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Result of a deep water survey in the NAFO Regulatory area in the spring of 1995, with emphasis on Greenland halibut

by

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Introduction

Since 1990, the southern sub-stock of Greenland halibut has become the target of a trawl fishery. Particularly in the NAFO Regulatory area, catch of Greenland halibut raised drastically after 1990 and these high level catch caused a concern that this sub-stock may experience the same fate as the northern cod stock (Bowering *et al.*, 1994). In spite of this situation, insufficient amount of information on a status of Greenland halibut stock in the deepwater area of Subareas 2 and 3 at the time of last June meeting of the NAFO Scientific Council in 1994 prevented the Council from giving an appropriate level of TAC (NAFO, 1994).

The purpose of this survey was to collect information of the status of stock of Greenland halibut in the deepwater area in the NAFO Regulatory area and to collect background information for the forthcoming cooperative survey on Greenland halibut in Subareas 1-3 recommended by the Council (NAFO, 1994).

Material and Method

The survey was conducted by the R/V Shinkai Maru (3395 GRT) in March and April 1995. The area and strata to be covered by the survey were based on the stratification charts and tables in Bishop (1994). Although the survey was planned to cover all strata at depths 300-800 fathoms, some strata were not covered due to a lack of experience and rough sea conditions at the time of the survey (Fig. 1). In Div. 3L, only the depth range 732-1280 m (400-700 fathoms) were covered while in Div. 3M, the entire depth range is represented in the survey. The position of each trawl station was chosen arbitrary within each stratum. The echo sounder was used only for check of depth. Scanmar equipment was used to measure the wing spread.

Trawl operations were made in daytime only. Towing speed was between 3.5 and 3.8 knot. Tow duration was around two hours. The mesh size of the codend was 140 mm and no liner was used in the codend. Detailed information on the vessel and gear is given in Yamada *et al.* (1988). Area swept method was applied to for biomass estimation, assuming a catchability coefficient of 1.0.

Greenland halibut were measured as total length to cm below and size composition were grouped into intervals of 1 cm. 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 and depth range was calculated as the average of the size composition of each stratum, using the stratum area as weighting factor. Maturity stages of female Greenland halibut were determined visually according to the criteria described in Yatsu and Jorgensen (1989).

Results

Trawl operation were made at 58 stations in Div. 3L and 131 stations in Div. 3M (Tables 2 and 3). Estimates of trawlable for Greenland halibut and other 6 species or species group by stratum are obtained (Table 1).

1. Greenland halibut

(1) Biomass and distribution

The density and the biomass estimate of Greenland halibut by stratum were showed in Table 2 and 3. In Div. 3L, relative high densities of Greenland halibut were observed in shallower strata (No. 741 and 745) which were in the northern part of the Flemish Pass. The strata covered by the survey was 62% of total area at the depth between 732 m and 1280 m in Div. 3L (Table 4). The sum of estimated trawlable biomass of strata covered by the survey was 6,400 tons (Table 2).

In Div. 3M, there were no distinct distribution pattern obtained in the survey, but generally high densities of Greenland halibut were observed in the north western area of the Flemish Cap (Table 3). The strata covered by the survey was 65% of total area at the depth between 550m and 1463m in Div. 3M and another three strata (No. 519, 534 and 531) were examined with one haul (Tables 3 and 4). The sum of estimated trawlable biomass of these strata was 13,000 tons.

(2) Size composition

The size composition is given by Division and by depth range in Figs. 2, 3 and 4. The size compositions in Div. 3L and 3M were unimodal with a mode around 43 cm in Div. 3L and 48 cm in Div. 3M (Fig 2). The density of the mode were two times higher in Div. 3L than in Div. 3M. In both of Div. 3L and 3M, the mode did not change by depth. Rather high density was observed in shallower depth range of Div. 3L (Figs. 3 and 4).

(3)Maturity

Figure 5 shows maturity stage distribution of female Greenland halibut by length. Figure 6 shows the relationship between gonad weight and total length. These data indicate the almost all female individuals smaller than 50 cm are immature and most female individuals are mature around 60 cm and larger in total length.

2. Other fishes

Estimated trawlable biomass of each species or species group are shown by stratum in Table 1. In comparison to the catch of Greenland halibut, catches of other species were very low. Relative high number of the biomass of roundnose grenadier were observed in the north and deeper strata of Flemish Cap. Catches of Rays, Dogfishes and Wolffishes were low but observed in almost all strata covered by the survey.

Discussion

Although the each trawl station was not selected at random but selected arbitrary, the relative large number of stations and the stable low value of standard error of estimated biomass of Greenland halibut in each stratum indicate that the survey reflects the stock of Greenland halibut in the area covered by the survey.

This survey was conducted with 140 mm meshes in the codend. Based on the study of Huse and Nedreaas (1995), L_{50} of Greenland halibut is around 36 cm with 135 mm meshes in codend. Jorgensen and Boje (1991) showed that trawl gear is less effective on the catch of Greenland halibut larger than 60 cm in compare to longline. therefore, the result of this survey is only applicable to the Greenland halibut of total length between 36 and 60 cm. Figure 2 (Div. 3L) shows that a significant amount of the trawlable biomass is affected by selectivity (individuals of 30-40 cm in total length).

Extrapolation of densities of Greenland halibut to strata by the use of the data from the survey enabled a rough estimation of total biomass of Greenland halibut in Div. 3L and 3M (Tables 2 and 3). The estimated trawlable biomass in Div. 3L at the depth between 732 and 1280 m was about 11,000 tons. The estimated trawlable biomass in Div. 3M at the depth between 551 and 1463 m was about 15,000 tons. Although the depth coverage of present survey is more narrow than that of Canadian spring deepwater survey in 1994 and the Canadian survey used a 28 mm codend; the estimated trawlable biomass was 5,000 tons higher in Div. 3M and 1,000 tons higher in Div. 3L (Morgan *et al.*, 1994). These differences may partly be attribute to the difference of the size of research vessel used in survey. Shinkai Maru is larger than the vessels used in Canadian survey. Larger vessels usually produce larger biomass estimate.

High density of smaller Greenland halibut in Div. 3L agreed with the result of Canadian spring deepwater survey in 1994 (Morgan *et al.*, 1994). This high density of smaller fish in Div. 3L in the present survey indicates that the relative high level of 1987 and 1986 year classes had recruited to the fishery. Figures 5 and 6 indicates that the estimated trawlable biomass in the present survey consists mainly of the immature Greenland halibut. Whether the large and mature Greenland halibut in Subareas 2+3 had lost or still exist in the fishing area beyond the reach of trawl gear has not been clarified by this survey.

References

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Table 1. Biomass estimate (ton) of each species or species group with the standard error by strata.

3M

	516	520	521	522	523	525	528	529	530	532
Redfishes	936(246)	537(131)	82(26)	0(0)	0(0)	1(1)	134(47)	38(8)	3(3)	0(0)
Greenland halibut	123(13)	702(172)	1022(164)	1587(166)	1105(148)	176(10)	1874(448)	2133(224)	3861(309)	858(104)
Roundnose grenadier	0(0)	6(4)	89(56)	795(230)	1035(714)	0(0)	18(9)	37(13)	1168(208)	167(76)
Wolffishes	6(6)	13(13)	138(41)	113(29)	119(87)	8(8)	49(23)	101(20)	197(42)	12(8)
Dogfishes	4(4)	5(5)	210(83)	373(107)	247(166)	7(7)	0(0)	31(15)	309(57)	33(13)
Rays	14(14)	15(7)	157(47)	341(64)	114(34)	0(0)	76(26)	194(41)	421(44)	67(26)
American placie	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	11(9)	96(45)	0(0)	8(8)

3L

	741	745	746	747	750
Redfishes	56(12)	76(15)	4(2)	0(0)	0(0)
Greenland halibut	1058(47)	1487(128)	1321(184)	1285(367)	1212(380)
Roundnose grenadier	0(0)	8(6)	38(18)	208(98)	48(18)
Wolffishes	3(2)	5(3)	16(7)	71(42)	59(53)
Dogfishes	3(2)	23(17)	7(3)	104(31)	75(52)
Rays	8(6)	137(52)	243(68)	301(75)	220(96)
American placie	0(0)	28(24)	61(37)	569(218)	277(201)

Table 2. Biomass estimate of G. halibut in Div. 3L at the depth between 401-700 fathoms.

Stratum	Depth Range (fathoms)	Area (km^2)	No. of Hauls	Density (kg/km^2)	Biomass[3] (ton)	S.E. of Biomass
737	401-500	779	-	(1.32)[1]	(1028)	-
741	401-500	765	6	1.38	1058	147
745	401-500	1194	18	1.25	1487	128
748	401-500	545	-	(1.32)[1]	(720)	-
738	501-600	758	-	(0.98)[2]	(743)	-
742	501-600	707	-	(0.98)[2]	(692)	-
746	501-600	1345	18	0.98	1321	184
749	501-600	432	-	(0.98)[2]	(424)	-
739	601-700	871	-	(0.58)[1]	(505)	-
743	601-700	724	-	(0.58)[1]	(420)	-
747	601-700	2483	10	0.52	1285	367
750	601-700	1907	6	0.64	1212	380
Total		12509	58		6363 (10954)[4]	

[1] ; Obtained by an average of data from the strata in the same depth range.
[2] ; Extrapolated from the data of stratum No. 746.
[3] ; Value in the parenthesis is obtained by a product of the extrapolated value of the density and the area of stratum.
[4] ; Sum of estimated values from the survey and extrapolated values.

Table 3. Estimated biomass of G. halibut in Div. 3M at the depth between 301-800 fathoms.

Stratum	Depth Range (fathoms)	Area (km^2)	No. of Hauls	Density (kg/km^2)	Biomass[1] (ton)	S.E. of Biomass
516	301-400	2175	2	0.06	123	13
517	301-400	741	-	(0.74)	(550)	-
518	301-400	720	-	(0.74)	(534)	-
519	301-400	1420	1	1.42	1162	-
538	301-400	665	-	(0.74)	(494)	-
520	401-500	1801	7	0.39	702	172
524	401-500	868	-	(0.71)	(616)	-
528	401-500	1818	8	1.03	1874	448
533	401-500	336	-	(0.71)	(239)	-
539	401-500	456	-	(0.71)	(324)	-
521	501-600	1773	18	0.58	1023	164
525	501-600	775	2	0.23	176	10
529	501-600	1674	23	1.27	2133	224
532	501-600	816	10	1.05	858	104
534	501-600	1667	1	1.95	3256	-
522	601-700	1828	15	0.87	1587	166
526	601-700	607	-	(0.93)	(565)	-
530	601-700	3890	39	0.99	3861	309
535	601-700	316	-	(0.93)	(293)	-
523	701-800	974	4	1.13	1105	148
527	701-800	587	-	(0.90)	(526)	-
531	701-800	696	1	0.66	462	-
536	701-800	384	-	(0.90)	(345)	
Total		26986	131		13442 (22808)[3]	

[1] ; Value in the parenthesis is obtained by an average of the densities in the same depth range.
[2] ; Value in the parenthesis is obtained by a product of the extrapolated value of the density and the area of stratum.
[3] ; Sum of estimated values from the survey and extrapolated values.

Table 4. Area of Divs. 3LM by depth range and proportion covered by the survey.

Division	Depth range (metres)	Area (km2)	Proportion covered by the survey
3L	732-914	3282	59.7%
	915-1097	3241	41.5%
	1098-1280	5985	73.4%
	Total	12508	61.5%
3M	550-731	5721	38.1%
	732-914	4822	75.0%
	915-1097	5495	91.7%
	1098 1280	7992	71.5%
	1281-1463	2957	32.9%
	Total	26987	64.9%

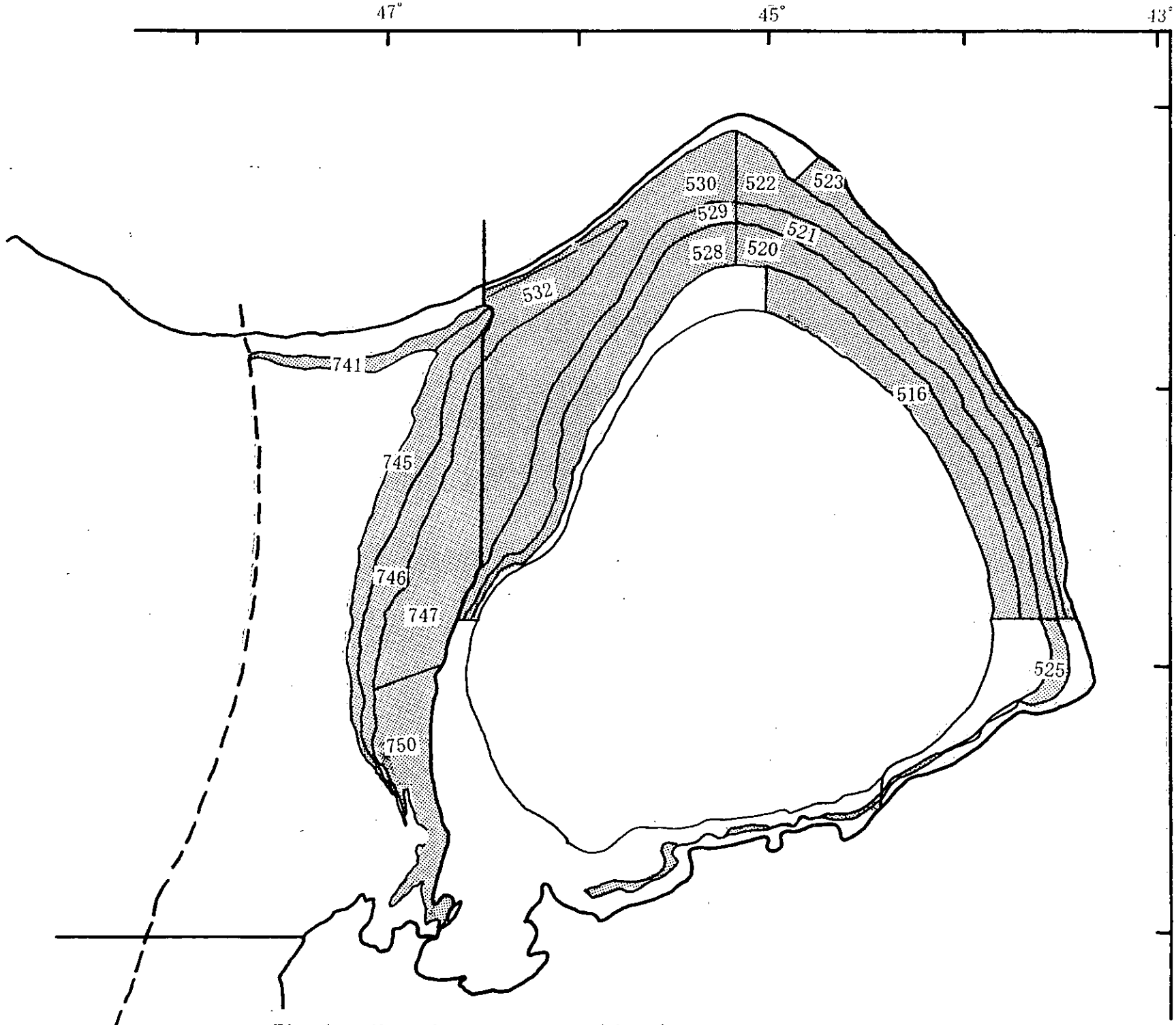
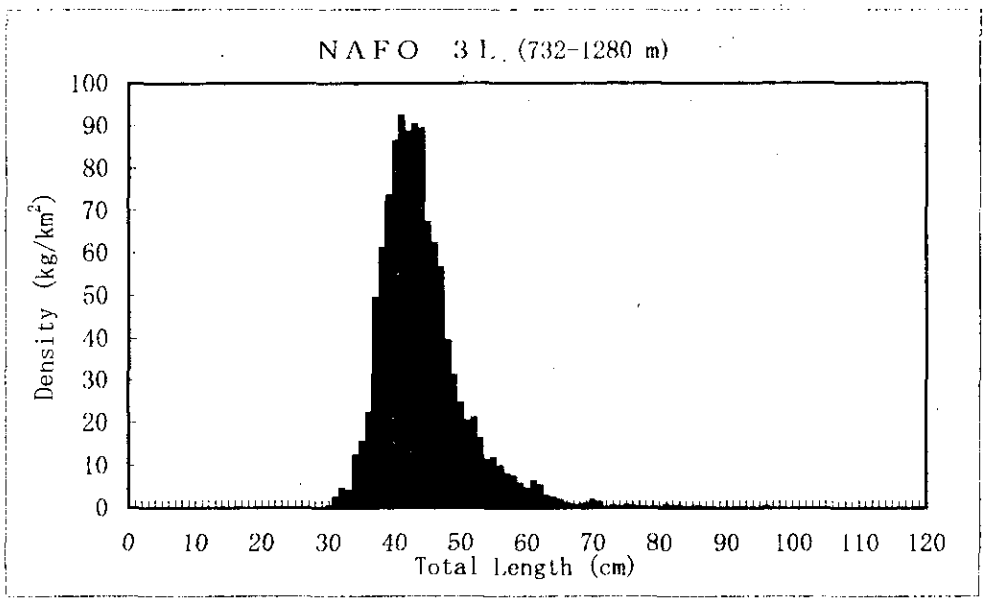


Fig. 1. Map of strata covered by the survey.



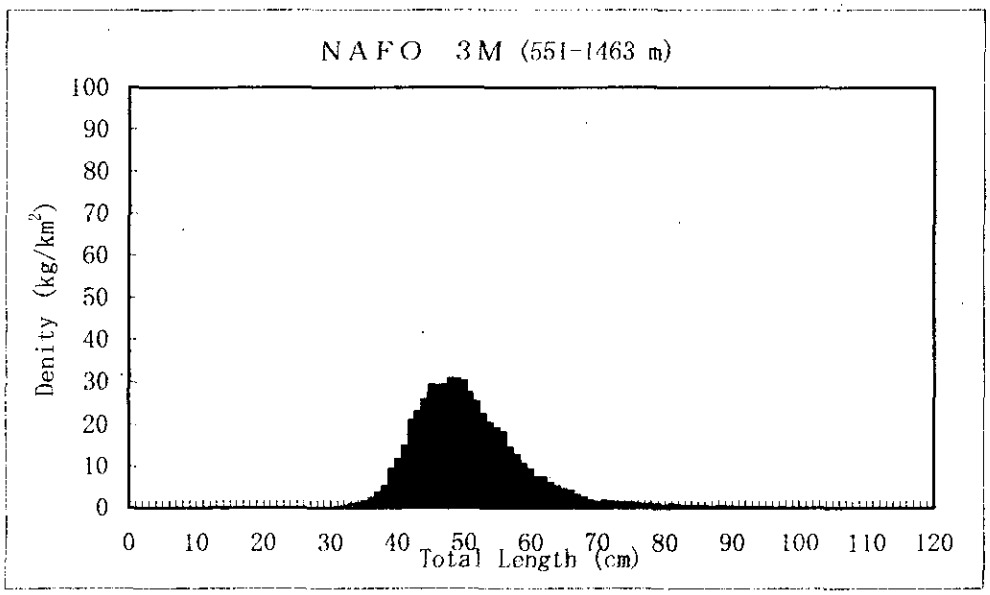
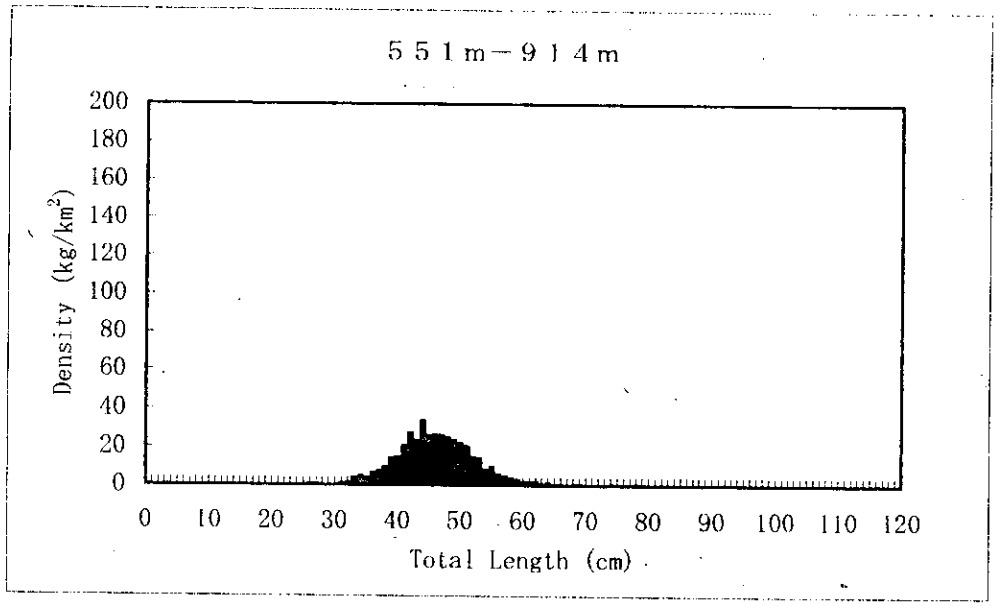


Fig. 2 Size compositions of G. halibut by Division.



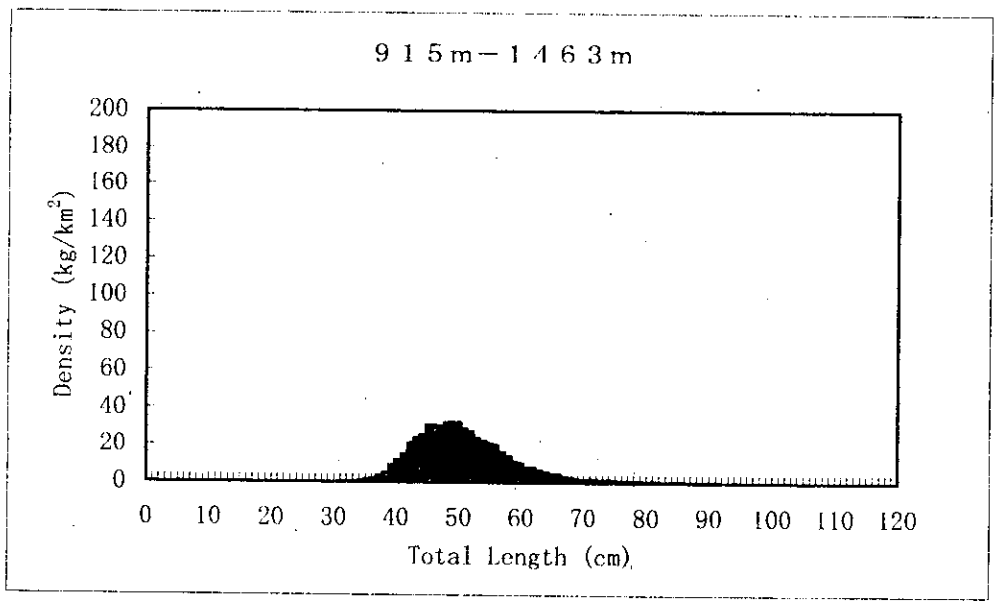


Fig. 3 Size compositions of G. halibut in Div. 3M by depth.

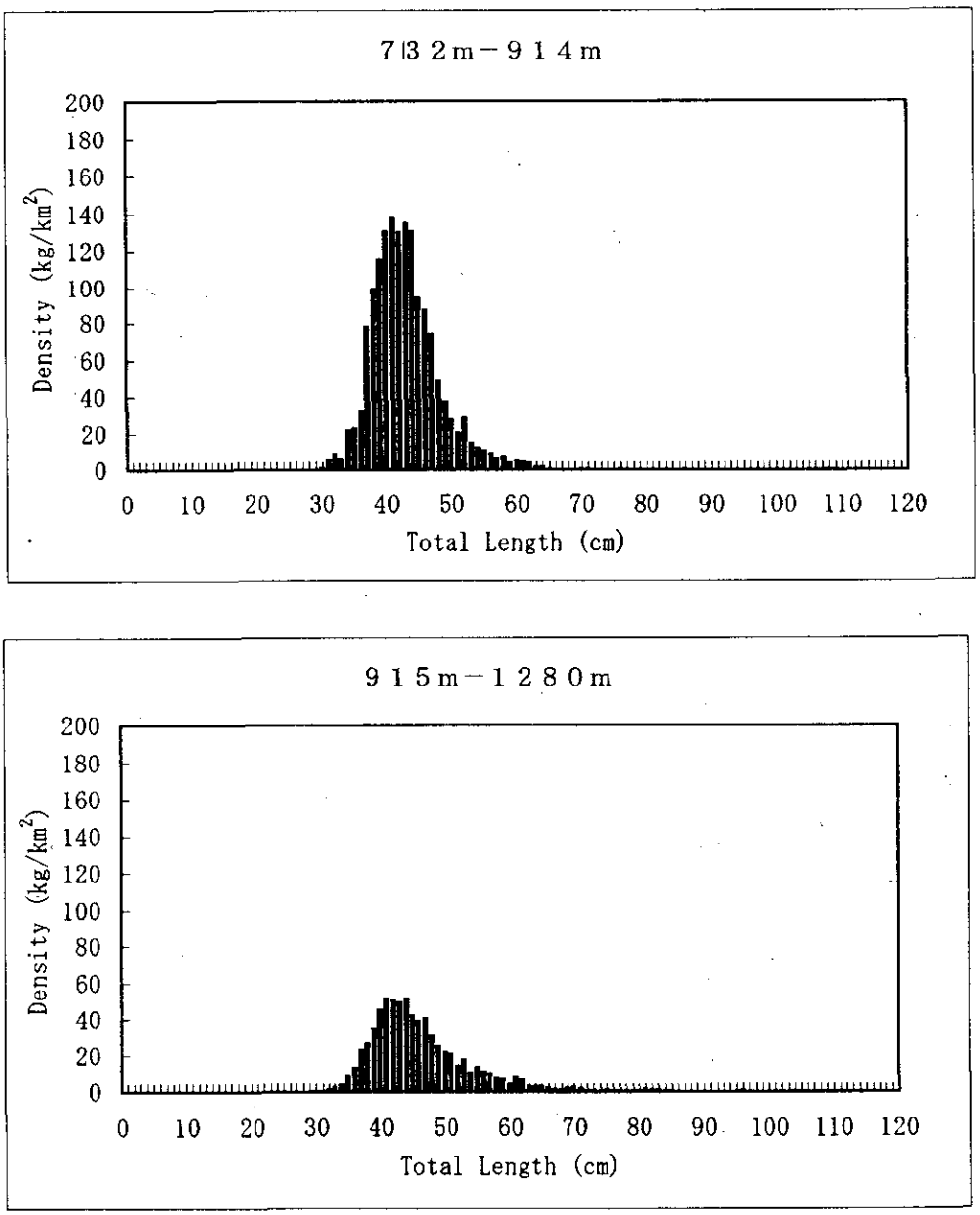


Fig. 4 Size compositions of G. halibut in Div. 3L by depth.

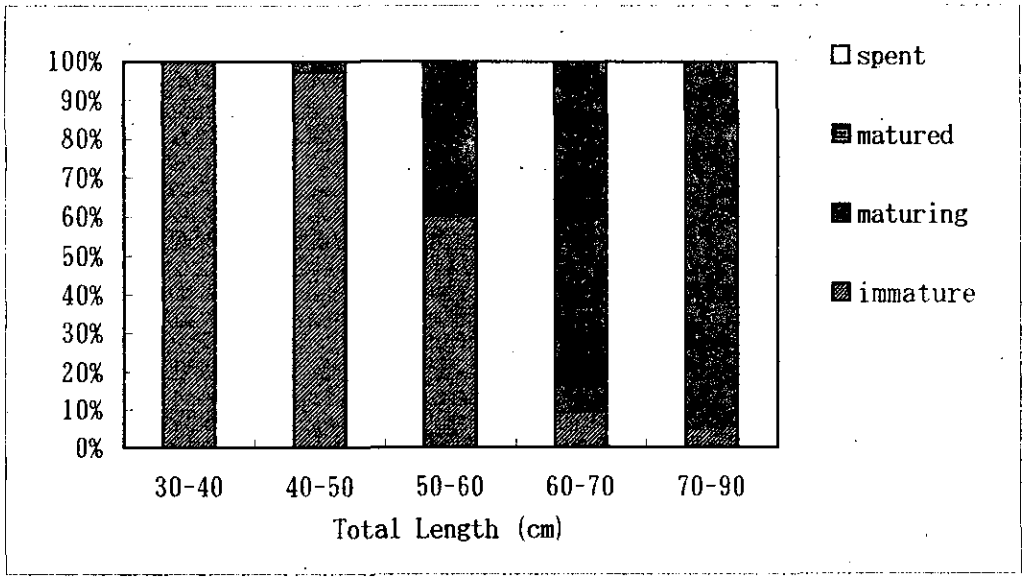


Fig. 5. Maturity stage distribution of female G. halibut by length.

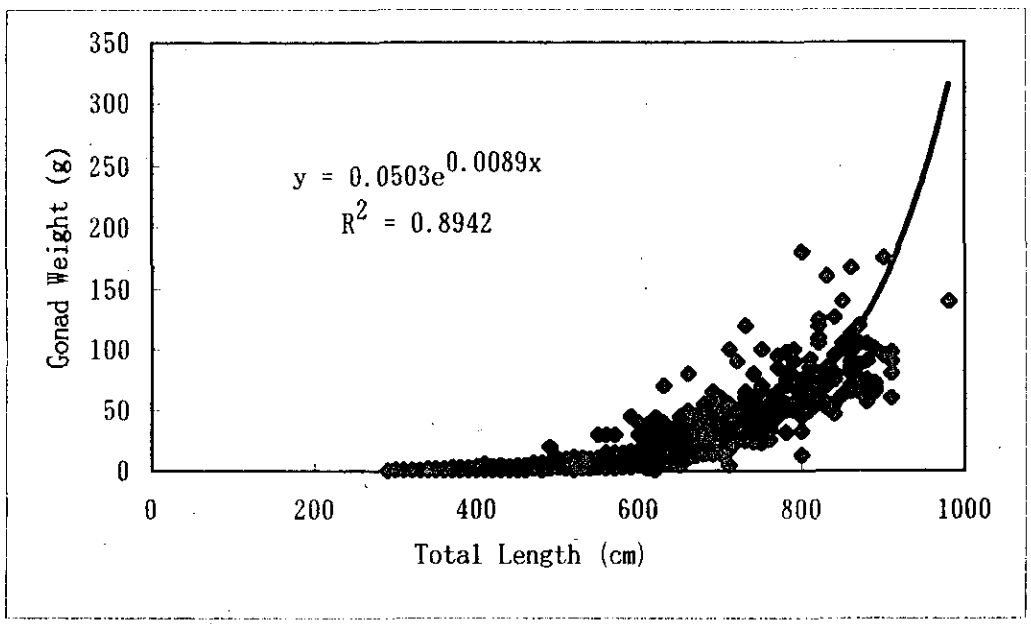


Fig. 6. Gonad weight and length relationship of female Greenland halibut (N=2058).