LSU-T-86-005 C2

LOUISIANA SEAFOOD PRODUCTION ECONOMICS

Produced by LOUISIANA SEA GRANT College Program LSU Center for Wetland Resources Baton Rouge, LA 70803-7507 OCTOBER 1986

# Interrelationships Between Public and Private Oyster Grounds in Louisiana: Economic Perspectives

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## Introduction

The Louisiana oyster harvest is produced primarily on privately controlled oyster grounds leased from the state. According to the National Marine Fisheries Service (NMFS), these grounds produced an average of 80 percent of the oyster harvest, in both quantity and value from 1962 to 1984. Although public grounds produce far fewer marketable oysters, these grounds also play an important part in the Louisiana oyster industry. On the state seed grounds, located in Sister Lake, Bay Junop, Hackberry Bay, and east of the Mississippi delta (Figure 1), oystermen are allowed to take under-marketsized oysters. These seed oysters are then planted on the oysterman's lease, grown to marketable size, and harvested. In this manner, public property contributes to private business.

This report serves three purposes. It describes the Louisiana state seed grounds using biological and economic data. An analysis of the exvessel price differences between oysters from public grounds and oysters from leased grounds is presented and the relationships between the state seed grounds and the production on private leases are examined.

The oyster industry is a unique fishery in that the right of private property exists within the industry. According to economic theory, the common-property nature of a fishery introduces inefficiencies. Because both public and private property exist in the same fishery, the oyster industry provides an opportunity to examine the effects of the property rights difference.

The data used in this study were provided by NMFS and the Louisiana Department of Wildlife and Fisheries (LDWF). NMFS records provided the landings and value data, subdivided by area of the state and the season of harvest. Prices were derived by dividing value by pounds landed. Landings were given in pounds of meat. This time-series data set ran from 1962 to 1981.

The LDWF was responsible for such information as salinities, oyster larvae production (spat set), water

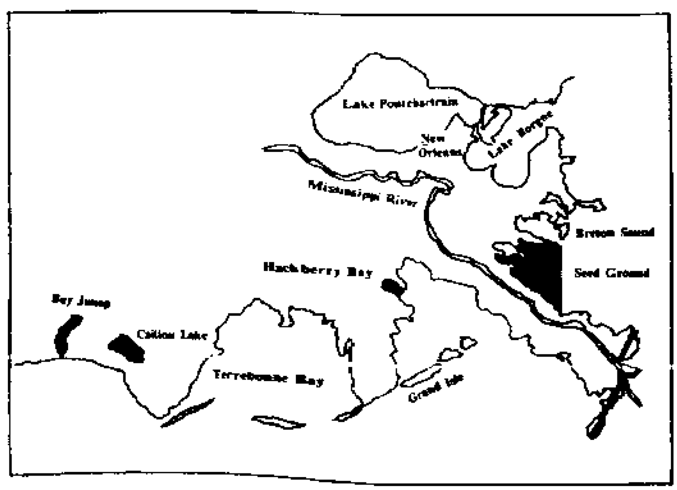


Figure 1. Location of Louisiana Oyster Seed Grounds (map not to scale).

temperature, turbidity of the water, and wind and cloud cover.

Of the four public areas shown in Figure 1, the area east of the Mississippi delta, in Plaquemines Parish, was selected as the study area. Included are Black Bay, Bay Gardene, and California Bay, large open bays containing broken marsh sand islands covered by saline vegetation (Figure 2). These 9000 acres of reef are considered the prime state seed grounds (Mackin and Hopkins 1969, in Dugas 1977) and are opened every year (unlike Sister Lake, Bay Junop, and Hackberry Bay, seed reservations that are generally open in alternating years). They also provide the majority of the seed produced in the state.

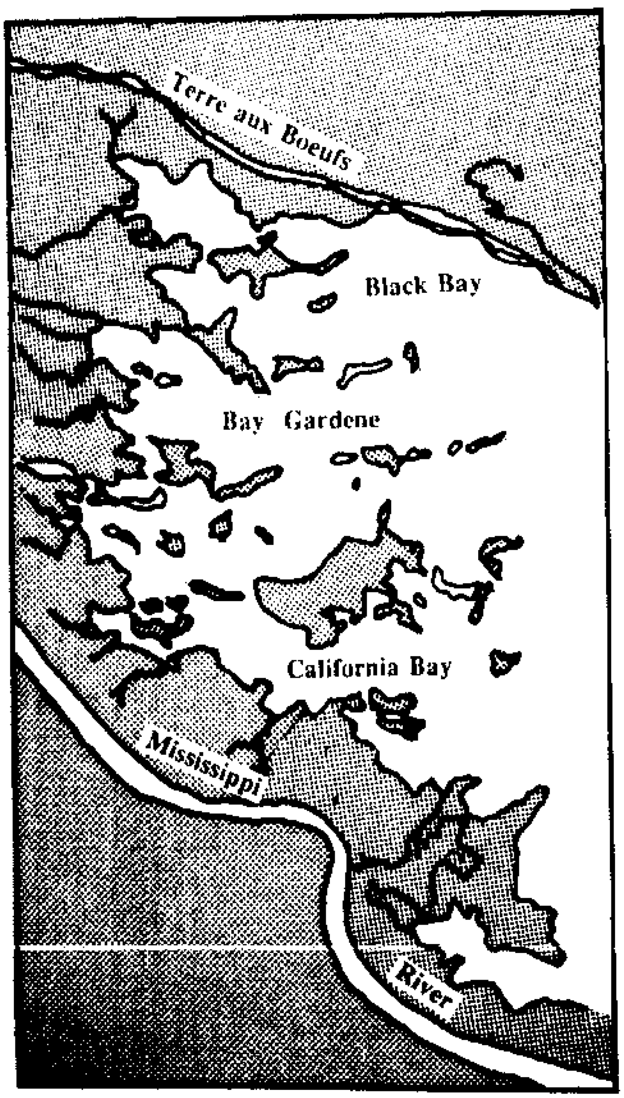


**Figure 2. Location of Bays within the State Seed Grounds East of the Mississippi Delta.**

## The State Seed Grounds in Breton Sound

The Louisiana Wildlife and Fisheries Commission has the legislative responsibility to manage public oyster grounds to insure a ready source of seed oysters (R.S.56, PartVII, Sub-Part D, Section456, in Dugas 1982), and as part of this responsibility regularly monitors the harvest of seed oysters. To facilitate data collection, the area is divided into grids, each covering nine square miles. Within each of the 19 grids, data are collected on salinity and temperature. Spat set is measured at only six of the grids. In the summer, before the grounds open, an estimate is made of seed oyster abundance using SCUBA diving gear. A random square meter of the reef is selected, and all organisms within the square are counted. This is repeated two or three times per reef. When the seed grounds are open, commercial vessels are sampled on various days to determine the quantity of oysters taken. These oysters are classified as barrel oysters, which are smaller than three inches and are used as seed, and sack oysters, which are of marketable size. The quantity of oysters harvested is divided by the number of surveyed days, then multiplied by the total number of workdays in the month to estimate harvest by grid.

Oysters reproduce by releasing eggs into the surrounding water where they are fertilized and become free-swimming larvae. When the larvae develop pairs of tiny shells, they are called "spat." They then attach themselves to a hard, clean surface where they grow and and spend their lives. Spat are very small and can easily be smothered by silt (Dugas 1982).

Studies have shown the importance of salinity in the life cycle of the oyster. It may be the prime factor in the determination of seed oyster production, with high and low salinities resulting in poor production (Chatry et al. 1983). The salinities in the summer months are especially important, because most of the spat set occurs in those months. Low salinities (<12 ppt) reduce the setting of spat and thereby reduce oyster production. Low oyster survival at high salinities (>22 ppt) is probably related to predation and disease (Chatry et al. 1983). As salinity increases, so does the number of oyster predators.

The relationship of spat set to seed production is generally an inverse one. Lighter sets produce more seed oysters, though very light spat sets of <.1 spat/cm$^2$ limit production (Chatry et al. 1983).

Data used in this section of the study covered nine oyster harvesting seasons, from October, 1974, to March, 1983. The data are not continuous since the public grounds are open from September to February or March of the next year. For 1981 to 1983, an estimation of effort on the grounds was obtained by counting the number of vessels that worked a grid.

Since most vessels use two dredges, they represent fairly homogenous capital inputs.

Figure 3 shows the production that occurred on the public grounds. Black Bay produced more than 1.2 million barrels of seed oysters, more than the other two bays combined. This area has been used for shell planting operations (1977, 1979, 1981, 1983; Ron Dugas, personal communication). The shell plants provide a clean place to set for the spat thus improving the productivity of the grounds. The total production of sack oysters from Black Bay was approximately one million sacks, and California Bay also produced one million sacks. Bay Gardene was far lower in production (Figure 4) as it is a seed reservation and is not open at all times. This bay is not managed in the same way as the other two, and is generally open every other year depending on environmental conditions.

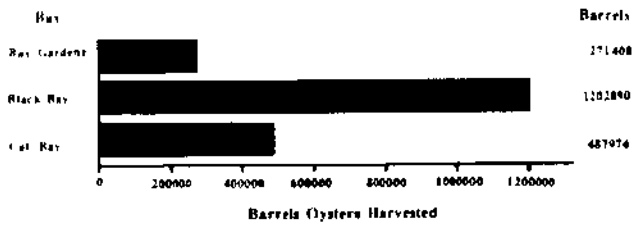


Figure 3. Cumulative Production of Seed Oysters by Bay in Barrels, by Area, 1974 to 1983.

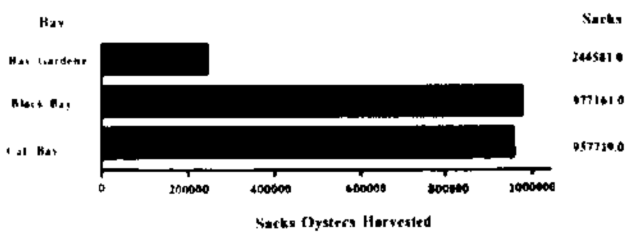


Figure 4. Cumulative Production of Sack Oysters by Bay in Sacks, by Area 1974 to 1983.

Figures 5 and 6 show the same data, but broken down by month instead of bay. Both sack and seed oyster harvests reveal the same pattern, with the highest peak after the season opens in September, but the quantity of seed oysters taken falls off more rapidly.

Table 1 contains the simple correlation coefficients between previously described variables and the harvests of barrel and sack oysters by bay and season. The results of the correlation analysis were consistent with other studies. If it is too high or low, salinity has been found by other studies to have adverse effects on oyster production. A very small quantity of spat is necessary to produce oysters.

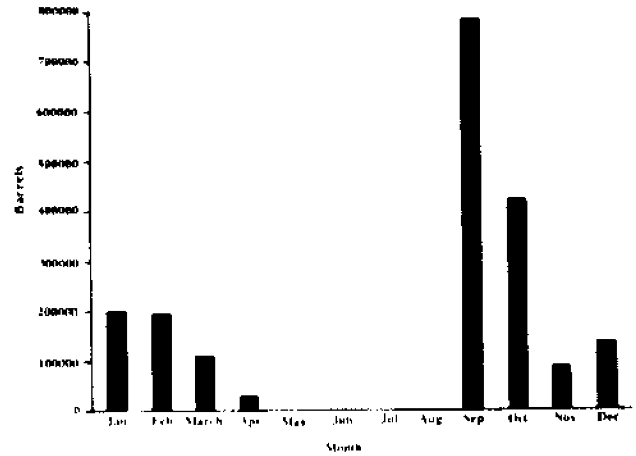


Figure 5. Total Harvest of Seed Oysters from the State Seed Grounds from 1974 to 1983 by Month.

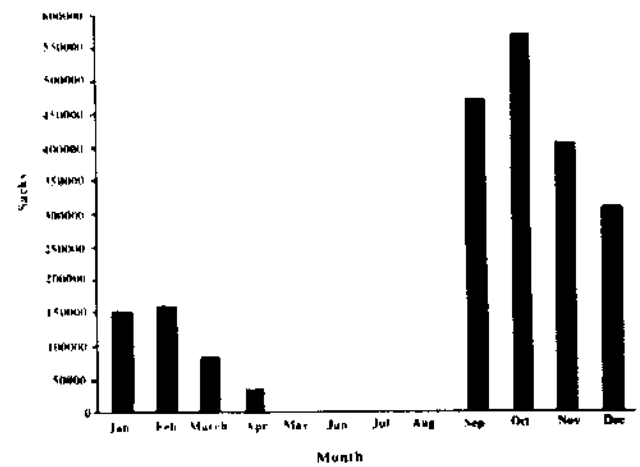


Figure 6. Total Harvest of Sack Oysters from the State Seed Grounds from 1974 to 1983 by Month.

**Table 1**. Correlations between explanatory variables and barrel (seed) and sack oyster production by bay and season, public grounds, Louisiana.

| | BARRELS (seed) | SACKS |
|---|---|---|
| Salinity | -0.388* | 0.247 |
| Spat set | -0.321 | 0.048 |
| Oysters per $m^2$ | 0.564** | 0.043 |
| Effort | 0.671** | 0.655** |

*Significant at 90% level of confidence.
**Significant at 95% level of confidence.

The simple correlation analysis that was performed is a measure of the linear relationship between two variables. Table 1 shows that there was no statistically significant correlation between spat set and either barrel or sack production. This result was not expected. Other studies hypothesized a nonlinear relationship between spat set and the resulting oyster production (Chatry et al. 1983). This is demonstrated in Figure 7. A very low level of spat set would result in no production, though slightly higher levels would be sufficient to produce harvestable quantities of oysters. As spat increases, oyster production reaches a peak, then declines. The mechanisms that cause the high levels of spat set to result in poorer production are not well understood, but have been documented

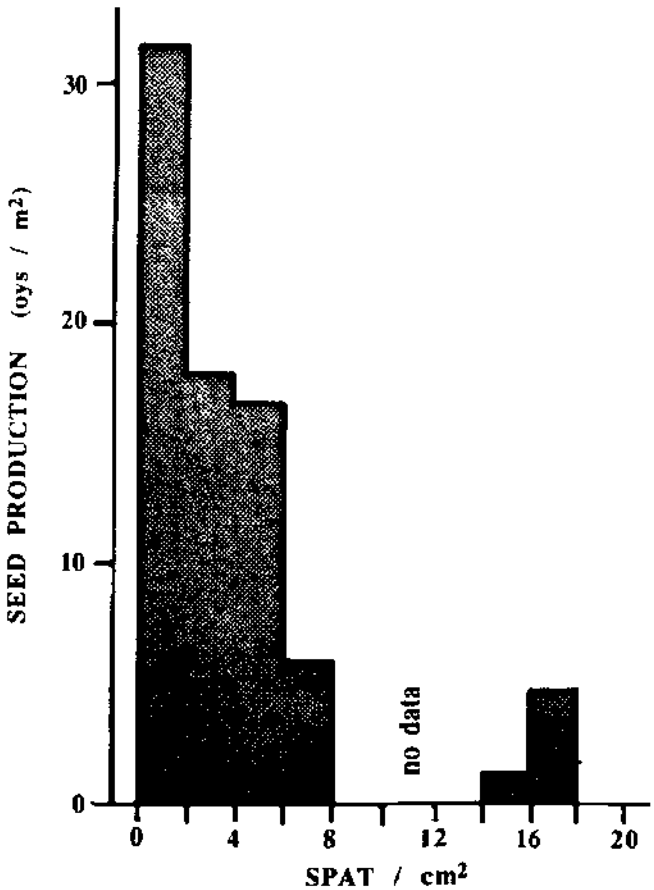


Figure 7. Seed Oyster Production versus Corresponding Setting Intensities of the Preceding Year.

For production for the lowest intensities (0.1 spat/cm$^2$) is obscured by the 0.2 spat/cm2 interval (from Chatry, et al)

by others (Chatry et al. 1983). Unfortunately, it was not possible to test for nonlinear correlation between spat set and oyster production.

The highly significant positive correlation between harvest of seed oysters and the quantity of oysters per meter square was hypothesized (Table 1). The meter square estimates are used primarily as a preseason measure of the productivity of the seed grounds; it is important for management purposes that the meter square estimates be a good measure of potential reef productivity.

It is not difficult to explain the lack of correlation between sack production and the meter square estimates of seed production, even though one might hypothesize that a positive correlation between areas with high levels of oysters per meter square would result in high levels of sack production. An alternative hypothesis which explains the lack of correlation is that areas with large amounts of seed are harvested before the oysters reach market size. Because of the nature of the reefs, it is not possible to conceal one's harvesting area. The areas with large amounts of seed are most heavily utilized by those involved in bedding (transfer to leases). Conversely, the areas with fewer seed oysters produce the greatest number of sack oysters.

The high positive correlation between effort and harvest was also expected. The total reef area is not that large. When one vessel discovers an area with a high concentration of seed or sack oysters, it is not possible to hide one's success. In this manner, vessels may congregate over the most productive reef areas. The concentration of harvest is shown in Figures 3 and 4.

Analysis of variance (ANOVA) was conducted in order to test for a differences between levels of spat set, salinity, oysters per meter square, and effort and the resulting levels of barrel and sack oyster production. The ANOVA provided further information about the relationships between the explanatory variables and the harvest data, as well as a guide to those variables that might be used in an econometric model.

As a result of the ANOVA, it was concluded (at the 95 percent level of confidence) that significant differences existed among the levels of spat set, salinity, meter square measures, and effort with respect to the levels of barrel and sack oyster harvest.

## Models of Seed Oyster Production

An econometric model of the state seed grounds was subsequently developed. After various model formulations and estimation techniques were considered, a linear ordinary least-square model was chosen. This method was selected because the process of oyster growth is essentially a recursive one, in which salinity affects spat set; spat set in turn affects seed oyster production; and production affects harvest.

Monthly data from 1974 to 1983 were used in the model. From the preceding correlation analysis, it was hypothesized that salinity would have a negative relationship with spat set. Oysters per meter square and effort would have a positive relationship with production of seed oysters. It was not possible to hypothesize the relationship between spat set and seed production because the previous correlation analysis was not significant. The signs on the coefficients for the dummy variables for each bay could not be predicted as their relationships with the dependent variables were not known.

Table 2 contains the coefficients and t-ratios for the model of production of seed oysters on state grounds by grid and month. All but one of the variables included in the model were significant at the 95 percent level of confidence. The hypothesized relationship between salinity and spat set was supported, as were the relationships between oysters per square meter and seed production and effort and seed production. The relationship between spat set and oyster seed per square meter was negative and significant. A negative relationship was found between these variables in other studies. The significance of the dummy variables for each bay reveals that there are differences in spat set and seed oysters per square meter at different locations in the seed grounds.

**Table 2.** Coefficients and t-ratios of model of monthly barrel oyster production on state seed grounds.

**Equation 1** - Dependent variable = mean summer spat set (per $cm^2$)

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | -5.511 | -9.528 |
| Mean summer salinity | 0.419 | 12.397 |
| California Bay dummy | -0.821 | -3.593 |
| Bay Gardene dummy | 0.319 | 0.879 |

$R^2$ = .477 F-ratio = 52.54 Degrees of Freedom = 173

**Equation 2** - Dependent variable = seed oysters (per $m^2$)

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | 149.273 | 17.975 |
| Mean summer spat set | -12.537 | -5.028 |
| California Bay dummy | -121.270 | -11.823 |
| Bay Gardene dummy | -120.983 | -7.495 |

$R^2$ = .490 F-ratio = 55.31 Degrees of Freedom = 173

**Equation 3** = Dependent variable = monthly seed oyster production in barrels

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | 1842.9 | 2.187 |
| Seed oysters per $m^2$ | 15.834 | 2.298 |
| Effort | 29.986 | 3.558 |

$R^2$ = .10 F-ratio = 9.90 Degrees of Freedom = 173

One difficulty with the model is the low explanatory nature of the monthly barrel oyster equation. Several different specifications were attempted, but none were entirely satisfactorily. This model was run on monthly production by grid, but many of the explanatory variables were only available as summer observations (salinity, spat set). It was decided to reestimate the model using yearly production data by bay.

This econometric model was developed for the yearly seed production by bay for the period 1974 to 1983. The model is linear and recursive, and was estimated using ordinary least squares. The results are given in Table 3.

**Table 3.** Model of yearly barrel oyster production on state seed grounds.

**Equation 1** - Dependent variable = mean summer spat set (per $cm^2$)

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | -6.93 | -1.97 |
| Mean summer salinity | 0.50 | 2.57 |

$R^2$ = .49 F-ratio = 6.60 Degrees of Freedom = 7

**Equation 2** - Dependent variable = seed oysters (per $m^2$)

| Variable | Coefficient | T=ratio |
|---|---|---|
| Intercept | 46.35 | 1.47 |
| Mean summer spat set | -5.75 | -0.58 |

$R^2$ = .05 F-ratio = 0.58 Degrees of Freedom = 7

**Equation 3** - Dependent variable = yearly seed production in barrels

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | 20630.1 | 0.86 |
| Seed oysters per $m^2$ | 946.78 | 3.62 |
| Effort | 24.04 | 1.63 |

$R^2$ = .81 F-ratio = 13.09 Degrees of Freedom = 6

All of the variables have the expected sign as indicated by the previous model. Again, a negative relationship between spat set and seed oyster per meter square was found. This equation also has a very low $R^2$, but no satisfactory method of improving the equation was found. However, the model's explanatory power for barrel oyster production was much higher than the previously described model because the mean summer observations are more suited for a yearly analysis and some of the variation was aggregated out of the delta.

As was previously stated, the salinity and the yearly spat set are extremely important in determining the production of seed oysters on the state seed grounds. It was decided to examine this relationship further. Chatry et al. (1983) found that the optimum level of salinity ranged from 12.2 to 17.4 parts per thousand. By creating a variable to reflect whether the mean summer salinity was lower, higher, or within this optimum range, it was possible to run an unbalanced ANOVA to determine whether there was a statistically significant difference in seed production caused by the change in salinity.

The results were sensitive to the variables used in the analysis, as shown in Table 4. When an ANOVA was run on the salinity dummy and the corresponding oysters per meter square, there was a highly statistically significant difference in the seed production. These data were for 1974 to 1983, one more year than covered in the Chatry et al. study.

**Table 4.** Analysis of variance run on salinities and production of oyster seed.

| Independent variable | Dependent variable | F value | Probability>F |
|---|---|---|---|
| Salinity dummy* | oysters per $m^2$ | 75.10 | <0.01 |
| Salinity dummy* | barrel oyster production by year | 1.52 | 0.24 |

*The salinity dummy was constructed by whether the salinity was lower, higher, or within the optimum salinity range as discussed by Chatry et al.

When the same analysis was performed on the actual quantity of barrel oysters taken from the grounds, the results were not significant. The reasons for this are unclear. One important difference between the square meter estimates and the barrels of oysters harvested is that the square meter estimates are a measure of abundance, representing the potential harvest from the reefs. If there are more seed oysters available than needed by the oyster industry, they will not be taken from the reefs and thus not represented in the barrel oyster figures. Therefore, care should be taken when examining salinity and production data for oysters, especially when far-reaching management decisions, such as the diversion of water from the Mississippi River to adjacent marsh and bay systems, are involved.

## Model of Sack Oyster Production

A model was developed of the sack oyster production from state seed grounds, though this presented some difficulty, because the grounds are managed mainly to produce seed oysters. The advantage of using these grounds for the study was the ready availability of environmental data, which were lacking in similar studies (Agnello and Donnelley 1975A). Several linear models were estimated before one was selected.

A recursive model was chosen as the best format and was estimated using ordinary least squares and yearly data from the 1974 to 1983 oyster seasons. Table 5 contains the model.

**Table 5.** Model of yearly sack oyster production on the state seed grounds.

**Equation 1** - Dependent variable = mean summer spat set (per $cm^2$)

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | -6.932 | -1.969 |
| Mean summer salinity | 0.497 | 2.570 |

$R^2$ = .49   F-ratio = 6.60   Degrees of Freedom = 7

**Equation 2** - Dependent variable = sack oyster production

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | -10665.3 | -0.403 |
| Mean summer spat set | 28428.92 | 4.454 |
| Effort | 46.666 | 3.482 |

$R^2$ = .85   F-ratio = 17.73   Degrees of Freedom = 6

All of the variables in the model are statistically significant and have the hypothesized signs. Seed oysters per square meter proved to be an insignificant variable within the model. It was hypothesized that areas with high concentrations of seed oysters are heavily fished, and the oysters are rebedded on private grounds before they have time to grow to sack oyster size. In contrast to the model of barrel production, the model of sack oyster production does not have a negative sign on the spat coefficient. Clearly, spat set is a better predictor of sack production than seed oyster production, though the reasons for this are unknown. Both equations explain a large amount of the variation in the dependent variable, considering the biological nature of the data.

## The Relationship Between State Seed Production and Oyster Harvest

The majority of Louisiana's oyster production comes from areas leased from the state and developed by the leaseholders. As can be seen in Figure 8, the state does not have a purely private production as studied in analysis by Agnello and Donnelly (1975b). The range of the ratio of private leases to total state production is 64 to 97 percent of the landings (Figure 9), and thus the importance of Louisiana's leasing program is evident. There was no discernible pattern within the ratio over time. The leased grounds contributed an average of 80 percent of the oyster harvest.

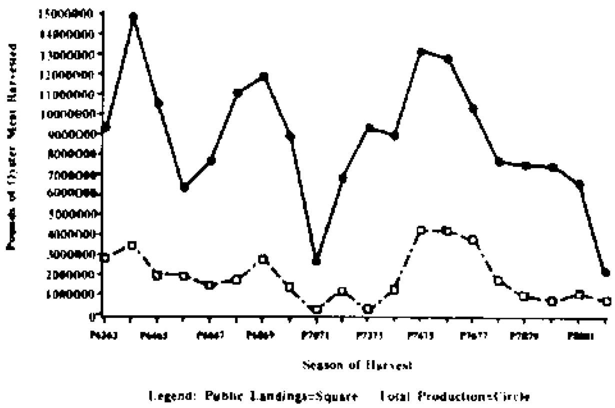


Figure 8. Louisiana Landings of Oysters on Public and Private Grounds, 1962 to 1982.

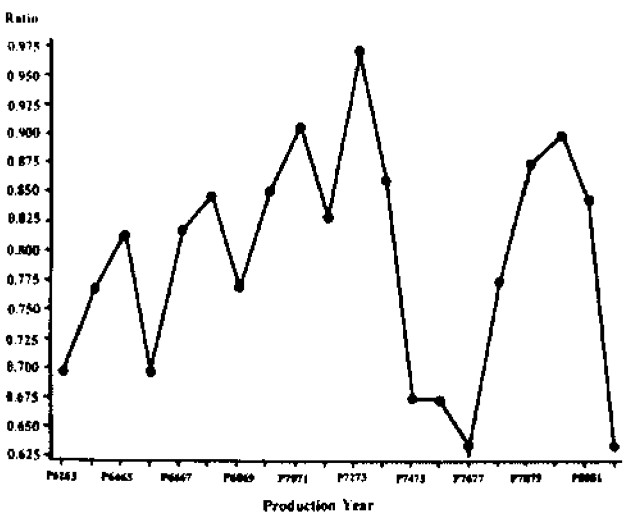


Figure 9. Ratio of Private Ground Oyster Harvest to Total Production, 1962 to 1982.

The analyses in previous sections dealt with relationships on public grounds, areas that are managed to produce both seed and market oysters. Because the production of seed via public management efforts is of value to leaseholders, identifying the impacts of seed oysters on the lease production of market oysters was important. Available data permitted analyses of lease production from three areas: Lake Pontchartrain, Breton Sound, and the Barataria basin. An analysis was also done of the areas combined.

Table 6 shows a significant finding: The production of seed oysters was correlated with the lease production of market oysters in Barataria basin at the 90 percent confidence level. This correlation might have been stronger had data on seed production in adjacent Hackberry Bay been available. The lack of correlation between seed production and landings from Lake Pontchartrain is caused by the low level of landings (only two million pounds over the entire data set) and the fact that landings were only reported for six of the 20 oyster seasons in the data set. The reasons behind the lack of correlation between seed production and private lease production in Breton Sound are not as clear. It may be that harvesters in the area are not as dependent on lease production because of the proximity of the public grounds.

**Table 6.** Simple correlations between production of seed oysters and landings of Louisiana oysters from leased grounds.

| Area | Lease Production | Lease Production (in dollars) | Total Production (in pounds) |
|---|---|---|---|
| Lake Pontchartrain to Bayou Lafourche | .23<br>(0.29)* | .06<br>(0.79) | .23<br>(0.26) |
| Lake Pontchartrain | -.66<br>(0.23) | -.61<br>(0.28) | -.63<br>(0.26) |
| Breton Sound | -.09<br>(0.86) | -.29<br>(0.52) | .50<br>(0.25) |
| Barataria Basin | .70<br>(0.08) | .61<br>(0.15) | .56<br>(0.19) |

*Probabilities in parentheses.

## Price Analysis

Figure 10 depicts the pounds and value of oyster landings in Louisiana from 1962 to 1982. In recent years, the value of landings has increased while the corresponding pounds landed has decreased. This indicates that prices were rising over time and should be analyzed further. The analysis of exvessel oyster prices from public and private grounds was undertaken for the period 1962 to 1981. It was hypothesized that oysters from leased grounds would be harvested and marketed in a manner resulting in a higher average price. The timing of the harvest during the year-round season and management for optimum market attributes such as size and saltiness were aspects that make a price difference plausible.

Data on the oyster harvest and value by season (spring of fall), area, and origin (public or leased ground) were available from the NMFS.

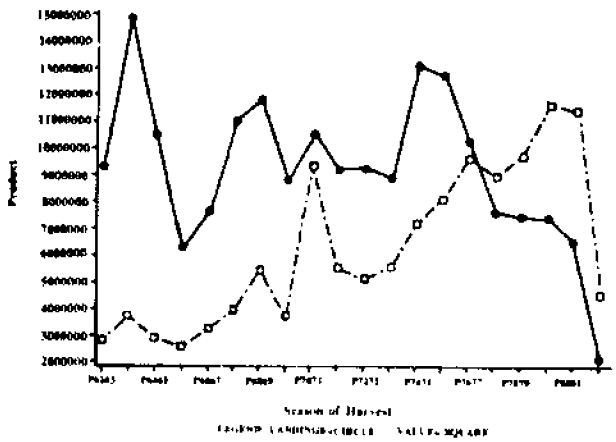

Figure 10. Value and Poundage of Louisiana Oyster Landings, 1962 to 1982.

The paired t-test procedure was selected for the analysis. Initial tests were designed to determine if a difference existed between the spring (January to June) and fall (July to December) prices within the same production period irrespective of whether the oysters were from public or private grounds. That is, spring data were compared with the previous year's fall data. The result shown in Table 7 indicates that the price of oysters varied between seasons in the same production year.

**Table 7.** Paired t-test for difference between average price in fall and spring oyster seasons, 1961 to 1981.

| Variable | Mean | Standard Error | T | Prob>T |
|---|---|---|---|---|
| Difference between fall and spring price* | .186 | 0.026 | 7.12 | <.01 |

*The order of subtraction is not important, the results of the test would be the same.

There being a statistically significant difference between spring and fall seasons, the test for price differences between public and leased grounds was run on two time series. The fall season exvessel prices for 1961 to 1982 made up one series. The spring season prices made up the second series. The results of these tests are given in Table 8. Neither season exhibited a significant difference between private and public prices, so that the hypothesis was not supported.

**Table 8.** Paired t-test for difference between private and public ground oyster prices, 1961 to 1981.

| Variable | Mean Difference | Standard Error | T | Prob>T |
|---|---|---|---|---|
| Fall Difference* | -0.021 | 0.013 | -1.64 | .119 |
| Spring Difference* | -0.043 | 0.025 | 1.69 | .109 |

*Both variables were created by subtracting the average private lease price from the corresponding average public ground price by season. The order of subtraction is not important. The results would be the same.

The differences in private and public prices were also tested, but in a different manner. Two areas of the state, Breton Sound and Calcasieu Lake, were selected and the difference in average price was tested. Since the former area is 65 percent private over the time period and the latter is almost totally public, a significant difference in average price for each area was hypothesized. The hypothesis was supported by the analysis. Table 9 contains the paired t-test which shows that the difference between the Calcasieu Lake average price and the Breton Sound average price was negative and statistically different from zero at the 95 percent confidence level. The hypothesis that private-lease oysters received a higher price than public ground oysters was supported.

**Table 9.** Paired t-test on prices from Lake Charles and Breton Sound.

| Variable | Mean Difference | T | Prob>T |
|---|---|---|---|
| Difference* | 0.33 | -2.09 | 0.049 |

*Calculated by subtracting average Breton Sound price from average Lake Calcasieu price, by year and season.

Agnello and Donnelley (1975b) used the following simple test to examine the relationship between property-right structure and the price of oysters. The analysis was cross-sectional. A 20-year average of exvessel oyster prices was calculated for the 16 coastal states from Massachusetts to Texas and was regressed on the ratio of public-ground harvest to total harvest. The hypothesized negative relationship between prices and the common property resource was supported; there was a negative relationship between the public total harvest ratio and price.

The same type of test was done on time-series Louisiana data, as there was sufficient variation in the public-to-total harvest ratio to warrant an analysis (Figure 8). Because the price-time series demonstrated a very high inflation rate throughout the last few years, it was decided that real (deflated) prices should be used in the analysis. Table 10 details the model. Although the public-to-total landings ratio had the hypothesized sign, the variable was not significant. This analysis supports the theory that, for Louisiana, there is no relationship between the property-right structure and the price received for Louisiana oysters.

**Table 10.** Model of relationship between oyster prices and public-to-total production ratio.

Dependent Variable - Real Annual Average Price Louisiana Oysters*

| Variable | Coefficient | T-value | Prob>T |
|---|---|---|---|
| Intercept | 0.566 | 8.807 | <.01 |
| Ratio** | -0.332 | -1.161 | .26 |

*Average annual price deflated by the consumer price index.
**Ratio of public to total harvest.

The preceding tests were run on the simple numerical average price. Further analysis was run on prices weighted by the quantity of the oyster harvest, which would more accurately reflect the actual market conditions. Monthly public price was weighted by the percentage of harvest from public grounds that month; monthly private price was weighted by the corresponding monthly private harvest. Only 1978 to 1982 data could be used, as previously the observations were not reported by month, making it impossible to calculate a weighted average price.

Before the weighted prices were examined, the unweighted prices, by season, were tested for a significant difference. The difference between public and private prices was found to be negative and significantly different from zero at the 95 percent level of confidence. When the prices were weighted by the percent of public or private harvest by season, the corresponding difference in price was found not to be significantly different from zero. Weighted prices were not found to be different from each other on a seasonal basis. These tests are summarized in Table 11.

**Table 11.** Paired t-tests on average price for oysters from public and private grounds.*

| Time Period | Mean Difference | T | Prob>T |
|---|---|---|---|
| 1978 to 1982 seasonal, unweighted | -0.10 | -2.58 | 0.036 |
| 1978 to 1982 weighted by seasonal production | -0.09 | -1.71 | 0.130 |

*All t-tests were run by subtracting average private lease price from average public price. Years of production were as defined on a July to June basis.

There was a strong positive correlation between the average price of oysters and time (Table 12). A graph of the price from 1961 to 1981 is given in Figure 11. There was also a strong positive correlation between time and deflated (real) price (Table 12). The real price of oysters was calculated by deflating the average price by the consumer price index (CPI). This deflated time series can also be seen in Figure 11.

**Table 12.** Simple correlation between average yearly oyster price and time.

| | Correlation Coefficient | Probability |
|---|---|---|
| Average Yearly Price | .88 | <.01 |
| Real Average Yearly Price * | .74 | <.01 |

*Calculated by deflating average yearly price by the consumer price index.

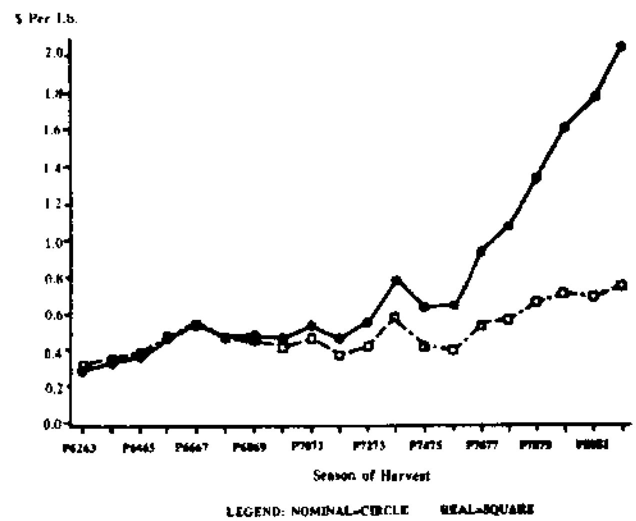


Figure 11. Nominal and Real Prices of Louisiana Oysters (REAL PRICES IN 1967 DOLLARS).

Although prices have been rising faster than the rate of inflation, this does not necessarily mean that oyster fishermen are better off than they were in the past. One must look at other factors such as loss of fishing areas because of increasing salinity, subsidence, erosion and pollution. The well-being of the fishery also depends on the quantity taken by each oyster fisherman.

The total number of oyster harvesting licenses increased 90 percent from 1976 to 1984 and, since

1980, there has been an 11 percent increase in the total number of oyster licenses sold. These licenses are divided into two categories--the oyster tonnage license (LDWF category #144003), which is used by hand tongers, primarily in the western portion of the state, and the oyster dredging license (LDWF category #144004) which permits the mechanical dredgers used on the public grounds and leases. Since 1976, there has been a 115 percent increase in the sales of this license (from 427 licenses to 919 in 1984) with much of the increase occurring after 1979. There was no corresponding increase in landings. Thus, not only does the oyster industry face the loss of fishing areas but also a smaller portion of the landings for each harvester. Table 13 documents the number of oyster licenses sold.

**Table 13.** Number of oyster licenses sold.

| Year | Oyster Tonnage* (144003)** | Oyster Dredging (144004)** | Total |
|---|---|---|---|
| 1976 | 1201 | 427 | 1628 |
| 1977 | 1754 | 356 | 2110 |
| 1978 | 2125 | 427 | 2552 |
| 1979 | 1964 | 464 | 2428 |
| 1980 | 2455 | 332 | 2787 |
| 1981 | 2652 | 390 | 3042 |
| 1982 | 2652 | 390 | 3042 |
| 1983 | 1885 | 757 | 2642 |
| 1984 | 2177 | 919 | 3096 |

*The license purchased by oyster tongers.

**The LDWF license code number.

## Exvessel Demand Estimation

The final step in analysis was to estimate a demand function for Louisiana oysters. The was done with annual NMFS data from 1961 to 1981. An econometric model was estimated using price of Louisiana oysters as the dependent variable. Price was selected as the dependent variable; because landings are fixed in the short run, price was a better measure of demand (Agnello and Donnelley 1975a). Through graphical analysis, the relationships in the model appeared to be linear. Several models were estimated. The independent variables that were examined during the course of the analysis included national per capita disposal income (real and nominal), total oyster production throughout the United States, total imports of oysters, per capita consumption of fish and per capita consumption of oysters (demand shifters), price of shrimp (a substitute good), and the lagged price of oysters.

Two different models of exvessel demand for Louisiana oysters were estimated, one using nominal price and nominal dependent variables, the other with real price and real variables. The model estimated with variables in real terms was selected because it did not suffer from autocorrelation as did the nominal model, and because, according to economic theory, consumers respond to changes in real income when making economic decisions.

Of all the variables examined, only real disposable income and Louisiana oyster landings were found to have the hypothesized signs and were significant. This agreed with a previous study which found that Louisiana's oyster landings were negatively related with price, which was not the case in other states where prices were relatively stable, keeping within 10 percent of the yearly average price (Dressel and Whittaker 1983). The model is presented in Table 14. It accounts for 67 percent of the variation in the average price of Louisiana oysters.

**Table 14.** Demand model for Louisiana oysters.

| Variable | Coefficient | T-ratio |
|---|---|---|
| Intercept | -0.025 | -0.105 |
| Landings of oysters | $-2.439 \times 10^{-5}$ | -2.935 |
| Real disposable per capita income | $2.545 \times 10^{-4}$ | 3.771 |

DW = 2.05 $R^2$ = .67 F-ratio = 17.51 Degrees of Freedom = 17

Price flexibility (the percentage of change in price associated with a 1 percent change in quantities, with all other factors held constant) is an especially important concept for agricultural products (Tomek and Robinson 1981). This is true for oysters because, like many agricultural products, oyster production is fixed at a certain level by biological factors that can vary from year to year, and oysters are not easily stored. Thus, price reacts to changes in quantity landed. The price flexibility for Louisiana oysters was calculated to be -.46. A 1 percent increase in quantity of the Louisiana oyster harvest will cause the price to fall approximately one-half of 1 percent. Price was found to be inflexible. A previous study (Agnello and Donnelley 1975a) found price flexibilities (which the authors presented under the more generic term of price elasticities) in the range of -.10 to -3.8 for the mid-Atlantic region.

A corresponding statistic that can be calculated from the model is the income flexibility for Louisiana oysters. This calculates the percentage of change in price caused by a 1 percent increase in income, all other factors held constant. The income flexibility was 1.51. A 1 percent increase in real disposable income causes a 1.5 percent increase in the price of Louisiana oysters. Agnello and Donnelley found that the price flexibility (presented as elasticities) ranged form 1.0 to 5.9 depending on the area of analysis, either mid-Atlantic or Delaware Bay.

## Summary and Conclusions

The purpose of this study was to provide an economic overview of the Louisiana oyster industry by examining the state's landings and prices, and the importance of the state's seed oyster production area to the production from privately leased grounds. Leased grounds produced from 65 to 95 percent of the state's landings, with an average of 80 percent.

The state seed grounds are managed, by law, to produce a ready supply of seed oysters that can be planted on private leases for later harvest. There was a strong positive correlation between (a) the estimates of oysters on the grounds (oysters per meter square) and seed production, and (b) effort (number of vessels per grid) and seed production. Salinity and spat set were not correlated with seed production, but the relationship of these variables with production has been shown to be nonlinear.

Using these variables, two models were developed of the state seed grounds, one using monthly production by "grid" as the dependent variable, the other, yearly production by bay. These models combined the use of an economic variable (effort) with environmental data to explain the variation in oyster seed production. Actual seed taken from the public grounds depended upon salinity, spat set, oyster seed per meter square, and effort. Further analysis of salinity's effects on oyster production produced mixed results. The optimum salinity range that was estimated by Chatry et al. (1983) did play a significant role in determining the amount of seed oysters per meter square.

However, the same analysis did not have significant results when the actual seed production figures were used. This may be because of measurement errors stemming from the manner in which the production data were collected. Oystermen harvesting the reef were asked how many barrels they had on board, and it is possible that this introduced a measurement error that affected the analysis. This should be investigated further.

Sack oyster production was also modeled, though there was some difficulty with this, as the seed grounds are managed primarily for seed oysters. Using these data provided an opportunity to combine economic and environmental data in a model of sack oyster production. Harvest was found to be a function of salinity, spat set, and effort. This model had a higher R-square than those estimated for the seed oysters. Spat set and salinity had better explanatory power for the variation in sack production than for the variation in seed production.

The use of seed oysters on private grounds was investigated. The Barataria basin system had a positive correlation with the state seed ground production. The importance of these grounds should thereby be apparent. The sheer magnitude of seed that is taken from the public grounds every season demonstrates the importance of these areas to the industry.

A paired t-test revealed a highly significant difference between spring and fall average oyster price. The spring and fall prices should not be pooled together for a statistical test. Therefore the test for differences between private-lease oyster price and public-ground price was run with each season's prices analyzed separately. There was no significant difference in private and public prices. This was supported by regression analysis when the ratio of public to total harvest was used as an explanatory variable for the prices of Louisiana oysters. When weighted prices were tested, again there was no significant difference in private and public ground prices. Thus, the findings of this research do not support the hypothesis that the common property oyster resource causes inefficiencies. Only one test supported this hypothesis. There was, however, a significant difference between the price received for oysters from Breton Sound and those harvested from Calcasieu Lake. This may have been caused by differences in marketing channels or the quality and size of the oysters from each region.

Although there was no significant difference between prices received for oysters from private and public oyster grounds, this does not mean that the use of oyster leases should be abandoned. The use of leases provides other benefits. The flow of income to the oysterman can be spread over the entire year, instead of being confined to the regulated oyster season of approximately seven months on public grounds. The same is true for fixed costs. The use of leases may be preventing wider swings in oyster prices by leveling supply. The consumer benefits from a continual supply of oysters throughout the year. Average nominal and real oyster prices were also highly correlated with time. This does not necessarily mean that the oystermen are better off than they were in the past. The number of licenses, especially for dredging, has increased, without a corresponding increase in landings. This leaves each vessel in the fishery with a smaller percentage of total landings. The demand for Louisiana oysters was also investigated. It was found that a 1percent increase in personal disposable income causes a 1.5 - percent increase in the real exvessel price of Louisiana oysters. A 1percent increase in the landings of Louisiana oysters causes a .46 percent decrease in the real exvessel price of Louisiana oysters. With real disposable income increasing at an average of about 3.5 percent per year, Louisiana's oyster industry can look forward to increasing real prices for their product. Also, if landings could be increased through the construction of freshwater diversion canals, the percentage of decrease in price would be less than the increase in production because of the inflexible price for Louisiana oysters.

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