Maquereaux immatures capturés pendant les campagnes internationales pour jeunes harengs dans la Mer du Nord

1. La distribution, croissance et l'abondance de maquereux immatures en 1975 et 1976 sont décrites par de données recueillies pendant les campagnes internationales de pêche pour jeunes harengs pendant ces mêmes années.

2. Les resultats de ces campagnes indiquent une nouvelle région 'nursery', située le long du bord oeust de la tranchée norvégienne, et au nord des régions principales 'nursery' décrits par Walsh (1974). Puisque cette région a été etudiée une seule fois pendant les années précédentes, ancun changement dans la distribution n'est suggéré. Dans la région originale déchantillonage, le mode de distribution était semblable à celui des années précédentes.

3. La longneur moyenne des individus du groupe d'âge en 1974 et 1975 était supérieure à la moyenne normale. Cela était bien marquée dans le groupe d'âge de 1975 qui était d'une longueur de 3cm supérieure à la moyenne prolongée des individus du groupe d'âge I pris pendant ces campagnes.

4. D'après les résultats de ces campagnes l'intensité des classes d'âge I en 1974 et 1975 parâit faible, et surtout celle de 1975 est la plus faible qui a été en registrée.

5. Une comparaison des évaluations de l'intensité des classe d'âge des campagnes pour jeunes harengs et de l'analyse de groupe COHORT, suggère que les calculs de ces campagnes ne peuvent pas être utilisés pour faire prédictions sur le recruitment à la population exploité par la pêche commerciale dans la mer du Nord. Une correlation entre les calculs provenant de ces sources, cependant, ne serait pas attendue si un gros pourcentage de cette population provenaient des régions au dehors de la mer du Nord, comme paraient indiquer les resultats des expériences de marquage norvégiennes.

6. Une correlation étroite entre les évaluations de l'intensité des mêmes classes d'âge des campagnes consecutives s'est montrée, un fait qui suggère que les campagnes peuvent fournir un indice assez précis de l'abondance de cette partie de la population de la mer du Nord provenant de la ponte dans la mer du Nord.

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ADOLESCENT MACKEREL IN THE NORTH SEA INTERNATIONAL YOUNG HERRING SURVEYS OF 1975 AND 1976

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Summary

1) The distribution, growth and abundance of adolescent mackerel in 1975 and 1976 are described from data collected during the International Young Herring surveys in those years.

2) An additional nursery area, along the western edge of the Norwegian deeps, and north of the main nursery grounds described in Walsh (1974), is shown from the results of these surveys. Since this latter area, however, had only been surveyed once in previous years, no change of distribution is implied. Within the original sampling area, the distribution pattern was broadly similar to previous years.

3) The mean length-at-age of one year old fish of both the 1974 and 1975 year-classes was above average. This was specially marked for the latter year-class which was over 3 cms larger than the long term average of one year-old mackerel taken in these surveys.

4) On the basis of these surveys, the strength of both the 1974 and 1975 year-classes appears to be poor, with that of 1975 being the weakest on record.

5) A comparison of estimates of year-class strength from the young herring surveys and from cohort analysis suggests that the survey estimates cannot be used to forecast recruitment to the population that is exploited by the fishery in the North Sea. A close correlation between these estimates, however, would not be expected if a high proportion of this population originated from outside the North Sea, as Norwegian tagging experiments appear to indicate.

6) A high level of correlation between estimates of the strength of the same year-class in consecutive surveys was found which suggests that the surveys may give a reasonable index of the abundance of that component of the North Sea population that recruits from spawning in the North Sea.

Introduction

International trawling surveys for young herring in the North Sea were begun in 1960 with the main objective of predicting recruitment of herring to the adult stock. Adolescent mackerel were also taken in these surveys and a first report was presented to ICES in 1974, reviewing data on this species from surveys up to and including that of 1974 (Walsh, 1974). This paper presents results of further surveys in 1975 and 1976 and assesses whether catches of adolescent mackerel from the young herring surveys can be used to forecast recruitment to the adult stock.

Details of the sampling procedure relevant to the mackerel investigations are given in Walsh (1974) for the surveys up to and including 1974. In the subsequent surveys in 1975 and 1976 changes were made to the programme to improve the sampling efficiency for herring (Anon, 1974). These changes included the introduction of stratified sampling which concentrated fishing effort in the areas of highest expected herring abundance. To estimate the year-class strength of herring, only hauls carried out during daytime (ie 15 minutes before sunrise to 15 minutes after sunset, within a standard area) were used, but additional hauls for gadoid species were also made at other times and in other areas. In practice approximately the same area was sampled in 1975 and 1976 as in 1974. The concentration of sampling in areas where herring were expected to be abundant did not improve the accuracy of estimates of mackerel abundance because the main nursery grounds of the two species show very little overlap. In all other respects (eg in trawling gear, method of fishing and duration of hauls), the survey procedure in 1975 and 1976 remained as in previous years (Corten, 1975 and 1976).

Mackerel data available in 1975 and 1976

The following information was collected in 1975 and 1976:-

1) Position, time and duration of each haul.
2) Total numbers of mackerel caught in each haul.
3) Length frequency distribution of mackerel in most hauls.

In addition 43 otoliths were collected for age determination in 1976 but none were obtained in 1975. The small number of otoliths collected in 1976 were supplemented by additional otoliths from N. Sea commercial catches in the first 6 months of the year to make up an age-length key.

Distribution of mackerel in 1975 and 1976

For each survey, mean catch-rates were calculated for each statistical rectangle by raising individual hauls to 1 hour, summing the raised totals and dividing by the total number of hauls in that rectangle. Catch-rates of 1 group, 2 group, 3 group and older mackerel were obtained for each statistical rectangle by applying an age-length key to the length frequencies in 1976 and by applying Petersen's method to the length frequencies in 1975.

In the case of hauls for which no length data were available the catches were allocated to age-groups according to other catches in the same statistical rectangle or by the mean of the catches from the nearest adjacent rectangles. In practice this only applied to a small proportion of the total catch. Where this procedure was followed catches are given in brackets on the distribution charts (Figures 1 and 2).

The distributions of 1-group mackerel in 1975 and 1976 are shown in Figures 1 and 2 respectively. The numbers of 2-group and older fish in both years were too small to warrant individual charts.

In 1975 1-group mackerel were taken in the greatest numbers along the western slope of the Norwegian deeps, to the north of the standard area (marked as A on Figures 1 and 2) used for making annual comparisons of abundance in previous surveys. Within this standard area the highest abundance was situated near its centre.

In 1976 1-group mackerel were caught in very small quantities in only a few statistical rectangles. As in 1975 the largest single catch was taken along the western slope of the Norwegian deeps outside the standard sampling area. The majority of the other catches were taken around the edges of the Dogger Bank within the standard area.

The existence of a mackerel nursery ground along the edge of the Norwegian deeps had not been demonstrated in previous surveys. However, this area was only surveyed in one previous young herring survey, 1974.

Within the standard sampling area the distribution pattern was broadly similar to that of previous years.

Abundance indices in 1975 and 1976

To obtain estimates of relative year-class strength comparable with those for previous years only catches in the standard area (Area A in Figures 1 and 2) were used. In addition abundance indices were calculated for the larger area (A + B in Figures 1 and 2) since this area was sampled in 1974 to 1976 and since the distribution of adolescent mackerel extended into it in 1975 and 1976.

An abundance index for each year-class in each survey was calculated by summing the mean number of mackerel caught in each statistical rectangle per hour's fishing and dividing by the number of rectangles fished in each of the sampling areas. The results are given in the text table on p. 5 with comparable estimates for year-classes sampled in previous years.

In both 1975 and 1976 catch rates of all age groups were low. As in all but one of the previous surveys, 1-group mackerel were more abundant in the catches than other age-groups. Within Area A the catch-rate of this age-group in 1975 was about the same as in the previous three surveys while in 1976 it was the lowest recorded since the surveys began. In both years the level was very much lower than in 1970 and 1971.

Within Area A + B the catch rate of the 1974 year class was markedly higher than that of 1973 or 1975 but comparison was unfortunately not possible with earlier year-classes.

Over the period 1970-1976 for which data are available these indices of year-class strength have varied by a factor of over 1,000.

Growth in 1975 and 1976

Mean lengths of 1-group fish were calculated for each statistical rectangle from discontinuities in the length compositions in 1975 and from an age-length key in 1976. (Figures 3 and 4). The numbers of older age-groups were too low to warrant similar treatment.

For comparison with earlier surveys, mean length compositions for the whole survey area were calculated for each year by summing the length compositions of individual statistical rectangles within area A (Table 1). The mean lengths of 1- and 2-group fish were then calculated and these data are given in Table 3.

In both 1975 (Figure 3) and 1976 (Figure 4) 1-group mackerel taken in area B, had a higher mean length than those taken in area A. As shown in the table below this was especially marked in 1975. The difference in mean lengths between the two areas in 1975 was significant at the 99.9% level while in 1976 it was significant at the 95% level.

Sub Area	1975		1976	
	mean length (cms)	number of measurements	mean length (cms)	number of measurements
B (see Figs 1 and 2)	21.21	3 703	23.22	22
A (see Figs 1 and 2)	19.44	330	22.07	63
Difference between means	1.77		1.15	

In view of this regional variation, data from sub area B could not be used for comparison with previous years and are therefore listed separately in Table 2.

The data in Table 3 shows that the mean lengths of 1- and 2-group fish were above average in 1975 and well above average in 1976. They also show a wide variation in mean length of 1-group mackerel during the period of years covered by the surveys.

In view of the wide variations, both in mean length-at-age and in the catch-rates, an investigation was carried out to test whether there was any correlation between these two parameters. The mean lengths of 1-group mackerel were compared first with catch-rates of this age-group and then with the sum of the catch-rates of this age-group and that of the preceding year-class taken as 1-group fish. The latter comparison was made because the two year-classes occur together on the nursery grounds and could possibly be competing together for food. The analysis did not show any significant correlation suggesting that changes in abundance could not alone account for the observed variations in growth.

An Evaluation of the usefulness of these Indices for forecasting Recruitment

Abundance indices of adolescent mackerel as one and two year-old fish from the young herring surveys of 1970-1976

Since the previous report (Walsh, 1974), two further year-classes have been sampled as adolescents in the young herring surveys making a total of seven consecutive year-classes from 1969 to 1975. Because each year-class is sampled in two consecutive surveys, two independent sets of abundance indices are available.

These are given in the text table below. The estimate for the 1969 year-class as one year-old fish in the 1970 survey was from a smaller sampling area than for subsequent year-classes and was derived by a comparison of the number of 1 year-olds caught in this smaller area in 1970 and 1971 (Walsh, 1974).

Year class	Average numbers of mackerel per 10 hrs trawling in area A (as shown in Figures 1 and 2)	
	1 Group	2 Group
1969	6 536	576
1970	3 250	226
1971	13	2
1972	28	12
1973	14	0.6
1974	26	0.3
1975	3	no data yet available
mean 1969-75	1 410	136

This table shows that the two sets of estimates are closely correlated ($r = 0.9945$; sig. at 99.9% level), thereby suggesting that they reflect real year to year differences in abundance rather than simply showing, for example, differences in behaviour pattern or in vertical distribution between years.

A comparison between estimates of year-class abundance from the IYH surveys and from Cohort Analysis of North Sea commercial catches

Estimates of year-class abundance are available from cohort analysis for the year-classes 1969-1975 (Anon, 1977) although those for the two most recent year-classes are less reliably estimated because they have only recently recruited to the commercial fishery. They are based on numbers of one year-old fish caught in the fishery and on an estimate of fishing mortality of 10% of that on the fully recruited year classes. The cohort analysis estimates for earlier year-classes are based on commercial catches from the North Sea minus a proportion of the catch taken from the Shetland area, which was allocated to the 'west UK stock' on the basis of Norwegian tag data (Anon, 1977). The cohort analysis estimates of abundance used refer to numbers of mackerel at age 2 because more estimates were available at this age than at other ages and the cohort analysis results suggest there was little variation in the survival rates from age 1 to age 2 over the period considered. For the 1969 year-class the numbers of two year-old fish had to be back-calculated from numbers at age 3. This was done by assuming a z of 0.25 (Hamre, 1975). A comparison of these estimates with those for one year-old mackerel from the survey data is given in the text table below:-

Year class	Comparative abundance estimates		
	From young herring surveys: average nos. 1 year olds per 10 hrs trawling		From cohort analysis: Estimated nos 2 year olds x 10^{-6} on January 1st
	Area A (figures 1 and 2)	Area A & B (figures 1 and 2)	
1969	6 536	-	5 692
1970	3 250	-	458
1971	13	-	639
1972	28	-	274
1973	14	12	588
1974	26	165	819
1975	3	4	168
mean 1969-1975	1 410	-	1 234

This table indicates that the two sets of estimates show some features in common as well as some differences. Both sets of data indicate that the 1969 year-class was a very strong one and that, by comparison, those of 1971 to 1975 were relatively weak. They also indicate that, of the last three year-classes sampled, that of 1974 was the strongest. The most marked difference between the estimates was for the 1970 year-class which had appeared to be strong both as one and two year-olds in the young herring surveys but did not appear in strength in the commercial catches of adult mackerel. The estimates from the surveys also indicated much greater variations in year-class abundance than is evident from commercial catches.

Discussion

When the idea of comparing estimates from the young herring surveys and from cohort analysis was first conceived it was assumed that the North Sea commercial catches were predominantly made up of fish recruited from North Sea nursery grounds and that the cohort analysis results could, therefore, be used as a means of checking the likely validity of the young herring survey estimates. During the course of these investigations, however, it became increasingly apparent, from Norwegian tagging data, that the North Sea commercial catches, upon which cohort analysis is based, contain a considerable proportion of fish which recruit from outside the North Sea. This is indicated by the fact that, in the Shetland area, an average of about 70% of the catch from 1972 to 1976 appears to have originated from outside the North Sea (Anon, 1977 text table p6) while, at the same time, the number of Celtic Sea tags per unit catch from other parts of the North Sea was frequently as high or higher than in the Shetlands (Anon, 1977 Table 3.1.3). Furthermore, according to Hamre (1975) important emigrations of mackerel from the North Sea also take place. Under these circumstances it is evident that some differences between estimates are to be expected.

From tagging results there is very little evidence of any recruitment of mackerel to the North Sea from other areas prior to three years of age. One would, therefore, not expect to see much evidence of mackerel from elsewhere in the

cohort analysis estimates for the 1974 and 1975 year-classes at this stage. For earlier year classes, however, one might expect to see marked differences between estimates where year classes are strong to the west of Britain and weak in the North Sea.

The estimated number of three year old fish in the 'west UK stock', as derived from cohort analysis (Anon, 1977 Table 4.2.1.) are given below for the year classes 1969 to 1973.

Year class	West UK stock: estimated numbers 3 year old fish x 10^{-6} on 1st January
1969	1 109
1970	1 387
1971	2 144
1972	861
1973	1 532

With the exception of the 1969 year class, these estimates are all more than three times the size of their equivalent year-class in the North Sea (as estimated by cohort analysis). The strongest of these was the 1971 year-class, followed by the 1973 year-class while that of 1972 was the weakest.

An investigation of these three year-classes in the North Sea indicates that, while they all appear to be very weak on the basis of the young herring surveys (with the 1972 year-class showing as marginally stronger than the other two), from the evidence of cohort analysis they do not appear to be so weak, and the 1971 year-class is the strongest while the 1972 year-class is the weakest. This is also the case with the west UK estimates from cohort analysis. For these year-classes, therefore, the results are not inconsistent with the hypothesis that a marked influx of fish into the North Sea took place. On this hypothesis and on the assumption that substantial emigration from west UK stock is likely to continue while the North Sea stock fails to produce a strong year-class, it seems probable that the North Sea estimates (from cohort analysis) for the 1974-1975 year-classes will increase in the next few years and especially that for the 1975 year-class which appears to be strong to the west of Britain although from the young herring surveys it appears to be extremely weak in the North Sea.

The most marked difference between the two sets of North Sea estimates was for the 1970 year-class and no entirely satisfactory explanation for this can be given. Thus, while it would be possible to explain the difference by postulating a large scale emigration of the year-class out of the North Sea after the age of two years it is hard to see why such an emigration should be mainly confined to one year-class.

An alternative explanation might be that the young herring surveys greatly over-estimated the strength of the year-class but it is difficult to explain why the catch rates of the year-class should have been high in the surveys in consecutive years if it had not been abundant. There is also some independent evidence that this year-class was relatively abundant as adolescents since it made up 39% of the commercial catch from the central and southern North Sea in 1972.

The 1970 year-class shows some unusual features. In the first place the average length-at-age was very low both as one and two year-old fish. These averages were respectively 4.23 cms and 2.61 cms below the long-term averages and might have increased the relative vulnerability of the year-class to capture in the young herring surveys.

Conclusions

From the data investigated it is clear that the young herring surveys do not provide an accurate index of the relative strengths of the mackerel year-classes recruiting to the North Sea commercial fishery. The results of tagging experiments indicate, however, that a large proportion of the North Sea catch may originate from outside the North Sea so that the surveys estimates could not be expected to forecast year-class strength in commercial catches. Some of the differences in estimates from the young herring surveys and from cohort analysis are consistent with the hypothesis of large scale immigrations of fish into the North Sea from outside but the 1970 year-class is an exception. The high level of correlation between the young herring survey estimates of year-class strength in consecutive surveys suggests that the surveys may give a reasonable index of abundance of the North Sea component of the North Sea commercial catches.

References

Anon. 1974 Report of the Working Group on North Sea Young Herring Surveys. Coun. Meet. int. Coun. Explor. Sea, 1974 (H:6): 1-16, 8 tabs, 27 figs [Mimeo]

Anon. 1977 Report of the Mackerel Working Group. Coun. Meet. int. Coun. Explor. Sea, 1977 (H: 2) 1-35, 13 tabs, 1 fig. [Mimeo]

Corten, A. 1975 Report on the International Trawling Survey for 1 m mature Herring in the North Sea 1975. Coun. Meet. int. Coun. Explor. Sea, 1975 (H:10) 1-4, 2 tabs, 4 Figs. [Mimeo]

Corten, A. 1976 Report on the ICES Young Herring Survey in the North Sea in 1976. Coun. Meet. int. Coun. Explor. Sea, 1976 (H:11) 1-5, 2 tabs, 4 figs.

Hamre, J. 1975 The Effect of recent changes in the North Sea mackerel fishery on stock and yield. The changes in the North Sea fish stocks and their causes. Int. Coun. Explor. Sea, Symp., Aarhus 1975 (22) 1-38 [Mimeo]

Walsh, M. 1974 The Distribution and abundance of Adolescent Mackerel in the North Sea. Coun. Meet. int. Coun. Explor. Sea, 1974 (H:32) 1-7, 3 tabs, 12 figs. [Mimeo]

Table 1 Mackerel length frequency distributions from the North Sea International Young Herring Surveys

length (cms)	1960	1961	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
11							12					
12							1 502			2		
13							21 331	8	4	1		
14			87				45 438	32	17	3	1	2
15			587				27 070	24	103	12		
16			1 077			1	11 118	16	165	33	5	
17		7	783			440	1 028		87	26	28	
18	1	25	342	11		3 223	281	6	65	11	107	3
19	2	11	156			4 542	52	34	41	19	91	1
20	9	3	57	67		3 039	83	58	27	35	48	9
21	13	1	3	1		500	126	32	23	26	40	14
22	6			11		5	9	18		4	7	13
23	1		3	11			31	47	3		3	11
24	1	1					189	570	3	4		5
25	10		1	1			1 141	1 439	3	6		5
26	20		14				2 809	702	2	13		1
27	9	1	13	22	1	19	2 870	91	2	42		3
28	2	3	1		1	15	1 626	24	1	55		2
29	1	10	1			23	468	3	3	46	2	6
30	6	14	1				159	9	5	22		2
31	16	11					15	4	1	22		
32	4	61					42	2	2	14	3	
33	11	183					28			5		
34	21	188					52			3		1
35	31	267					65			5		
36	22	219					44				1	
37	5	177			1	2	26					
38	4	69					14			1		
39		11	1				8					
40		11					10					
41		4				1	2					
42		1								1		
43												
44		1					1			1		
45												
Total	196	1 397	3 279	125	3	11 812	117 640	3 119	563	413	336	78

Table 2 A comparison between length frequency distributions in areas A and B (Figures 1 and 2) in 1975 and 1976

Length (cms)	1975 Area A	1975 Area B	1976 Area A	1976 Area B
14	1		1	
15				
16	5			
17	28			
18	107	18	3	
19	91	508	1	1
20	48	1 142	9	
21	40	1 194	14	2
22	7	577	13	8
23	3	236	11	5
24		19	5	3
25		9	5	2
26			1	1
27			3	
28			2	
29	2	2	6	4
30			2	8
31				31
32	3	9		17
33				1
34			1	3
35		2		
36	1			
37				
38		4		
39				
40				
Total	336	3 720	78	86

Table 3 Mean length-at-age of 1- and 2-group mackerel from the Internation North Sea Young Herring Surveys

Survey year	1-group		2-group	
	L	nos.	L	nos.
1960	22.38	32	26.59	43
1961	18.84	48	29.93	30
1967	16.96	3 092	27.01	32
1968	20.86	102	27.46	23
1969	Insufficient data		Insufficient data	
1970	19.50	11 750	28.57	57
1971	14.79	108 048	27.23	9 352
1972	18.49	215	25.58	2 878
1973	17.28	532	*	
1974	18.65	172	28.99	224
1975	19.44	330	29.50	4
1976	22.07	63	38.99	38
Unweighted mean 1960 - 1976	19.02		28.19	

* Inadequate age length key for fish over 1 year old.

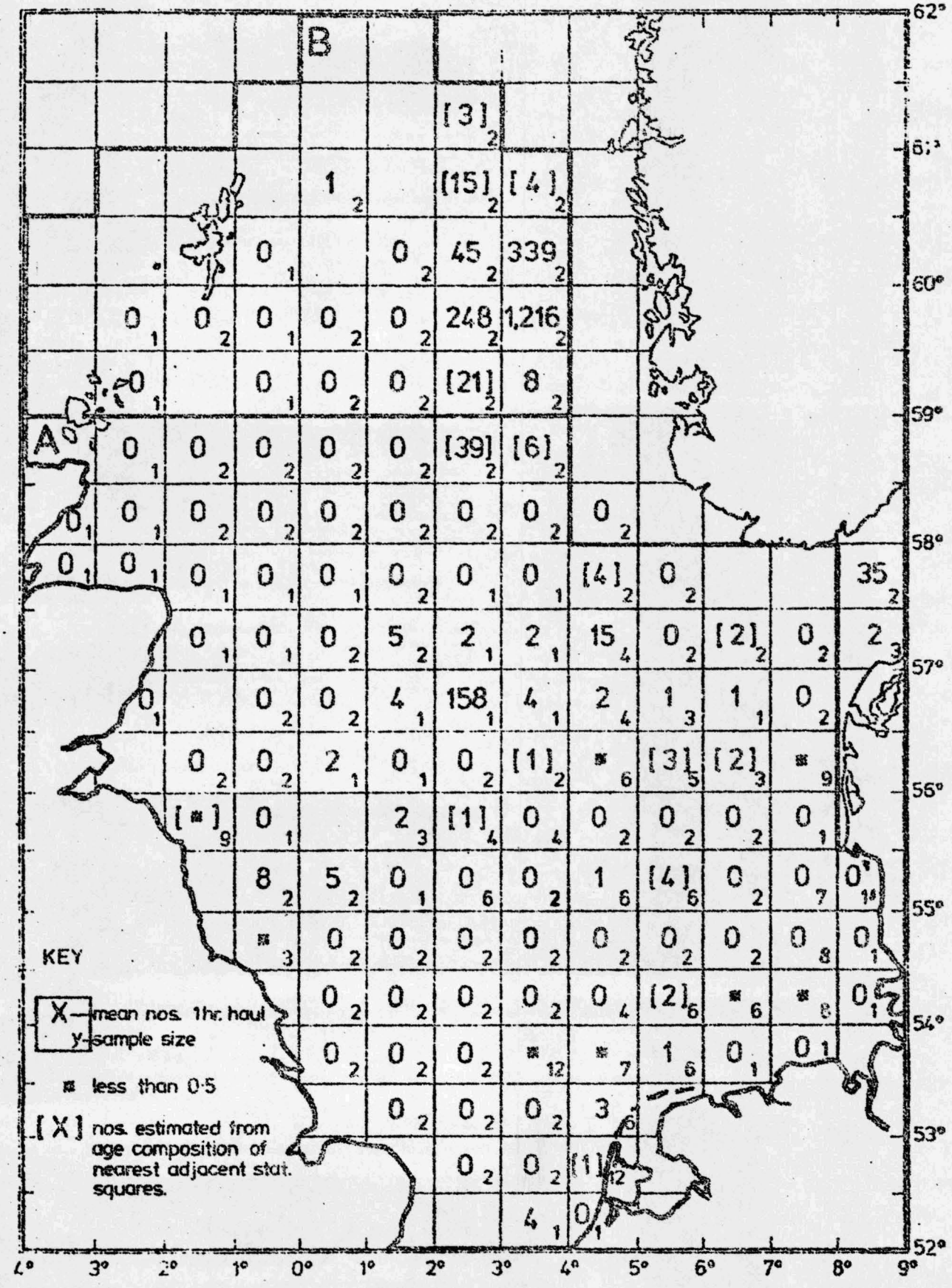

Fig. 1 Average numbers 1-group mackerel per 1 hour haul in 1975

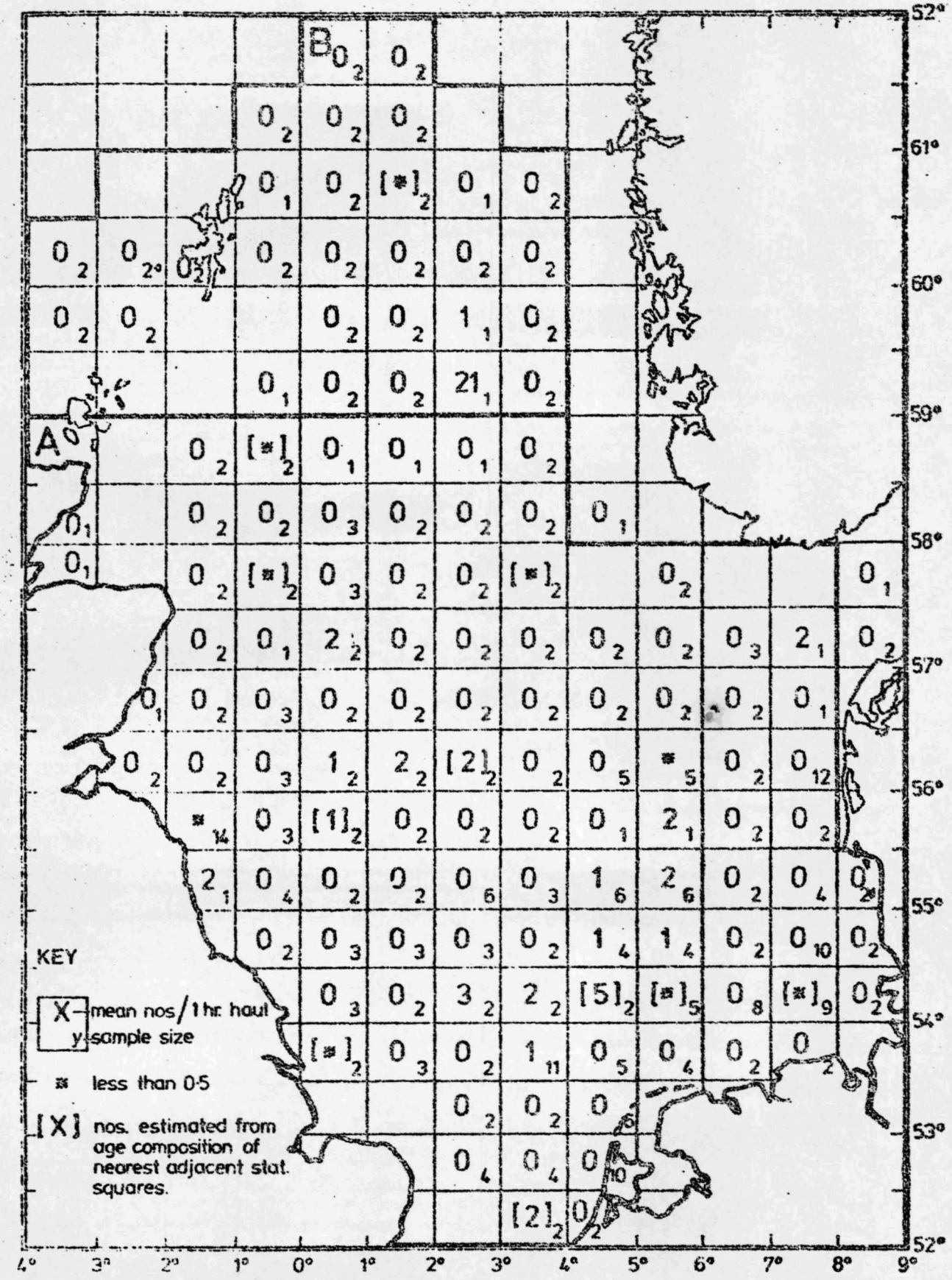

Fig. 2 Average numbers 1-group mackerel per 1 hour haul in 1976

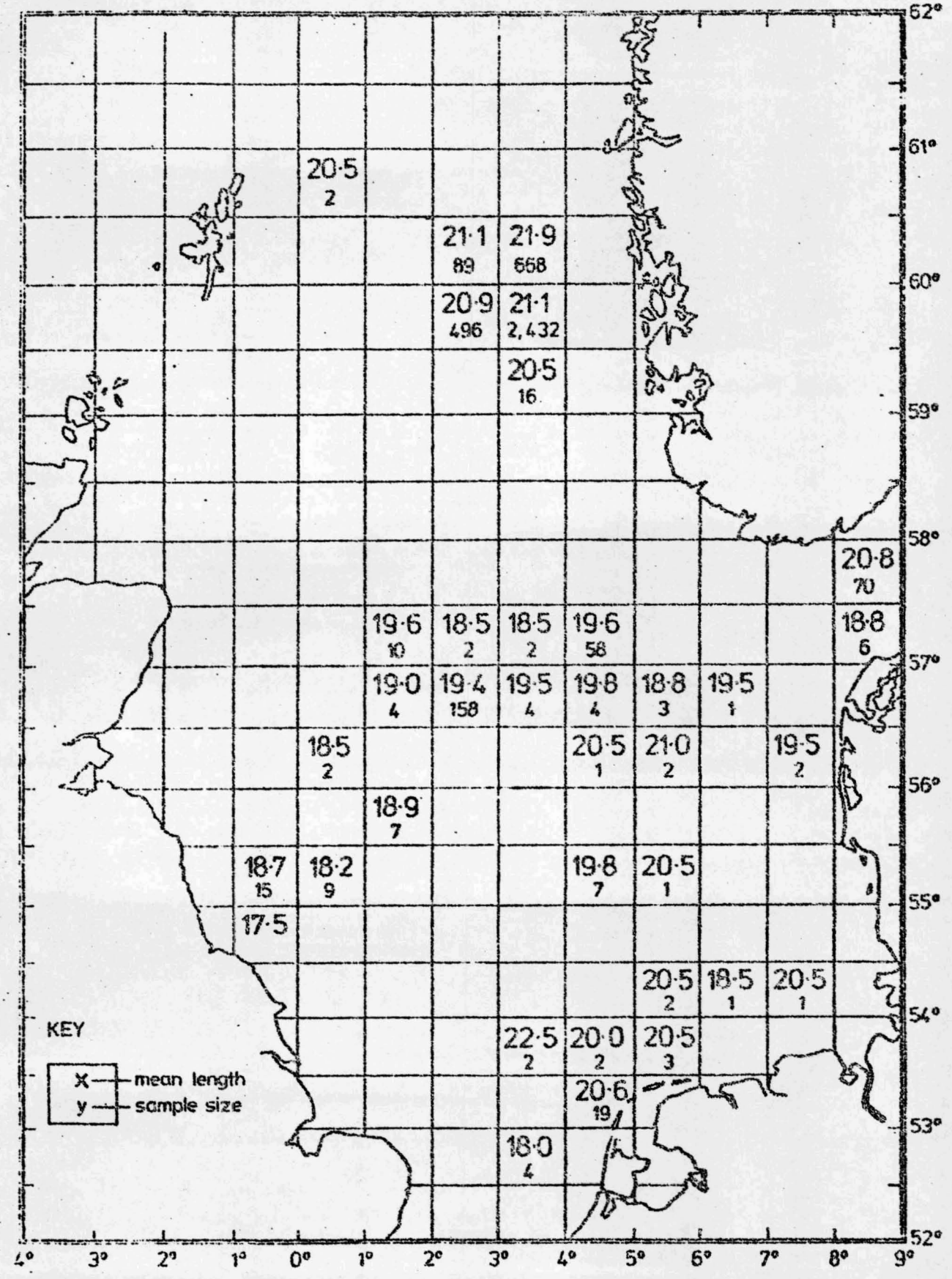

Fig. 3 Mean length-at-age of 1-group mackerel in 1975

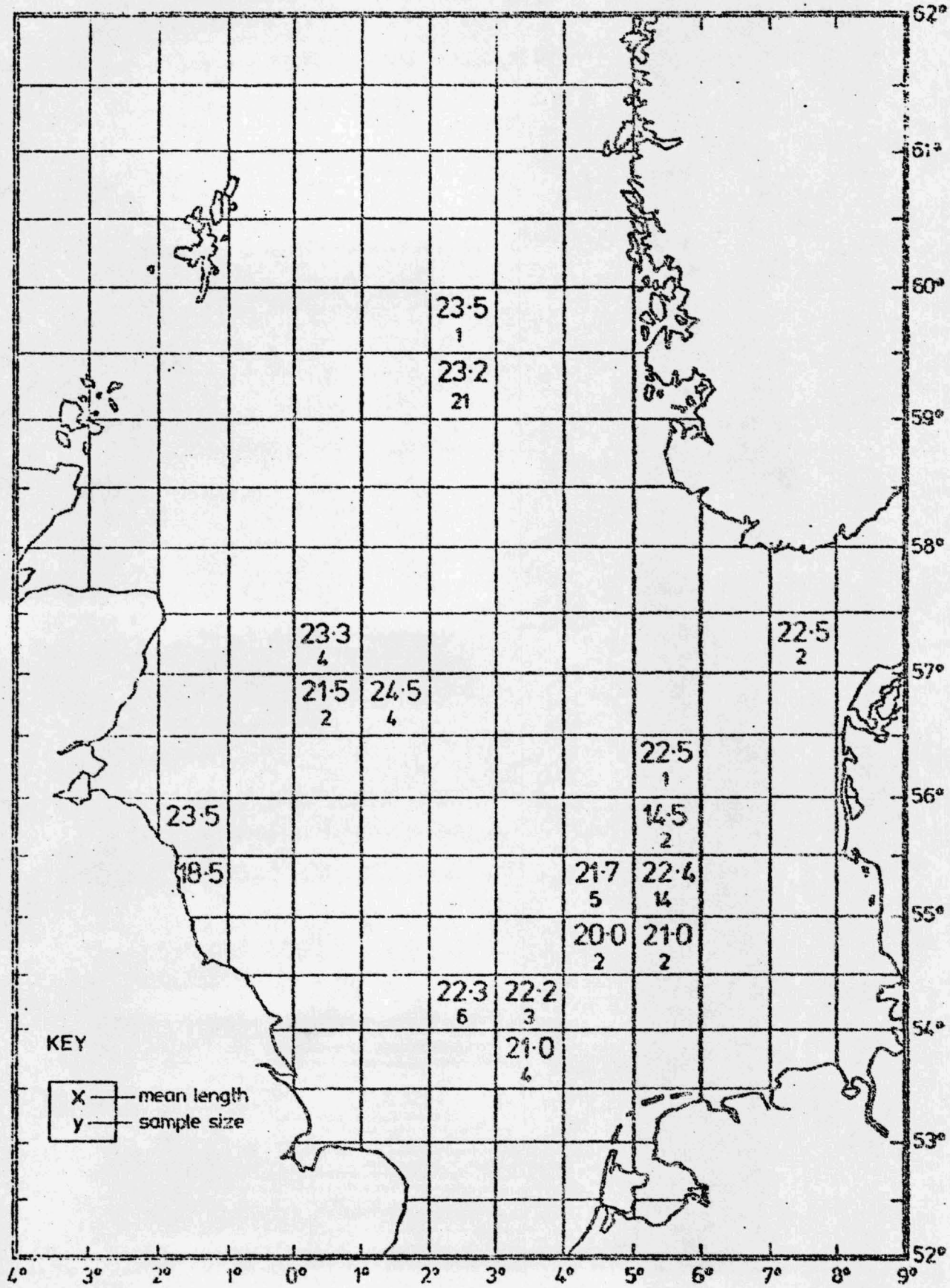

Fig. 4 Mean length-at-age of 1-group mackerel in 1976