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A Trial Longline Fishery for Greenland Halibut (*Reinhardtius hippoglossoides*) in the Northern Davis Strait, August 1993

by

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Abstract

A trial longline fishery with the Norwegian vessel M/S "Skarheim" was conducted in the northern Davis Strait in August 1993. The purpose of the fishery was to collect biological information on the commercial fish species, in particular Greenland halibut (Reinhardtius hippoglossoides) in order to evaluate the potential for a commercial longline fishery. The highest Greenland halibut catch rates of 153-260 kg per 1000 hooks were obtained at depths between 800-1200 m at three fishing localities, 2-4 in NAFO Subarea 1A and in water with temperatures above about 0.5 °C. Greenland halibut was caught in all investigated depth strata. The depth distribution of the catch rates in Subarea 1A indicates that depths between 800-1000m may be best suited for a commercial fishery on Greenland halibut. Below 1000m, large numbers of Arctic skates were taken in some of the settings. The size distributions of Greenland halibut in the catches were in the size range of 35-100 cm total length with the majority being from 45-75 cm. The mean length of Greenland halibut in the catches showed a weak increasing trend with depth down to about 1200m. In depth stratum 800-1000m the mean length of Greenland halibut in the catches decreased slightly with increasing latitude. Due to drifting West Ice no longline settings could be made on the continental slope below 1400m. Therefore, no final conclusions concerning the catch rates of Greenland halibut in relation to fishing depth could be drawn.

Introduction

In the later years the annual catch of Greenland halibut from the inshore areas (within 3-n.mile) of West Greenland has increased to above 10,000 tons - the highest level in the history of this fishery (Hansen and Herman, 1953; Smidt, 1969; Boje and Riget, 1988; Riget and Boje, 1989; Anon., 1994). The decreasing trends in the annual cod catches have increased the interest for a further development in the fishery for Greenland halibut both in inshore and offshore areas. Bottom trawl investigations to improve the knowledge on the abundance and biology of Greenland halibut in the deeper waters off Greenland were started in 1987 and continued the following years (Jørgensen and Yatsu, 1990; Anon., 1994). Longline investigations in the southern deep parts of the Davis Strait have been carried out from 1989-1992 (Nielsen, 1990; Boje, 1991; Boje and Hareide, 1993). Knowledge on the biology of Greenland halibut as well as the resource potential for a commercial longline fishery in the northern part of the Davis Strait/Baffin Bay is, however, sparse. Therefore, a trial fishery for Greenland halibut in the northern Davis Strait was considered to be important and of interest from a commercial and biological point of view. A trial longline fishery was carried out in the northern Davis Strait by the Møre and Romsdal Research Foundation, Norway (MRRF) and

the Greenland Fisheries Research Institute (GFRI). Cooperation between MRRF and GFRI was established in 1992 (Boje and Hareide, 1993). The purpose of the trial fishery in 1993 was to collect biological information from the catches on the fish species of commercial interest, in particular Greenland halibut (Reinhardtius hippoglossoides) and to evaluate the potential for a commercial longline fishery in the area surveyed. A more detailed description of the trial longline fishery and the results obtained is given in Gundersen et al. (1994).

Materials and Methods

The trial fishery was carried out by the Norwegian longliner, M/S "Skarheim" in the period 12 August to 1 September 1993 at six localities in NAFO Subareas 1A and 1B (Fig. 1). This vessel is a conventional autoliner, the largest in Norway and with a freezing capacity of about 10 tons per day ($600m^3$ in total). The equipment used for the fishing operations was a Mustad Autoline (EMS-D) with 7mm longlines and Easybite hooks no. 12/0. The length between the hooks was 140cm, the snood being 50cm. Squid was used as bait.

During the 13 days of fishing 154,328 hooks in 44 longline settings were hauled. The investigations were carried out at depths ranging from 400-1400m (Table 1). Drifting West Ice prevented fishing down to 2000m, as originally planned. The catch was registrated in 200m depth intervals. A longline setting consisted of two or three magazines of 10 lines each (about 1400 hooks per line). The longlines were set from the ice edge up the continental slope towards the coast of Greenland. Fishing conditions in the investigated area were good and the loss of gear was minimal. Four bait experiments were conducted to measure the percent of baited hooks. The purpose of the bait experiments was to obtain data on the baiting efficiency of the automatic baiting system on board. The percentage of baited hooks was 83% in average but varied between 66% and 92%; the lowest observed value was due to technical problems with the baiting machine. However, baiting efficiency has not been taken into account in the presented results.

Total length was measured for all species except for roughead grenadier, which was measured from the tip of the nose to the leading edge of the anal fin. Length-weight-relationships were calculated for the most abundant species. For Greenland halibut, gonado-somatic indeces (GSI) were calculated from the formula:

$$GSI=(\text{gonad weight (g)}/\text{total weight (g)})*100$$

A total of 704 Greenland halibut were tagged for future studies of migrations (Table 2). The tags were placed in the muscle at the base of the dorsal fin. Only fish in good condition, having red gills and with no hook damage, were tagged. No returns were obtained during the fishery.

Hydrographical data were collected, using a STD-meter. The temperature generally decreased from about 2 °C in the surface waters to below 0 °C at depths between 10-180m (Fig. 2). At most stations, the temperatures decreased to about -1.5 °C. at about 50m and increased again below 180m to about 2-3 °C. Below about 400m, the temperatures showed a decreasing trend. The extremely cold water in the 10-180m depth interval, was probably influenced by the western Polar Current, while the warmer intermediate water mass, probably, consisted of warm Atlantic water from the northern directed West Greenland Current (Buch, 1990).

Results

A total of 16,465 fish were caught (Table 3). Greenland halibut dominated the catches making up about 58.6% of the total weight of the catch, followed by Arctic skate (Raja hyperborea) (34.7%) and roughead grenadier (Macrourus berglax) (4.3%). Other species occurring in the catches were rocklings (Onogadus sp.), Zoarcidae sp., starry ray (Raja radiata), Greenland shark (Somniosus microcephalus), northern wolf-fish (Anarchichas denticulatus), spotted wolf-fish (Anarchichas minor), redfish (Sebastes mentella), halibut (Hippoglossus hippoglossus), round ray (Raja fyllae), spinytail skate

(Bathyraja spinicauda), sharpnosed skate (Raja lintea), and black dogfish (Centroscyllum fabricii).

Greenland halibut was caught in all depth strata investigated. The highest Greenland halibut catch rates of 153-260 kg/1000 hooks were obtained at depths between 800-1200 m at locality 2-4 (Table 4). The depth distribution of the catch rates indicates that the depth stratum 800-1000m was best suited for a commercial fishery on Greenland halibut. Below 1000m, a large number of Arctic skates were taken, especially on localities 2 and 3 (Table 4). The mean length of Greenland halibut in the catches show a weak increasing trend with depth down to about 1200m (Table 5). In depth stratum 800-1000m the catch rates of Greenland halibut decreased with increasing latitude (Table 4) whereas the mean length showed no decreasing trend with increasing latitude (Table 5). The length(L)-weight(W)-relationship for Greenland halibut was calculated to: $W=L^{3.45} \times e^{-13.28}$ (n=651, r^2 = 0.977). Gonado-somatic indices calculated from 533 Greenland halibut (361 females) were generally below 5 (Fig. 3). Males dominated the smaller sizes of Greenland halibut, females the larger (Fig. 4).

As for Greenland halibut the catch rates of Arctic skate decreased from south to north (Table 4). The males seemed to be smaller than the females and were generally dominating in the 55-75 cm length range (Fig. 5). The length-weight-relationships for Arctic skate was calculated to: $W=L^{2.80} \times e^{-10.75}$ (n=150, r^2=0.921).

The catch of roughead grenadier was low and most specimens were caught on locality 2. In the depth stratum 800-1000m the catches decreased from south to north (Table 4). The overall length frequency distribution of roughead grenadier on locality 2 is shown in Fig. 6. The length-weight-relationship was calculated to: $W=L^{2.86} \times e^{-8.74}$ (n=262, r^2=0.922).

A total of 19 Greenland sharks were caught at different depths during the survey, ranging in length from 1.0 to 3.5m (Table 6). The percent liver weight was calculated for some of the individuals and the results are presented in Table 7.

Starry ray was caught mostly on the southern localities, but a few specimens were also taken on locality 5. Catch rates were low, between 0.1-18.1 kg/1000 hooks. Of 407 starry rays, 193 were females and 214 were males. The size of starry rays ranged between 30-54cm with the majority being between 40-48cm.

Onogadus sp. and Zoarcidae sp. were caught at all localities. Specimens of Onogadus argentinus were taken mostly on the southern localities, whereas Onogadus ensis was mostly taken on the northern localities. Most Zoarcidae sp. were taken on locality 2.

Discussion

In this trial longline fishery the catch rates of Greenland halibut were highest in depth stratum 800-1200m. This differs from observations made in the southern part of the Davis Strait where the highest catch rates were obtained at depths below 1200m (Hareide, 1992; Boje and Hareide, 1993). The difference between the results obtained from this investigation and the investigation from the southern Davis Strait reported by Hareide (1992) may be explained by differences in hydrographical conditions e.g. the lower temperatures in the deeper waters of Baffin Bay. During the trial fishery presented in this paper the Greenland halibut were caught in water with temperatures above 0.5 °C. Although we were only able to make a few temperature measurements below 1000m there was a clear decreasing trend in the temperatures towards the deep which may explain the decreasing catch rates of Greenland halibut below 1000m. Chumakov and Savvatimsky (1990) observed that Greenland halibut is sensitive to changes in water temperatures and that Greenland halibut migrate to deeper and warmer water masses when surface water have cooled. In the southern Davis Strait the largest sizes of Greenland halibut were caught in the depth range from 1200 to 2000m (Hareide, 1992). In the present investigation, drift ice (West Ice) prevented fishing at depths below 1400m on locality 2-4 and below 1000m on locality 5 and 6. Therefore, no conclusion concerning the potential for a Greenland halibut fishery below these depths can be drawn. The low catch rates on locality 5 and 6 may be explained by low temperatures. However, no temperature measurements were obtained from these stations due to technical problems with the STD-meter.

There were minor differences in the length distributions of Greenland halibut catches between the 6 localities with trial fishery. The size distributions of the Greenland halibut catches ranged from 35-100cm with the majority being from 45-75 cm. These size distributions are comparable to size distributions reported from the southern Davis Strait by Nielsen (1990) and Boje (1991), but they are slightly different (Greenland halibut above 70cm occurs less frequent) from size distributions of the Greenland halibut catches in the fjords of the Ummannaq-district (Boje and Riget, 1988; Riget and Boje, 1989) and the Jakobshavn-district (Smidt, 1969).

The calculated gonado-somatic indices for Greenland halibut were mostly in the range 0-3, with a few values close to 5. A few females had partly red gonads with eggs 3-4mm in diameter. This may indicate that spawning occurred shortly before capture. These gonads were frozen for further examination at the GFRI. Jørgensen and Akimoto (1990) also found low gonado-somatic indices in April-May and June-July, whereas the indices found in October-November generally were about 10. They assume that the gonado-somatic indices exceed 10 before spawning. Spawning is assumed to occur in the deeper waters (below 1000m) of the southern Davis Strait from December to February (Smidt, 1969).

During the trial longline fishery presented in this paper, the number of species occurring in the catches were lower compared to bottom trawl catches in the same areas (Jørgensen and Yatsu, 1990 a,b; Due et al., 1991). Also the mean length of Greenland halibut was higher in the longline catches compared to the trawl catches. Longline fisheries have generally been found to catch and select larger fish compared to trawling (Klein, 1986; Løkkeborg and Bjordal, 1992; Nedreaas, et al. 1993).

Results presented in this paper from the northern Davis Strait indicates that the 800-1200m depth stratum in the area between localities 2-4 were best suited for a commercial longline fishery. However, in other time periods this may change due to changes in e.g. hydrographical conditions. Therefore, investigations of the catch rate distributions in the northern Davis Strait in relation to depth, temperatures and season, e.g. when ice coverage is less, seems to be needed in order to further evaluate the potential for a commercial fishery on Greenland halibut.

Acknowledgements

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Table 1. Number of hooks settings during the trial longline fishery in the northern Davis Strait, August 1993.

Locality	Total	Depth 400-599	600-799	800-999	1000-1199	1200-1399
1	14402	2956	11446	0	0	0
2	51775	7194	22091	14833	2072	5585
3	29431	0	12822	12464	2743	1402
4	34608	0	0	6548	19315	8745
5	11371	2850	3719	4802	0	0
6	12741	0	0	12741	0	0
SUM	154328					

Table 2. Number of Greenland halibut tagged by locality during the trial longline fishery in the northern Davis Strait, August 1993.

Locality	2	3	4	5	6
Tagged	158	32	252	154	108

Table 3. Overall catch by species during the trial longline fishery in the northern Davis strait, August 1993.

Species	Number	Weight (kg)	% of catch	Average weight (kg)	Average length (cm)
Greenland halibut	9.606	18.296,3	58,6	1,9	54,5
Arctic skate	4.065	10.809,9	34,7	2,7	64,4
Roughead grenadier	1.460	1.349,4	4,3	0,9	19,0
Rocklings	385	161,7	0,5	0,4	36,8
Zoarcidae sp	307	78,2	0,3	0,3	34,5
Starry ray	563	500,8	1,6	0,9	41,9
Other species	79				
Total	16.465	31.196,3			

Table 4. Catch rates (kg/1000 hooks) of Greenland halibut, Arctic skate and roughead grenadier during the trial longline fishery in the northern Davis Strait, August 1993.

Catch rates (kg/1000 hooks)		Depth 400-599m	600-799m	800-999m	1000-1199m	1200-1399m
Species	Locality					
Greenland halibut	1	0.4	10.5			
	2	55.2	186.1	229.5	152.6	25.2
	3		74.2	145.4	261,5	73.3
	4			260.5	166.8	18.2
	5	0.2	44.5	48.6		
	6			57.8		
Arctic skate	2	1.9	29.4	138.8	380.3	425.1
	3		40.8	90.8	331.7	437.4
	4			47.4	37.2	74.6
	5			11.1		
	6			1.0		
Roughead grenadier	1		10.0			
	2	5.3	20.0	14.3	9.0	0.8
	3		8.3	9.2	19.7	5.1
	4			5.7	3.8	0.7
	5		8.6	6.8		
	6			4.5		

Table 5. Mean lengths (cm) of Greenland halibut, Arctic skate and roughead grenadier during the trial longline fishery in the northern Davis Strait, August 1993.

Mean length		Depth					
		400-599m	600-799m	800-999m	1000-1199m	1200-1399m	All
Species	Locality						
Greenland halibut	1	51.0	52.6				52.6
	2	48.0	53.7	57.1	54.3	52.0	54.4
	3		48.8	53.6	62.0	56.2	53.0
	4			54.6	58.2	60.8	56.9
	5	37.0	47.4	51.3			49.3
	6			53.6			53.6
Arctic skate	2	81.3	77.6	69.5	68.9	65.1	68.1
	3		60.5	60.6	63.8	64.7	62.1
	4			58.6	58.8	61.0	59.5
	5			64.1			64.1
	6			54.8			54.8
Roughead grenadier	1		19.2				19.2
	2	16.4	19.7	18.5	18.1	21.5	18.9
	3		17.2	17.8	20.2	21.1	17.9
	4			19.9	20.5	24.5	20.4
	5		22.8	20.8			21.7
	6			26.4			26.4

Table 6. Length distribution of Greenland shark caught during the trial longline fishery in the northern Davis Strait, August 1993.

Size range	1-2m	2-3m	3-3.5m
Number caught	8	8	3

Table 7. Length, weight, liver-weight and liver percent measured on some of the Greenland shark caught during the trial longline fishery in the northern Davis Strait, August 1993.

Length (cm)	Weight (kg)	Liver-weight (kg)	% Liver
100	7		
145	16		
149	24	2,33	9,9
160	24	1,6	6,7
193	45	7,5	16
310	215	23,5	10,9

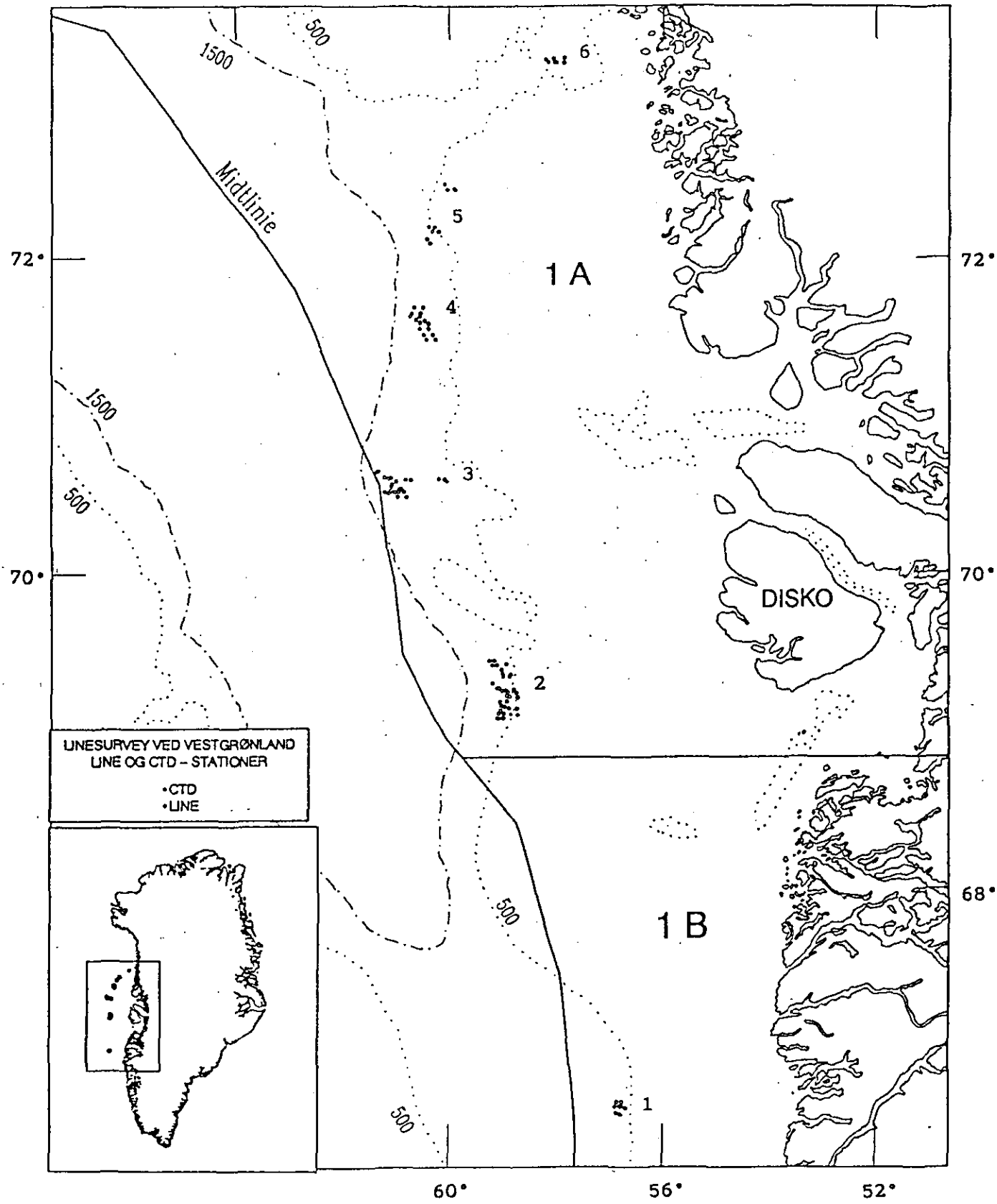

Fig. 1. Map showing the fishing (○) and the STD (●) stations during the trial longline fishery in the northern Davis Strait, August 1993. The fishing was carried out on six localities numbered from 1 to 6 on the map.

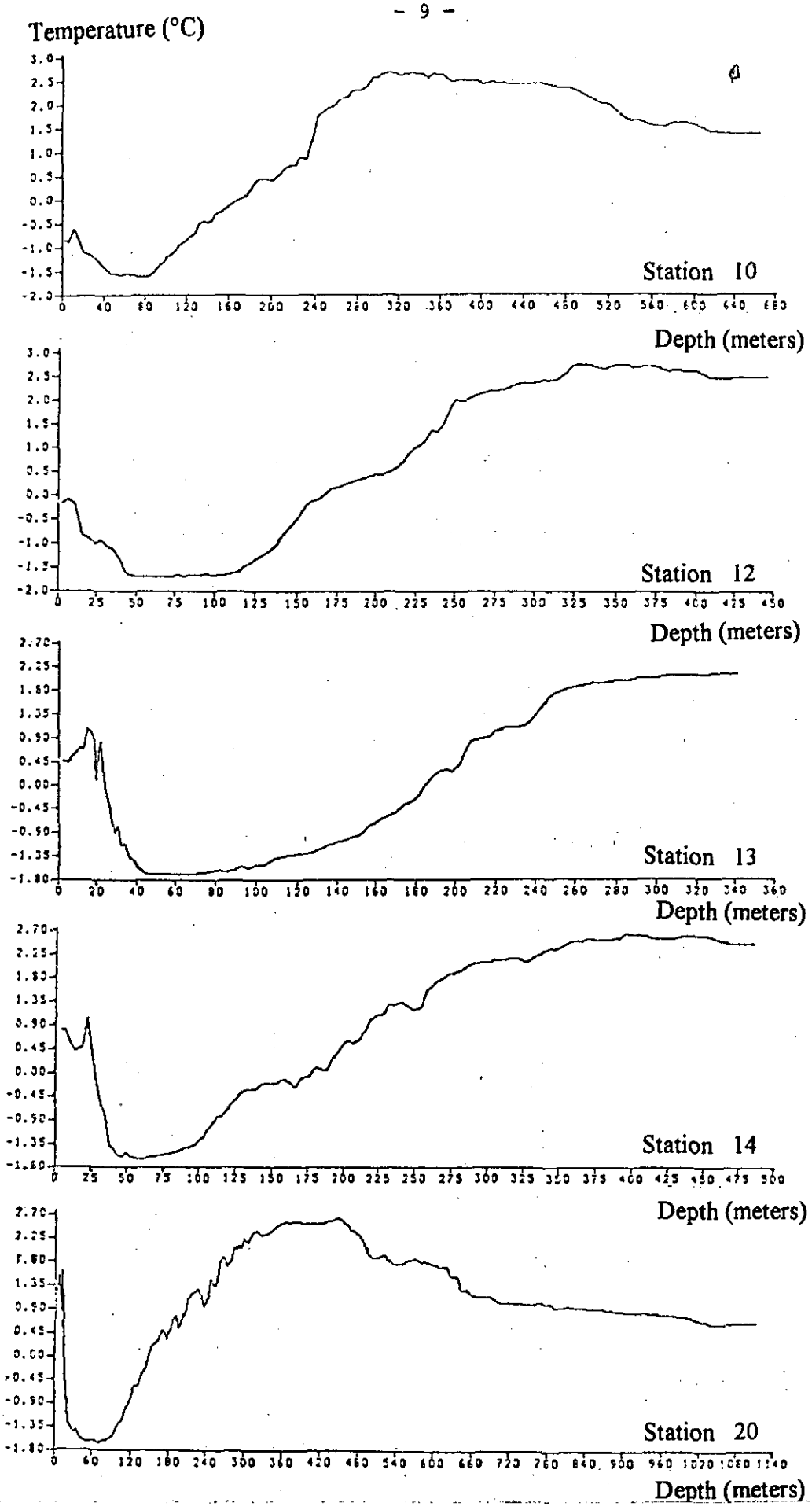

Fig. 2. Temperature profile on five stations on locality 2 during the trial longline fishery in the northern Davis Strait, August 1993.

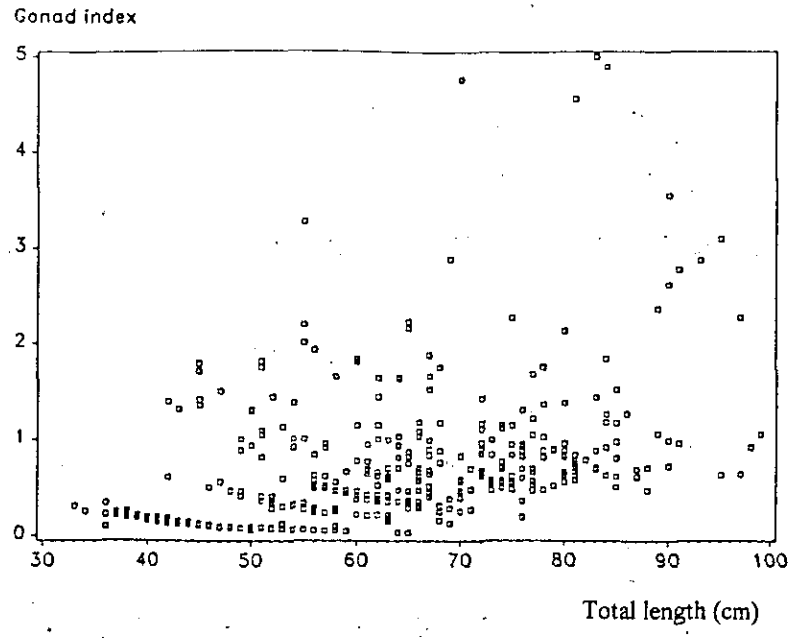

Fig. 3. Gonado-somatic indices (GSI) versus length for Greenland halibut caught during the trial longline fishery in the northern Davis Strait, August 1993.

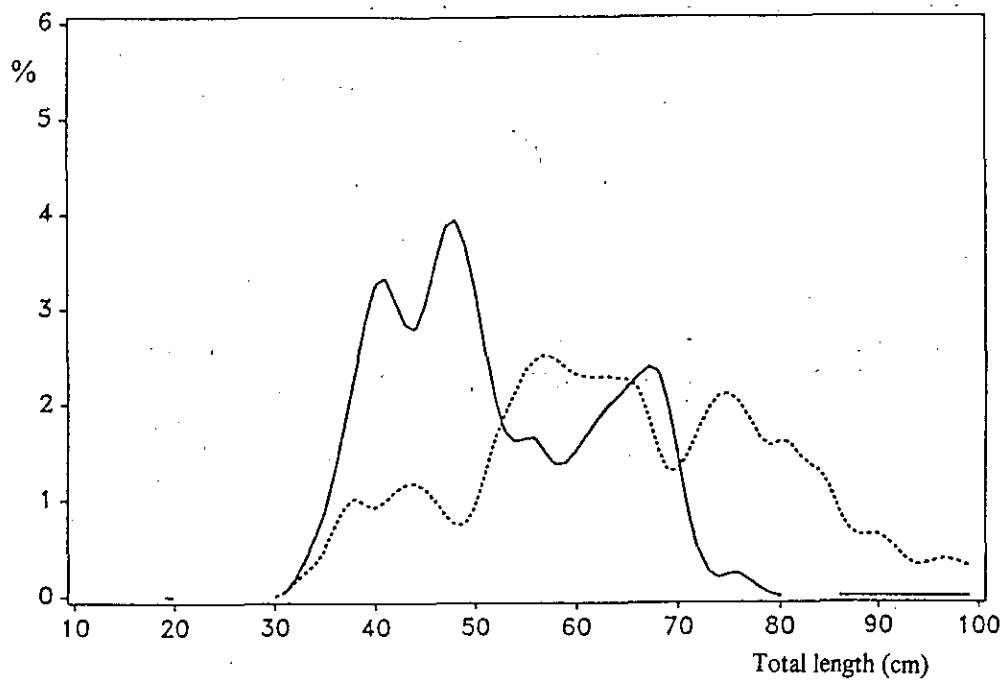

Fig. 4. Overall length frequency distributions of sex determined Greenland halibut caught during the trial longline fishery in the northern Davis Strait, August 1993. Females (----, n=361) and males (——, n=172).

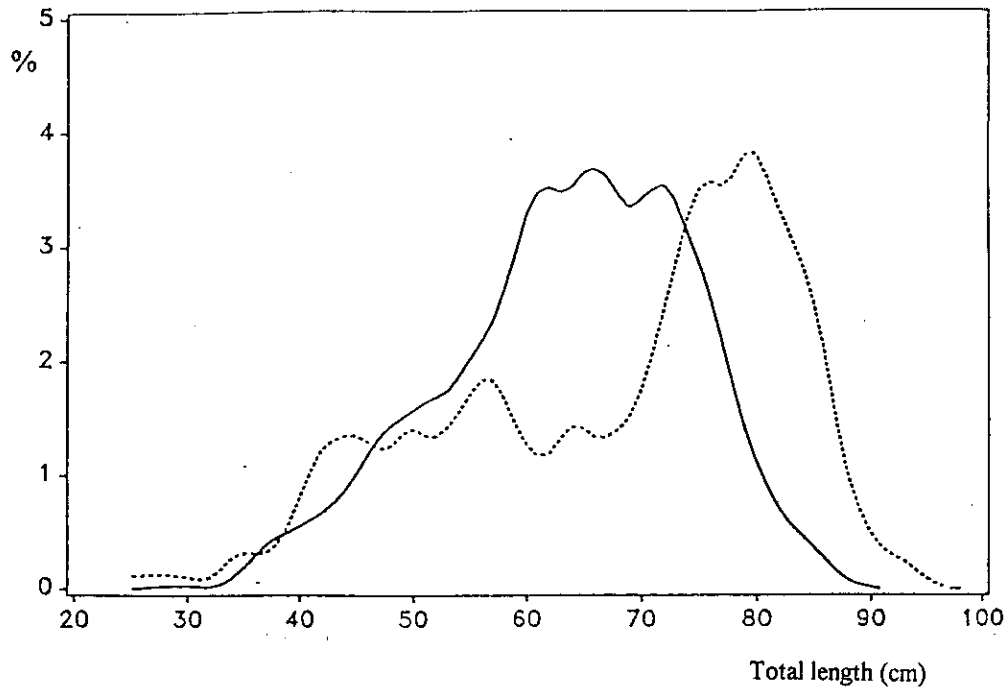

Fig. 5. Overall length frequency distributions of sex determined Arctic skates caught during the trial longline fishery in the northern Davis Strait, August 1993. Females (----, n=890) and males (——, n=2140).

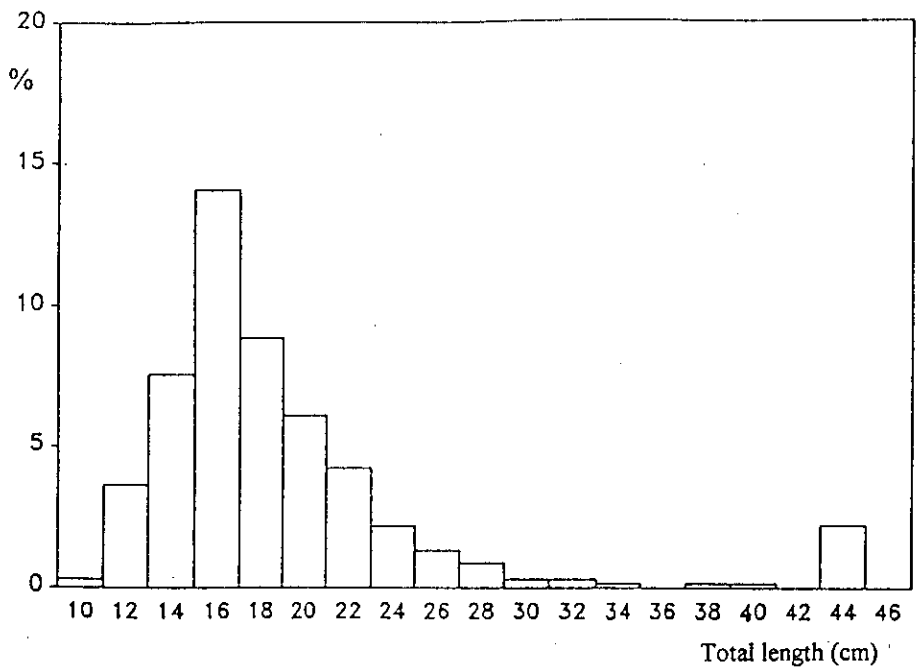

Fig. 6. Overall length frequency distributions of roughead grenadier caught on locality 2 during the trial longline fishery in the northern Davis Strait, August 1993.