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REPORT OF THE NORWEGIAN ACOUSTIC SURVEY ON BLUE WHITING, April 1983

by

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ABSTRACT

The spawning stock of Blue Whiting has been estimated on an acoustic survey with the Norwegian research vessel "Eldjarn". The fish were found located along the shelf edge west of The British Isles from the Porcupine Bank to west of Shetland. The area was covered in the period 14th to 27th of April under favourable weather conditions. The estimate gave a total of $30.1 \cdot 10^9$ specimens or 4.7 mill. tonnes of which 4.4 mill. tonnes were fish in the size group 26 cm and larger. An area inhabited by about 25% of the stock, was surveyed twice. The difference between the two estimates was 0.7%.

1. Introduction

During her cruise west of The British Isles in April 1983 (Fig. 1), the Norwegian research vessel "Eldjarn" made an acoustic survey on the Blue Whiting from which the size of the spawning stock has been estimated. The survey was carried out in the period 14 April to 27 April. The fish were distributed in a narrow band along the shelf edge between the Porcupine Bank and west of Shetland (Fig. 2 and 3). The survey legs were so conducted that the area inhabited by the Blue Whiting was completely covered, except in south and north where the zero-line were not observed. However, the observations in the north showed decreasing density and larger percentage of immature fish.

2. Acoustic Abundance Estimation

The number of fish within an area A (nautical miles)^2 is

$$Q_A = A \cdot \bar{\rho}_A$$

where $\bar{\rho}_A$ is the mean fish density (number per (n.m)^2). The mean fish density can be measured acoustically:

$$\bar{\rho}_A = \frac{1}{\bar{\sigma}_{b.s.}} \cdot \overline{C_I \cdot M}$$

Here $\bar{\sigma}_{b.s.}$ is the mean back scattering cross section of one fish, C_I is an instrument constant and M is the integrator deflection per nautical mile.

The instrument constant for the echo sounder system on "Eldjarn" was found by calibration with a copper sphere on 28/1 1983, to be $10\ C_I = 1.00\ m^2$ per $(n.m.)^2$.

The back scattering cross section of Blue Whiting has been suggested by Nakken in Appendix II of Anon. (1982) and given the following expression

$$\sigma_{b.s.} = 0.536 \cdot 10^{-7} \cdot l^{2.18}$$

where l is the fish length in cm.

The mean values $\overline{\sigma}_{b.s.}$ are calculated at each of the 18 trawl stations within the area covered (Tab. 1). The location of the trawl stations are shown in Fig. 5.

The area of distribution has been divided into 26 convenient sub-areas (Fig. 4). For each of the sub-areas are calculated area size in $(n.m)^2$ and mean integrator values (Tab. 2). Also, are listed the $\overline{\sigma}_{b.s.}$-values used in each of the areas, they are found from the values calculated for the trawl stations.

The number of fish (Q) for each subarea can now be calculated and are listed in Tab. 2. The total number of fish amount to more than 30×10^9 fish. The mean weight per fish has been calculated from the trawl station (Tab. 1) and the values used for the sub-areas are listed (Tab. 2). The total weight is found to be 4.7 mill. tonnes. About 4.4 mill. tonnes are fish 26 cm and larger and can be regarded as the size of the spawning stock.

Table 2 shows that the larger part of the Blue Whiting stock was located north of 58°N. The sub-area no 22 is inhabited by as much as 25% of the stock. This area was covered in the period 21 April to 23 April, and the calculation was based upon 39 five-mile values. The sub-area no 22 was again covered with a survey during 26th and 27th of April, this time covered with 47 five-mile observations. The results of the two surveys are given in Tab. 3. The difference is only 0.7%.

3. Discussion

The reliability of stock assessment based upon acoustic survey technique depends on some factors to be considered:

.1 Complete area coveraged.

During the present survey the zero lines of recordings were found in east and west, but not in south and north. However, the fish density of spawners in these areas were low (Tab. 2). Although, a small underestimate can be expected for this season.

.2 Recording conditions.

During the cruise the weather was generally good, but the vessel "Eldjarn" is sensitive to headsea, resulting in some reduction of the echo signal strength. To some extent this effect can be compensated in the integrating system, and the survey legs were always adjusted to avoid serious headsea. But again, some underestimate may be introduced.

.3 Effect of fish migration.

During the survey, the fish moved generally towards north, and since the survey route also passed northward, some overestimate can be introduced. The two estimates of subarea no. 22 gave the same result, but this might only explain that the same number of fish leaving the area in north also enter the area in south.

.4 The mean acoustic back-scattering cross section, $\overline{\sigma}_{b.s.}$

This important parameter is not only dependent of general knowledge of the target strength of the Blue Whiting but also on a representative sampling of length distribution. In this respect some more trawl stations would have been appreciated. This was not possible within the thirteen days allocated for the survey.

It is for the time being, impossible to give a better analysis of the accuracy of the Blue Whiting estimates. We would have been in a better position if the total stock estimate could have been broken down into estimates of each age group as pointed to by Nakken and Ulltang (1982).

4. References

Anon. 1982. Report of the international acoustic survey on Blue Whiting in the Norwegian Sea, July/August 1982. ICES, C.M. 1982/H:5.

Nakken, O. and Ulltang, Ø. 1982. A comparison of the reliability of acoustic estimates of fish stock abundances and estimates obtained by other assessment methods in the northeast Atlantic. Symposium on Fisheries Acoustics, Bergen, Norway, 21–24 June 1982 (ICES/FAO) No. 38.

Table 1. Length distribution on the trawl stations,

$\bar{\sigma}_{b.s.}$: mean back scattering cross section (m^2), $\bar{g}$: mean weight per fish in gr.

l(cm) \ T. St nr.	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104
17													1	4				
18					3								1	9	1	1		
19					8								4	23	2		1	
20					6								3	16	11			
21					4							1	6	25	6	1	1	
22					1								2	13	7		1	
23					2							1	1	1	3			
24		1	1	1	3									1				
25			2															
26		2	1	1	1									1			1	1
27	1	6	8	2	2				2			1	1				4	2
28	1	9	7	5	2	4	2	2	9		1	3	1	1	1		3	5
29	11	10	5	12	23	1	3	3	15	4	3	1	5	2	3	2	10	2
30	15	22	16	25	18	9	9	8	21	9	9	10	3	1	5	2	14	11
31	30	19	26	15	10	23	17	20	22	20	31	15	16		15	5	26	14
32	16	13	13	19	9	22	31	30	17	19	20	18	10	2	20	10	12	22
33	11	10	2	10	3	20	20	14	2	24	16	23	20		16	11	13	18
34	3	5	9	4	5	13	10	7	3	9	12	15	14		4	5	4	12
35	4	2	4	4		4		14	4	11	5	7	10	1	3		5	5
36	3	1	3			2	5	1	4	2	1	4	2		2	1	3	7
37	2		1	1		1	2	1		1	1	1						
38	2		1			1	1		1	1	1				1		2	
39																		
40				1														
41	1																	1
42																		
43			1															
$\bar{\sigma}_{b.s.} \cdot 10^6$:	100	90	94	92	77	112	105	105	104	106	116	105	94	42	85	80	97	104
$\bar{g}$:	152	169	165	156	121	170	180	182	152	185	167	171	154	63	136	164	162	176

Table 2. Calculated abundance within the sub-areas and the total abundance. The parameters used in the calculation are listed.

Sub-area no.	Area size $(n.m)^2$	$\bar{M}$	$\bar{\sigma}_{b.s.} \cdot 10^6$ (m^2)	Number $Q \cdot 10^{-9}$	Weight $\bar{g}$ (gr)	Total Ton 10^{-6}	$\geq$26 cm Ton 10^{-6}	Fish density Numbers $(n.m)^2 \cdot 10^{-6}$	ton $(n.m)^2$
1	270	1106	100	0,299	152	0,045	0,045	1,11	167
2	1900	123	90	0,260	169	0,044	0,044	0,14	23
3	1120	462	90	0,574	169	0,097	0,096	0,51	87
4	220	1084	94	0,254	165	0,042	0,041	1,15	191
5	110	771	94	0,090	165	0,015	0,015	0,82	136
6	24	1000	92	0,026	156	0,004	0,004	1,08	167
7	63	1819	92	0,125	156	0,020	0,020	1,98	317
8	210	1229	85	0,304	138	0,042	0,037	1,45	200
9	150	5192	77	1,012	121	0,122	0,092	6,75	813
10	150	518	90	0,087	169	0,015	0,014	0,58	100
11	270	1259	108	0,324	175	0,057	0,057	1,20	211
12	280	2167	108	0,562	175	0,098	0,098	2,01	350
13	340	4257	108	1,340	175	0,235	0,235	3,94	691
14	600	3523	105	2,013	173	0,348	0,348	3,36	580
15	640	9367	105	5,710	173	0,988	0,988	8,92	1544
16	212	7148	105	1,443	173	0,250	0,250	6,81	1179
17	130	8835	110	1,045	173	0,181	0,181	8,04	1392
18	170	2778	116	0,407	167	0,068	0,068	2,39	400
19	500	2661	110	1,210	173	0,209	0,209	2,42	418
20	875	490	100	0,429	166	0,071	0,036	0,49	81
21	720	425	100	0,306	166	0,051	0,051	0,43	71
22	1400	5426	100	7,596	166	1,261	1,261	5,43	900
23	600	315	42	0,450	63	0,028	0,002	0,75	47
24	1050	713	42	1,783	63	0,112	0,009	1,70	107
25	1575	320	70	0,720	100	0,072	0,036	0,46	46
26	2400	654	90	1,744	136	0,237	0,178	0,73	99
Total:				30,114		4,712	4,415		

Table 3. Results of two surveys of Sub-area no 22.

Date	Area size $(n.m)^2$	Number of five n.m. observations	$\overline{M}$	Number $Q \cdot 10^{-9}$
21–23 April	1400	39	5426	7.596
26–27 April	1400	47	5463	7.648

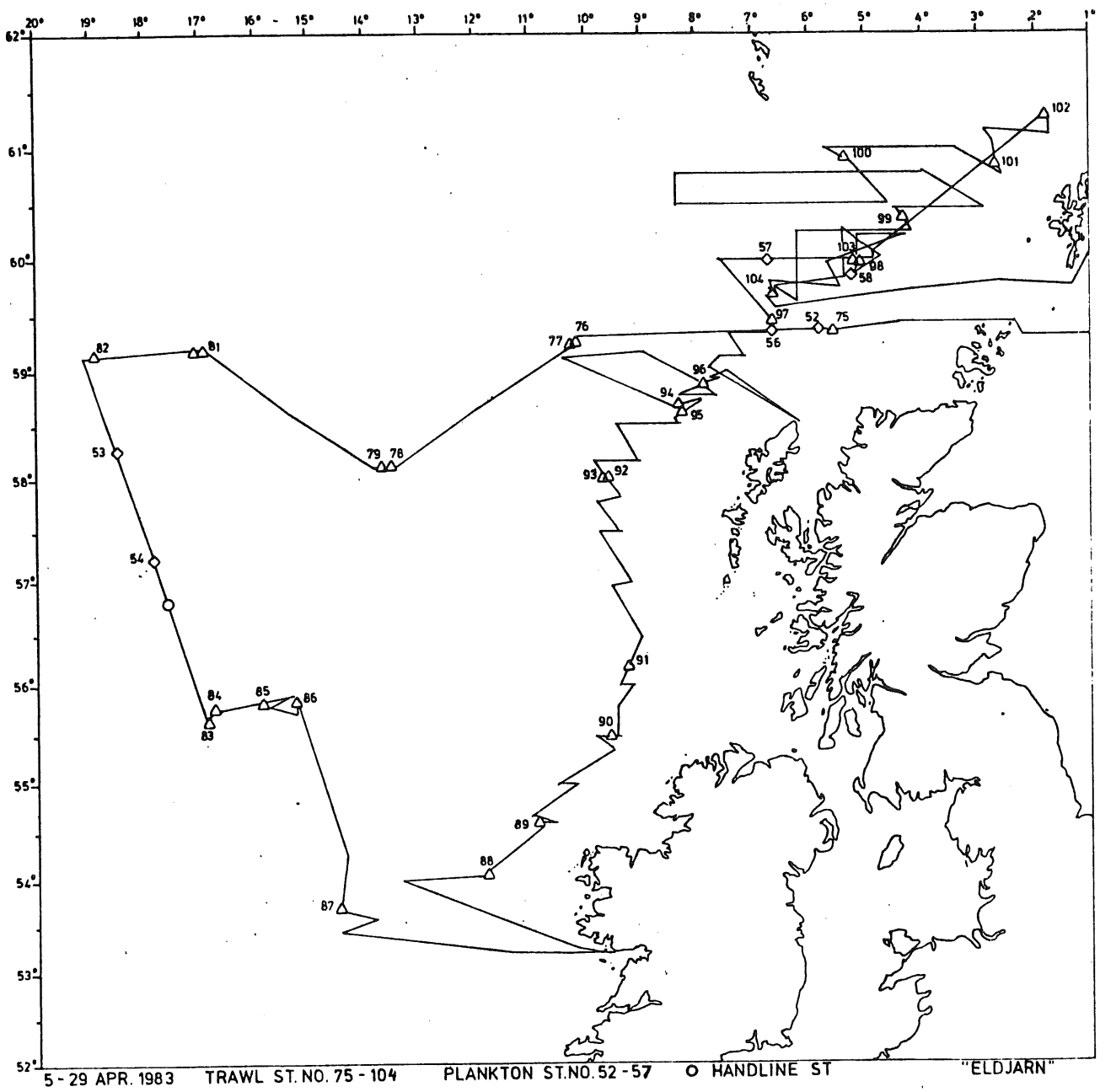

Fig. 1. Survey track and the trawl stations.

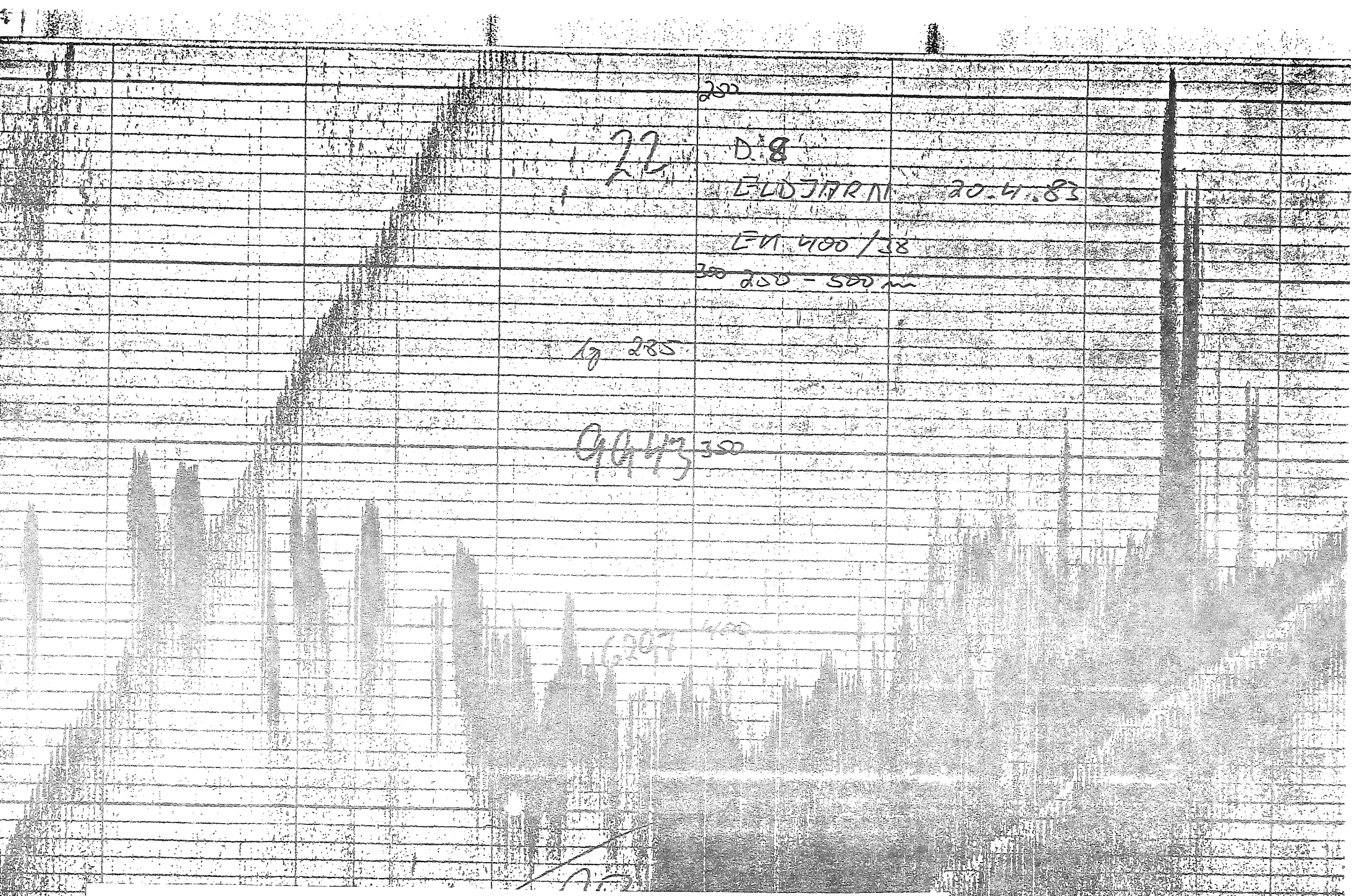

Fig. 2. Day recording of Blue Whiting in sub-area no. 17, 20 April 1983 08 GMT.

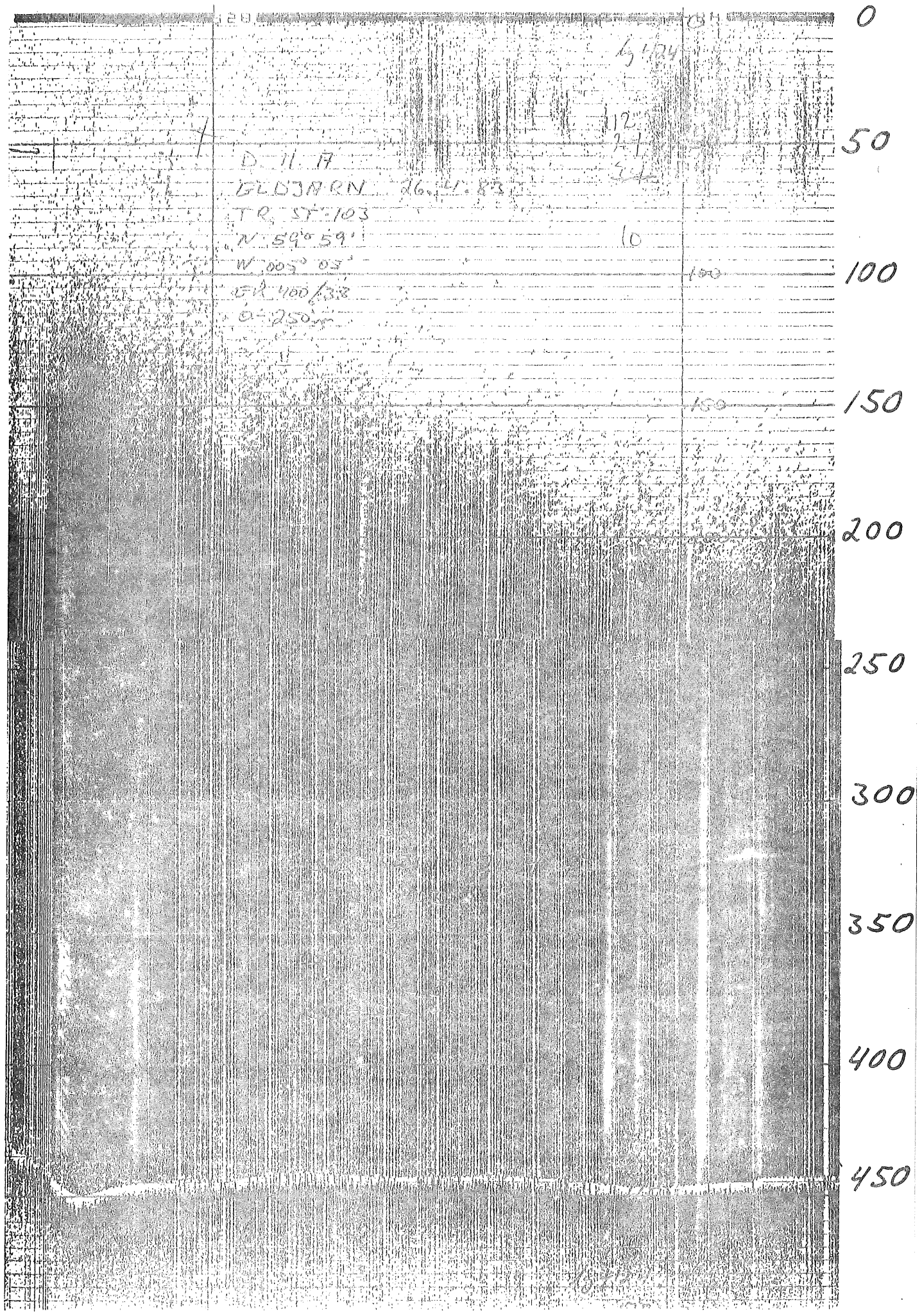

Fig. 3. Night recording of Blue Whiting on T.st. 103 ($59^{\circ}59'N$ $5^{\circ}05'W$) in sub-area no. 22, 26 April 1983 21.30 GMT.

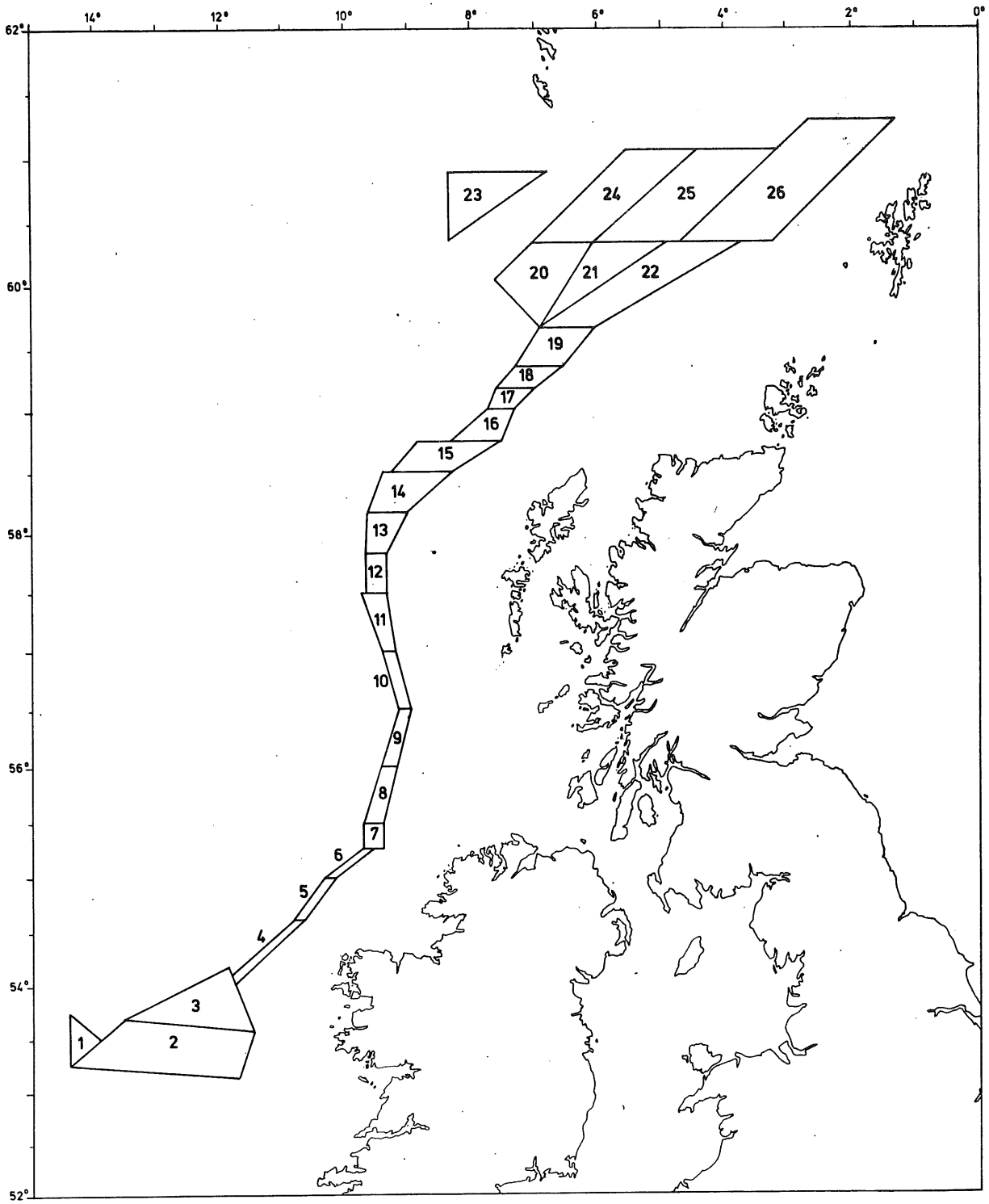

Fig. 4. The area of distribution divided into sub-areas.

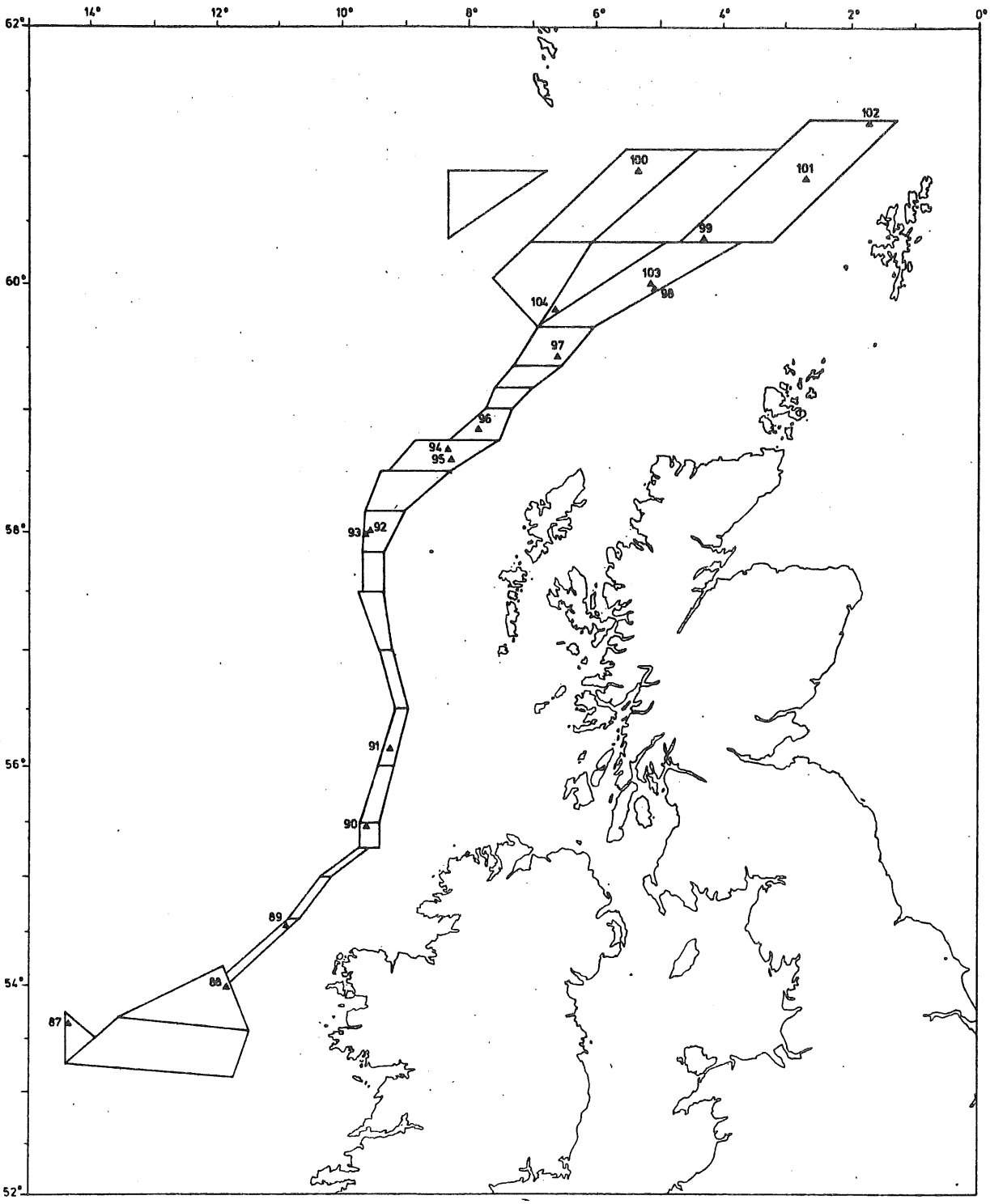

Fig. 5. Location of the trawl stations used in the estimation.