Effects of the 1981 Closure on the Texas Shrimp Fishery

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Introduction

Shrimp fisheries in the Fishery Conservation Zone (FCZ) in the Gulf of Mexico are federally managed by the Shrimp Fishery Management Plan, which was implemented by the Secretary of Commerce on 15 May 1981. A major regulation within this plan prohibits fishing for brown shrimp, *Penaeus aztecus,* in the FCZ off the coast of Texas during the time of year when large numbers of juvenile shrimp migrate from the bays and estuaries to offshore waters. The time of the closure corresponds with the closure by the State of Texas of its territorial sea. In 1981 the closure in the FCZ and Texas' territorial sea was from 22 May through 15 July.

The objective of the 1981 "Texas closure" regulation was to increase both the quantity and monetary value of brown shrimp harvested from the Texas coastal areas. It was anticipated that the closure of these areas when juvenile shrimp are migrating offshore would achieve this objective. The closure regulation was also expected to eliminate the discard of smaller, unmarketable shrimp by the fishermen because, simultaneous to the implementation of the plan, the State of Texas removed its law restricting landings of undersize shrimp. Before the implementation of the plan, the potential benefits of this closure regulation were estimated (NOAA, 1980). Nevertheless, considerable apprehension was expressed by some members of the fishing community that the regulation would be ineffective and would adversely affect shrimp fisheries in other Gulf States. Because of these concerns, the Southeast Fisheries Center was requested to monitor and evaluate the impacts of the regulation during the initial months after its implementation on 22 May 1981.

Research on various aspects of the Texas closure regulation was designed and conducted by scientists at the Southeast Fisheries Center and was composed of specific data collection and analytical efforts. Two fishery research vessels sampled shrimp populations in the closed area from May to July. Near-synoptic coverage of the Texas FCZ by these vessels provided an estimate of the magnitude and size composition of the shrimp population in the closed area. Additional coverage by one vessel in May and July provided information on temporal changes of the area's shrimp population. In addition, data on fishery activity (catch, effort, and location of fishing) were collected in each of the Gulf States (Texas to Florida) by interviewing dealers and selected fishermen. At-sea observers on shrimp vessels, in the course of other duties, collected data on magnitude and species composition of the incidental catch of fish both in the regulated area and in unregulated areas. Finally, daily sales data were collected from ice manufacturers in Louisiana, Mississippi, and Alabama as an estimate of shore facility use in these areas. Data from these field studies were processed, analyzed, and compared with available historical data. The results (as well as the research and analytical methodologies) were presented to the Gulf of Mexico Fishery Management Council in December 1981.

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This issue of the *Marine Fisheries Review* contains articles on the research done by the Southeast Fisheries Center on the effects of the Texas closure regulation. Our overview report synthesizes the scientific results from these articles and provides answers to technical questions relating to the management of this penaeid fishery. These questions, formulated in consultation with fishery administrators, were designed to provide scientific information upon which to base fishery management policies for the Gulf shrimp fisheries. The topics cover: 1) Size composition and abundance of shrimp in the area during the time it was closed to fishing; 2) quantity and value of brown shrimp harvested by the regulated fishery compared with amounts that would have been taken had the fishery not been regulated; 3) changes in fishing patterns and use of shore facilities that resulted from the closure regulation; and 4) other possible effects on the resource and fishery.

Abundance of Shrimp

A high abundance of brown shrimp in Texas in 1981 was documented by recruitment indices, results of trawl surveys made in the closed area, and statistical records on the fishery. Biologists annually measure abundance and survival of small shrimp in Texas bays

and estuaries; they reported that recruitment in these inshore areas was good in 1981. Brown shrimp recruitment was generally comparable with (but not better than) recruitment in the above-average shrimp production years of 1967, 1972, 1976, and 1977 (Klima et al., 1982). Only in one area of Texas, the lower Laguna Madre, was recruitment in 1981 substantially better than in the above-average years.

Evidence of good recruitment in Texas bays was accompanied by evidence of high shrimp abundance in the Texas offshore areas during June, July, and August 1981, as measured on the research cruises and by fishing records. Although historical data are somewhat limited, catch per unit of effort measured on research surveys in 1981 appeared to be greater than that measured in earlier years. The 1981 observations (Matthews, 1982) suggest that large biomasses of small shrimp were present along the entire Texas coast, with especially high concentrations of shrimp in the depth range of 10-20 fathoms (fm). Thus, shrimp were protected from fishing as a result of the closure. Fishing success off Texas was at record levels in July and August 1981. Offshore Texas catches were 10.3 million pounds from 16 to 31 July and 14.6 million pounds for August (Klima et al., 1982). Catch rates were 2,250 and 1,346 pounds per 24-hours fishing for July and August, respectively. These catches and catch rates were markedly higher than in any other year examined.

In Louisiana, abundances of brown shrimp were documented by recruitment indices and statistical records on the fishery. Brown shrimp recruitment in Louisiana in 1981 was reported to be at record levels[1]. Inshore recruitment occurred over an extended period, and survival during the spring recruitment phase was high because of favorable temperatures and salinities. These shrimp contributed to a reportedly successful fishery in the inside waters of Louisiana and after migration to a good fishery in offshore waters in June through August. Offshore catches were 7.5 million pounds in June, 7.4 million pounds in July, and 2.9 million pounds in August (Klima et al., 1982). However, these catches and the associated catch rates, unlike those reported in Texas waters, were not significantly higher than shrimp production in any other year.

Since the catches off the Texas coast were at record levels and recruitment did not appear to be significantly better than in above average years, other factors may have caused the record catches. For example, abundance of shrimp in Louisiana areas was high during the period of the closure regulation and it was suggested that migration from these areas may have supported the large abundance in the offshore Texas area. However, extensive data from marking studies previously conducted in Louisiana indicate that the majority of shrimp migrating offshore are captured in the immediate area (within about 60 miles of where they enter the ocean) and very few make longer migrations. Thus, while recruitment in Louisiana was very high in 1981 and the catch rates offshore of Louisiana were good, there is no evidence to indicate that these shrimp contributed to the fishery off Texas or other states.

In summary, although recruitment in both Texas and Louisiana waters was good in 1981, recruitment levels in neither area satisfactorily account for the highly successful July-August fishery off Texas. In particular, observed catches and catch rates offshore of Texas were markedly higher than would have been predicted from existing recruitment indices based on historical data.

Magnitude of Catch

In July and August, the offshore Texas fishery harvested approximately 875 million shrimp weighing 24.9 million pounds at average monthly catch rates of 2,250 and 1,346 pounds, respectively, per 24-hours fishing. In contrast, fishermen in the offshore Louisiana fishery from June through August harvested approximately the same number of shrimp (867 million) but weighing less (17.8 million pounds) and taken at lower catch rates of 687-858 pounds per 24-hours fishing. Moreover, as a consequence of the smaller size of shrimp caught in the offshore Louisiana fishery, the ex-vessel value of these shrimp was less than that of shrimp caught in the offshore Texas fishery. Of practical importance and analytical interest is the possible contribution of the regulation to the larger and more valuable catches in Texas waters. In other words, to what extent did the regulation enhance the yield and value obtained from the available recruitment? Two approaches to estimating yield provided information on this question.

First, a yield-per-recruit analysis was applied, using an estimated population age composition of 22 May (the start of the closure) as the measure of recruitment (Nichols, 1982). This population age composition was determined from measurements made on the research vessel survey of the FCZ off Texas in June, combined with estimates of growth and mortality. The simulation predicted that the standing stock of brown shrimp in the regulated area increased 78 percent in weight during the closed period, due to the gain in growth exceeding the loss from mortality. As a result, an enhancement of yield from closure of the Texas FCZ was predicted for most fishing mortality rates. The percentage gain in potential yield varied from less than zero at very small fishing mortality rates to more than 40 percent at higher rates.

Second, a virtual population analysis was applied, using catch and effort data for the Gulfwide, offshore brown shrimp fishery, which encompasses waters off Texas, Louisiana, Mississippi, Alabama, and eastern Florida. The observed catch in 1981 was compared with the predicted catch that would have been taken had the Texas FCZ not been closed. Results indicated that with the closure the May-August observed harvest of 52.8 million pounds was 11.7 million pounds (29 percent) higher than if there had been no closure. However, much of that increase

[1]White, Charles. Louisiana Department of Wildlife and Fisheries, 400 Royal Street, New Orleans, LA 70130, pers. commun.

in catch was realized at the expense of the standing stock. The biomass as of 1 August was reduced by 18 percent compared with the biomass estimated for an unregulated fishery. When the expected yield was compared over the fishable lifespan of the shrimp cohort (estimated as 2 years), the estimated harvest of 65.0 million pounds was 4.1 million pounds (7 percent) higher than if there had been no closure.

The two simulations of the effect of the regulation on harvest are in reasonable agreement. One method estimated the change in yield from the Texas FCZ only, whereas the other method estimated the change in yield from the Gulfwide fishery. Since the Texas FCZ contained about 29 percent of the Gulfwide brown shrimp population, and the likely increase in yield there from the closure was about 40 percent, the overall fishery gain of 12 percent estimated by the yield-per-recruit approach is close to the 7 percent gain estimated by the virtual population analysis.

Fundamental economic principles associated with the theory of supply and demand indicate that in unrestricted markets the price of a commodity can be expected to decrease if the supply of that commodity increases (assuming there is no change in demand). Therefore, since the regulation resulted in an (estimated) increase in the supply of domestically harvested brown shrimp, it is completely consistent with economic theory to expect a decrease in the ex-vessel price paid to the fishermen. The important analytical question is to estimate how much of the decrease in price can be explained based on historical changes in landings and the concomitant changes in ex-vessel prices.

The statistical relationship between changes in ex-vessel prices and changes in landings is termed "price flexibility." Since the estimation of price flexibilities is fundamental to estimating the effects on the ex-vessel value of the brown shrimp fishery, an analytical technique had to be used that estimated the relationship between price and landings while all the other influential factors were held constant. Price flexibilities were estimated by simple and multiple regression. The simple regression model estimated ex-vessel prices for the eight marketing or size categories of shrimp as a function of the amount of landings in the respective size categories. The hypothesis underlying this model specification was that ex-vessel prices were influenced differently (i.e., the estimated coefficients of the landings variables were statistically different) in good vs. average years of domestic shrimp production. Statistical results of estimating the simple regression model twice—using the good years of 1972, 1976, and 1977 as one data set and the remaining seven years as the second data set, and comparing the confidence intervals around the estimated coefficients—indicated that the hypothesis should be rejected at $\alpha = 0.05$. Thus, a difference does not exist between price flexibility estimates for good and average years, and this model specification was rejected (Poffenberger, 1982).

A multiple regression model was also used so that a more adequate specification of the effects that factors other than domestic supply have historically had on ex-vessel prices could be estimated (equation (2) in Poffenberger, 1982). This model was estimated using unadjusted prices and also prices that were adjusted (deflated) by the producer price index for meat, poultry, and fish. The purpose of such an adjustment was to account for the upward movement in prices over time and to permit the regression analysis to more adequately model short-term fluctuations in ex-vessel prices and landings. Empirical estimates of the adjusted and unadjusted models are close and are presented in Table 4 of Poffenberger (1982).

Price flexibilities estimated by the regression models were combined with the brown shrimp landings data simulated by Nichols (1982), assuming that the area off Texas was not closed during the regulated period. The estimated effect of the closure regulation during the period from May through August was to increase ex-vessel value by $21.5 million, or about 18 percent of the $119 million total ex-vessel value reported for this 4-month period.

Fishing Patterns

Seasonal fishing patterns were affected by the closure of the FCZ off Texas, as indicated by statistical records on the fishery. During the closure period, vessels in Texas ports either remained in port or fished in waters off the coasts of other states (mainly Louisiana). After 15 July, vessels from Texas ports and many vessels from ports in other states fished the Texas grounds. The pattern of fishing effort in 1981 was significantly different from the pattern observed in 1980 (Jones and Zweifel, 1982). However, declines in catch rates resulting from this different distribution of fishing activity, and from possible excessive concentration of effort, were not obvious. Although vessels from both Texas and Louisiana concentrated on western Louisiana grounds before 16 July, catch rates there did not appear depressed. Many vessels moved to the Texas grounds in late July and August, but they did so because of the exceptionally high catch rates there, not because of depressed catch rates on grounds off other states. The high catch rates off Texas continued through August 1981, the end of the period of observation included in these studies (Klima et al., 1982).

The disruption of historic seasonal fishing patterns resulting from the closure regulation had two effects on shore facilities—one anticipated and one unanticipated. The anticipated effect was that some vessels that historically fished off Texas in June fished off Louisiana in 1981, and a portion of these vessels landed their catch at Louisiana ports. These additional landings apparently were not large enough to have any serious effect on Louisiana's shore facilities. Temporary shortages of ice for fishing vessels were recorded at some ports, but no extended shortages occurred. Because two new ice manufacturing plants were in operation in 1981, use of the available ice capacity was actually less in 1981 than in 1980, despite the larger

catches (Ward and Poffenberger, 1982).

An unanticipated effect was the large landings at Texas ports after 15 July that resulted in difficulties in processing the catch. Vessels were delayed in unloading the catch, and on several occasions unprocessed catches had to be trucked to other localities for processing. These difficulties occurred mainly near the opening of the fishing season and were exaggerated by bad weather that caused many of the vessels to land their catches at the same time. After these initial problems, additional personnel were hired to process the larger catches, and no further major difficulties occurred.

Incidental Catch and Discards

Subtle impacts to the resource might be expected as a result of the high concentrations of fishing effort due to closure. Because of this, the NMFS Mississippi Laboratories examined the available data on fish caught incidentally to shrimping (Watts and Pellegrin, 1982), but no apparent effect on the amounts of fish caught incidentally to shrimping could be discerned from the available data. However, it should be noted that cessation of trawling for 55 days followed by very intensive fishing conceivably could have affected the numbers of shrimp predators as well as the number of shrimp themselves; Klima et al. (1982) reviewed information on the discarding of small, unmarketable shrimp.

Discarding was not a major difficulty, although some shrimp were discarded from the catches when fishing in the regulated area resumed on 16 July. This practice reportedly occurred because the crews could not process the large catches as they were brought aboard the vessels, and the problem was quickly resolved by hiring additional persons to work on the vessels.

Conclusions

We concluded from the research studies that the Texas closure provided a benefit by increasing the overall yield and value of the northern Gulf brown shrimp fishery over the short-term, from May through August, and probably increasing at least the overall yield of the long-term fishery on those cohorts affected by the closure. The increased benefits were large because of the high level of recruitment experienced in 1981. No specific attempts were made to measure who gained and who lost from this regulation, but obviously those vessels in the Texas fishery gained, and other vessels received less revenue due to price declines directly attributable to the closure. It appears from the estimates that the overall economic gains significantly outweighed the losses. The change in fishing patterns clearly affected the short-term density of shrimp populations. However, effects on animals associated with shrimp, which probably occurred, were not obvious. Thus, any long-term effects on the shrimp population itself from the change in shrimp density were not measurable in the short period of this study.

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