

International Council for the  
Exploration of the Sea

C.M. 1974/H:32  
Pelagic Fish (Northern) Committee

THE DISTRIBUTION AND ABUNDANCE OF ADOLESCENT MACKEREL IN THE NORTH SEA

by

M. Walsh

Marine Laboratory, Aberdeen, Scotland



Digitalization sponsored  
by Thünen-Institut

Summary

(1) The distribution of 1- and 2-group mackerel in the North Sea is described from data collected during the International Young Herring Trawling Surveys undertaken in 1960-1961 and from 1967-1974 inclusive.

(2) The distribution of both age groups appears to be fairly constant throughout the series.

(3) One-group mackerel occur mainly in the Central North Sea close to the northern edge of the Dogger Bank. Two-group mackerel have a wider and more scattered distribution.

(4) The young herring survey data suggest that fluctuations in mackerel year-class strength are very marked. In the years surveyed the 1966, 1969 and 1970 year-classes were relatively strong, while the three year-classes since 1970 have all been relatively weak or very weak.

(5) Abundance estimates and age composition data from commercial fisheries confirm the strengths of the 1966 and 1969 year-classes, but indicate a much smaller variation in year-class strength than is indicated by the young herring surveys.

Introduction

Little is known about the distribution and biology of mackerel in their first two years of life following metamorphosis. There are few references to young mackerel in the literature and no comprehensive surveys of their distribution or abundance appears to have been undertaken on either side of the N. Atlantic.

In 1960, the first international trawling survey for young herring was carried out in the North Sea under the auspices of ICES. This was repeated in 1961 and, after a lapse of four years, again in 1966 and subsequent years. Whilst these surveys were primarily intended for sampling young herring, catches of young mackerel were also taken. These catch data have been analysed to provide information on the distribution of the pre-recruit year-classes of mackerel and to assess whether such fishing surveys can provide an adequate index of abundance for forecasting recruitment.

## Background information on the International Young Herring Surveys

Surveys were carried out in 1960 and 1961 in the spring and autumn and from 1966 onwards in the spring only. In the spring surveys up to and including 1968 the bulk of the hauls were carried out in March whilst latterly most hauls were made in February.

The extent of the area covered varied somewhat over the period of the surveys according to prevailing weather conditions and the number of available research vessels. With the exception of 1966, in which only the central part of the North Sea was adequately sampled, the area between latitudes 52°N and 58°30'W was well sampled, and in 1960, 1961 and 1974 an additional area extending to 61°N was also surveyed. In all years at least a part of the Skagerrak and Kattegat was sampled. The fishing gear used by all countries was a herring bottom trawl fitted with a 20 mm mesh codend, though there was some variation in trawls used, since the participating research vessels were not all of equal fishing power. The duration of each haul was usually  $\frac{1}{2}$  hr or 1 hr, and usually at least two hauls were made in each statistical square.

More details of individual surveys are given in Annales Biologiques for the surveys from 1968 onwards and in Anon (1969), Zijlstra (1966) and Saville (1967) for previous surveys.

### Mackerel data

For the years 1960, 61 and 1966-69 data on mackerel are available only for the Scottish catches; for 1971 they are available for Scottish and Dutch catches, and for 1971-74 for all countries' catches.

From most hauls in the 1971-74 surveys the following information was collected:-

- (1) Position, time and duration of each haul.
- (2) Total numbers of mackerel caught in each haul.
- (3) Length frequency distributions of mackerel from each haul.

Otoliths for age determination were taken by Scotland over the last four surveys, also by Holland in the 1974 survey.

### Distribution

#### Treatment of data

In each survey, abundance indices for each statistical square were calculated by raising all individual hauls to 1 hr, summing the raised totals and dividing by the total number of hauls in that square.

The abundance of each age group in each square was calculated by applying age length keys to the length frequencies of the mackerel caught in that square.

There was very little overlap in the length distributions of 1- and 2-group fish in the two years (1971 and 1972) for which sufficient age data were available. Unfortunately it was not possible to obtain adequate numbers of otoliths in 1973 or 1974 nor were any obtained in the surveys before 1971. However, in most years it is fairly clear from the length frequencies where

the division between age groups lies. Where insufficient data are available, therefore, age groups have been separated from discontinuities in the length distributions. These are given in Table 1, which shows the summed length distributions from each survey.

For the 1971 and 1972 surveys no length data were available for German catches, which contributed a relatively large proportion of the total catch of mackerel. It was necessary, therefore, to estimate the relative numbers in each age group for these catches in order to derive a more complete picture of distribution and abundance. This was done by using the known age compositions of other catches in the same statistical square or the average from the totalled catches of adjacent statistical squares.

An independent check on the validity of the age distribution estimated in this way is possible because the total weight of the mackerel in the German catches is available along with the total numbers taken in each haul. One can therefore calculate the average weight per fish for each haul and, from a weight-length relationship, an equivalent average length. Where this average length comes close to the modal length of an age group one can assume the catch to be predominantly of that age group. Where the average length lies between the values for the two age groups one can assume the population sampled was of mixed age. This rough method of checking has some value because the length data indicate a fairly high degree of uniformity in the length frequencies of 1- and 2-group fish over the whole survey area and because catches did tend to be predominantly of one age group or the other, rather than a mixture.

The two methods of estimating the age composition of the German samples gave fairly good agreement. In only one case was there a fairly significant discrepancy where the weight data suggested an underestimate of the proportion of 1-ringed fish. This has been marked on the relevant distribution chart.

#### The distribution of 1-group mackerel

The distributions of 1-group mackerel are plotted separately for each of the years 1970-1974 (in Figures 1-5) and for all years combined in Figure 6. In Figure 6 all the spring survey data were used, including those from the earlier surveys; the figures in each statistical square are the mean numbers per hour's fishing for all the years in which each square was sampled.

Although 1-group mackerel were only taken in large numbers in one of the last four surveys, the general pattern of distribution was very similar in each year. The incomplete surveys of 1970 and earlier also gave this impression.

The location of positive catches suggests a very restricted distribution of this age group with either very low abundance or a complete absence over the greater part of the North Sea. Even in a year of high abundance (1970), positive catches were only taken in about one-third of the total area surveyed. Figure 6 shows that the largest catches of 1-group mackerel were taken in the Dogger Bank area. They were greatest along the northern edge of the Bank, and in most years the surveys yielded consistently smaller catches in the area between the western edge of the Bank and the English east coast. The catches along the southern and eastern edges of the Bank were very low, with no 1-group mackerel being caught there in some years. Hauls made on the shallowest part of the bank (squares 8G and 8H) never contained any 1-group mackerel.

In addition to the main concentration in the Dogger area, small catches of 1-group mackerel were taken in several surveys to the west of Ling Bank (15G), at the entrance to the Skagerrak in 1970, and off the Dutch coast in 1974. Catches of 1-group mackerel by Scottish research vessels outwith the international surveys also suggest that the area west of Ling Bank (15E, 16G) may be of importance as a nursery area in some years.

#### The distribution of 2-group mackerel

The distribution of catches of 2-group mackerel is given, by statistical squares, in each of the years 1970-74 and for all years combined in Figures 7-12. These show that this age group was caught over a wider area than 1-group mackerel. The central North Sea was again the main centre of distribution although within it there was a good deal more variation in the location of the best catches between surveys. An interesting feature here was the constancy of positive catches of this age group off the English north-east coast. Catches were made off the Dutch coast in 1972-74 inclusive and in two of these years the highest catch rates were achieved in this region. Relatively good catches were also taken occasionally in the northern North Sea between Ling Bank and the Fladen. As with 1-group fish, coastal waters were generally characterised by very low catches, apart from one patch in statistical squares 8L and 8M in the 1971 survey.

#### Abundance

##### (a) Treatment of data

To obtain comparative estimates of year-class strength from the surveys a standard area was chosen, as shown in Figure 1.

An abundance index for each survey was derived by summing the average number of each age group caught in each statistical square per hour's fishing and dividing by the number of squares fished. The estimates for the years 1971-74, in which most of the standard survey area was sampled, are directly comparable. However, because of incomplete sampling in earlier years the estimates for these may be biased, depending on whether the main centres of distribution were fished. As no part of the main distribution centre was sampled in the 1960, 1961 and 1969 surveys, these are excluded from the results table.

For the 1970 survey, where data are available for a fair proportion of the total area, an alternative and probably more reliable method has been used to estimate the relative abundance of the 1969 year-class. In this method the 1971 survey is used as a standard for comparison and only those squares which were fished in both years are compared.

Insufficient material was available to warrant similar estimates of abundance for earlier year-classes but the data are nonetheless of some value as they give indications of good and poor year-classes.

##### (b) Results

The estimates of abundance of 1-, 2- and 2+ age groups of mackerel (derived as above) are given in Table 2. Mackerel with more than two winter rings were taken in insignificant numbers after the 1961 survey, and are not considered further.

One- and 2-group mackerel were taken in relatively high numbers in some surveys and in very low numbers in others. This implies either that there are very marked fluctuations in year-class strength or that there are large

annual variations in catchability. The fact that two year-classes (1969 and 1970) which gave high indices of abundance as 1-ringers also did so as 2-ringers and that weak year-classes as 1-ringers also gave low indices as 2-ringers, suggests that these annual variations in abundance are a reflection of year-class strength rather than of variations in catchability.

The results given in Table 2 indicate that the year-classes 1966, 1969 and 1970 were relatively strong whilst the year-classes 1967, 1968, 1971, 1972 and 1973 were weak.

From the results of the last five surveys, estimates of the relative strengths of different year-classes show reasonable agreement when one compares 1- and 2-group figures, see text-table below, which uses year-class 1971 as a standard.

Year-class	Abundance Estimates	
	as 1-ringers	as 2-ringers
1969	212 [503*]	288
1970	250	113
1971	1	1
1972	2	6
1973	1	[not sampled yet]

\*On basis of bracketed figure used in Table 2.

These results suggest that year-class strength in North Sea mackerel may vary two-hundred fold from year to year.

A comparison between the abundance of mackerel as adolescents in the young herring surveys and as adults in the commercial fisheries

Published estimates of the abundance of mackerel year-classes exploited by the North Sea fisheries are only available for the year-classes prior to and including that of 1969 (Hamre 1970, 1971; Hamre and Ulltang 1972). These data are given in the text-table below.

Year-class	Estimated stock strength in millions as 2-ringers on 1 January
1962	4 790
1963	390
1964	956
1965	1 515
1966	1 920
1967	200-400
1968	200-400
1969	1 200*

\*The estimate for the 1969 year-class is a preliminary one based on data from August 1971 which was, however, poor and may be an underestimate of the real value (Hamre and Ulltang 1972).

With respect to the 1970 and 1971 year-classes Hamre comments that the former year-class was expected to appear in the commercial catches in the autumn catches of 1971 but failed to do so and therefore "seems to be extremely poor". He continues, "The 1971 year-class is more uncertain but may also be far below average. This is indicated by the fact that no occurrence of the O-group in Norwegian fjords was reported during autumn 1971, which is usual when a good year-class is recruited".

For the year-classes where abundance estimates are available both as adults and as adolescents there is quite good agreement. The 1966 and 1969 year-classes are strong and the 1967 and 1968 year-classes weak in both sets of data. The surveys of 1971 and 1972 indicate that the 1970 year-class was relatively strong whilst its low abundance in the Norwegian catches implies the reverse. This scarcity in the Norwegian catches, however, may be due to the slower growth of this year-class (see Table 1) which may have resulted in delayed recruitment to the fishery. There are also indications from a comparison of the distribution of the year-class as 1- and 2-ringers that a slight southward displacement of the main concentration occurred between the springs of 1971 and 1972 so that the bulk of the year-class may have been further south than the fishing grounds exploited by the Norwegian fleet.

Age composition data (Table 3) from Scottish commercial mackerel catches in the North Sea confirm the relative strengths of year-classes 1966 and 1969 and indicate that in 1972 and 1973 the 1970 year-class was about half the strength of the 1969 year-class, which agrees well with the estimates from the young herring surveys. However, it must be pointed out that Scottish catches of mackerel are predominantly by-catches of fisheries for demersal species in the north-western North Sea and therefore of dubious value as indices of abundance.

Comparing the relative abundance of the strongest and weakest year-classes from the text-table gives a ratio of 1:24 for the year-classes 1967:1962. This implies a much smaller range in year-class abundance than indicated by the young herring surveys.

On the basis of the above evidence the abundance indices derived from the young herring surveys appear to give reasonably reliable indications of changes in relative year-class strength of mackerel.

Year-class	Estimated stock strength in millions as 2-ringers on 1 January
1962	100
1963	100
1964	100
1965	100
1966	100
1967	100
1968	100
1969	100
1970	100
1971	100
1972	100
1973	100

The estimate for the 1969 year-class is a preliminary one based on data from August 1971 which was, however, poor and may be an underestimate of the real value (Hamre and Utting 1972).

## References

- Anon 1969 Report of the North Sea Young Herring Working Group. I.C.E.S. Coop. Res. Rep. (14).
- Hamre, J. 1970 Size and exploitation of the mackerel stock in the Skagerak and north-eastern North Sea. I.C.E.S., C.M. 1970: Pelagic Fish Cttee (N): H(26).
- Hamre, J. 1971 Further results of the Norwegian mackerel investigations. I.C.E.S., C.M. 1971: Pelagic Fish Cttee (N): H(23).
- Hamre, J. and Ulltang, Ø. 1972 The effects of regulations of the mackerel fishery in the North Sea. I.C.E.S., C.M. 1972: Pelagic Fish Cttee (N): H(30).
- Saville, A. 1967 Report on the international trawling survey in the North Sea 1967. I.C.E.S., C.M. 1967: Pelagic Fish Cttee (N): H(28).
- Sette, O.E. 1950 Biology of the Atlantic mackerel (Scomber scombrus) of North America. Part II - Migrations and habits. Fish. Bull., U.W., 51:251-358.
- Zijlstra, J.J. 1966 Report on the pilot study for future young herring research in the North Sea. I.C.E.S., C.M. 1966: Herring Cttee: H(9).

TABLE 1 - MACKEREL SUMMED LENGTH FREQUENCY DISTRIBUTIONS - INTERNATIONAL  
 YOUNG HERRING SURVEYS SHOWING BORDER LINES BETWEEN AGE GROUPS

1960-61 (Spring surveys only)  
 1967-74

Ca Group	Survey Year → 1960	1961	1967	1968	1969	1970	1971	1972	1973	1974
10										
11							12			
12							1 502			2
13							21 331			1
14			87				45 438	8	4	3
15			585				27 070	32	17	12
16			1 077				11 118	24	103	12
17		7	783			1	1 028	16	165	33
18		25	342	1 Gp	11	440	281	-	87	26
19	1	11	156	1 Gp	67	3 223	52	6	65	11
20	2	3	57	1 Gp	1	4 542	83	34	41	19
21	9	1	3		11	3 039	126	58	27	35
22	13	-	-		1	500	9	32	23	25
23	6	-	-		11	5	31	18	-	4
24	1	-	-		-	-	189	47	3	-
25	10	-	-		1	-	1 141	570	3	4
26	20	-	14	2 Gp	22	2 Gp	2 809	1 439	2 Gp	6
27	9	1	13	2 Gp	1	19	2 870	702	2	13
28	2	3	1		1	15	1 626	91	2	42
29	1	10	1			23	468	24	1	55
30	1	14	1			"	159	3	3	46
31	6	11	-			3	15	9	5	22
32	16	61	-			-	42	4	7	22
33	4	183	-			-	28	2	2	14
34	11	188	-			-	52			5
35	21	267	-	3 Gp and older		-	65			3
36	31	279	-	3 Gp and older		3 Gp and older	44			5
37	22	177	-		1	3 Gp and older	26			
38	5	69	-				14	3 Gp and older		1
39	4	11	1				8			and older
40		11	-				10			
41		4	-				2			1
42		1	-							
43		-	-							
44		1	-				1			1
45										
TOTAL	196	1 397	3 279	125	3	11 812	117 640	3 119	563	413



TABLE 2 - Abundance estimates of mackerel age-groups from Young Herring Surveys of 1967-1974

Survey Year Average nos. of each age group per stat. sq. per 10 hrs for standard survey area

	I Gp	II Gp	II+ Gps	Total
1967	1 665	22	1	1 687
1968	24	1	0	25
1970	2 756 [6 536*]	13	1	2 770
1971	3 250	576	6	3 832
1972	13	226	1	240
1973	28	2	1	31
1974	14	12	1	27

\*Estimate derived by comparison of those stat. sqs sampled in both 1970 and 1971 surveys.

TABLE 3 - Average %age age compositions - Scottish commercial and research vessel samples - N. Sea - 1970-1974.

Year-class	Sampling Years →									
	Age	1970	Age	1971	Age	1972	Age	1973	Age	1974*
1973	-		-		-		-		1	0
72	-		-		-		1	5.2	2	1.1
71	-		-		1	0.4	2	3.9	3	0.5
70	-		1	0	2	22.0	3	20.3	4	7.6
69	1	15.0	2	11.8	3	<u>57.0</u>	4	<u>37.4</u>	5	<u>57.5</u>
68	2	5.4	3	13.4	4	5.5	5	17.6	6	11.6
67	3	7.3	4	12.2	5	4.3	6	4.7	7	5.3
66	4	<u>20.7</u>	5	<u>24.1</u>	6	2.9	7	2.7	8	7.8
65	5	7.4	6	9.4	7	2.5	8	3.6	9	2.8
64	6	5.8	7	3.9	8	0.8	9	0	10	0.9
63	7	3.4	8	2.0	9	0.7	10	1.2	10+	4.7
62	8	14.6	9	10.9	10	1.6	10+	3.2		
61	9	1.7	10	0.3	10+	2.2				
60	10	0.2	10+	12.1						
59	10+	17.5								
Nos. samples		13		4		10		6		2
Nos. fish		878		317		2 588		1 213		1 084

\*April/May only



THE DISTRIBUTION OF 1 GP MACKEREL IN THE N. SEA  
 Figure 3 1972 5 Feb. - 3 Mar.

Avg. Nos. per  
 Stat. Sq./Hr.

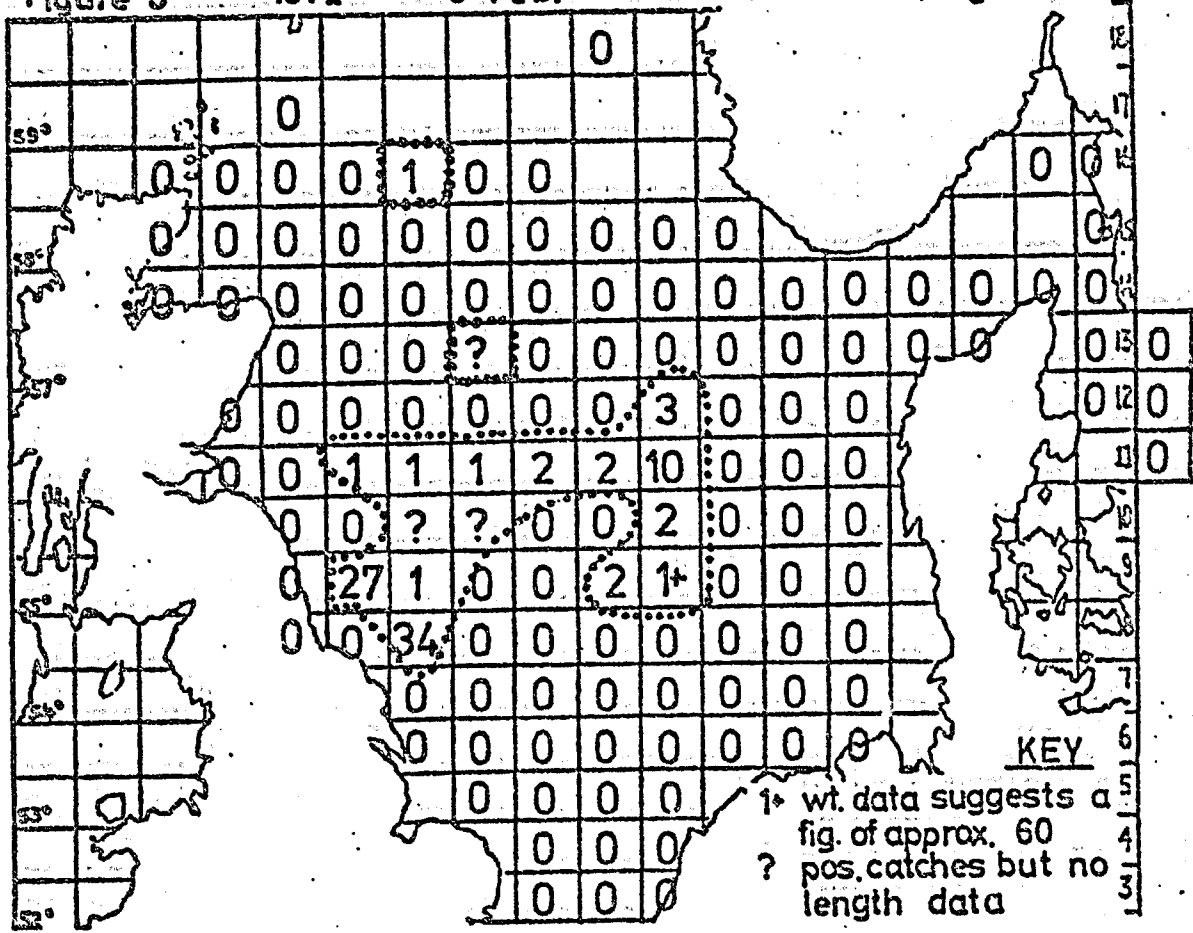
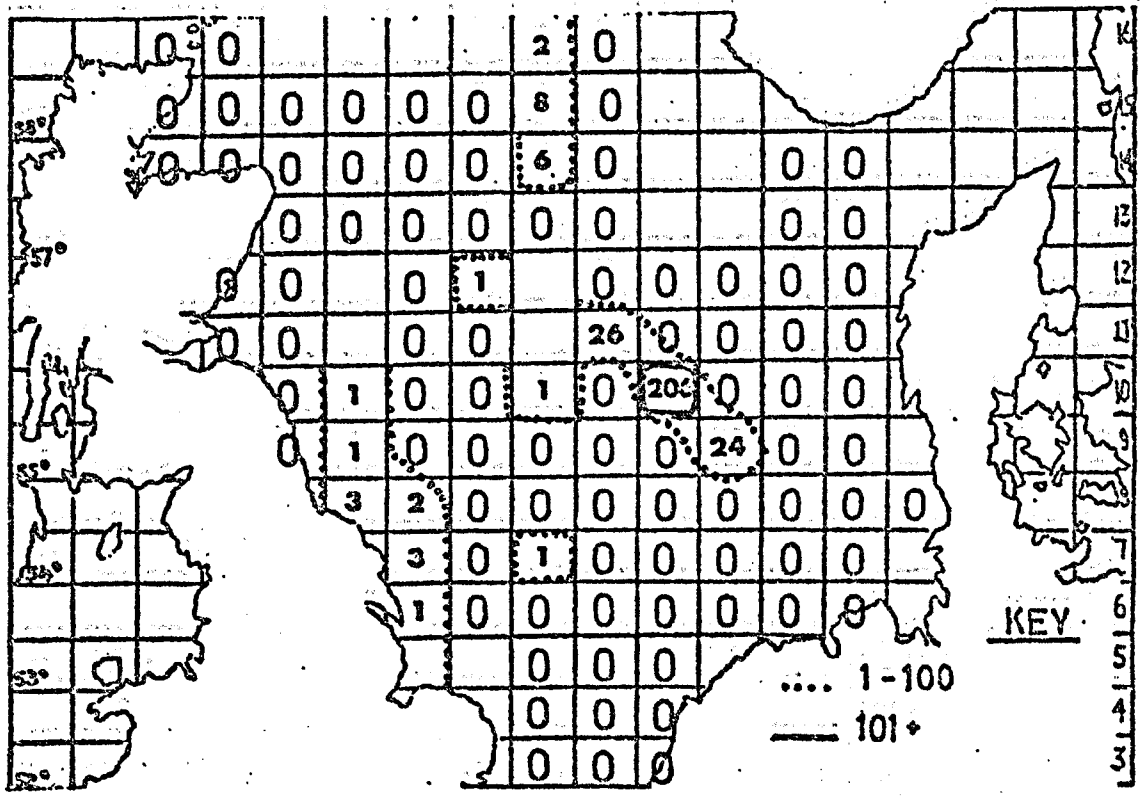


Figure 4 1973 16 Jan. - 27 Feb.



5° A B C D E F G H J K L M N P Q R

THE DISTRIBUTION OF 1GP MACKEREL IN THE N. SEA [ Av. Nos per  
Figure 5 1974 14 Jan. - 6 Mar. Stat. Sq./Hr. ]

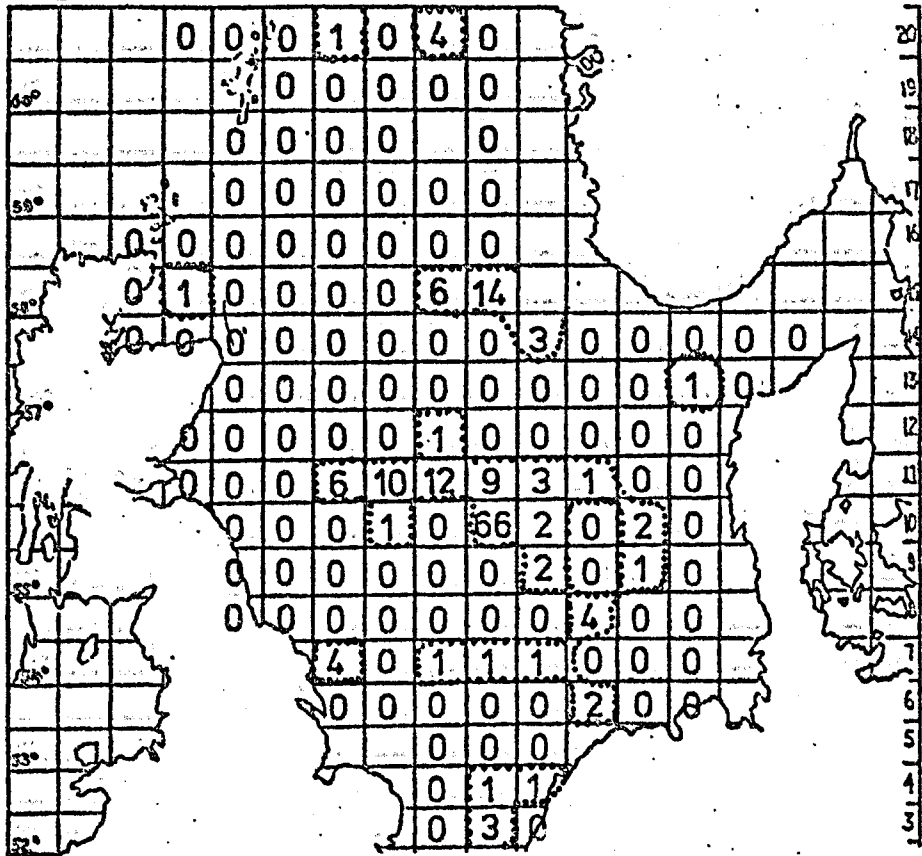
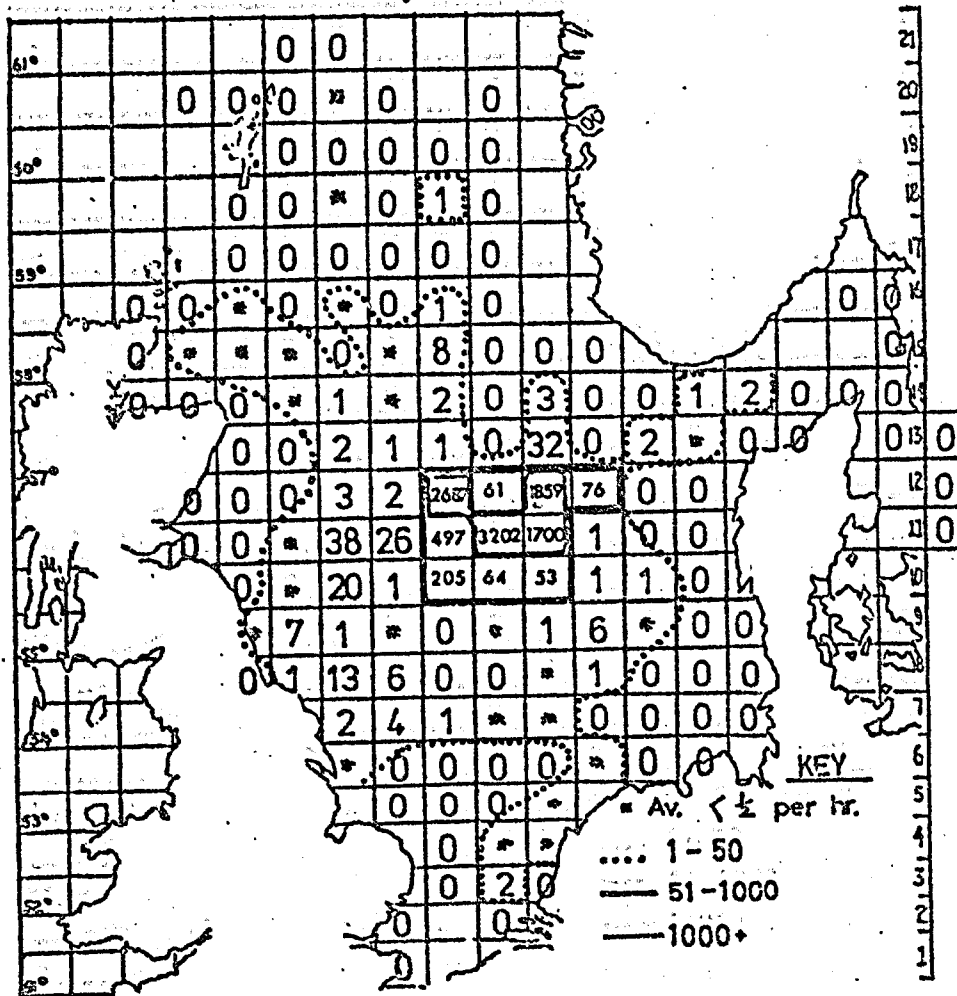


Figure 6 1960 - '61 } Combined  
1967 - '74 }



THE DISTRIBUTION OF 2 GP. MACKEREL IN THE N. SEA  
 Figure 7 1970 2 Feb - 17 Mar.

Avg. Nos. per  
 Stat. Sq. / Hr.

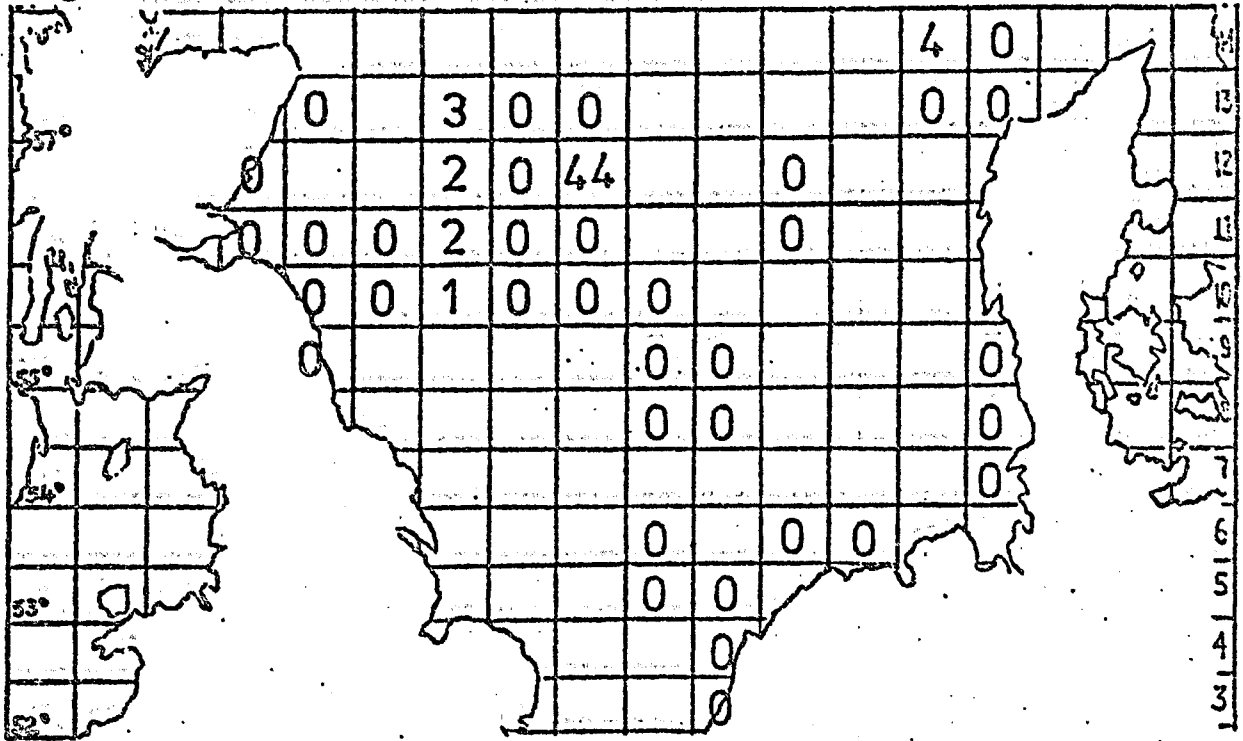
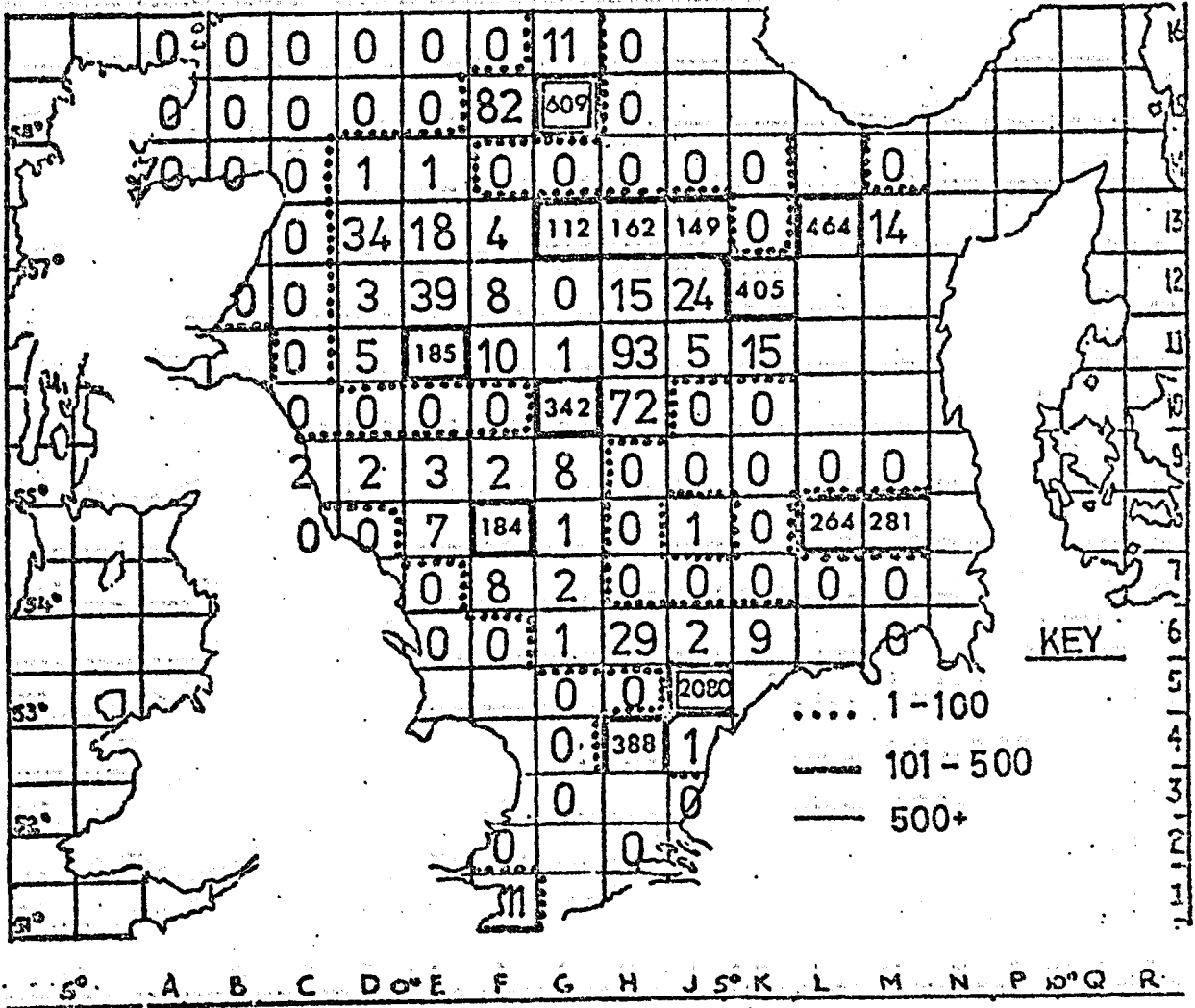


Figure 8 1971 28 Jan. - 21 Mar.



THE DISTRIBUTION OF 2 GR MACKEREL IN THE N. SEA  
Figure 9 1972 5 Feb. - 3 Mar.

Average No. per  
Stat. Sq. / Hr.

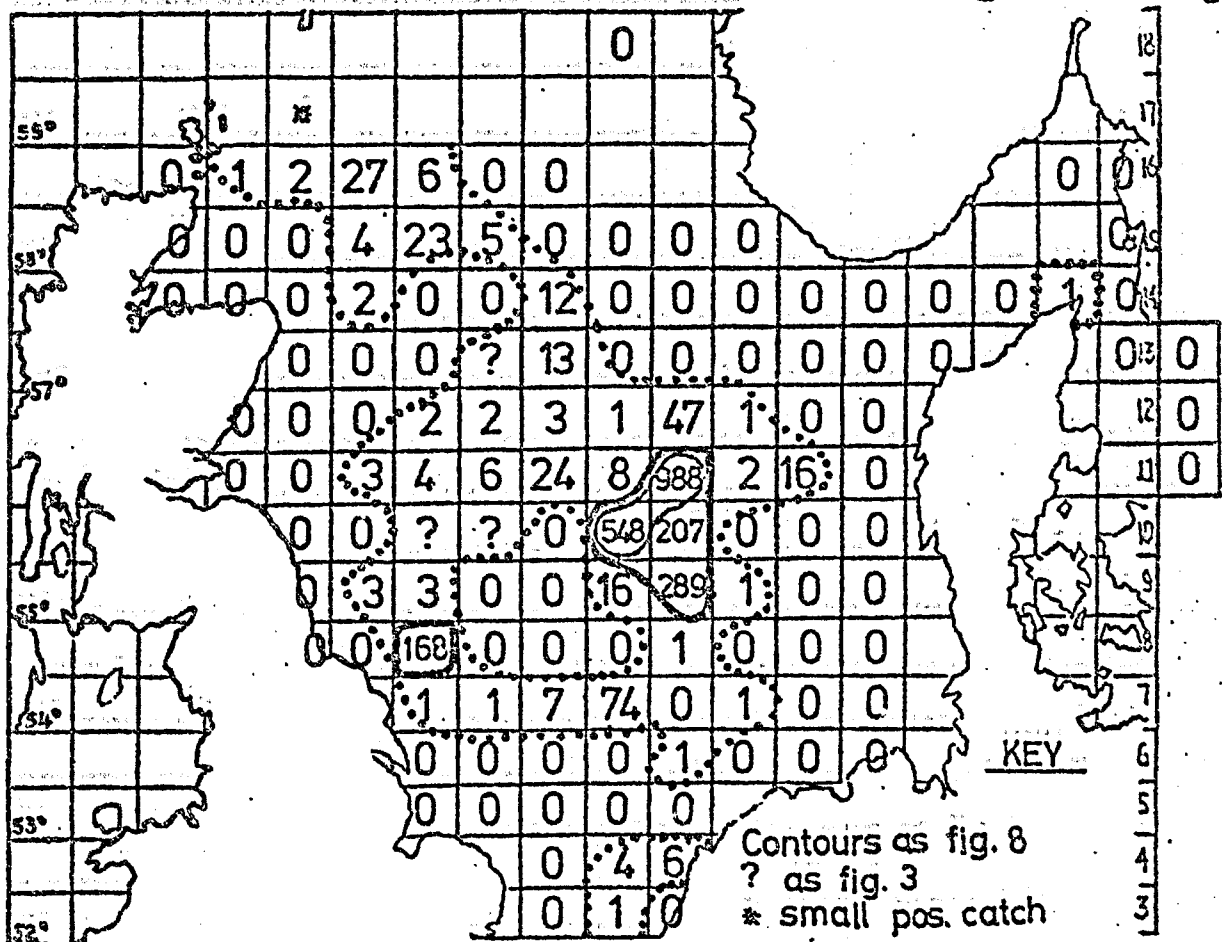


Figure 10 1973 16 Jan. - 27 Feb.

