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ANNUAL MEETING - JUNE 1956The Validity and the Possible Use of the Data
on Yields Per Unit of Effort

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From 1952 to 1954 an increasing quantity of data on landings and on fishing efforts have been reported to the Commission by member countries. This paper is an attempt to compile and compare the yields per unit of effort which can be calculated from these data in order to (a) show the extent of the material and the gaps which still exist (b) establish to what degree the data from the separate fishing fleets agree with one another, i.e. to control one set of data with another (c) to investigate what information on the relative density of the stocks is furnished by the data on the yield per unit of effort (d) establish yearly variations in the yield per unit of effort (e) examine the variations in yield per effort, by countries and by fishing fleets.

As the most complete series of yields per effort is available for the fleets of otter trawlers the results from this fishery will be considered most closely: only occasionally will data from pair-trawlers or liners be used.

a. Extent of material.

Table 1 shows the extent of the material, and the kind of data on efforts collected for the otter-trawl, pair-trawl and line fisheries by the separate countries in the years 1952, 53 and 54.

It is apparent that a large variety of effort data are reported by the member countries. No doubt it is quite unique that an area as large as the Convention Area is so well covered with refined data on fishing efforts. It should be remembered that in most cases these data are also collected by month and by subdivisions (23 subdivisions in all). However, there are gaps in the collection. Not one of the categories of effort data are collected by all participating countries. This of course makes a comparison of the yields per unit of effort difficult, and consequently the full value of the work involved in the collecting, reporting, and compiling of these data cannot be achieved yet. A special effort should be made to have the collection complete for all countries.

b. Comparison of data from various fishing fleets.

The yields per unit of effort of a fishing fleet vary from subarea to subarea and from year to year. The purpose of this comparison is to investigate whether the yields per unit of effort of the various fishing fleets follow the same pattern. If they generally do so, we will know that the data are accurate enough to allow deductions, f.i. as to the density of the stocks in various areas and years, and as to the varying efficiency of various types of vessels.

For this comparison we shall use total yield (all ground-fish) for otter-trawlers. The following categories of efforts will be considered: days on grounds, days fished and hours trawled. The categories, days absent and number of trips, are of less use for this purpose as the distances from the home ports to the fishing grounds vary considerably from one country to another.

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TABLE 1. EXTENT OF COLLECTION OF DATA ON EFFORTS

		No. of vessels	No. of trips	No. of days absent	No. of days on gr.	No. of days fished	No. of hours trawl.	No. of hooks used	No. of dory hours	No. of men	Gross ton- nage
Canada,	1952	+	+	+	+	+	+	+			
Maritimes	53	+	+	+	+	+	+	+			
Quebec	54	+	+	+	+	+	+	+			
Canada,	1952	+	+	+	+	+	+	+			
Newfound-	53	+	+	+	+	+	+	+			
land	54	+	+	+	+	+	+	+			
Denmark,	1952	+	+	+	+	+	+	+			
Faroes	53	+	+	+	+	+	+	+			
	54	+	+	+	+	+	+	+			
Denmark,	1952										
Greenland	53										
	54										
France	1952	+									
	53	+									
	54	+									
Germany	1952										
	53		+								
	54		+								
Iceland	1952	+	+	+							
	53	+	+	+							
	54	+	+	+							
Italy	1952	+	+	+							
	53	+									
	54	+									
Norway	1952	+	+	+	+	+					
	53	+	+	+	+	+					
	54	+	+	+	+	+					
Portugal	1952	+									
	53	+									
	54	+									
Spain	1952										
	53	+	+								
	54	+	+								
United	1952	+	+	+							
Kingdom	53	+	+	+							
	54	+	+	+							
United	1952										
States	53		+	+							
	54		+	+							

Table 2 gives the total yield per unit of fishing effort by subareas and by countries for the years 1952, 53 and 54.

Figure 1 shows graphically the material from Subarea 1 on annual changes in the yield per unit of effort. In the figure, data are included only for those countries which have data for more than one year. It is apparent that the data from the several fleets vary according to the same pattern. Thus the fleets of Denmark, Germany, Norway, Portugal, and Spain all increased their yields per unit of effort from 1953 to 1954, the yield of the United Kingdom fleet was the same in the two years. The scantier material for 1952-53 does not show the same agreement; here there is a decrease for Portugal and the United Kingdom and an increase for Denmark and Norway.

For Subarea 2 (Figure 2) the data of the four countries who have fished there agree fairly well, showing a strong decline from 1952 through 1953 to 1954.

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TABLE 2. SUBAREAS 1-4

		Total Yield Per Unit of Effort, with Means, for Other-Trawler Fleets											
		SUBAREA 1			SUBAREA 2			SUBAREA 3			SUBAREA 4		
		Total yield per Day on Day Hour grou- fish- traw- nds ed led			Total yield per Day on Day Hour grou- fish- traw- nds ed led			Total yield per Day on Day Hour grou- fish- traw- nds ed led			Total yield per Day on Day Hour grou- fish- traw- nds ed led		
1952	Canada 1)				11.7	13.3	2.50	12.8	14.8	1.39	10.8	11.1	0.82
	Denmark, Faroes	9.7											
	Iceland		18.1										
	Norway	10.8	12.1										
	Portugal	18.1		1.21	27.3		2.61	12.9		1.18	14.1		1.05
	U.K.			2.86			2.91						
1952	MEAN	12.9	15.1	2.04	19.5	13.3	2.67	12.9	14.8	1.29	12.5	11.1	0.94
1953	Canada 1)				7.5	7.5	0.72	12.8	13.3	1.29	9.9	10.2	0.86
	Denmark, Faroes	14.6											
	Germany		25.7						26.0				
	Norway	12.9	13.7	1.63									
	Portugal	14.5		0.89	29.5		2.44	17.1		1.32	11.8		1.24
	Spain		17.7	1.22		16.7	1.50		17.3	1.40		12.6	0.99
	U.K.			1.60			0.90			2.00			
1953	MEAN	14.0	19.0	1.34	18.5	12.1	1.39	15.0	18.9	1.50	10.9	11.4	1.03
1954	Canada 1)				1.0	1.0	0.17	13.8	14.7	1.49	12.0	12.6	1.07
	Denmark, Faroes	24.5											
	France		36.9			34.3			30.6			34.4	
	Germany		30.9										
	Norway	16.8	18.4	2.58									
	Portugal	25.7		2.64	12.8		1.17	15.1		1.23	16.1		1.82
	Spain		21.6	1.31		7.5	1.06		21.9	1.87		18.9	1.48
	U.K.			1.60						1.48			
1954	MEAN	22.3	27.0	2.03	6.9	14.3	0.80	14.5	22.6	1.51	14.1	22.0	1.46
1952)													
1953)	MEAN	16.4	20.4	1.80	15.0	13.2	1.62	13.1	18.8	1.43	12.5	14.8	1.16
1954)													

1) Average of Canada (Maritimes & Quebec) and Canada (Newfoundland).

Figure 3 gives the same kind of material for Subarea 3. The agreement here is perhaps not quite as strong as for Subareas 1 and 2. However, there still is agreement in far more cases than there is disagreement. The variations between the separate years are much smaller than in Subarea 1. This might be due to the fact that the weather conditions influencing the fishery are less extreme in Subarea 3 than in Subarea 1. It might also be due to the fact that the stock of fish is more stabilized in Subarea 3 than in 1 or 2. The size of year-classes and the rate of growth are surely more subject to yearly variations in Subarea 1 than in Subarea 3, as the cod, the main species caught, is living under more fluctuating conditions in Subarea 1 than in Subarea 3.

Figure 4 illustrates the material for Subarea 4. For this Subarea there is a very close agreement in the yearly variations of the yields by the various countries. It is worth noting that for this Subarea, as for Subarea 3, the variations from year to year are considerably smaller than for Subarea 1.

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The pronounced agreement in the variations from year to year in the yields per unit of effort of the separate fishing fleets makes it evident that the basic data (on efforts and on landings) are fairly accurate, and no doubt we are safe in using these yields in our studies of the conditions of the fishery in the ICNAF Area.

c. The relative density of the stock of fish in the different sub-areas determined through the yields per unit of effort.

The table 2 shows the total yield per unit of effort (day on grounds, day fished, and hour trawled) in each of the Subareas 1-4 for the separate countries in the three years 1952, 53, and 54. Subarea 5 is not included as data for the corresponding categories of effort are not available.

Figure 5 gives the yields per unit of effort by subareas as averages of all countries and years.

The yield per day on grounds shows a steady, but small decrease from Subarea 1 through 2 and 3 to Subarea 4, as follows:

Subarea 1	-	16.4	tons per day on grounds
Subarea 2	-	15.0	tons per day on grounds
Subarea 3	-	13.1	tons per day on grounds
Subarea 4	-	12.5	tons per day on grounds

The yield per day on grounds is thus about one third higher in Subarea 1 than in Subarea 4.

The yield per day fished is highest in Subarea 1, next but only a little below comes Subarea 3, then considerably lower Subarea 4 and as the lowest Subarea 2.

The graph (Figure 5) for the yield per hour trawled shows a very regular decline from Subarea 1 through 2 and 3 to 4, as follows:

Subarea 1	-	1.80	tons per hour trawled
Subarea 2	-	1.62	tons per hour trawled
Subarea 3	-	1.43	tons per hour trawled
Subarea 4	-	1.16	tons per hour trawled

A comparison like this is rather rough, especially as it is not always the same countries which are fishing in the same area.

To make up for this inaccuracy we shall now consider only those countries which fish in all four subareas, namely Portugal and Spain.

Table 3 (abstracted from Table 2) gives a comparison of the yields per unit of effort for the Portuguese and Spanish otter-trawler fleets fishing in Subareas 1, 2, 3, and 4.

For these two countries it is apparent that Subareas 1 and 2 have for the years in question the largest yields per unit, next comes Subarea 3. Subarea 4 shows the lowest yields.

As these yields per unit of effort indicate the density of the population of marketable fish on the fishing banks in the various areas, we find that in the years 1952-54 the most dense stock occurred in Subareas 1 and 2, in Subarea 3 the density was a little lower. Subarea 4 showed the lowest density of fish.

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TABLE 3. TOTAL YIELDS PER UNIT OF EFFORT - PORTUGAL AND SPAIN

	Yield per day on grounds				Yields per day fished				Yields per hour trawled			
	Subarea				Subarea				Subarea			
	1	2	3	4	1	2	3	4	1	2	3	4
Portugal												
1952	18.1	27.3	12.9	14.1	-	-	-	-	1.21	2.61	1.18	1.05
1953	14.5	29.5	17.1	11.8	-	-	-	-	0.89	2.44	1.32	1.24
1954	25.7	12.8	15.1	16.1	-	-	-	-	2.64	1.17	1.23	1.82
MEAN	19.4	23.2	15.0	14.0	-	-	-	-	1.58	2.07	1.24	1.37
Spain												
1953	-	-	-	-	17.7	16.7	17.3	12.6	1.22	1.50	1.40	0.99
1954	-	-	-	-	21.6	7.5	21.9	18.9	1.31	1.06	1.87	1.48
MEAN	-	-	-	-	19.7	12.1	19.6	15.8	1.27	1.28	1.64	1.24
Both Countries												
MEAN	19.4	23.2	15.0	14.0	19.7	12.1	19.6	15.8	1.45	1.76	1.40	1.32

The means for both countries are shown graphically in Figure 6.

These results cover very well the general impression of the size of the stock in the various areas. What could be astonishing perhaps is that the differences in the densities of the stocks in the four subareas are as small as appears from these figures. This might very well indicate that the percentage which the trawl takes of the amount of fish present in the area fished varies with varying density of the stock, so that the percentages taken become smaller as the density of the stock increases. Several reasons could be considered as accounting for this, e.g. 1) that the trawl fishes better the less fish it contains, 2) that in a dense stock the fish are more easily warned of the approaching trawl; such warning arising from the dense stream of fish in front of the trawl trying to escape capture. If this be so, we have to use the catch per unit of effort with caution, when judging the density of the stock from it.

If we use the yield per hour trawled, and calculate the density in percent of that found for the most dense population (that of Subarea 2), we get the following picture:

- Subarea 2 - 100 per cent
- Subarea 1 - 83 per cent
- Subarea 3 - 80 per cent
- Subarea 4 - 75 per cent

Subareas 1 and 3 thus show a density of around 80% of that in Subarea 2, and Subarea 4 a density of three-quarters of that in Subarea 2.

The question arises whether these rather small variations in yields correspond to similar small variations in density or if they are caused either by the afore-mentioned varying fishing power of the trawl or by the trawler captains' skill in finding, wherever and whenever they are fishing just the right spot for setting the trawl. This problem could be more closely studied by considering the refined data of yields by months and subdivisions.

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Another method for estimating the size of the marketable part of a fish stock, which has been used for estimation of the stock of plaice in the North Sea, is the following: to calculate the annual percentage of the fish stock taken by the fishery from data on the recaptures made in one year from marking experiments; and then to multiply the total number of fish landed in one year (calculated from the total weight of fish landed) by the reciprocal of this percentage (i.e. if 20% of the fish marked are recaptured in one year one multiplies by $\frac{100}{20}$).

The following is an attempt to use this method for cod in the Subareas 1, 3, and 4.

A. Calculation of Size of Cod Stock from Catches and Tagging Results, by Subareas

Recoveries during first year after tagging.

Subarea 1

Danish Experiments	-	1952	-	3.6%
" "	-	1953	-	5.3%
Norwegian Experiments	-	1953	-	4.7%
United Kingdom Experiments	-	1952	-	3.9%
	MEAN			<u>4.4%</u>

Subarea 3

Canadian Experiments	-	1950	-	13.1%
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Subarea 4

Canadian Experiments	-	1953	-	36.5%
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To these percentages 5% is added to make up for loss of tags on fish and for recaptures not reported; this figure is of course only a fictional one.

The amended recaptures are:

Subarea 1 (Greenland Banks)	-	9
Subarea 3 (Newfoundland Banks)	-	18
Subarea 4 (Scotian Shelf)	-	42

In order to be able to calculate the number of individuals from the landings given in tons, curves showing the size-distribution of cod caught by commercially used gears have been prepared from measurements of cod reported to the Commission in 1952, 53 and 54 (Figures 7 and 8).

The largest part of this material, that from Subarea 1, is shown in Figure 7, by countries (a-f), by years (g, h, and i), and for all years and all countries (j).

Norway (d) lands the largest cod, mean length 77.1 cm., mean weight 4.2 kgs.¹⁾ The mean lengths for the cod caught by the other countries (Denmark, Germany, Iceland, Portugal, and United Kingdom) are somewhat smaller, differing only little from country to country from 68.7 cm. to 71.9 cm.

There are slight variations in the mean lengths for the three years, from 71.1 cm. in 1952 to 71.9 cm. in 1954 (g, h, and i).

1) The mean weight is estimated by using the length-weight curve for cod from the Newfoundland Banks reported by France (French Res. Rep. for 1954, fig. 1. Ann. Proc. Vol. 5).

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The mean size for all countries and all years (j) for Subarea 1 is 71.4 cm. corresponding to a weight of ca. 3.4 kgs. per individual.

Figure 8 gives measurements reported by France and Spain from Subareas 2 and 3. The means of these measurements vary considerably from ca. 37 to ca. 75 cm. Therefore they were not used for the present purpose, and the figures for Subarea 1 were used for the whole area.

	Total yearly catch in 1000 tons 1953/54	Weight of one cod kg.	No. of indiv. (>ca. 50 cm.) caught millions	Tagging recaptures %	Total population (>ca. 50 cm.) millions	No. of sq. km. of area <100 F.	Density No. of cod (>ca. 50 cm.) per sq. km.
Subarea 1	234	3.4	69	9	767	189000	4058
Subarea 3	397	3.4	117	18	650	324000	2006
Subarea 4	146	3.4	43	40	108	341000	317

In evaluating these figures on density it should be born in mind that in Subarea 1 the whole area north of Disko is hardly inhabited by the cod, and that considerable parts of Subareas 3 and 4 are not cod grounds proper owing to the dominance of other species of the cod genus (haddock etc.). Therefore the following calculation B is made:

B. Calculation of Size of Cod Stock from Catches and Tagging Results from Selected Subdivisions of Subareas 1, 3, and 4, where cod are dominating.

Only the year 1953 is considered as far as landings are concerned.

	Total yearly catch in 1000 tons 1953/54	Weight of one cod kg.	No. of indiv. (>ca. 50 cm.) caught millions	Tagging recaptures %	Total population (>ca. 50 cm.) millions	No. of sq. km. of area <100 F.	Density No. of cod (>ca. 50 cm.) per sq. km.
Subarea 1 Tot. minus 1A	201	3.4	59	9	656	105000	6248
Subarea 3 Tot. minus 3O and 3P	307	3.4	90	18	500	191000	2618
Subarea 4 Tot. minus 4W and 4X	125	3.4	37	40	90	204000	441

In considering the figures in calculations "A" as well as in "B" it must be born in mind that a small change in the tagging recapture percentages will greatly change the density figures. The two calculations are only intended to show a possible way of calculating densities in our area, not to give final results.

For comparison with these figures on density of cod populations corresponding figures for cod yield per unit of effort calculated from the Portuguese and Spanish material are given in Table 4.

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TABLE 4. COD YIELDS PER UNIT OF EFFORT - PORTUGAL AND SPAIN

	Yield per day on grounds				Yields per day fished				Yields per hour trawled			
	Subarea				Subarea				Subarea			
	1	2	3	4	1	2	3	4	1	2	3	4
Portugal												
1952	18.1	27.3	12.9	9.0	-	-	-	-	1.21	2.61	1.18	0.67
1953	14.5	29.5	17.0	11.8	-	-	-	-	0.89	2.44	0.94	1.24
1954	25.7	12.8	15.0	16.1	-	-	-	-	2.64	1.17	1.23	1.81
MEAN	19.4	23.2	15.0	12.3	-	-	-	-	1.58	2.07	1.12	1.24
Spain												
1953	-	-	-	-	17.7	16.6	11.5	8.5	1.20	1.48	0.94	0.67
1954	-	-	-	-	21.6	7.5	16.6	15.3	1.31	1.06	1.42	1.20
MEAN	-	-	-	-	19.7	12.1	14.1	11.9	1.26	1.27	1.18	0.94
Both Countries												
MEAN	19.4	23.2	15.0	12.3	19.7	12.1	14.1	11.9	1.45	1.75	1.14	1.12

The cod yield is highest in Subarea 2, somewhat lower in Subarea 1, and considerably lower in 3 and 4, the two subareas where species other than cod play a considerable role in the fishery.

Using the yield per hour trawled and calculating the density, the yield, in percent of that found for the most dense population (that of Subarea 2), we get the following:

Subarea 2	-	100 percent
Subarea 1	-	83 percent
Subarea 3	-	65 percent
Subarea 4	-	64 percent

When we compare these figures with the density of the stock as calculated from the tagging experiments we get the following result.

	From tagging exp. Density, no. of ind. per sq. km.	From yield per unit Density in % of that in Subarea 2
Subarea 1	6248	83%
Subarea 2		100%
Subarea 3	2618	65%
Subarea 4	441	64%

The picture so far is the same for both calculations, in that Subarea 1 (Subarea 2 is not considered) shows the highest figure and Subarea 4 the lowest. But the differences as to the density shown by the tagging results are much greater than those shown by the yield per unit of effort. Whereas for Subarea 1 the tagging results show a density of cod about 2.5 times greater than for Subarea 3, the yields per units only shows the density in Subarea 1 to be around 1.3 times that in Subarea 3. Whereas tagging results show a six-times thinner stock in 4 than in 3, the yield per unit shows hardly any difference in density between these two subareas.

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As mentioned earlier (p.5) there may be other reasons for this disagreement than those deriving from defects in the material. These latter defects are supposed to be mainly found in the results from the tagging experiments.

A comparison of the variations from subarea to subarea of the yields per unit of effort, and of calculated density of stocks with the actual catch of number of individuals per square unit of area is possible.

For this purpose Subarea 2 is omitted because of the great yearly variations in landings, the small intensity of the fishery by certain countries, and the lack of tagging experiments. Subarea 5 is left out for want of sufficient data on fishing efforts. The comparison thus comprises only Subareas 1, 3 and 4.

The statistics from France, Spain and Portugal, the three countries fishing with otter-trawl in all these three subareas are considered.

The following is a survey of the cod yields per unit of effort for otter-trawlers:

		<u>Subarea 1</u>			<u>Subarea 3</u>			<u>Subarea 4</u>		
		Yield in tons per			Yield in tons per			Yield in tons per		
		day	day	hour	day	day	hour	day	day	hour
		on gr.	fish.	trawl.	on gr.	fish.	trawl.	on gr.	fish.	trawl.
France	1954		36.9			30.6			34.4	
Portugal	1952	18.1		1.21	12.9		1.18	9.0		0.67
	1953	14.5		0.89	17.0		1.30	11.8		1.24
	1954	25.7		2.64	15.0		1.23	16.1		1.81
Spain	1953		17.7	1.20		11.5	0.94		8.4	0.67
	1954		21.6	1.31		16.6	1.42		15.3	1.20
	MEAN	19.4	25.4	1.45	15.0	19.6	1.21	12.3	19.4	1.12

The mean landings in individuals per square km. of area are calculated from the area figures and individual weight given in the preceding "Calculations A and B", and the ICNAF statistics on landings, as follows:

Subarea 1 - Total area 1952-54 : 365 cod per 1 sq. km.
 Subarea 3 - Total area 1952-54 : 361 cod per 1 sq. km.
 Subarea 4 - Total area 1952-54 : 126 cod per 1 sq. km.

Subarea 1 - Total subarea less 1A, 1953 : 562 cod per 1 sq.km.
 Subarea 3 - Total subarea less 3O & 3P, 1953 : 471 cod per 1 sq.km.
 Subarea 4 - Total subarea less 4W & 4X, 1953 : 161 cod per 1 sq.km.

It is of interest to note that the number of cod trawled per square km. is much the same in Subareas 1 and 3, and about four times as large in these subareas as in Subarea 4.

The following table is a comparison between the data on yield per unit of effort and the calculated densities of the stock of cod (A, B) and the catch in individuals per onesquare kilometer.

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	Mean yield per			Density A	Density B	Catch, individuals	
	day on gr.	day fish.	hour trawl.	no. per sq. km. <100 F.	no. per sq. km. select. cod area<100 F.	per sq. km. tot. area	per sq. km. sel. area
Subarea 1	19.4	25.4	1.45	4058	6248	365	562
Subarea 3	15.0	19.6	1.21	2006	2618	361	471
Subarea 4	12.3	19.4	1.12	317	441	126	161

Figure 9 shows this comparison in graphic form. It is apparent from the curves that the trend of the variations from subarea to subarea is the same for the yields per unit of effort for the calculated densities of stock and for the catch of individuals per square km.

The trend of the variations from subarea to subarea is the same; however the degree, the range, varies considerably. This becomes apparent from the following survey which for Subareas 3 and 4 gives the abovecited figures in percentages of the corresponding figures for Subarea 1, the subarea which for all series shows the highest figure:

	Mean yield per			Density A	Density B	Catch, individuals	
	day on gr.	day fish.	hour trawl.	no. per sq. km. <100 F.	no. per sq. km. select. cod area<100 F.	per sq. km. tot. area	per sq. km. sel. area
Subarea 1	100%	100%	100%	100%	100%	100%	100%
Subarea 3	77%	78%	83%	49%	42%	99%	90%
Subarea 4	63%	76%	77%	8%	7%	35%	34%

These percentages are shown in graphic form in Figure 10. The range of variation is far less for yield per fishing units than for densities of stock; the range for catch of individuals per sq. km. is intermediary. The yields per unit of effort in Subarea 4 are about 2/3 to 3/4 of those in Subarea 1, whereas the densities calculated for Subarea 4 are less than 1/10 of those for Subarea 1; the catches, in individuals per sq. km., in Subarea 4 are just over 1/3 of those in Subarea 1.

d. Variations in the yield per unit of effort in the years 1952-54.

Table 5 gives, based on figures from Table 2, the figures for total yield per unit of effort for the years 1952, 53, and 54 for those countries and subareas for which the data are most complete. Graphs of these variations are shown in Figures 1-4.

Subarea 1. It is apparent from the graphs that the year 1953 on a whole gave the lowest yields per unit of effort, that 1952 was somewhat better, and that 1954 was decidedly better. It can be mentioned that for this subarea the total yield is very much equal to the cod yield.

It is of interest to note that the U.K. yield per hour trawled in 1952 was much higher than the Portuguese one, whereas in 1954 Portugal achieved a much higher yield than the U.K. This might well be caused by the fact that Portugal is mainly fishing the central W. Greenland Banks, whereas the U.K. fishery is carried out mainly off the S.W. and W. coast.

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TABLE 5. VARIATIONS IN THE TOTAL YIELD PER UNIT OF EFFORT - 1952-54

A. SUBAREA 1									
	Yield per hour trawled			Yield per day on grounds			Yield per day fished		
	1952	1953	1954	1952	1953	1954	1952	1953	1954
Denmark	-	-	-	13.9	14.6	24.5	-	-	-
Germany	-	-	-	-	-	-	-	25.7	30.9
Norway	-	1.63	2.58	10.8	12.9	16.8	12.1	13.7	18.4
Portugal	1.21	0.89	2.64	18.1	14.5	25.7	-	-	-
Spain	-	1.22	1.31	-	-	-	-	17.7	21.6
U.K.	2.86	1.60	1.60	-	-	-	-	-	-

B. SUBAREA 2									
	1952	1953	1954	1952	1953	1954	1952	1953	1954
Canada	2.50	0.72	0.17	11.7	7.5	1.0	13.3	3.3	1.0
Portugal	2.61	2.44	1.17	27.3	29.5	12.8	-	-	-
Spain	-	1.50	1.06	-	-	-	-	16.6	7.5
U.K.	2.91	0.90	-	-	-	-	-	-	-

C. SUBAREA 3									
	1952	1953	1954	1952	1953	1954	1952	1953	1954
Canada	1.39	1.29	1.46	12.8	12.6	13.8	14.8	13.3	14.8
Portugal	1.18	1.32	1.23	12.9	17.1	15.1	-	-	-
Spain	-	1.40	1.87	-	-	-	-	17.3	21.9
U.K.	-	2.00	1.48	-	-	-	-	-	-

D. SUBAREA 4									
	1952	1953	1954	1952	1953	1954	1952	1953	1954
Canada	0.82	0.86	1.07	10.8	9.9	12.0	11.1	10.2	12.6
Portugal	1.05	1.24	1.82	14.1	11.8	16.1	-	-	-
Spain	-	0.99	1.48	-	-	-	-	12.6	18.9

Subarea 2. For this subarea there is a general and considerable decline in the yields from 1952 through 1953 to 1954. The big difference in yield per unit of effort between Canadian and Portuguese catches is worth noting.

Subarea 3. There is hardly any difference in yield per unit of effort from 1952 to 1953. From 1953 to 1954 the Canadian and Spanish yields increased slightly, whereas the yields of the fishing fleets of Portugal and the United Kingdom decreased.

Subarea 4. 1952 and 1953 show about the same yields per unit of effort in this subarea. The yields per unit of effort are somewhat higher in 1954 than in 1952 and 1953.

It is worth noting that the yearly variations in the yields are considerably smaller in Subareas 3 and 4 than in Subareas 1 and 2. This may be attributed to the fact that the cod are living under more extreme conditions in Subareas 1 and 2 than in 3 and 4 (cod makes up nearly the whole of the catch in Subareas 1 and 2, and the main part of the catch - of the trawler fleets - in Subareas 3 and 4). Also the fact that the conditions for the fishery (weather and ice) are more changeable in Subareas 1 and 2 may account for the greater yearly variations in yields per unit of effort in these subareas.

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e. Variations in yield per unit of effort - by countries, and by fishing fleets.

Table 6 gives, for the otter-trawler fleets of the various countries, the total yields per hour trawled by subareas and years.

TABLE 6

	M. size of trawlers ts.	Subarea 1				Subarea 2			
		1952	1953	1954	M.	1952	1953	1954	M.
Canada	248	-	-	-	-	2.50	0.72	0.17	1.1
Norway	505	-	1.63	2.57	2.1	-	-	-	-
Portugal	1300	1.21	0.89	2.64	1.6	2.61	2.44	1.17	2.1
Spain	1170	-	1.20	1.31	1.3	-	1.50	1.06	1.3
U.K.	627	2.85	1.50	1.49	2.0	2.91	0.90	-	2.4
MEAN		2.0	1.4	2.0	1.8	2.7	1.9	0.8	1.8

	M. size of trawlers ts.	Subarea 3				Subarea 4			
		1952	1953	1954	M.	1952	1953	1954	M.
Canada	248	1.39	1.29	1.46	1.4	0.82	0.86	1.07	0.9
Norway	505	-	-	-	-	-	-	-	-
Portugal	1300	1.18	1.32	1.23	1.2	1.05	1.24	1.82	1.4
Spain	1170	-	1.40	1.87	1.6	-	0.99	1.48	1.2
U.K.	627	-	2.00	1.48	1.7	-	-	-	-
MEAN		1.3	1.5	1.5	1.4	0.9	1.0	1.4	1.1*

Already a first look at this table shows that there is not much relation between variations in size of trawlers and the yields per hour trawled. Norway and U.K., with trawlers of a mean size of 500-600, have yields as big as or even bigger than those of Portugal and Spain whose trawlers have a mean size of 1200-1300 tons.

This is seen more clearly from the following survey of yearly means for Subareas 1, 3, and 4 (Subarea 2 is not included owing to the much varying yields by years and the small extent of trawl fishing by some of the countries):

Subarea	Mean gross tonn.	Yield per hour tons
<u>Subarea 1</u>		
Norway	505)	2.1)
U.K.	627) 526	2.0) 2.1
Spain	1170)	1.3)
Portugal	1300) 1235	1.6) 1.5
<u>Subarea 3</u>		
Canada	248)	1.4)
U.K.	627) 438	1.7) 1.6
Spain	1170)	1.6)
Portugal	1300) 1235	1.2) 1.4
<u>Subarea 4</u>		
Canada	248	0.9
Spain	1170	1.2
Portugal	1300	1.4

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According to these figures the fleets composed of smaller trawlers have in certain cases even slightly larger catches per hour trawled than the fleets of larger trawlers. However, there are indications that the very smallest trawlers, those of Canada, have a somewhat smaller yield per hour trawled. These small trawlers might use trawls smaller than those used by the medium-sized and larger trawlers.

It might seem curious that a trawler of say 1300 tons can be content with fishing no more fish per hour than a trawler of 500 tons. The explanation might be that the larger trawler once upon the fishing ground can fish more continuously owing to its greater capacity of enduring hard weather, and for a longer period due to its larger fish holds.

This leads to an investigation of possible variation in the degree of use of the time spent on the grounds for actual trawling from one fleet to another.

The following Table 7 gives the number of hours trawled per day absent, day on ground and day fished:

TABLE 7. HOURS TRAWLED PER DAY ABSENT, DAY ON GROUNDS, AND DAY FISHED BY THE VARIOUS FLEETS IN SUBAREAS 1 - 4, AND IN THE YEARS 1952 - 54.

<u>SUBAREA 1</u>				<u>SUBAREA 2</u>					
Hours trawled per day				Hours trawled per day					
		<u>absent</u>	<u>on grounds</u> ¹⁾	<u>fished</u>		<u>absent</u>	<u>on grounds</u>	<u>fished</u>	
Norway	1952	-	-	-	Canada-Mar.	1952	3.4	4.6	5.3
	1953	5.0	7.9	8.4		1953	5.6	10.0	10.0
	1954	4.8	6.5	7.1		1954	3.0	6.0	6.0
Portugal	1952	-	15.0	-	Portugal	1952	-	10.4	-
	1953	-	16.2	-		1953	-	12.1	-
	1954	-	9.8	-		1954	-	11.0	-
Spain	1952	-	-	-	Spain	1952	-	-	-
	1953	-	-	14.8		1953	-	-	11.2
	1954	-	-	16.4		1954	-	-	7.1
U.K.	1952	3.1	6.7	-	U.K.	1952	2.5	4.9	-
	1953	4.3	8.9	-		1953	6.2	12.5	-
	1954	4.5	9.7	-		1954	-	-	-
<u>SUBAREA 3</u>				<u>SUBAREA 4</u>					
Can.-Mar.	1952	5.9	10.3	10.6	Can.-Mar.	1952	10.9	13.2	13.6
	1953	6.8	10.5	11.5		1953	9.4	12.3	12.7
	1954	6.4	10.7	11.1		1954	8.7	11.4	11.7
Can.-Nfld	1952	-	-	-	Can.-Nfld.	1952	-	-	-
	1953	6.2	8.9	9.2		1953	6.8	10.9	11.2
	1954	-	8.4	9.2		1954	-	10.8	11.4
Portugal	1952	-	11.0	-	Portugal	1952	-	13.5	-
	1953	-	13.0	-		1953	-	9.5	-
	1954	-	12.2	-		1954	-	8.8	-
Spain	1952	-	-	-	Spain	1952	-	-	-
	1953	-	-	12.0		1953	-	-	12.6
	1954	-	-	12.0		1954	-	-	12.7
U.K.	1952	-	-	-					
	1953	3.6	6.5	-					
	1954	7.8	12.6	-					

1) For U.K. no. of days on grounds are calculated from number of days absent by deducting 12 days for the duration of a return trip (no. of trips reported).

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From the figures in Table 1 it is obvious that there is in general a considerable difference in the use made of the time spent on the fishing grounds between Norway and the U.K. (with smaller trawlers) on the one hand and Portugal and Spain (larger trawlers) on the other; the following survey based on Table 7 gives the yearly means:

		Mean tonn. of trawlers	Hours trawled on grounds	Per day fished
<u>Subarea 1</u> 1953/54	Norway	505	7.2	7.8
	U.K.	627	9.3	-
	Portugal	1300	13.0	-
	Spain	1170	-	15.6
<u>Subarea 2</u> 1952/54	Canada - Mar.	253	6.9	7.1
	U.K.	627	8.7	-
	Portugal	1300	11.2	-
	Spain	1170	-	9.2
<u>Subarea 3</u> 1953/54	Canada - Mar.	253	10.5	11.1
	Canada - Nfld.	242	8.7	9.2
	U.K.	627	9.6	-
	Portugal	1300	12.1	-
	Spain	1170	-	12.0
<u>Subarea 4</u> 1953/54	Canada - Mar.	253	11.9	12.2
	Canada - Nfld.	242	10.9	11.3
	Portugal	1300	9.2	-
	Spain	1170	-	10.7

In Subarea 1 the large trawlers of Portugal and Spain actually trawl for nearly twice as many hours per day on grounds or days fished as the medium-sized trawlers of Norway and United Kingdom.

For Subarea 2 there is the same difference; further the same difference is found here between the quite small trawlers of Canada and the medium-sized trawlers of the U.K.

For Subareas 3 and 4 the differences are smaller and less regular. In Subarea 3 the Portuguese and Spanish have a slight advantage over the Canadians, but this is reversed in Subarea 4.

The fact that the large trawlers generally fish for more hours per day on grounds or day fished than do the smaller trawlers offers an explanation to the question, why a big trawler can be content to fish no more per trawl hour than a small trawler.

However, even if a larger trawler can continue fishing under worse weather conditions than a smaller one, it is surprising that the difference in number of hours trawled per day can be as great as that found for Subarea 1. There might be other reasons, e.g. that the smaller trawlers owing to their smaller crews have to stop fishing at intervals in order to manage the curing of the fish caught. It is possible that the difference to some degree is due to a differing understanding of what is included in the terms "day on grounds", "day fished", and "hours trawled", f.i. the problem of what to do with fractions of days? When we have to use these refined statistics on efforts, problems like these should be taken into account.

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The reason why the difference, between the smaller and larger trawlers as to hours trawled per day, is less in Subarea 3 than in 1 and 2 and completely lacking in Subarea 4, is no doubt that the small Canadian trawlers here fish close to their home ports, and therefore are able to seek these during hard weather. The larger foreign trawlers will to a greater degree stay on the fishing grounds during hard weather.

France and Germany do not report no. of hours trawled, but only no. of days fished. In order to draw these two countries into the comparison the following table of yields per number of days fished is given:

TABLE 8. OTTER-TRAWLERS, 1954, TOTAL YIELDS PER DAY FISHED

	<u>No. of days fished</u>	<u>Tot. catch tons</u>	<u>Tons per day fished</u>	<u>Mean tonn. of trawlers</u>
<u>SUBAREA 1</u>				
France	1179	43,542	36.9	1206
Germany	55	1,700	30.9	ca. 1200
Norway	463	8,517	18.4	505
Spain	102	2,202	21.6	1170
<u>SUBAREA 3</u>				
Canada - Mar.	1378	20,805	15.1	253
Canada - Nfld.	2422	34,301	14.2	242
France	595	18,169	30.6	1206
Spain	4527	99,253	21.9	1170
<u>SUBAREA 4</u>				
Canada - Mar.	3658	41,242	11.3	253
Canada - Nfld.	372	5,083	13.8	242
France	621	21,352	34.4	1206
Spain	331	6,250	18.9	1170

The table shows that the large, and modern, trawlers of France and Germany have a larger catch per day fished than the other fleets fishing in the subareas.

The figures for France show yields a little higher for Subarea 1 than for Subareas 3 and 4.

CONCLUSION

There is a general uniformity in the variations of the different kinds of yields per unit of effort, regionally, yearly, and by fishing fleets.

These variations further follow the same pattern (but show a different range of variation) as corresponding variations in calculated densities of stock and in numbers of cod caught per sq. km.

Consequently we can be justified in having confidence in the refined statistical data, as they are collected and reported by the various countries fishing in the Convention Area.

The figures for the years 1952-54 show that the most dense stocks occur in Subarea 1 (and possibly also in 2) with slightly declining densities towards the south through Subarea 3 to Subarea 4.

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They further show an increase in yields per unit from 1953 to 1954, which can indicate an increase in size of stocks.

Other statements in the preceding pages, e.g. as to varying effectiveness of various fishing fleets, of various sizes of vessels shall not, based as they are on very few years, and on rather scanty and scattered material, be regarded as definite results. However, they can be regarded as indications as to the kind of results, to be achieved from the collection and consideration of these refined statistics.

The large amount of refined data collected by subdivisions and by months have not been considered.

- THE END -

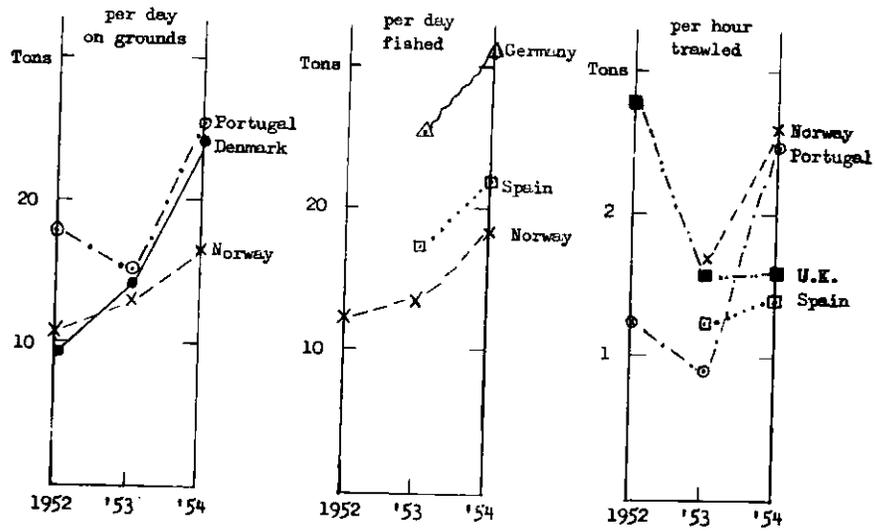


Figure 1. Total yields per unit of efforts, 1952-54, in Subarea 1; Denmark, Germany, Norway, Portugal, Spain, and United Kingdom.

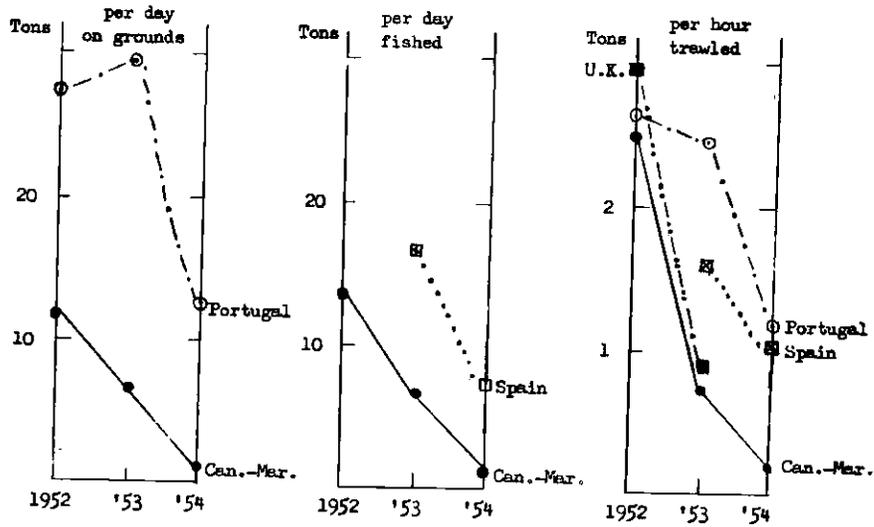


Figure 2. Total yields per unit of efforts, 1952-54, in Subarea 2; Canada-Maritimes, Portugal, Spain, and United Kingdom.

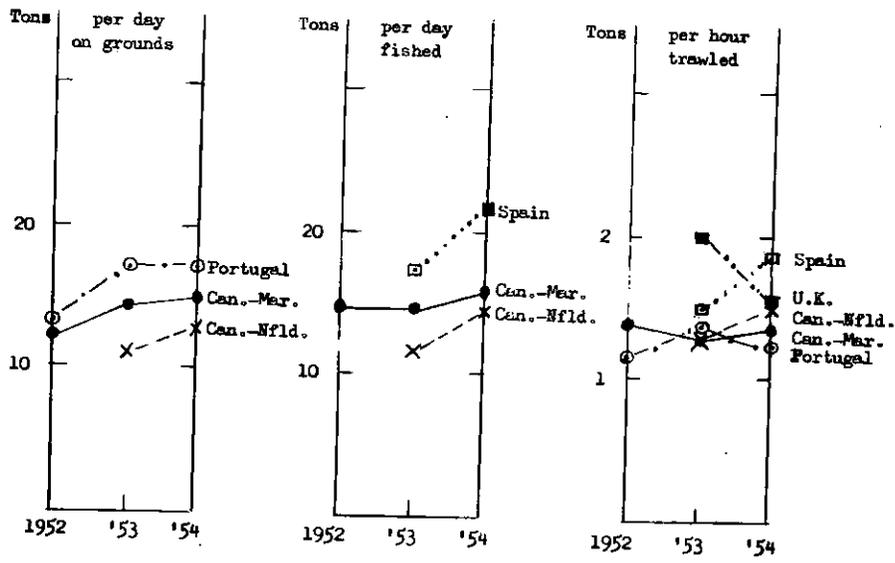


Figure 3. Total yields per unit of efforts, 1952-54, in Subarea 3; Canada-Maritimes, Canada-Newfoundland, Portugal, Spain, and United Kingdom.

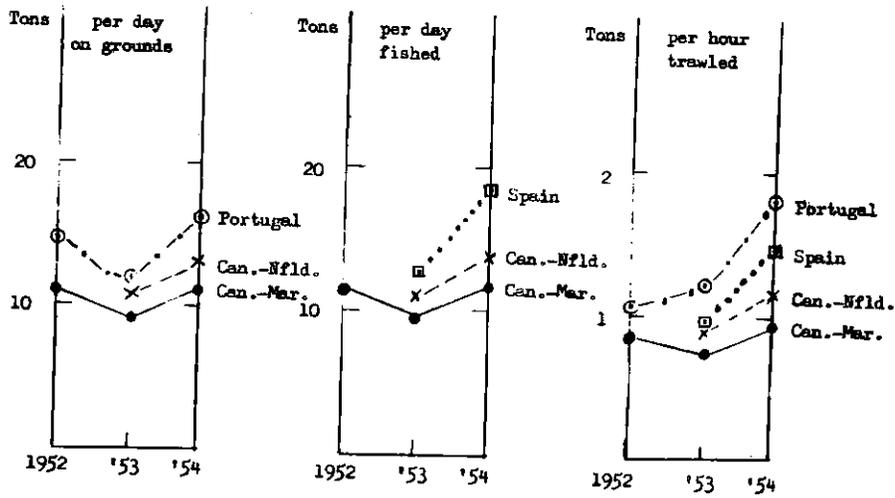


Figure 4. Total yields per unit of efforts, 1952-54, in Subarea 4; Canada-Maritimes, Canada-Newfoundland, Portugal, and Spain.

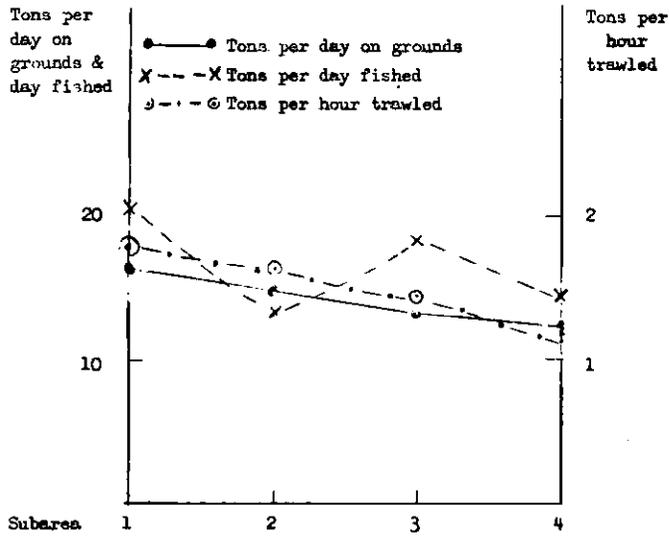


Figure 5. Total yields by subareas as means for all countries and all years (1952-54).

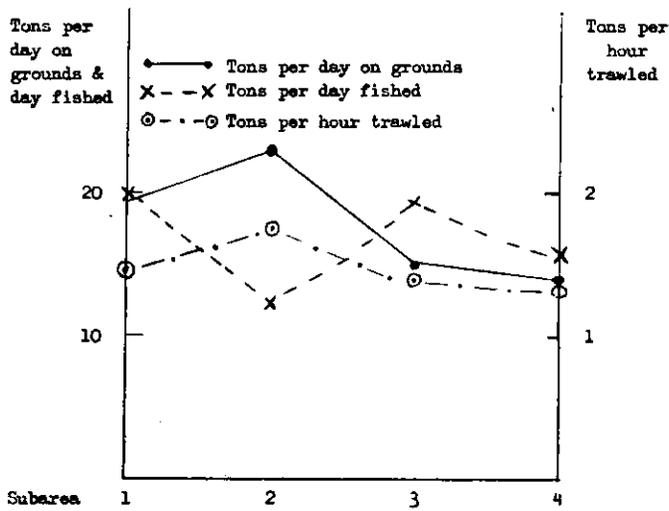


Figure 6. Total yields by subareas for Portugal and Spain, the countries fishing in all subareas, as means for all years (1952-54).

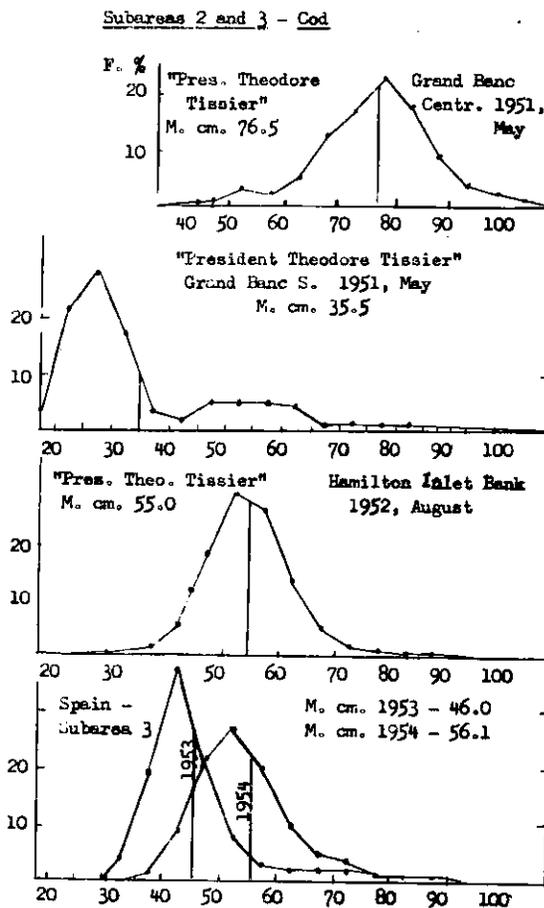
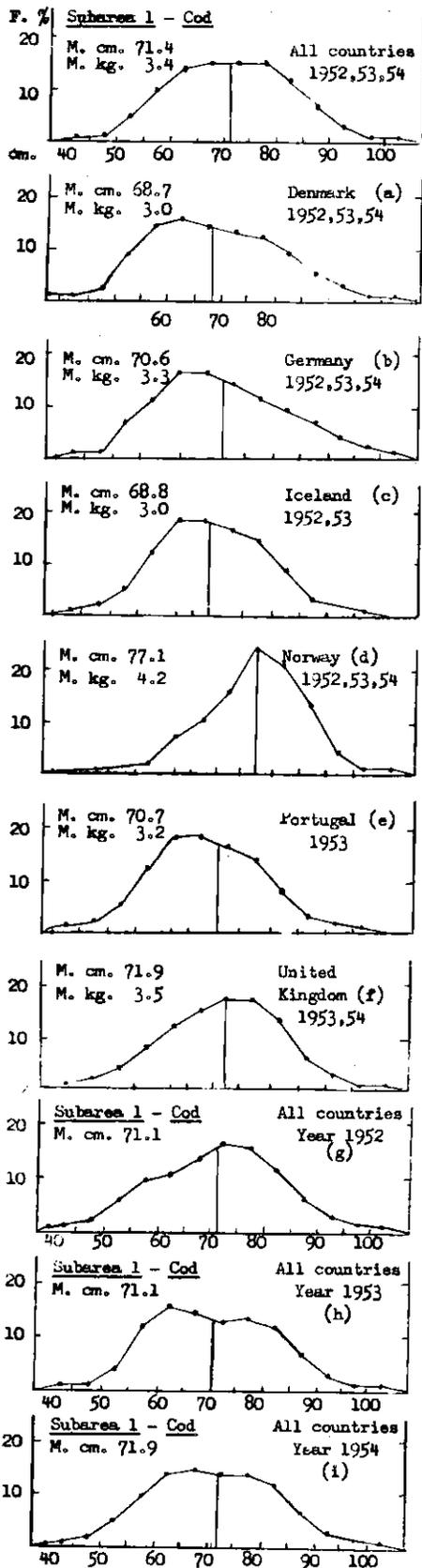


Figure 8. Length distribution curves for cod, Subareas 2 and 3. 1951-54.

Figure 7. Length distribution curves for cod, Subarea 1. 1952-54.

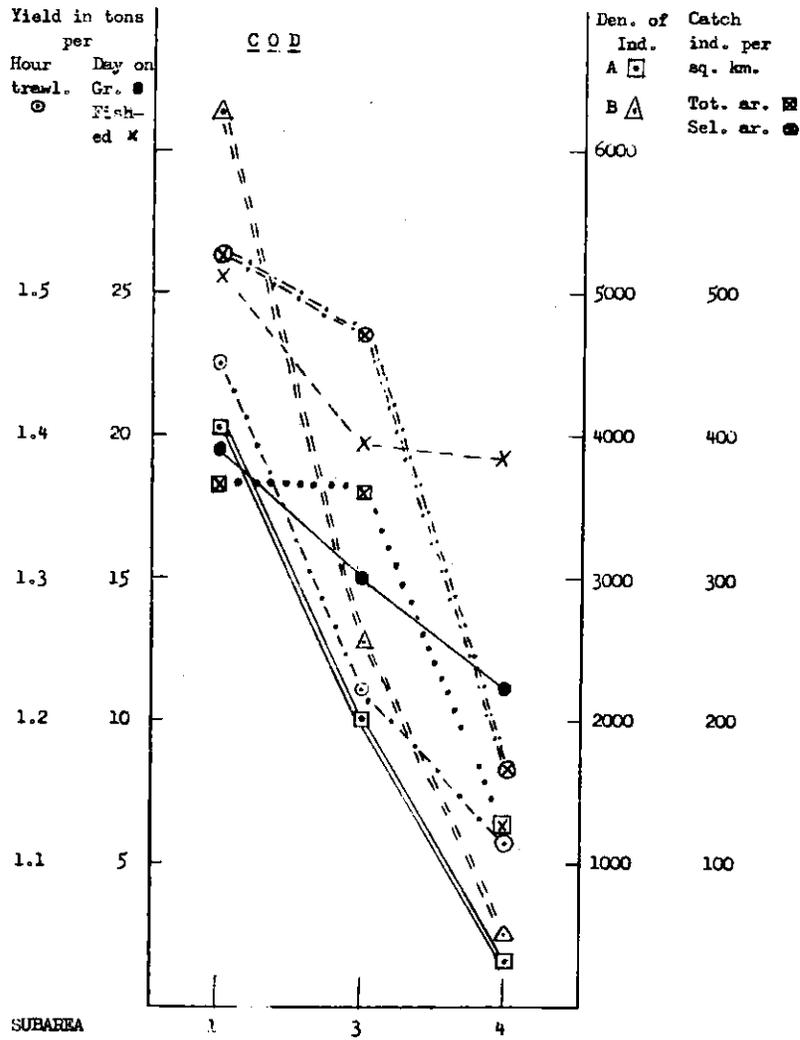


Figure 9. Cod, Subarea 1, 3, and 4, France, Portugal, and Spain. Comparisons of yields per unit with densities of stocks and catches by individual per square km.

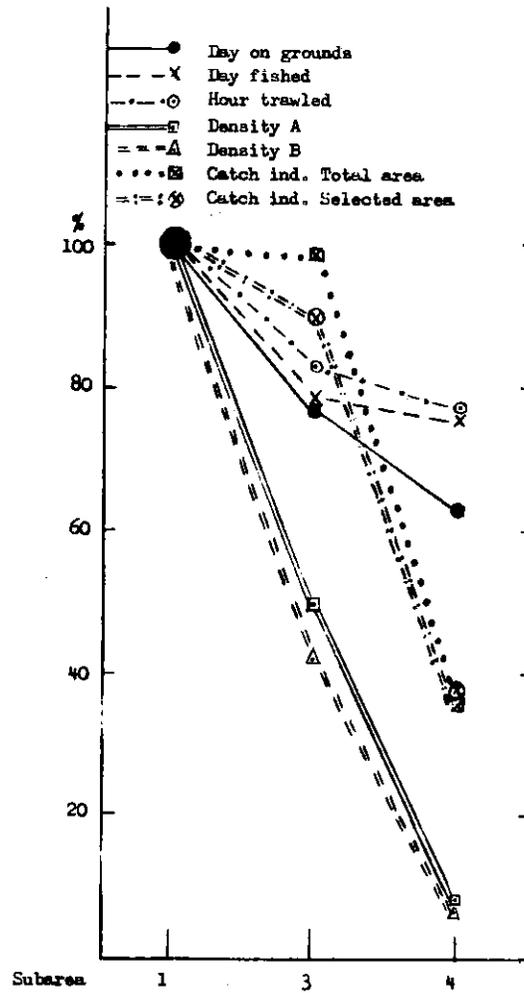


Figure 10. Cod. Subareas 1, 3, and 4. France, Portugal and Spain. Yields per unit of efforts, calculated densities and catch of individuals per sq. km. given for Subareas 3 and 4 as percentages of those for Subarea 1.