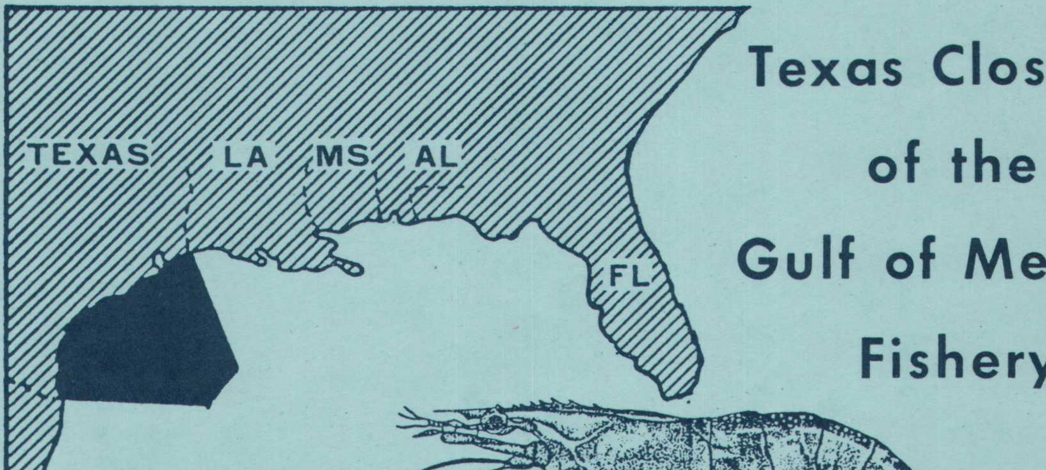
# NOAA Technical Memorandum NMFS-SEFC-149

# Relative Abundance and Size Distributions of *Penaeus* Shrimps Based on Samples Collected During the 1983 Seamap-Texas Closure Survey in the North and Northwestern Gulf of Mexico




Texas Closure of the Gulf of Mexico Fishery

DECEMBER 1984

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Center
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# RELATIVE ABUNDANCE AND SIZE DISTRIBUTIONS OF *PENAEUS* SHRIMPS BASED ON SAMPLES COLLECTED DURING THE 1983 SEAMAP-TEXAS CLOSURE SURVEY IN THE NORTH AND NORTHWESTERN GULF OF MEXICO.

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ABSTRACT

During May, June and half of July 1983, 283 sites were sampled for the SEAMAP-Texas Closure survey. Relative abundance of *Penaeus* spp. was measured by catch per unit effort which was standardized to lbs/40-ft net/30-min drag. CPUEs averaged 7.4 lbs in the Texas region, 1.1 lbs in the Louisiana region, 1.8 lbs in the Mississippi-Alabama region, and 0.3 lbs in the Florida region. Highest CPUEs for each statistical subarea were usually found between 10 and 20 fathoms. CPUEs were also highest in the southern statistical subareas, 20 and 21, off Texas. Mean lengths and length-frequency histograms showed the new-year-class strength in 1983 was about the same as that in 1982, and considerably weaker than that of 1981. Standing stocks for the area between 5 and 25 fm off Texas during the closures for 1981-1983 were 12.45, 9.4, and 6.1 million pounds, respectively, and were 555, 330, and 322 million shrimp, respectively.

CONTENTS

# INTRODUCTION

The shrimp fishery in the Gulf of Mexico centers on three species of *Penaeus*. Brown shrimp, *P. aztecus*, are most important to the Texas fishery, white shrimp, *P. setiferus*, are most important to the Louisiana fishery, and pink shrimp, *P. duorarum*, are most important to the Florida fishery. These are multimillion dollar fisheries that are based on the harvest of an annual crop of shrimp. The management of these fisheries has been assigned to the Gulf of Mexico Fisheries Management Council by the 1976 Magnuson Act, and it is under the direction of the Council that the National Marine Fisheries Service (NMFS) acts to assess the effectiveness of management acts.

The "Texas Closure" is a management act aimed at enhancing the dollar value of the shrimp harvest off Texas. This is done by closing the federal Fisheries Conservation Zone to shrimping for 45 to 60 days between late May and mid-July. It is during this period that the majority of the small, rapidly-growing, new-year-class brown shrimp leave the bays and migrate into the coastal waters of the Gulf of Mexico. These small shrimp, which average between 80 and 100 mm in total length at this time, can increase in length from 15 to 25% during the closure and thus increase in value by a dollar or more per pound.

During the summer of 1982, the Texas Closure survey was allied with the newly created Southeast Area Monitoring and Assessment Program (SEAMAP). SEAMAP was initiated by the Gulf States Marine Fisheries Commission's Technical Coordinating Committee in December 1981, for the purposes of collecting fisheries and environmental data and providing this data to users at a minimal cost in the area managed by the Southeast Fisheries Center of NMFS. As a result of this alliance the sampling effort in the northern Gulf of Mexico, including Louisiana, Mississippi, Alabama and Florida was increased in 1982, but the effort off Texas was reduced 60% from that of 1981, and remained at this level in 1983.

The objectives of this report are to describe the relative abundance and length-frequency distributions of shrimp in the closed waters off Texas, and to compare such distributions as well as standing stock estimates with those from the previous two closures. Additionally, the relative abundance and length-frequency distributions of shrimp collected off Louisiana, Mississippi, Alabama, and Florida during this 1983 SEAMAP survey period will be described.

## MATERIALS AND METHODS

### Definitions.

To simplify interpretation of results, sites were sorted into 5-fathom "depth zones". Depth zone 1 encompassed sites in 1 to 5 fathoms, depth zone 2 encompassed those in 6 to 10 fathoms, and so on through depth zone 9, which encompassed sites in 41 to 45 fathoms. Additional separation of sites was made by dividing these depth zones among "statistical subareas" which thus separated the sites by relative position alongshore. Statistical subareas 21-18 cover the Texas coast, 17-13 cover the Louisiana coast, 12-10 cover the Mississippi and Alabama coasts, and 9-1 cover the Florida Gulf coast. These statistical subareas have long been used for partitioning commercial fisheries landings and effort data (Klima, 1980).

The term "new-year-class" shrimp refers to young shrimp that are less than one year old and have just migrated from the bays into the Gulf. These shrimp generally have mean total lengths of 80, 90, and 100 mm for May, June, and July, respectively (Trent, 1967; Copeland, 1965). Total length (TL) is from tip of the rostrum to the tip of the telson. "Previous-year-class" shrimp are defined herein as those that have over-wintered in the shallow Gulf and have means from 125 to 180 mm TL during the same months. Given sufficient food and 30 to 45 days in the Gulf, the new-year-class shrimp are expected to grow an additional 20 to 30 mm (Parrack, 1979).

Catch per unit of effort (CPUE) is used as a measure of relative abundance. In this report, CPUE will mean pounds of shrimp (heads-on) caught per 30-minute drag using a 40-foot net. CPUEs are adjusted to differences in net sizes and towing times where needed.

### Sampling.

Sites to be sampled were chosen via a stratified random selection technique. A certain number of samples were designated to be taken in each depth zone of each statistical subarea. The location of each site was specified by the depth (in fathoms) and a randomly selected latitude or longitude--whichever was most readily identifiable along that part of the coast. The distribution of the sites among the nine depth zones in each of the statistical subareas is given in Table 1; more sites were established in depth zones which had the largest variances in shrimp catches during previous SEAMAP-Texas Closure studies. Site locations are plotted in Figures 1-4, for Texas, Louisiana, Mississippi-Alabama, and Florida regions, respectively.

A sample consisted of the catch from a 40-ft semiballoon shrimp trawl towed at 3 knots[1] for a minimum of 10 and a maximum of 30 minutes. The tow was designed to cover a depth change of 1 fathom where the starting depth of the tow was less than 30 fathoms, and to cover a depth change of 5 fathoms when the starting depth was 30 fathoms or greater. All Penaeus were culled from the catch, separated by species, and each species batch weighed. A subsample of up to 200 individual shrimp was obtained by randomly selecting shrimp from a species batch. These shrimp were then sexed and measured to obtain length-frequency distributions and set ratios. The total length of a shrimp was obtained in millimeters by measuring the distance from the tip of the rostrum to the tip of the telson.

Analyses and Statistics.

Basic fisheries statistics, such as ranges, means, and confidence limits, were calculated using standard statistical procedures (Sokal and Rohlf, 1969). Logarithmic transformations were applied to CPUEs before computations of means and confidence limits, analysis of variance (ANOVA), and Student-Newman-Keuls (SNK) tests. Square root transformations were applied to length data (Taylor, 1961).

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[1]A speed of 3 knots was designated in the mimeographs detailing sampling sites, cruise tracks, and sampling procedures for the 1982 and 1983 SEAMAP-Texas Closure surveys.

Standing stock estimates were based on several assumptions which need to be specified. The 40-ft net was assumed to spread 70% of its width. The vessels were assumed to be towing at 3 knots[1]. The average number of shrimp per pound was based on the mean length of the shrimp and a length-to-weight conversion by Fontaine and Neal (1971). Surface areas for each depth zone were obtained from a study by Patella (1975). The formula used for calculating the standing stock in a depth zone of a statistical subarea was:

$$\text{Standing stock} = \frac{\text{Area of the depth zone}}{\text{Area swept during a 30-min drag}} \times \text{Mean number of pounds of shrimp caught per 30-min drag} \times \text{Mean number of shrimp per pound}$$

## RESULTS

### Composition

Considerable differences were found in the percentage compositions by weight of brown, pink and white shrimp in the four major regions sampled during the 1983 SEAMAP-Texas Closure survey. Off Texas and Louisiana, brown shrimp accounted for 86% and 64% of the total shrimp catches, respectively (Table 2), while off Mississippi-Alabama and Florida they accounted for 38% and 54% of the total shrimp catches, respectively. Pink shrimp were important in the catches off Mississippi-Alabama (51%) and Florida (46%). White shrimp accounted for 31% of the shrimp off Louisiana, but for only 11% and 1% of those off Mississippi-Alabama and Texas, respectively. No white shrimp were caught off Florida.

In comparing the 1983 and 1982 surveys' shrimp species percentage compositions for each major region, several differences were noted. A 29% increase in white shrimp caught occurred in 1983 in Louisiana. A 9% increase occurred for white shrimp off Mississippi-Alabama. The percentages for the three species for 1982 and 1983 catches for Texas were almost identical.

## Relative Abundance

### 1983 Texas Closure.

During the 1983 Texas Closure survey, CPUEs ranged from 0.0 to 146.0 pounds (Table 3). Zero catches, and consequently CPUEs, were found at eight sites: 2 in statistical subarea 18, and 6 in subarea 19. CPUEs over 50 pounds were found at ten sites: 1 in subarea 19, 4 in subarea 20, and 5 in subarea 21. The overall mean CPUE for the Texas Closure survey was 7.4 pounds with 95% confidence limits of 6.52 to 8.28 pounds based on untransformed data from 106 samples.

The highest mean CPUE for a depth zone for the entire Texas coast was 14.3 pounds for depth zone 3(11-15 fm), and the second highest was 10.0 pounds for depth zone 4(16-20 fm). CPUEs in the other depth zone were 5 pounds or less. A 1-way ANOVA using log-transformed data showed that the differences among CPUE means for the depth zones was significant, and a SNK test showed that the means for depth zones 3 and 4 were significantly greater than the others, but not from each other (Table 3C).

Previous similar reports (Matthews, 1982a and b) showed differences in CPUEs not only among depth zones but also among statistical subareas. When the data for 1983 were partitioned into these two categories, substantial differences were again found. Results of a 2-way ANOVA support these observed differences as being significant (Table 4A), and the non-significant interaction term indicated the pattern of differences in means for the depth zones was about the same for each statistical subarea. Results of contrast tests of CPUE means for depth zones 2 thru 6 showed that the means for depth zones 3 and 4 were similar and were significantly greater than those for depth zones 2, 5, and 6 (Table 4B). Additional contrast tests showed there were significant differences in CPUE means for statistical subareas: 18

and 19 <20 <21.

In looking at CPUE means for depth zones in each statistical subarea, it is evident that means for depth zones 3 and 4 were usually the two highest (Table 5). There were two exceptions: the mean for depth zone 5 was highest in subarea 19, and the mean for depth zone 2 displaced that of zone 4 as the second highest in subarea 21. The range in highest mean CPUEs by depth zone and statistical subarea was from 8.7 to 56.6 pounds, or nearly an order of magnitude.

<u>1981-1983 Texas Closure Surveys Compared</u>.

The relative abundances of shrimp during the closure surveys varied considerably over the three years. Results of a 3-way Model I ANOVA testing for differences in CPUE means among depth zones, statistical subareas, and years indicate definite differences were present by the significant F-values for the main effects (Table 6). The significant F-values for the interaction terms of years-subareas and years-depth zones indicate that the differences in CPUEs for subareas and for depth zones did not follow the same pattern through the years. The non-significant interaction term for subareas-depth zones indicates differences in CPUEs for depth zones in each statistical subarea did follow similar patterns of differences. Because the interactions involving years were significant, it would be prudent to look at differences by years.

A series of 1-way ANOVAs testing CPUE means in each depth zone of each statistical subarea were run comparing the three years, where there were sufficient samples taken each year. Results were somewhat surprising (Table 7), in that a 4-to-5 fold difference between the lowest and highest means among the three years was not always significant. This is likely due to an insufficient number of samples and to large variances associated with the means for that particular depth zone through the years. The sizable variances associated with the means are represented by the 95% confidence intervals about the means as shown in Figure 5.

One of the premises of the Texas Closure management act is that given a month or so of protection, brown shrimp entering the gulf will have time to grow to a larger and consequently more profitable size. The benefit of this portion of the act depends on the number of shrimp that enter the gulf during the closure--the more that enter, the more benefit received. And this is balanced against the estimated mortality among the shrimp population that already exists on the shrimping grounds, and against the price structure in the shrimp market. Using the CPUE and the length data obtained during each closure survey, we can estimate the number of shrimp in an area. Data were adequate for estimating numbers of shrimp for depth zones 2-5 in statistical subareas 18-21 along Texas. From these numbers of shrimp in each depth zone we can see that the potential benefit was about twice as great in 1981 as in 1982 or 1983 for Texas as a whole (Table 24). But we also see that this benefit can vary for areas along the coast. There was a much higher benefit in statistical subarea 19 during the 1981 closure than during the 1983 closure, while in subareas 20 and 21 the benefits of the 1983 closure were equal and slightly superior to that of the 1981 closure for these respective subareas. The additional question of migration along the Texas coast by shrimp once they enter the Gulf becomes very important when we see the great numbers of shrimp in subarea 21. Should these shrimp grow and migrate south into Mexican waters, there would be a great loss to the Texas shrimping industry.

1983 Louisiana SEAMAP Survey.

Catches were generally low off Louisiana during the 1983 survey. CPUEs ranged from 0.0 to 9.2 pounds (Table 8). Zero shrimp catches occurred at 13 sites, spread over statistical subareas 13, 14, 16 and 17. The 9.2 CPUE was at a site in depth zone 2 in subarea 14. Over 80% of the sites off Louisiana had CPUEs below 4.0 lbs and the overall CPUE mean for Louisiana was only 1.1 lbs.

Although the mean CPUEs for depth zones for Louisiana as a whole were remarkably similar, the data were tested for differences among statistical subareas. CPUE statistics for each subarea's depth zones are presented in Table 9 and show that the low CPUE means were uniform across all subareas during this sampling period. A 2-way ANOVA for depth zones 2 thru 6 and statistical subareas 13 thru 17 yielded non-significant differences among CPUE means among statistical subareas and among depth zones (Table 10). Indeed, CPUEs for Louisiana were uniformly low.

1982 and 1983 Louisiana SEAMAP Surveys Compared.

The allocation of sampling sites was different for each survey because of the restricted sampling time, the variation in bottom topography which made some areas untrawlable, and the stratified random sel ction process for sites. Some depth zones in statistical subareas were not sampled in both years. It was still of interest, however, to compare CPUEs from the two surveys. The samples were thus partitioned by years and by depth zones, but not by statistical subareas. The means for these pooled depth zones showed a much greater uniformity during the 1983 survey than during the 1982 survey (Table 11A; Fig. 6). A 2-way ANOVA using the weighted squares of means method showed a significant difference between years but not among depth zones (Table 11B). When the 18 CPUE means for the 1982 and 1983 depth zones were tested with a SNK test, only the mean for depth zone 1 in 1982 was significantly lower than the rest, and only the means for depth zones 3 and 5 in 1982 were significantly greater than the others.

1983 Mississippi-Alabama SEAMAP Survey.

Although this area was originally designed to include statistical subareas 10, 11, 12, and portions of 9, this report limits coverage to subareas 10 and 11. Only a few samples were taken in subarea 12, and the samples taken in subarea 9 are covered with the Florida samples.

Among the 54 trawl samples collected in subareas 10 and 11, CPUEs ranged from 0.0 to 10.2 lbs. Zero shrimp catches occurred at 17 sites (30%), some of which occurred in almost every depth zone of each subarea (Table 12A). CPUEs over 4.0 lbs occurred at only seven sites (13%), all of which were in statistical subarea 11. The overall CPUE mean for these two subareas combined was 1.3 lbs which was very close to that in Louisiana.

Catches appeared to be slightly greater in statistical subarea 11 than in subarea 10 (Table 12A). A 2-way ANOVA testing CPUEs of these two subareas over depth zones 2 thru 6 showed this difference was significant, but that the differences among these five depth zones was not (Table 12B).

<u>1982 and 1983 Mississippi-Alabama SEAMAP Surveys Compared</u>.

Year to year differences in CPUE means for depth zones (statistical subareas combined) were slight (Table 13A). Results of a 2-way ANOVA testing for differences in CPUEs between 1982 and 1983 and using data from depth zones 1 through 9 showed the difference between years was not significant (Table 13B). CPUEs were significantly different among depth zones; however, due to small sample sizes for some depth zones, a SNK test could not identify individual depth zones with significantly different CPUE means. Despite this, the differences between means of 0.0 lbs and a mean of 3.4 lbs is substantial (Fig. 7).

<u>1983 Florida SEAMAP Survey</u>.

Shrimp were scarce in the Gulf of Mexico off northern Florida (statistical subareas 8 and 9). The range in CPUEs for the 25 samples collected was from 0.0 to 4.5 lbs (Table 14). The overall mean for these samples was 0.3 lbs with confidence limits of 0.0 and 1.2 lbs. Sixteen samples had no shrimp. The few samples containing shrimp did not warrant additional analyses.

## Size Distribution

### 1983 Texas Closure Shrimp Length Analyses.

Brown Shrimp. Sampling for the 1983 Texas Closure was conducted during the first two weeks of July. Mean lengths of the brown shrimp populations sampled showed the typical increases with increasing water depths and increasing distances from the passes (Table 15). New-year-class brown shrimp which have just migrated into the shallow coastal waters of the Gulf of Mexico during the closure period would be expected to have mean total lengths of between 100 and 110 mm in July (Trent, 1967; Copeland, 1965; Matthews, 1982a and b). Mean lengths for the brown shrimp collected in depth zones 1-4 were 103, 116 and 124 mm, respectively, which indicated the very substantial contributions of the new-year-class to these areas. Mean lengths increased to 132 mm and 139 mm for depth zones 5 and 6, and to 154 mm, 160 mm, and 169 mm for depth zones 7-9, respectively.

Length-frequency distributions were constructed for brown shrimp collected in each depth zone for the entire Texas coast (Figs. 8-10). Length-frequency distributions for depth zones 2-5 appeared as rather typical bell-shaped curves. The distribution for depth zone 6 indicated some bi-modality with smaller males and larger females which has been found for previous-year-class and older shrimp populations (Matthews, 1981, 1982a & b). The few shrimp collected, and measured, beyond 30 fathoms yielded flat distributions whose only other feature was the trend towards smaller males and larger females. The new-year-class shrimp composed about 80% of the very few shrimp collected in depth zone 1 and about 75% of the many shrimp collected and measured in depth zone 2. They composed about 60% of those in depth zone 3, and about 40% of those in depth zone 4. Beyond 20-fm depths the new-year-class contributed about 10% to the populations in depth zones 5 and 6, and only about 5% of those in depth zones 7 and 8. No new-year-class shrimp were found among the 27 shrimp collected from depth zone 9.

Brown shrimp length data were partitioned by statistical subareas to test the uniformity of the shrimp size to water depth relationship found for Texas as a whole (Table 16). Mean lengths for each sample containing brown shrimp were transformed to their square roots and were partitioned into their proper depth zones for the statistical subareas where the collection sites were located. Results of a 2-way ANOVA (Table 17) showed there was a significant difference among mean lengths for statistical subareas and for depth zones. The interaction term was not significant which indicated the differences in means among depth zones were in the same direction for each statistical subarea (Figure 11). The trend was most pronounced for subarea 18, but was also evident for the other subareas.

Pink Shrimp. Along the Texas coast, pink shrimp were collected mainly in depth zones 2-4. Only a few were taken in depth zones 1 and 5 (Table 15). Mean lengths tended to decrease slightly from 133 mm in depth zone 1 to 117 mm in depth zone 4 when measured shrimp from the four statistical subareas were pooled by depth zone. This trend is also evident in the length-frequency histograms for these four depth zones (Fig 12). However, a 1-way ANOVA using square root transformed mean lengths from each sample detected no significant difference among the depth zones (Table 18). When mean lengths were calculated and plotted for depth zones in each statistical subarea, a considerable amount of variability became evident (Fig. 13). Pink shrimp in the shallow depth zones were larger than most of the new-year-class brown shrimp in the same areas.

White Shrimp. Only 149 white shrimp were collected and measured off the Texas coast, and of these, 122 were collected in depth zone 2 of statistical subarea 18 (Table 15 ). Mean lengths for the four depth zones (1-4) in which the shrimp were collected ranged from 153 mm in depth zone 2 to 167 mm in depth zone 3. These shrimp were previous-year-class or older shrimp. Too few were collected to warrant further analysis.

1983 Louisiana SEAMAP Survey.

Brown Shrimp. Brown shrimp were relatively scarce during the June 1983 SEAMAP sampling off Louisiana. Pooling the samples collected in statistical subareas 13-17 and analyzing the changes in mean lengths among the depth zones revealed increasing lengths with increasing water depth from 97 mm in depth zone 1 to 186 mm in depth zone 8. The differences among mean lengths for depth zones 1-9 were significantly different (Table 19). This trend was also found in each statistical subarea; however, the range in mean lengths for the depth zones did vary among the subareas with those for subarea 13 being the lowest (Table 20).

Length-frequency histograms for depth zones 1-4 for the Louisiana region as a whole show substantial contributions by new-year-class shrimp to the brown shrimp populations in these depths (Fig. 14). Based on an expected mean length of 100 mm for new-year-class shrimp in June off Louisiana, about 95% and 90% of the shrimp in depth zones 1 and 2, respectively, were from the new-year-class. The percentages contributed to populations in depth zones 3-5 decreased substantially to 35, 20 and 15%, respectively.

Pink Shrimp. Pink shrimp were scarce in the shrimp catches off Louisiana. They accounted for only about 4% of the shrimp catch, and most of this was taken in depth zones 3 and 4 (Table 21). In both these depth zones, shrimp ranged greatly in size. In zone 3 they ranged from 88 mm to 200 mm with a mean of 137 mm, and in depth zone 4 they ranged from 67 mm to 200 mm with a mean length of 139 mm. About 30% of the shrimp in these two zones appeared to be the same size as new-year-class brown shrimp.

White Shrimp. These were collected mainly in depth zone 2, but several were also collected in depth zones 1, 3, 4, and 5 (Table 21). Mean lengths were quite similar among depth zones 2-5, being 165, 167, 169 and 170 mm, respectively. The mean length in depth zone 1 was slightly lower, at 151 mm. Length-frequency distributions showed all but a few of these white shrimp to be previous-year-class and older shrimp (Fig. 15).

1983 Mississippi-Alabama SEAMAP Survey.

Brown Shrimp. Mean total lengths increased from 99 mm in depth zone 1 to 129 mm in depth zone 5 (Table 22). The mean length for depth zone 6 was only 113 mm, which was surprisingly lower than that of zone 5, and may have been due to an unusual distribution of the population in the area surveyed by the single sample.

Length-frequency distributions for the brown shrimp caught in depth zones 2, 3, 4, and 6 showed the large contribution of new-year-class shrimp to these populations (Fig. 16). Such contributions ranged between 70% and 85% of these populations.

Pink Shrimp. Mean lengths increased from 110 mm in depth zone 5 (Table 22). Length-frequency distributions for populations in depth zones 2-4 indicated new-year-class shrimp were found mainly in depth zone 2 (Fig. 17). New-year-class shrimp in depth zone 2 accounted for about 70% of the population. They accounted for only about 20% of the populations in depth zones 3 and 4.

White Shrimp. The smallest shrimp was 142 mm, and the mean lengths for depth zones 1-4 were between 160 and 180 mm (Table 22). This indicated the populations were composed of previous-year-class and older shrimp.

## SUMMARY

1. Sampling was conducted during May, June and July in 1983, during which time 283 sites were sampled covering four regions in the gulf: Texas, Louisiana, Mississippi-Alabama, and Florida.

2. Species compositions for shrimp stocks were very similar for 1982 and 1983 closures in Texas, but they showed considerable decreases in brown shrimp contributions in Louisiana and Mississippi-Alabama. Brown shrimp accounted for 86.2, 64.5, 37.8, and 54.1 percent of the shrimp collected from Texas, Louisiana, Mississippi-Alabama, and Florida respectively. Pink shrimp accounted for 12.5, 4.1, 50.7, and 45.9 percent of the shrimp from these respective regions.

3. Relative abundances were low for the second year in a row in the Louisiana and Mississippi-Alabama regions, averaging 1.1 and 1.8 lbs/40-ft net/30-min drag, respectively.

4. Relative abundances were lower in Texas in 1983 than during the previous two closures. The averages were 7.4 lbs in 1983, compared with 9.1 and 12.4 lbs in 1982 and 1981, respectively.

5. In Texas, shrimp showed greatest relative abundances in depth zones 3 and 4, i.e. between 10 and 20 fathoms. Such abundances varied considerably along the coast, with higher values being found in the southern statistical subareas, 20 and 21, than in the northern ones, 18 and 19.

6. Mean total lengths of brown shrimp during the 1983 closure were generally above those found in 1981, and slightly lower than those found in 1982. They increased with increasing water depths from about 100 mm in depth zones 1 and 2, to about 175 mm in zones 8 and 9.

7. Standing stock estimates for depth zones 2-5 for the three Texas closure surveys showed 1982 and 1983 stocks to be fairly close. Based on poundages and numbers of shrimp, 1983 was slightly below 1982, and both were substantially lower than 1981.

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Table 1. Distribution of sampling sites among 5-fm depth zones in statistical subareas 8-21 during the 1983 SEAMAP-Texas Closure sampling period.

| Regions and Statistical Subareas | Depth Zones | | | | | | | | | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| FLORIDA | | | | | | | | | | |
| 8 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 3 | 7 |
| 9 | 1 | 3 | 4 | 4 | 3 | 2 | 0 | 1 | 0 | 18 |
| MISSISSIPPI-ALABAMA | | | | | | | | | | |
| 10 | 2 | 2 | 3 | 2 | 4 | 1 | 1 | 2 | 1 | 18 |
| 11 | 0 | 8 | 13 | 9 | 4 | 2 | 0 | 0 | 0 | 36 |
| LOUISIANA | | | | | | | | | | |
| 13 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 14 |
| 14 | 1 | 6 | 5 | 4 | 4 | 2 | 2 | 0 | 1 | 25 |
| 15 | 1 | 5 | 4 | 5 | 0 | 0 | 0 | 0 | 0 | 15 |
| 16 | 2 | 5 | 5 | 5 | 0 | 0 | 1 | 1 | 1 | 20 |
| 17 | 0 | 5 | 5 | 5 | 5 | 2 | 1 | 1 | 0 | 24 |
| TEXAS | | | | | | | | | | |
| 18 | 0 | 7 | 4 | 5 | 4 | 2 | 1 | 1 | 0 | 24 |
| 19 | 0 | 8 | 8 | 9 | 3 | 1 | 0 | 1 | 0 | 30 |
| 20 | 1 | 5 | 7 | 4 | 6 | 3 | 1 | 1 | 1 | 29 |
| 21 | 1 | 5 | 4 | 6 | 4 | 1 | 2 | 0 | 0 | 23 |

Table 2. Percentage composition of the brown, pink, and white shrimp catches for the four major regions sampled during the 1982 and 1983 SEAMAP-Texas Closure surveys.

| | | 1982 | 1983 |
|---|---|---|---|
| TEXAS | | | |
| | Brown | 86.9 | 86.2 |
| | Pink | 11.8 | 12.5 |
| | White | 1.3 | 1.3 |
| LOUISIANA | | | |
| | Brown | 94.7 | 64.5 |
| | Pink | 3.5 | 4.1 |
| | White | 1.8 | 31.4 |
| MISSISSIPPI-ALABAMA | | | |
| | Brown | 51.0 | 37.8 |
| | Pink | 46.4 | 50.7 |
| | White | 2.6 | 11.5 |
| FLORIDA | | | |
| | Brown | - | 54.1 |
| | Pink | - | 45.9 |
| | White | - | 0.0 |

Table 3. Statistics and analysis of CPUE data for the Texas coastal region as a whole. Data were obtained during the 1983 SEAMAP-Texas Closure survey and were transformed by: $\mathrm{Log}_e$ (CPUE + 1).

A. Statistics

| Depth Zone | Number of Samples | Minimum | Maximum | Mean CPUE | 95% Confidence Limits |
|---|---|---|---|---|---|
| 1 | 2 | 0.6 | 7.4 | 2.7 | 0.0 - 500.+ |
| 2 | 25 | 0.0 | 54.4 | 3.2 | 1.4 - 6.2 |
| 3 | 23 | 0.0 | 146.0 | 14.3 | 6.6 - 29.7 |
| 4 | 24 | 0.0 | 74.6 | 10.0 | 6.2 - 15.9 |
| 5 | 17 | 0.2 | 32.4 | 5.3 | 3.0 - 9.0 |
| 6 | 7 | 0.1 | 7.9 | 2.8 | 0.7 - 7.3 |
| 7 | 4 | 0.7 | 5.2 | 2.7 | 0.5 - 8.0 |
| 8 | 3 | 2.0 | 4.8 | 3.0 | 0.7 - 9.3 |
| 9 | 1 | 0.8 | - | 0.8 | - - - |
| | 106 | 0.0 | 146.0 | 7.4 | |

B. 1-way ANOVA

| Source of Variation | DF | MS | F | P = |
|---|---|---|---|---|
| Depth Zones | 8 | 4.1965 | 2.8737** | 0.007 |
| Error | 97 | 1.4603 | | |

C. SNK-test, a least significant range test. Means under separate lines are different at the 95% level of significance.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth Zones | 9 | 1 | 7 | 6 | 8 | 2 | 5 | 4 | 3 |
| Number of Samples | 1 | 2 | 4 | 7 | 3 | 25 | 17 | 24 | 23 |
| Mean CPUEs | 0.8 | 2.7 | 2.7 | 2.8 | 3.0 | 3.2 | 5.3 | 10.0 | 14.3 |
| Groups | ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ | ______ |

(Groups: 9, 1, 7, 6, 8, 2, 5 underlined together; 4, 3 underlined together.)

**Significant at the 99% level.

Table 4. Results of statistical tests with CPUE data obtained along the Texas coast during the 1983 SEAMAP-Texas Closure survey.

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A. Results of a 2-way ANOVA testing CPUE's among depth zones 2-6, and statistical subareas 18-21. Data were $\log_e$ (CPUE+1) transformed.

| Source of variation | DF | SS | MS | F | P = |
|---|---|---|---|---|---|
| Stat. Subareas | 3 | 28.36 | 9.45 | 11.28*** | 0.0001 |
| Depth Zones | 4 | 26.75 | 6.69 | 7.98*** | 0.0001 |
| Interaction | 12 | 5.36 | 0.45 | 0.53 n.s. | 0.887 |
| Error | 76 | 63.78 | 0.84 | | |

B. Results of simple contrasts between depth zones and between statistical subareas.

1) Depth zone groupings: 2-5-6 less than 3-4

2) Statistical subarea groupings:
18-19 less than 20 less than 21

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***Significant at the 99.9% level.

Table 5. CPUE statistics for shrimp caught in the Texas region during the 1983 SEAMAP-Texas Closure. CPUEs = lbs/40-ft net/30-min tow. Transformation is: $\log_e$ (CPUE + 1).

| Depth Zone | Number of Samples | Min. | Max. | Mean | 95% Confidence Limits |
|---|---|---|---|---|---|
| | | | Statistical Subarea 18 | | |
| 1 | 0 | - | - | - | - - - |
| 2 | 7 | 0.0 | 11.7 | 1.8 | 1.4 - 2.3 |
| 3 | 4 | 5.4 | 21.4 | 12.0 | 3.8 - 34.4 |
| 4 | 5 | 1.8 | 17.4 | 5.3 | 1.4 - 15.3 |
| 5 | 4 | 0.2 | 2.6 | 1.4 | 0.1 - 4.4 |
| 6 | 2 | 0.1 | 0.2 | 0.2 | 0.0 - 1.0 |
| 7 | 1 | 3.6 | - | - | - - - |
| 8 | 1 | 2.0 | - | - | - - - |
| 9 | 0 | - | - | - | - - - |
| | 24 | | | | |
| | | | Statistical Subarea 19 | | |
| 1 | 0 | - | - | - | - - - |
| 2 | 8 | 0.0 | 2.6 | 0.4 | 0.0 - 2.3 |
| 3 | 8 | 0.0 | 54.0 | 2.5 | 1.5 - 3.9 |
| 4 | 9 | 0.0 | 13.4 | 6.7 | 3.0 - 13.8 |
| 5 | 3 | 5.0 | 11.8 | 8.7 | 2.4 - 26.4 |
| 6 | 1 | 2.7 | - | - | - - - |
| 7 | 0 | - | - | - | - - - |
| 8 | 1 | 2.6 | - | - | - - - |
| 9 | 0 | - | - | - | - - - |
| | 30 | | | | |
| | | | Statistical Subarea 20 | | |
| 1 | 1 | 0.6 | - | - | - - - |
| 2 | 5 | 0.4 | 11.4 | 2.8 | 0.1 - 12.5 |
| 3 | 7 | 7.7 | 146.0 | 41.0 | 15.1 - 108.9 |
| 4 | 4 | 9.2 | 74.6 | 18.6 | 3.6 - 83.1 |
| 5 | 6 | 2.6 | 10.7 | 4.6 | 2.5 - 7.8 |
| 6 | 3 | 5.6 | 7.9 | 6.4 | 3.9 - 10.1 |
| 7 | 1 | 5.2 | - | - | - - - |
| 8 | 1 | 4.8 | - | - | - - - |
| 9 | 1 | 0.8 | - | - | - - - |
| | 29 | | | | |
| | | | Statistical Subarea 21 | | |
| 1 | 1 | 7.4 | - | - | - - - |
| 2 | 5 | 18.6 | 54.4 | 29.3 | 17.3 - 49.0 |
| 3 | 4 | 36.0 | 72.4 | 56.6 | 34.4 - 92.9 |
| 4 | 6 | 1.6 | 70.1 | 19.6 | 5.3 - 66.3 |
| 5 | 4 | 1.5 | 32.4 | 13.1 | 1.2 - 91.5 |
| 6 | 1 | 4.4 | - | - | - - - |
| 7 | 2 | 0.7 | 3.0 | 1.6 | 0.0 - 500+ |
| 8 | 0 | - | - | - | - - - |
| 9 | 0 | - | - | - | - - - |
| | 23 | | | | |

Table 6. Results of a Model I 3-way ANOVA testing for differences in CPUEs among depth zones (2-5), statistical subareas (18-21), and years (1981-1983) for the period of the Texas Closure only. CPUEs were log-transformed.

| Source of Variation | DF | SS | MS | F | P< |
|---|---|---|---|---|---|
| Year (y) | 2 | 5.40 | 2.70 | $4.36^{*}$ | 0.014 |
| Stat. Subarea (s) | 3 | 45.50 | 15.17 | $24.48^{***}$ | 0.001 |
| Depth Zone (d) | 3 | 47.88 | 15.96 | $25.76^{***}$ | 0.001 |
| Interactions | | | | | |
| ys | 6 | 13.79 | 2.30 | $3.71^{**}$ | 0.002 |
| yd | 6 | 14.07 | 2.34 | $3.78^{**}$ | 0.002 |
| d | 9 | 7.60 | 0.84 | 1.36 n.s. | 0.205 |
| ysd | 18 | 32.31 | 1.70 | $2.90^{***}$ | 0.001 |
| Error | 264 | 163.57 | 0.62 | | |

$^{*}$Significant at the 95% level.
$^{**}$Significant at the 99% level.
$^{***}$Significant at the 99.9% level.

Table 7. Comparative statistics for shrimp CPUE data collected during the 1981, 1982 and 1983 Texas Closure surveys in the northwestern Gulf of Mexico. CPUE = lbs/40-ft net/30-min drag. Data were transformed by: $\text{Log}_e$ (CPUE + 1).

| SS | Depth Zone | Depth fm | Mean CPUE's 1981 | Mean CPUE's 1982 | Mean CPUE's 1983 | ANOVA Results F | ANOVA Results P = | Groups[1] at the 90% Level |
|---|---|---|---|---|---|---|---|---|
| 18 | 2 | 6-10 | 9.3 | 6.2 | 1.8 | 3.01 | 0.080 | 1-2 3 |
| | 3 | 11-15 | 12.8 | 9.1 | 12.0 | 0.45 | 0.644 | 1-2-3 |
| | 4 | 16-20 | 3.3 | 7.0 | 5.3 | 0.33 | 0.732 | 1-2-3 |
| | 5 | 21-25 | 3.7 | 6.2 | 1.4 | 3.18 | 0.073 | 1-2 1-3 |
| | 6 | 26-30 | 2.9 | 1.9 | 0.2 | 13.69** | 0.005 | 1-2-3 |
| 19 | 2 | | 10.0 | 18.7 | 0.4 | 24.13*** | 0.000 | 1-2 3 |
| | 3 | " | 19.0 | 17.3 | 2.5 | 4.49* | 0.028 | 1-2 3 |
| | 4 | | 14.1 | 5.6 | 6.7 | 2.13 | 0.143 | 1-3 2-3 |
| | 5 | | 6.8 | 1.6 | 8.7 | 4.29 | 0.070 | 1-2-3 |
| 20 | 2 | | 9.3 | 30.2 | 2.8 | 10.59*** | 0.000 | 1 2 3 |
| | 3 | | 43.9 | 17.8 | 41.0 | 2.81 | 0.080 | 1-3 2 |
| | 4 | " | 21.0 | 5.0 | 18.6 | 3.50 | 0.053 | 1-3 2 |
| | 5 | | 7.1 | 1.3 | 4.6 | 6.31** | 0.010 | 1-3 2 |
| | 6 | | 5.3 | ns | 6.4 | 0.92 | 0.391 | 1-3 |
| 21 | 2 | | 11.4 | 15.7 | 29.3 | 2.06 | 0.162 | 1-2-3 |
| | 3 | | 34.1 | 28.7 | 56.6 | 0.85 | 0.443 | 1-2-3 |
| | 4 | " | 25.5 | 17.2 | 19.6 | 0.42 | 0.661 | 1-2-3 |
| | 5 | | 10.5 | 4.8 | 13.1 | 2.87 | 0.088 | 1-3 2 |
| | 6 | | 4.6 | 2.9 | ss | 1.21 | 0.389 | |

ns = no samples collected
ss = single sample collected

[1]Groups may be composed of 1, 2 and 3 which signify 1981, 1982 and 1983 respectively.

*Significant at the 95% level.
**Significant at the 99% level.
***Significant at the 99.9% level.

Table 8. Shrimp CPUE statistics for the Louisiana area west of the Mississippi River delta, based on samples collected during the 1983 SEAMAP-Texas Closure survey. CPUE data were $\log_e$ transformed.

| Depth Zone | Number of Samples | CPUEs (lbs/40-ft net/30-min tow) Min. | Max. | Mean | 95% Confidence Limits |
|---|---|---|---|---|---|
| 1 | 5 | 0.0 | 5.2 | 2.2 | 0.3 - 6.6 |
| 2 | 23 | 0.0 | 9.2 | 1.2 | 0.7 - 2.0 |
| 3 | 21 | 0.0 | 4.8 | 1.1 | 0.7 - 1.6 |
| 4 | 21 | 0.0 | 5.2 | 1.1 | 0.7 - 1.7 |
| 5 | 11 | 0.0 | 3.8 | 1.9 | 0.7 - 1.7 |
| 6 | 6 | 0.1 | 3.6 | 0.6 | 0.0 - 1.8 |
| 7 | 5 | 0.0 | 4.4 | 1.1 | 0.0 - 4.0 |
| 8 | 3 | 0.1 | 4.1 | 1.6 | 0.0 - 17.9 |
| 9 | 3 | 0.0 | 0.6 | 0.3 | 0.0 - 1.5 |
| | 98 | 0.0 | 9.2 | 1.1 | |

Table 9. CPUE statistics for shrimp caught in the Louisiana region during the 1983 SEAMAP-Texas Closure survey. CPUE = lbs/40-ft net/ 30-min drag. Transformation was: $\log_e$ (CPUE + 1).

| Depth Zone | Number of Samples | Min. | Max. | Mean | 95% Confidence Limits |
|---|---|---|---|---|---|
| | | Statistical Subarea 13 | | | |
| 1 | 1 | 0.0 | - | - | - - - |
| 2 | 2 | 0.3 | 0.6 | 0.4 | 0.0 - 4.4 |
| 3 | 2 | 0.8 | 2.0 | 1.3 | 0.0 - 58.6 |
| 4 | 2 | 1.8 | 1.6 | 1.3 | 0.0 - 11.1 |
| 5 | 2 | 0.2 | 0.7 | 0.6 | 0.0 - 2.5 |
| 6 | 2 | 0.1 | 0.2 | 0.1 | 0.0 - 1.0 |
| 7 | 1 | 3.6 | - | - | - - - |
| 8 | 1 | 2.0 | - | - | - - - |
| 9 | 1 | 0.6 | - | - | - - - |
| | | Statistical Subarea 14 | | | |
| 1 | 1 | 2.9 | - | - | - - - |
| 2 | 6 | 0.1 | 9.2 | 2.5 | 0.4 - 7.4 |
| 3 | 5 | 0.2 | 4.8 | 1.0 | 0.0 - 3.4 |
| 4 | 4 | 0.0 | 1.3 | 0.4 | 0.0 - 13.8 |
| 5 | 4 | 0.0 | 1.2 | 0.5 | 0.0 - 26.4 |
| 6 | 2 | 0.1 | 0.5 | 0.3 | 0.0 - 8.2 |
| 7 | 2 | 0.2 | 1.0 | 0.5 | 0.0 - 38.8 |
| 8 | 0 | - | - | - | - - - |
| 9 | 1 | 0.0 | - | - | - - - |
| | | Statistical Subarea 15 | | | |
| 1 | 1 | 5.2 | - | - | - - - |
| 2 | 5 | 0.5 | 3.0 | 1.4 | 0.5 - 2.7 |
| 3 | 4 | 0.9 | 3.0 | 1.3 | 0.3 - 3.1 |
| 4 | 5 | 1.1 | 3.9 | 1.7 | 0.8 - 3.1 |
| | | Statistical Subarea 16 | | | |
| 1 | 2 | 2.1 | 3.4 | 2.7 | 0.0 - 33.2 |
| 2 | 5 | 0.0 | 3.9 | 1.2 | 0.0 - 4.2 |
| 3 | 5 | 0.0 | 3.0 | 1.4 | 0.3 - 3.7 |
| 4 | 5 | 0.0 | 3.4 | 1.0 | 0.0 - 2.8 |
| 5 | 0 | - | - | - | - - - |
| 6 | 0 | - | - | - | - - - |
| 7 | 1 | 4.4 | - | - | - - - |
| 8 | 1 | 2.3 | - | - | - - - |
| 9 | 1 | 0.5 | - | - | - - - |
| | | Statistical Subarea 17 | | | |
| 1 | 0 | - | - | - | - - - |
| 2 | 5 | 0.0 | 3.8 | 0.5 | 0.0 - 2.5 |
| 3 | 5 | 0.0 | 1.9 | 0.6 | 0.0 - 1.8 |
| 4 | 5 | 0.2 | 5.2 | 1.4 | 0.0 - 5.6 |
| 5 | 5 | 0.0 | 3.8 | 1.4 | 0.2 - 4.0 |
| 6 | 2 | 0.5 | 3.6 | 1.6 | 0.0 - 500+ |
| 7 | 1 | 2.2 | - | - | - - - |
| 8 | 1 | 4.1 | - | - | - - - |

Table 10. Results of a 2-way ANOVA testing for differences in CPUEs among 9 depth zones and among 5 statistical subareas off Louisiana based on collections made during the 1983 SEAMAP-Texas Closure survey. CPUE data were log transformed.

| Source of variation | DF | MS | F | P = |
|---|---|---|---|---|
| Statistical Subareas | 4 | 0.696 | 2.247 n.s. | 0.074 |
| Depth Zones | 8 | 0.297 | 0.960 n.s. | 0.475 |
| Interaction | 22 | 0.374 | 1.206 n.s | 0.275 |
| Error | 63 | 0.310 | | |

Table 11. Comparative statistics for shrimp CPUE data which were collected during the 1982 and 1983 SEAMAP-Texas Closure surveys off Louisiana. CPUE = lbs/40-ft net/30-min drag. Data were transformed by $\log_e$ (CPUE + 1).

A. 1982 and 1983 CPUE means and confidence limits.

| Depth Zone | Year | Number of Samples | Mean | 95% Confidence Limits |
|---|---|---|---|---|
| 1 | 1982 | 4 | 0.24 | 0.0 - 1.38 |
| | 1983 | 5 | 2.19 | 0.78 - 4.73 |
| 2 | 1982 | 21 | 1.15 | 0.62 - 1.86 |
| | 1983 | 22 | 1.18 | 0.65 - 1.89 |
| 3 | 1982 | 24 | 3.44 | 2.40 - 4.80 |
| | 1983 | 21 | 1.07 | 0.56 - 1.76 |
| 4 | 1982 | 28 | 2.30 | 1.58 - 3.23 |
| | 1983 | 21 | 1.14 | 0.61 - 1.85 |
| 5 | 1982 | 27 | 3.34 | 2.37 - 4.58 |
| | 1983 | 11 | 0.89 | 0.27 - 1.81 |
| 6 | 1982 | 9 | 3.14 | 1.68 - 5.41 |
| | 1983 | 6 | 0.57 | 0.0 - 1.68 |
| 7 | 1982 | 5 | 3.14 | 1.30 - 6.43 |
| | 1983 | 5 | 1.11 | 0.04 - 2.36 |
| 8 | 1982 | 5 | 0.99 | 0.66 - 4.38 |
| | 1983 | 3 | 1.64 | 0.24 - 4.64 |
| 9 | 1982 | 5 | 1.89 | 0.61 - 4.19 |
| | 1983 | 3 | 0.34 | 0.0 - 1.85 |

B. 2-way ANOVA, years vs depth zones.

| Source of Variation | DF | MS | F | P = |
|---|---|---|---|---|
| Years | 1 | 5.00003 | 11.3693*** | 0.0009 |
| Depth Zones | 8 | 0.53105 | 1.2075 n.s. | 0.2959 |
| Interaction | 8 | 0.18230 | 0.4145 n.s. | 0.9114 |
| Error | 207 | 0.43978 | | |

***Significant at the 99.9% level.

Table 12. CPUE statistics for shrimp caught in the Mississippi-Alabama region during the 1983 SEAMAP-Texas Closure survey. CPUE = lbs/40-ft net/30-min drag. Transformation was by: $\log_e(\text{CPUE} + 1)$.

A. CPUE statistics for individual statistical subareas.

| Depth Zone | Number of Samples | Min. | Max. | Mean | 95% Confidence Limits |
|---|---|---|---|---|---|
| | | Statistical Subarea 10 | | | |
| 1 | 2 | 3.0 | 3.9 | 3.4 | 0.2 - 15.1 |
| 2 | 2 | 0.0 | 0.9 | 0.4 | 0.0 - 80.3 |
| 3 | 3 | 0.0 | 3.3 | 1.1 | 0.0 - 12.0 |
| 4 | 2 | 0.0 | 0.0 | 0.0 | - - - |
| 5 | 4 | 0.0 | 0.0 | 0.0 | - - - |
| 6 | 1 | 0.0 | - | 0.0 | - - - |
| 7 | 1 | 0.0 | - | 0.0 | - - - |
| 8 | 2 | 0.0 | 0.0 | 0.0 | - - - |
| 9 | 1 | 0.0 | - | 0.0 | - - - |
| | | Statistical Subarea 11 | | | |
| 1 | 0 | - | - | - | - - - |
| 2 | 8 | 0.8 | 10.2 | 5.5 | 1.7 - 6.8 |
| 3 | 13 | 0.0 | 6.0 | 1.6 | 0.8 - 2.7 |
| 4 | 9 | 0.0 | 5.9 | 1.6 | 0.6 - 3.2 |
| 5 | 4 | 0.0 | 2.1 | 0.6 | 0.0 - 2.6 |
| 6 | 2 | 0.0 | 5.4 | 1.5 | 0.0 - 500+ |

No samples from deeper zones.

B. 2-way ANOVA; statistical subareas (10 and 11) vs depth zones (2 through 6).

| Source of Variation | DF | MS | F | P = |
|---|---|---|---|---|
| Statistical Subareas | 1 | 3.9218 | 10.785** | 0.0022 |
| Depth Zones | 4 | 0.6109 | 1.680 n.s. | 0.1748 |
| Interaction | 4 | 0.0787 | 0.216 n.s. | 0.9277 |
| Error | 38 | 0.3636 | | |

**Significant at the 99% level.

Table 13. Comparative statistics for shrimp CPUE data which was collected off Mississippi and Alabama during the 1982 and 1983 SEAMAP-Texas Closure surveys. CPUE = lbs/40-ft net/30-min drag. Data were transformed by: $\log_e$ (CPUE + 1).

A. CPUE means and confidence limits.

| Depth Zone | Year | Number of Samples | Mean | 95% Confidence Limits |
|---|---|---|---|---|
| 1 | 1982 | 4 | 1.3 | 0.0 - 16.0 |
| | 1983 | 2 | 3.4 | 0.2 - 15.1 |
| 2 | 1982 | 25 | 1.4 | 0.8 - 2.3 |
| | 1983 | 10 | 2.6 | 1.1 - 5.3 |
| 3 | 1982 | 15 | 2.1 | 1.4 - 3.1 |
| | 1983 | 16 | 1.5 | 0.8 - 2.4 |
| 4 | 1982 | 6 | 1.1 | 0.1 - 3.1 |
| | 1983 | 11 | 1.2 | 0.4 - 2.4 |
| 5 | 1982 | 5 | 0.5 | 0.0 - 2.1 |
| | 1983 | 8 | 0.3 | 0.0 - 0.8 |
| 6 | 1982 | 2 | 0.0 | - - - |
| | 1983 | 3 | 0.9 | 0.0 - 25.6 |
| 7 | 1982 | 1 | 0.0 | - - - |
| | 1983 | 1 | 0.0 | - - - |
| 8 | 1982 | 1 | 2.2 | - - - |
| | 1983 | 2 | 0.0 | - - - |
| 9 | 1982 | 1 | 2.6 | - - - |
| | 1983 | 1 | 0.0 | - - - |

B. ANOVA: 1982 vs 1983 over depth zones 1-9.

| Source of Variation | DF | MS | F | P = |
|---|---|---|---|---|
| Years | 1 | 0.1090 | 0.241 n.s. | 0.625 |
| Depth Zones | 8 | 1.140 | 2.520 * | 0.016 |
| Interaction | 8 | 0.545 | 1.204 n.s. | 0.304 |
| Error | 96 | 0.452 | | |

*Significant at the 95% level.

Table 14. CPUE statistics for shrimp caught off the northwest coast of Florida during the 1983 SEAMAP-Texas Closure survey. CPUE = lbs/40-ft net/30-min drag. Transformation was by: $\log_e(\text{CPUE} + 1)$.

| Depth Zone | Number of Samples | Min. | Max. | Mean | 95% Confidence Limits |
|---|---|---|---|---|---|
| | | **Statistical Subarea 8** | | | |
| 1 | 0 | - | - | - | - - - |
| 2 | 1 | 0.9 | - | 0.9 | - - - |
| 3 | 1 | 0.2 | - | 0.2 | - - - |
| 4 | 1 | 0.0 | - | 0.0 | - - - |
| 5 | 1 | 0.3 | - | 0.3 | - - - |
| 6 | 0 | - | - | - | - - - |
| 7 | 0 | - | - | - | - - - |
| 8 | 0 | - | - | - | - - - |
| 9 | 3 | 0.0 | 4.5 | 1.1 | 0.0 - 17.4 |
| | 7 | | | | |
| | | **Statistical Subarea 9** | | | |
| 1 | 1 | 0.3 | - | 0.3 | - - - |
| 2 | 3 | 0.3 | 0.9 | 0.4 | 0.0 - 2.0 |
| 3 | 4 | 0.0 | 0.3 | 0.1 | 0.0 - 0.3 |
| 4 | 4 | 0.0 | 0.0 | 0.0 | - - - |
| 5 | 3 | 0.0 | 0.0 | 0.0 | - - - |
| 6 | 2 | 0.0 | 0.0 | 0.0 | - - - |
| 7 | 0 | - | - | - | - - - |
| 8 | 1 | 0.0 | - | 0.0 | - - - |
| 9 | 0 | - | - | - | - - - |
| | 18 | | | | |

Table 15. Mean total lengths for brown, pink, and white shrimp collected in 5-fathom depth zones along the Texas coast during the 1983 Texas Closure. Statistical subareas 18-21 were pooled.

| Depth Zone | No. of Samples Containing the Species | No. of Shrimp Measured | Mean Length (mm) | 95% Confidence Limits |
|---|---|---|---|---|
| BROWN SHRIMP | | | | |
| 1 | 1 | 13 | 103 | 87 - 119 |
| 2 | 18 | 1,364 | 100 | 99 - 101 |
| 3 | 20 | 3,778 | 116 | 115 - 117 |
| 4 | 25 | 3,259 | 124 | 123 - 125 |
| 5 | 17 | 1,409 | 132 | 131 - 133 |
| 6 | 7 | 217 | 139 | 136 - 142 |
| 7 | 4 | 73 | 154 | 148 - 160 |
| 8 | 2 | 53 | 160 | 153 - 167 |
| 9 | 2 | 27 | 169 | 160 - 178 |
| PINK SHRIMP | | | | |
| 1 | 2 | 25 | 133 | 127 - 139 |
| 2 | 15 | 1,233 | 126 | 125 - 127 |
| 3 | 12 | 641 | 123 | 122 - 124 |
| 4 | 10 | 110 | 117 | 114 - 120 |
| 5 | 2 | 6 | 118 | 108 - 128 |
| WHITE SHRIMP | | | | |
| 1 | 1 | 7 | 166 | 152 - 180 |
| 2 | 8 | 132 | 153 | 151 - 155 |
| 3 | 3 | 9 | 167 | 160 - 174 |
| 4 | 1 | 1 | 166 | - - - |

Table 16. Mean total lengths of brown shrimp populations sampled in depth zones 1-9 of statistical subareas 18-21 during the 1983 Texas Closure. "ns" means no samples were collected in this depth zone.

| Depth Zone | No. of Samples Containing Brown Shrimp | No. of Shrimp Measured | Mean Length (mm) | 95% Confidence Limits |
|---|---|---|---|---|
| STATISTICAL SUBAREA 18 | | | | |
| 1 | ns | - | - | - - |
| 2 | 4 | 272 | 98 | 97 - 99 |
| 3 | 3 | 344 | 116 | 114 - 118 |
| 4 | 7 | 371 | 130 | 128 - 132 |
| 5 | 4 | 44 | 159 | 154 - 164 |
| 6 | 2 | 2 | 178 | 0 - 375 |
| 7 | 1 | 12 | 171 | 158 - 142 |
| 8 | 1 | 8 | 183 | 167 - 196 |
| 9 | ns | - | - | - - |
| STATISTICAL SUBAREA 19 | | | | |
| 1 | ns | - | - | - - |
| 2 | 4 | 87 | 95 | 92 - 98 |
| 3 | 6 | 495 | 113 | 111 - 115 |
| 4 | 8 | 881 | 122 | 121 - 123 |
| 5 | 3 | 304 | 132 | 130 - 134 |
| 6 | 1 | 11 | 155 | 136 - 174 |
| 7 | ns | - | - | - - |
| 8 | 1 | 9 | 185 | 169 - 201 |
| 9 | ns | - | - | - - |
| STATISTICAL SUBAREA 20 | | | | |
| 1 | 0 | - | - | - - |
| 2 | 5 | 409 | 100 | 98 - 102 |
| 3 | 7 | 1,776 | 120 | 119 - 121 |
| 4 | 4 | 742 | 127 | 126 - 128 |
| 5 | 6 | 320 | 131 | 129 - 133 |
| 6 | 3 | 158 | 139 | 136 - 142 |
| 7 | 1 | 41 | 144 | 138 - 152 |
| 8 | 1 | 36 | 148 | 141 - 155 |
| 9 | 2 | 27 | 169 | 160 - 178 |
| STATISTICAL SUBAREA 21 | | | | |
| 1 | 1 | 13 | 103 | 87 - 119 |
| 2 | 5 | 596 | 102 | 100 - 104 |
| 3 | 4 | 1,163 | 111 | 110 - 112 |
| 4 | 6 | 1,265 | 121 | 120 - 122 |
| 5 | 4 | 741 | 131 | 130 - 132 |
| 6 | 1 | 46 | 134 | 130 - 138 |
| 7 | 2 | 20 | 164 | 154 - 174 |
| 8 | ns | - | - | - - |
| 9 | ns | - | - | - - |

Table 17. Results of a 2-way ANOVA[1] testing for differences in mean lengths of brown shrimp among statistical subareas 18-21 and among depth zones 2-6. Data were from collections made during the 1983 Texas Closure, and the means were transformed to their square roots.

| Source of Variation | DF | MS | F | P = |
|---|---|---|---|---|
| Statistical Subareas | 3 | 3.4435 | 10.667 *** | 0.0001 |
| Depth zones | 4 | 10.9697 | 31.192 *** | 0.0001 |
| Interaction | 12 | 0.1360 | 0.421 n.s. | 0.950 |
| Error | 67 | 0.3228 | | |

[1]The method of weighted squares of means was used, but the method of fitting constants gives the same significance levels in this case.

***Significant at the 99.9% level.

Table 18. Results of a 1-way ANOVA testing for differences in mean lengths of pink shrimp collected in depth zones 1-5 along the Texas coast during the 1983 Texas Closure. Data were mean lengths of pink shrimp in the samples, and these values were transformed to their square roots.

| Source of Variation | DF | MS | F | P = |
|---|---|---|---|---|
| Depth zones | 4 | 0.360 | 1.399 n.s. | 0.254 |
| Error | 36 | 0.257 | | |

Table 19. Mean total lengths of brown *shrimp* collected in depth zones 1-9 off Louisiana--statistical subareas 13-17 pooled--during the 1983 SEAMAP-Texas Closure survey, and an analysis of the variability of these lengths.

A. Mean lengths and confidence limits.

| Depth Zone | No. of Samples Containing Brown Shrimp | No. of Shrimp Measured | Mean Length (mm) | 95% Confidence Limits |
|---|---|---|---|---|
| 1 | 3 | 208 | 97 | 95 - 99 |
| 2 | 17 | 458 | 106 | 105 - 107 |
| 3 | 18 | 261 | 122 | 120 - 124 |
| 4 | 20 | 279 | 133 | 131 - 135 |
| 5 | 9 | 83 | 147 | 141 - 153 |
| 6 | 6 | 28 | 167 | 158 - 176 |
| 7 | 4 | 22 | 183 | 174 - 192 |
| 8 | 3 | 22 | 186 | 177 - 195 |
| 9 | 2 | 8 | 149 | 125 - 173 |

B. A 1-way ANOVA. Data consisted of the square root transformed mean lengths for each of the samples collected in the specified depth zones.

| Source of Variation | df | MS | F | P = |
|---|---|---|---|---|
| Depth zones | 8 | 8.1448 | 17.5473 *** | 0.0001 |
| Error | 73 | 0.4642 | | |

***Significant at the 99.9% level.

Table 20. Mean total lengths (mm) of brown shrimp collected in 5-fm depth zones of statistical subareas 13-17 off Louisiana during the 1983 SEAMAP-Texas Closure survey.

| Depth Zone | No. of Samples Containing Brown Shrimp | No. of Shrimp Measured | Mean Length (mm) | 95% Confidence Limits |
|---|---|---|---|---|
| STATISTICAL SUBAREA 13 | | | | |
| 1 | - | - | - | - |
| 2 | 2 | 7 | 103 | 94 - 112 |
| 3 | 2 | 35 | 107 | 102 - 112 |
| 4 | 2 | 10 | 116 | 105 - 127 |
| 5 | 2 | 15 | 109 | 104 - 114 |
| 6 | 2 | 4 | 133 | 85 - 181 |
| 7 | - | - | - | - |
| 8 | 1 | 1 | 152 | - |
| 9 | 1 | 7 | 143 | - |
| STATISTICAL SUBAREA 14 | | | | |
| 1 | 1 | 90 | 100 | 98 - 102 |
| 2 | 10 | 311 | 105 | 104 - 106 |
| 3 | 6 | 23 | 124 | 117 - 131 |
| 4 | 4 | 80 | 121 | 117 - 125 |
| 5 | 3 | 31 | 140 | 135 - 145 |
| 6 | 2 | 8 | 163 | 159 - 177 |
| 7 | 2 | 7 | 167 | 157 - 177 |
| STATISTICAL SUBAREA 15 | | | | |
| 1 | 1 | 27 | 111 | 108 - 114 |
| 2 | 5 | 24 | 121 | 115 - 127 |
| 3 | 5 | 74 | 131 | 126 - 136 |
| 4 | 5 | 77 | 127 | 133 - 141 |
| STATISTICAL SUBAREA 16 | | | | |
| 1 | 2 | 91 | 90 | 87 - 932 |
| 2 | 4 | 43 | 103 | 99 - 107 |
| 3 | 4 | 95 | 124 | 122 - 126 |
| 4 | 4 | 53 | 134 | 128 - 140 |
| 5 | - | - | - | - |
| 6 | - | - | - | - |
| 7 | 1 | 9 | 197 | 184 - 210 |
| 8 | 1 | 6 | 198 | 186 - 210 |
| 9 | 1 | 1 | 196 | - |
| STATISTICAL SUBAREA 17 | | | | |
| 1 | - | - | - | - |
| 2 | 3 | 73 | 108 | 105 - 111 |
| 3 | 3 | 34 | 112 | 105 - 119 |
| 4 | 5 | 59 | 148 | 144 - 152 |
| 5 | 4 | 37 | 167 | 162 - 172 |
| 6 | 2 | 16 | 178 | 170 - 186 |
| 7 | 1 | 6 | 182 | 165 - 194 |
| 8 | 1 | 15 | 183 | 172 - 194 |

Table 21. Mean total lengths of pink and white shrimp collected off Louisiana during the 1983 SEAMAP-Texas Closure survey. Shrimp from all samples collected in statistical subareas 13-17 were pooled to determined the means.

| Depth Zone | No. of Samples Containing the Species | No. of Shrimp Measured | Mean Length (mm) | 95% Confidence Limits |
|---|---|---|---|---|
| PINK SHRIMP | | | | |
| 1 | 0 | - | - | - - - |
| 2 | 6 | 5 | 123 | 95 - 151 |
| 3 | 9 | 31 | 137 | 127 - 147 |
| 4 | 2 | 44 | 139 | 131 - 147 |
| 5 | 0 | - | - | - - - |
| WHITE SHRIMP | | | | |
| 1 | 4 | 47 | 151 | 147 - 155 |
| 2 | 15 | 371 | 165 | 164 - 166 |
| 3 | 6 | 26 | 167 | 162 - 172 |
| 4 | 4 | 24 | 169 | 165 - 173 |
| 5 | 3 | 8 | 170 | 158 - 182 |

Table 22. Length statistics for brown, pink and white shrimp collected in coastal waters of statistical subareas 10 and 11 (pooled) off Mississippi and Alabama during the 1983 SEAMAP-Texas Closure survey.

| Depth Zone | No. of Samples Containing the Species | No. of Shrimp Measured | Mean Length (mm) | 95% Confidence Limits |
|---|---|---|---|---|
| BROWN SHRIMP[1] | | | | |
| 1 | 1 | 12 | 99 | 87 - 111 |
| 2 | 10 | 987 | 102 | 101 - 103 |
| 3 | 10 | 352 | 109 | 107 - 111 |
| 4 | 10 | 48 | 114 | 110 - 118 |
| 5 | 3 | 16 | 129 | 119 - 139 |
| 6 | 1 | 165 | 113 | 112 - 114 |
| PINK SHRIMP | | | | |
| 1 | 3 | 39 | 110 | 106 - 114 |
| 2 | 10 | 569 | 105 | 104 - 106 |
| 3 | 6 | 1,023 | 127 | 126 - 128 |
| 4 | 4 | 354 | 135 | 133 - 137 |
| 5 | 3 | 3 | 154 | 100 - 208 |
| WHITE SHRIMP | | | | |
| 1 | 2 | 31 | 160 | 157 - 163 |
| 2 | 8 | 112 | 162 | 160 - 164 |
| 3 | 8 | 27 | 173 | 168 - 178 |
| 4 | 2 | 6 | 164 | 152 - 176 |
| 5 | 1 | 1 | 184 | - |
| 6 | 1 | 4 | 162 | 153 - 171 |

[1]All brown shrimp were caught in statistical subarea 11.

Table 23. Estimated standing stocks of shrimp for the area between 5 and 25 fathoms off the Texas coast during the three Texas Closure surveys. Values are millions of pounds.

| | Statistical Subareas | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth | 18 | | | 19 | | | 20 | | | 21 | | |
| Zones | 1981 | 1982 | 1983 | 1981 | 1982 | 1983 | 1981 | 1982 | 1983 | 1981 | 1982 | 1983 |
| 2 | 1.28 | 0.85 | 0.25 | 0.64 | 1.20 | 0.03 | 0.26 | 0.83 | 0.08 | 0.27 | 0.37 | 0.69 |
| 3 | 0.98 | 0.65 | 0.86 | 1.89 | 1.72 | 0.25 | 2.14 | 0.87 | 2.00 | 0.93 | 0.78 | 1.54 |
| 4 | 0.17 | 0.35 | 0.27 | 0.94 | 0.37 | 0.45 | 0.88 | 0.21 | 0.78 | 0.78 | 0.55 | 0.62 |
| 5 | 0.19 | 0.32 | 0.07 | 0.25 | 0.06 | 0.33 | 0.24 | 0.05 | 0.15 | 0.53 | 0.25 | 0.67 |
| | 2.56 | 2.18 | 1.45 | 3.73 | 3.35 | 1.05 | 3.52 | 1.96 | 3.01 | 2.54 | 1.95 | 3.52 |

Totals: 1981 = 12.35
1982 = 9.44
1983 = 6.17

Table 24. Estimated standing stocks of shrimp for the area between 5 and 25 fathoms off the Texas coast during the three Texas Closure surveys. Values are millions of shrimp.

| | Statistical Subareas | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth | 18 | | | 19 | | | 20 | | | 21 | | |
| Zones | 1981 | 1982 | 1983 | 1981 | 1982 | 1983 | 1981 | 1982 | 1983 | 1981 | 1982 | 1983 |
| 2 | 53.7 | 33.3 | 14.8 | 36.1 | 51.6 | 1.7 | 19.5 | 34.1 | 4.5 | 19.6 | 16.8 | 37.1 |
| 3 | 32.2 | 15.7 | 31.4 | 92.8 | 63.7 | 9.7 | 98.5 | 28.1 | 66.0 | 47.3 | 27.7 | 63.9 |
| 4 | 5.7 | 8.5 | 6.9 | 47.9 | 11.6 | 13.9 | 32.5 | 9.3 | 21.9 | 30.9 | 17.5 | 19.9 |
| 5 | 3.3 | 5.7 | 1.1 | 7.1 | 1.3 | 19.1 | 7.9 | 1.0 | 3.9 | 20.3 | 4.5 | 16.7 |
| | 94.9 | 63.1 | 54.2 | 183.9 | 128.1 | 33.5 | 158.4 | 72.5 | 96.3 | 118.1 | 66.4 | 137.5 |

Totals: 1981 = 555.3
1982 = 330.2
1983 = 321.5