Technical Reviews of Multispecies Predator-Prey Model for the Gulf of Mexico

By Doug Butterworth, Ray Hilborn and Steve Cadrin

July 31, 2023

The Science Center for Marine Fisheries (SCEMFiS) has funded a review of "Identifying trade-offs and reference points in support of ecosystem approaches to managing Gulf of Mexico menhaden" by Berenshtein et al. (2023 Frontiers in Marine Science). This non-technical summary has been compiled from independent technical reviews.

Gulf menhaden are an important prey species, so managing sustainable fisheries for predators and prey rely on understanding the marine food web in the Gulf of Mexico. The development of a food web model for the Gulf is an important first step, but as recognized by the authors of the paper, there are several further developments that are needed before the results can be considered as a reliable basis for fishery management decisions. For example, the analyses have too many technical problems to currently justify the conclusion that "*a moderate reduction of menhaden fishing pressure would result in a favorable trend of predators' biomass towards their target value*".

A primary problem is uncertain diet information and the sensitivity of model results to that uncertainty. The extensive compilation of feeding studies is informative, but that cannot replace the long-term monitoring data which has been used to support the model used for Atlantic menhaden. We support the initiative by SCEMFIS to apply stable isotopes and genetics to help define predator-prey interactions in the Gulf.

Another problem with the multispecies analysis is that the model does not fit much of the data adequately. For example, the multispecies model predicts that there has been a substantial increase in biomass of blacktip shark, the predator with the largest dietary contribution from menhaden, that does not agree with the blacktip shark stock assessment. The multispecies model also had poor fits to the biomasses of other sharks, and these are even worse for the landings for many species. In terms of our experience, the model does not meet conventional standards for fishery stock assessment.

The paper also does not include the technical details necessary to understand how Maximum Sustainable Yield reference points were derived, how age-structure was modeled, or how stock-recruit relationships were specified; each of these has an important influence on the results. Some counter-intuitive results suggest that these technical problems and model settings may not have produced reliable conclusions regarding management. For example, biomass of some predators is expected to increase if menhaden is fished more heavily.

The many assumptions needed in multispecies modelling approaches render the results from a single approach alone unreliable in isolation. Therefore, it is essential to also apply alternative approaches to confirm that results are robust before using them for management. In the face of these challenges, multiple model types, including a "model of intermediate complexity, MICE", may perform better, as found for modeling predation of Atlantic menhaden.

In conclusion, the analysis by Berenshtein et al. (2023) is a considerable contribution to understanding predator-prey dynamics in the Gulf, but better data and model development is needed before the results can be considered for fishery management.