## Description of the West Branch Susquehanna Subbasin

The West Branch Susquehanna Subbasin drains an area of approximately 6,982 square miles from Carrolltown to Northumberland, Pennsylvania, which includes significant portions of Cambria, Clearfield, Elk, Cameron, Potter, Clinton, Centre, Tioga, Sullivan, Lycoming, Union, and Montour Counties. Three different ecoregions are found within this area:

- **Northern Appalachian Plateau and Uplands,**
- **North Central Appalachians, and**
- **Central Appalachian Ridges and Valleys** (Omerick, 1987) (Figure 2).

The West Branch Susquehanna Subbasin contains some of the most scenic forestland in Pennsylvania. This subbasin consists largely of rural lands dominated by state forests and game lands with a few small urban areas scattered throughout (Figure 3). The largest urban centers in this watershed are Williamsport, State College, Lock Haven, and Clearfield. Strip mining is a prominent industry in this area due to the large stores of coal located in the western portion of the watershed. The many miles of streams impacted by abandoned mine drainage (AMD) are evidence of the heavy mining activity in this region. Agricultural activity is found mostly in the eastern and southern portions of the watershed.

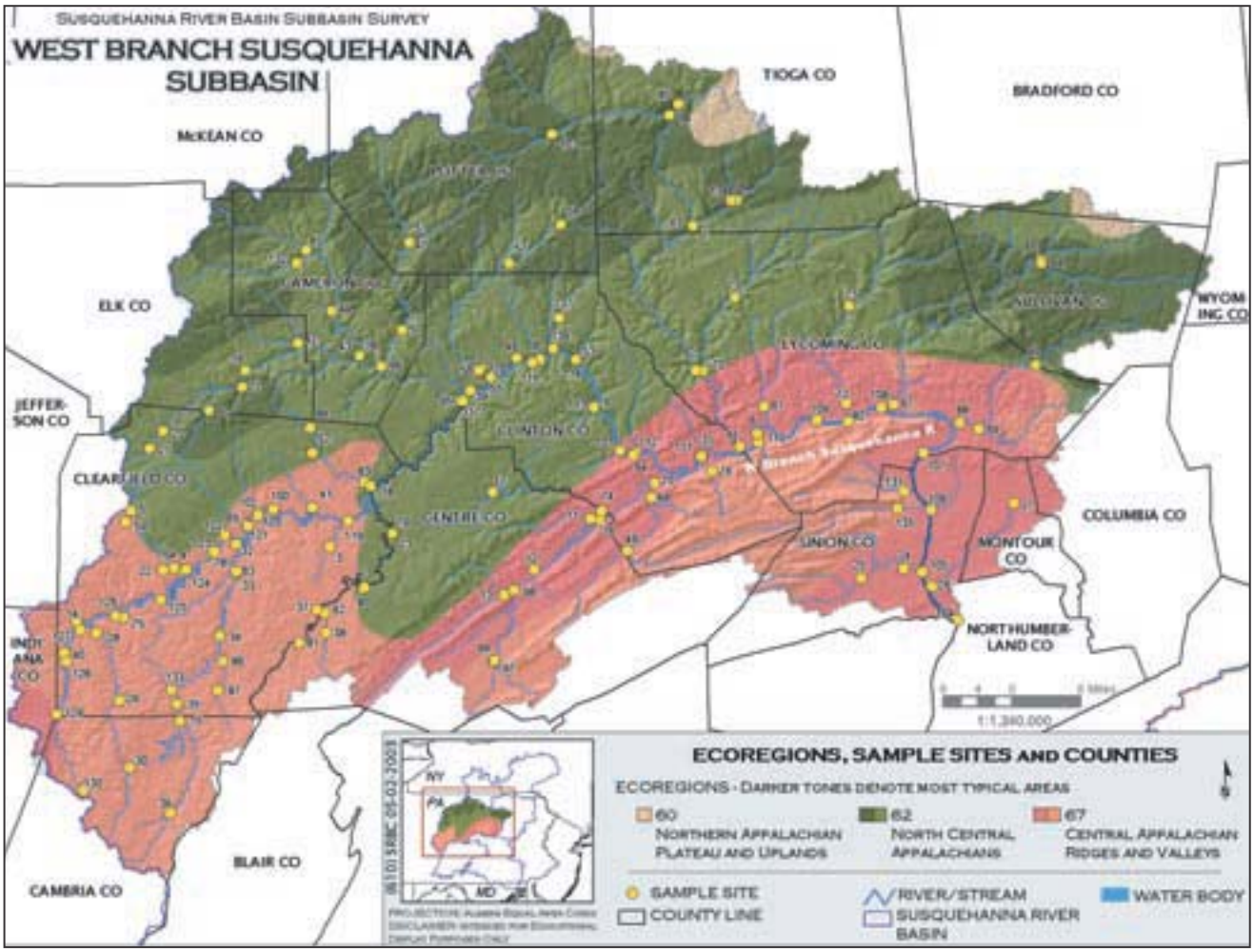
## Methods Used in the 2002 Subbasin Survey

### DATA COLLECTION

During the summer and fall of 2002, SRBC staff visited and collected samples from 137 sites throughout the West Branch Susquehanna Subbasin. Appendix A contains a list with the sample site number, the station name (designated by stream mile), a description of the sampling location, the latitude and longitude, the ecoregion, and the drainage size category. Macroinvertebrate samples were taken at 129 sites. Staff could not sample eight sites due to lack of riffle habitat or dry conditions. Habitat was rated at the sites where a macroinvertebrate sample was collected.

The sites were sampled once in this Year-1 sampling round in order to provide a point-in-time picture of stream characteristics throughout the whole subbasin. Samples were collected using a slightly 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).

***Figure 2.*** *Ecoregions and Counties in the West Branch Susquehanna Subbasin*

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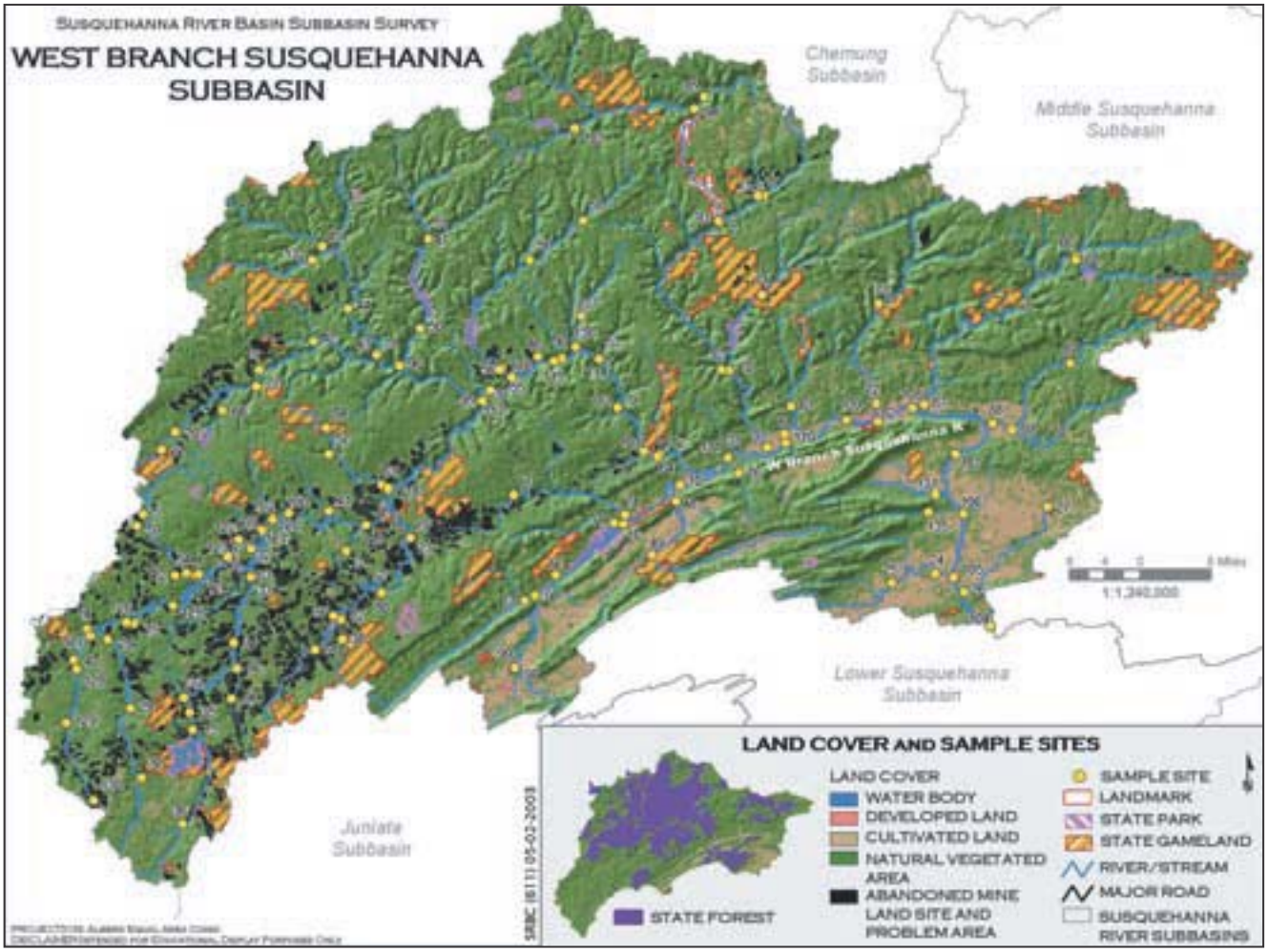


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***Figure 3.*** *Land Use in the West Branch Susquehanna Subbasin*

## WATER QUALITY

A portion of the water sample from each collection site was separated for laboratory analysis, and the rest of the sample was used for field analysis. A list of the field and laboratory parameters and their units is found in Table 1. 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 with a field thermometer in degrees Celsius. 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 titration of a known volume of sample water to pH 4.5 with 0.02N H2SO4. 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 (Pa. DEP), Bureau of Laboratories in Harrisburg, Pennsylvania.

***Table 1.*** *Water Quality Parameters Sampled in the West Branch Susquehanna Subbasin*

| 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** | |
| Specific Conductance, µmhos/cm | Total Sodium, mg/l |
| pH | Total Potassium, mg/l |
| Alkalinity, mg/l | Chloride, mg/l |
| Total Suspended Solids, mg/l | Sulfate - IC, mg/l |
| Total Nitrogen, mg/l | Total Fluoride, mg/l |
| Total Ammonia - N, mg/l | Total Copper, µg/l[d] |
| Nitrite - N, mg/l | Total Iron, µg/l |
| Nitrate - N, mg/l | Total Lead, µg/l |
| Total Phosphorus, mg/l | Total Manganese, µg/l |
| Total Organic Carbon, mg/l | Total Nickel, µg/l |
| Total Hardness, mg/l | Total Zinc, µg/l |
| Total Calcium, mg/l | Total Aluminum, µg/l |
| Total Magnesium, 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] µg/l = micrograms per liter

## 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.

## 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 about weather, substrate material composition, surrounding land use, and any other relevant features in the watershed.

## DATA ANALYSIS

Six reference categories were created for data analysis based on ecoregions (Omernick, 1987) and drainage size. The two ecoregions in the West Branch Susquehanna Subbasin where sampling sites were located were Ecoregion 62 (North Central Appalachians) and Ecoregion 67 (Central Appalachian Ridges and Valleys) (Figure 2). All the sites within each ecoregion were divided into small (< 50 square miles), medium (50 to 500 square miles), and large drainage areas (> 500 square miles).

Water quality was assessed by examining field and laboratory parameters that included nutrients, major ions, and metals (Table 1). Limit values were obtained for each parameter based on current state and federal regulations or references for approximate tolerances of aquatic life (Table 2). Laboratory values were used when field and laboratory data existed for the same parameter, and calcium and acidity were not analyzed due to inapplicability to the analysis. Ammonia values were not analyzed due to unusually high values, even in streams with known healthy fish populations. The difference between each value and the limit value was calculated for each site, and if the value did not exceed the limit value, the site was given a score of zero. If the limit value was exceeded, the difference was listed, and an average of all the parameters for each site was calculated. The sites were grouped according to

***Table 2.*** *Water Quality Limits and References*

| PARAMETERS | LIMITS | REFERENCE CODE |
|---|---|---|
| Temperature | >25°C | a,f |
| D.O. | <4 mg/l | a,g |
| Conductivity | >800 µmhos/cm | d |
| pH | <5 | c,f |
| Alkalinity | <20 mg/l | a,g |
| TSS | >15 mg/l | h |
| Nitrogen | >1.0 mg/l | k,l,m |
| Ammonia | >0.2 mg/l | f |
| Nitrite | >1.0 mg/l | f |
| Nitrate | >1.0 mg/l | e,i |
| Phosphorus | >0.1 mg/l | e |
| TOC | >10 mg/l | b |
| Hardness | >300 mg/ | e |
| Magnesium | >35 mg/l | j |
| Sodium | >20 mg/l | j |
| Potassium | >30 mg/l | b |
| Chloride | >150 mg/l | a |
| Sulfate | >250 mg/l | a |
| Fluoride | >2.0 mg/l | a |
| Copper | >12 µg/l | e |
| Iron | >1,500 µg/l | a |
| Lead | >1.0 µg/l | e |
| Manganese | >1,000 µg/l | a |
| Nickel | >158 µg/l | d |
| Zinc | >106 µg/l | e |
| Aluminum | >200 µg/l | c |
| Phos T Orth | >0.05 mg/l | m |

**REFERENCE CODES AND REFERENCES**

**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.fisheries.org/publications/bookpdf/aquaticmethods.pdf

**j**
http://www.dec.state.ny.us/website/regs/703.htm

**k**
http://water.usgs.gov/pubs/circ/circ1225/images/table.html

**l**
http://www.ecan.govt.nz/Land/pdf%20files/sheet13.pdf

**m**
http://h2osparc.wq.ncsu.edu/info/

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 ecoregions and drainage sizes. 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 (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).

## Methods Used in the 1994 Subbasin Survey

In the 1994 survey of the West Branch Susquehanna Subbasin, SRBC selected 92 sample sites. Eighty-seven sites were sampled once between July 5 and August 17, 1994, while five sites on the mainstem of the river were sampled on September 14, 1994, due to earlier storm events. The sites where data were collected in 1994, in addition to 2002, are indicated in Appendix A with an asterisk. The methods for sampling in 1994 were very similar to the methods in 2002, with some minor changes in protocol, equipment, and monitoring forms. As in 2002, benthic macroinvertebrates and water quality were sampled, and habitat was evaluated.

Biological and habitat conditions were evaluated according to USEPA RBP III (Plafkin, 1989). A different habitat form was used in 1994 than was used in 2002. Some of the parameters were slightly different, and were rated on a different scale than in 2002. Parameters relating to substrate and instream cover were rated on a scale of 0-20; these parameters included bottom substrate, embeddedness, canopy cover, and flow. Parameters relating to channel morphology were rated on a scale of 0-15; these included channel alteration, bottom scouring and deposition, pool/riffle-run/bend ratio, and bank capacity. Parameters relating to riparian and bank structure were rated on a scale from 0 to 10 and included bank stability, bank vegetative protection, streamside cover, and riparian zone.

### 1994 DATA ANALYSIS

The reference categories in the 1994 analysis differed since the USEPA's ecoregion coverage was used instead of the USGS's coverage. USEPA's coverage consisted of three ecoregions in the West Branch Susquehanna Subbasin. The third ecoregion that is not included in the USGS coverage is Ecoregion 69, the Central Appalachian region (Woods, 1996), where the headwaters of the West Branch Susquehanna River are located. Small streams (drainage areas <100 sq. mi.) were grouped by Level IV Ecoregion, medium streams (drainage area 100-500 sq. mi.) were grouped by Level III Ecoregion, and large streams (drainage area >500 sq. mi.) were grouped regardless of Ecoregion. Some of the small streams in subecoregions with similar characteristics were combined into a single reference category.

A different method was used to assess the 22 water quality parameters examined in 1994 (Table 3). Each parameter from every site was assigned a ranked percentile on a scale from 0 to 100 to obtain a percentile score. Water quality indices were developed from the median and average of all the parameter percentile scores from each site to be used in the designation of water quality conditions. Every parameter was characterized as "good," "fair," or "poor" based on: comparison of its percentile ranking to the median percentile of all sites for that parameter; the percentile derived from the established water quality standard for that parameter; and the median percentile of the reference sites. Each site was then designated "good," "fair," or "poor" based on analysis of its parameters and its water quality indices.

Different metrics were chosen in 1994 for analysis of the macroinvertebrate data; however, the overall method was the same as that which was used in 2002.

***Table 3.*** *Water Quality Parameters Analyzed in 1994*

| PHYSICAL | NUTRIENTS | MAJOR IONS | METALS |
|---|---|---|---|
| pH | Total nitrogen | Hardness | Copper |
| Dissolved oxygen | Total ammonia | Sodium | Dissolved iron |
| Conductivity | Total nitrate | Potassium | Lead |
| Alkalinity | Dissolved phosphate | Chloride | Total manganese |
| Acidity | | Sulfate | Nickel |
| Dissolved residue | | | Zinc |
| | | | Aluminum |