

Quantifying Connectivity Between Habitats and Fisheries to Influence Management

Cuantificar la Conectividad Entre Hábitats y Pesquerías para Influir en la Gestión

Quantifier la Connectivité Entre Habitats et Pêcheries pour Influencer la Gestion

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EXTENDED ABSTRACT

Animal movement frequently occurs across broad spatial scales in marine ecosystems, and therefore individuals often form connections between multiple habitats and fisheries. This has important implications for ecosystem dynamics and is highly relevant to habitat and fisheries management. For example, home range sizes are an essential consideration for designing effective marine protected areas and delineating fisheries management zones (Crossin et al. 2017). However, it is challenging to quantify fish habitat connectivity in large, open systems with highly mobile fishes.

Permit (*Trachinotus falcatus*) is a species in the Carangidae (jack) family that is found throughout the tropical and sub-tropical regions of the Western Atlantic Ocean, Caribbean Sea, and Gulf of Mexico in diverse habitat types including shallow water (<3m) flats, and nearshore structures including reefs and shipwrecks (Brownscombe et al. *In Review*). Permit support highly popular recreational fisheries in many areas of their range, such as South Florida, where they are a major component of a flats fishery valued at \$465 million annually (Fedler 2013). The shallow water flats fishery is almost entirely catch-and-release (C&R); however, Permit harvest is more common in fisheries on nearshore reefs and shipwrecks, where in some locations, high predator densities (mainly sharks) can also result in unsustainably high depredation rates of angled Permit. In order to protect Permit from overfishing, in 2011 the Florida Fish and Wildlife Conservation Commission established the Special Permit Zone (<http://myfwc.com/fishing/saltwater/recreational/Permit/>) spanning from Biscayne Bay to the Dry Tortugas. Permit harvest is more restricted throughout the year in the SPZ, and when this research was initiated in 2016, Permit harvest was completely prohibited in the months of May through July. This regulation was based on season patterns in Permit gonadal development.

Although there were spatially- and temporally-specific Permit fisheries management regulations in place, when this study was initiated, we lacked information on Permit movement patterns, which is essential to ensure the scale of fisheries management was effective to achieve conservation goals. Therefore, the objective of this research was to quantify Permit movement patterns in South Florida to assess their regional and habitat connectivity, as well as the timing of their spawning behavior, which involves aggregating in large numbers in proximity to nearshore structures such as reefs and shipwrecks. To accomplish this, we used a combination of acoustic telemetry to track long-term movement patterns, and stable isotope analysis (SIA) to assess foraging habitat and resource ecology.

This study was initiated in March of 2016 and is still ongoing. To date 114 Permit have been tagged with acoustic transmitters (V13 and V16; Vemco Inc, Halifax, Nova Scotia) throughout the Florida Keys in diverse habitat types including flats, reefs, and shipwrecks. Tagged Permit are being tracked with an array of 89 acoustic receivers maintained by our research group, in addition to 1000+ receivers maintained by other researchers in the broader region, with data sharing occurring through the Florida Acoustic Telemetry (FACT) and integrated Tracking of Animals in the Gulf (iTAG) networks. In addition, 171 Permit have also been sampled for carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) SI using fin tissue from the tip of the dorsal fin, which is being used to inform where Permit feed (i.e., on seagrass flats or offshore algae-based prey).

Findings to date show that Permit frequently moved amongst nearshore habitats in the Florida Keys, including the flats, reefs, and shipwrecks, and rely heavily on seagrass flats-based prey. However, there was a lack of connectivity between these habitats and offshore shipwrecks in the Gulf of Mexico, suggesting these are distinct groups of Permit. Overall, the majority of fish have remained within proximity to the Florida Keys, with the exception of one individual that moved 280 miles north to Fort Pierce. Permit were detected in their spawning habitats on the Florida Reef Tract primarily in the late spring and summer months, with the highest occupancy between April and July. Based on these findings, in 2018 the FWC

extended the Permit harvest closure period to include April, in addition to the previous closure period from May through July. This is a relatively rare example of a tracking study rapidly informing natural resource management; the factors contributing to this success are outlined in Brownscombe et al. (*In Review*). This study will continue until 2020, providing a comprehensive assessment of Permit movement patterns, regional and habitat connectivity to inform their conservation and management.

KEYWORDS: Recreational fisheries, coral reefs, seagrass

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