

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

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

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

Data Analysis

Chemical water quality

Chemical water quality was assessed by examining field and laboratory parameters. Limit values were obtained for each parameter based on current

state and federal regulations or references for aquatic life tolerances (Table 3, Buda, 2008).

Macroinvertebrate analysis

A series of macroinvertebrate metrics was calculated for each sample, and assessments of the sites were performed. Benthic macroinvertebrate samples were assessed using procedures described by Barbour and others (1999), Klemm and others (1990), and Plafkin and others (1989). Using these methods, staff calculated a series of biological indexes at each station. The metrics used in this survey are summarized in Table 4. Metric 2 (Shannon-Wiener Diversity Index) followed the methods described in Klemm and others (1990), and all other metrics were derived from Barbour and others (1999).

A reference condition approach was used to determine impairment levels for each sample. This protocol entails determining the best score for each metric. The 300-organism subsample data were used to generate scores for each of the seven metrics. Scores for metrics 1-4 were converted to a biological condition score, based on the percent similarity of the metric score, relative to the best possible metric score. Scores for metrics

5-7 were based on set scoring criteria developed for the percentages (Plafkin and others, 1989; Ohio Environmental Protection Agency, 1987). The sum of the biological condition scores constituted the total biological score for the sample, and total biological scores were used to assign each sample to a biological condition category (Table 5).

RESULTS

Water Quality

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

Table 3. Water Quality Limits and References

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

Reference Codes and References

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

* Background levels for natural streams

Table 2. Parameters for Laboratory Analysis

| Parameter | 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

^c nephelometric turbidity units

^b µg/l = micrograms per liter

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).

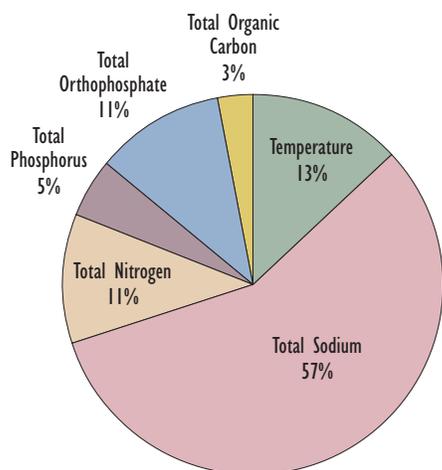
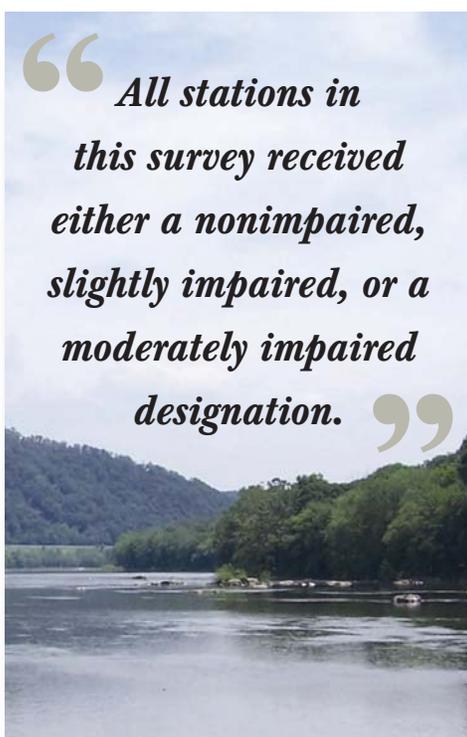


Figure 3. Parameters Exceeding Water Quality Standards



“All stations in this survey received either a nonimpaired, slightly impaired, or a moderately impaired designation.”

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 macroinvertebrate 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 |