Management Modeling of Suspended Solids and Living Resource Interactions

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Chesapeake Bay, the United States' largest, most valuable, estuary, is a classic example of a system in distress from eutrophication. The management and restoration of Chesapeake Bay has been the focus of the Chesapeake Bay Program for more than 25 years. Restoration is primarily focused on reducing nutrients and solids loads from the surrounding watershed. Mathematical modeling of the watershed and estuary has provided management guidance since the foundation of the program.

Management goals focus on relieving three water quality impairments: low dissolved oxygen, excess chlorophyll, and poor water clarity. Suspended solids, both organic and inorganic, are significant contributors to poor water clarity. Consequently, accurate, realistic, representation of suspended solids concentrations, loads, and processes is crucial in the management model suite.

Frequently, suspended solids modeling is considered from purely a physical approach. Suspended solids transport is often considered as an add-on to hydrodynamic models. However, biological processes contribute to and can dominate suspended solids transport and processing. Examples of biological processes include primary production of particles, particle filtration and removal by bivalves, and damping of resuspension by aquatic vegetation. Consequently, optimal modeling of suspended solids requires combining representations of physical processes with biological processes.

We have incorporated a fully-predictive suspended solids model into the Chesapeake Bay eutrophication model. The model includes four inorganic solids classes as well as multiple forms of organic solids. Physical processes include three-dimensional transport and particle resuspension due to currents and wind-generated waves. Biological processes include particle primary production and influences of aquatic vegetation and bivalves.

The model has been used in a range of management scenarios aimed at examining the effects of nutrient and solids load reductions on water clarity. Three broad conclusions can be reached: 1) The poorest water clarity is usually caused by high inorganic solids concentrations; 2) Inorganic solids respond to load controls only near local loading sources from the watershed; 3 The major improvements in water clarity are realized through reduction of organic solids and epiphytes achieved via nutrient controls.

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