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THE GEORGES BANK SEA SCALLOP FISHERY: Status in Spring of 1963 and Consideration of Management Measures.

Pertinent statistics regarding the Georges Bank sea scallop fishery are presented in Table 1. It will be noted that the total landings (United States and Canadian combined) increased markedly in 1959, and continued to increase through 1962; the 1962 figure being more than double that of 1958. This phenomenal and unprecedented increase was due to an increased abundance of the shellfish and an increased effort on the part of the Canadians. The days fished by U. S. vessels actually dropped in 1959 and 1960, although U. S. landings increased somewhat due to the high abundance of the scallops.

Abundance.

The rather sudden increase in abundance that occurred in 1959 was due to an unusually large year class of scallops that arrived at commercial size that year. This year class supported the fishery for four years. It is now declining and we see no similar year classes coming along.

We have three methods for estimating relative abundance; comparison of quantitative research vessel samples, landings per day on the grounds for the fleet, and Canadian records of catch per minute towed on commercial vessels carrying sea samplers. For various reasons, none of these gives a very precise estimate, but all of them show a decline for the marketable sizes (greater than 95 mm.) of about 30 percent in 1962 as compared with 1961.

63-04

Table 1. --Statistics of the Georges Bank Sea Scallop Fishery

	United States		Canada		Total	Average U.S. Fleet	
Year	Landings lbs x 10^6	Effort Days	Landings lbs x 10^6	Effort Days	Landings lbs x 10^6	Landings Per day	Gross Stock Per day
1953	16.3	10031	0.3	180*	16.6	1627	$ 717
1954	15.5	9343	0.2	120*	15.7	1671	748
1955	18.3	11619	0.3	190*	18.6	1570	821
1956	17.5	12243	0.7	490*	18.2	1442	778
1957	17.3	10500	1.8	1197	19.1	1650	800
1958	14.4	8775	2.6	1598	17.0	1637	793
1959	18.7	8558	4.4	2098	23.1	2187	1057
1960	21.9	8039	7.5	2301	29.4	2722	949
1961	23.6	8671	10.0	3147	33.6	2719	1030
1962	21.9	9070	13.0*	5400*	34.9	2410	980

* Estimated

None of these methods gives even an approximate measure of the strength of the pre-recruit year classes. We can say, how ever, that nowhere on the grounds sampled with the research vessel in 1962 was the year class to be recruited during 1963 present in large numbers. It is possible, but we believe unlikely, that there are any large concentrations of this year class in areas that we did not investigate. Consequently, we cannot be sanguine about the immediate future of the fishery.

Management.

The Georges Bank sea scallop population today is overfished in the sense that greater yields would be obtained if the scallops were allowed to grow to a larger size. The cull point today is at about 95 mm. (3-3/4 inches). The age of these scallops is about 4 years. Any delay in capture up to about 8 years would increase the sustained yield.

Table 2 presents the relative yields to be expected for different ages of cull and different degrees of fishing pressure. We estimate present fishing rate (instantaneous mortality rates) to be about 0.7. The table shows that we are also fishing too heavily to obtain maximum sustained yield with the present cull size. Thus we can increase the sustained yield by advancing the cull size or decreasing the fishing effort or by a combination of the two.

Advancing the cull size by increasing ring size in the dredges has been seriously studied by U.S. and Canadian biologists for several

Table 2.--Relative efficiency of various ages of cull at various levels of fishing effort. Values given as percent of the maximum yield at each level of F.

F Age Years	.5	.6	.7	.8	.9	1.0	1.1	1.2	L mm	W gm
4.0	76.5	73.3	70.0	67.5	65.4	63.6	62.1	60.8	80	8.0
5.0	89.8	87.5	85.2	83.5	82.1	80.8	79.7	78.8	96	13.7
6.0	97.4	96.4	94.9	94.0	93.2	92.4	91.7	91.2	108	19.4
7.0	100.0	100.0	99.4	99.1	98.9	98.5	98.2	98.0	118	25.2
8.0	98.6	99.6	99.6	99.9	100.0	100.0	100.0	100.0	125	29.8
9.0	94.0	95.8	96.5	97.2	97.7	98.0	98.2	98.4	131	34.2

years and it was discovered that present gear does not give sharp enough selection to provide the kind of sorting of the catch required for practical conservation.

Canadian scientists have embarked on a general study of gear with the hope they can devise some collecting device which will be commercially practical and yet release the smaller scallops.

Since the dredge will not screen the sizes adequately, there remains the possibility of screening them on board ship after they are caught. This possibility has not been explored but it needs investigation. Perhaps an adequate screening device could be made mandatory or a minimum size limit could be imposed. Since the scallops are shucked at sea, a minimum size regulation would be difficult to enforce.

The alternative is to limit the fishing pressure. Since adult sea scallops do not move about freely they are available at any time of the year and so fishing pressure can be regulated according to the convenience of the fishermen. Any period of the year, for instance, could be selected for a closed season. If this were not acceptable, a quota system of some sort could be instituted. How this could best be done is a matter for management and industry to work out.

In this connection there is a relationship of price to landings which requires study. One would need to know how the limitation of effort might effect the price and gross stock of the vessels.

4/1/63

UNITED STATES RESEARCH DURING 1962 ON THE SEA SCALLOP FISHERY IN SUBAREA 5Z

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LANDINGS

The 1962 landings of sea scallop (Placopecten magellanicus) meats from Subarea 5Z continued the upward trend which they have exhibited the past few years. Table 1 shows this to be caused by the

Table 1.--Landings of sea scallop meats from Subarea 5Z.

(millions of pounds)

Year	United States	Canada	Total
1954	15.5	0.2	15.7
1955	16.8	0.3	17.1
1956	16.8	0.7	17.5
1957	18.7	1.8	20.5
1958	16.4	2.6	19.0
1959	20.2	4.4	24.6
1960	22.4	7.5	29.9
1961	23.6	10.0	33.6
1962	21.8	12.5	34.3

increase in Canadian landings as a result of the expansion of their offshore scallop fleet. Some 40 Canadian vessels participated in this

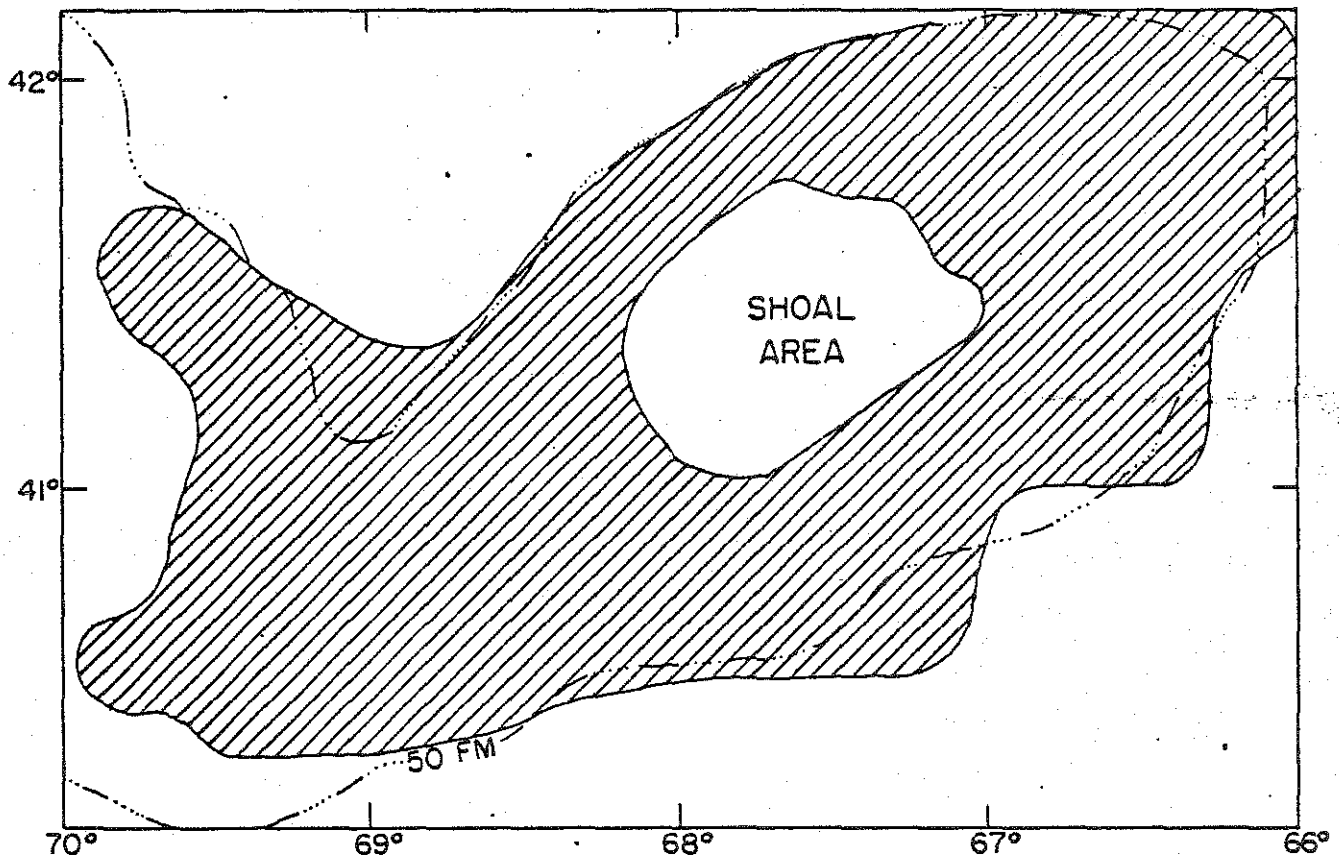

Figure 1. Sea scallop fishing grounds of Subarea 5Z.

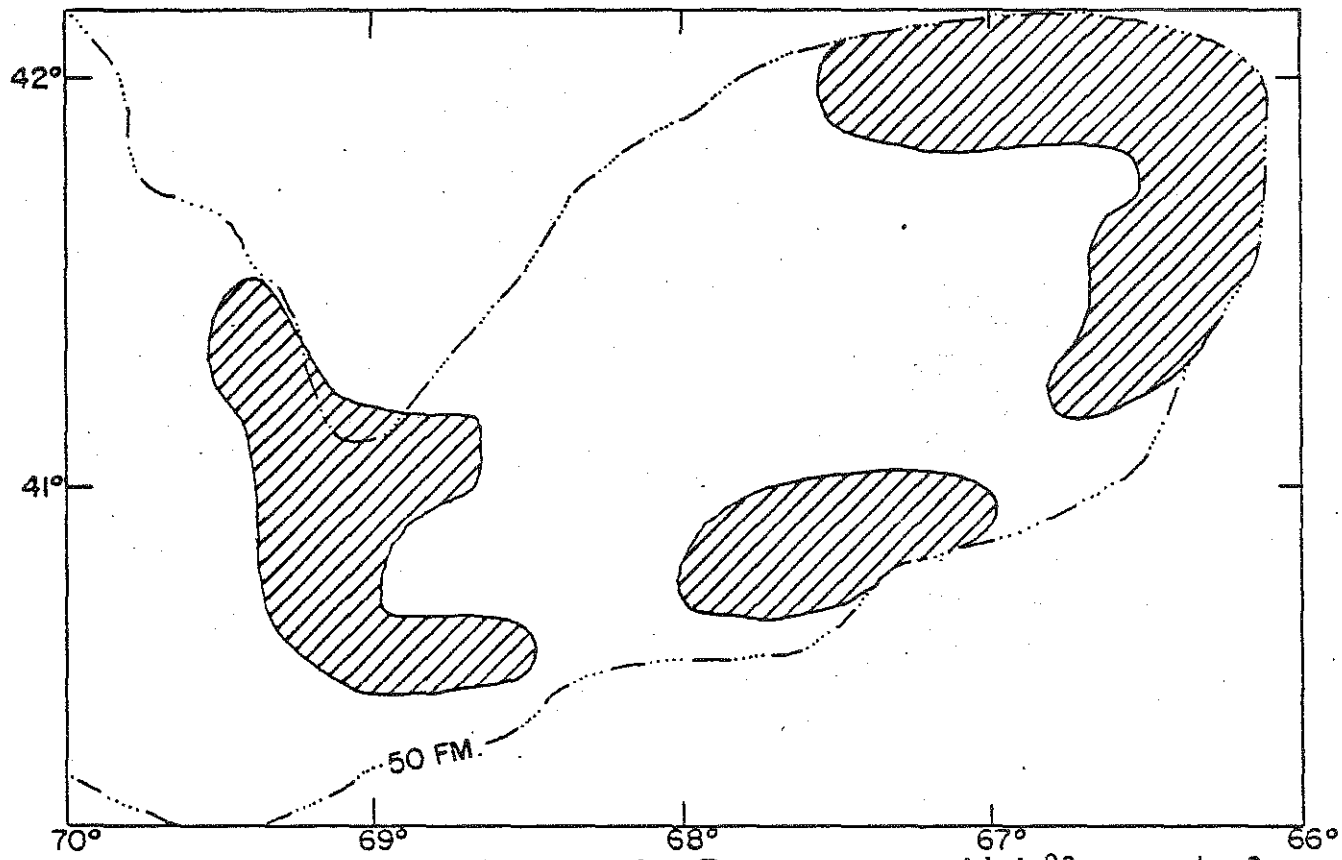

Figure 2. The most productive grounds. These areas provided 83 percent of the 1944-1961 landings.

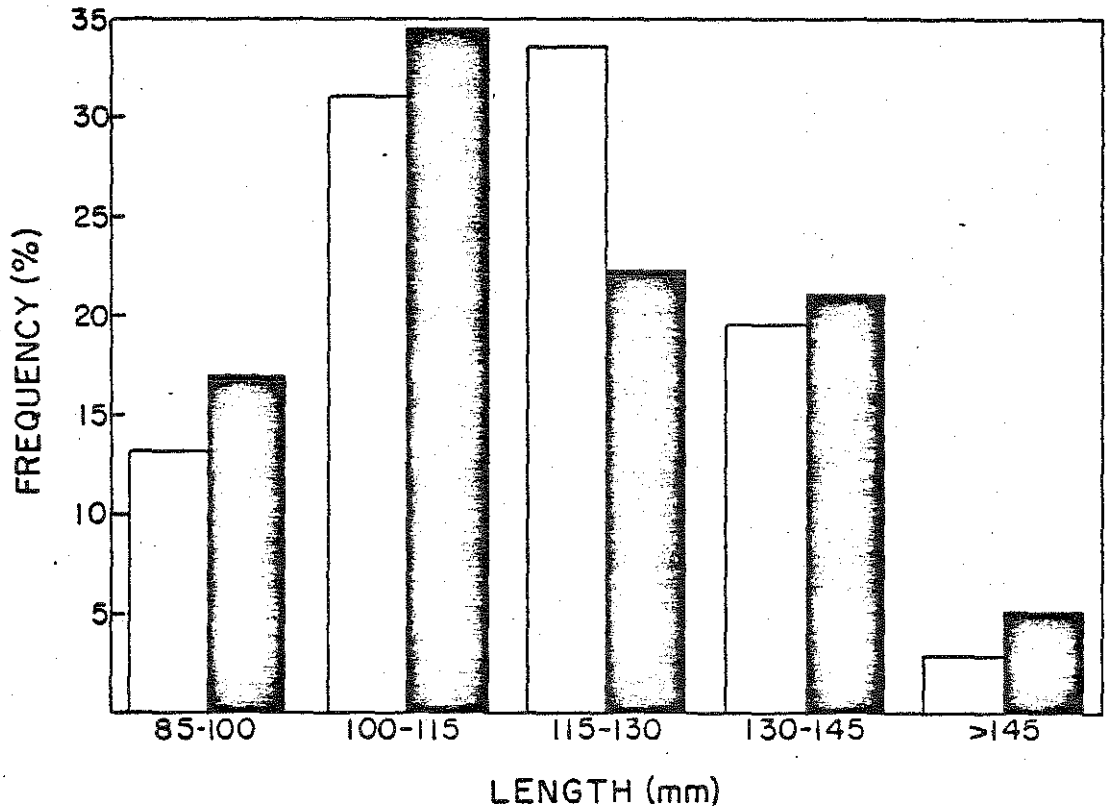

Figure 3. Size distribution of the United States landings in 1961 (light bars) and 1962 (dark bars).

fishery during 1962 as compared to about 8 in 1956.

An analysis of all landings from the area in the years 1944-1961 shows that, with the exception of the shoal area, all parts of Georges Bank made some contribution to the fishery (Figure 1). Closer examination of the data, however, shows that three grounds (Figure 2) provided most of the catch. The grounds ~~outlined~~ SHADED in Figure 2 represent about 40 percent of the area shaded in Figure 1 but they provided 83 percent of the total landings. This is true on annual basis as well. In 1953 these areas supplied 82 percent of the landings, in 1957, 76 percent, 1959, 85 percent, 1960, 89 percent, 1961, 88 percent, and 1962, 90 percent. The reasons why these specific grounds should be so much more productive than adjoining areas with similar substrates and hydrographic conditions are unknown.

SIZE DISTRIBUTION

Figure 3 shows the size distribution of the 1961 and 1962 U. S. landings. The only noticeable difference is a slight increase in the numbers of smaller scallops taken and a sharp decline in the 115-130 mm group. Using the average length weight ratio gives us an estimate

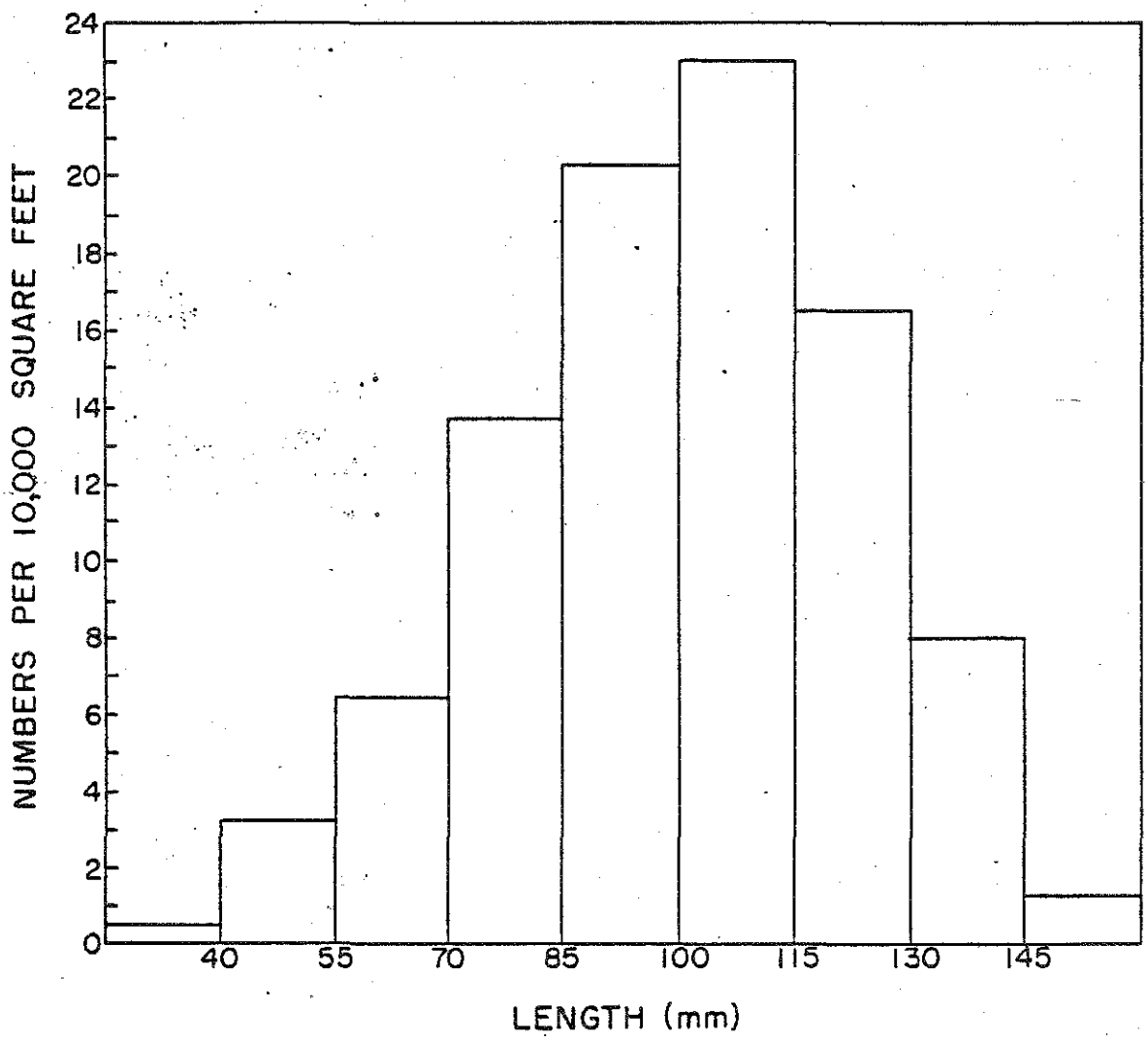

Figure 4. Size distribution of the research vessel samples collected with 2-inch ring gear during the period 1960-1962.

of 629 million individual scallops removed during 1962.

ABUNDANCE

Estimates of abundance are made from quantitative research vessel samples taken with small mesh gear. Their reliability is only fair since it is impossible to cover the entire area with a sufficiently dense pattern of stations. In the future, we intend to confine our efforts to the grounds (Figure 2) which have historically been the most productive. The gear is not efficient for the younger age-groups. Figure 4 shows the result of pooling all the research vessel samples collected since 1960. The relative scarcity of animals smaller than 100 mm is not the result of gear selection. On the average we took about 93 sea scallops of all sizes per 10,000 square feet dredged.

Considering only scallops larger than 70 mm, those that will reach marketable size during the following year, we found 112 per 10,000 square feet in May of 1960 and 102 when we sampled the same areas in May 1961. Areas sampled in May of 1961 and May of 1962 yielded 102 and 94 respectively. Areas sampled in September 1961 gave 140 and the same areas 85 in September 1962.

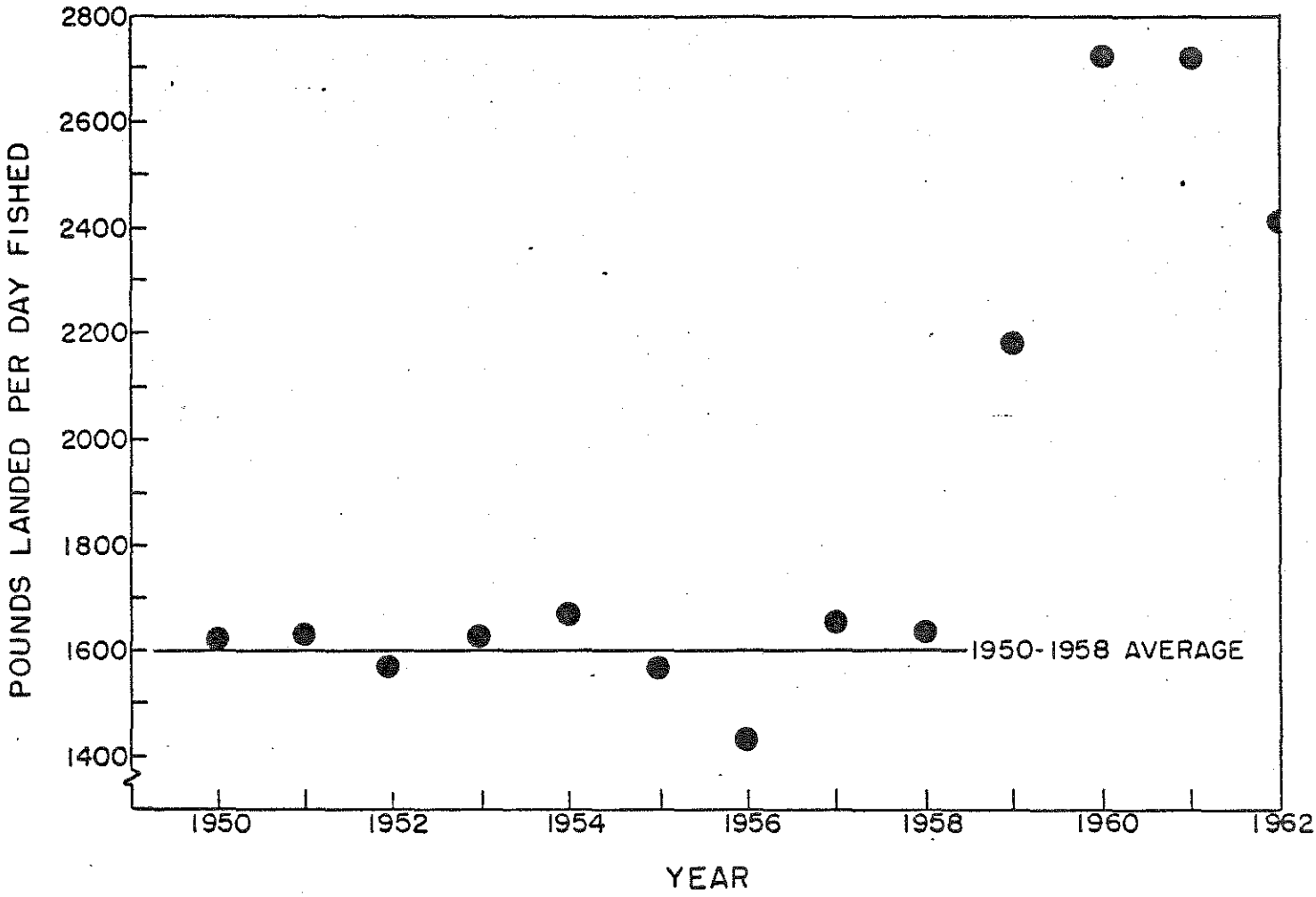

Figure 5. Average yearly landings per day spent on the grounds for the United States fleet.

The usual index of abundance, catch per unit of effort is not presently available for this fishery. The effort parameter, days spent on the grounds, is not an accurate measure of effort since it does not take account of the relative amount of time spent fishing as compared to the time spent shucking. The catch parameter, really landings, does not take account of discards or of the size distribution of those landed. Canadian investigators have introduced a log book system in their fleet which should improve their measure of effort. United States investigators are starting a log book system and commenced the design of instruments to measure either distance traveled by the dredge or time on the bottom.

Average landings per day spent on the grounds, therefore, will only indicate gross changes or trends in abundance of the sizes of scallops above the cull point. Figure 5 shows the yearly average figures for the United States fleet since 1950. The average for the years 1950-1958 was 1600 pounds with very little scatter except for the low year of 1956. The large increase in 1959 marked the recruitment during the summer of an unusually numerous year class the effects of which persisted

for the next few years. The downward trend in 1962 has continued into 1963. The first quarter average(1960 pounds) this year is the lowest since 1959 for the same period.

TOTAL MORTALITY RATE

Two methods have been used to estimate the total mortality rate; decline in abundance as measured by serial quantitative research vessel samples and the relative abundance of the year classes in samples which have been aged. Both give similar results.

Table 2 shows the results of the research vessel surveys. N_1 is the average number of sea scallops greater than 100 mm long taken per 10,000 square feet dredged. Scallops smaller than 100 mm are not fully subjected to the fishery. N_2 is the average number taken from the same area one year later. It includes all scallops larger than 110 mm to allow for growth and discount recruitment during the year. From these data we get an average estimate of $Z = .71$.

Table 2.--Calculation of Z from research vessel samples.

	N_1	N_2	Z
May 1960 - May 1961	87.0	42.9	.71
May 1961 - May 1962	50.5	24.1	.74
Sept. 1961 - Sept. 1962	68.9	34.2	.71
Average	68.8	33.7	.71

Since 1958, we have been collecting shell samples from both the commercial fleet and research vessels for age determination. Table 3 shows the relative abundance of the year classes with all samples collected during a year pooled. Ages 3 and 4 are not fully recruited

Table 3.--Relative abundance of the year classes in samples read for age determination.

Age	3	4	5	6	7	8	9	9+
Year								
1958	309	366	146	90	48	7	3	5
1959	56 1057	220	142	58	22	4	1	1
1960	218	56 107	43	47	12	5	2	24
1961	394	57 266	56 172	53	46	11	5	2
1962	332	207	57 275	56 155	81	18	9	11
1963	17	282	114	279	56 78	35	16	30

to the fishery and above age 9 the shells are difficult to age percisely so these ages were eliminated from further calculations.

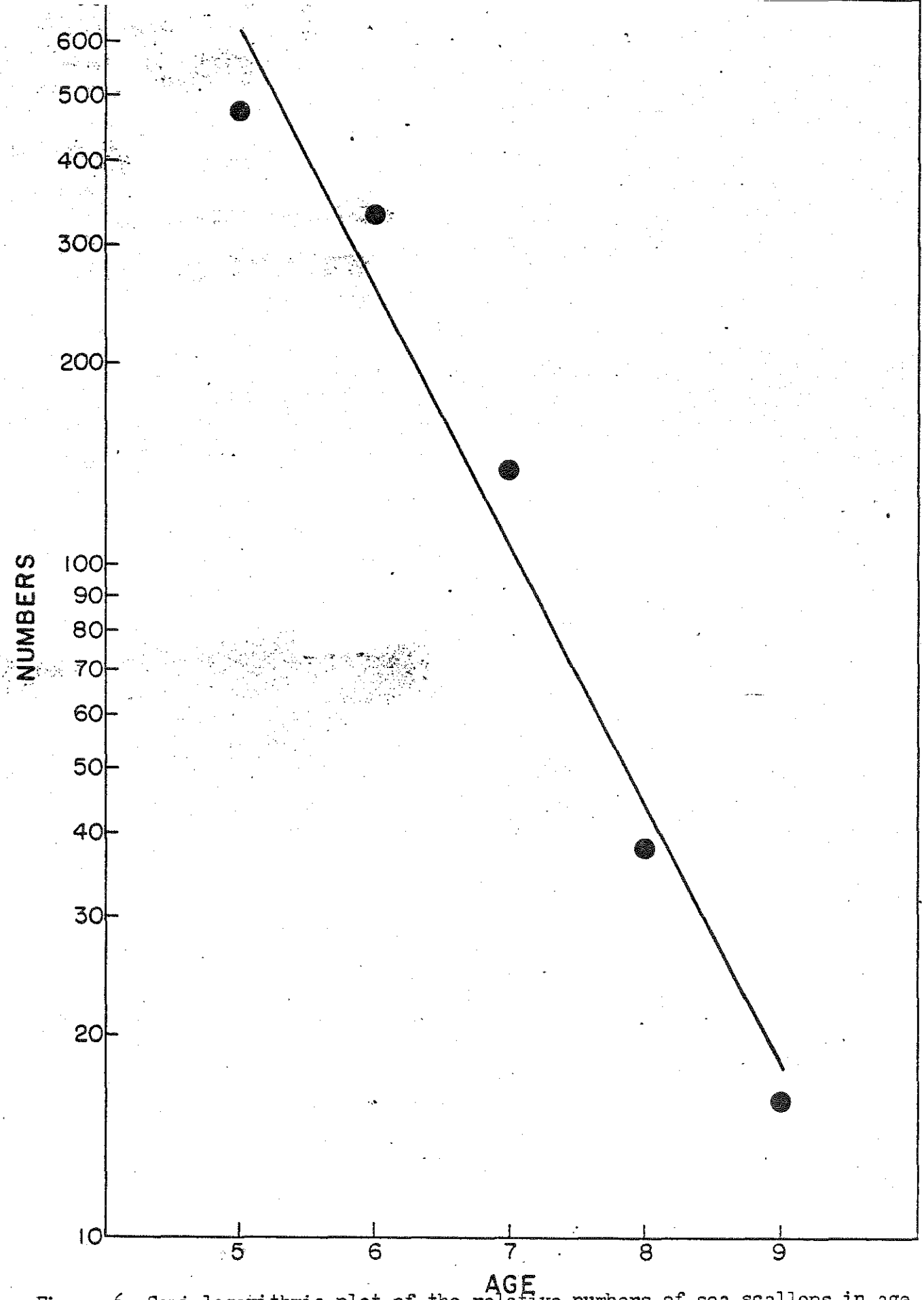

Figure 6. Semi-logarithmic plot of the relative numbers of sea scallops in age groups 5-9.

Table 4 shows the relative numbers in each age group per thousand scallops age 5-9 for each year and the average for the six years.

Table 4.--Relative numbers per thousand, age groups 5-9.

Year	Age 5	6	7	8	9
1958	498	307	164	24	10
1959	626	256	97	18	4
1960	394	431	110	46	18
1961	599	184	160	38	17
1962	512	288	151	33	17
1963	219	536	150	67	31
Average	474	333	139	38	16

Figure 6 shows a semi-logarithmic plot of the average numbers in each age group. The slope of the fitted line is 0.89, another estimate of Z.

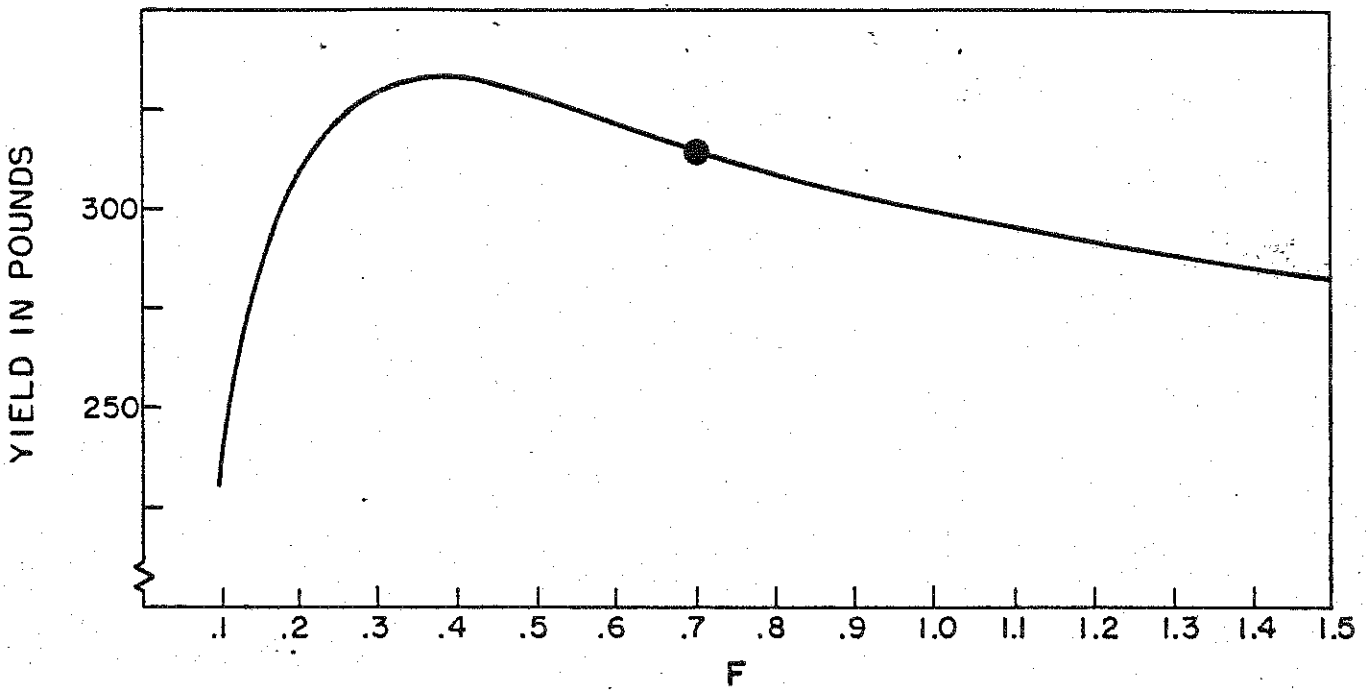

Figure 7. Yield to be expected at various levels of fishing pressure. Calculated for 10,000 recruits at age 3.5, natural mortality rate of .09, and fishing mortality initiated at age 5.

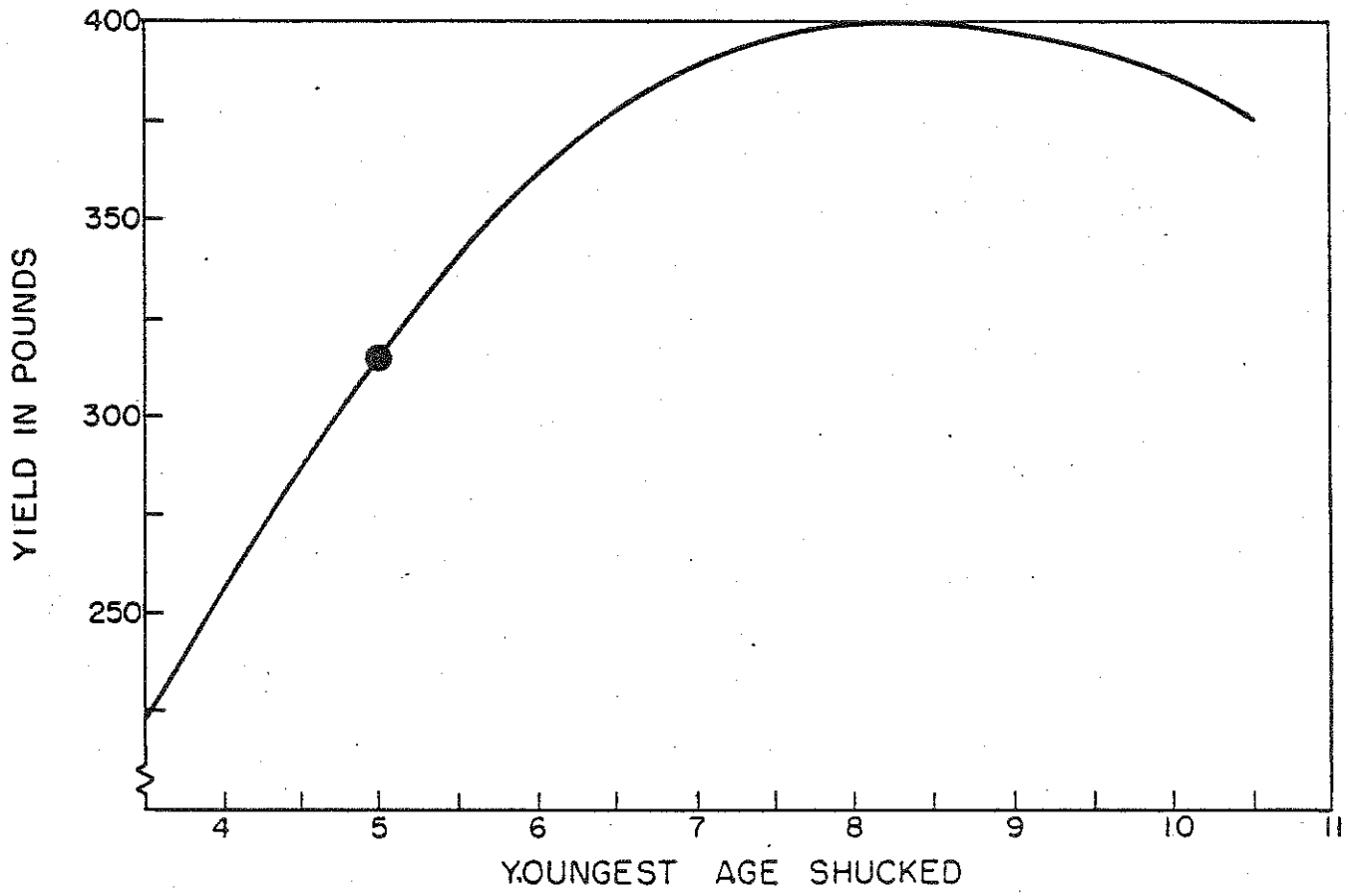

Figure 8. Yield to be expected if fishing mortality rate is held at .70 but initiated at various ages. Other conditions same as Figure 7.

NATURAL MORTALITY

Last year we reported our best extimate of M to be about .09 with a possible range of from .06 to .12. No evidence has accumulated since to suggest any change in that estimate.

YIELD

As shown above, we have two estimates of Z, .71 and .89 and an estimated range of M from .06 to .12. Taking the averages gives us estimates of F=.71 and M=.09. Figure 7 shows the effect on yield of leaving the age at which the scallops are first shucked at the present 5 and varying the fishing mortality rate. The maximum occurs at .4 and is about 5 percent greater than at .7. Figure 8 shows the effect of leaving the fishing mortality rate at .7 and starting to shuck the scallops at different ages. The maximum occurs at age 8 and is about 27 percent greater than at age 5.

GEAR SELECTION

Last year Dr. Neil Bourne reported, in Document No. 56, the results of some gear selection experiments by both Canadian and United States investigators. Canada used the chartered scalloper Cape Eagle

and tested the effect of 3" and 4" rings with linkages from single through quadruple. The experimental and standard (3-inch) dredges were towed simultaneously for 20-30 minutes to simulate commercial practice. The United States used the research vessel Delaware and tested the effect of 3", 4", and 5" rings with linkages from single through triple. The tows analyzed here were made sequentially with an odometer so that it was possible to adjust the catches for distance traveled. All tows were 10 minutes long to reduce the effect of trash clogging the bag.

In the analysis reported here, all types of linkage have been pooled and the catches divided into three size groups, those smaller than 95 mm, usually discarded; those between 95-110 mm, the sizes we would like to release for later capture; and those over 110 mm, the sizes we wish to retain.

On the Delaware, the use of the 4-inch ring reduced the catch of the smaller scallops by 45 percent, the 5-inch ring reduced it by 88 percent. On the Cape Eagle, making longer tows, the 4-inch ring reduced the catch of these sizes by only 23 percent.

The catch of the 95-110 mm group was reduced 28 percent by the

4-inch ring and 79 percent by the 5-inch ring on the Delaware. Cape Eagle catches were reduced only 9 percent by the 4-inch ring.

The catch of scallops larger than 110 mm was increased 14 percent by the use of the 4-inch ring on the Delaware and 11 percent on the Cape Eagle. The 5-inch ring on the Delaware reduced the catch of these sizes 43 percent.

As Dr. Bourne concluded, these results indicate that the introduction of a 4-inch ring in this fishery would reduce discards somewhat but would not materially postpone the age at which the scallops are first shucked. The use of a ring larger than 4-inch would reduce the catch of the youngest scallops now shucked but in such an erratic manner that we are unable to predict how much it would be reduced or to calculate an estimate of increased yield.

4/29/63