Upper Susquehanna Subbasin Survey: A Water Quality and Biological Assessment, June – September 2007

The Susquehanna River Basin Commission (SRBC) conducted a water quality and biological survey of the Upper Susquehanna Subbasin from June to September 2007. This survey is part of SRBC's Subbasin Survey Program, which is funded in part by the United States Environmental Protection Agency (USEPA). The Subbasin Survey Program consists of two-year assessments in each of the six major subbasins (Figure 1) on a rotating schedule. This report details the Year-1 survey, which consists of point-in-time water chemistry, macroinvertebrate, and habitat data collection and assessments of the major tributaries and areas of interest throughout the Upper Susquehanna Subbasin. The Year-2 survey will be conducted in the Tioughnioga River over a one-year time period beginning in summer 2008. The Year-2 survey is part of a larger monitoring effort associated with an environmental restoration effort at Whitney Point Lake. Previous SRBC surveys of the Upper Susquehanna Subbasin were conducted in 1998 (Stoe, 1999) and 1984 (McMorran, 1985).

Subbasin survey information is used by SRBC staff and others to:

- evaluate the chemical, biological, and habitat conditions of streams in the basin;
- identify major sources of pollution and lengths of streams impacted;
- identify high quality sections of streams that need to be protected;
- maintain a database that can be used to document changes in stream quality over time;
- review projects affecting water quality in the basin; and
- identify areas for more intensive study.

Description of the Upper Susquehanna Subbasin

The Upper Susquehanna Subbasin is an interstate subbasin that drains approximately 4,950 square miles of southcentral New York and a small portion of northeastern Pennsylvania. Three larger watersheds, the Unadilla, Chenango, and Tioughnioga Rivers, and many smaller watersheds feed into the mainstem Susquehanna River as it travels from its headwaters at Otsego Lake, N.Y., to the confluence of the Susquehanna River and the Chemung River near Athens, Pa. The primary counties in this subbasin are Broome, Chenango, Cortland, Delaware, Madison, Otsego, and Tioga in New York, and Bradford and Susquehanna in Pennsylvania (Figure 2).

There is only one major population center in this subbasin at Binghamton, N.Y. Some of the towns in the subbasin include Cooperstown, Cortland, Norwich, Oneonta, Sayre, and Sidney (Figure 3). Ecoregions that fall within the Upper Susquehanna Subbasin are (Figure 2):

- *Northern Appalachian Plateau (Ecoregion 60)*
- *Northern Central Appalachians (Ecoregion 62)*
- *Erie/Ontario Lake Plain (Ecoregion 61)*

Figure 1. The Susquehanna River Subbasins

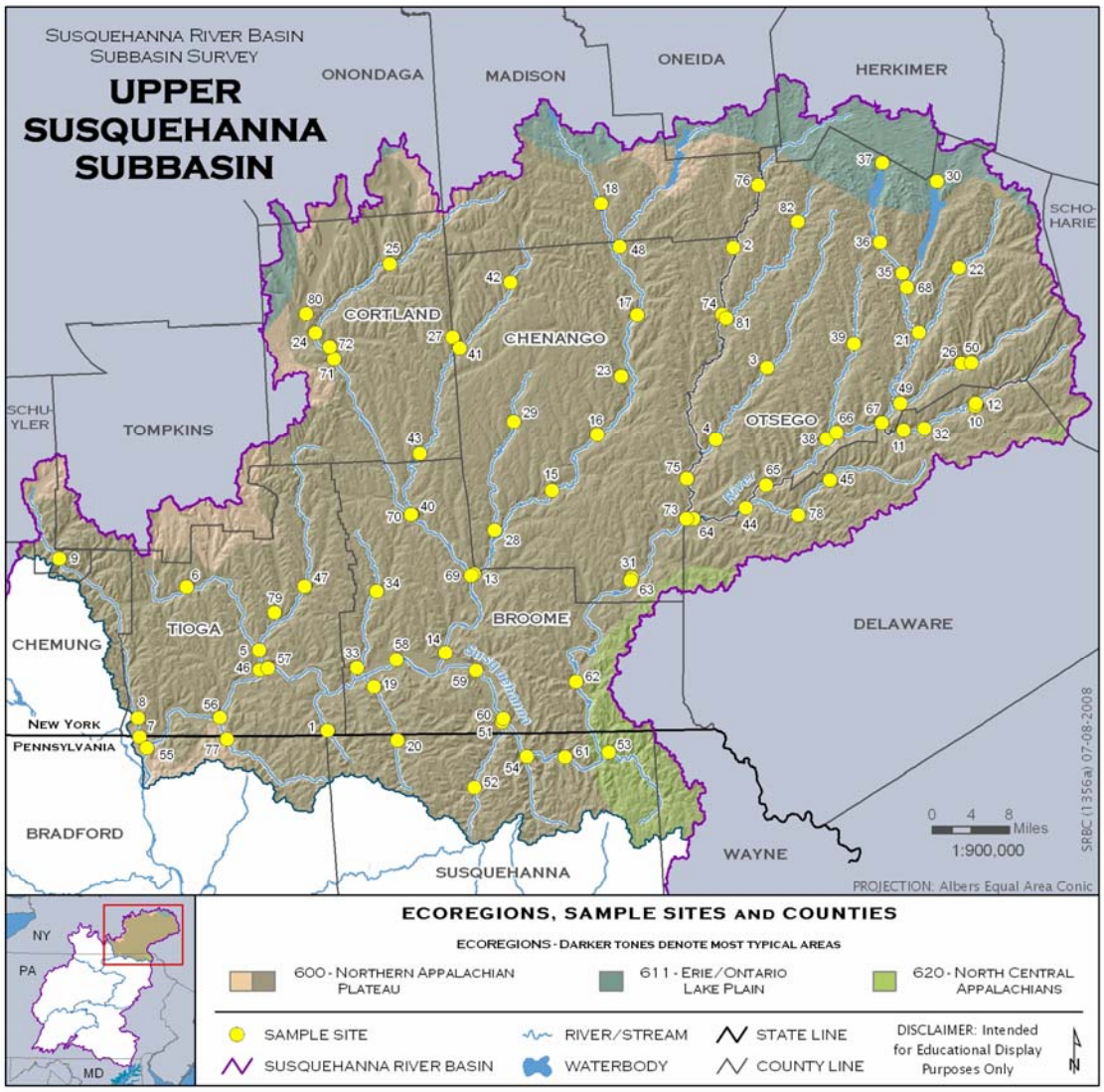

Figure 2. Ecoregions, Sample Sites, and Counties in the Upper Susquehanna Subbasin

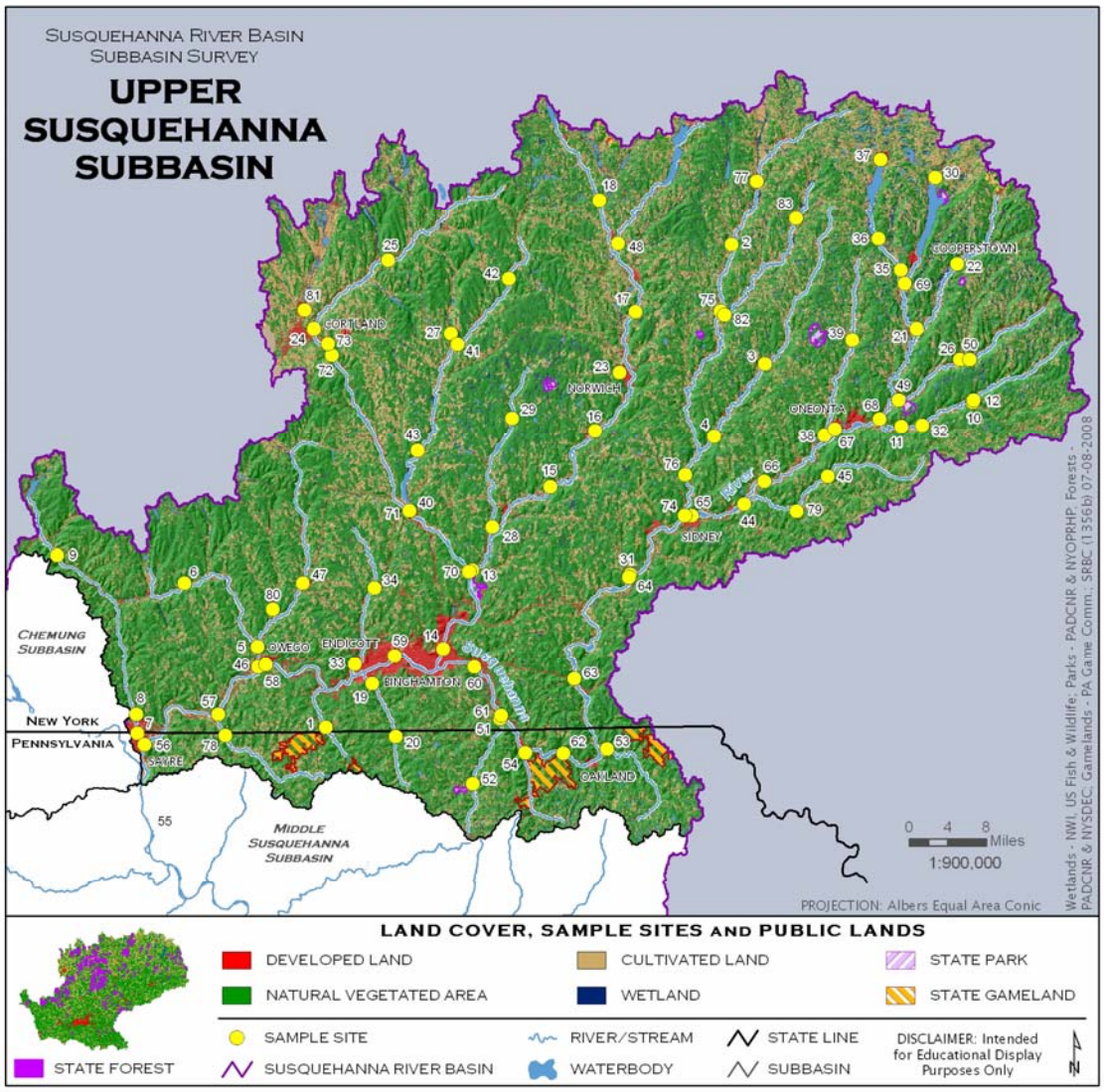

Figure 3. Land Cover, Sample Sites, and Public Lands in the Upper Susquehanna Subbasin

Ecoregion 60 consists of a combination of agriculture and forestland. It is a transition ecoregion between the more agricultural and urban ecoregions to the north and west and the more mountainous and forested ecoregions to the south and east. The agricultural lands in Ecoregion 60 are used mostly as pastures and for hay and grain cultivation to feed dairy cattle. The forests are comprised of mostly oaks and northern hardwoods. Ecoregion 62 is more densely forested, and land use is tied largely to recreation or logging and gas and mineral extraction. The geology of this rugged area consists mostly of sandstone, shale, siltstone, conglomerates, and coal. Ecoregion 61 is a glaciated area that displays characteristic landforms such as low rounded hills, end moraines, kettles, and wetlands. Many dairy farms operate in this

area, and the weather is largely influenced by Lake Erie. Most of the Upper Susquehanna Subbasin is within Ecoregion 60, with only a small portion in the southern part of the basin in Ecoregion 62, and a small portion in the northern part of the basin in Ecoregion 61 (Omernik, 1987; USEPA, 2007).

Land use in the Upper Susquehanna Subbasin is depicted in Figure 3. The primary land uses are natural vegetated areas and cultivated land. The largest urban center is the Binghamton, N.Y., area. Lakes and reservoirs dot the landscape, especially in the northeast corner of the subbasin.

Numerous watershed organizations are working in the Upper Susquehanna Subbasin to educate and involve local citizens and to restore and protect watersheds. Table 1 provides the names and contact information for some of those watershed groups. Many other local entities, such as county conservation districts and land conservation groups, protect and conserve land and water resources in the subbasin. These groups and others are excellent sources of local watershed information.

Table 1. Contact Information for Watershed Organizations in the Upper Susquehanna Subbasin

Organization Name	County	Contact	Address	Phone	Email or Website
Upper Susquehanna Coalition	All	James Curatolo, Coordinator	4729 State Route 414 Burdett, NY 14818	(607) 546-2528	http://www.u-s-c.org/html
Upper Susquehanna River Keeper	All	Paul Otruba	763 South Main Street Mansfield, PA 16933	(570) 404 0548	mtnbooks@quik.com
Endless Mountains Resource Conservation & Development Council	Bradford, Pa.; Susquehanna, Pa.	Stacy Koch, Coordinator	RR 5 Box 5030D Towanda, PA 18848	(570)265-5288, ext. 5	http://www.endlessmountainsrcd.org/home.html
Carantouan Greenway	Bradford, Pa.; Tioga, N.Y.; Chemung, N.Y.	Marty Borko, board president	P.O. Box 441 Sayre, PA 18840-0441	(607)565-2636	http://www.geocities.com/carantouan/
Al Hazzard Chapter Trout Unlimited	Broome, N.Y.; Susquehanna, Pa.	John Swider	328 Kattelville Rd, Binghamtom, NY 13901	(607)372-6330	http://www.alhazzardtu.org/alhazzardtu/index.jsp
Chenango Valley Trout Unlimited	Chenango, N.Y.	G Sweet	353 State Hwy. 320, Norwich, NY 13815	(607)336-2041	email: benwalkin@citlink.com
New York Rivers United	All	Bruce Carpenter, Executive Director	PO Box 1460, Rome, NY 13442	(315) 339-2097	http://www.newyorkriversunited.org/
Choconut Creek Watershed Association	Broome, N.Y.; Susquehanna, Pa.	Jack Davis, Co-Chair; Carolyn Doolittle, Co-Chair	Linda Gittoes, RR 1, Box 1702, Friendsville, PA 18818	(570) 553-2081	http://www.stny.rr.com/choconut/CCWA.htm
Snake Creek Watershed Association	Susquehanna, Pa.	James Chambers	c/o Susquehanna Conservation District 31 Public Avenue, Montrose, PA18801	(570) 663-2300; (570) 278-4600, ext. 280	email: jchambers@pronetisp.net
Citizens for the Catatonk Creek	Tioga, N.Y.	Ellen Evans	849 Candor Road, Spencer, NY 14883	(607) 659-5553	http://www.u-s-c.org/html/catatonkcreek_association.htm
Project Watershed Central New York	Onondaga, N.Y.; Cortland, N.Y.; Madison, N.Y.; Oneida, N.Y.	Bill Legg	2563 Webb Road Lafayette, NY 13084	(315)677-5194	http://www.projectwatershed.org/

New York State Department of Environmental Conservation (NYSDEC) will be sampling again in the Upper Subbasin in 2008 as part of the agency's Rotating Integrated Basin Studies (RIBS). More details on the program are available at http://www.dec.ny.gov/chemical/30951.html. Lakes/reservoirs and groundwater also will be sampled as part of this program. The information gathered in this sampling program will be used to update NYSDEC's Waterbody Inventory/Priority Waterbodies List (WI/PWL) from 2001 (NYSDEC, 2001).

Section 303(d) of the federal Clean Water Act requires a Total Maximum Daily Load (TMDL) to be developed for any waterbody designated as impaired, or not meeting the state water quality standards or its designated use. Streams in Pennsylvania are being assessed as part of the Pennsylvania Department of Environmental Protection's (PADEP's) Instream Comprehensive Evaluation Program, and if found to be impaired, a TMDL is calculated for the watershed. In the small section of the Upper Susquehanna Subbasin that is located in Pennsylvania, the Susquehanna River was the only waterbody on the 303(d) impaired waters list that was sampled in this subbasin survey. The source was unknown, and the causes of impairment listed were mercury, metals, and polychlorinated biphenyl (PCB) contamination. A few other streams that were not sampled in this survey were on the TMDL List (PADEP, 2008). In New York, NYSDEC performs assessments through its Statewide Waters Monitoring Program. Table 2 lists Upper Susquehanna Subbasin Survey streams on the WI/PWL that were determined as threatened, impacted, or needing verification and the causes and sources of impairment. These listings are from the 2001 report (NYSDEC, 2001). Additional possible and suspected pollution causes and sources are available in the report. More information on the Pennsylvania and New York TMDL programs is available on the web at http://www.dep.state.pa.us/watermanagement_apps/tmdl/default.asp and http://www.dec.ny.gov/chemical/31290.html, respectively.

Table 2. Upper Subbasin Survey Streams on NYSDEC's WI/PWL as Threatened, Impacted, or Need Verification (2001 Report)

Stream	Use Impairment Status	Primary Causes	Primary Sources
Apalachin Creek and tribs	Need Verification	Silt/Sediment	Hydro Modification
Canasawacta Creek, Lower and minor tribs	Impacted Segment	Silt/Sediment	Hydro Modification
Cayuta Creek and minor tribs	Impacted Segment	Silt/Sediment	Streambank Erosion
Chenango River, Lower, Main Stem	Impacted Segment - Fish consumption impaired	Metals	Atmosph. Deposition
Chenango River, Middle, Main Stem	Impacted Segment - Fish consumption impaired	Metals	Atmosph. Deposition
Chenango River, Upper, Main Stem	Impacted Segment	Metals	Atmosph. Deposition
Cherry Valley Cr, Lower and minor tribs	Impacted Segment	Nutrients, Pathogens	Failing On-Site Syst
Choconut Creek and tribs	Impacted Segment	Nutrients, Silt/Sediment	Streambank Erosion, Urban Runoff
East Branch Owego Creek, Upper and tribs	Impacted Segment	Nutrients, Silt/Sediment	Agriculture, Streambank Erosion
East Branch Tioughnioga, Lower and tribs	Impacted Segment	Nutrients	Agriculture
Hayden Creek and tribs	Need Verification	Nutrients, Silt/Sediment	Agriculture, Streambank Erosion
Kelsey Brook, Lower and minor tribs	Impacted Segment	Silt/Sediment	Agriculture
Mud Creek and tribs	Impacted Segment	Silt/Sediment	Streambank Erosion
Nanticoke Creek, Lower and tribs	Impacted Segment	Nutrients	Agriculture, Construction
Nanticoke Creek, Middle and minor tribs	Need Verification	Silt/Sediment	Agriculture, Construction, Streambank Erosion
Oaks Creek and minor tribs	Need Verification	Nutrients, Silt/Sediment	Agriculture
Ocquionis Creek and tribs	Impacted Segment	Nutrients	Agriculture
Otego Creek, Lower, and minor tribs	Impacted Segment	Nutrients	Agriculture
Otselic River, Middle, Main Stem	Impacted Segment	Nutrients, Silt/Sediment	Agriculture, Streambank Erosion
Otselic River, Upper and minor tribs	Impacted Segment	Nutrients, Silt/Sediment, Thermal Changes	Agriculture, Hydro Modification, Streambank Erosion
Owego Creek and minor tribs	Impacted Segment	Silt/Sediment	Streambank Erosion
Susquehanna River, Lower, Main Stem	Impacted Segment - Fish consumption impaired	Metals	Atmosph. Deposition
Susquehanna River, Lower, Main Stem	Impacted Segment - Public Bathing impaired, Fish consumption impaired	Metals, Pathogens	Comb. Sewer Overflow, Municipal, Atmosph. Deposition

Table 2. Upper Subbasin Survey Streams on NYSDEC's WI/PWL as Threatened, Impacted, or Need Verification (2001 Report) (continued)

Stream	Use Impairment Status	Primary Causes	Primary Sources
Susquehanna River, Main Stem	Impacted Segment - Recreation impaired	Metals, Pathogens	Failing On-Site Syst, Atmosph. Deposition
Susquehanna River, Upper, Main Stem	Impacted Segment	Metals	Atmosph. Deposition
Tioughnioga River, Lower, Main Stem	Impacted Segment	Silt/Sediment	Streambank Erosion
Tioughnioga River, Middle, Main Stem	Need Verification	Silt/Sediment	Agriculture, Streambank Erosion
Tioughnioga River, Upper, Main Stem	Impacted Segment	Nutrients	Municipal
Trout Brook and minor tribs	Impacted Segment	Nutrients	Agriculture
Unadilla River, Lower, Main Stem	Impacted Segment - Fish consumption impaired, Recreation impaired	Metals, Pathogens	Failing On-Site Syst, Atmosph. Deposition
Unadilla River, Upper, Main Stem	Impacted Segment - Recreation impaired, Habitat/hydrology impaired	Pathogens, Silt/Sediment	Agriculture, Failing On-Site Syst, Streambank Erosion
West Branch Owego Creek, Upper and tribs	Impacted Segment	Nutrients, Silt/Sediment	Agriculture, Streambank Erosion
West Branch Tiough Creek and minor tribs	Need Verification	Nutrients, Silt/Sediment	Agriculture

Source: NYSDEC (2001)

SRBC has additional monitoring and protection activities in the Upper Susquehanna Subbasin. One of the programs is the Enhanced Monitoring program, through which SRBC staff collects nutrient and sediment samples monthly and during storm events from the Unadilla River at Rockdale, N.Y., and the Susquehanna River at Conklin and Smithboro, N.Y. Data at these sites have been collected since October 2005 on the Unadilla River and Susquehanna River at Conklin, and since October 2004 on the Susquehanna River at Smithboro. The data are used to calculate nutrient and sediment loads and trends and to calibrate watershed models. The data and more information on the project can be found on SRBC's web site at http://www.srbc.net/docs/cbp/nutrientprogram.htm.

Another SRBC monitoring program that includes streams in the Upper Susquehanna Subbasin is the Interstate Streams Monitoring Program. This program has long-term data beginning in the 1980s and includes seasonal water quality data for some sites and annual macroinvertebrate and habitat assessments at all sites. Twenty streams that cross the New

York/Pennsylvania state line in the Upper Susquehanna Subbasin are sampled in the Interstate Streams Program. The data and more information on the project can be found on SRBC's web site at http://www.srbc.net/interstate_streams/index.asp.

Furthermore, SRBC assesses the quality of the mainstem Susquehanna River with the Large River Assessment Project. This project includes biological and chemical data assessment of 25 sites from Sydney, N.Y., to Marietta, Pa., on the mainstem Susquehanna River and at the mouths of three major tributaries: the Chemung, West Branch Susquehanna, and Juniata Rivers. The purpose is to conduct consistent monitoring along the mainstem Susquehanna River to provide baseline information, determine applicable sampling methods, and detect changes. A few of the stations in the Large River Assessment Project corresponded to the mainstem Susquehanna River stations in the Upper Susquehanna Subbasin Survey. More information on this project is available on SRBC's web site at http://www.srbc.net/pubinfo/techdocs/Publication_245/techreport245.htm.

SRBC also has developed an Early Warning System (EWS) program for portions of the Susquehanna River Basin to protect public drinking water supplies. A station in the Upper Susquehanna Subbasin at Binghamton, N.Y., is part of the EWS program. This program allows for early detection of spills or threats to public water supply and alerts water intake facilities. More information on the EWS program is available on SRBC's web site at http://www.srbc.net/programs/docs/EWSGeneral(2_07).pdf.

Methods Used in the 2007 Upper Susquehanna Subbasin Survey

DATA COLLECTION

During summer 2007, SRBC staff collected samples from 82 sites throughout the Upper Susquehanna Subbasin. The appendix contains a list with the sample site number, the station name (designated by approximate stream mile), a description of the sampling location, the latitude and longitude, the drainage size, and reference category. The reference category designation was based on drainage areas, which were divided into small (<100 square miles), medium (100 – 500 square miles), and large (>500 square miles). Staff sampled the sites once during the Year-1 effort to provide a point-in-time picture of stream characteristics throughout the whole subbasin. Staff collected samples using a slightly modified version of USEPA's Rapid

Bioassessment Protocols for Use in Streams and Wadeable Rivers (RBP III) (Barbour and others, 1999).

Water Quality

A portion of the water sample from each station was separated for laboratory analysis, and the rest of the sample was used for field analyses. A list of the field and laboratory parameters and their units is found in Table 3. Measurements of flow, water temperature, dissolved oxygen, pH, conductivity, alkalinity, and acidity were taken in the field. Flow was measured using standard U.S. Geological Survey (USGS) methodology (Buchanan and Somers, 1969). Temperature was measured in degrees Celsius with a field thermometer. A Cole-Parmer Model 5996 meter was used to measure pH. Dissolved oxygen was measured with a YSI 55 meter, and conductivity was measured with a Cole-Parmer Model 1481 meter. Alkalinity was determined by titrating a known volume of sample water to pH 4.5 with 0.02N H_2SO_4. Acidity was determined by titrating a known volume of sample water to pH 8.3 with 0.02N NaOH.

Table 3. Water Quality Parameters Sampled in the Upper Subbasin Survey

Field Parameters	
Flow, instantaneous cfs[a]	Conductivity, µmhos/cm[c]
Temperature, °C	Alkalinity, mg/l
pH	Acidity, mg/l
Dissolved Oxygen, mg/l[b]	
Laboratory Analysis	
Alkalinity, mg/l	Total Magnesium, mg/l
Total Suspended Solids, mg/l	Total Sodium, mg/l
Total Nitrogen, mg/l	Chloride, mg/l
Nitrite - N, mg/l	Sulfate - IC, mg/l
Nitrate - N, mg/l	Total Iron, µg/l[e]
Turbidity, NTU[d]	Total Manganese, µg/l
Total Organic Carbon, mg/l	Total Aluminum, µg/l
Total Hardness, mg/l	Total Phosphorus, mg/l
Total Calcium, mg/l	Total Orthophosphate, mg/l

[a] cfs = cubic feet per second
[b] mg/l = milligram per liter
[c] µmhos/cm = micromhos per centimeter
[d] NTU = nephelometric turbidity units
[e] µg/l = micrograms per liter

One 500-ml bottle and two 250-ml bottles of water were collected for laboratory analyses. One of the 250-ml samples was acidified with nitric acid for metal analyses. The other 250-ml sample was acidified with sulfuric acid for nutrient analyses. Water samples also were

placed in two, 40-mL VOA amber vials with Teflon septa membranes and preserved with 1:1 H_2SO_4 prior to analysis for total organic carbon (TOC). Samples were iced and shipped to the PADEP Bureau of Laboratories in Harrisburg, Pa., for laboratory analysis.

Macroinvertebrates

Benthic macroinvertebrates (organisms that live on the stream bottom, including aquatic insects, crayfish, clams, snails, and worms) were collected using a modified version of RBP III (Barbour and others, 1999). Two kick-screen samples were obtained at each station by disturbing the substrate of representative riffle/run areas and collecting dislodged material with a one-meter-square 600-micron mesh screen. Each sample was preserved in 95 percent denatured ethyl alcohol and returned to SRBC's lab, where the sample was sorted into a subsample of at least 200 organisms. Organisms in the subsample were identified to genus (when possible), except for midges and aquatic worms, which were identified to family.

Habitat

Habitat conditions were evaluated using a modified version of RBP III (Plafkin and others, 1989; Barbour and others, 1999). Physical stream characteristics relating to substrate, pool and riffle composition, shape of the channel, conditions of the banks, and the riparian zone were rated on a scale of 0-20, with 20 being optimal. Other observations were noted regarding weather, substrate material composition, surrounding land use, and any other relevant features in the watershed.

DATA ANALYSIS

Water quality was assessed by examining field and laboratory parameters that included nutrients, major ions, and metals (Table 3). Staff compared the data collected to water chemistry levels of concern based on current state and federal regulations, background levels of stream chemistry, or references for approximate tolerances of aquatic life (Table 4). Laboratory values were used when field and laboratory data existed for the same parameter. The difference between each value and the level of concern value from Table 4 was calculated for each site, and if the value did not exceed the level of concern value, the site was given a score of zero. If the level of concern value was exceeded, the difference was listed, and an average of difference amounts for all parameters was calculated for each site. All sites that received a score of zero (no parameters exceeded the limits) were classified as "higher" quality. Sites that had a

percentage value between zero and one were classified as “middle” quality, and sites that had a percentage value greater than one were classified as “lower” quality.

Benthic macroinvertebrate samples were analyzed using seven metrics mainly derived from RBP III (Plafkin and others, 1989; Barbour and others, 1999): (1) taxonomic richness; (2) modified Hilsenhoff Biotic Index; (3) percent Ephemeroptera; (4) percent contribution of dominant taxon; (5) number of Ephemeroptera/Plecoptera/Trichoptera (EPT) taxa; (6) percent Chironomidae; and (7) Shannon-Wiener Diversity Index. Reference sites were determined for each reference category, primarily based on the results of the macroinvertebrate metrics, and secondarily based on habitat and water quality scores, to represent the best combination of conditions. The metric scores were compared to the reference scores, and a biological condition category was assigned based on RBP III methods (Plafkin and others, 1989; Barbour and others, 1999). The ratings for each habitat condition were totaled, and a reference site was chosen based on the highest score of the habitat ratings in each reference category. A percentage of the reference site was calculated, and the percentages were used to assign a habitat condition category to each site (Plafkin and others, 1989; Barbour and others, 1999).

Taxonomic Richness: Total number of taxa in the sample. Number decreases with increasing stress.

Hilsenhoff Biotic Index: A measure of organic pollution tolerance. Index value increases with increasing stress.

Percent Ephemeroptera: Percentage of number of Ephemeroptera (mayflies) in the sample divided by the total number of macroinvertebrates in the sample. Percentage decreases with increasing stress.

Percent Contribution of Dominant Taxa: 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.

EPT Index: Total number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa present in a sample. Number decreases with increasing stress.

Percent Chironomidae: Percentage of number of Chironomidae individuals out of total number of macroinvertebrates in the sample. Percentage increases with increasing stress.

Shannon-Wiener Diversity Index: A measure of the taxonomic diversity of the community. Index value decreases with increasing stress.

Table 4. Water Quality Levels of Concern and References

Parameters	Limits	Reference Code
Temperature	>25 °C	a,f
D.O.	<4 mg/l	a,g,i
Conductivity	>800 µmhos/cm	d
pH	<6.0	i
Acidity	>20 mg/l	m
Alkalinity	<20 mg/l	a,g
TSS	>25 mg/l	h
Nitrogen*	>1.0 mg/l	j
Nitrite-N	>0.06 mg/l	f,i
Nitrate-N	>1.0 mg/l	e,j
Turbidity	>150 NTU	h
Phosphorus	>0.1 mg/l	e,k
TOC	>10 mg/l	b
Hardness	>300 mg/l	e
Calcium	>100 mg/l	m
Magnesium	>35 mg/l	l,i
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
Orthophosphate	>0.05 mg/l	l,f,j,k

Reference Code 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/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/

Results/Discussion

Water quality, biological (macroinvertebrate) community, and habitat site conditions for each sampling site in 2007 throughout the Upper Susquehanna Subbasin are depicted in Figure 4. Eleven sites, BUTT 2.8, CEBR 0.1, EMUD 1.2, GENE 15.3, OAKS 2.0, OTGO 13.1, OTSL 23.1, OTSL 8.7, STAR 0.9, SUSQ 395.5, and WHAR 0.6, demonstrated the best overall conditions in each category with nonimpaired macroinvertebrates, "higher" water quality, and excellent habitat. Nonimpaired biological conditions were found at 22 sites (27 percent) in this survey, slightly impaired conditions were found at 44 sites (54 percent), and moderately impaired conditions were found at 16 sites (19 percent). There were no sites with severely impaired conditions. Forty-five sites (55 percent) did not exceed water quality parameter levels of concern and received "higher" water quality ratings. Thirty-five sites (43 percent) slightly exceeded levels of concern and received a "middle" water quality rating, and two sites (2 percent) received a "lower" water quality rating. Habitat conditions were excellent at 39 sites (48 percent), supporting at 33 sites (40 percent), partially supporting at nine sites (11 percent), and nonsupporting at one site (one percent).

The parameters that exceeded levels of concern at the largest number of sites were total nitrogen (16) and water temperature (14) (Table 5). The highest number of levels of concern exceeded at a single site was four, occurring at only two sites, SUSQ 442 and TIOF 28.7. The highest or lowest value for each parameter is printed in bold on Table 5. Aluminum was the only metal to exceed levels of concern, occurring at only one site, KORT 0.7 (1,110 µg/l). The highest values for nitrogen forms were 2.78 mg/l for total nitrogen, 2.4 mg/l for nitrate-n, and 0.11 mg/l for nitrite-n. Total phosphorus and orthophosphate maximum values were 0.497 mg/l and 0.32 mg/l, respectively. The highest sodium value was 53.5 mg/l, and total suspended solids and water temperature were 30 mg/l and 27.9 °C, respectively. The lowest alkalinity was 17.2 mg/l (Table 5).

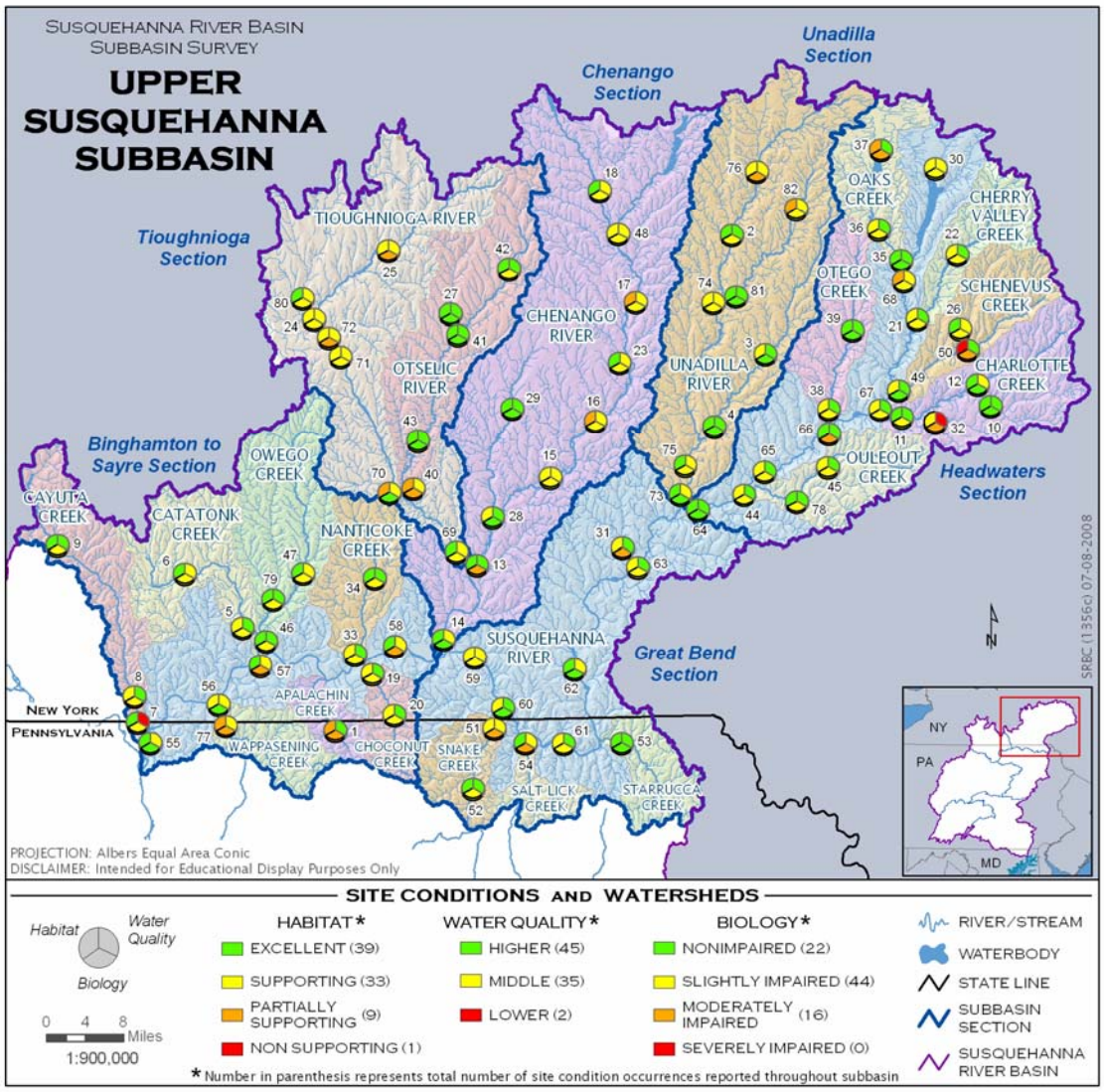

Figure 4. Water Quality, Biological, and Habitat Conditions in the Upper Susquehanna Subbasin in 2007

Table 5. Upper Susquehanna Subbasin Sites with Water Quality Values Exceeding Levels of Concern

Station	Alkalinity	Aluminum T	Nitrate-N T	Nitrite-N T	Nitrogen TOT	Phos T Ortho	Phos T	Sodium T	T Susp Solid	Water Temp	# Exceeds
	mg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	°C	
CATK 14.4			1.17		1.36						**2**
CAYT 1.6						**0.32**	0.349	**53.5**			**3**
CHAR 13.2	**17.2**										**1**
CHEN 2.4										26.4	**1**
CHEN 28.6					1.09						**1**
CHEN 38.6					1.22					25.5	**2**
CHEN 55.4					1.03						**1**
CHEN 69.3					1.1						**1**
CNWT 1.6										26.5	**1**
EBTF 1.6					1.08						**1**
EBTF 15.1			1.42		1.65						**2**
ELKC 0.1			1.22		1.44						**2**
HAYD 0.7									**30**		**1**
KORT 0.7		**1110**									**1**
OTSL 0.1										25.2	**1**
OWGO 12.4								21.3			**1**
SANG 1.5					1.24						**1**
SNAK 0.2										**27.9**	**1**
STLK 0.5										26.2	**1**
SUSQ 291.0										26.4	**1**
SUSQ 299.5						0.051		20.2		25.6	**3**
SUSQ 307.0							**0.497**	22			**2**
SUSQ 325.0						0.065		24.3			**2**
SUSQ 334.5										27	**1**
SUSQ 365.0										25.3	**1**
SUSQ 442.0				**0.11**	1.12	0.07	0.119				**4**
TIOF 0.1								22.6		26.3	**2**
TIOF 9.5								26.2			**1**
TIOF 28.7			1.18		1.6	0.063		28.8			**4**
TRBK 0.1					1.05						**1**
UNAD 0.3										25.3	**1**
UNAD 5.4										25.2	**1**
UNAD 26.7					1.23						**1**
UNAD 42.7			**2.4**		**2.78**						**2**
WAPP 2.5										25.3	**1**
WBTF 3.3			1.04		1.29			21.8			**3**
WHAR 16.8					1.33						**1**
# Exceeds	**1**	**1**	**6**	**1**	**16**	**5**	**3**	**9**	**1**	**14**	

Most extreme values for each parameter printed in bold

HEADWATERS SECTION

The site sampled farthest in the headwaters of the Susquehanna River Watershed was located on Hayden Creek (HAYD 0.7), a tributary to Otsego Lake. This site displayed middle water quality, a slightly impaired biological community, and supporting habitat conditions, and total suspended solids exceeded the level of concern at the time of sampling. An abundance of green algae was noted at this site in addition to sediment accumulated in the pool areas. Phosphorus attached to sediment and suspended solids might be attributing to the abundance of algal growth. Hayden Creek is listed on NYSDEC's WI/PWL (Table 2) as needing verification regarding nutrient and silt/sediment causes. Another headwater tributary watershed was Oaks Creek, which includes Canandarago Lake. A tributary to Canandarago Lake, Ocquionis Creek, showed habitat impairment that likely contributed to moderately impaired biological conditions. The stream was very shallow, and silt and sediment accumulation was noted in addition to human refuse. Ocquionis Creek is listed on NYSDEC's WI/PWL (Table 2) for impacts from nutrients. Downstream of the lake at OAKS 6.4, the habitat condition improved slightly to a supporting condition, and the biological condition also improved to slightly impaired. Farther downstream conditions improved further, and OAKS 2.0 demonstrated the best overall conditions in each category with nonimpaired macroinvertebrates, "higher" water quality, and excellent habitat. Oaks Creek is listed on NYSDEC's WI/PWL (Table 2) as needing verification of nutrients and silt/sediment causes.

Three tributary watersheds entering the Susquehanna River headwaters from the east were Cherry Valley Creek, Schenevus Creek, and Charlotte Creek. These watersheds had some impairments, mostly due to habitat problems, such as eroded streambanks and dredging. Both sites on Cherry Valley Creek had slightly impaired biological, "higher" water quality, and supporting habitat conditions. Eroded banks and possible dredging disturbance was noted at the upstream site, and abundant algae were noted downstream. The lower section of Cherry Valley Creek is listed on the NYSDEC WI/PWL for nutrients and pathogens from failing septic systems. Since this listing was from the 2001 report, it is possible the problem has been corrected or was not detected in the water chemistry at the time of sampling. Shenevus Creek appeared to have localized impairment due to cattle access to the stream corridor. The upstream site, SHEN 11.7, had nonsupporting habitat due to eroding banks, a silty and disturbed streambed, and bare areas in the pasture surrounding the stream. At SHEN 1.7, the localized

habitat was much better, and the biological conditions were nonimpaired. Elk Creek, a tributary to Shenevus Creek, had total nitrogen and total nitrate-n values slightly higher than background levels and slightly impaired biological conditions. Charlotte Creek had nonimpaired and slightly impaired conditions on the mainstem, with slightly low alkalinity levels toward the headwaters. Two tributaries were sampled, Center Brook and Kortright Creek, which displayed very different quality. Center Brook had nonimpaired biological condition, "higher" water quality, and excellent habitat. Aluminum values in the Kortright Creek water sample were high, the biological conditions were moderately impaired, and the habitat was rated supporting. The high aluminum could be from eroded sediment entering the stream or from acidic deposition leaching aluminum from the soil. Also, evidence of dredging and human trash at the stream was noted at the time of sampling.

Downstream on the Susquehanna River were two additional watersheds in the headwaters region that were sampled in this survey, Otego Creek and Ouleout Creek Watersheds. Otego Creek had the highest conditions in each category at the headwater site and slightly impaired biological conditions and supporting habitat in the sample at the mouth. A large percentage of beetles near the mouth indicated an imbalance in the biological community. No parameters exceeded levels of concern at the time of sampling; however, the lower section of Otego Creek was listed on the NYSDEC 2001 WI/PWL list for nutrients due to agriculture. Both sites on Ouleout Creek had slightly impaired biological conditions due to dominance of pollution-tolerant midges, although the water quality parameters analyzed did not exceed levels of concern. Sedimentation, algae, and turbid water were noted at the sites, in addition to a lack of stream cover. A tributary to Ouleout Creek, West Branch Handsome Brook, had slightly impaired biological conditions, "higher" water quality, and excellent habitat.

UNADILLA RIVER

Biological and habitat conditions in the Unadilla River improved toward the mouth. Also, the water quality parameters exceeding levels of concern changed from total nitrogen and nitrate-n to water temperature toward the mouth. The headwater site, UNAD 42.7, had moderately impaired conditions and supporting habitat. The biological community at this site was comprised mostly of midges and other pollution-tolerant species, and the habitat was impacted by sediment deposition and abundant algae. The total nitrogen and nitrate-n values at

UNAD 42.7 were the highest in the survey (Table 5). The sites sampled on the Unadilla River improved downstream, and the site at the mouth, UNAD 0.3, had nonimpaired biological and excellent habitat conditions. The temperature slightly exceeded the level of concern; however, the flow conditions were low due to dry summer conditions.

According to the NYSDEC 2001 WI/PWL, the upper and lower sections of the Unadilla River were impaired by pathogens due to failing septic systems and some agricultural practices, such as unrestricted cattle access to the river. Also, the upper Unadilla River had silt/sediment problems due to agriculture and streambank erosion, while the lower Unadilla River had high mercury levels, possibly due to atmospheric deposition. The tributaries to Unadilla River (Beaver Creek, Wharton Creek, and Butternut Creek) all contribute good water quality conditions to Unadilla River. No parameters exceeded levels of concern in the sites from these tributaries, except for site WHAR 16.8, which had slightly high total nitrogen. This headwaters site also had slightly impaired biological conditions and partially supporting habitat with erosion, siltation, algae, and evidence of disturbance. Wharton Creek improves toward the mouth, though, and WHAR 0.6 had nonimpaired biological conditions, "higher" water quality, and excellent habitat. The improvement in biological condition of the Unadilla River at the mouth might be contributed to the good quality water from Wharton and Butternut Creeks.

GREAT BEND SECTION

Four tributaries were sampled in the Great Bend Section; all had moderately impaired biological conditions, except for Starrucca Creek, which had nonimpaired biology, "higher" water quality, and excellent habitat. In this section, Kelsey Brook was the only stream on NYSDEC's WI/PWL. It was listed for silt/sediment from agriculture. At the time of sampling, SRBC staff noted abundant green filamentous algae and marginal bank condition at KELS 0.6. The biological community at KELS 0.6 had a few sensitive taxa, but was mostly dominated by pollution-tolerant species such as *Baetis* and Chironomidae (midges). Salt Lick Creek also was dominated by *Baetis* and midges, and Snake Creek had low numbers of sensitive species with beetles and midges dominant. Salt Lick Creek and Snake Creek both had middle water quality due to elevated temperature values, and staff noted marginal sediment deposition on Snake Creek. The temperature values probably were slightly high due to the dry, hot conditions and low flows during summer 2007 leading up to drought conditions in the fall (NCDC, 2007).

After the 1998 Upper Subbasin Survey, SRBC focused on Snake Creek with a small watershed study in 1999 and 2000 (Diehl, 2001). The study found Snake Creek to be in good condition and recommended protection efforts in the watershed, such as increasing natural riparian vegetation. The impairment noted in the watershed during this 2007 survey may indicate that conditions have changed and further study is needed. A comparison of the macroinvertebrate communities showed the same general taxa; however, less tolerant taxa were more prevalent in the 2007 community. Possibly the stressful low flow conditions were impacting the biological conditions temporarily in 2007.

CHENANGO RIVER

The Chenango River is the largest watershed in the Upper Susquehanna Subbasin with a drainage area of approximately 1,605 square miles. Total nitrogen values were slightly elevated in the upper portion of Chenango River (CHEN 69.3, CHEN 55.4, CHEN 38.6, and CHEN 28.6) and slightly impaired biological conditions were prevalent. Water temperature also slightly exceeded levels of concern at two of the Chenango River sites. Habitat problems listed in the Chenango River Watershed included erosion, condition of banks, excessive algae, and lack of vegetated riparian area. Low flow was an issue at the time of sampling and may have contributed to the moderately impaired conditions at CHEN 13.5 where the channel was wide. The mouth of the Chenango River had nonimpaired biology, excellent habitat conditions, and was rated “middle” quality due to slightly high temperature. The upper, middle, and lower sections of the Chenango River were listed on the 2001 NYSDEC WI/PWL for metals possibly due to atmospheric deposition, and fish consumption uses were impaired in some sections.

The Chenango River tributaries that were sampled during this survey had only slightly impaired or nonimpaired biological conditions. Sangerfield River had total nitrogen values slightly higher than natural background levels, and Canasawacta Creek had slightly high water temperature. These two water quality issues also were noted in the mainstem Chenango River. The Canasawacta Creek was listed on the NYSDEC WI/PWL list for silt/sediment due to hydrologic modification. Geneganslet Creek had nonimpaired biological conditions, and no water parameters exceeded levels of concern. GENE 15.3 was used as a reference site for small drainage area watersheds.

TIOUGHNIOGA RIVER

The Tioughnioga River is a tributary to the Chenango River, just downstream of CHEN 13.5. The headwaters of Tioughnioga River are split into two branches, east and west. Both East Branch Tioughnioga River and West Branch Tioughnioga River had total nitrogen and nitrate-n values higher than natural background levels and slightly and moderately impaired biological condition. The habitat in the East Branch Tioughnioga River was rated slightly lower due to slow flow, backwater areas, lack of riffle, and lack of vegetated riparian areas. Elevated sodium levels occurred at all three mainstem Tioughnioga River sample sites. TIOF 28.7 also had nitrate-n, total nitrogen, and orthophosphate values that exceeded levels of concern at the time of sampling. The biological conditions were only slightly impaired or nonimpaired, and habitat problems included channel alteration and lack of riffles at TIOF 9.5 and heavy sediment deposition and low frequency of riffles at TIOF 28.7. The East Branch, West Branch, and mainstem Tioughnioga River are all listed on the 2001 NYSDEC WI/PWL. Most of the impacts or suspected impacts needing verification were for nutrients and silt/sediment due to agriculture and streambank erosion. The upper Tioughnioga River was listed for nutrients due to the Cortland Wastewater Treatment Plant. The elevated nutrients during this 2007 survey at TIOF 28.7, located just downstream of Cortland, may be due to a municipal source.

The Otselic River is a major tributary to the Tioughnioga River and includes Whitney Point Lake, one of the largest reservoirs in the subbasin, near the mouth. The quality of the Otselic River degrades between upstream and downstream of the reservoir during this survey. The best condition ratings were evident in all categories in the three sites upstream of the reservoir and at a tributary, Mud Creek, except for slightly impaired biological conditions in the headwaters at OTSL 32.7. OTSL 8.7 served as a reference site for middle drainage watersheds. At the monitoring station downstream of the Whitney Point Lake (OTSL 0.1), moderately impaired biological, “middle” water quality, and partially supporting habitat conditions existed. The temperature slightly exceeded levels of concern; however, channel alteration adversely affected the channel sinuosity and substrate composition and layout. SRBC plans to further study Whitney Point Reservoir and its flow impacts in order to determine the potential impacts of increasing the storage in the reservoir to mitigate low flows. The impacts of increased flow on the area downstream of Whitney Point Lake will be included in this study. More information on this project can be found on SRBC’s web site http://www.srbc.net/programs/whitpoint_proj.htm.

Mud Creek and the upper and middle sections of the Otselic River were listed on NYSDEC's 2001 WI/PWL for nutrients, silt/sediment, and thermal changes due to agriculture, streambank erosion, and hydrologic modification; however, this survey does not show evidence of these issues.

BINGHAMTON to SAYRE SECTION

The watersheds sampled in the section from Binghamton, N.Y., to Sayre, Pa., were Choconut, Nanticoke, Apalachin, Owego, Catatonk, Wappasening, and Cayuta Creeks. All of the sites sampled in these watersheds had slightly or moderately impaired biological conditions. Some of the habitat problems noted in this section were due to channel alteration, bank erosion, and very low flow. Many of these streams have problems with flooding that result in infrastructure damage.

Many of the streams in this section were listed on the 2001 NYSDEC WI/PWL. The watersheds were listed for impacted segments or needing verification, mostly for nutrients and silt/sediment due to agriculture and stream bank erosion. Other possible sources listed were construction, urban runoff, and hydrologic modification. Streambank erosion and channel alteration by flooding or by anthropogenic disturbance were noted at many of the sites during this survey. Elevated nutrients were detected at two sites (CATK 14.4 and CAYT 1.6) during this survey, although abundant algal growth, an indication of higher nutrients, also was noted at a few sites. The elevated nutrients at CAYT 1.6 may be due to the Waverly Wastewater Treatment Plant or to agricultural and urban/suburban runoff upstream of the site. The orthophosphate and the sodium values at CAYT 1.6 were the highest in this survey.

SUSQUEHANNA RIVER MAINSTEM

The sites sampled on the Susquehanna River mainstem in the Upper Susquehanna Subbasin Survey had varying quality conditions, mostly impacted by urban areas along the river. Of the 14 mainstem sites, there were five nonimpaired, six slightly impaired, and three moderately impaired in biological condition. Seven of the sites had "higher" water quality, and seven had "middle" water quality. Six of the sites had excellent habitat conditions, seven had supporting habitat conditions, and one had partially supporting habitat conditions. The three sites with moderately impaired biological condition were located downstream of urban areas. SUSQ 417 was located downstream of Oneonta, N.Y.; SUSQ 325 was located downstream of

Binghamton, N.Y.; and SUSQ 307 was located in Owego, N.Y., downstream of Binghamton. The sites downstream of Binghamton showed elevated orthophosphate, total phosphorus, and sodium. SUSQ 307 had the highest total phosphorus in the Upper Susquehanna Subbasin Survey (Table 5). Orthophosphate and sodium still were elevated farther downstream at SUSQ 299.5; however, further study would be needed to determine if this was from Binghamton or other sources. The headwaters site on the mainstem Susquehanna River (SUSQ 442) also had elevated nutrients and the highest nitrite-n of the Upper Susquehanna Subbasin Survey water samples. This site was located downstream of Otsego Lake and Cooperstown, N.Y., and SRBC staff noted that the water was turbid at the time of sampling compared to other streams. The temperature value slightly exceeded levels of concern at four of the mainstem sites (Table 5).

According to the 2001 NYSDEC WI/PWL, fish consumption and public bathing are impaired on the mainstem Susquehanna River due to metals and pathogens, possibly from atmospheric deposition, combined sewer overflows, municipal sewer systems, and failing private on-site septic systems. The fish consumption advisory is due to mercury levels of concern documented by the New York State Department of Health in the lower portion of the Upper Susquehanna River. The advisory was extended to the entire Upper Susquehanna River as a precaution (NYSDEC, 2001). Antiquated public infrastructure and municipal sewer systems, such as combined sewer overflows, are problematic because untreated waste can enter the river and introduce pathogens that can impair public bathing uses.

During the Upper Susquehanna Subbasin Survey, zebra mussels (*Dreissena* sp.) were discovered for the first time living in the Susquehanna River mainstem. They were located at SUSQ 356, SUSQ 365, SUSQ 406, SUSQ 417, SUSQ 422.5, and near SUSQ 325 and SUSQ 341.5. Zebra mussels are an invasive species that can out-compete native mussels and cause problems by obstructing infrastructure, such as water intakes. More information about zebra mussels and their locations is available at http://seagrant.psu.edu/zm/index.htm.

COMPARISON of 2007 and 1998 Data

Overall, conditions in 2007 and 1998 were indicative of a healthy Upper Susquehanna Subbasin. The results for the biological, water quality, and habitat conditions in the 1998 Upper Subbasin Survey (Stoe, 1999) are depicted in Figure 5. The methods have changed slightly throughout the years, and the methods for the 1998 survey can be found in Stoe (1999).

Specifically, the number of macroinvertebrates subsampled changed from 100 to 200, the habitat assessment form changed to assigning each parameter 20 points instead of weighting the parameters with different point ranges, and the water quality assessment analysis has changed. In the 1999 report, Stoe designated water quality conditions based on median and averages of parameter percentile scores from each site. For comparison purposes, the 1998 data were analyzed using current methodology to acquire water quality site condition ratings. Furthermore, Stoe used different macroinvertebrate metrics to assess the biological condition. Percent Taxonomic Similarity and Percent Trophic Similarity were used in 1998 instead of Percent Ephemeroptera, Percent Contribution of Dominant Taxa, and Percent Chironomidae. The 1998 biological conditions were recalculated using the same metrics as in 2007; however, the biological condition categories remained similar, so the condition categories from Stoe (1999) were used for comparison.

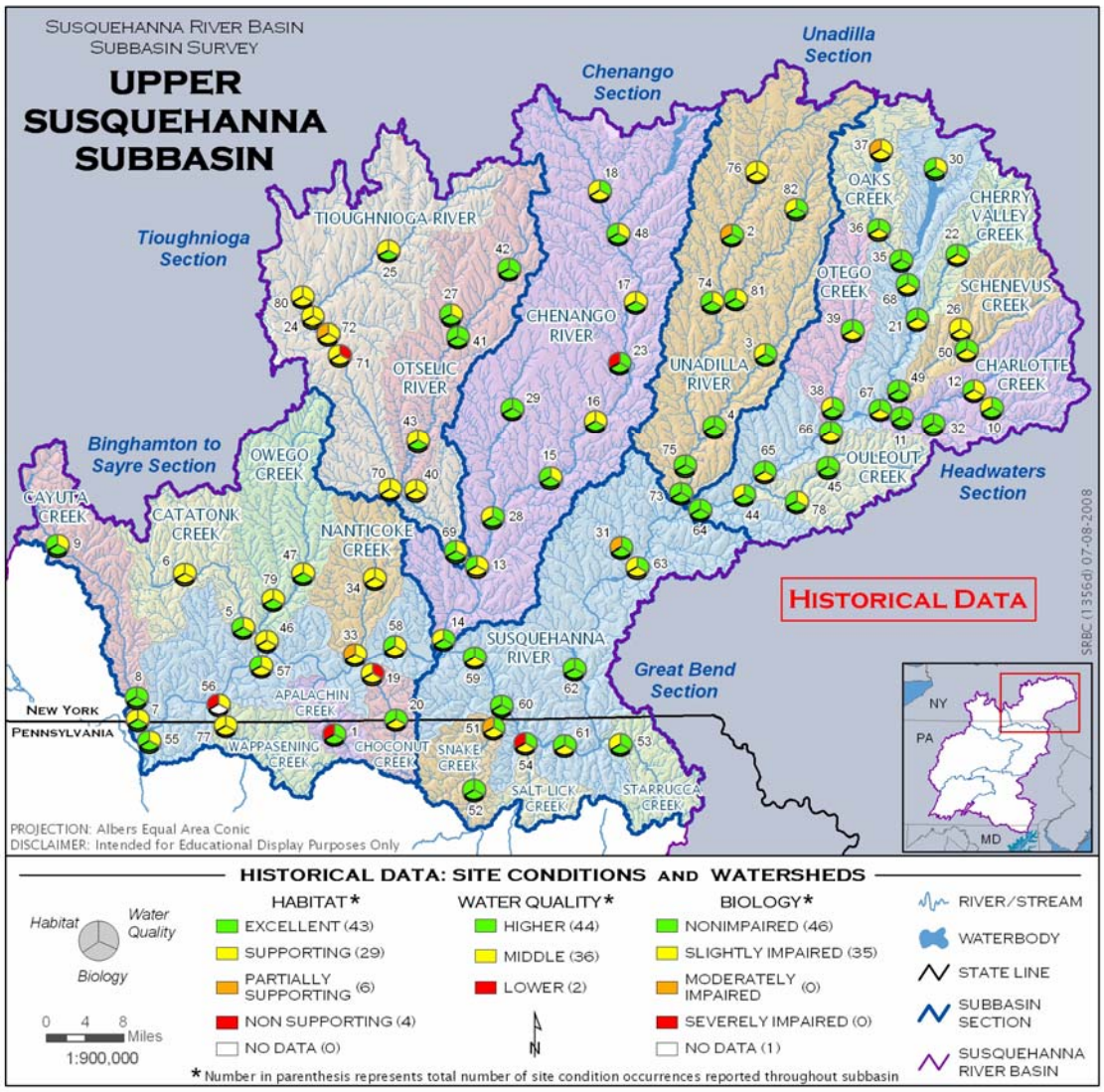

Figure 5. Water Quality, Biological, and Habitat Conditions in the Upper Susquehanna Subbasin in 1998

A comparison of the 2007 and 1998 data suggests that the water quality and habitat condition categories were very similar; however, the biological conditions were different. This difference may have been due to the different processing methods in 1998 compared to 2007 and possibly due to differences in flow conditions. The low flow conditions in 2007 may have resulted in more sites being impaired. The percentage of sites for each biological condition was quite different between the 2007 and 1998 data (Figures 6 and 7, respectively). Figure 6 of the 2007 data shows 27 percent of the sites were nonimpaired, 53 percent were slightly impaired, and 20 percent were moderately impaired. Figure 7 of the 1998 data shows 56 percent nonimpaired, 43 percent slightly impaired, and one percent no data for SUSQ 299.5, which was

not sampled for macroinvertebrates in 1998. There were no sites that were moderately impaired in the 1998 subbasin survey. Less than half (38 sites) were the same biological condition in 1998 and 2007. The biological condition had degraded at 40 sites and improved at four sites. Four of the sites that had degraded from 1998 to 2007 had degraded by more than one step in condition category. Those sites were APAL 5.3, EBTF 15.1, KELS 0.6, and KORT 0.7.

Habitat condition ratings were very similar between the 1998 and 2007 data. In 2007, approximately 48 percent were rated excellent, 40 percent supporting, 11 percent partially supporting, and one percent nonsupporting in habitat condition. In 1998, approximately 53 percent of the habitat conditions were rated excellent, 35 percent supporting, seven percent partially supporting, and five percent nonsupporting.

Water chemistry conditions were very similar in 2007 and 1998. In 2007, 55 percent of the Upper Susquehanna Subbasin Survey sites were rated "higher" water quality, while in 1998, 54 percent of the sites were rated "higher" water quality. Forty-three percent of the sites in 2007 were rated "middle" water quality, while 44 percent were rated "middle" quality in 1998. Both 2007 and 1998 data had two percent of the sites rated lower water quality. Fifty-five (67 percent) of the sites had the same water quality rating with the 2007 data as the 1998 data. Fourteen of the sites improved and 12 sites degraded in 2007 compared to 1998 data conditions. All sites only improved or degraded by one step in condition rating, except CHOC 1.7, which improved from "lower water quality rating in 1998 to "higher" water quality rating in 2007, and KORT 0.7, which degraded from a "higher" water quality rating in 1998 to a lower water quality rating in 2007.

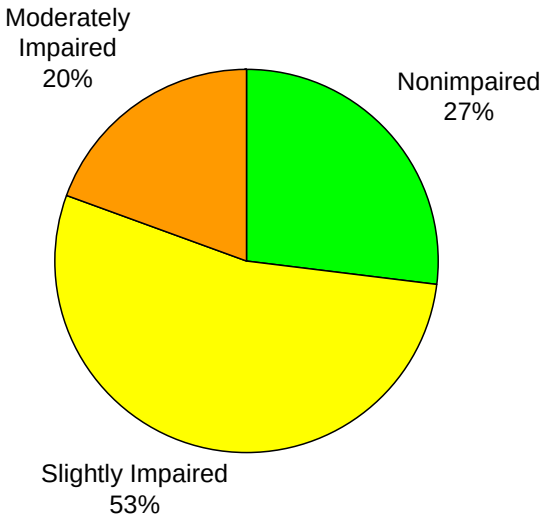

Figure 6. Habitat Conditions in the Upper Susquehanna Subbasin in 2007

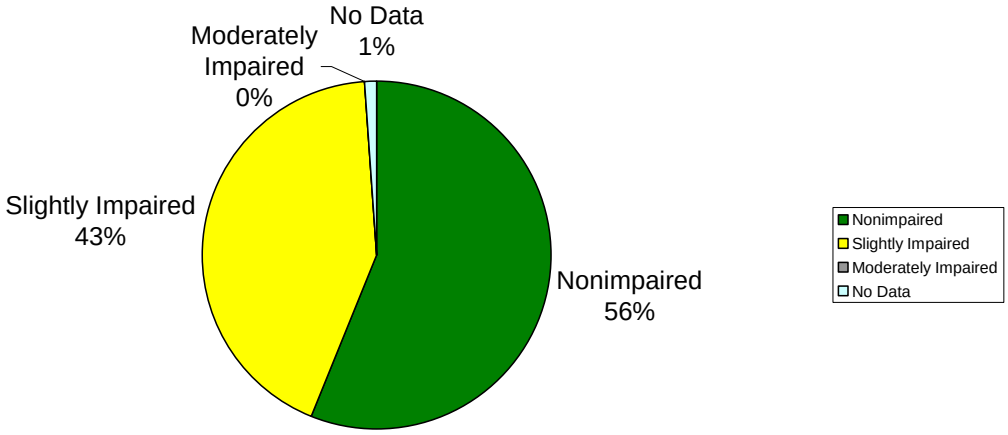

Figure 7. Habitat Conditions in the Upper Susquehanna Subbasin in 1998

Table 6 shows a comparison of the number of parameter values that exceeded levels of concern for sites that were sampled in both 2007 and 1998. The parameter that exceeded the level of concern most in both 2007 and 1998 data sets was total nitrogen, although total nitrogen levels were exceeded two times more in 1998 than in 2007. Sodium also frequently exceeded levels of concern in both years. Nitrate-n exceeded levels of concern more in 1998 and water temperature exceeded levels of concern more in 2007. Overall, 70 values exceeded levels of concern in 1998, whereas only 57 values exceeded levels of concern in 2007. The largest

difference was the number of total nitrogen and nitrate-n values that exceeded levels of concern. This difference may be attributable to higher flow conditions in 1998 than in 2007, since nitrate is water soluble and is more easily leached from soil during high flows. June 1998 was one of the wettest June months on record in New York State (NCDC, 2005) while drought conditions existed in 2007 (NCDC, 2007). Many of the sites exceeded the same parameters in 2007 as in 1998. Some Chenango River Watershed sites exceeded total nitrogen values in both years, and the East Branch, West Branch, and mainstem Tioughnioga River sites exceeded total nitrogen, nitrate-n, and sodium at many of the sites throughout the watershed in 1998 and 2007. In particular, TIOF 28.7 exceeded total nitrogen, nitrate-n, sodium, and orthophosphate in both 1998 and 2007. Some sites on the Unadilla River exceeded total nitrogen and nitrate-n in both years also. Identical parameters were exceeded in 2007 and 1998 at other tributary stations, such as CATK 14.4, CAYT 1.6, CHAR 13.2, ELKC 0.1, and OWGO 12.4. SUSQ 307 exceeded sodium levels in both years also.

Table 6. Number of Water Quality Values Exceeding Levels of Concern for the Same Sites in 1998 and 2007

	Alkalinity	Aluminum T	Nitrate-N T	Nitrite-N T	Nitrogen TOT	Phos T Ortho	Phos T	Sodium T	T Susp Solid	Water Temperature	
	mg/l	µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	°C	TOTAL
2007	1	1	6	1	16	5	3	9	1	14	**57**
1998	2		16		33	3	1	11	3	1	**70**

CONCLUSIONS

Overall, the conditions of the streams and rivers sampled in the Upper Susquehanna Subbasin in 2007 were very good. A majority of the sites had either nonimpaired or slightly impaired biological conditions, while no sites had severely impaired biological conditions. The water quality was very good, with more than 50 percent of the samples receiving "higher" quality ratings, and only two sites receiving a "lower" quality rating. Most of the parameter values that did exceed levels of concern were only slightly higher than the levels of concern. The parameter that exceeded levels of concern the most was total nitrogen; however, the exceeding values are only slightly higher than what is considered natural background levels for streams. The highest total nitrogen value was only 2.78 mg/l. Sodium values also exceeded levels of concern fairly often and appeared to be concentrated in the Tioughnioga River and the lower section of the Susquehanna River (including Cayuta and Owego Creeks). Further study

may be needed to determine if this is due to natural geology or to a land use impact. Habitat conditions were not largely impacted with 88 percent of the sites being excellent or supporting. Only one site had nonsupporting habitat.

Many of the sites that had moderately impaired biological conditions were located in urban or agricultural areas. Some of the urban areas have antiquated municipal sewer systems, and stormwater issues may also be a concern. The agricultural areas, mostly located in the headwater areas of the Upper Susquehanna Subbasin (Figure 3), may have excess nutrients and erosion problems that could improve with Best Management Practices recommended by local Soil and Water Conservation Districts. This region also is prone to flooding problems due to the unstable nature of the streams' substrate and riparian areas, and the flooding can cause a lot of disturbance to the channel. Protecting the streams and providing room for them to flood naturally may help to alleviate this problem. Other disturbances to the stream channel that impact the biological communities include dredging. During this survey, many of the streams and rivers were low due to the dry conditions that later led to a drought in the fall (NCDC, 2007). These low flow conditions could have negatively impacted the biological community.

Some of the highest quality watersheds sampled in this survey include the Otselic River upstream of Whitney Point, Geneganslet Creek, Butternut Creek, Starrucca Creek, Center Brook, and Otego Creek. Efforts should be made to protect these watersheds from degradation. Some of the most degraded watersheds in this survey were Kortright Creek, Kelsey Brook, Salt Lick Creek, Apalachin Creek, Wappasening Creek, Unadilla River in the headwaters, and portions of the Tioughnioga and Chenango Rivers. Further study is needed as to the source of impairment in some of these watersheds. Restoration efforts are needed in those areas where impairment source and cause are known.

SRBC staff is conducting the Upper Susquehanna Subbasin Survey, Year-2 assessment at Whitney Point Lake, focusing on backwater areas of the Tioughnioga River. This Year-2 study is part of a larger monitoring effort associated with an environmental restoration effort at Whitney Point Lake, which will be conducted in conjunction with the U.S. Army Corps of Engineers, NYSDEC, and United States Fish and Wildlife Service and will include data collection for water flow, water chemistry, fish, macroinvertebrates, wetlands, and submerged aquatic vegetation. More information on this project is available at http://www.srbc.net/programs/whitpoint_proj.htm.

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