INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 461 Document No. 19

ANNUAL MEETING - MAY 1957

Recruitment and Mortality of the Marketable Stock of Cod in W. Greenland Waters.

by Erik M. Poulsen

The cod fishery in the bank area off W. Greenland, Subarea 1, is very diversified, being carried out by fishing fleets from nine nations, and by ottertrawl as well as by various kind of hook and line fishing.

Most of the countries fishing in the subarea have, in accordance with the ICNAF research programs, reported data of the samples of their fisheries to ICNAF (ICNAF papers Ser. No. 426). For some countries sample data are available for a series of years prior to 1952.

The material dealt with below is from data reported to ICNAF and published the Research Reports (Ann.Proc. vol 3-6). In a few cases, when material prior to 1952 is used, the data are taken from reports published by ICES (Ann. Biol.).

Table 1 gives for all samples by all nations, years 1952-55, (see Table A), the average frequency per mille for each age-group (number of samples in brackets); numbers of individuals are not stated (the total number of specimens amounts to around 50.000):

Table 1. Cod, Subarea 1. Age distribution in °/oo, 1952-55, all countries, number of samples in ( ).

Age, years	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1A (12)		1	2	12	54	62	86	166	128	112	122	40	30	39	34	54	27	19	9	2	.1
1B+C (56)	1	18	113	143	198	148	59	82	72	48	52	13	12	18	8	7	6	2	1	.5	
1D+E (39)	1	14	90	116	187	238	57	75	79	30	42	17	8	10	14	7	8	5	1	.1	
1F (12)		19	93	67	127	182	102	132	90	32	48	26	11	14	19	17	12	4	2	.1	.1
1A-1F	.3	13	75	85	142	158	76	111	92	56	66	24	15	20	19	21	13	8	3.3	.7	.05
" smoothed	.1	14	62	101	134	140	116	95	79	63	50	39	30	23	17	13	10	7	5	.2	.05

The samples are taken during the summer half of the year, some two to eight months after spawning; thus cod shown in table as f.i. 3 years old are in fact 3 1/4 - 3 1/2 years old (III-Gr.).

Fig.1 shows these frequencies in graphic form. The bottom curve (also smoothed) gives the age distribution for the whole subarea. Up to the eighth year recruitment is stronger than mortality; from then on the strength of the age-groups decreases; mortality (including emigration) is stronger than recruitment. Very few cod enter the fishery at ages 3 and 4, it is only from an age of 5 years that the cod are caught in appreciable numbers. The oldest cod in the samples are 23 years old; they are exceedingly few; none of the age-groups older than 16 years yields more than 2%.

The age distribution differs to some degree from subdivision to subdivision. In the northern subdivision, 1A, recruitment is stronger than mortality right up to age 10. The recruitment over the ages 4-8 is here much smaller than in the central and southern subdivisions; compensating this the number of individuals of older ages are considerably higher.

The age distribution in B+C and D+E is very much alike with a steep recruitment curve, with peaks at 7-8 years, and with a strong decline in numbers after that age. The curve of age distribution for the southernmost subdivision F is intermediate between A and B-E.

.....2/

From the right declining parts of the curves a crude calculation of total mortality can be made. Crude only because it is not based on a follow of the separate year-classes through the years. However the fact that the percentages used are means of 4 consecutive years of observations to some degree compensates this deffect. Using this crude method on the figures in table 1 (both the observed (obs.) and the smoothed (sm.) figures) from the 8th year we get the following mortality rates:

Age	8	-	9	-	10	-	11	-	12	-	13	-	14	-	15	-	16	-	17	-	18	-	19	-	20	-	21	-	22	-	23	Total Mortality
Mort.obs.	52		+46		17		35		+18		64		30		+33		5		+11		36		38		38		86		86			ca. 25%
Mort.sm.	17		18		19		20		21		22		23		23		26		25		25		30		29		60		75			ca. 29%

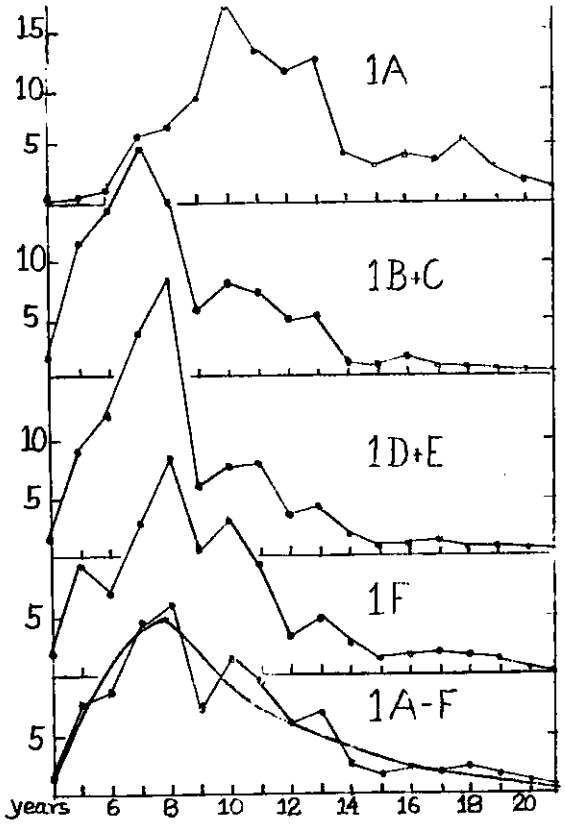

Fig. 1. Age distribution curves. Cod. Subarea 1, all samples, years 1952-55; with smoothed curve for the whole subarea (from Table 1).

It is obvious from the two lines of figures that the mortality increases with increasing age. It is to be noted that the mortality figures for the oldest age-groups in many cases are based on rather small numbers of specimens, and that they therefore vary very much. In fact minus figures for mortality occur right up to the oldest ages. When considering the figures for the oldest years this must be borne in mind, and the increase in the mortality figures for these years might not be an established fact. If the mean mortality is calculated for each of the three 5-years periods the following rates of mortality are found:

5 years period	obs.	sm.
age 8/9 to 12/13	8	19
" 13/14 to 17/18	11	24
" 18/19 to 22/23	57	44
all ages	25	29

For the ages after the 13th year, when recruitment may be considered as completed, the following mortality rates are found:

from observed figures: 34%

" smoothed figures: 34%

A certain check on these mortality rates is possible by using those separate fisheries from which sufficient sampling has been carried out.

For the Norwegian line fishery observations on age frequency are available for the years 1948-55 (Table B). From this table the following crude mortality rates are calculated from age 8 on for the years 1948-55 and for 1952-55, this latter for direct comparison with the ICNAF material from the same years:

Age	8	-	9	-	10	-	11	-	12	-	13	-	14	-	15	-	16	-	17	-	18	-	19	-	20	-	21	-22
1948-55	24		+3		22		0		14		+13		31		33		47		25		47		75		50		63	
1952-55	39		+76		14		24		27		67		+10		+3		45		+31		62		75		50			

.....3/

The figures for 1948-55 show a smaller irregularity of the variations over the years than in the ICNAF material and in the Norwegian material for only the years 1952-55.

The average mortality rates over 5 years periods are given below for the Norwegian material; the corresponding figures for the ICNAF material are shown for comparison:

Ages	Norway 1948-55	Norway 1952-55	ICNAF 1952-55
8/9 to 12/13	11	6	8
13/14 to 17/18	25	14	11
18/19 to 21/22	47	62	57
13/14 to 21/22	40	32	34
all ages	29	22	25

The Norwegian figures for 1948-55 show somewhat higher mortalities than the ICNAF figures; apart from ages 13/14 to 17/18 the difference is, however, not large. The Norwegian figures for 1952-55 coincide very closely with those for all ICNAF countries for the same years.

Another comparison can be made with the material from the Danish research vessel "Dana" from the years 1952-55. This material can be devided by subdivisions. The table below gives from age 8 the frequency percentages and the mortality rates calculated from them(based on Table A):

e	8	- 9	- 10	- 11	- 12	- 13	- 14	- 15	- 16	- 17	- 18	- 19	- 20	- 21	- 22
Fr.%	6.9	7.0	12.5	13.3	13.0	14.0	5.0	3.5	3.4	3.6	5.0	3.4	2.3	1.1	0.3
Mort.	+2	+79	+6	2	+7	64	30	3	+6	+39	27	32	52	73	
+C Fr.%	13.3	4.0	3.8	3.8	3.3	3.6	0.9	0.8	0.4	0.6	0.3	0.3	0.2	0.1	
" Mort.	70	5	0	13	+9	75	11	50	+50	50	0	33	50		
+E Fr.%	20.5	6.5	6.3	3.9	3.0	2.9	1.3	1.4	1.2	1.1	0.7	0.4	0.3	0.2	
" Mort.	68	3	35	23	3	55	+8	14	8	36	43	25	33		
Fr.%	11.0	12.8	11.8	9.8	4.3	5.8	3.1	1.4	1.8	2.8	2.6	1.7	0.7	0.3	0.1
Mort.	+16	8	17	56	+35	47	55	+22	+56	7	35	59	57	67	
-F Mort.	30	+16	12	24	+12	60	22	10	+26	14	28	37	48	70	
ort.	69	4	19	18	+3	65	2	32	+21	43	22	29	42		

When these mortality rates are calculated for the same periods of ages as for the above-treated samples the following results are found:

Subdivision	A	B+C	D+E	F	BCDE	A-F
Age 8/9 to 12/13	+18	16	26	6	21	8
" 13/14 to 17/18	10	27	21	6	24	16
" 18/19 to 21/23	50	28	34	55	31	50
" 13/14 to 21/23	31	27	26	27	27	33
All Ages	14	23	26	19	25	25

The agreement with the mortality rates for the ICNAF and Norwegian material is fairly good:

rea 1, Ages	8/9 to 12/13	13/14 to 17/18	18/19 to 22/23	13/14 to 22/23	All Ages
AF 1952-55	8	11	57	34	25
Norwegian 1952-55	6	14	62	32	22
"Dana" 1952-55	8	16	50	33	25

...../4/

All three series show an increased mortality with increasing age (cpr. also Fig. 2). The rather low "mortality" during the ages 8-12 is no doubt due to a considerable recruitment occurring during these years. If we consider the recruitment as completed at age 13, we get for the three series the following "true mortality" for the ages after the 13th year: 34, 32, 33. It must, however, be borne in mind that these figures are not just mortality rates; they include changes caused by immigration and emigration.

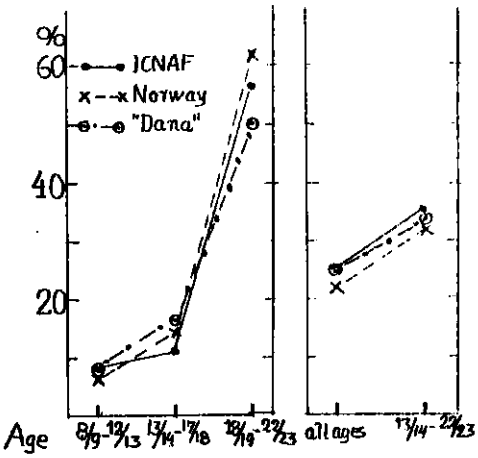

Fig.2- Comparison of mortality rates by ages of the material from the Norwegian line fishery, the "Dana" hook fishery, and from "all fisheries" by ICNAF countries 1952-55.

It can be noted that the "Dana" material which includes data from 5 subdivisions show some variations between mortality from one subdivision to another. In the northermost subdivision A there is no "mortality" for the ages 8/9 to 12/13, the figure + 18 denoting an increase; for the next period the mortality is low only 10. To a somewhat lesser degree this holds good also for Subdiv. F, where the mortality rates for these two periods are low, 6 and 6. For these two subdivisions also the mean mortality for all the ages (older than 8) is lower than in the central subdivisions: Mean A+F 16.5, mean B+C+D+E 24.5. It might be that these differences are due to the variation in the intensity of the fishery. Total landings were in 1955 distributed over the subdivisions as follows:

	1A	1B	1C	1D	1E	1F	?	Total
Tons, Round Fresh	1,364	55,629	36,054	91,388	6,526	8,269	66,088	265,318

The 66,088 not distributed by subdivisions were landed as follows:

Faroes -	35,811
Iceland -	9,180
Norway -	21,097

Iceland and the Faroes do not fish in A. When the Faroes and Iceland landings are distributed between B-F in proportion to the abovecited landings and the Norwegian landing between A-F in proportion to those Norwegian landings which are distributed by subdivisions, the following adjusted landings appear:

	1A	1B	1C	1D	1E	1F	Total
Tons, Round Fresh	2,098	72,956	48,010	120,520	11,187	10,547	265,318

The landings from 1A are thus quite negligible compared to those from B, C and D, and some 5 times smaller than the landings from E and F. This is not due to a thinner stock in those areas of 1A where cod fishery is carried out. The catch per unit of effort is not smaller in 1A than in the other subdivisions:

Norway, line fishery, tons per day fished

	1953	1954	1955
1A	7.8	6.7	7.0
1B	6.2	6.7	8.3
1C	7.6	8.4	8.5
1D	7.4	8.4	8.5
1E	4.3	12.4	9.8
1F	6.0	10.6	7.7

The very small landings from 1A must therefore be due to the very small effort spent on cod fishery, this again indicating that the cod stock there is nearly "virgin", and that fishing mortality therefore only can account

.....5/

for a small part of the total mortality.

The mean mortality for all ages older than 8 is in 1A 14 against in 1B to 25. Stipulating that the cod stock in 1A is virgin and living under the same conditions as in B-E, it means that fishing mortality in B-E would be 11. This figure can be compared with the 10% recaptures during the first year from Danish tagging experiments.

The above mentioned mortalities for the separate subdivisions are based on the "Dana" material only. When the material for "all countries" is subdivided by subdivisions the following figures appear:

	A	B+C	D+E	F	BCDE	A-F
Ages 8/9 to 12/13	+19	12	12	8	12	3
" 13/14 " 17/18	3	20	22	18	21	16
" 18/19 " 22/23	49	50	49	60	50	52
" 13/14 " 22/23	26	33	34	36	34	32
all ages	12	26	26	26	26	23

These figures show about the same variations in mortality rates by subdivisions as the "Dana" material; Figure 3 shows a comparison for "all ages".

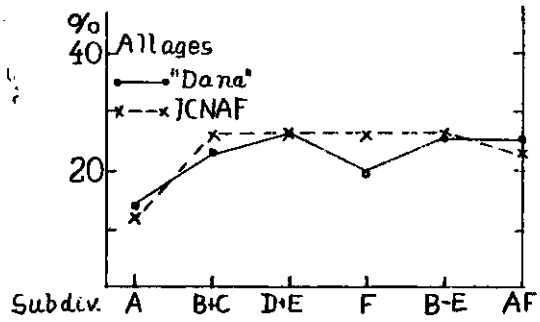

Fig.3 - Mortality rates for all ages by subdivisions, "Dana" and ICNAF material.

When, as a standard of mortality are taken the figures for subdivisions B, C, D and E, where the main fishery is carried out, we get the following survey:

	all countries	"Dana"
Age 8/9 to 22/23	26	26
" 13/14 " 22/23	34	28

This gives for W. Greenland cod a mortality rate of 26 for cod older than 8 years, and for cod older than 13 years (recruitment completed) of 28-34.

The mortality rates discussed in the preceding pages are all calculated just from the differences between strength of age-groups in samples from series of years. This method is- as already mentioned - a rather crude one. As a more refined method is generally considered the calculation of the total number fished of each age-group per fishing unit, and the calcution of the difference in strength of the same class from one year to another.

For the Norwegian line fishery samples as well as statistical data on efforts are available for a series of years; thus this fishery can be used for a more refined calculation.

Norwegian Line Fishery

Year	No.of Days Fished	Tons of Cod Round Fresh Caught	Mean Length of Cod in cm.	Mean Weight of Cod in Grams	No. of individuals caught	Tons Landed per 1 day's fishery	No.of Individuals Landed per 1 day's Fishery
1952	3,226	15,158	76	3,600	5,322,000	5.94	1,650
1953	2,254	15,898	73	3,050	5,212,000	7.05	2,313
1954	2,405	18,538	74	3,300	5,618,000	7.71	2,336
1955	2,100	17,093	74	3,300	5,180,000	8.14	2,467

In table C are shown a calculation of the number of individuals caught per 1 day's fishing based on the figures in the table above, and on the age distribution in the samples.

The table gives the following mean figures for recruitment and mortality om age 8:

Age	8 - 9	- 10	- 11	- 12	- 13	- 14	- 15	- 16	- 17	- 18	- 19	- 20	- 21	- 22
Mort.	+51 +7		13	22	24	25	(27)	16	45	37	29	+2	88	(33)

.....6/

It appears from the table that right up to the 11th year recruitment is stronger than mortality: from that age and onwards a gradual increase of the mortality rate is found.

When mean mortality is calculated for the same periods of ages as for the preceding cases the following figures appear:

	Norw. line fishery	"Dana" B+C
Age 8/9 to 12/13	+3	4
" 13/14 " 17/18	30	22
" 18/19 " 21/22	31	37
" 8/9 " 21/22	19	18
" 13/14 " 21/22	34	30

For comparison are shown the corresponding figures for the samples of the experimental "Dana" fishery in B-C, i.e. the subdivisions where also the main Norwegian fishery and sampling are carried out. The rates calculated from these two different kinds of material and in two different ways are fairly close to one another, especially for the two last series of figures comprising the ages from 8 years and from 13 years and upwards.

Comparing these "refined" figures for the Norwegian line fishery with crude figures we get the following survey:

Subdivision	Crude calculation for "all countries"	"Dana"	refined calculation Norway line fishery
BCDE 8-23 years	26	26	
" 13-23 "	34	28	
A-F 8-23 "	17	22	22
" 13-23 "	26	30	33

This gives for the W. Greenland cod stock a mortality of from 17-26 for all ages from 8 and upwards and from 26-33 for all ages from 13 and upwards.

The mortality is rather low compared to that found for some other cod stocks. This is of course due to the rather slow growth of the Greenland cod, and to the fact (connected with slow growth) that the fishery is carried out on a comparatively large number of age groups.

Only few cod samples have been reported to the Commission from the other subareas; these by France, Portugal and Spain. From these the following mortality rates are calculated:

Subdivision 2J (Southern Labrador)

Ages	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1952, French	0.6	6.1	20.4	24.2	21.1	12.1	6.4	3.1	2.4	1.1	0.8	0.9	0.6	0.2
1955, Port.	0.8	2.0	7.2	10.8	15.3	19.7	11.2	17.3	11.6	1.6	2.0	0.4		
Mean	0.7	4.1	13.8	17.5	18.2	15.9	8.8	10.2	7.0	1.4	1.4	0.7	0.3	0.1
Mortality		+486	+237	+27	+4	-13	-45	+16	-31	-80	0	-50	-57	-67

Subdivision 3L, 3O, 3N (Grand Bank of Newfoundland)

Ages	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1953,54,55,Sp.	5.0	18.0	21.3	23.0	16.3	7.3	3.3	1.7	2.3	1.3	0.3	0	0.3	0.2	0.2
Mortality		+260	+18	+8	-29	-56	-55	-48	+35	-43	-77	?	?	?	?

For the old ages (14+) the mortality is not calculated owing to the very scarce material.

Although one can not rely too much on these mortality rates based on so very few samples, it is perhaps worth noting that they differ considerably from those for Subarea 1. The fishery in Subareas 2 and 3 is based on a smaller number of age-groups and on younger age-groups than is the case in Subarea 1. Therefore the mortality rates are considerably higher. Mortality overrates recruitment at a younger age; in Subarea 1 from age 8-9, in Subarea 2 from age 7-8, and in 3 from age 6-7. The mean mortality for the series of ages after the age when mortality overrates recruitment is as follows:

.....7/

Subarea 1 (age 8/9 to 22/23) - ca 26
" 2 (age 7/8 to 15/16 - 36
" 3 (age 6/7 to 12/13) - 39

When the same ages are compared the difference of course is larger:
Subarea 1 (age 8/9 - 12/13) - 6
" 2 (" ") - 28
" 3 (" ") - 38

The big difference in mortality rates between the cod of W. Greenland and that of the Grand Bank is no doubt connected with the much slower growth in W. Greenland. The Labrador cod is even more slowgrowing than the W. Greenland cod (see ICNAF Serial No. 429). One should therefore expect its mortality rates to be lower, and the older ages-group to play a bigger role than in W. Greenland. This is, however, not so. The Labrador cod in fact holds a position intermediate between the stocks of W. Greenland and the Grand Bank. The explanation of this inconsistency may well be that considerable emigration takes place from the Labrador area, possibly to the Newfoundland area. In this connection it should be borne in mind that the term "mortality" as used here and elsewhere (in fisheries literature) is rather misleading. It is not a rate of mortality, but just a rate of change, decrease, this decrease being caused partly by mortality (natural and fishery) partly by emigration, or counteracted by immigration. When using the so called refined calculation, including the number of individuals caught per unit of effort, one further make the mortality rates dependent on such irrelevant factors as change from year to year in fishing effectivity (in gears, vessels, experience) or in the conditions for fishing, f.i. winds, ice.

Mortality rate, in the way it is calculated, is not an unchanging quality of a certain stock of fish, not even over a very short period of years; it is depending on a mixture of certain characteristics of that stock and changing outside factors working on the stock. The refined calculation of mortality for the Norwegian line fishery (Table C) shows to what a degree such mortality figures can change from one year to another:

Ages	10/11 to 13/14
1952/53	3
1953/54	18
1954/55	29

This gradual, but strong, increase of mortality rate during 1952 to 1955, can hardly be attributed to the stock of cod itself, or to changes of the conditions for its living during these years. There is, however, some reason to connect it with changes in the efficiency of the fishing. During these years the fishery by floating lines became more and more developed, and the yield in tons and number of individuals caught per 1 day fishing increased considerably:

1952 - 6.0 tons or 1650 ind.
1953 - 7.1 tons or 2313 ind.
1954 - 7.7 tons or 2352 ind.
1955 - 8.1 tons or 2472 ind.

Total mortality for the W. Greenland cod older than 8 years is around 25%. From tagging experiments a percentage of ca 10% is reported for the first year. Owing to the amount of recaptures this figure is too low; considerations (see Ser. No. 439) have led to a figure of 20% as a more true one. If we take the mean of these two figures 15%, the Total Mortality for W. Greenland cod can be devided as follows: Natural Mortality 10%, Fishing Mortality 15%.

The following conclusive remarks are made as an attempt to show - based on the mortality rates found for Subarea 1 cod - the effects on the landings which could be expected from an increase of age of first capture.

The youngest age-group now of some importance to the cod fishery on the W. Greenland banks is the V-Gr.

Table D shows the calculations of the effects on landings from an increase of age of first capture from age 5 to age 7. The calculations are following the lines of the example given in "Report of the ad hoc Committee established at the 4th Meeting of the Permanent Commission" p.13.

In W. Greenland waters recruitment is still strong for ages 5 to 8, in cases even for older ages. Therefore "natural mortality" (recruitment minus natural mortality) is positive for a few years after age 5, and small only for still some years.

For the ages 5, 6 and 7 "natural mortality" is, using the figures for age distribution, estimated to +115, +165, and +25 respectively. For the older ages two methods have been used: one (a) a fixed natural mortality of 10% for all following ages, and another gliding scale with increasing natural mortality for the older ages. Fishing mortality is fixed at 15% for all ages, which gives with the 10% of natural mortality of the fixed scale and with the mean of the rates of mortality of the gliding scale a total mortality of 25%.

The calculations give the following yields from 1000 fish at age 5 + recruits from older ages. The detailed calculations for "starting fishery at age 6 and 8" are not shown in the main table:

Mortality Scale		Gliding			Fixed		
Catch		No.of Cod	Weight Kgs.	Ind.Weight	No.of Cod	Weight Kgs.	Ind.Weight
Start.Fish at age	5	3,264	12,974	4.0	2,929	11,255	3.8
"	6				2,986	11,832	
"	7	3,327	14,240	4.3	2,930	12,201	4.2
"	8				2,713	12,005	
Increase age 5 to 7		63	1,266		1	946	
" " "	%		9			8	

By delaying fishery to start at age 7 an increase in yield of 8-9% is calculated. The gliding and the fixed scale for natural mortality give very much the same percentage increase but the catch figures are a little higher for the gliding than for the fixed scale. Delaying fishery even more, to age 8, will give no further gain.

- THE END -

TABLE A – Cod. Subarea 1. Age distribution in frequency percentages from samples reported to ICNAF 1952-55. The figures behind name of country denote number of samples. (The Danish samples from the Godthaab Fjord area excluded).

Age, years	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1A 1952-Denmark(4)		0.3	0.5	2	6	5	10	28	9	9	5	1	1	8	3	12	0.2				
" Norway(3)			0.4	1	5	4	15	34	12	6	6		1	6	2	7	0.3	0.5	0.2	0.1	
1953 Denmark(2)				1	2	7	3	8	34	5	12	4	1	0.5	10	2	9	1	0.5		
1954 " (2)				2	14	3	13	1	6	29	4	8	3	1	0.2	6	0.2	8	1		
1955 " (1)						12	2	12	3	7	34	7	9	4	2		4	0.1	3	1	0.1
1A-1952/55 Mean		0.1	0.2	1.2	5.4	5.2	8.6	16.6	12.8	11.2	12.2	4.0	3.0	3.9	3.4	5.4	2.7	1.9	0.9	0.2	0.1
1B+C-1952-Denmark(7)	3	43		8	22	4	2	7	1	3	0.9	0.6	0.1	1	0.1	0.4	0.1				
" Iceland(2)	0.2	4	51	11	21	4	2	4	1	1	0.5	0.3	0.5	0.2	0.2	0.5					
" Norway(2)			0.3	0.5	3	8	11	36	7	4	9		2	13	0.1	1	0.4				
1953 Denmark(12)		0.8	7	56	4	11	3	2	10	2	1	0.8	0.1	0.1	2		0.6				
" Norway(1)			0.9	19	5	10	5	9	29	6	4	3	0.6	2	3	2	0.9	0.1			
" Portugal(1)	1		7	38	11	11	8	7	6	2	2		1	2	0	1	1	0.6	0.3	0.1	
1954 Denmark(8)		9	2	12	60	3	7	1	2	3	0.3	0.3	0	0.3	0	0.2	0	0.3			
" Iceland(1)		3	3	18	62	6	5	1	0.5	2	0.1		0.1								
" Norway(4)			0.1	3	26	4	10	6	8	18	6	4	4	0.5	3	3	2	1.2	0	0.1	
1955 Denmark(11)		1.6	17	3	8	35	4	5	2	5	12	2	3	0.3	0.2	0.6	0.6	0.4	0.2		
" Norway(3)			0.6	0.5	8	36	8	9	6	7	17	3	2	1	0.1	0.2	0.5	0.2	0.7	0.1	
" Portugal(4)			5	3	8	45	6	11	13	5	10	2	0.8	0.9	0.5		0.5		0.4		
1B+C-1952/55 Mean	0.1	1.8	11.3	14.3	19.8	14.8	5.9	8.2	7.2	4.8	5.2	1.3	1.2	1.8	0.8	0.7	0.6	0.2	0.1	0.1	
1D+E-1952-Denmark(4)		0.8	16	4	41	8	4	12	2	2	2		1	2	2	2		0.7	0.1		
" Iceland(1)		1	45	8	35	3	3	4	0.5	0.1	0.1	0.1	0.1	0.3		0.1					
1953 Denmark(5)		2	3	29	5	35	4	3	12	1	2	0.6	1	1.5	2		0.4	0.2			
" Iceland(1)	0.1	0	1	40	10	36	3	3	5	0.4	0.2	0.2	0.1	0.7	0.1	0.1					
" Norway(1)			1	5	5	8	4	6	29	5	7	0	1	4	7	3	5	3			
" Portugal(3)		0.3	2	10	3	14	3	12	32	3	4		2	1	5	1	2	1.4	0.6	0.2	
1954 Denmark(9)		7	7	6	44	5	16	2	1	8	0.6	1	0.4	0.2	0.1	0.8	0.4	0.3			
" Faroes(1)		3	7	12	47	11	15	2	1	3	0.4										
1955 Denmark(7)		2	17	13	8	34	2	8	0.5	1	5	2.4	3	1.0	0.2	0.1	0.7		0.6		
" Iceland(1)			3	16	10	44	3	11	5	2	6	0.5	0.5								
" Norway(3)			2	4	8	37	7	14	5	7	12	2	1	0.7	0.6	1	1	0.3			
" Portugal(3)		1	4	2	8	51	4	13	2	3	11	0.5	0.1	0.3	0.2		0.4	0.2	0.2		
1D+E-1952/55 Mean	0.1	1.4	9.0	11.6	18.7	23.8	7.7	7.5	7.9	3.0	4.2	1.7	0.8	1.0	1.4	0.7	0.8	0.5	0.1	0.1	
1F-1952 Denmark(2)				2	23	12	11	17	2	6	6	4	3	4	3	4	1	0.5			
1953 Denmark(1)						7	3	8	34	6	10	6	0.5	3	8	6	5	2			
" U.K.(1)			0.7	13	14	41	11	8	7	2	1	0.2	1	0.8	0.4		0.4		0.2	0.4	0.1
1954 Denmark(1)		5	17	2	31	0.7	36	1	1	4		2	0.2	0.2	0	0.2	0	0.1	0.2	0.2	
1955 Denmark(6)		3	20	13	3	24	0.3	21	2	1	7	0.5	2	0.1	0.2		0.9		0.9		
" U.K.(1)		3	18	10	5	24		24	8		5	3									
1F-1952/55 Mean		1.9	9.3	6.7	12.7	18.2	10.2	13.2	9.0	3.2	4.8	2.6	1.1	1.4	1.9	1.7	1.2	0.4	0.2	0.1	0.1
1A-F 1952/55 Mean	0.1	1.3	7.5	8.5	14.2	15.8	7.6	11.1	9.2	5.6	6.6	2.4	1.5	2.0	1.9	2.1	1.3	0.8	0.3	0.1	0.1

TABLE B – Cod, Subarea 1: Age distribution in frequency percentages in samples from Norwegian Line fishery. 1948-51 after ICES, Ann. Biol.; 1952-55 after ICNAF, Ann. Proc.

Year	Years	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	1948			1	9	5	4	6	2	2	17	8	37	3	3	2	1					
	1949		1	2	4	18	7	5	8	2	3	16	8	20	3	2	1	1	0.2	0.1		
	1950		2	10	8	12	29	6	3	3	1	2	8	5	10	1	1	2	0.2		0.1	
	1951			2	6	7	11	30	10	6	5	1	3	9	2	5	1	0.2	0.2	0.1	0.1	
	1952			1	1	6	5	12	38	10	6	5	0	2	8	2	5	1	0.5	0.4		
	1953			1	18	5	9	5	9	29	6	5	4	1	2	3	1	1	0.2			
	1954			0.2	3	28	5	11	6	10	23	5	3	3	0.5	1	2	1				
	1955			1	1	1	40	8	10	5	6	15	3	2	1	0.2	0.3					
Mean	1948/55		0.4	2.3	6.3	10.3	13.9	10.5	10.8	8.4	8.4	7.2	8.3	5.7	3.8	2.0	1.5	0.8	0.2	0.1	0.03	
Mean	1952/55			0.8	5.8	10.0	14.8	9.0	15.8	13.5	10.3	7.5	2.5	2.8	2.9	1.6	2.1	0.8	0.2	0.1		

TABLE C – Cod. Subarea 1. Norwegian Long Line Fishery. Number of individuals caught per 1 day's fishing.

Age Gr.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1952	8	21	102	74	201	626	157	102	87	0	26	129	23	86	3	3	2	0	0
1953	23	419	117	210	117	209	673	139	117	93	29	47	70	23	23	5	0	0	0
1954	5	68	650	109	232	128	225	534	107	70	58	12	33	47	28	28	0	2	0
1955	19	30	170	994	200	245	118	150	357	64	39	22	5	7	30	5	10	2	0

Percentage "mortality": (∞ is disregarded)

Year	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	19-20	20-21	21-22	22-23
52-53	+5138	+457	+159	+58	+4	+8	11	15	+7	(+∞)	+89	-46	0	-73	+67	-100	-100	
53-54	+195	+55	-7	+11	+10	+8	-1	-23	-40	-38	-58	-30	-33	+22	+22	-100	(+∞)	
54-55	+500	+150	+53	+83	+6	-8	-33	-33	-40	-44	-80	-58	-79	-36	-82	-64	(+∞)	
Mean	+1934	+221	+68	+51	+7	+3	-22	-24	-25	(-27)	-16	-45	-37	-29	+2	-88	(-33)	

TABLE D. Expected Effect per 1000 Recruits at age 5 on the Yield through Change of Age of First Capture

				a. Fixed Scale of Natural Mortality									b. Gliding Scale of Natural Mortality								
				Starting Fishery with Age 5				Starting Fishery with Age 7					Starting Fishery with Age 5				Starting Fishery with Age 7				
Age Years	Mortality % Fish.	Nat.	Tot.	Number of Fish	Decrease in no. by Mortality Fish.	Nat.	Tot.	Catch in kg.[1]	Number of Fish	Decrease in no. by Mortality Fish.	Nat.	Tot.	Catch in kg.	Mortality % Fish.	Nat.	Tot.	Number of Fish	Decrease in no. by Mortality Fish.	Nat.	Tot.	Catch in kg.	Number of Fish	Decrease in no. by Mortality Fish.	Nat.	Tot.	Catch in kg.
5	15	+115	+100	1000	150	+1150	+1000	240	1000	0	+1150	+1150	0	15	+115	+100	1000	150	+1150	+1000	240	1000	0	+1150	+1150	0
6	"	+ 65	+50	2000	300	+1300	+1000	690	2150	0	+1397	+1397	0	"	+65	+50	2000	300	+1300	+1000	690	2150	0	+1398	+1398	0
7	"	+25	+10	3000	450	+750	+300	1305	3547	532	+887	+355	1543	"	+25	+10	3000	450	+750	+300	1305	3548	532	+887	+355	1543
8	"	5	20	3300	495	165	660	1733	3902	585	195	780	2048	"	1	16	3300	495	33	528	1733	3903	585	39	624	2048
9	"	10	25	2640	396	264	660	1505	3122	468	312	780	1778	"	3	18	2772	416	83	499	1581	3279	492	98	590	1870
10	"	"	"	1980	297	198	495	1277	2342	351	234	585	1509	"	4	19	2273	341	91	432	1466	2689	403	108	511	1733
11	"	"	"	1485	223	149	372	1004	1757	264	176	440	1188	"	5	20	1841	276	92	368	1242	2178	327	109	436	1472
12	"	"	"	1113	167	111	278	802	1317	198	132	330	950	"	7	22	1473	221	103	324	1061	1742	261	122	383	1253
13	"	"	"	835	125	84	209	625	987	148	99	247	740	"	8	23	1149	172	92	264	860	1359	204	109	313	1020
14	"	"	"	626	94	63	157	517	740	111	74	185	611	"	10	25	885	133	89	222	732	1046	157	105	262	864
15	"	"	"	469	70	47	117	420	555	83	56	139	498	"	11	26	663	99	73	172	594	784	118	86	204	708
16	"	"	"	352	53	35	88	333	416	62	42	104	391	"	12	27	491	74	59	133	466	580	87	70	157	548
17	"	"	"	264	40	26	66	272	312	47	31	78	320	"	14	29	358	54	50	104	367	423	63	59	122	428
18	"	"	"	198	30	20	50	219	234	35	23	58	256	"	15	30	254	38	38	76	277	301	45	45	90	329
19	"	"	"	148	22	15	37	172	176	26	18	44	203	"	17	32	178	27	30	57	211	211	32	36	68	250
20	"	"	"	111	17	11	28	141	132	20	13	33	166	"	18	33	121	18	22	40	149	143	21	26	47	174
Total		+80			2929			11255		2930			12201		+80			3264			12974		3327			14240

1) the individual weights used in the calculation are taken from Fig.1 of Ser.No.459