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UTILIZATION OF U. S. OTTER-TRAWL SHRIMP VESSELS IN THE GULF OF MEXICO, 1959-1961

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SUMMARY AND CONCLUSIONS

The study is based on an analysis of the operations of a sample of 1,000 United States otter-trawl shrimp vessels over 15 gross tons in size for each of the years 1959, 1960, and 1961.

There was substantial variation in average landings between and within vessel size classes over the time period studied. Average landings and fishing effort increased with vessel size through the 60- to 69-gross ton class, and the relative variation in productivity and fishing effort among vessels decreased through this same class. However, even within the more productive vessel size classes, such factors as weather, skill and luck of the captain and crew, and the availability of shrimp caused substantial variation in productivity and fishing effort among vessels.

The relatively high correlations between landings and days fished indicate that the "days fished" concept is an adequate measure of fishing effort. Additional fishing days on the average contributed substantially to increased landings. However, again there was considerable variation in results among vessels.

There was substantial seasonal variation in the extent to which shrimp vessels are utilized. Furthermore, this variation was inversely related to vessel size. Typically, a high proportion of the large vessels were active in shrimp fishing throughout the year which in part explains the higher annual average landings by those vessels. A substantial part of the shrimp fleet is underutilized, in the sense that it is inactive during the winter and early months of the year. If suitable alternative vessel uses could be found during those periods of low shrimp availability, the over-all economic productivity of those vessels would be increased. On the other hand, it is apparent that a substantial portion of the fleet is fully utilized in shrimp fishing when time allowance is made for vessel maintenance, running time, crew vacations, and adverse weather conditions. Many of the long-range vessels that fish over wide areas of the Gulf appear to be employed about as fully as could be expected.

BACKGROUND

This paper has as its purpose the presentation of the over-all purpose, procedures, and some of the findings of an extensive statistical analysis and study of shrimp vessels operating in the Gulf of Mexico. Those aspects of the findings of the study dealing with over-all vessel productivity, fishing effort, and seasonality of vessel operations are presented.

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OVER-ALL PURPOSE AND PROCEDURES

The basic study attempts to define the extent to which United States shrimp vessels were utilized in the Gulf of Mexico area in 1959, 1960, and 1961. Vessel utilization was measured primarily in terms of pounds of shrimp landed and "days fished," and was examined on an annual and seasonal basis as related to vessel size, controlling port, and area fished. A "day fished" is defined as 24 hours spent in some phase of the actual fishing operation. Vessel size was measured in gross tons. The controlling port is the port with which the vessel is identified for purpose of statistical compilation. The fishing areas are those used by the U. S. Bureau of Commercial Fisheries for statistical and biological research purposes.

A typical Louisiana offshore trawler of about 60 ft. over-all length and 16 net tons.

The basic data for the study were obtained from a random sample of 1,000 vessels selected from the U. S. Bureau of Commercial Fisheries listing on Machine Run No. 8 for each of the years 1959, 1960, and 1961. This sample size represents about one-third of the total shrimp vessels operating in the Gulf of Mexico in those years. The vessels selected were of 15 gross tons and over in size, and additional data on controlling port was obtained from the "Vessel Code Book" of the U. S. Bureau of Commercial Fisheries. The data from Machine Run No. 8 and that from the "Vessel Code Book" were punched on machine cards and extensive computations were made regarding landings, days fished, area fished, etc., as consistent with the purposes of the study. The findings were supported and validated by an informal field investigation throughout the Gulf area.

PRODUCTIVITY AND FISHING EFFORT OF SAMPLE VESSELS, 1959-1961

The landings of the 1,000 sample vessels amounted to 33.4 million pounds in 1959, 39.1 million pounds in 1960, and 27.2 million pounds in 1961 (table 1). In both 1959 and 1960 median[1/] landings per vessel were greater than the mean[2/] vessel landings. However, in 1961 this was reversed indicating that more than one-half of the vessels caught less than the arithmetic mean landings. There was considerable variability in landings among the vessels in all three years, with the greatest relative variation occurring in 1961.

The mean and median number of days fished for the 1,000 sample vessels amounted to approximately 45 to 52 days per year over the period. On a relative basis the variation among the sample vessels in terms of days fished, although considerable, was less than that on the basis of landings. The distributions of vessels in terms of days fished were more symmetrical than those when vessels were distributed on the basis of landings.

Landings and fishing effort also varied with vessel size. When the 1,000 vessels were sorted by vessel size, it was evident that average landings and days fished increased with ves-

1/The median means that there are just as many vessels landing more than the median vessel as there are vessels landing less than the median vessel.

2/The arithmetic mean is synonymous with "average," which is obtained by dividing the sum of the landings by the number of vessels.

sel size, at least through the 60- to 69-ton class (table 2). The vessels in the 60- to 69-gross-ton category recorded the highest average landings in 2 out of the 3 years and the highest average days fished in all 3 years. Furthermore, the relative variation in both landings and days fished decreased with vessel size through the 60- to 69-gross-ton category.

The relationship between productivity (as measured by landings) and fishing effort (as measured by days fished) was investigated further by simple linear regression and correlation techniques.[3/] This analysis revealed a high positive relationship between landings and days fished in each of the three years (table 3). The correlation coefficients and the amount of the variation "explained" by the regression of landings on days fished were somewhat lower for the medium to large vessels than for the very small and very large vessels. While this may seem contradictory to the analysis of mean landings, it primarily is explained in terms of the seasonal patterns of fishing activity by vessel size which is to be discussed in the following section.

The average addition to landings associated with an additional day fished (as measured by the regression coefficients) amounted to 733 pounds in 1959, 766 pounds in 1960, and 617 pounds in 1961. The standard error of the estimate for all size classes and for each year indicated substantial variability in results from additional fishing effort among the vessels.

Table 1 - Number of Sample United States Otter-Trawl Shrimp Vessels Fishing the Gulf of Mexico Area Classified by Landings and Days Fished, 1959-1961

Landings	1961	1960	1959
	(Number of Vessels Reporting)		
1,000 Lbs.			
10.9 and under	191	119	154
11.0 to 20.9	226	122	125
21.0 to 30.9	196	133	173
31.0 to 40.9	148	159	189
41.0 to 50.9	142	165	183
51.0 to 60.9	68	135	107
61.0 to 70.9	23	101	51
71.0 to 80.9	2	47	17
81.0 to 90.9	2	9	3
91.0 and over	2	13	2
Total vessels	1,000	1,003	1,004
	(1,000 Lbs.)		
Total landings	27,218.4	39,053.9	33,388.6
Mean: Landings per vessel	27.2	38.9	33.3
Median: Landings per vessel	25.2	39.0	33.6
Standard deviation of: Landings	17.0	21.5	18.6
	(Percent)		
Coefficient of variation of: Landings	62.4	55.3	56.1
Days Fished	(Number of Vessels Reporting)		
1,000 Lbs.			
10.9 and under	67	88	95
11.0 to 20.9	91	55	78
21.0 to 30.9	103	100	106
31.0 to 40.9	128	123	156
41.0 to 50.9	119	118	153
51.0 to 60.9	125	151	133
61.0 to 70.9	144	122	110
71.0 to 80.9	97	98	99
81.0 to 90.9	77	78	53
91.0 and over	49	70	21
Total vessels	1,000	1,003	1,004
	(Number)		
Total days fished	49,595.4	51,238.7	45,984.5
Mean: Days fished per vessel	49.6	51.1	45.8
Median: Days fished per vessel	50.9	52.2	45.4
Standard deviation of: Days fished	25.1	25.8	23.7
	(Percent)		
Coefficient of variation of: Days fished	50.6	50.5	51.7

Note: Source--Data in tables 1-4 were compiled from U. S. Bureau of Commercial Fisheries Machine Run No. 8. Landings in thousands of pounds and days fished in number of days. Four additional vessels in 1959 and three additional vessels in 1960 were inadvertently included in the tabulations. These were left in because of the difficulty of extricating the landings and effort of these vessels and further because with such a large sample size they will have little impact on the results.

SEASONALITY OF VESSEL UTILIZATION OF ALL SAMPLE VESSELS

Investigation of the activity of the 1,000 sample vessels on a monthly basis revealed substantial variation in landings and effort throughout each of the years 1959, 1960, and 1961 (table 4). The seasonal patterns were essentially the same in each year except that landings in June, July, August, and September of 1961 did not rise to normal levels because of the failure of brown shrimp to appear in usual quantities in the central and western Gulf. The seasonal low of vessel activity occurs in the months of February, March, and April when approximately only 50 to 60 percent of the vessels are active. Vessel activity increases from the low months to a peak in July and August and then gradually declines throughout the remainder of the year. Mean landings and days fished tend to follow the same pattern. The pattern of mean days fished per trip is inverse to that just described in that the lowest

3/Regression techniques show the functional relationship between two variables. In the case of this study it gives an expected change in productivity for a given change in fishing effort. Correlation techniques measure the proportion of the variations in the dependent variable (productivity) accounted for by variations in the independent variable (effort).

Table 2 - Means, Medians, Standard Deviations, and Coefficients of Variation of Landings and Days Fished of Sample Vessels in the Gulf of Mexico Area, Classified by Vessel Size, 1959-1961

Vessel Size in Gross Tons	Mean Landings and Days Fished			Median Landings and Days Fished			Standard Deviation of Landings and Days Fished			Coefficient of Variation of Landings and Days Fished			
	1961	1960	1959	1961	1960	1959	1961	1960	1959		1961	1960	1959
15 to 29:													
Landings (1,000 lbs.)	12.3	21.9	20.5	11.2	21.2	20.3	8.7	12.6	13.4	Percent	70.9	57.6	65.4
Days fished (no.) . .	28.3	30.4	28.9	26.6	30.7	29.5	17.5	17.7	17.2	Days	61.8	58.2	59.5
30 to 39:													
Landings (1,000 lbs.)	20.8	33.6	26.5	18.9	32.4	26.9	13.3	17.8	15.4	Percent	63.8	52.9	58.0
Days fished (no.) . .	40.6	44.8	37.4	39.3	45.2	38.1	20.9	20.7	19.4	Days	51.5	46.2	51.9
40 to 49:													
Landings (1,000 lbs.)	26.0	39.9	32.8	24.1	39.0	33.5	14.5	21.0	16.6	Percent	55.9	52.7	50.5
Days fished (no.) . .	48.3	50.4	45.6	49.8	52.8	45.4	22.4	23.4	21.0	Days	46.4	46.4	46.1
50 to 59:													
Landings (1,000 lbs.)	31.0	45.2	38.3	30.3	47.2	38.9	13.9	19.3	16.5	Percent	44.9	42.7	43.1
Days fished (no.) . .	56.7	59.2	52.5	58.4	62.1	55.3	22.6	22.5	20.6	Days	39.9	38.0	39.2
60 to 69:													
Landings (1,000 lbs.)	41.4	53.3	47.7	42.2	54.8	48.1	14.4	19.0	14.8	Percent	34.9	35.8	31.0
Days fished (no.) . .	69.2	70.1	65.8	71.4	74.0	68.6	18.1	23.0	20.2	Days	26.2	32.8	30.7
70 to 79:													
Landings (1,000 lbs.)	42.8	49.8	47.1	43.7	52.7	48.4	14.6	19.3	19.7	Percent	34.0	38.8	41.7
Days fished (no.) . .	69.0	62.9	59.7	71.0	67.5	65.3	18.8	23.5	20.5	Days	27.2	37.4	34.3
80 and over:													
Landings (1,000 lbs.)	33.3	42.0	40.4	33.0	43.0	41.0	16.5	26.9	23.8	Percent	49.6	64.0	59.0
Days fished (no.) . .	58.0	52.8	51.1	63.5	55.0	48.5	24.9	31.7	26.0	Days	42.9	60.0	50.9

Note: See table 1 for explanation of source data.

average days fished per trip occur in the months of peak landings and fishing activity. This is the result of large quantities of shrimp being available close to the mainland in the central and western Gulf areas. In the early months of the year a substantial portion of the shrimp fishing activity is located off the Mexican coast and the average days fished per trip is higher.

SEASONALITY OF VESSEL UTILIZATION BY VESSEL SIZE

It would be suspected that weather conditions and the location of shrimp in the winter months would affect the seasonality of vessel use in the various size categories, as was the case. Typically the proportion of smaller vessels active in the early months of the year was small while a higher proportion of the medium to large vessels remained active throughout the year. Only 25 to 30 percent of the vessels in the 15- to 29-gross-ton class were active during February and March as contrasted to over 55 percent active vessels in the 60- to 69-

Table 3 - Correlation Coefficients, Coefficients of Determination, Y Intercept Values, Regression Coefficients, and Standard Error of Estimates of Correlations Between Landings and Days Fished for Sample Otter Trawl Shrimp Vessels in the Gulf of Mexico Area, Classified by Vessel Size, 1959-1961

Vessel Size in Gross Tons	Correlation Coefficient			Coefficient of Determination			Y Intercept Values		
	1961	1960	1959	1961	1960	1959	1961	1960	1959
15 to 29	0.90	0.91	0.93	0.81	0.83	0.86	- 805.13	- 56.18	- 241.94
30 to 39	0.88	0.90	0.93	0.77	0.81	0.86	-1,958.79	-2,024.30	-1,793.99
40 to 49	0.87	0.89	0.92	0.76	0.79	0.85	- 491.39	- 46.12	- 994.20
50 to 59	0.87	0.89	0.90	0.76	0.79	0.81	603.18	962.15	40.76
60 to 69	0.85	0.89	0.81	0.72	0.79	0.66	-3,557.59	2,304.06	9,128.68
70 to 79	0.90	0.81	0.92	0.81	0.66	0.85	-3,543.26	7,908.36	-4,511.17
80 and over	0.93	0.97	0.92	0.86	0.94	0.85	-3,204.43	-1,609.76	-3,816.50
All sample vessels .	0.92	0.92	0.93	0.85	0.86	0.92	-3,398.12	- 203.91	- 327.72

Vessel Size in Gross Tons	Regression Coefficients			Standard Error of Estimates		
	1961	1960	1959	1961	1960	1959
15 to 29	463.64	722.86	718.07	3,889.22	5,738.25	4,986.61
30 to 39	560.14	794.22	756.06	6,235.22	8,126.44	5,951.77
40 to 49	548.88	792.26	741.56	7,265.86	9,892.74	6,684.49
50 to 59	535.50	747.56	727.49	6,875.45	9,306.06	7,201.02
60 to 69	649.22	726.59	586.80	7,502.83	8,670.31	8,442.36
70 to 79	671.65	665.84	864.72	6,164.24	11,623.21	7,799.04
80 and over	628.81	826.98	864.47	5,876.87	6,287.73	9,764.36
All sample vessels .	617.33	766.19	733.24	6,808.47	8,603.53	7,084.56

Note: See table 1 for explanation of source data.

gross-ton category. The highest proportion of vessels active for all vessel size classes was recorded in July through October.

The mean landings per active vessel by size class behaved in essentially the same manner as the proportion of vessels active. The mean landings per month of the vessels in the 60- to 69-gross-ton class were higher than those of the other size classes except in July and September when the vessels of 80 gross tons and over averaged higher landings. There were substantial differences in mean landings per active vessel between vessel size classes and substantial ranges in mean landings per active vessel within size classes over the year. Peak landings for all vessel size classes occurred in the months of June through October.

Table 4 - Number of All Sample Vessels in the Gulf of Mexico Area Reporting Activity and the Average Effort and Productivity by Month, 1959-1961

Month and Year	Vessels Reporting Activity	Mean Landings Per Vessel	Mean Days Fished Per Vessel	Mean Trips Per Vessel	Mean Landings Per Day Fished	Mean Landings Per Trip	Mean Days Fished Per Trip
	No.	Lbs.	No.	No.	Lbs.	Lbs.	No.
January:							
1961 . . .	604	3,076	5.0	2.3	617	1,353	2.2
1960 . . .	604	2,831	4.8	2.2	585	1,307	2.2
1959 . . .	640	1,997	4.3	2.2	462	891	1.9
February:							
1961 . . .	577	2,770	5.2	2.2	535	1,261	2.4
1960 . . .	578	2,424	4.5	2.0	540	1,202	2.2
1959 . . .	564	1,891	4.9	1.9	382	986	2.6
March:							
1961 . . .	576	3,107	6.1	2.7	511	1,169	2.3
1960 . . .	506	2,963	5.3	2.2	558	1,337	2.4
1959 . . .	537	1,815	5.5	2.5	332	730	2.2
April:							
1961 . . .	568	2,293	5.0	2.5	462	900	1.9
1960 . . .	617	3,004	5.4	2.4	553	1,271	2.3
1959 . . .	588	1,857	5.0	2.3	374	820	2.2
May:							
1961 . . .	651	2,236	5.5	2.6	404	860	2.1
1960 . . .	662	2,534	5.7	2.4	448	1,058	2.4
1959 . . .	684	2,084	5.5	2.4	380	870	2.3
June:							
1961 . . .	803	2,905	6.2	2.8	469	1,032	2.2
1960 . . .	766	3,490	6.3	2.7	555	1,293	2.3
1959 . . .	729	4,009	5.6	2.7	721	1,472	2.0
July:							
1961 . . .	864	3,808	6.9	3.3	550	1,156	2.1
1960 . . .	826	7,962	7.2	3.9	1,110	2,044	1.8
1959 . . .	764	6,477	6.3	3.3	1,026	1,991	1.9
August:							
1961 . . .	853	3,897	7.3	3.1	532	1,274	2.4
1960 . . .	838	6,735	6.9	3.6	982	1,881	1.9
1959 . . .	795	6,066	6.1	3.3	992	1,857	1.9
September:							
1961 . . .	770	3,162	4.6	2.5	681	1,284	1.9
1960 . . .	809	5,876	6.7	3.4	868	1,745	2.0
1959 . . .	785	5,992	6.3	3.2	951	1,867	2.0
October:							
1961 . . .	743	4,127	6.6	3.2	623	1,276	2.0
1960 . . .	826	6,501	7.0	3.4	935	1,912	2.0
1959 . . .	782	5,761	6.2	3.1	932	1,850	2.0
November:							
1961 . . .	677	3,333	5.3	2.7	626	1,248	2.0
1960 . . .	817	4,511	6.1	2.8	740	1,639	2.2
1959 . . .	735	3,671	4.6	2.6	796	1,437	1.8
December:							
1961 . . .	676	3,381	5.8	2.1	578	1,585	2.7
1960 . . .	679	2,981	4.7	2.1	641	1,431	2.2
1959 . . .	690	3,650	4.9	2.5	742	1,469	2.0

Note: See table 1 for explanation of source data.

In terms of mean days fished by active vessels, the vessels in the 60- to 69-gross-ton class were consistently higher than the vessels in the other size classes. The seasonal pattern was less well defined by this measure of vessel utilization, although for the smaller vessel size classes it was still well defined. Seasonality was well pronounced in terms of mean

landings per day fished for all vessel size categories, but the advantage of vessel size was less apparent.

Mean landings per fishing trip and mean days fished per trip by vessel size class clearly indicated differences associated with vessel size. The fishing trips of the larger vessels were longer and landings were greater. The vessels in the 60- to 69-gross ton class caught more shrimp per trip and made longer trips than the vessels in the other size classes. Further investigation revealed that the vessels in this size class were those which ranged the greatest distance over the Gulf of Mexico fishing the Campeche-Obregon area in the winter and spring, moving off the Texas coast in the summer and early fall, and then returning to Campeche.

SHRIMP RECIPES

SHRIMP DE JONGHE

- 4 cans (4½ or 5 ounces each) shrimp
- ¾ cup toasted dry bread crumbs
- ¼ cup chopped green onions and tops
- ¼ cup chopped parsley
- ¾ teaspoon crushed tarragon
- ¼ teaspoon crushed garlic
- ¼ teaspoon nutmeg
- ¼ teaspoon salt
- Dash pepper
- ½ cup butter or margarine, melted
- ¼ cup sherry

Drain shrimp. Cover shrimp with ice water and let stand for 5 minutes; drain. Combine crumbs, onion, parsley, and seasonings. Add butter and sherry; mix thoroughly. Combine crumb mixture and shrimp; toss lightly. Place in a well-greased, shallow 1-quart casserole. Bake in a hot oven, 400° F., for 15 to 20 minutes or until lightly browned. Serves 6.

SHRIMP MACARONI SALAD

- 3 cans (4½ or 5 ounces each) shrimp
- 2 cups cooked shell macaroni
- 1 cup chopped raw cauliflower
- 1 cup sliced celery
- ¼ cup chopped parsley
- ¼ cup chopped sweet pickle or drained pickle relish
- ½ cup mayonnaise or salad dressing
- 3 tablespoons garlic French dressing
- 1 tablespoon lemon juice
- 1 teaspoon grated onion
- 1 teaspoon celery seed
- 1 teaspoon salt
- ¼ teaspoon pepper
- Salad greens
- 1 hard-cooked egg, sliced

Drain shrimp. Cover shrimp with ice water and let stand for 5 minutes; drain. Cut large shrimp in half. Combine macaroni, cauliflower, celery, parsley, pickle, and shrimp. Combine mayonnaise, French dressing, lemon juice, onion, and seasonings; mix thoroughly. Add mayonnaise mixture to shrimp mixture and toss lightly; chill. Serve on salad greens. Garnish with egg slices. Serves 6.

SHRIMP CHOWDER

- 3 cans (4½ or 5 ounces each) shrimp
- ¼ cup chopped onion
- 2 tablespoons melted fat or oil
- 1 cup boiling water
- 1 cup diced potatoes
- ½ teaspoon salt
- Dash pepper
- 2 cups milk
- Chopped parsley

Drain shrimp and rinse with cold water. Cut large shrimp in half. Cook onion in fat until tender. Add boiling water, potatoes, and seasonings. Cover and cook for 15 minutes or until potatoes are tender. Add milk and shrimp; heat. Garnish with parsley. Serves 6.

PATIO SHRIMP PLATE

- 3 cans (4½ or 5 ounces each) shrimp
- 1 large cucumber, sliced
- Lettuce
- Patio Shrimp Sauce

Drain shrimp. Cover shrimp with ice water and let stand for 5 minutes; drain. Arrange shrimp and cucumber slices on lettuce. Serve with Patio Shrimp Sauce. Serves 6.

PATIO SHRIMP SAUCE

- 1 cup sour cream
- 1 tablespoon horseradish
- 1 tablespoon grated onion
- ½ teaspoon paprika
- ½ teaspoon salt

Combine all ingredients and blend well.