Relationships Between Spawning Behavior and Life History Traits in Gulf of Mexico Fishes: Implications for Vulnerability Assessments

Relaciones Entre el Comportamiento de Desove y los Rasgos de la Historia de Vida en los Peces del Golfo de México: Implicaciones para las Evaluaciones de Vulnerabilidad

Relations Entre le Comportement de Frai et les Traits d'Histoire de Vie des Poissons du Golfe du Mexique: Implications pour les Évaluations de la Vulnérabilité

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EXTENDED ABSTRACT

The vulnerability of marine fish to become overfished is dependent upon intrinsic aspects of their ecology, biology, and productivity as well as extrinsic factors related to the actions and management of the fishery that determine the level of exposure to fishing pressure (Dulvy et al. 2004, Jennings et al. 1998, Patrick et al. 2010). Traditionally, species that are long-lived, slow growing and late to mature are associated with a high vulnerability to become overfished. Consideration of reproductive behavior may provide additional insight that can help identify species that are particularly vulnerable to fishing during spawning. Spawning behavior is associated with productivity (Cheung et al. 2005) and resilience (Lowerre-Barbieri et al. 2017), but has not been comprehensively included in stock assessments, estimates of reproductive potential or management efforts.

There is increasing evidence that marine fishes that form spawning aggregations over short periods accompanied with large increases in density are more vulnerable to fishing pressure than those that form small aggregations or do not aggregate to spawn (Claro et al. 2009, Sadovy De Mitcheson and Erisman 2012, Erisman et al. 2017). Understanding the continuum of spawning behaviors related to aggregating behavior, changes in density, and duration of the spawning season may help scientists and managers identify species that are especially vulnerable to fishing during spawning and ultimately increase the effectiveness of management actions.

We synthesized information on the life history, spawning behavior, and management of 28 species in the Gulf of Mexico through a combination of literature searches and expert opinion. We tested for correlations between life history traits and reproductive behavior and evaluated how groups of traits correlate with stock status using principal component analysis. The average scores for each of the first two principal components were compared between stock status (overfished or not-overfished) with a t-test. We also evaluated vulnerability to fishing during spawning for each species using a framework that included reproductive behaviors (Robinson 2015) and compared those scores to previously published scores from a traditional productivity susceptibility analysis that did not include spawning behaviors.

We found that life history traits were not correlated with spawning behaviors, and spawning behaviors were a better indicator of stock status than life history traits. Principal component analysis separated each group of traits between the first two principal components, which explained 65.9% of the variation in the data. Further, species that have been overfished had significantly higher principal component scores than not overfished species along the spawning behavior axis, PC2 (t = 1.88, df = 13, p = 0.04), but not the life history axis, PC1 (t = -0.726, df = 15, p = 0.76). Aggregating behavior, duration of the spawning season and changes in density were also indicative of overall vulnerability to fishing during spawning, and our vulnerability analysis identified a different group of species as the most vulnerable than the previously published productivity-susceptibility scores.

Our results show that the consideration of spawning behavior traits can improve predictions of vulnerability and resilience in exploited stocks. Assessing species based solely on their size, longevity, maturation rate, and other traditional life history traits does not capture the true complexity of their biology and likewise their vulnerability to fishing pressure. This distinction is important, because reproductive behavior is rarely comprehensively incorporated within stock assessments or the management of exploited fishes in the Gulf of Mexico or elsewhere.

KEYWORDS: Fisheries management, marine fisheries, reproductive resilience, spawning aggregations, stock assessment

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