Robust Ecosystem-Based Management of the Chesapeake Bay Blue Crab Fishery

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The Chesapeake Bay is a complex multispecies system in which humans play a dominant role. Two central tenets of ecosystem-based fisheries management of systems like this are that humans must be treated as part of the system and that, given uncertainties, a precautionary approach is justified. However, a rigorous foundation for the necessary level of precaution and a formal inclusion of socioeconomic factors are often lacking. We developed and implemented a way of establishing robust policies that explicitly recognizes the uncertainty in the system to provide a formal approach for determining the amount of precaution associated with catch limits. Additionally, we linked economics and population dynamics models to evaluate the benefits provided by alternative suites of management options for the Chesapeake Bay blue crab *Callenectes sapidus* fishery.

Precaution is an important component in ecosystem-based fisheries management. However, the amount of precaution to include in management is usually selected using ad hoc methods or heuristics. Our objective was to apply a formal robust optimization approach to estimate the amount of precaution associated with catch level recommendations. We used robust optimization to develop precautionary maximum sustainable yield (MSY)-based catch level recommendations for the Chesapeake Bay blue crab fishery. The robust optimization approach uses the uncertainty of the joint set of parameters from the assessment model to estimate the lower bound of the confidence interval for MSY. The desired amount of precaution, in the form of a percentage for the confidence interval, is an input to the model. Using the uncertainty estimates from the stock assessment model, we are able to estimate the catch associated with a specific level of precaution (e.g., 95% confidence interval).

Management policies have been implemented to regulate the overexploitation problem for many fisheries. When making decisions, fisheries managers usually want to know the effects of policies on the health of the fish stock and as well as social economy. We developed an integrated model to evaluate alternative fishery policies with selected criteria. This model combines a newly developed demand model for Chesapeake Bay blue crab and two existing biological models, an individual-based simulation model and a stock assessment model. The resulting model is able to compare outcomes of alternative management scenarios considered by policy makers. In order to provide insights into the impacts of relevant policy components in a management scenario, we regressed the sustainable outcomes, sustainable yield and sustainable revenues, on the set of policy components. A short and temporarily closed female fishing season combined with a long male fishing season tend to increase both sustainable yield and sustainable revenue. For the size limit policy, lower minimum limits for males, females, peelers and soft-shell crabs appear to reduce sustainable outcomes, while a restrictive maximum size limit for mature females seems favorable to the blue crab fishery.