Growth of Early Stage Gray Snapper, *Lutjanus griseus*, Across a Latitudinal Gradient

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ABSTRACT

The gray snapper, *Lutjanus griseus*, is an ecologically and commercially important fish throughout the Caribbean. Despite its significant role in the marine ecosystem and its economic value, relatively little is known about the early life history of this species. Length of larval life may influence the geographic boundaries of local populations and linked to this is larval growth rate. Faster growth during larval life may result in shorter pelagic larval durations (PLD) and may give fish a survival advantage. Elucidating latitudinal differences in early life history traits and the environmental conditions leading to faster growth of larval and juvenile snapper should shed insight into the dynamics of larval life and the potential for population connectivity. As part of a larger study of population connectivity, young of the year *L. griseus* were collected from five sites in the southeastern United States during Fall 2000 and 2001: Florida Bay, Biscayne Bay, Sebastian Inlet, and Jupiter, Florida, and Core Sound, North Carolina. Fish were measured, weighed and the sagittal otoliths removed for aging. Standard otolith aging techniques were used to enumerate daily growth increments. Results demonstrated significant differences in growth rates among sites and between years, which may be correlated with environmental factors, such as temperature. There were also significant differences in the PLD of juveniles between years and sites. Despite this, the larval trajectories across sites and years were similar. The similarities among larval growth trajectories suggest that all of the snapper within a given year were either in similar water masses or the same water mass during their larval life. The disconnection between larval growth and PLD may imply that habitat availability during transport, not growth, is determining settlement.

KEY WORDS: Gray snapper, *Lutjanus griseus*, growth

Diferencias Locales y Latitudinales en el Crecimiento del Pargo de Mangle, *Lutjanus griseus*, Durante su Vida Pelagica

El pargo de mangle, *Lutjanus griseus*, es un pez ecologicalmente y commercialmente importante en todo el Caribe. A pesar de su importante función dentro del ecosistema marino y de su valor económico se sabe muy poco sobre el crecimiento de esta especie, especialmente durante los estadios pelágicos de su vida . Como parte de un estudio de conectividad de poblaciones, los *L. griseus* mas jovenes del año fueron colectados en cinco sitios al sureste de los Estados Unidos durante la temporada de otoño de los años 2000 y 2001: Bahia de Florida, Bahia de Biscayne, Inlet de Sebastian y Jupiter en Florida, y Core Sound en Carolina del Norte. Los peces fueron medidos y pesados y los otolitos sagitales fueron extraidos para determiner la edad. Incrementos diarios de crecimiento fueron contados usando técnicas estandarizadas de edad y la deposición del incremento diario fue validada. La tasa de crecimiento durante los estadios larvales y juveniles, y asi como la duración de las etapas larvales planctonicas parecen estar influenciadas por varios factores medioambientales a lo largo del gradiante de latitud. Los records de otolitos indican diferencias en las tasas de crecimiento entre sitios y años. Comparación de estos datos con datos similares colectados en la costa oeste de la Florida, indican la posibilidad que las diferencias entre las tasas de crecimiento sean causadas por el medio ambiente. Los datos de edad colectados a traves de este proyecto seran utilisados juntos con datos de microquimica para ayudar a dilucidar la probabilidad de conectividad de las ploblaciones de esta especie.

PALABRAS CLAVES: Pargo de mangle, *Lutjanus griseus*, crecimiento

INTRODUCTION

The gray snapper, *Lutjanus griseus,* is a moderate-sized (to 4.5 kg) widely distributed fish, found in the western Atlantic from Florida through Brazil, including Bermuda, the Caribbean and the northern Gulf of Mexico (Robins et. al. 1986). Gray snapper occupy a variety of habitats during their life cycle. Adults are found near complex habitats such as coral reefs, shipwrecks, rocky outcroppings and ledges, and other natural live-bottom areas (Miller and Richards 1980); they aggregate on the outer reef tract to spawn during full moons of late summer months (Starck and Schroeder 1971). Once hatched, pelagic larvae are presumably dispersed offshore, but the specific path they follow is not known. Eventually, late stage larvae enter shallow seagrass and mangrove nursery areas for settlement. The estimated pelagic larval duration (PLD) for this species is between 25 to 42 days (Lindeman 1997). With this PLD and the possibility of entrainment into the Gulf Stream, a broad geographical range of dispersal is possible. Furthermore, there is ample time for high mortality. Shortening this vulnerable stage by growing quickly may enhance survival. Larvae of some reef fish fishes with faster growth settle out of the plankton more quickly and are therefore less exposed to predation (Searcy and Sponaugle 2000). Currently, it is unknown what occurs during the early life stages of gray snapper. The purpose of this study was to measure a number of early life history traits of snapper settling to a latitudinal range of sites as a first step towards a better understanding of population connectivity in this species. Traits of interest include: larval growth, size and age at settlement and juvenile growth rate.

METHODS

Sample Collections

Early-stage juveniles of *L. griseus* were collected from four locations along the Florida coast (Jupiter, Sebastian Inlet, Biscayne Bay and Florida Bay) and one off the coast of North Carolina in the vicinity of Beaufort Inlet (Core Sound) during the year 2000 and 2001. Samples were collected near the end of the recruitment season (Sept./Oct.) as defined by larval ingress work in North Carolina (Tzeng et al. 2002) and in the Florida Keys. During sampling, environmental measurements were collected including: GPS position, bottom type, shore type, water temperature, salinity, and tidal stage. Collected samples were frozen and transported to the University of Miami- Rosenstiel School of Marine and Atmospheric Science for further analysis.

Daily Age Estimation and Growth

All the fish from each location were used for otolith age estimation. Prior to dissection, each fish was weighed and its standard length (SL), total length (TL) and fork length (FL) measured to the nearest 0.1 mm using digital calipers. The fish then were dissected to remove the sagittal otoliths using standard techniques (Brother 1987). First, all unclear, abnormally shaped (non-linear growth axis) sagittae were discarded. One sagittal otolith from each fish was used for aging. All otoliths were mounted in epoxy, sectioned, sanded and read following standard protocols (Secor et al. 1991). Otoliths were examined under a Leica transmitted light microscope at 400X. The microscope image was captured with a frame grabber and displayed on a computer screen. Using the Image-Pro image analysis system, we enumerated increments along the anterior dorsal portion of the otolith from the core to outer edge. Otolith length (radius)-at-age was recorded for every day in the larval and juvenile periods. The timing of settlement was determined by examining otoliths for optical marks associated with settlement. From this information, the larval duration, time of settlement and juvenile age, as well as daily growth rates (increment widths) and size at age during larval and juvenile periods were determined. To obtain a measure of PLD, two days were added to the number of increments to account for time to hatching.

Data Analysis

Analysis of covariance (ANCOVA) was used for comparing growth rates. Analysis of variance (ANOVA) was used to compare PLDs. Where possible Tukey's multiple comparison test was used to look at site specific differences in growth rates and PLDs (Zar 1984). The increment width data (growth trajectories) were analyzed using repeated measures analysis of variance (MANOVA).

RESULTS AND DISCUSSION

The larval snapper growth trajectories were similar across the latitudinal gradient, especially during the beginning of larval life. While there was slight variation in these trajectories, the overall trend was very similar. Growth trajectories are a proxy for somatic growth and also reflect the environment that the larvae were in. The similar nature of the larval trajectories from the various sites suggests that fish were in the same or similar water masses during their larval life.

Although the larval growth trajectories were similar, pelagic larval durations were longer for fish settling to northern sites. In reef fishes it has been shown that faster growth leads to quicker settlement (Searcy and Sponaugle 2000). However, in this case, growth was not faster for those fish with shorter pelagic larval durations. Even though the growth trajectories were similar, the size at settlement (based on otolith radius at settlement) was also larger at northern sites because the fish from the northern sites were in the plankton for a longer period and should therefore be larger. The combination of size at settlement, and similarities in larval growth trajectories, yet differing PLDs indicates that perhaps habitat availability rather than growth rates or competency may be affecting settlement.

The juvenile stage of gray snapper showed a very different trend from the larval stage. Juvenile growth rates were higher at southern locations compared to northern locations. This is especially evident when size-at-age is analyzed. Biscayne Bay fish had a larger size at age than fish from Core Sound in both years of this study. Differences in environmental factors, especially warmer water temperatures at southern locations, likely contribute to this pattern.

Although growth rates at the southernmost site (FLB) may have been influenced by the larger size range of fish collected (assuming progressive selective mortality of slower growers), there was a consistent trend of higher growth at southern sites relative to northern sites.

In the future, these data will be combined with microchemical analysis of the other sagittal otolith from the same fish to develop a model of population connectivity for *L. griseus*. Because of the important economic and ecological role of gray snapper in the coral reef and mangrove ecosystem, understanding where they spawn and how and where they are dispersed has important management implications.

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