

During periods of moderate abundance there is a one month delay from the time the shrimp leave the estuary until they appear in the commercial catches. In times of high abundance this delay may be up to two months. Work is under way to increase the precision of calculating both the index of abundance of migrating juveniles and the catch per unit of effort of small shrimp in the fishery.

Exploratory Fishing off the Orinoco Delta

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Abstract

From August, 1962, until May, 1964, five exploratory fishing expeditions were made off the Orinoco Delta. Trawling for shrimp and fish was done by a 75-foot shrimp trawler. The explored area was between 8°30'N and 9°50'N; 59°40'W and 61°30'W between 4 and 170 fathoms. Three different areas important to commercial fisheries were found.

Off the continental slope, below 150 fathoms, the bottom is rocky and valuable species seem very scarce. Some specimens of *Merluccius albidus* were caught.

FROM AUGUST, 1962, to June, 1964, the LaSalle Foundation surveyed the fishing resources off the Orinoco Delta. The main goal of the exploration was to collect information regarding the possibility of establishing commercial fishing in the area to provide sea food for the people newly settled near the industrial centers of La Guayana. The exploration was sponsored by three government institutions: the Corporación de la Guayana, the Corporación Venezolana de Fomento, and the Fondo Nacional de Investigaciones Agropecuarias del Ministerio de Agricultura y Cría.

The exploratory vessel

The exploratory vessel used in the survey was the shrimp trawler NEREID, similar to many trawlers operating in the Gulf of Mexico and off the eastern coast of the United States. The NEREID is 75 feet long, 96 gross tons, and powered with a 154 hp diesel engine.

On the first three of the five expeditions we used two shrimp nets with two-inch mesh in the cod end. On the last two trips, we alternately used nets with two-inch and four-inch mesh in the cod end.

The catch was analyzed for potential commercial fishing. The catch per hour per net represents "the catch per unit of effort".

The first expedition—August 26 to September 4, 1962

The main goal of the first expedition was to survey a wide area to discover the best fishing grounds, from the view point of sea floor characteristics and the variety and quantity of fish and shrimp at the various depths. We worked between 3 and 163 fathoms in an area of 250 square miles between 8°40' and 9°55'N latitude and 59°40' and 61°10'W longitude.

At depths of 3 to 14 fathoms, the sea floor is muddy and usually suitable for trawling. At times, the Orinoco deposits large quantities of debris that may be detrimental to the nets. Beyond the 5 fathom depth curve we did not

encounter trawling difficulties. The fauna was composed largely of many species of bagres, clupeids, and sciaenids typical of brackish waters. The only shrimp found in commercial quantities was *Xiphopenaeus kroyeri* mixed with small bagres, which made separating them difficult.

At depths of 15 to 35 fathoms, the sea floor was also muddy and suitable for trawling, but it was cleaner than the previous depth of 3 to 14 fathoms. Commercial fish found at this depth were mainly sciaenids, the most commercially important being corvina or seatrout (*Cynoscion virescens*) and roncador or drum (*Micropogon furnieri*). *Penaeus brasiliensis* and *P. aztecus* were caught but not in commercial quantities.

At depths of 36 to 60 fathoms, the sea floor was rocky, damaging our nets several times. The fauna changed considerably, with the most important species being small serranids, mullids, and scorpaenids. A fish of some commercial value and fair abundance was a small serranid, probably *Pristipomoides macrophthalmus*. Shrimp were scarce and of no commercial importance.

Finally, at depths of 160 to 170 fathoms, only two attempts were made, damaging the nets both times. The yields were stones and a small sample of fish of which the *Merluccius* sp. could be of some commercial importance.

This first expedition was designed to survey the area. Data of a commercial nature are given later in the paper.

The second expedition—December 11 to 18, 1962

Since the first expedition was made at the height of the rainy season which produces the largest outflow of fresh water from the Orinoco, the aim of the second expedition was to collect information on the influence of the river upon the distribution of commercial fish and shrimp. The same depth and a similar area were sampled.

The results of the first expedition were confirmed in the second expedition. Optimum depths for commercial exploitation were found between 15 and 30 fathoms. The range of the brackish water species had expanded a little offshore but no substantial changes were found. Beyond 30 fathoms, catches were extremely poor; and at 160 fathoms, the catch was of no commercial value. The best catch was made at 20 fathoms with 30.4 kg of fish per hour per net, and 13.8 kg of shrimp per hour per net.

The third expedition—April 22 to 30, 1963

With the results of the two previous expeditions in mind, we changed our program and trawled only in the depths and on the kinds of sea floor which seemed most interesting from the commercial point of view, that is, between 15 and 30 fathoms.

Between 13 and 22 fathoms, catches were commercially important. The sea floor was clean with no trawling obstructions. At these depths, corvina and roncador were dominant, usually of large size and weight like those found in an unexploited area. At 16.7 fathoms, the catch per hour was: sea trout, 105 kg; drum, 15 kg; shrimp, 22.2 kg; unusable, 75 kg; a total of 217.2 kg per hour per net.

From 22 to 25 fathoms, catches were poor and the variety of fish were of little commercial value.

Beyond 25 fathoms, there were no dominant species of commercial value, rather an increased proportion of invertebrates, molluscs, and crustacea.

In considering the results, we must remember that the nets used were for

shrimp, not for fish. Shrimp were surprisingly scarce in all expeditions. The largest catches of brown shrimp were 15 to 22.2 kg per hour per net which would be of the little commercial value.

The fourth expedition—October 12 to 16, 1963

Since the October rains are usually heavy, the bottom between 6 and 15 fathoms was littered with debris and the nets were damaged twice. Again, the nets were damaged by the rocky bottom between 38 and 45 fathoms.

The catches were considerably poorer than in April. The most profitable catches were made between 15 and 28 fathoms. Between 17 and 25 fathoms, catches of 80 to 120 kg of fish per hour per net were normal. Shrimp, except *X. kroyeri*, were scarce in shallow water and depths to 22 fathoms.

Corvina and roncador were scarce, but small sharks, commercially valuable in eastern Venezuela, were abundant. The difference in the catches of corvina and roncador compared with previous expeditions could be explained in part by some local migration due to the large flow of fresh water from the Orinoco.

The fifth expedition—April 28 to May 1, 1964

On the last expedition, the main goal was to gather reliable data on a day's catch of corvina and roncador. The ship worked for two days in approximately the same area making five 2-hour trawls per day between 16 and 24 fathoms. Most of the trawls were at 20 to 21 fathoms.

The results were encouraging even though we worked with shrimp nets. Between 80 and 104 kg per hour per net of commercial size corvina and roncador were caught in many trawls, with a total catch of 340 to 530 kg of fish per hour per net. Perhaps 20% more were lost due to the size of the improper net. Also caught were 25 kg of "sea bob" or *X. kroyeri* per hour. The possibility of catching 1½ to 2 tons of commercial fish per day, including 1 to 1½ tons of corvina, appears promising. Both corvina and roncador have market value.

For favorable results, a net of three inches in the cod-end would be advisable. Better catches are possible assuming that normally a ship can make between 8 and 10 trawls per day.

Conclusions

From the five expeditions we can conclude the following:

1. Near the Orinoco Delta, between 3 and 160 fathoms, shrimp appear to be scarce. The exception is *X. kroyeri*, abundant between 3 and 16 fathoms and as deep as 20 fathoms.

2. Between 3 and 13 fathoms, there are large quantities of fish, mainly small bagres of many species; small clupeids such as *Chirocentron* sp., *Odonthognathus*, *Ilisha* sp., and some *Harengula* sp.; engraulids such as *Anchoa spinifer* and *Lycengraulis barbouri*; small sciaenids as *Stellifer*, *Ophioscion*, and *Macrodon ancyclodon*. Among the abundant elasmobranchs are rays such as *Dasyatis geiskesi* and small sharks as *Mustelus higmani*. Occasionally large bagres and snook (*Centropomus undecimalis*) were caught. The sea floor is usually dirty due to the outflow of the Orinoco. At these depths large commercial exploitation appears unprofitable, but there may be some value for small local fisheries.

3. Between 13 and 25 fathoms, the best possibilities exist for development of commercial fishing to supply sea food to the growing industrial centers of the Venezuelan Guayana. The sea floor is clean and free from trawling hazards.

The two main species are corvina (*Cynoscion virescens*) and roncador (*Micro-pogon furnieri*).

4. Between 25 and 60 fathoms, the sea floor is rocky. A topographical survey and fishing charts would be necessary before attempting any commercial exploitation.

5. The loss of our nets twice off the continental shelf prevented us from collecting data in this area. It would be advisable to conduct topographical surveys of this area before conducting further exploratory fishing.

The Shrimp Fishery in Western Venezuela

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Abstract

Shrimp is the most valuable fishery in Venezuela. This fishery has developed rapidly over the last six years and shows indications of further development. Approximately 98% of all shrimp fished in Venezuela (3.9 million kg in 1963) come from the Lake of Maracaibo and the Gulf of Venezuela. Most of the production is exported to the United States as frozen product.

The Instituto Venezolano de Investigaciones Cientificas, with assistance from the University of Miami Institute of Marine Science, has begun a study of various biological and technological problems connected with this young fishery. The work is being supported by the Venezuelan Ministry of Agriculture.

Two methods of fishing are used. A fleet of trawlers fish the large shrimp in the Gulf, and numerous fishermen using large beach seines and cast nets fish the small shrimp found in the shallow waters of the adjoining Lake.

Preliminary investigation has shown eight species of shrimp (two caridean, six penaeid) to be present in commercial catches. Five of the penaeid species occur in large numbers. Programs of commercial and supplementary sampling, tagging, and post larval sampling, plus studies on maturation and larval and postlarval identification are designed to increase the knowledge of a previously neglected fishery.

SHRIMP IS TODAY Venezuela's most valuable fishery product (Table 1). In 1963 a total national production of more than 8.5 million pounds was reported. This was worth approximately \$1.4 million to the fisherman; because of its prime importance as an export item, its value to the economy of the country is substantially greater. More than 7 million pounds of processed Venezuelan shrimp was marketed outside the country in 1963 (Table 2), with by far the largest amount going to the United States.

Western Venezuela produces over 98% of this shrimp (Fig.1), and is responsible for the large increase in total Venezuelan production over the last few years.

Thus it is evident that western Venezuela possesses another valuable natural resource besides the petroleum that has made it so famous. But whereas petroleum reserves eventually will expire, the fishery has the potential of continual production, if wisely exploited.