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~~Preliminary~~
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REPORT ON AN ACOUSTIC SURVEY FOR MACKEREL
IN THE NORTH SEA, SKAGERRAK AND KATTEGAT
IN JULY - AUGUST 1987.

by

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ABSTRACT

An acoustic survey in the North Sea, Skagerrak and Kattegat was carried out in July-August 1987 by vessels from Denmark and Norway. This paper gives the distribution and the abundance estimates for mackerel.

1. Introduction.

Since 1985 an acoustic survey has been carried out in August in the eastern part of the North Sea and in Skagerrak and Kattegat. During these surveys relative high concentrations of mackerel have been observed.

In 1987 the area covered by the survey was extended. The north-eastern part of the North Sea was covered by RV "Eldjarn" and the eastern North Sea, Skagerrak and Kattegat by RV "Dana".

This report gives the distribution and abundance estimates of mackerel found during the two surveys.

2. Survey report RV "DANA" 31 July to 9 September

The acoustic survey on RV "Dana" was carried out as described by Degnbol et al. (1988).

The survey tracks are shown in fig. 1. The stratification used in the calculations of biomass are based on total depth within the sub-areas shown in fig. 2. The depth intervals used in the stratification are 0-20, 20-40, 40-60, 60-100, 100-300 and more than 300 m. The areas of the strata are given in table 1 together with number of nautical mile integrated.

The calculations of biomass are performed in accordance with Degnbol and Bangsberg (1985). Mean area back scattering values per strata are allocated to species and length groups according to the composition of the trawl catches and the target strength length relationships given in table 2.

The positions of the trawl hauls is shown in fig. 1.

The estimated number and biomass of mackerel at age in each geographical unit are shown in table 3 and 4. The observed mean weight at age are given in table 5.

About 80% of the total number of mackerel were found in stratum M. The estimate in stratum M is based on a very limit number of nautical miles integrated, covering only a small part the stratum.

3. Survey report RV "ELDJARN" 31 July to 11 August.

During the period 24 June to 11 August an acoustic survey was carried out by RV "Eldjarn" in the North Sea and Skagerrak. The distribution of mackerel was particular investigated during the period 31 July to 11 August. The survey grid and fishing stations are shown in fig. 3. The sub areas used in the calculations are shown in fig. 4. The areas of the sub areas are given in table 8.

During the survey 27 pelagic and 3 demersal trawl hauls were made to identify scattering layers. In addition handlines for catching mackerel were tried at 90 stations. Usually two handlines were used for at least 10 minutes. For comparison the age distributions of mackerel caught by pelagic trawl and by handlines in the south eastern part of Division IVa are shown in table 6. The two age distributions are similar indicating that the two fishing methods sampled the mackerel stock the same way.

During the survey both the sonar and the echosounder were working. The echosounder was connected to a counter for integrating the echoes. By combining the informations from the sounder, sonar and catches by trawl and handline it was possible to assigne parts of the integrator values to mackerel when scrutinizing the echograms. Mean integrator values by sub-areas are given in table 7.

In sub-area 1-6 (fig. 4) it was possible to spot mackerel on the echograms. Based on average length and weight of mackerel and the target strength relationship: $ts = 20 * \log(L) - 77.2$, the number and biomass were estimated within the different sub-areas (table 7 and 8).

4. Combined results.

Taking the mean of the two estimates in overlapping areas the total estimate for the area is 6954 millions mackerel or 1318 thousand tones. The Mackerel Working Group (Anon., 1988) estimates the Western Mackerel Stock to be 2 497 thousand tones in 1987 of which about 50% is present in the North Sea in third quarter. The North Sea Stock is assumed to be very weak (less then 100 thousand tones).

In the overlapping areas between the two surveys (RV "Eldjarn" sub-areas 3+4,5 and 6; RV "Dana" strata Z, T+O and U+P+I) the estimates from RV "Eldjarn" are 110, 545 and 609 millions (49 000, 239 000 and 224 000 tones), while the estimates from RV "Dana" are 39, 243 and 236 millions (18 000, 88 000 and 83 000 tones). The two surveys did not cover exactly the same area. The figures given above for RV "Dana" are adjusted so that they refer to the same number of square nautical miles as given in table 7 for sub-areas 3+4,5 and 6.

The estimates from RV "Dana" are about 40% of RV "Eldjarn"s estimates. The fact that the compared areas are not exactly identical may cause some of the differences. The difference may also be due to differences in calculation procedure.

The echo integrator data from RV "Eldjarn" were divided into mackerel and not mackerel, by visual inspection of the echosounder paper combined with information from the catches by trawl and handline. The intergrater values were then raised to number of mackerel using the ts-length relationship and the obeserved length distributions. The critical points in this method are the allocation of integrator value to species and the target strength value for mackerel.

There are few measurement of mackerel target strength, all showing very low values. The applied value is rather arbitrary due to the few measurements.

If e.g. herring schools are misclassified as mackerel, they will, because of the low target strength for mackerel, give rise to very high estimates of mackerel abundance.

In the method used on the data from RV "Dana" the species composition is set equal to the observed distribution in the trawl catches, and the estimated total number of fish is determined by the integrator output and the mean target strength for all species. In areas where mackerel is dominating, the biomass estimate is dependent on the applied target strength value for mackerel, while in areas where other species are dominating, the estimate is more dependent on the target strength for the dominating species than for mackerel.

References

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Table 1. Survey statistics. RV "Dana".

stratum	area NM**2	no. NM integrated
A	2317	153
B	2911	212
C	988	90
D	1837	193
E	5228	472
F	5724	52
I	3516	341
K	4350	318
L	2172	48
M	4949	39
O	3072	164
P	3871	67
Q	3983	98
R	4075	59
S	4199	65
T	3767	111
U	3873	107
V	3980	89
X	4100	62
Y	4192	21
Z	3654	164

Table 2. The species included in the calculations and the used target strength - length relationship. RV "Dana".

Herring	TS = 20.0*log(L)-71.2	(Anon. 1983)
Sprat	TS = 20.0*log(L)-71.2	1)
Horse Mackerel	TS = 20.0*log(L)-71.2	1)
Mackerel	TS = 20.0*log(L)-71.2	2)
Gadoids	TS = 20.0*log(L)-71.2	(Foote, 1986)

- 1) The herring TS-length relationship.
 2) 6 dB below the herring relationship.

Table 3. Estimated number (millions) of mackerel per age group and stratum. RV "Dana".

Stratum	Age									
	1	2	3	4	5	6	7	8	9	10
A	12	16	3	1	+	1	+	0	+	0
B	21	27	4	1	1	1	+	0	+	0
C	5	3	2	+	+	+	+	0	+	0
D	31	26	12	+	+	+	+	0	+	0
E	0	1	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0
I	19	39	1	+	+	+	+	0	+	0
K	1	+	1	+	0	+	+	+	0	0
L	2	+	1	+	+	+	+	+	0	0
M	3091	1914	89	0	19	0	2	0	0	0
O	0	20	42	3	3	3	2	+	0	+
P	6	12	9	+	3	1	1	1	0	0
Q	18	15	16	+	0	1	0	0	+	0
R	11	2	2	0	0	1	0	0	+	0
S	45	20	9	1	1	1	0	0	+	0
T	1	70	77	15	6	6	5	1	0	1
O	5	118	48	10	5	7	1	0	0	0
V	+	8	27	+	3	3	1	1	1	1
Y	231	170	48	8	15	5	5	1	+	0
Z	1	1	30	6	1	1	1	0	2	1
total	3500	2462	420	48	58	29	19	4	3	3

stratum	age					total
	11	12	13	14	15+	
A	0	+	0	0	0	34
B	0	+	0	0	0	56
C	0	+	0	0	0	11
D	0	+	0	0	0	70
E	0	0	0	0	0	1
F	0	0	0	0	0	0
I	0	+	0	0	0	59
K	0	0	0	0	0	3
L	0	0	0	0	0	4
M	0	0	0	0	0	5114
O	+	0	0	0	0	74
P	1	0	0	0	0	33
Q	0	0	0	0	0	51
R	0	0	0	0	0	16
S	0	0	0	0	0	77
T	+	+	+	1	0	182
U	0	0	1	1	0	195
V	0	0	0	0	+	45
Y	0	+	+	0	0	484
Z	2	1	0	1	2	48
total	3	2	1	2	2	6556

Table 4. Estimated biomass (tonnes) of mackerel per age and stratum. RV "Dana".

Stratum	age							
	1	2	3	4	5	6	7	8
A	2447	4582	1023	361	246	416	268	0
B	4469	7776	1451	543	562	480	293	0
C	860	859	672	52	74	47	32	0
D	5226	7203	3640	153	154	98	67	0
E	0	188	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0
I	3629	12434	216	81	147	93	64	0
K	222	104	250	49	0	125	66	64
L	237	93	249	103	64	92	39	33
M	403982	347122	23793	0	7535	0	839	0
O	0	5485	12736	1196	1724	1571	942	163
P	960	2892	2526	201	1585	672	586	591
Q	2869	3516	4634	21	0	287	0	0
R	1595	405	428	0	0	383	0	0
S	6387	4401	2432	184	291	232	0	0
T	156	20676	26043	6025	3666	3616	2393	401
U	938	30411	13937	3961	2200	2983	341	0
V	78	1825	8031	106	1031	1202	648	553
Y	34875	34292	11705	2135	4595	1491	1423	389
Z	415	208	11066	3183	455	222	1096	0
total	469343	484472	124832	18357	24327	14010	9099	2194

stratum	age							total
	9	10	11	12	13	14	15+	
A	48	0	0	69	0	0	0	9460
B	118	0	0	170	0	0	0	15861
C	15	0	0	22	0	0	0	2634
D	32	0	0	46	0	0	0	16620
E	0	0	0	0	0	0	0	188
F	0	0	0	0	0	0	0	0
I	31	0	0	44	0	0	0	16739
K	0	0	0	0	0	0	0	881
L	0	0	0	0	0	0	0	909
M	0	0	0	0	0	0	0	783271
O	0	190	207	0	0	0	0	24214
P	0	0	546	0	0	0	0	10558
Q	31	0	0	0	0	0	0	11359
R	107	0	0	0	0	0	0	2918
S	141	0	0	0	0	0	0	14068
T	0	535	144	341	341	599	0	64937
U	0	0	0	0	366	586	0	55722
V	265	371	0	0	0	0	40	14150
Y	51	0	0	64	60	0	0	91080
Z	1073	531	1121	537	0	531	1147	21586
total	1913	1627	2017	1293	767	1717	1187	1157154

Table 5. Mean weight (gram) of Mackerel by age group and strata. RV "Dana".

Stratum	age											
	1	2	3	4	5	6	7	8	9	10	11	12
A	198	282	348	381	599	470	627	-	640	-	-	-
B	211	285	387	412	610	562	656	-	640	-	-	920
C	181	268	311	529	610	644	665	-	640	-	-	920
D	167	274	307	500	610	655	665	-	640	-	-	920
E	-	192	-	-	-	-	-	-	-	-	-	-
I	193	320	414	563	610	644	665	-	640	-	-	920
K	166	267	320	357	-	402	534	527	-	-	-	-
L	153	247	295	378	426	380	489	494	-	-	-	-
M	131	181	269	-	390	-	470	-	-	-	-	-
O	-	270	304	425	506	599	564	497	-	580	632	-
P	163	248	290	580	596	654	563	852	-	-	787	-
Q	155	233	281	440	-	457	-	-	380	-	-	-
R	148	205	253	-	-	453	-	-	380	-	-	-
S	143	216	258	366	302	334	-	-	460	-	-	-
T	204	297	337	398	625	645	525	592	-	750	577	797
U	203	258	288	381	469	444	436	-	-	-	-	-
V	189	241	298	345	382	425	450	544	500	467	-	-
Y	151	202	242	254	306	283	279	322	385	-	-	480
Z	300	350	374	495	500	395	745	-	680	673	710	680

stratum	age		
	13	14	15+
A	-	-	-
B	-	-	-
C	-	-	-
D	-	-	-
E	-	-	-
I	-	-	-
K	-	-	-
L	-	-	-
M	-	-	-
O	-	-	-
P	-	-	-
Q	-	-	-
R	-	-	-
S	-	-	-
T	797	840	-
U	468	750	-
V	-	-	620
Y	450	-	-
Z	-	673	708

Table 6 Age distributions (%) of mackerel caught by pelagic trawl and handlines (IVa SE). RV "Eldjarn".

Age	Trawl	Handline
1	+	2
2	13	16
3	45	38
4	1	1
5	2	1
6	21	22
7	7	8
8	5	3
9	2	3
10	1	1
11	2	1
12	0	1
13	1	1
14	0	1
15+	1	4
N	292	184

Table 7 Estimated biomass of mackerel in different areas surveyed by "Eldjarn" 31 July - 11 August 1987.

Area	n.mile ²	mean integrator value	N x 10 ⁻⁶	tons x 10 ⁻³
1	785	16	39	19
2	1500	13	60	29
3	1830	15	88	39
4	1120	6	22	10
5	6500	26	545	239
6	9250	18	609	224
Sum			1363	560

Table 8 Estimated numbers of mackerel ($\times 10^{-6}$) by yearclass and area. RV "Eldjarn".

AGE	A R E A			
	1,2	3,4,5	6	SUM
1	-	2	8	10
2	4	51	127	182
3	24	212	343	579
4	3	13	0	16
5	6	13	10	29
6	25	170	79	274
7	22	71	20	113
8	6	33	10	49
9	5	33	4	42
10	0	9	0	9
11	2	16	0	18
12	1	5	0	6
13	0	7	2	9
14	0	7	0	7
15+	2	13	6	21

Table 9 Agedistribution (%) of mackerel obtained during the RV "Eldjarn" survey 24 June - 11 August 1987.

Age	1,2	3,4,5	6	IVb	IIIa
1	0	0.3	1.3	51.9	92.0
2	4.0	7.8	20.8	23.1	7.0
3	24.0	32.3	56.4	12.3	1.0
4	3.0	2.0	0	0.5	0
5	6.0	2.0	1.7	2.0	0
6	25.0	25.9	12.9	0.8	0
7	22.0	10.9	3.3	0.8	0
8	6.0	5.1	1.7	0.9	0
9	5.0	5.1	0.7	0.3	0
10	0	1.4	0	0.5	0
11	2.0	2.4	0	0.8	0
12	1.0	0.7	0	0.8	0
13	0	1.0	0.3	0.6	0
14	0	1.0	0	0.3	0
15+	2.0	2.0	1.0	4.5	0
N	100	294	303	644	100
L cm	36.9	36.0	33.8	28.3	27.3
W g	485	439	367	212	169

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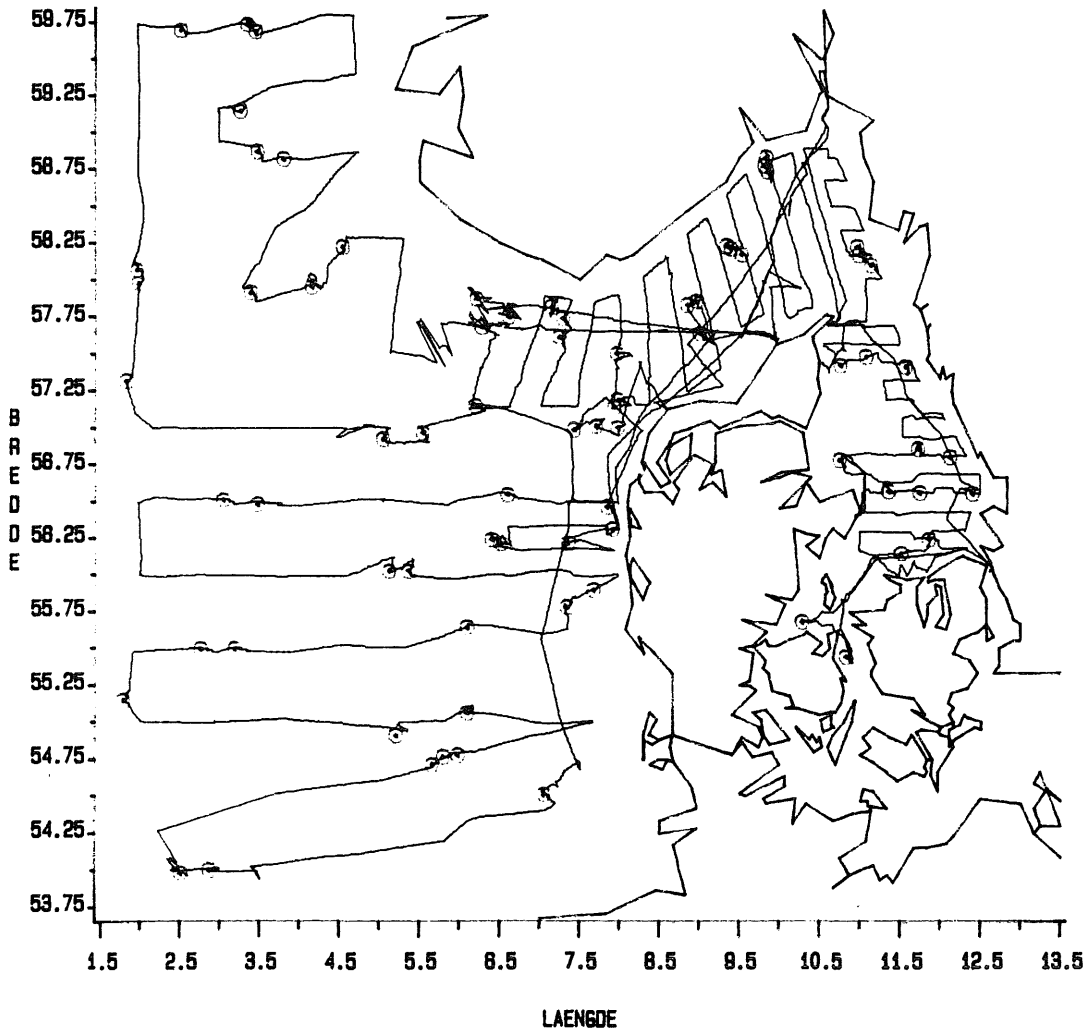


Fig. 1. Survey tracks and positions of trawl hauls for RV "Dana".

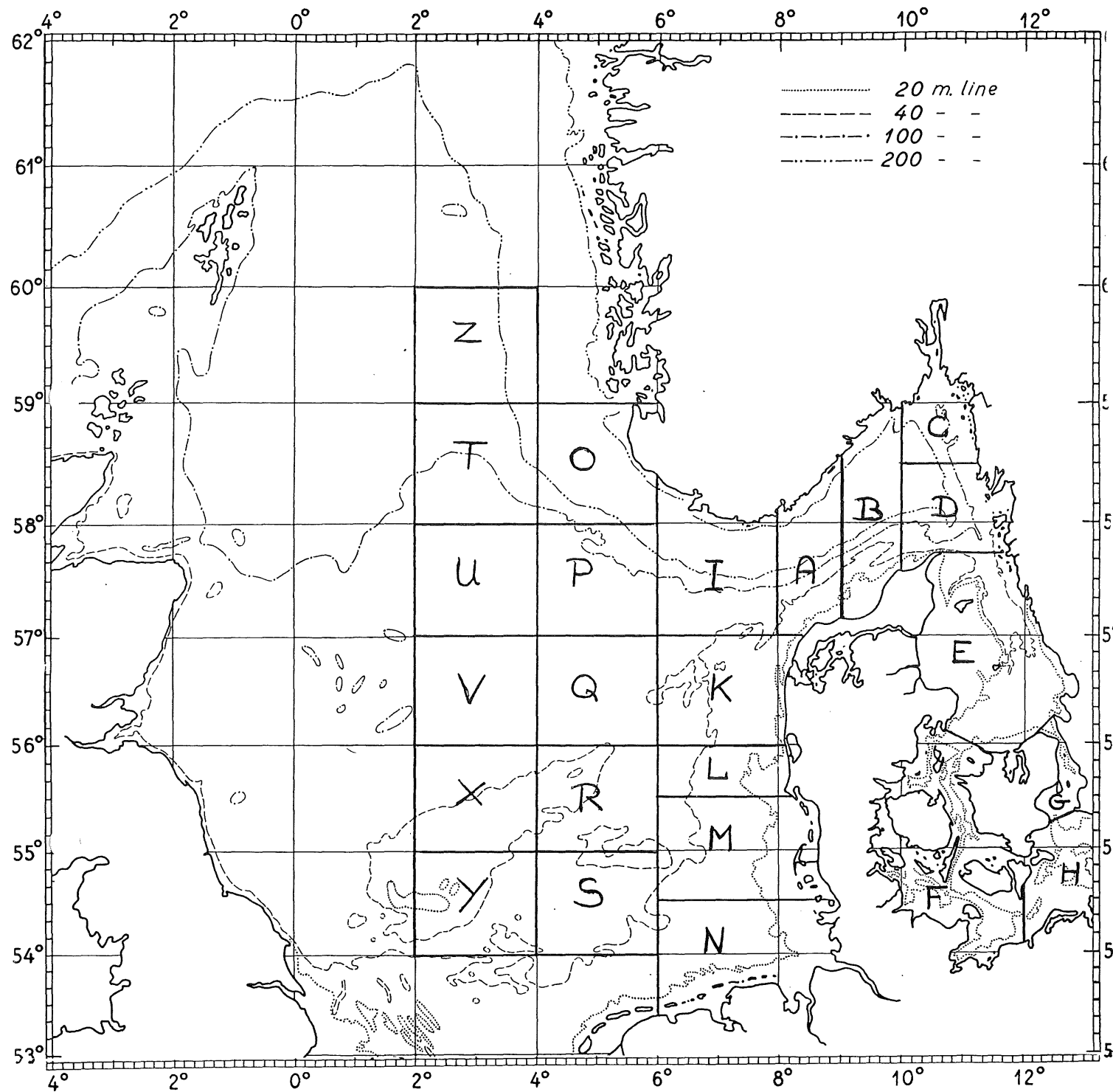


Fig. 2. Strata used in the survey carried out by RV "Dana"

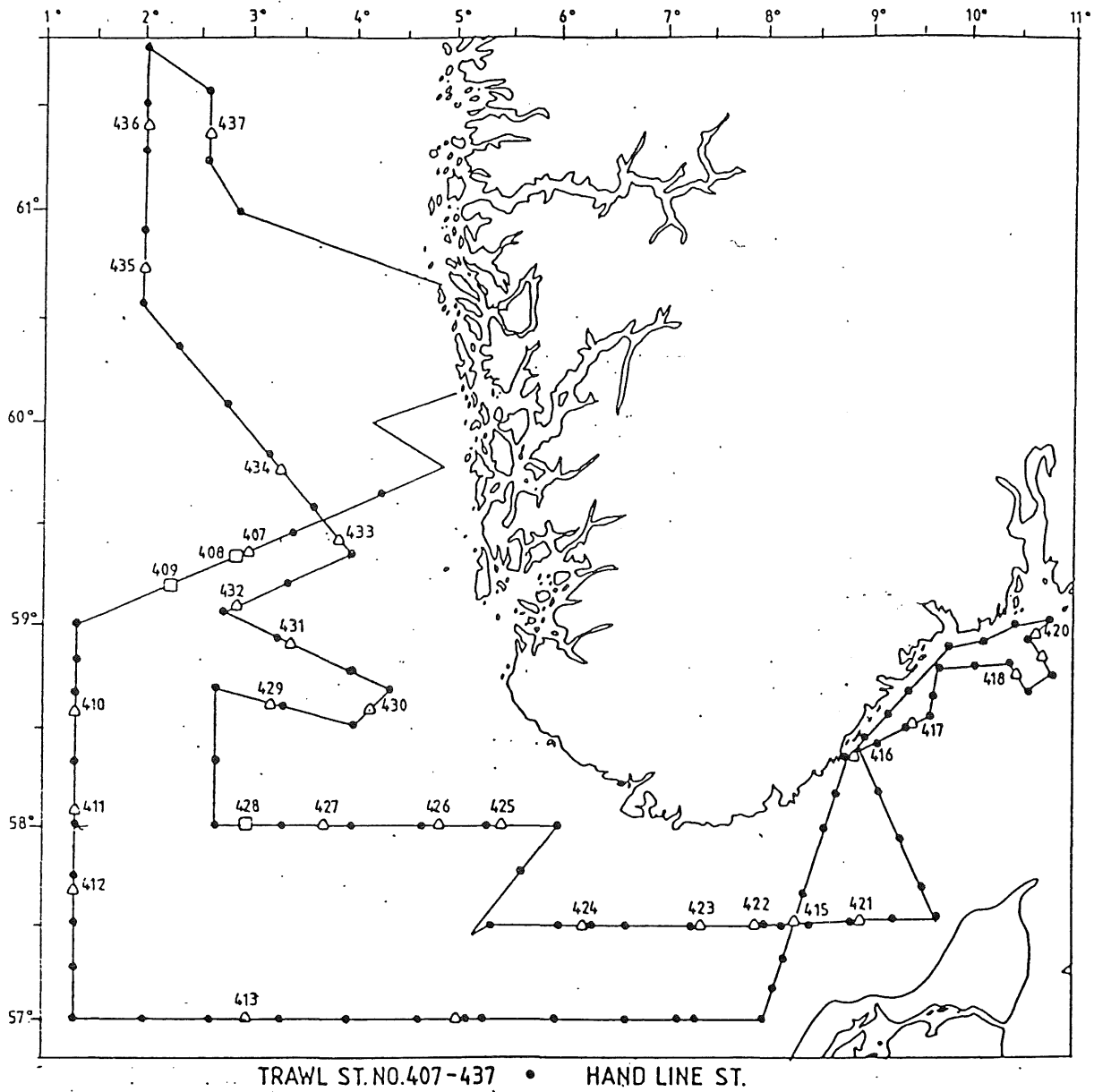


Fig. 3. Survey grid and stations worked by RV "Eldjarn" during 31 July -11 August 1987.

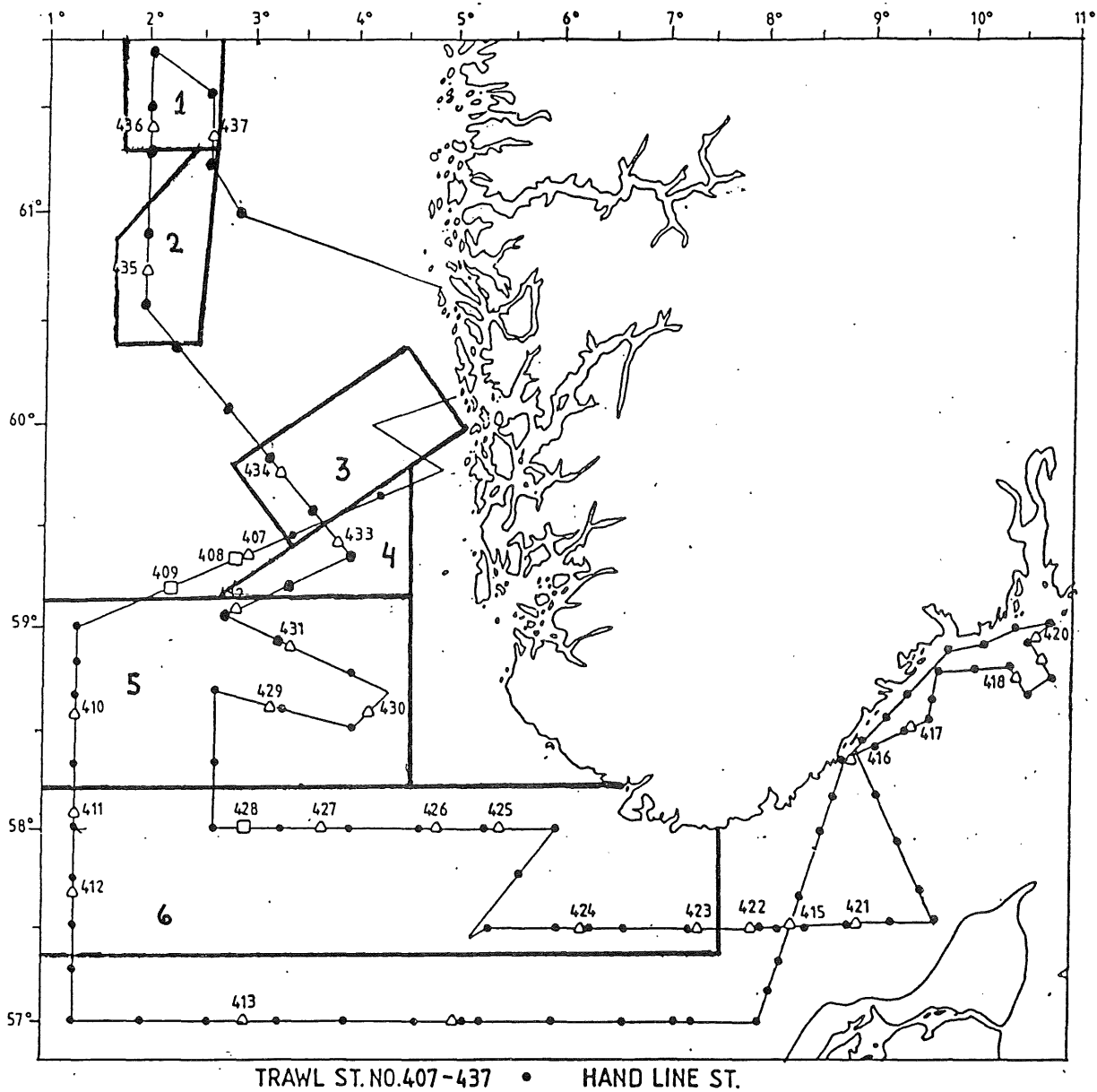


Fig. 4. Areas where mackerel was identified on the echograms from RV "Eldjarn".