METHODS

Field and Laboratory Methods

Sampling frequency

In 1989, the interstate streams were divided 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.

Streams with impaired water quality or judged to have a high potential for degradation due to large drainage areas or historical pollution have been assigned to Group 1. Each year, Group 1 streams are sampled in July or August, October, February, and May. Benthic macroinvertebrates are collected and habitat assessments are performed at all Group 1 streams during the summer sampling period.

Streams judged to have a moderate potential for impacts have been assigned to Group 2. Water quality samples, benthic macroinvertebrate samples, and physical habitat information were obtained from Group 2 stations once a year; usually during base flow conditions in the summer months of July or August.

Streams judged to have a low potential for impacts have been assigned to Group 3 and are sampled each May for macroinvertebrates, and habitat conditions are assessed. Field chemistry parameters also are measured on Group 3 streams at the time of biological sampling.

Stream discharge

Stream discharge is measured at all stations unless high stream flows makes access impossible. Several stations are located near U.S. Geological Survey (USGS) stream gages. These stations include the following: the Susquehanna River at Windsor, N.Y., Kirkwood, N.Y., Sayre, Pa., Marietta, Pa., and Conowingo, Md.; the Chemung River at Chemung, N.Y.; the Tioga River at Lindley, N.Y.; and the Cowanesque River at Lawrenceville, Pa. Recorded stages from USGS gaging stations and rating curves were used to determine instantaneous discharges in cubic feet per second (cfs). Instantaneous discharges for stations not located near USGS gaging stations were measured at the time of sampling, using standard USGS procedures (Buchanan and Somers, 1969).

Water samples

Water samples are collected at each of the Group 1 and Group 2 streams to measure nutrient and metal concentrations. Water samples are collected using a depth-integrated sampler. Composite samples are 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 are mixed thoroughly in the churn splitter and collected in a 500-ml bottle and two 250-ml bottles. The 500-ml bottle is for a raw sample. Each of the 250-ml bottles consists of a whole water sample, one fixed with concentrated nitric acid (HNO_3) for metal analysis and one fixed with concentrated sulfuric acid (H_2SO_4) for nutrient analysis. The samples are chilled on ice and sent to the Pennsylvania Department of Environmental Protection (PADEP), Bureau of Laboratories in Harrisburg, Pa., within 24 hours of collection.

Field chemistry

Temperature, dissolved oxygen, conductivity, pH, alkalinity, and acidity are measured in the field. Dissolved oxygen is measured using a YSI model 55-dissolved oxygen meter that is calibrated at the beginning of each day when water samples are collected. A VWR Scientific Model 2052 conductivity meter is used to measure conductivity. A Cole Parmer meter is used to measure pH. The pH meter is calibrated at the beginning of the day and randomly checked throughout the day. Alkalinity is determined by titrating a known volume of water to pH 4.5 with 0.02N H_2SO_4. Acidity is measured by titrating a known volume of sample water to pH 8.3 with 0.02N sodium hydroxide (NaOH). Total chlorine is measured at Cayuta and Ebaughs Creeks since CAYT 1.7 and EBAU 1.5 are located downstream of wastewater treatment plants. A HACH Datalogging Colorimeter model DR/890 is used with the DPD Test and Tube method (10101) to measure chlorine concentrations.

Macroinvertebrate and physical habitat sampling

SRBC staff collects benthic macroinvertebrate samples from Group 1 and Group 2 stations in July and August and from Group 3 streams in May. The benthic macroinvertebrate community is sampled to provide an indication of the biological condition of the stream. Macroinvertebrates are defined as aquatic insects and other invertebrates too large to pass through a No. 30 sieve.

Benthic macroinvertebrate samples are analyzed using field and laboratory methods described in Rapid Bioassessment Protocol for Use in Streams and Rivers by Barbour and others (1999). Sampling is performed using a 1-meter-square kick screen with size No. 30 mesh. The kick screen is stretched across the current to collect organisms dislodged from riffle/run areas by physical agitation of the stream substrate. Two kick screen samples are collected from a representative riffle/run at each station. The two samples are composited and preserved in denatured ethyl alcohol for later laboratory analysis.

In the laboratory, composite samples are sorted into 200-organism subsamples using a gridded pan and a random numbers table. The organisms contained in the subsamples are identified to genus (except Chironomidae and Oligochaeta) and enumerated using keys developed by Merrit and Cummins (1996), Peckarsky and others (1990), and Pennak (1989). Each taxon is assigned an organic pollution tolerance value and a functional feeding category.

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

Data Synthesis Methods

Chemical water quality

Results of laboratory analysis for chemical parameters are compared to New York, Pennsylvania, and Maryland state water quality standards. In addition, a simple water quality index (WQI) is calculated, using procedures established by McMorran and Bollinger (1990). The WQI is used to make comparisons between sampling periods and stations within the same geographical region; therefore, the water quality data are divided into two groups. One group contains stations along the New York-Pennsylvania border,

and the other group contains stations along the Pennsylvania-Maryland border. The data in each group are sorted by parameter and ranked by increasing order of magnitude, with several exceptions. Dissolved oxygen is ranked by decreasing order of magnitude, while pH, alkalinity, acidity, calcium, and magnesium are not included in the WQI analysis. The values of each chemical analysis are divided by the highest ranking value in the group to obtain a percentile. The WQI score is calculated by averaging all percentile ranks for each sample. WQI scores range from 1 to 100, and high WQI scores indicate poor water quality.

Biological and physical habitat conditions

Benthic macroinvertebrate samples are assessed using procedures described by Barbour and others (1999), Klemm and others (1990), and Plafkin and others (1989). Using these methods, staff calculates a series of biological indexes for a stream and compare them to a reference station in the same region to determine the degree of impairment. The metrics used in this survey are summarized below. Metric 2 (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 are used to generate scores for each of the seven metrics. Scores for metrics 1-4 are 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 are 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 scores are used to assign each site to a biological condition category. Habitat assessment scores of sample sites are compared to those of reference sites to classify each sample site into a habitat condition category.

Trend analysis

Long-term trend analysis has been performed on Group 1 streams that have been sampled since April 1986 to identify increases and decreases over time in total suspended solids, total ammonia, total nitrogen, total phosphorus, total chloride, total sulfate, total iron, total manganese, total aluminum, and the WQI. Overall these long-term trends do not change very much from year to year. Therefore, SRBC has decided to analyze for trends every five years. The next trend analysis will be in the 2008 Interstate Report.

The nonparametric trend test used in previous reports was the Seasonal Kendall Test, which is described by Bauer and others (1984), and Smith and others (1982). For more information on this test and how it was used to assess trends in the data see Trends in Nitrogen, Phosphorus, and Suspended Sediment in the Susquehanna River Basin, 1974-93 (Edwards, 1995), LeFevre (2003), and other previous Interstate reports.

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. Ratio 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. Ratio increases with increasing stress.

Sources: (a) Barbour and others, 1999 (b) Klemm and others, 1990

For more information concerning the Hilsenhoff Biotic Index for specific genera, please see http://www.washjeff.edu/Chartiers/Chartier/mbi2.htm#ODONATA.

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

SAMPLING AND ANALYSIS

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TOTAL BIOLOGICAL SCORE DETERMINATION

Metric	Biological Condition Scoring Criteria			
	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)				

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

Abbreviation Table

Abbreviation	Parameter	Abbreviation	Parameter
ALK	Alkalinity	TNO3	Total Nitrate
COND	Conductivity	TN	Total Nitrogen
TAl	Total Aluminum	DO	Dissolved Oxygen
TCa	Total Calcium	TP	Total Phosphorus
TCl	Total Chloride	TPO4	Total Orthophosphate
TFe	Total Iron	TS	Total Solids
TMg	Total Magnesium	TSO4	Total Sulfate
TMn	Total Manganese	TOC	Total Organic Carbon
TNH3	Total Ammonia	TURB	Turbidity
TNO2	Total Nitrite	WQI	Water Quality Index
TCln	Total Chorine	RBP	Rapid Bioassessment Protocol
SS	Suspended Sediment	TEMP	Water Temperature