Nitrogen Loads through Baseflow, Stormflow, and Underflow to Rehoboth Bay, Delaware

J.A. Volk, K.B. Savidge, J.R. Scudlark, A.S. Andres, and W.J. Ullman

ABSTRACT

A detailed study of water and nitrogen (N) discharge from a small, representative subwatershed of Rehoboth Bay, Delaware, was conducted to determine total N loads to the bay. The concentrations of ammonium (NH_4^+), nitrate + nitrite ($NO_3^- + NO_2^-$), and dissolved and particulate organic N were determined in baseflow and storm waters discharging from Bundicks Branch from October 1998 to April 2002. A novel hydrographic separation model that accounts for significant decreases in baseflow during storm events was developed to estimate N loads during unsampled storms. Nitrogen loads based on gauged flows alone (7100–19,100 kg/yr) significantly underestimated those based on land use–land cover (LULC) and estimated N export factors from different classes of LULC (32,000–40,600 kg/yr). However, when ungauged underflow and associated N loads were included in the total loads (25,500–33,800 kg/yr), there was much better agreement with LULC export models. This suggests that in permeable coastal plain sediments, underflow contributes significantly to N fluxes to estuarine receiving waters, particularly in drier years. Based on the similarity in LULC, N loads from the Bundicks Branch subwatershed were used to estimate upland loads to the entire Rehoboth Bay Watershed (259,000–316,000 kg/yr). These N loads from the watershed were much greater than those from direct atmospheric deposition (49,000–64,500 kg/yr) and from a local wastewater treatment plant (9700–13,700 kg/yr). While the watershed was the principal source of N at all times during the year, the relative contributions from the watershed, wastewater, and direct atmospheric deposition varied predictably with season.

ACKNOWLEDGMENTS

This research was supported principally by USEPA Star Grant R826945 (W.J. Ullman, project director), by the Center for the Inland Bays (J.R. Scudlark, principal investigator), and by the NOAA Air Resources Laboratory (NADP-AIRMON Program; J.R. Scudlark, principal investigator). The Delaware Department of Natural Resources and Environmental Control, the U.S. Geological Survey, and the Delaware Geological Survey provided additional support. J.A. Volk (formerly J.A. Jennings) was supported by a Delaware Water Resources Center Graduate Fellowship.

J.A. Volk, Watershed Assessment Section, Delaware Department of Natural Resources and Environmental Control. K.B. Savidge, J.R. Scudlark, and W.J. Ullman, College of Marine Studies, University of Delaware. A.S. Andres, Delaware Geological Survey, University of Delaware.

Published in J. Environ. Qual. 35:1742–1755 (2006).
Technical Reports: Landscape and Watershed Processes
doi:10.2134/jeq2005.0373

677 S. Segoe Rd., Madison, WI 53711 USA