Long-term Monitoring Program Shows Improving Nitrogen Trends in Maryland's Rivers and Streams

Background

The Maryland Department of Natural Resources (MDNR) conducts a long-term water quality monitoring network referred to as the Core/Trend Program that has compiled over 20 years of data. Monitoring stations are located on major non-tidal, freshwater rivers in the Choptank, Gunpowder, Patapsco, Patuxent, Susquehanna, Potomac and Youghiogheny River basins. Land use/land cover percentages (forest, urban, agriculture) for the watershed area draining to each station are highly variable (i.e., some stations drain mostly forested watersheds, while others are dominated by urban or agricultural influences). All 54 stations have been sampled monthly (12 collections/year) since 1986 on a pre-determined date. This sampling design allows the collection of data over a wide range of river flows and provides a robust data set for capturing long-term annual trends in water quality.

Methods

Water quality parameters collected by the Core/Trend Program include chlorophyll a, conductivity, dissolved oxygen, ammonium, nitrate, nitrite, nitrate plus nitrite, pH, orthophosphate, sulfate, total alkalinity, total organic carbon, total nitrogen, total phosphorus, total suspended solids, turbidity, and water temperature. Trends in water quality were examined from 1986 through 2006 with the use of a statistical technique referred to as the Seasonal Kendall tau test. Collection and analytical methods are described in detail in the Quality Assurance Project Plan report (March 2009) that can be downloaded at:
http://www.dnr.state.md.us/streams/pubs/mn0902_CT_QAPP.pdf

Kristen Heyer (MDNR) collecting a water sample from Potomac River at White's Ferry

1986 - 2006 Results

Total nitrogen is the primary focus of this fact sheet because it is one of the major pollutants impacting the health of the Chesapeake Bay and is one of the two nutrients targeted for reduction in our accelerated restoration efforts. Of the 54 Core/Trend stations, 43 (80%) show significant improving total nitrogen trends, only one shows a degrading trend, and ten have not shown any significant changes in nitrogen concentrations since 1986 (Figure 1). For the stations with improving trends, most had initial (1986 - 1989) mean nitrogen concentrations ranging from 1 to 5 mg/L (Table 1). Only two stations had initial concentrations that were < 1.0 mg/L, a level expected in rivers with minimal anthropogenic impacts. Overall, the majority of stations experienced slight (< 1.0 mg/L decrease) improvements in total nitrogen concentrations. Monitoring station PXT0603, located on the Patuxent River just east of Bowie, experienced the greatest improvement in total nitrogen concentration (Figure 2). The average concentration of total nitrogen declined from 4.68 mg/L (1986-1989) to 1.89 mg/L (2003-2006), a 2-1/2 fold decrease. The watershed area draining to this station is mixed: 43.8% agriculture, 30.3% forest, and 21.6% urban. This decrease in nitrogen is attributed primarily to upgrades at wastewater treatment plants to biological nutrient removal; however, implementation of best management practices to address nonpoint source (i.e., surface runoff) pollution has likely helped as well. Several Core/Trend stations whose watershed areas are dominated by agricultural land use/land cover have also shown significant improving total nitrogen trends. For example, total nitrogen concentrations at station BPC0035 (Big Pipe Creek) whose watershed is 75% agriculture, 22.7% forested, and only 1.9% urban decreased from 4.03 mg/L (1986-1989) to 3.74 mg/L (2003-2006) (Figure 3). The observed improving trends at stations whose drainages are dominated by agriculture may be explained by the implementation of best management practices that reduce runoff of nutrients and sediment.

Table 1

		Decrease in mean TN (mg/L) (1986-89 to 2003-06)		
Mean TN (1986-89) mg/L	**Number of Stations**	> 2 large	1 – 2 moderate	<1 slight
> 5	5	0	2	3
1 to 5	36	1	2	33
< 1	2	0	0	2
Total	43	1	4	38

Sally Bowen (MDNR) collecting a water sample from Potomac River above Little Falls Dam

Maryland River Basins and Total Nitrogen Trends (1986 - 2006) at Core/Trend Monitoring Stations

Figure 1

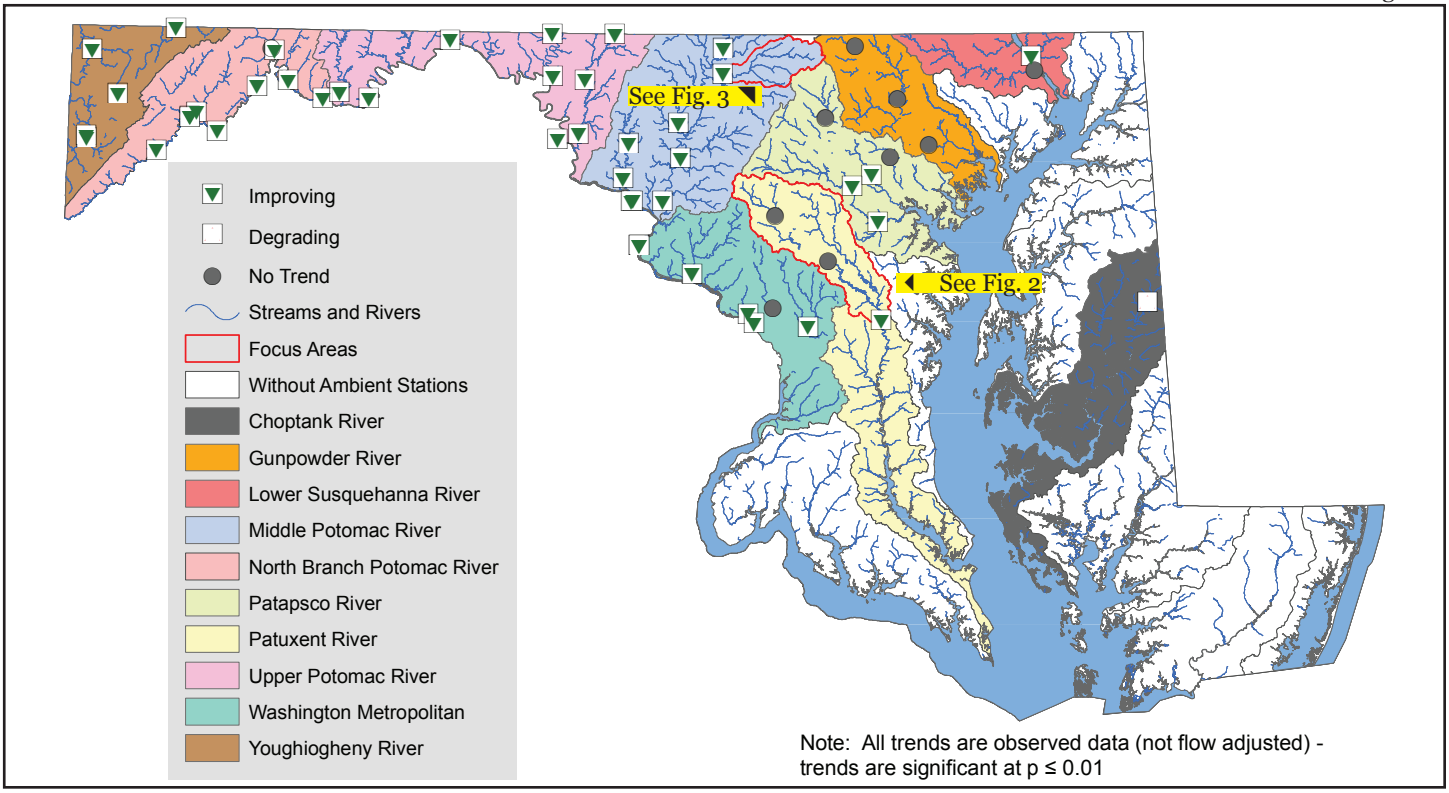


Figure 2 - Patuxent River, PXT0603

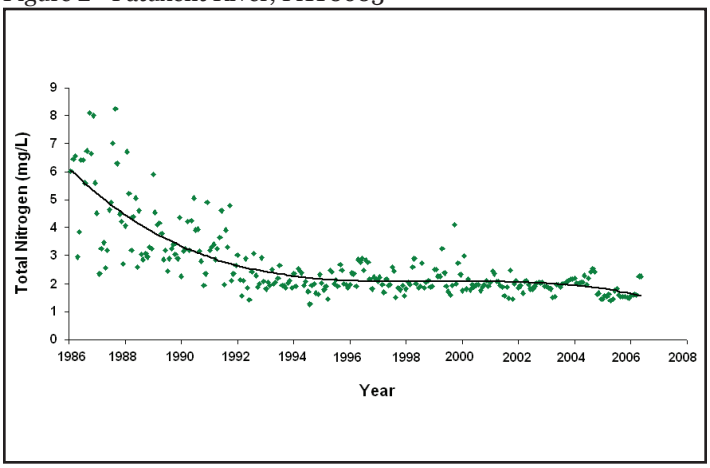
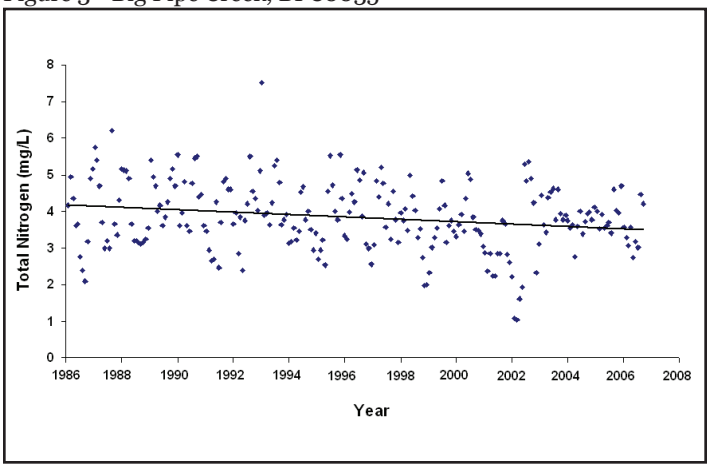


Figure 3 - Big Pipe Creek, BPC0035



Discussion

Trend results from 1986 - 2006 illustrate that most stations throughout the Potomac River watershed are improving, a result that is consistent with the trends observed at the Potomac River-Input Monitoring station (a collaborative effort between USGS and MDNR) located near Washington D.C. at Chain Bridge. Currently there is only one Core/Trend monitoring station located on Maryland's Eastern Shore; however, there will be an effort in the near future to expand the number of long-term non-tidal monitoring stations in this region. MDNR is currently updating trends analysis of our Core/Trend information to include data collected through 2008, a 23-year time series. In addition, MDNR is working to determine the natural and human-related factors that explain the observed trends in water quality at these long-term monitoring stations. Although some rivers across Maryland have experienced and are continuing to experience degrading water quality due to human activities, the long-term improvements in total nitrogen documented at 43 stations offer hope that aggressive management actions on the landscape can lead to more improving trends in water quality that will benefit both non-tidal and tidal ecosystems in Maryland, including the Chesapeake Bay.

Contact Information

Tony Prochaska
(410) 260-8616
tprochaska@dnr.state.md.us
Ron Klauda
(410) 260-8615
rklauda@dnr.state.md.us

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Andy Becker

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Maryland Department of Natural Resources
Resource Assessment Service
580 Taylor Avenue,
Annapolis, MD 21401