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United States Sea Scallop Research During 1959 in Subarea 5Z

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Introduction

United States investigators have continued during 1959 to interview the captains of sea scallop fishing vessels after each trip to obtain data on the location fished, number of days spent on the grounds, and the weight of meats landed. These data have been compiled by unit areas (10 minutes of longitude by 10 minutes of latitude) and a monthly summary of the landings from 5Z sent to ICNAF headquarters and to St. Andrews Biological Station of the Fisheries Research Board of Canada. Canadian investigators have sent similar data for their fleet to the United States.

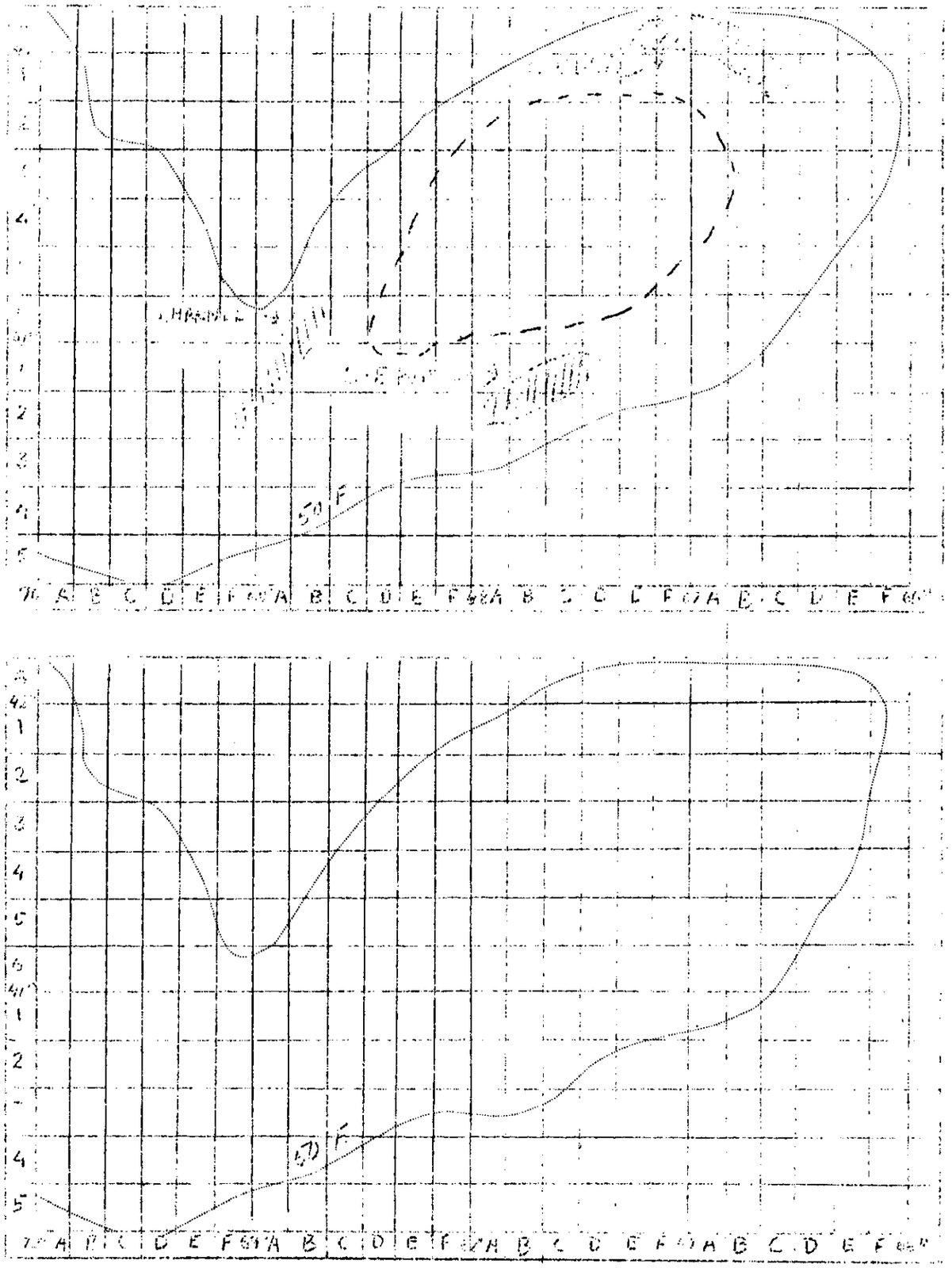
Data on the size composition of the landings have been obtained from samples of shells brought into port by the fishermen. Two cruises were made to Georges Bank with small-mesh gear to collect complete length-length frequency samples of the populations present on various fishing grounds. These methods are necessary because United States sea scallop fishermen usually throw all scallops smaller than 85 mm. back in the water and only bring the meats of those they keep ashore

The Fishery

There were 18.7 million pounds of sea scallop meats landed in the United States from Subar ea 5Z during 1959 as a result of 8480 days spent on the grounds. Specific area of capture information is available for 98 percent of these landings. Canadian vessels reported spending 2019 days on the grounds and landed 4.4 million pounds. Area of capture information is available for 85 percent of these catches. These are the highest landings on record; the previous high for the United States was 18.3 million pounds in 1955. There were additional landings of 3.4 million pounds in the United States and 0.6 million pounds in Canada from other areas making a record total of 27.1 million pounds of sea scallop meats landed during 1959. The previous high was 24.0 million pounds in 1957.

Along with the increase in landings there was an increased tendency for the fishermen to concentrate a large fraction of their effort on a few beds of quite limited extent on which the newly r ecruited year-class was abundant. Three beds (Figure 1, overleaf) with a combined area of about 700 square miles supplied about 70 percent of total United States landings from 5Z. The Channel ground provided 3.0 million pounds for 1421 days fished; the Northern Edge, 5.3 million pounds for 2254 days; the Southeast Part, 4.9 million pounds for 2039 days. The remaining 8000 square miles of Georges Bank provided 5.5 million pounds of meats for 2767 days of effort. Figure 2, overleaf, shows a summary of all the samples collected from the commercial catch during 1959; the samples from different grounds were weighted in proportion to the relative part of the landings which they represented. It will be noted that 60 percent of the catch in numbers was made up of sea scallops less than 110 mm.

Figure 1. The most heavily exploited fishing grounds on Georges Bank in 1959. The shallow central part of the bank has never had concentrations of sea scallops and very little fishing is ever done outside the 50 fathom isobath.



.../3

Figure 2. Length-frequency summary of all samples collected from the commercial catch during 1959.

Length	/ Frequency %	
85-90mm	(4.4)	oooo
90-95	(14.0)	oooooooooooooo
95-100	(18.5)	oooooooooooooooooo
100-105	(13.6)	oooooooooooooo
105-110	(9.8)	ooooooooooo
110-115	(7.5)	ooooooo
115-120	(6.3)	oooooo
120-125	(6.5)	oooooo
125-130	(6.4)	oooooo
130-135	(5.2)	ooooo
135-140	(3.7)	oooo
140-145	(3.5)	ooo
145-150	(0.6)	o

A more detailed analysis of these data gives a better picture of the 1959 sea scallop fishery. During the first quarter, effort was spread out over the bank in a pattern that we have come to consider "normal" (Table 1). The Northern Edge was providing 26 percent of the landings; 39 percent of all landings from 1949 to 1958 had come from this

Table 1 Catch and effort on the most heavily exploited grounds of Subarea 5Z.

	Channel			Southeast Part			Northern Edge		
Quarter	Effort days	Catch ('000 lbs.)	% of 5Z	Effort days	Catch ('000 lbs.)	% of 5Z	Effort days	Catch ('000 lbs.)	% of 5Z
1959									
First quarter	243	439	16	77	121	4	424	702	26
Second quarter	1052	2235	43	212	485	9	149	320	6
Third quarter	57	135	2	1425	3545	58	502	1248	20
Fourth quarter	69	146	3	325	718	15	1179	3067	64
Total	1421	2955	16	2039	4869	26	2254	5337	28
1960									
First quarter	17	39	1	564	1530	44	555	1369	39

general area. The length-frequency of the landings (Figure 3) shows a mode at about 107 mm. which is where we would expect to find the mode of

Figure 3. Length-frequency of sea scallops taken from grounds on the Northern Edge of Georges Bank by the commercial fleet. First quarter 1959

Length	/ Frequency %	
85-90mm	(1.4)	x
90-95	(3.9)	xxxx
95-100	(8.4)	xxxxxxxx
100-105	(14.9)	xxxxxxxxxxxxxx
105-110	(15.7)	xxxxxxxxxxxxxxx
110-115	(15.0)	xxxxxxxxxxxxxx
115-120	(11.0)	xxxxxxxxxx
120-125	(10.1)	xxxxxxxxxx
125-130	(6.7)	xxxxxxx
130-135	(6.2)	xxxxxx
135-140	(4.5)	xxxx
140-145	(2.3)	xx

.../4

the year-class recruited during 1958. During the second quarter, the focus of activity shifted heavily to the Channel grounds.

This shift to the Channel had actually started in March. We collected a population sample (Figure 4) in April by getting one of the

Figure 4. Length-frequency sample collected on the Channel grounds with small-mesh liner in April 1959.

Length	/ Frequency %	
65-70mm	(0.6)	x
70-75	(1.4)	x
75-80	(3.6)	xxxx
80-85	(9.6)	xxxxxxxxxx
85-90	(31.7)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
90-95	(34.0)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
95-100	(10.9)	xxxxxxxxxxx
100-105	(1.1)	x
105-110	(1.3)	x
110-115	(2.3)	xx
115-120	(0.8)	x
120-125	(0.6)	x
125-130	(0.5)	

fishermen to put a small-mesh liner in his dredge. This showed that a year-class had just been recruited with a modal size at about 90 mm. It made up over 90 percent of the population which was over the 85 mm. cull point. A summary of all the catch samples collected from these grounds during the second quarter (Figure 5) shows that this year-class had made up about 75 percent of the landings.

Figure 5. Length-frequency summary of all samples collected from the commercial landings from the Channel grounds during the second quarter of 1959.

Length	/ Frequency %	
85-90mm	(8.0)	xxxxxxxx
90-95	(24.6)	xxxxxxxxxxxxxxxxxxxxxxxx
95-100	(26.2)	xxxxxxxxxxxxxxxxxxxxxxxxx
100-105	(10.5)	xxxxxxxxxx
105-110	(5.6)	xxxxxx
110-115	(5.0)	xxxxx
115-120	(4.4)	xxxx
120-125	(4.3)	xxxx
125-130	(4.8)	xxxxx
130-135	(2.9)	xxx
135-140	(1.5)	xx
140-145	(2.1)	xx

In June, the fleet began to leave the Channel grounds. Some returned to the Northern Edge but most of the activity in the third quarter was on the grounds of the Southeast Part. This area does not have a history of providing large crops of sea scallops; only 14 percent of the 1949-1958 landings were from this general area. Fortunately, we had sampled this area from a research vessel in May. This sample (Figure 6) had shown a large year-class just being recruited. Samples collected from the commercial catch (Figure 7) showed that the boats working in

.../5

Figure 6. Length-frequency sample collected on the Southeast Part grounds by a research vessel with a 2-inch ring bag in May 1959.

Length	% / Frequency
70-75mm	(0.5)
75-80	(3.1) xxx
80-85	(8.0) xxxxxxxx
85-90	(52.9) xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
90-95	(26.7) xxxxxxxxxxxxxxxxxxxxxxxxxxx
95-100	(4.1) xxxx
100-105	(0.4)
105-110	(1.1) x
110-115	(1.4) x
115-120	(0.4)
120-125	(0.2)
125-130	(0.2)
130-135	(0.2)
135-140	(0.3)
140-145	(0.3)

Figure 7. Length-frequency sample of the commercial catch on the Southeast Part grounds in May 1959.

Length	% / Frequency
85-90mm	(0.9) x
90-95	(2.1) xx
95-100	(5.2) xxxxx
100-105	(16.1) xxxxxxxxxxxxxxxx
105-110	(22.0) xxxxxxxxxxxxxxxxxxxxxx
110-115	(10.7) xxxxxxxxxxx
115-120	(11.4) xxxxxxxxxxx
120-125	(8.8) xxxxxxxxx
125-130	(9.0) xxxxxxxxx
130-135	(6.2) xxxxxx
135-140	(5.2) xxxxx
140-145	(2.4) xx

the area had not yet started to exploit this year-class heavily. Evidently they were able to catch enough of the older animals and were discarding most of the new recruits. Samples collected in June (Figure 8)

Figure 8. Length-frequency of samples of the commercial catch taken from the fishing ground on the Southeast Part of Georges Bank, June 1959.

Length	% / Frequency
85-90mm	(3.2) xxx
90-95	(18.5) xxxxxxxxxxxxxxxxxx
95-100	(23.3) xxxxxxxxxxxxxxxxxxxxxx
100-105	(8.9) xxxxxxxxx
105-110	(3.8) xxxx
110-115	(4.9) xxxxx
115-120	(7.4) xxxxxxx
120-125	(6.7) xxxxxxx
125-130	(4.7) xxxxx
130-135	(5.0) xxxxx
135-140	(5.4) xxxxx
140-145	(7.9) xxxxxxxx

.../6

showed an increase in the proportion of the catch made up of the new recruits and by July (Figure 9) they accounted for about 90 percent of the landings.

Figure 9. Length-frequency of samples of the commercial catch taken from the fishing ground on the Southeast Part of Georges Bank, July 1959.

Length	/ Frequency %	
85-90mm	(10.3)	xxxxxxxxxx
90-95	(38.4)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
95-100	(33.5)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
100-105	(7.8)	xxxxxxxx
105-110	(1.2)	x
110-115	(1.8)	xx
115-120	(1.3)	x
120-125	(1.0)	x
125-130	(0.8)	x
130-135	(0.8)	x
135-140	(0.7)	x
140-145	(2.5)	xx

We again sampled these grounds with a research vessel in September (Figure 10) and found that the modal length had risen to about 95 mm. Samples of the commercial landings collected in the same month

Figure 10. Length-frequency sample collected on the Southeast Part grounds by a research vessel with a 2-inch ring bag in September 1959.

Length	/ Frequency %	
70-75mm	(0.1)	
75-80	(0.1)	
80-85	(0.4)	
85-90	(7.1)	xxxxxxx
90-95	(29.8)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
95-100	(43.0)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
100-105	(13.8)	xxxxxxxxxxxxxx
105-110	(1.8)	xx
110-115	(1.4)	x
115-120	(1.6)	xx
120-125	(0.5)	
125-130	(0.3)	
130-135	(0.3)	
135-140	(0.3)	
140-145	(0.2)	

(Figure 11) were almost identical to the research vessel samples since by this time even the slowest growing members of the new year-class were over 85 mm. and consequently very few were being thrown back. During the last quarter of 1959, most of the catch, 64 percent, was again coming from the Northern Edge. By this time, the new year-class on these grounds was well up into the catchable sizes (Figure 12) with a modal length at 102 mm.

.../7

Figure 11. Length frequency sample of the commercial catch on the Southeast Part grounds in September 1959.

Length	/ Frequency %	
85-90mm	(4.6)	xxxxx
90-95	(27.9)	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
95-100	(39.2)	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
100-105	(13.2)	xxxxxxxxxxxxx
105-110	(3.5)	xxx
110-115	(3.7)	xxxx
115-120	(2.9)	xxx
120-125	(1.5)	x
125-130	(1.0)	x
130-135	(1.2)	x
135-140	(0.6)	x
140-145	(0.6)	x

Figure 12. Length-frequency summary of sea scallops taken from grounds on the Northern Edge of Georges Bank. Fourth quarter 1959.

Length	/ Frequency %	
85-90mm	(1.2)	x
90-95	(7.7)	xxxxxxxx
95-100	(18.3)	xxxxxxxxxxxxxxxxxx
100-105	(27.0)	xxxxxxxxxxxxxxxxxxxxxxxxxx
105-110	(17.9)	xxxxxxxxxxxxxxxxx
110-115	(9.7)	xxxxxxxxxx
115-120	(5.7)	xxxxxx
120-125	(3.2)	xxx
125-130	(3.3)	xxx
130-135	(2.4)	xx
135-140	(1.4)	x
140-145	(2.0)	xx

In the first quarter of 1960, the fleet moved back to the Southeast Part again. The modal length of the year-class recruited in 1959 (Figure 13) had advanced to 102 mm. and it was making up about 85 percent of the catch in numbers.

Figure 13. Length-frequency of sea scallops taken from fishing ground on the Southeast Part of Georges Bank by the commercial fleet. First quarter 1960.

Length	/ Frequency %	
85-90mm	(1.1)	x
90-95	(8.8)	xxxxxxxxx
95-100	(27.3)	xxxxxxxxxxxxxxxxxxxxxxxxxx
100-105	(29.5)	xxxxxxxxxxxxxxxxxxxxxxxxxxxx
105-110	(13.1)	xxxxxxxxxxxxx
110-115	(7.5)	xxxxxxxx
115-120	(3.9)	xxxx
120-125	(2.3)	xx
125-130	(2.8)	xxx
130-135	(1.2)	x
135-140	(1.4)	x
140-145	(0.7)	x
145-150	(0.4)	

.../8

In summary, the United States fleet removed about 18.9 million pounds of sea scallop meats from Georges Bank in the period from April 1959 through March 1960. This interval, rather than the calendar year, seems more logical since the new year-class appears to be recruited in the second quarter of the year. Seventy-eight percent of the total landings, 14.9 million pounds, came from three grounds of limited area. The length-frequency samples of the landings from these ar eas show that about 77 percent of the catch in numbers and over 60 percent of the catch in weight, 9.3 million pounds was due to the year-class which was recruited to the fishery during the year.

Abundance

Statements made by the fishermen lead us to believe that the density of the newly recruited year-class was unprecedently high on the grounds that were heavily fished. We cannot say whether this means that this year-class was more abundant than usual or not since it may be that whatever factors cause aggregation merely concentrated the year-class to an unusual degree. We must wait until the fleet moves to other grounds or we are able to sample the lightly fished areas with a research vessel for the answer to this question. It is important to realize that the landings in pounds per day spent on the grounds is not a reliable, quantitative index of abundance. The factors which influence it differ so grossly from boat to boat, ground to ground, season to season, and, particularly, fleet to fleet, that the best we can say is that a high catch per unit of effort means plenty of scallops and a low catch per unit of effort means not so many.

We are now able to measure abundance directly from a research vessel by attaching an odometer to the dredge. This was done for selected areas during 1959. The sample shown in Figure 6, for example, contained 4403 sea scallops collected by towing a 10 foot dredge for 20 minutes during which it travelled about 9,520 feet. This works out to one scallop taken per 22 square feet ($0.5/M^2$). Unfortunately, the dredge with the odometer was lost on the first day of the September cruise so that we do not know tha area swept to collect the sample shown in Figure 10. We have built new odometers and will again sample the area quantitatively this year. From these data we will be able to calculate the reduction in numbers per unit area to get a measure of the total mortality rate.

The density of sea scallops on the three grounds discussed above was so high that it disrupted all of the usual practices of the New Bedford fleet. They had been accustomed to go out with a standard crew of 11 men, make about one set per hour, change watches strictly every six hours, and leave the ground when they had their trip of scallops iced down. Fishing under these conditions, the better boats in the fleet would make about 25-30 trips per year and land about 300,000 pounds of scallop meats. Last year, the better boats made up to 35 trips and brought in over 400,000 pounds.

It has been reported that these large landings were made by loading the decks with a few tows of the dredges and then the entire crew shucking until the decks were clear. Extra shuckers were taken out and the boats left the grounds with a deck-load to be shucked on the way in. It was common to see a scalloper going through Woods Hole passage on its way to New Bedford followed by a cloud of gulls, a sure sign that they were still shucking. One boat reported that the dredges were only towed a total of seventeen hours during the 96 hours they spent on the grounds and that they spent 20 hours shucking after they left the grounds. These practices make any quantitative comparison of pounds landed per day on the grounds useless since they change the definition of a fishing day.

Growth Rate

We have calculated the growth rates by reading annual rings on shell samples collected from each of the three heavily exploited areas

.../9

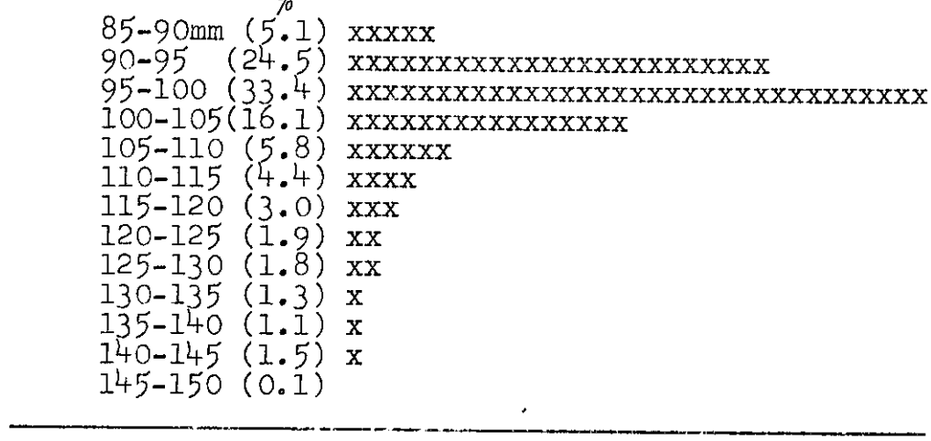
and find them to be similar. The sample from the Southeast Part is particularly interesting (Table 2) in that the newly recruited year-class, in spite of being more densely aggregated than any we had previously known, shows the fastest growth rate. The length-weight ratio, log W = 3.12 log L - 5.04395, is also quite similar to others that we have measured.

Table 2. Average size at ring of a sample of sea scallops collected on the Southeast Part of Georges Bank, November 1959.

Ring Number	1	2	3	4	5	6	7	8	9	Margin
Number	Length in millimeters									
8	33.5	65.4								83.2
421	26.8	61.3	85.4							94.5
6	24.1	52.7	79.9	96.9						104.4
13	21.1	51.2	76.0	96.1	107.2					112.4
3	21.7	55.0	77.6	94.1	107.5	115.6				119.7
3	23.3	45.5	69.7	93.2	107.8	115.8	122.4			125.3
2	19.5	50.4	73.8	91.0	105.4	115.5	123.1	127.5		129.8
1	29.4	53.4	73.8	93.4	111.7	124.6	134.2	139.3	143.8	144.8
457 L	24.9	54.4	76.6	94.1	107.9	117.9	126.6	133.4	143.8	

Figure 14 summarizes all the catch samples for the first year

Figure 14. Length-frequency summary of all scallops landed from grounds on the Southeast Part of Georges Bank, April 1959 - March 1960 weighted by the relative portion of the catch landed in each quarter.



this year-class was fished on the Southeast Part. The mean size taken was about 97.5 mm. with an average meat weight of 14.5 grams. At the average rate shown in Table 2, a 97.5 mm. sea scallop would grow to 110.7 mm. (21.5 grams) in one year and 120.0 mm. (27.6 grams) in two years. We cannot date this year-class reliably because the age at first ring formation is still not known. Further work is being done on this problem.

.../10

Mortality Rates

We have continued to collect clapper: live shell ratios for estimating natural mortality but have not yet been able to refine our estimates of the time required for the valves of a scallop dead from natural causes to separate. The number of clappers present in all the 1959 samples was quite low. We only found 39 clappers among a sample of 17,357 live scallops collected on the Southeast Part in September. The ratio for all collections made in 5Z last year was 1 clapper to every 55 live scallops. Using 100 days as the estimated time required for separation gives an estimate of M = 0.07.

We have said previously that we believed that our best estimate of the fishing mortality would come from the results of two tagging experiments in progress. At the end of 1959 there had been 1573 tags returned from 5375 put out in September 1957 and 1448 from 9539 put out in June 1958. Since fishing is not random and the marked scallops do not mix at random with the total population, we cannot use any of the simple methods for estimating mortality from rate of tag returns but must relate each tag return to the amount of effort required to catch it. This analysis is not yet complete.

The development of the dredge odometer mentioned previously gives us another, probably better, method of estimating mortality rates. Since sea scallops in the catchable sizes do not seem to move, we can quantitatively sample the same population repeatedly and relate the reduction in numbers to the catch and effort expended on it between the samples. We have collected such samples from three areas in May 1959 and will repeat the sampling in May 1960.

Other Research

Mesh selection data were obtained by experiments on research vessel cruises towing a dredge with 2-inch rings on one side and larger mesh gear on the other. These data will be summarized with data previously collected and the analysis reported at a later date.

Further consideration of the problem of evaluating the results of any management regulation that might be introduced into the sea scallop fishery leads us to feel that the best method would be to select one or more limited areas which could be studied intensively while one or more year-classes passed through the fishery.

Summary

Sea scallop landings from Subarea 5Z during 1959 were the highest on record. These record landings can be largely attributed to the fact that the newly recruited year-class was either more densely concentrated or more abundant than usual. During its first year in the fishery, this year-class provided over 60 percent of the catch in weight from the most heavily exploited grounds. These 9.3 million pounds represent about 290 million individual sea scallops with an average weight of 14.5 grams. If recruitment had been postponed for one year, the yield from these areas, taking natural mortality at 10 percent per year, would have been 3.0 million pounds greater for the same amount of effort. If recruitment had been postponed for 2 years, the same effort would have resulted in 5.0 million more pounds.