

CRUISE REPORT

R.V. "G. O. Sars", 20/7 - 17/8 1997

Cruise no 1997010

NORWEGIAN SEA

PARTICIPANTS

From the Institute of Marine Research, Bergen, the following persons participated:

Valantine Anthonypillay
Otte Bjelland
Ingve Fjeldstad
Ole Gullaksen
Tove Karlsen (from 28/7)
Terje Monstad (cruise leader)
Ronald Pedersen
Mona Sand (engagement/student)
Rolf Sundt
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Guest:

Bjørn Brudeseth, Institute of veterinary, Oslo (from 28/7).

INTRODUCTION

The present survey is part of the ICES-coordinated investigation on pelagic fish in the Norwegian Sea, with special emphasis on the Norwegian Spring Spawning Herring. The Planning Group (PGSPEN), with members from EU, Faroe Islands, Russia, Norway and Iceland, met in Bergen in February 1997. Terms of reference, objectives and further details for the programme are presented in the report from the meeting (Anon., 1997).

The survey is also part of the *Mare Cognitum* research programme of the Institute of Marine Research, Bergen, for studying pelagic fish distribution, migration and abundance in relation to the physical and biological environment. The species include blue whiting, mackerel, horse mackerel and herring, also with emphasis on the latter one, and also salmon, lumpsucker, mesopelagic fish and squid (*Gonatus*). Furthermore a number of fish stomachs were collected for studies on feeding ecology.

The various objectives claim varying time periods for sampling of their respective data. The results of these targets, however, overlap each other for mutual benefit, and a balanced strategy for an overall optimal run of the survey was found.

The area from the coast of Norway to the mid Norwegian Sea was covered between 61° and 74° N (the Faroe -Shetland area to 74° N) mostly by transects of SE-NW direction including the Svinøy and Gimsøy standard sections and a greater part of the Træna-Jan Mayen section (Figures 1 and 2).

MATERIAL AND METHODS

The integrator system BEI (Bergen Echo System) was connected to a Simrad EK-500/ES-38B-BM echo sounder for registration of fish and plankton echo traces throughout the survey. The following settings were used:

Transducer depth	5m/7.5m	2-way beam angle	-21.0
Absorbtion coeff.	10 dB/km	SV Transducer gain	22.2 dB
Pulse length	medium	SV Transducer gain	27.1 dB
Band width	wide	3dB Beam width	7.0 dg
Max power	4000w	Alongship offset	0.01 dg
Angle sensitivity	21.9	Athw.ship offset	0.00 dg

The integrated echo values (S_A) were allocated to species or group of species. In addition schools were recorded by use of the sonar (Simrad SA 950 multibeam) set in a fixed position at 90° to the ships course, tilted 2.0° - 3.0° down. The schools were counted and logged for each 5 n. mile.

For identification of the echo recordings and collection of biological samples, a pelagic trawl (Åkra) with 30 m vertical opening and inner-net in cod end of 22mm mesh size, was used. When used for sea surface trawling 2 big floats were attached to each trawl wing and a smaller one at the mid-headline. On the shelf, a bottom trawl (Campelen 1800), also with innernet in cod end of 22mm mesh size, was used. In addition to the echo recordings, the fish species were also recorded by counting their numbers in the sea surface trawl catches.

A net of hydrographic stations was worked by use of CTD-sonde down to 600m depth, including the Svinøy and the Gimsøy standard sections where the stations, however, were taken to the bottom. On these sections, nutrient salt and chlorophyll were sampled from 12 varying depths depending on the bottom depth at the stations.

For zooplankton sampling a standard WP-2 net with 180 μ m mesh was hauled vertically in 200-0 m on all CTD stations.. A 1m² MOCNESS, equipped with eight nets (180 μ m mesh size) was used at fixed positions on the Svinøy, the Gimsøy and the Træna-Jan Mayen sections, all stations from 700m depth, or from bottom when more shallow, covering the intervals 700-500, 500-400, 400-300, 300-200, 200-100, 100-50, 50-25 and 25-0m depths.

RESULTS

Surface schools

Recordings of schools near the sea surface were made by the sonar through most part of the area surveyed (Figure 3). However, only small schools were detected, some of them could as well have been groups of fish. In the northern area most of the sonar recordings were identified as herring schools, while in the south they were either herring, mackerel, horse mackerel and even single fish of lumpsucker, or a mixture of these species. Lumpsucker, which was caught in most areas near sea surface, has no swimbladder. However, they were observed to have airfilled stomach and gut to obtain buoyancy, and hence could give significant echoe traces on the sonar.

Herring

The averaged integrator values of herring (S_A) by rectangle are shown on Figure 4. In addition to the echo sounder and the sonar recordings (Figure 5), it was also recorded by the catches from the surface trawling (Figure 6). The main concentrations were

located north of 69° N, with the heaviest echo recordings made between 70° and 73° N east of 11° E. It appeared as a relatively thin, but very dense layer in the upper 40m of the water column, mostly at 20 m depth (Figure 7). Within some minor areas in the north it also appeared very scattered in mixture with blue whiting and redfish at depths around 300-500m.

The length and age distributions in the subareas II, IV and V marked on Figure 4, are shown on Figure 8. Most of the samples consisted of the 1990-92 yearclasses and only few specimens of the 1983 and -84 yearclasses were caught. The oldest and largest herring were caught at 400-500m depths in the area north of 69° N, having peak lengths at 33 cm (Figure 9), while herring caught at sea surface within the same area had a peak length of 30cm (Figure 10). Separate length frequencies and mean weights from each trawl station are given in Table 1.

Blue whiting

Recordings of blue whiting were made throughout the whole survey, with the limit of distribution only observed off Lofoten Islands towards the east, and towards the northwest between 73° and 74° N. The distribution and relative abundance are illustrated by the mean integrator values (S_a) per rectangle on Figure 11. The highest concentrations were recorded in the south, especially in the Faroes-Shetland area. Further north along the continental slope the concentrations decreased in density towards northwest. The blue whiting was mostly recorded at depths between 200 and 400m during daytime. During night time it dispersed upwards in the water column and occasionally also appeared in the upper sea surface layer.

The biomass was estimated at 4.9 mill. tonnes, using the same length dependent density coefficient as earlier for blue whiting estimates: $C_F = 1.488 \times 10^6 \times L^{-2.18}$, where L is the fish length. The corresponding abundance was 59.5×10^9 individuals (Table 2).

In 1995 and 1996 the biomass was estimated at 1.8 and 1.7 mill. tonnes respectively, i.e. less than half of the present estimate. However, this year a larger area was surveyed, especially in the south where the majority of the biomass was recorded, consisting mainly of the rich 1995 and 1996 yearclasses.

The age and length distributions are shown on Figures 12 for the 5 subareas marked on Figure 11, and on Figure 13 for the total recordings. The 1 and 2 year olds dominated, contributing with 51% and 43% by numbers respectively. The 1995 yearclass was known already as 0 group to be a very rich yearclass, and in the corresponding survey in 1996 it contributed with more than 80% in numbers. At present it is, however, at the same level as the one year olds, which is also a notable stronger than average yearclass.

Usually the youngest and smallest fish appear in the south and near the continental shelves, but this year the 1 year olds were the most numerous ones in the south and the north (subareas II and V), contributing with 59% and 47% respectively.

0-group blue whiting were observed in the southern area only, and at the shelf area northwest of Shetland (Pos. 61°12'N 02°42'E), 52 kg of the 1997 yearclass were caught

in a sea surface haul of half an hour duration. The length ranged from 9.5 - 13.0 cm with mean length 11.1 cm. Separate length frequencies and mean weights from each trawl station are given in Table 1.

Mackerel and horse mackerel

Mackerel and horse mackerel were caught in the southern parts of the covered area (Figures 14 and 15). The highest concentrations were found south of 66° N for both species, but some catches were also made further north. The northernmost catch of mackerel was made at 70° N, while all the horse mackerel catches were made south of 67° 30' N. Compared to the results of cruises made in 1995 and 1996, horse mackerel has a much wider distribution in the Norwegian Sea in 1997, whereas mackerel has a more limited distribution and was caught in fewer numbers compared to 1995 and 1996.

In Figures 16 and 17 the length distributions of mackerel and horse mackerel are given for the same areas as used for blue whiting, marked on Figure 11. Separate length frequencies and mean weights from each trawl station are given in Table 1.

Lumpsucker

Lumpsucker was caught in surface hauls more or less all over the covered area, with highest abundance in the northern and central parts (Figure 18). The length frequency is shown in Figure 19. Most fish were immature and belonged to the size group between 10 and 17 cm, while a second mode could be seen between 23 and 30 cm. Stomachs and otoliths were sampled for later analyses.

0-group fish

Haddock was the most frequently caught 0-group fish, but compared to 1996 only small catches were made (Figure 20). Only one haul yielded more than 15 individuals. As in 1996, 0-group haddock were found dispersed over a large area.

Except for blue whiting and haddock, only minor catches were made of other 0-group fish such as cod (Figure 21), whiting, saithe and herring.

Mesopelagic fish

Mesopelagic fish were acoustically recorded throughout the covered area, with the highest S_A -values in the southern and central parts (Figure 22). The densest layers of mesopelagic fish were found somewhat deeper than blue whiting, and the species composition could only be determined from the night hauls, when the mesopelagic fish ascended into the same depths as the blue whiting. These hauls showed that northern lanternfish (*Benthosema glaciale*) and the barracudina *Notolepis rissoi* comprised most of these registrations. As in 1996 only a few small catches were made of pearlside (*Maurollicus muelleri*).

Salmon

Two post-smolt salmon were caught in a trawl haul at 69° N and 0° S/E (Figure 23). Significantly more salmon have been caught during other cruises performed in the same area and at the same time the last couple of years.

Zooplankton

Throughout the whole survey plankton was recorded by the echo sounder, both in the upper water layers and at greater depths. The averaged integrator values (S_A) per rectangle are shown on Figure 24.

A total of 13 MOCNESS stations and 97 WP2 stations were taken (Figure 1). All zooplankton samples were divided to make subsamples for preservation in formaldehyd and for biomass measurements. The biomass part was sieved through 2000 μm , 1000 μm , 180 μm nylon mesh to separate plankton into three size groups. Euphausiids, shrimps and fish were sorted out from the >2000 μm fraction for separate dry weights. Weighing will be performed in Bergen. All zooplankton data were loaded into the Helix database during the cruise.

Hydrography

The horizontal temperature distribution at sea surface and at 20, 50, 100, 200 and 400m depths are shown on Figures 25-30.

Near the Norwegian coast the sea surface water temperature ranged from 12° C in the north to 15° in the south off Møre, which is 1-2° warmer than during the corresponding survey in 1996. The difference decreases towards west and northwest where the temperature ranged from 8 to 10° C. At 200 m depth the temperature was 7° along the whole coast, while in 1996 it varied between 8° and 6.5° C. Towards the west and northwest only minor differences from 1996 appeared at that depth.

Along the two standard sections negative water temperature appeared approximately the same depths as last year, i.e. at 600m near the shelf on the Svinøy section and somewhat deeper on the Gimsøy section (Figures 31 and B).

Whale observations

According to normal procedure on the Norwegian IMR cruises, the navigation personnel noted all observations of whale (Table 3). The area covered by this cruise is known from earlier whale counting surveys to be rich in several whale species.

The species observed on the cruise include Killer Whale, Common Dolphin, Pilot Whale, White-beaked Dolphin, Minke Whale, Sperm Whale, Humpback Whale and Sei Whale. The first observation of Sei Whale was rather dramatic, since the whale had been caught in our surface trawl. The trawl was destroyed and the cod end lost, but the whale seemed to escape without injuries.

The number of observations was probably negatively influenced by the varying weather conditions during the cruise and the fact that we did not have personnel especially dedicated for whale observation.

Bergen, 21 August 1997

Terje Monstad, Otte Bjelland, Valantine Anthonypillay, Ole Gullaksen, Ronald Pedersen, Rolf Sundt, Anders Thorsen.

Table 1. Length distributions with mean weights of herring, mackerel, horse mackere and blue whiting.

Date	970721		970721		970721		970721		970721		970721		970722		970722		970722		970722		970722		970722		970722						
St. no.	394		394		395		395		397		397		397		398		398		399		400		400		400		401				
Species	MACK		H MACK		MACK		H MACK		HERRING		MACK		H MACK		MACK		H MACK		BLUE WH		HERRING		MACK		H MACK		HERRING				
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)			
15																															
16																															
17																															
18																															
19																				1	30										
20																				6	39										
21																				6	45						1	65			
22																				10	54										
23																				13	62										
24																				30	73					1	225				
25								1	131		1	142								21	80										
26							1	183												9	89										
27						2	195		2	193		1	141		1	193				1	92										
28				1			5	211		2	213		1	218						1	121										
29		5	220		1			4	240		10	250		5	233																
30		23	244					1	267		10	259		6	248		1	200		1	213						2	244			
31		35	270		2			3	296		8	275		14	272		2	282		2	269					1	265		1	213	
32		24	288					2	299		12	289		2	288		3	317		2						5	287		2	269	
33		11	307			1	305		3	295		5	329		7	307		12	316		2										
34		2	368					4	326					2	375		15	350		1								1	284		
35					2			1	333					3	283		10	356		1	420						1	318		2	348
36					8			6	400					3	443		6	375		3							1	420			
37					2									6	412																
38					1				3	427				2	437																
39					4				1	416																					
40																															
41																															
42																															
43																															
44																															
45																															
46																															
Sum		100		21		1		36		50		45		58		4		13		100		9		4		7		1			
Mean W.			272		390		305		304		267		280		347		293		338		70		300		293		282		65		
Mean L.		31.9		36.0		33.5		33.0		30.9		32.2		35.0		32.5		33.7		23.3		32.0		32.5		31.2		20.5			

Table 1 (cont.)

Date	970722		970722		970730		970723		970723		970723		970723		970723		970723		970723		970723		970724		970724							
St. no.	401		401		402		403		403		403		404		404		405		405		406		407		408		409					
Species	MACK		H MACK		BLUE WH		HERRING		MACK		H MACK		BLUE WH		H MACK		HERRING		MACK		BLUE WH		MACK		BLUE WH		BLUE WH					
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)				
15																																
16																																
17																																
18					6	42							4	39												1	30					
19					20	47							5	49												9	47					
20					45	51							9	53							1	55			1	40	16	49				
21					15	54							13	58							5	57			1	55	25	56				
22					6	63							5	65							9	62			2	63	18	63				
23													18	73							35	72			3	68	11	74				
24					6	79							22	84							30	80			1	90	16	83				
25					1	85							13	90							18	86					2	95				
26					1	80							3	100							1	90					2	105				
27													3	105																		
28	2	180		1									2	125																		
29	9	232						1					2	118																		
30	19	246						1	230							1	305	8	273													
31	15	261						1	270				1	155					13	297												
32	3	283		2					2	303										4	323											
33				1					2	330										3	352											
34				2					1	310	1	345								1	370											
35	2	355		2					2	413	3	348																				
36				1					1	450	2	388			1	400					1	260	1	530								
37									1	450	1	425																				
38																																
39																																
40																																
41																																
42																																
43																																
44																																
45																																
46																																
Sum	50		9		100		2		11		7		100		1		1		29		100		1		8		100					
Mean W.		252		322		53		213		345		370		75		400		305		302		77		530		64				63		
Mean L.	31.1		33.7		20.8		30.3		34.2		36.2		23.5		36.5		30.5		31.9		24.1		36.0		22.8				22.2			

Table 1 (cont.)

Date	970724		970724		970724		970725		970725		970725		970725		970725		970726		970726		970726		9707XX		970726		970726				
St. no.	412		413		414		415		415		416		418		419		420		421		422		423		423		424				
Species	BLUE WH		MACK		BLUE WH		MACK		H MACK		BLUE WH		BLUE WH		MACK		H MACK		BLUE WH		MACK		MACK		H MACK		HERRING				
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)			
15																															
16																															
17																															
18	2	45																		1	50										
19	13	42			2	40					8	38	6	38						17	47										
20	15	47			10	50					10	45	28	46						34	53										
21	28	50			9	52					18	50	32	54						32	57										
22	10	62			9	64					12	58	16	59						9	61										
23	15	68			26	75					20	67	9	67						4	69										
24	7	77			26	80					14	75	6	78						2	83										
25	8	89			10	91					11	85	3	78						1	75										
26	2	100			5	102					7	102																			
27																															
28					2	118																				1	185				
29					1	135																		1	210	4	225				
30			1	240																				8	226	5	248				
31			3	285																			1	200	35	248	8	261	1	180	
32																							1	230	29	264	10	282			
33							1	340							1		4	313						16	280	14	301	1	300		
34																	7	326						7	329	15	316	1	330		
35			1	355											1		12	340						3	312	23	326				
36			2	385											1		9	372									12	342	1	385	
37							2	435									4	375						1	380	4	376				
38							3	427									4	421									1	395			
39			2	468													1	470									2	423			
40																	1	550					1	410							
41																	1	530					2	525							
42							1	550																							
43																															
44							1	650																							
45																															
46																															
Sum	100		9		100		8		2		100		100		3		43		100		5		100		99		4				
Mean W.		58		351		74		461			64		55				365		55		378		264		308		299				
Mean L.	22.0		35.0		23.6		39.1		37.5		23.0		21.7		34.2		35.4		21.1		36.8		31.6		33.4		33.0				

Table 1 (cont.)

Date	970726		970726		970726		970727		970727		970727		970729		970729		970729		970729		970729		970729		970729			
St. no.	424		424		425		426		426		426		427		427		428		428		429		429		429		429	
Species	MACK		H MACK		BLUE WH		HERRING		MACK		H MACK		BLUE WH		BLUE WH		MACK		H MACK		HERRING		BLUE WH		MACK		H MACK	
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)
15																												
16													1	20														
17																							1	30				
18													5	30									17	34				
19													20	35									32	39				
20					4	38							21	41									32	44				
21					8	47							21	48									12	50				
22					20	55							13	54									4	61				
23					33	64							10	67									1	72				
24					15	71							2	80									1	69				
25			2	163	4	80					1	150	2	83														
26			16	178	1	95					5	174																
27			25	191							8	198			1	117											1	185
28	1	225	15	207						20	221			1	137							1	218				1	200
29	10	226	17	242			1		8	238	8	246		1	151							2	232			3	252	
30	17	249	12	254	1	120	5		23	257	11	260														8	273	
31	33	259	3	270			2		23	280	9	280										1	307			19	288	
32	16	303	4	295			1		23	296	13	302										2	295			15	315	
33	6	303	2	308			1		5	315	9	321	1	72												9	348	
34	6	334	3	337					3	340	9	347														17	395	
35	5	364	1	360					1	415	6	358			1	357										8	447	
36	4	381													1	220										10	480	
37										1	360						1	432				3	438			6	498	
38	1	425													2	329						3	466					
39	1	470													2	325	1	639				2	442			1	562	
40																						2	474			2	668	
41																												
42																												
43																												
44																											1	766
45																												
46																											1	514
Sum	100		100		86		10		86		100		96		9		2		11		6		100		100		100	43
Mean W.		282		222		62		297		280		268		47		254		536		453		263		43		375		349
Mean L.	32.4		29.1		23.3		31.1		31.8		31.1		21.3		34.8		38.8		38.4		30.8		20.1		34.2		34.8	

Table 1 (cont.)

Date	970730		970730		970730		970730		970730		970730		970730		970731		970731		970731		970731		970731		970802						
St. no.	431		432		432		433		433		433		434		434		435		435		436		436		436		437				
Species	BLUE WH		HERRING		MACK		HERRING		MACK		H MACK		BLUE WH		H MACK		MACK		H MACK		HERRING		MACK		H MACK		MACK				
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)			
15																															
16																															
17																															
18	2	34										2	35																		
19	20	40										9	38																		
20	14	44										9	46																		
21	7	52										8	53																		
22	10	60										3	55																		
23	17	70										10	74																		
24	16	78										14	77																		
25	7	88										6	89																		
26	4	100										2	95																		
27	1	112																													
28												1	115																		
29	1	130	1		2	243						2	123																		
30	1	171			1	250	1	205																			1	207			
31																											1	275			
32							1	290	2	298						2	345			1	350						4	278			
33					2	359			1	295						3	402					1	365	1	315	6	335				
34									1	360	1	330				1	405	1	360						1	375	5	379			
35					1	393			1	405	2	353			1		3	448	3	390						2	434				
36									1	380						1	465										2	478			
37											1	365							2	475							2	520			
38																															
39											1	470												1	455		1	601			
40										1	565													1	660			1	600		
41										1	660																				
42																															
43																									1	715					
44										1	710																				
45																															
46																															
Sum	100		1		6		2		9		5		66		1		10		6		1		4		2		30				
Mean W.		63				308		248		441		374		65			411		413		350		549		2		345		369		
Mean L.	22.5		29.5		32.3		31.5		37.1		36.8		22.8		35.5		34.5		36.3		32.3		38.8		34.3		34.2				

Table 1 (cont.)

Date	970802		970802		970802		970802		970802		970802		970803		970803		970803		970803		970803		970803		970804				
St. no.	437		439		440		441		442		442		442		443		444		445		446		447		448		450		
Species	H MACK		MACK		BLUE WH		MACK		HERRING		MACK		H MACK		BLUE WH		H MACK		H MACK		BLUE WH		HERRING		MACK		BLUE WH		
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	
15																													
16																													
17																													
18																						2	42						
19					1	40							1	46							23	48							
20					4	46							1	47							32	55					1	56	
21					4	51															26	59					1	58	
22					6	57							1	59							6	69					3	67	
23					25	66							10	70							3	74					10	81	
24					19	76							11	81							2	91					5	90	
25					12	83							4	87													4	96	
26					5	86							1	101							2	99							
27					2	109							4	105							1	104							
28					1	105							1	222	2	122											2	121	
29					1	139						1	220	1	293														
30					2	254	3	166					1	291	1	137					3	146					1	169	
31					3	261	5	170			1		5	287						1	289			1	195			3	162
32	1	307	3	296	2	200	4	302					5	329													1	170	
33			4	339	1	199	2	334					7	351	3	342		1	340	1	336						4	198	
34	4	370	1	325	3	233	3	381					4	356	2	364											2	194	
35	3	398	1	445	2	236	3	425					1	371	1	395		2	360	3	379				2	449	1	231	
36					2	262								1	420		1	420	1	410					2	483			
37	3	423	1	511			1	410			2	458						1	420	1	384				2	494	1	372	
38	1	535			1	372												1	420						3	529			
39					1	338																							
40																													
41																													
42																											1	684	
43																													
44																													
45																													
46																													
Sum	12		15		100		13		1		25		10		36		5		7		100		1		10		39		
Mean W.		398		321		101		362			339		337		83		380		365		60		195		512		123		
Mean L.	35.9		33.2		26.0		34.4		31.3		33.5		33.3		24.8		35.9		35.3		21.3		31.3		38.0		27.2		

Table 1 (cont.)

Date	970804		970805		970805		970805		970806		970806		970806		970806		970806		970807		970807		970807		970808		970808			
St. no.	451		453		456		458		459		459		460		461		464		467		468		469		471		471			
Species	MACK		BLUE WH		BLUE WH		BLUE WH		HERRING		MACK		MACK		BLUE WH		BLUE WH		BLUE WH		HERRING		HERRING		HERRING		BLUE WH			
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)		
15																														
16																														
17																														
18			1	39	4	44	1	32																			1	25		
19			1	45	39	49	2	47																			3	38		
20			1	52	42	54	2	48						7	38	1	35										7	44		
21			2	64	15	59	3	58						11	44					4	43						11	49		
22			4	71			8	65						9	50	7	50			4	48						8	58		
23			6	83			12	71						12	58	11	58	10	57								16	69		
24			2	95			21	84						21	67	2	63	19	66								18	82		
25			1	93			12	89						24	76	4	77	29	77								12	81		
26			1	115			1	92						12	84			19	86								10	99		
27							2	113						3	89			7	102								5	107		
28			1	124			2	111						1	105			3	99								4	125		
29																				1	96									
30																				3	129					1	160			
31									1	265																	3	250	1	135
32														1	315					1	152	1	300			10	280			
33														1	285												11	292	1	198
34									1	405																	15	321		
35																											11	354		
36											1	480															7	394		
37											2	495	1	460													11	406		
38	1										1	485															4	450		
39																											5	485		
40																														
41																														
42																														
43																														
44																														
45																														
46																														
Sum	1		20		100		66		2		5		3		100		29		100		1									
Mean W.				78		52		78		335		495		353		65		53		77		300		160		77		100		
Mean L.	38.0		23.2		20.2		24.0		32.5		37.3		34.4		23.2		21.8		24.5		31.3		29.3		34.3		23.4			

Table 1 (cont.)

Date	970808		970810		970810		970811		970811		970811		970812		970812		970812		970812		970813		970814		970814		970815		
St. no.	472		474		475		478		479		480		481		483		484		486		490		497		497		500		
Species	HERRING		HERRING		BLUE WH		HERRING		BLUE WH		HERRING		HERRING		HERRING		BLUE WH		HERRING		HERRING		HERRING		BLUE WH		BLUE WH		
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	
15																													
16																													
17					3	26			1	32																			
18					8	31			4	37																			
19					19	36			14	43																			
20					15	40			14	47																			
21					14	47			4	53																			
22					19	55			7	60																			
23					10	65			9	71						2	83												
24					9	75			21	76						2	86												
25					3	85			13	90						4	109												
26			1	149					6	97						1	114												
27			1	187			1	156	2	110			3	186			1	126											
28			4	203					1	131			10	196															
29			4	217					1	162			24	223					4	219			1	222					
30			1	233			4	195					43	248					9	254									
31			2	244					1	151			12	265	1	190	2	160	20	272			9	270	1	209			
32	1	235	1	232			3	248	1	178	1	230	6	290					14	296	1	249	20	278			2	207	
33			1	280			2	272			1	290	1	323					9	315			20	296			2	216	
34			1	304															3	322			16	316			3	241	
35	1	266							1	280									3	382			8	343			4	246	
36													1	412					1	535			5	340	2	307.5	2	242	
37	1	455																	2	397			1	363	1	354	2	299	
38																													
39																													
40																													
41																													
42																													
43																													
44																													
45																													
46																													
Sum	3		16		100		10		100		2		100		1		12		65		1		80		4		19		
Mean W.		319		222		49		222		72		260		242		190		111		293		249		300		294.5		265.1	
Mean L.	34.9		30.1		21.4		31.4		23.2		33.3		30.3		31.3		26.4		32.3		32.0		33.7		35.6		35.7		

Table 1 (cont.)

Date	970815		970815		970815		970815		970815		970816		970816		970816		970816		970816		970817				
St. no.	500		502		503		503		504		505		506		507		507		508		509		510		
Species	HERRING		HERING		HERRING		BLUE WH		HERRING		HERRING		HERRING		BLUE WH		HERRING		HERRING		BLUE WH		HERRING		
cm	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	n	w (g)	
15																									
16																									
17																									
18																									
19															6	36									
20															28	45					2	46			
21															40	51									
22															14	55					2	53			
23															5	59					1	58			
24															5	75					4	65			
25							3	99				1	112			2	82				9	79			
26							10	107				2	139						1	143	5	84			
27							4	121	1	138		3	139								4	97			
28							4	130				7	174	1	169			1	195	8	175	2	105		
29							3	149	1	194	15	191							6	192	1	106			
30							4	166	4	204	11	223	7	210					21	216	3	97			
31							1	215	5	216	20	242	16	231				1	260	34	243	1	131		
32							2	188	18	246	21	261	35	253				2	275	21	260	1	133		
33	1	280			1	290	4	211	7	271	10	277	23	272					8	290	5	178	3	268	
34	4	317					2	257	6	264	7	285	11	279							1	196	1	250	
35	3	335	1	290			4	264	5	282	1	303	3	319				2	310	1	271	1	217		
36	2	350					3	284					3	339											
37	1	392					4	302			1	325												1	383
38	4	395					2	305	1	355			1	268											
39	2	447					1	312			1	419												2	434
40																									
41																									
42																									
43																									
44																									
45																									
46																									
Sum	17		1				51		48		100		100		100		6		100		42			7	
Mean W.		360		290		290	185.5		248		235		258		50.8		6		271		235		100.3		329
Mean L.	35.5		34.8		32.8		30.3		31.9		30.4		31.9		20.6		31.7		30.3		26.6		34.5		

Table 2. Blue whiting acoustic assessement, G.O.Sars, Norwegian Sea, July/August 1997.

Antall i omr. : N x 10 Exp-6
Gj.vekt : Gram

Middel-lengde : Cm
Kondisjon : 1000 x Vekt/ Lengde Exp+3

Vekt i omr. : Tonn x 10 Exp-3
Dato : 20/ 8-1997
6 -2.18

Område : Alle

C : 1.490 * 10 * L

Lengde	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15+	Tot	Vekt	Gj.v
17.0-17.9	151															151	4.1	27.2
18.0-18.9	1377															1377	46.8	34.0
19.0-19.9	6714															6714	281.7	42.0
20.0-20.9	10174															10174	484.5	47.6
21.0-21.9	8635	943														9578	501.8	52.4
22.0-22.9	2922	3721														6643	392.9	59.1
23.0-23.9	254	8624														8878	618.7	69.7
24.0-24.9		7726	145													7871	618.5	78.6
25.0-25.9		3788	308													4096	360.0	87.9
26.0-26.9		685	611													1296	127.4	98.3
27.0-27.9		151	309	146												606	67.0	110.6
28.0-28.9			95	235	19											349	40.9	117.2
29.0-29.9			56	193	52	52										353	47.1	133.3
30.0-30.9				49	162	17										228	35.1	154.0
31.0-31.9				156	53	34	85									328	55.0	167.8
32.0-32.9					14	91	60	52	7							224	42.1	188.0
33.0-33.9						104	8	19								131	25.8	197.2
34.0-34.9						46	6	14	28	11						105	22.4	213.2
35.0-35.9						35	44	13	18							110	29.5	268.2
36.0-36.9						27	21	21	27	20						116	30.0	258.5
37.0-37.9							14	2	29	2						47	14.3	304.6
38.0-38.9						1	22	16	14	14						67	22.1	330.0
39.0-39.9										58	20					78	25.9	332.5
Antall:	30227	25638	1524	779	300	407	260	137	123	105	20	0	0	0	0	59520		
Gj.lgd:	20.68	23.98	26.55	29.29	30.47	32.97	33.86	34.51	36.13	38.23	39.50	.00	.00	.00	.00	22.66		
Vekt:	1456.6	1895.2	153.9	102.9	45.8	79.8	56.4	32.9	32.1	31.1	6.9	.0	.0	.0	.0	3893.7		
Gj.vkt:	48.2	73.9	101.0	132.1	152.5	196.2	217.1	240.4	260.7	296.6	347.0	.0	.0	.0	.0	65.4		
Kond.:	5.4	5.3	5.4	5.2	5.4	5.4	5.5	5.8	5.5	5.3	5.6	.0	.0	.0	.0	5.4		

Table 3. Whale observations on the «G.O.Sars» cruise in the Norwegian Sea from 20 July until 17 August 1997.

<u>Date</u>	<u>Position</u>	<u>Species</u>	<u>Number</u>	<u>Remarks</u>
July 22	N63°33'E28°36'	Killer Whale	2	Heading south
July 22	N63°34'E2°30'	Common Dolphin	15-20	Heading south-east
July 22	N64°12'E1°03'	Pilot Whale	15	Species uncertain
July 23	N63°10'E2°46'	White-beaked Dolphin	5	
July 24	N63°10'W5°00'	Minke Whale	1	
July 25	N61°09'W2°58'	Minke Whale	2	
July 25	N61°21'W2°31'	White beaked Dolphin	3	
August 6	N66°28'E10°20'	Sei Whale	1	Caught in surface trawl
August 9	N69°17'E11°33'	Humpback Whale	1	
August 10	N68°40'E13°19'	Killer Whale	2	
August 10	N69°02'E12°12'	Sperm Whale	2	
August 11	N69°41'E10°12'	Sperm Whale	1	
August 12	N71°19'E5°01'	Humpback Whale	2	
August 13	N72°25'E7°31'	Humpback Whale	3	
August 14	N72°26'E3°25'	Fin Whale	1	
August 14	N73°29'E3°23'	Minke Whale	1	Small
August 14	N73°50'E4°32'	Sei Whale	1	
August 14	N73°50'E4°40'	Minke Whale	2	
August 14	N73°50'E4°54'	Minke Whale	2	
August 14	N73°50'E8°19'	Minke Whale	1	
August 14	N73°50'E9°29'	Minke Whale	2	Species uncertain
August 14	N73°50'E9°24'	Minke Whale	2	
August 14	N73°50'E9°28'	White-beaked Dolphin	3	
August 14	N73°50'E10°2'	White-beaked Dolphin	7	
August 15	N73°50'E14°15'	White-beaked Dolphin	50	
August 15	N73°04'E12°48'	Fin Whale	2	
August 15	N73°04'E12°48'	Minke Whale	3	

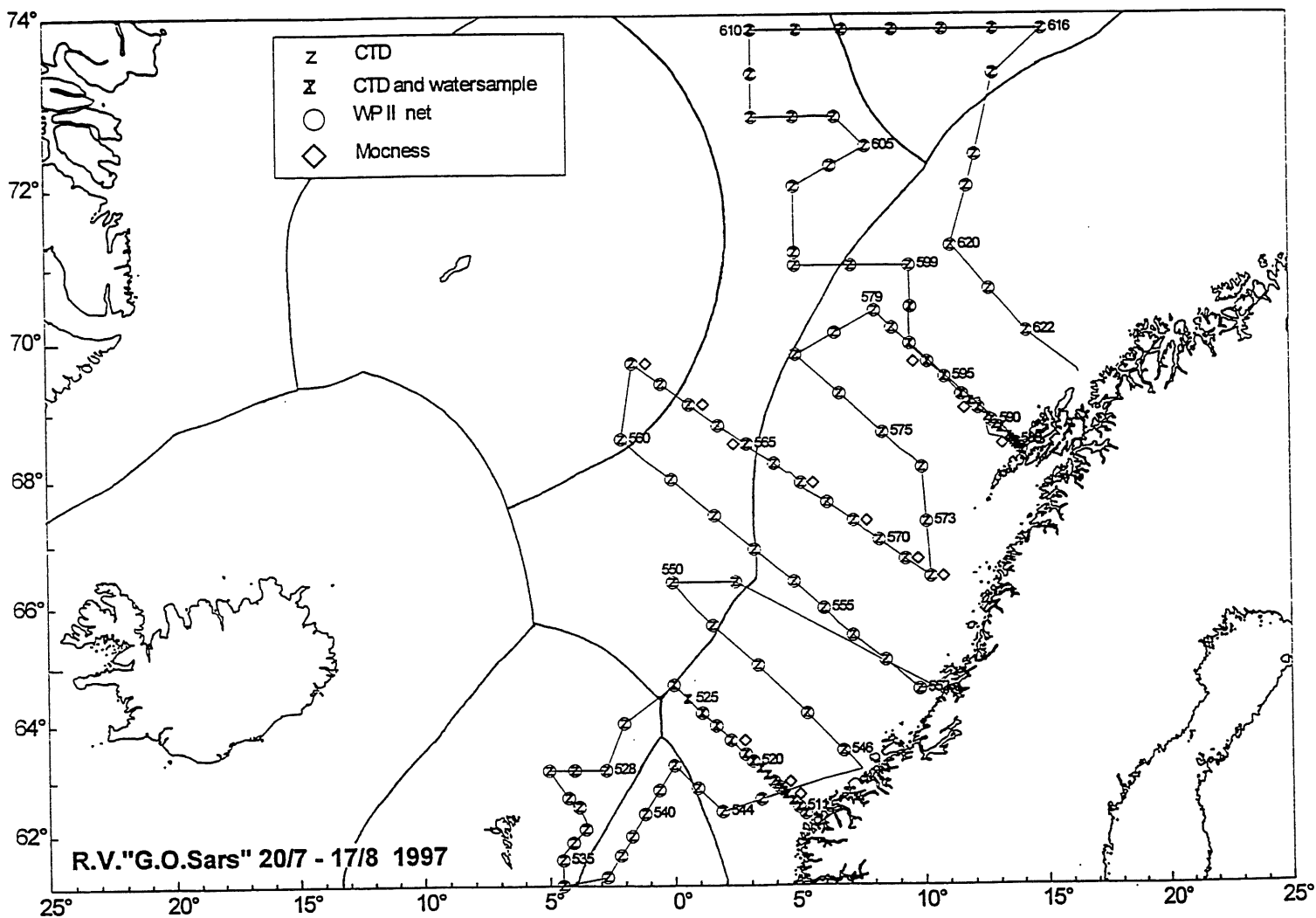


Figure 1. Cruise track with hydrography and plankton stations, R.V. "G.O.Sars" 20/7-17/8 1997.

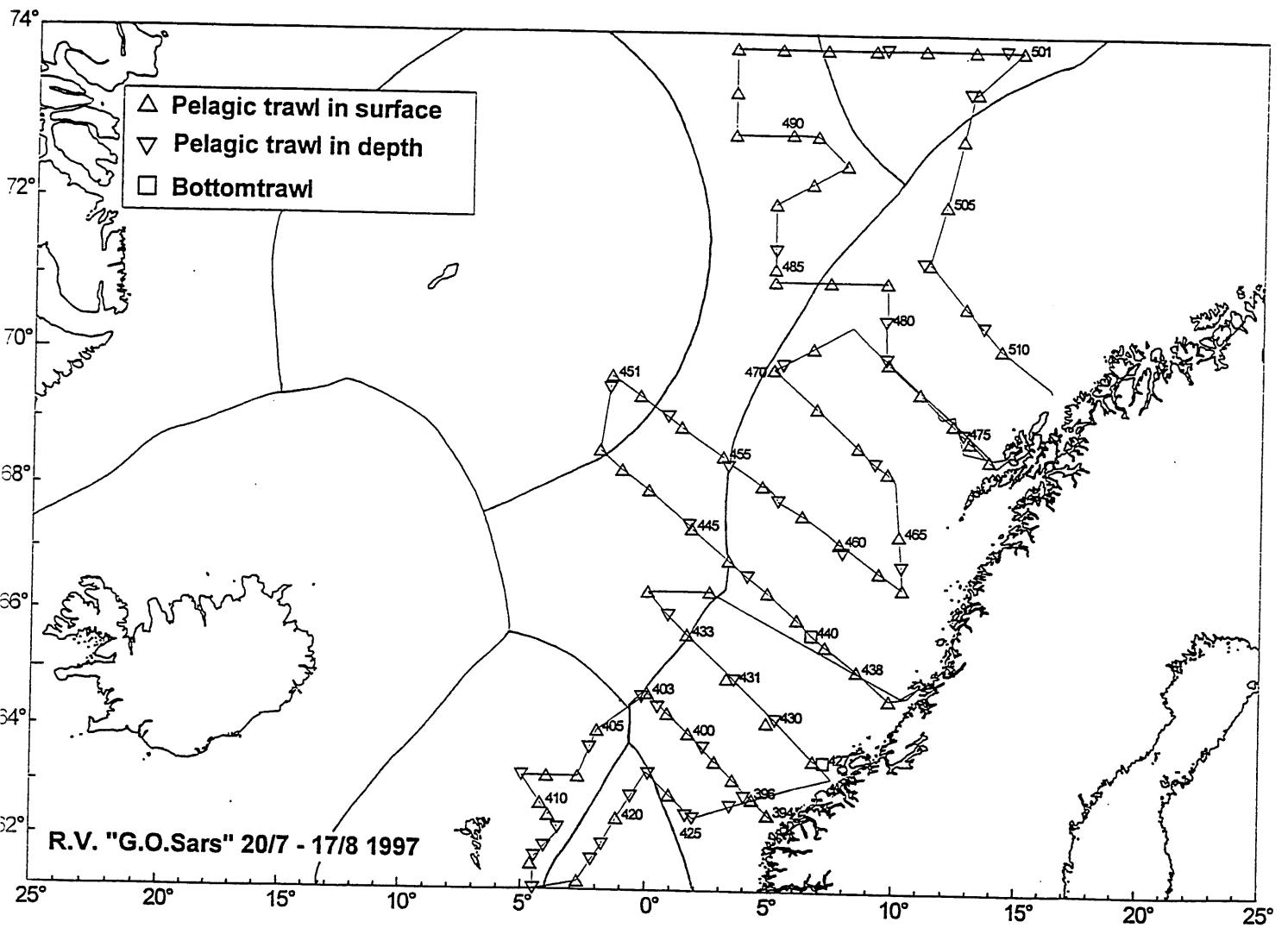


Figure 2. Cruise track with fishing stations, R.V. "G.O.Sars" 20/7-17/8 1997.

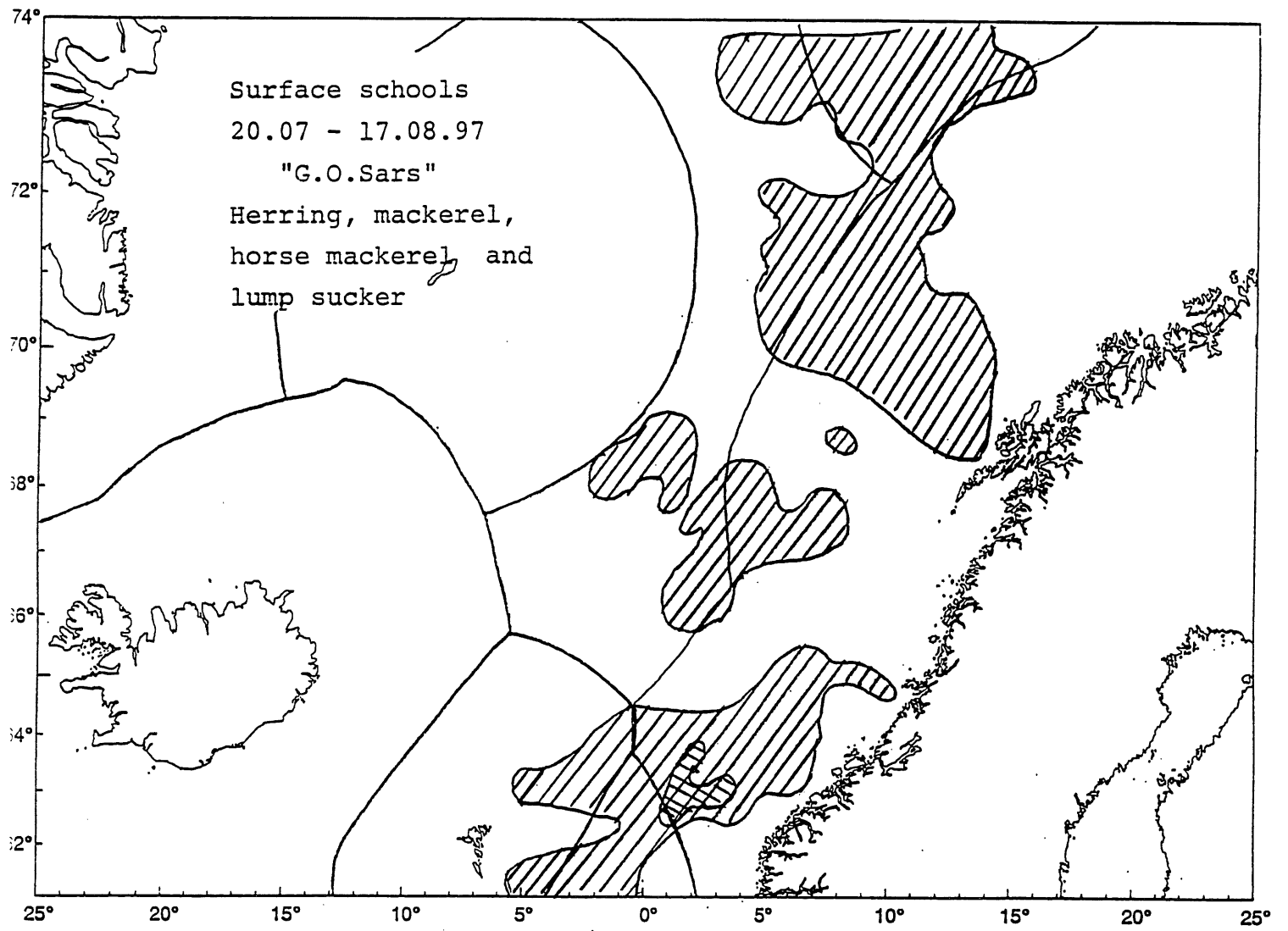


Figure 3. Sonar recordings of schools in the sea surface.

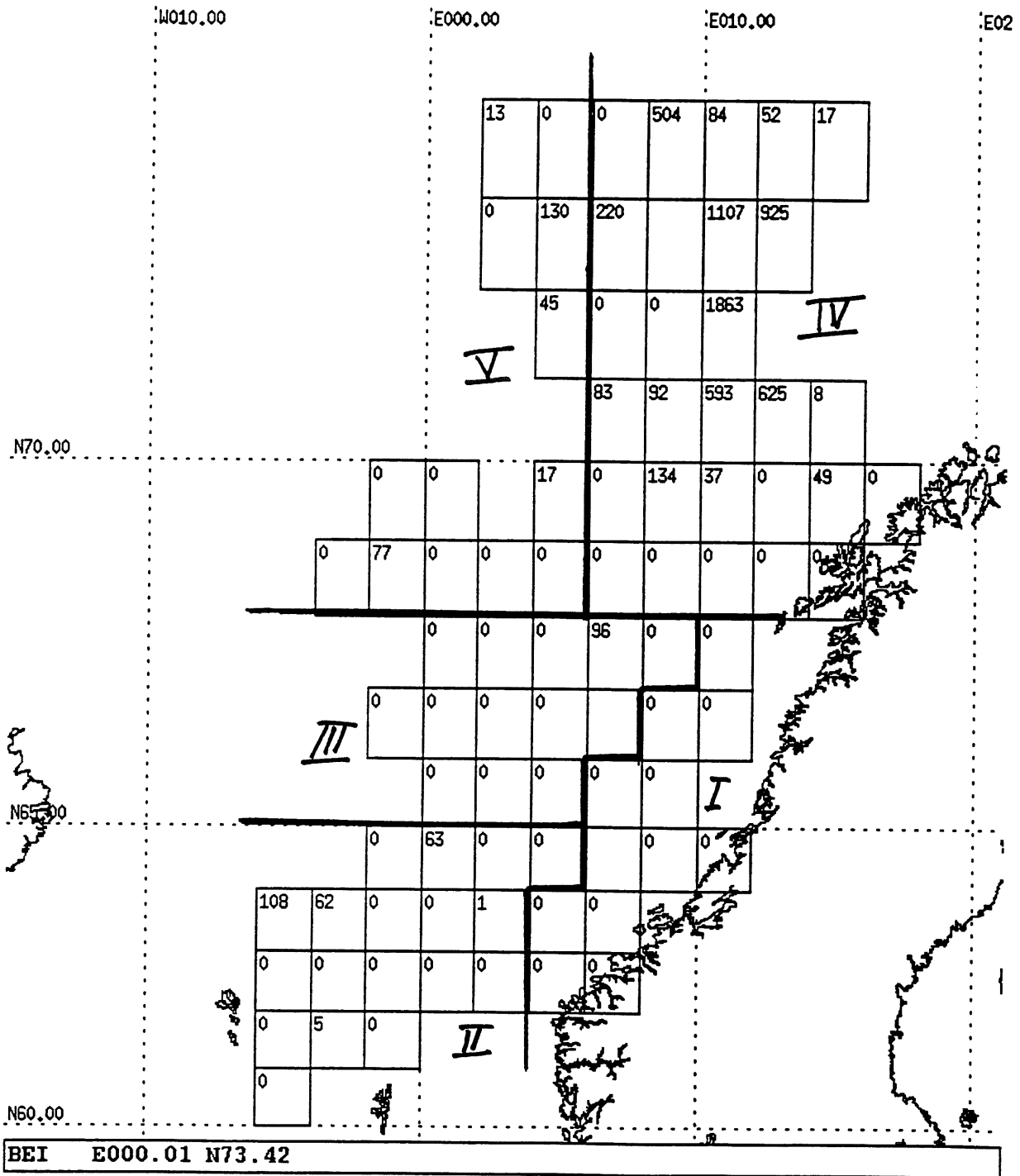


Figure 4. Herring distribution; BEI-map of S_A -values. July-August 1997, I-IV are subareas for presentation of the length and age distributons.

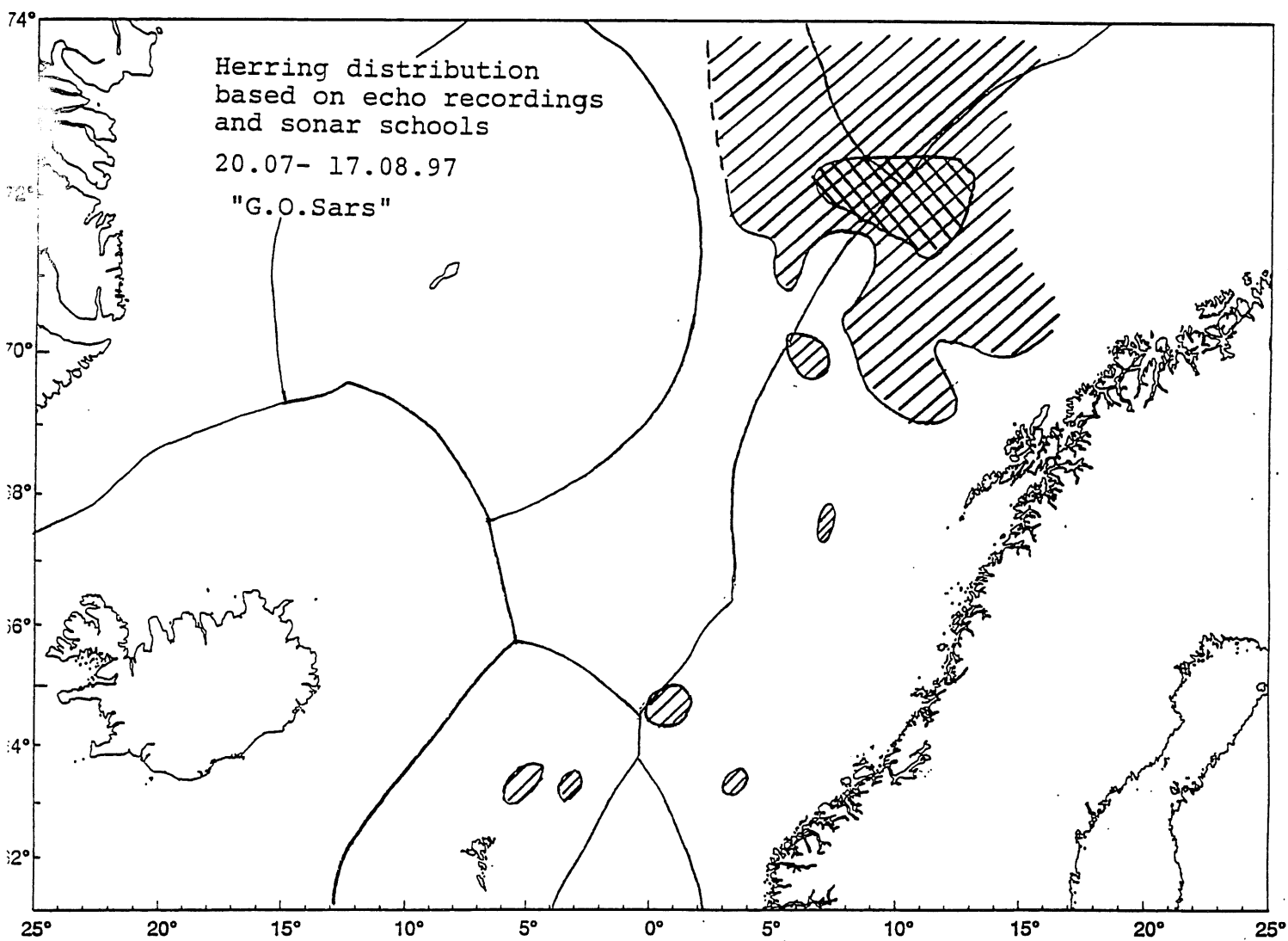


Figure 5. Herring distribution; combined recordings of schools and S_A -values, July-August 1997

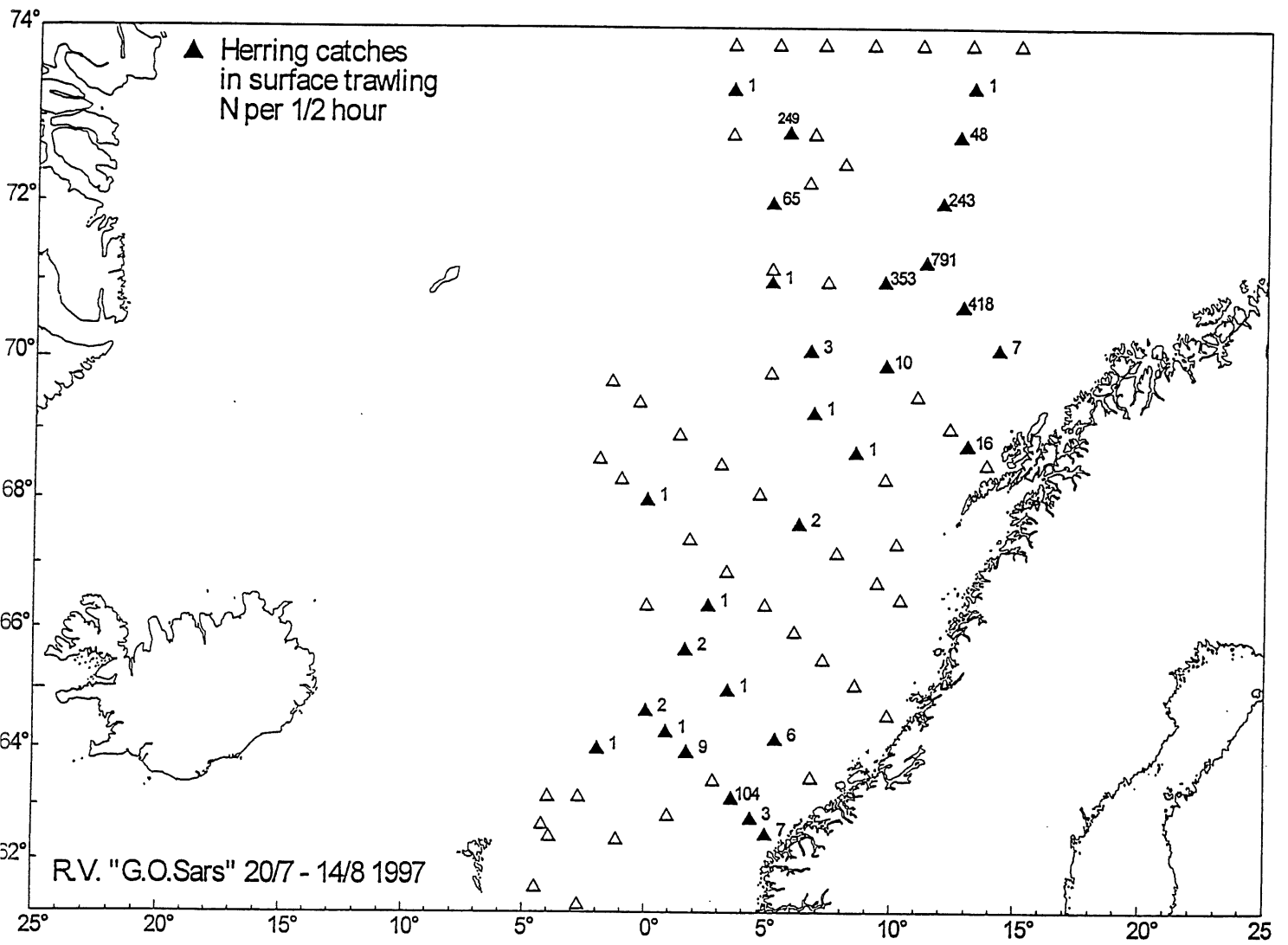
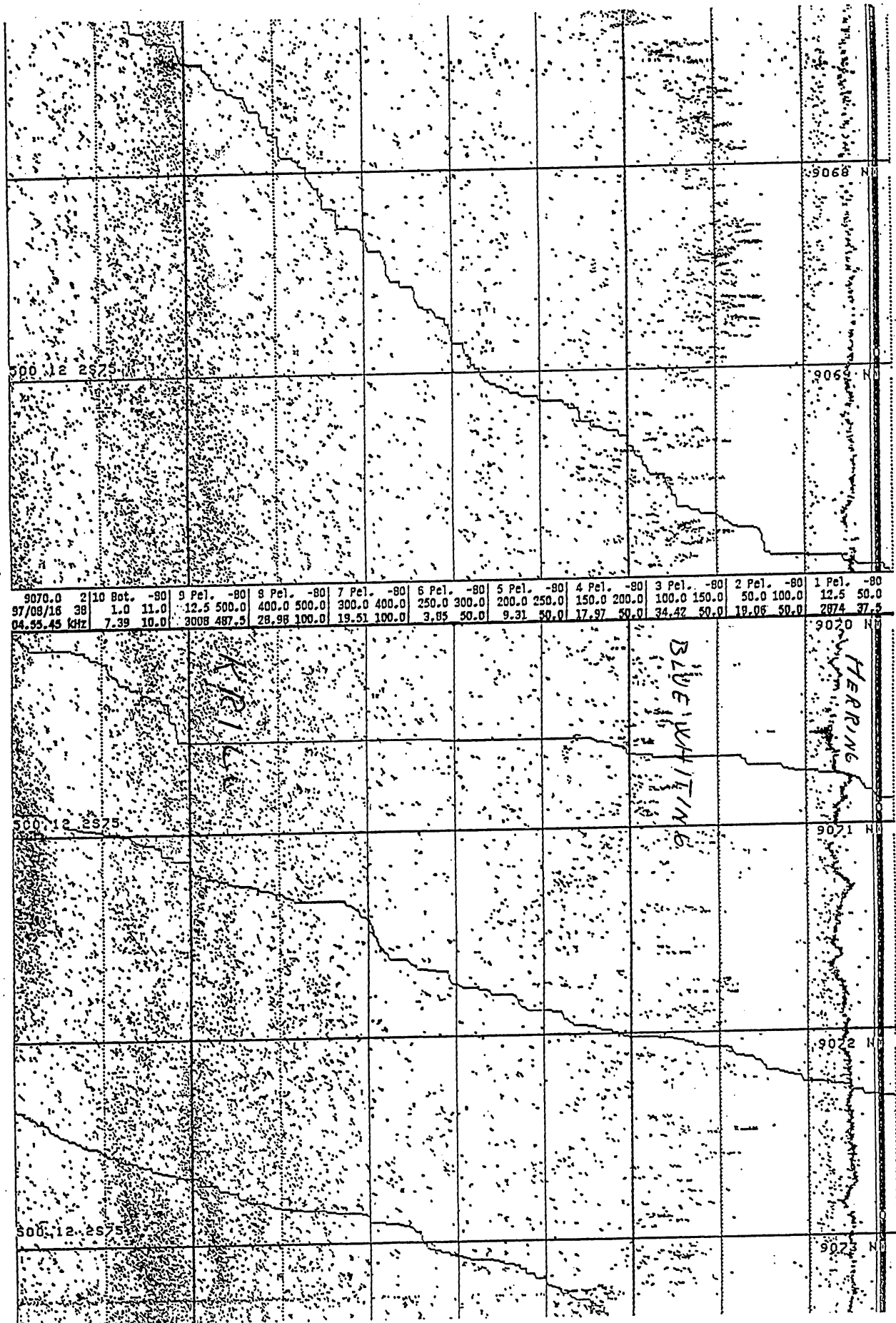


Figure 6. Catch of herring in the sea surface, July-August 1997.

Figure 7. Echo recordings of herring in upper layer, blue whiting in the middle and plankton (krill) in depth, by R.V. "G.O. Sars" at Pos. 71°10'N 11°30'E, 16 August 1997.



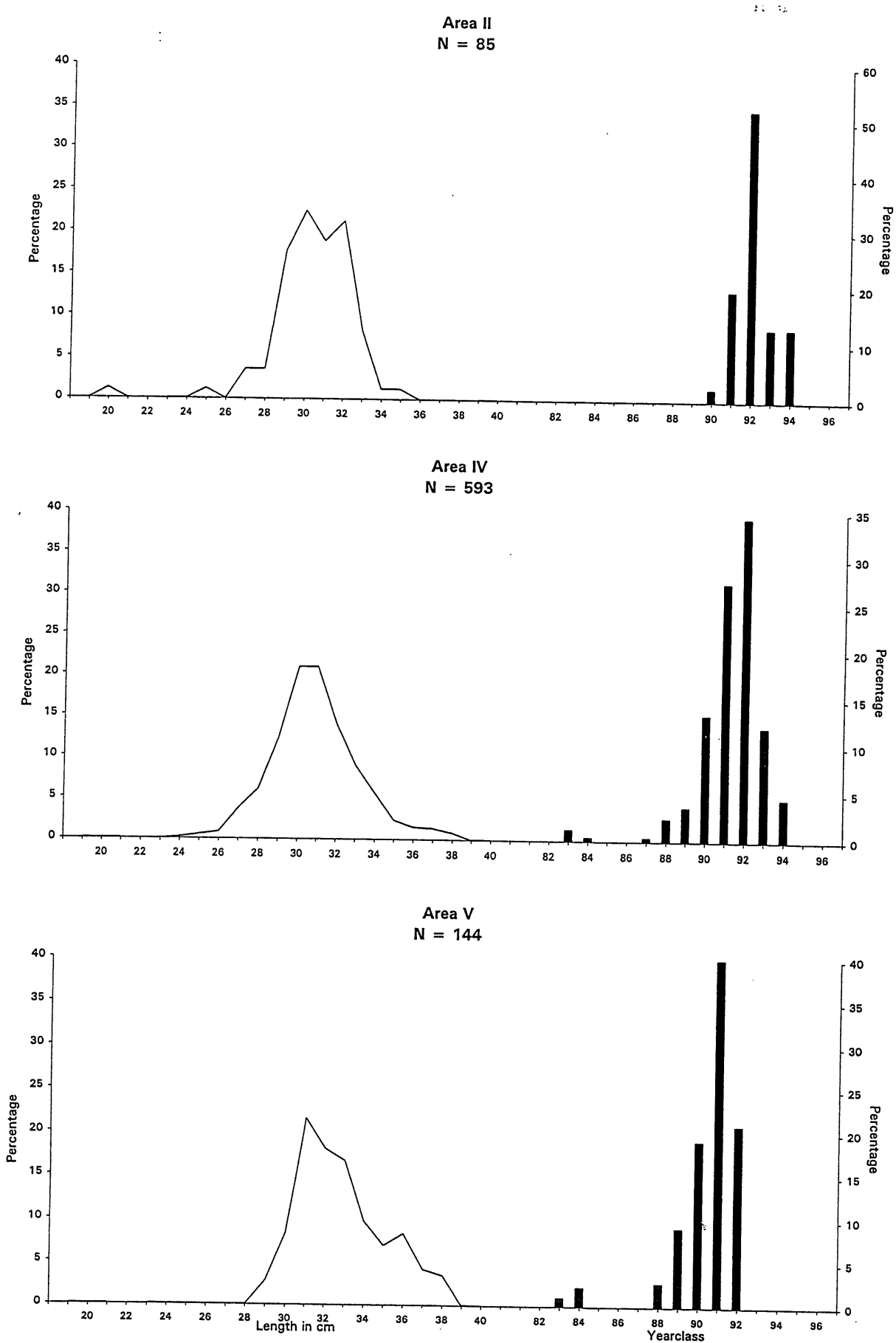


Figure 8. Length and age distribution of herring in subareas II, IV and V marked on Figure 4.

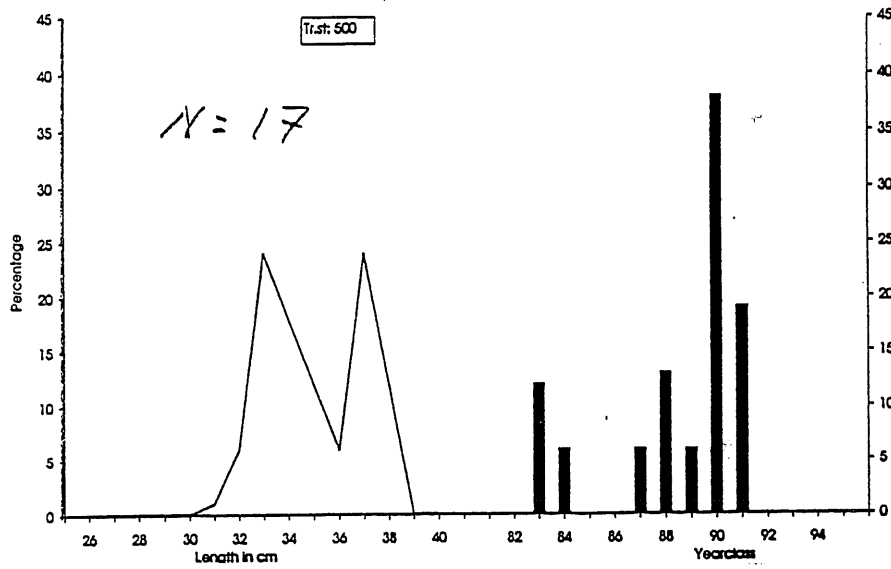
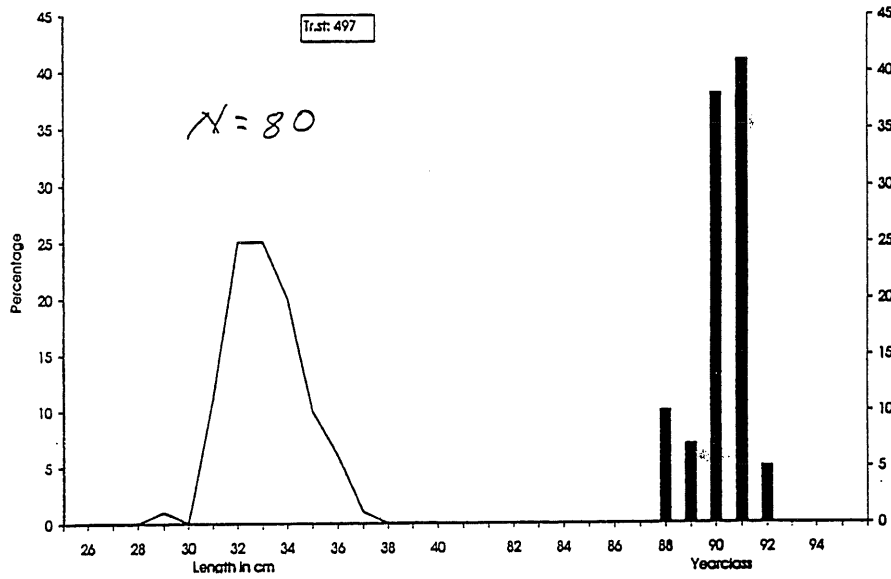
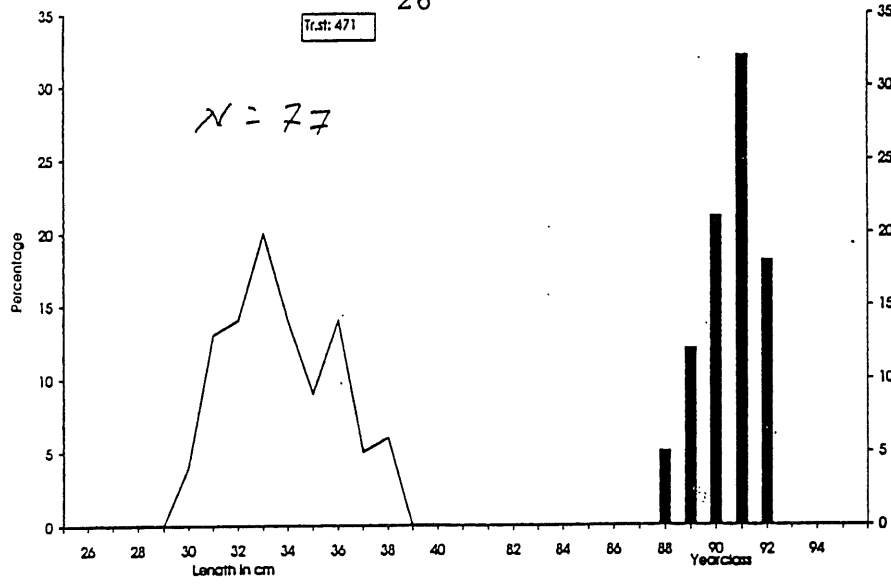


Figure 9. Length and age distribution of herring from 3 trawl stations at 400-500m depth north of 69°N, August 1997.

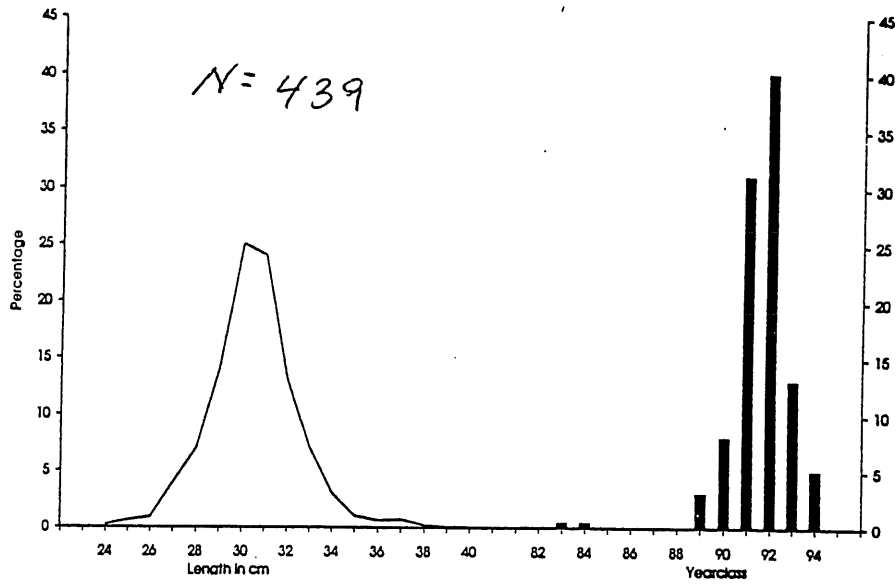


Figure 10. Length and age distribution of herring from 8 trawl stations in the sea surface north of 69°N, August 1997.

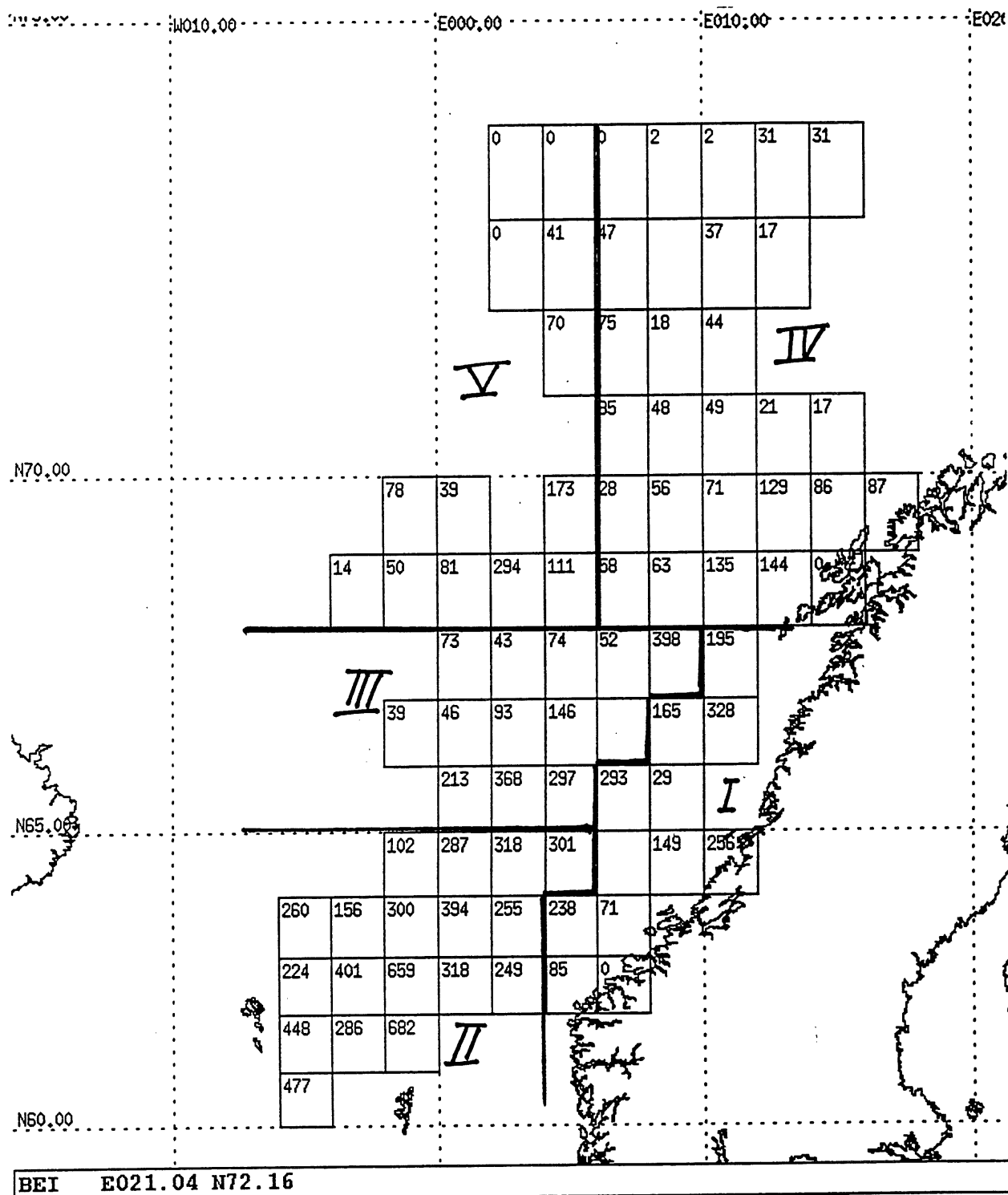


Figure 11. Blue whiting distribution ; BEI-map of S_A -values. July-August 1997, I-IV are subareas for presentation of the length and age distributons.

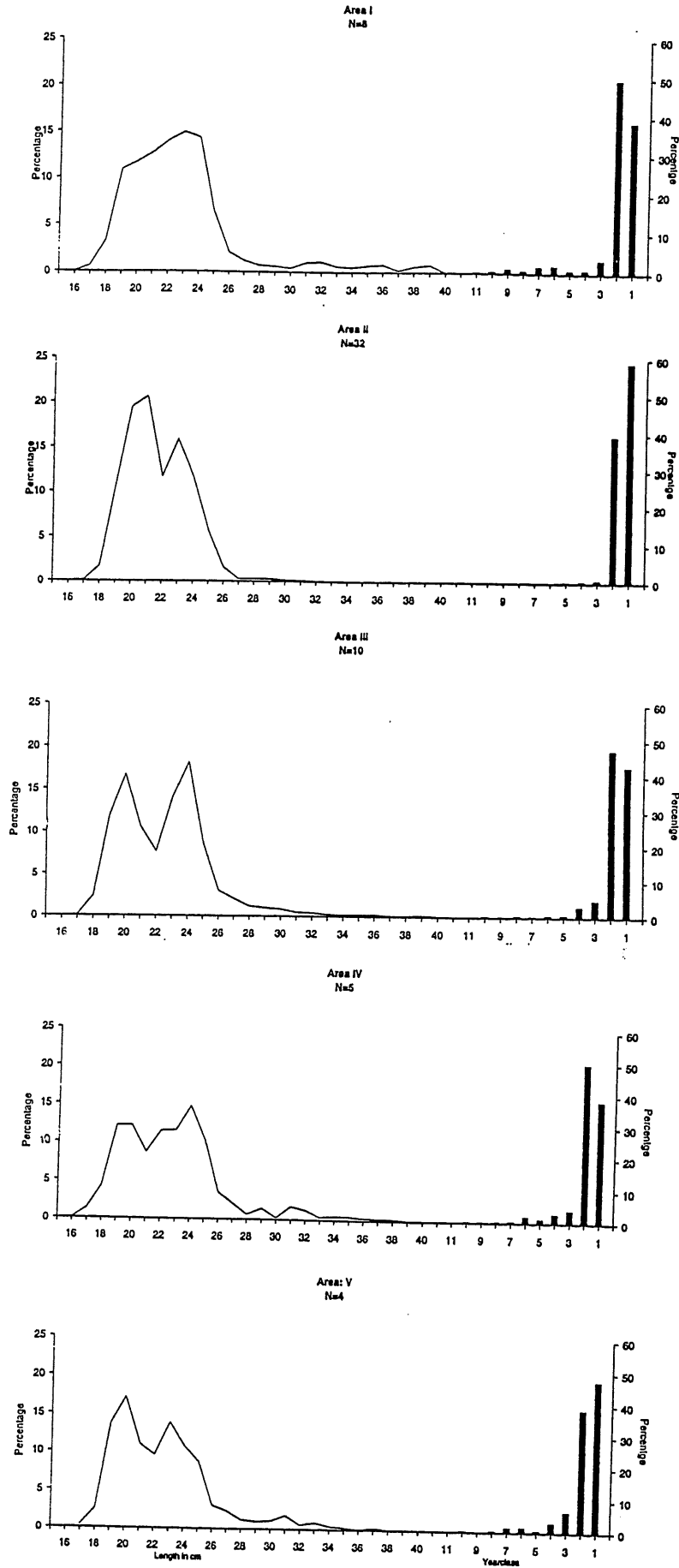


Figure 12. Length and age distribution of blue whiting in the 5 subareas marked on Figure 11, July-August 1997. $N = 10^9$, weighted by abundance.

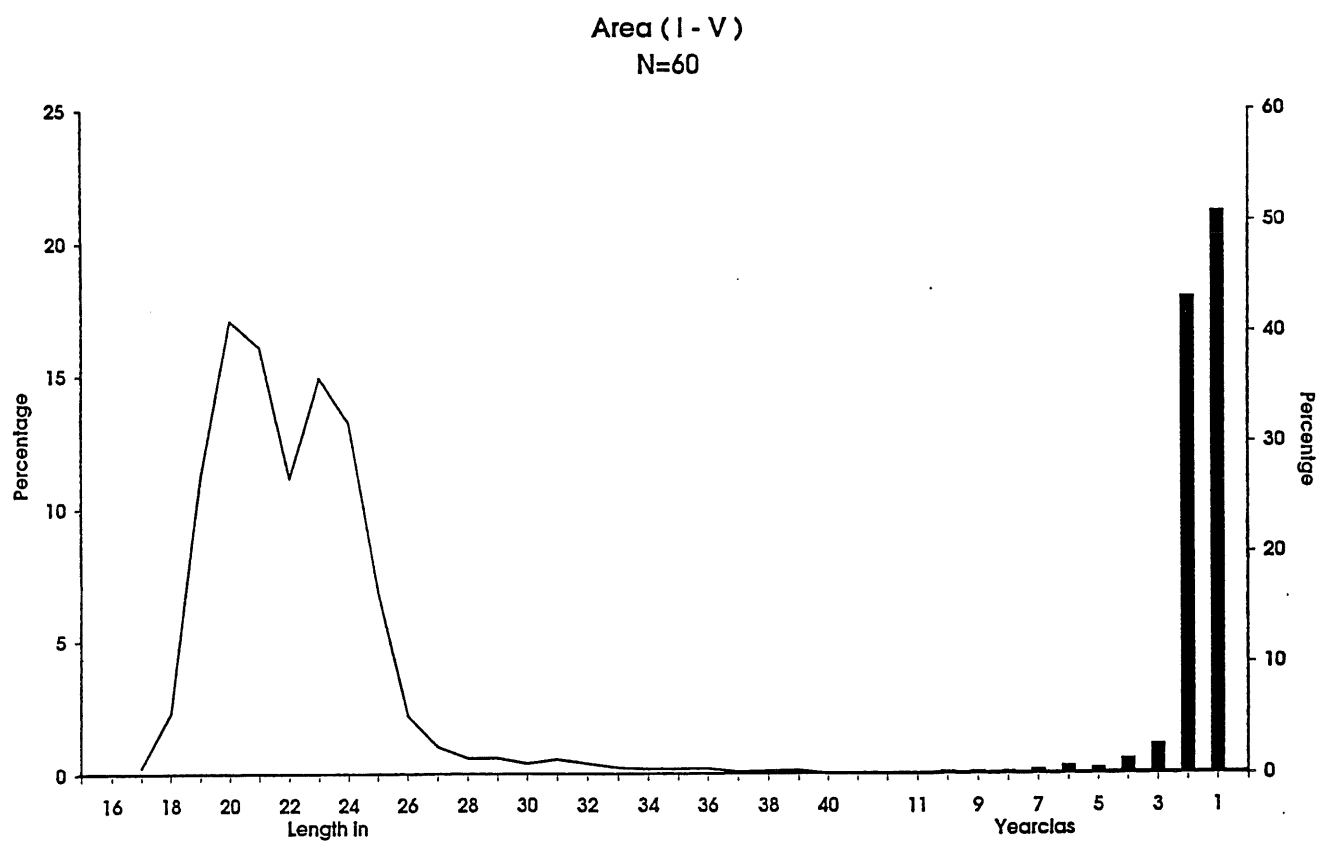


Figure 13. Total length and age distribution of blue whiting, July-August 1997. N = 10^9 , weighted by abundance.

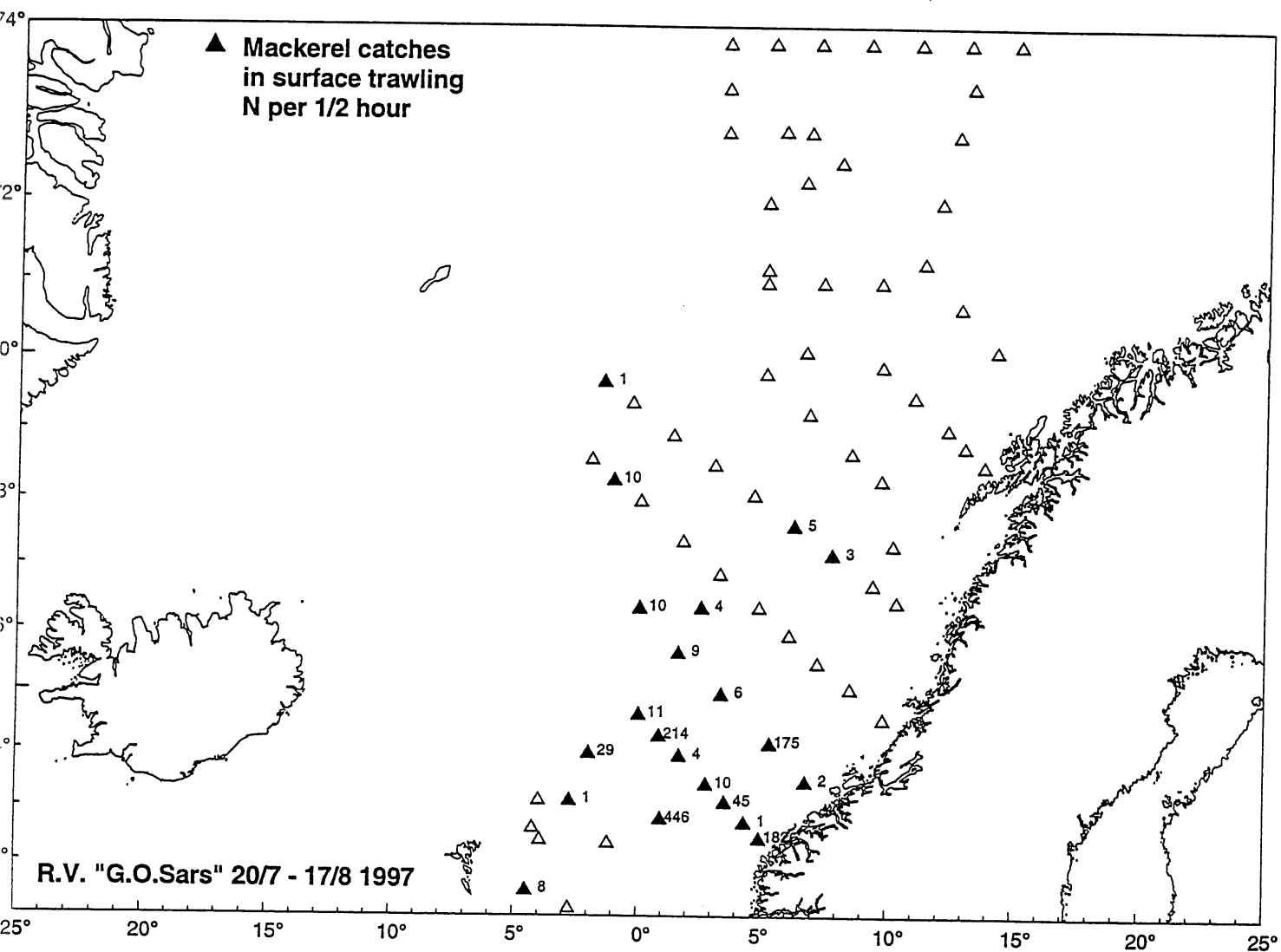


Figure 14. Catch of mackerel in the sea surface, July-August 1997.

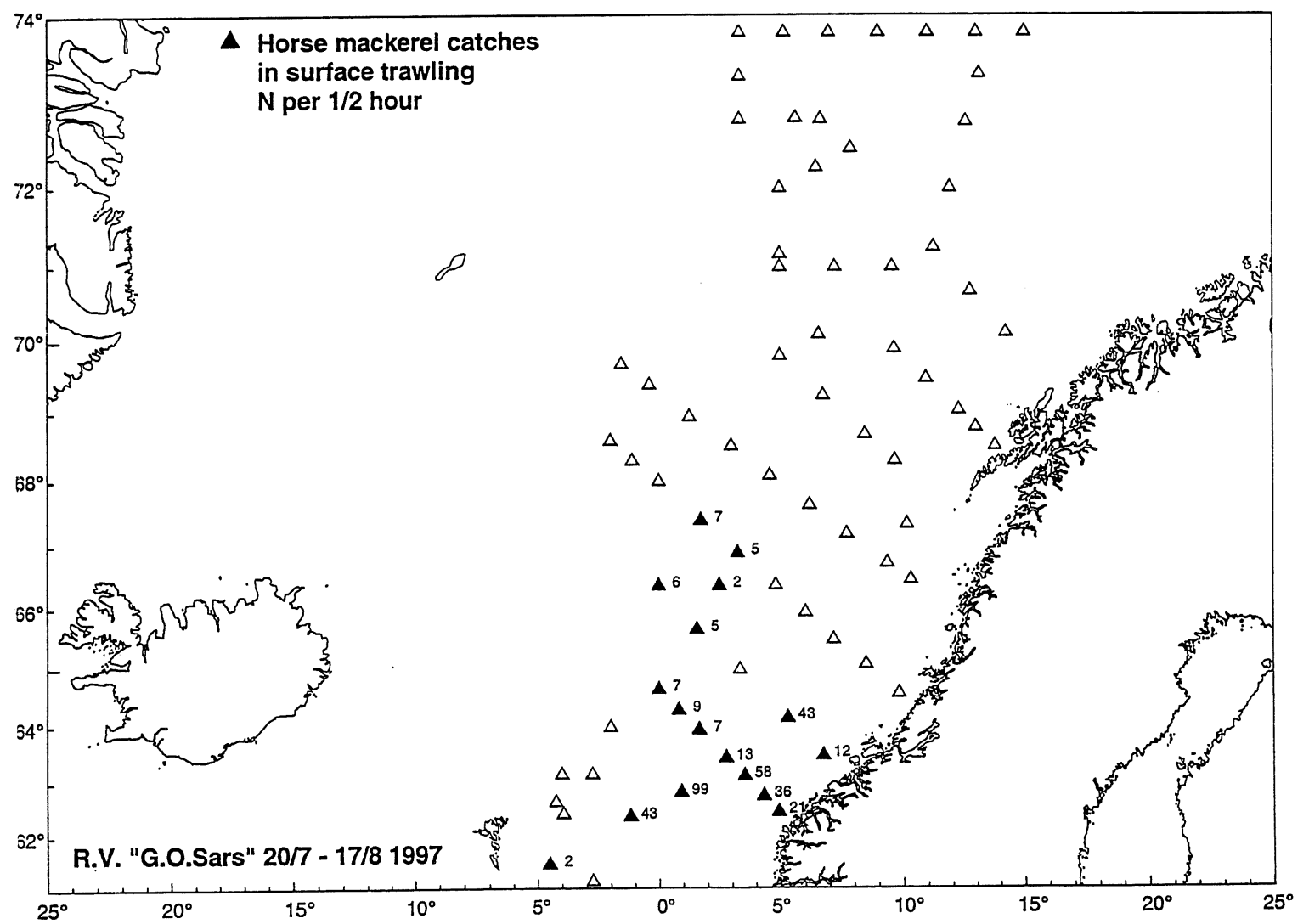


Figure 15. Catch of horse mackerel in the sea surface, July-August 1997.

Mackerel

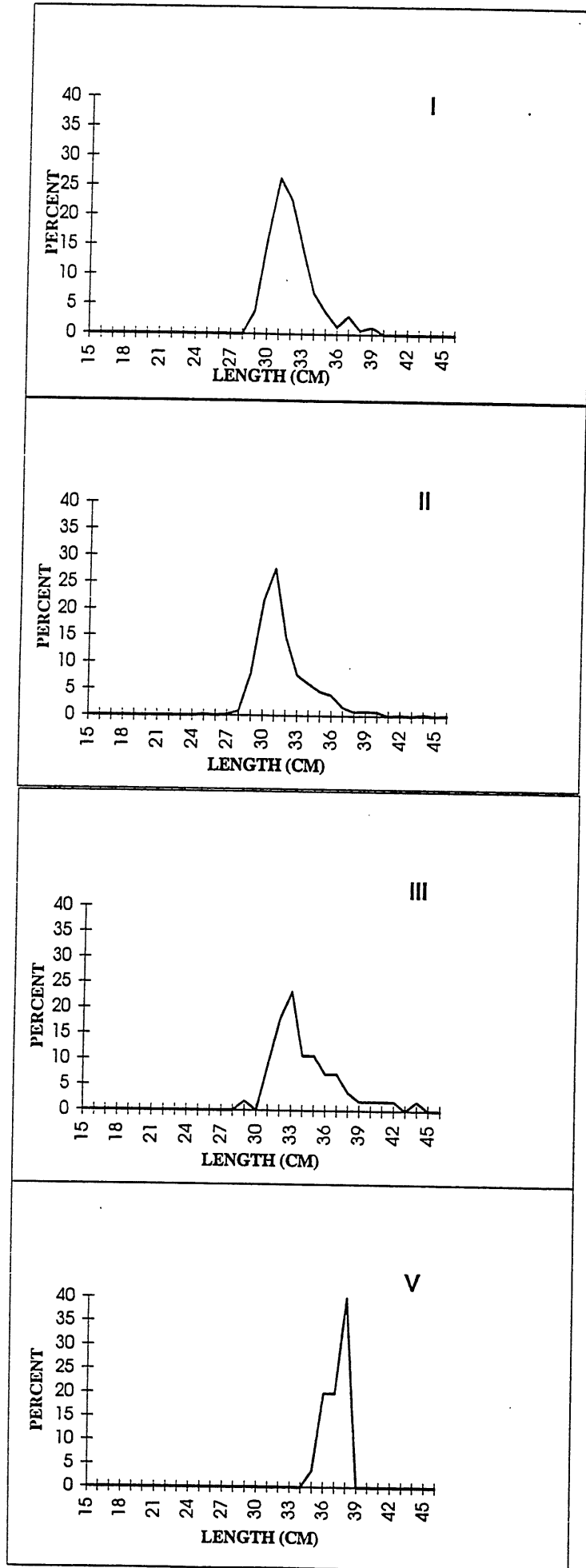


Figure 16. Length distribution of mackerel in 4 subareas marked on Figure 11.

HORSE MACKEREL

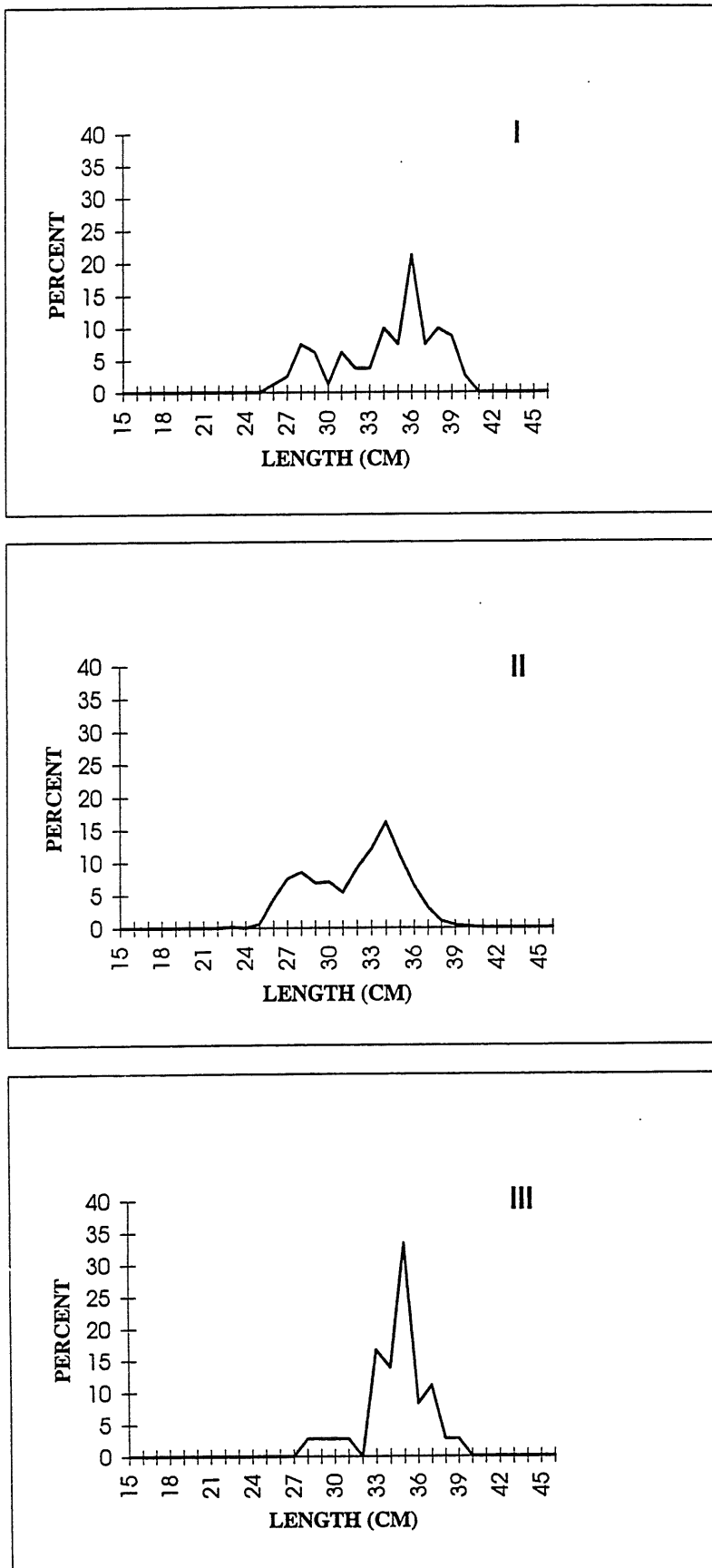


Figure 17. Length distribution of horse mackerel in 3 subareas marked on Figure 11.

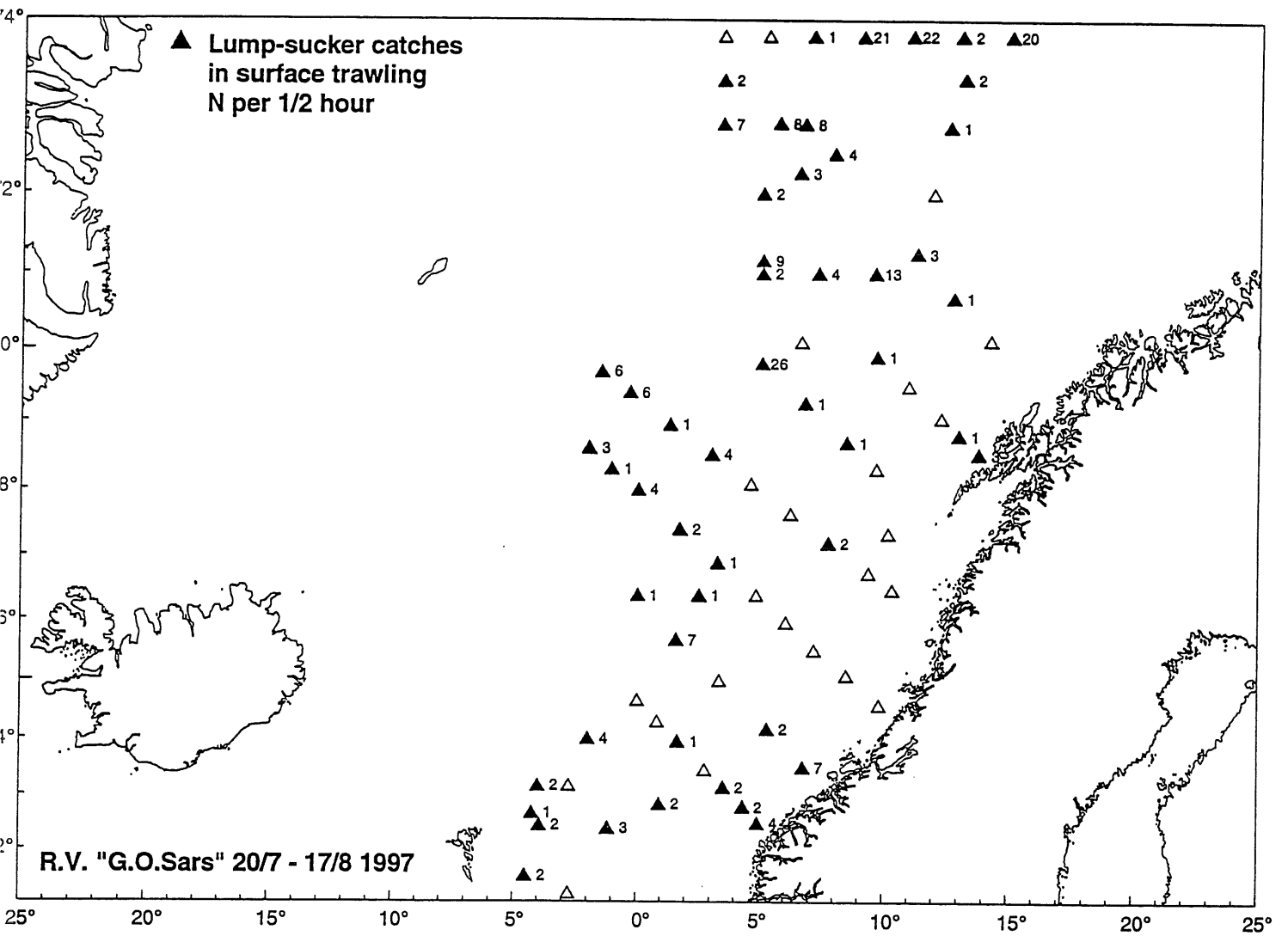


Figure 18. Catch of lumpsucker in the sea surface, July-August 1997.

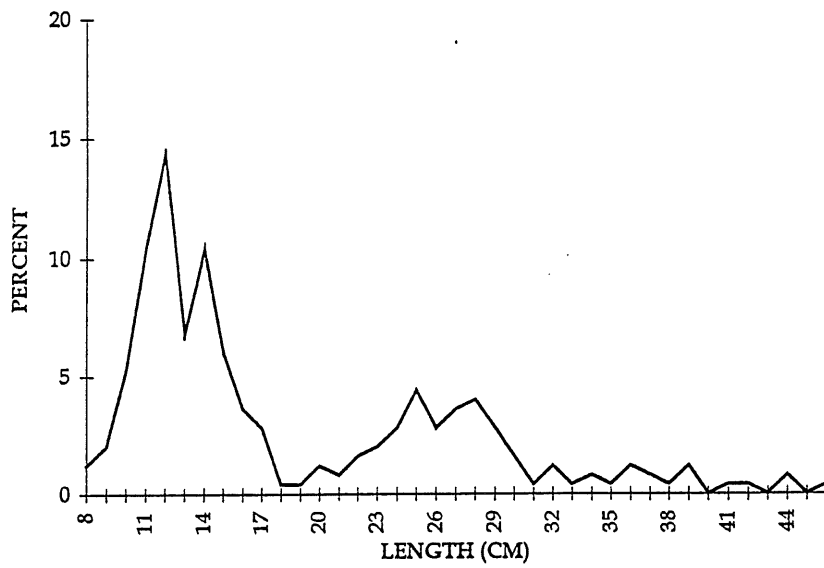


Figure 19. Total length distribution of lumpsucker caught in the sea surface, July-August 1997. N=250.

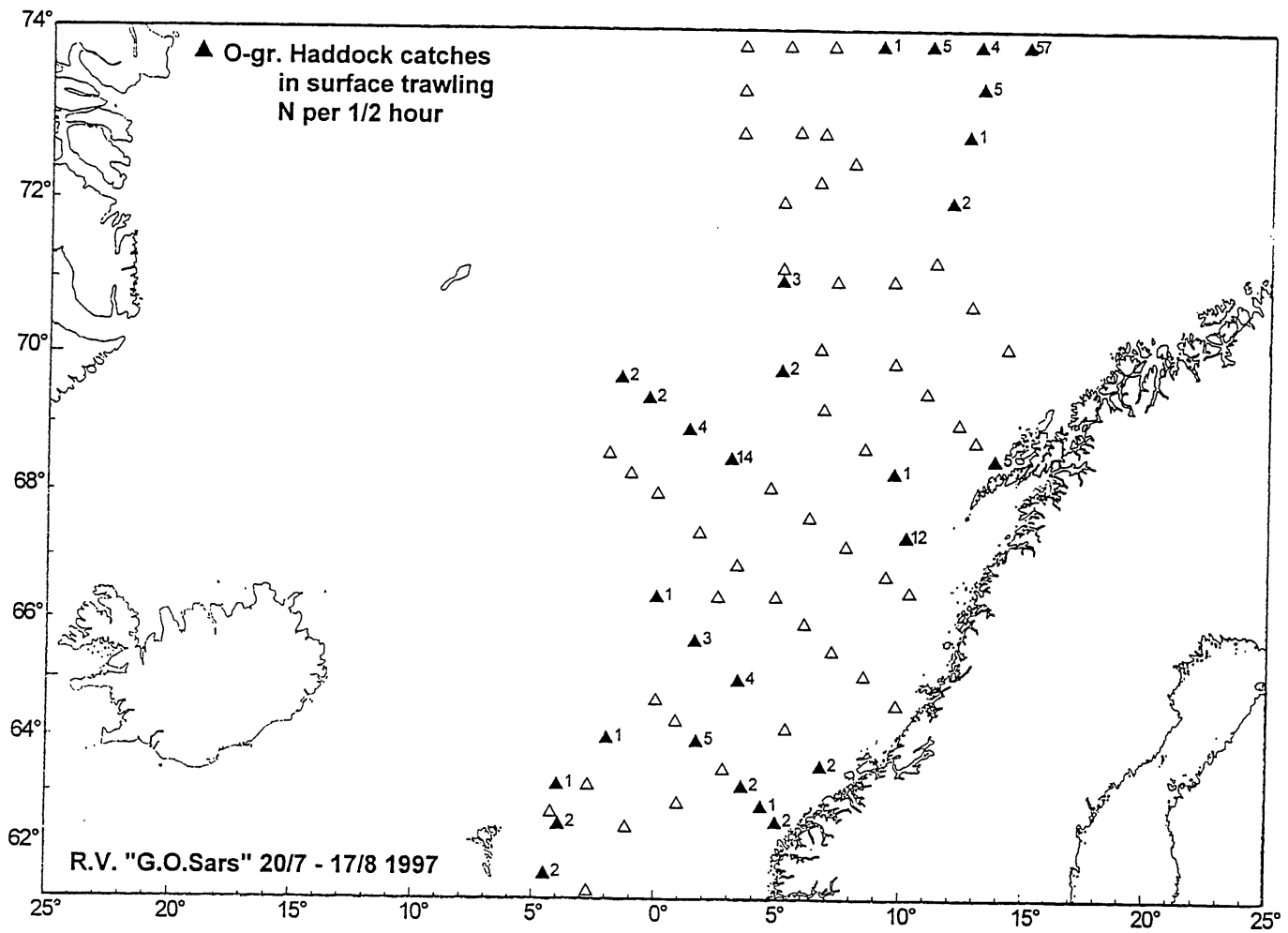


Figure 20. Catch of 0-group haddock in the sea surface, July-August 1997.

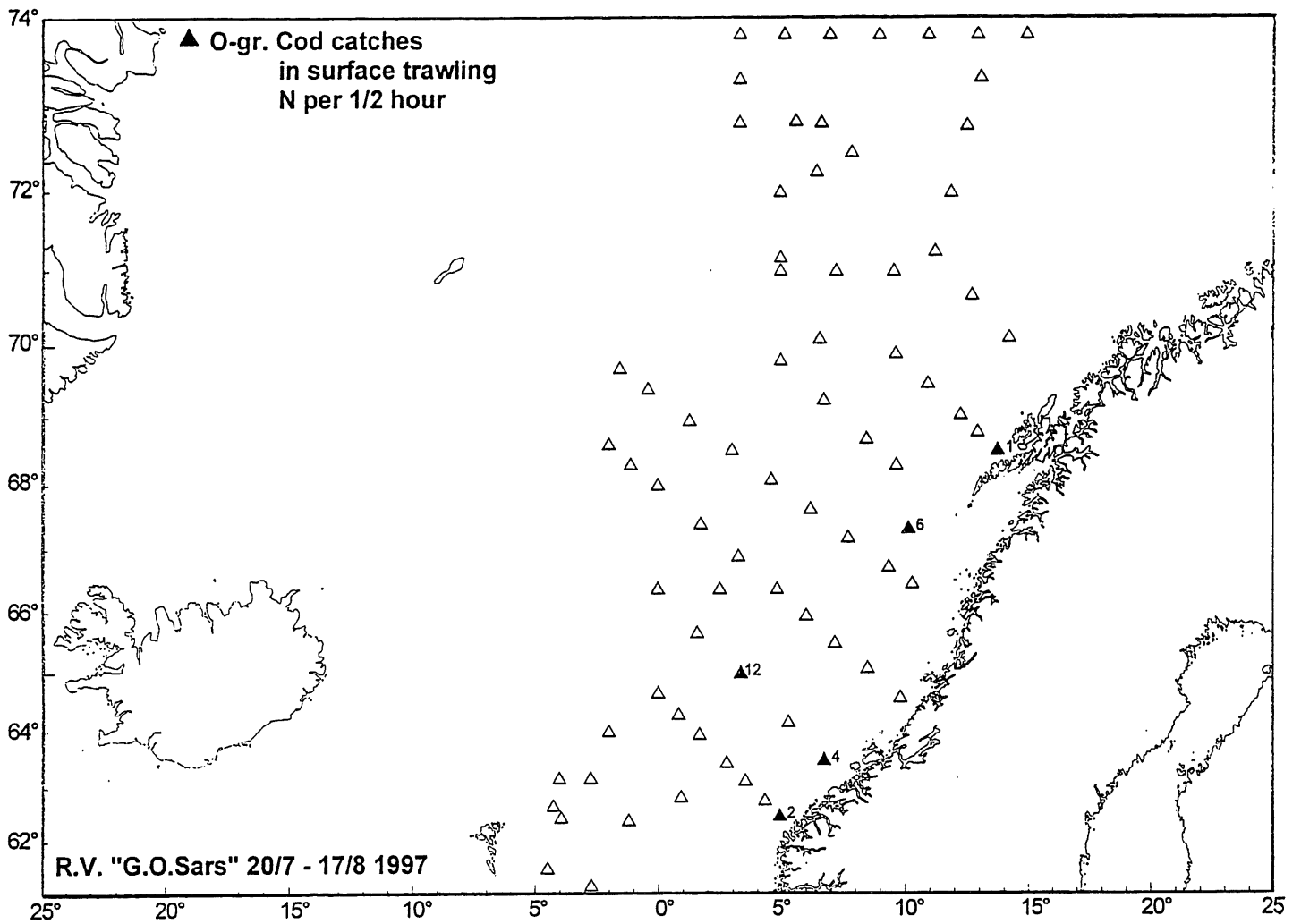


Figure 21. Catch of 0-group cod in the sea surface, July-August 1997.

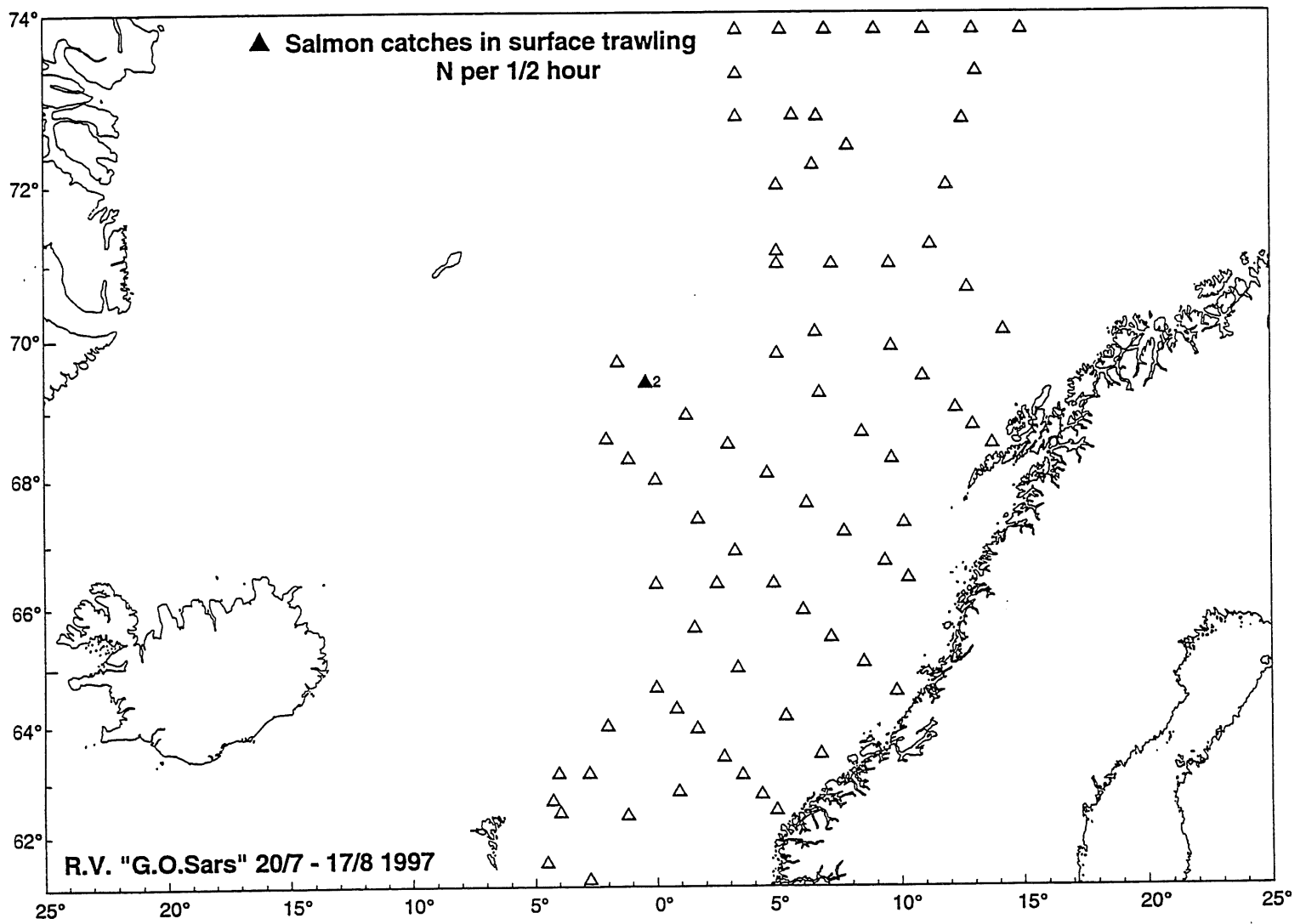


Figure 23. Catch of salmon (smolt) in the sea surface, July-August 1997.

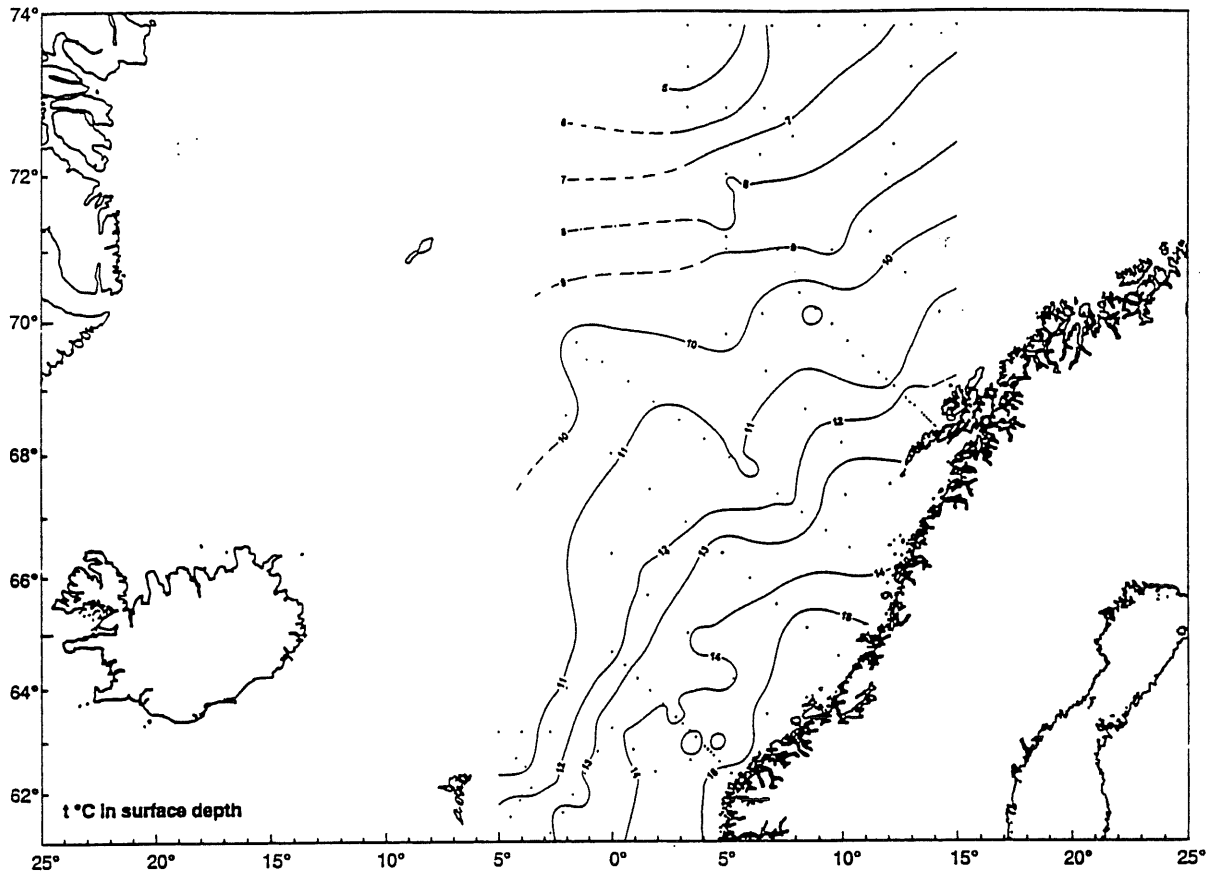


Figure 25. Temperature, $t^{\circ}\text{C}$, in the sea surface, July-August 1997.

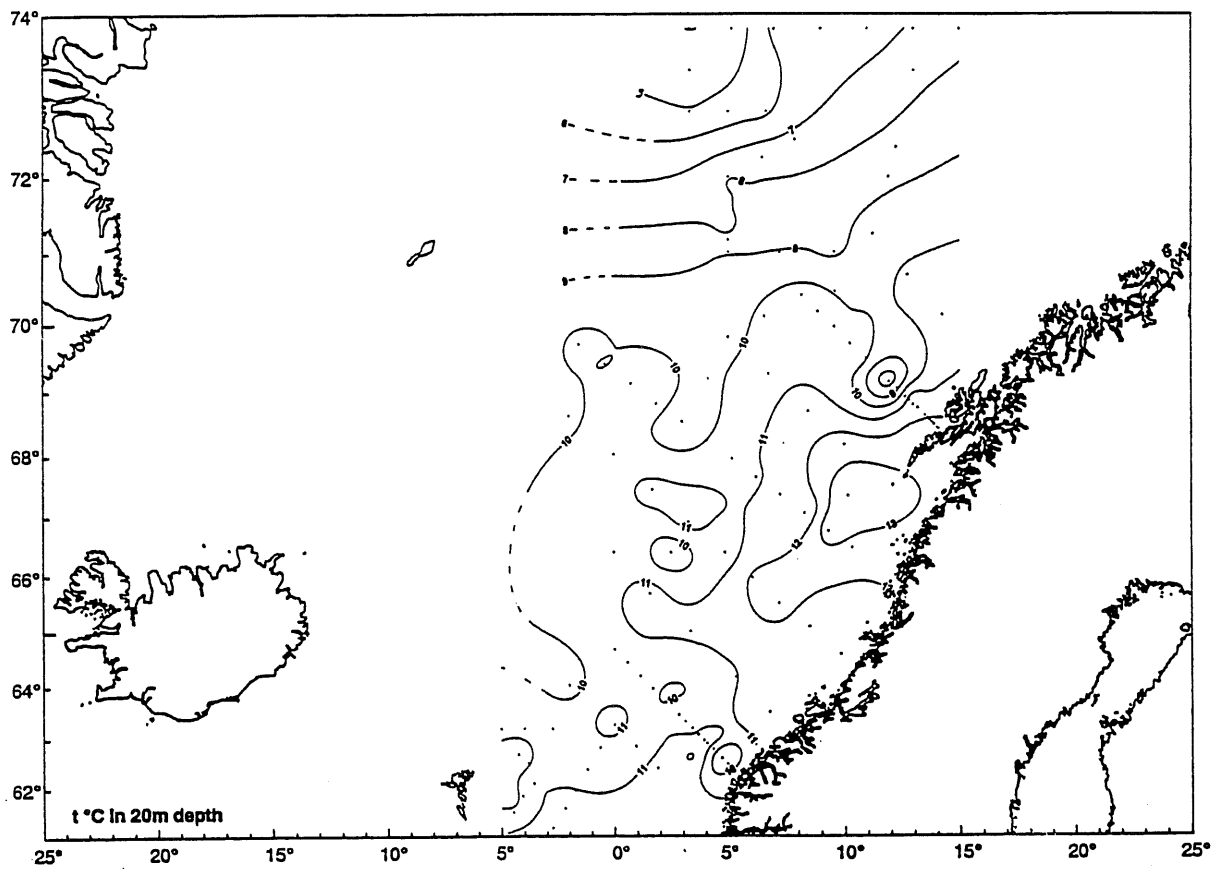


Figure 26. Temperature, $t^{\circ}\text{C}$, in 20m, July-August 1997.

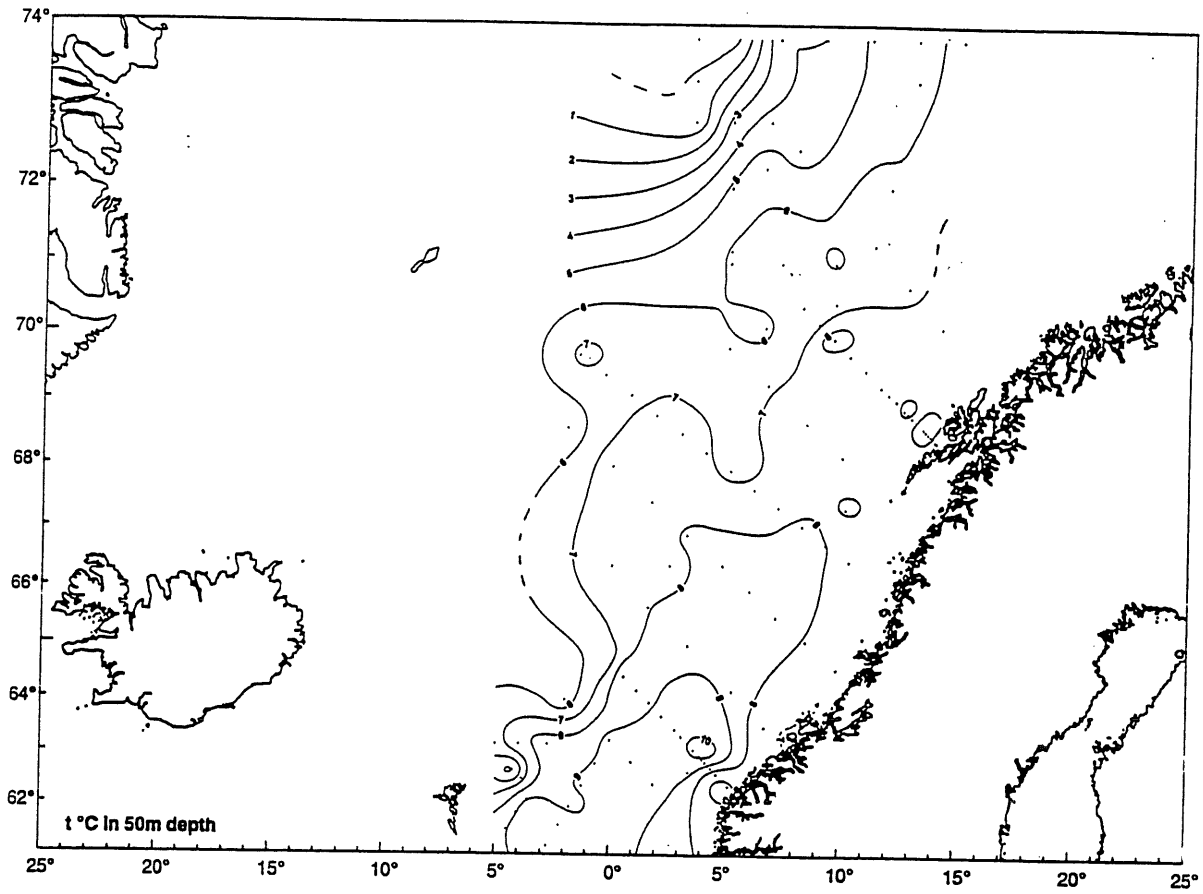


Figure 27. Temperature, $t^{\circ}\text{C}$, in 50m, July-August 1997.

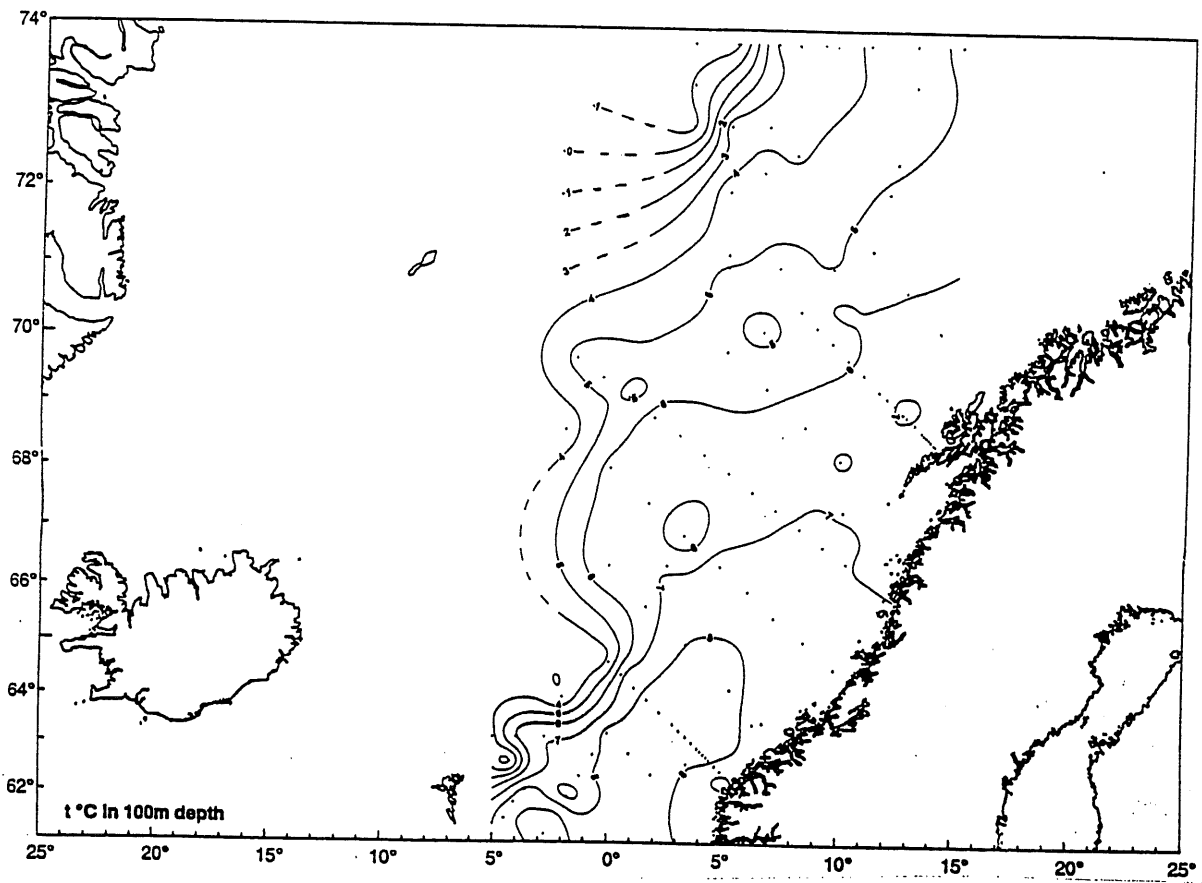


Figure 28. Temperature, $t^{\circ}\text{C}$, in 100m, July-August 1997.

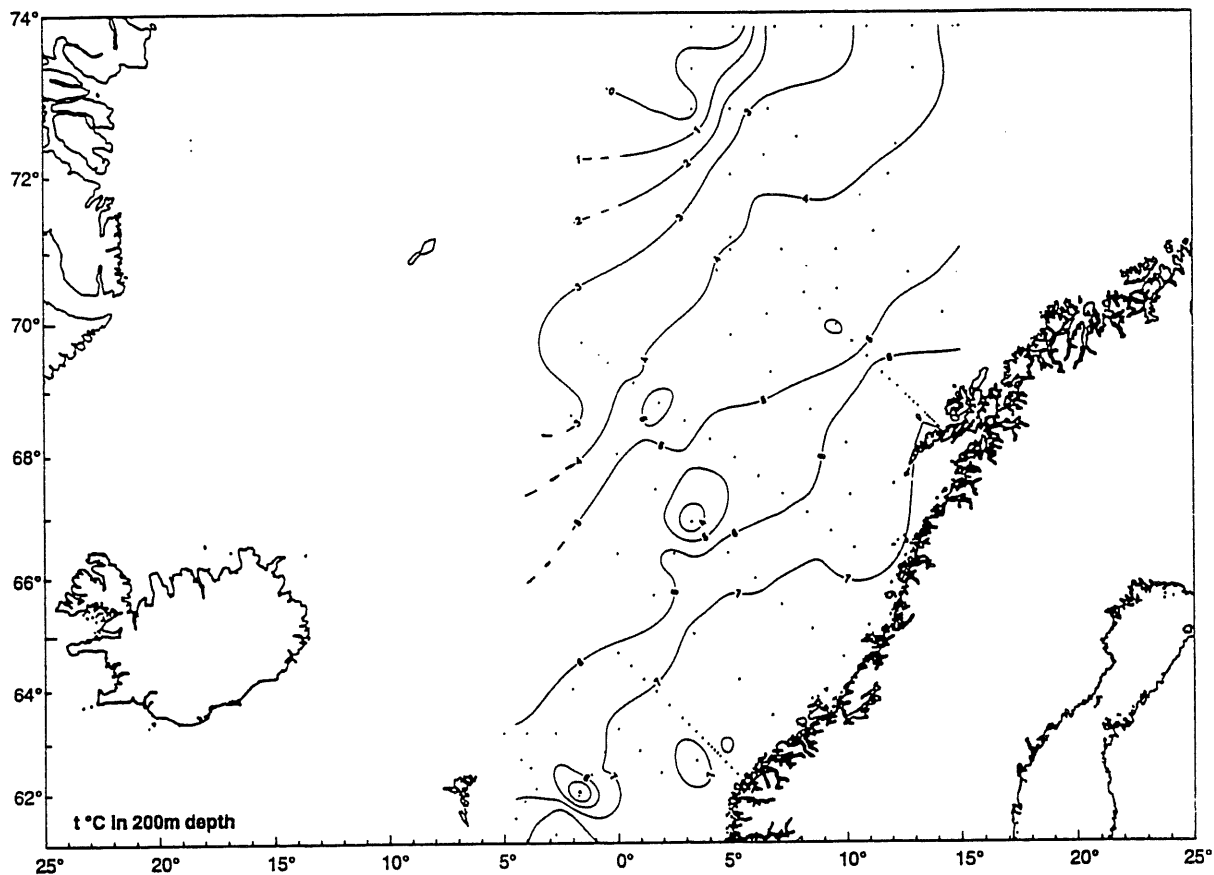


Figure 29. Temperature, $t^{\circ}\text{C}$, in 200m, July-August 1997.

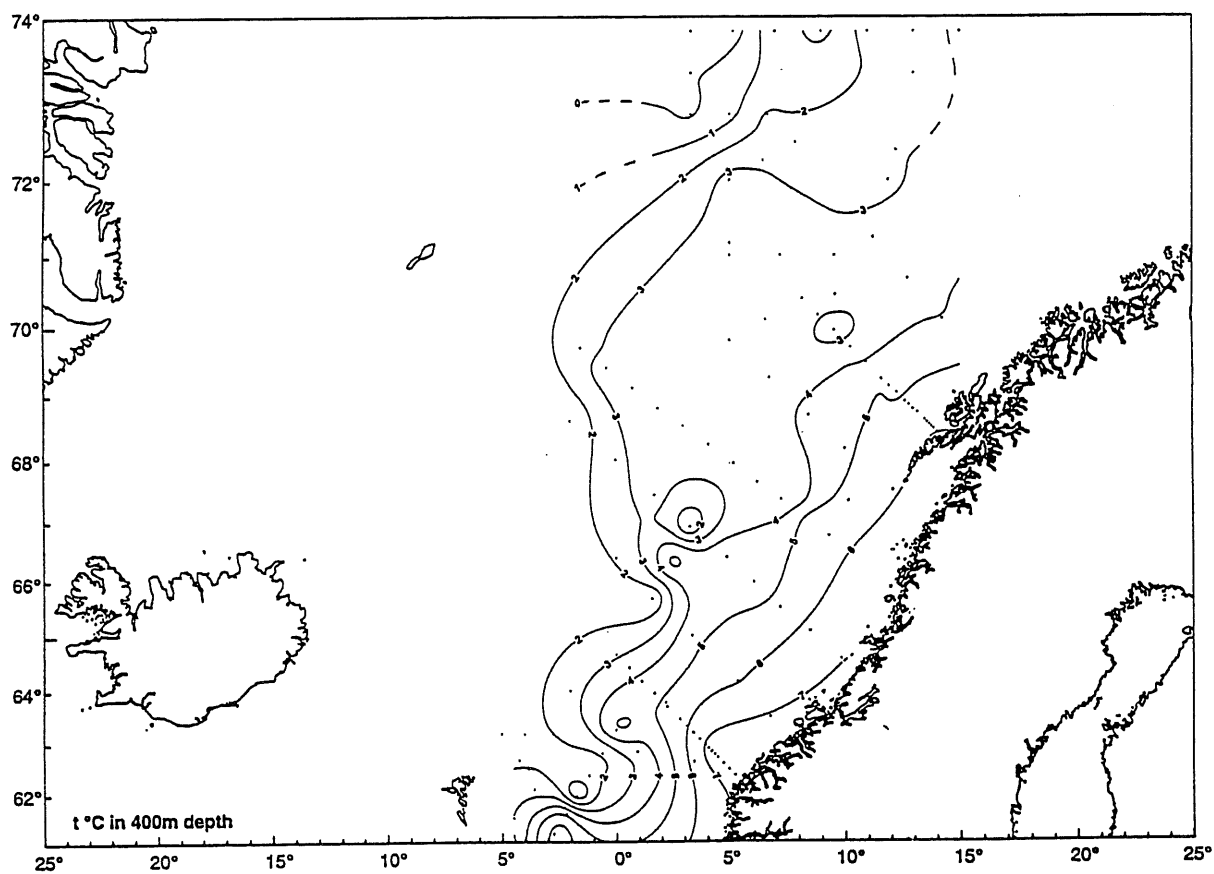


Figure 30. Temperature, $t^{\circ}\text{C}$, in 400m, July-August 1997.

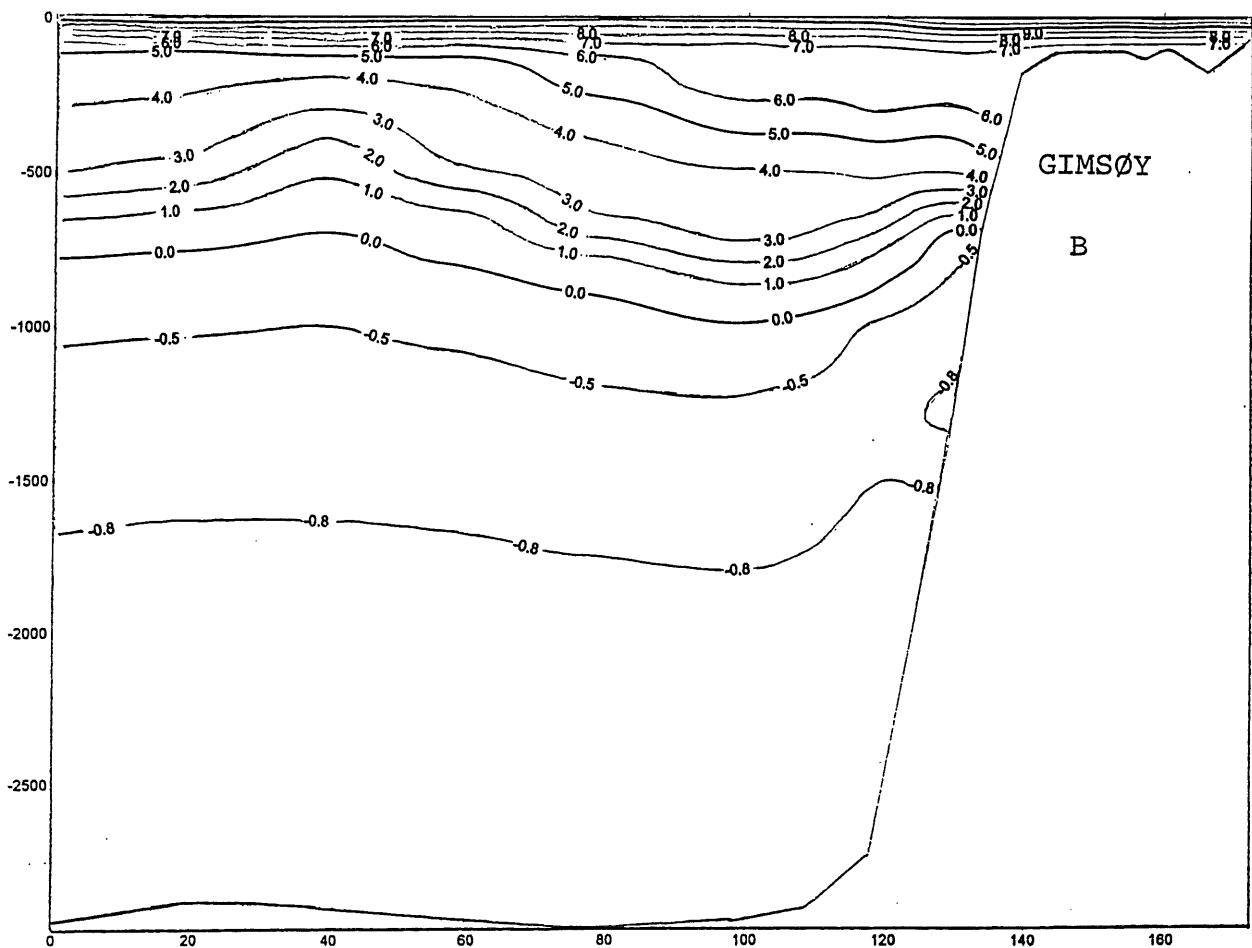
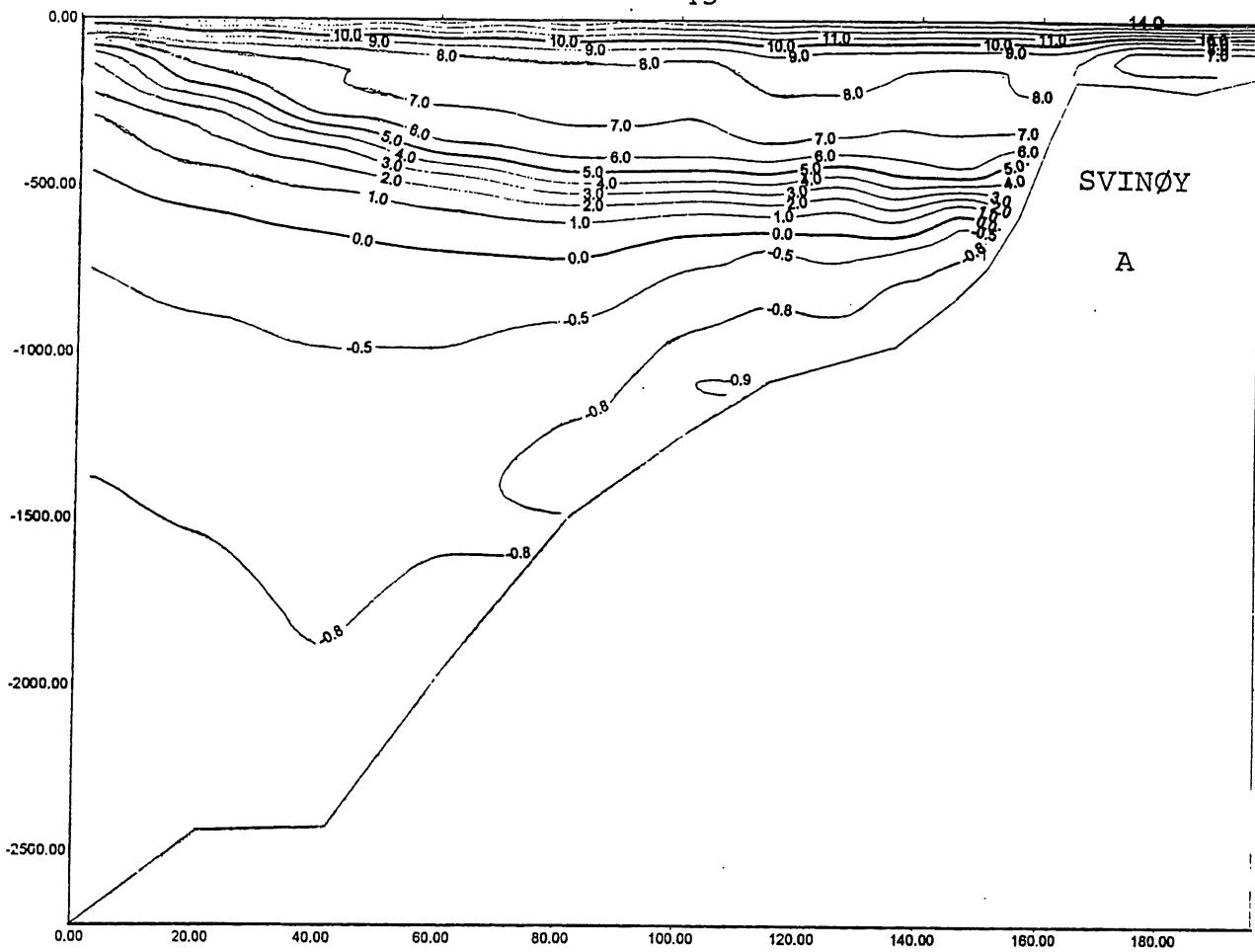


Figure 31. Vertical distribution of temperature, $t^{\circ}\text{C}$, in A) the Svinøy-NW section 21-23/7 1997 and B) the Gimsøy-NW section 8-11/8 1997.