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.

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. Following a new fish community sampling protocol initiated in 2009, all Group 1 and Group 2 sites are to be sampled during the May sampling period during alternate years. The large river sites CHEM 12.0, COWN 1.0, COWN 2.2, SUSQ 10, SUSQ 44.5, SUSQ 289.1, SUSQ 340.0, SUSQ 365.0, and TIOG 10.8 were excluded from fish sampling due to sampling difficulties associated with large size.

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. All Group 2 sites are sampled for fish in alternating years, following the new fish community sampling protocol previously mentioned.

Group 3

Streams judged to have a low potential for impacts have been assigned to Group 3, which includes 22 sites along the Pennsylvania-New York border. No Group 3 sites are located along the Pennsylvania-Maryland border. In May of each year, macroinvertebrates, field chemistry parameters, and habitat conditions were assessed at Group 3 sites.

Stream Discharge

Stream discharge was measured at all sites unless high streamflows made access hazardous or impossible. Several sites are located near U.S. Geological Survey (USGS) stream gages. The sites include the following: the Susquehanna River at Windsor, N.Y. (SUSQ 365.0), the Susquehanna River at Kirkwood, N.Y. (SUSQ 340.0), the Susquehanna River at Sayre, Pa. (SUSQ 289.1), the Susquehanna River at Marietta, Pa. (SUSQ 44.5), 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 & COWN 2.2), 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 discharges for sites not located near USGS gaging stations were measured at the time of sampling, using standard USGS procedures (Buchanan and Somers, 1969) and a FlowTracker.

Water Samples

Water samples were collected at each of the Group 1 and Group 2 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 them 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. In addition to the parameters listed above, alkalinity and acidity were also measured in the field for all Group 3 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. When alkalinity and acidity were to be measured at Group 3 stations, pH was determined by using a Cole-Parmer Model 5996 meter that was calibrated at the beginning of each day. Alkalinity was then determined by titrating a known volume of sample water to pH 4.5 with 0.02N sulfuric acid (H_2SO_4). Acidity was measured by titrating a known volume of sample water to pH 8.3 with 0.02N sodium hydroxide (NaOH).

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 Rapid Bioassessment Protocol for Use in Streams and Rivers by Barbour et al. (1999). Sampling was performed using a 1-meter-square kick screen with size No. 30 mesh. The kick screen was stretched across the current to collect organisms dislodged from riffle/run areas by physical agitation of the stream substrate. Two kick screen samples were collected from a representative riffle/run at each station. The two 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 et al. (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 were adapted from the RBP manual (Barbour et al., 1999) and from the Maryland Biological Stream Survey (Roth et al., 1998). Electrofishing at 25 wadeable Group 1 and 2 interstate stream stations occurred in alternate years, beginning in 2009. Eighteen stations were initially sampled in 2009, and five were sampled in 2010. The remaining nine Group 1 and 2 streams were too large to be effectively sampled using current protocols. 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 sufficient to allow visual detection of immobilized fish at all depths. Every possible effort was made prior to departure for sampling activities to ensure that ideal conditions were realized.

Electrofishing at each site consisted of two passes on a 75-meter segment containing best available habitat. Efforts were made to locate the upstream point at a natural cutoff (e.g., impassible riffles, falls, head of a pool) that could deter fish from moving out of the sample

reach. If a natural cutoff was not present, 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 occurred within ± 5 meters of the 75-meter mark. If there was no natural cutoff at the upstream margin of the reach, block nets were used.

GPS coordinates for the upstream and downstream limits of the sample reach were recorded on the field data sheet. Sampling teams consisted of three or four members, depending on stream size. Backpack (battery-powered electrical-generated) or towed barge electrofishing units with two handheld probes were used. Electrofishing consisted of a two-pass coverage of the entire width and length of the selected stream segment. Beginning at the downstream limit of the sample reach, the sampling team proceeded upstream, covering the entire stream width and using a sinuous pattern when necessary. Each team member made every effort to capture all fish sighted that were more than 25mm in length so that a representative sample was collected. Start and stop times, as well as accumulated electrofishing time (shock time), were recorded on the field data sheet.

Nets and holding cages with 0.25-inch mesh were used to prevent escape. All fish were identified to species in the field, when possible. Fish that could not be readily identified in the field were preserved in 10-percent formalin and returned to the laboratory for identification. Digital photographs were taken of all unknown specimens, as were voucher (reference) photographs of each species. After processing fish from the first 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 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 (nine 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 sores indicating poor water quality.

Biological and physical habitat conditions

Benthic macroinvertebrate samples were assessed using procedures described by Barbour et al. (1999), Klemm et al. (1990), and Plafkin et al. (1989). Using these methods, staff calculated a series of biological indices for a stream and compared them 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 et al. (1990), and all other metrics were taken from Barbour et al. (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 et al., 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 et al., 2000; Southerland et al., 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 metric biomass per square meter was omitted from the analysis as biomass data were not available at the time of sampling. 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 et al., 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.

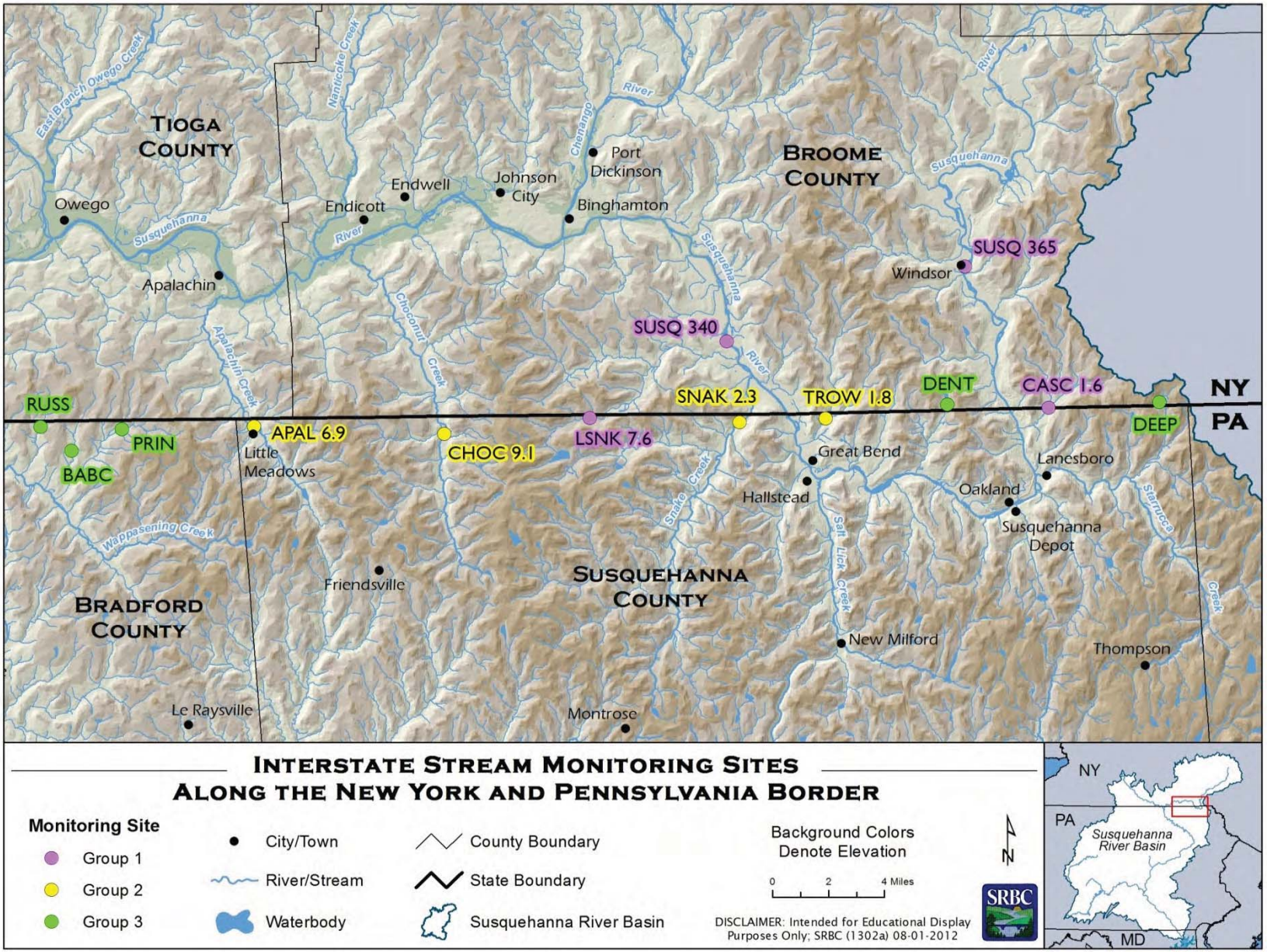
List of New York-Pennsylvania Interstate Streams

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 2.2	Cowanesque River, Lawrenceville, PA	1	Impacts from flood control reservoir
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 340.0	Susquehanna River, Kirkwood, NY	1	Large drainage area (2,232 sq. mi.); historical pollution due to sewage from Lanesboro, Oakland, Susquehanna, Great Bend, and Hallstead
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

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
SUSQ 44.5*	Susquehanna River, Marietta, PA	1	Bracket hydroelectric dams near the state line
SUSQ 10.0*	Susquehanna River, Conowingo, MD	1	Bracket hydroelectric dams near the state line

*denotes no macroinvertebrates were collected in 2011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Johnson City
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Apalachin
Little Meadows
Friendsville
Great Bend
Hallstead
Lanesboro
Oakland
Susquehanna Depot
New Milford
Thompson
Montrose
Le Raysville
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East Branch Owego Creek
Nanticoke Creek
Chenango River
Choconut Creek
Apalachin Creek
Wappasening Creek
Snake Creek
Salt Lick Creek
Starrucca Creek
RUSS
PRIN
BABC
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SNAK 2.3
TROW 1.8
SUSQ 340
SUSQ 365
DENT
CASC 1.6
DEEP
INTERSTATE STREAM MONITORING SITES
ALONG THE NEW YORK AND PENNSYLVANIA BORDER
Monitoring Site
Group 1
Group 2
Group 3
City/Town
River/Stream
Waterbody
County Boundary
State Boundary
Susquehanna River Basin
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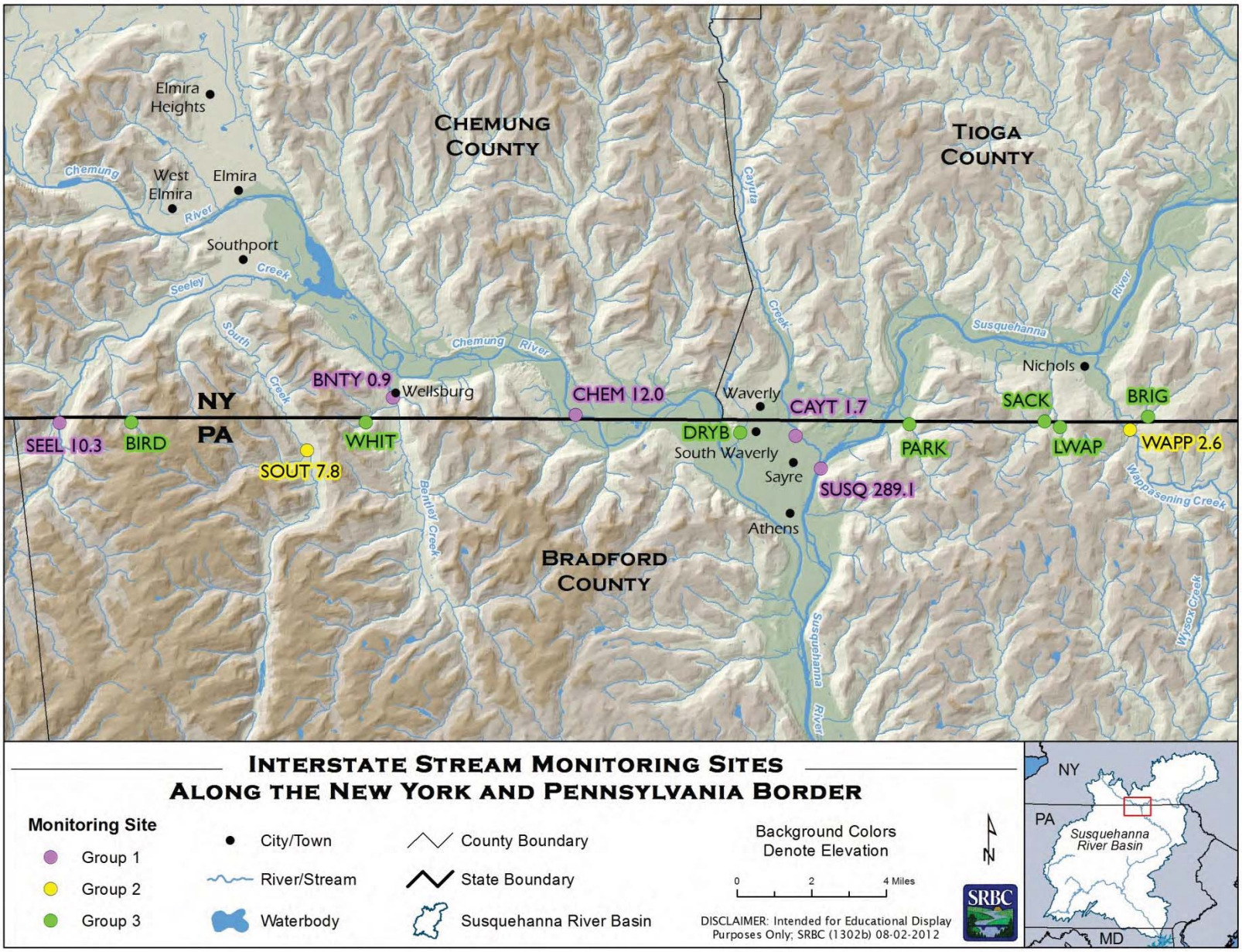
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BNTY 0.9
Wellsburg
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Waverly
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SACK
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Sayre
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Wappasening Creek
Athens
Bradford County
Bentley Creek
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Wysox Creek
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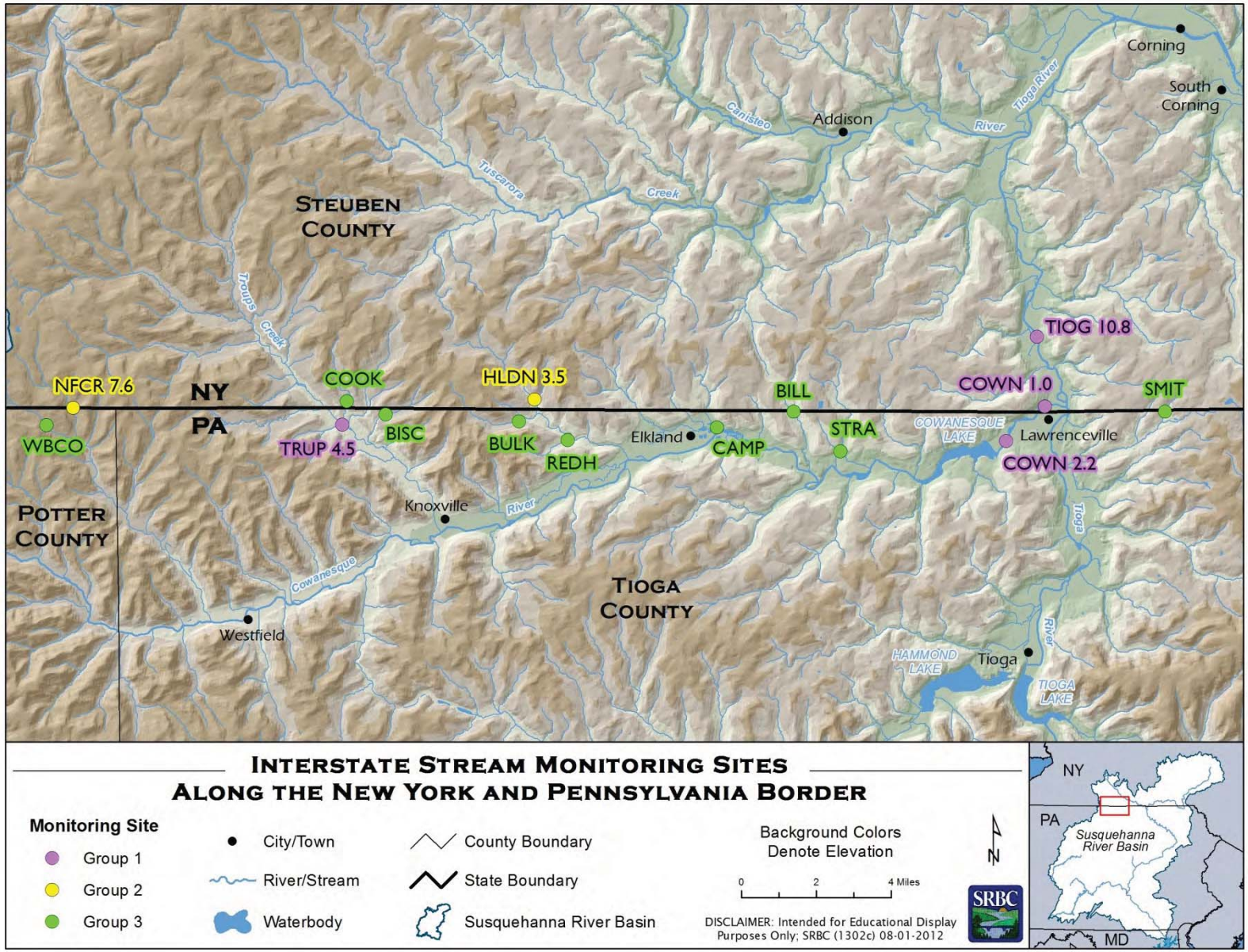
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Westfield
HAMMOND LAKE
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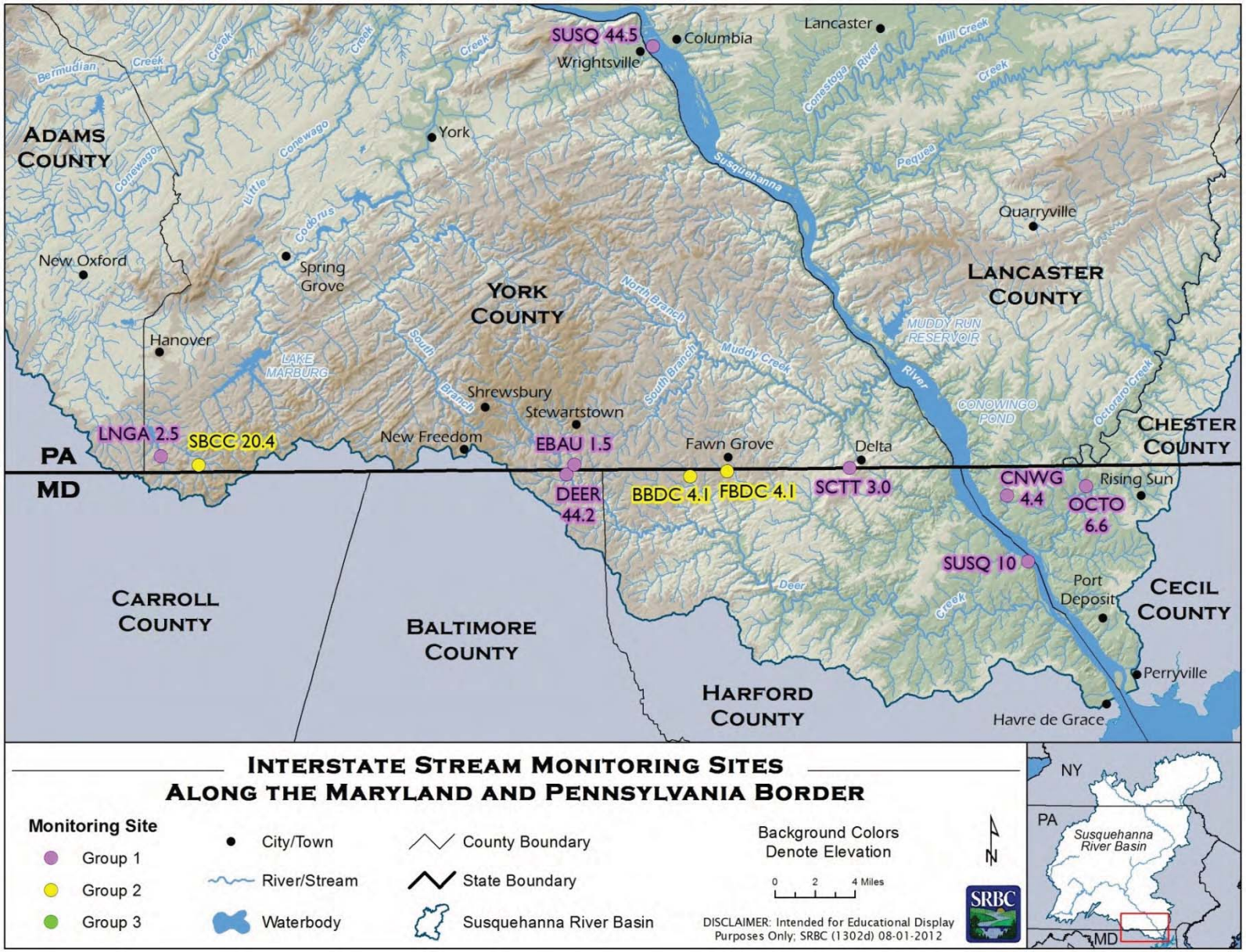
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Conewago
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Susquehanna
Pequea
Quarryville
New Oxford
Spring Grove
YORK COUNTY
North Branch
LANCASTER COUNTY
MUDDY RUN RESERVOIR
Hanover
LAKE MARBURG
South Branch
Muddy Creek
River
Shrewsbury
Stewartstown
CONOWINGO POND
Octoraro Creek
CHESTER COUNTY
LNGA 2.5
SBCC 20.4
New Freedom
EBAU 1.5
Fawn Grove
Delta
PA
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DEER 44.2
BBDC 4.1
FBDC 4.1
SCTT 3.0
CNWG 4.4
Rising Sun
OCTO 6.6
SUSQ 10
Port Deposit
Deer Creek
CECIL COUNTY
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
Perryville
Havre de Grace
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