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Results of two Stratified Random Bottom Trawl Surveys at West Greenland in 1991

by

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Introduction

Since 1987 annual Japan-Greenland cooperative trawl research surveys to assess trawlable biomass of especially Greenland halibut (Reinhardtius hippoglossoides), redfish (Sebastes spp.), and roundnose grenadier (Coryphaenoides rupestris) have been conducted in the waters around Greenland. In continuation of this joint venture program two stratified random trawl surveys were carried out in August/September and November 1991 at West Greenland (NAFO Subarea 1) by Japan Marine Fishery Resources Research Center (JAMARC) and Greenland Fisheries Research Institute (GFRI).

The aim of the surveys was to estimate stock sizes and obtain information on distribution, size composition and biology of Greenland halibut and roundnose grenadier at deep water area between Div. 1A and Div. 1D, and of redfish and Greenland halibut at the nursery shallow water area in Div. 1A and Div. 1B. Further, there were collected fish stomachs in connection to a project at the GFRI on the relations between fish and shrimp stocks. The results of the project will be reported elsewhere.

Materials and Methods

The bottom trawl surveys were conducted as stratified random sampling method by the R/V Shinkai Maru (3395.12 tons, 94.93 m in length) of the JAMARC and took place from 4 August to 7 September and 11 to 28 November, respectively. The first survey (Survey No. 1) was divided into two parts. Part a) covered the area between NAFO Division 1As (south of 70°N) and Div. 1D at depths of 401 m to 1500 m, and was subdivided into three depth strata: 401-600 m, 601-1000 m, and 1001-1500 m, respectively (Table 1). Part b) covered the area between Div. 1As (south of 70°N) and Div. 1B at depths of 1 m to 400 m, and was subdivided into four depth strata: 1-100 m, 101-200 m, 201-300 m, 301-400 m, respectively (Table 2). Survey No. 2 covered the area between Div. 1As (south of 70°N) and Div. 1B at depths of 1 m to 1000 m, and was subdivided into six depth strata: 1-100 m, 101-200 m, 201-300 m, 301-400 m, 401-600 m, and 601-1000 m, respectively (Table 3).

The trawling stations were randomly selected in each stratum and the number of stations in each stratum was allocated in proportion to the area of each stratum, but with a minimum of two planned hauls per stratum (Tables 1-3).

All trawling stations were determined by satellite navigation. Stations were trawled only during daytime. Generally, a haul was 30 minutes trawl at towing speed about 3.5 knot. The trawling procedure was according to the NAFO manual on Groundfish Survey in the North West Atlantic. The net was equipped with a 140 mm mesh-size in cod-end with a 30 mm mesh-size liner. Wing spread was approximately 38 m. Detailed information of the vessel and gear is given in Yamada et al. (1988a). Biomass estimates were obtained by applying the swept area method taking the catchability coefficient of all species as 1.0. The coefficient of variation (c.v.) is calculated by the following formula: c.v.= standard error of estimate/estimated biomass x 100.

All specimens of Greenland halibut were measured on total length (TL) in 1 cm below, but sub-samples were taken to measure TL in 1 cm below for beaked redfish (Sebastes mentella) and to

measure preanal length (PAL) in 0.5 cm below for roundnose grenadier. The size composition for redfish and roundnose grenadier in each stratum was calculated as the average of the size composition of the hauls, expressed in number per Km^2 swept area. Overall size composition of the species was calculated as a weighted average of the size composition at each stratum, using the stratum area as a weighting factor. Specimens for size frequency analysis were grouped into 3 cm intervals for Greenland halibut, 2 cm intervals for beaked redfish, and 1 cm intervals for roundnose grenadier.

Results and Discussion

Of the 90 (Survey No. 1, part a) and 50 (Survey No. 1, part b), and 59 (Survey No. 2) predetermined stations, 90, 49 and 51 stations were sampled, respectively (Tables 1-3). No smooth ground was found in one station in Survey No. 1, part b and seven stations in Survey No. 2. Due to ice coverage three stations near the midline against Canada were abandoned or moved in Survey No. 2.

Biomass estimates for 37 species or species category are given by survey in Table 4.

1. Greenland halibut

(1) Catch distribution and biomass

Greenland halibut, most abundant species, was caught at all stations except to a few stations at shallow water (1-300 m in depth) in Div. 1As and Div. 1B (Figs. 1-3). The density (catch per Km^2) was generally highest at depths greater than 900 m (Figs. 1-3). The high densities were found in the central part of Div. 1D and around border between Div. 1C and Div. 1D (Fig. 2).

The total trawlable biomass was estimated to 79,750 tons in Survey No. 1, part a, 2,910 tons in Survey No. 1, part b, and 11,030 tons in Survey No. 2, respectively (Table 4). The biomass estimate of Greenland halibut at 401-1500 m (Survey No. 1, part a) in 1991 is slightly higher than found in 1987-1990 (51,300-63,700 tons) although a direct comparison between the estimates should be done with caution because of dissimilarities

in coverage with regard to area, depths and time of year (Yamada et al., 1988b; Yatsu and Jørgensen, 1989; Jørgensen and Akimoto, 1990; 1991).

The biomass estimates by survey, NAFO Division and depth stratum are shown in Tables 5-7, respectively. The biomass was estimated to 35,890 tons (45.0 % of the total estimated biomass) in Div. 1C and 32,370 tons (40.6 %) in Div. 1D (Table 5). The biomass estimates of Div. 1C and Div. 1D in 1987-1990 always were higher than those of Div. 1A and Div. 1B as the results in 1991 (Jørgensen and Akimoto, 1990, 1991), and those occupied 18.2-66.5 % ($\bar{X}$=35.5 %) in Div. 1C and 19.4-81.8 % ($\bar{X}$=46.3 %) in Div. 1D of the total estimated biomass of each year.

(2) Size composition

In Div. 1As, the size ranged from 6-82 cm in Survey No. 1 and from 5-58 cm in Survey No. 2. The overall size composition showed that there were three size peaks, 11.0-13.9 cm, 29.0-31.9 cm, and 38.0-40.9 cm in Survey No. 1, and were three size peaks, 5.0-7.9 cm (newly settled fish), 11.0-13.9 cm and 29.0-31.9 cm in Survey No. 2 (Fig. 4).

In Div. 1B, the size ranged from 5-106 cm in Survey No. 1 and from 5-64 cm in Survey No. 2. The overall size composition showed that there were three size peaks, 11.0-13.9 cm, 17.0-19.9 cm and 26.0-28.9 cm in Survey No. 1, and were two size peaks, 11.0-13.9 cm and 29.0-31.9 cm in Survey No. 2 (Fig. 4).

In Div. 1C, the specimen ranged in size from 9-104 cm with a single mode at 47.0-49.9 cm (Fig. 4).

In Div. 1D, the specimens ranged in size from 15-112 cm with a single mode at 47.0-49.9 cm (Fig. 4). This mode is observed in all surveys since 1987 (Yamada et al. 1988b; Yatsu and Jørgensen, 1989; Jørgensen and Akimoto, 1990, 1991) and is probably due to selection of the gear rather than reflecting the real size composition in the stock (Jørgensen and Boje, this meeting).

As seen in previous years there is a distinct change in size by depth, with smaller fish dominating at shallower water and larger fish being relatively more abundant at greater depths, and, further, an increase in mean size from north to south is noticed (Jørgensen and Akimoto, 1991).

2. Beaked redfish

(1) Catch distribution and biomass

Beaked redfish was mainly caught in Div. 1B and the northern part of Div. 1C, but the catches were low (Figs. 5-7). The main catch depth was between 201 and 600 m.

The total trawlable biomass was estimated to 4,760 tons (c.v.=25.5 %) in Survey No. 1, part a, 3,290 tons (c.v.=20.0 %) in Survey No. 1, part b, and 6,200 tons (c.v.=27.4 %) in Survey No. 2 (Table 4). In Survey No. 1, part a the main biomass was found in Div. 1C and estimated to 3,510 tons (73.7 % of the total estimated biomass)(Table 8). Both in Survey No. 1, part b and Survey No. 2, the main biomass was found in Div. 1B and estimated to 3,040 tons (92.4 %) and 6,140 tons (99.0 %), respectively (Tables 9 and 10).

(2) Size composition

In Div. 1As, the size ranged from 6-36 cm in Survey No. 1 and from 5-34 cm in Survey No. 2. The mode of the fish both in Survey No. 1 and Survey No. 2 was at 7.0-8.9 cm (49 % and 75 % of total estimated fish number, respectively) (Fig. 8). Few fish with a peak at 19.0-20.9 cm found at shallow water (101-400 m) and that there were two size peaks at 19.0-20.9 cm and 35.0-36.9 cm at deep water (401-1500 m) in Survey No. 1.

In Div. 1B, the specimens ranged in size from 5-37 cm with a single mode at 7.0-8.9 cm (68 % of total estimated fish number) in Survey No. 1 (Fig. 8). Few fish with a peak at 29.0-30.9 cm found at shallow water (1-400 m) and that there were three size peaks at 15.0-16.9 cm, 29.0-30.9 cm and 35.0-36.9 cm at deep water (401-1000 m) in Survey No. 1. The specimens ranged from 4-35 cm with a single mode at 7.0-8.9 cm in Survey No. 2 (Fig. 8).

In Div. 1C, the size ranged form 6-52 cm. The overall size composition showed that there were three size peaks, 7.0-8.9 cm, 19.0-20.9 cm, and 35.0-36.9 cm (Fig. 8).

In Div. 1D, the size ranged from 18-46 cm. The length of the fish peaked at 21.0-22.9 cm, 29.0-30.9 cm, and 35.0-36.9 cm, with a possible peak between 45.0-46.9 cm (Fig. 8).

3. Roundnose grenadier

(1) Catch distribution and biomass

Roundnose grenadier was only taken in Survey No. 1, part a and exclusively taken south of 65°N (Fig. 9). The main distribution was found in Div. 1C and Div. 1D where it was taken at all stations except two stations in Div. 1C (Fig. 9). This species was mainly caught at depth greater than 601 m. The total trawlable biomass was estimated to 41,730 tons (c.v.=18.8 %)(Table 4). A substantial part of the biomass was found in Div. 1C at depths between 601 and 1000 m (15,420 tons, corresponding to 37.0 % of total estimated biomass) and in Div. 1D at depths between 1001 and 1500 m (16,490 tons, 39.5 %), respectively (Table 11).

(2) Size composition

The size ranged from 1 to 22 cm with modes at 5.0-5.9 cm and 8.0-9.9 cm in both Div. 1C and Div. 1D, although the proportion of larger fish seems to be a little higher in Div. 1D (Fig. 10).

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Yamada, H., K. Okada, and O. Jørgensen. 1988a. West Greenland groundfish biomasses estimated from an stratified-random trawl survey in 1987. NAFO SCR Doc., 88/31.

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Table 1. Areas of depth strata in Km^2, size of depth strata in percent relative to total stratification area, number of planned hauls, and number of successful hauls in parenthesis in Suvey No. 1 part a.

NAFO Div.	Depth 401-600 m	601-1000 m	1001-1500 m	Total
1As	1683	793	1271	3747
percent	2.96	1.39	2.24	6.59
No. hauls	3(3)	2(2)	2(2)	7(7)
1B	5120	2649	23	7792
percent	9.00	4.66	0.04	13.70
No. hauls	8(8)	4(4)	0(0)	12(12)
1C	3131	17611	603	21345
percent	5.51	30.97	1.06	37.54
No. hauls	5(5)	27(27)	2(2)	34(34)
1D	888	5451	17643	23982
percent	1.56	9.59	31.03	42.18
No. hauls	2(2)	8(8)	27(27)	37(37)
Total	10882	26504	19540	56866
percent	19.03	46.61	34.37	100.00
No. hauls	18(18)	41(41)	31(31)	90(90)

Table 2. Areas of depth strata in Km^2, size of depth strata in percent relative to total stratification area, number of planned hauls, and number of successful hauls in parenthesis in Suvey No. 1 part b.

NAFO Div.	Depth 1-100 m	101-200 m	201-300 m	301-400 m	401-600 m	601-1000 m	Total
1As	(693)	6818	8338	3815	(1683)	(793)	18971
percent		11.35	13.87	6.35			31.57
No. hauls		3(3)	10(9)	5(5)			18(17)
1B	10939	11339	8186	10660	(5120)	(2649)	41124
percent	18.20	18.87	13.62	17.74			68.43
No. hauls	4(4)	5(5)	10(10)	13(13)			32(32)
Total	10939	18157	16524	14475			60095
percent	18.20	30.21	27.50	24.09			100.00
No. hauls	4(4)	8(8)	20(19)	18(18)			50(49)

Table 3. Areas of depth strata in Km^2, size of depth strata in percent relative to total stratification area, number of planned hauls, and number of successful hauls in parenthesis in Suvey No. 2.

NAFO Div.	Depth 1-100 m	101-200 m	201-301 m	301-400 m	401-600 m	601-1000 m	Total
1As	(693)	6818	8338	3815	(1683)	(793)	18971
percent		10.05	12.29	5.62			27.96
No. hauls		3(3)	10(7)	5(4)			18(14)
1B	10939	11339	8186	10660	5120	2649	48893
percent	16.12	16.71	12.06	15.71	7.54	3.90	72.04
No. hauls	4(4)	5(4)	10(9)	13(12)	6(6)	3(2)	32(28)
Total	10939	18157	16524	14475	5120	2649	67864
percent	16.12	26.76	24.35	21.33	7.54	3.90	100.00
No. hauls	4(4)	8(7)	20(16)	18(16)	6(6)	3(2)	59(51)

Table 4. Biomass estimates (x 1000 tons) and coefficient of variation (c.v.) off West Greenland.

English name	Scientific name	Survey No. 1 Part a		Survey No. 1 Part b		Survey No. 2	
		Biomass	c.v.	Biomass	c.v.	Biomass	c.v.
Greenland halibut	Reinhardtius hippoglossoides	79.75	9.1	2.91	14.1	11.03	11.0
Roundnose grenadier	Coryphaenoides rupestris	41.73	18.8	0.00	-	0.00	-
Greenland shark	Somniosus microcephalus	8.04	57.2	0.00	-	17.70	35.3
Beaked redfish	Sebastes mentella	4.76	25.5	3.29	20.0	6.20	27.4
Roughhead grenadier	Macrourus berglax	3.83	8.1	0.01	48.6	0.02	67.7
other fishes		3.49	24.5	0.56	25.0	0.36	46.1
Octopus	Octopoda	3.26	24.0	0.02	18.9	0.03	15.6
Black dogfish	Centroscyllium fabricii	2.82	24.2	+	100.0	0.00	-
other codfishes	Gadiformes	1.57	10.7	+	32.7	0.03	28.5
Skates	Rajidae	1.50	16.4	1.92	42.8	1.12	12.7
Pink shrimp	Pandarus borealis	1.35	25.7	8.19	15.5	9.59	14.3
Halibut	Hippoglossus hippoglossus	1.34	23.3	0.05	100.0	0.30	46.3
Spiny eel	Notocanthidae	1.03	11.2	+	100.0	0.00	-
Eels	Anguilliformes	0.81	6.0	+	58.9	0.00	-
Golden redfish	Sebastes marinus	0.60	29.5	0.18	31.1	0.05	44.3
other shrimps		0.50	9.7	1.64	59.7	0.35	24.0
Eelpouts	Zoarcidae	0.49	23.5	0.40	30.7	0.35	13.5
Sculpins	Psychrolutidae	0.48	10.5	0.02	31.5	0.06	25.5
Grenadier	Coryphaenoides guentheri	0.45	16.2	0.00	-	0.00	-
Northern catfish	Anarhichas denticulatus	0.44	42.0	0.00	-	0.00	-
Ratfish	Hydrolagus affinis	0.36	39.5	0.00	-	0.00	-
other crustacea		0.23	29.4	0.37	58.4	0.10	28.3
American plaice	Hippoglossoides platessoides	0.17	22.6	1.32	15.8	1.68	15.8
Polar cod	Boreogodus saida	0.12	47.6	2.12	24.4	1.45	16.6
Sculpins	Cottidae	0.11	79.2	0.36	19.6	0.54	47.4
Hagfish	Myxine glutinosa	0.10	29.3	+	38.5	+	74.2
Snailfishes	Liparidae	0.09	15.7	0.09	22.3	1.43	27.5
Squids	Teuthoidea and Sepioidea	0.09	12.9	0.07	18.6	0.06	12.8
Grenadiers	Macrouridae	0.07	39.5	0.00	-	0.00	-
other mollusks		0.03	18.0	0.03	19.9	0.01	26.6
Spotted catfish	Anarchias minor	0.02	49.4	0.33	46.5	0.09	37.5
Atlantic cod	Godus morhua	0.02	39.0	0.18	66.0	0.03	44.1
Blue ling	Molva dipterygia	0.02	54.5	0.00	-	0.00	-
Pricklebacks	Stichaeidae	+	14.5	0.35	16.0	0.35	13.2
Lumpsuchers	Cyclopterydae	+	59.8	0.21	64.3	0.33	23.4
Atlantic catfish	Anarhichas lupus	+	71.0	0.09	34.7	0.11	42.6
Sand lance	Ammodytes sp.	+	72.7	0.38	37.5	0.50	49.6
Total		159.63	9.9	20.41	12.8	53.85	12.1

Table 5. Biomass estimates (x 1000 tons) of Greenland halibut in Survey No. 1, part a by NAFO Divisons and depth strata.

NAFO Div.	Depth stratum (m) 401-600	601-1000	1001-1500	Total
1As	0.53	1.52	0.52	2.57
1B	5.47	3.45	-	8.92
1C	3.16	30.97	1.76	35.89
1D	0.03	10.03	22.31	32.37
Total	9.19	45.97	24.59	79.75

Table 6. Biomass estimates (x 1000 tons) of Greenland halibut in Survey No. 1, part b by NAFO Divisions and depth strata.

NAFO Div.	Depth stratum (m) 1-101	101-200	201-300	301-400	Total
1As	-	0.01	0.08	0.38	0.47
1B	0.01	0.03	0.22	2.18	2.44
Total	0.01	0.04	0.30	2.56	2.91

Table 7. Biomass estimates (x 1000 tons) of Grenland halibut in Survey No. 2 by NAFO Divisions and depth strata.

NAFO Div.	Depth stratum (m) 1-100	101-200	201-300	301-400	401-600	601-1000	Total
1As	-	0.02	0.41	0.07	-	-	0.50
1B	0.01	0.28	1.00	4.59	3.26	1.39	10.53
Total	0.01	0.30	1.41	4.66	3.26	1.39	11.03

Table 8. Biomass estimates (x 1000 tons) of beaked redfish in Survey No. 1, part a by NAFO Divisions and depth strata.

NAFO Div.	Depth stratum (m) 401-600	601-1001	1001-1500	Total
1AS	0.20	+	0.00	0.20
1B	0.33	0.02	-	0.35
1C	2.53	0.97	0.01	3.51
1D	0.10	0.54	0.06	0.70
Total	3.16	1.53	0.07	4.76

Table 9. Biomass estimates (x 1000 tons) of beaked redfish in Survey No. 1, part b by NAFO Divisons and depth strata.

NAFO Div.	Depth stratum (m) 1-100	101-200	201-300	301-400	Total
1As	-	0.01	0.01	0.23	0.25
1B	0.02	0.09	1.97	0.96	3.04
Total	0.02	0.10	1.98	1.19	3.29

Table 10. Biomass estimates (x 1000 tons) of beaked redfish in Survey No. 2 by NAFO Divisons and depth strata.

NAFO Div.	Depth stratum (m) 1-100	101-200	201-300	301-400	401-600	601-1000	Total
1As	-	+	0.02	0.03	-	-	0.06
1B	0.00	0.97	2.58	2.10	0.48	0.01	6.14
Total	0.00	0.97	2.60	2.13	0.48	0.01	6.20

Table 11. Biomass estimates (x 1000 tons) of roundnose grenadier in Survey No. 1, part b by NAFO Divisons and depth strata.

NAFO Div.	Depth stratum (m) 401-600	601-1000	1001-1500	Total
1As	0.00	0.00	0.00	0.00
1B	0.00	+	-	+
1C	0.05	15.42	1.78	17.26
1D	0.26	7.72	16.48	24.47
Total	0.31	23.14	18.28	41.73

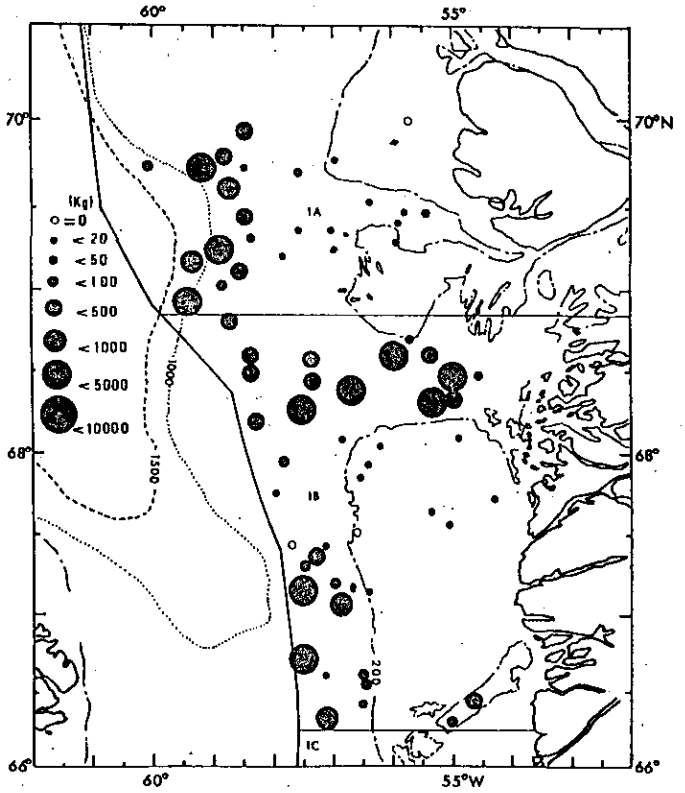

Fig. 1. Catch distribution in Kg per trawled Km^2 of Greenland halibut in NAFO Div. 1As and Div. 1B of Survey No. 1.

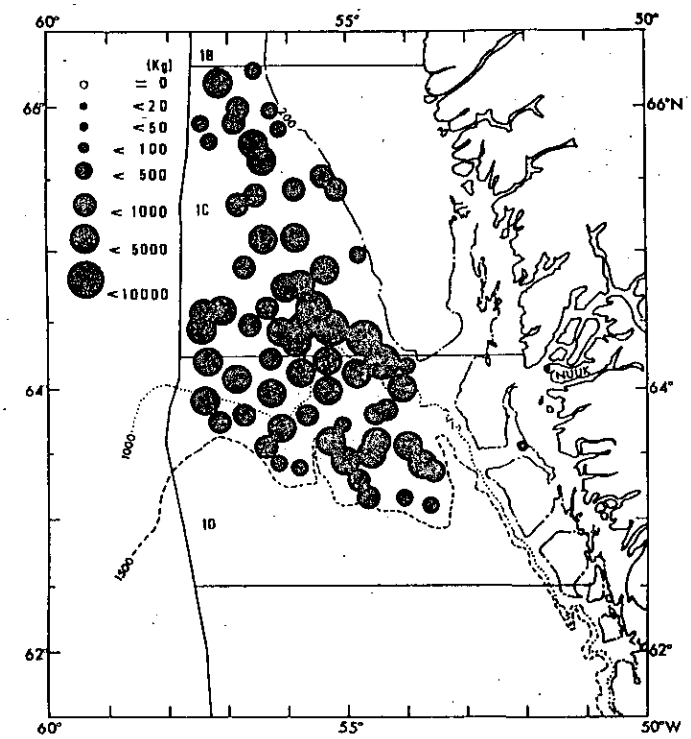

Fig. 2. Catch distribution in Kg per trawled Km^2 of Greenland halibut in NAFO Div. 1C and Div. 1D of Survey No. 1.

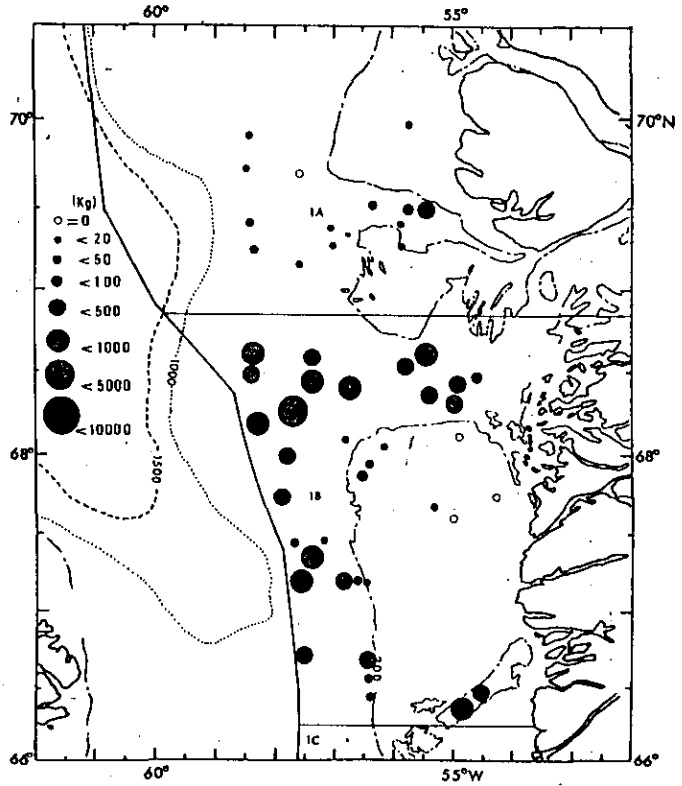

Fig. 3. Catch distribution in Kg per trawled Km^2 of Greenland halibut in NAFO Div. 1As and Div. 1B of Survey No. 2.

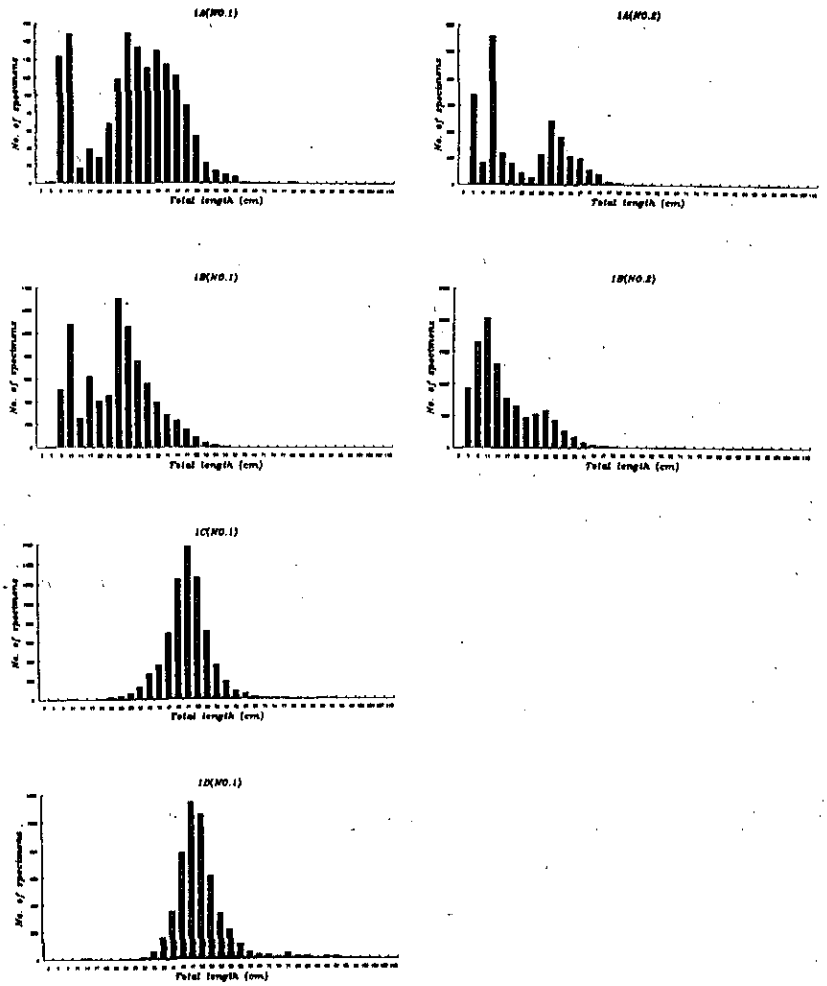

Fig. 4. Length-frequency distribution, by NAFO Division (1A-1D) and survey (No. 1 and No. 2), for Greenland halibut. Specimens are grouped into 3 cm size classes.

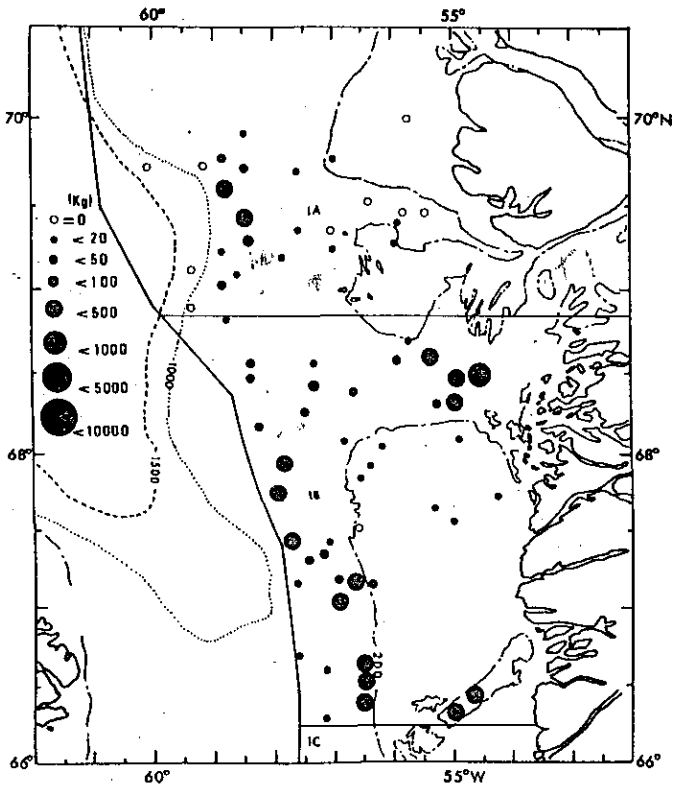

Fig. 5. Catch distribution in Kg per trawled Km^2 of beaked redfish in NAFO Div. 1As and Div. 1B of Survey No. 1.

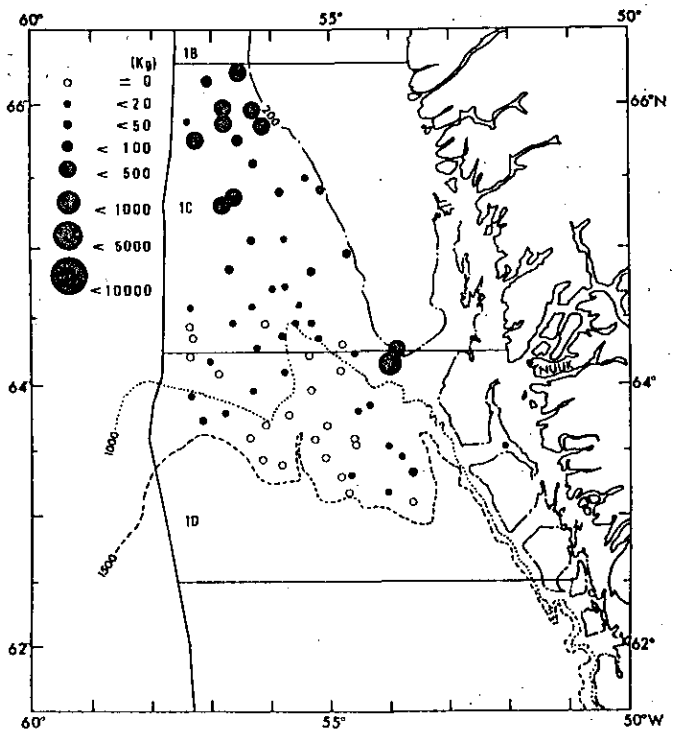

Fig. 6. Catch distribution in Kg per trawled Km^2 of beaked redfish in NAFO Div. 1C and Div. 1D of Survey No. 1.

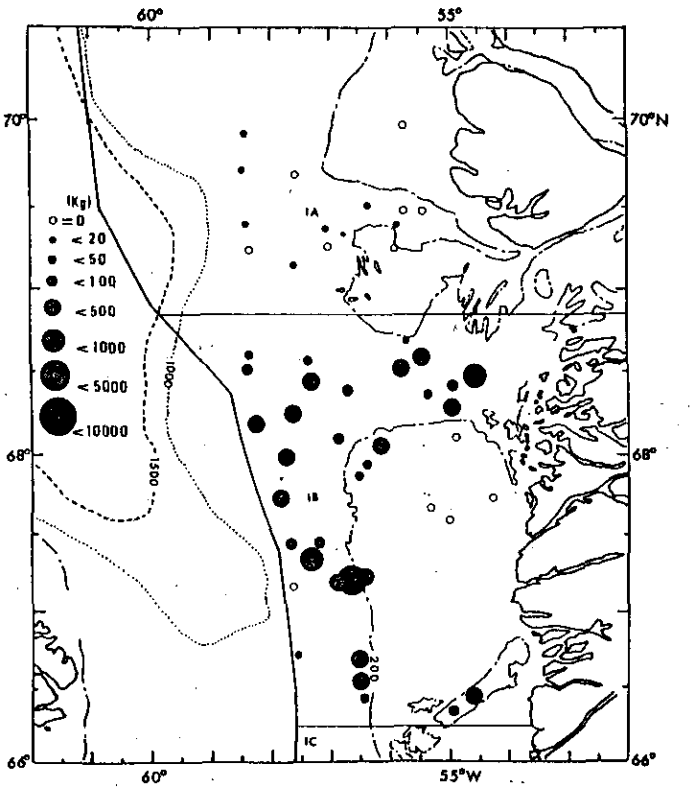

Fig. 7. Catch distribution in Kg per trawled Km^2 of beaked redfish in NAFO Div. 1As and Div. 1B of Survey No. 2.

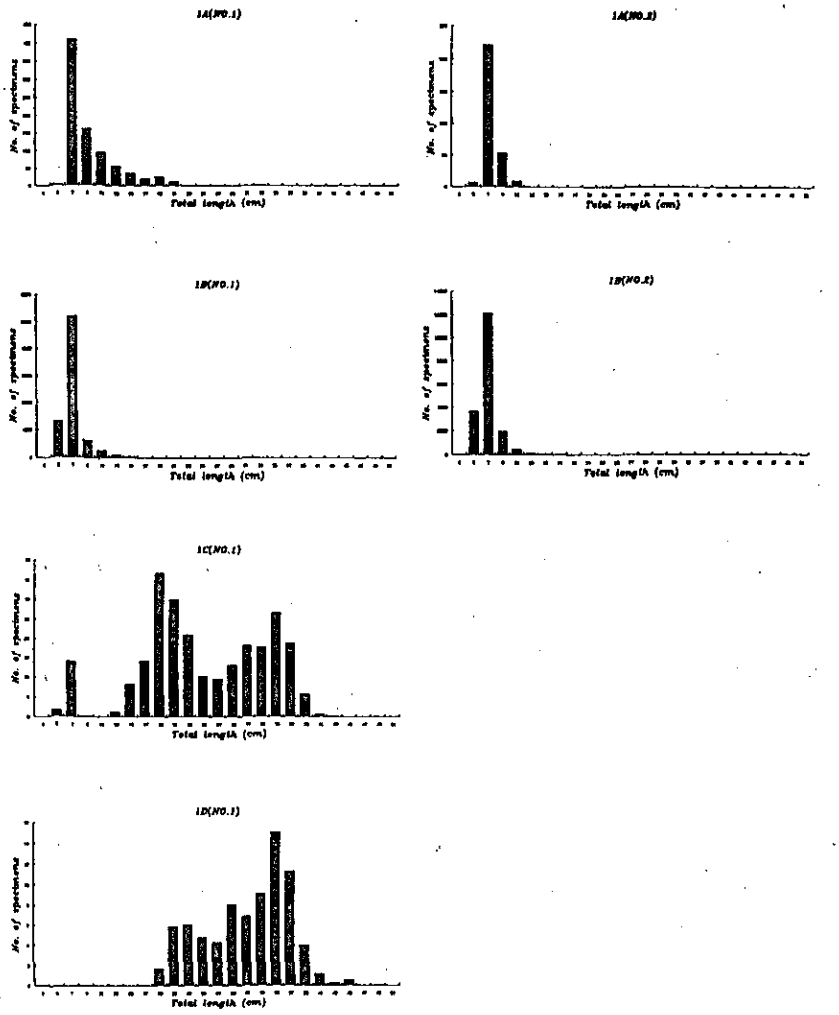

Fig. 8. Length-frequency distribution in number per Km^2 swept area, by NAFO Division (1A-1D) and survey (No. 1 and No. 2), for beaked redfish. Specimens are grouped into 2 cm size classes.

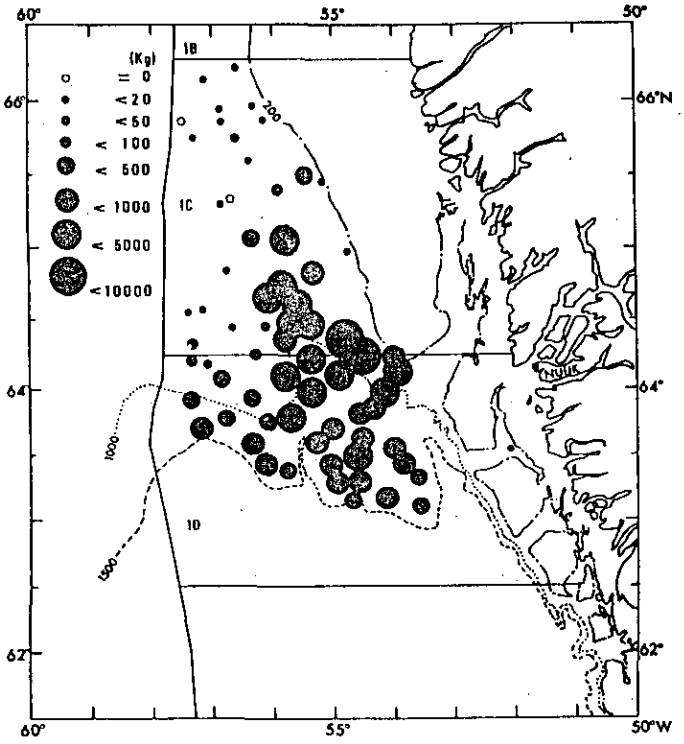

Fig. 9. Catch distribution in Kg per trawled Km^2 of roundnose grenadier in NAFO Div. 1C and Div. 1D of Survey No. 1.

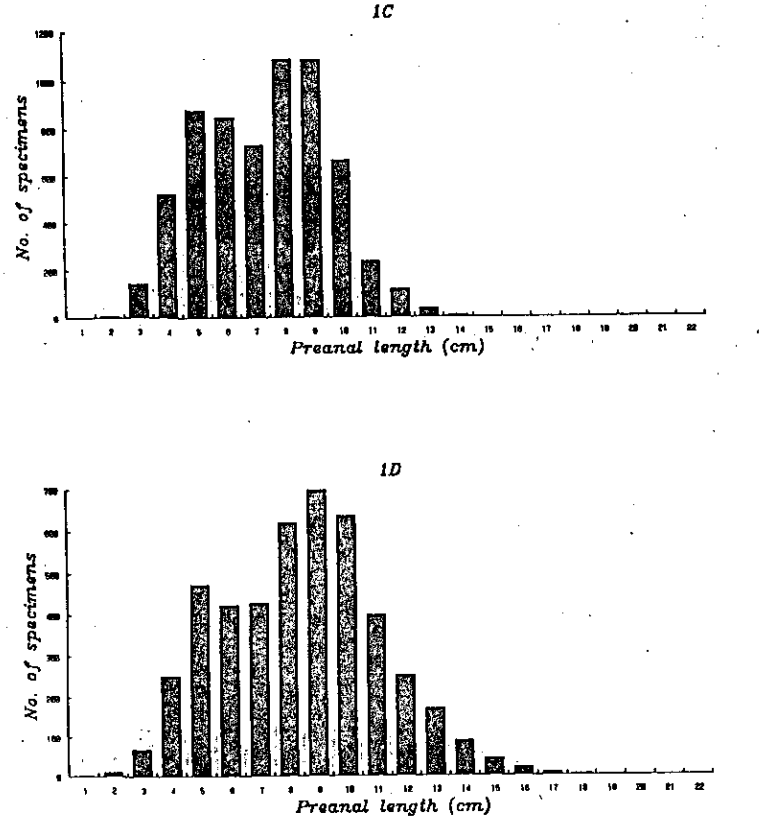

Fig. 10. Length-frequency distribution in number per Km^2 swept area, by NAFO Divisions (1C and 1D) of Survey No. 1, for roundnose grenadier. Specimens are grouped into 1 cm size classes.