Age structure of red snapper (*Lutjanus campechanus*) in the Gulf of Mexico by fishing mode and region

Robert J. Allman, Linda A. Lombardi-Carlson, Gary R. Fitzhugh, and William A. Fable

SEDAR74-RD18

February 2021

Age Structure of Red Snapper (*Lutjanus campechanus*) in the Gulf of Mexico by Fishing Mode and Region

ROBERT J. ALLMAN, LINDA A. LOMBARDI-CARLSON, GARY R. FITZHUGH, and WILLIAM A. FABLE
Panama City Laboratory
Southeast Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
3500 Delwood Beach Road
Panama City, Florida 32408 USA

ABSTRACT

Red snapper were sampled from the commercial and recreational fisheries of the Gulf of Mexico from Texas to the west coast of Florida during 1998 and 1999. Sectioned sagittal otoliths (n = 8,169) were used to estimate the age structure of the commercial and recreational fisheries and to compare ages between the western and eastern gulf. Ages of red snapper ranged from 1 to 47 years. Age 3 fish dominated the commercial and recreational hand-line fishery in 1998. In contrast, full recruitment to the commercial long-line fishery did not occur until age 5. In 1999, four year old fish were most common in the commercial long-line and hand-line catches, while three and four year old fish dominated the recreational catches. Similar to 1998, the commercial sector consisted of the largest percentage of older fish in 1999. In 1998 red snapper age structure landed by the commercial hand-line fishery was similar between the eastern and western Gulf of Mexico, while the commercial long-line and "for hire" data suggested older fish were collected from the western gulf. The commercial hand-line and "for hire" fisheries both indicated older fish were collected in the western Gulf of Mexico in 1999.

KEY WORDS: Age structure, otoliths, red snapper

INTRODUCTION

Red snapper (*Lutjanus campechanus*) are large, carnivorous reef fish which commonly occur along the U.S. Atlantic coast to North Carolina and throughout the Gulf of Mexico. This species is an important component of the commercial and recreational fishery in the Gulf of Mexico (Wells 1975, Hoese and Moore 1977). Commercial landings in the Gulf of Mexico have declined from a high of over 14 million pounds in 1965 to a low of 2.2 million pounds in 1991. Similarly, recreational landings have declined from 6.5 million pounds in 1981 to 1.2 million pounds in 1990 (Schirripa and Legault 1999). Despite restrictions placed on the commercial and recreational fisheries since 1991, controversy recently existed over the status and management of red snapper in the Gulf of Mexico (MRAG Americas Inc. 1997). This controversy led to a congressional mandate for an independent

scientific stock assessment and funding was made available for increased sampling of the recreational and commercial fishery in 1998 and 1999.

Understanding the age structure of the red snapper fishery is crucial for accurate stock assessments and for determining year class strength. Previous studies have used otoliths to age red snapper and provide basic information on growth and annulus formation (Futch and Bruger 1976, Bortone and Hollingsworth 1980, Nelson and Manooch 1982, Wilson et al. 1994, Manooch and Potts 1997). Our objectives were to compare the age and size structure of red snapper collected from the commercial and recreational fishery in the Gulf of Mexico by fishing mode and sampling region.

MATERIALS AND METHODS

Red snapper were sampled from the commercial and recreational fisheries of the Gulf of Mexico from Texas to the west coast of Florida. All fish were measured to total length TL (mm) or measurements converted to total length TL(mm) = 1.061 x FL(mm) + 2.651, $r^2 = 0.99$. Sagittal otoliths were collected with corresponding fishery data from January 1998 to November 1999. We followed the otolith processing method of Cowan et al. (1995). The sectioned otoliths were viewed under a dissecting microscope (25X), and three readers made independent age determinations with 20% of the otoliths aged by all readers for estimates of precision. Ages were assigned based on the count of annuli (opaque zones observed with reflected light) and the degree of marginal edge completion. For example, otoliths were advanced a year in age after January 1st if their edge-type was a nearly complete translucent zone. After June 30, when opaque zone formation is typically complete in the Gulf of Mexico (Wilson et al. 1998), all fish were assigned an age equal to the annulus count by convention. By this traditional method, an annual age cohort is based on a calender year rather than time since spawning (Jearld 1983).

Prior to beginning aging the 1998 samples we participated in age calibration and otolith exchange exercises with investigators at two laboratories (Louisiana State University and the University of South Alabama). In addition we made exchanges of a small otolith set (100 otoliths) with investigators at the National Marine Fisheries Service, Beaufort laboratory and South Carolina Marine Resources Research Institute.

RESULTS AND DISCUSSION

A total of 24,626 red snapper were sampled for otoliths during 1998 and 1999. Both the recreational fishery (i.e., charter boat, head boat and private boat) and commercial fishery (i.e., hand-line and long-line) were sampled and a random subsample of 8,169 otoliths (33%) was chosen for sectioning and age determination. This subsample approximately corresponded to the landings in the fishery by fishing sector; that is ½ commercial and ½ recreational (Figure 1). In addition, the resulting subsample reflected the landings by state. Approximately ½ of the samples

were drawn from eastern gulf states (Florida, Alabama and Mississippi) and ½ from western gulf states (Louisiana and Texas).

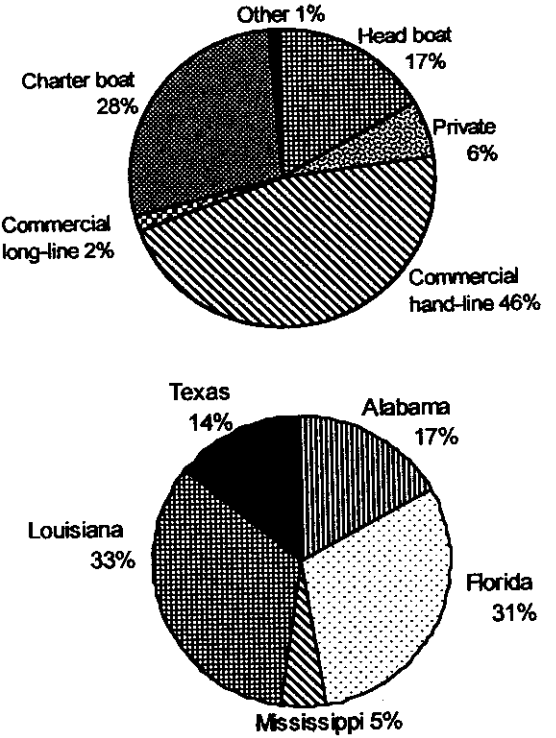

Figure 1. Percent composition of 1998 and 1999 subsample selected for age determination

In 1998 red snapper ages ranged from 1 to 39 years. Age-3 red snapper dominated the commercial hand-line and recreational sectors (Figure 2) and age-3 appeared to be the age at recruitment into these fisheries during 1998. The age proportions of hand-line caught fish (i.e., commercial hand-line, charter boat, head boat and private boat) appeared to be very low beyond age eight or nine dropping to less than 1% of the ages within each fishing sector. In contrast, red snapper reached age five or six before they fully recruited to commercial long-line gear which correlated to the larger sizes recorded from long-line catches. Similarly, red snapper caught by long-line gear were commonly much older with fish reaching age 18 before the proportion of age was less than 1%. Size-at-age data indicated that rare and relatively old fish (ages in the 20s and 30s) were caught in all fishing sectors but more commonly in the commercial sectors (Figure 3).

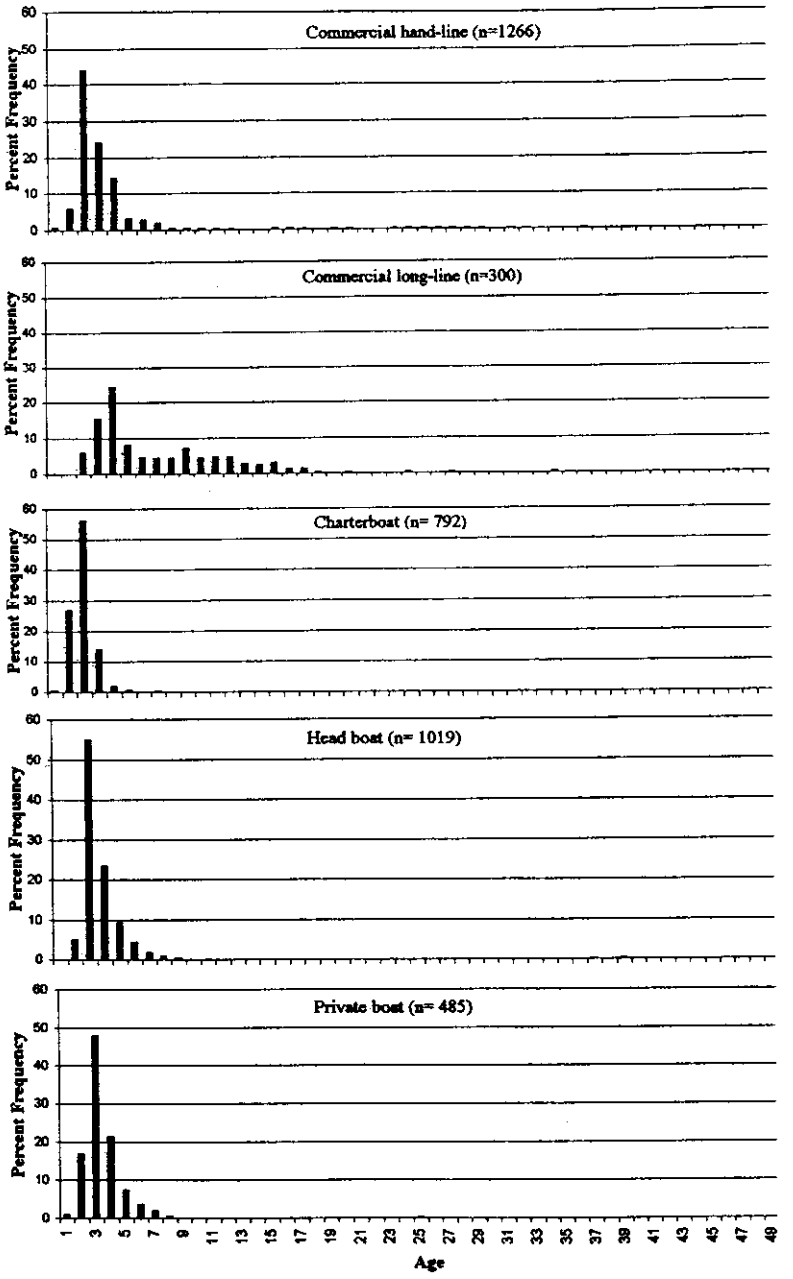

Figure 2. Age frequency of red snapper by fishing mode in 1998

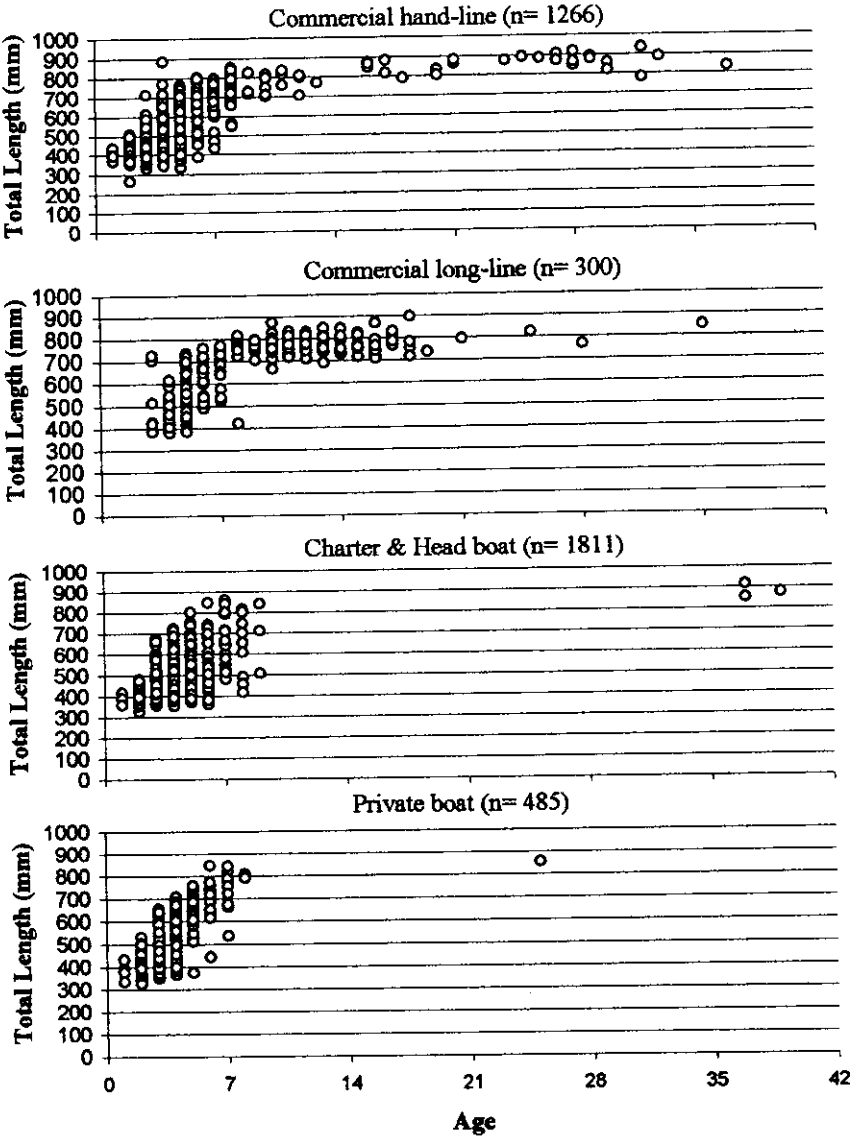

Figure 3. Size at age of red snapper from 1998

Red snapper collected in 1999 ranged in age from 2 to 47 years with age-3 or 4 appearing to be the age of recruitment to the fishery. Age frequency distributions indicated that age-4 red snapper dominated the commercial long-line and hand-line catches, while approximately equal numbers of age 3 and 4 year old fish were most abundant in the recreational catches (Figure 4). The commercial catches included the largest percent of older fish with fish reaching age 10 before the proportion was less than 1%. In contrast, the recreational caught fish only reached seven before the proportion was at 1%. Size at age data reflected this trend indicating that larger and older fish were most common in the commercial sector (Figure 5). We were somewhat puzzled to discover a few relatively old but small fish (e.g., 30 years and 500 mm TL) from the "for hire" (i.e., charter boat and head boat) fishery. These fish were re-aged and the original data checked to determine if an error had been made. Barring an error in the recorded TL from the port agent, it seems that these apparent outliers reflect a few very slow growing fish.

We compared ages by region across the eastern and western Gulf of Mexico. Western gulf fish consisted of fish landed in Louisiana and Texas while, the eastern gulf fish consisted of fish landed in Florida, Alabama and Mississippi. In 1998 red snapper age structure landed by the commercial hand-line fishery was similar between the east and west. Three year old fish dominated both regions with few fish recorded beyond five years (Figure 6). The commercial long-line fishery did suggest some age differences between east and west. The eastern gulf long-line ages had no fish beyond seven years, while in the western gulf 45% of the fish were greater than seven years. However, long-line fish from the eastern gulf consisted of a relatively small number of individuals (n = 25) in 1998. The western "for hire" catch consisted of older fish with approximately equal numbers of three and four year old fish, while the eastern gulf was dominated by three year old fish (Figure 7). Private boat age distributions were not compared regionally due to small sample size. It is not surprising that larger older fish were collected from the commercial long-line fishery since this fishery generally exploits deeper water out of reach of most recreational anglers.

The age structure of the commercial hand-line fishery from 1999 was fairly similar between east and west however, the Western Gulf of Mexico indicated a slightly larger proportion of older fish (> four years) (Figure 8). The "for hire" fishery in the western Gulf of Mexico also consisted of a greater percentage of older fish (32% > four years) than the "for hire" fishery in the eastern gulf (7% > four years). In 1999 the commercial long-line samples were comprised of fish exclusively from the eastern gulf (Figure 4). From this study it appears that older and larger red snapper from the western gulf may reflect a geographic pattern. This is consistent with anecdotal evidence from commercial fishers and port samplers claiming that red snapper west of the Mississippi River are larger than their eastern counterparts. However, in a smaller sampling area Wilson et al. (1998) found no significant difference in age distributions between fish collected from Eastern Louisiana and Western Louisiana (i.e., east and west of the Atchafalaya River). Our data also

reflected the presence of a potentially strong 1995 year class which was expressed in the dominance of age 3 fish in 1998 and age 4 fish in 1999. Preliminary aging results from red snapper landed in 1997 also indicated a large number of 2 year old fish. Further evidence for a stronger year classes from 1995-1997 was suggested by juvenile abundance from the fall groundfish survey (Schirripa and Legault 1999).

Precision and accuracy are issues of importance for measures of age-structure, particularly for tracking year class strength and effective stock assessment (Beamish and McFarlane 1995). Validation of annulus formation from relatively young age classes of red snapper has been accomplished using marginal increment analysis (Manooch and Potts 1997, Patterson 1999). Age estimates of red snapper from the Gulf of Mexico as old as 50 years has recently been validated by radiometric dating (Baker 1999) and resolves an earlier controversy surrounding estimates of longevity in red snapper (see Rothschild et al. 1997). But even though basic validation of annulus formation and longevity has been accomplished for red snapper, judging the overall accuracy of age-structure determinations is very difficult in many fisheries (Beamish and McFarlane 1995).

Measures of reader error as inferred from precision estimates provides some ability to judge the aging results for red snapper. Generally, reader agreements increased between the 1998 and 1999 samples. We improved from better than 90 % ± 1 yr. agreement among readers to better than 96% ± 1 yr. for 1998 and 1999 respectively. Our in-house measurements of precision (average percent error; Beamish and Fournier, 1981) ranged from 8% in 1998 to 5.2% in 1999 approaching a suggested target of 5% for production aging programs (Morison et al. 1998). In our otolith exchanges between laboratories, all parties generally agreed upon interpretation of annulus structure. But while the mean size-at-age results were very similar within laboratory groups, there were some differences between groups of laboratories (the three Gulf laboratories versus the two Atlantic coast laboratories) based on an initial exchange of 100 otoliths. Mean size-at-age among our gulf group tended to reflect that at any size mode from about 400 to 700 mm (TL), ages were about 1 year younger on average, than those assigned by the Atlantic coast group. During a recent workshop reviewing these findings, all parties agreed that the most difficult interpretation centered around the variable appearance of the first annulus which seems to be a general problem for many reef fishes (Fowler, 1995). While our future efforts will focus on resolving this issue, we acknowledge that age determinations are certainly not made without error and we plan to continue to make exchanges and work towards standardized interpretations. Despite these efforts, inferences about good or poor year classes will be stronger if independent measures, such as juvenile surveys, are conducted for corroboration.

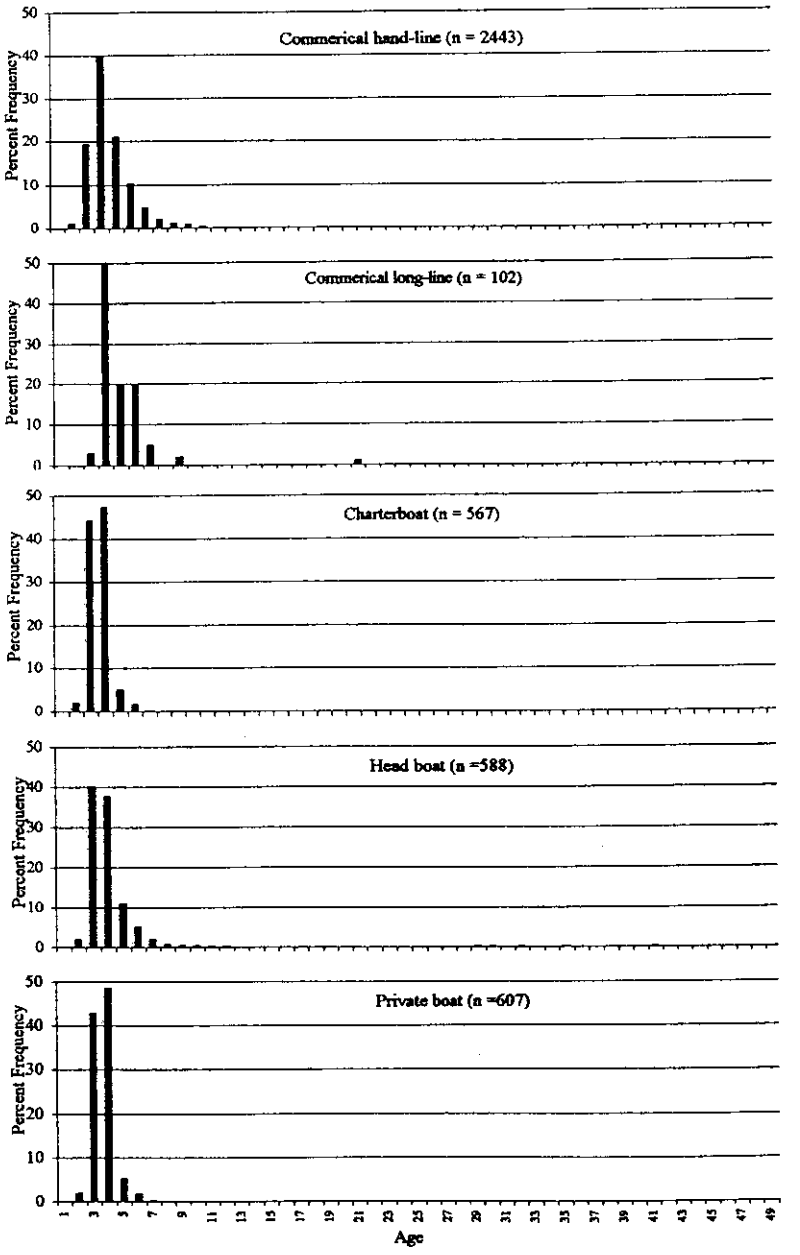

Figure 4. Age frequency of red snapper by fishing mode in 1999

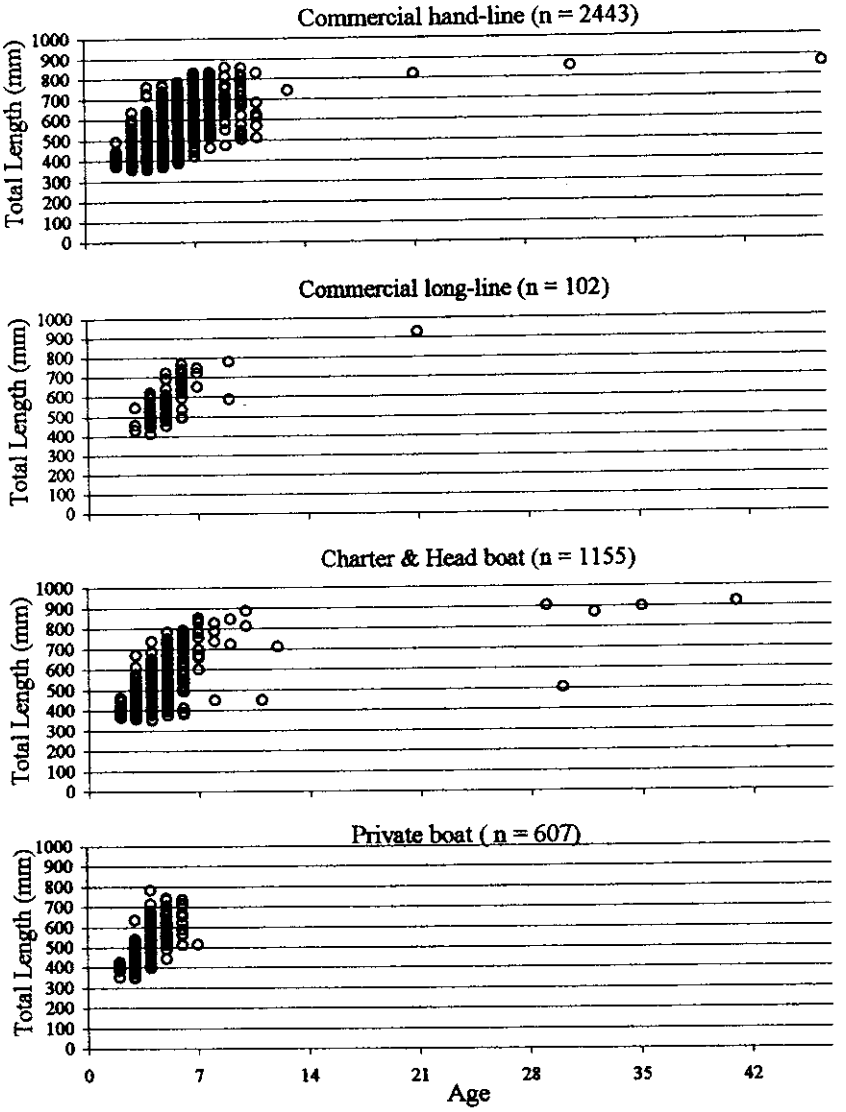

Figure 5. Size at age of red snapper from 1999

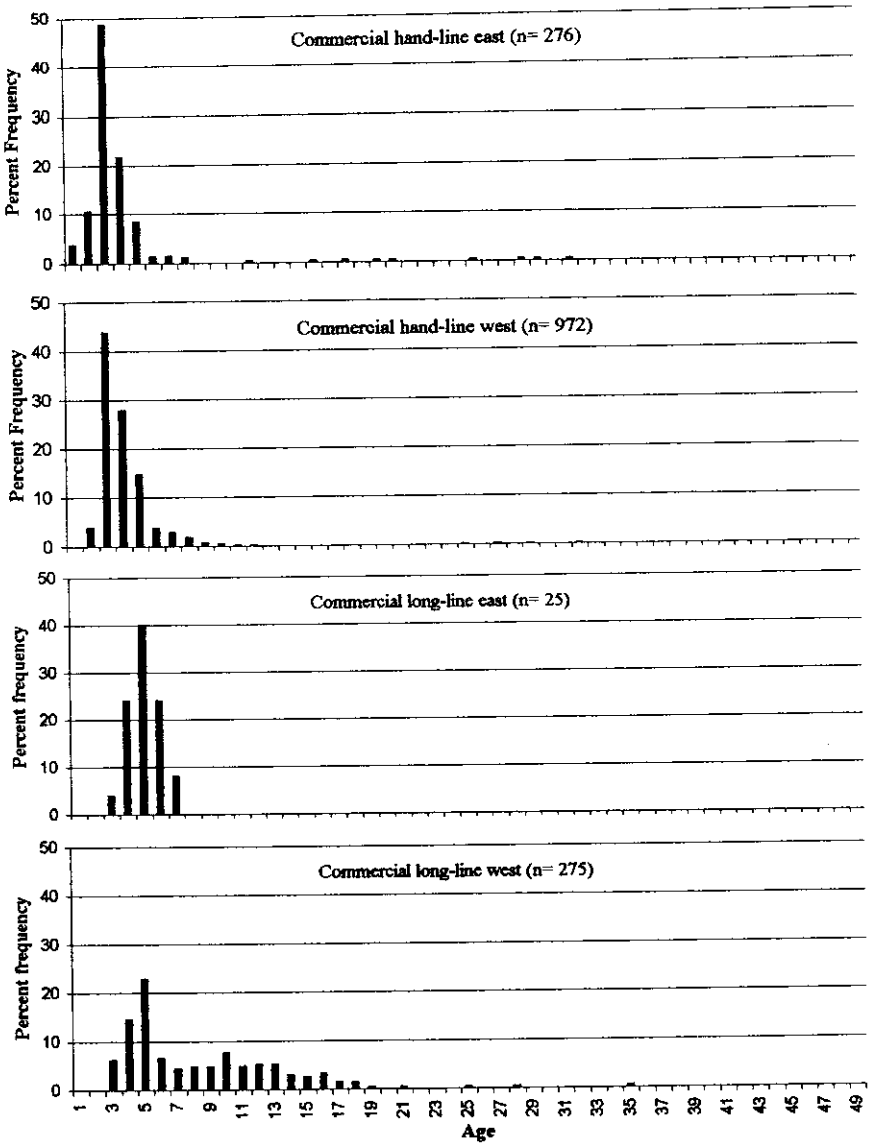

Figure 6. Age frequency of the commercial fishery by sampling region in 1998

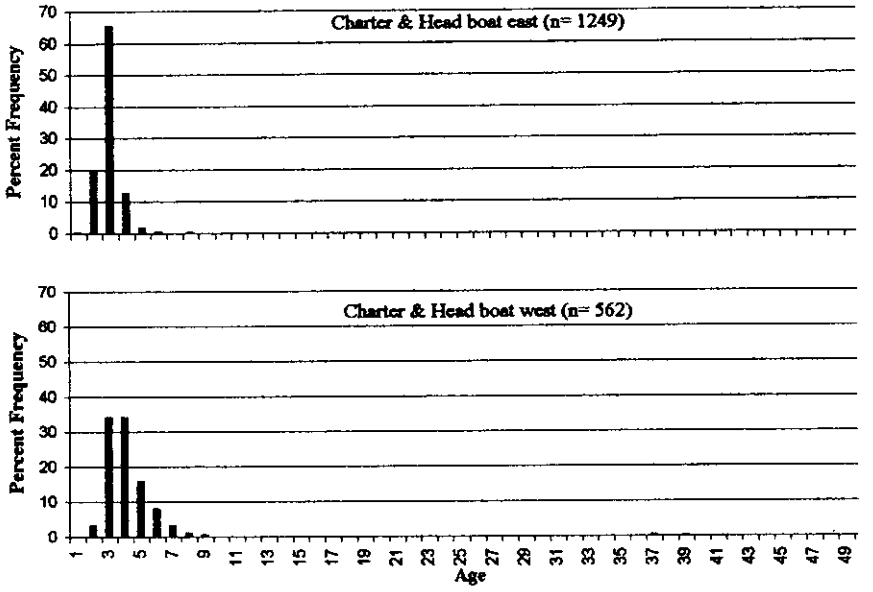

Figure 7. Age frequency of the recreational fishery by sampling region in 1998

ACKNOWLEDGMENTS

We thank Meredith Burnett and Nancy Evou for help in the laboratory. We thank colleagues for their participation in an otolith exchange; Louise Stanley formerly of Louisiana State University, Walter Ingram and Will Patterson, formerly of the University of South Alabama, Pat Harris of the South Carolina Marine Resources Research Institute and Chuck Manooch and Jennifer Potts of the National Marine Fisheries Service, Beaufort, NC Laboratory. Extended thanks are due Jennifer Potts for plotting mean size-at-age from the exchange. We acknowledge the efforts of dedicated port agents without whom this work could not have been accomplished. Partial support was provided by the Marine Fisheries Initiative (MARFIN) Program.

LITERATURE CITED

Baker, M.S., Jr. 1999. Radiometric age validation of red snapper, *Lutjanus campechanus*, and red drum, *Sciaenops ocellatus*, from the northern Gulf of Mexico. M.S. Thesis. Louisiana State University, Baton Rouge, Louisiana USA. 59 pp.

Beamish, R.J. and D.A. Fournier. 1981. A method for comparing the precision of a set of age determinations. *Canadian Journal of Fisheries and Acuatic. Science* **38**:982-983.

Beamish, R.J. and G.A. McFarlane. 1995. A discussion of the importance of aging errors, and an application to walleye pollock: the worlds largest fishery. Pages 545-565 in: D.H. Secor, J. M. Dean and S.E. Campana (eds.) *Recent Developments in Fish Otolith Research*. Univ. of S. Carolina Press. Columbia, South Carolina USA.

Bortone, S.A. and C.L. Hollingsworth. 1980. Ageing red snapper, *Lutjanus campechanus*, with otoliths, scales and vertebrae. *Northeast Gulf Science* **4**(1):60-63.

Cowan, J.H. Jr., R.L. Shipp, H.K. Bailey IV, and D.W. Haywick. 1995. Procedurefor rapid processing of large otoliths. *Transactions of the American Fisheries Society* **124**:280-282.

Fowler, A.J. 1995. Annulus formation in otoliths of coral reef fish–a review. Pages 45-63 in: D.H. Secor, J. M. Dean and S.E. Campana (eds.) *Recent Developments in Fish Otolith Research*. Univ. of S. Carolina Press. Columbia, South Carolina USA.

Futch, R.B. and G.E. Bruger. 1976. Age, growth, and reproduction of red snapper in Florida waters. Pages 165-183 in: H.R. Bullis Jr., and A.C. Jones, (eds.) *Proceedings: Colloquium on Snapper-grouper Fishery Resources of the Western Central Atlantic Ocean*. Florida Sea Grant College Program Report No. 17.

Hoese, H.D. and R.H. Moore. 1977. *Fishes of the Gulf of Mexico*. Texas A&M University Press. College Station, Texas USA. 327 pp.

Jearld, A. Jr. 1983. Age determination. Pages 301-324 in: Nielsen, L.A. and D.L. Johnson, (eds.) *Fisheries Techniques*. Southern Printing Company, Inc., Blacksburg, Virginia USA.

Manooch, C.S. III and J.C. Potts. 1997. Age and growth of red snapper, *Lutjanus campechanus*, Lutjanidae, collected along the southeastern United States from North Carolina through the east coast of Florida. *Journal of the Elisha Mitchell Scientific Society*. **113**(3):111-122.

MRAG Americas Inc. 1997. Consolidated report on the peer review of red snapper (*Lutjanus campechanus*) research and management in the Gulf of Mexico. Prepared by: MRAG Americas Inc., St. Petersburg, Florida USA.

Morison, A.K., S.G. Robertson, and D.C. Smith. 1998. An integrated system for production fish aging: Image analysis and quality assurance. *North American Journal of Fisheries Management* **18**:587-598.

Nelson, R.S. and C.S. Manooch III. 1982. Growth and mortality of red snappers in the west-central Atlantic Ocean and northern Gulf of Mexico. *Transactions of the American Fisheries Society* **111**:465-475.

Patterson, W.F., III. 1999. *Aspects of the Population Ecology of Red Snapper, Lutjanus Campechanus, in an Artificial Reef Area off Alabama*. Ph.D. Dissertation. University of South Alabama, Mobile, Alabama USA. 164 pp.

Rothschild, B.J., A.F. Sharov and A.Y. Bobyrev. 1997. Red snapper stock assessment and management for the Gulf of Mexico. An independent assessment completed for the Office of Science and Technology, National Marine Fisheries Service, NOAA, Silver Springs, Maryland USA. 173 pp.

Schirripa, M.J. and C.M. Lagault. 1999. Status of the red snapper in the U.S. waters of the Gulf of Mexico: Updated through 1998. National Marine Fisheries Service, Southeast Fisheries Science Center, Miami Laboratory Miami, Florida USA. Cont. SFD-99/00-75. 86 pp.

Wells, J.G. 1975. *Fishes of the northern Gulf of Mexico*. T.F.H. Publications, Inc. Neptune City, New Jersey USA. 432 pp.

Wilson, C.A., J.H. Render and D.L. Nieland. 1994. Life history gaps in red snapper (*Lutjanus campechanus*), swordfish (*Xiphias gladius*), and red drum (*Sciaenops ocellatus*) in the northern Gulf of Mexico; age distribution, growth and some reproductive biology. Final report to U.S. Dept. Comm., Nat. Mar. Fish. Ser., Mar. Fish. Init. (MARFIN) Coop. Agreement NA17FF0383-02. 79 pp.

Wilson , C.A., D.L. Nieland, A.L. Stanley and A.J. Fischer. 1998. Age and size distribution of commercially harvested red snapper *Lutjanus campechanus* in the northern Gulf of Mexico. Final report to U.S. Dept. Comm., Nat. Mar. Fish. Ser., Mar. Fish. Init. (MARFIN) Coop. Agreement NA57FF0287. 65 pp.