# Red Snapper in the Northern Gulf of Mexico: Fishery Dependent and Fishery Independent Characterization of Age and Length

DAVID L. NIELAND[1] and CHARLES A. WILSON[1,2]
[1]*Coastal Fisheries Institute*
[2]*Department of Oceanography and Coastal Sciences*
*Center for Coastal, Energy, & Environmental Resources*
*Louisiana State University*
*Baton Rouge, LA 70803 USA*

ABSTRACT

Red snapper from the northern Gulf of Mexico off Louisiana were found to differ significantly in age and fork length distribution between fishery dependent and fishery independent sources. Commercially harvested red snapper ranged from 320 to 880 mm fork length and from 2 to 48 yr; those from among the mortalities subsequent to the explosive removal of an obsolete oil and gas platform varied from 220 to 730 mm and from 1 to 9 yr. The truncated age distribution of the fishery independent sample supports the hypothesis that red snapper recruit to structures such as oil platforms at age 2 yr and then emigrate to other habitats after several years of residency. Fork length was also found to be a competent predictor of age for red snapper < 500 mm. Due to the virtual absence of age 2 red snapper both in the commercial and recreational harvests and in fishery independent trawl collections, sampling of red snapper populations at explosive removal sites is the lone method of tracking cohort strength at age two.

KEY WORDS: Age frequency, length frequency, red snapper

## INTRODUCTION

The management of the red snapper *Lutjanus campechanus* in the Gulf of Mexico (GOM) remains among the more problematic issues facing fishery managers of the region. Since 1991 both the commercial and recreational red snapper fisheries have been constrained by size limits, creel or trip limits, seasonal closures, and quotas as established by the Gulf of Mexico Fisheries Management Council in response to reports of overfishing (Goodyear 1995). Shrimp trawlers have also been required to install bycatch reduction devices in their nets to curtail mortality among juvenile red snapper. The intent of these regulations is both to achieve a 20 percent spawning potential ratio and to allow populations to recover.

The management of red snapper is complicated by the longevity of the species. Maximum red snapper age, based on estimates from otoliths, has been variously reported as 25 yr (Manooch and Potts 1997), 42 yr (Szedlmayer and

Shipp 1994), 49 yr (Wilson, et al. 1998), and 53 yr (Render 1995). Thus, accurate information on the age and length structure of red snapper populations in the GOM is essential to monitor year class strength, to conduct stock assessments, and to demonstrate population recovery. Since 1995 we have collected otoliths and morphometric data of red snapper landed in the commercial harvest of the northern GOM off Louisiana. From these materials and data we have been able to characterize the age and size structure of this harvest (Wilson, et al. 1998). However, legitimate questions have been raised as to whether the age and size structure of the commercial catch is truly representative of the red snapper population as a whole. The root of these questions is the very nature of the fishery itself. Red snapper commercial fishermen are currently allowed a Gulf-wide quota of 2,114 metric tons (4.65 million lb) two-thirds of which is allocated to a winter season beginning in February and one-third to an autumn season beginning in September. Additionally, both the winter and autumn seasons are open to red snapper harvest only for the first 15 days of each successive month until the quota is achieved. A trip limit of 0.91 metric ton (2000 lb) for holders of federally issued reef fish permits and the modest number of available fishing days has resulted in a Aderby@ fishery which necessitates maximum catch in a minimum of time. Also, to optimize revenue the fishermen are targeting the 1 - 4 kg red snapper which yield the highest dockside price.

To compete in this derby fishery, many red snapper fishermen have concentrated their efforts at the numerous offshore oil and gas platforms of the northern GOM, particularly those closest to port. These easily located structures can hold large numbers of red snapper (Continental Shelf Associates 1982, Putt 1982, Stanley and Wilson 1990, Stanley 1994). The usual routine (called Arig hopping@) involves test fishing at successive platforms until a large and readily caught population of red snapper is found. Under the appropriate conditions and with some good fortune, a single trip may last less than one day.

Given the nature of the red snapper fishery in the northern GOM, it is highly unlikely that the age and size structure of the commercial catch is representative of the entire population. Rather, it may more certainly reflect the age and size distribution of only those red snapper which are both associated with oil and gas platforms and legal to retain by fishermen. We have speculated that red snapper recruit to platforms at age 1 or 2, occupy these habitats for a few years, and then emigrate to other habitats. Older, larger red snapper may avoid platforms and gravitate to other structure such as shipwrecks, sea bottom depressions or lumps, and natural reefs. However, there are few fishery independent studies which have allowed characterization of age and size of red snapper associated with oil and gas platforms.

Herein we report the age and length distributions of the red snapper commercial harvest from the northern GOM and those of a Asnapshot@ of red snapper randomly sampled from among the mortalities resulting from the explosive removal of an offshore oil platform. Our objectives were to compare these respective fishery dependent and fishery independent data to determine whether fishery dependent age and size data can be appropriately extrapolated to red snapper populations in the northern GOM. We further attempt to infer important life history information, such as size at age for age 2 and 3 yr individuals and patterns of recruitment to oil and gas platforms.

## MATERIALS AND METHODS

Red snapper from the commercial harvest of the northern GOM were randomly sampled from March 1995 through March 1998. Although the majority of our sampling efforts were targeted at wholesale facilities located near Leeville, LA, the area of coverage extended from the Mississippi River Delta in the east to the LA/TX border in the west. A fishery independent population of red snapper was randomly sampled from among the mortalities produced subsequent to the explosive removal of an obsolete oil platform located in Block 209 of the Ship Shoal oil and gas lease planning area (approx. 185 km SW of New Orleans, LA) on 30 July 1998. The four pile platform measured 6.1 X 7.6 m at the water's surface and 12.2 X 13.7 m at the substrate. Water depth at the site was 32 m; thus, the volume of water enclosed by the platform was approximately 3,100 $m^3$. Following detonation of explosives placed in all four piles and in the lone well conductor at 5 m below substrate level, all floating fishes were collected. A representative sample of fishes which had sunk to the bottom was also retrieved by SCUBA divers.

Fork length (FL) in mm and both sagittal otoliths were taken from each specimen. We had also anticipated removing the gonads from the Ship Shoal red snapper for reproductive analyses; however, as the explosive concussion caused severe damage to the gonads, this aspect of the sampling regime was eliminated. Otoliths were prepared and sectioned for ageing analyses as described in Beckman et al. (1988). Counts of increments (opaque zones) were accomplished by reading along the medial surface of the transverse section ventral to the sulcus; increments were often inconsistent in other regions of the otolith section. The appearance of the otolith margin was also coded as either opaque or transparent (Beckman et al. 1988, Beckman et al. 1990, 1991). Age estimates of red snapper were based on otolith opaque increment counts and adjusted, if necessary, by edge condition. Opaque increments in red snapper otoliths have been demonstrated to be annual in their formation by Manooch and Potts (1997) and Wilson et al. (1998). Based on previous studies of red snapper reproduction

(Wilson et al. 1994, Render 1995), we assigned a uniform hatching date of 1 July to all specimens.

Comparisons of red snapper fork length and age distributions were performed among three sets of data. The first included all specimens from the 1995-1998 sampling of the commercial harvest. The second was comprised of only those specimens from the commercial harvest during February and March of 1998. These provided for relatively synchronous comparisons with the third data set: those specimens from Ship Shoal 209. All distributions were tested for statistical variation with the Komolgorov-Smirnov test at the 0.05 level (Sokal and Rohlf 1981).

## RESULTS

The sampling of 2,793 red snapper from the commercial harvest yielded 2,793 FL measurements and 2,786 age estimates. The February/March 1998 subset of these includes 556 specimens for which all FL and age estimates are available. The recovery of fish mortalities from the Ship Shoal 209 detonation yielded 1,005 total individuals dominated by red snapper, gray snapper *L. griseus*, lane snapper *L. synagris*, sheepshead *Archosargus probatocephalus*, and Atlantic spadefish *Chaetodipterus faber* (*pers. comm.*, Gregg Gitschlag, National Marine Fisheries Service, Galveston, TX). Three hundred FL and 295 age estimates were obtained from a random sampling of 300 of the 373 total red snapper mortalities.

Among all red snapper sampled from the commercial catch, FL ranged from 320-880 mm (Figure 1A). The lower limit of the size distribution is specified by the 380 mm minimum total length (351 mm FL) regulation applied to the fishery. Modal FL was 360 mm and 50% of the specimens were less than 420 mm. Ages estimated for these specimens ranged from 2 to 48 yr (Figure 2); however, the vast majority (97.2%) of these individuals were age 3-7.

The FL distribution of the February/March 1998 subset of the commercial harvest is somewhat more variable than and it does not show as smooth a decline in abundance with increasing length as the above (Figure 1B). However, there is no statistical difference between the two. Fork lengths of these specimens varied from 340 to 820 mm and exhibited a mode of 400 mm; median FL was 440 mm. Although age estimates ranged from 2 to 39 yr, again the great majority (98.4%) of specimens were age 3-7 (Figure 2). A statistical difference in age distributions between the two commercial data sets is the result of a greater proportion (32.2% vs. 24.2%) of age 3 individuals among the specimens sampled in February/March 1998.

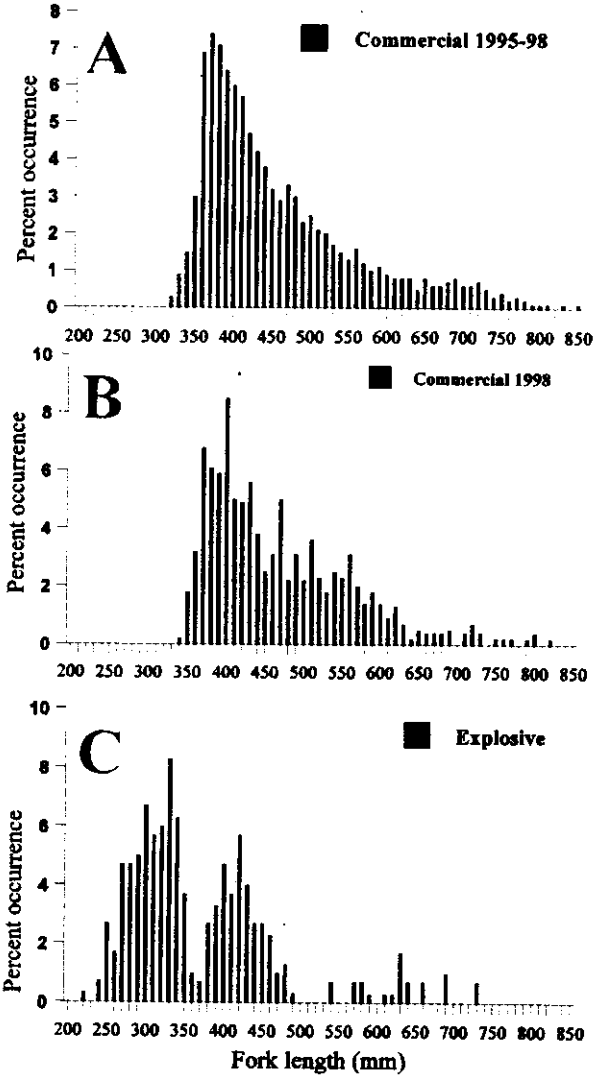


**Figure 1.** Fork length distributions for red snapper *Lutjanus campechanus* from the northern Gulf of Mexico: A) 2,793 specimens from the commercial harvest, 1995-1998, B) 556 specimens from the commercial harvest, February and March 1998, and C) 300 specimens from among mortalities subsequent to the explosive removal of an oil and gas platform located in Ship Shoal block 209.

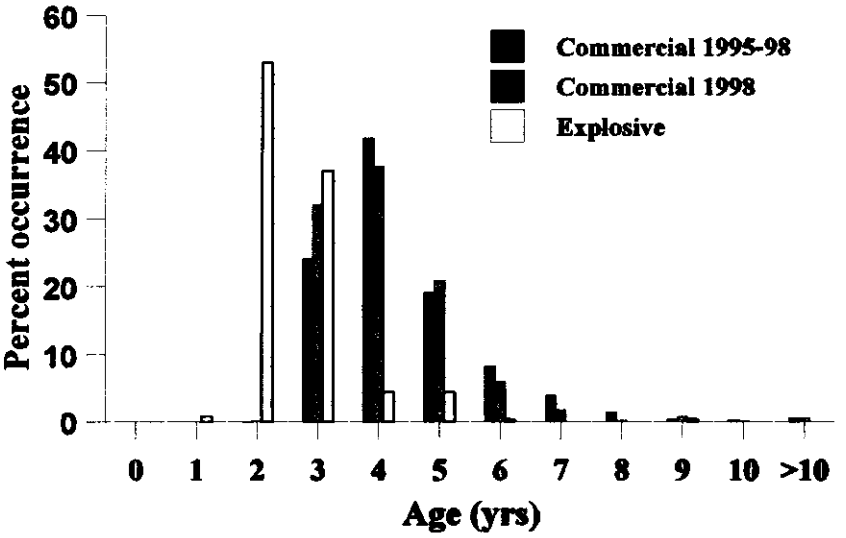


**Figure 2.** Age distributions for red snapper *Lutjanus campechanus* from the Northern Gulf of Mexico: black bars) 2,786 specimens from the commercial harvest, 1995-1998, gray bars) 556 specimens from the commercial harvest, February and March 1998, and white bars) 295 specimens from among mortalities subsequent to the explosive removal of an oil and gas platform located in Ship Shoal block 209.

Fork lengths and age estimates among the red snapper sampled from the Ship Shoal 209 population evidence radically and statistically different distributions from those seen in the commercial catch (Figure 1C, Figure 2). In addition to having both a lesser minimum (220 mm) and a lesser maximum (730 mm) length, the FL distribution is distinctly trimodal. The distribution of ages (1 - 9 yr) is also severely truncated and includes a large proportion (52.9%) of age 2 individuals which are not present in the commercial landings. A plot of FL at age for the Ship Shoal population (Figure 3) indicates that the first two major FL modes (220-360 mm and 370-490 mm) are composed largely of individuals at age 2 yr and age 3 yr, respectively. The third minor mode (540-730 mm) is comprised of red snapper of age 4-9 yr.

## DISCUSSION

Analysis of the fishery independent red snapper data gathered from the Ship Shoal 209 must be tempered with the recognition that it is indeed a chronological Asnapshot@ of the red snapper population and cohort strength. Previous reports of red snapper populations associated with oil and gas platforms have shown conclusively that numbers can vary significantly among seasons (Putt 1982)

Stanley 1994). Red snapper are also known to stratify by size at different depths around platforms; further, larger individuals are less obligate in their association to platforms than are smaller individuals (Render 1995). Thus, we must assume that red snapper of all sizes and at all depths would be similarly susceptible to explosive induced mortality and that mortality is 100 % in the near vicinity of the platform.

The fishery independent sampling of fishes at Ship Shoal 209 reveals a relatively large population of red snapper. Fully 37 % of the fish mortalities recovered subsequent to the explosive detonation were red snapper. Other fishery independent surveys of fishes around oil and gas platforms have reported red snapper populations consisting of 8 - 52% (Stanley 1994) and 2 - 4 % (Putt 1982) of the total fishes inhabiting platforms. However, 56% of the Ship Shoal 209 red snapper would have been unavailable for harvest due to the minimum length regulation enforced Gulf-wide. This is amply reflected in the virtual absence of individuals < 330 mm FL in both commercial data sets.

The Ship Shoal 209 red snapper population is also relatively homogeneous in both age and length distribution. The individuals within the first two large modes of the FL distribution make up 92.3% of the total 300 individuals sampled. Further, individuals of age # 3 yr totaled 90.5 % of all red snapper sampled. This homogeneity is reflected neither in the age nor in the FL distribution of the commercial catch. Along the size spectrum of platforms in the GOM, the Ship Shoal 209 platform ranks at the lower end of this

distribution. In a hydroacoustic study of the fish population around a much larger platform (45 m X 20 m; 19,800 $m^3$ volume), Stanley (1994) reported the red snapper population varying from 1,200 to 8,200 individuals. One could speculate that among such numbers, older and larger red snapper might be present in appreciable numbers. Commercial fishing effort at such structures could provide for the diversity of ages and lengths seen in the fishery dependent data.

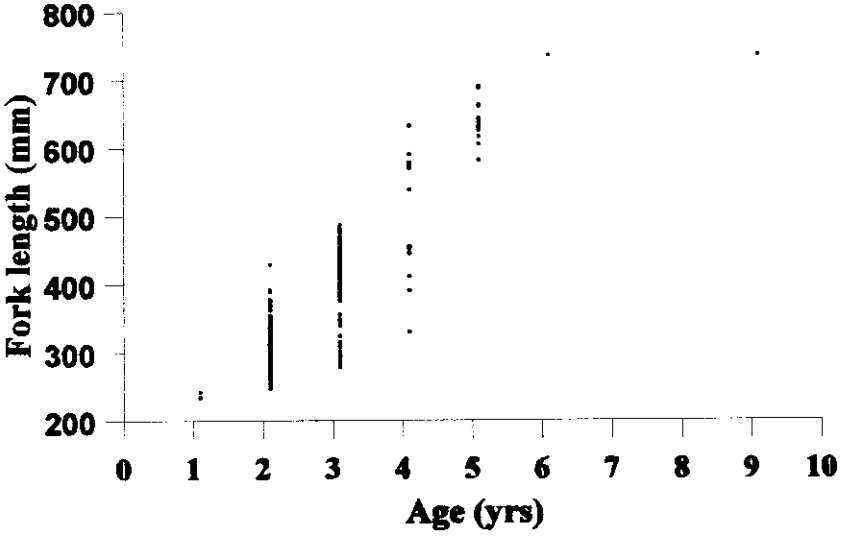


**Figure 3.** Fork length at age for red snapper *Lutjanus campechanus* sampled from among mortalities subsequent to the explosive removal of an oil and gas platform located in Ship Shoal block 209. N = 295.

The truncation of the red snapper size and length distributions at Ship Shoal 209 might also reflect the life history of red snapper. Juvenile red snapper are known to inhabit shallow water areas devoid of large structures where they are vulnerable to capture in trawls. This behavior is illustrated in fishery independent trawl data from the GOM, specifically the Fall Groundfish Survey and the Summer SEAMAP Survey, in which the great majority of red snapper captured are age 0 and 1 (Schirripa and Legault 1997). It is hypothesized that the disappearance of older red snapper from the trawl data represents migration to structures such as oil and gas platforms which presumably provide refuge from large predators (Render 1995). Both the paucity of individuals of age < 2 and the bounty of age 2 and 3 individuals at Ship Shoal 209 assuredly support this hypothesis. The drastic decrease in numbers of individuals of age > 3 may represent emigration away from the structure to alternative habitats, removal from the population through fishing activities and natural mortality, or reduced recruitment among those cohorts.

The fishery independent data from Ship Shoal 209 also provide verification of size at age for young red snapper in the northern GOM. Within the first FL mode (240-360 mm) illustrated in Figure 1C, 90% of the 150 individuals contained therein are age 2. The second mode (370-500 mm FL) in Figure 1C is comprised of 89 % (92 of 103) age 3 individuals. Such fidelity in the age at size relations for age 2 and age 3 could prove useful in two instances. Red snapper ranging from 250 to 500 mm FL can be aged with relative confidence simply from their length; time consuming and costly removal, sectioning, and reading of otoliths becomes unnecessary. Further, age determined from length could be used to confirm age estimates derived from counts of otolith increments.

Management of the red snapper in the GOM is predicated in part on estimates of relative cohort strength at age 1derived from the fishery independent trawl surveys mentioned above (Schirripa and Legault 1997) and on fishery dependent data such as that reported herein. However, due to the virtual ubiquity of age 0 and 1 individuals in the trawl catch and to the 380 mm minimum total length regulation enforced within both the commercial and recreational fisheries, there is little information on which to gauge cohort strength at age 2. Over the past few years the National Marine Fisheries Service has undertaken periodic assessment of the effects of explosive platform removal on the associated fish populations at select sites in the GOM. Such efforts apparently afford the sole opportunity to monitor red snapper cohort strength at age 2 and to bridge the data gap between existing data sources. They also prove to be crucial in our understanding of red snapper recruitment to and emigration from reefs and other structures such as oil and gas platforms. Continuation of this program would positively impact the current and future management of red snapper and help assure the future of the species in the GOM

ACKNOWLEDGMENTS

We are indebted to Jane Black for allowing us access to the commercially caught red snapper landed at the facilities of USA Fish (Leeville and Cameron, LA). Our gratitude is also extended to Aly Hakam (Winmar Consulting Services), Spirit Energy, Gregg Gitschlag (National Marine Fisheries Service Galveston Laboratory), and Scott Baker and Darin Doumite (Louisiana State University) for their cooperation in our effort to sample the red snapper population at Ship Shoal 209. This research was funded by the U. S. Department of Commerce Marine Fisheries Initiative (MARFIN) Program administered by the National Marine Fisheries Service.

LITERATURE CITED

Beckman, D.W., C.A. Wilson and A.L. Stanley. 1988. Age and growth of red drum, *Sciaenops ocellatus*, from offshore waters of the northern Gulf of Mexico. *Fish. Bull.* **87**:17-28.

Beckman, D.W., A.L. Stanley, J.H. Render and C.A. Wilson. 1990. Age and growth of black drum in Louisiana waters of the Gulf of Mexico. *Trans. Am. Fish. Soc.* **119**:537-544.

Beckman, D.W., A.L. Stanley, J.H. Render and C.A. Wilson. 1991. Age and growth-rate estimation of sheepshead *Archosargus probatocephalus* in Louisiana waters using otoliths. *Fish. Bull.* **89**:1-8.

Continental Shelf Associates. [1982] Study of the effect of oil and gas activities on reef fish populations in Gulf of Mexico OCS area. OCS Report MMS 82-10. New Orleans, Louisiana. U.S. Department of Interior, Minerals Management Service, Gulf of Mexico OCS Region. 210 p. Unpubl. Ms.

Goodyear, C. P. [1995] Red snapper in U.S. waters of the Gulf of Mexico. National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, Contribution MIA-95/96-05. Unpubl. Ms. 171 pp.

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. *J. Elisha Mitchell Sci. Soc.* **113**:111-122.

Putt, R.E., Jr. 1982. A quantitative study of fish populations associated with a platform within Buccaneer oil field, northwestern Gulf of Mexico. M.S. Thesis. Texas A&M University. College Station, TX. 116 pp.

Render, J.H. 1995. *The life history (age, growth, and reproduction) of red snapper (Lutjanus campechanus) and its affinity for oil and gas platforms.* Ph.D. Dissertation. Louisiana State University, Baton Rouge. 76 pp.

Schirripa, M.J., and C.M. Legault. [1997] Status of the red snapper in U.S. waters of the Gulf of Mexico: Updated through 1996. National Marine Fisheries Service, Southeast Fisheries Center, Miami Laboratory, Contribution MIA-97/98-05. Unpubl. Ms. 40 pp.

Sokal, R.R., and F.J. Rohlf. 1981. *Biometry*, 2nd ed. W.H. Freeman, San Francisco. 859 pp.

Stanley, D.R. 1994. *Seasonal and spatial abundance and size distribution of fishes associated with a petroleum platform in the northern Gulf of Mexico.* Ph.D. Dissertation. Louisiana State University, Baton Rouge. 123 pp.

Stanley, D.R. and C.A. Wilson. 1990. A fishery dependent based study of fish species composition and associated catch rates around petroleum platforms off Louisiana. *Fish. Bull.* **88**:719-730.

Szedlmayer, S.T. and R.L. Shipp. 1994. Movement and growth of red snapper, *Lutjanus campechanus*, from an artificial reef area in the northeastern Gulf of Mexico. *Bull. Mar. Sci.* **55**:887-896.

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. Department of Commerce, National Marine Fisheries Service, Marine Fisheries Initiative (MARFIN), Cooperative Agreement NA17FF0383. Unpubl. Ms. 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. Department of Commerce, National Marine Fisheries Service, Marine Fisheries Initiative (MARFIN), Cooperative Agreement NA57FF0287. Unpubl. Ms. 43 pp. + 22 fig.