Modeling Reproductive and Population Impacts of Hypoxia in the Northern Gulf of Mexico.

Peter Thomas, University of Texas at Austin; Kenneth Rose, Dubravko Justic, Louisiana State University; Kevin Craig-Florida State University, Thomas Grothues, Rutgers University

Problem: The long term effects of the recent marked increase in the incidence of seasonal coastal hypoxia in the northern Gulf of Mexico (nGOM) on reproduction in fish and maintenance of their populations are unknown.
Rationale: Recent model simulations predict exposure to stressors that decrease reproductive output can lead to dramatic population declines. Marked suppression of reproductive output in Atlantic croaker have been documented at several hypoxic sites in the nGOM. However, additional model development and new data on these species that address current model uncertainties are required to increase the accuracy of the model predictions and to assess their utility as a management tool. Therefore, the overall aims of this collaborative, multidisciplinary proposal are to determine the effects of hypoxia on reproduction of croaker throughout the nGOM and to accurately model the population outcomes.
Hypothesis: Persistent seasonal hypoxia decreases the reproductive output of croaker throughout the nGOM resulting in model predictions of long-term declines in population size.
Objectives:
(1) Refine population dynamic models and test them for scaling individual level reproductive effects of hypoxia in fish and copepods to cohort and population-level responses .
(2) Quantify possible exposure scenarios of individual croaker based on alternative assumptions about behavioral movement.
(3) Determine the spatial extent of reproductive impairment of croaker.
(4) Estimate the duration of hypoxia exposure of croaker in the nGOM and its relationship to reproductive impairment.
(5) Provide resource managers with the results of the modeling predictions and assist them in interpreting the findings for incorporation into their management decisions.
Approach:: Existing population/cohort models will be adapted for the nGOM and data on reproductive effects of hypoxia (Objectives 3-4) and likely exposure scenarios (Objective 2) will be inputs into the model. Population outcomes of various hypoxia regimes will be predicted using the model. Particle tracking will be added to an existing 3-D hydrodynamic model for the nGOM to derive exposure scenarios for population modeling. Data from Objective 4 will be used to constrain movement and to check model outputs. Croaker will be collected during the croaker reproductive season (September) and when the hypoxic zone is extensive (July) from 4 normoxic (reference) sites east of the Mississippi delta and from 10 sites that span the entire spatial extent of the hypoxic region for measurement of a suite of reproductive biomarkers. Movement of croaker in the hypoxic nGOM region will be investigated using acoustic transmitter tags and hypoxia exposure will be assessed by measurement of tissue hypoxia inducible factor levels in croaker from field and laboratory hypoxia studies. The duration of hypoxia necessary to impair reproduction and potential interactive effects of hypoxia with an additional environmental stressor, a model pollutant, will be investigated in controlled laboratory studies.