all individuals were returned to the stream at a point downstream of the reach, where fish could not travel back into the sample reach. All data were entered into the SRBC's Access database.

Data Synthesis Methods

Chemical Water Quality

Results of laboratory analysis for chemical parameters were compared to New York, Pennsylvania, and Maryland state water quality standards. Additionally, a simple water quality index (WQI) was calculated using procedures established by McMorran (1988). The WQI was used to make comparisons between sampling periods and stations within the same geographical region; therefore, the water quality data were divided into three groups. One group contains stations along the New York-Pennsylvania border (14 stations), another contains stations along the Pennsylvania-Maryland border (nine stations), and the remaining group compares large river stations (five stations). The data in each group were sorted by parameter and ranked by increasing order of magnitude, with several exceptions. Dissolved oxygen was ranked by decreasing order of magnitude, while pH, alkalinity, acidity, calcium, and magnesium were not

included in the WQI analysis. The values of each chemical analysis were divided by the highest ranking value in the group to obtain a percentile. The WQI score was calculated by averaging all percentile ranks for each sample. WQI scores ranged from 1 to 100, with high WQI scores indicating poor water quality.

Biological and Physical Habitat Conditions

Benthic macroinvertebrate samples were assessed using procedures described by Barbour and others (1999), Klemm and others (1990), and Plafkin and others (1989). Using these methods, staff calculated a series of biological indices for a stream and compared the results to a reference station in the same region to determine the degree of impairment. The metrics used in the survey are summarized in the Appendix. The calculation of the Shannon Diversity Index followed the methods described in Klemm and others (1990), and all other metrics were taken from Barbour and others (1999).

The 200-organism subsample data were used to generate scores for each of the seven metrics. Scores for metrics 1-4 were converted to a biological condition score, based on the percent similarity of the metric score, relative to the metric score of the reference site. Scores for metrics 5-7 were based on set scoring criteria developed for the percentages (Plafkin and others, 1989; Ohio Environmental Protection Agency, 1987b). The sum of the biological condition scores constituted the total biological score for the sample site, and total biological score was used to assign each site to a biological condition category of nonimpaired, slightly impaired, moderately impaired, or severely impaired. Habitat assessment scores of sample sites were compared to those of reference sites to classify each sample into a habitat condition category of excellent, supporting, partially supporting, or nonsupporting.

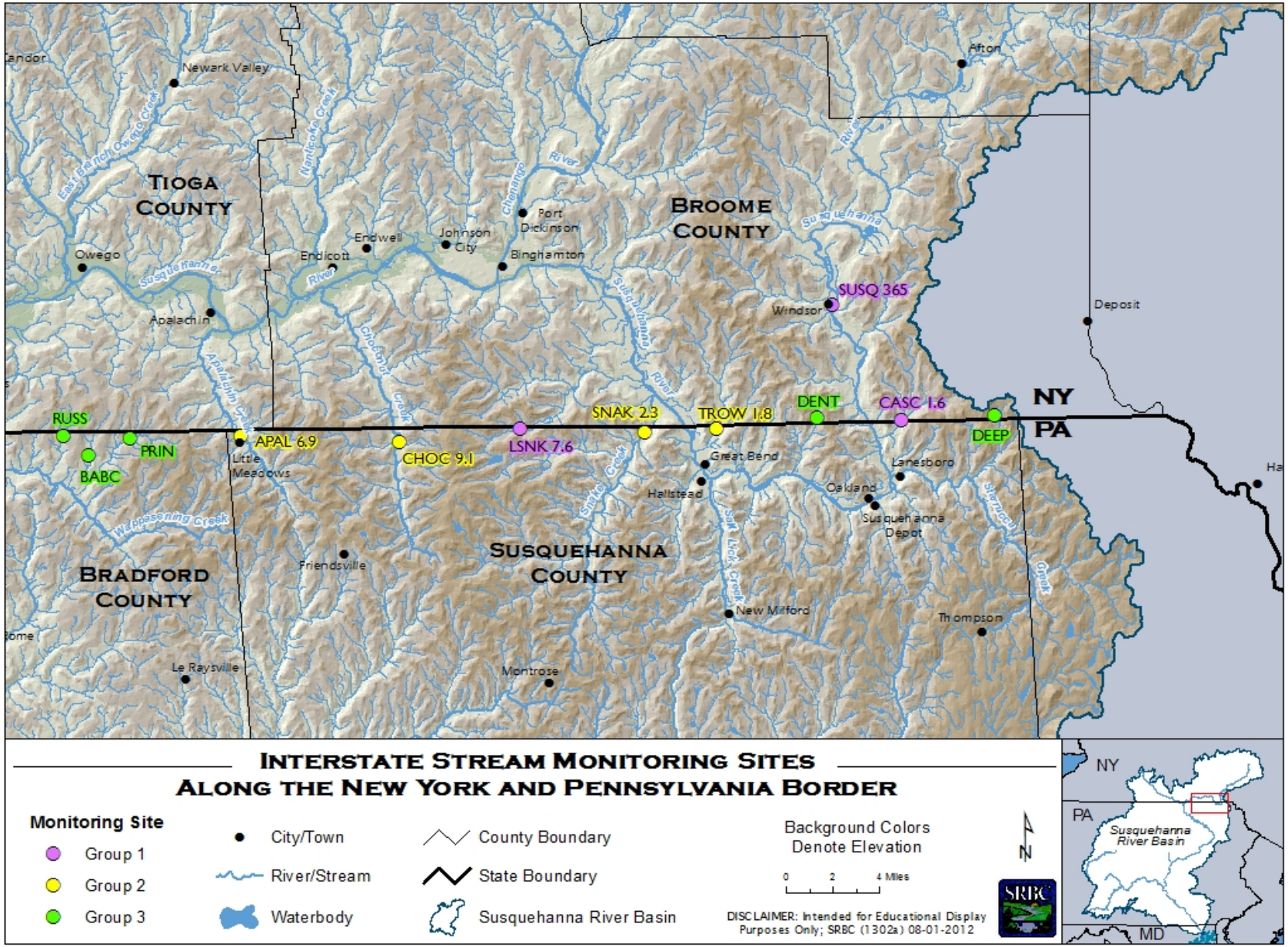
Fish data were analyzed using an adapted version of the Maryland Biological Stream Survey (MBSS) Fish Index of Biological Integrity (IBI) (Roth et al., 1998; Roth and others, 2000; Southerland and others, 2005). Two versions of the Fish IBI were used depending on the location of the stream. All Pennsylvania-Maryland border streams were assessed using the Eastern Piedmont version while Pennsylvania-New York streams were assessed using the Highlands version. The Eastern Piedmont version used contains the following eight metrics: number of native species, number of benthic species, number of intolerant species, percent tolerant fish, percent abundance of dominant species, percent generalists, omnivores, and invertivores, percent lithophilic spawners, and number of individuals per square meter. The Highlands version used contains the following six metrics: number of benthic species, number of intolerant species, percent tolerant fish, percent generalists, omnivores, and invertivores, percent insectivores, and percent lithophilic spawners. Each metric received a score of 1, 3, or 5 based on scoring criteria for each ecoregion (Roth and others, 2000). Metric scores were then averaged and the fish community received a classification of good, fair, poor, or very poor according to the table listed in the Appendix.

List of New York-Pennsylvania Interstate Streams (not sampled in 2013)

Station	Stream and Location	Monitoring Group	Rationale
APAL 6.9	Apalachin Creek, Little Meadows, PA	2	Monitor for potential water quality impacts
BABC	Babcock Run, Cadis, PA	3	Monitor for potential impacts
BILL	Bill Hess Creek, Nelson, PA	3	Monitor for potential impacts
BIRD	Bird Creek, Webb Mills, NY	3	Monitor for potential impacts
BISC	Biscuit Hollow, Austinburg, PA	3	Monitor for potential impacts
BNTY 0.9	Bentley Creek, Wellsburg, NY	1	Monitor for potential water quality impacts
BRIG	Briggs Hollow, Nichols, NY	3	Monitor for potential impacts
BULK	Bulkley Brook, Knoxville, PA	3	Monitor for potential impacts
CAMP	Camp Brook, Osceola, PA	3	Monitor for potential impacts
CASC 1.6	Cascade Creek, Lanesboro, PA	1	Monitor for potential water quality impacts
CAYT 1.7	Cayuta Creek, Waverly, NY	1	Municipal discharge from Waverly, NY
CHEM 12.0	Chemung River, Chemung, NY	1	Municipal and industrial discharges from Elmira, NY
CHOC 9.1	Choconut Creek, Vestal Center, NY	2	Monitor for potential water quality impacts
COOK	Cook Hollow, Austinburg, PA	3	Monitor for potential impacts
COWN 1.0	Cowanesque River, Lawrenceville, PA	1	Recovery zone from upstream flood control reservoir
DEEP	Deep Hollow Brook, Danville, NY	3	Monitor for potential impacts
DENT	Denton Creek, Hickory Grove, PA	3	Monitor for potential impacts
DRYB	Dry Brook, Waverly, NY	3	Monitor for potential impacts
HLDN 3.5	Holden Creek, Woodhull, NY	2	Monitor for potential water quality impacts
LSNK 7.6	Little Snake Creek, Brackney, PA	1	Monitor for potential water quality impacts
LWAP	Little Wappasening Creek, Nichols, NY	3	Monitor for potential impacts
NFCR 7.6	North Fork Cowanesque River, North Fork, PA	2	Monitor for potential water quality impacts
PARK	Parks Creek, Litchfield, NY	3	Monitor for potential impacts
PRIN	Prince Hollow Run, Cadis, PA	3	Monitor for potential impacts
REDH	Redhouse Run, Osceola, PA (formerly Beagle Hollow Run)	3	Monitor for potential impacts
RUSS	Russell Run, Windham, PA	3	Monitor for potential impacts
SACK	Sackett Creek, Nichols, NY	3	Monitor for potential impacts
SEEL 10.3	Seeley Creek, Seeley Creek, NY	1	Monitor for potential water quality impacts
SMIT	Unnamed tributary to Smith Creek, East Lawrence, PA	3	Monitor for potential impacts
SNAK 2.3	Snake Creek, Brookdale, PA	2	Monitor for potential water quality impacts
SOUT 7.8	South Creek, Fassett, PA	2	Monitor for potential water quality impacts
STRA	Strait Creek, Nelson, PA	3	Monitor for potential impacts
SUSQ 365.0	Susquehanna River, Windsor, NY	1	Large drainage area (1,882 sq. mi.); municipal discharges from Cooperstown, Sidney, Bainbridge, and Oneonta
SUSQ 289.1	Susquehanna River, Sayre, PA	1	Large drainage area (4,933 sq. mi.); municipal and industrial discharges
TIOG 10.8	Tioga River, Lindley, NY	1	Pollution from abandoned mine discharges and impacts from flood control reservoirs
TRUP 4.5	Troups Creek, Austinburg, PA	1	High turbidity and moderately impaired macroinvertebrate populations
TROW 1.8	Trowbridge Creek, Great Bend, PA	2	Monitor for potential water quality impacts
WAPP 2.6	Wappasening Creek, Nichols, NY	2	Monitor for potential water quality impacts
WBCO	White Branch Cowanesque River, North Fork, PA	3	Monitor for potential impacts
WHIT	White Hollow, Wellsburg, NY	3	Monitor for potential impacts

List of Pennsylvania-Maryland Interstate Streams (sampled in 2013)

Station	Stream and Location	Monitoring Group	Rationale
BBDC 4.1	Big Branch Deer Creek, Fawn Grove, PA	2	Monitor for potential water quality impacts
CNWG 4.4	Conowingo Creek, Pleasant Grove, PA	1	High nutrient loads and other agricultural runoff; nonpoint runoff to Chesapeake Bay
DEER 44.2	Deer Creek, Gorsuch Mills, MD	1	Past pollution from Gorsuch Mills, MD, Stewartstown, PA; nonpoint runoff to Chesapeake Bay
EBAU 1.5	Ebaughs Creek, Stewartstown, PA	1	Municipal discharge from Stewartstown, PA; nonpoint runoff to Chesapeake Bay
FBDC 4.1	Falling Branch Deer Creek, Fawn Grove, PA	2	Monitor for potential water quality impacts
LNGA 2.5	Long Arm Creek, Bandanna, PA	1	Monitor for potential water quality impacts
OCTO 6.6	Octoraro Creek, Rising Sun, MD	1	High nutrient loads due to agricultural runoff from New Bridge, MD; water quality impacts from Octoraro Lake; nonpoint runoff to Chesapeake Bay
SBCC 20.4	South Branch Conewago Creek, Bandanna, PA	2	Monitor for potential water quality impacts
SCTT 3.0	Scott Creek, Delta, PA	1	Historical pollution due to untreated sewage


INTERSTATE STREAM MONITORING SITES
ALONG THE NEW YORK AND PENNSYLVANIA BORDER
Monitoring Site
Group 1
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City/Town
River/Stream
Waterbody
County Boundary
State Boundary
Susquehanna River Basin
Background Colors
Denote Elevation
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MD
Susquehanna
River Basin
TIOGA
COUNTY
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SUSQUEHANNA
COUNTY
BRADFORD
COUNTY
RUSS
PRIN
BABC
APAL 6.9
CHOC 9.1
LSNK 7.6
SNAK 2.3
TROW 1.8
DENT
CASC 1.6
DEEP
SUSQ 365
Newark Valley
Owego
Apalachin
Endwell
Endicott
Johnson City
Port Dickinson
Binghamton
Windsor
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Friendsville
Le Raysville
Montrose
Hallstead
Great Bend
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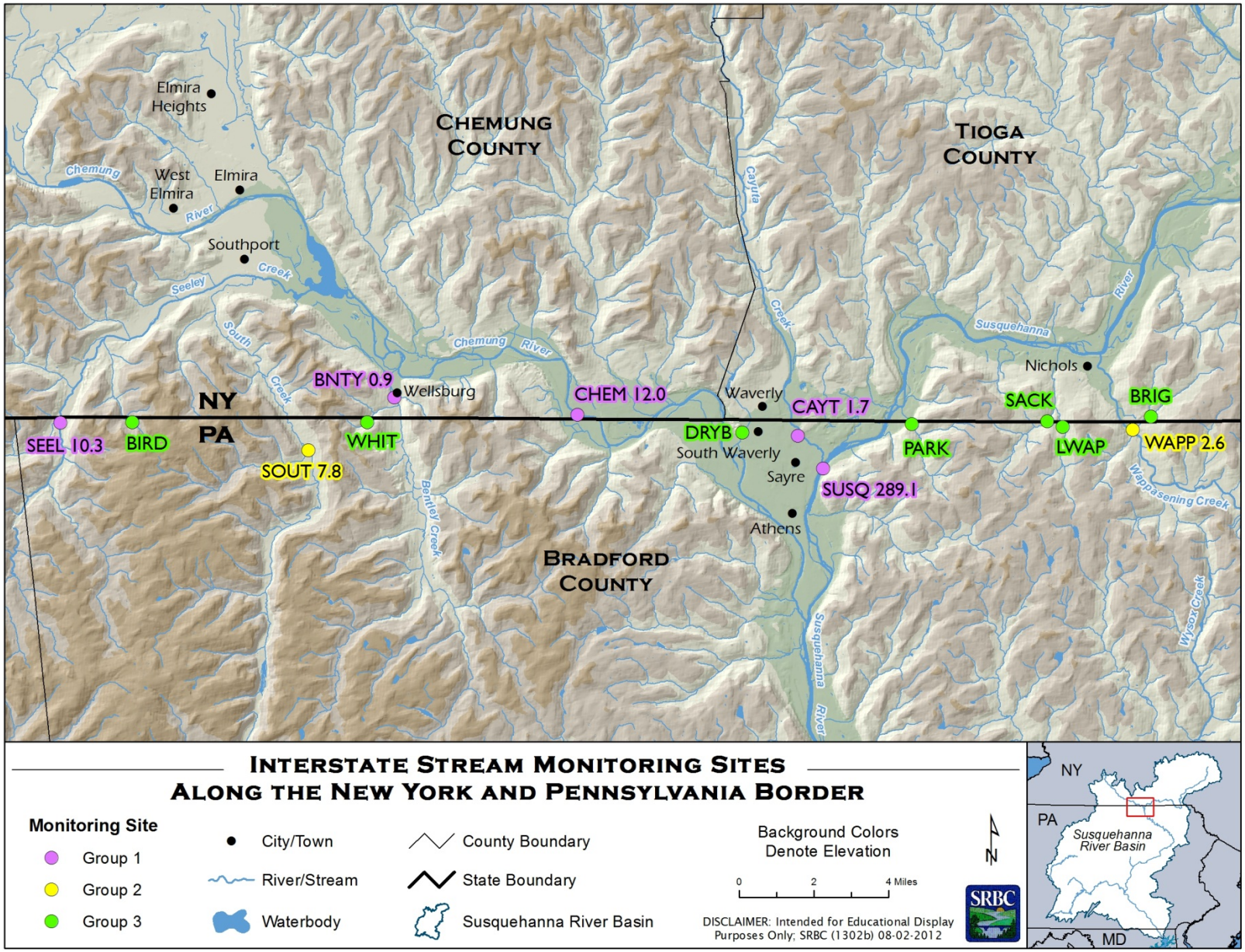
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Tioga County
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Elmira
River
Southport
Seeley Creek
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Chemung River
Cayuta Creek
Susquehanna River
Nichols
BNTY 0.9
Wellsburg
CHEM 12.0
Waverly
CAYT 1.7
SACK
BRIG
NY
PA
SEEL 10.3
BIRD
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DRYB
South Waverly
PARK
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WAPP 2.6
Sayre
SUSQ 289.1
Wappasening Creek
Athens
Bradford County
Bentley Creek
Susquehanna River
Wysox Creek
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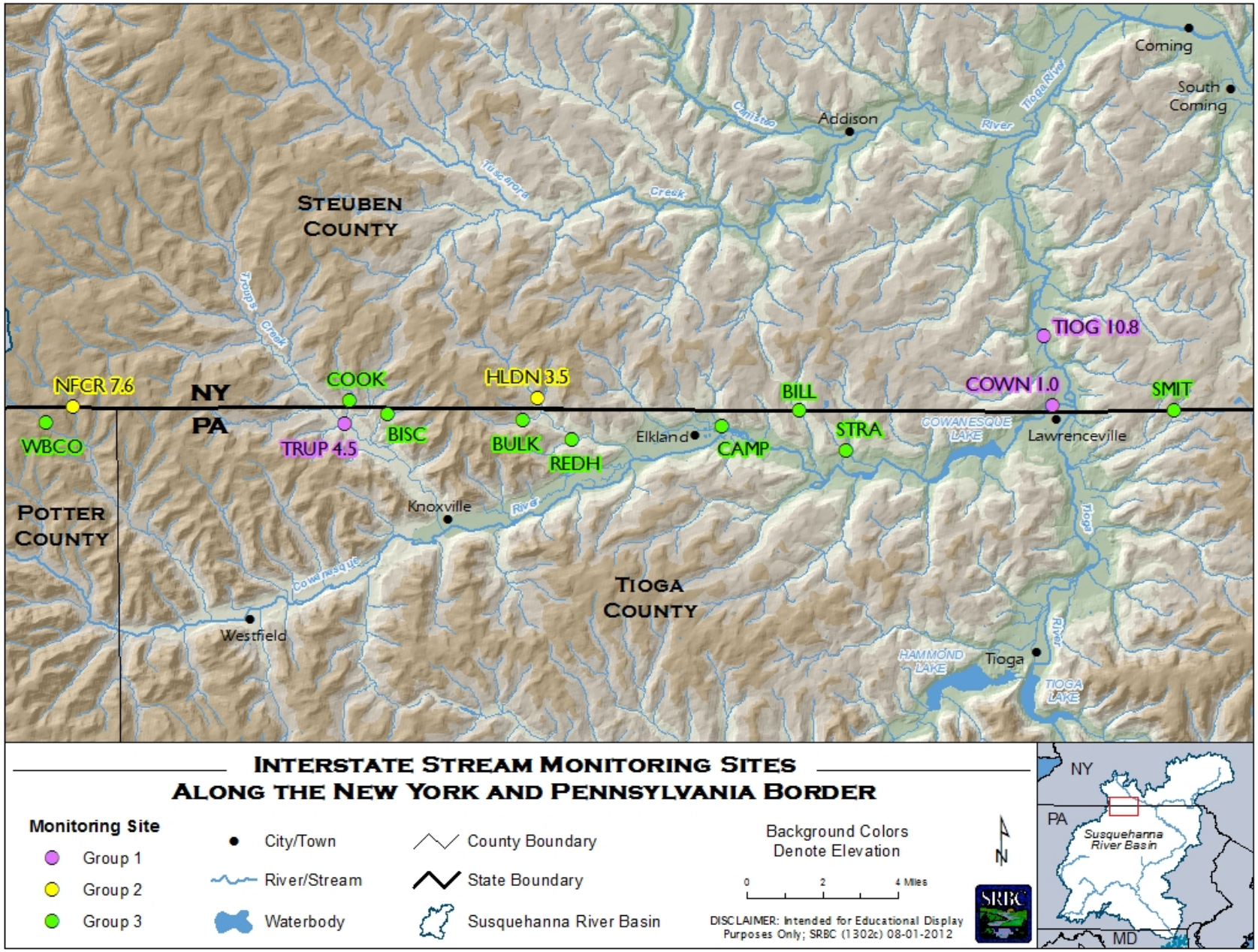
Coming
South Coming
Addison
Tioga River
Canisteo
River
Tuscarora
Creek
STEUBEN COUNTY
Troups Creek
TIOG 10.8
NFCR 7.6
NY
PA
COOK
HLDN 3.5
BILL
COWN 1.0
SMIT
WBCO
TRUP 4.5
BISC
BULK
REDH
Elkland
CAMP
STRA
COWANESQUE LAKE
Lawrenceville
POTTER COUNTY
Knoxville
Tioga
Cowanesque
TIOGA COUNTY
Westfield
HAMMOND LAKE
Tioga
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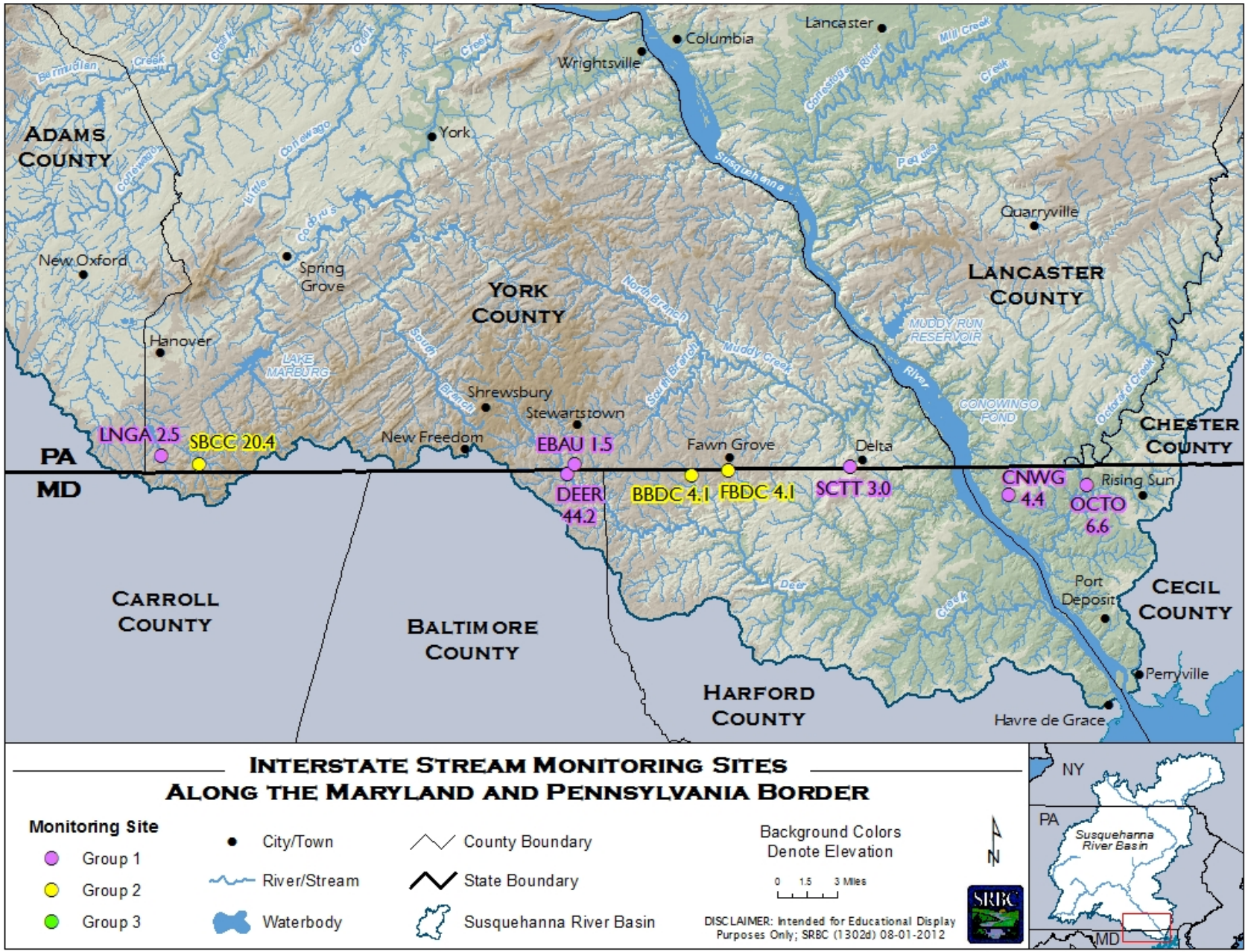
ADAMS COUNTY
YORK COUNTY
LANCASTER COUNTY
CHESTER COUNTY
CECIL COUNTY
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
PA
MD
Lancaster
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Wrightsville
York
New Oxford
Spring Grove
Hanover
Shrewsbury
Stewartstown
New Freedom
Fawn Grove
Delta
Quarryville
Rising Sun
Port Deposit
Perryville
Havre de Grace
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SBCC 20.4
EBAU 1.5
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BBDC 4.1
FBDC 4.1
SCTT 3.0
CNWG 4.4
OCTO 6.6
Susquehanna
Conestoga River
Mill Creek
Pequea
Muddy Run Reservoir
Conowingo Pond
Muddy Creek
North Branch
South Branch
Lake Marburg
Deer Creek
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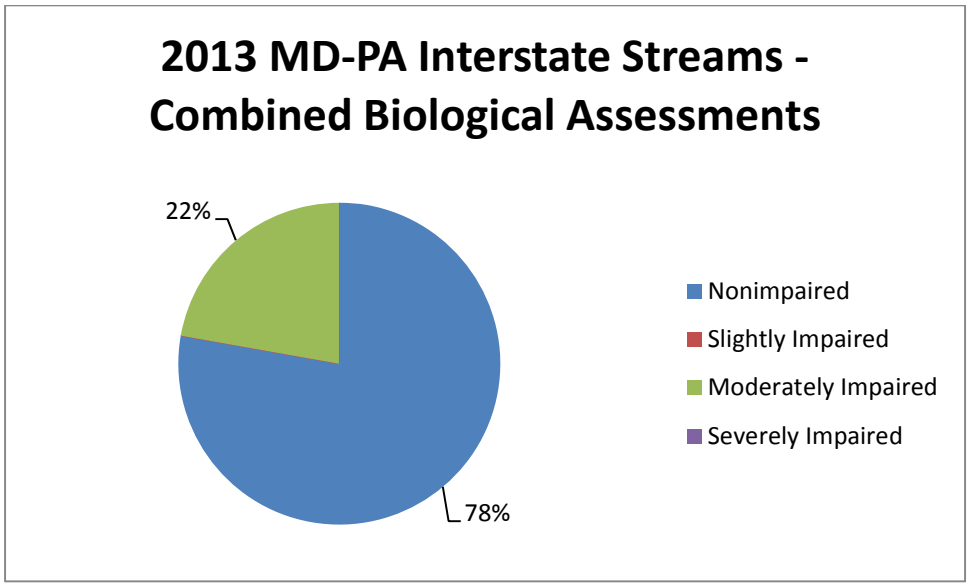
Overall Results

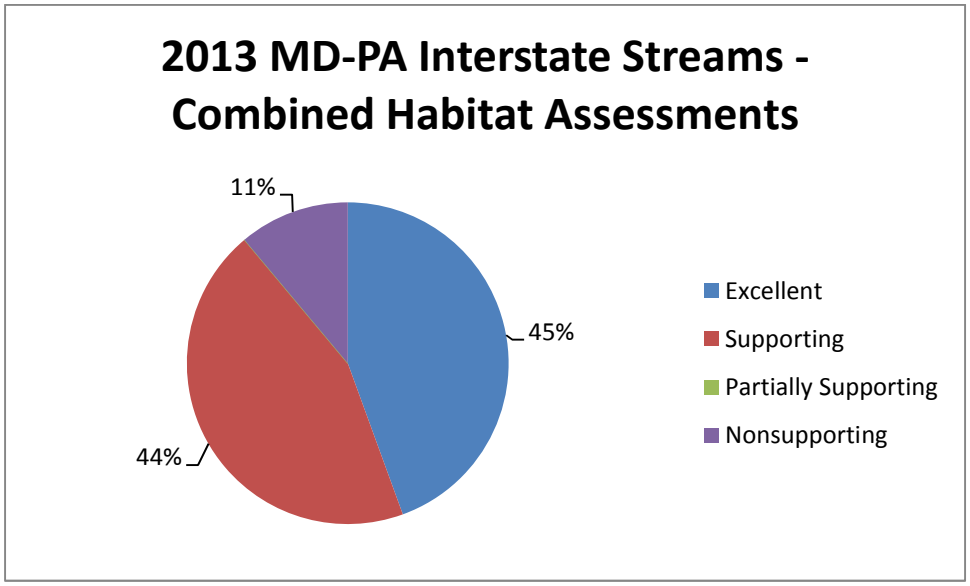
	LNGA 2.5	SBCC 20.4	EBAU 1.5	DEER 44.2	BBDC 4.1	FBDC 4.1	SCTT 3.0	CNWG 4.4	OCTO 6.6
Biological	Moderately Impaired	Nonimpaired	Nonimpaired	Nonimpaired	Nonimpaired	Nonimpaired	Moderately Impaired	Nonimpaired	Nonimpaired
Fish	Fair	Fair	Good	Good	Good	Fair	Fair	Good	N/A
Habitat	Supporting	Excellent	Supporting	Supporting	Supporting	Excellent	Nonsupporting	Excellent	Excellent
WQI	51.81	41.78	46.64	42.31	38.78	51.26	61.73	55.65	81.79

Biological and Habitat

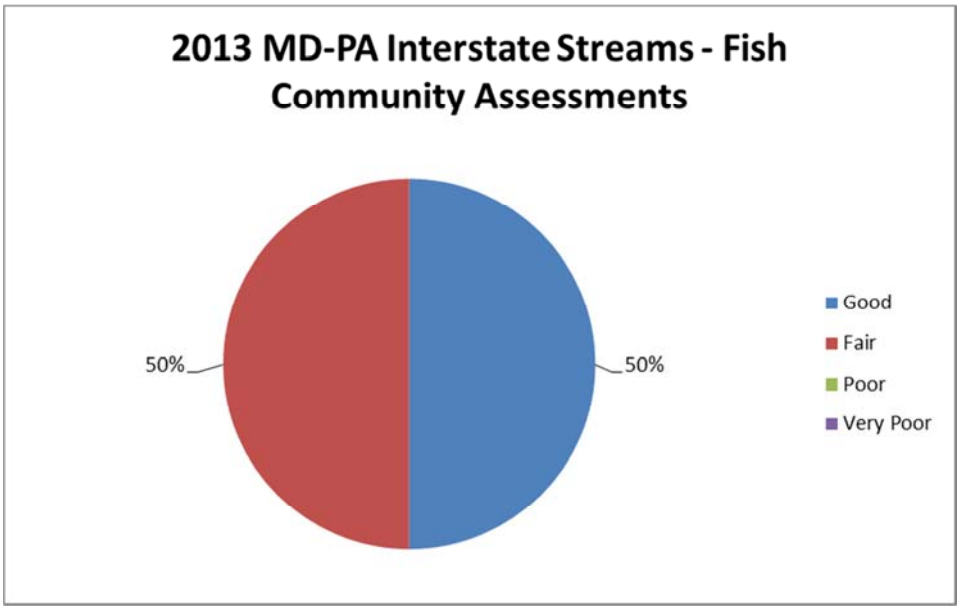
In 2013, 78 percent (seven sites) of the Maryland-Pennsylvania interstate streams assessed had a biological community deemed nonimpaired. Twenty-two percent (two sites) of stations were classified as possessing moderately impaired biological communities. The overall physical habitat of the sampled streams was very good with eight of nine sites receiving a rating of supporting or excellent.



Deer Creek (DEER 44.2) was chosen to serve as the reference site to which all other Maryland-Pennsylvania streams were compared. Deer Creek has routinely served as the reference stream for the MD-PA border region analyses. In 2013, Deer Creek possessed the best combination of biological, chemical, and physical properties throughout the year. Scott Creek (SCTT 3.0) again ranked poorly in terms of biology and habitat. The stream has consistently been characterized by low species diversity and pollution-tolerant macroinvertebrate communities. Physical habitat at Scott Creek has been negatively impacted by the surrounding urban development and related human influences.



Collectively, the Maryland-Pennsylvania border streams monitored in the Interstate Streams project showed consistent to slightly improving conditions in terms of overall stream health. In general, results from the 2013 assessment were quite similar to the previous survey in 2011. The addition of examining biological integrity through fish sampling has supported the assessments made from macroinvertebrate communities.



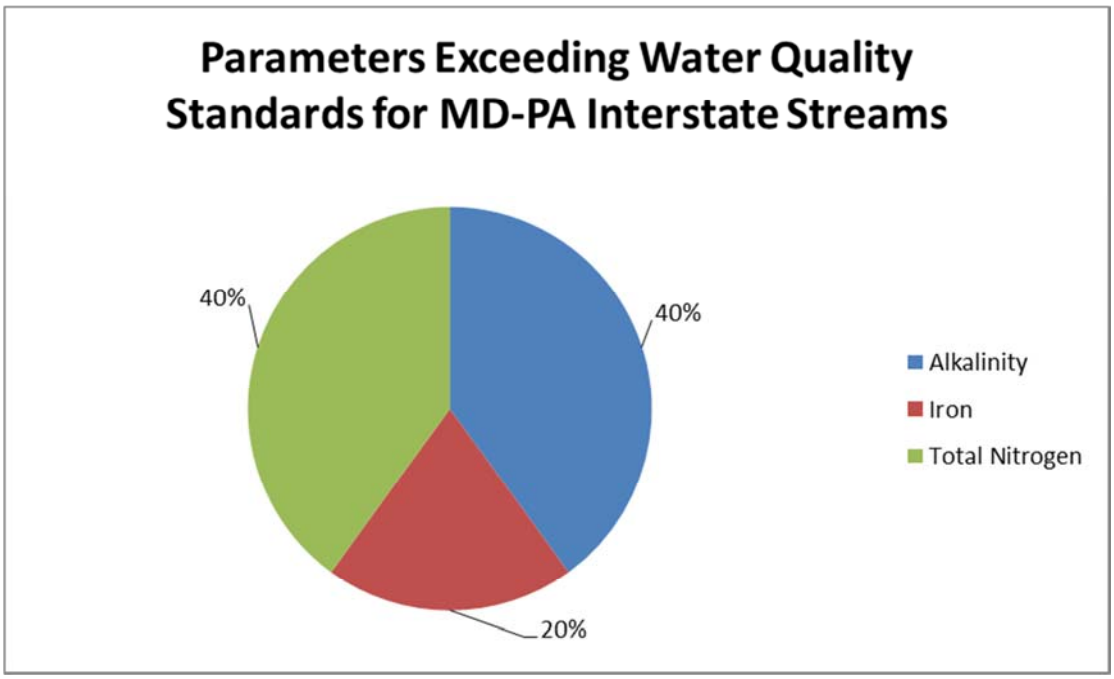
Fish sampling was performed at all PA-MD Interstate sites except Octoraro Creek (OCTO 6.6) where high flow conditions prohibited safe electrofishing. Overall stream health as indicated by fish communities was good in 2013 with all sampled stations receiving a fish IBI rating of Fair or Good. Any streams receiving a fish community rating of Poor or Very Poor typically exhibited some strong deviation from reference condition while streams rated as Good or Fair showed only slight or no deviation from reference condition. Scott Creek and Long Arm Creek shared the distinction of possessing the lowest fish IBI scores of 2013. Scott Creek has historically scored poorly in terms of biology, habitat, and water quality. Long Arm Creek has shown greater variation in stream health over time but the influence of the nearby reservoir appears to be the greatest factor influencing the fish community. The fish community of the LNGA 2.5 site as sampled in 2013 is likely not truly representative of the stream as the majority of fish collected are typical of larger lentic environments. BBDC 4.1 and EBAU 1.5 both received classifications of good, which is supported by the wild brown trout populations both streams possessed. CNWG 4.4 and DEER 44.2 also received the highest possible rating, with both streams showing good species diversity (19) and the presence of significant number of pollution intolerant taxa.

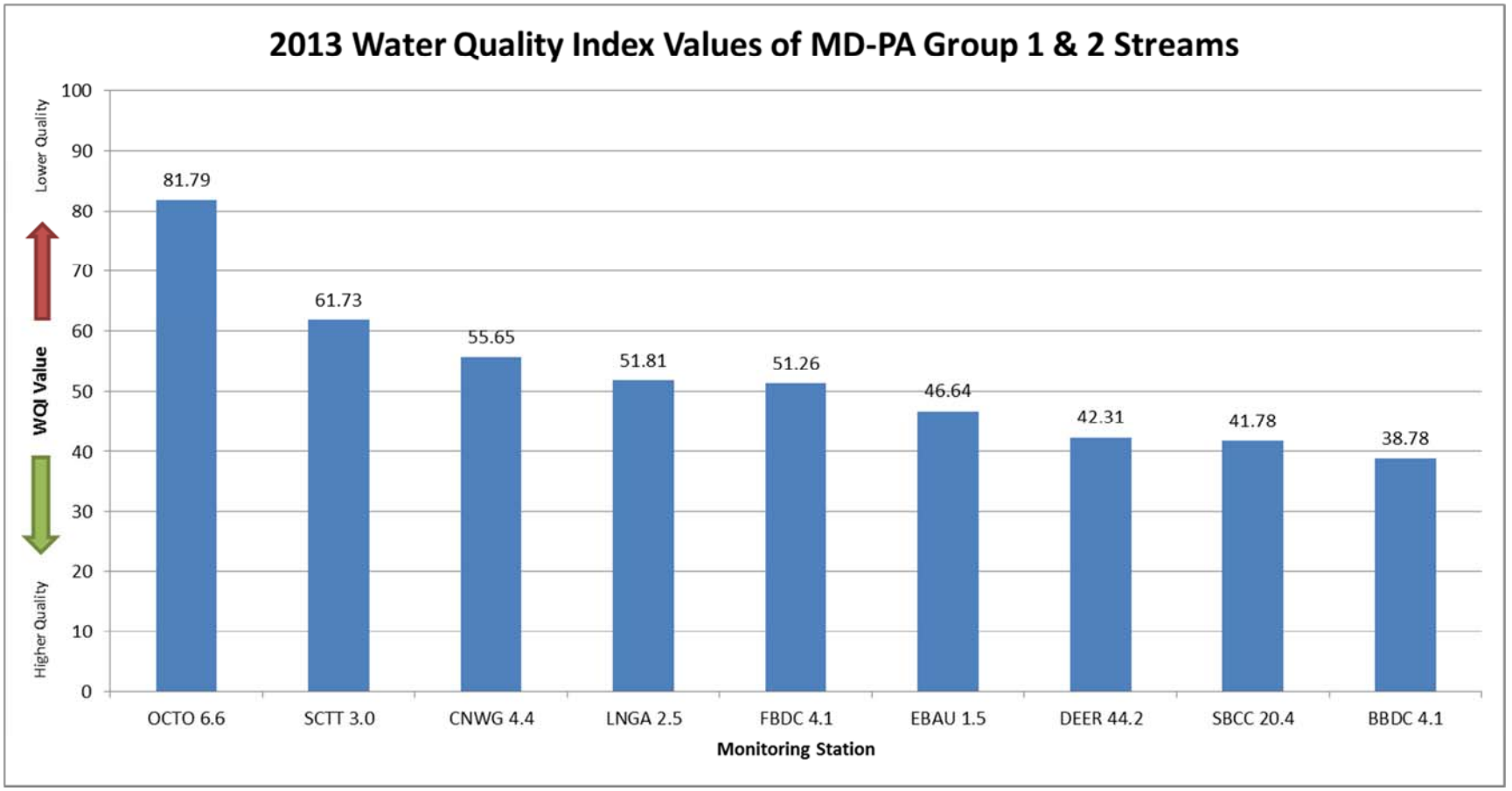
Site	Total Fish IBI Score	Average IBI Metric Score	Rating
LNGA 2.5	27	3.00	Fair
SBCC 20.4	31	3.44	Fair
EBAU 1.5	37	4.11	Good
DEER 44.2	39	4.33	Good
BBDC 4.1	37	4.11	Good
FBDC 4.1	31	3.44	Fair
SCTT 3.0	27	3.00	Fair
CNWG 4.4	39	4.33	Good
OCTO 6.6	N/A	N/A	N/A

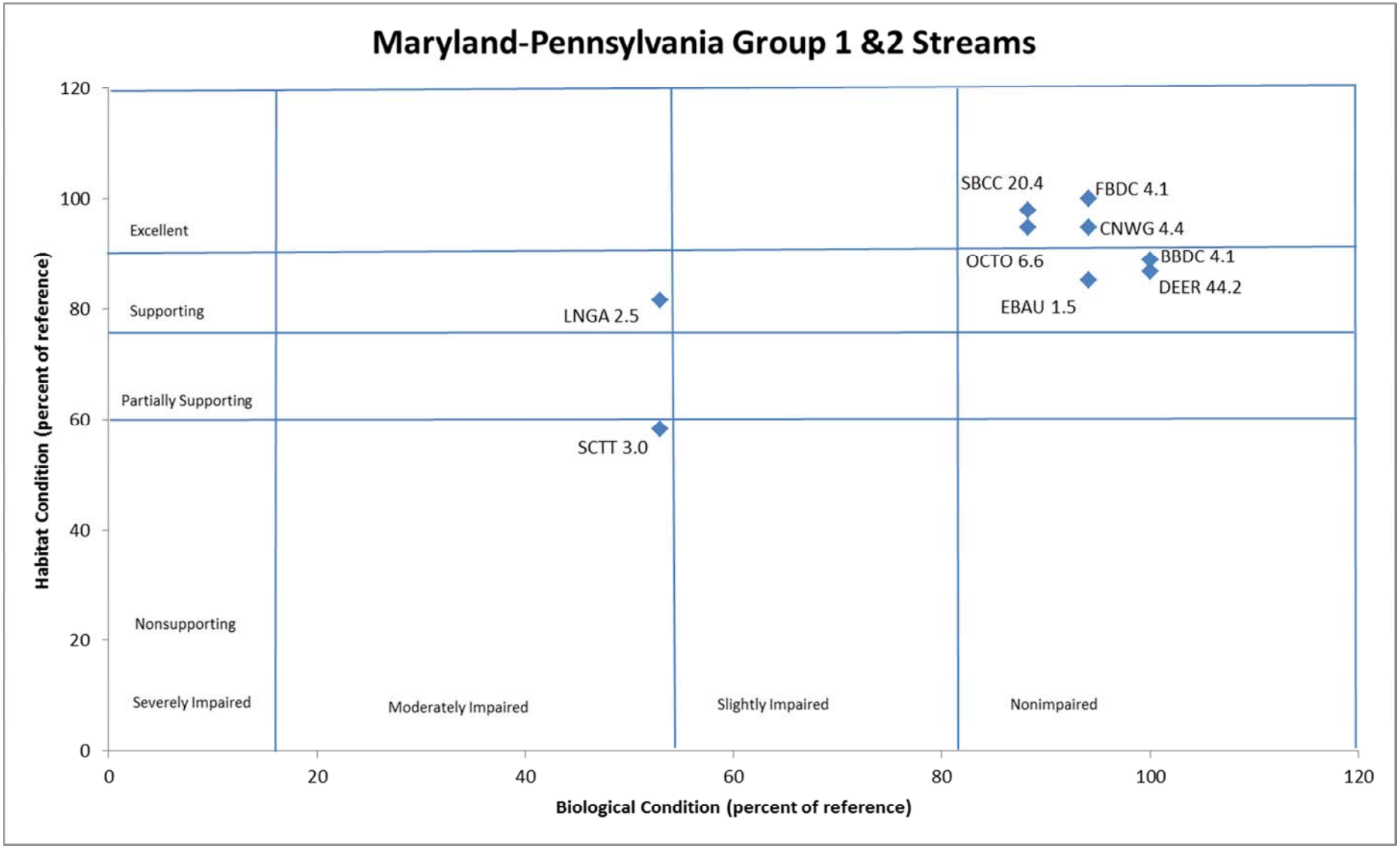
Water Quality

Overall water quality conditions of the Maryland-Pennsylvania streams sampled in 2013 were good with only 2 percent of measured parameters falling outside of accepted standards. Conowingo Creek (CNWG 4.4) exhibited elevated levels of total nitrogen during spring and fall sampling, measured at 11.2 mg/L and 11.1 mg/L, respectively. A total iron concentration of 1700 µg/L was detected from Octoraro Creek (OCTO 6.6) during spring sampling. Additionally, two tributaries to Deer Creek, Falling Branch Deer Creek (FBDC 4.1) and Big Branch Deer Creek (BBDC 4.1), possessed alkalinity levels below the Pennsylvania standard of 20 mg/L.

Parameter	Standard	Standard Value	Number of Observations	Number Exceeding Standards
Alkalinity	PA aquatic life	20 mg/L	30	2
Total Aluminum	NY aquatic (chronic)	100 µg/L	30	0
Total Iron	NY aquatic (chronic) PA aquatic life	300 µg/L 1500 µg/L	30	1
Nitrate plus Nitrite	PA public water supply	10 mg/L	30	2
pH	NY general MD aquatic life PA aquatic life	6.5-8.5 6.5-8.5 6.0-9.0	30	0
Total Manganese	NY aquatic (chronic)	300 µg/L	30	0
Turbidity	MD aquatic life	150 NTU	30	0
Dissolved Oxygen	PA aquatic life	5.0 mg/L	30	0




2013 Water Quality Index Values of MD-PA Group 1 & 2 Streams
Lower Quality
WQI Value
Higher Quality
100
90
80
70
60
50
40
30
20
10
0
81.79
61.73
55.65
51.81
51.26
46.64
42.31
41.78
38.78
OCTO 6.6
SCTT 3.0
CNWG 4.4
LNGA 2.5
FBDC 4.1
EBAU 1.5
DEER 44.2
SBCC 20.4
BBDC 4.1
Monitoring Station


Maryland-Pennsylvania Group 1 &2 Streams
Habitat Condition (percent of reference)
Biological Condition (percent of reference)
120
100
80
60
40
20
0
0
20
40
60
80
100
120
Excellent
Supporting
Partially Supporting
Nonsupporting
Severely Impaired
Moderately Impaired
Slightly Impaired
Nonimpaired
SBCC 20.4
FBDC 4.1
CNWG 4.4
OCTO 6.6
BBDC 4.1
DEER 44.2
EBAU 1.5
LNGA 2.5
SCTT 3.0

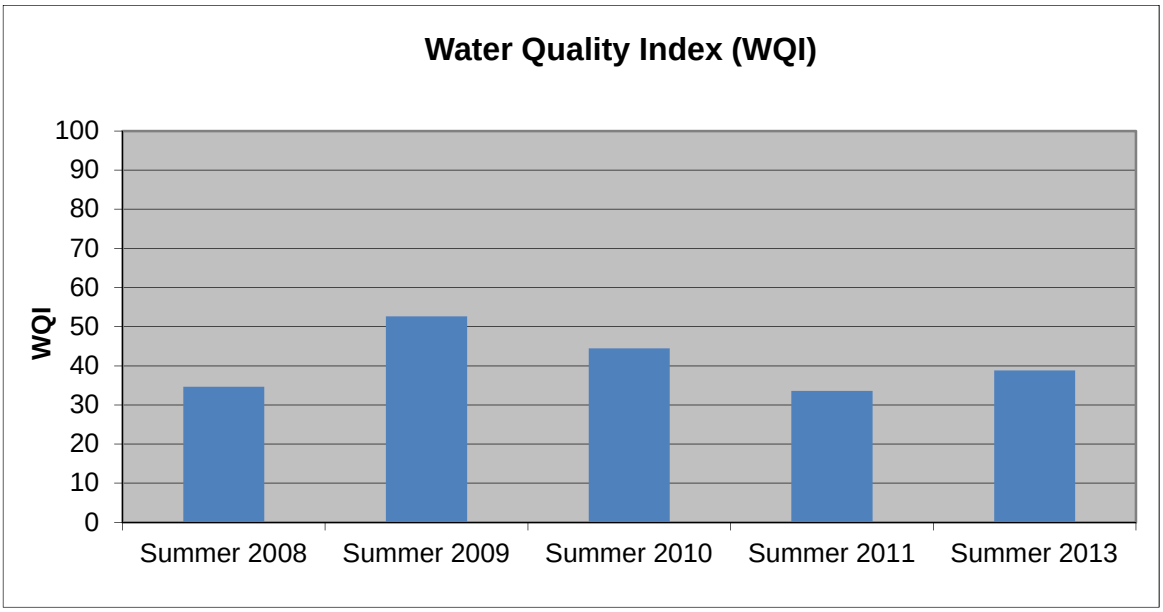
Site Results for MD-PA Group 1 and 2 Streams

Big Branch Deer Creek at Fawn Grove, PA (BBDC 4.1)

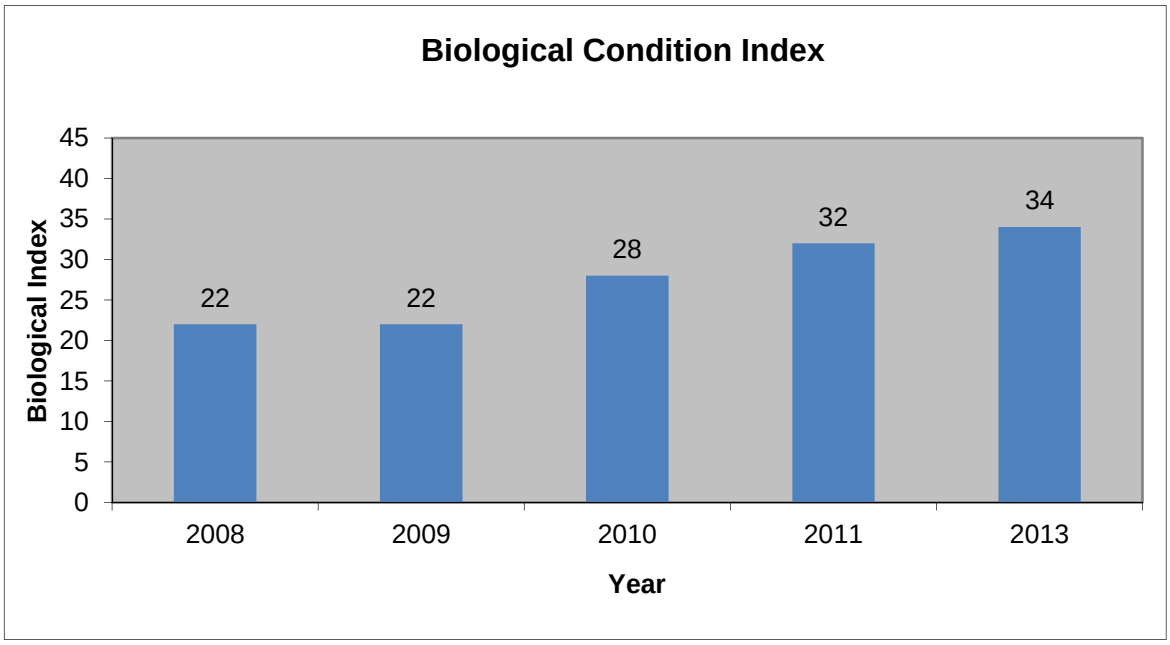
Group 2

Habitat Condition: Overall physical habitat was rated as supporting with a total score of 168 out of 220 possible points. Instream habitat was generally good, but the site was limited by narrow vegetative buffers and suboptimal bank conditions.

Water Quality: Big Branch Deer Creek possessed the lowest water quality index value of all sites in the project, suggesting excellent water quality. Alkalinity was found in a concentration of 14 mg/L, below the Pennsylvania water quality standard of 20 mg/L.



Biological Condition: BBDC 4.1 received a biological condition classification of nonimpaired in 2013. The macroinvertebrate sample possessed high overall taxonomic diversity and a strong contribution of sensitive individual taxa. The fish community received the highest possible MBSS IBI rating of good. BBDC 4.1's ten fish species represent strong diversity for a small stream, draining less than one square mile. Additionally, the stream possessed a robust population of wild brown trout, undetected in previous surveys.

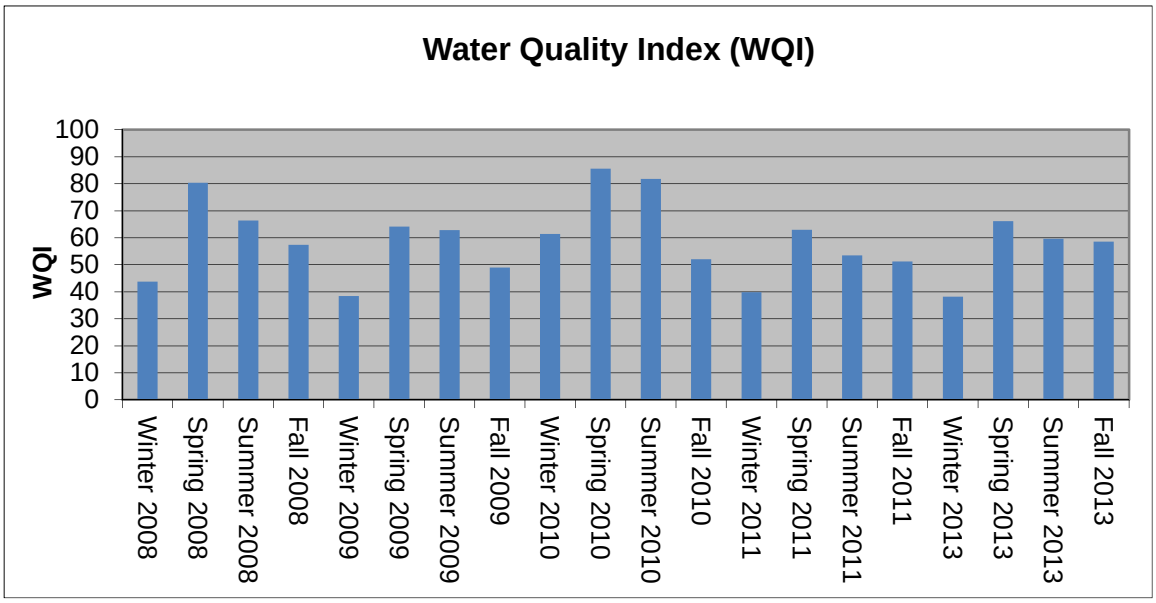


Conowingo Creek at Pleasant Grove, PA (CNWG 4.4)

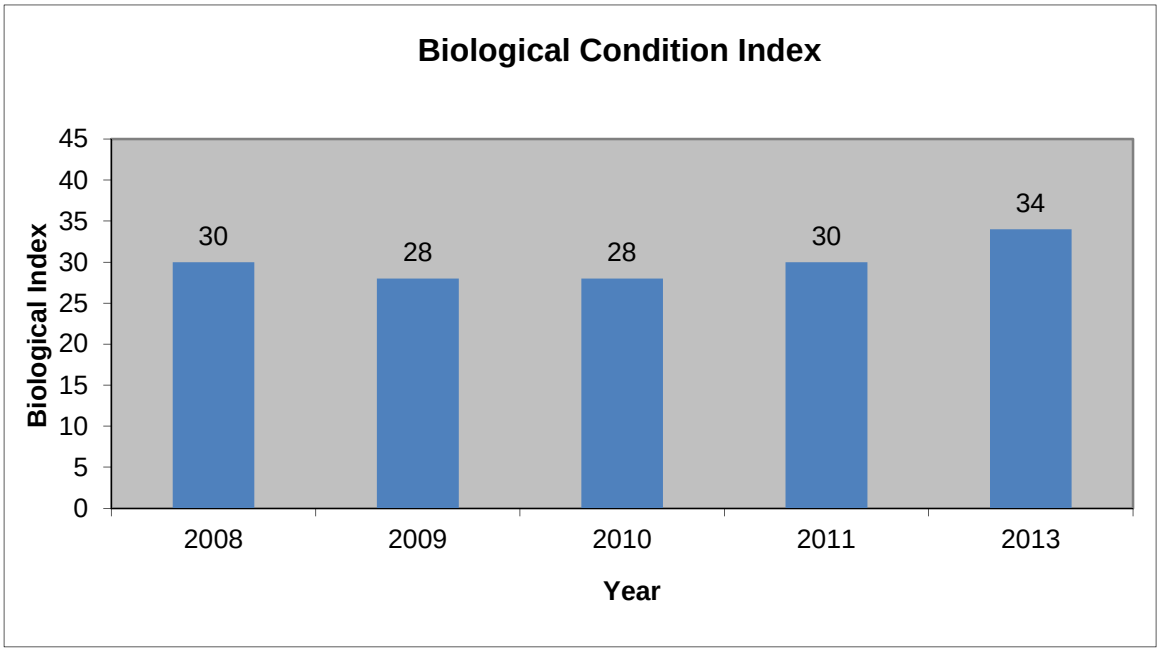
Group 1

Habitat Condition: Overall physical habitat was rated as excellent in 2013. The site possessed varied velocity/depth regimes and optimal riparian buffer widths. The left descending bank was noted as unstable and eroding.

Water Quality: Total nitrogen (nitrate + nitrite) levels were 11.1 mg/L in February and 11.2 mg/L in October at CNWG 4.4. May and August total nitrogen levels were 9.5 mg/L and 9.7 mg/L, respectively. The Pennsylvania water quality standard for total nitrogen is 10.0 mg/L. Conowingo Creek has consistently approached or exceeded this standard during previous monitoring years.



Biological Condition: CNWG 4.4 received a biological condition rating of nonimpaired in 2013. The macroinvertebrate sample scored highly due to a low contribution of pollution tolerant Chironomid taxa and a high proportion of individuals from the more sensitive mayfly order Ephemeroptera. The site also obtained a fish community rating of "good" with relatively high overall species diversity and a high number of benthic species.

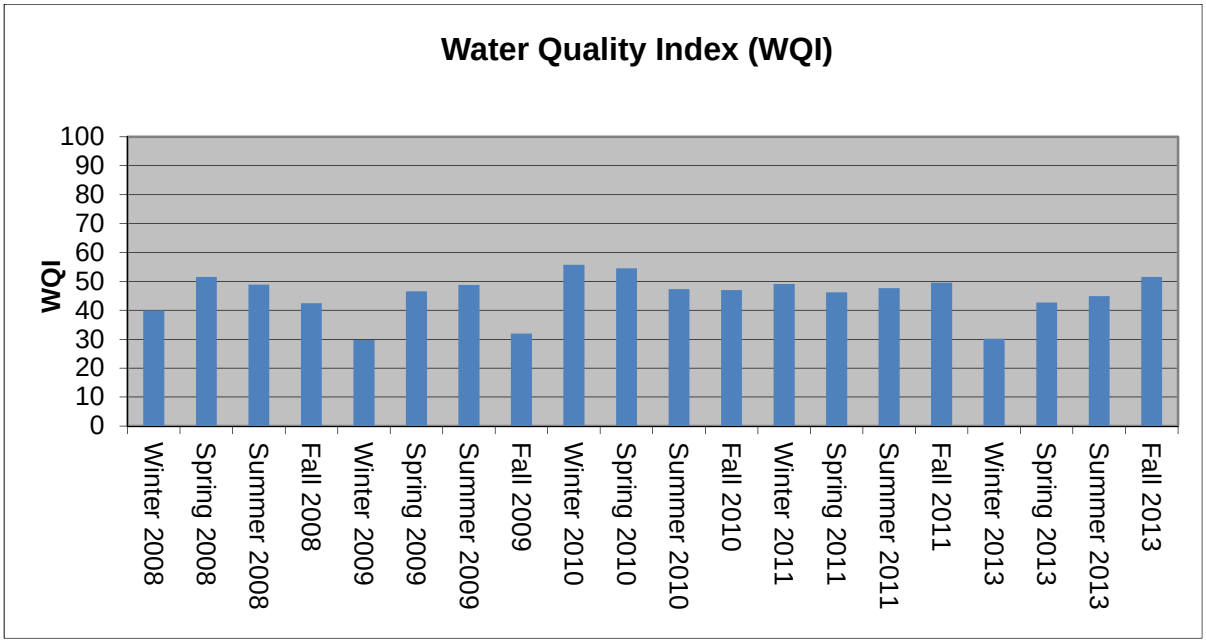


Deer Creek at Gorsuch Mills, PA (DEER 44.2)

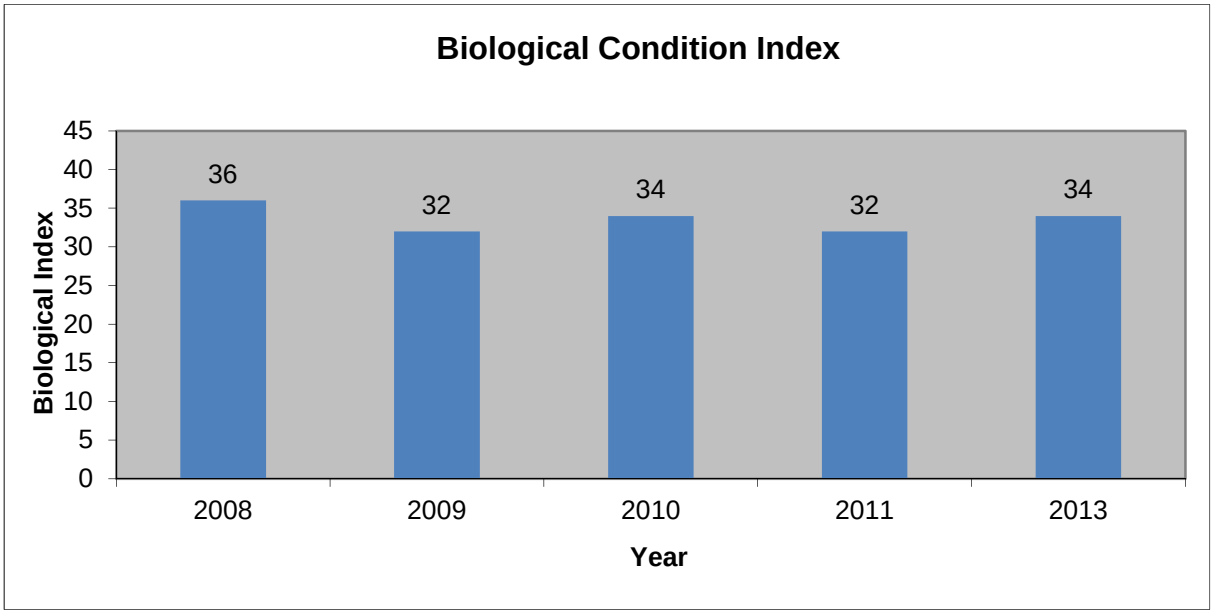
Group 1

Habitat Condition: Located in an area of mixed forest and agricultural lands, DEER 44.2 attained a habitat classification of supporting. Instream cover and flow conditions were deemed optimal but embedded substrates and poor bank conditions limited the overall habitat score.

Water Quality: Deer Creek possessed excellent overall water quality, receiving the third most favorable water quality index score of all interstate streams sampled in 2013.



Biological Condition: Deer Creek possessed a biological condition rating of excellent in 2013, sharing the highest scoring macroinvertebrate community with the site's direct tributary, Big Branch Deer Creek. Based on the combined relative high scores in terms of habitat, biology, and water quality, Deer Creek was again chosen as the reference site to which all other sites were compared. Deer Creek also received the highest possible fish community assessment of "good" when analyzed using the Maryland Fish IBI.

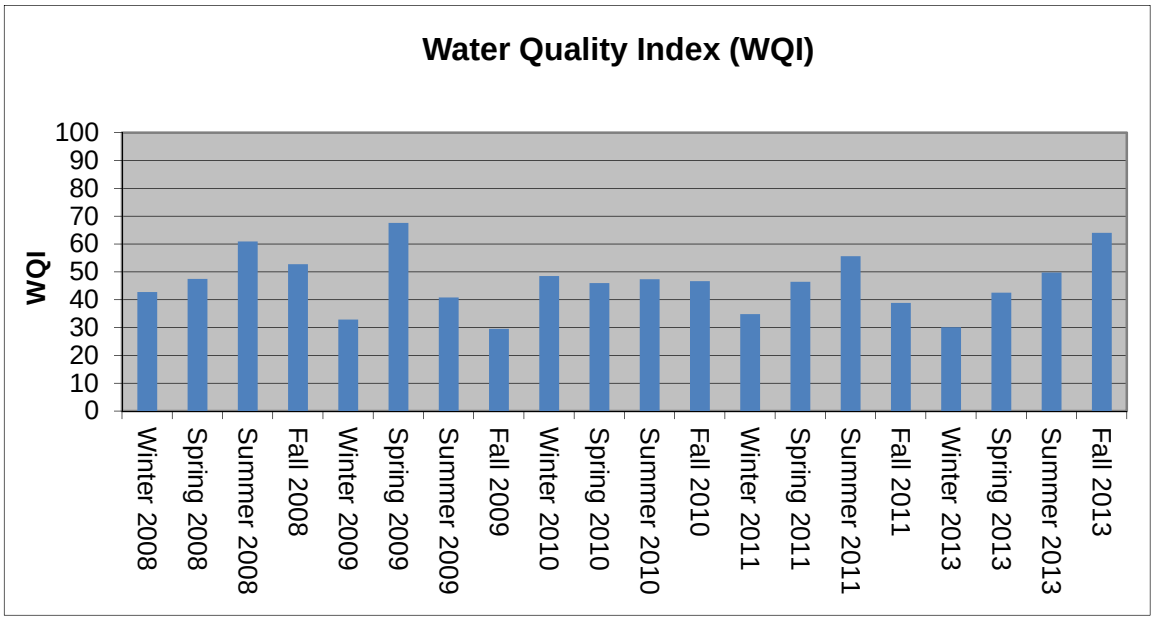


Ebaughs Creek at Stewartstown, PA (EBAU 1.5)

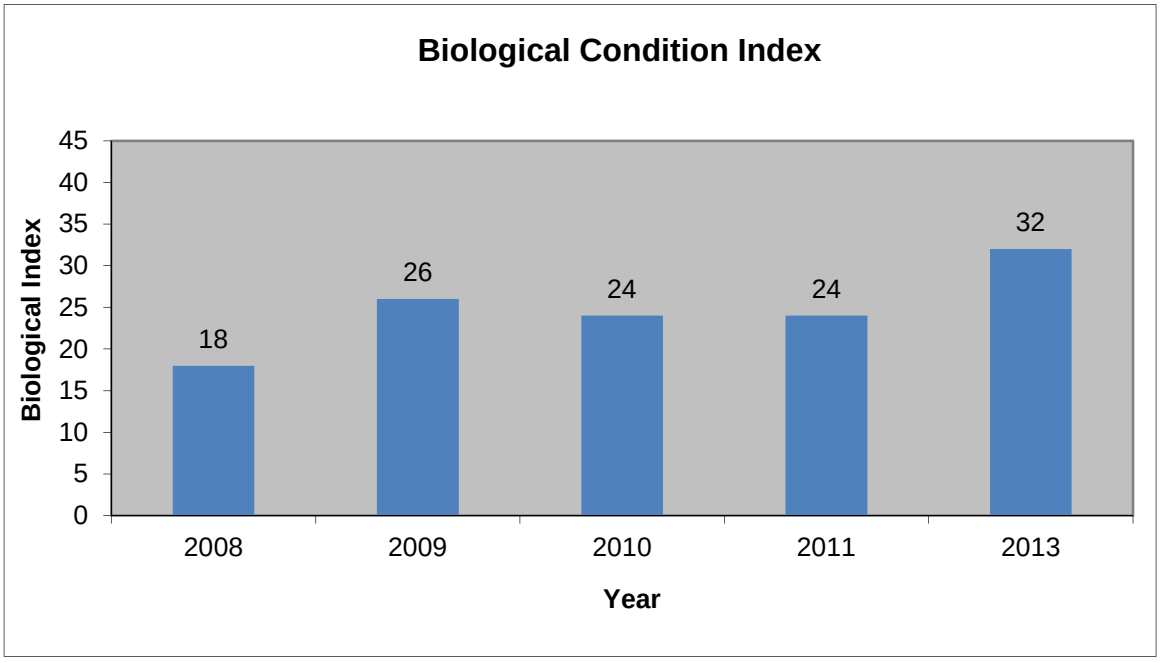
Group 1

Habitat Condition: Available physical habitat was rated as supporting when assessed in August 2013. Suboptimal habitat attributes included level of embeddedness, sediment deposition, and available instream cover.

Water Quality: EBAU 1.5 possessed good water quality when assessed in 2013. No measured parameters exceeded state thresholds.



Biological Condition: EBAU 1.5's macroinvertebrate sample, characterized by good overall taxonomic diversity, with over 30 percent of individuals belonging to the traditionally more sensitive taxons of Ephemoptera, Plecoptera, and Trichoptera, received an assessment rating of nonimpaired. The fish community was rated as good with five of nine metrics achieving the maximum possible value.

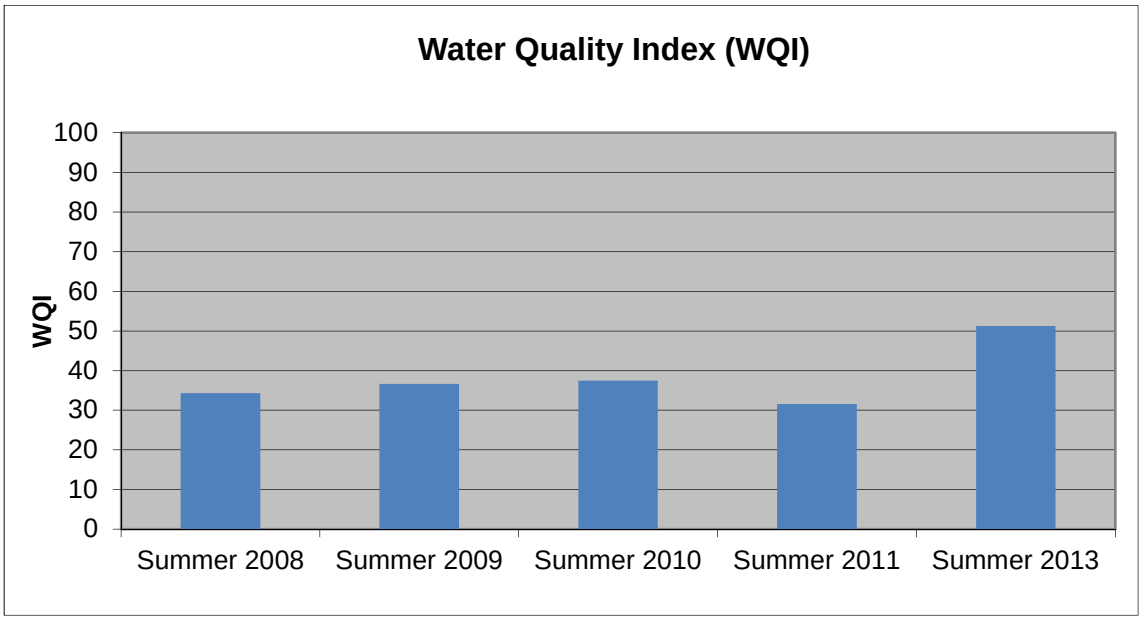


Falling Branch Deer Creek (FBDC 4.1)

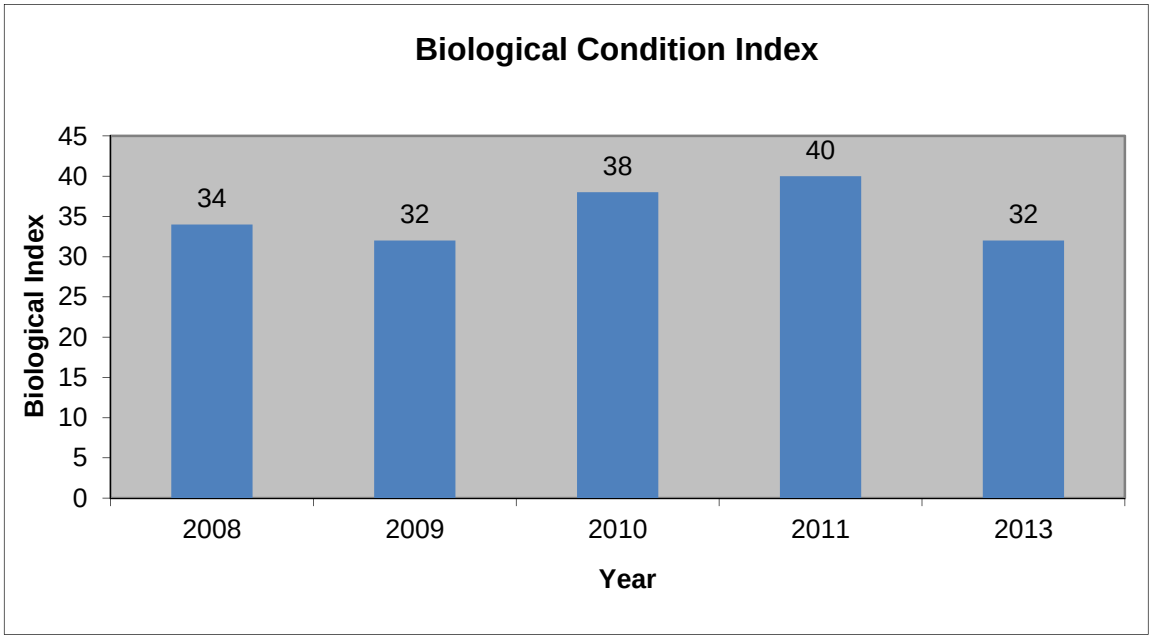
Group 2

Habitat Condition: Available physical habitat at Falling Branch Deer Creek was rated as excellent during 2013. The site received the highest habitat score of all interstate streams monitored during the year. All eleven parameters assessed scored in the highest possible category.

Water Quality: Total alkalinity was determined to be 13 mg/L when sampled in August 2013. The Pennsylvania water quality standard for total alkalinity is 20 mg/L.



Biological Condition: Falling Branch Deer Creek received a biological condition rating of nonimpaired based on macroinvertebrates. The fish community received a qualitative assessment value of fair indicating some deviation from reference condition. The fish community lacked significant numbers of intolerant taxa and possessed low overall species diversity relative to the expected value for comparably sized stream.

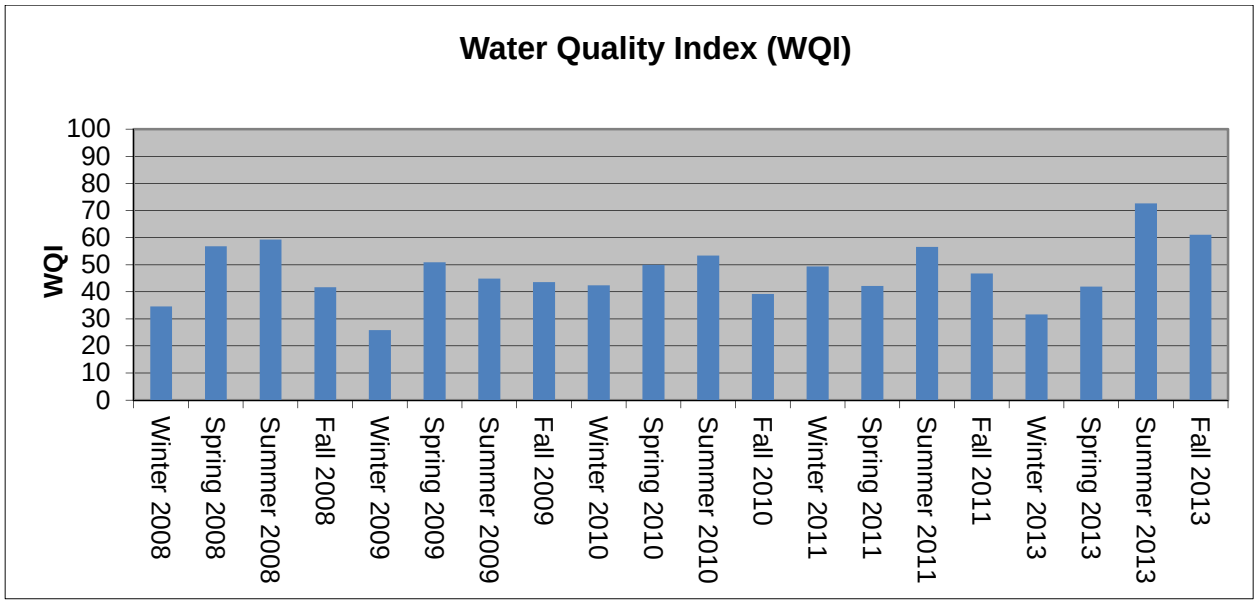


Long Arm Creek at Bandanna, PA (LNGA 2.5)

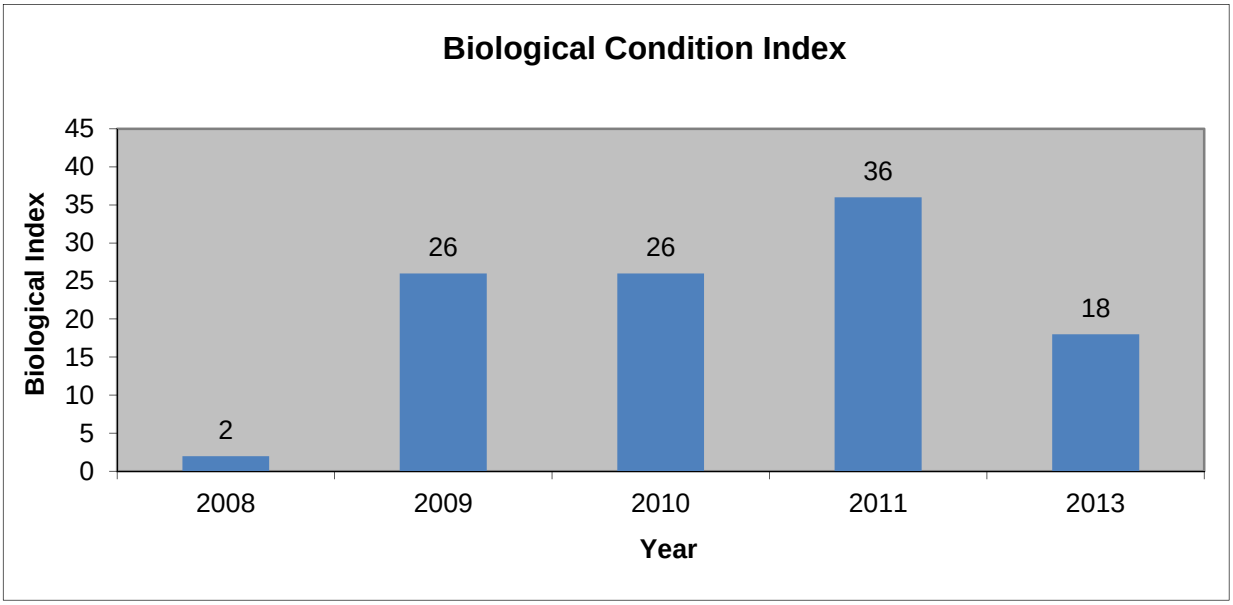
Group 1

Habitat Condition: The sample site on Long Arm Creek is located immediately upstream of the Long Arm Reservoir. Under high flow conditions, the sampling location becomes inundated by the reservoir, and conditions often transition to those more typical of a lentic environment. The site received a habitat score of 154 out of a possible 220 points.

Water Quality: With minimal potential upstream impacts, the overall water quality of LNGA 2.5 was good. All measured water quality parameters were within accepted limits across all four sampling rounds.



Biological Condition: The macroinvertebrate community at LNGA 2.5 received a biological assessment value of moderately impaired in 2013. The sample possessed the highest overall diversity with 29 taxa identified in the subsample but numerically was dominated by tolerant Chironomids. The fish sample received a rating of fair and was heavily influenced by large numbers of Centrachid species more typically found in warmwater and lentic environments.

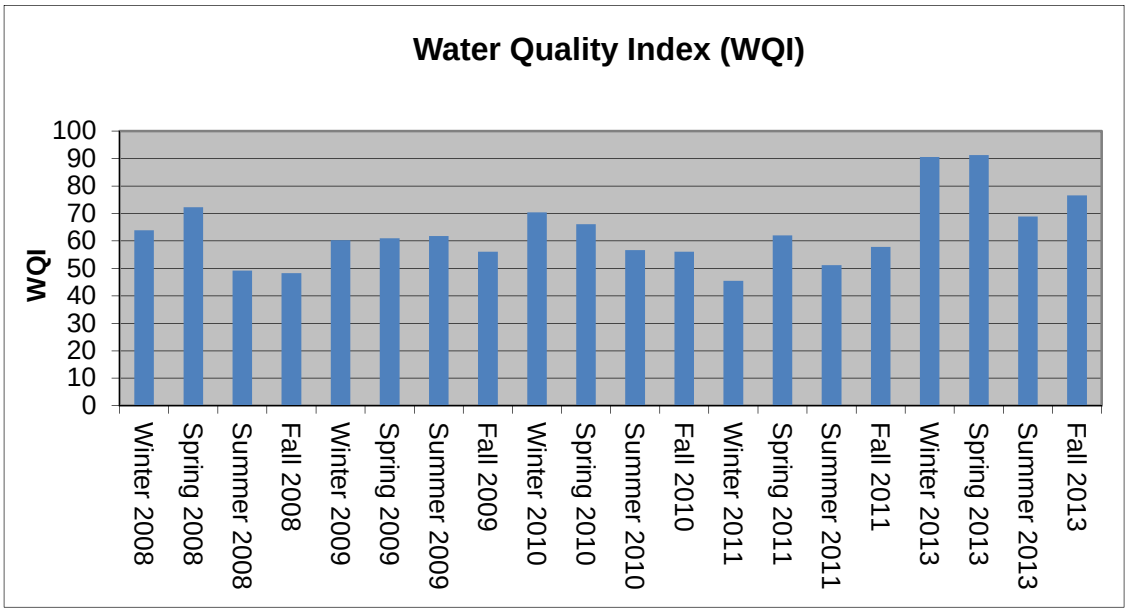


Octoraro Creek at Rising Sun, MD (OCTO 6.6)

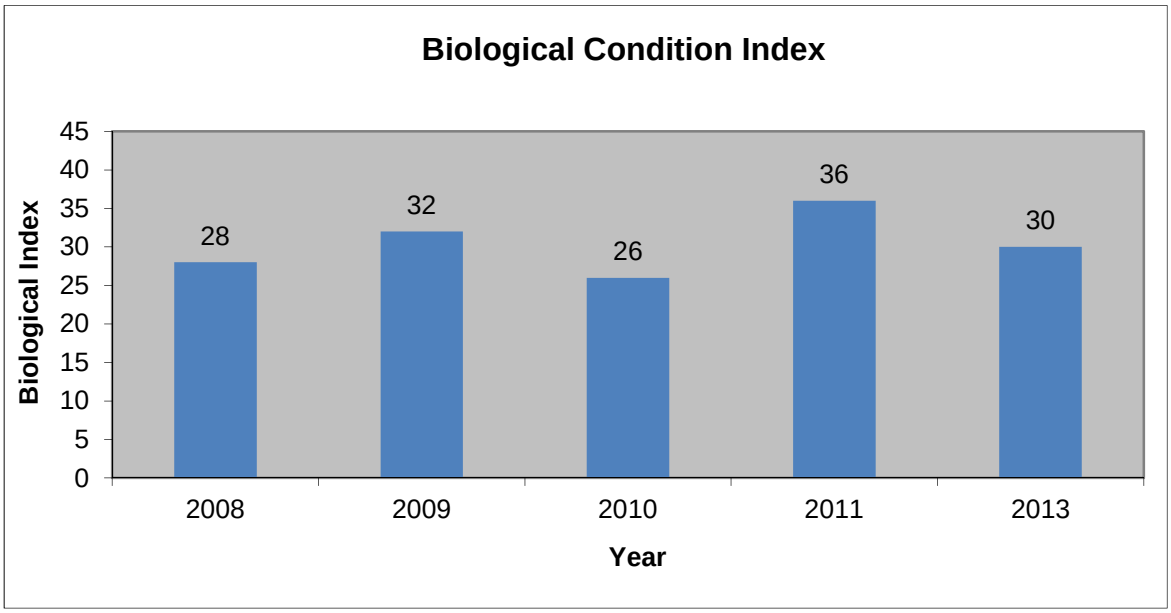
Group 1

Habitat Condition: The available physical habitat at OCTO 6.6 was deemed excellent in 2013. Staff noted optimal amounts instream cover and stable, well-protected banks. The overall habitat score assigned was 179 out of a possible 220.

Water Quality: OCTO 6.6 received the highest water quality index score of all interstate streams sampled in 2013, suggesting problematic water quality. This value is not truly representative of the water quality as high flows were observed during 50 percent of sampling events, skewing results relative to flow conditions encountered at other streams during the sampling rounds.



Biological Condition: Fish sampling was not conducted at OCTO 6.6 due to consistently high flows during the summer months. The macroinvertebrate sample did score well in high taxa richness and a favorable Shannon Diversity Index score. The overall classification of the biology was excellent.

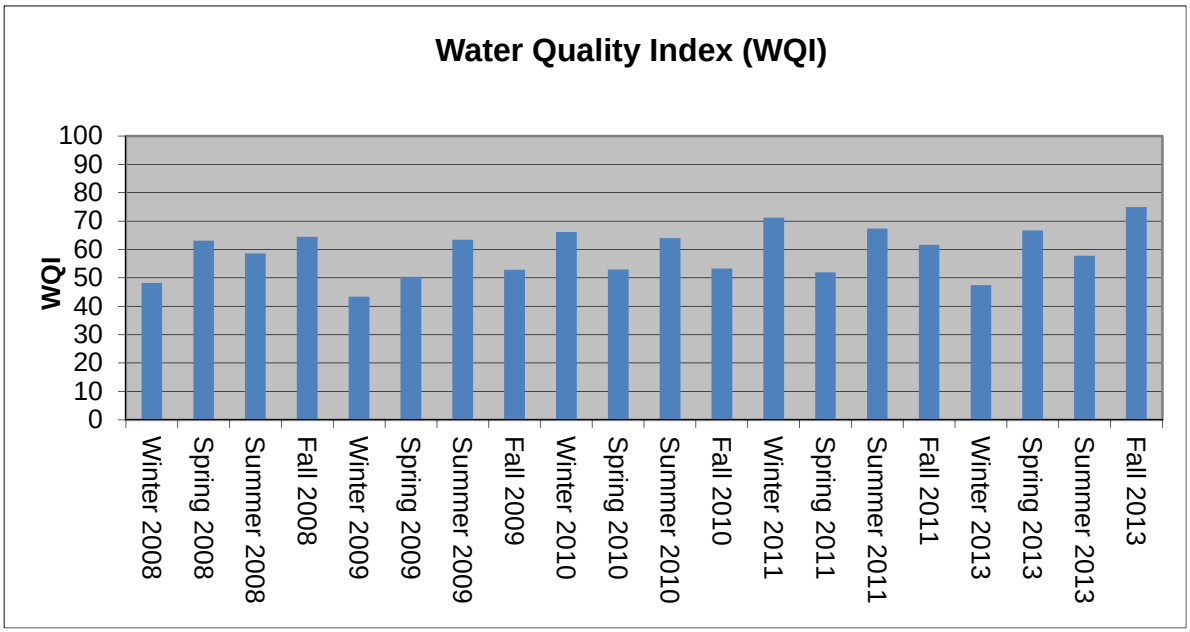


Scott Creek at Delta, PA (SCTT 3.0)

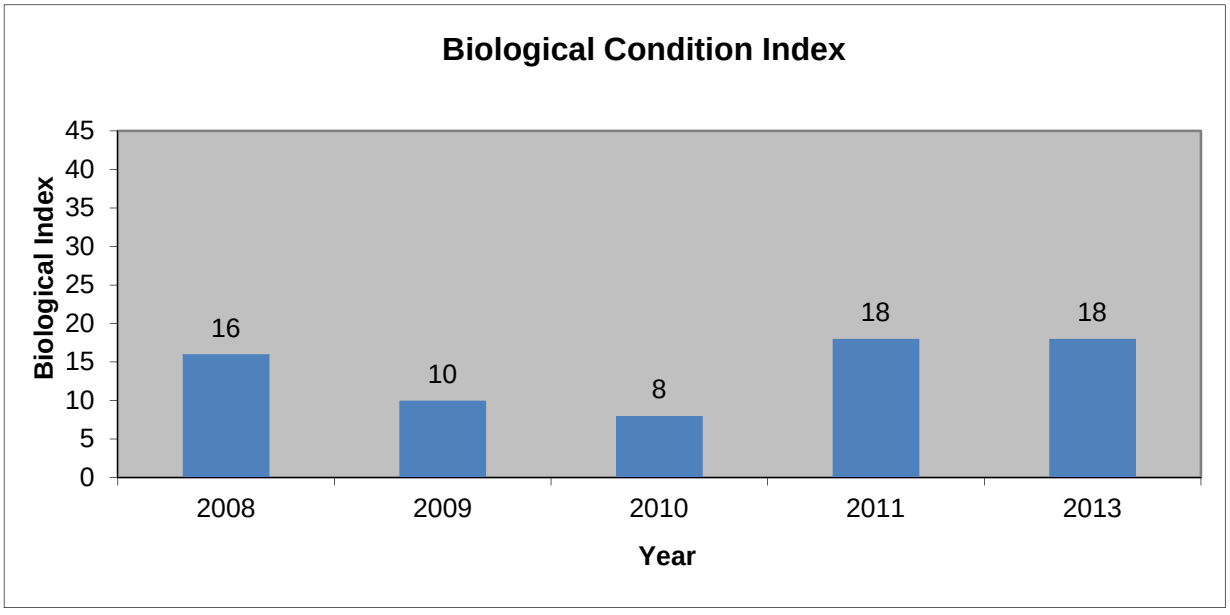
Group 1

Habitat Condition: Scoring 110 out of a possible 220, the physical habitat of Scott Creek received a rating of nonsupporting. SCTT 3.0 was the only interstate stream to receive the lowest designation during 2013. Surrounded by commercial and residential properties, the habitat of this station has consistently scored poorly throughout the duration of the long running Interstate Streams project.

Water Quality: Though no individual parameter exceeded state water quality standards during the sampling year, Scott Creek has routinely exhibited relatively poor water quality compared to other Maryland-Pennsylvania border streams. SCTT 3.0 had higher concentrations of manganese, iron, magnesium, and aluminum than all other streams surveyed as part of this assessment.



Biological Condition: For the sixth consecutive year, Scott Creek's biology was considered moderately impaired using the SRBC macroinvertebrate metrics analysis. Using the fish community as an assessment tool yielded a similar result with the stream being designated as fair by the Maryland Fish IBI. Over 98 percent of the fish sample consisted of Eastern blacknose dace, creek chubs, and white suckers. All three of these ubiquitous species are considered highly pollution tolerant.

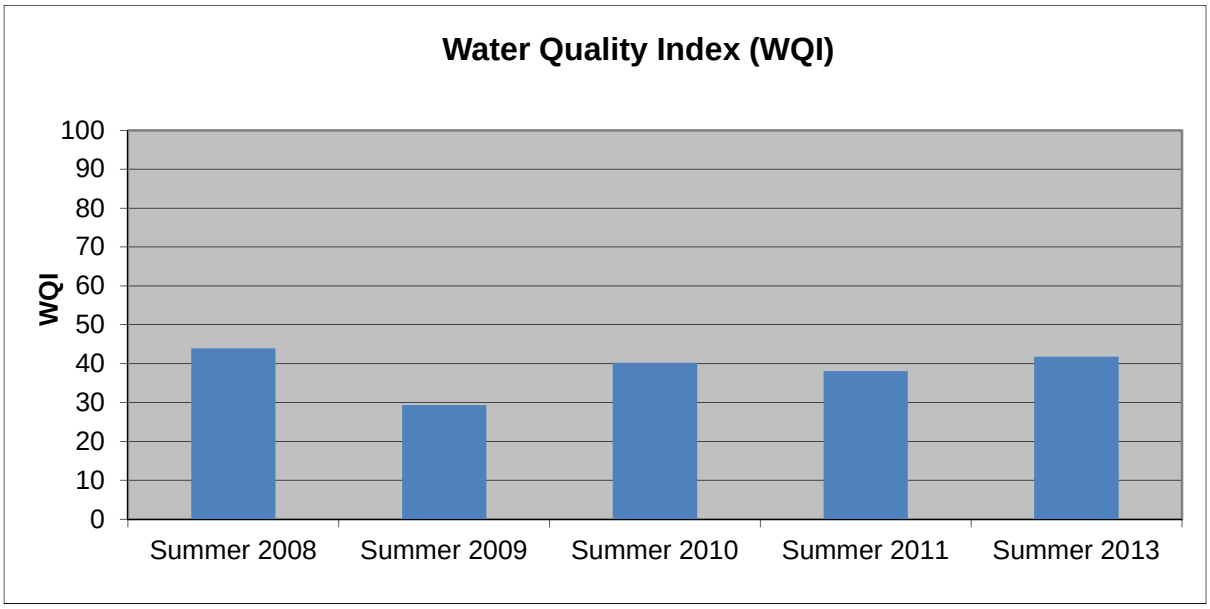


South Branch Conewago Creek at Bandanna, PA (SBCC 20.4)

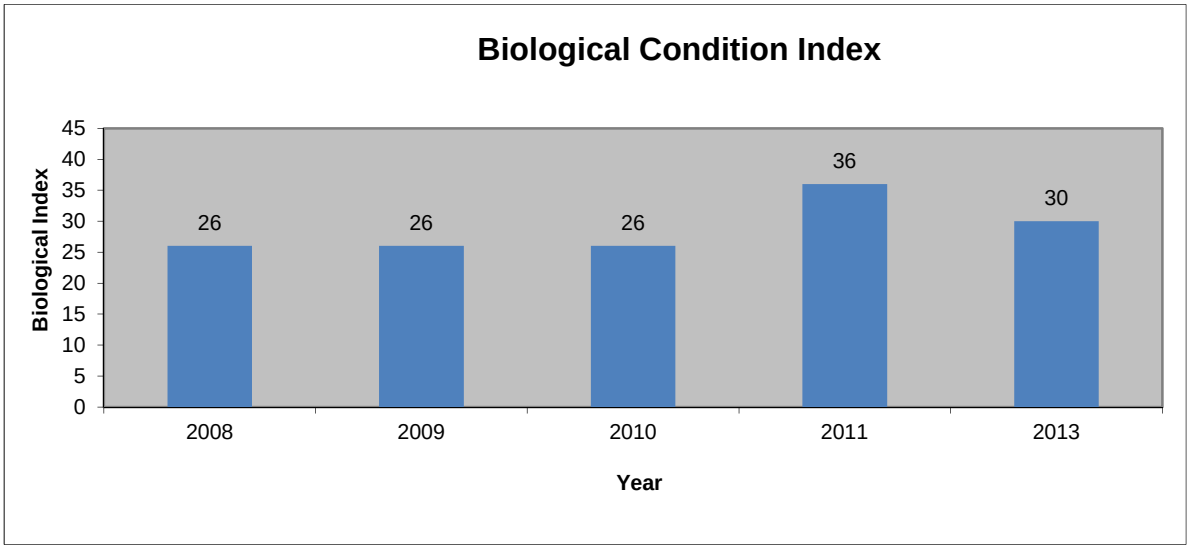
Group 2

Habitat Condition: Situated in a small, highly forested watershed, the physical habitat at SBCC 20.4 was rated as excellent when assessed in August 2013. Though some bank instability and erosion was noticed, all other habitat parameters scored well. Staff noted wide vegetated buffers and abundant instream cover providing near optimal habitat conditions.

Water Quality: The South Branch of Conewago Creek possessed the second lowest water quality index value of all Maryland-Pennsylvania streams, suggesting very good overall water quality relative to the other interstate streams.



Biological Condition: SBCC 20.4 received a biological condition assessment value of fair based on the fish community and a classification of nonimpaired from the macroinvertebrate sample. The fish IBI score likely undervalued the integrity of the stream due to the stream's very small size. The Maryland fish IBI warned of the possibility of misclassification of small streams, especially when other indicators are in disagreement with a seemingly low fish IBI score.



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Appendix

Criteria Used to Evaluate Physical Habitat

Habitat Parameter	OPTIMAL (20-16)	SUBOPTIMAL (15-11)	MARGINAL (10-6)	POOR (5-0)
1. Epifaunal Substrate (R/R)[1]	Well-developed riffle/run; riffle is as wide as stream and length extends 2 times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than 2 times width; abundance of cobble; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the width; some cobble present.	Riffle or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
1. Epifaunal Substrate (G/P)[2]	Preferred benthic substrate abundant throughout stream site and at stage to allow full colonization (i.e., log/snags that are not new fall and not transient).	Substrate common but not prevalent or well suited for full colonization potential.	Substrate frequently disturbed or removed.	Substrate unstable or lacking.
2. Instream Cover (R/R)	> 50% mix of boulders, cobble, submerged logs, undercut banks, or other stable habitat.	30-50% mix of boulder, cobble, or other stable habitat; adequate habitat.	10-30% mix of boulder, cobble, or other stable habitat; habitat availability less than desirable.	< 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious.
2. Instream Cover (G/P)	> 50% mix of snags, submerged logs, undercut banks, or other stable habitat; rubble, gravel may be present.	30-50% mix of stable habitat; adequate habitat for maintenance of populations.	10-30% mix of stable habitat; habitat availability less than desirable.	Less than 10% stable habitat; lack of habitat obvious.
3. Embeddedness [a] (R/R)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediments.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediments.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediments.	Gravel, cobble, and boulder particles are >75% surrounded by fine sediments.
3. Pool Substrate Characterization (G/P)	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.	All mud or clay or sand bottom; little or no root mat; no submerged vegetation.	Hard-pan clay or bedrock; no root mat or vegetation.
4. Velocity/Depth Regimes [b] (R/R)	All 4 velocity/depth regimes present (slow/deep, slow/shallow, fast/deep, fast/shallow).	Only 3 of 4 regimes present (if fast/shallow is missing, score lower than if missing other regimes).	Only 2 of 4 regimes present (if fast/shallow or slow/shallow are missing, score low).	Dominated by 1 velocity/depth regime.
4. Pool Variability [c] (G/P)	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.	Majority of pools large-deep; very few shallow.	Shallow pools much more prevalent than deep pools.	Majority of pools small-shallow or pools absent.

Criteria Used to Evaluate Physical Habitat—Continued

Habitat Parameter	OPTIMAL (20-16)	SUBOPTIMAL (15-11)	MARGINAL (10-6)	POOR (5-0)
5. Sediment Deposition (R/R)	Little or no enlargement of islands or point bars and <5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; >50% of the bottom changing frequently; pools almost absent due to sediment deposition.
5. Sediment Deposition (G/P)	Less than 20% of bottom affected; minor accumulation of fine and coarse material at snags and submerged vegetation; little or no enlargement of island of point bars.	20-50% affected; moderate accumulation; substantial sediment movement only during major storm event; some new increase in bar formation.	50-80% affected; major deposition; pools shallow, heavily silted; embankments may be present on both banks; frequent and substantial movement during storm events.	Channelized; mud, silt, and/or sand in braided or non-braided channels; pools almost absent due to substantial sediment deposition.
6. Channel Flow Status (R/R) (G/P)	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
7. Channel Alteration [d] (R/R) (G/P)	No channelization or dredging present.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization (>20 yr) may be present, but not recent.	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; >80% of the reach channelized and disrupted.
8. Frequency of Riffles (R/R)	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the stream width is between 15-25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is >25.
8. Channel Sinuosity (G/P)	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line.	The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.	The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line.	Channel straight; waterway has been channelized for a long time.
9. Condition of Banks [e] (R/R) (G/P)	Banks stable; no evidence of erosion or bank failure, little potential for future problems; <5% of bank affected; on Glide/Pool streams side slopes generally <30%.	Moderately stable; infrequent, small areas of erosion mostly healed over; 5-30% of bank in reach has areas of erosion; on Glide/Pool streams side slopes up to 40% on one bank; slight erosion potential in extreme floods.	Moderately unstable, 30-60% of banks in reach have areas of erosion; high erosion potential during floods; on Glide/Pool streams side slopes up to 60% on some banks.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars; on Glide/Pool streams side slopes > 60% common.
(score each bank 0-10)	**(9-10)**	**(6-8)**	**(3-5)**	**(0-2)**

Criteria Used to Evaluate Physical Habitat—Continued

Habitat Parameter	OPTIMAL (20-16)	SUBOPTIMAL (15-11)	MARGINAL (10-6)	POOR (5-0)
10. Vegetative Protective Cover (R/R) (G/P)	>90% of the streambank surfaces covered by vegetation; vegetative disruption through grazing or mowing minimal.	70-90% of the streambank surfaces covered by vegetation; disruption evident but not affecting full plant growth potential to any great extent.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation.	<50% of the streambank surfaces covered by vegetation; disruption is very high; vegetation removed to 5 cm or less.
(score each bank 0-10)	**(9-10)**	**(6-8)**	**(3-5)**	**(0-2)**
11. Riparian Vegetative Zone Width (R/R) (G/P)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clearcuts, lawns, or crops) have not impacted zone.	Width or riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone only minimally.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
(score each bank 0-10)	**(9-10)**	**(6-8)**	**(3-5)**	**(0-2)**

[1] R/R – Riffle/Run — Habitat assessment parameters used for streams characterized by riffles and runs.

[2] G/P – Glide/Pool — Habitat assessment parameters used for streams characterized by glides and pools.

[a] Embeddedness — The degree to which the substrate materials that serve as habitat for benthic macroinvertebrates and for fish spawning and egg incubation (predominantly cobble and/or gravel) are surrounded by fine sediment. Embeddedness is evaluated with respect to the suitability of these substrate materials as habitat for macroinvertebrates and fish by providing shelter from the current and predators and by providing egg deposition and incubation sites.

[b] Velocity/Depth Regimes — The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow.

[c] Pool Variability — Rated based on the variety and spatial complexity of slow- or still-water habitat within the sample segment. It should be noted that even in high-gradient segments, functionally important slow-water habitat may exist in the form of plunge-pools and/or larger eddies. General guidelines are any pool dimension (i.e., length, width, oblique) greater than half the cross-section of the stream for separating large from small and 1 m depth separating shallow and deep.

[d] Channel Alteration — A measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, rip-rap, or other structures.

[e] Condition of Banks — Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to be unstable. Left and right bank orientation is determined by facing downstream.

Source: Modified from Barbour et al., 1999.

Summary of Metrics Used to Evaluate the Overall Biological Integrity of Stream and River Benthic Macroinvertebrate Communities

Metric	Description
1. Taxonomic Richness (a)	The total number of taxa present in the 200-organism subsample. Number decreases with increasing stress.
2. Shannon Diversity Index (b)	A measure of biological community complexity based on the number of equally or nearly equally abundant taxa in the community. Index value decreases with increasing stress.
3. Modified Hilsenhoff Biotic Index (a)	A measure of the organic pollution tolerance of a benthic macroinvertebrate community. Index value increases with increasing stress.
4. EPT Index (a)	The total number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa present in the 200-organism subsample. Number decreases with increasing stress.
5. Percent Ephemeroptera (a)	The percentage of Ephemeroptera in the 200-organism subsample. Percentage decreases with increasing stress.
6. Percent Dominant Taxa (a)	Percentage of the taxon with the largest number of individuals out of the total number of macroinvertebrates in the sample. Percentage increases with increasing stress.
7. Percent Chironomidae (a)	The percentage of Chironomidae in a 200-organism subsample. Percentage increases with increasing stress.

Sources: (a) Barbour et al., 1999 (b) Klemm et al., 1990

Summary of Criteria Used to Classify the Biological Conditions of Sample Sites

SAMPLING AND ANALYSIS

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TOTAL BIOLOGICAL SCORE DETERMINATION				
	Biological Condition Scoring Criteria			
Metric	**6**	**4**	**2**	**0**
1. Taxonomic Richness (a)	>80 %	79 – 60 %	59 – 40 %	<40 %
2. Shannon Diversity Index (a)	>75 %	74 – 50 %	49 – 25 %	<25 %
3. Modified Hilsenhoff Biotic Index (b)	>85 %	84 – 70 %	69 – 50 %	<50 %
4. EPT Index (a)	>90 %	89 – 80 %	79 – 70 %	<70 %
5. Percent Ephemeroptera (c)	>25 %	10 – 25 %	1 – 9 %	<1 %
6. Percent Chironomidae (c)	<5 %	5 – 20 %	21 – 35 %	>36 %
7. Percent Dominant Taxa (c)	<20 %	20 – 30 %	31 – 40 %	>40 %
Total Biological Score (d)				

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BIOASSESSMENT	
Percent Comparability of Study and Reference Site Total Biological Scores (e)	**Biological Condition Category**
>83	Nonimpaired
79 - 54	Slightly Impaired
50 - 21	Moderately Impaired
<17	Severely Impaired

(a) Score is study site value/reference site value X 100.

(b) Score is reference site value/study site value X 100.

(c) Scoring criteria evaluate actual percent contribution, not percent comparability to the reference station.

(d) Total Biological Score = the sum of Biological Condition Scores assigned to each metric.

(e) Values obtained that are intermediate to the indicated ranges will require subjective judgment as to the correct placement into a biological condition category.

Summary of Criteria Used to Classify the Habitat Conditions of Sample Sites

DETERMINATION OF HABITAT ASSESSMENT SCORES				
	Habitat Parameter Scoring Criteria			
Parameter	**Excellent**	**Good**	**Fair**	**Poor**
Epifaunal Substrate	20-16	15-11	10-6	5-0
Instream Cover	20-16	15-11	10-6	5-0
Embeddedness/Pool Substrate	20-16	15-11	10-6	5-0
Velocity/Depth Regimes/Pool Variability	20-16	15-11	10-6	5-0
Sediment Deposition	20-16	15-11	10-6	5-0
Channel Flow Status	20-16	15-11	10-6	5-0
Channel Alteration	20-16	15-11	10-6	5-0
Frequency of Riffles/Channel Sinuosity	20-16	15-11	10-6	5-0
Condition of Banks (a)	20-16	15-11	10-6	5-0
Vegetative Protective Cover (a)	20-16	15-11	10-6	5-0
Riparian Vegetative Zone Width (a)	20-16	15-11	10-6	5-0
Habitat Assessment Score (b)				

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HABITAT ASSESSMENT	
Percent Comparability of Study and Reference Site Habitat Assessment Scores	**Habitat Condition Category**
>90	Excellent (comparable to reference)
89-75	Supporting
74-60	Partially Supporting
<60	Nonsupporting

(a) Combined score of each bank
(b) Habitat Assessment Score = Sum of Habitat Parameter Scores

Summary of metrics, scoring criteria and narrative descriptions of stream biological integrity associated with each of the IBI categories

Metrics and scoring criteria for the recommended final fish IBI. Some metrics [(a)] were adjusted for watershed area, based on linear relationships [(b)] between the metric and log(watershed area) in acres

	Scoring criteria		
Eastern Piedmont	**5**	**3**	**1**
Number of native species[(a)]	Criteria vary with stream size (see below)		
Number of benthic fish species[(a)]	Criteria vary with stream size (see below)		
Number of intolerant species[(a)]	Criteria vary with stream size (see below)		
Percent tolerant fish	≤ 41	41 < x ≤ 65	> 65
Percent abundance of dominant species	≤ 30	30 < x ≤ 52	> 52
Percent generalists, omnivores, and invertivores	≤ 86	86 < x ≤ 99.7	> 99.7
Number of individuals per square meter	≥ 0.81	0.35 ≤ x < 0.81	< 0.35
Biomass per square meter	≥ 8.0	3.7 ≤ x < 8.0	< 3.7
Percent lithophilic spawners	≥ 62	22 ≤ x < 62	< 22

(a) Adjusted value = observed/expected value, where expected value = m * log (watershed area in acres) + b

	Scoring criteria		
Eastern Piedmont	**5**	**3**	**1**
Number of native species - Adjusted value	≥ 1.02	0.56 ≤ x < 1.02	< 0.56
Number of benthic species - Adjusted value	≥ 0.99	0.50 ≤ x < 0.99	< 0.50
Number of intolerant species - Adjusted value	≥ 0.59	0.18 ≤ x < 0.59	< 0.18

(b) Slope and intercept values for selected metrics, based on linear regression relationships between metric and log(watershed area) in acres

	slope (m)	**intercept (b)**
Eastern Piedmont		
Number of native species	5.5701	-8.1135
Number of benthic fish species	1.3245	-2.6437
Number of intolerant species	4.4052	-8.8991

Narrative descriptions of stream biological integrity associated with each of the IBI categories		
Good	IBI score 4.0-5.0	Comparable to reference streams considered to be minimally impacted. On average, biological metrics fall within upper 50% of reference conditions.
Fair	IBI score 3.0-3.9	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of these minimally impacted streams. On average, biological metrics are within the lower portion of the range of references sites (10th to 50th percentile).
Poor	IBI score 2.0-2.9	Significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating some degredation. On average, biological metrics fall below the 10th percentile of reference site values.
Very Poor	IBI Score 1.0-1.9	Strong deviation from reference conditions, with most aspects of biological integrity not resmbling the qualities of minimally impacted streams, indicating severe degredation. On average, biological metrics fall below the 10th percentile of reference site values; most or all metrics below this level.