N and P Transport Processes in a Mid-Atlantic Coastal Plain Watershed

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ABSTRACT

The Millsboro Pond Outlet (MPO) drains a 157 km^2 Coastal Plain watershed located on the Delmarva Peninsula in southeastern Sussex County, Delaware. The MPO watershed includes several other small millponds connected in series to Millsboro Pond. It is the largest single discrete source of freshwater to the Indian River and Inland Bays estuary. Because animal-based agriculture (poultry) comprises a large portion of land use in the Indian River and Inland Bays watersheds, water flowing from MPO carries significant loads of nitrogen and phosphorus, and the waters of the Inland Bays exhibit serious symptoms of eutrophication.

In order to better document nutrient loads and the response of the watershed to evolving management practices, the Delaware Department of Natural Resources and Environmental Control funded installation and operation of a continuous discharge measurement station and a high frequency water quality data analyzer (Greenspan, Aqualab®) at the MPO. Sensors in the Aqualab measure dissolved O_2, electrical conductivity, temperature, pH and turbidity on an hourly basis, and determine nitrate (NO_3^-), ammonium (NH_4^+), and soluble reactive P (SRP) concentrations every four hours. NO_3^- and NH_4^+ are determined by specific ion electrode and SRP is determined by colorimetry.

Analysis of the MPO hydrograph indicates that total streamflow is almost always dominated by baseflow, much the same as other streams on the Delmarva Peninsula. Over the 15 year period of observation total annual flow consists of 70 to 80 percent baseflow depending on climate. Only during the largest storms does stormflow exceed baseflow. Further, storm hydrographs typically return to baseflow within three to four days of the end of the storm. These characteristics are due to the low topographic relief of the watershed and the relatively thick and permeable nature of the underlying Columbia aquifer.

High frequency Aqualab data provide new insights into how watershed land cover and hydrography affect N and P transport to and through Millsboro Pond Outlet to Delaware's Inland Bays during storms. Through October 2006, more than 13,000 samples have been successfully analyzed, including more than 3,500 samples analyzed for nitrogen and phosphorus. The concentration of NO_3^- is diluted during storms, reflecting the high concentrations of NO_3^- in local ground water and the relatively lower concentrations in rainfall and storm runoff. NO_3^- concentrations then return to baseflow levels within 1 to 3 days following a storm event coincident with the storm-flow recession. As a result, NO_3^- loads, which are a good estimate of total nitrogen loads at this site, reflect baseflow discharge and seasonal baseflow concentrations. In contrast to NO_3^-, SRP concentrations increase during storms and remain relatively high for up to a week or more reflecting, perhaps, in-pond or riparian remobilization of P. As a result, SRP loads reflect the frequency and magnitude of storm activity to a larger extent than do NO_3^- loads.

Turbidity exhibits patterns that somewhat similar to SRP indicating that in-pond or riparian processes are responsible for P transport rather than overland flow processes.

KEYWORDS
Watershed, baseflow, stormflow, nitrogen, phosphorus, dissolved oxygen, sampling