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REPORT OF THE PELAGIC 0-GROUP GADOID SURVEY IN THE NORTH SEA IN 1975

by

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1. INTRODUCTION

The 1975 standard 0-group survey was carried out in the period between 4 June and 8 July by 4 vessels, DANA (Denmark), TRIDENS (Netherlands), EXPLORER (Scotland) and CORELLA (England). In order to evaluate the relative efficiencies of these 4 vessels in catching small gadoids a comparative fishing experiment was made in which the JOHAN HJORT (Norway) and CLIONE (England) also participated. In addition, to test some of the methodology used in these surveys, these 6 vessels took part in an experiment to determine the stratification of 0-group gadoids.

2. THE COMPARATIVE FISHING EXPERIMENT

2.1 Method: The experiment was conducted during the period 23-24 June 1975 in statistical square 19E (49F0), in which a grid of 6 sub-rectangles, each approximately 3x1.5 miles, was laid out. Each day was divided into 4h periods, during which each vessel made as many standard hauls as possible in a sub-rectangle. Within the limitations that each sub-rectangle was occupied by one vessel and that each vessel fished each sub-rectangle at least once, vessels were allotted to sub-rectangles on a random basis. The TRIDENS, DANA and CORELLA fished the Dutch version of the standard international young gadoid pelagic trawl (IyGPT) and the EXPLORER the Scottish version. The JOHAN HJORT fished a 33mx33m capelin trawl and the CLIONE a 2mx3m Boothbay net. A standard tow is defined as shown in Fig 1. In addition to standard hauls the CLIONE carried out a series of V-hauls with the Boothbay, the catches of which were adjusted to represent the catch of a 1h haul.

2.2 Results: The programme went as planned except that the EXPLORER was unable to participate at all and the CORELLA on 23 June only. However, these two vessels made 4 comparative hauls on 27 June.

2.2.1 Numbers of fish caught

The numbers by species caught in consecutive hauls by each vessel are given in Table 1. On theoretical grounds (cf. JONES, 1954) trawl catches are likely to have a negative binominal distribution and chi-squared tests for the

cod data revealed no significant deviations from such a distribution. Therefore the data were transformed to natural logarithms, after adding 1, in order to test the differences between ships. The statistical analysis is laid out in Table 2. First a Bartlett test for homogeneity of the variances was applied to the 4 ships using the IYGPT, the two methods of fishing the Boothbay net and finally to the 3 types of gear being used. Within gears the variances were not significantly different for any of the species, but between gears they were different at the 1% level for all species except Whiting (Table 2a). It should be noted that the DANA did not report any 0-group whiting, which was apparently due to identification problems, and it is assumed that they were identified as other species. The absence of whiting in the catch of the JOHAN HJORT is more likely to be related to the escape of the generally smaller sized whiting through the larger meshes in the codend of the Capelin trawl (see section 2.2.3). The results of the Bartlett's test fullfil the requirement of homogeneity of the variances for the analysis of variance for the IYGPT and the Boothbay separately, and the results are set out in Table 2b. The F ratios obtained indicate significant differences in catch rates between vessels using the IYGPT for haddock and Norway pout, but not for cod and whiting. The standard and oblique hauls with the Boothbay net yield comparable catches for all species except Norway pout. The estimated confidence limits of the back transformed average catch were calculated for each vessel and for the methods of fishing separately (Table 2c). Except for Norway pout, the catches of which varied enormously, the ranges of the confidence limits within gears overlap to a large extent and the orders of magnitude are comparable. The data suggest that the TRIDENS' catches are slightly below average and those of the DANA slightly above. The very much larger capelin trawl fished by JOHAN HJORT yielded extremely high catches of Norway pout and slightly higher haddock catches than the IYGPT. (The logarithmic transformation resulted in absurd values of the averages for the catches by this gear and therefore the confidence limits are based on the assumption of a normal distribution; the reason for this is that the distribution probably does not fit the negative binomial). Comparing the Boothbay net with the IYGPT also reveals some remarkable differences in species composition. The relative proportions of the catches of the Boothbay to the IYGPT were 0.9, 0.15, 0.10 and 0.005 for whiting, cod, haddock and Norway pout respectively.

2.2.2 Length compositions

The length compositions of the catches by species by the different vessels are given in Table 3. For cod, haddock and whiting the length compositions of

CORELLA, DANA, EXPLORER and TRIDENS are identical and there is no significant difference between the mean lengths. The mean lengths observed in the Boothbay catches are rather lower and those of the JOHAN HJORT higher.

The length distribution of Norway pout was bimodel. The CORELLA, EXPLORER and the JOHAN HJORT caught fish from the higher mode, whereas the DANA and TRIDENS caught fish from both modes, those from the smaller mode predominating in the catches of the DANA. The CLIONE caught very few Norway pout, mainly small fish.

2.2.3 Discussion

The relatively constant catches of cod, haddock and whiting in the IYGPT hauls indicate that these fish are fairly spread out over the area and do not tend to concentrate in dense and large schools, which is apparently true for Norway pout. The bimodal length distribution of this latter species adds another factor to the variability in individual trawl hauls. The general conclusion can be drawn that differences in fishing power, if any, between ships using the same standard trawl are relatively small and certainly cannot be expected to influence the estimates of yearly abundance to the extent that year class strength fluctuations would become masked. Also the variances among the catches in individual hauls in a limited area of the 0-group gadoids would seem not to be large enough to affect the estimates of relative abundance to a significant extent, except for Norway pout. Thus the standardized fishing methods in this survey appear to be appropriate to the main aim of getting an early and reliable index of 0-group abundance.

The cross sectional area of the Boothbay net is $6m^2$ and that of the codend of the IYGPT approximately $12m^2$. Except for whiting the standard trawl outfished the Boothbay by more than 2:1, it also caught larger fish. These data indicate that shepherding of fish as small as 2cm took place. The result for whiting caught by CLIONE is peculiar in that the catches were equal to those of the CORELLA and greater than those of the TRIDENS and also included 1cm fish which were almost entirely absent from those of the other vessels (see Table 3). This indicates that the IYGPT is an appropriate gear for catching 0-group fish larger than 2cm and that the Boothbay net is not suitable for these surveys.

The codend of the capelin trawl was nde of 16mm knotless netting and that of the other gears of 10mm (nominal) woven mesh. It would appear likely from the differences in catches of Norway pout and of the size composition of the fish caught by the capelin trawl and the IYGPT that the former caught more fish but retained only the larger specimens, mainly 3cm+. This is particularly

marked for whiting, which were all small (see Table 3) and which were almost entirely absent from the catches of the capelin trawl.

3. THE STANDARD SURVEY

The statistical squares fished by each vessel are shown in Figure 2. The mean numbers per 1h standard haul for each species are shown in Figures 3 to 8. Cod were found in the three usual concentrations, east of the Shetland Islands, off the Firth of Forth and off the Danish coast. As in previous years most haddock were found east of the Shetlands between 59°N and 61°N with the distribution extending south-east to the Danish coast. East of Shetland the whiting distribution was more northerly than usual, few fish being caught south of 60°N, whereas the concentration in this area usually extends to 59°N. Elsewhere the distribution of whiting was normal. Norway pout were caught further south than in 1974, 55°30'N compared with 57°N; the main concentration was east of Shetland. Few blue whiting and saithe were caught.

The average numbers per haul, mean length, standard deviation and range of each species by 4 statistical rectangles are shown in Table 4.

Mean numbers, based on geometric means, and 95% confidence limits for cod, haddock and whiting for 1969 to 1975 are shown in Table 5: the methods of calculation are those described in the section 2.2.1; the areas are those shown in Figure 2.

The data for 1969-71 are based on Scottish surveys only, none of which fully covered the area shown in Figure 2. In 1972 the northern North Sea was fished by 'EXPLORER' and 'TRIDENS' using the IYGPT and the few hauls made by 'CLIONE' using a Boothbay net have been excluded. The results for the other two areas are based mainly on catches taken with a Boothbay net, which the comparative fishing experiment showed underestimates abundance compared with the IYGPT. Two sets of results are shown for 1975, those including and excluding the Danish data, the comparative fishing experiment having shown that the Danes were probably misidentifying some whiting. The results for the 1975 survey for the British east coast almost certainly underestimate 0-group abundance for the year because the standard survey in this area took place too early. A later survey made with a Boothbay net found cod, haddock and whiting. For some years and areas, notably the British east coast and the German Bight, where in some years no 0-group gadoids were found in most of the statistical squares, the distribution probably approaches the Poisson and not the negative bi-nomial. Such results are marked by very wide 95% confidence limits.

All three species were less abundant in all three areas in 1975 than in 1974, and in the northern North Sea the differences were statistically significant. Considering the seven years for which there are data for the northern North Sea, the abundance for 1975 ranked fourth for cod and third for haddock and whiting, (Table 6). The estimates of year-class size as 1 year-old fish taken from virtual population analyses are also shown in Table 5 but there are too few years for which the surveys have been carried out in a standard manner to make meaningful comparisons between the two sets of data.

4. STRATIFICATION EXPERIMENT

A co-operative exercise took place to discover how the young gadoids were stratified in the water column at the end of June. Such information is necessary for determining which is the correct strategy for sampling these fish.

The water column was divided into 6 depth strata, each of which was fished during a 4h period by one of the vessels equipped with a pelagic trawl. During each 4h period 3 of these 5 ships were on watch and were allocated to depth strata on a random basis. The CLIONE used a standard Granton bottom trawl with a 10mm (nominal) woven mesh codend cover over a 40mm codend, which retained larger fish and rubbish satisfactorily. The experiment was planned to last from 0800h/25June to 0800h/27 June but was curtailed by bad weather; all vessels had to stop fishing by 1200h/26 June.

Pelagic hauls were paired; the net was towed for half an hour at the depth stratum and as soon as the haul was completed a 'control' haul was made, which consisted of shooting the net to the depth that had just been sampled and then hauling immediately. This approach was adopted to determine what proportion of the catch taken from a particular depth might have been taken during the shooting and hauling operations. The catches are given in Table 7.

The data from three vessels (TRIDENS, CORELLA and EXPLORER) were analysed. The Norwegian data were not used as the gear used by the JOHAN HJORT was different and the DANA did not make any paired hauls. Because the experiment was curtailed and data were limited they were grouped by 3 depth strata (0-40m, 40-80m and 80-120m), all times combined. The average catches per 0.5h were calculated for each stratum, pooling the data from all three ships. Similarly, the average catches taken in the control hauls were calculated and subtracted from the first set of catches to give the 'corrected' values shown in Table 8. These results indicate that cod, haddock and whiting were largely restricted to the upper 40m. The distribution of Norway pout was more general, however. Although the efficiency of the CLIONE's gear at catching 0-group

gadoids is unknown, the few that it did catch suggests that they were not abundant on the bottom. The mean lengths of the fish in CLIONE's bottom trawl hauls did not differ significantly from those caught by vessels using the IYGPT showing that large fish had not adopted a demersal habit by the time of the experiment. Bailey (1975) has shown that by August, young cod in the same area were caught primarily near the sea bed whilst the majority of the haddock were commuting between the upper and lower water layers, as were Norway pout. It appears, therefore, that it is in July that the young fish begin to change their habits.

Except for these data it is considered that there were too few length data obtained in the stratification to warrant further analysis.

5. FUTURE SURVEYS

5.1 The standard haul

The group agreed that the method of 1h standard haul as shown in Figure 1 should be continued.

5.2 Standard gear

The comparative fishing experiment showed that the differences between ships fishing the IYGPT were neglible but that those between ships fishing the IYGPT and vessels fishing other gear were not. Therefore all ships participating in the North Sea 0-group gadoid survey must use the IYGPT if their results are to be comparable.

5.3 Timing and number of surveys

The series of surveys to date have shown that the time at which 0-group gadoids are at the critical length (2-6cm) for capture by the IYGPT varies from year to year. Therefore one survey at a fixed time will not produce indices of abundance that are comparable from year to year, the provision of these indices is one of the objectives of the survey. To meet this objective the group considered that at least 2 surveys should be made each year. A series of surveys would also enable estimates of 0-group gadoid mortality to be made and provide some understanding of the population regulatory mechanisms.

To decide the area that should be surveyed mean numbers of cod, haddock and whiting caught in each survey were calculated from all the surveys from 1969 onwards (Figures 9-11). From these the standard survey area shown in Figure 12 was determined.

5.4 Timing of survey

The group decided that the best time for commencing the surveys was mid-June of each year and that the series should be completed within 3-4 weeks of the start of the first survey. The number of surveys would depend upon the number of countries that participated.

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TABLE 1. Number of 0-group gadoids caught per standard haul during comparative fishing experiment: times are GMT; n = mean number of fish per haul

CORELLA:

Date	24	24	24	24	24	27	27	27	27	n
Sub-rectangle	E	E	B	A	D	A	A	E	D	
Time Shot	0656	0843	1205	1345	1721	0745	0922	1156	1329	
Cod	48	21	28	38	29	24	28	11	18	27
Haddock	940	440	686	361	975	851	1227	179	279	660
Whiting	104	27	91	81	176	48	139	23	99	88
Norway Pout	280	31	3206	12283	2958	3312	13388	1528	1256	4249

EXPLORER:

Date	27	27	27	27	
Sub-rectangle	A	A	E	D	
Time shot	1000	1133	1306	1437	
Cod	54	27	10	18	27
Haddock	985	272	52	320	407
Whiting	486	154	30	108	195
Norway Pout	552	41	47	920	390

TRIDENS:

Date	23	23	23	23	23	23	23	24	24	24	24	24	24	24	
Sub-Rectangle	B	B	F	A	A	B	B	D	F	C	E	E	F	C	
Time shot	0745	0930	1330	1515	1645	1845	2010	0735	0935	1125	1313	1450	1832	2006	
Cod	9	9	8	29	21	24	4	11	32	38	12	25	21	38	20
Haddock	142	236	253	295	432	272	68	208	1040	392	232	392	111	232	308
Whiting	25	12	57	56	115	23	13	13	38	124	4	40	152	84	54
Norway Pout	39	24	73	198	1104	98	18	153	28	33	112	264	1648	92	277

DANA:

Date	23	23	23	23	24	24	24	24	
Sub-rectangle	F	B	B	A	C	D	E	A	
Time Shot	0705	1030	1445	1945	0650	1134	1500	1840	
Cod	0	7	24	23	37	39	48	102	35
Haddock	0	235	579	497	952	1556	1574	1254	831
Whiting	0	0	0	0	0	0	0	0	0
Norway pout	0	291	293	2224	1410	974	679	1539	926

JOHAN HJORT:

Date	23	23	23	23	23	23	24	24	24	24	24	24	24	25	
Sub-Rectangle	A	A	D	D	D	D	B	B	E	F	F	C	C	E	
Time Shot	0740	1040	1302	1520	1745	1935	0813	1103	1346	1655	1815	2040	2255	0555	
Cod	5	0	5	13	15	0	12	9	27	36	0	72	0	0	14
Haddock	302	317	1143	1951	4894	766	84	285	810	1740	0	1944	112	0	1025
Whiting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Norway pout	37	15	0	58	73	24640	4148	4127	14779	17333	0	102875	3467	0	12254

CLIONE (Boothbay standard):

Date	23	23	23	23	23	24	24	24	24	24	24	24	
Sub-rectangle	C	C	E	F	B	D	A	C	B	A	D	D	
Time shot	0646	1150	1512	1840	2246	0241	0533	0910	1215	1428	1737	2006	
Cod	3	1	2	5	8	6	0	6	3	3	1	2	3
Haddock	30	25	34	50	147	30	38	11	87	121	20	42	53
Whiting	62	31	175	140	128	47	51	39	108	107	50	41	82
Norway pout	0	2	0	1	60	2	0	0	0	2	0	0	6

CLIONE (Boothbay oblique):

Date	23	23	23	23	24	24	24	24	24	24	
Sub-rectangle	C	C	E	F	E	D	A	B	A	D	
Time shot	0933	1306	1727	2019	0054	0404	0729	1057	1636	1901	
Cod	4	4	3	1	12	7	7	2	6	4	5
Haddock	18	17	52	32	223	62	30	33	36	19	52
Whiting	35	9	247	31	115	74	60	47	26	60	70
Norway pout	4	0	2	3	20	34	17	3	9	4	10

TABLE 2

Statistical analysis of comparative fishing experiment

A. Bartlett's test for homogeneity of variance (S_y^2)

	N	COD	HADDOCK	WHITING	NORWAY POUT
CORELLA	9	0.1668	0.4286	0.4775	3.5551
EXPLORER	4	0.4582	1.4510	1.2861	2.5965
TRIDENS	14	0.4022	0.4185	1.0151	1.8094
DANA	7	0.6154	0.4923	-	0.6450
Chi-squared		2.7871	2.5200	1.4926	4.1568
Df		3	3	2	3
P		>10%	>10%	>10%	>10%
Boothbay ST	12	0.2770	0.5284	0.3296	1.4121
Boothbay OB	10	0.2872	0.5598	0.7545	1.1267
Chi-squared		0.0031	0.0079	1.6145	0.1189
Df		1	1	1	1
P		>10%	>10%	>10%	>10%
IYGPT	34	0.4071	0.7329	1.0276	3.4050
Capelin Trawl	14	2.3474	6.8357	-	16.3389
Boothbay	22	0.3679	0.5190	0.5242	1.5775
Chi-squared		21.6584	39.3398	2.4715	25.3492
Df		2	2	2	2
P		<1%	<1%	>10%	<1%

TABLE 2

B. Analysis of variance

IYGPT (CORELLA, EXPLORER, TRIDENT, DANA)

		COD	HADDOCK	WHITING	NORWAY POUT
Between ships	SS	1.8776	7.9335	5.8437	48.7404
	MS	0.6259	2.6445	2.9218	16.2468
	DF	3	3	2	3
Within ships	SS	11.6306	16.3432	20.8749	63.6225
	MS	0.3877	0.5448	0.8698	2.1208
	DF	30	30	26	33
F ratio		1.61	4.85	3.36	7.66
P		>5%	<1%	>5%	<1%

Boothbay (Standard, Oblique)

Between ships	SS	0.7297	0.0490	0.5916	8.0296
	MS	0.7294	0.0490	0.5916	8.0296
	DF	1	1	1	1
Within ships	SS	6.9957	10.8505	10.4158	25.6738
	MS	0.3498	0.5425	0.5208	1.2837
	DF	20	20	20	20
F ratio		2.09	0.09	1.14	6.26
P		>5%	>5%	>5%	<2½%

2 C. Confidence limits of the back-transformed catch rates ($y = \ln(x+1)$; $\bar{C}_G = \exp\bar{y} + (0.4994\, S^2_{\bar{y}}(N-1)/N) - 1$; $\bar{C}_A$ = arithmetic mean catch)

	N	$\bar{y}$	S^2_y	$S_{\bar{y}}$	$\bar{C}_A$	$\bar{C}_G$	95% conf. limits $\bar{C}_G$	N	$\bar{y}$	S^2_y	$S_{\bar{y}}$	$\bar{C}_A$	$\bar{C}_G$	95% conf. limits $\bar{C}_G$
COD								HADDOCK						
CORELLA	9	3.2700	0.1668	0.1362	27.2	27.3	20-38	9	6.3258	0.4286	0.2182	660	675	408-1117
EXPLORER	4	3.1705	0.4582	0.3384	27.2	27.3	9-82	4	5.5612	1.4510	0.6023	404	447	65-3044
TRIDENS	14	2.8818	0.4022	0.1695	20.1	20.5	14-30	14	5.5308	0.4105	0.1729	305	305	210-441
DANA	7	3.4756	0.6154	0.2965	35.0	40.5	20-83	7	6.6778	0.4923	0.2652	831	980	512-1876
TOT IYGPT	34	3.1384	0.4071	0.1094	25.9	27.1	21-34	34	5.9810	0.7329	0.1468	519	564	418-760
JOHAN HJORT	14	1.7926	2.3474	0.4095	13.9	16.8	6-42	14	5.5566	6.8357	0.6988	1025		(262-1788)*
BB STAND.	12	1.3597	0.2770	0.1519	3.3	3.4	2-5	12	3.7372	0.5284	0.2098	53	53	33-84
BB OBLIQUE	10	1.6676	0.2872	0.1695	5.0	5.0	3-8	10	3.6423	0.5598	0.2366	52	48	28-82
TOT BOOTHBAY	22	1.4682	0.3679	0.1293	4.1	4.2	3-6	22	3.6941	0.5190	0.1536	53	50	36-70
WHITING								NORWAY POUT						
CORELLA	9	4.3008	0.4775	0.2303	87.6	90.2	53-154	9	6.5054	0.3773	0.2047	4249	7982	1873-34010
EXPLORER	4	4.8393	1.2861	0.5670	194.5	203.6	33-1242	4	6.0448	1.2163	0.5514	390	472	35-6146
TRIDENS	14	3.6017	1.0151	0.2693	54.0	57.7	32-104	14	5.7825	0.3578	0.1599	277	243	111-530
DANA	-	-	-	-	-	-	-	7	6.7186	0.4961	0.2662	926	1095	521-2303
TOT IYGPT	27	4.0181	1.0276	0.1951	86.0	90.1	60-135	34	6.1975	0.5925	0.1320	1476	1851	972-3524
JOHAN HJORT	-	-	-	-	-	-	-	14	5.5768	6.8426	0.6991	12254		(-3477 - 27985)*
BB STAND.	12	4.2619	0.3296	0.1657	81.6	81.5	57-117	12	4.7788	0.3362	0.1674	5.6	2.7	1-7
BB OBLIQUE	10	3.9325	0.7545	0.2747	70.4	70.6	38-131	10	4.5994	0.5521	0.2350	9.6	10.0	4-22
TOT BOOTHBAY	22	4.1122	0.5242	0.1544	76.5	77.4	56-107	22	4.6973	0.4211	0.1383	7.4	6.2	3-12

* Figures represent confidence limits on the assumption of a normal distribution, because in these cases the data do not fit to a negative binominal distribution.

Table 3. Number of Each Species, per Hour's fishing, caught in Comparative fishing experiment in statistical rectangle 49FO (19E) and by CLIONE in stratification experiment

COD									WHITING								
cm	J. HJORT	DANA	TRIDENS	EXPLORER	CORELLA	CLIONE			cm	J. HJORT	DANA	TRIDENS	EXPLORER	CORELLA	CLIONE		
						B'bay Standard	B'bay Oblique	Bottom trawl							B'bay Standard	B'bay Oblique	Bottom trawl
1.0									1.0			0.4			3.6	3.2	
5			0.2			0.3	0.2		5			1.7	1.8	0.4	17.7	11.2	0.6
2.0		0.1	1.5	0.2	0.1	1.0	1.3	0.4	2.0			5.4	27.2	10.4	26.1	21.7	4.5
5		3.1	2.4	1.8	2.4	0.9	1.9	0	5			22.1	71.2	42.1	23.7	22.6	4.0
3.0	0.6	11.4	5.5	8.2	5.0	0.3	1.2	0.5	3.0			18.6	72.0	27.2	7.5	9.2	2.2
5	0.9	12.4	3.1	7.8	8.7	0.4	0.2	0.2	5			4.4	20.2	6.1	1.5	2.2	0.2
4.0	2.9	7.0	3.5	4.5	4.3		0.2	0.6	4.0			0.9	1.5	0.3	0.5	0.2	0.1
5	2.6	4.3	2.1	3.2	3.7	0.1		0.2	5			0.1	0.2	0.6	0.1	0.5	
5.0	5.6	1.0	0.9	0.2	1.8	0.1		0.2	5.0			0.1	0.2	0.3			
5	0.4	0.4	0.6	1.0	0.1				5								
6.0	0.9	0.1	0.1	0.2	0.2				6.0			0.1					
5			0.1						5								
7.0					0.1				7.0								
Total	14	40	20	27	26	3	5	2	Total	0	0	54	194	88	81	71	12
$\bar{l}$	4.85	3.79	3.71	3.83	3.87	2.76	2.80	3.81	$\bar{l}$	-	-	2.95	2.98	2.94	2.39	2.48	2.64
Sd	0.72	0.43	1.06	0.74	0.76	0.98	0.60	0.95	Sd	-	-	0.56	0.46	0.70	0.56	0.62	0.48

HADDOCK									NORWAY POUT								
1.0			0.1			0.1			1.0			0.4	0.5		0.1	0.5	
.5		2.1	2.2	1.5	3.1	3.9	3.0		5		5.0	9.5	0.8		1.0	1.4	2.2
2.0	0.1	24.6	10.9	9.2	39.9	12.7	9.6	2.6	2.0	6.5	229.7	47.8	7.8	7.9	2.7	6.4	21.2
5	18.6	164.4	47.2	71.0	122.8	14.0	13.7	5.9	5	135.0	341.7	69.7	24.5	51.2	0.7	1.1	2.9
3.0	85.5	232.1	70.3	118.2	164.7	12.5	10.7	5.9	3.0	1216.2	130.9	19.6	89.5	340.9	0.1	0.3	1.4
5	145.9	208.6	68.3	100.2	148.3	5.0	7.8	5.2	5	2653.5	115.0	29.4	109.2	1298.2	0.5		2.6
4.0	167.6	118.1	35.4	56.8	90.1	2.7	3.5	3.5	4.0	3393.3	118.9	52.0	81.7	1286.7			1.9
5	151.3	69.3	29.1	29.2	47.1	0.4	2.1	2.2	5	1722.7	59.4	16.5	42.0	609.0			0.5
5.0	115.3	46.6	20.1	9.2	21.7	0.5	1.0	0.5	5.0	1271.1	21.9	4.8	25.2	287.8	0.2		0.2
5	80.0	27.0	8.5	7.0	10.7	0.1	0.6	0.7	5	875.8	18.6	10.0	6.5	214.1	0.2		0.1
6.0	73.0	26.7	5.9	1.2	5.6	0.1	0.1	0.7	6.0	674.3	14.6	17.6	2.2	75.9			
5	58.4	13.1	3.2	2.2	2.6	0.1	0.2		5	299.5	2.4	0.1		30.0	0.1		
7.0	33.4	8.6	2.4		1.0				7.0	3.0							
5	27.9	4.1	1.3	0.2	0.4												
8.0	19.2	1.3	0.6				0.1										
5	21.2	2.0	0.4	0.2													
9.0	22.0	0.6	0.4	0.5													
5	5.4	0.4		0.2													
Total	1025	950	306	407	658	52	52	27	Total	12251	1058	277	390	4202	6	10	33
$\bar{l}$	5.15	3.86	3.87	3.64	3.60	2.90	3.17	3.57	$\bar{l}$	4.48	3.25	3.54	3.89	4.26	2.51	2.16	2.61
Sd	1.54	1.10	1.08	0.82	0.86	0.74	0.88	0.48	Sd	0.90	0.96	1.20	1.53	0.73	1.36	0.53	0.75

TABLE 4 - Catch rates, mean length (cm), standard deviations and ranges of lengths by species and blocks of 4 statistical rectangles: ships combined except 'DANA' data excluded

Block	Date	Ship	COD				HADDOCK				WHITING				SAITHE				NORWAY POUT				BLUE WHITING			
			N/h	$\bar{l}$	sd	Range	N/h	$\bar{l}$	sd	Range	N/h	$\bar{l}$	sd	Range	N/h	$\bar{l}$	sd	Range	N/h	$\bar{l}$	sd	Range	N/h	$\bar{l}$	sd	Range
50-49 E6,7	29/6	E	0				1	2.0	-	1.5-2.4	2	2.08	0.41	1.5-2.9	0				0				<1	1.75	-	1.5-1.9
50-49 E8,9	28-30/6	E	5	3.46	0.78	2.0-5.9	312	4.69	0.84	1.5-8.4	31	2.69	0.60	1.0-4.4	0				5	2.47	0.83	1.5-5.4	<1	2.75	-	2.5-2.9
50-49 F0,1	20,23-4,27-8/6	C/E/T	28	3.87	0.86	1.5-7.4	488	3.87	1.02	1.0-9.9	85	2.93	0.52	1.0-6.4	<1	3.15	0.29	2.5-4.4	4003	4.04	0.44	1.0-6.9	1	3.38	0.65	2.0-4.9
50-49 F2,3	28-9/6	E	42	3.33	0.74	2.0-4.9	671	3.51	1.08	1.0-7.4	442	2.27	0.54	1.5-3.9	5	3.75	0.50	2.5-4.9	239	2.55	0.57	1.5-4.9	2	3.00	0.36	2.5-3.4
48-47 E6,7	2/7	E	0				0				5	2.08	1.0	1.5-2.9	1	2.50	-	2.0-2.9	0				0			
48-47 E8,9	24,30/6; 4/7	E	1	4.13	1.60	2.5-5.9	63	3.71	0.93	1.5-10.4	1	2.15	0.55	1.0-2.9	0				1825	5.81	0.67	4.0-7.9	0			
48-47 F0,1	20,27/6; 3/7	E	5	4.72	1.59	2.0-7.4	54	5.62	1.80	2.0-10.4	<1	4.75	-	4.5-4.9	0				8333	5.32	0.87	2.0-6.9	0			
46-45 E6,7	6-7/7	E	1	3.00	0.29	2.5-3.4	<1	3.25	-	3.0-3.4	33	2.55	0.63	1.5-4.9	2	2.58	0.52	1.5-3.4	10	2.33	0.39	1.5-2.9	0			
46-45 E8,9	4,6/7	E	<1	2.75	-	2.5-2.9	1	3.38	1.38	1.5-4.9	14	1.89	0.54	1.0-3.4	0				6	3.17	0.55	2.0-4.4	0			
46-45 F0,1	19,27/6; 4/7	E/T	<1	3.50	0.35	3.0-3.9	<1	3.25	-	3.0-3.4	0				<1	2.75	-	2.75	12	3.51	0.66	2.0-6.4	0			
44-43 E6,7	7/7	E	0				1	5.25	-	5.0-5.4	50	2.72	0.87	1.0-4.9	<1	1.75	-	1.75	5	2.70	0.44	2.0-3.4	0			
44-43 E8,9	5-8/7	E	1	3.13	0.63	2.0-3.9	3	5.84	1.43	3.5-8.4	38	3.93	1.22	1.5-5.9	0				5	2.33	0.42	1.5-2.9	0			
44-43 F0,1	19, 27/6; 5/7	E/T	0				0				0				0				9	5.36	0.71	3.0-6.9	0			
42-41 E6,7	7/6; 8/7	C/E	26	3.15	0.50	2.0-4.4	1	4.75	0.71	4.0-5.4	21	2.63	0.73	1.5-4.9	0				0				0			
42-41 E8,9	8/6; 5,8/7	C/E	0				<1	6.25	-	6.0-6.4	1	2.58	0.76	1.5-3.4	0				0				0			
42-41 F0,1	30/6; 2,5/7	C/T/E	<1	6.25	-	6.0-6.4	<1	3.25	-	3.0-3.4	0				0				<1	2.25	-	2.0-2.4	0			
42-41 F6,7	29/6	C	2	3.03	0.62	1.5-3.9	45	4.06	1.08	2.0-8.4	77	3.26	0.99	1.5-6.9	0				0				0			
40-39 E8,9	5, 7/6; 1,3/7	C/T	0				<1	3.25	-	3.0-3.4	3	2.63	0.42	2.5-3.4	0				0				0			
40-39 F0,1	5/6; 1-3/7	C/T	0				<1	?	-	-	<1	2.75	0.21	2.0-3.4	0				1	2.58	0.29	2.0-2.9	0			
40-39 F2,3	1-2/7	C/T	0				0				1	2.50	0.50	2.0-3.4	0				0				0			
40-39 F4,5	18/6; 1/7	C/T	0				0				14	3.71	0.95	1.5-6.4	0				0				0			
40-39 F6,7	18/6	T	0				0				2	3.50	0.50	2.5-3.9	0				0				0			
38-37 E8,9	4-5/6	C	0				0				0				0				0				0			
38-37 F0,1	4-5/6	C	0				0				0				0				0				0			
38-37 F4,5	17/6	T	0				0				0				0				0				0			
38-37 F6,7	17/6	T	0				0				0				0				0				0			
36-35 F0,1	4/6	C	0				0				0				0				0				0			
36-35 F4,5	16/6	T	0				0				0				0				0				0			

Table 5. Mean numbers, based on geometric means, and 95% confidence limits, of 0-group cod, haddock and whiting caught in 1h hauls: areas are shown in Figure 2. 1975(a) excludes Danish results, 1975(b) includes them. Year-class size are millions of 1 year old fish from virtual population analyses, taken from Table 23, Anon., 1974.

		1969	1970	1971	1972	1973	1974	1975(a)	1975(b)
COD									
Northern North Sea	$\bar{n}$	3.8	13.0	5.1	11.2	2.7	74.4	5.7	5.2
	95%	1.9- 7.1	6.2-26.1	3.1- 8.2	6.5- 18.8	1.6- 4.1	40.6- 135.9	3.1- 9.8	3.2- 8.4
British east coast	$\bar{n}$	-	-	-	9.6	4.7	1.3	0.7	-
	95%				5.1- 17.4	1.8- 10.6	0.5- 2.5	0.1- 1.7	
German Bight	$\bar{n}$	-	-	-	18.4	7.3	261.0	0.6	2.2
	95%				9.3- 35.4	3.5- 14.5	83.8- 809.2	0.6- 1.4	0.9- 4.3
Year-class size		363	458	73	163	(55)	-	-	-
HADDOCK									
Northern North Sea	$\bar{n}$	71.9	35.4	347.9	34.0	56.5	1625.2	147.5	103.4
	95%	25.1-202.9	18.0-68.7	151.5-796.9	20.7- 55.5	28.7-110.6	683.6-3861.8	60.5-357.6	50.0-213.2
British east coast	$\bar{n}$	-	-	-	1.7	1.0	0.3	0.3	-
	95%				0.7- 3.1	0.4- 1.8	0.1- 0.5	0.1- 0.5	
German Bight	$\bar{n}$	-	-	-	0.4	2.5	10.5	6.6	7.3
	95%				0.1- 0.7	1.1- 4.7	4.4- 23.6	1.7- 20.8	2.8- 17.0
Year class size		102	877	1175	221	(486)	-	-	-
WHITING									
Northern North Sea	$\bar{n}$	5.1	1.3	17.0	124.6	10.7	302.8	43.8	23.0
	95%	2.6- 9.2	0.6- 2.3	10.3- 27.6	71.8-215.9	6.2- 18.0	138.2- 662.5	21.0- 90.1	12.4- 41.9
British east coast	$\bar{n}$	-	-	-	16.6	17.3	0.1	1.2	-
	95%				6.9- 37.9	6.2- 44.8	0.0- 0.3	0.4- 2.5	
German Bight	$\bar{n}$	-	-	-	137.0	56.7	8.2	32.0	49.2
	95%				44.0-421.8	20.6-153.3	3.4- 18.4	9.0-107.6	19.3-122.8
Year class size		683	763	1743	2885	(2083)	-	-	-

TABLE 6 - Rank order for cod, haddock and whiting for Northern North Sea, based on data in Table 5

Rank	Cod	Haddock	Whiting
1	1974	1974	1974
2	1970	1971	1972
3	1972	1975	1975
4	1975	1969	1971
5	1971	1973	1973
6	1969	1970	1969
7	1973	1972	1970

TABLE 7 Stratification experiment. Numbers of cod, haddock, whiting and Norway pout caught by each vessel in each haul.
(The Danish data have been omitted because of the probability that some species were incorrectly identified).

Ship	"JOHAN HJORT"																	
Gear	capelin trawl																	
Type of haul	S	C	S	C	S	C	S	S	C	S	C	S	C	S	C	S	C	
Stratum *	D	D	B	B	A	A	F	C	C	F	F	D	D	B	B	E	E	
Date	25.6	25.6	25.6	25.6	25.6	25.6	25.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	
Time shot (GMT)	0830	0952	1106	1215	1350	1448	1550	0016	0117	0210	0313	0405	0519	0605	0706	0826	0936	
Cod	0	0	2	4	49	0	0	15	1	0	2	0	0	48	0	0	0	
Haddock	5	0	28	.64	1449	62	92	223	23	104	103	138	345	1167	0	0	0	
Whiting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Norway pout	0	0	121	4880	0	0	0	605	36	10	7	0	715	1754	0	15	0	

Ship	"EXPLORER"															
Gear	IYGPT +															
Type of haul	S	C	S	C	S	C	S	C	S	C	S	C	S	C	S	C
Stratum *	B	B	E	E	B	B	F	F	D	D	B	B	E	E	F	F
Date	25.6	25.6	25.6	25.6	25.6	25.6	25.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
Time shot (GMT)	0745	0900	0945	1055	2020	2125	2225	0005	0050	0150	0223	0320	0402	0515	0555	0707
Cod	82	67	14	11	60	5	0	5	70	48	192	45	22	37	0	21
Haddock	1634	992	256	116	378	474	90	21	483	312	1746	261	266	317	335	199
Whiting	176	473	135	30	52	17	20	9	161	108	744	184	106	103	15	139
Norway pout	20519	115	274	320	587	60	292	4410	9535	2106	4717	188	6	190	730	796

Ship	"CORELLA"											
Gear	IYGPT +											
Type of haul	S	C	S	C	S	C	S	C	S	C	S	C
Stratum *	C	C	D	D	B	B	F	F	A	A	E	E
Date	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
Time shot (GMT)	1216	1321	1350	1455	1635	1803	1827	1934	2011	2108	2132	2238
Cod	3	6	3	5	30	13	11	7	76	8	1	10
Haddock	75	150	83	88	303	478	142	36	1456	116	23	86
Whiting	7	76	7	41	82	34	49	28	245	42	7	50
Norway pout	915	35	8	16	100	481	10	11	145	7	16	1050

Ship	"TRIDENS"										
Gear	IYGPT +										
Type of haul	S	C	S	C	S	C	S	C	S	S	C
Stratum *	D	D	E	E	B	B	D	D	A	E	E
Date	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	26.6	26.6	26.6
Time shot (GMT)	1625	1711	1810	1852	2027	2112	2225	2305	0015	0208	0303
Cod	10	17	15	8	52	24	11	14	56	8	20
Haddock	141	286	263	254	2336	416	480	296	2048	95	424
Whiting	73	52	37	20	104	48	68	59	264	43	52
Norway pout	35	17	63	7	1984	290	232	70	4608	36	176

Ship	"CLIONE"										
Gear	Granton trawl with herring codend and FRYMA codend										
Type of haul	0.5 S	S	C	S	S	S	S	S	C	S	S
Stratum	Bottom										
Date	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
Time shot (GMT)	0450	0553		0800	0935	1148	1322	1527	1704	1737	1907
Cod	1	3	4	4	0	6	1	0	0	1	2
Haddock	13	57	25	31	0	90	17	10	0	0	17
Whiting	4	13	11	31	17	20	2	16	0	0	0
Norway pout	3	6	2	163	12	63	29	14	0	1	2

* A: 0-20m B: 20-40m C: 40-60m D: 60-80m E: 80-100m F: 100m - bottom
\+ International young gadoid pelagic trawl
S = standard haul = 0.5 h for all ships except "CLIONE" which trawled for 1 h except for first haul that was 0.5 h
C = control 'shoot and haul immediately' haul

TABLE 8 - Average numbers of cod, haddock and whiting per 0.5h trawling by TRIDENS, CORELLA and EXPLORER during stratification experiment: numbers have been corrected for the shooting and hauling components of catches.

Stratum (m)/Species	Cod	Haddock	Whiting	Norway pout
0 - 40	51	1377	104	4476
40 - 80	1	26	- 4	1696
80 - 120	- 6	27	- 2	692

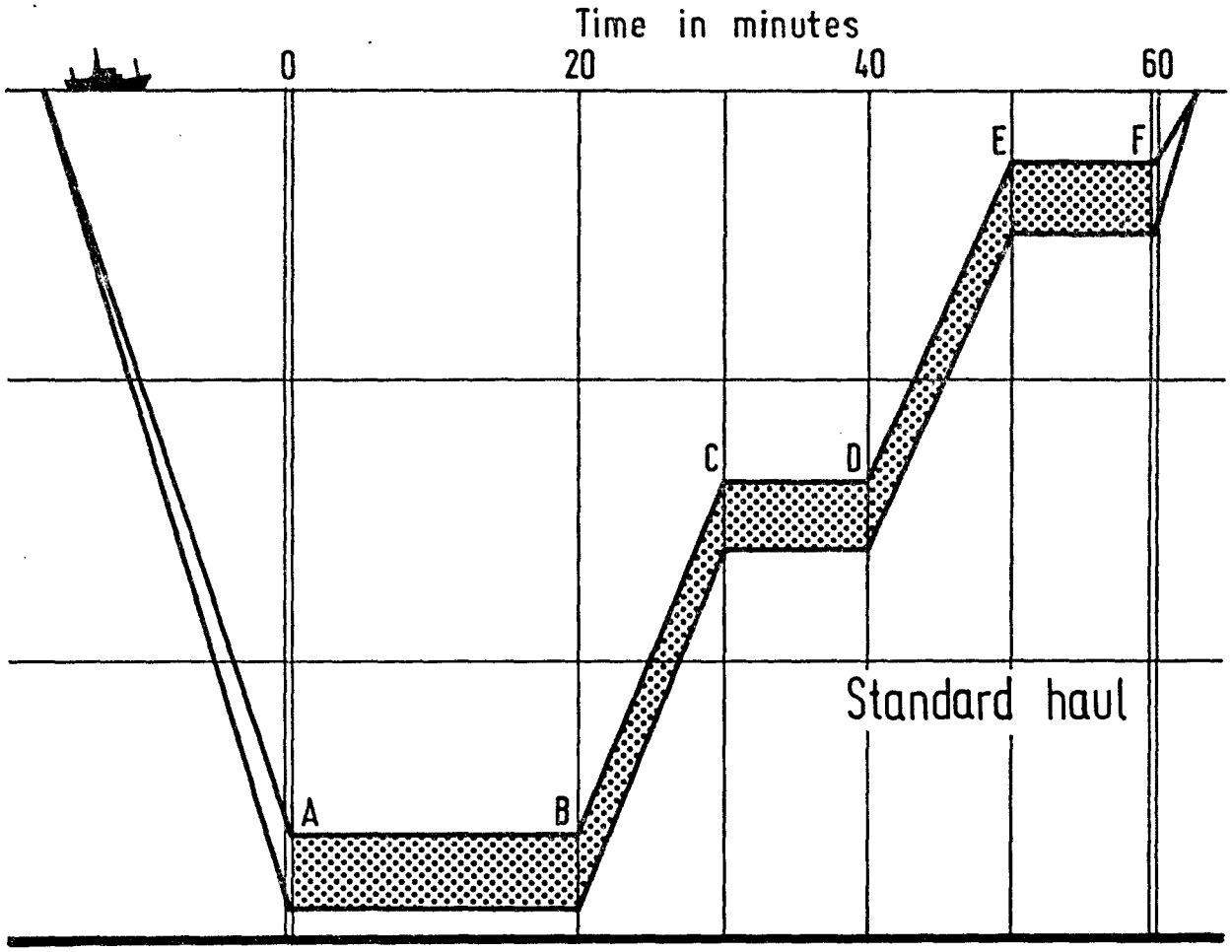

Fig 1. Method of making a standard 1 hour haul: C-D is at thermocline if one present.

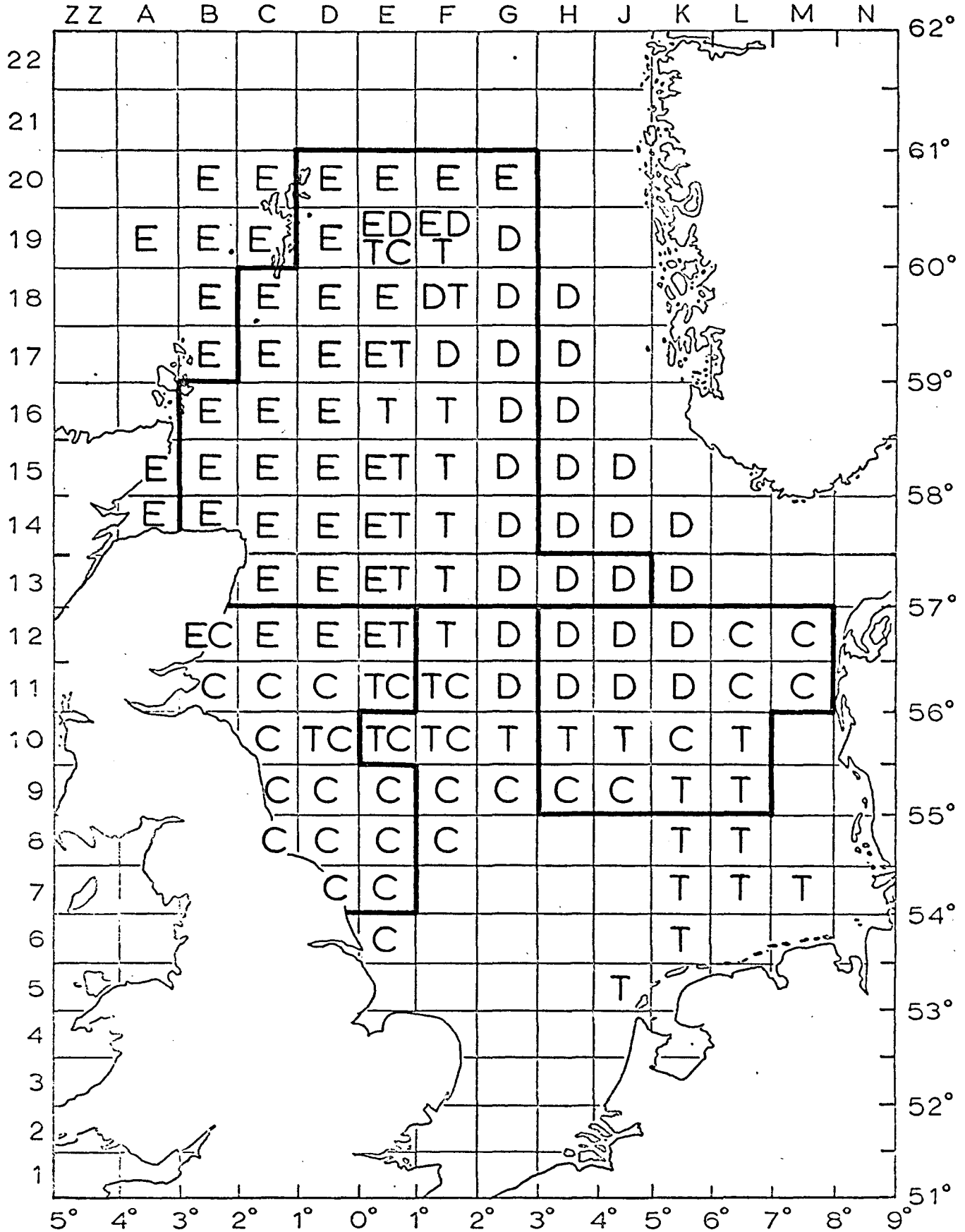

Fig. 2. Statistical rectangles sampled by each vessel: C=Corella, D=Dana, E=Explorer, T=Tridens. For meaning of larger areas; see text.

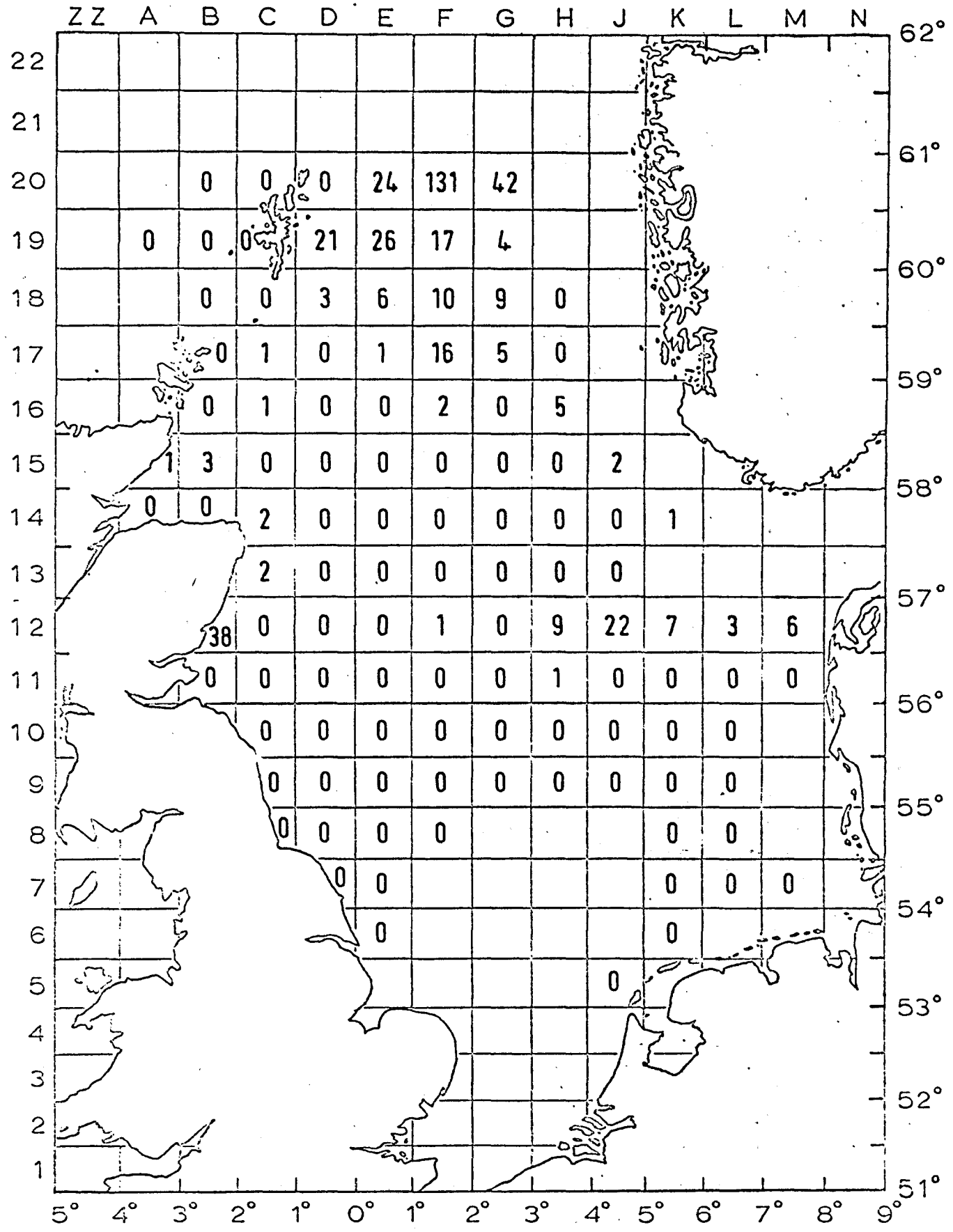

Figure 3 Mean numbers of 0-group cod per standard haul.

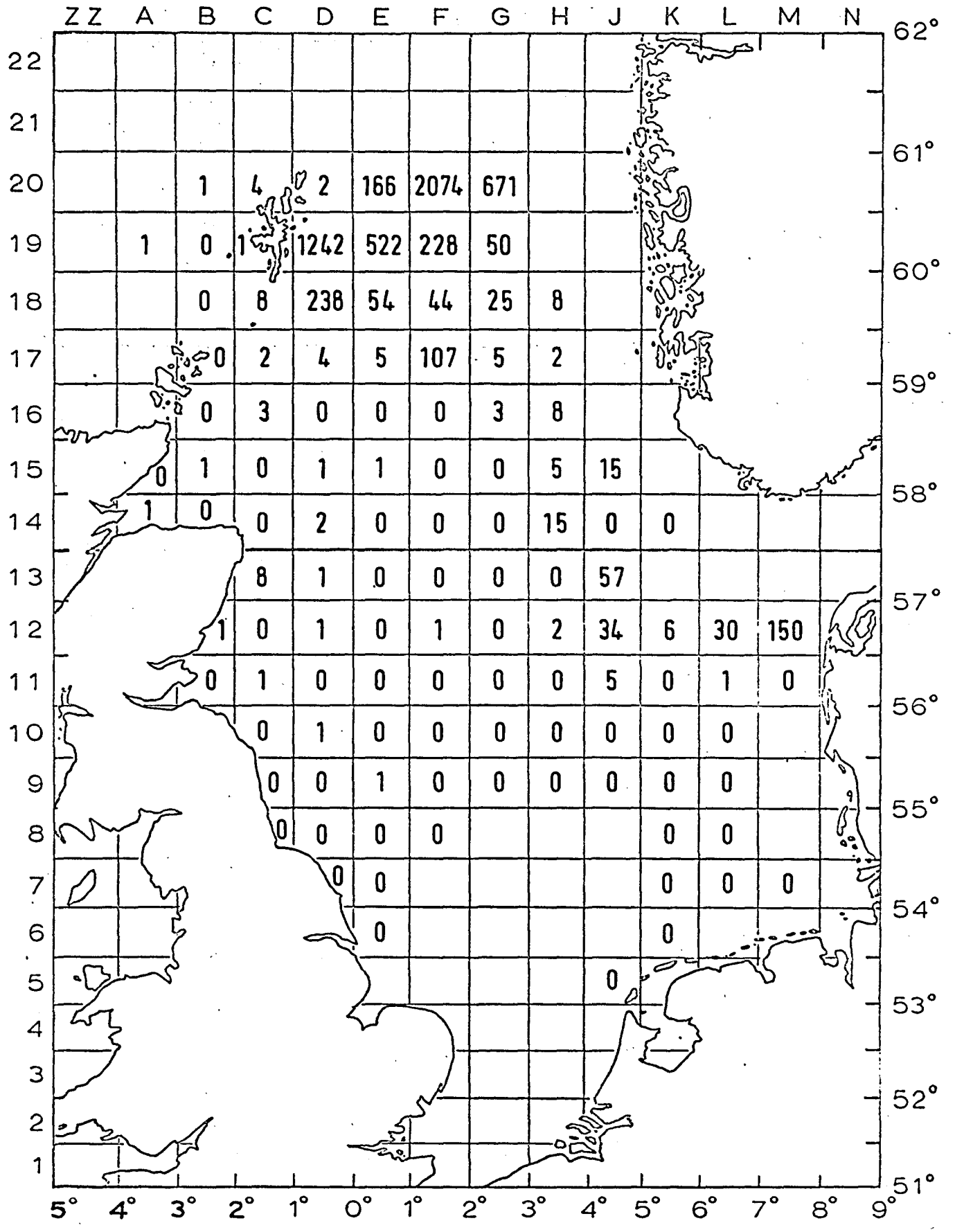

Figure 4 Mean numbers of 0-group haddock per standard haul.

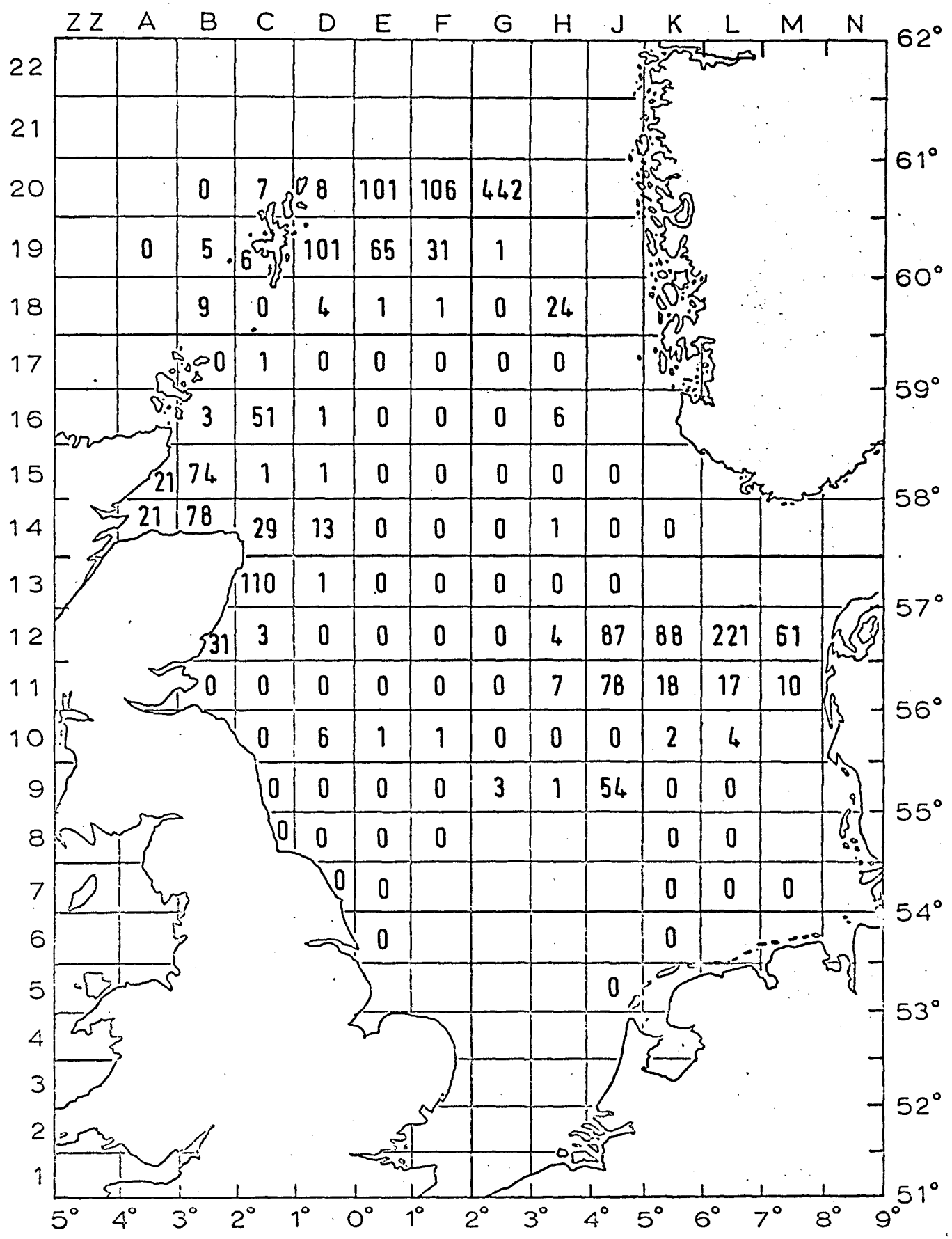

Figure 5 Mean numbers of 0-group whiting per standard haul.

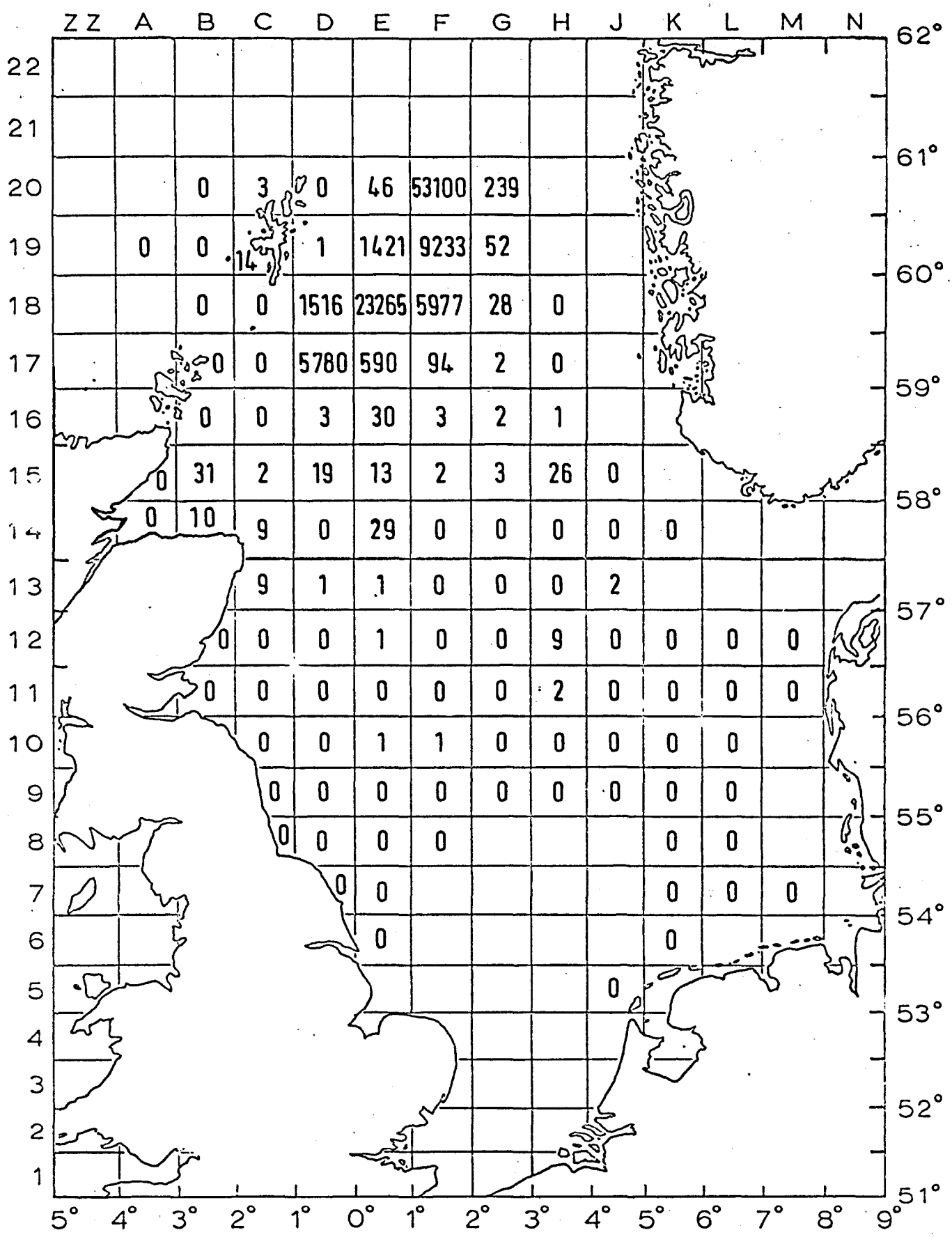

Figure 6 Mean numbers of 0-group Norway pout per standard haul.

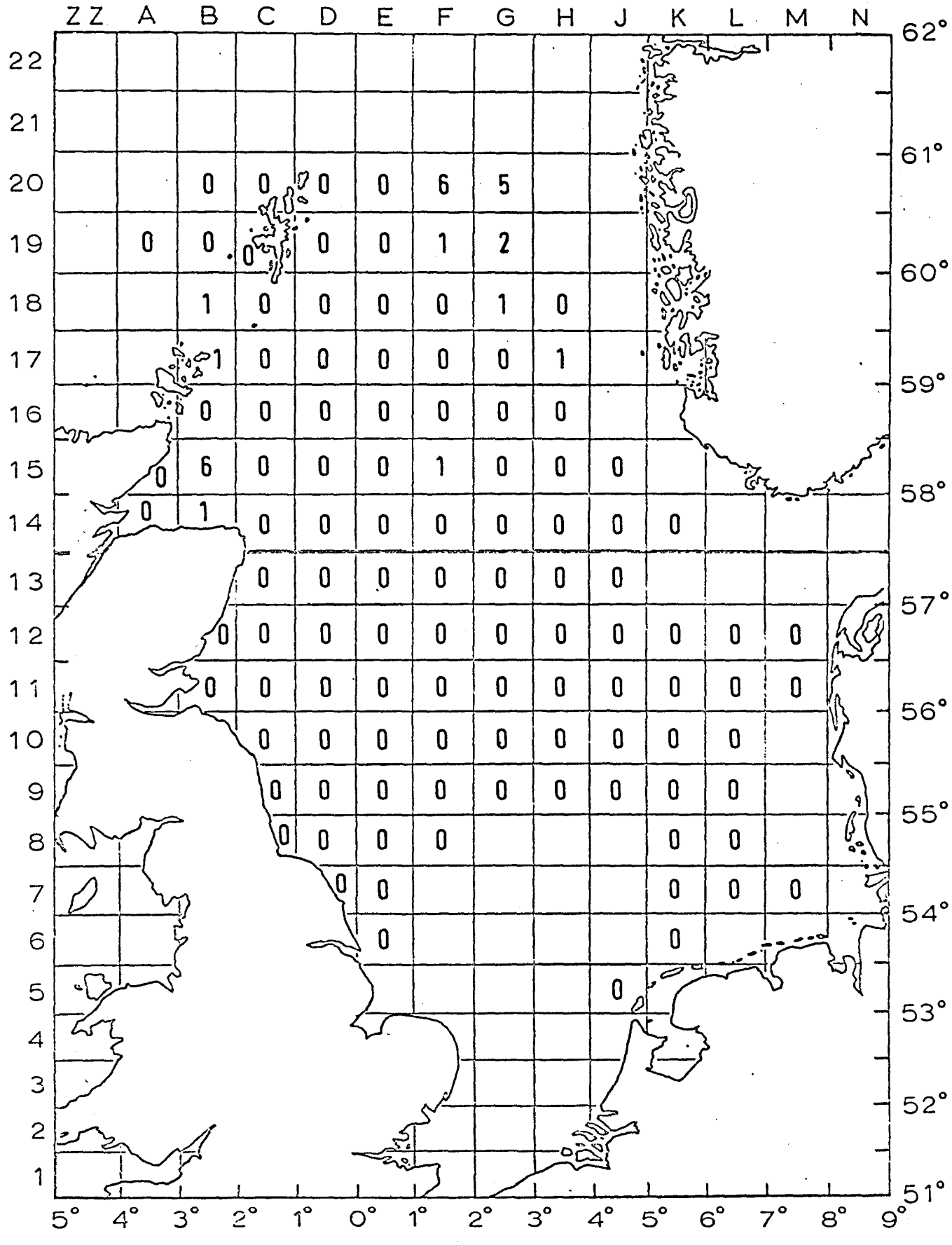

Figure 7 Mean numbers of 0-group saithe per standard haul.

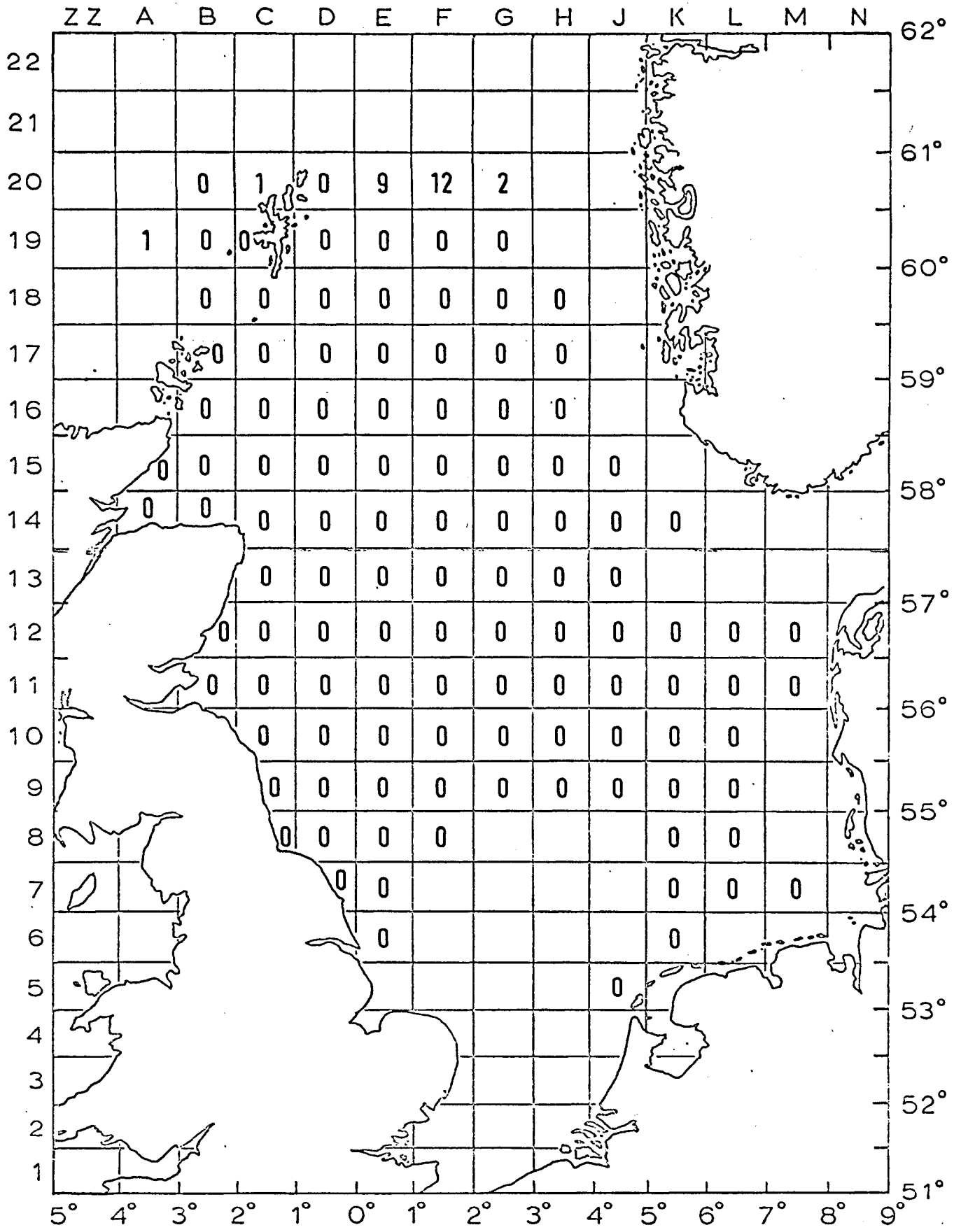

Figure 8 Mean numbers of 0-group blue whiting per standard haul.

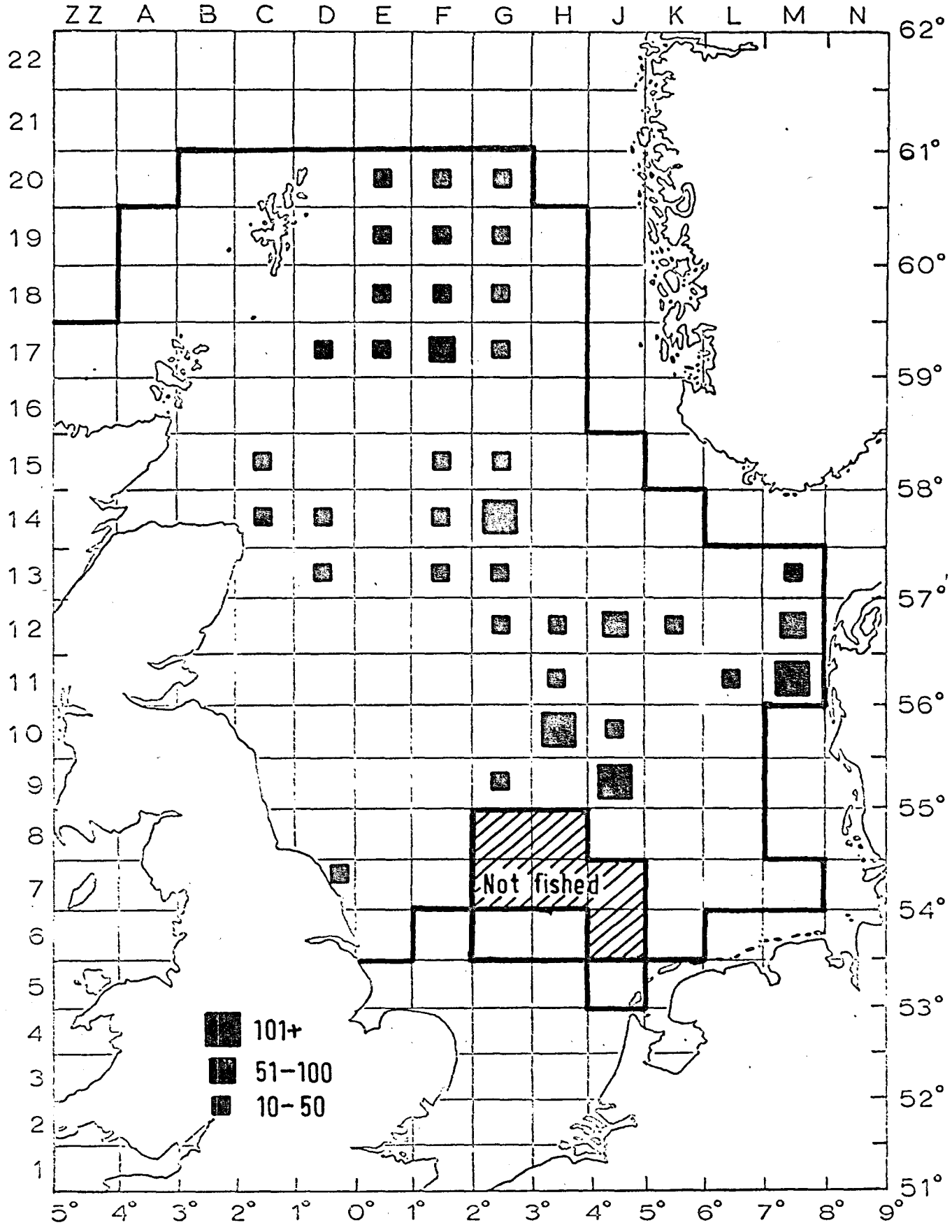

Figure 9 Mean numbers of cod per statistical rectangle based on results from all surveys, 1969-1975. Heavy line shows area which has been fished although not all statistical squares have been fished each year.

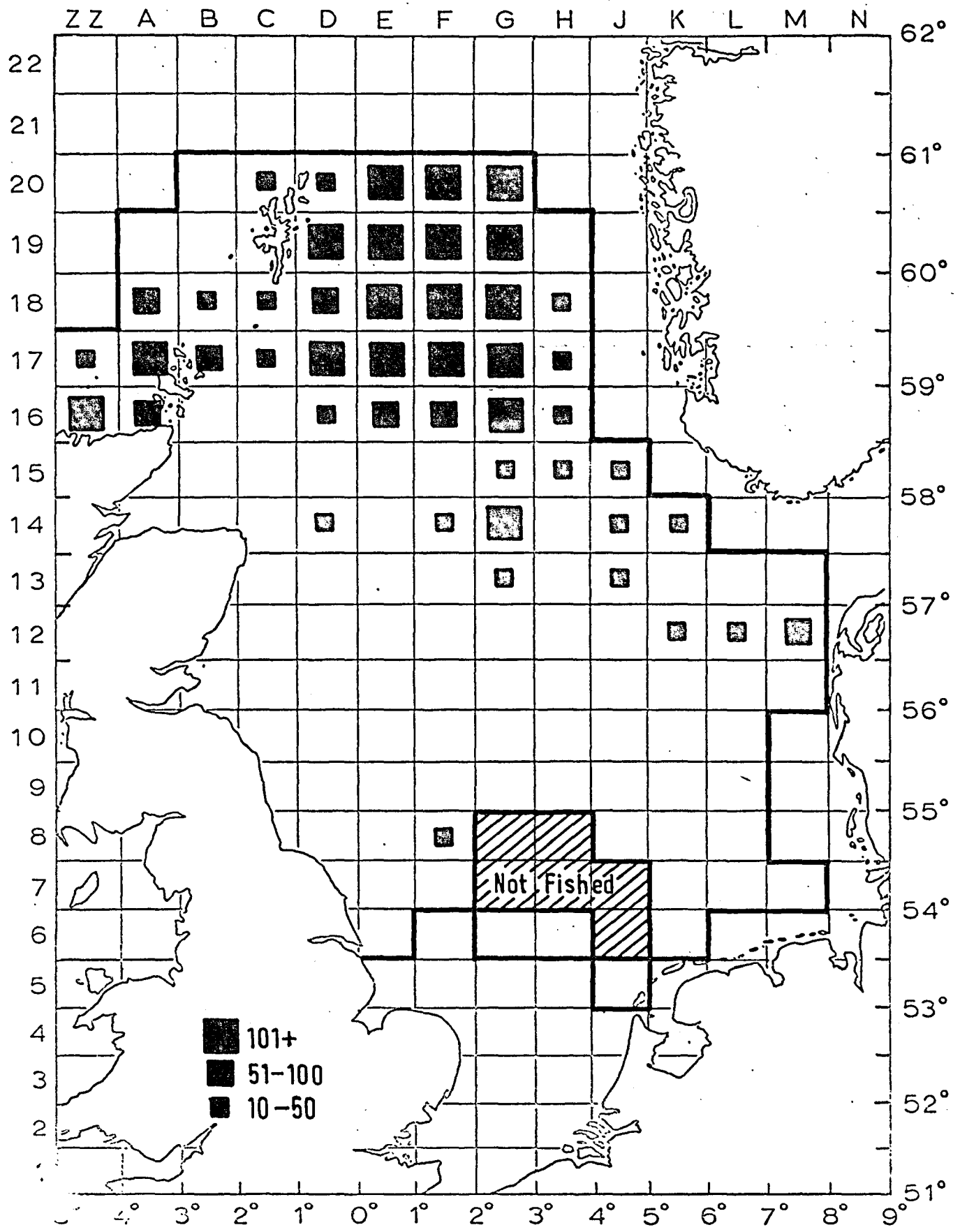

Figure 10 Mean numbers of haddock per statistical rectangle: source of data etc as in Fig 9.

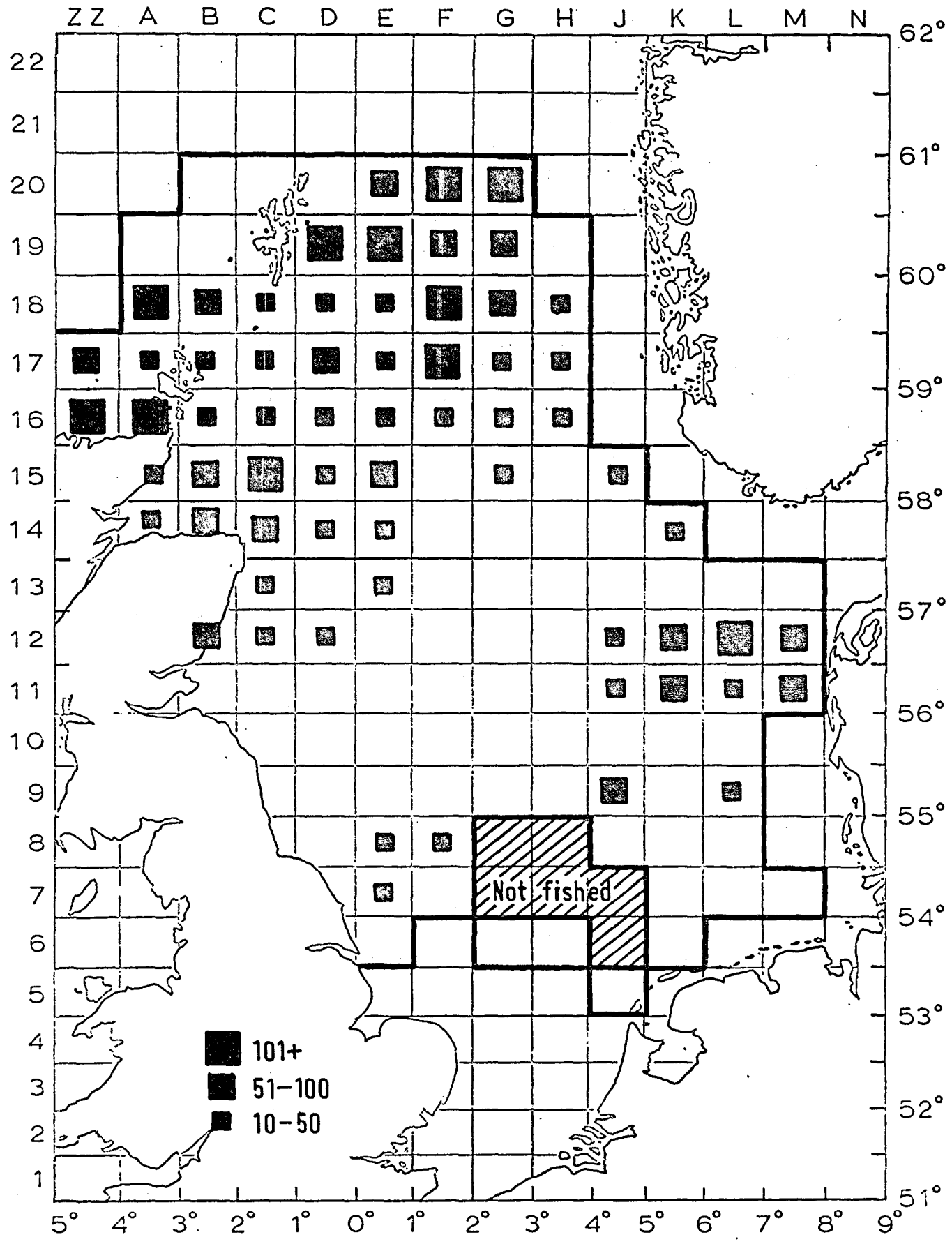

Figure 11 Mean numbers of whiting per statistical rectangle: source of data etc as in Fig 9.

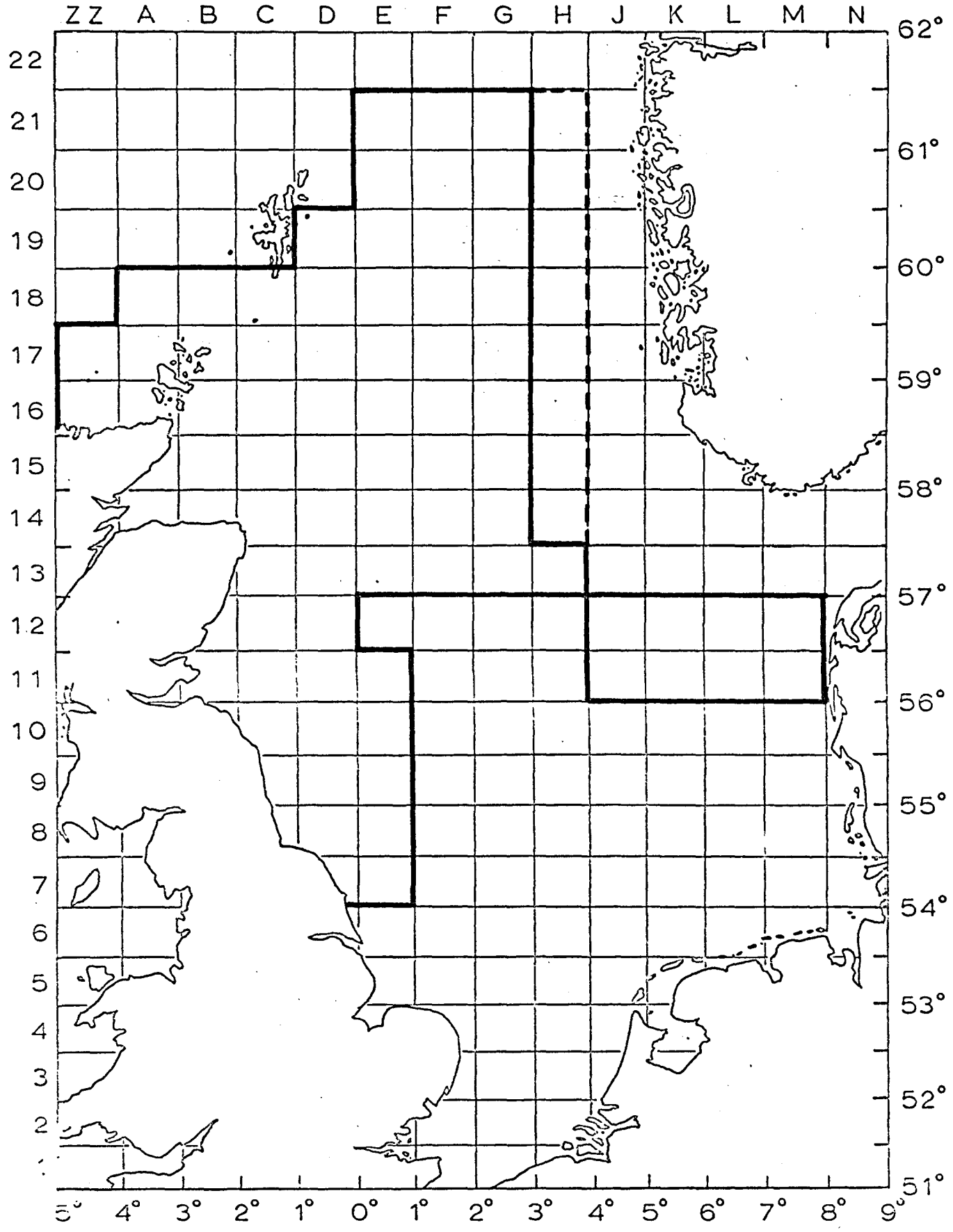

Figure 12 Proposed future survey area: dotted line includes area to be fished if time permits.