# Data Summary of Red Snapper (*Lutjanus campechanus*) Collected During Small Pelagic Trawl Surveys, 1988 – 1996

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## Introduction and Methods

In the early 1980s, the National Marine Fisheries Service (NMFS) initiated a program to investigate the abundance and distribution of the Gulf of Mexico (GOM) coastal pelagics species complex. Early efforts centered around the development of fishing gear effective at capturing pelagic species, since the use of standard groundfish trawling gear and techniques was believed to be inappropriate for capturing the schooling, fast-swimming pelagics (Link et al. 2000). By the late 1980s, it was determined that large, high-opening trawls offered the best potential for capturing these fishes in deeper waters (Gledhill 1989, Reese 1993).

A previous study (Link et al. 2000) provided an initial analysis of these data that included information on the distribution, abundance, geographic range, catch frequency, and size composition of the most common pelagic species collected during these surveys. The object of this document was to likewise summarize the distribution, abundance, catch frequency, and size composition of GOM red snapper, *Lutjanus campechanus*, which was collected during this study. This was done to ascertain the efficacy of this database to provide useful information for stock assessment.

Trawling was done with a 27.5 m small pelagics trawl and a 37.5 m Shuman trawl from the NOAA vessel *Chapman.* Sampling designs were either stratified random, two dimensional systematic or systematic random, spanned the entire Gulf of Mexico (Link et al. 2000, Gledhill 1989, Reese 1993; Table 1), including depths from 10 to 420 m (6 to 233 fathoms). Bottom trawls were conducted for approximately 30 minute at each station, and total catch per unit effort was standardized to one hour. Cruises associated with the pelagics program that were related to gear development or that were directed sampling were also omitted from this analysis (Link et al. 2000). A comparison between the two types of gear mentioned above was conducted with paired trawls in 1991 indicated that the two gears exhibited no significant differences in catch rates (Gledhill, unpubl. data), and we do not distinguish between gear types in this analysis.

Once onboard, the entire trawl catch was weighed and then subsampled if the catch was greater than 150 kg. Subsamples (or the entire catch if less than 150 kg) were sorted, identified, enumerated, weighed, and measured to the nearest mm following standard NMFS and Southeast Area Monitoring and Assessment Program (SEAMAP) protocols (Link et al. 2000).

A total of 15 cruises were conducted from 1988 to 1996, primarily during spring and fall (Table 1). These data are highly imbalanced both spatially and temporally (Table 1) due to varying cruise objectives, temporal constraints, mechanical difficulties, and similar logistical considerations.

We present results of analyses in which annual means (+/- standard error) of catch per unit effort (CPUE, number trawlhour$^{-1}$) were derived by Pennington's (1983, 1996) Δ-method across combinations of depth and geographic stratification regimes, which were assigned *a posteriori.* The first stratification regime consisted of East and West

GOM geographic strata (i.e., GOM divided at 89° west longitude). The next regime included data only collected between 88° and 93° west longitude (i.e., central GOM). Stratification by depth mimicked those currently used by NMFS Bottom Longline Surveys (i.e., 5 – 30 fm, 30 – 100 fm, and 100 – 200 fm; Grace and Mitchell 2002). We also examined length frequency distributions across the aforementioned depth and geographic strata in the GOM.

**Results and Discussion**

Red snapper occurred throughout the western and central GOM primarily in waters of less than 100 fms in depth (Figure 1). Due to effort being only in the De Soto Canyon area during 1991, data collected during this sampling year were dropped from subsequent analyses.

The many charts of Figure 2 reiterate the highly imbalanced nature, both spatially and temporally, of effort during this study. Trends in CPUE are represented in Figures 3 – 5. The central GOM (i.e., between 88° and 93° west longitude) appears to be sampled in all years of the time series save 1991. Therefore, to deal with imbalanced effort only data collected between 88° and 93° west longitude each year was analyzed (Figures 6 - 7). Due to the zero-inflated nature of the catch data, Pennington's (1983, 1996) Δ-method was deemed most appropriate in deriving unbiased estimates of mean CPUE. However, for a mean derived by the Δ-method, snapper must occur at least twice within each combination of strata. Therefore, for those combinations of strata with only one occurrence, an arithmetic mean was derived.

In most permutations of annual CPUE indices there is a peak in CPUE during 1990, a trough in 1992, a subsequent increase through 1994/1995, finally followed by a decrease in 1996. The main inconsistency between those indices based on all data west of 85.5° west longitude and those based on data collected in the central GOM is the index for year 1993. This was due to large catches in the western GOM that were not included in the central GOM indices. Coefficients of variation (CV) on the mean annual CPUE indices for most years were large indicating high variability and/or inadequate sampling.

The length frequency distribution for all red snapper measured in this study indicated that the majority of red snapper captured were between 50 and 300 mm total length. The length frequency distribution itself is skewed to the right with several larger specimens being captured (Figure 8). The median and mean (± standard error) total length of the 1490 red snapper collected and measured during this study was 144 mm and 178 (± 3) mm, respectively (Figure 8). Figure 9 illustrates that the majority of red snapper were collected in the shallow depth stratum during this study. Figure 9 also illustrated an increase in red snapper total length with depth. Figure 10 illustrated that while the majority of the red snapper in the study were collected in the western GOM, those collected in the eastern GOM were larger.

Due to the aforementioned highly imbalanced nature trawling effort during this study, catch trends (Figures 3 – 5) may not be truly representative of changes in red snapper abundance. Therefore, the use of this data for abundance indices is not recommended. However, the data do provide insight into the distribution and size ranges of trawl-caught red snapper to 100 fms in depth. Since 2002, the NMFS Pascagoula Lab has conducted an annual fall survey of small pelagic fishes in the GOM using the 27.5 m trawl mentioned earlier. This survey has been conducted in depths from 50 to 275 fms.

Based on this study, this survey will be expanded to include shallower stations (i.e., to 30 fms) in order to gain more information on red snapper inhabiting the mid- to outer-shelf.

**Literature Cited**

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Grace, M. A. and K. M. Mitchell. 2002. Cruise Results, 07/31 – 09/21/2002, Longline Survey, Coastal Sharks – Red Snapper, NOAA Ship *Oregon II*, Cruise OT-02-04(251). USDOC, NOAA, NMFS, SEFSC, Mississippi Laboratories. 20 p.

Link, J.S., T.A. Henwood and C.T. Gledhill. 2000. Small pelagics in the Gulf of Mexico: A description of the abundance, geographic distribution, size and depth distribution of major pelagic species. *Proceedings: Gulf of Mexico Fish and Fisheries: Bringing Together New and Recent Research*. OCS Study, MMS 2002-004.

Pennington, M. 1983. Efficient Estimators of Abundance, for Fish and Plankton Surveys. *Biometrics* 39:281-286.

Pennington, M. 1996. Estimating the mean and variance from highly skewed marine data. *Fish. Bull.* 94:498-505.

Reese, G.B. (ed.) 1993. 1992 Annual MARFIN report: Small Pelagics, TED Technology Transfer, Reef Fish. NMFS, SEFSC, ML. Pascagoula, MS. 225 p.

Table 1. Summary of trawling effort for this study (from Link et al. 2000). Latitudes and longitudes are in degrees and minutes North and West respectively. Gear size is the headrope length, in meters, of the trawl. SysRdm=systematic random, 2DSys=two-dimensional systematic, StratRdm=stratified random.

| Year | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
|---|---|---|---|---|---|---|---|---|---|
| Cruise | 88-03 | 89-04 | 90-02,90-03 | 91-01 | 92-01 | 93-03 | 94-02 | 95-07 | 96-06 |
| Months | 3,4 | 8,9 | 3,4,5 | 1,2 | 3,4 | 3,4 | 3,4 | 10,11 | 10,11 |
| Survey Design | SysRdm | StratRdm | SysRdm,2DSys | StratRdm | SysRdm | SysRdm | SysRdm | StratRdm | StratRdm |
| Cruise | 88-08 | 89-05 | 90-08 | -- | 92-06 | 93-07 | -- | -- | -- |
| Months | 10,11 | 10,11 | 10,11 | -- | 10,11 | 10,11 | -- | -- | -- |
| Survey Design | 2DSys | SysRdm | SysRdm | -- | SysRdm | SysRdm | -- | -- | -- |
| Total # Stations | 154 | 65 | 118 | 53 | 123 | 158 | 81 | 67 | 92 |
| Max Latitude | 30°59.46' | 29°58.48' | 30°59.90' | 29°59.48' | 30°59.84' | 29°59.79' | 30°59.60' | 30°58.12' | 29°59.48' |
| Min Latitude | 27°00.09' | 27°00.92' | 27°00.15' | 29°35.44' | 27°00.45' | 26°00.01' | 27°00.00' | 27°00.97' | 26°00.41' |
| Max Longitude | 96°59.95' | 91°59.48' | 94°58.92' | 87°48.58' | 93°56.85' | 97°59.90' | 91°58.50' | 97°57.79' | 97°59.11' |
| Min Longitude | 83°00.09' | 85°02.69' | 85°01.73' | 86°19.54' | 82°00.30' | 88°01.00' | 83°00.40' | 84°01.83' | 84°00.26' |
| Gear Size | 37.5 | 37.5 | 37.5 | 37.5,27.5 | 27.5,37.5 | 27.5,37.5 | 27.5 | 27.5 | 27.5 |

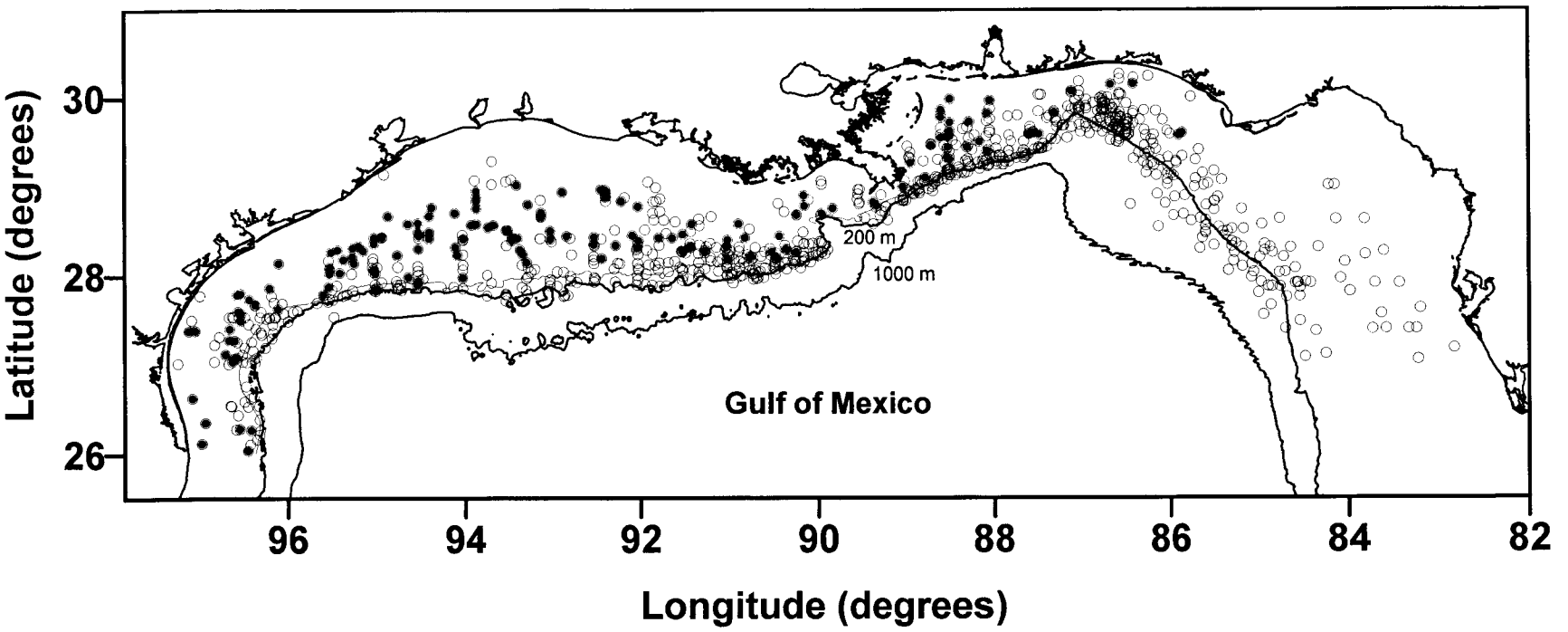



Figure 1. Trawling effort included in this study (open circles) and stations where red snapper were collected (closed circles).

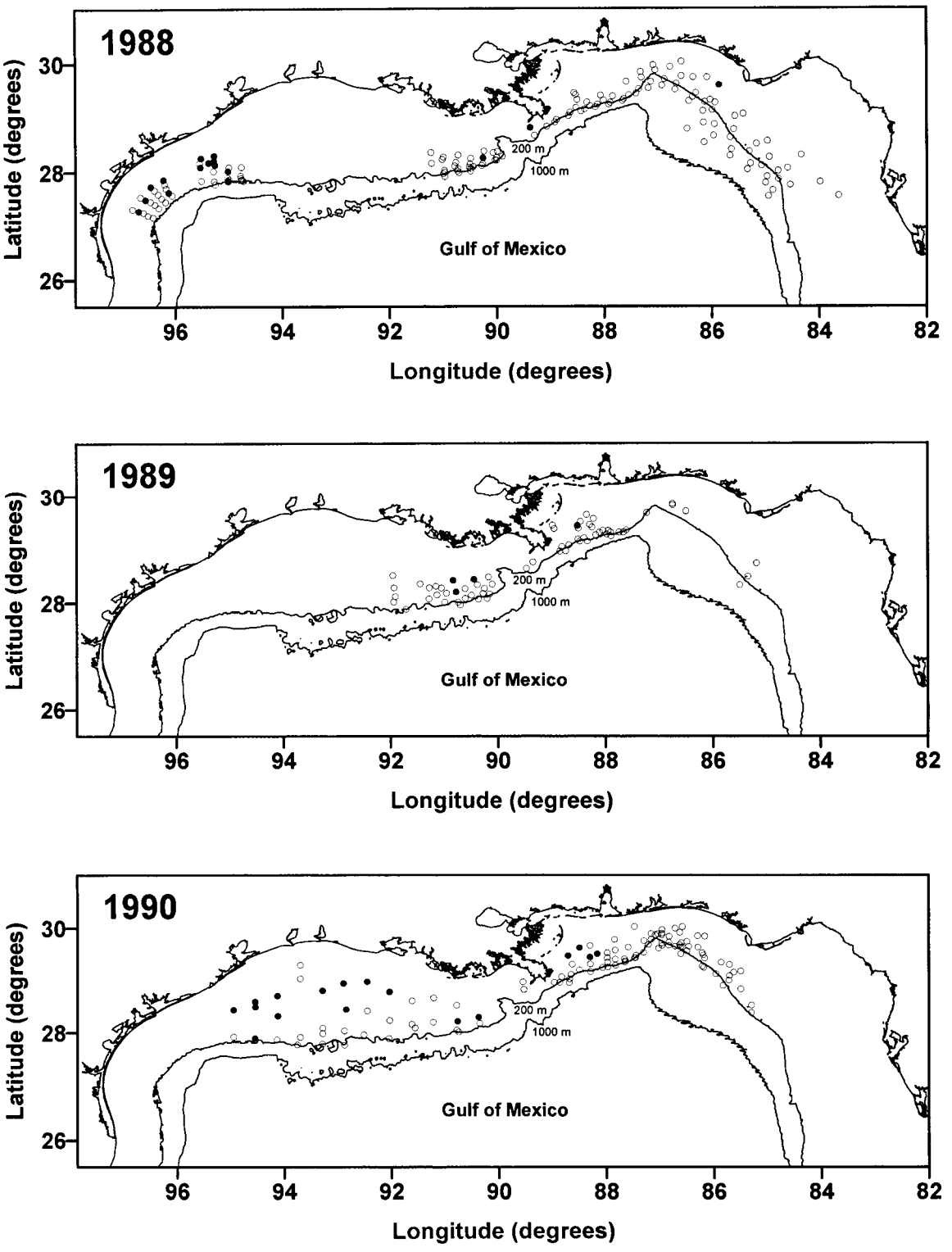



Figure 2. This figure consists of eight charts each depicting trawling effort (open circles) and stations where red snapper were collected (closed circles) for each year of this study.

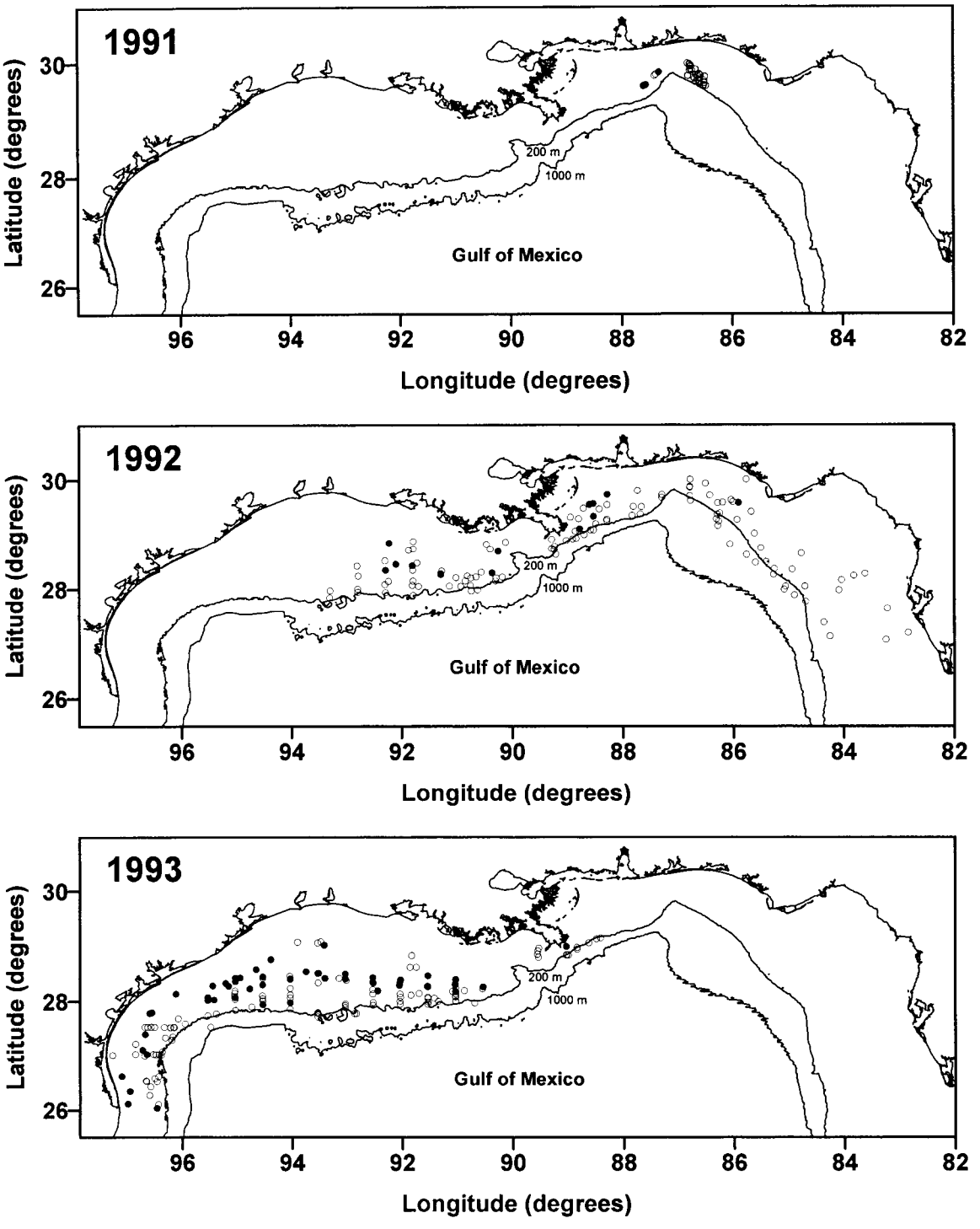



Figure 2 continued.

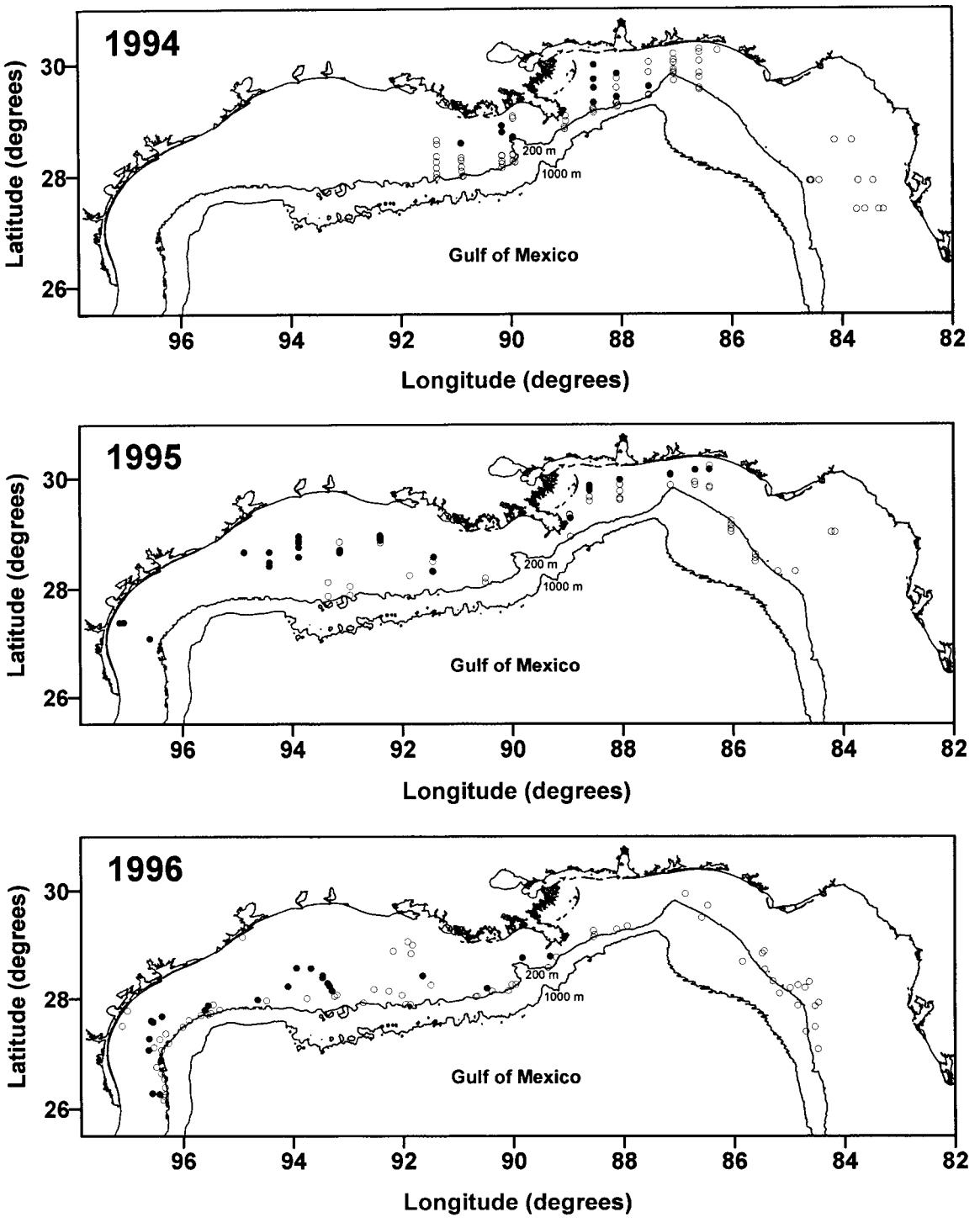
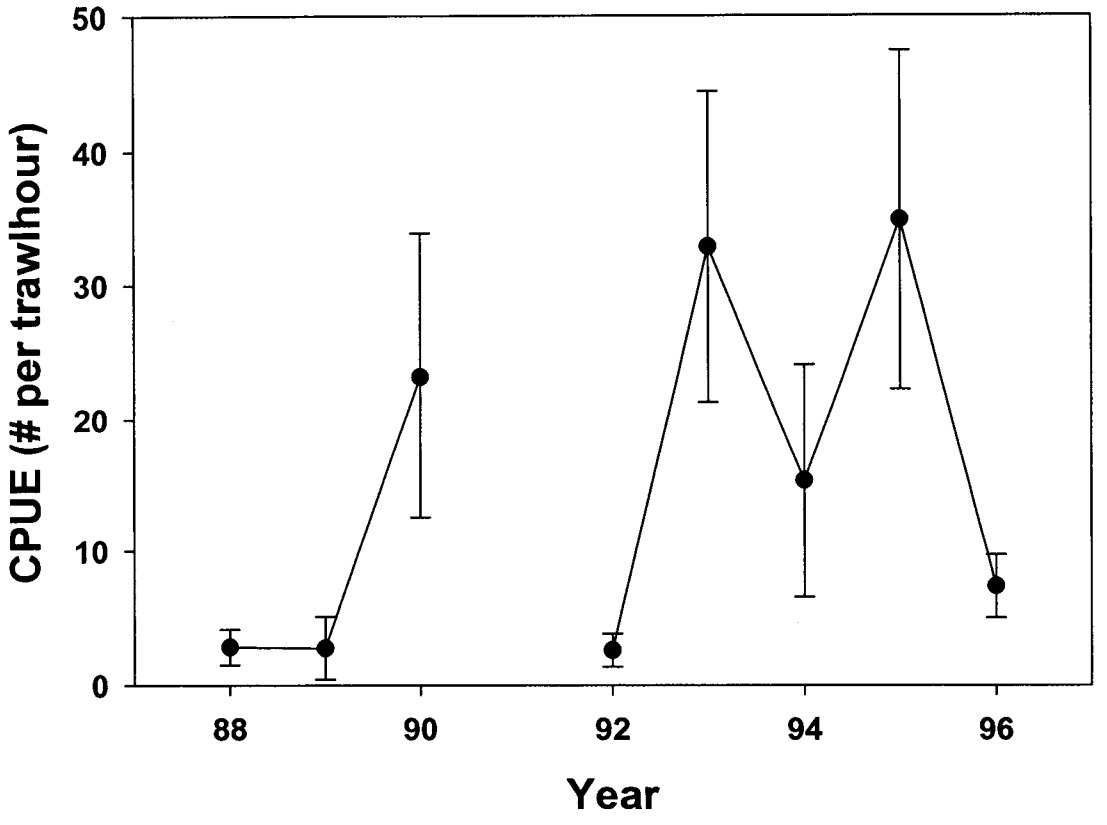
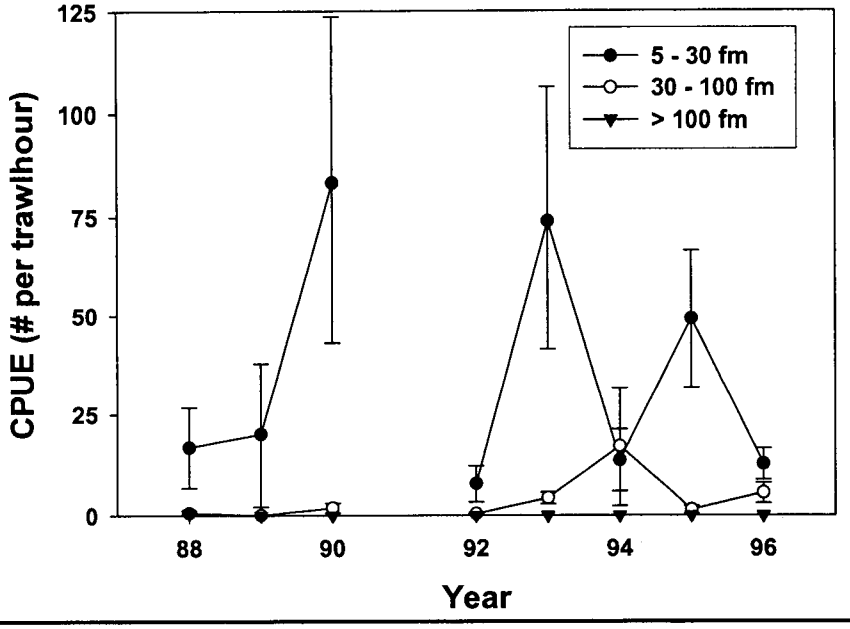



Figure 2 continued.



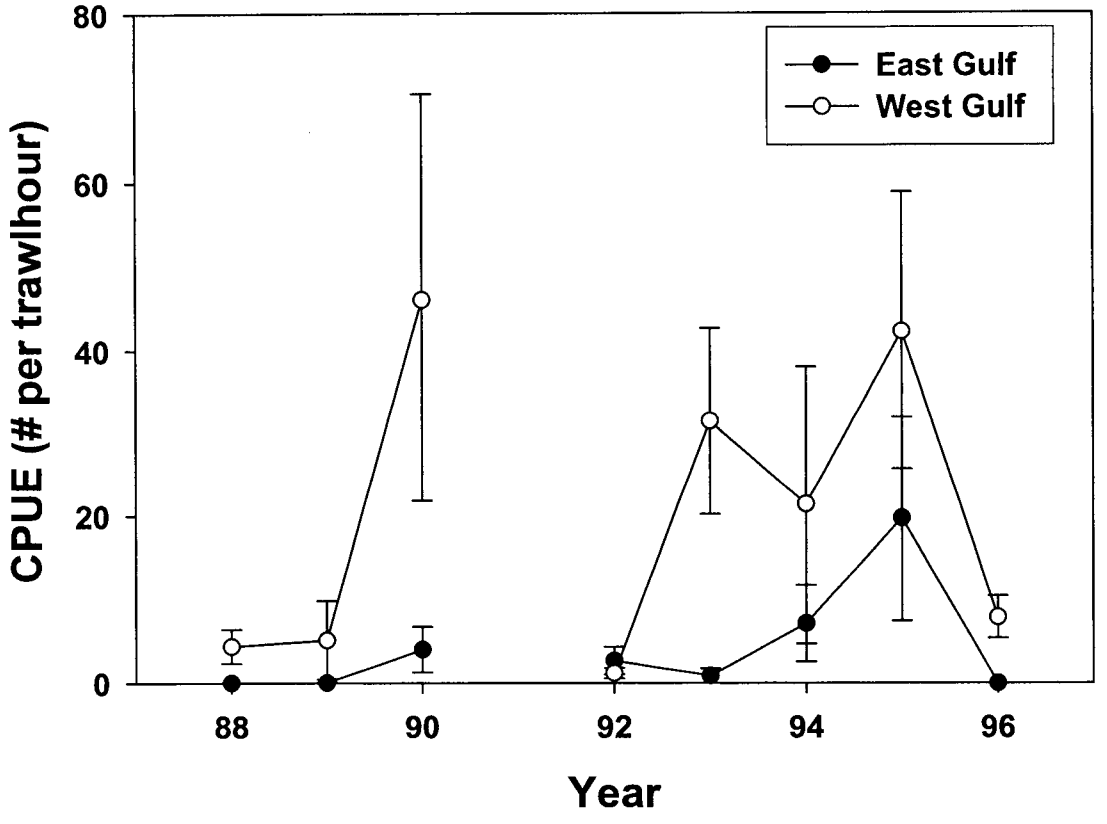

| Year | Occurrences | Stations | Mean CPUE | Standard Error | CV |
|---|---|---|---|---|---|
| 1988 | 15 | 97 | 2.85 | 1.32 | 0.46 |
| 1989 | 4 | 48 | 2.77 | 2.34 | 0.84 |
| 1990 | 17 | 91 | 23.23 | 10.65 | 0.46 |
| 1992 | 13 | 97 | 2.61 | 1.22 | 0.47 |
| 1993 | 47 | 140 | 32.88 | 11.58 | 0.35 |
| 1994 | 11 | 66 | 15.32 | 8.80 | 0.57 |
| 1995 | 28 | 60 | 34.89 | 12.61 | 0.36 |
| 1996 | 22 | 72 | 7.33 | 2.34 | 0.32 |

Figure 3. CPUE of red snapper collected during this study in the U.S. GOM from 1988 to 1996.



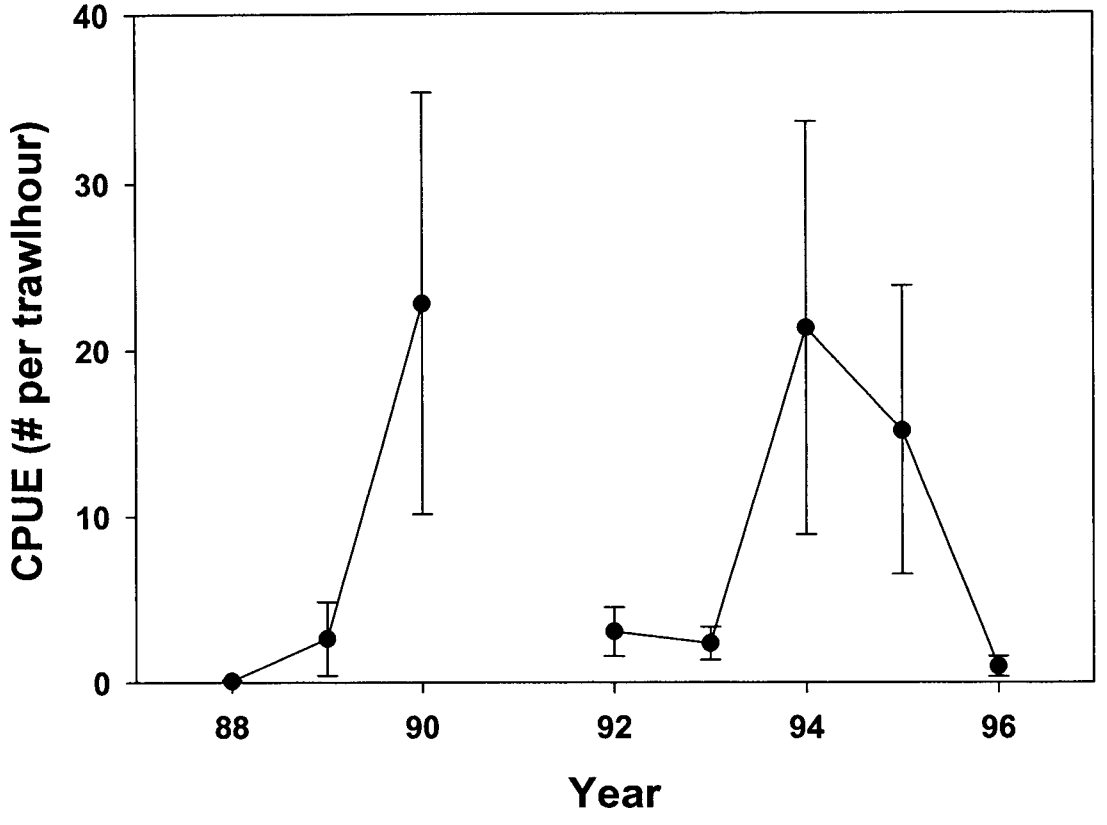

| Depth Stratum | Year | Occurrences | Stations | Mean CPUE | Standard Error | CV |
|---|---|---|---|---|---|---|
| 0-30 fm | 1988 | 7 | 16 | 16.72 | 10.05 | 0.60 |
| | 1989 | 3 | 8 | 20.06 | 17.91 | 0.89 |
| | 1990 | 13 | 25 | 83.38 | 40.29 | 0.48 |
| | 1992 | 8 | 34 | 7.72 | 4.45 | 0.58 |
| | 1993 | 30 | 74 | 73.87 | 32.44 | 0.44 |
| | 1994 | 7 | 30 | 13.51 | 7.71 | 0.57 |
| | 1995 | 25 | 42 | 49.15 | 17.37 | 0.35 |
| | 1996 | 9 | 16 | 12.58 | 3.88 | 0.31 |
| 30-100 fm | 1988 | 8 | 81 | 0.60 | 0.29 | 0.48 |
| | 1989 | 1 | 40 | 0.05 | 0.05 | 1.00 |
| | 1990 | 4 | 66 | 1.83 | 1.23 | 0.67 |
| | 1992 | 5 | 63 | 0.42 | 0.22 | 0.52 |
| | 1993 | 17 | 66 | 4.18 | 1.41 | 0.34 |
| | 1994 | 4 | 36 | 16.99 | 14.69 | 0.86 |
| | 1995 | 3 | 18 | 1.34 | 0.94 | 0.70 |
| | 1996 | 13 | 56 | 5.40 | 2.49 | 0.46 |
| >100 fm | 1988 | 1 | 57 | 0.60 | 0.60 | 1.00 |
| | 1989 | 0 | 17 | 0 | | |
| | 1990 | 0 | 27 | 0 | | |
| | 1992 | 0 | 26 | 0 | | |
| | 1993 | 0 | 18 | 0 | | |
| | 1994 | 0 | 15 | 0 | | |
| | 1995 | 0 | 7 | 0 | | |
| | 1996 | 0 | 20 | 0 | | |

Figure 4. CPUE of red snapper by depth in the U.S. GOM from 1988 to 1996.



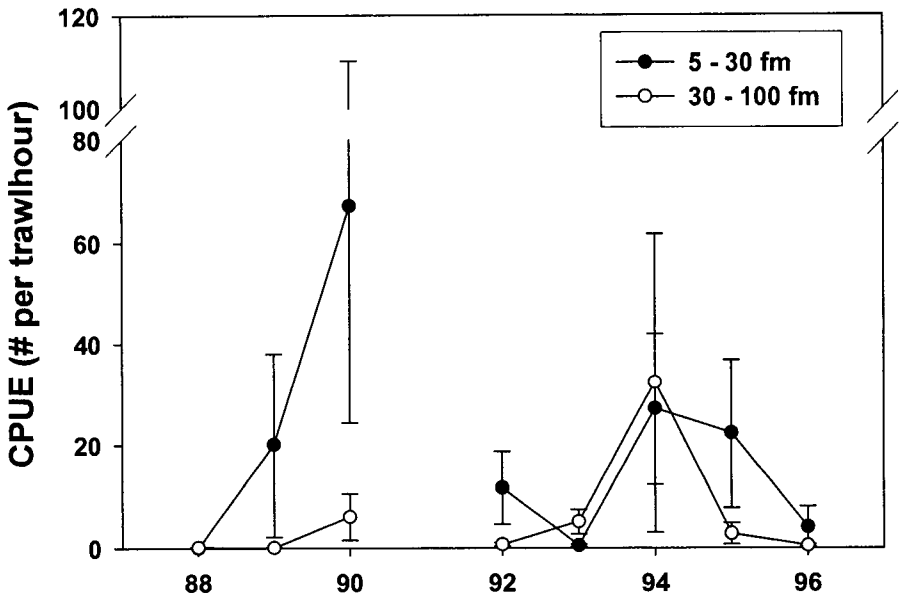

| Region | Year | Occurrences | Stations | Mean CPUE | Standard Error | CV |
|---|---|---|---|---|---|---|
| East Gulf | 1988 | 1 | 79 | 0.03 | 0.03 | 1.00 |
| | 1989 | 1 | 34 | 0.06 | 0.06 | 1.00 |
| | 1990 | 4 | 79 | 4.04 | 2.74 | 0.68 |
| | 1992 | 6 | 75 | 2.71 | 1.64 | 0.61 |
| | 1993 | 1 | 9 | 0.89 | 0.89 | 1.00 |
| | 1994 | 7 | 52 | 7.15 | 4.56 | 0.64 |
| | 1995 | 7 | 35 | 19.64 | 12.20 | 0.62 |
| | 1996 | 0 | 25 | 0.00 | | |
| West Gulf | 1988 | 15 | 75 | 4.43 | 2.04 | 0.46 |
| | 1989 | 3 | 31 | 5.18 | 4.68 | 0.90 |
| | 1990 | 13 | 39 | 46.13 | 24.34 | 0.53 |
| | 1992 | 7 | 48 | 1.20 | 0.63 | 0.53 |
| | 1993 | 46 | 149 | 31.42 | 11.26 | 0.36 |
| | 1994 | 4 | 29 | 21.33 | 16.64 | 0.78 |
| | 1995 | 21 | 32 | 42.24 | 16.60 | 0.39 |
| | 1996 | 22 | 67 | 7.88 | 2.51 | 0.32 |

Figure 5. CPUE of red snapper east and west of the Mississippi River Delta in the U.S. GOM from 1988 to 1996.




| Year | Occurrences | Stations | Mean CPUE | Standard Error | CV |
|---|---|---|---|---|---|
| 1988 | 2 | 49 | 0.08 | 0.06 | 0.70 |
| 1989 | 4 | 51 | 2.61 | 2.20 | 0.85 |
| 1990 | 10 | 39 | 22.78 | 12.65 | 0.56 |
| 1992 | 12 | 70 | 3.02 | 1.45 | 0.48 |
| 1993 | 12 | 61 | 2.32 | 0.97 | 0.42 |
| 1994 | 10 | 49 | 21.29 | 12.39 | 0.58 |
| 1995 | 10 | 28 | 15.14 | 8.67 | 0.57 |
| 1996 | 4 | 27 | 0.94 | 0.61 | 0.64 |

Figure 6. CPUE of red snapper in the central U.S. GOM from 1988 to 1996.




| Depth Stratum | Year | Occurrences | Stations | Mean CPUE | Standard Error | CV |
|---|---|---|---|---|---|---|
| 0-30 fm | 1988 | 0 | 1 | 0.00 | | |
| | 1989 | 3 | 8 | 20.06 | 17.91 | 0.89 |
| | 1990 | 7 | 12 | 67.18 | 42.91 | 0.64 |
| | 1992 | 7 | 19 | 11.59 | 7.09 | 0.61 |
| | 1993 | 3 | 22 | 0.46 | 0.27 | 0.58 |
| | 1994 | 7 | 15 | 27.02 | 14.84 | 0.55 |
| | 1995 | 8 | 20 | 22.23 | 14.51 | 0.65 |
| | 1996 | 1 | 5 | 4.00 | 4.00 | 1.00 |
| 30-100 fm | 1988 | 2 | 30 | 0.13 | 0.09 | 0.69 |
| | 1989 | 1 | 34 | 0.06 | 0.06 | 1.00 |
| | 1990 | 3 | 20 | 6.01 | 4.50 | 0.75 |
| | 1992 | 5 | 40 | 0.66 | 0.34 | 0.51 |
| | 1993 | 9 | 28 | 5.02 | 2.37 | 0.47 |
| | 1994 | 3 | 23 | 32.29 | 29.33 | 0.91 |
| | 1995 | 2 | 8 | 2.75 | 2.03 | 0.74 |
| | 1996 | 3 | 17 | 0.47 | 0.27 | 0.57 |
| >100 fm | 1988 | 0 | 18 | 0.00 | | |
| | 1989 | 0 | 9 | 0.00 | | |
| | 1990 | 0 | 7 | 0.00 | | |
| | 1992 | 0 | 11 | 0.00 | | |
| | 1993 | 0 | 11 | 0.00 | | |
| | 1994 | 0 | 11 | 0.00 | | |
| | 1996 | 0 | 5 | 0.00 | | |

Figure 7. CPUE of red snapper by depth in the central U.S. GOM from 1988 to 1996.

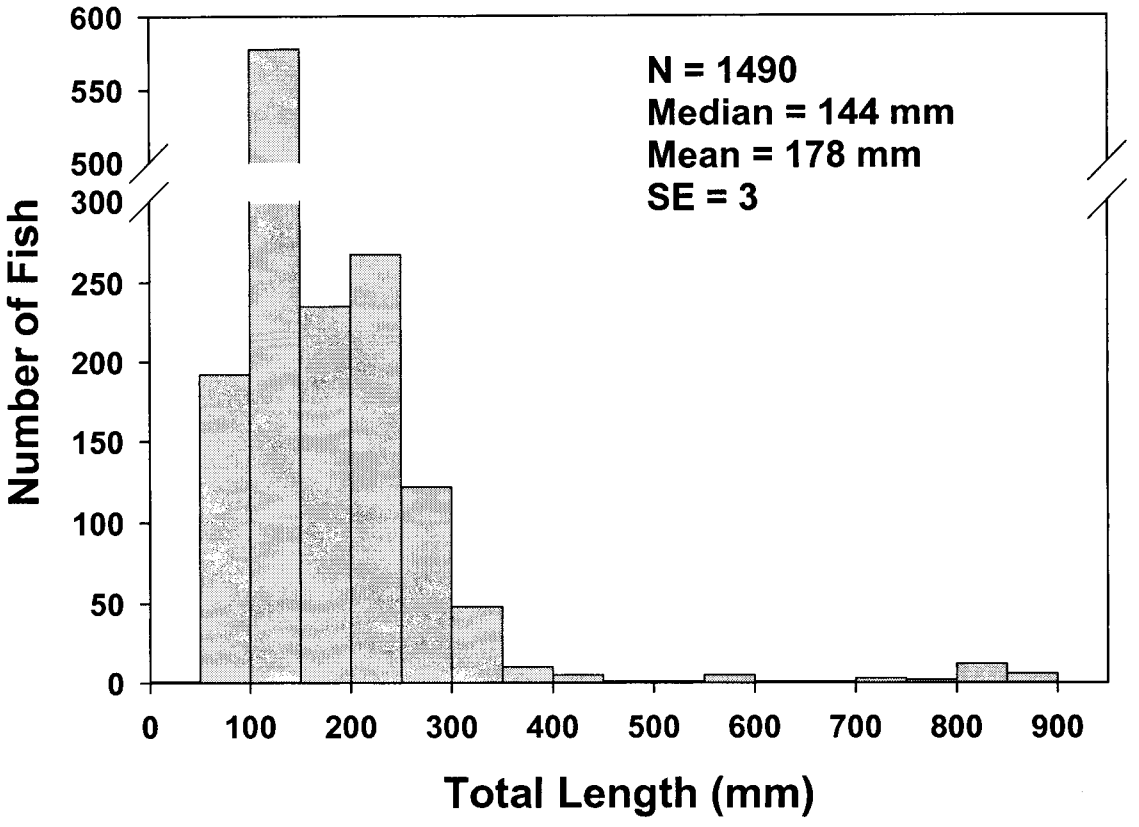



Figure 8. Length frequency of red snapper collected during this study.

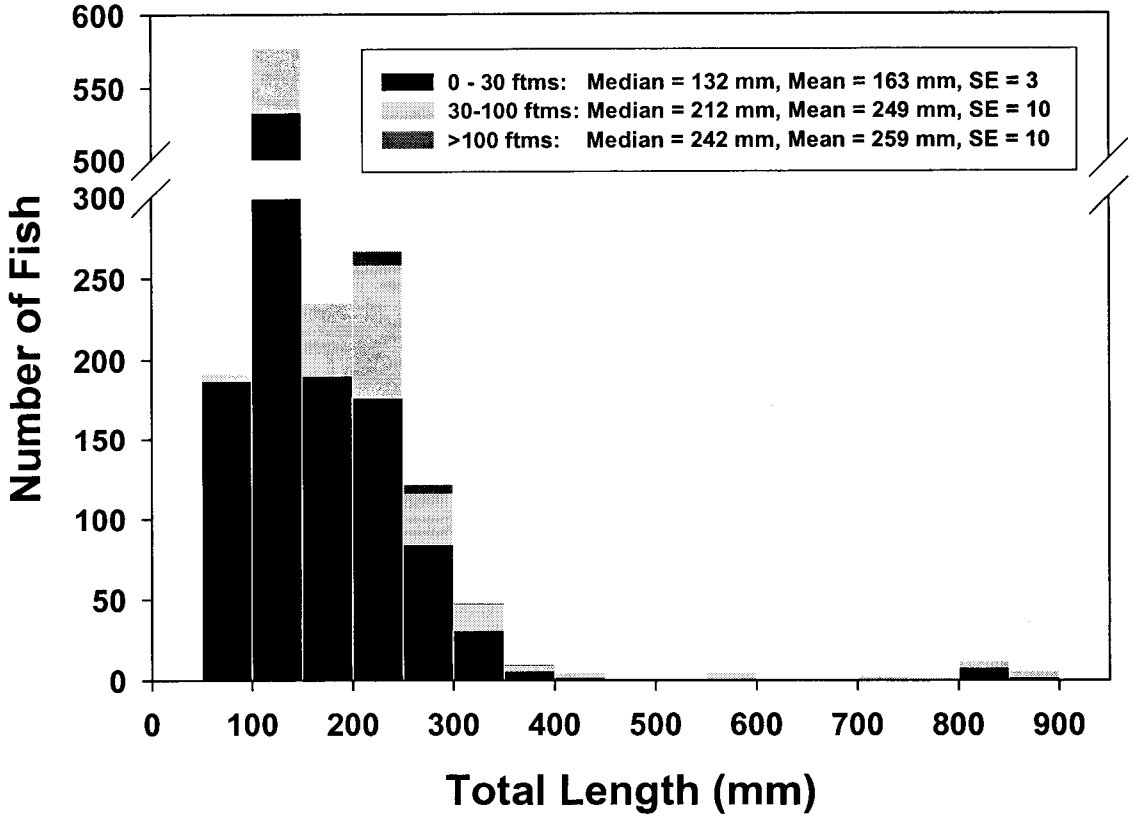



Figure 9. Length frequency of red snapper collected during this study grouped by depth strata.

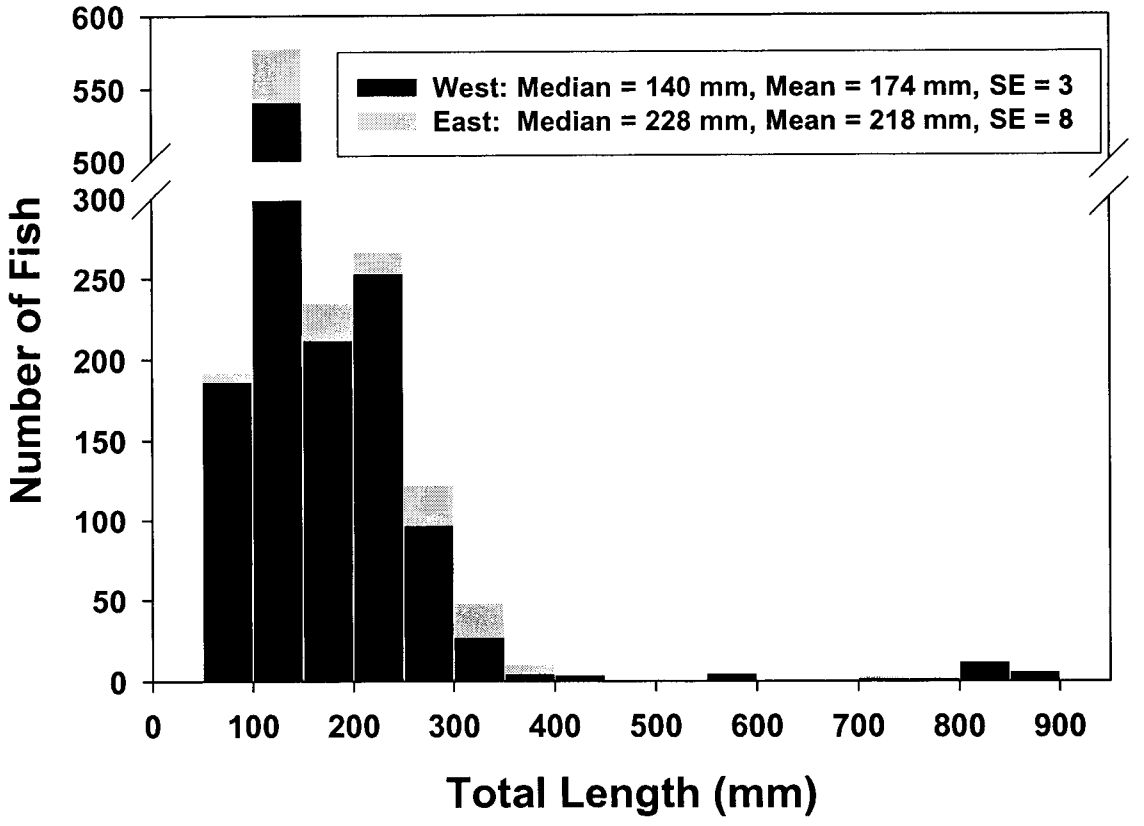



Figure 10. Length frequency of red snapper collected during this study east and west of the Mississippi River Delta.