METHODS

Field and Laboratory Methods

Data collection

During August 27-September 27, 2007, SRBC staff collected D-frame macroinvertebrate samples on the mainstem Susquehanna River from Sidney, N.Y., to Marietta, Pa., and at the mouths of its major tributaries. Field chemistry measurements were taken at each site, and chemical water quality samples also were collected for laboratory analysis. Macroinvertebrate samples were labeled with the site number, the date, and the number of bottles used.

Chemical water quality

Water samples were collected at each sampling site to measure nutrient and metal concentrations in the river. Field water quality measurements included water temperature, dissolved oxygen, conductivity, and pH. Temperature was measured with a field thermometer in degrees Celsius. Dissolved oxygen was measured with a YSI 55 meter that was calibrated at the beginning of every day when samples were collected, and conductivity was measured with a Cole-Parmer Model 1481 meter. A Cole-Parmer Model 5996 meter that was calibrated at the beginning of each sampling day and randomly checked throughout the day was used to measure pH.

A list of laboratory parameters is located in Table 2. Laboratory samples consisted of one 500-ml bottle of raw water and two 250-ml bottles of acidified water. One of the 250-ml bottles was acidified with nitric acid for metal analyses. The other 250-ml bottle was acidified with H_2SO_4 for nutrient analyses. Samples were iced and shipped to the Pennsylvania Department of Environmental Protection, Bureau of Laboratories, Harrisburg, Pa., for analysis.

Macroinvertebrates

Benthic macroinvertebrates (organisms that live on the stream bottom, including aquatic insects, crayfish, clams, snails, and worms) were collected for analysis during this survey. Staff collected benthic macroinvertebrate samples using a D-frame kick net with 500 µm mesh. A

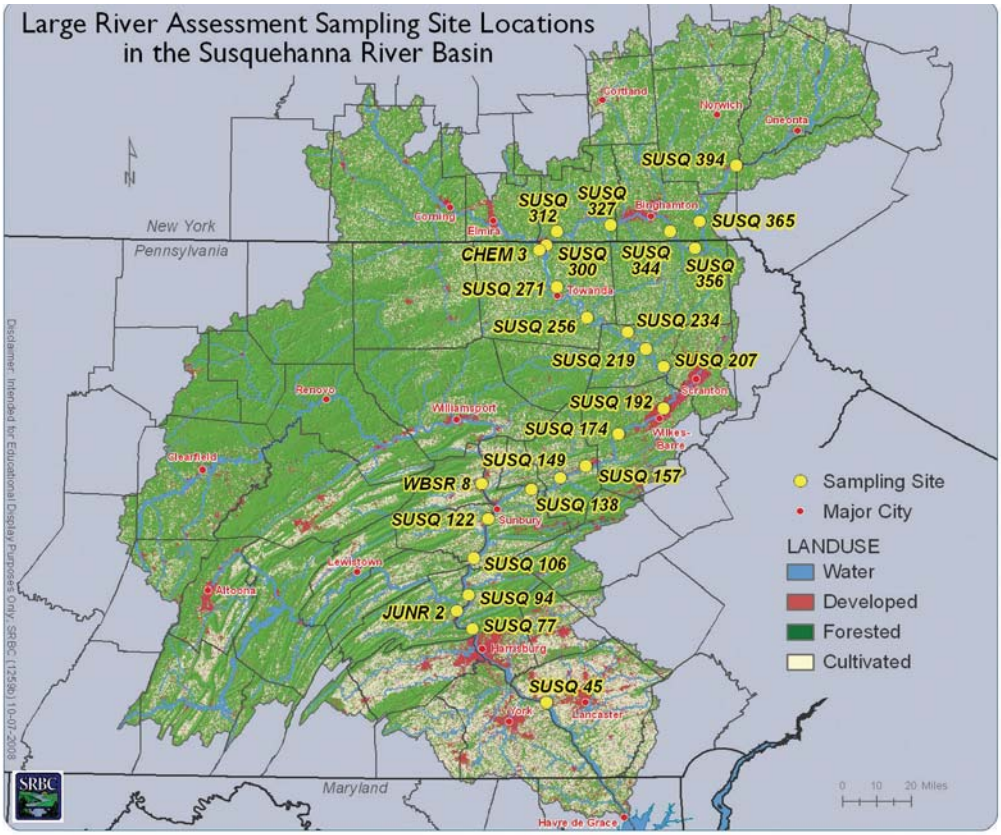

Figure 1. *Large River Assessment Sampling Site Locations*

Station Number	County/State	USGS Quad	Latitude	Longitude	Site Description
SUSQ 394	Chenango/N.Y.	Sidney, N.Y.	42.3113	-75.4199	Susquehanna River near Sidney, N.Y.
SUSQ 365	Broome/N.Y.	Windsor, N.Y.	42.0747	-75.6351	Susquehanna River at Windsor, N.Y.
SUSQ 356	Susquehanna/Pa.	Great Bend, Pa.	41.9612	-75.6620	Susquehanna River near Oakland, Pa.
SUSQ 344	Broome/N.Y.	Binghamton East, N.Y.	42.0347	-75.8017	Susquehanna River at Kirkwood, N.Y.
SUSQ 327	Tioga/N.Y.	Apalachin, N.Y.	42.0653	-76.1426	Susquehanna River near Apalachin, N.Y.
SUSQ 312	Tioga/N.Y.	Barton, N.Y.	42.0400	-76.4464	Susquehanna River at Barton, N.Y.
SUSQ 300	Bradford/Pa.	Sayre, Pa.	41.9819	-76.5065	Susquehanna River at Sayre, Pa.
SUSQ 271	Bradford/Pa.	Towanda, Pa.	41.7627	-76.4393	Susquehanna River at Towanda, Pa.
SUSQ 256	Bradford/Pa.	Wyalusing, Pa.	41.6705	-76.2786	Susquehanna River near Wyalusing, Pa.
SUSQ 234	Wyoming/Pa.	Meshoppen, Pa.	41.6099	-76.0509	Susquehanna River near Meshoppen, Pa.
SUSQ 219	Wyoming/Pa.	Tunkhannock, Pa.	41.5351	-75.9502	Susquehanna River near Tunkhannock, Pa.
SUSQ 207	Wyoming/Pa.	Ransom, Pa.	41.4594	-75.8524	Susquehanna River near West Falls, Pa.
SUSQ 192	Luzerne/Pa.	Kingston, Pa.	41.2500	-75.8845	Susquehanna River near Wilkes-Barre, Pa.
SUSQ 174	Luzerne/Pa.	Nanticoke, Pa.	41.1774	-76.1085	Susquehanna River near Shickshinny, Pa.
SUSQ 157	Columbia/Pa.	Mifflinville, Pa.	41.0405	-76.2945	Susquehanna River near Berwick, Pa.
SUSQ 149	Columbia/Pa.	Catawissa, Pa.	40.9935	-76.4369	Susquehanna River near Bloomsburg, Pa.
SUSQ 138	Northumberland/ Pa.	Danville, Pa.	40.9422	-76.6011	Susquehanna River near Danville, Pa.
SUSQ 122	Snyder/Pa.	Sunbury, Pa.	40.8182	-76.8420	Susquehanna River at Hummels Wharf, Pa.
SUSQ 106	Snyder/Pa.	Dalmatia, Pa.	40.6517	-76.9226	Susquehanna River at McKees Half Falls, Pa.
SUSQ 94	Dauphin/Pa.	Halifax, Pa.	40.4958	-76.9516	Susquehanna River at Montgomery Ferry, Pa.
SUSQ 77	Dauphin/Pa.	Harrisburg West, Pa.	40.3358	-76.9125	Susquehanna River at Fort Hunter, Pa.
SUSQ 45	Lancaster/Pa.	Columbia West, Pa.	40.0365	-76.5239	Susquehanna River at Marietta, Pa.
JUNR 2	Perry/Pa.	Duncannon, Pa.	40.4258	-77.0159	Juniata River at Amity Hall, Pa.
CHEM 3	Bradford/Pa.	Sayre, Pa.	41.9607	-76.5324	Chemung River at Athens, Pa.
WBSR 8	Northumberland/ Pa.	Lewisburg, Pa.	40.9679	-76.8797	West Branch Susquehanna River at Lewisburg, Pa.

Table 1. *Large River Assessment Station Locations*

three-kick composite sample was collected at each of 10 equidistant transects along a one-kilometer sampling reach. Alternating banks were utilized for each transect. For example, transects two, four, six, eight, and ten were sampled on the right bank, while transects one, three, five, seven, and nine were sampled on the left bank. Multiple habitats, including bottom substrate, woody debris, undercut banks, and macrophytes, were included in sample collection. Sampling was conducted in a 10 meter area surrounding each transect, to a depth of 0.5 meters.

Each sample was preserved in the field in 95 percent denatured ethyl alcohol. After sampling was completed at a given site, all equipment that came in contact with the sample was rinsed thoroughly, examined carefully, and picked free of algae or debris before sampling at the next site. Additional organisms that were found on examination were placed into the sample containers.

Subsampling and sorting procedures were based on the 1999 RBP document (Barbour and others, 1999). In the laboratory, composite samples were sorted into 300-organism subsamples, when possible, using a gridded pan and a random numbers table. The organisms contained in the subsamples were identified to genus (except Chironomidae and Oligochaeta), when possible, and enumerated.

Data Analysis

Chemical water quality

Chemical water quality was assessed by examining field and laboratory parameters. Limit values were obtained for each parameter based on current state and federal regulations or references for aquatic life tolerances (Table 3, Buda, 2008).

Macroinvertebrate analysis

A series of macroinvertebrate metrics was calculated for each sample, and assessments of the sites were performed. 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 indexes at each station. The metrics used in this survey are summarized in Table 4. Metric 2 (Shannon-Wiener Diversity Index) followed the methods described in Klemm and others (1990), and all other metrics were derived from Barbour and others (1999).

A reference condition approach was used to determine impairment levels for each sample. This protocol entails determining the best score for each metric. The 300-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 best possible metric score. Scores for metrics 5-7 were based on set scoring criteria developed for the percentages (Plafkin and others, 1989; Ohio Environmental Protection Agency, 1987). The sum of the biological condition scores constituted the total biological score for the sample, and total biological scores were used to assign each sample to a biological condition category (Table 5).

Table 2. *Parameters for Laboratory Analysis*

Parameter	
Alkalinity, mg/l[a]	Total Suspended Solids, mg/l
Total Nitrogen, mg/l	Total Sodium, mg/l
Total Nitrite, mg/l	Total Chloride, mg/l
Total Nitrate, mg/l	Total Sulfate, mg/l
Total Phosphorus, mg/l	Total Iron, µg/l[b]
Total Orthophosphate, mg/l	Total Manganese, µg/l
Total Organic Carbon, mg/l	Total Aluminum, µg/l
Total Hardness, mg/l	Turbidity, NTU[c]
Total Magnesium, mg/l	Total Calcium, mg/l

[a] mg/l = milligrams per liter
[b] µg/l = micrograms per liter
[c] nephelometric turbidity units

RESULTS

Water Quality

During late summer 2007, water quality at most of the river sites met water quality standards. Limit values were exceeded for 38 out of 667 total water chemistry values (5.7 percent). Results from duplicate samples are included in the results. Most of these

Table 3. *Water Quality Limits and References*

Parameter	Limit	Reference Code
Temperature	> 25 °C	a,f
Dissolved oxygen	< 4 mg/l	a,g,i
Conductivity	>800 µmhos/cm	d
pH	<6.0	i
Alkalinity	< 20 mg/l	a,g
Nitrogen*	>1.0 mg/l	j
Nitrite	> 0.06 mg/l	f,i
Nitrate	> 1.0 mg/l	e,j
Phosphorus	> 0.1 mg/l	e,k
Orthophosphate	> 0.05 mg/l	l,f,j,k
TOC	> 10 mg/l	b
Hardness	> 300 mg/l	e
Magnesium	> 35 mg/l	i,l
Calcium	> 100 mg/l	m
TSS	> 25 mg/l	h
Sodium	> 20 mg/l	i
Chloride	> 250 mg/l	a,i
Sulfate	> 250 mg/l	a,i
Iron	>1,500 µg/l	a
Manganese	>1,000 µg/l	a
Aluminum	> 750 µg/l	n
Turbidity	> 150 NTU	h

Reference Codes and References

a: http://www.pacode.com/secure/data/025/chapter93/s93.7.html
b: Hem (1970) - http://water.usgs.gov/pubs/wsp/wsp2254/
c: Gagen and Sharpe (1987) and Baker and Schofield (1982)
d: http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm
e: http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm
f: http://www.hach.com/h2ou/h2wtrqual.htm
g: http://sites.state.pa.us/PA_Exec/Fish_Boat/education/catalog/pondstream.pdf
h: http://www.epa.gov/waterscience/criteria/sediment/appendix3.pdf
i: http://www.dec.ny.gov/regs/4590.html
j:* http://water.usgs.gov/pubs/circ/circ1225/images/table.html
k: http://water.usgs.gov/nawqa/circ-1136/h6.html#NIT
l: http://www.epa.gov/waterscience/criteria/goldbook.pdf
m: based on archived data at SRBC
n: http://www.epa.gov/waterscience/criteria/wqctable

* *Background levels for natural streams*