Susquehanna River Basin Commission

Susquehanna Large River Assessment Project

Publication 261
September 2008

Report by Jennifer L.R. Hoffman
Section Chief, Monitoring and Assessment

www.srbc.net

SRBC • 1721 N. Front Street • Harrisburg, PA 17102 • 717.238.0423 • srbc@srbc.net

Printed on recycled paper

ABSTRACT

In 2002, the Susquehanna River Basin Commission (SRBC) conducted a pilot study to determine appropriate methods of biologically assessing the large rivers of the Susquehanna River Basin (basin). Based on the results of that survey, SRBC determined that a combination of rock basket samplers and traditional Rapid Bioassessment Protocol (RBP) methods was the most efficient and consistent collection method to sample the Susquehanna River. These methods were implemented in the 2005 Susquehanna Large River Assessment Project (Hoffman, 2006) at 25 stations on the mainstem Susquehanna River and at the mouths of its major tributaries: the West Branch Susquehanna River, the Juniata River, and the Chemung River.

The U.S. Environmental Protection Agency (USEPA) has developed a field operations manual for the National River and Stream Assessment (NRSA), detailing data collection methods for both wadeable and nonwadeable streams (USEPA, 2008). During summer 2007, SRBC staff collected macroinvertebrate and water chemistry data at the same 25 stations as above using the draft USEPA river assessment protocols.

Composite benthic macroinvertebrate samples were collected at each station from three D-frame net sweeps at each of 10 transects. Field and laboratory water quality samples and overall observations of the site also were collected at each site.

Eight of the sites were designated as nonimpaired, 14 sites were slightly impaired, and three sites were moderately impaired. Only 38 out of 667 laboratory and field water quality data points exceeded standards or levels of tolerance for aquatic life, indicating that the Susquehanna River contains fairly good water quality.

For future river assessment projects, SRBC plans to continue data collection using slightly modified USEPA collection methodologies, possibly incorporating fish data collection at selected sites. Staff also will be considering alternative methods for assessing physical habitat and determining ways to assess the reservoir system at the lower end of the Susquehanna River.

INTRODUCTION

SRBC has been performing biological assessments throughout the basin since the late 1970s. When USEPA introduced the first version of the RBP manual (Plafkin and others, 1989), SRBC adopted those methods for use in its interstate stream monitoring program and its rotating subbasin surveys. However, neither the previous nor current RBP methods (Barbour and others, 1999) used by SRBC in the aforementioned surveys accurately depict the biological integrity of the basin's large rivers: the mainstem Susquehanna, Chemung, West Branch Susquehanna, and Juniata Rivers. Thus, in 2002, SRBC initiated a pilot project to determine proper methods of biologically assessing the large rivers in the basin. From this pilot project, staff determined that a combination of rock-filled basket samplers and traditional RBP methods was the most effective and consistent collection method for sampling the Susquehanna River (Hoffman, 2003).

In summer 2005, staff collected biological and water quality data at 25 stations on the mainstem Susquehanna River and at the mouth of its major tributaries using the methodology described above. During summer 2007, staff changed the methodology to mimic the methods drafted by USEPA for the NRSA (USEPA, 2008). The results are described in the sections below.

Although the NRSA data collection includes fish, physical habitat, toxicology, and other parameters in addition to benthic macroinvertebrates, SRBC staff chose to focus efforts on benthic macroinvertebrate sampling. Benthic macroinvertebrates were used to assess biological conditions for several reasons. Benthic macroinvertebrates are sensitive to a wide range of stressors, have a wide range of documented pollution tolerances, and are found in a wide variety of habitats throughout lotic systems (Flotemersch and others, 2001a). Additionally, SRBC has background macroinvertebrate data from various sites on the large rivers of the basin from subbasin surveys and interstate streams monitoring, as well as the previous river assessment studies.

Basin Geography

The Susquehanna River Basin is the largest river basin on the east coast of the United States, draining 27,510 square miles. The Susquehanna River originates at Otsego Lake, N.Y., and flows 444 miles through New York, Pennsylvania, and Maryland to the Chesapeake Bay at Havre de Grace, Md.

The study area for this survey stretched from Sidney, N.Y., to Marietta, Pa., and encompassed every subbasin in the Susquehanna River Watershed. A total of 25 sampling stations were established as follows: seven in the Upper Susquehanna Subbasin; one at the mouth of the Chemung River; 10 in the Middle Susquehanna Subbasin; one at the mouth of the West Branch Susquehanna River; five in the Lower Susquehanna Subbasin; and one at the mouth of the Juniata River (Figure 1 and Table 1). Downstream of Marietta, Pa., the river flows through a series of impoundments and could not be sampled using the methods in this study.

SRBC staff preparing a macroinvertebrate sample at Sidney, N.Y.

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

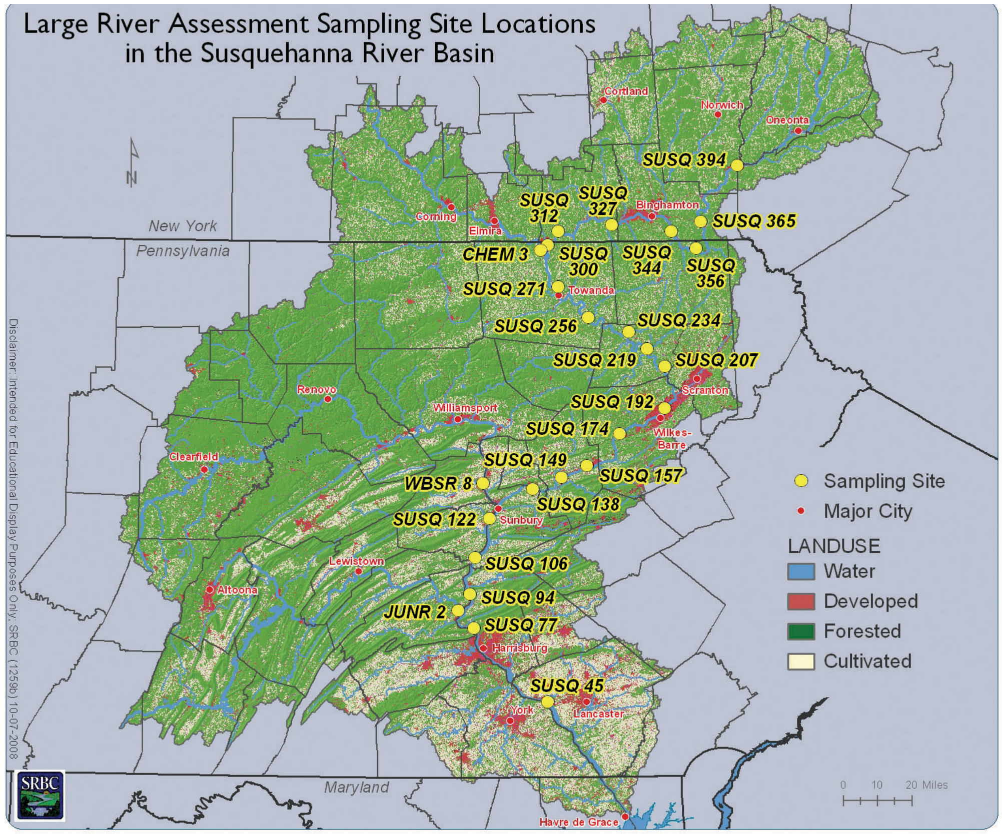


Figure 1. *Large River Assessment Sampling Site Locations*

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 sub-sample 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).

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 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

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* exceedances were for total sodium, total nitrogen, total phosphorus, and water temperature. The exceedances are listed in Table 6 and depicted in Figure 3.

Biological Communities

Biological conditions for each sampling site are depicted in Figure 4. All stations in this survey received either a nonimpaired, slightly impaired, or a moderately impaired designation. No stations were rated as severely impaired. Nonimpaired biological communities were found at eight of the 25 stations (32 percent), slightly impaired conditions were found at 14 stations (56 percent), and moderately impaired conditions were found at three stations (12 percent).

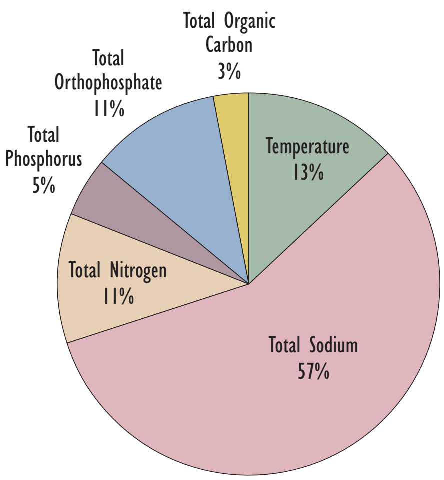


Figure 3. *Parameters Exceeding Water Quality Standards*

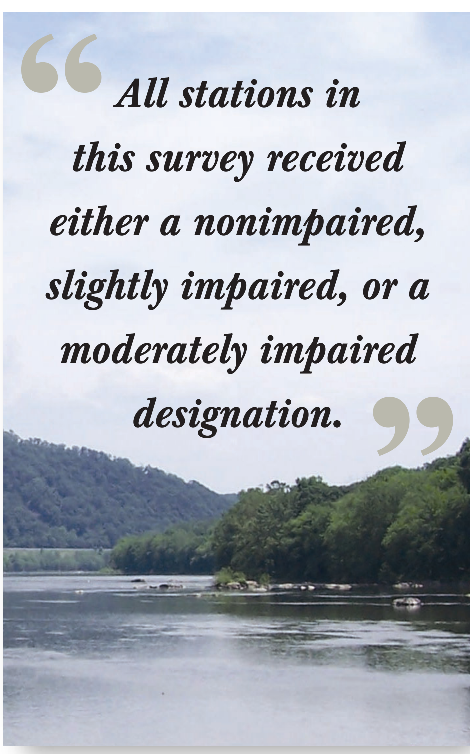


Table 4. *Summary of Metrics Used to Evaluate the Overall Biological Integrity of River Benthic Macroinvertebrate Communities*

Metric	Description
1. Taxonomic Richness (a)	The total number of taxa present in the 300-organism subsample. Number decreases with increasing disturbance or stress.
2. Shannon-Wiener Diversity Index (b)	A measure of biological community complexity based on number of equally or nearly equally abundant taxa in the community. Index value decreases with increasing stress.
3. Hilsenhoff Biotic Index (a)	A measure of the organic pollution tolerance of a benthic macro-invertebrate 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 300-organism subsample. The index decreases with increasing stress.
5. Percent Ephemeroptera (a)	The percentage of Ephemeroptera in a 300-organism subsample. Percentage decreases with increasing stress.
6. Percent Dominant Taxa (a)	A measure of community balance at the lowest positive taxonomic level. Percentage increases with increasing stress.
7. Percent Chironomidae (a)	The percentage of Chironomidae in a 300-organism subsample. Percentage increases with increasing stress.

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

Table 5. *Summary of Criteria Used to Classify the Biological Conditions of Sample Sites*

SAMPLING AND ANALYSIS

↓

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-Wiener Diversity Index (a)	> 75%	74-50%	49-25%	<25%
3. 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 Dominant Taxa (c)	< 20%	20-30%	31-40%	>40%
7. Percent Chironomidae (c)	< 5%	5-20%	21-35%	>35%
Total Biological Score (d)				

↓

BIOASSESSMENT

Percent Comparability of Study and Reference Condition 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 condition value X 100
(b) Score is reference condition value/study site value X 100
(c) Scoring Criteria evaluate actual percentage 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

Table 6. *Summary of Exceedances of Water Quality Standards*

Parameter	Limit Concentration	# of Exceedances	# of Data Points
Temperature	25 degrees Celsius	5	29
Total Sodium	20 mg/l	22	29
Total Nitrogen	1.0 mg/l	4	29
Total Orthophosphate	0.05 mg/l	4	29
Total Phosphorus	0.1 mg/l	2	29
Total Organic Carbon	10 mg/l	1	29

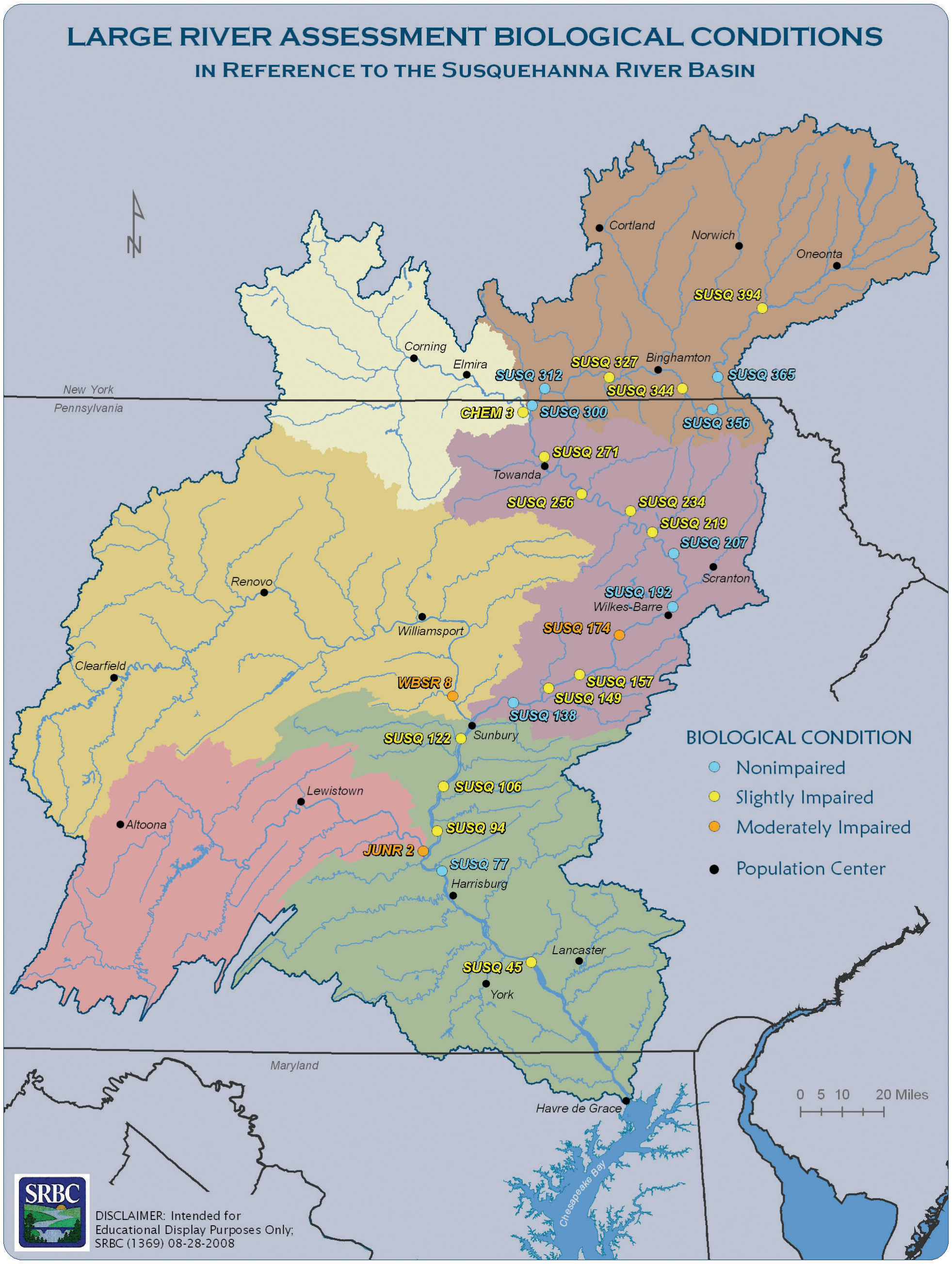


Figure 4. *Biological Conditions at Large River Assessment Stations in 2007*

DISCUSSION

Water Quality

A comparison of water quality samples from the present large river assessment project (August-September 2007) to water quality samples collected for the most recent interstate streams survey (Steffy, 2007), Upper Susquehanna Subbasin Survey (Buda, 2008), Chemung Subbasin Survey (Buda, 2007), Middle Susquehanna Subbasin Survey (LeFevre, 2002), West Branch Subbasin Survey (LeFevre, 2003), Juniata River Subbasin Survey (LeFevre, 2005), and Lower Susquehanna Subbasin Survey (LeFevre, 2006) indicates that water quality conditions on the Susquehanna River between Sidney, N.Y., and Marietta, Pa., and at the mouths of its major tributaries, are stable and generally below limits, although temperatures were greater than 25 degrees Celsius at several stations and total sodium exceeded the level of concern in many samples. From the data analysis, it appears that the Susquehanna River, in the stretch encompassed by this study, contains fairly good water quality, with some slightly elevated parameters.

Macroinvertebrate Communities

Upper Susquehanna River and the Chemung River

The section of the Susquehanna River from the headwaters at Cooperstown, N.Y., to the confluence with the Chemung River at Sayre, Pa., encompasses the Upper Susquehanna Subbasin. This survey included seven stations on the mainstem Susquehanna River from Sidney, N.Y., to Sayre, Pa. The river in this part of the basin flows through mostly agricultural and forested land with some small communities and one larger population center, Binghamton, N.Y. Zebra mussels (*Dreissena polymorpha*), an aquatic invasive species, were found throughout this reach from Sidney downstream to Apalachin, N.Y., during this survey and the 2007 Upper Susquehanna Subbasin Survey. Overall, the sites at Sidney (SUSQ 394), which was rated as slightly impaired, and Windsor (SUSQ 365), N.Y., which was rated as nonimpaired, exhibited high taxa richness and diversity, although SUSQ 394 had lower values for EPT Index and percent Ephemeroptera. The station at Great Bend (SUSQ 356), Pa., where the Susquehanna River enters Pennsylvania briefly before flowing back into New York State, also had non-impaired biological conditions. This site also had the highest number of taxa (36) and highest number of EPT taxa (19) of any river station. The site at Kirkwood (SUSQ 344), N.Y., was designated as slightly impaired.

However, downstream of Binghamton, N.Y., conditions degraded slightly. At Apalachin (SUSQ 327), N.Y., the station was rated as slightly impaired, but had poor ratings for percent Ephemeroptera, number of EPT taxa, and percent dominant taxa. In fact, this site had the lowest percent Ephemeroptera of all stations in the survey (4.8 percent).

> *“Zebra mussels (Dreissena polymorpha), an aquatic invasive species, were found throughout this reach from Sidney downstream to Apalachin, N.Y.”*

At Barton (SUSQ 312), N.Y., the river seemed to improve, as this station was designated as nonimpaired. The station at Waverly (SUSQ 300), N.Y., also was rated as nonimpaired; this station had the highest diversity index of all river stations.

The Chemung River empties into the Susquehanna at Athens, Pa. At this point, the Chemung is nearly a third of the size of the Susquehanna. Staff sampled the Chemung River at Athens (CHEM 3), Pa., and found slightly impaired biological conditions during this survey.

Middle Susquehanna River and the West Branch Susquehanna River

The section of the Susquehanna River from the confluence with the Chemung River at Sayre, Pa., to the confluence with the West Branch Susquehanna River at Sunbury, Pa., is termed the Middle Susquehanna River. During this survey, 10 stations were sampled on the mainstem Susquehanna in this section of the river, in addition to a site on the West Branch Susquehanna at Lewisburg, Pa. This stretch of the river is very diverse with sections located in agricultural land, some sections flowing through forested hills, and some portions draining urban settings, particularly the Wilkes-Barre/Scranton, Pa., area. Abandoned mine drainage (AMD) is a prevalent issue within this watershed as well.

The stations near Towanda (SUSQ 271), Wyalusing (SUSQ 256), Meshoppen (SUSQ 234), and Tunkhannock (SUSQ 219), Pa., were designated as slightly impaired. SUSQ 234 had the highest Hilsenhoff Biotic Index of all Large River Assessment sites, possibly due to the large number of snails collected at the site. At West Falls (SUSQ 207) and Wilkes-Barre (SUSQ 192), Pa., the stations were designated as nonimpaired, although the number of EPT taxa was reduced at SUSQ 192. The station at Shickshinny (SUSQ 174), Pa., was rated as moderately impaired. This site is located downstream of the urban population centers of Wilkes-Barre and Scranton, Pa., and may be impacted by both urban runoff and AMD from the surrounding watersheds. The poorest scores for taxonomic richness, percent dominant taxa, number of EPT taxa, and Shannon diversity index in this survey were recorded at SUSQ 174. The stations at Berwick (SUSQ 157) and Bloomsburg (SUSQ 149), Pa., were designated as slightly impaired, although SUSQ 149 had the lowest percent Chironomidae score in the survey. The station on the Susquehanna River near Danville (SUSQ 138), Pa., was designated nonimpaired.

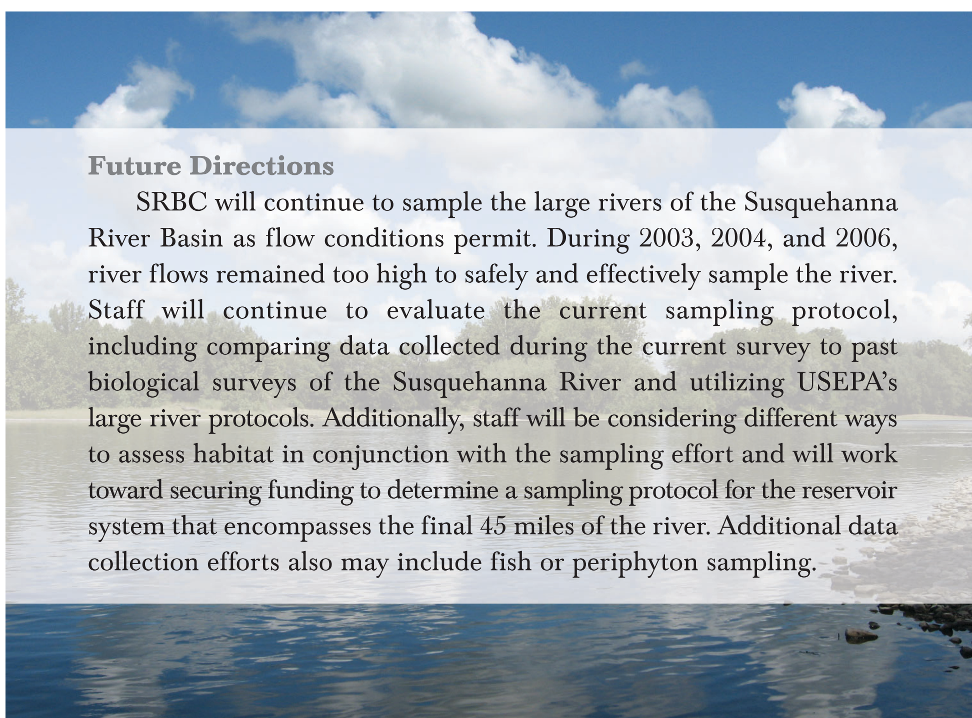
Staff collected a sample near the mouth of the West Branch Susquehanna River at Lewisburg (WBSR 8), Pa. This site was designated as moderately impaired, with low EPT diversity and a large number of midges in the sample. The West Branch Susquehanna is impacted heavily by AMD from the headwaters to downstream of Williamsport, Pa.

Lower Susquehanna River and the Juniata River

The portion of the watershed from the confluence of the mainstem with the West Branch Susquehanna River to the outlet of the Susquehanna River at Havre de Grace, Md., is termed the Lower Susquehanna River Subbasin. Staff sampled five stations on the mainstem Susquehanna River and one station on the Juniata River during this survey. This subbasin contains a large amount of agricultural land and several larger population centers, including Harrisburg, York, and Lancaster, Pa. The final 45 miles of river are ensconced in a series of reservoirs and were not sampled for this survey.

Staff sampled the biological condition of the river downstream of Sunbury (SUSQ 122), Pa., which was designated as slightly impaired, with a low number of EPT taxa. The stations at McKees Half Falls (SUSQ 106) and Halifax (SUSQ 94), Pa., also were rated as slightly impaired, although SUSQ 94 had the best scores of Hilsenhoff Biotic Index and percent Ephemeroptera of all stations in the survey. However, SUSQ 94 also had a depressed number of EPT taxa, which offset the high scores from the other metrics. At Fort Hunter (SUSQ 77), Pa., the station was rated as nonimpaired, while at Marietta (SUSQ 45), Pa., the biological condition category was slightly impaired.

A station was located near the mouth of the Juniata River near Duncannon (JUNR 2), Pa. This site was rated as moderately impaired, with poor scores for percent dominant taxa, number of EPT taxa, and percent Chironomidae.



Future Directions

SRBC will continue to sample the large rivers of the Susquehanna River Basin as flow conditions permit. During 2003, 2004, and 2006, river flows remained too high to safely and effectively sample the river. Staff will continue to evaluate the current sampling protocol, including comparing data collected during the current survey to past biological surveys of the Susquehanna River and utilizing USEPA's large river protocols. Additionally, staff will be considering different ways to assess habitat in conjunction with the sampling effort and will work toward securing funding to determine a sampling protocol for the reservoir system that encompasses the final 45 miles of the river. Additional data collection efforts also may include fish or periphyton sampling.

References

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Brown, A.V. and P.P. Brussock. 1991. Comparisons of benthic invertebrates between riffles and pools. Hydrobiologia, 220: 99-108.

Buda, S.L. 2008. Upper Susquehanna Subbasin Survey: A Water Quality and Biological Assessment, June-September 2007. Publication 260. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

_____. 2007. Chemung Subbasin Survey: A Water Quality and Biological Assessment, June - August 2006. Publication 251. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

Cooper, S.D. and L.A. Barmuta. 1993. Field Experiments in Biomonitoring. In Freshwater Biomonitoring and Benthic Macroinvertebrates. Ed. by D.M. Rosenbert and V.H. Resh. Chapman and Hall, New York. 488 pp.

Flotemersch, J.E., B.C. Autrey, and S.M. Cormier. 2000a. Comparisons of Boating and Wading Methods Used to Assess the Status of Flowing Waters. EPA/600/R-00/108. U.S. Environmental Protection Agency, Cincinnati, Ohio.

Flotemersch, J.E., B.C. Autrey, and S.M. Cormier, eds. 2000b. Logistics of Ecological Sampling on Large Rivers. EPA/600/R-00/109. U.S. Environmental Protection Agency, Cincinnati, OH.

Hall, L.W., Jr., and others. 1999. Pilot Study to Develop Assessment Methods and Biological Indicators for Tidal Streams in Maryland's Coastal Plain. Chesapeake Bay and Watershed Programs, Monitoring and Non-Tidal Assessment, State of Maryland, Department of Natural Resources, CBWP-MANTA-EA-99-1.

Hoffman, J.L.R. 2006. Susquehanna Large River Assessment Project. Publication 245. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

_____. 2003. Susquehanna River Pilot Study: Large River Assessment Project. Publication 228. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

Karr, J.R. 1999. Defining and measuring river health. Freshwater Biology, 41:221-234.

Kay, W.R., and others. 1999. Patterns of distribution of macroinvertebrate families in rivers of north-western Australia. Freshwater Biology, 41: 299-316.

Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. EPA/600/4-90/030. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

LeFevre, S.R. 2006. Lower Susquehanna Subbasin Survey: A Water Quality and Biological Assessment, June - November, 2005. Publication 247. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

_____. 2005. Juniata River Subbasin Survey: A Water Quality and Biological Assessment, July-November 2004. Publication 240. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

_____. 2003. West Branch Susquehanna Subbasin Survey: A Water Quality and Biological Assessment, July - November 2002. Publication 226. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

_____. 2002. Middle Susquehanna Subbasin: A Water Quality and Biological Assessment, July - September 2001. Publication 222. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

LeFevre, S.R. and D.L. Sitlinger. 2003. Assessment of Interstate Streams in the Susquehanna River Basin: Monitoring Report No. 16, July 1, 2001, through June 30, 2002. Publication 227. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

Merritt, R.W., K. W. Cummins, and V.H. Resh. 1996. Design of Aquatic Insect Studies: Collecting, Sampling and Rearing Procedures. In An Introduction to the Aquatic Insects of North America, 3rd ed. Ed. by R.W. Merritt and K.W. Cummins. Kendall/Hunt Publishing Company, Dubuque, Iowa.

Norris, R.H. and M.C. Thoms. 1999. What is river health? Freshwater Biology, 41: 197-209.

Parsons, M. and R.H. Norris. 1996. The effect of habitat-specific sampling on biological assessment of water quality using a predictive model. Freshwater Biology, 36: 419-434.

Resh, V.H. and E.P. McElravy. 1993. Contemporary Quantitative Approaches to Biomonitoring Using Benthic Macroinvertebrates. In Freshwater Biomonitoring and Benthic Macroinvertebrates. Ed. by D.M. Rosenbert and V.H. Resh. Chapman and Hall, N.Y. 488 pp.

Resh, V.H. and J.K. Jackson. 1993. Rapid Assessment Approaches to Biomonitoring Using Benthic Macroinvertebrates. In Freshwater Biomonitoring and Benthic Macroinvertebrates. Ed. by D.M. Rosenbert and V.H. Resh. Chapman and Hall, N.Y. 488 pp.

Steffy, L.Y. 2007. Assessment of Interstate Streams in the Susquehanna River Basin, July 1, 2005 - June 30, 2006. Publication 249. http://www.srbc.net/interstate_streams.

Steffy, L.Y. and D.L. Sitlinger. 2006. Assessment of Interstate Streams in the Susquehanna River Basin. Publication 244. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

Stoe, T.W. 1999. Upper Susquehanna Subbasin: A Water Quality and Biological Assessment. Publication 203. Susquehanna River Basin Commission, Harrisburg, Pennsylvania.

Stribling, J.B. and others. 1998. Development of a Benthic Index of Biotic Integrity for Maryland Streams. Chesapeake Bay and Watershed Programs, Monitoring and Non-Tidal Assessment, State of Maryland, Department of Natural Resources, CBWP-MANTA-EA-98-3.

United States Environmental Protection Agency. 2008. National Rivers and Streams Assessment: Field Operations Manual. Office of Water, Office of Environmental Information, Washington, D.C. EPA-841-B-07-009.

United States Geological Survey. Methods for Collecting Benthic Invertebrate Samples as part of the National Water Quality Assessment Program. Open File Report 93-406. http://water.usgs.gov/nawqa/protocols/OFR-93-406/inv1.html.

Wood, A.J., J.M. Omernick, D.D. Brown, and C.W. Killsguard. 1996. Level III and IV Ecoregions of Pennsylvania and the Blue Ridge Mountains, the Ridge and Valley, and the Central Appalachians of Virginia, West Virginia, and Maryland. U.S. Environmental Protection Agency, EPA/600/R-96/077, Digital Coverage.

Printed on recycled paper