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Trends in Catch-Effort Relationships With Economic Implications: Gulf of Mexico Shrimp Fishery

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INTRODUCTION

The shrimp fishery of the Gulf of Mexico is the most valuable in the United States. Government-collected statistics are published regularly on catch and total value of shrimp by months and years and for each major Gulf port. In 1973 landings of shrimp at U.S. Gulf ports by all vessels were estimated to be 114 million lb (heads-off) valued at $173 million.

The long-term viability of a fishery is dependent on many factors, both biological and economic. The size of the biomass, reproduction capabilities, and other factors affecting the physical quantities available to be landed describe only part of the important considerations for the industry. Equally significant are measures of fishing effort, prices, costs, and returns in the economic realm of analysis. An analysis of the condition of a fishery should include all of these.

This paper reviews the recent trends relating to catch and fishing effort in the Gulf of Mexico shrimp fishery. The scope of this report is limited to presenting some of the basic findings in a descriptive format using simple time series and trends to illustrate the relationships developed.

The information presented is based on data collected from all vessels of 5 GT and larger landing shrimp at U.S. Gulf ports. The basic data series utilized are drawn from the records collected by the National Marine Fisheries Service (NMFS) and summarized in Table 1. The index used to estimate fishing effort was developed under a research contract with the NMFS and is described in the detailed report presented at the completion of that contract[1].

The analysis was limited to the years 1962 through 1971. Although more recent data were not available at the time the research was completed, most of the series have been extended to reflect conditions in 1972 and 1973. This was done to better reflect the current status of the industry. While certain assumptions were necessary, published data sources were used in addition to the basic relationships established for the 1962-1971 period so that the estimates for 1972 and 1973 are adequate for the purpose of illustrating current trends in the industry. Detailed discussion of the basic research procedures and results will not be presented here as they are available elsewhere[1,2].

TRENDS

Effort

Some measure of the amount of effort expended in a fishery is important for the purpose of evaluating the underlying causes of a change in landings which may be occurring. One

[1]Griffin, W.L., M.L. Cross, R.D. Lacewell, and J.P. Nichols. 1973. Effort Index for Vessels in the Gulf of Mexico Shrimp Fleet. Contract Research Report to the National Marine Fisheries Service. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University, College Station, TX 77840.

[2]Griffin, W.L., J.P. Nichols, and R.D. Lacewell. 1973. Trends in Catch/Effort Series: Gulf of Mexico Shrimp Fishery. Contract Research Report to the National Marine Fisheries Service. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University, College Station, TX 77840.

Table 1.—Selected data series, Gulf of Mexico shrimp fishery, 1962-1973[1]

Year	Number of Vessels	Days Fished	Index of Effort	Total Effort[2]	Catch by Vessels[2]	Total Gulf Landings	CPUE[2]	Ex-vessel Price	Gross Revenue/ Vessel
		(1,000)		(1,000)	Million lb (Heads-off)	Million lb (Heads-on)	lb	$/lb	$
1962	2,542	128	1.26	161.6	64.6	141.7	399	.76	19,319
1963	2,653	140	1.07	149.6	91.3	203.1	610	.57	19,621
1964	2,795	141	1.15	161.4	89.8	179.0	556	.59	18,959
1965	2,804	141	1.16	163.8	97.9	195.2	597	.63	21,992
1966	2,924	132	1.20	158.2	89.0	179.2	562	.80	24,350
1967	3,098	134	1.36	182.3	110.0	225.7	603	.71	25,219
1968	3,346	144	1.56	225.9	98.3	204.0	435	.84	24,668
1969	3,362	175	1.48	259.0	91.1	200.4	351	.92	24,925
1970	3,298	147	1.58	232.9	105.3	230.5	451	.86	27,449
1971	3,282	153	1.62	248.2	100.6	227.1	405	1.12	34,317
[3]1972	3,535	169	1.72	290.7	104.6	228.5	361	1.32	39,176
[3]1973	3,574	170	1.80	306.0	83.1	181.4	271	1.73	40,306

[1]All data series except total Gulf landings are derived from NMFS data tapes on Gulf of Mexico shrimp landings by vessels of 5 GT and larger. Data for 1972 and 1973 are projections from this data base and other published sources.
[2]Relationships between total effort, catch, and CPUE have been estimated from data in this table and have been presented in text footnote 2. These results will be reported in forthcoming publications.
[3]Projections by authors.

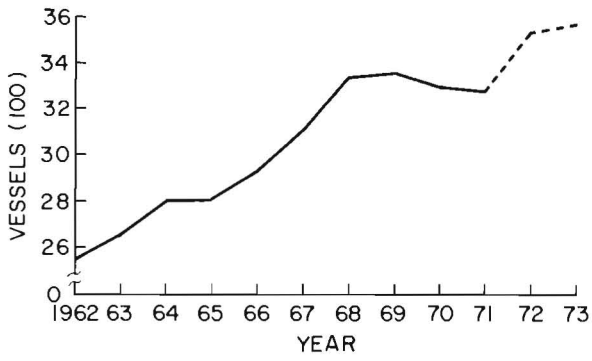

Figure 1.—Number of vessels 5 GT and larger reporting shrimp landings, Gulf of Mexico, 1962-1973.

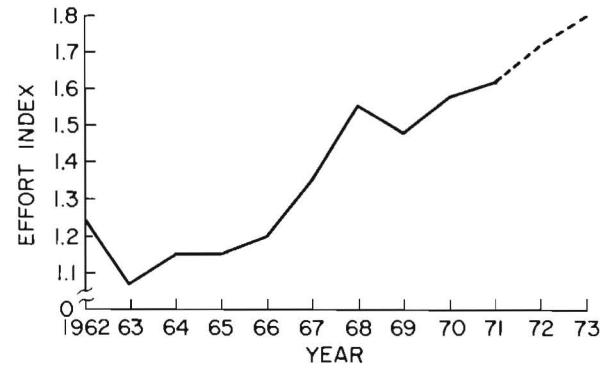

Figure 3.—Index of fishing effort for the average vessel 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

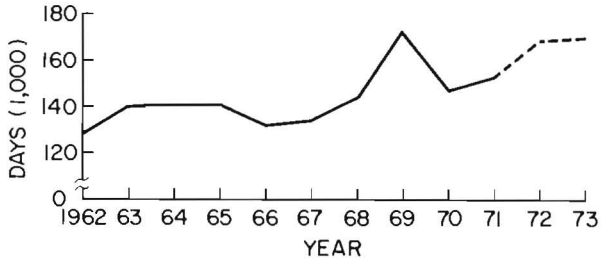

Figure 2.—Total days fished by vessels 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

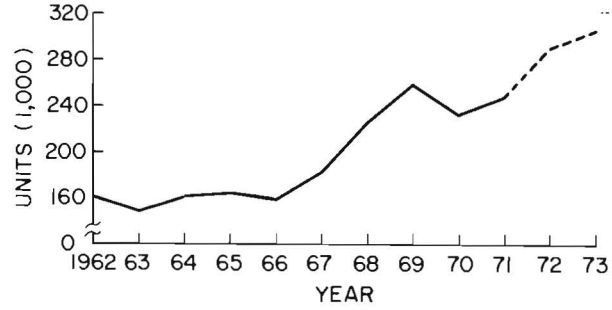

Figure 4.—Total fishing effort by vessels 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

basic indicator of the trend in fishing effort is the number of vessels operating in the fishery. Illustrated in Figure 1 is the number of vessels of 5 GT and larger reported to have landed shrimp at a U.S. Gulf port each year. In 1962 the number was 2,542 vessels. This had increased by 24 percent through 1971 when 3,298 vessels reported landings. The same general upward trend is projected to have occurred during the last 2 yr related to prospects for profits in the industry (over 3,500 vessels in 1973).

Another factor important to the determination of fishing effort is the total number of days fished (Fig. 2). In the Gulf shrimp industry, this figure increased about 9 percent from 1962 (140,167 days) to 1971 (153,058 days). Each day in this case represents a full 24-h. period of actual time on the grounds. An unusually large number of days fished was reported for 1969, apparently related to very favorable weather conditions. Analysis of preliminary data for 1972 and 1973 permitted a projection which shows an increase to 170,000 days in 1973.

It is well recognized in the industry that shrimp trawlers have changed over the past decade. It is important then to consider this change as a factor affecting total fishing effort in the industry. To gain an understanding of the extent to which average fishing power of vessels has changed, a statistical analysis was made to relate the catch of an average vessel to various physical characteristics (gross tons, length, horsepower, size of nets, etc.)[2]. It was found that a combination of horsepower and net size was more significant in accounting for variation in catch. This is logical since these two factors together determine the amount of bottom that a trawler can cover in a given period of time. The results of this analysis are expressed as an effort index (Fig. 3). The effort index for vessel i is expressed as:

$$EI_i = \frac{HP_i^{0.1385}\, LFR_i^{0.4064}}{HP_S^{0.1385}\, LFR_S^{0.4064}}$$

where EI_i is the effort index for vessel i, HP_i is the horsepower rating for vessel i, LFR_i is the length of footrope as reported in NMFS data for vessel i, HP_S is the horsepower rating for standard vessel (arbitrarily selected smallest horsepower classification), and LFR_S is the length of footrope for standard vessel (arbitrarily selected smallest net size classification).

The average vessel which reported landings in 1963 had an index of 1.07 while in 1971 it had increased to 1.62 (a 51 percent increase). The estimate for 1962 is considered to be high due to the unusually poor catch that year. This change in the index means that the average vessel in 1971 exerted 51 percent more fishing effort for each day fished than the average vessel in 1963. The period 1963 through 1971 showed a generally steady upward trend. The projections for 1972 and 1973 are based on a straightline projection of the period 1963-1971. It is estimated that the average vessel effort index increased to a high of 1.8 units by 1973.

Notice up to this point that there has been a slowly increasing level of total days fished and a more rapidly increasing level of average vessel fishing power in the fleet. To get a true picture of the amount of total fishing effort being expended in the Gulf shrimp industry, these two factors must be considered together. A measure of total units of effort was derived by multiplying the effort index for each vessel by the total days fished

each year by that vessel and aggregating across all vessels in the fleet (Fig. 4). This measure of fishing effort is a significant improvement over days fished because it takes into account the ever increasing power of the vessels in the fleet. From 1963 to 1971 total fishing effort exerted by vessels in the Gulf shrimp fleet increased 65 percent from 149,640 effort units to 248,197. Again, the projection to 1973 shows a definite continuation of this trend to 305,000 effort units.

It is apparent from all evidence that fishing effort in the Gulf of Mexico shrimp fishery has increased over the last decade. However, a closer look at the trend in total effort reveals that nearly all of this has occurred since 1966. The increase from 1966 to 1973 is approximately 94 percent or a rate of 13 percent/yr.

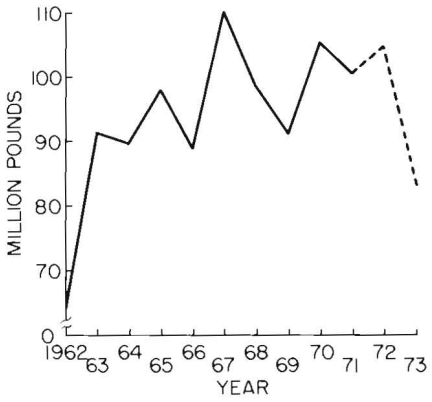

Figure 5.—Shrimp landings reported by vessels 5 GT and larger, heads-off weight, Gulf of Mexico, 1962-1973.

Catch

Shrimp landings by these same vessels (5 GT and larger) show a less clear trend than the effort statistics discussed above. The heads-off weight of the catch has varied from a low of 64.6 million lb in 1962 to a high of 110 million lb in 1967 (Fig. 5). The projection for 1973 reflects the poor landings that year. Ignoring the two poorest years, 1962 and 1973, it might be observed that there is slight upward trend in catch from 1963 to 1972. However, reviewing the longer trend in landings from the Gulf, this short term trend becomes less significant. Figure 6 shows the total landings of shrimp (boats and vessels) from the Gulf on a heads-on basis since 1890. In 1954 the record catch was made which has not been exceeded since. One interpretation of this graph is that a definite plateau has been reached in the Gulf of Mexico shrimp catch since the 1950's.

Catch/Unit of Effort

Having developed a series of data on both effort expended in the fishery and the associated landings, a measure of catch per unit of effort (CPUE) can be developed by simply dividing the total catch for each year (Fig. 5) by the corresponding total effort units (Fig. 4). The result is illustrated in Figure 7 which shows that the amount of shrimp caught for each unit of effort expended has generally declined over the last decade. Once again the observation derived for 1962 is discounted due to the unusual conditions of that year. Notice that all the decline in CPUE has occurred since 1967. By 1971 CPUE was only 67 percent of what it was only 4 yr earlier. The projection to 1973 indicates that CPUE has continued to decline. By 1973 the amount of shrimp landed for each unit of effort utilized in the industry had declined to less than one-half its 1967 level.

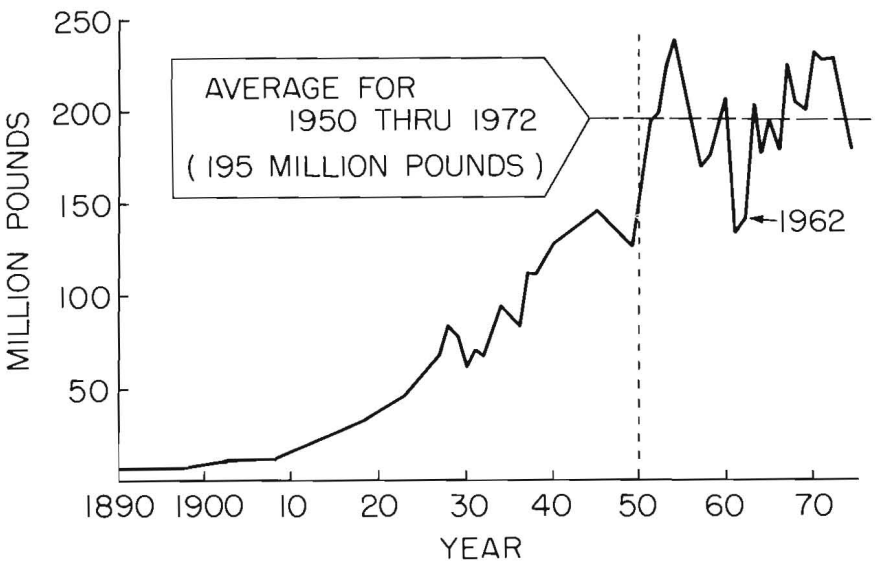

Figure 6.—Total shrimp landings (boats and vessels) heads-on weight, Gulf of Mexico, 1890-1973.

DISCUSSION AND IMPLICATIONS

It is at this point that the discussion must turn to the economic implications raised. If it could be assumed that the cost of producing a unit of effort in shrimp trawling has remained the same since 1967[3], then it could be concluded that the cost of landing 1 lb of shrimp in 1973 was nearly double that of 1967 since, on the average, CPUE declined 50 percent. If this is true, then how could shrimping operations have remained profitable during this period of time? The answer, of course, is that prices and gross revenues have increased dramatically since 1967. The trend in price is illustrated in Figure 8 where it is superimposed on the graph for CPUE. The clear picture is that since 1967, while CPUE has declined (and costs per unit caught increased), the ex-vessel price reported for these landings has risen significantly — 150 percent from 1967 to 1973. It is apparent that the high prices have drawn additional effort into the industry and that these same high prices through 1973 allowed these vessels to remain profitable on the average. Figure 9 illustrates another way of viewing this trend. Gross returns for these vessels (pounds landed × price) also shows an upward trend, though most of the increase occurred in the mid-1960's and again in 1969-1972.

It must be noted here that the major problem with extending this analysis in the economic realm is the lack of

[3]While this is a debatable point, possible economies gained through the use of larger vessels and nets probably have been offset by increased costs for inputs.

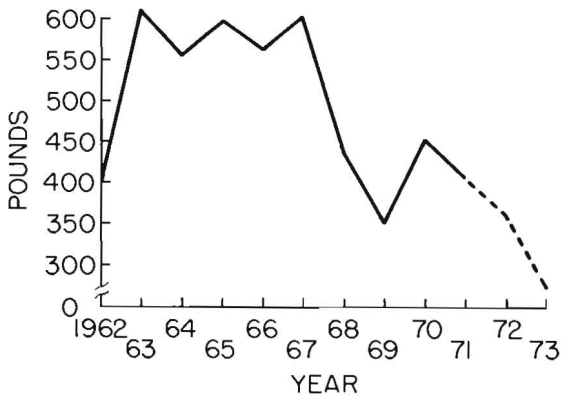

Figure 7.—Estimated catch per unit of fishing effort for the average vessel 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

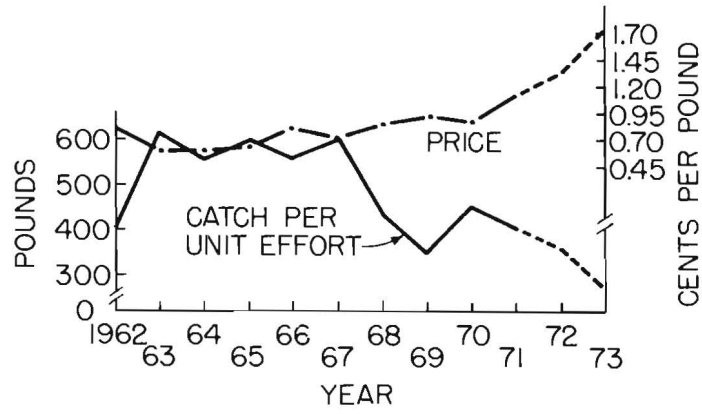

Figure 8.—Price and catch per unit of effort for shrimp landed by vessels, Gulf of Mexico, 1962-1973.

data on what really has happened to the cost structure in shrimp trawling since 1962. It was suggested above that perhaps the cost of landing shrimp doubled from 1967 to 1973 based on the assumption that the cost of producing a standard unit of effort remained unchanged during that time. The data to verify or refute this are simply not available. Only in the past year have studies been initiated specifically for the purpose of determining the cost structure for the shrimp trawling industry[4,5].

In a short-run analysis, the recent decline of prices in the Gulf shrimp fishery, combined with lower than expected landings through the summer of 1974, has created a great deal of financial strain on owners and operators. Much of the investment in additional vessels, which in the recent past was supported by high prices, is now vulnerable as prices have declined. At the same time operating costs (particularly fuel costs) have increased dramatically, causing additional problems. If returns are not sufficient to cover variable costs the rational vessel owner will discontinue active fishing operations until industry conditions improve. This does not, however, solve the problems of covering fixed costs and making regular payments to mortgage holders on many of the vessels. The main point which can be inferred from this analysis is that the real impact of the large increase in effort in the shrimp industry over the past 5 yr will be felt most severely now that prices have declined from the record high levels of 1973. The exact magnitude of this effect in economic terms cannot be measured until an improved data base on costs of owning and operating shrimp vessels is obtained. With these additional resources, management guidelines can be established for both private firms in the industry and policy makers in the many public agencies concerned with fishery resources.

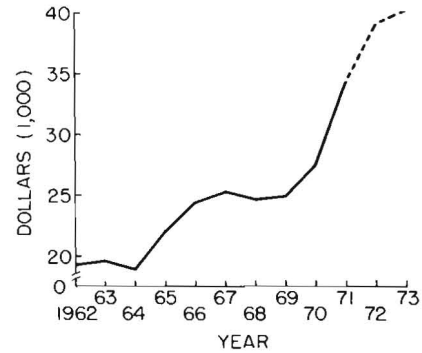

Figure 9.—Estimated average annual gross revenue for vessels, Gulf of Mexico shrimp fishery, 1962-1973.

[4]Lacewell, R.D., W.L. Griffin, J.E. Smith, and W.A. Hayenga. 1974. Estimated Costs and Returns for Gulf of Mexico Shrimp Vessels: 1971. Departmental Technical Report Number 74-1. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University, College Station, TX 77840.

[5]Research is also underway at Texas A&M University to establish costs for 1973 and a reporting system for subsequent years.

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