

PRELIMINARY REPORT OF THE ASSESSMENT GROUP ON NORTH SEA HERRING

I. Introduction

The Liaison Committee of ICES, acting on a general concern expressed about the North Sea herring fisheries at the NEAFC Meeting in May 1968, invited the Pelagic Fish (Northern) Committee of ICES to set up a Working Group to describe the present state of the North Sea herring stocks and to discuss measures for the improvement of the fisheries. At its meeting in October 1968 in Copenhagen, the Pelagic Fish (Northern) Committee of ICES appointed such a Working Group with Mr. J. J. Zijlstra (Netherlands) as Chairman. Member States nominated the following scientists:-

Mr. H. Ackefors	Sweden
Mr. A. C. Burd	U.K.
Dr. S. S. Fedorov	U.S.S.R.
Mr. S. Haraldsvik	Norway
Prof., Dr. G. Hempel	Germany
Mr. A. S. Malkov	U.S.S.R.
Mr. A. Maucorps	France
Mr. K. Popp Madsen	Denmark
Dr. J. Popiel	Poland
Mr. K. H. Postuma	Netherlands
Mr. A. Savillé	U.K.
Dr. K. Schubert	Germany.

The Group met between 6th and 11th January 1969 at ICES Headquarters, Charlottenlund Slot, Charlottenlund. It was noted with regret that Dr. Popiel was unable to attend the meeting.

Post-war changes up to 1960 in the herring stocks and in the fisheries of North Sea herring were reviewed by former Working Groups of ICES.

The 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. 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.

The present Working Group considered mainly 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 present 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 present, the concern about the North Sea herring and its fisheries is much more general, including the whole North Sea and Skagerrak area. The Working Group, therefore, decided - particularly in view of the limited time available - to consider the North Sea and Skagerrak for this assessment, as a whole, paying little attention to the stock structure.

Justification for this approach is offered by the results of tagging experiments, which indicated connections between the herring stocks, fished in all central and northern North Sea areas, including the Skagerrak (see also Coop.Res. Rep., Ser.B, Annex II, Figure 1).

In a former Liaison Committee Report, presented to NEAFC in 1965, attention was drawn to the shape of the yield curve in herring, which differs in some respects from the yield curve of demersal species, such as plaice and cod. Heavy fishing on demersal stocks generally results in a decrease of the total catch, whereas in herring heavy exploitation will not lead to a decline in the total catch. It must be noted that the total catch of the herring fisheries with increasing effort will remain steady only if recruitment is not affected by heavy exploitation of the stock.

As pointed out in the former Report, the difference in the shape of the yield curve is mainly caused by the fact that those demersal species increase in weight by 20-30 times during the exploited adult state, the herring only by 2 to 3 times.

Factors other than total yield also play an important role in the economy of the fisheries, e.g. profitability of the individual fishing vessel in terms of catch per effort, stability of the landings from year to year and optimum size range of the fish can be affected by heavy exploitation.

## II. Material

The material available for consultation to the Working Group, covering mainly the period 1960-1967, varied considerably in quantity and quality between areas and fisheries.

In the course of the discussions it appeared that the material from the southern and central North Sea was sufficient to follow the developments in the stocks of fisheries. For the northern North Sea and Skagerrak, the areas of major importance since the mid-fifties (Table 1), the material available was generally considered to be less satisfactory. There was for instance doubt concerning the allocation of the landings as to different areas for some countries. With some exceptions the catch/effort statistics were found to be poor in the northern areas and, when available, did mostly not refer to the main fisheries.

Similar objections were applicable to sampling, again with some exceptions. Sampling was most often doubtful in relation to the actual catches, referring sometimes to the catch of fisheries of minor importance or to research-vessel catches, and sampling intensity stood in no relation to the magnitude of the landings from the areas.

## III. The Development of the Herring Fisheries in the North Sea

The development of the herring fisheries in the North Sea up to 1963 has been described in a previous Report to the Liaison Committee (Coop.Res.Rep., Ser.B, 1965). Since then there have been further major changes in the fisheries. There has thus been a further decline in the drift-net fisheries in all areas particularly in the central and southern North Sea, where drift-net fishing is now on a very small scale.

The trawl fisheries changed in their nature. The large German trawlers which in the 1950's formed a large part of the trawling effort have almost completely withdrawn from the North Sea herring fisheries, but the number of trawlers from other countries most likely increased. No direct information on the size of the trawl fleets operating was available to the Working Group. In the trawling fleet there has been a general change from bottom trawling to pelagic or semi-pelagic pair- and single-boat trawling, the introduction of sonar leading to greater fishing efficiency and new fishing tactics.

The most striking change in the fisheries, however, has been the introduction of purse-seining for North Sea herring. This was started by the Norwegian fleet in the autumn of 1963 in the north-eastern North Sea and Skagerrak. The Norwegian fleet extended the range of the purse-seine fishery to the Shetland area in the summer of 1965 and have since been joined in these areas by purse-seine vessels of other countries.

a) The landings

Table 1 shows the landings from the North Sea and Skagerrak by statistical areas in the years 1947-1968. The recorded landings of juvenile herring from the central North Sea (area IVb) have been separately accounted for. It should be noted, however, that the landings of "adult" herring, especially for the north-eastern North Sea and Skagerrak, comprise a proportion of juvenile herring, and it was reported that the amount of juvenile herring landed in the "adult" herring fisheries increased in recent years.

Tables 2 to 6 show the landings in countries from different statistical areas from the North Sea and Skagerrak in the years 1960-1968 (see Figure 1).

The main features in the landings statistics were:-

1. The total catch of adult herring from the North Sea, Skagerrak and English Channel fluctuated around 775,000 tons in the post-war period up to 1963. Then followed a sharp increase to a peak of 1,400,000 tons in 1965, followed by an equally sharp decrease to about 700,000 tons in 1968 (provisional figure).
2. The decline in the total landings from the southern North Sea and the English Channel (areas IVc + VIII d, e) mentioned in the previous Report (Coop.Res.Rep., Ser.B, 1965) continued after 1963.
3. In the central North Sea (area IVb) the landings fluctuated around 200,000 tons up to 1964, but tended to decline after that year.
4. In the northern North Sea (area IVa) landings fluctuated around 200,000 tons until 1954 and around 350,000 tons in the period 1955 to 1962. After 1962 the landings increased sharply to a peak of 930,000 tons in 1965, then fell to 400,000 tons in 1968 (provisional figure).

In the north-western North Sea (Table 2) a large catch (over 250,000 tons) was made in the years 1965 and 1966, due entirely to the entry of the Norwegian purse-seine fleet. In recent years (1967, 1968) the landings from the area decreased sharply again.

In the north-eastern North Sea (Table 3) the landings rose from a level of 300,000 tons in the years 1960-1963 to around 600,000 tons in 1964-1965, again due to the effort of the Norwegian purse-seine fleet. Since 1965 the landings declined again and possibly returned in 1968 to the former level of 300,000 tons.

5. In the Skagerrak (area IIIa) trends in the total landings were less sharply defined than in the other areas, although since 1963 the landings have been at an average level of about 250,000 tons, about twice the average level of the preceding years.

Some doubt has been expressed about the 1966-1967 landings, which were thought to be partly derived from other areas.

6. The recorded landings of juvenile herring (Tables 1 and 5) from the central North Sea (Bløden area) have been rather stable since 1955 at an average level of about 100,000 tons.

b) Catch-per-unit-effort

Estimates of the catch-per-unit-effort might be used to indicate stock abundance.

In Table 7 the catches per unit of effort of those fisheries are given for which data were available in the period observed and in which no radical changes in gear and fishing technique occurred during this period. The series covers the years 1960-1967 (1968) and, where possible, the average catch per unit of effort in the period 1955-1959 has been included.

The choice of fisheries, from which the data could be derived, is rather limited, including often those fisheries, which in recent years have yielded only a small proportion of the total catch.

In the southern North Sea both the drift-net - and trawl - catch per effort showed in general a falling trend, certainly when compared with the estimate for 1955-1959.

In the central North Sea the 1955-1959 average estimate for the catch-per-unit-of-effort was higher than any estimate in the years 1960-1967, for both drift-net and trawl, with the exception of the drift-net estimate for 1963. Since 1960, no definite trend is apparent in the two estimates.

In the north-eastern North Sea, where the two sets of data are by no means derived from at present important fisheries in the area, the trawl estimate shows a definite decline in the catch-per-unit-of-effort. The drift-net estimate varies considerably between years, but tends to decline since 1965.

In the north-western North Sea the drift-net and trawl estimates also show different features. The drift-net estimates show no obvious trend, but the trawl catch-per-unit-of-effort tends to decline at least since 1964. Compared with the average for 1955-1959 the trawl estimates were on a lower level, the drift-net estimates on about the same level as in the years 1960-1967.

With the exception of the southern North Sea, where abundance is indicated to have declined since 1960, it is difficult to decide from the catch-per-unit-of-effort information, how and if the abundance level of the North Sea herring changed since 1960 or 1955, the trawl data indicating a generally declining level, the drift-net data a much more stable situation.

#### c) Effort

Direct estimates of effort, e.g. number and type of vessels in operation, time of fishing etc. were lacking for most countries. The information available indicated an increase in the purse-seine operations in the years 1963-1966, but a decrease in the trawling activities of some countries in the years 1966-1968.

Indirect estimates have been obtained by dividing the total landings from an area by the catches-per-unit-of-effort of some of the fisheries in that area. This technique can be expected to produce fairly reliable results in cases where the catches-per-unit-of-effort have been derived to the major fisheries in the area. Estimates of effort, obtained by this method, are shown in Table 8 and indicate that:-

1. in the southern North Sea and English Channel the effort tended to decline since 1960, which means a continuation of a decline which started around 1955. (Coop.Res.Rep., Ser.B, 1965).
2. in the central North Sea the effort fluctuated up to 1965, but thereafter tended to decline to approximately half its former level.
3. in the north-western North Sea both effort indices show a sharp increase by about 3-4 times in the years 1965-1966, decreasing again in 1967.
4. in the north-eastern North Sea and Skagerrak the estimates of the catch per unit effort available were not derived from the major fisheries (pair trawl, purse-seine), so that the effort estimates are not very reliable.

Taking, however, the more stable catch-per-unit-of-effort of the drift-net fisheries, a strong increase, in the order of 3-4 times, in the effort is indicated since the early 60's. After 1962 the effort seems to have fluctuated without a definite trend.

5. taking the North Sea as a whole, it seems reasonably certain that between 1963 and 1965 the effort rose sharply in the northern areas. After 1965 it is impossible to define exactly how the effort developed, but some decrease might have taken place.

#### d) Total catches in number

A first attempt was made to convert the total catches of North Sea herring into numbers of fish by age groups, by using, where available, estimates of the mean weight of the fish caught and the age distribution of the fish. This method was applied to the different areas, mentioned in Tables 2 to 6. In the time available and with the material at hand only annual estimates of mean weight and age composition could be obtained, whereas a proper analysis should be done on a monthly basis.

In the case of the southern, central and north-western North Sea fairly extensive series of data by years and sometimes months were available. The series for the juvenile fishery in the central North Sea (Bløden) of the mean weights and age compositions of the herring in the catches was most extensive. Unfortunately, the information from the north-eastern North Sea and Skagerrak was not very satisfactory, as mentioned in Section II. Material. It seems likely that in these areas the numbers of fish caught are too low and the catches from younger age groups are underestimated, especially in the later years.

Table 9 gives the numbers of immature herring caught each year in each area and also the catch of adult herring. It is seen that in the Skagerrak area there ~~has been~~ a sharp increase after 1964 in the numbers of immature herring taken; the total catch of all ages rose by over 3 times, while the catch of immatures has risen by up to 5 times. There is some doubt, however, as to the size of the catch from the Skagerrak in 1967, which was probably lower than shown by the statistics. In the north-eastern area too, the catches of immature herring have risen by 3-4 times, and the adult catch by about 2-3 times. The year-classes entering the 1965, 1966 and 1967 fisheries are indicated from other data available to be not above average compared with earlier year-classes (see Section IV.e). The increased catch of these fish must be a reflection of increased effort.

In the north-western area there has been an overall small increase in total catch in numbers. In contrast, in the central and southern areas, there have been declines in the numbers caught of the order of up to 2 times in the former and 10 times in the latter.

#### IV. The Herring Stocks

##### a) Age composition

From the preliminary analysis described in Section III.d, converting the catches in weight into catches in numbers by age groups, age compositions by areas were obtained. Table 9 shows the herring caught in different regions, divided into three groups: immature herring (1-2 years old), young adult herring (3-4 years old), and older adult herring (over 4 years old). Due to uncertainties about the age composition and weight of the fish in the two important areas - north-eastern North Sea and Skagerrak - the figures in Table 9 for these areas are not very reliable. The main features in Table 9 are:-

- 1) an increase in the catch in numbers in the total North Sea since 1963;
- 2) a decline in the numbers of herring caught in the southern North Sea since 1960, but a recent increase in the proportion of older herring;
- 3) a decrease in the numbers of herring caught in the central North Sea, and a decline in the proportion of older fish;
- 4) a sharp rise in the numbers of herring caught in the north-western North Sea in the years 1965-1966, followed by a decline in 1967, which affected the older adults more than the younger age groups;
- 5) after an initial rise in the number of adult herring caught in the north-eastern North Sea and Skagerrak in the years up to 1965, a decline set in, which reduced the catches of older herring more than the younger age groups;
- 6) an increase in the catches of immature herring in both the north-eastern North Sea and the Skagerrak.

The preliminary nature of this information must be stressed and a further analysis of the material is thought necessary.

##### b) Mortality rates

Table 10 gives the mean average mortality rates over four-year periods for the north-western, central and southern North Sea. The values for the north-western North Sea are calculated from the abundance indices of the Scottish drift-net fishery in August-September; for the central North Sea from the abundance indices of the British drift-net fishery on the spawning grounds along the English north-east coast and of the Dutch trawl fishery on spawning herring in the Dogger area. Those from the southern North Sea are derived from the English drift-net fishery in the southern Bight.

For the north-western North Sea the only mortality data available show a sharp increase after 1955, but a constant, lower level thereafter up to 1967. In the central North Sea the mortality level would seem to have increased in each four-year period considered, but with a sharp increase after 1960. In the southern North Sea mortality has been high throughout the period considered, but increased considerably from 1955 to 1959, and decreased to a level of the period 1951-1955 in the last four years considered.

The catches by age group in number (Table 9, Total North Sea) have been used to calculate mortality estimates per year-class for the total North Sea. The values of Z are given in Table 11, where it can be seen that there has been a steady increase in total mortality on successive year-classes. The values of Z derived by this technique, as they are in total number and not in catch per effort, tend to be lower in value than those obtained by the other method. The increase in total mortality would suggest that there has been an increase in effort in the North Sea by over two times since 1960.

#### c) Abundance as estimated from tagging

Since 1964 several Norwegian tagging experiments have been made in the Skagerrak and the northern North Sea. These experiments, carried out with internal steel tags, have given a high number of returns to be dealt with. Though the experiments only partly fulfilled the requirements for making a quantitative assessment, they allow to make rough estimates of the abundance of the herring stock in this part of the North Sea in the winters of 1966 and 1967.

In the winter of 1966 the herring stock in the Skagerrak and the north-eastern North Sea was estimated to be about 2,55 million tons which correspond to  $15.8 \times 10^9$  millions of herring (Dragesund and Haraldsvik, 1968). One year later, in winter 1967, the herring stock in the northern North Sea was calculated to be 1,05 million tons or  $6.3 \times 10^9$  millions of herring (Haraldsvik, personal communication). These figures give a decline in stock abundance from winter 1966 to winter 1967 of about 60%, which correspond to a total instantaneous mortality rate of  $Z = 0.9$ . The stock size figures above are, however, estimated from different tagging experiments and are not directly comparable due to probable recruitment differences during the two tagging periods.

It should therefore be stressed that the figures of stock abundance and mortality rate based on tagging experiments are rough estimates and are included in this report only to indicate that a drastic reduction in stock abundance has taken place in the northern North Sea between winter 1966 and winter 1967.

#### d) Larval abundance

Abundance of young larvae of less than 10 mm has been considered as a measure of the size of the spawning stock.

Table 12 compiles data from the literature and unpublished results of the International Larval Surveys. The figures for the Downs stock refer to average larval abundance in December and January in the eastern English Channel and the Southern Bight. Data for the central North Sea came from the western slope of the Dogger Bank only, they do not include some of the major spawning grounds of the area. The figures on the northern North Sea cover most of the north-western North Sea up to the Shetland area (Saville, 1968). Attempts to locate larvae in other areas (north-eastern North Sea), which were made in recent years, failed, except in the eastern Kattegat.

The following might be concluded from the figures.

Larval abundance of the Downs stock went down to very low figures.

The figures given for the central North Sea indicate very low production during the past three seasons. These figures, however, do not include spawning off Whitby and on the North-East Bank.

Taking the northern North Sea as a whole, larval production had been more or less the same from 1951-1965. During the last three seasons, however, larval production was poor in the northern North Sea too, the decrease being more pronounced in the Buchan area than in the Shetland-Orkney area, where during the last decade spawning was always more intense than on the Buchan grounds.

The larval abundance in the North Sea has obviously decreased during recent years pointing to a decrease in spawning potential. It has been pointed out in earlier reports that a reduction of spawning potential to a certain level will lead to a noticeable decline of recruitment. It is, however, an open question whether at present the spawning potential has already reached such a low level.

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 two years old,
3. from the International Young Herring Surveys, in March at an age of  $1\frac{1}{2}$  years old.

In Figure 2 recruitment to the adult stocks is shown. In the northern and central North Sea a fair degree of similarity exists in the recruitment estimates by year-classes, showing no obvious trend in the period 1951-1964 (1965). Three relative strong year-classes recruited in the recent ten years, e.g. 1956, 1960 and 1963. In the southern North Sea recruitment declined in the period 1948-1964, with only year-class 1958 as outstanding.

In Figure 3 a 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 agree reasonably well, with the exception of the most recent year-classes (1962-1964) in the Bløden fishery. None of the three estimates shows an obvious trend. The slight tendency for recruitment to decline in the later years could easily be explained in terms of the high natural variability of recruitment in the North Sea herring.

## V. Discussion

The inadequacies of the material, mainly in the at present major fishing areas in the North Sea, make an evaluation of the situation in the herring fisheries rather difficult. The fact that the changes in fisheries and stocks are of recent date, leaving only few years to follow the situation, accentuates the difficulties.

The increase in the landings of North Sea herring in the years 1963-1965 has almost certainly been the result of a sharp increase in the effort in the northern North Sea. This follows not only from the indirect effort calculations (Section III,c) but also from the fact that the landings rose in a period of rather steady recruitment. Whether the decline in the landings since 1965 is partly or completely the result of a decrease in the effort is not at all certain, although some decrease in the effort seems likely.

There are some indications of a reduction of the adult stock and a high rate of exploitation following the rise in effort.

Thus the proportion of adult herring in the landings declined in the most recent years and the fishery tended to turn to immature and probably pre-recruit herring.

The mortality rates estimated in central North Sea fisheries increased considerably since 1960, and also in the total North Sea, as appeared from catch curves. The relatively low mortality rate in the Scottish data for the north-western North Sea, however, does not indicate a higher rate of exploitation.

On the other hand, tagging experiment in the northern North Sea in 1966-1967 indicated a strong reduction of the abundance of the adult herring and a high mortality rate (60% per year).

Larval abundances in the North Sea tended to decline, especially since 1965 (northern and central North Sea), suggesting a reduction in the adult stocks.

A reduced abundance of the herring is not clearly indicated by the data on catches per unit of effort, which give rather contradictory evidence. It seems questionable, however, whether catch-effort data in a herring fishery give much information on abundance under the present fishing techniques and tactics, including shifts to other fishing areas and to other species, when catches fall below a certain minimum. The fact that some fishing fleets have been reported to have left the North Sea in recent years for reasons of rentability of the fishing operations would certainly indicate a lower abundance of the herring.

The relatively high numbers of older herring caught since 1964, according to the analyses of the catch in numbers of North Sea herring, do not agree very well with a concept of a high rate of exploitation. It must be kept in mind, however, that these high numbers were found by using poor information on age composition in the north-eastern North Sea, where most of the older fish were caught according to the analysis.

Recruitment was indicated to be fairly steady up to 1964, but it should be realised that a possible effect of stock reduction on recruitment can only appear in the year-classes originating after 1964. It is thus too early to say that recruitment was not affected by a reduction of the stocks.

Under these conditions and with the material available, the Working Group has drawn the following Conclusions.

#### VI. Conclusions

In the former report of the North Sea Working Group it was shown that in the period 1950-1962 the total North Sea catch was remarkably stable for a long period at a level fluctuating around 900.000 tons, including immature fisheries, in spite, probably, of a gradual increase in overall effort.

After 1962 a steep rise in the effort took place and resulted for the first years in an increase in the total landings of up to a level of 1.5 million tons of North Sea herring. During the last three years (1966-1968) the total catch has been falling off down to the previous level of steady yield. This was probably accompanied by some decrease in effort for reasons of rentability of the fishing operations.

The recent high effort resulted in a reduction of the mature stock. With the increase of fishing intensity the proportion of immature herring in the catches increased. The catches are composed of fish of lower age, length and weight than before.

From those events the Working Group concluded that under the present environmental conditions the steady yield of the population of North Sea herring will be about 850,000 tons of adult and juvenile herring. A maintenance of effort at the high level experienced in recent years will not lead to a sustained higher yield, but will have some unfavourable consequences:-

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

In addition, the low abundance of mature herring under heavy exploitation will result in low egg production and possibly in lower recruitment.



In the light of these considerations the Working Group recommends

that steps be taken to stabilize the effort at a lower level than exerted during recent years, in order to increase average age in the stock.

This might be achieved by the introduction of an overall quota for North Sea herring fisheries. In view of the complexity of the herring population and the herring fisheries in the North Sea, direct reduction of effort through reduction of the fleets or through closed areas and closed seasons would not be feasible.

To allow a recovery of the stock, the quota has to be well below 850.000 tons but might be adjusted in later years according to the development of the resource.

How far, in addition, specific regulatory measures on the immature herring fisheries are advisable has to await reliable figures on the effect of such fisheries on the yield and adult stock. The international tagging scheme for juvenile herring, to be carried out under the auspices of ICES in 1969-1970, is aimed at providing the necessary information on this question. In the meantime the only advice would be to introduce an overall quota, restricting both juvenile and adult fisheries.

Table 1. Total Catch of Herring from the North Sea, Eastern Channel and Skagerrak by Statistical Areas (Landing in Tons).

Year	Catch of "adult" Herring by Areas						Total "adult" North Sea	Total recorded Catch of Young Herring from Area IVB (Central North Sea)	Total Catch
	IIIA (Skagerrak)	IVA (Northern North Sea)	IVB (Central NS)	IVC + VIIC+D (Southern NS + English Channel)	Total "adult" North Sea				
1947	52,671	220,906	212,402	197,521	683,500	683,500	0	683,500	
1948	81,364	221,841	196,362	244,105	743,672	743,972	300	743,972	
1949	78,529	195,477	200,863	172,776	647,645	647,845	200	647,845	
1950	91,244	154,570	191,188	197,374	634,376	639,776	5,400	639,776	
1951	103,974	174,416	296,230	245,553	820,173	864,768	44,595	864,768	
1952	138,794	220,434	239,140	221,365	819,733	869,918	50,185	869,918	
1953	137,358	226,724	275,477	277,861	917,420	995,827	78,407	995,827	
1954	99,293	205,336	257,368	225,573	787,570	882,864	95,294	882,864	
1955	113,466	352,750	182,247	168,412	816,875	929,325	112,450	929,325	
1956	123,262	303,307	165,874	133,964	726,407	830,102	103,695	830,102	
1957	158,197	341,856	165,530	125,402	790,985	894,175	103,190	894,175	
1958	215,807	279,913	183,436	93,416	772,572	931,452	158,880	931,452	
1959	205,448	370,800	193,845	77,324	847,417	1,003,774	156,357	1,003,774	
1960	119,641	386,729	171,009	78,117	755,496	871,070	115,574	871,070	
1961	138,259	348,280	178,897	101,431	761,867	858,635	96,768	858,635	
1962	168,583	344,892	152,953	60,219	726,647	832,548	105,901	832,548	
1963	230,741	417,676	232,575	51,162	932,154	1,003,718	71,564	1,003,718	
1964	367,113	592,507	183,032	54,797	1,197,449	1,319,035	121,586	1,319,035	
1965	324,254	931,026	132,120	25,679	1,413,079	1,565,232	152,153	1,565,232	
1966	212,943	756,121	125,797	12,166	1,107,027	1,199,809	92,782	1,199,809	
1967	307,141	564,109	84,904	9,570	965,724	1,067,740	102,016	1,067,740	
1968*	250,696	401,236	39,450	-	706,382**	828,382	122,000	828,382	

\* Provisional.

\*\* Including extra 15,000 from Germany.

Table 2. Total Catch in Tons by Countries from the NW North Sea (Area IVa west of 2°E).

Germany	Holland	Belgium	England	Scotland	Norway	Sweden	USSR	Denmark	France	Faroes	Iceland	Total
47,765.6	23,827.6	100.3	172.1	23,197.2	-	1,654.5	-	222.0	-	-	-	109,791.1
19,183.0	14,669.6	-	-	17,538.0	-	1,137.0	-	-	-	-	-	60,480.6
7,007.2	6,577.2	-	-	18,958.8	-	66.1	-	-	-	-	-	36,235.1
11,279.2	17,149.2	-	-	29,565.4	2,586.2	3,636.0	-	-	-	-	-	74,829.8
6,063.0	15,481.2	-	-	17,044.5	2,590.9	3,809.0	-	-	-	-	-	56,524.0
4,488.8	15,121.0	-	-	19,990.8	194,074.0	-	20,095.0	-	-	-	-	286,391.8
7,064.0	5,319.7	-	-	17,186.3	205,111.4	524.0	-	-	-	-	-	259,839.6
7,074.0	4,496.0	-	-	21,412.0	41,151.3	213.0	-	1,277.2	-	-	-	83,221.8
4,268.0	6,247.0	-	-	27,717.6	100,289.0	-	-	-	-	-	-	138,521.6

Table 3. Total Catches in Tons - Countries from the NE North Sea (Area IVa east of 2°E).

Germany	Holland	Belgium	England	Scotland	Norway	Sweden	USSR	Denmark	France	Faroese	Iceland	Var. Sweden	Σ
33,386.0	11,477.0	22.0	-	1,598.0	18,000.0	92,912.0	63,105.0	46,964.0	1,151.0	-	-	-	278,512.0
13,498.0	43.0	120.0	9.0	3,877.0	19,000.0	93,429.0	67,722.0	70,363.0	9,381.0	-	-	14,892.0	287,780.0
9,915.0	5,072.0	125.0	14.0	4,899.0	17,000.0	90,612.0	100,265.0	52,180.0	8,467.0	-	-	26,690.0	308,658.0
10,921.0	794.0	343.0	17.0	-	12,435.0	112,011.0	75,965.0	63,856.0	10,165.0	-	-	61,724.0	318,366.0
15,405.0	5,252.0	155.0	8.0	627.0	124,319.0	103,345.0	39,637.0	58,869.0	9,289.0	973.0	-	53,979.0	536,979.0
25,471.0	3,306.0	227.0	41.0	6,789.0	334,984.0	107,008.0	27,227.0	55,282.0	6,092.0	3,111.0	1,757.0	53,884.0	644,635.0
14,445.0	90.0	178.0	-	13,186.0	237,633.0	129,412.0	16,442.0	57,438.0	3,924.0	1,491.0	1,047.0	3,573.0	493,114.0
3,595.0	631.0	200.0	15.0	-	203,231.0	140,538.0	27,221.0	55,000.0	8,374.0	35,993.0	5,684.0	-	484,324.0
255.0	710.5	-	-	16.5	91,178.0	70,554.0	60,000.0	40,000.0	-	-	-	-	262,714.0

Table 4. Total Herring Catch in Tons in the Area IIIA (Skagerrak and Kattegat).

Year	Poland	Germany	Norway	Sweden	Denmark	Various		Total IIIA
						Denmark + Sweden	Total IIIA	
1960		44	4,204	27,658	62,654	25,081	119,641	
1961		9	7,772	28,314	85,806	11,358	133,259	
1962		3	7,917	38,862	108,257	12,950	168,583	
1963	594		8,249	49,563	150,175	21,190	230,741	
1964	329	1,235	87,088	45,494	178,465	48,016	367,113	
1965	4,324	3,726	87,745	45,860	143,600	37,471	324,254	
1966	5,330	4,248	30,943	55,687	119,620	4,881	212,943	
1967	511	1,301	96,720	60,300	144,441	2,151**	304,998	
1968*	127	1,259	98,296	?	152,400	-	250,696	

\* Provisional.

\*\* Iceland Catch.

Table 5. Total Catch by Countries in the Central North Sea (Area IVB).

Year	Adult Herring Fisheries										Young Herring Fisheries		Total All Fisheries
	Poland	Germany	Netherlands	Belgium	Denmark	France	Norway	Total	Germany	Denmark	Total		
1960	48,479	45,574	61,540	115	9,816	5,116	369	171,009	35,074	80,580	115,574	286,583	
1961	49,054	44,408	70,336	121	8,579	2,207	4,182	178,897	10,168	78,600	96,768	275,665	
1962	45,030	50,935	47,255	124	6,076	326	3,207	152,953	26,501	79,300	105,801	258,754	
1963	54,370	65,568	81,524	558	14,465	7,626	8,464	252,975	9,764	61,308	71,564	304,139	
1964	58,726	42,422	63,314	351	9,235	3,745	5,239	183,032	28,386	93,200	121,586	304,618	
1965	44,815	36,406	47,951	47	8,524	1,330	3,447	132,120	26,253	125,900	152,153	284,273	
1966	34,085	36,946	42,608	69	9,646	823	2,220	125,797	14,882	77,900	92,782	218,579	
1967	26,370	27,997	22,379	5	6,809	779	445	84,984	5,016	97,000	102,016	187,000	
1968*			6,779		4,125	26		25,190		14,260	122,000	147,190	

\* Provisional.

Table 6. Herring Catch in the Southern North Sea and the English Channel (Areas IVc + VIIId + VIIIe).

Year	Adult Herring Fisheries					Young Herring Fisheries		Total
	Poland	Germany	Netherlands	Belgium	France	England	France	
1960	5,076	11,562	26,868	3,405	6,375	22,931	78,117	
1961	10,727	17,180	44,773	2,905	9,262	16,584	101,431	
1962	5,458	9,773	28,617	868	5,904	9,599	60,219	
1963	2,246	6,844	27,020	942	8,359	5,771	51,162	
1964	2,054	5,433	32,179	1,101	7,290	6,740	54,797	
1965	1,237	2,113	14,342	502	2,970	4,515	25,679	
1966	1,097	1,227	6,691	144	1,030	1,977	12,166	
1967		1,303	4,374	205	1,391	2,296	9,570	

Table 7. Catch-per-unit-of-effort in Drift-net and Trawl Fisheries in the Southern, Central, North-Western and North-eastern North Sea.

Years	North-Western North Sea		North-Eastern North Sea		Central North Sea		Southern North Sea	
	Drift <sup>1)</sup>	Trawl <sup>2)</sup>	Drift <sup>3)</sup>	Trawl <sup>4)</sup>	Drift <sup>5)</sup>	Trawl <sup>6)</sup>	Drift <sup>7)</sup>	Trawl <sup>8)</sup>
Av. 1955-59	4.9*	45.6		19.9	3.2	59.0	3.3	100.2
1960	3.2*	33.0	3.36	11.2	2.4	31.0	3.1	113.0
1961	4.2	27.3	3.26	10.3	2.1	42.0	3.0	169.0
1962	3.7	21.7	1.84	12.9	2.0	25.0	2.5	56.0
1963	3.9	24.3	1.20	11.6	5.6	45.0	2.0	50.0
1964	3.4	33.7	2.48	6.3	2.6	45.8	3.4	57.5
1965	3.4	24.9	3.03	4.8	2.7	36.7	1.7	38.7
1966	4.3	18.2	2.76	6.2	2.8	45.0	1.3	-
1967	4.7	9.9	1.81	0.7	2.9	25.6	1.3	-
1968		16.6		0.8	-	20.1		-

- North-Western North Sea
- 1) Drift-net Scottish, catch per shot (tons). \*) mean catch per arrival.
  - 2) Trawl Netherlands, catch (tons) per 100 hours of a trawler of 500 BHP. (July-September).
- North-Eastern North Sea
- 3) Drift-net Polish drift-net, catch per shot (tons).
  - 4) Trawl Netherlands, catch (tons) per 100 hours of a trawler of 500 BHP (July-December).
- Central North Sea
- 5) Drift-net Netherlands, catch (tons) per shot.
- Southern North Sea
- 6) Trawl Netherlands, catch (tons) per 100 hours fishing trawler 500 BHP (August-October).
  - 7) Drift-net English catch (tons) per shot in East Anglian fishery.
  - 8) Trawl Netherlands, catch (tons) per 100 hours fishing of a trawler 500 BHP.

Table 8. Effort estimates, obtained by dividing the total catch in an area by the catches per unit of effort of the drift-net and trawl fisheries in that area. - It should be noted that no comparison between areas is possible.

Year	North-Western North Sea		North-Eastern North Sea + Skagerrak		Central North Sea		Southern North Sea	
	Drift <sup>1)</sup> (Scottish)*	Trawl <sup>2)</sup> (Dutch)*	Drift <sup>1)</sup> (Polish)*	Drift <sup>1)</sup> (Dutch)*	Trawl <sup>2)</sup> (Dutch)*	Drift <sup>1)</sup> (English)*	Trawl <sup>2)</sup> (Dutch)*	
1960	34.3	33.3	118.5	71.3	55.2	25.2		
1961	14.4	22.2	129.2	85.2	42.6	33.8		
1962	9.8	16.7	259.4	76.5	61.2	24.1		
1963	19.2	30.8	457.6	41.5	51.7	25.6		
1964	16.6	16.8	364.2	70.4	40.0	16.1		
1965	84.2	115.0	319.8	48.9	36.0	15.1		
1966	61.7	145.8	255.8	44.9	28.0	9.4		
1967	17.7	84.0	438.1	29.3	33.2	7.4		

1) In '000 of shots.

2) In '000 of hours fishing.

\* refers to the fishery, where catch-per-effort was used.

Table 9. Annual Catch in Numbers ( $\times 10^{-6}$ ), by Areas and Age Groups (provisional).

Year	Immature 1 + 2 years old	Young Adult 3 + 4 years old	Old Adult over 4 years old	Total	Year	Immature 1 + 2 years old	Young Adult 3 + 4 years old	Old Adult over 4 years old	Total
<u>Skagerrak</u>									
	%	%	%			%	%	%	
1960	687	293	91	1071	1960	1720	1213	163	3096
1961	352	659	103	1114	1961	1113	1166	397	2676
1962	966	564	81	1611	1962	1385	451	251	2087
1963	73	1446	217	1736	1963	1016	1251	76	2343
1964	316	1476	421	2213	1964	1839	922	76	2837
1965	1788	707	416	2911	1965	1780	908	43	2731
1966	1380	603	323	2306	1966	717	875	53	1645
1967	3233	338	79	3650	1967	1249	699	44	1992*
<u>North Eastern North Sea</u>									
1960	152	693	611	1456	1960	16	520	28	564
1961	5	294	1036	1335	1961	1	735	48	784
1962	193	703	832	1728	1962	12	306	46	364
1963	39	1396	702	2137	1963	2	270	24	296
1964	293	2191	492	2976	1964	19	268	6	293
1965	428	903	2034	3365	1965	-	85	38	123
1966	232	1665	1160	3057	1966	3	59	13	75
1967	651	1211	911	2773	1967	3	41	5	49
<u>North Western North Sea</u>									
1960	7	512	146	665	1960	2528	3231	1039	6852
1961	-	69	240	309	1961	1471	2923	1824	6218
1962	2	28	141	171	1962	2558	2052	1351	5961
1963	165	180	94	439	1963	1295	4543	1113	6951
1964	1	254	48	303	1964	2468	5111	1043	8622
1965	237	654	719	1610	1965	4233	3257	3250	10740
1966	6	786	784	1576	1966	2338	3988	2333	8659
1967	25	260	172	457	1967	5161	2549	1211	8921
<u>Total North Sea (sum)</u>									
1960	15	47	47	1039	15	47	47	1039	15
1961	29	47	47	1824	29	47	47	1824	29
1962	23	34	34	1351	23	34	34	1351	23
1963	16	65	65	1113	16	65	65	1113	16
1964	12	59	59	1043	12	59	59	1043	12
1965	31	30	30	3250	31	30	30	3250	31
1966	27	46	46	2333	27	46	46	2333	27
1967	14	29	29	1211	14	29	29	1211	14

\* Only part of the Bleden catch added, due to uncertainties about an admixture of sprat in the landings.

Table 11. Total Mortality Estimates derived from Catch Curves, using the Number caught by Age Groups in the total North Sea.

Year-class	Z
1955/56	0.30
1956/57	0.30
1957/58	0.42
1958/59	0.45
1959/60	0.46
1960/61	0.50
1961/62	0.54
1962/63	0.55
1963/64	0.64

Table 10. Mortality estimates from some northern, central and southern North Sea fisheries.

Periods	North-Western North Sea		Central North Sea		Southern North Sea	
	Drift-net	Trawl (Dogger)	Drift-net (Whitby)	Trawl (Dogger)	Drift-net	Trawl (Dogger)
1951/52-1954-55	0.23	0.45*	?	0.45*	1.05	1.05
1955/56-1958/59	0.68	0.51	0.90	0.51	1.38	1.38
1959/60-1962/63	0.44	0.70	1.20	0.70	1.32	1.32
1963/64-1966/67	0.47	0.96	1.48	0.96	1.01	1.01

\* Data from Belgian trawl fishery.

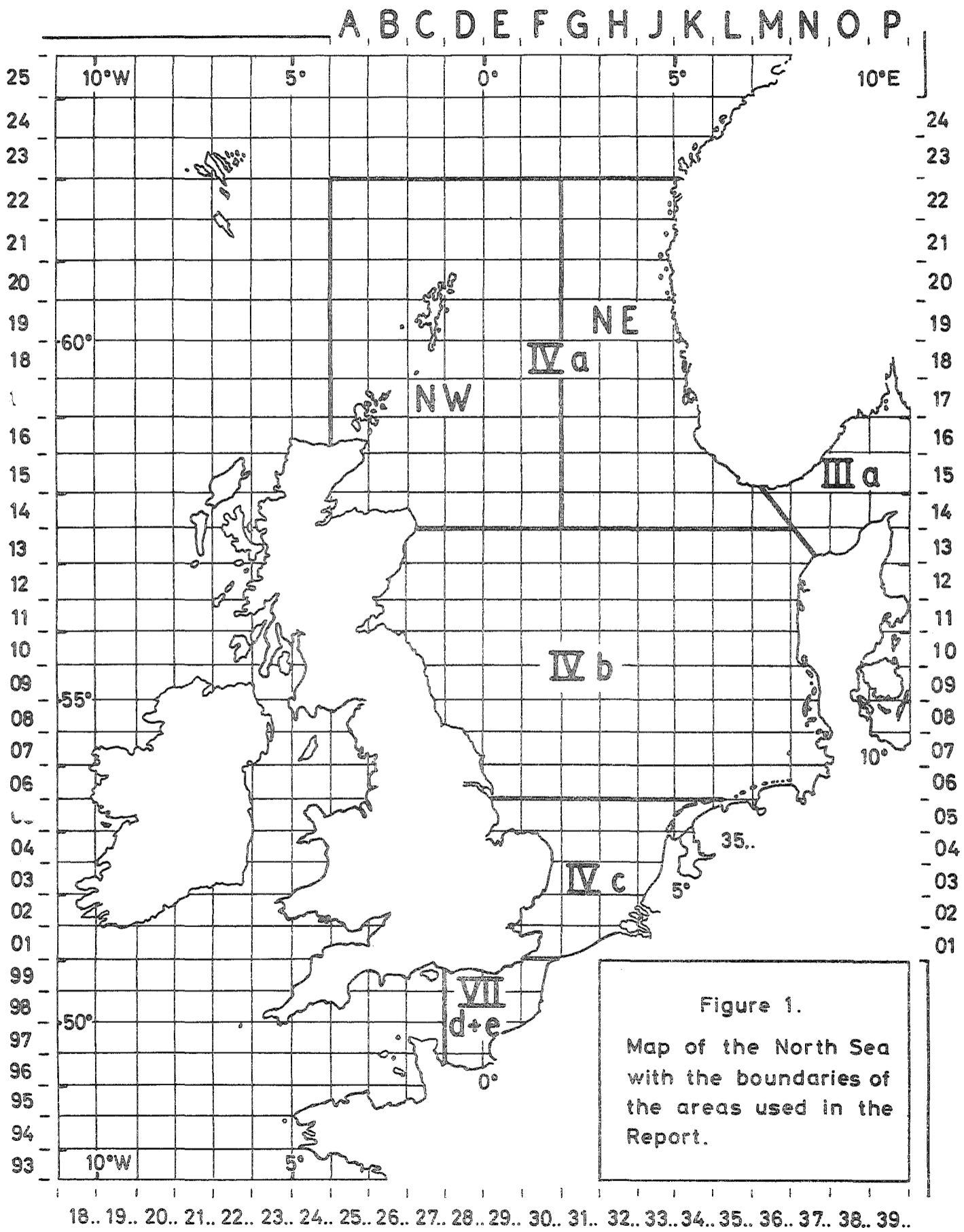
Table 12. Larval Abundance.

Year	Downs <sup>a)</sup>	Central <sup>b)</sup>	Baughan	Shetland	North-Western North Sea (Buchan & Shetland) <sup>c)</sup>
1946	537				
1947	596				
1948					
1949	288				
1950	255				
1951			300	420	1320
1952			890	100	990
1953			2110	940	3050
1954			670	700	1570
1955	98		20	700	720
1956	56		-	-	-
1957	15	232	300	-	300
1958	63	437	220	2800	3020
1959	8	97	300	860	1160
1960	16	137	440	640	1080
1961	56	59	380	4940	5320
1962	29	98	400	720	1120
1963	7	-	440	580	1020
1964	6	52	920	880	1800
1965	5	254	70	2220	2290
1966	1	23	10	680	690
1967	40	22	0	440	440
1968	351)	201)	0	2061)	2061)

a) Larval abundance ( $\times 10^{-9}$ ) in December-January. b) Larval abundance ( $\times 10^{-9}$ ) on western slope of Dogger in October.

c) Larval abundance ( $\times 10^{-9}$ ) in the north-western North Sea in September. 1) Preliminary figures.





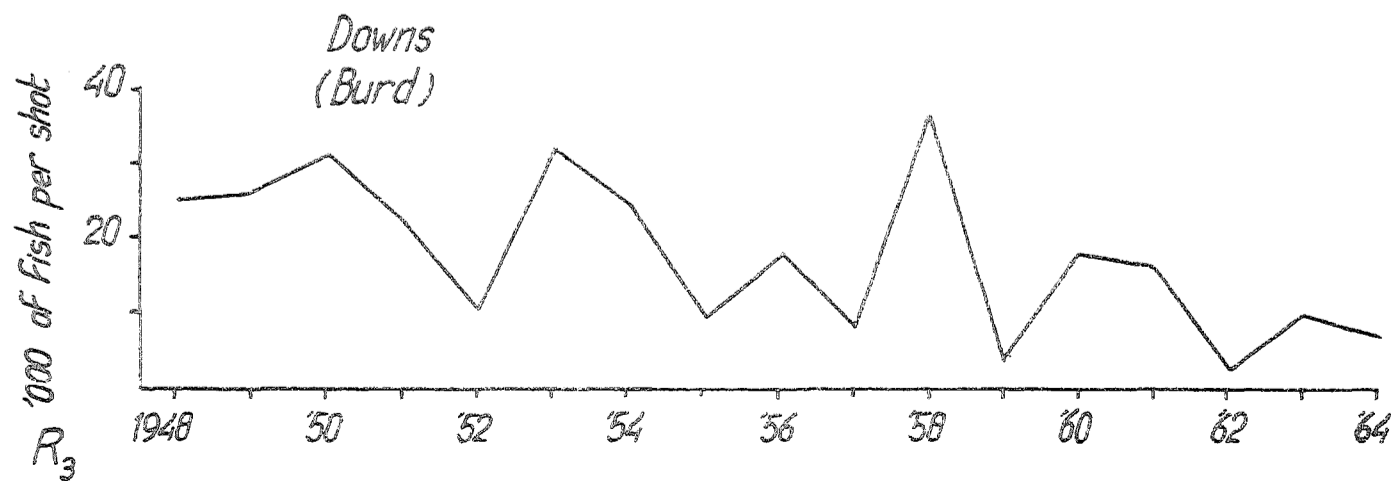
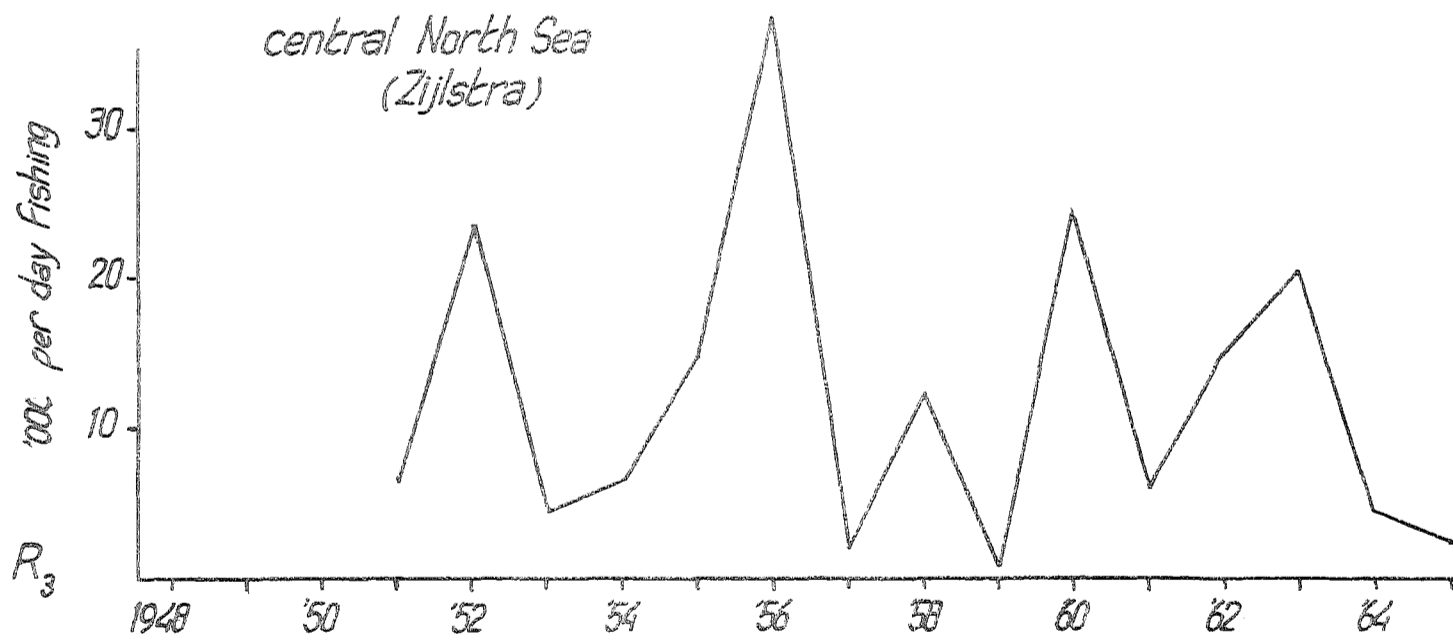
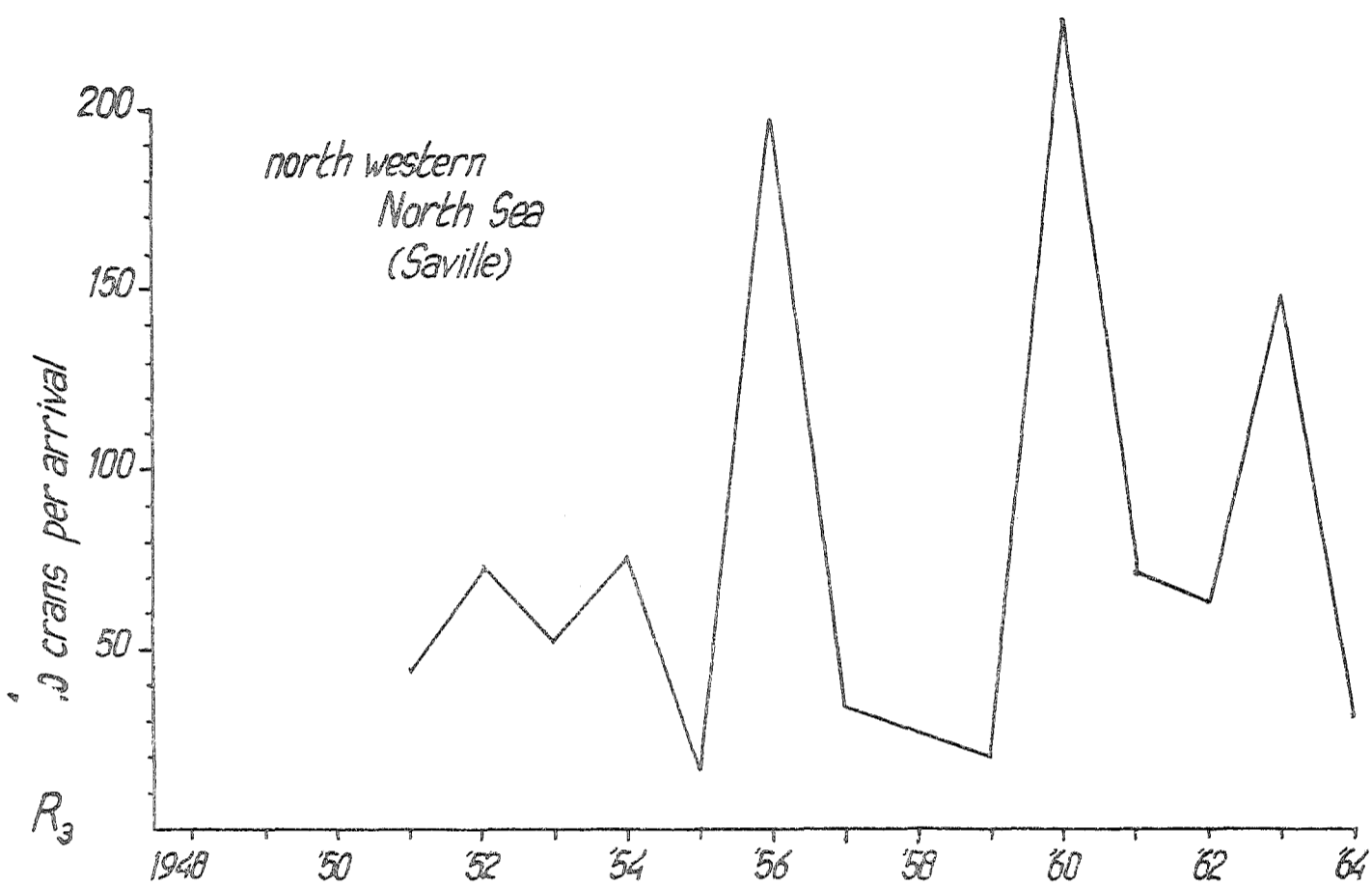
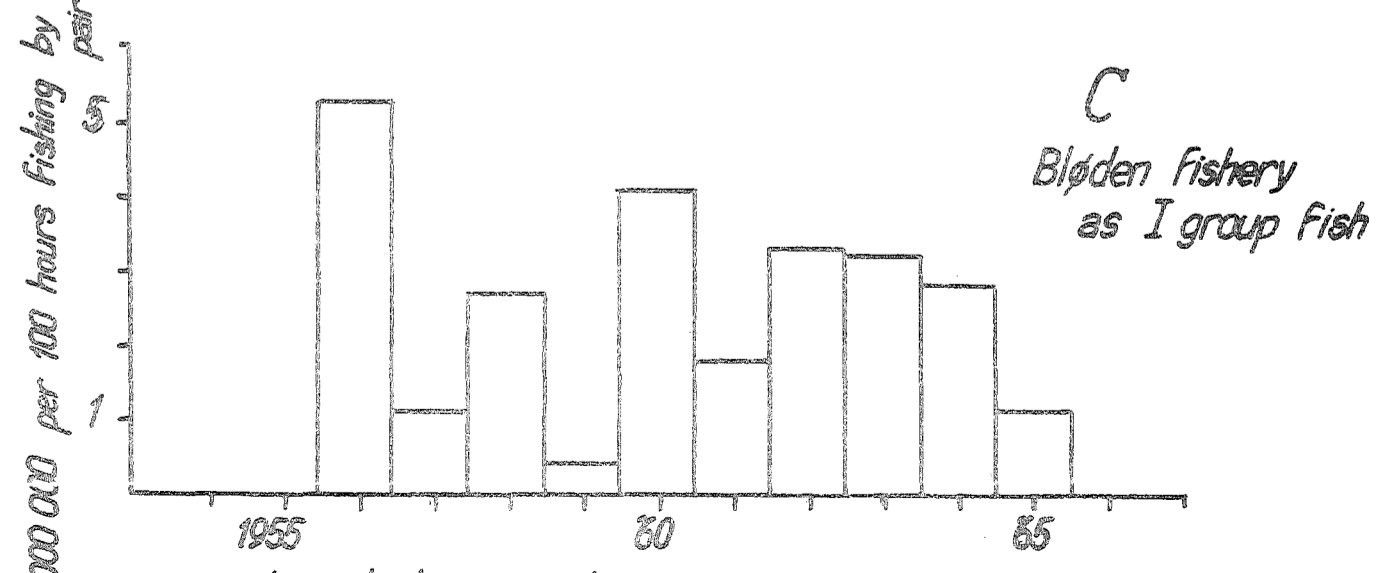
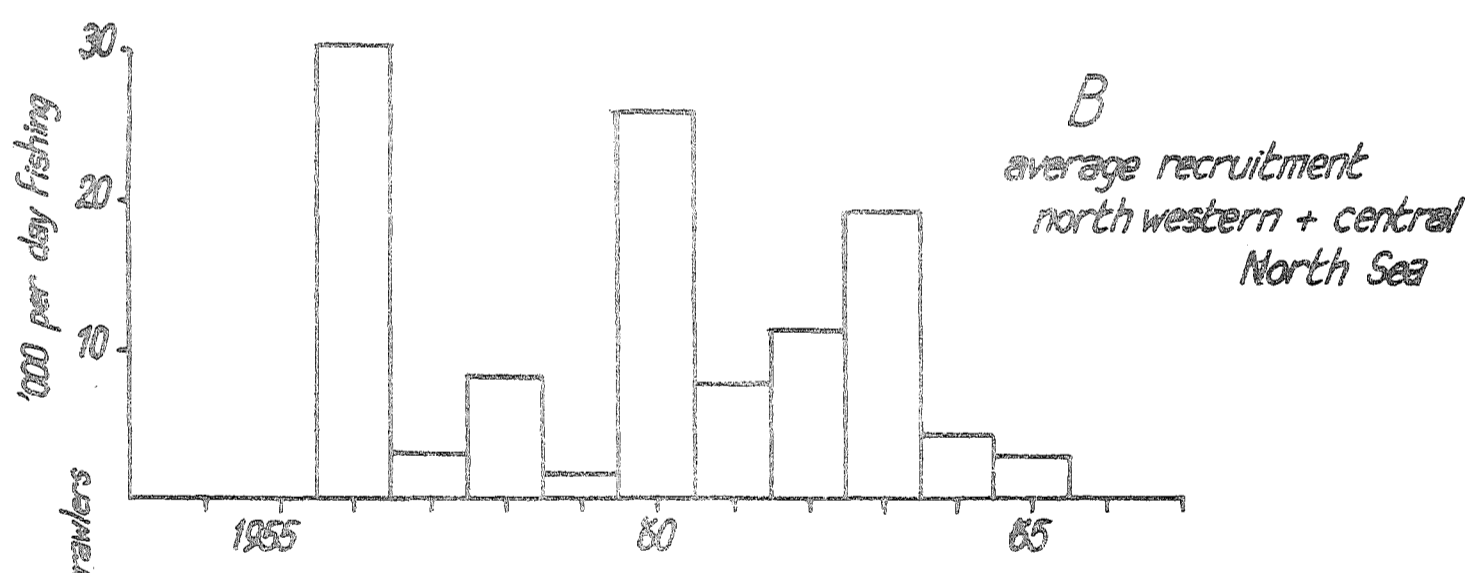
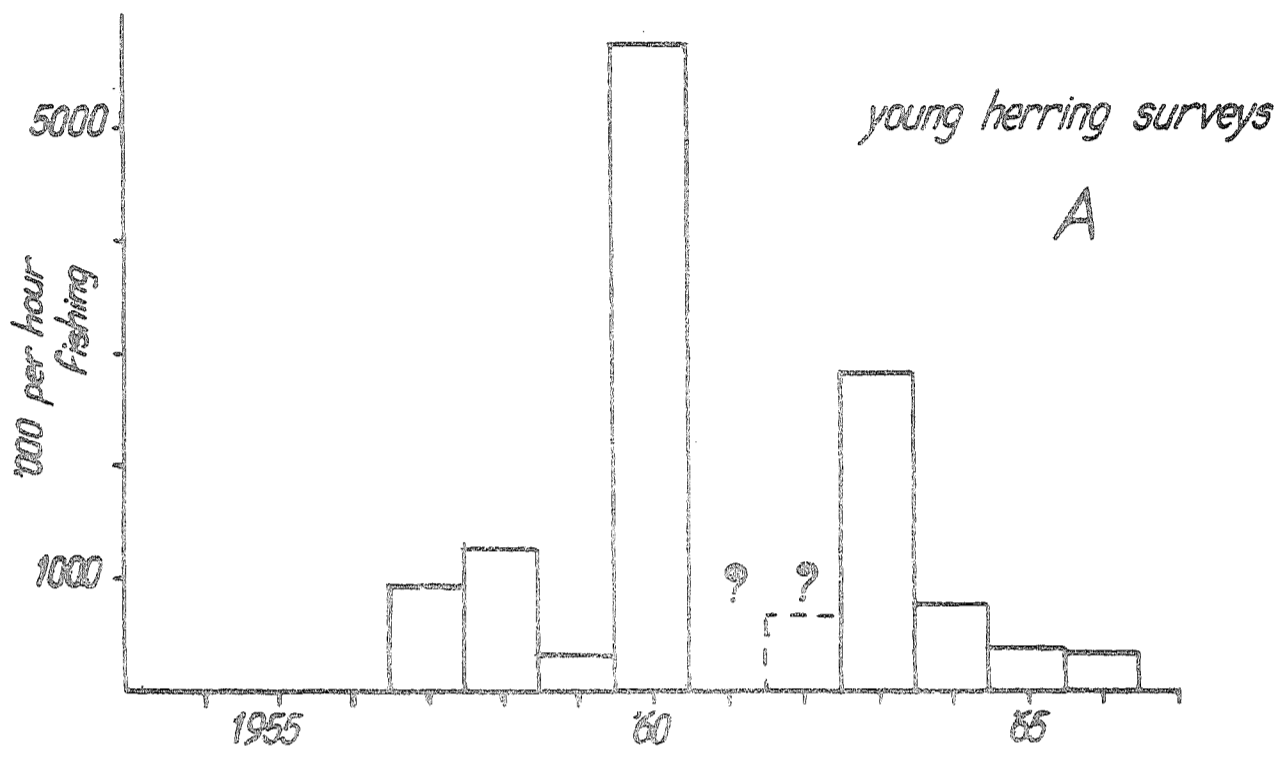


Fig. 2



recruitment by yearclasses

Fig. 3