International Council for the
Exploration of the Sea

C.M.1971/H:2

Pelagic Fish (Northern) Committee

REPORT OF THE MEETING OF THE WORKING GROUP ON ATLANTO-SCANDIAN HERRING

Copenhagen, 12 - 13 January 1971

Appendix to previous Report: Coop.Res.Rep., Ser.A, No.17, 1970

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Report of the Meeting of the Working Group on Atlanto-Scandian Herring

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Introduction

A. Terms of Reference and Participation

Considering the continued decline of the Atlanto-Scandian herring stocks it was decided during the ICES meeting in 1970 that the Working Group on Atlanto-Scandian Herring should meet again in order to compile new data and information on these herring stocks (C.Res.1970/2:8).

The Working Group met on 12th and 13th January 1971 in Charlottenlund Castle with the following scientists participating:-

Mr. J. Jakobsson (Iceland), Chairman
Mr. O.V. Bakurin (U.S.S.R.)
Mr. A.C. Burd (U.K.)
Dr. O. Dragesund (Norway)
Dr. S.S. Fedorov (U.S.S.R.)
Mr. K. Hoydal (Faroes)
Mr. E. Jónsson (Iceland)
Mr. K. Popp Madsen (Denmark)
Mr. J.J. Zijlstra (Netherlands)

In addition, Mr. J. Møller Christensen, Secretary of the Liaison Committee attended the meeting.

B. Material and Agenda

The Working Group decided that the present report could only be considered as an appendix to the Working Group's previous Report (Anon, 1970) and that according to the terms of reference the Group would add all new available data to the various sections and tables in the previous report. In addition the Working Group decided to attempt new calculations on data from the small- and fat-herring catches in order to elucidate further the effect of this fishery on the Norwegian spring spawners.

The numbering of each section and of the tables in this Report corresponds to that of the previous report. Also tables, where no new data could be added have been reproduced. Tables 22 and 23 are new tables.

I. Description of Stock Units in the Atlanto-Scandian Herring

The Working Group decided that as regards this section there was no need to add anything to the description given in its previous Report (Anon,1970).

II. Norwegian Spring Spawners

II.a The Adult Herring Fisheries

A. Total Catch

Tables 1 to 3 show the catches of adult and pre-recruit Norwegian spring spawning herring during the period 1950-1970. The catch figures for 1969 and 1970 show that the decline which started in 1967 has continued. Thus the total summer and autumn catch which in 1965-1966 amounted to about 1 million tons was only 3.6 thousand tons in 1969 and in 1970 the summer and autumn catch was practically nil (Table 1). The winter herring fishery decreased to 20.5 thousand tons in 1969. In 1970 this fishery was also very low being 20.9 thousand tons. Consequently the total catch of Norwegian spring spawners which during the peak years in 1965-1967 amounted to some 1.5 million tons was reduced to about 20 thousand tons during the two previous years. Figure 1 illustrates how the stock size as well as the total catch have decreased in the last few years while the proportion of the small- and fat-herring fishery of the total catch has rapidly increased.

B. Effort

Table 4 shows that the total number of boats participating in the herring fisheries based on Norwegian spring spawners has decreased drastically in recent years. Thus the number of participating Norwegian purse-seiners was 418 in 1967 but in 1969 and 1970 there were 128 and 129 respectively. The number of Icelandic purse-seiners was reduced from 139 boats in 1967 to 25 in 1969 and nil in 1970.

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Similarly the Soviet drifter fleet decreased from 342 in 1967 to 79 in 1969 and nil in 1970. At its meeting in 1969 the Working Group decided to use Soviet drifter units for effort and catch per effort estimates. Since this fishery was completely stopped in 1970 only estimates for 1969 could be added to Tables 5 and 6. The total effort in drift-net units which in 1967 was about 20 millions was in 1969 reduced to about 1 million nets or less.

C. Age Composition

The percentage age composition as presented in Tables 7 and 8 shows that the catches in 1969 and 1970 are based on the same year-classes as in say 1966-1968. Thus the year-classes from 1959, 1960 and to some extent from 1961 are still the predominant year-classes there being no sign of increased recruitment to the adult stock. It is of special interest to note that the year-classes from 1963, 1964 which according to the O-group surveys were of average strength and gave rise to rich immature fishery in 1965-1968 are quite negligible in the age composition of the adult stock.

D. Estimates of Absolute Stock Abundance

Unfortunately there were no new estimates available of absolute stock abundance. As a result of the small catches in recent years practically no adult herring has been used for reduction purposes and hence tagging returns have been negligible. In spite of repeated attempts Soviet scientists have not been able to carry out their stock estimates based on echo-surveys because herring concentrations could not be located for this purpose. In the absence of new estimates the Working Group decided not to attempt extrapolation of older data for this purpose although such methods could give some rough estimates of absolute stock abundance (probably about 0.7 million tons in 1970 assuming no changes in M).

It is of interest to note that the fluctuations of the Soviet catch per drift net during February as presented in Table 5 correspond to those of the absolute stock abundance estimates based on tagging data or echo-surveys. Therefore it is possible to consider the catch per unit effort of the Soviet fleet during February as a stock abundance indices completely independent from the other two presented in Table 16 of the previous Report.

E. Mortality Rates

Owing to the complete breakdown of the fisheries in recent years it has become impossible to calculate comparable mortality rates for the adult Norwegian spring spawners.

II.b The Immature Herring Fisheries

In the former Report (Anon, 1970) attention was drawn to the probable serious effect of the increased exploitation rate on fat herring.

With more extensive data available it has been possible to make new estimates of the numbers of herring in the small- and fat-herring catches. These estimates are now based on revised age distributions and on relevant mean weights per age-group per season, Table 19. A revised set of abundance indices of O-group herring is also included in the Table. With the revisions in catches, changes in the exploitation rates of both small and fat herring occurred. These are shown in Figure 2 and indicate an increasing rate of exploitation in the small herring fisheries. In the fat herring fishery, however, the exploitation dropped after the very high levels on the 1963 and 1964 year-classes but increased again on the most recent year-classes.

The Working Group in its previous Report (Anon, 1970) drew attention to the probable reduction in recruitment to the adult stock of the 1963 and 1964 year-classes. The present Working Group has examined the problem in more detail. An attempt has been made to compare the stock size in numbers as 3 year olds (the fat herring stage) with the catches in number from the fat herring fisheries. The stock sizes of a number of year-classes have been compared with the abundance indices of these classes as O-groups.

From the data in Table 9 the catches in number of 6-8 year olds have been taken as indices of fully recruited herring. Using estimates of F

derived from Tables 13 and 16 stock sizes in number for the 1959-1962 year-classes have been calculated for the year of assumed full recruitment using

$$C = S \cdot \frac{F}{Z} (1-e^{-Zt})$$

A value of M = 0.15 has been assumed (Anon, 1970) for all ages down to age 3 the herring being then over 20 cm. Previous years' stock levels of a year-class were derived from the relation:-

$$S_{n-1} = S_n \times e^M + C_n$$

The maximum estimates of year-class strength derived by this method are shown in Table 22, where they are compared with the estimates of the same year-classes as 0-group herring derived from echo-sounding techniques (Dragesund, 1970). It is seen there is good agreement in the relative year-class strength for all except the 1962 year-class. This year-class was very weak in the adult catches but was heavily exploited as small herring (Anon, 1970).

Assuming that the 0-group abundances (Dragesund and Nakken, 1970) are comparable over the whole period to 1969, it is possible to make estimates of the potential stock sizes of the year-classes as 3 year old fish from the ratios given in Table 19 (column A). These estimates are given in Table 23 (column A) together with the fat herring catches of each year-class in number. Considering the year-classes 1959-1961 the exploitation rate in the fat herring stage, and not including the small herring, would appear to have varied between about 10-50%.

It can be seen that in some year-classes the numbers of herring caught in the fat herring fishery approach or exceed the total stock estimate given by back calculation. In view of the assumption made on mortality coefficients in the adult herring and the low sampling rate in the fat herring fisheries relative to their complicated nature, these results are well within the range of expectancy. They imply that the fat herring fishery practically annihilated the 1963 and 1964 year-classes as was tentatively suggested in the previous Report (Anon, 1970).

Dragesund (1970) using a different technique on the 1963 year-class came to the same conclusion. The failure of the 1963 and 1964 year-classes to recruit to the adult fisheries as shown in Table 9 could thus be consequent to the exploitation of the juvenile herring.

II.c Changes in the Migration Pattern

The recent drastic changes in migration pattern of the Norwegian spring spawners were schematically shown on Charts 1-3 of the previous Report (Anon, 1970). In addition to these changes in migration pattern the shoaling behaviour of the Norwegian spring spawners has changed drastically during the last few years. Thus instead of assembling into dense over-wintering concentrations the herring has since 1968 been widely scattered. This holds true for practically the whole year with very sporadic and infrequent exceptions.

III. The Icelandic Herring Stocks

The Report of the Working Group on Atlanto-Scandian Herring (Anon, 1970) dealt with the catch statistics of the Icelandic herring stocks during the period 1957-1967. In Table 20 these are extended to 1970. The catch during the last few years has been very low as expected or about 20 thousand tons per year. The regulations described in the previous Report (Anon, 1970; see also Jakobsson 1969) are still in force and the fishing effort is thus greatly reduced as compared with the earlier years of unrestricted fisheries. Since practically no herring has been used for reduction purposes in Iceland since 1967 estimates of absolute abundance based on tagging data are not available for the last three years. At present, data on stock abundance are therefore not available for 1968-1970 but recent trends in age composition (Jakobsson, Annls.biol., 1968-1969) tend to indicate a decrease in annual total mortality which is probably due to less fishing intensity than before. There can, however, be no doubt that the abundance of the Icelandic stocks is still at a very low level.

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IV. Causes of the Recent Decline in the Yields of the Atlanto-Scandian Herring

The Working Group decided that the development in 1969 and 1970 of the herring fisheries based on adult Norwegian spring spawners confirmed the statement made in the previous Report (Anon, 1970) that the causes for the recent drastic decline in these fisheries are primarily due to lack of recruitment since there has been practically no recruitment to the adult stock since the 1959-1961 year-classes were fully recruited in 1966. This decline of the stock was accelerated by higher exploitation rate in recent years especially during the period 1965-1967. Since 1968 the low availability of the herring has caused a sharp decline in effort due to diversion to other stocks. To some extent this probably resulted in a lower exploitation rate in the adult stock during the last three years.

As regards recruitment to the adult stock in the coming years, the results from the Norwegian and international echo-surveys show that the 1962 and 1965-1970 year-classes are all very poor. The 1963-1964 year-classes, which were estimated to be of reasonable strength as 0-group fish were so heavily exploited in the fat-herring stage that their recruitment to the adult stage has been negligible. Similarly the exploitation rate of the 1969 year-class as fat herring appears to be very high or at about the same order as of the 1963-1964 year-classes. The other small year-classes in recent years (1965-1968) have probably not suffered such a high exploitation rate in the fat-herring state but in contrast they were exploited more heavily in the small-herring state. Thus the recruitment to the adult stock from the poor year-classes in recent years (1965-1969) is expected to be almost nil. At present the Norwegian spring spawning stock of herring appears to be in a phase of very low reproductive potential.

In view of the present critical state of the stock it would be advisable in order to maximize recruitment and safeguard the continued existence of the Norwegian spring spawning stock to keep the exploitation rate of small- and fat herring at a much lower level than in recent years. The adjustment of this exploitation rate should be made relative to the independent estimates of year-class strength derived from 0-group surveys rather than by arbitrary catch adjustment.

V. References

Anon   1970   "Report of the Working Group on Atlanto-Scandian Herring, 21-25 April 1969". ICES, Coop.Res.Rep., Ser. A, No. 17.

Dragesund, O.   1970   "Distribution, abundance and mortality of young and adolescent Norwegian spring spawning herring (Clupea harengus Linné) in relation to subsequent year-class strength". Fisk.Dir.Skr.Ser.Havunders., 15: 451-556.

Dragesund, O. and Nakken, O.   1970   "Relationship of parent stock size and year-class strength in Norwegian spring spawning herring"; ICES Symposium on "Stock and Recruitment", Doc. No. 20 (mimeo).

Jakobsson, J.   1969   "On the Icelandic herring stocks and their exploitation". ICES, C.M.1969/H:13 (mimeo).

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Table 1. Summer and Autumn Fishery (Norwegian spring-spawners).
Catch (in thousands of tons)
of adult non-spawning herring 1950- 1970

Year	Iceland	Norway	USSR	Faroes	Germany	Total
1950	30.7	10.1	14.0	-	-	54.8
1951	48.9	14.3	41.7	-	-	104.9
1952	9.2	19.6	61.0	-	-	89.9
1953	31.5	22.1	101.5	-	-	155.1
1954	15.2	11.4	133.3	27.4	-	187.3
1955	18.1	13.9	168.2	12.9	-	213.1
1956	41.2	14.8	188.8	23.0	-	267.8
1957	18.2	17.5	239.9	16.2	-	291.8
1958	22.6	11.4	306.1	15.8	-	355.9
1959	34.5	10.5	314.9	13.0	-	372.9
1960	26.7	18.3	365.7	9.4	-	420.1
1961	85.0	42.0	207.7	16.9	-	351.6
1962	176.2	72.1	259.6	9.8	-	517.7
1963	177.5	68.9	278.7	12.9	-	538.0
1964	367.4	80.1	231.9	18.3	-	697.7
1965	540.0	33.1	324.4	31.5	5.6	929.0
1966	691.4	37.0	296.6	44.0	22.7	1 069.0
1967	359.3	52.1	236.2	17.7	7.4	665.3
1968	75.2	30.1	111.3	x)	1.1	231.4
1969	0.1	0.7	0.5	2.0	0.3	3.6
1970	0.000	0.0	>0.1	0.0	0.0	>0.1

x) No information available

Table 2. Winter Fishery. (Norwegian spring-spawners).
Catch (in thousands of tons)
of Norwegian winter herring 1950- 1970

Year	Norway	USSR	Faroes	Ice-land	Germany	Total
1950	771.3	-	-	-	-	771.3
1951	888.0	1.3	-	-	-	889.3
1952	820.5	8.9	-	-	-	829.4
1953	670.1	8.5	-	-	-	678.6
1954	1 092.2	26.7	0.2	-	-	1 119.1
1955	965.4	38.8	0.2	-	-	1 004.4
1956	1 145.9	46.2	0.7	-	-	1 192.8
1957	795.6	60.1	0.8	-	-	856.5
1958	345.3	81.9	1.9	-	-	429.1
1959	416.4	93.1	0.7	-	-	510.2
1960	300.1	99.3	1.6	-	-	401.0
1961	69.0	77.3	-	-	-	146.3
1962	84.1	49.4	-	-	-	133.5
1963	61.5	71.3	-	-	-	132.8
1964	286.3	133.9	-	-	-	420.2
1965	226.4	164.8	-	-	-	391.2
1966	460.9	150.8	16.7	-	3.4	631.8
1967	371.6	67.7	17.2	-	2.3	458.2
1968	25.6	13.0	1.7	-	0.7	39.9
1969	14.9	2.7	2.4	0.5	0.0	20.5
1970	20.3	0.0	0.6	0.0	0.0	20.9

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Table 3. Total Catch.

Catch (in thousands of tons) of
adult and pre-recruit Norwegian
spring-spawning herring 1950-1970

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	70.0	-	-	919.3
1953	31.5	692.2	110.0	17.0	-	850.7
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	330.0	12.9	-	650.8
1964	367.4	366.4	365.8	19.3	-	1 118.3
1965	540.0	259.5	489.2	31.5	5.6	1 325.8
1966	691.4	497.9	447.4	60.2	26.1	1 723.0
1967	359.3	423.7	303.3	34.9	9.7	1 130.9
1968	76.2	55.7	124.3	15.4	1.8	272,4
1969	0.6	15.6	3.2	4.4	0.3	24.1
1970	0.0	20.3	0.0	0.6	0.0	20.9

x) No information available

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Table 4. Fleet composition and effort estimates.

Country	Norway		Iceland			USSR				
						Drift-Net				Purse-Seiner
						Winter Season		Summer Season		
Year	Purse-Seiner No. of Boats	Drift-Net No. of Boats	Purse-Seiner No. of Boats	Number of Days in Action	Average Tonnage	No. of Boats	Total No. of Nets shot (in millions)	No. of Boats	Total No. of Nets shot (in millions)	No. of Boats
1954	492	1 450	-	-	-	188	0.94	199	2.40	-
1955	549	1 435	132	-	-	231	1.26	253	2.90	-
1956	561	1 321	187	-	-	273	1.49	293	3.58	-
1957	599	1 408	234	-	-	400	2.36	372	4.12	-
1958	593	1 413	241	-	-	436	2.73	380	4.57	-
1959	564	1 297	224	-	-	491	2.83	410	4.18	-
1960	439	1 162	258	-	-	524	4.25	244	3.30	-
1961	254	789	215	-	-	455	3.26	251	3.19	-
1962	197	-	224	16 761	99	302	2.68	164	1.26	-
1963	214	-	226	19 697	109	344	3.27	184	2.51	-
1964	268	-	233	22 507	183	384	3.08	187	2.12	-
1965	318	-	189	31 176	145	488	3.91	107	0.95	-
1966	382	-	191	33 089	181	484	4.16	92	1.23	7
1967	418	-	139	23 397	220	342	3.97	43	0.58	19
1968	397	-	80	7 500	280	137	1.73	10	0.21	69
1969	128	-	25	500	280	79	0.11	0.0	0.0	12
1970	129	-	0	0		0	0	0	0	0

Table 5.   Catches per effort of the USSR drift-net fishery.
(a. From the annual catch. b. From the February
catch = spawning fishery only).

Year	a. Catch per drift-net (total catch) kg	b. Catch per drift-net (February catch) kg
1958	53.5	131.0
1959	63.3	132.0
1960	60.2	115.2
1961	44.4	76.0
1962	57.3	56.1
1963	61.6	87.2
1964	66.4	108.0
1965	94.4	113.5
1966	79.0	115.0
1967	56.3	55.3
1968	28.3	26.3
1969	24.2	38.9
1970	0.0	0.0

Table 6.   Estimates of total effort in drift-net units.

Year	Total Number of Nets in Millions (Total Catch)	Total Number of Nets in Millions (February only)
1958	14.65	6.00
1959	13.95	6.70
1960	13.64	7.13
1961	11.21	6.55
1962	9.62	9.83
1963	10.56	7.46
1964	19.84	10.35
1965	14.04	11.68
1966	21.68	14.89
1967	20.09	20.45
1968	9.11	9.77
1969	1.0	0.63
1970		

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Table 7.   Percentage age composition 1950-70   Norwegian winter fishery.

Year / Age	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
2	.1	-	.1	.1	.1	-	-	.2	-	-	-	-	-	-	-	-	-	-	-	-	-
3	8.3	.2	1.3	4.0	1.3	1.5	.6	.4	.5	.4	-	-	.1	-	.2	-	-	-	-	-	0.3
4	5.5	11.6	2.0	1.9	25.2	6.3	5.0	7.4	1.0	1.3	.3	.4	-	-	5.9	5.2	.1	.2	-	0.1	1.8
5	5.5	5.2	19.9	4.1	3.3	46.9	5.9	4.3	6.1	1.4	1.6	.9	.5	.4	60.6	13.6	8.8	.4	.7	-	0.4
6	16.3	4.8	4.5	14.4	5.4	2.7	50.6	5.6	4.7	7.5	1.2	3.3	.9	.4	.3	66.3	28.9	12.8	1.3	3.3	0.6
7	18.7	15.2	6.7	3.2	11.0	4.3	2.3	56.5	6.6	5.1	6.5	2.9	2.5	.5	.1	.1	54.5	33.7	12.1	0.8	4.4
8	2.3	17.7	12.4	4.2	2.8	5.8	3.9	1.8	50.5	7.8	3.5	7.7	1.5	1.7	.2	.2	.2	48.5	35.0	13.2	1.3
9	2.5	2.0	12.2	12.0	4.2	1.7	4.6	2.6	2.6	47.3	5.0	4.8	8.0	1.0	.8	.1	.1	.2	47.7	38.2	17.0
10	3.1	2.2	2.4	14.4	9.2	4.0	2.2	2.4	3.5	2.2	58.1	6.5	4.0	8.6	.5	.3	.1	-	.1	41.6	35.2
11	2.4	2.6	2.5	2.0	9.5	5.5	3.5	1.6	3.4	3.3	1.6	59.0	6.6	3.6	3.4	.5	.2	.1	-	-	37.9
12	5.4	2.7	3.1	2.8	1.7	3.3	4.1	2.2	2.3	4.5	3.8	4.4	63.5	8.2	1.8	1.4	.2	.3	.2	0.3	0.1
13	10.4	6.7	3.0	2.9	1.9	1.0	1.9	2.7	2.2	1.9	4.1	3.0	2.1	60.0	2.6	.8	.6	.2	.2	0.1	0.1
14	1.6	9.1	5.0	3.0	2.5	1.4	.9	1.5	1.8	2.3	1.5	2.3	3.6	2.0	20.9	1.3	.6	.5	.3	0.3	0.1
15	2.7	1.5	7.0	6.6	2.2	1.8	1.2	.5	1.1	2.2	1.0	1.5	3.4	2.7	.6	9.2	.4	.3	.5	0.1	0.1
16	4.8	3.0	1.6	7.0	3.4	1.9	1.4	.6	.6	.9	1.3	1.4	0.7	2.0	.7	.3	5.0	.3	.4	0.3	0.1
17	1.1	4.0	2.2	2.2	4.3	2.2	1.7	.8	.7	.5	.9	.9	1.0	2.0	1.1	.3	-	2.5	-	0.1	0.2
18	.5	.4	3.4	2.9	1.7	1.3	1.6	1.0	.7	.7	.5	.3	1.0	.8	.1	.3	-	-	1.4	1.3	0.2
19	-	.2	.8	2.9	1.4	1.5	.6	.7	.5	.4	.3	.4	.3	.4	.1	-	.3	-	-	-	0.3
20	.1	-	.1	.7	1.0	.7	.6	.3	.3	.3	.5	.1	-	.2	.1	-	-	-	-	-	-
21	-	.1	-	.1	.1	.2	.3	.2	.2	.2	.3	.1	.2	-	-	.2	-	-	-	-	-
22	-	-	-	-	.1	.1	.1	-	-	.1	.1	.1	-	-	-	-	-	-	-	-	-
>22	-	-	-	-	-	-	-	-	-	.1	.1	-	.1	.1	-	-	-	-	-	-	-
?	8.6	10.8	9.8	8.6	7.8	5.9	7.0	6.6	10.6	10.0	7.8	-	-	-	-	-	-	-	-	-	-
n =	3 973	3 841	3 336	2 796	4 839	4 174	4 998	2 779	972	1 116	1 155	452	398	399	1 481	1 402	2 531	1 599	2 255	2 207	3 511

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Table 8. Age compositions 1962 – 1969 in %.

a) Iceland – Summer

Year / Age	1962	1963	1964	1965	1966	1967	1968	1969
1	-	-	-	-	-	-	-	-
2	3.4	0.3	0.1	1.5	-	-	-	-
3	17.4	2.3	4.0	0.4	2.7	-	-	-
4	0.1	22.9	10.1	5.8	0.8	0.1	0.1	0.3
5	0.0	0.2	46.8	12.7	7.9	1.2	0.2	0.6
6	0.2	0.0	0.4	42.3	18.7	1.1	2.4	3.1
7	0.7	0.1	0.0	0.6	49.8	11.6	2.1	5.8
8	0.5	0.7	0.0	0.4	1.1	31.8	13.0	14.8
9	2.2	0.9	0.6	0.2	0.4	50.3	31.4	29.2
10	3.0	4.4	1.0	0.5	0.5	0.3	47.2	43.7
11	7.7	4.7	2.1	1.1	0.7	0.3	0.3	0.3
12	48.2	8.5	2.6	2.7	1.2	0.1	0.2	-
13	2.9	41.6	5.2	3.2	1.8	0.2	0.1	-
14	3.4	4.3	21.2	4.0	1.9	0.3	0.4	0.6
15	4.6	3.0	1.7	19.2	2.9	0.5	0.4	0.6
16	1.9	3.3	1.5	2.2	8.9	0.5	0.2	-
17	1.8	1.4	1.5	1.6	0.5	0.5	0.5	-
18	0.8	1.1	0.3	0.9	0.3	1.3	0.7	-
19	0.8	0.3	0.7	0.4	0.2	0.1	0.6	0.9
20	0.4	0.1	0.4	0.3	0.1	-	-	-
21	-	-	-	0.2	-	-	-	-
22	0.1	-	-	-	-	-	-	-
n =	2 429	3 190	3 416	4 853	6 103	552	2 935	325

b) USSR – All Areas

Year / Age	1962	1963	1964	1965	1966	1967	1968	1969
1	-	-	-	-	-	-	-	-
2	4.2	2.2	-	0.5	-	-	+	-
3	46.8	10.2	6.5	0.1	0.7	0.2	+	0.2
4	1.8	66.3	15.5	6.8	0.2	1.4	0.1	0.1
5	2.4	3.1	66.7	20.6	8.7	0.4	2.1	0.7
6	5.2	1.5	1.9	63.9	28.1	9.9	1.4	3.0
7	2.9	1.0	0.6	0.8	56.0	26.5	13.7	3.9
8	4.2	1.6	0.6	0.4	0.6	51.9	34.1	18.6
9	6.2	2.0	0.8	0.7	0.4	0.8	43.6	37.7
10	7.2	2.8	1.0	0.9	0.3	0.3	0.5	31.5
11	7.3	2.7	1.5	1.0	0.4	0.6	0.6	0.9
12	8.5	5.2	0.8	1.3	0.6	0.7	0.7	0.5
13	1.5	0.7	2.5	1.2	0.9	1.1	0.6	0.5
14	0.8	0.5	1.4	1.2	0.9	1.5	0.7	0.6
15	0.5	0.2	0.1	0.5	1.3	1.3	0.7	0.5
16	0.3	-	0.1	0.1	0.7	2.1	0.6	0.7
17	0.1	-	-	+	0.1	1.0	0.5	0.5
18	0.1	-	-	+	0.1	0.1	0.1	0.1
19	-	-	-	-	-	0.1	-	+
20	-	-	-	-	-	0.1	-	-
21	-	-	-	-	-	-	-	+
22	-	-	-	-	-	-	-	-
n =	7 352	11 769	14 046	7 228	8 564	10 269	6 982	3 967

Table 9. 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
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	1 917.7	2 195.8	2 868.3	1 718.2	345.9	36.3	28.2
1960	49.8	38.2	307.6	570.4	1 290.6	1 135.0	134.8	33.5	26.7
1961	-	-	90.2	245.9	459.1	422.2	93.9	11.6	13.2
1962	-	-	2.2	12.1	26.5	27.0	14.3	0.7	1.0
1963	-	-	-	45.1	80.6	25.7	15.2	2.9	3.3
1964	-	-	-	-	-	-	-	-	0.4
1965	-	-	-	-	-	-	-	0.2	0.3
1966	-	-	-	-	-	-	-	-	1.3
1967	-	-	-	-	-	-	-	-	0.2
Total	1 684.4	1 932.2	3 581.8	4 340.6	5 486.5	3 475.9	628.0	87.7	75.5

Table 10. Catches in numbers per drift-net shot per net of
Norwegian spring-spawners in the years 1962-. 1969
using:
Upper figure: equivalent effort from Soviet annual
catch per net (drift-net fishery)
Lower figure: equivalent effort from Soviet February
catch per net (drift-net fishery).

Year Class	Years							
	1962	1963	1964	1965	1966	1967	1968	1969
1948	6.66	5.74	2.57	3.71	0.41	-	-	1.1
	6.52	0.12	4.17	4.46	0.59	-	-	1.75
1949	5.12	7.56	2.74	5.00	0.69	0.09	-	.2
	5.02	10.70	4.45	6.01	1.00	0.09	-	.32
1950	99.72	88.32	45.82	50.07	18.11	3.20	0.59	1.1
	97.59	125.03	74.55	60.19	26.37	3.14	0.55	1.75
1951	14.44	16.48	9.02	9.81	4.47	0.71	0.45	0.2
	14.13	23.34	14.68	11.79	6.51	0.70	0.42	0.32
1952	6.16	0.76	4.94	7.61	3.33	0.71	0.40	0.3
	6.08	12.40	8.04	9.15	4.84	0.70	0.37	0.48
1953	6.66	10.20	5.72	7.16	3.19	0.87	0.20	0.2
	6.52	14.44	9.30	8.60	4.64	0.86	0.18	0.32
1954	1.38	0.88	1.74	2.85	0.51	0.44	0.29	-
	1.35	1.25	2.83	3.42	0.74	0.44	0.27	-
1955	2.10	1.73	1.48	1.36	1.20	0.42	0.27	0.3
	2.05	2.45	2.41	1.64	1.75	0.42	0.26	0.48
1956	0.68	0.33	0.18	0.53	0.80	0.17	0.09	0.2
	0.66	0.47	0.29	0.63	1.17	0.17	0.08	0.32
1957	0.21	0.16	0.09	1.06	0.66	0.28	0.12	0.3
	0.20	0.23	0.14	1.28	0.97	0.28	0.11	0.48
1958	0.15	0.46	0.78	1.39	1.75	0.44	0.22	-
	0.14	0.66	1.27	1.67	2.55	0.44	0.20	-
1959	26.58	38.72	113.88	156.40	132.30	85.53	37.97	36.3
	26.01	54.81	185.29	188.00	192.63	84.02	35.40	57.62
1960	5.18	3.62	18.27	40.63	59.53	56.50	14.80	33.5
	5.07	5.12	29.72	48.83	86.67	55.50	13.80	53.17
1961	-	0.49	5.36	17.51	21.18	21.82	10.31	11.6
	-	0.70	8.71	21.05	30.83	20.65	9.61	18.41
1962	-	-	0.13	0.86	1.22	1.34	1.57	0.7
	-	-	0.21	1.04	1.79	1.32	1.46	1.11
1963	-	-	-	3.21	3.72	1.28	1.67	2.9
	-	-	-	3.86	5.41	1.26	1.56	4.60
1964	-	-	-	-	-	0.09	0.12	-
	-	-	-	-	-	-	0.11	-
1965	-	-	-	-	-	-	-	0.2
	-	-	-	-	-	-	-	0.32

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Table 11.[x] Estimates of absolute abundance of adult
stock of Norwegian spring-spawners
1952/53 - 1967/68 (in million tons).

Years (Winter Season)	From Tagging Data	From Echo-Surveys and Underwater Photography
1952/53	12.5	-
1953/54	12.1	-
1954/55	13.9	..
1955/56	12.0	-
1956/57	9.4	-
1957/58	6.6	-
1958/59	5.0	6.0
1959/60	-	-
1960/61	-	3.1
1961/62	-	2.5
1962/63	-	2.8
1963/64	5.0	3.3
1964/65	7.7	6.8
1965/66	6.6	-
1966/67	4.0	-
1967/68	-	2.0

[x] Reproduced from previous Report (Anon, 1970) without amendments.

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Table 12.[x] Mortality rates derived from the Norwegian drift-net fishery (Østvedt).

Year-Period	Z	Year-Period	Z
1950/51	0.23	1955/56	0.15
1951/52	0.18	1956/57	0.32
1952/53	-0.04	1957/58	0.18
1953/54	-0.07	1958/59	-0.03
1954/55	0.69	1959/60	0.46
Mean	0.20	Mean	0.22

Table 13.[x] Instantaneous mortality coefficients.
  (a) From total catch per effort.
  (b) From winter catch per effort.

Years	Recruitment at 6 years		Recruitment at 7 years	
	(a)	(b)	(a)	(b)
1962/63	0.08	-0.31	0.08	-0.31
1963/64	0.58	0.46	0.58	0.46
1964/65	-0.18	0.11	-0.18	0.12
1965/66	0.39	0.20	0.94	0.76
1966/67	0.42	0.81	0.59	0.98
1967/68	0.95	1.18	0.99	1.26
Mean 1962/65	0.16	0.09	0.16	0.09
Mean 1965/68	0.59	0.73	0.64	1.00
Grand Mean	0.38	0.41	0.40	0.54

Table 14.[x] Total stock numbers (10^7) of the 1959-61 year-classes.

Year-class	YEARS					
	1963	1964	1965	1966	1967	1968
1959	34.2	753.5	1 628.3	1 392.1	681.3	413.2
1960	-	58.5	277.9	722.1	448.1	301.3
1961	-	-	83.1	268.5	187.1	121.6

[x] Reproduced from previous Report (Anon, 1970) without amendments.

Table 15.[x] Estimates of exploitation rate, $\frac{F}{F+M}$, and components of mortality.

Year-class	$\frac{F}{F+M}$	F+M	F	M
1959	0.66	0.47	0.31	0.160
1960	0.62	0.42	0.26	0.160
1961	0.64	0.43	0.28	0.155

Table 16.[x] Estimates of F derived from stock size indices obtained from tagging experiments and acoustic surveys in mid-winter landings (Thousand of metric tons).

Season	Stock size estimates			Year	Stock size index for year n, obtained from estimate season $\frac{n-1/n + n/n+1}{2}$	Landings	F
	From tagging	From echo-surveys	Mean stock index				
1952/53	12 500	–	12 500	1953	12 300	851	0.07 ⎫
1953/54	12 100	–	12 100	1954	13 000	1 306	0.10 ⎪
1954/55	13 900	–	13 900	1955	12 950	1 218	0.10 ⎪
1955/56	12 000	–	12 000	1956	10 700	1 461	0.15 ⎬ 0.12
1956/57	9 400	–	9 400	1957	8 000	1 148	0.15 ⎪
1957/58	6 600	–	6 600	1958	6 050	785	0.14 ⎭
1958/59	5 000	6 000	5 500	1959	–	883	–
1959/60	–	–	–	1960	–	821	–
1960/61	–	3 100	3 100	1961	2 800	498	0.20 ⎫
1961/62	–	2 500	2 500	1962	2 650	551	0.23 ⎪
1962/63	–	2 800	2 800	1963	3 475	651	0.21 ⎬ 0.21
1963/64	5 000	3 300	4 150	1964	5 700	1 118	0.22 ⎪
1964/65	7 700	6 800	7 250	1965	6 925	1 326	0.21 ⎭
1965/66	6 600	–	6 600	1966	5 300	1 723	0.39 ⎫ 0.43
1966/67	4 000	–	4 000	1967	3 000	1 131	0.47 ⎭
1967/68	–	2 000	2 000	1968	–	257	

[x] Reproduced from previous Report (Anon, 1970) without amendments.

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Table 17[x] Summary of estimates of total mortalities (Z)
and fishing mortalities (F).

	Z	F	Source
1950/55	0.20		Table 12
1955/60	0.22		Table 12
1962/65	0.16		Table 13 (a) average
	0.09		Table 13 (b) average
1965/68	0.62		Table 13 (a) average
	0.87		Table 13 (b) average
1962/68	0.43		Table 13 Grand Mean, average
Year Class Estimates			
1959 (65/68)	0.54		Calculated from Table 10
1959 (65/68)	0.47	0.31	Table 15
1960 (66/68)	0.42	0.26	Table 15
1961 (67/68)	0.43	0.28	Table 15
Stock Size Catch			
1953/58		0.12	Table 16
1961/65		0.21	Table 16
1966/67		0.43	Table 16

[x] Reproduced from previous Report (Anon, 1970)
without amendments.

Table 18. Catches of small- and fat-herring
(in thousand tons) taken by Norway and USSR.

Year	Small-Herring Norway	USSR	Total	Fat-Herring Norway	USSR	Total	Grand Total
1901-10	22.3	-	22.3	53.7	-	53.7	76.0
1911-20	65.3	-	65.3	40.5	-	40.5	105.8
1921-30	83.4	-	83.4	46.5	0.3	46.8	130.2
1931-40	155.6	-	155.6	53.2	36.7	89.9	245.5
1941-50	108.5	-	108.5	35.1	4.3	39.4	147.9
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

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Table 19. Total numbers caught in the small- and fat-herring fisheries in relation to O-group abundances for the year-classes 1959-1969.

| Year-class | O-group a | | Catches in numbers | | Measures of exploitation rate | |
	Abundance Index	Relative Index	Small herring b	Fat herring c	Small herring $\frac{10 b}{a}$	Fat herring $\frac{10 c}{a}$
1959	326	1.00	31.08	3.248	1.14	0.10
1960	147	0.45	28.89	1.630	1.97	0.11
1961	38	0.12	11.35	1.315	2.99	0.35
1962	15	0.05	5.84	0.319	3.89	0.21
1963	54	0.17	8.27	5.100	1.53	0.94
1964	75	0.23	8.96	5.164	1.19	0.69
1965	9	0.03	3.00	0.009	3.33	0.01
1966	23	0.07	13.31	0.222	5.79	0.10
1967	4	0.01	0.66	0.084	1.65	0.21
1968	2	0.01	1.34	0.016	6.70	0.08
1969	5	0.02	1.81	0.384	3.62	0.79

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Table 20. Total catch (thousand tons) of Iceland herring taken by Icelandic and Norwegian fishing fleets.

| Year | Spring spawners | | | Summer spawners | | | ? | |
	North coast	South coast	Total	North coast	South coast	Total	South coast	Grand Total
1957	62.1	-	-	22.7	-	-	19.0	103.8
1958	80.5	-	-	20.0	-	-	33.0	133.5
1959	147.6	-	-	23.8	-	-	28.0	199.4
1960	104.7	-	-	36.1	-	-	23.0	163.8
1961	192.6	42.7	235.3	3.4	64.9	68.3	-	303.6
1962	250.7	58.8	309.5	3.8	90.1	93.9	-	403.4
1963	85.2	30.7	115.9	12.0	91.4	103.4	-	219.3
1964	61.5	36.5	98.0	8.6	77.4	86.0	-	184.0
1965	23.0	38.4	61.4	11.6	131.6	143.2	-	204.6
1966	18.0	8.6	26.6	2.8	50.2	53.0	-	79.6
1967	2.4	14.3	16.7	0.3	65.2	65.5	-	82.2
1968	0	2.9	2.9	0	17.2	17.2	-	20.1
1969	0	3.2	3.2	0	20.3	20.3	-	23.5
1970	0	-	-	0	-	-	-	17.0

Table 21.[x] Estimate of F and stock size from tagging data. (Icelandic herring).

Year	F	Stock estimate (thousand tons)
1962	0.56	931
1963	0.44	619
1964	0.52	457
1965	1.11	304
1966	0.35	270

[x] Reproduced from previous Report (Anon, 1970) without amendments.

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Table 22.   Estimates of stock as 3 year old fish (fat herring stage),
assuming full recruitment at age 6-8, compared with 0-group
abundance indices (Dragesund, 1970).

Year-class	Stock		Abundance index 0-group	
	numbers x 10^{-9}	Relative to 1959	Index	Ratio
1959	24.0	1.00	326	1.00
1960	9.1	0.38	147	0.45
1961	2.9	0.12	38	0.12
1962	0.1	0.004	15	0.05

Table 23.   Stock size (numbers) at age three, as back-calculated
from full recruited adult herring (year-classes 1959-
1962) and by comparison via 0-group abundance indices
(1963-1969)(A). Stock sizes at age 3 are compared
with numbers caught in the fat herring fishery up to
the year 1970 (B).

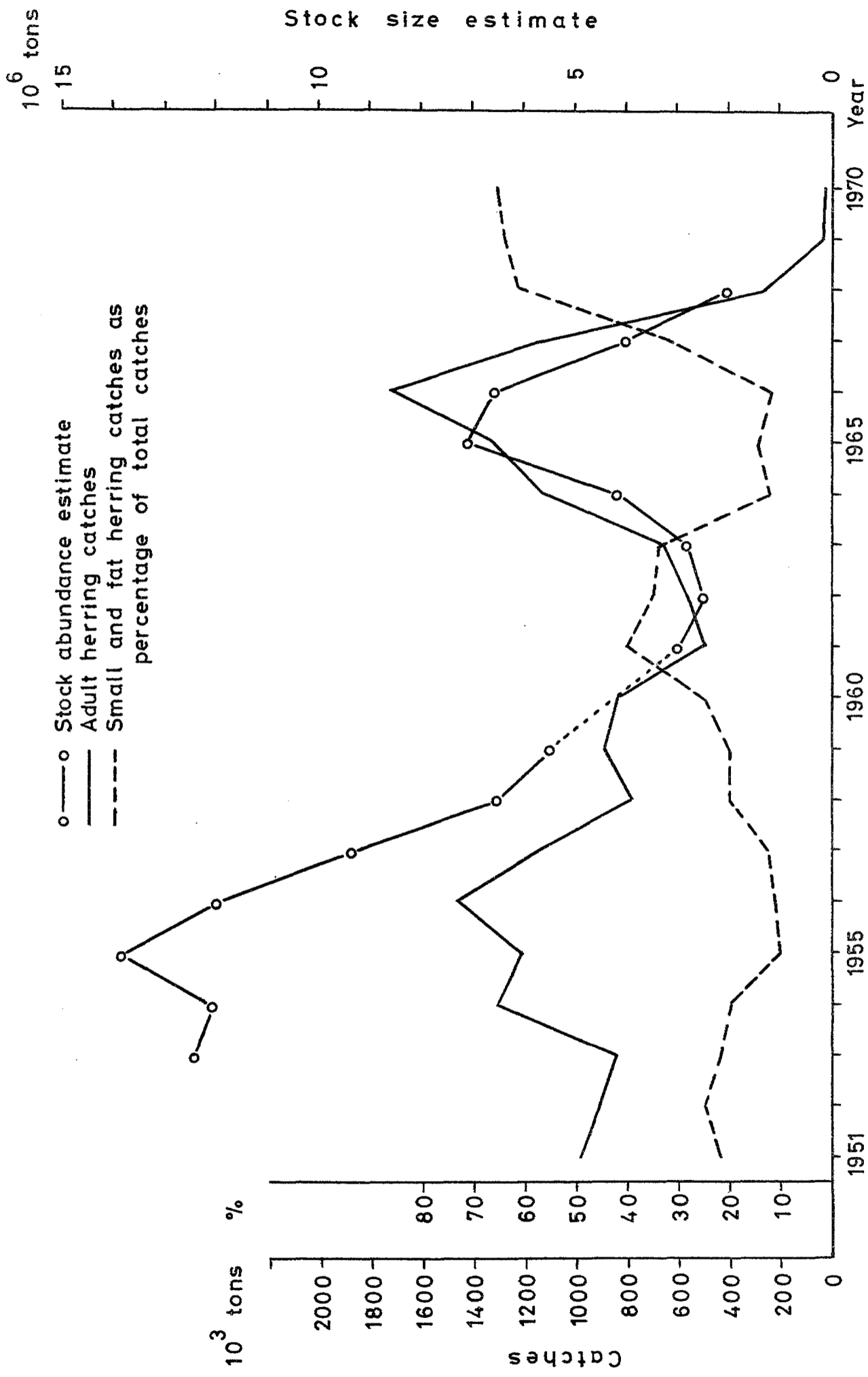| Year-class	A (x 10^{-9})	B (x 10^{-9})
1959	24.0	3.25
1960	9.1	1.63
1961	2.9	1.32
1962	0.1	.32
1963	4.1	5.10
1964	5.5	5.16
1965	0.7	0.002
1966	1.7	.10
1967	0.2	.08
1968	0.2	.02
1969	0.5	.38

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Figure 1. Stock abundance estimate, adult herring catches and small- and fat-herring catches as percentages of total catches 1951-1970.
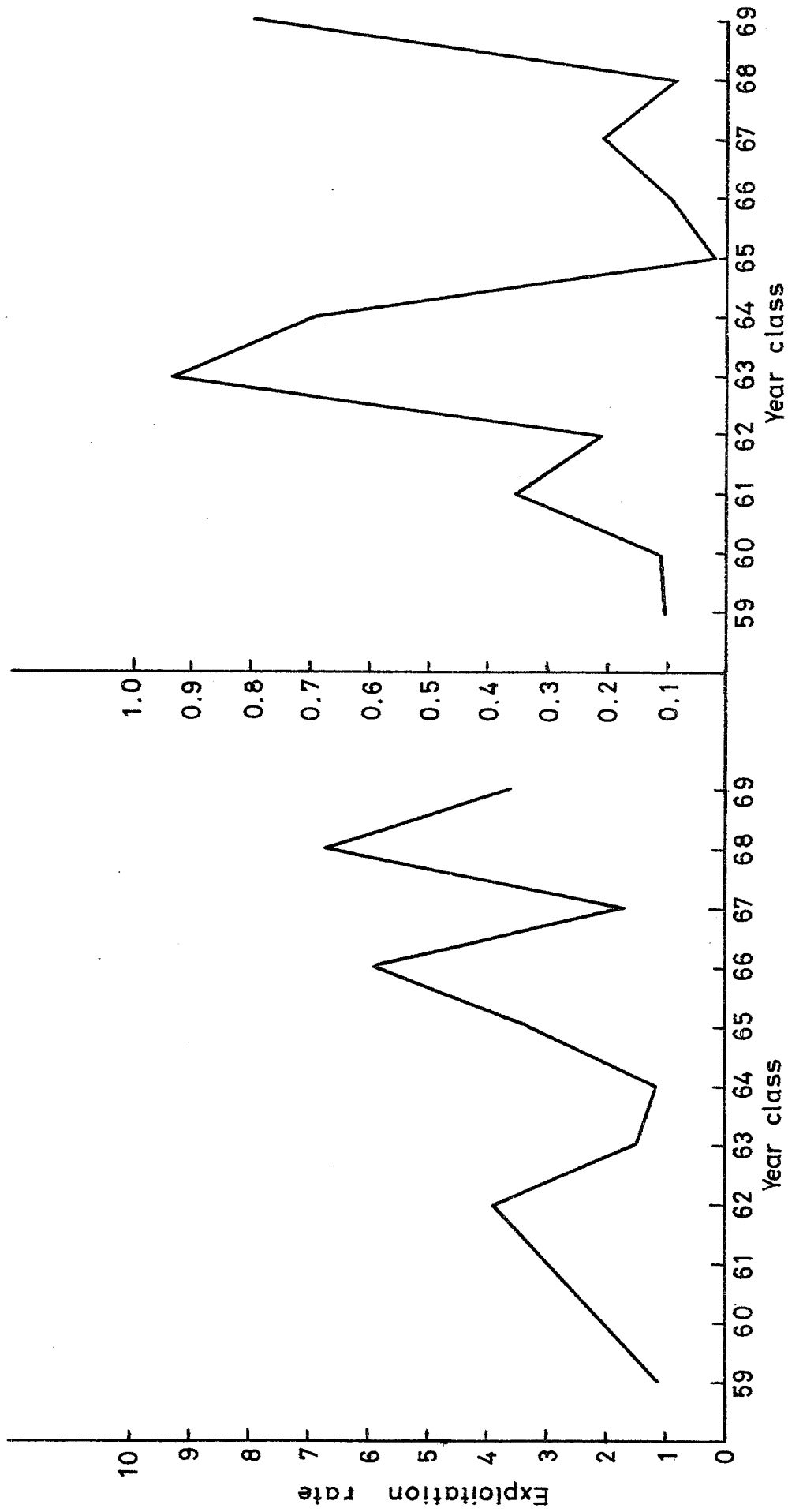
Figure 2a. Exploitation rate in the small herring
fisheries as catch in numbers/0-group
abundance for year-classes 1959-1969
(cf. Table 19).

Figure 2b. Exploitation rate in the fat herring
fisheries as catch in numbers/0-group
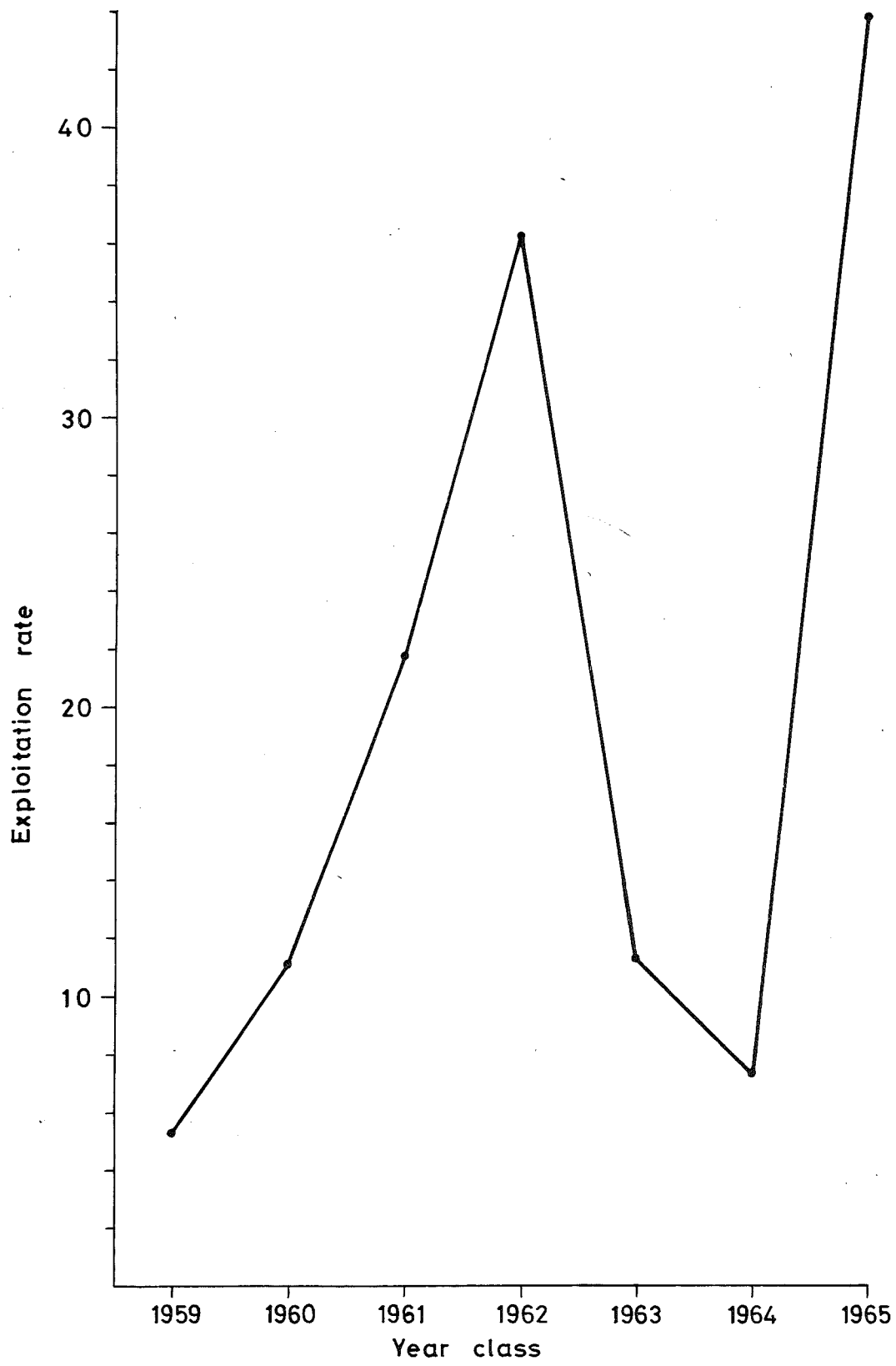abundance for year-classes 1959-1969
(cf. Table 19).

Figure 4. Exploitation rate in the small herring fisheries as catch / 0-group abundance for year-classes 1959 – 65 (cf. Table 19)