Methods

DATA COLLECTION

During October 2002 to September 2003, SRBC collected water chemistry and macroinvertebrate samples, and assessed habitat at 28 sites throughout the Wyalusing Creek Watershed. Appendix A contains a list of the sample site numbers, the station name (designated by stream mile), a sampling location description, latitude and longitude coordinates, and drainage size categories. Water chemistry was collected at all stations bimonthly during the months of November, February, April, May, June, and September. Water quality and flow samples were not collected in February at sites SBWC 0.1, DEER 0.1, EBWC 0.1, GAYL 0.1, ROCK 0.1, CAMP 0.1, and BILL 0.1 due to frozen stream conditions. Macroinvertebrate samples and habitat assessments were completed in May 2003 according to a modified version of the U.S. Environmental Protection Agency's (USEPA's) Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (RBP III) (Barbour and others, 1999).

Water quality of the streams in the Wyalusing Creek Watershed was analyzed mostly for nutrients and sediment based on the rural character of the watershed and the concerns of the watershed group. A list of the field and laboratory parameters and their units is found in Table 1. Samples were split into a 500-ml bottle for nutrient analysis, a 500-ml bottle for all additional parameters, and a cleaned glass bottle for sediment analysis. All other water quality, macroinvertebrate collection, and habitat assessment methods follow the methods listed in LeFevre (2003).

DATA ANALYSIS

Two reference categories were created for data analysis based on drainage size. Small drainage size sites were less than 50 square miles, and medium drainage size sites were between 50 and 500 square miles. Water quality was assessed by comparing the data collected to water chemistry values that were at a level of concern based on current state and federal regulations or references for approximate tolerances of aquatic life (Table 2). Alkalinity was not used in the water quality analysis, due to ubiquitous low alkalinity values in this watershed, suggesting naturally lower alkalinity conditions. The difference between each value and the level of concern value from Table 2 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 all the parameters for each site was calculated. The six bimonthly sample averages were combined for a cumulative average. The sites were grouped according to their reference categories, and a percentage of the highest average value (representing the worst water quality) was taken in order to account for differences in water quality between drainage sizes. All sites that received a 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.

Table 1. *Water Quality Parameters Sampled in the Wyalusing Creek Watershed*

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	
Total Suspended Solids, mg/l	Total Phosphorus, mg/l
Total Nitrogen, mg/l	Total Orthophosphate, mg/l
Total Ammonia - N, mg/l	Total Organic Carbon, mg/l
Total Nitrite - N, mg/l	Total Residue, mg/l
Total Nitrate - N, mg/l	Suspended Sediment, ppm[d]

[a] cfs = cubic feet per second
[b] mg/l = milligram per liter
[c] µmhos/cm = micromhos per centimeter
[d] ppm = parts per million

Table 2. *Water Quality Levels of Concern and References*

PARAMETERS	LIMITS	REFERENCE CODES
Temperature	>25 °C	a,f
Dissolved Oxygen	<4 mg/l	a,g
Conductivity	>800 µmhos/cm	d
pH	<5	c,f
Alkalinity	<20 mg/l	a,g
Total Suspended Solids	>15 mg/l	h
Nitrogen	>1.0 mg/l	j,k,l
Ammonia	>0.2 mg/l	f
Nitrite	>1.0 mg/l	f
Nitrate	>1.0 mg/l	e
Phosphorus	>0.1 mg/l	e
Total Orthophosphate	>0.05 mg/l	l
Total Organic Carbon	>10 mg/l	b
Residue	>500 mg/l	a,i,m
Sediment	>80 ppm	n

REFERENCE CODES/REFERENCE	
a	http://www.pacode.com/secure/data/025/chapter93/s93.7.html
b	Hem (1970)
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.deq.state.va.us/pdf/watrregs/fish.pdf
i	http://www.dec.state.ny.us/website/regs/703.htm
j	http://water.usgs.gov/pubs/circ/circ1225/images/table.html
k	http://www.ecan.govt.nz/Land/pdf%20files/sheet13.pdf
l	http://h2osparc.wq.ncsu.edu/info/
m	http://www.epa.gov/safewater/mcl.html#mcls
n	http://www.pac.dfo-mpo.gc.ca/sci/psarc/HSRs/hab1.pdf

Benthic macroinvertebrate samples were analyzed using seven metrics mainly derived from RBP III (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 same reference sites were used in the analysis for the habitat scores. The ratings for each habitat condition were totaled, and a percentage of the reference site was calculated. 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 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 (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) 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.

A comparison of the TMDL limits for South Branch Wyalusing Creek was determined by converting the nitrogen, phosphorus, and sediment results from SBWC 0.1 to a mass loading expressed in pounds per year (lb/yr). This was achieved through converting flow from cubic feet per second (cfs) to million gallons per day (MGD) and then using the formula: lb/yr = concentration mg/l * [(8.345lb/MG)/(mg/l)]* flow MGD * 365 days/year. The average values of the five water quality samples for each parameter were compared to the TMDL limits for South Branch Wyalusing Creek.

Results/Discussions

Water quality, biology, and habitat site conditions for each sampling site are depicted by smaller watersheds in Figure 2. Five sites in the watershed achieved the highest overall ratings in water quality, biology, and habitat. Those sites included two sites on the East Branch Wyalusing Creek (EBWC 8.0, EBWC 0.1), and one site each on Cold Creek (COLD 0.1), Deer Lick Creek (DEER 0.1), and Stonestreet Creek (STON 0.1). The site with the worst overall ratings was Pettis Creek (PETT 0.1) with "lower" water quality and severely impaired biology. There were no non-supporting ratings for habitat. Fifteen sites had "lower" ratings for water quality (see Figure 2).

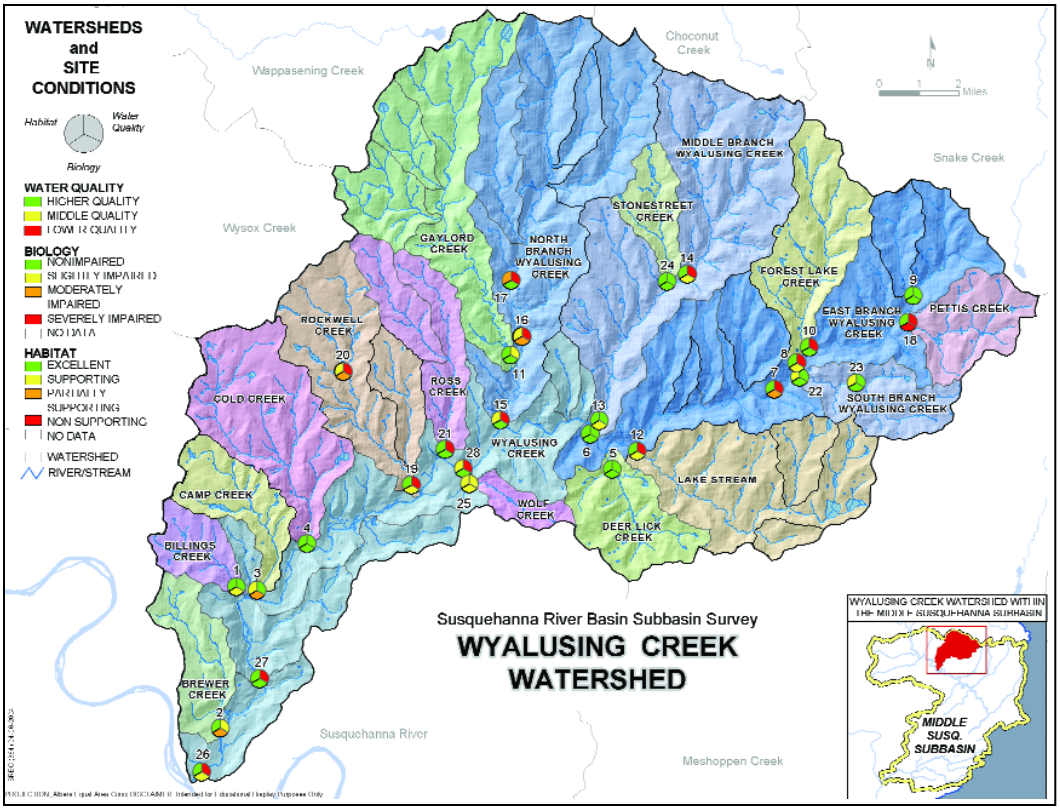

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Figure 2.
Watersheds and Site Conditions in the Wyalusing Creek Watershed

Inset shows the location of the Wyalusing Creek Watershed within the Middle Susquehanna Subbasin.