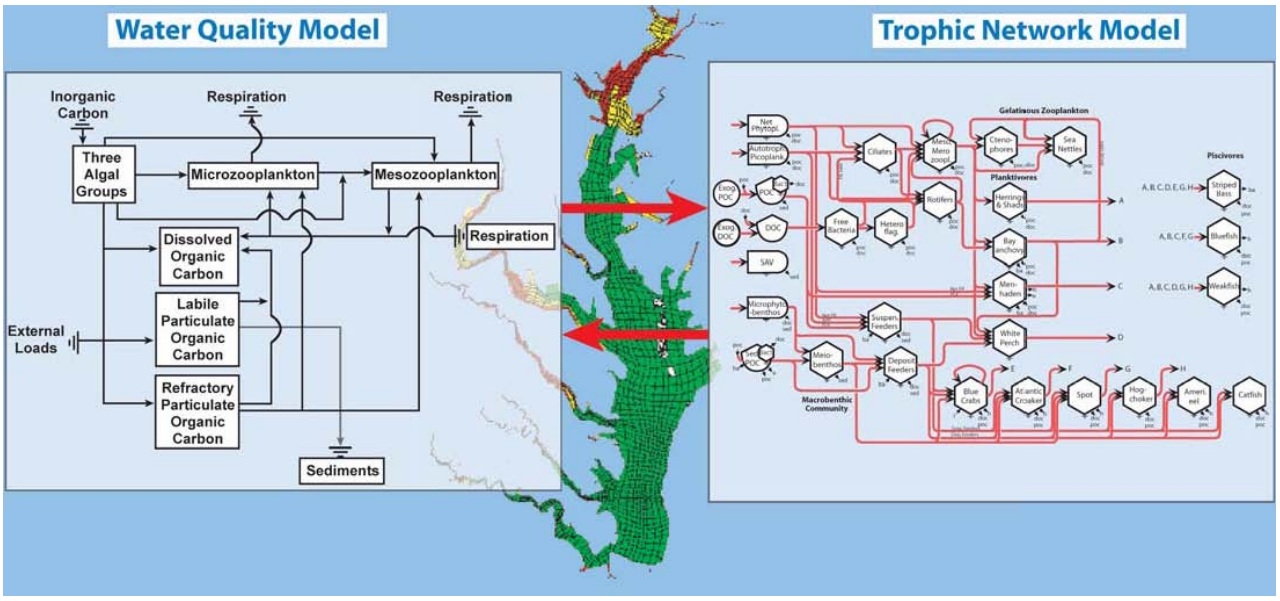
System-Wide Water SWWRP Resources Program

ICM Eutrophication Model with the Ecopath Fisheries Model

Description: Integrated Compartment Model (ICM) is a spatially and temporally-resolved eutrophication model focused on nutrient cycling and primary production. Ecopath is a fisheries model focused on the food web of upper trophic-level organisms. Ecopath treats primary production as an input rather than a calculated quantity. A method is desired to couple the lower-trophic-level, bottom-up, and dynamics of ICM with the higher-trophic-level, food-web, and dynamics of Ecopath. Initial aspects of this project investigated "hooks" or commonalities between the two models. Interfacing was accomplished via hand entry into Ecopath of ICM output summaries. A graphical interface or "GUI" has been developed to facilitate the exchange of information between ICM and Ecopath. The GUI allows the user to select information from ICM and read this directly into an Ecopath model.



Application: The models and interface are presently set up for Chesapeake Bay. The coupling is between the 12,000-cell ICM model employed in the most recent management of the Bay and a 32-variable Ecopath application. The models are being set up to examine the effects of management of the menhaden fishery on eutrophication processes. The hypothesis is that reduced fishing effort on menhaden will result in enhanced predation by these fish on phytoplankton. The resulting decrease in phytoplankton via menhaden consumption may substitute for phytoplankton reduction via costly nutrient controls. This work will be delivered to the EPA Chesapeake Bay Program and will figure in the formulation of Total Maximum Daily Loads for the Bay.

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Benefits: The management of water quality usually is based on a "bottom up" approach. That is, nutrient loads are reduced with the intention of limiting the excess production of phytoplankton and associated effects (low dissolved oxygen, reduced water clarity, species shifts). Recent developments in management focus on a "top down" approach. The "top down" approach is based on the premise that restoration of algal predators, such as oysters and menhaden, will limit excess phytoplankton production and, perhaps, substitute for costly nutrient control programs. Our linkage provides a novel method for examining the effects of fisheries management on eutrophication processes as well as for examining the influence of nutrient management on fisheries. These coupled models will provide guidance in the determination of Total Maximum Daily Loads for Chesapeake Bay. Implementation of expected load reductions will cost a minimum of $4.3 billion so potential alternatives to load reductions are highly valued.

Data Requirements: The interfacing of ICM and Ecopath requires the availability of operational versions of both models. These models each have extensive data requirements including hydrodynamic and water quality observations, loadings from the watershed, and populations of higher-trophic-level organisms. Details can be obtained from Cerco, C., and Tillman, D. 2008. *Use of coupled eutrophication and network models for examination of fisheries and eutrophication processes.* ERDC/EL-TR-08-10. Vicksburg MS: US Army Engineer Research and Development Center.

Future Capabilities: The ICM-Ecopath coupling is one aspect of a larger investigation entitled "Coupling Ecological Models with Eutrophication Models." The next phase of the study explores the coupling of eutrophication models with agent-based fisheries models. Specifically, a coupling will be developed between the ICM Chesapeake Bay model and an agent-based menhaden model. Results from this detailed approach will be contrasted with the results from interfacing ICM with Ecopath.

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