



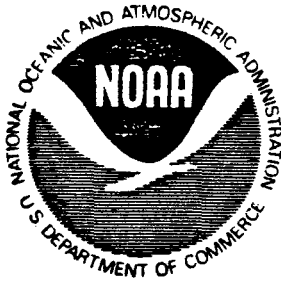
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Estimated Impacts of Texas Closure Regulation
on Ex-Vessel Prices and Value, 1984 and 1985

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ABSTRACT

A Federal regulation, mandated in 1981, closes the fishery conservation zone (FCZ) in the Gulf of Mexico off of the coast of Texas to fishing for brown shrimp beginning in late May until the middle of July when the area is re-opened to commercial fishing. The objective of this regulation is to essentially eliminate fishing mortality on brown shrimp during a period of rapid growth in their life cycles. Analyses are performed to estimate the effects of these regulations on the amount of shrimp caught (and landed) and the value of the catch. The effects on catch are estimated in Nichols (1986) and his estimates are used to estimate the effects of the Closure on ex-vessel prices and value. According to Nichols, the Closure during May 1984 through mid-July 1984 resulted in an increase of 1.4 million pounds of brown shrimp. This increase in landings is estimated to have resulted in an increase in total revenue to the fishery of about \$18.7 million.

This report also presents preliminary estimates of the effects of the closed season from May 1985 through mid-July 1985. These preliminary estimates are made for the four month period, May through August, and are used by the Gulf of Mexico Fishery Management Council in their recommendations regarding the status of the regulation in the FCZ. Nichols (1986) estimates that the closed season during 1985 resulted in a loss of between 1.3 and 0.8 million pounds of brown shrimp. The estimated ex-vessel values for these losses in catch range between a loss of \$5.2 million and a gain of \$756 thousand to the fishery.

INTRODUCTION

A Federal regulation was promulgated in 1981 that aids in the management of brown shrimp in the Gulf of Mexico. This regulation closes the fishery conservation zone (FCZ) in the Gulf off of the coast of Texas for approximately 45 days. The FCZ closure coincides with the closure of the territorial sea which is under the jurisdiction of the State of Texas. The management objective of these joint closures is to greatly reduce, or eliminate, fishing mortality on brown shrimp during a period of rapid growth in their life cycles. Juvenile brown shrimp grow rapidly as they migrate offshore after leaving the bay systems along the Texas coast. The intended effects of the joint closure regulations, known as the Texas Closure, is to increase the total pounds and value of brown shrimp by allowing them to grow to larger, more valuable sizes before they are harvested.

Although the closure of the FCZ is a Federal regulation, the Gulf of Mexico Fishery Management Council has the responsibility for monitoring the effects of the regulation. The Council reviews the effects of the regulation each year, along with input from the fishing industry, and makes a recommendation to the Secretary of Commerce regarding the status of the regulation, either to continue, discontinue or amend the regulation. The purpose of this report is to provide estimates of the effects of the closure regulations on ex-vessel prices and value of brown shrimp caught in the Gulf of Mexico. The direct effects of the regulations are on the amount of brown shrimp harvested in the western Gulf of Mexico. Estimates of the changes in brown shrimp catches due to the closed

areas are made by Nichols (1986) and his estimates are the changes in supply that are used to estimate the changes in ex-vessel prices and value presented in this report.

To assist in the Council's recommendations, two sets of estimates are provided. The first set of estimates presents the effects of the closures during the current year. The complexities of fishery statistics and the time required to collect and process these statistics limit the scope of these preliminary estimates to data from May through August of the current year in order to meet the Council's January timetable. The second set of estimates is considered final. These estimates include the effects of the closure over a twelve month period and are made for the closures during the previous year. Thus, this report includes preliminary estimates of the closures' effects of the closures during 1985 (i.e., the areas were closed from May 20, 1985 through July 8, 1985) and final estimates of the effects of the 1984 closed season (i.e., the areas were closed on May 16, 1984 and fishing was permitted on July 7, 1984).

The Council has also requested that estimates be made for the following two conditions; (1) only the Texas territorial sea was closed during the May-July period and (2) both the FCZ and Texas territorial sea were open to fishing (i.e., unregulated fishing) during the entire year. Estimates for these two management scenarios are presented in section III, Analytical Results. Section II presents a discussion of the research methodology and presents the statistical results of the multiple linear regression models. The final section summarizes the report and presents comparisons of the effects of the closures on the brown shrimp fishery during the five years it has been in effect.

II. METHODOLOGY

Simulated brown shrimp landings were estimated for fishing effort and catches under the assumption that the FCZ in the Gulf of Mexico off the coast of Texas was open to fishing during the May through mid-July period (Nichols, 1986). The differences between the reported landings of brown shrimp (i.e., when the FCZ is closed) and the landings estimated by the simulation analyses (i.e., the FCZ is open to fishing) are used to estimate the effects on ex-vessel brown shrimp prices as a result of the Texas Closure. The ex-vessel prices estimated from the simulated changes in landings are used to calculate the "simulated" ex-vessel value of the brown shrimp fishery. The difference between the reported brown shrimp value and the simulated value is the effect of the Closure on the total revenue to the fishery.

Statistical analyses using multiple linear regression techniques indicate that statistically significant relationships exist between ex-vessel prices and landings. The coefficients from the regression equations provide estimates of the absolute relationships between ex-vessel prices and landings, assuming all other variables in the regression equation are held constant. This absolute value can be converted to a relative measure by multiplying the regression coefficients by the ratio of the mean value of ex-vessel prices to the mean of the reported shrimp landings. These relative measures are called price flexibilities of brown shrimp prices. Specifically, a price flexibility is defined as the percentage change in ex-vessel prices given a one percent change in shrimp landings.

Shrimp prices are reported in eight marketing categories. For analytical purposes, however, weighted averages for ex-vessel prices are calculated for the following three aggregated size categories. The Large Category includes brown shrimp in the four largest marketing categories -- i.e., <15, 15-20, 21-25 and 26-30. The Medium Category includes the 31-40, 41-50 and 51-67 marketing categories. The Small Category includes all small shrimp landed in the >67 marketing category. These three size categories are used to estimate the changes in ex-vessel prices due to the Closure regulation.

The statistical relationships between ex-vessel prices and landings were estimated using multiple linear regression. The results of these regression equations, as well as the summary statistics are presented in the Appendix. The summary statistics from these regressions, specifically the Durbin-Watson statistics, indicate that the assumption of independence in the error terms is violated. The presence of serial correlation in a regression equation usually causes the t and F statistics in ordinary least squares (OLS) regressions to be invalid and can result in potentially misleading statistical conclusions regarding the significance of the estimated coefficients. The Cochrane-Orcutt iterative technique is an analytical method that adjusts for first order serial correlation in the error terms.

The estimated regression coefficients from both the OLS and the Cochrane-Orcutt technique are compared in Table 1. Only small absolute differences exist between the estimated coefficients for the OLS and the Cochrane-Orcutt technique for the Large and Small size categories. The magnitude of the difference between the estimated coefficients for the two regression

techniques is nearly two hundred percent for the Medium size category. The regression coefficients estimated using the Cochrane-Orcutt technique are used to calculate the price flexibilities. The price flexibilities (m), also provided in Table 1, are used to calculate the empirical effects of the Closure regulation on projected ex-vessel prices and total revenue for the brown shrimp fishery. These empirical results are presented in the next section.

III. ANALYTICAL RESULTS

Although the research methodologies are essentially the same, analytical results are presented for several different aspects of the seasonal closure regulations. There are two areas in the Gulf of Mexico off of the coast of Texas that are regulated under separate authorities. The territorial sea (from 0 to 9 nautical miles), which is under the jurisdiction of the state of Texas and the fishery conservation zone (from 9 to 200 nautical miles), which is under Federal jurisdiction. Under the mandate of the Federal law, the FCZ is closed coincidentally with the Texas territorial sea. Therefore, a relevant empirical question has been asked regarding the estimated effects of opening the two areas separately. For that reason, the effects on brown shrimp catches have been estimated for the following two scenarios; 1) closing only the territorial sea, i.e., opening the FCZ to shrimp fishing, and 2) opening both the territorial sea and the FCZ (Nichols, 1986). The estimated changes in ex-vessel value from the above two closure scenarios are discussed in separate sections.

The effects of the Texas Closure regulation are calculated on a 12-month period beginning in May and continuing through April of the following year. This time period has been designated the biological year for the analysis of brown shrimp in Gulf of Mexico. Because management decisions regarding the continuation of the Closure regulation need to be made several months prior to the closure period, preliminary estimates of the effects of the current year's Closure regulation are made for the May through August period. After the data are available for the entire biological year, final estimates of the Closure's effects are made for the 12-month period. Thus, this section is further divided into a discussion of the final estimates due to the 1984 closure of the FCZ and the preliminary estimates of the 1985 closure.

Prior to discussing the empirical estimates of the effects of the Texas Closure regulation, a cautionary note should be made regarding arithmetic comparisons between the estimated landings and ex-vessel values. In reviewing Tables 2 through 9, one may be tempted to divide ex-vessel value by catch and get the price per pound due to the Closure. For example, \$18,677 thousand could be divided by 1,356 thousand pounds to get \$13.77 per pound (Table 2). This price is greater than the ex-vessel prices reported for even the largest (< 15 count) size category. The reason that it is inappropriate to calculate ex-vessel prices from the estimated changes in catch and ex-vessel value is because of the arithmetic involved in this calculation. Ex-vessel prices that are reported in the fishery statistics are calculated as weighted averages for the marketing categories. Ex-vessel prices calculated from the estimated catches and value in this report are not weighted averages. In calculating a weighted average, the individual size categories are summed and then divided. For the

Texas Closure analysis, the estimated catches and values are calculated by subtracting the simulated landings from the reported landings, not adding as is done for weighted averages. Thus, prices per pound cannot be calculated from the estimated landings and values provided in Tables 2 through 9 by making a simple pounds into value division.

Closure of Fishery Conservation Zone

Final Estimates for the 1984 Closure

The change in brown shrimp landings due to the closure of the FCZ during late May through mid-July 1984 was estimated to have increased landings by about 1.4 million pounds (Nichols, 1986). Because most of this increase was in the Large and Medium size categories, the total revenue from the brown shrimp fishery was about \$18.7 million more than it would have been during May 1984 through April 1985, if the FCZ had been open to shrimp fishing (Table 2).

It is estimated that about \$8.5 million of the \$18.7 million increase occurred during May through August, 1984 when fishing for brown shrimp in the western Gulf was the most intense (Table 3). Because of the timing of these catches, the remaining \$10.2 million may have been due to factors not directly attributable to the Texas Closure regulation. A major contributing factor to the increases in catch was the larger standing stocks that occurred in the fall. In his simulation analyses, Nichols (1986) was unable to attribute these anomalies directly to the Closure, so it is likely that \$18.7 million is an over-estimate of the effects of the Closure regulation alone.

Preliminary Estimates for the 1985 Closure

The simulation analysis of fishing effort in the western Gulf of Mexico is based on the fishing patterns in the years just prior to 1981 (the first year of the Closure regulation). Some concern exists that the estimates of fishing effort used in the simulation analyses may not be as realistic as they were for the first few years after 1981. Specifically for 1985, unusually intensive nearshore (0-5 fm) fishing took place in statistical areas 13 and 14. For that reason, two scenarios of fishing effort are used to simulate the fishing patterns for the analysis of the 1985 closure. For the first scenario, Nichols (1986) assumed that fishing effort in the inshore areas was not affected by the closed seasons in Texas. He assumed, however, that part of the increase in fishing effort in the nearshore areas (0 to 5 fathoms) was due to the closures and he made adjustments to the fishing effort in the nearshore areas. For the second scenario, he assumed that fishing effort in both the inshore and nearshore areas was not affected by the closure regulations. For both scenarios, fishing effort in the Gulf of Mexico beyond 5 fathoms is simulated as it has been for the analyses in previous years. The actual amount and distribution of fishing effort expended by the fishermen during this period in 1985 is probably somewhere between these two scenarios.

Under the first scenario, Nichols (1986) estimates that the Closure resulted in an overall loss of 1.3 million pounds of brown shrimp during May through August 1985 (Table 4). The market value of this loss is estimated to be about \$5.2 million (Table 4). However, a closer look at the pattern of shrimp landings estimated using this scenario indicates a pattern contrary to what

would be expected. The Closure should reduce fishing effort early in the season when young, small shrimp are leaving the bays and estuaries as they migrate offshore. Thus, with the Closure in effect, catches should contain more larger size shrimp compared to the catches if the Closure were not in effect. The estimates in Table 4 however, show just the opposite. The catches of small shrimp have increased slightly (approximately 956 thousand pounds); whereas, the catches of larger shrimp are below the simulated landings for the open situation (i.e., the differences are negative for the Medium and Large categories).

The second scenario shows a pattern of shrimp landings that is closer to what would be expected from the closure of the FCZ during the spring and early summer (Table 5). For this scenario, catches of medium size (i.e., 31-67 count) shrimp are greater than the simulated landings and the landings of small shrimp (67 count) are less than the simulated estimates (Table 5). Overall, the preliminary estimates for this scenario indicate a loss of about 800 thousand pounds in brown shrimp landings (Table 5). However, because the catches of medium size shrimp are greater than the simulated catches and the weighted average prices for these shrimp are greater than the price of small shrimp (about \$2.50 per pound versus \$0.95 per pound), the net effect on total revenue to the fishery is an increase of about \$756 thousand (Table 5).

Closure of the Fishery Conservation Zone and the Territorial Sea

Because the Texas territorial sea is from 0 to 9 nautical miles, the effects of eliminating fishing effort on the juvenile brown shrimp in both the territorial sea and the FCZ is expected to be greater than the effects of only closing the FCZ. The changes in landings and ex-vessel value due to the closure

of both the territorial sea and the FCZ are estimated for the May 1984 through April 1985 biological year (Table 6). An increase of 5.1 million pounds of brown shrimp landings is estimated by Nichols (1986) which is estimated to have resulted in an increase of \$37.4 million in revenue to the Gulf shrimp fishery.

V. SUMMARY AND HISTORICAL COMPARISONS

The Texas Closure regulation during 1984 resulted in an estimated increase in landings of brown shrimp in the Gulf of Mexico of about 1.4 million pounds for the 12-month, 1984-1985 biological year. The estimated change in revenue to the fishery is an increase of \$18.7 million. The reported landings of brown shrimp during this 12-month period were 83.5 million pounds valued at \$210.5 million. Comparatively, the revenue to the fishery would have been \$18.7 million lower if the closure of the FCZ had not been in effect. The preliminary estimates of the 1985 Texas Closure for the May through August period are losses of 1.3 to 0.8 million pounds in landings which are estimated to change revenue between a minus \$5.2 million and an increase of \$756,000 depending on the scenario of fishing effort that is assumed.

The changes in landings and value if both the Texas territorial sea and the FCZ were open to fishing are estimated to have resulted in increases of 5.1 million pounds and \$37.4 million during the 1984-1985 biological year.

Since the Closure regulation has been in effect during the mid-May through mid-July period beginning in 1981, it is interesting to review the estimated effects of the regulation over this five year period. The estimated changes in brown shrimp landings and ex-vessel value for the past five years are presented in Tables 8 and 9 for the closure of the FCZ and the combined closure of the

territorial sea and the FCZ, respectively. For decision-making purposes, it is probably better to compare the estimated effects of the Texas Closure regulations for the four-month, May through August, periods (the lower portion of Table 8). The Closure during 1981 had the most significant effect on brown shrimp landings and value of all the years. Landings were estimated to have increased about 4 million pounds (about a 5 percent increase over the total reported landings) and total revenue was estimated to have increased about \$10.4 million. The effects of the regulations declined during the next two years, but the effects of the 1984 Closure showed a substantial increase in revenue to \$8.5 million. The interesting aspects of the 1984 estimates are the effects on landings that the Closure regulation is estimated to have had. Overall, landings were estimated to have decreased slightly, but the analyses indicate that landings in the larger size categories increased which resulted in the \$8.5 million increase in total revenue.

The changes in landings and value due to the closure of both the territorial sea and the FCZ are more dramatic in absolute and relative terms than the closing of just the FCZ (Table 9). The estimated effects for the 1984-1985 biological year show slight increases over the effects during the previous two years. The increases in landings and value of 5.1 million pounds and \$37.4 million during this 12-month period ended a downward trend that began in the 1982-1983 biological year.

Literature Cited

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- Nichols, Scott, W. 1986. Impacts of the Texas Closure on brown shrimp yields: Final report for 1984, preliminary report for 1985. Report prepared for the Gulf of Mexico Fishery Management Council. Southeast Fisheries Center, Miami, Florida.
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Table 1. Comparison of ordinary least squares (OLS) and Cochrane-Orcutt regression coefficients and price flexibility estimates for brown shrimp prices.

| Size Categories | Pounds Landed (million pounds) | Ex-Vessel Prices (\$) | OLS | | Cochrane-Orcutt | |
|-----------------|--------------------------------|-----------------------|-------------------|--------|-------------------|--------|
| | | | $\frac{dRP}{dLB}$ | m | $\frac{dRP}{dLB}$ | m |
| < 30 | 1.714 | 1.88 | $-4.61(10^{-8})$ | -0.042 | $-4.62(10^{-8})$ | -0.042 |
| 31-67 | 2.516 | 1.27 | $-1.76(10^{-8})$ | -0.035 | $-0.82(10^{-8})$ | -0.016 |
| > 67 | 2.105 | 0.63 | $-1.74(10^{-8})$ | -0.058 | $-1.77(10^{-8})$ | -0.059 |

a/The pounds landed and ex-vessel prices are averages of the monthly 1972 through 1983 data set. Ex-vessel prices are in real dollars, i.e., adjusted by the consumer price index.

b/The regression coefficients (dRP/dLB) were estimated using multiple regression analysis. The results of these regressions are presented in the Appendix. The price flexibility estimates (m) were calculated at the mean of the 1972-1983 data set.

Table 2. Reported and simulated landings and revenue for the 12-month biological year, May 1984 - April 1985, due to the closure of the Fishery Conservation Zone.*

| Size Categories | Pounds | | | Revenue(\$) | | |
|-----------------|----------|-----------|------------|-------------|-----------|------------|
| | Reported | Simulated | Difference | Reported | Simulated | Difference |
| < 30 | 19,736 | 15,144 | 4,592 | 90,032 | 69,252 | 20,780 |
| 31-67 | 28,884 | 27,707 | 1,177 | 78,005 | 74,589 | 3,416 |
| > 67 | 34,841 | 39,254 | -4,413 | 42,490 | 48,009 | -5,519 |
| Total | 83,461 | 82,105 | 1,356 | 210,527 | 191,850 | 18,677 |

All values are in thousands.

Table 3. Reported and simulated landings and revenue for the 4-month period, May 1984-August 1984, due to the closure of the Fishery Conservation Zone.*

| Size Categories | Pounds | | | Revenue(\$) | | |
|-----------------|----------|-----------|------------|-------------|-----------|------------|
| | Reported | Simulated | Difference | Reported | Simulated | Difference |
| < 30 | 7,509 | 5,293 | 2,216 | 34,041 | 24,493 | 9,548 |
| 31-67 | 26,022 | 24,513 | 1,509 | 69,969 | 65,622 | 4,347 |
| > 67 | 34,339 | 38,701 | -4,362 | 41,945 | 47,347 | -5,402 |
| Total | 67,870 | 68,507 | -637 | 145,955 | 137,462 | 8,493 |

All values are in thousands.

Table 4. Reported and simulated landings and revenue for May through August, 1985 due to the closure of the Fishery Conservation Zone - Scenario one.*

| Size Categories | Pounds | | | Revenue(\$) | | |
|-----------------|----------|-----------|------------|-------------|-----------|------------|
| | Reported | Simulated | Difference | Reported | Simulated | Difference |
| < 30 | 5,593 | 5,901 | -308 | 26,750 | 28,231 | -1,481 |
| 31-67 | 23,648 | 25,565 | -1,917 | 59,596 | 63,427 | -3,831 |
| > 67 | 37,347 | 36,391 | 956 | 34,735 | 34,645 | 90 |
| Total | 66,588 | 67,857 | -1,269 | 121,081 | 126,303 | -5,222 |

All values are in thousands. For scenario one, it was assumed that the Closure regulations caused changes in fishing effort in the nearshore areas (0-5 fathoms). Fishing effort in the inshore areas was assumed to be unaffected.

Table 5. Reported and simulated landings and revenue for May through August, 1985 due to the closure of the Fishery Conservation Zone - Scenario two.*

| Size Categories | Pounds | | | Revenue(\$) | | |
|-----------------|----------|-----------|------------|-------------|-----------|------------|
| | Reported | Simulated | Difference | Reported | Simulated | Difference |
| < 30 | 5,593 | 5,540 | -53 | 26,750 | 26,971 | -221 |
| 31-67 | 23,648 | 23,351 | 297 | 59,596 | 57,855 | 1,741 |
| > 67 | 37,347 | 38,373 | -1,026 | 34,735 | 35,499 | -764 |
| Total | 66,588 | 67,370 | -782 | 121,081 | 120,325 | 756 |

All values are in thousands. For scenario two, it was assumed that fishing effort in both the inshore and nearshore areas was unaffected by the Closure regulations.

Table 6. Reported and simulated landings and revenue for May 1984 through April 1985 due to the closure of both the Fishery Conservation Zone and the Texas Territorial Sea.*

| Size Categories | Pounds | | | Revenue(\$) | | |
|-----------------|---------------|---------------|--------------|----------------|----------------|---------------|
| | Reported | Simulated | Differences | Reported | Simulated | Differences |
| < 30 | 19,736 | 13,962 | 5,774 | 90,032 | 64,962 | 25,070 |
| 31-67 | 28,884 | 20,439 | 8,445 | 78,005 | 54,897 | 23,108 |
| > 67 | 34,841 | 43,940 | -9,099 | 42,490 | 53,298 | -10,808 |
| Total | <u>83,461</u> | <u>78,341</u> | <u>5,120</u> | <u>210,527</u> | <u>173,157</u> | <u>37,370</u> |

* All values are in thousands.

Table 7. Reported and simulated landings and revenue for May through August, 1984 due to the closure of both the Fishery Conservation Zone and the Texas Territorial Sea.*

| Size Categories | Pounds | | | Revenue(\$) | | |
|-----------------|---------------|---------------|--------------|----------------|----------------|---------------|
| | Reported | Simulated | Difference | Reported | Simulated | Difference |
| < 30 | 7,509 | 4,349 | 3,160 | 34,041 | 20,947 | 13,094 |
| 31-67 | 26,022 | 17,242 | 8,780 | 69,969 | 45,871 | 24,098 |
| > 67 | 34,339 | 43,259 | -8,920 | 41,945 | 52,477 | - 10,532 |
| Total | <u>67,871</u> | <u>64,851</u> | <u>3,020</u> | <u>145,955</u> | <u>119,295</u> | <u>26,660</u> |

* All values are in thousands.

Table 8. Comparison of differences in landings and revenue in the brown shrimp fishery due to the closure of the Fishery Conservation Zone.*

| Year | Pounds | | | Revenue(\$) | | |
|--|----------|-----------|--------------|-------------|-----------|--------------|
| | Reported | Simulated | Differences | Reported | Simulated | Differences |
| ----- 12 Month Totals, May through April ----- | | | | | | |
| 1981-82 | 102,246 | 98,001 | 4,245 (4%) | 236,020 | 226,309 | 9,771 (4%) |
| 1982-83 | 74,063 | 72,667 | 1,396 (2%) | 226,799 | 220,822 | 5,977 (3%) |
| 1983-84 | 61,467 | 61,093 | 374 (1%) | 194,704 | 188,008 | 6,696 (3%) |
| 1984-85 | 83,461 | 82,105 | 1,356 (2%) | 210,527 | 191,850 | 18,677 (9%) |
| ----- 4-Month Totals, May through August ----- | | | | | | |
| 1981 | 79,329 | 75,331 | 3,998 (5%) | 144,723 | 134,328 | 10,395 (7%) |
| 1982 | 60,193 | 59,451 | 742 (1%) | 155,880 | 150,568 | 5,312 (3%) |
| 1983 | 48,663 | 48,663 | -500 (-1%) | 130,098 | 127,955 | 2,143 (2%) |
| 1984 | 67,870 | 68,501 | -637 (-1%) | 144,955 | 137,462 | 8,493 (6%) |
| 1985a | 66,588 | 67,857 | -1,269 (-2%) | 121,081 | 126,303 | -5,222 (-4%) |
| 1985b | 66,588 | 67,370 | -782 (-1%) | 121,081 | 120,325 | 756 (1%) |

*All values, except percent changes which are in parenthesis, are in thousands.

The estimates for 1985 a and b are preliminary.

1985 a and b are the simulation results assuming two scenarios of fishing effort. For scenario one (1985 a), it was assumed that the Closure regulations caused changes in fishing effort in the nearshore areas (0-5 fathoms). Fishing effort in the inshore areas was assumed to be unaffected. For scenario two (1985 b), it was assumed that fishing effort in both the inshore and nearshore areas was unaffected by the Closure regulations.

Table 9. Comparison of estimated differences in landings and revenue in the brown shrimp fishery due to the closure of the Fishery Conservation Zone and the Texas Territorial Sea.*

| Year | Pounds | | | Revenue(\$) | | |
|---|----------|-----------|-------------|-------------|-----------|--------------|
| | Reported | Simulated | Difference | Reported | Simulated | Difference |
| ----- -12-month totals, May through April ----- | | | | | | |
| 1981-82 | 102,246 | 92,455 | 9,791 (10%) | 236,020 | 176,522 | 59,498 (25%) |
| 1982-83 | 74,063 | 69,209 | 4,854 (7%) | 226,799 | 183,578 | 43,221 (19%) |
| 1983-84 | 61,467 | 58,007 | 3,460 (6%) | 194,704 | 162,990 | 31,714 (16%) |
| 1984-85 | 83,461 | 78,341 | 5,120 (6%) | 210,527 | 173,157 | 37,370 (18%) |

*All values, except percent change which are in parenthesis, are in thousands.

APPENDIX

Linear regression estimates for brown shrimp prices reported in the north central Gulf of Mexico are presented here. These estimates were made using monthly data from January 1972 through December 1983 (144 observations). Both the OLS (ordinary least squares) estimates and the estimates derived from the Cochran-Orcutt correction for serial correlation are presented.

Ordinary Least Squares

Large brown shrimp - < 30 count per pound:

$$RP = 0.53 + 0.78 RWP - 0.46(10^{-7}) LB$$

(5.2) (30.1) (-5.4)

$$-0.0085 INT - 0.28(10^{-5})STOR - 0.10 DV$$

(-3.8) (-3.4) (-4.1)

$$\bar{R}^2 = .92$$

$$F(5,138) = 336.1$$

$$DW = 1.50$$

Medium brown shrimp - 31-67 count per pound:

$$RP = -0.106 + 0.81 RWP - 0.142 (10^{-7}) LB$$

(-0.8) (18.0) (-3.1)

$$+ 0.231(10^{-5}) STOR - .040 DV$$

(2.1) (1.2)

$$\bar{R}^2 = .81$$

$$F(4,139) = 148.8$$

$$DW = 1.08$$

Small brown shrimp - >67 count per pound:

$$\begin{aligned} \text{RP} &= 0.098 + 0.54 \text{ RWP} - 0.174 (10^{-7}) \text{ LB} \\ &\quad (1.2) \quad (14.4) \quad (-7.9) \\ &+ 0.157 (10^{-5}) \text{ STOR} \\ &\quad (2.2) \end{aligned}$$

$$\bar{R}^2 = .69$$

$$F(4,140) = 131.0$$

$$\text{DW} = 1.64$$

Because there was an indication of serial correlation, as evidenced by the values of the Durbin-Watson statistic, the price equations were also estimated using a technique developed by Cochran and Orcutt to correct for the serial correlation. Those results follow:

Large brown shrimp - <30 count per pound:

$$\begin{aligned} \text{RP} &= 0.666 + 0.72 \text{ RWP} - 0.462 (10^{-7}) \text{ LB} \\ &\quad (5.0) \quad (21.0) \quad (-4.9) \\ &- 0.0076 \text{ INT} - 0.318 (10^{-5}) \text{ STOR} - 0.091 \text{ DV} \\ &\quad (-2.4) \quad (-3.0) \quad (-3.5) \end{aligned}$$

$$\bar{R}^2 = .85$$

$$F(5,137) = 158.2$$

Medium brown shrimp - 31-67 count per pound:

$$RP = -0.06 + 0.725 RWP - 0.41 (10^{-8}) LB$$

(-0.03) (9.7) (-0.9)

$$+ 0.26 (10^{-5}) STOR - 0.08 DV$$

(1.6) (-2.6)

$$\bar{R}^2 = .53$$

$$F(4,138) = 40.7$$

Small brown shrimp - >67 count per pound:

$$RP = -0.08 + 0.53 RWP - 0.177 (10^{-7}) LB$$

(-0.8) (12.1) (-7.6)

$$+ 0.14 (10^{-5}) STOR$$

(1.7)

$$\bar{R}^2 = .63$$

$$F(4,140) = 79.8$$

Definition of terms for regression equations:

RPB = ex-vessel prices by size deflated by the consumer price index;

RWP = wholesale price by size reported by the New York Fulton fish market deflated by the CPI;

DV = a dummy variable measuring the seasonality of ex-vessel prices (DV = 1 for months between June and October and zero elsewhere);

LB = pounds of brown shrimp by size landed at ports in the north central Gulf of Mexico;

INT = short-term prime interest rate; and

STOR = beginning of the month cold storage holdings in product weight.

Summary statistics:

R = R-squared adjusted for the degrees of freedom;

F = F-statistic; and

DW = Durbin and Watson statistic.

Note, the t-values are presented in parentheses below the respective regression coefficients.