Continuous Monitoring of Nitrate and Chlorophyll *a* in North Carolina Estuaries

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Biographical Sketch
Jerad Bales is a hydrologist in the Water Resources Discipline of the U.S. Geological Survey, where he has conducted investigations of surface-water hydrology and water-quality at a number of locations across the Southeast. Jerad has published more than 100 papers, reports, and abstracts on the hydrology and water-quality of rivers, reservoirs, and estuaries, including reports on flooding, estuarine flow and transport models, and reservoir water-quality models.

Abstract
In September – October 1999, Hurricanes Dennis, Floyd, and Irene produced prolonged record flooding in eastern North Carolina. Floodwaters from coastal rivers severely affected the hydrologic and chemical characteristics of North Carolina's estuaries. Freshwater inflow to the Pamlico River estuary during September 1999, was more than 90 percent of the mean annual inflow, and September inflow to the Neuse River estuary was about 60 percent of average annual inflow. More than half the average annual nitrogen load was carried in floodwaters of the Neuse River and Tar River, which drains to the Pamlico River estuary, between mid-September and mid-October. The long-term effect of the nutrient and organic matter loading to the Pamlico River and Neuse River estuaries from these floods was a matter of great concern to water-quality and fishery resource managers in North Carolina.

For one year following the flooding, the U.S. Geological, in cooperation with the North Carolina Division of Water Quality, monitored the effects of the flooding on estuarine water quality while testing the application of advanced water-quality monitoring instrumentation. Two sites were established—one each on the Pamlico River estuary and the Neuse River estuary—and were equipped with sensors to measure near-surface and near-bottom nitrate concentration, fluorescence (chlorophyll *a* concentration), salinity, temperature, dissolved-oxygen, and pH. Nitrate and chlorophyll *a* were measured hourly and other parameters were measured at 15-minute intervals.

The new nitrate and chlorophyll sensors were challenging to operate in the estuarine environment, and there were several periods during which data were of unacceptable quality. Most of the nitrate data were collected during the spring and summer, when concentrations were low—typically less than the sensor detection limit of 0.07 milligrams per liter. Nitrate concentrations were greater than 0.1 milligrams per liter during June 2001 in the Neuse River estuary, when river flows were higher than normal. A statistically significant relation ($p < 0.05$) between fluorescence and sampled chlorophyll *a* concentration was developed for the Pamlico River estuary, but the relation was much weaker for the Neuse River estuary. The data are being analyzed to evaluate relations among freshwater inflow, nitrate concentrations, density stratification, dissolved-oxygen concentration, and algal production.