The Utility of High Frequency Nutrient Monitoring in Post-Auditing of Nonpoint Source Load Estimating Models

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ABSTRACT

Delaware's Inland Bays are located in the southeastern part of the State of Delaware and have a drainage area of about 803 km^2, of which 84 km^2 is water. Agriculture is the dominant land use within the watershed although residential land uses are increasing. Delaware's Inland Bays are classified as Waters of Exceptional Recreational or Ecological Significance (ERES) by the State of Delaware; however, they are also considered degraded because of high levels of nitrogen and phosphorus, which contribute to low dissolved oxygen levels, fish kills, and loss of habitat.

To assess and quantify nutrient overenrichment of the Inland Bays and to develop corrective management actions, several water quality and watershed modeling studies have been conducted over the past 20 years. The results of these studies were used by Delaware Department of Natural Resources and Environmental Control (DNREC) to establish Total Maximum Daily Loads (TMDLs) for nitrogen and phosphorus in 1998 and 2005.

In order to document and track progress toward achieving TMDL targets, DNREC deployed a remote water quality and nutrients data analyzer (Greenspan, Aqualab®) at the outflow of Millsboro Pond, the largest tributary to the Inland Bays. Aqualab is capable of collecting and analyzing water samples on frequent basis (up to hourly). High frequency nutrient data collected at this site has been used to calculate daily nutrient loads from Millsboro Pond. Furthermore, the collected data has been used to post-audit the performance of past modeling and load estimating studies for the watershed.

The result of high frequency nutrient monitoring at the above site during calendar year 2006 (which was a "normal" hydrologic year) indicates that the annual nutrient loads during this year were 14.9 lbs/acre/year for nitrogen and 0.1 lbs/acre/yr for phosphorus, respectively. Comparing the results obtained through this monitoring effort with previous nonpoint source load estimating studies for the watershed shows that the models generally underestimated nitrogen load and overestimated phosphorus load.

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Overestimating phosphorus load by various models may be due to the fact that the function of Millsboro Pond, which helps in settlement of suspended particles, hence lowering phosphorus load, was not fully considered in those models. Furthermore, the load estimating models were more accurate in predicting nitrogen load than predicting phosphorus load. Nitrogen loading estimates were all within $\pm$ 0.5 standard deviation of the observed nitrogen daily load with relative differences ranging from -53% (for the HSPF model) to +2% (for the US Army Corps of Engineers' CH3D-CE-QUAL model). The relative differences for phosphorus daily load ranged from +52% (for the HSPF model) to +281% (for loading rate method). The above differences between observed daily loads and various modeling estimates may reflect natural variations of nutrient loads as well as complexities, uncertainties, and assumptions which are inherited with different models.

KEYWORDS

Nutrient, monitoring, data analyzer, nonpoint source, nutrient load, model, post-audit

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