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Denmark (Greenland) Research Report for 1980.

edited by

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This report contains information on the fisheries by Greenland vessels and on research carried out by Greenland Fisheries Investigations (Grønlands Fiskeriundersøgelser) in the NAFO Area and at East Greenland (ICES Subarea XIV) in 1980. Various colleagues in the institute have contributed to the report. The hydrographic research has been reported by Mr. Erik Buch (Institute of Physical Oceanography, University of Copenhagen), and the information on ice has been reported by Mr. H. H. Valeur (The Danish Meteorological Institute).

STATISTICAL AREA / SUBAREA 0

A small part (around 10%) of the commercial fishery for shrimp (*Pandalus borealis*) by Greenland trawlers took place in SA 0 on the grounds adjacent to those in Division 1B. The catch of the Royal Greenland Trade Department amounted to 815 tonnes with an average catch per hour trawled of 486 tonnes, being close to the average for the total offshore area.

SUBAREA 1

A. STATUS OF THE FISHERIES

1. General trends

The nominal catches by Greenland vessels in 1980 are given in Table 1. The figures are provisional.

The nominal catch increased by about 12% from 1979 to 1980 to reach the highest level on record for the fishery by Greenland. The increase from 1979 to 1980 was mainly due to the increase in the shrimp fishery. The landings of redfish, wolffishes, and Greenland cod increased significantly from the 1979 level.

The major part of the offshore finfish catches were taken in Division 1D, while for shrimp Division 1B was the most important division.

For the inshore finfish catches Division 1F and 1E were the most important whereas Division 1A was the one with the highest landings of shrimps.

Table 1. Nominal catches by Greenland vessels in Subarea 1, 1980 (provisional figures), and the relative changes from 1979 to 1980.

Species	Nominal catch 1980 (tonnes round fish)	Percentage change from 1979.
Cod	46 607	+ 1
Greenland cod	5 257	+ 45
Redfish	1 206	+ 380
Wolffishes	3 901	+ 125
Grenadiers (<i>M. berglax</i>)	32	+ 52
Greenland halibut	5 308	+ 1
Halibut	330	+ 150
Capelin	298	+ 14
Atlantic salmon	1 194	- 15
Arctic char	258	+ 47
Lumpsucker x)	1 241	+ 171
Herring	7	+ 40
Industrial fish and fish not specified	210	+ 32
Shrimp	34 266	+ 17
TOTAL (rounded)	100 115	+ 12

x) converted from roe to round fish, factor 3.31.

2. Cod

a. The fisheries. The nominal catch by Greenland vessels was about the same as in 1979. The larger trawlers' catch decreased by 33% because of decrease in effort as well as catch per unit. Catch rate by trawlers in 1980 was just above half that in 1978. The inshore fisheries had a 10% increase occurring mainly in Division 1D and 1E.

The catch of the offshore Greenland trawlers was rather evenly distributed between Division 1B, 1C, 1D, and 1E while the catch in Division 1A and 1F was negligible as usual. The most interesting observation is their catch in Division 1B of about 1 800 tonnes where in 1977-79 virtually no offshore cod fishing took place. This northward shift of part of the fishery is based upon new year classes (1975-77) with a more northern distribution than the 1973 year class which was totally dominating in the 1977-79 fisheries.

The high proportion (60%) in Division 1E-1F of the inshore landings can still be attributed to the 1973 year class which seems to have accounted for more than 80% of the landings in these southern divisions.

b. Forecast for 1981-82. Catches in the first four months of 1981 have been above those in the corresponding period of 1979. Trawlers' catch by the end of April is approaching their total catch of 1980. This increase is due mainly to increased effort which has occurred because access to the shrimp grounds has been rather difficult due to ice.

Reports indicate a very high variation in age composition of the various concentrations of cod, even inside the same parts of the fishing grounds, and the trawlers seem to move around more than previously to find shoals of large fish.

New year classes, especially the 1977 year class, seem to become predominating in the 1981-82 fishery, especially in Division 1B-1D, and a further expansion of the fishery in these northern divisions may be expected. In Division 1E-1F the 1973 year class may continue to be a very important part of the catch, and for these divisions there is at present no observations reported to indicate the same improved recruitment prospects as in the northern divisions.

Further details on the cod stock and the fisheries are found in NAFO SCR Doc. 81/VI/ .

3. Shrimp (*Pandalus borealis*)

a. The fisheries. Nominal catch by Greenland trawlers increased from about 20 thousand tonnes in 1979 to more than 30 thousand tonnes in 1980. This increase pertains only to the offshore fishery while the inshore catches remained stable around 8 000 tonnes.

In earlier years the offshore fishery has mainly been concentrated in Division 1B, but this year the fishing activity has been extended farther northward than in previous years. This displacement of the fisheries has been observed also during the earlier years but in a much smaller scale, part of the displacement being only seasonal within Division 1B. Vessels other than those from Greenland have been restricted from fishing in areas north of 68°N.

b. Forecast for 1981. The stock situation on the offshore shrimp grounds was assessed by the Working Group on Shrimp in November 1980 (NAFO SCS Doc. 80/XI/34). Information discussed at that meeting did not give rise to any proposal for any change in the TAC for the offshore grounds in SA 1, and the adjacent parts of SA 0 (29 500 tonnes). Due to the lack of observations of pre-recruits and to the few age groups in the major part of the catch it is difficult to give a firm forecast for the shrimp fishery in this region.

4. Other fish

The landings of Greenland cod increased considerably compared to the two previous years and reached the same level as in 1977, i.e. about 6 000 tonnes. Landings of Greenland halibut were the same as in 1979, whereas landings of wolffishes and redfish increased compared to 1979 which was mainly due to the increase in catches by trawlers.

The catch of salmon was 1 194 tonnes which fulfilled the quota at 1 191 tonnes. The quota was reached after 26 days' fishing.

B. SPECIAL RESEARCH STUDIES

1. Environmental studies

a. Hydrography (supplied by Erik Buch, Institute of Physical Oceanography, University of Copenhagen). The Greenland Fisheries Investigations did in 1980

decide to increase their hydrographical investigations in the waters off West Greenland and the Disko Island, which resulted in two major cruises in July and November covering the stations shown in Figure 1. Additionally, the Fylla Bank section was visited regularly during the year. A more detailed presentation and discussion of the observations will be published by the present author in the near future.

Vertical Distribution of Temperatures

Through some detective work in a number of old publications, of which Kiillerich (1943) and Hermann (1967) were the most helpful, it has been possible to show the mean temperature in medio June over the upper 40 meters at Fylla Bank (Station 2 in Section I) for the last 100 years (Figure 2). Obviously, observations are missing for a number of years in the period 1880-1940. The broken line at 1.8°C indicates the temperature widely accepted as the lower limit of high survival of cod larvae. It is seen that the temperature in 1980 is just above this limit.

Figure 3 shows the variations of the temperature during 1980 west of the Fylla Bank (Station 4 in Section I). In a short period around 1st April temperatures below 0°C are found in the upper 100 metres, the rest of the year the whole water column has positive temperatures. During the summer a thermocline develops down to a depth of about 40 metres with a maximum surface temperature of 5.7°C around 1st September.

The lower 400 metres (200-600 m depths) are fairly homogeneous at the beginning of the year with temperatures around 1.5°C , but in March-April the first signs of inflowing Irminger water turns up, and at the end of the year this inflow is rather intense with temperatures above 5°C at 200 metres.

The inflow of Irminger water is also clearly seen in Figures 4-7 which show vertical distribution of temperatures in Section I (Fylla Bank), and III (Holsteinsborg) in July and November.

The Disko Bay is in the summer characterized by very sharp vertical gradients in the upper 30 metres, and by surprisingly high surface temperatures, above 10°C , in the area near Godhavn. The temperatures below 100 metres did not change very much from July to November.

Horizontal Temperature Distribution

The horizontal distribution of the temperature for the whole investigated area is visualized in Figures 8-11, showing the distribution at the surface and at 50 metres, which is the column of water with the highest vertical gradients in temperature as well as the water column in which the primary production takes place. At Section V off the Disko Fiord the outer station is clearly influenced by the Baffin Land current in November, with temperatures near the freezing point at the surface (Figure 9.)

These figures also illustrate the inflow of Irminger water as well as the great vertical temperature gradients in the Disko Bay mentioned above.

Current and Optical Observations

During the July cruise observations of currents and a number of optical parameters were carried out.

The currents were measured using gelatine pendulums, Haamer (1974), put out at hydrographical standard depths down to a depth of 300 metres. Figure 12 shows the observed currents at 10 metres. This current pattern is fairly consistent with the hydrographical observations, although the rather strong current in the Vaigat presumably is influenced by the tide.

In the field of optical oceanography observations of light quanta, colour of the sea, secchi depths, and particle scattering were performed. Figure 13 shows the depth of the euphotic zone z_q (1%), i.e. the depth at which 1% of the daylight is left. In the offshore area z_q (1%) is fairly stable with values around 40-50 metres. In the Disko Bay z_q (1%) is smaller and more variable due to particles in the fresh water runoff at various places in the bay.

b. Observations on ice (supplied by Hans H. Valeur, The Danish Meteorological Institute). Regular aerial observations of the sea ice around Greenland are carried out by the Danish Meteorological Institute (DMI). Observations in 1980, as usual, were concentrated on the waters around Cape Farewell, while other areas have been observed periodically, according to navigational need.

Further, a special reconnaissance programme has been executed jointly by DMI and Danish Hydraulic Institute during the period July the 17th to September the 24th covering the waters off the east coast between 66°N and 77°N aiming to support geological offshore investigations.

In addition to the aerial observations satellite images have been used increasingly, especially concerning the waters off East Greenland.

The ice conditions were very close to or slightly lighter than normal. Particularly, it should be mentioned that the break-up in Melville Bay was slightly earlier (about 2 weeks) than usual. Further, the polar ice belt off the east coast decreased a few weeks earlier than normally, i.e. at the end of August the ice belt was hardly present south of 70°N .

c. Plankton. Oblique hauls with 2 m stramin net (30 min., 225-0 m wire, app. 50-0 m depth) were taken in July in the same standard sections where hydrographic observations were made, at some northern stations west of Disko Bay and Disko Island, and in the Disko Bay. Furthermore, plankton hauls were made throughout the year at the entrance to Godthåbsfjord.

Three sections (Fylla Bank, Lille Hellefiskebanke, Holsteinsborg sections) have been operated regularly for a series of years in July. The mean volume per 30 min. haul for all stations was very big in 1980, mainly due to big quantities of *Aglantha digitale*, but also other plankters were numerous. In Table 2 are shown the mean volumes during the last five years.

Table 2. Mean plankton volume in millilitre per 30 min. stramin net haul in Davis Strait in the three sections (Fylla Bank, Lille Hellefiskebank, Holsteinsborg) in 1976-80.

Year	Fresh	Preserved		Number of hauls
	volume	volume	% of fresh	
1976	268	53	20	15
1977	822	145	18	15
1978	418	86	21	15
1979	624	99	16	15
1980	1245	444	36	15

Fish larvae were more numerous in 1980 than in 1979. Mean number of shrimp larvae was normal in the three sections; however, they were more concentrated in the southern section than in previous years. North of the standard sections and in the Disko Bay dense concentrations of shrimp larvae were observed at some stations. Mean numbers of shrimp (*Pandalus borealis*) larvae and some fish larvae during the last five years in Davis Strait are shown in Table 3. A dense concentration of sand eel larvae was located north of the standard sections off Disko Bay (1350 larvae in one haul), while the other fish larvae were almost limited to the three standard sections mentioned. Capelin larvae were frequent in Disko Bay, but were not observed in offshore water. Eggs of American plaice are normally numerous in Davis Strait.

Table 3. Mean numbers of shrimp larvae and some fish larvae per 30 min. stramin net haul in Davis Strait (Fylla Bank, Lille Hellefiskebank, and Holsteinsborg sections).

Year	Shrimp	Cod	Greenland	American	Sand eel
			halibut	plaice	
1976	?	0.7	3.5	2.9	47.1
1977	49	0.6	3.6	0.9	6.5
1978	2	0.3	1.7	0	2.3
1979	48	0.9	0.4	1.5	1.1
1980	43	2.9	17.7	18.7	3.4

d. Other environmental studies. Monitoring studies at a disposal site for tailings from a lead-zinc mine and mill in West Greenland continued. Lead, zinc, cadmium, and copper are monitored in sea water, sediments, and marine organisms including fish, seals, seaweed, and mussels.

Baseline studies at a uran deposit in South Greenland continued. A suite of elements in the marine environment is being measured by means of atomic absorption spectrometry and instrumental neutron activation analysis. Furthermore, radioactivity measurements are being made.

A mussel watch program expected to run for 5 years was initiated in a

fiord system in West Greenland unaffected by local inputs of pollutants. The objective of this study is to improve the knowledge of the natural variation of the level of a suite of elements in *Mytilus edulis*, *Ascophyllum nodosum*, *Fucus vesiculosus*, and *Fucus distichus*. Samples of these are analysed by means of atomic absorption spectrometry and instrumental neutron activation analysis.

2. Biological studies

a. Cod.

Eggs and larvae. The average number of cod larvae found in the plankton in July was 2.9 per 30 min. haul in Sections I-III, the highest since 1975 (3.2 larvae), but still a rather small number. The reference temperature on Fylla Bank (see section on hydrography) was just above the "critical" level of 1.8°C. The year class of 1980 may thus show up as one of the relatively good ones amongst those after 1973 although not comparable to the good year classes of the 1950-60's. Occurrence of cod larvae is shown in Figure 14.

Occurrence of pre-recruit cod. Cod at age 1 (the 1979 year class) did not have a chance to be observed in the 1980 research, nor in the commercial fishery. However, in the beginning of 1981 it has been observed as by-catch in catches of shrimp in the southern part of Division 1B. It is considered to be a year class which will contribute to a continuation of the northward expansion of the fishery mentioned in the section on the status of the fisheries.

2-year old cod (year class 1978) have not occurred in any noteworthy number in discards from pound nets, nor in research catches, and the year class is still a very poor one.

3-year old fish (year class 1977) on the other hand have shown up in considerable quantities in catches by all gears in Division 1B-1D. A good part of the catch of this age group may have been discarded as indicated by the skew length distribution of some of the samples (see Figure 16). It will no doubt be the predominating year class in the 1981-82 fishery, at least in Division 1B-1D.

More details on judgement of the pre-recruits are found in NAFO SCR Doc. 81/VI/ .

Cod in commercial landings. The 1973 year class, which was the major contributor to the 1977-79 fisheries, still played the role as the most important one in 1980. This position was, however, maintained only due to its very large proportion (above 80%) in the fisheries in Division 1E-1F. In the offshore fishery by Greenland trawlers in Division 1B-1E the 1975 year class was the predominating one (in terms of number) followed by the 1973 and 1974 year class.

In the inshore fisheries in Division 1B-1D year classes 1979, 1976, and 1975 were the most numerous ones in the said order, and there is likely to have been a considerable discard of fish belonging to the 1977 year class.

Figure 15 and 16 show examples of age and length composition of landings from offshore trawlers and from inshore fisheries, respectively. Further de-

tails on numbers caught by age are given in NAFO SCR Doc. 81/VI/ .

Tagging experiments. A total number of 1022 cod was tagged, mainly in Division 1D and 1E. Tagging lists have been supplied and distributed by the NAFO Secretariat.

b. Atlantic salmon. Scales from about 600 salmon were sampled from the small research cutter TORNAQ in an area south of Godthåb (Division 1D). The scales will be analysed in Canada and incorporated in the report from the ICES Working Group on North Atlantic Salmon.

A biologist from the Danish Institute for Fisheries and Marine Research participated in the Canadian salmon cruise at West Greenland in August.

c. Redfish. Samples of small redfish caught as by-catches in the offshore shrimp fishery show that almost all small redfish taken in that fishery belong to the species *Sebastes mentella*.

Preliminary investigations in the Godthåb Fiord (Division 1D) show a local population of *Sebastes mentella*, which spawn in the fiord from about March to May. It is the only place at West Greenland where mature females of redfish (both *Sebastes marinus* and *Sebastes mentella*) have been taken in quantities.

d. Other fish. Age and/or length samples of commercial species other than those already mentioned were sampled on a routine basis from research vessels. These are Greenland cod, Greenland halibut, striped and spotted wolffish, American plaice, and Atlantic halibut. From commercial landings samples of Greenland halibut, Atlantic halibut, striped and spotted wolffish were taken.

Studies of change in weight during storage have been carried out for cod and shrimp.

A break down into species of the two wolffishes taken in the various fisheries has been started.

Tagging experiments. In connection with the environmental program the following species have been tagged in Division 1A: Greenland halibut 30, American plaice 3, cod 12, Greenland cod 13, and spotted wolffish 9.

e. Shrimp (*Pandalus borealis*). Like in previous years, the research on shrimp had high priority in the program of the institute. As the major part of the research and the results were presented in research documents and working papers to the November shrimp assessment meeting only a list of the activities is given here (Ref. NAFO SCR Doc. 80/XI/169 & 80/XI/174).

I) Sampling of catch statistics from the commercial shrimp fishery.

II) Bottom photography was carried out on the offshore grounds in Division 1A-1B between 66°N and 69°30'N to assess the density of the shrimp. A total of 17 stations were operated in August. A mathematical model for the distribution of shrimp was introduced to describe the biomass dependency of some easily measurable parameters and thus derive biomass estimates for the whole area sampled.

III) Research vessel hauls and sampling on a number of offshore standard stations of which some have been operated since 1968.

IV) Monthly observations and sampling on board commercial shrimp vessels from January to July as a continuation of the 1979 sampling program to elucidate a.o. the nature of the diurnal migration of different sexual components to the shrimp stock.

f. Participation in cruise by other nations. Scientists from the institute participated in surveys with WALTHER HERWIG and ANTON DOHRN of the Federal Republic of Germany, and with the Icelandic research vessel BJARNI SÆMUNDSSON. All these surveys were concentrated on occurrence of cod and redfish.

g. Marine Mammals. Previous years' collecting of material from the harvest of harp and hooded seals was continued. At the November 1980 meeting of STACRES were presented an analysis of reproductive material of hooded seal collected in South Greenland (SCR Doc. 80/XI/158), a review of hooded seal studies in Greenland 1970-79 (SCR Doc 80/XI/170), and a report on harp seal recoveries in Greenland 1979-80 (SCR Doc 80/XI/171).

As in 1979 sampling of biological material of minke whale and observations of all whale species were carried out in June-September on a Norwegian whaling vessel operating in the Davis Strait. In addition, 10 fin whales, 4 humpback whales, and one minke whale were marked.

EAST GREENLAND

A. STATUS OF THE FISHERIES

The total Greenlandic landings from this area (ICES Subarea XIVb) amount to 2000 tonnes in 1980 (preliminary figures), a decrease of about 30% from 1979. The local fishing at Angmagssalik resulted in landings of 1550 tonnes cod (approximately the same as in 1979) and 1 ton of Atlantic salmon.

The decrease in the total landings from ICES Subarea XIVb might be due to the decrease in the offshore catches of cod which dropped about 1300 tonnes compared to 1979.

B. SPECIAL RESEARCH STUDIES

Practical fishing experiments

a. Cod. In 1980 a pound net fishery for cod was introduced in the Angmagssalik district. The experiment was carried out from late spring to autumn.

b. Capelin. Experimental fishery for capelin in the offshore areas of ICES Division XIVa and XIVb was carried out by a number of Danish purse seiners. A total catch of 10.762 tonnes was obtained.

c. Shrimp (*Pandalus borealis*). In 1980 the institute introduced a special research on the East Greenland shrimp stock. The results from this research together with information from the commercial fishery have been presented in research documents and working papers to the shrimp assessment meeting in November 1980 (NAFO SCR Doc. 80/XI/164).

The research activities were:

I) Sampling of catch statistics from the commercial fishery and analysis of logbook information to give a description of the fishing area and of the distribution of this stock.

II) Observations and sampling on board commercial trawlers in April, August, and October to obtain information on the biology and composition of the stock and to observe the species composition and the amount of by-catches.

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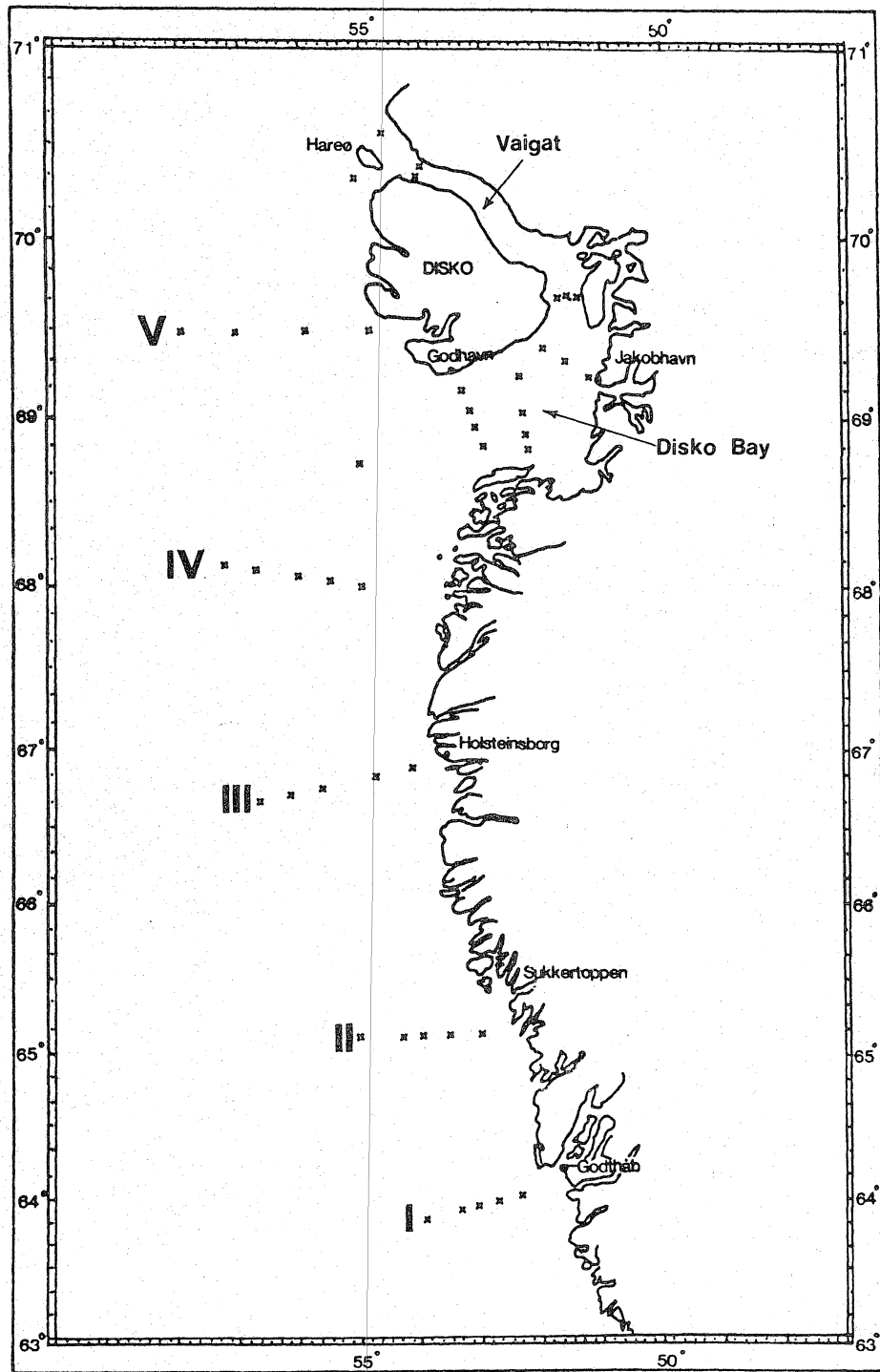


Figure 1. Hydrographic stations operated in 1980. The international standard sections are I (Fylla Bank), II (Lille Hellefiskebanke), III (Holsteinsborg), and IV (Egedesminde). The stations are numbered from east to west.

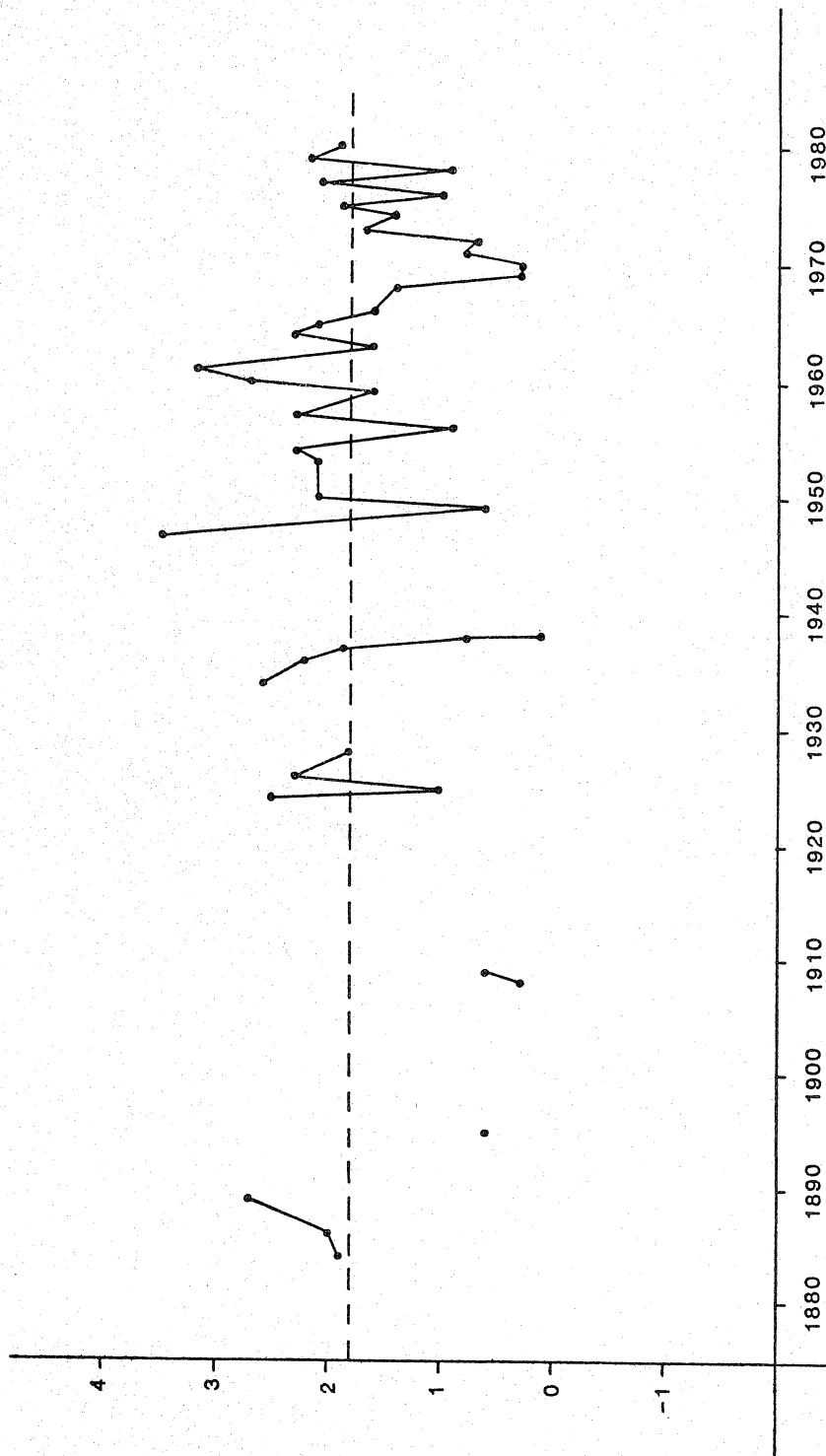


Figure 2. Mean temperatures ($^{\circ}\text{C}$) over Fylla Bank at Station 2 (0-40 m depths) in June in the period 1880-1980. The broken line indicates the critical lower temperature (1.8°C) for a good survival of the cod larvae.

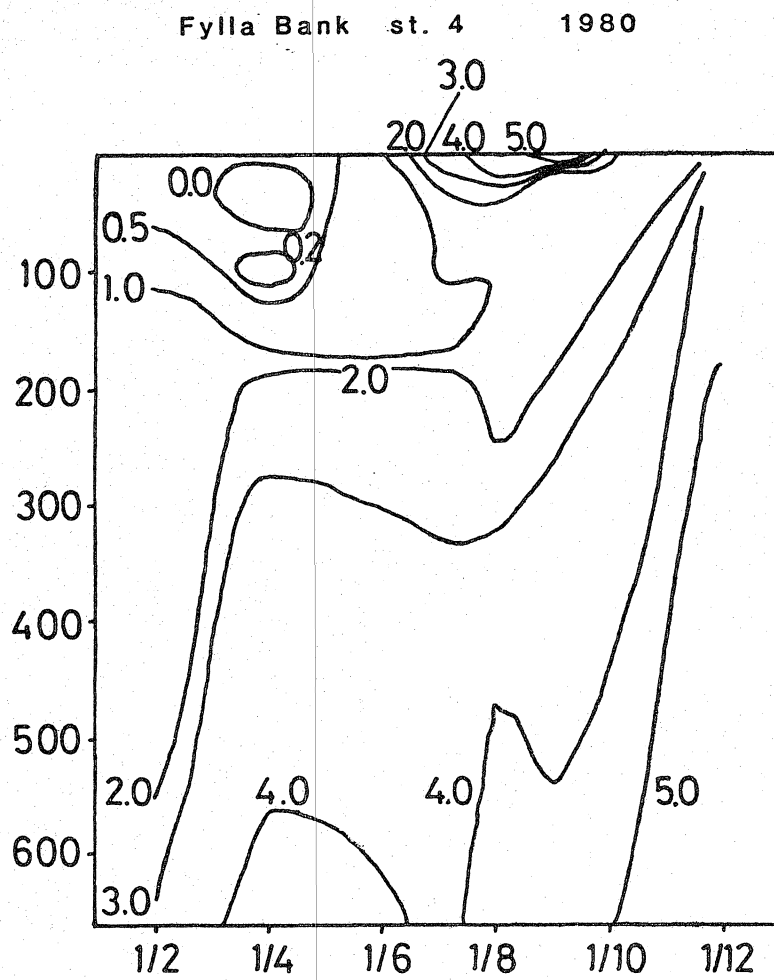


Figure 3. Temperatures ($^{\circ}\text{C}$) during 1980 west of Fylla Bank,
Section I, Station 4.

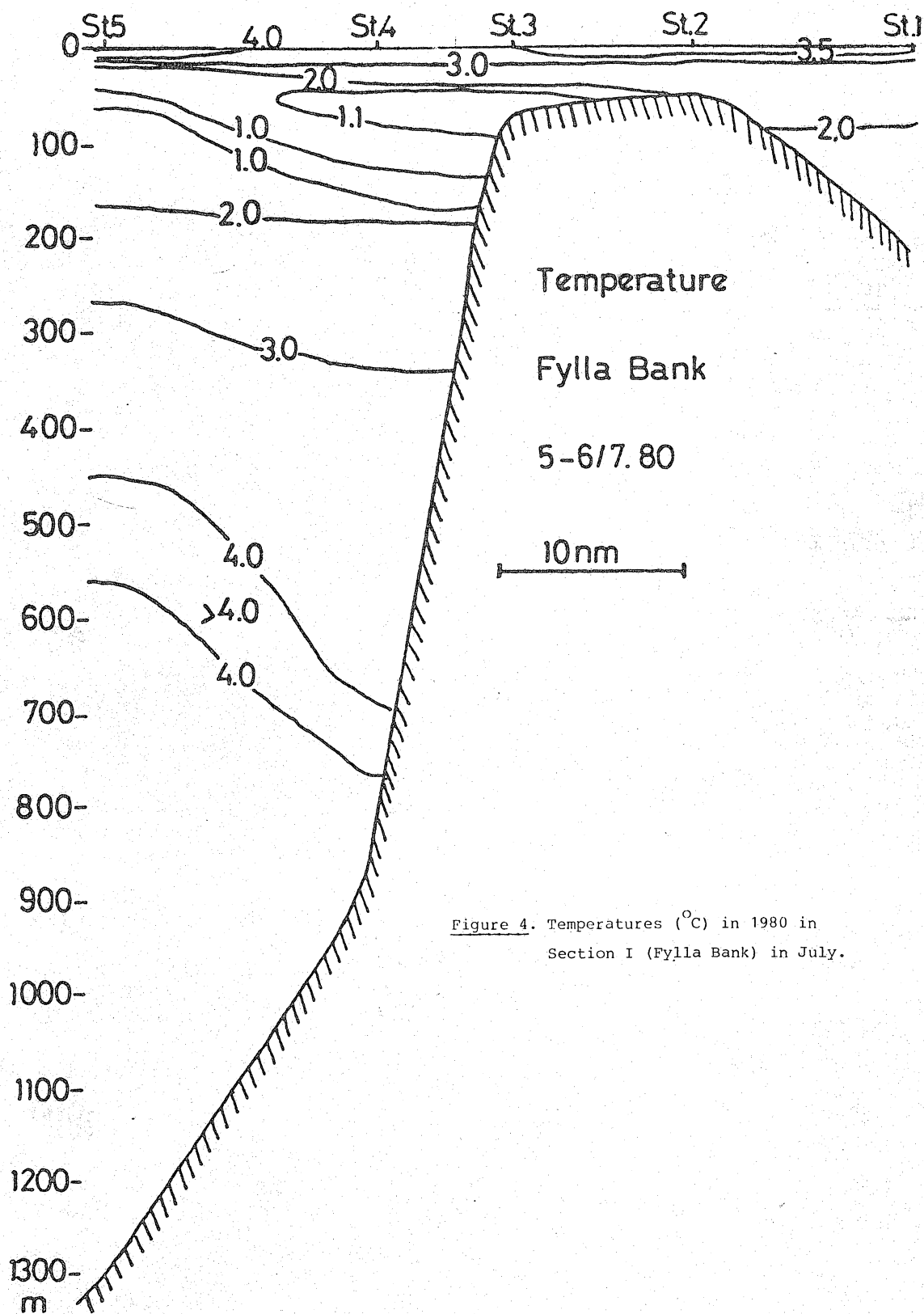


Figure 4. Temperatures ($^{\circ}\text{C}$) in 1980 in
Section I (Fylla Bank) in July.

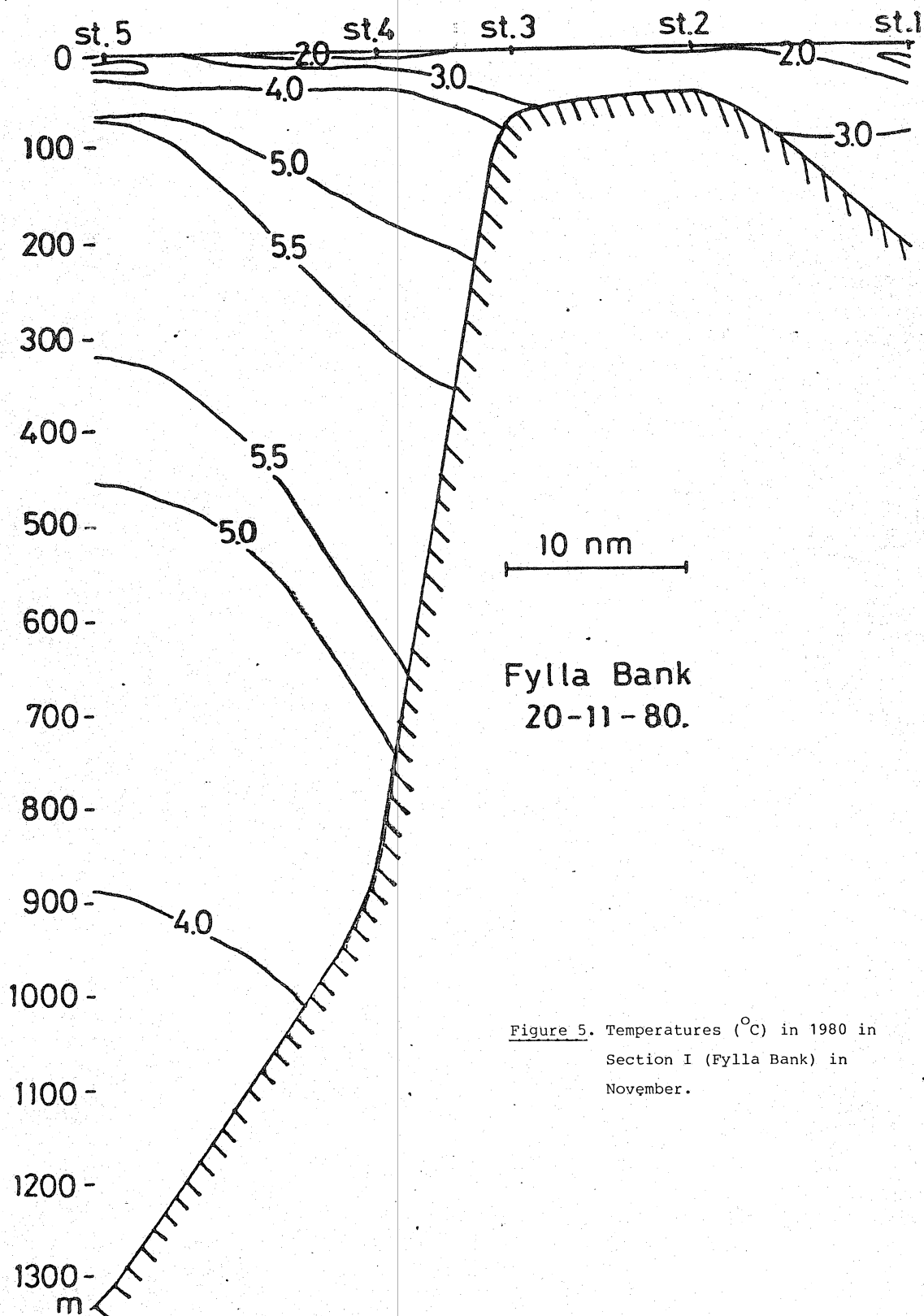


Figure 5. Temperatures ($^{\circ}\text{C}$) in 1980 in Section I (Fylla Bank) in November.

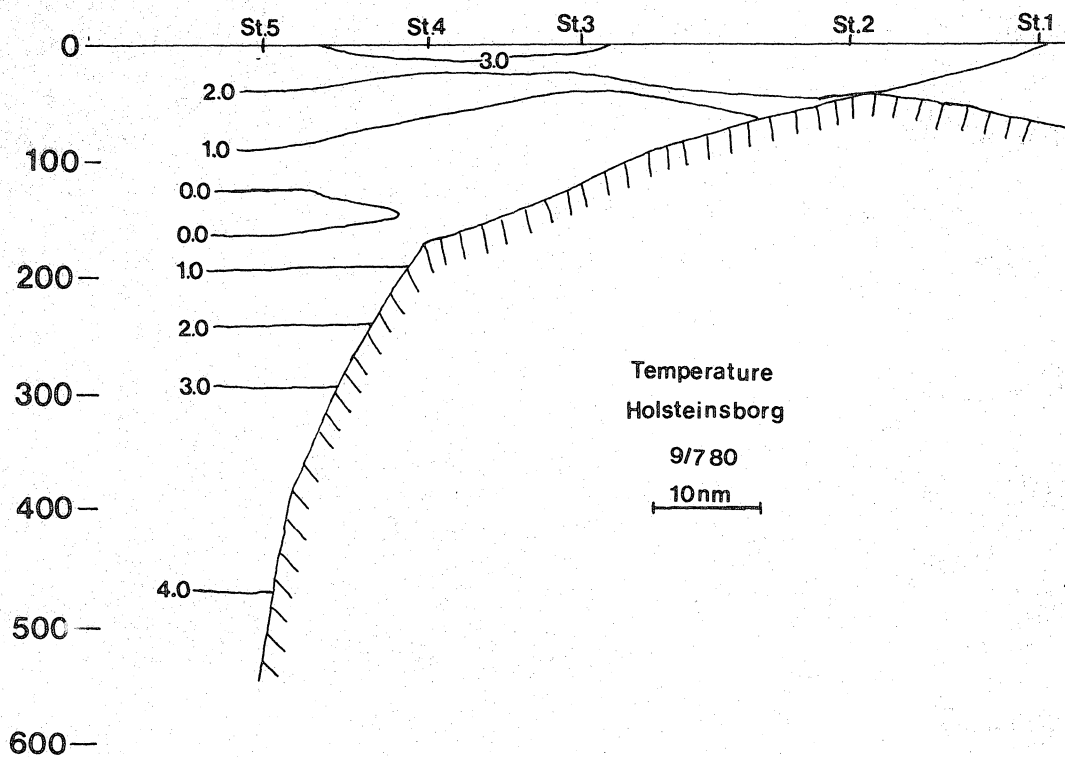


Figure 6. Temperatures ($^{\circ}\text{C}$) in 1980 in Section III (Holsteinsborg) in July.

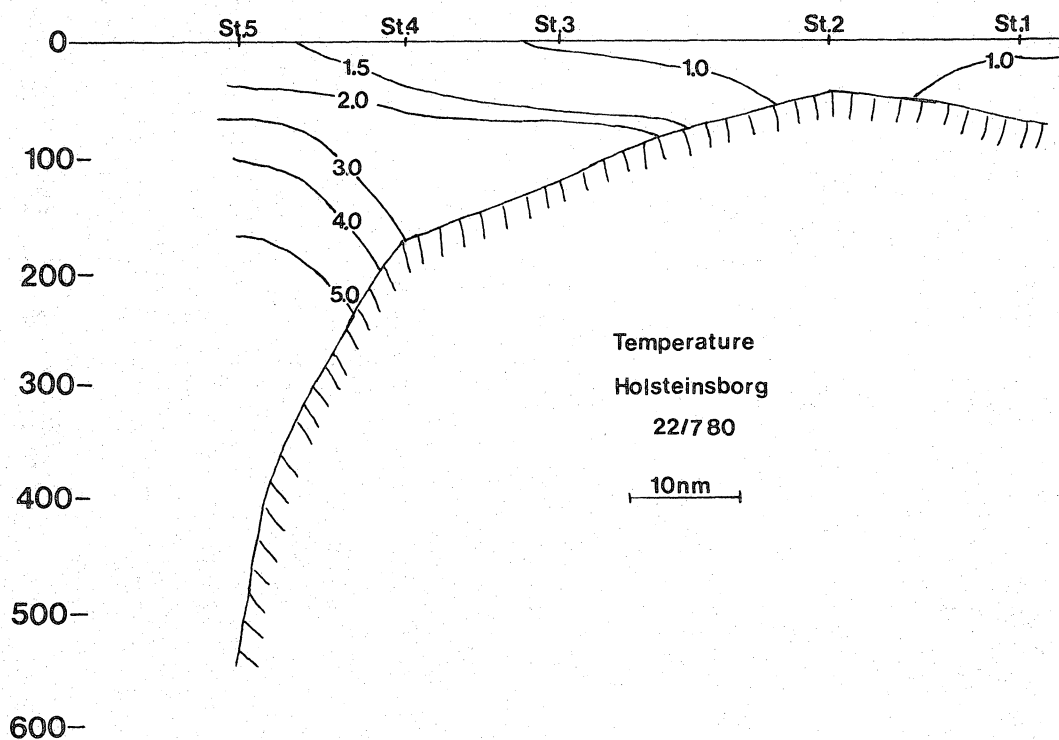


Figure 7. Temperatures ($^{\circ}\text{C}$) in 1980 in Section III (Holsteinsborg) in November.

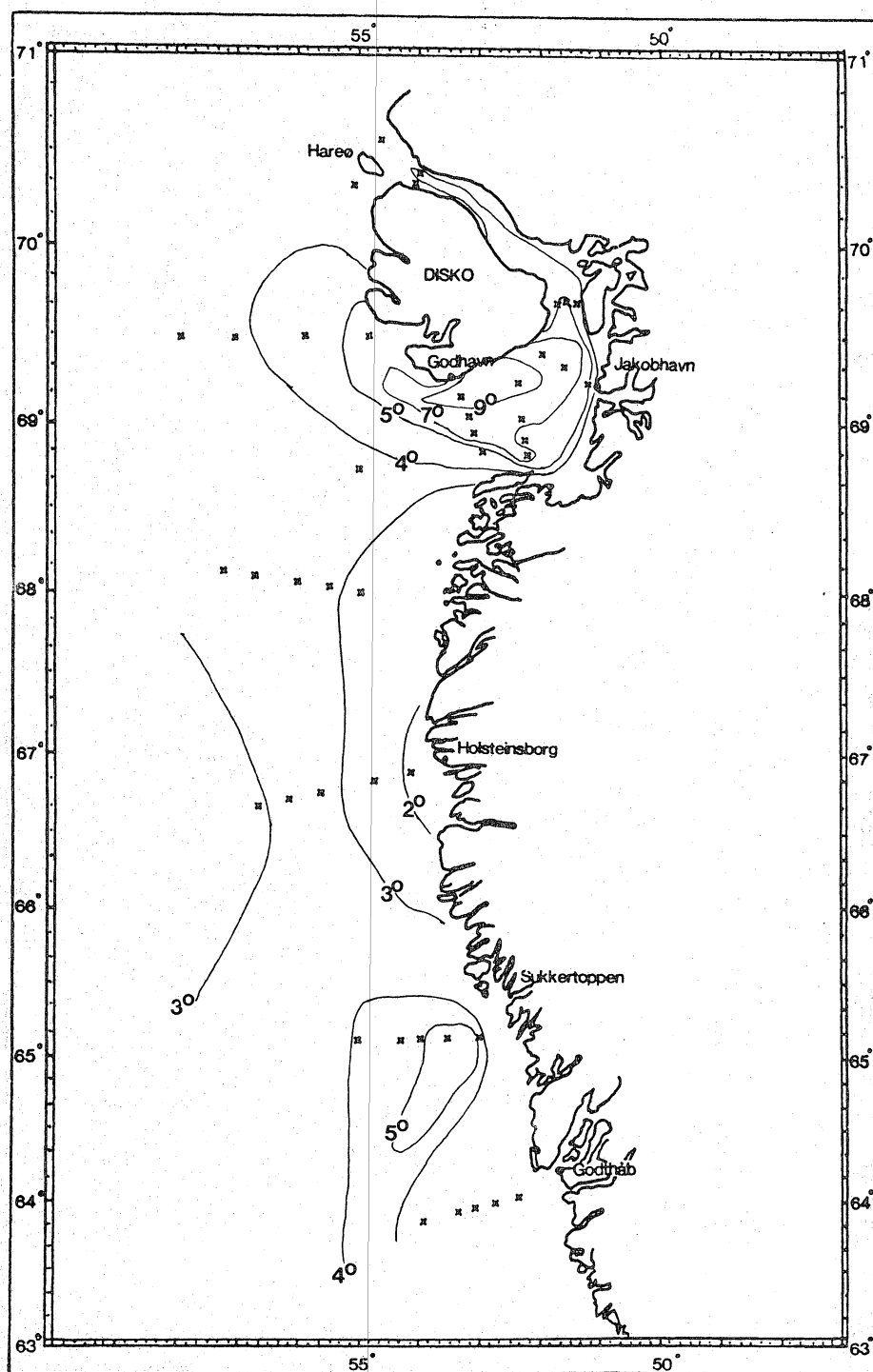


Figure 8. Surface temperatures ($^{\circ}\text{C}$) in 1980 in July.

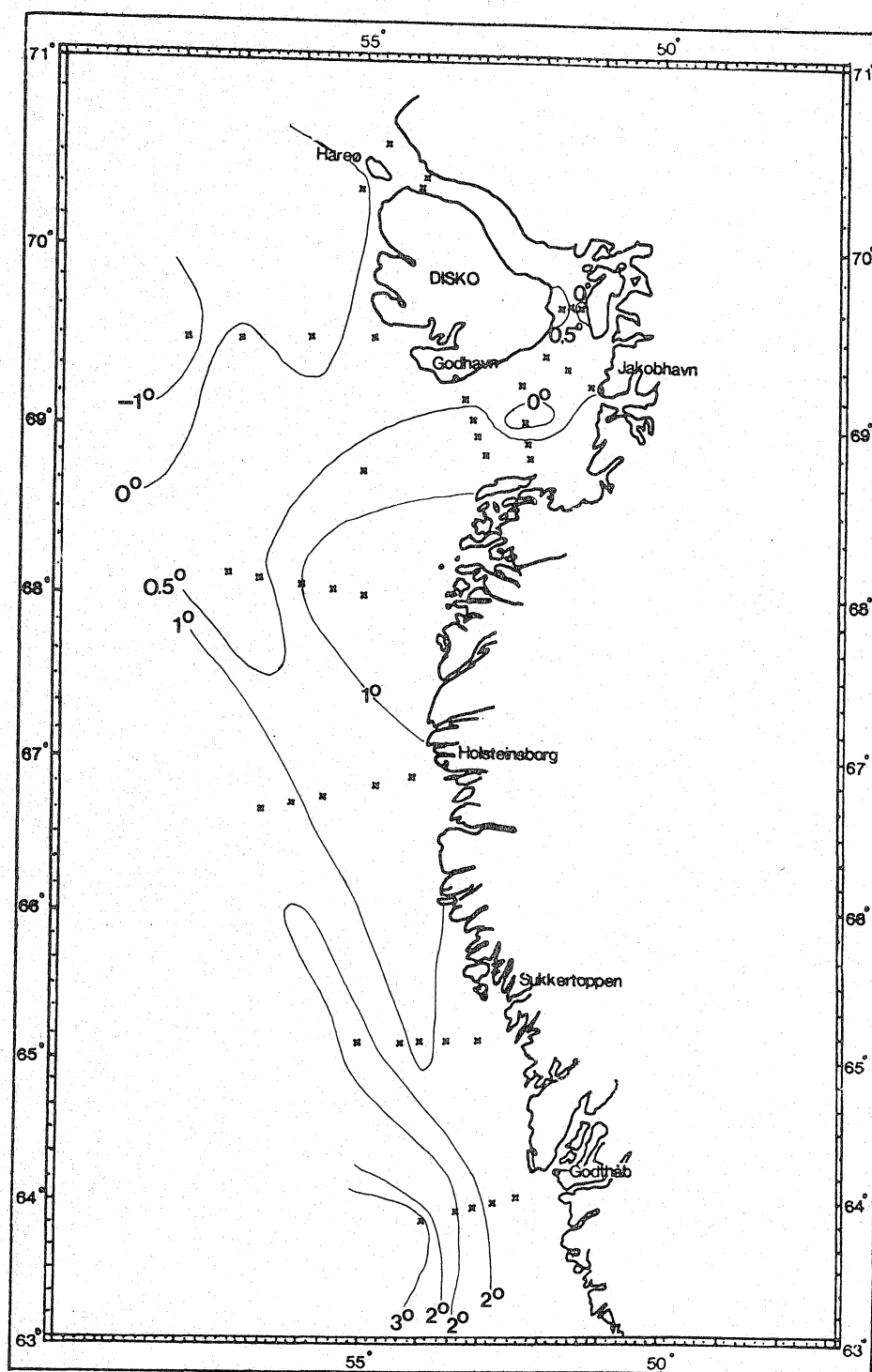


Figure 9. Surface temperatures ($^{\circ}\text{C}$) in 1980 in November.

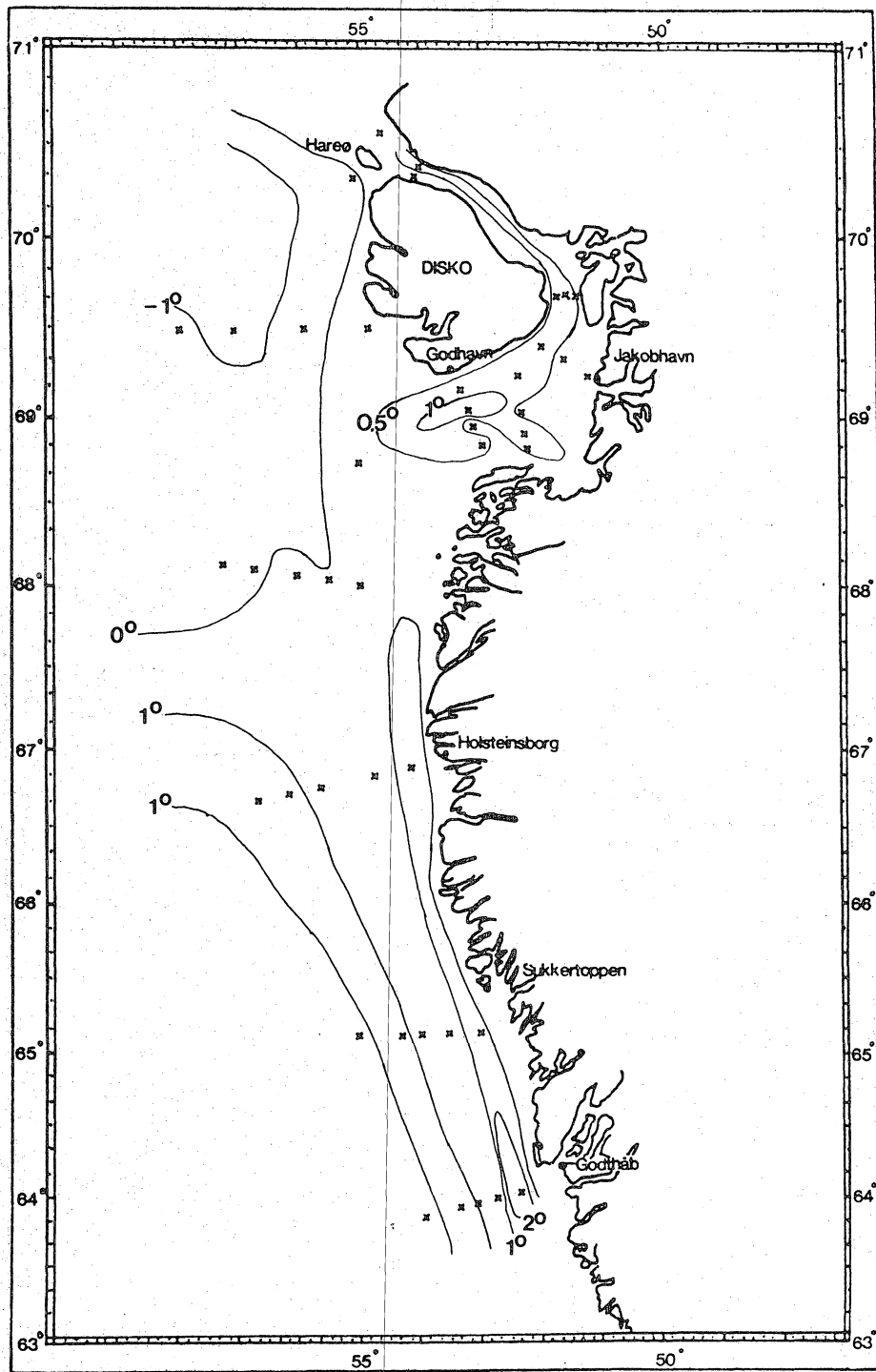


Figure 10. Temperatures ($^{\circ}\text{C}$) at 50 m depth in 1980 in July.

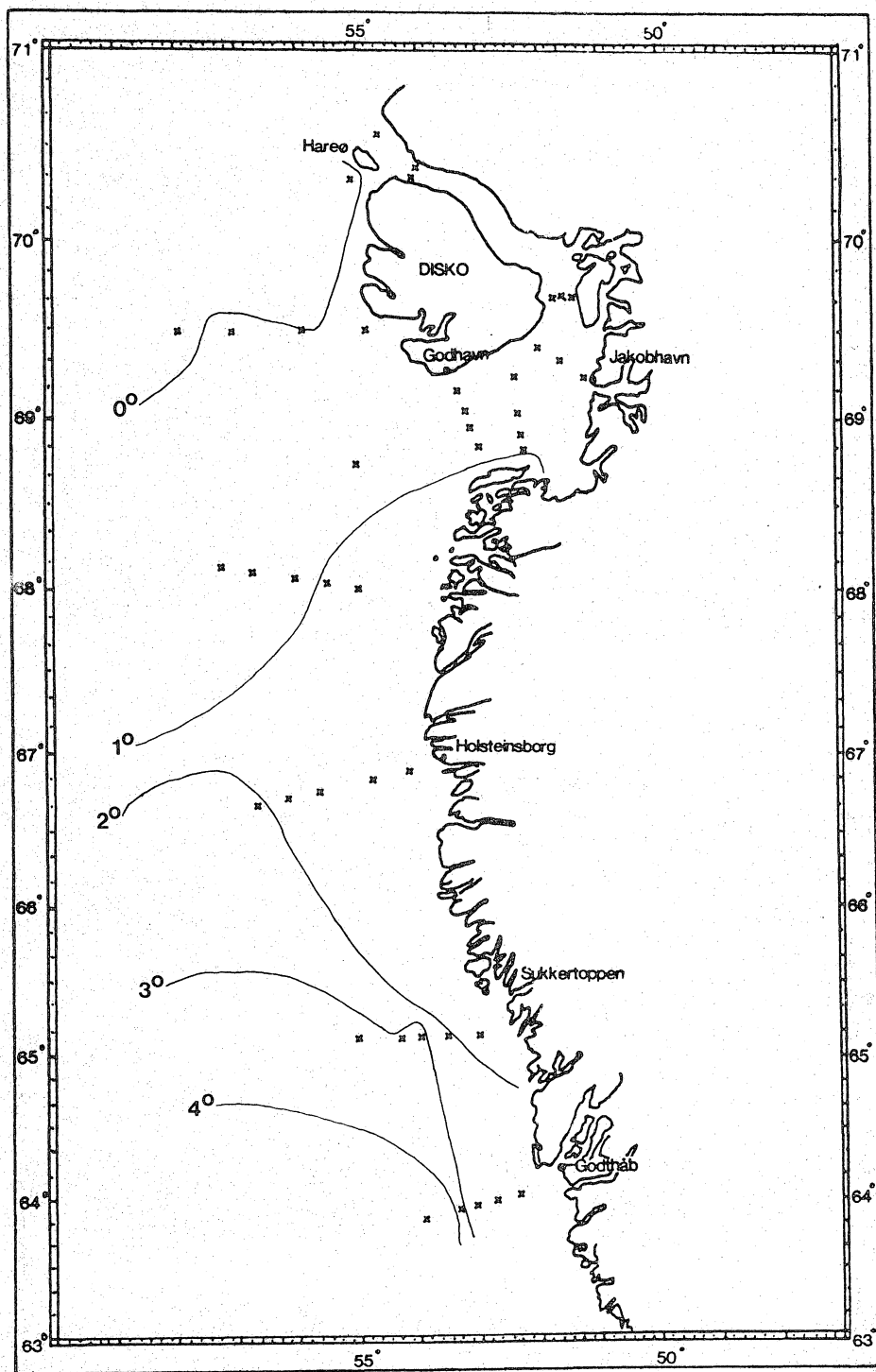


Figure 11. Temperatures ($^{\circ}\text{C}$) at 50 m depth in 1980 in November.

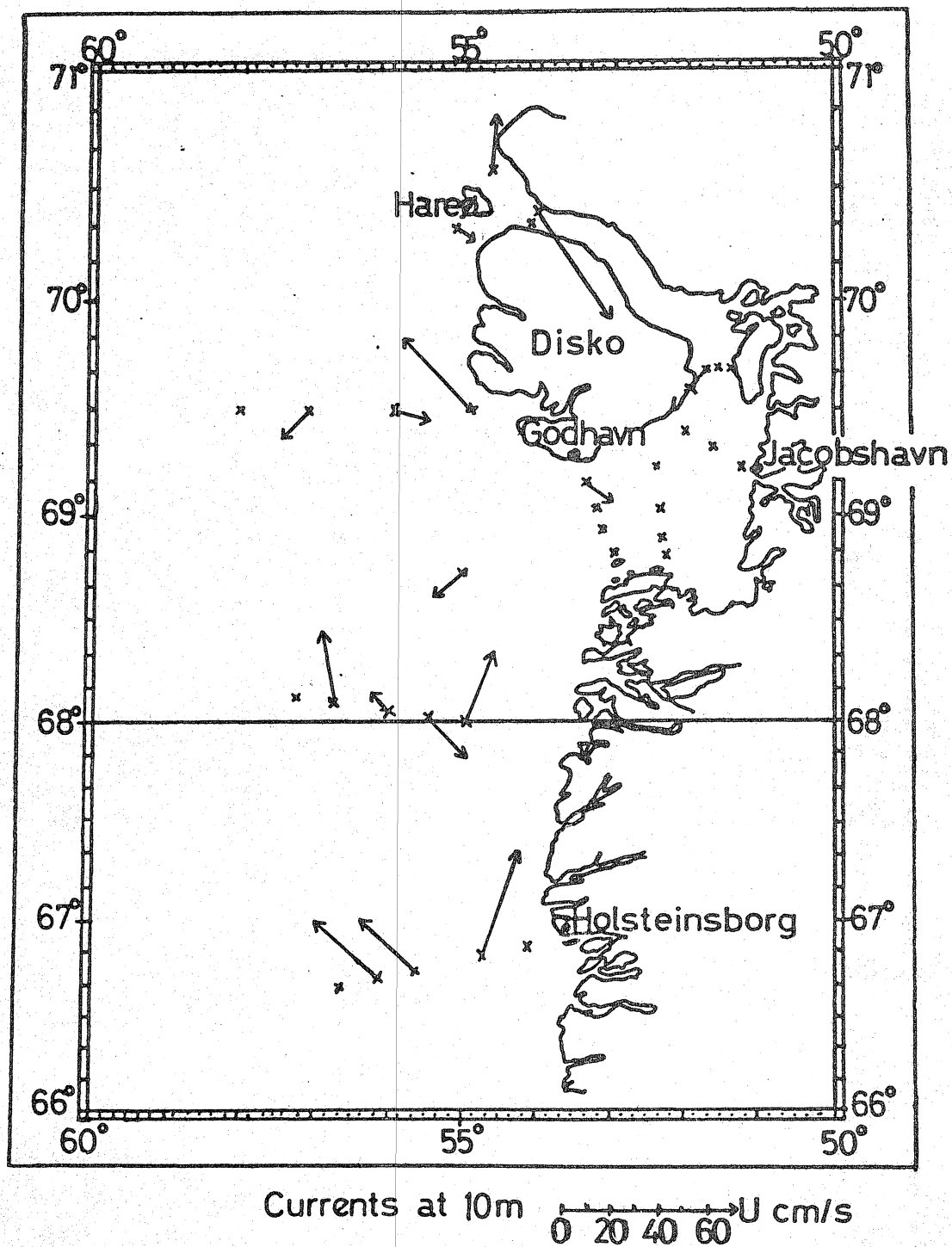


Figure 12. Currents (cm/sec) at 10 m depth in July 1980.

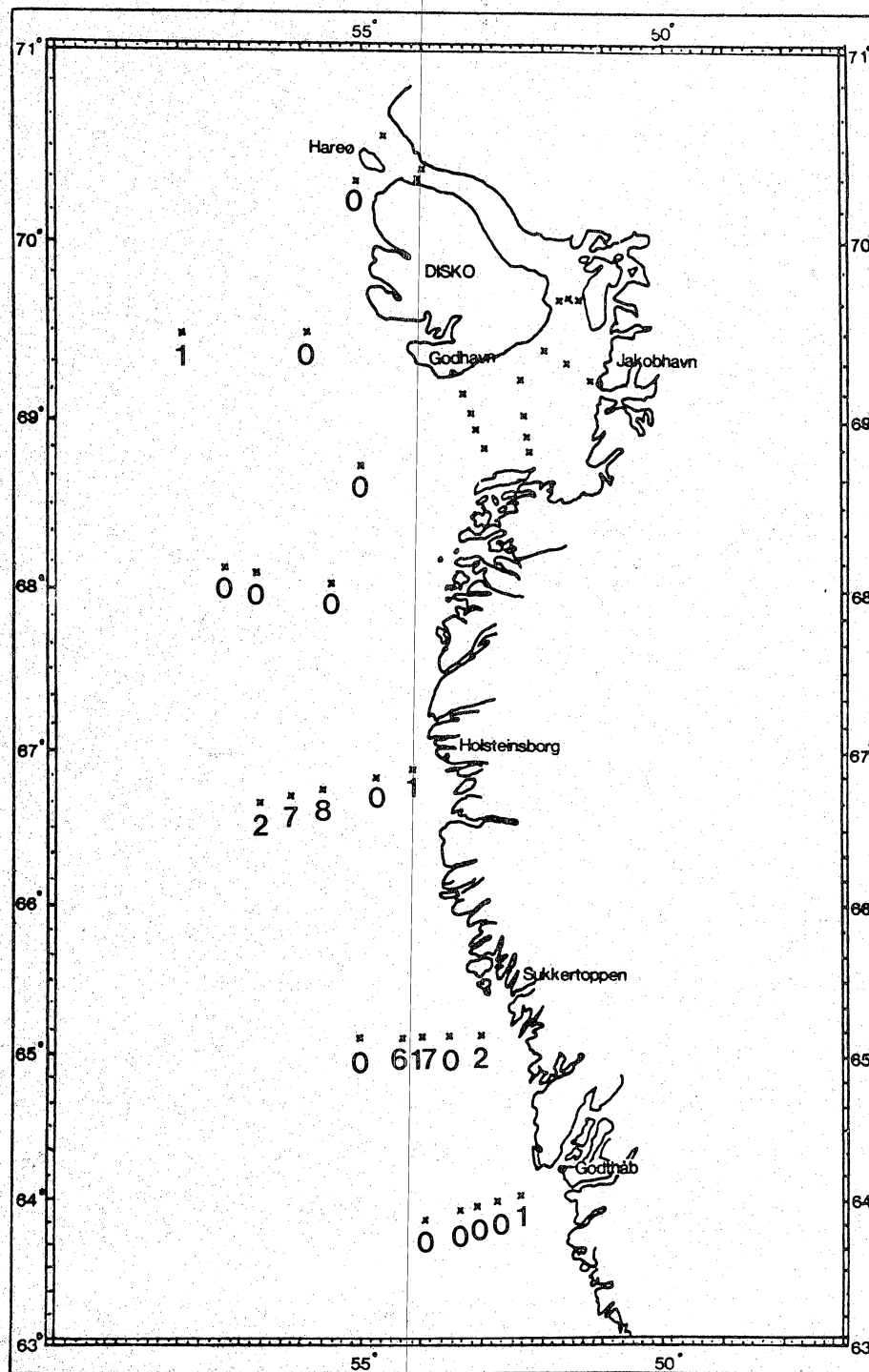


Figure 14. Cod larvae (number per 30 min. haul) taken by 2 m stramin net in the upper water layers (max. depth 50 m) in July 1980.

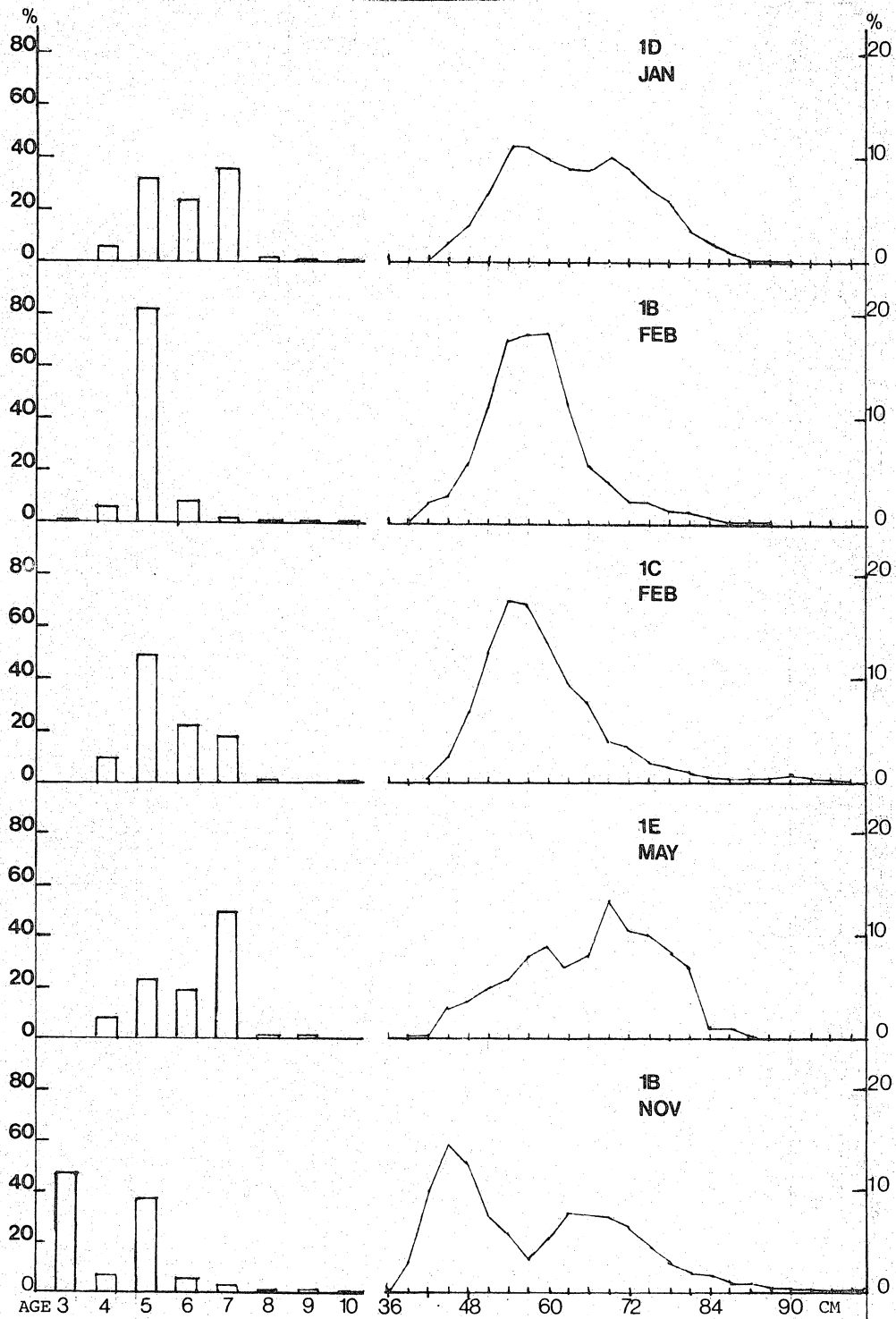


Figure 15. Age and length distribution of some of the offshore samples from trawlers' landings. Lengths are plotted for 3-cm groups, the first cm in some of the groups given on the length scale. In 1B-1D age-groups 5-7 were predominant, but at the end of the year a strong inflow of 3-year-old fish (year-class 1977) was observed. In 1E the 1973 year-class dominated.

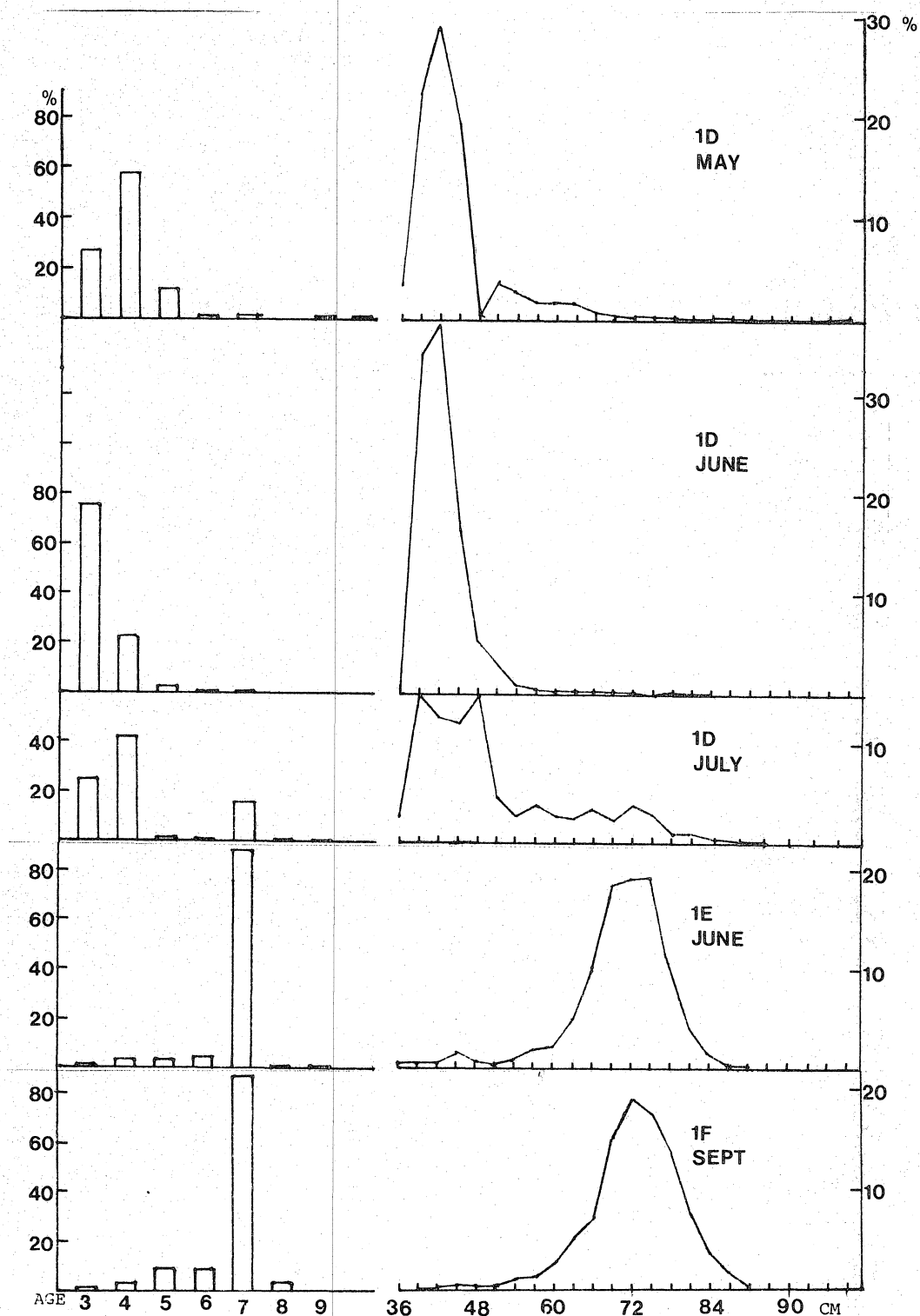


Figure 16. Age and length distribution of some of the inshore samples. Lengths are plotted for 3-cm groups, the first cm in some of the groups given on the length scale. The lower-most sample (1F) from hand-line landings, the other four samples from pound-net landings. In 1E-1F the 1973 year-class was by far the major one, whereas younger fish dominated in the other divisions. The skewness of the left hand side of the length distribution indicates discard of fish (below 40 cm local minimum landing size).

