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Recent information on landings, age-composition and recruitment of Subarea 1 cod, and estimates of yield in 1972-75.

by

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1. Introduction.

The present paper is a revision of a working paper (same title) presented to the ICNAF Subcommittee on Assessment at its Mid-Term Meetings in Rome, January 1973. Revised figures for mean weights of various age groups have been introduced in the analysis, and information on stock composition received during December 1972 and the first four to five months of 1973 is to some extent incorporated. The general findings regarding future yields remain the same as in the working paper presented in January 1973.

2. Nominal catches 1968-1971.

Since it seems desirable to make assessment of Subarea 1 cod for Divisions 1A-1D and 1E-1F separately it is necessary to allocate landings from unknown division (Div. 1NK) on the Subarea 1 divisions. This has been done by the author on various principles. The paper would probably be too lengthy if each individual allocation should be mentioned. It is, therefore, just mentioned that the various principles try to take into account information on time (month), gear, vessel size and category, and traditional fishing of the fleets. Clearly the allocation can not be absolutely correct. However, it is considered an improvement compared to the situation where catches from Div. 1NK are not allocated.

Nominal catches by division and gear category for the years 1968-1971 are shown in Tables 1-4.

3. Mean length and weight of age groups in 1972.

Tables 5 and 6 show age group frequencies, and mean length and weight of each age group in Danish cod samples from 1972. The overall mean length and weight for each age group in Divs. 1A-1D as given in Table 7 has been taken as straight mean of figures in Table 5. For Divs. 1E and 1F no offshore samples were taken in 1972. The overall mean lengths and weights in these two divisions also given in Table 7 have, therefore, been taken as straight mean of the two samples from Div. 1F inshore given in Table 6.

The plot of the mean weight versus mean length of age groups is shown in Figs. 1 and 2 for offshore and inshore samples respectively. In Fig. 1 and Table 5 it is found that mean weight (condition) in November-February is better than in the period March-July (around the spawning season). The curves fitting these plots have been calculated and are shown on the figure. The relation between mean total length (cm below) and mean weight (kg, round fresh) was found to be

Offshore samples, November-February : $\bar{w} = \bar{l}^{2.750} \times 2.79 \times 10^{-5}$

Offshore samples, March-July : $\bar{w} = \bar{l}^{2.710} \times 3.19 \times 10^{-5}$

Inshore samples, June-August : $\bar{w} = \bar{l}^{2.897} \times 1.64 \times 10^{-5}$

For all plots combined the equation was found to be

$$\bar{w} = \bar{l}^{2.792} \times 2.49 \times 10^{-5}$$

The curves may be used to readily obtain mean weight of an age group in cases where only mean length is known. Strictly speaking the curves are, of course, only valid when the standard deviation on mean length of age groups is similar to that found in the 1972 samples. It seems, however, to be a fair assumption that standard deviation on mean length of the various age groups will not differ much between samples and years.

Arno Meyer (ICNAF Res.Doc. 73/38) has presented a very extensive material on mean length and mean weight of cod in Subarea 1. Table 3 in A.Meyer's paper gives weighted mean values for the years 1965-72 for Divs. 1A-1D and

1E-1F separately. The weighting factors applied are the monthly international catches in 1970. Such a weighting may not be relevant if the data are used to describe fluctuations in growth rate between years, areas and age groups, but the weighting is proper and very important for obtaining mean weights for converting nominal catches to numbers landed and vice versa.

Since the present paper tries to make predictions for future yields by means of virtual population analysis the author has adopted figures given by Meyer, also because Meyer's material is much greater than the Danish material and represents a major part of the fishery. The figures used in the analysis of the present paper are set out in Table 7 together with figures used by the Assessment Subcommittee in 1972 (Redbook 1972) and those obtained as straight mean from figures in Tables 5 and 6 of the present paper. For comparison between figures see Section 7.

4. Numbers landed per age group in the years 1965-71.

Based on mean weights as given by Meyer (l.c.) and on landings as given in Tables 2-4, and using samples as presented in Sampling Yearbook the numbers landed (nominal catch) of each age group have been calculated for the years 1969-1971. For the years 1965 and 1966 figures as given by A.Schumacher (1971) have been adopted, and for the years 1967 and 1968 also figures by A. Schumacher (pers.comm.) have been adopted except that for all four years (1965-68) the figures by Schumacher have been adjusted according to differences between Schumacher's figures for nominal catches and those by the author. The results are given in Tables 8-10.

5. Information on future recruitment.

In Subarea 1 recruitment of cod to the fisheries will start at an age of (3-) 4 years. The year classes in question for recruitment in the period 1972-1975 are thus year-classes 1968-1972.

Predictions for the strength of the 1972 year-class can at present be made only on hydrographic and plankton observations in 1972. As indicated in the Danish Research Report, 1972 (Horsted, 1973) there are no reasons to expect that this year class will be more than a poor one. The same applies to the 1971 year-class (Hermann, 1972. Horsted and Smidt, 1972).

Also the 1970 year-class was on the basis of larval surveys predicted a poor one (Smidt, 1971). It has not yet been observed as undersized fish

in commercial catches and there is, therefore, no reason to change the prediction.

The 1969 year-class was in 1969 regarded a rather poor one (Horsted,1970). Pre-recruit surveys in 1972 have, unfortunately, been so limited that scarcely any new information on the 1969 year-class has been achieved. In samples taken from the trawlers' landings at the end of 1972 it is represented with very few individuals only. It must, therefore, still be regarded a poor year class.

The 1968 year-class has to some extent occurred in catches in Divs. 1A-1D in 1971 (see Table 8) and in 1972 it has been of increasing importance in all divisions (see age-group IV in Tables 5 and 6). In the sample from Div.1D, offshore, December 1972 it constituted more than half the individuals, and it seems to form by far the major part of discards from inshore pound net catches as shown in Table 11.

Further material has been collected in the first part of 1973. The age reading has not yet been carried out, but the length frequencies are illustrated in Fig. 3. Since the mean length of the age-group 4 was 52.2 cm in the November 1972 sample and 50.6 cm in the December 1972 sample it seems quite clear that the very pronounced mode on the length frequency curves in Fig. 3 is due to a very considerable part of the catch being of the 1968 year-class.

Indeed it seems likely that the landings up to 1975 will be based to a very great extent on the 1968 year-class. Its actual size is, however, rather difficult to judge at present but may well be of the size as judged by the ICES/ICNAF Working Group on Cod Stocks in the North Atlantic, i.e. 90 millions by age 3 in Divs. 1A-1D and 72 millions by age 3 in Divs.1E-1F plus ICES Area XIV (see Table 8 in the Report of the Working Group, ICNAF Res. Doc. 72/33).

For predictions of future yields the strength of the pre-recruit or recruiting year classes is at present set as follows (millions of 3 year olds):

Year-class	Divs. 1A-1D	Divs. 1E-1F
1968	90	40
1969	30	15
1970	30	15
1971	20	10
1972	30	15

The figures for 1968-70 Divs. 1A-1D are those given by the above mentioned Working Group. The figures by the Working Group for Divs. 1E-1F plus ICES

Area XIV were for the 1968 year-class 72, for 1969 25, and for 1970 25 millions. It has been regarded here that well above half of the fish occur in Divs. 1E-1F.

6. Results of recent tagging experiments.

Tagging experiments on cod in recent years have unfortunately been made to a less extent than previously and have been made chiefly on small cod discarded from pound nets in coastal waters and fjords. The material from such experiments is not yet worked up but seems to be of value only for judging local fishing mortality in the fjords and for indication of migratory routes but not for judging fishing mortality on fully recruited cod in the international fishery. Tagging of cod bigger than 50 cm in the coastal and offshore waters has been rather limited, viz:

1968 :	649	in Divs. 1A-1D,	and	359	in Divs. 1E-1F
1969 :	926	" " ,	"	298	" "

The recaptures (in per mille of numbers tagged) for these experiments by the end of 1972 are shown in Table 12. A remakable high proportion of the tags has been reported from Icelandic and East Greenland waters, also for tags applied in Divs. 1D and 1C. Whether this indicates an increasing tendency of south and eastward migration or a decreasing recapture (or reporting) rate at West Greenland is very difficult to judge. It may well be that the 1963 year-class, which is to a great extent of East Greenland origin, and which has formed a significant part of the stock in the years regarded has a relatively great tendency to undertake spawning migration to East Greenland and Iceland. Anyway the recapture rate (or probably reporting rate) at West Greenland seems to have decreased in recent years as shown in Table 13 from a level of about 15% to a level of about 4% (with no correction for non-reporting). This may by itself indicate a decreasing fishing mortality in recent years, but the situation is very complicated because traditionally well reporting fleets have a rapidly decreasing part of the fishery, and because experiments with different tags and tagging methods disturb the picture.

However, it should be noted that the slope of the regression line of log of recapture percentage still shows a rather high value. The slope as calculated in Table 13 is, however, also affected by any migration out of Subarea 1. Bearing in mind the above made remarks on the possible migration of year-class 1963 the slope for the 1968-69 experiments may well be used as a measure for

total mortality but this mortality contains a significant migration out of the subarea. If natural mortality is taken as M = 0.20 and migration is taken to be equal to an extra natural mortality of M = 0.15 then the fishing mortality coefficient for Subarea 1 as a whole in recent years may well be no higher than 0.55 for fully recruited age groups. It must be considered, however, that the material itself is very limited and probably does not allow one to draw too many conclusions.

7. Virtual population analyses and prognoses 1972-75.

Analyses by the virtual population method have been made in an attempt to predict catches for 1972-75 at various levels of fishing mortality. Material for the analyses is:

Numbers landed per age group and year : Tables 8-10.
Estimates of recruitment (strength of year-classes 1968-72) : Page 4.
Natural mortality for all age groups : M = 0.20.
Extra "mortality" due to migration for age-groups VII and older in Divs. 1E-1F : $M_{extra} = 0.15$.

Partial recruitment (or fluctuation of F with age) is taken as given in Table 15 of the report of the N.Atl. Cod Working Group (Anon., 1972), viz.: (Figures are F as percentage of F in fully recruited age groups)

Age-group	Divs. 1A-1D	1E-1F
III	9	1
IV	27	8
V	64	41
VI	100	67
VI+	100	100

These figures correspond rather closely with those found by Horsted and Garrod (1969).

It was hoped that the analyses would have given values of F for the most recent years. However, the data do not seem to produce any meaningful indication of F in recent years, whereas there seems to have been a rather steady fishing mortality up to and including 1968.

Tables 1-4 show that the fishery itself dropped abruptly from a level of 350-400,000 tons to about half that level in 1969 and further to a level of 115-130,000 tons in 1970. Also fishing pattern itself changed in these years with a greater tendency to exploit spawning concentrations from southern part of Div. 1C to SE Greenland. It may well be that sampling since 1969

has not been adequate or that parameters, e.g. those of fluctuation of F with age and those of mean weight of age groups, have changes drastically. Anyway, the model and the analysis unfortunately did not permit the author to draw firm conclusions on values of F in most recent years.

The programme for prognoses, therefore, had to be made on basis of a given (assumed) value of F for 1971. This value has for fully recruited age groups in Divs. 1A-1D been taken as

$$F_{71,\ A\text{-}D} = 0.50$$

whereas for Divs. 1E-1F where the greatest uncertainties may be two values have been taken, viz.

$$F_{71,\ E\text{-}F} = 0.30 \quad \text{and} \quad F_{71,\ E\text{-}F} = 0.65$$

in the hope that the true value lies somewhere between the two values given.

The value for Divs. 1A-1D and the lower value for Divs. 1E-1F correspond closely to those given by the N.Atl. Cod Working Group (l.c. Table 9 : $F_{70,\ A\text{-}D} = 0.49$, $F_{70,\ E\text{-}F+XIV} = 0.30$) but are somewhat lower than the value used by the Assessment Subcommittee at its 1972 Meetings (F = 0.60 in 1970/71 for Subarea 1 as a whole).

Predictions for the 1972-75 yields have been made on the basis of a fishing mortality rate of F equal to that regarded as F_{max} and F_{opt} by the N.Atl. Cod Working Group (l.c.), i.e.

for Divs. 1A-1D: $F_{max} = 0.56$, $F_{opt} = 0.35$, and

for Divs. 1E-1F: $F_{max} = 0.65$, $F_{opt} = 0.45$.

The results are set out in Tables 14a and 14b below for the lower and upper F_{1971} values respectively.

Table 14a. Prognoses for Subarea 1 Cod. Nominal catches 1972-75 (metric tons).

F_{1971}	Divs. 1A - 1D		Divs. 1E - 1F		Subarea 1	
	0.50		0.30			
$F_{1972-75}$	F_{max} 0.56	F_{opt} 0.35	F_{max} 0.65	F_{opt} 0.45	F_{max}	F_{opt}
Catch 1972	79608	53987	60721	45597	140329	99584
" 1973	73781	57299	37092	32361	110873	89660
" 1974	66974	58514	26277	25005	93251	83569
" 1975	52691	51234	21330	21308	74021	72542

Table 14b. Prognoses for Subarea 1 Cod. Nominal catches 1972-75 (metric tons).

	Divs. 1A - 1D		Divs. 1E - 1F		Subarea 1	
F_{1971}	0.50		0.65			
$F_{1972-1975}$	F_{max} 0.56	F_{opt} 0.35	F_{max} 0.65	F_{opt} 0.45	F_{max}	F_{opt}
Catch 1972	79608	53987	24294	18197	103902	72184
" 1973	73781	57299	18992	15913	92773	73212
" 1974	66974	58514	18017	15901	84991	74415
" 1975	52691	51234	17955	16780	70646	68014

For predicted catches in Divs. 1A-1D the above given values for 1972-73 by F_{max} are somewhat higher than those by the Assessment Subcommittee, 1972, for a value of F of 0.60. For predicted catches in Divs. 1E-1F the values by $F_{1971} = 0.30$ are much higher for 1972 and a little lower for 1973 than predicted by the Assessment Subcommittee, 1972, whereas by $F_{1971} = 0.65$ predictions for 1972 as well as for 1973 are lower than the Assessments Subcommittee's figures. The following Tables 15a and 15b compare the two set of figures.

Table 15a. Comparison between prognoses by F_{max} in present paper, Table 14a, and in Assessment Report, Redbook 1972.

	1972			1973		
	1A-1D	1E-1F	Subarea 1	1A-1D	1E-1F	Subarea 1
Redbook 1972 (F= 0.60)	59000	38000	97000	61000	41000	102000
Present paper ($F_{1971,E-F}$=0.30)	79000	61000	140000	74000	37000	111000
Difference in percent of Redbook figure	+34%	+61%	+44%	+21%	-10%	+8%

Table 15b. Comparison between prognoses by F_{max} in present paper, Table 14b, and in Assessment Report, Redbook 1972.

	1972			1973		
	1A-1D	1E-1F	Subarea 1	1A-1D	1E-1F	Subarea 1
Redbook 1972 (F= 0.60)	59000	38000	97000	61000	41000	102000
Present paper ($F_{1971,E-F}$=0.65)	80000	24000	104000	74000	19000	93000
Difference in percent of Redbook figure	+36%	-37%	+7%	+21%	-54%	-8%

Part of the explanation for the difference may be sought in the difference between figures for mean weight of age groups used in the two estimates. The weight figures and the difference between them are shown in Table 7.

For Divs. 1A-1D the figures by Meyer and those obtained from Table 5 correspond rather well with each other, especially for those age groups (5-7) which make up by far the major part of the landings. For Divs. 1E-1F the correspondence between Mayer's figures and those obtained from Table 6 is also rather good for the important age groups, but there are high discrepancies between very old (10 years or more) and very young (4 years) cod.

Meyer's figures, which are used for analysis in the present paper, differ rather much from figures used by the Assessment Subcommittee in 1972, especially when figures for Divs. 1E-1F are considered. Meyer's figures for these divisions are rather lower (except for age-group 8) than those used by the Assessment Subcommittee. This could partly explain why present estimates of 1972-73 yields in Divs. 1E-1F are lower than predicted by the Assessment Subcommittee last year.

Clearly figures for mean weight by age are critical figures, which - because they can fluctuate very much between years and year classes - should be kept under careful and constant review.

Another most critical figures in the present paper is the fishing mortality rate in 1971. However, even assuming a very wide range of this parameter for Divs. 1E-1F does not change the general picture that the Subarea 1 cod in the next couple of years will reveal catches which are only about one-third of the level in the 1960'ies.

8. Acknowledgement.

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Table 1. Nominal catch (metric tons x 10^{-3}) of cod in Subarea 1, 1968 by division and gear. Catches reported as Div. 1NK have been allocated by the author. Catches under LINES may include some catches taken by gill nets (GN).

DIV.	OT	DV	LINES	GN	Mixed(Denm.G)	TOTAL
1A	881		271		142	1 294
1B	13 392	1 968	6 790		1 669	23 819
1C	103 483	9 096	8 652		2 738	123 969
1D	102 271	7 397	14 398	268	6 123	130 457
1E	72 072		12 282		2 837	87 191
1F	16 539		3 064		7 207	26 810
TOTAL	308 638	18 461	45 457	268	20 716	393 540

Table 2. Nominal catch (metric tons x 10^{-3}) of cod in Subarea 1, 1969 by division and gear. Catches reported as Div. 1NK have been allocated by the author. Catches under "Mixed" gear may include OT catches of about 9000 tons.

DIV.	OT	DV	LINES	GN	Mixed(Denm.G and F)	TOTAL
1A	538	207	180		57	982
1B	7 679		2 995		3 809	14 483
1C	32 810	2 009	4 182		7 364	46 365
1D	63 536	213	2 694	365	15 693	82 501
1E	41 586		5 087		5 862	52 535
1F	11 146				6 795	17 941
TOTAL	157 295	2 429	15 138	365	39 580	214 807

Table 3. Nominal catch (metric tons x 10^{-3}) of cod in Subarea 1, 1970 by division and gear. Catches reported as Div. 1 NK have been allocated by the author.

DIV.	OT	DV	LINES	GN	Mixed (Denm. G and F)	TOTAL
1A	278				136	414
1B	3 295	424	125	1 425	2 969	8 238
1C	14 194	740	125	1 425	3 719	20 203
1D	25 377	911	125	1 518	5 661	33 592
1E	23 783		125	1 425	3 924	29 257
1F	17 406				6 887	24 293
TOTAL	84 333	2 075	500	5 793	23 296	115 997

Table 4. Nominal catch (metric tons x 10^{-3}) of cod in Subarea 1, 1971 by division and gear. Preliminary figures taken from ICNAF Res.Doc. 72/124 as revised August 11, 1972. Catches reported as Div. 1NK have been allocated by the author. Some catches under "other gears" may well be OT catches.

DIV.	OT (minimum)	Other gears (max.)	TOTAL
1A	39	255	294
1B	1 615	6 113	7 728
1C	25 233	11 323	36 556
1D	21 408	10 462	31 870
1E	10 579	6 438	17 017
1F	19 806	7 014	26 820
TOTAL	78 680	41 605	120 285

Table 5. Subarea 1 cod, 1972. Danish samples from landings of commercial otter trawlers fishing offshore.
o/oo = Frequencies in per mille.
cm = Uncorrected mean total length in cm (cm below) ± standard deviation.
kg. = Mean weight in kg round, fresh ± standard deviation. Values are calculated from observed gutted weights (head on) by conversion factor 1.22.

Age group	Division	1C	1C	1C+1D	1D	1D+1E
	Month	JAN	FEB	MAR-APR	JULY	JUNE
III	o/oo	0	0	0	0	0
	cm	-	-	-	-	-
	kg	-	-	-	-	-
IV	o/oo	69	175	149	224	46
	cm	48.6 2.3	47.7 2.5	47.3 2.5	50.3 4.2	47.5 2.6
	kg	1.19 0.17	1.07 0.15	1.03 0.17	1.45 0.32	1.13 0.20
V	o/oo	368	537	274	109	60
	cm	55.0 4.1	53.6 4.1	52.0 3.3	57.5 5.1	55.7 6.5
	kg	1.70 0.37	1.54 0.34	1.37 0.27	2.00 0.43	1.69 0.52
VI	o/oo	395	221	502	231	249
	cm	65.2 4.9	62.8 5.6	58.8 5.2	68.0 5.2	64.7 6.6
	kg	2.80 0.66	2.51 0.70	1.99 0.49	3.06 0.60	2.50 0.67
VII	o/oo	123	44	43	182	232
	cm	74.5 6.4	72.4 8.1	62.9 5.9	75.3 4.5	73.1 6.0
	kg	4.29 1.05	4.05 1.37	2.45 0.81	3.90 0.57	3.50 0.76
VIII	o/oo	7	2	21	86	126
	cm	77.9 8.4	77.0 9.2	68.1 5.1	76.3 6.1	71.2 8.0
	kg	5.08 1.79	4.86 1.84	2.93 0.67	4.10 0.88	3.27 1.09
IX	o/oo	13	5	8	104	174
	cm	72.0 8.0	72.1 9.5	70.3 5.4	79.7 5.7	76.6 8.2
	kg	3.83 1.29	4.05 1.79	3.11 0.62	4.56 0.88	3.97 1.13
X	o/oo	1	ø	0	7	42
	cm	81.0 -	81.0 -	-	87.1 2.7	80.5 7.4
	kg	5.56 -	5.77 -	-	5.87 0.41	4.53 1.13
XI	o/oo	13	7	2	34	33
	cm	85.4 7.6	90.0 11.1	86.5 6.4	82.1 9.6	84.4 7.6
	kg	6.50 1.71	8.08 2.79	6.04 1.46	5.13 1.74	5.21 1.18
XII	o/oo	5	5	0	23	21
	cm	93.4 7.3	94.1 6.0	-	95.2 6.1	89.1 6.6
	kg	8.46 1.76	8.95 1.49	-	7.39 1.46	5.90 1.39
XIII	o/oo	4	1	0	1	6
	cm	108.5 16.9	106.0 -	-	101.0 -	91.4 11.8
	kg	14.72 7.05	12.81 -	-	9.52 -	6.75 2.81
XIV	o/oo	1	0	0	1	0
	cm	88.1 5.4	-	-	93.0 -	-
	kg	7.60 1.18	-	-	6.98 -	-
XV	o/oo	1	2	1	3	8
	cm	100.0 -	99.1 9.2	88.0 -	92.0 2.0	96.6 4.9
	kg	9.76	10.27 2.24	5.85 -	7.03 1.15	7.90 1.40
XV+	o/oo	1	0	0	0	1
	cm	119.0 -	-	-	-	97.0 -
	kg	18.91 -	-	-	-	6.40 -
Overall mean length		61.7	56.1	55.8	67.5	70.4
Overall mean weight		2.65	1.91	1.74	3.18	3.30
Discards		none	none	none	no inf.	no inf.
Nos. sampled		923	925	778	1084	770
Landed weight (in tons round, fresh) represented by sample		210	26	115	20	116

Table 5 cont. .....

Table 5 (continued)

Age group	Division	1D		1D	
	Month	NOV		DEC	
III	o/oo	0		3	
	cm	-		37.7	1.2
	kg	-		0.56	0.02
IV	o/oo	367		535	
	cm	52.2	5.0	50.6	5.3
	kg	1.46	0.44	1.31	0.41
V	o/oo	181		158	
	cm	63.6	4.6	58.3	5.1
	kg	2.64	0.55	1.98	0.53
VI	o/oo	239		151	
	cm	71.0	4.3	69.2	5.5
	kg	3.69	0.72	3.38	0.83
VII	o/oo	96		71	
	cm	78.8	4.2	77.3	6.5
	kg	5.02	0.77	4.71	1.11
VIII	o/oo	51		24	
	cm	79.7	5.1	81.4	8.2
	kg	5.16	1.00	5.57	1.59
IX	o/oo	54		26	
	cm	82.5	5.9	78.6	13.1
	kg	5.78	1.24	5.20	2.17
X	o/oo	5		8	
	cm	92.3	5.1	84.8	10.3
	kg	7.94	1.25	6.33	2.03
XI	o/oo	2		17	
	cm	96.5	3.5	94.1	5.2
	kg	9.97	1.42	8.45	1.58
XII	o/oo	2		7	
	cm	98.0	14.1	93.7	11.4
	kg	10.66	4.94	8.87	3.32
XIII	o/oo	1		1	
	cm	99.0	-	88.0	-
	kg	10.98	-	6.65	-
XIV	o/oo	0		0	
	cm	-		-	
	kg	-		-	
XV	o/oo	2		0	
	cm	92.0	1.4	-	
	kg	8.02	0.65	-	
XV+	o/oo	0		0	
	cm	-		-	
	kg	-		-	
Overall mean length		64.8		59.2	
Overall mean weight		3.05		2.39	
Discards		none		none	
Nos.sampled		1083		964	
Landed weight (in tons round, fresh) represented by sample		162		30	

Table 6. Subarea 1 cod, 1972. Danish samples from landings of inshore fisheries, gear mainly pound net. o/oo, cm, and kg as in Table 5.

Age group	Division	1B(north)		1B (south)	1C	1D	1F	1F
	Month	JUNE	SEP[2]	JULY	JULY	JULY	JUNE	AUG
III	o/oo	0	0	0	0	0	0	0
	cm							
	kg							
IV	o/oo	110	11	147	327	742	262	5
	cm	48.2 3.7	53.3 0.6	51.3 4.8	51.4 3.4	45.6 4.9	47.2 2.6	57.0 -
	kg	1.48 0.35	-	-	1.58 0.31	0.88 0.27	1.13 0.20	1.71 -
V	o/oo	453	20	507	413	112	279	5
	cm	54.1 4.6	61.8 6.7	59.5 5.7	56.6 4.5	51.1 5.4	51.0 4.4	52.0 -
	kg	2.10 0.55	-	-	2.08 0.42	1.23 0.38	1.47 0.46	1.59 -
VI	o/oo	352	59	281	190	110	145	30
	cm	58.7 7.3	76.5 4.6	65.2 6.7	67.0 5.2	61.8 4.9	53.4 4.4	59.0 3.8
	kg	2.76 0.95	-	-	3.40 0.75	2.10 0.44	1.70 0.49	2.50 0.49
VII	o/oo	80	309	35	40	15	26	25
	cm	62.3 8.6	82.4 4.5	73.7 4.9	69.0 5.3	62.3 10.6	58.3 5.2	61.4 3.0
	kg	3.61 1.22	-	-	3.55 0.71	2.35 1.18	2.26 0.59	2.67 0.37
VIII	o/oo	5	42	5	10	18	91	330
	cm	85.0 -	82.8 7.0	75.0 -	76.0 1.4	51.8 11.6	64.4 8.7	66.4 4.9
	kg	6.34 -	-	-	4.70 0.60	1.39 0.98	2.95 1.19	3.36 0.61
IX	o/oo	0	46	20	10	4	159	510
	cm		86.0 6.5	77.8 11.5	90.5 9.2	84.0 -	69.1 6.5	70.3 5.5
	kg		-	-	8.30 1.38	5.10 -	3.55 1.02	3.89 0.73
X	o/oo	0	49	0	0	0	22	65
	cm		90.1 5.7				71.5 6.5	74.3 5.0
	kg		-				3.94 1.08	4.40 0.61
XI	o/oo	0	264	5	5	0	12	30
	cm		92.4 5.2	88.0 -	87.0 -		74.4 6.6	76.5 9.4
	kg		-	-	6.83		4.28 0.82	5.34 2.32
XII	o/oo	0	172	0	5	0	2	0
	cm		93.6 8.0		94.0 -		93.0 -	
	kg		-		7.81 -		-	
XIII	o/oo	0	11	0	0	0	0	0
	cm		85.0 2.6					
	kg		-					
XIV	o/oo	0	7	0	0	0	3	0
	cm		98.5 2.1				83.8 10.8	
	kg		-				-	
XV	o/oo	0	10	0	0	0	2	0
	cm		100.3 7.2				92.5 9.2	
	kg		-				-	
XV+	o/oo	0	0	0	0	0	0	0
Overall mean length		56.1	(86.9)[2]	60.9	58.3	48.5	55.6	68.7
Overall mean weight		(2.40)[1]	-	-	2.37	1.10	2.45[3]	3.03
Discards		no inf.	no inf.	no inf.	no inf.	4)	25-50% by weight	no inf.
Nos sampled		199	284	200	199	274	719	200
Landed weight (tons round, fresh) represented by sample		no inf.	no inf.	no inf.	no inf.	3)	7	no inf.

1) Weight uncertain. May have been round, fresh weight originally observed and, therefore, 1.22 times too high here.

2) Some recorded lengths suspicious, probably recorded 10 cm too long.

3) Projected weights used for age groups, where observed weight does not exist: XII, XIV and XV : 9.1, 6.2 and 8.9 kg.

Table 7. Mean weight (kg round, fresh) by age groups as obtained from Tables 5 and 6 (straight mean). For comparison figures by Meyer (Res.Doc. 73/38, Table 3) and those used by the ICNAF Subcommittee on Assessment, 1972 (Redbook 1972, I : 20) are also given. Figures by Meyer have been used in the analysis in the present paper.

	Age	3	4	5	6	7	8	8+	9	10	10+
1.	Divs. 1A-1D from Table 5	0.56	1.23	1.85	2.85	3.99	4.42	-	4.36	6.00	8.61
2.	Divs. 1A-1D after Meyer	0.58	1.08	1.94	2.80	3.60	3.98	-	4.63	5.48	6.23
3.	Divs. 1E-1F from Table 6	-	1.42	1.53	2.10	2.46	3.16	-	3.72	4.17	4.80
4.	Divs. 1E-1F after Meyer	0.41	0.82	1.27	1.88	2.68	3.25	-	3.90	5.02	6.23
5.	All divisions Ass.Subc.1972	0.62	1.18	2.1	2.7	3.0	3.0	5.5	-	-	-
	5.-2. in per cent of 5	+6	+8	+8	-4	-20	-33				
	5.-4. in per cent of 5	+34	+31	+40	+30	+11	-8				

Table 8. Numbers of cod (x 10^{-3}) in nominal catches from Divs. 1A-1D per year and age group, and nominal catch 1965-1971. Figures for 1965-1966 after Schumacher (1971) and for 1967-1968 after Schumacher (pers.comm.).

Age group \ Year	1965[x]	1966[x]	1967[x]	1968[x]	1969	1970	1971
2	2648		53				
3	14163	350	1678	3756	662	49	272
4	54481	5876	14021	6982	12257	2597	2453
5	47115	42294	27246	25957	5542	8846	9054
6	7166	35344	47457	19852	12078	3142	7219
7	4780	4327	18762	23071	8069	5222	1963
8	11430	1937	2117	7769	7749	1376	3104
9	1187	4680	1627	1543	4053	936	811
10	343	582	4320	710	470	633	1184
11	330	204	297	2034	162	61	746
12	1359	74	65	164	558	52	68
13	53	795	130	32	14	104	27
14	13	108	378	31	60	7	105
14+	171	150	53	258	6	34	41
Total Nos. x 10^{-3}	145239	96721	118204	92159	51680	23059	27047
Nominal catch (tons)	296204	290545	343728	279539	144331	62447	76448

x) The original figures by Schumacher have been adjusted according to differences between Schumacher's figures for nominal catch and those by the author as given in the table. The figures for nominal catch used by Schumacher are: 1965: 307809, 1966: 305146, 1967: 358866, and 1968: 269598 tons.

Table 9. Numbers of cod (x 10^{-3}) in nominal catches from Divs. 1E-1F per year and age group, and nominal catch 1965-1971. Figures for 1965-66 after Schumacher (1971) and for 1967-68 after Schumacher (pers.comm.).

Age group	Year	1965[x]	1966[x]	1967[x]	1968[x]	1969	1970	1971
2			112					
3			1180	49	8			
4		2447	1996	1070	994	142	171	66
5		5336	19836	3211	10713	3167	1496	1118
6		1889	4597	14391	9972	15355	3323	2064
7		5110	1588	5800	11520	6595	8763	3274
8		3965	3018	583	2236	4662	2989	6054
9		1662	2232	369	182	731	1874	1266
10		223	707	917	123	43	647	657
11		158	79	55	314	75	88	207
12		552	56	28	23	146	33	10
13		22	186	36	5	27	97	24
14		24	31	75	11	2	20	29
14+		105	97	32	45	2	7	15
Total Nos. x 10^{-3}		21493	35715	26616	36146	30947	19508	14784
Nominal catch (tons)		64137	77661	85751	114001	70476	53550	43837

x) The original figures by Schumacher have been adjusted according to differences between Schumacher's figures for nominal catch and those by the author as given in the table. The figures for nominal catch used by Schumacher are: 1965: 52532, 1966: 60980, 1967: 70613, and 1968: 112271 tons.

Table 10. Numbers of cod (x 10^{-3}) in nominal catches from Subarea 1 per year and age group, and nominal catch 1965-1971. (Combined figures from Tables 8 and 9).

Age group	Year	1965	1966	1967	1968	1969	1970	1971
2		2648	112	53				
3		14163	1530	1727	3764	662	49	272
4		56928	7872	15091	7976	12399	2768	2519
5		52451	62130	30457	36670	8709	10342	10172
6		9055	39941	61848	29824	27433	6465	9283
7		9890	5915	24562	34591	14664	13985	5237
8		15395	4955	2700	10005	12411	4365	9158
9		2849	6912	1996	1725	4784	2810	2077
10		566	1289	5237	833	513	1280	1841
11		488	283	352	2348	237	149	953
12		1911	130	93	187	704	85	78
13		75	981	166	37	41	201	51
14		37	139	453	42	62	27	134
14+		276	247	85	303	8	41	56
Total Nos. x 10^{-3}		166732	132436	144820	128305	82627	42567	41831
Nominal catch (tons)		360341	368206	429473	393540	214807	115997	120285

Table 11. Subarea 1 cod, 1972. Sample of cod discarded from pound net catches in Div. 1F, June. Cod above 40 cm will be retained for landing. Frequencies, length and weight as in Tables 5 and 6.

Age group		1F JUNE	
III	o/oo	67	
	cm	32.0	2.7
	kg	0.32	0.07
IV	o/oo	918	
	cm	35.9	2.8
	kg	0.44	0.10
V	o/oo	15	
	cm	39.9	1.1
	kg	0.60	0.05
Overall mean length		35.7	
Overall mean weight		0.44	
Nos. sampled		297	

Table 12. Recaptures from tagging experiments in Greenland offshore and coastal waters (excl. fjords) 1968-69 given as per mille of numbers tagged within each division and length group. Significant numbers of recaptures may still occur in the 3rd and 4th year after tagging.

Tagged in Division		1A + 1B			1C			1D			1E			1F		
Length group tagged	Calendar year after release	Total	Icl.	E.Grl. or Icl.	Total	Icl.	E.Grl. or Icl.	Total	Icl.	E.Grl. or Icl.	Total	Icl.	E.Grl. or Icl.	Total	Icl.	E.Grl. or Icl.
50-59	0	-	-	-	20	-	-	-	-	-	-	-	-	14	-	-
	1	48	-	-	7	-	-	-	-	-	41	-	-	9	-	-
	2	-	-	-	20	7	-	-	-	-	27	-	14	9	-	-
	3	16	16		7	-	-	-	-	-	-	-	-	18	-	5
	4+	-	-	-	-	-	-	-	-	-	-	-	-	9	5	5
	o/oo	64	16	-	54	7	-	-	-	-	68	-	-	59	5	10
	Nos.tagged	62			149			30			73			219		
60-69	0	8	-	-	7	-	-	-	-	-	-	-	-	19	-	-
	1	35	-	-	28	14	7	8	-	-	43	17	9	48	-	10
	2	4	4	-	28	7	7	-	-	-	35	26	9	19	-	10
	3	-	-	-	-	-	-	8	8	-	17	17	-	19	10	10
	4+	-	-	-	-	-	-	-	-	-	-	-	-	10	10	-
	o/oo	48	4	-	63	21	14	15	8	-	96	61	17	115	19	29
	Nos.tagged	259			144			132			115			104		
70-79	0	15	-	-	11	-	-	-	-	-	-	-	-	-	-	-
	1	19	-	-	55	44	-	29	6	-	14	-	-	-	-	-
	2	15	7	-	22	22	-	6	-	-	-	27	-	107	71	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	o/oo	49	7	-	88	66	-	35	6	-	41	27		107	71	
	Nos.tagged	267			91			173			73			28		
80-89	0	-	-	-	-	-	-	18	-	-	-	-	-	125	-	-
	1	-	-	-	-	-	-	12	-	6	32	-	32	-	-	-
	2	-	-	-	-	-	-	-	-	-	65	65	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	o/oo	-	-	-	-	-	-	29	-	6	97	65	32	125	-	-
	Nos.tagged	71			22			171			31			8		

Table 13. Cod tagged by Denmark in ICNAF Subarea 1 (excluding fjords) 1960-69 and recaptured in Subarea 1. Only cod 50 cm or bigger when tagged are included. Significant number of recaptures may still occur in the 1968 and 1969 experiments' 3rd and 4th year.

Division and period of tagging		Nos. tagged	Recaptures in Subarea 1 in year of tagging (0) and first to fourth calendar years after year of tagging in numbers and as percentage of numbers tagged.						Regression lines of $\log_e$ (% recapt.) (excl. year 0)
				0	1	2	3	4+	Total	
1960-64	1A - 1D	10 023	Nos.	329	841	298	169	127	1 766	y = 2.54 - 0.62x
			%	3.28	8.39	2.97	1.69	1.29	17.62	
	1E - 1F	3 412	Nos.	36	227	119	49	52	483	y = 2.31 - 0.53x
			%	1.06	6.65	3.49	1.44	1.52	14.16	
	Subarea 1	13 435	Nos.	365	1 068	417	218	181	2 249	y = 2.49 - 0.60x
			%	2.72	7.95	3.10	1.62	1.35	16.74	
1965-67	1A - 1D	1 890	Nos.	64	141	44	11	6	266	y = 3.02 - 1.09x
			%	3.39	7.46	2.33	0.58	0.31	14.07	
	1E - 1F	869	Nos.	11	42	30	14	3	100	y = 2.72 - 0.86x
			%	1.27	4.83	3.45	1.61	0.35	11.51	
	Subarea 1	2 759	Nos.	75	183	74	25	9	366	y = 2.94 - 1.01x
			%	2.72	6.63	2.68	0.91	0.33	13.27	
1968-69	1A - 1D	1 575	Nos.	15	24	9	1	0	49	y = 2.25 - 1.62x
			%	0.95	1.52	0.57	0.06	0.00	3.11	
	1E - 1F	657	Nos.	6	12	5	5	0	28	y = 0.90 - 0.44x
			%	0.91	1.83	0.76	0.76	0.00	4.26	
	Subarea 1	2 232	Nos.	21	36	14	6	0	77	y = 1.35 - 0.89x
			%	0.95	1.61	0.63	0.27	0.00	3.45	

Fig.1.
COD. SUBAREA 1.
offshore 1972

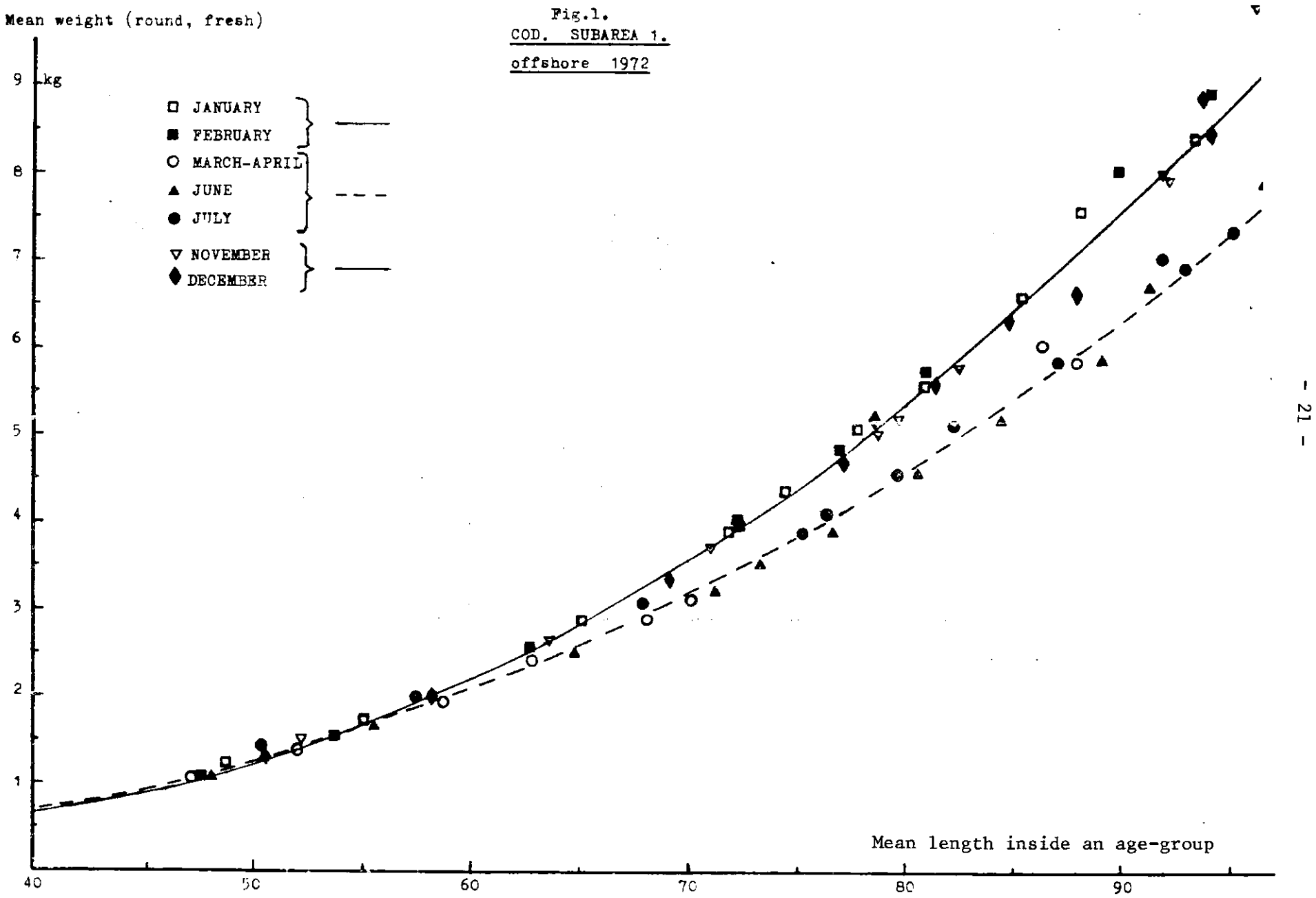
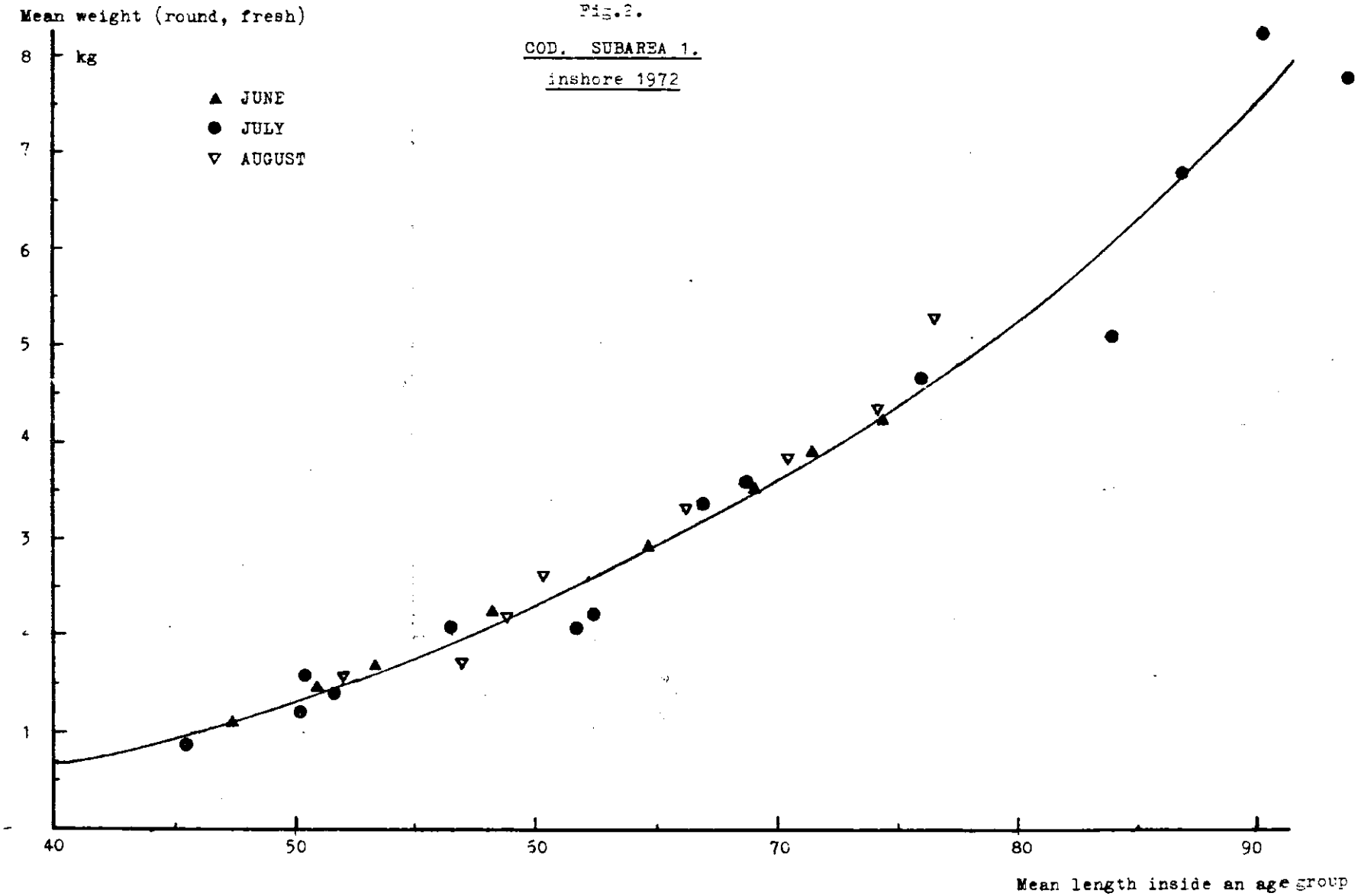


Fig.2.

COD. SUBAREA 1.

inshore 1972



GG

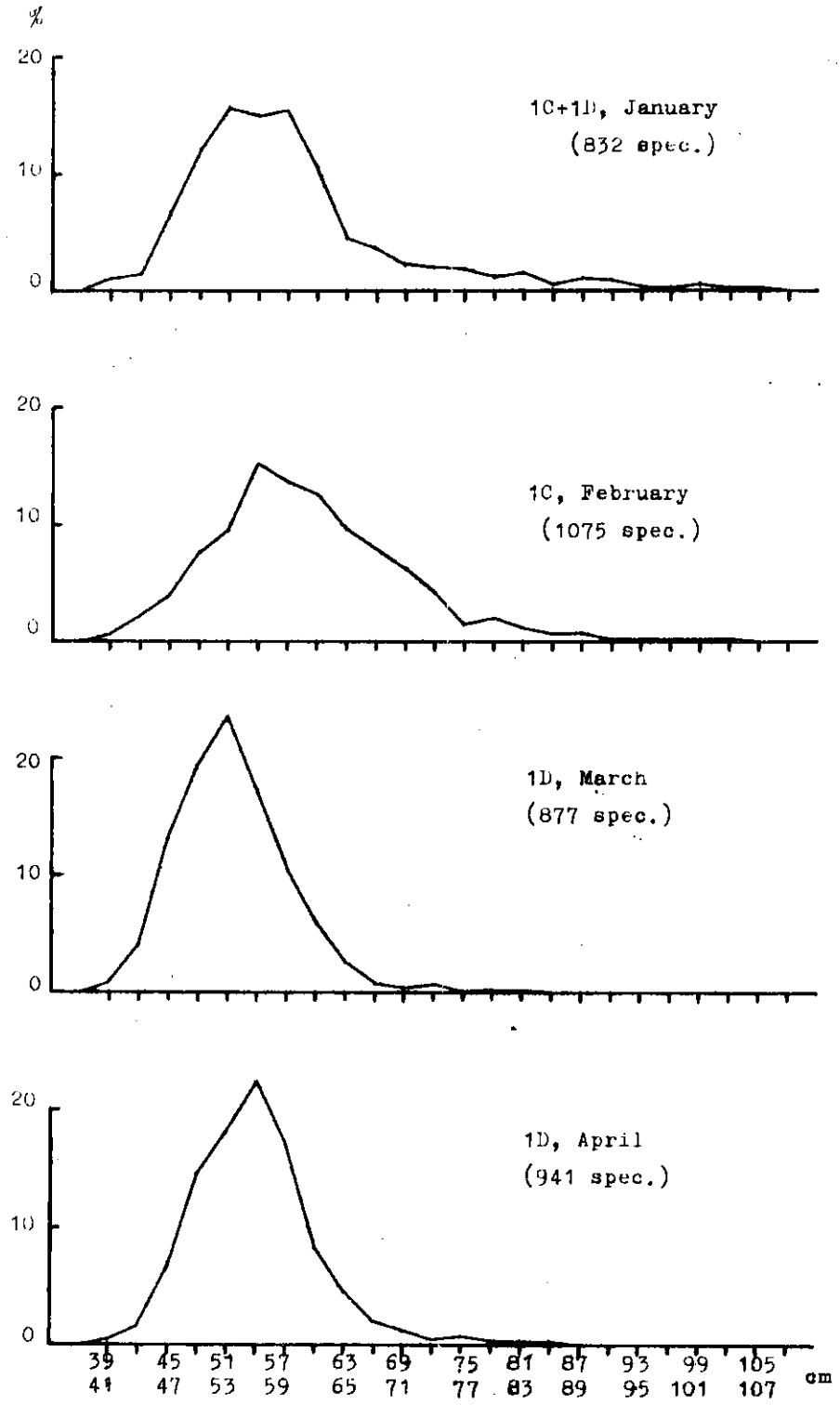


Fig.3. Length distribution (frequencies in per cent) of landings by Greenland otter trawlers, offshore banks, beginning of 1973. Total length, cm below.