International Council for the
Exploration of the Sea

C.M.1974/F:5
Demersal Fish (Northern) Committee

REPORT OF THE NORTH SEA ROUNDFISH WORKING GROUP

Charlottenlund, 4-8 March 1974

Contents

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Report of the North Sea Roundfish Working Group

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 Copenhagen 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	F.R.G.
F Wagner	F.R.G.
N Daan	Netherlands
J F de Veen (Chairman, North Sea Flatfish Working Group)	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.

1. 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 1967-1972.

Cod (Tables 1 and 2, p. 16)

During the period 1967-1972, cod landings averaged 271 000 tons. The highest landing was 346 000 tons in 1972.

Haddock (Tables 3 and 4, p. 17)

During the period 1967-1972, haddock landings averaged 348 000 tons with values exceeding 600 000 tons in 1969 and 1970.

Whiting (Tables 5 and 6, p. 18)

During the period 1967-1972, whiting landings averaged 140 000 tons with a maximum value of 199 000 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. LANDINGS PER UNIT EFFORT (Table 7, p. 18)

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.

3. 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.

4. DATA FOR MAKING ASSESSMENTS

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

4.1 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 Netherlands, so that for this country it has been possible to estimate numbers caught as well. (Figure 1, p.35 and Tables 8-10, p.19-21).

Cod (Table 8)

Cod length compositions have been supplied by Belgium, Denmark, France, England, Scotland and 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 1964-1970 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.

4.2 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. 10). In addition estimates of the numbers discarded in each age group were made by the Netherlands and these data are shown in Table 11 (p.22). 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, p. 23).

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, p.24)

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, p.24)

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 "length composition", these estimates were based on very inadequate sampling.

5. 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 (p.25-30), arranged by age group and year of capture.

5.1 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.

5.2 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.

6. 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, p. 31.

7. 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.

7.1 Yields per recruit (Table 25, p.31)

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 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(p.36) 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, (p. 37) 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, p.27) 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 1967-1968 and also 1969-1971. 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 sustainable 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 (p. 37) 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.

7.2 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.

7.3 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 TAC's 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.

7.4 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 (p.32) 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 (p.33) 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 (p.34) gives only one possible set of estimates for each year.

7.4.1 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.

7.4.2 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 gains 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.

8. 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.

8.1 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.

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.

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

a) The TAC required to prevent the 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 TAC's (in tons) were as follows:

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

8.3 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. Separate estimates for English, Scottish and Dutch vessels are given in Table 28 (p. 34).

9. RECOMMENDATIONS

9.1 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.

9.2 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 fishing effort.

9.3 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.

10. REFERENCES

ANON., 1971. Preliminary Report of the North Sea Roundfish Working Group. ICES, C.M.1971/F:4. (mimeo).

GULLAND, J. A., 1961. The estimation of the effect on catches of changes in gear selectivity. J.Cons.int.Explor.Mer, 26(2):204-214.

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

JOINT STATEMENT BY THE NORTH SEA ROUNDFISH AND FLATFISH[x)] 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 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.

[x)] 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. 1963-1967:

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.

Division 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 Work-Sheet (p. 12).

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.

Section 2. 1968 onwards (ctd)

Faroes

Total landings from Division IVa.

1968- Age composition data for Scottish north 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 Federal Republic of Germany)

Division 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.

Division IVb-c South and west areas.

Poland (As 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 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:

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

<u>WORKSHEET</u> Method of deriving "other nations" age compositions for the period 1963-67 for Divisions IVb-c: example for 1967.

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

Age Years	A	B	$\frac{B}{A}$ =C	$\overline{W}$	D	$C.\overline{W}.D. \times 10^{-3}$	$\frac{C.\overline{W}.D.R.}{\overline{W}}$
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.

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

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

$C.\overline{W}.D.$ = 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.

E = 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'.

HADDOCK

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

Seine. Scottish seine age frequencies were adjusted by SOP,[1)] 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 to 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 1966-1970 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).

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[1)] to agree with the total Scottish North Sea landings by all gears other than trawl (Scottish Sea Fisheries Statistical tables).

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1) "Adjusted by SOP" means that 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.15 for the mean weights-at-age for this purpose).

2) England - Trawl.

i) 1959-1969 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 Shield 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) 1959-1970 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 - 1960 length frequencies (SNL) were added to give IVa + IVb and IVc length frequencies. ALK's 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 - 1968. 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.

iii) 1969 - 1971. 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 1959-1966 (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 ALK's (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.

Denmark (ctd.)

For the period 1967 - 1969, 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 1962-1964. (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 - 1969 were then estimated on the basis of the ratios of the weights landed in corresponding years, e.g.

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

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 1967-1972, with Provisional Figures for 1973.

Year	Belgium	Denmark	England	France	Germany (F.R.)	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
a)1973	9 403	49 372	46 286	21 000	22 324	25 294	5 600	48 805		1 551			

a) 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 1967-1972.

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	1 699	2 151	512	-	4 362

Table 3. Nominal Catch of North Sea HADDOCK by Country in Metric Tons According to "Bulletin Statistique" for 1967-1972, with Provisional Figures for 1973.

Year	Belgium	Denmark	England	France	Germany (F.R.)	Netherlands	Norway	Scotland	Sweden	Others	USSR	Total
1967	1 218	25 010	8 367	8 325	1 872	8 856	787	70 916	7 633	91	34 333	167 408
1968	873	39 101	8 800	4 788	2 268	7 301	524	65 304	5 770	16	4 724	139 469
1969	4 753	316 516	14 090	7 562	3 376	13 233	792	70 253	5 108	4	203 488	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	1	62 398	257 915
1972	1 601	34 858	20 827	7 595	4 020	5 188	1 146	96 197	5 305	38	36 467	213 247
a) 1973	1 869	13 834	16 200	9 000	3 117	3 102	5 000	88 130		1 053		

a) 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 1967-1972.

Year	IVa	IVb	IVc	Not 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 1967-1972, with Provisional Figures for 1973.

Year	Belgium	Denmark	England	France	Germany (F.R.)	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	8 802	542	15 181	32	20 573	1 090	-	5 509	199 029
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
a) 1973	2 830	74 743	4 153	20 000	200	10 141	25	20 688		7		

a) 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 1967-1972.

Year	IVa	IVb	IVc	Not 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 Weights).

Year	COD			HADDOCK		WHITING	
	Scotland (1)	Netherlands (2)	England (3)	Scotland (4)	England (5)	Scotland (6)	England (7)
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)x)		Belgium 4)	France 5)
		Trawl + Otter	North Sea 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

x) Netherlands - landings and catch.

1) 1972.

2) Mean 1969-73.

3) Mean 1969-72.

4) Mean 1971-73.

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

Table 9. HADDOCK. Numbers(millions) at each Length.(x)

Length	England[1)] Trawl	England[1)] Seine	Scotland[2)] Trawl	Scotland[2)] Seine	USSR[3)]	Netherlands[4)] Landings	Netherlands[4)] Catch	Norway[5)]
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

(x) Landings for United Kingdom, Netherlands and Norway. Catches for USSR and Netherlands.

1) Mean 1967-1973

2) Mean 1967-1972

3) Mean 1967-1970

4) Mean 1969-1972

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

Table 10. WHITING. Numbers (millions) at each Length.(x)

Length	Denmark 1) (Trawl)	England 2) Trawl	England 2) Seine	Scotland 3) Trawl	Scotland 3) Seine	Netherlands 4) Landings	Netherlands 4) Catch	Belgium 5)
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

(x) Landings for all countries plus catches for Netherlands

1) Mean 1970-1971

2) Mean 1967-1973 (including an estimate of discards)

3) Mean 1967-1972

4) Mean 1969-1972 - all gears

5) Mean 1971-1972

Table 11. WHITING and HADDOCK. Estimates of Numbers (millions) Discarded by the Dutch Fleet (all years).

Age Group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
WHITING														
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	.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)
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

1) Values used for current stock assessments.

Note: Values of F assumed initially are shown in the column headed "1972" and in the row labelled "10".

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)
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

1) Values used for current stock assessments.

Note: Values of F assumed initially are shown in the column headed "1972" and in the row labelled "10".

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)
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

1) 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".

M = 0.3

Age Group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	Current Values 1)
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

1) 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

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

M = 0.3

Age Group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Values for 1967-68 1)
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

1) 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	1158.1	1242.7	6 939.6	5 757.1	3 053.9	1 801.4	1176.0

M = 0.3

Age Group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
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	1027.6	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	1071.9	5 146.2	3 745.0	2 195.4	1344.7	1493.6	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	1282.1	1977.7	544.6	1003.4	832.7	1004.9	2759.6	950.1	2092.9	-	-
1	370.8	575.0	414.7	918.4	1567.0	387.9	642.6	649.4	795.7	2124.3	698.5	626.7	-
2	244.5	249.8	386.8	233.2	614.2	1013.4	218.4	418.5	261.7	518.6	1310.9	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	1584.7	1528.6	2284.5	3367.7	2923.8	2753.8	2538.6	2618.8	4167.7	3880.0	4391.9	-	-

M = 0.3

Age Group \ Year	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
0	983.8	700.8	1724.5	2854.1	716.6	1290.3	1065.9	1332.3	3618.7	1187.4	2278.3	-	-
1	470.4	711.5	505.3	1153.0	2064.8	475.9	786.2	759.0	961.3	2552.6	804.4	662.8	
2	283.6	297.4	447.4	273.5	723.6	1273.9	258.5	480.4	306.8	586.2	1484.9	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	2001.6	1906.6	2904.2	4548.6	3728.2	3442.6	3096.2	3186.1	5283.2	4644.3	4887.4	-	-

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			61	1 560	619	390	1 282
1962			205	12 000	3 253	2 170	1 978
1963			157	20	64	80	545
1964			230	80	64	540	1 003
1965	214	38	220	90	145	290	833
1966	7	5	39	3 060	720	400	1 005
1967	51	5	63	20 000	6 178	1 380	2 760
1968	322	75	315	1 100	391	60	950
1969	388	72	437	970	141	160	2 093
1970	5	3	11	3 000		140	
1971		50		7 000		1 000	
1972				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 1 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.1969)

Trawl	Mesh Size(mm)
U.S.S.R.	81
U.K.	81
France	64
Netherlands	73
Belgium	75
Sweden	83
Denmark	19.6

Seine:

U.K. 73/103 (single synthetic)
Sweden 70 mm.

		COD[1]	HADDOCK[2]	WHITING[3]
Selection factor 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
90 mm	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 50% Ages for the Mesh Sizes in use, and the Difference between these and the 50% ages for various Larger Mesh Sizes.

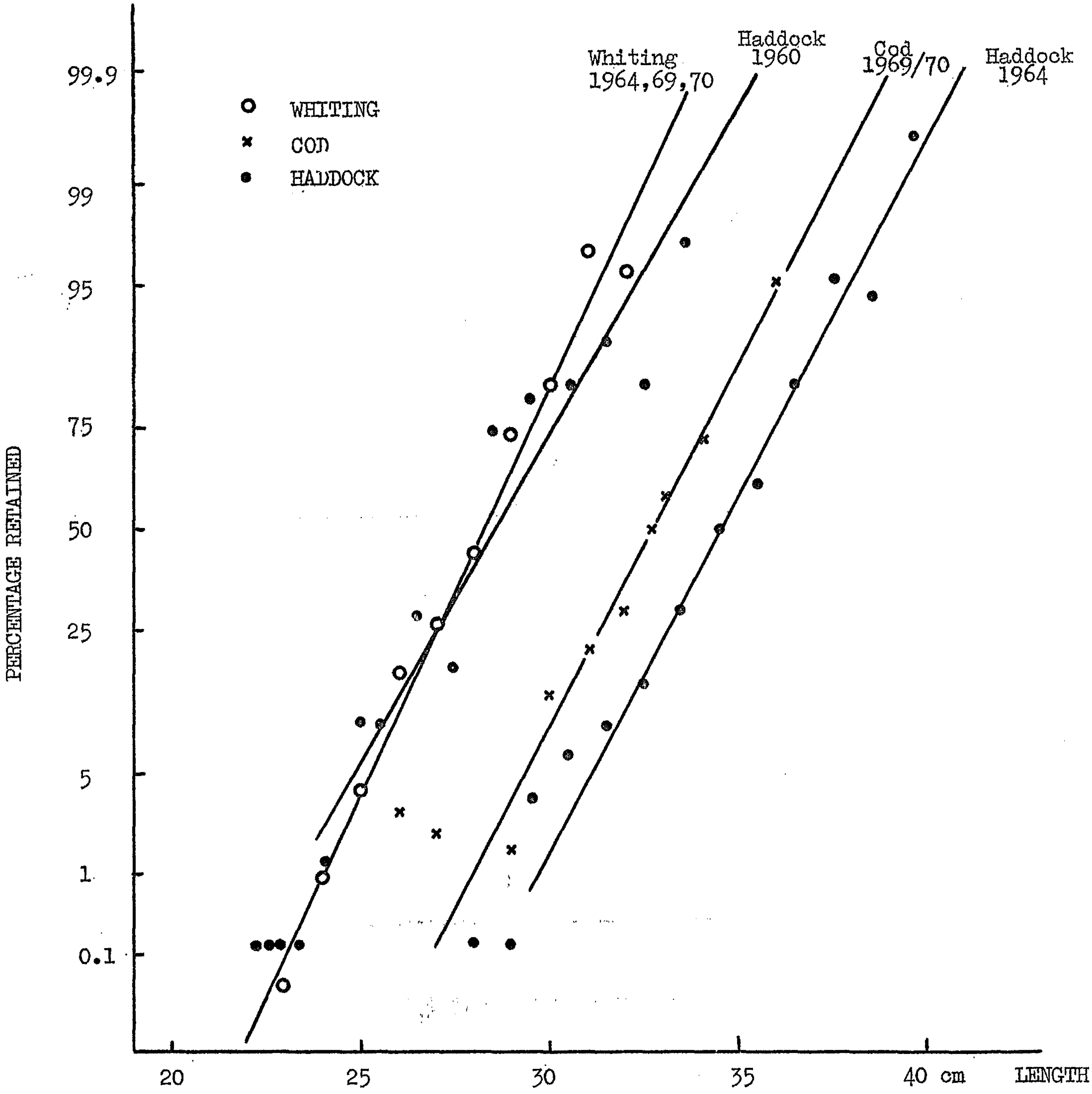
Species	Country	Current Mesh Size	Differences in 50% Age		
			80	85	90
COD	England Trawl & Seine	80	-	0.1	0.2
	Scotland Trawl & Seine	75	0.1	0.2	0.3
	Netherlands	75	0.1	0.2	0.3
HADDOCK	England Trawl & Seine	80	-	0.2	0.4
	Scotland Trawl & Seine	75	0.2	0.4	0.6
	Netherlands	75	0.2	0.4	0.6
WHITING	England Trawl & Seine	80	-	0.3	0.6
	Scotland Trawl & 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	
	U.K. + 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	
	U.K. + 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	
	U.K. + 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%.



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

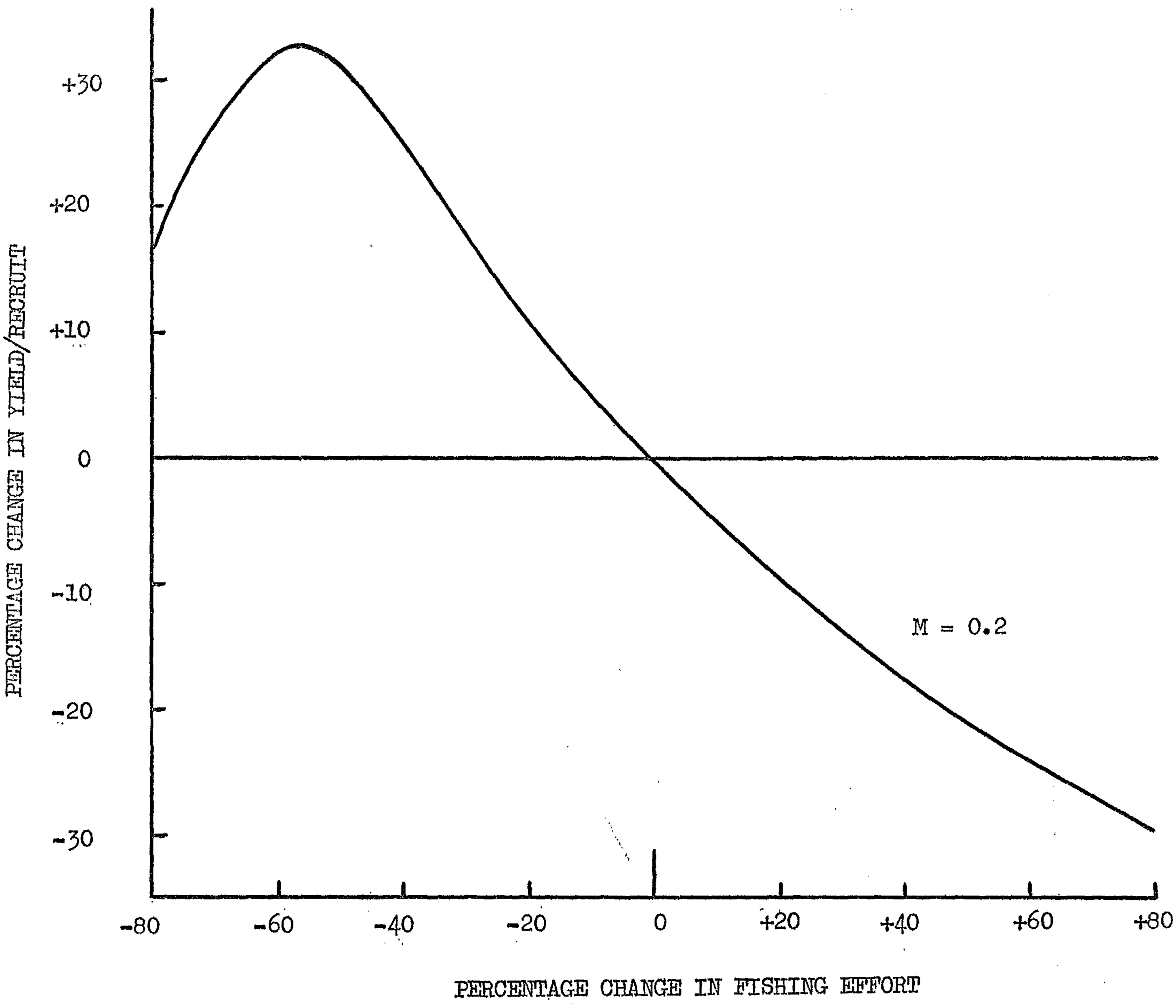


Figure 2. COD. Percentage changes in yield per recruit for various percentage changes in fishing effort.

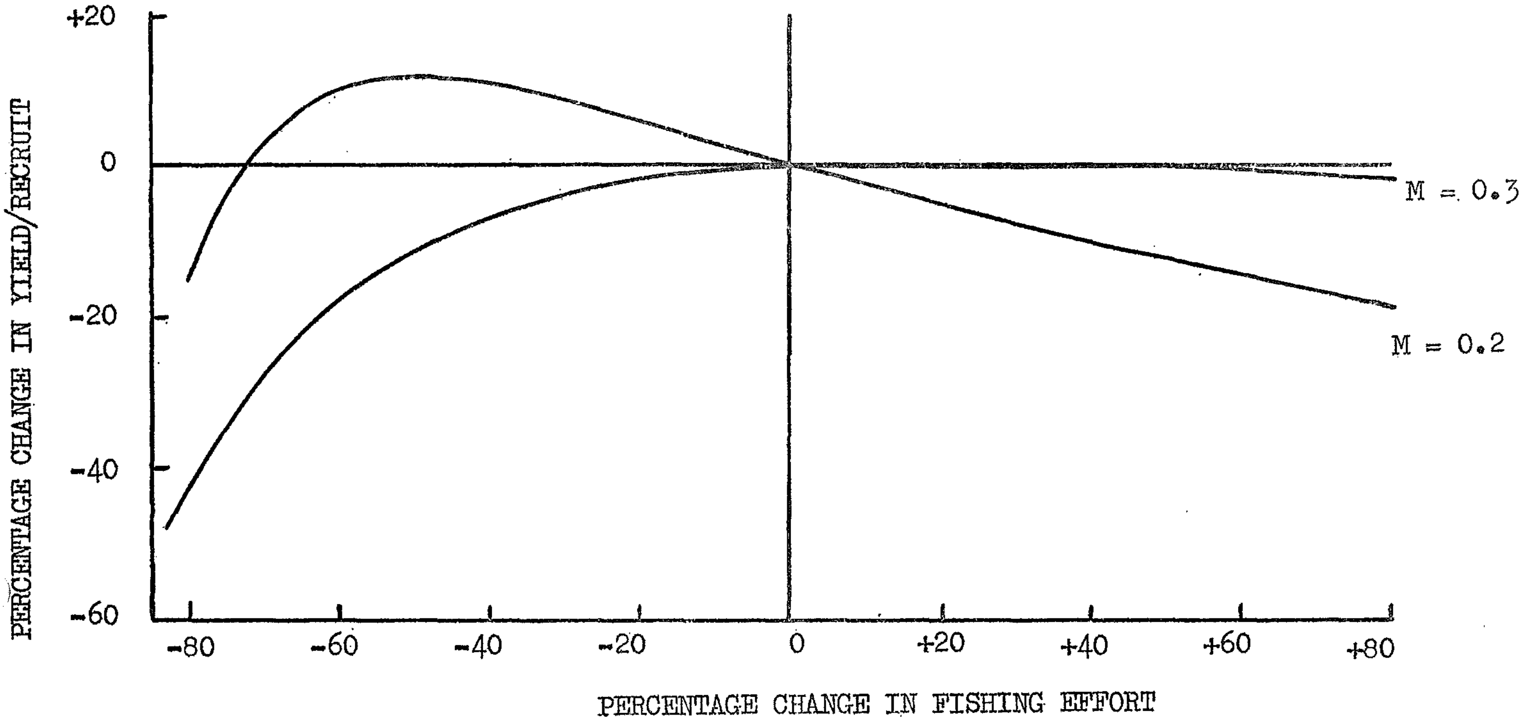


Figure 3. HADDOCK. Percentage changes in yield/recruit for various percentage changes in fishing effort (relative to current levels of yield/recruit and effort).

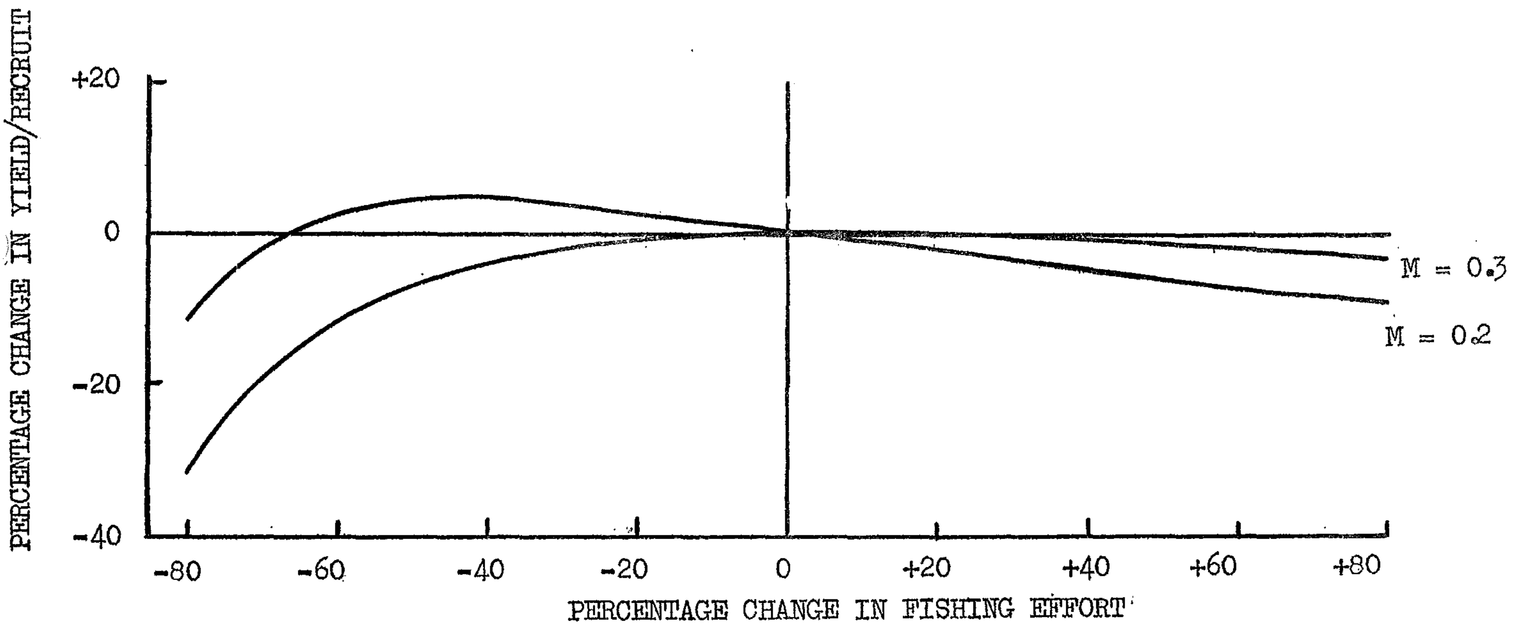


Figure 4. WHITING. Percentage changes in yield/recruit for various percentage changes in fishing effort (relative to current levels of yield/recruit and effort).