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Abundance and Distribution of Postlarvae in the 0-group Saithe Survey in the North-East Arctic in 1985

by

Kjell Nedreaas

Institute of Marine Research, P. O.Box 1870
N-5011 Bergen-Nordnes, Norway

ABSTRACT

From 11 May to 31 May 1985 a pelagic trawl survey was carried out outside the Norwegian coast north of 62°N. The purpose of this pilot survey was to examine the possibility of getting useful information about the year class strength of the North-East Arctic saithe before too many of the postlarvae had drifted or migrated inshore. Attempts at this have so far not been successful for any saithe stock, and recruitment estimates are badly needed for the catch projections.

The sampling was carried out with a mid-water trawl and the results are promising. There are also interesting biological aspects. Some systematic size differences of the saithe postlarvae seemed to appear within the investigated area. Distribution charts and tables of postlarvae of different species have been presented. An index of the year class strength of saithe has been calculated.

INTRODUCTION

The North-East Arctic saithe spawn at 150-200 meter depths outside the Norwegian coast. North of 62°N the main spawning grounds are on the banks off Møre, Haltenbanken, and in the Lofoten area.

It is well known that alevins and postlarvae drift, or as they grow larger, probably migrate inshore. However, we have so far not been able to arrive at the understanding of what physical or biological mechanisms that are involved. From a size of 2-4 cm until becomming 3-6 years old, oldest in the northern part of Norway, the saithe stay inshore. Above a minimum size the saithe are during this period exposed to a considerable purse seine fishery.

While the saithe stay inshore it is almost impossible to measure the strength of the year class, and before it is possible to get any information about the recruitment, the stock is exposed to fishing. Therefore the aim of this pilot survey was to bound the area of distribution and to try to get a measure of the year class strength before the alevins or postlarvae reached the coast.

Hitherto very little has been done on this subject. DAMAS (1909) described the distribution of fry and alevins of saithe off Møre.

WIBORG (1954,1956,1957,1960a,1960b,1961,1962) and DRAGESUND AND HOGNESTAD (1966) have described the occurrence of fish eggs and larvae in Norwegian coastal and offshore waters. BJØRKE (1983) has done some research on the distribution of eggs and larvae of gadoid fishes from Stad to Lofoten during April 1976-1983, and on postlarvae of gadoid fishes north of Lofoten in June and July (internal survey reports). However, most of these reports present the results from surveys carried out either too early or too late to give a reliable measure of the abundance of 0-group saithe.

MATERIALS AND METHODS

A mid-water capelin trawl with a 10 meter fine meshed (8 mm stretched mesh) net inside the cod-end, was used as the main gear in this survey. Height and depth sensors from SCANMAR A/S together with sensors measuring the distance between the wings of the trawl, gave information about the trawl geometry.

The trawl was towed with 3 knots for 10 minutes with the headrope at the surface, then 10 minutes in 20 meter, and 10 minutes in 40 meter. Six 70'' bladders were fastened to the headrope. It took some time to stabilize the trawl in these depths. The total sailed distance therefore became 1.8 nautical miles as a mean, with a total towing time of about 36 minutes. The trawl survey was carried out both day and night.

The known spawning grounds of the saithe and a calculated drift of the larvae up to the beginning of the survey, were used as the basis for how far south it was necessary to go. However, the southernmost track gave no satisfactory southern limit of the abundance of saithe, and it was therefore decided to do some trawling further south on the return to Bergen. These trawl- and hydrographical stations were consequently taken later in time.

The actual area was covered by a rectangular survey grid (Figure 1). The distance between the main tracks, which have been numbered by Roman numerals I-XII, was 30 nautical miles, and the distance between two stations on the same track was 15 nautical miles.

The catch was shaked down in a tub with water and filtered out. Afterwards the whole cod-end was thoroughly shaked and the remainder swept up from the deck. The entire catch was sorted, and the length of each fish species or category measured.

Because of the uncertainty concerning the choice of the best sampling device, another two sampling gears were tested. The catch efficiency of Isaacs Kidd (9 m^2) and MOCNESS (1 m^2) midwater trawls were on respectively five and two stations compared with the bigger capelin trawl. The Isaacs Kidd trawl was lowered down to 60 meter, and the MOCNESS was hauled through 1000 m^3 seawater in each of the four depths 10, 20, 30, and 40 meter.

In order to try to estimate acousticly the abundance of alevins and postlarvae an EK-400 (Simrad), connected to a Nord 10 ekkointegrator with a Simrad QX preprocessor, was used. However, it was impossible to separate the postlarvae from krill and zooplankton, and the acoustic estimate was therefore judged to be unreliable as a measure of the postlarvae abundance.

RESULTS

Hydrography

Hydrographical observations were normally made on each trawl station along all the survey tracks (Figure 2). Horizontal temperature distribution is shown for 0, 25, 50, and 100 meter (Figures 3-6). Figure 7 shows some temperature sections with the number of saithe postlarvae caught on each station recorded in the right relative position in the section. The horizontal distribution of the salinity in 25 meter is shown in Figure 8.

Distribution and abundance of 0-group fish

Trawl stations with and without catch are for three species given on the distribution charts in Figures 9, 11 and 13. Isolines have been drawn to better visualize the distribution.

An abundance index has only been calculated for 0-group saithe, the target species of the survey. With the aid of hydroacoustic equipments from SCANMAR A/S the height and width of the trawl entrance was found, and the volume, V_1, of a haul was calculated.

V_1 = 0.0108 nm (height of the entrance=20 meter)· 0.0108 nm (width of the entrance=20 meter)· 1.8 nm (distance towed) = $\underline{2.0995 \cdot 10^{-4} \text{ nm}^3}$

Around each trawl station a square of 15 x 30 nautical miles has been drawn with the station itself in center. Knowing the maximum depth of trawling, 58 meter when the headrope is in 40 meter, the volume, V_2, of such a constructed block can be found.

V_2 = 15 nm · 30 nm · 0.0313 nm (maximum depth=58 meter) = $\underline{14.09 \text{ nm}^3}$

Calculation of the index, I:

$I = \sum V_2/V_1 \cdot x_i = V_2/V_1 \cdot \sum x_i$, where x_i is the number of 0-group saithe caught during a haul of 1.8 nm on station i.

Saithe, Pollachius virens.

The geographical distribution of 0-group saithe is shown in Figure 9. It shows many similarities with the horizontal distribution of the temperature, especially in 25 and 50 meter. Areas with temperature equal or above 7^0C turned out to contain the greatest numbers of 0-group saithe (Figure 7). Far north in the investigated area where the temperature did not become that high, the greatest catches of 0-group saithe were done in the warmest water.

Very little can be said about the vertical distribution of the postlarvae. In addition to the two experiments using the MOCNESS trawl (see that paragraph), the capelin trawl was on trawl station 238 only towed at the surface for ten minutes, on station 239 only in 20 meter, and on station 240 only in 40 meter. The trawl was unfortunately also towed through the water column to and from these depths. This only experiment showed least postlarvae in 20 meter (Table 3). The horizontal distributions of the temperature or the salinity in several depths may also tell something about the vertical distribution of saithe postlarvae since they seem to stay in water masses of a certain temperature or salinity.

The length distributions of 0-group saithe caught on each survey track have been shown in Table 1. On the first eight tracks (I-VIII) the mean lengths varied between 27.7 mm and 29.5 mm. On tracks IX, X, and XI the mean lengths are somewhat less, 25.1 - 26.6 mm. The six postlarvae caught on the northernmost track, track XII, were larger. The mean length was 31.3 mm. Trawl stations 236 - 247 were taken on the return to Bergen at the end of May, and it is therefore natural that these postlarvae were larger. The mean length was 35.0 mm.

Between inner and outer stations on the same track there were more pronounced length differences of the 0-group saithe. In order to illustrate this the five southernmost tracks (I-V) were divided into an inner, a central, and an outer part with 1/3 of the trawl stations in each part. Figure 10 shows the length distribution of 0-group saithe from each of these three parts. The postlarvae on the inner stations were larger than on the outer stations indicating a drift or migration inwards to the coast.

An index of the abundance of 0-group saithe has been calculated:

Number of 0-group saithe within the area covered by the regular survey tracks, I_1:

$$I_1 = V_2/V_1 \cdot \sum x_i = 14.09/2.0995 \cdot 10^{-4} \cdot 8462 \text{ saithe} = \underline{567.9 \cdot 10^6 \text{ saithe}}$$

The triangular area south of the southernmost track with trawl catches of 100 0-group saithe or more covered an area of 5.610 nm^2. With a depth of 58 meter or 0.0313 nm the volume is $V_3 = \underline{175.6 \text{ nm}^3}$.

Number of 0-group saithe within this "triangle", I_2:

$$I_2 = V_3/V_1 \cdot \sum x_i = 175.6/2.0995 \cdot 10^{-4} \cdot 322 \text{ saithe (mean per station)}$$
$$= \underline{269.3 \cdot 10^6 \text{ saithe}}$$

The volume of the area with catches less than 100 saithe per station south of the southernmost track, $\underline{V_4 = 96.6 \text{ nm}^3}$.

Number of saithe within this area, I_3:

$$I_3 = V_4/V_1 \cdot \sum x_i = 96.6/2.0995 \cdot 10^{-4} \cdot 11 \text{ saithe (mean per station)}$$
$$= \underline{5.1 \cdot 10^6 \text{ saithe}}$$

The number of 0-group saithe, I, within the total investigated area is used as the index of abundance of the 1985 year class of North-East Arctic saithe north of 62^0N:

$$I = I_1 + I_2 + I_3 = \underline{842.3 \cdot 10^6}$$

Herring, Clupea harengus.

The geographical distribution of herring larvae before metamorphosis is shown in Figure 11. The area of distribution was neither in the south nor in the north satisfactory limited, and no abundance index has therefore been calculated.

The two experiments considering the vertical distribution of herring larvae gave two different distributions (number larvae) as shown below.

Depth in meter	MOCNESS St.no.135	Capelin trawl St.no.238-240
0	-	1220
10	0	-
20	1	20
30	8	-
40	14	2

There were rather small length differences between herring larvae caught on different stations. For three areas (A,B,and C) with a catch of 10 larvae or more per station, separate length distributions have been presented to show the most pronounced differences (Figure 12). Area A include six stations as shown in Figure 11. Area C include the stations south of the southernmost track, and area B the rest of the stations with 10 or more larvae per station. The herring larvae in area A were somewhat smaller than in the other areas.

Catfish, Anarhichas lupus

Scattered catches of catfish postlarvae were done all over the surveyed area (Figure 13). The concentrations were small, only on six stations it was caught 10 postlarvae or more. The length distribution of all the catfish postlarvae is given in Table 2.

Gonatus fabricii

Figure 14 shows the geographical distribution of the ten armed pelagic squid Gonatus fabricii. The length distributions from trawl stations no. 151 and 218 have been summarized and presented in Table 2. The area of distribution and the size composition in the catches showed many similarities with observations done by WIBORG (1979,1982) and WIBORG,GJØSÆTER AND BECK (1984).

Other species

An overview of all species or fauna categories caught on each trawl station is given in Table 3.

Pearlsides, Maurolicus muelleri, were only caught around midnight. At this time the pearlsides gathered above 50 meter, and were clearly visible on the echo sounder.

Redfish postlarvae were regulary caught from outside Lofoten and northwards. Two size groups of these postlarvae appeared. Up to station no. 226 the length of the redfish postlarvae was between 8 and 13 mm, while from station no. 229 the postlarvae were 15 mm or more. Table 2 shows the total length distribution. Many of the redfish postlarvae were probably too small for the trawl to catch them quantitatively well.

In the entire surveyed area only four postlarvae of haddock were caught, all of them west of Haltenbanken. Postlarvae of cod were not recorded at all.

Comparison and judging of gears

On five stations in the beginning of the survey the catch efficiency of an Isaacs Kidd mid-water trawl and the capelin trawl was compared. The overview below shows the catch taken by these gears.

St.no.	Capelin trawl	Isaacs Kidd
100	Catfish: 10	Catfish: 1
	Sculpin: 1	
103	Catfish: 4	No catch
108	Herring: 11	No catch
110	Saithe: 4	No catch
	Catfish: 2	
	Herring: 3	
114	Saithe: 331 (22-43 mm)	Saithe: 3 (32,36,38,mm)
	Catfish: 2	
	Gonatus sp.: 19	
	Norway pout: 1	

The results show that the capelin trawl was the best gear for the purpose of the survey, and this gear was therefore used in the continuation.

On station no. 135 the MOCNESS mid-water trawl caught 1 saithe postlarvae while the capelin trawl caught 76. On station no. 147 the MOCNESS caught nothing while the capelin trawl caught 748 specimens.

The MOCNESS was considered not suitable for catching saithe postlarvae of this size, but it seemed to be a better gear for catching smaller and weaker herring larvae.

CONSIDERATIONS

The capelin trawl seemed to be a suitable gear for catching 2-3 mm postlarvae of saithe and other fishes. However, considering the permeability of the cod-end, it may be better to use a single fine meshed net instead of a standard cod-end net with a fine meshed net inside.

To what extent it is possible to tell whether the index of abundance will show the right picture of the year class strength, a time series of such indices is needed. Then it will be possible to compare the index with the number of saithe of that year class entering the fishery. Nevertheless, this pilot survey was promising.

There were also interesting biological aspects. Size differences of the saithe postlarvae may tell something about the spawning and the mechanisms for the inshore drift or migration. The bulk of the saithe postlarvae stayed in the warmest water.

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Table 1. Length distributions (%) of saithe postlarvae.

Length-group mm	Track I st.no. 110-124	Track II st.no. 125-139	Track III st.no. 140-154	Track IV st.no. 155-168	Track V st.no. 169-180	Track VI st.no. 181-190	Track VII st.no. 191-197	Track VIII st.no. 198-203	Track IX st.no. 205-210	Track X st.no. 211-216	Track XI st.no. 217-222	Track XII st.no. 223-230	St.no. 236-247
10-14													
15-19	1.6	2.8	0.3	0.2	0.7	4.8	2.0	0.2	7.1		11.1		0.1
20-24	17.6	16.6	17.7	10.2	16.3	7.2	20.8	11.1	28.6	71.4	48.1		3.2
25-29	30.5	30.0	52.8	51.6	45.6	42.2	29.7	55.3	23.2		11.1	16.7	15.1
30-34	34.3	32.3	23.1	31.6	29.4	38.6	35.6	31.7	39.3	14.3	18.5	83.3	32.4
35-39	15.0	15.3	5.4	6.0	6.9	3.6	11.9	1.4	1.8		11.1		27.1
40-44	1.0	2.5	0.6	0.4	1.2	3.6		0.2		14.3			12.8
45-49		0.4	0.1										6.2
50-59													3.1
Number	1939	1127	1843	2239	607	83	101	425	56	7	27	6	1964
Mean length	29.28	29.47	27.74	28.63	28.29	29.12	28.31	28.26	26.61	25.14	25.48	31.33	35.04
St.dev.	4.90	5.48	3.78	3.72	4.19	4.79	5.01	2.98	4.95	8.03	5.96	1.63	6.43

Table 2. Length distribution (%) of C.fabricii, catfish, and redfish.

Length gr. mm	C.fabricii	Catfish	Redfish
5- 9			13.8
10-14	1.0		24.1
15-19	5.9		27.6
20-24	6.9	10.6	31.0
25-29	16.7	34.3	3.4
30-34	37.8	22.4	
35-39	24.1	16.1	
40-44	6.2	8.7	
45-49	1.3	4.7	
50-54		2.0	
55-59		1.2	
Number	878	254	58
Mean length	31.88	32.80	16.33
St.dev.	6.58	7.61	5.45

Table 3. Catch in numbers of different species or categories on each trawl station. Catches of specimens older than 0-group have been marked.

St.no.	Time (GMT)	Notes	Gonatus sp.	Catfish	Yarrel's blenny	Haddock	Pearlside[4]	Lumpenus	Lump-sucker	Saithe	Sand-eel	Herring	Redfish	Sculpin	Krill (ml)
100	16			7	1										
101	20			10										1	
102	22	No catch													
103	02			4											
104	05			7											
105	09			2											
106	13								1						
107	18	No catch													
108	23											11[1]			
109	04					1[1]				1		6			50
110	08			2						4		3			
111	11			1						9					
112	14	1 Blue-mouth		5	6					495		384			
113	16		3	5						4					
114	18	1 Norway pout	19	2						331					60
115	22	2 Gr.silver smelt		2			7200		1	118					8400
116	00		16				400		1	335					900
117	03		2	1						96		1			
118	05		3	1						169		7			100
119	08		3							274		29			100
120	11		44							13		1			20
121	14		2							73		1			30
122	17		19	1					1	11	1	2			40
123	19		35							7					30
124	23		340				4								5
125	03		384							3		1			30
126	05		214						1						35
127	08		29							9					10
128	10		18	1						45		26			80
129	12		14	1						2					5
130	15		1		1					171		60			25
131	18									26		50			35
132	20		46	1			2			210		61			100
133	22		3				13			41					1200
134	01									57		16			1950
135	03				1					76	1	780			120
136	07			1				1		36		317[2]			8
137	10		1	4					2	52		1140[2]			
138	12		1	6	1					379		28	1		
139	14									20		1			2
140	18									3		7			
141	20				1					15		15			90
142	23						2	4		10		204			4000
143	01		3	1	3			3		53		73			30
144	03		9							10		125			
145	06		2					3	1	52		30			
146	11									80		58			1000
147	18	1 Callionymus sp.	47							748		10			450
148	22	1 Garfish[3]	250				4			411		3			100
149	00		46	2			3			104		1			10
150	03		42							222		5			90
151	05		162							128		208			180
152	08		411	1	1					1					15
153	10		102						1	1					10
154	13		97	1						5		1			25
155	16		508[2]						1			1			30
156	19		1579[2]							1					
157	21		627[2]				16								
158	23		86				15			1					10
159	02		578							2					
160	04		88							17					
161	07		120						1	876					80
162	09		70	3						672		1			20
163	11		4							555		5			50
164	14		2							42		1			10
165	16		8	2				2		58		64			8
166	18		4	1				1		11	1	150			
167	20		1		1					2		11			170
168	22									2					3000
169	02									1		21			40
170	05		4	1						1		485			

Table 3. continue

St.no.	Time (GMT)	Notes	Gonatus sp.	Catfish	Yarrel's blenny	Haddock	Pearlside[4]	Lumpenus	Lump-sucker	Saithe	Sand-eel	Herring	Redfish	Sculpin	Krill (ml)
171	07				1					3		22			
172	09		2							10		11			
173	12		1	1						77	1	75			
174	15		9	1						114		5			50
175	17	1 Salmon (58 cm)	8							360		1			130
176	20	1 Salmon (55 cm)	64	1	2					37		108	1		35
177	23		150	1			20			1					10
178	01		227				206			1		1			
179	04		160	2			3			2					
180	08		53						1						15
181	13		35	1	1				1	10		2			180
182	15		148	6					1	9		1			120
183	18		533	9						7		2			5
184	20		45	1						6		205			5
185	23		120	2			1			25		10			4800
186	01		10	1						12		16			20
187	03		4	1					1	11		130 (+3 large)			
188	06									2		2			
189	08											3			
190	11									1		4			
191	15											7			
192	17									3		13			20
193	19			1						31		13			15
194	21								1	21		31			20
195	00		7	4						43		124			650
196	02									3	1	15			50
197	04	1 Jellycat	34	11					1			3			16
198	08		125	6	1					2		1	1		200
199	10	1 Salmon (47 cm)	5	4				1	1	329		17			
200	13		6	3				1	2	90		39			60
201	15									2		22			30
202	17								1	2		13			10
203	20					1[1]						2 (+3 large)			
204	22	1 Cod (70 cm)										1			
205	01											25			
206	03		3					1		5		8			
207	05		42	4				2		5		2	1		12
208	07								1	28		259			50
209	10		6							17		143			10
210	12		10	5						1		13	2		80
211	17														
212	19		17	3						5		44			220
213	22		482[2]		1				1			1	1		
214	01			1					1	2		3			
215	03		3												
216	05			3	1							2			
217	17									8		2			
218	19		716	1	2			1	1	12 (+1 big)		26			
219	22		62	7	1			2		2		9			15
220	00		289	11	2			3		4		2	4		
221	02		24	1					1	1		1			
222	05		34	3				2	2			2	8		240
223	10		8										1		
224	13		3	5									1		
225	16		13										1		
226	19		8	3								10	1		110
227	22		136	7			4					108			20
228	01		39	2											3600
229	03		3	4					1	5			2		420
230	05		1	4	2			5		1		6	3		125
231	07		14	29	1			7	1			13[3]	25		10
232	10		17	14	1	2[1]		3		1		8	4		30
233	14		3	12				1				5	1		5
234	04	No catch													
235	07			1										2	
236	08								2	121		309			180
237	12		2					1	1	231	1	174			500
238	16	0 meter only								140		1220			10
239	17	20 meter only		1		2				17	3	20			5
240	18	40 meter only	2							199		2			5
241	21					1		7	1	472	3	3333[2]			900
242	00			1		1		23		111	1	1131			450
243	04							1		17		325[2]			
244	08			2	6			7	2	640		330[2]			
245	12							1	2	10		44			
246	14									6		10			
247	18	No catch													

[1] [4] Larger fish, not 0-group [2] The trawl net itself was covered by this species, and it was difficult to quantify the catch [3] + 1 large herring
The lengths of the pearlsides were between 25 and 40 mm.

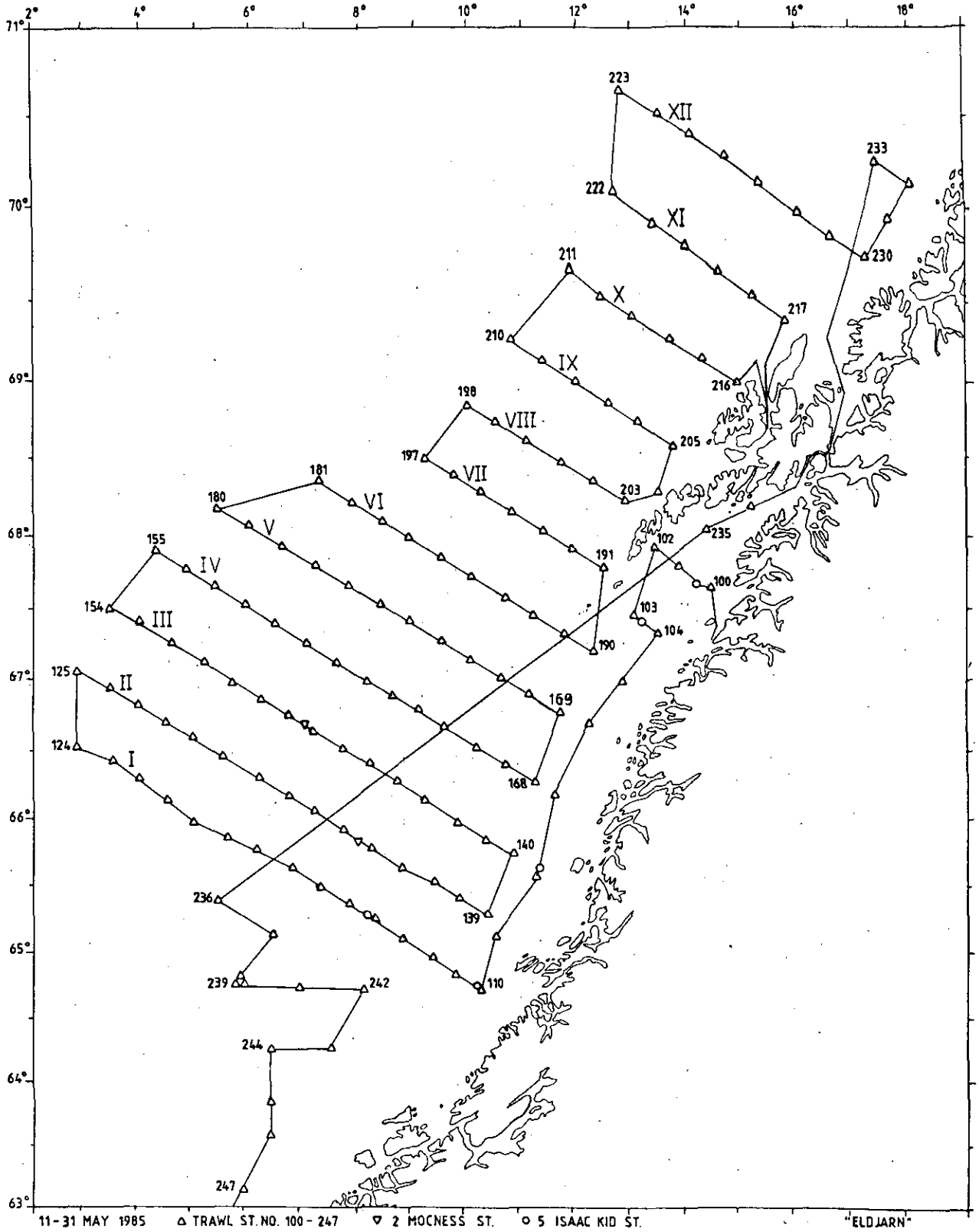


Figure 1. Survey tracks and the grid of trawl stations. The main tracks have been numbered by Roman numerals I-XII.

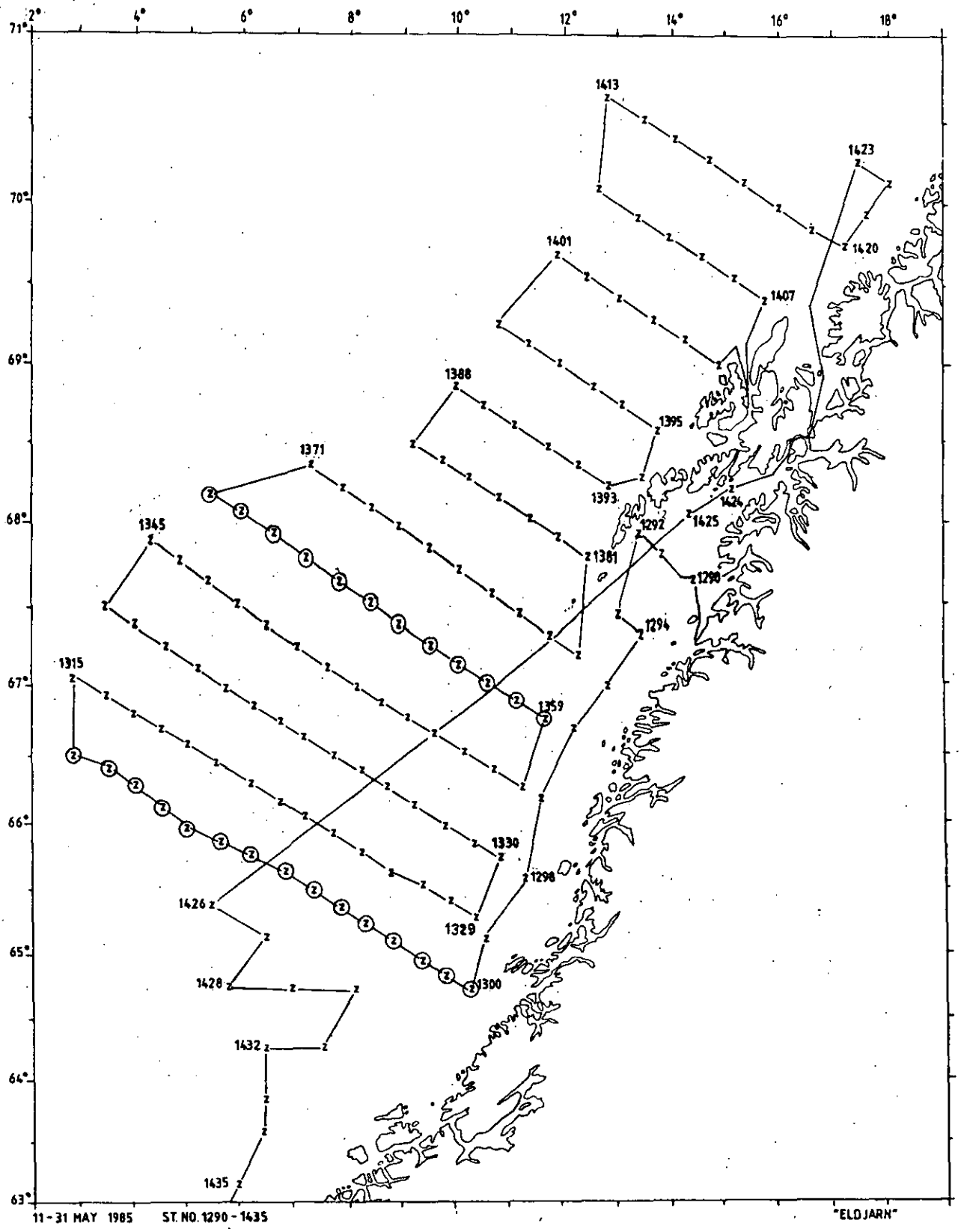


Figure 2. Survey tracks and the grid of hydrografic stations. On the encircled stations the CTD-sonde was lowered to the bottom or maksimum 1500 meter. On the other stations the sonde was lowered down to maksimum 500 meter.

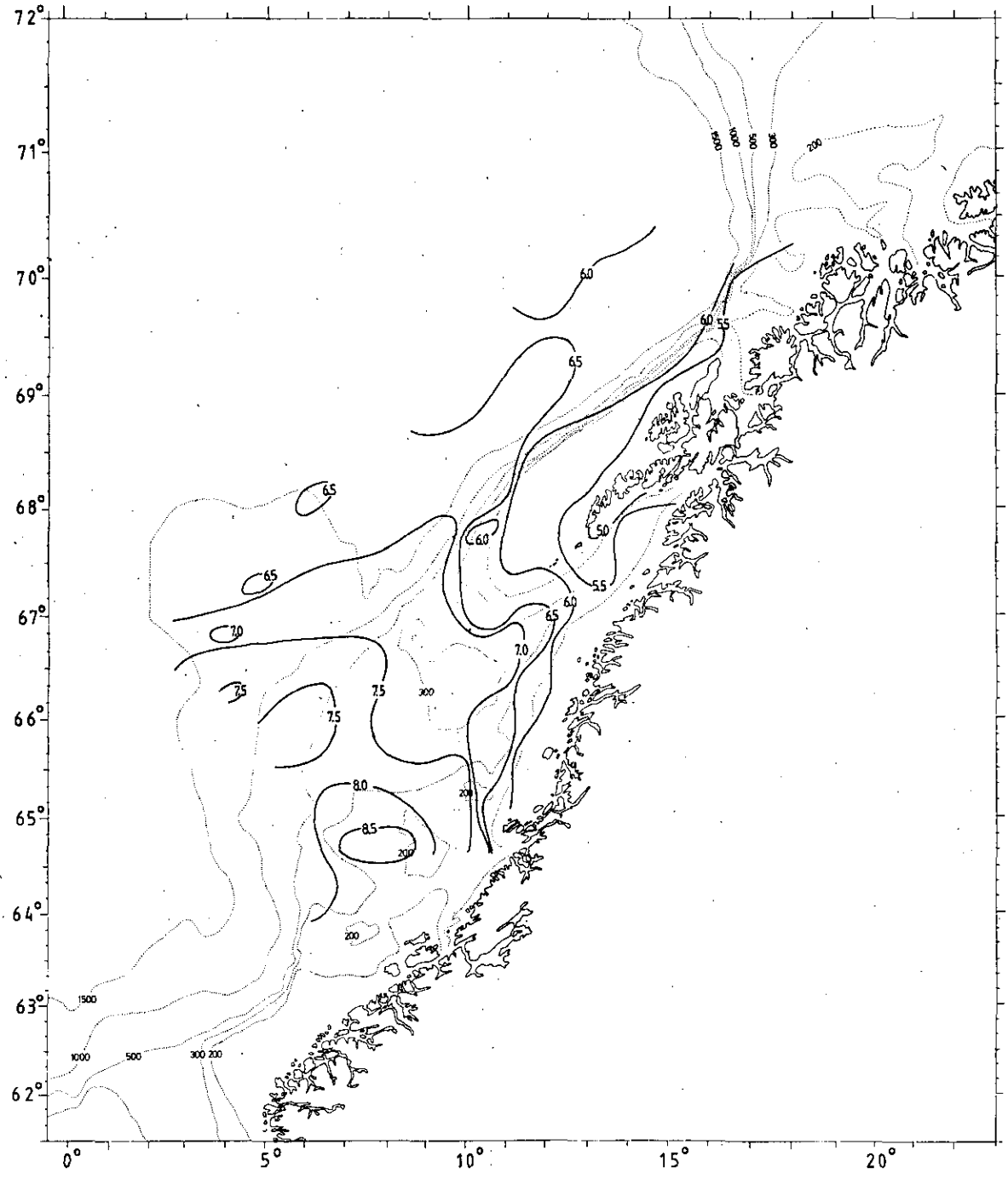


Figure 3. Distribution of temperature (^{0}C) at the surface.

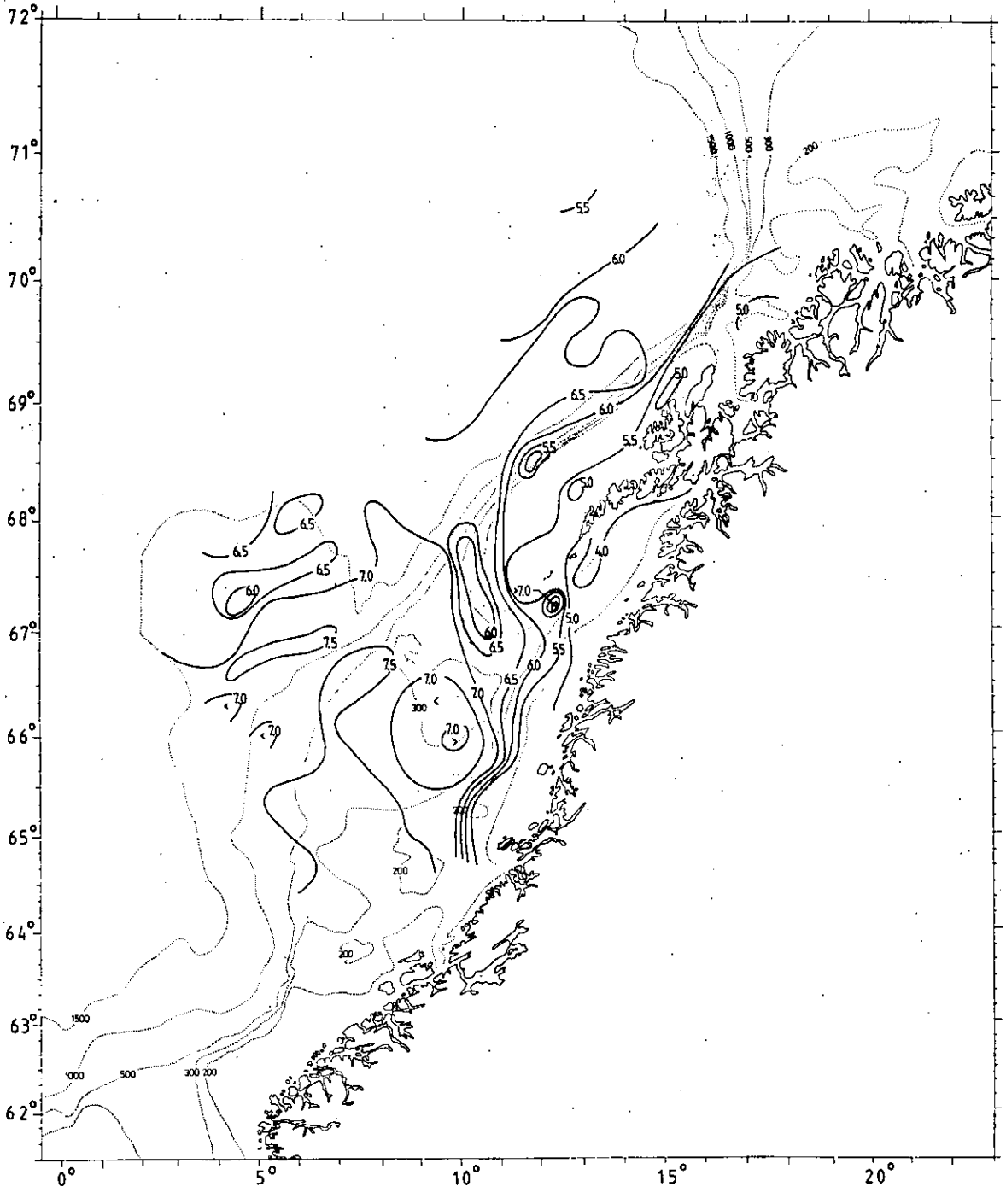


Figure 4. Distribution of temperature (^{0}C) in 25 meter depth.

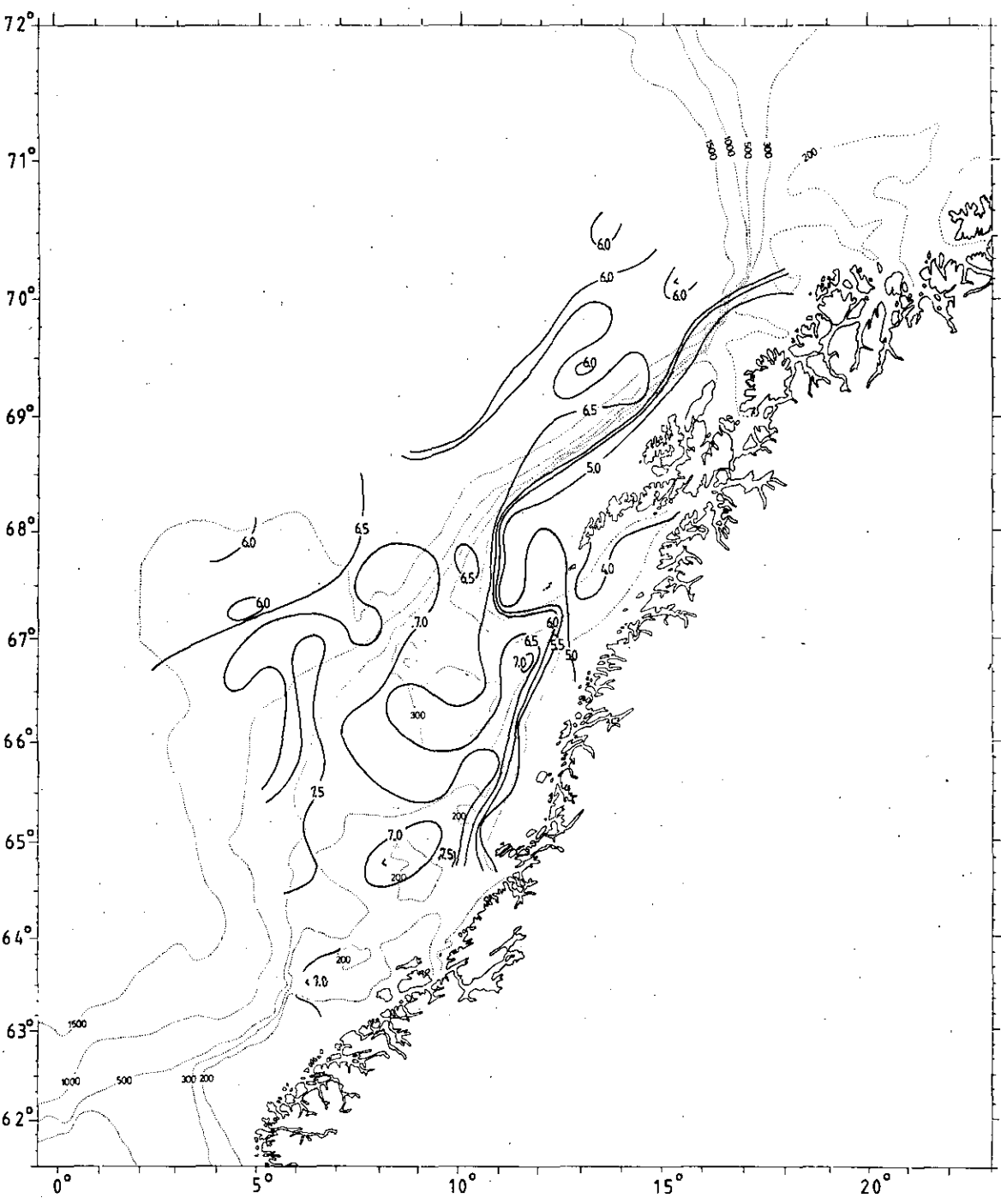


Figure 5. Distribution of temperature (^{0}C) in 50 meter depth.

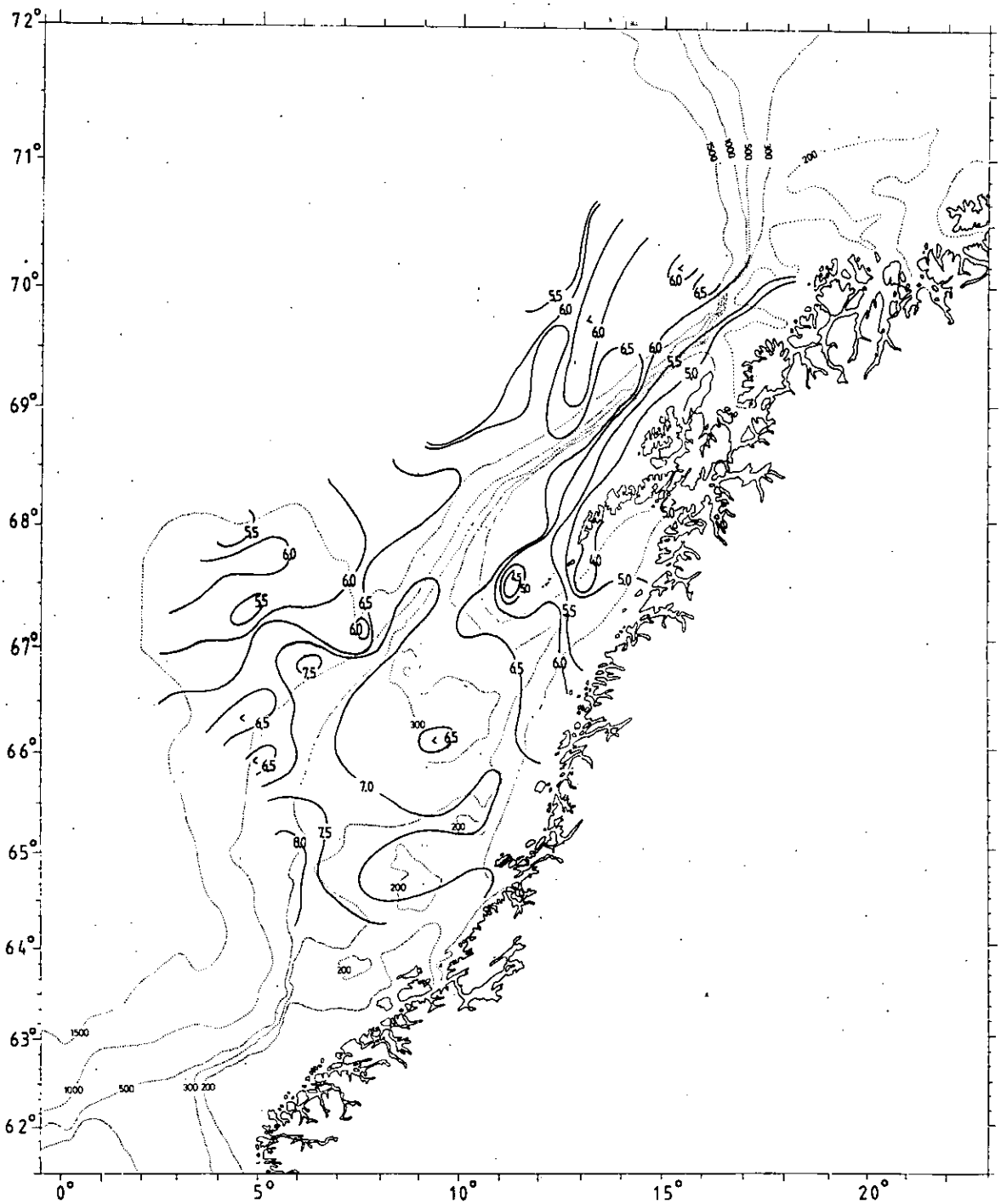
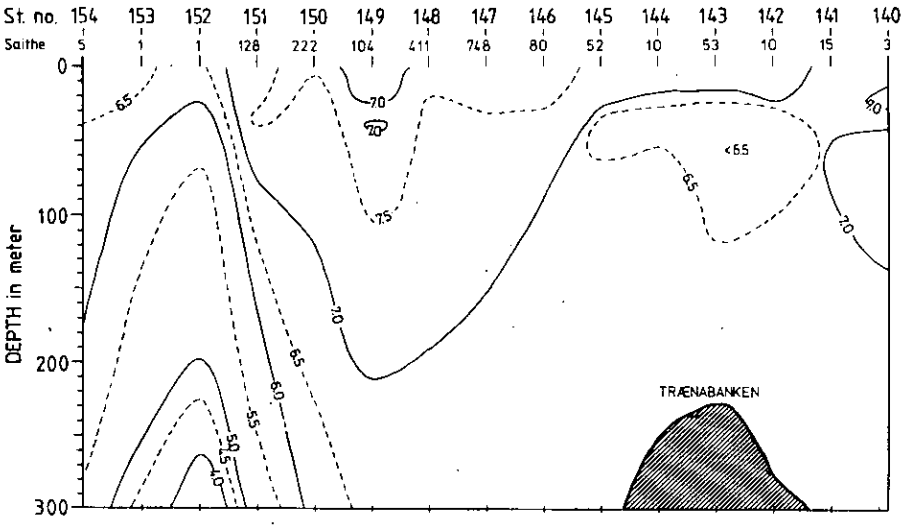


Figure 6. Distribution of temperature (^{0}C) in 100 meter depth or at the bottom where the bottom depth was less than 100 meter.

Survey track III:



Survey track I:

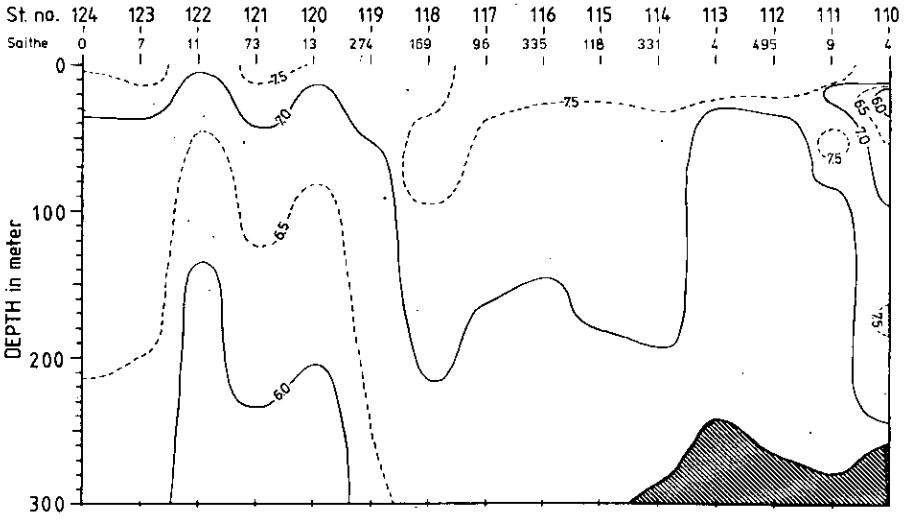
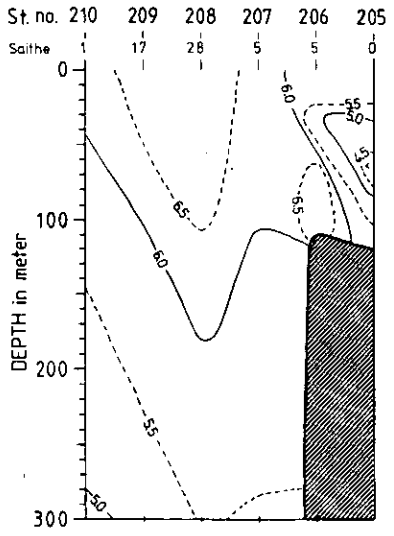
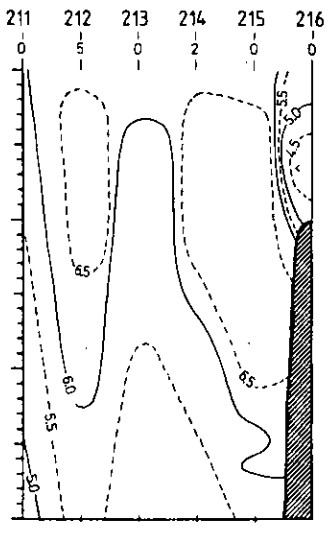


Figure 7. Hydrographical sections from some of the survey tracks showing the vertical distribution of temperature. Station numbers with the corresponding catch of 0-group saithe have been recorded in the right relative position.

Survey track IX:



Survey track X:



Survey track V:

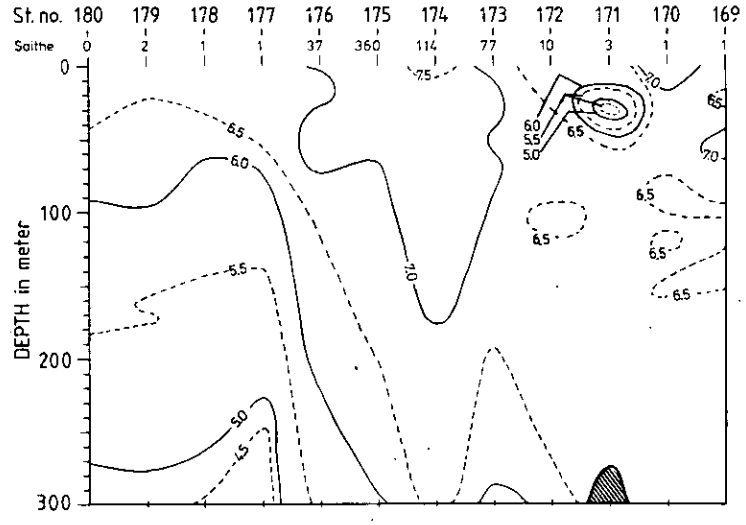


Figure 7 (continue.) Hydrographical sections.

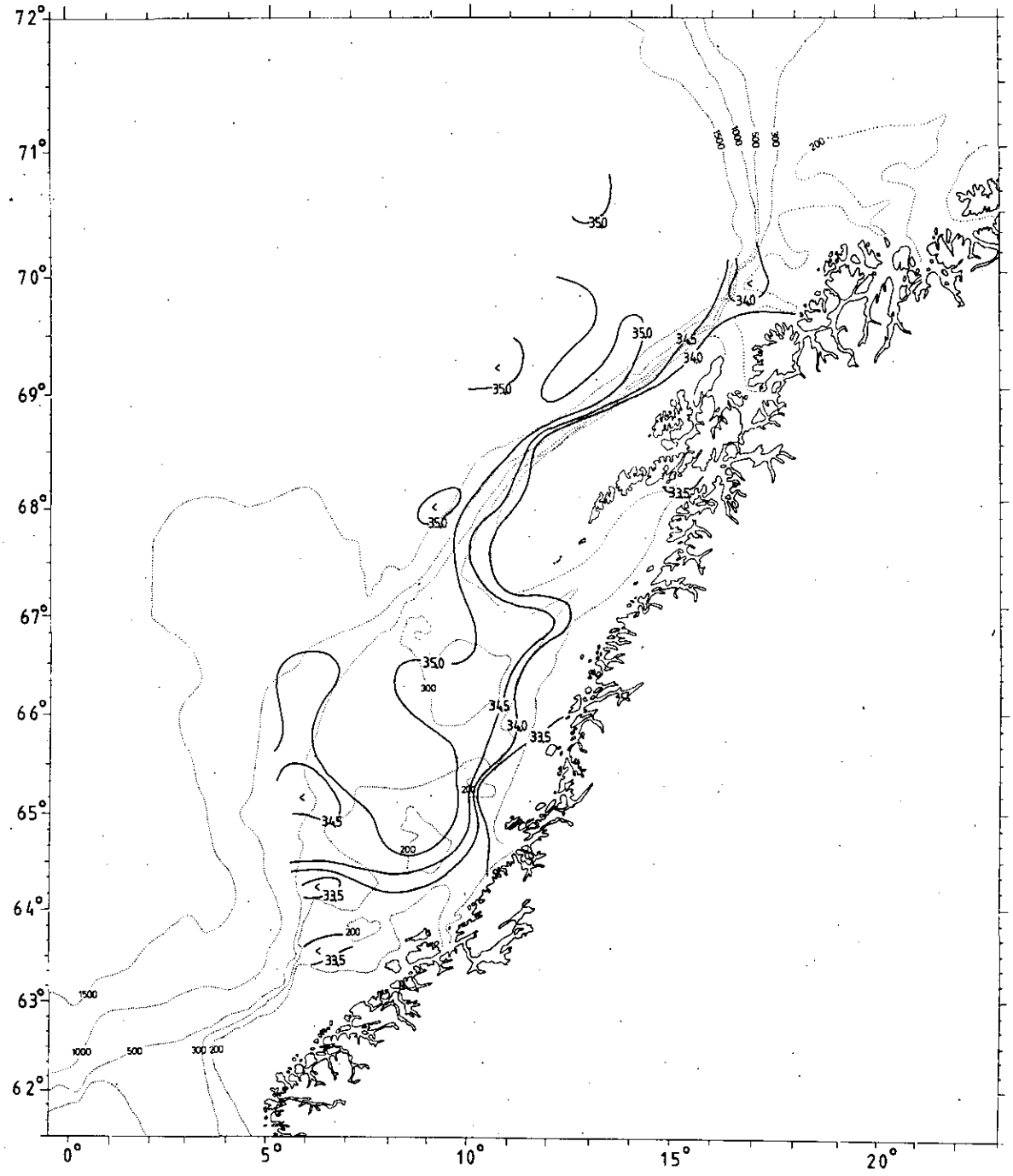


Figure 8. Distribution of salinity in 25 meter depth.

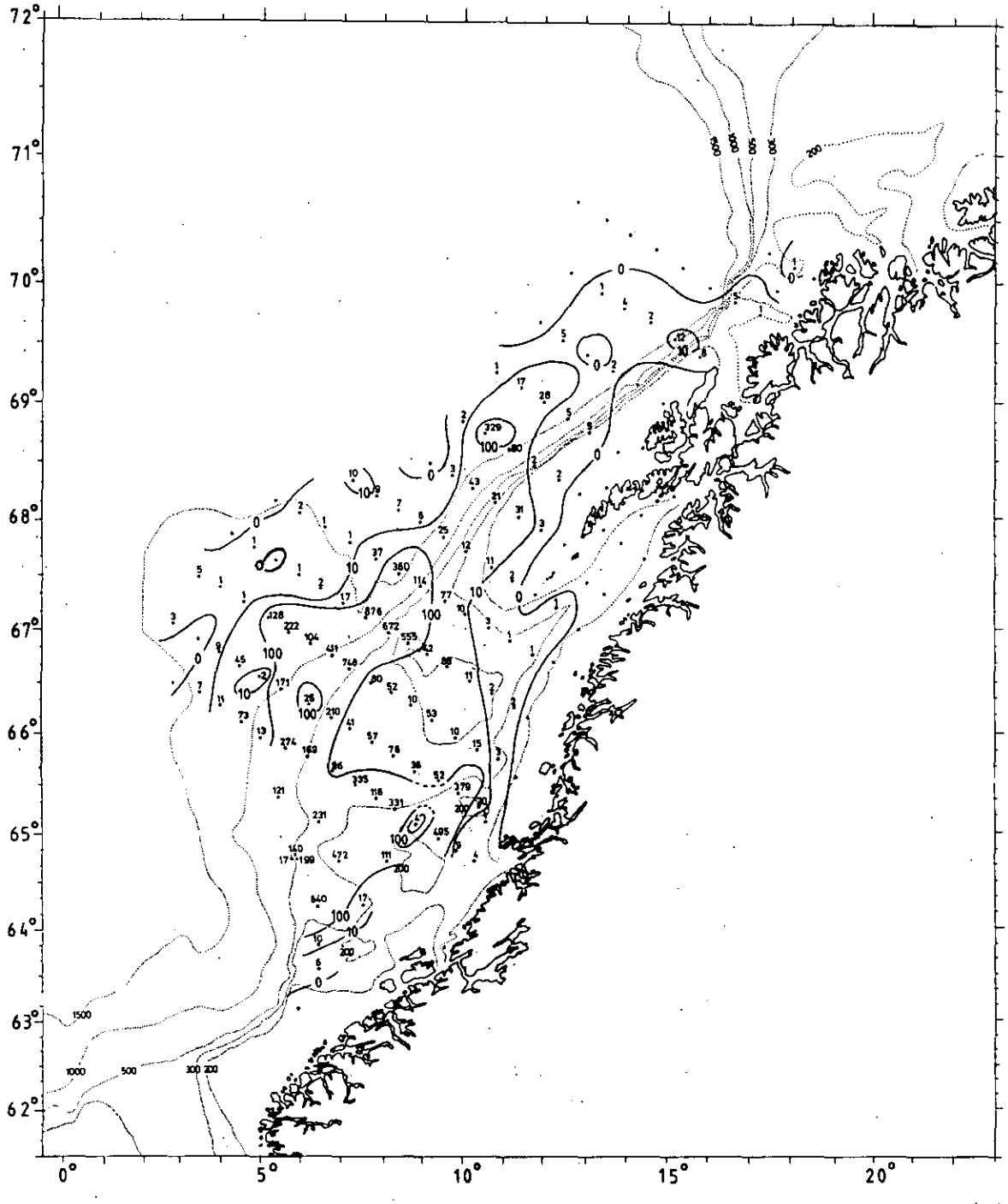


Figure 9. SAITHE. Distribution of saithe postlarvae. Number per 1.8 nautical miles. Stations without catch have only been marked.

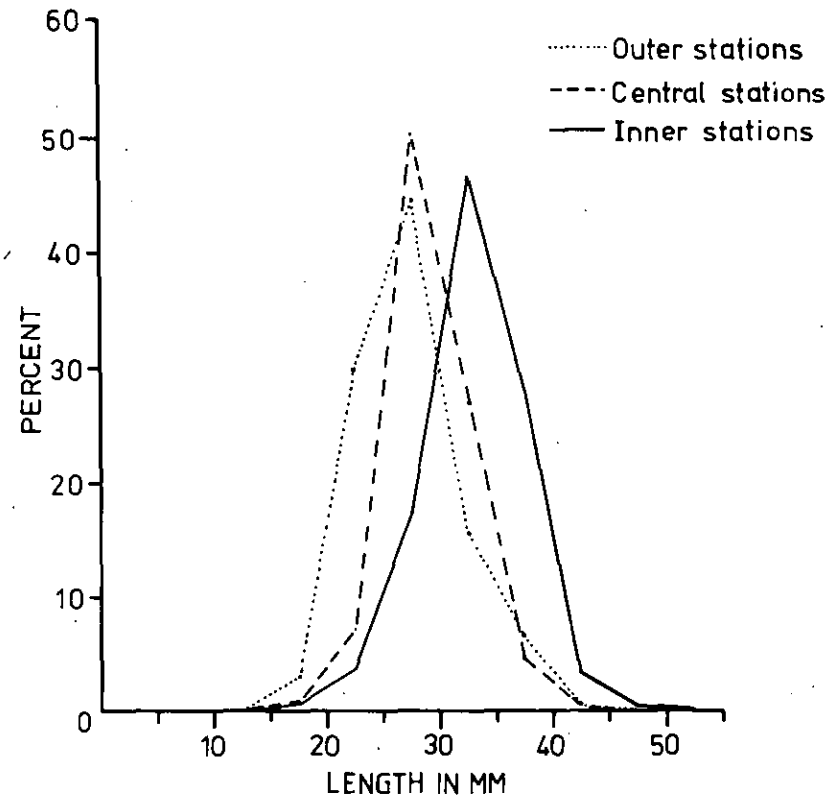


Figure 10. Length distribution of saithe postlarvae on the outer (western), central, and inner (eastern) third of the five southernmost tracks.

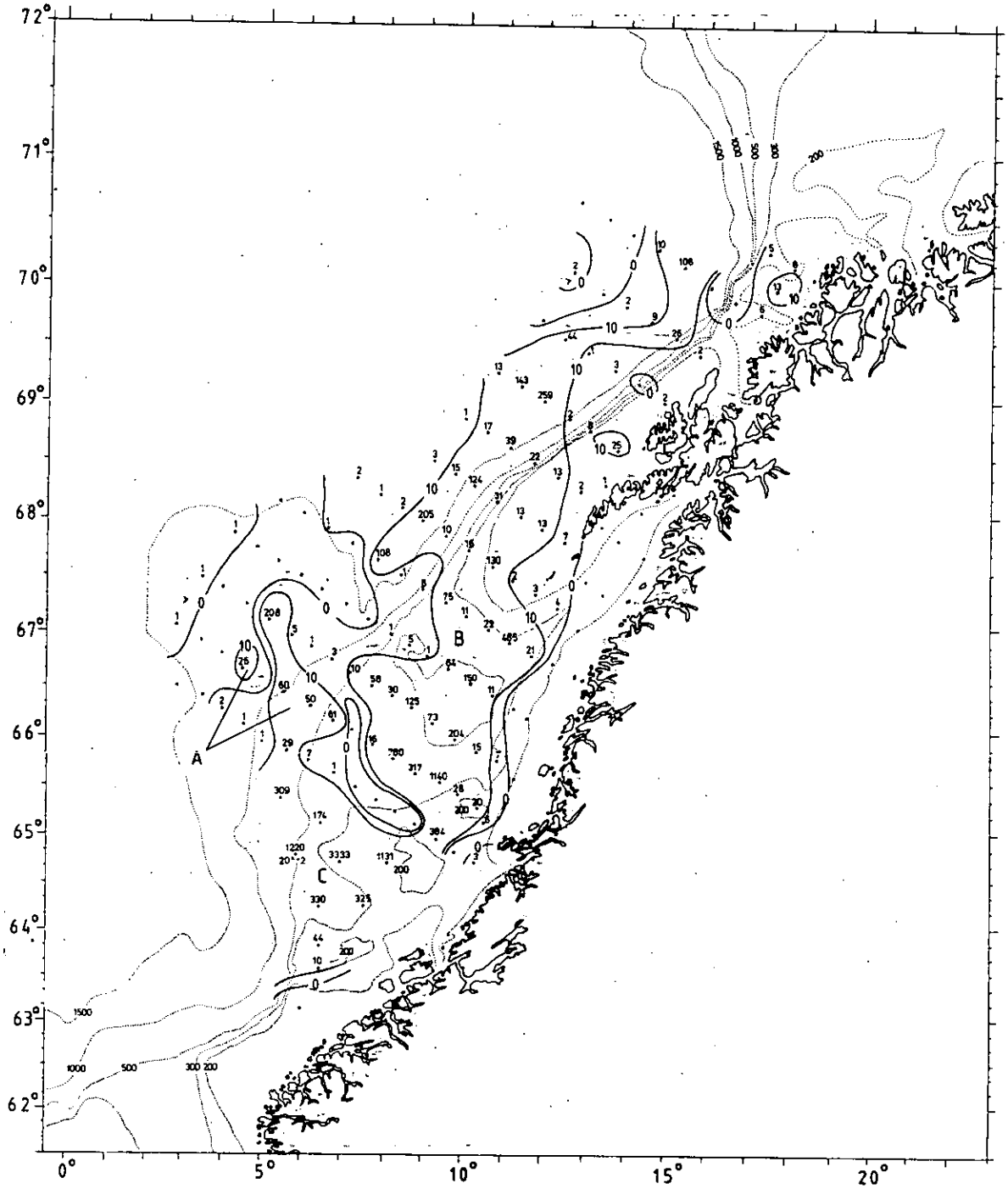


Figure 11. HERRING. Distribution of herring larvae. Number per 1.8 nautical miles. Stations without catch have only been marked. Separate length distributions of larvae from each of the areas A, B, and C have been presented in Figure 12.

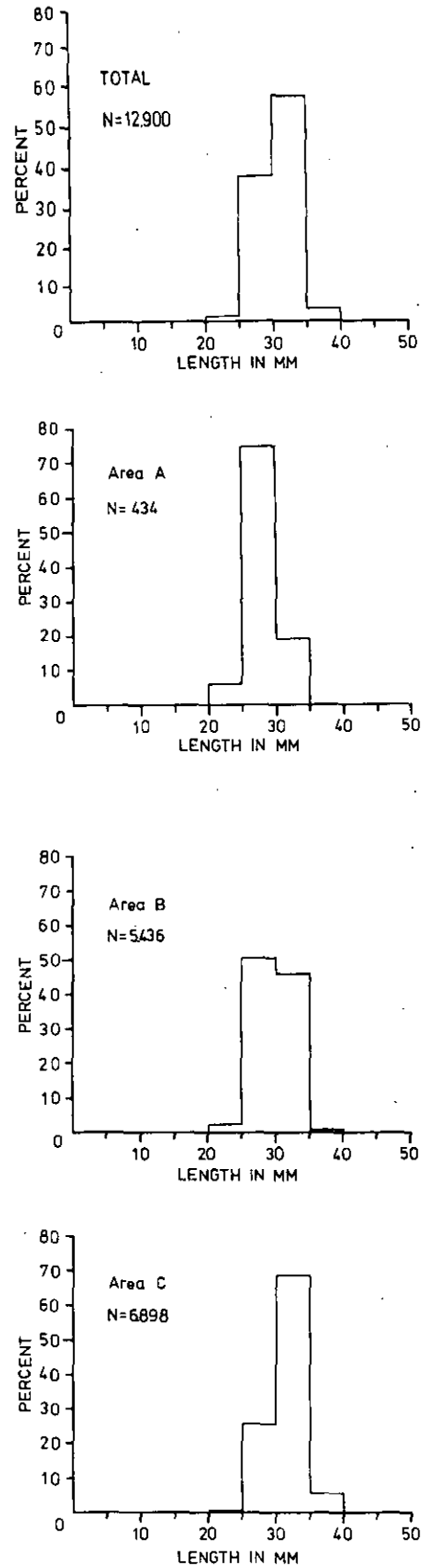


Figure 12. Length distributions of herring larvae from the total surveyed area and from the subareas showed in Figure 11.

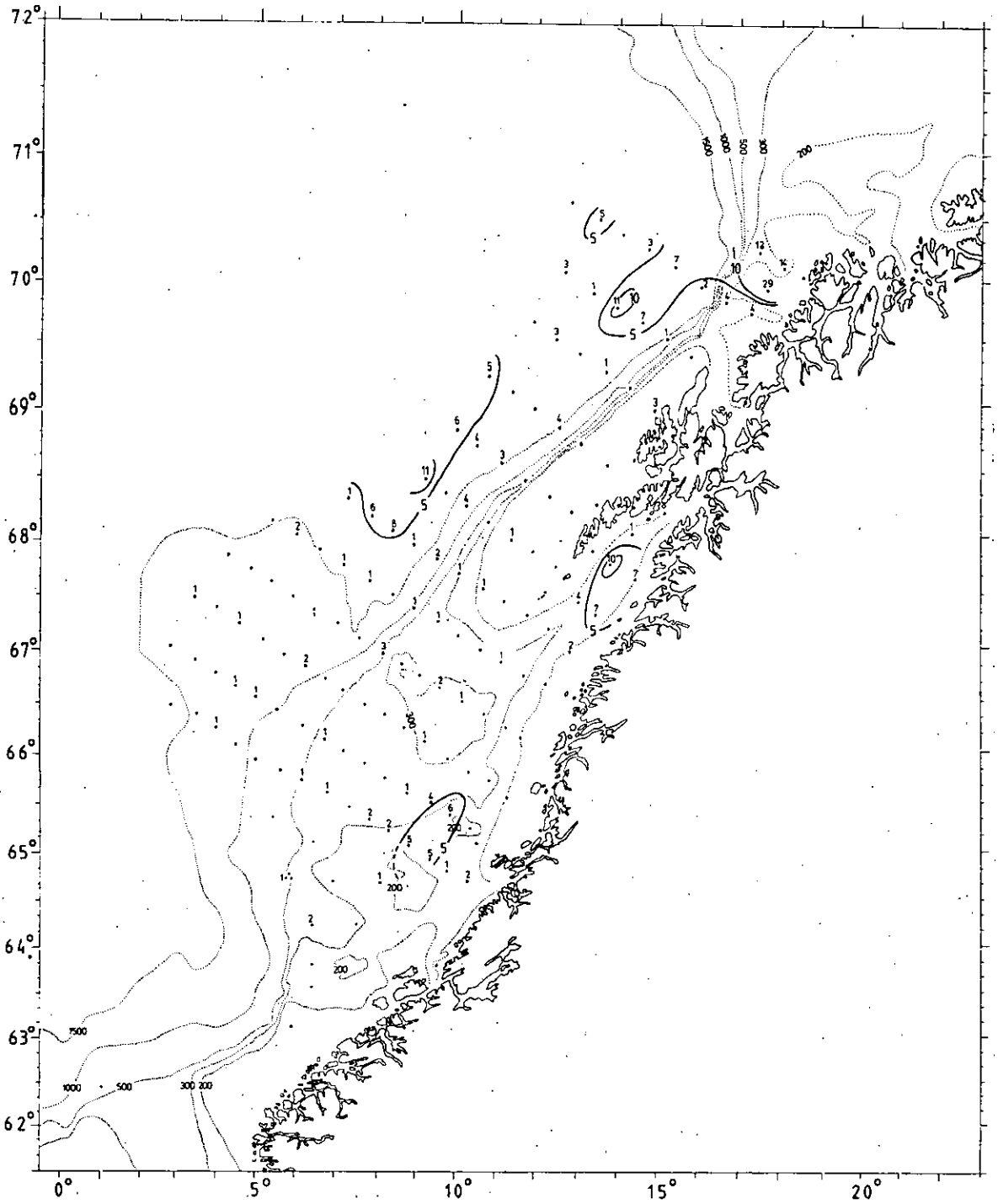


Figure 13. CATFISH. Distribution of catfish postlarvae. Number per 1.8 nautical miles. Stations without catch have only been marked.

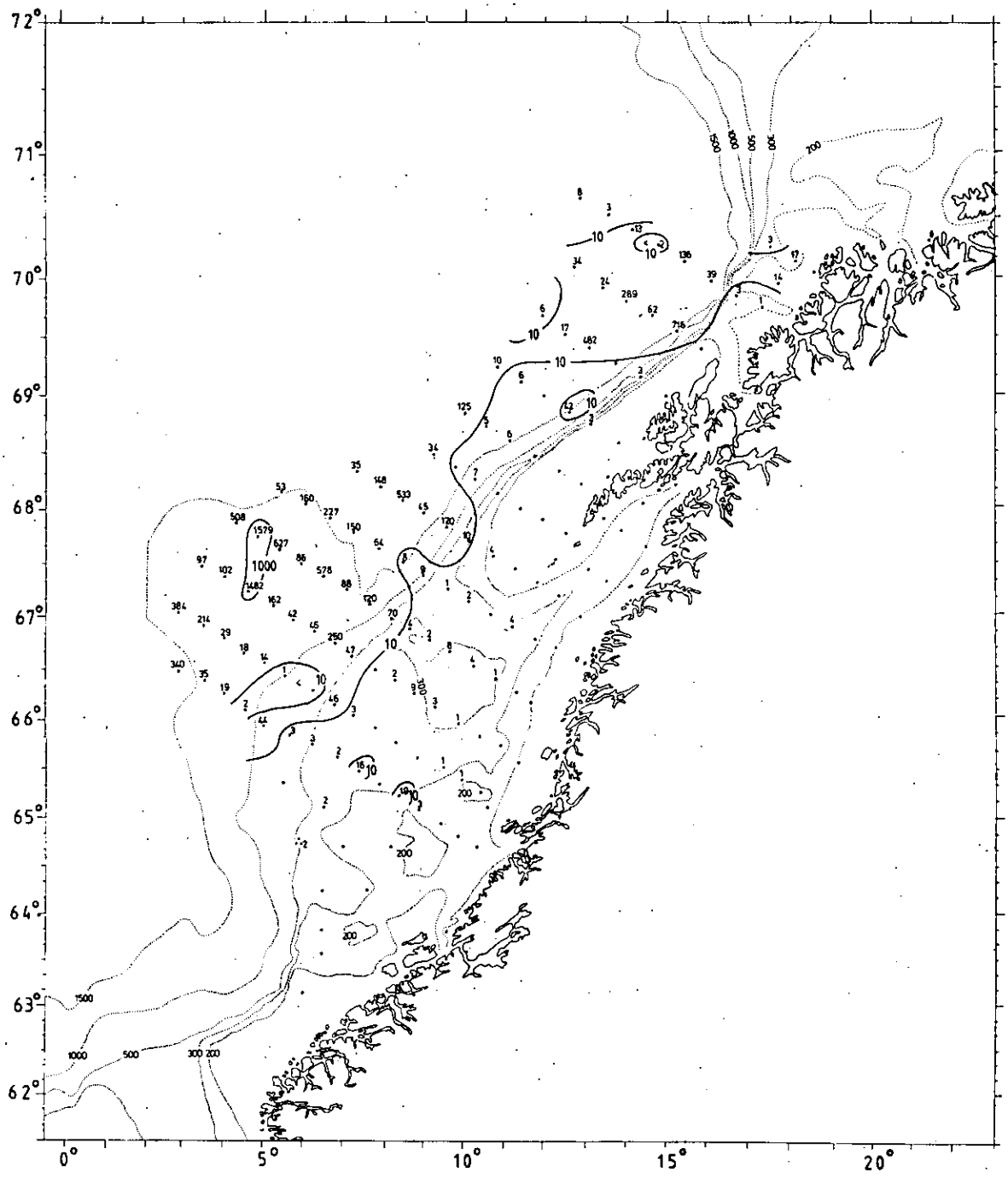


Figure 14. Gonatus fabricii. Distribution of this ten armed squid presented as number per 1.8 nautical miles. Stations without catch have only been marked.