Are there Demographic Differences in the Reproductive Potential of Red Snapper (*Lutjanus campechanus*) Between Artificial and Natural Habitats in the Gulf of Mexico?

¿Existen Diferencias Demográficas en el Potencial Reproductivo de Pargo (*Lutjanus campechanus*) entre Hábitats Artificiales y Naturales en el Golfo de México?

Y at-il des Différences Démographiques dans le Potentiel de Reproduction du Vivaneau Rouge (*Lutjanus campechanus*) entre les Habitats Naturels et Artificiels dans le Golfe du Mexique?

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EXTENDED ABSTRACT

Reproductive potential is an important component of fisheries management that can help identify either stock recovery or signs of overexploitation. Without a healthy spawning population a stock may have a difficult time recovering from overfishing (Trippel 1995). The red snapper *(Lutjanus campechanus)* fishery is especially sensitive to overfishing because the species is long lived (50+ years) and reaches peak fecundity at around 10 years of age, although red snapper can mature as early as age 2 (Collins et al. 1996). Red snapper are broadcast gonochoristic spawners with the ability to spawn multiple times during a season. Juvenile mortality is high and the probability of an egg surviving to become a reproductively active adult and contribute to the population is very low. The recreational and commercial fisheries for red snapper are economically important to Louisiana and generally within the Gulf of Mexico (GOM). Therefore, a substantial, healthy spawning population of red snapper would greatly benefit both the species and the managers of this species.

Information regarding red snapper reproduction in the northern GOM is based almost exclusively on studies at artificial habitats (AH). Previous studies have shown differences in red snapper reproduction between demographic regions of the GOM, as well as between natural and artificial habitats within the GOM (Woods 2003, Kulaw 2012). The lack of information on red snapper from the natural habitats (NH) makes comparisons of life history variables between the habitat types difficult.

Few quantitative studies of red snapper reproduction have been conducted on specimens from offshore NH banks in the northern GOM. The reefs sampled in this study were located 80 to 120 km off the coast of Louisiana in 30 to 300 m of water. The entire series of reefs runs along the Louisiana/Texas continental shelf from the Mississippi River to the West and East Flower Gardens south of Galveston, Texas. This study focused on three NH that represent an east to west gradient among the reefs and that are accessible by vessel from southern Louisiana. Two AH in the study represent eastern and western AH within the northern GOM; both AH sites are within the Louisiana Artificial Reef Planning areas and are oil and gas platforms.

This study compares reproductive potential of red snapper from AH and from NH. The reef sites in the GOM are thought by some to be historical centers of abundance for this species, given that red snapper are a reef associated fish and the existence of the banks precedes artificial habitats in the GOM. Red snapper were collected in the summer (June-August) from 2011 to 2013. Three NH sites (Jakkula, McGrail, and Bright Banks) and two AH sites (East Cameron and Eugene Island) were sampled. Red snapper were collected opportunistically with vertical long lines and single hook lines. All female red snapper were measured for total length, total weight, and eviscerated body weight. Ovaries were removed and frozen at sea. In the lab, ovaries were thawed, weighed, and fixed in 10% formalin for a minimum of two weeks. Histological slides from sectioned ovaries were then prepared either at the LSU Veterinary School or in our laboratory. Mean gonadosomatic index (GSI) values were plotted by month to examine seasonal changes in red snapper reproductive potential among sites. The GSI is indicative of the energy a fish has invested in reproduction, thus a larger GSI corresponds with a greater potential reproductive output. Maturity was also assessed by oocyte stage determination and plotted against age.

Red snapper spawning season lasts from May to September, peak spawning season is June, July, and August. Mean GSI was significantly different between habitats during May, June, July, and August (ANOVA, May ($p = 0.0194$), June ($p < 0.0001$), July ($p = 0.0008$), and August ($p = 0.0025$)) (Figure 1). There was not a statistically significant difference in GSI between habitats during other months (Figure 1). Also, red snapper at the AH only show a strong peak in June, potential evidence for a truncated spawning season.

Maturity was assessed with the presence of vitellogenic oocytes as a benchmark for maturity. Red snapper females at NH displayed 100% maturity regardless of age with the exception of one 6 year old female (Figure 2); females at AH showed a progression towards 100% maturity with increased age (Figure 2). Previous studies have found red snapper to be 100% mature between 6 and 8 years of age (Woods 2003, Kulaw 2012).

I hypothesize the difference in red snapper reproductive potential between habitats may be attributed to a difference in red snapper nutritional condition between the habitats. A study concurrent to this one found that red snapper at NH were in better nutritional condition than the red snapper at AH (Schwartzkopf 2014). Early-in-life red snapper are expending large amounts of energy on somatic growth and if the red snapper at AH are in poor condition, there will be little energy allocated for reproduction. Conversely, if the red snapper at NH are in good nutritional condition there can be more energy allocated to reproduction during the spawning season. Due to their superior condition, the red snapper at NH may have a surplus of energy, leading to earlier maturation than the red snapper at AH. Also, the truncated spawning season at AH may be due to lowered nutritional condition of red snapper at these habitats. This study presents strong evidence for a disparity in the potential reproduction of red snapper between natural and artificial habitats in the northern GOM. The difference between habitats needs to be explored further, due to likely management implications.

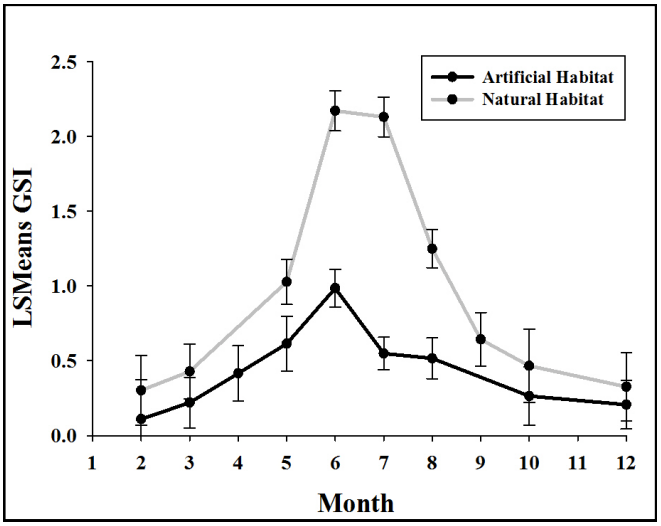

Figure 1. Mean monthly gonadosomatic indices (GSI) for female red snapper (*Lutjanus campechanus*) at artificial and natural habitats; vertical bars represent standard errors of monthly means. Least squared means are used instead of actual means to give a better representation of compared values. * indicates a significant difference in mean GSI between habitats at that month (ANOVA, p <.05).

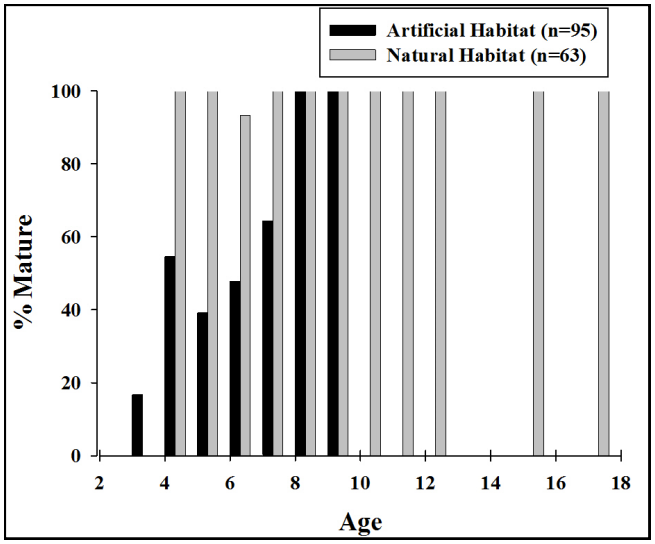

Figure 2. Percent of mature female red snapper (*Lutjanus campechanus*) caught during peak spawning months (June, July, and August) by age. Determined by oocyte stage analysis of histological slides.

KEY WORDS: Red snapper, reproduction, habitat, GSI, maturity

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