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International Council for the
Exploration of the Sea

C.M.1970/H:6
Pelagic Fish (Northern) Committee

REPORT OF THE NORTH SEA HERRING ASSESSMENT WORKING GROUP

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Report of the North Sea Herring Assessment Working Group

I. Terms of Reference and Participation

The Liaison Committee of ICES, acting on a general concern expressed at the NEAFC Meeting in May 1968 about the North Sea herring fisheries, invited the Pelagic Fish (Northern) Committee of ICES to set up a Working Group to review the present state of the North Sea herring stocks and to discuss measures for the improvement of the fisheries exploiting them. At its meeting in Copenhagen in October 1968 the Pelagic Fish (Northern) Committee of ICES appointed such a Working Group with Mr. J. J. Zijlstra (Netherlands) as Chairman. At its next meeting in Dublin in September-October 1969, after having discussed a preliminary report of the Working Group (ICES, C.M.1969/H:4), the Pelagic Fish (Northern) Committee decided that a second meeting of the Working Group was necessary, to allow completion of its work.

Member States nominated the following scientists:-

Mr. H. Ackefors	Sweden	6-11 January and 7-12 December 1969
Mr. A. C. Burd	U.K.	6-11 January and 7-12 December
Dr. S. S. Federov	U.S.S.R.	6-11 January and 7-12 December
Mr. S. Haraldsvik	Norway	6-11 January and 7-12 December
Prof. G. Hempel	Germany	6-11 January 1969
Mr. A. S. Malkov	U.S.S.R.	6-11 January and 7-12 December
Mr. A. Maucorps	France	6-11 January and 7-12 December
Mr. J. Molloy	Ireland	part of 7-12 December 1969
Mr. K. Popp Madsen	Denmark	6-11 January and 7-12 December
Dr. J. Popiel	Poland	
Mr. K. H. Postuma	Netherlands	6-11 January and 7-12 December
Mr. A. Saville	U.K.	6-11 January and 7-12 December
Dr. K. Schubert	Germany	6-11 January
Dr. A. Schumacher	Germany	7-12 December
Mr. J. J. Zijlstra	Netherlands	6-11 January and 7-12 December

Both meetings were attended by Mr. J. Møller Christensen, in his capacity of Secretary to the Liaison Committee.

The Group met between 6 and 11 January 1969 and between 7 and 12 December 1969 at ICES' Headquarters, Charlottenlund Slot, Charlottenlund. It was noted with regret that Dr. J. Popiel was unable to attend either meeting.

II. Material and Agenda

Post-war changes up to 1960 in the herring stocks and in the fisheries for North Sea herring were reviewed by former Working Groups of ICES (Anon., 1965). Working Groups of the Liaison Committee presented reports covering the years up to 1963, which were submitted to NEAFC at its meetings in May 1964 and May 1965, respectively (Anon., 1966). Moreover, a Working Group met early in 1967 to consider plans for an experimental closure of the fisheries in the Southern Bight and the Bløden Area, the Report of which was submitted to NEAFC at its meeting in May 1967 (Anon., 1967).

The present Working Group mainly considered the development in the stocks and fisheries in the North Sea since 1960 and took note of the findings of the former Working Groups on North Sea herring.

The material available for consultation by the Working Group, covering mainly the period 1960-68, varied considerably in quantity and quality between areas and fisheries.

Catch statistics and data on the biological composition of the units from the southern and central North Sea were sufficient to follow the developments in the stocks and fisheries. For the northern North Sea and Skagerak, which in the 1960's became the areas of major importance, the available material was generally less satisfactory. There were for instance serious doubts concerning the allocation of the landings for some countries to different areas and even about the actual quantity landed. With some exceptions the catch-effort statistics were found to be poor in the northern areas and, when available, generally did not refer to the major fisheries. Similar objections applied to sampling, again with some exceptions. A high proportion of the samples were taken from the catch of fisheries of minor importance or from research vessel catches, and sampling intensity bore no relation to the size of the landings from the areas. These inadequacies of the material seriously hampered an assessment of the situation.

This Report diverges from the approach in the Liaison Committee Working Groups of 1964 and 1965. At that time the concern expressed in NEAFC centred mainly on the fisheries and stocks in the Southern Bight and eastern part of the English Channel (Downs herring). In order to investigate the causes of this decline much attention had to be given to the complicated stock structure of North Sea herring.

At the present time, the concern about the North Sea herring and its fisheries is much more general, involving the whole of the North Sea and the Skagerak area. The Working Group, therefore, decided to consider the North Sea and Skagerak, for this assessment, as a whole, paying little attention to the stock structure. Justification for this approach is to be found in the results of tagging experiments, which indicated connections between the herring groups, fished in all central and northern North Sea areas, including the Skagerak. (Anon., 1966). Moreover, the material available did not allow a detailed analysis of the situation on a stock-separation basis.

The Assessment Group considered the state of the fisheries, the yields, the catches per effort and effort development (Section III); the herring stocks, their age-composition, mortality rates, stock abundance from tagging experiments and larval data, recruitment and growth (Section IV). In Section V the results of Sections III and IV are discussed, while Section VI gives a conclusion on the state of the herring stocks and fisheries, including some remarks about possible conservation measures.

III. The Fisheries

III. a) Development and Changes

The development of the herring fisheries in the North Sea up to 1963 has been described in a previous report to the Liaison Committee (Anon., 1966), showing a gradual replacement of the old drift-net fisheries by trawl fisheries.

Since the early 60's there have been further major changes in the fisheries. The decline in the drift-net fisheries has continued, particularly in the central and southern North Sea, where drift-net fishing is now on a very small scale.

The trawl fisheries have changed their nature; the large German trawlers, which in the 1950's formed a major part of the trawling effort have almost completely withdrawn from the North Sea, but the number of trawlers from other countries have probably increased. In the trawling fleet there has been a general change from bottom trawling to pelagic or semi-pelagic pair- and single-boat trawling, which together with the introduction of new acoustic fish-finding equipment (sonar, head-line oscillator) led to new fishing tactics and to a greater efficiency of the fishing.

The most striking change in the fisheries, however, has been the introduction of the purse-seine in the North Sea herring fishing. This was started by the Norwegian fleet in the autumn of 1963 in the north-eastern North Sea and Skagerak. The Norwegian fleet extended the range of the purse-seine fishery to the Shetland area in the summer of 1965 and has since been joined in these areas by purse-seiners of other countries, e.g. Faroes, Iceland, Scotland and the U.S.S.R.

In addition to changes in fishing methods there has also been a change in fishing area. Figures 2a and 2 show a very approximate picture of the distribution of the catches in the North Sea in the late 50's (1955-58) and the late 60's (1965-68), demonstrating a shift in the main fishing grounds towards the northern edges of the North Sea, to the Shetland area and to the north-eastern North Sea and Skagerak. The fishing grounds of the late 50's, where adult herring was caught in summer and autumn just prior to and during spawning in the central western and southern North Sea, are now of only minor importance. It is likely that the changes in fishing grounds are partly related to the changes in fishing methods, which allowed fishermen to exploit the deeper waters of the North Sea.

III. b) Landings

1. Tables 1-8 (p. 22) show landings from the North Sea and Skagerak in the years 1947-69. The figures in these Tables are not comparable with those published in the "Bulletin Statistique" for the same years and areas. The present data have been compiled from different sources (cf. Annex I: Explanatory Notes for Tables 1-6 and foot-note on Table 1c).
2. The total catch of herring in the North Sea and Skagerak has fluctuated between 0.7 and 0.9 million tons from the beginning of the 50's until 1963 (Tables 1a and 1c). It then increased to a peak of 1.4 million tons in 1965, but thereafter decreased to a level of about 1.0-1.1 million tons in 1966-68. The catch figure for 1969 (Table 1b), 721 000 tons, is provisional.

It should be noted that the figures in Table 1a and Table 1c are not directly comparable. Those in Table 1a constitute a summary of Tables 2-6, which have been thoroughly checked and corrected by the Working Group members, while those in Table 1c are partly derived from the previous report and are known to be incorrect for some countries.

3. Catches from the Skagerak, Division IIIa (Table 2) have increased steadily in the period 1960-64, from less than 100 000 tons to 274 000 tons. They decreased in 1965 and 1966, but in 1967 and 1968 they again rose to the 1964 level. In these two years, the USSR and Iceland reported herring catches from the Skagerak.

The Swedish catches in Table 2 exclude those catches from the Kattegat which were landed in Denmark (Table 8), but include unknown quantities of Kattegat herring landed in Sweden.

4. In the north-eastern North Sea, Division IVa, east of 2°E (Table 3) the catches increased slightly from 1960 to 1963 to about 300 000 tons. In 1964 and especially in 1965 there was a sharp rise in the catches to over 600 000 tons, mainly due to the introduction of a large Norwegian purse-seine fishery in the area. From 1966 to 1968 the catches have declined again to about the 1963 level.
5. In the north-western North Sea, Division IVa, west of 2°E (Table 4) the maximum catch of almost 300 000 tons was also reached in 1965. There was a sharp decline in the catches in 1967 to about one-third of the 1965 catch, but in 1968 they again rose to a 300 000 t level. In this area the fluctuations in total catch are also greatly influenced by Norway. However, it should be noted that in recent years the Faroe Islands, Iceland and USSR have been fishing substantial quantities of herring in the north-western North Sea.
6. In Table 5, the catch data from the central North Sea, Division IVb, have been split into catches of adult and young herring. The adult fishery has declined steadily from 228 000 tons in 1963 to 58 000 tons in 1968. The young herring fishery has fluctuated between 68 000 and 150 000 tons. While the German young herring fishery decreased sharply from 26 000 tons in 1965 to less than a thousand tons in 1968, the Danish fishery, after a decrease from 109 000 tons in 1965 to 54 000 tons in 1966, rose to more than 106 000 tons in 1968 and to 125 000 tons in 1969 (see Table 7), the highest yield ever recorded.
7. In the southern North Sea and the English Channel (Divisions IVc and VIId and e, Table 6), the catches which were still almost 100 000 tons in 1961 declined to less than 10 000 tons in 1968.

8. In Tables 7 and 8 the Danish and Swedish landings in Denmark in the years 1960-1969 have been separated into industrial landings and landings for human consumption.

Most of the Danish landings came from industrial fisheries (Table 7). The Danish landings for human consumption have been at a rather steady level in the early 60's, but tended to decrease after 1965, while the industrial landings increased. The increase in industrial landings was rather steady from the northern North Sea fisheries (Division IVa), but was accompanied by large fluctuations in the Skagerrak and the central North Sea fisheries (Divisions IIIa and IVb).

The greater part of the Swedish landings was destined for human consumption (Table 8). There was, however, an increase in the industrial landings after 1963.

III. c) Catch per Unit Effort

In Table 9 (p. 33) catches per unit effort are given for those fisheries, for which data are available for the period considered (1955-1968) and in which during this period no radical changes in gear and fishing technique occurred. This condition limited the choice of fisheries from which the data could be derived and resulted in the indices being largely from fisheries, which in recent years have provided only a small proportion of the total catch. With one exception (Bløden fishery) all the fisheries selected are human consumption herring fisheries, which in the past were the major fisheries but which land at present only a small proportion of the total catch. Although no radical changes took place in the unit of effort in the fisheries used, the possibility cannot be excluded that the efficiency of the fleets changed and probably increased.

In the southern North Sea both drift-net and trawl catch per effort showed a marked decline. After 1965 the Netherlands trawl fishery in this area virtually ceased.

In the central North Sea the drift-net fishery showed no clear trend in catch per unit effort up to 1967, when this fishery disappeared. The catch per unit effort in the 1960's for the trawl fishery in this area was much lower than the average value for the late 1950's and shows a further decline in 1968 and 1969 to values below those ever previously recorded.

In the north-eastern North Sea the three sets of data given are not derived from fisheries which take major catches in the area and are also not completely representative in that they chiefly operate in the northern part of the area. The data of all three fisheries indicate large fluctuations in the catches per effort, with a marked declining trend, particularly after 1965.

In the north-western North Sea the drift-net and trawl estimates show different features. The drift-net catch per unit effort shows no trend, while the trawl estimates show a marked decline, particularly between 1965 and 1967, when the fishery almost disappeared. It should be noted, however, that the drift-net fishery in this area has since 1964 been almost entirely concentrated in the area around Shetland, while in earlier years much of the catch came from grounds south of 59°N. Finally, in the Bløden fishery for young herring only a slight decline in the catch per effort can be observed.

In so far as estimates of catch per unit effort in herring fisheries can be considered as indicative of stock abundance, the data suggest a marked decline in the herring stock in the southern North Sea since about 1961 and in the north-eastern North Sea since 1965. In the north-western and central North Sea the trawl catch per unit effort indicate a striking decline in herring abundance since 1965, while the drift-net indices would suggest a more stable situation.

However, as explained, the drift-net indices for the north-western area may have been distorted by a change in the area fished.

III. d) Effort

Direct estimates of effort, such as the numbers and types of vessels operating and the amount of herring fishing carried out by them, were not available for several countries. The existing information indicates an increase in purse-seining in the period 1963-1966 and a decline in trawling activity in some countries after 1965.

Indirect estimates of effort have been obtained by dividing the total catches in each area by the catch per unit effort, given in Table 9, for that area. This method should give fairly reliable results, where the catch per unit effort is derived from fisheries taking an appreciable part of the catch in that area and whose catch composition is similar to the composition of the total catch. These conditions, however, are met only in the southern and central North Sea. In the northern North Sea the catches per unit effort have been derived from the now relatively unimportant fisheries for human consumption herring, so that estimates of effort from that area should be considered with some care. Moreover, in the Skagerak, which yields about a quarter of the total North Sea herring catch, no catch per unit effort estimate was available, and so no estimate of effort can be made. Considering the increase in the total catch in that area between 1960-68, and the general decline of the catches per unit effort in the neighbouring area, the north-eastern North Sea, a sharp increase in the effort in the Skagerak in the 60's seems highly likely.

Estimates of effort are shown in Table 10 (p. 34) by years and for the periods 1960-63 and 1964-68, for the north-western, north-eastern, central and southern North Sea - English Channel and for the Bløden area.

In the southern North Sea effort has declined sharply since 1963; the increase indicated in 1968 is likely to be unrealistic. The decline in effort has probably been a continuation of a decline which started in 1955 and which was described in an earlier Working Group Report (Anon., 1966).

In the central North Sea fisheries for adult herring the effort fluctuated up to 1965 and thereafter tended to decline to about half its former level in the last year (1968), for which estimates are available. Drift-net and trawl estimates of effort indicate about the same decline in effort (about 25%), comparing the periods 1960-63 and 1964-68.

In the north-western North Sea both estimates show no clear trend up to 1964, but a sharp increase thereafter. Comparing the periods 1960-63 and 1964-68, the drift-net estimate would indicate an increase of about 3 times, the trawl estimate an increase of about $4\frac{1}{2}$ times.

In the north-eastern North Sea the, not very reliable, estimates indicate an increase in effort between 1960-68, in particular after 1964. Comparing again the periods 1960-63 and 1964-68, the increase in the effort is indicated to be between 1.4 and 4.5 times.

Finally, the effort estimate of the Bløden fishery shows large variations without a clear trend.

In the North Sea as a whole it seems reasonably certain that between 1963 and 1965 effort rose sharply in the northern areas, including the Skagerak. After 1965, particularly in the light of the uncertainties regarding the north-eastern North Sea and Skagerak, it is impossible to define the development of the effort.

IV. Herring Stocks

IV. a) Age Compositions

Attempts have been made to assess the total catches in number of each age group of autumn-spawning herring in the different areas of the North Sea and Skagerak. The quality of the age data varied greatly between the different areas of the North Sea. The age compositions of the catches in the southern, central and north-western North Sea have been based on a series of samples from the commercial fisheries supported by considerable quantities of length measurements of the herring in the commercial catches. The percentage age compositions used for the different area catches are given in Tables 11, 12 and 13 (p. 35-36), together with the mean number of fish per kilo used for converting the total catch in weight to number.

While the age data refer to the age distribution of autumn-spawning herring only, spring-spawning herring are also taken in the catches, in particular in the north-western, north-eastern North Sea and Skagerak. Some estimates of the proportions of spring spawners are given in Table 14 (p. 36). The catch in number from the north-western area has

been reduced by the proportion of spring spawners in the Scottish catches. This procedure was not applied to the north-eastern North Sea and Skagerak, as the information on the proportion of spring spawners covered only part of the period considered.

In the case of the north-western area, some differences were seen in the age composition derived from the drift-net and purse-seine catches compared with those from trawl catches. Age data and mean number per kilo from the Dutch trawl catches were used to raise the trawl catches of Belgium, France, Germany and the Netherlands. Scottish data were used for all catches by other countries in the area. The total catch per age group for the region is the sum of the two raised distributions.

The percentage age distribution for the adult herring fisheries of the central region IVb is the mean distribution obtained by combining the English, Scottish and Dutch data (Table 12, p.35). The mean number per kilo was similarly derived. In 1968 Norwegian catches of juvenile herring were made in the area, and these have been separately converted to numbers using Norwegian data for the Skagerak catches. The age distributions of the juvenile herring fishery in the central area IVb are based on Danish material and appear in the summary (Table 16, p.38).

Table 13 (p.36) is derived from the combined English and Dutch data from the East Anglian fishery.

Age data of autumn-spawning herring in the north-eastern North Sea were available from Germany, Sweden, Norway and Denmark. As there appeared to be differences in age composition between the German trawl data and the Swedish, Norwegian and Danish data, the reported herring catches have been treated by groups of countries (Table 15, p.37). Most of the Norwegian catch and part of the Danish and Swedish catches (see Tables 7 and 8 and notes to Tables 1-6) were used for reduction to meal and oil, while the German, French, Dutch, USSR and Polish catches were for the human consumption market. Little sampling for age distribution has been made in the area, involving some few thousand fish examined per year. In addition, the material available tends to refer to the human consumption proportion of the catch rather than to the particularly in later years important industrial catches. Norwegian data on industrial catches landed in Norway in the years 1965, 1967 and 1968, which gave very complete information on the mean weight of the fish landed but included little age data, showed a relatively high number of fish per kilo (Table 15, 1965 + 1967). Because of the inadequacy of the age data and in particular the lack of information concerning the industrial catch, little confidence can be placed on the estimated age structure of the total catch in the north-eastern North Sea. It seems likely that the numbers of young herring have been underestimated, in particular in later years.

The estimates of total catch of each age group in millions of fish are summarised for the North Sea in Table 16 (p.38). In addition to the age compositions of the fisheries in the southern, central, north-western and north-eastern North Sea the age composition of the young herring fisheries in the eastern part of the central North Sea (Bløden area) have been included. These were obtained by raising the total catch of Denmark and Germany by the age composition of the Danish catches. Adjustments have been made in recent years for an admixture of sprats in the Danish catches, but not in those of Germany.

Examination of the annual area catches shows that though the mean number caught per annum has varied about 1400 million fish the proportion taken in the central and southern North Sea has declined. No major changes occur in the age compositions in these areas (see also Tables 11-13), with the exception of the central North Sea (Table 12) and the north-western North Sea trawl fisheries (Table 11, A) where the proportion of older fish tended to decrease in later years.

Catches of immature herring in the Bløden fishery (IVb, young herring fishery) varied about 1300 million fish and tended to decline, although catches increased again in the course of the last three years (Table 17, p.40, see also Table 7). In the north-eastern North Sea, for which the material present was far from adequate, the data show a considerable expansion of the fisheries, with an increased exploitation of juvenile herring (0-I group) (Table 17). Though it is thought that the proportion of immature fish has been underestimated in this area, it should be noted that according to the material used the numbers of immature herring caught in the north-eastern North Sea are well below the numbers caught in the "Bløden" fishery, even in the most recent years.

Age compositions for the Skagerak catches have not been included in Table 16, as no age data were present for this area prior to 1963. The material available for the years 1963-68 was even less satisfactory than that for the north-eastern North Sea. As in the latter area, the age data and number per kilo tend to be derived more from consumer herring than from industrial catches. Only in the years 1965, 1967 and 1968 was good information available for the Norwegian landings on the number per kilo. German data were used for compiling the age distribution of the German and Polish herring trawl fisheries, while Norwegian, Swedish and German data were used for the catches of Denmark, Norway and Sweden (Table 18, p. 40). Though the Danish catch represented about half the total, no sampling had been made on these landings. As in the north-eastern North Sea it is thought possible that the age compositions underestimate the numbers of young herring in the catches.

Table 19 (p. 41) gives an estimate of the catch per age group in number from Skagerak. Taking three-year-period means the catch in the period 1966-68 has risen by about 1000 million fish while the proportion of juveniles (0 + I group) has risen from 36% in 1963-65 to 77% in 1966-68 (Table 17).

Combining the data of Tables 16 and 19 the total herring catch of the North Sea and Skagerak is given in Table 20 (p.41). The gross limitations of some data used in Table 20 should be recognized, the trouble being that the quality of the data available for the north-eastern North Sea and Skagerak, which became of major importance in the fisheries in the 60's, must be considered as extremely poor. Taking the age data at their face value it is clear that in 1967 and 1968 at least 50% of the total catch was taken as juvenile herring (0 + I group).

The effects of this juvenile catch in reducing the adult spawning stock is underestimated in this treatment of the data. In the main, the herring recruit to the adult spawning stocks as 3-year-old herring (2-ringers) in late summer and autumn. Apart from the truly juvenile 0 and I group fish a portion of the increased catches are taken as 3-year-old fish before they make their first spawning. Thus, in 1968 81% of the total catch consisted of fish with less than 3 winter rings. It is probable that even though this is likely to be an underestimate, the data for 1968 give the best estimate of the present distribution of the catch by age in the North Sea and Skagerak fisheries.

IV. b) Mortality Rates

Estimates of mortality rates, calculated from annual age compositions weighted by catches per unit of effort as a measure of abundance, were available for some fisheries only.

The Scottish drift-net fishery in the north-western North Sea, for which the age compositions and abundance indices from the fishery, mainly on pre-spawning fish, in the months August-September were used, provided the only source of information from the northern North Sea. For the central North Sea two estimates were available, one derived from a British drift-net fishery on spawning herring along the English north-east coast (Whitby) in the months August-September, the other from a Dutch trawl fishery on spawning herring in the Dogger area in September-October. For the southern North Sea again two estimates were available, one from combined British-Dutch data from drift-net fisheries carried out mainly on pre-spawning herring in the Southern Bight in October-December, the other from the Dutch trawl fishery on the spawning herring in the Sandettié-Channel area.

The instantaneous mortality rates, as two year running means and averages over four to five years periods, are given for the period 1952-69 in Table 21 (p.42). Only in the case of the trawl fishery in the southern North Sea is the series incomplete, as this fishery virtually stopped after 1965.

Mortality rates in the north-western North Sea tended to increase in the period 1952-60, declined to a lower level in the years 1960-66 and increased sharply thereafter. In the spawning fisheries in the central North Sea the mortality level would seem to have increased, in each four years period considered, with a sharp increase in the early 60's in the estimates from the drift-net fishery and around the mid-60's in those from the trawl fisheries. In the southern North Sea mortality has been high throughout, with an increase in the years 1952-57 and a high, more or less steady level thereafter.

The data indicate that in the last few years in all areas mortality had reached a level of at least $Z = 1.00$.

IV. c) Estimates of Stock Size from Tagging

Estimates of stock size for North Sea herring are only available from some Norwegian tagging experiments in the Skagerak and the northern North Sea. Although the tagging experiments only partly fulfilled the requirements for making a quantitative assessment, they allow one to make rough estimates of the herring stock in this part of the North Sea in the late autumn of 1965 and in the summer of 1966.

In the autumn of 1965 the herring stock in the Skagerak and the north-eastern North Sea was estimated to be about 2.55 million tons (Dragesund and Haraldsvik, 1968). During the summer of 1966 the herring stock in the north-eastern North Sea was estimated to be 0.54 million tons, while the stock in the Shetland waters was estimated to be 0.57 million tons (Haraldsvik, 1969). Assuming the north-eastern North Sea and the Skagerak to be the main overwintering areas for the "Bank" and "Buchan" spawners, and the north-eastern North Sea and the Shetland waters to be the main feeding areas for the same stocks, the figures indicate a decline of the stock from 2.55 million tons to 1.11 million tons in a period of about 9 months. This decline of 56% in 9 months would correspond roughly to an annual instantaneous mortality rate (Z) of 1.10, which is in good agreement with the estimates of Z obtained from age compositions and catch/effort data.

Because of uncertainties about the composition of the catches in the northern North Sea and Skagerak in relation to the composition of the estimated stock in the area, no attempt has been made to assess the fishing mortality rate (F) from catch and stock size. It should be noted, however, that the catches in 1965-67 were large in comparison with the estimated stock size, suggesting a high value of F .

IV. d) Larval Abundance

Estimates of the abundance of small herring larvae were considered, as these can be taken under certain assumptions as relative measures of the size of the spawning stock.

The material reviewed, shown in Table 22 (p. 43), includes data from the literature, results of the International Larval Surveys (Saville, 1968; Boëtius, 1969) and unpublished material from various laboratories. Figures for the southern North Sea (Downs stock) refer to larval abundance in the eastern English Channel and the Southern Bight (Bridger, 1961). Data for the central North Sea were available for a longer series from the western and southern slopes of the Dogger Bank (Zijlstra, in press); data from other central North Sea spawning grounds (English north-east coast, North-East Bank etc.) were only available as from 1967. The figures from the northern area cover most of the north-western North Sea up to the Shetlands (Saville, 1968). Attempts made in recent years to locate larvae in other areas (north-eastern North Sea) failed, except in the eastern Kattegat (Postuma, 1966; Saville, 1968). The data for the eastern Kattegat were only available for the last five years; they showed low numbers of larvae and are not included in Table 22.

The following might be concluded from the figures:-

- (I) Larval abundance in the southern North Sea - Channel area (Downs stock) decreased to very low figures in the period 1946-1965, but tended to recover somewhat in the last few years.
- (II) The figures for the central North Sea indicate a very low production on the slopes of the Dogger Bank during the past four seasons. The short series, partly based on incomplete data, on the total central North Sea also suggests a decrease in larval abundance in the last few years.
- (III) Taking the northern North Sea as a whole, larval production was more or less steady from 1951-65. Since 1965, however, larval abundance has decreased in the northern North Sea too. The decline was greatest in the Buchan area, where no small larvae were found in the last three seasons. In the Shetland area, where during the last decade spawning was always more intense than on the Buchan grounds, larval abundance was also found to be relatively low since 1965.

The larval abundance in the North Sea as a whole has obviously decreased during recent years, pointing to a decrease in the spawning potential of the stock.

Accepting the larval abundance figures as straight indices of the spawning potential of the North Sea stocks and comparing the figures from the late 50's - early 60's with those of the years 1966-68, a severe reduction in the spawning potential is indicated, of the order of about 80%. If the age- and length composition of the spawners was the same in the two periods, the reduction in the size of the adult stock would be of the same order.

IV. e) Recruitment

Estimates of recruitment to the North Sea herring stocks were available from three different sources:-

1. from the adult fisheries in the northern, central and southern North Sea, calculated as abundance at 3 years of age;
2. from the Bløden fishery on immature herring at an age of 2 years;
3. from the International Young Herring Surveys in February-March at an age of $1\frac{1}{2}$ years.

In Figure 3 (p.48), recruitment to the adult stocks is shown. In the north-western and central North Sea, a certain degree of similarity exists in the recruitment estimates by year-classes. Three relatively strong year-classes have been recruited in both areas in the past ten years, i.e. 1956, 1960 and 1963.

In the northern North Sea (Buchan stock) no obvious trend in the period 1951-65 is shown. In the central North Sea (Bank stock) the 1964, 1965 and 1966 year-classes have all been extremely poor. In the period considered there is no previous record of three such poor successive year-classes, and so there is some evidence of a decline in recruitment in this area. In the southern North Sea (Downs stock) there is clearly an overall trend of decline in year-class strength from 1950-65, with only year-class 1958 as outstanding. There is, however, some evidence that the 1966 year-class in the Downs stock, which cannot yet be measured in a comparable way, is relatively strong.

In Figure 4 (p.49) comparison is made between the adult recruitment estimates averaged for the northern and central North Sea (B), with the estimates from the immature herring in the International Young Herring Surveys (A), and the Bløden fishery (C).

The three independent estimates of recruitment tend to agree reasonably well, in particular those of the adult herring (B) and the Young Herring Surveys (A). The Bløden estimates (C), which show less variation than the other two estimates, agree with the exception of the year-classes 1962, 1964 and particularly 1966, which was a good year-class according to the Bløden estimate, but poor in the Young Herring Surveys and in most adult fisheries, according to the information available. It seems possible that a change, which occurred in later years in the Bløden fishery season from summer-autumn to the spring period, and which was probably connected with increased growth of the herring (Section IV, f)) has affected the comparability of the estimates. Another possibility is that increased fishing on immature herring in recent years (Section IV, a))

removed a large part of some later year-classes, in particular of the 1966 year-class, thereby upsetting the comparison with estimates of recruitment in the adult fisheries. In that case, however, the low estimates for these year-classes in the Young Herring Surveys, obtained at about the same age as in the Bløden fisheries, have to be explained.

Taking into account the high natural variability of recruitment in North Sea herring, it is difficult to discover an obvious trend in any of the three estimates. It should be noted, however, that in the Young Herring Surveys, after the 1963 year-class, no good year-class was recorded in four consecutive years (year-classes 1964-67), and provisional information indicates that the 1968 year-class will be poor too.

IV. f) Growth Rate

In an earlier Working Group Report on North Sea Herring (Anon., 1966) it was shown that the growth rate had increased from the early 30's to the early 60's. It was stated that this increase seemed to be a long-term development, with more sudden increases in the early 50's and the early 60's.

In Table 23 (p. 44) the lengths of 3 year old herring from the southern, central and northern North Sea are given for the years 1955-68. These demonstrate a further increase in growth in the late 60's (1967-68). As stated in the section on recruitment, a similar increase in growth rate was noted for the immature herring in the Bløden area. The exact cause or causes of the growth increase are unknown, but the possibility should be mentioned, that the phenomenon is in some way related to the suggested reduction in the size of the North Sea herring stocks.

An increase in growth rate, as recorded for North Sea herring, will tend to increase the sustainable yield of the fisheries, provided recruitment and natural mortality remain unchanged. Taking the length increase of the 3 year old herring from 1955-59 to 1965-68 as 4% and the length increase of $1\frac{1}{2}$ year old herring from 1960-61 to 1967-69 as 7% (Young Herring Surveys), a theoretical increase in the sustainable yield of between 10-20% could be calculated. When the growth increase is considered over a longer period of years, for instance since the early 30's, the theoretical increase in sustainable yield would be higher, possibly of the order of 30-40%.

V. Discussion

The increase in the landings of North Sea herring in the years 1964-65 almost certainly resulted from a sharp increase in effort in the northern North Sea, due, for a large part, to the introduction of the purse-seine fishery in that area. This can be deduced not only from indirect effort calculations, but also from the fact that the landings rose in a period of rather steady recruitment. The years of rapid increase in landings and effort were preceded by a period of relatively steady landings in the years 1951-63, during which according to a former Liaison Committee Report

(Anon., 1966) the effort probably rose gradually, first in the southern North Sea and later in the central and northern North Sea.

The Report of the former Working Group also mentions changes in the period 1951-63, which could be related to the general increase in effort, such as a decrease in average age, an increase in mortality rates and a decline of the catch per unit effort in several herring fisheries. Although not limited to the southern part of the North Sea, these changes in the herring stocks were most pronounced in that area.

Since the steep rise in 1964-65 in effort in the northern North Sea, an area mainly inhabited by the adult fish of the spawning stocks of the central and north-western North Sea (Anon., 1966), indications of a high rate of exploitation and a severe reduction of the adult stocks are evident in the whole North Sea. Thus mortality rates increased considerably in the central North Sea in the last decade and in the north-western North Sea in the last few years, so that now mortality rates are high (of the order of $Z \geq 1.00$, 68% per year) in the whole North Sea. A high rate of exploitation and a strong reduction of the adult stocks are also suggested by the few tagging experiments carried out in the northern North Sea in 1965-66.

The abundance of larvae declined strongly, first in the southern part of the North Sea and, after 1965, in the northern North Sea. Accepting larval abundance as index of the size of the spawning stock, a reduction of as much as 80% over ten years in adult North Sea herring is indicated.

In most fisheries on adult herring, especially in those operating with trawls, catches per unit of effort declined, sometimes to such an extent that the fisheries stopped. This decline, which was first and in its most severe form experienced in the southern North Sea, again points to a serious reduction of the adult stocks. Finally, the proportion of adult fish in the landings was found to decrease in the most recent years, indicating that some fisheries have turned to immature herring.

It should be noted, that although the complicated stock structure of North Sea herring and the inadequacies of the data indicated earlier make a full assessment of the developments in North Sea herring very difficult if not impossible, there are strong indications that the changes described in the stocks follow the development of fishing effort in the different parts of the North Sea. Thus these changes all started in the south, where the effort was built up in the early 50's and were experienced last in the north, after the rise in the effort there in 1964-65.

Since 1965 the landings have decreased, in the years 1966-68 to a level of just over a million tons. In fact, the landings in 1967-68 were surprisingly high, considering the decrease indicated in the adult stocks. A sustained high effort could be partly responsible. It is true that some countries diminished their effort by leaving the North Sea or by turning to other species, but others, notably some countries who

used to exploit the Atlanto-Scandian herring, turned to the North Sea, especially in 1967-68. The increased exploitation of immature herring in 1967-68, too, could be partly responsible for the relatively high catches in the last years. It should be noted, that a shift of the fisheries to the immature part of the stock can only increase the landings for a short period. Finally, the increased growth rate and the shift of the fisheries to more northern areas, where herring belonging to stocks other than North Sea autumn spawners are known to be present, could have contributed to the high landings in 1967-68.

In the Report of the former Working Group (Anon., 1966) attention was drawn to the shape of the yield per recruit curve in herring, which in some respects differ from the yield curve of demersal species such as plaice and cod. Heavy fishing on demersal stocks generally results in a decrease in the total catch, whereas in herring heavy exploitation will not lead to a decline in the total catch. This difference in the shape of the yield curves is mainly due to the fact, that those demersal species increase in weight by 20-30 times during their exploited adult stage, herring only by 2-3 times.

The recent history of the North Sea herring fisheries, showing relatively stable landings in the years 1951-63 at a time of probably increasing effort, seems to suggest that the sustainable yield of North Sea herring was reached in that period and does not exceed 700-800 thousand tons, accounting for the steady rise in the effort in that period. The subsequent increase in catch in the years after 1963, with a maximum of 1 450 000 tons in 1965, could only have been attained by a sharp reduction in the size of the stock. Evidence that this has taken place is given in Section III.a) The fall in total catch since 1965 and in particular in 1969 would suggest that these high catches cannot be sustained. It should also be noted that the total catch of the herring fisheries will remain at the maximum sustainable yield with increasing effort only if recruitment is not affected by heavy exploitation and a consequently low abundance of the adult stock.

It is too early to say what effect the apparent decline in the adult stocks have had on recruitment, considering the high natural variability in recruitment to North Sea herring. It is clear that recruitment to the southern North Sea has declined, in particular since the late 50's. Estimates of overall recruitment to the North Sea herring are somewhat contradictory, in particular in the most crucial years after 1964. The estimates derived from the Bløden fishery would suggest that recruitment was unaffected, in which case the low recruitment to the adult stocks must be caused by the increased fishing on immatures. The estimates of the Young Herring Surveys, on the other hand, suggest a succession of five poor year-classes (1964-68), which would indicate poor recruitment to the adult stocks at least up to 1971. It should be noted, that judging from past experience a series of five poor year-classes is unusual in North Sea herring.

VI. Conclusions

In the former Report of the North Sea Working Group (Anon., 1966) it was shown that in the period 1950-62 the total North Sea herring catch was remarkably stable for a long period at a level fluctuating around 850 000 tons, including immature fisheries, in spite, probably, of a gradual increase in overall effort.

After 1963 a steep rise in effort took place and resulted initially in an increase in the total landings up to a level of 1,44 million tons of North Sea herring. During the last three years (1966-68), for which complete data are available, the total catch has been at a level of just over a million tons. The catch in 1969 up to the 1st of November was about 720 000 tons.

The high effort since 1964 has resulted in a, probably serious, reduction of the adult stock, as indicated by low larval abundances, high mortality rates and low catches per unit of effort in most adult herring fisheries. With the increase in fishing intensity the proportion of immature herring (under three years of age) increased considerably, especially in the last two years (1967-68), suggesting a shift in the fishery to the juvenile part of the stock. The catches are composed of fish of lower age, length and weight than before.

From those events the Working Group concluded that under normal environmental conditions the steady yield of the populations of North Sea autumn-spawning herring will be about 700 - 800 thousand tons of adult and juvenile herring. A maintenance of effort at the high level experienced in recent years will, the Working Group fears, only accentuate the unfavourable consequences already observed:-

- a. a low catch per unit effort;
- b. a young population, in which the fishery is based on very few year-classes, with the danger of wide annual fluctuations in the total catch;
- c. a relatively low number of large-sized herring for human consumption markets.

A low abundance of mature herring as a consequence of heavy exploitation will result in a low egg production, as appears from the recent sharp decline in larval production in the North Sea. Indications for most North Sea fisheries are that recruitment since the abundant 1963 year-class has been poor. Moreover, estimates of the strength of year-classes of immature fish suggest that recruitment will continue to be poor in the next two years. Although the stock level at which recruitment becomes related to stock size (larval abundance) is unknown, it cannot be excluded that a maintenance of the present high level of effort will induce a stock-recruitment relationship.

In the light of all these considerations the Assessment Group advises that steps be taken to stabilise the effort at a lower level than exerted in recent years, in order to increase the size of the adult stock.

Regulatory Measures

A direct increase in the size of the adult stock independent of any stock-recruitment relationship, could be achieved in principle in two ways: a) by increasing recruitment; b) by reducing mortality in the adult stock or preferably by a combination of both. The following measures to obtain one or both of these ends will be discussed below. It should be noted that to achieve the recovery of the stocks to a satisfactory level under average recruitment conditions the fishing intensity will have to be reduced to about 50% of the present level.

(1) Minimum Mesh-Size

The introduction of a minimum mesh-size can only operate through an increase of recruitment. However, with larger meshes the industry will almost certainly be faced with a serious meshing problem, causing losses of time and possibly even losses of nets. Moreover, the effectiveness of mesh-size regulations in herring fisheries is very doubtful, as escaped fish may not be viable.

(2) Closing of Spawning Grounds

Such a measure is normally aimed at protecting the spawning products and consequently at increasing recruitment. There is no direct evidence that fishing interferes with the spawning behaviour or is destructive of spawn. Therefore, such a measure could only have predictable effect through the reduction in adult fishing mortality. The proportion of the total catch, caught in spawning conditions, is now extremely low in the North Sea. Such a measure could therefore not achieve a substantial reduction in total mortality. Apart from such doubts as have been stated above, an additional difficulty would be the exact definition of a spawning area.

(3) Minimum Size

The introduction of a size limit in herring fisheries would have its effect through an increase of recruitment to the adult stock.

Because of the difficulties in applying minimum mesh-sizes as discussed above, the direct effect would be to prohibit fishing on grounds, where small herring were dominant. The distribution of herring in the North Sea is such, that small and adult herring are largely separated in space. The length, dividing the immature from the adult herring, in the North Sea, lies roughly between 20-23 cm.

Because of inadequacies of the material available from some of the major fishing areas, notably the north-eastern North Sea and

Skagerak, it is difficult to quantify the effect of such a measure either in reducing the total catch in the short-term or in increasing recruitment in the long-term, but both must be considerable.

(4) Closed Area

A closed area could be effective either by reducing adult mortality or by increasing recruitment, depending on the area closed. In order to obtain a sufficiently large reduction in the mortality of either the adult or the immature fish, the area to be closed would be of considerable extent, of the order of $\frac{1}{4}$ - $\frac{1}{2}$ of the North Sea. The North Sea areas to be closed to protect the immature fish would be the eastern part of the central North Sea, the southern part of the north-eastern North Sea and the Skagerak. A reduction of adult mortality by closed areas should be sought in the western and/or the north-eastern North Sea mainly. Assessing the effect of such a measure on mortality of adult or immature herring, apart from the difficulties mentioned under "Minimum Size", is made virtually impossible because of diversions of effort to the "open" areas.

(5) Closed Seasons

Most of the comments made under (4) apply to this measure. Moreover, the two are not necessarily mutually exclusive, as an area could be closed for part of the year. To obtain the required effect the closed season would have to be over a considerable part of the year, i.e. 4-6 months.

(6) Direct Restriction of Effort

This measure, applied to all national fisheries, would decrease the mortality rate of the adult stock and increase recruitment to it under average recruitment conditions. The effect on fishing mortality of adults will be proportional to the reduction in effort, but no accurate assessment can be made of the effective increase in recruitment by reducing effort on the immature herring. As pointed out in the body of the report the measurement of the effective effort in herring fisheries raises major problems. Effective reduction of effort by any specified level could only be achieved by a reduction in the activities of the herring fleets in each method of fishing by that amount. Subsequent changes in the type of effort would make assessment of the effect on overall effort practically impossible as the different fishing techniques cannot be equated in terms of effective effort. In the present situation a reduction of effective fishing effort of the order of 50% will be necessary.

(7) Catch Quota

The effects of the introduction of a catch quota are biologically comparable with a restriction in effort. If set on a realistic level it will effect a reduction in adult mortality and an unspecified

increase in recruitment to the adult stock. It has, however, the advantage that it is more easily quantified and has no inhibiting effect on development in fishing techniques. The long-term sustained yield of North Sea herring under average recruitment conditions would be about 750 000 tons. However, to allow a recovery of the stock to a satisfactory level, the quota would need to be set, under the 1968 conditions, at about 500 000 tons. If the present level of exploitation is continued it is probable that the quota will have to be set considerably lower.

VII. Recommendations

1. In the light of the problems with catch and effort statistics of North Sea herring encountered during the assessment, the Assessment Group strongly recommends, that adequate catch and effort statistics are collected by the countries exploiting the North Sea herring. These statistics should be broken down preferably to statistical rectangles and months, but at least in the larger areas used in the assessment. (Areas VII d, e; IVc, IVb, IVa west of 2°E.L., IVa east of 2°E.L., Skagerak and Kattegat).
2. Biological sampling on North Sea herring including as a minimum length, age, weight and maturity of the fish, should be improved, in particular in the eastern part of the North Sea and Skagerak. Samples should be derived from commercial catches, as well for human consumption as for industrial purposes, rather than from research vessel catches.
3. The Assessment Group recognizes the importance of abundance estimates of North Sea herring, independent of estimates obtained from the commercial fisheries, as for instance estimates from larval and young herring surveys. It recommends that such surveys be continued and, where possible, improved.

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Table 1a. Herring. Catch in tons by countries 1960-1968
North Sea and Skagerak
(Sub-area IV, Divisions VIIId, e, Division IIIa,
Kattegat excluded).

Country	1960	1961	1962	1963	1964	1965	1966	1967	1968
Belgium	3 642	3 146	1 117	1 843	1 607	776	391	410	134
Denmark	162 600	195 500	196 600	222 700	271 100	254 000	181 100	235 400	306 700
England	16 354	17 849	11 994	22 821	16 533	11 494	10 716	8 215	5 128
Faroes	-	-	-	-	973	3 111	1 491	35 993	49 995
France	11 137	23 042	12 271	18 062	23 295	16 480	10 711	11 478	12 852
Germany, Fed.R.	148 430	100 951	89 059	94 643	92 650	81 280	54 589	32 778	21 218
Iceland	-	-	-	-	-	1 757	1 047	7 835	45 184
Netherlands	125 713	129 841	87 521	126 487	116 226	80 320	56 742	37 270	22 342
Norway	16 471	15 024	12 510	32 419	189 668	604 754	454 900	335 071	283 769
Poland	76 304	78 082	59 925	72 791	94 015	103 460	74 582	37 943	11 996
Scotland	29 006	23 038	22 416	34 571	21 125	20 569	17 557	18 138	16 477
Sweden	126 977	138 580	151 040	202 000	240 000	227 000	186 000	210 000	170 000
U.S.S.R.	63 105	67 722	100 265	75 965	139 637	47 322	16 442	27 221	88 825
Total	779 739	792 775	744 718	904 302	1206 829	1452 323	1066 268	997 752	1034 620
Non-Member Countries	360 000	?	?	?	?	67 700	30 600	27 700	?

Table 1b. Total catch in 1969, January-
October included, in thousands
of tons.
x) Estimated at 1968 level.

Country	1969
Belgium	- x)
Denmark	237
England	5
Faroes	40 ^x)
France	15 ^x)
German Fed.R.	20 ^x)
Iceland	40 ^x)
Netherlands	16
Norway	129
Poland	10
Scotland	16
Sweden	143
U.S.S.R.	50
Total	721

Table 1c. Herring. Catch in '000 tons 1947-1959.
North Sea (Sub-area IV and Divisions VIIId and e) by country.
Skagerak and Kattegat (Division IIIa) total catch.

Country	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Belgium ¹⁾	36	23	17	10	8	13	16	18	16	6	2	2	3
Denmark ¹⁾	9	7	5	8	34	33	50	58	66	83	88	134	145
England ²⁾	101	114	71	75	73	66	71	61	39	36	32	22	21
Faroes	-	-	-	-	-	-	-	-	-	-	-	-	-
France ¹⁾	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 ²⁾	155	163	131	133	149	158	186	174	148	136	129	127	118
Norway ²⁾	4	6	3	4	1	2	2	3	5	5	8	8	17
Poland ¹⁾	-	-	-	-	-	-	-	-	39	46	49	56	71
Scotland ²⁾	81	90	53	37	42	77	82	59	69	43	41	30	48
Sweden ¹⁾	25	26	25	27	31	37	37	39	47	38	49	50	57
U.S.S.R. ¹⁾	-	-	-	-	-	-	-	-	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

1) Data according to Coop.Res.Rep., Series B, 1965, Annex II, Table 9.

2) Data supplied by Working Group members.

Germany: Data according to Statistical Newsletters, No.11B, 1961. Denmark: Industrial and adult fishery. Skagerak not included.
England: Source of data: "Stat.branch ledgers. Annual Summary". Netherlands: Source of data: Bulletin Statistique. Figures from 1947-56 raised by conversion factor 1.17. Scotland: Excluding immature herring fisheries in Moray Firth and Firth of Forth.
Sweden: Excluding catches in Skagerak.

Table 2. Herring. Total catch in tons.
Skagerak
 (Division IIIa excl. Kattegat)

Year	Denmark	German Fed.R.	Iceland	Netherlands	Norway	Poland	Sweden	U.S.S.R.	Total
1960	43 200	42	-	-	2 578	-	26 218	-	72 038
1961	56 700	7	-	-	4 584	-	28 114	-	89 405
1962	70 600	3	-	-	5 049	594	37 862	-	114 108
1963	105 100	828	-	-	10 971	329	52 000	-	169 228
1964	129 500	6 064	-	-	85 916	4 324	48 000	-	273 804
1965	95 300	4 248	-	-	83 864	5 330	42 000	-	230 742
1966	75 200	432	-	74	30 438	511	39 000	-	145 655
1967	100 400	466	2 151	-	95 039	127	48 000	15 561	261 744
1968	143 600	2	695	36	71 865	42	33 000	18 796	268 036

Table 3. Herring. Total catch in tons.
North Sea, North-East
 (Division IVa east of 2°E)

Year	Belgium	Denmark	England	France	German Fed.R.	Iceland	Netherlands	Norway	Poland	Scotland	Sweden	U.S.S.R.	Total
1960	-	41 800	-	-	29 455	-	15 442	9 005	15 749	1 598	99 104	63 105	275 258
1961	-	61 500	-	-	14 043	-	6 318	7 630	11 020	3 877	109 329	67 722	281 439
1962	-	49 600	3	-	8 913	-	6 990	5 793	5 036	4 899	113 112	100 265	294 611
1963	-	58 900	4	-	10 069	-	8 448	18 255	3 335	-	145 000	75 965	319 976
1964	-	53 100	-	-	9 972	-	9 313	91 006	12 949	627	188 000	139 637	504 604
1965	-	49 700	-	-	23 428	1 757	6 912	323 361	16 200	-	185 000	27 227	633 585
1966	-	51 400	6	-	12 329	1 047	4 555	205 239	11 690	186	146 000	16 442	448 894
1967	-	51 600	-	-	2 558	5 684	1 709	176 628	2 986	-	161 000	11 660	413 825
1968	-	57 100	-	-	2 487	9 355	1 022	66 046	1 880	-	137 000	30 799	305 689

Table 4. Herring. Total catch in tons.
North Sea, North-West
 (Division IVa west of 2°E).

Year	Belgium	Denmark	England	Faroes	France	German Fed.R.	Iceland	Netherlands	Norway	Poland	Scotland	Sweden	U.S.S.R.	Total
1960	122	-	163	-	1 151	45 746	-	19 863	3 343	7 000	22 292	1 655	-	101 335
1961	120	-	8	-	5 796	19 146	-	8 414	2 173	7 271	16 954	1 137	-	61 019
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	5 000	-	73 446
1964	155	-	8	973	6 405	7 319	-	11 420	4 350	15 962	16 753	4 000	-	67 345
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	1 000	-	278 784
1967	200	-	15	35 993	1 515	7 941	-	3 418	41 664	8 454	17 359	1 000	-	117 559
1968	23	-	-	49 995	1 349	7 150	35 134	3 072	131 598	2 806	16 324	-	39 230	286 681

Table 5. Herring. Total catch in tons.
North Sea, Central
 (Division IVb)

Year	Adult Herring Fisheries										Young Herring Fisheries			TOTAL ALL FISHERIES
	Belgium	England	France	German Fed.-R.	Netherlands	Norway	Poland	Scotland	Total	Denmark	German Fed.-R.	Total		
1960	115	9 816	369	39 326	61 540	1 545	48 479	5 116	166 306	77 600	22 322	99 922	266 228	
1961	121	8 579	2 535	35 402	70 336	637	49 064	2 207	168 881	77 300	16 549	93 849	262 730	
1962	124	6 076	2 886	40 772	47 255	831	45 030	326	143 300	76 400	23 975	100 375	243 675	
1963	558	14 465	8 296	60 818	81 524	552	54 370	7 626	228 209	58 700	9 017	67 717	295 926	
1964	351	9 235	7 750	36 361	63 314	8 396	58 726	3 745	187 878	88 500	28 126	116 626	304 504	
1965	47	8 524	7 037	22 520	47 551	1 041	44 815	1 330	132 865	109 000	26 009	135 009	267 874	
1966	69	9 646	6 261	21 183	42 008	0	34 085	823	114 075	54 500	12 737	67 237	181 312	
1967	5	6 809	6 540	18 917	26 769	21 740	26 370	779	107 929	83 400	1 849	85 249	193 178	
1968	13	4 170	8 196	10 439	13 285	14 260	7 241	153	57 757	106 000	847	106 847	164 604	

Table 6. Herring. Total catch in tons.
North Sea, South, and English Channel, East and West.
 (Divisions IVc and VIIId and e)

Year	Belgium	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

Explanatory Notes to Tables 1 - 6

- Belgium
1. All data derived from "Bulletin Statistique".
 2. Catches from Division IVa are ascribed to IVa west of 2°E (Table 4, p.26).
- Denmark
1. All data used in the Tables are based upon Danish national statistics (Popp Madsen) (see Table 7, p.32).
 2. Catches from Division IIIa (Skagerak and Kattegat) (Table 7), are in agreement with the data published in "Bulletin Statistique" for that Division. In Tables 1-3 (p. 22-25) catches from the Kattegat have been excluded.
 3. Catches from Division IVa are ascribed to IVa east of 2°E (Table 3). For 1967 and 1968 catches from IVa east and IVa west of 2°E are given separately (Table 7).
 4. Catches from Division IVb (Young Herring Fishery) have been reduced for content of other species (1960 - spring 1965 by 5%, autumn 1965-1968 by estimates from individual years; Popp Madsen). (Tables 5 and 7).
- England
1. All data derived from "Bulletin Statistique".
 2. Separation of catches in Division IVa east and west of 2°E according to national statistics (Tables 3 and 4).
- Faroes
1. Catches only from Division IVa according to "Bulletin Statistique". Ascribed to IVa west (Table 4).
- No information on the distribution of the fishery is available.
- France
- The data given have been supplied by the "Institut des Pêches", Boulogne s/Mer. They are stated to be as near to the actual catches as possible. They differ from the figures published in "Bulletin Statistique".
- German Fed.R.
1. All data are according to German national statistics (Schumacher). They are compiled by the "Bundesforschungsanstalt für Fischerei", Hamburg, according to log books. They are of approximately the same order of magnitude as the corresponding figures compiled at the fish market and published in "Bulletin Statistique".
- However, for the North Sea Divisions IVa, b and c, the figures given in Tables 1-6 are ^{and} less than the corresponding figures in "Bulletin Statistique". The largest discrepancies are found in Division IVb, where the "Bulletin Statistique" figures exceed those shown in Table 5 (adult + young herring) by approximately 20% for 1960-62, approximately 10% for 1963-65 and approximately 30% for 1966-68.
- Iceland
1. All data derived from "Bulletin Statistique".
 2. Separation of catches in Division IVa east and west of 2°E are according to Icelandic statistics.
- Netherlands
1. All data derived from "Bulletin Statistique".
 2. Separation of catches in Division IVa east and west of 2°E are according to Dutch national statistics.
 3. For 1967, 5 190 tons published in "Bulletin Statistique" as "Not accounted for" have been divided between Division IVb and Divisions IVc and VIId, e.

Norway

The data are according to Norwegian official statistics. The separation of catches is based upon the statistics of the fishermen's organisations. - The official statistics are not in agreement with "Bulletin Statistique" because:

- a) The figures supplied to this publication are often preliminary.
- b) Some spawning winter herring which have been caught along the west coast of Norway (especially in former years) and catches of immature herring in inshore waters have been excluded from the present Tables.

The figures given here are stated to be "pure" North Sea herring.

Poland

1. All data according to "Bulletin Statistique".
2. Separation of catches in Division IVa east and west of 2°E is according to Polish national statistics.
3. Catch statistics received directly from Poland disagree with "Bulletin Statistique" data for Division IVa for 1961 and 1965, as follows:-

<u>Year</u>	<u>Polish Statistics</u>	<u>"Bulletin Statistique"</u>
1961	16 291	18 291
1965	57 562	52 078

The figures from "Bulletin Statistique" have been used in Tables 3 and 4, split up according to Polish STANA Forms 1E.

Scotland

1. All data are according to "Bulletin Statistique".
2. Separation of catches in Division IVa east and west of 2°E is according to Scottish national statistics.
3. The catches in Division IVa, west of 2°E (Table 4) comprise the total catch in Division IVa minus the catch in the area east of 2°E (given in Table 3) and minus the immature herring fishery in the Moray Firth being:-

<u>Year</u>	<u>Tons</u>
1960	905
1961	584
1962	1 767
1963	110
1964	292
1965	7 540
1966	14 247
1967	1 994
1968	1 893

Sweden

1. All data from 1960-62 are according to "Bulletin Statistique"; however, the following quantities registered under "Unsorted and Unidentified Species" have been added to the catch data for Divisions IVa and IIIa:

1960	8 500 tons
1961	20 000 tons
1962	30 000 tons

2. Catches from 1963 to 1968 are according to the Swedish West Coast Fishermen's Organisation:

<u>Sweden (ctd.)</u>	<u>Year</u>	<u>For industrial Purposes</u> (tons)	<u>For Consumption</u> (tons)	<u>Total</u> (tons)
	1963	45 000	157 000	202 000
	1964	97 000	143 000	240 000
	1965	87 000	140 000	227 000
	1966	58 000	128 000	186 000
	1967	81 000	129 000	210 000
	1968	67 000	103 000	170 000

3. Separation of catches in Division IVa east and west of 2°E is according to Swedish national statistics, but is supposed to be rather unreliable. A greater part of the catches presumably comes from Division IVa, west of 2°E (Table 4).
4. Division IIIa (Table 2). The data include Swedish catches from Kattegat landed in Sweden but exclude those landed in Denmark (see Table 7).

U.S.S.R.

1. All data according to "Bulletin Statistique".
2. Separation of catches in Division IIIa Skagerak, IVa east and IVa west of 2°E are according to Soviet national statistics.

Table 1 c

See footnotes to the Table, p. 23.

Table 7. Account of Danish herring catches (thousands of tons) in the years 1960-1969, separated into catches by areas and into landings for human consumption (C) and for industrial purposes (I). Catches in Division IVb have been corrected for by-catches of other species (1960 - spring 1965 = reduced by 5%, autumn 1965 - 1968 = reduced by estimates for individual years).

A separation in the landings in Division IVa as to east and west of 2°E (NE and NW) was only possible for the years 1967-68.

Year	Division IVa		Division IVb	Skagerak (IIIa)		Kattegat IIIa	
	C	I	I	C	I	C	I
1960	24.5	17.3	77.6	15.4	27.8	5.8	13.6
1961	40.2	21.3	77.3	11.8	44.9	6.0	23.2
1962	26.6	23.0	76.4	7.8	62.8	4.1	29.5
1963	33.9	25.0	58.7	15.9	89.2	4.6	40.5
1964	28.9	24.2	88.5	17.2	112.3	4.4	44.5
1965	24.8	24.9	109.0	15.0	80.3	5.8	42.6
1966	23.0	28.4	54.5	6.5	68.7	6.3	38.1
1967	17.5	34.1	83.4	16.1	84.3	6.1	38.0
1968	19.4	37.7	106.0	8.5	135.1	9.0	58.4
1969*	14.4	45.1	125.0	9.2	43.3	6.6	26.0

* January-October inclusive.

	Division IVa	
	NE	NW
1967	35.3	21.8
1968	49.6	9.9

Table 8. Account of Swedish landings in Danish ports (thousands of tons), in 1960-1969, separated into catches by areas and into human consumption herring (C) and industrial herring (I). Swedish landings are separated into area catches according to the distribution of the Danish fishery based upon a comparison in the years 1967-68. A separation of the Swedish catches for Divisions IVa, north-west, IVa north-east and IV was only possible in the years 1967-68.

Year	(1) IVa + b		(2) Skagerak (IIIa)		(3) Kattegat IIIa		Sub-total (1) + (2)
	C	I	C	I	C	I	
1960	24.1	0.5	7.4	0.8	2.8	0.4	32.8
1961	35.3	0.6	7.2	1.2	3.7	0.6	44.3
1962	64.0	1.2	13.0	3.3	6.9	1.6	81.5
1963	80.6	1.8	21.1	6.3	6.1	2.9	109.8
1964	81.8	7.0	24.4	32.6	6.3	13.0	145.8
1965	82.8	6.7	24.9	21.5	9.6	11.4	135.9
1966	78.9	4.4	15.6	10.6	15.3	5.9	109.5
1967	75.4	6.4	28.4	15.9	10.8	7.1	126.1
1968	71.5	6.1	18.0	22.0	19.1	9.5	117.6
1969*	39.8	3.5	19.0	6.6	12.2	1.5	68.9

* January-October inclusive.

	North Sea		
	IVa NE	IVa NW	IVb
1967	40.1	10.0	31.8
1968	67.5	3.5	6.6

Table 9. Catch per unit effort in drift-net and trawl fisheries in the southern, central, north-eastern and north-western North Sea.

Years	North-west		North-east			Central		South		Bløden
	Drift ¹	Trawl ²	Drift ³	Trawl ⁴	Trawl ⁵	Drift ⁶	Trawl ⁷	Drift ⁸	Trawl ⁹	Trawl ¹⁰
1955	5.2	44.0	?	9.8	1.5	2.8	56.0	3.6	104	?
1956	3.9	23.7	?	13.9	3.6	3.5	46.0	4.5	88	?
1957	3.6	47.6	4.8	7.0	3.3	3.5	80.0	4.0	78	?
1958	4.1	27.1	3.1	13.3	4.3	3.0	27.0	3.2	81	1.94
1959	4.0	52.9	2.8	6.4	2.9	3.1	66.7	2.7	150	1.74
1960	3.2	29.6	3.4	13.0	2.7	2.4	25.1	3.4	113	1.22
1961	4.2	23.9	3.3	6.7	1.8	2.1	42.0	3.2	169	1.22
1962	3.7	18.8	1.8	4.1	2.0	2.0	24.8	2.7	56	1.94
1963	3.9	21.7	1.2	7.2	3.6	5.6	42.3	2.2	50	1.16
1964	3.4	25.4	2.5	9.5	3.4	2.6	38.3	3.8	58	1.78
1965	3.4	19.9	3.0	5.1	2.5	2.7	30.7	1.8	38	1.46
1966	4.3	14.7	2.8	2.9	1.6	2.8	37.5	1.4	?	0.98
1967	4.7	8.4	1.8	1.0	1.0	2.9	25.8	1.4	?	1.35
1968	3.8	?	1.6	1.5	1.0	-	18.7	0.3	?	1.64
1969	4.8	?		2.3	?	-	19.7 ⁺	-	?	1.51

1. Scottish catch per arrival in May-September (tons).
 2. Netherlands catch per 100 hours' fishing by a standard (500 BHP) trawler in July-September (tons).
 3. Polish catch per shot in April-July (tons).
 4. Netherlands catch per 100 hours' fishing by a standard trawler in January-April (tons).
 5. German logger trawl, catch per day (only catches with over 60% herring) (tons).
 6. Netherlands catch per shot (tons) (May-September).
 7. Netherlands catch per 100 hours' fishing by a standard trawler (tons) (August-October).
 8. United Kingdom catch per shot (tons)(October-December).
 9. Netherlands catch per 100 hours' fishing of a standard trawler (tons) (November-December).
 10. Danish catch per hour (tons) in the immature herring fishery in the Bløden area.
- + Provisional.

Table 10. Effort estimates, obtained by dividing the total catch in an area by the catches per unit effort of drift-net and trawl fisheries in that area.

Year	A R E A										
	North-west			North-east			Central		South		Bløden
	Drift ¹⁾ Scottish	Trawl ²⁾ Dutch	Drift ³⁾ Polish	Trawl ⁴⁾ Dutch	Trawl ⁵⁾ German	Drift ⁶⁾ Dutch	Trawl ⁷⁾ Dutch	Drift ⁸⁾ English	Trawl ⁹⁾ Dutch	Trawl ¹⁰⁾ Danish	
1960	31.7	3.4	81.0	21.2	101.9	69.4	6.6	19.1	0.6	81.9	
1961	14.5	2.5	85.3	42.0	156.4	80.1	4.0	30.7	0.6	77.0	
1962	10.2	2.0	163.7	71.9	147.3	71.4	5.8	20.3	1.0	52.0	
1963	18.8	3.9	266.6	44.4	88.9	40.6	5.4	20.8	0.9	57.2	
1964	19.8	2.7	201.8	53.1	148.4	72.2	4.9	14.9	1.0	65.8	
1965	86.3	15.0	211.2	124.2	253.4	49.3	4.3	12.1	0.5	92.2	
1966	64.8	19.0	160.3	154.8	280.6	40.7	3.0	8.3	?	68.9	
1967	25.0	14.0	229.9	413.8	413.8	37.1	4.2	8.1	?	63.2	
1968	75.4	?	191.1	203.8	305.7	?	3.1	32.0	?	64.9	
Period											
1960-63	18.8	3.0	149.2	44.9	123.6	65.4	5.5	22.7	0.8	67.0	
1964-68	54.3	12.7	198.9	169.9	280.4	49.8	3.9	15.1	?	71.0	

- 1) Arrivals (x 1000)
- 2) Fishing hours (x 100 000)
- 3) Shots (x 1 000)
- 4) Fishing hours (x 100 000)
- 5) Days fishing (x 1 000)
- 6) Shots (x 1 000)
- 7) Fishing hours (x 100 000)
- 8) Shots (x 1 000)
- 9) Fishing hours (x 1 000)
- 10) Fishing hours (x 1 000)

Table 11. North-western North Sea: Division IVa, west of 2°E.
Percentage age composition and mean number per kilo.

	Year	Age in winter rings									No./kilo
		1	2	3	4	5	6	7	8	>8	
A	1960	-	34.0	56.5	2.5	3.5	2.0	1.0	0.5	-	5.90
	1961	-	7.0	24.0	56.0	4.0	4.0	1.0	3.0	1.0	4.93
	1962	-	2.0	9.9	10.9	59.4	3.0	5.0	3.0	6.9	4.48
	1963	0.5	83.2	1.5	2.5	1.5	7.4	0.5	2.0	1.0	5.45
	1964	0.5	30.5	46.5	2.0	2.5	1.0	15.0	0.5	1.5	4.75
	1965	16.0	25.0	26.0	28.0	-	1.0	-	3.0	1.0	5.12
	1966	-	31.7	19.8	12.9	19.8	2.0	-	3.0	10.9	4.32
	1967	1.0	35.6	51.5	10.9	-	1.0	-	-	-	6.75
	1968	51.5	16.2	16.2	4.0	6.1	6.1	-	-	-	7.48
B	1960	-	17.6	51.1	3.4	9.5	6.4	6.2	2.9	3.0	6.60
	1961	1.2	6.1	15.8	57.3	3.5	7.3	2.5	3.9	2.4	6.06
	1962	0.4	13.8	5.3	14.5	47.9	3.1	8.0	3.4	3.5	6.90
	1963	-	57.2	2.9	3.3	5.4	22.9	1.2	4.4	2.8	6.23
	1964	0.1	29.5	52.5	1.8	1.6	2.5	9.2	0.8	2.0	5.75
	1965	1.9	34.5	19.8	31.8	1.3	1.3	1.7	6.2	1.4	6.12
	1966	0.8	44.3	15.6	9.8	20.8	0.5	0.6	2.0	5.7	5.75
	1967	1.9	14.8	45.6	9.8	8.7	11.9	0.8	0.7	5.7	5.71
	1968	5.5	35.3	14.4	23.7	5.3	5.4	5.6	0.7	4.2	5.49

A - Data used for trawled herring from Belgium, Germany, France and the Netherlands.

B - Data used for all other herring catches.

Table 12. Central North Sea, adult herring fisheries, Division IVb: percentage age distribution and mean number per kilo.

Year	Age in winter rings										No./kilo
	0	1	2	3	4	5	6	7	8	>8	
1960	-	2.5	23.8	60.2	4.7	3.5	1.2	3.1	0.6	0.4	6.03
1961	-	3.0	57.0	9.8	29.3	0.9	-	-	-	-	5.81
1962	-	6.8	9.3	50.0	9.6	21.2	1.9	0.7	0.3	0.3	5.01
1963	-	2.9	87.6	5.1	4.5	-	-	-	-	-	5.41
1964	-	4.7	43.6	43.6	1.4	3.0	0.9	2.9	-	-	4.83
1965	-	7.7	60.2	11.8	13.6	1.2	1.1	0.5	1.3	2.5	5.40
1966	-	0.2	79.8	13.6	2.3	3.4	-	0.2	0.2	0.2	5.93
1967	-	4.3	37.1	45.6	9.4	1.2	2.5	-	-	-	5.24
1968	-	3.0	56.4	13.6	20.0	4.2	1.2	1.8	-	-	5.16
(a)	65.6	26.8	6.3	0.7	0.3	0.2	-	-	-	-	10.72

(a) Age used for Norwegian catch.

Table 13. Southern North Sea and eastern part of English Channel. Divisions IVc and VIId,e: Percentage age composition and mean number per kilo.

Year	Age in winter rings									No./kilo
	1	2	3	4	5	6	7	8	>8	
1960	2.9	61.9	30.3	3.5	1.2	0.2	-	-	-	7.20
1961	0.1	82.6	11.2	5.4	0.7	-	-	-	-	7.22
1962	3.4	12.4	71.5	8.6	3.9	0.2	0.1	-	-	6.06
1963	0.7	87.8	3.4	7.3	0.8	0.1	-	-	-	6.70
1964	6.5	67.7	23.9	0.2	1.8	-	-	-	-	5.80
1965	0.3	20.4	48.3	26.0	1.7	1.9	0.4	-	1.0	5.70
1966	5.0	75.5	13.6	1.6	4.3	-	-	-	-	6.25
1967	5.2	61.8	22.5	7.1	3.2	0.2	-	-	-	6.00
1968	9.5	36.0	31.3	15.2	2.3	4.7	1.0	-	-	6.62

Table 14. Proportion of spring-spawning herring in the north-western North Sea, north-eastern North Sea and the Skagerak (Scottish and Norwegian material).

Year	North-western North Sea	North-eastern North Sea	Skagerak
1960	4.9	-	-
1961	4.0	-	-
1962	26.6	-	-
1963	25.8	-	-
1964	10.5	16.0	5.6
1965	14.4	13.8	5.8
1966	24.1	12.2	7.8
1967	20.5	19.4	4.9
1968	26.2	18.0	3.4
1969			
1970			

Table 15. North-eastern North Sea. Division IVa, east of 2°E: Percentage age composition and mean number per kilo.

Year	Age in winter rings										No./kilo
	0	1	2	3	4	5	6	7	8	>8	
1960	-	9.1	8.9	41.8	3.8	5.5	5.2	6.6	3.4	14.6	6.25
1961	-	0.5	4.8	14.3	53.6	5.3	8.0	4.0	4.0	5.5	5.18
1962	-	14.6	13.2	11.4	11.4	32.8	4.3	5.2	2.9	4.2	6.21
1963	-	1.6	51.5	6.4	7.0	7.0	18.0	1.4	3.6	3.5	6.85
A 1964	0.4	0.2	7.1	70.1	7.9	5.4	1.7	5.1	0.6	1.5	6.67
1965	0.1	11.9	11.8	13.2	42.5	2.7	4.9	3.6	6.4	2.9	5.88
1966	-	6.9	36.7	8.8	8.4	24.7	2.6	4.2	1.7	6.0	6.21
1967	0.7	10.5	14.9	32.0	11.3	8.9	8.2	0.7	1.5	10.4	5.26
1968	-	50.7	32.0	4.9	6.4	2.0	2.0	1.0	0.5	0.5	8.13
1960	-	0.9	13.2	63.1	6.6	5.8	4.4	3.0	1.0	2.0	6.02
1961	0.1	5.4	5.8	12.4	53.8	5.7	7.9	2.8	1.9	4.3	7.10
1962	-	1.3	3.2	7.9	11.4	52.3	6.9	8.0	5.0	4.0	6.30
1963	-	4.1	76.1	4.3	2.3	2.2	7.1	0.9	1.1	1.9	6.81
B 1964	-	1.4	39.9	41.3	2.0	2.5	3.2	7.0	0.9	1.8	6.91
1965											
(a)	-	0.5	15.2	25.7	37.1	4.2	2.4	2.3	10.8	1.8	5.84
(b)	0.1	17.9	14.7	14.2	39.3	2.5	3.2	2.0	6.0	0.1	6.90
1966	0.1	12.7	37.6	13.5	9.5	17.5	1.1	1.6	2.1	4.7	7.02
1967											
(a)	-	22.8	10.7	20.7	11.9	11.9	6.7	3.9	5.4	6.0	5.63
(b)	-	10.5	20.7	32.2	7.4	7.0	14.9	1.5	1.4	4.4	8.82
1968	-	27.3	43.6	6.7	10.2	3.4	2.9	4.1	0.1	1.7	7.15

A German age data used for herring catches of Germany, France, Netherlands, Poland and U.S.S.R.

B Danish, Swedish and Norwegian data used for catches of these countries.

(a) Danish and Swedish catches only.

(b) Norwegian catch only.

Table 16. Distribution of the North Sea herring catch in millions of fish per age.

Year	Division	Age in Winter Rings										Σ
		0	1	2	3	4	5	6	7	8	>8	
1960	IVa W of 2°E	-	-	174.3	339.3	17.6	35.4	22.5	18.0	8.5	6.8	622.4
	IVa E of 2°E	-	8.3	121.3	579.9	60.7	53.3	40.4	27.6	9.2	18.4	919.1
	IVb	-	25.1	238.8	604.1	47.1	35.2	12.1	31.1	10.0	4.1	1007.6
	IVb Young herring fishery	171.0	2004.9	229.2	24.5	-	-	-	-	-	-	2429.6
	IVc	-	13.5	289.1	141.4	16.3	5.6	0.9	-	-	-	466.8
	TOTAL NORTH SEA	171.0	2051.8	1052.7	1689.2	141.7	129.5	75.9	76.7	27.7	29.3	5445.5
1961	IVa W of 2°E	-	2.0	21.8	66.0	188.0	12.4	18.8	5.9	11.5	5.7	332.1
	IVa E of 2°E	1.2	66.6	71.6	153.0	663.9	70.3	97.5	34.6	23.4	53.1	1235.2
	IVb	-	29.4	560.0	96.1	287.4	8.8	-	-	-	-	981.7
	IVb Young herring fishery	1104.8	205.2	545.1	9.7	-	-	-	-	-	-	1864.8
	IVc	-	0.7	585.7	79.4	38.3	5.0	-	-	-	-	709.1
	TOTAL NORTH SEA	1106.0	303.9	1784.2	404.2	1177.6	96.5	116.3	40.5	34.9	58.8	5122.9
1962	IVa W of 2°E	-	0.6	22.3	14.9	29.5	114.2	6.8	15.6	7.2	10.1	221.2
	IVa E of 2°E	-	12.9	31.7	78.2	112.9	517.8	68.3	79.2	49.5	39.6	990.1
	IVb	-	48.9	66.6	358.4	68.8	151.9	13.7	5.0	4.2	2.1	719.6
	IVb Young herring fishery	118.2	1635.7	2.6	13.1	-	-	-	-	-	-	1769.6
	IVc	-	11.3	41.1	237.2	28.5	12.9	0.7	0.3	-	-	332.0
	TOTAL NORTH SEA	118.2	1709.4	164.3	701.8	239.7	796.8	89.5	100.1	60.9	51.8	4032.5
1963	IVa W of 2°E	-	0.6	135.7	3.0	4.5	3.7	17.1	0.9	4.2	2.2	171.9
	IVa E of 2°E	-	54.6	1014.5	57.3	30.6	29.3	94.7	12.0	14.7	25.3	1333.0
	IVb	-	36.3	1080.5	62.5	55.0	-	-	-	-	-	1234.3
	IVb Young herring fishery	-	312.6	815.6	39.2	-	-	-	-	-	-	1167.4
	IVc	-	2.2	275.0	10.6	22.9	2.5	0.3	-	-	-	313.5
	TOTAL NORTH SEA	-	406.3	3321.3	172.6	113.0	35.5	112.1	12.9	18.9	27.5	4220.1
1964	IVa W of 2°E	-	0.8	107.7	182.2	6.7	6.9	7.2	40.1	2.5	6.6	360.7
	IVa E of 2°E	-	28.0	797.8	825.8	40.0	50.0	64.0	140.0	18.0	36.0	1999.6
	IVb	-	42.6	395.0	395.0	12.6	27.2	8.2	26.2	-	-	906.8
	IVb Young herring fishery	345.3	2020.2	134.4	-	-	-	-	-	-	-	2499.9
	IVc	-	21.3	22.3	78.5	0.7	5.9	-	-	-	-	328.7
	TOTAL NORTH SEA	345.3	2112.9	1657.2	1481.5	60.0	90.0	79.4	206.3	20.5	42.6	6095.7

(continued on page 39...)

Table 16 (continued)

Year	Division	Age in Winter Rings											Σ
		0	1	2	3	4	5	6	7	8	>8		
1965	IVa W of 2°E	-	52.9	613.2	367.2	571.7	21.9	23.2	28.6	108.2	24.9	1811.8	
	IVa E of 2°E	2.3	418.4	483.0	570.2	1257.8	97.3	96.6	67.8	240.4	19.3	3253.1	
	IVb	-	55.3	432.2	84.9	98.3	8.6	7.9	3.6	27.3	18.1	736.2	
	IVb Young herring fishery	105.3	1799.7	411.2	27.3	-	-	-	-	-	-	2343.5	
	IVc	-	0.4	25.5	60.5	32.6	2.1	2.4	0.5	-	1.3	125.3	
	TOTAL NORTH SEA	107.6	2326.7	1965.1	1110.1	1960.4	129.9	130.1	100.5	375.9	63.6	8269.9	
1966	IVa W of 2°E	-	12.2	693.5	249.2	156.8	328.5	8.7	9.1	32.2	93.2	1583.4	
	IVa E of 2°E	2.7	348.2	1030.9	370.1	260.4	479.8	30.2	43.9	57.6	128.8	2752.6	
	IVb	-	1.3	539.4	91.6	15.9	23.5	-	1.3	2.7	1.3	677.0	
	IVb Young herring fishery	273.9	662.3	119.6	4.5	-	-	-	-	-	-	1060.3	
	IVc	-	3.6	54.8	9.9	1.2	3.1	-	-	-	-	72.6	
	TOTAL NORTH SEA	276.6	1027.6	2439.2	725.3	434.3	834.9	38.9	54.3	91.5	223.3	6145.9	
1967	IVa W of 2°E	-	12.2	119.1	315.6	67.7	51.5	71.4	4.7	4.1	33.8	680.1	
	IVa E of 2°E	-	374.5	428.3	702.8	226.3	219.9	299.2	59.3	71.3	124.7	2506.3	
	IVb	-	24.3	209.4	257.4	53.1	6.8	14.1	-	-	-	565.1	
	IVb Young herring fishery	534.6	805.5	200.3	31.7	-	-	-	-	-	-	1572.1	
	IVc	-	3.6	42.4	15.4	4.9	2.2	0.1	-	-	-	68.6	
	TOTAL NORTH SEA	534.6	1220.1	999.5	1322.9	352.0	280.4	384.8	64.0	75.4	158.5	5392.2	
1968	IVa W of 2°E	-	83.1	577.7	231.5	372.1	83.5	86.8	89.8	10.6	63.5	1598.6	
	IVa E of 2°E	-	444.4	709.8	109.0	166.1	55.4	47.2	66.8	1.6	27.6	1627.9	
	IVb	-	9.0	166.8	40.6	59.9	12.6	3.6	5.4	-	-	297.9	
	IVb Young herring fishery	488.9	990.9	114.9	11.1	-	-	-	-	-	-	1605.8	
	IVc	-	6.0	22.9	19.9	9.7	1.5	3.0	0.6	-	-	63.6	
	TOTAL NORTH SEA	488.9	1533.4	1592.1	412.1	607.8	153.0	140.6	162.6	12.2	91.1	5193.8	

Table 17. Catch of immature herring (0+I group) in the western North Sea (Divisions IVc, IVb and IVa, west of 2°E), in the north-eastern North Sea, in the Bløden area (Young herring fisheries in Division IVb) and in the Skagerak. (Millions of fish).

In brackets: % of total catch in the area.

Period	Western North Sea	North-eastern North Sea	Bløden Area	Skagerak
1960-62	43.8 (2%)	29.6 (3%)	1 746.6 (86%)	? (?)
1963-65	70.8 (4%)	167.8 (8%)	1 527.7 (76%)	699.1 (36%)
1966-68	51.8 (3%)	389.9 (17%)	1 252.0 (99%)	2 212.5 (77%)

Table 18. Skagerak (Division IIIa): percentage age age composition and mean number per kilo.

Year	Age in winter rings										No./kilo
	0	1	2	3	4	5	6	7	8	>8	
1963	-	11.2	71.8	1.9	2.4	1.5	5.6	0.9	2.9	1.8	6.58
1964	17.6	25.9	16.0	26.4	1.9	2.2	2.3	4.8	1.4	1.5	7.09
A 1965	19.3	24.0	16.3	11.9	19.5	1.0	1.6	1.3	3.2	1.9	7.63
1966	-	23.6	57.0	10.8	2.8	4.5	0.1	0.3	0.3	0.6	6.94
1967	4.9	71.5	10.8	6.8	2.3	0.7	2.8	-	0.1	0.1	9.01
1968	-	79.2	12.8	2.1	3.7	-	1.1	1.1	-	-	8.93
1963	-	5.0	76.2	3.6	3.1	2.0	7.1	1.6	0.8	0.7	7.75
1964	-	12.6	26.2	49.1	1.3	1.7	1.8	5.8	0.9	0.5	7.09
B 1965	8.1	61.5	14.9	5.4	7.1	0.6	0.3	0.7	1.1	0.3	11.24
1966	0.1	45.4	33.6	6.5	3.1	5.4	3.1	-	1.0	1.8	9.17
1967	3.8	80.2	10.8	2.8	1.3	0.5	0.5	0.02	0.02	0.02	12.82
1968	48.7	33.4	13.9	2.1	1.1	0.7	-	-	-	-	15.38

A German age data used for German and Polish catches.

B Age data used for herring catches of Denmark, Norway and Sweden.

Table 19. Millions of fish per age group in Skagerak.

Year	Age in Winter Rings									Σ	
	0	1	2	3	4	5	6	7	8		>8
1963	-	66.2	1 001.6	47.2	40.7	26.2	93.3	20.9	10.7	9.3	1 316.1
1964	13.1	254.2	500.6	935.5	25.7	33.3	35.3	111.7	17.8	10.5	1 937.7
1965	215.8	1 547.9	382.7	143.1	191.0	15.7	8.7	18.3	29.7	8.9	2 561.8
1966	1.3	603.9	449.6	86.9	41.3	71.9	41.1	-	13.3	23.9	1 333.2
1967	126.7	2 628.7	355.7	97.8	44.2	16.7	19.7	0.6	0.8	0.8	3 291.7
1968	1 866.5	1 410.3	553.8	84.0	48.3	26.8	1.9	1.9	-	-	3 993.5

Table 20. Total North Sea and Skagerak Catch in millions of fish per age group.

Year	Age in Winter Rings									Σ	
	0	1	2	3	4	5	6	7	8		>8
1963	-	472.5	4 322.9	219.8	153.7	61.7	205.4	33.8	29.6	36.8	5 536.2
1964	358.4	2 367.1	2 157.8	2 417.0	85.7	123.3	114.7	318.0	38.3	53.1	8 033.4
1965	323.4	3 874.6	2 347.8	1 253.2	2 151.4	145.6	138.8	118.8	405.6	72.5	10 831.7
1966	277.9	1 631.5	2 888.8	812.2	475.6	906.8	80.0	54.3	105.8	247.2	7 480.1
1967	661.3	3 848.8	1 355.2	1 420.7	396.2	297.1	404.5	64.6	76.2	159.3	8 683.9
1968	2 355.4	2 982.9	2 145.9	496.1	656.1	179.8	142.5	164.5	12.2	91.1	9 226.5

Table 21. Mortality estimates, derived from age-composition and catch/effort data, for some fisheries in the northern, central and southern North Sea.

Period	NW North Sea ¹⁾ Drift-net (Aug.-Sept.) mainly pre-spawning fish		Central North Sea Drift-net, NE-English coast, spawning fish 2)		Southern North Sea Drift-net, East Anglia, pre-spawning fish mainly 4)		Southern North Sea Trawl, Sandettié, Channel, spawning fish 5)	
1952/1954	0.22		0.52	0.46	0.60			
1953/1955	0.27	1952/1957	0.95	0.41	0.79	1952/1957		
1954/1956	0.28		0.78	0.51	0.90			
1955/1957	0.64		0.74	0.47	0.94	0.81	1.09	
1956/1958	0.62	1957/1961	0.84	0.27	1.26	1957/1961	1.37	1957/1961
1957/1959	0.73		0.90	0.54	1.11		1.09	
1958/1960	0.88		0.64	0.73	1.24		1.13	
1959/1961	0.44		0.70	0.66	1.20		1.17	1.13
1960/1962	0.33	1961/1965	1.60	0.60	0.65	1961/1965	1.25	1961/1965
1961/1963	0.43		1.52	0.73	1.34		1.80	
1962/1964	0.48		1.11	0.85	1.54		1.67	1.55
1963/1965	0.41		1.16	0.93	1.06		1.31	
1964/1966	0.48	1965/1969	1.12	1.00	1.12	1965/1968		
1965/1967	0.40		1.25	0.98	1.13			
1966/1968	0.88		1.11	1.04 ⁶⁾	2.06			
1967/1969	1.06			1.07		1.44		

1) Scottish data.

2) English data.

3) Netherlands data, except 1952-1955 (Belgian data.)

4) English data.

5) Netherlands data.

6) Provisional.

Table 22. Larval abundance in the North Sea (- = no observations)
(Numbers x 10⁻⁹).

Year	1)	Central North Sea		North-Western North Sea 4)		
	Southern North Sea	Dogger ²⁾	Total ³⁾	Buchan	Shetland	Total
1946	537	-	-	-		
1947	596	-	-	-		
1948	-	-	-	-		
1949	-	-	-	-		
1950	288	-	-	-		
1951	255	-	-	900	420	1 320
1952	-	-	-	890	100	990
1953	-	-	-	2 110	940	3 050
1954	-	-	-	870	700	1 570
1955	98	-	-	20 ^{x)}	700	720
1956	56	-	-	-	-	-
1957	15	232	-	300	-	-
1958	63	252	-	220	2 800	3 020
1959	8	97	-	300	860	1 160
1960	16	138	-	440	640	1 080
1961	56	86	-	380	4 940	5 320
1962	29	66	-	400	720	1 120
1963	7	-	-	440	580	1 020
1964	6	52	63 ^{x)}	920	880	1 800
1965	5	275	490 ^{x)}	70	2 220	2 290
1966	-	3	142 ^{x)}	10	680	690
1967	40	0	275	0	440	440
1968	6	0	28	0	162	162
1969	108 ^{xx)}	0 ^{xx)}	11 ^{xx)}	0 ^{xx)}	212 ^{xx)}	212 ^{xx)}

- 1) Larval abundance in Downs area in December-January (Bridger).
 - 2) Abundance of larvae <11 mm in October on the western and southern slopes of Dogger Bank (Zijlstra).
 - 3) Abundance of larvae <10 mm in September-October in the central part of the North Sea.
 - 4) Abundance of larvae < 10 mm in the north-western North Sea, apart for the southern area (Buchan), the northern area (Shetland) and the total north-western North Sea (Saville).
- x) Incomplete data.
xx) Provisional data.

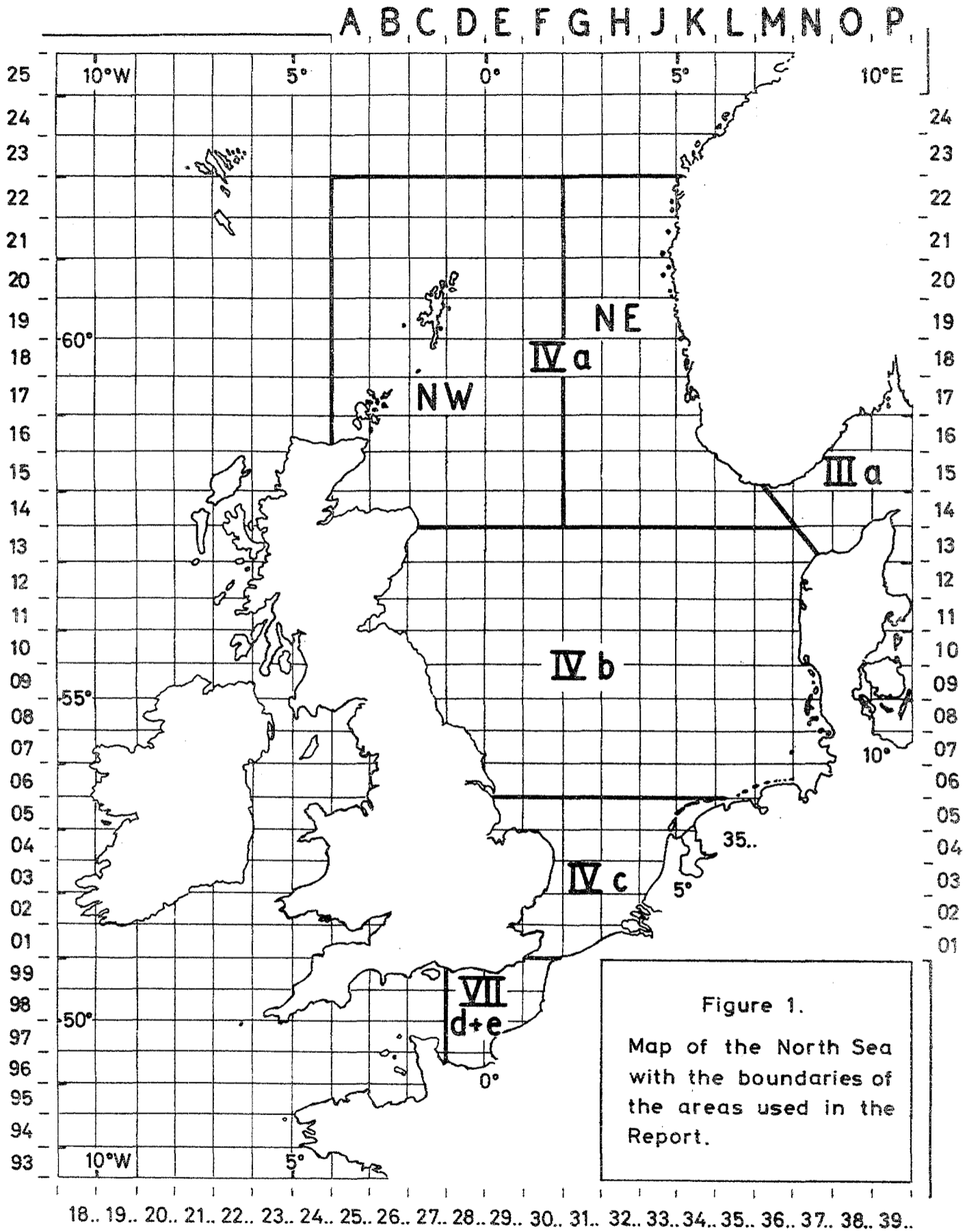
Table 23. Length of 3 year old herring in the southern, central and northern North Sea in the years 1955 - 1968.

Year	Area		
	Southern ¹⁾ (cm)	North Sea Central ²⁾ (cm)	Northern ³⁾ (cm)
1955	24.4	25.3	24.2
1956	23.6	25.1	24.8
1957	24.0	24.8	24.3
1958	24.3	25.3	24.5
1959	23.0	23.9	24.9
1960	23.7	25.0	24.6
1961	24.4	25.6	25.0
1962	25.1	25.9	25.7
1963	25.1	26.1	25.8
1964	25.9	26.2	25.8
1965	23.9	24.8	24.8
1966	24.3	25.0	24.9
1967	26.2	26.3	25.3
1968	25.2	26.3	26.8

1) Netherlands data.

2) Netherlands data.

3) Scottish data.



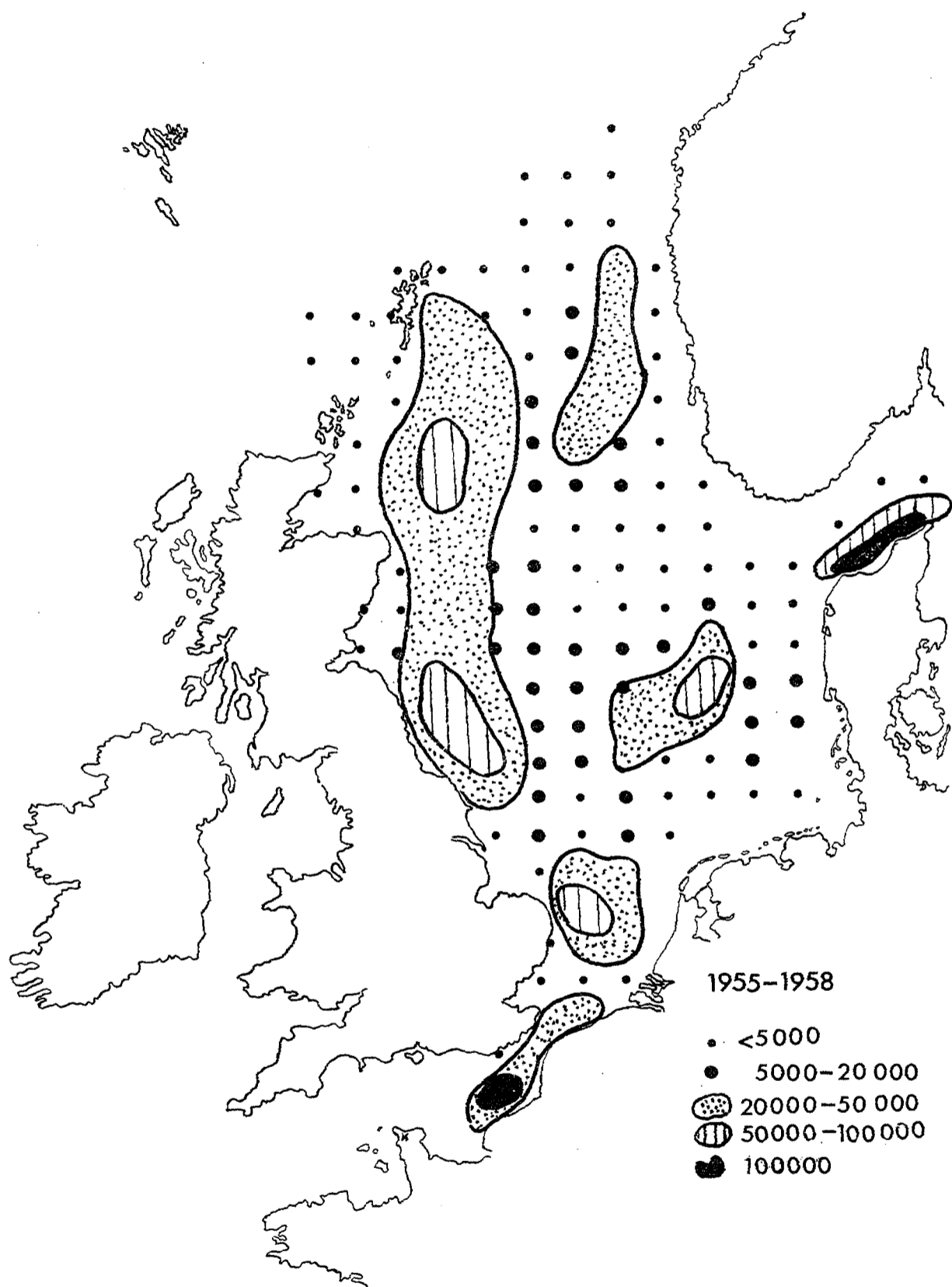


Figure 2a. Estimates of summed catches in tons (4 year period) by statistical rectangles, obtained from information supplied by "Statistical Newsletters" and national statistics in the period 1955-1958).

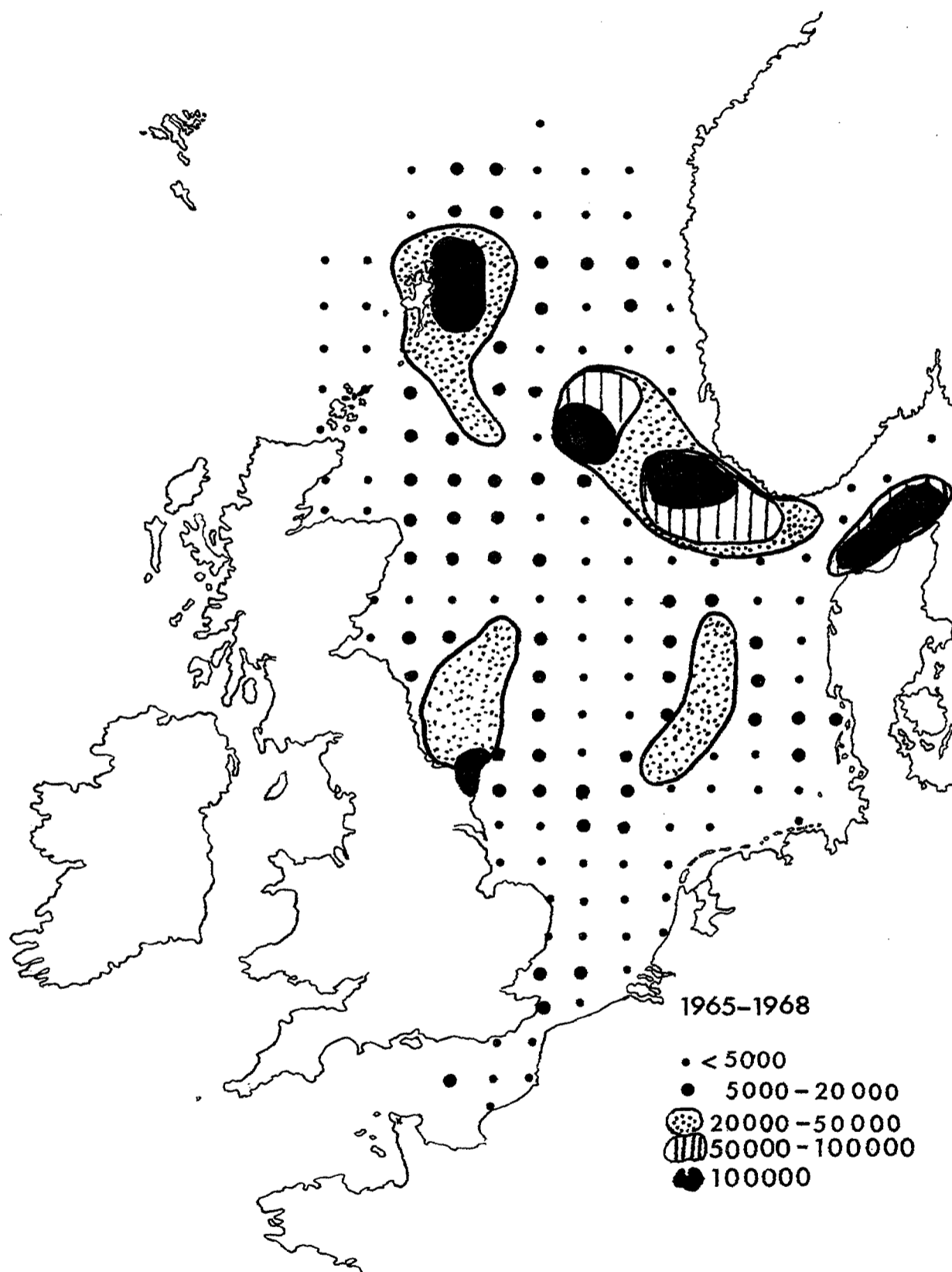


Figure 2b. Estimates of summed catches in tons (4 year period) by statistical rectangles, obtained from information supplied by "Statistical Newsletters" and national statistics in the period 1965-1968.

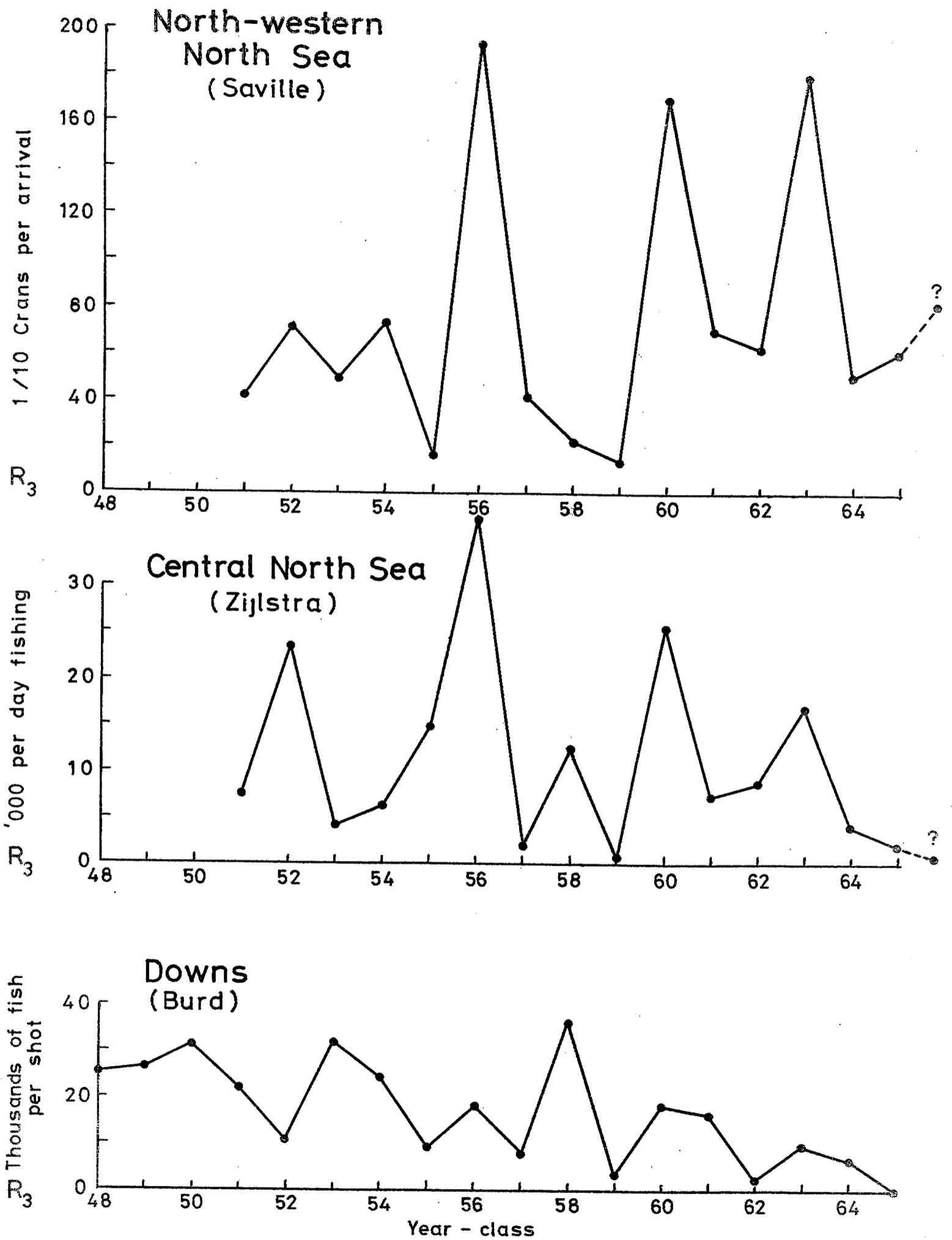


Figure 3. Recruitment, measured as at 3 years of age, in the north-western North Sea (Buchan stock), central North Sea (Bank stock) and southern North Sea (Downs stock).

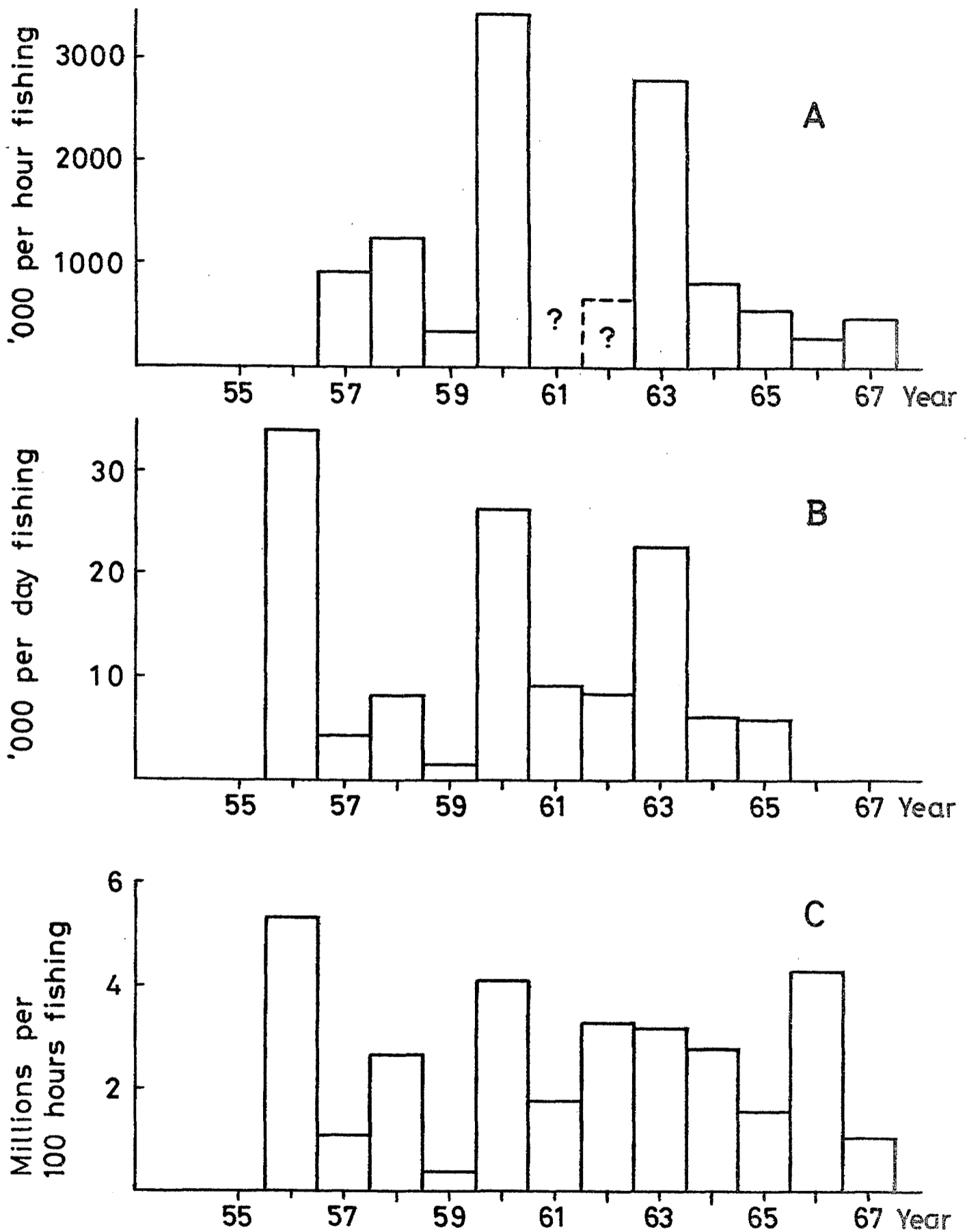


Figure 4. Estimates of recruitment by year-classes:-

- A. Estimates from the International Young Herring Surveys (thousands per hour fishing).
- B. Average recruitment of the Buchan and Bank stocks, derived from data in Figure 3 (thousands per day fishing).
- C. Estimates from the Bløden fishery, as I-group fish (millions per 100 hours' fishing by pair-trawlers).