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Results of Two Stratified Random Bottom Trawl Surveys off West Greenland in 1992

by

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Introduction

Since 1987 Japan Marine Fishery Resource Research Center (JAMARC) and Greenland Fisheries Research Institute (GFRI) have conducted cooperative trawl surveys off West and East Greenland (Yamada et al., 1988a: Yamada et al., 1988b: Yatsu and Jorgensen, 1989: Jorgensen and Akimoto, 1990: Jorgensen and Akimoto, 1991: Yano and Jorgensen, 1992). In 1992 two stratified random bottom trawl surveys were carried out only off West Greenland. The aim of the surveys was to estimate stock sizes of groundfishes and to obtain information on distribution, size composition and biology of Greenland halibut (Reinhardtius hippoglossoides), beaked redfish (S. mentella) and roundnose grenadier (Coryphaenoides rupestris) on the continental slope between Div. 1A (south of 70°N) and 1D.

Materials and Methods

Two stratified random bottom trawl surveys were conducted by the R/V Shinkai Maru (3395 GRT) in August and in November/December 1992. The first survey (Survey 1) covered the continental slope at depths of 400-1500m between Div. 1A (south of 70°N) and 1D. The second survey (Survey 2) covered the continental slope at depths of 400-1500m in Div. 1C and 1D. The Divisions were subdivided into strata with isobaths of 600m and 1000m. The number of trawl stations in each stratum was allocated in proportion to the area of each stratum with a minimum of two stations per stratum. The trawl stations were selected at random within each stratum (Table 1).

Trawl operations were made only during daytime. Towing duration and speed were 30 minutes and 3.5 knot. The net was equipped with a 140 mm mesh codend with a 30mm mesh liner. Wing spread was approximately 38 m. Detailed information on the vessel and gear is given in Yamada et al. (1988a). Area swept method was applied to for biomass estimation, assuming the catchability coefficient as 1.0. The coefficient of variation (C.V.) is standard error of estimate divided by the estimate.

Greenland halibut and beaked redfish were measured to cm below and roundnose grenadier to half cm below. The size composition in a stratum was calculated as the average of standardized size composition of each station (fish/km^2 swept area). Size composition by Division was calculated as the average of the size composition of each stratum, using the stratum area as weighting factor. Finally, size compositions were grouped into intervals of 3cm for Greenland halibut, 2cm for beaked redfish, and 1cm for roundnose grenadier.

In Survey 2 the trawl was severely damaged in haul no 15 and was replaced with another trawl. Although the two trawls were almost identical they showed a significant difference in catchability. 13 of the hauls set before the net was torn were from Div. 1C, depth stratum 600-1000 m. Immediately after the change of net, 9 hauls were set in the same area and depth stratum. Haul 15 is excluded from the analysis. The mean catches of Greenland halibut, roundnose grenadier and roughhead grenadier, (which were the most abundant species in the catches), in the two trawl series were:

	Before		After	
Greenland halibut	375.08 kg/km^2		185.67 kg/km^2	
Roundnose grenadier	10.40	-	3.33	-
Roughhead grenadier	17.66	-	6.66	-

Only the difference in mean catch for Greenland halibut was found to be significant (< 0.05) tested with a single factor ANOVA. The differences were not significant for the two grenadier species probably due to a great variation in the catches.

Further analysis on Greenland halibut were conducted. The two trawl series (called SURV1 and SURV2) were log transformed and the impact from the trawl series and from depth (DYB) were separated using a multiple factor ANOVA. The depth stratum 600-1000 m was separated into four substrata: (601-700 (1)), 701-800 (2)), 801-900 (3)) and 901-1000 m (4)). The first analysis included cross effect of trawl series and depth (SURV*DYB), but this cross effect was found not to be significant (SAS, type III test Pr>F: 0.0947) and was removed from the analysis. There was the expected effect of depth (type III test Pr>F:0.0069), but also a significant difference between the two trawl series was noticed (type III test, Pr>F: 0.0004) (Table 2). The difference between the two trawl series is estimated as exp 0.87624 = 2.40 (Table I). Beaked redfish, roundnose grenadier and roughhead is also adjusted using the factor 2.4. Although the difference in the trawl series was not significant for this species, the observed ratio between the mean catches is about 3.

There was found no difference in the selectivity of the two trawls.

Results and Discussion

Trawl operations were successfully made at 90 and 49 stations in Surveys 1 and 2, respectively (Table 1). Biomass estimates for 35 species or species groups are obtained (Table 3).

1. Greenland halibut

(1) Distribution and biomass

Greenland halibut, most abundant species, was caught at almost all stations in Surveys 1 and 2 (Figs. 1 and 3). While good catches were observed at depths between 400-600m in Div. B in Survey 1, density (kg/km^2) was generally higher at depths greater than 1000m. The biomass was estimated as 64,500 tons (C.V.=11%) in Survey 1 and 50,600 tons (C.V.=18%) in Survey 2, respectively (Table 3). The biomass estimate for the comparable area in Survey 1 was 51,800 tons. The biomass estimate for Div. 1A-1D in Survey 1 is within the range of the past estimated (51,300-79,800 tons). The biomass estimates by strata are shown in Tables 4 and 5.

(2) Size composition

The size composition by Division shows that the density of small-sized fish was higher in Div. 1B (Fig. 2). There were three modes of the small-sized fish; 15-21cm, 24-30cm, and 33-39cm. Although the smallest fish with a mode around 9-14cm did not occur in 1992, other modes coincided with those observed in the previous surveys in summer. The density of middle-sized fish were moderate in all Divisions. The size composition in Div. 1C and 1D in Survey 2 was similar to those in Survey 1 (Fig. 4).

2. Beaked redfish
2

(1) Distribution and biomass

Beaked redfish was mainly caught at depths less than 600m in Div. 1B and 1C, although the catches were low especially in Survey 2 (Figs. 5 and 6). The biomass was estimated as 3,700 tons (C.V.=36%) in Survey 1, and 600 tons (C.V.=30%) in Survey 2, respectively (Table 3). The biomass estimates by strata are shown in Tables 6 and 7.

(2) Size and composition

The density of small-sized fish was higher in Div. 1A and 1B in Survey 1 (Fig. 6). The smallest fish with a mode of 6-8cm were caught in Div. 1C and 1D in Survey 2 (Fig. 8).

3. Roundnose grenadier

(1) Distribution and biomass

Roundnose grenadier was taken exclusively in Div. 1C and 1D in Survey 1 (Fig. 9). The biomass was estimated as 40,200 tons (C.V.=17%) in Survey 1, and 1,100 tons (C.V.=28%) in Survey 2, respectively (Table 3). The biomass estimates by strata are shown in Tables 8 and 9. The low catches in Survey 2 is probably due to the seasonal migration.

(2) Size composition

The size composition is rather simple with a mode around 5-6cm in Div. 1C and two modes at 5-6cm and 8-10cm in Div. 1D (Fig. 10). The two modes coincided with those in the 1991 survey.

References

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Yatsu, A. and O. Jørgensen. 1989. Distribution, abundance, size, age, gonad index, and stomac contents of Greenland halibut (Reinhardtius hippoglossoides) off West Greenland in September/October 1988. NAFO SCR Doc., 89/31.

Table 1. Area of each stratum (km^2 and percent to total area), and number of successful trawl stations in Surveys 1 and 2.

Div.	Area / No. of sta.	Depth 401-600m	601-1000m	1001-1500m	Total
1A(south of 70°N)	km^2	1683	793	1271	3747
	%	2.96	1.39	2.24	6.59
	Survey 1	3	2	2	7
	Survey 2	-	-	-	-
1B	km^2	5120	2649	23	7792
	%	9.00	4.66	0.04	13.70
	Survey 1	8	4	-	12
	Survey 2	-	-	-	-
1C	km^2	3131	17611	603	21345
	%	5.51	30.97	1.06	37.54
	Survey 1	5	27	2	34
	Survey 2	2	22	2	26
1D	km^2	888	5451	17643	23982
	%	1.56	9.59	31.03	42.18
	Survey 1	2	7	28	37
	Survey 2	1	5	17	23
Total	km^2	10882	26504	19540	56866
	%	19.03	46.61	34.37	100.00
	Survey 1	18	40	32	90
	Survey 2	3	27	19	49

Table 2. The impact of two different trawls and depth on the catches of Greenland halibut. Statistical output from the multiple factor ANOVA.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
SURV	1	3.51263585	3.51263585	19.48	0.0004
DYB	3	3.08087025	1.02695675	5.69	0.0069

General Linear Models Procedure

Dependent Variable: CATCH

Parameter		Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT		5.607257290 B	25.01	0.0001	0.22417822
SURV	1	0.876235845 B	4.41	0.0004	0.19853557
	2	0.000000000 B	.	.	.
DYB	1	-0.985958057 B	-3.77	0.0015	0.26127948
	2	-0.825220660 B	-3.35	0.0038	0.24617610
	3	-0.519830035 B	-1.67	0.1123	0.31040478
	4	0.000000000 B	.	.	.

NOTE: The X'X matrix has been found to be singular and a generalized inverse was used to solve the normal equations. Estimates followed by the letter 'B' are biased, and are not unique estimators of the parameters.

Table 3. Biomass estimate (x*1000 tons*) of each species or species group with the coefficient of variation (C.V) in Surveys 1 and 2.

English name	Scientific name	Survey 1 Biomass(C.V.)	Survey 2 Biomass(C.V.)
G. halibut	Reinhardtius hippoglossoides	64.48(10.5)	50.63(17.7)
Roundnose grena.	Coryphaenoides rupestris	40.17(17.0)	1.09(27.7)
Beaked redfish	Sebastes mentella	3.68(36.1)	0.57(30.3)
other fishes		2.37(15.2)	2.06(8.2)
Pink shrimp	Pandarus borealis	2.35(31.4)	0.11(58.4)
Dogfish	Squalidae	2.24(16.4)	0.36(19.5)
Roughhead grena.	Macrourus berglax	1.96(9.7)	1.47(26.4)
Skates	Rajidae	1.55(39.0)	0.10(21.5)
other codfishes	Gadiformes	1.09(16.8)	0.43(23.2)
Halibut	Hippoglossus hippoglossus	1.06(22.5)	0.87(48.8)
Octopus	Octopoda	0.92(19.6)	0.62(28.6)
Spiny eel	Notocanthidae	0.73(13.7)	0.22(29.0)
Greenland shark	Somniosus microcephalus	0.69(70.3)	0.00(-)
Northern catfish	Anarhichas denticulatus	0.52(38.3)	0.37(57.8)
American plaice	Hippoglossoides platessoides	0.45(14.0)	0.11(59.1)
Eels	Anguilliformes	0.42(6.4)	0.27(11.6)
other shrimps		0.42(23.9)	0.33(16.9)
Ratfish	Hydrolagus affinis	0.33(49.5)	0.00(-)
Eelpouts	Zoarcidae	0.30(27.9)	0.02(31.4)
Golden redfish	Sebastes marinus	0.22(41.7)	0.01(100.0)
Grenadier	Coryphaenoides guentheri	0.21(25.0)	0.06(36.1)
Sculpins	Psychrolutidae	0.15(19.5)	0.06(27.6)
Spotted catfish	Anarchias minor	0.13(71.5)	0.00(-)
other crustacea		0.13(45.9)	0.01(84.3)
Polar cod	Boreogodus saida	0.09(35.0)	0.00(-)
Grenadiers	Macrouridae	0.08(26.5)	0.01(52.1)
Squids	Teuthoidea and Sepioidea	0.08(15.5)	0.03(21.6)
Snailfishes	Liparidae	0.07(24.2)	0.01(64.9)
Atlantic cod	Godus morhua	0.04(52.2)	0.06(80.3)
Hagfish	Myxine glutinosa	0.02(26.9)	0.01(28.3)
Sculpins	Cottidae	0.02(81.1)	0.00(-)
Blue ling	Molva dipterygia	0.00(100.0)	0.00(-)
Pricklebacks	Stichaeidae	0.00(100.0)	0.00(-)
Lumpsuchers	Cyclopterydae	0.00(-)	0.01(69.1)
other mollusks		0.00(100.0)	0.00(-)
Total		126.97(10.3)	59.90(9.9)

Table 4. Biomass estimates (x1000 tons) of Greenland halibut by strata in survey 1 (Aug. 1992).

NAFO Div.	Depth stratum (m)			Total
	401-600	601-1000	1001-1500	
1A*	0.07	1.17	1.20	2.44
1B	7.38	2.88	-	10.26
1C	0.77	19.69	1.05	21.51
1D	0.27	5.95	24.05	30.27
Total	8.49	29.69	26.30	64.48

* south of 70°N

Table 5. Biomass estimates (x1000 tons) of Greenland halibut by strata in survey 1 (Nov./Dec. 1992).

NAFO Div.	Depth stratum (m)			Total
	401-600	601-1000	1001-1500	
1A*	-	-	-	-
1B	-	-	-	-
1C	0.5	7.1	1.3	8.8
1D	0.1	2.4	39.2	41.8
Total	0.6	9.5	40.5	50.6

* south of 70°N

Table 6. Biomass estimates (x1000 tons) of beaked redfish by strata in survey 1 (Aug. 1992).

NAFO Div.	Depth stratum (m)			Total
	401-600	601-1000	1001-1500	
1A*	0.07	0.01	0.00	0.08
1B	0.64	0.05	-	0.69
1C	0.26	2.09	0.00	2.35
1D	0.24	0.30	0.03	0.57
Total	1.21	2.45	0.03	3.68

* south of 70°N.

Table 7. Biomass estimates (x1000 tons) of beaked redfish by strata in survey 1 (Nov./Dec. 1992).

NAFO Div.	Depth stratum (m)			Total
	401-600	601-1000	1001-1500	
1A*	-	-	-	-
1B	-	-	-	-
1C	0.33	0.17	0.00	0.50
1D	0.05	0.02	0.00	0.07
Total	0.38	0.19	0.00	0.57

* south of 70°N

Table 8. Biomass estimates (x1000 tons) of roundnose grenadier by strata in survey 1 (Aug. 1992).

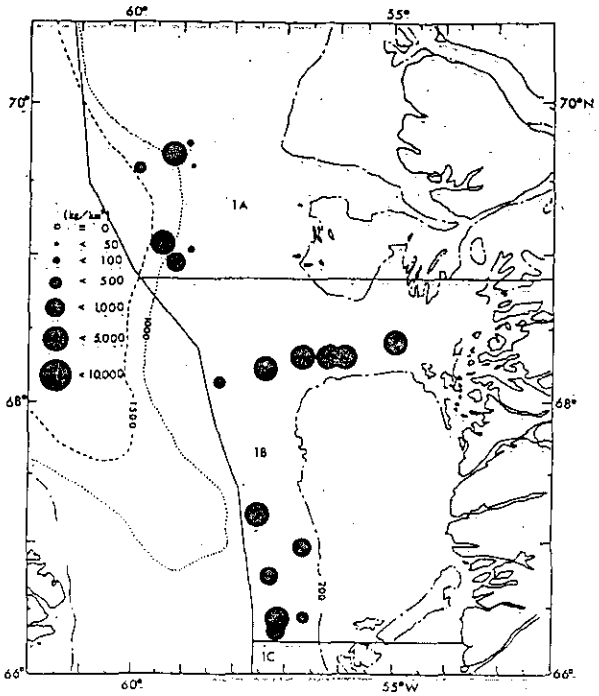
NAFO Div.	Depth stratum (m)			Total
	401-600	601-1000	1001-1500	
1A*	0.00	0.00	0.00	0.00
1B	0.00	0.00	-	0.00
1C	0.02	10.14	0.51	10.67
1D	0.12	8.48	20.89	29.49
Total	0.14	18.62	21.40	40.17

* south of 70°N

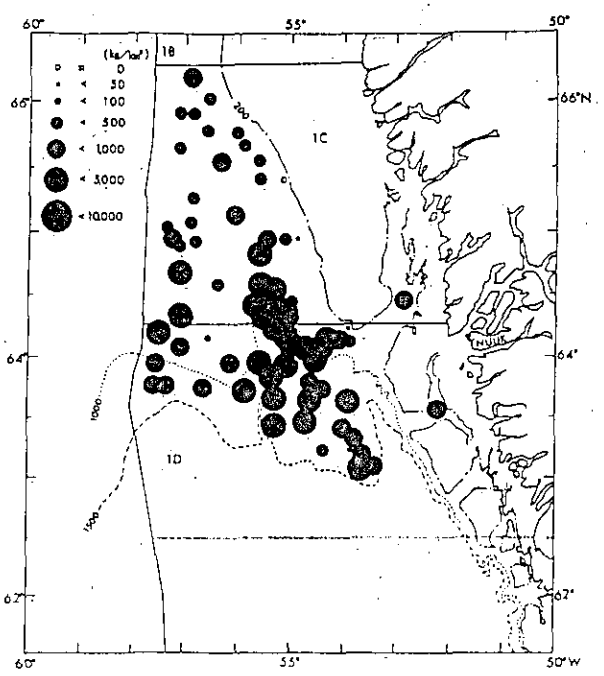
Table 9. Biomass estimates (x1000 tons) of roundnose grenadier by strata in survey 1 (Nov./Dec. 1992).

NAFO Div.	Depth stratum (m)			Total
	401-600	601-1000	1001-1500	
1A*	-	-	-	-
1B	-	-	-	-
1C	0.00	0.17	0.03	0.20
1D	0.06	0.03	0.81	0.90
Total	0.06	0.20	0.84	1.10

* south of 70°N



Div. 1A -1B
(south of 70°N)



Div. 1C-1D

Fig. 1. Catches (kg/km²) of Greenland halibut in Survey 1 (Aug. 1992).

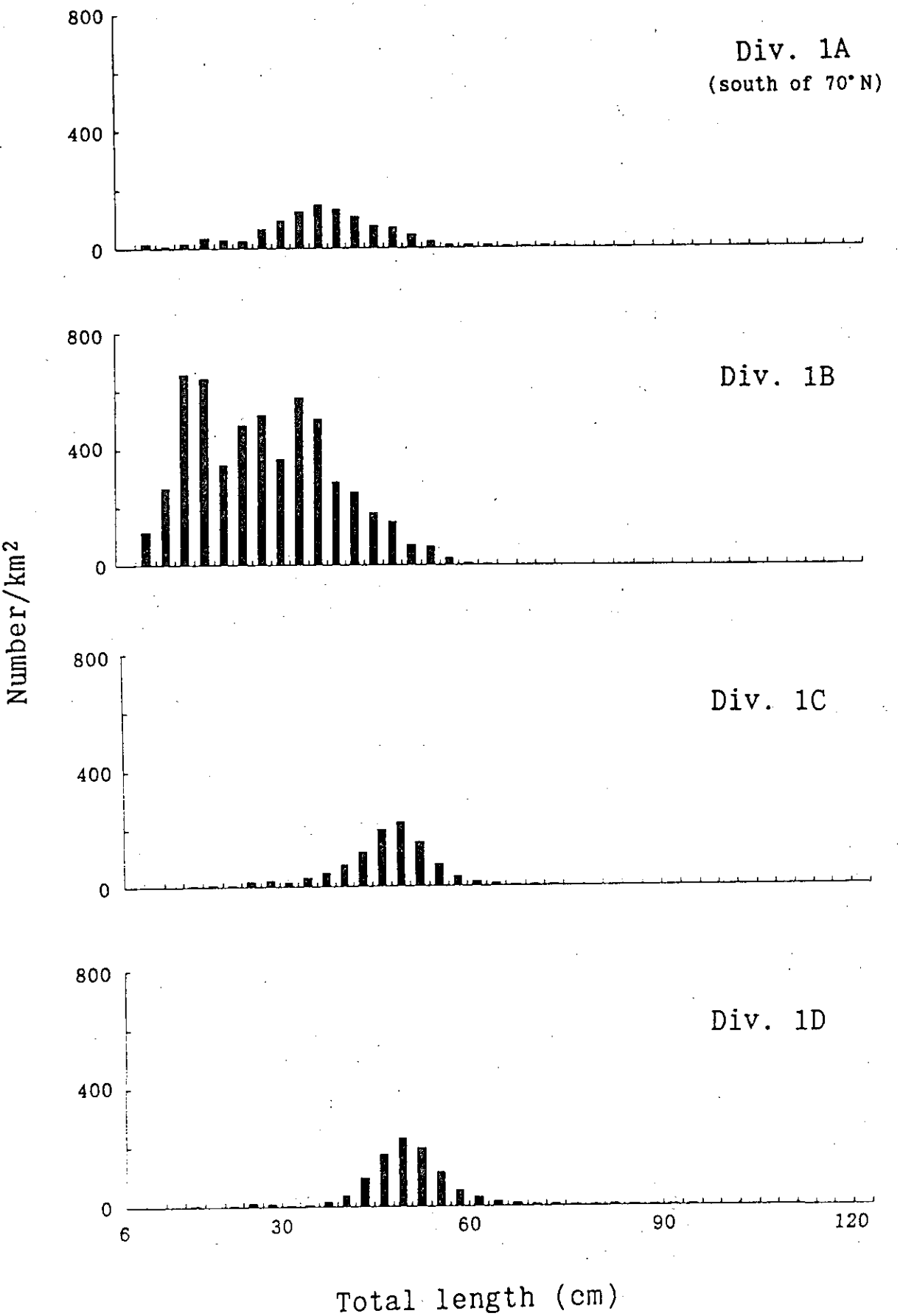


Fig. 2. Size compositions of Greenland halibut in Survey 1 (Aug. 1992).

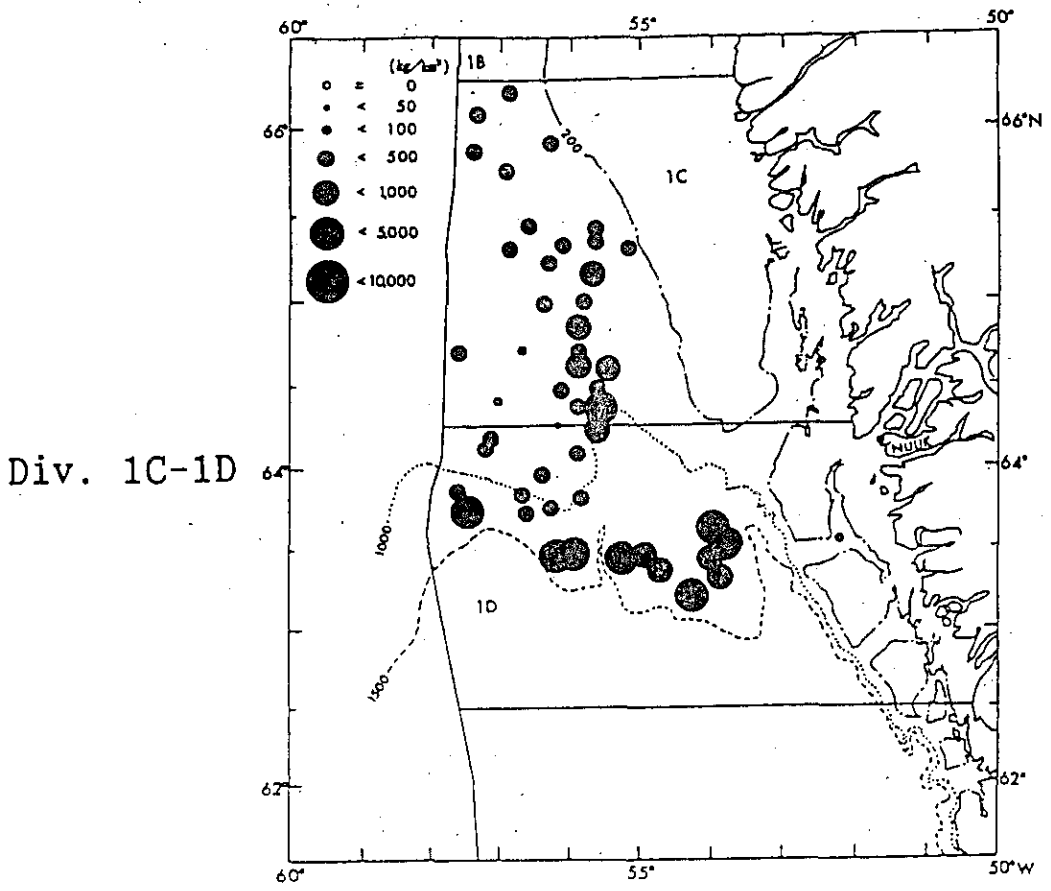


Fig. 3. Catches (kg/km²) of Greenland halibut in Survey 2 (Nov./Dec. 1992).

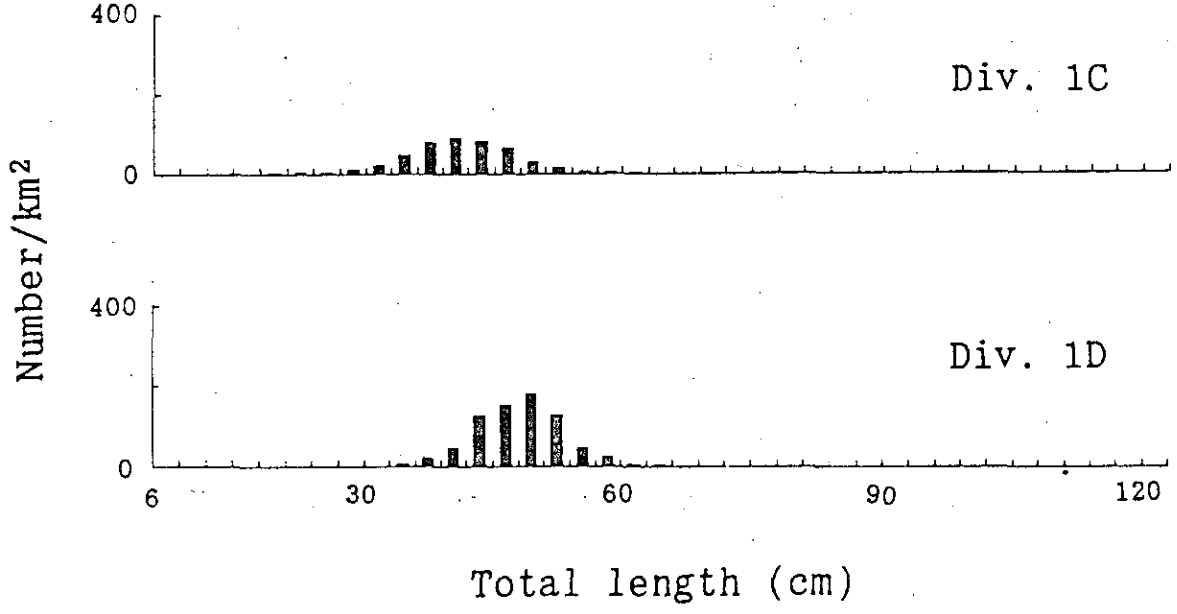
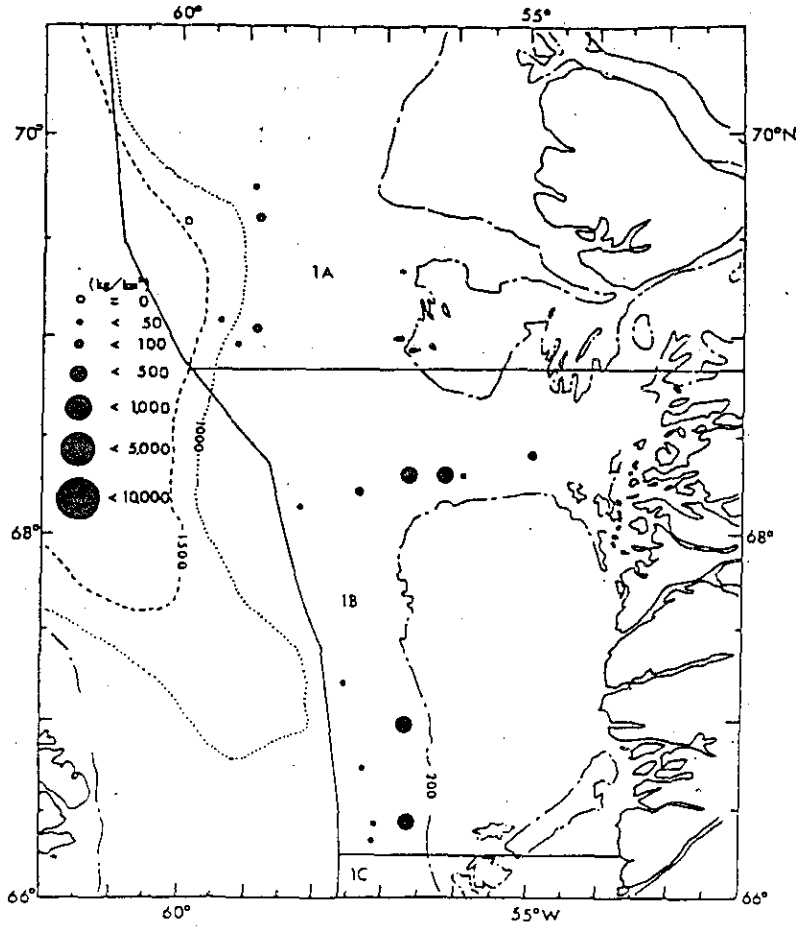
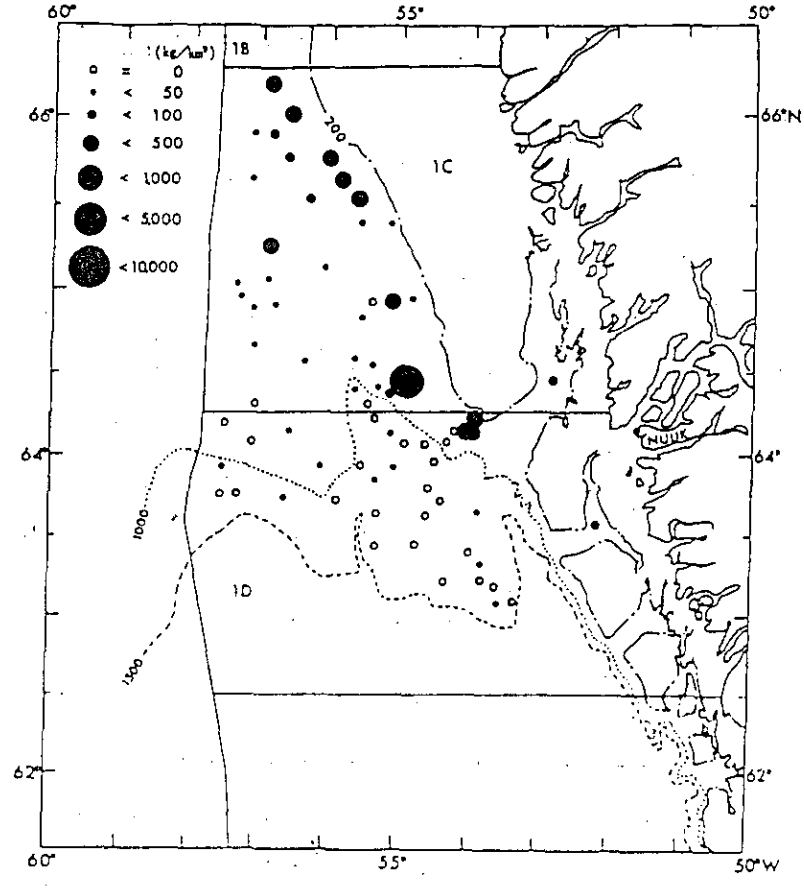


Fig. 4. Size compositions of Greenland halibut in Survey 2 (Nov./Dec. 1992).



Div. 1A -1B
(south of 70°N)



Div. 1C-1D

Fig. 5. Catches (kg/km²) of beaked redfish in Survey 1 (Aug. 1992).

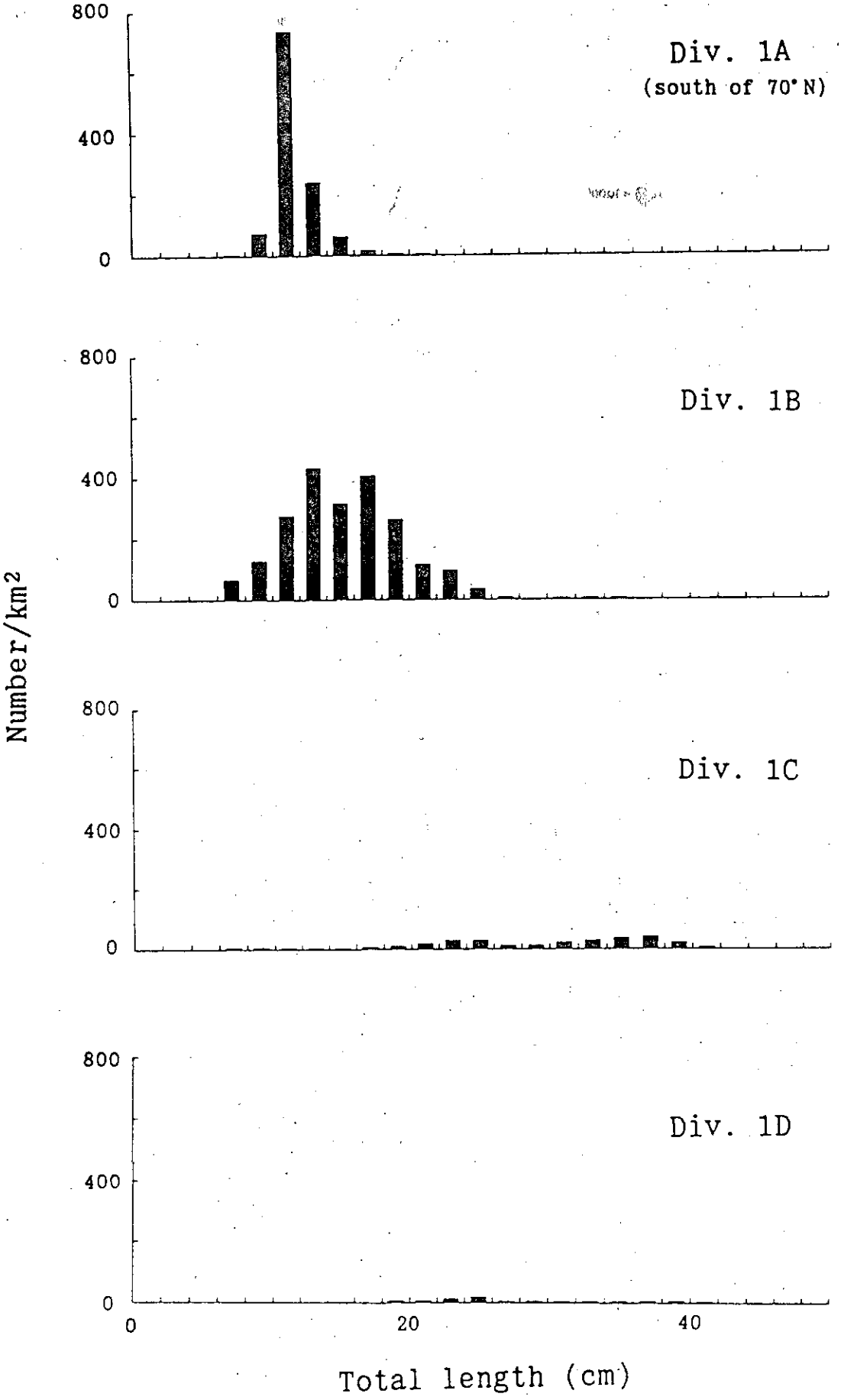


Fig. 6. Size compositions of beaked redfish in Survey 1 (Aug. 1992).

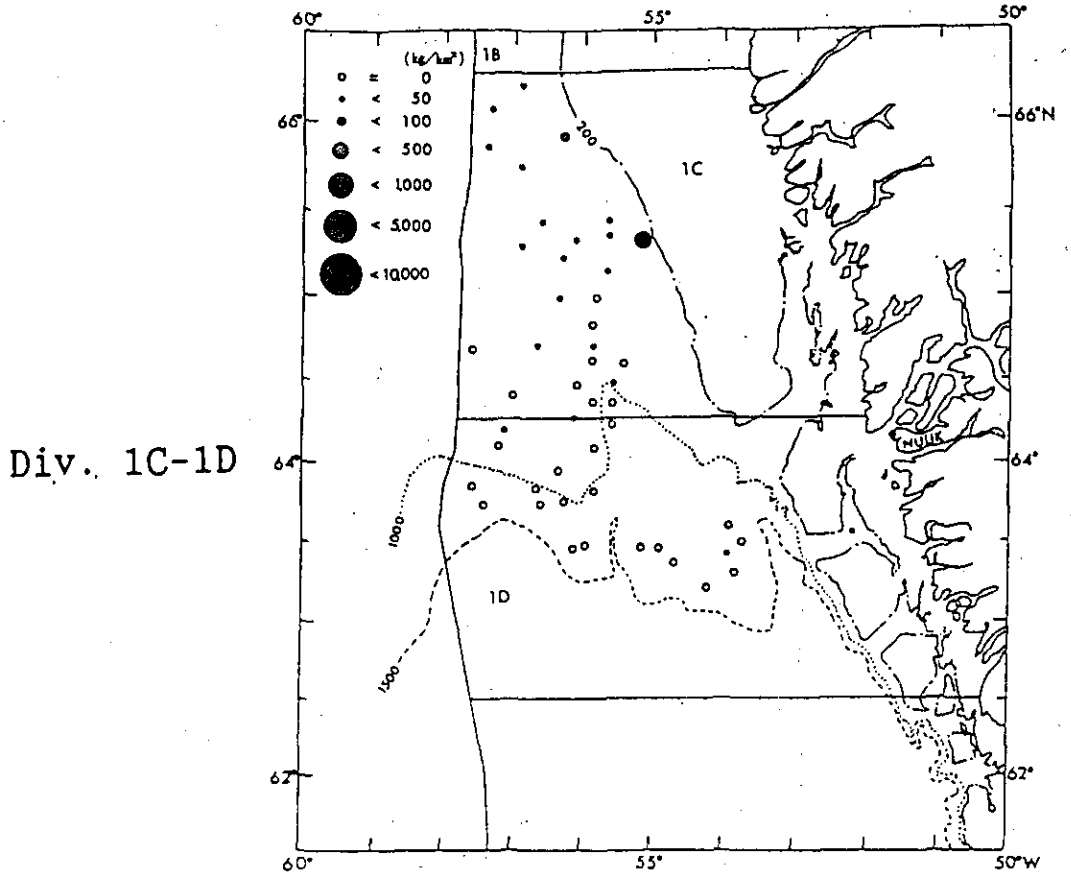


Fig. 7. Catches (kg/km²) of beaked redfish in Survey 2 (Nov./Dec. 1992).

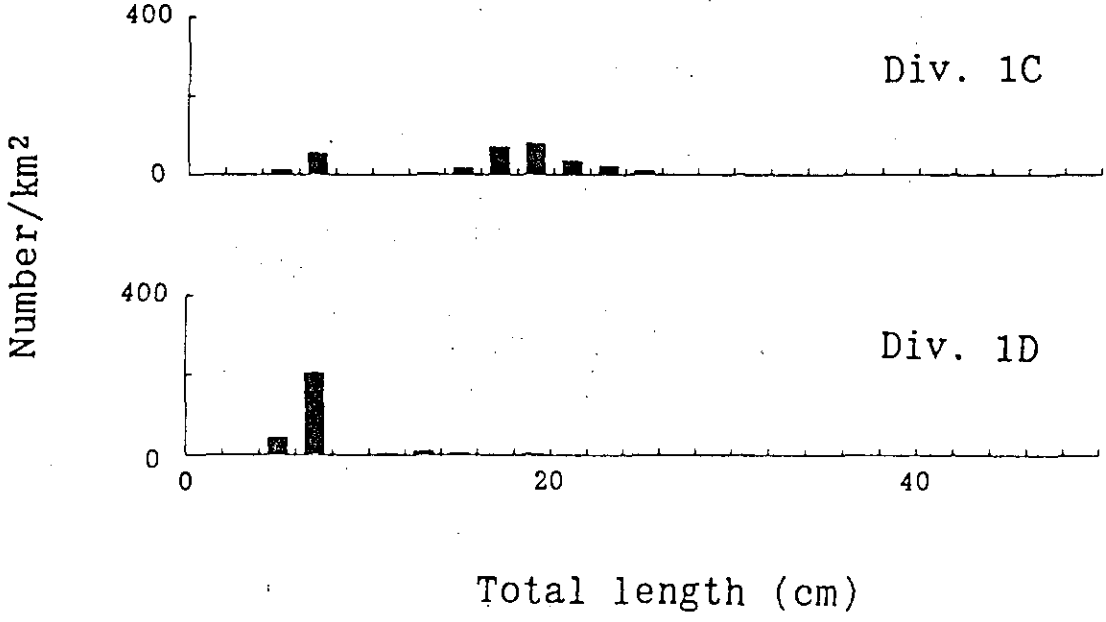
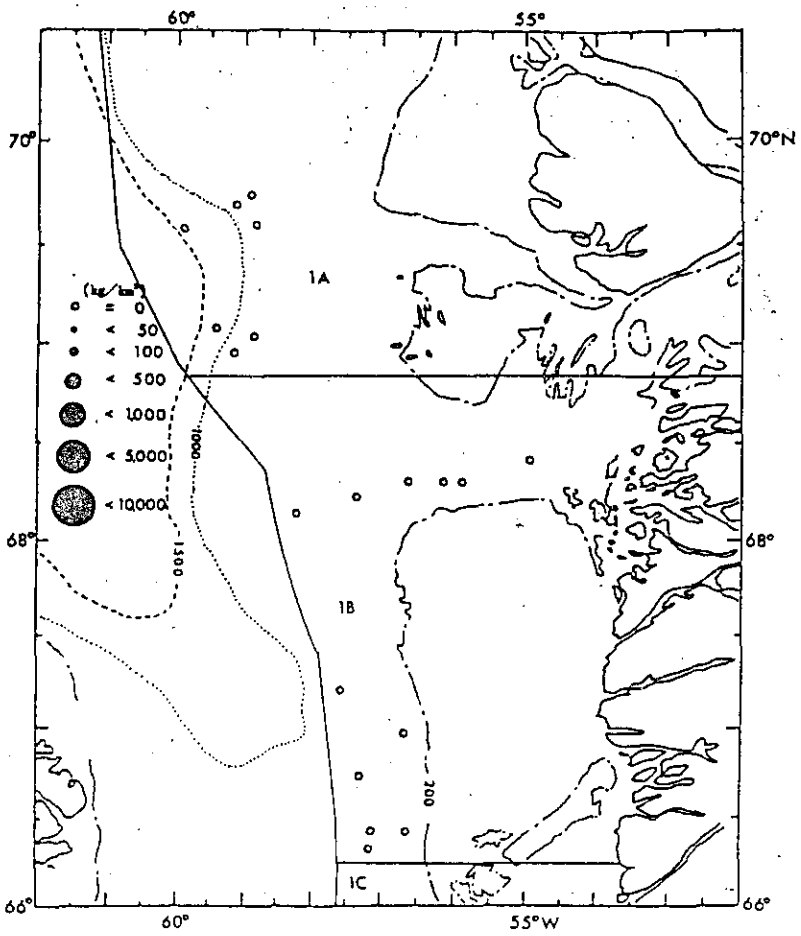
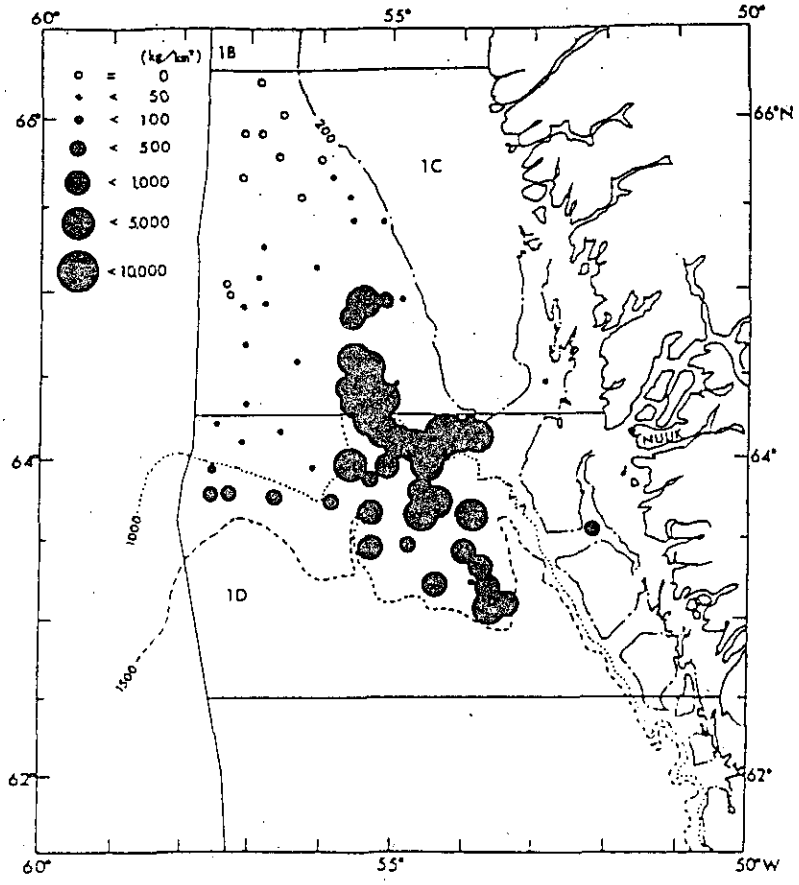


Fig. 8. Size compositions of beaked redfish in Survey 2 (Nov./Dec. 1992).



Div. 1A -1B
(south of 70°N)



Div. 1C-1D

Fig. 9. Catches (kg/km²) of roundnose grenadier in Survey 1 (Aug. 1992).