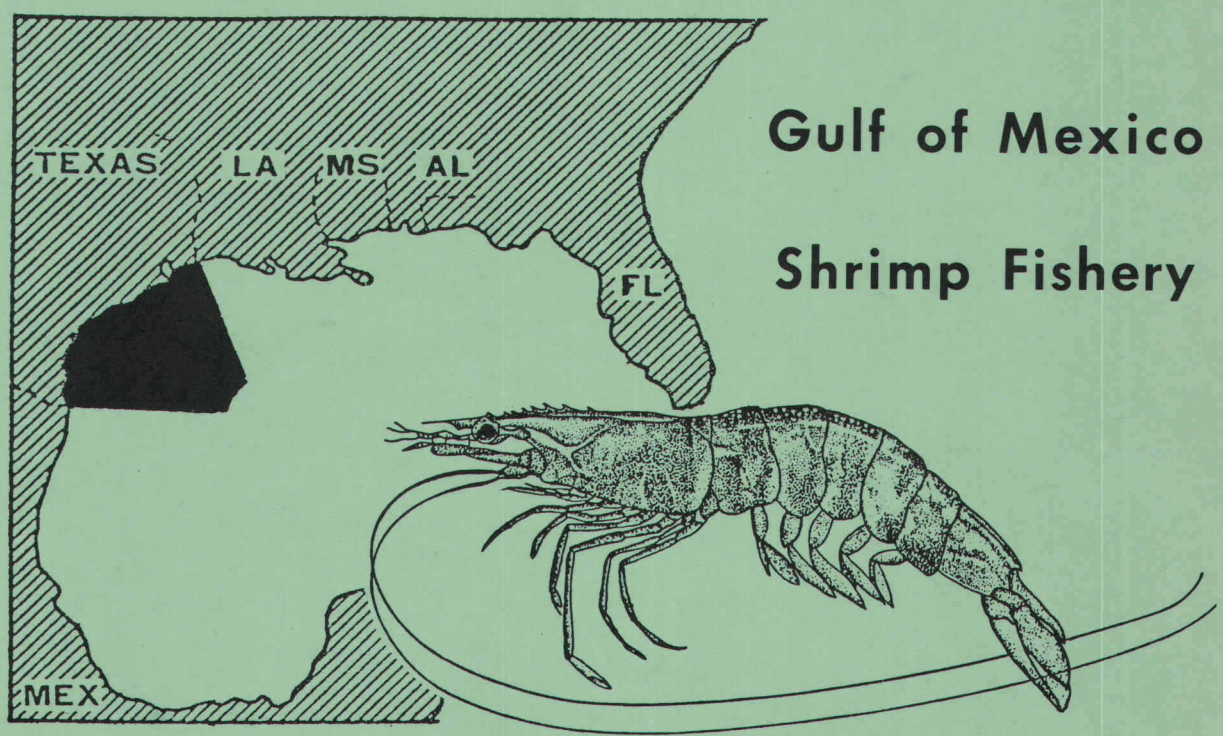
NOAA Technical Memorandum NMFS-SEFC-136

Review of the 1983 Texas Closure for the Shrimp Fishery off Texas and Louisiana



March 1984

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
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Review of the 1983 Texas Closure for the Shrimp Fishery off Texas and Louisiana

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MARCH 1984

1983 TEXAS CLOSURE REPORT

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INTRODUCTION

The implementation of the Gulf of Mexico shrimp fishery management plan (FMP) in May 1981 permitted, for the first time, closure of the brown shrimp fishery from the coastline to 200 miles off the Texas coast and was in effect from 22 May to 15 July 1981. The Gulf of Mexico Fishery Management Council (GMFMC) agreed to continue the seasonal closure of the brown shrimp fishery off the Texas coast in 1982 and again in 1983 and implemented the third closure from 27 May to 15 July.

The objectives of the Texas closure management measure are to increase the yield of shrimp and to eliminate waste caused by discard of undersized shrimp in the fishery conservation zone (FCZ). According to the FMP, shrimp yield would be increased by protecting shrimp from fishing during the period when they are predominantly small and are growing rapidly. Discards would be reduced by eliminating the count restriction in order to allow all shrimp caught to be landed.

The purpose of this report is to provide information to determine how well the objectives of the Texas closure regulations were achieved in 1982 and 1983. This report reviews and analyzes the characteristics of the Texas and Louisiana fisheries west of the Mississippi River and describes the catch, fishing effort, relative abundance and recruitment to the offshore fishery from June 1982-Aug 1983.

MATERIALS AND METHODS

Fisheries Statistics

A collection of detailed catch statistics describing the U.S. Gulf of Mexico shrimp fishery is available since 1956 and the procedures used to collect them are described by Klima (1980). The monthly statistics compiled by the Southeast Fisheries Center (SEFC), Fishery Information and Management Division (FIMD), consisting of catch by statistical subareas (Fig 1), effort data (in 24 hrs of fishing, time expressed as days fished and number of trips) and size composition of the catch were used to analyze the effects of the Texas closure. Only commercial catch statistics from areas west of the Mississippi River (statistical subareas 13-21) were examined.

Locations and amount of fishing effort expended in 24 hours fishing were obtained by interviewing fishing vessel captains at the termination of trips. All catch data were recorded as heads off by species and size category, by statistical subarea, depth zone and month, and are reported in "Fishery Statistics of the United States (1956-1979)" and "Shrimp Landings (1956-1979)". Catch and effort data from 1980 to the present are on file at the SEFC/FIMD office where they are available for inspection. These data were used to compute catch per unit effort (CPUE) per 24 hours of fishing and catch per trip. Number of shrimp caught were estimated by multiplying the pounds caught by the mid point of the size category, and in the case of <15 or >116 count, 15 and 116 were used respectively. Starting in May 1982, FIMD started to recorded pounds caught in size categories larger than 68 count as follows: 68-80, 81-100, 101-115 and 116 count or greater. Messrs. Orman Farley[1] and Orville Allen and Tom Dawley[2] provided specific

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information concerning the Texas and Louisiana inshore and offshore shrimp fisheries relative to fleet activities, changes in the fleet, number of trips, discards and specifics of catch and effort for the fishing area during 1982 and 1983.

We feel, in general, that the fishing effort off Texas was almost the same in all three years, 1981-1983, yet by calculations of days fished which is expanded from vessel-interview data, we found substantial differences between years. During these years approximately the same number of trips were exerted, in 1983 a total of 5,971 trips were recorded in July and August and in 1981 and 1982, 6,354 and 6,204 trips were recorded respectively. We feel that the differences in terms of days fished were artifacts, and that the major differences occurring between those three years were introduced biases attributable to a greatly reduced interview level which was about 36% in 1983, compared to 76% and 63% in 1981 and 1982 respectively. Because of these differences in interview levels we feel it is best to use total trips as a measure of fishing effort, and have done so as a measure of fishing effort in examining the catch rate off Texas and Louisiana for May-Aug 1983.

Statistical Treatment

Catch data frequently follow skewed distributions,show heteroscedasticity and have non-additive components. Transformations applied to the original data are often able to alleviate these problems and permit valid statistical analyses of the data employing t-tests and 2-way analysis of variance (ANOVA) (Sokal and Rohlf, 1969). Taylor's (1961) test analyzing relationships between means and variances was apieed to the brown shrimp catch data. It showed that catch data should be transformed to their logarithms, fishing effort data did not need to be transformed, and CPUE data should be transformed to their square roots. The analyses of these transformed data provided statistical support to what the untransformed data showed. The summaries are presented here with untransformed data.

The commercial catch data were grouped into biological years May-Apr, since brown shrimp are recruited to the fishery in May of each year. The first and last biological years identified are May 1960-Apr 1961 and May 1982-Apr 1983.

Mean monthly catch, mean monthly fishing effort and mean monthly CPUEs for the 1960-1979* period were compared with the May 1982-Apr 1983 monthly data via 2-way ANOVA using paired observations. Additional comparisons between the May-Aug monthly means of the fisheries data for statistical subareas 13-17 and 18-21 for the entire time series 1960-1979 and the five latest years (1975-1979)* were compared with the 1983 monthly data from May-Aug, using paired observations in a 2-way ANOVA and in t-tests. The shrimp size distributions for each month were compared with the historical data set 1960-1979 and 1982 and 1983 monthly size distributions by visual inspection. Unless otherwise stated, tests of significance were performed at the 95% level (P = 0.05) (Sokal and Rohlf, 1969).

RESULTS

1982 TEXAS CLOSURE

The 1982 offshore brown shrimp fishery from the mouth of the Mississippi River to the U.S./Mexican border yielded 39.9 million pounds. Louisiana produced 17.9 million pounds and texas produced 21.4 million pounds, well below the historical average production of 27.3 for Texas. total brown shrimp production in this area amounted to 59.1 million of which 15.1 and 4.1 were harvested from the inshore waters of Louisiana and Texas, respectively.

Klima et al., (1983) reported on the 1982 closure for the months of July and August and showed that the catch, fishing effort and CPUE off the Texas coast (statistical subareas 18-21) were greater than the catch and CPUE off Louisiana (statistical area 13-17) during the same period, but were not significant different

*Does not include 1980 data because this data file has not been verified at this time.

than the historical catch, effort and CPUE for Texas from 1960-1979. The Sept-Dec 1982 landings off Texas were 7.3 million pounds with 18.0 thousand days of effort whereas the landing off Louisiana (subareas 13-17) were 2.8 million pounds and only 6.2 thousand days of fishing effort (Fig 2 and Fig 3). The CPUEs were approximately the same 447 and 403 per 24 hr day for Louisiana and Texas, respectively. Historically the Jan-Apr fishery contributes less than 10% to the annual production and the Jan-Apr 1983 fishery was no exception as only 1.4 and 0.8 million lbs of brown shrimp were produced off Louisiana and Texas respectively. Fishing effort was low in both states as was the CPUE (Table 1). The monthly landing efforts and CPUE's from Sept 1982-Apr 1983 data for Texas and Louisiana offshore waters have been analyzed by 2-way ANOVA, results indicate that the landings in Texas and Louisiana offshore waters during this time frame were not significantly different nor were monthly efforts, (Figs 2 and 3, Table 2) nor were CPUE's.

Catch, fishing effort and CPUE for each month from September and 1982-April 1983 were compared with the respective historical data for the same months for the Texas coast (statistical subareas 18-21). Results of t-tests revealed no significant differences between recent and historical catches, effort or CPUE for each month (Fig 4; Tables 5 and 6).

We also examined the differences in the catch, fishing effort and CPUE from Sept 1982-Apr 1983 with the means for the same months from Sept 1975-Dec 1979. This comparison was made because there may have been some slight changes in the fishery patterns in the last five years compared to the historical 20-year data set. Results of t-tests in the catch, fishing effort and CPUE showed no significant differences (Table 6). We have already noted in previous reports (Klima et al., 1982) that fishing effort has decreased slightly from January-April in the last few years.

1983 TEXAS CLOSURE

In 1983, the FCZ of the United States and the territorial sea of the State of Texas were closed to all shrimp fishing from 27

May-15 July, except for a daytime nearshore fishery directed at white shrimp.

Recruitment

Louisiana.

In 1983 Louisiana Department of Wildlife Fisheries (LDWF) projected there were less than one million acres of optimum brown shrimp nursery grounds in Louisiana (Perret and Bowman, P. C.)[3]. This is a 40% reduction from the 1.5 million acres recorded in 1982 and a 66% reduction from the 3.0 million acres recorded in 1981. Further, the average catch and size of brown shrimp sampled by trawls from March-May 1983 in Barrataria Bay by LDWF was below the good and poor shrimp production indicator years. Based on these data Mr. Corky Perret (P.C.) indicated that the Louisiana spring brown shrimp season would be poor and production probably would be much less than in 1982; a slightly better than average year for both inshore and offshore from the Mississippi River to the Louisiana-Texas State line. The total inshore catch from May-Aug 1983 was 20.9 million pounds, whereas it was 28.8 and 38.3 in 1982 and 1981 respectively.

Texas.

Estimates of the potential yield from the spring 1981 and 1982 brown shrimp crops were made by the Texas Parks and Wildlife Department (TPWD)[4] and the National Marine Fisheries Service (NMFS). Both estimates indicated that the 1981 crop was projected

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[3]Perret, Corky, Personal Communication, Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA.
Bowman, Phillip, Louisiana Department of Wildlife and Fisheries, Houma, LA.

[4]Bryan, C. E., personal communication; Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, TX 78744

to be slightly better than average (Klima et al., 1982). We (NMFS) estimated a yield of approximately 29 million pounds (±2.7 million pounds at the 95% confidence level); however, more than 40 million pounds of brown shrimp were caught in offshore Texas waters from July 1981-May 1982. The difference in the projected estimates and actual higher catch was attributed to the Texas closure (Klima et al., 1982).

The 1983 season indices of post larval and juvenile abundance were based on information collected from Galveston Bay from February through June 10th 1983, which we feel provides a reasonable forecast for the entire Texas coast. However, primarily we use as our most reliable means of predicting the brown season the relative abundance of brown shrimp caught by the Galveston Bay bait shrimp fishery.

Postlarval Brown Shrimp Index. Mass movements of postlarval brown shrimp into nursery areas usually occur after water temperatures reach or exceed 60°F. This year bay waters were generally below 60°F until the first week in April. Low catches of postlarval brown shrimp were observed throughout the spring (Feb-May) and were much lower than the 15-year average postlarval index for Galveston Bay.

Juvenile Brown Shrimp Indices. Sampling of juvenile shrimp with the drop sampler in a salt marsh at Galveston Island State Park indicated much lower densities in March and April 1983 as compared with 1982. Late recruitment of juveniles was reflected by high densities in May 1983. Over 70% of the juveniles in May were less than 30 mm in length and did not move into the primary bay areas and become available to the inshore fishery until late June. The lack of an early crop of juveniles in the salt marsh grass habitat in March/April severely limited the inshore and offshore abundance of brown shrimp in 1983.

Another measure of the abundance of brown shrimp is an estimate of the standing stock of shrimp in Sydnor Bayou, a secondary bay in Galveston Bay. In 1970, an above average brown shrimp year, we estimated the standing stock to be 6,500 shrimp per acre: In May 1983 we estimated the standing stock to be 2,600 per acre.

Texas Inshore Bay Fishery. The Texas inshore brown shrimp season opened on May 15th. Catch rates were relatively low, less than 45 lb/hour in all bays; especially Galveston Bay where shrimpers concentrated on catching white shrimp in May. Although we do not have comparable measures of catch rates from previous years we feel the 1983 catch rates were low; good catch rates from previous years were in the range from 75 to 100 lbs per hours.

Bait Shrimp Index. Our best estimate of the relative magnitude of the brown shrimp crop comes from data collected from the Galveston Bay bait shrimp fishery during May and early June (Table 7 and Fig. 5). The bait shrimp model developed by Baxter (Klima et al., 1982) predicted that the 1982 yield would be poor compared to 1981 (Fig 5). It predicted a catch of approximately 21.6 million pounds ($\pm$ 2.8 million pounds at the 95% confidence level) from July 1982-June 1983. The bait shrimp model has a relatively high degree of correlation with landings for data covering the past several years (Table 7). The actual catch from statistical subareas 18-21 from July 1982 thru June 1983 was 21.8 million pounds a difference of only 0.3 million pounds from our prediction.

The 1983 bait shrimp index was extremely low. We predicted a total catch from July 1983 - June 1984 of about 17.8 million pounds, with a range between 16.0 and 19.4 million pounds, i.e. a well below average year. Average offshore brown shrimp production for statistical subareas 18-21 from 1960 - 1982 was 27.5 million lbs.

Early Offshore Fishery Production. Another indicator of annual production is the offshore catch in July and Aug in statistical subarea 18-21. Historically, the July and Aug brown shrimp catch averages 47% of the total annual production from July-June of each year. Since 1981 with the inception of the first closure the July-Aug catch amounts to about 60% of the total annual production. The offshore catch in July-Aug 1983 from subareas 18-21 amount to 9.8 million pounds or an estimated annual production of 20.9, or 16.3 million pounds if the 47 and 60% values are used respectively. Thus, our bait shrimp index appears to be accurate to date in 1983.

Discards

Mr. Farley[5] indicated that no major culling of juvenile brown shrimp occurred immediately after the season's opening on 15 July 1983 except 1) usual culling of from 1-10 pounds of shrimp per drag encountered by all vessels during most of the year, and 2) scattered discards of shrimp when drags contained several hundred pounds of small fish and few shrimp. Farley indicated that culling before 1982 was dependent upon size count laws and the absence of markets for small shrimp. He further indicated that in 1982, and 1983 there was a market for small shrimp and that quite heavy landings of 60-count and smaller shrimp were landed during the last two weeks in July 1983 (caught mostly in area 19). Vessels operating off Louisiana, Mississippi and Alabama did not discard large quantities of small shrimp. It appears that low discarding of small shrimp was encountered during the 1983 brown shrimp season in July and August.

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[5]Orman Farley DOC, NOAA, NMFS, SEFC FIMD, 4700 Ave. U, Galveston, Texas

Inshore Fisheries

Inshore shrimp fisheries of Texas and Louisiana are managed by the respective states. Specific regulations concerning fishing activities are in force for both states, limiting the time of fishing during the day, size of fishing gear, fishing areas and seasons.

Louisiana.

The inshore Louisiana brown shrimp fishery averaged 10.9 million pounds ± 4.1 million pounds standard deviation from 1960-1982 (Fig 6). Peak production in Louisiana appears to be cyclic in that low production was observed from 1960-1966 and above average production on all other years except in 1973-1975 and 1980. Historically, the Louisiana inshore fishery is concentrated from May-Aug, with peak production in May and June.

The May-August 1983 catch in Louisiana for inshore waters amounted to 12.1 million pounds, with peak production in May and June. This years inshore production was lower than the 15.1 and 15.2 million pounds recorded in 1982 and 1981, respectively. In 1983, May production was 3.8 million pounds and June production was 7.1 million pounds, dropping to slightly more than 1.0 million pounds by July. The size composition of the Louisiana catch in 1981 during the peak months was predominated by 68-count shrimp or smaller. In 1982, FIMD agents collected specific size information of shrimp smaller than 68-count; the May-August 1982 data revealed that the size composition in Louisiana was predominately 116-count or larger size group (Klima et al., 1983). The May-Aug 1983 catch was also predominately composed of shrimp in the 116-count size group (Table 8).

Texas.

Landings for the inshore brown shrimp fishery for Texas have been increasing for the past several years. The average catch over the 23-year period (1960-1982) is 1.9 million pounds ± 1.4 million pounds standard deviation (Fig 7). The landings in 1979, 1980, 1981 and 1982 were 4.1, 4.7, 4.2 and 4.1 million pounds, respectively. These are significantly above the 23-year average.

The inshore brown shrimp fishery takes place from late Apr-Aug. Peak production in Texas waters occurs in June. The total inshore catch for Texas in 1983 was 5.9 million pounds up from the 4.1 million pounds produced in 1982 and well above the historical average of 1.9 million pounds. Specifically, the catch in 1983 peaked in June, with a production of about 3.2 million pounds compared with 1.1 million pounds in May. Matagarda and Aransas Bays had the major inshore product this year whereas in the past Galveston Bay was one of the major producing Bays. This year less than 900 thousand pounds or 15% of the total inshore catch were caught in Galveston Bay. this system. In 1981 and 1982 Galveston Bay produced 29 and 24% of the inshore crop, respectively.

The size composition of the inshore catch from May-Aug is predominated by 68-count shrimp or smaller. In 1982, FIMD statistical agents collected information on the specific size categories of shrimp larger than 68-count. These data indicated that the catch was composed primarily of 116-count shrimp or larger size groups in May and June of 1982 (Klima et al., 1983). The 1983 catch in May and June was also predominately composed of shrimp in the 116-count size group (Table 9).

Size Distribution.

The inshore size distribution of brown shrimp caught in Louisiana and Texas is remarkably the same from May-Aug. Generally in 1983, the average size in May ranged from 99-104

count/pound in Texas and Louisiana, respectively, whereas in June the average count in Texas and Louisiana was about 105. In July, the average size count dropped to approximately 92-97 count shrimp in both states and by August, when the fishery drops drastically, the average size count dropped to less than 61-count shrimp in Texas and 69-count shrimp in Louisiana (Figs 8a, 8B).

Offshore Fisheries

Louisiana.

Annual production of brown shrimp from May-April in Louisiana offshore water averaged 15.0 million pounds ± 8.3 standard deviation from 1960-1982. The annual yield was low in the early 1960's and increased to about 15 million pounds by 1967 and remained at this level through 1972 (Fig 9). The yield dropped to about 10 million pounds from 1973 through 1975. Thereafter the yield was above the historical average of 15.0 million pounds, with high yields of about 30 million pounds in 1977, 1978, and 1981.

In 1982 the Louisiana offshore fishery produced 17.9 million pounds of brown shrimp. Total offshore brown shrimp production of the 1983 year class from May through August in statistical subareas 13-17 was 8.8 million pounds from 21 thousand days of fishing effort with an average CPUE of about 420 pounds per day. A total of 14,045 trips were expended off Louisiana with a resulting catch per trip of 627 lbs. The 1982 catch from May-August was 13.7 million pounds from 16,186 trips and an average CPUE of about 846 pounds per trip.

In May 1983, the fishery off Louisiana produced 1.0 million pounds of brown shrimp and occurred primarily in the shallow waters of statistical subarea 13. Little production was realized from other zones (Figs 10, 11). Fishing effort was relatively low off Louisiana (2.9 thousand days from 1463 trips) but the CPUE averaged only 609 pounds/day (314 pounds/trip). Highest

catch was recorded off statistical subarea 13, with a low catch in all other statistical subareas.

In June, the fishery off Louisiana produced 2.9 million pounds of brown shrimp with a fishing effort of 6.7 thousand days (4077 trips) and average CPUE of 429 pounds/day or 710 pounds/trip. The highest CPUE was recorded off statistical subarea 14 but there was little difference in the low CPUE's between statistical subareas 15-17 (Fig 12).

During June, Texas vessels did not fish off the Texas coast for brown shrimp but primarily concentrated their activities in western Louisiana. Approximately 372 thousand pounds of brown shrimp were landed by vessels which returned to Texas ports. In addition to the brown shrimp, the Texas fleet also caught 194 thousand pounds of white shrimp off the beaches of Louisiana. A total of 1,131 trips were recorded for Texas vessels fishing in Louisiana waters with 1,287 days of fishing effort expended. Over 80% of the brown shrimp landed in Texas were caught in statistical subareas 16-17, primarily between the 6-15 fathom depth zones.

The July fishery in statistical subareas 13-17 produced 2.6 million pounds of brown shrimp with 6.3 thousand fishing days (i.e. 3828 trips). Relative abundance averaged 414 pounds/day or 678 pounds/trip, with the highest CPUE observed off statistical subarea 14 (Fig 13) and the lowest CPUE in statistical subarea 13. The maximum production occurred inside of 10 fathoms.

In August, the Louisiana offshore fishery produced approximately 2.3 million pounds of brown shrimp with an average CPUE of 441 pounds/day 495 pounds/trip. Fairly large differences were observed in the amount caught, fishing effort and CPUE between statistical subarea 14 and the other areas off the Louisiana coast (Fig 14).

Texas.

Average annual brown shrimp yield from May-Apr in Texas offshore waters from 1960-1982 is 27.4 million pounds ± 7.8 standard deviation (Fig 15). Peak production occurred in 1967 and 1981 with a yield of 48 and 41 million pounds, respectively.

The 1983 production from May-Aug amounted to 10.5 million pounds with 9.8 million pounds being produced in July and August. Production in July and August was 24.9 and 13.1 million pounds in 1981 and 1982, respectively. The dramatic reduction in the July-Aug yield is attributed to poor recruitment to the offshore from Texas bays and to slightly less fishing effort being expended in 1983 than 1981 and 1982. In July-Aug 1983 a total of 5,791 trips was expended, a 3 and 7 percent lower level than in 1982 and 1981, respectively (Table 10). The average relative abundance in July-Aug was 1,642 pounds per trip in 1983 down from the 2,095 pounds/trip in 1982.

The May fishery off the Texas coast was concentrated on brown shrimp in which 522 thousand pounds were landed. Over 204 thousand pound were small shrimp (>41 count). The predominant modal group was 68 count. In addition to the brown shrimp fishery, almost 183 thousand pounds of white shrimp were landed. Major brown shrimp fishing zones were in statistical subareas 20 and 21, which produced over 59% of the catch (Fig 16). The white shrimp fishery was located primarily in statistical subareas 18-19, which produced over 70% of the catch.

No fishing for brown shrimp was permitted from 27 May to 15 July. A daytime fishery from the beach to 4 fathoms for white shrimp was permitted along the entire coast during this period. The total landed catch in June for the daytime fishery was approximately 181,000 lbs for brown shrimp and 141,000 lbs for white shrimp. Over 132,000 lbs of brown shrimp were caught in statistical area 19 and over 77% of the white shrimp were caught in area 18 and only 21% were caught in area 19, which indicate that the day

fishing in area 19 was targeted on small brown shrimp. The July white shrimp catch was 594 thousand pounds with over 80% being produced in statistical subarea 18.

With the opening of the offshore brown shrimp season in mid-July, production 5.0 million pounds were caught in the last 2 weeks of July in statistical subareas 18-21, with 3,181 trips with an average CPUE of approximately 1,575 pounds/trip. Highest CPUE (4,418 lbs/trip) was observed in statistical subarea 21 (Fig 14). Peak production came from the 11-15 fathom depth zones in statistical subareas 20-21 (Fig 16). Production from subareas 18 and 19 was low amounting to less than 0.5 and 1.0 million pounds, respectively.

In August, the Texas catch amounted to 4.8 million pounds, with fishing effort decreasing to 2,788 trips. CPUE averaged 1708 pounds/trip, ranging from a high of 2,143 pounds/trip in statistical subarea 21 to a low of 1,152 pounds/trip in statistical subarea 18 (Fig 14). The August peak production occurred in the 16-20 fathom depth zone in statistical subarea 19 (Fig 16). High production also occurred in statistical subareas 20-21 from 11-15 fathoms. Limited production of about 900 thousand pounds was observed in statistical subarea 18 from 11 fathoms seaward. Limited production occurred from most areas seaward of 20 fathoms.

A comparison of the July catch between 1981, 1982 and 1983 indicates a similar fishing pattern except fewer brown shrimp were caught in waters deeper than 16 fathoms in 1982 and 1983 compared to 1981. August 1981, 1982 and 1983 production appeared to be similar in statistical subarea 18 but was drastically different in statistical subareas 19-21, as lower production was realized in these three areas because smaller quantities of shrimp were caught seaward of 16 fathoms in 1983 compared to 1981. The data indicate that in 1981 there were large quantities of shrimp out to 35 fathoms. This does not appear to be the case in 1982 or 1983, as only small quantities of shrimp were found seaward of 20 fathoms

along the Texas coast in July and August.

In comparing the fishing effort and CPUE between 1981 (July-Aug) and 1982 for statistical subareas 18-21, it is obvious there were large differences; namely, the 1981 CPUE was more than doubled that in 1983. Fishing effort was about the same in July-Aug 1981, 1982 and 1983 periods.

The resultant catch from the 1981 fishing effort was far greater than that observed in 1982: 24.9 million pounds versus 13.1 million pounds and both were greater than the 9.8 million lbs landed in 1983. There is no question that the fishery in 1981 produced more shrimp from the Texas coast than it did in 1982 and 1983. Relative abundance was far greater in 1981 than 1982, and 1983 resulting in record production in 1981 average production in 1982. Relative abundance was similar between 1982 and 1983 in both July and Aug as was fishing effort. The lower production is attributed to a lower level of shrimp abundance.

Size Distribution.

The size composition (measured by the number of shrimp/lb) of the 1983 commercial offshore catch of brown shrimp from statistical subareas 13-17 from May-Aug 1982 was dominated by 68-count and smaller shrimp in May, June and July (Fig 17). In August, the catch was more uniformly distributed between the 31-40 to the 68-count size category. The average number of brown shrimp/pound caught in statistical subareas 13-17 in Louisiana from May-Aug decreased from about 81-count to approximately 55-count and little or no difference was observed between 1982 (Klima et al., 1983) and 1983 (Fig 18).

The monthly size distribution for the catch of brown shrimp from statistical subareas 18-21 from May-Aug 1982 was significantly different than that observed off Louisiana. In May, the catch was composed of nearly equal amounts of size categories larger than 31-40's. In June a considerable amount of shrimp

(181,000 lbs) of 68-count or smaller of which almost 100,000 pounds were landed off the San Benard River off the Texas coast. In July, the 31-40 count was the predominant modal group, as it was in August (Fig 18). The 31-40 size class was the dominant modal group of brown shrimp caught in July-Aug 1981 and 1982 off Texas (Klima et al., 1982 and 1983). No difference was observed between the May, July and August 1981 and 1982 and 1983 average number/pound of shrimp caught off Texas. There appeared to be some difference in the average number/pound between June 1981 and June 1982; however, the catch was extremely small and amounted to less than 1% of the total catch of brown shrimp in the Gulf of Mexico in June (Klima et al., 1983).

In 1982, FIMD agents began to collect shrimp size in categories smaller than 68-count. These data show that, in western Louisiana, the average size count for the offshore fishery was 88 in May, 95 in June, 68 in July and 55 in August whereas for the Texas coast, the average size count was 51 in May, 79 in June, 45 in July and 38 in August (Fig 17). It appears that the greatest differences in the size composition between Texas and Louisiana occurred in the May, July and August catches.

In addition to describing the pounds landed by size count, we have converted the size category into numbers of shrimp caught in Texas and Louisiana, both for offshore and inshore waters. Large numbers of shrimp were caught in Louisiana inshore waters in May and June but the catch decreased drastically in July and August (Fig 19). The Louisiana inshore and offshore fisheries caught about 1.5 billion shrimp in May and June, with the catch dropping to slightly less than 300 million in July and less than 140 million in August. Less than 500 million shrimp were caught in Texas waters in May and June 1983; however, production was approximately 348 million and 196 million in July and August, respectively (Fig 19).

In comparing the two states for the total number of shrimp

landed, it is evident that in 1983 Louisiana produced more shrimp in numbers than did Texas (1.9 billion versus 1.0 billion, respectively) (Fig 19). However, total production in Texas was 16.4 million pounds compared to 20.9 million pounds in Louisiana for the May-Aug period. Texas and Louisiana offshore production during this period was almost identical (10.5 and 8.8 million pounds, respectively). Louisiana inshore waters produced 12.1 million pounds whereas Texas only produced 5.9 million pounds, which accounts for the large difference in total catch between these two areas.

The inshore fisheries of both Louisiana and Texas accounted for the majority of the number of shrimp landed from May-Aug. In Louisiana 1.3 billion shrimp were caught in inshore waters and almost 0.6 billion shrimp were caught in Texas inshore waters. This amounts to 66 and 56% of the total number of brown shrimp landed in Louisiana and Texas, respectively.

DISCUSSION

1982 FISHERY

It is quite obvious recruitment to Texas offshore waters in 1982 was much lower than that observed in 1981 (Klima et al. 1982). The catch from July through June 1982 amounted to 21.9 million pounds. The National Marine Fisheries Service recruitment model predicted a catch of 21.5 million pounds. Maximum production obviously occurred from July through September when approximately 72% of the annual catch was recorded. Lower CPUE's were also observed when comparing 1981 with 1982. The 1982 catch and CPUE in Texas offshore waters in July through September were at least half that observed in 1981. Average CPUE per day was 1,279, 629 and 475 for July, August respectively. The combined catch for July, August and September was 30.7 and 15.8 million pounds in 1981 and 1982 respectively. Comparing the remaining portion of the year from September 1982 through April 1983, we observed no differences in the catch, CPUE and effort when comparing either Texas with Louisiana or comparing Texas to the historical data base. Obviously, the major portion of the offshore shrimp fishery occurs from July through September and this is the time when one can expect vast changes in production and relative abundance.

The fishery in 1982 appeared to achieve the Fishery Management Plan's goals and objectives, that of protecting juvenile shrimp emigrating from the estuaries and allowing the fishery to concentrate on 31-40 count shrimp during the peak period of the season and thereby minimizing discards. We observed little or no discards during the July-September period and the fishery off Texas caught predominately 31-40 count size shrimp or larger. The catch and the relative abundance as measured by CPUE's were higher off Texas than off Louisiana. This we attributed to the Texas Closure management measure. The prevention of trawling protected juvenile shrimp while they were emigrating and allowed them to grow to a

larger size, predominantly 31-40 count or larger off Texas. The Texas inshore and Louisiana inshore and offshore fisheries in May and June were open to trawling and these fisheries concentrated on shrimp that were available, and consequently caught large numbers of small juvenile shrimp (Klima et al., 1983).

1983 FISHERY

Recruitment of the offshore stocks in Texas as well as in Louisiana appeared to be much lower than that observed in 1982 and significantly lower than that observed in 1981. Mr. Corky Perret and Phil Bowman (personal communication) indicated there would be a sizeable reduction in the brown shrimp catch due to a number of indicators as measured by Louisiana Wildlife and Fisheries. We predicted an average catch off Texas of 17.8 million pounds with a range of 16 to 19.4 million pounds, significantly below the historical average for Texas offshore waters. We attributed the poor recruitment to a number of environmental factors that adversely affected juvenile shrimp in the upper Texas bay systems. July offshore production was best in statistical areas 20 and 21. In previous years area 19 usually produced the most brown shrimp in July and August; this was not the case in July, and in August area 19 barely outproduced area 20. We feel the reason for the poor production in 19 and extremely poor production in area 18 was due at least partially to poor recruitment from Galveston Bay.

The offshore relative abundance appeared to be much lower in 1983 than in previous years. Matthews (1984) utilizing SEAMAP data, has indicated that the offshore biomass was approximately 19% lower in 1983 than in 1982 and 40% lower than in 1981 in Texas offshore waters. The average catch off Texas was 12.4, 9.1 and 7.4 pounds per 30-minute tow in 1981, 1982 and 1983 respectively (Matthews 1982 and 1984). Examination of the fishery-dependent data revealed similar trends. Catch per trip in 1983 for July and

August was 1,641 pounds whereas in 1982 it was 2,095 and in 1981 it was 3,935 per trip (Table 10). The lower levels of abundance resulted in lower catches off the Texas than in previous years. The total catch in 1983 was 9.8 million pounds compared to 13 million pounds in 1982 and 25 million pounds in 1981. A similar trend was also observed off Louisiana with lower levels of relative abundance in 1983 as compared with previous years (Table 10). Likewise, the catch was somewhat lower in both inshore and offshore Louisiana waters in 1983 as compared to 1982 and 1981 (Table 11).

Of considerable concern is the increase in the juvenile brown shrimp catch during the month of June in statistical area 19. One hundred thirty-two thousand pounds of approximately 79 count shrimp were caught in a directed white shrimp fishery. It is our belief that this was primarily a directed brown shrimp fishery as only 29,000 pounds of white shrimp were caught. If this trend continues, we can anticipate greater problems with enforcement of the Texas Closure and likewise a decrease in the potential yield of a larger size shrimp since smaller shrimp are being harvested in the offshore waters.

The Texas inshore catch is composed primarily of shrimp ranging in count size from 93 to 105 in May, June and July, whereas the offshore average size ranged from 39 to 44 in July and August. About 600 million shrimp were caught in Texas inshore waters from May-August with only about 400 million shrimp caught offshore. Therefore, the inshore catch comprised 60% in numbers of the total brown shrimp catch. We feel that the increasing take of small juvenile shrimp in Texas inshore waters will have a significant impact on the offshore fishery in future years unless this fishery is limited. The Fishery Management Plan attempts to regulate the shrimp fishery through maximizing the size of shrimp at harvest, yet the inshore fisheries of both Texas and Louisiana have no restrictions on the size or amount of shrimp harvested. Juvenile shrimp of a small size are available to these fisheries in May,

June and to some extent, July and the average size of these shrimp as has been pointed out by Klima et al., (1983),are extremely small. There is some variation from year to year, but one can expect the size of these shrimp to range between 80 and 100 count during the peak months. This large number of shrimp if harvested at a small size would not be fully utilized since they would have the opportunity to grow to a larger size if protected. This could result in a greater potential yield to the offshore fisheries. Nichols (1983), has indicated that inshore fishing mortality may impact total production.

We feel that the objectives of the Fishery Management Plan have been realized this year through implementation of the closed fishing season. The average size of shrimp caught in the offshore waters was again predominated by the shrimp in the 31-40 count size categories. It was also our observation that little or no discarding occurred after the season was open. Therefore, the closed area has protected emigrating juvenile shrimp until they grow to a larger size, thereby optimizing for a larger size shrimp. Without the closure there is no question that small juvenile shrimp would be exploited and that the average size of shrimp anticipated to be caught in June and part of July would be similar to that encountered off the Louisiana coast this year, namely 95-100 count shrimp, thereby increasing the take of small shrimp at the cost of harvesting larger shrimp at a later time. We believe that the Texas Closure has indeed been a benefit to the fishery by allowing them to harvest larger shrimp even though this 1983 season has been poor due to poor recruitment.

SUMMARY

Brown shrimp production in statistical subareas 18-21 from June 1982-May 1983 amounted to 21.4 million pounds. Peak production occurred from July-Sept, which accounted for 72% (15.8 million pounds) of the total landings. Fair catches and fair levels of relative abundance occurred off the Texas coast in July and August. A peak in CPUE of almost 1,279 pounds/day occurred in July but dropped to 629 pounds/day in August. Production of brown shrimp from Sept-Dec 1982 amounted to 7.3 million pounds with an average CPUE of around 403 pounds/day. In the Jan-Apr period, production amounted to only 800 thousand pounds with the CPUE falling to an average of approximately 242 pounds/day.

The offshore brown shrimp production in statistical subareas 13-17 from June 1982-May 1983 amounted to 17.9 million pounds. The 5.1 million-pound brown shrimp catch in Louisiana offshore waters during the July-Aug 1982 period was much lower than in Texas waters. The CPUE averaged 524 pounds/day. The Sept-Dec Louisiana offshore catch amounted to 2.8 million pounds; down from 4.3 in 1981. This time period's overall CPUE of 447 pounds/day, was about 10% higher than in Texas offshore waters. The catch in Jan-Apr amounted to only 1.4 million pounds with an average CPUE of 326 pounds/day, or about 25% higher than in Texas.

In comparing the catch, fishing effort and CPUE for offshore waters of Texas from Sept 1982-Apr 1983 with those for the same period in the historical data set (1960-1979), we found no significant differences. The major differences that were observed were the catches and CPUEs that occurred in July and August.

Recruitment to the Texas brown shrimp fishery in 1982 was below average. Our predicted annual production of 21.5 million pounds from July 1982-June 1983 was very close to the actual catch of 21.9 million pounds, and was well below the average 27 million pounds for offshore production covering the past 22 years.

Recruitment in 1983 appeared to be even poorer than in 1982. We estimated an annual yield of 17.8 million pounds with a range from 16 to 19.4 million pounds for Texas offshore waters. The offshore catch in July-Aug 1983 from subareas 18-21 amounted to 9.8 million pounds or an estimated annual yield of 20.9 or 16.3 million pounds depending on the percent caught during July-Aug. Louisiana Wildlife and Fisheries also indicated that brown shrimp recruitment to Louisiana fisheries would be lower in 1983 than in 1982.

The catch off Texas in July-Aug 1983 amounted to 9.8 million pounds compared to 13.1 million pounds in 1982. The average CPUE for this period was 1,692 pounds/trip compared to almost 2,095 pounds/trip in 1982 and 3,935 pounds/trip in 1981. The July-Aug 1983 catch off Louisiana amounted to 4.9 million pounds with an average CPUE of 576 pounds/trip, whereas the July-Aug 1982 catch was 5.1 million pounds with an average CPUE of 817 pounds/trip. The July-Aug 1983 Texas offshore brown shrimp catch and CPUE were 2.0 and 2.9 times greater than the respective catch and CPUE off Louisiana. The difference in the offshore catches is assumed to be attributed to more larger shrimp being present which may be due to the Texas closure management measure. The lower CPUE off Louisiana may also be due to the Louisiana inshore and offshore fisheries in May and June.

Because of the almost 60% decrease in catch and 40% decrease in the CPUE in the July-Aug 1983 period compared to July-Aug 1981, we estimate that the shrimp biomass off Texas was approximately half the level encountered in 1981. The major difference in 1981 and 1983 shrimp distributions is that in 1981 shrimp were found in good quantities from the beach out to approximately 35 fathoms all along the Texas coast, whereas in 1983, good concentrations of shrimp were found mainly inside 20 fathoms off the Texas coast and mostly in statistical areas 20 and 21 in July.

In previous years statistical area 19 produced more brown

shrimp than the other statistical areas. In 1983 this was not the case in July and area 19 only barely produced more brown shrimp in Aug than area 20. Poor production in areas 19 and 18 may be due to the poor recruitment from Galveston Bay system.

In 1983 the total Louisiana May-Aug catch was 73% of 1982 and in Texas the total catch was 91% of 1982. Both states recorded lower landings in 1983 and the inshore fisheries shares of the total landings increased from 52% to 58% in Louisiana and from 23% to 36% in Texas.

The Louisiana inshore brown shrimp fishery produced approximately 12.1 million pounds in 1983 compared with 15.1 million pounds in 1982, but the offshore fishery in 1983 produced only 8.8 million pounds in 1983 compared with 13.7 million pounds in 1982. The inshore catch was predominated by shrimp in the 116-count or larger size category. Texas inshore fisheries accounted for approximately 5.9 million pounds of brown shrimp in 1983 and 4.1 million pounds in 1982. The inshore catch in 1983 was predominated also by shrimp of 116-count or larger size. The increased inshore Texas catch may seriously impact the Texas offshore shrimp fishery if not limited. Further, almost 200 thousand pounds of 79 count size brown shrimp were caught in the June white shrimp fishery, continuation and or increase in the catch of the juvenile brown shrimp in June may also impact the offshore shrimp fishery in July and August.

The size composition of the 1983 offshore brown shrimp catch in Texas waters was approximately the same as in 1981 and 1982, dominated by the 31-40 count size category.

The 1983 production of brown shrimp in July-Aug from statistical subareas 18-21 was only greater than 1961, 1962, 1963 and 1979. We concluded that the 1983 season is below average compared to the brown shrimp fishery from 1960 to the present.

The goals of the Fishery Management Plan were achieved in 1983 as they were in 1982 and 1981. Small emigrating brown shrimp were protected and allowed to grow to an average size of 31-40

count and discarding was not prevalent. Without a prohibition on trawling from May 27 to July 15 it is anticipated that large quantities of small shrimp would have been caught resulting in wastage and a lower yield.

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LIST OF TABLES

Table 1. Monthly summary of total offshore brown shrimp catch in millions of pounds, total fishing effort in 1000's of days and CPUE for Louisiana statistical subareas 13-17, and Texas statistical subareas 18-21 for 1972-1983 (1980 not included)

	Jan.		Feb.		Mar.		Apr.	
Area	13-17	18-21	13-17	18-21	13-17	18-21	13-17	18-21
1972								
Catch	0.5	0.9	0.5	0.5	0.7	0.4	0.2	0.3
Effort	0.9	2.0	1.1	1.6	1.8	1.2	0.6	1.3
CPUE	541	451	469	304	368	349	274	212
1973								
Catch	1.1	0.4	0.8	0.3	0.8	0.4	0.5	0.4
Effort	1.6	1.4	2.0	0.7	2.0	1.0	1.2	1.7
CPUE	695	272	414	439	400	350	411	222
1974								
Catch	0.5	1.1	0.4	0.6	0.3	0.5	0.2	0.4
Effort	1.1	1.7	1.0	1.5	0.8	1.5	0.6	1.9
CPUE	448	653	408	427	385	301	308	202
1975								
Catch	0.4	0.7	0.4	0.6	0.4	0.3	0.2	0.2
Effort	0.5	1.8	1.1	1.7	1.0	1.0	0.6	0.0
CPUE	754	407	376	327	388	293	324	0.0
1976								
Catch	0.8	0.5	0.6	0.6	0.4	0.4	0.5	0.5
Effort	1.4	1.3	1.3	2.0	1.0	1.7	1.2	2.1
CPUE	534	384	501	289	401	245	370	227
1977								
Catch	0.5	0.2	0.4	0.2	0.5	0.1	0.4	0.3
Effort	1.8	1.0	1.6	0.9	1.8	0.7	1.8	1.5
CPUE	296	193	249	163	274	149	232	201
1978								
Catch	0.9	0.7	1.1	0.5	1.4	1.2	0.5	0.4
Effort	1.1	2.0	2.1	1.3	3.4	0.9	1.2	1.6
CPUE	836	353	531	371	413	174	438	247
1979								
Catch	0.7	0.7	1.0	0.6	0.8	0.5	0.6	0.4
Effort	1.9	2.3	2.0	2.4	2.3	2.1	2.0	1.5
CPUE	374	312	524	266	361	235	312	293
1980								
Catch								
Effort								
CPUE								
1981								
Catch	0.2	0.3	0.1	0.1	0.2	0.06	0.08	0.06
Effort	0.6	1.0	0.4	0.4	0.4	0.3	.04	0.2
CPUE	319	253	329	296	387	228	195	301
1982								
Catch	0.5	0.6	0.6	0.6	0.4	0.2	0.2	0.2
Effort	0.9	1.4	1.2	1.9	1.1	0.6	0.7	0.8
CPUE	549	454	446	317	370	276	281	271
1983								
Catch	0.4	0.3	0.3	0.2	0.4	0.1	0.3	0.2
Effort	1.2	1.0	1.2	1.0	1.1	0.5	0.8	0.8
CPUE	373	261	281	206	331	255	346	215

Table 1. cont. Monthly summary of total offshore brown shrimp catch in millions of pounds, total fishing effort in 1000's of days and average CPUE for Louisiana statistical subareas 13-17, and Texas statistical subareas 18-21 for 1972-1983 (1980 not included)

	May		June		July		Aug.	
Area	13-17	18-21	13-17	18-21	13-17	18-21	13-17	18-21
1972								
Catch	1.1	0.8	1.3	3.1	2.9	7.9	4.6	9.5
Effort	1.7	1.2	2.0	4.3	3.1	6.9	5.0	9.6
CPUE	637	612	667	724	940	1155	924	989
1973								
Catch	0.8	0.7	2.5	2.8	1.1	7.2	1.3	4.0
Effort	1.9	2.9	3.7	3.0	2.8	7.3	3.2	10.2
CPUE	423	261	673	925	402	989	406	392
1974								
Catch	0.8	0.6	1.1	1.8	2.1	5.9	1.9	7.1
Effort	2.2	2.9	2.3	3.9	3.3	7.3	3.0	10.8
CPUE	374	219	480	455	628	806	637	657
1975								
Catch	1.0	0.5	0.7	2.7	1.5	6.1	1.4	5.4
Effort	1.4	2.2	1.4	3.4	2.0	6.8	2.3	8.2
CPUE	724	208	529	797	723	891	620	651
1976								
Catch	1.4	0.8	3.8	1.2	4.8	6.2	3.1	5.3
Effort	3.2	3.1	5.0	2.5	5.4	7.4	3.6	8.8
CPUE	456	246	770	497	880	839	866	607
1977								
Catch	3.6	0.5	6.4	2.1	5.9	8.6	5.9	8.1
Effort	4.3	3.6	7.7	2.8	6.3	7.5	6.3	9.0
CPUE	839	150	835	771	935	1147	943	891
1978								
Catch	5.3	0.8	5.6	2.6	8.5	5.4	5.1	6.3
Effort	7.7	3.8	8.0	3.8	9.0	5.5	7.2	8.4
CPUE	685	217	708	677	941	982	713	746
1979								
Catch	4.1	0.9	5.7	1.9	4.2	3.9	5.3	3.5
Effort	7.6	3.2	10.4	3.3	14.7	5.6	9.6	6.3
CPUE	536	271	554	582	285	685	555	548
1980								
Catch								
Effort								
CPUE								
1981								
Catch	5.0	0.4	7.6	-	7.5	10.4	3.0	14.6
Effort	5.8	1.1	9.0	-	8.1	4.4	3.8	10.4
CPUE	861	308	842	-	927	2382	799	1408
1982								
Catch	3.3	0.8	5.3	-*	3.3	6.6	1.8	6.4
Effort	5.4	2.6	8.8	-	6.4	5.2	3.4	10.2
CPUE	609	295	604	-	525	1279	522	629
1983								
Catch	1.0	0.5	2.9	0.2	2.6	5.0	2.3	4.8
Effort	2.9	1.9	6.7	0.7	6.3	3.7	5.3	6.8
CPUE	363	276	429	262	414	1373	441	700

Table 1. cont. Monthly summary of total offshore brown shrimp catch in millions of pounds, total fishing effort in 1000's of days and CPUE for Louisiana statistical subareas 13-17, and Texas statistical subareas 18-21 for 1972-1983 (1980 not included)

	Totals and Averages for Jan-Apr.		Totals and Averages for May-June		Totals and Averages for July-Aug.		Totals and Averages for Sept.-Dec.	
Area	13-17	18-21	13-17	18-21	13-17	18-21	13-17	18-21
1972								
Catch	1.9	2.1	2.4	3.9	7.5	17.4	5.1	13.1
Effort	4.4	6.1	3.7	5.5	8.1	16.5	6.3	21.1
CPUE	413	329	652	668	932	1072	950	588
1973								
Catch	3.2	1.5	3.3	3.5	2.4	11.2	1.8	7.1
Effort	6.8	4.8	5.6	5.9	6.0	17.5	3.5	15.1
CPUE	480	321	548	593	404	691	590	506
1974								
Catch	1.4	2.6	1.9	2.4	4.0	13.0	3.5	8.4
Effort	3.5	6.6	4.5	6.8	6.3	18.1	4.8	13.5
CPUE	387	396	427	337	633	732	807	575
1975								
Catch	1.4	1.8	1.7	3.2	2.9	11.5	3.1	8.3
Effort	3.2	4.5	2.8	5.6	4.3	15.0	4.1	16.5
CPUE	461	257	627	503	671	771	940	497
1976								
Catch	2.3	2.0	5.2	2.0	7.9	11.5	5.7	10.7
Effort	4.9	7.1	8.2	5.6	9.0	16.5	9.6	19.1
CPUE	452	286	613	372	873	723	590	504
1977								
Catch	1.8	0.8	10.0	2.6	11.8	16.7	5.8	12.6
Effort	7.0	4.1	12.0	6.5	12.6	16.5	8.1	20.7
CPUE	263	177	837	461	939	1019	765	586
1978								
Catch	3.9	1.8	10.9	3.4	13.6	11.7	4.1	10.9
Effort	7.8	5.8	15.7	7.6	16.2	13.9	8.9	24.4
CPUE	555	286	697	447	827	864	451	436
1979								
Catch	3.1	2.2	9.8	2.8	9.5	7.4	4.1	6.4
Effort	8.2	8.3	18.0	6.5	24.3	11.9	11.2	15.0
CPUE	393	277	545	427	420	617	387	420
1980								
Catch								
Effort								
CPUE								
1981								
Catch	0.6	0.5	12.6	0.4	10.5	25.0	4.3	14.1
Effort	1.8	1.9	14.8	1.1	11.9	14.8	6.6	21.1
CPUE	308	269	852	308	863	1895	654	648
1982								
Catch	1.7	1.6	8.6	0.8	5.1	13.1	2.8	7.3
Effort	3.9	4.7	14.2	2.6	9.8	15.7	6.2	18.0
CPUE	412	330	607	295	524	922	447	403
1983								
Catch	1.4	0.8	3.9	0.7	4.9	9.8	-	-
Effort	4.3	3.3	9.6	2.6	11.6	10.5	-	-
CPUE	326	242	406	269	422	933	-	-

Table 2. Results of paired comparisons test of landings data. Sept 1982-Apr 1983 from statistical subareas 13-17 and 18-21.

Source	Degrees of Freedom	Mean Square	F
Areas	1	0.073	0.174 n.s.
Months	7	1.312	3.118 n.s.
Error	7	0.421	
Total	15		
			F.05(1,7) = 5.59
			F.05(7,7) = 3.77

Table 3. Results of paired comparisons test of fishing effort data Sept 1982-Apr 1983 from statistical subareas 13-17 and 18-21.

Source	Degrees of Freedom	Mean Square	F
Areas	1	7307425.4	4.209 n.s.
Months	7	3128677.3	1.802 n.s.
Error	7	1735984.2	
Total	15		
			F.05(1,7) = 5.59
			F.05(7,7) = 3.77

Table 4. Results of paired comparisons test of CPUE data - Sept 1982-Apr 1983 from statistical subareas 13-17 and 18-21.

Source	Degrees of Freedom	Mean Square	F
Areas	1	1.347	0.132 n.s.
Months	7	28.071	2.756 n.s.
Error	7	10.186	
Total	15		
			F.05(1,7) = 5.59
			F.05(7,7) = 3.77

Table 5. Results of t-tests of monthly catch, effort and CPUE for statistical subareas 18-21 combined for Sept 1982-April 1983, versus the means for these months based on the historical data set 1960-1979.

Month	df	Catches	df	Effort	df	$CPUE^2$
Sept	19	-0.953	19	-0.322	19	1.364
Oct	19	-0.656	19	-0.048	19	-0.299
Nov	19	0.056	19	0.997	19	0.429
Dec	19	-0.733	19	0.268	19	-0.330
Jan	18	-0.965	18	-0.537	18	-1.032
Feb	18	-0.785	18	-0.378	18	-0.934
Mar	18	-1.221.	18	-1.055	18	-0.266
Apr	18	-1.611	17	-0.999	17	-0.513

$t.05(2)17 = 2.110$

$t.05(2)18 = 2.101$

$t.05(2)19 = 2.093$

Table 6. Results of t-tests of monthly catch, effort and CPUE for statistical subareas 18-21 combined for September 1982-April 1983, versus the means for these months based on the data from 1975-1979.

Month	df	Catches	Effort	CPUE
Sept	4	-0.436 n.s.	-0.067 n.s.	1.262 n.s.
Oct	4	-0.819 "	-0.915 "	-0.535 "
Nov	4	0.842 "	0.197 "	0.466 "
Dec	4	-0.783 "	-0.368 "	-0.875 "
Jan[1]	3	-0.500 "	-0.868 "	-1.467 "
Feb[1]	3	-0.924 "	-0.915 "	-0.652 "
Mar[1]	3	-0.778 "	-1.108 "	1.008 "
Apr[1]	3	-3.733 "	-2.881 "	-0.625 "

$t_{.05(2)4} = 2.776$

$t_{.05(2)3} = 3.182$

[1]Based on four years; 1980 data were not used.

Table 7. Galveston Bay Bait shrimp index from 1960 through 1983.

Year	Bait Index	Predicted catch	Actual Texas Offshore catch July-June in millions of lbs	Difference in million of lbs.
1960	53.6	29.1	34.5	+ 5.4
1961	20.8	20.0	13.2	- 6.8
1962	26.1	21.5	17.3	- 4.2
1963	53.0	29.0	24.6	- 4.4
1964	30.2	22.6	18.6	- 3.9
1965	41.0	25.6	26.5	+ 0.9
1967	89.4	39.0	42.7	+ 3.7
1968	28.0	22.0	27.9	+ 5.9
1969	43.5	26.3	24.7	- 1.6
1970	70.0	33.7	30.7	- 3.0
1971	82.3	37.1	34.5	- 2.6
1972	85.6	38.0	35.5	- 2.5
1973	18.7	19.4	23.3	+ 3.9
1974	34.3	23.8	26.4	+ 2.6
1976	34.1	23.6	25.7	+ 2.1
1977	58.1	30.3	34.4	+ 4.0
1978	40.5	25.5	27.7	+ 2.2
1980	45.0	26.7	25.7	- 1.0
1981	54.3	29.3	40.0	+10.7
1982	26.3	21.5	21.8	+ 0.3
1983	12.7	17.8	16.3-20.8*	

*preliminary data

Table 8. Inshore brown shrimp catch 1983, in 1000 of pounds - Louisiana from the Mississippi River to Texas.

Size Count	May	June	July	Aug.	Total
15				.6	.6
16-20				.8	.8
21-25	.1			.7	.8
26-30	.3			.5	.8
31-40	14.8		.7	13.5	29.0
41-50	5.0	1.9	1.8	19.8	28.5
51-67	59.6	26.8	39.6	50.6	176.6
68-80	27.4	479.9	264.3	16.3	787.9
81-100	1,478.1	1,228.9	240.9	23.9	2,971.8
101-115	306.7	1,664.8	163.9	15.0	2,150.4
>116	1,933.9	3,694.7	364.7	8.5	6,001.8
Total	3,825.9	7,097.0	1,075.9	150.2	12,149.0

Table 9. Texas inshore brown shrimp catch 1983, in 1000 of pounds.

Size Count	May	June	July	Aug.	Total
15					
16-20		.4	1.4	.6	2.4
21-25	.7	.9	1.8	1.1	4.5
26-30	4.1	1.7	.8	.3	6.9
31-40	21.0	25.9	8.8	13.6	69.3
41-50	30.9	41.2	7.1	31.3	110.5
51-67	68.2	44.1	72.0	131.7	316.0
68-80	121.8	259.2	281.9	24.2	687.1
81-100	173.4	232.2	452.9	18.9	1,177.4
101-115	168.8	571.3	326.7	4.5	1,071.3
>116	549.2	1,713.2	204.1	1.5	2,468.0
Total	1,138.1	3,190.1	1,357.5	227.7	5,913.4

Table 10. Monthly summary total offshore brown shrimp catch in millions of pounds, total fishing effort in trips and CPUE for Louisiana statistical subareas 13-17 and Texas statistical subareas 18-21.

	May		June		July		Aug		July-Aug		Total	
Area	13-17	18-21	13-17	18-21	13-17	18-21	13-17	18-21	13-17	18-21	13-17	18-21
1983												
Catch	1.0	0.5	2.9	0.2	2.6	5.0	2.3	4.8	4.9	9.8	8.8	10.5
Trips	1,463	877	4,077	635	3,828	3,183	4,677	2,788	8,505	5,791	14,045	7,303
CPUE	714	596	710	286	678	1,575	495	1,708	576	1,692	627	1,436
1982												
Catch	3.3	0.8	5.3	-	3.3	6.6	1.8	6.4	5.1	13.0	13.7	13.8
Trips	6,127	956	3,724	249	3,752	3,297	2,493	2,907	6,245	6,204	16,186	7,409
CPUE	533	803	1,420	192	894	2,022	720	2,192	817	2,095	846	1,863
1981												
Catch	5.0	0.4	7.6	-	7.5	10.4	3.0	14.6	10.5	25.0	23.1	25.4
Trips	7,739	525	7.728	25	5,878	3,361	1,534	2,993	7,412	6,354	15,467	6,904
CPUE	645	671	985	187	1,277	3,091	1,957	4,879	1,417	3,935	1,494	3,679

Table 11. May-Aug catch of brown shrimp in millions of pounds from inshore and offshore Louisiana waters in statistical subareas 13-17 and in Texas waters in statistical subareas 18-21.

	Years					
Area	1983	1982	1981	1908	1979	1978
Louisiana:						
Inshore	12.1	15.1	15.2	7.3	10.6	14.1
Offshore	8.8	13.7	23.1	11.7	19.3	24.5
Total	20.9	28.8	38.3	19.0	29.9	38.6
Texas:						
Inshore	5.9	4.1	4.2	4.5	4.1	2.0
Offshore	10.5	13.9	25.3	12.6	10.1	15.1
Total	16.4	18.0	29.5	17.1	14.2	17.1

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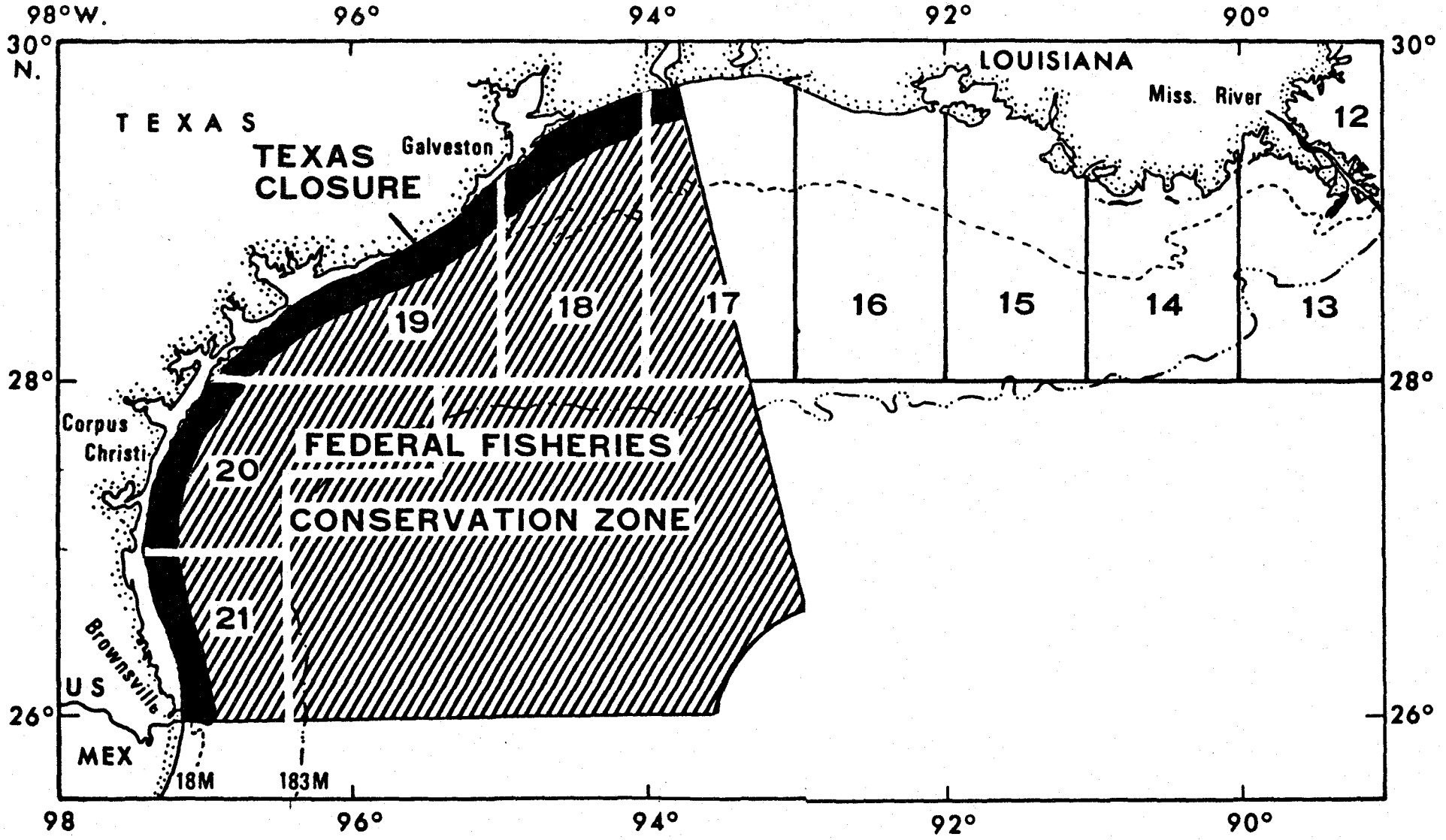

Figure 1. Location of statistical subareas and the Texas closure area.

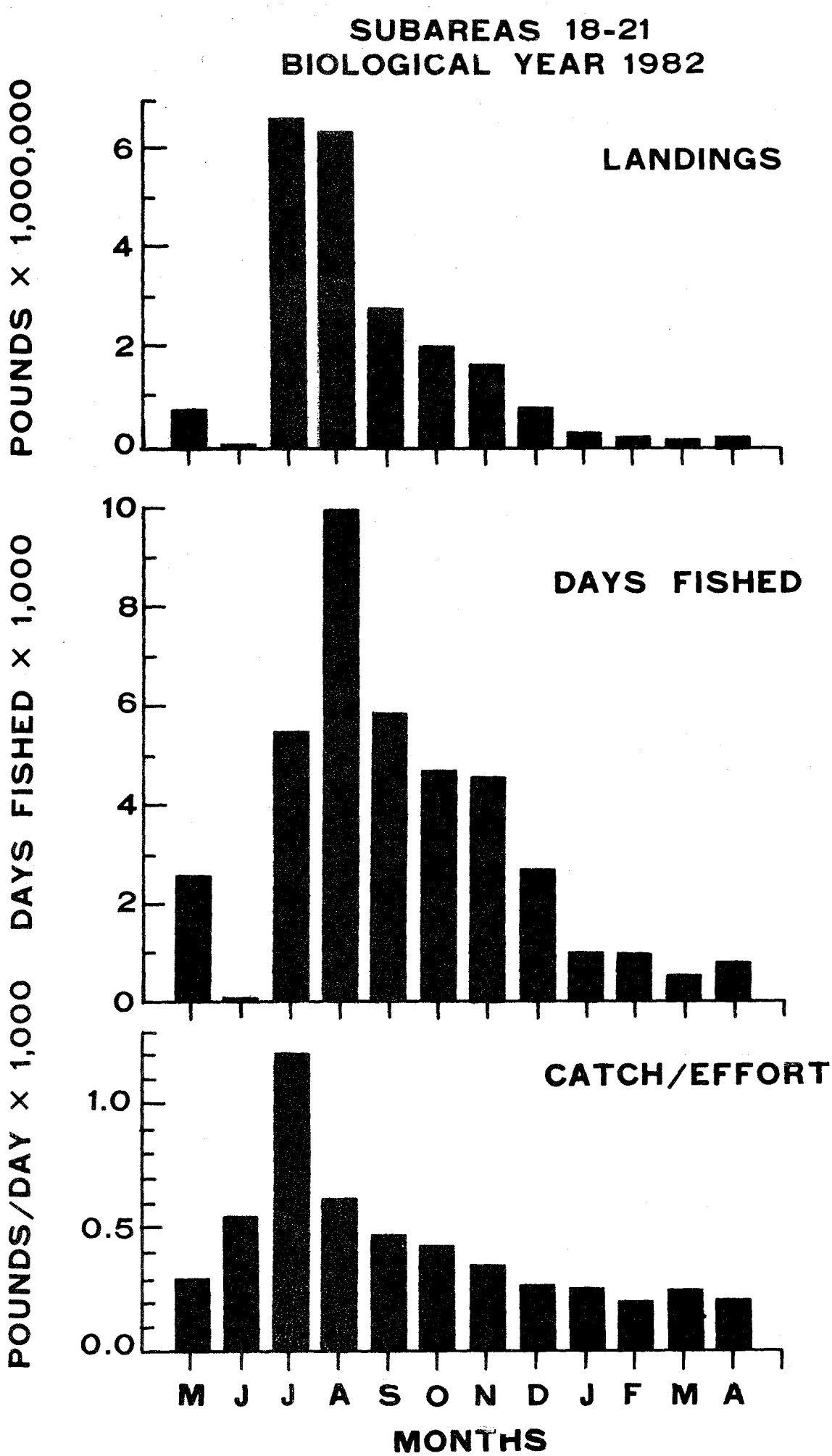

Figure 2. Commercial catch statistics from May 1982-April 1983 for statistical subareas 18-21 a) catch in millions of pounds, b) fishing effort in thousands of days fished and c) CPUE.

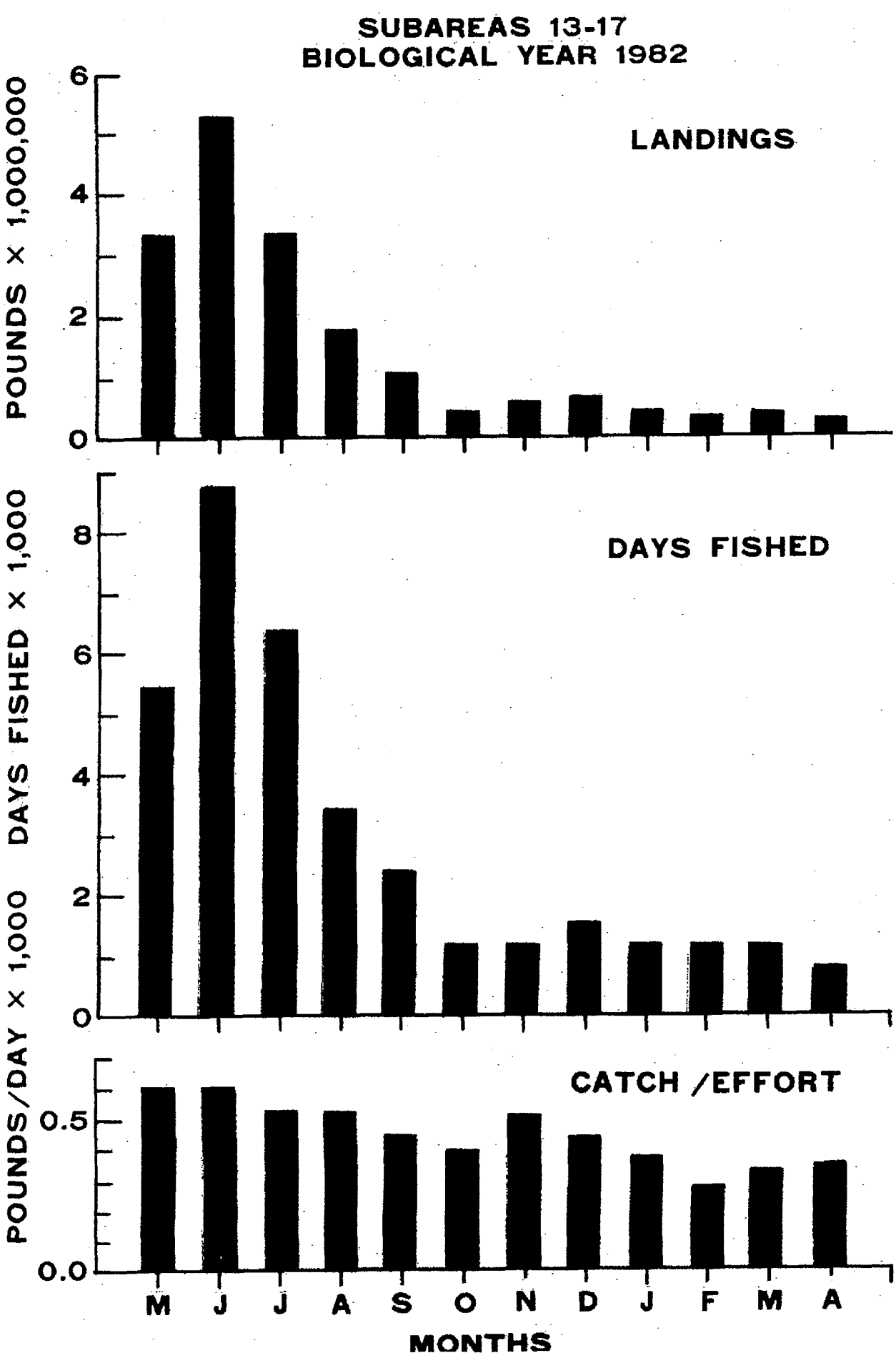

Figure 3. Commercial catch statistics from May 1982-April 1983 for statistical subareas 13-17 a) catch in millions of pounds b) fishing efforts in thousands of days and c) CPUE.

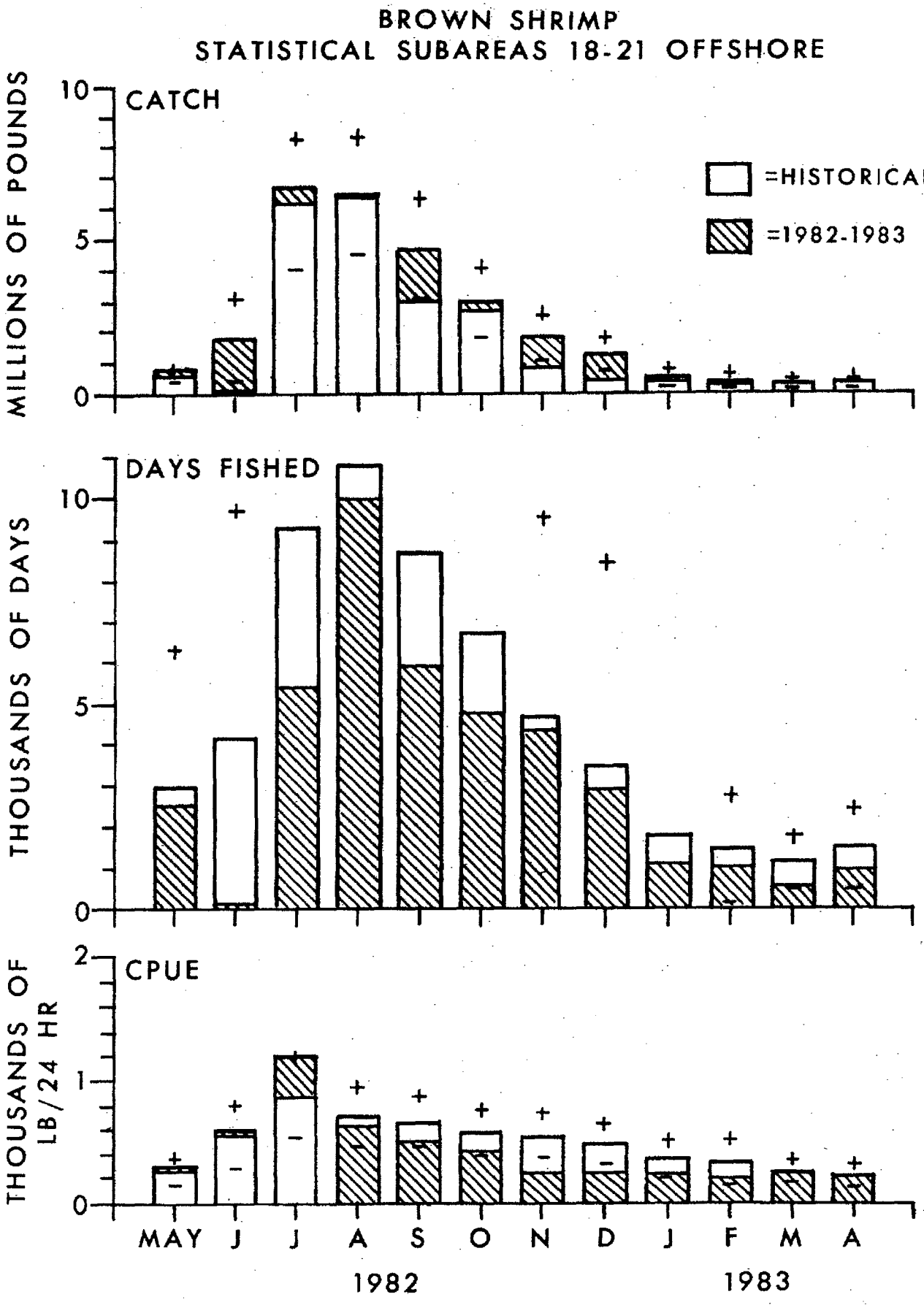

Figure 4. Average monthly historical commercial catch statistics with standard deviation (±) 1960-1981 and catch statistics from May 1982-April 1983 for statistical subareas 10-21 a) catch in millions of pound, b) fishing effort in 1000s of days fished and c) CPUE

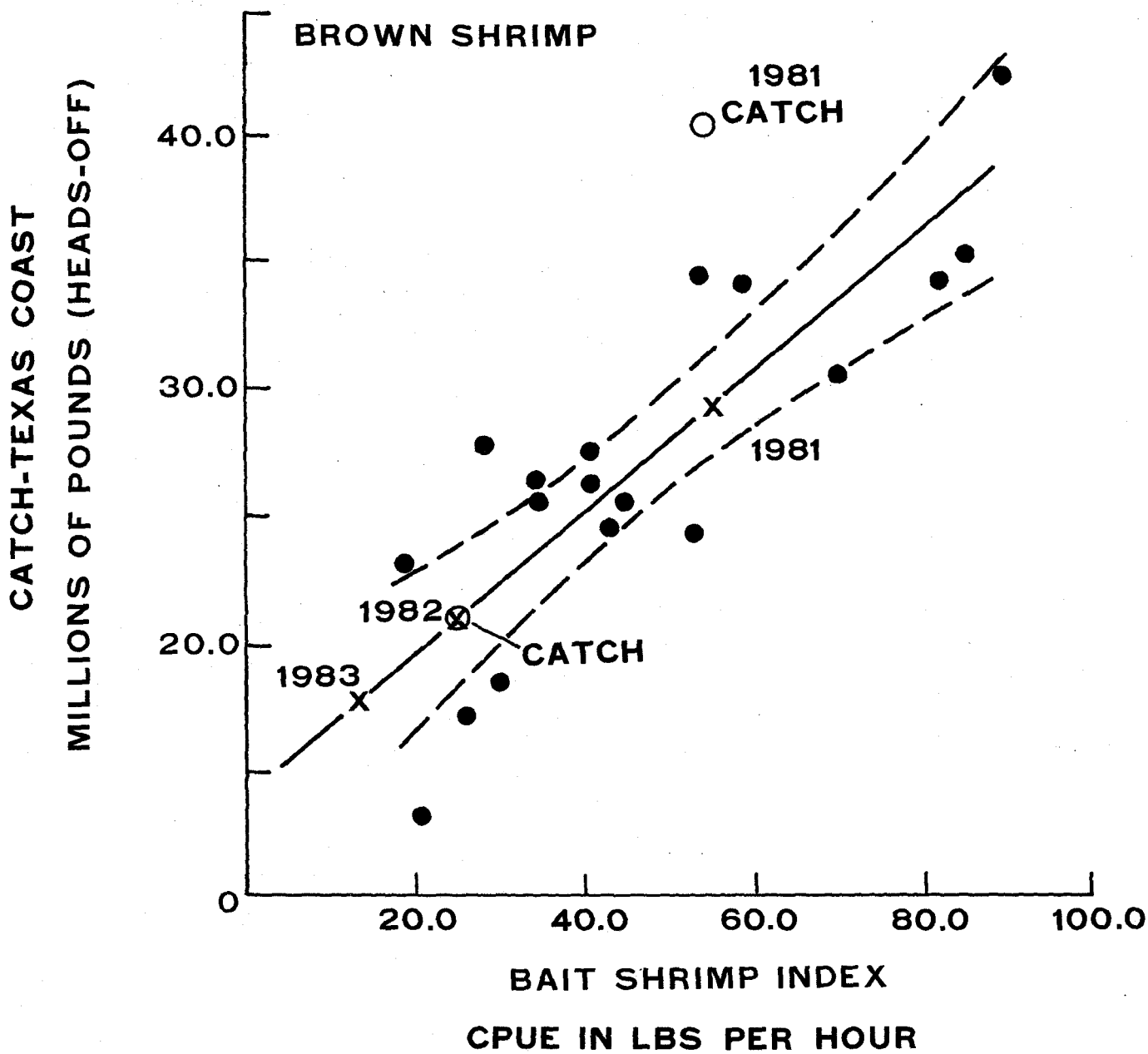

Figure 5. Predicted annual July-June brown shrimp offshore catch in Texas, 1960-1980.

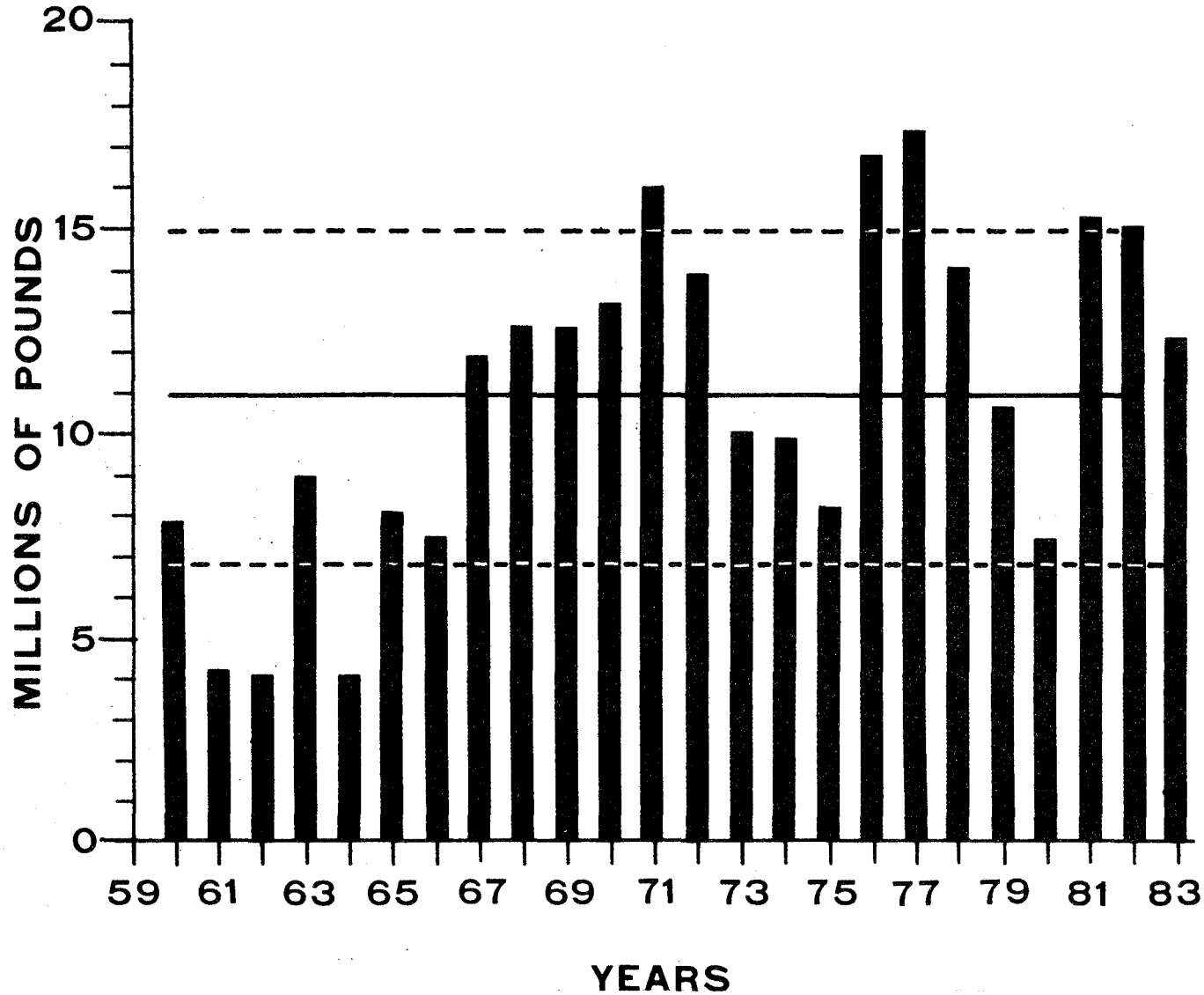

Figure 6. Annual inshore brown shrimp landings in Louisiana most of the Mississippi River (solid line is average 1960-1982 and broken line is standard deviation).

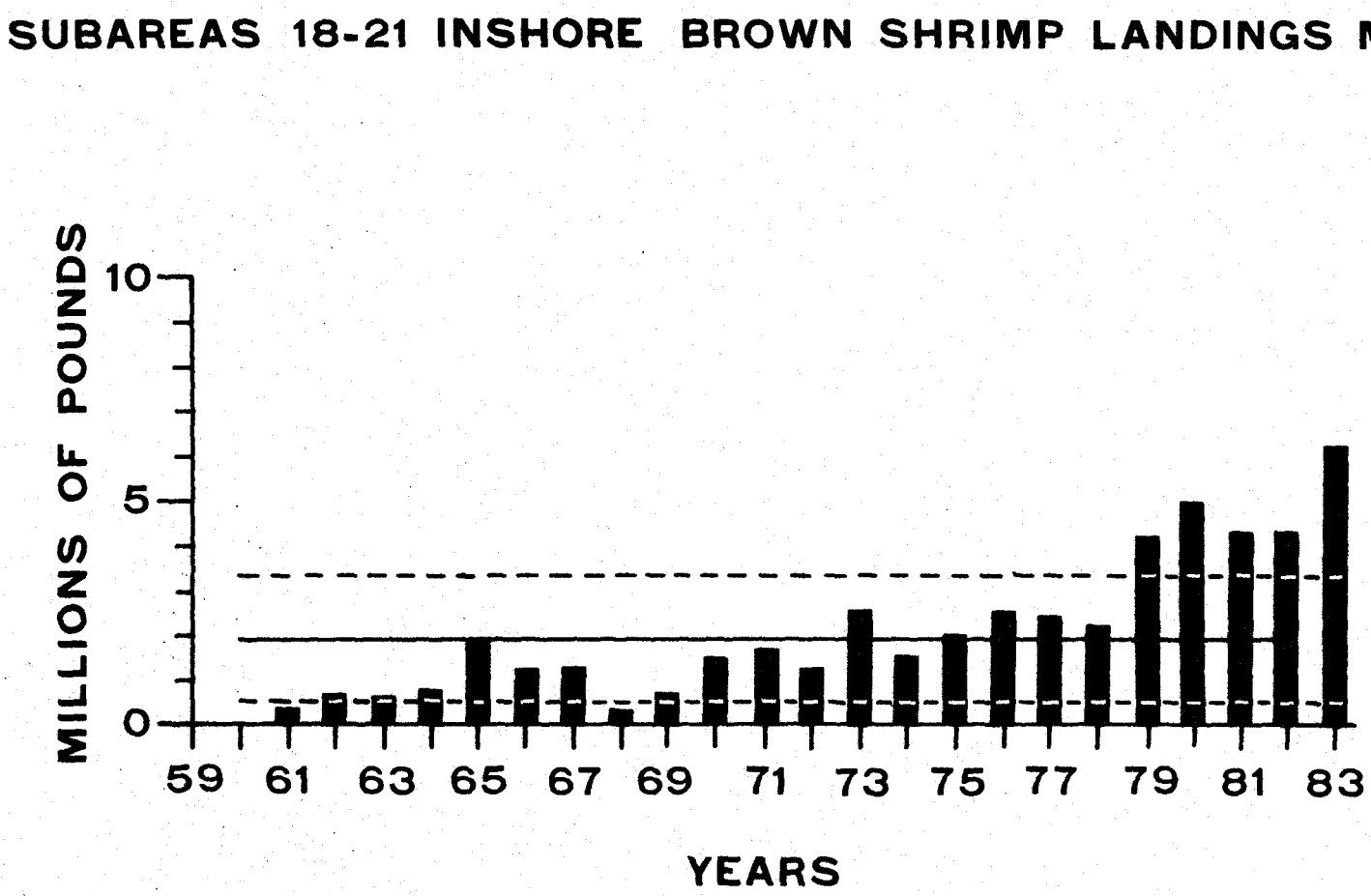

Figure 7. Annual inshore brown shrimp landings in Texas (solid line is average 1960-1982 and broken line is one standard deviation).

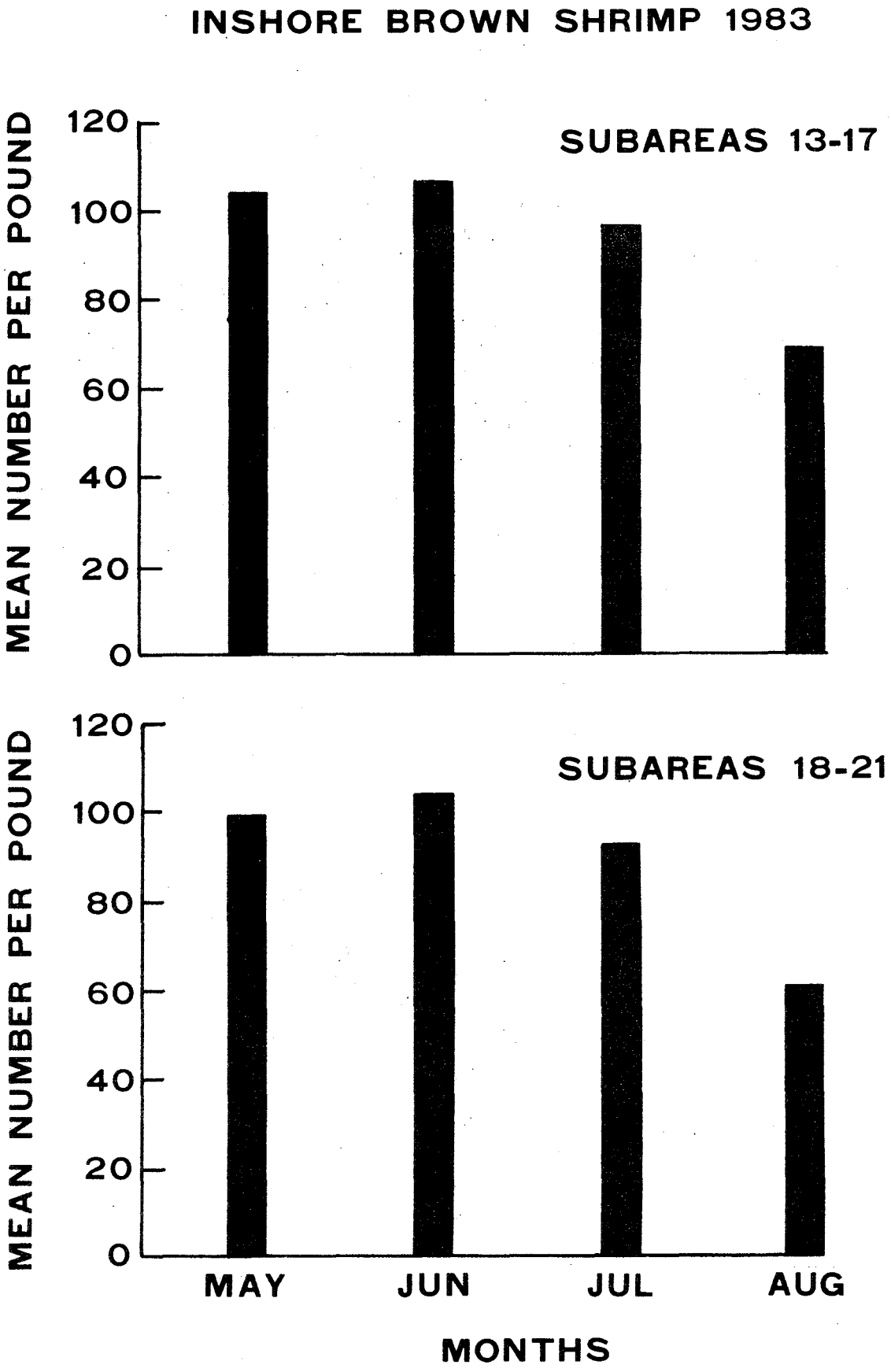

Figure 8. Average number of shrimp per pound caught in the inshore waters of a) Louisiana and b) Texas using size categories 15/116-16.

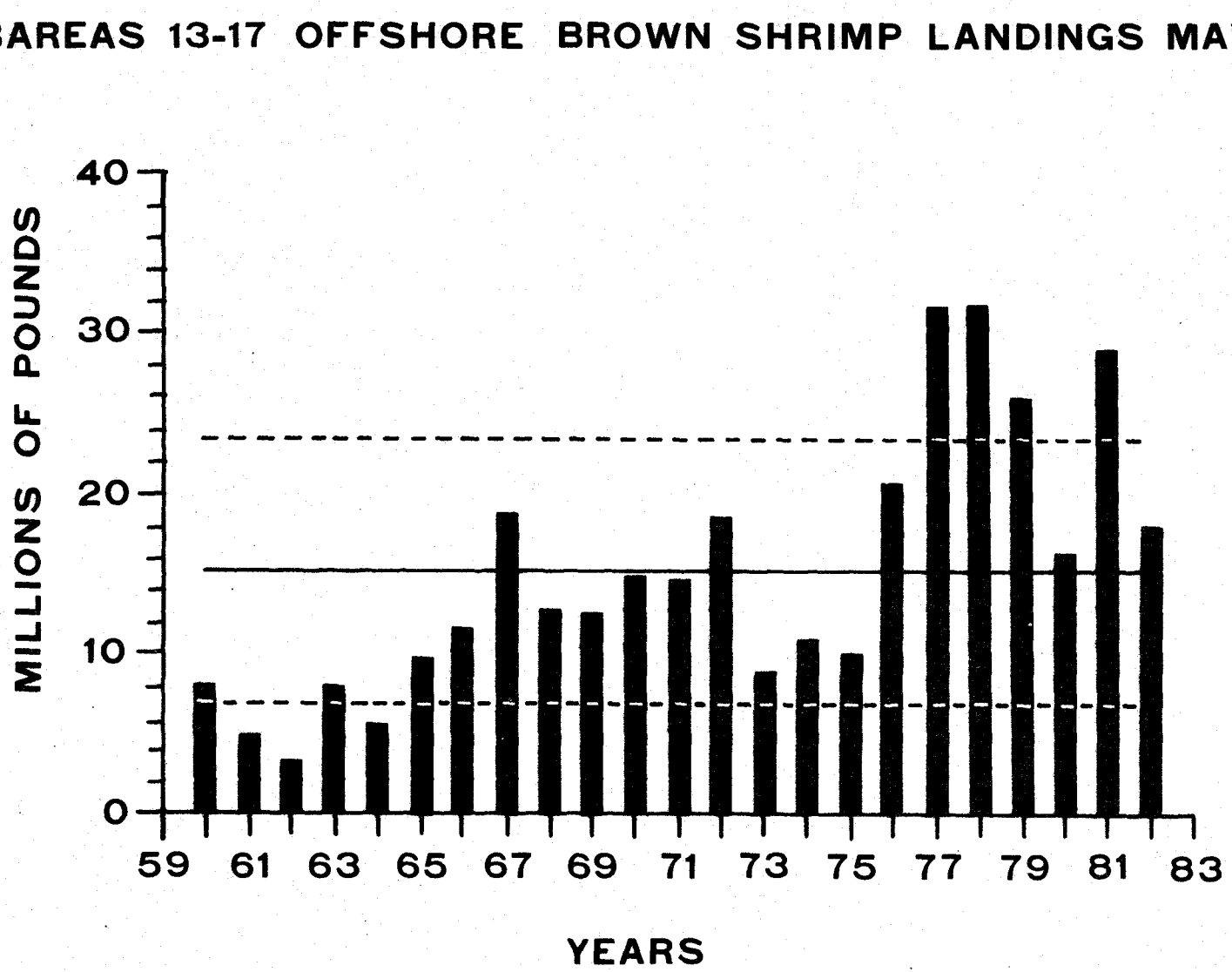

Figure 9. Annual offshore brown shrimp landings from statistical subareas 13-17 (solid line is average 1960-1982 and broken line is one standard deviation).

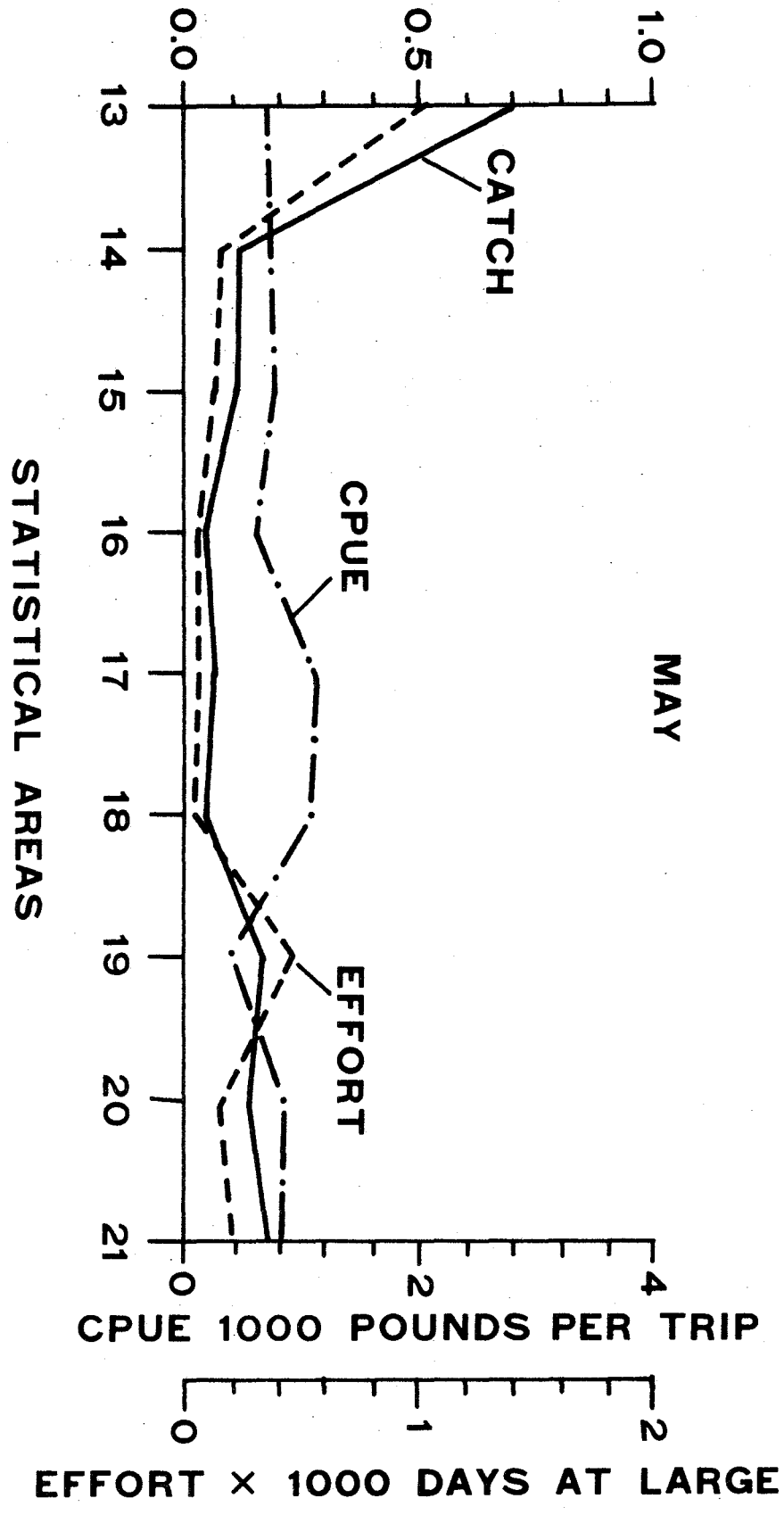

Figure 10. Offshore brown shrimp catch fishing effort in trips and CPUE in statistical subareas 13-21 in May 1983.

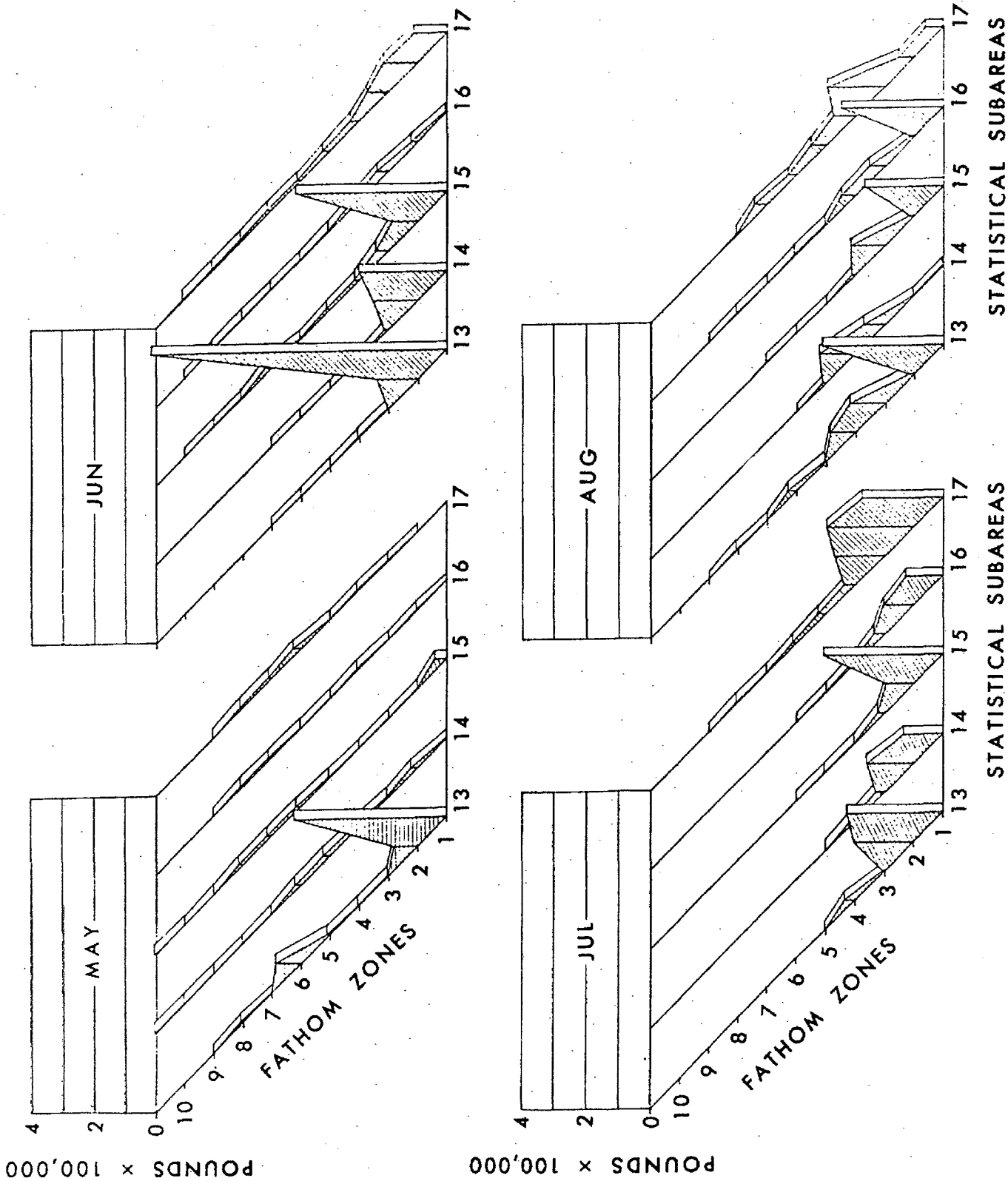

Figure 11. Offshore brown shrimp catch in statistical subareas 13-17 in May, June, July and August 1983.

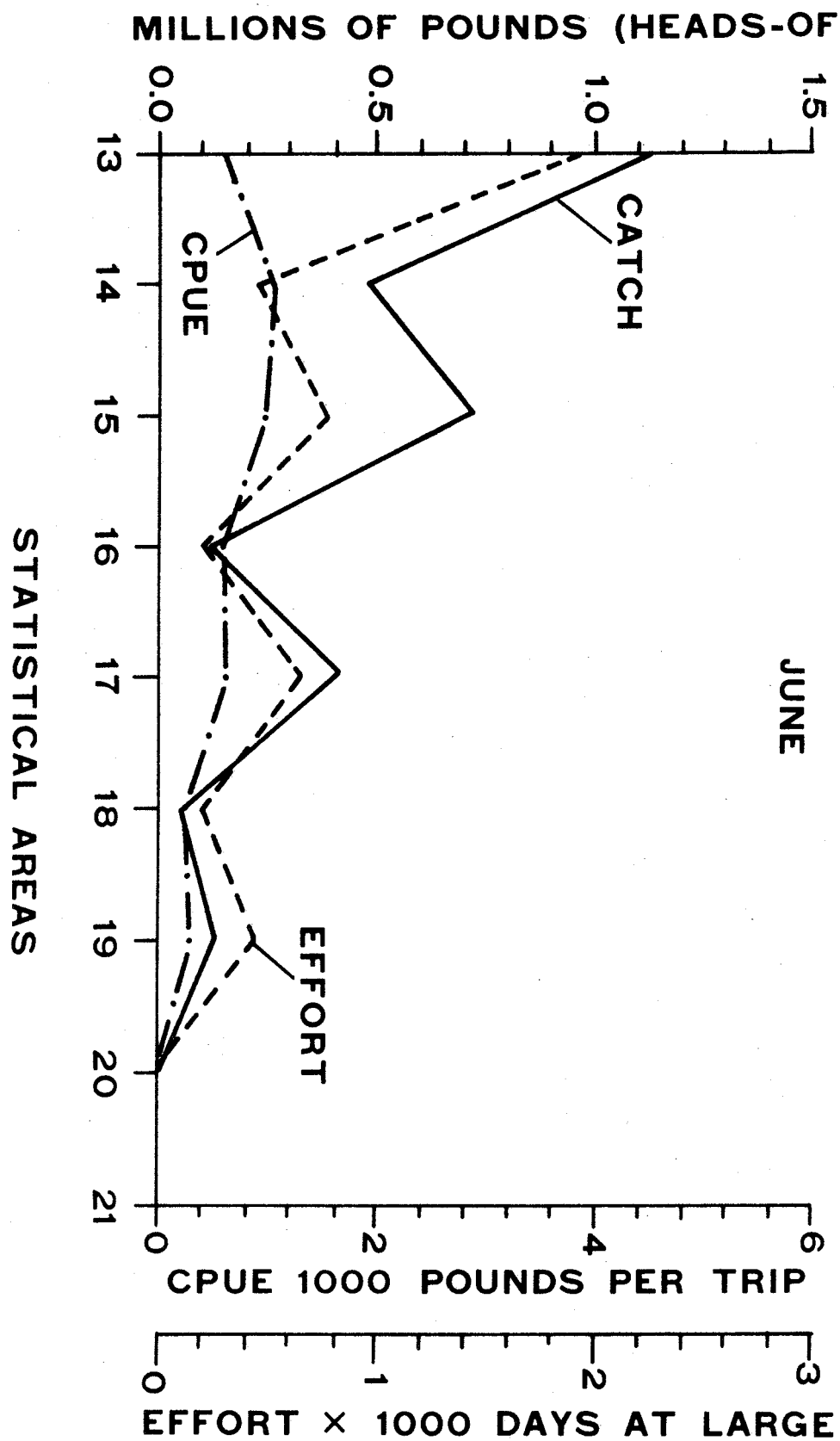

Figure 12. Offshore brown shrimp catch fishing effort in trips and CPUE in statistical subareas 13-21 in June 1983.

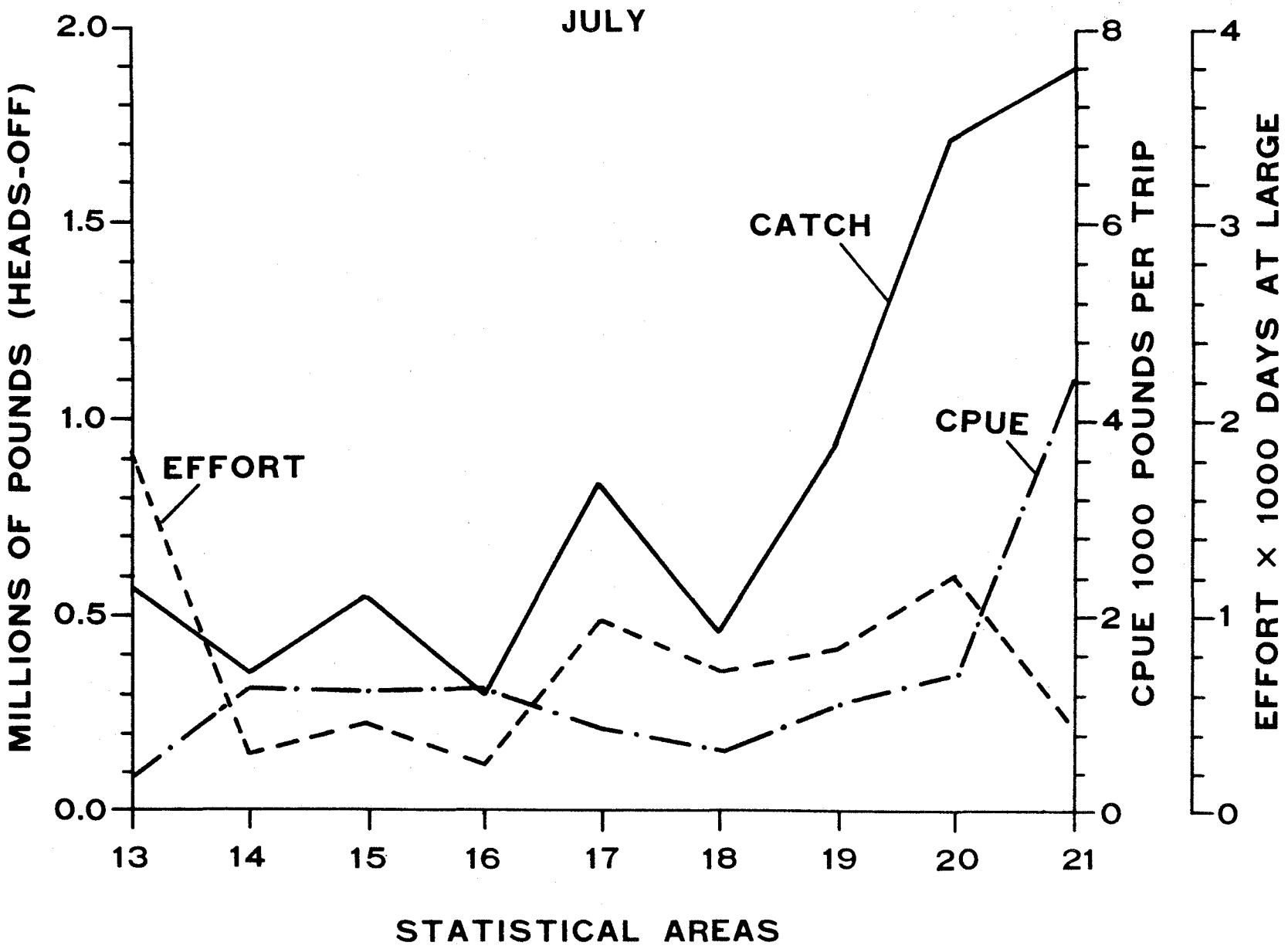

Figure 13. Offshore brown shrimp catch, fishing effort in trips and CPUE in statistical subareas 13-21 in July 1983.

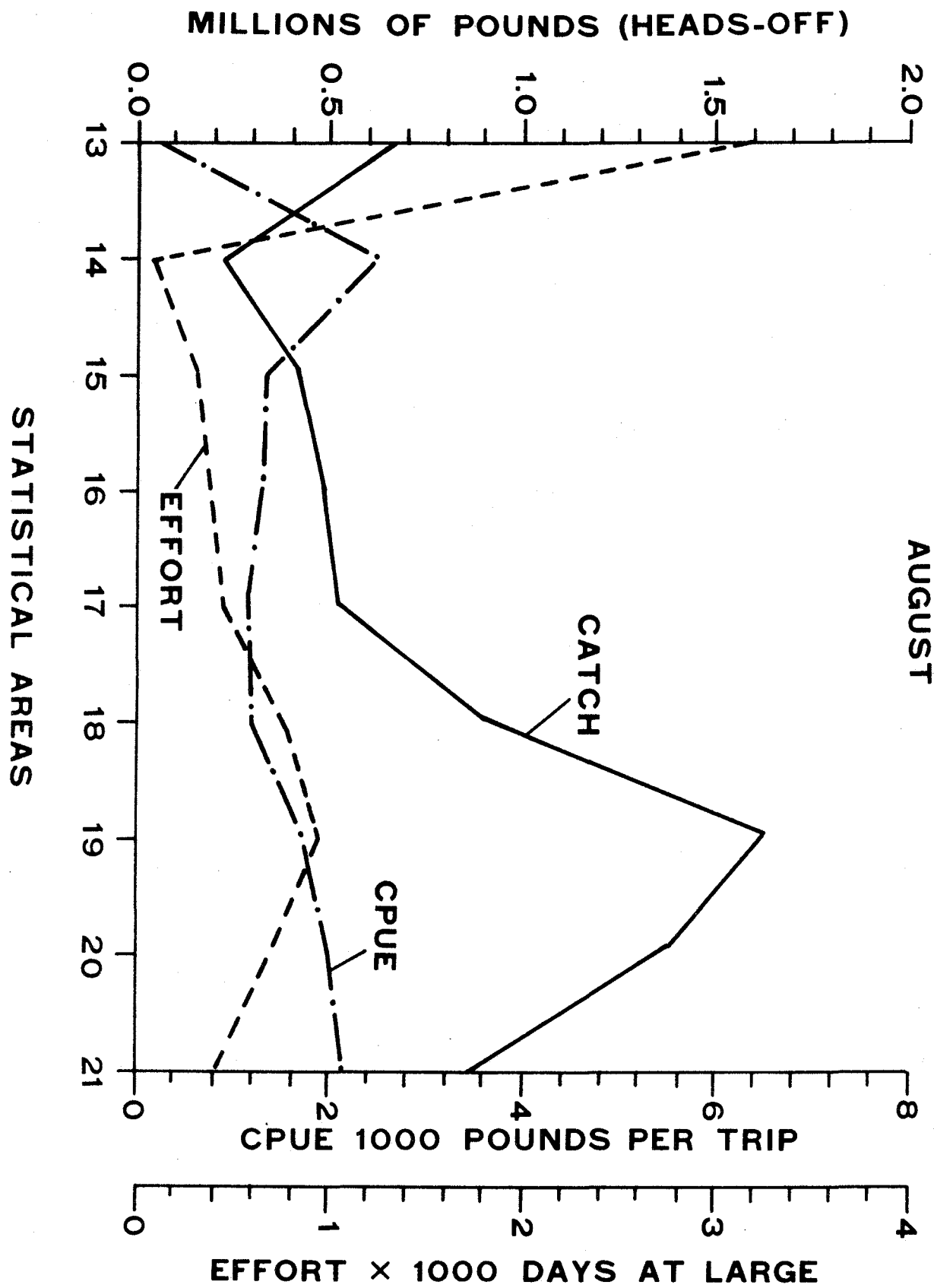

Figure 14. Offshore brown shrimp catch, fishing effort in trips and CPUE in statistical subareas 13-21 in August 1983.

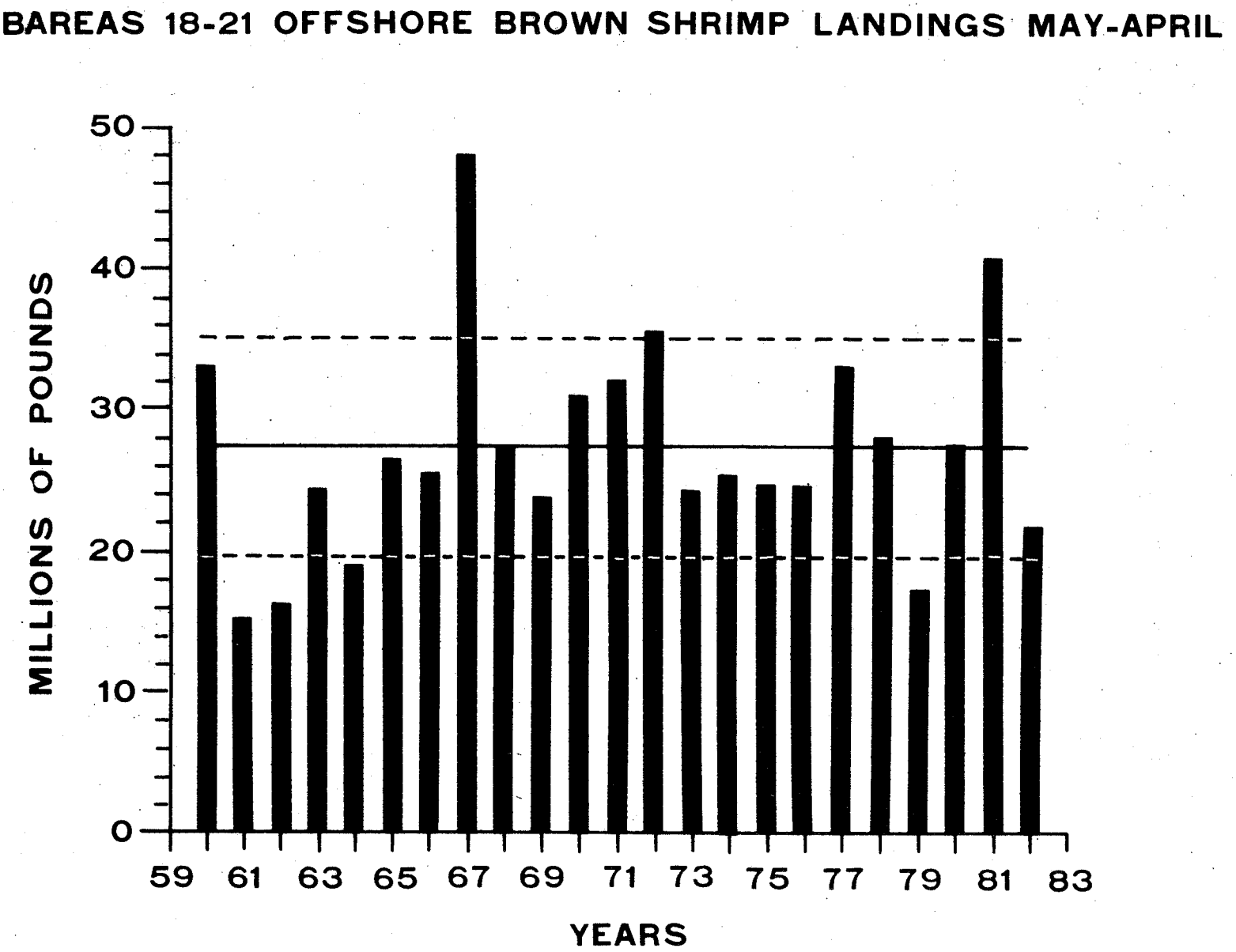

Figure 15. Annual offshore brown shrimp landings from statistical subareas 18-21 (solid line is average 1960-1982 and broken line is one standard deviation).

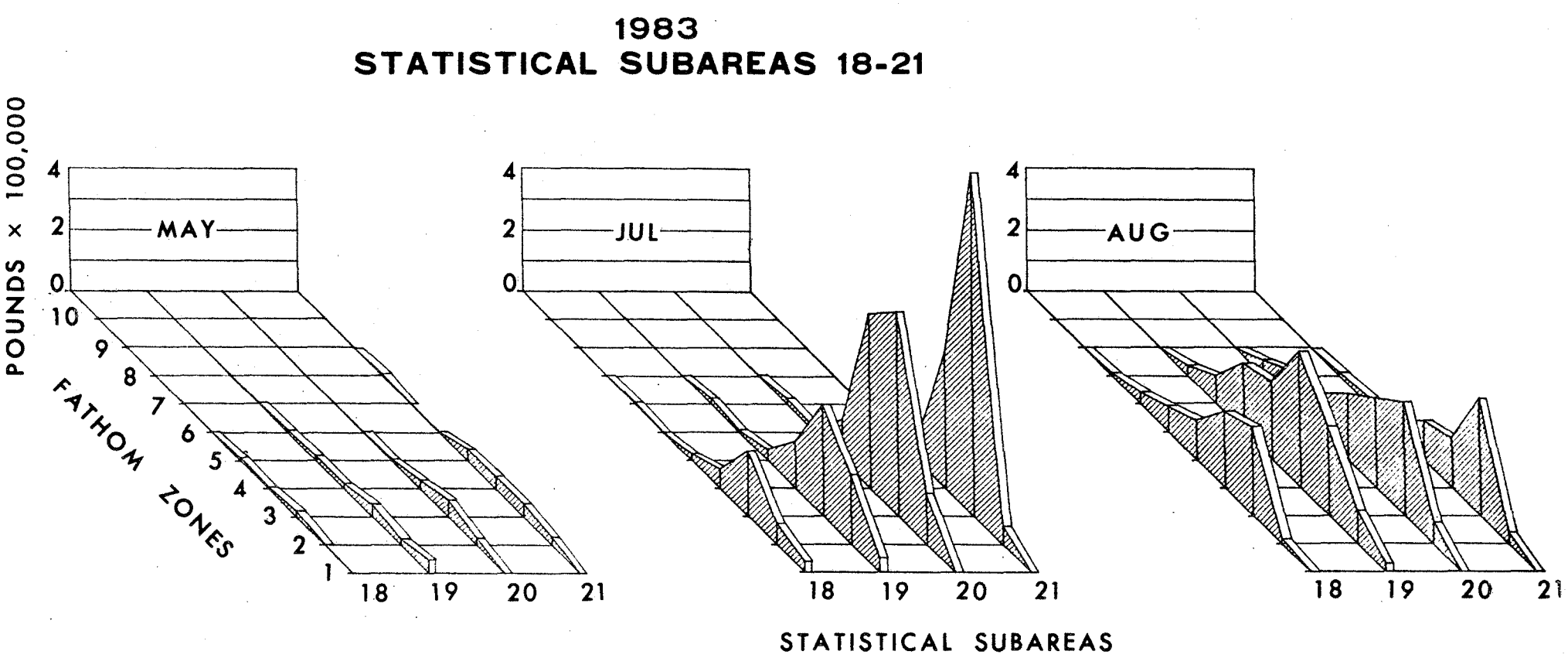

Figure 16. Offshore brown shrimp catch from statistical subareas 18-21 in May, July and August 1983.

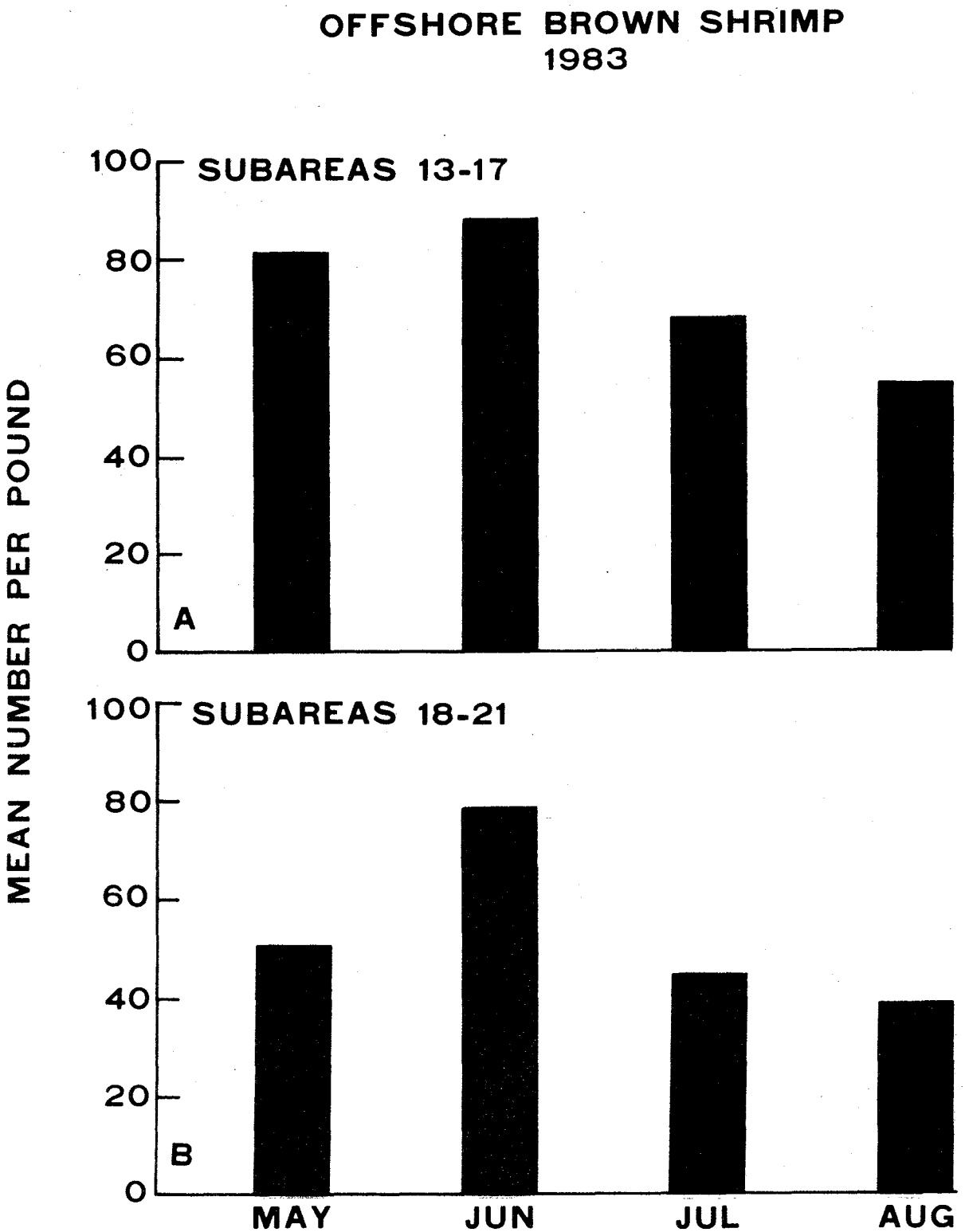

Figure 17. Mean number per pound of brown shrimp caught in statistical subareas a) 13-17 May-Aug 1983 and b) 18-21 May-Aug 1983.

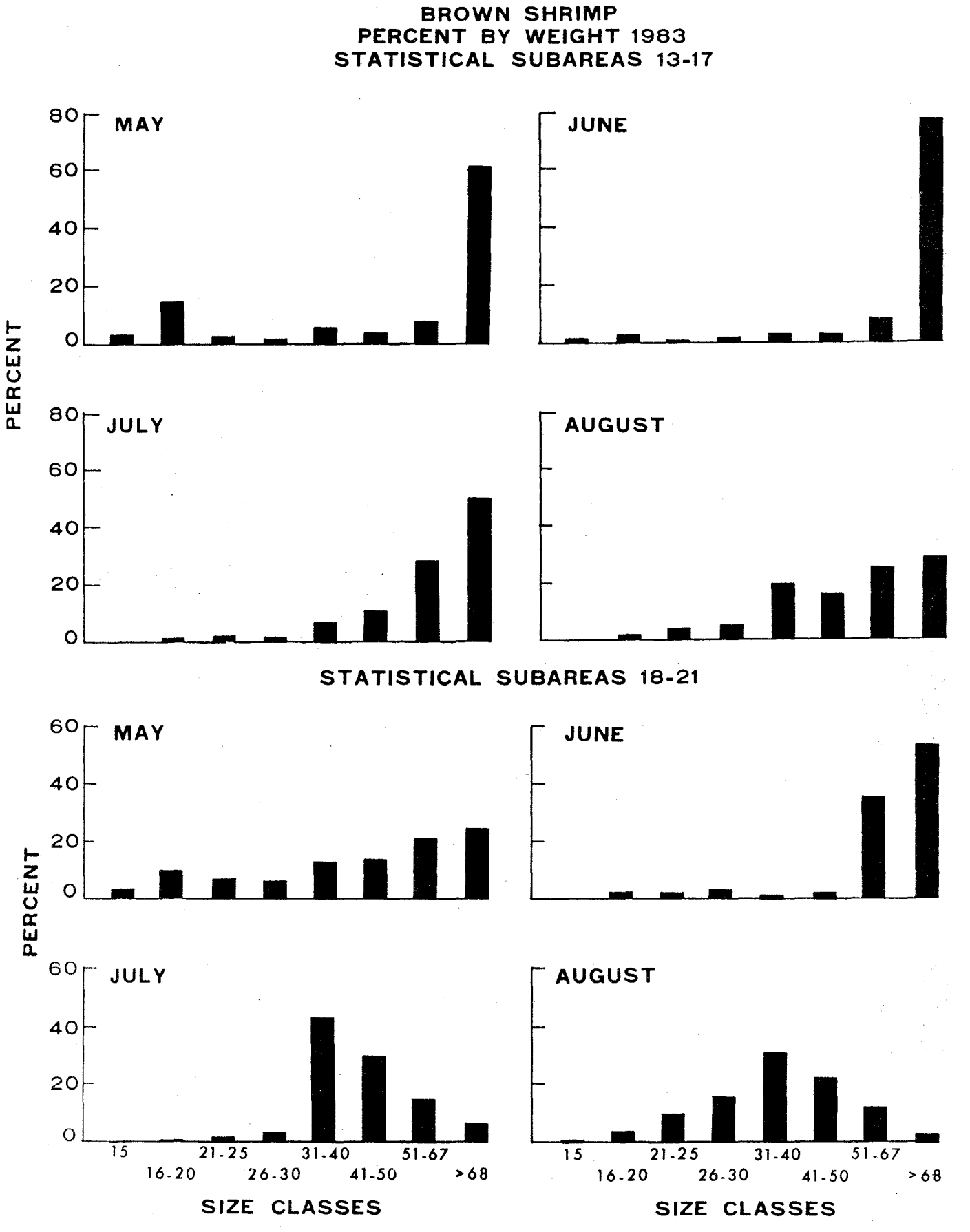

Figure 18. Percent size distribution of brown shrimp caught in a) statistical subareas 13-17 and b) statistical subareas 18-21 using size categories 15/116 count.

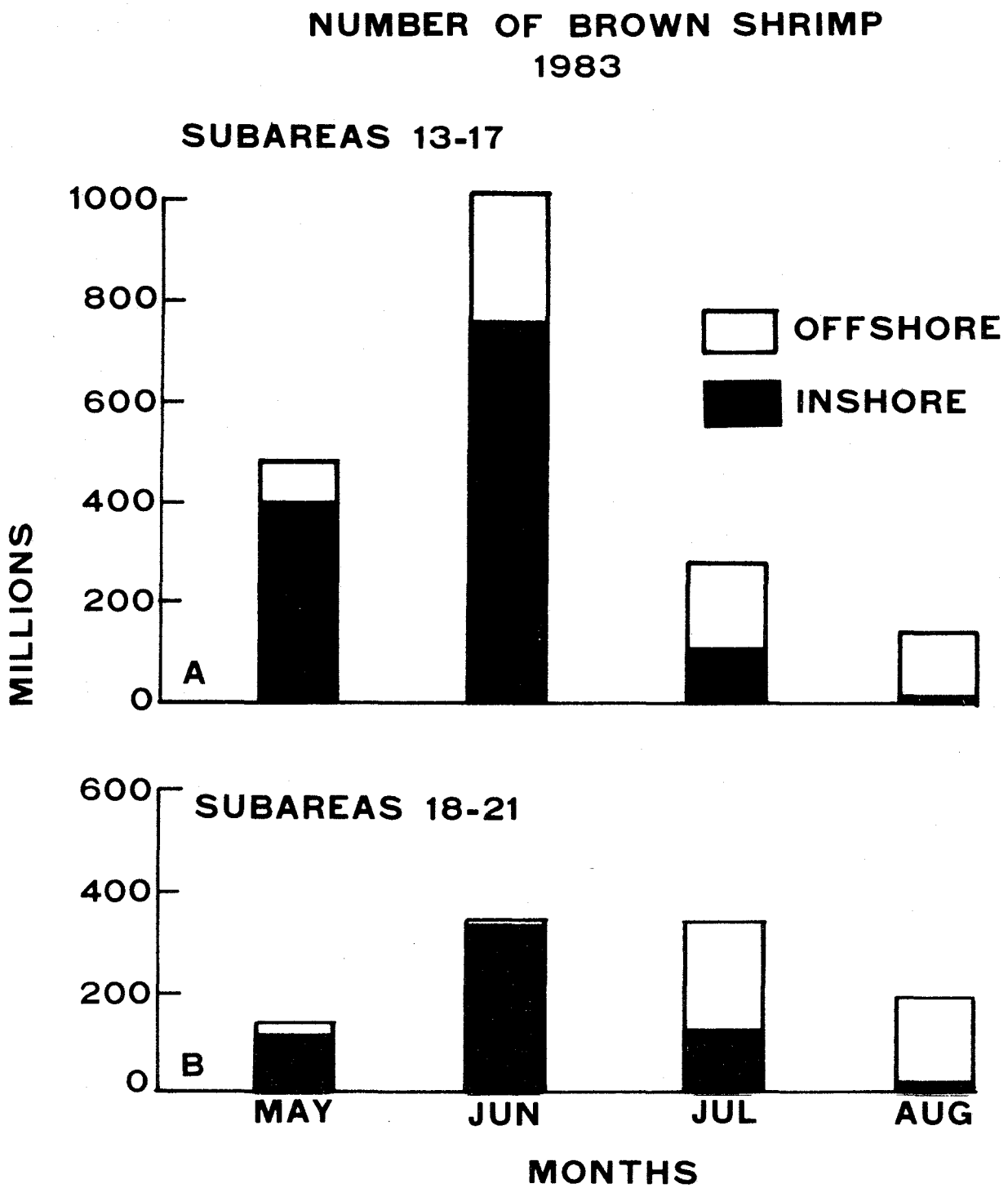

Figure 19. Number of brown shrimp caught in a) Louisiana inshore and offshore water west of the Mississippi River and b) Texas inshore and offshore waters.