NY • PA • MD • USA

SRBC

WWW.SRBC.NET

Susquehanna River Basin Commission

Sediment and Nutrients Assessment Program

2013 Summary Report

www.srbc.net/programs/CBP/nutrientprogram.htm Publication No. 296A

About the Program

From 1984 to 1989, SRBC conducted an initial 5-year nutrient monitoring program involving 14 sampling sites to establish a database for estimating nutrient (nitrogen and phosphorus) and suspended sediment loads in the Susquehanna basin. This initial effort, funded by the Pennsylvania Department of Environmental Protection and conducted as part of the Chesapeake Bay Restoration Program, consisted of monthly base flow sampling and periodic sampling during high flows.

The sampling network — consisting of sites on the mainstem Susquehanna, major tributaries and smaller watersheds to represent different land uses — was established to: collect the data needed to enable accurate allocation of nutrient and suspended sediment loads to the mainstem Susquehanna River reaches and to the major subbasins; and to provide a long-term nutrient and suspended-sediment database and loading data in sufficient detail to track and better define nutrient loading dynamics.

After the initial effort, the monitoring sites were reduced to the following six sites to continue evaluating trends from the major subbasins: Susquehanna River at Towanda, Pa. (to estimate loads from New York State); Susquehanna River at Danville, Pa.; Susquehanna River at Marietta, Pa.; West Branch Susquehanna River at Lewisburg, Pa.; Juniata River at Newport, Pa.; and Conestoga River at Conestoga, Pa. (to provide data from a major tributary watershed with intensive agricultural activity and increasing development).

The long-term monitoring at these six sites has allowed SRBC to determine whether conditions were improving (decreasing trends), staying the same, or becoming worse (increasing trends) over the years for nitrogen, phosphorus, and suspended sediment loads. SRBC releases its findings annually.

Between 2004, 2005, and 2012, the U.S. Environmental Protection Agency provided funding to significantly expand SRBC's overall monitoring network to 26 sites in the basin (Figure 1). These additional sites were added as part of the Chesapeake Bay Program's Non-tidal Monitoring Network.

Susquehanna River Basin Commission
4423 North Front St.
Harrisburg, PA 17110

This report summarizes the findings of the technical report *2013 Nutrients and Suspended Sediment in the Susquehanna River Basin*. Detailed information on monitoring sites, data collection, and data analysis can be found in the full report and on the SRBC web site at *www.srbc.net/programs/cbp/*.

This summary report provides an overview of the following report findings:

Nutrient and Suspended Sediment Loads and Yields

— basic information on annual and seasonal loads and yields of nutrients and suspended sediment (SS) measured during calendar year 2013 at SRBC's six long-term monitoring sites;

Data Comparisons

— data comparisons with Long-Term Means (averages) and historical baseline datasets. Significant deviations from baselines indicate a change in annual yields that warrant further evaluation; and

Nutrient and Suspended Sediment Trends

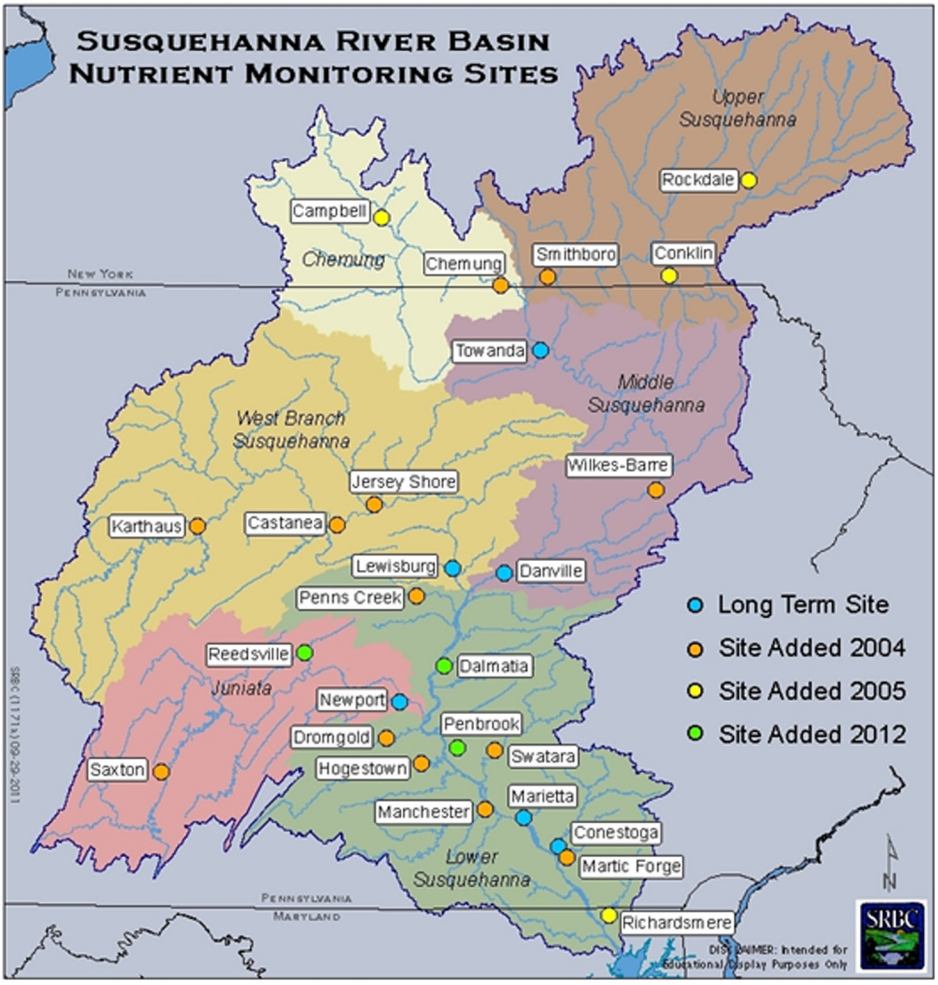
— changes over time in the concentrations of nutrients and sediment found in waterways, taking into account the effects of flow.

> **"Since the Bay monitoring project began, Total Nitrogen has expressed the most consistent and distinct downward trend throughout the basin."**
>
> ***James Shallenberger***
> ***SRBC Monitoring & Protection Program Manager***

2013 Precipitation & Discharge Stats

- **Precipitation was fairly well distributed and within 10% of LTM for all stations.**
- **Flow was below LTMs except at Conestoga due to regional storm events.**
- **Regional storms occurred in the Upper Susquehanna subbasin in June and in the Lower Susquehanna subbasin in October.**
- **Basin-wide rainfall events occurred in January and November. High flows during winter months were exacerbated by melting snow.**

Figure 1. Location of Sampling Sites within the Susquehanna River Basin



Monitoring Locations

Data were collected from six sites on the Susquehanna River, three sites on the West Branch Susquehanna River, and 17 sites on smaller tributaries in the basin. These 26 sites, selected for long-term monitoring of nutrient and SS transport in the basin, are shown in Figure 1. All sites have been co-located with U.S. Geological Survey (USGS) stream gaging stations to obtain discharge data.

Parameters Monitored

All water samples were analyzed for various species of Total and Dissolved Nitrogen (TN and DN), Total and Dissolved Phosphorus (TP and DP), Total Organic Carbon (TOC), and Suspended Sediment (SS).

For Group A sites (six long-term sites), two samples were taken each month: a fixed-date sample and a base flow sample. Samples were also drawn during high flow events, targeting one per season. At Group B sites (20 additional sites), fixed-date samples were taken monthly in addition to two storm samples collected each quarter.

Nutrient and Suspended Sediment Loads & Yields

Loads and yields represent two methods for describing nutrient and SS amounts within a basin (see box). Loads and yields are calculated using the USGS ESTIMATOR model. This tool relates a constituent's concentration to water discharge, seasonal effects, and long-term trends.

The full technical report includes tables that show the loads and yields for Group A, as well as the average annual concentrations for each constituent.

Terms to Know

LOAD — Mass of a pollutant that passes a point in a river or stream over some period of time (lbs/year).

YIELD — Mass of a pollutant delivered by a watershed on a unit area-adjusted basis (lbs/acre-year).

LONG-TERM MEAN (LTM) — the average of a set of numbers over a defined number of years.

WATER DISCHARGE — volume rate of water flow that is transported through a given cross-sectional area, measured as cubic feet per second (cfs).

FLOW-ADJUSTED CONCENTRATION (FAC) — concentration of a parameter in a waterway after the effects of flow are removed. FAC represents the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed.

RUNOFF RATIO (RR) — proportion of discharge to the amount of precipitation observed in a basin for a specified duration. The RR regime reflects key aspects of the basin water balance and is a direct measure of water availability.

SRBC Contact
Kevin McGonigal
Environmental Scientist

Email: srbc@srbc.net
Web Site: www.srbc.net
P (717) 238-0423 / F (717) 238-2436

SRBC's Sediment and Nutrients Assessment Program is funded largely through grants from the U.S. Environmental Protection Agency and Pennsylvania Department of Environmental Protection.

Discerning Trends

Nutrient and sediment transport processes are largely governed by precipitation and stream flow, as well as seasonal cycles of plant communities and the timing of fertilizer applications. A substantial challenge to understanding pollutant trends is whether management outcomes can be separated from the plethora of factors that influence nutrient and sediment dynamics. Although the relationship is not always linear, high flow generally increases constituent loads in streams.

Results for annual, seasonal, and monthly loads were compared to long-term mean (LTM) to identify changes through time. A subset of cases were analyzed according to the ratio of discharge to rainfall (Q/P - the runoff ratio) as another means to discern trends and facilitate a more thorough understanding of processes that influence nutrient and sediment transport in the basin (see back page).

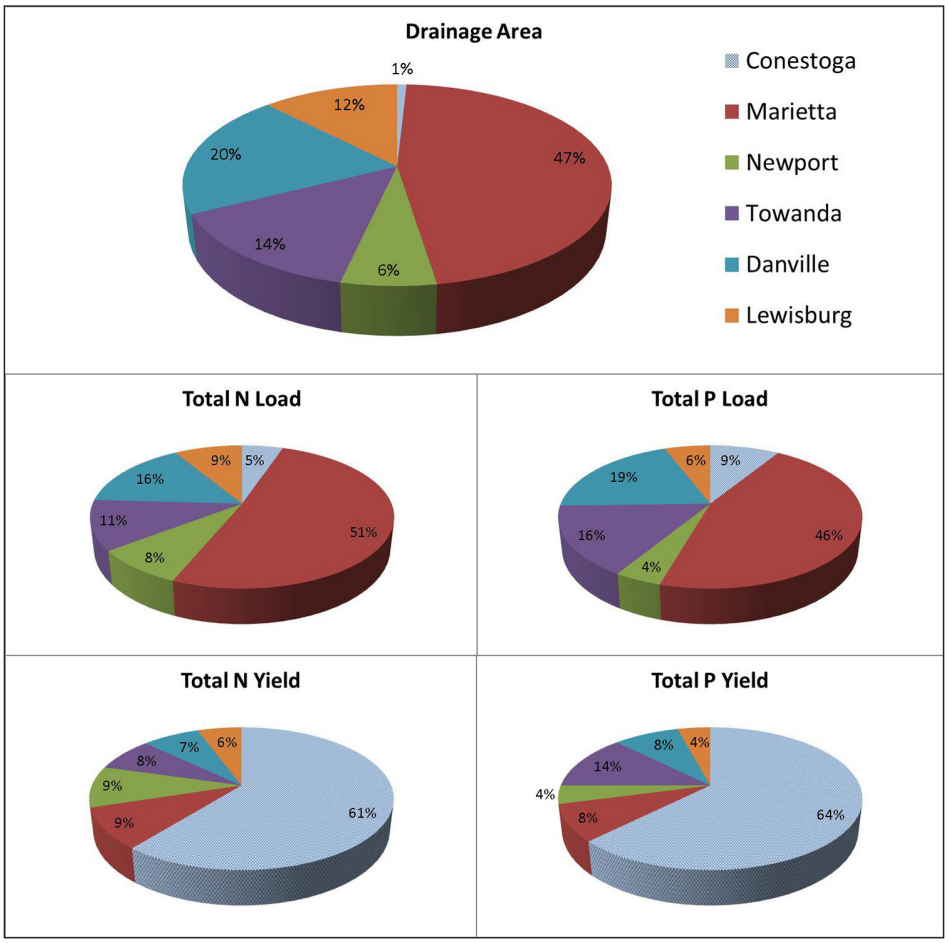
KEY FINDINGS — LOADS & YIELDS

Annual nutrient and sediment loads were below LTMs at all sites.

Conestoga watershed consistently delivers the highest TN, TP, and SS yields in the network; this station monitors both the highest proportion of agriculture and developed land among the long-term stations. Marietta station provided the highest overall loadings for TN, TP, and SS in 2013 (See Figure 2).

Sediment loads are significantly increased by large storm events, which have the ability to overwhelm best management practices in the watershed, scour streambeds, and erode stream banks.

Figure 2. Pie Chart Series Showing Relative Differences in Drainage Area, N and P Yield, and N and P Load for the Long-term Monitoring Station Network in the Susquehanna River Basin



Conestoga is the smallest drainage area in the network, yet the TN, TP, and SS yields are disproportionately the highest. Conestoga lies in the highly fertile Lancaster County region. The Marietta station, the largest watershed in the network, provided the highest overall pollutant loads in 2013.

Baseline Comparisons

Annual fluctuations in nutrient and suspended sediment loads make it difficult to determine whether the changes were related to land use, nutrient availability, or annual water discharge. To help make that determination, historical data sets are used to create baseline relationships between annual yields and water discharge.

This report used several different baselines: (1) inital five-year period of each data set (usually 1985-1989); (2) first half of the data set (1985-1997 data); (3) second half of the data set (usually 1998-2013); and (4) entire data set (1985-2013).

KEY FINDINGS — BASELINE COMPARISONS

TN, TP, SS were below all baseline yields – a strong indication that pollutant management strategies are working.

Initial five-year baseline analyses demonstrate that changes in total nitrogen are underlain by changes in the relative proportions of individual forms of nitrogen in the overall loads. For example, TNO_x at Lewisburg composed 57% of the TN load during the first five years of the program and 75% of the TN load during the most recent five years.

Long-Term Trends

Trends for monthly mean flow and Flow-Adjusted Concentrations (FAC) were computed using data from the stations' inception through 2013 for flow, SS, TOC, and several forms of nitrogen and phosphorus (Figure 3). Summary statistics for all sites are included in the full report.

KEY FINDINGS — TRENDS

In 2013, most individual forms of N and P as well as TN, TP, and SS adhered to trends of improvement, meaning that flow adjusted concentrations declined with respect to prior years.

Since the Bay monitoring project began, TN has expressed the most consistent and distinct downward trend throughout the basin.

Trends in individual species of TN and DN show the smallest reductions for TNO_x and DNO_x, which constitute the largest fraction of TN and DN and appear to constitute a larger percentage as time passes. *(NO_x sources include automobiles and other mobile sources and electric power plants.)*

Majority of long-term trends were unchanged. No trends in flow.

Runoff Ratio (RR) Approach

In simple terms, the runoff ratio is the percent of drainage basin precipitation that becomes streamflow. The RR analysis is a way to reduce noisy data signals associated with climatic and hydrologic factors, ultimately leading to stronger conclusions regarding the effectiveness of pollution reduction strategies.

The initial RR analysis emphasizes the impact that single outlier events, such as Tropical Storm Lee in 2011, exert on TP and SS loadings and dramatically illustrates the influence of latent sediment within the system.

Figure 3. Flow-Adjusted Concentration Trends through 2013

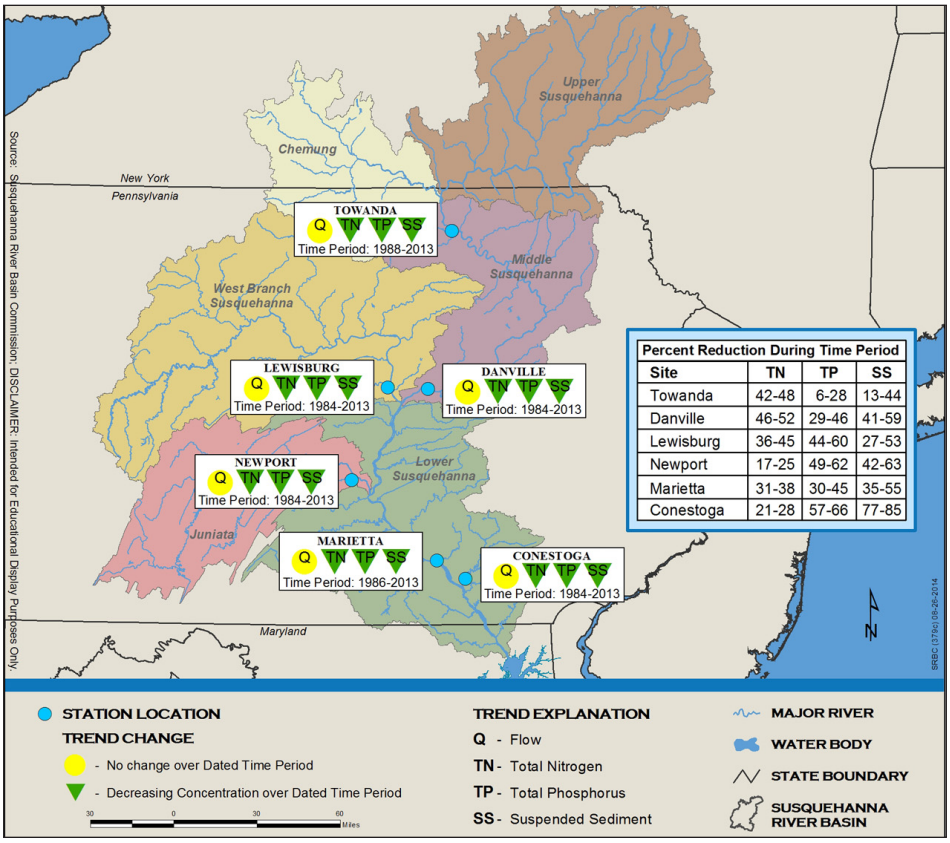


Figure 4. Comparison of 1989-'93 to 2009-'13 at Conestoga: Precipitation, Runoff Ratio (RR), and Total P by Quarters

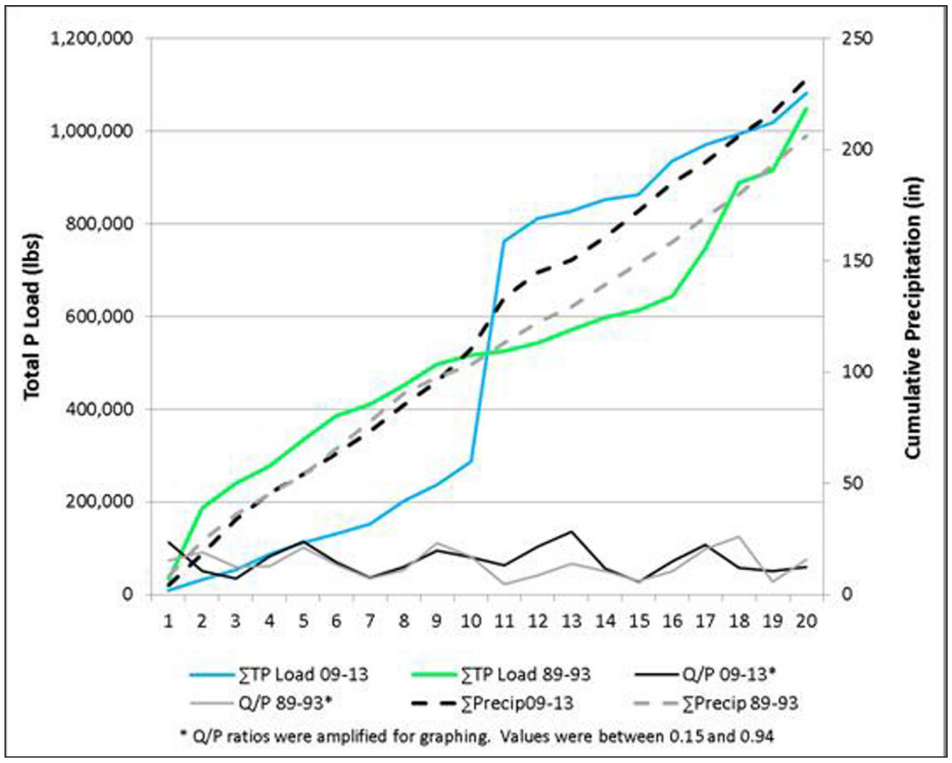


Figure 4 shows Total P loads over two five-year periods at Conestoga. During the first 10 quarters, TP loads improved for the later five-year period except during the 10th-11th quarters in 2011, which coincided with Tropical Storm Lee in September 2011, essentially erasing the gains realized through the prior 2.5 years. Other RR analyses suggests that nitrogen reduction strategies have been effective at lowering TN loads. SRBC plans to expand use of this approach in the future.