Background

The Gulf of Mexico Shrimp Fishery Management Plan (FMP), prepared by the Gulf of Mexico Fishery Management Council and implemented in May 1981, regulates the fishing for brown shrimp in the fishery conservation zone (FCZ) off the coast of Texas. This regulation prohibited shrimp fishing in the FCZ for three periods: May 22 - July 15, 1981; May 26 - July 14, 1982; and May 27 - July 15, 1983. State of Texas regulations prohibited shrimp fishing in the territorial sea off Texas during these same periods, except for the white shrimp fishery inside 4 fm. Thus all shrimp fishing for brown shrimp was prohibited during these periods in waters along the Texas coast, except for an incidental catch of brown shrimp in the white shrimp fishery.

The management objectives of the Texas Closure regulation (as specified in the FMP) were to increase the yield of shrimp and eliminate the waste of a valuable resource caused by discarding undersized shrimp caught during the period in their life cycle when they are growing rapidly. Thus, the temporary closure of the offshore fishery from late May to mid-July each year should provide larger shrimp available to the fishery when fishing is again permitted beginning in mid-July. The monetary benefits of this management regulation result from catching larger, more valuable shrimp, thus increasing the ex-vessel value of the fishery.

Historically, discarding of undersized shrimp resulted from lack of market and a Texas state law that prohibited fishermen from landing shrimp that were

below a certain size. Since this law was enforced based on the percentage of the catch that was below this size, fishermen would often discard a portion of their catch that was below the legal size. The Texas Closure regulation, which was expected to increase the size of shrimp, therefore, should help eliminate the need for discarding. The most effective method of eliminating the discarding problem would be to delete the application of the law to the Gulf fishery, which the State of Texas did in 1981.

In order to assist the Gulf Council in evaluating the effectiveness of the Texas Closure regulation, the National Marine Fisheries Service was requested to monitor and estimate the effects of the regulation. Data collected specifically for these evaluations were used to describe the fishery and estimate the impact of the regulation. The scientific conclusions of the first two years of the studies were presented to the Council in December 1981 and December 1982. Similar studies were conducted in 1983 and the conclusions from these studies are presented in this Executive Summary.

Methods

The research approach in 1983 was basically similar to that taken in 1981 and 1982. The scientific analyses were based on resource survey and fishery statistical data. Fishery research vessels from federal and state fishery management agencies collected data on the populations of shrimp in offshore waters before and during the closure period. These data were used to describe the species, size, and location of shrimp. The data also provided input to yield-per recruit type models to evaluate the closure effects.

Port agents collected statistics on the catch, effort, and fishing location of shrimp vessels operating in the Gulf of Mexico. These data provided information on the species, size, and location of shrimp, as well as information on the catch rates and fishing tactics of the vessels in the fleet. The data were used as input to cohort-type models to estimate recruitment, fishing mortality, and the effects of closure. The data were also used to describe fleet activity as affected by the closure regulation. Price data, collected by the port agents were incorporated into models to evaluate the economic impact of the closure. In 1983 the analyses considered the impact of closing only the FCZ as well as the impact of closing both the territorial sea and the FCZ. Analyses in 1981 and 1982 addressed only the effect of closing the FCZ area.

Conclusions

The 1983 research reports (listed in Table 1) present the preliminary results of the 1983 closure and the final results of the 1982 closure. The results of these studies are summarized in the following six sections concerning the abundance and size composition of the shrimp during the closure, the amount of recruitment to the fishery, the commercial fishing results, the vessel activity patterns, the impact of closing only the FCZ, and the impact of closing both the terrritorial sea and FCZ. Summary statistics are given in Tables 2 and 3.

1. Abundance and Size Composition of Shrimp During the Closure.

The relative abundance of shrimp off the Texas coast during the 1983 closure was lower than in 1981 or 1982. The SEAMAP survey during the 1983 closed season showed that the average CPUE of brown shrimp off Texas was 7.4 pounds per 30-minute tow compared with 9.1 pounds and 12.4 pounds in 1982 and 1981, respectively (Table 2). The highest relative abundances in 1983 were found between 10 and 20 fms, but varied considerably along the Texas coast, with higher values occurring in the southern satistical subareas 20 and 21 than in the northern subareas 18 and 19.

The average sizes of brown shrimp during the survey were generally larger than those found in 1981, and slightly smaller than those found in 1982. The brown shrimp standing stock in the area from 6 to 25 fathoms was slightly lower in 1983 than in 1982 and much lower than in 1981.

2. Recruitment to Texas Offshore Waters

Recruitment of brown shrimp to Texas offshore waters in 1983 appears to have been lower than in 1982 and significantly lower than in 1981. We predicted the 1983 annual offshore yield to be 17.8 million pounds with a range from 16 to 19.4 million pounds, well below the average (long-term) production of 27 million pounds. This prediction was based on data collected from the Galveston Bay bait shrimp fishery during May and early June.

Other estimates of recruitment, although less quantifiable or based on a smaller data base than the prediction made from the bait shrimp index, also indicated low recruitment in 1983. The estimates were

based on the catches of postlarval brown shrimp in Galveston Bay, the catches of juvenile shrimp with a drop sampler at Galveston Island State Park and in a secondary bay of Galveston Bay, and catch rates of the Texas inshore brown shrimp fishery which opened on May 15.

3. The Commercial Fishing Results

The Texas July-August offshore brown shrimp catch in July and August 1983 was 9.8 million pounds compared to 13.0 million pounds in 1982 and 25.0 million pounds in 1981. The average CPUE (July-August) in 1983 was 1,692 pounds/trip compared to 2,095 pounds/trip in 1982 and 3,935 pounds/trip in 1981. Little discarding of small shrimp was encountered in 1983. The July-August 1983 catch off Louisiana amounted to 4.9 million pounds with an average CPUE of 576 pounds/trip.

In 1983 the total Louisiana May-August catch was 73% of 1982 and in Texas the total catch was 71% of 1982. Although both states recorded lower brown shrimp landings in 1983, the inshore fishery share of the total landings increased from 52 to 58% in Louisiana and from 23% to 36% in Texas. The inshore catch of both states was predominated by shrimp in the 116-count or larger size category.

About 1.9 and 1.0 billion shrimp were caught from May-August in Louisiana and Texas, respectively. Of these, approximately 66% (Louisiana) and 56% (Texas) were caught by the inshore fisheries.

4. Vessel Activity

Time and regional differences in vessel participation in the Gulf shrimp fisheries, which had existed before the Texas Closure, were accentuated by the closure. Texas and Louisiana were the States most affected, with more vessels fishing off Texas after the closure and more vessels fishing off Louisiana during the closure, compared to years of no closure. Although the total number of vessels in the Gulf fisheries increased from 1972-4 to 1981-3, there was very little change between the two periods in the relative numbers of vessels fishing only off Texas, those fishing only off Louisiana, or those fishing off both Louisiana and Texas. Vessel activity relative to the Texas Closure changed after the closure but it is uncertain how much of the change is due to the closure and how much is due to other factors.

5. Impact of the FCZ Closure on CPUE, Yield, and Ex-vessel Value

The benefits of closing the FCZ area alone in 1983 were estimated to be small, although generally positive. The magnitude of benefits from an FCZ closure in any year is dependent on the amount of the recruitment, the size of the shrimp migrating offshore, the timing of this migration, and the portion of the migrants which enter the FCZ. The benefits also depend on current and future fishing patterns and price structures.

In 1983 the CPUE ratio following the closure period was high, indicating that the closure markedly increased shrimp abundance and therefore fishing success. However, the high CPUE ratio lasted only a short time in 1983. The ratio (CPUE off Texas to CPUE elsewhere) for July 1983 was 2.15, compared to the average July ratio of 1.25 for 1960-80. The ratios for July 1981 and July 1982 were 2.24 and 2.09, respectively. The CPUE ratio for August 1983 was 1.03, compared to the average August ratio of 1.07. The ratios for August 1981 and 1982 were 1.56 and 1.08, respectively. Thus, abundance was sharply higher in all Julys following the closure compared to years of no closure, but for Augusts the ratio was higher only in 1981. The short period of high catch rates in 1982 and 1983 is attributed to the lower recruitment in these years as compared to 1981.

Yield-per-recruit analyses indicated that the closure of the FCZ benefitted the fishery in 1983. A net benefit from closure is indicated over the likely range of natural mortality at moderate to high values of fishing mortality and even with low values of fishing mortality at low natural mortality. The estimated increase in yield in 1983 (+12% to +33%) was higher than in 1982 (-10% to +10%); however, yield per recruit results are very sensitive to estimates of natural mortality rate and small changes (certainly those of 10% or less) probably do not have much significance.

Simulation models of fishing had the FCZ been open in 1983 project a a small increase of 1.6 million pounds in the May-August catch due to the closure. The annual catch estimate (projecting forward to April 1984) estimates a small loss (0.8 million pounds). Such projections are sensitive to estimates of recruitment size and fishing mortality rates, and it is not unreasonable to expect that the final estimate for 1983 will be positive. The estimated changes in yield due to the FCZ closure are considered small because of their relation to total yield (3% of total yield for the May-August period and -1% for the May-April period). The best interpretation of the analysis is that the inceased yield, if any, due to the FCZ closure in 1983, was small.

The simulation model was extended to project changes in ex-vessel value due to the FCZ closure. The estimate was that the change in value due to the 1983 closure was small; however, the estimate was negative, indicating a loss of $0.6 million. The monetary benefits of the FCZ closure in 1983 (actually, a slight loss) were smaller than those estimated for 1981 (an $8.3 million gain) or 1982 (a $1.4 million gain). Most benefits except the 1981 May-August estimate (which was larger), are small on a percentage basis and within 3%. The decrease in ex-vessel value, which is counter-intuitive since the estimated change in landings is positive, is due to the relatively large estimated decreases in landings of medium size shrimp during August and also the price increase of these size shrimp from June through August. The estimate is preliminary and likely to change as data are available and the landings for the entire year are simulated.

6. Impact of the Combined Closure of the Territorial Sea and FCZ of Texas on Yield and Ex-vessel Value.

In 1983 (as in 1981 and 1982) the Territorial Sea and the FCZ off the coast of Texas were simultaneously closed to shrimp fishing by separate actions of the State of Texas and federal governments. The combined closure provided the potential for achieving a larger benefit than from closure of the FCZ alone. This is conceptually plausible because a larger area is involved, and because the shrimp when they enter the territorial sea are smaller and have a higher growth potential than when they later enter the FCZ. Benefits of the combined closure were calculated for 1981 and 1982. Sufficient data have not accumulated from the fishery statistical data to make the fishing mortality estimates and subsequent calculations for 1983.

Gulf-wide yields with both the Territorial Sea and FCZ closed exceed the yields projected for fishing with both areas open by 8.9 million pounds (9%) for the 1981 season and by 4.2 million pounds (6%) for the 1982 season. The increase in ex- vessel value of the Gulf brown shrimp fishery due to the combined closure was $54.5 million (1981) and $41.3 million (1982). The benefit in pounds in 1981 was much greater than in 1982. This should be expected because recruitment was considerably larger in 1981. Closure management is aimed at improving yield <u>per recruit</u> and is not expected to impact recruitment. However,

not explained is the smaller percentage benefit in 1982 (6% in 1982 as compard to 9% in 1981). This difference could be a consequence of factors other than recruitment (e.g., higher inshore/nearshore fishing mortality rates).

Generalized yield per recruit models indicate that the maximum gain in yield (pounds) that could be expected from any closure policy is about 17%. This increase is attainable with fishing delayed 1½ months after recruitment (to when the shrimp are about 68 tails/pound). Actual percentage gains that would be achieved for the Texas Closure are, of course, smaller because only the stock off Texas is protected until July, fishing is permitted inside 4 fm, and there are already delayed openings in place in the other Gulf States.

The generalized yield per recruit models were also used to separate the effects of the inshore and offshore fisheries on offshore yields and on total yields. Offshore yields in pounds respond very rapidly to changes in inshore fishing mortality. Halving inshore fishing (keeping offshore fishing constant) will increase offshore poundage yields by 56% (for a given recruitment). Doubling inshore fishing will reduce offshore yields 59%. Offshore yields are not quite as responsive to offshore fishing mortality rate. Doubling offshore fishing (holding inshore fishing constant) would increase offshore yield (pounds) by 17%; halving offshore fishing would decrease offshore yields by 28%.

Total yield per recruit (pounds) from the fishery is not very responsive to changes in either inshore or offshore fishing. Doubling inshore fishing mortality (holding offshore fishing constant) would reduce total yields 7%; halving the inshore fishery would increase total yield per recruit by 4%. Doubling offshore fishing (inshore constant) would increase total yield per recruit 8%; halving would lead to a 12% decrease.

Table 1. Titles of reports on the Texas Closure Submitted to the Gulf Council in December 1983.

1. 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. Geoffrey A. Matthews.

2. Review of the 1983 Texas Closure for the Shrimp Fishery off Texas and Louisiana. Edward F. Klima, K. Neal Baxter, Frank J. Patella, and Geoffrey A. Matthews.

3. A comparision of vessel activity before and after the seasonal closure of the federal fishery conservation zone off Texas. Joan Browder.

4. Impacts of the 1982 and 1983 closures of the Texas FCZ on brown shrimp yields. Scott Nichols.

5. Impacts of the combined closures of the Texas territorial sea and FCZ on brown shrimp yields. Scott Nichols.

6. Estimated Impacts of Texas Closure regulation on ex-vessel prices and value, 1982, and 1983. John R. Poffenberger.

Table 2. Summary of commercial catch statistics and resource survey results for the Gulf of Mexico brown shrimp fishery.

July-August brown shrimp catch in millions of pounds, number of trips and catch per trip

	1981	1982	1983
Texas Offshore			
Catch	25.0	13.0	9.8
Effort	6,354	6,204	5,791
CPUE	3,935	2.095	1,692
Louisiana Offshore			
Catch	10.5	5.1	4.9
Effort	7,412	6,245	8,505
CPUE	1,417	817	576

May-August brown shrimp catch in millions of pounds

	1981	1982	1983
Texas Inshore	4.2	4.1	5.9
Offshore	25.3	13.9	10.5
Total	29.5	18.0	16.4
Louisiana Inshore	15.2	15.1	12.1
Offshore	23.1	13.7	8.8
Total	38.3	26.8	20.9

Offshore survey results for CPU in pounds per 30 minute tow and biomass in millions of pounds

	1981	1982	1983
Texas			
CPUE	12.4	9.1	7.4
Biomass (6-25 fathoms)	29.2	22.0	21.1

SUMMARY

The regulation to close the FCZ waters off the coast of Texas to shrimp fishing from May 27 to July 15, 1983, benefitted the Gulf brown shrimp fishery by increasing the yield by about 3% (1.6 million pounds), based on May-August data. No increase in ex-vessel value for 1983 was shown, although the estimate at this time is preliminary and subject to change. In 1981 and 1982 the FCZ closure provided benefits of 3.6 million pounds (1981) and 1.5 million pounds (1982), which represented increases to the Gulf fishery of 5% and 3% respectively. Benefits in dollars were $8.3 million (1981) and $1.4 million (1982), which represented increases of 7% and 1%. The best estimate is that overall the Texas FCZ closure provided a small but positive benefit in both yield and ex-vessel value to the fishery.

The combined closure of the territorial sea and FCZ waters off Texas provided considerably larger benefits than closure of the FCZ alone. These benefits represented a major economic contribution to the industry. The benefit of the combined closure in 1981 was 8.9 million pounds or $54.5 million. The 1982 benefit was 4.2 million pounds or $41.3 million. Benefits of the combined closure in 1983 have not yet been calculated.

The closure of the waters offshore of Texas (either FCZ or combined territorial sea and FCZ) protects juvenile shrimp until they grow to a larger size, thereby significantly increasing the value of the catch. This protection and increase in value is achieved both in years of good and poor recruitment. However, the magnitude of the benefit in years of good recruitment is considerally larger than in poor years. The FMP goal of increasing the ex-vessel value by a temporary closure of the Texas offshore waters appears to have been achieved. Without this prohibition of trawling offshore of Texas, large quantities of small shrimp would have been caught, resulting in lower overall yield.

Table 3. Summary of analytical results of the Texas Closure shrimp fishery management measure, 1981-83. Values shown are the statistics used to measure the effect of the closure for the FCZ alone or for the Territorial Sea and FCZ combined.

Statistic		Year 1981	1982	1983
FCZ Closure				
CPUE ratio Texas/elsewhere [1]	July	2.24	2.09	2.15
	Aug.	1.56	1.08	1.03
Increase in Y/R at F=1.0, M = 0.15-0.28		14 to 37%	-10% to +10%	12 to 33%
Change in Gulf Wide Yield (Million Pounds)				
(May - Aug)		+3.6 (5%)	+1.5 (3%)	+1.6 (3%)
(May - April)		+3.9 (4%)	+2.5 (3%)	-0.8 (-1%)
Change in Gulf Wide Value (Million $)				
(May - Aug)		8.3 (7%)	+1.4 (1%)	-0.6 (-1%)
(May - April)		5.2 (3%)	+5.5 (3%)	[2]
Terr. Sea + FCZ Closure				
Change in Gulf Wide Yield (Million Pounds)				
(May - Aug)		+8.9 (9%)	+4.2 (6%)	[2]
Change in Gulf Wide Value (Million $)		+54.5 (18%)	+41.3 (15%)	[2]

1. Long-term average CPUE ratio (Texas/elsewhere) 1960-80 is 1.25 (July) and 1.07 (Aug).

2. Estimate not made because estimation procedures require future data not available at the time this report was prepared.