Red Snapper (*Lutjanus campechanus*) Movement Patterns Based on Acoustic Positioning Around Oil and Gas Platforms in the Northern Gulf of Mexico

Patrones de Movimiento del Pargo Rojo (*Lutjanus campechanus*) Basados en el Posicionamiento Acústico Alrededor de las Plataformas de Petróleo y Gas en el Norte del Golfo de México

Modes de Déplacement du Vivaneau Campèche (*Lutjanus campechanus*) Basés sur le Positionnement Acoustique Autour des Platesformes Pétrolières et Gazières du Nord du Golfe du Mexique

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EXTENDED ABSTRACT

Introduction

Historically over 4,000 offshore oil and gas platforms have been added to the northern Gulf of Mexico (Pulsipher et al. 2001; Kaiser and Pulsipher 2003). These offshore oil and gas platforms have provided critical habitat for many marine fish species, for example important Red Snapper (*Lutjanus campechanus;* Gallaway et al. 2009). In 2017, only 2,000 oil and gas platforms remained due to removal of obsolete platforms (30 C.F.R. § 250.1701 2017). The most common method of removal is explosive cutting of support legs, but such removals usually result in high mortalities of Red Snapper and other species (Gitschlag et al. 2003). There have been few studies of Red Snapper platform use and thus it was critical to examine movement patterns and residency of Red Snapper on these structures. The present study used acoustic telemetry to estimate the fine scale movement patterns of Red Snapper on oil and gas platforms. Specifically, did Red Snapper show any site fidelity and what were their diel or seasonal patterns of movement around platforms? Also, was there an optimum time to use explosive removals that would result in the lowest amount of Red Snapper mortality?

Methods

Three oil and gas platforms were selected to deploy VEMCO telemetry receiver arrays. The East site (17 m depth) was located 25 km off coastal Alabama, USA and was deployed on 28 March 2017. The Center (30 m depth) and West (23 m depth) sites were located 96 km off coastal Louisiana, USA and were deployed on 4 and 7 July 2017. Each receiver array consisted of six VEMCO VR2Tx receivers. The center receiver was placed 20 m north of the platform and four receivers (northwest, northeast, southwest, southeast) were placed 300 m from the center receiver, and one receiver was placed 415 m south of the center receiver. A dissolved oxygen (DO) and temperature logger (U26 - 001, Onset Incorporated) was placed on the center receiver mooring line at each site. Red Snapper were captured hook and line, weighed, measured and surgically implanted with V16-6x transmitters and external Floy® FM-95W tags at each site. Receivers and loggers were retrieved and replaced at four-month intervals and additional fish were tagged to maintain 10 fish per site throughout the study.

Fish positions were analyzed in ArcMap 10.4.1 with proximity tools to determine the frequency of positions near (< 136 m) and inside platform structure (McKinzie et al. 2014). Home range area use (95% kernel density estimates, KDE) was calculated in the R program and then compared over diel and seasonal periods using repeated measures (GLIMMIX in SAS 9.4, Piraino and Szedlmayer 2014, Williams-Grove and Szedlmayer 2016a, b). If significant differences were detected specific differences were determined with a Tukey-Kramer test. The effects of dissolved oxygen and temperature on area use were analyzed with linear regression.

Site fidelity and residency times were estimated based on the Kaplan-Meier known fate model in the MARK program that removes events not of interest, for example fishing mortality (Kaplan and Meier 1958; Schroepfer and Szedlmayer 2006; Topping and Szedlmayer 2011; Williams-Grove and Szedlmayer 2016a). Site fidelity was defined as percent survival of all fish remaining on release platforms after one year at liberty. Residency time was defined as time period when 50 % of the tagged Red Snapper still remained on release platforms over the entire study period.

Results

Red Snapper (n = 54) were tracked from March 2017 to May 2018 around three oil and gas platforms in the northern Gulf of Mexico and provided approximately 700,000 accurate (± 7 m) positions at ~5 min intervals. Red Snapper had a high affinity for offshore oil and gas platforms with 98% of all positions near or within platform structure. Diel patterns differed significantly among study sites ($F_{71, 4255} = 8.42$, $p < 0.0001$). Red Snapper area use at the East site was similar among all diel periods (Figure 1a). Fish at the Center site showed similar area use during day, dusk and night, but smaller area use during dawn (Figure 1b). Fish at the West site showed larger area use during the day compared to night, dusk and dawn (Figure 1c). Seasonal area use was largest in the summer and fall and smaller in winter ($F_{3, 257} = 27.22$, $p < 0.0001$; Figure 2). Temperature and dissolved oxygen had significant effects on area use for all sites ($p < 0.003$). Site fidelity was 30% per year and residency time was 11 months.

Discussion

Both the East and Center sites had similar area use patterns during day and night. Both platform sites were manned 24 hours and thus required to have extensive illumination (Keenan et al. 2007). This may have created an opportunity for Red Snapper to forage more efficiently at night compared to unlighted platforms. In contrast, the West site was unmanned and only displayed small navigation lights, and fish showed larger area use during the day.

Short-term (< 3 days) emigrations occurred from August to November (93%). These emigrations were likely foraging excursions to nearby soft bottom habitat during the night (77% left and returned) and provided evidence for homing behavior in Red Snapper. Larger area use and foraging excursions in the late summer and fall were likely driven by increased metabolic rates with higher temperature and avoidance of lower bottom DO (Johnston and Dunn 1987, Piraino and Szedlmayer 2014, Williams-Grove and Szedlmayer 2016a).

Red Snapper site fidelity (30% per year) on platforms was less than previous telemetry studies on smaller artificial reefs (72 – 88% per year; Topping and Szedlmayer 2011, Piraino and Szedlmayer 2014, Williams-Grove and Szedlmayer 2016a). Platforms are complex habitats that support large numbers and many species of fish. These greater fish populations at platforms may increase both interspecific and intraspecific competition that may cause increased Red Snapper emigrations in comparison to smaller artificial reefs with less numbers of fish.

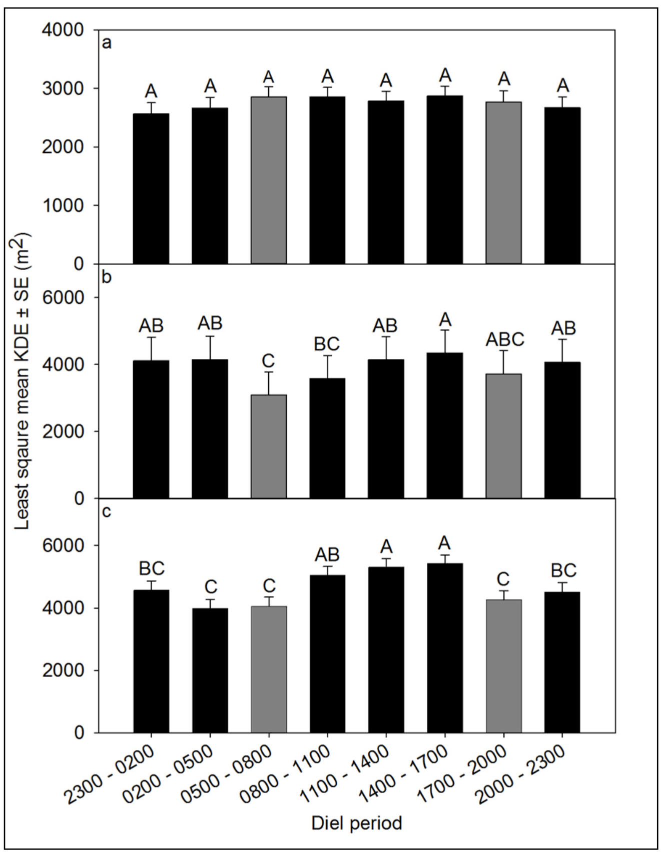

Figure 1. Diel patterns of Red Snapper (*Lutjanus campechanus*) on oil and gas platforms in the northern Gulf of Mexico. Bars = home range (95% KDE); error bars = SE, Gray bars = dawn and dusk. Different letters indicate significant differences ($p \leq 0.05$). East site = a, Center site = b, and West site = c.

Conclusions

Red Snapper were closely associated to platform structure. They displayed both diel and season movement patterns. Site fidelity was 30% per year and residency time was 11 months. The optimal time for removal would be in the late summer and early fall when Red Snapper were farther away from platform structure. Also, this was the time when Red Snapper populations were depleted by fishers ($F = 0.75$) on platforms, creating a time period when mortalities from explosive removals would be reduced.

KEYWORDS: Telemetry, artificial reefs, Red Snapper

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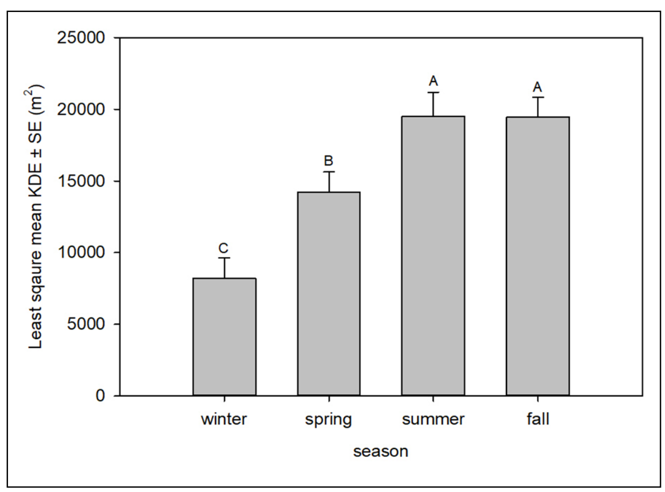

Figure 2. Seasonal area use of Red Snapper (*Lutjanus campechanus*) on oil and gas platforms in the northern Gulf of Mexico. Bars = home range (95% KDE) and error bars = SE. Different letters indicate significant differences ($p \leq 0.05$).

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