Trends in Gulf of Mexico Red Snapper Population Dynamics, 1979-85

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Introduction

The Gulf of Mexico (GM) red snapper, *Lutjanus campechanus*, is exploited both commercially and recreationally. Nominal U.S. GM commercial catches ranged between 4.3 and 8.1 million pounds from 1964 to 1985. Estimated recreational catches by U.S. fishermen varied between 1.5 to 6.0 million fish from 1979 to 1985. Catches of red snapper by U.S. sport fishermen and foreign nationals (i.e., Cuba and Mexico) previous to 1979 are not known although recreational catch information exists for specific geographical areas (see Gulf of Mexico Reef Fish Fishery Management Plan (GM FMP, 1981).

Biological studies of red snapper are numerous. The species range extends throughout the Gulf of Mexico to the Yucatan Pennisula, into Atlantic waters along the southeastern U.S. to Bermuda, and along the northern coast of Cuba. Several synopses of the literature on western Atlantic lutjanids exist (Tashiro 1979, Dennis (unpublished) 1984, Grimes 1985, Leis 1985). These studies addressed systematics, maturation, reproduction, early development, age and growth, and adult movements and distribution. The taxonomic status of the adult red snapper, reviewed several times (Jordan and Swain 1885, Jordan and Fesler 1893, Jordan and Evermann 1898, Hildebrand and Ginsburg 1925, Ginsburg 1930 - all cited in Rivas 1966), is summarized here. About ten snapper species historically have been marketed as red snapper; however, only five of these have been considered as 'true' red snapper (*L. aya*, *L. blackfordii*, *L. campechanus*, *L. purpureus* and *L. vivanus*). Rivas (1966) revised the western Atlantic species of *Lutjanus* and concluded that:

1. two species of allopatric red snapper occur - *L. campechanus* (Gulf of Mexico red snapper) and *L. purpureus* (Caribbean red snapper).

2. L. vivanus (silk snapper) occurs with both species of red snappers and is their closest phylogenetic relative.

3. L. blackfordii is synonymous with L. campechanus, the latter specific title recognized as the oldest and most valid.

4. the snapper referred to as L. aya (Bloch 1790) was probably not a lutjanid.

This study deals only with U.S. Gulf of Mexico L. campechanus which is referred to as red snapper throughout this paper.

The complete population dynamics of the GM red snapper resource has not been previously addressed. Information needed to investigate historical trends in population abundance and exploitation levels of the entire resource is not available. Population studies thus far have reported nominal U.S. commercial catches and estimates of sport catches and investigated trends in recreational catch per unit of effort in the GM (Cummings and Chewning 1986), addressed aspects of yield per recruit (Waters and Huntsman 1984), and provided results of fitting production models to historical catch (landings) and effort data for isolated geographical regions (Gazey and Galloway 1980).

History of the Fishery

Documentation exists describing development of the GM commercial red snapper fishery (Stearns 1885, Jarvis 1935, Camber 1955, Moe 1963, Carpenter 1965). A brief account taken from these sources is summarized below. The initial fishery began about 1835. New England vessels sailed to the northwestern GM and fished inside the 40 fm contour between Mobile, Alabama and Pensacola, Florida (Figure 1). Grounds reportedly having fishable concentrations of red snapper were discovered off the Florida Middle Grounds by 1850 and off Texas (The "Western" grounds or "Galveston Lumps") and Tortugas, Florida by around 1880 and 1890. According to the available information, American vessels fished the Campeche Banks off Mexico ("Eastern", "Arcas", and "Between the Reefs" grounds) beginning around 1891.

The early fishery captured fish mainly by handline using various baits (e.g., squid, lady fish, spanish mackerel, blue runner, mullet, menhaden, and shrimp) and preserved the catch primarily in live wells. Ice was also used to preserve the catch; however, this was not a widespread practice until around 1895 because of costs. Vessels used in the early fishery were mainly two types of sail-powered craft:

1. "smacks": Gloucester and Portland vessels about 50-100 feet in length and from 30-60 tons in size, having a crew capacity of about 12 persons, and capable of making trips 2-4 weeks long.

2. "chings": Small vessels about 30-40 feet long and about 10-20 ton size, holding a crew of up to 7, and making trips of up to about one week long.

Changes likely affecting production in the early fishery occurred in the early 1920's with the introduction of gasoline and diesel powered engines to the fleet. According to historical accounts of the fishery, conversion from a 100% sail-powered fleet to one completely auxillary powered occurred by 1945, but as late as the 1960's many vessels in the fleet still used some sail power in addition to the main engine. Other operational changes to the fishery which may or may not have affected production were:

1. Addition of vessels to the fleet with greater horsepower, crew capacity, and catch-holding capacity

2. Introduction of more efficient fishing gear (i.e., power and hand driven reels) in the 1950's

3. Discovery of other unfished and productive grounds using modern navigation instruments (sonar and LORAN).

Records indicate the fleet may have contained as many as 100 full-time snapper boats in 1935 and, although few boats were added between 1935 and 1955, as many as 300 vessels may have been in operation in 1965.

The present commercial red snapper fishery remains mainly a rod and reel fishing operation (employing one armed bandit gear (bicycle rigs) or electric reels). Catches of red snapper by stationary gear (bottom longline and buoy), although apparently unsuccessful in the early fishery, were a major portion of removals between 1981 and 1985. The precise number of full-time vessels in the present fishery is unknown because vessels participating in the red snapper fishery of the 1980's also operate in other GM fisheries (directed shrimping, hook and line and bottom longlining for groupers, and tuna fisheries). Information obtained from those familiar with the fishery regarding the number of vessels presently participating in the U.S. Gulf of Mexico red snapper fishery is given (Table 1).

Objectives

This study investigates the population dynamics of U.S.-managed red snapper resources in the Gulf of Mexico. Estimates of numbers caught at size are developed, 1979-85, from annual reported commercial catches in total weight, estimates of recreational catches in numbers, size frequency samples from commercial and sport catches, and weight-length relations. Information derived from age and growth studies (Parrack 1986a) is used to convert estimated annual densities of catch by length interval (size) to annual catch at age densities. These annual catch at age densities and red snapper stock abundance indices based on catch per unit of effort samples from commercial (bottom longline and rod and reel) and recreational (headboat) fisheries are used to investigate trends in historical red snapper stock abundance and exploitation levels.

Stock Structure

Information is not available to determine with reasonable certainty the number of or geographical boundaries of red snapper stocks in the Gulf of Mexico. Federal management in the GM is restricted under the Fishery Conservation Management Act (FCMA) to catches taken from within the U.S. Fishery Conservation Zone (FCZ) (corresponding to GM statistical reporting zones 1-21). Historically, the fishery operated inside the 100 fathom contour (GM Reef Fish FMP 1981) corresponding approximately with the outer edge of the continental shelf.

Evidence exists indicating adult and juvenile red snapper undergo movements mainly from near-shore to offshore (Beaumariage 1969, Wade 1978, Fable 1980, Holt and Arnold 1982, Rosman 1983). Results from these studies suggest limited movements from shallow to deeper waters may occur (thought by some to be associated with nearing of winter) and a general seaward migration has been observed for some regions (off Alabama). The majority of the studies presented results showing virtually little movement outside the release area (home reef system). A few investigators reported movements of individual fish that were considered significant (i.e., > 5 nm and up to 150 nm) (Table 2). Although this study does not consider transboundary movements, possible movement outside the area of management by the U.S. (statistical reporting zones 1-21) seems likely.

In consideration that alongshore movement is very limited and general knowledge of those familiar with the fishery that isolated densities in the vicinity of bottom obstructions are common, locations of commonly known snapper grounds were charted and studied (Figure 1). This information indicated five general areas in the GM, three on the east of the Mississippi outfall and two on the west. An analysis of available growth data (Parrack 1986b) indicated strong differences in growth between the eastern and western GM; therefore, this study assumed two stocks, the east (statistical zones 1-12) and the west (statistical zones 13-21). Within each of these, major grounds existed where gear-year-quarter specific size samples from catches were similar. These grounds include: Tortugas (statistical zones 1-5), the Middle Grounds (statistical zones 6-10) and the Mississippi River delta region (areas 11 and 12) in the Eastern Gulf, and the Galveston Lumps and north central GM (Western grounds) (statistical zones 13-18) and the Western grounds (zones 19-21) in the Western Gulf.

Catches

Reported commercial catches (in weight), estimates of sport catches (in numbers), size frequency (length) samples, and weight-length relations were used to estimate numbers caught at age of historical red snapper catches since 1979. Data were not available to determine numbers captured by all fisheries that exploited GM red snapper before 1979. Data sources for the catches and samples of the catches (commercial and sport), estimation procedures for determining numbers captured at length interval, and methodology used to convert numbers at length to numbers at age were similar for the eastern and western stocks. Sources of catches and size frequency samples and procedures used to estimate annual age specific catches of the commercial and sport fisheries are given below and address the two stocks together. This study addressed historical trends in stock abundance and exploitation levels of U.S. managed red snapper resources. Total numbers captured were estimated only for U.S. GM catches from statistical reporting zones 1-21 and these estimates then used to develop estimates of annual numbers in the catches by age.

Commercial Catches

Nominal U.S. catches (in weight) were available from the National Marine Fisheries Service (NMFS), Southeast Fisheries Center (SEFC), Economics and Statistics Office (ESO). Information available for all catches excluding catches by Florida fishermen was the year, month, county landed, statistical reporting zone, gear of capture, and whole weight caught (pounds). Catches from Florida were reported in gutted weight and were available by two reporting stratifications:

1. year-month of capture and county landed or
2. year captured, county landed, gear of capture, and statistical reporting zone.

Florida's reported red snapper catches from the second partitioning were used in this study and were raised to whole weights using the NMFS, Washington, D.C., conversion factor of 1.08.

The magnitude of non-reporting and the degree of mixed species reporting in the commercial catches are unknown. Landings by Florida west coast fishermen ranged from 41 to 70 percent of the 1979-85 total landings (see Table 4); red snapper, mangrove, lane, yellowtail, vermillion, mutton, and white snapper have been reported separately in these landings since 1960 (Fisheries Statistics of the U.S.). Some existing information suggests the amount of mixed species reporting may be small for Texas rod and reel catches (Cummings and Chewning 1986). Catches by trawl gear contribute insignificantly to the total red snapper catch (in weight) (about 3-4 percent per year since 1979) (see Table 5), thus this source of error is likely small.

An attempt was made to further quantify the magnitude of mixed species reporting in the rod and reel catches. Field personnel involved with collection and reporting of the commercial catch statistics were contacted. Information obtained indicated historical rod and reel snapper catches landed in Mississippi contained significant quantities of vermillion snapper, Rhomboplites aurorubens (beeliners), since about 1980 (Hermes Hague, personal communication). According to the information obtained, the magnitude of beeliner landings in Mississippi before 1980 was probably insignificant. Prior to that time a limited market for beeliners existed so landings of this species may not have been large because catches were discouraged. Data were obtained from the NMFS port agent in Mississippi to quantify the magnitude of vermillion snapper catches included in historical Mississippi red snapper landings for 1984 and 1985 (Table 3). These data were used to adjust the historical reported commercial catches (in weight) of red snapper for 1984 and 1985 and are believed to be the best information available.

Annual Gulf of Mexico red snapper commercial catches (by U.S. fishermen) ranged from 4.3 to 7.1 million pounds and averaged 5.4 million pounds during 1979-85 (Table 4). These removals are given by type of fishery (rod and reel, longline, trawl, other) and general fishing grounds (i.e., Tortugas, Middle Grounds, Delta, Galveston Lumps, Western) (Table 5). Catches from 1964 to the present are also given (Table 1 of the Appendix). Red snapper catches from the Eastern Gulf stock declined by about half (in weight) over the seven year period, 1979-1985, while reported catches (in weight) from the Western Gulf stock increased by about one-third. Peak catches occurred in 1983 at about 2.8 and 4.3 million pounds (east, west stock). The reported 1985 catches were 57 and 28 percent below the 1983 values (east, west). Removals by rod and reel fishermen dominated the seven year catch period. Hook and line gear has been the primary snapper gear fished throughout the Gulf of Mexico since 1950 (Cummings and Chewning 1986). Catches from longlining operations contributed secondly in importance to red snapper removals. The GM directed bottom longline fishery for snappers and groupers began in 1980 and catches of red snapper peaked in 1983 for the east stock (429 thousand pounds) and 1985 for the west stock (816 thousand pounds). Annual reported landings by longline gear ranged between 5 and 22 percent of the total Gulf catch during 1980-85. Catches by trawl gear are an insignificant portion of annual catches for both stocks ranging from 1.7% to 3.6% (east stock) and from 3.3% to 5.6% (west stock) of the total catches for each stock over the seven year period. In 1985, 67 and 85 percent of the total rod and reel and longline catch (respectively) were from the west stock.

Recreational Catches

Estimates of U.S. recreational red snapper catches were obtained from the NMFS, National Fishery Statistics Program (NFSP), Washington, D.C., for 1979 to 1985. These data were available by year, two-month catch interval (wave), state caught, fishery (i.e., charter/party, private-rental, man-made/structure/beach-bank), and area off shore catch partitions (Table 6). Estimated numbers caught from this source include separate estimates of fish landed whole, fish caught and released, and fish used for bait, discarded, etc. The sport catch estimates used in this study are all three of the above estimates combined. Estimated standard errors and the coefficient of variation of estimated numbers caught from this source were available by year for the total GM sport catch.

Estimates of numbers caught by U.S. sport fishermen are not available from this source for the 1981 January through February catch interval (wave 1) for all states. The red snapper sport catch during wave 1 1981 was estimated for each year-state-fishery-offshore area catch partition by assigning the average proportion of the wave 1 sport catch over the entire historical period (i.e., 1979, 1980, 1982, 1983, 1984, and 1985) to the 1981 year total. Estimates of numbers caught provided from this program also do not include removals by the charter/party or the private-rental fisheries in Texas for 1982, 1983, or 1984. The sport catches of these recreational fishing sectors were obtained directly from published estimates of harvest determined from recreational fishing surveys carried out by the Texas Parks and Wildlife Department (TPWD) and are believed to be conservative estimates of the true catches (Table 7). Published harvest estimates from the TPWD include numbers caught by headboats and party boats (privately owned for hire fishing vessels usually carrying > 8 or $\leq$ 8 fishermen respectively) and of fishermen from individually owned small boats (private-rental fishery) by specific geographical areas of the Texas coast for a year-season catch period. Information on the standard error of these estimates is available for some estimates. Estimates of sport catches for the 1985 November-December catch interval (wave 6) were not available from the NMFS, NFSP at the time this assessment was performed. No attempt was made to estimate these catches; therefore, the 1985 sport catches should be viewed as preliminary values.

Estimated U.S. GM sport catches ranged from 1.5 to 6.0 million fish annually, 1979-85, with fishermen from Louisiana annually having the largest catches with the single exception of 1979 (Table 8). The charter/party (or party/headboat) and private rental sectors were the main contributors to the red snapper sport catches during 1979-1985 based on the data in Tables 7 and 8.

Estimates of sport catches obtained from the NMFS, NFSP are summarized by year, state caught, and area offshore catch reporting partitions (Table 9). Total sport catches of the two stocks ranged from 0.7 to 3.1 and 0.7 to 3.5 million fish (east, west) annually over the seven year period with peak estimates occurring in 1979 and 1981 (east, west) (Table 10). During all years estimated sport catches from the west were higher than east stock sport catches.

Mortality from causes other than directed commercial and sport snapper fisheries (i.e., discards, incidental catch by the shrimp fleet) may have occurred during the period under investigation in this study (1979-85). Comprehensive information on such removals does not exist. The amount of discarded catch is believed to be negligible for purposes of this study. It is certain that mortality is imposed by the GM directed shrimp fishery; however, the exact magnitude and size composition of red snapper captured incidentally as a by-catch in the GM directed shrimp fishery are unknown. Some information on total weight and total numbers of red snapper caught (in shrimp trawls) is available from research trawl surveys and from by-catch samples for specific geographical areas (Nelson et al. 1982, Pellegrin et al. unpubl.). Information does not exist to quantify the precise age structure of such catches and it is not known to what extent individuals from such catches are available (recruited) to the commercial and recreational snapper fisheries. Although the magnitude of this indirect mortality and the subsequent effect on the population have not been precisely estimated, the likelihood of a significant effect cannot be dismissed.

<u>Size Frequency Samples of the Catches</u>

Randomly collected samples from GM U.S. commercial and recreational red snapper catches were obained from several sources including NMFS, SEFC port agents, other federal laboratories, state agencies, private individuals, NMFS State-Federal Cooperative Statistics Program (the CSBSP), and the NMFS Marine Recreational Fishermen Statistics Survey (MRFSS) for catches from 1972-85 (Table 11). For each individual fish sampled the year and month captured, day sampled, general location of capture (or port of landing), and one or more observed measures of length (fork, total, or standard (mm)) or weight (grams or pounds) were recorded. For the majority of the samples obtained type of fishing gear used was known (e.g., commercial (hook and line, bottom longline, vertical longline (buoy fishing), recreational (headboat, party boat, private, other)). It was possible to assign nearly all samples to a statistical reporting grid (see Figure 1) from location of capture data given and state landed was always known for those samples not assigned to a statistical grid. These latter samples were mainly from sport catches, were few in number, and could usually be designated as taken from a catch of the east or west stock easily. Recorded also for many samples were offshore area (in miles) and depth of fishing information. The latter, depth of fishing, was not retained for estimating total numbers in the catches. Depth information was not included for the catches and the reliability of this information on the samples was unknown. Information regarding the distance offshore of samples was not retained either for estimation of numbers in the catch. The majority of the commercial catches (in weight and frequency) were reported taken either > 10 miles from shore or else the location was not reported (Table 12). Recreational catch estimates were available by area offshore partitions; however, the majority of the sport catch samples obtained in this study were reported taken from > 10 miles from shore (Table 13). Information provided from TPWD publications indicates catches of red snapper by headboat fishermen are the major portion of annual red snapper catches in Texas and, the majority of such catches are taken from fishing grounds located in the FCZ (i.e., > 10 miles from shore) (Osburn and Ferguson 1985, 1986). Some samples included information on sex, however, the majority did not. Analysis results of red snapper age and growth studies indicated growth was likely not different between sexes (Futch and Bruger 1976, Nelson 1980, Zastrow 1984, Parrack 1986a). Further support for not retaining sex specificity within samples for use in determining numbers in the catch at length interval (by sex) regards the frequency of males and females in catches (or samples). Available information indicates observed sex ratios in historical catches are not grossly different from 1:1 (Table 14).

Plots of the individual length frequency samples by year-month-fishing grounds-gear partitions were made and visually inspected to identify if likely errors (keypunch) existed or if gross outliers were present. These plots were inspected also to identify general patterns in size structure of catches within year, month (and quarter), fishing grounds, and gear catch partitions.

Size frequency samples were obtained for 1970-85, however, information on the catches was incomplete prior to 1979 so only samples from 1979 forward used in assessment of historical abundance are discussed here. Numbers of red snapper sampled for length from sport and commercial catches ranged from about 5,000 fish to 12,000 fish from 1979-85 (Table 15). Samples were obtained from commercial rod and reel and longline (bottom and buoy) catches and from all three recreational fisheries (private-rental, charter/party (headboat), other). Only a very few samples were reported from trawl catches. Numbers of fish sampled by the Florida Department of Natural Resources, the TPWD, and the NMFS State-Federal Cooperative Statistics Programs made up the majority of samples. The size (length) range of fish sampled varied widely depending upon the specific fishery (i.e., commercial or sport), fishing grounds, year, and/or season. Casual inspection of the size frequency plots (available upon request) indicated a large number of small fish ($\leq$ 40 cm fork length) in the samples and that the majority of these were from sport catches. These plots indicate the commercial rod and reel fishery captured fish of a wide size range. Sampling intensity was highly variable between years for both stocks and is not unexpected since intensive sampling of the GM reef fish fisheries began only in the mid-1980's with placement of an FMP. The sample sizes shown here indicate namely:

1. red snapper commercial catches for many individual year-month-fishing ground-gear partitions were poorly sampled or were not sampled at all for both stocks and

2. recreational catches from both stocks were reasonably well sampled for most year-fishing ground-quarter catch partitions.

Few samples included size information on weight and not length, so the latter measure of size (length) was used to estimate total numbers in the commercial catches and numbers at length interval from sport and commercial catches. Little size frequency information was lost by excluding samples without length data from the red snapper historical size frequency data base used to determine annual numbers in the catch by length interval for 1979-85. All fishing grounds and all months of the year were represented in the samples, however, not all year-month-fishing ground-gear catch partitions were sampled (Table 15). All length samples were converted to fork length (cm) for use in estimating total numbers in the catch using length conversion formulae developed by Parrack (1986b) (Table 16).

Estimation of Numbers Caught at Size and Age

Reported commercial catches (in weight) and estimates of sport catches (in numbers) were combined to estimate total numbers in the catch by length interval since 1979. Prior to 1979 comprehensive information on sport catches and removals by foreign nationals did not exist. Estimates of total annual numbers caught were developed separately for the east and west stocks, 1979-85, for commercial and sport catches using annual reported commercial catches (in weight), estimates of recreational catches (in numbers), length samples of the 1979-85 catches, and weight-length relations. Estimates of total numbers in the catches were distributed over length and then over age. General methodology and estimation procedures for determining numbers caught (for commercial catches), numbers at length interval and at age were similar for both stocks and are addressed below. Details of estimating numbers at length and at age are given separately following this general overview.

First the total numbers in each reported commercial catch were determined by dividing the reported weight caught by an estimate of the average weight of an individual in the catch, the latter determined from the average size (length) in the catch and an appropriate weight-length equation. Since the exact size structure of the catches was unknown, samples (described above, p. 11) were used to estimate numbers caught. Samples were not available for all year-month-fishing ground-gear catch partitions, so substitutions were made for many catches. Substitions were also made in cases when a matching sample existed for a year-quarter-fishing ground-gear specific catch, but was rejected because: (1) the sample size was considered extremely low (< 25 fish), (2) the length sample appeared truncated, or (3) the sample was grossly different from other samples of the same gear or quarter or area partition. Substitutions were made by selecting samples from nearby quarters, similar gears, and nearby fishing grounds (Table 17). Then, the estimated total numbers in the catch were distributed over length according to the numbers at length in the sample. Recreational catches were reported in total numbers, so after selection of an appropriate length sample(s), these values were simply distributed over length interval in the same manner. Then, the individual densities of numbers in the catch by length interval were transformed to densities of numbers at age using analysis results of red snapper age and growth investigations (Parrack 1986a). Two methods were used to convert length densities to age densities. First the von Bertalanffy growth functions developed by Parrack (1986a) were inverted and age determined for each length in the catch at length density. The stochastic method described by Shepherd (1985) was employed to obtain a second set of annual catch at age estimates. Finally, the individual densities of catch at age (resulting from the two methods) were combined across quarter of the year, fishing gear, and fishing grounds within year for each stock to develop annual catch at age tables by year for each method and these results were studied.

Estimation of Numbers at Length

Temporal and spatial resolution within year of the catches and of samples were considered sufficient to use quarter of the year-major fishing area-gear catch partitions for determining total numbers in the commercial catches. This temporal and spatial resolution was considered the largest which would still have a reasonable probability of reflecting accurate size structure of catches, and the minimum which would ensure a likelihood of obtaining reasonable sample sizes. Age and growth studies indicated red snapper growth slowed down after age 2 and averaged about 2 cm per quarter thereafter (Parrack 1986a); thus, within year resolution of quarters seemed adequate for reflecting within year catch biometrics. In addition samples of the catches were unavailable for many year-month-fishing area-gear catch partitions for which catches occurred (see Table 15). Age and growth studies indicated growth differed between the Eastern and Western Gulf, and inspection of plots of size frequency samples suggested the size structure of catches varied between major fishing grounds. Therefore, the five major fishing grounds (Figure 1) were used as the smallest spatial resolution for assigning samples to catches. Inspection of plots of individual size frequency samples indicated the size composition of catches differed between the commercial and sport fisheries. Six major gear types present in the samples and in the catches (commercial (rod and reel, trawl, longline, trap, other) and sport) were designated as the smallest resolution in fishing gear for assigning samples.

Estimates of sport catches obtained from the NMFS, NFSP were not available for the charter and party sectors separately and, although length samples used in this study were separated for these two fisheries, no attempt was made in this study to separate the NMFS, NFSP catch estimates for those fisheries. Published harvest estimates obtained from the TPWD publications were provided separately for these fishing sectors (i.e., headboat (party), party (charter)) in Texas. In this study sport samples were combined across all sport gears within year-quarter-fishing ground partitions as were sport catch estimates and numbers at length interval of recreational red snapper catches determined.

The catches were combined within year-quarter-major fishing ground and gear (commercial-rod and reel, trawl, longline, other) catch partitions, and one or more length samples assigned to each catch. Total numbers in the catch were computed for the commercial catches from the equation below:

$$C = \frac{W}{\sum_{l=min}^{max} (P_l \, a l^b)} \qquad \text{Equation 1}$$

where

C = estimated catch (in numbers)
W = reported catch (in weight)
P_l = proportion of catch sample of length l (fork length (cm))

and

min and max refer to the minimum and maximum observed lengths in the sample, and a and b are quarter specific weight-length equation constants (Table 16)

and then the estimated total catch (C) (recreational, sport) was proportioned over length as

$$C_l = C * \frac{f_l}{\sum_{l=1}^{n} f_l} \qquad \text{Equation 2}$$

where

f refers to frequency at length interval.

Here, quarter of the year-specific weight length relations (Table 16) were used. Separate weight-length relations were not available for all year-quarter-fishing grounds partitions for which a catch was reported. Results of weight-length investigations indicated the variability in weight at length was low and the use of quarter-specific weight-length equations adequately described the weight-length relationship (Parrack 1986b). It is almost certain, however, that year to year variation exists. Finally, the individual length-specific catches were combined within year and gear for each stock across quarter of the year and fishing ground partitions to obtain annual densities of numbers caught at length interval for each stock.

A number of catches required special attention. Such catches were ones for which the quarter of capture was not known. These were commercial catches reported by Florida and some of the Texas headboat and private/rental sport catch estimates, published by the TPWD, during 1982, 1983, and 1984. In addition to not knowing quarter captured, a few of the TPWD published harvest estimates covered a year-season catch interval that included two years. These were special cases and were handled conservatively by assigning one or more samples to each, and then distributing the entire catch over quarter (or year and quarter) directly according to the distribution of the numbers in the samples. In the case of Florida catches, samples from the entire year were used. For the Texas sport catches, samples from the year-season reporting period were used. If the estimated catch included two years (e.g., September 82-May 83), then samples from 1982 (September-December) and 1983 (January-May) were used to estimate the catch at length for that catch. This procedure of allocating the catch to quarter of the year was not optimal, however, it was reasonable and may be more logical than distributing the catch evenly across the time interval or simply assigning the catch to an arbitrary time period of the year. Available information suggests that Florida's commercial red snapper catches are taken during all months of the year (Table 18); however, the distribution of catches within year is not available by gear and fishing grounds or by either of these partitions alone (see Commercial Catches, p. 7 for a review of information available for catches).

The rationale used in assigning samples to catches was summarized by computing "sizing method" fractions for each stock, year, and fishery (commercial, sport). Here, catches were combined within year and stock across quarter of the year and gear (within commercial and sport sectors). Then the proportions of those catches assigned substitute samples (according to substitution categories given in Table 17) or assigned matching samples from the same year-quarter-fishing ground-gear catch partition were computed. These results provide a simple way of summarizing the logic used here to estimate numbers at length interval (Tables 19-22), and illustrate objectively the strengths and weaknesses of the size frequency database. Optimally, it would have been desirable for all year-quarter-fishing ground-gear catches to have been sampled; however, this was not the case for this resource and should be recognized.

Calculated sampling proportions indicate the majority of year-quarter-fishing ground-sport catches were sampled in terms of frequency of catches and in terms of total numbers of the annual sport catches (Tables 19 and 22). Very few substitutions were required for recreational catches of either stock with the exception of 1984 and 1985 for catches from the east stock (Delta region). Commercial catches (from both stocks) were moderately well sampled (in terms of weight) during 1979, 1980, 1984 and 1985, however, commercial gears were much less intensively sampled during all years than the recreational fishery. Between 1980 and 1983 all commercial red snapper fisheries in the eastern Gulf of Mexico were only moderately sampled. Commercial catches from the rod and reel fishery off the Florida Middle Grounds were reasonably sampled during 1979 and 1980 (Table 15). Trawl catches from both stocks were either lightly sampled or not sampled at all in most years with regard to quarter of the year and fishing grounds. Sample sizes of available catch samples show that within year or within quarter or within fishing grounds partitions (but not in combination), both fisheries (i.e., commercial, sport) were sampled. These results also indicate that many commercial gear-year-quarter-fishing ground catches were not sampled, with 1983 being one of the least sampled years during the seven year period.

Estimated total numbers of red snapper captured by sport and commercial fishermen combined ranged from 0.9 to 3.2 and 1.4 to 4.3 million fish annually during 1979-85 (east, west stock) (Table 23). These estimates (and Table 10) indicate peak commercial catches occurred in 1983 for both stocks at about 900 thousand (east) and 1.4 million (west) fish. As was the case for reported commercial yields (see Table 5), estimates of numbers caught (by commercial gears) from the west stock are much higher during all years of the study period.

The lowest estimated commercial catch (in numbers) on record during the period occurred during 1985 for the west stock and in 1981 for the east stock. In terms of weight caught, the lowest (commercial) catches during the seven year period were 1985 and 1979 for the east and west stocks respectively. Reported numbers caught (estimates of) by sport fishermen are about 2-3 times higher than estimated numbers of fish captured by commercial fishermen (see Tables 10 and 23). The variability of sport estimates is probably not low. Estimated coefficients of variation for the NMFS, NFSP sport catches indicate annual estimates may vary by as much as 26 to 72 percent over the entire combined GM (i.e., Florida, Alabama, Mississippi, Louisiana, and Texas) (Table 24) catches. General information exists concerning the variability of sport catches estimates; however, no attempt was made in this initial investigation to adjust individual year-state-wave-fishery catch partition catch estimates because precision of the individual estimates is unknown (NMFS 1984, 1985a,b, 1986). Estimated annual numbers caught by length interval (Tables 25 and 26, Figures 2 and 3) at best provide information on general trends in size composition of historical red snapper catches. These estimates are in error due to: 1. inaccuracies in the commercial catches (i.e., misreporting, non-reporting), 2. variability in recreational catches, 3. estimation error from determining numbers caught in commercial catches from reported weight, and 4. errors introduced from the rationale used to size catches and, therefore, should be used with caution. A consistent observation from these results is the dominance of small fish in the total annual catches and the lack of large numbers of old fish.

Estimation of Numbers at Age

Estimates of annual numbers at age in U.S. GM red snapper catches, 1979-85, were developed for the east and west stocks (separately) from estimates of numbers caught by length interval developed in this study. Age-length keys were not available for all year-quarter catches of either stock, however, growth information was present from the eastern and western GM and provided a way of transforming length frequency to age frequency. Two methods were used to transform annual densities of numbers caught at length interval (within quarter, gear, and fishing ground catch partitions) to numbers caught at age. Estimates of catch at age were developed using two assumptions of red snapper growth based on results of growth investigations (Parrack 1986a):

1. growth differed between the eastern and western Gulf of Mexico.

2. within year resolution of quarters was sufficient for describing within year growth.

Inspection of size frequency samples indicated fish as small as 10 cm and as large as 120 cm were present in the catches, however, the majority of individuals sampled were between 15 and 95 cm in length corresponding to young of the year (age 0+) to age 16. Estimation of numbers at age was carried out assuming 15 discrete age groups and a 16+ category assigned to individuals estimated to be age 16 or greater.

The first method employed to convert length densities to age densities was referred to as the growth equation method. The von Bertalanffy function

$$L_a = L_\infty (1 - e^{-k\,(a - t_\phi)})$$

von Bertalanffy (1934)
Equation 3

where,

a = age and k, L_∞ and t_ϕ are equation parameters derived for the eastern and western GM red snapper stocks by non-linear least squares methods (Parrack 1986b) (Table 16).

was inverted to give the following deterministic equation for estimating age from length.

$$a = \frac{1}{k} * \ln \left(\frac{L_\infty}{L_\infty - L_t} \right) + t_\phi$$

Equation 4

The densities of catch in numbers at length interval were combined across fishing grounds within year, quarter, and gear partitions for each stock. Then the equation (above) was used to estimate age for each length specific catch and that age subtracted from the reported catch year to establish year of birth (cohort). Here, fish whose birth time computed as falling between the first and fourth quarters were designated as belonging to that year's year class. This procedure was repeated until age was determined for all lengths of a catch and until all length densities were converted to age densities. The age specific catch densities were then summed up over quarter and gear within year and stock to give numbers caught at age and year for the two stocks (Tables 27-28).

The use of the above method to transform length frequency to age frequency introduces several biases into the resulting estimates of numbers at age (Bartoo and Parker 1983):

1. estimation bias in L_∞ requiring observed lengths > L be omitted from calculations or dealt with individually.

2. as lengths approach the maximum determined by the von Bertalanffy equation (L_∞) the method gives unreasonable old ages.

3. the deterministic age produced from model parameters for length ℓ is not the only age that exists (for ℓ) and may not be the most probable.

4. bias introduced from reversing the independent variable between the von Bertalanffy equation and the inverted form (equation 4).

Shepherd (1985) suggests a non-linear least squares system that accounts for the variance of length given age and thus avoids bias due to the above problems. The method estimates age frequency by minimizing the expression

$$SS = \sum_{\ell} (N_l - (\sum_{j}' Pr\ (\ell:j))_e N_j)^2. \qquad \text{Equation 5}$$

with respect to the N_j (Numbers at age j) where the numbers at length (N_l) are established for catches and the probability of length given age (Pr(l:j)) from ageing studies. Use of this non-linear method suggested by Shepherd (1985) prevents the resulting estimates of the N_j from being negative as frequently occurs with the linear least squares method (Bartoo and Parker 1983). Information on the variance of length at age was available from growth analysis results of Parrack (1986a) and was used to construct separate matrices of the probability of length at age for each quarter of the year for each stock. Results of that study suggested the coefficient of variability (CV) of observed length (at expected length) was similar for the two regions (0.0748 (west), 0.0664 (east)) and was 0.0713 for the two areas combined. The length specific catches were combined over fishing grounds within year-quarter-gear catch partitions for each stock as was done for the growth equation method. Then, for each length frequency non-linear least squares fitting procedures (Levenberg 1944, Marquardt 1963) were used to find least squares estimates of age frequency (N_j) in equation 5 (assuming a single CV for the two stocks). As before, 15 specific age groups were assumed and a 16 plus group assigned to that part of the catch age 16 or greater. Birth year and cohort were established by subtracting the estimated age from the reported catch year and assigning all fish falling between the 1st and fourth quarters to that year's cohort as before. The age specific catch densities were summed up over gear and quarter within year and stock partitions to estimate numbers killed at age (Tables 29-30).

These two methods yield somewhat similar catch tables. The annual age specific catches from the stochastic method were considered more probabilistic than those derived from growth equations alone and therefore were used in all further investigations in this study. These estimates indicate annual catches of both stocks were dominated by age 1-3 fish throughout the time period, 1979-85. These age groups comprised > 40% of annual catches from both stocks. Length frequencies indicated small fish were consistently caught by the sport fishery while catches from commercial hook and line gear were characteristically of a broad size range. Estimates of annual catches by this fishery (sport) are much larger than corresponding annual estimates for the commercial fishery (see Tables 10 and 23). These results indicate catches are mainly composed of age 1-3 fish and sport catches are the largest proportion of annual total removals from both stocks (from 40-84 and 46-75 percent between 1979 and 1985; east, west stock) (see Tables 2 and 3 of the Appendix).

Catch Per Effort Indices of Abundance

Several sets of catch per unit (CPUE) samples were used to index abundance for both the east and west stocks (Table 31). Some of the indices were in terms of weight caught and others were in terms of numbers caught. In the east, recreational charterboat, commercial bottom longline and rod and reel (combined), and shrimp trawl by-catch samples were available. In the west recreational charterboat and headboat samples, the latter taken by the TPWD from the Texas recreational fishery existed. Simple averages were computed for the first quarter samples in some cases, and in others, the results of catch per unit of effort standardization analyses (Robson 1966) were used to provide indices of CPUE. Finally, the resulting CPUE abundance indices were appraised by investigating the ability of each to index abundance trends resident in the GM red snapper age-specific catches developed in this study.

The CPUE abundance indices were appraised with linear least squares techniques according to the analysis method developed by Parrack (1985). The procedure minimizes the squared difference between the observed indices of CPUE and virtual population analysis (VPA) (Fry 1949) stock size estimates of abundance (i.e., the residual sums of squares) with respect to the fishing mortality rate (terminal F) in the last year of catch (1985), a constant rate of change due to factors other than the reported catch (X), and a proportionality constant between VPA stock abundance and the CPUE index of stock abundance. Optimally, such abundance indices extend over a reasonable time interval, are spatially inclusive of a major portion of the resource's distribution, and include information on the size (or age) structure to which the index applies. The procedure yields diagnostic statistics which quantify the ability of the index to reflect abundance trends resident within the catch at age table. These include the amount of variation present in the observed abundance indices explained from VPA stock size abundance estimates, the response surface from the minimization search, and residual plots of the results (i.e., observed - expected abundance indices). This diagnostic procedure does not identify the "answer" to what actual reality may exist; however, it does provide an objective method of judging a particular set of abundance data and allows selection between sets. Analyses of the CPUE indices were carried out separately for the east and west stocks since results of red snapper age and growth studies indicated growth differed between the eastern and western GM (Parrack 1986a), and results of mark and release studies showed very little movement occurs outside the home reef system (see Table 2).

East Stock

Observations of CPUE from the east stock were available from three GM fisheries. Dealer sales records of individual bottom longline and rod and reel fishing trips in the eastern Gulf were collected during 1980-1985 during the first quarter of the calendar year. Size frequency (weight) samples from those trips indicated catches were composed mainly of fish > 2 pounds (Figure 4) and that the CPUE might index the abundance of ages 3+ (see Table 32) in the east stock catches (see Table 16). Annual quarter 1 indices were computed as the simple average of pounds caught per fishing trip within the first quarter (Table 31). The 1981 and 1982 indices appeared different from any of the other years and were considered questionable. Further study of the individual catch per trip observations indicated during 1981 and 1982 red snapper contributed insignificantly to the total catch (57, 8, 8, 60, 61, 59 percent annually, 1980-85), suggesting those trips may not have been directed towards red snapper. The eastern GM bottom longline fishery for reef fishes (groupers and snapper) began in 1980 and was mainly directed towards yellowedge grouper (Ephinephelus flavolimbatus) (Ms. Debby Fable personal communication). Three separate analyses of these CPUE data were performed using these longline and rod and reel catch per trip data. The first included all years (1980-1985) in the analysis, the second included only observations from 1980 and 1983-1985, and the third included only 1983-1985 observations. Such interviews were also available from trips of shrimp vessels that landed snapper as a by-catch during 1980-1985; however, 1982 was excluded from the dataset because only one catch per trip observation was present during quarter 1. These interviews included quarter 1 samples during 1980-81 and 1983-85 (Table 31). Weight-frequency samples from those catches suggested fish captured by shrimp trawls during the first quarter probably included ages 1 and 2 (Figure 5, Table 32). As before, simple averages of weight landed per trip were computed to yield annual quarter 1 indices (Table 31). Samples of catch per fishing hour from daily fishing logs of charterboat catches standardized for year (1983, 1984, 1985), month (1-12 individually), and area (Florida, Alabama) following the method described by Robson (1966) and performed previously on these data (see Cummings and Chewning 1986 for results) were also re-investigated (Table 31). These samples were generously made available from the SEFC, NMFS, Panama City Laboratory, Panama City, Florida. Collection procedures for those samples have been described (Brusher et al. 1984; Williams et al. 1984; Williams et al. 1985). Size (length) samples from charterboat catches (Figure 6) indicated those catches were mainly composed of age 1 and 2 fish (see Table 32).

Results: The east stock CPUE analyses indicated the commercial bottom longline and rod and reel combined CPUE (Figure 7) indexed the abundance of age 3+ fish from historical catches in a reasonable manner (Table 33). Although results of the three separate analyses (of these indices were somewhat different, the CPUE data were considered useful in indexing stock abundance. The residual distributions that resulted did not show evidence of a year trend, and the probability of a positive correlation between the observed index and estimated stock abundance was 0.83 (1980-1985 entire), 0.95 (1980, 1983-1985 data), and 0.95 (1983-1985 data). The shrimp trawl by-catch CPUE was also correlated with the abundance of ages 1 and 2 (Pr (rho > 0.) = 0.91); however, a very strong U-shaped trend in the residuals with time destroyed its usefulness as an index of stock abundance. Likewise, the charterboat CPUE was correlated with the abundance of age 1 and 2 fish (Pr (rho > 0.) > .99). This CPUE set was characterized by a strong linear trend in the residuals with time which precluded its use in further analyses. Calibration results of two CPUE sets investigated here (i.e., the 1983-1985 bottom longline and rod and reel combined samples and the shrimp by-catch observations) predicted relatively high loss rates due to other causes.

West Stock

Samples of catch per fishing hour from daily logs of charterboat catches off Louisiana, Mississippi, and Texas during 1982-1985 were available from the NMFS, SEFC, PCL, Panama City, Florida. These specific samples were analyzed using general linear regression estimation techniques as were applied to the east stock charterboat samples to provide annual standardized CPUE abundance indices adjusted for year (1982, 1983, 1984, 1985), area (Louisiana, Mississippi, Texas), and month (1-12 separately) for the western Gulf (Table 31). Size frequency samples from charterboat catches in these areas indicated the age structure was of age 1 and 2 fish (Figure 8, Table 32). At-sea interview samples from Texas privately owned recreational headboats have been collected and computerized by the TPWD. Analysis results from investigation of these samples exist, however, some of the published CPUE indices provided by the TPWD cover a time interval which includes two years (e.g., mean catch rate of headboats, September 1981-1982, as reported by McEachron 1984, page 11). Because it was important to isolate out those samples taken during the first quarter of the year to develop annual CPUE abundance indices for adjusting VPA stock size estimates, the published TPWD estimates were not used. A request was made of the TPWD to make available for this assessment size frequency and CPUE samples from all of the Texas recreational fisheries. The original field interview forms for these headboat samples were copied and re-computerized for this study.

Size frequency samples collected from headboat catches during 1979-1985 indicated that both large and small fish were captured (Figure 9). Annual CPUE indices for the headboat samples were developed as follows. First, the average CPUE during the first quarter was computed. Then, the proportion of the annual sport catch that was age 3+ was computed (from Table 28 and Table 3 of the Appendix) and the average headboat catch per trip was partitioned accordingly into two parts, ages 1 and 2 and ages 3+, to index the abundance of each of these two groups (Table 31).

Results: Diagnostic information from calibrations performed for these three CPUE datasets (Figure 10) for the west stock is given in Table 33. Although the sums of squares surface for the TPWD headboat age 3+ index indicated the minimia occurred within a reasonable parameter range (F_{85} = 0.27, X = 0.13) the residuals were poorly distributed. The probability that a positive correlation existed (between observed CPUE and age 1 and 2 stock size was unacceptably low (Pr (rho > 0.0) > .69). The intercept of the relation between estimated and observed abundance was about 2.5 million fish rather than zero. The TPWD headboat age 1-2 index exhibited well distributed residuals and a high probability of positive correlation (Pr = 0.97), however, the minimum sums of squares occurred outside reasonable ranges of parameter values (X = -2.99). The NMFS, PCL charterboat CPUE indexed the abundance of age 1 and 2 fish very well. The probability of a positive correlation was high (Pr = 0.99). The residuals were evenly distributed and did not indicate year trends. The sums of squares surface (of observed abundance minus expected abundance) minimized at Full F_{85} = 0.08 and X = 0.61.

Stock Abundance and Stock Production

Estimates of annual age specific catches, CPUE stock abundance indices, and VPA methodology were used to investigate trends in historical red snapper stock abundance and production since 1979. Estimates of the annual catch at age (commercial and sport) were developed from estimates of the numbers caught by length interval, von Bertalanffy growth functions, estimates of the variance of length given age, and a stochastic method of determining age from length. Analysis results of CPUE indices developed from charterboat catches (west stock) and commercial bottom longline and rod and reel (combined) catches (east stock) indicated observed abundance indices from those samples correlated reasonably well with the stock abundance trends resident in catch at age data. Those data were used to calibrate historical abundance and exploitation rates. All of the CPUE sets investigated here were found to be positively correlated with the annual age-specific catches. Some sets were considered more reasonable than others, based on the ability to reflect abundance trends present in the annual catches (the bottom longline and rod and reel (combined) and the age 1 and 2 charterboat).

The CPUE sets and catch at age data are temporally limited considering the extensive history of exploitation. Catches are also qualitatively uncertain due to reporting problems. These uncertainties include lack of information regarding misreporting in commercial catches, species mix problems, lack of quantitative information on removals by the directed shrimp fishery (both the magnitude and size structure of), and low precision in the recreational catch estimates. In addition, the estimated annual catches contain estimation error introduced in determining length from weight and age from length. The annual estimates of catch at age, although developed from all available data, likely contain additional error introduced by the catch sizing process (i.e., determining numbers in the catch by length interval) - namely from the lack of size frequency samples for all year-month-fishing ground-gear catch partitions that existed. The time period for which catch statistics are available (1979-1985) is very short, and the quantitative uncertainty that is resident within the annual length-specific and age-specific catches may be large. These limitations are recognized to exist in the basic dáta used to determine historical levels in population abundance and exploitation; however, the estimated annual age specific catches, in addition to the observed CPUE stock abundance indices, still provide information on general trends in recent population characteristics of Gulf of Mexico red snapper stocks.

Historical abundance trends were investigated separately for the east and west stocks employing the age specific catches developed from stochastic age determination methodology (Tables 29 and 30), CPUE abundance information (Table 31), and VPA methodology. Complete information regarding estimation of numbers at length and at age, sources of size frequency (length) samples, and methods and results of CPUE analyses was given earlier in this report. A least squares technique was used in this study to "tune" or "calibrate" VPA parameter estimates to CPUE abundance indices (Parrack 1985) and thus to derive historical population characteristics in abundance and exploitation levels.

This technique was applied earlier in this study in judging the ability of CPUE indices to reflect abundance trends present in the annual age specific catches. Those results indicated several of the data sets were more useful than others in predicting observed abundance and might be appropriate for use in standardizing results of VPA calculations. The tuning method developed by Parrack (1985) yields least squares estimates of age-specific stock sizes and fishing mortality rates with respect to fishing mortality rate during the last year of recorded catch (1985 in this study), the loss rate (X) due to all other causes other than reported catches, and a proportionality constant assumed to hold between VPA stock abundance and observed abundance indices. Summary results of the calibration include plots of observed-expected stock abundance (residuals), the probability of a positive correlation coefficient between estimated stock abundance and observed CPUE, and the sums of squares surface at the minima. The method can be modified to allow the mortality rate from causes other than catches (i.e., X) to be fixed if information on the magnitude of this death rate is known. The true magnitude of this death rate is unknown; however, results of movement studies indicate migration rates are probably very low for red snapper (Table 2), so this loss rate may include natural mortality (M) alone. Estimates of M from traditional analyses of catch and fishing effort data or from marking experiments do not exist. Estimates of natural mortality for this species based on life history characteristics (i.e., L , K, water temperature) according to Pauly (1980) at water temperature of 22°C are 0.29 (west stock) and 0.27 (east stock). In this study, VPA calculations were made at fixed levels of X (0.1, 0.2, and 0.3) in addition to determining the magnitude of this parameter by least squares estimation.

In an attempt to further investigate historical changes in U.S. GM red snapper resources, estimates of annual production were computed for each stock. Annual stock production was calculated as the sum of recruitment biomass, accumulation from growth (and death), and annual stock yield (fishing). In addition, the net change in annual stock biomass was computed as ending year biomass minus beginning year biomass (excluding recruits). These calculations were made using VPA estimates of stock sizes developed in this study, von Bertalanffy growth functions (Parrack 1986a), weight-length relations (Parrack 1986b), estimates of weight at age (Table 32), and estimates of annual recruitment estimated by VPA. Estimated stock sizes, developed from VPA calibrations that employed the CPUE abundance indices developed for ages 3 plus from the 1980 and 1983-85 bottom longline and rod and reel (east stock) and charterboat samples (west stock), assuming a loss rate from causes other than catches of 0.2 (east) and 0.3 (west) (Appendix Tables 6 and 7 and 14 and 15), were used to develop annual production information for each stock. The tuning method used in this study to obtain final VPA starting parameter estimates (i.e., F's and

N's) for determining VPA population sizes and fishing mortality rates at age does not estimate starting F's for partially recruited ages in the last year of catch, so VPA stock size calculations were not made for ages 1 and 2 (east) or for age 1 (west) in 1985. Estimates of partial recruitment rates (partial F's) for those ages were computed as the simple average F-ratio during 1979-1983 for each partially recruited age to the first fully recruited age.

East Stock Results

Information on red snapper stock abundance from the eastern Gulf of Mexico, independent of the annual age specific catches, was available from three fisheries (commercial rod and reel and bottom longline (combined), shrimp by-catch, and the recreational charterboat) (Figure 7). Results of analyzing those CPUE data sets (see Catch Per Unit of Effort Abundance Indices, p. 27 and Table 33) indicated the bottom longline and rod and reel CPUE observations performed reasonably well in reflecting trends in stock abundance of age 3+ fish resident in the catch at age data. The remaining CPUE indices investigated for that stock (shrimp by-catch and charterboat), although correlated with VPA stock size estimates, were rejected for use in investigating trends in stock abundance based on appearance of residuals and/or the range of parameter estimates. The commercial bottom longline and rod and reel CPUE was used to calibrate VPA stock size estimates of age 3+ fish for levels of M of 0.1, 0.2, and 0.3.

These results indicate a decline in both adult and recruiting population sizes in recent years from the 1979 level. This observation was consistently observed for all three loss rates (due to X) that were investigated as well as from results of the least squares estimated X. Recruitment levels (at M = 0.2) declined between 1979 and 1981 by about 43%, increased in 1982, and appear to have declined thereafter. The decline between 1979 and 1985 of recruiting fish appears to be greater than the corresponding decline in adult stock (age 3+) (99% vs 70%). Observed abundance indices from the bottom longline and rod and reel combined CPUE and charterboat CPUE indices show a decline during the period also. Average fishing mortality rates (unweighted) of age 3+ fish varied between 0.33 and 0.61, 1979-1983, suggesting annual exploitation rates ranging from 28 to 46 percent of fully recruited fish in those years. Fishing mortality rates of partially recruited fish (ages 1 and 2) were very variable during the seven-year period. These general trends are consistently observed for all separate calibration runs. Summary results of these calibrations are given (Table 34 and Figures 11 and 12). Results of individual calibrations are given in Tables 4-9 of the Appendix.

Annual production estimates were made using VPA stock size and fishing mortality estimates resulting from calibrations using only the 1980, 1983-85 CPUE indices (see Tables 6 and 7 of the Appendix) and assuming a loss rate (X) of 0.2. Total stock production from rcruitment, growth (+ mortality), and fishing varied from about 1.4 (1985) to 6.8 (1979) million pounds over the period (Table 35). These results indicate production (from these sources) has dropped by 79% since 1979. Corresponding to this decline, total stock biomass has declined from about 22 to about 18.5 million pounds (or about 30%). Both recruitment biomass and recruitment numbers show very severe drops since 1979 (see Table 35 and Appendix Tables 6 and 7). The net change between beginning and ending year stock biomass was negative during all years except 1980 and 1982 of the seven-year period. These results suggest that surplus production was positive during only 1980 and 1982 for the east stock.

West Stock Results

Two sets of CPUE abundance information were available for the west stock for adjusting VPA estimates of stock size and fishing mortality rates (Figure 10). Observations existed for headboat catches off Texas, 1979-1980 and 1982-1984. Observations also were also available from charterboat catches of small fish, 1982-85, from Louisiana, Mississippi, and Texas. Results of those investigations indicated the headboat age 3+ CPUE was not useful in indexing the abundance of adult fish (Table 33), so that abundance index set was not used to examine trends in historical stock abundance. The age 3+ headboat CPUE produced reasonable parameter estimates for Full F_{85} and X; however, the residuals were not evenly distributed and the probability of a positive correlation was very low. The headboat data were also used to develop a small (young) fish index for calibration purposes. Analysis results of those indices suggested those data did not perform as well as desired in indexing abundance of age 1 and 2 fish either. Calibration results for the headboat young fish index set predicted a very large value for the loss rate due to X. The charterboat CPUE was believed to perform better than either of the other data sets in indexing stock abundance. That set was used to tune VPA calculations of stock sizes and exploitation rates of ages 1 and 2 for the west stock.

Results of VPA calibrations for the west stock yielded least squares estimates of Full F in 1985 and a loss rate from other mortalities that appear reasonable for initial estimates (Full F = 0.08, X = 0.61). The annual catches were also calibrated separately assuming fixed loss rates for X of 0.1, 0.2, and 0.3 to assess changes in resulting F's and N's produced by changes in input parameter X. Resulting VPA stock sizes, fishing mortality rates, and other diagnostic results from these calibrations are summarized (Table 34 and Figures 11 and 12), and individual calibration results are given in Tables 10-15 of the Appendix. General trends from resulting VPA calculations for the west stock (for M = 0.3) suggest annual stock sizes of adults and recruits declined during the seven year period. Adult stock size in 1985 was about 47% below the 1979 level . Recruitment shows some decline (about 17%) since 1979, however, the drop does not appear extremely severe. Although the 1985 recruitment level was lower than the 1979 estimated recruitment an increase in recruitment occurred between 1980 (the lowest recruitment during the period) and 1981 of 75%. Analysis results suggest population levels of red snapper from the west stock may be greater than the east stock and estimated fishing mortality rates (unweighted) for adult fish (age 3+) are larger for the east stock.

Estimates of annual production (Table 36) were made assuming stock sizes based on results of VPA calibrations, assuming a loss rate other than from catches (X) of 0.3 that yielded a full F in 1985 of 0.20 (see Appendix Tables 14 and 15). This level of M was selected because it falls between the estimate of M from Pauly's (1980) procedure (0.29) and the level of X from the least squares calibration (0.61). If the estimated VPA stock sizes are believed to be reflective of historical stock abundance trends these calculations indicate the net change in beginning and ending stock biomass was negative during 1980-1984. These calculations indicate a positive production (from recruitment, growth (and natural mortality), and yield) occurred in all years, however, total net production of the stock was negative during most years. Total stock production declined by 46% from 1979 to 1985 with production from recruitment down by 17%. Between 1979 and 1983 total stock biomass averaged about 36 million pounds.

Concluding Comments

This report presents information which updates reported commercial catches (in weight) and estimated recreational catches (in numbers) of U.S. Gulf of Mexico red snapper resources. Estimates of recreational catches provided by the NMFS, NFSP and the TPWD are used jointly to obtain a complete time series of numbers caught (estimates of) by sport fishermen since 1979. Although nominal commercial catches have been reported, prior to 1979 catch statistics are believed incomplete because removals by Cuba and Mexico are not known and comprehensive information on catches by sport fishermen does not exist. The time series of catches available for investigative use in this study, 1979-85, is very short; however, the data still provide some information on general trends in recent exploitation and abundance. Estimates of total annual catches at size (length) and at age were so developed from commercial catches (in weight); sport catches (in numbers); all size (length) frequency samples available for 1979-85; and updated results of red snapper biometric investigations of weight-length relations, length conversions, and age and growth analyses. These annual age specific catches and abundance indices, independent from catches, were used to obtain initial estimates of stock sizes and fishing mortality rates of GM red snapper assuming an Eastern GM and a Western GM stock for 1979-1985. General conclusions from these investigations indicate adult and recruiting population levels of both stocks are below the levels existing in 1979, the first year of the analysis. The very short time series of data available for this study and the quantitative uncertainty resident within the annual catches, however, do not support determination of exact magnitudes of population abundance or exploitation levels.

The analysis results from these investigations do indicate GM red snapper stocks have declined since 1979 as predicted from VPA investigations. These results indicate the east stock decline is large in regards to both adult and recruiting population levels. General trends for the west (stock) suggest a decline in adult and recruiting population abundance has occurred. Adult stocks appear to have been affected most based on these results. Findings presented in this report show that during all years annual catches were mainly composed of very young ($\leq$ age 3) fish. This was a consistent observation for all seven years of the time period examined. According to the annual age specific catches red snapper become fully recruited to the fishery by age three in the eastern Gulf of Mexico and by age two in the western Gulf. Inspection of individual plots of size frequencies from the separate fisheries (sport, commercial rod and reel, longline) suggested that sport fishermen captured predominantly small fish ($\leq$ 40 cm), while commercial gear took individuals of a large size range. These plots suggest the commercial rod and reel and bottom longline fisheries generally do not capture fish as small as are taken by the recreational fishery. The precise size structure of trawl catches is not known. These observations, in addition to information on growth, suggest that the present red snapper fishery may not be achieving maximum yield per recruit possible. These results also indicate recruitment is occurring at an earlier age than corresponding size (age) of maturity (age 4 or about 38 cm (females), 43 cm (males) (Collins et al. 1986 unpubl.).

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Table 1. Information on the size of the Gulf of Mexico commercial red snapper fishery during 1985.

	State					
	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total
Number of ports where red snapper were landed	18	2	2	9	6	37
Number of producers reporting catches	109	29	29	10	—	177
Number of hook and line vessels[1]	293[2]	6	11[3]	3[4]	17	330
Number of bottom longline vessels[1]	203[2]	1	1	2[4]	27	234

Source: Port Agents.

[1]May include vessels fishing groupers and snappers other than red snapper.

[2]Some duplication may exist in these values because of vessels landing in more than one port.

[3]From 3-6 of these vessels reportedly fish the Caribbean during some months.

[4]May be Florida owned vessels.

-- Unknown.

Table 2. Information on results of Gulf of Mexico red snapper (<u>Lutjanus campechanus</u>) mark and release studies.

Author	Geographical Area of Study/Time Period/Release Size Range/Tag Types Used/Depth Range (fm)	Number of Releases	Number of Recaptures	Return Rate	Time at Liberty (Days)	Study Findings
Beaumariage (1969)	• Northwest Florida, Southeast Atlantic • 1961-1965 • — • spaghetti (Floy), internal anchor, Peterson • —	1372	384	28%	Average = 130.7	1. Movement information indicated most individuals were recaptured within 5 nautical miles (nm) of release site. 2. 17 fish (4.4%) were recaptured > 5 nm from from the release site (ranging from +5 nm to about 150 nm). Of these 17 fish, 8 were recaptured east or southeast, 7 north or northeast, 1 west, and 1 south of the release sites (see Beaumariage and Wittich 1966, Beaumariage 1969).
Wade (1978)	• Dauphin Is., Alabama • February 1976-September 1979 • 8-10 inches (TL) • spaghetti • 10-15 fm	1137	82	7.2	• tmax = 127 • range = 2-355	1. Author noted that recapture location data indicated most individuals were recaptured within 5 nm of the release site. 2. One individual released in 8 fm (December 1976) was recovered 10.5 nm southeast of the release site in 10 fm (April 1971). 3. One individual tagged in 5 fm (fall 1977) was recovered 60 miles southeast of the release site (after December 1977).

Table 2. Continued.

Author	Geographical Area of Study/Time Period/Release Size Range/Tag Types Used/Depth Range (fm)	Number of		Return Rate	Time at Liberty (Days)	Study Findings
		Releases	Recaptures			
Fable (1980)	• Port Aransas, Texas • May 1977-December 1977 • 170-540 mm (FL) • spaghetti • 30 fm	299	17	5.6%	• Range = 30-847	1. Of the 17 total recaptures one individual moved from 1 oil rig to another about 5 km (about 2.2 nm) after 112 days.
Gallaway and Martin (1980)	• Buccaneer oil and gas platform • Galveston, Texas • — • — • —	121	21	17.4%	—	1. No large scale movements noted.
Holt (1982)	• Liberty ship reef (Port Aransas, Texas) • March-December 1979 • 117-350 mm (TL) • internal anchor • 17 fm	267	35	13%	• Range = 1-92 • 63% recaptured within 30 days	1. Author noted all individuals recaptured on the ship reef.
Rosman (1983)	• Galveston, Texas • September 1981-November 1982 • 24.7 cm (average of recaptures) • spaghetti • most < 16 fm (71% of all releases were made < 11 fm)	1431	129	9.08%	• average = 32 • Range = 1-401	1. 17 individuals (1.19%) moved from 9.3-27.9 km (5-15 nm). 2. A few (?) individuals moved from shallow to deep, vice versa, and a few remained in the same depth.

— No specific information obtained on these items.

Table 3. Reported landings (Pounds) of vermillion snapper, *Rhomboplites aurorubens*, included in the Mississippi red snapper landings during 1984 and 1985[1].

	Month												
Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1984	3,800	14,000	6,200	--	--	--	37,500	44,500	--	22,200	18,800	19,000	166,000
1985	11,300	13,000	--	--	--	--	50,500	40,600	--	10,600	17,300	--	143,300

[1]These landings were reported taken from NMFS statistical reporting zones 12-18 and were from hook and line gear.

-- = No information available.

Source: Hermes Hague, NOAA, NMFS, SEFC, Mississippi Port Agent, August 1986.

Table 4. Reported commercial catches (Pounds) of Gulf of Mexico red snapper, *Lutjanus campechanus*, from statistical reporting zones 1-21, 1979-85 used in this study.

	State of Landing					
Year	Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total
1979	2900340	248273	890590	175931	134600	4349734
1980	3014888	164074	735600	201430	230700	4346692
1981	3379129	346142	673570	421283	521400	5341524
1982	3576728	514327	958450	467941	529500	6046946
1983	4113849	442760	1096080	718361	724200	7095250
1984	2806236	339988	759705[1]	1487456	723300	6116651
1985	1760450[2]	199280	421736[1]	1155904	766800	4304170[2]

[1] Mississippi red snapper catches adjusted for 1984 and 1985 using information given in Table 3.

[2] Preliminary values.

Data Source: NOAA, NMFS, SEFC, ESO.

Table 5. Reported commercial catches (Pounds) of Gulf of Mexico red snapper, *Lutjanus campechanus*, by gear and major fishing ground, 1979-85 used in this study.

Year	Fishing Grounds[1]	Gear: Hook & Line	Trawl	Longline	Other[2]	All Gears
1979	Tortugas	487836	4536			492372
	Middle Grounds	1202735	36		432	1203203
	Delta	268329	29673		200	298202
	Galveston Lumps	2174604	97653			2272257
	Texas	49500	34200			83700
	Combined	4183004	166098		632	4349734
1980	Tortugas	364903	12292	32499		409694
	Middle Grounds	1156201	877	58958		1216036
	Delta	259317	55882			315199
	Galveston Lumps	2068335	101868	42860		2213063
	Texas	83100	10000	99600		192700
	Combined	3931856	180919	233917		4346692
1981	Tortugas	398292	15019	77158		490469
	Middle Grounds	1257892	1080	97791		1356763
	Delta	350443	54773			405216
	Galveston Lumps	2414069	110567	115140		2639776
	Texas	75900	49100	324300		449300
	Combined	4496596	230539	614389		5341524
1982	Tortugas	367164	16021	98610	1784	483579
	Middle Grounds	1269066	590	115928		1385584
	Delta	526328	57753	6000		590081
	Galveston Lumps	2929549	92603	133850		3156002
	Texas	100800	48100	282800		431700
	Combined	5192907	215067	637188	1784	6046946

Table 5. Continued.

Year	Fishing Grounds	Gear: Hook & Line	Trawl	Longline	Other[2]	All Gears
1983	Tortugas	301800	15604	219118		536522
	Middle Grounds	1435772	1014	209767		1646553
	Delta	518194	58615	3775		580584
	Galveston Lumps	3426441	153268	107293		3687002
	Texas	92600	51489	500500		644589
	Combined	5774807	279990	1040453		7095250
1984	Tortugas	245362	3065	186724		435151
	Middle Grounds	897005	2233	149365		1048603
	Delta	410474[3]	31503	22389	9100	473466
	Galveston Lumps	3023684[3]	150330	307546	205	3481560
	Texas	158400	57800	461500		677700
	Combined	4734925	244931	1127524	9305	6116685
1985[4]	Tortugas	218164	1232	87431		306827
	Middle Grounds	686722	763	43238		730723
	Delta	148091[2]	26869	15457		190417
	Galveston Lumps	2041930[2]	63287	346779	3807	2455803
	Texas	113500	38100	468800		620400
	Combined	3208407	130251	961705	3807	4304170

[1]See Figure 1 for location of major fishing grounds.

[2]Includes trap, etc.

[3]Includes adjustments from Table 3.

[4]Preliminary values.

Data Source: NOAA, NMFS, SEFC, ESO.

Table 6. Partitions in the U.S. GM recreational red snapper (Lutjanus campechanus) catches obtained from the NMFS, NFSP and used in this study.

Partitions	Levels Within Each Major Partition
1. Year	1979, 1980, 1981, 1982, 1983, 1984, 1985[1]
2. Two Month Catch Interval (i.e., wave)	1. January-February 2. March-April 3. May-June 4. July-August 5. September-October 6. November-December
3. State Caught	Florida West Coast, Alabama, Mississippi, Louisiana, Texas
4. Fishery	charter/party, private-rental, beach/bank, structure (i.e., oil rig, pier), man-made
5. Area off shore	inland, ocean $\leq$ 3 miles, ocean $\geq$ 3 miles, ocean 3-10 miles, ocean $\geq$ 10 miles, unknown

[1]Complete through October.

Table 7. Estimated recreational catches (Numbers) of red snapper (*Lutjanus campechanus*) from Texas private-owned boat fisheries, 1982-84 used in this study.

Year	Fishery[1]	Reported Catch Period	Geographical Area of Catch[2]	Estimated Catch (Numbers)	Source of Information
1982	Party	June-August	Galveston/Freeport	15716	McEachron 1984
1982	Party	June-August	TPWD areas 2, 3 & 4[3]	16393	McEachron 1984
1983	Party	14 May-20 November	TPWD areas 2, 3 & 4[3]	10700	Osburn and Ferguson 1986
1984	Party	14 May-20 November	TPWD areas 2, 3 & 4[3]	200	Osburn and Ferguson 1986
1981/82	Headboat	September 81-August 82	Galveston/Freeport	415248[4]	McEachron 1984
1981/82	Headboat	September 81-August 82	TPWD areas 2, 3 & 4[3]	30135[4]	McEachron 1984
1982/83	Headboat	September 82-May 83	Galveston/Freeport	310356	McEachron et al. 1984
1982/83	Headboat	September 82-May 83	TPWD areas 2, 3 & 4[3]	43789	McEachron et al. 1984
1983	Headboat	15 May-20 November	Galveston/Freeport	134100	Osburn and Ferguson 1986
1983	Headboat	15 May-20 November	TPWD areas 2, 3 & 4[3]	43100	Osburn and Ferguson 1986
1983/84	Headboat	21 November-14 May	Galveston/Freeport	56600	Osburn and Ferguson 1985
1983/84	Headboat	21 November-14 May	TPWD areas 2, 3 & 4[3]	24200	Osburn and Ferguson 1985
1984	Headboat	15 May-15 September	Galveston/Freeport	214300	Osburn and Ferguson 1986
1984	Headboat	15 May-15 September	TPWD areas 2, 3 & 4[3]	69700	Osburn and Ferguson 1986
1982	Private-Rental	15 May-20 November	Galveston/Freeport	9500	Osburn and Ferguson 1986
1982	Private-Rental	15 May-20 November	TPWD areas 2, 3 & 4[3]	35400	Osburn and Ferguson 1986
1983	Private-Rental	15 May-20 November	Galveston/Freeport	26800	Osburn and Ferguson 1986
1983	Private-Rental	15 May-20 November	TPWD areas 2, 3 & 4[3]	20800	Osburn and Ferguson 1986
1984	Private-Rental	15 May-20 November	Galveston/Freeport	300	Osburn and Ferguson 1986
1984	Private-Rental	15 May-20 November	TPWD areas 2, 3 & 4[3]	14400	Osburn and Ferguson 1986

Table 7. Continued.

Year	Fishery[1]	Reported Catch Period	Geographical Area of Catch[2]	Estimated Catch (Numbers)	Source of Information
1982/83	Private-Rental	21 November-14 May	Galveston/Freeport	2600	Osburn and Ferguson 1986
1982/83	Private-Rental	21 November-14 May	TPWD areas 2, 3 & 4[3]	11100	Osburn and Ferguson 1986
1983/84	Private-Rental	21 November-14 May	TPWD areas 2, 3 & 4[3]	2500	Osburn and Ferguson 1986
1984/85	Private-Rental	21 November-14 May	TPWD areas 2, 3 & 4[3]	8000[5]	Osburn and Ferguson 1986

[1]Includes catches from private recreational vessels operating for hire and referred to as party boats (carrying $\leq$ 8 persons) and/or headboats (carrying $\geq$ 8 persons) and catches from private-rental vessels by the TPWD.

[2]See Figure 1.

[3]Includes estimated catches from Matagorda to Lower Laguna Madre.

[4]The 1981 portion of this estimate removed before incorporating into the estimated 1979-85 GM red snapper sport catches.

[5]The 1985 portion of this estimate removed before incorporating into the estimated 1979-85 total GM red snapper sport catches.

Table 8. Estimated sport catches (Numbers) of Gulf of Mexico red snapper, *Lutjanus campechanus*, by state of capture and two month catch estimation interval, 1979-85, as reported by the NMFS, NFSP.[1]

		Catch Period						
Year	State	January - February	March - April	May - June	July - August	September - October	November - December	All Months
1979	Florida	0	42998	777605	4143	921506	0	1746252
	Alabama	25970	0	12791	276479	989688	732	1305660
	Mississippi	0	0	0	0	824	0	824
	Louisiana	0	0	16223	490301	93659	222534	822717
	Texas	0	0	177868	1082831	468066	427043	2155808
	Combined	25970	42998	984487	1853754	2473743	650309	6031261
1980	Florida	3949	521504	122899	173211	50588	0	872151[2]
	Alabama	0	0	0	11977	66622	0	78599
	Mississippi	0	0	1154	0	50129	0	51283
	Louisiana	0	120624	24149	1017872	407548	1854	1572047
	Texas	70854	851697	0	399660	202176	84933	1609320[2]
	Combined	74803	1493825	148202	1602720	777063	86787	4183400
1981[3]	Florida	45734	0	259084	162189	112496	24419	603922
	Alabama	12615	287907	482230	11009	146560	75237	1015558
	Mississippi	0	0	0	0	0	0	0
	Louisiana	142877	1098954	143942	760797	693029	0	2839599
	Texas	4712	0	222918	246881	172307	0	646818
	Combined	205938	1386861	1108174	1180876	1124392	99656	5105897
1982[4]	Florida	29559	189899	453725	119947	0	12087	805217
	Alabama	0	0	36056	414235	160882	0	611173
	Mississippi	0	0	22571	0	0	4959	27530
	Louisiana	0	95480	2083252	107825	52305	9201	2348063
	Texas	0	0	0	0	0	0	0
	Combined	29559	285379	2595604	642007	213187	26247	3791983
1983[4]	Florida	139155	4544	27886	82365	18209	81613	353772
	Alabama	67778	67576	46455	337302	804923	25124	1349158
	Mississippi	0	7642	0	0	0	0	7642
	Louisiana	584362	85756	310560	521140	423370	31872	1957060
	Texas	0	4398	0	0	0	0	4398
	Combined	791295	169916	384901	940807	1246502	138609	3672030

Table 8. Continued.

Year	State	Catch Period: January - February	March - April	May - June	July - August	September - October	November - December	All Months
1984[4]	Florida	6818	8019	54416	16920	19980	19959	126112
	Alabama	2452	25087	6726	20753	21584	382611	459213
	Mississippi	237	0	0	0	0	0	237
	Louisiana	7087	35853	9939	182117	412683	53289	700968
	Texas	0	0	0	0	0	20896	20896
	Combined	16594	68959	71081	219790	454247	476755	1307426
1985	Florida	858	28738	8444	199164	53199	—	290403
	Alabama	0	104186	76102	162135	84767	—	427190
	Mississippi	0	0	0	1543	0	—	1543
	Louisiana	4315	15233	259146	187229	3662	—	469585
	Texas	0	0	0	240226	31803	—	272029
	Combined	5173	148157	343692	790297	173431	—	1460750

[1]Includes estimates of fish landed in whole form, fish used as bait, harvested, etc., and fish released referred to by the NMFS, NFSP as Type A, B1, and B2 catch estimates respectively.

[2]This estimate differs from the estimate in the current Fishery Statistics Publication, Volume 8324.

[3]The January-February catch estimated as the weighted wave 1 catch over 1979-1980 and 1982-1985 of 1981 year total.

[4]Does not include charter/party or private/rental boat modes for Texas in 1982, 1983, or 1984.

— *Not available at the time of this assessment.*

Data Source: Computer printout obtained from Mark Holliday, NMFS, NFSP, Washington, D.C.

Table 9. Estimated recreational catches of red snapper (*Lutjanus campechanus*) by year, state caught, and area offshore reporting classifications during 1979-85 as determined by the NMFS, NFSP.

		State Caught					
Year	**Area Offshore (Miles)**	**Florida West Coast**	**Alabama**	**Mississippi**	**Louisiana**	**Texas**	**Total**
1979	≤ 3 miles	42998	1292997	824	743531	1865473	3945823
	≥ 3 miles	469193	12663			18159	500015
	Other	1234061			79186	272176	1585423
	Combined	1746252	1305660	824	822717	2155808	6031261
1980	≤ 3 miles	3002		338	30929	13589	47858
	≥ 3 miles	192838	58973	50945	1467851	781019	2551626
	3-10 miles	348380				74722	423102
	> 10 miles	303066				727239	1030305
	Other	24865	19626		73267	12751	130509
	Combined	872151	78599	51283	1572047	1609320	4183400
1981[1]	≤ 3 miles	31818	18815				50633
	≥ 3 miles	295382	762331		2337478		3395191
	3-10 miles	98964				195116	294080
	> 10 miles	131085				443945	575030
	Other	939	221797		359244	3045	585025
	Combined	558188	1002943	0	2696722	642106	4899959
1982[2]	≤ 3 miles	147304	588573		70330		806207
	≥ 3 miles	10724	5543	27530	2277733		2321530
	3-10 miles	218170					218170
	> 10 miles	429019					429019
	Other		17057				17057
	Combined	805217	611173	27530	2348063		3791983
1983[2]	≤ 3 miles	20548	20087		81113		121748
	≥ 3 miles		30385	7642			38027
	3-10 miles	10572					10572
	> 10 miles	314520			1828249		2142769
	Other	8132	1298686		47698	4398	1358914
	Combined	353772	1349158	7642	1957060	4398	3672030

Table 9. Continued.

Year	Area Offshore (Miles)	State Caught: Florida West Coast	Alabama	Mississippi	Louisiana	Texas	Total
1984[2]	≤ 3 miles	35267	4975		85663		125905
	≥ 3 miles		428769	237	615305		1044311
	3-10 miles	16811					16811
	> 10 miles	55736					55736
	Other	18298	25469			20896	64663
	Combined	126112	459213	237	700968	20896	1307426
1985[3]	≤ 3 miles	35601			18366		53967
	≥ 3 miles		394878	1543	451219		847640
	3-10 miles	64608				31803	96411
	> 10 miles	184077				240226	424303
	Other	6117	32312				38429
	Combined	290403	427190	1543	469585	272029	1460750

[1]Does not include the January-February catches.

[2]Does not include Texas boat modes during 1982, 1983, or 1984.

[3]Data complete through October 1985.

Table 10. Estimated total numbers of red snapper, *Lutjanus campechanus*, captured by recreational fishermen in the U.S. Gulf of Mexico, 1979-85 for the two stocks considered in this study.

Year	Stock East	Stock West	Combined
1979	3052736	2978525	6031261
1980	1002033	3181367	4183400
1981	1619480	3486717	5105897
1982	1443920	2837730	4281650
1983	1710572	2425013	4135585
1984	585562	1070839	1656401
1985[1]	719136	741614	1460750

[1]1985 values complete through October.

Data Source: East Stock - NMFS, NFSP (see Table 8).
West Stock - NMFS, NFSP (see Table 8).
- TPWD published harvest estimates (see Table 7).

Table 11. Sources and information on red snapper size frequency samples for 1979-85 used in this study.

Source	Geographical Area of Samples	Fishery/ Time Period	Total Number of Fish Sampled
• Florida Department of Natural Resources St. Petersburg, Florida	• Florida Middle Grounds	• Commercial Hook & Line, 1979-81	1671
• National Marine Fisheries Service, Southeast Fisheries Center (Port Agents; CSBSP; NMFS, MRFSP)	• Louisiana • Texas, St. Petersburg (Florida), Panama City (Florida) • Gulf of Mexico (entire)	• Commercial Hook & Line, 1979-80 • Bottom Longline, 1981-83 • Recreational, 1979-85 • Commercial, 1979-85	24688
• Colleen Zastrow College Spring, Maryland (see Zastrow 1984)	• Galveston and Port Aransas, Texas	• Recreational headboat, 1980-81	676
• Ian Rosman Bryan, Texas (see Rosman 1983)	• Galveston, Texas	• Recreational headboat, 1981-82	7005
• Texas Parks and Wildlife Department Austin, Texas	• Texas Coast (Galveston-Freeport, Aransas Bay System, Lower Laguna Madre)	• Recreational headboat, 1979-84 • Party boat, 1979-83	21132
• Flower Gardens National Oceanic and Atmospheric Administration, Environmental Data and Information Service (EDIS), Washington, D. C. (see Boland et al. 1983)	• Flower Garden Banks	• 1980-1982	676

Table 12. Reported commercial catches (Thousands of Pounds) of U.S. GM red snapper, *Lutjanus campechanus*, by area offshore and statistical capture zone (1963-1985 combined).

Area Offshore (Miles)	Statistical Grid 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Total
Unknown	42	1606	293	1680	5515	1579	1108	4794	3843	2792	2242	2	9038	7423	5206	1883	1713	5058	1721	4183	3437	65158
0-3	0	5	0	2	0	0	0	112	0	46	47	5	14	29	77	0	13	7	0	0	0	357
3-10	1	267	3	268	1023	974	10	419	266	102	624	7	531	729	15	70	31	0	32	33	16	5421
10+	5	1795	966	1331	3201	2757	525	6959	3364	3967	4792	50	11027	10008	5149	4565	3929	5217	1348	2514	2042	75510
Foreign Coasts	0	0	20	0	0	0	0	0	0	5	0	0	0	0	0	29	0	24	0	0	0	78

Data Source: NMFS, SEFC, ESO.

Table 13. Distribution of recreational red snapper size frequency samples (numbers of fish) by area off shore, 1979-85.

Year	Fishery	Area Offshore (miles) 0-3	3-10	10+	Unknown
1979	Party	223	0	0	0
	Charter	0	0	1036	6
	Private-Rental	115	2	0	18
	Other Sport	0	622	1467	0
1980	Party	0	26	49	0
	Charter	0	127	1522	11
	Private-Rental	5	144	19	2
	Other Sport	0	0	2513	0
1981	Party	0	34	10	0
	Charter	10	99	3	0
	Private-Rental	0	95	37	41
	Other Sport	1	0	8225	0
1982	Party	5	139	18	43
	Charter	6	44	42	10
	Private-Rental	109	77	6	0
	Other Sport	0	0	8179	0
1983	Party	238	183	67	70
	Charter	62	404	37	87
	Private-Rental	10	70	3	26
	Other Sport	15	0	5200	12
1984	Party	13	14	18	3
	Charter	64	158	28	275
	Private-Rental	20	53	0	5
	Other Sport	0	0	4244	11
1985	Party	6	56	154	10
	Charter	0	75	0	0
	Private-Rental	4	19	50	27
	Other Sport	0	0	1200	0

Table 14. Information on observed sex ratios in U.S. Gulf of Mexico red snapper (*Lutjanus campechanus*) catches.

Investigator/Study Period	Geographical Area of Study	Sample Size	Observed Ratio of Males to Females	Size Range (mm)
• Camber (1955)				
• July 1951	Arcas Cay, Campeche, Mexico	125	46.8%:53.4%	251-800
• December 1951	Arcas Cay, Campeche, Mexico	135	47.1%:52.9%	251-750
• Bradley and Bryan (1975)	Galveston, Texas to	1129	1:1	
• 1971-1975	Port Isabel, Texas		(560:569)	
• Wakeman et al. (1979)	Dream Reef	90	42:48	
• July	Port Aransas, Texas			
• Zastrow (1984)[1]				
• winter	West Flower Garden Bank	36	11:25**	
• spring	West Flower Garden Bank	20	9:11	
• summer	West Flower Garden Bank	30	5:12	
• fall	West Flower Garden Bank	18	10:8	
• combined (1980-1982)	West Flower Garden Bank	91	35:56	
• spring	East Flower Garden Bank	79	37:42	
• summer	East Flower Garden Bank	85	44:41	
• fall	East Flower Garden Bank	37	22:15	
• combined (1980-1982)	East Flower Garden Bank		103:98	
• Nelson (1986)[1]	Flower Garden Bank	300		
• 1980-1982				

[1]These investigators made observations on the same fish in some cases.

**Computed Chi square value (5.44) significant at α = 0.05.

Table 15. Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85.

1979

TORTUGAS

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
LONGLINE	(C)	0	0	0	0	0	0	23	54	0	0	0	0	77
ALL GEAR		0	0	0	0	0	0	23	54	0	0	0	0	77

MIDDLE GROUND

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
HOOK & LINE	(C)	28	256	167	82	106	182	140	268	111	78	72	35	1525
CHARTER	(R)	0	135	32	79	122	156	106	166	103	117	0	0	1016
HEADBOAT	(R)	0	0	0	0	0	0	0	0	0	2	0	0	2
OTHER	(R)	0	27	0	0	0	39	2	30	179	344	0	0	621
ALL GEAR		28	418	199	161	228	377	248	464	393	541	72	35	3164

MISS./ALABAMA

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
PARTY	(R)	0	0	0	50	0	53	63	57	0	0	0	0	223
PRIVATE	(R)	0	7	0	0	6	0	8	7	0	1	0	3	32
ALL GEAR		0	7	0	50	6	53	71	64	0	1	0	3	255

GALV. LUMPS

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
HOOK & LINE	(C)	63	0	125	159	419	74	0	0	0	0	0	0	840
TRAWL	(C)	0	0	0	0	0	0	0	0	0	24	0	0	24
CHARTER	(R)	0	0	0	0	0	0	4	22	0	0	0	0	26
PRIVATE	(R)	0	0	0	0	1	4	1	3	28	0	11	0	48
HEADBOAT	(R)	0	309	101	80	203	102	200	111	0	0	0	0	1106
ALL GEAR		63	309	226	239	623	180	205	136	28	24	11	0	2044

S. WESTERN GULF

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
LONGLINE	(C)	0	8	3	0	0	0	0	0	0	0	0	0	11
PRIVATE	(R)	0	0	0	0	0	26	2	13	0	0	14	0	55
HEADBOAT	(R)	200	0	0	0	0	159	0	0	0	0	0	0	359
OTHER	(R)	0	0	0	0	0	0	1	0	0	0	0	0	1
ALL GEAR		200	8	3	0	0	185	3	13	0	0	14	0	426

Table 15(cont.). Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85.

1980

TORTUGAS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
LONGLINE	(C)	0	0	36	9	10	0	0	0	29	2	0	0	86
PARTY	(R)	0	5	2	0	0	0	0	0	0	0	0	0	7
CHARTER	(R)	0	0	1	0	0	0	0	0	0	0	0	0	1
PRIVATE	(R)	0	0	0	0	0	1	0	0	0	0	0	0	1
ALL GEAR		0	5	39	9	10	1	0	0	29	2	0	0	95

MIDDLE GROUND

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	29	52	36	0	0	3	29	0	0	0	0	0	149
PARTY	(R)	0	0	0	0	1	0	0	0	0	0	0	0	1
CHARTER	(R)	0	0	0	28	40	30	0	0	0	10	0	0	108
PRIVATE	(R)	0	0	0	10	1	7	3	0	10	1	0	0	32
ALL GEAR		29	52	36	38	42	40	32	0	10	11	0	0	290

MISS./ALABAMA

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PARTY	(R)	0	0	0	0	0	0	0	0	0	25	0	0	25
CHARTER	(R)	0	0	0	0	0	0	0	0	0	23	0	0	23
PRIVATE	(R)	0	0	0	0	0	2	4	0	11	2	0	0	19
ALL GEAR		0	0	0	0	0	2	4	0	11	50	0	0	67

GALV. LUMPS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
TRAWL	(C)	0	30	0	0	0	0	0	0	0	0	0	0	30
PARTY	(R)	0	0	0	0	0	0	0	0	6	0	0	0	6
CHARTER	(R)	0	0	0	179	199	195	19	243	545	76	0	0	1456
PRIVATE	(R)	0	0	0	2	0	10	58	5	28	0	0	0	103
HEADBOAT	(R)	0	0	0	0	0	0	0	0	200	97	203	204	704
OTHER	(R)	0	0	0	0	0	75	147	72	0	55	16	51	416
OTHER	(C)	0	0	0	0	0	0	0	0	0	0	19	1	20
ALL GEAR		0	30	0	181	199	280	224	320	779	228	238	256	2735

S. WESTERN GULF

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
TRAWL	(C)	0	0	0	0	0	0	0	0	0	0	0	45	45
LONGLINE	(C)	0	1	0	0	0	0	0	0	0	0	0	0	1
PARTY	(R)	0	0	0	0	0	0	36	0	0	0	0	0	36
CHARTER	(R)	0	0	0	69	0	0	0	0	0	0	3	0	72
PRIVATE	(R)	0	10	0	0	0	0	1	0	4	0	0	0	15
HEADBOAT	(R)	0	0	0	0	112	27	32	111	385	342	284	100	1393
ALL GEAR		0	11	0	69	112	27	69	111	389	342	287	145	1562

Table 15 (cont.). Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85.

1981

TORTUGAS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PARTY	(R)	0	0	0	0	0	0	0	0	3	0	0	0	3
CHARTER	(R)	0	0	2	0	0	0	0	0	0	0	0	0	2
PRIVATE	(R)	7	1	2	0	0	10	0	10	9	0	1	0	40
ALL GEAR		7	1	4	0	0	10	0	10	12	0	1	0	45

MIDDLE GROUND

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PARTY	(R)	0	0	0	0	0	9	1	0	0	0	0	0	10
CHARTER	(R)	0	0	0	0	0	0	0	15	0	0	1	0	16
PRIVATE	(R)	0	0	0	0	0	0	1	9	18	0	2	0	30
OTHER	(R)	0	0	0	0	0	1	0	0	0	0	0	0	1
ALL GEAR		0	0	0	0	0	10	2	24	18	0	3	0	57

MISS./ALABAMA

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PARTY	(R)	0	0	0	0	20	2	0	0	0	0	0	0	22
CHARTER	(R)	0	0	0	21	31	10	0	0	0	0	0	0	62
PRIVATE	(R)	0	0	0	0	0	0	10	0	0	20	21	0	51
ALL GEAR		0	0	0	21	51	12	10	0	0	20	21	0	135

GALV. LUMPS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PARTY	(R)	0	0	0	0	0	0	0	9	0	0	0	0	9
CHARTER	(R)	0	0	0	30	0	0	0	2	0	0	0	0	32
PRIVATE	(R)	0	0	0	0	0	0	19	0	0	16	0	0	35
HEADBOAT	(R)	100	100	191	100	289	107	221	317	2460	1076	837	244	6042
OTHER	(R)	58	0	0	20	0	0	30	0	0	27	0	0	135
OTHER	(C)	9	0	0	20	0	0	17	0	0	0	0	0	46
ALL GEAR		167	100	191	170	289	107	287	328	2460	1119	837	244	6299

S. WESTERN GULF

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PRIVATE	(R)	0	0	0	0	0	0	7	10	0	0	0	0	17
HEADBOAT	(R)	297	271	287	59	175	160	215	249	118	114	103	0	2048
ALL GEAR		297	271	287	59	175	160	222	259	118	114	103	0	2065

Table 15.(cont.) Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85.

1982

TORTUGAS

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
LONGLINE	(C)	0	0	0	0	19	0	0	0	0	0	0	0	19
PRIVATE	(R)	0	0	0	0	2	0	0	0	0	0	0	0	2
ALL GEAR		0	0	0	0	21	0	0	0	0	0	0	0	21

MIDDLE GROUND

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
LONGLINE	(C)	0	0	0	0	0	0	6	0	0	60	40	0	106
PARTY	(R)	0	0	10	0	7	6	1	5	0	0	0	0	29
CHARTER	(R)	0	0	15	4	9	1	0	0	0	0	0	0	29
PRIVATE	(R)	0	0	2	0	1	1	40	16	0	0	0	0	60
ALL GEAR		0	0	27	4	17	8	47	21	0	60	40	0	224

MISS./ALABAMA

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
CHARTER	(R)	0	0	0	0	10	25	0	0	0	15	0	0	50
PRIVATE	(R)	0	0	0	0	1	0	13	0	0	0	6	0	20
ALL GEAR		0	0	0	0	11	25	13	0	0	15	6	0	70

GALV. LUMPS

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
PARTY	(R)	0	0	0	0	0	123	18	10	3	11	0	11	176
CHARTER	(R)	0	0	0	0	0	18	0	0	0	5	0	0	23
PRIVATE	(R)	0	0	9	5	15	7	16	51	1	6	0	0	110
HEADBOAT	(R)	161	750	306	692	569	647	1040	542	597	300	200	100	5904
OTHER	(R)	0	0	0	19	55	0	0	135	0	14	0	0	223
OTHER	(C)	0	0	0	0	0	0	0	1	0	0	0	0	1
ALL GEAR		161	750	315	716	639	795	1074	739	601	336	200	111	6437

S. WESTERN GULF

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
LONGLINE	(C)	0	0	0	303	159	140	0	0	0	0	0	0	602
HEADBOAT	(R)	132	243	271	61	88	122	186	192	241	316	100	100	2052
ALL GEAR		132	243	271	364	247	262	186	192	241	316	100	100	2654

Table 15. (cont.) Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85

1983

TORTUGAS

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
PARTY	(R)	0	0	0	0	8	3	3	12	3	2	0	2	33
CHARTER	(R)	0	0	6	14	0	0	0	0	0	0	0	0	20
PRIVATE	(R)	0	0	0	3	0	0	0	0	0	0	0	0	3
ALL GEAR		0	0	6	17	8	3	3	12	3	2	0	2	56

MIDDLE GROUND

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
LONGLINE	(C)	4	0	0	0	0	0	0	0	0	0	0	0	4
PARTY	(R)	0	0	50	0	0	7	2	18	0	2	0	0	79
CHARTER	(R)	0	10	56	0	0	4	0	0	0	0	9	0	79
ALL GEAR		4	10	106	0	0	11	2	18	0	2	9	0	162

MISS./ALABAMA

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
PARTY	(R)	0	0	0	2	0	0	0	0	0	0	0	0	2
CHARTER	(R)	0	0	88	0	0	0	0	0	0	0	0	0	88
PRIVATE	(R)	0	0	5	2	0	0	0	0	0	0	0	0	7
OTHER	(R)	0	0	1	0	0	0	0	0	0	0	0	0	1
ALL GEAR		0	0	94	4	0	0	0	0	0	0	0	0	98

GALV. LUMPS

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
HOOK & LINE	(C)	0	0	0	0	0	0	0	0	91	0	0	0	91
PARTY	(R)	0	8	0	50	0	0	102	202	0	80	0	2	444
CHARTER	(R)	0	0	0	0	122	149	90	0	0	42	0	0	403
PRIVATE	(R)	0	10	21	9	24	0	0	14	6	5	10	0	99
HEADBOAT	(R)	100	299	218	162	158	386	316	431	243	120	200	100	2733
OTHER	(R)	0	0	1	21	0	0	0	4	0	0	0	0	26
ALL GEAR		100	317	240	242	304	535	508	651	340	247	210	102	3796

S. WESTERN GULF

		MONTH 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
TRAWL	(C)	0	0	0	0	0	0	0	6	0	47	0	0	53
HEADBOAT	(R)	258	337	200	54	0	300	100	54	211	360	219	374	2467
ALL GEAR		258	337	200	54	0	300	100	60	211	407	219	374	2520

Table 15(cont.). Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85.

1984

TORTUGAS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	0	0	0	5	292	0	167	110	0	300	24	0	898
LONGLINE	(C)	0	0	0	0	142	79	72	88	58	54	161	2	656
PARTY	(R)	0	2	1	1	0	3	2	0	0	0	2	0	11
CHARTER	(R)	0	14	10	0	0	0	0	0	0	0	0	0	24
PRIVATE	(R)	0	0	0	0	6	0	0	0	0	0	0	0	6
ALL GEAR		0	16	11	6	440	82	241	198	58	354	187	2	1595

MIDDLE GROUND

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	0	0	0	0	53	444	513	502	436	196	28	44	2216
LONGLINE	(C)	0	0	0	0	0	37	7	34	38	14	46	0	176
PARTY	(R)	0	0	8	0	0	0	0	0	0	0	0	0	8
CHARTER	(R)	0	0	0	0	16	175	5	0	0	93	0	0	289
PRIVATE	(R)	0	0	0	0	0	5	0	0	0	0	0	0	5
ALL GEAR		0	0	8	0	69	661	525	536	474	303	74	44	2694

MISS./ALABAMA

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	0	0	0	0	0	0	0	0	0	180	235	0	415
LONGLINE	(C)	0	0	0	0	0	0	0	104	50	0	0	0	154
CHARTER	(R)	0	0	0	2	0	0	0	0	0	0	0	0	2
PRIVATE	(R)	0	11	0	0	4	0	0	0	0	0	0	0	15
OTHER	(C)	0	0	0	0	3	2	7	0	0	0	0	0	12
ALL GEAR		0	11	0	2	7	2	7	104	50	180	235	0	598

GALV. LUMPS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	0	0	0	0	8	101	165	50	500	361	621	288	2094
TRAWL	(C)	0	0	0	0	0	0	0	0	0	16	0	0	16
LONGLINE	(C)	0	0	0	0	0	0	0	0	129	0	236	0	365
PARTY	(R)	0	10	0	7	12	0	0	0	0	0	0	0	29
CHARTER	(R)	0	0	0	7	85	7	60	37	0	0	9	5	210
PRIVATE	(R)	0	0	18	6	2	3	15	0	0	0	0	8	52
HEADBOAT	(R)	222	0	308	318	300	236	295	302	100	0	0	0	2081
OTHER	(R)	0	0	0	0	0	0	0	0	0	0	11	0	11
ALL GEAR		222	10	326	338	407	347	535	389	729	377	877	301	4858

S. WESTERN GULF

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
TRAWL	(C)	0	0	0	10	0	0	0	21	0	0	0	0	31
HEADBOAT	(R)	200	237	490	284	143	385	300	124	0	0	0	0	2163
ALL GEAR		200	237	490	294	143	385	300	145	0	0	0	0	2194

Table 15(cont.) . Distribution of red snapper size frequency samples by year, month, fishing grounds, and gear catch partitions for 1979-85.

1985

TORTUGAS

		MONTH											TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	23	6	0	13	116	93	0	50	134	138	119	0	692
LONGLINE	(C)	73	126	10	85	24	51	1	59	96	242	12	0	779
PARTY	(R)	0	0	0	0	0	0	0	0	1	1	0	0	2
CHARTER	(R)	0	1	0	0	0	0	0	0	0	0	0	0	1
PRIVATE	(R)	0	0	0	5	0	0	0	0	0	0	0	0	5
OTHER	(C)	44	0	158	0	0	0	0	0	0	0	0	0	202
ALL GEAR		140	133	168	103	140	144	1	109	231	381	131	0	1681

MIDDLE GROUND

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	39	78	66	35	2	0	0	0	0	0	0	0	220
LONGLINE	(C)	0	0	2	10	4	0	0	0	1	0	0	0	17
PARTY	(R)	0	0	12	0	0	0	0	0	0	0	0	0	12
PRIVATE	(R)	0	0	0	27	0	0	0	3	0	0	0	0	30
ALL GEAR		39	78	80	72	6	0	0	3	1	0	0	0	279

MISS./ALABAMA

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	56	6	51	20	20	6	21	45	0	0	0	0	225
LONGLINE	(C)	0	8	0	0	0	0	0	0	0	0	0	0	8
CHARTER	(R)	0	0	0	0	0	0	0	0	0	9	25	0	34
PRIVATE	(R)	0	0	0	0	0	0	1	0	0	2	0	0	3
ALL GEAR		56	14	51	20	20	6	22	45	0	11	25	0	270

GALV. LUMPS

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
HOOK & LINE	(C)	212	391	512	35	253	342	206	881	568	727	106	45	4278
LONGLINE	(C)	69	0	101	0	83	0	10	112	0	88	0	0	463
PARTY	(R)	0	6	1	55	0	10	0	61	79	0	0	0	212
CHARTER	(R)	0	0	0	0	0	30	10	0	0	0	0	0	40
PRIVATE	(R)	0	0	1	0	0	0	0	5	0	4	10	0	20
HEADBOAT	(R)	0	0	0	0	0	0	0	0	205	0	0	0	205
ALL GEAR		281	397	615	90	336	382	226	1059	852	819	116	45	5218

S. WESTERN GULF

		MONTH												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
PRIVATE	(R)	0	0	0	0	0	0	0	17	0	0	25	0	42
HEADBOAT	(R)	0	0	0	0	0	0	0	206	789	0	0	0	995
ALL GEAR		0	0	0	0	0	0	0	223	789	0	25	0	1037

Table 16. Red snapper (*Lutjanus campechanus*) biometric relations used in this study.

Biometric Attribute	Relationship Used	Source of Information
1. Conversion of total length (mm) to fork length (mm)	$FL = 0.9248(TL)+1.2746$	Parrack (1986b, Table 4)
2. Conversion of standard length (mm) to fork length (mm)	$FL = 1.1419(SL)+17.5348$	Parrack (1986b, Table 4)
3. Estimation of weight (grams) at fork length (mm) by quarter of year		Parrack (1986b, Table 2)
1. January-March	• $W = 0.1527E-4(FL)**3.0219$	
2. April-June	• $W = 0.4342E-5(FL)**3.2209$	
3. July-September	• $W = 0.1371E-4(FL)**3.0432$	
4. October-December	• $W = 0.1488E-4(FL)**3.0283$	
4. Determination of length (cm) at age (years)		Parrack (1986a, Table 9)
1. Eastern Gulf of Mexico	• $FL = 134.9(1.-\exp(-0.072(age + 1.592)))$	
2. Western Gulf of Mexico	• $FL = 106.2(1.-\exp(-0.123(age + 0.418)))$	

Table 17. Pooling categories employed in assigning size frequency samples to catches and definitions of nearby quarters[1], close fishing grounds[2], major areas[3], and similar gears[4].

Pooling Category	Description	Priority Level Set Sizing Catches	
		Sport	Commercial
1	Assign sample within same year-quarter-major fishing ground-gear catch partitions (Direct match).	1	1
2	Cross samples over nearby quarters, within year-major fishing grounds-gear catch partitions.	2	3
3	Cross samples over close fishing grounds within year-quarter-gear catch partitions.	3	5
4	Cross samples over close fishing grounds and over nearby quarters within year-gear catch partitions.	4	NU
5	Cross samples over similar gears within year-fishing ground-quarter catch partitions.	5	2
6	Cross samples over similar gears and nearby quarters within year-fishing ground catch partitions.	6	4
7	Cross samples over gears (within sport, within commercial), all quarters, within the two major areas within year partitions.	NU	6
8	Cross samples over all gears (within sport, commercial), all quarters, all fishing grounds within year.	7	7
9	Cross samples over all gears, all quarters, all fishing grounds within year.	NU	8

Table 17. Continued.

Pooling Category	Description	Priority Level Set Sizing Catches: Sport	Commercial
10	Assign all 1983 commercial samples to 1983 commercial catches.	NU	9

NU = Not used.

[1]Near by quarters were defined as follows:
- Quarter 1 - use quarters 2 and 3 in order
- Quarter 2 - use quarters 1 and 3 in order
- Quarter 3 - use quarters 2 and 4 in order
- Quarter 4 - use quarters 3 and 2 in order

[2]Close fishing grounds were defined as follows:
- Tortugas - use Middle Grounds and Delta in order
- Middle Grounds - use Tortugas and Delta in order
- Delta - use Middle Grounds and Tortugas in order
- Galveston Lumps - use Western
- Western - use Western

[3]Major Areas were:
- Eastern: Tortugas, Middle Grounds and Delta combined (statistical zones 1-12)
- Western: Galveston Lumps and Western region combined (statistical zones 13-21)
- Combined: All of the above combined (statistical zones 1-21)

[4]Similar gears:
1. Rod and Reel: Use rod & reel, buoy, all commercial in order
2. Trawl: Use trawl, all commercial (excluding longline) in order
3. Longline: Use longline, buoy, rod and reel, all commercial combined in order
4. Trap: Use trap, rod & reel, all commercial (except longline) in order
5. Other: Use rod and reel, all commercial (except longline) in order
6. Sport: Use sport, commercial rod and reel in order

Table 18. Reported landings (Thousands of Pounds) of red snapper, Lutjanus campechanus, by Florida west coast fishermen, 1977-1985.

Year	Month 1	2	3	4	5	6	7	8	9	10	11	12	All Months
1977	173	157	159	138	307	342	298	320	382	334	267	213	3090
1978	181	166	236	175	166	290	328	230	305	290	331	285	2983
1979	131	180	191	242	248	251	217	376	130	364	245	325	2900
1980	118	255	165	170	262	264	273	256	431	249	276	311	3029*
1981	190	235	201	256	313	309	267	297	353	294	357	313	3385*
1982	176	237	386	184	343	284	322	308	379	318	328	320	3586*
1983	303	251	236	267	491	392	354	437	371	363	352	301	4119*
1984	186	273	241	180	226	239	318	215	179	230	231	293	2811*
1985**	136	134	158	137	173	119	121	122	179	177	164	141	1761

*Total annual landings differ slightly from annual totals reported by gear type and area of capture stratifications (i.e., NMFS, SEFC, ESO, Florida General Canvas Catch Statistics).

**Preliminary data.

Data Source: NMFS, SEFC, ESO, Florida landings detail data files partitioned by year, month of capture and country (port) of landing.

Table 19. Percent of recreational catch (in numbers) sized according to substitution method for the east stock.

	Substitution Method									
	1	2	3	4	5	6	7	8	9	10
1979	0.9819	0.0093	0.0000	0.0000	0.0000	0.0000	0.0000	0.0087	0.0000	0.0000
1980	0.7333	0.0000	0.0887	0.0000	0.0000	0.0000	0.0000	0.1780	0.0000	0.0000
1981	0.7604	0.0255	0.1640	0.0000	0.0000	0.0000	0.0000	0.0501	0.0000	0.0000
1982	0.6373	0.0426	0.0332	0.0000	0.0000	0.0000	0.0000	0.2869	0.0000	0.0000
1983	0.2290	0.0018	0.0596	0.6824	0.0000	0.0000	0.0000	0.0272	0.0000	0.0000
1984	0.1746	0.0428	0.0119	0.0000	0.6903	0.0354	0.0000	0.0450	0.0000	0.0000
1985	0.1629	0.0032	0.0047	0.0000	0.2507	0.0000	0.0000	0.5785	0.0000	0.0000

Table 20. Percent of commercial catch (in weight) sized according to substitution method for the east stock.

	Substitution Method									
	1	2	3	4	5	6	7	8	9	10
1979	0.6032	0.0000	0.1346	0.0000	0.0002	0.2470	0.0150	0.0000	0.0000	0.0000
1980	0.6083	0.0000	0.0000	0.0000	0.0350	0.1943	0.1624	0.0000	0.0000	0.0000
1981	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
1982	0.0471	0.0000	0.0425	0.0000	0.5163	0.0000	0.3940	0.0000	0.0000	0.0000
1983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
1984	0.9383	0.0000	0.0000	0.0000	0.0617	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.9035	0.0000	0.0000	0.0000	0.0965	0.0000	0.0000	0.0000	0.0000	0.0000

Table 21. Percent of recreational catch (in numbers) sized according to substitution method for the west stock.

	Substitution Method									
	1	2	3	4	5	6	7	8	9	10
1979	0.7714	0.0009	0.1530	0.0000	0.0000	0.0000	0.0000	0.0747	0.0000	0.0000
1980	0.9747	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0223	0.0000	0.0000
1981	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1982	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1983	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1984	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1985	0.9920	0.0018	0.0004	0.0000	0.0000	0.0000	0.0000	0.0058	0.0000	0.0000

Table 22. Percent of commercial catch (in weight) sized according to substitution method for the west stock.

	Substitution Method									
	1	2	3	4	5	6	7	8	9	10
1979	0.6885	0.0000	0.0000	0.0000	0.2760	0.0000	0.0355	0.0000	0.0000	0.0000
1980	0.6227	0.0000	0.0269	0.0000	0.3151	0.0000	0.0353	0.0000	0.0000	0.0000
1981	0.7815	0.0000	0.0246	0.0000	0.0731	0.0000	0.1209	0.0000	0.0000	0.0000
1982	0.7693	0.0435	0.0000	0.0000	0.1457	0.0415	0.0000	0.0000	0.0000	0.0000
1983	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
1984	0.6900	0.0000	0.1103	0.0000	0.1906	0.0000	0.0091	0.0000	0.0000	0.0000
1985	0.7761	0.0000	0.1896	0.0000	0.0218	0.0000	0.0124	0.0000	0.0000	0.0000

Table 23. Estimated total annual numbers caught of U.S. Gulf of Mexico red snapper, *Lutjanus campechanus*, 1979-85 by commercial and recreational fishermen.

Year	Stock: East	Stock: West
1979	3236944	4340049
1980	1168007	4121714
1981	2236001	4342337
1982	1603486	3864015
1983	2586209	3797395
1984	1103865	2194438
1985	948999	1391855

Data Source: Recreational Catches (see Tables 7 and 8). Commercial Catches estimated using reported catches (in weight) (Table 4), size frequency samples (Table 15), and weight-length information (Table 16).

Table 24. Estimated standard errors (S.E.) of numbers of red snapper caught (Thousands) by recreational fishermen in the U.S. Gulf of Mexico, 1979-85, as reported by the NMFS, NFSP.

Year	Estimate	S.E.	C.V %
1979	6031	3971	66
1980	4146[1]	428	10
1981	4900	1238	25
1982[2]	3792	1464	39
1983[2]	3672	974	27
1984[2]	1274	325	26
1985	1954	440	23

[1]This estimate differs from the value received via computer printout of the NMFS, NFSP data (equals 4182 in that printout).

[2]Estimated numbers caught not inclusive of the Texas private-owned boat modes for 1982, 1983, or 1984.

Table 25. Estimated annual catches by length interval (fork) of Gulf of Mexico red snapper (Lutjanus campechanus) during 1979-85 for the eastern stock.

	YEAR						
LENGTH (cm)	1979	1980	1981	1982	1983	1984	1985
15	0	0	0	8957	0	0	0
17	0	0	0	8957	0	0	0
18	0	0	0	30104	0	0	0
19	658	0	0	0	0	3186	0
20	19050	12614	0	88400	43343	1637	0
21	75670	52526	23820	3989	2084	1682	1447
22	38736	45412	13296	51254	63699	2488	1501
23	49423	28635	9660	108509	42437	7131	0
24	89694	5235	28109	16919	63886	6720	0
25	284657	33110	62947	71242	119062	6566	1447
26	174281	25584	55335	39521	66848	17384	939
27	59392	76467	123687	44128	212888	22689	330
28	140965	110054	84389	78206	235151	23473	939
29	249096	83611	27954	31649	193534	24826	11027
30	196491	88377	33403	113760	105893	32297	7564
31	247947	70687	115550	80123	83476	22047	12014
32	124600	93926	113044	40396	40368	35637	27970
33	164364	8543	115078	83274	106440	39629	18216
34	88243	25266	91725	58866	209599	41056	39317
35	114898	40012	86978	77170	199062	45812	33674
36	76486	56760	144029	76098	131211	66586	24588
37	47658	25481	123989	55621	124133	85906	29764
38	63348	34769	88717	31619	119348	65642	33762
39	56045	15233	91905	6662	54970	61613	38272
40	55890	37031	99705	11121	12411	50884	22161
41	53079	8259	100279	44183	53017	35679	30736
42	38035	932	69630	8619	8703	41037	31261
43	27835	6450	122562	39200	7703	29531	17289
44	30121	2039	42538	16598	10961	17218	13639
45	14790	3072	45293	10289	11851	19342	50811
46	16194	4597	57983	8619	10110	14845	29790
47	21884	7143	68189	1412	7145	15087	26049
48	24655	0	11301	12766	10562	18535	23681
49	25122	836	31207	8619	46102	35938	28748
50	22611	7077	42512	0	11044	37557	11968
51	38340	4539	14733	805	5007	14979	29728
52	23189	1668	10964	5221	43343	16026	19194
53	28505	836	10697	6662	0	9843	13875
54	36275	8117	4152	10972	0	12373	22866
55	21476	3336	8706	5115	4829	8124	29315
56	29280	4164	15870	12384	0	9453	21548
57	17283	6443	5576	23969	1377	5802	25442
58	24964	5973	0	4310	7064	5980	16772
59	16049	2780	5918	3627	0	8922	15518
60	20714	8049	342	2217	0	5221	31247
61	16379	10040	3682	23969	0	8329	14327
62	22380	4727	4498	1412	4829	7747	7243
63	11003	3331	6583	1412	0	5588	14511
64	7676	3004	3335	4233	0	2749	16478
65	20318	3979	342	8847	0	6347	15194
66	14297	7961	0	1412	4829	2780	8844
67	19410	10038	0	1412	0	3736	4720
68	24480	8748	0	0	0	1589	11675
69	13289	4677	0	6171	18688	2799	5790

Table 25 (cont.). Estimated annual catches by length interval (fork) of Gulf of Mexico red snapper (Lutjanus campechanus) during 1979-85 for the eastern stock.

	YEAR						
LENGTH (cm)	1979	1980	1981	1982	1983	1984	1985
70	17110	3472	3682	8387	4829	5647	3355
71	15642	1758	0	4233	1377	4116	483
72	19506	5848	342	4958	17019	2978	6793
73	9599	2644	0	4233	0	3501	970
74	16113	5995	0	5763	0	907	2210
75	9911	6573	342	5038	0	1514	2287
76	6848	4213	4498	10404	0	1190	1948
77	8684	4530	0	7054	0	2050	1708
78	6696	3318	0	1412	0	1598	578
79	5348	3942	0	18339	0	1216	1608
80	3264	930	4024	7054	17019	1662	1190
81	4392	2871	2901	10291	9404	1370	745
82	3678	930	0	7859	2758	1853	2611
83	662	2724	0	5643	17019	2165	2892
84	962	378	0	7054	0	1066	473
85	1244	1810	0	1940	17019	723	3876
86	3749	836	0	1412	0	496	1835
87	614	94	0	0	0	428	6506
88	1234	143	0	1412	0	284	4830
89	1151	1071	0	0	2758	257	1846
90	932	1066	0	0	0	94	237
91	384	238	0	0	0	320	4789
92	768	238	0	0	0	118	1696
93	0	0	0	0	0	138	64
94	614	143	0	0	0	31	21
95	614	94	0	0	0	0	96
96	0	0	0	0	0	0	10
97	0	0	0	0	0	0	108
98	0	0	0	0	0	0	33
101	0	0	0	0	0	0	10
120	0	0	0	0	0	96	0
TOTAL	3236944	1168007	2236001	1603486	2586209	1103865	948999

Table 26. Estimated annual catches by length interval (fork) of Gulf of Mexico red snapper (Lutjanus campechanus) during 1979-85 for the western stock.

	YEAR						
LENGTH (cm)	1979	1980	1981	1982	1983	1984	1985
10	0	0	0	155	0	0	0
13	0	0	0	1043	0	1173	401
14	0	0	321	1198	0	0	201
15	0	1259	0	155	0	0	201
16	9910	0	3981	2458	0	163	1606
17	5747	1259	19600	8804	3979	845	2609
18	63033	3780	58706	21904	6499	6847	4416
19	37023	17975	137916	49886	16051	10935	7684
20	142234	35223	425418	112412	26295	23280	91773
21	195668	44934	270987	138762	59149	25791	25154
22	177398	82195	258651	177104	104342	48277	8577
23	185597	114475	275254	248169	132320	47684	8311
24	202836	74521	244723	293251	244069	63564	3951
25	300688	79726	226343	243789	306486	84288	7320
26	295757	78262	176838	315190	274669	123875	42332
27	339284	106941	168727	233830	347366	134770	22871
28	377149	138473	168802	235174	488148	172096	42157
29	312920	193256	153471	173001	255108	166884	57980
30	281784	189445	146598	151347	267432	118370	61715
31	157956	190328	81537	122486	200902	125795	165442
32	128211	208845	94966	191211	201927	110165	82371
33	113150	180139	59723	79249	150462	75016	65860
34	128494	223116	124126	85874	86929	79850	75579
35	132223	205533	70703	45616	75220	51862	52839
36	118619	248653	109803	46711	98102	62875	80137
37	54648	198710	72717	37311	79646	46478	31106
38	65061	197644	71510	36777	74951	53522	49245
39	57749	157175	85467	56625	22582	47820	30314
40	18106	104914	83679	39092	19779	65586	29496
41	26711	147051	79639	66324	18116	32601	34837
42	28442	101714	82348	36705	8701	37355	21431
43	30690	116918	77400	60506	5699	30733	16321
44	23552	90761	56584	60264	5313	21217	17589
45	21269	88420	32204	34049	3052	19519	9880
46	8698	47440	40712	38721	3929	27754	11223
47	17971	66528	73831	23298	4214	14493	15768
48	6233	34800	21481	57375	1041	15058	9269
49	13147	48795	51369	79526	1637	13678	10202
50	11980	16504	42253	35879	4545	8022	9145
51	24583	21377	29937	24633	1849	9077	12392
52	20260	15701	17786	10416	1464	7974	8832
53	33672	8528	29509	35839	338	13209	7189
54	1740	8192	2636	6555	1941	6685	5711
55	10461	8234	8537	17294	8078	4960	5670
56	13090	6657	28576	9324	625	6462	6596
57	10461	6513	16561	12252	714	3936	3998
58	1515	17967	1023	14669	1164	6225	5217
59	14745	18871	15434	9324	1422	12880	5169
60	15655	3683	429	9654	769	6770	4111
61	7731	12076	2647	18646	701	10498	9917
62	5747	7092	100	9453	7594	7002	4299
63	7347	4097	10185	1303	0	10625	4369
64	0	4191	7854	6710	911	5172	3325

Table 26 (cont.). Estimated annual catches by length interval (fork) of Gulf of Mexico red snapper (<u>Lutjanus campechanus</u>) during 1979-85 for the western stock.

	YEAR						
LENGTH (cm)	1979	1980	1981	1982	1983	1984	1985
65	6377	2510	1536	1662	0	5080	3777
66	12059	7634	1910	1047	7568	3026	4331
67	5288	3788	2296	1450	751	1934	2943
68	7262	9694	591	2222	0	3311	3752
69	1600	13929	248	926	26743	6686	4345
70	0	4641	1667	5141	9310	3992	3464
71	[illegible]	3476	11	575	1819	3877	3446
72	3200	10947	160	6754	26777	3118	2373
73	6233	9025	3035	1257	0	6360	7753
74	8862	3616	1430	1811	0	6722	3085
75	3200	5960	1430	2034	0	5911	12059
76	5802	8056	4	2162	0	5279	5797
77	5828	3797	0	1501	26	8014	5658
78	26	4452	0	1763	701	15023	4007
79	0	9619	241	1562	701	6851	8567
80	0	8575	610	1716	27376	9998	4807
81	26	7537	7562	1212	14806	5598	6065
82	26	4059	0	818	0	4718	3441
83	0	2812	0	441	26701	2685	1670
84	0	3207	0	235	68	2132	1474
85	26	2879	0	201	26675	1726	795
86	26	3928	0	222	442	931	1360
87	26	1822	4	0	0	192	1129
88	11490	2520	0	0	0	192	661
89	0	1685	0	0	0	192	257
90	0	1259	0	0	0	0	0
92	0	1396	0	0	0	0	0
97	0	0	0	0	0	0	731
98	0	0	0	0	0	656	0
99	0	0	0	0	0	163	0
100	0	0	0	0	0	192	0
101	0	0	0	0	0	163	0
107	0	0	0	0	701	0	0
TOTAL	4340049	4121714	4342337	3864015	3797395	2194438	1391855

Table 27. Estimated age specific catches of red snapper, _Lutjanus campechanus_, 1979-85 for the east stock as determined from growth equations.

Age	Year 1979	1980	1981	1982	1983	1984	1985
1	832457	197914	251874	460686	775213	82556	6773
2	1273343	549377	604518	448920	1033645	335713	93203
3	349981	220064	721987	320766	455495	315032	189686
4	167340	31966	442973	121870	85876	146717	196794
5	157344	14956	145206	26402	105162	99528	128355
6	144982	26355	31629	64566	12042	41856	127479
7	80281	32586	21999	35526	6057	35582	95628
8	91076	33099	7706	23878	21997	15429	48156
9	63762	17150	342	17579	24745	12996	17749
10	41049	20971	4840	39756	0	5663	8706
11	19401	12110	2927	30646	63070	6216	3792
12	7245	5726	0	11479	149	4342	9307
13	5371	2883	0	1412	2609	1203	14462
14	2084	2443	0	0	149	789	8163
15	1149	381	0	0	0	169	489
16	79	26	0	0	0	74	257
total	3236944	1168007	2236001	1603486	2586209	1103865	948999

Table 28. Estimated age specific catches of red snapper, *Lutjanus campechanus*, 1979-85 for the west stock as determined from growth equations.

Age	Year: 1979	1980	1981	1982	1983	1984	1985
1	835654	249267	1297790	336743	520314	142541	149958
2	2167403	1260804	1456051	2251895	2354128	1080092	442745
3	822036	1611144	753939	596643	656573	536583	453486
4	221052	621138	482394	333471	60214	196810	138427
5	126182	154756	243445	203681	12313	55850	55963
6	67055	58169	65087	68887	14183	41265	30051
7	29479	27875	24623	37645	8505	34063	29185
8	26277	39658	8438	12152	63867	20665	17617
9	16086	30256	3053	9031	20330	22999	23182
10	17179	19032	2864	7521	727	31653	23279
11	26	28107	1846	4430	39140	21473	15597
12	52	6704	2803	1480	45958	7034	6636
13	52	7944	0	436	442	1771	3431
14	11516	4205	4	0	0	384	1353
15	0	1259	0	0	0	81	214
16	0	1396	0	0	701	1174	731
total	4340049	4121714	4342337	3864015	3797395	2194438	1391855

Table 29. Estimated age specific catches of U.S. Gulf of Mexico red snapper, *Lutjanus campechanus*, 1979-85 for the east stock as determined by the stochastic ageing method described by Shepherd (1985).

Age	Year 1979	1980	1981	1982	1983	1984	1985
1	952821	200039	267081	425714	728397	78176	3772
2	1207102	567845	556668	456655	1047579	324673	101339
3	315659	222703	831426	381523	462059	373093	192851
4	133101	6810	381004	77422	69643	72564	185826
5	155881	24145	138859	5622	121585	142288	130029
6	198912	18375	22384	102381	7786	39997	139756
7	8560	35860	14921	28455	765	21469	99820
8	124941	33825	10106	6983	47598	21919	35681
9	102706	15169	1669	16742	6335	6026	9286
10	16291	23698	6307	74160	4045	9462	6867
11	9453	9010	2042	18369	81225	11983	818
12	6477	3339	2207	5846	5100	855	13518
13	2790	1146	225	485	492	440	27510
14	1050	586	154	592	1173	169	712
15	251	290	254	788	1054	343	922
16+	942	5171	690	1747	1371	407	280
total	3236937	1168011	2235997	1603484	2586207	1103864	948987

Table 30. Estimated age specific catches of red snapper, *Lutjanus campechanus*, 1979-85 for the west stock as determined by the stochastic ageing method described by Shepherd (1985).

Age	Year 1979	1980	1981	1982	1983	1984	1985
1	673730	168017	1360311	227860	322958	106607	155889
2	2233451	1176624	1347974	2331734	2485307	1067382	458486
3	847657	1817046	768908	546141	635376	571694	452481
4	188183	589196	522828	403328	26649	195506	114847
5	186880	89896	241322	219507	20980	20323	47877
6	76427	94100	36805	44558	9982	78936	35933
7	36290	6093	28855	55798	13216	30323	30087
8	15043	49523	11231	3486	84970	5548	5088
9	58184	44683	7869	8567	35344	14880	23070
10	906	32030	5534	13444	428	92854	49084
11	689	38595	2831	3058	154881	4186	17654
12	318	13291	2345	610	1058	2170	63
13	17521	1179	2280	222	1180	1918	304
14	353	201	607	1723	1558	344	93
15	3507	375	790	1629	2785	150	727
16+	903	864	1852	2348	719	1619	167
total	4340042	4121713	4342342	3864013	3797391	2194440	1391850

Table 31. Catch per unit of effort indices of abundance for Gulf of Mexico red snapper (*Lutjanus campechanus*) investigated in this study.

Stock	Fishery	Ages	Units of CPUE	Source of Information	CPUE Indices (Number data points)[1] 1979	1980	1981	1982	1983	1984	1985
East	Bottom Longline and Rod & Reel	3+	Pounds/trip	Ms. Debby Fable, NMFS, SEFC Port Agent	--(0)	2482.4(9)	367.8(36)	632.2(42)	3377.2(36)	3055.9(21)	2512.4(12)
	Shrimp trawl by-catch	1-2	Pounds/trip	Ms. Debby Fable, NMFS, SEFC Port Agent	--(0)	230.9(3)	178.1(19)	16.0(1)	38.2(6)	89.6(8)	127.1(7)
	Charterboat	1-2	Numbers/fishing hour	NMFS, SEFC, PCL, Panama City, Florida[2]	--	--	--	--	0.4384(785)	0.2099(315)	0.1817(516)
West	Charterboat	1-2	Numbers/fishing hour	NMFS, SEFC, PCL, Panama City, Florida[2]	--	--	--	0.9333(141)	1.2728(507)	0.8310(499)	0.6694(289)
	Texas headboat	1-2	Numbers/man-hour	TPWD, Austin, Texas	1.920(5)	--	1.39(16)	1.17(14)	1.92(18)	0.31(18)	--
	Texas headboat	3+	Numbers/man-hour	TPWD, Austin, Texas	0.52 (5)	--	0.41(16)	0.25(14)	0.67(18)	0.10(18)	--

[1]All indices are simple averages of CPUE during quarter 1 except charterboat indices - which are from standardization analyses as described by Robson (1966).

[2]The NMFS, SEFC, Gulf of Mexico charterboat survey began in 1982.

-- = No data available.

Table 32. Estimated weight (kilograms) at age for Gulf of Mexico red snapper (*Lutjanus campechanus*)[1].

Stock	Age (years)	Fork Length (cm)	Initial Weight	Mid-Year Weight
East	1	23.0	0.198	0.338
	2	30.7	0.478	0.692
	3	38.0	0.906	1.195
	4	44.7	1.483	1.844
	5	51.0	2.204	2.631
	6	56.8	3.058	3.543
	7	62.2	4.028	4.564
	8	67.3	5.099	5.676
	9	72.0	6.253	6.863
	10	76.3	7.472	8.107
	11	80.4	8.741	9.393
	12	84.2	10.044	10.706
	13	87.7	11.368	12.035
	14	91.0	12.701	13.366
	15	94.0	14.031	
West	1	17.0	0.080	0.208
	2	27.3	0.335	0.568
	3	36.5	0.800	1.132
	4	44.5	1.464	1.880
	5	51.7	2.295	2.773
	6	58.0	3.252	3.773
	7	63.6	4.293	4.837
	8	68.5	5.381	5.934
	9	72.9	6.486	7.034
	10	76.7	7.581	8.114
	11	80.1	8.646	9.157
	12	83.1	9.668	10.152
	13	85.8	10.637	11.091
	14	88.2	11.545	11.968
	15	90.3	12.391	12.782

[1]Estimates derived using von Bertalanffy growth functions and red snapper weight-length relations developed by Parrack (1986b, Table 4) (1986c, Table 2).

Table 33. Performance characteristics of six Gulf of Mexico red snapper CPUE abundance indices.

CPUE Index	Correlation		Appearance of	Estimates[1]	
	rho	Pr (rho>o)	Residual Distribution	F_{85}	X
Eastern Gulf Bottom Longline and Rod & Reel Ages 3+					
• 1980-1985	.47	.83	No trend, uneven	0.00	0.25
• 1980, 1983-85	.89	.95	No trend, uneven	2.01	-0.23
• 1983-1985	.99	.95	No trend, even	0.40	0.34
Eastern Gulf Shrimp Trawl Ages 1-2 (1980-81, 83-85)	.71	.91	Strong, U-shaped	0.00	0.44
Eastern Gulf Charterboat Ages 1-2 (1983-85)	>.99	>.99	extremely linear	0.14	-1.09
Western Gulf Charterboat Ages 1-2 (1982-85)	.97	>.99	even, no trend	0.08	0.61
Western Gulf Headboat Ages 1-2 (1979, 81-84)	.85	.97	even, no trend	0.09	-2.99
Western Gulf Headboat Ages 3+ (1979, 81-84)	.31	.69	No year trend, uneven	0.27	0.13

[1]F_{85} = Starting F (fishing mortality rate) for fully recruited ages in 1985.

X = loss rate due to causes other than catches.

Table 34. Summary results of Gulf of Mexico red snapper VPA investigations of the stochastically derived annual catches.

Stock	Summary Statistic	Natural Mortality 0.1: 1979	1980	1981	1982	1983	1984	1985	% Gain or Loss from 1979
East	• Adult stock size (age 3+)	2512589	2115855	3051893	2525084	2534620	2389411	1941760	-23
	• Recruitment	3503610	2193725	194[illegible]703	2709518	1679206	403183	23823	-99
	• Total stock size (age 1+)	8225060	6576326	6794516	6743334	6261319	3622871	2256205	-73
	• Average F (age 3+) Unweighted	0.7861	0.3984	0.3609	0.4488	0.4630	0.4072	0.6056	-23
	• Average F (age 3+) Weighted by Catches	0.8250	0.3382	0.8951	0.5017	0.6258	0.4816	0.6056	-27
	• Average F (age 1) Unweighted	0.3354	0.1006	0.1554	0.1802	0.6043	0.2274	0.1817	-46
West	• Adult stock size (age 3+)	4654513	5722903	4166228	3068401	2696005	2669609	3474672	-25
	• Recruitment	4030896	2759171	5515449	4522264	4045039	2377023	3911375	- 3
	• Total stock size (age 1+)	14196662	11489795	12018607	11290977	10616399	8399879	9435541	-34
	• Average F (age 3+) Unweighted	0.4666	0.7014	0.4164	0.4755	0.6562	0.7466	0.2673	-43
	• Average F (age 3+) Weighted by catches	0.5043	0.9540	0.7522	0.9882	1.1693	0.6694	0.2673	-47
	• Average F (age 1) Unweighted	0.1928	0.0661	0.2991	0.0544	0.0876	0.0483	0.0428	-78

Table 34. Continued.

Stock	Summary Statistic	Natural Mortality 0.2 1979	1980	1981	1982	1983	1984	1985	% Gain or Loss from 1979
East	• Adult stock size (age 3+)	3459173	3037526	4198855	3809498	3751378	3544594	2944959	-15
	• Recruitment	4894762	3406301	2816733	3658898	2237090	637937	38844	-99
	• Total stock size (age 1+)	11097619	9593986	9623929	9533718	8600428	5360912	3435651	-99
	• Average F (age 3+) Unweighted	0.6114	0.2926	0.2589	0.3295	0.3302	0.2901	0.3770	-38
	• Average F (age 3+) Weighted by Catches	0.6353	0.2483	0.6095	0.3491	0.4293	0.3317	0.3770	-41
	• Average F (age 1) Unweighted	0.2407	0.0669	0.1103	0.1371	0.4410	0.1449	0.1131	-53
West	• Adult stock size (age 3+)	6372863	7115949	5276939	3870022	3337220	3219028	4124525	-35
	• Recruitment	5187906	3486130	6577234	5590290	5368123	3088979	4715162	- 9
	• Total stock size (age 1+)	17901605	14242519	14556738	13621736	13076609	10411647	11272490	-37
	• Average F (age 3+) Unweighted	0.3815	0.5888	0.3408	0.3915	0.5897	0.6535	0.2321	-39
	• Average F (age 3+) Weighted by catches	0.4010	0.8324	0.6306	0.7935	1.0468	0.5670	0.2321	-76
	• Average F (age 1) Unweighted	0.1542	0.0546	0.2578	0.0460	0.0686	0.0388	0.0371	-42

Table 34. Continued.

Stock	Summary Statistic	1979	1980	1981	1982	1983	1984	1985	% Gain or Loss from 1979
		Natural Mortality 0.3							
East	• Adult stock size (age 3+)	5961692	5552362	7472082	7516934	7206041	6778265	5732139	- 4
	• Recruitment	8721115	6899104	5127095	6002542	3730362	1303366	80420	-99
	• Total stock size (age 1+)	18832308	18097883	17538771	17089051	15018914	10224501	6711199	-64
	• Average F (age 3+) Unweighted	0.4116	0.1793	0.1517	0.1985	0.1892	0.1662	0.1858	-55
	• Average F (age 3+) Weighted by Catches	0.4261	0.1454	0.3195	0.1931	0.2296	0.1792	0.1858	-56
	• Average F (age 1) Unweighted	0.1347	0.0341	0.0621	0.0855	0.2544	0.0718	0.0557	-59
West	• Adult stock size (age 3+)	9526593	9434905	7061706	5122200	4279210	3987782	5002506	-47
	• Recruitment	6995697	4590648	8031809	7078277	7335886	4106292	5804927	-17
	• Total stock size (age 1+)	23946363	18632041	18350430	16990420	16663606	13252053	13758103	-43
	• Average F (age 3+) Unweighted	0.3010	0.4819	0.2720	0.3144	0.5243	0.5618	0.1972	-34
	• Average F (age 3+) Weighted by catches	0.3017	0.7087	0.5110	0.6141	0.9234	0.4689	0.1972	-35
	• Average F (age 1) Unweighted	0.1178	0.0432	0.2169	0.0379	0.0522	0.0305	0.0316	-73

Table 35. Annual estimates of production for the Eastern Gulf of Mexico red snapper (*Lutjanus campechanus*) during 1979-85 determined from VPA investigations of the stochastically derived catches (M=0.20).

	initial stock biomass (kg)						
AGE	1979	1980	1981	1982	1983	1984	1985
1	969163	674448	557713	724462	442944	126295	7691
2	1311481	1505776	1246787	987224	1248517	563266	215950
3	869431	1057866	1873638	1481220	1159982	1088245	-609951
4	719570	745418	1120506	1407742	1476463	940683	962038
5	628718	612130	893453	614706	1559008	1658057	1000453
6	1584953	289905	628774	634327	682763	1436273	1491944
7	2922231	991981	246045	596815	316246	708002	1403627
8	1146022	2989245	863410	186634	487994	324242	635136
9	1064843	455509	2810422	809866	148093	224523	202704
10	308679	360411	343697	2738282	679605	102372	179122
11	223114	168205	160416	279520	2039543	618999	24961
12	145359	124867	77451	132428	98939	1187625	473984
13	64224	68915	81618	49248	63333	40017	1091740
14	34051	27141	49941	72079	39496	52298	31569
15	8410	17612	17165	43219	57704	20986	45161
total	12000249	10089429	10971036	10757772	10500630	9091883	8376031

Year	1979	1980	1981	1982	1983	1984	1985
Initial Biomass w/o recruits	11031084	9414981	10413323	10033310	10057686	8965587	8368340
Final Biomass with recruits	9419068	10425096	10045178	10085531	9002738	8382404	6251539
Net Change in Stock Biomass	-1612016	1010116	-368145	52220	-1054949	-583183	-2116802
Stock Production	3077186	2675979	2486846	2634104	2148478	1238154	648776
recruitment biomass	969163	674448	557713	724462	442944	126295	7691
accumulation from growth	-2581179	335668	-925859	-672242	-1497893	-709478	-2124493
yield removed	4689202	1665864	2854991	2581884	3203427	1821338	2765578

Table 36. Annual estimates of production for the Western Gulf of Mexico red snapper (Lutjanus campechanus) during 1979-85 determined from VPA investigations of the stochastically derived catches (M=0.30).

	inital stock biomass (Kg)						
AGE	1979	1980	1981	1982	1983	1984	1985
1	559656	367252	642545	566262	586871	328503	463699
2	2487065	1543174	1091067	1604631	1691251	1727923	988474
3	2793612	2883760	1929830	1019969	1270491	1320984	2329619
4	4256297	2731781	1675340	1661807	708378	936684	1082070
5	3973170	4573311	2025807	935103	1146341	770297	707138
6	548168	3651343	4550411	1459877	383396	1144921	752036
7	3232071	259718	3225337	4314745	1264165	338294	831255
8	661392	2833985	213137	2861951	3749492	1112963	176199
9	1023740	507234	2255941	128463	2536186	2877269	962984
10	546465	513289	155969	1902270	56467	1966912	2394754
11	491948	454988	200663	91123	1507694	44540	982320
12	198590	401813	69450	142844	50387	49424	3920
13	286288	158965	207638	35464	110870	31482	20811
14	22169	62118	116172	144461	26322	77504	6910
15	192072	13898	47257	85931	96632	4936	57974
total	21272703	20956629	18406564	16954901	15184943	12732636	11760163

Year	1979	1980	1981	1982	1983	1984	1985
Initial Biomass w/o recruits	20713047	20589378	17764021	16388640	14598072	12404133	11296463
Final Biomass with recruits	20701322	17770781	16416993	14647488	12449181	11298680	11502669
Net Change in Stock Biomass	-11725	-2818598	-1347028	-1741153	-2148891	-1105453	206205
Stock Production	4449721	3058705	2760262	2320584	2510189	2016460	2407451
recruitment biomass	559656	367252	642545	566262	586871	328503	463699
accumulation from growth	-571381	-3185849	-1989573	-2307415	-2735762	-1433956	-257494
yield removed	4461445	5877302	4107290	4061737	4659080	3121913	2201246

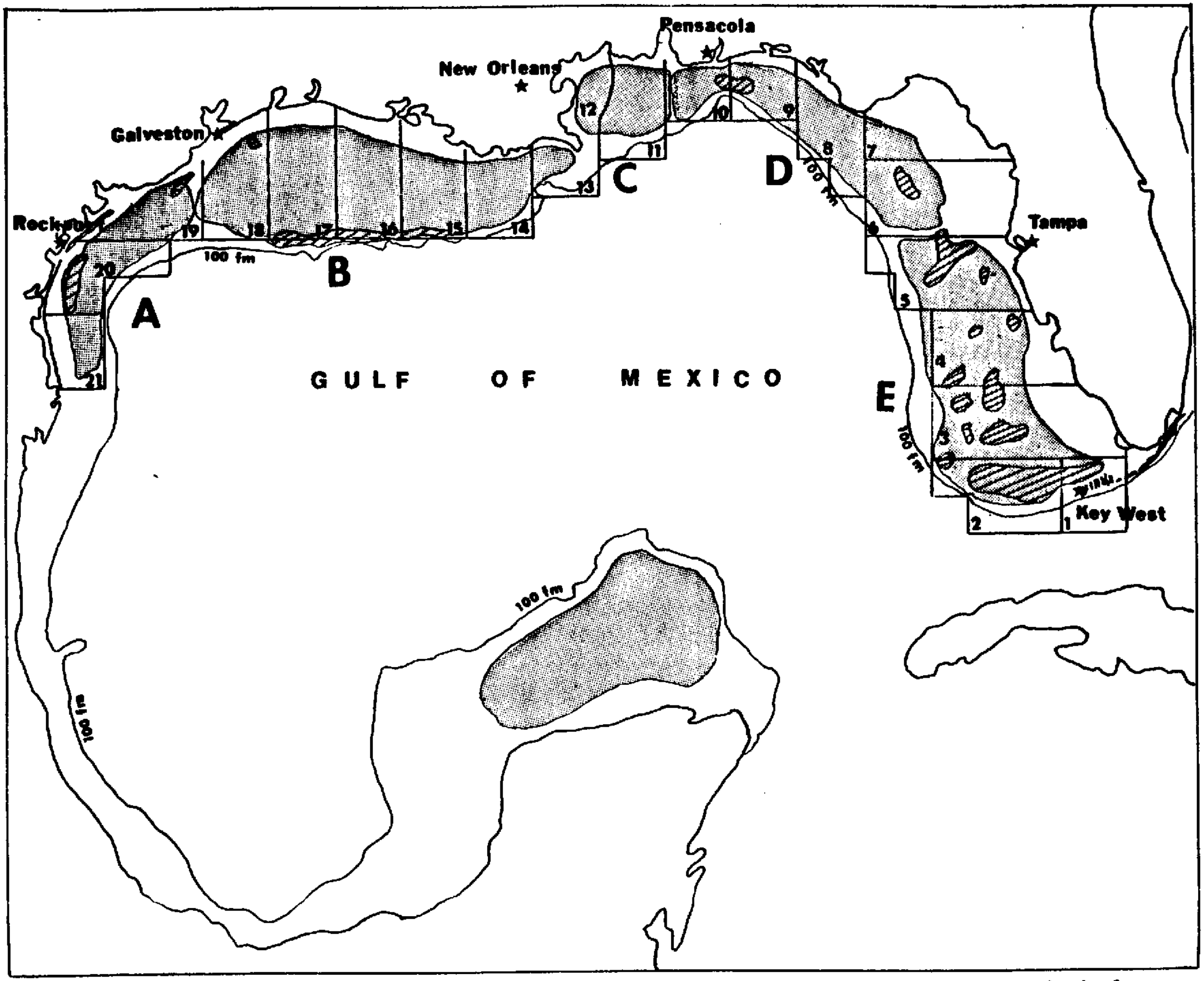


Figure 1. Chart of Gulf of Mexico historical red snapper fishing grounds and statistical reporting zones (A = Western zone, B = Galveston Lumps, C = Delta, D = Middle Grounds, E = Tortugas)

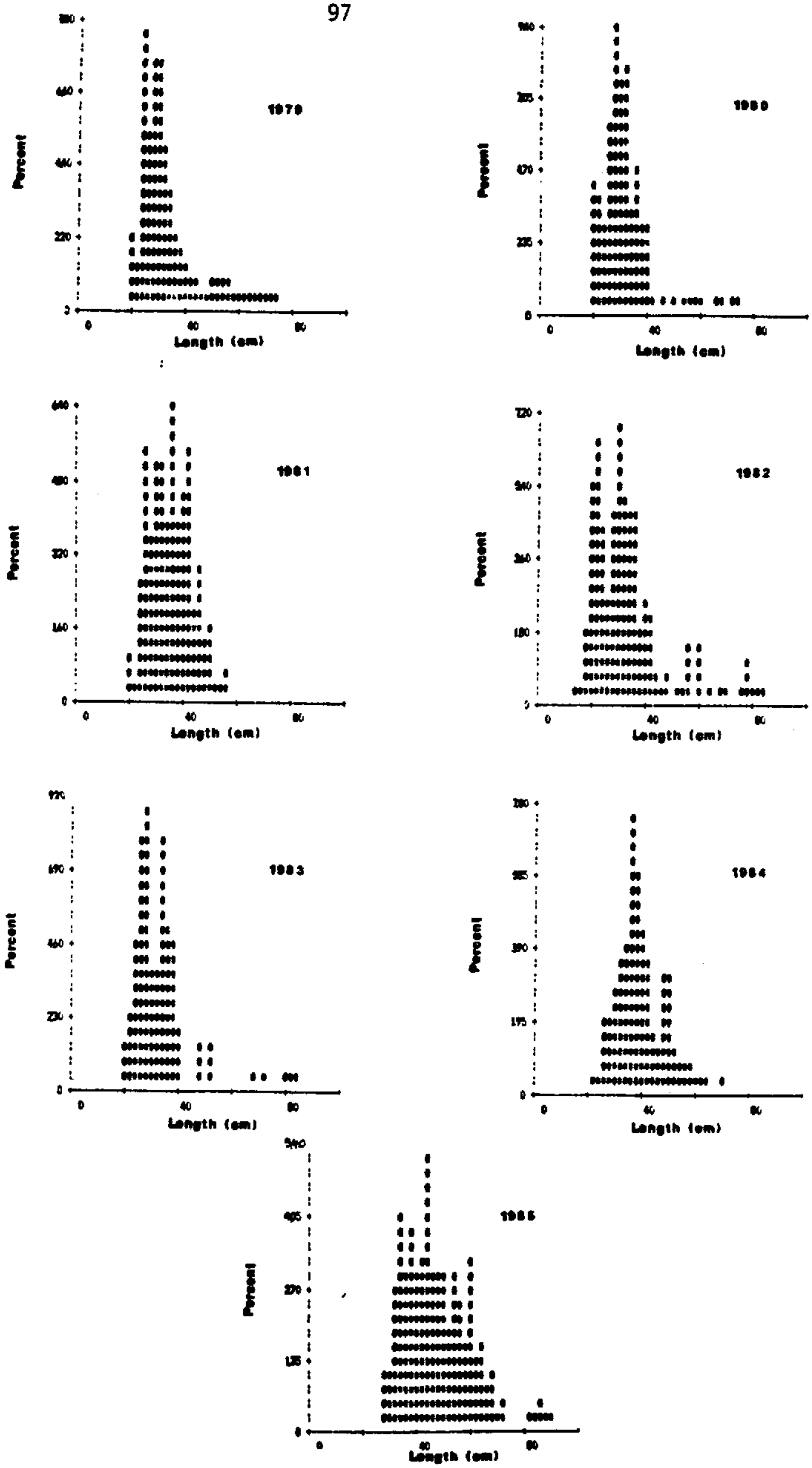


Figure 2. Estimated annual length specific catches of Gulf of Mexico red snapper during 1979-85 for the eastern stock.

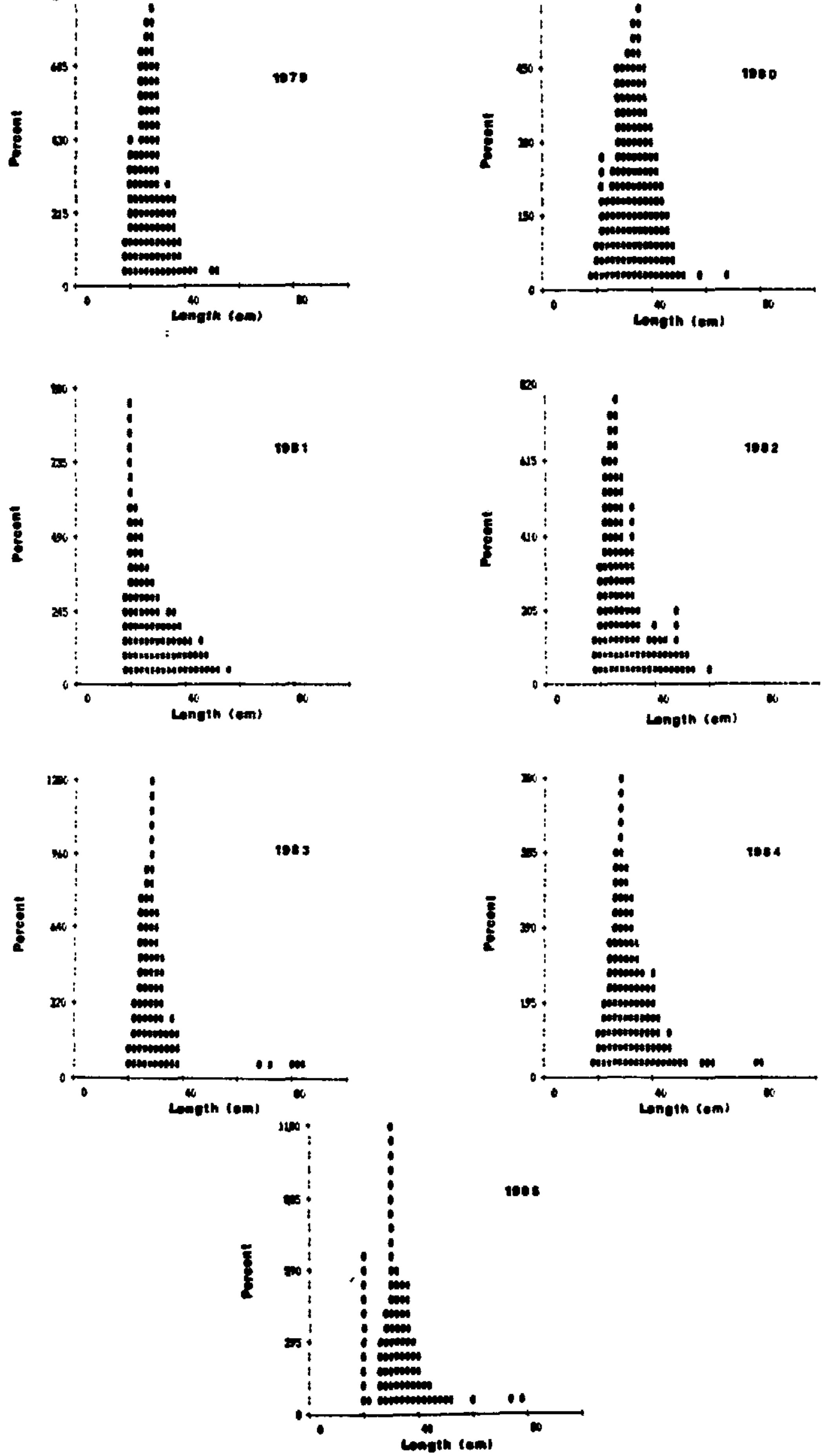


Figure 3. Estimated annual length specific catches of Gulf of Mexico red snapper during 1979-85 for the western stock.

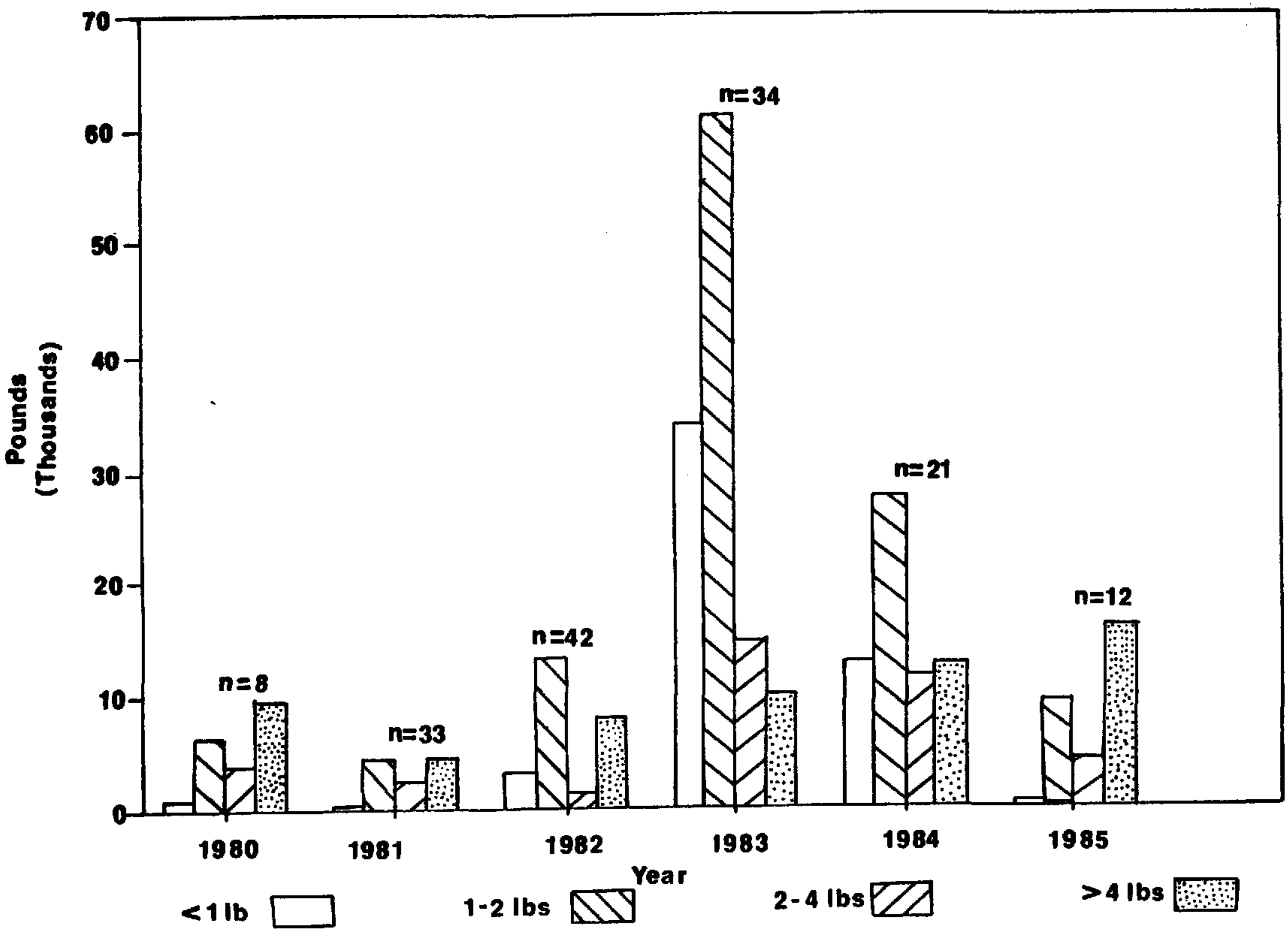


Figure 4. Catches of Red Snapper by Weight Class Groups for Positive Red Snapper Trips for Commercial Rod and Reel and Bottom Longline Trips for First Quarter of Each Year.

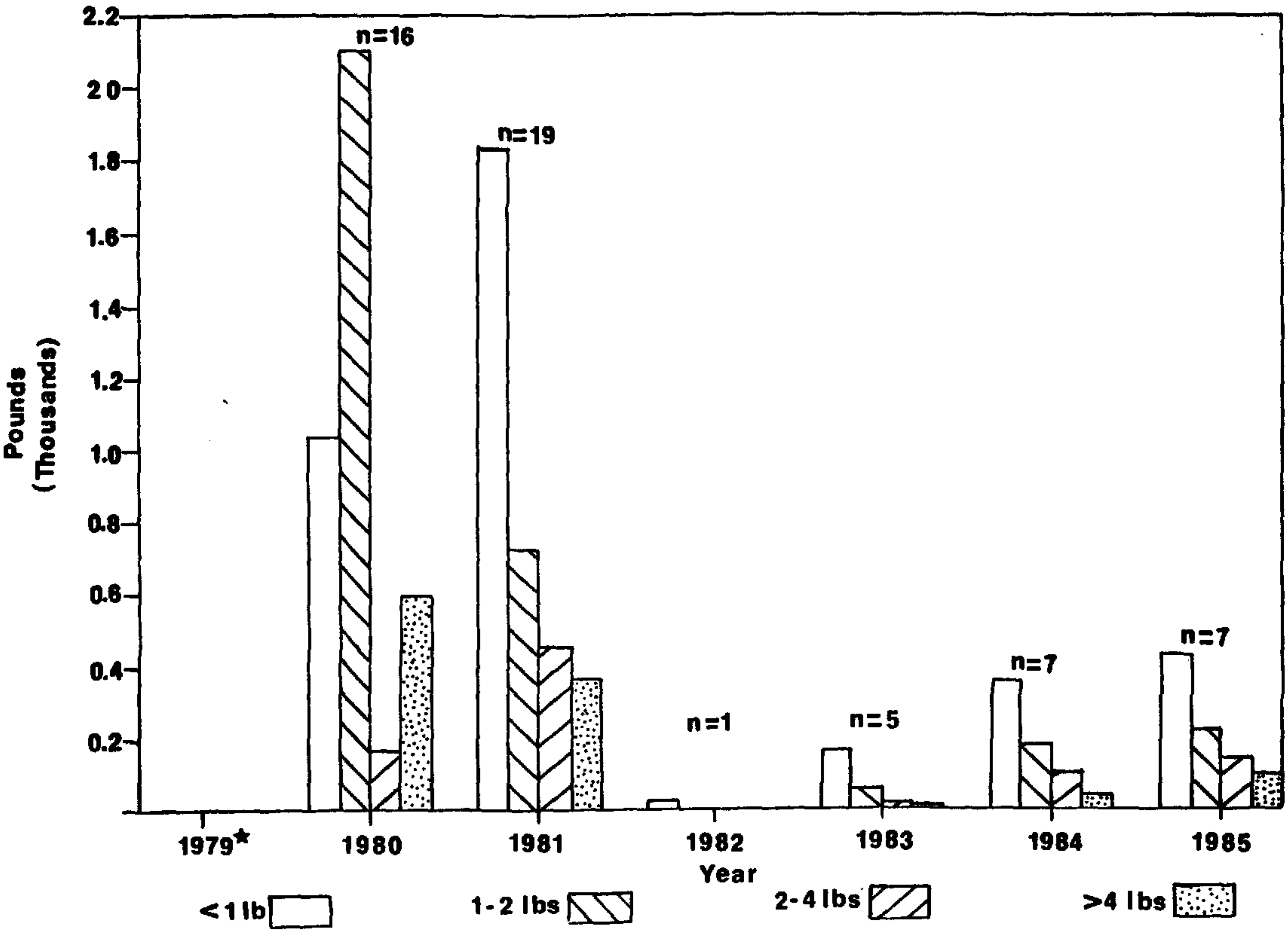
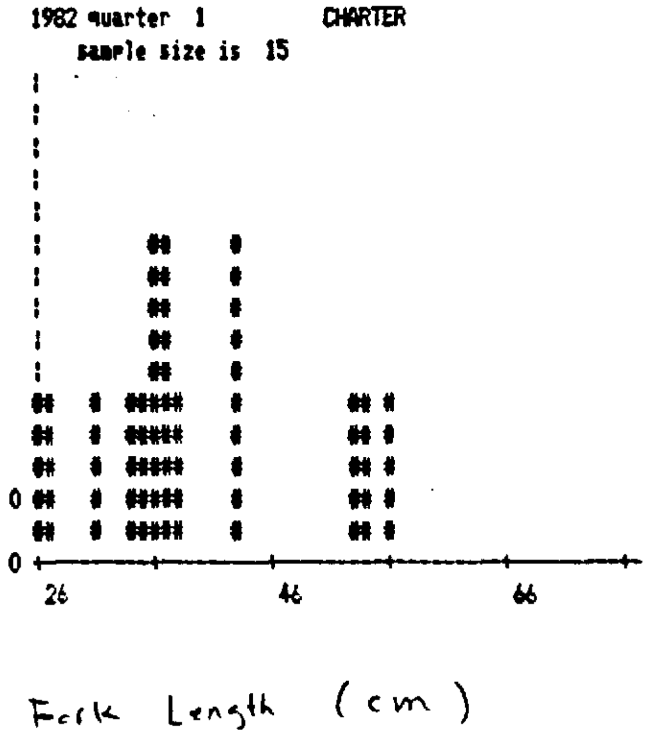
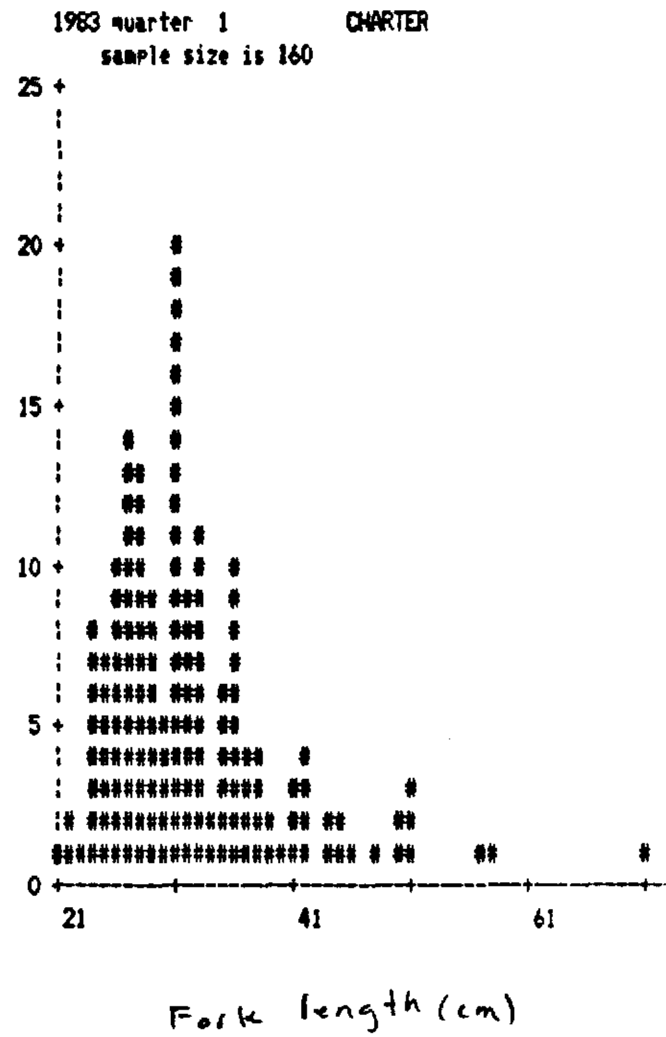


Figure 5. Catches of Red Snapper by Weight Class Groups for Positive Red Snapper Trips for Shrimp By-catch for First Quarter of Each Year.





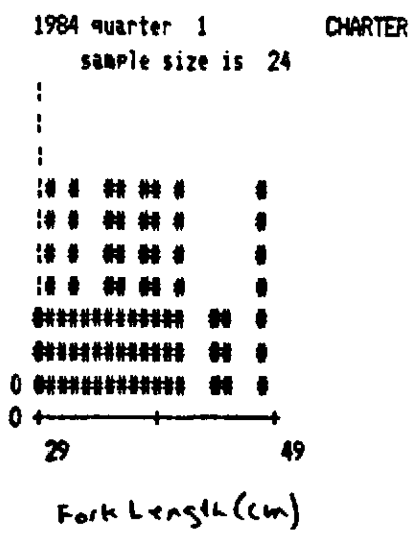


Figure 6. Length frequencies from recreational charterboat catches of red snapper in the eastern Gulf of Mexico during 1982-1985.

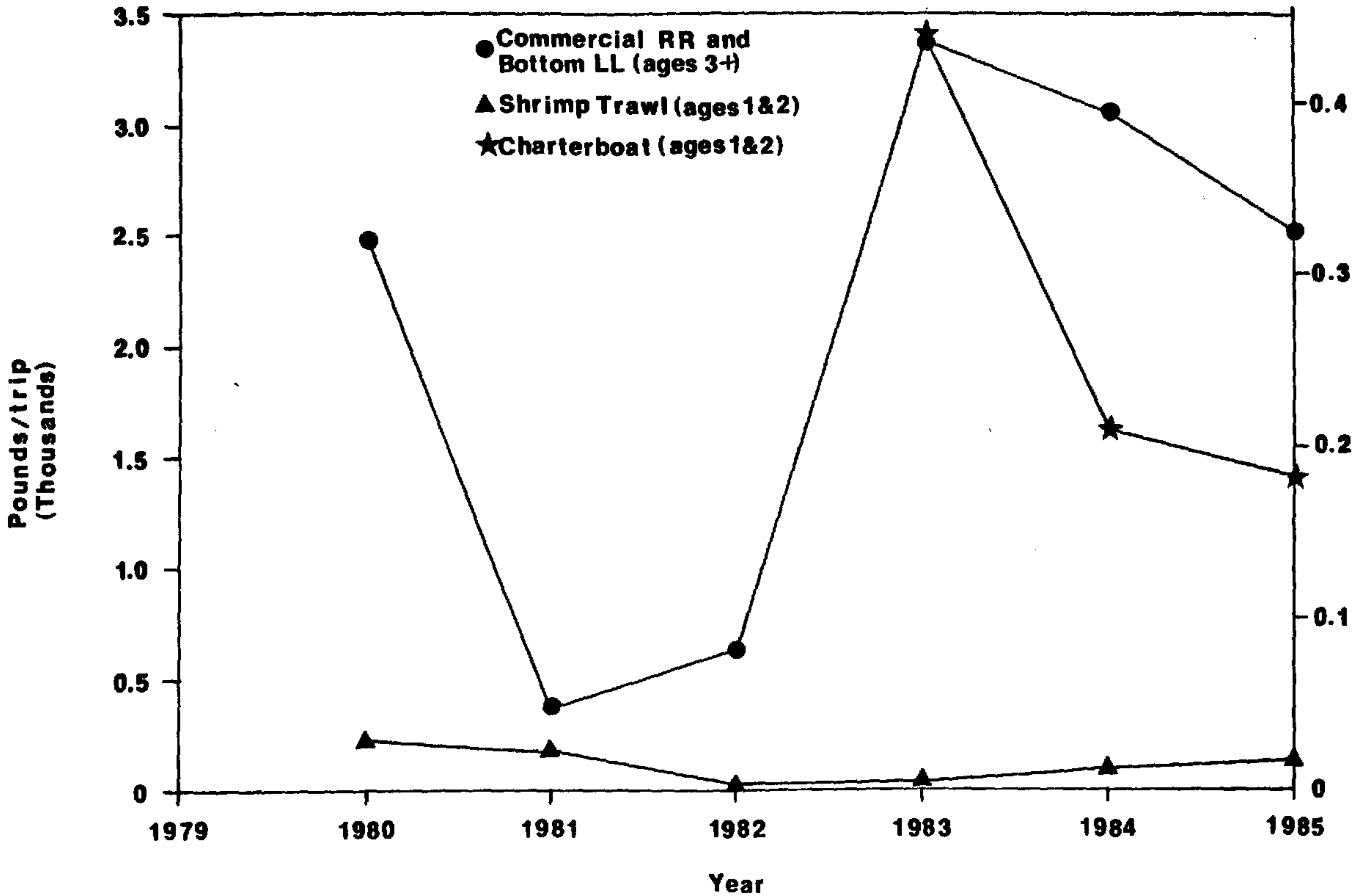


Figure 7. Catch per unit of effort from red snapper commercial bottom longline and rod and reel (combined) and shrimp trawl trips (Pounds per trip) and from recreational charterboat catches (catch per fishing hour) during quarter 1, 1980-1985 in the eastern Gulf of Mexico.

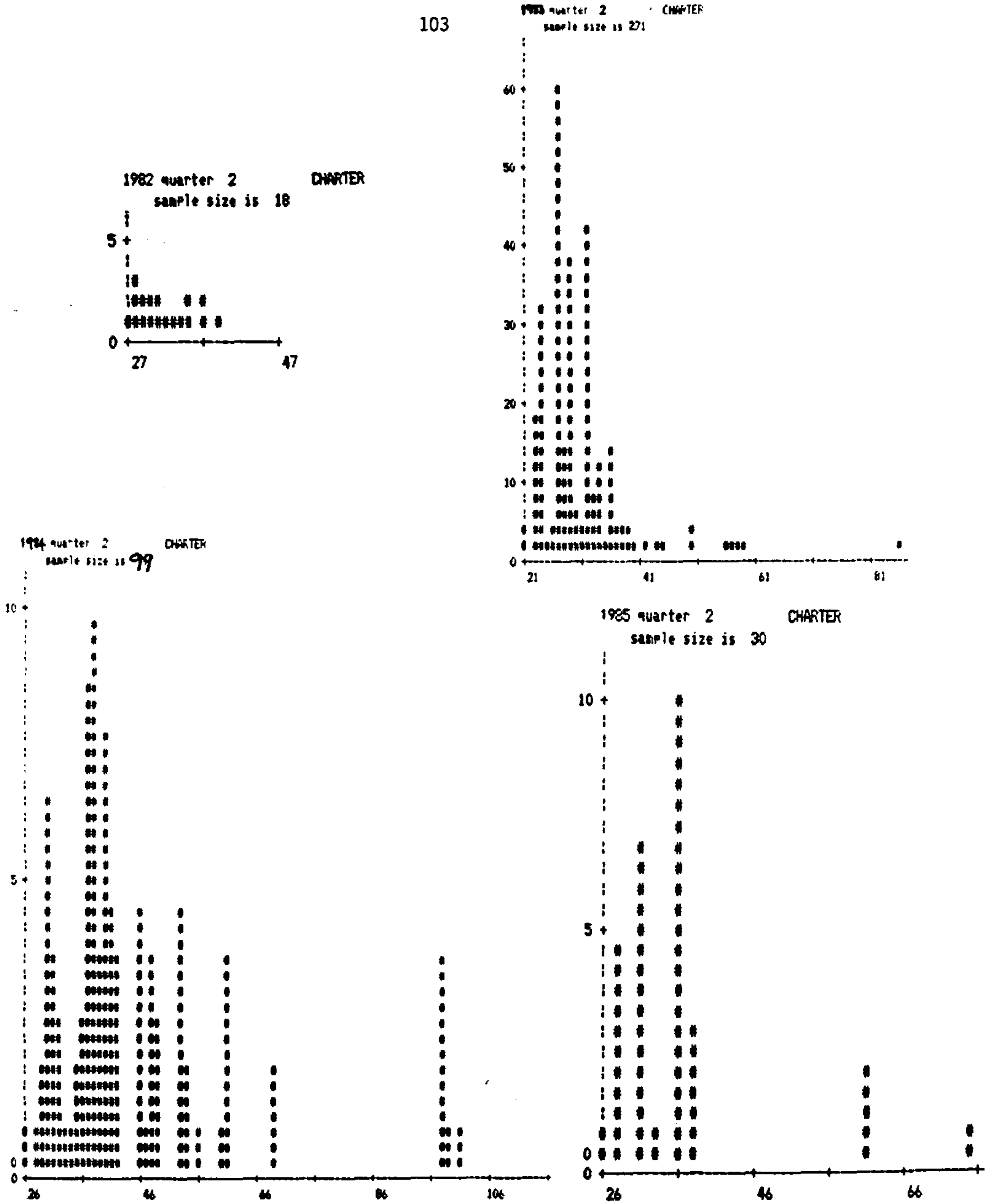


Figure 8. Length frequencies from recreational charterboat catches of red snapper in the western Gulf of Mexico during 1982–1985
(Fork Length in cm)

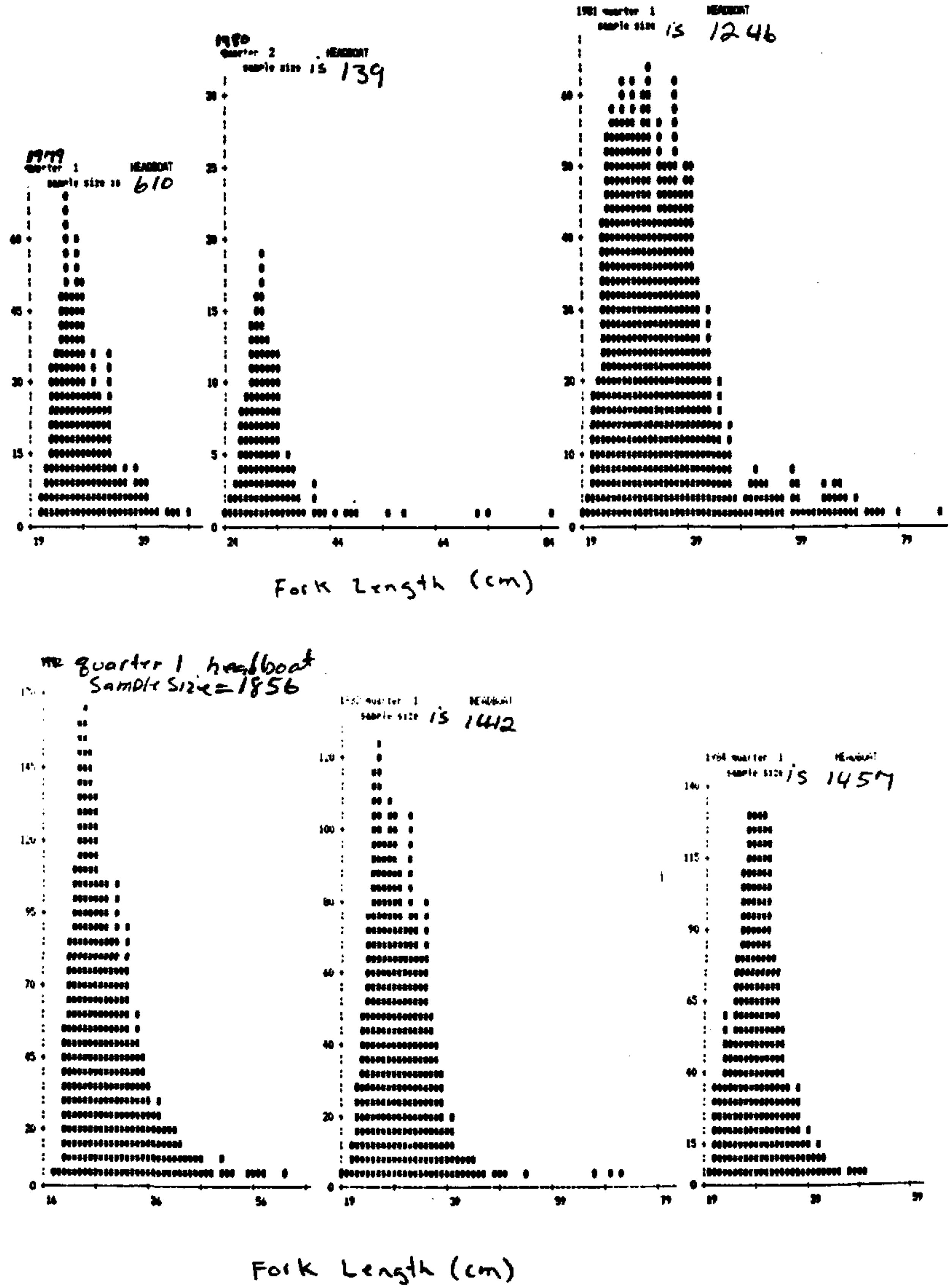


Figure 9. Length frequencies from recreational headboat catches of red snapper in the western Gulf of Mexico during 1979-1985.

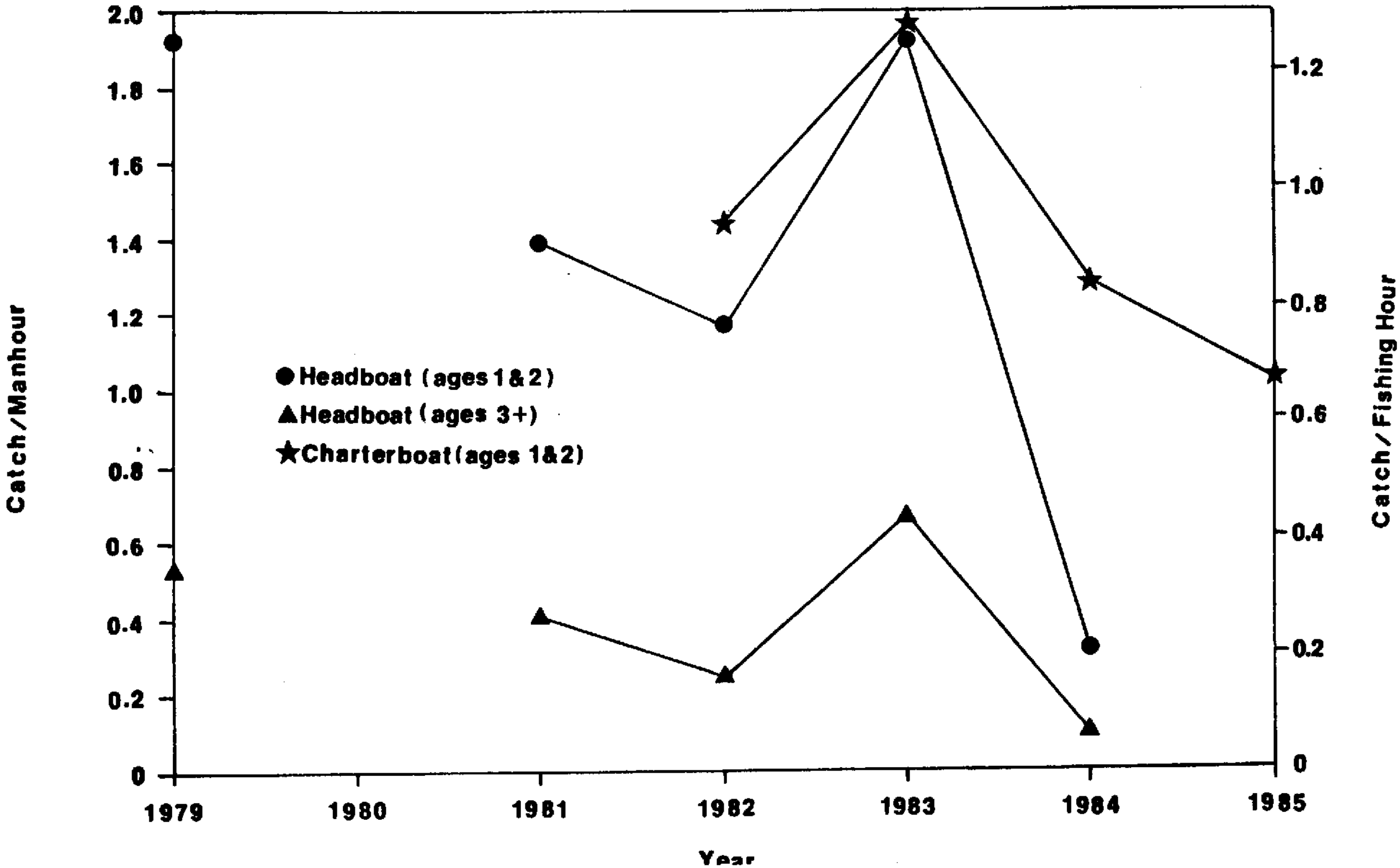


Figure 10. Catch per unit of effort of red snapper from recreational headboats (catch per man-hour) and charterboats (catch per fishing hour) during quarter 1, 1979-1985 in the western Gulf of Mexico.

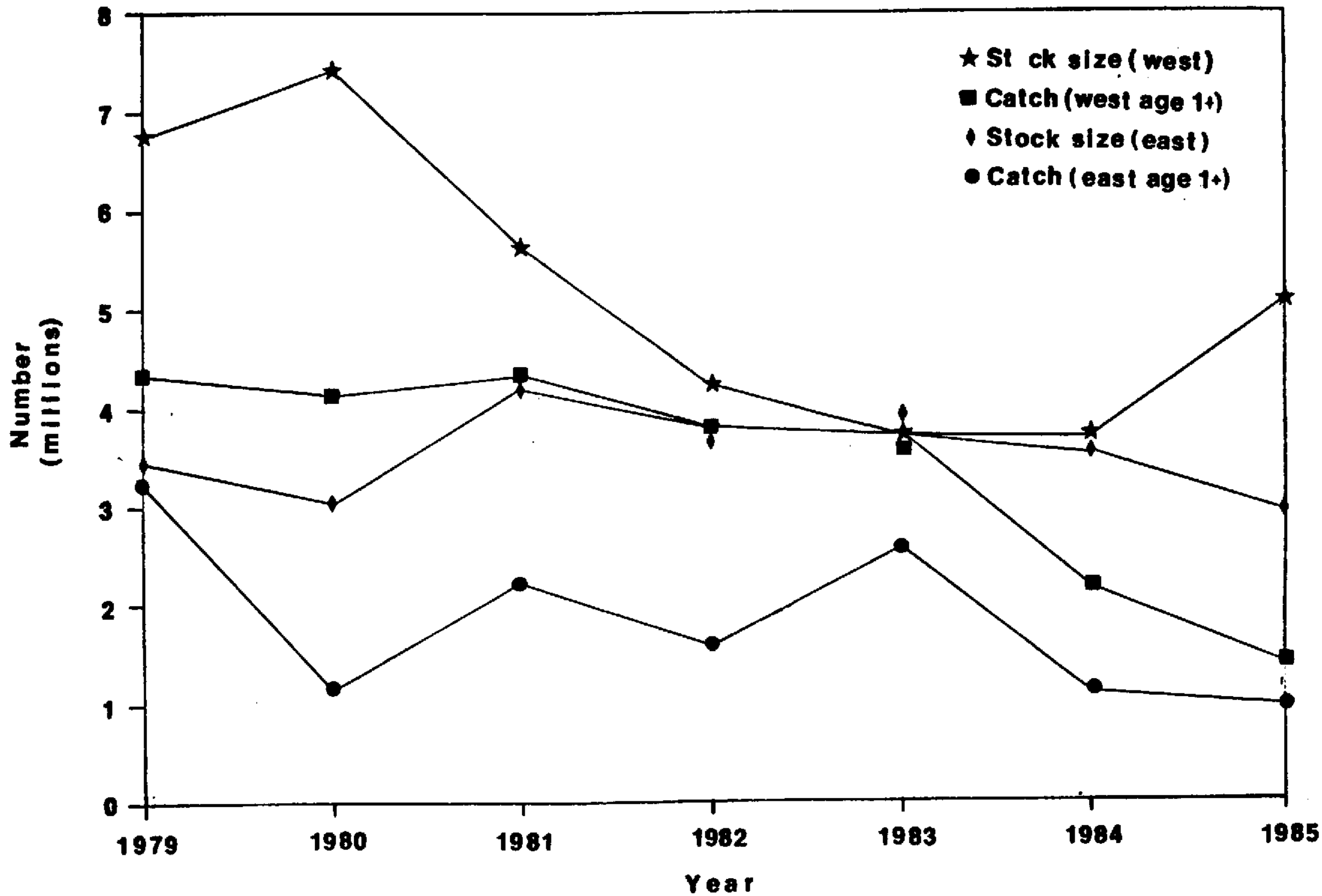


Figure 11. Estimated annual VPA stock sizes of ages 3 plus (M = 0.2) and estimated annual total catches for the eastern and western Gulf of Mexico red snapper stocks.

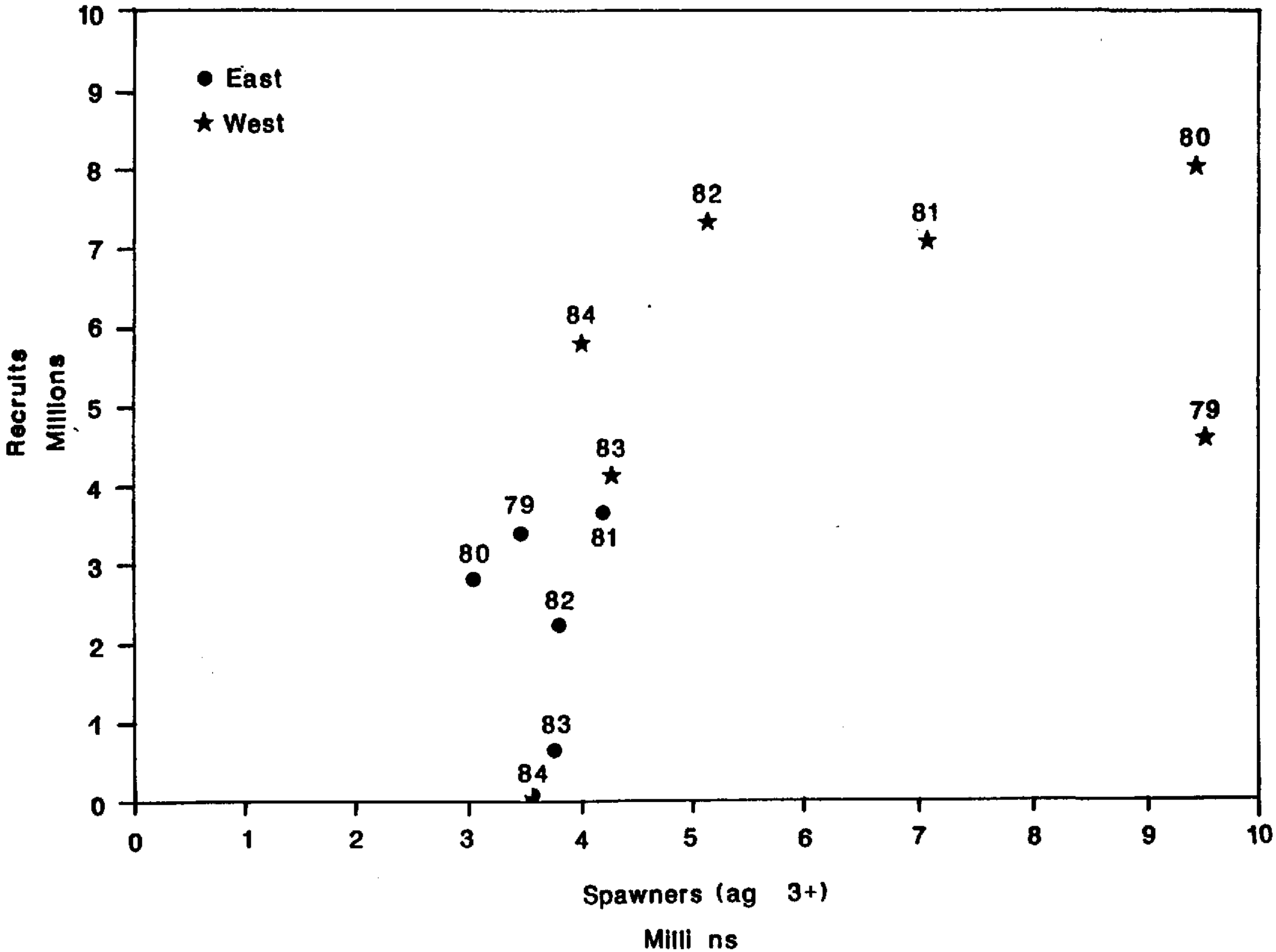


Figure 12. Estimated annual VPA stock sizes of ages 3 plus and of recruits (M = 0.2) for the eastern and western Gulf of Mexico red snapper stocks.

Appendix

Table 1. Historical catches (Pounds) of red snapper, _Lutjanus campechanus_,[1] by GM state landed and area of catch[2] during 1964 to 1985.

	State Landed										All States Combined	
	Florida[2]		Alabama		Mississippi		Louisiana		Texas			
Year	U.S. Shelf	Foreign	U.S. Shelf	Foreign	U.S. Shelf	Foreign	U.S. Shelf	Foreign	U.S. Shelf	Foreign	U.S. Shelf	Foreign
1964	4898988	2146392	74300	2318600	513600	1335600	309900		1264100	985700	7060888	6786292
1965	5043060	1497960	94300	2400800	627600	1737900	242800		1210800	1001000	7218560	6637660
1966	3742632	1820124	308900	2392400	727200	2047700	207700		1049600	603500	6036032	6863724
1967	4108860	1305504	533100	1755300	1251200	1574400	301800		828800	579800	7023760	5215004
1968	4008096	615276	831800	382000	1831000	1820000	276900		719300	408200	7667096	3225476
1969	4004856	577584	413500	832400	1350800	1592000	129600		619400	305300	6518156	3307284
1970	3840696	290844	545300	437900	1538300	980700	254800		676400	240000	6855496	1949444
1971	3857544	311256	722800	216400	1878100	520900	161600		862400	220000	7482444	1268556
1972	3647808	338796	733037	317554	1537050	728600	258875		938000	300000	7114770	1684950
1973	3883896	154008	727766	232641	1837490	493600	353791		669400	112000	7472343	992249
1974	4810536	147420	693129	197593	1614950	284800	286224		662900	80000	8067739	709813
1975	4682664	99144	723285	109665	1324600	384500	150756		518300	109100	7399605	702409
1976	4233168	71280	533710	101145	1331800	543600	57877		341100	154000	6497655	870025
1977	3030588	30996	343214	176487	1274550	164900	99085		305000	135000	5052437	507383
1978	2873340	97092	276452	149880	1003040	90500	71022		227200	150000	4451054	487472
1979	2900340		248273	287003	890590	166800	175931		134600	80000	4349734	533803
1980	3014888		164074	253485	735600	194000	201430		230700	80700	4346692	528185
1981	3379129		346142	157979	673570	301800	421283		521400	57000	5341524	516779
1982	3576728		514327	66291	958450	83000	467941		529500		6046946	149291
1983	4113849		442760	92400	1096080	20200	718361		724200		7095250	112600
1984	2806236		339988		759705[3]	103700	1487456		723300		6116685	103700
1985	1760450[4]		199280		421736[3]	372300	1155904		766800		4304170[4]	372300

[1]May include catches of snappers other than _Lutjanus campechanus_ marketed as red snapper (particularly in catches taken outside the U.S. GM zones 1-21).

[2]Area of catch designated as: 1. U.S. Shelf - inclusive of catches taken from statistical zones 1-21.
2. Foreign - catches taken within GM waters only and outside of statistical zones 1-21.

[3]Adjusted using data from Table 3.

[4]Preliminary figures.

Data Source: NOAA, NMFS, SEFC, ESO.

Appendix.

Table 2. Proportion (cumulative) of annual red snapper (Lutjanus campechanus) catches by gear and age group for the eastern Gulf of Mexico stock.

Commercial Rod & Reel

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
79	0.0002	0.0003	0.0007	0.0012	0.0090	0.0306	0.0327	0.0345	0.0478	0.0514	0.0532	0.0547	0.0555	0.0557	0.0557	0.0559
80	0.0033	0.0070	0.0102	0.0147	0.0198	0.0329	0.0609	0.0877	0.0982	0.1169	0.1239	0.1262	0.1268	0.1271	0.1271	0.1309
81	0.0001	0.0135	0.0981	0.1763	0.2276	0.2365	0.2396	0.2435	0.2437	0.2439	0.2446	0.2453	0.2454	0.2454	0.2455	0.2456
82	0.0015	0.0045	0.0073	0.0093	0.0125	0.0170	0.0231	0.0267	0.0358	0.0770	0.0862	0.0864	0.0866	0.0868	0.0871	0.0877
83	0.1655	0.2232	0.2335	0.2336	0.2337	0.2351	0.2352	0.2497	0.2500	0.2506	0.2762	0.2763	0.2763	0.2763	0.2763	0.2764
84	0.0223	0.1499	0.2835	0.3273	0.3709	0.3950	0.4012	0.4079	0.4093	0.4133	0.4207	0.4207	0.4209	0.4209	0.4210	0.4210
85	0.0000	0.0098	0.0509	0.1053	0.1554	0.1706	0.1942	0.1942	0.2031	0.2099	0.2104	0.2130	0.2136	0.2136	0.2136	0.2136

Commercial Trawl

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
79	0.0000	0.0000	0.0000	0.0000	0.0003	0.0006	0.0006	0.0007	0.0009	0.0009	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
80	0.0001	0.0003	0.0004	0.0007	0.0008	0.0012	0.0022	0.0033	0.0036	0.0043	0.0045	0.0046	0.0046	0.0047	0.0047	0.0048
81	0.0000	0.0005	0.0035	0.0063	0.0080	0.0083	0.0085	0.0086	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087	0.0087
82	0.0001	0.0002	0.0003	0.0004	0.0005	0.0007	0.0009	0.0011	0.0015	0.0028	0.0031	0.0031	0.0031	0.0031	0.0032	0.0032
83	0.0055	0.0074	0.0078	0.0078	0.0078	0.0078	0.0078	0.0083	0.0083	0.0083	0.0092	0.0092	0.0092	0.0092	0.0092	0.0092
84	0.0010	0.0051	0.0092	0.0102	0.0109	0.0110	0.0114	0.0114	0.0115	0.0115	0.0115	0.0115	0.0115	0.0115	0.0115	0.0115
85	0.0000	0.0030	0.0073	0.0092	0.0098	0.0104	0.0105	0.0105	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108	0.0108

Commercial Bottom Longline

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
80	0.0002	0.0005	0.0005	0.0009	0.0011	0.0018	0.0032	0.0040	0.0047	0.0054	0.0058	0.0061	0.0062	0.0063	0.0064	0.0064
81	0.0000	0.0012	0.0086	0.0154	0.0198	0.0205	0.0210	0.0213	0.0213	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214	0.0214
82	0.0002	0.0005	0.0007	0.0009	0.0010	0.0015	0.0020	0.0025	0.0033	0.0066	0.0082	0.0083	0.0083	0.0084	0.0084	0.0085
83	0.0317	0.0428	0.0448	0.0448	0.0448	0.0451	0.0451	0.0479	0.0480	0.0481	0.0530	0.0530	0.0530	0.0530	0.0530	0.0530
84	0.0002	0.0019	0.0053	0.0065	0.0126	0.0229	0.0239	0.0243	0.0256	0.0298	0.0331	0.0338	0.0338	0.0338	0.0338	0.0339
85	0.0003	0.0020	0.0048	0.0063	0.0072	0.0093	0.0125	0.0140	0.0146	0.0150	0.0151	0.0172	0.0176	0.0177	0.0178	0.0178

Commercial Other

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
84	0.0003	0.0014	0.0027	0.0027	0.0029	0.0029	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030

Sport Rod and Reel

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
79	0.2941	0.6669	0.7640	0.8047	0.8448	0.8843	0.8849	0.9215	0.9398	0.9412	0.9423	0.9427	0.9428	0.9429	0.9430	0.9431
80	0.1676	0.6497	0.8370	0.8377	0.8529	0.8543	0.8547	0.8550	0.8565	0.8566	0.8568	0.8570	0.8572	0.8573	0.8575	0.8579
81	0.1193	0.3533	0.6381	0.7126	0.7173	0.7175	0.7204	0.7204	0.7210	0.7236	0.7238	0.7240	0.7241	0.7241	0.7241	0.7243
82	0.2537	0.5450	0.7799	0.8258	0.8281	0.8846	0.8955	0.8956	0.8957	0.8961	0.8966	0.8999	0.9000	0.9000	0.9001	0.9005
83	0.0789	0.4133	0.5793	0.6061	0.6531	0.6543	0.6544	0.6551	0.6572	0.6578	0.6580	0.6600	0.6601	0.6606	0.6610	0.6614
84	0.0471	0.2067	0.4015	0.4221	0.5002	0.5020	0.5136	0.5264	0.5292	0.5295	0.5297	0.5298	0.5299	0.5300	0.5303	0.5305
85	0.0037	0.0960	0.2510	0.3891	0.4745	0.6037	0.6621	0.7181	0.7182	0.7183	0.7185	0.7281	0.7560	0.7566	0.7575	0.7578

Appendix.

Table 3. Proportion (cumulative) of annual red snapper (Lutjanus campechanus) catches by gear and age group for the western Gulf of Mexico stock.

Commercial Rod & Reel

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
79	0.0012	0.1159	0.2392	0.2723	0.2828	0.2864	0.2865	0.2895	0.2952	0.2952	0.2952	0.2952	0.2952	0.2952	0.2953	0.2953
80	0.0001	0.0397	0.1083	0.1809	0.1990	0.1994	0.2009	0.2026	0.2036	0.2046	0.2046	0.2046	0.2046	0.2046	0.2047	0.2049
81	0.0001	0.0042	0.0438	0.1142	0.1492	0.1538	0.1573	0.1573	0.1573	0.1574	0.1580	0.1581	0.1585	0.1585	0.1586	0.1586
82	0.0003	0.0522	0.1102	0.1913	0.2254	0.2349	0.2414	0.2418	0.2418	0.2429	0.2431	0.2431	0.2431	0.2432	0.2432	0.2433
83	0.0362	0.2177	0.2338	0.2339	0.2340	0.2356	0.2372	0.2554	0.2555	0.2555	0.2934	0.2935	0.2935	0.2936	0.2936	0.2936
84	0.0025	0.1487	0.2925	0.3501	0.3554	0.3811	0.3941	0.3941	0.3985	0.4268	0.4280	0.4288	0.4289	0.4289	0.4290	0.4290
85	0.0001	0.0776	0.2079	0.2554	0.2822	0.3010	0.3186	0.3211	0.3252	0.3455	0.3570	0.3570	0.3572	0.3572	0.3573	0.3573

Commercial Trawl

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
79	0.0002	0.0098	0.0159	0.0171	0.0178	0.0178	0.0179	0.0181	0.0183	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184
80	0.0000	0.0031	0.0058	0.0095	0.0097	0.0098	0.0098	0.0100	0.0100	0.0102	0.0102	0.0102	0.0102	0.0102	0.0102	0.0102
81	0.0000	0.0004	0.0034	0.0077	0.0099	0.0101	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104
82	0.0000	0.0013	0.0030	0.0055	0.0064	0.0068	0.0071	0.0071	0.0072	0.0077	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078
83	0.0021	0.0127	0.0136	0.0136	0.0136	0.0137	0.0138	0.0149	0.0149	0.0149	0.0171	0.0171	0.0171	0.0171	0.0171	0.0171
84	0.0003	0.0090	0.0161	0.0193	0.0197	0.0217	0.0220	0.0220	0.0225	0.0243	0.0244	0.0244	0.0245	0.0245	0.0245	0.0245
85	0.0000	0.0044	0.0096	0.0114	0.0125	0.0135	0.0141	0.0142	0.0146	0.0156	0.0161	0.0161	0.0161	0.0161	0.0161	0.0161

Commercial Bottom Longline

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
80	0.0000	0.0053	0.0094	0.0121	0.0122	0.0124	0.0124	0.0124	0.0126	0.0130	0.0130	0.0131	0.0131	0.0131	0.0131	0.0131
81	0.0000	0.0037	0.0090	0.0206	0.0263	0.0271	0.0278	0.0279	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280	0.0280
82	0.0003	0.0020	0.0045	0.0079	0.0091	0.0099	0.0106	0.0110	0.0119	0.0134	0.0138	0.0138	0.0138	0.0141	0.0143	0.0145
83	0.0061	0.0367	0.0395	0.0396	0.0396	0.0399	0.0400	0.0427	0.0500	0.0500	0.0507	0.0507	0.0507	0.0507	0.0507	0.0507
84	0.0006	0.0135	0.0257	0.0385	0.0386	0.0454	0.0455	0.0455	0.0459	0.0579	0.0584	0.0585	0.0585	0.0585	0.0585	0.0585
85	0.0001	0.0210	0.0435	0.0617	0.0668	0.0696	0.0702	0.0706	0.0795	0.0930	0.0930	0.0930	0.0930	0.0931	0.0931	0.0932

Commercial Other

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
85	0.0002	0.0002	0.0004	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007

Sport Rod and Reel

AGE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
79	0.1538	0.5401	0.6101	0.6192	0.6510	0.6649	0.6732	0.6734	0.6808	0.6810	0.6812	0.6812	0.6853	0.6853	0.6862	0.6863
80	0.0406	0.2781	0.6426	0.7075	0.7110	0.7331	0.7331	0.7431	0.7528	0.7590	0.7684	0.7715	0.7718	0.7718	0.7718	0.7719
81	0.3132	0.6184	0.7446	0.7787	0.7914	0.7942	0.7964	0.7988	0.8006	0.8018	0.8018	0.8022	0.8023	0.8024	0.8026	0.8029
82	0.0584	0.6069	0.6861	0.7034	0.7241	0.7249	0.7318	0.7319	0.7332	0.7335	0.7337	0.7338	0.7338	0.7339	0.7341	0.7344
83	0.0406	0.4724	0.6199	0.6268	0.6322	0.6329	0.6345	0.6349	0.6368	0.6368	0.6369	0.6370	0.6374	0.6377	0.6385	0.6386
84	0.0452	0.3637	0.4612	0.4767	0.4802	0.4817	0.4821	0.4846	0.4861	0.4863	0.4864	0.4864	0.4871	0.4873	0.4873	0.4880
85	0.1119	0.3382	0.5050	0.5199	0.5213	0.5245	0.5274	0.5280	0.5311	0.5316	0.5323	0.5323	0.5323	0.5323	0.5327	0.5328

Appendix

Table 4. Estimated annual (age specific) fishing mortality rates for the stochastically derived catches of the eastern Gulf of Mexico red snapper stock (M=0.10).

	Fishing Mortalities						
AGE	1979	1980	1981	1982	1983	1984	1985
1	0.3354	0.1006	0.1554	0.1802	0.6043	0.2274	0.1817*
2	0.8446	0.3046	0.3928	0.3813	0.7642	0.5262	0.4542*
3	0.5937	0.3172	0.8525	0.4530	0.7291	0.6017	0.6056
4	0.5085	0.0196	1.2060	0.1500	0.1232	0.2071	0.6056
5	1.1103	0.1430	0.5874	0.0393	0.3290	0.3502	0.6056
6	0.8250	0.3105	0.1714	1.0467	0.0633	0.1530	0.6056
7	0.0228	0.2964	0.3952	0.3043	0.0155	0.2216	0.6056
8	1.1187	0.1062	0.1139	0.2889	1.0600	0.6778	0.6056
9	1.2472	0.3261	0.0061	0.2492	0.4088	0.3087	0.6056
10	0.6796	1.0045	0.1953	0.3583	0.0787	1.7427	0.6056
11	0.7165	0.9008	0.1814	1.1669	0.7338	0.3113	0.6056
12	0.9031	0.5267	0.5057	0.9816	1.1359	0.0128	0.6056
13	0.9788	0.3400	0.0532	0.1747	0.1699	0.2270	0.6056
14	0.7293	0.4896	0.0622	0.1730	0.7093	0.0729	0.6056
15	0.7861	0.3984	0.3609	0.4488	0.4630	0.4072	0.6056

* Starting F determined as the average of ages 1 and 2 to full F over 1979-83.

Appendix

Table 5. Estimated annual (age specific) stock sizes for the stochastically derived catches of the eastern Gulf of Mexico red snapper stock (M=0.10)

	Initial Stock Sizes							
AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	3503610	2193725	1947703	2709518	1679206	403183	23823	0
2	2208861	2266745	1794920	1508731	2047493	830276	290622	17975
3	737247	858846	1512451	1096536	932327	862825	443898	166972
4	349430	368420	565909	583491	630782	406896	427728	219202
5	242083	190152	326886	153311	454441	504604	299296	211217
6	369555	72164	149126	164387	133378	295903	321686	147796
7	398691	146533	47869	113682	52224	113286	229762	158852
8	193231	352613	98575	29173	75875	46527	82129	113459
9	149912	57122	286924	79594	19773	23785	21374	40556
10	34516	38971	37302	258032	56133	11888	15806	10555
11	19304	15828	12914	27765	163173	46948	1883	7805
12	11360	8532	5818	9746	7822	70880	31115	930
13	4659	4166	4559	3175	3305	2273	63322	15365
14	2118	1584	2683	3911	2412	2523	1639	31269
15	481	924	878	2281	2977	1074	2122	809
total	8225060	6576326	6794516	6743334	6261319	3622871	2256205	1142763

Correlation between observed CPUE and stocksize = 0.9429

Appendix

Table 6. Estimated annual (age specific) fishing mortality rates for the stochastically derived catches of the eastern Gulf of Mexico red snapper stock (M=0.20).

	Fishing Mortalities						
AGE	1979	1980	1981	1982	1983	1984	1985
1	0.2407	0.0669	0.1103	0.1371	0.4410	0.1449	0.1131*
2	0.6543	0.2209	0.2671	0.2782	0.5768	0.3598	0.2828*
3	0.4467	0.2353	0.5787	0.2960	0.5023	0.4161	0.3770
4	0.3579	0.0151	0.7966	0.0941	0.0802	0.1346	0.3770
5	0.9016	0.1007	0.4700	0.0225	0.2095	0.2331	0.3770
6	0.5441	0.2395	0.1277	0.7716	0.0392	0.0985	0.3770
7	0.0131	0.1746	0.3121	0.2371	0.0108	0.1444	0.3770
8	0.9267	0.0657	0.0680	0.2353	0.7803	0.4738	0.3770
9	1.0614	0.2598	0.0041	0.1535	0.3473	0.2040	0.3770
10	0.5640	0.7663	0.1636	0.2515	0.0503	1.3682	0.3770
11	0.5194	0.7145	0.1307	0.9775	0.4797	0.2059	0.3770
12	0.6702	0.3491	0.3766	0.6615	0.8290	0.0080	0.3770
13	0.7723	0.2329	0.0352	0.1315	0.1023	0.1480	0.3770
14	0.5589	0.3578	0.0441	0.1220	0.5319	0.0463	0.3770
15	0.6114	0.2926	0.2589	0.3295	0.3302	0.2901	0.3770

* Starting F determined as the average of ages 1 and 2 to full F over 1979-83.

Appendix

Table 7. Estimated annual (age specific) stock sizes for the stochastically derived catches of the eastern Gulf of Mexico red snapper stock (M = 0.20)

	Initial Stock Sizes							
AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	4894762	3406301	2816733	3658898	2237090	637937	38844	0
2	2743683	3150160	2608341	2065322	2611960	1178381	451848	28402
3	959637	1167623	2068033	1634901	1280334	1201154	673235	278829
4	485212	502642	755567	949253	995592	634311	648711	378076
5	285262	277736	405378	278905	707354	752294	453926	364303
6	518297	94802	205616	207432	223271	469677	487882	254916
7	725479	246271	61084	148167	78512	175770	348467	273985
8	224754	586241	169329	36602	95704	63589	124561	195693
9	170293	72846	449452	129516	23684	35906	32417	69951
10	41312	48235	45998	366472	90954	13701	23972	18205
11	25524	19244	18352	31978	233331	70816	2856	13462
12	14472	12431	7711	13185	9851	118242	47191	1604
13	5649	6062	7179	4332	5571	3520	96036	26501
14	2681	2137	3932	5674	3110	4118	2486	53932
15	999	1255	1223	3080	4112	1496	3219	1396
total	11097619	9593986	9623929	9533718	8600428	5360912	3435651	1959254

Correlation between observed CPUE and stocksize = 0.9609

Appendix

Table 8. Estimated annual (age specific) fishing mortality rates for the stochastically derived catches of the eastern Gulf of Mexico red snapper stock (M = 0.30).

	Fishing Mortalities						
AGE	1979	1980	1981	1982	1983	1984	1985
1	0.1347	0.0341	0.0621	0.0855	0.2544	0.0718	0.0557*
2	0.4055	0.1234	0.1393	0.1596	0.3488	0.1918	0.1394*
3	0.2880	0.1340	0.2989	0.1487	0.2687	0.2247	0.1858
4	0.2089	0.0098	0.3988	0.0451	0.0404	0.0679	0.1858
5	0.6712	0.0588	0.3147	0.0099	0.1027	0.1205	0.1858
6	0.2637	0.1674	0.0788	0.4569	0.0188	0.0493	0.1858
7	0.0058	0.0766	0.2224	0.1512	0.0059	0.0731	0.1858
8	0.7037	0.0313	0.0308	0.1715	0.4555	0.2593	0.1858
9	0.7835	0.1858	0.0021	0.0725	0.2595	0.1048	0.1858
10	0.4181	0.4672	0.1219	0.1359	0.0248	0.8872	0.1858
11	0.3026	0.4890	0.0725	0.6979	0.2416	0.1058	0.1858
12	0.4131	0.1851	0.2356	0.3406	0.4787	0.0039	0.1858
13	0.5177	0.1313	0.0187	0.0824	0.0476	0.0750	0.1858
14	0.3634	0.2153	0.0258	0.0695	0.3267	0.0229	0.1858
15	0.4116	0.1793	0.1517	0.1985	0.1892	0.1662	0.1858

* Starting F determined as the average of ages 1 and 2 to full F over 1979-83.

Appendix

Table 9. Estimated annual (age specific) stock sizes for the stochastically derived catches of the eastern Gulf of Mexico red snapper stock (M = 0.30).

	Initial Stock Sizes							
AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	8721115	6899104	5127095	6002542	3730362	1303366	80420	0
2	4149501	5646417	4939593	3569575	4082512	2142870	898640	56347
3	1449806	2049314	3697516	3183627	2254353	2133863	1310401	579133
4	813089	805301	1327829	2031529	2032525	1276496	1262666	806165
5	362999	488810	590743	660191	1438678	1446072	883532	776799
6	986751	137444	341445	319491	484262	961803	949626	543553
7	1722221	561554	86129	233792	149883	352077	678266	584215
8	281308	1268514	385317	51082	148888	110380	242448	417272
9	214683	103103	910756	276791	31880	69942	63097	149155
10	54620	72650	63432	673273	190721	18220	46660	38818
11	41592	26638	33734	41600	435393	137823	5558	28706
12	21929	22767	12101	23243	15335	253315	91853	3419
13	7890	10748	14016	7083	12248	7039	186927	56509
14	3953	3483	6983	10191	4832	8652	4838	114999
15	852	2036	2080	5041	7043	2582	6265	2976
total	18832308	18097883	17538771	17089051	15018914	10224501	6711199	4158065

Correlation between observed CPUE and stocksize = 0.9332

Appendix

Table 10. Estimated annual (age specific) fishing mortality rates for the stochastically derived catches of the wsetern Gulf of Mexico red snapper stock (M = 0.10).

	Fishing Mortalities						
AGE	1979	1980	1981	1982	1983	1984	1985
1	0.1928	0.0661	0.2991	0.0544	0.0876	0.0483	0.0428
2	0.5515	0.5264	0.9202	1.0684	1.1023	0.4055	0.2673
3	0.5299	1.0755	0.6926	1.1239	0.8589	0.7191	0.2673
4	0.2233	0.7674	0.9538	0.8635	0.1198	0.6228	0.2673
5	0.3250	0.1417	0.7393	1.3401	0.0827	0.1135	0.2673
6	1.0668	0.2406	0.0714	0.2539	0.1544	0.4421	0.2673
7	0.1094	0.1853	0.0968	0.1324	0.0997	0.8150	0.2673
8	0.2076	0.1915	0.5336	0.0137	0.2718	0.0499	0.2673
9	0.7991	1.3874	0.0378	0.8980	0.1674	0.0625	0.2673
10	0.0187	1.3515	0.5345	0.0755	0.0843	0.7476	0.2673
11	0.0241	2.0924	0.3312	0.5646	3.6672	2.6982	0.2673
12	0.0398	0.7259	0.6582	0.0984	0.3434	0.9191	0.2673
13	1.8974	0.1817	0.2270	0.1030	0.2494	1.6732	0.2673
14	0.3581	0.0757	0.1204	0.2393	1.7758	0.0958	0.2673
15	0.4666	0.7014	0.4164	0.4755	0.6562	0.7466	0.2673

* Starting F determined as the average of ages 1 and 2 to full F over 1979-83.

Appendix

Table 11. Estimated annual (age specific) stock sizes for the stochastically derived catches of the western Gulf of Mexico red snapper stock (M = 0.10).

	Initial Stock Sizes							
AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	4030896	2759171	5515449	4522264	4045039	2377023	3911375	0
2	5511253	3007720	2336932	3700312	3875355	3353247	2049495	3390987
3	2155940	2872822	1607593	842476	1150267	1164578	2022651	1419484
4	986405	1148325	886766	727673	247744	440914	513382	1400892
5	705876	713934	482349	309124	277638	198854	214017	355569
6	121390	461490	560619	208385	73236	231283	160625	148228
7	367650	37797	328277	472294	146275	56788	134493	111249
8	84176	298189	28415	269623	374353	119799	22744	93150
9	110387	61887	222799	15079	240651	258116	103126	15753
10	51261	44922	13983	194117	5558	184190	219412	71425
11	30451	45522	10522	7414	162869	4623	78916	151965
12	8561	26899	5082	6836	3814	3765	282	54657
13	21340	7444	11777	2381	5606	2448	1359	195
14	1229	2896	5617	8492	1944	3953	416	941
15	9845	777	2429	4506	6049	298	3250	288
total	14196662	11489795	12018609	11290977	10616399	8399879	9435541	7214784

Correlation between observed CPUE and stocksize = 0.7219

Appendix

Table 12. Estimated annual (age specific) fishing mortality rates for the stochastically derived catches of the western Gulf of Mexico red snapper stock (M = 0.20).

	Fishing Mortalities						
AGE	1979	1980	1981	1982	1983	1984	1985
1	0.1542	0.0546	0.2578	0.0460	0.0686	0.0388	0.0371
2	0:4870	0.4370	0.7837	0.9386	0.9611	0.3360	0.2321
3	0.4308	0.9640	0.5735	0.8860	0.7333	0.6092	0.2321
4	0.1370	0.6085	0.8467	0.6839	0.0900	0.5242	0.2321
5	0.2156	0.0896	0.5438	1.1390	0.0651	0.0918	0.2321
6	0.8911	0.1603	0.0481	0.1791	0.1277	0.3674	0.2321
7	0.0799	0.1528	0.0674	0.0955	0.0738	0.6947	0.2321
8	0.1798	0.1490	0.4618	0.0104	0.2059	0.0401	0.2321
9	0.6812	1.2130	0.0318	0.7851	0.1377	0.0503	0.2321
10	0.0167	1.0571	0.4493	0.0696	0.0765	0.6345	0.2321
11	0.0188	1.8956	0.2300	0.4823	3.4586	2.4765	0.2321
12	0.0274	0.5834	0.5593	0.0707	0.3047	0.7883	0.2321
13	1.6033	0.1342	0.1828	0.0914	0.1896	1.4881	0.2321
14	0.2961	0.0587	0.0947	0.2047	1.6135	0.0774	0.2321
15	0.3815	0.5888	0.3408	0.3915	0.5897	0.6535	0.2321

* Starting F determined as the average of ages 1 and 2 to full F over 1979-83.

Appendix

Table 13. Estimated annual (age specific) stock sizes for the stochastically derived catches of the western Gulf of Mexico red snapper stock (M = 0.20).

	Initial Stock Sizes							
AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	5187906	3486130	6577234	5590290	5368123	3088979	4715162	0
2	6340836	3640440	2702564	4161424	4371266	4103640	2432802	3719716
3	2653107	3190087	1925327	1010576	1332806	1368777	2400939	1579240
4	1617906	1411912	996048	888295	341146	524135	609397	1558556
5	1059577	1155021	629054	349717	367017	255270	254043	395587
6	140898	699289	864566	298983	91665	281556	190666	164911
7	520775	47318	487750	674626	204655	66051	159647	123770
8	100575	393636	33250	373299	502012	155633	26998	103634
9	128502	68795	277656	17155	302483	334516	122413	17525
10	60421	53235	16745	220221	6406	215797	260448	79464
11	40895	48651	15145	,8748	168171	4858	93675	169068
12	12978	32860	5984	9852	4422	4334	334	60809
13	23594	10338	15012	2800	7516	2669	1613	217
14	1512	3887	7402	10237	2092	5091	493	1047
15	12124	921	3001	5513	6830	341	3858	320
total	17901605	14242519	14556738	13621736	13076609	10411647	11272490	7973865

Correlation between observed CPUE and stocksize = 0.7996

Appendix

Table 14. Estimated annual (age specific) fishing mortality rates for the stochastically derived catches of the western Gulf of Mexico red snapper stock (M = 0.30).

	Fishing Mortalities						
AGE	1979	1980	1981	1982	1983	1984	1985
1	0.1178	0.0432	0.2169	0.0379	0.0522	0.0305	0.0316
2	0.4225	0.3469	0.6379	0.8040	0.8176	0.2717	0.1972
3	0.3267	0.8474	0.4538	0.6689	0.6091	0.5038	0.1972
4	0.0777	0.4485	0.7327	0.5209	0.0658	0.4307	0.1972
5	0.1330	0.0536	0.3762	0.9401	0.0498	0.0725	0.1972
6	0.7247	0.1018	0.0309	0.1217	0.1029	0.2979	0.1972
7	0.0573	0.1236	0.0454	0.0663	0.0533	0.5782	0.1972
8	0.1521	0.1149	0.3931	0.0076	0.1516	0.0315	0.1972
9	0.5464	1.0353	0.0265	0.6780	0.1102	0.0396	0.1972
10	0.0146	0.7707	0.3689	0.0639	0.0687	0.5258	0.1972
11	0.0141	1.6914	0.1516	0.4042	3.2296	2.2421	0.1972
12	0.0181	0.4557	0.4676	0.0489	0.2658	0.6605	0.1972
13	1.3098	0.0955	0.1447	0.0800	0.1399	1.2984	0.1972
14	0.2376	0.0441	0.0723	0.1728	1.4445	0.0610	0.1972
15	0.3010	0.4819	0.2720	0.3144	0.5243	0.5618	0.1972

* Starting F determined as the average of ages 1 and 2 to full F over 1979-83.

Appendix

Table 15. Estimated annual (age specific) stock sizes for the stochastically derived catches of the western Gulf of Mexico red snapper stock (M = 0.30).

	Initial Stock Sizes							
AGE	1979	1980	1981	1982	1983	1984	1985	1986
1	6995697	4590648	8031809	7078277	7335886	4106292	5804927	0
2	7424073	4606488	3256915	4789942	5048510	5157979	2950669	4166828
3	3492015	3604700	2412288	1274962	1588114	1651230	2912023	1794690
4	2907307	1865971	1144358	1135114	483864	639811	737119	1771184
5	1731229	1992728	882704	407452	499495	335641	308121	449555
6	168563	1122799	1399265	448917	117896	352067	231253	187409
7	752870	60498	751301	1005065	294471	78801	193630	140656
8	122912	526665	39609	531862	696802	206832	32745	117772
9	157838	78204	347817	19806	391025	443612	148471	19916
10	72083	67707	20574	250926	7448	259453	315889	90305
11	56900	52624	23209	10539	174380	5152	113616	192134
12	20539	41562	7184	14775	5212	5112	405	69105
13	26915	14943	19521	3334	10423	2960	1956	247
14	1920	5381	10061	12513	2280	6713	599	1190
15	15500	1122	3814	6934	7799	398	4679	364
total	23946363	18632041	18350430	16990420	16663606	13252053	13758103	9001353

Correlation between observed CPUE and stocksize = 0.9701.