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TABLE OF CONTENTS

Tables of Contents (ctd)

1. REPORT OF THE WORKING GROUP ON FISH STOCKS AT THE FAROES, 1974

1.1 PARTICIPANTS

The Working Group met at Charlottenlund Slot 11-15 February 1974 with the following participants:

Mr N Daan	Netherlands
Mr K Hoydal (Chairman)	Faroe Islands
Mr B W Jones	U.K. (England)
Mr R Jones	U.K. (Scotland)
Dr H H Reinsch	F.R.G.
Mr O Smedstad	Norway

Mr D de G Griffith, ICES Statistician, also took part in the meeting.

1.2 TERMS OF REFERENCE

At the 61st Statutory Meeting of ICES a resolution (C.Res.1973/2:7) was passed recommending the establishment of a Working Group on Fish Stocks at the Faroes, to undertake a study of the state of the demersal fish stocks in the Faroes region. The species mainly referred to in this report are cod, haddock, saithe, blue ling, redfish, lemon sole, halibut and plaice.

1.3. ADMINISTRATIVE MEASURES AFFECTING THE FISHERY

A three-mile limit was in operation until 1959 with an adjustment due to a change in the base lines established by agreement with effect from 1 July 1955. From 27 April 1959 non-Faroese vessels were excluded from a six-mile zone, and during certain seasons of the year also from three areas between six and twelve miles which were reserved for line fishing only. From 1 March 1964 non-Faroese vessels' rights to fish in any part of the six-to-twelve-mile zone were withdrawn, and a new twelve-mile limit was redrawn from base lines running from headland to headland.

This effectively has meant a ban on trawl fishing inside the twelve-mile limit, with the exception that in 1971 and 1973 a licensed trawl fishery by Faroese boats under 60 GRT has been allowed in the summer period.

Through the "Arrangement Relating to Fisheries in Waters Surrounding the Faroes", certain areas are to be closed seasonally to trawl fishing. At present little can be said about how this will affect the fishing pattern and the fishing mortality in the stock.

In the early sixties, the mimimum trawl mesh size (for single braided manila) was increased to 80 mm. This was increased to 100 mm with effect from 1 January 1967, and further to 110 mm with effect from 1 January 1970. With effect from 1 January 1974 the mesh size was increased to 130 mm.

1.4 STATE OF STOCKS IN THE FAROE AREA

1.4.1 COD

1.4.1.1 Introduction

There are two separate stocks of cod at Faroe, the main one on Faroe Plateau and a much smaller stock on Faroe Bank. All evidence indicate that the two stocks are self-contained with no mixing between the stocks or with stocks outside the Faroe area.

The Plateau stock is by far the more important and contributes the greater part of the catches from the Faroe area (Table 7.1.2). For this reason the assessments have been concentrated on the Plateau stock. Data for the Bank stock are less reliable and small errors in the division of catches between the two stocks result in big errors for the Bank stock but negligible errors for the Plateau stock.

1.4.1.2 Trends in catch, effort and catch per unit effort

Since 1950 total landings from the ICES statistical Division Vb (Table 7.1.a) have fluctuated between 23 000 tons and 39 000 tons, with an average of 30 000 tons. In earlier years, landings of up to 45 000 tons were recorded.

Fishing effort (Table 7.1.3) tended to increase in the post-war period, with a maximum in the years 1960-61. This increase in fishing effort was accompanied by a decline in catch rates which reached a minimum level in 1962. Catch rates subsequently improved as the amount of fishing reduced.

1.4.1.3 Estimates of mortality rates (Plateau stock)

Fishing mortality coefficients were estimated from Virtual Population Analysis (VPA) and estimates of coefficients of total mortality were available from age composition data per unit fishing effort from English landings.

Data for the VPA were based on age compositions of landings by English, Scottish and Faroese vessels. The Faroese data were not available for Plateau and Bank separately, and it was assumed that 80% of Faroese landings came from the Plateau. Numbers of fish landed in each age group for England, Scotland and Faroe were summed and then raised to the landings for all countries combined (Table 4.1.1).

Analyses were made using values for the coefficient of natural mortality (M) of 0.2 and 0.3. Estimates of fishing mortality coefficients from the analyses are given in Tables 4.1.2 and 4.1.3, where the assumed values of F in the oldest age group of each year class are also indicated. The trend in average F for age groups 5 to 8 is what would be expected from the trend in fishing effort over the same period. Maximum values of F were obtained in 1960 and 1961 when fishing effort reached its highest level. Subsequently F values decreased with a smaller increase again in recent years.

The relationship between fishing mortality and fishing effort has been examined in more detail in Figure 1. The fishing mortality coefficients (for M = 0.2) have been estimated for each country separately according to the ratios of the numbers of fish in the catches. The resultant values of F were averaged for each year (age groups 4-7 England, 3-7 Scotland and 5-8 Faroe) and average F was then plotted against fishing effort for each country separately. The same effort units were used for English and Scottish effort and a geometric mean regression line has been fitted. The correlation is significant at the 95% level and the intercept is close to zero. The correlation for the Faroese fishery is not so good, probably due to the difficulty in estimating fishing effort in the line fishery.

A calculation of yield per recruit was made for each country's fishery separately for values of F at each age averaged for the period 1968-70 (Tables 4.1.4 and 4.1.5). The weight at age data used were derived from the mean length of age groups

in the English landings converted to weight in kg using the relationship $W = L^3 \times 10^{-5}$. With an overall yield per recruit of 1.45 kg an average recruitment of 23.9 million one-year-olds would be required to provide total average landings of 34 584 tons. From the VPA the estimated average year class strength for the appropriate year classes (1962-66) is 21.7 million.

In Table 4.1.6 estimates of the coefficient of total mortality (Z) calculated from annual age compositions per unit effort for the English fishery can be compared with values of Z (= F+M) from the VPA.

1.4.1.4 Recruitment and year class strength

Estimates of year class strength as the numbers of one-year-old fish are given in Table 4.1.7. Year classes 1960 to 1966 showed little variation in abundance with the exception of the very poor 1963 year class. The 1958 and 1959 year classes were of lower abundance. In recent years the data suggest that year classes from 1967 onwards have been of very low abundance. It should be remembered, however, that estimates of year class strength in the most recent years will be in error if incorrect values were assumed for fishing mortality in 1972 in the VPA.

1.4.1.5 Growth

Von Bertalanffy growth parameters were calculated for the Plateau and Bank stocks using mean length at age data from English landings and a least squares fit of the growth curve. The calculated values are given in Table 7.1.5.

1.4.1.6 Yield per recruit and age at first capture

Yield in weight per recruit was calculated using the Beverton and Holt constant parameter model with the growth parameters given in Table 7.1.5 and a natural mortality coefficient of 0.2. The results plotted as yield curves are shown in Figure 2.

Results of the VPA estimates of fishing mortality indicate that full exploitation in the fisheries of the Plateau stock may not be reached until about 7 years of age. Cod are caught first in the Scottish fishery where the full exploitation rate is reached at about 3 years old. In the English fishery the full rate of exploitation is not reached until about 4 years. The equivalent age for the Faroese fishery is about 7 years. Thus fishing mortality increases with age over the range of 1 to 7 years. The equivalent mean age at first capture as used in the Beverton and Holt equation would thus be in the range of 3-4 years. For a mean age at first capture of 3.5 years, the maximum yield per recruit is obtained at F = 0.4 for the Plateau stock. The mean value of F in the exploited phase as estimated from VPA is about 0.5 and for this level of F the theoretical yield per recruit of 1.62 kg is about 1% below maximum. (This can be compared with the value of 1.45 kg per recruit obtained by the variable F model).

For the Bank stock, which has a faster growth rate, optimum age at first capture for any given value of F is lower than for the Plateau stock.

1.4.1.7 Mesh change assessment

The effect on catches of the change in trawl cod end mesh size from 110 mm to 130 mm was calculated using a modification of the Gulland

method developed by Mr K P Andersen. The method checks the assumptions on growth parameters and selection and recruitment curves, and states if they are consistent with the catches observed. Furthermore, it gives the changes in the fishery through the transition period after a change in selectivity, until a new equilibrium has been reached. All the computations were performed by Mr K P Andersen. The Working Group is indebted to Mr Andersen for his keen work on the mesh assessment problem, and hopes that a full description of the method and programmes involved will be made available to all those interested. The calculation used the same selection curve for both English and Scottish trawlers. Logistic curves were used to describe the normal selection ogives, and in addition a reverse logistic curve was applied to allow for the oldest fish not being available to the trawlers.

The results of the assessments indicate that the immediate effect would be a loss of about 4% in weight for the trawl fisheries with no change for the Faroese long-liners. The long-term effect would be no change for the trawl fisheries, a 4% gain for the Faroese long-line fishery with an overall net gain of 2%. The results are consistent with what would be expected from earlier assessments (Anon., 1967). Table 4.1.8 gives some indication of the changes in the transition period until the new stable situation is reached.

Coincident with the introduction of the larger mesh size in 1974 will be the commencement of new regulatory measures for the Faroe fisheries. In addition to limiting catches, certain areas will be closed to trawlers at certain times of year. The system of closed areas will result in a major change in pattern of trawl fishing. Trawlers will be unable to work many of their traditional grounds at the preferred times of year. Such changes in the seasonal distribution of the trawl fleets are bound to have an effect on their catches and catch composition. In these circumstances it is likely to be impossible to distinguish any mesh change effects from the effects of changes in the pattern of fishing. Over the past history of the fishery a change in the distribution of fishing of comparable magnitude was the introduction of the 12-mile limit in 1964. One of the results of this change was a reduction in fishing mortality on the younger age groups of cod and haddock and this is clearly seen in the results of the VPA.

With recruitment at an average level a total allowable catch (TAC) of 30 000 tons, as was adopted in the "Arrangement Relating to Fisheries in Waters Surrounding the Faroes", would be consistent with the present level of exploitation. It has been mentioned in an earlier section that the year classes 1967 and onwards appear to be well below average abundance. Estimates for these recent years, however, could be subject to error if the values assumed for F in 1972 used in the VPA were incorrect. If in fact there is a series of poor year classes recruiting to the fishery a lower TAC would be advisable.

Table 4.1.1 Faroe Plateau Cod.
Total catch by all countries (thousands of fish) in each age group used for VPA.

Year class	1	2	3	4	5	6	7	8	9	10+	
1949										6	
1950									10	38	
1951								50	61	40	
1952							207	131	29	5	
1953						200	171	78	22	2	
1954					1 731	876	372	94	30	14	
1955				858	513	232	93	48	41	7	
1956			4 239	2 574	1 066	481	204	79	63	42	
1957		2 002	4 027	1 331	855	284	158	48	33	27	
1958	331	4 728	2 686	1 255	662	350	155	104	27	45	
1959	859	3 093	2 500	1 280	630	363	197	64	11	3	
1960	1 223	4 424	3 958	2 300	1 416	606	309	105	92	40	
1961	815	4 110	3 021	2 564	1 339	847	452	203	44	71	
1962	1 181	2 033	3 230	2 080	1 706	1 226	713	300	179	25	
1963	122	852	970	860	945	477	244	114	25		
1964	162	1 337	2 690	2 663	1 538	752	510	154			
1965	53	1 609	3 322	3 300	1 685	1 451	596				
1966	127	1 529	3 106	2 172	1 287	1 021					
1967	34	878	1 163	821	596						
1968	68	402	757	810							
1969	35	328	1 176								
1970	78	875									
1971	44										

Derived from English, Scottish and Faroese catch in numbers. Faroese catch on Plateau estimated as 0.8 x total Vb.

Table 4.1.2 Faroe Plateau Cod.
Estimates of fishing mortality coefficients from VPA analysis (M = 0.2).

Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972*
Age group														
1	.02	.06	.05	.04	.05	.01	.01	.00	.01	.00	.01	.00	.01	
2	.18	.45	.34	.28	.25	.12	.12	.09	.08	.10	.13	.07	.05	.1
3	.49	.68	.50	.50	.42	.30	.27	.20	.26	.24	.29	.26	.18	.25
4	.48	.63	.50	.47	.53	.47	.44	.28	.27	.44	.39	.34	.29	.3
5	.65	.60	.59	.70	.48	.54	.60	.44	.39	.55	.50	.35	.34	.35
6	.43	.82	.61	.59	.54	.51	.69	.56	.56	.54	.60	.49	.58	.5
7	.68	.83	1.07	.52	.53	.65	.45	1.08	.62	.66	.71	.71	.72	.5
8	.29	1.36	1.27	.91	.57	.41	.42	.63	1.46	.44	.73	.76	.90	.5
9	.16	.68	1.54	2.06	.86	1.54	.67	.58	.33	1.20	.90	.33	1.70	.5
10+*	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Average 5-8 years	.51	.90	.89	.69	.53	.53	.54	.68	.76	.55	.64	.58	.64	

* Values of F shown for 1972 and for age group 10+ are assumed values.

Table 4.1.3 Faroe Plateau Cod.
Estimates of fishing mortality coefficients
from VPA analysis (M = 0.3).

Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972*
Age Group														
1	0.01	0.05	0.04	0.03	0.03	0.01	0.01	0.001	0.004	0.002	0.01	0.002	0.01	
2	0.14	0.35	0.27	0.21	0.19	0.08	0.08	0.01	0.01	0.01	0.01	0.04	0.03	0.08
3	0.40	0.56	0.39	0.41	0.34	0.23	0.20	0.15	0.20	0.17	0.21	0.19	0.13	0.2
4	0.40	0.52	0.41	0.37	0.44	0.38	0.35	0.22	0.22	0.35	0.30	0.25	0.22	0.24
5	0.56	0.50	0.48	0.58	0.38	0.46	0.49	0.36	0.32	0.46	0.40	0.27	0.26	0.28
6	0.38	0.72	0.51	0.47	0.43	0.40	0.62	0.46	0.46	0.46	0.50	0.39	0.46	0.4
7	0.61	0.75	0.94	0.44	0.43	0.52	0.35	0.98	0.51	0.54	0.62	0.60	0.59	0.4
8	0.23	1.24	1.17	0.77	0.50	0.33	0.33	0.49	1.31	0.37	0.57	0.68	0.74	0.4
9	0.12	0.55	1.32	1.81	0.70	0.13	0.54	0.46	0.25	1.01	0.74	0.26	1.47	0.4
10+*	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Average 5-8 years	0.45	0.80	0.78	0.57	0.44	0.43	0.45	0.57	0.65	0.46	0.52	0.49	0.51	

* Values of F shown for 1972 and for age group 10+ are assumed values.

Table 4.1.4 Faroe Plateau Cod.
Estimates of average fishing mortality coefficients for the period 1968-70, subdivided between the main countries.

Age group	Average fishing mortality 1968-70			
	Total	England	Scotland	Faroe
1	.00	.00	.00	.00
2	.10	.02	.06	.01
3	.26	.05	.13	.05
4	.39	.07	.14	.13
5	.47	.07	.11	.24
6	.54	.06	.09	.32
7	.69	.09	.14	.35
8	.64	.07	.10	.40
9	.81	(.09)	(.13)	(.51)
10+	(.7)	(.08)	(.11)	(.44)

Table 4.1.5 Faroe Plateau Cod.
Estimates of yield per recruit taken by main countries.

Age group	N	Total F	$F/Z(1-e^{-Z})$	$\bar{w}$	Yield in weight			
					E	S	F	Total
1	1 000	.00						
2	819	.10	.086	.98	13.8	41.4	6.9	69.0
3	607	.26	.208	1.93	46.3	121.8	46.3	243.6
4	383	.39	.295	3.10	63.1	126.1	115.6	350.3
5	212	.47	.343	4.12	44.9	68.9	152.8	297.5
6	109	.54	.382	5.18	23.7	36.6	127.1	215.5
7	52	.69	.457	6.38	19.7	30.4	77.4	151.8
8	21	.64	.433	7.66	7.7	11.2	43.9	69.7
9	9	.81	.510	8.52	4.3	6.3	24.7	39.2
10+	3	.7	.462	9.27	1.4	2.1	8.2	13.0
Yield per recruit (kg)					0.225	0.445	0.603	1.450
Average landings 1968-70 (tons)					5 840	10 188	14 909	34 584

Table 4.1.6 Faroe Plateau Cod.
Comparison of estimates and coefficients of total mortality (Z) from English catch per unit effort data and from VPA analysis.

From catch per unit effort Average 1967/68-1971/72		From VPA analysis Average 1967-71		
			Z	
Age group	Z	Age group	M = 0.2	M = 0.3
		4	0.55	0.57
4-5	0.48			
		5	0.63	0.64
5-6	0.74			
		6	0.75	0.75
6-7	0.72			
		7	0.88	0.87
7-8	1.03			
		8	1.06	1.03

Table 4.1.7 Faroe Plateau Cod.
Estimates of year class strength as the numbers of one-year-old fish from VPA.

Year class	Stock size (millions)	
	M = 0.2	M = 0.3
1958	17.7	24.7
1959	15.4	21.0
1960	26.0	36.8
1961	25.6	37.8
1962	26.4	40.6
1963	10.0	15.7
1964	21.3	33.0
1965	28.2	45.3
1966	22.5	36.0
1967	9.7	15.5
1968	8.1	13.0
1969	9.2	14.2
1970	15.2	17.8

Table 4.1.8 Faroe Cod.
Effect of a change of trawl cod end minimum mesh size from 110 to 130 mm.

Years after change	Percentage change		
	UK trawlers	Faroese long-liners	Total All gears
1	-4	0	-2
5	-1	+2	0
10	0	+3	+2
15	0	+4	+2

Figure 1. Faroe Plateau Cod. Relationship between annual estimates of the fishing mortality coefficient (M = 0.2) and fishing effort for England, Scotland and Faroe. Lines fitted by geometric mean regression (England and Scotland) and by eye (Faroe).

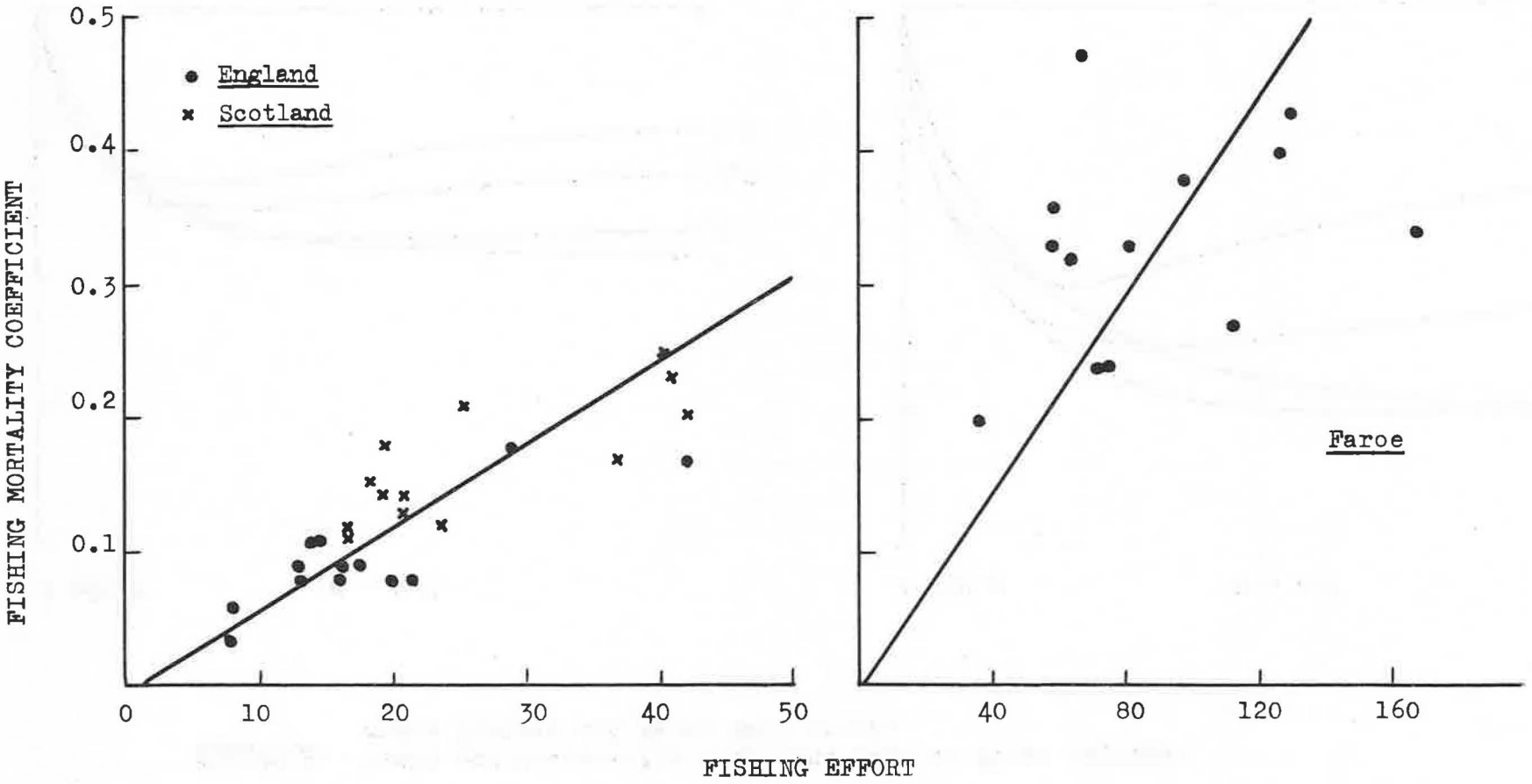
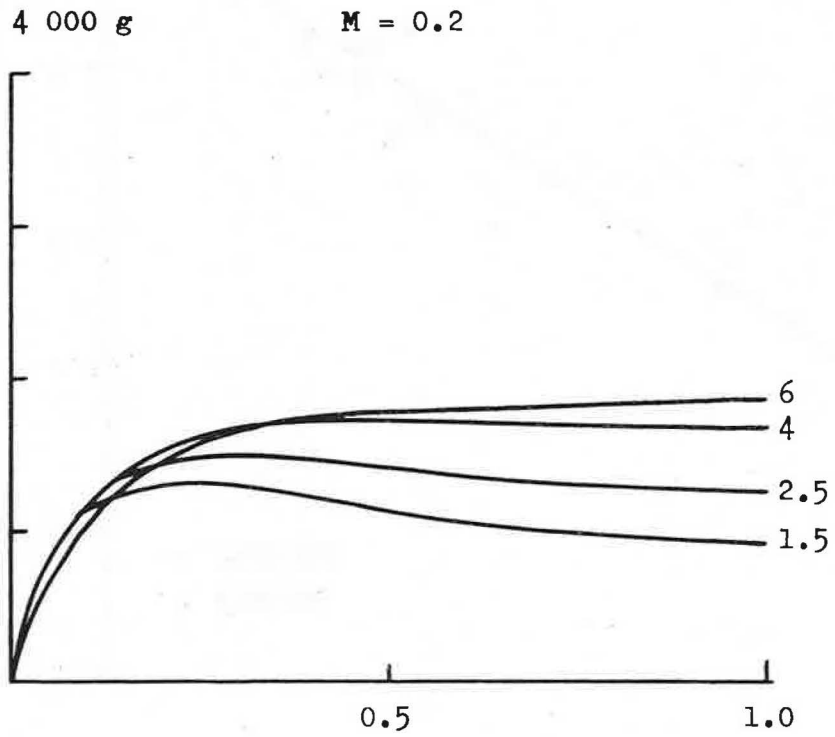
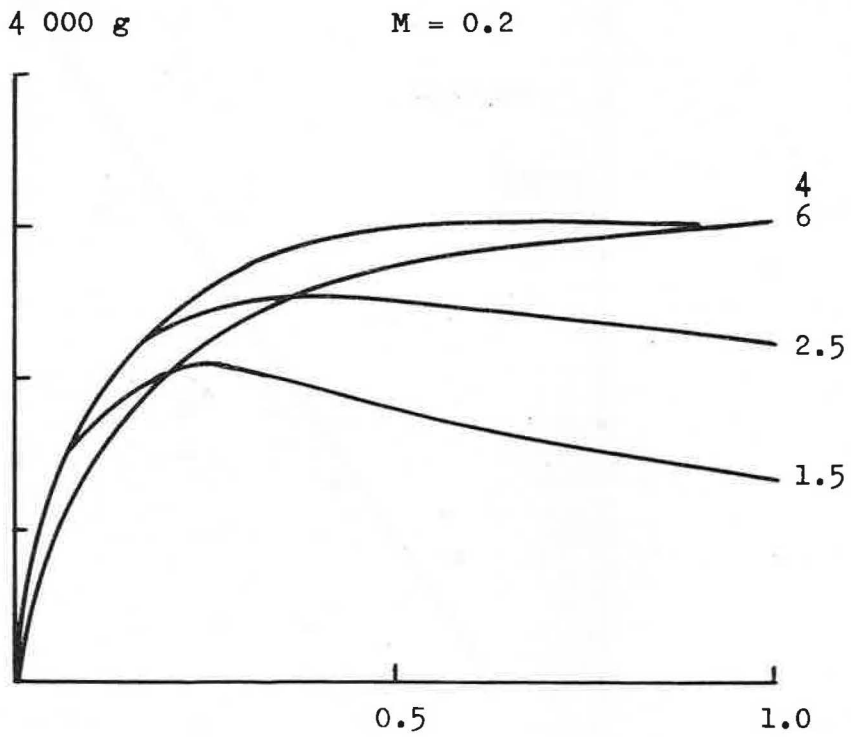


Figure 2. Yield per Recruit for different ages at first capture.
Faroe Plateau and Faroe Bank stock.



FAROE PLATEAU COD



FAROE BANK COD

1.4.2 HADDOCK

1.4.2.1 Introduction

As in the case of cod, there are stocks of haddock on Faroe Bank and Faroe Plateau that are believed to be independent of each other. Most haddock data have been collected from the Plateau stock and for this reason, as well as because the greater part of the catches come from this area, assessments have been made for this stock only.

Total international landings of haddock have tended to increase in the long term over the period 1924-63. During this period, landings increased from about 10 000 tons annually to about 24 000 tons annually. Since 1963, landings have decreased and in 1972 they were 16 000 tons (Table 7.1.b).

Landings by Scottish vessels have followed a similar trend to the total landings, increasing to a maximum in 1962 and then declining. English landings increased from about 8 000 to 13 000 tons from 1924-38. After the war, landings decreased from 11 000 tons to about 2 000 tons from 1946-73. Recorded Faroese landings were negligible before the war, but increased gradually after the war to a maximum of 12 000 tons in 1970. Since then Faroese landings have declined.

1.4.2.2 Landings per unit effort (Table 7.1.3)

For haddock there have been annual fluctuations, but no significant trend in the landings per unit effort during the past 20 years. Good year classes in 1961 and 1966 accounted for the increase in landings in 1963 and 1969.

1.4.2.3 The Virtual Population Analysis

The virtual population analysis has been based on estimates of the numbers of haddock of each age group landed each year by Scottish, English and Faroese vessels fishing at Faroe.

For Scottish vessels, samples for length and age composition have been taken monthly on the Aberdeen fish market since 1950. For English vessels samples for length composition have been taken by the Lowestoft Laboratory for the years 1957-72. Age compositions have been determined for these data using the Scottish age/length keys. For Faroese line vessels, samples for length composition have been supplied by the Fisheries Laboratory, Tórshavn in 1960, 1961 and 1969. These have been combined and converted into a single age composition using Scottish age/length keys and this has been used to derive an age composition for the Faroese landings for each year from 1957-72.

By combining the numbers landed by Scottish, English and Faroese vessels estimates were made of the total numbers landed at each age by these nations. These are arrayed by year class and age in Table 4.2.1. If required, these can be further raised, so as to be applicable to the landings by all nations, by increasing each number by 7%.

A VPA was done for each year class separately (Tables 4.2.2 and 4.2.3). These tables show values of F and stock numbers for each year class, arranged by year of capture.

1.4.2.4 Mean values of F

Inspection of the values of F shows that these vary both with time and age. For the two youngest age groups sampled (i.e. the one- and two-year-old fish) values of F tend to be very small due to the fact that these age groups are only partially exploited. For fish more than 6 years of age the values are variable, and in any event unreliable, since these are dependent on the starting values adopted for F. For calculating annual values therefore, only the values for 3 to 6 year-old fish have been used, and mean values for these four age groups are shown in Tables 4.2.2 and 4.2.3.

To investigate the relationship between fishing mortality and fishing effort, the annual values of F were plotted against estimates of annual fishing effort. To make this comparison as meaningful as possible, the values of F were first subdivided into estimates of F for each country separately. This was done by subdividing each value on the basis of the proportions of the total landings attributable to each country in each year. These annual values of F were then plotted against the respective national fishing efforts for each country separately.

Some results are shown in Figure 3 based on values of F derived from the VPA assuming M = 0.3. The relationship between F and effort (f) were found to be highly correlated. The geometric mean regressions were found to be as follows:

Scotland	F = .0017	f = 0.024
England	F = .0050	f = 0.025
Faroe	F = .0037	f = 0.112

Similar plots were tried starting with values of F from the VPA based on values of M of 0.2, 0.4 and 0.5. In each case the results appeared similar to those in Figure 3. There appeared to be no good reason for accepting the results based on any one value of M as being better than the others so that no estimate of M could be obtained by this method. It was reassuring, however, to find such good correlations between the national values of F and their respective fishing efforts.

1.4.2.5 Mortality rates of haddock

Total instantaneous mortality coefficients (Z) have been estimated by various methods and the results are shown in Table 4.2.4. Values based on the landings per unit effort in successive years using Aberdeen and English trawl data, gave values of Z for fish of 3-7 years of age of about 0.6 - 0.8. Estimates based on VPA were very similar, although they tended to be a little lower for the younger age groups.

1.4.2.6 Recruitment

Estimates of year class strength for Faroe haddock are given in Table 4.2.5. These include estimates based on research vessel estimates of haddock in their second year of life. There are also estimates based on the landings per 100 hours' fishing by Aberdeen trawlers of haddock in their fourth year of life. For comparison, absolute estimates are given of year class strength based on the VPA.

Of particular significance in recent years has been the occurrence of a good year class in 1966, followed by a sequence of average or less than average year classes. This has contributed to the decline in total haddock landings since 1969.

1.4.2.7 Estimation of growth parameters

Bertalanffy parameters have been calculated for Faroe haddock based on mean lengths of fish and each age landed on the Aberdeen fish market for the period 1950-71. Parameters obtained are given in Table 7.1.5. These values for the various parameters were used in subsequent Beverton and Holt yield per recruit assessments.

1.4.2.8 First availability and age at first capture

Young haddock are widely distributed over the Plateau and the Bank and are thought to become available to trawling at an average age of 1 to 1½ years and a length of about 18-25 cm. With a mesh size of 130 mm, the 50% lengths and ages at first capture (i.e. the length, or age, at which 50% of the fish are retained by the cod end) are 44.2 cm and 3.5 years for haddock. For this species, therefore, the age at first capture is mainly influenced by mesh size rather than by availability as in cod.

1.4.2.9 The effect on haddock landings of an increase in mesh size

Assessments of the effect of an increase in mesh size from 110 mm to 130 mm have been made using the same method as that used for cod. The results are given in Table 4.2.6. These show that in the first year after the change, Scottish and English trawlers could be expected to lose 32% and 28% of their catches. Faroese long-liners should benefit by 2%.

Values for intermediate years are given in the table and it is shown that the long-term effect would be for Scottish and English trawlers to lose 20% and 16% respectively and for Faroese vessels to gain 22%.

Previous estimates (Anon., 1966) took account of the possible effect of discards on the assessments. No recent discard data are available, but it should be noted that if discarding does occur, the losses experienced by trawlers should not be as great as indicated in Table 4.2.6. In the absence of the necessary data for calculating this effect, the trawl losses indicated should be regarded as overestimates.

1.4.2.10 The effect of fishing on haddock

Assessments have been made of the relationship between yield and fishing mortality rate for Faroe haddock. Figure 4 shows yield per recruit curves calculated using the Beverton and Holt constant parameter formula. For haddock, the maximum yield per recruit is expected from a fishing mortality rate of 0.3 - 0.5. The present fishing mortality rate is about 0.5. This assessment indicates, therefore, that the yield per recruit is close to its theoretical maximum. Estimates of fishing mortality rate at each age from the VPA show that these are not constant with age. This suggests that a more realistic estimate could be made by using a model in which F is varied with age in the way indicated by the VPA. This has been done using the values of F at each age calculated for the period 1970-71. The effect on the landings of varying F at each age by various percentages was determined by the method of Jones (1961), and the results are shown in Figure 5. Curves are drawn

for values of M = 0.2 and M = 0.3, and they confirm the conclusion from the constant parameter assessment that at present the yield per recruit is close to its theoretical maximum.

1.4.2.11 The effect of the closure of certain areas to fishing

A large proportion of the haddock stock at Faroe is taken within the 100 fathom depth contour and much of this is within 20 miles of the present base-line. For this reason the closure of areas outside the current 12-mile limit will restrict the activities of trawlers to a smaller proportion of the region within the 100 fathom line. It is not possible to assess the effect of this with any certainty. It is possible, however, that it could lead to the reduction in fishing effort on at least some age groups, and possibly, therefore, to an alteration in the way in which the fishing mortality rate varies with age.

Table 4.2.1 Landings of Faroe Haddock (thousands).
Faroe, Scotland, England combined.

Year class	Age									
	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+
1947										57.5
1948									93.9	104.5
1949								226.6	125.2	46.9
1950							585.2	293.5	97.8	27.8
1951						893.9	817.3	235.7	85.3	13.1
1952					1 615.2	1 298.8	720.5	243.2	59.2	21.7
1953				8 442.0	3 378.1	1 843.6	1 169.0	263.2	72.3	23.3
1954			7 130.2	5 679.4	2 055.8	1 559.0	838.3	270.1	74.7	7.3
1955		4 133.3	8 020.7	4 543.6	2 482.4	1 305.1	867.5	256.8	49.1	7.7
1956	44.7	6 255.3	7 662.8	6 655.2	1 937.3	1 406.6	859.7	198.4	42.5	9.2
1957	116.0	3 970.6	10 659.1	5 134.0	2 361.2	1 539.4	727.7	1 345.0	53.5	12.6
1958	524.5	6 060.9	7 330.3	5 232.5	2 242.3	1 119.8	672.5	179.8	51.8	11.7
1959	853.6	7 932.4	13 976.7	7 403.4	2 259.8	1 208.5	739.7	197.2	68.1	20.3
1960	941.2	9 631.1	8 907.4	3 898.5	1 442.5	1 111.8	630.5	230.2	113.9	10.3
1961	784.2	13 551.8	7 457.0	5 133.1	2 710.0	1 426.2	922.6	377.9	68.0	102.2
1962	356.2	2 284.1	4 285.6	4 804.3	1 784.9	1 525.8	1 223.9	325.7	146.7	94.8
1963	45.5	1 367.8	3 303.5	2 598.8	1 524.3	1 484.9	1 098.5	222.3	113.1	
1964	39.4	1 080.8	2 405.1	2 812.0	1 564.8	1 383.0	863.5	179.6		
1965	89.6	1 424.9	4 096.8	4 567.0	1 624.1	1 292.2	695.7			
1966	69.6	5 881.4	7 539.1	6 580.8	3 267.4	1 170.6				
1967	48.8	2 383.8	4 855.4	4 727.0	2 706.4					
1968	94.7	1 728.2	4 392.7	4 179.3						
1969	56.7	717.4	3 744.1							
1970	55.1	750.0								
1971	42.7									

Table 4.2.2 Faroe Haddock, M = 0.2.
Virtual Population Analysis.
Numbers alive (millions) based on individual year classes.

Age \ Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	47.4	52.3	43.5	62.2	47.0	58.4	36.3	26.2	23.0	29.3	48.6	39.0	37.2	34.2	16.2
2	34.6	38.7	42.7	35.1	50.2	37.6	47.1	29.4	21.4	18.8	24.0	40.0	32.3	30.9	29.4
3	25.0	24.6	26.1	31.4	23.3	33.9	22.2	26.4	22.0	16.3	14.4	18.4	27.4	24.3	23.7
4	19.9	14.0	12.9	14.5	16.1	12.5	15.3	10.2	14.9	14.2	10.4	9.6	11.4	15.7	15.5
5	5.4	8.8	6.4	6.5	5.9	8.6	5.6	5.9	4.8	7.6	7.3	6.2	5.4	5.2	6.9
6		2.9	4.1	3.4	3.1	3.1	4.9	2.5	2.8	2.7	3.8	4.4	3.6	3.0	2.8
7			1.2	1.7	1.4	1.4	1.3	2.7	1.1	1.2	1.2	1.9	2.2	1.7	1.2
8				0.4	0.4	0.4	0.4	0.3	1.5	0.3	0.3	0.4	0.7	0.7	0.4
9					0.1	0.1	0.1	0.06	0.06	0.08	0.07	0.10	0.14	0.3	0.3
10															

Values of F (M = 0.2)

Age \ Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972*
1	0.001	0.002	0.013	0.015	0.022	0.015	0.011	0.002	0.002	0.010	0.010	0.010	0.010	0.010	0.010	-
2	0.14	0.20	0.11	0.21	0.19	0.33	0.38	0.09	0.073	0.066	0.068	0.18	0.085	0.064	0.027	0.06
3	0.37	0.44	0.39	0.46	0.42	0.60	0.58	0.37	0.24	0.25	0.20	0.28	0.36	0.25	0.23	0.20
4	0.62	0.58	0.49	0.70	0.43	0.61	0.75	0.54	0.47	0.46	0.32	0.39	0.58	0.61	0.41	0.35
5	0.40	0.55	0.43	0.54	0.44	0.36	0.58	0.54	0.40	0.49	0.31	0.32	0.39	0.42	0.72	0.44
6		0.66	0.66	0.69	0.62	0.68	0.42	0.66	0.63	0.60	0.52	0.48	0.58	0.71	0.69	0.61
7			0.98	1.29	1.05	1.15	1.29	0.36	1.13	1.07	0.85	0.78	0.92	1.21	1.48	1.04
8				1.17	1.04	1.29	1.51	1.37	2.78	1.15	0.98	0.91	0.90	0.67	0.88	0.8
9					1.08	1.16	2.10	1.70	1.45	1.39	1.42	1.22	2.17	0.39	0.74	0.8
10*	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Mean 3-6 years		0.56	0.49	0.60	0.48	0.56	0.58	0.53	0.44	0.45	0.34	0.37	0.48	0.50	0.51	0.40

* Values of F shown for 1972 and for age group 10 are assumed values.

Table 4.2.3 Faroe Haddock, M = 0.3
Virtual Population Analysis.
Numbers alive (millions) based on individual year classes.

Age \ Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
1	67.4	77.9	61.4	86.1	64.8	82.2	56.2	41.0	35.4	43.6	69.6	64.7	55.1	49.7	21.2
2	45.3	49.9	57.6	45.0	63.0	47.2	60.3	41.3	30.3	26.2	32.7	52.1	49.2	41.9	39.7
3	30.7	30.0	31.6	39.3	28.2	39.9	26.8	33.1	28.7	21.3	18.5	23.0	33.6	34.4	29.6
4	23.4	16.7	15.4	16.9	20.1	14.6	17.7	12.3	18.2	17.6	13.0	11.6	13.5	18.5	21.3
5	6.4	10.2	7.5	7.6	6.9	10.5	6.4	6.9	5.8	9.1	8.9	7.4	6.2	6.2	8.1
6		3.3	4.7	3.8	3.5	3.5	5.8	2.9	3.2	3.1	4.4	5.1	4.2	3.3	3.2
7			1.4	1.9	1.5	1.5	1.4	3.0	1.2	1.3	1.3	2.1	2.5	1.8	1.3
8				0.4	0.4	0.4	0.4	0.3	1.6	0.3	0.4	0.5	0.8	0.8	0.4
9					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3
10															

Values of F (M = 0.3)

Year \ Age	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972*
1	0.001	0.002	0.010	0.012	0.017	0.011	0.007	0.001	0.001	0.010	0.010	0.010	0.010	0.010	0.010	-
2	0.11	0.16	0.083	0.17	0.16	0.27	0.30	0.066	0.054	0.049	0.052	0.14	0.058	0.049	0.021	0.05
3	0.31	0.37	0.33	0.37	0.35	0.51	0.48	0.30	0.19	0.20	0.16	0.23	0.30	0.18	0.19	0.16
4	0.53	0.49	0.41	0.60	0.35	0.52	0.65	0.45	0.39	0.38	0.26	0.32	0.49	0.52	0.29	0.30
5	0.34	0.48	0.38	0.47	0.39	0.30	0.51	0.47	0.34	0.42	0.26	0.27	0.34	0.36	0.61	0.30
6		0.59	0.60	0.62	0.56	0.62	0.36	0.59	0.57	0.54	0.46	0.42	0.52	0.65	0.62	0.53
7			0.90	1.18	0.97	1.07	1.20	0.33	1.04	0.98	0.77	0.70	0.82	1.12	1.43	0.96
8				1.09	0.97	1.22	1.42	1.28	2.67	1.08	0.91	0.86	0.82	0.61	0.84	1.2
9					1.04	1.12	2.04	1.65	1.40	1.34	1.37	1.18	2.11	0.37	0.71	1.2
10*						1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Mean 3-6 years		0.48	0.43	0.52	0.41	0.49	0.50	0.45	0.37	0.38	0.28	0.31	0.41	0.43	0.43	0.32

* Values of F shown for 1972 and for age group 10 are assumed values.

Table 4.2.4 Faroe Haddock.
Estimates of total instantaneous mortality coefficient (Z) by different methods.

1			2			
			M			
Age	Aberdeen	English	0.1	0.2	0.3	Age
			0.56	0.59	0.62	3
3-4	0.62	0.48				
			0.74	0.74	0.75	4
4-5	0.85	0.81				
			0.66	0.68	0.71	5
5-6	0.74	0.72				
			0.78	0.80	0.82	6
6-7	0.70	0.64				
			1.10	1.08	1.07	7
7-8	0.89	0.79				
			0.90	0.91	0.92	8
8-9	1.14	0.93				

1: Comparison of mortality estimates (Z) derived from Aberdeen and English trawler landings per unit effort for the period 1957-68.

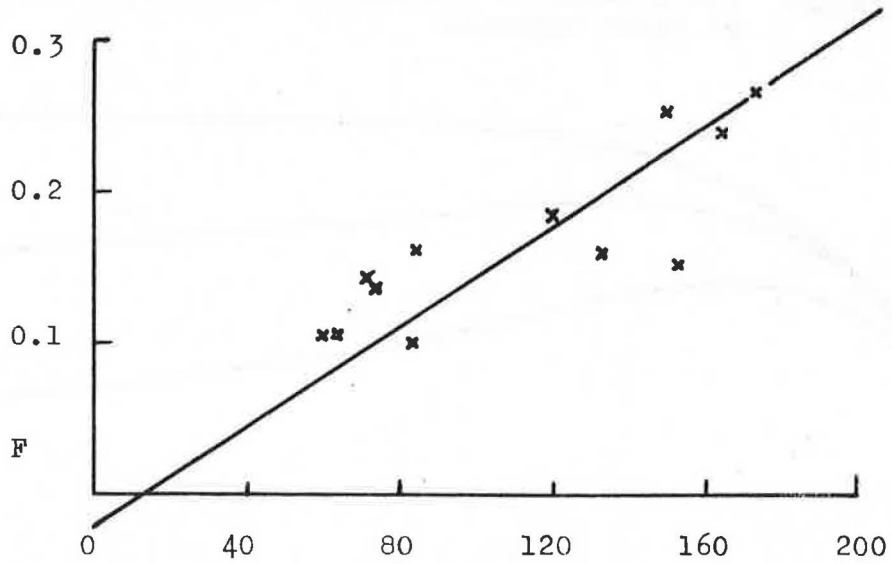
2: Total mortality estimates (Z) derived from a VPA due to vessels of all countries during the period 1958-63.

Table 4.2.5 Faroe Haddock.
Relative year class strengths.

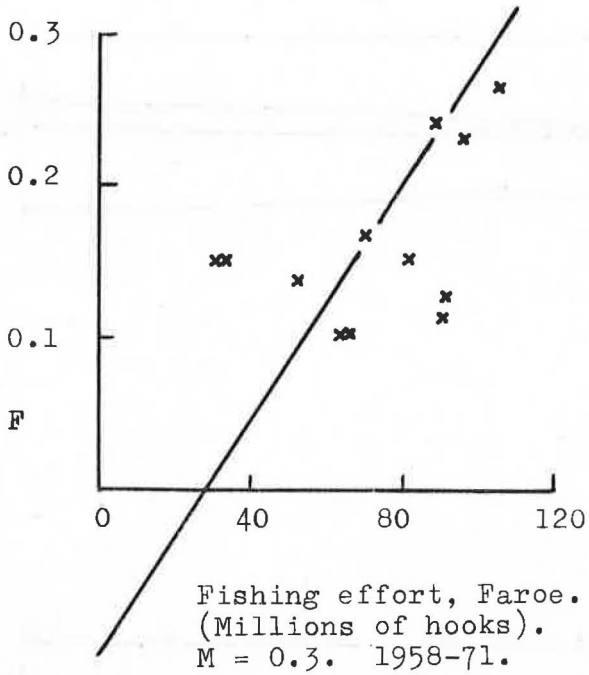
Research vessel catches/10 hrs as 1+ fish				Year class	Aberdeen trawler 4th year frequencies/10 hrs	From VPA (millions)	
Year class	Old "Explorer"	Year class	New "Explorer"			M = 0.2	M = 0.3
1922	112	1957	3003	1947	170		
1923	179	1958	1500	1948	360		
1924		1959	2300	1949	320		
1925		1960	3800	1950	270		
1926	391	1961	6260	1951	330		
1927		1962	4000	1952	220		
1928	1350	1963	2700	1953	890		
1929		1964	375	1954	430		
1930	435	1965	68	1955	380		
1931		1966	3000	1956	450	47	67
1932	2240	1967	1500	1957	370	52	78
1933		1968	3500	1958	310	44	61
1934	1197	1969	350	1959	600	62	86
1935	4815	1970	2120	1960	380	47	65
1936	35	1971		1961	640	58	82
1937	647	1972	3600 ("Scotia")	1962	320	36	56
1938	2221			1963	200	26	41
1939				1964	190	23	35
				1965	340	29	44
1946	253			1966	590	49	70
1947	38			1967	280	39	65
1948	1258			1968	300	37	55
				1969	110		
				1970			

Table 4.2.6 Faroe Haddock.
Effect of increase in mesh size to 130 mm (values show percentage changes).

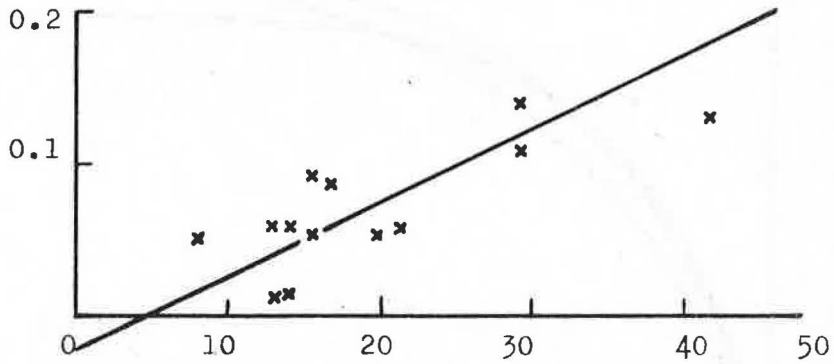
Gear / Years after change	English	Scottish	Faroese	Total
1	-28		+2	-14
2	-23	-28	+8	-9
3	-20	-24	+12	-4
4	-17	-21	+16	-1
5	-16	-20	+18	+1
Long term	-16	-20	+22	+3



Fishing effort, Scotland. (Thousand hours). M = 0.3. 1958-71.



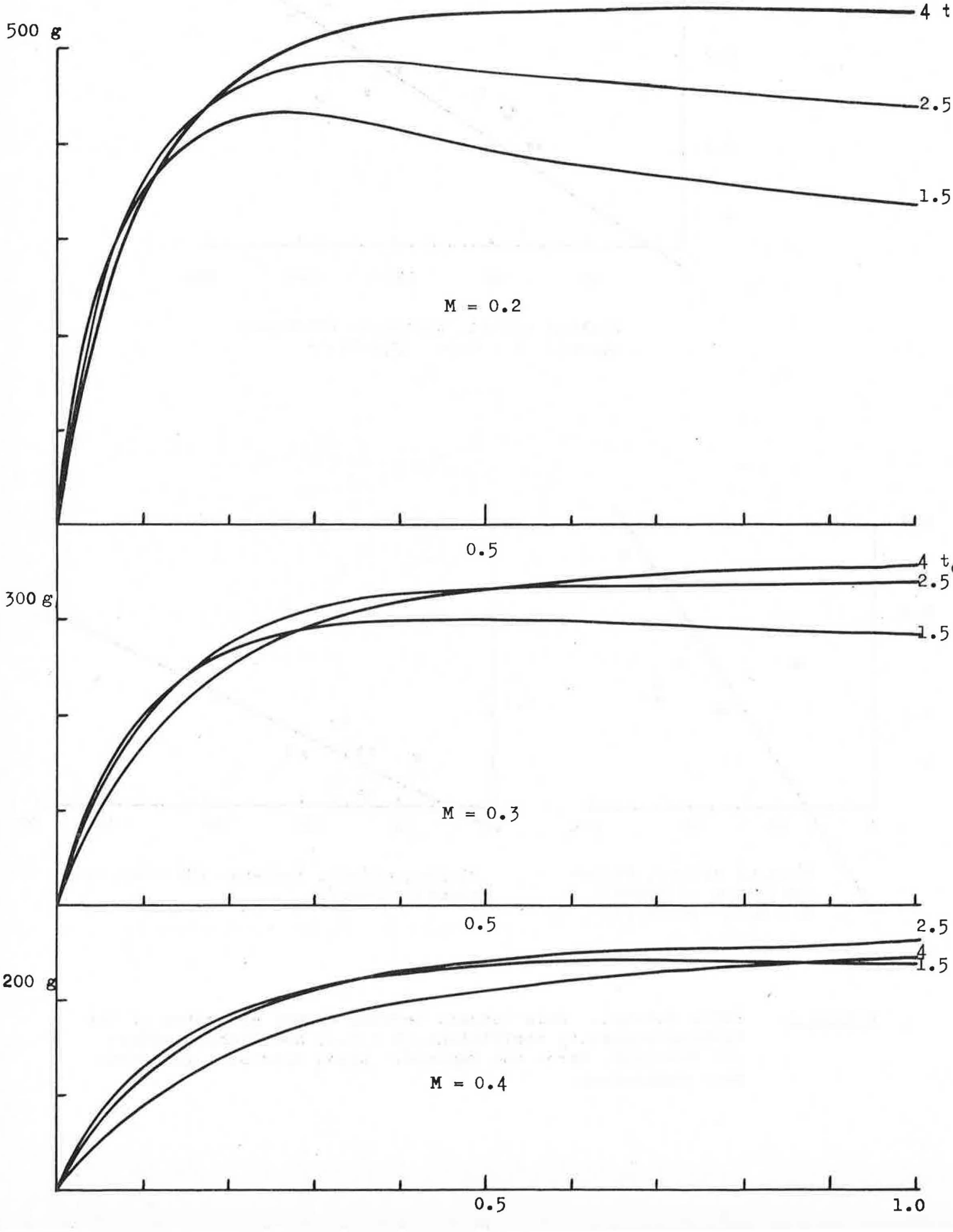
Fishing effort, Faroe. (Millions of hooks). M = 0.3. 1958-71.



Fishing effort, England. (Million ton hours). 1958-71.

Figure 3. Faroe Haddock. Relationship between annual estimates of the fishing mortality coefficient (M = 0.3) and fishing effort for Scotland, Faroe and England. Lines represent geometric mean regressions.

Figure 4. Faroe Haddock. Yields per recruit for different ages at first capture.



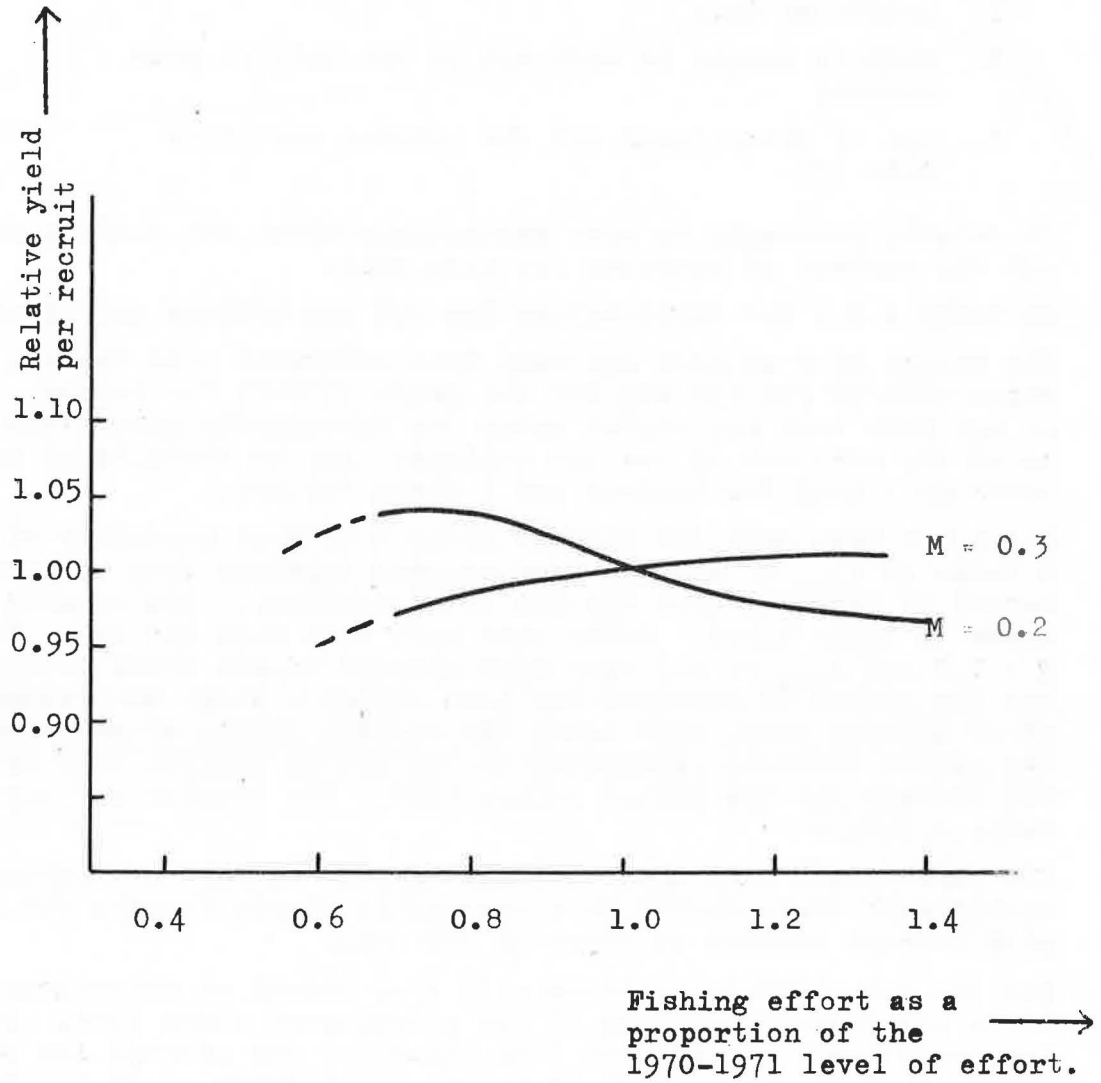


Figure 5. Faroe Haddock. Equilibrium yield curves against effort.

1.4.3 CATCH PREDICTIONS FOR VARIOUS ASSUMPTIONS FOR COD AND HADDOCK

The predictions have been made using a programme developed at the Danish Fisheries and Marine Research Institute. The programme demands estimates of:

1. Values of F for each age group, as proportions of the maximum F;
2. Weight at age;
3. Numbers caught at each age in the initial year chosen;
4. Age of recruitment and the natural mortality rate (M).

It is also necessary to make assumptions about the fishing mortality and the numbers of recruits for each year.

In Table 4.3.1 the input values for cod and haddock are given.

The values of F at each age have been estimated from the VPA for the years 1968-70 for cod and for the years 1970-71 for haddock. Weights at age have been calculated using the Bertalanffy parameters referred to in the sections on cod and haddock. Age at recruitment has been taken as 1 year for haddock and 2 years for cod.

A run has been made for haddock using a natural mortality of 0.2. A value of F_{max} of 1.0 has been assumed together with an average number of recruits from the VPA of 43 millions. The results are shown in Table 4.3.2. Three runs have been made for cod. Values of M = 0.2 and F_{max} of 0.7 have been assumed on all three occasions, but the number of recruits has been varied - about an average value of 10 million fish, this being the average number of recruits for the period 1968-71. According to the VPA 20 million fish is about the average for the period before 1968. The results are given in Table 4.3.2.

The predictions show that with the present pattern of fishery and recruitment there should be a reasonably stable fishery for haddock with average catches of about 16 000 tons.

For the cod stock the catches will also depend on recruitment and there are some indications of low recruitment since 1969. With low recruitment (10 million fish annually) the catches can be expected to decline. With an annual recruitment of 15 million fish, the fishery should remain at the current level. With an annual recruitment of 20 million fish, catches should improve and reach a higher level.

Both predictions suggest that the quotas set in the "Arrangement relating to Fisheries in Waters Surrounding the Faroes" allowing a total catch of 30 000 tons of cod and 22 000 tons of haddock are too high for application to 1976.

Table 4.3.1 Input values for prognoses of catches of haddock and cod.

Age	Proportions of Maximal F on age groups M = 0.2	Weight at age (kg)	Catches in numbers in initial year 1971
	COD		
1	0.0	0.551	1 223
2	0.14	1.05	3 093
3	0.37	1.88	2 686
4	0.56	2.897	1 331
5	0.67	4.046	1 066
6	0.77	5.277	232
7	1.0	6.542	372
8	1.0	7.805	78
9	1.0	9.042	29
	HADDOCK M = 0.2		
1	0.01	0.249	55
2	0.046	0.475	717
3	0.24	0.795	4 392
4	0.51	1.069	4 727
5	0.57	1.403	3 267
6	0.7	1.740	1 292
7	1.0	2.070	864
8	0.78	2.386	222
9	0.7	2.582	146

Table 4.3.2 Catch predictions.
Prognoses for the cod and haddock fishery under various assumptions.
Initial year 1971.

(predicted catches in tons)

COD

Year	1st run	2nd run	3rd run
1972	17 515	17 960	18 405
1973	14 895	16 789	18 683
1974	14 248	18 152	22 056
1975	14 560	20 259	25 959
1976	15 529	22 565	29 600

1st run: recruitment 10 000 000 fishes
2nd run: recruitment 15 000 000 fishes
3rd run: recruitment 20 000 000 fishes

HADDOCK

Year	1st run
1972	16 716
1973	13 665
1974	13 198
1975	16 401
1976	18 735
1st run M = 0.2	

1.4.4 SAITHE

No new assessments on saithe were made by the present Working Group as the Faroe saithe had been included in the assessments of the Saithe Working Group which met in the previous week. A summary of the results are included here for convenience.

(i) Provisional estimates of saithe landings in 1973 indicate that the catches have doubled since 1970-71, the main increase being in the reported landings by French vessels.

(ii) From VPA the recent level of fishing mortality on saithe is believed to be within the range 0.2 - 0.5, indicating that the stock is moderately exploited.

(iii) Average age at first capture is consistent with that required to give maximum yield at the estimated present rate of fishing mortality.

(iv) Under the "Arrangement relating to Fisheries in Waters Surrounding the Faroes" future catches of saithe will be restricted but because of the terms of the Arrangement, it is not possible to define the maximum catch which may be taken. However, it is expected that the overall catch in the near future will not increase by more than about 10%. For non-Faroese vessels the greater part of the fishery takes place outside the shallower areas of the Continental Shelf where the youngest age groups are generally not available. Thus any increase in fishing mortality due to trawl fishing would be expected to be confined to the older age groups and in these circumstances a moderate increase in fishing mortality would not be expected to be detrimental to the stock.

1.4.5 FLATFISH

1.4.5.1 Halibut

Total catches (Table 7.1.i) show a declining trend since the late fifties and early sixties when landings were between 2 000 and 3 000 tons. Faroese catches, however, have remained fairly stable during the whole period. Therefore, the reduced catches are considered to reflect a decrease in fishing effort in line fishery of all countries except those of Faroe, rather than a decrease in abundance. English taging experiments of small halibut indicate that at first these fish spread over both the Faroe Plateau and the Bank, but at an older age halibut tagged on the Plateau tend to be returned from as far as Iceland, whereas halibut tagged on the Bank disperse mainly to the south-west (Bill Bailey Bank, Lowry Bank and Outer Bill Bailey Bank).

1.4.5.2 Plaice, Lemon Sole

Total catches of plaice have slightly increased over the period (Table 7.1.h). Lemon sole (Table 7.1.g) in contrast seem to be

less exploited than in the early sixties. Since these species are taken only as a by-catch of the demersal fishery, biological information is limited and data on length and age composition are available only for some recent years.

The Bertalanffy growth curves were fitted to Faroese and Scottish length at age data (Table 7.1.5). Faroese data were often inconsistent with the theoretical curve which may perhaps be due to the fishing pattern, because only the younger age groups are present in the catches. The Scottish data presented more realistic estimates of L-infinity as compared with the length range observed in the catches. Therefore, these have been selected for yield per recruit calculations for different values of fishing mortality and age at first capture (Figures 6 and 7).

Catch curves from Scottish data for recent years are plotted in Figures 8 and 9, indicating the value of total mortality for plaice and lemon sole to be of the order of 0.3 and 0.4 respectively, and indicating low rates of exploitation. According to the catch curve, recruitment to the Scottish fishery is not complete until 6 years of age. Considering that the Faroese tend to fish the somewhat younger age groups, the mean age at recruitment can be estimated at 4 to 5 years old. The corresponding points on the yield per recruit curves are indicated in the figures. Although exploitation of the stock is very low, apparently not much gain can be expected from an increase in fishing effort on these species.

1.4.6 BLUE LING

This stock is exploited mainly by trawlers from the Federal Republic of Germany and from Norwegian long-liners. Catches have been reported by the Federal Republic of Germany since 1963 and by Norway since 1964. Varying amounts of blue ling have probably been included with common ling in earlier years. According to the preliminary figures, the catches have been increasing since the mid-sixties. In Table 4.6.1 total catches, catches per fishing day and estimates of total effort have been tabulated. Catch per unit effort has increased in 1971 and 1972 to almost twice the mean for the period 1963-72 (mean CPUE = 1.1 ton/fishing day). It is not certain if this reflects a real increase in abundance or if it is the effect of a change in the fishing pattern due to effort being directed more towards blue ling.

The lack of sampling for biostatistical data in the blue ling fishery in the Faroe area has made it impossible for the Working Group to proceed any further in an analysis of the state of this stock.

It is not known if there is an interchange of the blue ling between the Faroe and other areas.

1.4.7 REDFISH

There is a trawl fishery by the Federal Republic of Germany for redfish in the deeper waters around the Faroes. It is the only country catching any substantial quantities of this species in the area. Preliminary catch figures for 1973 indicate a catch of about 9 400 tons, which is about 600 tons less than the maximum catch which was recorded in 1955. Estimates of CPUE and total fishing effort given in Table 4.6.1 do not show any clear trends,

the CPUE's for 1971 and 1972 being about the average for the period 1963-72 (mean CPUE = 3.3 tons/fishing day).

No age and length data were available to the Working Group and nothing is known about possible connections between this stock and the redfish stocks in the open sea in the North Atlantic.

Table 4.6.1 Blue Ling and Redfish catches off Faroe Islands 1963-72, and total effort from catches taken by the Federal Republic of Germany per fishing day.

	Total catch for all countries (tons)		German (F.R.) catch per fishing day (tons)		Total effort for all countries	
Year	Blue Ling	Redfish	Blue Ling	Redfish	Blue Ling	Redfish
1963	478	2 493	1.0	4.1	-	608.05
1964	2 675	7 908	1.5	4.3	1 783.33	1 839.07
1965	2 732	5 512	1.2	3.5	2 276.67	1 574.85
1966	1 280	3 228	0.7	2.7	1 828.57	1 195.56
1967	1 371	4 899	0.8	3.3	1 713.75	1 484.55
1968	2 646	6 667	1.0	3.5	2 646.00	1 904.86
1969	1 047	1 258	0.4	1.8	2 617.50	698.89
1970	2 947	2 053	0.6	3.7	4 911.67	554.86
1971	2 032	2 503	1.9	3.1	1 069.47	807.42
1972	3 982	4 080	2.2	3.2	1 810.00	1 275.00

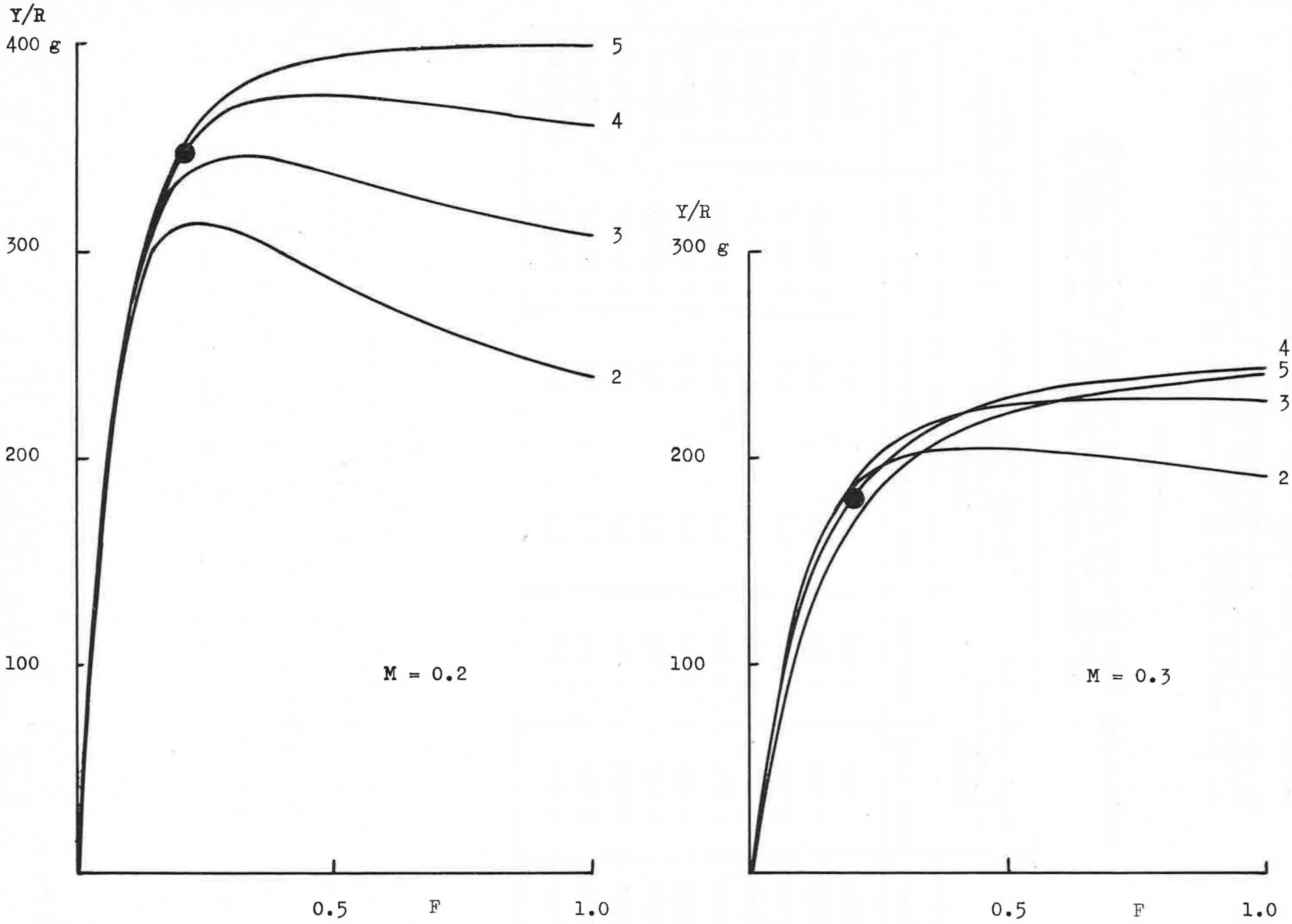
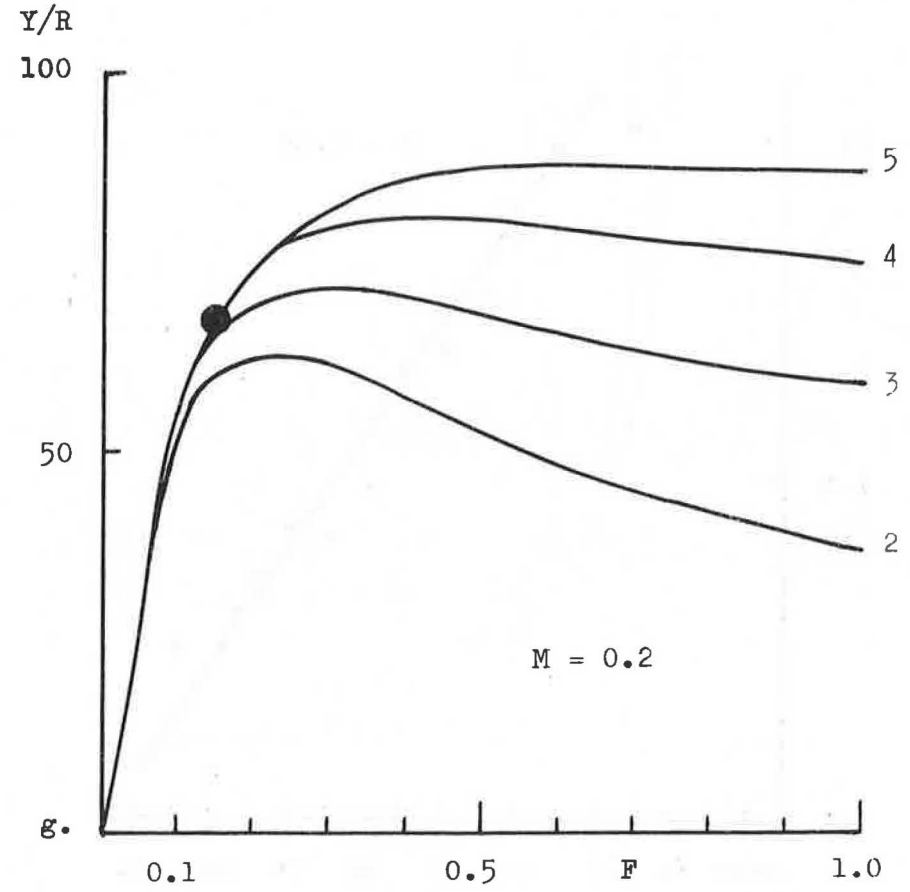


Figure 6. Yield per recruit of Faroe Plaice. (Bertalanffy parameter derived from Scottish data 1972.) $W = .011\ L^{5}$. Dots indicate present level on the yield curve.



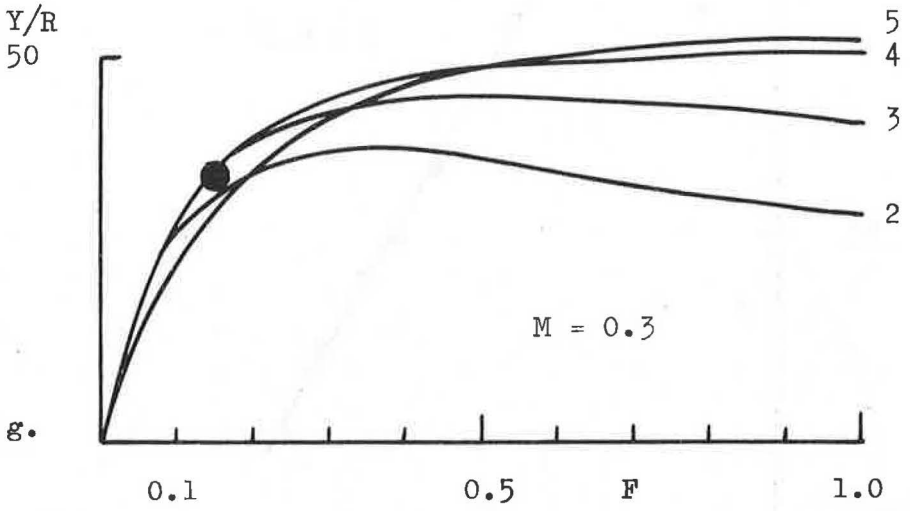
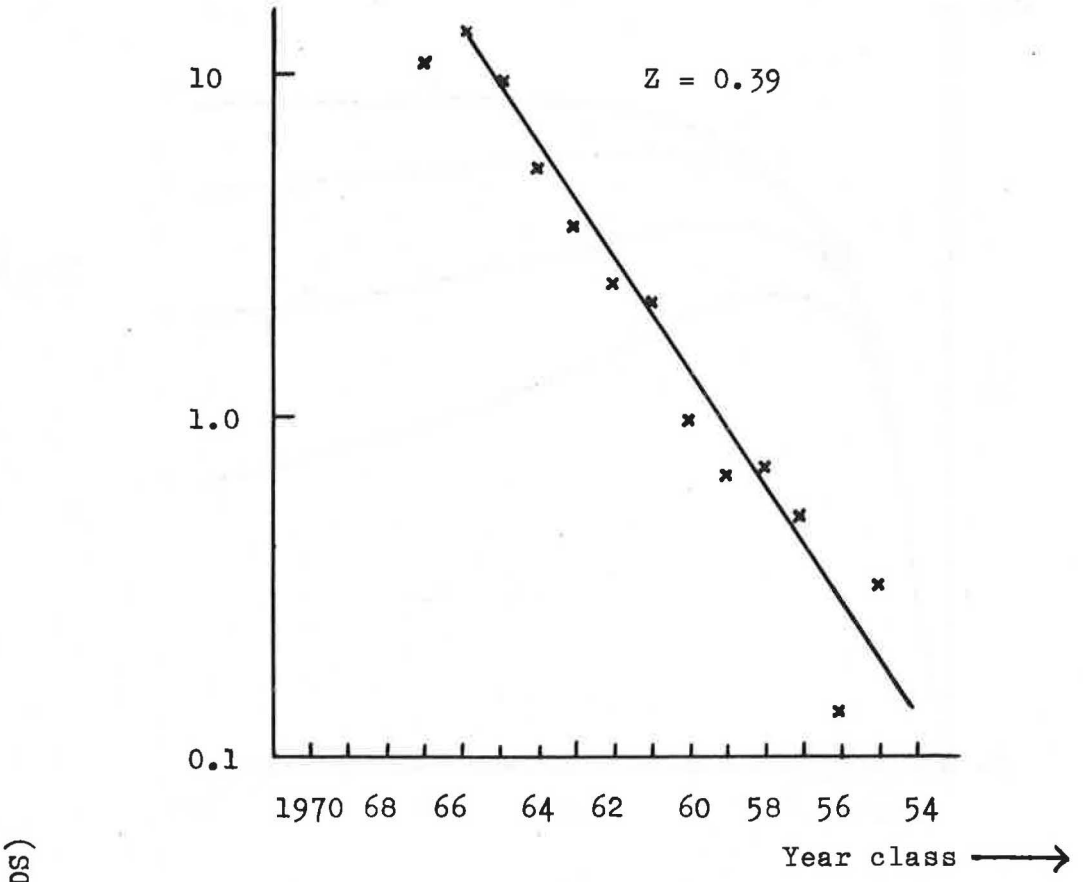


Figure 7. Yields per recruit of Faroe Lemon Sole. (Bertalanffy parameters derived from Scottish data 1972.) $W = 0.0107\ L^3$. Dots indicate present level on the yield curve.

Figure 8. Catch curve. Faroe Plaice 1972.



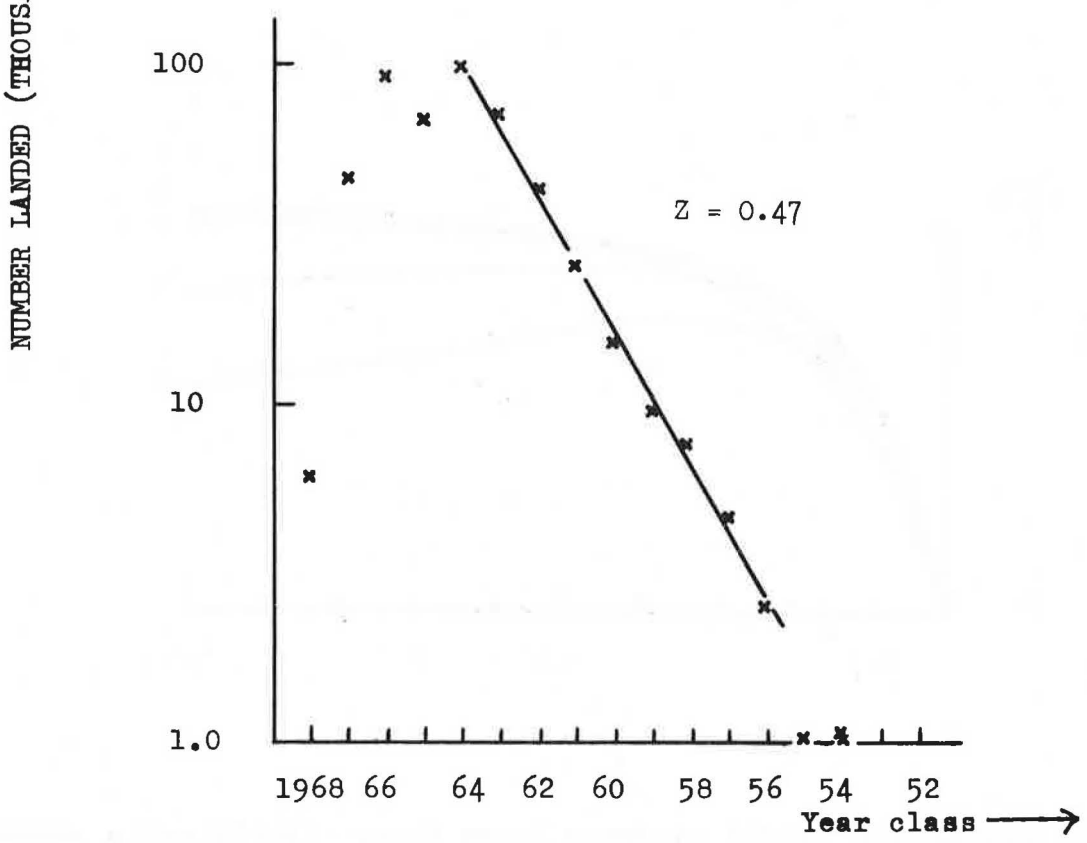


Figure 9. Catch curve. Faroe Lemon Sole 1972.

1.4.8 OTHER SPECIES

In Table 7.1.m catches for several species are given, including tusk, ling, angler, rays and skates, dogfishes, several species of flatfishes, catfishes and others. No data other than of catch were available to the Working Group, and thus no attempt was made to analyse the state of these stocks.

1.5 ADEQUACY OF DATA

Time has not allowed the Working Group to make any detailed study of the adequacy of data and sampling. From the report it will be seen that for several species catch statistics only are at hand.

For redfish and blue ling effort data from the Federal Republic of Germany are available, but no sampling of age and length composition. For the lemon sole and plaice stocks some Scottish and Faroese data for the most recent years were available for the length and age distribution, allowing estimation of growth parameters and yield/recruit curves. The most complete data were available for cod, haddock and saithe allowing estimates of mortalities, stock numbers, effects of changes in fishing effort and mesh size and predictions of catches. The agreement between independent estimates of mortality gave confidence in the results. However, it should be noted that the Faroese cod data in the former years have been taken from the spring long-line fishery for spawning cod only and are therefore not representative for the long-line fishery as a whole. Also, the Faroese haddock sampling has been very scanty in former years.

To be able to assess the state of stocks other than those of cod, haddock and saithe in more detail and for continuing work on these three species, it will be necessary for all countries to sample their catches in order to estimate the numbers of fish of each size landed each year. In addition, age/length keys will be required for all years.

1.6 REFERENCES

Anon., 1967. Coop.Res.Rep., Series B, 1967. ICES.

Jones, R., 1961. The assessment of the long-term effects of changes in gear selectivity and fishing effort. Journ. Mar.Res., 1961 (2).

TABLES 7.1 Catches in ICES Division Vb by country and species 1952-72, metric tons, round fresh.

Table 7.1.a COD

Year	Faroe Islands	France	Germany (Fed.Rep.)	Norway	U.K. England	U.K. Scotland	Others	Total
1952	4 550	175	-	-	12 365	13 283	-	30 373
1953	4 137	-	-	-	12 469	10 535	-	27 052
1954	5 190	600	37	125	16 017	14 238	-	36 164
1955	7 902	700	216	-	17 223	12 380	-	38 421
1956	7 938	-	689	-	8 337	10 610	-	27 574
1957	6 920	-	1 085	-	10 067	13 413	-	31 485
1958	6 535	-	1 011	-	9 828	10 523	-	27 897
1959	4 676	-	697	-	10 087	10 522	-	25 982
1960	8 723	-	451	-	13 746	16 300	-	39 220
1961	9 521	-	417	168	3 891	12 954	-	26 951
1962	6 751	100	301	505	5 521	11 052	-	24 230
1963	7 428	720	376	147	4 558	10 875	-	24 104
1964	8 888	989	1 162	333	5 845	7 791	-	25 008
1965	9 948	1 538	854	419	5 470	7 868	-	26 097
1966	7 957	1 120	669	314	4 871	7 855	130 xx)	22 916
1967	7 835	871	815	650	7 996	8 546	-	26 603
1968	13 763	2 519	1 180	686	7 096	8 524	-	33 768
1969	15 718	2 557	447	476	6 717	12 249	-	38 164
1970	15 245	2 616	225	238	3 707	9 790	-	31 821
1971	12 754	1 426	337	881	3 485	9 102	-	27 985
1972	12 143	1 462	262	266	3 019	6 483	-	23 635
1973 x)					5 167			

Table 7.1.b HADDOCK

1952	3 225	-	-	-	7 714	6 653	-	17 592
1953	2 788	-	-	-	5 965	6 404	-	15 157
1954	2 645	-	1	-	6 069	6 832	-	15 547
1955	3 865	-	33	-	5 148	7 667	-	16 713
1956	4 221	-	20	-	5 937	7 512	-	17 690
1957	4 453	-	38	-	7 105	9 602	-	21 198
1958	6 850	-	19	-	7 637	9 573	-	24 076
1959	5 670	-	10	-	5 536	9 220	-	20 436
1960	7 772	-	6	-	7 298	10 943	-	26 019
1961	8 454	-	22	-	2 765	9 590	-	20 831
1962	7 042	166	18	-	3 766	16 159	-	27 149
1963	6 336	792	22	-	4 655	15 766	-	27 571
1964	6 952	1 866	32	111	3 442	7 087	-	19 490
1965	6 673	1 939	8	119	3 385	6 355	-	18 479
1966	6 902	2 717	40	-	2 867	6 240	-	18 766
1967	5 246	1 091	30	-	2 347	4 656	8	13 378
1968	6 751	2 286	31	-	2 445	6 339	-	17 852
1969	11 122	3 314	45	-	1 976	6 815	-	23 272
1970	11 791	2 006	6	-	1 137	6 421	-	21 361
1971	10 488	790	1	-	2 323	5 762	-	19 393
1972	8 314	2 666	25	-	1 371	4 109	-	16 485
1973 x)			46		2 464			

x) Preliminary estimates.

xx) U.S.S.R.

Table 7.1.c SAITHE

Year	Faroe Islands	France	Germany (Fed.Rep.)	Norway	U.K. England	U.K. Scotland	Others	Total
1952	47	-	-	-	5 663	1 188	-	6 898
1953	9	-	-	-	6 087	1 088	-	7 184
1954	4	-	13	-	5 543	652	-	6 212
1955	89	-	484	-	5 643	1 018	-	7 234
1956	37	-	4 998	-	4 673	1 176	-	10 884
1957	979	-	21 082	-	3 869	928	-	26 858
1958	339	-	4 299	-	6 880	1 460	-	19 978
1959	536	-	6 781	-	5 688	1 540	-	14 545
1960	685	-	2 583	-	6 437	2 140	-	11 845
1961	929	-	2 219	-	4 230	2 214	-	9 592
1962	2 494	620	985	-	3 724	2 631	-	10 454
1963	2 431	2 207	1 471	-	3 178	3 463	-	12 750
1964	1 338	6 458	6 294	+	4 329	3 309	-	21 728
1965	1 000	8 565	3 611	-	5 265	3 794	-	22 235
1966	1 167	9 967	4 772	2 498	3 321	3 581	-	25 306
1967	2 242	5 555	6 119	-	4 536	3 996	-	22 448
1968	2 629	424	7 532	-	5 123	4 778	-	20 486
1969	4 835	7 899	4 775	378	4 303	5 346	-	27 536
1970	2 694	11 036	2 249	1 495	3 066	8 608	-	29 148
1971	5 653	10 621	2 251	1 839	3 305	7 198	63	30 930
1972	5 646	28 346	3 613	470	2 453	6 225	-	46 753
1973[x]			8 602	ca.200	7 460			

Table 7.1.d WHITING

1952	-	-	-	-	332	1 300	-	1 632
1953	-	-	-	-	563	1 167	-	1 730
1954	-	-	-	-	522	716	-	1 238
1955	-	-	1	-	298	581	-	880
1956	-	-	+	-	213	415	-	628
1957	-	-	+	-	157	554	-	711
1958	-	-	+	-	167	333	-	500
1959	-	-	+	-	249	246	-	495
1960	-	-	-	-	70	403	-	473
1961	222	1 200	-	-	50	257	-	1 729
1962	-	-	-	-	26	197	-	223
1963	-	-	+	-	33	285	-	318
1964	-	-	+	-	25	117	-	142
1965	-	1 421[a]	+	-	29	97	-	1 547
1966	-	225	-	-	28	139	-	392
1967	-	254	1	-	31	138	3[xx]	427
1968	-	80	1	-	46	172	-	299
1969	-	191	+	-	46	515	-	752
1970	-	73	-	-	35	251	-	359
1971	150	195	1	-	26	166	-	542
1972	-	194	-	-	137	139	-	470
1973[x]			7					

x) Preliminary estimates.

xx) Denmark.

a) Includes Iceland grounds.

Table 7.1.e TUSK

Year	Faroe Islands	France	Germany (Fed.Rep.)	Norway	U.K. England	U.K. Scotland	Others	Total
1952	187	-	-	1 007	92	387	-	1 673
1953	593	-	-	711	93	483	-	1 880
1954	560	-	7	511	95	401	-	1 574
1955	1 005	-	40	384	114	472	-	2 015
1956	818	-	58	484	83	586	-	2 029
1957	845	-	99	199	80	694	-	1 917
1958	812	-	48	1 068	106	1 066	-	3 100
1959	984	-	87	637	69	1 275	-	3 052
1960	1 306	-	32	734	135	1 260	-	3 467
1961	1 301	-	29	1 401	67	1 062	-	3 860
1962	1 902	-	21	1 134	54	1 405	-	4 516
1963	2 007	-	29	802	28	695	-	3 561
1964	2 775	-	137	875	30	799	-	4 616
1965	1 645	-	115	1 565	32	924	-	4 281
1966	1 488	-	87	1 221	21	482	-	3 299
1967	2 070	-	109	2 729	18	432	-	5 358
1968	2 798	-	91	2 906	23	549	-	6 367
1969	1 454	-	21	1 338	16	412	-	3 241
1970	1 028	-	19	1 475	11	515	-	3 048
1971	1 489	-	44	1 872	13	419	-	3 837
1972	1 918	-	139	2 421	16	386	-	4 880
1973[x]			134	ca.2 800				

Table 7.1.f LING AND BLUE LING

Year	Faroe Isl.	France	Germany[xx] (Fed.Rep.)		Norway[xxx]		U.K. England	U.K. Scotland	Others	Total
1952	56	-	-		679		489	540	-	1 764
1953	144	-	-		486		476	935	-	2 041
1954	122	-	1 247		414		474	479	-	2 736
1955	235	-	2 799		711		751	560	-	5 056
1956	277	-	2 025		1 036		533	749	-	4 620
1957	259	-	1 882		626		579	879	-	4 225
1958	616	-	2 115		795		589	823	-	4 938
1959	394	-	1 758		917		379	691	-	4 139
1960	520	-	895		400		629	855	-	3 299
1961	603	-	11		521		241	829	-	2 205
1962	450	387	9	B.Ling	326		247	572	-	1 991
1963	365	1 512	17	478	496	B.Ling	183	396	-	3 447
1964	480	2 844	48	2 493	736	182	322	632	-	7 737
1965	416	2 618	30	1 612	832	1 120	184	388	-	7 200
1966	416	1 827	39	850	2 115	430	276	496	-	6 449
1967	736	23	60	1 133	3 203	238	172	364	-	5 929
1968	1 209	177	68	1 858	3 340	788	152	679	-	8 271
1969	486	195	45	249	1 952	798	225	602	-	4 552
1970	699	578	42	335	1 737	2 612	164	883	-	7 050
1971	752	728	46	1 475	2 898	557	152	879	-	7 487
1972	1 572	866	74	2 779	3 958	1 203	146	772	-	11 370
1973[x]			157	2 929	ca3 000	ca4 000				

x) Preliminary estimates.

xx) 1954-62: Ling and Blue Ling not separated.

xxx) 1952-63: Ling and Blue Ling not separated.

Table 7.1.g LEMON SOLE

Year	Faroe Islands	France	U.K. England	U.K. Scotland	Total
1952	-	-	373	753	1 126
1953	-	-	361	462	823
1954	-	-	365	580	945
1955	-	-	307	480	787
1956	-	-	192	548	740
1957	-	-	343	678	1 021
1958	-	-	292	670	962
1959	-	-	358	752	1 110
1960	-	-	351	1 026	1 377
1961	-	-	156	1 009	1 165
1962	-	-	187	910	1 097
1963	-	-	142	706	848
1964	-	27	112	305	444
1965	-	42	110	393	545
1966	-	49	99	297	445
1967	-	14	104	321	439
1968	-	20	84	404	508
1969	-	-	77	362	441
1970	-	-	68	424	492
1971	590	-	76	303	969
1972	300	-	35	244	579
1973					

Table 7.1.h PLAICE

1952	115	-	79	140	334
1953	13	-	53	113	179
1954	27	-	78	142	247
1955	81	-	57	129	267
1956	19	-	57	145	221
1957	+	-	75	189	264
1958	4	-	75	157	236
1959	5	-	83	149	237
1960	64	-	62	209	335
1961	83	-	38	194	315
1962	26	-	73	164	263
1963	4	226	39	130	399
1964	11	131	64	99	305
1965	6	92	79	143	320
1966	1	108	106	161	376
1967	7	54	120	172	345
1968	102	28	158	170	458
1969	192	31	82	181	486
1970	288	-	59	205	552
1971	143	-	45	173	361
1972	130	+	50	111	291
1973					

Table 7.1.i HALIBUT

Year	Faroe Islands	France	Germany (Fed.Rep.)	Norway	U.K. England	U.K. Scotland	Total
1952	243	-	-	420	467	720	1 850
1953	149	-	-	437	414	663	1 663
1954	226	-	13	561	433	735	1 968
1955	335	-	428	560	554	866	2 743
1956	390	-	57	187	407	901	1 942
1957	374	-	125	366	557	1 165	2 587
1958	616	-	112	390	580	1 165	2 863
1959	404	-	125	180	593	1 261	2 563
1960	218	-	58	439	686	1 397	2 798
1961	222	-	165	327	287	1 237	2 238
1962	137	-	11	299	325	1 126	1 898
1963	161	-	10	128	241	887	1 427
1964	174	-	63	110	239	792	1 378
1965	276	-	35	124	292	725	1 452
1966	169	-	36	120	248	636	1 209
1967	245	-	57	180	178	749	1 409
1968	267	-	64	90	130	698	1 249
1969	205	-	18	151	124	558	1 056
1970	296	-	10	182	74	514	1 076
1971	234	-	14	197	92	371	908
1972	212	-	35	155	60	256	718
1973[x]			52	ca.70			

Table 7.1.j MEGRIM

1952	-	-	-	-	5	12	17
1953	-	-	-	-	4	19	23
1954	-	-	-	-	5	11	16
1955	-	-	-	-	5	21	26
1956	-	-	1	-	2	13	16
1957	-	-	3	-	3	12	18
1958	-	-	1	-	4	10	15
1959	-	-	1	-	5	6	12
1960	-	-	-	-	9	21	30
1961	-	-	-	-	8	17	25
1962	-	-	-	-	6	19	25
1963	-	-	-	-	5	26	31
1964	-	50	-	-	5	20	75
1965	-	47	-	-	5	17	69
1966	-	237	-	-	5	14	256
1967	-	212	-	-	1	6	219
1968	-	250	-	-	3	6	259
1969	-	312	-	-	3	8	324
1970	-	99	-	-	1	9	109
1971	-	37	-	-	2	9	48
1972	-	38	-	-	3	10	51
1973							

x) Preliminary estimates.

Table 7.1.k REDFISH

Year	Faroe Islands	France	Germany (Fed.Rep.)	U.K. England	U.K. Scotland	Total
1952	-	-	-	20	10	30
1953	-	-	-	139	16	155
1954	-	-	2 114	87	2	2 203
1955	-	-	10 020	151	2	10 173
1956	-	-	5 018	25	7	5 050
1957	-	-	5 217	27	7	5 251
1958	-	-	4 451	58	13	4 522
1959	-	-	3 440	38	11	3 489
1960	-	-	2 295	276	60	2 631
1961	-	-	3 577	50	38	3 665
1962	-	-	2 237	52	49	2 338
1963	1	366	2 035	31	60	2 493
1964	-	705	7 119	41	43	7 908
1965	1	582	4 864	38	27	5 512
1966	-	-	3 180	8	40	3 228
1967	-	-	4 853	24	22	4 899
1968	1	-	6 613	43	10	6 667
1969	5	-	1 225	13	15	1 258
1970	-	-	2 020	13	20	2 053
1971	-	-	2 479	12	12	2 503
1972	-	-	4 027	40	13	4 080
1973						

Table 7.1.l ANGLER (MONK)

1952	-	-	-	86	376	462
1953	-	-	-	69	320	389
1954	-	-	-	85	344	429
1955	-	-	3	157	338	498
1956	-	-	3	157	429	589
1957	-	-	3	214	631	848
1958	-	-	+	263	580	843
1959	-	-	13	269	629	911
1960	-	-	7	314	811	1 132
1961	-	-	11	167	695	873
1962	-	-	4	179	641	824
1963	-	-	-	160	618	780
1964	-	-	3	218	347	568
1965	-	-	-	212	326	538
1966	-	-	-	164	349	513
1967	-	-	-	118	308	426
1968	-	-	3	159	335	497
1969	1	26	1	175	429	632
1970	-	10	-	127	542	679
1971	-	-	-	132	532	664
1972	-	3	2	99	388	490
1973 x)			6			

x) Preliminary estimate.

Table 7.1.m OTHER SPECIES

Year	Dab	Turbot	Witch	Various Pleuro-necti-forms	Hake	Pollack	Various Gadi-forms	Cat-fishes	Conger Eel	Gurnards	Dog-fishes	Rays and Skates	Non-teleost fishes	Various un-identified fishes
1952	114	2	4		74	53		133	4	63	898	397		146
1953	198	3	4		90	12		113	5	42	686	508		137
1954	259	1	1		62	4		136	2	18	662	348		293
1955	192	4	3		26	7		174	2	21	579	485		802
1956	129	2	2		15	2		242	2	10	526	518		568
1957	126	1	3		18	3		259	3	13	524	485		552
1958	107	2	3		20	3		217	1	24	754	450		326
1959	114	3	1		26	5		222	2	17	738	471		645
1960	261	3	6		41	8		348	9	29	1 089	659		499
1961	119	2	6	8 771	39	4	679	231	2	22	720	564	3	190
1962	121	2	51	341	167	5	345	202	4	18	663	475	12	1 209
1963	108	+	50	379	270	6	605	364	2	9	1 166	473	30	838
1964	56	18	27	264	144	4	2 365	145	2	15	1 070	616	2	615
1965	68	13	27	660	123	8	1 711	97	4	10	1 140	657	1	554
1966	54	7	10	537	103	5	1 269	67	10	7	376	537	591	1 501
1967	68	3	12	227	48	2	1 298	86	8	9	359	481	393	98
1968	105	+	1	580	311	12	2 850	89	15	30	330	551	1	2 007
1969	203	1	2	51	361	20	1 101	56	18	21	400	621	946	2 160
1970	56	1	4	48	36	6	3 132	92	13	2	174	534	94	127
1971	49	1	1	11	28	5	1 937	100	5	5	153	400	129	176
1972	45	+	2	417	56	3	3 975	209	16	324	97	380	541	823

Table 7.1.2 Quantity of Cod, Haddock and Saithe landed ('000 cwt) from the Faroe Plateau and the Faroe Bank by British trawlers landing in Scotland.

Year	Cod		Haddock		Saithe	
	Plateau	Bank	Plateau	Bank	Plateau	Bank
1961	187.6	3.3	162.6	3.2	35.3	1.1
1962	162.6	6.4	274.6	7.4	42.3	1.6
1963	159.8	6.3	263.1	12.1	54.0	2.8
1964	106.4	6.2	118.8	4.6	51.8	2.4
1965	110.9	4.0	107.0	3.3	60.1	2.0
1966	115.3	6.3	102.0	6.7	54.2	4.4
1967	112.1	8.2	76.1	4.9	58.8	6.7
1968	115.2	11.8	101.0	8.8	68.4	9.9
1969	180.9	8.3	103.6	6.2	81.9	4.3
1970	132.6	15.1	94.8	16.4	123.1	18.1
1971	120.5	11.4	86.2	12.9	103.7	14.3
1972	82.3	10.8	49.5	18.7	88.0	14.0

Table 7.1.3 Faroe Division Vb. Fishing effort and landings per unit effort.

	Estimated total effort			Landings per unit effort		
Year	Cod (1)	Haddock (1)	Saithe (2)	Cod (3)	Haddock (3)	Saithe (4)
1950	54	45	34	666	303	160
1951	65	54	41	544	272	212
1952	65	59	32	511	298	216
1953	53	53	28	511	286	260
1954	56	55	27	641	283	227
1955	59	56	30	654	299	245
1956	58	49	42	474	363	259
1957	64	58	146	494	367	182
1958	76	79	53	368	304	243
1959	74	82	71	352	248	203
1960	118	141	74	331	199	161
1961	108	106	42	250	196	230
1962	101	92	56	239	295	186
1963	90	80	60	267	343	214
1964	80	78	80	315	250	267
1965	81	75	64	336	246	344
1966	63	70	91	363	268	279
1967	52	61	76	510	218	277
1968	74	71	51	464	252	399
1969	71	87	76	537	269	359
1970	79	85	68	405	252	427
1971	65	61	68	435	316	454
1972	72	79	189	328	209	247

(1) British units = million ton-hours.

(2) English units = million ton-hours steam + motor trawl.

(3) Tons per million ton-hours, British trawlers.

(4) Tons per million ton-hours, English trawlers.

Table 7.1.4 TOTAL DEMERSAL. Faroes[x]. Total landings, round fresh weights in '000 metric tons.

Year	England	Scotland	Faroes	Others	Total
1924	55.3	13.7	4.9	-	73.9
1925	45.5	9.5	7.9	0.7	63.7
1926	44.2	16.7	6.4	1.1	68.3
1927	46.9	18.0	8.2	1.0	74.0
1928	40.9	12.7	5.0	3.0	61.6
1929	38.3	9.2	2.2	1.2	51.0
1930	42.3	12.8	2.6	3.2	61.2
1931	58.6	17.3	1.8	1.4	79.1
1932	61.6	17.6	5.3	1.0	85.4
1933	55.6	15.8	2.6	0.8	74.9
1934	53.0	15.0	2.3	0.1	70.4
1935	53.8	15.2	2.0	0.1	71.2
1936	54.1	18.7	1.6	1.0	75.4
1937	39.0	15.2	3.7	1.3	59.3
1938	40.6	14.8	3.5	0.4	59.2
1946	32.8	19.7	-	-	52.4
1947	31.7	22.7	-	0.1	54.5
1948	15.0	21.5	-	-	36.5
19[illegible]9	21.6	26.5	-	-	48.1
1950	27.2	32.4	-	0.4	60.1
1951	32.8	31.3	-	1.9	65.9
1952	28.8	25.9	8.4	1.3	64.4
1953	27.6	22.9	7.9	1.6	59.9
1954	30.5	25.7	8.9	5.8	70.9
1955	31.2	25.2	13.5	17.2	87.1
1956	21.2	23.8	13.7	15.2	73.9
1957	23.5	29.5	13.8	31.3	98.1
1958	26.9	27.0	15.8	14.7	84.5
1959	23.9	27.0	13.1	14.9	78.9
1960	31.0	36.6	19.6	8.0	95.3
1961	12.5	31.1	21.3	19.8	84.7
1962	14.7	35.6	19.2	9.1	78.6
1963	13.6	34.5	19.1	14.4	81.6
1964	15.1	21.9	20.8	34.5	92.3
1965	15.6	21.9	20.2	35.9	93.6
1966	12.4	20.6	18.3	36.2	87.5
1967	15.1	20.5	18.5	29.1	83.2
1968	15.8	23.1	27.7	33.9	100.5
1969	14.2	28.1	34.2	47.1	123.6
1970	8.7	28.7	32.1	29.7	99.2
1971	9.9	25.4	32.1	29.2	96.6
1972					

[x] Plateau and Bank combined.

Table 7.1.5 Estimates of Bertalanffy growth parameters.[1)]

Species	Source	Year	L_∞	$s^2_{L_\infty}$	K	s^2_K	t_o	$s^2_{t_o}$	Notes
Haddock**)	Scotland	1950-72	82.7	13.5	.149	.00039	-1.55	.119	♂ + ♀ 1+ excluded
Cod**), Bank stock	England	1959-72	111.7	1.6	.354	.00042	0.46	.00114	♂ + ♀ 1+ excluded
Cod**) Plateau stock	England	1959-72	129.9	68.3	.131	.00043	-1.21	.12	♂ + ♀ 1+ excluded
Plaice	Faroe	1967	56.5	8.6	.476	.043	0.45	.422	♂
Plaice	Faroe	1967	69.8	7.9	.248	.0020	-0.24	.248	♀
Plaice	Scotland	1972	83.4	7.1	.113	.00014	-1.18	.155	♂ + ♀ 3+ included
Plaice**)	Scotland	1972	84.8	14.1	.105	.00026	-1.55	.485	♂ + ♀ 3+ excluded
Lemon sole	Faroe	1967	36.7	53.6	.222	.138	-2.55	84.21	
Lemon sole**)	Scotland	1972	44.0	0.67	.175	.00043	0.05	.368	♂ + ♀ 4+ excluded
Lemon sole	Scotland	1972	44.6	0.70	.159	.00026	-0.54	.242	♂ + ♀ 4+ included
Lemon sole	Faroe	1961	36.9		.223		-2.32		♂ *)
Lemon sole	Faroe	1965	33.3		.591		1.20		♂ *)
Lemon sole	Faroe	1966	41.9		.253		-0.55		♂ *)
Lemon sole	Faroe	1961	38.7		.372		-0.15		♀ *)
Lemon sole	Faroe	1965	50.9		.072		-8.67		♀ *)
Lemon sole	Faroe	1966	40.4		.359		-0.14		♀ *)

*) From mean variance data.

**) Estimates used for yield calculation.

1) The estimation is done according to a programme running at the Danish Institute for Fisheries and Marine Research, Charlottenlund. By an iterative process a least square fit of the growth curve to the observed data is found.

2. REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP, 1974

2.1 INTRODUCTION

The Working Group was set up at the request of the Liaison Committee at the 1973 Statutory Meeting of ICES and a meeting was held in Charlottenlund from 4-8 March 1974. The following members participated:-

R de Clerck	Belgium
K Popp Madsen	Denmark
H Knudsen	Denmark
E Nielsen (Mrs)	Denmark
G Rauck	Germany (Fed.Rep.of)
F Wagner	Germany (Fed.Rep.of)
N Daan	Netherlands
J F de Veen (Chairman, North Sea Flatfish WG)	Netherlands
J Lahn-Johanessen	Norway
R Jones, Chairman	U.K.
M J Holden	U.K.
D W Armstrong	U.K.
R C A Bannister	U.K.
V Anthony	U.S.A.
E G Heyerdahl	U.S.A.

Mr D de G Griffith, ICES Statistician, also took part in the discussions.

The principal objectives of the Group (see C.Res.1973/2:23) were to re-assess the state of cod, haddock and whiting stocks in the North Sea, and to recommend total allowable catches for these species. In addition, at the end of the meeting (see C.Res.1973/2:22) the North Sea Roundfish Working Group joined with the North Sea Flatfish Working Group to consider multi-species mesh assessments for cod, haddock, whiting, plaice and sole.

2.2 TRENDS IN LANDINGS

During the last decade, landings of cod, haddock and whiting have all been very high, relative to long-term landings. For each of these species the highest individual annual landings on record occurred during the period 1967-72.

Cod (Tables 1 and 2). During the period 1967-72, cod landings averaged 271 000 tons. The highest landing was 346 000 tons in 1972.

Haddock (Tables 3 and 4). During the period 1967-72, haddock landings averaged 348 000 tons with values exceeding 600 000 tons in 1969 and 1970.

Whiting (Tables 5 and 6). During the period 1967-72, whiting landings averaged 140 000 tons with a maximum value of 215 829 tons in 1969.

For all three species, the relatively very high level of landings has been largely due to good year classes. For example, the 1964, 1965, 1966 and 1970 year classes of cod have been good in all parts of the North Sea, as were those of 1963 and 1969 in the southern North Sea.

For haddock, the best year class recorded this century occurred in 1967 and this accounted for the extremely high landings in 1969 and 1970.

For whiting there was also a very good year class in 1967, and this contributed to the high landings in 1969.

The relatively high landings for the three species during the past decade are also partly due to the increase in exploitation by countries that in previous years did not land large quantities from the North Sea. In particular there has been a growth of the Danish fishery for industrial fish species to a high level in the course of which large quantities of young whiting and haddock have been caught in certain years. Also, there have been years when Soviet vessels have operated in the North Sea.

2.3 LANDINGS PER UNIT EFFORT (Table 7)

Landings per unit effort for cod, haddock and whiting by various classes of vessels are shown in Table 7. They largely reflect fluctuations in year class strengths although the years in which good year classes made their maximum impact varied with both area and gear.

2.4 EFFORT

The Group considered the value of making estimates of total fishing effort in units of particular kinds of gear. It was felt that the North Sea gadoid stocks were so heterogeneous and were fished in so many ways, and by so many different gears, that to measure total fishing effort in units of any one gear, might be misleading. No estimates of total fishing effort have therefore been calculated.

2.5 DATA FOR MAKING ASSESSMENTS

The principle data available for making assessments consisted of length and age composition data.

2.5.1 Length compositions

For each country, for which data were available, the length compositions have been raised to numbers landed per year. This was done by raising the numbers in each length composition so that the sum of the products of the numbers in each length group, times the average round fresh weights corresponding to each length group, equalled the weight of the landings for the species and country in question shown in "Bulletin Statistique".

In addition, estimates of the numbers discarded have been made by the Netherlands, so that for this country it has been possible to estimate numbers caught as well. (Figure 1, and Tables 8-10).

Cod (Table 8). Cod length compositions have been supplied by Belgium, Denmark, France, England, Scotland and the Netherlands and these are shown in Table 8.

Haddock (Table 9). Haddock length composition data have been supplied by England, Scotland, Netherlands, Norway and U.S.S.R. For the Soviet fishery, the only data available were for the period 1964-70 from Anon. (1971), and these refer to numbers caught, not numbers landed.

Whiting(Table 10). Whiting length composition data were supplied by Belgium, Denmark, England, Scotland and the Netherlands. The

Group noted that the numbers of whiting taken by Denmark in their industrial fishery were disproportionately greater than those taken by the other countries for which length composition data were available. However, the estimates of the numbers landed by Danish vessels at each length are unreliable because there are few sampling data.

2.5.2 Age compositions

Estimates of the numbers of fish landed by age and year of capture have been determined. Computational details are summarised in Appendix 1 (p. 56). In addition estimates of the numbers discarded in each age group were made by the Netherlands and these data are shown in Table 11. It was noted that various methods of raising age compositions to total landings had been adopted. It was recommended that before the next meeting, the Group should try to standardise the procedure for doing this.

Cod (Tables 12 and 13)

For cod, separate estimates of numbers landed were made for Divisions IVa and IVb,c and the values are shown in Tables 12 and 13. In both areas, fish were mainly captured when two or three years of age, although in some years considerable numbers of one year old cod were taken, especially in Divisions IVb,c.

Haddock (Table 14)

For haddock insufficient information was available to enable separate assessments to be made for different parts of the North Sea and estimates of the numbers landed from the entire North Sea are given in Table 14. Haddock were mainly captured when 2-4 years of age.

Whiting (Table 15)

As in the case of haddock, it was not possible to make separate estimates for whiting for different parts of the North Sea. Table 15 shows estimates of the numbers landed by year and age group for the whole North Sea. This species was mainly taken as 0-4 year old fish. The Group noted that all the 0-group, and a considerable proportion of the one year old fish were taken in the Danish industrial fishery, although, as mentioned under 2.5.1 Length compositions, Whiting, these estimates were based on very inadequate sampling.

2.6 VIRTUAL POPULATION ANALYSIS (VPA)

As part of the stock assessment procedure, a VPA was done for each species, using estimates of the numbers caught in each year class and age group. For this purpose, the numbers landed given in Tables 12-15, together with the estimates of the numbers discarded by the Netherlands (Table 11) were used. Analyses were done for each year class. These provided estimates of instantaneous rates of fishing mortality (F) and of numbers of fish in the sea and these are shown in Tables 16 to 23, arranged by age group and year of capture.

2.6.1 Mortality rates

Estimates of the instantaneous fishing mortality rate (F) at each age and for each year are given in Tables 16-19. In each table the values of F assumed initially, are shown in the penultimate right-hand column and in the bottom row.

It should be noted that because the analysis requires assumptions about the values of F in the oldest age group sampled, in each year class the estimates for the three oldest age groups for the three most recent years are less reliable than the other estimates.

Cod (Tables 16 and 17)

Estimates of F are given for cod in Divisions IVa and IVb,c, separately, in Tables 16 and 17. In both areas the values of F obtained for the one year old fish were relatively low. For the older fish, in IVb,c, the values of F tend to be highest for the younger age groups. In IVa, however, trends in F with age are less noticeable. *)

Haddock (Table 18)

Estimates of F by age and year of capture for this species are given in Table 18 for two values of the instantaneous rate of natural mortality (M). The values tend to increase with age.

Whiting (Table 19). Estimates for whiting of F by age group and year of capture are shown in Table 19. Apart from 1969 and 1970, when high values of F were obtained for 0- and 2-group fish, there has been an increase in fishing mortality rate with increasing age.

2.6.2 Estimates of numbers in the sea

In addition to estimates of fishing mortality, the VPA provides estimates of actual numbers of fish in the sea at each age, and in each year. The results are shown for cod, haddock and whiting in Tables 20-23.

2.7 YEAR CLASS STRENGTH

Estimates of year class strength have been made both from the VPA for each species, and also from research vessel samples. These are summarised and compared in Table 24.

2.8 STOCK ASSESSMENTS

Four different assessments have been made for each species. These deal with:-

Yields per recruit,

catch rates,

total allowable catch for 1975,

the effects of increase in mesh size.

2.8.1 Yields per recruit (Table 25)

Yields per recruit were calculated using the principle of the Beverton and Holt yield/recruit model modified to take account of variations in the fishing mortality rate with age. The calculations were made with reference to an estimated yield per recruit applicable to the present-day situation, using the arrays of F at each age summarised in the extreme right-hand columns of Tables 16-19. It was

*) See also the Supplement (p.85-86).

assumed that any given percentage change in fishing effort would cause the fishing mortality rate at each age to change by the same percentage. It was also assumed that any percentage change in the fishing mortality rates at each age, would apply equally to all gears and to all countries.

The effects of various percentage changes in the fishing mortality rates at each age were calculated using a modification of the numerical technique described by Jones (1961). Minor adjustments were made to the mean weights at age, to allow for the fact that changes in effort would alter the average age of capture within each age group. The results for various values of natural mortality are shown below.

Cod. The percentage changes in yield per recruit plotted against percentage changes in the fishing mortality rate (both with reference to present-day levels) are shown in Figure 2 and Table 25 for a value of M = 0.2. The results show that the maximum sustainable yield per recruit should be attained if the fishing mortality rate were reduced by 60% of its current level. At this level of effort the yield per recruit should be about 33% higher than it is at present.

Haddock. For haddock, although no reliable estimates are available for M, unpublished data by Jones suggest that this may be rather higher than previously assumed. For this reason, yields per recruit were calculated assuming values of M = 0.2 and also 0.3. The results are shown in Figure 3 and Table 25. These suggest that a reduction in effort should increase the yield per recruit if M = 0.2, but not if M = 0.3.

Whiting. Since 1969, fishing mortality rates for whiting appear to have increased in the younger age groups (see Table 19) as a result of the large numbers of very young whiting landed recently (Table 15). Assessments were therefore made, starting with values of F at each age for the periods 1967-68 and also 1969-71. Values of M = 0.2 and 0.3 were also used.

The results suggest that prior to 1969, fishing effort may have been near the level required for obtaining the maximum yield per recruit. Since 1969, however, the level of fishing effort may have risen to a level in excess of that required for obtaining the maximum sustainable yield per recruit. Mean results are shown in Figure 4 and Table 25.

The Group wish to emphasize that these calculations refer only to the effects of changes in effort on yield per recruit, assuming no change in natural mortality or growth rate. In addition, for all three years, actual yields (as distinct from yield per recruit) could be influenced if the mean level of recruitment were to change with changes in stock size. At present there are insufficient data to allow for these factors.

2.8.2 Catch levels

Changes in fishing effort can be expected to influence catch rates (i.e. catches per unit fishing time) as well as total yield.

For all three species, it is expected that catch rates should improve if fishing effort were reduced. Conversely, any increase in fishing effort should cause catch rates to decline.

2.8.3 Total allowable catch (TAC) for 1975

The Group made two estimates of TAC:

a) that which would prevent the fishing mortality rate from increasing above its current level.

b) that which would reduce the fishing mortality rate by 50-60%, this being the reduction required to obtain the maximum sustainable yield per recruit for cod.

The values (in tons) recommended under each of these headings were as follows:-

	(a)	(b)
Cod	250 000	130 000
Haddock	240 000	140 000
Whiting	190 000	110 000

The Group noted that for haddock and whiting, the TACs were particularly dependent on the estimates of the most recent year class strengths. To date, the estimates of these are unreliable and for this reason less confidence can be placed on the estimates of TAC for haddock and whiting than on those for cod.

2.8.4 The effect of changes in mesh size

Assessments were made of the effect of changes in mesh size using the method described by Gulland (1961), modified to take account of ways in which fish released by one nation may become available to capture by other nations. It was assumed that the fishing mortality rates at each age remained constant at their present level.

Information on the mesh sizes at present in use was taken from the Cooperative Research Report for 1969 and this is shown in Table 26 together with the selection factors used for each species and values of the 25%, 50% and 75% selection lengths.

Values of the mesh sizes in use which were used in the calculations are shown in Table 27 along with other selectivity data. Assessments were made for increases in mesh size to 85 and 90 mm for haddock and whiting and for an increase to 90 mm only for cod. (All mesh sizes refer to double synthetic twines.)

Cod, haddock and whiting released in some parts of the sea would not necessarily become available to vessels fishing in all other parts of the sea. Consequently, assumptions have to be made about the ways in which released fish would become distributed. Due to lack of time, it was not possible to do this for a full range of possibilities. Consequently, Table 28 gives only one possible set of estimates for each year.

2.8.4.1 Immediate effects

Cod. For cod, the immediate effects on landings of an increase in mesh size to 90 mm would be a loss of 2% - 3%.

Haddock. Mesh increases should lead to the following percentage losses in landings:

3% - 8% for an increase to 85 mm

6% -13% for an increase to 90 mm.

Whiting. Mesh increases should lead to the following percentage losses in landings:-

19% - 37% for an increase to 85 mm

35% - 52% for an increase to 90 mm.

2.8.4.2 Long-term effects

Cod. The long-term effect of an increase in mesh size to 90 mm would be a gain of about 10%.

Haddock. Increases in mesh size should lead to the following overall long-term gains in landings for United Kingdom and Netherlands vessels:-

5% for an increase to 85 mm

8% for an increase to 90 mm.

Whiting. Increases in mesh size should lead to the following overall long-term gain in landings for United Kingdom and Netherlands vessels:

14% for an increase to 85 mm

18% for an increase to 90 mm.

For this species the assessments were made on the assumption that there was no change in the mesh size used in the Danish industrial fishery. Any increase in the mesh size used by these vessels should lead to gains by the vessels of other countries. The Group did not, however, take time to calculate how large these gains should be. *)

2.9 SUMMARY

The principle objectives of the meeting were to assess the state of the cod, haddock and whiting stocks in the North Sea, to recommend total allowable catches for these species, and to calculate the effects of changes in mesh size.

For cod the present level of fishing mortality rate is higher than that required for obtaining the maximum sustainable yield per recruit. This should be attained by reducing fishing mortality rate at each age by about 40-60% below its present level, which should increase the yield per recruit by about 33%.

For haddock and whiting, fishing effort is probably also too high, although for these species it is more difficult to determine by how much effort should be reduced in order to obtain the maximum sustainable yield per recruit.

*) See also the Supplement (p.85-86).

These assessments have been made on the assumption that all fisheries reduce their effort by proportionately the same amounts.

For all three species, a reduction in effort should lead to an increase in the catch per unit effort.

Two estimates of TAC for 1975 were made for each species. These were:-

a) The TAC required to prevent fishing mortality rate from increasing above its present level.

b) The TAC required to reduce the fishing mortality rate by 50-60% of its present level.

The recommended TACs (in tons) were as follows:-

	(a)	(b)
Cod	250 000	130 000
Haddock	240 000	140 000
Whiting	190 000	110 000

The effects of increases in mesh size to 85 and 90 mm (all mesh sizes refer to double synthetic twine) were considered for countries for which recent length composition data were available.

Due to lack of time, however, assessments were made for only one of a number of possible assumptions about the way in which fish released by one nation might become available for capture by other nations.

For cod, an increase in mesh size to 90 mm should lead to small gains for U.K. and Dutch vessels.

For haddock and whiting, an increase in mesh size to 90 mm should lead to overall gains for U.K. and Dutch vessels. Seperate estimates for English, Scottish and Dutch vessels are given in Table 28.

2.10 RECOMMENDATIONS

(i) The Working Group recommended that those countries that do not at present collect cod, haddock and whiting length composition data should do so. If possible, age composition material should also be collected.

(ii) The Working Group recommended that further assessments should be made to assess the effects of change in mesh size, and also to assess the effects of simultaneous changes in mesh size and fish effort.

(iii) The Working Group recommended that before their next meeting, a standard procedure should be agreed, by correspondence, for estimating the numbers landed at each age.

2.11 REFERENCES

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JOINT STATEMENT BY THE NORTH SEA ROUNDFISH AND FLATFISH* WORKING GROUPS

The two Working Groups met for a short time on 8 March to make a multi-species mesh assessment. This was discussed but it was agreed that at present there were neither the data nor the biological knowledge necessary for doing this. The Working Groups therefore had no alternative but to make mesh assessments for each species separately, and to consider the implications of the results in a general way. This was done for cod, haddock, whiting, sole and plaice.

It was agreed that there should be a long-term gain to the fishery for each species from an increase in mesh size to at least 90 mm. The effect of this on national fisheries is shown in Table 28.

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*) Report of the North Sea Flatfish Working Group, ICES, Doc. C.M.1974/F:6 (mimeo).

APPENDIX 1

METHODS OF ESTIMATING TOTAL AGE DISTRIBUTIONS OF LANDINGS FROM THE NORTH SEA

COD

Section 1. 1963-67:

Division IVa:

1. English and Scottish age compositions from Statistical News Letters (SNL) were calculated in the manner described in Section 2.
2. For other nations the age distributions for Scottish northern and north central areas were raised to total landings of all other nations by weight.

Divisions IVb,c

1. English age compositions were calculated in the manner described in Section 2.
2. For other nations an age composition was derived from the English and Netherlands age compositions for 1968 and 1969 as shown in the Worksheet (p. 58).

Section 2. 1968 onwards:

Belgium

Total landings included in IVb,c stock.

1968-69	Length distributions converted to age distributions using Netherlands age/length key (ALK).
1970-	Age compositions from SNL.

England

1963-

Division IVa	Age composition of landings at North Shields (SNL) raised to English total landings by weight.

Divisions IVb,c

1963	Age compositions of landings at Grimsby (SNL) raised to total English landings by weight.
1964-	Age compositions of landings at Grimsby and Lowestoft (SNL) raised to total English landings by weight.

Denmark

Total landings included in IVb,c stock.

1968-70	Age composition of cod caught by Grimsby seiners raised by weight.
1971-	Length distribution in SNL converted to age distributions using English (Grimsby) ALK, on a quarterly basis.

Faroes

Total landings from Division IVa.

1968- Age composition data for Scottish northern and north central areas raised to total landings.

Federal Republic of Germany

1968-

Division IVa — Scottish age compositions for northern and north central areas raised by weight.

Divisions IVb,c — Netherlands age composition for southern area raised by weight.

France

1968-

Division IVa — (as for Federal Republic of Germany).

Divisions IVb,c — French length distributions converted to age distributions using English (Lowestoft) ALK: on an annual basis for 1968-69, and on a quarterly basis for 1970.

Netherlands

Age data available from SNL.

Division IVa — North and east areas.

Divisions IVb,c — South and west areas.

Poland — (as for Faroes)

Scotland

Total landings from Division IVa.

1963- Landings from northern and north central areas given in SNL taken as actual landings from these areas. Age composition data for remaining areas then raised to total landings given in Bulletin Statistique (Bull.Stat.) minus landings from northern and north central areas.

U.S.S.R. — (as for Faroes).

EXPLANATORY NOTE

"Raised by weight": in all cases the age compositions have been raised to total weight of cod landed by each country from each ICES Division by multiplying by the ratio:

$$\frac{\text{Total weight landed from ICES Division}}{\text{Total weight of cod corresponding to age distributions used}}$$

$$R = \frac{88\ 740}{44\ 114} = \frac{\text{Actual landings}}{\Sigma\ (C.\bar{W}.D.)}$$

Age Years	A	B	$\frac{B}{A} = C$	$\bar{W}$	D	$C.\bar{W}.D.$ x 10^{-3}	$\frac{C.\bar{W}.D.R.}{\bar{W}}$
1	370	7 154	19.335	183	1 453	5 141	56 513
2	15 371	32 227	2.097	930	9 696	18 906	40 893
3	14 777	11 260	0.762	2 186	4 997	8 324	7 660
4	4 597	2 998	0.652	3 730	2 929	7 124	3 842
5	2 272	892	0.393	5 358	533	1 120	420
6	834	643	0.771	6 928	380	2 030	589
7	237	98	0.414	8 359	234	811	195
8+	284	141	0.497	9 614	130	658	131 (p)
Totals						44 114	

A = English age composition by numbers x 10^{-3} for 1968-69.

B = Netherlands age composition by numbers x 10^{-3} for 1968-69.

$\bar{W}$ = mean weight (g).

D = English age composition by numbers x 10^{-3} for 1967.

$C.\bar{W}.D.$ = estimated weight of "other nations" landings for 1967, total = 44 114 tons.

R = ratio of actual weight of "other nations" landings for 1967 to those of estimated landings.

Σ = derived "other nations" age composition in numbers x 10^{-3}.

(p) = this figure then divided into appropriate older age groups by reference to English data.

Derived "other nations" age compositions for subsequent years are obtained by substituting English age compositions at 'D'.

WORKSHEET: Method of deriving "other nations" age compositions for the period 1963-67 for Divisions IVb,c; example for 1967.

HADDOCK

1) Scotland - Trawl. Scottish trawl age frequencies were adjusted by the sum of products (SOP)* to agree with total Scottish North Sea landings by trawlers (Scottish Sea Fisheries Statistical Tables).

Seine. Scottish seine age frequencies were adjusted by SOP*, to agree with total Scottish North Sea landings by all gears other than trawl (Scottish Sea Fisheries Statistical Tables).

2) England - Trawl. English length frequencies (SNL) for Lowestoft, Grimsby and North Shields were combined and converted to age frequencies using Scottish ALK for central and north central areas. These age frequencies were adjusted by SOP to agree with the total English North Sea landings by trawlers (English Sea Fisheries Statistical Tables).

Seine. As for trawlers using length frequencies (SNL) for North Shields and adjusting the resultant age frequencies by SOP to agree with the English North Sea landings by all gears other than trawl (English Sea Fisheries Statistical Tables).

3) Netherlands (data for 1967-72 only) - Age frequencies (SNL) for otter and herring trawl, pair trawl, and beam trawl, were combined and adjusted by SOP to agree with the Netherlands North Sea landings.

4) U.S.S.R. (data for 1966-70 only). Data in Anon. (1971) were adjusted by SOP to agree with the total U.S.S.R. North Sea landings.

5) The data for Scottish, English, Netherlands and U.S.S.R. trawlers were added within years and adjusted by SOP to agree with the total North Sea landings for all countries except Denmark.

6) The English and Scottish seine data were then combined with the data obtained in (5).

7) The data obtained in (6) were then adjusted by SOP to agree with the total North Sea landings for all countries (i.e. including Denmark).

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*) "Adjusted by SOP" means that the numbers at each age were adjusted so that the sum of products of the numbers in each age group with the mean round weights of each age group were equal to the appropriate Bulletin Statistique landings, or other landings data where explicitly stated. In all cases, the mean weights-at-age used were those calculated for Scottish haddock. (See Appendix 2, p.62 for the mean weights-at-age for this purpose.)

WHITING

1) Scotland - Trawl. Scottish trawl age frequencies adjusted by SOP to agree with the total Scottish North Sea landings by trawlers (from the Scottish Sea Fisheries Statistical Tables).

Seine. Scottish seine age frequencies were adjusted by SOP to agree with the total Scottish North Sea landings by all gears other than trawl (Scottish Sea Fisheries Statistical Tables).

2) England - Trawl. i) 1959-69 trawler length frequencies (SNL) for Lowestoft, North Shields and Grimsby were combined and converted to age frequencies using Scottish ALK for central and north central areas. These age frequencies were adjusted by SOP to agree with the English North Sea landings by trawlers (English Sea Fisheries Statistical Tables).

ii) 1970 Lowestoft and North Shields inshore age distributions (SNL) were added and raised to include the numbers of whiting landed by Grimsby and North Shields offshore trawlers. This age frequency was adjusted to SOP to agree with (Bull. Stat.IVa + IVb English landings) minus (English landings from the North Sea by all gears other than trawl).

iii) The 1971 North Shields offshore age frequency was added to the Lowestoft and North Shields inshore age frequencies (SNL). The resulting age frequency was raised to include the numbers landed by trawlers at Grimsby, and then adjusted by SOP as in (ii) above.

Seine. i) 1959-70 North Shields seine length frequencies were converted to age frequencies using Scottish ALK for central and north central areas. These age frequencies were adjusted by SOP to agree with the English North Sea landings by all gears other than trawl (English Sea Fisheries Statistical Tables).

ii) 1971. The North Shields age frequencies were adjusted by SOP as in (i) above.

3) Netherlands

i) 1959-60 length frequencies (SNL) were added to give IVa + IVb and IVc length frequencies. ALKs supplied by Netherlands laboratory used to convert these length frequencies to IVa + IVb and IVc age frequencies respectively. IVa + IVb age frequencies were adjusted by SOP to agree with IVa + IVb Netherlands landings. The IVc age frequency was similarly adjusted to give IVc Netherlands landings.

ii) 1961-68. SNL age frequencies were added to give IVa + IVb and IVc age frequencies. These were adjusted by SOP to agree with IVa + IVb and IVc landings respectively.

Netherlands (ctd) iii) 1969-71. IVc beam trawl age frequencies (SNL) were adjusted by SOP to agree with IVc beam trawl landings (SNL). Pair trawl age frequencies (SNL) were treated similarly. Otter and herring trawl age frequencies (SNL) were adjusted by SOP to agree with (IVc Netherlands total landings) minus (IVc beam trawl + IVc pair trawl).

The IVa + IVb otter and herring trawl age frequencies (SNL) were adjusted by SOP to agree with Netherlands IVa + IVb landings.

4) Denmark

Annual length frequencies were available for the period 1959-66 (Coop.Res.Rep., 1969, Ser.A, No.9) and for 1970 and 1971 (supplied by the Danish Fisheries Laboratory). It was assumed that all the fish in these length frequencies were landed in the second half of the year, and age frequencies were derived from them using Scottish research vessels ALKs (taken from the second half of the year). Note: a proportion of the fish were landed in the first half of the year, and during this period 1+ whiting have a very similar length frequency distribution to that of 0+ whiting in the second half of the year. This means that, since an age/length key constructed from data collected in the second half of the year has been used, the number of 0+ whiting has been overestimated and the number of 1+ whiting has been underestimated.

For the period 1967-69, no length frequencies were available. It was therefore assumed that the "shape" of the age frequency in each of these years was the same as that in the corresponding year in the period 1962-64. (Note: these periods were chosen because the 1962 and the 1967 whiting year classes were both relatively large). Total numbers at age in the period 1967-69 were then estimated on the basis of the ratios of the weights landed in corresponding years, e.g.

$$1967 \text{ age frequency} = 1962 \text{ age frequency} \times \frac{1967 \text{ wt landed}}{1962 \text{ wt landed}}$$

5) Age frequencies for Scottish trawl, English trawl and Netherlands IVa + IVb otter and herring trawl were then combined within years. These age frequencies were adjusted by SOP to agree with the IVa + IVb landings for all countries except Denmark and France.

6) Netherlands otter and herring trawl data for IVc were raised by SOP to agree with the IVc total landings by all countries except Denmark and France.

7) The data derived in (5) and (6) were combined and raised by SOP to agree with the total North Sea landings by all countries except Denmark.

8) Data for Scottish and English seiners, Netherlands beam and pair trawl and the Danish landings were then combined with the data derived in (7) to produce the grand total.

APPENDIX 2

MEAN WEIGHTS-AT-AGE USED FOR WORKING GROUP ASSESSMENTS

(round fresh weight, g)

Age Group	Whiting	Haddock	Cod	
	All areas	All areas	IVa	IVb,c
0	126	-	-	-
1	213	230	420	610
2	241	280	780	1 190
3	267	410	2 270	3 010
4	310	580	4 210	5 090
5	377	710	6 280	7 060
6	471	940	8 260	8 740
7	563	1 210	10 010	10 100
8	690	1 500	11 510	11 160

Table 1. Nominal catch of Cod by country in metric tons according to "Bulletin Statistique" for 1967-72, with provisional figures for 1973.

Year	Belgium	Denmark	England	France	Germany (Fed.Rep.)	Netherlands	Norway	Scotland	Sweden	Poland	USSR	Others	Total
1967	18 641	38 090	48 964	13 988	25 038	23 162	5 720	38 943	11 770	1 677	23 810	-	249 803
1968	23 018	47 293	61 616	19 981	34 005	30 004	8 284	46 143	12 717	664	1 589	-	285 314
1969	13 470	36 986	44 263	10 460	20 625	19 511	8 953	33 208	8 401	136	2 970	52	199 035
1970	8 076	40 017	38 464	16 058	20 093	25 212	5 374	30 079	8 925	219	32 174	78	224 769
1971	19 334	68 179	55 525	24 254	46 647	46 614	7 732	37 229	9 062	178	5 153	124	320 031
1972	21 133	72 520	62 503	23 507	49 431	47 634	4 377	55 190	8 769	189	774	284	346 275
1973*	9 403	49 372	46 286	21 000	22 324	25 294	5 600	48 805		1 551			

* Estimated values for some countries.

Table 2. Nominal catch of Cod in the North Sea by Divisions in 100 metric tons according to "Bulletin Statistique" for 1967-72.

Year	IVa	IVb	IVc	No split	Total
1967	899	1 343	256	-	2 498
1968	741	1 759	353	-	2 853
1969	558	1 220	212	-	1 990
1970	796	1 103	349	-	2 248
1971	668	1 850	682	-	3 200
1972	800	2 151	512	-	3 463

Table 3. Nominal catch of North Sea Haddock by country in metric tons according to "Bulletin Statistique" for 1967-72, with provisional figures for 1973.

Year	Belgium	Denmark	England	France	Germany (Fed.Rep.)	Netherlands	Norway	Scotland	Sweden	U.S.S.R.	Others	Total
1967	1 218	25 010	8 367	8 325	1 872	8 856	787	70 916	7 633	34 333	91	167 408
1968	873	39 101	8 800	4 788	2 268	7 301	524	65 304	5 770	4 724	16	139 469
1969	4 753	316 516	14 090	7 562	3 376	13 233	792	70 253	5 108	203 488	4	639 175
1970	3 691	158 276	19 500	10 392	5 075	8 278	963	112 952	8 704	344 000	-	671 831
1971	971	31 043	16 648	8 436	3 045	6 914	1 063	121 539	5 857	62 398	1	257 915
1972	1 601	34 858	20 827	7 595	4 020	5 188	1 146	96 197	5 305	36 467	38	213 247
1973*	1 869	13 834	16 200	9 000	3 117	3 102	5 000	88 130			2 553	

* Estimated values for some countries.

Table 4. Nominal catch of Haddock in the North Sea by Divisions in 100 metric tons according to "Bulletin Statistique" for 1967-72.

Year	IVa	IVb	IVc	No split	Total
1967	1 225	448	0.5	-	1 674
1968	753	627	14	-	1 395
1969	2 719	3 618	54	-	6 392
1970	4 556	2 126	35	-	6 718
1971	1 970	582	26	-	2 578
1972	1 347	753	31	-	2 131

Table 5. Nominal catch of North Sea Whiting by country in metric tons according to "Bulletin Statistique" for 1967-72, with provisional figures for 1973.

Year	Belgium	Denmark	England	France	Germany (Fed.Rep.)	Netherlands	Norway	Scotland	Sweden	Poland	USSR	Total
1967	3 063	22 952	3 580	16 683	612	9 567	55	30 266	1 771	2	2 694	91 245
1968	2 978	57 367	3 123	25 267	698	13 127	55	30 286	1 501	-	10 518	144 920
1969	2 410	142 622	2 268	25 602	542	15 181	32	20 573	1 090	-	5 509	215 829
1970	2 799	102 698	3 398	25 842	392	10 115	43	21 080	820	-	14 319	181 506
1971	2 108	55 618	4 158	15 863	233	6 322	25	26 755	616	-	541	112 239
1972	2 745	50 109	3 789	19 171	264	7 613	28	23 846	596	-	613	108 774
1973*	2 830	74 743	4 153	20 000	200	10 141	25	20 688		7		132 787

* Estimated values for some countries.

Table 6. Nominal catch of Whiting in the North Sea by Divisions in 100 metric tons according to "Bulletin Statistique" for 1967-72.

Year	IVa	IVb	IVc	No split	Total
1967	432	414	66	-	912
1968	517	769	163	-	1 449
1969	296	1 582	112	-	1 990
1970	322	1 260	233	-	1 815
1971	226	707	188	-	1 122
1972	322	667	98	-	1 087

Table 7. Landings per unit effort by commercial vessels (gutted weight).

	COD			HADDOCK		WHITING	
Year	Scotland (1)	Nether-lands (2)	England (3)	Scotland (1)	England (3)	Scotland (1)	England (3)
1967	5.1	2.20	3.36	12.8	0.77	3.8	0.28
1968	5.0	5.00	4.58	10.4	0.80	3.2	0.26
1969	5.2	2.35	3.23	11.3	1.30	2.6	0.20
1970	5.2	1.65	2.69	23.4	1.83	2.9	0.33
1971	4.0	5.12	4.23	23.6	1.66	3.6	0.33
1972	5.8	4.78	4.38	15.4	1.96	3.0	0.30
1973	5.6	2.03	3.33	11.5	1.45	2.4	0.37

(1) From Scottish trawl statistics (tons/100 hrs fishing).

(2) Tons/100 hrs fishing (beam trawl, Southern Bight) (winter).

(3) Metric tons gutted /100 hrs fishing by motor trawlers longer than 12 m.

Table 8. Cod. Numbers (millions) at each length.*

Length (cm)	Denmark[1]	England[2]			Scotland[2]	Netherlands[3]		Belgium[4]	France[5]
		Trawl: otter	N.Shields Seine	Grimsby Seine		Landings	Catch		
5-9									
10-14									
15-19									
20-24									
25-29		0.01	0.01	0.02	0.14	0.07	6.4		
30-34	1.15	0.48	0.36	0.02	2.83	2.9	10.0	1.55	1.36
35-39	6.54	1.61	0.77	0.11	5.22	6.4	7.1	3.81	3.24
40-44	9.66	1.95	0.59	0.29	4.44	6.6	6.6	3.31	2.08
45-49	7.88	1.61	0.40	0.48	3.26	4.5	4.5	2.27	2.01
50-54	5.09	1.19	0.30	0.51	2.41	2.2	2.2	1.18	1.08
55-59	3.70	0.89	0.19	0.34	1.90	1.1	1.1	0.98	0.77
60-64	2.54	0.66	0.13	0.27	1.31	0.7	0.7	0.57	0.46
65-69	1.49	0.50	0.10	0.23	0.94	0.5	0.5	0.32	0.30
70-74	0.96	0.36	0.08	0.19	0.74	0.4	0.4	0.15	0.27
75-79	0.43	0.27	0.06	0.15	0.62	0.3	0.3	0.07	0.22
80-84	0.28	0.26	0.06	0.17	0.49	0.2	0.2	0.04	0.08
85-89	0.38	0.22	0.06	0.16	0.34	0.2	0.2	0.02	0.02
90-94	0.38	0.20	0.05	0.16	0.22	0.1	0.1	0.02	+
95-99	0.43	0.14	0.03	0.11	0.14	0.09	0.09	0.01	+
100-104	0.38	0.09	0.01	0.06	0.12	0.07	0.07		+
105-109	0.24	0.04	0.003	0.02		0.02	0.02		
110-114	0.09	0.01	0.001	0.01		0.008	0.008		
115-119	0.04	0.01	+	0.002		0.003	0.003		
120-124	0.04								
125-129	0.02								
Total	41.72	10.5	3.2	3.3	25.1	26.4	40.5	14.3	11.89

*) Netherlands - landings and catch.

1) 1972.

2) Mean 1969-73.

3) Mean 1969-72.

4) Mean 1971-73.

5) Mean landings from Divisions IVb,c for the years 1967-72.

Table 9. Haddock. Numbers (millions) at each length.*

Length (cm)	England[1]		Scotland[2]		USSR[3]	Netherlands[4]		Norway[5]
	Trawl	Seine	Trawl	Seine		Landings	Catch	
10-14					0.6			25.7
15-19					5.1			6.3
20-24	-	-			40.5	0.01	2.4	5.6
25-29	1.1	0.9	6.5	21.1	166.1	1.3	20.9	4.5
30-34	5.8	3.0	27.1	47.6	198.8	8.4	13.7	2.0
35-39	6.4	2.5	28.8	32.4	62.1	6.4	6.5	1.3
40-44	4.9	1.3	12.1	14.2	15.0	1.8	1.8	0.4
45-49	1.4	0.4	3.8	5.3	4.9	0.4	0.4	0.05
50-54	0.6	0.1	1.0	1.5	2.0	0.1	0.1	-
55-59	0.3	0.05	0.3	0.5		0.05	0.05	-
> 60	0.1	0.01	0.1	0.2		0.03	0.03	-
Total	20.6	8.3	79.7	122.8	495.1	18.5	45.9	45.8

*Landings for United Kingdom, Netherlands and Norway.
Catches for USSR and Netherlands.

1) Mean 1967-73.

2) Mean 1967-72.

3) Mean 1967-70.

4) Mean 1969-72.

5) 1973. Estimates based on samples of landings for reduction purposes from the northern North Sea.

Table 10. Whiting. Numbers (millions) at each length*

Length (cm)	Denmark[1] (Trawl)	England[2]		Scotland[3]		Netherlands[4]		Belgium[5]
		Trawl	Seine	Trawl	Seine	Landings	Catch	
5-9	147							
10-14	415							
15-19	402					0.01	0.2	
20-24	291	0.1	0.02	0.2	1.0	1.5	30.1	0.01
25-29	120	2.1	1.1	5.5	22.4	11.0	52.5	0.40
30-34	17	3.2	2.7	12.3	28.0	13.8	14.8	3.55
35-39	0.7	1.7	1.1	6.4	9.1	4.1	4.1	1.90
40-44		0.5	0.2	1.7	2.1	0.8	0.8	0.38
45-49		0.1	0.03	0.5	0.6	0.2	0.2	0.04
50-54		0.01	+	0.09	0.1	0.04	0.04	0.01
55-59		+		0.02	0.02			
>60								
Total	1 393	7.7	5.1	26.7	63.3	31.4	102.7	6.3

* Landings for all countries plus catches for the Netherlands.

1) Mean 1970-71.

2) Mean 1967-73 (including an estimate of discards).

3) Mean 1967-72.

4) Mean 1969-72 - all gears.

5) Mean 1971-72.

Table 11. Whiting and Haddock. Estimates of numbers (millions) discarded by the Dutch fleet (all years).

WHITING														
Age \ Year Group	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	-	-	-	-	-	-	-	3.5	-	-	-	-	-	-
1	8.9	1.4	26.3	85.8	28.0	48.7	40.6	38.0	40.0	88.8	17.6	19.7	67.7	80.0
2	8.9	8.4	25.5	12.6	38.9	7.1	19.9	21.2	11.8	19.2	30.6	3.7	9.9	28.3
3	0.2	0.2	0.2	0.3	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.04	0.07
HADDOCK														
0			-	-	-	-	-	-	-	-	-	-	-	-
1			4.4	9.2	4.8	174.6	2.0	48.4	1.4	22.3	138.2	12.0	0.9	9.7
2			-	-	-	-	14.0	-	-	-	-	-	-	-

Table 12. Northern North Sea Cod. (Division IVa).
All countries. Numbers landed (in millions).

Age group \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	1.6	0.9	7.0	6.3	7.3	1.8	0.2	3.0	10.4	2.1
2	25.0	10.0	9.4	21.2	32.3	18.5	14.4	9.7	25.5	48.8
3	3.0	12.0	7.5	6.7	14.5	11.4	10.8	11.2	2.4	10.9
4	1.3	2.1	4.5	3.7	2.7	3.0	7.1	4.9	2.8	1.2
5	0.6	0.8	1.0	1.9	1.8	0.7	2.3	2.5	1.3	1.2
6	0.3	0.3	0.5	0.5	0.8	0.4	0.5	0.7	0.6	0.5
7	0.06	0.09	0.18	0.3	0.2	0.2	0.3	0.14	0.2	0.2
8	0.06	0.03	0.13	0.2	0.15	0.09	0.08	0.12	0.06	0.08
9	-	0.3	-	-	0.06	0.02	0.04	0.07	0.03	0.03
10	-	-	0.04	0.05	0.03	0.01	0.04	0.04	0.03	0.03
11	-	-	-	-	-	-	0.04	0.02	-	-
Total	31.9	26.5	30.3	40.9	59.8	36.1	35.8	32.4	43.3	65.0

Table 13. Southern North Sea Cod. (Divisions IVb,c).
All countries. Numbers landed (in millions).

Age group \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	16.2	46.0	31.5	73.5	58.0	5.6	2.9	38.7	43.8	2.4
2	13.0	13.9	58.3	51.1	50.6	61.6	8.6	18.3	125.5	147.0
3	3.2	4.0	6.2	22.1	12.7	25.6	20.9	5.3	12.3	32.9
4	1.8	1.4	1.7	2.9	6.8	8.2	7.9	7.5	3.2	3.9
5	1.8	0.7	0.7	0.9	1.0	5.0	2.9	4.4	4.8	1.2
6	1.2	1.4	0.3	0.7	1.0	0.9	2.4	1.3	1.8	2.4
7	-	0.3	0.3	0.2	0.4	0.4	0.4	0.9	0.5	1.2
8	0.4	0.07	0.14	0.2	0.2	0.2	0.3	0.09	0.3	0.5
9	-	0.06	0.01	0.08	0.09	0.14	0.14	0.16	0.16	0.3
10	-	-	0.03	0.02	0.01	0.09	0.02	0.10	0.06	0.08
11	-	-	-	0.03	-	0.02	0.07	0.03	0.06	-
12	-	-	-	0.01	0.01	-	-	0.02	0.03	-
13	-	-	-	-	-	0.01	-	-	-	0.01
Total	37.6	67.8	99.2	151.7	130.8	107.8	46.5	76.8	192.5	191.9

Table 14. North Sea Haddock. All countries. Numbers landed (in millions)

Age group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	32.5	26.4	20.5	64.4	25.0	.01	24.6	11.7	48.8	44.6	69.5	4.3	31.0	11.0
2	17.2	117.4	64.3	23.7	118.1	426.5	3.7	6.7	25.2	187.2	1 563.3	116.4	22.7	210.8
3	8.4	9.9	66.0	32.7	13.5	146.4	460.8	17.7	3.3	27.4	168.3	1 494.4	37.4	30.8
4	79.7	6.0	3.9	18.6	12.2	17.1	33.2	410.5	6.7	2.4	24.8	34.5	372.2	23.0
5	14.5	23.2	2.3	1.2	6.5	9.5	6.8	24.6	194.8	2.2	4.8	.6	11.4	170.1
6	3.4	3.0	7.4	.7	.5	4.3	3.8	4.3	4.9	65.7	2.1	.5	.7	3.8
7	2.2	1.0	.8	3.4	.4	.3	.7	.4	.5	.6	39.3	.2	.2	.1
8	.3	.4	.4	.3	.9	.5	.3	.08	.3	.1	4.8	2.6	1.9	.5
9	.03		.06	.03	.01	.06	.02	.005	.03		.01	.01	.8	.01
10				.004	.01	.01							.2	.09
Total	158.2	187.3	165.7	145.0	177.1	604.7	533.9	476.0	284.5	330.2	1 876.9	1 653.5	478.5	450.2

Table 15. North Sea Whiting. All countries. Numbers landed (in millions).

Age group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	20.2	16.2	145.6	57.8	64.3	198.8	35.8	26.5	149.7	88.0	1 079.4	1 032.8	937.9
1	50.9	91.9	92.2	67.1	271.6	61.8	79.0	264.4	107.6	387.6	305.4	459.6	207.8
2	71.3	50.2	130.8	72.5	212.6	149.7	46.9	173.6	66.8	231.4	479.0	24.5	36.5
3	41.8	73.2	84.7	90.6	56.9	106.5	217.2	64.5	72.7	76.4	105.5	351.9	12.8
4	81.3	12.4	24.9	26.8	35.0	21.7	65.2	197.7	20.7	45.2	27.2	40.9	111.5
5	24.7	17.7	1.5	6.4	8.2	12.4	8.3	29.8	58.7	7.6	11.1	10.6	12.4
6	4.8	2.8	3.8	0.3	1.7	3.1	3.8	3.5	7.5	32.1	1.8	4.2	2.3
7	14.0	0.9	0.2	1.3	0.01	0.6	0.9	1.2	1.0	3.0	7.7	0.7	0.8
8	1.6	2.0	0.3	0.04	0.1	0.1	0.1	0.5	0.2	0.2	0.9	2.2	0.8
Total	310.6	267.3	484.0	322.84	650.4	554.7	457.2	761.7	484.9	871.5	2 018.0	1 927.4	1 322.8

Table 16. Northern North Sea Cod (Division IVa).
Estimates of the fishing mortality rate (F)
from Virtual Population Analysis for M = 0.2.

Age group \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	Current values*
1	0.04	0.03	0.11	0.08	0.13	0.04	0.01	0.05	-	-	0.05
2	0.64	0.40	0.48	0.55	0.70	0.56	0.51	0.93	0.71	-	0.72
3	0.41	0.74	0.60	0.76	0.94	0.58	0.76	0.98	0.62	0.77	0.79
4	0.37	0.56	0.69	0.68	0.81	0.50	0.90	0.98	0.71	0.77	0.86
5	0.38	0.43	0.54	0.75	0.84	0.51	0.97	1.01	0.83	0.77	0.94
6	0.49	0.37	0.50	0.55	0.85	0.43	0.85	0.83	0.77	0.77	0.82
7	0.23	0.29	0.39	0.53	0.62	0.51	0.73	0.65	0.78	0.77	0.72
8	0.10	0.15	0.92	0.98	0.71	0.48	0.40	0.75	0.70	0.77	0.62
9	4.40	1.30	0.00	0.00	0.98	0.15	0.43	0.73	0.42	0.77	0.53
10	0.44	0.42	0.54	0.63	0.77	0.46	0.64	0.86	0.75	0.77	0.53

Table 17. Southern North Sea Cod (Division IVb,c).
Estimates of the fishing mortality rate (F)
from Virtual Population Analysis for M = 0.2.

Age group \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	Current values*
1	0.34	0.28	0.25	0.43	0.34	0.17	0.05	0.15	-	-	0.11
2	0.64	0.56	0.70	0.81	0.60	0.74	0.44	0.53	0.94	-	0.64
3	0.39	0.42	0.53	0.63	0.48	0.71	0.61	0.53	0.83	0.70	0.66
4	0.49	0.28	0.32	0.51	0.40	0.67	0.49	0.46	0.74	0.70	0.56
5	0.43	0.36	0.24	0.28	0.31	0.59	0.53	0.57	0.61	0.70	0.57
6	0.85	0.66	0.28	0.39	0.53	0.56	0.62	0.51	0.48	0.70	0.54
7	0.05	0.68	0.31	0.29	0.43	0.48	0.49	0.53	0.39	0.70	0.47
8	1.00	0.72	0.62	0.34	0.37	0.42	0.73	0.19	0.37	0.70	0.43
9		0.32	0.28	1.01	0.25	0.67	0.48	1.12	0.61	0.70	0.43
10			0.32	1.03	0.17	0.44	0.16	0.85	2.13	0.70	0.43

* Values used for current stock assessments.

Note: Values of F assumed initially are shown in the columns headed "1972" and in the rows labelled "10" in Tables 16 and 17.

Table 18. North Sea Haddock. Estimates of fishing mortality rate (F) from Virtual Population Analysis for M = 0.2 and M = 0.3.

M = 0.2

Age group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	Current values*
1	0.10	0.13	0.16	0.12	0.01	0.00	0.54	0.09	0.08	0.01	0.22	0.03	-	-	0.02
2	0.54	0.64	0.58	0.41	0.36	0.29	0.13	0.30	0.31	0.54	0.46	0.78	0.26	-	0.50
3	0.44	0.71	0.94	0.62	0.29	0.96	0.39	0.72	0.22	0.62	1.21	0.99	0.55	0.65	0.96
4	0.96	0.65	0.68	0.78	0.49	0.73	0.60	0.69	0.67	0.24	2.54	0.90	0.73	0.80	1.10
5	1.24	0.86	0.55	0.46	0.70	0.93	0.74	1.32	0.85	0.49	1.08	0.44	0.90	0.90	0.80
6	0.91	0.98	0.75	0.32	0.36	1.61	1.36	1.76	1.12	0.79	1.29	0.29	1.48	0.90	0.80
7	1.24	0.76	0.79	0.99	0.31	0.37	1.59	0.47	1.18	0.37	2.04	0.37	0.18	0.90	0.80
8	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.90	0.80

M = 0.3

1	0.09	0.11	0.12	0.10	0.01	0.00	0.41	0.08	0.06	0.01	0.18	0.03	-	-	0.01
2	0.46	0.56	0.50	0.33	0.31	0.24	0.11	0.23	0.27	0.48	0.40	0.67	0.23	-	0.40
3	0.36	0.60	0.84	0.53	0.25	0.85	0.33	0.62	0.17	0.57	1.09	0.87	0.48	0.60	0.84
4	0.86	0.54	0.57	0.69	0.44	0.65	0.54	0.61	0.58	0.20	2.35	0.80	0.64	0.70	1.00
5	1.13	0.76	0.46	0.39	0.64	0.84	0.68	1.21	0.76	0.44	0.90	0.39	0.80	0.80	0.70
6	0.82	0.89	0.68	0.28	0.31	1.51	1.24	1.65	1.01	0.74	1.17	0.23	1.34	0.80	0.70
7	1.17	0.70	0.74	0.93	0.29	0.35	1.51	0.44	1.11	0.35	1.95	0.35	0.15	0.80	0.70
8	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.70

* Values used for current stock assessments.

Note: Values of F assumed initially are shown in the column headed "1972" and in the row labelled "8".

Table 19. North Sea Whiting. Estimates of fishing mortality rate (F) from Virtual Population Analysis for M = 0.2 and M = 0.3.

M = 0.2

Age group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Values for 1967-68*
0	0.03	0.03	0.13	0.03	0.14	0.25	0.05	0.03	0.06	0.11	1.01	-	-	0.05
1	0.20	0.20	0.38	0.20	0.24	0.37	0.23	0.71	0.23	0.28	0.70	1.72	-	0.25
2	0.45	0.30	0.58	0.51	0.59	0.19	0.41	0.71	0.40	0.75	0.55	0.12	0.80	0.60
3	1.19	0.97	0.94	0.82	0.78	0.54	0.42	0.89	0.64	0.87	0.85	0.97	0.90	0.75
4	1.31	1.73	1.13	0.91	0.91	0.80	0.77	0.88	0.83	1.11	0.91	1.00	1.00	0.97
5	2.01	1.28	1.17	1.09	0.81	1.02	0.84	1.04	0.71	0.86	0.95	1.22	1.00	0.80
6	1.29	2.21	1.13	0.79	1.02	0.86	1.09	1.12	0.83	1.16	0.51	1.31	1.00	1.00
7	1.52	0.94	1.27	2.03	0.05	1.41	0.66	1.41	1.27	1.00	1.03	0.38	1.00	1.10
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

M = 0.3

0	0.02	0.03	1.03	0.02	0.11	0.20	0.04	0.03	0.05	0.09	0.93	-	-	0.05
1	0.16	0.16	0.31	1.66	0.18	0.31	0.19	0.61	0.19	0.24	0.61	1.64	-	0.22
2	0.39	0.26	0.51	0.44	0.51	0.15	0.35	0.62	0.35	0.67	0.50	0.11	0.80	0.50
3	1.11	0.88	0.83	0.73	0.69	0.47	0.37	0.78	0.57	0.78	0.77	0.91	0.90	0.68
4	1.21	1.59	1.03	0.81	0.82	0.71	0.69	0.78	0.72	1.01	0.84	0.93	1.00	0.85
5	1.91	1.18	1.04	0.99	0.72	0.93	0.76	0.94	0.64	0.75	0.88	1.15	1.00	0.70
6	1.19	2.09	1.06	0.69	0.94	0.77	1.01	1.04	0.76	1.07	0.44	1.24	1.00	0.91
7	1.45	0.88	1.20	1.94	0.05	1.33	0.62	1.33	1.20	0.94	0.97	0.35	1.00	1.05
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

* Values for assessments for 1967-68.

Note: Values of F assumed initially are shown in the column headed "1971" and in the row labelled "8".

Table 20. Northern North Sea Cod (Division IVa).
Estimates of numbers in the sea (millions)
from Virtual Population Analysis.

M = 0.2

Age group \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	42.1	34.1	74.4	92.2	65.8	50.3	21.4	70.1	132.4	30.7
2	57.8	33.1	27.1	54.7	69.8	47.3	39.6	17.4	54.7	99.0
3	9.8	24.9	18.2	13.7	25.7	28.3	22.1	19.5	5.6	22.0
4	4.5	5.3	9.7	8.2	5.3	8.2	13.0	8.5	6.0	2.5
5	2.0	2.5	2.5	4.0	3.4	1.9	4.1	4.3	2.6	2.4
6	0.7	1.1	1.4	1.2	1.5	1.2	0.9	1.3	1.3	0.9
7	0.3	0.4	0.6	0.7	0.6	0.5	0.6	0.3	0.5	0.5
8	0.7	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.14	0.17
9	-	0.50	0.14	0.07	0.11	0.13	0.12	0.15	0.10	0.06
10	0.02	-	0.11	0.12	0.06	0.03	0.09	0.07	0.06	0.05
Total	117.9	102.1	134.4	175.2	172.6	138.1	102.2	121.9	203.4	158.3

Table 21. Southern North Sea Cod (Divisions IVb,c).
Estimates of numbers in the sea (millions)
from Virtual Population Analysis.

M = 0.2

Age group \ Year	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	60.8	205.1	156.7	230.3	219.9	38.6	62.9	315.4	437.3	10.8
2	30.0	35.3	126.6	100.0	122.7	128.1	26.5	48.9	223.4	318.6
3	11.0	13.0	16.5	51.6	36.3	55.2	49.9	14.0	23.7	71.3
4	5.1	6.1	7.0	8.0	22.5	18.4	22.3	22.2	6.8	8.4
5	5.7	2.6	3.8	4.2	3.9	12.3	7.7	11.2	11.5	2.6
6	2.2	3.0	1.5	2.5	2.6	2.3	5.6	3.7	5.2	5.1
7	0.2	0.8	1.3	0.9	1.4	1.2	1.1	2.5	1.8	2.6
8	0.7	0.16	0.3	0.8	0.6	0.7	0.6	0.6	1.2	1.0
9	0.01	0.2	0.06	0.14	0.4	0.3	0.4	0.2	0.4	0.7
10	0.01	0.01	0.13	0.04	0.04	0.3	0.13	0.2	0.07	0.17
Total	115.7	266.3	313.9	398.5	410.3	257.4	177.1	418.9	711.4	421.3

Table 22. North Sea Haddock.
Estimates of numbers in the sea (millions)
from Virtual Population Analysis.

M = 0.2

Age group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
1	367.7	236.3	154.3	619.4	3 252.9	63.9	64.3	145.3	720.1	6 177.9	391.1	141.3	783.2	127.3
2	44.8	271.8	169.7	107.9	449.1	2 640.6	52.1	30.6	108.4	545.5	5 017.8	257.7	111.8	613.2
3	26.0	21.3	117.6	77.5	58.8	257.3	1 621.6	37.5	18.6	64.9	259.1	2 583.0	96.4	70.3
4	140.1	13.8	8.6	37.5	34.2	36.0	80.5	901.5	14.9	12.3	28.6	63.0	786.4	45.5
5	22.0	43.8	5.9	3.6	14.2	17.1	14.2	36.2	371.4	6.2	7.9	1.9	20.9	311.6
6	6.2	5.2	15.2	2.8	1.8	5.8	5.5	5.6	7.9	130.5	3.1	2.2	1.0	7.0
7	3.3	2.1	1.6	5.9	1.6	1.1	0.9	1.2	0.8	2.1	48.3	0.7	1.3	0.2
8	0.6	0.8	0.8	0.6	1.8	1.0	0.6	0.16	0.6	0.2	1.2	5.1	0.4	0.9
Total	610.7	595.1	473.7	855.2	3 814.4	3 022.5	1 839.7	1 158.1	1 242.7	6 939.6	5 757.1	3 053.9	1 801.4	1 176.0

M = 0.3

1	459.1	301.6	203.1	791.4	4 483.3	88.2	83.5	185.8	899.9	7 975.7	483.2	183.5	1 070.5	133.5
2	53.6	312.3	200.9	132.9	531.2	3 299.8	65.3	41.0	127.6	624.8	5 870.3	298.6	132.3	766.5
3	31.8	25.1	132.1	90.6	70.5	289.0	1 932.2	43.5	24.2	71.9	285.4	2 904.3	112.9	77.9
4	156.9	16.4	10.3	42.4	39.5	40.7	91.1	1 027.6	17.3	15.1	30.1	70.9	897.3	52.0
5	24.1	49.3	7.1	4.3	15.7	18.9	15.7	39.4	414.5	7.1	9.2	2.1	23.5	350.6
6	6.9	5.8	17.0	3.3	2.2	6.2	6.0	5.9	8.7	143.1	3.4	2.8	1.1	7.8
7	3.6	2.3	1.7	6.4	1.9	1.2	1.0	1.3	0.8	2.4	50.7	0.8	1.6	0.2
8	0.6	0.8	0.8	0.6	1.9	1.0	0.6	0.16	0.6	0.2	1.2	5.4	0.4	1.0
Total	736.6	713.6	573.0	1 071.9	5 146.2	3 745.0	2 195.4	1 344.7	1 493.6	8 840.3	6 733.5	3 468.4	2 239.6	1 389.5

Table 23. North Sea Whiting.
Estimates of numbers in the sea (millions)
from Virtual Population Analysis.

M = 0.2

Age group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	724.6	524.4	1 282.1	1 977.7	544.6	1 003.4	832.7	1 004.9	2 759.6	950.1	2 092.9	-	-
1	370.8	575.0	414.7	918.4	1 567.0	387.9	642.6	649.4	795.7	2 124.3	698.5	626.7	-
2	244.5	249.8	386.8	233.2	614.2	1 013.4	218.4	418.5	261.7	518.6	1 310.9	283.5	91.8
3	65.2	128.3	151.8	176.8	114.7	278.0	688.5	119.1	168.7	143.7	201.0	617.1	206.7
4	120.3	16.2	39.8	48.8	63.8	43.1	132.1	368.7	40.0	73.0	49.5	70.4	191.5
5	30.5	26.5	2.4	10.5	16.1	21.0	15.9	50.0	125.8	14.3	19.6	16.3	21.3
6	7.1	3.4	6.1	0.6	2.9	5.9	6.2	5.6	14.4	50.6	5.0	6.2	3.9
7	19.3	1.6	0.3	1.6	0.2	0.9	2.0	1.7	1.5	5.1	13.0	2.4	1.4
8	2.4	3.4	0.5	0.07	0.17	0.17	0.17	0.9	0.3	0.3	1.5	3.8	1.4
Total	1 584.7	1 528.6	2 284.5	3 367.7	2 923.8	2 753.8	2538.6	2 618.8	4 167.7	3 880.0	4 391.9	-	-

M = 0.3

0	983.8	700.8	1 724.5	2 854.1	716.6	1 290.3	1 065.9	1 332.3	3 618.7	1 187.4	2 278.3	-	-
1	470.4	711.5	505.3	1 153.0	2 064.8	475.9	786.2	759.0	961.3	2 552.6	804.4	662.8	-
2	283.6	297.4	447.4	273.5	723.6	1 273.9	258.5	480.4	306.8	586.2	1 484.9	323.1	95.6
3	70.7	142.0	170.4	199.1	130.4	323.1	809.8	135.0	191.4	160.5	222.9	668.4	215.2
4	130.2	17.3	46.6	54.9	71.0	48.6	148.9	415.2	45.7	80.1	54.4	76.2	199.3
5	32.1	28.8	2.6	11.5	18.1	23.2	17.7	55.4	141.3	16.4	21.5	17.5	22.2
6	7.8	3.5	6.6	0.7	3.2	6.5	6.8	6.1	16.0	55.1	5.7	6.6	4.1
7	20.5	1.7	0.3	1.7	0.3	0.9	2.2	1.8	1.6	5.6	14.0	2.7	1.4
8	2.5	3.6	0.5	0.07	0.18	0.18	0.18	0.9	0.4	0.4	1.3	3.9	1.4
Total	2 001.6	1 906.6	2 904.2	4 548.6	3 728.2	3 442.6	3 096.2	3 186.1	5 283.2	4 644.3	4 887.4	-	-

Table 24. Estimates of year class strength.

Year class	COD (IVb,c)			HADDOCK		WHITING	
	(1)	(2)	(3)	(4)	(5)	(4)	(6)
1958				1 130	368	120	-
1959				350	236	220	725
1960				310	154	350	524
1961				1 560	619	390	1 282
1962			61	12 000	3 253	2 170	1 978
1963			205	20	64	80	545
1964			157	80	64	540	1 003
1965			230	90	145	290	833
1966	214	38	220	3 060	720	400	1 005
1967	7	5	39	20 000	6 178	1 380	2 760
1968	51	5	63	1 100	391	60	950
1969	322	75	315	970	141	160	2 093
1970	388	72	437	3 000		140	
1971	5	3	11	7 000		1 000	
1972		50		1 606		3 600	

(1) Catches per unit effort in numbers of 2 year old cod per 10 hours beam trawling in the Southern Bight (Dutch data).

(2) Average numbers per hour's fishing during the International Young Herring Surveys.

(3) Millions of fish at age from VPA with M = 0.2.

(4) Catches per 10 hours' fishing of 1 year old fish by Scottish research vessels.

(5) Millions of fish 1 year old from VPA with M = 0.2.

(6) Millions of fish at age 0 from VPA with M = 0.2.

Table 25. Percentage changes in yield/recruit for various percentage changes in total fishing effort (relative to current levels of yield/recruit and effort).

% change in effort from assessment level	% changes in yield per recruit				
	COD	HADDOCK		WHITING	
	M = 0.2	M = 0.2	M = 0.3	M = 0.2	M =0.3
-60%	+33	+12	-15	+5	-10
-40%	+25	+11	-5	+6	-5
-30%	+18	+9	-3	+4	-3
-20%	+11	+5	-2	+2	-2
0	0	0	0	0	0
+20%	-9	-5	0	-2	0
+30%	-14	-8	0	-4	0
+40%	-17	-11	-1	-5	-1
+60%	-24	-16	-2	-8	-3

Table 26. Selectivity data.

(Ogives transformed to logistic curves = $\frac{p}{1-p} = e^{2(aL - b)}$)

Present mesh sizes in use (double synthetic, wedge gauge. From Coop.Res.Rep., No.25 (1969).

Trawl	Mesh Size (mm)	Seine
U.S.S.R.	81	U.K. 73/103 (single synthetic)
U.K.	81	Sweden 70 mm.
France	64	
Netherlands	73	
Belgium	75	
Sweden	83	
Denmark	19.6	

	COD[1]	HADDOCK[2]	WHITING[3]
Selection factor for trawl[4]	3.6	3.4	3.8
75 mm 50% retention + range 25-75%	27.0 ± 2.4	25.5 ± 2.1	28.5 ± 2.6
a	0.2289	0.2616	0.2113
b	6.1796	6.6701	6.0212
80 mm 50% retention + range	28.8 ± 2.6	27.2 ± 2.3	30.4 ± 2.9
a	0.2113	0.2388	0.1894
b	6.0846	6.4961	5.7582
85 mm 50% retention + range	30.6 ± 2.8	28.6 ± 2.4	32.3 ± 3.1
a	0.1962	0.2289	0.1772
b	6.0031	6.5458	5.7234
90mm 50% retention + range	32.4 ± 2.9	30.6 ± 2.5	34.2 ± 3.3
a	0.1894	0.2197	0.1665
b	6.1370	6.7234	5.6927
100 mm 50% retention + range	36.0 ± 3.1	34.0 ± 2.6	38.0 ± 3.5
a	0.1772	0.2113	0.1569
b	6.3790	7.1832	5.9638

1) Selection ranges interpolated between haddock and whiting.

2) Selection ranges according to Scottish data.

3) Selection ranges estimated from Coop.Res.Rep.No.25:

(< 75 mm range = 42 mm
75-85 mm range = 62 mm
85-95 mm range = 74 mm
>105 mm range = 82 mm).

4) Selection factors according to Coop.Res.Rep., No.25.

Table 27. Showing the differences between the 50% ages for the mesh sizes in use, and the 50% ages for various larger mesh sizes.

Species	Country	Current mesh size (mm)	Differences in 50% age		
			80 mm	85mm	90 mm
COD	England Trawl and Seine	80	-	0.1	0.2
	Scotland Trawl and Seine	75	0.1	0.2	0.3
	Netherlands	75	0.1	0.2	0.3
HADDOCK	England Trawl and Seine	80	-	0.2	0.4
	Scotland Trawl and Seine	75	0.2	0.4	0.6
	Netherlands	75	0.2	0.4	0.6
WHITING	England Trawl and Seine	80	-	0.3	0.6
	Scotland Trawl and Seine	75	0.3	0.6	0.9
	Netherlands	75	0.3	0.6	0.9

Table 28. Effects on certain national fisheries of changes in mesh size.[a]

Species	Fishery	Immediate losses;% Mesh size (mm)				Long-term change in yield;% Mesh size (mm)			
		80	85	90	100	80	85	90	100
COD	England, Scotland			2				+13	
	Netherlands (landings)			3				+11	
	Netherlands (catch)			9				+ 4	
	UK + Netherlands (landings)							+12	
HADDOCK	England trawl		3	6			+ 8	+14	
	England seine		5	10			+ 6	+ 9	
	Scotland trawl		5	9			+ 6	+11	
	Scotland seine		8	14			+ 3	+ 5	
	Netherlands (landings)		6	13			+ 5	+ 6	
	Netherlands (catch)		12	33			-11	-18	
	UK + Netherlands (landings)						+ 5	+ 8	
WHITING	England trawl		19	35			+36	+43	
	England seine		21	41			+33	+31	
	Scotland trawl		27	40			+ 4	+ 6	
	Scotland seine		35	50			- 7	-11	
	Netherlands (landings)		37	52			+19	+28	
	Netherlands (catch)		53	68			-11	-15	
	UK + Netherlands (landings)						+14	+18	
SOLE	England otter trawl		7	17	36	+52	+79	+99	+155
	Belgium beam trawl	5	13	22	44	+44	+66	+87	+126
	Netherlands beam trawl	8	18	28	48	+21	+30	+38	+ 47
	Netherlands beam trawl (discards)	12	14	15	15				
	Total these countries					+23	+34	+42	+ 55
PLAICE	England otter trawl + seine[b]		o	o	o	+ 2	+ 3	+ 4	+ 6
	Scotland otter trawl[b]	-	-	-	o	+ 2	+ 3	+ 4	+ 6
	Scotland seine[b]	-	-	-	o	+ 2	+ 3	+ 4	+ 6
	Netherlands beam trawl	-	-	-	-	+ 2	+ 2	+ 2	+ 2
	Netherlands beam trawl (discards)	1	1	2	3				
	Germany otter trawl	-	-	-	-	+ 2	+ 3	+ 4	+ 6
	Denmark otter trawl	-	-	-	-	+ 2	+ 3	+ 4	+ 6
	Total these countries					+ 2	+ 2	+ 3	+ 4

a) Data on sole and plaice taken from the Report of the North Sea Flatfish Working Group, ICES Doc. C.M.1974/F:6, Tables 7-11.

b) o = less than 0.5%.

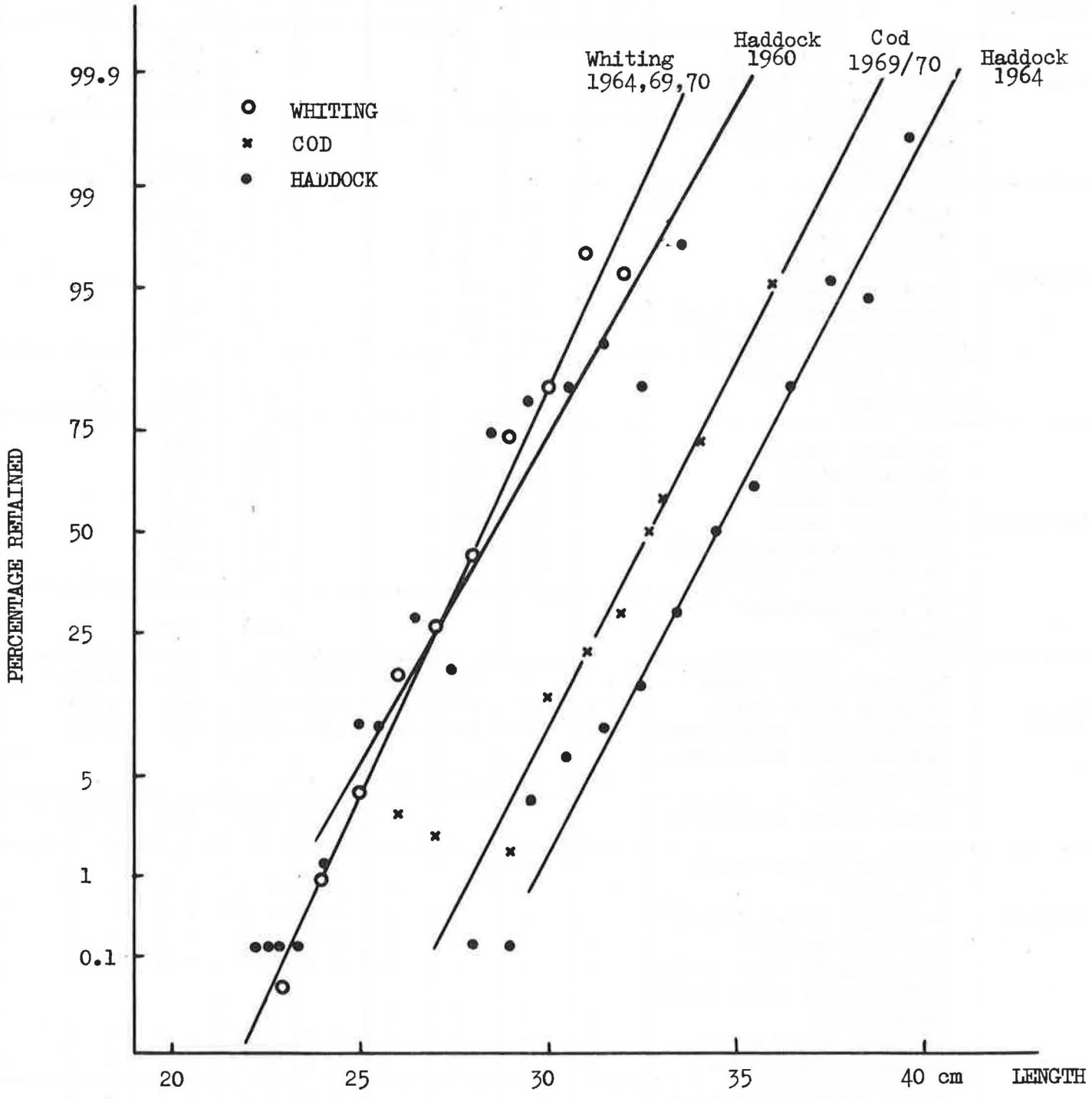

Figure 1. Discard ogives. Percentages of ROUNDFISH retained by Dutch beam and otter trawls (from Daan, unpubl.)

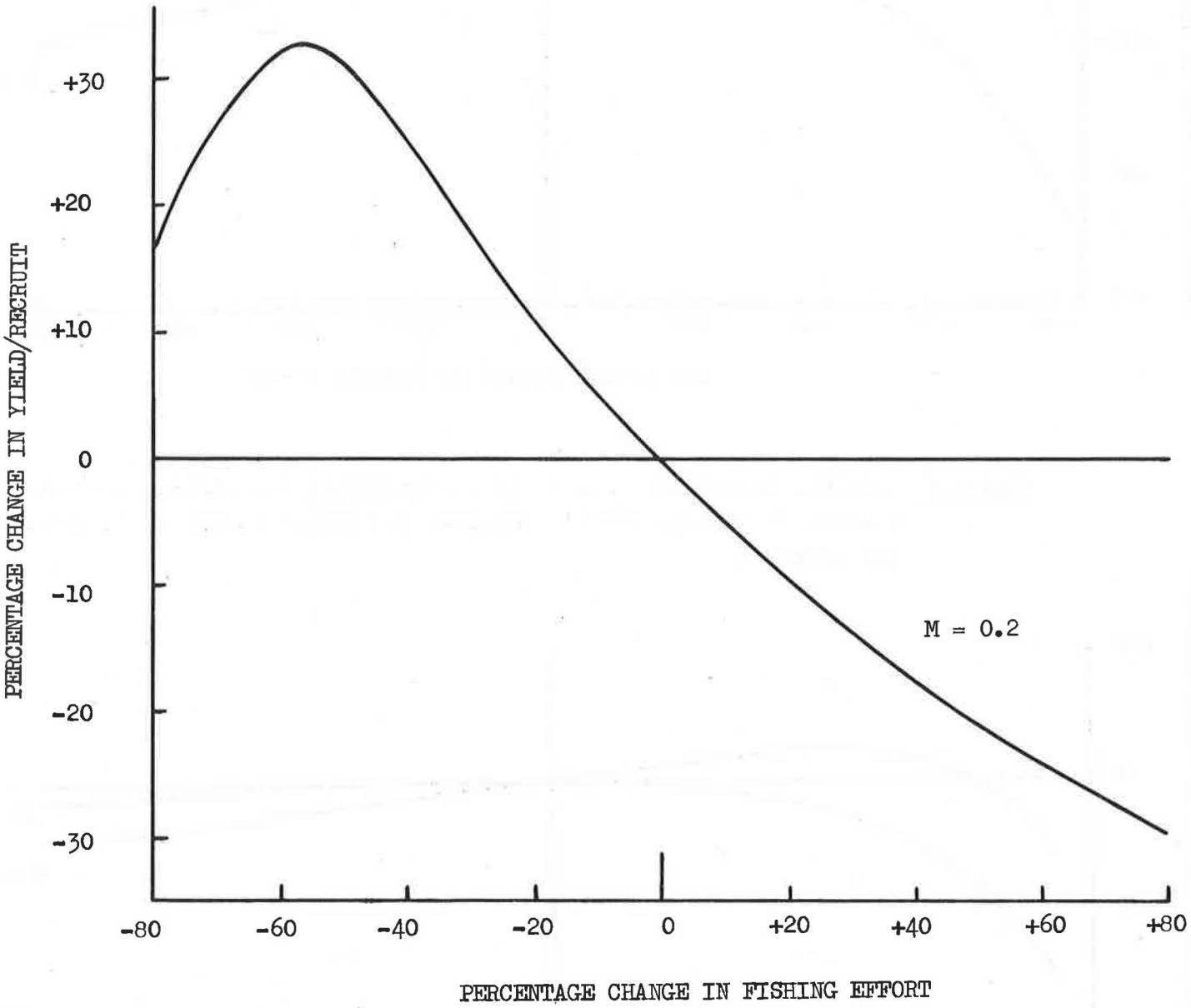

Figure 2. COD. Percentage changes in yield per recruit for various percentage changes in fishing effort.

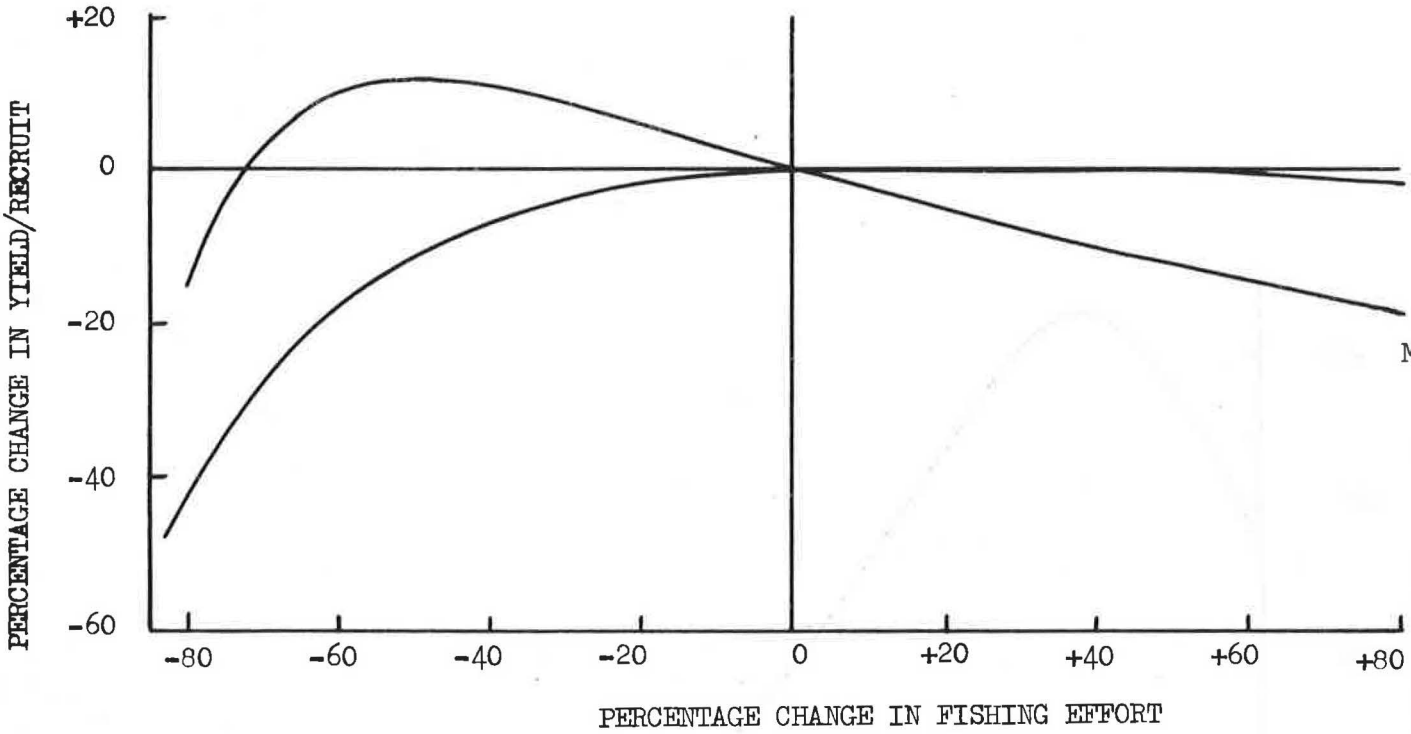

Figure 3. HADDOCK. Percentage changes in yield/recruit for various percentage changes in fishing effort (relative to current levels of yield/recruit and effort).

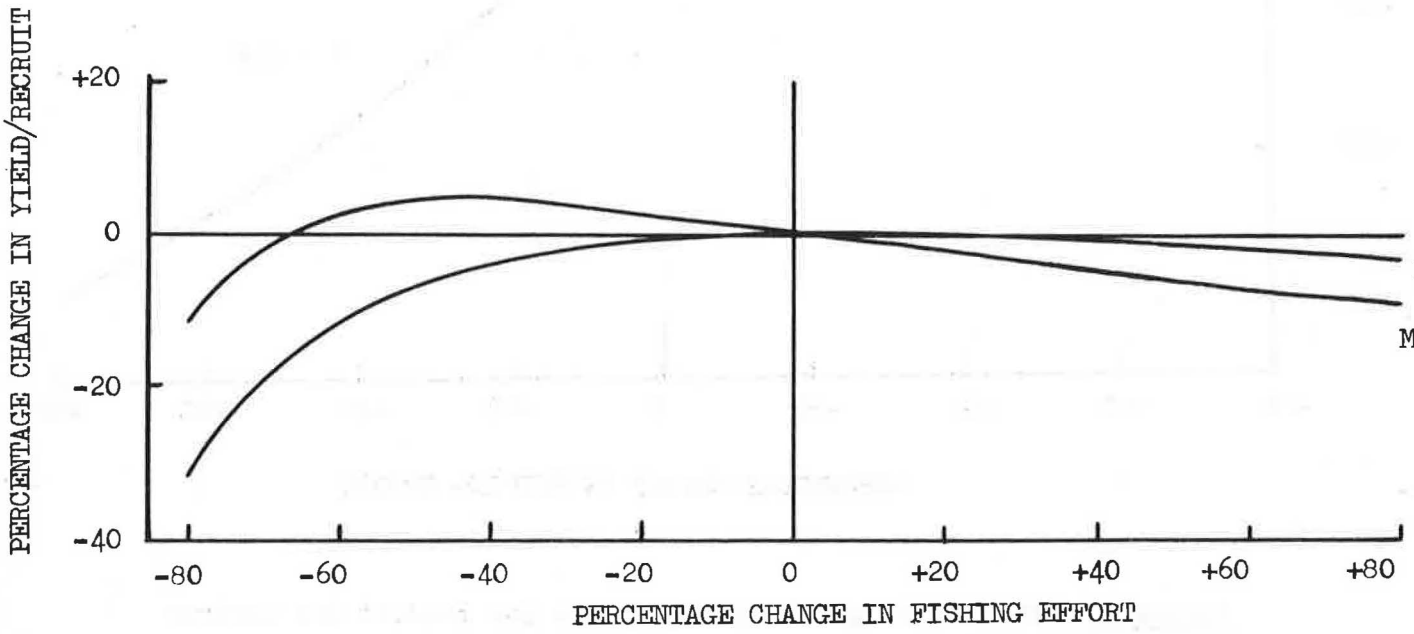

Figure 4. WHITING. Percentage changes in yield/recruit for various percentage changes in fishing effort (relative to current levels of yield/recruit and effort).

SUPPLEMENT

At the Liaison Committee meeting in 1974 two points arose concerning the Report of the North Sea Roundfish Working Group which members of the Group were asked to resolve by correspondence. These were:

1. An incorrect figure for Sweden's catch of cod in 1972 was taken from a photocopy of a Bulletin Statistique manuscript and tabulated by the Working Group. The Group was asked to investigate the effect of using this incorrect figure on the virtual population analysis for cod.

2. In addition to the whiting mesh assessment made by the Working Group the Liaison Committee had before it an independent set of calculations made by Mr K P Andersen of the Danish Institute. The Liaison Committee noted that the two methods gave a completely different pattern of long-term gains and losses and the Working Group was asked to resolve this discrepancy.

The Cod Virtual Population Analysis

At the Working Group meeting, the age compositions used for the virtual population analysis for the northern North Sea cod stock excluded those for both Sweden and Norway because the conclusion of previous Working Groups was that the catches of these 2 nations were not taken from the North Sea stocks for which age compositions were available. Thus, estimates of the total mortality rate were unaffected by the incorrect Swedish catch for 1972. In calculating the TAC for the northern North Sea, the allowable catch (that calculated from the age composition data obtained from the virtual population analysis) was raised to the total allowable catch by the ratio of the average total catch from the northern North Sea to that of the average of the catch less Norway's and Sweden's. In this calculation the data for 1972 were excluded because there was some doubt about the authenticity of the Swedish catch data. Also, it was felt that even if it had been correct, it would not have fairly represented the long-term average catch by Sweden.

The cod analyses carried out are therefore in no way affected by the incorrect Swedish catch for 1972.

Whiting Mesh Assessments

Regarding the whiting mesh assessments, the Working Group had predicted long-term gains for a number of countries, whereas Mr Andersen had predicted primarily long-term losses. The reason for this was that Mr Andersen and the Working Group, had based their calculations on different assumptions. Mr Andersen, in his assessments, had assumed that a proportion of the fish released by UK and Ducth vessels would be recaptured by Danish vessels. The Working Group however had assumed that this would be unlikely and that it would be better to assume that none of the fish released by UK and Dutch vessels would be recaptured by Danish vessels.

One of the difficulties of making mesh assessments for North Sea demersal fish species is that the present state of knowledge about migrations is still incomplete.

For example, if a country increases its mesh size and releases some fish that otherwise would have been retained, it is not yet possible to predict how these fish would move and hence in what proportions they would be eventually captured by the various nations that fish in the North Sea.

Another factor is that Danish vessels take about 90% by number of the total North Sea catch of whiting. This proportion is so large, that its inclusion or exclusion from the assessments makes a very big difference to the results.

The Working Group considered that the estimates given in the Working Group Report, and those arrived at by Mr K P Andersen provide limits within which the current estimates might be expected to lie. The Working Group further considered that the correct estimates were likely to lie nearer to the Working Group estimates than to those given by Mr Andersen, but that until more is known about the movements of whiting in the North Sea, it is not possible to be more precise.

The Working Group felt, therefore, that it would not be possible to improve significantly upon the whiting mesh assessments already made, until more is known about the movements of whiting within the North Sea.
