RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 1904
(D.c.2)

ICNAF Res Doc 67/104

ANNUAL MEETING - JUNE 1967

Remarks on Year-class Fluctuations in the West Greenland Cod Stocks.

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At the meetings of the Bio-Economics Working Group in 1966-67 various regulatory measures for the North Atlantic fisheries were discussed. The working group found that a catch quota measure was perhaps the most appropriate one but stressed that when setting catch quotas one has to take into account the fluctuations in year-class strength in the various fish stocks. The present paper deals with the year-class fluctuations observed in the Greenland cod stocks. The material hitherto available (Sampling Yearbook, Research Reports) is, however, in many cases far from being ample enough for a real judgment of the year-class strength. This together with rather poor information on discards does that the actual figures of year-class strength given in this paper must be taken with some reservation. Still, however, the author believes that the figures give a fair idea of the magnitude of the year-class fluctuations and the magnitude of the fluctuations in future annual landings due to this year-class fluctuations.

Year-class fluctuations in the Greenland cod stocks are of major importance to the fishery on these stocks. This has been known since regular fisheries investigations started in West Greenland in 1924. In the course of the years several papers have been published dealing with this year-class fluctuation. Also annual reports on fisheries and research carried out published in ICNAF and ICES series deal with the year-class fluctuation. Summaries and discussion of the fluctuations are published by Hansen (1949 and 1953) and by Hermann, Hansen and Horsted (1965) covering year-classes 1924-47 and 1924-51 respectively.

Hansen (l.c.) and Hermann et.al. (l.c.) have given the relative strength of the year-classes based on the importance of the year-classes in the fishery of the Greenlanders (an inshore fishery). Table 1 shows the relative year-class

strength found and published by the authors mentioned.

The author tried to continue this table in the same manner as used earlier but found it so difficult to get a usable weighting factor for the Greenlanders' effort in recent years that the attempt was given up and another method had to be used.

In the present paper the author has tried to measure the strength of the year-classes since 1947 given as number of recruits in the West Greenland area. The following precedure has been followed.

1. Landings from Div. 1NK have been allocated to known divisions according to Horsted (1965).
2. Within each division annual landings have been splitted up in four groups viz. a) landings from otter trawlers, b) from dory vessels, c) from liners, d) Greenlanders' landings.
3. Existing age-frequency samples have been pooled annually per division and group mentioned above under Item 2.
4. The weight of the pooled samples has been calculated according to the age-weight key given in Fig. 1 and Table 2.
5. The annual numbers landed of each year-class are calculated by raising weight of pooled samples to weight landed.
6. The year-classes 1947-54 are regarded as recruited when 5 years old, while year-classes 1955-61 are regarded as recruited when 4 years old due to the increased growth rate in recent years. Fishing mortality in the year of recruitment is regarded as being only 25% of the overall fishing moratlity in that year and fishing mortality on younger age-groups has not been taken into account.
7. The mean fishing mortality (F) in Subarea 1 is given in Table 3. Natural mortality (M) is taken as being 0.2o.

Following the items mentioned above the numbers of recruits in each year-class since 1947 are calculated as shown in the example below. The final figures for number of recruits are given in Table 4, which also gives the theoretical number of age-group I supposing M=0.2o for age-groups I-IV.

Example of calculating number of recruits. Year-class 1955. 1000 recruits (IV-group) would be reduced in the following way according to F in Table 3 and M=0.2o.

age-group	IV	V	VI	VII	VIII	IX +
No.of fish present	1000	741	391	192	97	46
No.of fish dying	259	350	199	95	51	46
No.of fish caught $(\frac{F}{F+M})$	86	241	143	67	37	34

No. landed of age-groups IV - VIII : 574

actual number landed of age-groups IV - VIII according to samples : 38569×10^3

actual number of recruits (IV-group) = $\frac{38'62 \times 10^3 \times 1000}{574} = 67.2 \times 10^6$

Taking number of recruits as the best measure of year-class strength and considering only the year-classes since 1947 it follows that

a) Maximum relative difference between successive year-classes is 5 : 1 (year-class 1953 : 54)

b) Greatest difference between year-classes is 8.3 : 1 (year-class 1961 : ..)

c) Average divergence of single year-classes from long-term mean is about 61% of mean year-class strength.

Supposing that the year-class variation as given by the year-classes since 1947 can be regarded as typical for Subarea 1 (subject to the necessary destinction between the northern and the southern region) the author has tried to evaluate the influence of such a variation on the annual landings supposing a fishing intensity as in most recent years (F likely to be about 0.65) as well as a 30% reduction in effort. The results are given in Table 5. The landings given in this table are generally below the actual landings obtained, and it is hence most likely, that the figures in Table 4 are biassed with a tendency to be underestimated. The reason for this may be, that some of the assumptions made do not hold, especially Item 6, page 2 may be too simple an assumption. A much better knowledge of discards is required in this connection.

Although the figures given in Table 4 and hence also Table 5 therefore may be biassed the relation between the figures may nevertheless give a valuable idea of the year-class variation and the influence of this variation on the fisheries.

A general picture obtained from Table 5 is that with a high fishing mortality the output of the fisheries will follow the year-class variation more directly than with a reduced fishing mortality (effort). If effort is still increasing we may expect great fluctuations in annual landings, and in this connection it may be necessary to point out, that the relative good landings obtained with a high effort in recent years are based on the favourable recruitment in these years with year-classes 1957, 60 and 61 being well above mean, year-class 1956 close to mean, and year-class 1958 being of some importance although below mean.

Possibility of predicting year-class strength:

Hansen (l.c.) and Hermann et.al. (l.c.) have pointed out, that the relative year-class strength may be predicted with some accuracy from observations of cod of age-groups I, II, and III, from larval abundance and even from hydrographical conditions. Time has not permitted the author to try to make any analysis of this rather important problem, but from some of the samples taken by research vessels fishing with commercial trawls with covered codend the author has the impression, that it is worth while trying to study this problem, as the chance of making predictions with success seems rather good.

References:

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Table 1.

West Greenland cod. Relative year-class strength (from Hermann, Hansen and Horsted 1965).

Year-class:	1924	25	26	27	28	29	30	31	32	
Relative strength:	100	3	74	12	9	24	18	43	36	
Year-class:	1933	34	35	36	37	38	39	40	41	
Relative strength:	18	109	33	81	16	13	28	28	32	
Year-class:	1942	43	44	45	46	47	48	49	50	51
Relative strength:	86	28	23	59	13	148	21	11	52	17

Table 2. Age - weight relation used in this paper. See also Fig.1.

Age group	Mean weight (round fresh)	
	year-classes 1947 - 54	1955 - 61
III	.550 kg	.620
IV	.890 -	1.180
V	1.540 -	2.100
VI	2.330 -	3.080
VII	2.870 -	3.810
VIII	3.470 -	4.540
IX +	5.000 -	5.550

Table 3.

Fishing mortality coefficient (F). Subarea 1 cod.
The figures for the years 1952 - 58 follow those given by the Greenland Cod Working Group (Anon. 1966), while the figures for 1959 - 65 correspond with those given by Gulland (MS for the Bio-Economics Working Group 1967).

Year	1952	53	54	55	56	57	58	59	60	61	62	63	64	65
F	.21	.21	.28	.28	.30	.30	.38	.41	.44	.51	.43	.54	.59	.65

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Table 4.

Number of recruits in the year-classes 1947-61. Age at recruitment being 5 for year-classes 1947-54 and 4 for year-classes 1955-61. Theoretical corresponding number in age-group I given supposing M=0.20 for all age-groups.

Year class:	1947	48	49	50	51	52	53	54	55	56	57	58	59	60	61
No x10^6 of age group I:	722	166	127	432	164	176	528	105	122	294	678	204	112	422	715
No. x10^6 of recruits in															
Div.1A - 1D	305.9	71.4	38.9	145.4	58.7	62.3	200.4	40.0	58.1	96.8	335.3	72.1	56.2	224.5	363.8
Div.1E - 1F	18.4	3.2	18.3	48.7	15.1	16.7	36.6	7.3	9.1	64.5	36.9	39.6	5.3	6.9	28.5
Subarea 1	324.3	74.6	57.2	194.1	73.8	79.0	237.0	47.3	67.2	161.3	372.2	111.7	61.5	231.4	392.3
Index	100.0	23.0	17.6	59.9	22.8	24.4	73.1	14.6	20.7	49.8	114.8	34.5	19.0	71.4	121.0

Table 5.

Theoretical landings of Subarea 1 cod if recruitment change as in the year classes 1947-60. Growth rate considered steady as in the years since 1960 (Table 2). F in year of recruitment only considered as 25% of the F given in the table.

Year	F = 0.65 $\frac{F}{Z}$ = 0.76		F = 0.46 $\frac{F}{Z}$ = 0.70	
	landings in		landings in	
	tons x 10^3	No.x 10^6	tons x 10^3	No.x 10^6
1	293.8	132	289.3	117
2	356.6	147	341.7	131
3	259.3	90	266.7	86
4	202.7	79	228.2	78
5	228.6	92	227.5	83
6	186.5	69	186.7	60
7	181.1	81	176.4	72
8	235.7	99	214.9	86
9	187.9	66	190.7	62
10	158.3	66	161.7	61
11	232.5	117	217.9	100
12	368.3	160	335.6	137
13	276.9	102	265.8	94
14	232.0	92	232.7	85
15	310.0	148	344.0	138
16	434.5	185	412.0	162
17	353.9	139	343.4	127
Landings from a mean year - class.				
	268 x 10^3 tons 110x 10^6 sp. mean weight 2.44 kg.		270 x 10^3 tons 101 x 10^6 sp mean weight 2.67 kg.	

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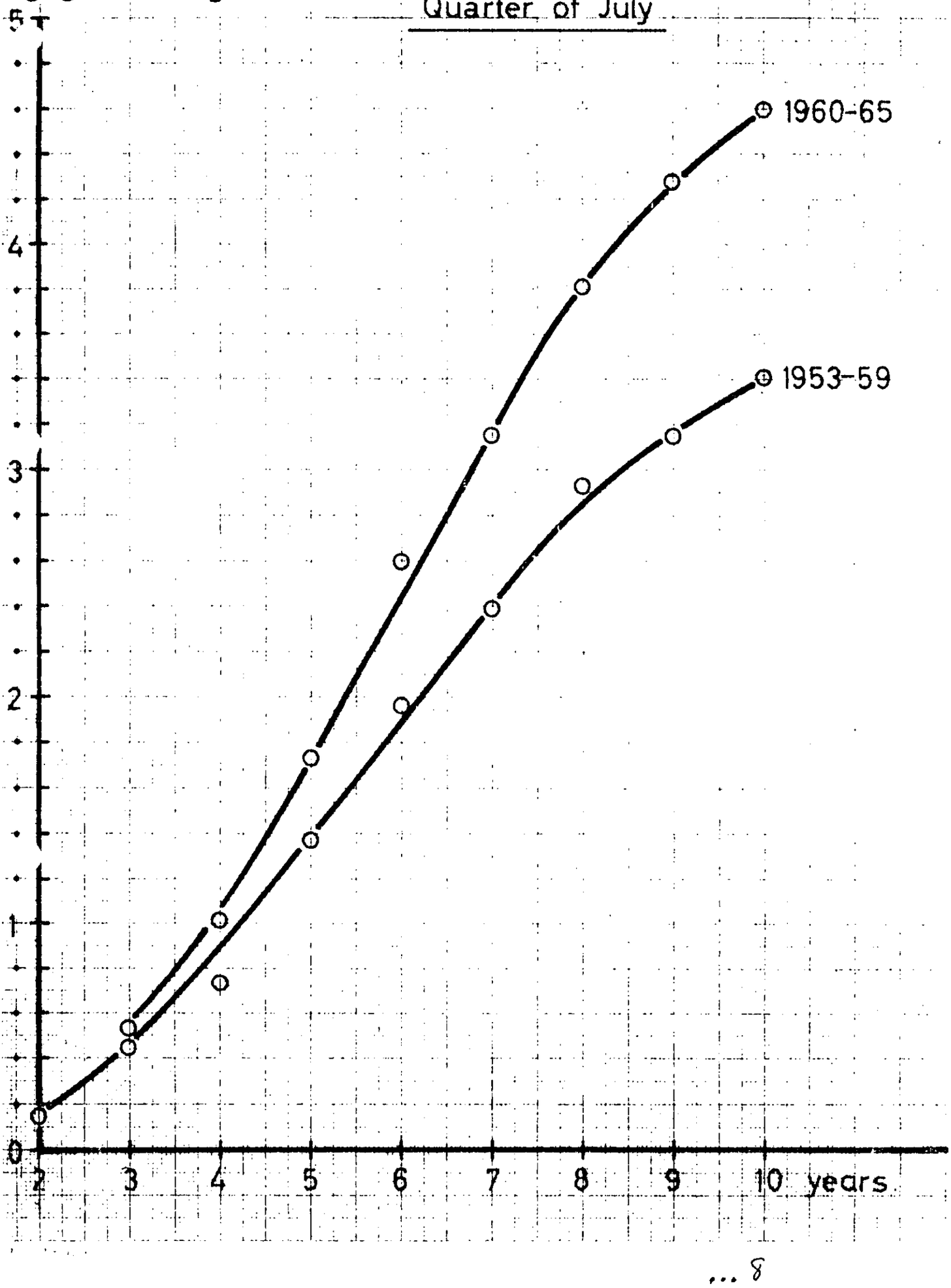
Growth of cod

Divisions 1A 1D offshore

Quarter of July



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