Introduction

Impacts on populations and communities from high-intensity low-duration stressors such as oil spills result from a wide range of direct and indirect effects. For organisms embedded in complex food webs, toxicological studies alone are often insufficient to predict population or community level impacts. More than eight years after the 2010 Deepwater Horizon Macondo well blowout, we are developing a clearer picture of the impact of the oil spill on saltmarsh ecosystems. For marsh fishes and large-bodied invertebrates (crabs and shrimp), there has been a largely consistent finding of significant impacts at the individual or organismal level but no impact at the population level (Fodrie et al. 2014). Several hypotheses have been proposed to explain this apparent paradox. First, even small-bodied marsh fishes are capable of detecting and dispersing away from patches of crude oil (Martin 2017). Second, short generation times of small-bodied marsh fishes and high intrinsic rates of population increase translate to a potential for rapid recovery (Vastano et al. 2017; Jensen et al., in review). Third, fishes and invertebrates may have experienced predatory release as some of their important predators, such as picivorous birds and dolphins, were impacted by the spill (Short et al. 2017). Finally, many fish and invertebrates are caught as target species or bycatch in commercial and recreational fisheries. Temporary closure of these fisheries may have offset mortality from the oil spill (van der Ham and de Mutsert 2014). While the first two hypotheses have received much devoted research, the final two remain largely unproven across a diversity of saltmarsh taxa.

A variety of commercial and recreational fisheries target fish and invertebrate populations in Barataria Bay, but stringent closures were put in place following the Deepwater Horizon spill to prevent human ingestion of oil-contaminated seafood.

Populations of picivorous predators suffered some of the worst mortality following the spill that, in some cases, persisted for several years.

Ecosystem models allow us to integrate both the direct impacts of stressors and the indirect impacts of stressors that are mediated through food web interactions. In this respect, they have been used to study the impact of stressors such as oil spills (Ainsworth et al. 2018), hypoxia (de Mutsert et al. 2017), ocean acidification (Marshall et al. 2017), others, on populations and communities. The ability of ecosystem models to account for predator-prey interactions, population dynamics, fisheries, and, in some cases, biophysical forcing makes them valuable tools for strategic management and can give scientists and managers a high-level understanding of major risks and drivers in an ecosystem. Their ability to account for all food web interactions, including ones that may not be assumed to be influential a priori, makes ecosystem models particularly useful for generating new hypotheses and ruling out implausible ones (cite). However, because ecosystem models are heavily parameterized and key parameters are often poorly informed by data, their major utility is likely to remain in the more strategic realm

In this study we use mass-balance food web models coupled with a generalized equilibrium model to examine whether fishery closures, predator mortality, or both can plausibly explain the persistence of nearshore fish and invertebrates following the Deepwater Horizon oil spill. Furthermore, we explore this question quantifying 1) only direct impacts of fisheries and predators and 2) both the direct impacts and impacts mediated through all food web interactions. This allows us to understand the added benefit of using the more holistic food web model to answer this question.

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