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International Council for the
Exploration of the Sea

C.M.1976/F:5
Demersal Fish (Northern) Committee



REPORT OF THE MEETING ON ABUNDANCE ESTIMATES OF JUVENILE
COD, HADDOCK AND WHITING FROM THE 'INTERNATIONAL YOUNG
HERRING SURVEYS' IN THE NORTH SEA

Charlottenlund, 12-13 March 1976

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Report of the Meeting on Abundance Estimates of Juvenile Cod, Haddock and Whiting from the 'International Young Herring Surveys' in the North Sea

1. Terms of Reference

At the 1975 Statutory Meeting of ICES in Montreal it was resolved (C.Res. 1975/2:28 (ii)) that:

"gadoid data collected from the North Sea Young Herring Surveys should be summarised in time for the meeting of the North Sea Roundfish Working Group in March 1976. To facilitate this, the scientists involved should meet for two days immediately prior to the meeting of that Working Group".

2. Participation

The meeting which was held in Charlottenlund on 12-13 March 1976 was attended by:

Dr N Daan (Chairman)	Netherlands
Dr J R G Hislop	U.K. (Scotland)
Mr J Lahn-Johannessen	Norway
Mr C T Macer	U.K. (England)
Mr C J Rørvik	Norway
Mr E Steffensen	Denmark
Mr G Wagner	Germany, Federal Republic of

The Group regretted the absence of representatives from U.S.S.R. and France, whose countries participated in the 1976 survey. However, most of their data were available to the Group, as they had been exchanged by radio contact during the survey.

3. Introduction

The value of an abundance estimate for the 1975 year class of the different gadoid species to be derived from the Young Herring Survey 1976 is completely dependent on an accurate reference level of the abundance during surveys in former years. Although these surveys have been carried out in the first quarter of each year from 1965 onwards and a limited amount of data on gadoids has been exchanged on earlier occasions, a detailed analysis of the collected information has been carried out only since 1972 (cf. ICES, C.M.1972/F:19, C.M.1973/F:35; C.M.1974/F:16 and C.M.1975/F:37). Even then, however, the reports were of a rather preliminary nature, because agreement upon the analysis had to be reached by correspondence and up to this time there has been no possibility of discussing the different aspects of the surveys in relation to the objective of estimating year class strengths of gadoid species. For that reason the participating countries had been asked before the meeting to extract as many gadoid data as possible from former surveys, and the Group decided to re-analyse the complete set of surveys in order to provide the required reference level to evaluate the abundance of juvenile fish in 1976.

4. Surveys 1965-1975

4.1 Data base

Since the surveys started in 1965 an increasing number of countries have been participating and an increasing amount of information on gadoids has been collected. Although otolith sampling was only introduced recently on board most participating vessels, length distributions of the two youngest

age groups in the catch are generally sufficiently well separated from each other and from the older fish so that an approximate split in age groups has been possible for all hauls where length measurements of fish were available. There has been a gradual improvement both in the quality of the sampling and in the area covered by the surveys. Tables I A-C summarise the data available from each survey and for each species separately.

The Group considered the exchange of the basic information between countries and decided that in view of the vast amount of paper involved one complete archive, from which data could be supplied upon special request, would suffice. However, complete sets of summary tables of catches per year class per haul and of length-at-age data for all years will be sent to participating countries.

4.2 Survey design

Since there are differences in the geographical distribution and behaviour of young herring, cod, haddock, whiting and Norway pout in the North Sea, the Group recognised that a single combined survey is bound to become a compromise of conflicting methodological considerations. Although there was insufficient time for discussing the matter in detail, the design of the survey in relation to the distribution of young gadoids was briefly discussed, and the following points were agreed as being worthy of further attention.

- 4.2.1 The basic stratum of the gadoid part of the survey is the ICES rectangle. It was noted that the variances of the catch rates in individual rectangles were often large, which is perhaps only to be expected when it is considered that within a rectangle there may be great variation in such factors as water depth and substrate. The Group considered the possibility of changing the survey design from the present method, whereby the freedom of each vessel to select its own trawling stations randomizes the distribution of hauls to a method whereby trawling stations within each rectangle are fixed. Although the latter method would result in improved comparability of abundance from year to year in each rectangle, it might seriously affect the statistical basis of the surveys.

A detailed analysis of the variances of catch rates within rectangles is required in order to improve upon the survey design, especially in relation to an optimum spread of the research effort available. A particular point of the study relates to diurnal variations in catch rates of young gadoids. At present roundfish trawl stations may be fished both by daylight and during the night, but no information is available on the extent to which this affects the variation in catch rates.

- 4.2.2 The problem of comparability of fishing power between participating research vessels, which might seriously affect the survey results can be alleviated by standardising the gear. Every effort should be made to come to an agreement on this point as soon as possible.

- 4.2.3 The importance of covering the whole area inhabited by significant numbers of young gadoids was stressed. The long-term average distribution chart for I-group haddock (Figure 5) shows that such considerable numbers occur to at least latitude 61°N. It is recommended to extend the coverage so that the area surveyed is limited according to the 200 m line.

It was noted that due to adverse weather conditions and other factors, sometimes no data were available for individual or even groups of rectangles. To reduce the chance of such gaps in the information, it was considered desirable to ensure that, when the survey is planned, as far as practicable each rectangle is allocated to at least two countries.

5. Yearly Distribution of Juvenile Cod, Haddock and Whiting

Figures 1 A-K, 2 A-J and 3 A-K present the abundance in mean numbers per hour fishing of I-group and II-group cod, haddock and whiting, respectively.

6. Long-Term Average Distribution

In order to provide a guideline for determining the areas of highest density of young fish, which are to be covered in future surveys, and also to delimit suitable areas for calculating abundance estimates from the available surveys, long-term average catches per hour fishing per rectangle were calculated for both I-group and II-group cod, haddock and whiting over the years of surveys (Figures 4, 5 and 6).

6.1 Cod (Figure 4)

I-group cod appear to be the most densely distributed along the continental coast. A secondary band of higher catch rates runs from the English north-east coast over the Dogger Bank towards the Skagerak. Low abundance is observed southeast of the Dogger Bank and young cod are virtually absent from Scottish waters. In the northern North Sea there are only 2 years of observation, during which large catches have been reported in the central part only.

II-group cod show the same general distribution pattern, with a markedly low abundance southeast of the Dogger Bank. However, compared to the I-group cod, the II-group fish are much less concentrated along the continental coast and more widely distributed in the northern North Sea.

6.2 Haddock (Figure 5)

Both I-group and II-group haddock are almost exclusively found to the west and north of the Dogger Bank, where they appear to be rather evenly distributed. Considerable quantities occur at the northern limit of the present survey.

6.3 Whiting (Figure 6)

Young whiting are distributed more generally throughout the North Sea than both haddock and cod. The largest catches of I-group whiting are made along the east coast of the British Isles and in the German Bight and relatively few are found to the north of latitude 58°N. Although the distribution of the II-group whiting is broadly similar, these fish are more abundant than the I-group between 58°N and 60°N.

7. Estimates of Abundance

Estimates of annual abundance were made for I- and II-group cod, haddock and whiting using the data from the surveys in 1965 to 1975 and the provisional data on I-group fish obtained in 1976. When estimates were made from untransformed data, the variances turned out to be considerably in excess of the mean, suggesting a negative binomial distribution of the catches over the North Sea. Accordingly, the estimates of abundance given in this report were made using data that had been transformed to natural logarithms after the addition of 1 to each data point.

Two sets of indices were calculated in order to take account of the fact that the coverage of the North Sea had gradually changed. One set of indices for all three species refers to Divisions IVb-c in which all the fishing had taken place prior to 1969 (Table II) and which thus provides the longest series of comparable years. In addition a separate index has been calculated for cod in Division IVa (Table III) in view of the fact that the North Sea Roundfish Working Group generally assesses the cod stocks in the two areas separately. For haddock and whiting an index for the whole North Sea has also been provided (Table III).

The rectangles included in the calculations are outlined in Figures 4, 5 and 6. For haddock the whole southerly area has been omitted, because this area is of no significance for this species. Similarly, other boundaries of the ICES regions have been slightly adjusted to fit the present requirements.

No trials were made at this stage to compare the results with estimates of year class size from VPA, since it was assumed that an updated VPA would be calculated at the North Sea Roundfish Working Group meeting immediately following the present meeting. However, a comparison of the log-transformed indices of I-group and II-group cod, haddock and whiting revealed highly significant correlation coefficients ($P < 0.02$ for all species, Figure 10), indicating that the surveys present reproducible results for each of these two age groups in consecutive years.

No evaluation of the data in Table III has been made, because these refer to a rather limited number of years only. It may be observed, however, that for cod in Division IVa there seems to be no correlation between I-group and II-group cod abundance, which suggests that the cod in this area might recruit from elsewhere.

8. Preliminary Results 1976 Survey

Figures 7, 8 and 9 show the catches of I-group cod, haddock and whiting during the 1976 Survey. The figures are provisional, because except for Scotland and Denmark, which countries brought their final data to the meeting, most countries were not able to analyse their otolith samples in time. Consequently, an estimate of the catches of I-group fish has been made on the assumption that all cod < 25 cm and all haddock and whiting < 20 cm belonged to the 1975 year classes.

It is seen that in the northern North Sea a number of squares have not been fished due to the bad weather conditions during the first part of the survey period.

8.1 Cod (Figure 7)

The general distribution pattern of the cod year class 1975 corresponds very well with the long-term average (Figure 4 A), but catches were very poor throughout the North Sea. The estimated abundance (Table III) indeed indicates a very poor year class.

8.2 Haddock (Figure 8)

The catches of young haddock were very poor throughout the North Sea, the year class strength index for 1975 being comparable to the extremely poor year classes 1965 and 1969 (Table III).

8.3 Whiting (Figure 9)

The distribution of young whiting in 1976 was rather patchy. The English northeast coast yielded high catches, whereas in the southeastern part and in the northern part of the North Sea the catches were below average. One extremely large catch was made in the tailend area. The overall index of the whiting 1975 year class appears to be above average (Table III).

9. Recommendations

1. A vast amount of information in growth of individual year classes is available in the basic material, the analysis of which might reveal a relation to the abundance of the year classes. In view of the relevance of density-dependent growth to stock assessment it is recommended that the growth data are worked up.

2. Problems relating to survey design should be studied in detail. The data file contains a vast amount of valuable information, which could be used for this purpose.
3. Every effort should be made to ensure that:
 - (a) the gear is standardised as far and as soon as possible;
 - (b) all rectangles where young roundfish might be present in significant numbers are covered by the survey each year. A change in the planning is recommended so that each square is allocated to at least two countries. This would reduce the possibility of a square not being sampled.

Figures 1 A-K, 2 A-J and 3 A-K represent the mean catches per 1 hour's trawling per statistical rectangle of I- and II group cod, haddock and whiting taken during the International Young Herring Surveys of 1965* to 1975. The numbers of valid hauls can be supplied on request.

Figures 4, 5 and 6 give the mean numbers per 1 hour's fishing of I- and II-group cod, haddock and whiting taken during the period 1965-75. The number of years for which data were available can be supplied on request.

Figures 7, 8 and 9 represent preliminary estimates of mean number per hour's fishing of juvenile cod, haddock and whiting during the 1976 Young Herring Survey. The numbers of valid hauls can be supplied on request.

* Haddock data were available from 1966 onwards

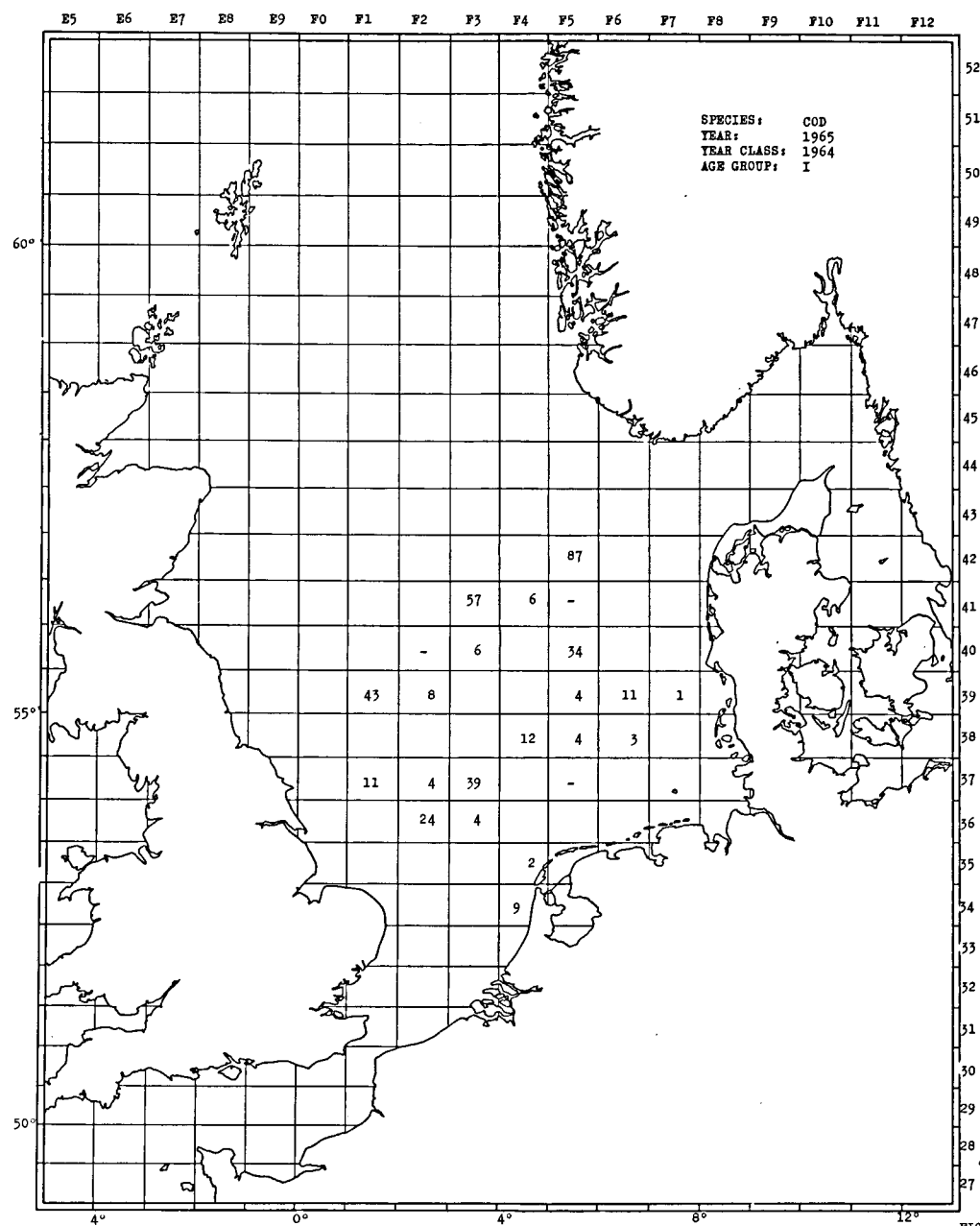
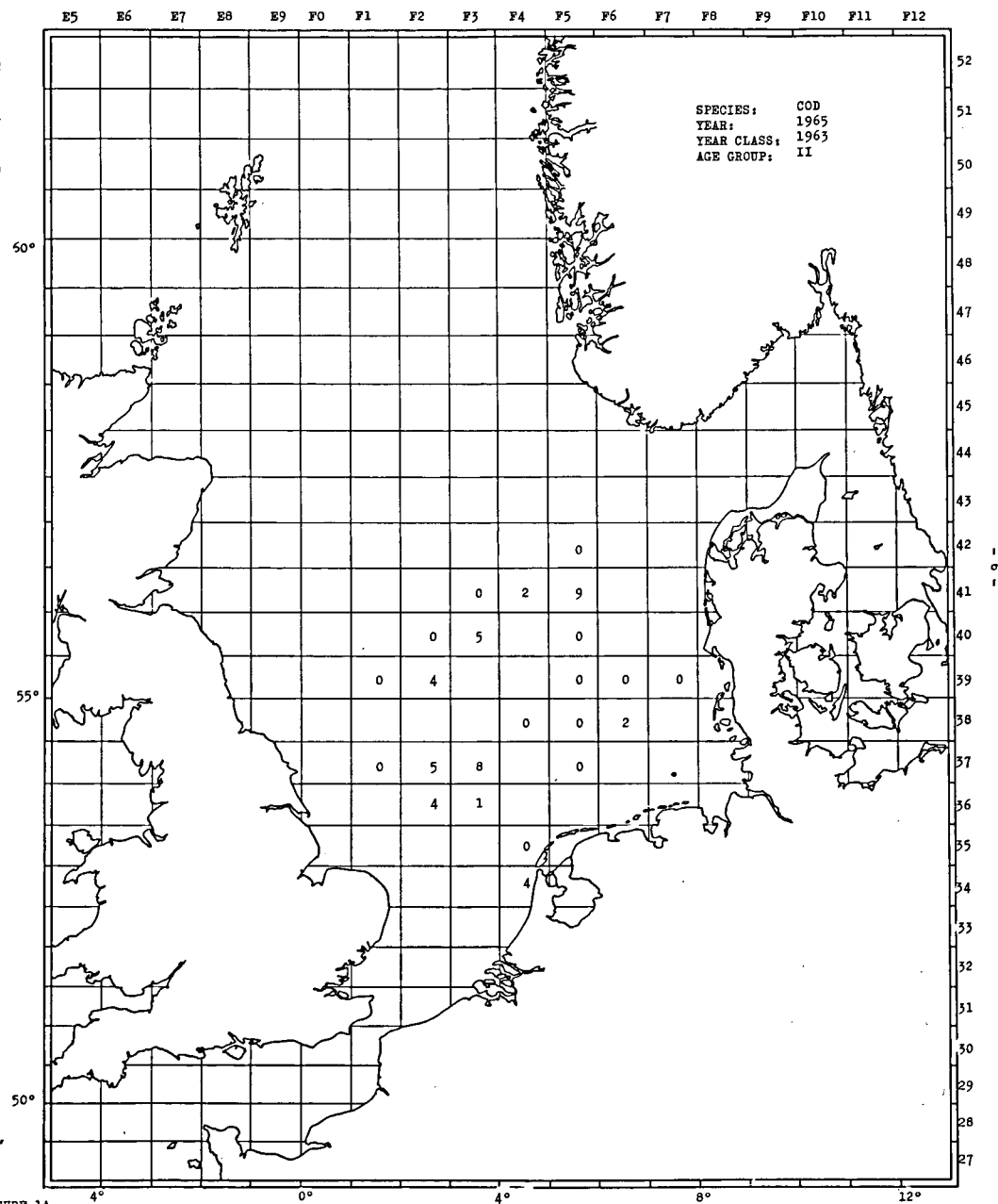


FIGURE 1A



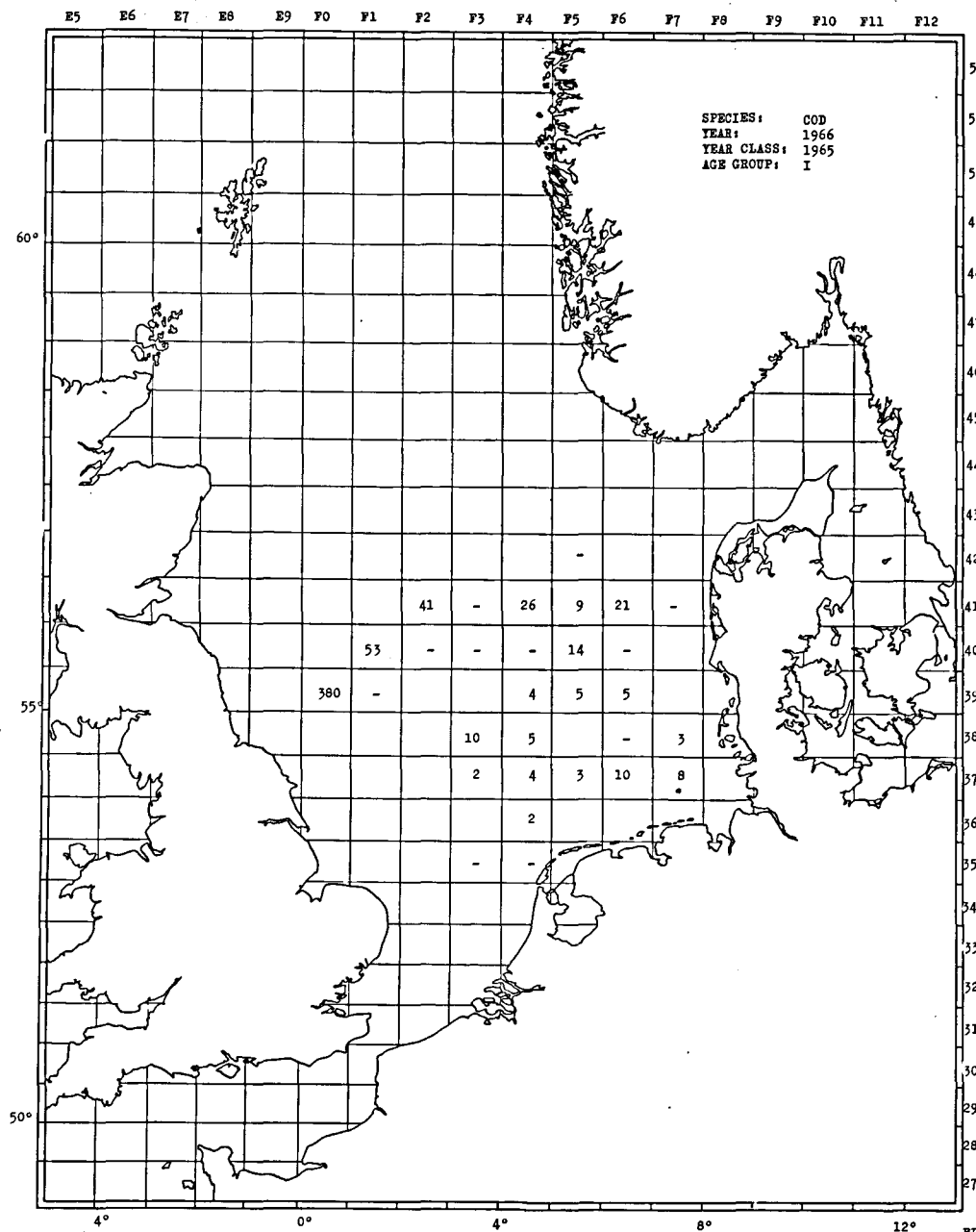
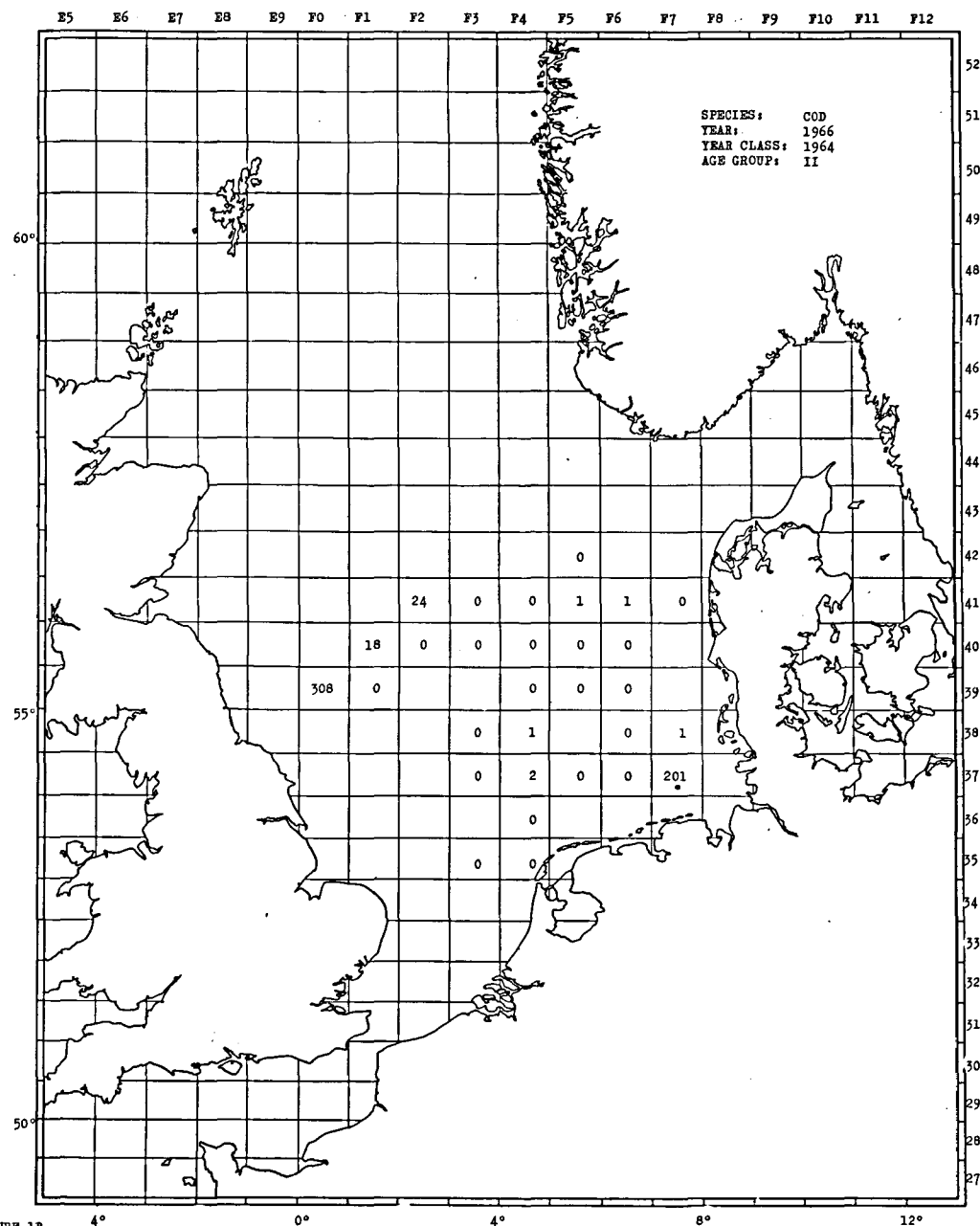


FIGURE 13



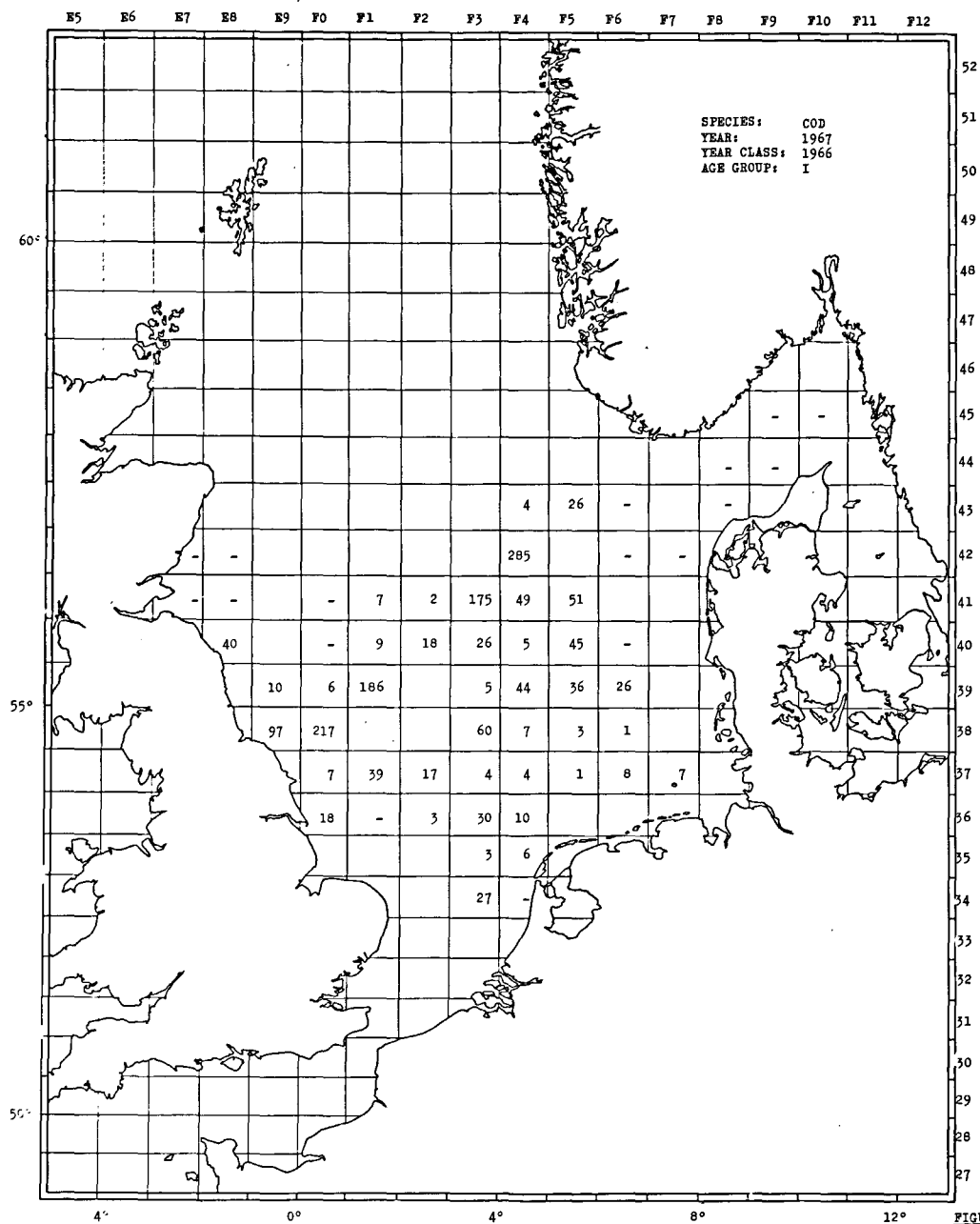
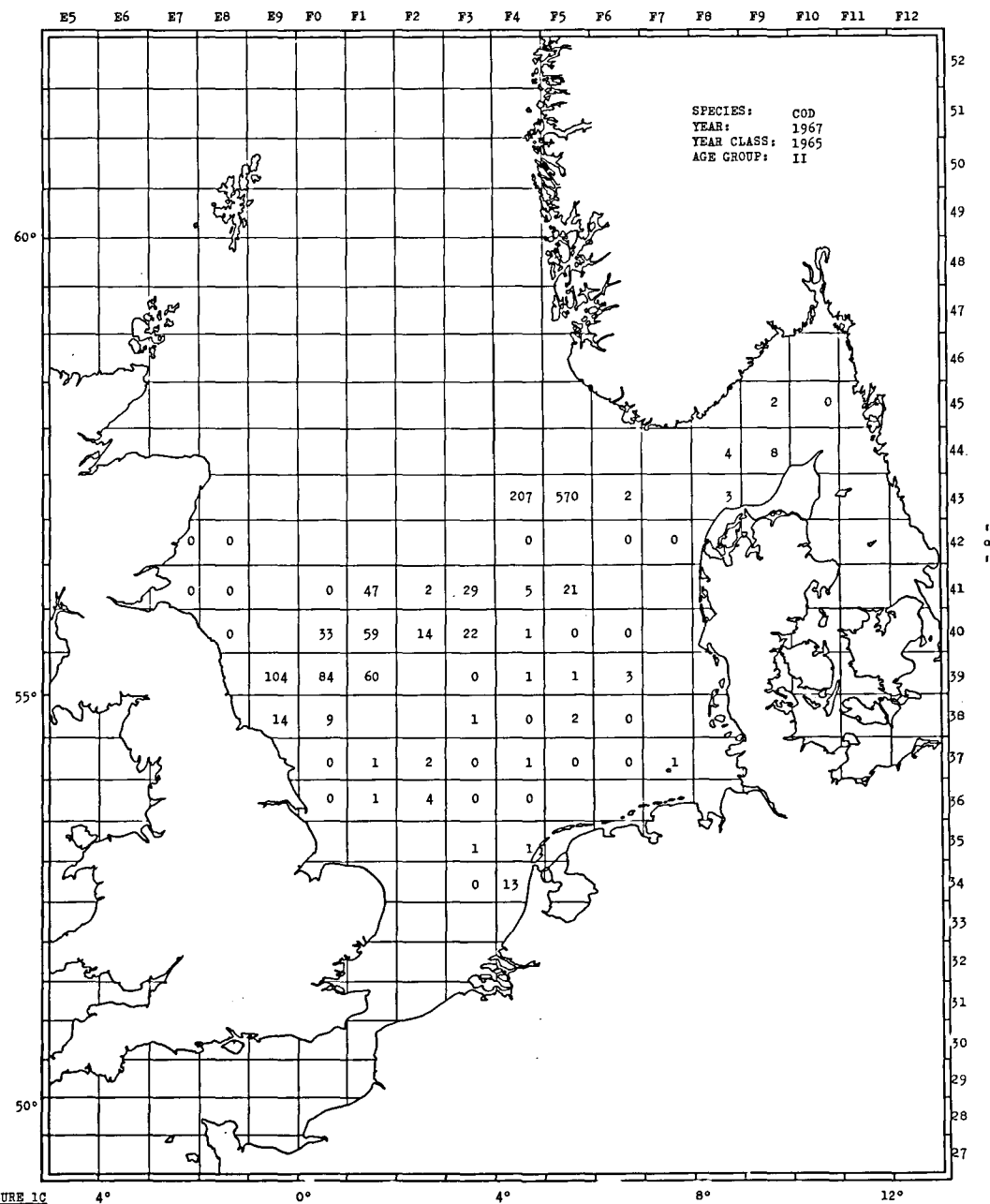


FIGURE 1C



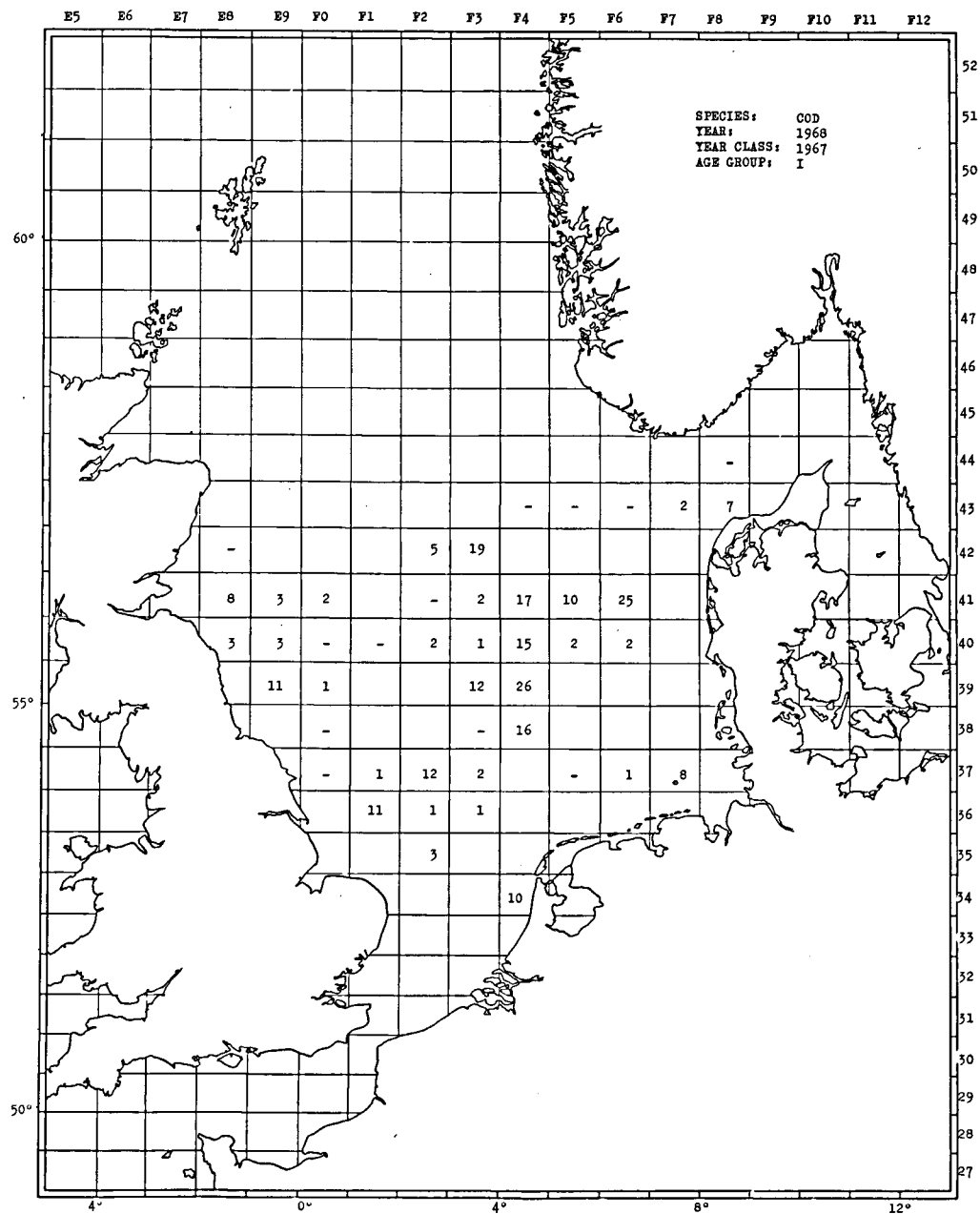
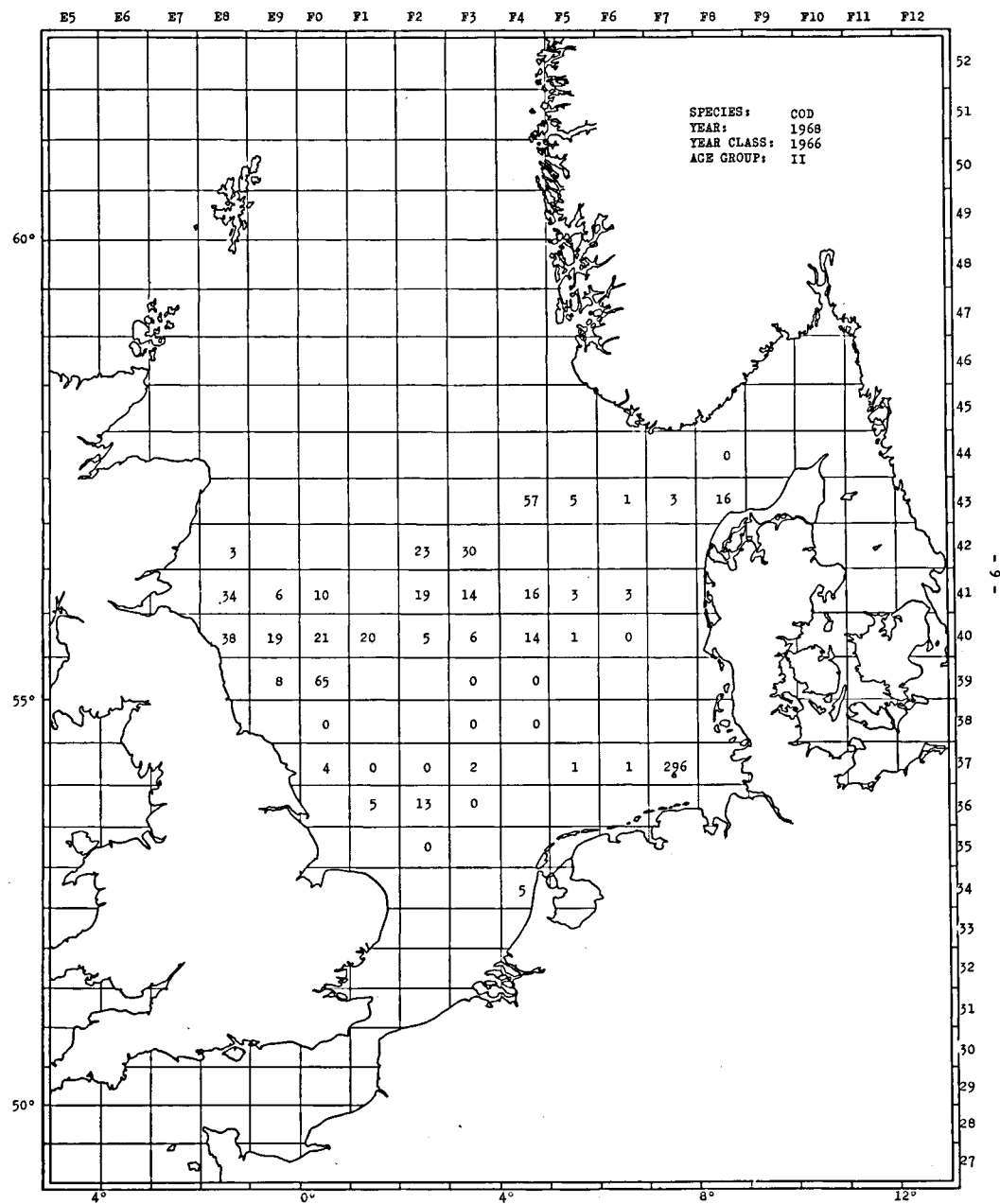


FIGURE 1D



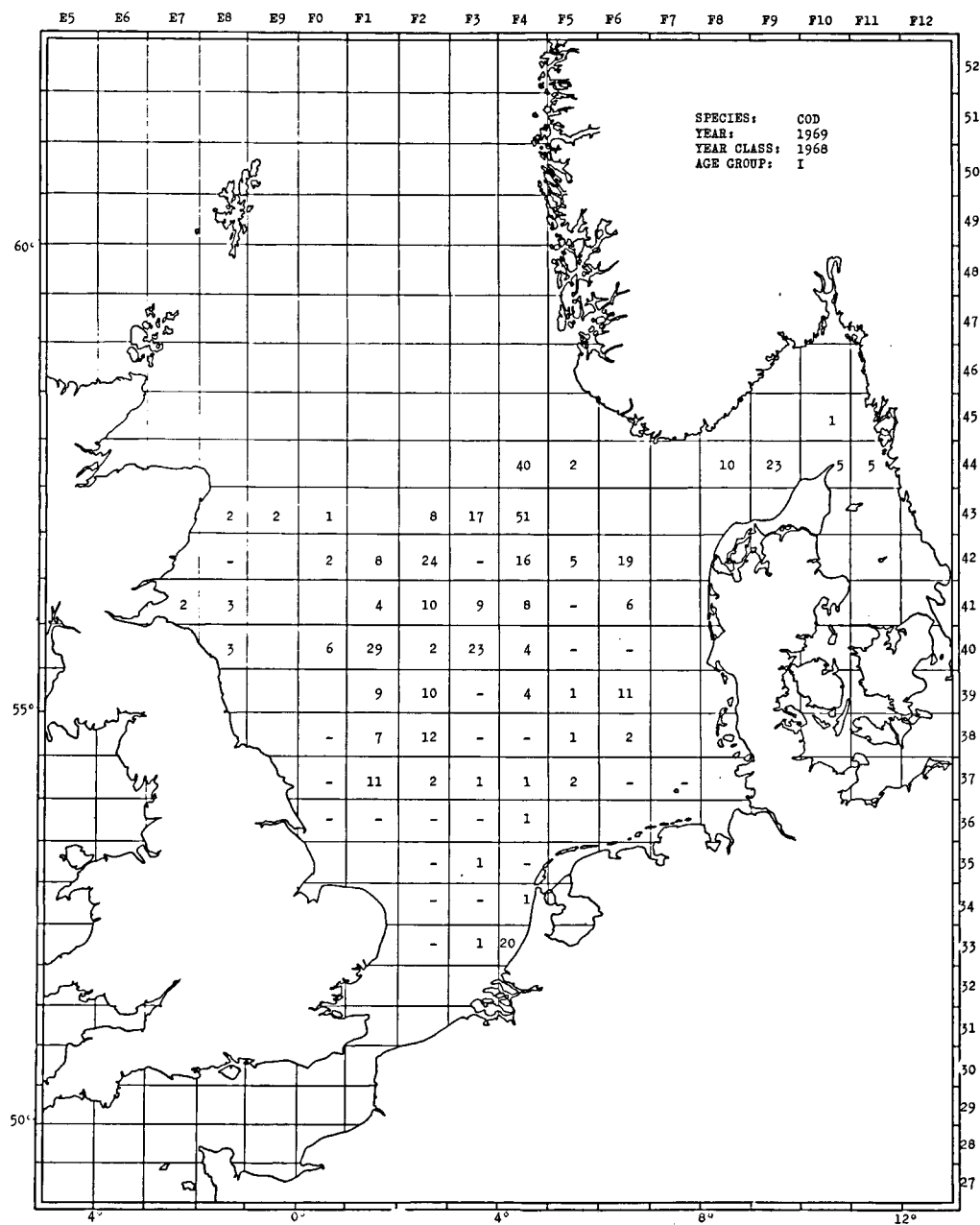
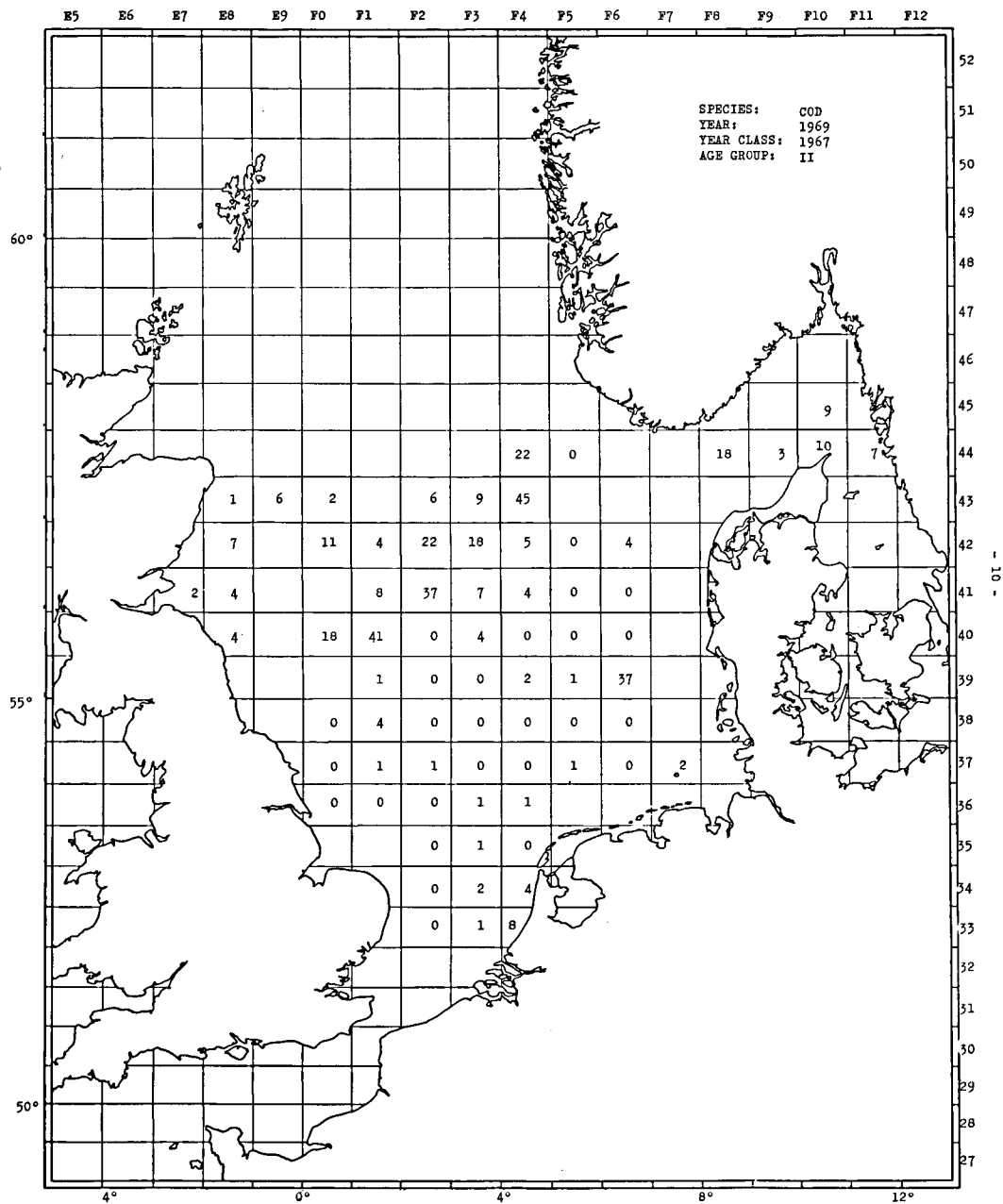


FIGURE 1B



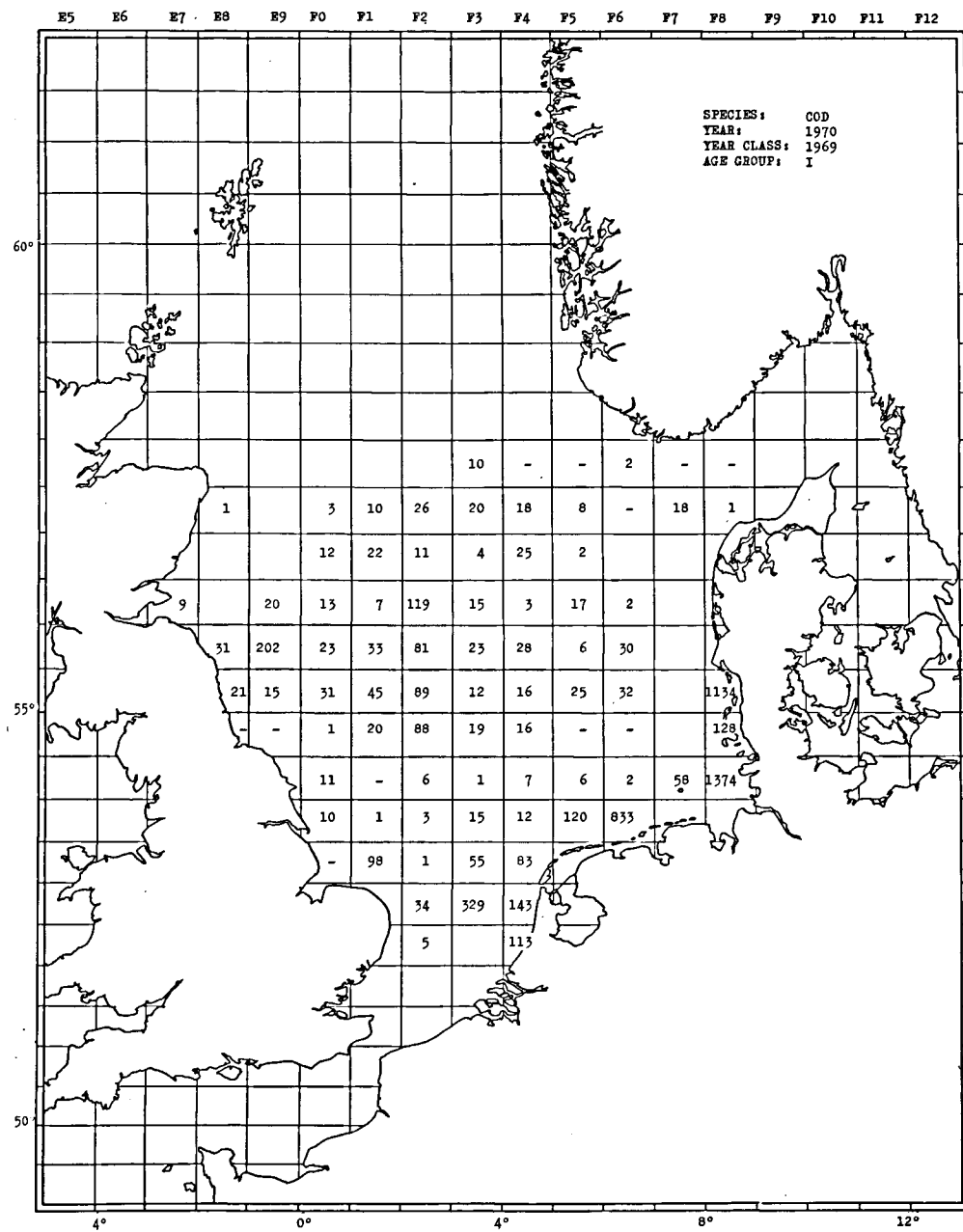
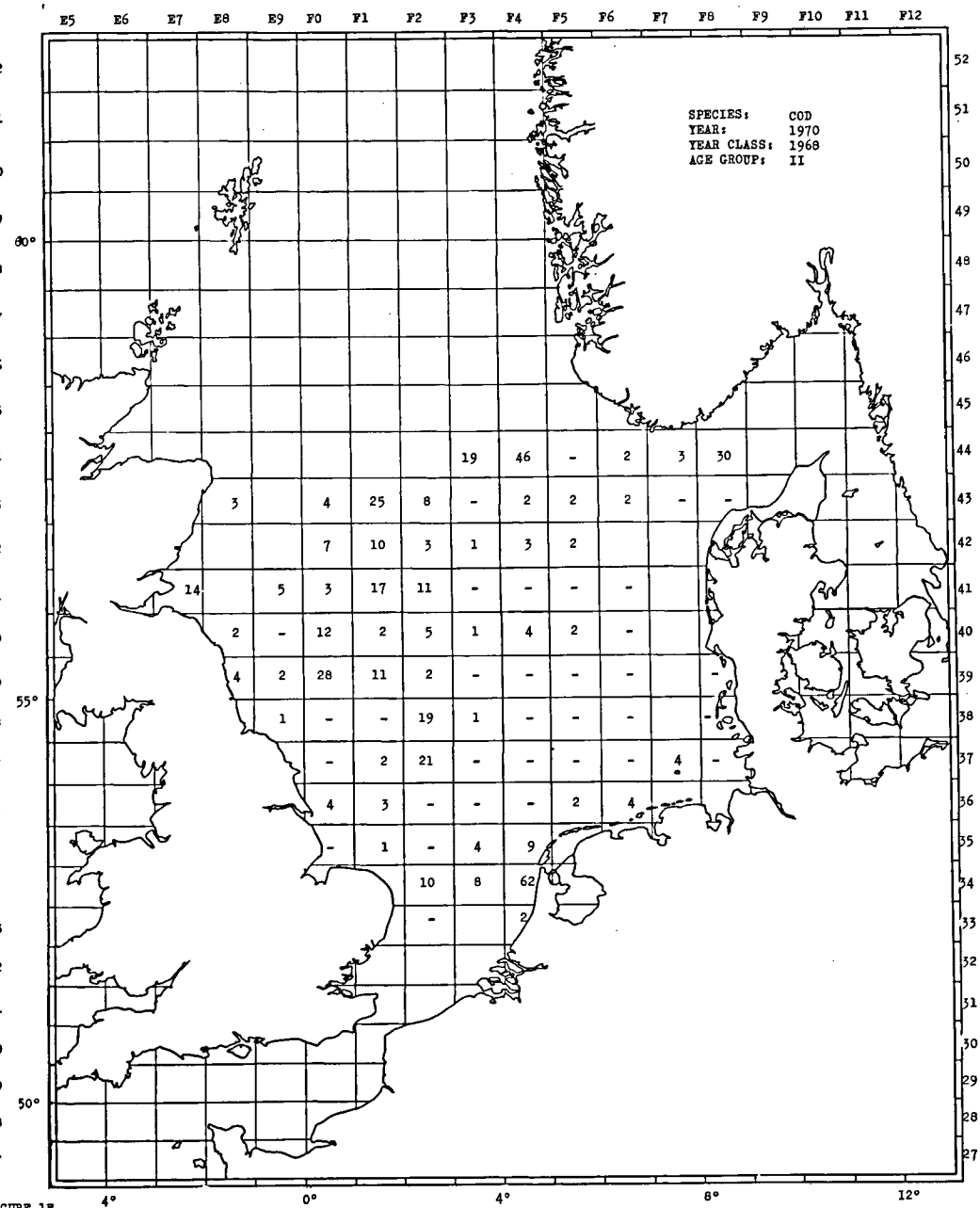


FIGURE 12



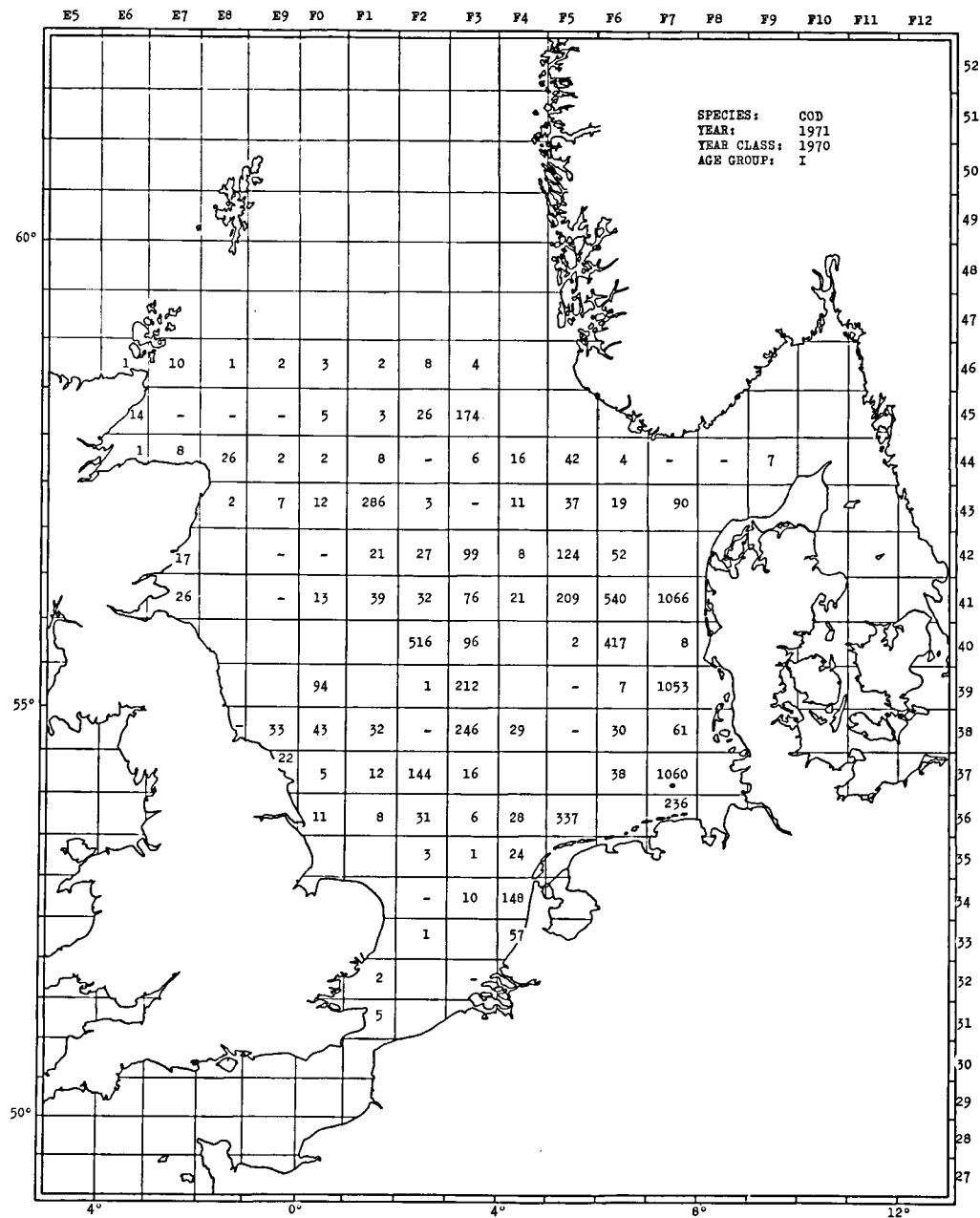
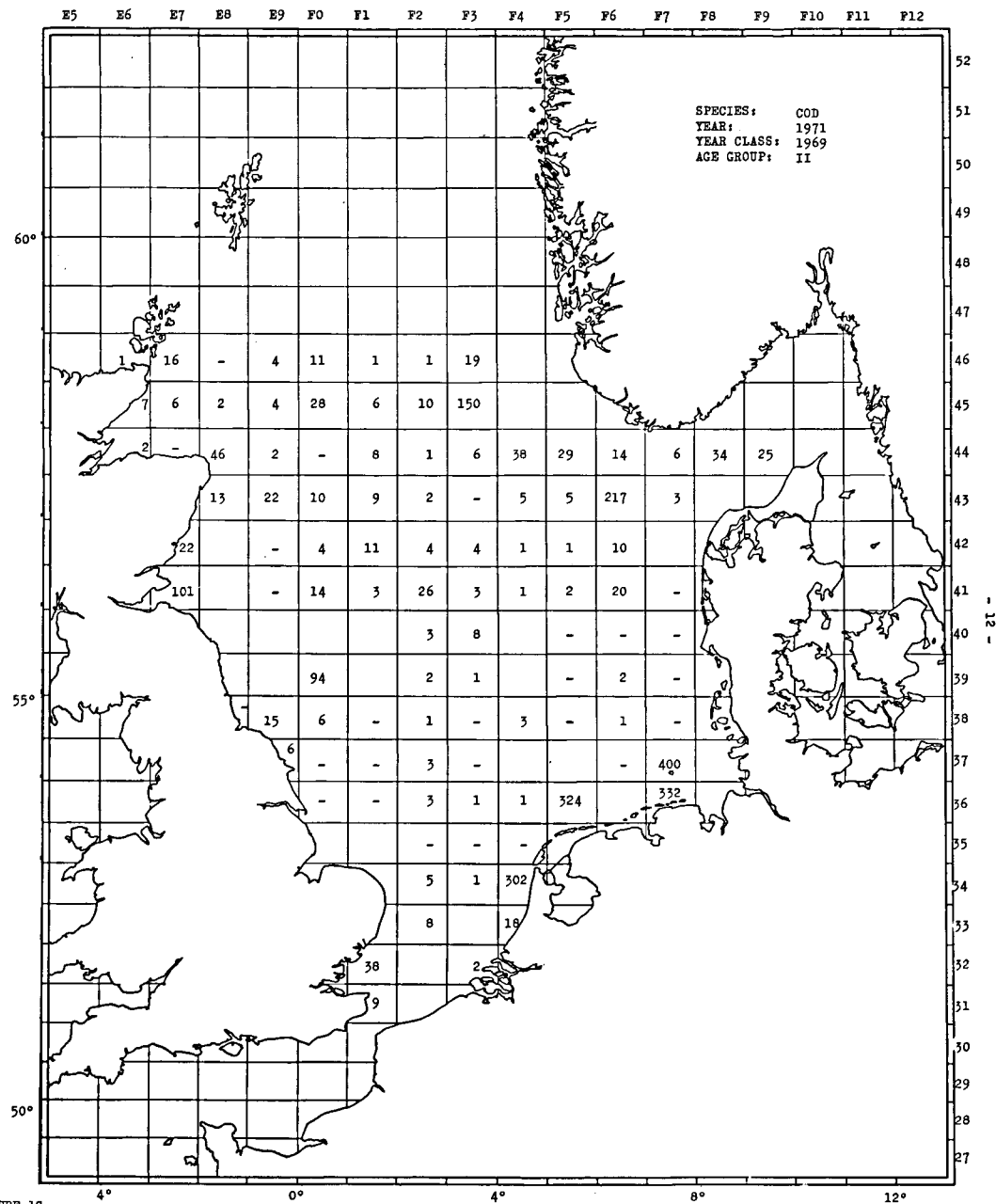


FIGURE 1G



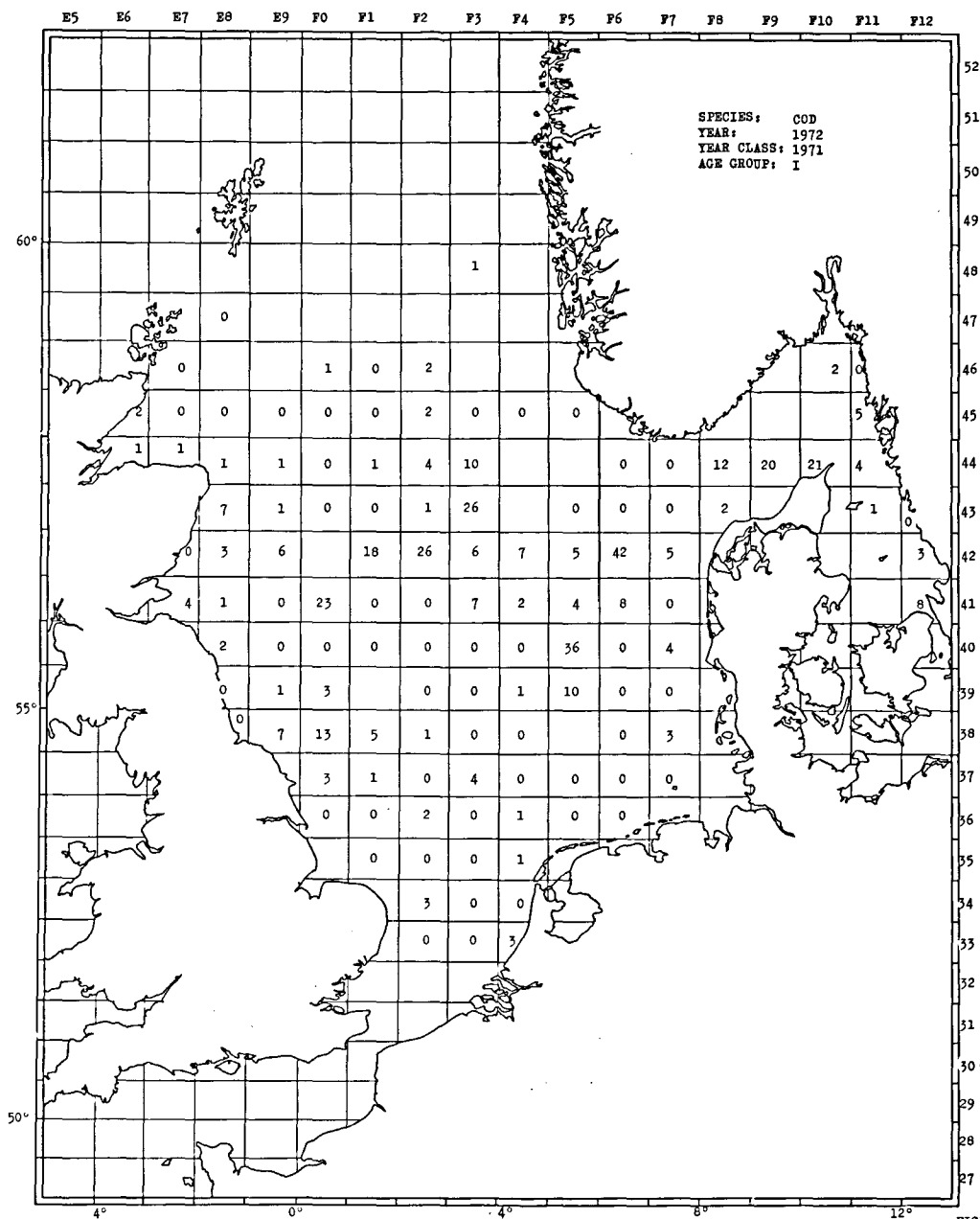
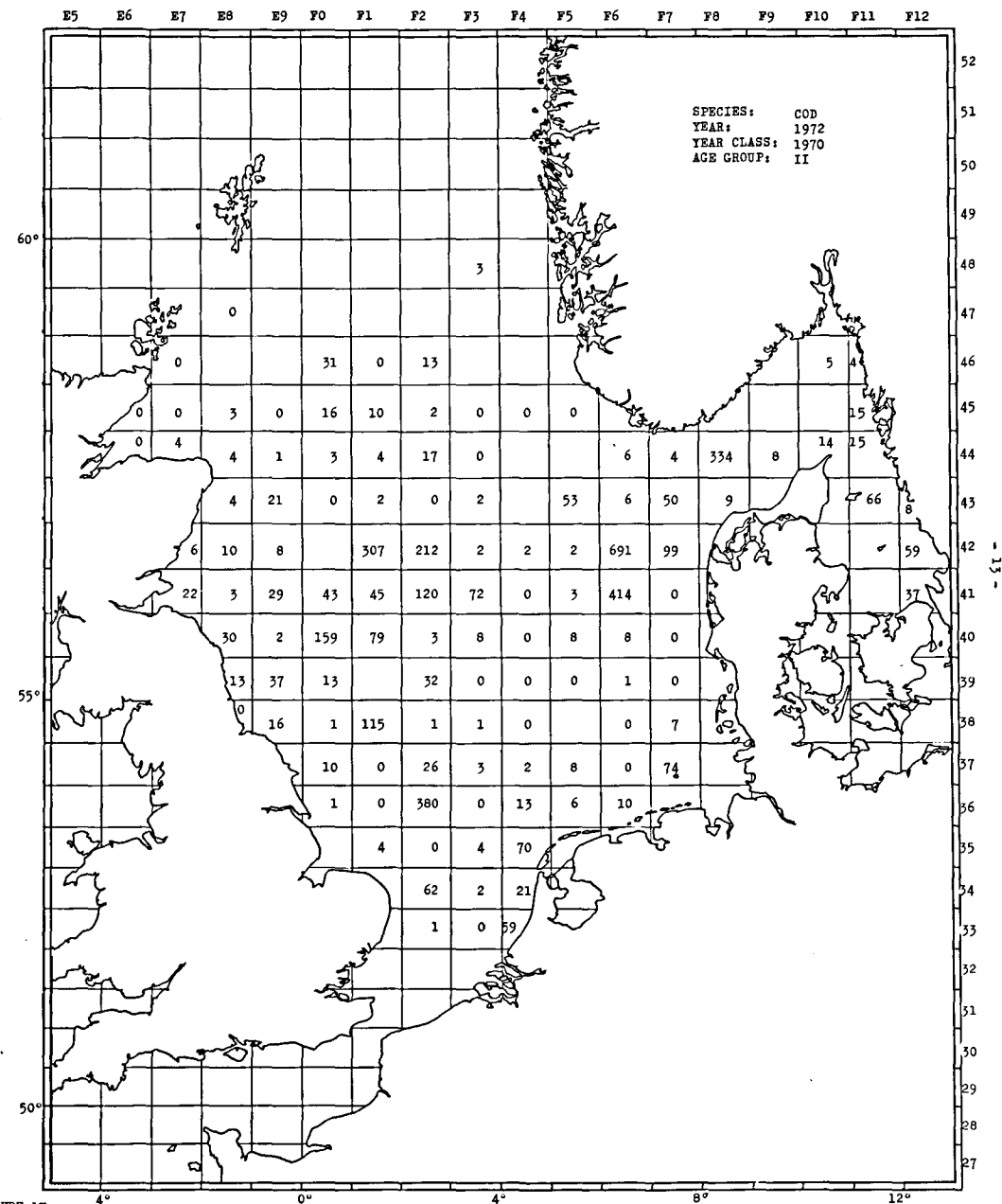


FIGURE 1H



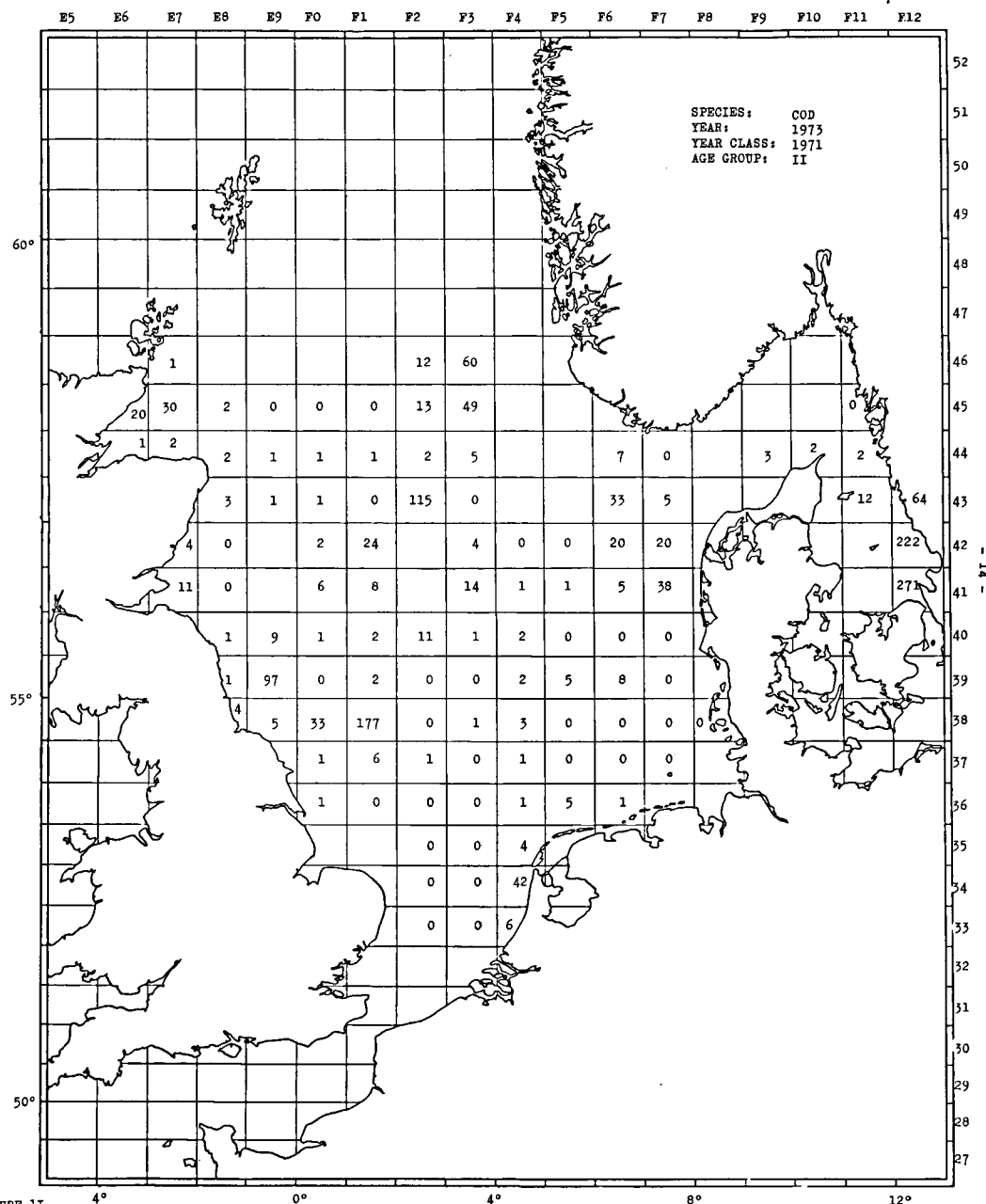
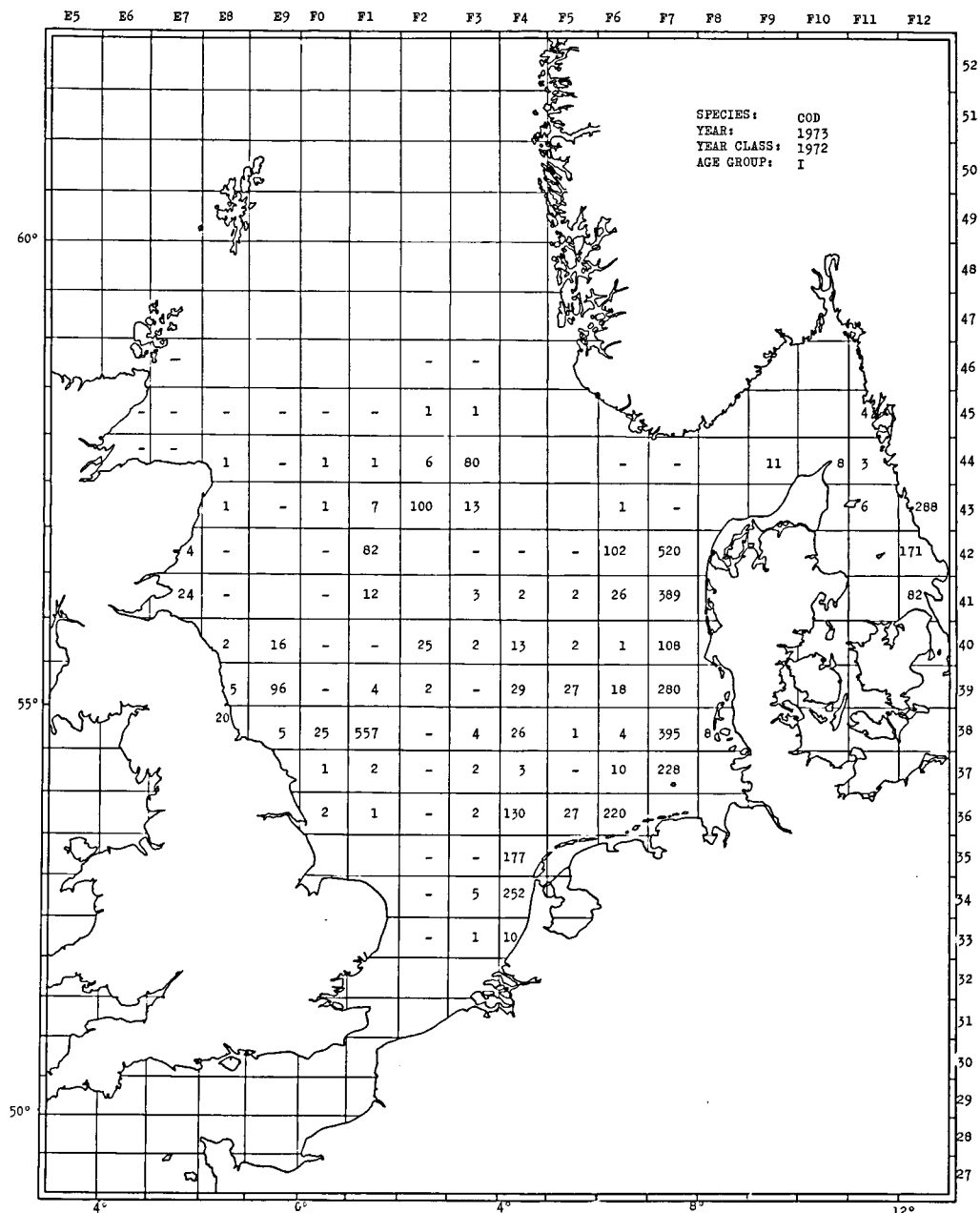


FIGURE 11

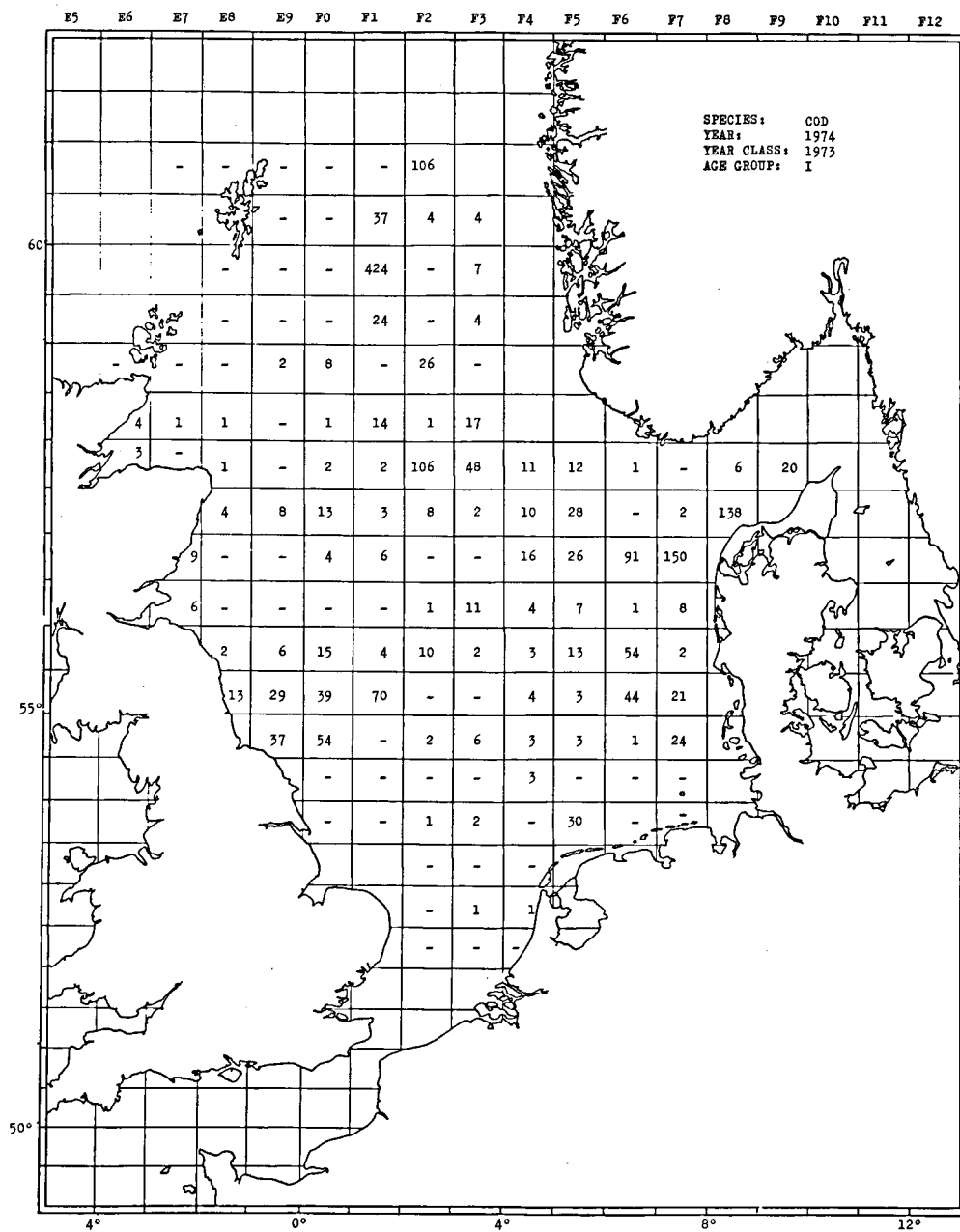
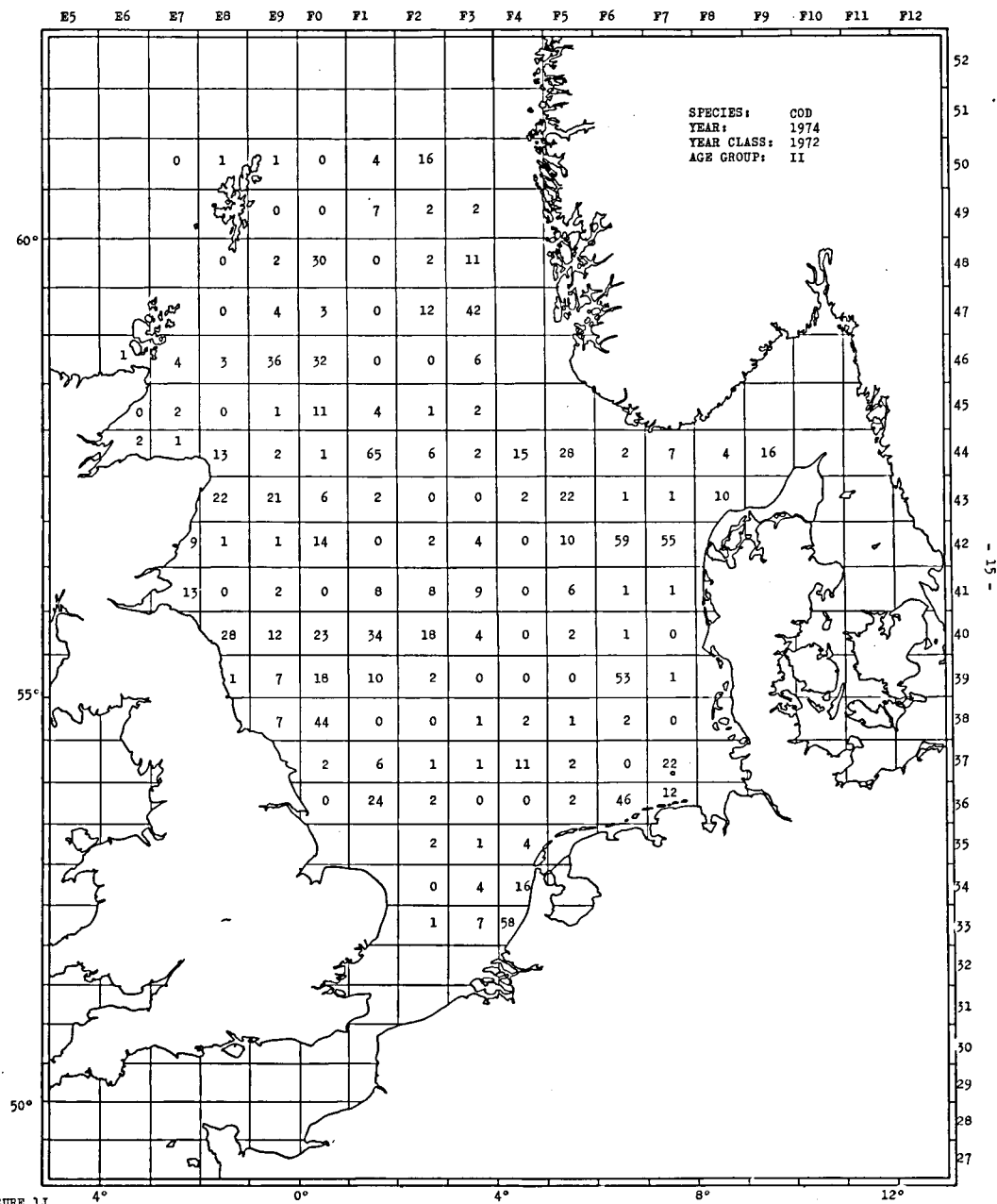


FIGURE 11



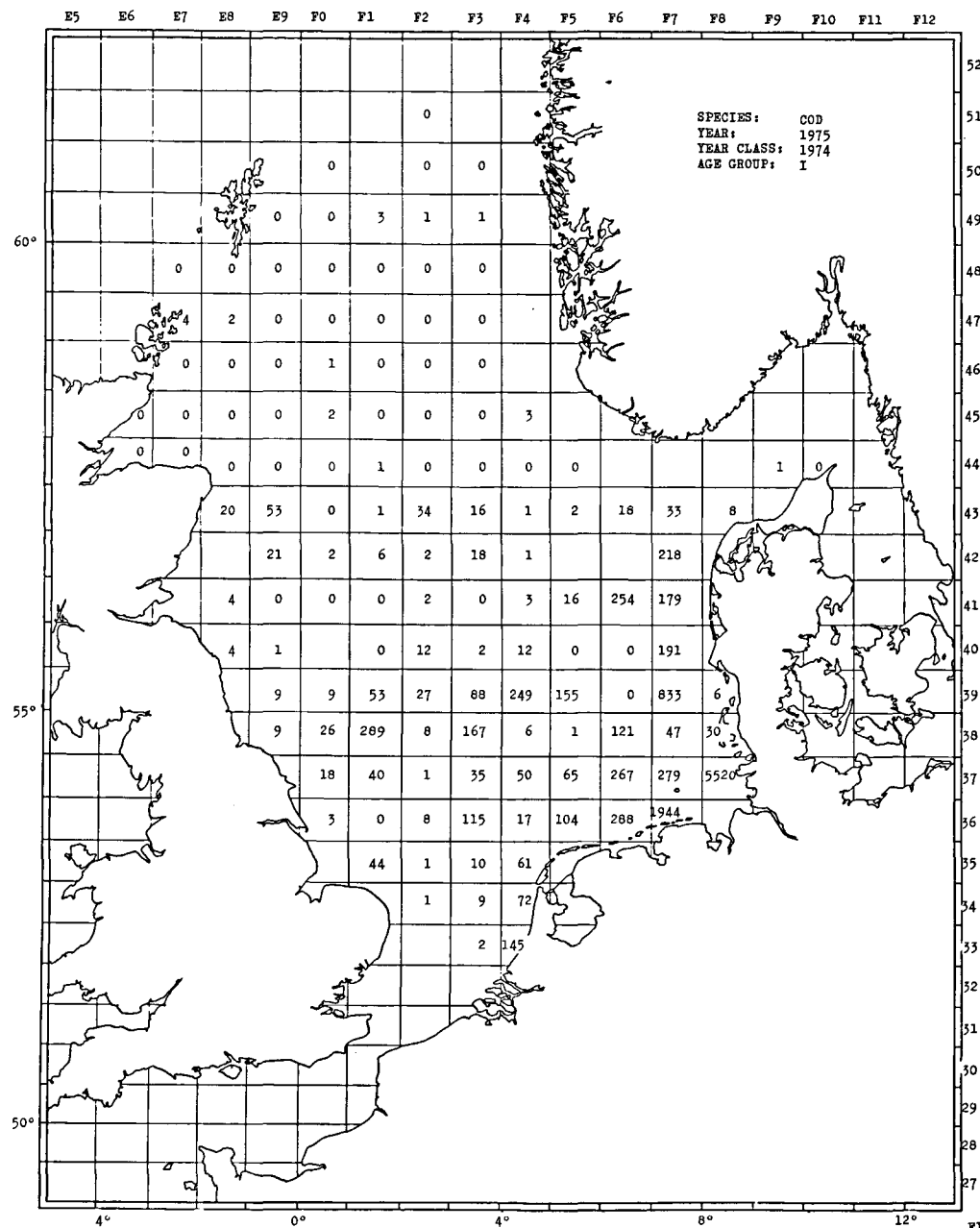
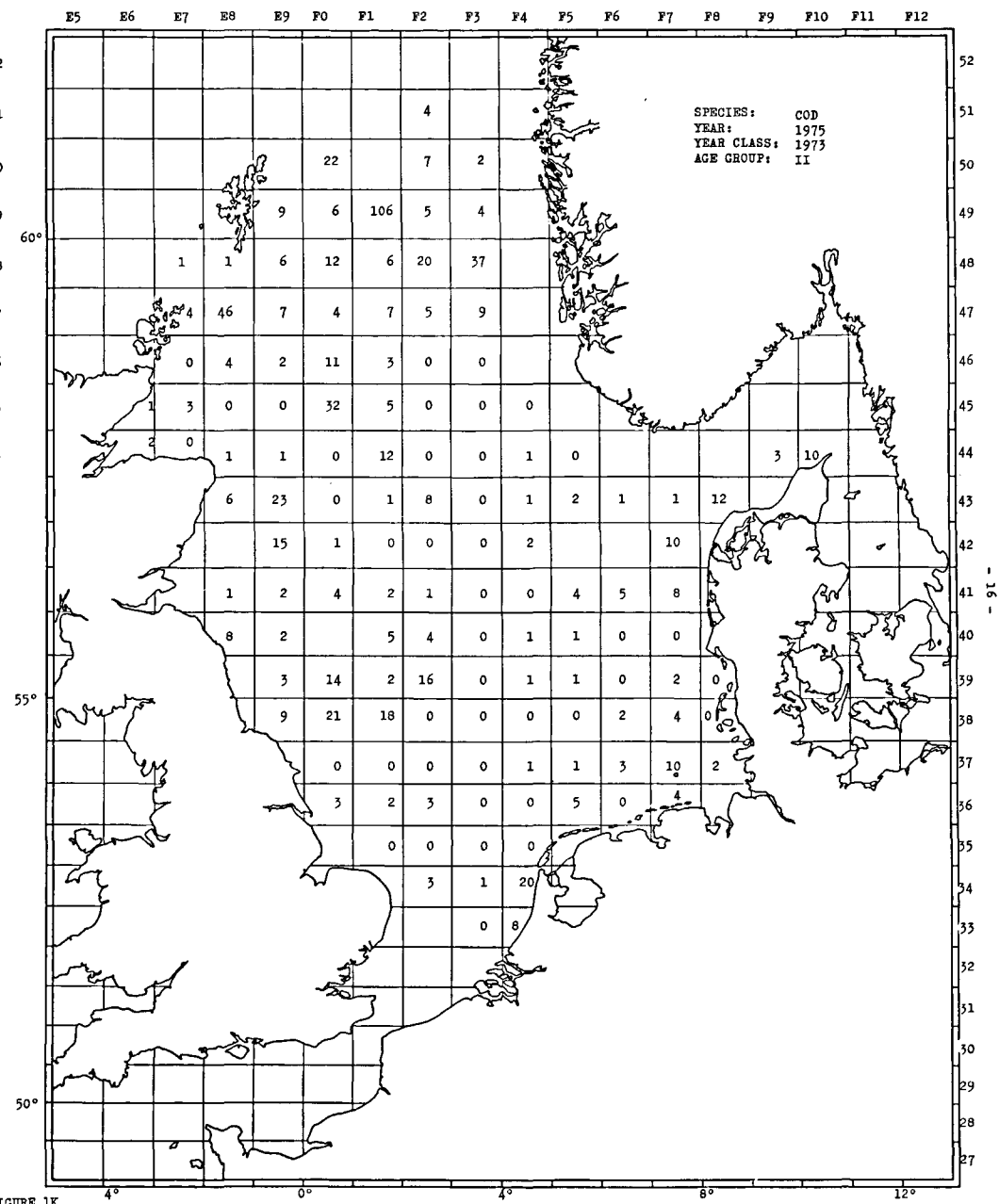


FIGURE 1K



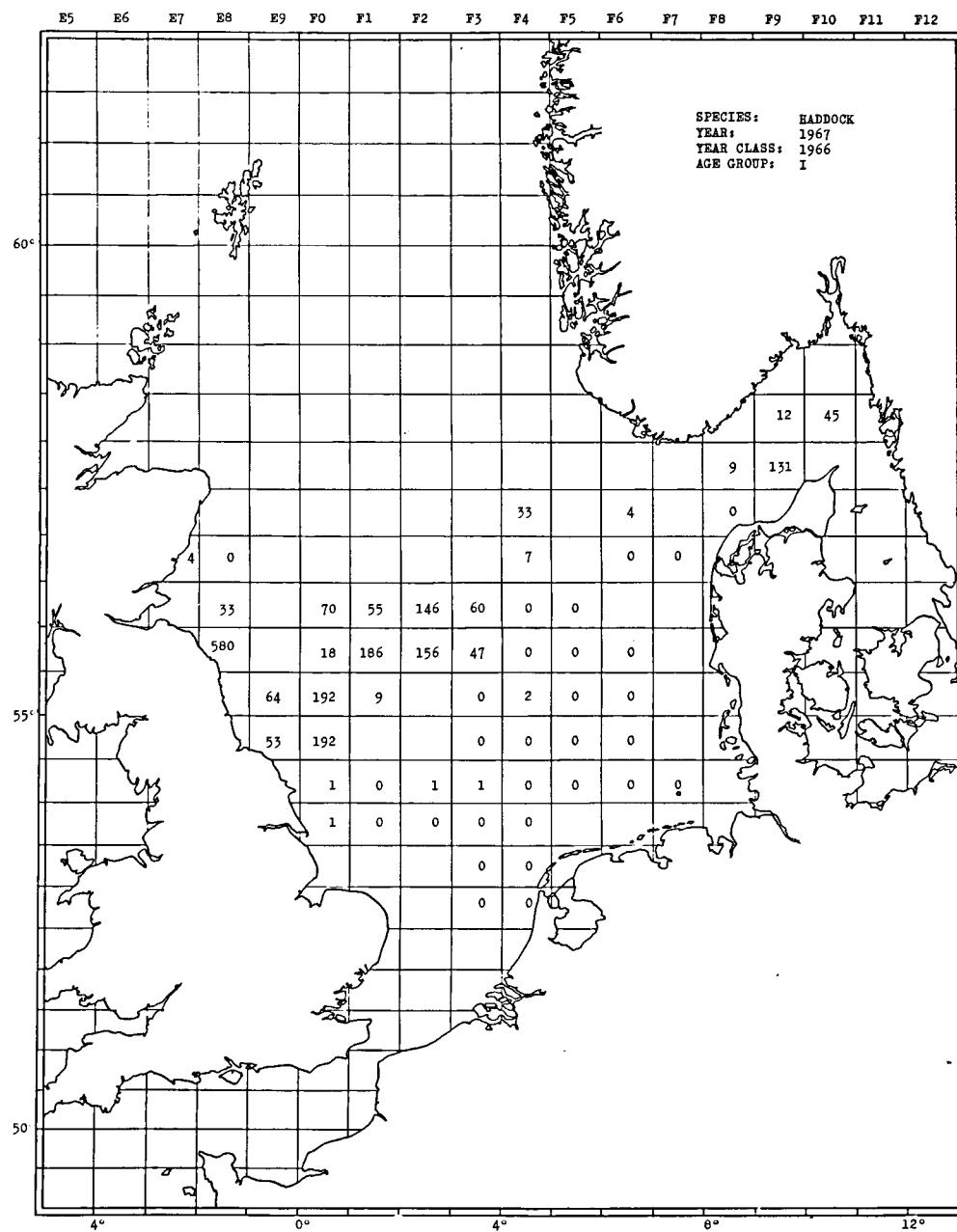
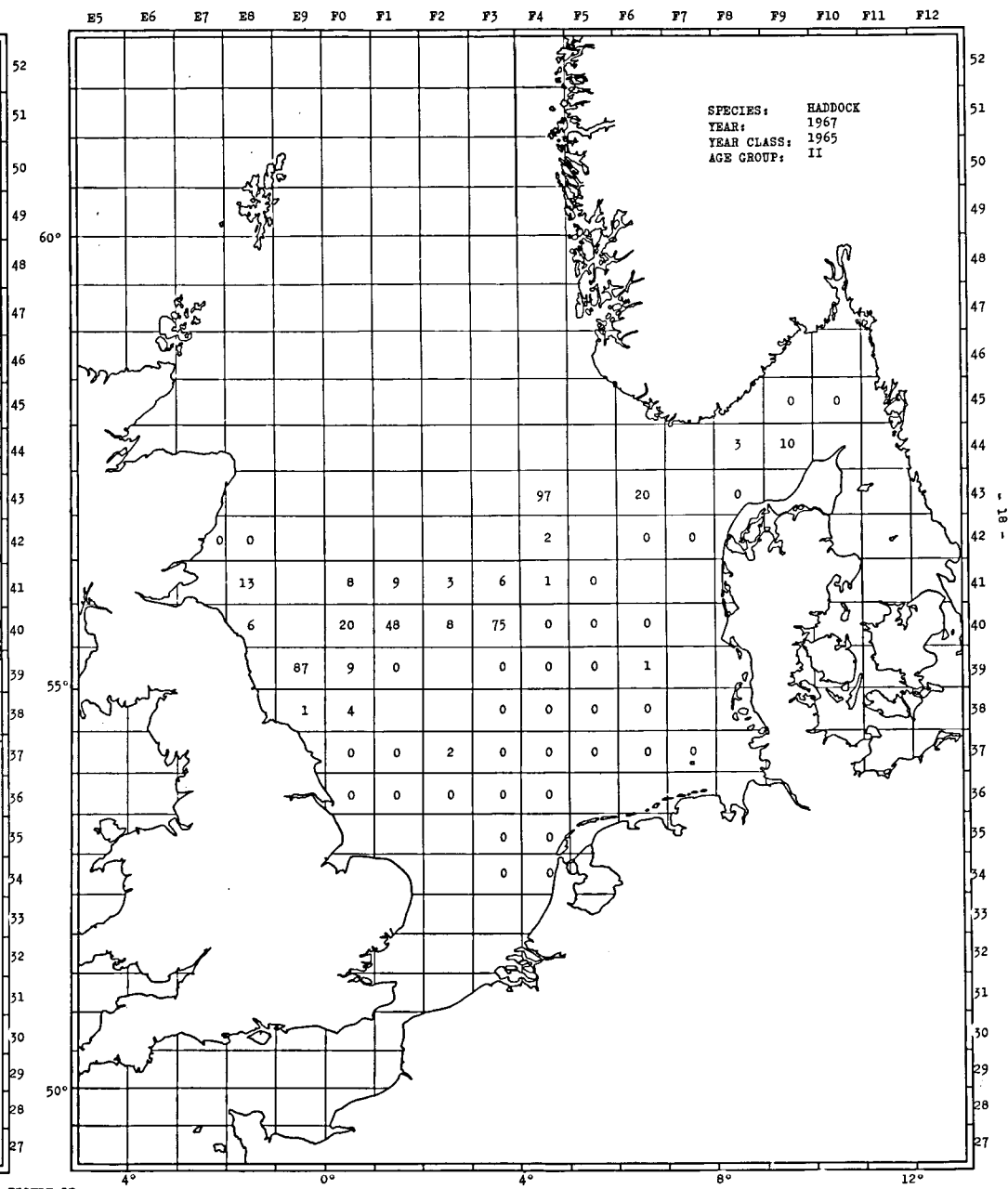


FIGURE 2B



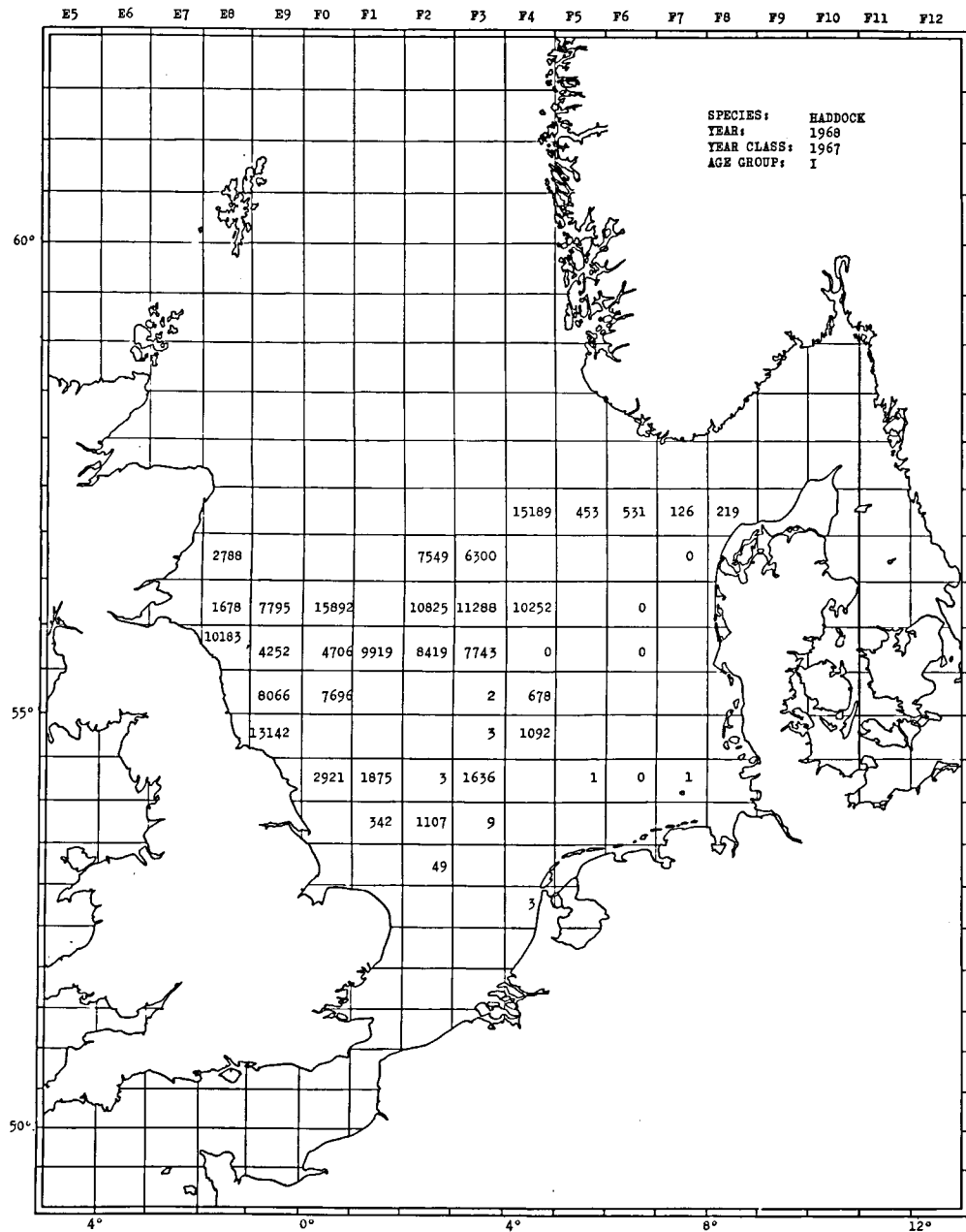
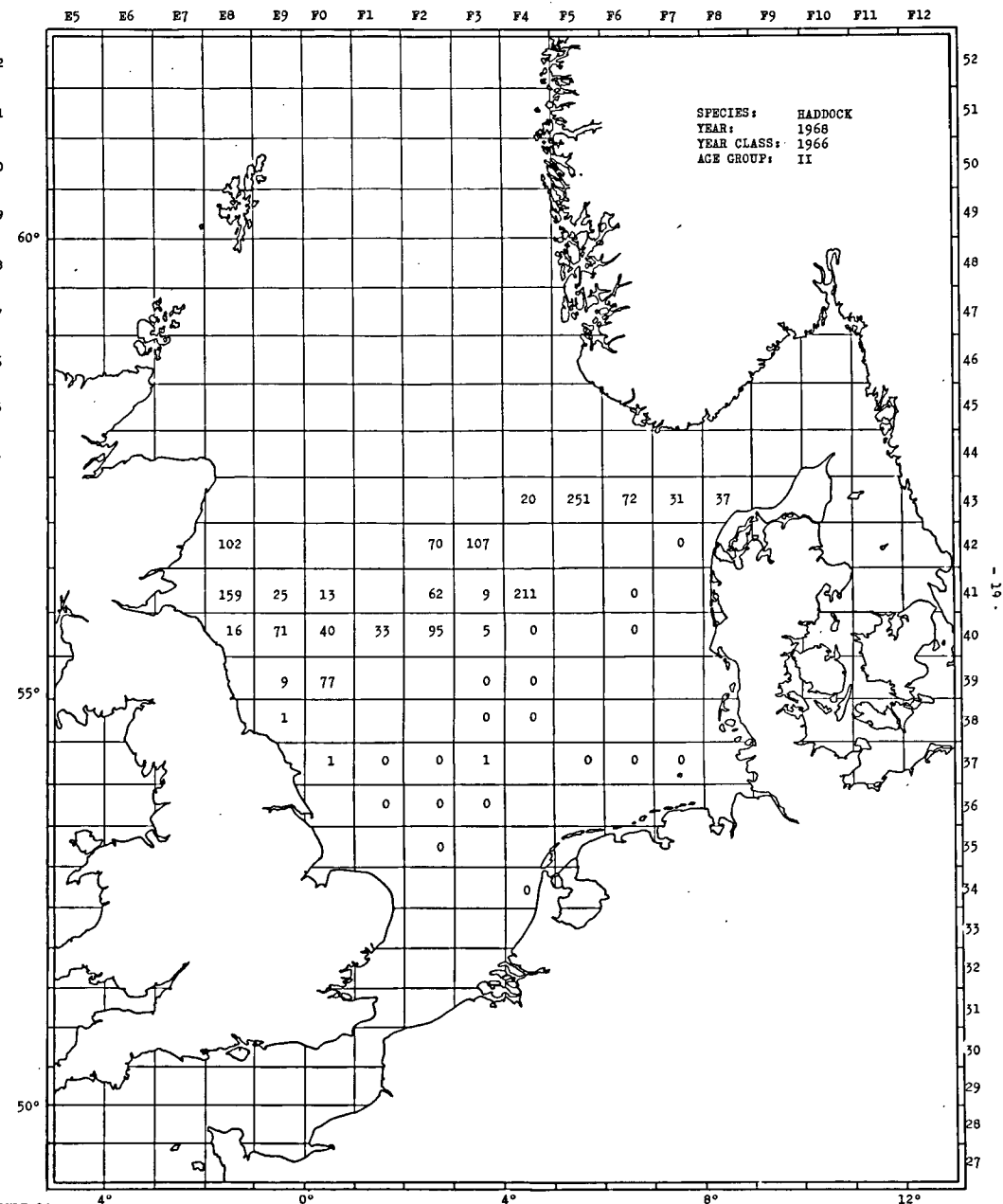


FIGURE 2C



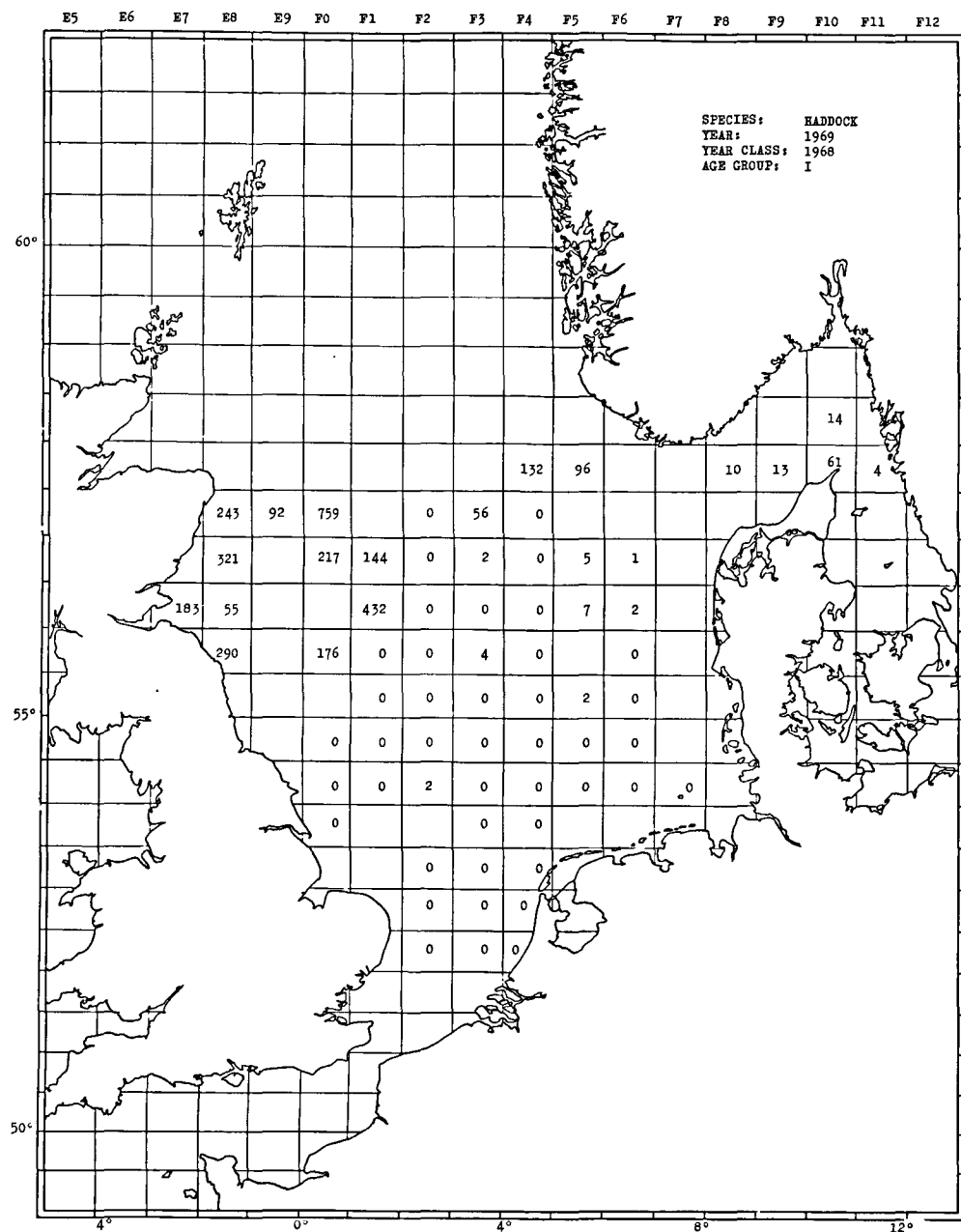
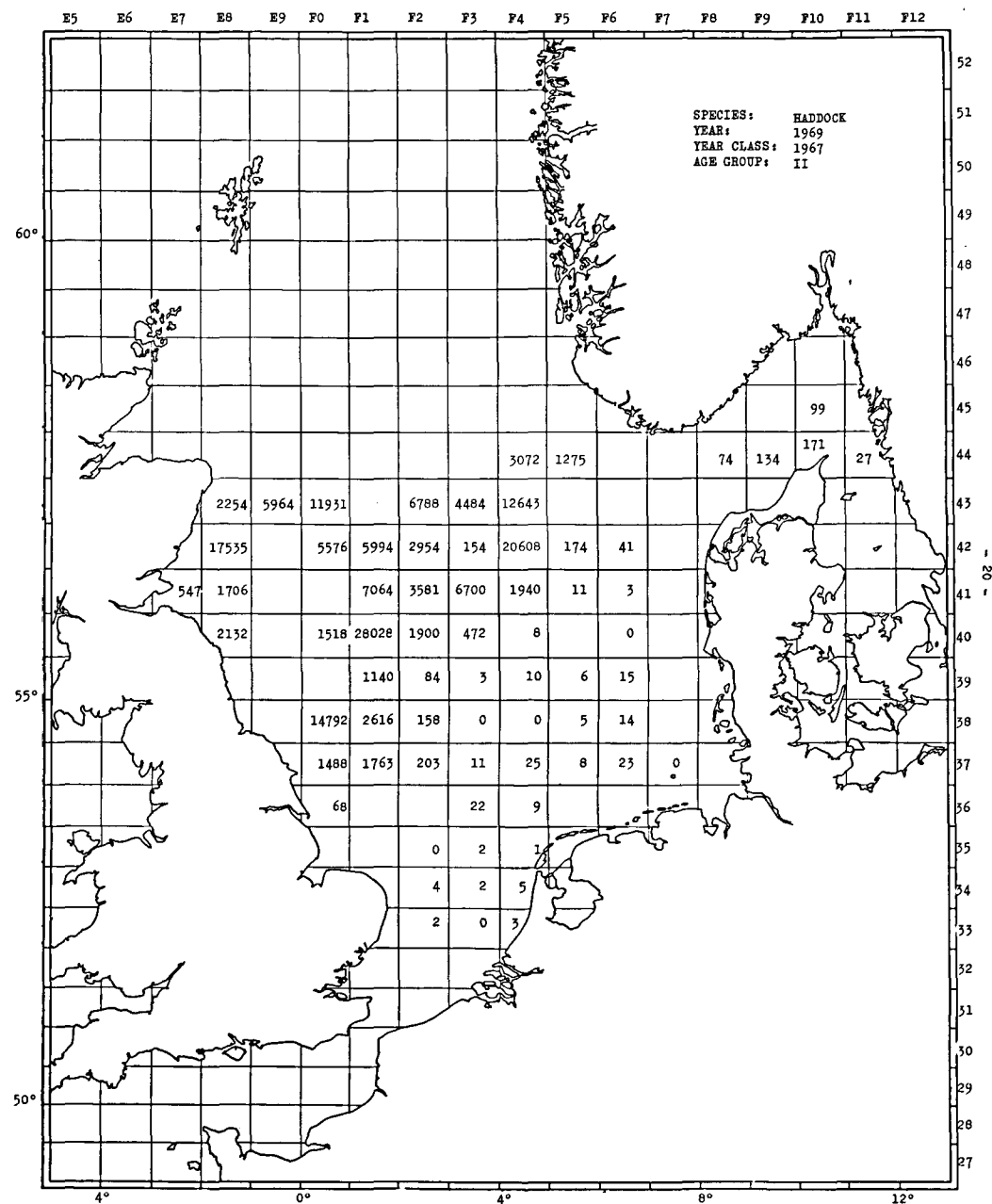


FIGURE 2D



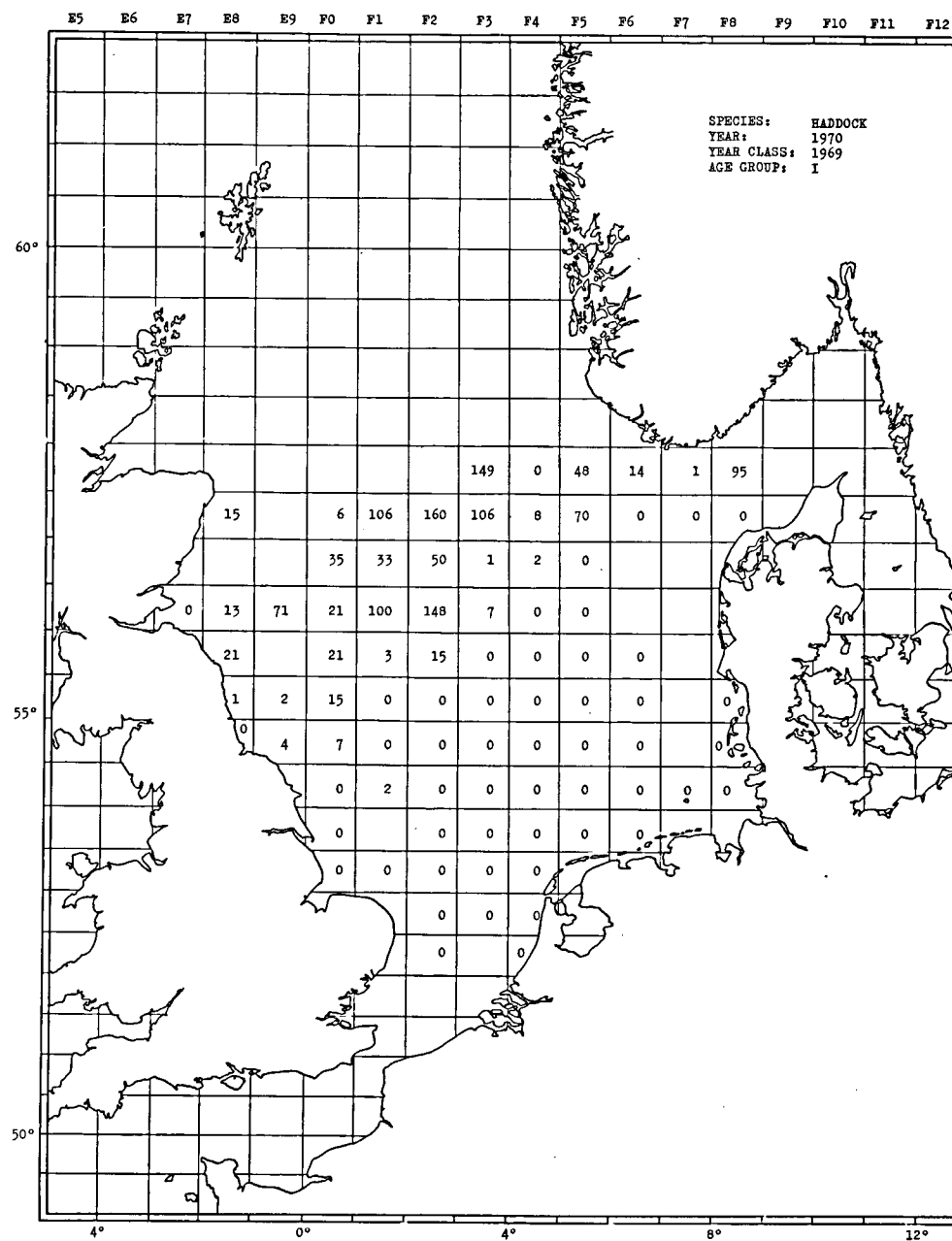
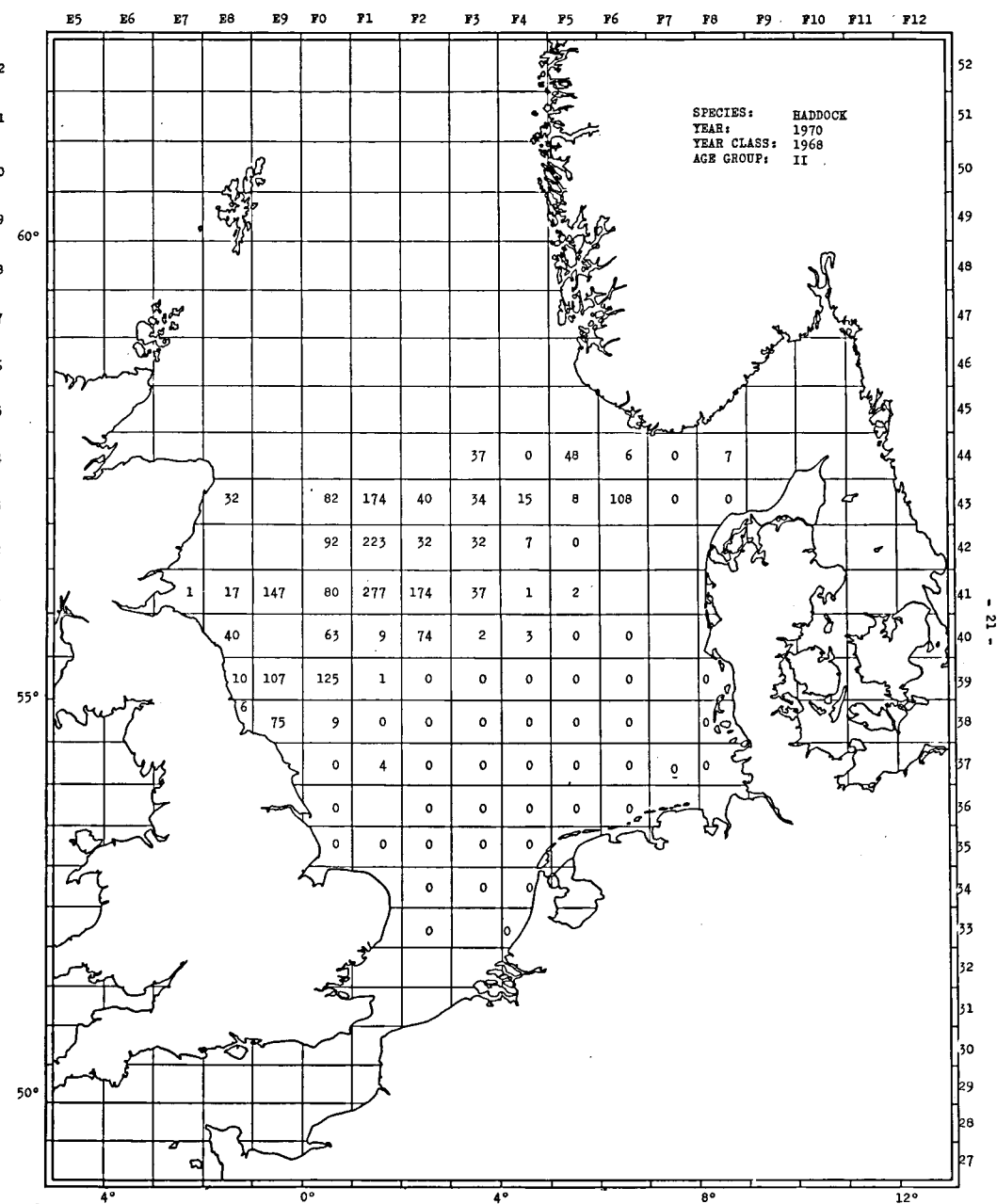


FIGURE 2E



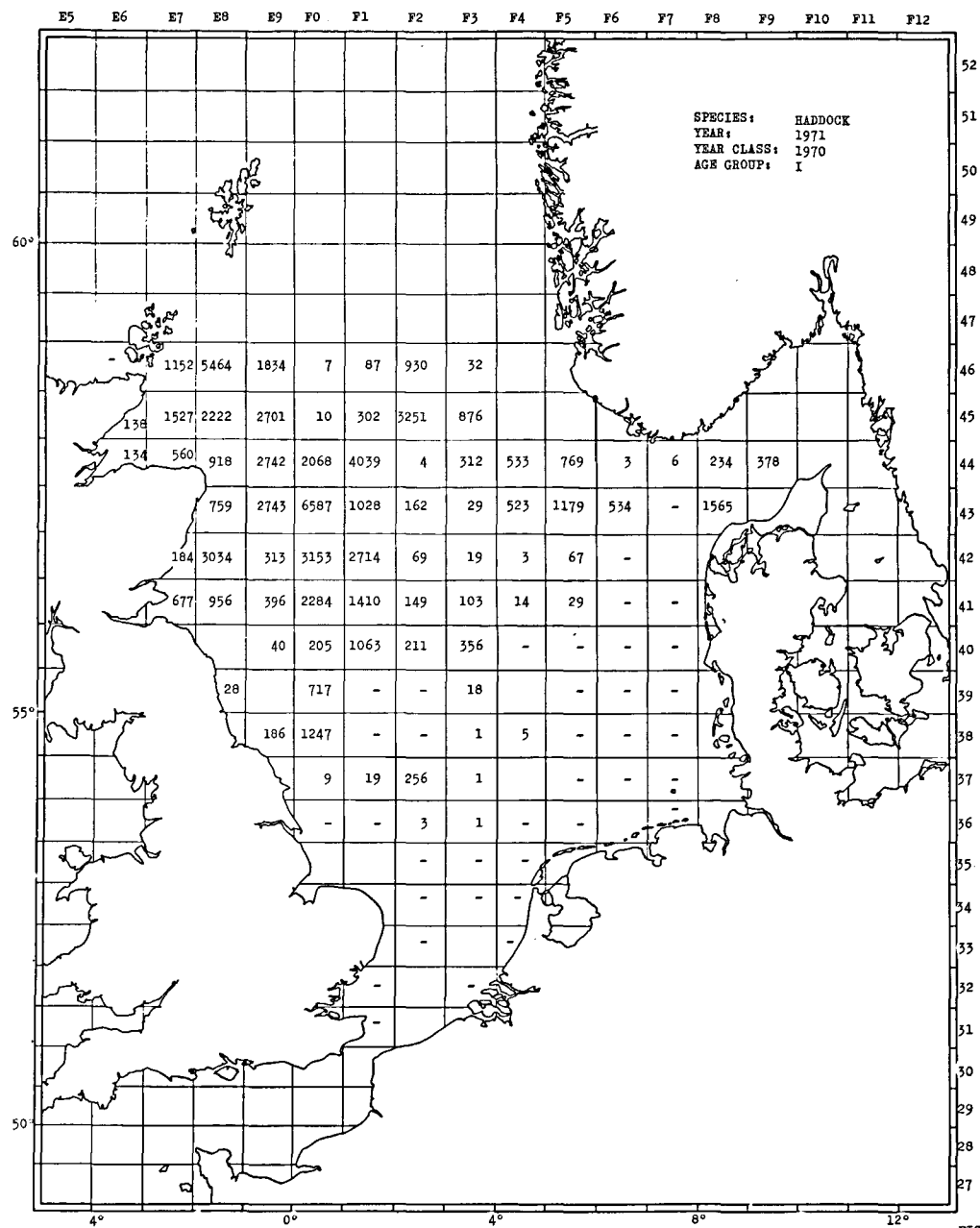
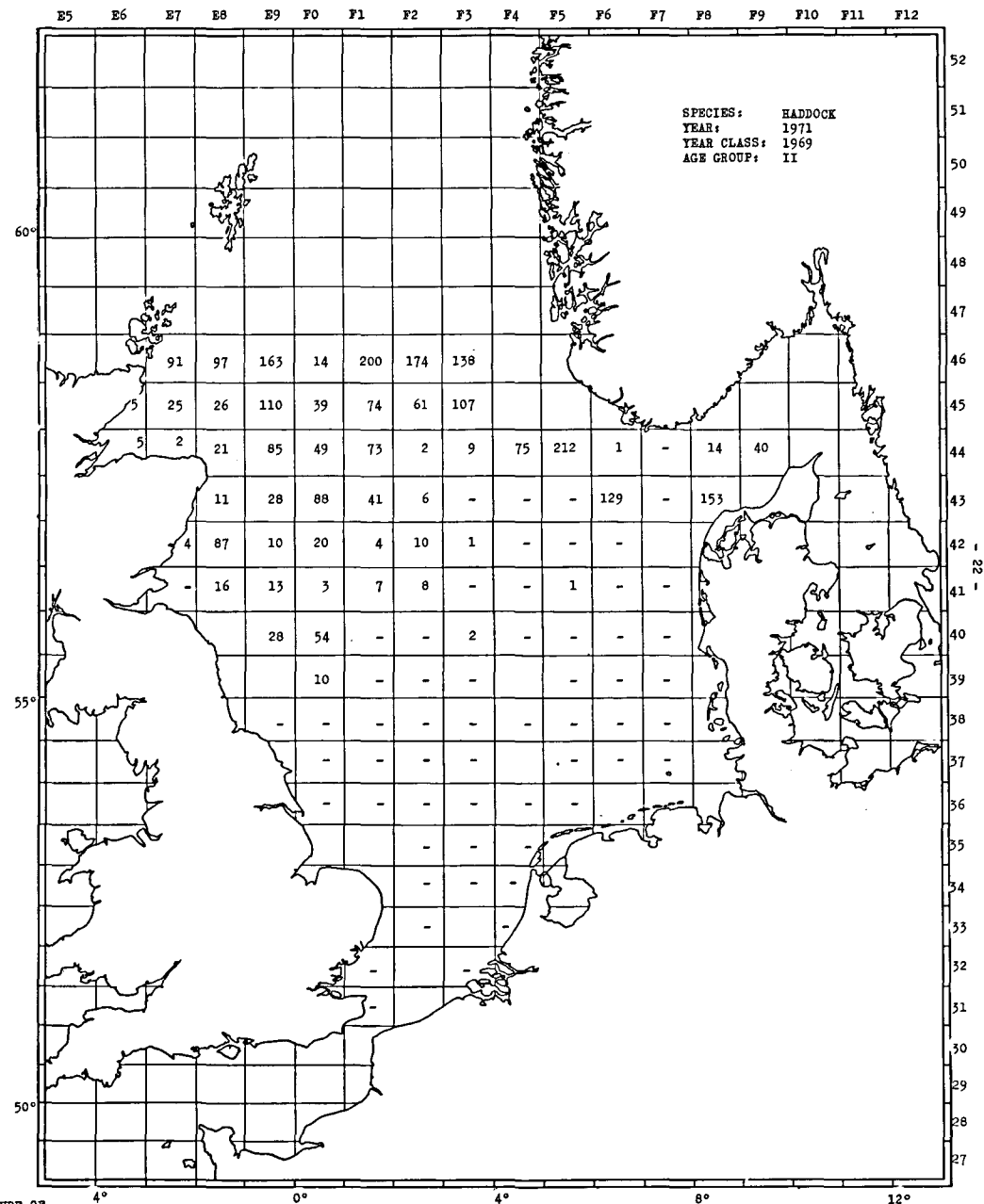


FIGURE 2P



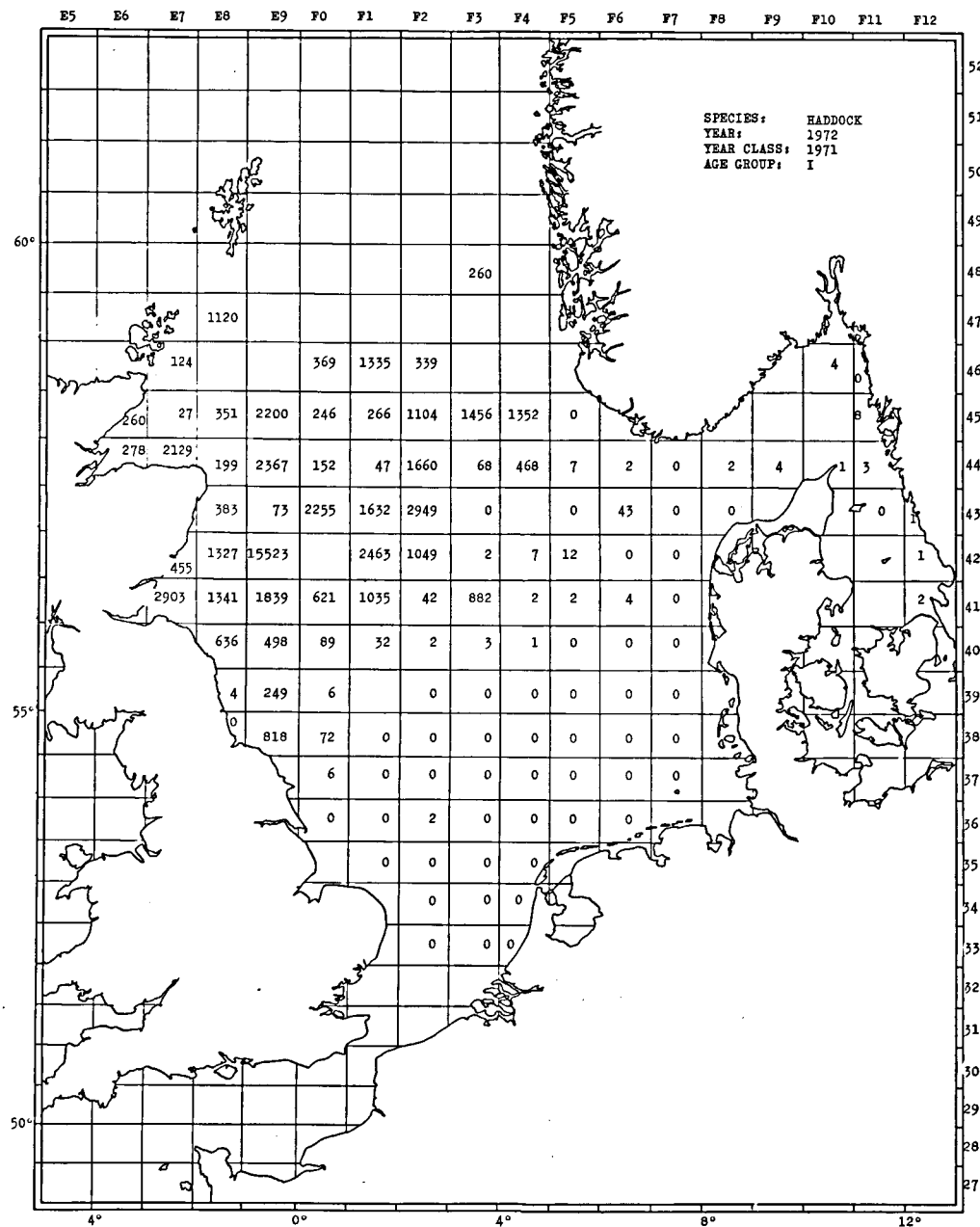
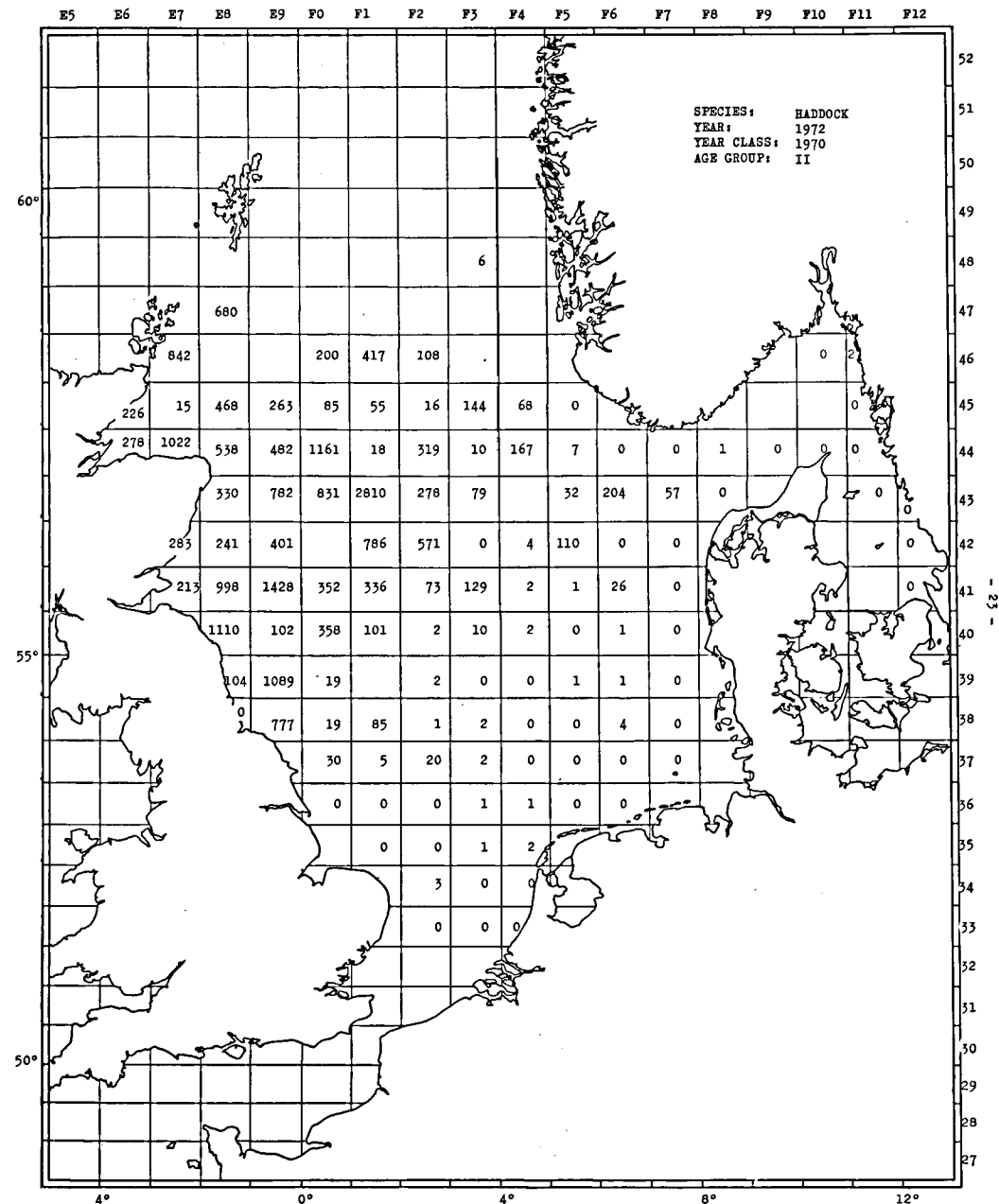


FIGURE 20



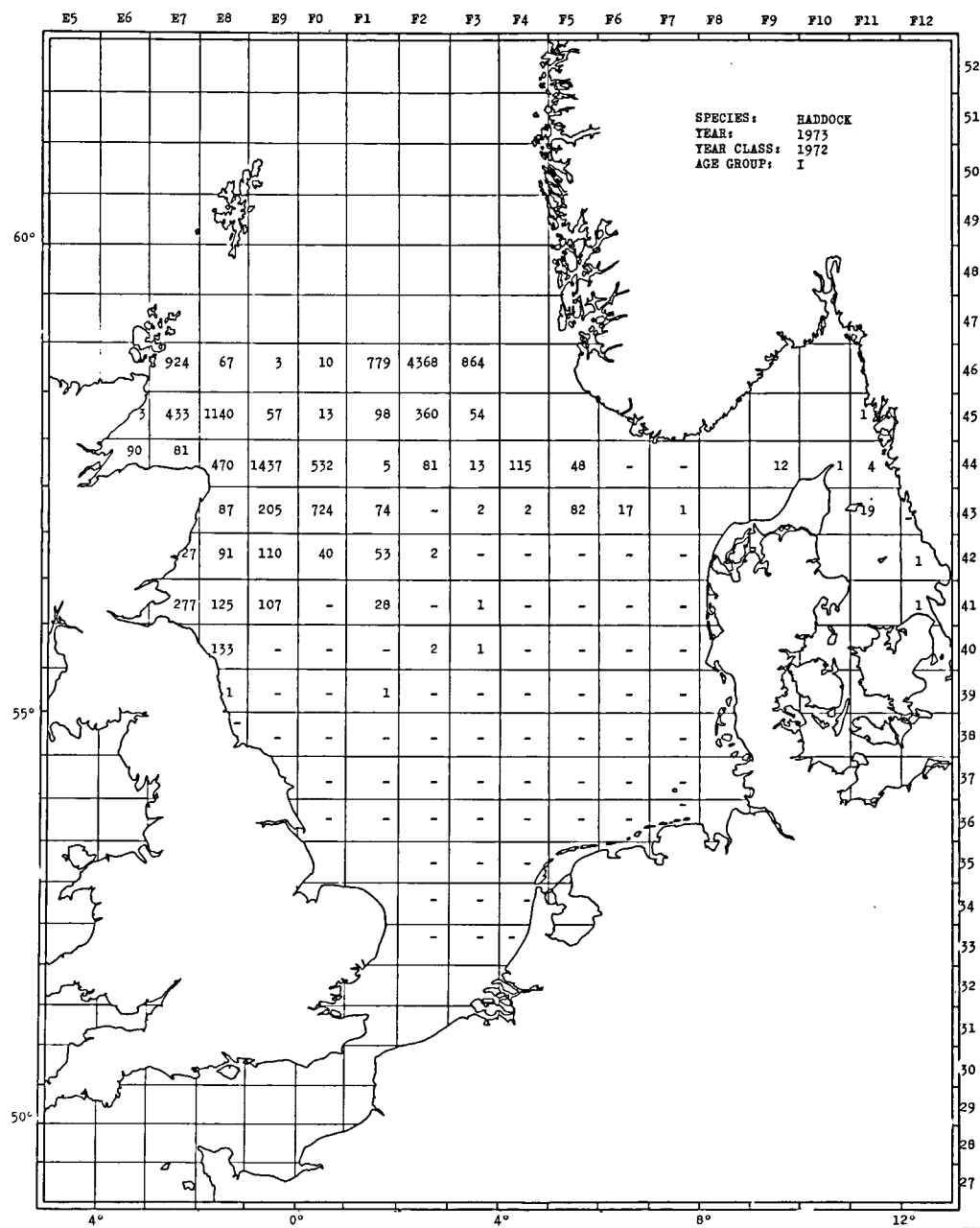
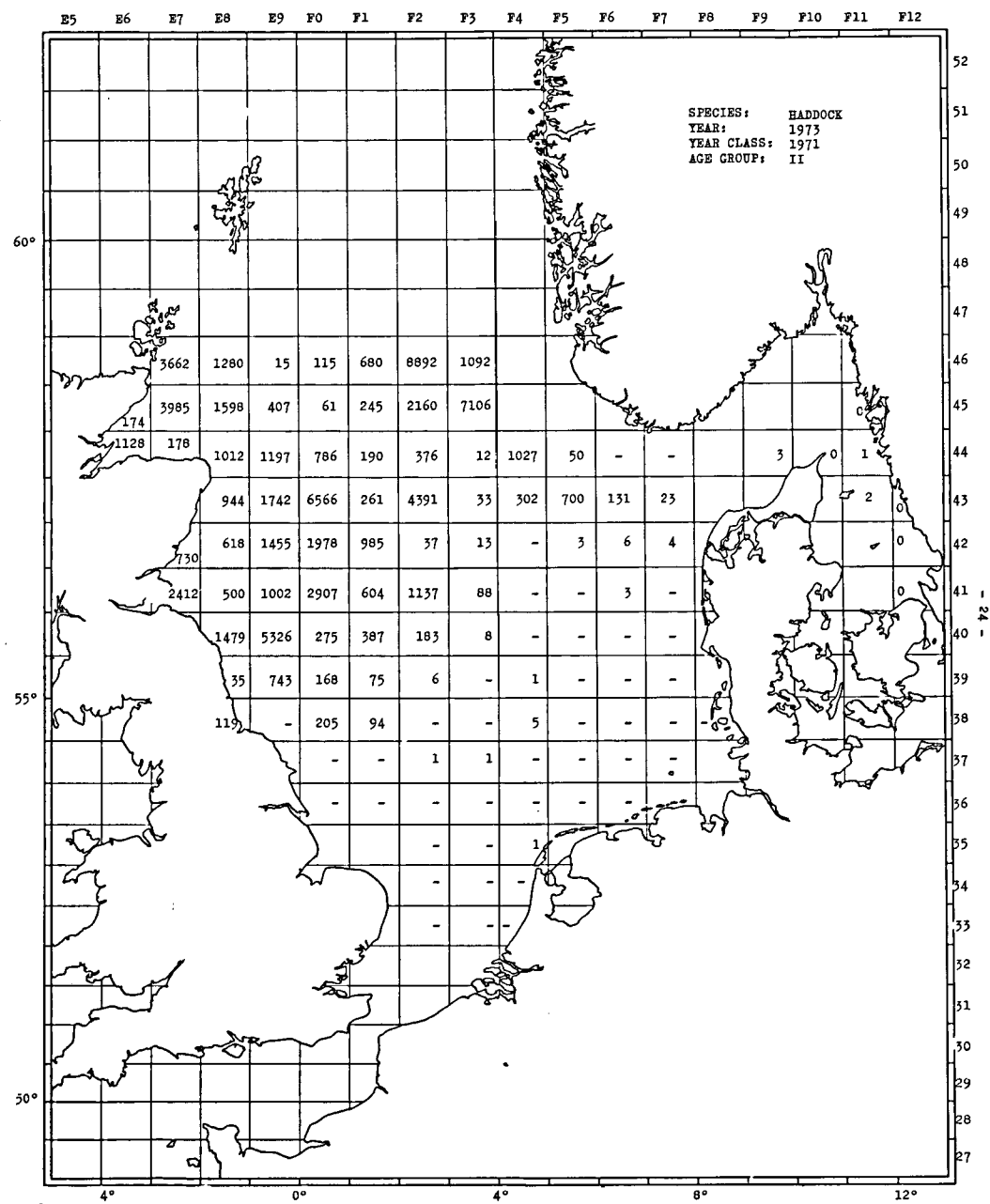


FIGURE 2H



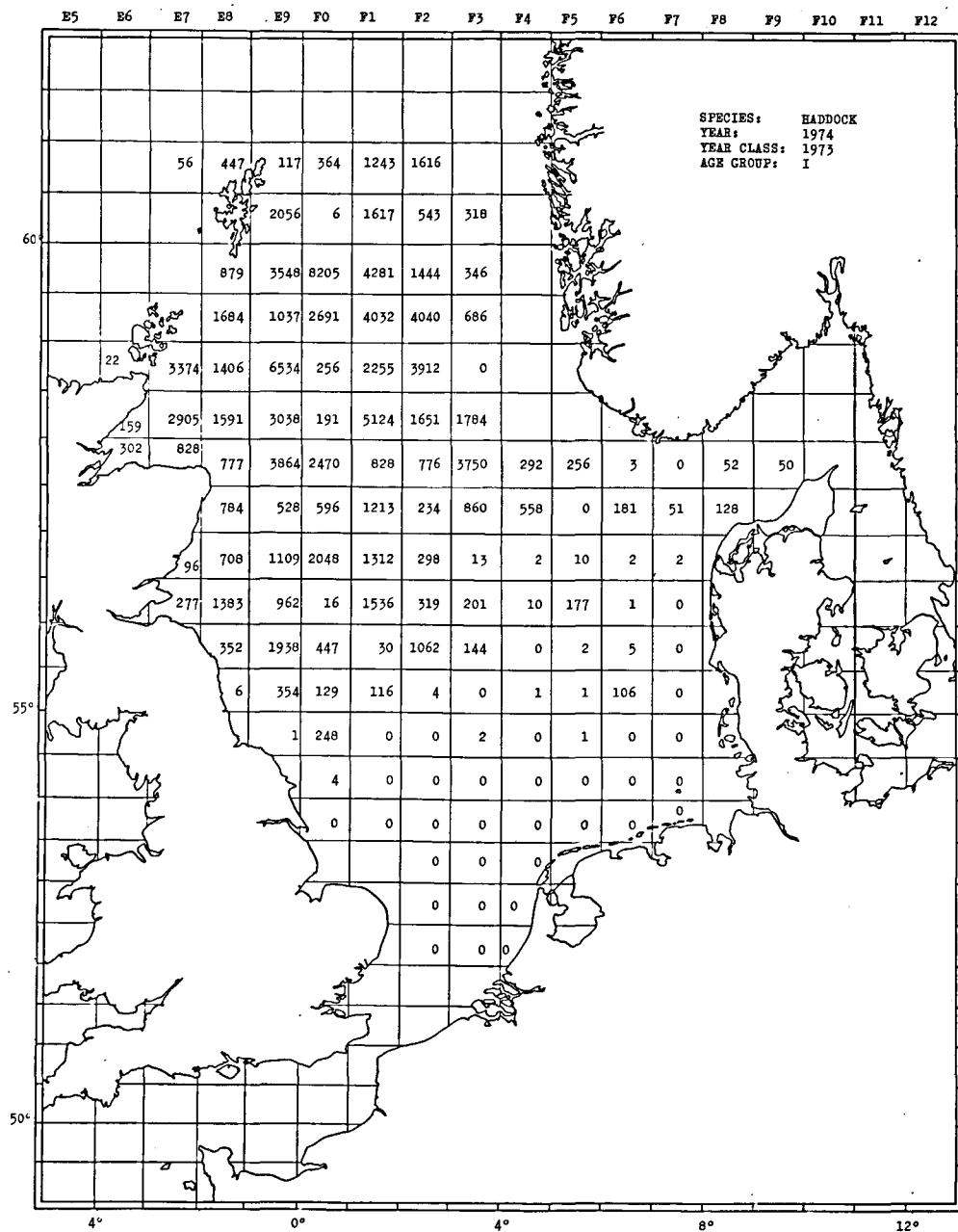
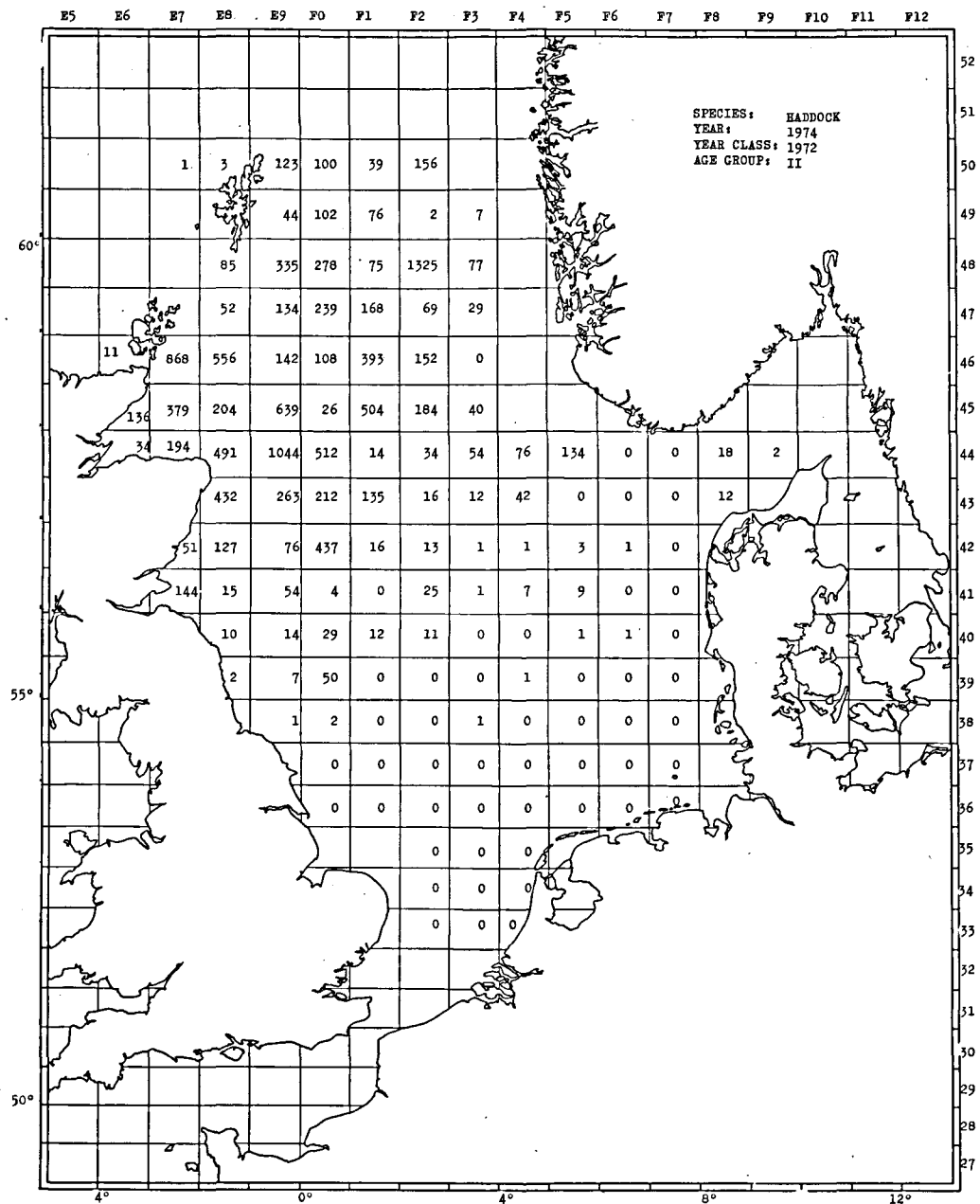


FIGURE 21



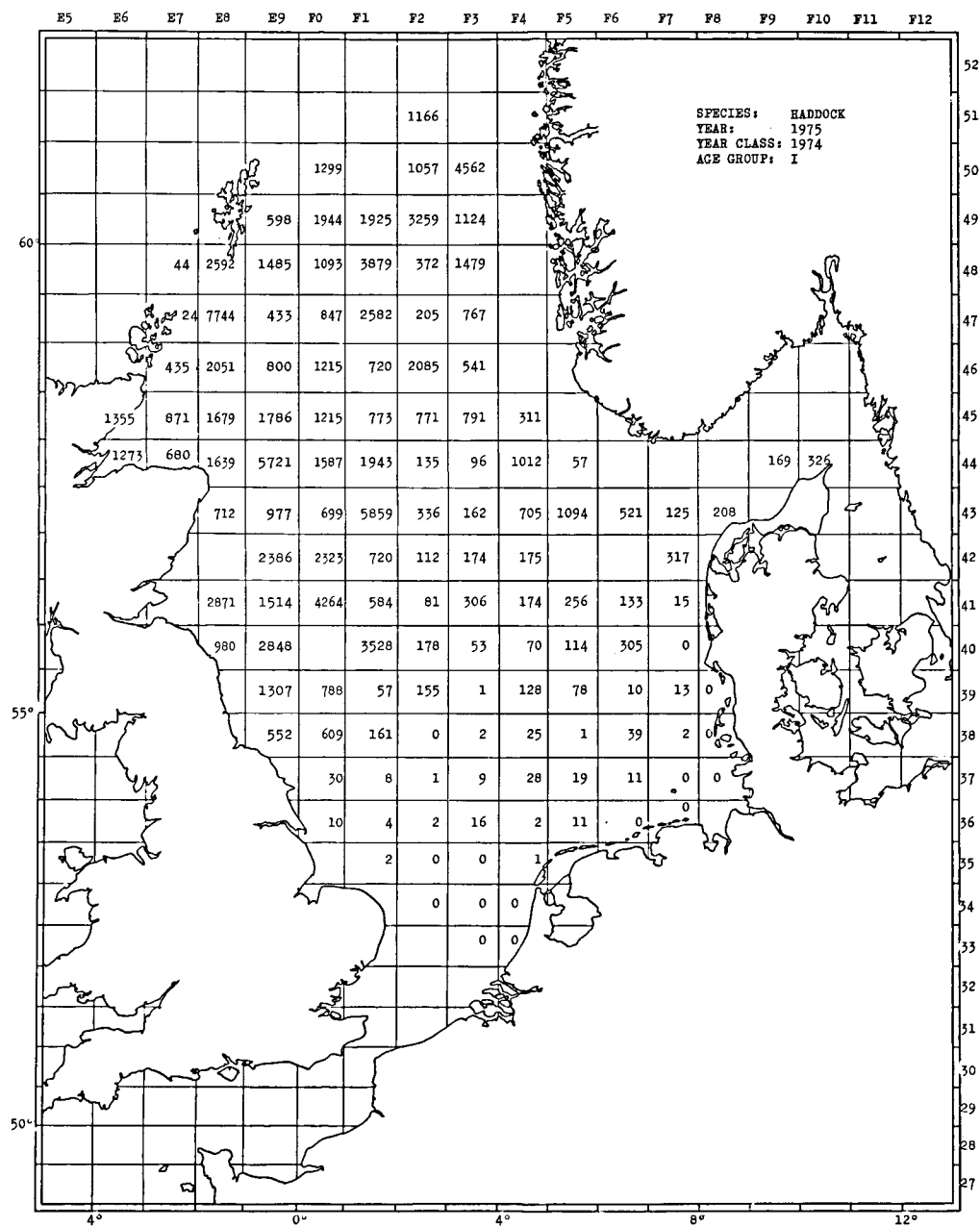
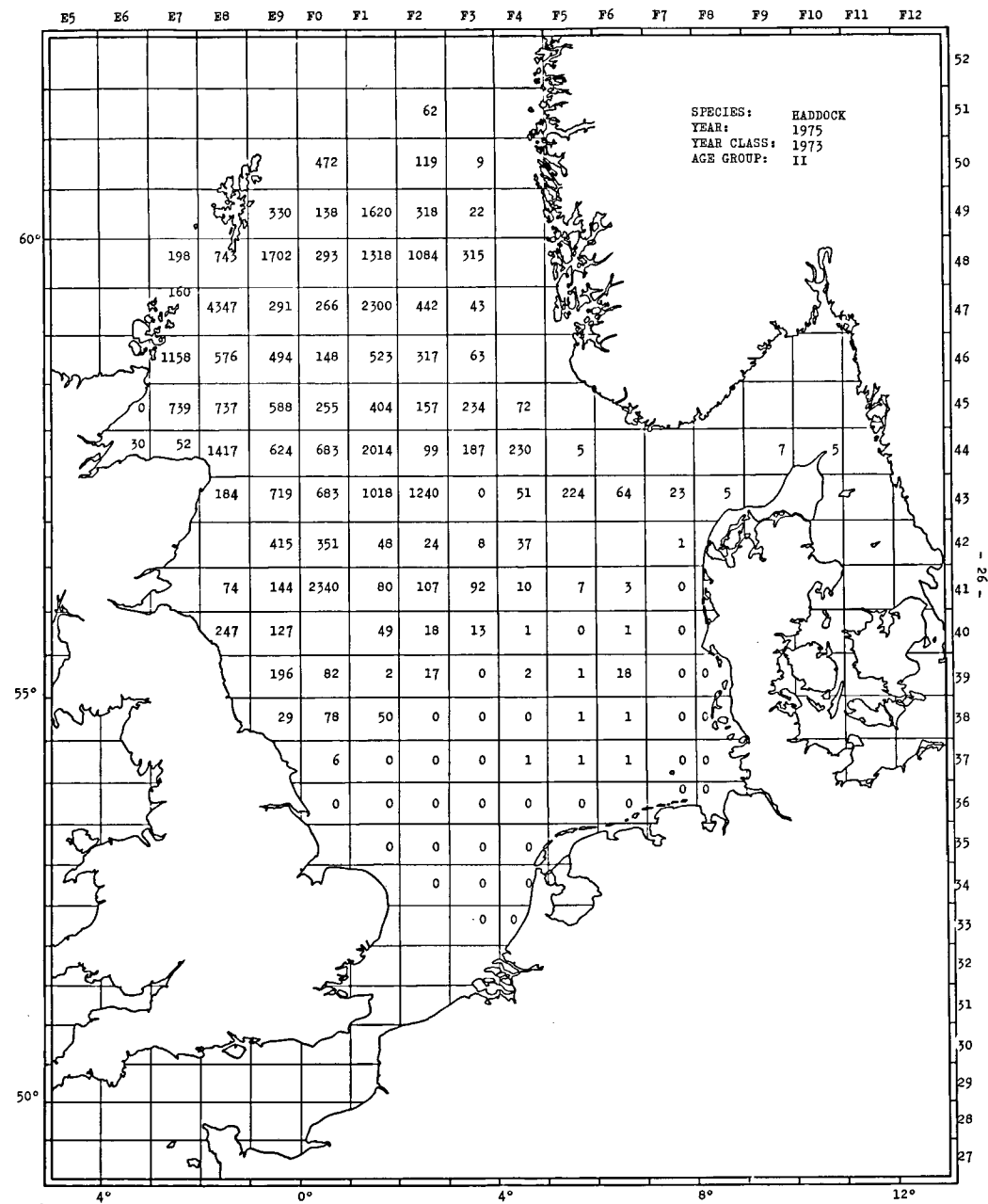


FIGURE 2J



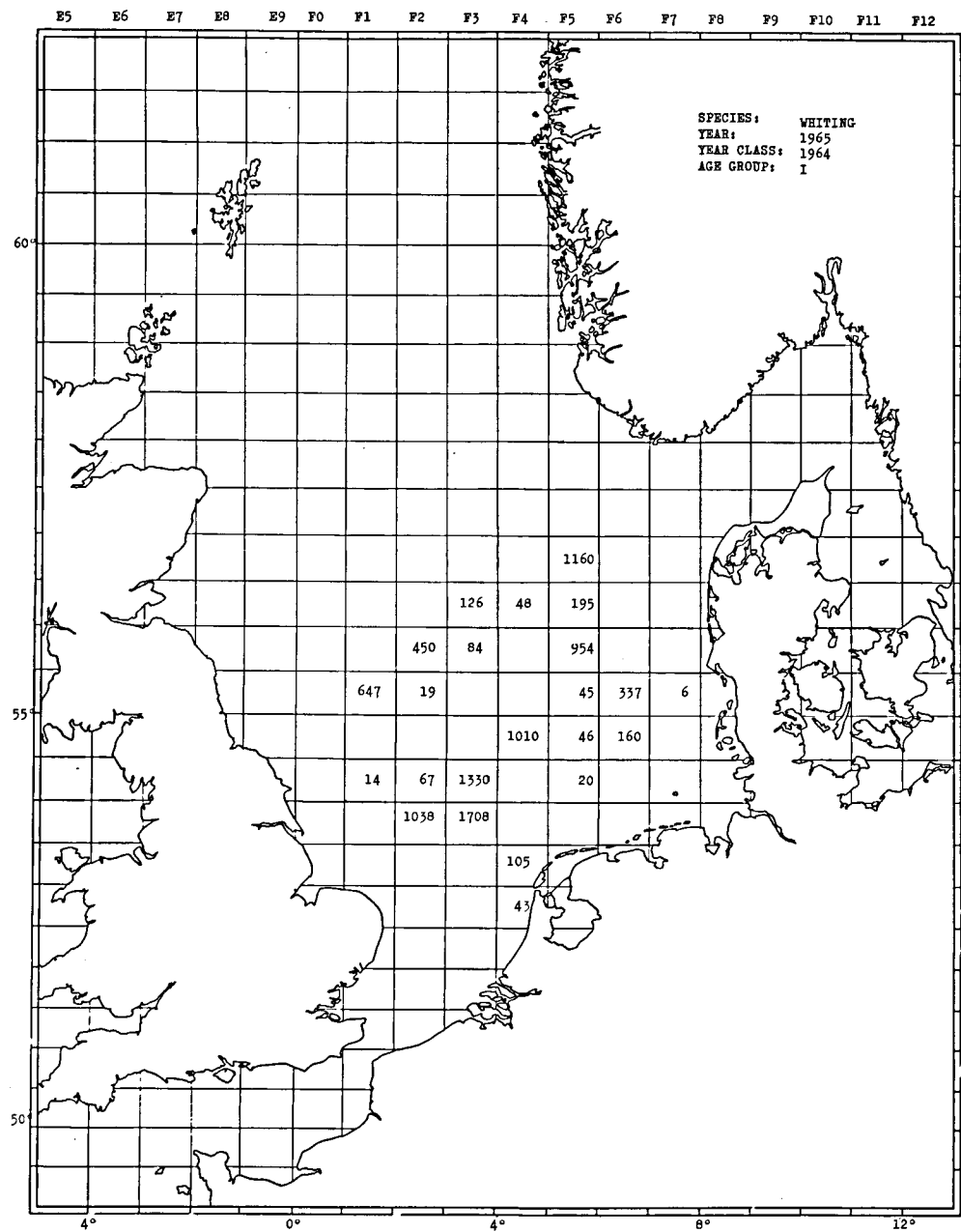
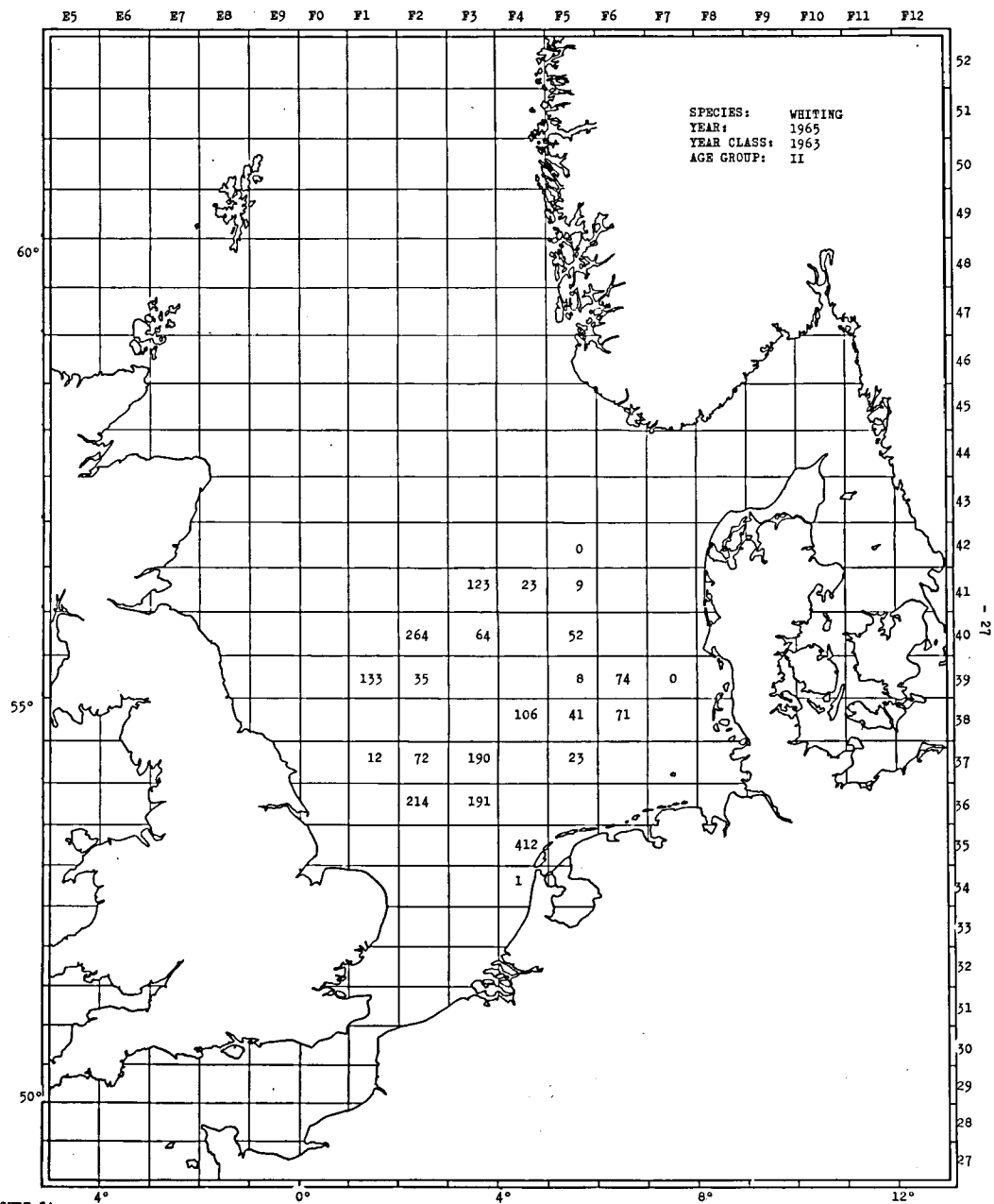


FIGURE 2A



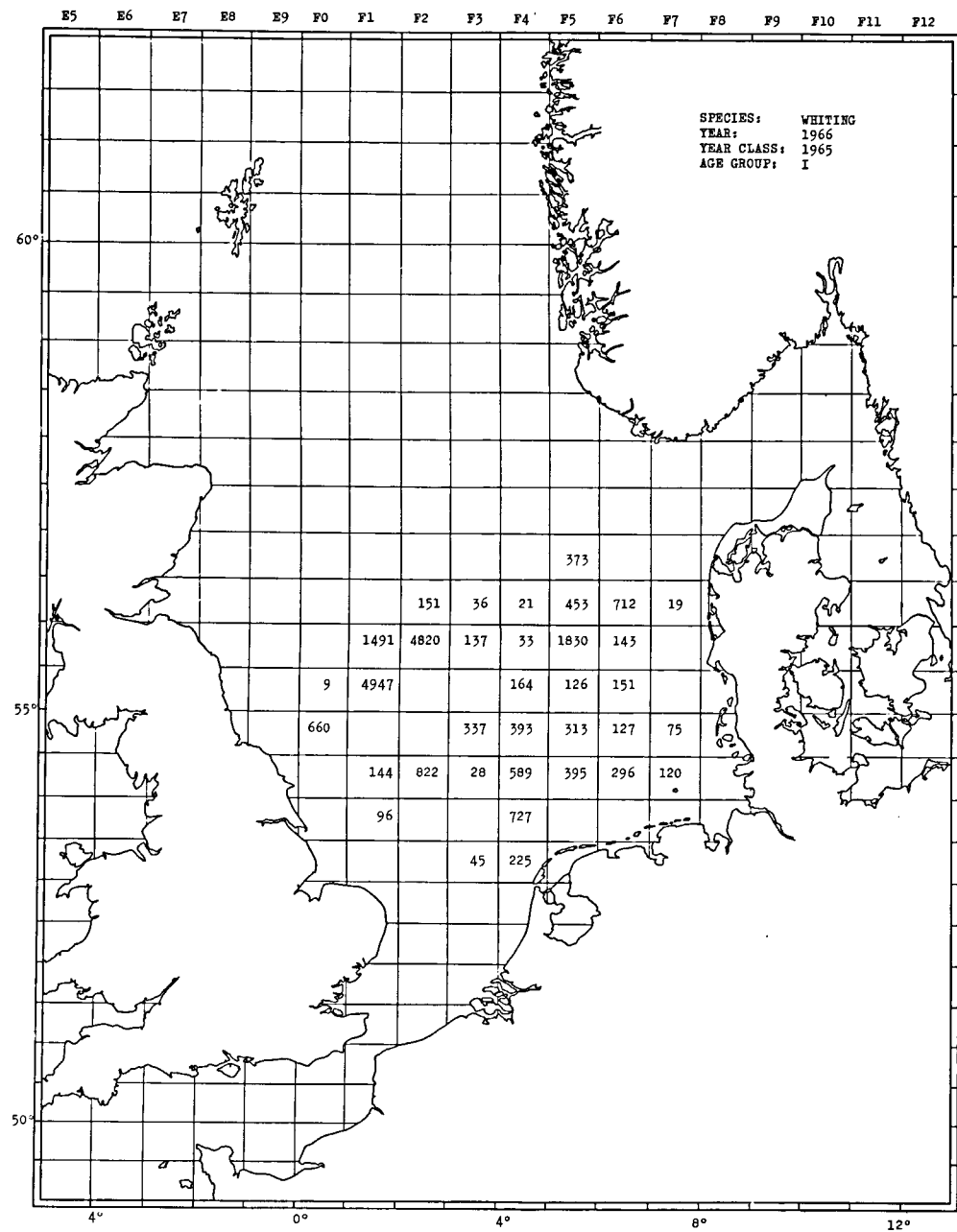
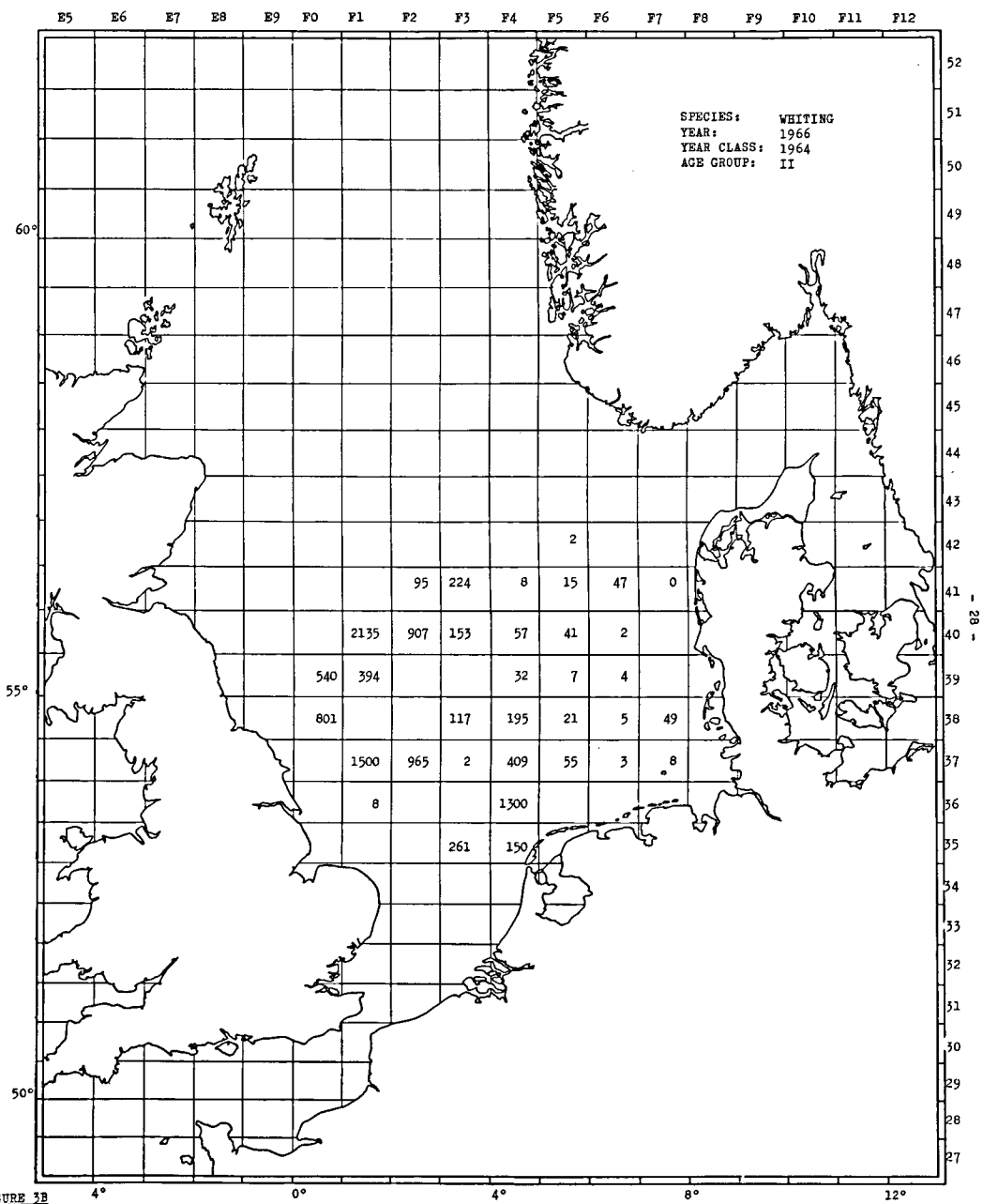


FIGURE 3B



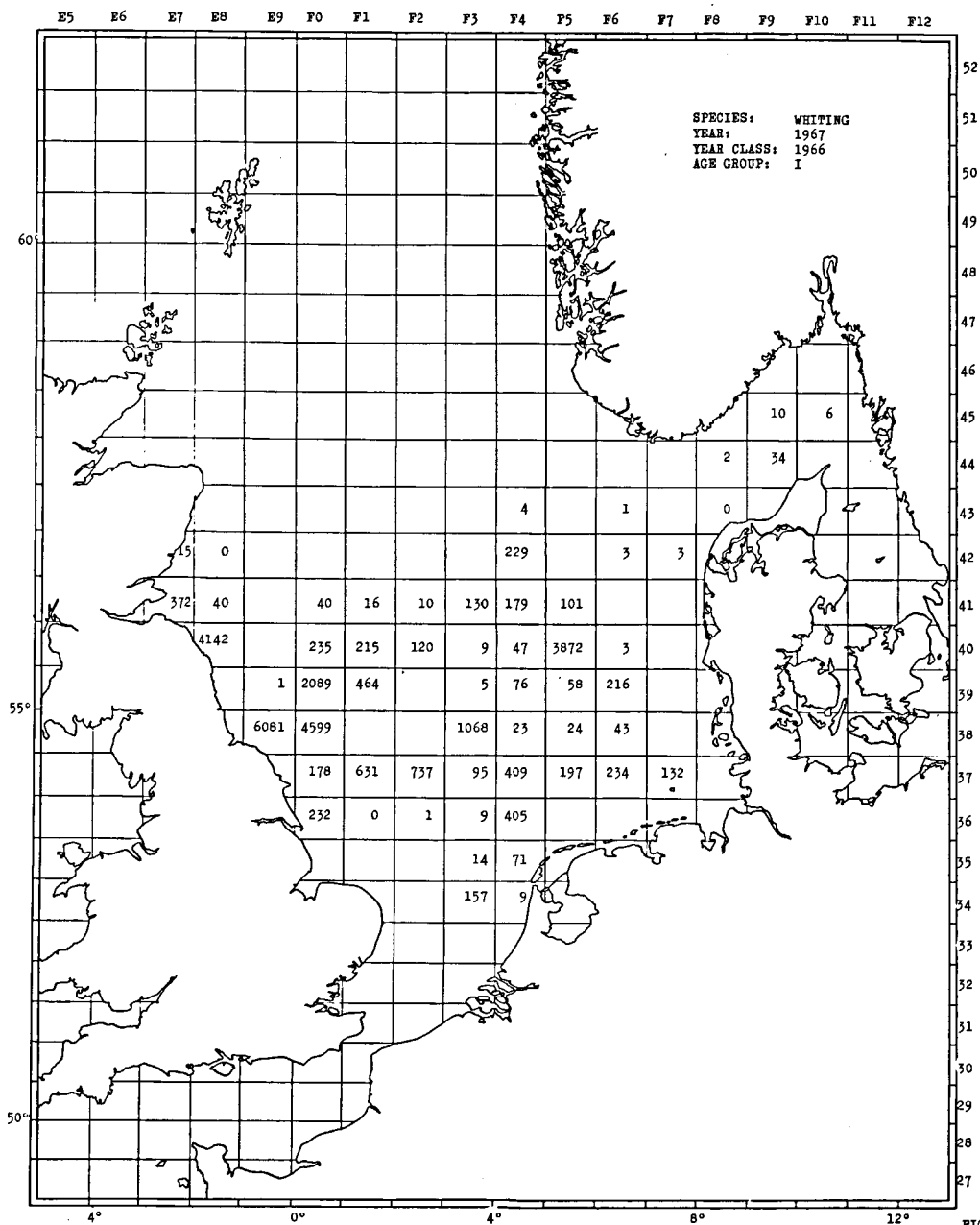
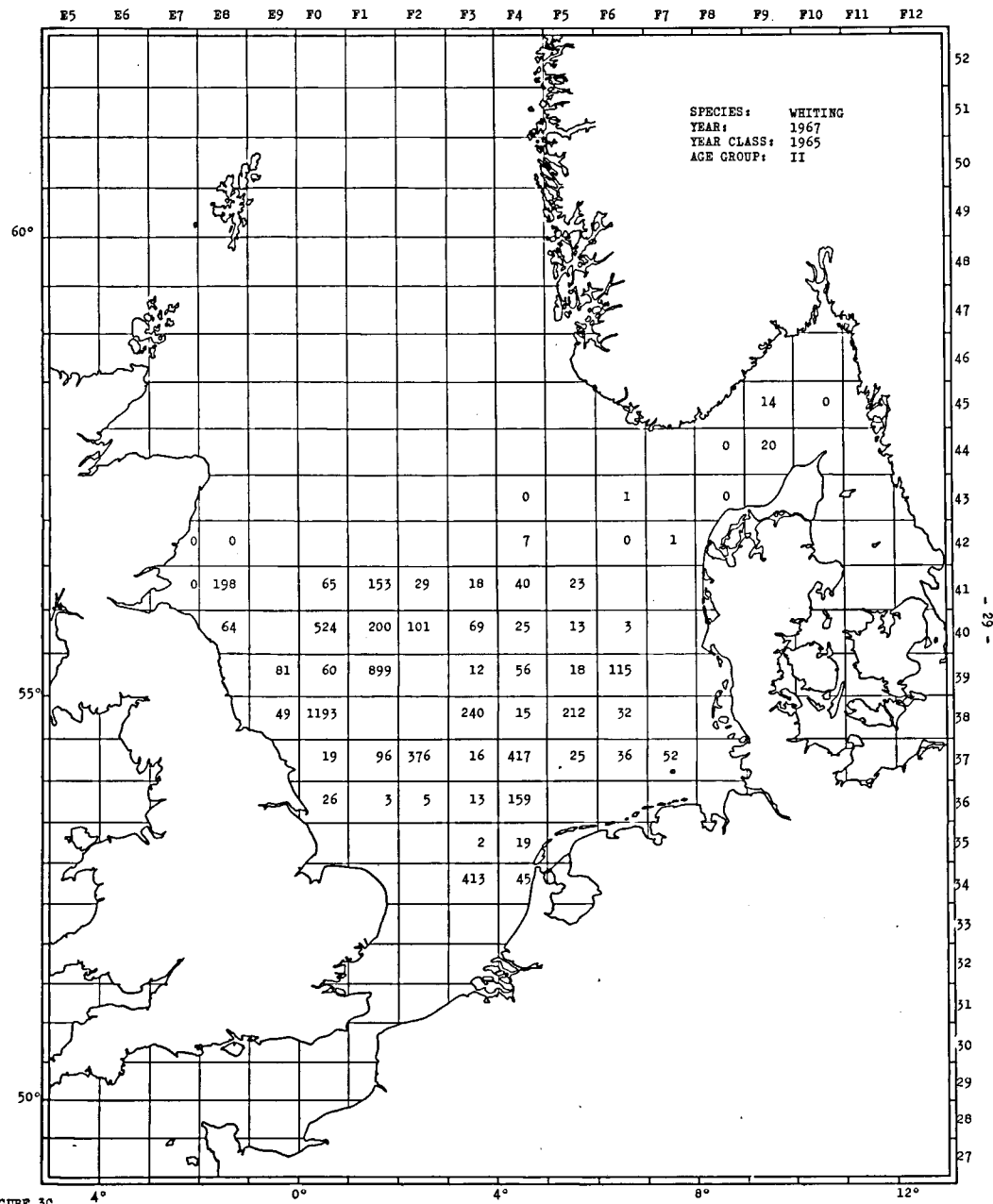


FIGURE 30



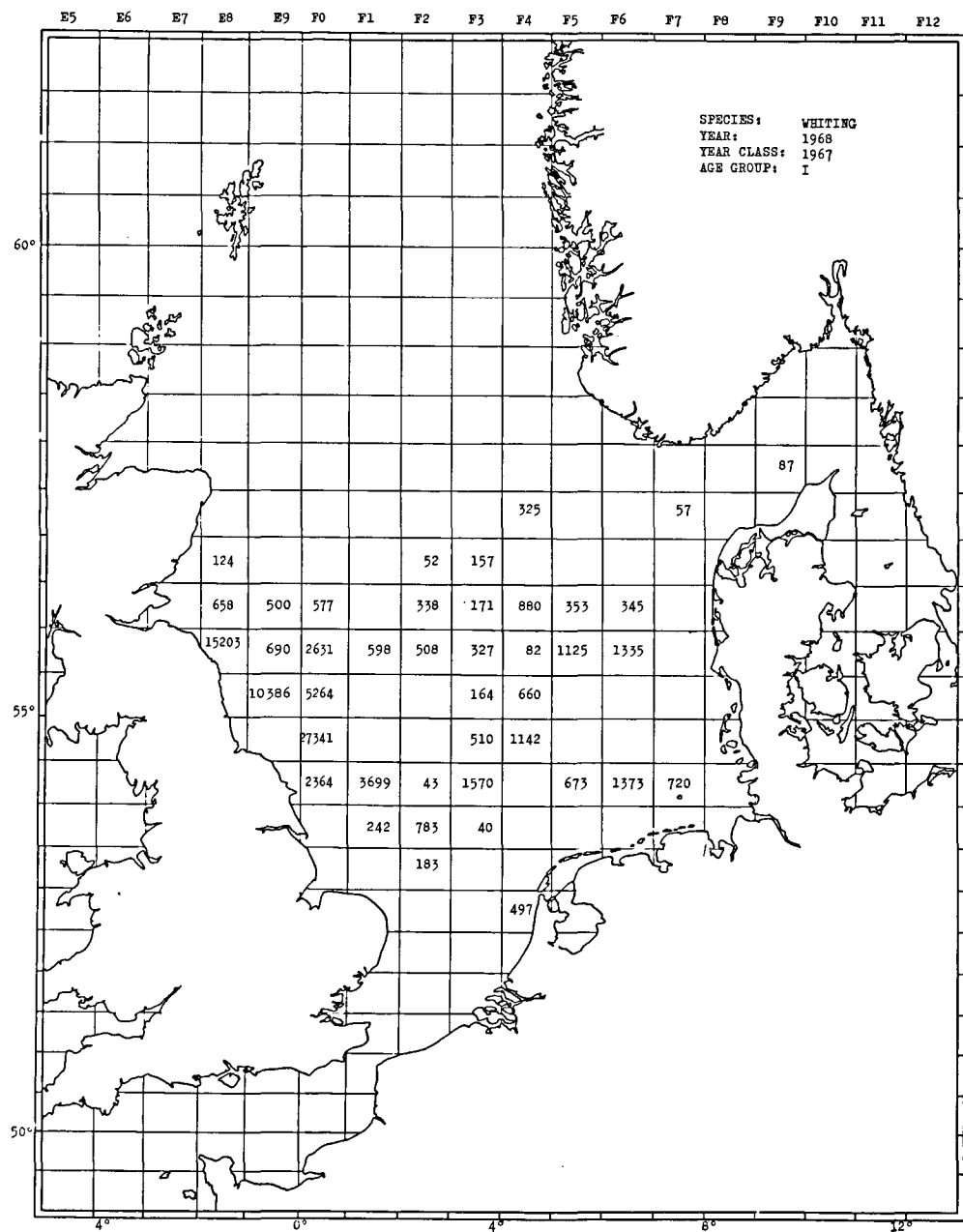
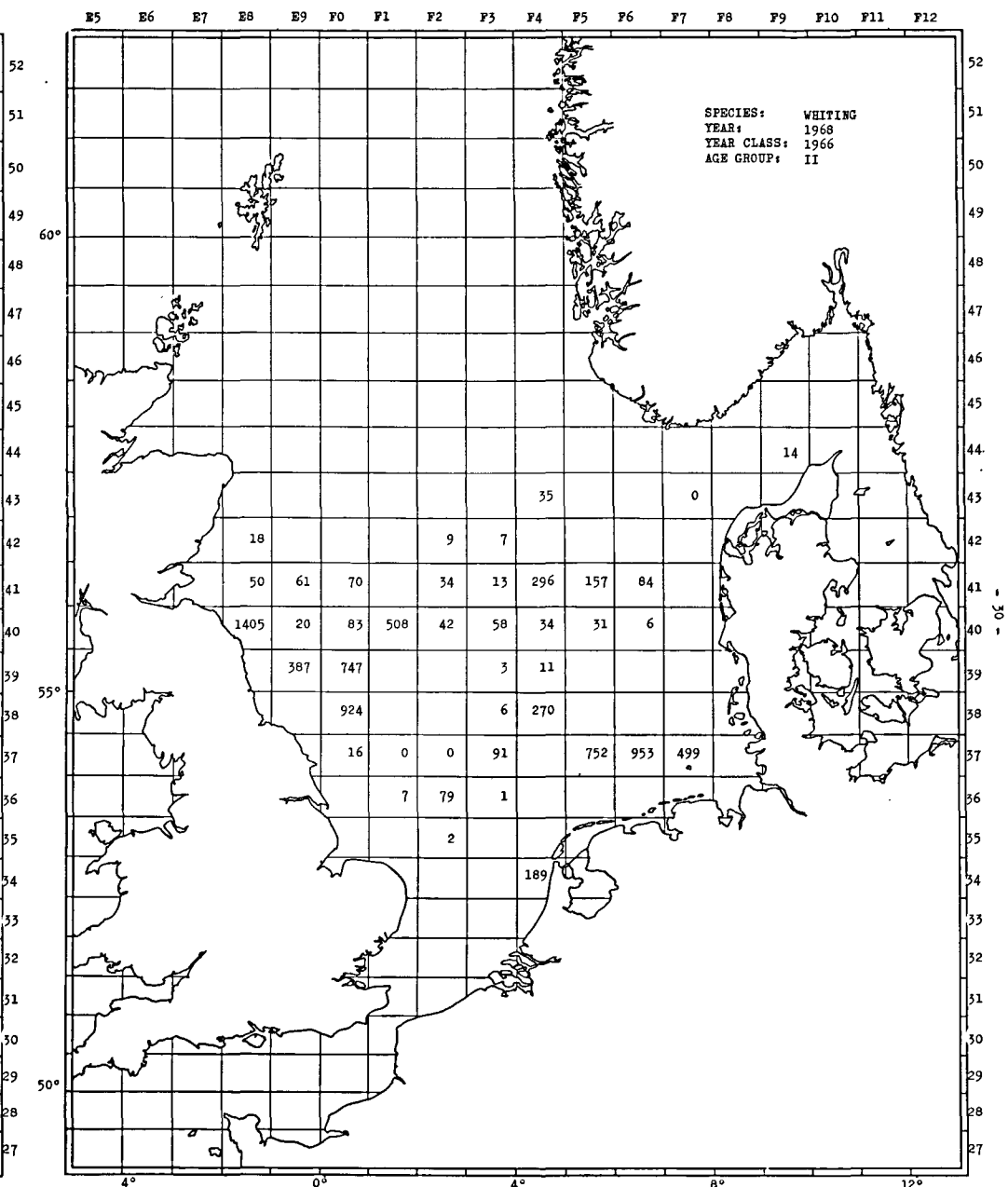


FIGURE 3D



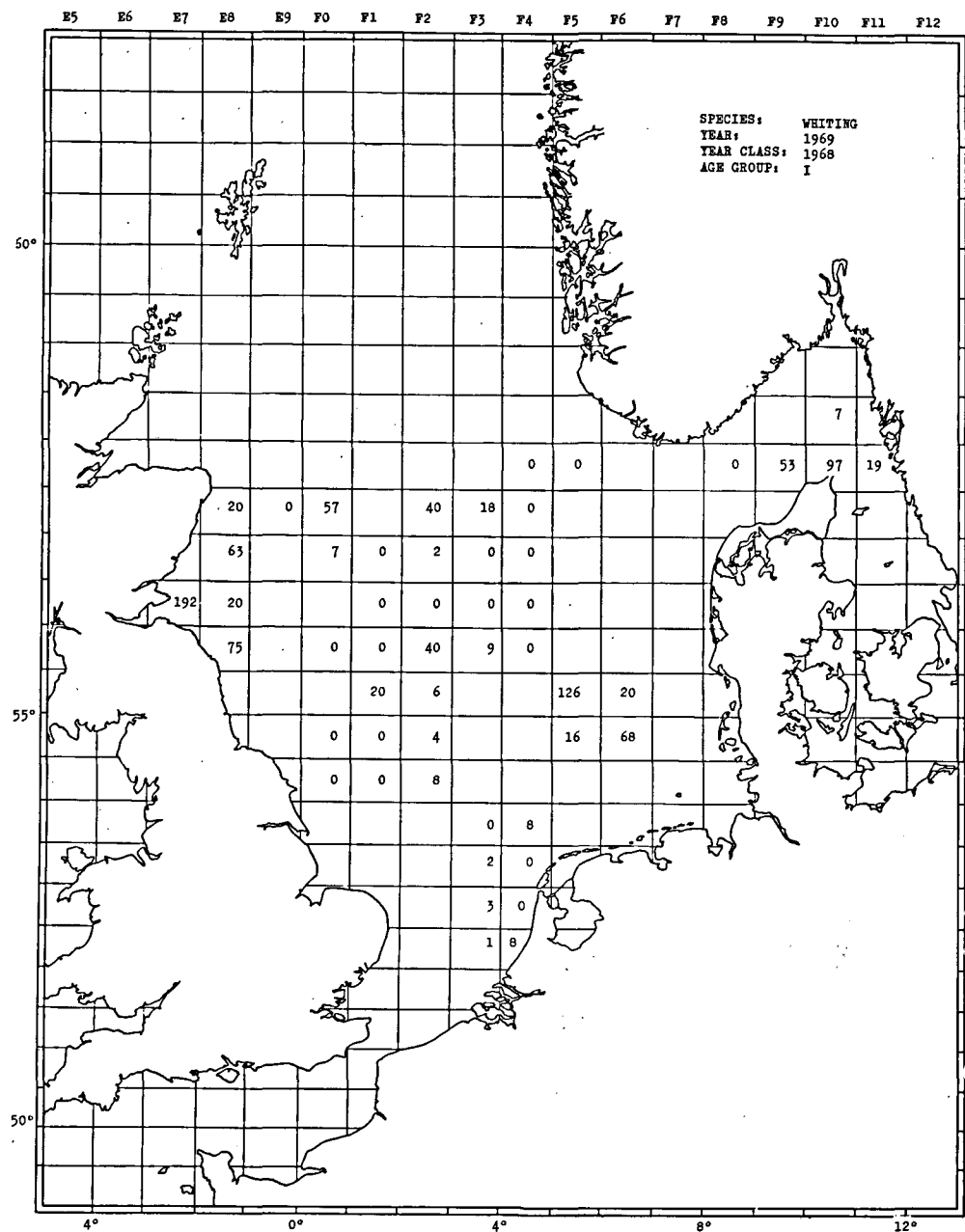
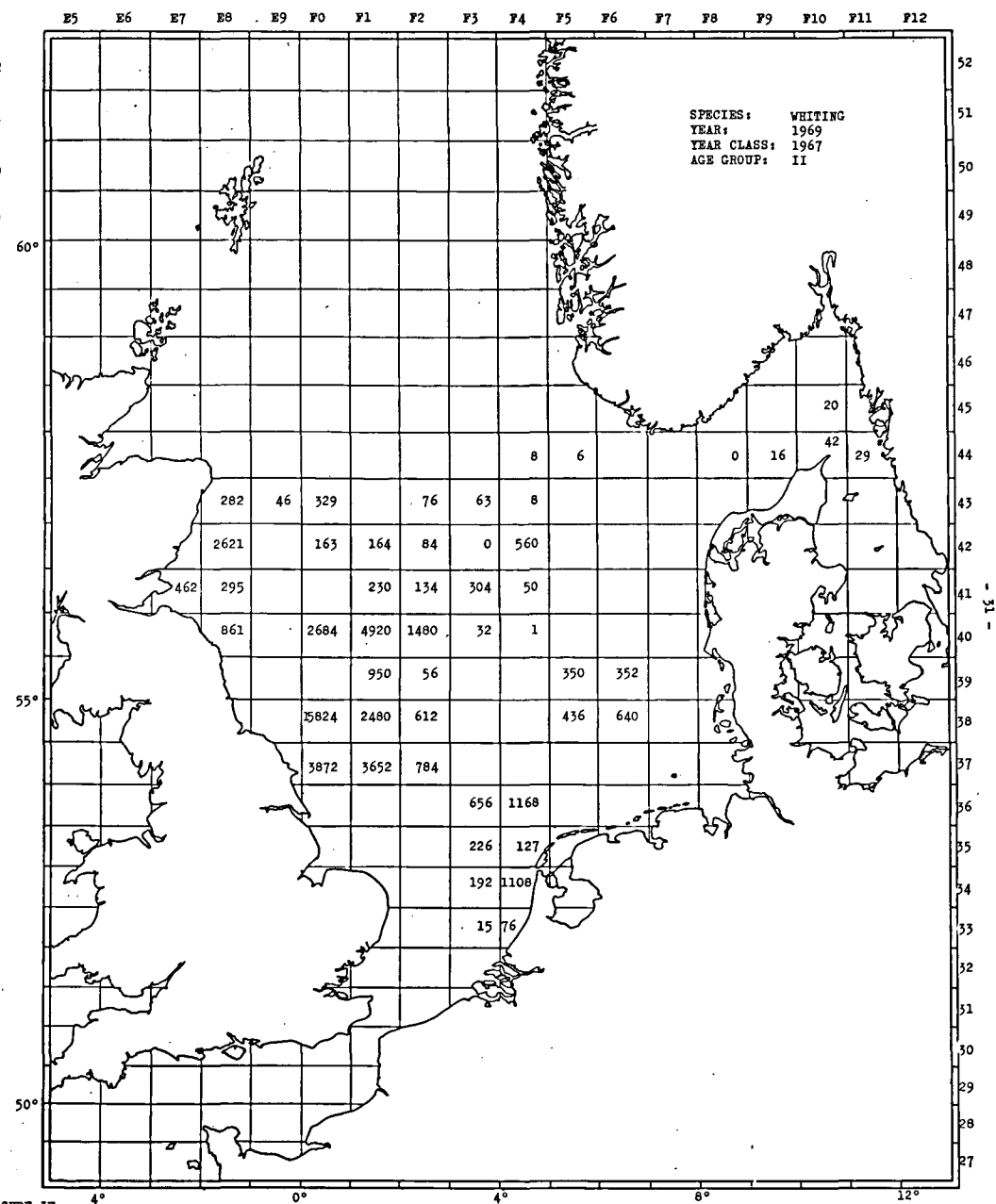


FIGURE 1E



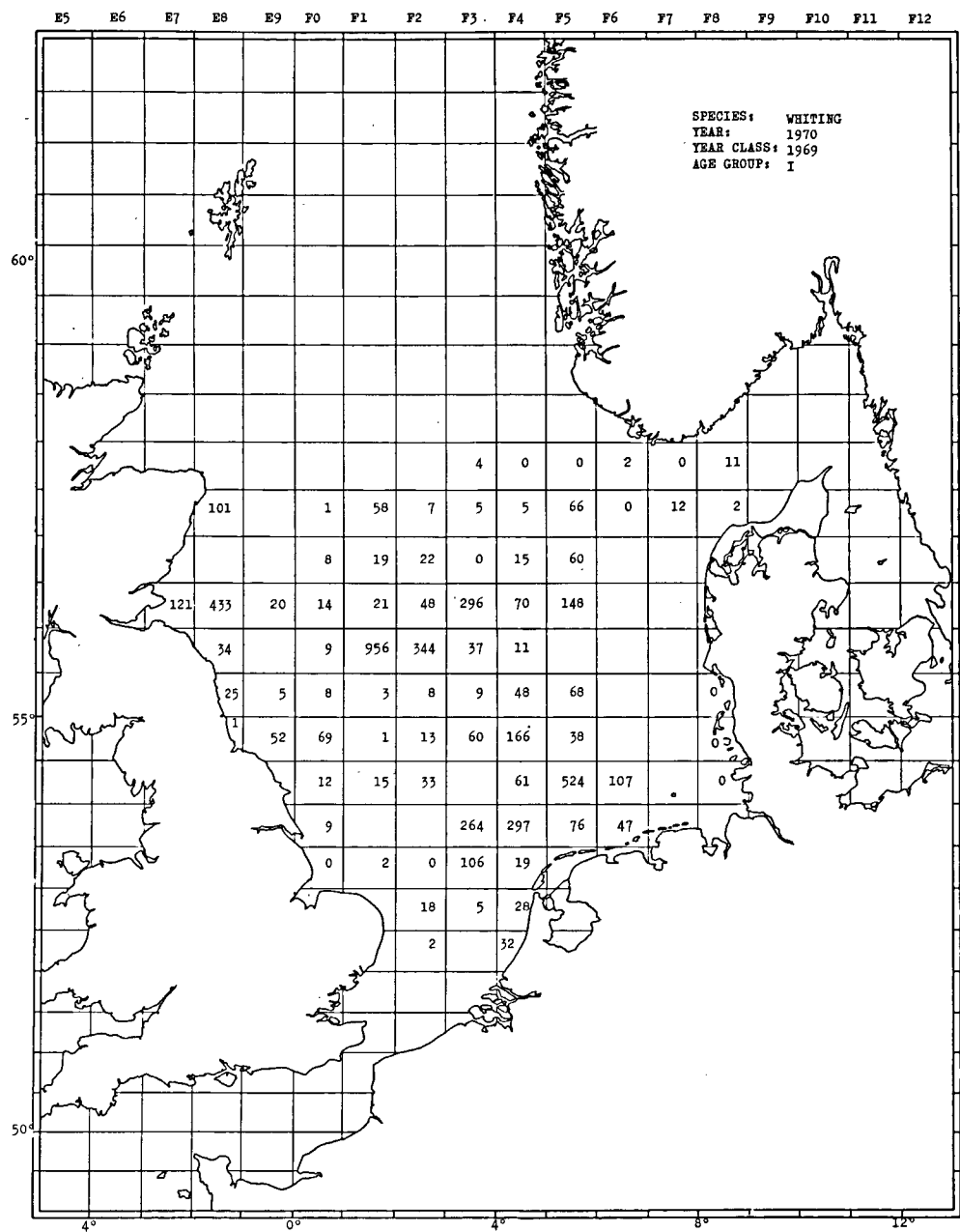
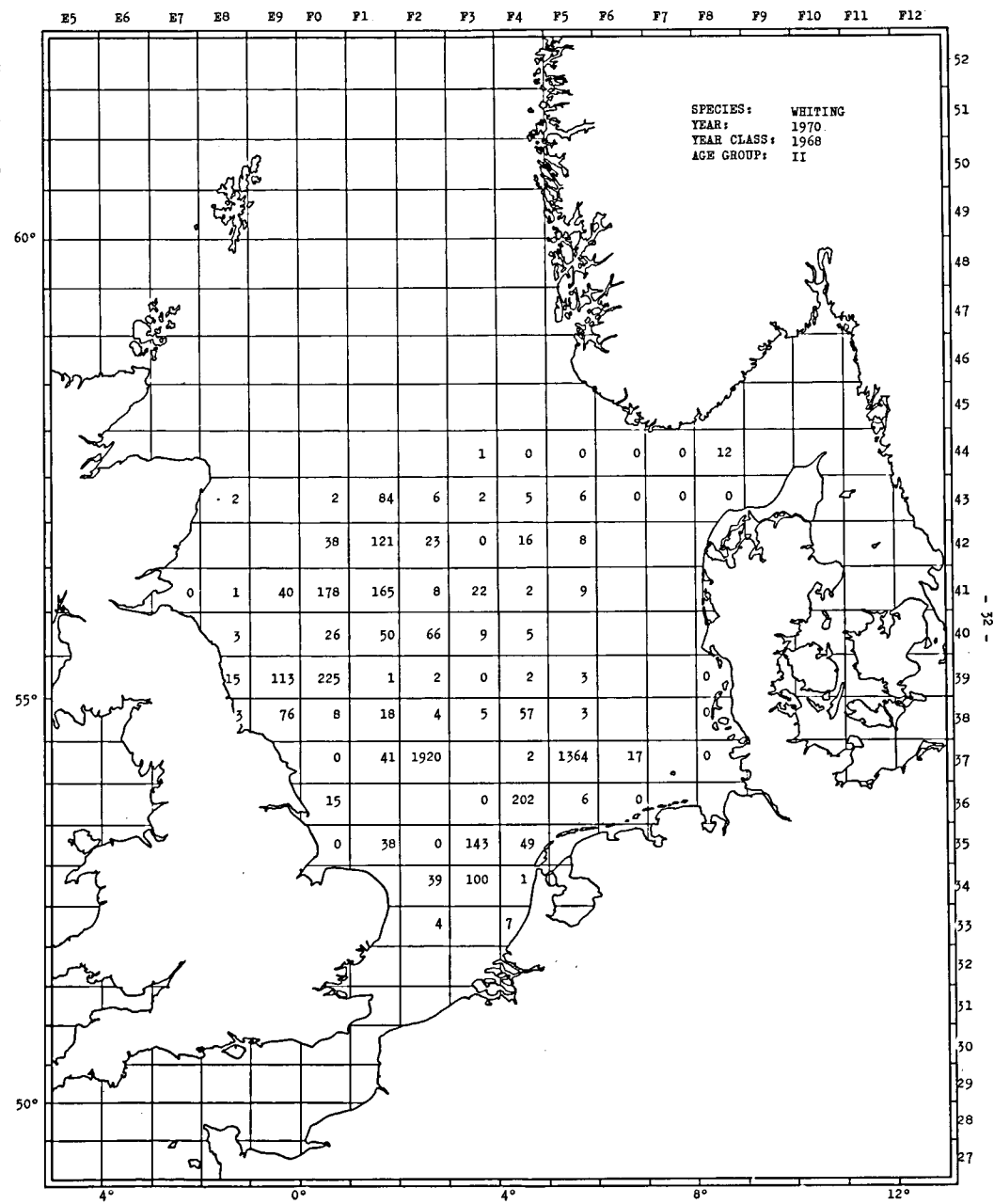


FIGURE 3F



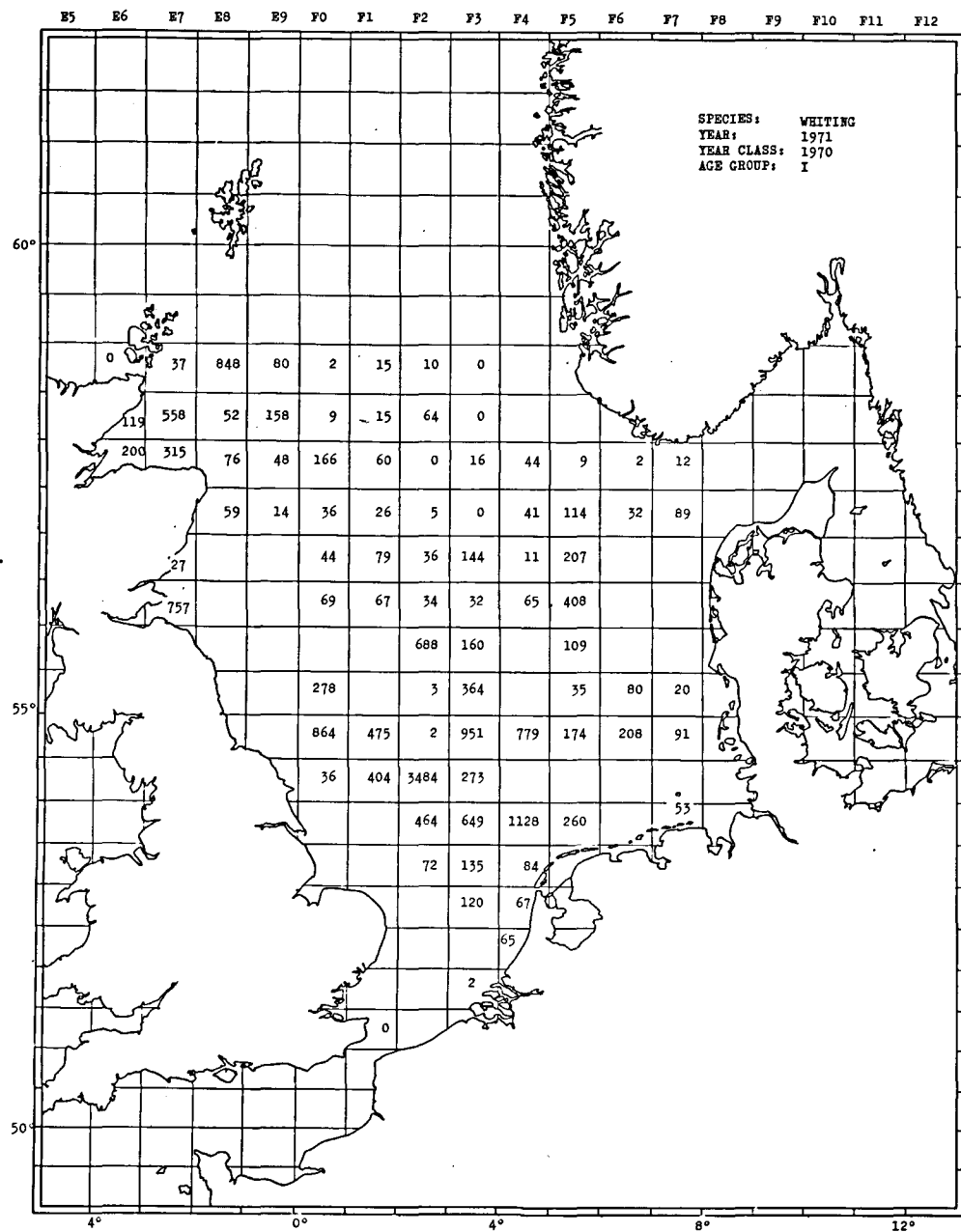
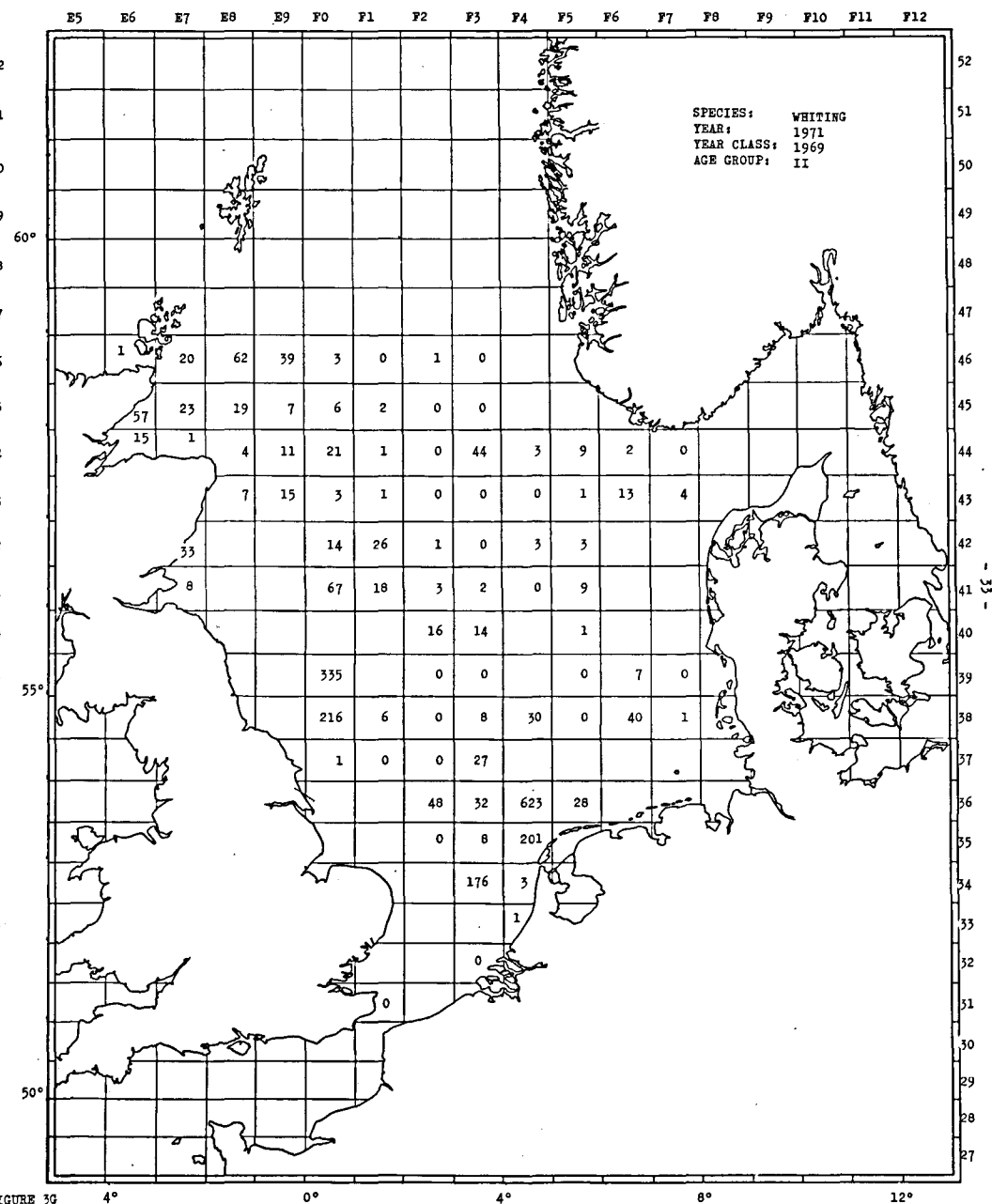


FIGURE 30



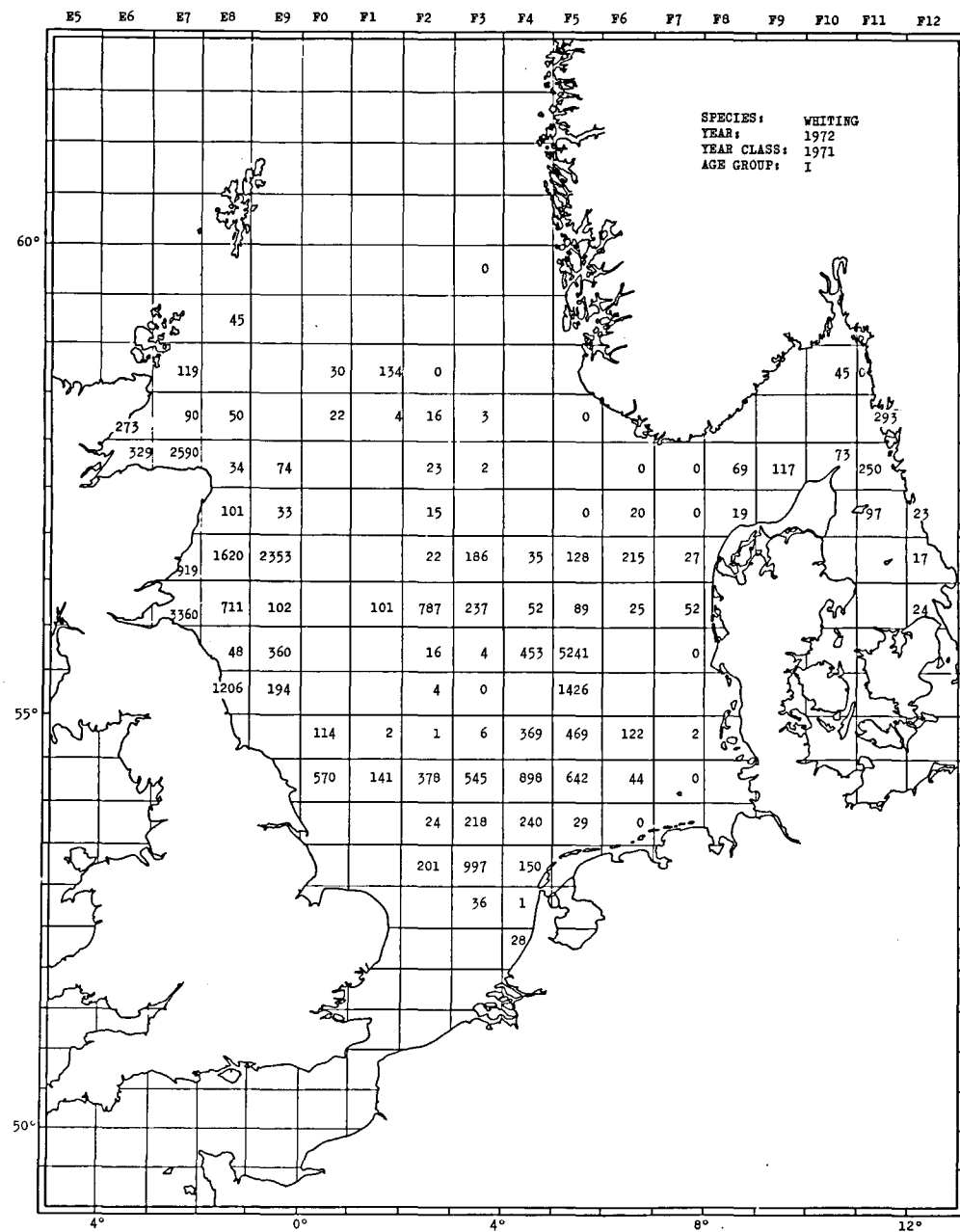
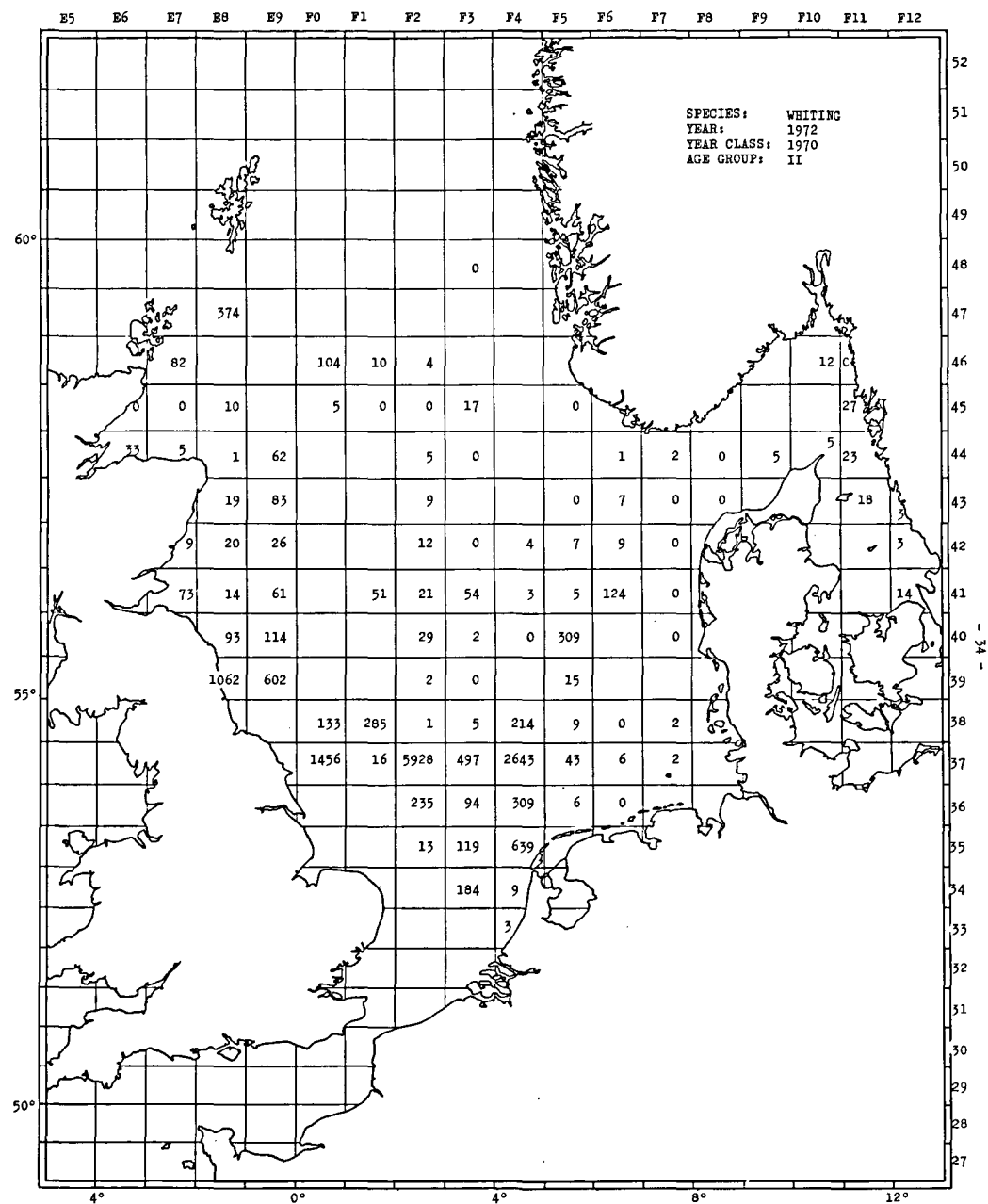


FIGURE 3H



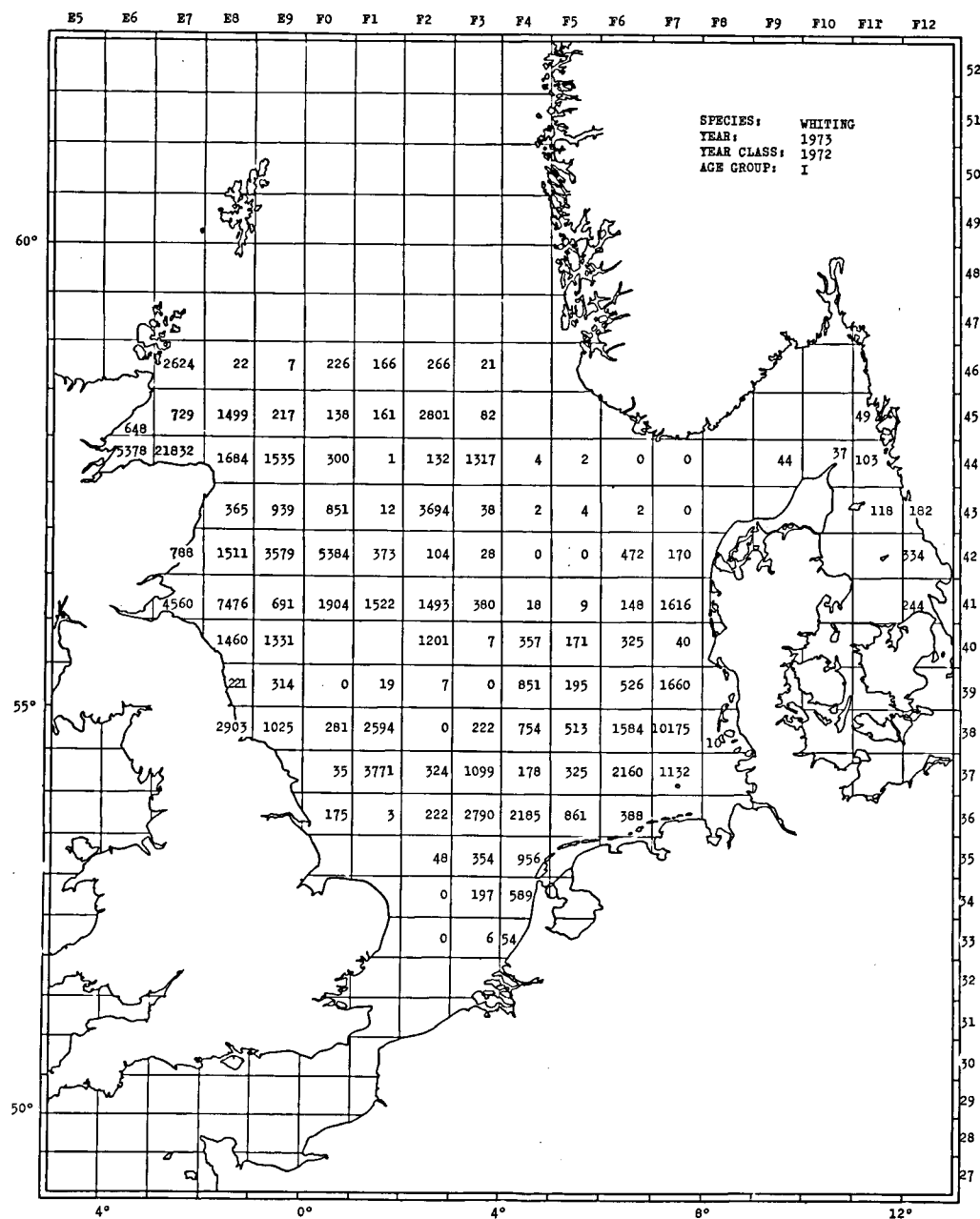
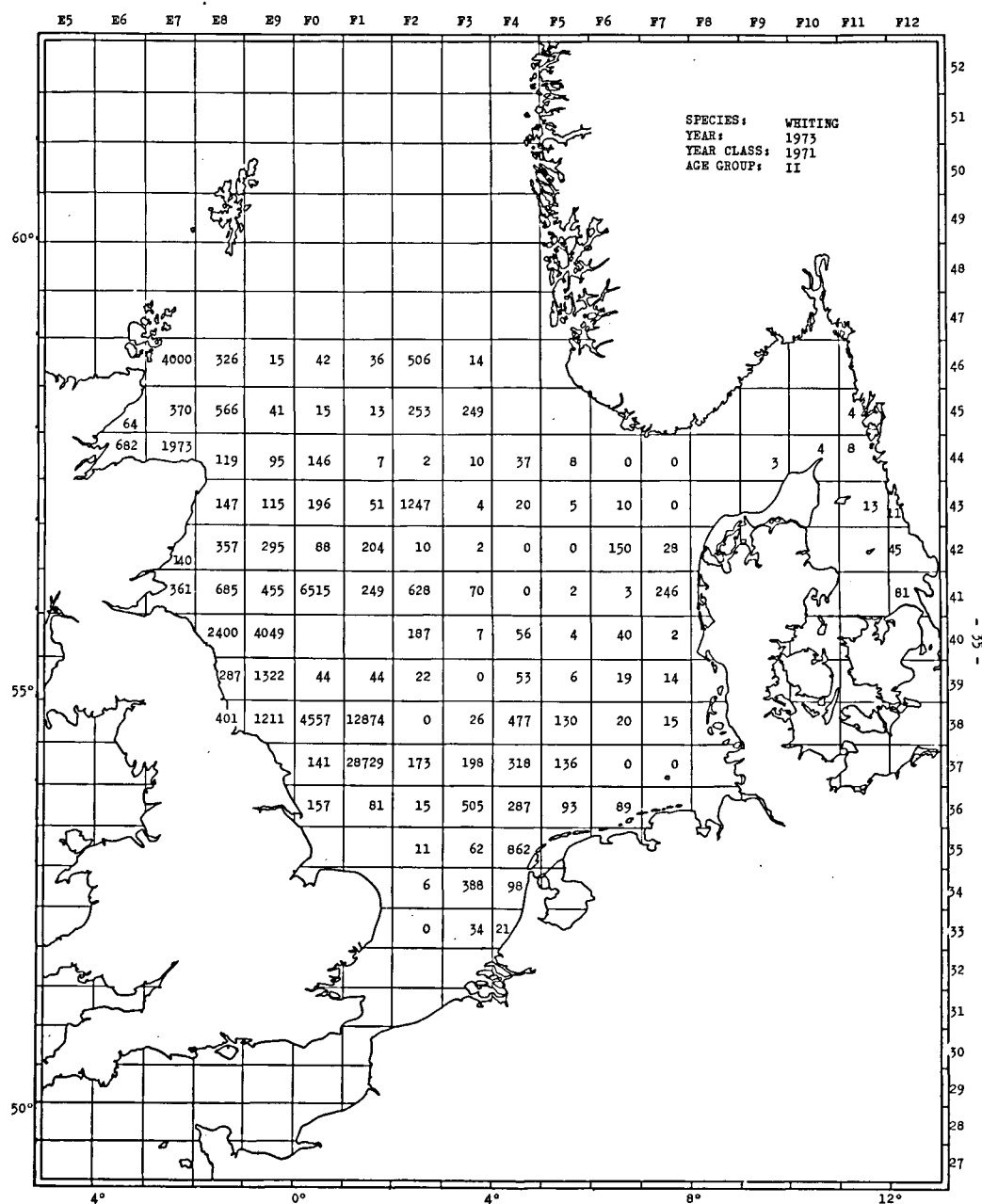


FIGURE 31



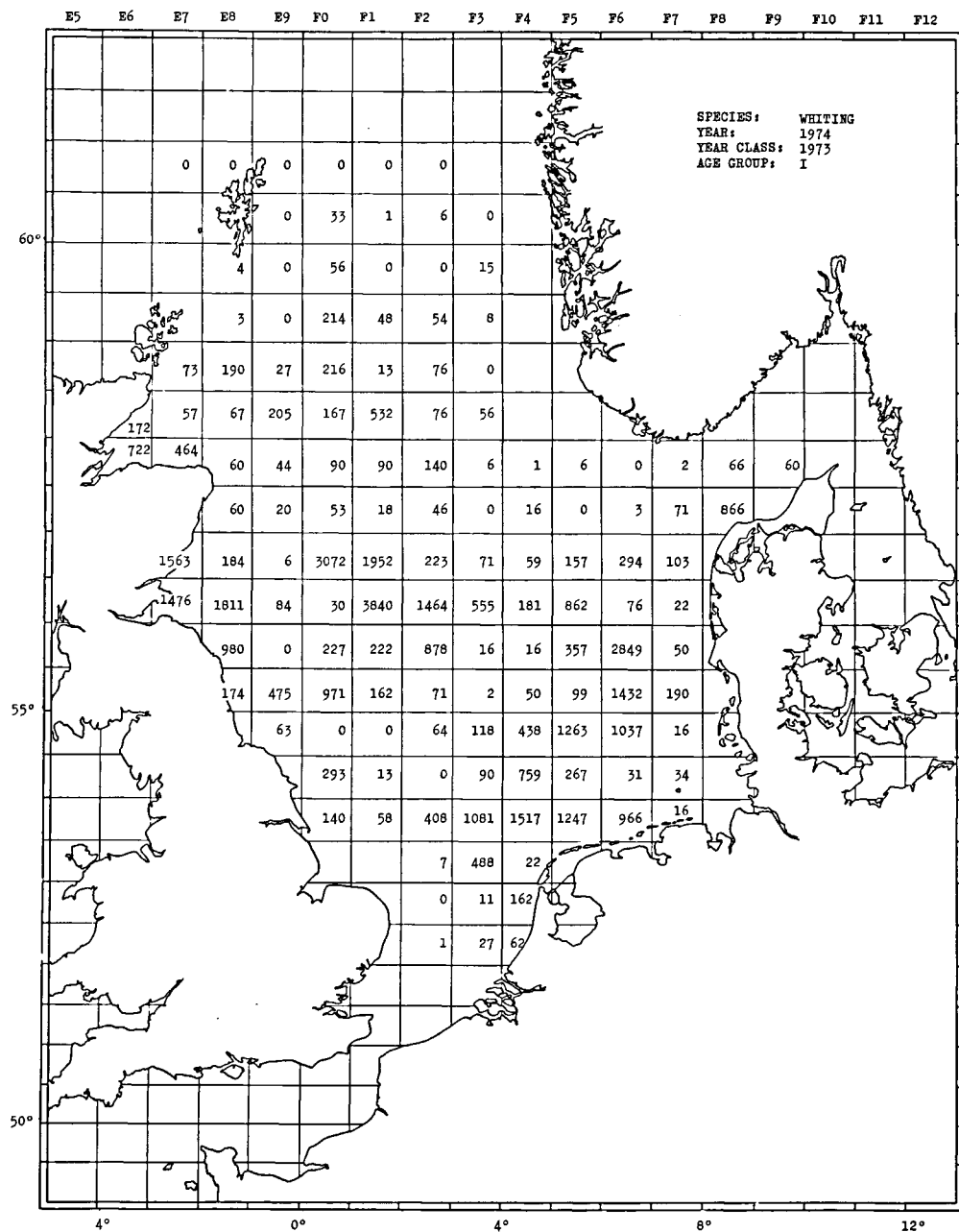
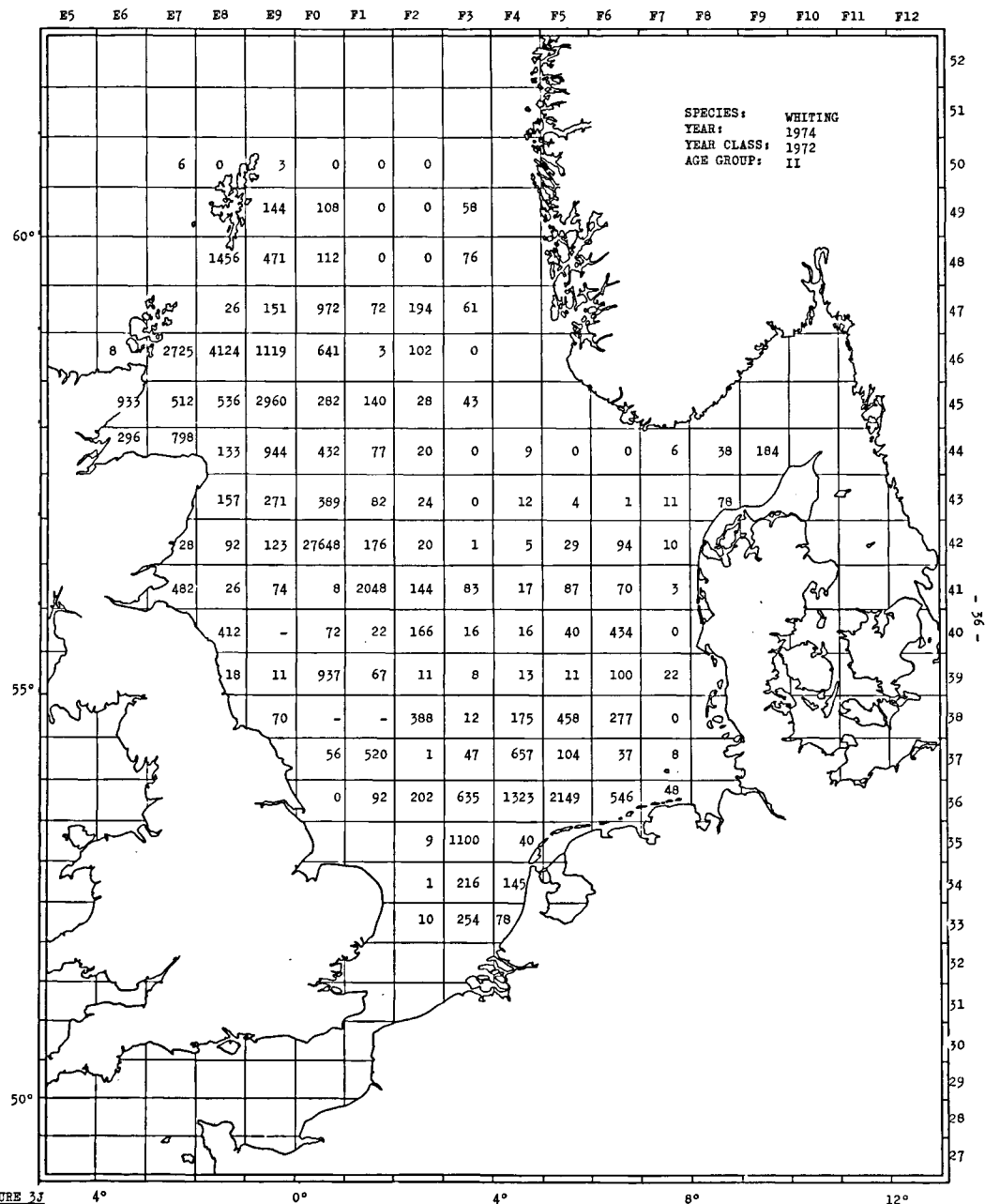


FIGURE 3J



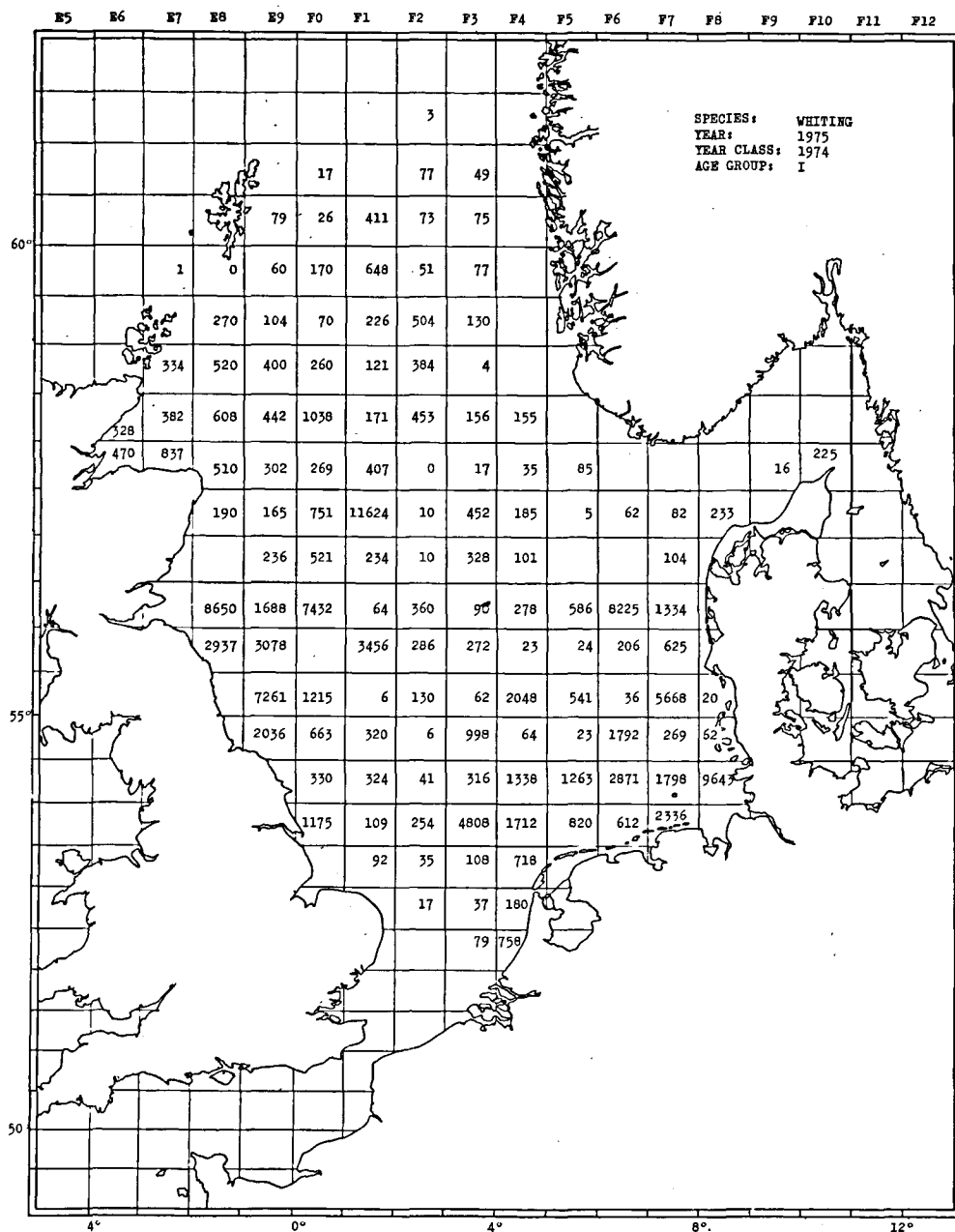
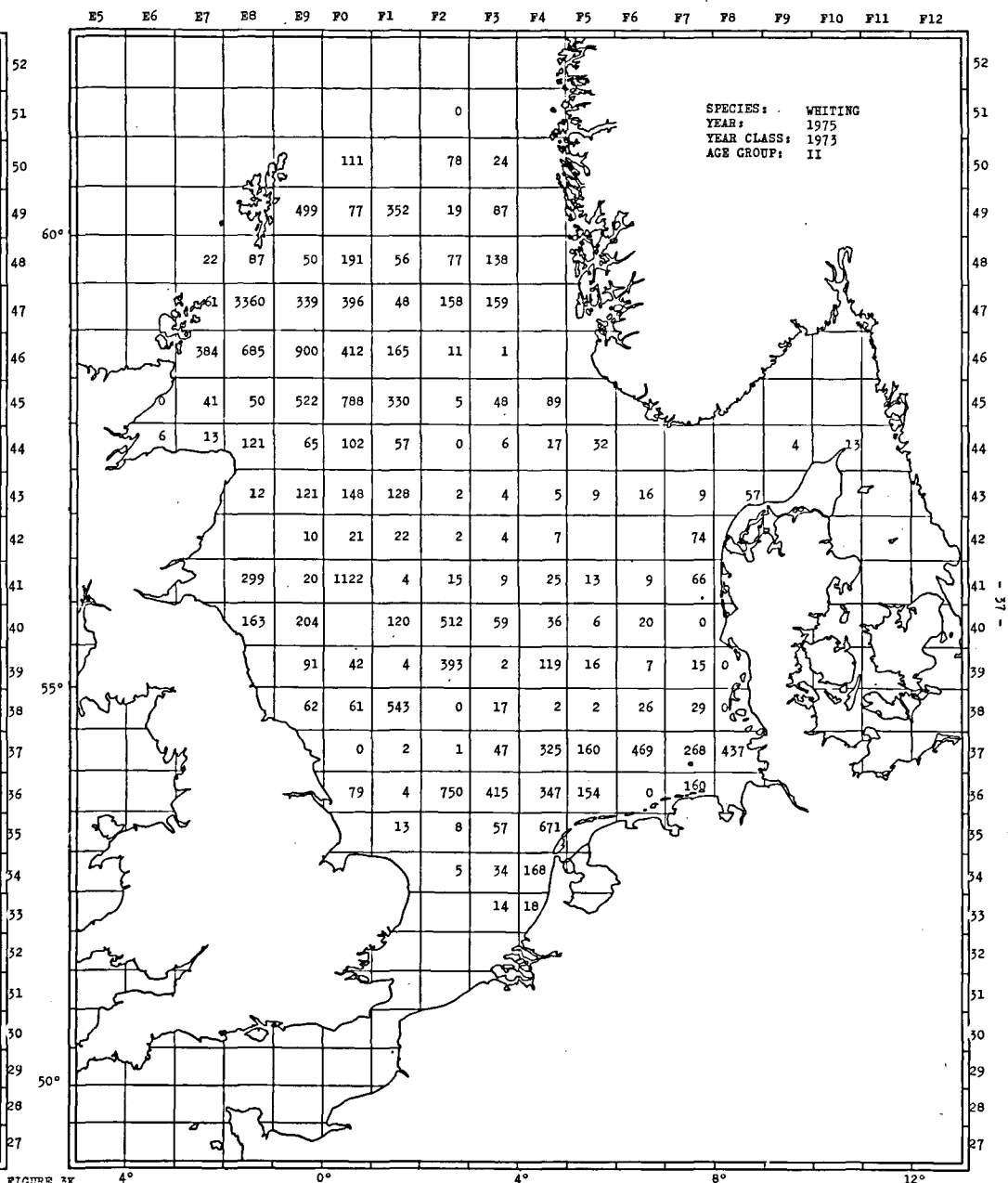


FIGURE 3K



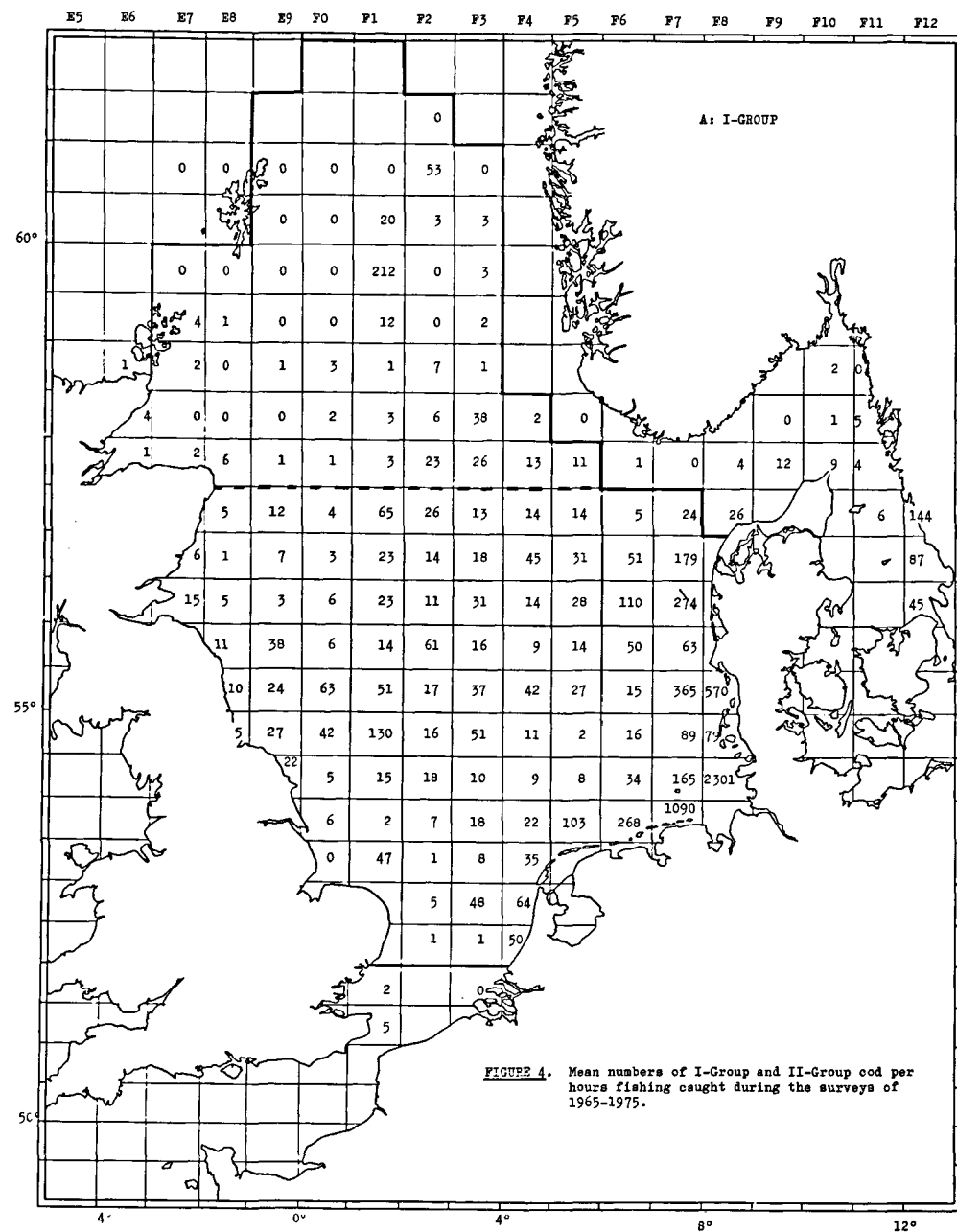
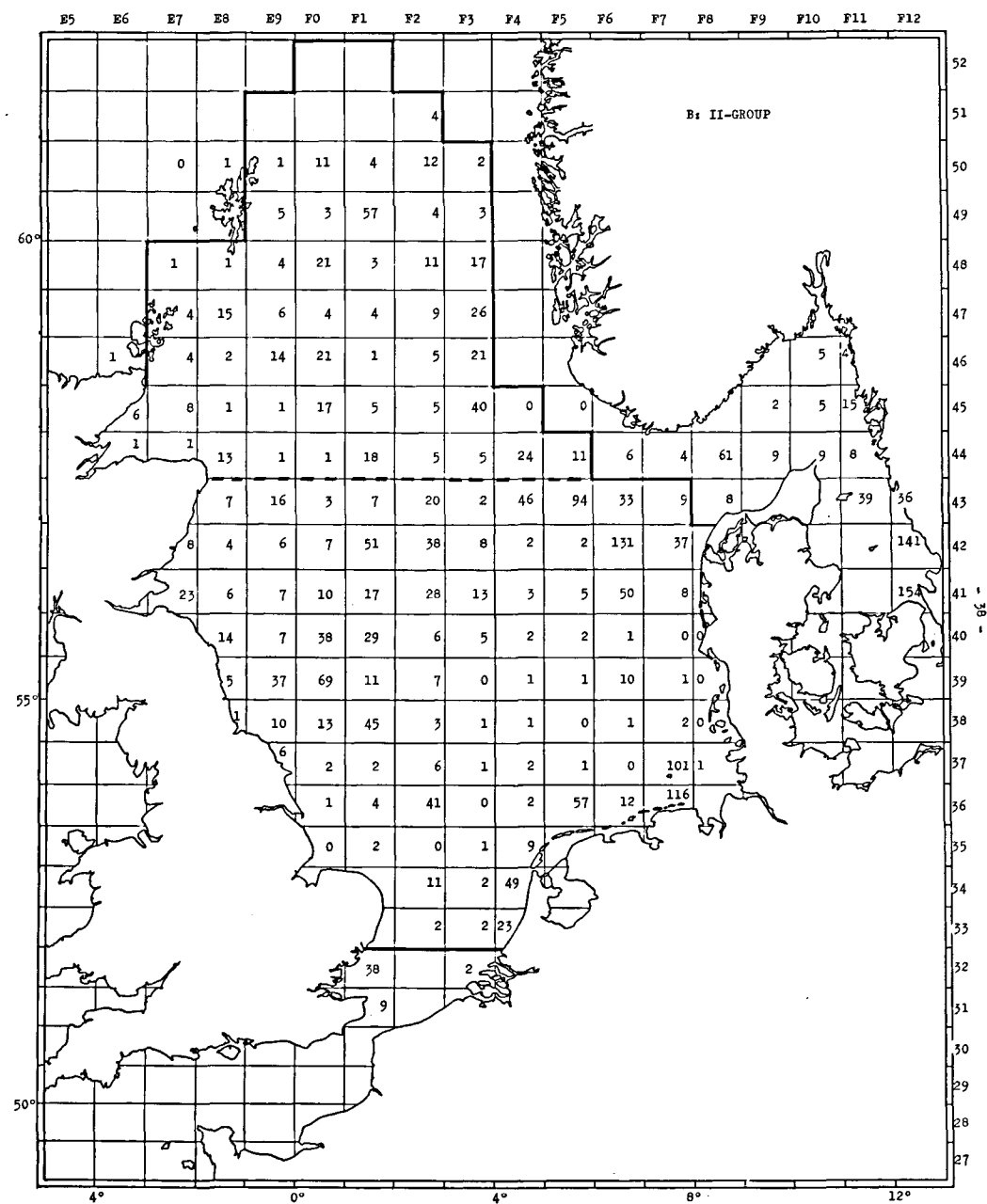


FIGURE 4. Mean numbers of I-Group and II-Group cod per hours fishing caught during the surveys of 1965-1975.



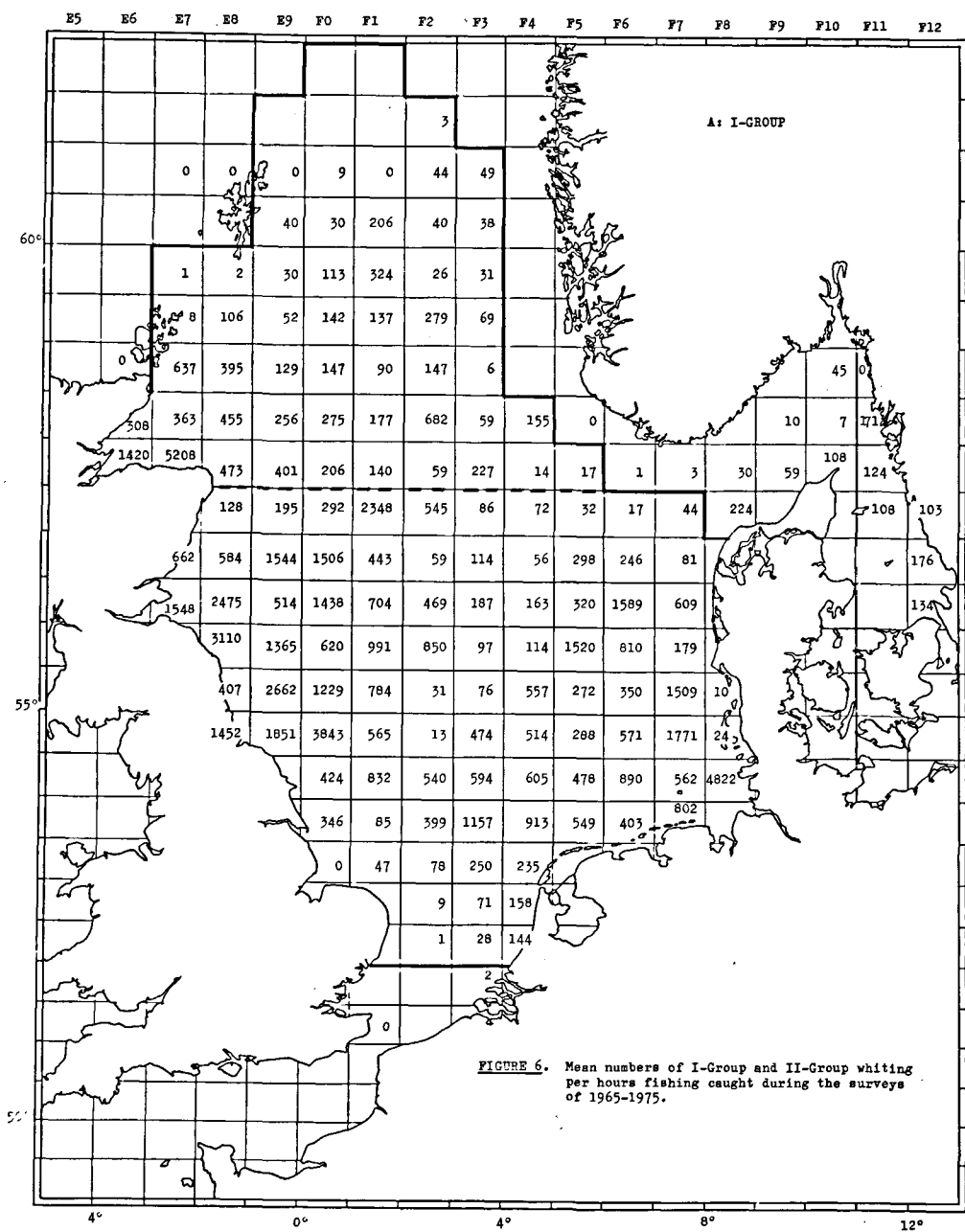
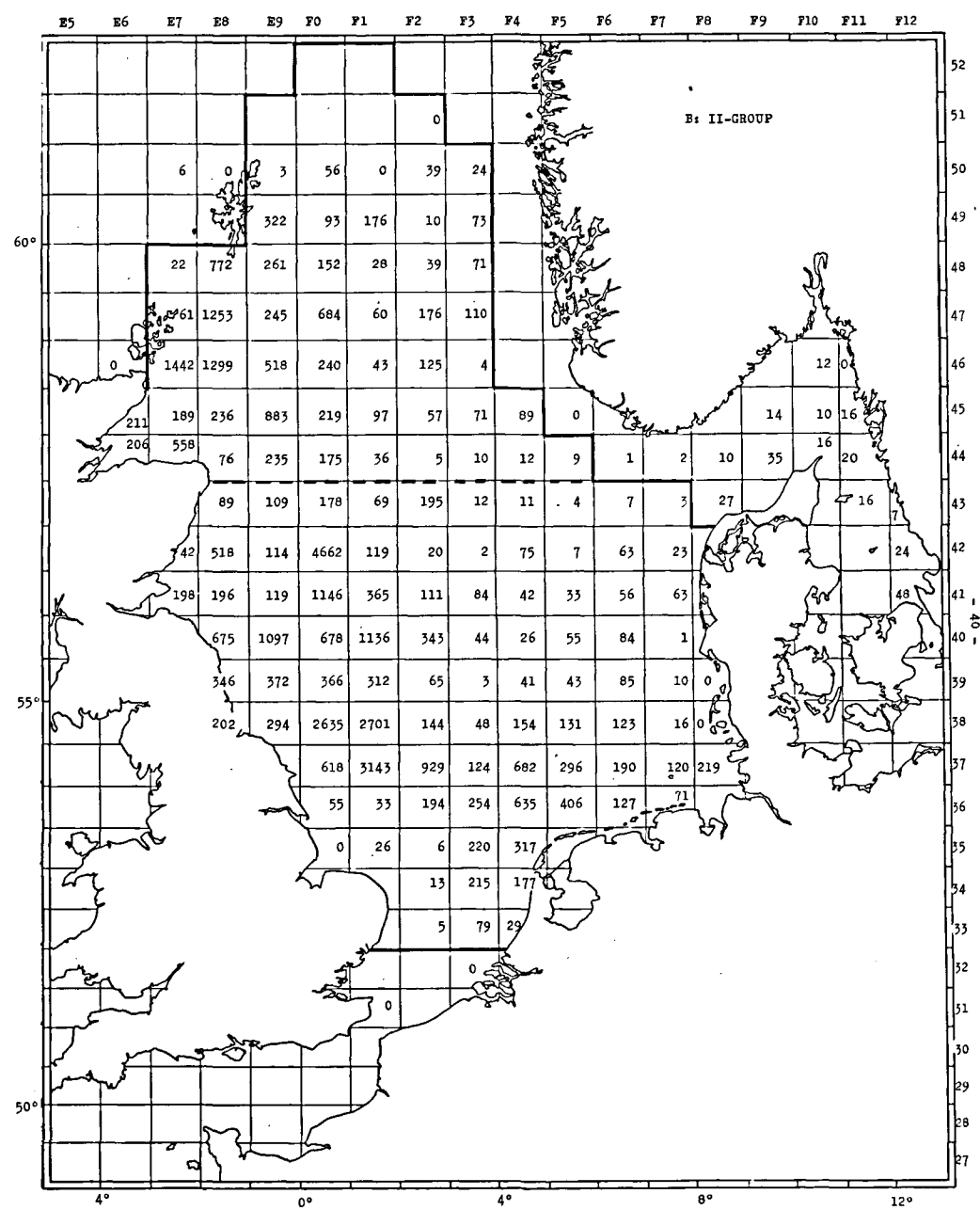


FIGURE 6. Mean numbers of I-Group and II-Group whiting per hours fishing caught during the surveys of 1965-1975.



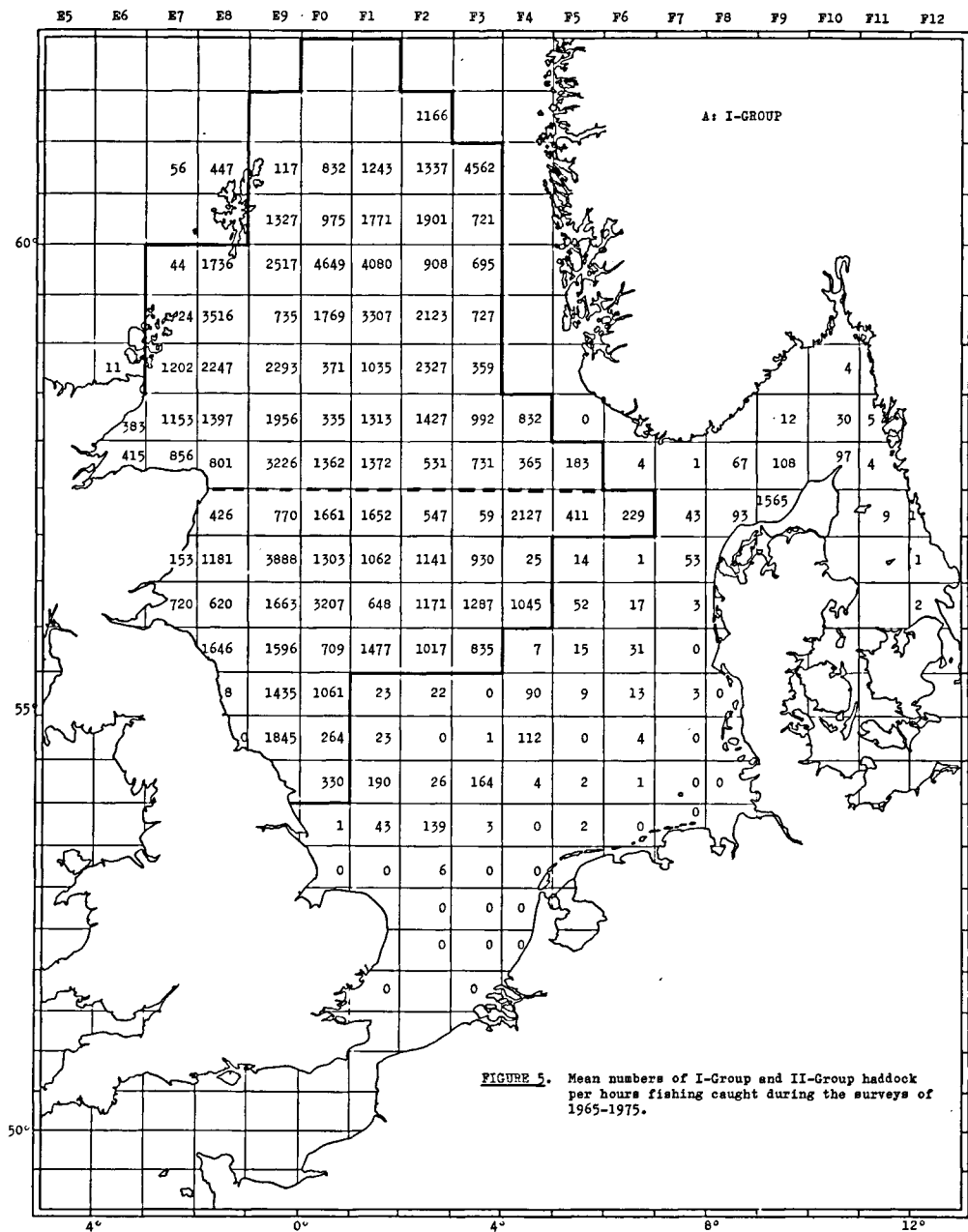
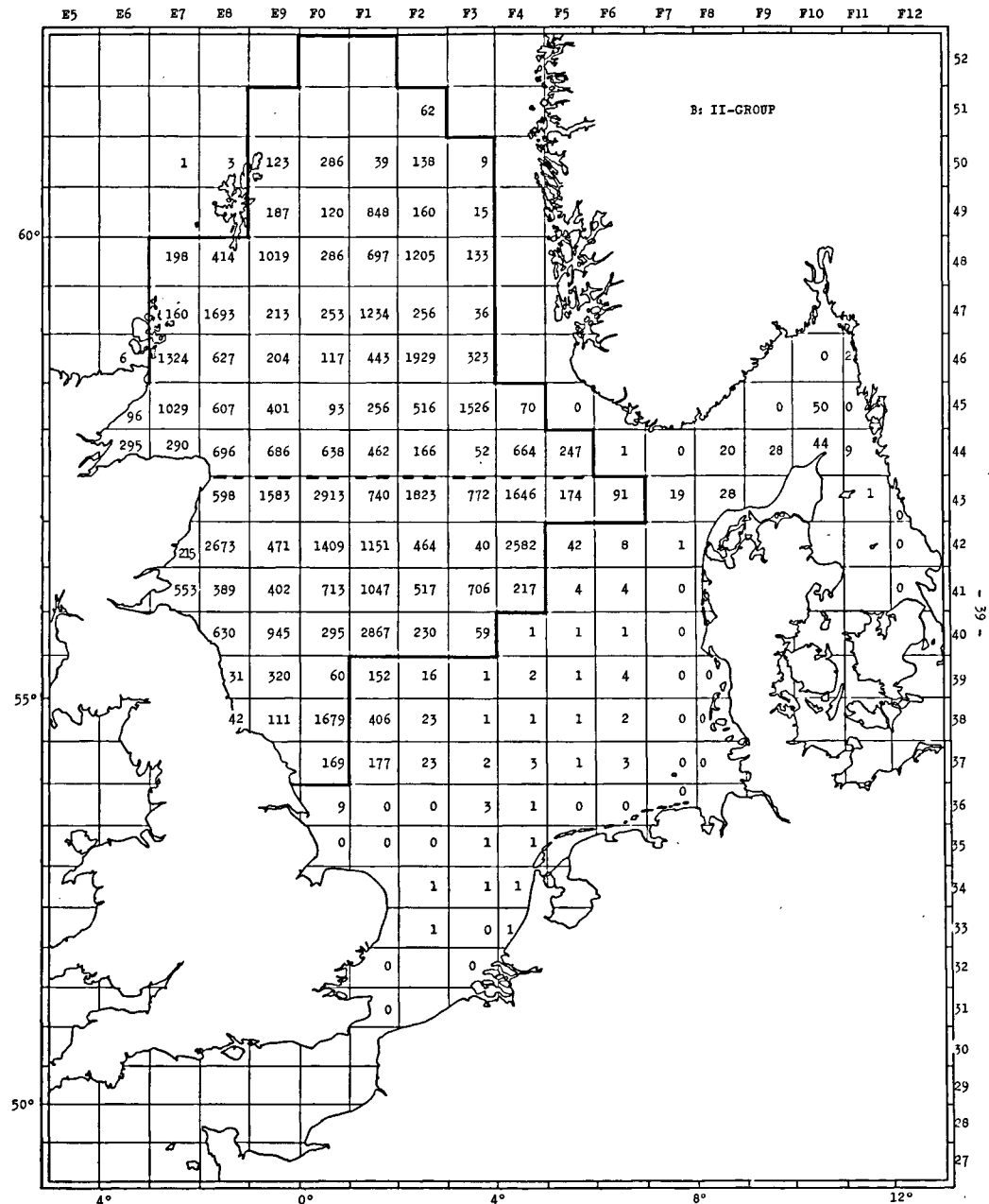
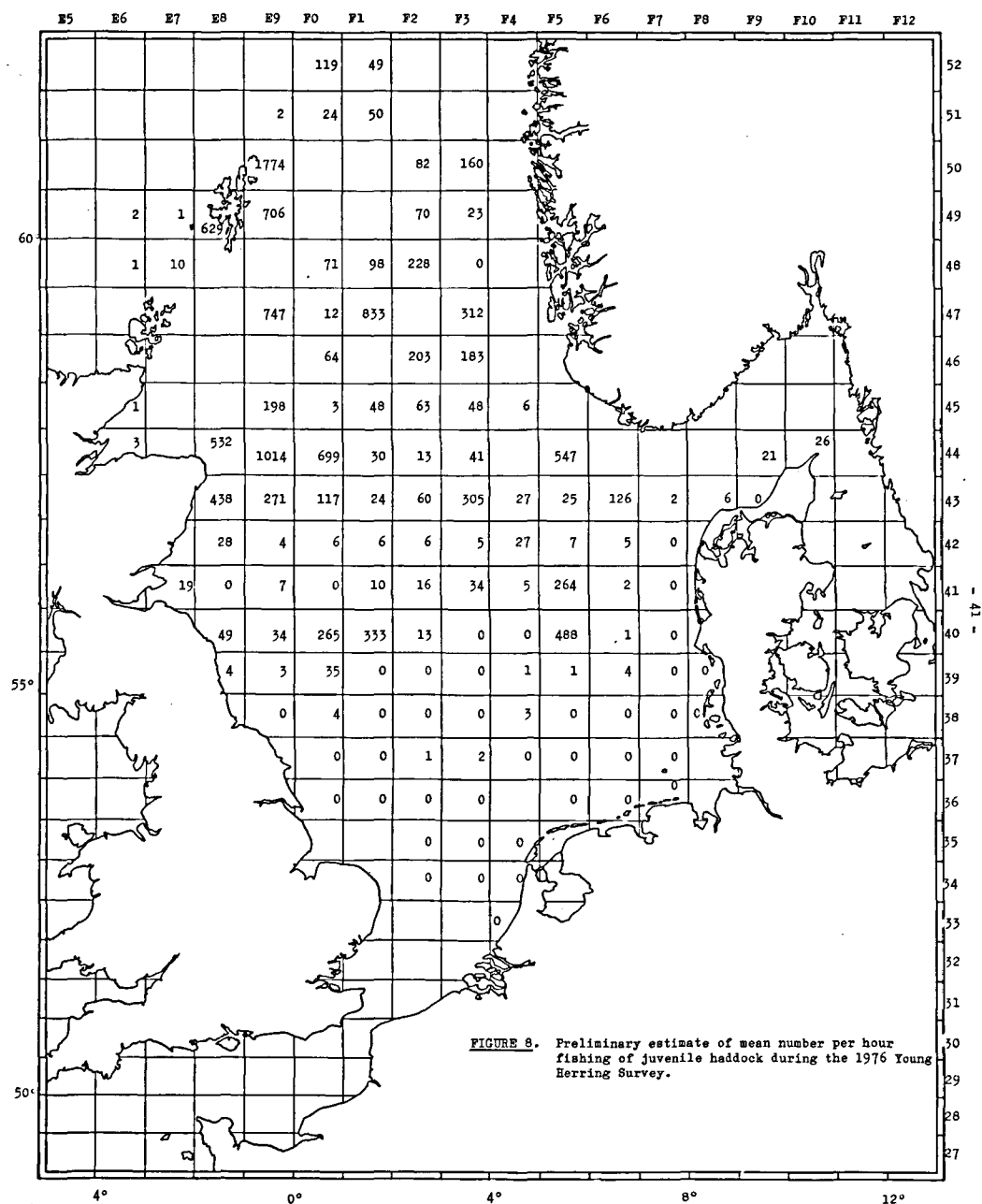
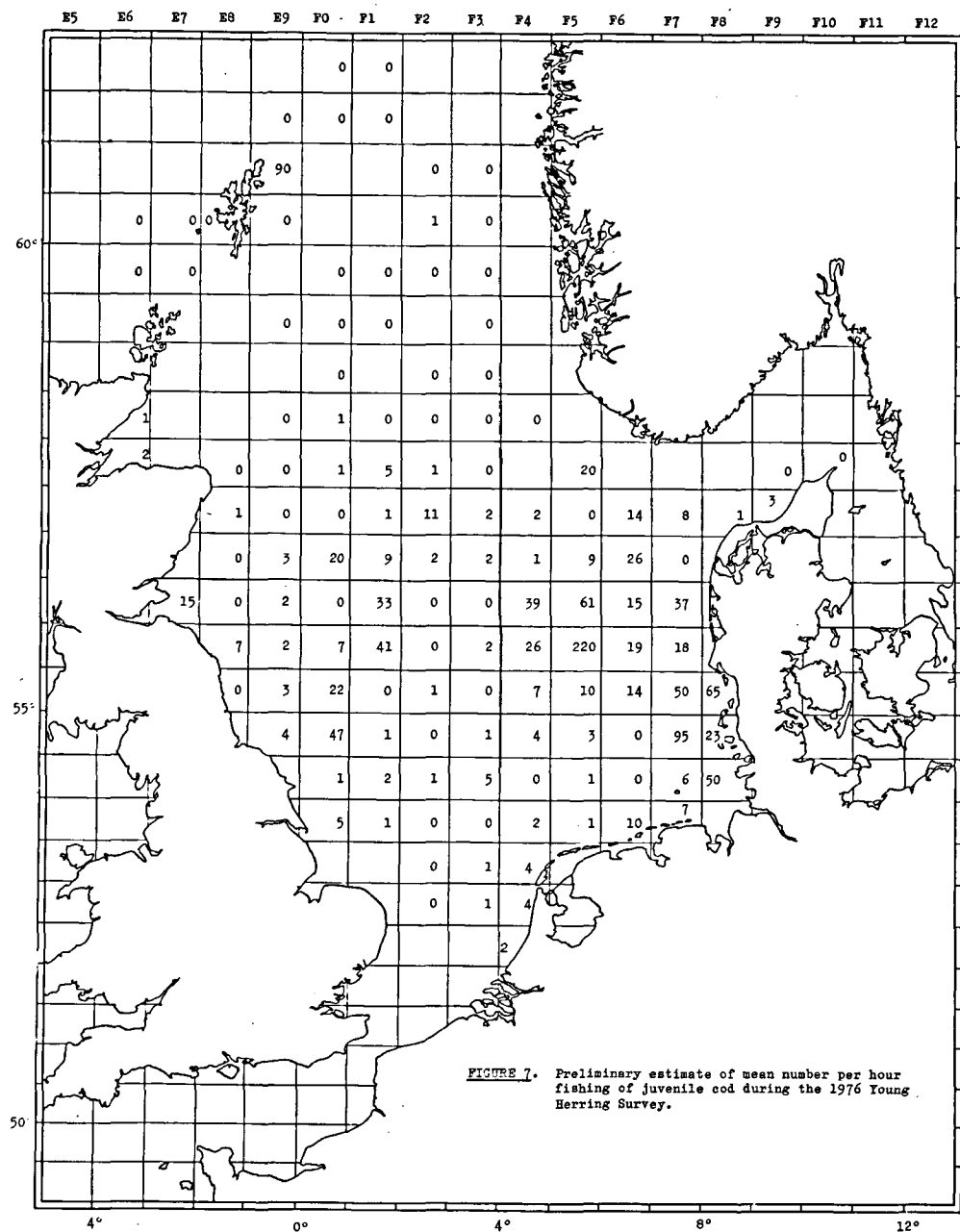


FIGURE 5. Mean numbers of I-Group and II-Group haddock per hours fishing caught during the surveys of 1965-1975.





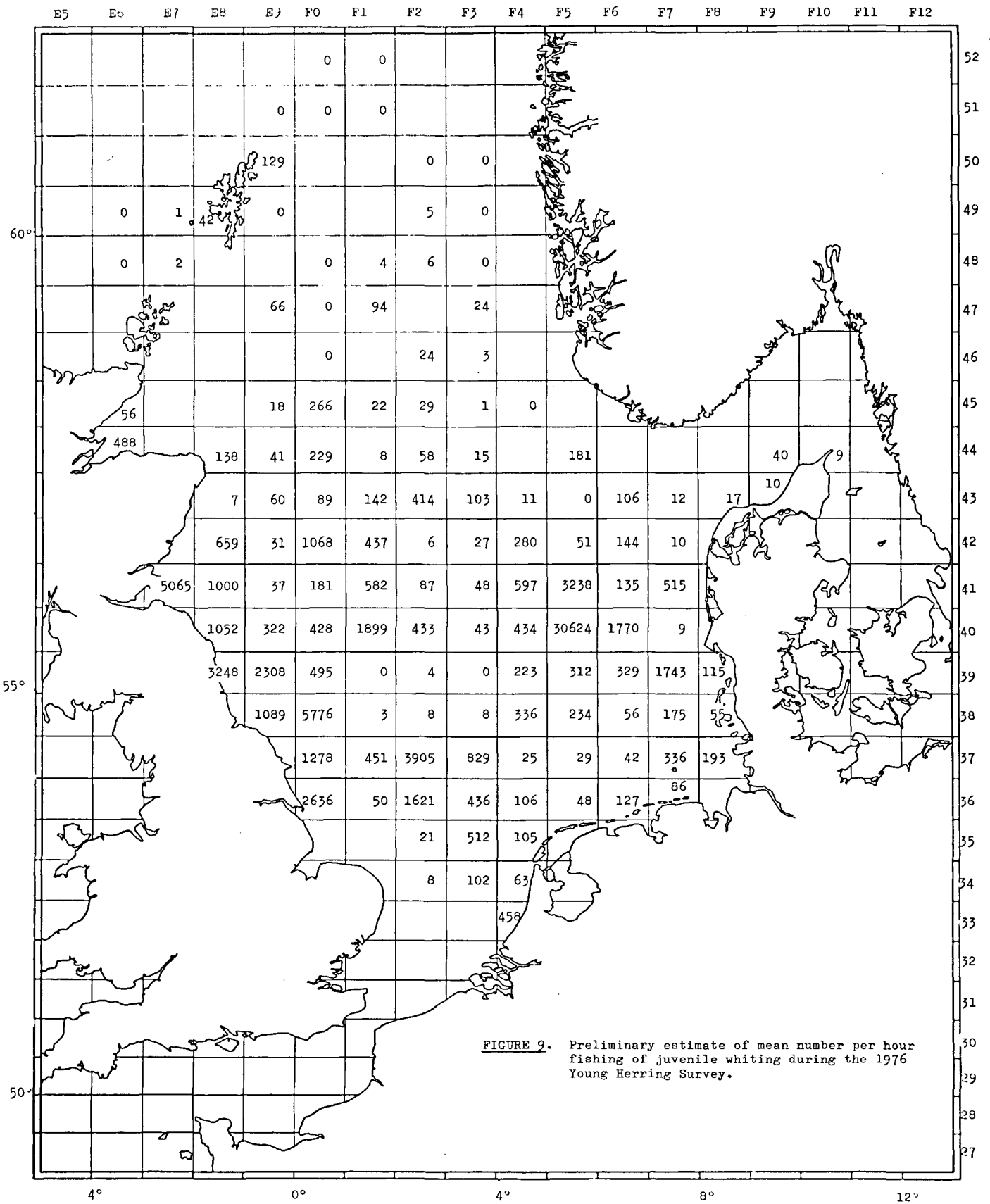


FIGURE 9. Preliminary estimate of mean number per hour fishing of juvenile whiting during the 1976 Young Herring Survey.

Figure 10. GM regressions of e/og transformed year class strength estimates of I-group on II-group cod, haddock and whiting.

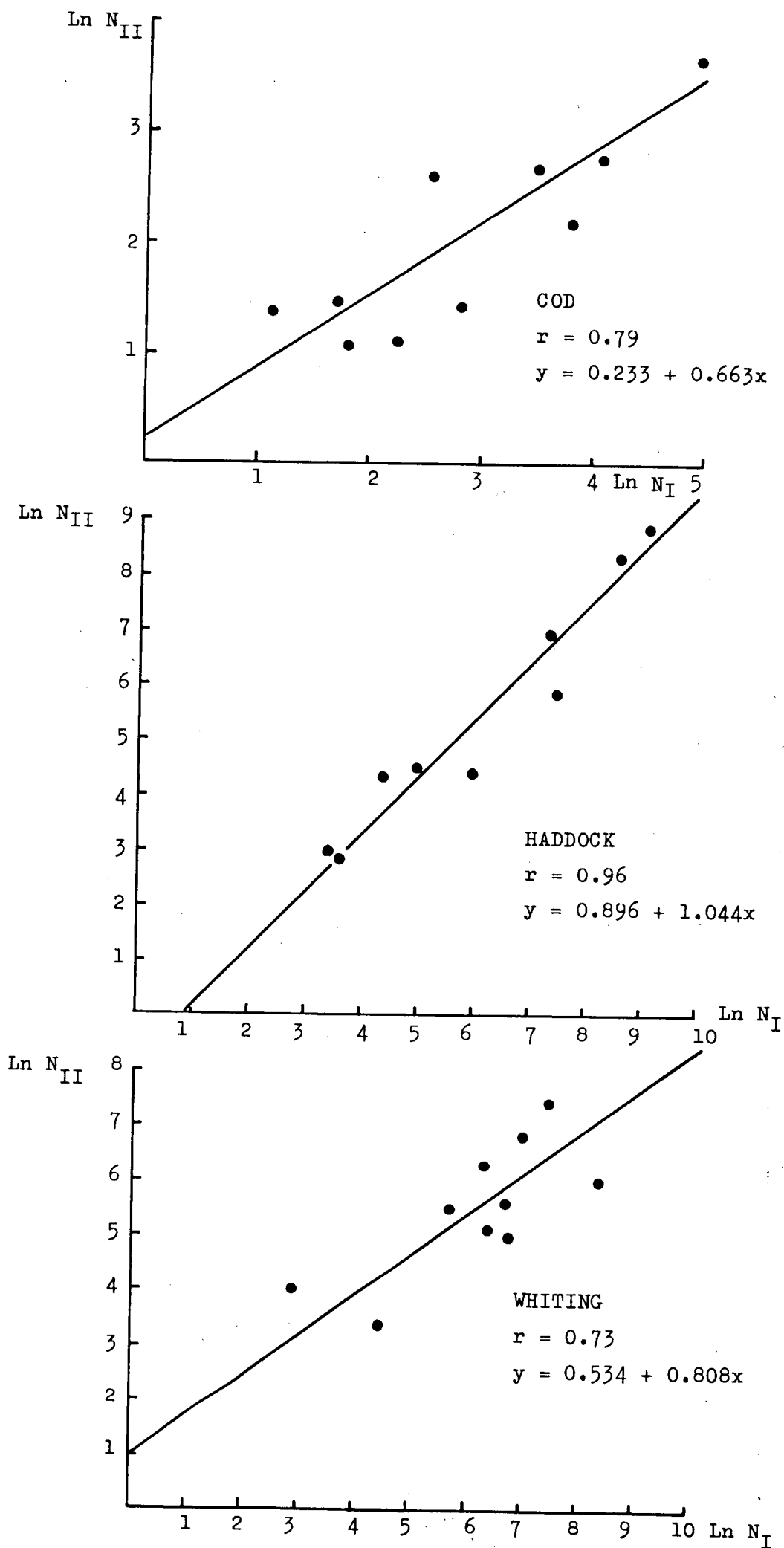


Table Ia. IYHS. Details of data available for COD.

	Denmark		England		France		Germany (F.Rep.)		Nether- lands		Norway		Scotland		Sweden		USSR	
Year	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data	No. of hauls *	Data
1965	x	x	x	x	x	x	x	x	18	L	x	x	x	x	x	x	x	x
1966	x	x	x	x	x	x	34	L	26	L	x	x	x	x	x	x	x	x
1967	x	x	7	L	x	x	50	L	27	L	x	x	15	LA	x	x	x	x
1968	x	x	-	-	x	x	36	L	22	L	x	x	31	LA	x	x	x	x
1969	x	x	24	L	x	x	x	x	43	L	x	x	11	LA	12	L	x	x
1970	x	x	28	L	x	x	43	L	50	L	x	x	15	LA	?	?	x	x
1971	14	L	12	L	x	x	7	L	36	L	17	L	40	LA	x	x	49	L
1972	23	L	22	LA	x	x	5	L	38	LA	22	L	42	LA	35	L	31	L
1973	20	LA	22	LA	x	x	46	L	39	LA	x	x	45	LA	16	L	?	?
1974	27	LA	24	LA	x	x	48	L	52	LA	13	L	39	LA	?	?	39	LA
1975	43	LA	36	LA	x	x	79	L	61	LA	44	L	11	LA	35 ¹⁾	L	26	L
1976	+	LA	+	LA	+	LA	+	L	+	LA	+	LA	+	LA	?	?	+	L

x No participation.

- = No data collected

? Data not available.

L = Length distributions

1) Data were received but could not be used.

* Excluding hauls in which cod were counted only.

A = Age readings.

Table Ib. IYHS. Details of data available for HADDOCK.

	Denmark		England		France		Germany (F.Rep.)		Nether- lands		Norway		Scotland		Sweden		USSR	
Year	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data
1965	x	x	x	x	x	x	x	x	-	-	x	x	x	x	x	x	x	x
1966	x	x	x	x	x	x	66	L	27	L	x	x	x	x	x	x	x	x
1967	x	x	7	L	x	x	50	L	27	L	x	x	15	LA	x	x	x	x
1968	x	x	-	-	x	x	23	L	22	LA	x	x	31	LA	x	x	x	x
1969	x	x	24	L	x	x	x	x	43	LA	x	x	11	LA	11	L	x	x
1970	x	x	28	L	x	x	39	L	50	L	x	x	15	LA	?	?	x	x
1971	19	L	13	L	x	x	34	L	36	L	17	L	40	LA	x	x	49	L
1972	15	L	22	LA	x	x	19	L	38	LA	20	LA	42	LA	35	L	31	L
1973	20	LA	22	LA	x	x	46	LA	39	LA	x	x	45	LA	16	L	29	L
1974	27	LA	24	LA	x	x	49	LA	52	LA	13	LA	39	LA	?	?	39	LA
1975	43	LA	36	LA	x	x	79	LA	61	LA	44	L	11	LA	35 ¹⁾	L	33	LA
1976	+	LA	+	LA	+	LA	+	L	+	LA	+	LA	+	LA	?	?	+	LA

x No participation.

- = No data collected.

*Excluding hauls in which haddock were counted only.

? Data not available.

L = Length distributions.

A = Age readings.

1) Data were received but could not be used.

Table Ic. IYHS. Details of data available for WHITING.

Year	Denmark		England		France		Germany (F.Rep.)		Nether- lands		Norway		Scotland		Sweden		USSR	
	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data	No. of hauls*	Data
1965	x	x	x	x	x	x	x	x	29	L	x	x	x	x	x	x	x	x
1966	x	x	x	x	x	x	52	L	27	L	x	x	x	x	x	x	x	x
1967	x	x	7	L	x	x	49	L	27	L	x	x	15	LA	x	x	x	x
1968	x	x	-	-	x	x	20	L	22	L	x	x	31	LA	x	x	x	x
1969	x	x	-	-	x	x	x	x	43	L	x	x	11	LA	10	L	x	x
1970	x	x	28	L	x	x	27	L	50	L	x	x	15	LA	?	?	x	x
1971	-	-	-	-	x	x	2	L	36	L	17	L	40	LA	x	x	49	L
1972	2	L	-	-	x	x	11	L	38	LA	20	LA	42	LA	35	L	31	L
1973	20	LA	22	LA	x	x	42	L	39	LA	x	x	45	LA	16	L	29	L
1974	27	L	24	LA	x	x	52	L	52	LA	13	L	39	LA	?	?	39	LA
1975	43	LA	36	LA	x	x	79	L	61	LA	44	L	11	LA	35 ¹⁾	L	32	LA
1976	+	LA	+	LA	+	LA	+	L	+	LA	+	LA	+	LA	?	?	+	LA

x No participation.

- = No data collected.

* Excluding hauls in which whiting were counted only.

? Data not available.

L = Length distributions.

A = Age readings.

1) Data were received but could not be used.

Table II. Indices of year class strength as numbers per hour fishing for I-group and II-group cod, haddock and whiting from survey data in Divisions IVb-c.

$$N = e^{\bar{y} + [0.4994 s_y^2 (n-1)/n]} - 1; \quad y = \ln(x + 1); \quad n = \text{no. of squares fished.}$$

Year class	COD				HADDOCK				WHITING			
	I		II		I		II		I		II	
	n	N	n	N	n	N	n	N	n	N	n	N
1963			23	1.8							23	156
1964	23	17	30	4.3			8	(1)	23	543	35	529
1965	30	13	54	14	8	31	21	21	35	602	53	173
1966	54	33	43	15	21	151	22	88	53	803	41	286
1967	43	5.6	65	4.4	22	8 891	25	7 856	41	1 726	44	1 766
1968	65	5.3	79	4.0	25	400	33	88	44	19	70	59
1969	79	61	72	16	33	38	35	18	70	89	56	29
1970	72	142	83	40	35	1 569	36	1 035	56	313	64	247
1971	83	3.0	81	6.2	36	5 223	38	4 395	64	936	85	1 080
1972	81	46	86	8.8	38	82	36	78	85	4 475	85	405
1973	85	9.6	82	3.1	36	1 840	32	337	85	934	82	152
1974	82	121			32	1 366			82	1 940		
Average		42				1 823				1 125		
1975	86	11			36	44			86	1 269		

Table III. Indices of year class strength as numbers per hour fishing for I-group and II-group cod, haddock and whiting from survey data in Division IVa (cod) and Divisions IVa,b,c (haddock and whiting) (see also Table II for legends).

Year class	DIVISION IVa				DIVISIONS IVa,b,c							
	COD				HADDOCK				WHITING			
	I		II		I		II		I		II	
	n	N	n	N	n	N	n	N	n	N	n	N
1967			2	(15)			27	7 300			46	1 811
1968	2	(25)	3	(37)	27	425	36	88	46	18	73	56
1969	3	(3.2)	25	15	36	45	60	60	73	86	81	24
1970	25	75	23	4.6	60	2 114	61	730	81	296	83	177
1971	23	1.1	18	11	61	3 044	63	3 577	83	710	110	877
1972	18	1.9	45	7.8	63	461	82	272	110	4 272	131	692
1973	45	11	47	7.8	82	3 685	81	703	131	703	130	222
1974	47	0.2			81	1 663			130	1 292		
Average		18				1 634				1 053		
1975	38	36			74	177			124	1 233		