International Commission for the Northwest Atlantic Fisheries

1950

1970

ANNUAL MEETING - JUNE 1970

Fishing mortality and stock size in the West-Greenland cod.

by Albrecht Schumacher

Institute for Sea Fishery, Hamburg

Abstract

The"virtual population technique" has been used for estimating fishing
mortality per age group in the stock of cod in Subarea I for the years
1956-1969. Changes of mortality in correlation to estimated fishing intensity
are discussed. In order to assess the actual state of the stock, the number
of cod present at the beginning of the years 1960-1969 has been estimated,
also the possible yield in 1971 at different level of fishing mortality.

1. Fishing mortality

During the last ten years, an improvment in fishing technique has taken
place leading to an increase in efficiency of the different fleets in all
parts of the North-Atlantic. In addition the behaviour of a part of the fleet
exploiting the Subarea I cod has changed to a more seasonal fishery by
economical reasons. Therefore, the effort data for the West-Greenland fishery
and consequently the catch per unit effort data becomes incomparable in a
longer time series. Consequently it is impossible to use the catch per unit
of effort as an index of stock abundance to estimate the mortality in the
Subarea I cod.

In order to overcome these difficulties, the method of "virtual populations"
developed by FRY (1949, 1957) and modified by GULLAND (1965) and R.JONES
(1961, 1967) has been used for an estimation of F. This method is completely
independent of effort data, but needs the total annual catch taken from
this stock in number per age groups for a series of years. These basic data
were taken from the age compositions, published in ICNAF Sampling Yearbook
and from the catch figures published in ICNAF Statistical Bulletin, separately
for the different years, Subdivisions and seasons. Combining these data, it
was possible to estimate the total number of cod per age group caught in
Subarea I in the years 1956-1966 (s.Tab.1)

In addition to these basic data a good estimate of natural mortality is
nessessary. The most reliable estimate available is given by HORSTED (1968)
from tagging experiments in the years 1935-1939. As a result of the recaptures
during the war time a value of 0.28 for total mortality has been estimated.

Taking into account the relatively small fishery at that time carried out
by Greenlandic boats, a value of M= 0.20 will not be# very far from the truth.

The results of the estimation of fishing mortality are given in Tab.2.
for the years 1956-1964. Using the catch figures for 1965-1969 and the
figures on abundance of new coming yearclasses discussed during the 1970
midterm meeting of the Assessment Subcommittee in London, fishing mortality
values have been extrapolated for the years 1965-1969.

It is shown clearly, that in all age groups fishing mortality for the
period 1962-1964 is more than twice the corresponding values for the
previous 1956-1961 period. In the fully recruited age groups a level of
$F \sim 0.8$ was reached in 1964 and did not decrease markedly up to 1969.

A comparison of these fishing mortality figures with corresponding
values given in previous assessments shows a resonable agreement with
figures presented by HORSTED (1969).

2. Mortality and fishing intensity

As pointed out above there is no good estimate of effort available for
the more recent years. For the years 1956-1963 however, a reliable estimate
of fishing intensity for Subarea I cod has been published by HORSTED (1965)
(s. bottom line of Tab.2). There is a very good correlation between this
estimated total fishing intensity and the mean fishing mortality for the
age groups 3-13 in the years 1956-1963. The regression line goes nearly
through the origin; there is only a small intercept of 0.012. This confirmes
the validity of estimated natural mortality used in this and in previous
assessments (s.Fig.1).

3. Stock size

In order to show the developement of the stock in Subarea I during
the last ten years the number of fish per age group present in the stock
at the beginning of the year has been estimated using catch figures and
mortality. The results are given in Tab.3 and Fig.2 and are showing a
remarkable decline of the number of fish during the last five years.

4. Catch in 1971

The catch in 1971 will be highly dependent on the results of the
fishery in 1969 and 1970. The new recruiting yearclasses in 1970 and 1971
are from minor importance and will not contribute very much to the yield
in 1971 because of the very low fishing mortality in the two years after
first recruitment.

So it was possible to draw a diagram (Fig.3) showing on the y-axis
the possible yield for different level of F in fully recruited age groups
and on the x-axis the sum of the 1969 and 1970 catch as percentages of the
1968 catch. This diagram shows clearly that - assuming a moderate fishery
from about 50% of the 1968 catch in 1969 and in 1970 too - the catch in 1971
will not exceed a level of 250 000 t assuming F - 0.7-0.8 in 1971 (1968 level).
If the result of the 1970 fishery will be higher, the 1971 catch will decrease
markedly below this level.

References

FRY, F.E.J., 1949: Statistics of a lake trout fishery, Biometrics 5,1,27-67.

-- 1957: Assessments of mortalitys by use of virtual populations. Ms.Paper p.15, Meeting ICNAF/ICES/FAO, Lissabon, Mai 1957.

GULLAND, J.A., 1965: Estimation of mortality rates. Annex to Arctic Fisheries Working Group Report. ICES, C.M. 1965 (3)(Mimeo).

HORSTED, S.A., 1965:Fishing Activity, Effort and Intensity in Subarea 1, 1952-1963. ICNAF Res.Doc.65/67 (Mimeo).

-- 1968: Cod in Subarea 1. Review and Revision of Parameters. Reassessment. ICNAF Res.Doc.68/57 (Mimeo).

-- 1969: On the possibility of assessing stock size and catch quota for Subarea 1 cod. ICNAF Res.Doc.69/74 (Mimeo.).

ICNAF, 1958-1968: Sampling Yearbook 1956-1966, 1-11

ICNAF, 1958-1968: Statistical Bulletin 1956-1966, 6-16.

JONES, R., 1961: The assessment of the long-term effects of changes in gear selectivity and fishing effort. Mar.Res., No.2, 1-19.

-- 1964: Estimating Population size from Commercial Statistics when Fishing Mortality Varies with Age. ICES, Rapp.P.-V.Cons.perm.int.explor. Mer 155, 38,210-214.

-- 1968: Appendix to the Report of the North-Western Working Group. ICES, C.M.1968 (20)(Mimeo.)

Tabl. 1   Cod, Subarea I,   Number of cod caught per year and age group

Age (Years)	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
2		544	488			24		296	8	2752	88
3	209	1177	348	578	435	2946	869	7612	8655	14718	1294
4	1758	19353	1772	2866	6186	22958	11423	6589	27181	58619	7738
5	4996	12493	15136	5464	5168	19756	70311	19301	11407	53331	59987
6	17901	9362	6751	27411	4652	8055	29344	48418	18264	8994	40726
7	6622	17367	7501	6622	20250	6980	7816	22517	30864	9152	5791
8	6400	3967	17177	3881	4492	23126	5050	3973	11355	15125	4403
9	24418	4061	3181	5996	2743	4359	13772	1708	2543	2595	6667
10	2345	8893	3652	1124	5363	2333	2433	6768	1027	539	1166
11	4106	1271	12981	1477	805	4724	1709	1104	4138	472	276
12	1014	1899	1691	4327	1438	528	2599	1156	591	1864	122
13	1363	485	2168	999	5195	1138	720	2325	321	73	981
14	2893	436	725	836	741	5052	1219	189	933	34	137
14+	1194	1383	3271	960	1859	2383	2897	3718	747	265	234

1951
Year Class

Tab. 2   C O D   S U B A R E A   I   Fishing Mortality

Age (Years)	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969*	Change of F with age in % of F in fully recruited age groups
3	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	3
4	0.02	0.04	0.04	0.05	0.04	0.08	0.11	0.11	0.09	0.10	0.10	0.10	0.10	0.06	13
5	0.09	0.23	0.08	0.15	0.13	0.18	0.35	0.28	0.27	0.28	0.20	0.28	0.28	0.18	40
6	0.16	0.23	0.19	0.21	0.18	0.30	0.43	0.44	0.47	0.42	0.36	0.42	0.42	0.27	60
7	0.30	0.22	0.29	0.28	0.23	0.45	0.55	0.70	0.55	0.56	0.48	0.56	0.56	0.36	80
8	0.22	0.30	0.36	0.24	0.31	0.44	0.70	0.61	0.96	0.70	0.60	0.70	0.70	0.45	100
9	0.29	0.21	0.42	0.20	0.27	0.55	0.52	0.55	1.03	0.70	0.60	0.70	0.70	0.45	100
10	0.24	0.16	0.29	0.26	0.27	0.39	0.69	0.52	0.76	0.70	0.60	0.70	0.70	0.45	100
11	0.40	0.20	0.37	0.18	0.30	0.40	0.56	0.79	0.70	0.70	0.60	0.70	0.70	0.45	100
12	0.34	0.33	0.43	0.20	0.27	0.33	0.40	0.97	1.04	0.70	0.60	0.70	0.70	0.45	100
13		0.27	0.78	0.48	0.38	0.35	1.00	0.75		0.70	0.60	0.70	0.70	0.45	100
3 – 13	0.21	0.20	0.30	0.21	0.22	0.32	0.48	0.52	0.59	0.51	0.43	0.51	0.51	0.33	
Fishing Intensity**	5.94	7.99	11.01	9.79	10.50	16.95	17.31	18.04							

* assuming catch in 1969 = 50% of 1968 catch = ± 180 000 t.

** HORSTED 1965

Tab. 3   Cod, Subarea I   Number of fish present in the stock at the beginning of the year

$$(x \quad 10^{-6})$$

| Age (Years)	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
3	404	164	97	423	481	171	72	70	150	100
4	172	328	120	69	348	386	137	58	56	120
5	47	132	261	87	54	254	268	102	43	42
6	31	34	92	149	53	36	157	184	63	26
7	108	21	20	49	80	28	19	90	99	34
8	18	71	11	10	20	38	13	10	42	46
9	13	11	37	4	4	6	15	6	4	17
10	25	8	5	18	2	1	3	7	2	2
11	3	16	4	2	9	1	0.5	1	3	1
12	7	2	9	2	1	4	0.3	0.2	0.5	1
13	18	4	1	5	0.6	0.2	1	0.1	0.1	0.2
14	2	10	2	0.3	2	0.2	0.1	0.7	0.1	0.1
14$^+$	4	5	6	7	1	0.7	0.4	0.2	0.3	0.2
$\sum_3^{14^+}$	852	806	665	825	1056	908	686	529	313	290
$\sum_4^{14^+}$	448	642	568	402	575	737	614	459	163	190
$\sum_5^{14^+}$	276	314	448	333	227	351	477	401	107	70
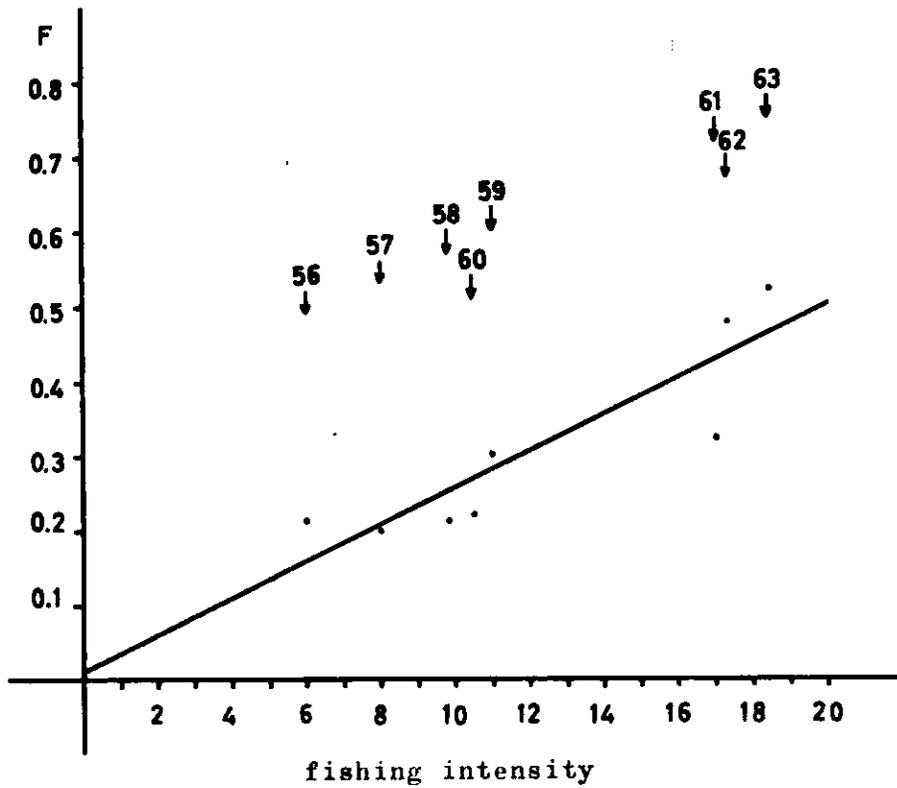
Fig. 1   C O D   SUBAREA I

Correlation of mean fishing mortality
with fishing intensity 1956 - 1963
($y = 0.0124 + 0.0243x$; $s_b = 0.005$)

Fig.2 COD SUBAREA I   Number of cod per age - group at the beginning of the year (x 10⁻⁶)

(Below the date of the year: 1. Catch in 1000 t;
2. F (7⁺); 3. Total number of fish of age 3⁺;)

Fig. 3 C O D SUBAREA I
Yield in 1971 at different level of F
in fully recruited age – groups
and different catch in 1969
and 1970