International Council for the
Exploration of the Sea

C.M.1975/H:4
Pelagic Fish (Northern) Committee

Li:11

REPORT OF THE WORKING GROUP ON ATLANTO-SCANDIAN HERRING

10 - 12 March, Bergen, Norway.

CONTENTS

x) General Secretary,
ICES,
Charlottenlund Slot,
DK-2920 Charlottenlund,
Denmark.

1. Introduction and Participation.

1.1. Acting upon a recommendation from NEAFC the International Council for the Exploration of the Sea (ICES) at its Statutory Meeting in 1974 decided that the Working Group on Atlanto-Scandian Herring should meet again "to assess the present state of the Atlanto-Scandian herring stock".

The Working Group met in Bergen during the period 10.-12. March 1975.

1.2. Participants.

Mr. E. Bakken	Norway
Mr. J. Hamre	Norway
Mr. J. Jakobsson (Chairman)	Iceland
Mr. E. S. Prosvirov	U.S.S.R.
Mr. A. Saville	U.K. (Scotland)
Mr. Ø. Ulltang	Norway
Mr. M. Volodarsky	U.S.S.R.
Mr. O. J. Østvedt	Norway

1.3. In former working group reports attention has always been concentrated on the Norwegian spring spawning herring as being by far the most important component of the Atlanto-Scandian herring tribe. These reports have, however, also dealt briefly with the Icelandic spring and summer spawners. The working group decided that at this meeting only the Norwegian spring spawning herring would be dealt with since a recent assessment on the Icelandic herring stock has been published (JAKOBSSON 1973). Since 1971 catches have been negligible as Icelandic national regulation has restricted fishing to the use of driftnets only.

2. Historical review.

2.1 The first Working Group on Atlanto-Scandian herring met in 1963, 1964 and 1965 and reported to the Statutory meetings of the ICES. These reports dealt with the stock structure as well as state of the Atlanto-Scandian herring up to the year 1963 and were the basis of an Assessment Report to NEAFC presented in 1965 (ICES, Coop. Res. Rep., Series B, 1965, pp. 33-79.).

2.2 After a period of three years the Atlanto Scandian Working Group was reconvened in 1969 and 1971 and the resulting reports were published as Coop. Res. Rep., Series A Nos 17 and 30. These reports dealt in more detail than the former ones, with the exploitation of the Atlanto Scandian herring. Particular attention was paid to total and fishing mortality rates and stock size and to the effect of the small and fat herring fisheries on recruitment. These reports include data up to the year 1970. Their main conclusions can be summarized as follows.

2.3 The two periods of very high catches of adult herring in 1954-1957 and 1964-1967 coincided with the recruitment of strong year-classes especially those of 1950 and 1959.

2.4 The abundance estimates of the adult stock show a sharp decline during the period 1955-1962, a temporary increase from 1962-1966 and a further decline from 1966 onwards. The second decline was accelerated by an increase in exploitation rate in the adult stock in the years 1963-1967 as compared to earlier period but primarily the decline was caused by practically no recruitment to the adult stock after the 1959-1961 year-classes were fully recruited in 1966.

2.5 The lack of recruitment to the adult stock was due both to a series of weak year-classes (1962, 1965-1968) and an increased rate of exploitation of immature herring. Thus the two year-classes from 1963 and 1964 which had been estimated in the International O-group fish surveys in the Barents Sea to be of average strength failed to recruit to the adult stock due to the high exploitation of the year-classes as fat herring.

2.6 During the period 1960-1969 it was shown that major changes took place in the pattern of distribution, spawning grounds and migration routes of the adult stock. Thus the spawning grounds off western Norway south of Stadt were abandoned and instead the main spawning was centered much farther north and in some years a large component spawned as far north as Lofoten. From 1965 onwards, the migration routes of the herring changed. Instead of migrating to north and northeast of Iceland during the summer, the herring migrated northwards and spent the summer in the area west of Bear Island and Spitsbergen.

3. Total catches, catch in number and age composition.

3.1 Table 3.1 shows the total catch of adult and pre-recruit Atlanto-Scandian herring (Norwegian spring spawning herring) for the years 1950-1971.

As pointed out in former reports the highest catches of adult herring were taken in 1966 (1 723 500 tons). The catches declined in 1967 to 1 131 500 tons but in 1968 only 273 199 tons were caught. In 1969 and 1970 there was a further collapse to 24 100 and 20 500 tons. In those years no fishable concentrations could be found except during the spawning season. In 1971 the yield was only 6 900 tons. Since 1971 the only catches of adult herring have been for scientific purposes.

3.2 Table 3.2. shows the catch in number per age of adult herring during the period 1962-1971. The catch in number which amounted to 5 486 millions in 1966 declined to only 21 million in 1971. The 1961 year-class was the last one which contributed significantly to the adult fisheries.

3.3 Table 3.3 shows the total catches of small and fat herring in the years 1951-1974. In 1967 the total catch of immature herring reached a peak of 545 700 tons. In 1968 the catches were still at

the high level of 439 100 tons whereas in 1969 and 1970 they fell to 43 700 and 40 300 tons. During 1971 and 1972 the catches of small and fat herring were 14 200 and 13 200 tons respectively. In 1973 and 1974 catch quotas were introduced limiting the catches to 6 800 and 6 300 tons respectively.

3.4 Table 3.4 shows the catch in number by age in the small and fat herring fisheries. The total catches were raised to numbers using Norwegian age weight data. During the period 1962-1968 the catch in numbers of immature herring remained at a very high level (6-15 000 million herring per year). In 1970 the catches of immature herring decreased to 709 millions and in 1972, the first year of regulated fishery the catches consisted of 279 million herring of which 179 million were O-group.

3.5 The percentage age composition as derived from the Norwegian winter fishery is given in Table 3.5. For the last three years 1972-1974, when no commercial fishery were allowed, the data refer to samples taken during experimental fishing. The age composition data show that until 1971 the catches were based on the year-classes 1959, 1960 and 1961. Until 1972 subsequent year-classes recruited to the spawning stock only in very small numbers. In 1972, however, the year-class 1969 at an age of only three years recruited to the spawning stock and in 1973 and 1974 this year-class contributed more than 80% of the experimental catches.

3.6 The 1969-year-class was probably already fully recruited at an age of four years which is at least one year earlier than previous year-classes. The low age at first maturity can be explained by an unusual fast growth. Fig. 1. shows that at an age of five years in 1974 the year-class 1969 had a mean length of 33.5 cm corresponding to mean length of 7-8 year olds in the fifties (Østvedt per. comm.). It appears that the 1969 year-class was found in near coastal waters also during autumn of 1972 when relatively large numbers in maturity stage IV were caught in the fat herring fishery along the coast of northern Norway.

Thus in recent years when no offshore concentrations of adult Atlanto-Scandian herring have been located evidence from Norwegian surveys shows that adult herring spend most of the year close inshore and only migrate out of the fjords for a short period in late autumn or early winter.

4. Abundance estimates and recruitment.

4.1 In former working group reports (Coop. Res. Rep., Series A, 17 and 30) independent abundance estimates for the adult Atlanto-Scandian herring were based on tagging and echosurvey data. In addition abundance indices were derived from drift-net catch per unit effort data.

4.2 DRAGESUND and ULLTANG (1973) compared these abundance estimates with their results using cohort analyses starting with catches in 1971 and then calculating the adult stock size (4 years and older) backwards. This comparison (Fig. 2) shows that the Working Group estimates were in good agreement with the cohort analyses. Thus at least three independent and fundamentally different methods of stock abundance estimates confirm that in the mid-fifties the adult stock of the Atlanto-Scandian herring was of the order of 10-15 million tons. During the late fifties there was a sharp decline to about 3 million tons in 1962. In 1964 both working group estimates and cohort give the stock size at about 6 million tons. For the years 1965-1967 the working group estimates are considerably higher than the cohort ones, unless a higher value of M is used in 1968 and in subsequent years in the cohort analyses.

Both working group and cohort estimates show a sharp decline of the adult stock from 1966 onwards. The causes of this low recruitment level and increased exploitation rate are discussed in 2.4 and 2.5.

4.3 The low recruitment to the adult stock is not indicative of O-group year-class strength. Cohort analyses using catch in number by age (DRAGESUND and ULLTANG in press), including catches from the small and fat herring fishery shows that the year-classes 1964 and 1966 were (as O-group) of the same strength as the 1961 year-class i.e. about 17×10^9 (Fig. 3). The strength of the 1963 year-class was estimated as somewhat stronger or about 26×10^9 as O-group. With regard to the 1963 and 1964 year-classes it has already been pointed out that they were exploited at a very high rate in the fat herring fishery, while the 1966 year-class was reduced to a very low level, in the small herring fishery.

4.4 In the cohort analyses referred to above a constant value of M=0.16 was applied. In section 4.2 it was mentioned that natural mortality in the adult stock might possibly have increased since 1968 (DRAGESUND and ULLTANG 1973). This would of course have been a major factor in the collapse of the adult stock. If this was the case the 1963 and 1964 year-classes would also have been affected by such an increase in natural mortality and thus larger proportions of these year-classes might have survived the fat herring fisheries without this being detected in the cohort analyses. However, the age composition in the winter fishery (Tabel 3.5) shows that both year-classes contributed little to the catches in 1969-1971 even compared with that of the 1961 year-class which as O-group was of similar strength as the 1963-1964 year-classes and would presumably have been subject to the same high natural mortality.

Thus all the available evidence shows that no large quantities of the 1963-1964 year-classes can have survived the heavy exploitation rate they were subjected to in the fat herring fishery.

4.5 Although the 1963, 1964 and 1966 year-classes were much weaker than the 1959 year-class they were never the less of reasonable strength as O-group. A major factor in the recruitment failure to the adult stock in the late sixties was therefore fishing of immature herring.

4.6 Preliminary cohort analyses on the 1967-1969 year-classes using catch in number in the small and fat herring fishery up to 1974 (DRAGESUND and ULLTANG, in press) indicates that these three year-classes were of the same order of magnitude as O-group. They are estimated to be about one tenth of the strength of the 1963, 1964 and 1966 year-classes (Fig. 3).

A preliminary cohort estimate of the 1970 year-class suggests that it is only about one percent of the 1963-1964 year-classes. For later year-classes no cohort estimates are available but catch data for the 1971 and 1972 year-classes indicate that they are all very poor.

4.7 In October-November 1974 the Institute of Marine Research, Bergen, tried to determine the distribution and abundance of young herring in the fjords of western and northern Norway. An acoustic survey technique similar to that used on sprat (BAKKEN 1975) was applied. Indices of abundance of O-group (1974 year-class) and I-group (1973 year-class) herring were calculated for the different fjord systems. The preliminary results presented to the Working Group, indicate that the 1973 and 1974 year-classes are very weak. The survey of the fjords in late autumn will be continued. This is in full agreement with the results of the International O-group surveys in the Barents Sea, where practically no O-group herring have been observed since 1969.

The Soviet participants proposed that a joint survey programme on the Atlanto-Scandian Herring should be carried out in late 1975 and in 1976. They undertook to send detailed proposals to the interested countries at an early date.

5. Conclusions

5.1 There is no evidence of any improvement in the state of the Norwegian spring spawning herring stock. Recruitment to the adult stock since 1966 has been negligible. This failure of recruitment to the adult stock has to a considerable extent resulted from a high exploitation rate of year-classes in the juvenile fisheries in the middle and late 1960's. The spawning stock is probably now at such a low level that it is not capable of producing a strong year-class.

5.2 Under these circumstances no fishing either on adult or juvenile herring of this stock should be allowed until there is evidence of a build up of the adult stock to an acceptable level.

References

Anon, 1970. Report of the Working Group on Atlanto-Scandian Herring. ICES Coop. Res. Rep., Series A, 17.

Anon, 1972. Report of the Meeting of the Working Group on Atlanto-Scandian Herring. ICES Coop. Res. Rep., Series A, 30.

Dragesund, O. and Ø. Ulltang, 1973. Further Studies on Stock Size, Fluctuations and Rate of Exploitation of the Norwegian Spring Spawning Herring 1950-1971. ICES C.M. 1973/H:19 (mimeo).

- In press. Stock Size Fluctuations and Rate of Exploitation of the Norwegian Spring Spawning Herring 1950-1974.

Jakobsson, J., 1973. Population Studies on the Icelandic Herring Stocks. ICES C.M. 1973/H:4 (mimeo).

Table 3.1 Total catch

Catch (in thousands of tons) of adult and Norwegian spring spawning herring 1950 - 1971

Year	Iceland	Norway	USSR	Faroes	Germany	Total
1950	30.7	781.4	14.0	-	-	826.1
1951	48.9	902.3	43.0	-	-	994.2
1952	9.2	840.1	69.9	-	-	919.2
1953	31.5	692.2	110.0	16.2	-	849.9
1954	15.2	1 103.6	160.0	27.6	-	1 306.4
1955	18.1	979.3	207.0	13.1	-	1 217.5
1956	41.2	1 160.7	235.0	23.7	-	1 460.6
1957	18.2	813.1	300.0	17.0	-	1 148.3
1958	22.6	356.7	388.0	17.7	-	785.0
1959	34.5	426.9	408.0	13.7	-	883.1
1960	26.7	318.4	465.0	11.0	-	821.1
1961	85.0	111.0	285.0	16.9	-	497.9
1962	176.2	156.2	209.0	9.8	-	551.2
1963	177.5	130.4	350.0	12.9	-	670.8
1964	367.4	366.4	365.8	18.3	-	1 117.9
1965	540.0	259.5	489.2	31.5	5.6	1 325.8
1966	691.4	497.9	447.4	60.7	26.1	1 723.5
1967	359.3	423.7	303.9	34.9	9.7	1 131.5
1968	75.2	55.7	124.3	16.1	1.8	273.1
1969	0.6	15.6	3.2	4.4	0.3	24.1
1970	-	20.3	-	0.6	-	20.9
1971	-	6.9	-	-	-	6.9

3.2 Total catch in numbers of Norwegian spring spawning herring in the adult fisheries (millions)

Year class	Years									
	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1948	64.1	60.6	43.2	52.1	8.8	0.0	0.0	-	-	-
1949	49.3	79.8	46.1	70.2	14.9	1.9	-	-	-	-
1950	959.3	932.7	771.6	703.0	392.7	64.3	5.4	1.1	0.2	-
1951	138.9	174.1	151.9	137.7	96.9	14.3	4.1	0.2	-	-
1952	59.8	92.5	83.2	106.9	72.1	14.3	3.6	0.3	0.1	-
1953	64.1	107.7	96.3	100.5	69.1	17.5	1.8	0.2	0.1	-
1954	13.3	9.3	29.3	40.0	11.0	8.9	2.6	-	0.1	-
1955	20.2	18.3	24.9	19.1	26.1	8.5	2.5	0.3	0.1	-
1956	6.5	3.5	3.0	7.4	17.4	3.5	0.8	0.2	0.1	-
1957	2.0	1.7	1.5	14.9	14.4	5.7	1.1	0.3	0.1	-
1958	1.4	4.9	13.1	19.5	38.0	8.9	2.0	-	0.1	-
1959	255.7	408.9	1917.7	2195.8	2868.3	1718.2	345.9	36.3	28.2	5.5
1960	49.8	38.2	307.6	570.4	1290.6	1135.0	134.8	33.5	26.7	6.9
1961	-	-	90.2	245.9	459.1	422.2	93.9	11.6	13.2	4.4
1962	-	-	2.2	12.1	26.5	27.0	14.3	0.7	1.0	0.4
1963	-	-	-	45.1	80.6	25.7	15.2	2.9	3.3	1.1
1964	-	-	-	-	-	-	-	-	0.4	1.0
1965	-	-	-	-	-	-	-	0.2	0.3	0.4
1966	-	-	-	-	-	-	-	-	1.3	0.9
1967	-	-	-	-	-	-	-	-	-	0.6
1968	-	-	-	-	-	-	-	-	-	0.3
Total	1684.4	1932.2	3581.8	4340.6	5486.5	3475.9	628.0	87.7	75.5	21.5

Table 3.3 Catches of small and fat herring (in thousand tons) taken by Norway and USSR

Year	Small herring			Fat herring			Grand total
	Norway	USSR	Total	Norway	USSR	Total	
1951	190.1	10.5	200.6	80.5	2.5	83.0	284.2
1952	276.4	2.1	278.5	55.2	1.9	57.1	335.6
1953	147.0	3.8	150.8	84.7	5.2	89.9	240.7
1954	190.1	8.8	198.9	138.0	1.2	139.2	338.1
1955	94.3	3.0	97.3	36.0	9.0	45.0	142.3
1956	86.8	-	86.8	102.0	10.0	112.0	198.8
1957	118.5	3.8	123.3	46.4	1.5	47.9	171.2
1958	133.5	8.1	141.6	55.1	4.6	60.0	201.6
1959	164.5	7.2	171.7	46.8	9.5	56.3	228.0
1960	212.0	5.7	217.7	62.2	0.8	63.0	280.7
1961	222.7	0.9	223.6	108.5	0.1	108.6	332.2
1962	124.5	0.7	125.2	171.3	0.9	172.2	297.4
1963	157.9	-	157.9	143.8	12.0	155.8	313.7
1964	106.8	-	106.8	56.9	0.2	57.1	163.9
1965	116.9	-	116.9	94.3	10.7	105.0	221.9
1966	78.8	-	78.8	147.9	21.9	169.8	248.6
1967	107.1	-	107.1	346.0	92.6	438.6	545.7
1968	26.3	-	26.3	341.1	71.7	412.8	439.1
1969	14.4	-	14.4	21.2	8.1	29.3	43.7
1970	11.2	-	11.2	29.1	-	29.1	40.3
1971	1.1	-	1.1	13.1	-	13.1	14.2
1972	3.3	-	3.3	9.9	-	9.9	13.2
1973	0.3	-	0.3	6.5	-	6.5	6.8
1974	0.6	-	0.6	5.7	-	5.7	6.3

Table 3.4. Total catch in numbers of Norwegian spring-spawning herring in the small and fat herring fisheries (millions). Preliminary figures. (DRAGESUND and ULLTANG, in preparation).

Year-class	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1956		0.1											
1957	0.7	0.1											
1958	6.5	0.3	0.6										
1959	1633.0	422.0	127.7	3.7	9.8								
1960	1001.0	721.0	91.1	0.6	17.2								
1961	4027.0	2051.0	24.4	10.2	5.9								
1962	3667.0	2122.0	218.0	77.9	1.0								
1963		4811.0	2727.0	2805.0	1956.0	3239.0	1362.0	1.8					
1964			3613.0	3752.0	1670.0	1395.0	1890.0	8.8	2.9	0.1	0.5		
1965				2303.0	664.0	70.1	98.2	0.6	0.3		0.2		
1966					3893.0	9910.0	384.0	187.0	17.3	0.3	1.0		
1967						428.0	434.0	141.0	11.3	0.4	2.2		
1968							1782.0	507.0	28.6	1.5	1.6		0.06
1969								556.0	530.0	85.1	33.6	0.1	8.4
1970									119.0	42.9	8.5	0.9	0.14
1971										30.5	52.3	0.4	0.46
1972											179.0	70.1	9.1
1973												18.2	8.2
1974													35,6
Total	10335.0	10128.0	6802.0	8952.0	8217.0	15042.0	5950.0	1403.0	709.0	161.0	279.0	90.0	67.0

Table 3.5. Percentage age composition 1962 - 1974 Norwegian winter fishery.

Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972 [1]	1973 [1]	1974 [1]
2	-	-	-	-	-	-	-	-	-	-	-	0.2	6.7
3	.1	-	.2	-	-	-	-	-	0.3	0.6	44.1	5.1	2.0
4	-	6.9	5.9	5.2	.1	.2	-	0.1	1.8	3.3	19.5	83.7	7.3
5	.5	.4	60.6	13.6	8.8	.4	.7	-	0.4	4.4	13.1	2.8	82.0
6	.9	.4	.3	66.3	28.9	12.8	1.3	3.3	0.6	1.8	9.1	4.1	0.9
7	2.5	.5	.1	.1	54.5	33.7	12.1	0.8	4.4	4.9	2.2	1.7	0.8
8	1.5	1.7	.2	.2	.2	48.5	35.0	13.2	1.3	5.1	4.2	0.8	0.2
9	8.0	1.0	.8	.1	.1	.2	47.7	38.2	17.0	1.7	0.9	0.6	-
10	4.0	8.6	.5	.3	.1	-	.1	41.6	35.2	20.9	0.1	0.9	0.1
11	6.6	3.6	3.4	.5	.2	.1	-	-	37.9	32.1	2.3	+	-
12	63.5	8.2	1.8	1.4	.2	.3	.2	0.3	0.1	25.0	2.3	+	-
13	2.1	60.0	2.6	.8	.6	.2	.2	0.1	0.1	-	2.2	+	-
14	3.6	2.0	20.9	1.3	.6	.5	.3	0.3	0.1	+	-	+	-
15	3.4	2.7	.6	9.2	.4	.3	.5	-	0.1	-	-	+	-
16	0.7	2.0	.7	.3	5.0	.3	.4	0.2	0.1	+	-	+	-
17	1.0	.8	1.1	.3	-	2.5	-	0.3	0.2	+	-	-	-
18	1.0	.5	.1	.3	-	-	1.4	0.1	0.2	+	-	-	-
19	.3	.4	.1	-	.3	-	-	1.3	-	+	-	-	-
20	-	.2	.1	-	-	-	-	-	0.3	-	-	-	-
>20	.3	.1	-	.2	-	-	-	-	-	+	-	-	-
n =	398	399	1481	1402	2531	1599	2255	2207	3511	2516	856	1994	2178

1) Age data from samples taken during experimental fishing.

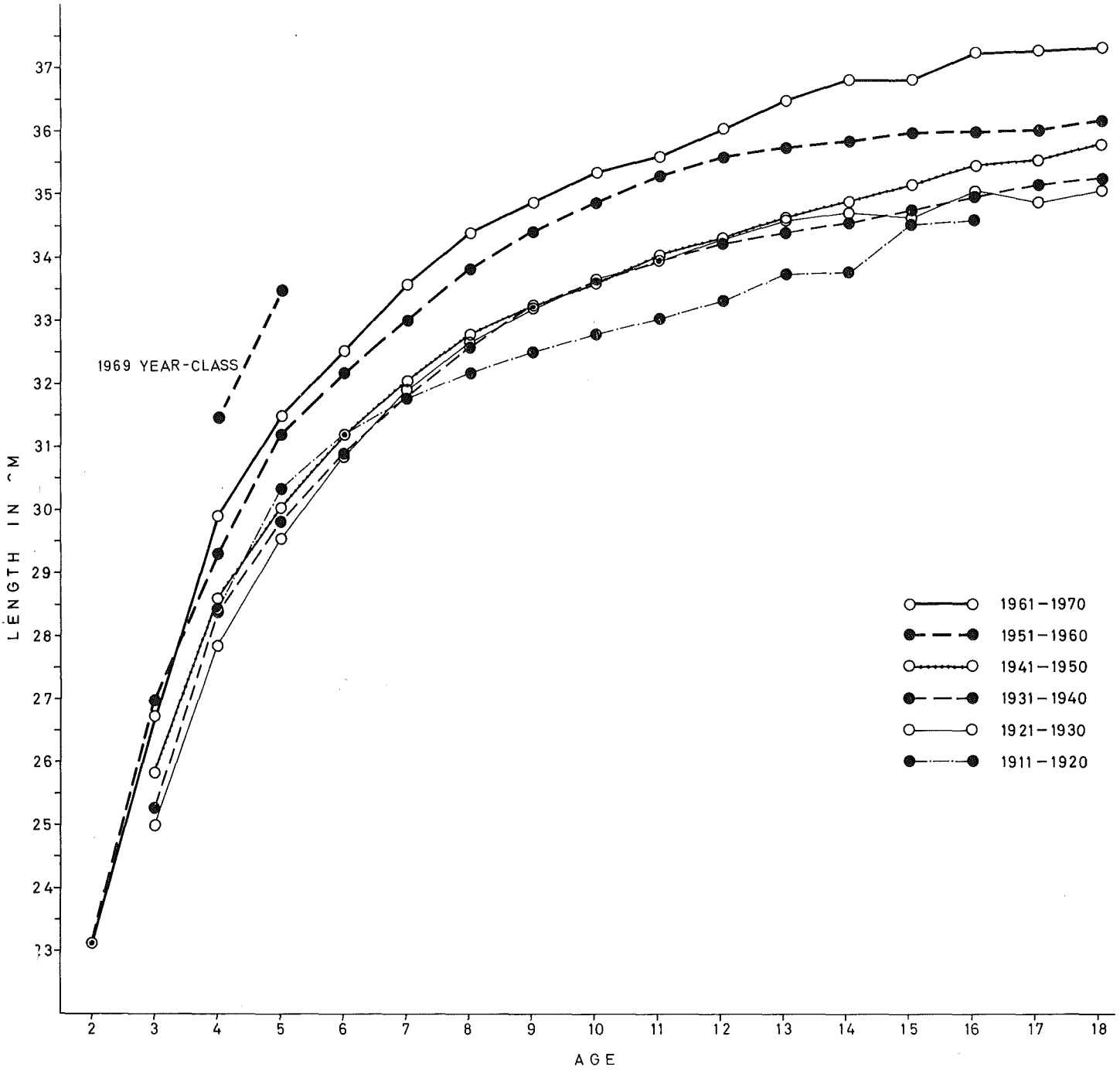

Figure 1. Mean length at age 4 and 5 of the 1969 year class as compared to mean length at age for Atlanto-Scandian herring in earlier periods (Østvedt, per.comm.).

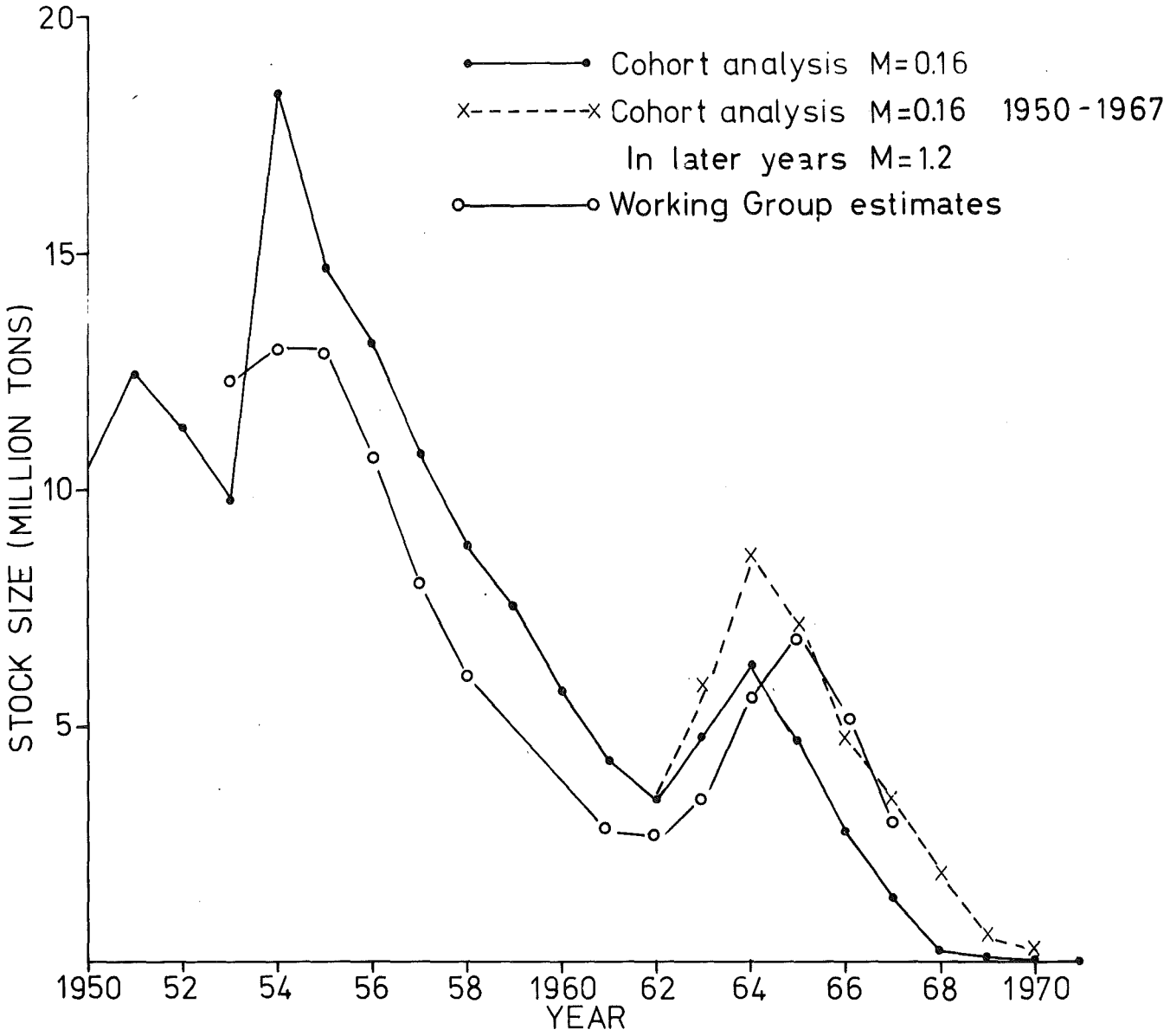

Figure 2. The calculated total stock size in weight of four year old and older herring from cohort analysis for two alternatives of natural mortality compared to the adult stock size estimates in the Report of the Working Group on Atlanto-Scandian Herring 1971. (Dragesund and Ulltang, 1973).

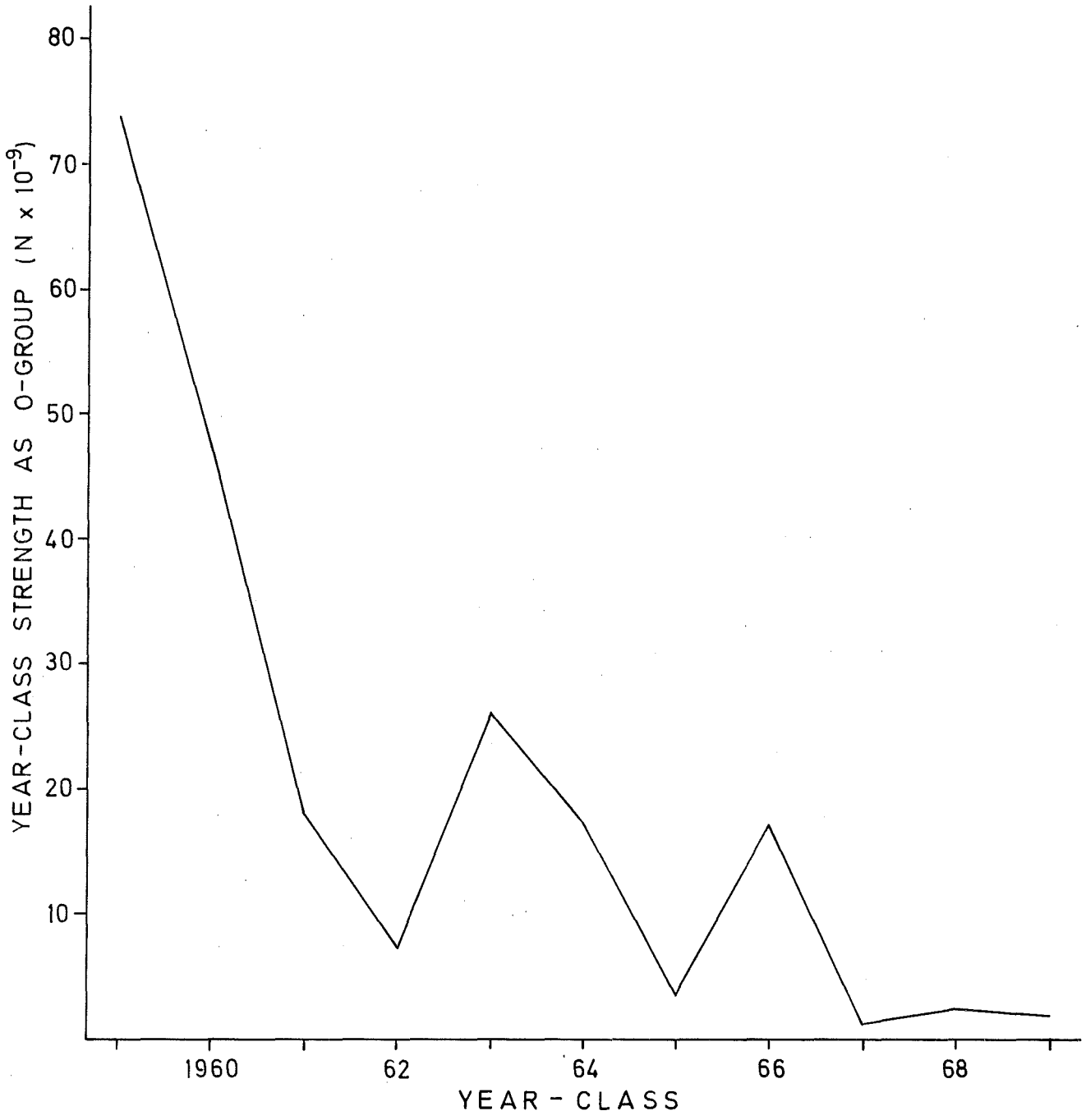

Figure 3. Cohort estimates of the O-group strength of the 1959-1969 year-classes (Dragesund and Ulltang in press).