NOAA Technical Memorandum NMFS-SEFC-120

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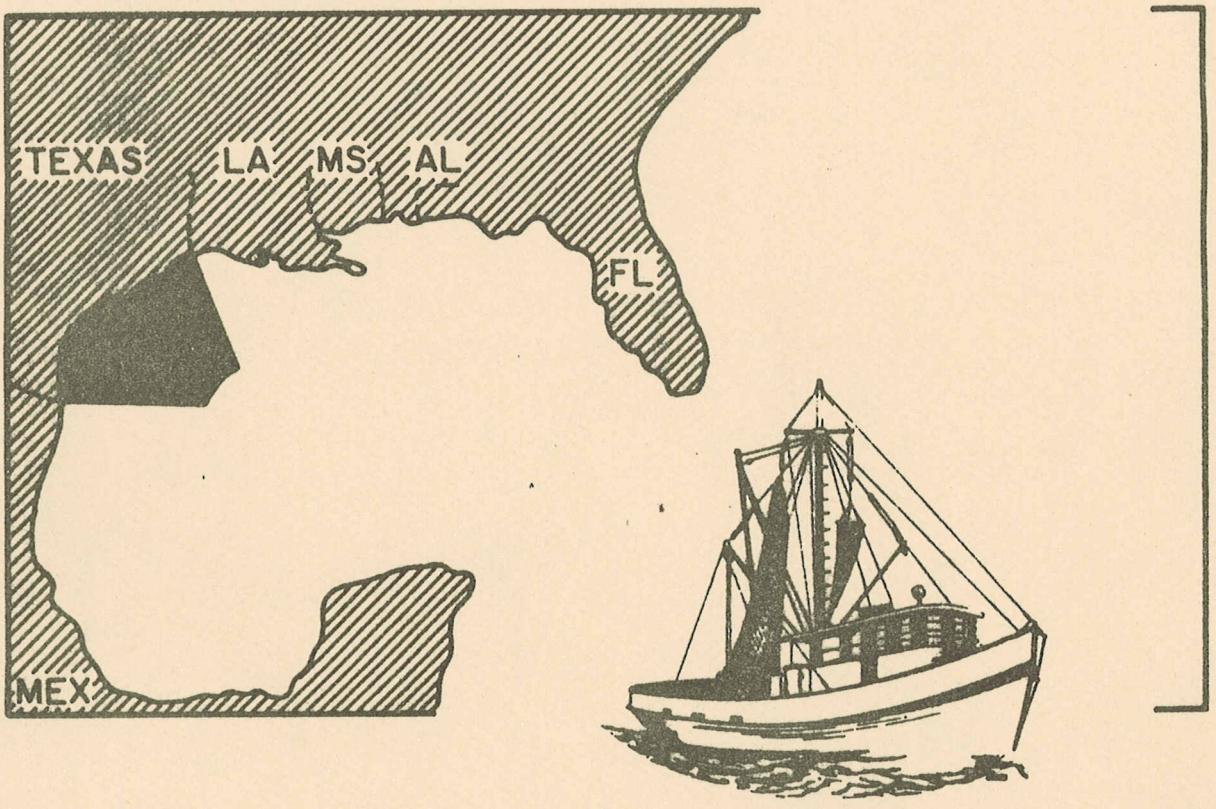

JULY 1983

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INTRODUCTION

This study, designed to describe the mobility of shrimp vessels in the Texas fishery in 1981, will be used to develop guidelines for a complete analysis of the Gulf of Mexico shrimp fleet: its structure, behavior and mobility patterns. Specific objectives are to:

1) identify vessels fishing off Texas in 1981;
2) determine their mobility patterns in the Gulf of Mexico;
3) determine seasonal fishing and port use patterns;
4) identify physical vessel characteristics according to mobility pattern;
5) determine vessel activity according to mobility pattern;
6) discover if relationships exist between vessel characteristics and activity; and
7) determine the suitability of available data bases for further studies of fleet structure and behavior.

DESCRIPTION OF DATA BASES

In this section we describe the two data bases used in the study--the 1981 Gulf of Mexico Shrimp Landings File and the 1978 Vessel Operating Units File.

1981 Gulf of Mexico Shrimp Landings File

The Gulf of Mexico Shrimp Landings File is based on information recorded by dealers at the time of landing and initial sale of shrimp. This information is collected and compiled by port agents of the National Marine Fisheries Service (NMFS), Southeast Fisheries Center. The 1981 Gulf Shrimp

Landings File also includes data collected during port agents' interviews with vessel captains.

The Gulf of Mexico shrimp fleet is comprised of both vessels and boats. If the weight of a commercial fishing craft exceeds 5 net tons, it is classified as a vessel and must register with the United States Coast Guard. The vessel is assigned a 6-digit official number which is kept on file at the Coast Guard Vessel Documentation Office. A commercial fishing craft less than 5 net tons is not required to register.

Shrimp are separated by size and species of catch, either at sea or by a shrimp dealer at a local fish house, who determines the weight and dollar value of the catch, according to species and size. The dealer records this information along with the vessel name and the date of landing.

Periodically, a port agent completes a shrimp purchase "schedule" (recording form) on which he enters the dealer information. He assigns one schedule number to each trip made by a vessel and applies the same number to all multiple records of that trip. The agent records the dealer name and schedule number in addition to the port of landing, grid area and depth of catch, type of grading, and size and species of catch. Separate records are kept of species and size of shrimp, depth, grid area, and shore code. A trip is assigned only to the first record. Prior to 1981, the trips were prorated for each record of a schedule based on the proportion of the trip spent in each area. Scheduling procedures are set forth in "Port Agent Instructions for Collection of Shrimp Statistics" (National Marine Fisheries Service, 1957).

The port agent interviews many vessel captains returning from their trips to determine the time spent trawling (expressed in 24-hour days), as well as the grid area and depth zone fished and the type of gear employed.

In 1981, approximately 52 percent of the trips made in U.S. Gulf waters were covered by port agent interviews.

Before the shrimp schedules and interview data are processed, the data entries are coded in accordance with the shrimp vessel code books. After these data are processed, they become available for research and statistical analyses.

The Gulf Shrimp Landings File consists of two schedules. The first, termed the "unconsolidated schedule", contains information on individual trips. The vessel making a trip is identified by its official documentation number. The second schedule, called a "consolidated schedule", contains information from a number of trips taken by boats or by vessels, which are not identified. When large numbers of undocumented boats land in a port, the port agent consolidates the boats' landings into a single schedule. The total number of trips, pounds, and revenues are combined, and a special identification number is assigned to the schedule. The identification code for boats is five 9's followed by a 1-digit state code denoting the port of landing. Again, multiple records may be registered for the same schedule number by species, size, and area of catch.

A port agent will also consolidate vessel records if he cannot locate the official number of a vessel; if there were a large number of trips to the same grid area and depths; or if the agent has not frequented the port in a long time. Identification numbers are also assigned to these consolidated records by state of landing. The identification code for vessels is four 9's, one 8, and a 1-digit state code. Vessels that are ordinarily recorded by official number may be included in consolidated records, if one of the above situations occurs at the time of landing.

Only the schedules that provide information on individual vessels were used for our analyses. We attempted to correct our results for the loss of information in consolidated schedules by using the proportion of total trips, landings, and gross revenues that were on consolidated schedules. Lack of individual records affects data on inshore trips to a greater extent than it affects offshore trips. For instance, the percentage of individually identifiable (unconsolidated) trips made by vessels in both inshore and offshore areas is only 43, whereas the percentage of individually recorded trips in only the offshore area is 72. Since there were few inshore trips in the unconsolidated data set (14 percent of the total trips), we used the percentages of total trips, landings, and gross revenues in the consolidated schedules of offshore trips only to correct our results for the information lost by the consolidation of schedules. Shown in Table 1 is the number of offshore trips by grid zone, from consolidated and unconsolidated vessel records and from boat records. Seventy-two percent of the vessel trips (Table 1), 80 percent of their landings (Table 2), and 83 percent of their gross revenues (Table 3) were recorded individually.

1978 Vessel Operating Units File

NMFS vessel operating units files are based on U.S. Coast Guard files compiled from vessel documentation information. NMFS port agents add specific fisheries information to the file, based on their observations. The 1978 Vessel Operating Units File contains 9,036 records of vessel characteristics including: vessel name, official number, landing port (state and country), vessel length, engine horsepower, number of crew members, gear type and quantity, type of construction, engine type, gross tonnage, and year built. The 1978 file is the most recent file available

for computer use at NMFS. There are 5,658 vessels (weighing over 5 net tons) in this file. Multiple records are listed for a vessel if more than one type of gear was employed during the year, or if the vessel landed frequently at more than one port. Although parameters such as vessel length and type of construction usually remain the same from year to year, such variables as the type and quantity of gear and the number of crew members may vary. Therefore, a vessel's 1978 characteristics may not necessarily coincide with the vessel's 1981 characteristics.

For our study, we were concerned only with vessels rigged with shrimp otter trawls. Physical vessel characteristics selected from this file included: vessel length, engine horsepower, gross tonnage, vessel age, and gear quantity (footrope length).

METHODS

The Texas shrimp grounds encompass statistical grids 18-21 (Figure 1). We identified the vessels that fished in grids 18, 19, 20, or 21 in 1981, which are referred to as "Texas vessels" (the term does not imply that the home port of these vessels is in Texas). A file containing 94,579 records for 1,891 Texas vessels was used to determine the number of trips taken to each grid area throughout the Gulf of Mexico and the seasonal use of ports.

The same data set was used to determine the vessel mobility pattern of each of the 1,891 vessels. Mobility classes were defined by the combinations of regions fished. Grids 1-4 delineate the Tortugas shrimp grounds; grids 5-9 are Florida west coast grounds; grids 10-12 are Alabama and Mississippi grounds; grids 13-17 are Louisiana grounds; and grids 18-21 are

Texas grounds. There were 16 mobility classes representing all possible combinations of the Texas region with the four other regions.

The next step was to match the 1978 Vessel Operating Units File with our preliminary Texas shrimp file. This was done by vessel documentation number. There were no records available for approximately one-third of the 1,891 Texas vessels, probably because new vessels entered the fleet after 1978 or some older vessels did not fish in 1978 but did fish in 1981. The final product was a file with 1,269 Texas vessels.

Total pounds and total revenues for brown, pink, white, and other shrimp species, total trips, and total trips to Texas for each of the 1,269 vessels were calculated from the 1981 Texas shrimp landings file. The values were then concatenated to the Texas vessel file. This combined file was used to generate frequency distribution histograms of vessel characteristics and vessel activity from Texas landings such as: number of vessels by length, engine horsepower, annual landings, annual revenues, annual trips, footrope length, and percent revenues. Histograms were generated for all vessels and for each mobility class individually. The percentages of total trips, landings, and revenues covered by unconsolidated records (Tables 1, 2, and 3) were used to correct our results for the information not included in our data base. Using information available for interviewed trips only, we also generated histograms showing the number of trips taken by the number of days fished.

The 1,891-vessel Texas shrimp file was used to produce scattergrams and regression statistics for the following relationships: annual trips with vessel length, annual trips with gross revenues, average landings per trip and average gross revenues per trip with vessel length, and average gross revenues per trip with engine horsepower and with footrope length.

Finally, we used the Texas shrimp file to produce a matrix of the number of vessels by port of maximum landings for each mobility class. We adopted "port of maximum landings" as a vessel characteristic to describe the fishing behavior and port-use patterns of a vessel. We feel that this is a more meaningful parameter in terms of understanding fleet behavior than the Coast Guard's "home port" designation, since it is the actual port most heavily used by the vessel.

RESULTS AND DISCUSSION

In this section we describe seasonality of effort (in terms of trips) and seasonal use of Texas ports. We then examine vessel mobility patterns, the distribution of physical vessel characteristics and activity among the Texas fleet, and the relationships between these distributions.

Seasonal Distribution of Trips

Our analysis showed a peak in number of trips in July and August in Texas grid areas 18-21 (Figure 2). A peak in number of trips in grid areas 5-17 (Florida west coast, Alabama/Mississippi, Louisiana) occurred May through July. The peak shifted to January through April for grid areas 1-4 (Dry Tortugas and Sanibel) (Figure 2). This trend indicates a gradual movement around the Gulf toward Texas as the brown shrimp season began (vessels arrived in Texas for the opening of the season in mid-July). A secondary peak in number of trips occurred in October in grid areas 5-17 as vessels returned to the Dry Tortugas for the winter months. Effort then was probably directed toward white shrimp in Louisiana, Mississippi, and Alabama waters and toward pink shrimp along the west coast of Florida.

The number of trips per month was underestimated by our analysis, because our data base included only unconsolidated records. Possibly as much as 28 percent of the total trips taken by Texas vessels were contained in consolidated rather than unconsolidated records. For this reason, absolute values of trips are not valid; however, this should not affect the characterization of the seasonal variation in trips. Another source of error was caused by the fact that a trip is recorded only once per schedule in the shrimp landings data base, whereas a trip can cover more than one grid zone. This error affected 0.4 percent of the total trips to grid areas 1-4, 7 percent of the trips to grid areas 5-17, and 21 percent of the trips to grid areas 18-21.

Seasonal Use of Ports

The majority of trips (95 percent) that occurred in grid areas 18-21 in July through September ended at Texas ports in 1981 (Figure 3). During the winter months, the Texas ports were used mainly by local shrimpers who fished off Texas year-round. Freeport was the port most heavily used. According to shrimp dealers we interviewed in the Dry Tortugas, some of the shrimp dealers in Texas moved their businesses to Dry Tortugas ports during the winter months.

Vessel Mobility Patterns

Vessels that fished in Texas waters and other regions of the Gulf of Mexico in 1981 were assigned to 16 mobility classes (9-24). These 16 classes represent all possible combinations of the Texas region (grid areas 18-21) with four other regions: Florida west coast (grid areas 5-9), Alabama/Mississippi (grid areas 10-12), Louisiana (grid areas 13-17), and

the Dry Tortugas (grid areas 1-4) (Table 4). Classes 1-8 were previously assigned to vessels that fished in the Dry Tortugas in 1981 (Fonyo et al., 1982), and classes 9-16 contain vessels that fished in both the Dry Tortugas region and Texas region. Classes 17-24 were newly assigned for this analysis and were not included in our previous study of mobility patterns and characteristics of vessels that fished in the Dry Tortugas. There were two dominant mobility classes: Mobil 17, vessels that fished in Texas waters only, and Mobil 24, vessels that fished in Texas and Louisiana waters. Mobil 17 represented 22 percent of the 1,891 Texas vessels, and Mobil 24 comprised 52 percent of the total number of vessels. The other 26 percent of the Texas vessels were fairly uniformly distributed among the 14 remaining mobility classes. Results of our analyses will be presented for only the two major classes, Mobil 17 and Mobil 24, and the fleet as a whole (all 1,891 or 1,269 vessels).

Vessels that fished in all the regions (Mobil 9) landed the most pounds per vessel, earned the highest gross revenues per vessel, and had the greatest mean vessel length and mean engine horsepower (Tables 5 and 6). Mobil 9 vessels also had the greatest catch and gross revenues per trip. The highest price per pound of shrimp was received by vessels that fished in west Florida, Louisiana, and Texas waters (Mobil 21). Vessels that fished in all regions, except Louisiana (Mobil 10), received the lowest average price per pound of all 16 mobility classes.

Summarized in Table 7 are the data available for only that portion of the trips covered by interviews. Texas port agents were available to interview shrimpers year-round and interview coverage was high, averaging 93 percent of the total vessels (and 76 percent of the total trips taken by Texas vessels in 1981). The highest average number of days fished (24-hour

days) per trip is shown for vessels that fished in all regions except the Dry Tortugas (Mobil 20). Yet, the highest average catch per trip occurred for vessels that fished in all five regions (Mobil 9).

The summary statistics in Tables 5A and 6A have been adjusted to include estimates of the trips, landings, and gross revenues in consolidated records. Since we could not identify vessels contained in these records by mobility class, we used the correction factors for Texas vessels as a whole (Table 8) to adjust the activity of each class.

Physical Vessel Characteristics

The vessel characteristics analyzed were: vessel length, engine horsepower, footrope length, gear type, and port of maximum landings. Results are based on analysis of the file containing records for 1,269 vessels.

Vessel length. Seventy percent of the 1,269 vessels listed on the Texas vessel file were 60 to 70 feet long. The mean length was 67 feet (Figure 4). Thirty-one vessels less than 40 feet long might have fished in Texas bay areas. According to Swartz (1980), 60 percent of the out-of-state fishermen in the Texas shrimp fleet operated 55 to 70 foot vessels for the period 1975-1980.

Engine horsepower. About 72 percent of the 1,269 Texas vessels were equipped with 300 to 400 horsepower engines (Figure 5). The mean value was 333 horsepower. The most mobile vessels (Mobil 9) had the greatest mean engine horsepower and mean vessel length.

Gear. All 1,269 shrimp trawlers on file used shrimp otter trawls in 1978. There were variations in the type of net rigging used. Many vessels had twin rigs, or quads, which consist of two nets on each side of the vessel -- usually 88 feet of width per side. Some vessels also employed

other gear: butterfly nets, handlines, and scallop trawls. Longlines were added to some of the vessels by 1981, but we have no quantitative information on the number of vessels involved. Shrimpers have recently been experimenting in other fisheries such as swordfish, snapper-grouper, and tuna (Gulf of Mexico Fishery Management Council, 1981).

Footrope length. Footrope length is the sum of the length of the lead line along the bottom edge of each of the trawls. For example, a vessel with a quad rig (4 nets) of 45 feet each would have a footrope length equal to 60 yards (180 feet). Sixty-four percent of all Texas vessels had a footrope length of 40 to 50 yards (120 to 150 feet, Figure 6). Footrope length may have increased since the 1978 data were recorded, because the use of additional trawls has been noted on some vessels.

Port of maximum landings. This index was used in place of "home port" (described in Methods) to describe the ports most heavily used by vessels in each mobility class. Brownsville, Texas was the port of maximum landings for Mobil 17 vessels, and Aransas, Texas was the port of maximum landings for Mobil 24 vessels. Swartz (1980) noted that Aransas had the largest number of shrimp boats of any port in Texas, but most were less than 40 feet long. Over 70 percent of the 55-70 foot Gulf vessels operated out of Brownsville-Port Isabel from the period 1975-1980. A major portion of vessels that fished in Texas, Louisiana, and the Dry Tortugas (Mobil 15) had their port of maximum landings in Texas and traveled to the Tortugas grounds seasonally (Table 9).

Vessel Activity

Vessel activity was examined in terms of the number of trips taken, number of days fished, pounds landed, and gross revenues received by the shrimp vessels during the entire year. The number of vessels within speci-

fied ranges for each activity is given in Figures 7, 9, and 10. As a basis for the following discussion, the ranges of each distribution were adjusted (not shown on the figures) to include information lost in consolidated records, using percentages derived from Tables 1-3 (see Table 8). The distribution of number of trips by days fished was not affected by loss of data in consolidation; therefore, no adjustments were made for discussion of values in Figure 8.

Annual trips. After adjusting our figures for consolidated records, we estimate that 38 percent of the 1,269 Texas vessels listed in the vessel file made between 12 and 21 trips to all areas of the Gulf in 1981, with a mean number of all annual trips taken by these vessels equal to 13.1 (Figure 7). Twenty-nine percent made less than 12 trips, and 33 percent made more than 21 trips. Vessels in mobility class 17 made fewer trips than the entire fleet, with 64 percent taking less than 12 trips in 1981. The number of trips by Mobil 24 vessels was higher, with 44 percent making between 12 and 21 trips in 1981.

The adjusted distribution of number of trips per vessel in 1981 indicated that most vessels took fewer than the 24 trips per vessel per year estimated by port agents on the basis of their observations. This disparity between data and observations may be a result of any of several factors. Promulgation of the Texas closure may have reduced the yearly average number of trips taken; use of gear innovations, such as longlines, may have diverted the shrimping effort to other fisheries; or some of the vessels may also have fished in the South Atlantic, where landings are not presently recorded by trip.

Days fished. Interview data covered 69 percent of the trips taken by Mobil 17 vessels, 63 percent of the trips taken by Mobil 24 vessels, and 76

percent of trips taken by all Texas vessels. According to interview data, an average of about 30 percent of all trips made by Texas vessels and covered by interviews were from 2.5 to 5.0 days long (assuming 24 fishing hours per fishing day). About 39 percent of Mobil 17-24 vessels fished less than 2.5 days per trip, and about 45 percent fished more than 3.5 days per trip (Figure 8). For Mobil 17 vessels, about 49 percent of the trips were less than 2.5 days long; about 17 percent were of 2.5 to 3.5 days in duration; and about 34 percent were longer than 3.5 days. These percentages were fairly well distributed, and are probably representative of the actual time spent fishing, because of the high proportion of trips and vessels that were covered by interview.

Total landings. Approximately 20 percent of the pounds of shrimp landed offshore by vessels in 1981 were grouped under consolidated records in the original data base (see Methods). The distribution of pounds landed (Figure 9) represents only the remaining 80 percent of the total pounds landed by unconsolidated vessels. Adjusting the scale in Figure 9 to cover landings not included in our data base (Table 8), we estimated that 54 percent of all vessels landed less than 50,000 pounds.

For mobility class 17 vessels, we estimated that 90 percent of all vessels landed less than 50,000 pounds. This low value may be due in part to a state law restricting vessels in inshore waters to 300 pounds (heads-on) per trip.

We estimated that 45 percent of the Mobil 24 vessels landed less than 50,000 pounds, and about 53 percent landed between 50,000 and 100,000 pounds. Vessels that fished off Texas and Louisiana had a much greater catch than those that fished off Texas only. This may have been due in part to the Texas Closure restrictions for May through July.

Total revenues. Adjusting by 17 percent (Table 8) for information lost in consolidated records, we estimate that 36 percent of all Texas vessels received less than $100,000 in revenues in 1981 (Figure 10). Twenty-three percent of the mobility class 17 vessels received between $100,000 and $200,000 for their landings in 1981, while 75 percent made less than $100,000 in gross revenues.

Only 24 percent of Mobil 24 vessels received gross revenues of less than $100,000. Twenty-seven percent grossed more than $200,000 for their landings. Seventy-five percent of these vessels received more than half of their revenues from Texas landings.

Relationships between Vessel Characteristics and Vessel Activity

The following relationships were examined: annual trips versus vessel length, average pounds per trip versus vessel length, annual gross revenues versus trips, average gross revenues per trip versus vessel length, average gross revenues per trip versus engine horsepower, and average gross revenues per trip versus footrope length.

Annual number of trips versus vessel length. One might expect that large vessels make relatively few trips, but long ones; and conversely, that small vessels make many short trips. We used regression analysis to determine if this assumption was correct for Texas vessels in 1981. Referring to Table 10, the proportion of the variation in the number of trips that can be explained by the length of the vessel was low for all Texas vessels, Mobil 17 vessels only, and Mobil 24 vessels only. Although the regression relationship was significant for Mobil 17 and Mobil 24 vessels, the relationship was positive rather than negative for one of these groups. Loss of information in the consolidated schedules (accounting for about 28 percent of the

total trips) may have introduced error that reduced the observed correlation between vessel length and number of trips. Vessels were concentrated in the 60 to 70 foot length range, and this small range in the independent variable may also have reduced the potential for strong correlation. A higher proportion of variation might have been explained if other parameters, such as the number of days fished per trip, had been included in the analysis. This information, however, is available only for interviewed trips.

Average pounds landed per trip versus vessel length. Liao (1979) noted in his study of vessel mobility in the U.S. South Atlantic that average vessel productivity per day was higher for larger vessels. We examined our data to determine whether the number of pounds landed per trip was related to vessel length. For all Texas vessels, Mobil 17 and Mobil 24 vessels only, the degree of variation in landings that could be explained by variation in vessel length was moderately low (Table 10). There was a significant relationship between the two parameters for the entire Texas fleet, and for Mobil 17 and Mobil 24 vessels.

Average gross revenues per trip versus vessel length. Revenues per trip might be an even better indicator than pounds per trip of the effects of vessel length on "take" per trip, because revenues account for differences in size and species of shrimp landed as well as for volume. Larger vessels may spend more time in search of larger shrimp to increase the value per volume of shrimp caught. For all three groups examined (all Texas, Mobil 17 and Mobil 24), the regression relationship between gross revenues and vessel length was stronger than the relationship between landings and vessel length. The relationship was very significant for the entire fleet and for both mobility categories 17 and 24 (Table 10).

Average gross revenues per trip versus engine horsepower. There is a good correlation for the entire fleet and for Mobil 24 vessels, while for Mobil 17 vessels there is almost no relation between gross revenues per trip and engine horsepower (Table 10). This finding confirms our assumption that mobile vessels with more powerful engines earn higher gross revenues. Vessels that fished in Texas waters only (Mobil 17) did not need as powerful engines since they fished only in Texas bays and offshore areas. In each case, the relationship was highly significant (α = 0.001). Osterbind and Pantier's (1961) analysis concluded that, on the average, vessels leading in productivity had greater engine horsepowers and tonnage capacities. The larger, more powerful vessels have a greater capacity to catch and store shrimp and to be more mobile, and revenues increased proportionally.

Average gross revenues per trip versus footrope length. Footrope length is a measure of the effective width of the otter trawls used by a shrimp vessel. The regression coefficients for this relationship for the entire fleet, Mobil 17 and Mobil 24, were highly significant (α = 0.001) verifying our assumptions that footrope length is positively related to revenues (Table 10). Mobil 17 vessels showed the strongest relationship, with a coefficient of determination (R^2) of 0.21567. We would not have expected the category with the lowest relationship between engine horsepower and revenues to have the highest relationship between footrope length and revenues. Larger net areas should require more power for towing.

Griffin et al. (1973) found that, of all vessel characteristics, engine horsepower and length of footrope gave the most consistent regression results when related to catch per day fished. They attributed this to the fact that, together, footrope length and engine horsepower determine the surface area of the Gulf floor that can be covered in a fishing day. These

two characteristics were used by Griffin et al. to estimate the fishing power of a shrimp vessel, and to determine the expected catch (adjusted for abundance) per unit of time. They also noted that the skill of the vessel captain and crew was most important in determining the catch of a vessel. Data are not readily available to quantify these parameters.

Annual gross revenues versus annual number of trips. The regression of gross revenues on number of trips was highly significant for all three groups. The explained variance was high for Mobil 17 vessels, but low for Mobil 24 vessels and for the entire Texas fleet (Table 10). Only gross revenues, based on the price offered per pound of shrimp at the time of landing, were available for our analysis. Relative gross revenues among vessels may have differed considerably from relative net revenues. Net revenues are influenced by fuel, maintenance, and other costs that, like gross revenues, vary according to usage.

Data Problems

This vessel mobility study was based on 1981 shrimp landings data. Several problems were encountered when we used the 1981 shrimp landings data in this vessel mobility study.

1. Approximately 20 percent of the pounds landed and 17 percent of the gross revenues received were consolidated in 1981, lowering averages calculated from our data base, which consisted of unconsolidated records only. Twenty-eight percent of the total number of trips was excluded from our analysis due to consolidation of records.
2. Trip records for vessels that were identified by documentation number in some schedules may occasionally have been covered by a

consolidated schedule, causing calculated values per vessel to be lower than actual values.

3. There is no way to determine mobility patterns for vessels in consolidated schedules. In our presentation of results, we attempted to correct for the consolidated information on trips, landings, and gross revenues. Our corrections assumed that the distribution of lost information was proportional to the distribution for each vessel activity indicated in the unconsolidated data.
4. In the 1981 landings records, one trip was assigned to the first record in each schedule, even when the trip had covered more than one grid. This meant that, in the few cases where trips were made to more than one grid, only the first grid was counted. For this reason the trips to some grids were slightly overestimated and the trips to other grids were underestimated. Only 7 percent of the schedules of all trips in the Gulf of Mexico in 1981 was to more than one grid.
5. Since only 76 percent of the trips taken in 1981 had interview coverage, some of the grid areas may have been erroneously estimated by port agents (i.e., vessels landing brown shrimp in Texas may have caught their shrimp in Louisiana waters, but the Texas agent might have recorded it as a Texas landing, since the area fished was not determined by interview).
6. The number of days fished was determined by interview; therefore, this information was available for only a portion of the total days fished. The interview records did not cover all trips of the year made by any vessel; therefore, it was not possible to determine the

total number of days fished by any vessel on the basis of the interview records. Interviews may be somewhat biased, since port agents sometimes interview the same vessel captains repeatedly.

7. The latest vessel operating units file available on computer at the Southeast Fisheries Center (SEFC) is the 1978 file. Only 67 percent of the 1,891 Texas vessels operating in 1981 could be found on the vessel operating units file. This meant we could not fully use all the landings data in much of our analysis.
8. An additional problem with having to use the 1978 Vessel Operating Units File in conjunction with 1981 landings data was that information on some of the characteristics may have been out of date for some vessels. For instance, gear may have been added or replaced since 1978.
9. It is possible for the same vessel name to appear several times for different vessels in the Coast Guard files, which are the basis for the vessel operating units files. A port agent must match the vessel name to a documentation number, and it is possible that he may not always choose the correct number for that vessel. (New vessels could be matched with old documentation numbers if the vessel name is the same.) Therefore, individual vessel characteristics are not always accurate. Recent regulations requiring vessels to print their documentation numbers visibly on the boat may alleviate this problem.
10. Landings data were not available for Texas vessels fishing in the U.S. South Atlantic or regions other than Gulf of Mexico grid areas 1-21. Therefore, annual landings, trips, and revenues calculated per vessel may be slightly lower than actual values. Information

on revenues received by Texas vessels in other (non-shrimp) fisheries also were not covered by the data sources used in this study.

11. Available data did not allow us to compare the net revenues of vessels in different mobility classes. The relative profitability of mobility patterns may differ considerably from the relative gross returns of mobility patterns.

The Texas Closure, implemented in 1981, may have caused vessels that normally fished in Texas waters to shift to other Gulf regions during the months that the closure was in effect (Jones and Zweifel, 1982). Analysis of historical vessel mobility patterns in the Gulf of Mexico will reveal whether the closure caused patterns to change.

Summary

Seasonal fishing patterns closely followed the peak shrimping seasons in each region. Most vessels fished off Texas during peak summer months (July through September), and in other regions during the peak fall and winter months of the white and pink shrimp seasons. Texas ports were used seasonally in conjunction with the peak effort in that region.

Shrimp vessels that fished in Gulf of Mexico grid areas 18-21 were chosen for our analysis. The 1,891 identified vessels were assigned to sixteen mobility classes, based upon the combinations of four other regions of the Gulf of Mexico in which they fished. About 74 percent of the vessels occurred in mobility classes 17 (Texas only) and 24 (Texas and Louisiana).

Vessel characteristics were available for 1,269 vessels. Average vessel length for the entire fleet was 64.4 feet. Mobility class 17 vessels

averaged 60.5 feet in length and Mobil 24 vessels averaged 65.6 feet. The highest mean vessel length was shown by Mobil 9 and 10 vessels at 70 feet (Mobil 9 vessels also landed the greatest number of pounds per vessel and the highest mean engine horsepower in 1981). Average engine horsepower was 339 hp, with little variation between mobility classes. All 1,269 vessels employed shrimp otter trawls with various types of rigging, and some used other gear as well.

An average of 18.5 trips per vessel were taken by all Texas vessels in 1981. Mobil 18 vessels showed the highest average of 31.1 trips per vessel. Mobil 22 vessels made the fewest trips per vessel, with an average value of 9.6. These values include 28 percent adjustment for data in consolidated schedules.

Seventy-six percent of all trips were covered by interview records, which indicated that an average of three 24-hour days were fished per trip. Average days fished per trip was highest for Mobil 20 and Mobil 24 vessels.

Fifty-four percent of all Texas vessels landed less than 50,000 pounds in 1981. Mobility class 9 and 13 vessels landed the greatest number of pounds per vessel. Thirty-six percent of all vessels received less than $100,000 in gross revenues for their landings. Mobil 9 received the highest gross revenues per vessel. The most profitable mobility pattern in terms of gross revenues was that which covered all regions. Average price per pound of shrimp was $2.89/lb, and the highest price per pound was obtained by Mobil 21 vessels at $3.21/lb.

Larger vessels spent more time fishing and gained a greater annual return for their landings than smaller vessels. The more mobile vessels, especially those that fished in Louisiana as well as Texas, grossed the highest incomes in 1981. Vessels that fished only off Texas earned less in

gross revenues. The profitability of mobility classes may not be directly proportional to the gross revenues of mobility classes because of the higher capital investment and fuel and maintenance requirements of the larger vessels in the more mobile categories.

Results of the analyses suggest that the Gulf of Mexico shrimp fishery data bases can be useful in describing shrimp vessel characteristics and mobility patterns.

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Table 1. Number of trips taken offshore, 1981 Gulf Shrimp Landings File

Grid zone	Unconsolidated vessel trips	Consolidated vessel trips	Boat trips	Grid area total		Unconsolidated as percent of total vessel trips
				All trips	Vessel trips	
01-04	4,504	2,323	3	6,830	6,827	66
05-09	1,990	268	1,232	3,490	2,258	88
10-12	2,180	643	421	3,244	2,823	77
13-17	15,050	6,519	35,193	56,762	21,569	70
18-21	11,638	3,704	856	16,198	15,342	76
Total grids 01-21	35,362	13,457	37,705	86,524	48,819	72

Table 2. Number of pounds landed offshore, 1981 Gulf Shrimp Landings File

Grid zone	Unconsolidated vessel landings	Consolidated vessel landings	Boat landings	Grid area total		Unconsolidated as percent of total vessel landings
				All landings	Vessel landings	
01-04	10,299,476	5,314,969	4,550	15,618,995	15,614,445	66
05-09	3,532,560	563,060	534,814	4,630,434	4,095,620	86
10-12	5,017,283	1,460,431	108,748	6,586,462	6,477,714	77
13-17	35,751,741	12,956,830	7,408,216	56,116,787	48,708,571	73
18-21	41,976,533	3,298,983	266,744	45,542,260	45,275,516	93
Total grids 01-21	96,577,593	23,594,273	8,323,072	128,494,938	120,171,866	80

Table 3. Gross revenues received offshore, 1981 Gulf Shrimp Landings File

Grid zone	Unconsolidated vessel revenues	Consolidated vessel revenues	Boat revenues	Grid area total		Unconsolidated as percent of total vessel revenues
				All revenues	Vessel revenues (only)	
01-04	$25,487,725	$13,252,959	$9,987	$38,750,671	$38,740,684	66
05-09	9,155,583	1,501,406	931,938	11,588,927	10,656,989	86
10-12	13,905,113	2,966,873	188,112	17,060,098	16,871,986	82
13-17	100,211,287	28,439,435	10,140,395	138,791,117	128,650,722	78
18-21	127,825,186	9,016,104	588,735	137,430,025	136,841,290	93
Total grids 01-21	276,584,894	55,176,777	11,859,167	343,620,838	331,761,671	83

Table 4. Texas vessel mobility classes by region fished

Mobility class	Region
9	Texas (Tex) + Florida West Coast (WFLA) + Alabama/Mississippi (ALA/MISS) + Louisiana (LA) + Dry Tortugas (DT)
10	TEX + WFLA + ALA/MISS + DT
11	TEX + WFLA + LA + DT
12	TEX + WFLA + DT
13	TEX + ALA/MISS + LA + DT
14	TEX + ALA/MISS + DT
15	TEX + LA + DT
16	TEX + DT
17	TEX
18	TEX + WFLA
19	TEX + WFLA + ALA/MISS
20	TEX + WFLA + ALA/MISS + LA
21	TEX + WFLA + LA
22	TEX + ALA/MISS
23	TEX + ALA/MISS + LA
24	TEX + LA

Table 5. Gulf shrimp landings data for 16 Texas vessel mobility classes, 1981

SUMMARY STATISTICS

Mobility class	Region	No. vessels	Pounds landed (1,000's)	Gross revenues (1,000's $)	Trips	Trips inshore (bay)	% Inshore (bay) Trips of Total Trips
9	TEX + WFLA + ALA/MISS + LA + DT	28	1,642.8	4,545.6	452	14	3
10	TEX + WFLA + ALA/MISS + DT	5	117.2	318.6	61	9	15
11	TEX + WFLA + LA + DT	40	1,934.8	5,588.2	609	5	1
12	TEX + WFLA + DT	27	1125.9	3195.5	375	17	5
13	TEX + ALA/MISS + LA + DT	34	1898.8	5133.5	529	11	2
14	TEX + ALA/MISS + DT	7	121.7	301.8	83	0	0
15	TEX + LA + DT	179	8065.8	23990.8	2777	1	<1
16	TEX + DT	47	1395.7	4072.1	621	0	0
17	TEX	424	5631.7	17008.2	2308	61	3
18	TEX + WFLA	10	136.9	396.3	177	106	60
19	TEX + WFLA + ALA/MISS	2	17.3	46.2	12	0	0
20	TEX + WFLA + ALA/MISS + LA	24	1307.3	4167.3	341	5	1
21	TEX + WFLA + LA	15	615.9	1974.3	191	12	6
22	TEX + ALA/MISS	14	192.7	514.9	81	21	26
23	TEX + ALA/MISS + LA	57	2097.2	6319.8	693	78	11
24	TEX + LA	978	39922.6	122824.5	11854	73	1
		1891			21164	413	2

Table 5A. Texas shrimp file data corrected for consolidated records, 1981

SUMMARY STATISTICS

Mobility class	Region	Vessels (corrected)	Pounds landed (1,000's)	Gross revenues ($1,000's)	Trips	Avg. lbs/ vessel (1,000's)	Avg. $/ vessel ($1,000's)	Avg. trips/ vessel	Avg. $/ lbs
9	TEX + WFLA + ALA/MISS + LA + DT	28	2,054	5,455	628	73	195	22.4	2.66
10	TEX + WFLA + ALA/MISS + DT	5	147	382	85	29	76	17	2.60
11	TEX + WFLA + LA + DT	40	2149	6706	847	60	168	21.2	2.77
12	TEX + WFLA + DT	27	1407	3435	521	52	127	19.3	2.44
13	TEX + ALA/MISS + LA + DT	34	2374	6160	735	70	181	21.6	2.59
14	TEX + ALA/MISS + DT	7	152	362	115	22	52	16.4	2.38
15	TEX + LA + DT	179	10082	28789	3860	56	161	21.6	2.86
16	TEX + DT	47	1745	4887	863	37	104	18.4	2.80
17	TEX	424	7040	20410	3208	17	48	7.6	2.90
18	TEX + WFLA	10	171	476	246	17	48	24.6	2.78
19	TEX + WFLA + ALA/MISS	2	22	55	17	11	28	8.5	2.50
20	TEX + WFLA + ALA/MISS + LA	24	1634	5001	474	68	208	20	3.06
21	TEX + WFLA + LA	15	770	2369	265	51	158	17.8	3.08
22	TEX + ALA/MISS	14	241	618	113	17	44	8.1	2.56
23	TEX + ALA/MISS + LA	57	2622	7584	963	46	133	16.9	2.89
24	TEX + LA	978	49903	147389	16477	51	151	16.9	2.95
		1891							

Table 6. Combined data from 1981 Gulf Shrimp Landings File and 1978 Vessel Operating Units File for 16 Texas vessel mobility classes

SUMMARY STATISTICS

Mobility class	Region	Vessels	Pounds landed (1,000's)	Gross revenues (1,000's)	Trips	Avg. lbs/ vessel	Avg. revenue/ vessel	Avg. $/ lb.	Avg. (ft) vessel length	Avg. trips/ vessel	Avg. H.P. of engine	Avg. foot rope length (yards)	Avg. lbs/ trip	Avg. $/ trip
9	TEX + WFLA + ALA/MISS + LA + DT	18	974.0	2718.9	264	54,111	151,050	2.99	70.0	14.7	381	35.8	3689	10299
10	TEX + WFLA + ALA/MISS + DT	4	81.3	197.7	40	20,325	49,425	2.43	70.0	10.0	363	15.8	2033	4943
11	TEX + WFLA + LA + DT	29	1355.2	4024.3	455	46,731	138,769	2.97	67.2	15.7	356	47.8	2978	8845
12	TEX + WFLA + DT	21	838.7	2396.3	312	39,938	114,110	2.86	66.1	14.9	330	44.5	2688	7680
13	TEX + ALA/MISS + LA + DT	22	1081.9	2849.2	348	49,177	129,509	2.63	66.8	15.8	350	45.5	3109	8187
14	TEX + ALA/MISS + DT	3	40.9	113.1	39	13,633	37,700	2.77	62.5	13.0	342	41.7	1049	2900
15	TEX + LA + DT	121	5469.5	16450.5	1943	45,203	135,955	3.01	66.1	16.1	351	44.3	2815	8467
16	TEX + DT	35	1170.2	3352.8	532	33,434	95,794	2.87	62.8	15.2	326	41.0	2200	6302
17	TEX	236	4097.6	12413.0	1728	17,363	52,597	3.03	60.5	7.3	292	38.9	2371	7183
18	TEX + WFLA	7	108.4	309.0	157	15,486	44,143	2.85	53.9	22.4	282	39.3	690	1968
19	TEX + WFLA + ALA/MISS	1	11.1	29.9	7	11,100	29,900	2.69	67.5	7.0	350	45.0	1586	4271

Table 6b. (continued)

SUMMARY STATISTICS

Mobility class	Region	Vessels	Pounds landed (1,000's)	Gross revenues (1,000's)	Trips	Avg. lbs/ vessel	Avg. revenue/ vessel	Avg. $/ lb.	Avg. (ft) vessel length	Avg. trips/ vessel	Avg. H.P. of engine	Avg. foot rope length (yards)	Avg. lbs/ trip	Avg. $/ trip
20	TEX + WFLA + ALA/MISS + LA	11	452.8	1426.1	151	41,164	129,645	3.15	66.6	13.7	339	44.1	2999	9444
21	TEX + WFLA + LA	12	400.7	1287.9	157	33,392	107,325	3.21	66.7	13.1	346	42.6	2552	8203
22	TEX + ALA/MISS	7	99.1	266.1	48	14,157	38,014	2.69	55.4	6.9	339	35.0	2065	5544
23	TEX + ALA/MISS + LA	29	1018.0	3107.1	385	35,103	107,141	3.05	63.4	13.3	328	39.9	2644	8070
24	TEX + LA	713	29759.0	90822.3	9287	41,738	127,381	3.05	65.6	13.0	342	42.6	3204	9780

Table 6A. Combined Texas vessel file data and shrimp landings data corrected for consolidated records

SUMMARY STATISTICS

Mobility class	Region	Vessels (corrected)	Pounds landed (1,000's)	Gross revenues ($1,000's)	Trips	Avg. lbs/ vessel (1,000's)	Avg. $/ vessel	Avg. trips/ vessel	Avg. $/ lb.
9	TEX + WFLA + ALA/MISS + LA + DT	18	1217.5	3262.7	367	67.6	181.3	20.4	2.68
10	TEX + WFLA + ALA/MISS + DT	4	101.6	237.2	56	25.4	59.3	14	2.33
11	TEX + WFLA + LA + DT	29	1694	4829.2	632	58.4	166.5	21.8	2.85
12	TEX + WFLA + DT	21	1048.4	2875.6	434	49.9	136.9	20.7	2.74
13	TEX + ALA/MISS + LA + DT	22	1352.4	3419	484	61.5	155.4	22	2.53
14	TEX + ALA/MISS + DT	3	51.1	135.7	54	17.8	45.2	18	2.66
15	TEX + LA + DT	121	6836.9	19740.6	2701	56.5	163.1	22.3	2.89
16	TEX + DT	35	1462.8	4023.4	739	41.8	115.0	21.1	2.75
17	TEX	236	5122	14895.6	2402	21.7	63.1	10.2	2.91
18	TEX + WFLA	7	135.5	370.8	218	19.4	53.0	31.1	2.74
19	TEX + WFLA + ALA/MISS	1	13.9	35.9	10	13.9	35.9	10	2.58
20	TEX + WFLA + ALA/MISS + LA	11	566	1711.3	210	51.5	155.6	19.1	3.02
21	TEX + WFLA + LA	12	500.9	1545.5	218	41.7	128.8	18.2	3.09
22	TEX + ALA/MISS	7	124.9	319.3	67	17.8	45.6	9.6	2.56
23	TEX + ALA/MISS + LA	29	1272.5	3728.5	535	43.9	128.6	18.5	2.93
24	TEX + LA	713	37198.8	108986.8	12909	52.2	152.9	18.1	2.93

Table 7. Interview data from 1981 Gulf of Mexico Shrimp Landings File for 16 Texas vessel mobility classes

Mobility class	Region	Vessels	Pounds landed (1,000's)	Trips	Days fished (24-hr days)	Vessels covered %	Trips covered %	Avg. DF/ trip	Avg. lbs/ trip	Avg. CPUE (lbs/24 hr DF)
9	TEX + WFLA + ALA/MISS + LA + DT	26	557.3	126	467	93	28	3.7	4400	1193
10	TEX + WFLA + ALA/MISS + DT	5	52.6	19	42	100	31	2.2	2800	1252
11	TEX + WFLA + LA + DT	40	981.3	265	868	100	44	3.3	3700	1131
12	TEX + WFLA + DT	27	598.4	206	639	100	55	3.1	2900	936
13	TEX + ALA/MISS + LA + DT	33	994.6	223	865	97	42	3.9	4500	1150
14	TEX + ALA/MISS + DT	5	54.2	24	50	71	29	2.1	2300	1084
15	TEX + LA + DT	177	4499.9	1268	4051	99	46	3.2	3600	1111
16	TEX + DT	41	587.4	240	656	87	39	2.7	2500	895
17	TEX	339	4117.3	1604	4868	80	69	3.0	2600	846
18	TEX + WFLA	7	66.9	78	92	70	44	1.2	900	727
19	TEX + WFLA + ALA/MISS	2	9.3	6	8	100	50	1.3	1600	1163
20	TEX + WFLA + ALA/MISS + LA	24	586.8	134	592	100	39	4.4	4400	991
21	TEX + WFLA + LA	13	338.0	100	298	87	52	3.0	3400	1134
22	TEX + ALA/MISS	10	115.9	46	98	71	51	2.1	2500	1183
23	TEX + ALA/MISS + LA	57	1143.2	337	1211	100	49	3.6	3400	944
24	TEX + LA	954	27945.4	7517	29587	98	63	4.0	3700	936

Table 8. Method to correct vessel activity for consolidated shrimp file records

Parameter	Mobility class	% Unconsolidated of total (x)[a] (see Table 1)	Correction factor (c.f.)(1/x)	Uncorrected range	Uncorrected percentage of total	Corrected percentage of total	Corrected range (uncorrected/ c.f.)
Number of Trips Taken	All	72	1.39	<12 trips	48	29	<8.6 trips
				12-21 trips	42	38	8.6-15.1 trips
				>21 trips	10	33	>15.1 trips
	Mobil 17	72	1.39	<12 trips	75	64	
				12-21 trips	25	23	
				>21 trips	0	13	
	Mobil 24	72	1.39	<12 trips	47	25	
				12-21 trips	44	44	
				>21 trips	9	31	
Number of Pounds Landed	All	80	1.25	<50,000 lbs	71	54	<40000 lbs
				50,000-100,000 lbs	29	44	40-80000 lbs
				>100,000 lbs	<1	2	>80000 lbs
	Mobil 17	80	1.25	<50,000 lbs	98	90	
				50,000-100,000 lbs	2	10	
				>100,000 lbs	0	0	
	Mobil 24	80	1.25	<50,000 lbs	64	45	
				50,000-100,000 lbs	36	53	
				>100,000 lbs	<1	2	
Gross Revenues Received ($)	All	83	1.20	<$100,000	44	36	<$83333
				$100,000-$200,000	46	41	$83333-166666
				>$200,000	10	23	>$166666
	Mobil 17	83	1.20	<$100,000	81	75	
				$100,000-$200,000	19	23	
				>$200,000	<1	2	
	Mobil 24	83	1.20	<$100,000	35	24	
				$100,000-$200,000	52	49	
				>$200,000	13	27	

[a] Offshore Landings Records Only

Table 9. Distribution of the number of vessels in each mobility class by the region in which their largest catch was landed

Region	Ports	Mobility class 9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Texas	70-89	5	1	25	17	8	4	142	27	417	5	1	2	5	11	18	796
Dry Tortugas and Sanibel	1-5	1	0	7	7	6	2	26	19	0	1	0	0	0	0	0	0
Florida West Coast	6-17	4	1	3	3	0	0	0	0	0	4	1	2	4	0	0	0
Alabama and Mississippi	20-21 and 30-32	15	3	3	0	18	1	4	0	1	0	0	15	2	3	23	0
Louisiana	42-54	3	0	2	0	2	0	7	1	6	0	0	5	4	0	16	182

Table 10. Regression statistics for vessel characteristics with vessel activity.

Parameters	Number in sample (n)	Texas Shrimp Fleet Slope (b)	R^2	Significance (α)
Gross revenues vs Number of trips:				
All	1269	2743.25804	0.09363	0.001
Mobil 17	236	4921.48843	0.30978	0.001
Mobil 24	713	928.32826	0.01155	0.002
Pounds/trip vs Vessel length:				
All	1269	99.42126	0.14095	0.001
Mobil 17	236	98.14532	0.15283	0.001
Mobil 24	713	98.53996	0.12165	0.001
Gross revenues/trip vs Vessel length:				
All	1269	327.50976	0.15902	0.001
Mobil 17	236	304.71140	0.15691	0.001
Mobil 24	713	339.54351	0.14653	0.001
Number of trips vs Vessel length:				
All	1269	-0.01290	0.00024	0.292
Mobil 17	236	0.09651	0.04416	0.001
Mobil 24	713	-0.19392	0.04271	0.001
Gross revenues/trip vs Engine horsepower:				
All	1269	32.23613	0.14966	0.001
Mobil 17	236	24.83748	0.08964	0.001
Mobil 24	713	35.99227	0.18093	0.001
Gross revenues/trip vs Footrope length:				
All	1269	248.56427	0.13221	0.001
Mobil 17	236	395.30609	0.21567	0.001
Mobil 24	713	260.45445	0.12267	0.001

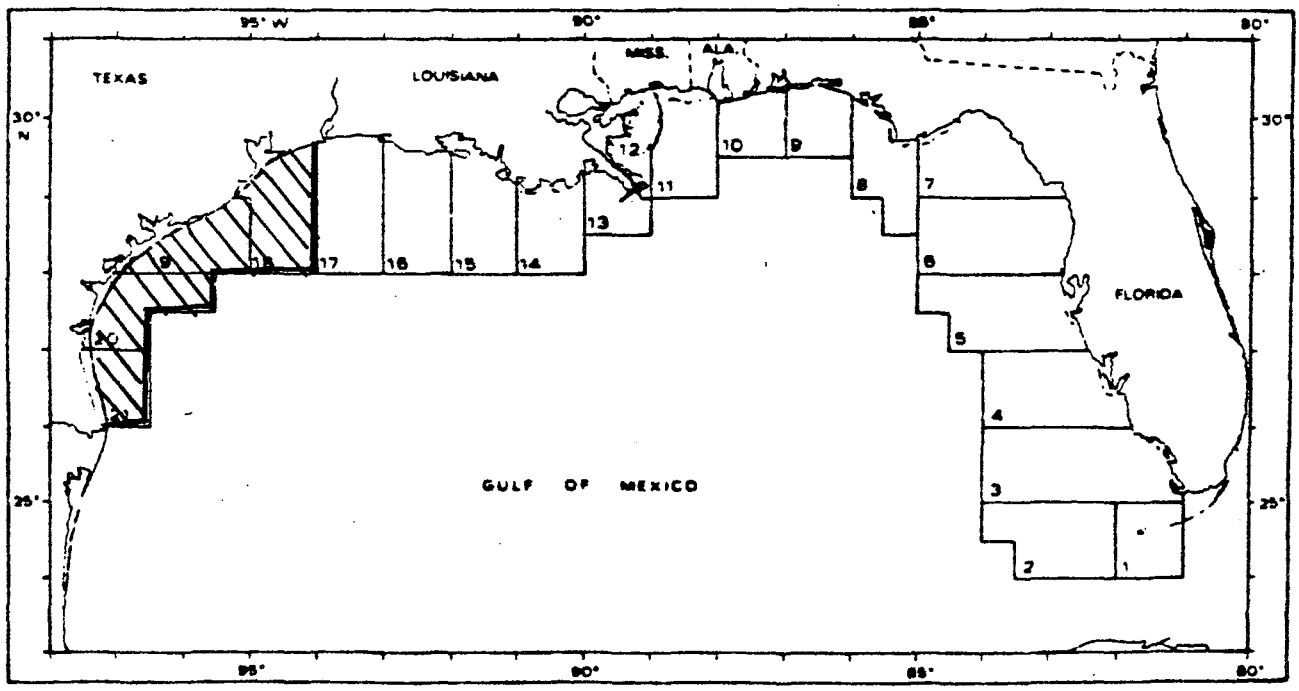

Figure 1. Statistical subareas used in reporting Gulf Coast Shrimp Data(after Kutkuhn,1962).

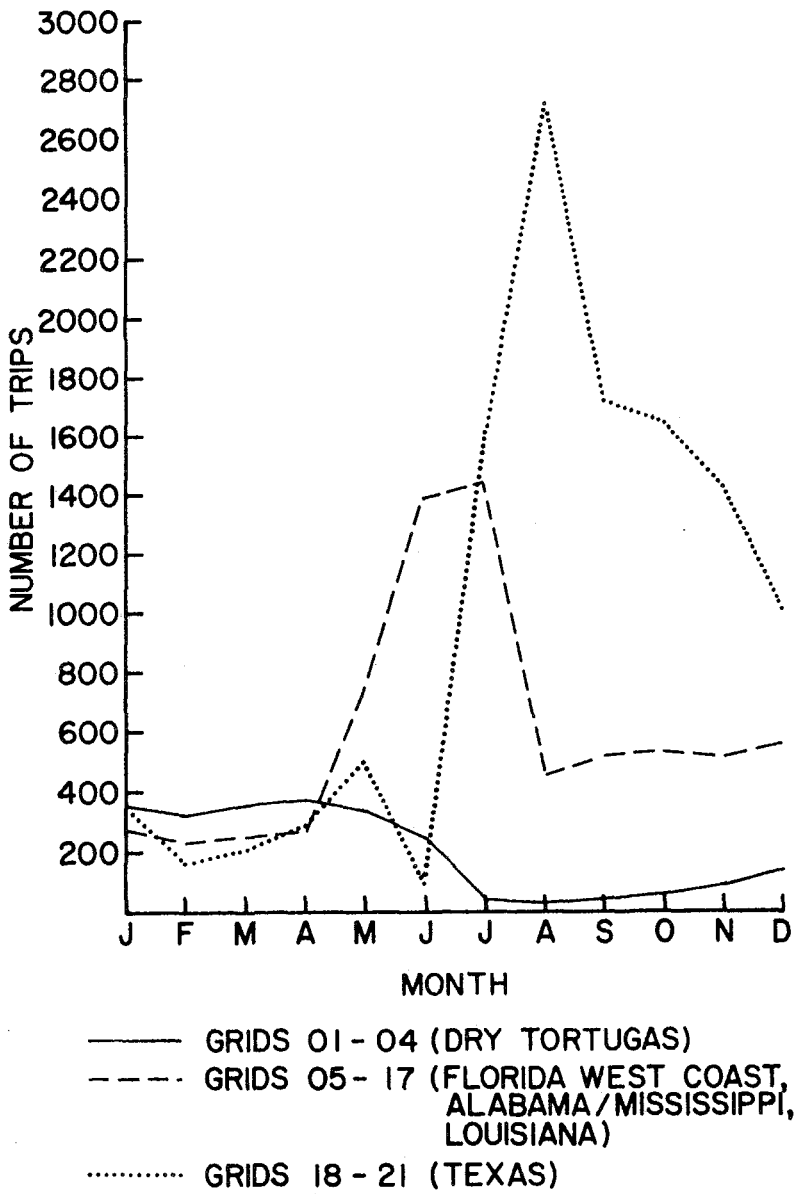

Figure 2. Monthly distribution of trips by Texas vessels in 1981.

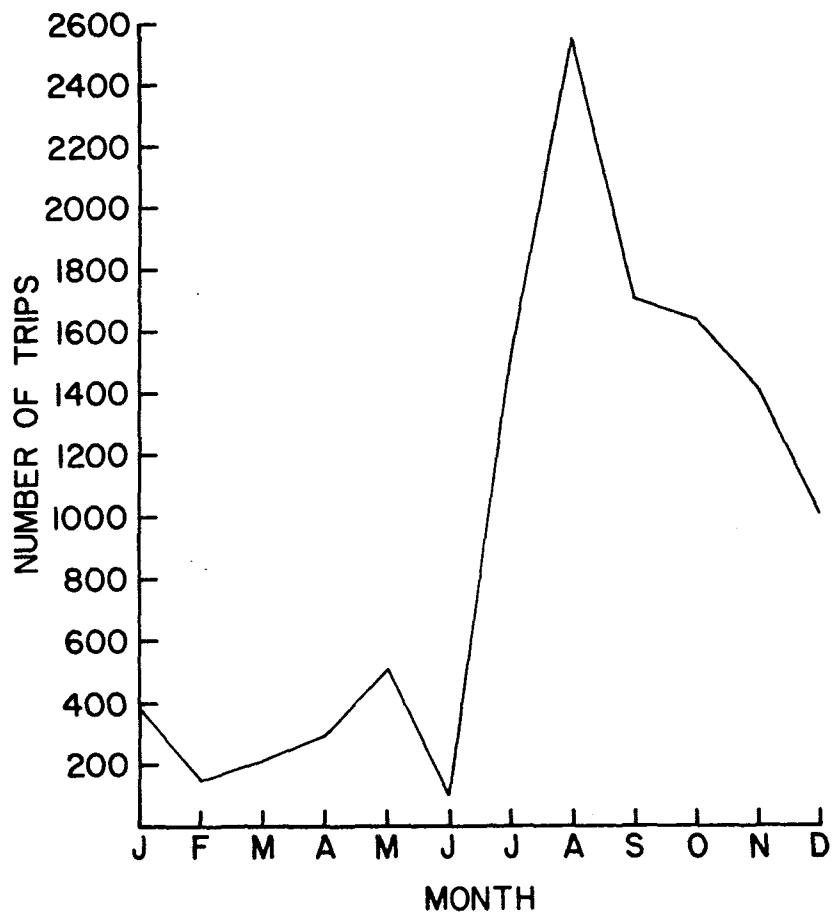

Figure 3. Monthly number of trips completed at Texas ports in 1981.

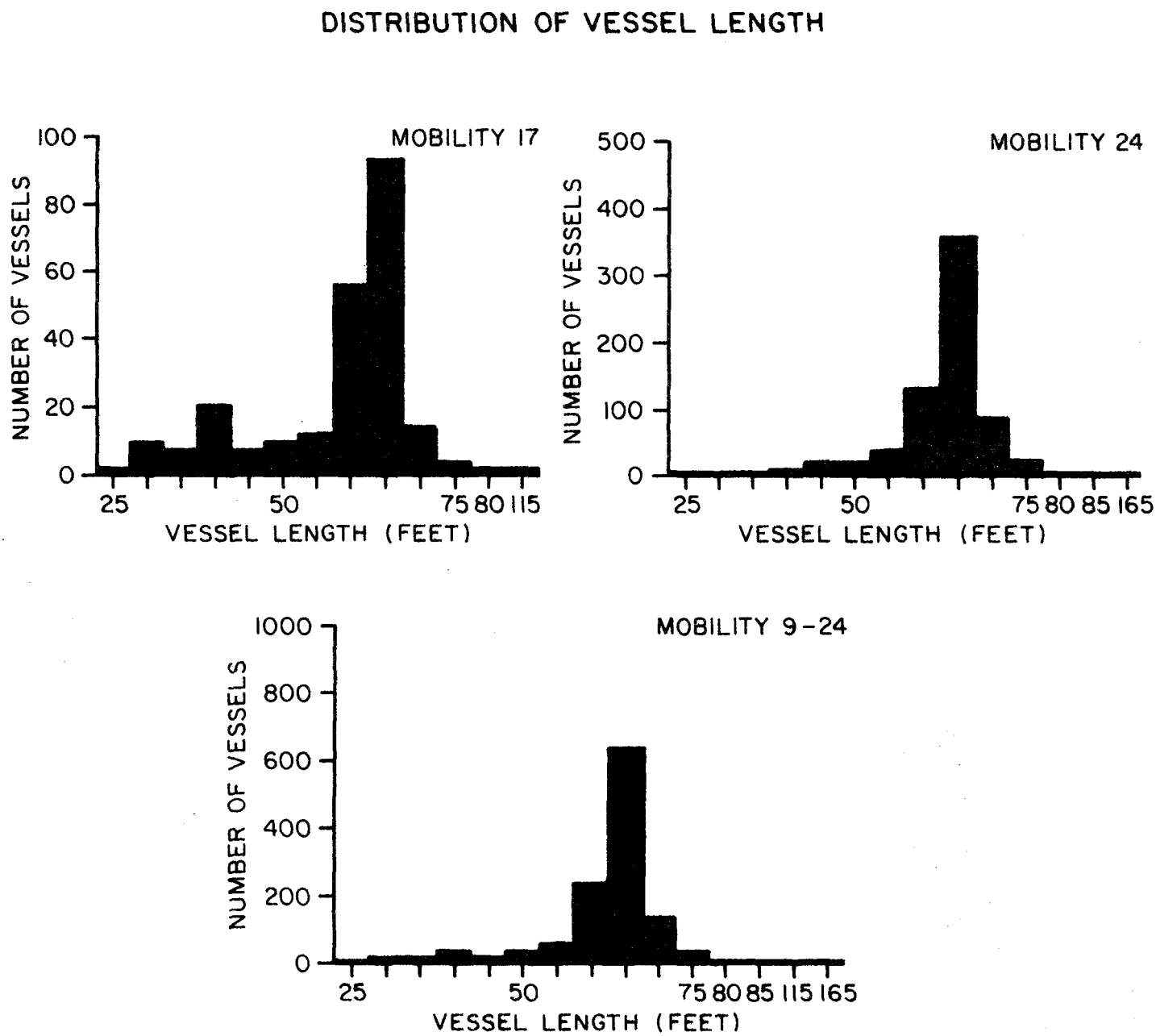

Figure 4. Frequency distributions of the number of vessels, by vessel length, for all Texas vessels (mobility classes 9-24), vessels that fished in Texas only (mobility class 17), and vessels that fished in Louisiana and Texas (mobility class 24).

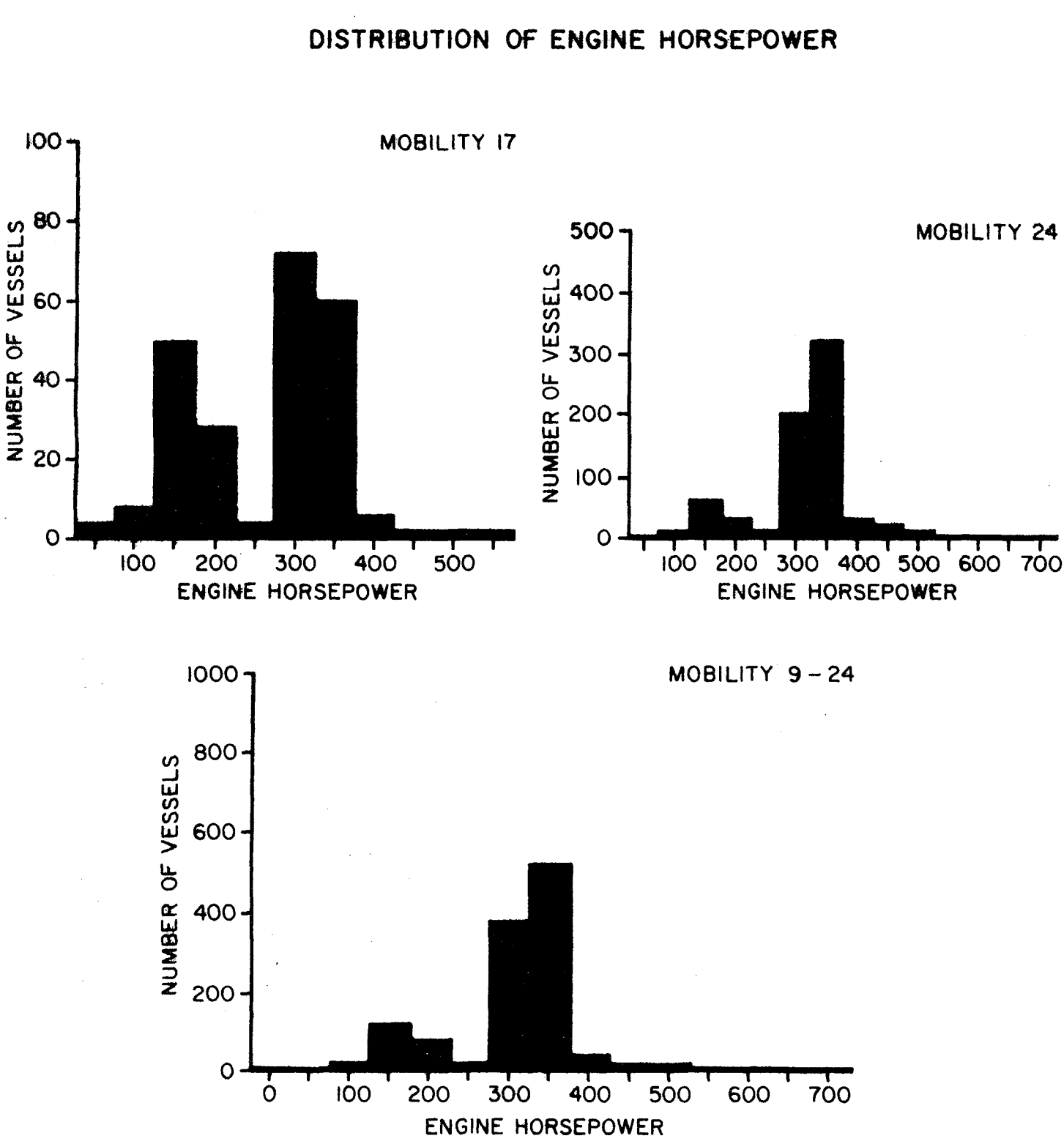

Figure 5. Frequency distributions of the number of vessels, by engine horsepower, for all Texas vessels (mobility classes 9-24), vessels that fished in Texas waters only (mobility class 17), and vessels that fished in Louisiana and Texas waters (mobility class 24).

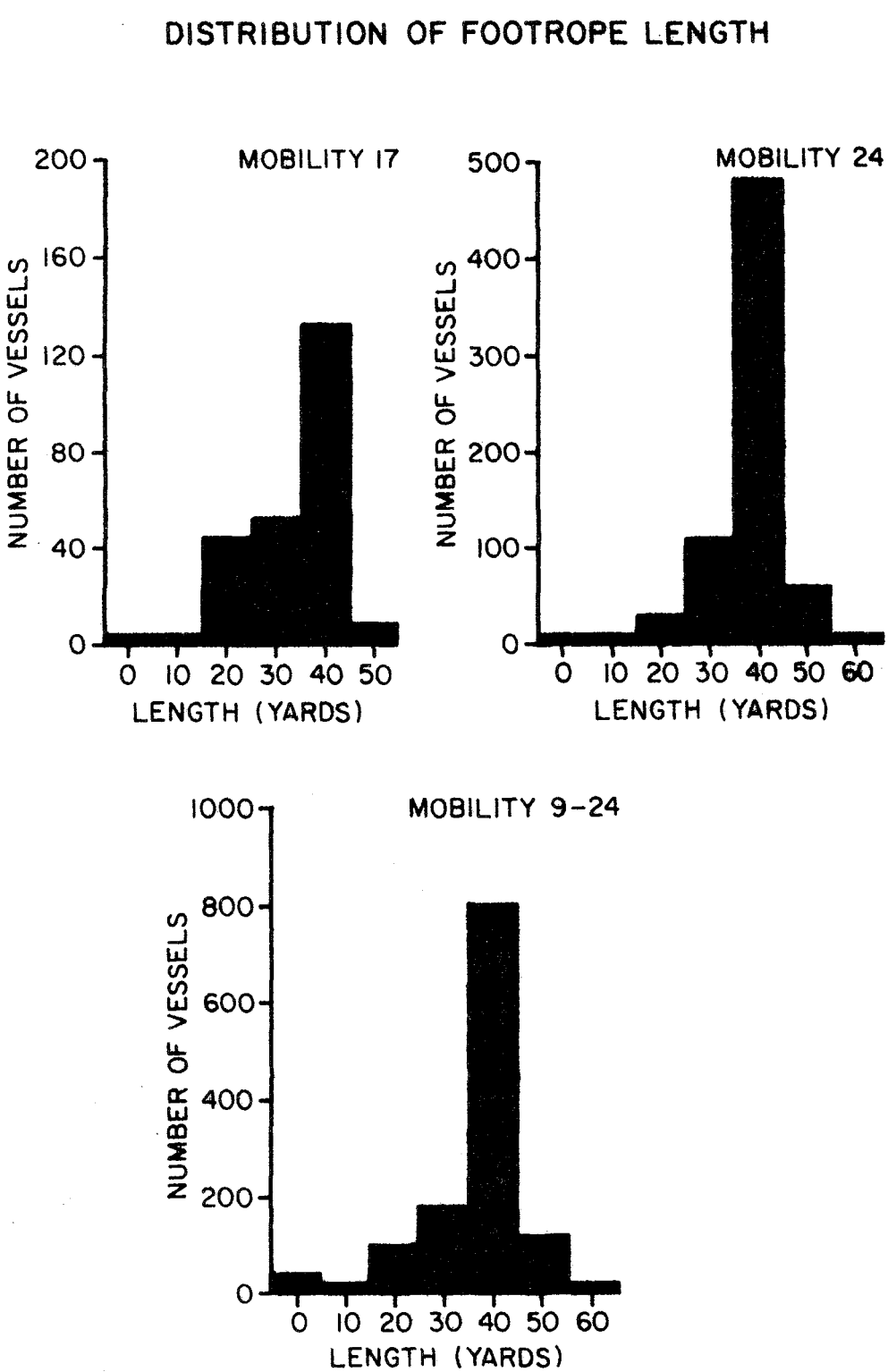

Figure 6. Frequency distributions of the number of vessels, by footrope length, for all Texas vessels (mobility classes 9-24), vessels that fished in Texas waters only (mobility class 17), and vessels that fished in Texas and Louisiana waters (mobility class 24).

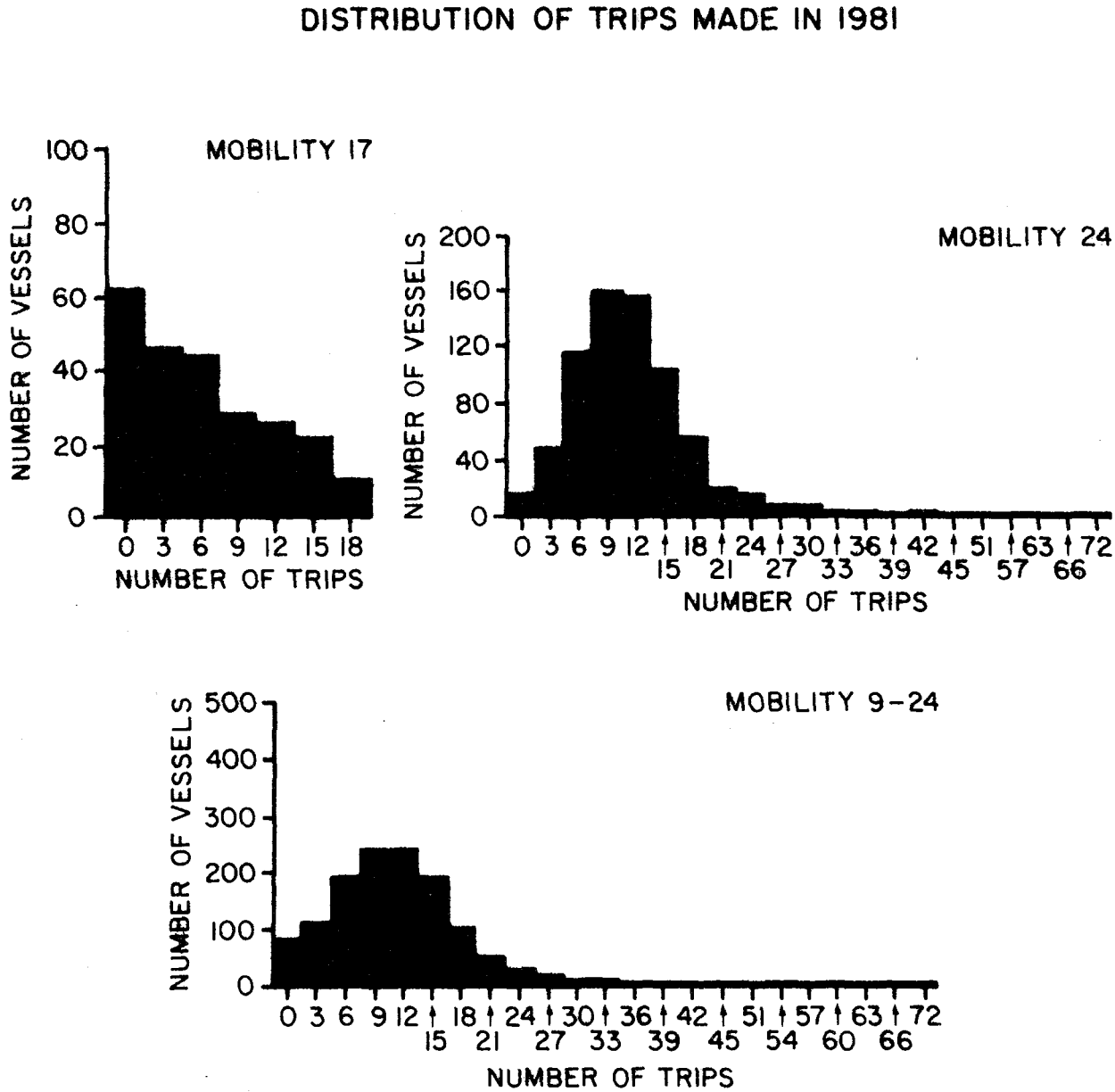

Figure 7. Frequency distributions of the number of vessels, by number of trips in 1981, for all Texas vessels (mobility classes 9-24), vessels that fished only in Texas waters (mobility class 17), and vessels that fished in Louisiana and Texas waters (mobility class 24).

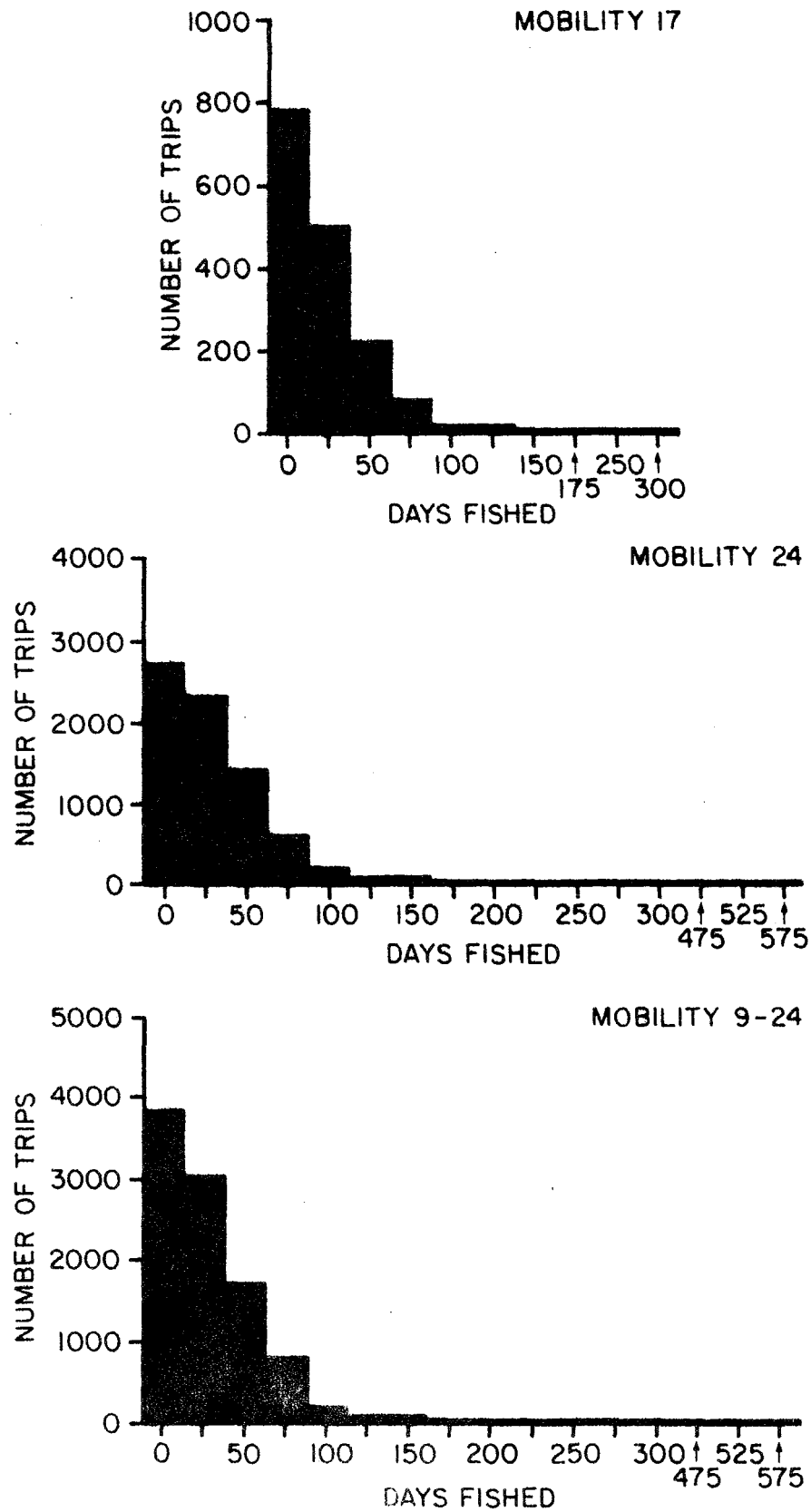

Figure 8. Frequency distributions of the number of vessels, by number of 24-hour days fished in 1981, for all Texas vessels (mobility classes 9-24), vessels that fished in Texas waters only (mobility class 17), and vessels that fished in Louisiana and Texas waters (mobility class 24).

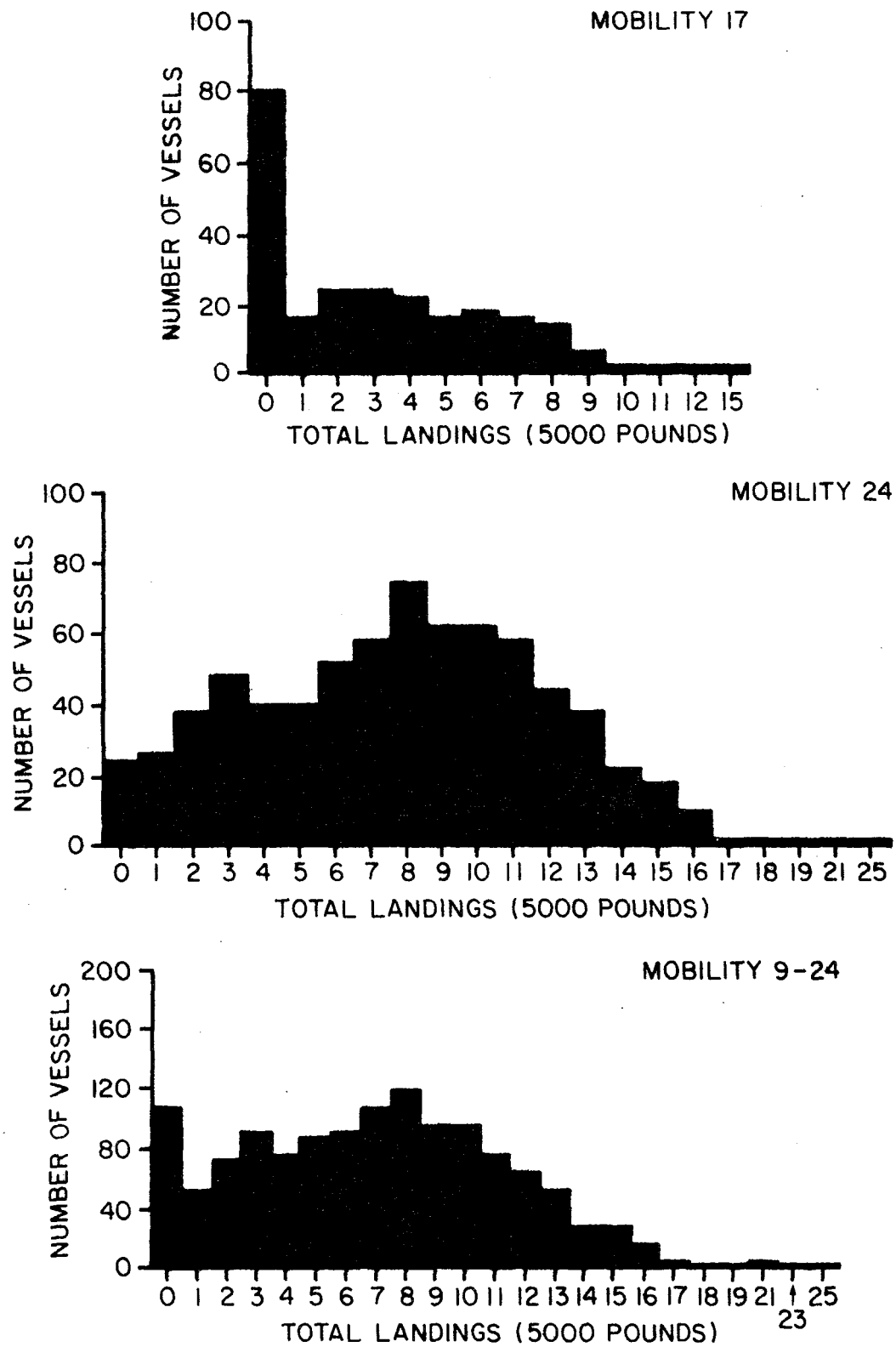

Figure 9. Frequency distributions of the number of vessels, by total landings in 1981, for all Texas vessels (mobility classes 9-24), vessels that fished in Texas waters only (mobility class 17), and vessels that fished in Louisiana and Texas waters (mobility class 24).

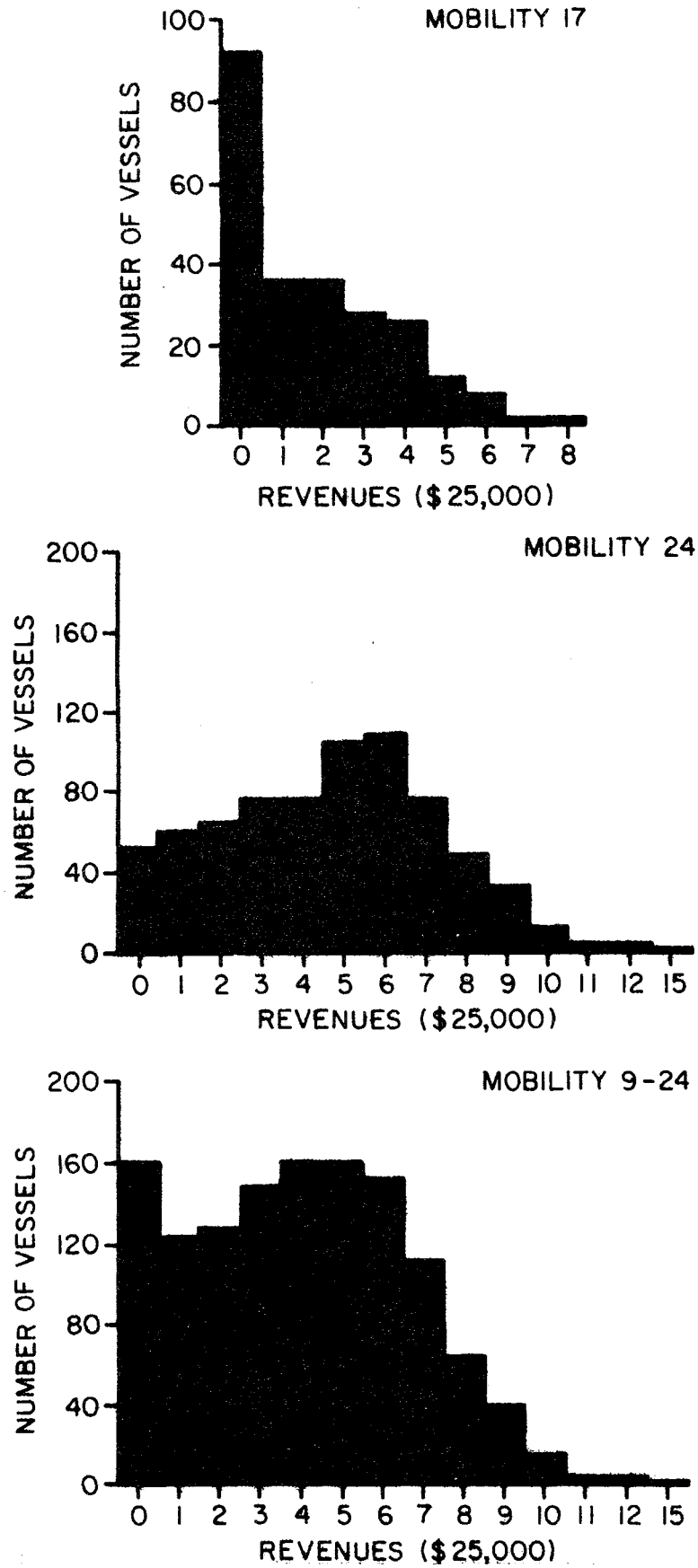

Figure 10. Frequency distributions of the number of vessels, by total gross revenues in 1981, for all Texas vessels (mobility classes 9-24), vessels that fished in Texas only (mobility 17), and vessels that fished in Louisiana and Texas waters (mobility class 24).