where the 'sugpo' spread without the necessity of handling them.

3. Observations made during limited periods on the rate of growth of the shrimp are recorded. Studies should be undertaken to find out suitable feed when the natural food is exhausted.

4. The low rate of survival may be due to predators as well as to the difficulty encountered in the total cropping of the stock. It is necessary to stock 'sugpo' in ponds which have previously been cleaned, drained and dried so as to reduce the danger of predation to a minimum.

5. Proper pond layout and construction may also eliminate the cumbersome methods of collecting and transplanting the stock. Studies should also be made to develop appliances to facilitate harvesting, such as are used in shrimp capture from natural waters.

6. The most important factor that may limit the development of this promising industry is the uncertain and limited supply of the stocking material. A nationwide survey should be made to determine 'sugpo' fry grounds and seasons as well as the feasible methods for their capture.

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SHRIMP EXPLORATION AND GEAR RESEARCH IN THE GULF OF MEXICO

by

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There is little known about the origin of the commercial shrimp fishery in the United States. Reports show that shrimp were successfully canned on the coast of the Gulf of Mexico as early as 1867. The first known commercial shrimp fishing was done with cast nets and beach or haul seines. Until 1915 all of the catch was taken with this gear, both along the coast of the Gulf of Mexico and on the South Atlantic coast of the United States. About this time the otter trawl was introduced into the fishery and rapidly gained wide acceptance, replacing almost all other gear.

The fishery developed on several relatively restricted fishing grounds along the South Atlantic and Gulf coasts, although the use of otter trawls opened new grounds in deeper waters not available to seiners. By the mid 1920's mechanical hoisting equipment had been introduced and wire cable was replacing rope for trawling warps. During the 1930's and 40's the most noticeable change was in the progressively increasing size of trawls and vessels. The various restricted fishing localities fostered the gradual development of specialized gear designs. There was relatively little liaison between fishermen and net makers from the different areas and each localized fishery used its own favourite gear. No valid comparisons could be made between the various designs.

In 1950, the consumer acceptance of two species of shrimp previously found unacceptable coupled with the discovery of new beds of these species in the Gulf of Mexico caused a sensational influx of shrimp boats from the Atlantic coast, and for the first time the popular trawls from different areas were put on a competitive basis. The Atlantic coast vessels brought in the balloon trawls and fished it in competition with the different types of flat trawls that had previously gained wide acceptance in the Gulf. Soon, fishermen who had never used anything but flat trawls were trying balloon trawls. Later, trawls embodying features of both styles were used. Some trawl makers in the north Gulf tried making balloon nets without ever having seen one, and unusual designs were produced. Gulf fishermen,

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not quite willing to go all the way with a new idea, were tying the wing tips of the balloon trawl up close to the trawl door instead of allowing the customary 15 to 30 feet between wing tip and door.

Thus, the gradual evolution that has taken place during the development of shrimp fishing equipment follows three general lines. First, there were vessel design changes that were needed to cope with the changing nature of the fishery. The trend was toward increased size permitting greater payloads and seaworthiness, and resulted in the growth of a large migrant fleet that was capable of travelling seasonally between widely scattered shrimping areas and fishing in deeper water. Second, there were deck gear and equipment changes and additions such as better winches, refrigeration, an expanding use of electronic navigational aids, and the wide-spread use of radio-telephones that effectively disseminated fishing information among the fleet. And, third, changes were made in the fishing gear itself, that is, the trawls and otter boards.

It would be impossible to enumerate the myriad of minor experiments that have taken place in the shrimp industry that have resulted in the gear that is being used today. Probably every shrimp fisherman at one time or another has tried minor gear modifications. During the course of shrimp explorations in the Gulf of Mexico by the U.S. Fish and Wildlife Service M/V *Oregon* an attempt is being made to analyze the relative effectiveness of different types of trawling gear now being used in the fishery. Attempts to select the best 'catcher' have been inconclusive. In the areas of very good fishing, no appreciable difference was found between a 74-foot balloon net and a 100-foot flat trawl. The balloon trawl caught more trash fish and less bottom debris such as shells and sponges, and the catch of shrimp was generally in better condition than catches taken by flat trawls.

Comparisons of the effectiveness of trawls are very difficult to make even when most of the factors of difference can be determined. For example, several comparative pairs of drags were made in the same place using a 40-foot flat trawl and a 100-foot flat trawl. The 40-foot net caught approximately two-fifths as much material in 30 minutes as did the 100-foot net but since the vessel travelled two nautical miles dragging the 40-foot trawl, and the 100-foot trawl travelled only one and one-quarter miles during the 30-minute interval, the relationship of the catch between the two net sizes could be coincidental. There is little question that each rig combination (net, doors, cable and boat) not only has an optimum working speed but is selective in regard to the catch to a considerable degree.

During the expansion of the shrimp fishing grounds the fishermen have come up against the same problem that trawlers in other fisheries have had. Slowly through experimentation many have been overcome; others have not. For many years it was known that certain areas around the Mississippi Delta held large quantities of shrimp but the soft mud bottom which quickly bogged the existing trawling gear prevented exploitation. In 1952 a device known as the mud rope was introduced from the North Atlantic trawl fishery and permitted utilization of many of these areas. The mud rope was nothing more than a cable wrapped with old fish netting and burlap to a diameter of four to six inches and tied directly to the ground line of the shrimp trawl.

One of the most vexing problems found on the Campeche and Dry Tortugas pink shrimp grounds was the vast accumulation of shell and other bottom debris that was picked up by the trawl and held in the cod ends, rapidly wearing through the netting and causing the loss of the entire catch. Within a year a 'shell line' had been evolved which practically eliminated this problem. This 'shell line' was simply a length of 3/8" chain shackled on each end to the trawl doors, running parallel to the ground line of the trawl and attached to it at one foot intervals with 8-inch sections of light chain or manila rope premitting the ground line (on which the net was hung) to ride up off the bottom. The shell and other debris passed between the chain and the ground line and escaped being caught.

Since the opening of the Dry Tortugas grounds in 1950, exploration has been carried out along most of the west Florida coast by the U.S. Fish and Wildlife Service, the State of Florida, and a good many individual fishermen. Although no grounds rivaling those at Dry Tortugas have been located, several indications of a fishery potential were found over a wide area. This area, however, is characterized by a heavy growth of loggerhead sponges and has even to this time held exploitation to a minimum. Occasionally small pockets of shrimp have been found in heavy concentrations. The customary procedure for the boat has been to buoy off the area and spend several days literally cleaning out the sponge beds. For the most part, this approach has required more effort than was justified by the volume of shrimp caught. Some work has been carried out on the *Oregon* developing a bottomless-type trawl that rides high enough off the bottom to avoid catching the sponge while using a tickler chain between the doors to tear the sponge loose and scare the shrimp up where they can be caught by the trawl.

Very little exploration has been carried out on live coral bottom. A few successful drags have been made using excessively heavy gear (such as 42-thread small mesh cotton netting hung on wire rope with the bottom of the net protected with heavy bullhide).

Many of the gear problems encountered during the *Oregon's* shrimp exploration have presented certain unique aspects that require lengthy experimentation. In 1950 a few catches of commercially desirable but hitherto unmarketed species of red shrimp were made in very deep water in the northeast Gulf of Mexico. Subsequent work showed that this species was found concentrated only in depths of 200 to 275 fathoms. During this additional exploratory work gear damage and loss was so excessive that the commercial potentialities appeared questionable. The bottom throughout this entire area is characterized by a cohesive mud that does not easily wash through the meshes of the trawl, often causing overloading and bogging. It was determined, through trial and error over a period of several years, that one of the most critical features involved was the amount of trawling cable that was used during a drag. If the normal ratio of length of trawling wire to depth of water was employed the gear invariably bogged and was lost. The problem of determining an optimum ratio is still under experimentation since there is an apparent ratio change with depth. However, it appears to be desirable to obtain the bare minimum length which will keep the trawl riding lightly on the bottom. Future efforts toward the solution of this problem will include the use of wire cable meters to determine the precise footage used, and dynamometers attached to the trawling wires to indicate the length of time it takes for a trawl to reach bottom when different wire lengths are used, as well as indicating how hard the trawl doors and net are digging on the bottom.

In summary, the shrimp fishery in the Gulf of Mexico and the southeastern United States is still in a state of development, and gear changes can be expected to continue indefinitely or until such a time that all local utilizable stocks have been discovered and are being exploited and the attending exploitation problems encountered are solved.

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