DISTRIBUTION, ABUNDANCE AND AGE STRUCTURE OF RED SNAPPER (*Lutjanus campechanus*) CAUGHT ON RESEARCH LONGLINES IN U.S. GULF OF MEXICO

by

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Abstract

Two pilot surveys (1999 & 2000) were conducted in the northern Gulf of Mexico (Gulf) to determine the feasibility of sampling red snapper (*Lutjanus campechanus*) populations in offshore waters (64-146 m) using bottom longline gear. Based upon the results of the pilot surveys, expanded longline surveys targeting red snapper were conducted in 2001 and 2002 (to 366 m depth). The first pilot survey off Mississippi/Alabama was conducted in May 1999 and yielded seven snapper from 60 stations. The second pilot survey was off Texas in June 2000 and yielded 76 snapper from 44 stations. The catch per unit effort (CPUE) was 0.12 red snapper/100 hook hr (CV=0.54) in 1999 and 1.73 red snapper/100 hook hr (CV=0.21) in 2000. Otoliths were removed from all collected red snapper and ages were assigned with an average percent error of 3.71%. The size of red snapper for the 1999 survey ranged from 405-873 mm total length (TL) (545 mm TL median) and ages ranged from 3-19 years (median age 5 years). The red snapper from Texas ranged in size from 380-903 mm TL (755 mm TL median) and ranged in age from 3-53 years (median age 11 years). The 2001 and 2002 surveys yielded 86 snapper and 75 snapper respectively. The 2001 snapper ranged in size from 427 to 950 mm TL (770 mm TL median) and age from 3-37 years (median age 12 years). The 2002 snapper ranged in size from 409-950 mm TL (815 mm TL median) and age from 4-44 years (median age 13 years). Twelve red snapper were captured in the eastern Gulf (east of the Mississippi River) and the ages ranged from 3-19 years (median age 6 years). The 232 red snapper that were caught in the western Gulf ranged in age from 3-53 years (median age 12 years). A difference in catch rates by depth was also noted with most red snapper catches occurring in the 55-92 m depth range.

Introduction

The red snapper (*Lutjanus campechanus)* is considered by many to be the premier food fish in the Gulf of Mexico (Gulf). A commercial fishery for red snapper has existed for over 150 years, but with improving fishing techniques and technologies the species has become increasingly vulnerable to commercial and recreational exploitation. Federal management of red snapper began in 1984 with the implementation of the Reef Fish Fishery Management Plan, and a series of management actions to rebuild the stock have followed since that time. Currently, red snapper are considered to be overfished and controversy continues over what actions are necessary to recover the species to former abundances. For an in-depth summary of red snapper management issues see Goodyear (1995)[1] and Schirripa (1998)[2].

In March 1999, the Gulf of Mexico Fisheries Management Council (GMFMC) recommended that "National Marine Fisheries Service (NMFS) research priority be given to items regarding red snapper including analysis of the fate of offshore stocks and estimates of fecundity, and that results be applied to the red snapper model as applicable". In response to this request, NMFS Southeast Fisheries Science Center, Mississippi Laboratories, scheduled two 14 day surveys to evaluate the feasibility of using longline gear to capture red snapper in sufficient numbers for

[1]Goodyear, C. P. 1995. Red Snapper in U.S. waters of the Gulf of Mexico. National Marine Fisheries Service, Southeast Fisheries Science Center, Miami Laboratory, Miami MIAC95/96-05.

[2]Schirripa, M.J. 1998. Status of the red snapper in U.S. waters of the Gulf of Mexico: updated through 1997. NOAA/NMFS Sustainable Fisheries Division Contribution, SFD-97/98-30.

age and growth studies, and distribution and abundance estimation. The first study was conducted off the Mississippi-Alabama coast and the second was conducted in waters off Texas. Both surveys occurred in deeper waters (64-146 m) where larger and older red snapper were suspected to occur. Based on the results of these studies, an offshore snapper/grouper component was added to annual shark longline surveys conducted by the Mississippi Laboratories. The shark longline surveys have been conducted since 1995 and fished depths from 9-55 m (Grace & Henwood 1997). The 2001 survey was expanded offshore to depths of 366 m to include areas where red snapper were encountered during the 1999 and 2000 surveys. This paper will address the number, size and age of red snapper caught during these surveys and the regional differences in abundance.

Materials and Methods

The 1999 study was conducted aboard the National Oceanic and Atmospheric Administration (NOAA) Ship *Ferrel* in the north-central Gulf from 89° W to 87° W at depths ranging from 64-146 m, an area not considered to be part of the historical snapper fishing grounds (Fig. 1A). Six random stations per ten minute block (stratum) were selected by longitude and depth for a total of 12 blocks and 72 stations. The bottom was surveyed to evaluate topographic conditions before each longline set, and each set was made parallel to the depth contour. The longline gear consisted of 409-455 kg test monofilament mainline with 2.44 m, 182 kg test gangions and #15/0 circle hooks. One hundred hooks baited with Atlantic mackerel (*Scomber scombrus)* were set at each station and soaked for one hour. The hour began when the last high flier (4 m pole at the beginning and end of the mainline to identify the location of the gear) was deployed and ended when the first high flier was retrieved. All captured fish were weighed (kg), measured (mm)

(total (TL) and fork length (FL)), and sagittal otoliths were removed for ageing.

The 2000 study occurred aboard the NOAA Ship *Gordon Gunter* in the northwestern Gulf from 94° W to 97° W longitude above 26° N latitude at depths ranging from 64-146 m (Fig. 1A), an area where large red snapper have historically been observed and harvested with longline gear (Prytherch[3]). Six random stations per 20 minute block (stratum) were selected by longitude (or latitude) and depth for a total of 12 blocks and 72 stations. Stratum size was increased in the 2000 study to cover the entire Texas coast in the time allotted for the survey. Thus, effort expended in the 2000 survey was designed to be the same as in the 1999 survey, but the area covered was approximately doubled. The bottom was surveyed as in the 1999 study and sets were made parallel to the depth contour. The mainline was 409-455 kg test monofilament, but the gangions were changed to 318 kg test and 3.66 m in length to compensate for the greater freeboard of the NOAA Ship *Gordon Gunter*. The set procedure was again a one hour soak time and 100 hooks baited with Atlantic mackerel.

In 2001, the annual longline survey was expanded to cover the entire U.S. Gulf over depths ranging from 9-366 m (Fig. 1B). Effort was proportionally allocated based upon shelf width within 60 nautical mile statistical zones (81°-82° W, 82°-83° W, 83°-84° W, ..., etc.) and stratified by depth with effort distributed as follows: 50% of effort 9-73 m, 40% of effort 73-183 m and 10% of effort 183-366 m. Longline gear was the same as used in the 2000 study and the

[3]Prytherch, H.F. 1983. A descriptive survey of the bottom longline fishery in the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFC-122.

NOAA Ship *Oregon II* served as the survey platform. The 2002 longline survey also followed this survey design, as will future surveys.

Catch per unit effort (CPUE=number of red snapper per 100 hook hour) was calculated for each survey by depth and by survey. The coefficient of variation (CV=coefficient of variation for the mean=standard error of the mean/mean) was also calculated for each CPUE.

Sagittal otoliths were removed from all red snapper captured. Otoliths from 1999-2002 were processed and sectioned following the methods of Cowan et al. (1995). The sectioned otoliths were viewed under a dissecting microscope with reflected light (25X) and two readers (GRF and RJA) made independent annulus counts (opaque zones). Ages (years) were assigned based on the number of annuli and edge condition. Those individuals with advanced translucent edges (judged at least 2/3 complete) were advanced one year in age in the expectation that opaque zones would have formed soon. With this traditional approach, an annual age cohort is based on a calender year (Jearld 1983). Reproducibility of age estimates based on initial independent readings was determined with average percent error (APE) (Beamish and Fournier 1981). When counts disagreed, otolith sections were re-examined jointly by the two readers. Any unresolved counts and illegible otoliths were excluded from the analyses.

Results

During the 1999 survey, seven red snapper were caught at four of the 60 longline stations occupied (Fig 2A). The total weight of red snapper was 20.4 kg with the largest individual

weighing 8.5 kg. The size of red snapper collected during the 1999 survey ranged from 405-873 mm TL (545 mm TL median), and ranged in age from 3-19 years with a median age of 5.

In the 2000 survey, 76 red snapper were caught at 21 of the 44 stations occupied (Fig. 2A). The total weight of red snapper was 463.5 kg with the largest individual weighing 10.2 kg. The 76 red snapper from the 2000 survey off Texas ranged in size from 380-903 mm TL (median 755 mm TL) and ranged in age from 3-53 years with a median age of 11.

During the 2001 survey, 277 stations were completed and 86 red snapper were caught with the largest snapper weighing 11.8 kg and the total weight of snapper was 556 kg (Fig. 2B). The sizes ranged from 427-950 mm TL (770 mm TL median) and the ages ranged from 3-37 years with a median age of 12. The 2002 survey completed 212 stations and caught 75 red snapper with the largest red snapper weighing 11.2 kg and the total weight 534 kg (Fig. 2B). The sizes ranged from 409-950 mm TL (815 mm TL median) and ranged in age from 4-44 years with a median age of 13.

The ages reported above were based on two independent counts of red snapper annuli which resulted in an APE of 3.71% (%CV=5.25). After undergoing a review of differences in order to achieve reader agreement and to improve the likelihood of assigning a correct age, the "final" ages were assigned and used to characterize the age structure.

Red snapper catches varied geographically and with depth. A breakdown of catch per unit effort by depth for all longline surveys revealed that red snapper were more abundant in depths ranging

from 55-92 m with catches dropping off both inshore and offshore (Fig. 3). Regional differences were observed across the Gulf with only 12 red snapper caught in the eastern Gulf (east of the Mississippi River; 269 stations), whereas 232 red snapper were caught in the western Gulf (west of the Mississippi River; 324 stations) (refer to Fig. 2A&B). A difference in age and size of fish was also noted with older, larger red snapper in the western Gulf (up to 53 years; median age 12, median TL 784 mm) and younger, smaller fish in the eastern Gulf (up to 19 years; median age 6, median TL 625 mm) (Figs. 4&5).

Red snapper CPUE was much greater in the 2000 survey conducted off Texas than during the 1999 survey off Mississippi/Alabama. Mean CPUE for Texas catches was 1.73 red snapper (CV= 0.21) in comparison to mean CPUE of 0.12 red snapper (CV= 0.54) for the 1999 survey. For comparative purposes using only data from 64-146 m depths and dividing the Gulf into eastern and western components, the 2001 annual Gulf-wide longline survey yielded CPUE estimates of 0.08 red snapper (CV=0.74) for the eastern Gulf and 1.38 (CV=0.27) for the western Gulf. The 2002 survey yielded CPUE estimates of 0.12 red snapper (CV=0.68) for the eastern Gulf and 0.72 (CV=0.27) for the western Gulf.

Discussion

The longline surveys indicated several patterns of species distribution and differences in age and size structure due to geography and depth. An early study (Prytherch[3]) of longline catches from the then-young commercial longline fleet in the early 1980's, also revealed very similar

geographic results over a similar depth range[4]. Based on commercial longline CPUE (same units: red snapper per 100 hook hr) from the Prytherch study, red snapper was the most abundant "food-fish" from the western Gulf (broadly defined as the Texas area) with an average CPUE of 1.14. Red snapper were less abundant from the north-central Gulf (denoted the Panama City Florida Area)(10% of catch, second most abundant "food fish") and rare in the eastern Gulf (denoted the St. Petersburg Florida Area)(0.6% of catch, seventh most abundant "food fish") (Prytherch[3]). Anecdotal information indicates that current fishing practices also reflect this geographic pattern (Personal Communication; Debbie Fable, Port Agent, NMFS, Panama City, Florida). For example, commercial longliners departing northwest Florida ports reportedly seek red snapper as a principal target species when they travel west (e.g. off Louisiana), whereas, commercial longliners fishing the west Florida shelf view red snapper as infrequent bycatch in the grouper-directed longline fishery. Together, these results indicate a likelihood of a difference in the distribution of red snapper from the western compared to northern and eastern areas of the Gulf, and this difference may have persisted since the early 1980s. Results from the 2001 and 2002 longline surveys support this observation.

Catch rates for red snapper also varied with depth with highest abundance of snapper caught in depths of 55-92 m. A Texas scientific longline study (1977-1979) reported low catches of red snapper (average CPUE = 0.23 red snapper/100 hook hr) in depths less than 92 m, but this study

[4]Fishing practices in the commercial fishery were different from the 1999-2002 surveys. The commercial fishery targeted relief and other "hotspots", hooks were set closer together, soak time and bait also varied (Pytherch[3]).

contained many stations outside the optimal depth range of the large snapper observed in our surveys (Cody and Avent[5]). Thus, inclusion of shallower stations (< 55 m) would reduce CPUE estimates proportionately. Historically, in the hook-and-line fishery, fishing depth ranged from about 31-156 m (mean depth 82 m)(Jarvis[6]).

Commercial longliners at the beginning of the fishery in the late 1970s early 1980s deployed gear at depths between 73-183 m, with deepest sets made to 311 m (Prytherch[3]). Since 1990 however, bottom longlining has been prohibited at depths less than 92 m along most of the U.S. Gulf coast, and prohibited at depths less than 37 m along the west Florida shelf east of Cape San Blas[7]. Patterns in commercial catch at depth are likely related to habitat features and U.S. depth regulations. Historical catches were associated with coral and hard bottom, particularly in the eastern Gulf, and "mud lump" features offshore of Texas (Jarvis[6], Prytherch[3]). These habitat features are principally thought to have formed as Pleistocene reefs during periods of lower sea level and were the focus of much commercial fishing at the 73-110 m depth range (Moe 1963, Darnell 1990, Sager et al. 1992).

[5]Cody, J.C. and R.M. Avent. 1980. Assessment of bottom longline fishing off the central Texas coast. Management Data Series No. 16. Texas Parks and Wildlife Dept. Austin, TX . 24 p.

[6]Jarvis, N.D. 1935. Fishery for red snappers and groupers in the Gulf of Mexico. U.S. Dept. of Comm., Bureau of Fisheries, Investigational Report No. 26. U.S. Govt. Printing Office, Washington D.C. 29 p.

[7]Reef Fish Fishery Management Plan. 1981. Gulf of Mexico Fishery Management Council, 5401 West Kennedy Blvd., Tampa, FL. 9-1p.

The 1999-2002 longline surveys yielded a notably older age-structure of red snapper than has been detected from other gears. The red snapper sampled during the Texas 2000 survey ranged in age to 53 years, median age 11, and ages reaching 17 years before the proportion by age dropped to less than 1%. The 2001 and 2002 longline surveys, which covered the U.S. Gulf, collected red snapper which ranged in age to 37 years with median age 12, and 44 years with median age 13 respectively. This pattern is similar to the age distribution observed in longline samples taken from the commercial fishery of the western Gulf (Allman et al. 2002). In contrast, commercial and recreational hook-and-line fisheries, which account for greater than 99% of the entire harvest, have been recently dominated by age 2-6 (> 90 % of ages) red snapper. Annual median age of red snapper taken in these fisheries is 3-4 years, with age proportions dropping to less than 1% beyond age 8 or 9 (Allman et al. 2002, Wilson et. al., Wilson and Nieland[8]). This apparent age difference suggests disparity in the ages of fish subject to capture by the various gears because of the areas and depths fished, or features of the gear such as hook size and fish behavior.

Age composition of red snapper also varied from west to east in the survey area as did distribution. Although red snapper were rarely caught east of the Mississippi River, they were younger than their western counterparts. Of the 12 red snapper captured east of the Mississippi River the youngest was 3 and the oldest was 19 years. The red snapper caught west

[8]Wilson, C.A., & D.L. Nieland. 2000. 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 NA77FF0544. 55 p.

of the Mississippi River ranged in age from 3-53 years. There is some evidence that this trend may have been evident at least as far back as the early 1980s based on sizes of red snapper. When the Gulf commercial longline fishery was just beginning, Prytherch[3] noted that longlined red snapper from Texas were generally larger than their eastern counterparts with 95% of red snapper weighed (n=315) from the west exceeding 6.4 kg and only 50% of red snapper weighed (n=6) from the east exceeding 6.4 kg. This geographic pattern is not as clear among the red snapper sampled from the commercial and recreational hook-and-line fisheries. However, there is a slight trend toward increased age (higher proportion of fish older than age 4) for western- as compared to eastern-Gulf red snapper caught by hook-and-line (Allman et al. 2002).

There are several issues that remain to be addressed for improving survey estimates of abundance and stock structure. One issue is the determination of gear selectivity that is attributed to area fished versus gear effects. Current catch patterns may not be as closely associated with natural habitat as was historically evident. Fishing practices, regulations, creation of artificial habitats (oil and gas platforms, artificial reefs, etc.), and ephemeral environmental phenomena such as hurricanes may affect stock distribution patterns (Patterson 1999[9]). Therefore, we initiated a survey design of random longline sets stratified only by depth and longitude rather than by habitat. Much seafloor mapping and analysis remains to be done in U.S. southeastern continental waters before adequate sampling designs based on habitat can be

[9]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. 164 pp.

undertaken (Coral Reef Research Plan 2000[10]) but habitat-based stratification would be a desired goal in future surveys. Once the relative effect of locality and depth on age/size structure is better known, gear effects can be resolved into their component effects such as hook size, hook saturation and fish behavior/attraction. The question of assessing population distribution as a function of habitat may be difficult to address with longlines alone, due to the problems of gear loss and hangs near reefs and artificial structure (Jarvis[6]). Due to the selectivity of various gear types, incorporating other gear such as traps into the survey design would be useful for comparison and may help address size and age selection across habitat gradients. The use of longline gear for assessments offers many advantages, particularly for a species such as red snapper that may be much less reef-obligate than other Lutjanids. Longline gear proved to be an effective sampling tool for red snapper but the next step will be to determine whether or not it is reasonably non-selective among ages at individual sites. This issue of selectivity will be a primary objective in future studies.

Conclusions

The results of the pilot studies and two years of Gulf-wide surveys provide some important insights into the status of red snapper populations in the Gulf of Mexico. The Texas/Louisiana snapper population seems to be relatively stable exhibiting a distribution of age classes out to 50+ years, and abundance levels (based on CPUE estimates) similar to those observed in the 1970s and 1980s. The eastern Gulf, on the other hand, contains fish in the 3-6 year age range

[10]Coral Reef Research Plan. 2000. Southeast Fisheries Science Center. Nat. Mar. Fish. Ser. FY 2001-2005. Miami, FL.

comparable in numbers to the western Gulf, but with minimal recruitment to what might best be termed a remnant population of adult brood stocks. We speculate that a healthy red snapper population in the eastern Gulf would look similar in terms of abundance and age structure to what we currently see in Texas.

From a management perspective, our findings suggest that recovery of red snapper in the Gulf of Mexico may require different strategies in different areas. Assuming there is a single population of snapper in the Gulf, recovery of eastern Gulf snapper to former levels of abundance would appear to be a formidable task, while maintaining "status quo" for western Gulf snapper may require less stringent regulatory actions. It may be necessary to develop separate status of stocks estimates for eastern and western Gulf snapper even if they are not distinct stocks, and develop models to determine what must be done to rebuild stocks in the eastern Gulf and maintain or increase current stock levels in the western Gulf.

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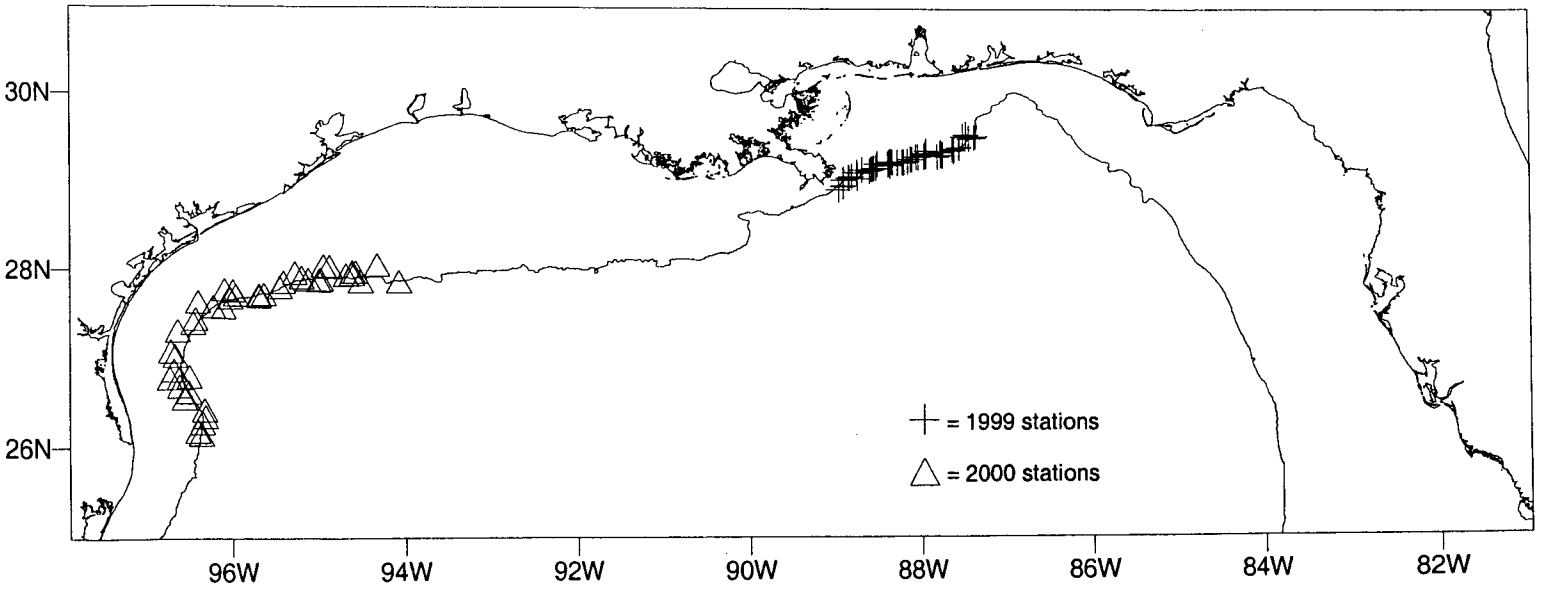

Figure 1A. Station locations for snapper longline cruise in 1999 (60 stations) in north-central Gulf of Mexico and 2000 (44 stations) in north-western Gulf of Mexico. Depths of sampling locations range from 64-146 m.

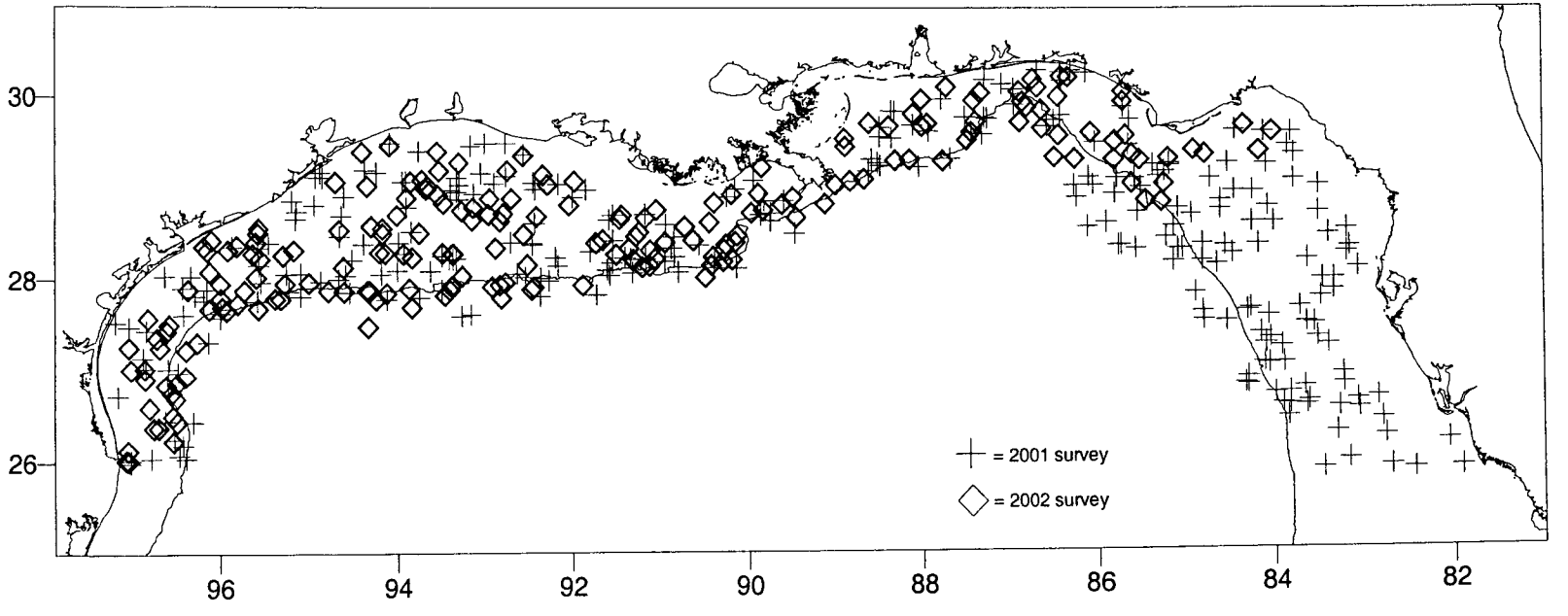

Figure 1B. Station locations for 2001 (277 stations) & 2002 (212 stations) NMFS longline surveys in the U.S. Gulf of Mexico. Depths of sampling locations range from 9-366 m.

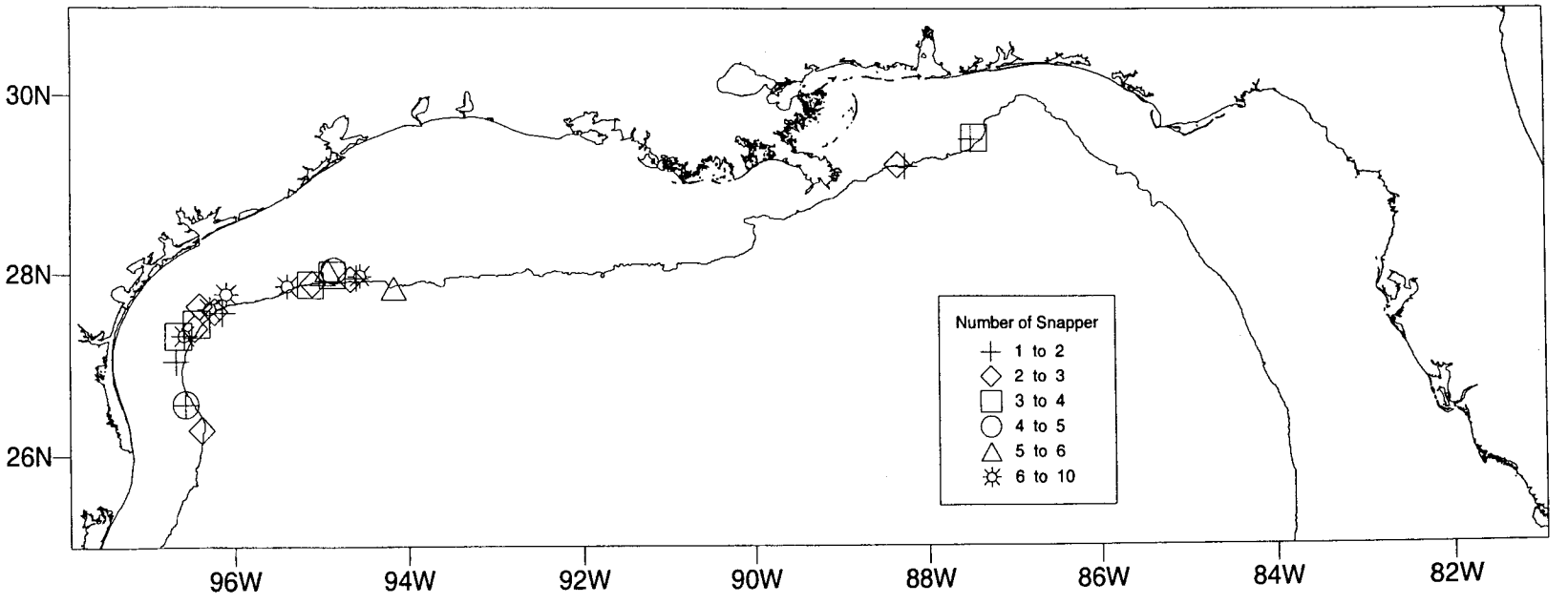

Figure 2A. Red snapper locations for 1999 (7 snapper: 4 stations) and 2000 (76 snapper: 21 stations) longline surveys in the U.S. Gulf of Mexico. Depths of sampling locations ranged from 64-146 m.

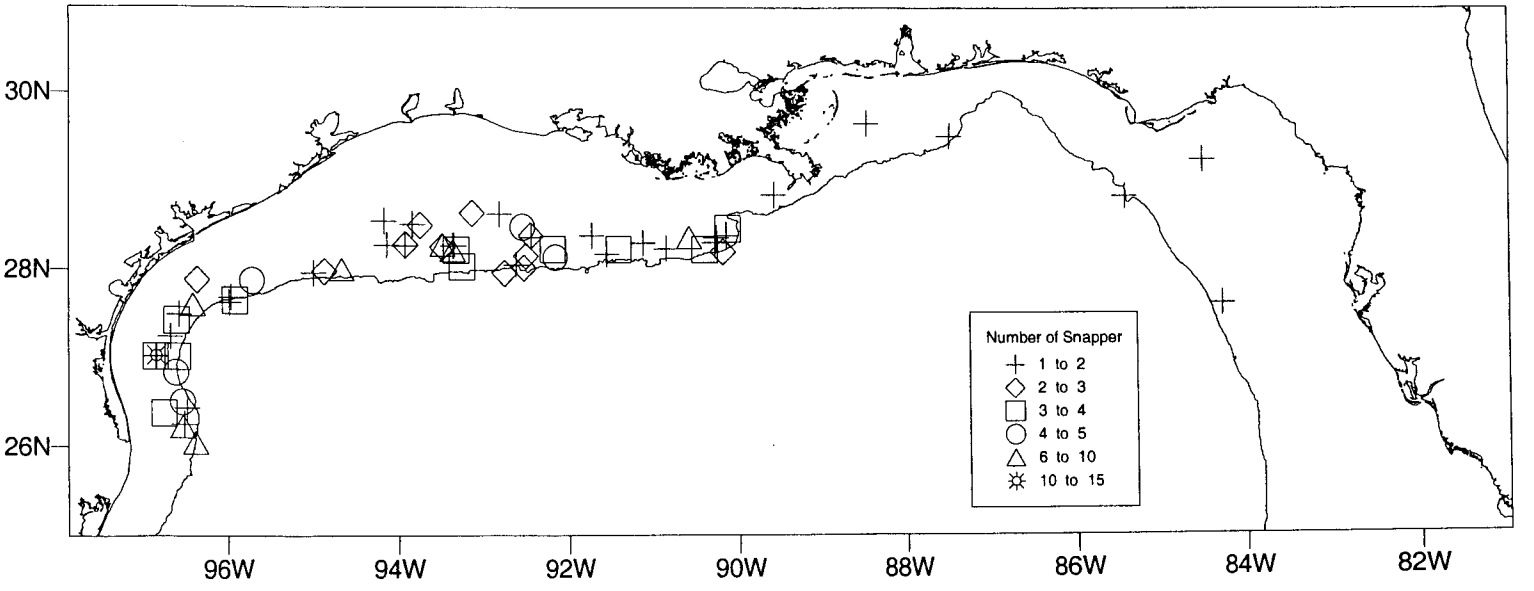

Figure 2B. Red snapper locations for 2001 (86 snapper: 28 stations) and 2002 (75 snapper: 37 stations) longline surveys in the U.S. Gulf of Mexico. Depths of sampling locations ranged from 9-366 m.

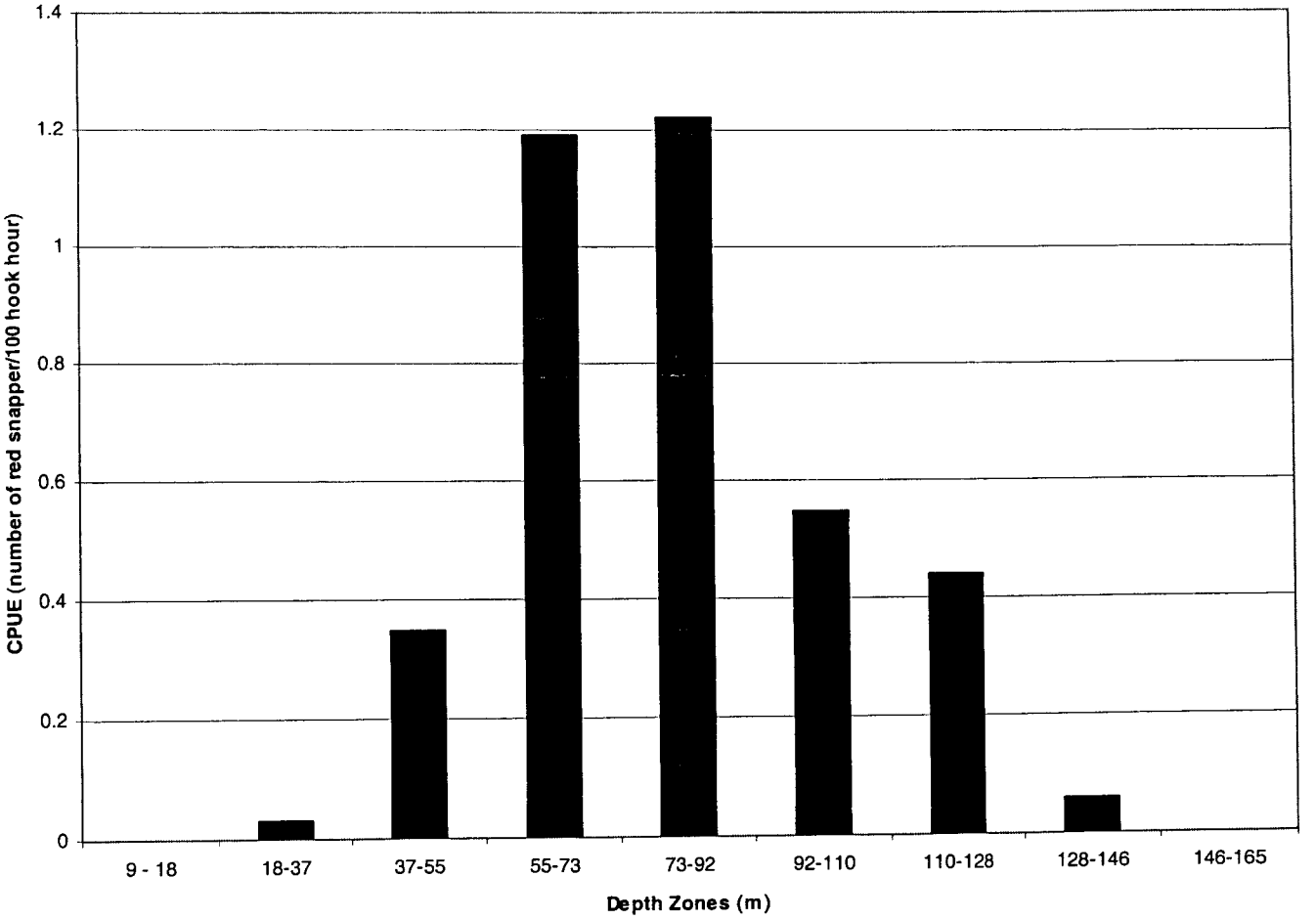

Figure 3. Depth distribution by CPUE (number of red snapper/100 hook hour) for red snapper (593 stations) caught during NMFS research longline surveys from 1999-2002 in depths of 9-366 m.

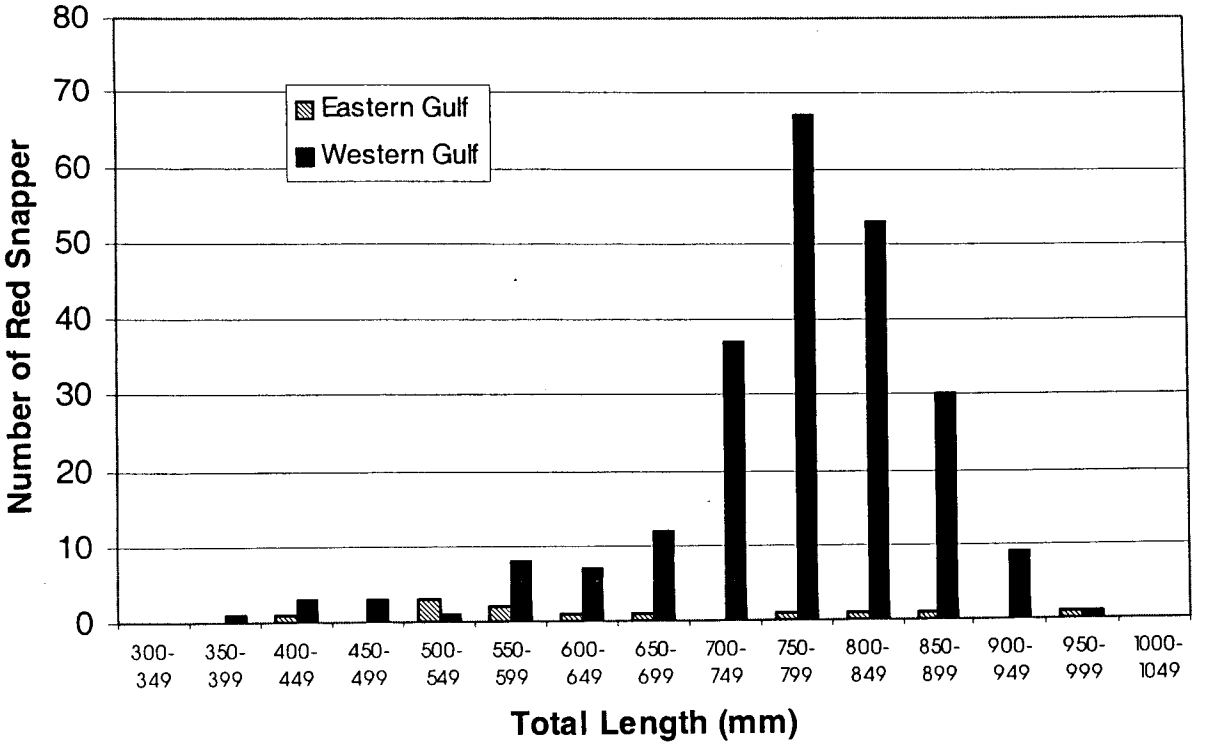

Figure 4. Length of red snapper caught during NMFS research longline surveys from 1999-2002 in depths of 9-366 m in the eastern Gulf of Mexico (MS, AL, FL)(12 snapper) and in the western Gulf of Mexico (LA&TX)(232 snapper).

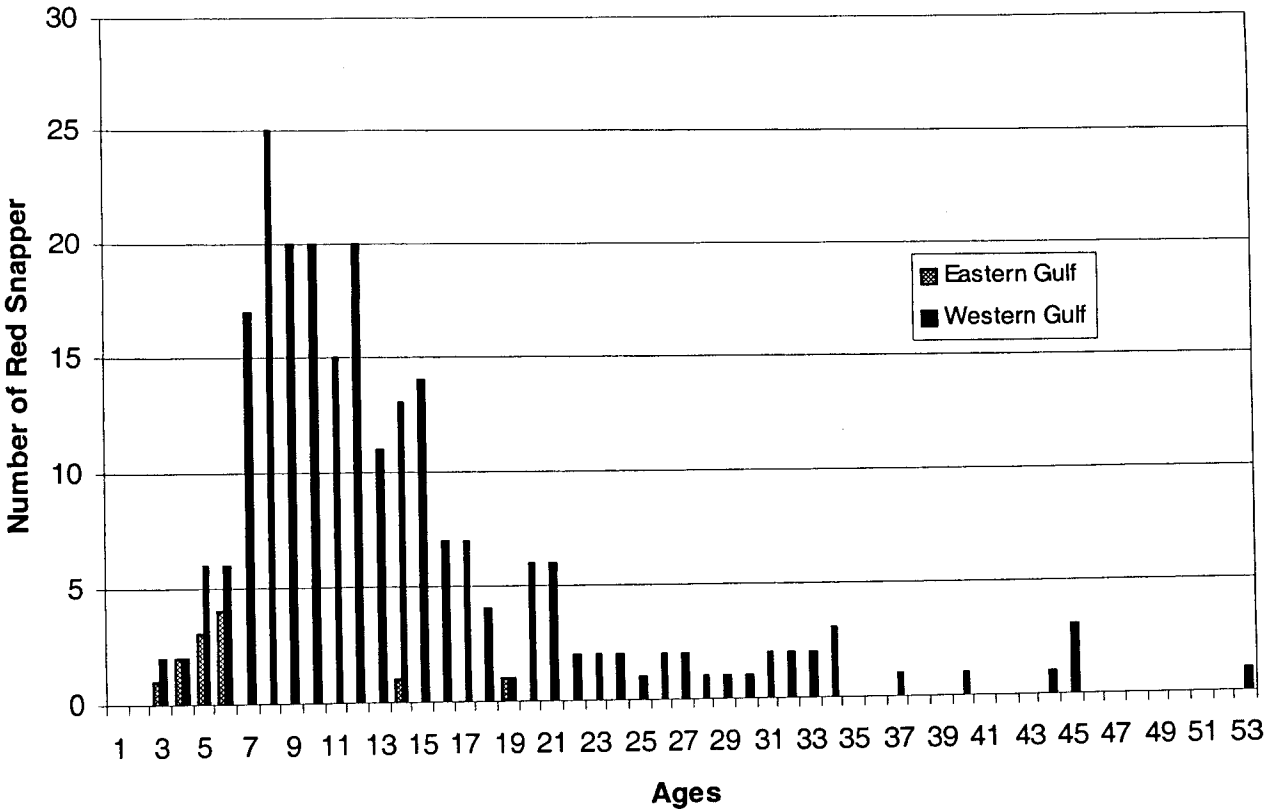

Figure 5. Age of red snapper caught during NMFS research longline surveys from 1999-2002 in depths of 9-366 m in the eastern Gulf of Mexico (MS,AL,FL)(12 snapper) and in the western Gulf of Mexico (LA&TX) (232 snapper).