Shrimp Vessel Efficiency Studies

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Recent statistics compiled by the U.S. Fish and Wildlife Service indicate that approximately 6,000 vessels of various types and sizes are engaged in the shrimp fishery in the South Atlantic and Gulf areas. Of these, about 3,000 were constructed since 1945. No changes have been made in the basic design of the vessels, although sizes have increased. New types of main and auxiliary engines, shafts, and propellers were installed; radio telephones, depth recorders, direction finders and auto-pilots become standard equipment on all vessels over 60 feet. Some have been fitted with additional specialized electronic equipment. New types of insulating material are being used for the holds, and new types of freezers are being used. Also there has been a tendency toward steel hull construction. There has been almost no research to determine either the contributions of the various pieces of equipment aboard a shrimper toward more efficient operation, or the cost advantages of this equipment. There has been no information available on what appear to be the structural and mechanical weaknesses in shrimp vessels which consistently contributed toward the reduction of effective fishing time, and increased the hazard of operation.

The purchase of a new boat (from $30,000 to $60,000, depending on size and equipment) obviously represents a large initial investment, with high yearly operating expenditures. The fixed costs of operation which are independent of the catch are determined by the efficiency of the vessel and the quality of maintenance. For example, a Tampa trawler, fishing Campeche during 1954, used $500 to $600 worth of diesel fuel and $300 worth of ice per thirty-five day trip, irrespective of catch or the price of shrimp. The expense of hauling, painting, repairs, amortization and depreciation, bear little short term relation to the yearly vessel catch and its value. In other words, the operation of a shrimp trawler is based upon a high fixed cost, resulting in great profits during favorable times and similarly large losses during recession. Under these circumstances, the need for maximum vessel efficiency and the economical operation is the key to profitable shrimping.

Many factors enter into the determination of what constitutes an efficient shrimp fishing vessel. Such a vessel spends a minimum of time idle at the dock or in the repair yards and is properly maintained. When at sea, it proceeds directly to the fishing grounds, and spends a minimum time en route to and from the grounds. On the trawling grounds, when under the command of a good skipper and crew, the efficient vessel will keep its gear in operation for the maximum time. The gear will also be attended to and last longer. Biological factors being equal, an efficient vessel then produces a high catch at low unit cost.

The various activities engaged in by the shrimp vessel are outlined in Table 1. The relationship between the various factors determining vessel efficiency can be visualized best from Table 2.

To isolate the vessel efficiency from the biological, human and weather factors, it is necessary to reduce the latter elements to constants. These can be approximated by selecting vessels fishing similar grounds during the same

TABLE 1
Breakdown of Vessel Time

Vessel Time	Time at Sea	Fishing	— Income
		Anchored	Expense
		Running	
	Time at Dock	Unloading	
		Refueling	
		Icing, etc.	
	Time under Repair	Ways (hull)	
		Engine	

periods of time with crews of nearly the same experience. In similar fashion, the human elements can be isolated by equating the vessel, biological, time and weather factors.

The objectives of this short, six months, study made for the U.S. Fish and Wildlife were to determine the breakdown of vessel time for vessels operating out of eleven major shrimp ports, analyze their catches, fuel and ice consumption, and relate these to the construction of the vessel, the equipment aboard, and the crew.

Field work included coverage of eleven ports ranging from Atlantic Beach, N.C. to Brownsville, Texas. Early work on the project indicated that in order to obtain the information necessary, the number of vessels to be surveyed would have to be increased from the original thirty. The sample was therefore expanded to seventy-one vessels. Even this number is small compared to the 6,000 vessels operating in the fishery. Consideration of the many fields encompassed by vessel efficiency, the many areas to be covered, and the time restrictions imposed by the amount of contract funds, much of the work should be regarded as background material, requiring further research, using larger samples, and perhaps concentrated in a smaller area. In the opinion of the authors, the present data form a basis for a comprehensive study in this field.

Breakdown of Vessel Time

Table 3 shows the time breakdown for vessels operating from various areas.

Much of the vessel time at the dock is essential for loading, unloading and routine maintenance of the vessel. Vessels fishing the Campeche banks from Tampa, Fla., make the most efficient use of vessel time, with less than 25 per cent spent at the dock. Actual fishing time for the Tampa fleet is almost identical to that of vessels fishing local grounds from Key West, Fla., to Biloxi, Miss., and Brownsville, Texas. To be able to spend as much as 25 per cent time fishing, the Tampa vessels must spend a greater amount of time at sea. Therefore, their operations are the most vulnerable to depression of shrimp prices or reduction of catches. This is emphasized by the fact that most of the Brownsville fleet fished the local grounds in 1954 when catches on the Campeche banks were reduced.

At first glance it appears that Key West, Tampa, Biloxi, and Brownsville vessels spend much (30-35%) non-productive time at sea. However, the crews are small, with two or three men per vessel. If fishing time of nine to twelve hours per night is considered together with the additional time spent

TABLE 2

FACTORS INVOLVED IN VESSEL EFFICIENCY

POUNDS CAUGHT—VESSEL		*X* *CREW*		*X* *BIOLOGICAL FACTORS*	*X* *WEATHER AND OCEANOGRAPHIC CONDITIONS*
Hull	Construction	Captain	Initiative	Abundance	Hurricanes
	Dimensions		Experience	Availability	Rough Weather
	Power		Age	Size Count	Harbor Conditions
	Ice and Fuel Capacities		Race	Depth Fished	Tides
	General Design		Owner or Hired	Seasonal Variation	
Auxiliary Equipment	Generators	Crew	Number		
	Battery		Experience		
	Winches				
	Booms				
	Cables				
	Pumps				
Navigational Aids	Loran				
	Direction Finder				
	Radio Telephone				
	Fathometer				
	Automatic Pilot				
	Fischlupe				
	Radar				
Fishing Equipment	Net Size and Type				
	Mesh Size				
	Doors				
	Cable Arrangement				
Port and Repair Facilities	Ways				
	Dockage				
	Net Repairs				
	Electronic Repairs				
	Engine Service				

TABLE 3

HOUR AND PER CENT BREAKDOWN OF VESSEL TIME

FISHING DIFFERENT GROUNDS OUT OF DIFFERENT PORTS.

		TIME AT DOCK		*TIME AT SEA*					
				Running Time		*Fishing Time*		*Non Productive T.*	
Fished out of:	*Area Fished*	*Hours*	*%*	*Hours*	*%*	*Hours*	*%*	*Hours*	*%*
Rockville, S. C.	Offshore	7275	83.0	228	2.6	1257	14.4	0	0
Thunderbolt, Ga.	Offshore	6139	70.1	219	2.5	1751	20.0	651	7.4
Mayport, Fla.	Offshore	7033	80.3	314	3.6	1413	16.1	0	0
Key West, Fla.	Tortugas	3529	40.3	458	5.2	2180	24.9	2593	29.6
Tampa, Fla.	Campeche	2175	24.8	1195	13.7	2246	25.6	3144	35.9
Biloxi, Miss.	Offshore	2940	33.6	567	6.5	2248	25.6	3005	34.3
Brownsville, Tex.	Offshore	3391	38.7	192	2.2	2220	25.3	2957	33.8

heading and icing the catch, little time remains if the crew is to obtain an adequate amount of sleep. Some of the more ambitious crews make or mend nets during this free time. Others fish for snapper or grouper with hand-lines. At present, the fish houses handling snapper and grouper discourage the production of fish on a part-time basis by the shrimp vessels.

To determine why repairs are necessary, a study of damage and claim records for shrimp vessels was made during the period between 1952 and 1955 from insurance company files. A summary of this information shows that the accidents can be divided into two general categories: a) those due to the negligence and errors in judgment of the captain or crew and b) those due to mechanical failure of the vessel equipment. Some of the latter may be attributed to poor maintenance of the equipment by the crew or by shore personnel.

About 28 per cent of the accidents reported in the files made available to the investigators were the direct result of human error. Many of the mechanical failures may have been avoided had proper preventative maintenance been practiced. About 13 per cent of all accidents resulted from careless or inexperienced vessel handling and were avoidable. A proper crew training program could, perhaps, have reduced the incidence of this type of accident.

About 20 per cent of all mechanical failures were attributed to reduction gear and clutch mechanism failure. Hydraulic clutches appeared to be less vulnerable. The weakening of rudder fastenings, perhaps by electrolysis and the disablement of the steering mechanism, caused about 17 per cent of accidents. Of five fires, three were caused by inadequately protected exhausts and two by faulty wiring. Four accidents were associated with inadequate anchorage. Two breakdowns were caused by water in the fuel.

Many of the above accidents, which resulted in large claims to the insurance companies involved, might have been avoided with systematic inspection and maintenance of the equipment. A check list for captains and shore mechanics is suggested as an aid in this direction.

Hull Construction

• Until the discovery of the pink shrimp grounds off the Dry Tortugas and Campeche, Mexico in 1950 and 1951, most vessels were built by shipwrights scattered along the coastline. Construction was slow but apparently quite thorough. The sudden demand for more and larger vessels requiring increased financing developed a new trend in the industry. In ordering a vessel the fisherman gave foremost consideration to the delivery date, financing, and price of the vessel. To meet the problem of rapid delivery and low construction costs a number of yards started to mass produce vessels. Hundreds of vessels were constructed in spite of the shortages that developed in skilled shipwrights and various kinds of lumber used in boatbuilding. The importance of regular vessel maintenance cannot be overestimated. The best constructed vessel will deteriorate rapidly if not attended to.

Navigational and fishing aids, electronic devices such as radio-telephones and depth recorders were evaluated. Radio transmitters usually range from five watts output to the maximum permissible of 150 watts. Some sets are increased beyond this point. In many cases the sets aboard the vessels are inoperative, at least part of the time. One of the main reasons is, apparently, that the 32 volt bank of batteries is charged by generators and voltage regulators that are set to cut out at about 36 volts. This constant overload on the electronic equipment shortens the life of the tubes, resistors, and condensors in the sets. The introduction of rheostats in the system added to this problem as captains, in attempting to increase the power of their signal, turn up the rheostat, and, of course, contribute further to the voltage overload.

Interviews with radio technicians revealed that many radio-repairmen attempt to fix sets with which they are not familiar. In addition, there are, reportedly, captains and crew members who try to repair the equipment themselves and further aggravate the condition of the set. It has been reported that inadequate copper wiring, insulation, copper-grounding, aerials, and improper crystals are common in the fleet. It is believed by technicians that many of the sets operate at about 50 per cent below their theoretical output.

The depth-recorder is one of the most useful tools in increasing the efficiency of vessel operation if full advantage is taken of the recordings. The author's personal experiences, combined with interviews held during the current survey, indicate that many captains are not well instructed in the care and use of the device. A tendency exists among many captains to use the recorder intermittently to conserve recording paper, thus defeating one of the more important functions of the instrument, that of detecting rough bottom where gear will be lost. Recently "Echographs" of German manufacture have been installed aboard some shrimp vessels. These have proved to be superior to other similar products.

The above were examples of the type of information which has been obtained.

Productivity

We investigated the productivity of various grounds when fished by various vessels. The number of vessels surveyed was relatively small and figures are therefore of general interest only. A study of the catch per night fishing indicated that the vessel success depends to a large extent on the season and grounds fished. For example, two 67 foot vessels fishing half the year at Tortugas grounds, and half at Campeche, caught 261 and 267 pounds per night. The same sized vessels fishing only Campeche grounds during the year caught 30 to 80 pounds more per night fishing. Vessels of the same size, fishing the Brownsville grounds, caught an average of 278 to 417 pounds per fishing night. Forty to fifty foot vessels fishing the Mayport, Fla. grounds all year round caught 65 to 97 pounds per day while the same class of vessel fishing from Rockville, S. C. caught an average of 172 to 197 pounds per day. In this case, the latter vessels were more highly powered. (See Table 4.)

TABLE 4

RANGE OF CATCHES PER DAY/NIGHT IN VARIOUS AREAS DURING 1954

Port	*Grounds*	Catch in lbs. (headless)		
		Jan.-Apr.	*May-Aug.*	*Sep.-Dec.*
Thunderbolt, Ga.	local	——	119-169	184-328
Key West, Fla.	local	150-222	144-177	203-285
Biloxi, Miss.	local	70-124	313-330	180-244
Brownsville, Tex.	local	142-288	248-342	483-651

Engine Power

The importance of power was investigated. Five larger vessels, each powered by a total of 330 horsepower, were compared with a similar number of vessels of the 67 foot class, powered by a total of 170 horsepower. The catches for Campeche ranged from 415 to 496 pounds per night, headless, by the larger vessels, while the lower powered vessels had catches ranging from 291 to 342 pounds. These were non-owner vessels. A captain-owner with a large vessel powered by 330 horsepower produced 725 pounds, while a similar smaller vessel with half as much power produced 278-417 pounds per night. Higher production does not mean that they operated more efficiently or economically.

Most of the vessel owners interviewed agreed that the skill of the crew was the most important single factor in obtaining efficient vessel operation. They claimed that owner-operated vessels, as a rule, fished more days per year, thus increasing their catch, and had lower maintenance costs through proper handling and care of their gear. This is borne out by the fact that the smallest vessel of the group with the least horsepower, but owner-operated, produced the best total catch per night in a certain area.

Comparisons were made of fuel consumption by Key West, Biloxi, and Brownsville fleets. The lowest daily fuel consumption was recorded by the Biloxi fleet, the highest by Brownsville. It was of interest to note that the Brownsville fishing vessels used nearly twice as much fuel as the Key West vessels, even though the engines used were similar. Shrimp production in the Brownsville area was considerably higher, however, thus nearly equalizing the cost of production. Apparently the vessels fished harder and/or more efficiently.

In conclusion, our preliminary survey indicates that improvements in vessel maintenance will increase the life of the vessels. A detailed study of this complex problem of design and construction would point out to the prospective vessel owner what to demand in construction, the hull shape and power best suited for shrimp fishing. It is also felt that in order to obtain a comprehensive picture of the efficiency of the different elements in the vessel, one important fishing area be selected for detailed study. Records for several years should be obtained on more vessels to confirm the indications presented in this paper.

A Study of the Efficiency of Domestic Shrimp Processing Plants

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THIS WORK, carried on for the Fish and Wildlife Service, is specifically an industrial engineering survey, designed to check the efficiency of operations and processes in shrimp processing plants throughout the United States. The project, along with a similar one which First Research Corporation is carrying on aboard shrimp fishing vessels, is an integral part of the over-all Fish and