Mesh Size Regulations as a Possible Method of Managing the Tortugas Shrimp Fishery

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Introduction

"Florida Landings" (1950-1956) show the Tortugas pink shrimp (*Penaeus duorarum*) to support one of Florida's most valuable fisheries. The discovery of this population in 1949 and its subsequent exploitation has created an industry employing several hundred boats yearly. The fishing grounds lie north of a line drawn from Key West to Loggerhead Key in the Tortugas group. The area is about 70 miles long and 20 to 25 miles wide. There is some fishing west and northwest of the Tortugas in waters deeper than 21 fathoms, but the majority of the fishing is done in 14 to 20 fathoms. In addition to the Key West fleet, boats from Tampa, Ft. Myers, Everglades, Naples, Marathon, and other Florida ports fish the grounds. Boats from Georgia, North and South Carolina and several other states also fish the Tortugas, usually selling their catch in Key West. A few Cuban boats also work the grounds.

A reported decline in the landings of larger shrimp and possible depletion of the stocks caused by landing quantities of small shrimp (70 count and above, heads off) led the Florida State Board of Conservation to ask The Marine Laboratory of the University of Miami to make a study of the problem. Experiments begun in October 1955 were primarily concerned with net selectivity and were designed to provide an interim measure until further investigations would reveal the basic aspects of the biology of the shrimp, especially growth and mortality rates, necessary to reach a permanent solution. It cannot be overemphasized that we are not in a position to decide whether it is more desirable, economically and biologically, to catch shrimp at a small size or whether it is better to let them grow bigger. Work necessary to make such decisions is already underway, both at the University of Miami and other laboratories.

Specifically the purposes of the present study were:

1. To study the effect of different cod end mesh sizes on the size composition of the catch and the escapement of shrimp.
2. To determine the effect on small shrimp of passing through the cod end.

Acknowledgments

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Methods and Equipment

The vessel *Manboy* out of Key West, owned and captained by Andrew E.

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Downing, was used for all the regular monthly field work. She is 110 ft. in length and has a 14 ft. beam. While not a shrimp boat by design, there is no reason to believe that a trawl operated by the *Manboy* will perform any differently with regard to net selectivity than that operated by a "typical" shrimp boat. Our objective was not to see how many shrimp could be caught, but rather, what sizes would be caught and what sizes escaped through the meshes of the cod ends. The experiments are valid if the net sampled all sizes in the proportions that they occur on the grounds. The boat is only a machine to pull the net. A big boat with more power can perhaps catch more shrimp, but there is no evidence to show that it will catch different sized shrimp than are on the grounds. Greatly different trawling speed might affect sizes of shrimp caught by catching more of the faster animals. *Manboy* trawls within the range of the normal speed of regular boats.

The otter boards, or doors, used to spread the net were nine ft. long by three ft. four in. high. The bridles leading from the doors to the wings of the trawl were 15 ft. long. The trawl used was a standard 100 ft. Florida balloon shrimp trawl. A tickler chain was employed between the doors. The opening at the mouth of the trawl was about 69 feet. Four cod ends of different mesh sizes were used during the course of the work, 1¾″, 2″, 2¼″ and 2½″. These are manufacturer's measurements which were taken at the midpoints of knots. They were all made of 42 thread cotton twine. The trawl and all of the cod ends were treated with a creosote preservative before use, just as are nearly all nets used commercially in the fishery.

The cover bag used to catch the escaping shrimp and trash was sewn to the cod end about 12 meshes below the place of attachment of the cod end to allow room for the operation of the lazy line. It covered the entire cod end and extended three to four ft. beyond the end of the cod end. It was made of cotton twine with one in. stretched mesh which shrinks after first immersion to between ¾ and ⅞ in.

Fishing was done on two successive nights during the first two weeks of each month, except when inclement weather made postponement necessary. Three hauls were made each night of two hours duration over a standard sampling pattern consisting of six stations which ranged in depth from 70 to 95 ft.

The net was set and retrieved just as in a regular commercial operation. When the cod end was swung on deck at the end of the drag the cover bag was first opened and the catch from it deposited in a basket which was set aside. Then the cod end was opened and its catch allowed to fall to the deck. Estimates were made of the weight of the total catch, of the shrimp alone and of the trash, both by the skipper and the scientist on the vessel. Shrimp fishermen are fairly accurate at estimates of this type, since their livelihood depends to some extent on these estimates. A sample of the cod end catch was chosen at random, since it was impractical to measure all the shrimp taken and an estimate was made of what proportion this sample was of the total. As a rule all the shrimp from the cover bag were returned for measuring.

A head length measurement was taken from the orbital notch inside the orbital spine in a line parallel to the lateral rostral sulcus to the caudad margin of the cephalothorax. This measurement was taken with calipers to the nearest millimeter. The rostrum of a shrimp may be broken off and regenerate; thus if total length had been used, some error may have been introduced due to the variation in the length of the regenerating rostra. Measuring the total length also presents an added difficulty when working with shrimp preserved in forma-

fin. There is usually some amount of curve in the abdomen which is almost impossible to straighten out without breaking the animal in two. The relationship of carapace length and count per pound, heads off, was determined. All counts given are heads off.

For holding live shrimp on board the *George M. Bowers* a wooden tank of about 11 cubic feet was used. This was placed upon the deck of the vessel and supplied with sea water at the rate of about four gallons per minute.

Effect of Different Mesh Sizes on Catch

First it was necessary to determine if the various sized meshes (1¾″, 2″, 2¼″, 2½″) caught different sized shrimp. To accomplish this the numbers of shrimp of each size in the cod end and cover bag were added together and plotted for each sample (Figure 1). A curve was then drawn through the average points. This represents the sizes and relative numbers of the total population of shrimp available. The curve shows that in each set of samples the sizes available were much the same. This means that small shrimp were always available on the ground to escape.

To show the escapement of the various sizes of shrimp for each size of net the number of shrimp in each size category in the cod end was compared with the number in the same size category in the cover bag. Then the percentage of the shrimp in the cover bag and those in the cod end and cover bag added together, for each size shrimp, was plotted. The broken line in Figure 1 is the average curve for these points.

Since the relationship shown between the escapement and total catch curves depends in part upon the ability of the observers accurately to judge the proportion of the total catch constituting their sample, the validity of these estimates was examined. If the estimates of the proportion which the sample was of the total in the cod end had been of a random nature, sometimes too high and sometimes too low, then it should be expected that an average curve would result which would approximate the true situation. On the other hand, if the percentage escapement figures of all sizes of shrimp for individual months fell entirely below or above the average curve it would indicate that estimates of total catch in the cod end vary greatly from month to month. It was found in plotting the data that escapement points for each of the various months fell both above and below the average curve for each of the sizes of shrimp. Therefore it seems likely that the variation of the escapement of the different sized shrimp had a greater effect from sample to sample than did the estimates of total catch.

It can be seen in Figure 1 that the variability about the average escapement points is not great and we believe that our samples, taken at different times of the year, have provided reliable averages.

Escapement

That different size meshes in the cod ends caught different sized shrimp, and that approximately the same sizes were available to be caught during each month, has been shown. The next step is to determine what percentage of the various sizes escaped, and what percentage of these sizes were available to escape. Considering first the 1¾″ mesh samples taken October, November, and December, we see that the 110 count shrimp (18 mm) are so few, (only five per cent of the total catch) that the 10 per cent of this group that escapes is not important. Of the 83 count shrimp (23 mm) nearly five per cent escaped,

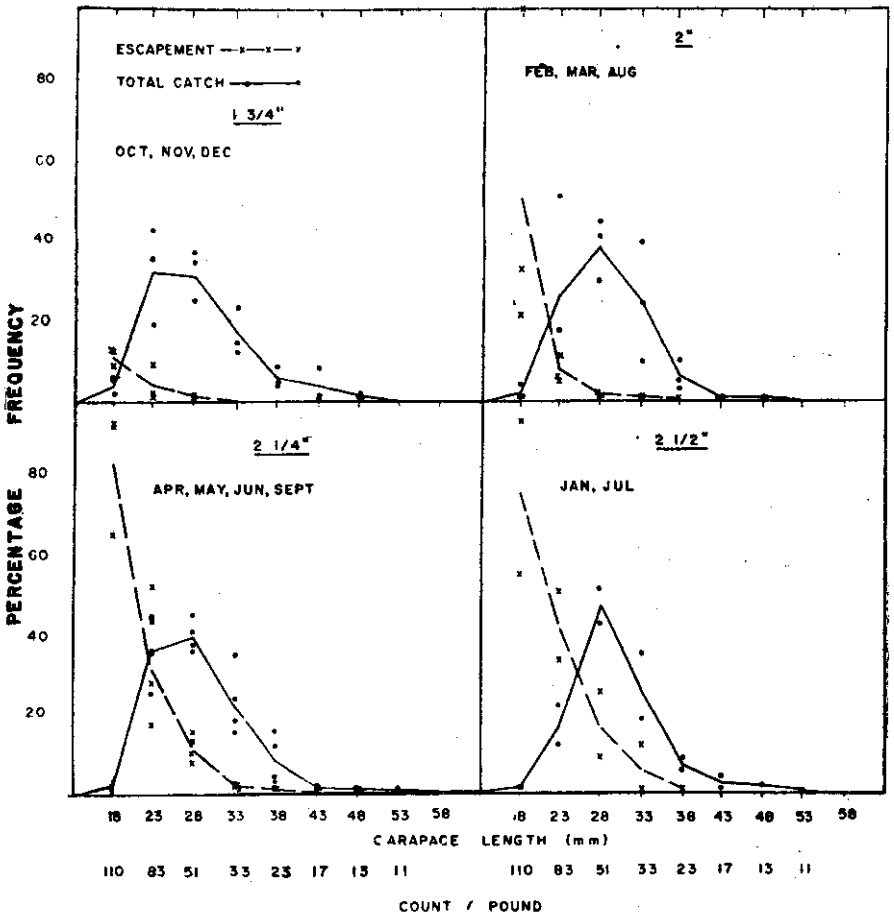

FIGURE 1. Size distributions of pink shrimp in the cod end and cover bag combined and escapement through the cod end.

and about 30 per cent of the total catch was made up of this size. Shrimp of 51 count (28 mm) and larger showed no escapement. The 2″ mesh cod end was tested during February, March, and August. Again, although escapement of 110 or greater count shrimp is high (50 per cent), so few were taken it can be ignored. In fact, this is true for the escapement of shrimp in this size category for all mesh sizes tested. The 83 count shrimp (23 mm), which formed about 30 per cent of the catch, show an average escapement of 10 per cent and practically no escapement of 51 count (28 mm) and larger.

There is a rather sharp change in the escapement from the 1¾″ and 2″ cod ends when the escapement of the 2¼″ mesh cod end during April, May, June, and September are examined. Approximately 35 per cent of the catch was made up of 83 count shrimp (23 mm) and of this amount this cod end allowed about 30 per cent to escape. Of the 40 per cent of 51 count shrimp (28 mm)

present in these catches about 10 per cent escaped. None of the 33 count (33 mm) or larger escaped through the meshes.

The 2½" mesh cod end used during January and July in general shows a slightly higher escapement than the 2¼" mesh cod end. The 83 count (23 mm) shrimp, which make up about 17 per cent of the catch, show an escapement of 40 per cent. Of the 47 per cent of the 51 count shrimp (28 mm) it can be seen that about 15 per cent escape. About five per cent of the 33 count (33 mm) escape and these made up about 26 per cent of the catch.

It can be concluded from these results, that to allow an appreciable number of small shrimp to escape a minimum mesh size of at least 2¼", manufacturer's measure is required and 2½" is too large.

Effect of Passing Through the Meshes of a Net

The question can reasonably be raised that even if small shrimp are allowed to escape, will they live after escapement? A test was therefore conducted to determine the mortality or damage to shrimp which pass through the meshes of the cod end of a trawl. To answer this question, 35 small shrimp that had passed through the 2¼" mesh of the cod end and were found in the cover bag after four hauls of 1½ to 2 hours duration were placed in the tank on deck of the Fish and Wildlife Service vessel *George M. Bowers.* During the observation period the shrimp swam about and appeared to be in good condition. Although the antennal flagella of most were found to be damaged after the experiment was terminated approximately 92 hours from the time the first shrimp was added, all lived to the end of the experiment.

From this it would seem that passing through the meshes of an otter trawl apparently does not harm small shrimp.

Sex Ratio

These experiments revealed the fact that a regulation which involves an increase in mesh size from that presently used in the fishery may well alter the ratio of sexes in the commercial catch. It has been demonstrated by Williams (1955) that the female *Penaeus duorarum* in North Carolina are larger than the males and this tendency is also clearly evident in our data. Thus, as the mesh size increases more and more males are released and the proportion of females to males in the catch increases. At this time we do not know the magnitude of this change or what effect it may have, in fact it may be very difficult or impossible to test what effect it would have, on the fishery. It is a factor to keep in mind when studying the effects of this regulation.

Conclusion

It has been demonstrated above that a method for preventing capture of small shrimp is by regulation of the mesh sizes of commercial trawls. The experiments showed that the 2¼" manufacturer's measure net would best serve this purpose because it releases significant numbers of small shrimp and few of the larger shrimp. The escaping shrimp appear to pass through the meshes of nets with little or no injury.

REFERENCES

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