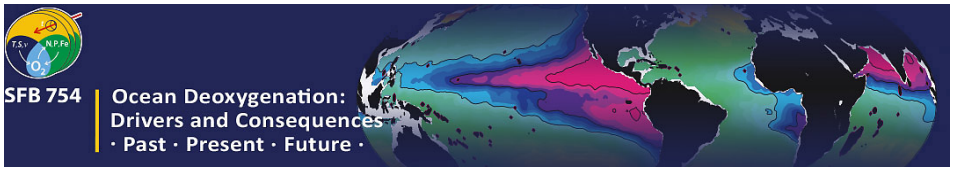

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Simulating fish population responses to coastal hypoxia: movement behavior and the tradeoff between more oxygen and less food

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The Gulf of Mexico experiences a large hypoxic area in the summer from nutrient loadings that originate from activities in the watershed. We are developing individual-based population models of croaker, menhaden, and shrimp to analyze how hypoxia effects on reproduction, growth, mortality, and movement of individuals leads to population-level responses. These population models are the last step in a series of coupled models: DLEM (nutrient delivery from watershed to coast) to Delft3D (diversions for restoration) to FVCOM (3-D physics) to WASP (water quality) to fish population model. The population models follow the hourly growth, mortality, reproduction, and movement of individuals within the 3-D FVCOM spatial grid. Currents, temperature, salinity, dissolved oxygen, and chlorophyll-a concentrations generated by the FVCOM-WASP models are used as inputs to the population models. Hypoxia effects were imposed using laboratory-based relationships that convert exposure to dissolved oxygen concentrations to reductions in growth, fecundity, and survival. We used 50-year simulations under present-day and reduced nutrient loadings (e.g., implementation of best management practices in watershed) to quantify the tradeoff of reduced nutrients resulting in higher oxygen but also potentially less food. Because of the uncertainties of the linkage of nutrient loadings to fish food, several alternative assumptions were simulated ranging from no effects on food to a direct reduction proportion to the lowered chlorophyll concentrations. We also simulated fish population responses under several assumptions of individual fish avoidance behavior, which affects their exposure to low dissolved oxygen concentrations and subsequent effects of hypoxia on mortality, growth, and reproduction. We illustrate the tradeoff between more oxygen and less food and the effects of avoidance behavior using the coupled modeling approach configured for croaker.

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