Spatially resolved bycatch estimation for the Gulf of Mexico Shrimp fishery

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Background:

There are a wide number of ecosystem effects of fishing (Dayton et al. 2003, Hobday et al. 2011) however, among them, fishery bycatch, or the incidental capture of non-target species, is of critical concern for both conservation (Kelleher 2005) and management (Gardner et al. 2008). Bycatch represents almost a quarter (~23%) of global fishery landings (Dunn et al. 2010) with indiscriminate fishing gears (e.g. trawls, long-line, drift nets) of particular concern (Gardner et al. 2008). In 2002 fishery discards were estimated at 1.06 million tons for US marine fisheries, with a nationwide discard to landings ratio of 0.28 (Harrington et al. 2005). In that same year the discard ratio for shrimp fisheries in the Gulf of Mexico was an astounding 4.56 (Harrington et al. 2005). The importance of bycatch issues is apparent in the increasing frequency of bycatch related studies in the peer-reviewed literature (Soykan et al. 2008) with a number of those studies focusing on the Gulf of Mexico. Previous studies concerning bycatch in the Gulf of Mexico have examined issues on the feasibility of bycatch quotas (Diamond 2004), bycatch species composition (Scott-Denton et al. 2012), as well as population level examinations on elasmobranchs (Shepherd and Myers 2005), Atlantic croaker (*Micropogonias undulatus*) (Diamond et al. 2000), and Red snapper *(Lutjanus campechanus*) (Gallaway et al 1998).

A key issue in understanding or predicting the spatial distribution of fishery bycatch is predicated on knowledge of the spatial and temporal dynamics of fishing effort and resource abundance. Fleet dynamics are spatially heterogeneous and notably prone to inter-annual patterns of variability (Salas and Gaertner 2004, Van Putten et al. 2012). Species abundance patterns are also highly variable, generally responding to variability in underlying environmental parameters (Craig et al. 2005, Craig and Crowder 2005, Craig 2012). This spatial heterogeneity in fleet dynamics and species distributions creates the possibility for alterations in catchability due to spatial aggregations of fishery resources and increased opportunities for incidental capture of non-target species. A recent analysis of fishery-independent survey data in the northwestern Gulf demonstrated shelfwide increases in the abundance of a number of finfish species associated with a striking decline in shrimping effort beginning in the early 2000s, demonstrating that variations in fishing effort can influence the temporal dynamics of bycatch species (Purcell and Craig 2014). However, how the abundance of bycatch species varies spatially in the Gulf during periods of increasing and of decreasing fishing pressure is unknown.

We propose an integrated analysis of multiple existing fishery-dependent and fishery-independent data sets currently available in the northern Gulf of Mexico to better understand the interaction between shrimp fleet dynamics, spatial patterns in shrimp and finfish abundance, and the spatial dynamics of shrimp trawl bycatch. Further, we propose to evaluate the current methodology used to estimate bycatch rates in the northern Gulf of Mexico by comparing bycatch estimates using alternative data sets (i.e., fishery-dependent and fishery-independent surveys) and methodologies.

Approach:

Currently, bycatch rate estimates produced through the fishery observer program are supplemented with bycatch rates from the SEAMAP trawl survey. A core assumption underlying this analytical approach is that the rate of incidental capture of non-target species is comparable between shrimp fishery operations and resource monitoring surveys. We plan to empirically test this assumption by estimating bycatch rates across the spatial and temporal range over which the datasets co-occur (2007-present) to examine correlation between bycatch rates produced from both data sources.

Additionally, we plan to examine the relationships between spatial patterns in shrimping effort, resource abundance and bycatch rates in the Gulf shrimp fishery using geospatial regression models (Hastie and Tibshirani 1993, Wood 2004, Wood 2006). These models are a class of regression model that allow us to map patterns in a particular model parameter (shrimp effort, abundance) in geographic space (Wood 2006), and have recently been applied in a number of fishery-related studies (Bacheler et al. 2010, Bartolino et al. 2010, Ciannelli et al. 2007, Ciannelli et al. 2012). We have recently applied similar models to evaluate the effect of hypoxia in the northwestern Gulf on the spatial dynamics of the Gulf shrimp fishery (Purcell and Craig 2014). The application of these models will allow us to examine the effect of spatial patterns in resource abundance and shrimping effort on the spatial distribution of bycatch. The models would permit us to identify areas where total bycatch and bycatch rates are either positively or negatively correlated with shrimping effort, resource abundance, or both. This type of approach would not only allow us to evaluate the relative drivers of fishery bycatch but also generate predictions of the spatial distribution of bycatch.

Deliverables:

The project will produce maps of the spatial distribution of bycatch and associated shrimping effort at seasonal and annual time scales. Such maps are routinely requested and incorporated in stock assessments of several federally managed species. Determining whether bycatch 'hotspots' exist, their spatial location, and temporal stability would be useful for assessing the efficacy of both current efforts to monitor bycatch as well as the efficacy of potential spatial management strategies. The project will provide an evaluation of and possibly improvements to current methodologies used to estimate shrimp trawl bycatch. Because a number of harvested species in the Gulf are subject to both directed fisheries as adults and indirect harvest (i.e., bycatch) as juveniles, bycatch estimates are an important data source in several Gulf stock assessments. The proposed modeling approach will provide an evaluation of the relative contribution of shrimping effort and resource abundance on spatial patterns of shrimp trawl bycatch. Such information will help inform the extent to which monitoring effort should be focused on quantifying spatial patterns in abundance of harvested resources, the spatial dynamics of the shrimp fleet, or both.

This work will primarily be conducted by a postdoctoral researcher Kevin Purcell, who would collaborate closely with J.K. Craig and K. Siegfried from NMFS Beaufort Laboratory, as well as J. Nance, and E. Scott-Denton from the NMFS Galveston laboratory. Currently, J.K. Craig and K. Purcell are collaborating on project involving Gulf shrimp fleet dynamics in relation to seasonal hypoxia. J. Nance coordinates the Gulf shrimp statistics database and is an agency expert on the Gulf shrimp fishery. K. Siegfried and E. Scott-Denton have extensive experience working with the Gulf fishery observer data set.

Budget:

Postdoctoral stipend: (includes health & benefits)	$86,500.00
Present Findings: (meeting)	$ 3,000.00
Project Meeting	$ 3,500.00
Publication (open-access fees)	$ 2,000.00
Administrative costs	$ 2,000.00
TOTAL:	$97,000.00

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