Susquehanna River Basin Commission

Juniata River Subbasin Year-1 Survey

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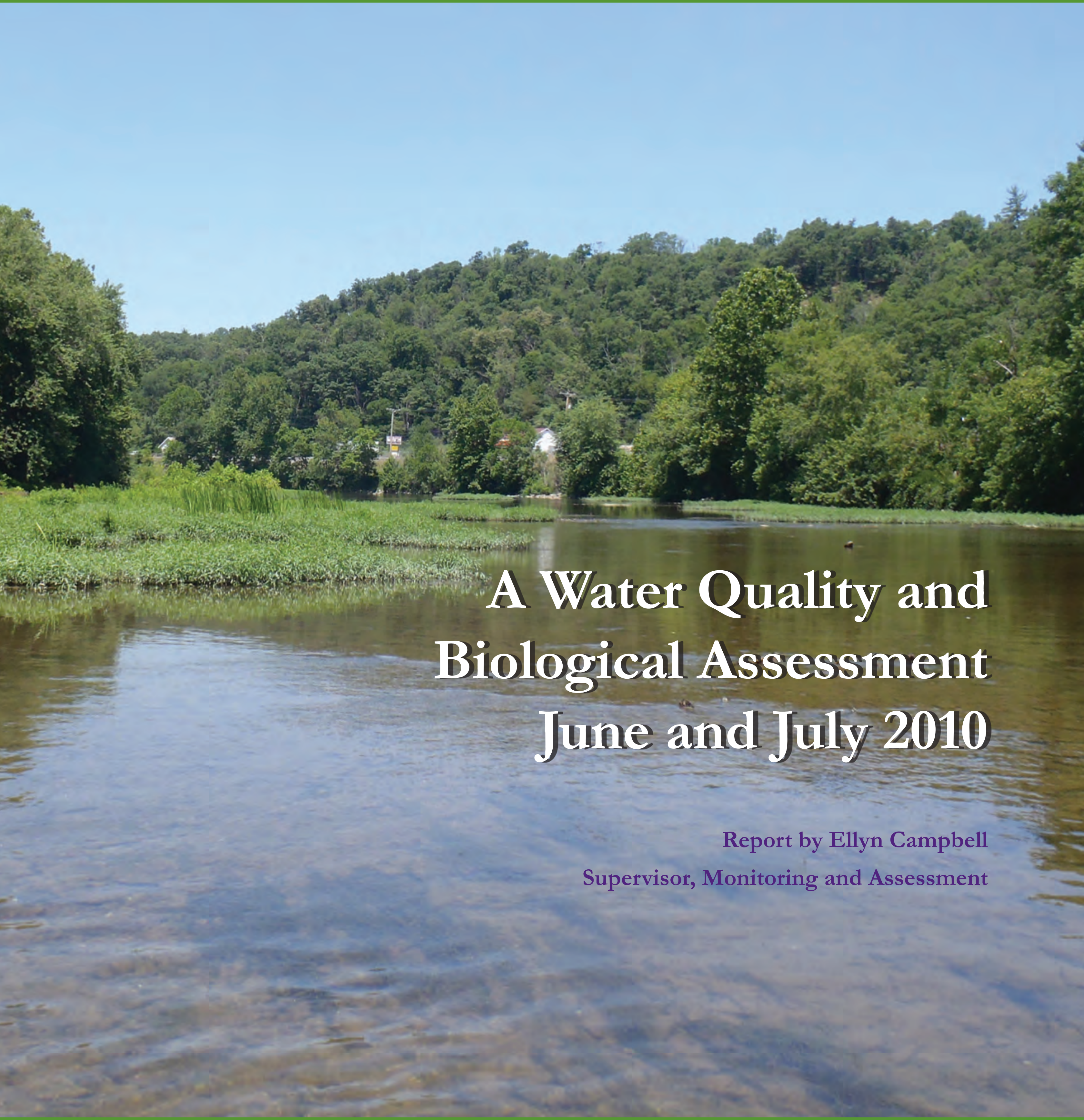

A Water Quality and Biological Assessment June and July 2010

Report by Ellyn Campbell

Supervisor, Monitoring and Assessment

Introduction

The Susquehanna River Basin Commission (SRBC) conducted a survey of the Juniata River Subbasin in June and July 2010. This survey was conducted through SRBC's Subbasin Survey Program, which is funded in part through the United States Environmental Protection Agency (USEPA). This program consists of two-year assessments in each of the six major subbasins (Figure 1) on a rotating schedule. Included in this report are details of the Year-1 survey, which included one-time samples of the macroinvertebrate community, habitat, and water quality at 101 sites in the major tributaries and areas of interest throughout the Juniata River Subbasin.

The Year-2 survey is a more focused, in-depth study. The Year-2 survey for the Juniata River Subbasin will involve the Low Flow Monitoring pilot project, which was started in 2010 and continued through 2011. For this Year-2 survey, 27 sites will be sampled in both base flow and low flow conditions to document changes in the biological community, habitat availability, and water chemistry during extended periods of low flow conditions and/or drought. Previous surveys of the Juniata River Subbasin were conducted in 1985 (McMorran, 1986), 1995 (McGarrell, 1997), and 2004 (LeFevre, 2005). A comparison of the 1995 and 2004 data along with the 2010 results is included in this report.

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 stream 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.

Figure 1. Six Major Subbasins of the Susquehanna River

Description of the Juniata River Subbasin

The Juniata River Subbasin drains an area of approximately 3,400 square miles from west of Bedford to Duncannon, Pa., which includes significant portions of Bedford, Blair, Fulton, Huntingdon, Perry, Juniata, and Mifflin Counties. Two different ecoregions are found within this area (Omernik, 1987):

- Central Appalachian Ridges and Valleys (Ecoregion 67), and
- Central Appalachians (Ecoregion 69).

Clover Creek, Blair County, Pa.

Ecoregion 67 is characterized by almost parallel ridges and valleys formed by folding and faulting events. Predominant geologic materials include sandstone, shale, limestone, dolomite, siltstone, chert, mudstone, and marble. Springs and caves are common in this ecoregion. Ecoregion 69 is largely a plateau formation that is predominantly sandstone, shale, conglomerate, and coal. Mining for bituminous coal has occurred in this ecoregion.

Six different subecoregions are found in the Juniata River Subbasin (Omernik and others, 1992) (Figure 2):

- 67a, Northern Limestone/Dolomite Valleys,
- 67b, Northern Shale Valleys,
- 67c, Northern Sandstone Ridges,
- 67d, Northern Dissected Ridges and Knobs,
- 69a, Forested Hills and Mountains, and
- 69b, Uplands and Valleys of Mixed Land Use.

Bells Gap Run at Hunter Road near Reightown, Blair County, Pa.

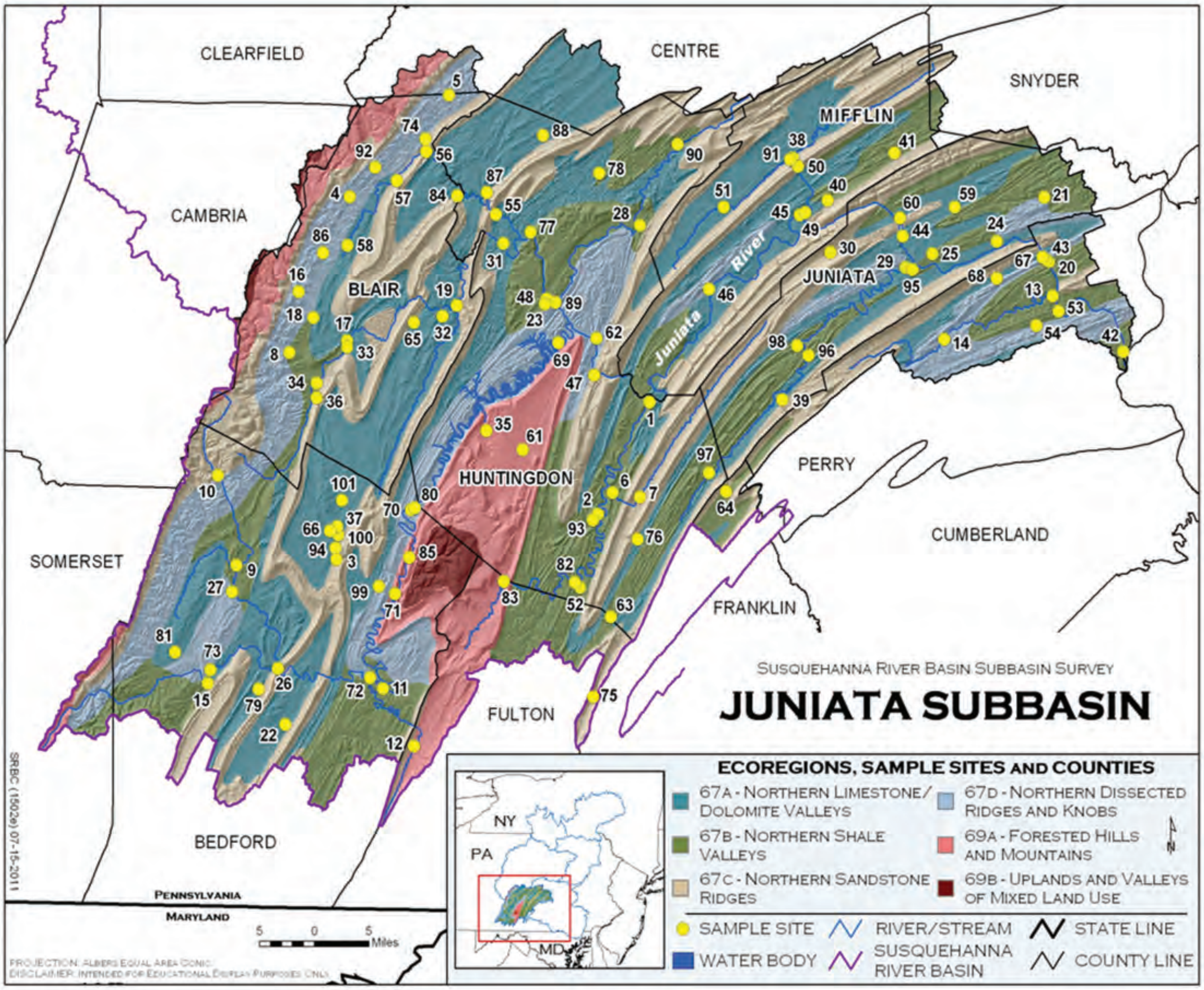

Figure 2. Juniata Subbasin Ecoregions and Sample Sites

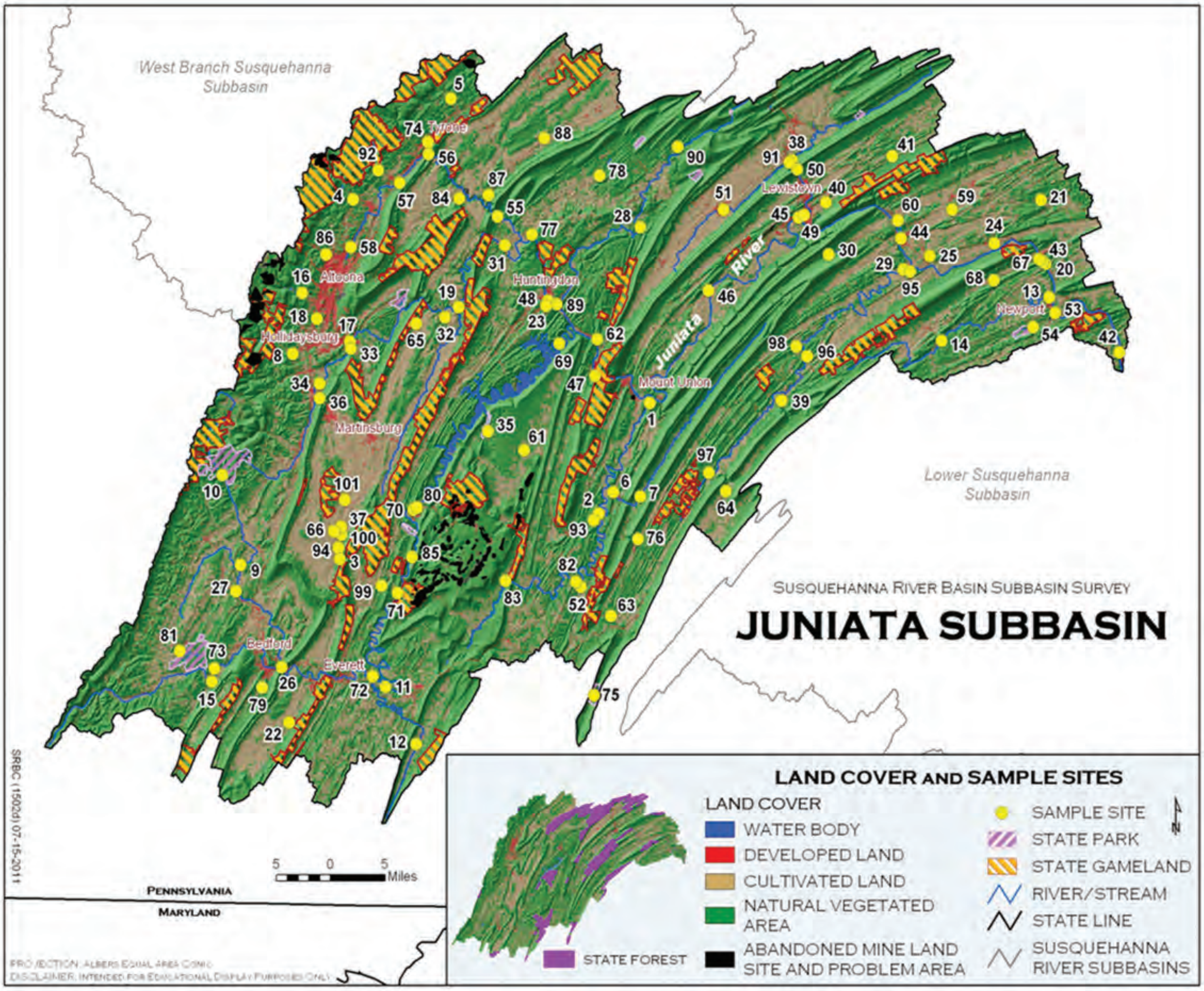

Figure 3. Juniata Subbasin Land Cover and Sample Sites

The mixed land use in the Juniata River Subbasin primarily includes forested areas concentrated in the ridges, with agricultural and urban areas in the valleys (Figure 3). Many of the forested areas include state forest or state game lands. The largest urban center is Altoona, with other notable developed areas including Bedford, Everett, Tyrone, Huntingdon, Mount Union, Lewistown, and Newport. Other important land uses in this subbasin are abandoned mine lands (AML) and impounded water in Raystown Lake. Raystown Branch Juniata River was dammed in 1968 primarily for flood control, but the lake is also used as a recreational impoundment. Today, some hydroelectric power is generated at this dam.

SRBC staff processing a macroinvertebrate sample at Buffalo Creek near Newport, Perry County, Pa.

Methods

Data Collection

During June and July 2010, SRBC staff visited 101 sites throughout the Juniata River Subbasin. Appendix A contains a list with the sample site number, station name (designated by approximate stream mile), description of the sampling location, latitude and longitude, drainage in square miles, and subecoregion and drainage size category. Water quality was sampled at all 101 sites. Because of high flow and access issues, macroinvertebrate samples were taken at 96 sites, and habitat was assessed at 99 sites. The sites were sampled once during this Year-1 sampling effort to provide a point-in-time picture of stream characteristics throughout the whole subbasin.

Water Quality

Field chemistry analysis was done at the time of sampling, and water samples from each sampling site were also collected for laboratory analysis. A list of the field and laboratory parameters and their units is found in Table 1. A multi-meter YSI sonde was used to collect all field chemistry parameters (temperature, conductivity, pH, and dissolved oxygen) simultaneously. The probes of all meters were rinsed with distilled water and sample water prior to collection of water quality data, and calibrations were conducted as detailed in the Quality Assurance Project Plan (QAPP). At stations with no USGS gage, flow measurements were made by field personnel using a FlowTracker and standard USGS procedures (Buchanan and Somers, 1969). Water samples were collected using depth-integrated water sampling methods (Guy and Norman, 1969) and were iced and shipped to the Pennsylvania Department of Environmental Protection (PADEP), Bureau of Laboratories in Harrisburg, Pa.

Table 1. Water Quality Parameters Sampled in the Juniata 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	
Alkalinity (mg/l)	Total Magnesium (mg/l)
Total Dissolved Solids (mg/l)	Total Sodium (mg/l)
Total Suspended Solids (mg/l)	Chloride (mg/l)
Total Nitrogen (mg/l)	Sulfate-IC (mg/l)
Nitrite-N (mg/l)	Total Iron (µg/l[e])
Nitrate-N (mg/l)	Total Manganese (µg/l)
Turbidity (NTU[d])	Total Aluminum (µg/l)
Total Organic Carbon (mg/l)	Total Phosphorus (mg/l)
Total Hardness (mg/l)	Total Orthophosphate (mg/l)
Total Calcium (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

Macroinvertebrates

Benthic macroinvertebrates (organisms that live on the stream bottom, including aquatic insects, crayfish, clams, snails, and worms) were collected using a slightly modified version of the USEPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (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. The two kick-screen samples were composited into one sample, which was preserved in 95-percent denatured ethyl alcohol and returned to SRBC's lab. The sample was then subsampled, and approximately 200 (± 20%) organisms were identified to genus, except for midges and aquatic worms, which were identified to family.

Habitat

Habitat conditions were also 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 recent precipitation events, 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 1). 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 2). The difference between each value and the level of concern value from Table 2 was calculated for each site. If the measured value exceeded the level of concern value, the difference between the two was listed. If the measured value did not exceed the level of concern value, the difference was listed as zero. An average of all the differences 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.

Seven reference categories were created for macroinvertebrate and habitat data analysis. All the sites were divided into small

(<100 square miles), medium (100 to 500 square miles), and large (>500 square miles) drainage areas. The small drainage areas were then grouped according to ecoregions and subecoregions (Omernik, 1987; Omernik, 1992). The seven reference categories used were 67a, 67b, 67c, 67d, 69a, medium-sized drainage, and large-sized drainage. One reference site was chosen in each of the seven reference categories, 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 within each category.

Benthic macroinvertebrate samples were analyzed using seven metrics mainly derived from RBP III: (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. Each site's metric scores were compared to the scores at its corresponding reference site, and a biological condition category of nonimpaired, slightly impaired, moderately impaired, or severely impaired was assigned based on RBP III methods. The same reference sites were used in the analysis for the habitat scores. The ratings for each habitat condition were totaled, and a percentage score of the reference site was calculated. The percentages were used to assign a habitat condition category of excellent, supporting, partially supporting, or nonsupporting to each site.

Table 2. Water Quality Standards and Levels of Concern

Parameters	Limits	Reference Code	Reference
Based on state water quality standards:			
Temperature	> 30.5 ºC	a	a. http://www.pacode.com/secure/data/025/chapter93/s93.7.html
Dissolved Oxygen	< 4 mg/l	a	b. http://www.pacode.com/secure/data/025/chapter93/s93.8c.html
pH	< 6.0	a	c. http://www.dec.ny.gov/regs/4590.html#16132
Alkalinity	< 20 mg/l	a	d. http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.03-3.htm
Total Chloride	> 250 mg/l	a	
Total Dissolved Solids	> 500 mg/l	c	
Total Sulfate	> 250 mg/l	a	
Total Iron	> 1500 µg/l	a	
Total Manganese	> 1000 µg/l	a	
Total Aluminum	> 750 µg/l	b	
Total Magnesium	> 35 mg/l	c	
Total Sodium	> 20 mg/l	c	
Total Suspended Solids	> 25 mg/l	a	
Turbidity	> 50 NTU	d	
Based on background levels or aquatic life tolerances:			
Conductivity	> 800 µmhos/cm	e	e. http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm
Total Nitrogen	> 1 mg/l	f	f. http://water.usgs.gov/pubs/circ/circ1225/images/table.html
Total Nitrate	> 0.6 mg/l	f	g. http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm
Total Nitrite	> 1 mg/l	c	h. Hem (1970)
Total Phosphorus	> 0.1 mg/l	g	i. Based on archived data at SRBC
Total Orthophosphate	> 0.02 mg/l	f	
Total Organic Carbon	> 10 mg/l	h	
Total Hardness	> 300 mg/l	g	
Acidity	> 20 mg/l	i	
Calcium	> 100 mg/l	i	

Results/Discussion

To assess water quality, macroinvertebrate, and habitat conditions, SRBC sampled a total of 101 sites in the Juniata River Subbasin in 2010. The results of the 101 sites are depicted in Figures 4-6.

Ninety-six of those sites included a benthic macroinvertebrate collection. Twenty-nine sites (29 percent) had nonimpaired macroinvertebrate communities, 37 sites (36 percent) had slightly impaired communities, 29 sites (29 percent) had moderately impaired communities, and only one site had a severely impaired community (Figure 4).

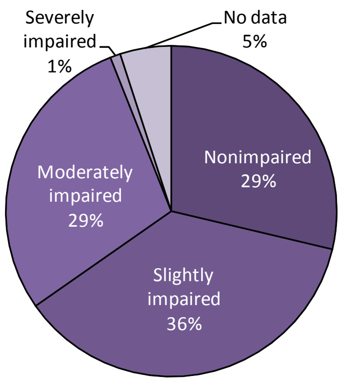

Figure 4. 2010 Biological Condition Categories for 101 Juniata Subbasin Sites

A total of 99 sites were evaluated for habitat conditions, which on the whole were rated highly. Fifty-eight sites (57 percent) had excellent habitat, 39 sites (39 percent) had supporting habitat, and two sites (2 percent) had partially supporting habitat (Figure 5).

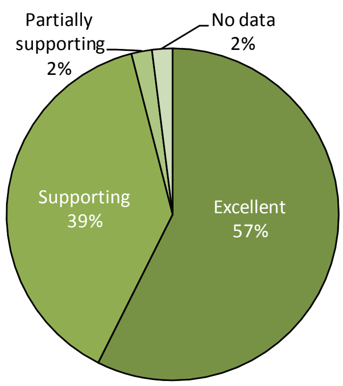

Figure 5. 2010 Habitat Condition Categories for 101 Juniata Subbasin Sites

Water chemistry was evaluated at all 101 sites. Thirty sites (30 percent) did not exceed any water quality levels of concern and received a higher water quality designation. A total of 71 sites (70 percent) had at least one parameter exceed levels of concern, with 66 sites (65 percent) receiving a middle water quality designation and five sites (5 percent) receiving a lower water quality designation (Figure 6). Fifty-three sites (52 percent) had at least two parameters exceed levels of concern, and 12 sites (12 percent) had four or more parameters exceed levels of concern.

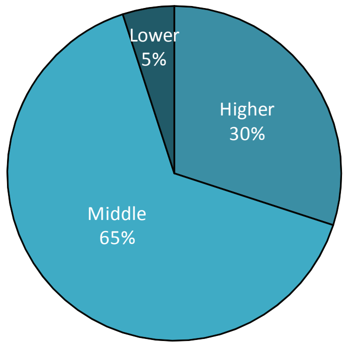

Figure 6. 2010 Water Quality Condition Categories for 101 Juniata Subbasin Sites

Eleven sites (11 percent) had the ideal combination of nonimpaired macroinvertebrate communities, excellent habitat, and higher water quality designations. An additional eighteen sites (19 percent) had nonimpaired communities and either higher or middle water quality designations.

The most widespread parameters of concern within the subbasin were total nitrogen and nitrate, at 56 percent and 47 percent of sites, respectively. The values set for total nitrogen and nitrate (1.0 mg/l) are based on natural background concentrations, which means 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 highest levels of nitrate and total nitrogen were 11.9 mg/l and 12.27 mg/l, respectively, both of which occurred on Yellow Creek in Woodbury (YELL 12.0).

"The most widespread parameters of concern within the subbasin were total nitrogen and nitrate."

Orthophosphate and total phosphorus exceeded background concentrations at 16 percent and 10 percent of sites, respectively. The Frankstown Branch Juniata River near Hollidaysburg (FRNK 32.5) had the highest levels of both orthophosphate (0.355 mg/l) and total phosphorus (0.418 mg/l). High phosphorus levels can be indicators of wastewater and septic systems, detergents, chemical fertilizers, animal waste, some industrial discharges, and soil erosion.

Other parameters that exceeded levels of concern at multiple sites included alkalinity (11 percent of sites), sodium (7 percent), and aluminum (5 percent).

Section 303(d) of the 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 State Surface Waters Assessment Program, and if they are found to be impaired, a TMDL is calculated for the watershed (PADEP, 2010). Some of the watersheds in the Juniata River Subbasin have been rated impaired, and subsequently will require a TMDL. Since the Subbasin report in 2005, six TMDLs have been established for streams that are part of the Year-1 study. TMDLs were established for Sixmile Run (SIXM 0.3) and Burgoon Run (BURG 0.5) for abandoned mine drainage (AMD) and for Beaverdam Branch (BVDB 0.1 and 5.0) and Frankstown Branch (FRNK 32.5) for AMD, combined sewer overflow, and urban runoff. TMDLs were also established for Yellow Creek (YELL 9.1 and 12.0) for siltation and nutrients and Little Juniata River (LJUN 29.6) for municipal point source and urban runoff.

Major sources of impairment within the Juniata River Subbasin include agriculture (general, crop-related, grazing-related, and animal feeding-related), AMD, combined sewer overflows, urban runoff, small residential runoff, industrial point source, municipal point source, road runoff, and construction activities. Pollutants from these sources are listed as mercury, siltation, nutrients, organic enrichment, low dissolved oxygen, metals, low pH, nonpriority organics, priority organics, suspended solids, PCBs, and thermal modifications.

Confluence of Plum and Halter creeks, near Roaring Spring, Blair County, Pa.

Frankstown Branch & Raystown Branch of the Juniata River

Frankstown Branch Juniata River

Site conditions for the Frankstown Branch and Raystown Branch of the Juniata River are depicted in Figure 7. The Frankstown Branch drains the urban area of Altoona, Pa., some AML, agricultural lands, and forested areas with sections of state game lands. Of the 11 sites in the Frankstown Branch, nine sites (82 percent) had parameters above levels of concern. Nitrogen and phosphorus were the most common parameters to exceed background levels in the Frankstown Branch at 73 percent and 55 percent, respectively.

Two of the 11 sites had higher water quality (BLRG 2.5 (Blair Gap Run) and BVDB 0.1 (Beaverdam Branch)), and three sites had lower quality. Two of these three lower water quality sites (FRNK 32.5 and 38.1) had elevated nitrate, total nitrogen, orthophosphorus, phosphorus, and sodium levels, but the one benthic macroinvertebrate sample that was taken indicated only slight impairment. The third lower water quality site (BURG 0.5) experienced the highest levels of magnesium, acidity, and metals, as well as the lowest values of alkalinity and pH, and had the only severely impaired benthic community in the entire Juniata River Subbasin. This site is heavily impacted from AMD and the substrate of the stream is covered in iron precipitate.

Only one site within the Frankstown Branch had a nonimpaired benthic community (FRNK 1.6), which also had middle water quality influenced by elevated nutrients and sodium. Four sites were slightly impaired, and four sites were moderately impaired. The moderately impaired sites largely correlated with middle water quality resulting from higher nitrate, nitrogen, orthophosphate, and phosphate levels. Both FRNK 18.9 and BVDB 5.0 had elevated sodium, while BVDB 5.0 also had higher aluminum and magnesium levels. Both BVDB 5.0 and BURG 0.5 receive AMD and display iron precipitate on the substrate. The moderately impaired community at BVDB 0.1 is not as easily explained as it had higher water quality and supporting habitat, and further investigation would be required.

As previously mentioned, the Frankstown Branch Juniata River near Hollidaysburg (FRNK 32.5) had the highest levels of both orthophosphate (0.355 mg/l) and total phosphorus (0.418 mg/l). There are numerous sewage treatment plants and other industrial discharges that may account for this.

"Of the 11 sites in the Frankstown Branch, nine sites (82 percent) had parameters above levels of concern."

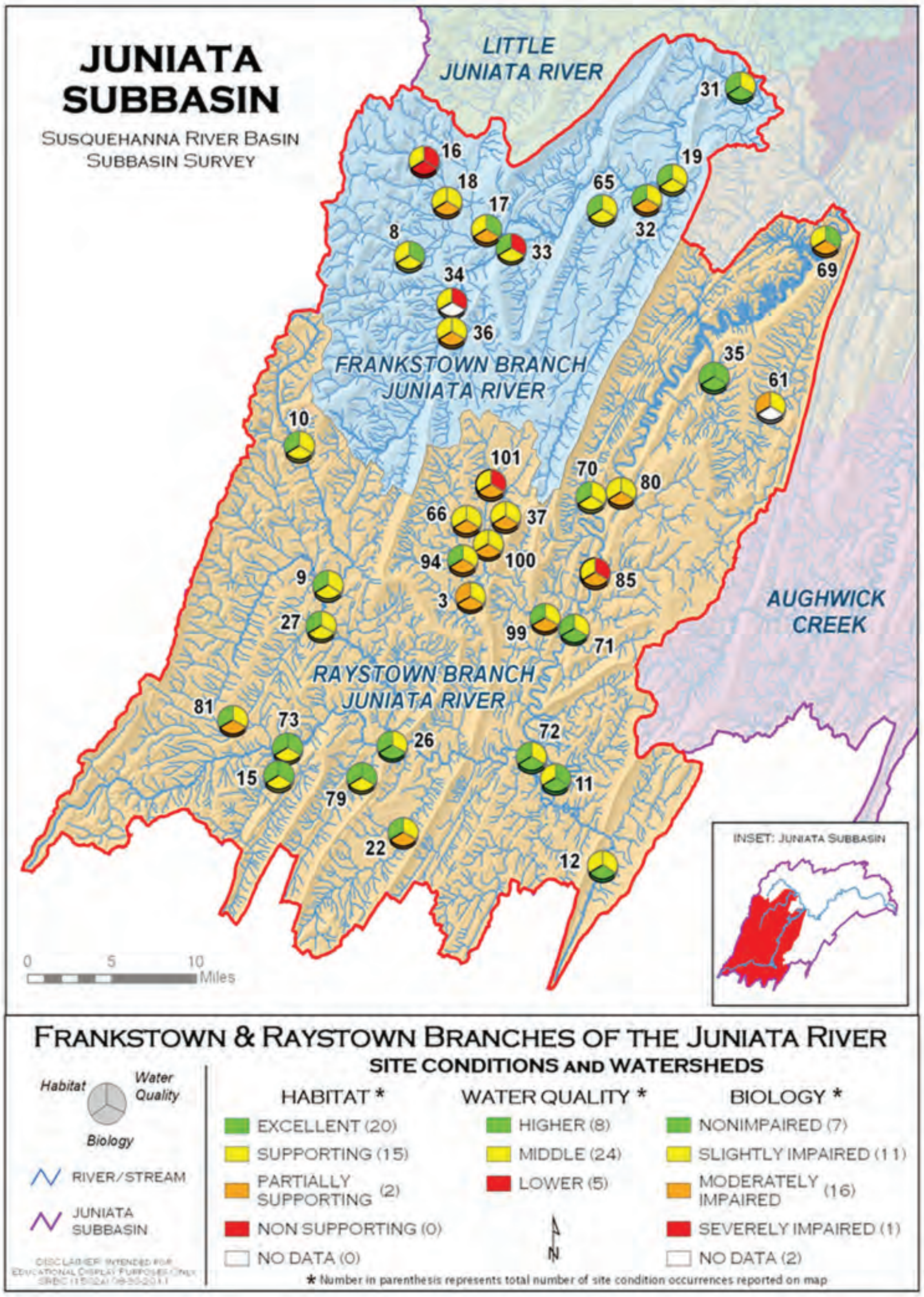

Figure 7. Frankstown and Raystown Site Conditions and Watersheds

Raystown Branch Juniata River

The Raystown Branch Juniata River drains the area west of Bedford to near Huntington, Pa., the lower section of which is dammed for approximately 28 miles, forming Raystown Lake. The land use in the Raystown Branch Subwatershed is similar to that of the Frankstown Branch, but less urbanized. The most agricultural area within this watershed is Yellow Creek, located in the Morrison Cove area.

A total of 26 sites were located throughout the Raystown Branch Watershed. Seventy-seven percent of those sites had water quality parameters above the levels of concern. The vast majority of these parameters included nitrate and nitrogen (58 percent of all sites), indicating the presence of agricultural land use, as well as typical AMD indicators such as excessive hardness and metals and depressed pH and alkalinity. Total aluminum was problematic at 12 percent of sites.

Two of the seven ecoregion-specific reference sites (GTRC 2.9 and RAYS 54.1) are located within the Raystown Branch Watershed. Both of these sites had nonimpaired benthic macroinvertebrate communities and excellent habitat, but GTRC 2.9 had higher water quality while RAYS 54.1 had middle water quality. Six sites had nonimpaired benthic communities.

Six sites had higher water quality: BRUS 0.1 (Brush Creek), BUFR 0.4 (Buffalo Run), GTRC 2.9 (Great Trough Creek), RAYS 4.6 and 103 (Raystown Branch), and SHOB 0.4 (Shobers Run). The vast majority of sites had middle water quality. Two sites had lower water quality and moderately impaired benthic communities. One of these sites is SIXM 0.3 on Sixmile Run, which is affected by AMD. The other site, YELL 12.0, suffered from lower water quality stemming from the highest levels of nitrate, nitrogen, hardness, and magnesium levels seen in the entire study. Most sites within the Yellow Creek Watershed (including BEAV 0.1 (Beaver Creek), HKBC 0.1 (Hickory Bottom Creek), PTRC 0.1 (Potter Creek), TSPR 0.1 (Three Springs Run), and YELL 3.5 and 9.1 (Yellow Creek)) had moderately impaired benthic communities, middle water quality, and moderately higher levels of nitrate and nitrogen, indicating surrounding agricultural land use.

Raystown Branch near Breezewood, Bedford County, Pa.

Based on water quality results, AMD appears to be affecting three streams in addition to Sixmile Run—Cove Creek (COVE 7.7), Shawnee Branch (SHWN 4.2), and Shoups Run (SHUP 0.1)—resulting in moderately impaired benthic communities and middle water quality. Raystown Branch at RAYS 4.6 also had a moderately impaired benthic community, but had higher water quality and supporting habitat.

Upper Juniata River

Site conditions for the Upper Juniata River section are illustrated in Figure 8. The Upper Juniata River section includes Little Juniata River, Shavers Creek, Crooked Creek, Standing Stone Creek, Mill Creek, and Aughwick Creek Watersheds. A total of 30 sites were located within this section. Sixty percent of those sites had water quality parameters above levels of concern. Forty percent of sites had elevated levels of nitrate and nitrogen, with 13 percent having elevated orthophosphate or phosphorus levels. Twelve of the sites had higher water quality, with the vast majority of the sites (18) having middle water quality.

The Upper Juniata River section contains four of the seven ecoregion-specific reference sites: BIGF 1.0 (Big Fill Run), NBLA 1.4 (North Branch Little Aughwick Creek), and STST 1.0 and 26.8 (Standing Stone Creek). These sites have nonimpaired benthic communities and either higher or middle water quality.

Twelve sites had slightly impaired benthic communities, while six sites had moderately impaired benthic communities. Five of these six moderately impaired sites occur in the Little Juniata River Watershed, with two sites, SINK 0.3 (Sinking Run) and SPRU 10.6 (Spruce Creek), draining agricultural lands and having nitrogen and nitrate issues. Two more moderately impaired sites were on the Little Juniata River itself (LJUN 19.4 and 29.6) and had orthophosphorus, phosphorus, and sodium issues in addition to elevated nitrogen and nitrate. These two sites, as well as LJUN 15.0 (no biological sample taken), drain urban centers Altoona, Bellwood, and Tyrone. The fifth site, SBEC 1.4 (South Bald Eagle Creek), had higher water quality, despite draining the town of Tyrone. The sixth moderately impaired site was located in the upstream reaches of South Branch Little Aughwick Creek (SBLA 8.3) and had issues with low alkalinity. All six moderately impaired sites had either excellent or supporting habitat quality.

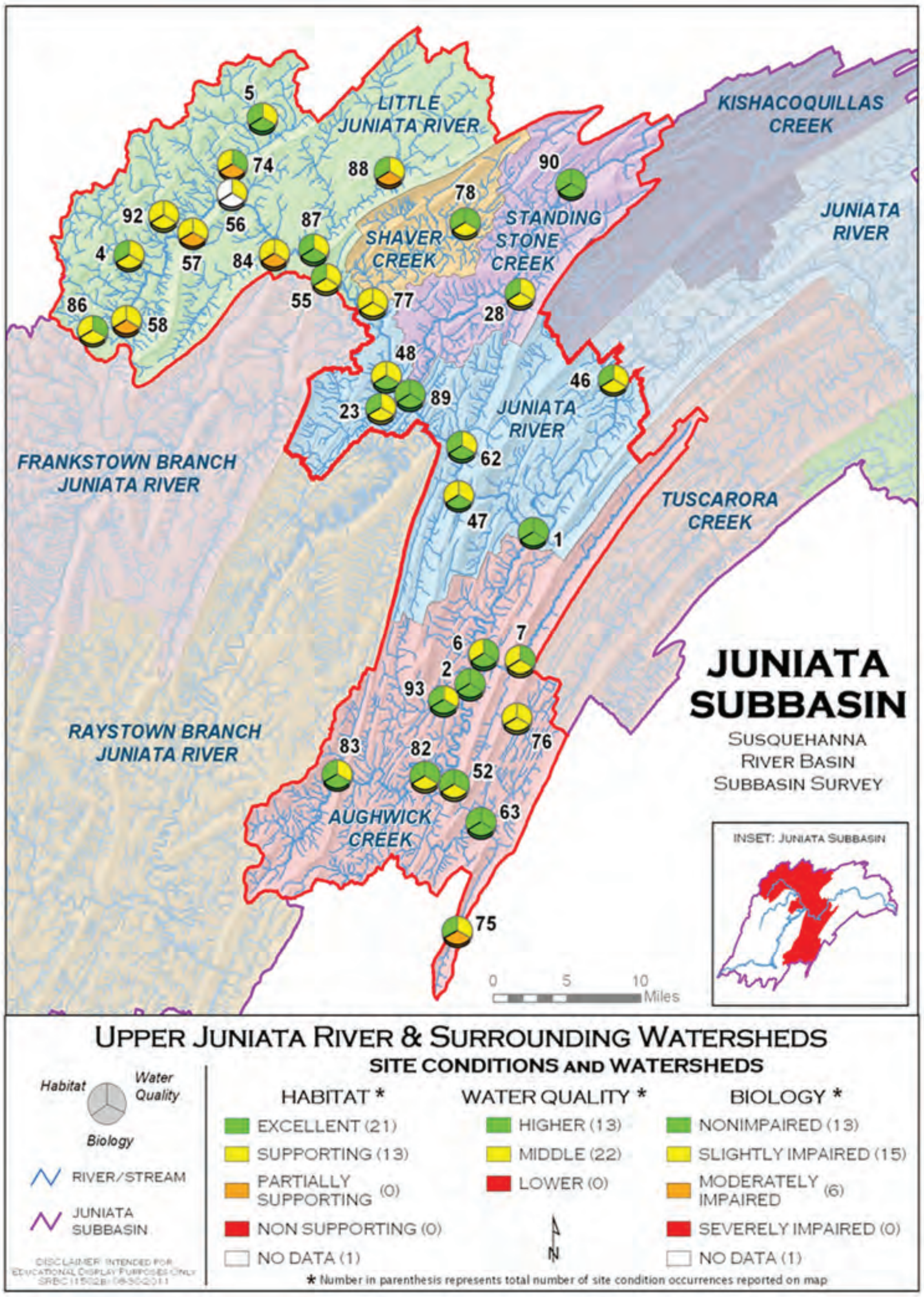

Figure 8. Upper Juniata Site Conditions and Watersheds

Crooked Creek in Huntingdon, Huntingdon County, Pa. — Upper Juniata River Subbasin.

Lower Juniata River

Site conditions for the Lower Juniata River section are shown in Figure 9. The Lower Juniata River section consists of Kishacoquillas Creek, Jacks Creek, Lost Creek, Doe Run, Tuscarora Creek, Delaware Creek, Raccoon Creek, Cocolamus Creek, Buffalo Creek, and Little Buffalo Creek. A total of 27 sites were evaluated within this section. Seventy-four percent of these sites had parameters above levels of concern. Seventy percent of the sites had elevated levels of nitrogen and/or nitrate. Eleven percent had orthophosphate and/or phosphorus above background levels. Seven percent had issues with total suspended solids.

The Lower Juniata River section contains one ecoregion-reference site, ELKC 9.8 (East Licking Creek), which had higher water quality and a nonimpaired benthic community. A total of seven sites had higher water quality, with three of those sites also having nonimpaired communities. The 20 remaining sites had middle water quality. Most of the sites had slightly impaired benthic communities, but eight sites had nonimpaired communities, including BUFF 0.4 and 14.6 (Buffalo Creek), DELA 0.2 (Delaware Creek), ELKC 9.8, HONY 0.2 (Honey Creek), JACK 2.9 (Jacks Creek), and TUSC 0.6 and 22.5 (Tuscarora Creek).

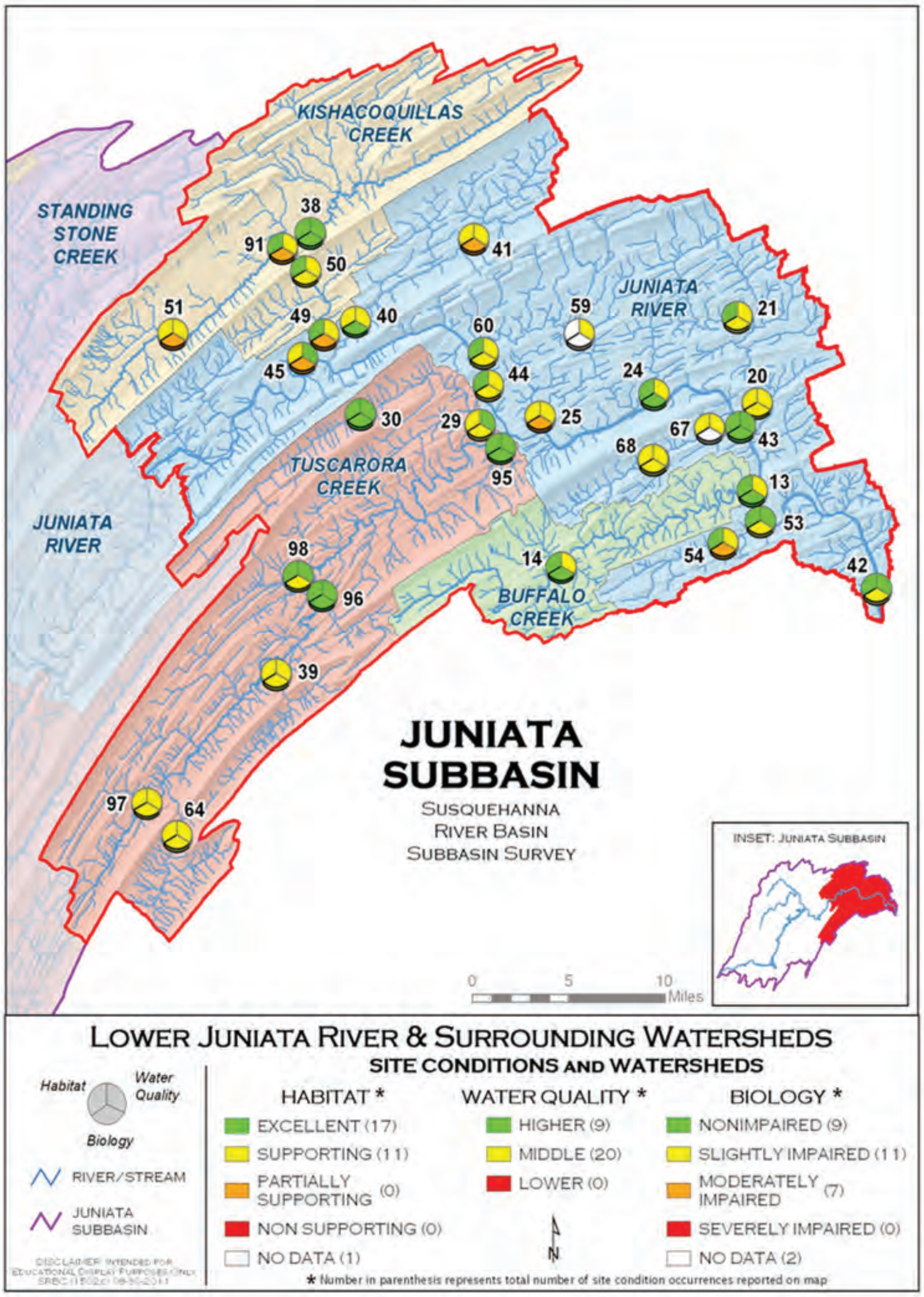

Figure 9. Lower Juniata Site Conditions and Watersheds

Six sites had moderately impaired benthic communities, and all had middle water quality. Both TEAC 0.1 (Tea Creek) and JACK 11.7 (Jacks Creek) have nitrate and/or nitrogen problems. These watersheds drain croplands, pasture, and varying degrees of urbanization. In addition to nitrate and/or nitrogen, both LBUF 2.1 (Little Buffalo Creek) and DOER 0.3 (Doe Run) also have elevated levels of total suspended solids and aluminum. Their drainage areas include roads, crops, pastures, and industrialized and urbanized areas. Sites KISH 0.4 and 15.6 (Kishacoquillas Creek) are in the urbanized areas of Burnham, Highland Park, Lewistown, and part of Belleville and experience issues with elevated nitrogen/nitrate, total suspended solids (TSS), and orthophosphate. All sites had either excellent or supporting habitat.

Kishacoquillas Creek, near Belleville, Mifflin County, Pa. — Lower Juniata River Subbasin.

Juniata River Mainstem

Site conditions for the Juniata River mainstem are illustrated in both Figures 8 and 9. A total of seven sites were sampled on the Juniata River mainstem. Fifty percent of the sites had parameters that exceeded water quality standards or levels of concern. Seventy-four percent of the sites had elevated nitrogen and/or nitrate, and 28 percent had orthophosphate over levels of concern. Three of the sites had higher water quality, and four sites had middle water quality. No sites had lower water quality. Three sites had nonimpaired benthic communities, including JUNR 17.3 near Millerstown, JUNR 84.6 near Mapleton, and JUNR 94 in Huntingdon. Three sites had slightly impaired communities. One site, JUNR 47.0 in Lewistown, had higher water quality but also had a moderately impaired benthic community, possibly because of its size and limited riffle habitat. All sites either had excellent or supporting habitat.

Comparison to Historical Data

The data collected from the Juniata River Subbasin in 2010 were compared against the data collected in 1995 and 2004. Approximately 68 percent more sites were sampled in 2010 and 2004 than in 1995, so overall watershed trends in biological condition categories, habitat condition categories, and water quality may not be directly comparable. However, while the 1995 dataset is smaller than the 2004 and 2010 datasets, it is robust enough that it is representative of the watershed and land use conditions at that time. Consequently, inferences about the biological, habitat, and chemical health can be generalized over the course of the three sampling periods. The results for biology, habitat, and water quality conditions for these three years are depicted in Figures 10 through 12.

Biology

The percent of sites with levels of impairment to benthic communities increased in 2010. Overall, the percentage of nonimpaired communities went from 54 percent in 2004 and 56 percent in 1995 to only 30 percent in 2010 (Figure 10). This increase in impaired communities corresponds to the number of sites with slightly impaired benthic communities (39 percent in 2010, compared to 32 and 31 percent in 2004 and 1995, respectively) and, more strikingly, in moderately impaired benthic communities (30 percent in 2010, compared to 10 and 14 percent in 2004 and 1995, respectively). Only one site was designated as severely impaired in 2010, which has improved from the 4 percent of sites that were designated the same in 2004. No sites were severely impaired in 1995.

Condition categories determined in 2010 were compared to those determined in the previous sampling event for each site (Table 3). Improvement in biological condition categories occurred in 3 to 33 percent of sites throughout the different sections of the Juniata basin, with the Frankstown Branch and Juniata mainstem sections seeing the most improvement, at 30 and 33 percent of their sites, respectively. All sections experienced some moderate biological degradation, from 31 percent (Upper section) to 52 percent (Lower section) of sites. Many sites within the sections retained their previous biological condition categories, with the Juniata mainstem experiencing the least retention (17 percent of its sites) to the Upper section, which is the least developed of all sections, having the most retention (66 percent of its sites).

Habitat

Similar patterns held true for the habitat data (Figure 11). In 2010, only about 59 percent of the sites had excellent habitat, as compared to the 2004 estimation of 81 percent. The 2010 findings, however, were similar to the estimation observed in 1995 of 54 percent. The 2010 decrease in excellent habitat conditions also corresponds to an increase in the number of sites with more degraded conditions. For example, supporting habitat increased to 39 percent in 2010, compared to 16 percent in 2004 and 29 percent in 1995. Sites that were noted to have partially supporting habitat in 2010 was 2 percent, which is similar to that observed in 2004, and lower than the 10 percent noted in 1995.

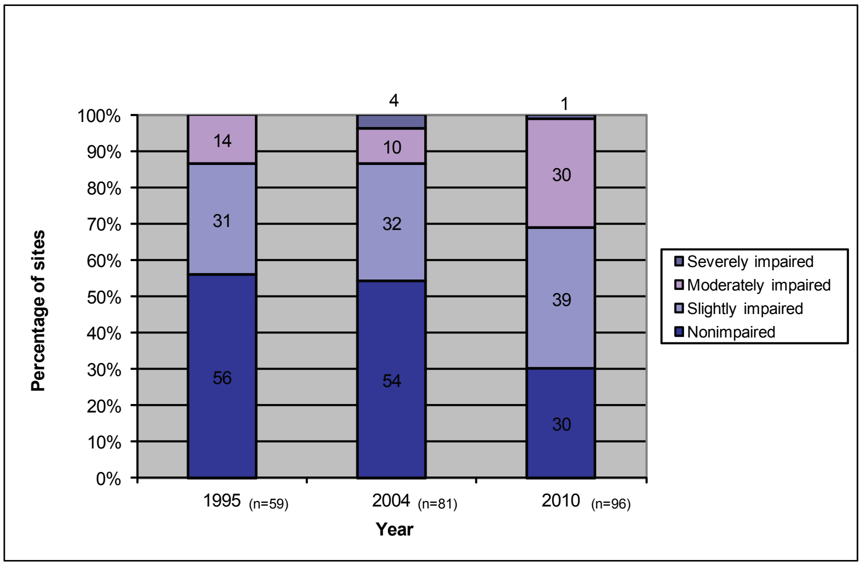

Figure 10. Historical Biological Condition Categories Documented in the Juniata Subbasin Studies

Table 3. Comparison of Condition Categories (1995, 2004, and 2010 Data)									
	Percent of sites with a change in Condition Categories (1995, 2004, and 2010 data)								
	Biology			Habitat			Water Quality		
	Improved	Degraded	No Change	Improved	Degraded	No Change	Improved	Degraded	No Change
Frankstown Branch	30	40	30	9	36	55	45	18	36
Raystown Branch	4	44	52	4	28	68	12	0	88
Upper	3	31	66	14	24	62	10	16	73
Lower	4	52	44	12	36	52	33	0	67
Mainstem	33	50	17	17	33	50	43	0	57
Mean	15	43	42	11	31	57	29	7	64

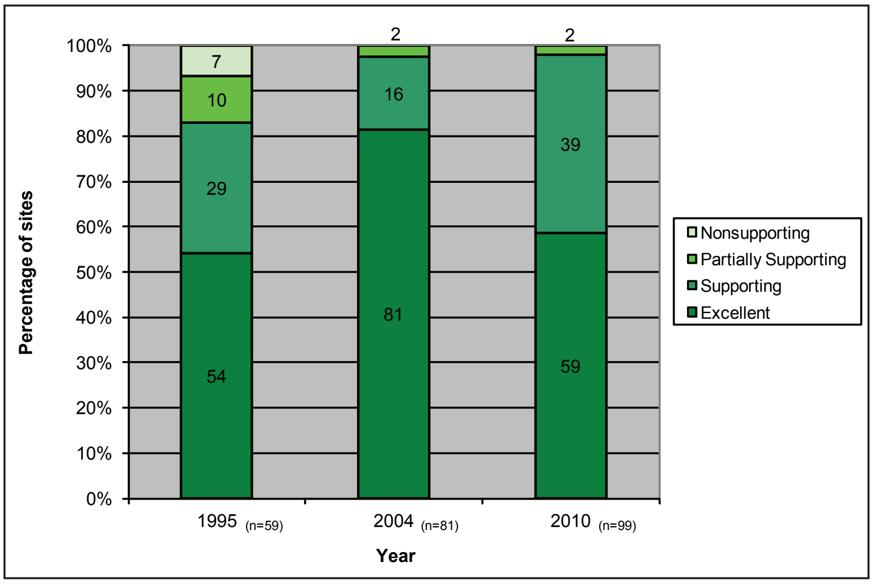

Figure 11. Historical Habitat Condition Categories Documented in the Juniata Subbasin Studies

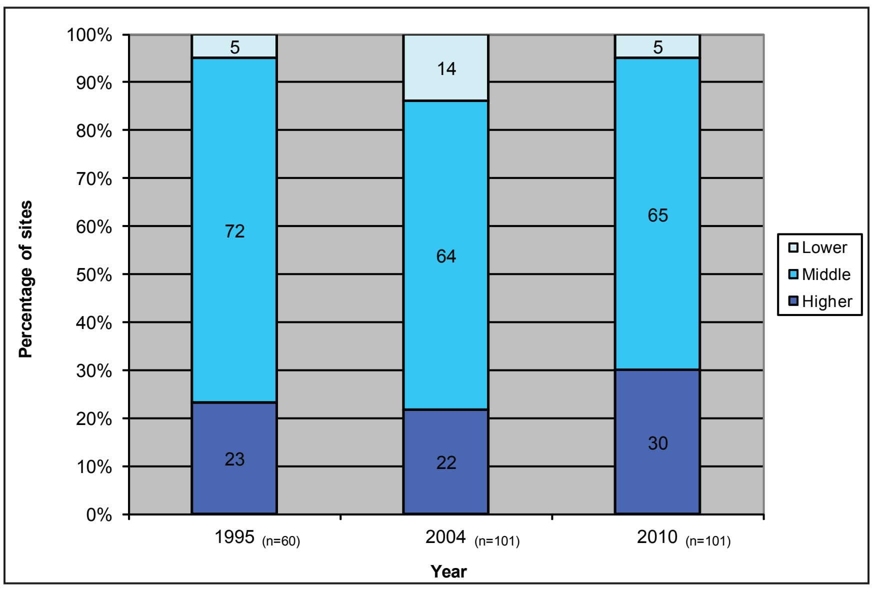

Figure 12. Historical Water Quality Condition Categories Documented in the Juniata Subbasin Studies

Habitat can be a difficult variable to compare between sampling event years because its assessment is somewhat subjective. A slight majority of sites within the sections were noted to have retained the same habitat condition categories in 2010 compared to 2004 or 1995 data, ranging from 50 percent of sites within the Juniata mainstem section to 68 percent within the Raystown Branch section. Between 24 percent (Upper section) and 36 percent (in both the Frankstown Branch and Lower sections) of sites experienced degradation in habitat. Between 4 percent (Raystown Branch) and 17 percent (Juniata mainstem) of sites showed an improvement in habitat condition categories.

Water Quality

Water quality trends are illustrated in Figure 12. Lower water quality conditions were observed at only 5 percent of sites in 2010, which is an improvement from the 2004 finding that was at 14 percent. The 2010 findings, however, were similar to the 5 percent observed in 1995. As a result of the improved findings in 2010, more sites were documented to have higher and middle water quality conditions than in 2004. Higher water quality was observed at 30 percent of sites in 2010, compared to 22 percent in 2004, and 23 percent in 1995. Stations with middle water quality were observed at 65 percent of sites in 2010 compared to 64 and 72 percent in 2004 and 1995, respectively.

Between 36 percent (Frankstown Branch) and 88 percent (Raystown Branch) of sites sampled in 2010 retained water quality condition categories from the last time they were sampled. The Frankstown Branch and the Upper section were the only two sections to experience degradation in water quality (16 and 18 percent, respectively), while no sites in the Raystown Branch, Lower section, and Juniata sections experienced water quality degradation. Between 10 percent (Upper section) and 45 percent (Frankstown Branch) of sites saw improvement in their water quality condition categories.

Overall, most sections experienced both improvements and degradation in the three condition categories among their sites, but a large percentage of condition categories remained stable compared to the last subbasin survey. On average, approximately 42 percent of all 2010 sites with historical data did not see a change in biological condition categories, with 43 percent of the sites showing degradation, and 15 percent showing improvement. Approximately 57 percent of all sites showed no condition category change for habitat, with 31 percent showing degradation, and 11 percent showing improvement. Approximately 64 percent of all sites showed no change in water quality condition categories, with 7 percent showing degradation, and 29 percent showing improvement.

Water quality data that were collected during the last three surveys in 1995, 2004, and 2010 were compared to determine what sites have chronic issues exceeding levels of concern and what parameters are involved (see Table 4). Consistent with patterns observed in the 2010 data, nitrate and total nitrogen were the parameters that were consistently elevated at many of the sites throughout the three surveys. Out of the 73 sites that had elevated parameters, a total of 53 sites had consistently elevated total nitrogen, and 45 sites had consistently elevated nitrate. The Lower section harbored the majority of these sites, followed closely by the Raystown Branch.

The next most common parameter seen at concerning levels was alkalinity, which was observed consistently at ten sites largely divided between the Upper section and Raystown Branch. Consistently elevated orthophosphate levels were found at seven sites, most of which were concentrated in the Frankstown Branch section.

Two sites in the Frankstown Branch had the highest number of parameters that consistently exceeded levels of concern. Burgoon Run (BURG 0.5) had a total of six parameters that were consistently problematic throughout the study periods, including high acidity, low pH, low alkalinity, and high aluminum, iron, and manganese. Halter Creek (HALT 0.6) had five parameters of issue, including elevated hardness, nitrate, total nitrogen, orthophosphate, and total phosphorus levels. Three other sites had four parameters at consistently problematic levels: FRNK 38.1 (nitrate, total nitrogen, orthophosphate, and sodium), LJUN 19.4 (nitrate, total nitrogen, orthophosphate, and phosphorus), and YELL 12.0 (hardness, magnesium, nitrate, and total nitrogen).

Two sites had consistently elevated hardness levels, YELL 12.0 and HALT 0.6. Magnesium was consistently elevated only at YELL 12.0, and consistently elevated sodium levels were only found at FRNK 32.5. Elevated levels of magnesium and hardness at YELL 12.0 are likely a natural result of the karst geology in the area. The sites SIXM 0.3 (Sixmile Run) and BURG 0.5 had consistently high iron levels, while BURG 0.5 and BVDB 5.0 (Beaverdam Branch) were the only sites to have consistently elevated manganese levels.

Table 4. List of Sites with Parameters Consistently Exceeding Levels of Concern (1995, 2005, and 2010 Data)

Variable	Number of Measurements	Minimum	Maximum	Median	Total Number of Sites with Consistent Issues	Number of sites with issues in each section*				
						Raystown Branch	Frankstown Branch	Upper	Lower	Mainstem
Total Nitrogen	146	1.05	12.27	2.4	53	15	8	8	18	4
Nitrate	128	1.04	11.9	2.3	45	13	7	7	16	2
Alkalinity	22	0	18.6	11.4	10	4	BURG 0.5	5		
Orthophosphate	38	0.052	0.463	0.1	7		5	LJUN 19.4	LLOS 0.5	
Aluminum	10	203	7177	300	4	2	2			
Hardness	6	305	382	324	2	YELL 12.0	HALT 0.6			
Iron	7	1550	5839	2060	2	SIXM 0.3	BURG 0.5			
Manganese	5	1080	7507	1800	2		2			
Total Phosphorus	27	0.103	0.471	0.2	2		HALT 0.6	LJUN 19.4		
Acidity	4	23	96	32	1		BURG 0.5			
pH	4	3.08	5.11	4.5	1		BURG 0.5			
Magnesium	4	35.3	39.6	39.3	1	YELL 12.0				
Sodium	15	20	146	33.7	1		FRNK 32.5			
TSS	4	26	44	31	0					

* The site name was reported when it was the only site having issues within the specific watershed.

Conclusions

In general, the streams in the Juniata River Subbasin had good macroinvertebrate community health, habitat, and water quality in 2010. The majority of sites sampled had either nonimpaired or only slightly impaired macroinvertebrate communities, and nearly all sites had either excellent or supporting habitat. Most sites had at least one water quality parameter exceed a level of concern. The most widespread water quality parameters were the nutrients total nitrogen and nitrate, indicating that the continuing largest source of impairment in streams appears to be from agricultural activities, although many streams exhibited only slight increases over background levels. Higher levels of orthophosphate and total phosphorus were observed largely in the Frankstown Branch, Raystown Branch, and Lower Juniata River section.

Areas of AMD pollution were concentrated mostly in the area west of Altoona and Hollidaysburg and in the area from Hopewell to Saxton. Urban pollution was detected mostly in the Altoona area. Some of the highest quality watersheds within this subbasin were Aughwick Creek, Brush Creek, Buffalo Creek, Buffalo Run, Great Trough Creek, Shobers Run, Standing Stone Creek, and Tuscarora Creek. The Frankstown Branch had the most impairment overall, with AMD, agriculture, and urban influences. The Raystown Branch had isolated areas of impairment contributing AMD and agricultural pollution near the start of the impoundment of water from the dam and also received heavy agricultural influence from the Yellow Creek Subwatershed. Efforts should be made to restore the most degraded watersheds within this subbasin and to protect the higher quality ones. Agricultural Best Management Practices (BMPs) can be used to limit the impacts associated with farming operations. Several Conservation Districts in the Juniata River Subbasin and the Western Pennsylvania Conservancy continue to work with farmers to implement BMPs and improve nonpoint pollution control. Urban influences can be minimized with low impact development and by allowing for groundwater recharge areas.

SRBC is currently completing an in-depth study of water quality and water availability in the Morrison Cove region of the Juniata River Subbasin. Supplemental sampling of 27 sites began in 2010 as part of a two-year Low Flow Monitoring pilot project. These sites are currently undergoing sampling in both base flow and low flow conditions to document changes in the biological community, habitat availability, and water chemistry.

Cabbage Creek near Roaring Spring, Blair County, Pa.

Appendix: Sample Site List

Sample Site #	Station Names	Location Description	Latitude	Longitude	Drainage (miles^2)	Designation
1	AUGH 0.4	Aughwick Creek at T403 bridge near Aughwick, Huntingdon Co.	40.335	-77.860	320.12	M
2	AUGH 17.2	Aughwick Creek downstream of Three Springs Creek and Rt. 994 near Pogue, Huntingdon Co.	40.215	-77.927	203.82	M
3	BEAV 0.1	Beaver Creek at mouth in Loysburg, Bedford Co.	40.160	-78.375	19.1	67a
4	BELG 2.4	Bells Gap Run at Hunter Road near Reightown, Blair Co.	40.607	-78.353	21	67d
5	BIGF 1.0 *	Big Fill Run off Rt. 350 near Bald Eagle, Blair Co.	40.738	-78.194	12.1	67d
6	BLLG 0.9	Blacklog Creek along T599 upstream of Rockhill and Orbisonia, Huntingdon Co.	40.241	-77.895	66.5	67b
7	BLLG 4.6	Blacklog Creek upstream of Peterson Road Bridge, upstream of Shade Creek, Huntingdon Co.	40.232	-77.863	34.12	67c
8	BLRG 2.5	Blair Gap Run upstream of Mill Run Road near Foot of Ten, Blair Co.	40.416	-78.452	16.7	67b
9	BOBS 0.9	Bobs Creek at tractor crossing near Reynoldsdale, Bedford Co.	40.151	-78.545	64.2	67b
10	BOBS 11.4	Bobs Creek at ball field near Pavia, Bedford Co.	40.262	-78.590	22.1	67c
11	BRUS 0.1	Brush Creek upstream of SR 2026 west of Breezewood, Bedford Co.	39.994	-78.315	85.1	67b
12	BRUS 14.1	Brush Creek upstream of SR 3017 in Gapsville, Bedford Co.	39.952	-78.240	35.5	67c
13	BUFF 0.4	Buffalo Creek upstream of SR 1007 (Fairground Road) covered bridge near Newport, Perry Co.	40.489	-77.158	67.3	67b
14	BUFF 14.6	Buffalo Creek off of Rt. 849 upstream of Eschol, Perry Co.	40.452	-77.316	43.8	67d
15	BUFR 0.4	Buffalo Run upstream of Rt. 31/96 bridge in Manns Choice, Perry Co.	40.002	-78.597	24.3	67a
16	BURG 0.5	Burgoon Run at Leopold Park downstream of Lake Altoona near Altoona, Blair Co.	40.487	-78.438	13.7	67d
17	BVDB 0.1	Beaverdam Branch along T405 near Hollidaysburg, Blair Co.	40.428	-78.379	74.8	67a
18	BVDB 5.0	Beaverdam Branch upstream of Westerly Wastewater Treatment Facility near Canan, Blair Co.	40.458	-78.427	37.7	67b
19	CLOV 0.1	Clover Creek at church near mouth in Cove Forge, Blair Co.	40.477	-78.176	50.1	67a
20	COCO 0.2	Cocolamus Creek at old Rt. 22 bridge in Millerstown, Blair Co.	40.538	-77.145	64.11	67b
21	COCO 9.6	Cocolamus Creek at T475 bridge upstream of Dimmsville, Juniata Co.	40.618	-77.155	27.11	67b
22	COVE 7.7	Cove Creek at SR 1004 bridge downstream of New Enterprise Stone and Lime near Ashcom, Bedford Co.	40.006	-78.422	41.5	67a
23	CRKD 0.3	Crooked Creek upstream of SR 3033 bridge in Huntingdon, Huntingdon. Co.	40.480	-78.021	26.95	67b
24	DELA 0.2	Delaware Creek along Rt. 333 downstream of Rt. 22/322 in Thompsontown, Juniata Co.	40.568	-77.234	11.18	67d
25	DOER 0.3	Doe Run near mouth in Mexico, Juniata Co.	40.536	-77.352	7.6	67b
26	DUNN 0.1	Dunning Creek near mouth upstream SR 1001 near Bedford, Bedford Co.	40.024	-78.478	196.3	M
27	DUNN 9.9	Dunning Creek at SR 4032 bridge upstream of Reynoldsdale, Bedford	40.153	-78.565	59.2	67b
28	EBSS 0.5	East Branch Standing Stone Creek upstream of 2nd SR 1019 (East Branch Road) bridge crossing from mouth near Jackson Corner, Huntingdon Co.	40.610	-77.824	14.06	67a
29	ELKC 0.1	East Licking Creek in park along Rt. 333,upstream of Port Royal, Juniata Co.	40.534	-77.398	45.46	67a
30	ELKC 9.8	East Licking Creek upstream of Clearview Reservoir in Tuscarora State Forest near Martins Crossroad, Juniata Co.	40.548	-77.526	21.78	67c
31	FRNK 1.6	Frankstown Branch Juniata River upstream bridge in Alexandria, Huntingdon Co.	40.556	-78.099	378.7	M
32	FRNK 18.9	Frankstown Branch Juniata River at USGS gage upstream of SR 2015 bridge in Williamsburg, Blair Co.	40.463	-78.200	289.3	M
33	FRNK 32.5	Frankstown Branch Juniata River upstream of Beaverdam Branch upstream of SR 2007 near Holidaysburg, Blair Co.	40.431	-78.358	122.1	M
34	**FRNK 38.1**	**Frankstown Branch Juniata River at Rt. 36 bridge near Brooks Mill, Blair Co.**	**40.377**	**-78.420**	**90.6**	**67b**

35	GTRC 2.9 *	Great Trough Creek upstream of Trough Creek State Park upstream of T370 (Trough Creek Drive) bridge near Newburg, Huntingdon Co.	40.286	-78.121	71.5	69a
36	HALT 0.6	Halter Creek at Rt. 36 bridge near McKee, Blair Co.	40.361	-78.418	32.7	67a
37	HKBC 0.1	Hickory Bottom Creek upstream Rt. 36 bridge near Waterside, Bedford Co.	40.192	-78.376	7.3	67a
38	HONY 0.2	Honey Creek near mouth in Reedsville, Mifflin Co.	40.663	-77.593	93.71	67a
39	HSVR 0.5	Horse Valley Run along SR 3002 downstream of Kansas Valley Run as exiting Tuscarora Mountain gap near East Waterford, Juniata Co.	40.359	-77.608	14.86	67c
40	JACK 2.9	Jacks Creek upstream SR 2004 east of Lewistown, Mifflin Co.	40.613	-77.532	57.02	67b
41	JACK 11.7	Jacks Creek upstream T707 in Shindle, Mifflin Co.	40.672	-77.416	27.25	67b
42	JUNR 2.0	Juniata River mouth upstream of Rt. 11/15 bridge near Amity Hall, Perry Co.	40.419	-77.017	3402.5	L
43	JUNR 17.3	Juniata River upstream of Millerstown, Perry Co.	40.548	-77.158	3174.36	L
44	JUNR 34.0	Juniata River at Rt. 35 bridge in Mifflintown, Juniata Co.	40.569	-77.401	2842.19	L
45	JUNR 47.0	Juniata River at Rt. 103 bridge upstream of Kishacoquillas Creek in Lewistown, Mifflin Co.	40.594	-77.578	2518.07	L
46	JUNR 63.6	Juniata River on both sides of the island at bridge in McVeytown, Mifflin Co.	40.498	-77.736	2461.7	L
47	JUNR 84.6	Juniata River at bridge in Mapleton, Huntingdon Co.	40.395	-77.940	2026.76	L
48	JUNR 94.0	Juniata River at 4th Street bridge in Huntingdon, Huntingdon Co.	40.483	-78.012	846.2	L
49	KISH 0.4	Kishacoquillas Creek near mouth at the Kepler Bridge road off SR 2004 in Lewistown, Mifflin Co.	40.602	-77.560	190.02	M
50	KISH 5.5	Kishacoquillas Creek in Jacks Mountain gap near Burnham, Pa.	40.655	-77.583	162.95	M
51	KISH 15.6	Kishacoquillas Creek at T350 bridge in Belleville, Mifflin Co.	40.601	-77.724	29.61	67a
52	LAUG 0.1	Little Aughwick Creek at T309 bridge in Maddensville, Huntingdon Co.	40.123	-77.959	56.7	67b
53	LBUF 0.1	Little Buffalo Creek near mouth in Newport, Perry Co.	40.475	-77.129	20.11	67b
54	LBUF 2.1	Little Buffalo Creek downstream of Little Buffalo State Park Road in Little Buffalo State Park, Perry Co.	40.458	-77.168	15.37	67d
55	LJUN 3.8	Little Juniata River at SR 4004 bridge in Barree, Huntingdon Co.	40.587	-78.100	335.32	M
56	**LJUN 15.0**	**Little Juniata River along Rt. 453 near Tyrone Forge, Blair Co.**	**40.668**	**-78.231**	**160.8**	**M**
57	LJUN 19.4	Little Juniata River along T502 between Tipton and Fostoria, Blair Co.	40.627	-78.297	75.8	67a
58	LJUN 29.6	Little Juniata River upstream Homer Gap Run in northeast section of Altoona, Blair Co.	40.537	-78.375	13.2	67a
59	**LLOS 0.5**	**Little Lost Creek at SR 2007 bridge near Oakland Mills, Juniata Co.**	**40.605**	**-77.311**	**6.47**	**67a**
60	LOSC 0.2	Lost Creek upstream SR 1002 bridge near Cuba Mills, Juniata Co.	40.594	-77.400	39.6	67a
61	**LTRO 0.8**	**Little Trough Creek upstream SR 3008 bridge near Cherry Grove, Huntingdon Co.**	**40.297**	**-78.058**	**27.2**	**69a**
62	MILL 0.3	Mill Creek near mouth upstream of Rt. 22 bridge at Lions Club Park at Mill Creek, Huntingdon Co.	40.438	-77.932	37.52	67d
63	NBLA 1.4 *	North Branch Little Aughwick Creek upstream T457 bridge near Burnt Cabins, Fulton Co.	40.092	-77.909	18	67b
64	NBTC 3.1	Narrows Branch Tuscarora Creek upstream SR 4007 bridge in Concord, Franklin Co.	40.248	-77.704	19.51	67b
65	PINY 0.6	Piney Creek near mouth at Franklin Forge, Blair Co.	40.472	-78.232	25.3	67a
66	PTRC 0.1	Potter Creek upstream Rt. 36 bridge along Rt. 868 in Waterside, Bedford Co.	40.189	-78.377	13.3	67a
67	**RACC 0.2**	**Raccoon Creek upstream SR 4006 bridge near Millerstown, Pa.**	**40.543**	**-77.156**	**21.67**	**67d**
68	RACC 5.0	Raccoon Creek upstream of bridge in Donnally Mills, Perry Co.	40.516	-77.236	11.84	67a
69	RAYS 4.6	Raystown Branch Juniata River near mouth downstream of Raystown Dam, Huntingdon Co.	40.455	-77.983	962.1	L
70	RAYS 42.8	Raystown Branch Juniata River upstream Rt. 913 bridge in Stonerstown, Bedford Co.	40.215	-78.265	753.7	L
71	RAYS 54.1 *	Raystown Branch Juniata River upstream of Yellow Creek in Hopewell, Bedford Co.	40.133	-78.269	626.9	L

72	RAYS 80.5	Raystown Branch Juniata River upstream of Greys Run east of Everett, Bedford Co.	40.005	-78.300	459.5	M
73	RAYS 103.0	Raystown Branch Juniata River upstream of covered bridge on SR 4007 near Manns Choice, Bedford Co.	40.007	-78.598	77.3	67a
74	SBEC 1.4	South Bald Eagle Creek near mouth in Tyrone, Blair Co.	40.670	-78.237	52.6	67c
75	SBLA 8.3	South Branch Little Aughwick Creek upstream SR 1005 (Aughwick Road) upstream of Cowans Gap Lake in Cowans Gap State Park, Fulton Co.	39.973	-77.942	3.2	67c
76	SHAD 1.8	Shade Creek along Rt. 522 at Shade Gap, Huntingdon Co.	40.188	-77.869	20.06	67c
77	SHAV 1.4	Shaver Creek upstream SR 4011 bridge near Petersburg, Huntingdon Co.	40.583	-78.046	56.24	67a
78	SHAV 10.0	Shaver Creek upstream T536 bridge downstream of dam in PSU Experimental Forest near Masseyburg, Huntingdon Co.	40.644	-77.932	10.54	67a
79	SHOB 0.4	Shobers Run along Business Rt. 220 downstream of Bedford Springs, Bedford Co.	39.999	-78.504	16.3	67a
80	SHUP 0.1	Shoups Run along Rt. 913 near Middletown, Huntingdon Co.	40.222	-78.215	18.1	69a
81	SHWN 4.2	Shawnee Branch upstream of T443 bridge upstream of Shawnee Lake near Schellsburg, Bedford Co.	40.038	-78.654	18.1	67a
82	SIDE 0.1	Sideling Hill Creek at mouth near Maddensville, Huntingdon Co.	40.131	-77.957	96.7	67b
83	SIDE 13.9	Sideling Hill Creek in Sideling Hill gap along Rt. 913 between Waterfall and New Granada, Fulton Co.	40.134	-78.080	44.9	69a
84	SINK 0.3	Sinking Run at SR 1013 bridge near Union Furnace, Blair Co.	40.614	-78.176	28.6	67a
85	SIXM 0.3	Sixmile Run along SR 1036 in Riddlesburg, Bedford Co.	40.161	-78.249	14.7	69a
86	SPRR 1.0	Spring Run upstream of Penn State Altoona Campus in Altoona, Blair Co.	40.543	-78.417	4.7	67d
87	SPRU 1.0	Spruce Creek at Pa. Fish and Boat Commission Special Regulations Area near Colerain, Huntingdon Co.	40.620	-78.125	106.06	M
88	SPRU 10.6	Spruce Creek at Rt. 45 bridge in Graysville, Huntingdon Co.	40.691	-78.029	63.72	67a
89	STST 1.0 *	Standing Stone Creek along Rt. 26 in Huntingdon, Huntingdon Co.	40.493	-77.994	131.62	M
90	STST 26.8 *	Standing Stone Creek at SR 1023 bridge near McAlevys Fort, Huntingdon Co.	40.652	-77.823	33.95	67a
91	TEAC 0.1	Tea Creek upstream of West Logan Street in Reedsville, Mifflin Co.	40.663	-77.597	10.86	67a
92	TIPT 1.3	Tipton Run upstream of SR 4021 in Tipton, Blair Co.	40.635	-78.299	17.9	67a
93	TSPC 0.1	Three Springs Creek upstream of T341 near Pogue, Huntingdon Co.	40.208	-77.941	30.94	67b
94	TSPR 0.1	Three Springs Run upstream of Rt. 36 along Rt. 869 north of Loysburg, Bedford Co.	40.172	-78.379	9.8	67a
95	TUSC 0.6	Tuscarora Creek near mouth at Rt. 75/Rt. 333 bridge in Port Royal, Juniata Co.	40.528	-77.392	259.96	M
96	TUSC 22.5	Tuscarora Creek upstream of T322 bridge near McCullochs Mills, Juniata Co.	40.419	-77.564	129.48	M
97	TUSC 39.3	Tuscarora Creek upstream of SR 2010 bridge in Blairs Mills, Huntingdon Co.	40.285	-77.720	30.59	67b
98	WILL 0.4	Willow Run near mouth at T305 bridge near McCullochs Mills, Juniata Co.	40.419	-77.596	10.64	67b
99	YELL 3.5	Yellow Creek near mouth along Rt. 26 near Hopewell, Bedford Co.	40.143	-78.286	93.5	67d
100	YELL 9.1	Yellow Creek upstream of Potter Creek along Rt. 36 in Waterside, Bedford Co.	40.190	-78.376	17.6	67a
101	YELL 12.0	Yellow Creek upstream T638 bridge in Woodbury, Bedford Co.	40.230	-78.368	6.3	67a

Bolded sites have incomplete 2010 data.
Blue shaded sites have complete data for biology, habitat, and water quality for 1995, 2004, and 2010.

* Sites serve as ecoregion reference sites for the 2010 study.

REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Buchanan, T.J. and W.P. Somers. 1969. Discharge Measurements at Gaging Stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, Washington, D.C. 65 pp

The Commonwealth of Pennsylvania. 2010. The Pennsylvania Code: Title 25 Environmental Protection. Fry Communications, Inc., Mechanicsburg, Pennsylvania. http://www.pacode.com.

Guy, H.P. and V.W. Norman. 1969. Field Methods for Measurement of Fluvial Sediment. U.S. Geological Survey Techniques of Water Resources Investigation, Book 3, Chapter C2 and Book 5, Chapter C1. Washington, D.C.

Hach Company. 2003. Important Water Quality Factors. http://www.hach.com/h2ou/h2wtrqual.htm.

Hem, J.D. 1970. Study and Interpretation of the Chemical Characteristics of Natural Water. 2nd Ed. Geological Survey Water-Supply Paper 1473. United States Department of the Interior. United States Government Printing Office, Washington, D.C. http://water.usgs.gov/pubs/wsp/wsp2254/.

Kentucky Natural Resources and Environmental Protection Cabinet. 2003. Kentucky River Basin Assessment Report: Water Quality Standards. http://www.uky. edu/WaterResources/Watershed/KRB_AR/wq_standards.htm.

_____. 2003. Kentucky River Basin Assessment Report: Water Quality Parameters. http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm.

LeFevre, S.R. 2005. Juniata River Subbasin Survey: A Water Quality and Biological Assessment, June-November 2004. Susquehanna River Basin Commission (Publication No. 240), Harrisburg, Pennsylvania.

New York State, Department of Environmental Conservation. 1999. Regulations, Chapter X, Part 73: Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations. http://www.dec.ny.gov/regs/4590.html.

McGarrell, C.A. 1997. Water Quality and Biological Assessment of the Juniata Subbasin. Susquehanna River Basin Commission (Publication No. 178), Harrisburg, Pennsylvania.

McMorran, C.P. 1986. Water Quality and Biological Assessment of the Juniata River Subbasin. Susquehanna River Basin Commission (Publication No. 103), Harrisburg, Pennsylvania.

Omernik, J.M., D.D. Brown, C.W. Kiilsgaard, and S.M. Piersen. 1992. Draft Ecoregions and Subregions of the Blue Ridge Mountains, Central Appalachian Ridges and Valleys, and Central Appalachians of USEPA Region 3: Corvallis, Oregon, U.S. Environmental Protection Agency, Environmental Research Laboratory, 1 map.

Omernik, J.M. 1987. Aquatic Ecoregions of the Conterminous United States. U.S. Geological Survey, Reston, Virginia.

Pennsylvania Department of Environmental Protection (PADEP). 2010. 2010 Pennsylvania Integrated Water Quality Monitoring Assessment Report. http://www.portal.state.pa.us/portal/server.pt/community/water_quality_standards/10556/ integrated_water_quality_report_-_2010/682562.

____. 2008. Title 25, Chapter 93: Water Quality Standards, Water Quality Criteria. http://www.pacode.com/secure/data/025/chapter93/s93.7.html and http://www.pa code.com/secure/data/025/chapter93/s93.8c.html.

Plafkin, J.L., M.T. Barbour, D.P. Kimberly, S.K. Gross, and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/440/4-89/001. U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

State of Maryland, Department of the Environment. 2010 Code of Maryland Regulations (COMAR) 26.08.02.03-3: Water Quality Specific to Designated Uses (Code of Maryland Regulations). http://www.dsd.state.md.us/comar/comarhtml/26/26.08.02.03-3.htm.

Susquehanna River Basin Commission (SRBC). 2004. "Susquehanna Basin Streams, Groundwater, and Soil Moisture All Above Normal in Response to Near-Record Precipitation in 2004: SRBC summarizes hydrologic conditions and flooding in 2004." Press Release, December 15, 2004. Harrisburg, Pennsylvania. http://www.srbc.net/Press%20Releases/2004HydrologicConditions%20Dec2004.pdf.

U.S. Geological Survey. 1999. The Quality of Our Nation's Waters: Nutrients and Pesticides. Circular 1225. U.S. Department of the Interior, Reston, Virginia. http://water.usgs.gov/pubs/circ/circ1225/images/table.html.

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