AGRICULTURE AND THE ENVIRONMENT: ACHIEVING A BALANCE
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"THE CURRENT STATE OF NUTRIENTS IN THE WATER: A PROGRESS REPORT"

by
Paul O. Swartz
Executive Director
Susquehanna River Basin Commission

SCREEN 1 – INTRODUCTION

My job this morning is to provide you with a progress report about the "state of nutrients" in the Susquehanna River Basin, based on long-term monitoring our agency has performed in the basin for more than two decades. Here are several questions I'll attempt to answer during my presentation:

1. Why is monitoring important?
2. What kind of monitoring does SRBC do?
3. What do we know about the trends of pollutants of concern to the Chesapeake Bay -- nitrogen, phosphorus and sediment -- in the Susquehanna River Basin? Are the trends IMPROVING, DEGRADING or NOT SIGNIFICANT?

I'd like to start by sharing some background information that I think provides a useful context:

SCREEN 2 – CHESAPEAKE BAY WATERSHED MAP WITH SRB OUTLINED

1. The Susquehanna River and the Chesapeake Bay, both hyrdologically and in other respects, are part of the same ecosystem.

In fact, did you know that hundreds of thousands of years ago, the Susquehanna accepted water from all the tributaries that currently feed the Chesapeake – including the Potomac, the Patuxent, the Pocomoke, the James, the York and the Patuxent Rivers? And did you know that the Susquehanna River once flowed all the way to the Atlantic Ocean, ending in the vicinity of the current mouth of the Chesapeake Bay, just north of Virginia Beach?

Susan Stranahan, in her book Susquehanna, River of Dreams, describes the inextricable link between the Susquehanna and the Chesapeake Bay more eloquently than I could. She says:

"Without the Chesapeake, the Susquehanna would remain a mighty river, albeit one devoid of many creatures that the bay helps sustain. Without the Susquehanna, however, the Chesapeake would see its extraordinary mix of plants and animals shrink to that contained in a large saltwater inlet."

Perhaps the Chesapeake Bay should be renamed the Susquehanna Bay!

SCREEN 3 – BASIN MAP

2. When it comes to the Chesapeake, the Susquehanna rules!

+ The Susquehanna is Bay's single largest tributary, providing 50% of the freshwater flow to the Bay and 90% to the upper Bay.

+ The Susquehanna watershed – consisting of 27,510 square miles – constitutes almost half (42.9%) of the land area of the entire 64,000 square miles Chesapeake Bay watershed.

SCREEN 4 – NUTRIENT & SEDIMENTS TO BAY (PHOTO OF 2004 FLOOD)

3. Nutrient and sediment loadings from the basin have an obvious connection to river flows, which can be highly variable.

+ The highest flow in the basin was recorded on June 24, 1972. It was 1,130,000cfs or 507,500,000 gallons per minute. At this flow it would take a drop of water only 2 ¾ days to travel from Cooperstown, New York to the Chesapeake Bay.

+ The lowest recorded flow in the basin was recorded on September 18, 1964. It was 1,700 cfs or 763,500 gallons per minute. At this flow it would take a drop of water 18 days to travel from Cooperstown, New York to the Chesapeake Bay.

+ Pollution loadings to the Chesapeake Bay from the Susquehanna River can be and are very different from year to year, depending on whether we have dry years or wet years. And loadings can be highly variable from month to month, both because of normal seasonal variations in flow as well as because of the occurrence of major storm events that can result in much higher than average pollution loads.

SCREEN 5 - FLOODING

4. Due to the size of the basin, the basin's steep topography and the number of stream miles in the basin, the Susquehanna River Basin is one of the most flood prone basins in the nation. Certain major flood events can deliver most of the loads from the basin during the course of a year.

+ The Susquehanna Basin has 49,325 miles of streams

+ Since gage records were first kept in 1810, the Susquehanna River has experienced major flood events, on average, once every 14 years.

+ The Susquehanna is a “flashy” basin. A “flashy” watershed is one that is characterized by rapid increases in river flows resulting from runoff from precipitation events. The "flashiness" of a river is determined by the slope of its watershed, geologic structure and rock compositions, soil infiltration and retention, vegetative buffers and other factors.

+ As I mentioned, a few storms or even a single storm event can dominate nutrient and sediment loads to the Bay. For example, we had a flood of record in the upper Susquehanna Subbasin in June, 2006. The data we collected reveal that almost 2/3 of the total phosphorus load at Towanda in 2006 (4,288,912 of 6,906,798 billion of pounds) was recorded during the month of June as the result of that storm event. Other examples that come to mind are Tropical Storm Agnes in 1972, the ice flood in January, 1996, and Hurricane Ivan in 2004.

SCREEN 6 – NONPOINT SOURCES

5. Nonpoint sources account for the majority of nitrogen, phosphorus and sediment loads delivered to the Bay from the Susquehanna River Basin, and agriculture accounts for most of the nonpoint source loads from the basin. According to Pennsylvania’s Chesapeake Bay Tributary Strategy:

+ Nonpoint sources account for 89% of the total nitrogen loads and 82% of the total phosphorus loads delivered from the Susquehanna River Basin to the Chesapeake Bay.

+ Agriculture is the principal source of the delivered nitrogen loads (49%), phosphorus loads (63%) and sediment loads (72%) from the Susquehanna River Basin.

SCREEN 7 – POINT SOURCES

6. Point source discharges, according to Pennsylvania’s tributary strategy, contribute about 11% of the total nitrogen and about 18% of the total phosphorus to the Chesapeake Bay from Pennsylvania waters based on 2002 estimates. I’m sure you’re all aware that the annual nutrient cap loads that have been allocated to point source dischargers in Pennsylvania – and the estimated costs to achieve those cap loads – have been a subject of considerable discussion and controversy.

<u>SRBC MONITORING PROGRAMS</u>

SCREEN 8 – WEB SCREEN SHOTS

First, I would like to refer you to SRBC’s website, where we have a wealth of information about our various monitoring programs and activities. With respect to our Chesapeake

Bay related monitoring, for example, you will find everything from the loads and yields for TN, TP and SS from 1985 to the present, to trend maps and statistics, to information about our quality assurance protocols, to selected technical reports we have published over the years.

SCREEN 9 – SNAP SAMPLING PHOTOS

Since its inception in 1971, SRBC has been monitoring and assessing streams throughout the Susquehanna River Basin. Our various monitoring programs incorporate biological, water quality, and physical habitat monitoring. Today I'll be focusing on our Nutrient and Sediment Monitoring Program, otherwise known as the Susquehanna Nutrient Assessment Program.

SCREEN 10 – OTHER MONITORING PROGRAMS

Before doing so, let me briefly mention some of our other monitoring programs/ activities:

+ Our Subbasin Survey Monitoring Program, which addresses regional water quality, physical habitat and biological conditions throughout the basin;

+Our Interstate Stream Monitoring Program, a water quality network established in 1986 to assess compliance with water quality standards for streams that cross state lines; and

+Our Large River Assessment Program, which is intended to determine the proper methods for biologically assessing the large rivers in the basin.

We publish a water quality assessment report every two years as part of our 305(b) monitoring work that provides a summary of SRBC's assessment of the water quality, physical habitat, and biological status of the basins's rivers and streams. We recently completed the 2008 report and it is available on our website (www.srbc.net.). Incidentally, over 81% of the more than 5,000 stream miles (5015.26) that were assessed in this report fully support designated uses.

SCREEN 11 – Why Is Monitoring Important?

Why is monitoring important?

Fundamentally, monitoring is important in order to allow mangers to make informed decisions. It provides a baseline that allows managers to determine real improvement and to track progress over time. Monitoring is also important in order to calibrate models. Modeling is an important tool for the Chesapeake Bay Program and in the field of water resource management in general.

SUSQUEHANNA NUTIENT ASSESSMENT PROGRAM

Where Do We Monitor? (Monitoring Locations)

SCREEN 12 – Map of Group A and Group B Sites

We monitor at two sets of sites, which we refer to as "Group A" and "Group B" sites. "Group A" sites consists of six monitoring locations on the mainstem Susquehanna River, while "Group B" sites consist of an additional 17 locations on the major tributaries to the mainstem Susquehanna River. My presentation this morning is focused on the "Group A" sites.

First, let me orient you to how we tend to think of the Susquehanna River Basin – namely in terms of its six major subbasins, which are depicted on this map.

SCREEN 13 – Map of Group A Sites W/Photos

Our long term monitoring sites are at the Susquehanna River at Towanda, Pa., the Susquehanna River at Danville, Pa., the West Branch Susquehanna River at Lewisburg, Pa., the Juniata River at Newport, Pa., the Susquehanna River at Marietta, Pa. and the Conestoga River at Conestoga, Pa.

+The Susquehanna River at Towanda site captures loads from the entire New York portion of the basin – which accounts for almost 25% of the basin's land area. Most of the land area in two of our major subbasins – the Chemung Subbasin and the Upper Susquehanna Subbasin – is located in the New York portion of the basin. The drainage area at Towanda is 7,797 square miles.

+ The Susquehanna River at Danville site has a drainage area of 11,220 square miles, which includes the 3,755 square mile Middle Susquehanna Subbasin.

+ Data collected from the West Branch Susquehanna River at Lewisburg includes the loadings from the largest of the six major subbasins, which has a drainage area of 6,847 square miles and includes much of northcentral Pennsylvania. This watershed is predominately forested (81%). The drainage area at Lewisburg and Danville represents 65.7 percent of the total Susquehanna River Basin.

+ The Juniata River at Newport drains much of southcentral Pennsylvania and has a drainage area of 3,354 square miles. The drainage area at Newport, Lewisburg and Danville represents 77 percent of the total Susquehanna River Basin and 88.9 percent of the drainage above Harrisburg.

+ The Susquehanna River at Marietta is the southern-most sampling site upstream from the lower Susquehanna hydroelectric dams and represents the inflow to the reservoirs behind them from its 235,900 square mile drainage area. This drainage area represents 94.5 percent of the total Susquehanna River Basin.

+ Data collected from the Conestoga River at Conestoga provide loadings from a major tributary watershed that is actively farmed. The drainage area of this basin at the sampling site is 470 square miles. I'll have more to say about the Conestoga watershed later.

+ In addition to these monitoring stations, the United States Geologic Survey maintains a monitoring station at the Conowingo Dam. Data from this site reflects loads from the entire Susquehanna River Basin before it enters the Chesapeake Bay.

SCREEN 14 –Map of Group B Sites

Our "Group B" sites – shown as the yellow and orange points on the map – are part of an enhanced tidal network that has been developed for measuring attainment of commitments made by the Chesapeake Bay Program to meet water quality criteria (dissolved oxygen, chlorophyll, and water clarity) in the Bay and its tributaries. More information about these sites can be found in SBRC's Quality Assurance/ Quality Control Plan, which is available on our website.

SCREEN 15 – SRBC MONITORING TEAM PHOTO

Who Does Our Monitoring?

SRBC uses its own experienced staff to collect samples at these monitoring locations. Jen Hoffman, a biologist who heads the Monitoring and Assessment Section of SRBC's Division of Watershed Assessment and Protection, has the overall responsibility for the SNAP. Kevin McGonigal, who is a Water Quality Program Specialist, has the primary responsibility for the data collection.

SCREEN 16 – WHEN AND WHAT DO WE MONITOR

When Do We Monitor – and What Do We Monitor For?

We collect filtered and unfiltered samples from base blow once a month at the Group A stations and from storm runoff during at least four high flow events annually, with one storm event targeted for each season. We collect at least two discreet samples for each storm, one during the rise and the other during the peak of flow on different days.

We analyze for a suite of 21 parameters from the samples we collect – from Dissolved Oxygen, pH, Temperature and Specific Conductance to specific parameters for nitrogen, phosphorus and sediment.

For all Group A and Group B sampling stations, we collect a "trends sample" at the same time each month (generally on or about the 15th of the month).

SCREEN 17 – HOW DO WE MONITOR

How Do We Monitor?

The collection of water quality samples representative of river conditions is essential for the program to be successful. Spatial variability inherent to a sampling site is addressed by taking depth-integrated, discharge weighted water samples across the cross section at the sampling site and thus reflects the composite effect of whatever has occurred upstream from the site. Data are collected within the same time frame at all locations to be representative of conditions in the Susquehanna River within a specified time period.

Procedures for sampling, sample custody and documentation, calibration and maintenance of monitoring equipment, and data reduction and reporting are detailed in our Quality Assurance/ Quality Control Plan, which is approved by USEPA.

Who is Responsible for Analyzing the Samples We Collect?

All of our samples are analyzed by the Pennsylvania DEP laboratory, with the methods used by the lab listed in the SRBC's Quality Assurance/ Quality Control Plan and in the DEP Lab Quality Assurance Plan.

SCREEN 18 – HOW DO WE ANALYZE

How Do We Analyze The Monitoring Data?

Once again, our Quality Assurance/ Quality Control Plan includes information on analytical methods and detection limits as well as estimating loads and flow-adjusted trends.

Trends in discharge indicate the natural changes in hydrology. Changes in flow and the cumulative sources of flow (base flow and overland runoff) affect the observed concentrations and the estimated loads of nutrients and suspended sediment. The Flow Adjusted Concentration (FAC) is the concentration after the effects of flow are removed. Trends in FAC indicate that changes have occurred in the processes that deliver constituents to the stream system. This is the concentration that relates to the effects of nutrient-reduction activities and other actions taking place in the watershed.

Trends are considered NOT SIGNIFICANT, IMPROVING, or DEGRADING

SCREEN 19 – RESULTS – TRENDS MAP

What Are the Results of Our Monitoring?

The answer to this question is: "it depends." It depends on several variables:

- First, it depends on what period of time we're looking at. If we're looking at the long term trend, over the entire period of time for which monitoring data are available, we may get a different answer than for a shorter period of time.

- Second, it depends on the particular constituent in question. For example, the trend for nitrogen may be different than the trend for phosphorus.

- Third, it depends on the monitoring location. Trends may be different at one monitoring station than for another.

Let's start by taking a look at our long term trends. The good news is that ALL long-term linear trends are IMPROVING (that is decreasing) at ALL sites with the exception of TP at Towanda and SS at Lewisburg, where there are NO SIGNIFICANT trends. And let me add that NO SIGNIFICANT trend is not a bad thing; it simply means that there are no statistically significant IMPROVING or DEGRADING trends. Let me state this good news story in the converse. For ALL of the constituents we have monitored during the past 2 plus decades – TN, TP and SS – there are NO DEGRADING trends. None.

SCREEN 20 – FIVE YEAR TREND GRAPHIC

This is not to say that we never see any degrading trends in our monitoring data. To the contrary, as shown on this slide – which I realize is rather busy -- in looking at a five year average value in a given year, we see degrading trends for phosphorus at most of our monitoring stations for 1998 and at all of our monitoring stations for 1999 and 2000. And we again see increasing trends at Lewisburg, Towanda and Danville for the years 2004 and 2005.

Let me be clear that what we're depicting on this graphic is a five year average value. So, for example, when we see an increasing trend indicated for TP in 1998, we're seeing that trend for the period starting in 1996 and ending in 2000.

Let me also point out at the bottom of this graphic that, <u>for the fifteen year period 1992 to 2007</u>, we are seeing:

- DECREASING TRENDS at all but one station (Newport) for TN
- NO SIGNIFICANT TRENDS for TP at all but one of our monitoring stations (Conestoga, where we are seeing a DECREASING TREND)
- DECREASING TRENDS at four of our six stations for SS; we are seeing NO SIGNIFICANT TRENDS at the other two stations (Newport and Marietta)

For the 10 year period from 1997 to 2007 we are seeing:

- DECREASING TRENDS for 4 of our six stations for TN and NO SIGNIFICANT TRENDS at the other two stations (Newport and Lewisburg)

- INCREASING TRENDS for TP at three stations, a DECREASING TREND at two stations (Conestoga and Marietta) and NO SIGNIFICANT TREND at the sixth station (Newport)
- For SS we are seeing DECREASING TRENDS at all six stations.

SCREEN 21 – ROLLING VERSUS LINEAR TRENDS, CONESTOGA EXAMPLE

Another way to depict trends is linear trends vs. rolling trends. These graphs for the Conestoga station show two things, the 5 year rolling trend data and linear trend data. The linear trend is simply the long term trend that we typically portray in the trends map visual. This graph is meant to compare changes in concentrations when considering the linear long term trend as compared to the rolling trends plots, which could be showing the same trend as the linear long term trend, or a different one for a given period of time.

SCREEN 22 – RESULTS – TRENDS CHART FOR CONCENTRATION

Yet another way to look at monitoring data is by comparing values for a particular year to the long-term linear trends. Here, for example, we are looking at flows and concentrations for TN, TP and SS in 2007 versus the Long Term Mean (LTM) for these constituents. I realize it is probably difficult to see this slide, but what we are seeing is that, corresponding to the lower than average flow values in 2007, we had lower concentration values for most of the parameters we monitor. While the values for TN were somewhat lower than the LTM at all of our monitoring stations, the values for TP and SS were significantly lower in 2007 all the stations.

OTHER IMPMORANT INFORMATION

SCREEN 23 – BAY GRASSES

<u>Is the water quality of the Susquehanna River reflected in the ecological health of the Chesapeake Bay?</u>

The short answer to that question is "yes."

Bay grasses are one of the indicators used by the Chesapeake Bay Program to assess the Bay's health. Their abundance has a profound effect on the Bay and its aquatic life, as it provides critical habitat to key species such as striped bass and blue crabs while improving the clarify of local waters.

Bay grasses are one of the most important habitats in the Bay and are closely related to the quality of local waters. As such, according to the 2007 Chesapeake Bay Health & Restoration Assessment, "they serve as an excellent barometer for the overall health of the estuary."

The most recent baywide data from 2007 show bay grasses covering nearly 65,000 acres – or about 35% of the 185,000 acre restoration goal. Although an increase from 59,000 acres in 2006, grasses have not yet recovered to the recent high level of 90,000 acres in 2002.

The total Bay grass abundance goal has been broken down by three zones. For 2007:

- Middle Bay grasses covered roughly 30,000 acres or 26% of the 115,229 acre goal
- Grasses in the Lower Bay covered 16,000 acres or 35% of the 36,030-acre goal
- Bay grasses in the Upper Bay in 2007 covered about 19,000 acres, or 80% of the 23,630 acre goal.

The goal achievement for Bay grasses in Upper Bay –which is dominated by the freshwater flow from the Susquehanna River -- is more than twice that of the goal achievement in Lower Bay and more than three times the goal achievement in the Middle Bay. I think these results speak for themselves.

SCREEN 24 – COMPARISON OF SR AND BAY WQ

<u>How does Water Quality in the Susquehanna River compare to Water Quality in the Chesapeake Bay?</u>

According to the 2007 Chesapeake Bay Health and Restoration Assessment Report, for 2007, nitrogen loads reaching the Bay (318 million pounds) were similar to the average load for 1990-2007. The phosphorus load to the Bay (15 million pounds) was below that average. The sediment load delivered to the Bay (2.8 million tons) was below the average load for 1990-2007. The report states:

In 2007, the Bay Program was 21 percent of the way toward meeting Bay water quality goals, a drop from 23 percent in 2006.

SCREENS 25, 26, 27 – GRAPHS SHOWING FLOW-ADJUSTED CONCENTRATIONS FOR N, P, S FOR SR AND TRIBS.

<u>How does the Susquehanna's water quality compare to other Bay tributaries?</u>

Another useful – and important -- way to consider the Susquehanna's water quality is in terms of the flow weighted concentrations of the various parameters we monitor to other major tributaries of the Bay. What is a flow-weighted concentration? It is an average monthly concentration, rather than a single observed concentration, and is more representative of monthly stream quality conditions. This is the concentration that affects the biological processes of the stream.

This slide and the two to follow slides show the flow-weighted concentrations for TN, TP and SS for major tributaries of the Chesapeake Bay -- namely the Choptank, Patuxent, Potomac, Rappahhaock, Pamunkey, Mallaponi, James, Appamattox and Susquehanna

Rivers. While the Susquehanna is among the highest flow-weighted TN concentrations, it is among the lowest flow-weighted concentrations for TP and SS.

So while the loads for these constituents are undeniably higher from the Susquehanna than from the other Bay rivers – due to sheer magnitude of the water provided to the Bay by the Susquehanna relative to the other rivers – the relative concentrations of these constituents tell as different story.

SCREEN 28 – TMDL FOR CONESTOGA WATERSHED

I will conclude my remarks by showcasing a monitoring project that SRBC is currently undertaking for DEP. It involves monitoring for the development of a TMDL for the Conestoga Watershed, which is largely within Lancaster County.

As I'm sure many of you already know, a TMDL (or Total Maximum Daily Load) calculates the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and allocates that amount to the pollutant's sources. Monitoring is critical for knowing what constituents or pollutants are in the water column. TMDLs go the next step by helping to separate out the sources for the constituents, thereby allowing managers to recommend needed actions to achieve reductions.

A TMDL is needed for the Conestoga Watershed because some 330 miles of the mainstem Conestoga River and its tributaries are listed as impaired on the 303(d) list, primarily for nutrients and sediment.

While the Conestoga watershed is a rapidly developing one, agriculture remains the dominant land use at 60 percent. The greatest loads of nutrients from nonpoint sources are received primarily during storm events. In terms of point sources, there are more than 50 permitted dischargers in the watershed.

SCREEN 29 – FINDINGS FROM TMDL PROJECT

SRBC is currently preparing an interim data report, which is scheduled for release later this month (JUNE). Because the first phase of our monitoring was limited solely to sampling and analyzing for nutrients and sediment during base flow conditions, the interim report will likewise be exclusively those base flow results.

Our findings from the base flow samplings show that in some places, more than 50% of the stream flow during base flow conditions is comprised of effluent from point discharges.

The next phase of our monitoring effort for this TMDL project will target normal and high flow conditions to document nonpoint source contributions. Given the numerous nonpoint sources within the Conestoga watershed, we expect to see other results during the normal to high flow conditions.

As part of this TMDL project, we will be making recommendations for nutrient and sediment reductions from all sources in the watershed.

CONCLUSION

That concludes my remarks. Thank you for this opportunity to provide this progress report on the status of nutrients in the Susquehanna River Basin. I hope that you found it to be of interest.