Age and Growth Comparisons of Red Snapper, *Lutjanus campechanus*, on the Natural Shelf-edge Reefs in the Northern Gulf of Mexico

Comparaciones de Edad y Crecimiento de Huachinango, *Lutjanus campechanus*, sobre de los Arrecifes Natural en el Norte del Golfo de Mexico

Âge et la Croissance des Comparaisons de Vivaneau Rouge, *Lutjanus campechanus*, sur les Récifs Naturel dans le Nord du Golfe du Mexique

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EXTENDED ABSTRACT

The red snapper fishery is a complex mixture of competing sectors in the northern Gulf of Mexico (GOM) that provides profits from commercial harvests and recreational charters, supports local communities, and stimulates the economy through tourism and jobs. This project produced age structure and growth estimates for red snapper at four natural shelf-edge reefs (Bright, Jakkula, McGrail, and Midnight Lumps) to provide empirical comparisons to refine estimates of red snapper growth, mortality, and productivity. These estimates will inform fishery managers of the distributions of strong year classes and red snapper growth along the continental shelf-edge off the coast of Louisiana.

Red snappers were collected quarterly aboard the R/V Blazing 7 from the four preselected natural shelf-edge reefs and processed after *rigor mortis* for morphometric data (total length (TL), total weight (TW), and sex), and for the removal of the right sagittal otolith. Each otolith was sectioned transversely anterior to the core. The number of opaque annuli and the edge condition were determined under a dissecting microscope with transmitted light and a polarized light filter at 20X to 64X magnifications. Two readers made annulus counts and assessed edge conditions, and accuracy between readers was analyzed with the Average Percent Error (APE), the Coefficient of Variation (CV), and the Kappa Coefficient (Viera and Garrett 2005). Red snapper in the northern GOM have been assigned a hatching date of July 1st and opaque annulus deposition has been shown to begin in January.

Analyses of Covariance (ANCOVA) models were used to compare TL, TW, and age distributions of red snapper among habitats. To meet the assumptions of normality and homogeneity of variance, a post hoc Tukey-Kramer adjustment was made for pair-wise comparison of means. All statistical tests and analyses were done in SAS 9.3; significance was measured at an alpha (α) of 0.05.

An ANCOVA was used to compare differences in the TW-TL relationships of red snapper among habitats. Red snapper von Bertalanffy growth models were fitted with nonlinear regression by least squares to TL with biological age as the explanatory variable for each study site. Due to low sample sizes at ages less than 3 years of age, t_0 was forced through zero to better estimate the TL-at-age for young individuals. The red snapper von Bertalanffy growth models were compared with an asymptotic chi-square approximation. This test compares the chi-square estimation to a one-sided critical value of Chi-square$_{df,\ alpha}$ (Kimura 1980).

A total of 365 red snapper otoliths were collected from the four shelf-edge reefs in the years, 2011, 2012, and 2013. An generalized linear model was fit to a binomial distribution and showed that the total ratio of males to females did not differ from 1:1 ($\chi^2 = 0.73$, $p = 0.3937$) but sex ratios by site differed significantly ($\chi^2 = 26.66$, $p < 0.0001$). Ages for red snappers from all sites ranged from 2 to 26 years with the majority (92.23%) of individuals between the ages of 4 - 11 years; the mean age was 7.05 ± 0.16 years. The distributions of red snapper cohorts (82.33 %) were dominated by the 2004, 2005, 2006, and 2007 year-classes: A Tukey-Kramer grouping of mean ages found that only red snapper at Midnight Lumps differed significantly from those at all other reefs. Jakkula had the largest proportion of red snapper longer than 550 mm (83.53%), with McGrail (69.57%), Bright (63.67%) and Midnight Lumps (45.24%) having lesser proportions.

Significant differences in red snapper TW-TL regression models were detected among reefs for combined tests for equality of slopes and intercepts ($F_{3,\,351} = 2.64$; $p = 0.0492$; $r^2 = 0.969$)($F_{3,\,351} = 2.72$; $p = 0.0445$; $r^2 = 0.969$). Therefore, one model was not appropriate for specimens from all habitats. The TW-TL equation for red snapper from Jakkula had a larger growth coefficient ($b = 3.15$) and a smaller intercept ($a = 4.96 \times 10^{-9}$) and differed significantly from red snapper from all other shelf-edge reefs. Likelihood ratio tests for red snapper strongly suggest that L_∞ ($p < 0.0001$) is significantly different at the four shelf-edge reefs, but the growth coefficient k ($p = 0.2815$) is not significantly different.

Long-term stability and infrequent strong year-classes present difficulties for fishery managers. As strong years-classes recruit to the fishery, an increase in catch-per-unit-effort often occurs in the recreation and commercial fisheries, which in turn adds pressure from competing sectors to increase harvest levels. As harvest levels increase, it becomes gradually more difficult to reduce harvest guidelines as weak year-classes recruit to the fishery (Cowan et al. 2011). Protection of the natural shelf-edge reefs from fishing pressure may add long-term stability to the red snapper population by allowing strong year-classes to reach reproductive maturity and maximum spawning potential.

Von Bertalanffy growth parameters for red snapper at all reefs are smaller for both L_∞ and k in the northwestern GOM compared to the eastern and western GOM red snappers and among fishing sectors (SEDAR 2013). Previous red snapper growth estimates in the GOM were based on fishery-dependent data collected from portside sampling where sub-regional

differences are difficult to address. However, fishery-dependent studies have the great advantage of larger sample sizes that effectively reduce L_{∞}, while allowing for better estimates of *k.* Therefore, comparisons of von Bertalanffy growth models between studies is problematic; parameter estimates reflect growth in a particular region over a certain time period, which captures a 'snapshot' of the population and ignores the recruitment of younger red snapper over time and the low-site fidelity of older individuals (Fischer 2007).

This study was the first of it's kind to describe the age and growth parameters of red snapper at individual shelf-edge reefs. Future research should focus on the movement of red snapper in and among the natural shelf-edge reefs. Tagging studies should address the interconnectivity of the shelf-edge reefs with respect to site-fidelity in the north-western GOM as well as shelf-edge reefs located in close proximity to one another to elucidate seasonal trends in habitat preference

KEY WORDS: Red snapper, age, growth

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