

## Nutrients in the Watershed and Impact on Chesapeake Bay

### Excess Nutrients in the Chesapeake Bay

Nutrients are one of the most intensively studied environmental stressors on the health of the Chesapeake Bay ecosystem. Nutrients, such as nitrogen and phosphorous, are naturally occurring chemicals in the environment that help plants and animals grow. They come from a number of natural sources, and they are added into a variety of man-made products, from fertilizers to cleaning solutions, to help those products work better and more quickly.

An overabundance of nutrients is directly related to excess algae growth. This leads to low dissolved oxygen levels and poor water clarity, which create problems for the plants and animals that live in the Bay. The Bay was listed as an "impaired water body" under the Clean Water Act due to low dissolved oxygen that has killed fish and other organisms.

The Chesapeake Bay Program (CBP) has a goal to reduce nutrient and sediment loadings to Bay to meet criteria for dissolved oxygen, chlorophyll, and water clarity by the year 2010. An understanding of the sources, transport, and delivery of nutrients from the watershed to the bay is critical to successfully revise the management strategies to reduce nutrients.

### USGS Chesapeake Bay Science Studies

The USGS is providing critical science to help the CBP formulate and assess the effectiveness of tributary strategies to reduce nutrients and sediment to the Bay. The USGS is:

- (1) using watershed models to relate nutrient sources to loads,
- (2) Monitoring the concentrations and loads of nutrients in the watershed,
- (3) Enhancing trend analysis and understanding the factors relating nutrient sources to trends,
- (4) Documenting the influence of ground water on nitrogen movement, and
- (5) Conducting studies of nutrient cycling.

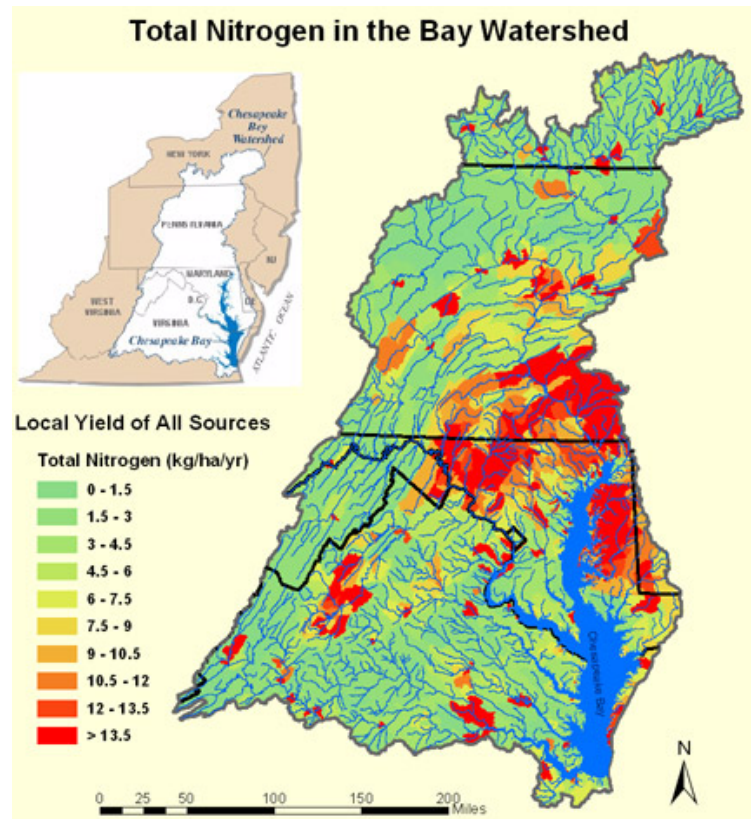
The USGS has multiple studies addressing these issues and more information can be found at: <http://chesapeake.usgs.gov/studiesproject.html>. Information from several of these issues is provided in the following text.



## Relating Nutrients Sources to Loads in the Watershed (SPARROW)

Land use and natural processes affect the occurrence and distribution of nutrients throughout the Bay watershed. A USGS watershed model, "SPARROW" (SPATIally Referenced Regressions On Watershed attributes), relates stream water quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and stream transport. SPARROW provides data on the distribution of nitrogen loads and their relation to nitrogen sources in more than 1,400 streams in the watershed (Preston and Brakebill, 1999). The SPARROW model provides complimentary information for the CBP Phase V watershed model. These predictive tools provide information to help States and local governments formulate and implement the tributary strategies.

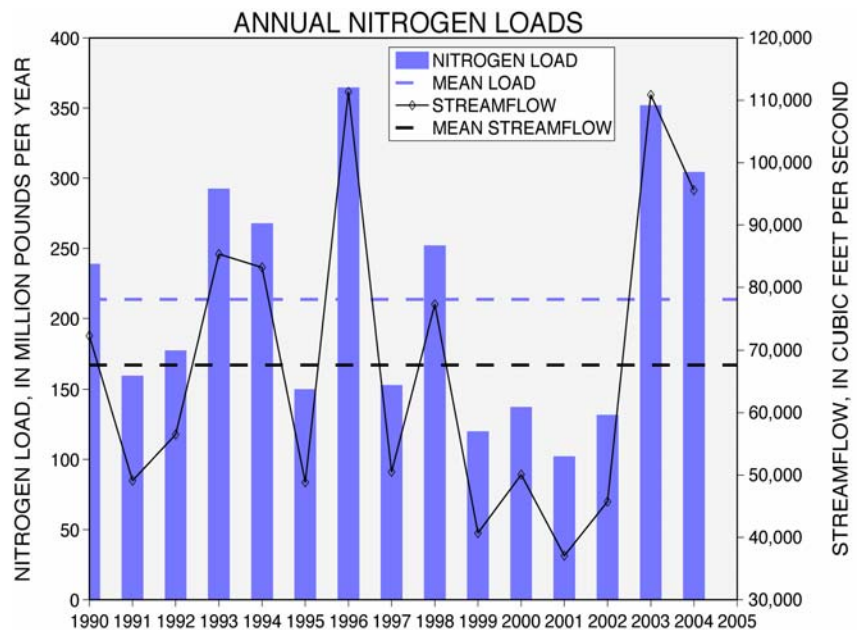
The SPARROW models provide reliable, scale-independent estimates of the total N and total P contributions to watershed export from five categories of nutrient sources. High nitrogen loads, generally associated with agricultural inputs, occur in an arc-shaped area from central Virginia through south-central Pennsylvania and along the Eastern Shore of Maryland and Virginia. (see the figure to the right). The locations of individual nutrients sources, including atmospheric deposition, can be found at <http://md.water.usgs.gov/gis/chesbay/SPARROW.htm>. The SPARROW also provides an estimate of amount of nutrients ultimately reaching the bay. Model results indicate that, on a median basis, about 20 percent of the nitrogen sources actually reach the bay.



## Nutrient Concentrations and Loads

Documenting the amount and changes of nutrients delivered to the Bay from its major rivers is accomplished through the River-Input project. The nutrient loads and trends over time reflect the influence of natural conditions, primarily the variability in streamflow and the effectiveness of management actions to reduce nutrient concentrations and their associated sources. The USGS, in cooperation with State and Federal partners, measures the streamflow and water quality to estimate the loads and trends of nutrients and sediments in the 9 major rivers entering the bay. The river-input sites monitor about 78% percent of the Bay watershed but are upstream of some large urban areas such as Washington D.C. Monitoring of additional sites in the watershed is being implemented under the CBP Nontidal Water-Quality Network. The graph shows the annual amount of nitrogen that is delivered to the Bay from its nine major rivers. More information can be found on the River-Input Project at <http://va.water.usgs.gov/chesbay/RIMP/>

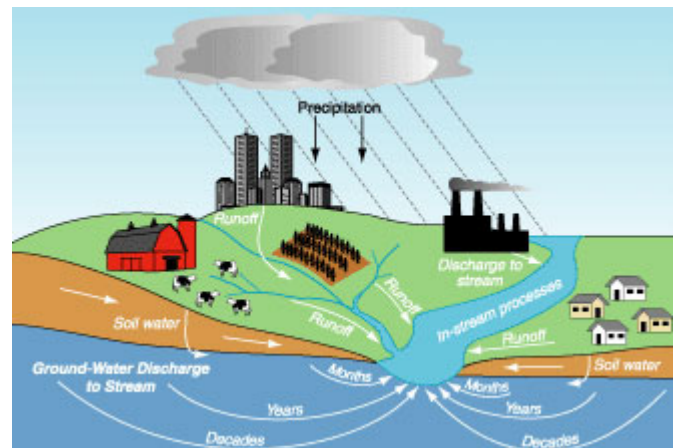
Nitrogen closely follows changes in streamflow (black line) with an average of about 225 million pounds since 1990. Since the drought conditions of 1999-2002, nitrogen loads have been above average.



### Ground Water and Nitrogen

In addition to surface water, ground water is an important pathway for nitrogen to reach Chesapeake Bay. Some of the nutrients applied to the land surface, especially nitrate, infiltrate the underlying ground-water system and are slowly transported through shallow aquifers to springs and streams. The fact sheet “The Influence of Ground Water on Nitrogen Delivery to the Chesapeake Bay, Online Publication - FS-091-03” summarizes the USGS study of the discharge, nitrogen transport, and age of ground water into streams of the Chesapeake Bay watershed. Some of findings included:

- Resource managers need to understand the “lag time” between implementation of management practices and improvement in water quality in the Bay to help develop future nutrient- and sediment-reduction strategies. One factor affecting the lag time is the influence of ground water on the transport of nitrogen to streams in the Bay watershed.
- Ground water supplies a significant amount (about half) of water and nitrogen to streams in the watershed and is therefore an important pathway for nitrogen to reach Chesapeake Bay.
- The age of ground water in shallow aquifers in the Chesapeake Bay watershed ranges from modern (less than 1 year) to more than 50 years, with a median age of 10 years.
- In addition to ground water, stream water will be influenced by surface runoff and soil water. Runoff and soil water both have very young ages (hours to months) and supply, on average, about half of the water to a stream.
- Proposed water-quality criteria in the Bay probably will not be met by 2010 due to the time needed to implement management practices and the effect of ground water and other watershed properties on nutrient transport.



### **Implications and Need for Targeting Nutrient-Reduction Strategies**

Proposed water-quality criteria in the Bay probably will not be met by 2010 due to the time needed to implement management practices and the effect of ground water and other watershed properties on nutrient transport. The USGS findings show that variations in land use, watershed characteristics, streamflow, and ground water all affect the occurrence of nutrients in the watershed and their delivery to the bay. The most effective nutrient-reduction strategies would be more targeted, local actions based on nutrient sources and the watershed and stream characteristics that their delivery to the bay.

USGS Activities in the Chesapeake Bay Homepage – [chesapeake.usgs.gov](http://chesapeake.usgs.gov)