METHODS

DATA COLLECTION

In June and July 2010, SRBC staff assessed water chemistry, stream discharge, and physical habitat, as well as macroinvertebrate, periphyton, and fish communities during summer baseline flow conditions at 27 stations in the Juniata River Subbasin. The stations sampled during the LFM Pilot Study were selected based on records of biologically non-impaired conditions from previous SRBC field surveys. In addition, stations were chosen to represent a variety of stream orders, subwatersheds, geology types, and drainage area sizes.

SRBC chose the exceedance probability flow of Annual P95 (the flow exceeded 95 percent of the time in any given year) as the trigger to initiate low flow sampling in 2010. Staff monitored flow conditions by accessing real-time streamflow data from the U.S. Geological Survey (USGS) web site (http://waterwatch.usgs.gov). Seventeen of the 27 stations were resampled between August and September 2010 when flows dropped below Annual P95 thresholds in an attempt to quantify any ecological, habitat, and water quality changes that may have occurred during low flow conditions. The remaining ten stations were not resampled because flows at these locations never dropped below Annual P95.

Water chemistry, stream discharge, physical habitat, macroinvertebrate, periphyton, and fish sampling were repeated the following year in June and July 2011 during summer baseline flow conditions. A seasonal August/September/October mean P95 (ASO P95) was designated as the trigger flow to initiate low flow sampling in 2011. Proponents of ecological flow management suggest that seasonal or even monthly exceedance values should be used to define low flow conditions and guide water management decisions (DePhilip and Moberg, 2010). The ASO P95 was chosen as the trigger flow in 2011 because the lowest average annual flows historically occurred during these months. However, Hurricane Irene and Tropical Storm

Table 1. Levels of Concern and Aquatic Life Tolerances for Measured Water Quality Parameters

Parameters	Limits	Reference Code	Reference
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	

Lee caused record precipitation and historic flooding in the Susquehanna River Basin in late August and early September 2011. As a result, flows in the Juniata subbasin never dropped below ASO P95, precluding low flow sampling. Consequently, for the purposes of this report, only results for the 17 stations that were sampled during low flow in 2010 will be discussed.

Figure 1 shows the extent of the Juniata River Subbasin and the locations of the 17 LFM Pilot Study sampling stations where Annual P95 occurred in 2010. Appendix A lists additional information about all stations sampled, including location descriptions, geographic coordinates, and drainage areas.

HABITAT

Habitat conditions were assessed using a modified version of the U.S. Environmental Protection Agency's (USEPA's) Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (RBP III) (Plafkin and others, 1989; Barbour and others, 1999). Physical stream characteristics relating to substrate, pool, and riffle composition, flow status, 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 of the surrounding landscape.

At stations with no USGS gage, staff took flow measurements using a FlowTracker and standard USGS procedures (Buchanan and Somers, 1969). For stations located at a USGS gage, the flow at the time of sampling was obtained from the USGS stream gage web site (http://waterwatch.usgs.gov). A second stream transect was characterized using the FlowTracker to record stream width and water depths across the channel. Additional habitat information was collected at each vertical location along the transects, including dominant substrate type, presence of sedimentation, and flow regime.

WATER QUALITY

Field chemistry parameters were measured at the time of sampling, and water samples were collected for laboratory analyses. Table 1 lists all water quality parameters measured and their associated water quality standards based on current state or federal regulations, background levels for uninfluenced streams, or references for aquatic life tolerances. A handheld multi-probe YSI sonde was used to collect all field chemistry parameters (temperature, conductivity, pH, and dissolved oxygen) simultaneously. The probes 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 (Quality Assurance/Work Plan, Document Control Number SRBC – QA042). Water samples for laboratory analyses were collected using depth-integrated water sampling methods (Guy and Norman, 1969) and were kept on ice until delivery to the Pennsylvania Department of Environmental Protection (PADEP), Bureau of Laboratories in Harrisburg, Pa., (2010) or to ALS Environmental, in Middletown, Pa., (2011).

MACROINVERTEBRATES

Benthic macroinvertebrates were collected using a modified version of RBP III (Barbour and others, 1999). Sampling was conducted in the best available riffle/run habitats at each station using a D-frame kick net with 500-micron mesh. Samples consisted of a composite of six kicks with each kick disturbing approximately one square meter immediately upstream of the net for approximately one minute. Samples were preserved with 95-percent denatured ethyl alcohol and returned to SRBC's lab. The sample was then subsampled following procedures outlined in PADEP's benthic macroinvertebrate index of biotic integrity (PADEP, 2012). Most insect taxa in the subsample were identified to genus level and enumerated. Midges were identified to the family level of Chironomidae. Non-insect taxa (i.e., worms, mollusks, and mites) were identified to family, order, class, or phylum depending on available keys.

FISH

The fish community was sampled using methods adapted from the RBP manual (Barbour and others, 1999) and PADEP's draft index of biological integrity (IBI) protocols. Electrofishing was conducted in wadeable reaches using either a backpack electroshocker or a tow barge unit, depending on the size of the stream. Reach length was equal to ten times the average wetted width of the stream channel, plus or minus 10 meters,

Commisssion staff using a D-frame kick net to sample bugs at Tuscarora Creek, Juniata Co., Pa., during low flow in September 2010.

Commission staff using a backpack electrofishing unit to sample fish in September 2010 at Blacklog Creek, Huntingdon County, Pa.

with a minimum length of 100 meters and a maximum length of 400 meters. Three electrofishing passes were made per station, and all accessible habitats in the stream reach were sampled. All fish caught were identified to species and enumerated. The first 50 individuals of each game fish species collected were also weighed and measured. All fish were returned to the stream after processing unless there was a question regarding identification, in which case the specimen was returned to the laboratory and identified.

PERIPHYTON

Periphyton collection methods followed USEPA's National River and Stream Assessment protocols (USEPA, 2007). Periphyton were sampled by removing natural rocks from the stream bed at each of 11 transects established throughout the sampling reach. Attached periphyton from a delimited area on the surface of each rock were scraped and rinsed into a bottle. A 50-ml aliquot of water from the rinse bottle was vacuum filtered onto a filter paper, chilled on ice, and shipped to the PADEP lab for analysis of periphyton chlorophyll-a concentration. A second 50-ml aliquot was preserved with 5 ml of formaldehyde and sent to EcoAnalysts, Inc., Moscow, Id., for identification of periphyton taxa.

DATA ANALYSIS

Water quality was assessed by comparing field and laboratory parameter data to current water quality standards (see Table 1). Habitat assessment scores from the modified RBP III were used to classify each station into a habitat condition category. Scores from 171 to 220 were designated excellent. A habitat score of 116 to 170 indicated supporting conditions, scores between 61 to 115 designated partially supporting habitat, and a score of less than 60 was deemed non-supporting.

Streamflows during baseline flow and low flow periods were compared, and actual flow exceedance percentiles at the reference gages at the time of sampling were calculated for each time period. Using information from the second transect water depth/channel width profile, staff estimated the percentage of wetted area lost between baseline flow and low flow periods (Chow, 1959; Mecklenburg and Ward, 2005).

Macroinvertebrate, fish, and periphyton data were used to calculate biological metrics assessing various aspects of the assemblages. Fish and macroinvertebrate metrics were taken primarily from Barbour and others (1999), the PADEP's benthic macroinvertebrate index of biotic integrity for freestone wadeable streams (PADEP, 2012), and from TNC's report outlining ecosystem flow requirements for the Susquehanna River Basin (DePhilip and Moberg, 2010). Periphyton metrics were based primarily on diatom taxa as this algal group is most often used in biomonitoring. Soft-bodied algae were identified to genus and enumerated only. A complete list and description of macroinvertebrate, fish, and periphyton metrics calculated can be found in Table 2.

Table 2. Description of Biological Metrics Calculated Using Low Flow Monitoring Pilot Study Data

Metrics	Description
Macroinvertebrates	
Taxa Richness	Total number of macroinvertebrate taxa identified
% Sensitive (PTV ≤ 3)	Percentage of individuals in the assemblage that have Pollution Tolerance Values (PTVs) 0 - 3
Shannon Diversity Index	Taxonomic composition metric measuring taxonomic richness and evenness of individuals across taxa of a subsample
Hilsenhoff Biotic Index	Taxonomic composition metric calculated as an average of the number of individuals in a subsample, weighted by PTVs
% EPT	Percentage of individuals from orders Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, caddisflies)
% Dominant	Percentage of subsample represented by the dominant taxon
% Multivoltine	Percentage of multivoltine (multiple generations per year) individuals in the subsample
% Desiccation Tolerant	Percentage of desiccation tolerant individuals in the subsample
% Strong Adult Flying Ability	Percentage of individuals in the subsample having strong adult flying ability
% Common/Abundant in Drift	Percentage of individuals in the subsample common or abundant in drift
% Strong Swimmers	Percentage of individuals in the subsample with strong swimming ability
% Small-bodied	Percentage of small-bodied individuals in the subsample
% Free-living	Percentage of free-living individuals (taxa not utilizing cases or other forms of substrate attachment) in the subsample
% Erosional	Percentage of erosional (riffle-dwelling) individuals in the subsample
% Obligate Depositional	Percentage of obligate depositional (pool-dwelling) individuals in the subsample
% Shredders	Percentage of shredder individuals in the subsample
% Herbivores	Percentage of herbivore taxa in the subsample
% Collector-Filterers	Percentage of collector-filterer individuals in the subsample
% Predators	Percentage of predator individuals in the subsample
% Eurythermal	Percentage of eurythermal (wide temperature range) individuals in the subsample
% Cold Stenothermal	Percentage of cold stenothermal (narrow temperature range) individuals in the subsample
% Burrowers	Percentage of burrower individuals in the subsample
Fish	
Species Richness	Total number of fish species identified
% Tolerant	Percentage of tolerant individuals
% Intolerant	Percentage of intolerant individuals
% Dominant	Percentage of assemblage represented by the dominant species
% Cyprinids	Percentage of assemblage represented by Cyprinidae (minnows)
% Piscivores	Percentage of piscivorous individuals
% Insectivores	Percentage of insectivorous individuals
% Generalists	Percentage of generalist individuals
% Herbivores	Percentage of herbivorous individuals
% Coldwater	Percentage of coldwater individuals (brook trout, brown trout, rainbow trout, sculpin)
% Riffle Obligates	Percentage of riffle obligate individuals (margined madtom, longnose dace, central stoneroller, fantail darter)
% Riffle Associates	Percentage of riffle associate individuals (white sucker, shorthead redhorse, northern hogsucker, walleye)
Periphyton	
Diatom species richness	Total number of diatom species identified
Soft-bodied algae taxa richness	Total number of soft-bodied algae taxa identified
% Dominant (diatoms)	Percentage of assemblage represented by the dominant diatom species
Disturbance Index	Percentage of *Achnanthes minutissima* individuals in the sample; higher percentage indicates increased disturbance
Siltation Index	Percent relative abundance of individuals (*Navicula, Nitzschia, Surirella*) adapted to living on silty substrates
Diatom Model Affinity (DMA)	A percent similarity, reference-based community metric (Passy and Bode, 2004)
Chlorophyll-a Concentration	Chlorophyll-a (chl-a) concentration is a surrogate for algal biomass; biomass is at nuisance levels when chl-a > 10 µg/cm2