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TECHNICAL SERIES

No. 42

The Status of the Florida Spiny Lobster Fishery, 1962-63

by

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THE MARINE LABORATORY

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Virginia Key, Miami, Florida 33149

August, 1963

ML 63346

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The Status of the Florida Spiny Lobster Fishery, 1962-63

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SUMMARY

1. The spiny lobster currently supports the fifth most valuable commercial marine fishery in Florida.
2. The lobster fishery has been studied from the standpoint of whether it exhibits the usual evidence of overfishing, i.e., declining total catch, declining catch per unit of effort, and decreasing size of individuals entering the catch.
3. There has been a general upward trend in total landings of spiny lobsters in Florida since 1950. The 1962-63 season shows the highest landings since the record 1957-58 season.
4. Catch per unit of effort figures obtained by three different methods show that there has been a decline through the 1961-62 fishing season. However, all three measures indicate a slight increase in catch per unit of effort for the 1962-63 season.
5. The average size of lobsters measured during 1962-63 is similar to the average size of those measured during 1945-49, suggesting that increased fishing pressure is not reducing the average size and age of lobsters entering the catch.
6. The evidence suggests that the lobster stocks of south Florida are not depleted in the biological sense. While a decline in catch per unit of effort may indicate reduced stocks, it is our view that in the lobster fishery this decline is a reflection of increasing fishing pressure upon relatively stable stocks.
7. Detailed data on the fishing patterns of a group of Key West lobster fishermen indicate that catch per trap-day decreases as the time the traps are allowed to fish increases.
8. Observations made on commercially caught lobsters during 1962-63 confirm that there is some mating and spawning activity throughout the year.
9. Spiny lobster phyllosoma larvae were removed from plankton tows taken July, 1960, through June, 1962. Phyllosoma were not numerous, although they were widely distributed geographically and seasonally. Less than seven per cent of the lobster larvae were identified as *Panulirus*.
10. It is recommended that the definition of the minimum legal size of lobsters be changed to not less than $3\frac{1}{8}$ inches from between the "horns" to the trailing edge of the carapace at the mid-dorsal line.
11. An economic-biological survey should be conducted to obtain information to formulate a management scheme. Regulations should not be instituted until a thorough understanding has been gained of lobster population dynamics, and of the economic aspects of the problem.

INTRODUCTION

The spiny lobster fishery of Florida is concentrated in the southern part of the state, mostly on the east coast of the mainland and in the Keys (Figure 1). Small landings are made in Collier, Lee, and Sarasota Counties on the west coast of Florida, but these are lobsters landed by shrimp trawlers. There is no trap fishery in these counties.

Panulirus argus is the species which supports the fishery, although occasional individuals of *P. guttatus* and *P. laevicauda* are taken. The latter two species occur as far north as Palm Beach County, but are rare (Moore, 1962). *P. argus* occurs as far north as North Carolina and the northern Gulf of Mexico, but is not present in sufficient quantities to support a commercial fishery north of St. Lucie County.

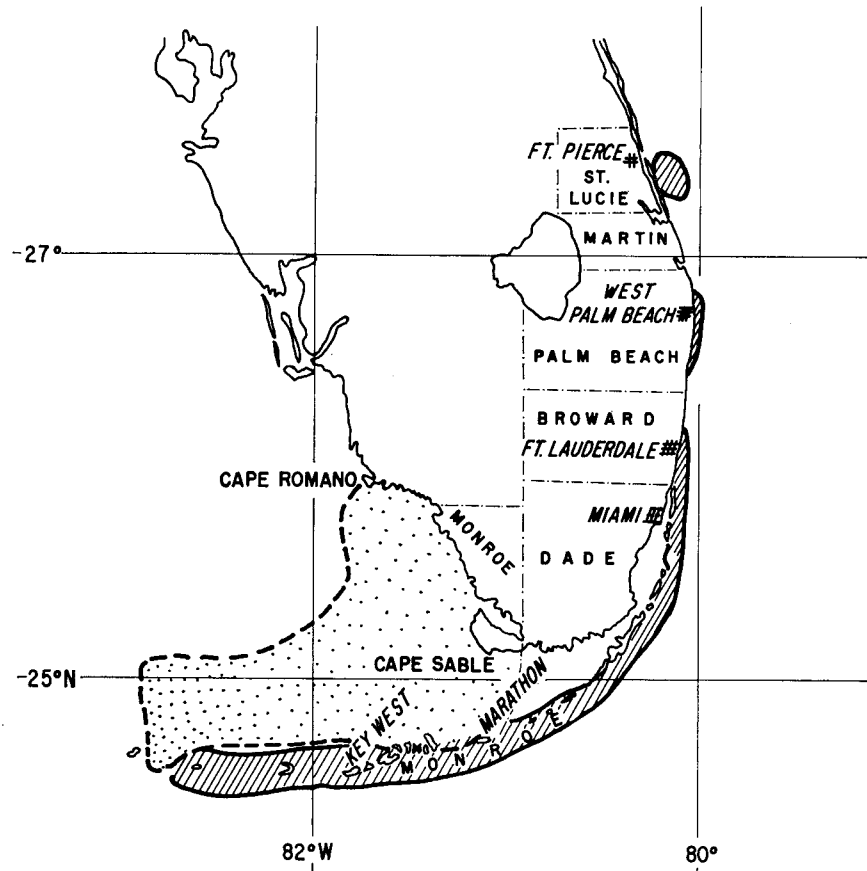


FIGURE 1. Shaded areas represent the approximate location of the Florida spiny lobster fishery. Stippled area represents the approximate area sampled for phyllosoma larvae.

The spiny lobster supports the fifth most valuable commercial marine fishery in Florida, following shrimp, lisa (black mullet), red snapper, and oysters (Rosen and Robinson, 1963). This fishery is the most valuable in Dade County, and the second most valuable in Monroe County, following shrimp in the latter area. Dade and Monroe Counties produce over 96 per cent of the Florida spiny lobster landings.

The present study, initiated in January, 1962, and terminated in June, 1963, was supported by the Florida State Board of Conservation. The objective of the study was to determine whether a reported decline in landings was due to over-exploitation. In addition, the occurrence of phyllosoma larvae was noted in plankton samples made in Florida Bay and on the Tortugas fishing grounds in connection with shrimp research.

CONDITION OF THE FISHERY

The lobster fishery has been studied here from the standpoint of whether it exhibits the usual evidence of overfishing, i.e., declining total catch, declining catch per unit of effort, and decreasing size of individuals entering the catch. Opinions of those engaged in the industry were also sought.

TOTAL CATCH

The total lobster catch in the state has shown a general upward trend over the years (Figure 2), although this trend was interrupted in the 1959-60 and 1960-61 seasons. Table 1 shows that there was a sharp increase in landings from the 1953-54 fishing season to the 1957-58 fishing season, followed by a marked decline to the 1959-60 season. Since then the total catch has been increasing steadily. The landings for the 1962-63 season were the highest since the 1957-58 season, and the third highest on record. The 3,085,270 pounds landed in 1962-63 represent a net increase of 62.5 per cent over the 1952-53 season. Since fishing effort has increased steadily over the past ten years, the record yield in the 1957-58 season and the slump in the 1959-60 season probably represent normal fluctuations in the apparent abundance of lobsters, i.e., the numbers of lobsters, affected by their availability (Marr, 1951).

The sharp declines in total catch in 1958-59 and 1959-60 were probably major factors in the alarm felt by those associated with the industry, causing some to expect a continued fall in catch; over-exploitation was feared.

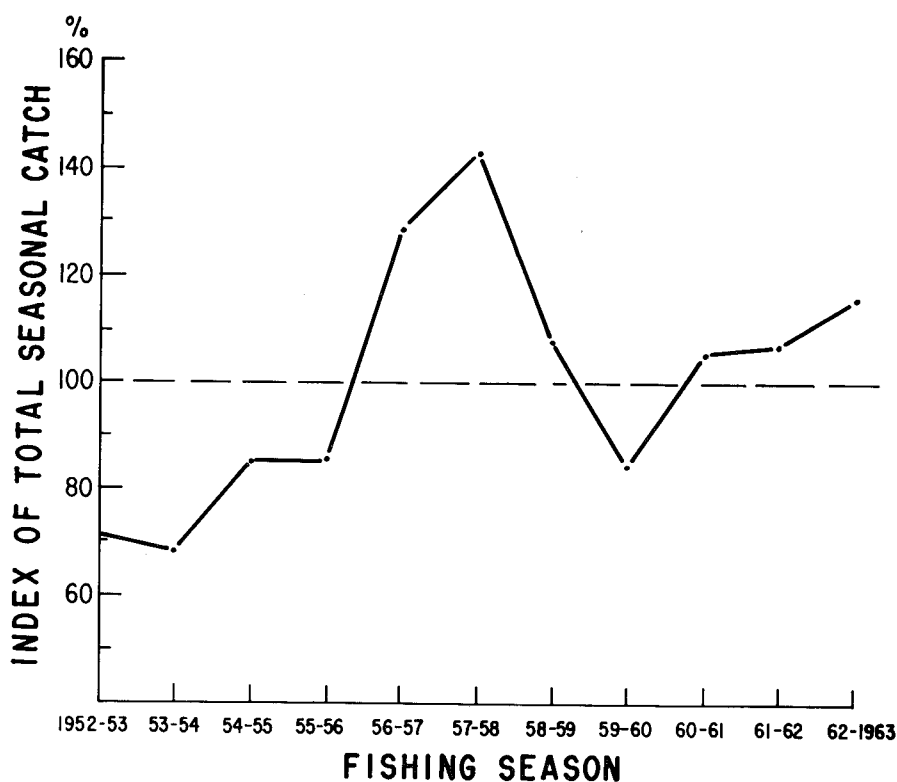


FIGURE 2. Index of catches of spiny lobsters by fishing seasons. Base = average of 1952-1962 fishing seasons.

CATCH PER UNIT OF EFFORT

Trends in total catch are affected by relative amounts of fishing effort as well as by abundance and availability, and are thus not fully reliable indices of the latter two parameters. The amount of fishing effort in the spiny lobster fishery has increased rapidly in recent years, as illustrated by the fact that requests for fishing permits have increased by 440 per cent since 1954. Meanwhile, the total catch has only increased by about 35 per cent.

There are a number of ways of calculating the catch per unit of fishing effort in the Florida spiny lobster fishery, and four were employed in the present study. These were catch per fishing permit issued, catch per man-day for the trap fishery as a whole, catch per trip for a selected sample of fisher-

TABLE 1

Landings, fishing effort, and catch per licensed fisherman for the spiny lobster fishery (1952-1962 fishing seasons).

FISHING SEASON	APPROXIMATE LENGTH OF SEASON (MOS.)	TOTAL LANDINGS* (LBS.)	NUMBER OF FISHING PERMITS ISSUED**	AVERAGE ANNUAL CATCH PER LICENSED FISHERMAN (1,000 LBS.)
1952-53	9	1,898,612	—	—
1953-54	10	1,829,087	—	—
1954-55	9	2,288,453	255	8.97
1955-56	9	2,282,333	229	9.97
1956-57	8	3,448,924	328	10.52
1957-58	9	3,842,656	636	6.04
1958-59	8	2,893,190	814	3.55
1959-60	8	2,246,989	848	2.65
1960-61	8	2,820,675	1073	2.62
1961-62	8	2,862,188	1255	2.28
1962-63	8	3,085,270	1377	2.24

*About 3 per cent of the total landings are taken by gear other than traps.

**Source—Florida State Board of Conservation. Lobster permits were not issued before 1954.

men, and catch per trap-day for a group of Key West fishermen. The results of each of these four calculations are presented below, followed by a discussion of the relative reliability of each. Only the first three of these are available for enough years to be used as indices of availability of lobsters. The other is presented as a reliable method for possible future use.

Catch per fishing permit: A sharp decline is shown since the 1956-57 fishing season, in the average seasonal catch per fishing permit issued (Table 1). The catch per permit for the 1962-63 season was about the same as that for the previous season.

The decline in catch per unit of effort following the 1954-55 season may not be as great as is shown by this method. This is because some men obtain permits but for one reason or another do not fish. Information from an officer of the Florida Lobstermen's Association indicates that some men hold the permits (which are free) from year to year, hoping to sell them in the future if the number of permits is ever limited. If the number of inactive licenses, the average number of traps fished by license holders, or the

efficiency of the gear changes significantly from year to year, this measure of catch per unit of effort may be inaccurate. However, there is no evidence that any of these variables has changed, and the errors are probably of the same relative magnitude each year.

Catch per man-day: The second measure of catch per unit of effort used was the catch per man-day for the trap fishery as a whole. A slight decline took place in the catch per man-day from the 1959-60 season through the 1961-62 season (Table 2). The average catch per man-day for the 1962-63 season rose more than 16 pounds over that of the 1961-62 season. This is probably a reflection of the increase in apparent abundance, which is also indicated by the larger total catch for the 1962-63 season.

TABLE 2.
Monthly catch per man-day (lbs.) for the lobster trap fishery.

MONTH	MAN-DAYS	1959-60 LANDINGS	C/E	MAN-DAYS	1960-61 LANDINGS	C/E
Aug.	1098	154,737	140.9	1400	184,299	131.6
Sept.	828	102,118	123.3	995	114,106	114.7
Oct.	788	116,818	148.2	848	152,279	179.6
Nov.	561	102,204	182.2	714	109,579	153.5
Dec.	438	79,864	182.3	468	65,098	139.1
Jan.	526	36,637	69.7	462	51,191	110.8
Feb.	321	34,851	108.6	361	38,897	107.7
Mar.	446	40,611	91.1	521	48,487	93.1
Season Total . .	5006	667,840	133.4	5769	763,936	132.4

MONTH	MAN-DAYS	1961-62 LANDINGS	C/E	MAN-DAYS	1962-63 LANDINGS	C/E
Aug.	1727	228,518	132.3	1702	260,786	153.2
Sept.	1430	182,019	127.3	1385	174,485	126.0
Oct.	1117	168,206	150.6	1290	161,452	125.2
Nov.	1038	144,296	139.0	1315	238,828	181.6
Dec.	654	87,848	134.3	976	201,507	206.5
Jan.*	549	62,370	113.6	683	94,102	137.8
Feb.	351	35,168	100.2	484	51,031	105.4
Mar.	443	48,621	109.8	722	76,149	105.5
Season Total . .	7309	957,046	130.9	8557	1,258,340	147.1

*Figures for Jan. - Mar. 1963 are preliminary.

These figures are based on catches recorded on fish tickets, which represent about 30 per cent of the total landings of spiny lobsters. This program was a part of the regular collection of commercial landings statistics for the State of Florida. Dealers who volunteered to take part in the program were supplied with sales receipt books on which they recorded the individual catch, the gear type used, and the number of man-days of fishing. Three copies were made, one of which was turned in to the State. These copies of individual purchases by the dealer replaced the mandatory monthly report of fish landings.

The decline shown by this measure may be less than that of the whole fishery because dealers reporting their catches on fish tickets in the 1960-61 and 1961-62 seasons probably had some more highly skilled fishermen than other dealers, particularly in the Marathon area. Their skill may have produced higher than average catches.

The catch per man-day does not fully reflect the abundance or availability of lobsters, since the number of traps which can be fished, and hence the catches, do not increase proportionately with the number of men fishing from a single boat. The average catches of three boats which sometimes carried one and at other times two fishermen were computed for several randomly selected months in the 1960-61 fishing season. The results showed that when two men were fishing together the average catch per boat per trip was increased by about six per cent over the catch per trip of one man, while the catch per man-day decreased by 47 per cent. However, unless the average number of men per boat changes significantly from year to year, the ratios among years will be comparable, and this method will serve to indicate trends in availability.

Catch per trip for selected fishermen: The third measure employed was the catch per trip for eleven selected fishermen. Those selected were full time fishermen whose records were available for several seasons. These men were probably all above average in ability and probably exhibited consistency in their manner of operation from year to year. The data were obtained from fish tickets, which were available only since 1959, and only for part of the fishery.

The catch per trip of the selected fishermen was computed by dividing the total season's catch of each fisherman by the number of landings he made during the season (Table 3). Records are available since the 1959-60 season for fishermen numbers 1-6, and since the 1960-61 season for fishermen numbers 7-11.

These data show that by the 1961-62 season, the catch per trip of eight of the eleven men had declined. The average catches of three others had

increased. The gain made by one fisherman (number 7) is probably because he fished nearly twice as many traps in the 1961-62 season than he did during the previous season. The number of traps fished by the other ten men remained fairly constant. Between the 1961-62 and the 1962-63 seasons eight men increased their catch per trip, while two showed declines; the other

TABLE 3.

Changes in seasonal catch per trip (lbs.) for selected fishermen.

FISHERMAN NO.	1959-60	1960-61	1961-62	1962-63
1	238.6	219.0	210.9	270.0
2	273.9	178.0	235.0	135.9
3	543.0	338.8	266.1	Retired
4	229.3	286.4	132.1	357.5
5	248.0	249.0	205.1	239.6
6	218.0	238.1	170.0	269.5
7	—	337.1	452.4	521.7
8	—	194.5	171.7	269.7
9	—	224.5	236.4	301.4
10	—	427.7	314.8	216.4
11	—	223.1	286.0	290.3

man (number 3) had retired from fishing. The very great increase shown by fisherman number 4 is partly explained by the fact that he only fished from August through November of the 1962-63 season, the best fishing months. Smaller catches, which bring down the seasonal average, are made in January, February, and March. Many fishermen, including fisherman number 4, quit lobster fishing after December to engage in the Spanish mackerel fishery during January - April.

This measure probably is a reasonably reliable method of measuring availability of the lobsters. It overcomes one problem encountered in average catch per trip of the whole fishery. This is that inexperienced, casual and part-time fishermen are continually entering and leaving the fishery, and their catches may affect the averages greatly. The men whose records were studied here were steady, full-time fishermen whose activities are nearly constant from year to year. Further, the data from fish tickets, both the size of landings and the number of landings, are much more accurate than those from monthly reports. On the other hand, the sample is small, and this decreases its reliability.

Catch per trap-day: A fourth measure of catch per unit of effort was obtained when the average catch per trap was corrected for variations caused by the number of days the traps were in the water. This analysis was possible through the kindness of a Key West dealer who provided detailed information for the 1962-63 season on the number of traps pulled to obtain individual catches, and the number of days the traps were allowed to fish before being pulled.

The catch per trap-day appears to be the most precise measure of availability of spiny lobsters of those used in that it takes into account the variation in catch per man-day caused by differences in the number of traps pulled by individual fishermen per trip. However, these data can only be obtained through logbooks or by other means involving considerable effort.

The catch per trap-day was compared with the catch per trip of the same group of fishermen (Figure 3). The trends of the two curves are

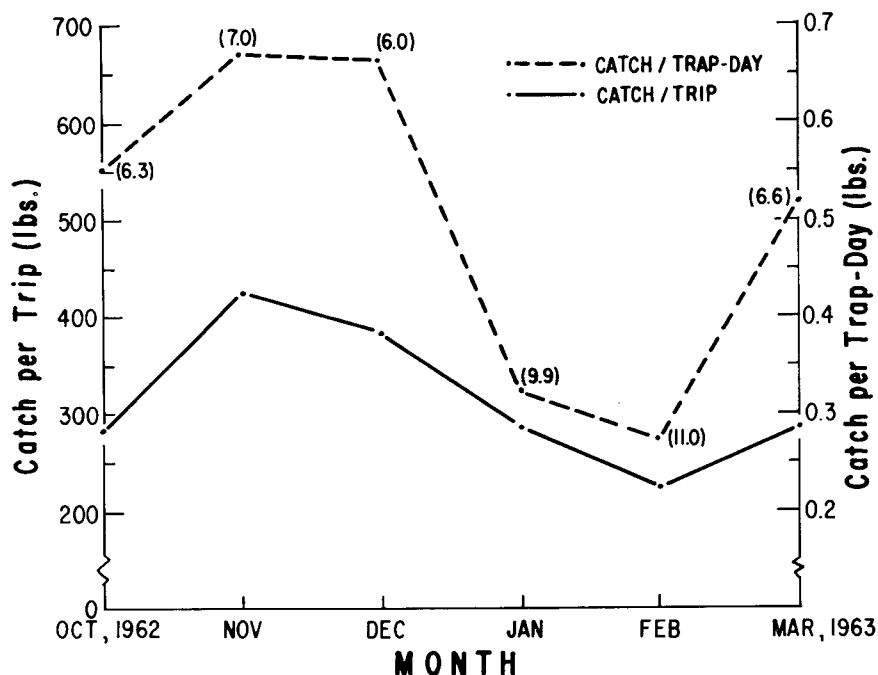


FIGURE 3. Comparison of catch per trap-day with catch per trip as measures of the catch per unit of effort of a group of Key West fishermen. Figures in parentheses are the mean number of days that the group allowed their traps to fish before each trip to pull them.

similar, although the slopes in the catch per trap-day curve are more pronounced. The sharp decline in catch per trap-day for January and February occurred when the mean number of days the traps were allowed to fish increased greatly. This agrees well with the trend in catch per trap-day shown in Figure 6.

SIZE OF LOBSTERS CAUGHT

During January - March, 1962, and August, 1962 - March, 1963, the carapace (cape) length of 3,497 lobsters was measured. These data were compared with 10,935 measurements reported by Dawson and Idyll (1951) for 1945 - 49. When the length frequencies were graphed by two mm. groups, the mode fell at about 82 mm. cape length in both samples (Figure 4). The mean size of the 1945 - 49 sample was about 85.3 mm., and of the 1962 - 63 sample, 88.8 mm.

From these comparisons it appears that there has been no important change since 1945 - 49 in the size of lobsters landed. This uniformity of sizes landed may go back much further, since Schroeder (1924) states that the average market size of lobsters in Key West in the early 1920's was 9 - 10 inches total length (75 - 90 mm. cape length).

One difference appears between the length frequency distributions of the two samples measured in 1945 - 49 and in 1962 - 63 in that the ascending limbs of the histograms are different (Figure 4). The earlier sample shows a greater proportion of small animals. This difference can be accounted for by the fact that the data for 1962 - 63 are all from the commercial catch, and are therefore truncated at the lower limit by the minimum legal size limit regulations, while during 1945 - 49 lobsters of all sizes caught in slat traps were measured. For comparative purposes, Figure 4 includes only those measurements over the minimum size limit.

Sexual dimorphism exists in spiny lobsters. The average cape length of males is larger than that of females; but among individuals of the same length, the females are slightly heavier. These observations agree with those of Crawford and De Smidt (1923). The statement by Schroeder (1924) that males are heavier than females of the same length is erroneous. The sample reported here includes more males than females (54.9 per cent).

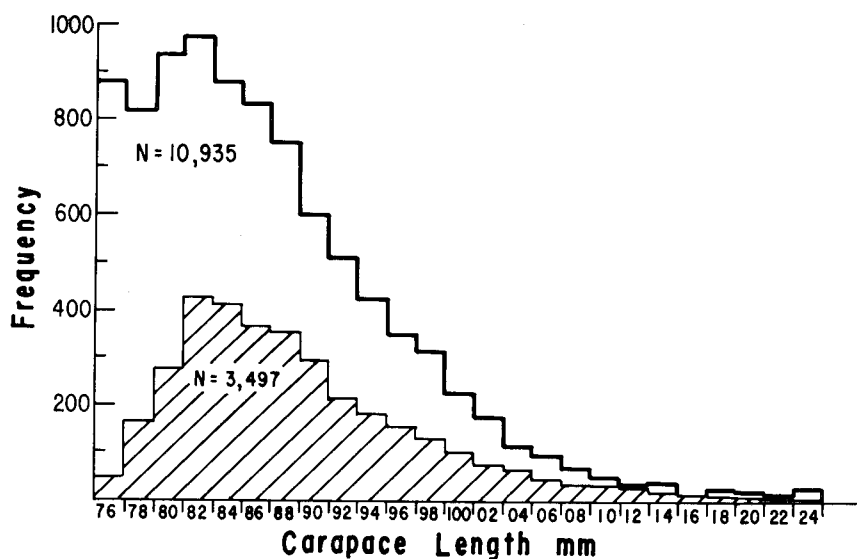


FIGURE 4. Comparison of length frequency distributions of spiny lobsters from slat trap catches made in 1945 - 49 (plain histogram) and 1962 - 63 (shaded).

STATUS OF THE FISHERY

The evidence suggests that the lobster stocks of south Florida are not depleted in the biological sense. Without trustworthy data on growth rates and mortality rates this cannot be said with certainty, since at our present state of knowledge we are unable to determine if the total yield from the fishery is as large as the theoretical maximum sustained yield. Under these circumstances the evidence of trends in total yield, catch per unit of effort, and average size of animals caught is used to draw tentative conclusions.

Two of these lines of evidence, total catch and average size of lobsters, suggest that the stocks are not reduced in abundance compared with years past. The catch per unit of effort shows a decline, and this may indicate reduced stocks. However, since the amount of fishing effort has increased rapidly during the period the catch per unit of effort has gone down, it is possible that this decline is a reflection of many more traps sharing a stable quantity of lobsters. It is our view that this is the situation at present. This opinion is also generally shared by the fisherman and lobster dealers whose views on the point were sought. Many believed that lobsters were as abundant as formerly; some even thought there were larger numbers than in many years past. Most fishermen believe that so much effort is being applied to the fishery that profitable fishing is becoming increasingly rare.

OPTIMUM FISHING PATTERN

From the data on catch per trap corrected for the number of days between hauling, it was possible to determine the effect of increasing fishing time on the catch of the individual trap, and hence to determine the best fishing pattern in terms of the number of days between hauls.

The catches were totaled for all trips throughout the season in which the traps had been fishing for two days, and the total divided by the number of traps used in making these catches. This procedure was repeated for all trips where the traps had been allowed to fish for three days, four days, and so on. Data from a total of 556 trips from October 11, 1962 to March 31, 1963 were examined. Of these, 553 trips were made to pull traps which had been allowed to fish from 2 to 30 days, two trips were made to pull traps which had been out 60 days, and one to pull traps which had been out 80 days. The last three trips were not included in the total since they represent unusual cases.

These data are shown in Figure 5, in which the curve was fitted by eye to computed points which represent the average catch per trap for groups

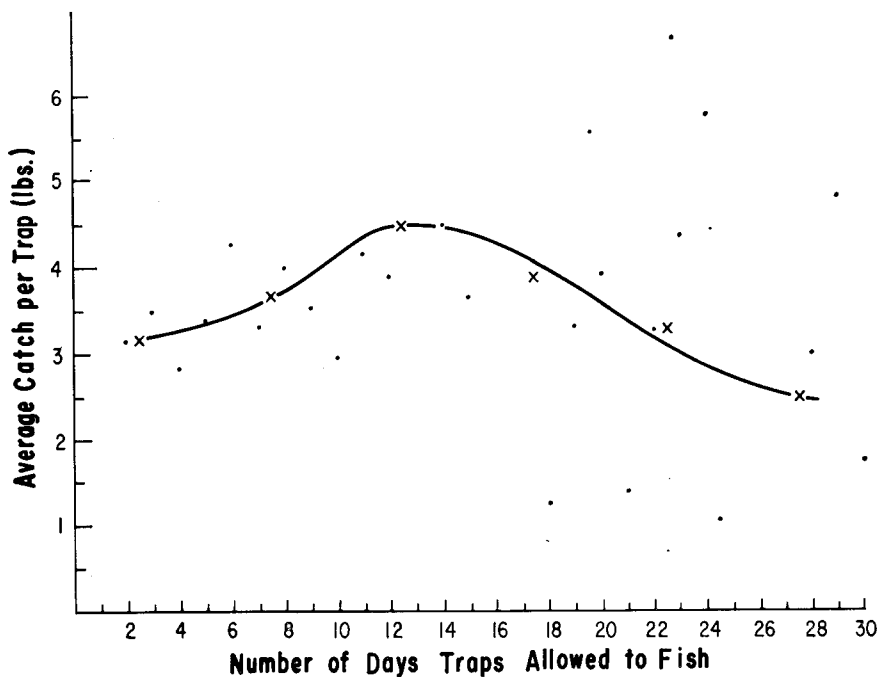


FIGURE 5. Change in average catch per trap with varying lengths of time between trips to pull the traps (October, 1962 - March, 1963). Dots represent average catch by one day periods. Crosses represent average catch by five day periods.

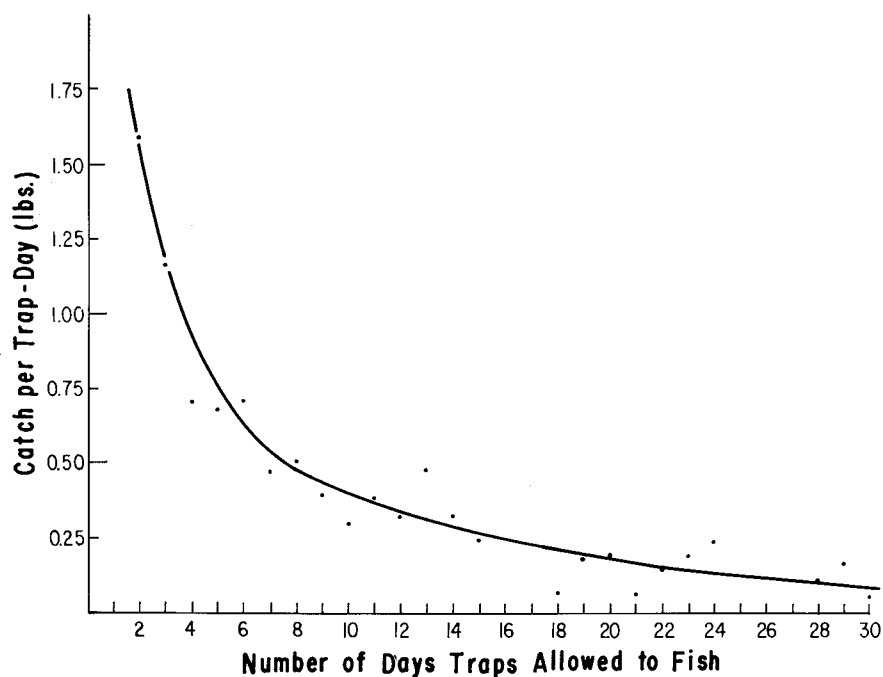


FIGURE 6. Change in catch per trap-day with varying lengths of fishing time (October, 1962 - March, 1963).

of five days fishing time. This curve shows that, for this group of fishermen, maximum total catches were made from traps which were emptied every 12-14 days.

The decline in catch per trap after the 14th day is probably due to two factors. First, these lobsters suffered a loss of weight from starvation. Secondly, in general, the fishermen who left their traps out more than two weeks were not regular, full-time lobster fishermen. As such, they might be less skillful than the regular fishermen. The computed points on the right-hand side of the curve are less reliable than those to the left, due to larger variation in the average catch per trap.

Maximum total catch per trap is not the only criterion for measuring fishing efficiency. The ascending limb of the curve in Figure 5 shows that catch per trap for this group of fishermen does not increase proportionately with increasing time the traps are allowed to fish. It is obvious, therefore, that another parameter (time) must be included to give the best measure of efficiency. Figure 6 shows the average catch per trap-day for increasing periods between pulling the traps. These data were obtained in the same manner as for the preceding curve, except that the total catch for each fishing

period was divided by the product of the number of traps involved and the number of days they were allowed to fish. Thus, catch per trap-day bears the same relationship to catch per trap as does catch per fisherman-day to catch per fisherman. Inspection of the curve in Figure 6 (fitted by eye) shows that catch per trap-day, or gear use efficiency, decreases as the time the traps are allowed to fish increases. The fishing record for this group of fishermen shows that the average time the traps were allowed to fish was 6 to 7 days in October, November, December, and March. Fishing is generally poor in January and February, and this is reflected in the fact that the average time between hauls for these months was 9.9 and 11.0 days, respectively.

REPRODUCTION

Dawson and Idyll (1951) noted that there is some mating and spawning activity throughout the year. Observations made during these investigations confirm this. In November, 1962, six sperm-bearing females were observed in a sample of 130. In December, one sperm-bearing female and one egg-bearing female were seen in a sample of 60. In January, 1963, no sperm-bearing females were found in a sample of 28. In February, four sperm-bearers were found in a sample of 151.

OCCURRENCE OF PHYLLOSOMA LARVAE

As a part of the investigation of the lobster fishery, the abundance and distribution of *Panulirus argus* larvae in the Tortugas Shelf region was studied. Plankton tows made on the Tortugas Shelf were the source of this material. These tows were made as part of a larval shrimp study currently in progress at the Institute of Marine Science of the University of Miami, under the sponsorship of the U. S. Bureau of Commercial Fisheries.

METHODS

The plankton samples examined for phyllosoma larvae had been collected during the two years from July, 1960 through June, 1962. Samples from each month in this period were examined except from January - April, 1961. Most of the samples were taken aboard chartered shrimp vessels or research vessels of the Institute of Marine Science working the Tortugas Shelf waters; a small number were taken from bridges between the Florida Keys during tidal exchange of water between Florida Bay and the Atlantic Ocean.

In the preliminary phase of this investigation plankton samples collected from August through December, 1961 were examined for the presence of phyllosoma larvae. Starting with samples taken in January, 1962, all phyllosoma larvae were removed from the plankton samples, counted, and

identified to genus where this was possible. In a small number of cases, this more thorough examination was given samples from certain stations occupied in August - December, 1961.

Since all the plankton samples available from the period July, 1960 to August, 1961 could not be re-examined, certain standardized tows were used. These were taken at four areas over the grounds (near-shore and off-shore, and at different depths).

The plankton tows were made with a modified Discovery net having a $\frac{3}{4}$ -meter diameter mouth. The cod-end mesh was of 0.366 mm. aperture size. All tows were step-oblique, with three steps; at five feet from the bottom, at mid-depth, and at two feet below the surface. The duration of the tows was 30 minutes at an average boat speed of 2 knots. In general, the area sampled each month extended from off Cape Sable westward to Dry Tortugas.

Details of sampling and laboratory methods are described in Jones *et al.* (ms). The appendix of that report includes charts of the area, station locations, and sampling patterns for each cruise, as well as tabulated lists of the stations and cruises. Included are surface and bottom temperatures, and salinities for all stations and cruises for which measurements were made. Hydrographic data for these cruises are tabulated in a series of reports published by the Institute of Marine Science (ML 61-3, ML 62-4, ML 62-6, ML 62-11).

ANALYSIS OF PLANKTON TOWS

There are 17 species of spiny lobsters whose larvae might be found in the Tortugas Shelf area. Ten of these are scyllarids, or shovel lobsters (Holthuis, 1960; De Man, 1916; Springer and Bullis, 1956). Seven are palinurids, of which four species of *Panulirus* are known: *P. argus*, *P. guttatus*, *P. laevicauda*, and *P. echinatus* (Smith, 1958; Holthuis, 1960a).

Larval descriptions exist for only one of the species of lobsters encountered in this study, *Panulirus argus* (Lewis, 1951). Separation of the many kinds of phyllosoma larvae recovered from our samples were made on the basis of a key constructed by Gurney (1936), supplemented by the descriptions and illustrations of *P. argus* prepared by Lewis; use was also made of descriptions of larvae given by Prasad and Tampi (1959, 1960) of a large number of Indian palinurid and scyllarid phyllosomas; by Johnson (1956) of *P. interruptus* from the Pacific; and by Lebour (1949) of some stages of *P. argus*.

Few of the larvae examined were *P. argus*, most of them appearing to belong to the genera *Scyllarus* and *Scyllarides*. A tabulation of the plankton tows examined and the results are presented in a data report (Institute of Marine Science, ML 63835). The numbers of larvae found in the samples are summarized in Table 4 of this report. In Table 4 some of the numbers are actual counts of larvae in whole samples, while others are projections from numbers recovered from sub-samples of the whole catch.

TABLE 4
Phyllosoma larvae sorted from plankton tows.

DATE	CRUISE	NO. OF STATIONS WITH LARVAE	NO. OF TOWS WITH LARVAE	TOTAL NO. OF LARVAE	NO. IDENTIFIED	NO. OF SCYLLARUS	NO. OF PANULIRUS	NO. OF OTHERS
Tows from four areas were examined; entire tow was examined and actual count made.								
7/60	19	3	8	23	1	1		
8/60	20	4	12	44	2	1	1	
9/60	21	1	2	2	1		1	
10/60	22	3	8	19	6	6		
11/60	23	1	1	1				
12/60	24	1	2	3				
5/61	28	5	10	41	6	5	1	
6/61	29	4	10	33	7	4	3	
7/61	31	4	8	16	5	5		
Presence or absence of larvae was noted; some tows were re-examined and counts projected from sub-samples. (+ signifies that presence of larvae was noted but no counts were made.)								
8/61	33	2	2+					
9/61	34-35	11	17+	82+	21	13	4	4
10/61	37	1	1+					
12/61	40-41	2	2+	4+				
All tows were examined, counts were projected from sub-samples.								
2/62	43	4	4	16	4	4		
3/62	44-45	6	15	186	35	35		
4/62	47	17	44	398	127	127		
5/62	48-49	15	41	338	95	84	11	
6/62	50-51	8	17	122	49	45	4	
Total 1-6/62			121	1060	310	295	15	
5/61 Key Bridge								
Tows		1	2	17	17			17
TOTAL			206	1345	376	330	25	21

ABUNDANCE AND DISTRIBUTION

A total of 1098 plankton tows were examined for the presence of phyllosoma larvae. Of these tows, 206 contained phyllosomas; a total of 1345 larvae were found.

Of the 376 larvae identified to genus, 25 (6.7 per cent) were *Panulirus*. Since *P. argus* greatly dominates in numbers in the adult phase, most of those 25 larvae may have been of this species, but there is no certainty of this.

In the period from January to June, 1962, the most intensive examination of plankton tows was made, and 467 samples were examined. Of these, 121 tows contained 1060 phyllosoma larvae. (This number is a projection from numbers of larvae counted from sub-samples.) A total of 310 larvae were identified to genus; 295 were *Scyllarus* and 15 (4.8 per cent) were *Panulirus*.

Phyllosoma larvae were found in every month of the year except January. The greatest abundance and widest distribution of phyllosomas occurred in the spring (March - June) of 1962. Numbers were highest in April, 1962 followed in order by May and June, 1962. In September, 1961, larvae were more widespread, and were probably more abundant than in March, 1962, but the sub-sampling procedure obscured this. Similarly in 1961, May, June, and July were the peak months, followed by August and September, 1960. However, the abundance in the spring of 1962 far surpassed any other catches.

The average number of larvae per tow was low. In the month of greatest abundance, April, 1962, only 398 phyllosoma larvae were caught in 127 tows, an average of 3.1 per tow. The larvae were found at 17 stations ranging in depth from 6 to 21 fathoms in an area from north of Sugarloaf Key to north of Dry Tortugas (Garden Key).

Panulirus larvae occurred only in plankton samples collected in May, June, August, and September of both years. The greatest abundance occurred in May, 1962, followed by September, 1961, June, 1962, and June, 1961. Distribution was limited; larvae were never found at more than two stations in one month.

With one exception, all the larvae were found at stations north of Rebecca Channel, which separates the Dry Tortugas from the shallow water area surrounding the Marquesas Keys. The depths were 15 to 26 fathoms. The *Panulirus* stages were young, less than 4 mm. in size. One older stage, 12.7 mm. in size, was found at 26 fathoms in September, 1960. No *Panulirus* larvae were found in tows from bridges on the Florida Keys.

The scarcity of *Panulirus* phyllosoma on the Tortugas Shelf might be attributed to several factors:

It is true that a reduction of the minimum size limit would increase the catch, at least temporarily, but this higher yield might not be sustained. This change should not be made without a much better understanding of the size where a balance is achieved between growth and mortality rates in this lobster population. A study of this sort should be launched without delay.

From the economic standpoint a $\frac{3}{4}$ pound lobster, with approximately a $\frac{1}{4}$ pound tail including the shell, is smaller than the size most desired on the market. Most dealers prefer lobsters from $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds, so that the minimum size which now exists is smaller than optimum. A smaller tail size would reduce the average value of the catch. In addition, the cost of handling small tails is higher than that of handling large tails. The suggested change is thus believed to be a poor one, and as such is not recommended at present.

A maximum size limit would be of no value. Instead, it would result in the waste of the large lobsters released. The common proposal of such regulations (and, in fact, their continued existence in some marine fisheries, including some for the northern lobster, *Homarus americanus*) is based on the presumption that a limiting factor in the abundance of the species concerned is the number of eggs and young produced. While this is a valid assumption for some mammals and birds, it has never been demonstrated that a direct relationship exists between egg production and the resultant adult population in a marine species of high fecundity such as the spiny

1. Length of planktonic larval life. It has been suggested by Lewis (1951), Sheard (1949), Johnson (1960), and others that the larvae spend from six to nine months in the plankton, giving them ample time to drift away from the area of spawning.

2. Lack of *Panulirus* adults in the area. Springer and Bullis (1956) report only Scyllaridae from the MV *Oregon* stations in the Gulf of Mexico, although *P. argus* was noted in the northern Gulf of Mexico (Moore, 1962). Hildebrand (1955) reports no lobsters from the pink shrimp grounds in the Gulf of Campeche. The Tortugas Shelf area sampled was north of the reefs and chain of Florida Keys ending at Dry Tortugas. Although lobsters are landed at Key West, the general habitat is the reef region to the south. Only 600 pounds of lobsters were landed from the west coast of Florida north of Monroe County in 1962, and none were reported from any other area of the Gulf of Mexico. Lobsters normally avoid shelterless muddy bottoms, which predominate in this area.

3. Movement of larvae by currents. Johnson (1960) and Sheard (1949) have extensive observations on the movement of larvae by currents. The general current pattern on the Tortugas Shelf is tidal oscillation in shallow water, and density currents in deeper water. The resultant currents in deeper water move usually to the south-west, west, and north-west (Rinkel and Dunlop, in litt.). This would tend to move phyllosoma spawned on the reefs away from the Tortugas Shelf area. Occasionally the current through Rebecca Channel was noted to have reversed its customary southerly direction and to move directly to the northwest. This might explain the presence of *Panulirus* phyllosoma at those stations north of Rebecca Channel. The only other station at which *Panulirus* was found is at the eastern end of the shrimp grounds, north of Key West.

RECOMMENDATIONS

Those in the industry have suggested a number of changes in the regulations now in force in the spiny lobster fishery.

There is a considerable body of opinion among fishermen which advocates changing the minimum size limit from one which prohibits the landing of lobsters less than one pound in weight to one which specifies a carapace length of $2\frac{3}{4}$ inches as the minimum. A lobster of this length weighs approximately $\frac{3}{4}$ of a pound, and this change would thus reduce the size limit. Advocates of this change argue that it would increase the catch. To offset effects on the reproduction of the stock they propose a maximum size limit, prohibiting the capture of lobsters larger than three pounds in weight. These animals produce more eggs than smaller individuals, and since the demand for them on the market is weak, it is suggested that they are most valuable as brood stock.

There is a considerable variation in weight among lobsters of the same size, particularly comparing males and females. There is also a marked variation in the weight of the animals after they have been preserved in ice or cooked. Further, many lobsters are landed lacking antennae or legs. Fishermen, buyers and enforcement officers are at a considerable disadvantage in attempts to obey or to enforce the law as it now exists.

Therefore, it has been suggested by many dealers and fishermen that a minimum carapace length be substituted for the weight limit.

In March, 1963, samples of lobsters measuring 75 mm. (about 3 inches) to 85 mm. (about $3\frac{1}{2}$ inches) carapace length were weighed. In all, 31 males and 57 females were checked. Males of 79 mm. carapace length (approximately $3\frac{1}{8}$ inches) averaged 15.22 ounces, and females of the same length averaged 16.10 ounces. When the sexes were combined, 79 mm. lobsters averaged 15.97 ounces. This sample was small but the results agreed well with measurements reported to us by dealers in Miami and Key West.

Weights were also taken of various lobster appendages. The combined weight of the antennae from one pound lobsters averaged about one ounce. The legs of an individual lobster are not all of the same size. However, the general average weight of the individual legs of a one pound lobster is roughly one-half ounce each. It is generally believed by those in the industry that lobsters with carapace lengths of $3\frac{1}{8}$ inches would average about one pound in weight, and that this size would be a convenient and fair substitute

be too high, at least from the point of view of the fisherman. Closed seasons give depleted reef areas a chance to be replenished by diffusion of lobsters from adjacent areas. In addition, meat of spawning female lobsters is of poor quality and the value of the catch is low at this period.

There is strong evidence that the problems of the Florida spiny lobster fishery are economic in nature. The reduced returns to the fishermen are the result not of reduced total abundance, but of small catches per man resulting from sharply increasing numbers of fishermen. Since commercial fisheries are common property resources, entry into an unrestricted fishery tends to continue until profits are reduced to a minimum. Nesbit (1943), Crutchfield (1962), Sheard (1962), and others contend that the proper objective of fishery management is maximum economic yield, and this should be preserved by limiting the number of persons engaged in the fishery. Sheard (1962) says that the objective of the management program for the fishery for the Australian crayfish (*Panulirus longipes*) should be "the production of that degree of sustainable yield of good quality, best average weight crayfish tails at that degree of economic surplus, as will assure the existence of a stable and continuing fishing industry together with good living standards for the fishermen and all operatives." He goes on to say that in an intensely exploited fishery the need is for a class of fishermen with a strong sense of responsibility for the well-being of the industry. Therefore, licenses should be restricted to professional fishermen whose whole income is earned within the fishing industry. This policy has also been advocated by the Florida Lobstermen's Association.

However, the problem is exceedingly complicated. Schaefer (1957) points out that a preferential licensing system negates one possible benefit of fishery management, that of providing maximum opportunity for employment in the fishery. Further, a limitation on entry into the fishery involves the problem of establishing an equitable system for deciding who should fish. Our data indicates that there is so much fishing effort in this fishery that the catches of individual fishermen, and hence their income, are reduced. However, an economic-biological survey should be conducted to obtain enough information to formulate a management scheme, possibly including limitation of entry. Regulations should not be instituted until a thorough understanding has been gained of lobster population dynamics, and of the economic aspects of the problem.

The authors wish to thank David L. Dubrow, Richard Chesher, and William Eschmeyer for their assistance in the collection and analysis of data for this report. Thanks are also due to many lobster dealers and fishermen for their patient cooperation.

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