0.02N H_2SO_4. Acidity was determined by titration of a known volume of sample water to pH 8.3 with 0.02N NaOH.

One 500-ml bottle and two 250-ml bottles of water were collected for laboratory analyses. One of the 250-ml bottles was acidified with nitric acid for metal analyses. The other 250-ml bottle was acidified with sulfuric acid for nutrient analyses. Samples were iced and shipped to the Pennsylvania Department of Environmental Protection (PADEP), Bureau of Laboratories in Harrisburg, Pa.

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, except for midges and aquatic worms, which were identified to family.

Table 3. *Water Quality Levels of Concern and References*

PARAMETERS	LIMITS	REFERENCE CODES
Temperature	>25 °C	a,f
D.O.	<4 mg/l	a,g
Conductivity	>800 µmhos/cm	d
pH	<5.0	c,f
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,n,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	i
Sodium	>20 mg/l	i
Chloride	>250 mg/l	a
Sulfate	>250 mg/l	a
Iron	>1,500 µg/l	a
Manganese	>1,000 µg/l	a
Aluminum	>200 µg/l	c
Phos T Ortho	>0.05 mg/l	l,f,j,k

REFERENCE CODES/REFERENCE

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.state.ny.us/website/regs/part703.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://srmwww.gov.bc.ca/risc/pubs/aquatic/interp/

** Background levels for natural streams*

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 2). The data collected were compared to water chemistry values that were at a level of concern based on current state and federal regulations, background levels for uninfluenced streams, or references for approximate tolerances of aquatic life (Table 3). 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 3 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. 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.

Six reference categories were created for macroinvertebrate and habitat data analysis based on drainage size, ecoregions, and subecoregions (Omernik, 1987; Omernik, 1992). All the sites were divided into small (< 100 square miles), medium (100 to 500 square miles), and large drainage areas (> 500 square miles). The small drainage areas were then grouped according to ecoregions and subecoregions. Based on the location of the sampling sites, the six reference categories used were 67a, 67b, 67c, 67d, 69a, and medium size drainage. None of the large drainage size area sites were sampled for macroinvertebrates due to the high flows after flooding.

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 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.

Results/Discussion

Water quality, macroinvertebrate, and habitat site conditions for each sampling site in the Juniata Subbasin in 2004 are depicted in Figures 4 - 6. Twelve sites demonstrated the best overall conditions in each category with nonimpaired macroinvertebrates, "higher" water quality, and excellent habitat. Twenty-three sites did not exceed water quality levels of concern and received a "higher" water quality designation. Sixty-four sites slightly exceeded levels of concern and received a "middle" quality designation, and 14 sites were considered "lower" quality. Nonimpaired biological conditions were found at 44 sites (54 percent), slightly impaired conditions were found at 26 sites (32 percent), moderately impaired conditions were found at eight sites (10 percent), and severely impaired conditions were found at three sites (four percent). Habitat conditions throughout the subbasin were rated highly. Habitat conditions were excellent at 66 sites (81.5 percent), supporting at 13 sites (16 percent), and partially supporting at two sites (2.5 percent).

Seventy-eight sites had at least one parameter that exceeded a level of concern (Table 4). The highest number of parameters exceeding levels of concern occurred at BURG 0.5 and HALT 0.6. Total nitrogen exceeded the level of concern at 66 sites while total nitrate-n exceeded the level of concern at 61 sites. The values set for nitrogen and nitrate-n (1.0 mg/l) are based on natural background concentrations; therefore, values higher than 1.0 mg/l indicate the potential presence of nitrogen sources such as agriculture in the watershed. This level is not based on aquatic life tolerances or levels of concern, as standards have not yet been developed for nutrients in Pennsylvania.

The third highest parameter to exceed levels of concern was total aluminum, which was exceeded 16 times. At seven of those 16 sites, abandoned mine drainage (AMD) conditions were the likely cause of the higher aluminum values, and atmospheric deposition was most likely the cause for at least one other site. The cause for high aluminum at the other eight sites needs further research. Since the sample is a one-time sample, duplication of these results at different times, flows, and seasons would be necessary. The land use in many of these watersheds contains agricultural activity, some of which includes farmland applications of biosolids from municipal wastewater treatment plants. In fact, farms that apply or in the past have applied biosolids are located in the area of at least six of those eight sites with higher aluminum values (PADEP, 2005). Some wastewater treatment plants use alum as a flocculent to settle out solids. Research suggests that chemicals, such as alum, added to waste during the treatment process can affect the chemical composition of the biosolids (USEPA, 1999).

Agricultural land use appeared to influence many of the Juniata Subbasin Survey sampling sites. Total nitrogen values were very high at some sites, with the highest value being 11.64 mg/l (Table 4). Total phosphorus and orthophosphate values were exceeded four and 11 times, respectively. Orthophosphate and phosphorus can be indicators of wastewater and septic systems,