

## A Multi-tier Modelling Approach to Sustainable Management of Coastal Water and Sediment Quality

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Eutrophication remains a persistent problem in coastal waters, affecting both water and sediment quality, and leading to undesirable effects on turbidity, oxygenation, and aquatic vegetation. Turning off nutrients in source waters has provided some relief, but mitigation of eutrophication is also achieved by increasing herbivory via cultured bivalves. Regulation of eutrophication is amenable to simulation modeling, and scenarios involving the added benefit of commercial shellfish are valuable not only for control of coastal nutrients, but for planning and management of shellfish culture. Several levels of modeling may be undertaken in order to optimize both model effort and spatial resolution. A primary effort is ASSETS (Assessment of Estuarine Trophic Status), a screening model involving quantitative and qualitative indicators of pressure, state and response. A second tier of modeling includes spatially discrete dynamic ecosystem models resolved as boxes or finer grids, generating time series of variables such as nutrients and chlorophyll. An approach between screening and full ecosystem models includes the FARM (Farm Aquaculture Resource Model) model of local seston depletion within aquaculture leases. In all cases, sustainability criteria are generated as a function of targeted state variables, for example whether suspension-feeders influence chlorophyll beyond the bounds of natural variation. Integration of watershed submodels is particularly important, including those that incorporate land use, since development scenarios and nutrient responses are core components of this approach. Examples of the application of these models are presented for estuaries in Europe and Canada. Together the models constitute an operational approach to management of coastal ecosystems, amenable to quantification of present conditions, as well as scenario-building and prediction.

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