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Pelagic Fish (Northern) Committee

REPORT OF THE NORTH SEA HERRING ASSESSMENT WORKING GROUP

Charlottenlund, 3 - 7 September 1973

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Report of the North Sea Herring Assessment Working Group

1. Introduction

1.1 A description is given of the changes in the state of the North Sea herring stocks since the second World War in terms of total catch, stock size, fishing mortality, spawning potential and recruitment. It is concluded that the high fishing intensity exerted on the stock during the last decade has reduced the spawning potential at a rate of about 20% per year. The decrease in biomass has led to a decline in the total North Sea herring catch which at present is based upon a few young year classes.

1.2 Based on the assumption that future year classes will be of average strength, a prognosis of future catch and biomass is given for different combinations of fishing mortalities for juvenile and adult herring. Total allowable catch levels are deduced from this prognosis.

1.3 The existence of a stock/recruitment relationship for the total North Sea stock has not yet been demonstrated. The possibility that such a relation could arise by further deterioration by the spawning potential is pointed out. This could lead to a rapid collapse of stocks and fisheries.

2. Terms of Reference

2.1 At its Eleventh Annual Meeting in London, May 1973, NEAFC agreed that an extraordinary meeting of the Commission should be held in December 1973 in order to recommend conservation measures - especially quota regulations - to improve the state of the-herring stocks and fisheries. The Commission also agreed that a NEAFC Working Group of administrators and scientists should meet in London in late October in order to prepare basic material for the extra-ordinary meeting.

2.2 The terms of reference for the NEAFC Working Group are:-

> "To assemble and evaluate for presentation to a Special Meeting of the Commission information on measures for regulating catch with relation to herring stocks in the North and Celtic Seas.
>
> To consider and evaluate scientific data on the state of stocks of North Sea herring, including an assessment of the total allowable catch provided by the Liaison Committee of ICES.
>
> To consider and report to the Special Meeting on what further measures of conservation if any other than regulation of catch may be required for North Sea and Celtic Sea Herring."

2.3 The North Sea Herring Assessment Working Group consequently met at ICES headquarters, Charlottenlund, Denmark, in the period 3 - 7 September 1973. It had already met in February 1973 with two objectives: to revise its last report (Anon., 1972) for publication in ICES Cooperative Research Reports series and to report to the Liaison Committee on the preliminary data on the herring stocks and fisheries in 1972. A statement is included in the Liaison Committee's subsequent Report (Coop.Res.Rep., Liaison Cttee, 1973).

3. Participation

3.1 The following members of the Working Group took part in the meeting:-

A C Burd	U.K.
A Corten	Netherlands
J Jakobsson	Iceland
H Lassen	Denmark
A Maucorps	France
K Popp Madsen(Chairman)	Denmark
K Postuma	Netherlands
A Saville	U.K.
A Schumacher	F.R.G.
Ø Ulltang	Norway
G Wagner	F.R.G.
O J Østvedt	Norway.

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

The absence of members from Poland, Sweden and U.S.S.R. was noted with regret.

4. The Development of the Fishery in 1972

4.1 A review of the history of the North Sea herring fishery in the period 1947-71 is given in the Report of the North Sea Herring Assessment Working Group (Anon., 1972).

4.2 The final figures for the catch made in 1972 show a total of 491 100 tons for the North Sea and 66 900 tons for the Skagerrak. The overall total of 558 000 tons is thus about the same as in 1971 (Table 2). As in 1971 a large part of the catch (40%) was taken in the northwestern area. The landings from the young herring fisheries in the central North Sea increased from 165 200 tons in 1971 to 184 900 tons in 1972.

4.3 As in recent years the landings were mainly composed of 0, 1 and 2-ringed fish as shown in the table below.

Millions of herring caught per age group (winterrings)

Year/Age	0	1	2	3	4	5 and older	Total
1968	839	2425	1795	1494	621	571	7746
1969	112	2503	1883	296	133	336	5246
1970	890	1196	2003	884	125	143	5249
1971	684	4378	1147	662	208	97	7177
1972	750	3341	1441	344	131	40	6047

4.4 Considering that about half of the catch of the 2-ringed fish is taken before spawning about 80% of the total North Sea catch in 1971-72 consisted of juvenile and first time pre-spawners.

5. Spawning Potential

5.1 Using the estimates of each age group of the adult stock for the total North Sea derived from the Cohort analysis (Table 11) the spawning potential of the stock was calculated from fecundity data on northern North Sea herring (Figure 1):

5.2 Fecundity per age group (From Baxter, 1959)

Rings	2	3	4	5	>5
No. of eggs ($x\ 10^{-3}$)	45	67	87	96	101

5.3 Spawning potential

(Number of adult females x Mean number of eggs per age group x 10^{-12})

Year	Sp.pot.	Year	Sp.pot.	Year	Sp.pot.
1947	730	1955	459	1963	431
1948	622	1956	435	1964	481
1949	627	1957	405	1965	453
1950	585	1958	336	1966	338
1951	557	1959	520	1967	266
1952	500	1960	452	1968	197
1953	465	1961	434	1969	131
1954	460	1962	322	1970	146

5.4 The high spawning potential in 1947 is obviously a result of an accumulation during the war period of older fish having high fecundity.

5.5 From 1947 to 1958 the spawning potential declined in the course of 11 years by about 50%. This decline is associated with a steady increase in fishing mortality on adults from 0.24 in 1947 to 0.45 in 1958.

5.6 In the following period 1959 to 1965 the spawning potential fluctuated by about 25% around an average of 440×10^{12}. The fishing mortality during this period fluctuated in a similar way between values of 0.3 and 0.48. Within this range a remarkable increase in spawning potential was observed in 1959 and 1964 as a result of the outstanding year classes 1956 and 1960.

5.7 In the course of the 5 years period after 1965 the spawning potential declined sharply by 70% from the level of the preceding period. This decline is associated with a sharp increase in fishing mortality from the previous level of 0.45 up to a level of 1.0 and even higher.

5.8 As shown in Figure 1 and mentioned above the two very good year classes 1956 and 1960 increased the spawning potential considerably and counteracted the rapid decline of the spawning potential caused by fishing. The good year class 1963, which was about 40% above the long-term average, did not lead to an increase in spawning potential. This was due to the increasing exploitation of the juvenile component, and leads to the conclusion that at the present high level of exploitation of the juveniles, even a good year class can hardly contribute significantly to the spawning potential.

6. Fishing Mortality from VPA and Catch per Unit Effort Data

6.1 Fishing mortality rates calculated for each age group, in each year, over the period 1947-70, are given in Table 12 for the total North Sea stock.

6.2 For the adult stock the changes in the fishing mortality rates can most easily be followed from the value $F_{w \geq 2}$ This value was about 0.2 prior to 1951; fluctuated between 0.31 - 0.48, with a mean of 0.4, in the period 1952-64; and thereafter increased very much to a mean of 0.71 in 1965-67 and to 1.13 in 1968-70.

6.3 In the early 1950's when the Bløden fishery started, the calculated fishing mortalities were low, at a value of 0.1 for the 1-ringers. From 1954 to 1963 the mortality fluctuated without trend in the range 0.18-0.46, with a mean value of 0.3. In the period 1964-69 the fishing mortality rate was appreciably higher in the range 0.36-0.54 with a mean of 0.5.

6.4 The catch data indicate that subsequent to 1970 the fishing mortality in the young herring fishery has increased even further. For several alternative values of F on 2-ringers in 1972, the value of F on 1-ringers in 1971 was calculated applying a VPA analysis. The results indicate that at present the fishing mortality rate on 1-ringers is at the same level or even higher than that of the adults i.e. about 0.7.

6.5 From the ICES Bløden Herring Tagging Experiment estimates were made of the fishing mortality of the 1967 and 1968 year classes as 1-ringed fish (Anon., 1973). The values derived are in close agreement with those obtained from the Cohort analysis.

6.6 In the table below are given total mortality rates calculated from catch per unit effort and age composition data for the northwestern, central and southern North Sea adult stocks separately. As these are rather variable from year to year they are presented as mean values for 4-year periods. The values in this table up to 1969 are taken from Table 22 of Anon. (1971); those subsequent to 1969 have been calculated during this meeting.

Period	Northwestern North Sea 1)	Central North Sea 2)	Southern North Sea 3)
1952-57	0.39	0.44	0.81
1957-61	0.58	0.60	1.13
1961-65	0.42	0.83	1.55
1965-69	0.73	1.01	1.33
1969-72	0.67	0.89	1.22

1) Derived from Scottish drift-net catch per unit effort in May-July.

2) Derived from Netherlands trawl catch per unit effort in August-September.

3) Derived from Netherlands trawl catch per unit effort in November-December.

6.7 In the northwestern area the total mortality rates in the period prior to 1965 were in the range 0.4 - 0.6 but subsequent to 1965 they increased to about 0.7. In the central North Sea these total mortality rates were at about the same level as in the northwestern area prior to 1961 and then rose more sharply. In the southern North Sea the total mortality rate was quite high at 0.8 even in the earliest period considered here, and increased progressively up to 1965 to a level of 1.5.

6.8 The mortality rates from catch per unit effort data can only be compared with those derived from the VPA analysis by weighting these area estimates by the relative stock sizes in each area to get an overall mean. Data on the sizes of the adult stock in the three areas have been taken from Burd (1973). When this is done and 0.1 subtracted to get an F value, the resulting values are given in the following together with the VPA values for comparison.

Period	Fishing mortalities derived from:	
	Catch per unit effort	VPA
1952-57	0.41	0.38
1957-61	0.49	0.44
1961-65	0.44	0.49
1965-69	0.67	0.89
1969-72	0.64	?

6.9 The close agreement up to 1965 gives some confidence in the catch per unit effort estimates for the period 1969-72 when no efficient estimate of F can be obtained from the VPA. The value of 0.64 for this period derived from catch per unit effort is very close to the value of 0.7 used in the prognosis for the input value of the adult stock.

7. Recent Recruitment Estimates

7.1 The magnitude of any regulatory measures to be taken in order to restore the North Sea spawning stocks is partly dependent upon the level of current recruitment to these stocks. The 1969 year class is the last one for which some estimate can be made from the adult North Sea fisheries. In the central North Sea fisheries the abundance was low as it also was in the spawning fishery in the Southern Bight. This year class contributed largely to the fishery in the northwestern North Sea around the Orkneys and Shetlands, and in catches in VIa. The recent year class abundances for both areas from Scottish catches are given below.

7.2 Scottish estimates of recruitment of recent year classes

Year class	IVa W tons/drifter landings (May-July) as 2-ringers	VIa Stock in 10^{-9} as 0-group
1967	3.06	1.01
1968	1.68	1.53
1969	1.50	2.30
1970	1.41	1.58

7.3 The table indicates that the 1969 year class was particularly strong in VIa while in IVa it was about the same strength as the 1968 and 1970 year classes in contrast to the situation in other North Sea adult fisheries.

7.4 Estimates of the strength of these year classes were available as juvenile fish. The table below gives the abundances in the English 0-group surveys, the ICES Young Herring Surveys and the Danish industrial fishery.

7.5 Estimates of recruitment as juvenile fish

Year class	English 0-group 1)	ICES Young Herring Surveys 2)		Danish industr. fishery 3)	
		I	II	I(spring)	II(autumn)
1967	1799	455	87	1082	318
1968	1259	442	73	305	173
1969	2793	1241	354	1006	455
1970	1245	844	57	1278	307
1971	907	411			

1) Numbers per hour per station. 2) Numbers per hour per rectangle.

3) Weighted average number per cpue (Feb-Mar).

7.6 The 1969 year class is dominant in each series except in spring 1971 in the Danish fishery. The 1970 year class was also above average in the ICES Young Herring Surveys and the Danish fishery. The 1967 year class, which was much stronger in the northwestern North Sea than in VIa, also appears as above average strength in the juvenile estimates. From the few data available the 1971 year class as juvenile fish appears to be about average strength.

7.7 The interpretation of the juvenile abundance estimates in relation to the North Sea spawning stocks is problematic. While the 1969 year class appeared abundant from the juvenile assessments it recruited poorly in the North Sea, except in the northwestern area. It was also abundant in VIa, and the possibility exists that a part of that year class of juvenile herring in the North Sea were recruits to the stock in VIa.

7.8 A number of returns from the Bløden Tagging Experiment can be ascribed to fishing position. These are mostly returns from Norwegian and Scottish meal plants. Figure 3 shows the returns reported from the July/August fishery in 1970 and 1973. It appears that some fish of the year classes 1967 and 1968 tagged on the Bløden south of 55°30' migrated to the west of the Shetlands and Orkneys and even into the Minch.

7.9 The abundances of larvae in the North Sea surveys over the period 1946-72 are summarized in Table 13. This table is a complete revision of that previously reported (Anon., 1972). In recent years in the Downs area there has been some improvement from the very low levels in 1963-66. In the central North Sea the major production in recent years is centered on the Yorkshire coast and Longstone spawning grounds, while on the Dogger there has been no appreciable production since 1966. In the Buchan area some larval production occurred in 1971 and 1972 after the low levels in 1967-70. The abundance of larvae in the Orkney/Shetland area seems to be very variable from year to year. If these larvae, or even older larvae from areas further west, are drifted into the North Sea and as juveniles eventually exploited in the young herring fisheries, a component of variability is introduced which causes difficulty in making forecasts of recruitment from these.

7.10 In the prognosis the recruitment of the incoming 1971, 1972 and subsequent year class has been put at average.

8. Stock/Recruitment Relationship

8.1 Although no stock/recruitment relationship for the herring stock of the North Sea has so far been established, a continuation of the steady decrease in spawning potential during the past years makes it likely that such a relationship could be effective. In that case the result will be that the protection measures discussed in the present report will be over-optimistic. If very severe protection measures are not then taken immediately, a complete breakdown of the North Sea herring stock will be evident within a couple of years.

9. Prognosis

9.1 A new prognosis (Table 14) has been made for catches in 1973 and changes in catch and biomass in subsequent years, using final catch figures for 1972.

9.2 The assumptions used for the new prognosis differ in some respects from those used in the previous Report (Anon., 1972). Both sets are given in the following for comparison:-

9.3

Assumptions used in:	This Report	The previous Report
Year class 1971	Average (7.9×10^9)	Average (7.9×10^9)
Year class 1972	Average (7.9×10^9)	Average (7.9×10^9)
Natural mortality	0.1	0.1
Fishing mortality, 0-group, 1972	0.14	0.05
Fishing mortality, I-group, 1972	0.70	0.5
Fishing mortality, adults, 1972	0.70	1.0
$F_{0-gr.} = 0.2 \times F_{1-gr.}$		

9.4 The age composition as at 1 January 1973 is given below:-

Age	0	1	2	3	4	5	6	7	8	Biomass in tons
Nos $\times 10^{-9}$	7.9	6.2	3.1	1.34	0.32	0.12	0.031	0.005	0	0.77×10^6

9.5 The change in fishing mortalities for adult and juvenile herring was based on the catch in numbers for 1972. Assuming year classes 1969 and 1970 to be not far above average strength, the high numbers of these year classes caught as juveniles can only be explained by an increased fishing mortality on juvenile herring. The numbers of adult herring caught were lower than was to be expected at F = 1.0. Therefore, fishing mortality on adult herring has been reduced to 0.70.

10. Total Allowable Catch

10.1 The objective of introducing a quota regulation is either to prevent a reduction of the current stock size, and hence of the catch, or to allow an increase in stock size and future yields from it. With the size and age composition of the stock at their present levels the fishery is very largely dependent on the youngest age group. Any succession of poor year classes, whether naturally induced or due to a stock/recruitment relationship, would effectively eliminate the North Sea herring fisheries very quickly. The objective therefore must be to bring about an appreciable increase in stock size over a fairly short time period. Table 14 gives the forecast catches in 1973, and the increases expected by 1976 in catch and stock size, at various levels of fishing mortality on the juvenile and the adult components of the stock.

10.2 This prognosis is based on the catch figures of 1972, assumed F's on adults and juveniles of 0.7 and average recruitment. The provisional catch figures for 1973 suggest that the F values in that year are likely to remain at about the same level. The prognosis shows that there is little change in stock biomass at these levels of F and therefore the values in Table 14 for 1973 can be taken as equally valid for 1974. Similarly the values for 1976 are valid for 1977. To illustrate the options which are available two levels of increase in stock size, 100% and 200%, have been selected and the various strategies which will achieve these by 1977, given average recruitment, are shown in the tables below.

10.3 If the objective is to increase the stock biomass by 100%, from the current level of 770 000 tons to about 1.5 million tons, this can be achieved by any of seven combinations of the adult and juvenile fishing mortalities according to Table 14. These are shown in the text table (see 10.4) with their effects on total allowable catch in 1974, and with the maintenance of these F's in the ensuing years, on the catch in 1977.

10.4 100% increase in stock biomass by 1977 (in '000 tons)

Juvenile F		0.0	0.1	0.2	0.3	0.4	0.6	0.8
Adult F		0.8	0.7	0.6	0.5	0.4	0.3	0.2
Allowable catch in 1974	Juveniles	-	30	60	80	110	150	180
	Adult	390	350	310	280	230	180	130
	Total	390	380	370	360	340	330	310
Allowable catch in 1977	Juveniles	-	30	60	80	110	150	180
	Adults	820	730	640	560	470	350	240
	Total	820	760	700	640	580	500	420

10.5 The smaller the juvenile F selected the higher will be the catch which can be taken in 1974; and the catch in 1977 will be very appreciably higher, increasing in the extreme case from 420 000 to 820 000 tons.

10.6 If the greatest yield is the objective, then this would be achieved by completely stopping the juvenile fishery and retaining the exploitation rate of the adult fish at about the current level. The total allowable catch in 1974 would then be set at 390 000 tons. Retention of these levels of F to 1977 would give a total allowable catch in that year of 820 000 tons.

10.7 If the aim is to increase the stock size over the period 1974 to 1977 by 200% (to 2-3 million tons) only four combinations of the adult and juvenile F's listed in Table 14 will obtain the objective. These are shown below.

10.8 200% increase in stock biomass by 1977 (in '000 tons)

Juvenile F		0.0	0.2	0.25 x)	0.3	0.6
Adult F		0.4	0.3	0.25	0.2	0.1
Allowable catch in 1974	Juveniles	0	60	70	80	150
	Adult	230	180	160	130	70
	Total	230	240	230	210	220
Allowable catch in 1977	Juveniles	0	60	70	80	150
	Adult	700	510	410	380	170
	Total	700	570	480	460	320

x) interpolated.

10.9 These give a small range of 210 000 - 240 000 tons of total allowable catch in 1974. With the retention of these F values the levels of catch taken in 1977 are, however, very different, with a major increase in catch with decreasing F's in the juvenile fishery.

10.10 It must be stressed that if a total allowable catch is set without differentiating between adult and juvenile herring, the 1977 catch will be very much lower than that obtainable by a proportionally greater decrease in the juvenile than in the adult fishery.

10.11 With a stock size increase of 200% by 1977 the maximum sustainable yield would thereafter be taken by not exploiting the stock until the fish are 2-ringers and applying a fishing mortality rate of 0.4. The annual yield, with stable recruitment would then be about 825 000 tons.

10.12 The expected long-term developments in catches and stock biomass are shown in Figure 4 A and Figure 4 B, respectively. It should be noted that the MSY for North Sea herring is obtained at a fishing mortality of 0.4 for adults and no fishing for 0 and 1 groups.

11. Additional Regulatory Measures

11.1 Minimum mesh size

The effectiveness of mesh size regulations in herring fisheries is very doubtful as fish which have escaped through the meshes may not be viable.

11.2 Minimum size

The introduction of a size limit in herring fisheries would have its effect through increased recruitment to the adult stock. Because of the difficulties in applying minimum mesh sizes, the direct effect would be to prohibit fishing on grounds where small herring are dominant. The length dividing the immature from the adult herring lies roughly between 20-23 cm.

11.3 Area closures

Closing of certain areas can be used for protecting specific components of the stocks e.g. by closing spawning grounds and nursery areas.

11.4 Seasonal closures

Because of the increase in weight of the herring from spring to summer and autumn, some increase in yield would be obtained by reducing the fishery in the first half of the year. A closed season from 1 February to 15 June increases the yield in the juvenile and adult fisheries by about 23% and 5% respectively, compared with the yield generated by the same annual fishing mortalities when there is no seasonal restrictions (Ulltang, 1972). The same quota in weight can thus be obtained with reduced catch in number by seasonal restrictions.

11.5 Other conservation measures were discussed in the former reports of the Working Group (Anon., 1971 and 1972).

12. Discussion

12.1 The data in Tables 1-8 refer solely to herring catches in the North Sea and Skagerrak, while in "Bulletin Statistique" no distinction is made between catches derived from the Skagerak and Kattegat. It is also known that some of the socalled herring catches in "Bulletin Statistique" contain varying quantities of other species. The catch figures in the present report are about 30-40% less than the official figures in "Bulletin Statistique".

12.2 It is stressed that the total allowable catch levels for North Sea autumn spawners in the present report are based on the catch data presented here, which are the better estimates of North Sea herring catches.

12.3 The final catch figures for 1972 differ little from the preliminary ones given in the Liaison Committee Report (Anon., 1973) and at 558 000 tons the total catch is close to that in 1971. The catch composition, however, shows a further increase in the proportion of young fish.

12.4 The preliminary catch figures for the first seven months of 1973 already amount to 264 000 tons despite the closure in force from 1 February to 15 June. This catch represents about half the expected annual catch if fishing mortalities had remained at the levels of 1972. The major part of the catch was taken after 15 June.

12.5 Prognoses of future catches have been made on the basis of the 1972 age composition and on certain assumptions including that of average recruitment levels being maintained after the 1971 year class entered the stock.

12.6 The assumption of average recruitment would be invalid if a stock/recruitment relationship exists. Total North Sea estimates of recruitment have remained high despite a reduction of spawning potential of about 80% since 1947. The actual catches from the juvenile fisheries have remained high and have even increased. There is evidence to suggest that the apparent sustained abundance of juveniles in the North Sea may be supported by an influx of progeny from stocks north and west of Scotland. As these fish may not contribute to the adult North Sea stocks, they could mask an actual decline in North Sea recruits and the existence of a stock/recruitment relationship. Though the critical level to which spawning potential might be reduced before recruitment is effected is not known, any further reduction from the present level must be regarded with concern.

12.7 With the present mortalities on juveniles and adults little change is expected by 1976 in biomass or catch if recruitment remains constant. However, because of the dependence of the fishery on the recruit brood the occurrence of a single poor year class would result in an immediate drop in total catch and a subsequent decline in spawning potential. For this reason alone it would be beneficial for the fisheries to be based on a stock of higher average age and biomass.

12.8 The stock biomass can only be increased by reduction in fishing mortality. In view of the errors inherent in the catch statistics on herring and on the assumption of future recruitment, it is necessary to aim at an increase of at least 100% over the 1972 biomass in the course of 3-4 years.

13. References

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<u>Table 1a.</u> Herring. Catch in '000 tons 1947-1959.
North Sea (Sub-area IV and Divisions VIId and e) by country.
Skagerak and Kattegat (Division IIIa) total catch.

Country / Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium	36	23	17	10	8	13	16	18	16	6	2	2	3
Denmark	9	7	5	8	34	33	50	58	66	83	88	134	145
England	101	114	71	75	73	66	71	61	39	36	32	22	21
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	-	-
France	77	77	60	61	125	65	76	54	59	45	34	34	35
Germany F.R.	110	117	107	117	177	158	297	263	268	217	237	200	147
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	155	163	131	133	149	158	186	174	148	136	129	127	118
Norway	4	6	3	4	1	2	2	3	5	5	8	8	17
Poland	-	-	-	-	-	-	-	-	39	46	49	56	71
Scotland	81	90	53	37	42	77	82	59	69	43	41	30	48
Sweden	25	26	25	27	31	37	37	39	47	38	49	50	57
U.S.S.R.	-	-	-	-	-	-	-	-	2	28	37	29	40
Total North Sea	598	623	472	472	640	609	817	729	758	683	706	692	702
Total Skagerak and Kattegat	53	81	79	91	104	139	137	99	113	123	158	216	205
Grand Total	651	704	551	563	744	748	954	828	871	806	864	908	907

<u>Table 1b.</u> Herring. Catch in tons 1960-1971.
North Sea (Sub-area IV and Divisions VIId and e) by country.
Skagerak and Kattegat (Division IIIa) total catch.

Year / Country	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Belgium	3 642	3 146	1 117	1 843	1 607	776	391	410	134	468	1 200	681	1 337
Denmark	119 400	138 800	126 000	117 600	141 600	158 700	105 900	135 000	163 100	180 260	133 331	185 393	213 738
England	16 354	17 849	11 994	22 821	16 533	11 494	10 716	8 215	5 128	6 666	9 702	4 113	650
Faroe Isl.	-	-	-	-	973	3 111	1 491	35 993	49 995	40 640	58 405	25 635	48 444
France	11 137	23 042	12 271	18 062	23 295	16 480	10 711	11 478	12 852	15 307	11 482	11 408	12 901
Germany F.R.	148 388	100 944	89 056	93 815	86 586	77 032	54 157	32 312	21 216	12 798	7 150	3 952	3 065
Iceland	-	-	-	-	-	1 757	1 047	5 684	44 489	19 997	22 951	36 992	31 998
Netherlands	125 713	129 841	87 521	126 487	116 226	80 320	56 668	37 270	22 306	29 769	49 416	32 479	24 829
Norway	13 893	10 440	7 461	21 448	103 752	520 890	424 462	240 032	211 904	114 938	177 341	122 570	110 969
Poland	76 304	78 082	59 331	72 462	89 691	98 130	74 071	37 816	11 954	9 221	5 057	2 031	2 235
Scotland	29 006	23 038	22 416	34 571	21 125	20 569	17 557	18 138	16 477	22 053	21 885	25 073	17 227
Sweden	89 289	103 744	110 353	140 012	130 132	132 182	121 970	121 591	88 061	33 109	34 670	36 880	7 366
U.S.S.R.	63 105	67 722	100 265	75 965	139 637	47 322	16 442	11 660	70 029	61 549	18 078	9 500	16 386
Total N.Sea	696 231	696 648	627 785	725 086	871 157	1168 763	895 583	695 599	717 645	546 775	550 668	496 707	491 145
Skagerak	75 820	85 291	104 246	163 228	309 804	256 742	144 655	279 744	280 036	113 279	70 527	61 411	66 962
Kattegat	31 000	41 100	51 600	64 200	79 300	81 400	75 300	72 000	108 900	59 300	74 300	90 200	107 519
Grand Total	803 051	823 039	783 631	952 514	1260 261	1506 905	1115 538	1047 343	1106 581	719 354	695 745	648 318	665 626
Non-Member Countries	36 000	?	?	?	?	67 700	30 600	27 700	?	?	250	?	?

Table 2. Herring. Total catch in thousands of tons in the North Sea and Skagerak

Year	Area							Total
	Northwest	Northeast	Central	South	Industrial Fishery (IVb)	Total North Sea	Skagerak	
1947	211.3	0.3	214.4	160.6	-	586.6	40.9 x)	627.5 x)
1948	169.4	1.9	168.0	162.5	0.3	502.1	54.9 x)	557.0 x)
1949	134.2	2.0	178.8	193.3	0.2	508.5	52.4 x)	560.9 x)
1950	125.1	1.6	181.3	178.3	5.4	491.7	51.3 x)	543.0 x)
1951	123.0	1.2	266.0	165.6	44.6	600.4	46.7 x)	647.1 x)
1952	168.4	6.6	203.1	236.1	50.2	664.4	61.1 x)	725.5 x)
1953	178.8	7.5	224.6	209.2	78.4	698.5	47.9 x)	746.4 x)
1954	168.0	4.3	218.4	276.9	95.3	762.9	99.1 x)	862.0 x)
1955	287.8	67.4	170.3	168.4	112.5	806.4	89.0	895.4
1956	194.5	79.1	163.9	134.0	103.7	675.2	82.0	757.2
1957	209.0	97.3	150.7	122.7	103.2	682.9	90.5	773.4
1958	164.7	98.2	156.1	92.6	158.9	670.5	131.0	801.5
1959	259.6	144.2	147.1	77.2	156.4	784.5	139.0	923.5
1960	101.1	264.0	166.3	64.9	99.9	696.2	75.8	772.0
1961	61.0	274.8	168.9	98.2	93.8	696.7	85.3	782.0
1962	37.6	291.8	143.3	54.7	100.4	627.8	104.2	732.0
1963	73.1	301.3	228.2	45.7	67.7	716.0	163.2	879.2
1964	66.1	444.0	187.9	56.6	116.6	871.2	309.8	1 181.0
1965	298.3	580.8	132.9	21.8	135.0	1 168.8	256.7	1 425.5
1966	278.6	424.0	114.1	11.6	67.2	895.5	144.7	040.2
1967	117.3	373.7	107.9	11.4	85.2	695.5	279.7	975.2
1968	286.7	256.8	57.8	9.6	106.9	717.8	280.0	997.8
1969	213.1	148.1	40.0	24.3	121.2	546.7	113.3	660.0
1970	312.6	21.3	111.7	27.1	74.8	550.7	70.5	621.2
1971	279.0	17.5	26.6	21.5	165.2	496.7	64.2	560.9
1972	229.5	22.7	30.7	23.3	184.9	491.1	66.9	558.0

x) Data include some Kattegat catches.

Table 3. Herring. Total catch in tons.
Skagerak (Division IIIa excl. Kattegat)

Year	Denmark	Faroe Islands	German Fed.R.	Iceland	Netherlands	Norway	Poland	Sweden	U.S.S.R.	Total
1960	43 200	-	42	-	-	2 578	-	30 000	-	75 820
1961	56 700	-	7	-	-	4 584	-	24 000	-	85 291
1962	70 600	-	3	-	-	5 049	594	28 000	-	104 246
1963	105 100	-	828	-	-	10 971	329	46 000	-	163 228
1964	129 500	-	6 064	-	-	85 916	4 324	84 000	-	309 804
1965	95 300	-	4 248	-	-	83 864	5 330	68 000	-	256 742
1966	75 200	-	432	-	74	30 438	511	38 000	-	144 655
1967	100 400	-	466	2 151	-	95 039	127	66 000	15 561	279 744
1968	143 600	-	2	695	36	71 865	42	45 000	18 796	280 036
1969	57 965	-	-	-	-	13 957	-	41 357	-	113 279
1970	30 107	-	-	6 453	-	7 037	-	26 930	-	70 527
1971	26 985	5 636	-	3 066	-	5 961	-	19 763	-	61 411
1972	34 900	4 115	-	7 317	-	986	-	19 644	-	66 962

Table 4. Herring. Total catch in tons.
North Sea, Northeast (Division IVa east of 2°E)

Year	Belgium	Denmark	England	Faroe Islands	France	German Fed.R.	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	U.S.S.R.	Total
1960	-	41 800	-	-	-	29 455	-	15 442	9 005	15 749	1 598	87 825	63 105	263 979
1961	-	61 500	-	-	-	14 043	-	6 318	7 630	11 020	3 877	102 676	67 722	274 786
1962	-	49 600	3	-	-	8 913	-	6 990	5 793	5 036	4 899	110 287	100 265	291 786
1963	-	58 900	4	-	-	10 069	-	8 448	18 255	3 335	-	135 350	75 965	301 326
1964	-	53 100	-	-	-	9 972	-	9 313	91 006	12 949	627	127 425	139 637	444 029
1965	-	49 700	-	-	-	23 428	1 757	6 912	323 361	16 200	-	132 182	27 227	580 767
1966	-	51 400	6	-	-	12 329	1 047	4 555	205 239	11 690	186	121 141	16 442	424 035
1967	-	51 600	-	-	-	2 558	5 684	1 709	176 628	2 986	-	120 838	11 660	373 663
1968	-	57 100	-	-	-	2 487	9 355	1 022	66 046	1 880	-	88 061	30 799	256 750
1969	32	55 550	-	12 805	278	16	6 300	2 084	15 618	166	9 785	26 035	19 392	148 061
1970	50	1 800	-	5 898	48	10	1 220	281	3 331	123	1 929	5 560	1 012	21 262
1971	-	6 219	-	239	-	-	-	167	10 442	-	-	-	-	17 067
1972		19 711	-	979		9	1 943	40	50				-	22 732

Table 5. Herring. Total catch in tons.
North Sea, Northwest (Division IVa west of 2°E)

Year	Belgium	Denmark	England	Faroe Islands	France	German Fed.R.	Iceland	Nether-lands	Norway	Poland	Scotland	Sweden	U.S.S.R.	Total
1960	122	-	163	-	1 151	45 746	-	19 863	3 343	7 000	22 292	1 464	-	101 144
1961	120	-	8	-	5 796	19 146	-	8 414	2 173	7 271	16 954	1 068	-	60 950
1962	125	-	11	-	3 757	7 125	-	4 659	837	3 807	17 191	66	-	37 578
1963	343	-	13	-	5 121	11 377	-	9 495	2 641	12 511	26 945	4 662	-	73 108
1964	155	-	8	973	6 405	7 319	-	11 420	4 350	15 962	16 753	2 707	-	66 052
1965	227	-	-	3 111	7 303	4 489	-	11 515	196 488	35 878	19 239	-	20 095	298 345
1966	178	-	34	1 491	2 628	7 069	-	3 414	219 223	27 199	16 548	829	-	278 613
1967	200	-	15	35 993	1 515	7 941	-	3 418	41 664	8 454	17 359	753	-	117 312
1968	23	-	-	49 995	1 349	7 150	35 134	3 072	131 598	2 806	16 324	-	39 230	286 681
1969	68	11 360	-	27 835	605	448	13 697	474	99 316	362	10 051	6 765	42 157	213 138
1970	750	61 423	-	40 884	818	177	20 587	177	146 397	2 069	17 767	4 470	17 066	312 585
1971	-	44 500	-	25 142	514	389	36 992	5 755	112 114	1 288	24 711	4 954	9 500	265 580
1972	-	29 711	74	37 004	888	100	29 721	1 967	94 825	1 620	17 227	-	16 386	229 523

Table 6. Herring. Total catch in tons.
North Sea, Central (Division IVb)
Adult Herring Fisheries.

Year	Belgium	Denmark	Faroe Islands	England	Iceland	France	German Fed.R.	Nether-lands	Norway	Poland	Scotland	Sweden	Total
1960	115	-	-	9 816	-	369	39 326	61 540	1 545	48 479	5 116	-	166 306
1961	121	-	-	8 579	-	2 535	35 402	70 336	637	49 064	2 207	-	168 881
1962	124	-	-	6 076	-	2 886	40 772	47 255	831	45 030	326	-	143 300
1963	558	-	-	14 465	-	8 296	60 818	81 524	552	54 370	7 626	-	228 209
1964	351	-	-	9 235	-	7 750	36 361	63 314	8 396	58 726	3 745	-	187 878
1965	47	-	-	8 524	-	7 037	22 520	47 551	1 041	44 815	1 330	-	132 865
1966	69	-	-	9 646	-	6 261	21 183	42 008	-	34 085	823	-	114 075
1967	5	-	-	6 809	-	6 540	18 917	26 769	21 740	26 370	779	-	107 929
1968	13	-	-	4 170	-	8 196	10 439	13 285	14 260	7 241	153	-	57 757
1969	-	-	-	5 964	-	3 362	3 528	16 542	4	8 077	2 217	309	40 003
1970	-	-	11 623	8 731	1 144	2 433	6 005	28 815	27 613	2 836	2 189	24 640	116 029
1971	8	2 488	254	4 113	179	4 734	-	10 172	14	743	362	1 926	24 993
1972	-	1 589	10 460	271	334	2 014	21	11 372	-	615	-	4 068	30 744

Table 7. Herring. Total catch in tons. North Sea, Central (Division IVb).

Year	Young Herring Fisheries					
	Denmark	German Fed. R.	Sweden	Norway	Total	Total young and adult fisheries (Tables 6 and 7)
1960	77 600	22 322	-	-	99 922	266 228
1961	77 300	16 549	-	-	93 849	262 730
1962	76 400	23 975	-	-	100 375	243 675
1963	58 700	9 017	-	-	67 717	295 926
1964	88 500	28 126	-	-	116 626	304 504
1965	109 000	26 009	-	-	135 009	267 874
1966	54 500	12 737	-	-	67 237	181 312
1967	83 400	1 849	0	-	85 249	193 178
1968	106 000	847	0	-	106 847	164 604
1969	113 350	7 900	0	-	121 250	161 253
1970	70 108	400	0	-	70 508	186 537
1971	132 161	3 055	30 000	-	165 216	190 209
1972	162 671	2 823	3 298	16 094	184 886	215 514

Table 8. Herring. Total catch in tons.
North Sea, South and English Channel, East and West
(Divisions IVc and VIId and e)

Year	Belgium	Denmark	England	France	German Fed.R.	Netherlands	Poland	Total
1960	3 405	-	6 375	9 617	11 539	28 868	5 076	64 880
1961	2 905	-	9 262	14 711	15 804	44 773	10 727	98 182
1962	868	-	5 904	5 628	8 271	28 617	5 458	54 746
1963	942	-	8 339	4 645	2 534	27 020	2 246	45 726
1964	1 101	-	7 290	9 140	4 808	32 179	2 054	56 572
1965	502	-	2 970	2 140	586	14 342	1 237	21 777
1966	144	-	1 030	1 822	839	6 691	1 097	11 623
1967	205	-	1 391	3 423	1 047	5 374	6	11 446
1968	98	-	958	3 307	293	4 927	27	9 610
1969	367	-	702	11 062	906	10 669	616	24 322
1970	400	-	971	8 183	558	16 945	29	27 086
1971	673	25	-	6 160	126	16 385	-	23 369
1972	1 337	57	305	9 999	112	11 450	-	23 260

Explanatory Notes to Tables 1 - 8

Table 1a.

Data from Belgium, Denmark, France, Poland and Sweden according to Coop. Res. Rep., Series B, 1965, Annex II, Table 9. Data from England, Netherlands, Norway and Scotland submitted by Working Group Members. Data from Germany according to Statistical News Letters, No. 11B, 1961.

Table 1b.

Data derived as listed below under each country. The Kattegat catches are according to Danish national statistics and information from the Swedish laboratory at Lysekil.

Table 2.

1947 - 1954. Catches for northwest and northeast are derived from Statistical News Letters 11A and 11B. The national distributions of catch by area in some cases refer to all catches and in others to a large sub-sample of the catches.

Catches for central and south are taken from Cushing and Bridges 1966, Appendix 4. The catches for the south refer to the seasonal winter fishery and not the calendar year.

Catches for the industrial fishery are derived from Coop. Res. Rep. Ser. B, 1965, Annex II, Table 12.

The catches for the Skagerak for some countries also include Kattegat catches, (Bull. Stat.). Taking the catches ascribed to areas for the North Sea, their total covers an average of 98% of the annual catches given in Table 1 for the period 1947 - 1954.

1955 - 1959. Catches for the northwest, northeast and central are based on data in Cushing and Bridges (1966). The Swedish catch from Division IVa (Bull. Stat.) was regarded as taken in the northeastern area.

Catches for the south and the industrial fisheries are derived from Coop. Res. Rep. Ser. B, 1965, Annex II, Tables 11 and 12.

1960 - 1968. Data from Coop. Res. Rep. Ser. A, 26.

Industrial Fishery: These data refer only to the juvenile herring catches in Division IVb by Denmark and Germany, and also Norway and Sweden for 1971 and 1972. A separation into industrial and consumption catches was not possible for any other area.

Skagerak: 1955 - 1972 data from Danish national statistics and from the Fisheries Laboratory at Lysekil.

Belgium

All data derived from "Bulletin Statistique". Catches from Division IVa for 1960 - 1968 are ascribed to IVa west of 2°E.

Denmark

All data used in the Tables are based upon Danish national statistics (Popp Madsen). Catches from Division IVa are ascribed to IVa east of 2°E for 1960 - 1968. Catches from Division IVb (Young Herring Fishery) have been reduced for content of other species (1960 to spring 1965 by 5%, autumn 1965 - 1971 by estimates from individual years; Popp Madsen). Catches from the Kattegat for 1972 have been derived by subtracting the catch figure for the Skagerak (supplied by Popp Madsen) from the total 1972 catch for Area IIIa (Kattegat + Skagerak) given in Bulletin Statistique.

England

All data derived from "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E according to national statistics.

Faroe Islands

Catches only from Division IVa according to "Bulletin Statistique". Ascribed to IVa westfor 1960 - 1968. From 1969 - 1971 the distribution of catches to fishing areas are based on landings in Danish ports. Landings for 1972 have been supplied by the Faroese statistics reporting agency.

France

The data given have been supplied by the "Institut des Pêches", Boulogne s/Mer.

German Fed.R.

All data are according to German national statistics (Schumacher). They are compiled by "Bundesforschungsanstalt für Fischerei", Hamburg, according to log books.

Iceland

All data derived from "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E are according to Icelandic statistics for 1960 - 1969, 1971 and 1972, and according to landings in Danish ports for 1970.

Netherlands

All data derived from "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E are according to Dutch national statistics.

Norway

The data are according to reports from "Noregs Sildesalslag". Catches in inshore waters are not included.

Poland

All data according to "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E up to 1971 is according to Polish national statistics. The 1972 catch in Div. IVa has been allocated to IVa west.

Scotland

All data are according to "Bulletin Statistique". Separation of catches in Division IVa east and west of 2°E is according to Scottish national statistics. Catches from the Moray Firth are not included.

Sweden

Data according to Swedish national statistics (Ackefors). Division IIIa: Data obtained from proportion of Skagerak catches in Swedish landings in Danish ports applied to total Swedish landings. Separation of catches in Division IVa east and west of 2°E (up to 1971) according to Swedish national statistics, but is supposed to be rather unreliable. A greater part of the landings presumably comes from Division IVa, west of 2°E. Allocation by area for the North Sea catch for 1972 was not possible, and was separated only into industrial and consumption herring landed in Sweden and abroad. Total consumption catch was supplied for the North Sea as a whole, and constituted 9% of the consumption catch from all areas. This catch was allocated to the Central Div. IVb, and by applying the proportion to the grand total of industrial and consumption herring landed in Sweden and abroad, the industrial and consumption catch from IVb was derived.

U.S.S.R.

All data according to "Bulletin Statistique". Separation of catches in Division IIIa Skagerak, IVa east and IVa west of 2°E up to 1971 are according to Soviet national statistics. For 1972, the total IVa catch has been allocated to IVa west.

Table 9. Preliminary Catch for 1973.

Country	Period	Total North Sea	IIIa	North Sea + Skagerak	West 4°W
Belgium					
Denmark	1/1 - 30/7	92 056	13 077	105 133	
Faroe Isl.[x)]	1/1 - 1/8	16 100	4 185	20 285	
France	1/1 - 1/7	355	-	355	
Germany					
Iceland	1/5 - 1/8	13 621	389	14 010	
Netherlands	1/1 - 1/7	4 456		4 456	
Norway[xx)]	1/1 - 31/8	85 900		85 900	44 600
Poland					
Sweden[x)]		2 106	6 336	8 442	
U.K. England	1/7 - 1/9	1 000		1 000	
U.K. Scotland	1/5 - 18/8	8 686		8 686	
U.S.S.R.					
Total		224 280	23 987	248 267	

x) Landed in Danish harbours.

xx) A national catch quota of about 66 000 tons set on herring landed for industrial purposes is expected to be reached early September.

Table 10. North Sea Catch in Millions of Fish by Age

Year	Area	Age in Winter Rings										
		0	1	2	3	4	5	6	7	8	>8	Total
1971	IVaW of 2°E	136.7	818.3	516.9	488.3	154.2	24.1	28.8	25.1	-	9.8	2 202.2
	IVaE of 2°E	14.0	95.4	54.5	38.5	10.4	2.1	1.4	1.1	-	0.2	217.6
	IVb	-	2.1	140.3	54.4	12.6	-	-	-	-	2.1	211.5
	IVbYH	533.0	3 440.9	304.3	39.6	-	-	-	-	-	-	4 317.8
	IVc+VIId,e	0.3	21.8	130.8	41.7	31.1	0.7	0.3	0.6	-	0.3	227.6
	Total NS	684.0	4 378.5	1 146.8	662.5	208.3	26.9	30.5	26.8	-	12.4	7 176.7
1972	IVaW of 2°E	-	338.9	830.1	176.8	88.6	19.3	4.1	-	0.5	0.4	1 458.7
	IVaE of 2°E	-	75.1	91.0	17.8	5.8	0.7	0.1	-	-	-	190.5
	IVb	-	25.2	46.4	98.8	20.5	6.7	0.6	0.2	0.6	-	199.0
	IVbYH	750.4	2 896.6	337.9	21.1	6.4	1.2	0.2	-	-	-	4 013.8
	IVc+VIId,e	-	4.8	135.1	29.3	9.3	5.0	-	-	-	-	183.5
	Total NS	750.4	3 340.6	1 440.5	343.8	130.6	32.9	5.0	0.2	1.1	0.4	6 045.5

(Data for earlier years are presented in C.M.1972/H:13)

Table 11. Total North Sea (TNS): Calculated stock in number x 10^{-9} (after Burd 1973).

Winter rings \ Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
0	7.26	4.72	4.10	5.68	6.90	7.69	9.10	8.07	7.70	4.76	21.37	5.64	7.82
1	5.22	6.57	4.27	3.71	5.14	6.24	6.96	8.09	7.10	6.81	4.22	19.07	5.01
2	3.80	4.73	5.99	3.86	3.34	4.22	4.98	5.32	5.93	4.46	4.56	2.41	13.19
3	2.85	3.05	3.96	4.97	3.04	2.53	2.76	3.03	3.37	3.53	2.27	2.57	1.21
4	3.56	2.10	2.07	2.87	3.50	1.99	1.74	1.64	1.66	2.07	2.04	1.36	1.38
5	2.13	2.57	1.55	1.41	2.03	2.06	1.29	1.21	0.96	1.04	1.39	1.24	0.93
6	2.67	1.43	1.78	1.12	1.00	1.30	1.22	0.90	0.85	0.55	0.71	0.93	0.68
7	1.35	1.69	0.86	1.11	0.81	0.68	0.78	0.74	0.59	0.55	0.31	0.44	0.70
8	1.76	0.81	1.22	0.52	0.77	0.60	0.43	0.52	0.44	0.42	0.40	0.15	0.33
Juvenile, 0+1	12.48	11.29	8.37	9.39	12.04	13.93	16.06	16.16	14.80	11.57	25.59	24.71	12.83
Adult, 2-8	18.12	16.38	17.43	15.86	14.49	13.38	13.20	13.36	13.80	12.62	11.68	9.10	18.42

Winter rings \ Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	1.98	16.72	7.33	8.73	10.95	5.76	5.30	7.64	7.83	5.57	7.66
1	7.07	1.63	13.92	6.50	7.48	9.44	5.07	4.44	6.30	6.29	4.93
2	3.01	4.13	1.14	10.56	4.68	3.96	5.50	3.27	2.43	3.40	3.32
3	7.27	1.64	1.95	0.77	6.75	2.58	1.49	2.54	1.85	0.51	1.30
4	0.63	4.71	1.03	1.01	0.53	3.98	1.09	0.64	1.01	0.27	0.18
5	0.77	0.41	2.88	0.61	0.77	0.33	1.68	0.56	0.23	0.33	0.12
6	0.62	0.54	0.26	1.58	0.48	0.55	0.17	0.68	0.22	0.06	0.12
7	0.38	0.45	0.34	0.11	1.22	0.34	0.35	0.11	0.24	0.12	0.01
8	0.52	0.23	0.35	0.17	0.08	0.86	0.20	0.25	0.04	0.02	0.07
Juvenile, 0+1	9.05	18.35	21.25	15.23	18.43	15.20	10.37	12.08	14.13	11.86	12.59
Adult, 2-8	13.20	12.11	7.95	14.81	14.51	12.60	10.48	8.05	6.02	4.71	5.12

Table 12. Total North Sea (TNS): Calculated fishing mortality (after Burd 1973)

Year / Winter rings	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
0							0.02	0.03	0.02	0.02	0.01	0.02	
1					0.09	0.13	0.17	0.21	0.37	0.30	0.46	0.27	0.41
2	0.12	0.08	0.08	0.14	0.18	0.32	0.40	0.36	0.42	0.57	0.47	0.59	0.50
3	0.20	0.29	0.22	0.25	0.32	0.27	0.42	0.50	0.39	0.45	0.41	0.52	0.55
4	0.22	0.20	0.28	0.25	0.43	0.33	0.26	0.44	0.36	0.30	0.40	0.29	0.48
5	0.29	0.27	0.23	0.24	0.35	0.43	0.27	0.25	0.46	0.29	0.30	0.49	0.31
6	0.36	0.41	0.37	0.22	0.28	0.41	0.39	0.31	0.33	0.46	0.37	0.18	0.48
7	0.41	0.22	0.40	0.26	0.20	0.35	0.29	0.42	0.24	0.22	0.67	0.19	0.20
8	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.40	0.30
$F_{w \geq 2}$	0.24	0.21	0.20	0.22	0.31	0.34	0.36	0.39	0.39	0.44	0.42	0.45	0.48

Year / Winter rings	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	0.11	0.08	0.02	0.06	0.05	0.03	0.08	0.09	0.12	0.02	0.13
1	0.43	0.25	0.18	0.23	0.54	0.44	0.34	0.50	0.52	0.54	0.29
2	0.51	0.65	0.29	0.35	0.49	0.88	0.67	0.47	1.45	0.86	0.99
3	0.33	0.37	0.56	0.28	0.43	0.77	0.74	0.82	1.81	0.92	1.23
4	0.32	0.39	0.42	0.18	0.35	0.77	0.57	0.92	1.02	0.71	1.22
5	0.26	0.38	0.49	0.15	0.23	0.59	0.81	0.81	1.21	0.92	0.56
6	0.21	0.37	0.73	0.16	0.23	0.34	0.32	0.93	1.12	1.74	0.76
7	0.42	0.15	0.59	0.23	0.25	0.45	0.21	1.01	1.23	1.11	1.74
8	0.30	0.30	0.30	0.30	0.40	0.70	0.70	0.40	0.50	0.60	1.00
$F_{w \geq 2}$	0.36	0.47	0.48	0.30	0.41	0.77	0.67	0.69	1.46	0.88	1.05

Table 13. Larval Abundance in the North Sea

Number x 10^{-9} (- = no observations)
(+ = $<0.5 \times 10^{-9}$)

Year	Southern North Sea[1]	Central North Sea		North-western North Sea[4]		
		Dogger[2]	Total[3]	Buchan	Orkney-Shetland	Total
1946	1 193	-	-	-	-	-
1947	1 134	-	-	-	-	-
1948	-	-	-	-	-	-
1949	-	-	-	-	-	-
1950	281	-	-	-	-	-
1951	686	-	-	2 205	1 029	3 234
1952	-	-	-	2 180	245	2 425
1953	-	-	-	5 170	2 303	7 473
1954	-	-	-	2 132	1 715	3 847
1955	183	-	-	32	1 715	1 747
1956	165	-	-	-	-	-
1957	36	232	-	735	-	-
1958	139	252	-	539	6 860	7 399
1959	12	97	-	735	2 107	2 842
1960	147	138	-	1 078	1 568	2 646
1961	187	86	-	931	12 103	13 034
1962	>30	66	-	980	1 764	2 744
1963	22	-	-	1 078	1 421	2 499
1964	9	52	> 63	2 254	2 156	4 410
1965	13	275	>490	172	5 439	5 611
1966	+	3	>142	25	1 666	1 691
1967	26	0	599	+	854	854
1968	16	0	137	0	222	222
1969	108	0	14	+	493	493
1970	126	0	387	2	230	232
1971	7	+	177	143	711	854
1972	67	+	112	25	2 803	2 828

1. Larval abundance (all size groups) in Downs area in December-January.
2. Abundance of larvae < 11mm in October on western and southern slopes of Dogger Bank.
3. Abundance of larvae < 10mm in September-October in central area of North Sea.
4. Abundance of larvae < 10mm in September in the north-western North Sea (north of 56°N).

Table 14. Initial catch levels (1973) and percentage increase in catch and biomass 1973-1976 at different combinations of mortalities for juvenile and adult North Sea autumn spawning herring.

Juvenile Mortalities (0- and 1-ringers)

Adult mortalities (2-ringers and older)

F	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.0	0.0 100.0 496.3	30.6 0 445.5	58.6 0 400.3	84.1 0 359.9	107.4 0 323.9	128.7 0 291.8	148.2 0 263.1	166.1 0 237.5	182.4 0 214.6
0.1	66.5 333.3 391.6	97.1 206.3 348.3	125.0 144.1 309.6	150.6 107.1 275.2	173.9 82.4 244.4	195.2 64.7 217.0	214.7 51.4 192.6	232.6 40.9 170.8	248.9 32.4 151.3
0.2	126.7 279.4 312.4	157.3 199.8 275.0	185.3 150.0 241.6	210.8 115.9 211.9	234.1 91.1 185.4	255.4 72.3 161.8	274.9 57.6 140.8	292.8 45.7 122.0	309.2 36.0 105.2
0.3	181.3 235.9 251.7	212.0 176.7 219.1	239.9 135.8 190.1	265.4 106.0 164.2	288.7 83.4 141.1	310.1 65.7 120.6	329.6 51.5 102.2	347.4 39.9 85.9	363.8 30.3 71.3
0.4	230.8 200.6 204.7	261.5 152.9 176.0	289.4 118.2 150.5	314.9 92.1 127.7	338.3 71.6 107.5	359.6 55.3 89.4	379.1 42.1 73.3	396.9 31.1 58.9	413.3 21.9 46.1
0.5	275.7 171.8 168.0	306.4 131.5 142.5	334.3 101.4 119.8	359.8 78.0 99.6	383.1 59.5 81.6	404.5 44.5 65.5	424.0 32.2 51.2	441.8 22.0 38.5	458.2 13.3 27.1
0.6	316.4 148.1 138.9	347.1 113.1 116.0	375.0 86.3 95.7	400.5 65.3 77.6	423.9 48.4 61.4	445.2 34.5 47.1	464.7 23.1 34.3	482.5 13.5 22.8	498.9 5.4 12.6
0.7	353.4 128.5 115.6	384.0 97.4 95.0	411.9 73.3 76.6	437.5 54.0 60.2	460.8 38.5 45.6	482.1 25.7 32.6	501.6 15.0 21.0	519.4 6.0 10.7	535.8 -1.6 1.5
0.8	386.8 112.1 96.8	417.5 84.1 78.0	445.4 62.1 61.2	470.9 44.4 46.3	494.3 29.9 33.0	515.6 18.0 21.1	535.1 8.0 10.5	552.9 -0.5 1.1	569.3 -7.7 -7.3
0.9	417.2 98.5 81.5	447.8 72.8 64.2	475.8 52.5 48.8	501.3 36.1 35.0	524.6 22.6 22.8	545.9 11.4 11.9	565.4 2.0 2.2	583.3 -6.0 -6.5	599.7 -12.9 -14.2
1.0	444.8 87.0 68.9	475.4 63.3 52.8	503.3 44.3 38.5	528.9 28.9 25.8	552.2 16.3 14.5	573.5 5.7 4.4	593.0 -3.2 -4.6	610.8 -10.8 -12.6	627.2 -17.3 -19.8

Upper figure: Catch in 1973 (1 000 tons)

Middle figure: Increase in catch in 1976 as a percentage of that in 1973.

Lower figure: Increase in biomass as at the beginning of 1977 (% in weight)

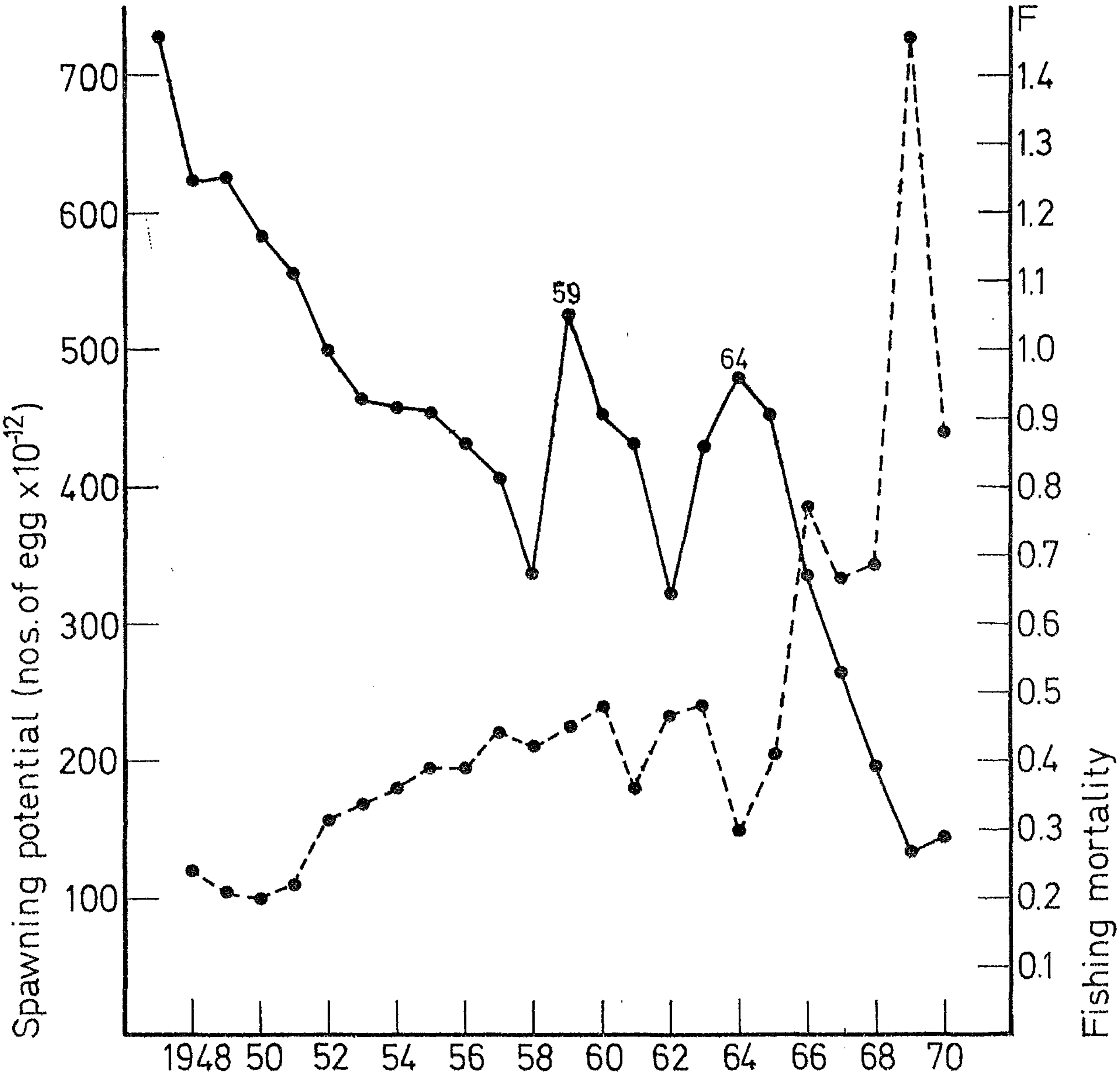

Fig. 1. The Spawning potential of the total North Sea herring stock 1947-1970 (full line) compared with the fishing mortality in the preceding year (hatched line).

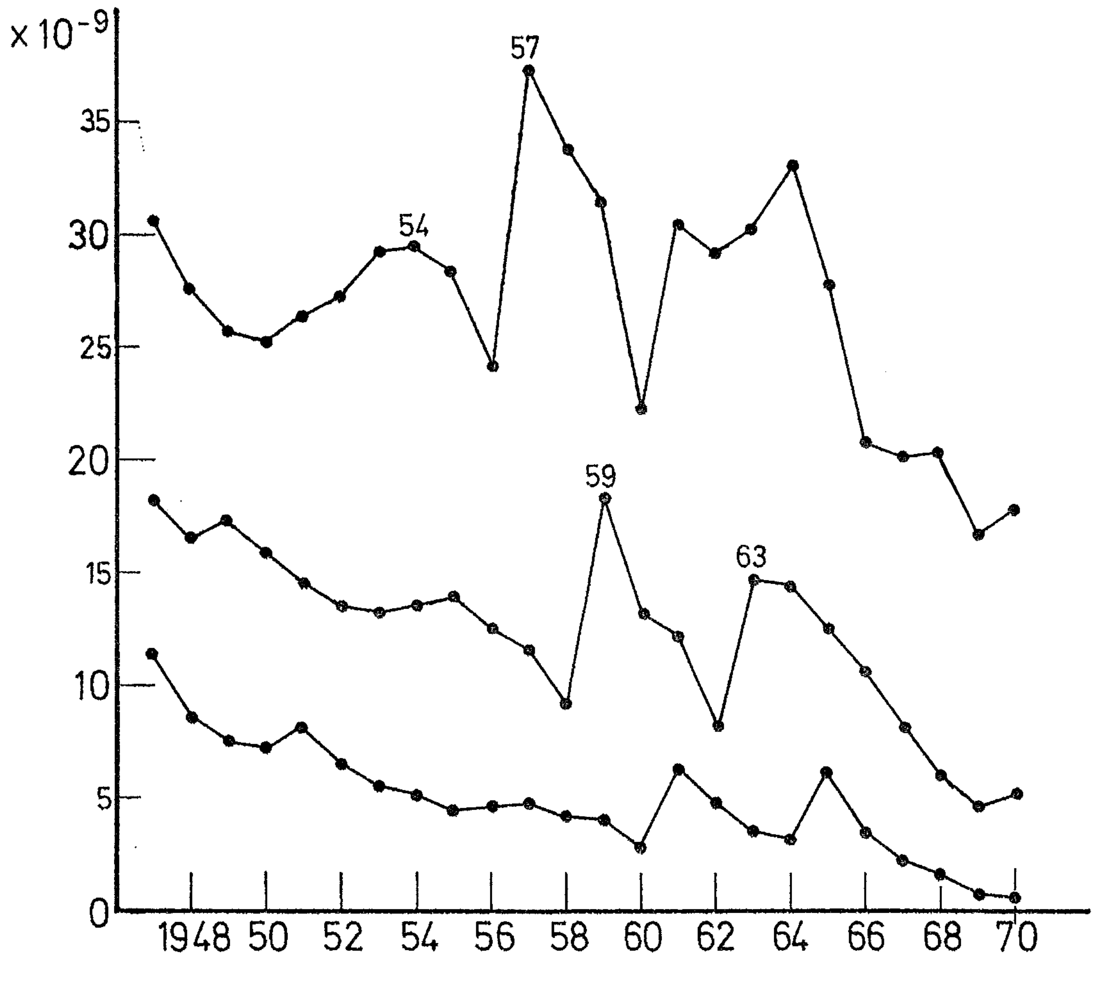

Fig. 2. The North Sea herring stock in numbers (x 10^{-9}). Upper curve: total stock. Middle curve: adults as 2-ringers and older. Lower curve: adults as 4-ringers and older.

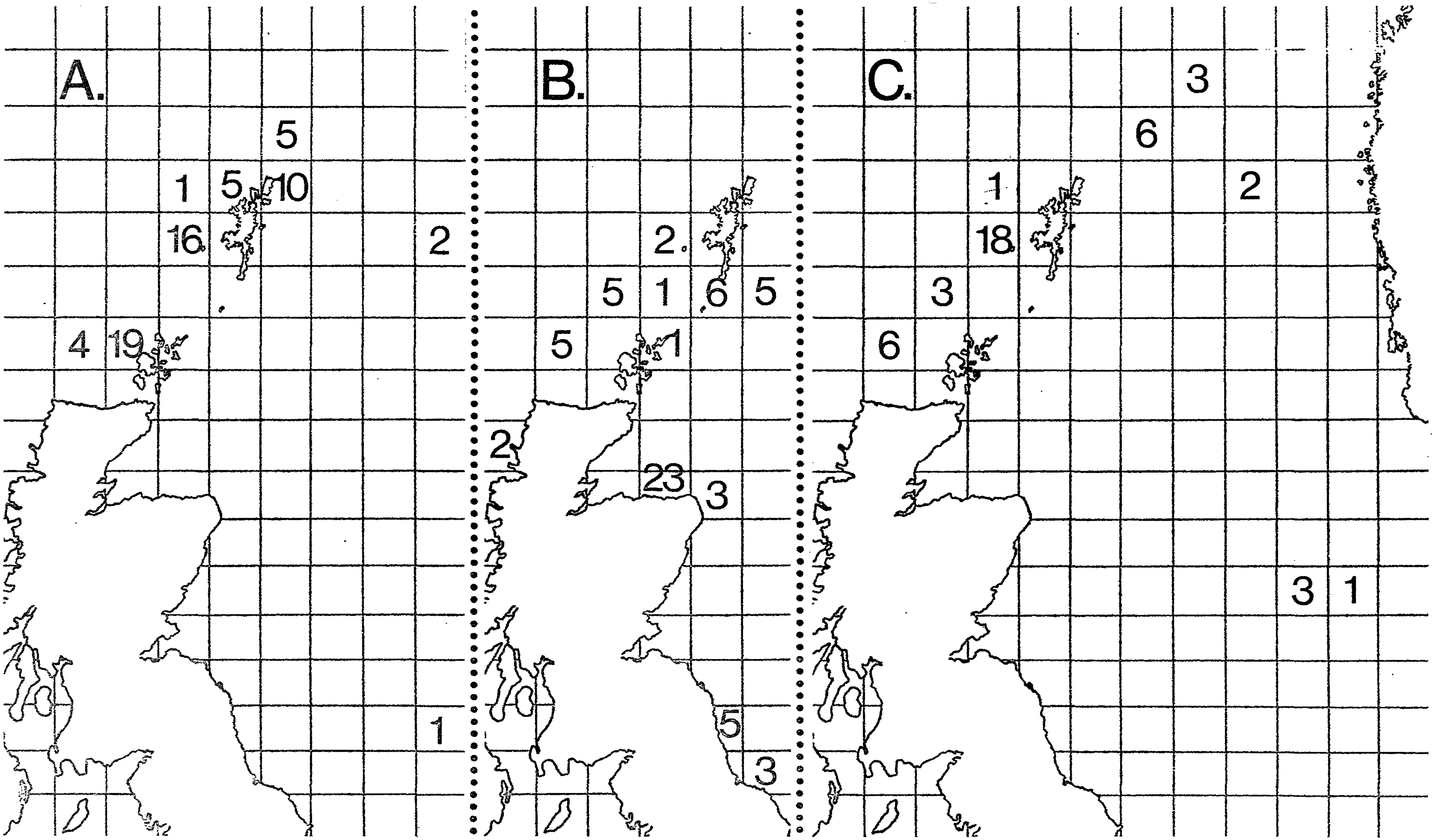

Fig. 3. Number of recaptures with specified catch position. ICES's Bløden Herring Tagging Experiment 1969.

A)Norwegian recaptures in July-August 1970
B)Scottish " " " " 1970
C)Norwegian " " July 1973.

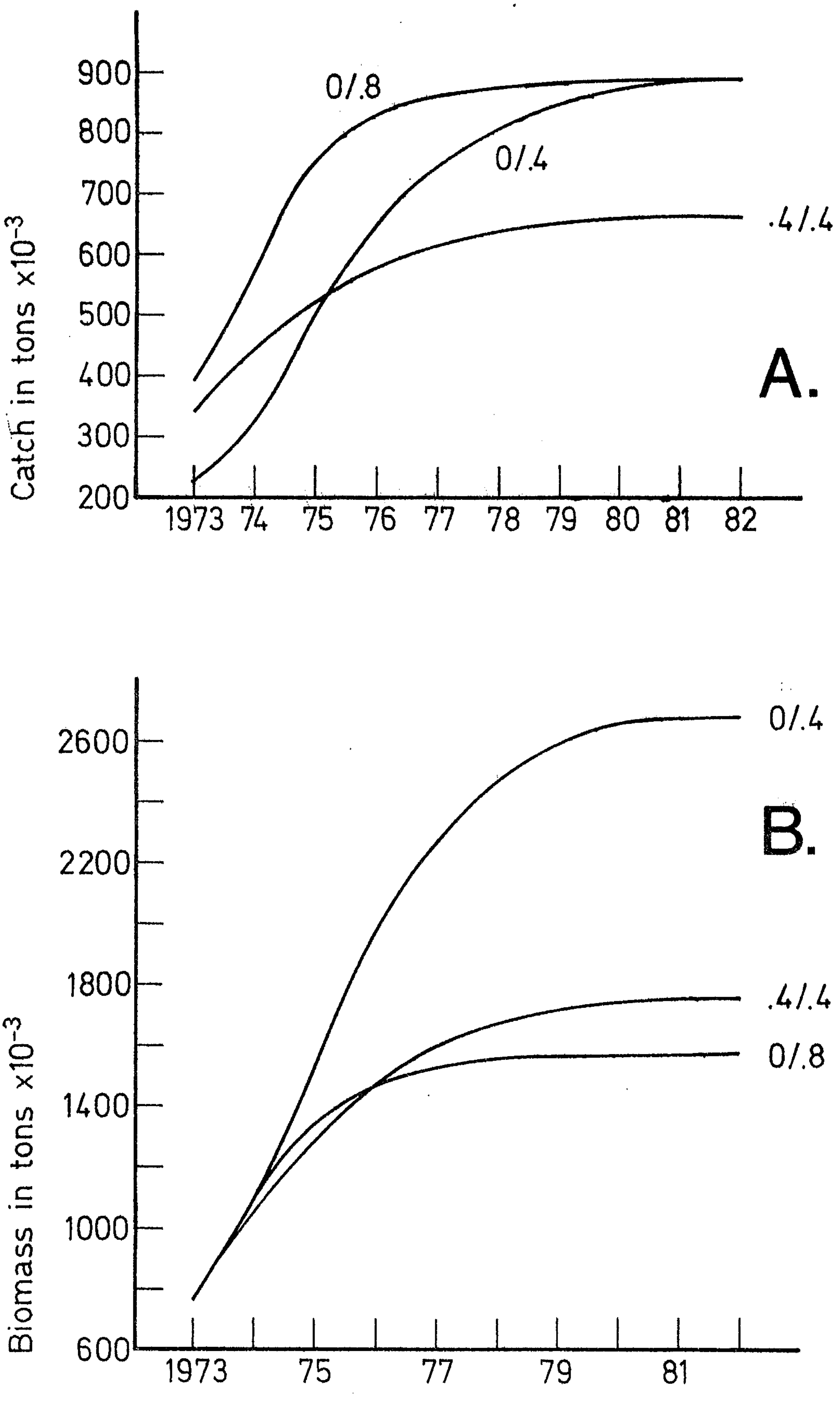

Fig. 4. Forecasted long-term development in catch (A) and total biomass (B) at three combinations of juvenile and adult fishing mortalities (juv./adult). Assumptions: see section 9.