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Results of the Joint Japan/Greenland Bottom Trawl Surveys at West Greenland During 1987-95 Greenland Halibut (*Reinhardtius hippoglossoides*, Walbaum)

by

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Abstract

During the period 1987-1995 Japan Marine Fishery Resources Research Center and Greenland Institute of Natural Resources jointly conducted 12 stratified random bottom trawl surveys at West Greenland. The surveys covered the area between Cap Farewell and 72°51'N at depths down to approximately 1500 m depth. The survey area has been restratified in 200 m depth intervals and the biomass and abundance of Greenland halibut has been recalculated and the results of all surveys are presented together with information on length, age and sex distribution and catches in relation to bottom temperature.

Introduction

During the period 1987-1995 Japan Marine Fishery Resources Research Center (JAMARC) and Greenland Institute of Natural Resources (former Greenland Fisheries Research Institute) jointly conducted 12 bottom trawl surveys and 4 pelagic surveys (Jorgensen, 1997b; Jorgensen, MS 1997c.) at West Greenland as part of a joint venture agreement on fisheries development and fisheries research in Greenland waters. The surveys were primarily aimed at Greenland halibut (*Reinhardtius hippoglossoides*) and some of the results have previously been reported to NAFO as a number of Research Documents. (Yamada *et al.*, MS 1988a; Yamada *et al.*, MS 1988b; Yatsu and Jorgensen, MS 1989a; Yatsu and Jorgensen, MS 1989b; Jorgensen and Akimoto, MS 1990; Jorgensen and Akimoto, MS 1991; Yano and Jorgensen, MS 1992; Satani *et al*,. MS 1993; Ogawa *et al.*, MS 1994; Yokawa *et al.*, MS 1995; Yokawa *et al.*, MS 1996).

The bottom trawl surveys were conducted as stratified random surveys. In the stratification schemes used in former work (*loc. sit.*) the depth range in some of the strata was very broad (601-1000 m and 1001-1500 m) due to lack of detailed sea charts. Since then more detailed digitised sea charts have become available and in the present paper all the surveys in the time series have been restratified in 200 m depth intervals in order to achieve a better description of the distribution of Greenland halibut and hence more accurate estimates of biomass and abundance. Further, information on age and sex distribution and distribution in relation to temperature, not previously reported, is given. The digitised sea charts have enabled a more accurate measurement of the survey area.

Materials and Methods

Data and material were collected during 12 bottom trawl surveys which were directed mainly at Greenland halibut (*Reinhardtius hippoglossoides*). The surveys were conducted from 1987 to 1995 at different times between April and December and a total of 1036 trawl hauls were carried out (Table 1). The surveys covered West Greenland from south of Cape Farewell, 59°27'N, to 72°51'N, between the 3-mile limit and the 200-mile limit or the midline Canada-Greenland, at depths from 34 to 1497 m. NAFO divisions 1C and 1D were covered by all surveys except one, while areas north of 69°57'N and south of 63°03'N, were only covered once (Table 1, Fig. 1).

All surveys were carried out by the Japanese research vessel SHINKAI MARU, a 3.395 GRT stern trawler with 5.000 HP. Towing time was usually 30 min, but towing times down to 15 min were accepted. Average towing speed was 3.5 kn. Wing spread (w) was estimated as:

$$w = \text{net length} / (\text{hand rope length} + \text{net length}) \times DT, \text{ where}$$

net length = 63 m,
hand rope length = 94 m,
DT =distance between trawl doors

DT was measured by an Otter Grap, or, in most cases, estimated as:

$$DT=10.9 + 13.0\ln(WL), \text{ where}$$

WL=warp length

The wing spread varied between approximately 37 and 45 m. The net height was measured by a Furono Net recorder and varied between 6.5 and 7.5 m. Mesh size was 140 mm with a 30 mm mesh codend liner. Trawling was carried out in day time only. All catches were standardised to catch per km^2 from the actual towing speed and estimated wing spread. Biomass and abundance estimates were obtained by applying the swept area method taking the catchability coefficient as 1.0.

After each haul the catch was sorted by species and weighed to nearest 0.1 kg, the number of specimens recorded (not in all strata in 1987), measured as total length (TL) to 1.0 cm below, and fish above approximately 15 cm were sexed. In 1987 Greenland halibut was measured as fork length, which was transformed to total length by multiplying with 1.02; no fish were sexed.

The survey area was stratified by NAFO Division except NAFO Division 1A which was divided in 1AN and 1AS, - north and south of 70°N, respectively. Prior to the restratification the NAFO Divisions were subdivided in depth strata: 1-200, 201-400, 401-600, 601-1000 and 1001-1500 m, except 1AN which was divided in three strata : 201-600, 601-1000 and 1001-1500m. Based on better digitised charts the survey area has been restratified. NAFO Division 1AN has been restratified in 3 strata: 201-500, 501-1000 and 1001-1500 m. NAFO Divisions 1AS-1E have been restratified in 200 m depth intervals, except depth stratum 1401 to 1500 m. Further, the size of the strata have been recalculated (Table 2).

Due to lack of time, bad weather, ice coverage and restratification some strata have not been covered in some surveys. In survey used for comparison between years (surveys conducted in July - October) the biomass and abundance in strata without hauls have been estimated by a two-way ANOVA anticipating that the distribution was the same in all years (Jørgensen, 1997a), according to the following:

$$\ln(\text{biomass or abundance } (km^{-2})) = \alpha + \beta_1 Y + \beta_2 D + \varepsilon, \text{ where}$$

Y=Year and D=Depth stratum. The ANOVA was made by NAFO Division to avoid that the high biomass and abundance in the shallow strata in Div. 1B influenced the estimation of biomass and abundance in shallow strata without hauls in Div. 1C and 1D where the biomass and abundance usually was low, and vice versa in deep water. The model was statistically significant ($P > 0.01$) in all cases and explained between 63% and 91% of the variation in data. Biomass and abundance was first of all estimated in depth stratum 801-1000 in Div. 1B, a rather small stratum (671 km^2) with relatively low biomass and abundance and in depth strata > 1000 m in 1987. In strata where biomass and abundance was estimated by the ANOVA and in strata with only on haul, the Standard Error (S.E.) was estimated from a regression between mean biomass/abundance km^{-2} and S.E.

Otoliths for age determination were soaked in water and read in transparent light. Age distributions were estimated using age/length keys and survey length frequencies pooled in 5 cm groups.

Near-bottom temperatures were measured, by 0.1 °C, as close as possible to the bottom either by CTD or XBT at 861 of the 1036 trawl stations.

Results

The majority of the surveys covered NAFO Divisions 1B - 1D at depths between 400 and 1500 m at approximately the same time (July-October). Unless anything else is mentioned this area is used for comparison of between years variation. The recalculation of the size of this area showed an increase from 53119 km^2 to 62132 km^2 (17 %) (Table 2) (Yatsu and Jørgensen, MS 1989a).

1987

The survey was conducted between July 15 and August 13 and covered Div. 1AS to 1F at depths between 34 and 998 m. In total 117 successful hauls were made (Fig. 1, Table 1).

The biomass of Greenland halibut in Div. 1B-1D, 401-1500 m was estimated at 115158.5 tons (S.E. 25366.9) which is by far the highest estimate in the time series (Table 3, Fig. 2). However, the estimate was based on 31 hauls only, and the biomass at depths > 1000 m was estimated by an ANOVA. The highest biomass was found in Div. 1C depth stratum 801-1000 and 601-800 m and the biomass was estimated to be high in Div. 1D depth stratum 1001-1200 and 1201-1400 m. The biomass was low at depths < 400 m in all Divisions (Table 3), except in Div. 1B stratum 201-400 m (3354.9 tons, S.E. 866.8). Div. 1E and 1F was surveyed for the only time in the survey series, but the survey covered shallow waters (< 500 m) only, and the estimated biomass was low (Table 5).

The abundance was the highest observed in the time series ($149918.5*10^3$, S.E $34757.6*10^3$) and the distribution of the abundance resembled the distribution of the biomass (Table 4).

In Div. 1AS and 1B the length distribution was dominated by very distinct modes around 11 and 19 cm. The length distribution in Div. 1C was dominated of fish between 38 and 58 cm with a broad mode around 46 cm, while the distribution in Div. 1D consisted mainly of fish between 42 and 70 cm with several modes (Fig. 3).

1988

The survey was conducted between September 12 and November 11 and covered Div. 1AN to 1D at depths between 422 and 1402 m (259-1398 m in 1AN). In total 109 successful hauls were made (Fig. 1, Table 1).

The biomass of Greenland halibut in Div. 1B-1D, 401-1500 m, was estimated at 58647.2 tons (S.E. 9133.9) which was only half the estimate in 1987, but the difference is not statistically significant (95 % level) due to large variation in data (Fig. 2, Table 3). The highest biomass was found in Div. 1C depth strata 601-800 and 801-1000 m, and in Div. 1D depth strata 1001-1200 and 1201-1400 m. In 1988 Div. 1AN was surveyed for the only time in the survey series, and 21 hauls were made in the area. The biomass was estimated at 19335.2 tons (S.E. 4694.9) of which the larger part (10017.8 tons) was found in depth stratum 501 - 1000 m (Fig. 1, Table 6).

The abundance in Div. 1B-1D (401-1500 m) dropped from $149918.6*10^3$ (S.E. $34757.6*10^3$) in 1987 to $68121.1*10^3$ (S.E. $16696.1*10^3$) in 1988 (statistically insignificant (95 % level)) (Table 4, Fig. 2). The distribution of the abundance resembled the distribution of the biomass, except that a high abundance was observed in Div. 1B depth stratum 401-600 m. In 1AN the abundance was estimated at $98056.8*10^3$ specimens (S.E. $10614.3*10^3$) of which more than 50% was found in depth stratum 201-500 m (Table 6).

In Div. 1AN and 1B the length distribution was dominated by three very distinct modes around 11, 19 and 24 and 28 cm in Div. 1AN and 1B, respectively. The length distribution in 1AS was dominated by a mode around 25 cm and a broad mode between 34 and 52 cm, reflecting a dominance of hauls in the deeper strata. The length distribution in Div. 1C was dominated of fish between 38 and 58 cm with a broad mode around 50 cm, while the distribution in Div. 1D consisted mainly of fish between 42 and 70 cm with a mode around 52 cm (Fig. 3).

The age distribution in Div. 1A (1AN + 1AS) consisted of fish age 1 to 7, where the younger fish mainly were found in 1AN, while the older fish mainly came from Div. 1AS. Div. 1B was dominated by young fish < 5 years, while the age distributions in Div. 1C and 1D were unimodal with modes around 7 and 8 years, respectively (Fig. 4). (The otoliths have been reread after the material given in Yatsu and Jorgensen (1989b)).

1989

The survey was conducted between April 30 and May 17 and covered Div. 1C and 1D at depths between 494 and 1497 m. In total 61 successful hauls were made (Fig. 1, Table 1). Div. 1AS, 1B and the western part of Div. 1C and 1D was not surveyed due to ice.

The biomass of Greenland halibut in Div. 1C-1D, 401-1500 m, was estimated at 69085.6 tons (S.E. 13855.4) which is an statistically insignificant (95 % level) increase in biomass on approximately 17000 tons compared to the estimate for the same area in 1988. The two surveys were, however, conducted at different time of the year which makes comparison difficult (Fig. 2, Table 3). The highest biomass was found Div. 1D depth strata 1001-1200 and 1201-1400 m as in the previous years. The biomass was, however, concentrated more southerly and at greater depths compared to 1987 and 1988, probably reflecting annual movements between the spawning ground and feeding areas (Jorgensen 1997a).

The abundance in Div. 1C-1D, 401-1500 m, was estimated at $57525.7*10^3$ (S.E. $11116.8*10^3$) which was an increase from $43883.9*10^3$ compared to the same area in 1988. The distribution of the abundance resembled the distribution of the biomass in a more southerly and deeper distribution compared to previous year (Fig 2, Table 4).

Fish were generally larger in Div. 1D compared to 1C and the distributions were monomodal with modes around 50 and 48 cm, respectively (Fig. 3).

The age distribution in Div. 1C and 1D were unimodal with modes around 7 and 8 years, respectively, as in 1988, but there were fewer young fish in Div. 1C compared to 1988 (Fig. 4).

1990

In 1990 two surveys were conducted. The first survey took place between June 9 and June 22 and covered Div. 1B to 1D at depths between 449 and 1482 m. In Div. 1B only depth stratum 401-600 m was covered. In total 75 successful hauls were made, (Fig. 1, Table 1). The second survey took place between August 27 and September 12 and covered Div. 1AS to 1D at depths between 422 and 1467 m. In total 87 successful hauls were made (Fig. 1, Table 1).

In the first survey the biomass of Greenland halibut in Div. 1C-1D, 401-1500 m, was estimated at 62778.9 tons (S.E.13466.1) which was close to the 69000 tons estimated in the same area in 1989, where the survey took place approximately a month earlier (Table 3). The main biomass was found at depths between 601 and 1000 m, and generally on shallower water and more northerly compared to 1989.

In the second survey the biomass in Div. 1B-1D, 401-1500 m, was estimated at 51744.3 tons (S.E. 9296.7), which was comparable to the estimated 58647.2 tons in approximately the same period in 1988 (Fig. 2, Table 3). The estimate for Div. 1C-1D was 44018.1 tons, which was substantial, although not statistically significant, lower than in the comparable areas in the first survey in 1990 (62778.9 tons) and in 1989 (69085.6 tons). The highest biomass was found in Div. 1C depth strata 601-800 and 801-1000 m and in Div. 1D depth strata 1001-1200 and 1201-1400 m.

In the first survey the abundance in Div. 1C-1D, 401-1500 m, was estimated at $51210.1*10^3$ (S.E. $11463.3*10^3$), which is a little lower than in the same area in 1989 ($57525*10^3$) (Table 4). The derivation of the abundance resembled the distribution of the biomass *i.e.* the main abundance was found at depths between 601 and 1000 m. Compared to 1989 the abundance was generally found on shallower water and more northerly.

In the second survey the abundance in Div. 1B-1D, 401-1500 m, was estimated at $53611.5*10^3$ (S.E. $10060.4*10^3$), which is somewhat lower than the estimate on $68121.1*10^3$ from approximately the same period in 1988 (Fig. 2,

Table 4). The estimate for Div. 1C-1D was $37951.4*10^3$ (S.E. $7136*10^3$), which was substantial, although not statistically significant, lower, than the comparable areas in the first survey in 1990 ($51210.1*10^3$) and 1989 ($57525.7*10^3$). The highest abundance was found in Div. 1B depth stratum 401-600 m, Div. 1C depth strata 601-800 and 801-1000 m and in Div. 1D depth strata 801-1000 and 1001-1200 m.

In the first survey the length distribution in Div. 1B was dominated by three modes around 10, 19 and 24 and a boarder mode around 34 cm The length distribution in Div. 1C and 1D was dominated by fish between approximately 40 and 65 cm with clear modes around 50 cm, but with a tendency towards slightly larger fish in Div. 1D (Fig. 3).

In the second survey the length distribution in Div. 1B was dominated by the same four modes as in the first survey, but the fish seems to have grown 2-3 cm between the two surveys. The length distribution in Div. 1C and 1D was dominated by fish between approximately 40 and 65 cm with clear modes around 50 and 52 cm in Div. 1C and 1D, respectively. There was a tendency towards slightly larger fish in Div. 1D. In Div. 1AS fish were generally between 20 and 50 cm, with several unclear modes (Fig. 3).

<u>1991</u>
In 1991 were conducted two surveys. The first survey took place between August 4 and August 30 and covered Div. 1AS to 1D at depths between 38 and 1490 m. In total 139 successful hauls were made (Fig. 1, Table 1). The second survey took place between November 12 and November 27 and covered Div. 1AS and 1B at depths between 38 and 774 m. In total 51 successful hauls were made (Fig. 1, Table 1).

In the first survey the biomass of Greenland halibut in Div. 1B-1D, 401-1500 m, was estimated at 81746.4 tons (S.E.15360.1), which was the second largest estimate in the time series, and an, although not statistically significant (95% level), increase on approximately 30000 tons compared to the second survey in 1990 (Fig 2, Table 3). Almost all the increase was observed in Div. 1C in depth strata 601-800 m and 801-1000 m, while the estimates form the other strata were at approximately the same level as the year before. The reason for the increase is unclear. The coverage was the same in the two years. The main biomass was found at depths between 601 and 1000 in Div. 1C and 1001-1200 m in Div. 1D

In the second survey the biomass in Div. 1AS (0-400 m) - 1B (0-800 m) was estimated at 11361.7 tons (S.E. 2483.6) which was a little lower compared to 13247.5 (S.E. 2613.1) in the same area in the first survey in 1991. The bulk of the biomass was found in Div. 1B at depths between 201 and 800 m in both surveys, but the biomass seemed to be distributed at shallower depths compared to the first survey (Table 3).

In the first survey the abundance in Div. 1B-1D, 401-1500 m, was estimated at $89974.8*10^3$ (S.E. $16608.2*10^3$), which is a heavy, although not statistically significant, increase compared to the year before ($53611.5.7*10^3$) (Fig 2, Table 4). Almost all the increase was seen in Div. 1B depth stratum 401-600 m and Div. 1C depth strata 601-800 m. and 801-1000 m. The increase was statistically significant (95% level) in the two latter strata.

In the second survey the abundance in 1AS (0-400 m) - 1B (0-800 m) was estimated at $115834.2*10^3$ (S.E.*32784.6 10^3) which was about twice the estimate on $54330.7*10^3$ in same area in the first survey. (Table 4) The increase was primarily seen in depth strata 0-201 and 201-400 m especially in Div. 1B, and was mainly caused by settling of a great number of 0+ fish.

In the first survey the length distribution in Div. 1B was dominated by three very distinct modes at 11, 18 and 27 cm, while the length distribution in Div. 1C and 1D was dominated of fish between approximately 40 and 60 cm with clear modes around 50 cm, but with and a tendency towards slightly larger fish in Div. 1D. In Div. 1AS were the first two modes seen in Div. 1B (11 and 18 cm) also noticed. Further, three modes at 30, 34 and 39 cm were seen (Fig. 3).

In the second survey the length distribution in Div. 1AS and 1B was dominated by two modes at 7-8 and 12-13 cm, respectively, of which the first mode represented newly settled 0+ fish. The larger fish seen in the first survey was probably missing due to lack of hauls in the deeper strata in Div. 1AS (Fig. 3).

<u>1992</u>
In 1992 were conducted two surveys. The first survey took place between August 11 and August 28 and covered Div. 1AS to 1D at depths between 417 and 1475 m. In total 90 successful hauls were made (Fig. 1, Table 1). The second

survey was conducted between November 25 and December 7 and covered Div. 1C-1D at depths between 510 and 1400 m. In total 49 successful hauls were made (Fig. 1, Table 1). Due to severe damage of the trawl in the second survey , the trawl was replaced at haul 15. Although the two trawls were almost identical there was found a statistically significant difference in the catchability of Greenland halibut in the two trawls (Satani *et al.* MS 1993). All catches after haul 15 are therefor multiplied by 2.4.

In the first survey the biomass of Greenland halibut in Div. 1B-1D, 401-1500 m, was estimated at 72588.6 tons (S.E.15883.2) which was a statistically insignificant drop compared to 81746.4 tons in the first survey in 1991 (Fig 2, Table 3). The decrease was primarily seen in Div. 1C depth stratum 601-800 m (statistically significant (95 % level) and in Div. 1D depth strata 801-1000 m and 1401-1500 m (statistically significant (95 % level). while the estimates were more or less at the same level in the remaining depth strata in. The largest biomasses were found in Div. 1C depth stratum 801-1000 m, Div. 1D depth stratum 1001-1200 m and in Div. 1B depth stratum 401-600, m where the biomass estimate was the largest in the time series.

In the second survey the biomass in Div. 1C-1D, 401-1400 m, was estimated at 50863.1 tons (S.E. 11571.2) which was a insignificant drop compared to 59900.9 tons (S.E. 12713.9) in the same area in the first survey in 1992 (Table 3). The bulk of the biomass was found in Div. 1D at depths between 1001 and 1401 m. Generally the biomass was found at greater depths in the second survey compared to the first, probably due to annual migrations and some fish might have migrated into deeper water outside the survey area (Jorgensen 1997a)

In the first survey the abundance in Div. 1B-1D, 401-1500 m, was estimated at $102325.8*10^3$ (S.E. $26582.1*10^3$), which was the second largest estimate in the survey series. The increase in abundance was, however, not statistically significant compared to the $89974.8*10^3$ estimated in 1991 Almost all the increase was seen in Div. B depth stratum 401-600, while there was a marked drop in abundance in Div. 1C depth stratum 601-800 m. The changes in the other strata were limited. (Fig 2, Table 4).

In the second survey the abundance in Div. 1C- 1D, 401-1400 m, was estimated at $58095.6*10^3$.(S.E. $12215.8*10^3$) which is at the same level ($55977.9*10^3$) as in same area in the first survey, but the main distribution was deeper and more southerly *i.e.* in Div. 1D at depths between 1001 and 1400 m.

In the first survey the length distribution in Div. 1B was dominated by four distinct modes at 12. 18. 27 and 35 cm, respectively. The length distribution in Div. 1C and 1D was dominated of fish between approximately 40 and 60 cm with clear modes around 50 cm, however, with and a tendency towards slightly larger fish in Div. 1D. The first two modes seen in Div. 1B (12 and 18 cm) was also observed in Div. 1AS. Further, a broad mode around 36-40 cm and a mode at 48 cm were seen (Fig 3).

In the second survey the length distribution in Div. 1C was dominated by modes at 38, 40 and 44 cm, while the length distribution in Div. 1D was dominated by a single mode around 49 cm, indicating a migration of larger fish towards deeper water compared to the first survey (Fig. 3).

<u>1993</u>

The survey was conducted between August 20 and September 8 and covered Div. 1B to 1D at depths between 435 and 1418 m. In total 87 successful hauls were made (Fig. 1, Table 1).

The biomass of Greenland halibut in Div. 1B-1D, 401-1500 m, was estimated at 40759.8 tons (S.E. 7108.0) which is a marked, but statistically insignificant, decrease compared to 1992 (72588.6 tons S.E. 15883.2) (Fig. 2, Table 3). The reduction in biomass was seen in almost all depth strata, but it was most pronounced in Div. 1C depth stratum 801-1000 (statistically significant (95 % level). The highest biomass was found in Div. 1D depth stratum 1001-1200.

The abundance in Div. 1B-1D, 401-1500 m, was almost halved from $102325.8*10^3$ (S.E. $26582.1*10^3$) in 1992 (1) to 55712.0 10^3 (S.E. 11620.0 10^3) in 1993 (statistically insignificant (95 % level)) (Table 4, Fig. 2) .The distribution of the abundance resembled the distribution of the biomass, *i.e.* a reduction in almost all depth strata and a significant reduction in abundance in Div. 1C depth stratum 801-1000 m. The highest abundance was observed in Div. 1B depth stratum 401-600 m as in the previous two years.

In Div. 1B the length distribution is dominated by two very distinct modes around 12 and 18 cm. The length distribution in Div. 1C was dominated by fish between 38 and 58 cm with a mode around 48 cm, while the distribution in Div. 1D mainly consisted of fish between 40 an 60 cm with a mode around 50 cm (Fig. 3).

1994
The survey was conducted between August 2 and August 19 and covered Div. 1B to 1D at depths between 439 and 1472 m. In total 80 successful hauls were made (Fig. 1, Table 1).

The decrease in biomass seen since 1991 continued in 1994 and the lowest estimated biomass in the time series was observed. The biomass in Div. 1B-1D, 401-1500 m, was estimated at 33958.5 tons (S.E. 7537.6) which was significant (95 % level) lower than the 81746.4 tons (S.E. 15360.1) estimated in 1991, and somewhat lower than the estimate on 40759.8 tons (S.E. 7108) in 1993 (Fig. 2, Table 3). The reduction in biomass was seen in almost all depth strata except Div. 1C depth stratum 801-1000 and Div. 1D depth strata 1201- 1400 m and 1401-1500 m where small increases were observed. The highest biomass was found in Div. 1D depth stratum 1001-1200 as in the previous three years.

The decrease in abundance seen since 1991 continued in 1994 and the estimated abundance in Div. 1B-1D, 401-1500 m, 35853.6*10^3 (S.E. 8742.5*10^3) was significantly (95% level) lower than the estimate from 1991 (89974.8*10^3 S.E. 16608.2*10^3) (Table 4 Fig. 2). (The estimated abundance in 1992 was 102325.8*10^3 (S.E. 26582.1*10^3) but this figure was not significantly different from the 1994 figure). The 1994 estimate was also marked lower than the estimate in 1993 (55712.0*10^3 S.E. 11620.0*10^3). The largest decrease in abundance compared to 1993 was seen in Div. 1B depth stratum 401-600 m, where the lowest abundance seen in the time series was observed. In contradiction to the previous yeas the highest abundance was found in Div. 1D depth stratum 1001-1200 and not in Div. 1B depth stratum 401-600 m.

In Div. 1B the length distribution is dominated by four modes around 12, 18, 24 and 29 cm of which the two first modes have been seen in all surveys. The length distribution in Div. 1C was dominated of fish between 38 and 58 cm with a clear mode around 48 cm, while the distribution in 1D consisted mainly of fish between 40 and 60 cm with a mode around 50 cm (Fig. 3).

The age distribution in Div. 1B was dominated by fish age 1 to 4 corresponding to the four modes in the length distribution. The age distribution in Div. 1C was dominated by fish age 6 and 7 where fish age 6 were more frequent compared to 1988 and 1989. In Div. 1D the age distribution was dominated by fish between 6 and 8 years and as in Div. 1C. The mode in the age distribution had, however, changed a year from age 8 to age 7 compared to the late 80'ies (Fig. 4).

1995
The survey was conducted between August 12 and September 1 and covered Div. 1AS to 1D at depths between 422 and 1463 m. In total 91 successful hauls were made (Fig. 1, Table 1).

The decrease in biomass seen since 1991 seemed to have stopped in 1995 and the estimated biomass in Div. 1B-1D, 401-1500 m, had stabilised at 43408.5 tons (S.E. 9446.8) compared to 33958.5 tons (S.E. 7537.6) in 1994 (Fig. 2 Table 3). The increase in biomass was seen in almost all depth strata except Div. 1C depth strata 401-600 m and 1001-1200 m and Div. 1D depth stratum 1201- 1400 m, where small decreases were observed. The highest biomass was found in Div. 1D depth stratum 1001-1200 as in the previous four years.

The decrease in abundance seen since 1991 also seemed to have stopped in 1995 where the abundance in Div. 1B-1D, 401-1500 m, was estimated at 63416.2*10^3 (S.E. 16452.3*10^3) which was marked, but not significantly higher, than the estimate from 1994 (35853.6*10^3 S.E. 8742.5*10^3). The increase in abundance was seen in all strata, except Div. 1D depth stratum 1201-1400 m. with the highest increase in Div. 1B depth stratum 401-600 m, where the highest abundance also was observed. (Table, 4 Fig. 2).

The length distribution in Div. 1B was dominated by four modes around 12, 20, 26 and 32 cm of which the two first modes have been seen in all surveys. The length distribution in Div. 1C was dominated of fish between 38 and 58 cm with a mode around 48 cm, while the distribution in Div. 1D consisted mainly of fish between 40 and 60 cm with a mode around 50 cm. The length distribution in Div. 1AS consisted of several more or less well defined modes at 23, 30, 37, 44, 50, 54, and 59 cm (Fig. 3).

The age distribution in Div. 1B was dominated by fish age 1 to 4 (Fig. 4) corresponding to the four modes in the length distribution (Fig.3). The age distribution in Div. 1C was dominated by fish age 7 and the relative importance of age 6 had decreased compared to 1994. In 1988 and 1989 the age distribution was dominated by age 7 and age 8. In 1995 it was still age 7 that was the most dominant but age 6 was now more dominant than age 8. In Div. 1D the age distribution was dominated by fish between 6 and 8 years with a clear mode at age 7 and ages 6 and 8 being equally dominant. The same pattern was seen in the late 80'ies, except that it was age 8 that was the most dominant and ages 7 and 9 were about equally dominant. The age distribution in Div. 1AS was dominated of the ages 3 to 8, probably corresponding to the six modes at 30 - 59 cm. Hence the annual increase will be around 5 cm, greatest at the younger ages.

Sex ratio.

Although varying between years the trends in the sex distribution was the same through the period. The sex ratio was about 50:50 at depths < about 600 m. The percentage of males gradually increased by depth until about 1000 m where males made up around 75 % in Div. 1C and 1D, somewhat less in the more northerly Divisions (Table 7). At greater depths the number of males declined gradually by depth and the sex ratio was again about 50:50 at depths above 1400 m. Those differences could be due to different in migration patterns by males and females and by the fact that males are shorter living than females. Catches at great depth were thus dominated by large (old) fish (Jorgensen 1997a).

Distribution in relation to bottom temperature.

The near bottom temperatures in the survey area ranged between -2.1 and 4.9 °C (Table 8). Temperatures were generally low in shallow waters due to the influence of the cold West Greenland Current. In the northern part of the survey area the temperature was highest on the banks in Div. 1B, 2-3 °C, and decreased gradually towards deeper water and against north. In Div. 1C and 1D the temperature increased by depth to 401-600 m (3.9 °C), and then decreased gradually by depth to about 3.1 °C at 1401-1500 m. In Div. 1E and 1F the data were scarce but the temperature was indicated to increase by depth to 4.6-4.8 °C at 401-600 m. In depth strata < 800 m in Div. 1B and 1C and < 200 m in Div. 1D-1F the range in the temperature is considerable, probably because the West Greenland Current only covered parts of these depth strata (*i.e.* a rather steep temperature gradient within the stratum), and because the extension of the current is varying both within years and between years. In Div. 1C at depths > 800 m and in Div. 1D at depths > 200 m the bottom temperatures seemed to be rather constant, 3-4 °C. The largest catches (in kg/km^2)were generally made at temperatures between 3 and 4°C (in Div. 1C and 1D), but a number of relatively good catches were also made at temperatures around 1°C (primarily in Div. 1B but also in 1AS) (Fig. 5.) God catches in $numbers/km^2$ were made in the temperature range 1-4 °C. High concentrations of small fish, < 20 cm, were primarily found in shallow cool waters in Div. 1B and 1AS and larger fish, 45-55 cm, were primarily found at depths between 800 and 1200 m in the warmer water in Div. 1C and 1D (Fig. 6).

Discussion

Greenland halibut was found all over the area surveyed. The largest biomasses were generally found in Div. 1C at depths between 601 and 1000 m and in Div. 1D at depths between 801 and 1200 m, where also the highest abundance was found. High abundances were also found in 0-600 m depths in Div. 1B and 1AS. The population in this area consisted mainly of small fish and the abundance was probably severely underestimated, because a large part of the stock was distributed in the water column (Jorgensen 1997b). In Div. 1C and 1D Greenland halibut was scarce at depths < 200 m. This probably also applies to Div. 1E and 1F, but the number of hauls were few in the area and it was covered down to about 500 m, only.

The estimated biomass and abundance fluctuated during the period but with a decreasing trend since 1991 coinciding with the increase in the offshore fishery in Div. 0B and 1C-1D (Fig. 2). The highest biomass and abundance in the time series was observed in 1987, however, as the biomass and abundance at depths > 1000 m was estimated by an ANOVA and as 1987 was the first year in the time series the estimate is uncertain. On the other hand the observed biomasses and abundances in all strata at depths < 1000 m were either the highest or among the highest ever observed in the time series. Although Greenland halibut seems to be distributed in the same area year after year during the summertime (Jorgensen 1997a), it can not be excluded that the distribution in 1987 was exceptional.

The biomass and abundance was estimated by the ANOVA in first of all depth stratum 801-1000 m in Div. 1B, but also in depth strata 401-800 m in Div. 1D. These strata are, however, small and the figures estimated by the ANOVA contributed only little to the total estimates (Tables 3 and 4).

The length and age distribution in Div. 1AN (data form 1988 only) was dominated by young fish (1-3 years of age), mainly from depth stratum 201-500 m. There was, however, only a single haul at depths > 1000 m, thus the number of larger/older fish in the area was probably underestimated (Fig. 3 and 4). In Div. 1AS the length distribution was dominated by fish between 10 and 50 cm, but the distribution varied between years, probably reflecting the distribution of the hauls (Table 3), as small fish are found in shallow water and fish are getting larger with increasing depth (Jorgensen 1997a). The length distribution in Div. 1B was dominated by small fish and usually modes around 11, 19 and 26 cm were seen corresponding to ages 1 - 3. In all surveys Div. 1C and 1D were dominated by fish between 40 and 60 cm with one clear mode around 48-50 cm. Despite the frequent sampling from research catches through the years no growth of year-classes could be observed in the size distributions This could be caused by a migration of larger fish out of the survey area. However, the length distribution in both commercial and trial long line catches showed that larger fish are present in the area, indicating that the lager fish are capable of escaping a bottom trawl towed with 3.5 knots (Jorgensen 1995, Jorgensen and Bech MS 1996). In Div. 1C and 1D the age distributions were dominated by fish age 6-9. From the beginning to the end of the time series there has been a shift towards slightly younger fish, but the age reading in the two periods had been done by two different age readers, which may have influenced the estimated age composition.

The southern part of 1AS and especially the northern part of Div. 1B are considered as the most important nursery areas at West Greenland. This is in accordance with Smidt 1969, although he considered the area west of Disko Island (1AS) to be by far the most important. Smidt also mentions the area south of Nuuk (64°N) as an important nursery area, but there has been no indication of small fish in greater numbers. The coverage of the area was, however, poor. During the survey in 1988 a high abundance of small fish in Div. 1AN was found. The importance of his area as nursery area is, however, unknown as only one survey has been carried out.

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Table 1. Year and cruise number, number of hauls, area covered, depth range and period covered in the joint Japan Greenland surveys at West Greenland.

Year/ cruise	Hauls no of	Area	NAFO div.	Depth range (m)	Date
1987	117	59°27'N-69°57'N	1A-1F	34 - 998	Jul. 15 - Aug. 13
1988	109	63°06'N-72°51'N	1A-1D	259 - 1402	Sep. 12 - Nov. 11
1989	61	63°03'N-65°43'N	1C-1D	494 - 1497	Apr. 30 - May 17
1990 1	75	63°05'N-68°26'N	1B-1D	449 - 1482	Jun. 9 - Jun. 22
1990 2	87	63°11'N-69°42'N	1A-1D	422 - 1467	Aug. 27 - Sep. 12
1991 1	139	63°07'N-69°57'N	1A-1D	38 - 1490	Aug. 4 - Aug. 30
1991 2	51	66°21'N-69°57'N	1A-1B	38 - 774	Nov. 12 - Nov .27
1992 1	90	63°04'N-69°45'N	1A-1D	417 - 1475	Aug. 11 - Aug. 28
1992 2	49	63°10'N-66°11'N	1C-1D	510 - 1400	Nov. 25 - Dec. 7
1993	87	63°11'N-68°25'N	1B-1D	435 - 1418	Aug. 20 - Sep. 8
1994	80	63°08'N-68°21'N	1B-1D	439 - 1472	Aug. 2 - Aug. 19
1995	91	63°06'N-69°46'N	1A-1D	422 - 1463	Aug. 12 - Sep. 1
Total	1036	59°27'N-72°51'N	1A-1F	34 - 1497	Apr. 30 - Dec. 7

Table 2. Areas (km^2) by NAFO Division and depth stratum (m). 1AN: 201-500 m, 501-1000 m 1001-1500 m

	Depth stratum (m)							
Divi-sion	1-200	201-400	401-600	601-800	801-1000	1001-1200	1201-1400	1401-1500
1AN	10102	35367	17592			4894		
1AS	8523	13562	1370	828	919	1441	1092	516
1B	23815	19052	5376	3716	671	63	-	-
1C	17196	5314	3366	16120	6066	611	-	-
1D	8921	3562	903	1940	3874	10140	6195	3091
1E	7871	2000	329	341	325			
1F	8808	3330	1211	1156				

Table 3. Biomass (tons), number of hauls and Standard Error (S.E.) by NAFO Division, depth stratum, year and cruise number. Biomass figures in **bold** are estimated from an two-way ANOVA and S.E. in **bold** are estimated from a regression between biomass and S.E. (see text).

	Year	1987	1988	1989	1990	1990	1991	1991	1992	1992	1993	1994	1995
Div	Depth (m)				1	2	1	2	1	2			
1AS	0-200	6.4 8/4.5					9.9 3/5.0	26.2 3/18.2					
	201-400	441.6 9/133.4					522.8 15/207.8	517.8 11/271.3					
	401-600	481.4 2/66.1	239.5 **1/52.7**			156.8 2/66.1	429.6 3/184.0		79.3 2/0.7				
	601-800						1403.5 **1/308.8**		529.9 **1/116.6**				
	801-1000		3302.6 2/518.8			1355.1 2/498.6	1969.6 **1/433.3**		2133.2 **1/469.3**				214.5 2/22.2
	1001-1200					1234.8 **1/271.7**							206.5 2/155.2
	1201-1400		601.7 2/165.3			331.9 **1/73.0**	377.3 2/310		1907.8 **1/419.7**				
	1400-1500								70.0 **1/15.4**				
1B	0-200	20.9 15/15.1					29.3 3/24.1	269.9 8/164.7					
	201-400	3354.9 14/866.8					2477.3 22/551.0	5061.3 21/1052.2					
	401-600	5564.4 5/1266.8	3013.5 7/774.8		3541.4 7/650.1	3051.6 8/520.3	5745.2 8/1109.1	3538.4 6/703.9	7439.1 9/2171.9		4678.8 7/1339.0	1605.9 8/415.7	4013.4 9/1159.1
	601-800	4548.3 3/810.9	3553.7 3/1284.7			3871.7 3/547.4	4463.0 3/716.1	1948.1 2/273.3	4033.8 4/730.1		1951.9 3/577.2	339.2 4/199.1	920.9 5/279.6
	801-1000	**1033.4** **/227.3**	557.2 **1/122.6**			802.9 **1/176.6**	1103.5 **1/242.8**		**1125.3** **/247.6**		**620.8** **/136.6**	**151.6** **/33.4**	**394.9** **/86.9**
1C	0-200	17.3 10/14.4											
	201-400	214.2 6/118.2											
	401-600	838.1 3/299.2	152.5 5/60.7	570.3 4/107.3	1936.4 5/307.7	339.4 5/66.6	672.2 5/156.1		853.5 5/433.9	506.7 2/115.0	630.7 4/262.2	154.8 4/141.4	129.2 3/67.2
	601-800	19617.4 8/2909.0	10324.2 18/1434.9	4415.0 10/454.3	12450.9 13/1775.3	6504.0 16/796.9	14163.7 16/1602.0		6824.1 20/828.0	4579.3 14/419.4	5059.6 22/461.3	2195.7 16/520.6	5180.2 16/628.2
	801-1000	23474.5 5/6946.7	8704.1 11/1310.0	6263.0 8/1367.5	11161.0 13/3272.5	6255.2 11/1046.0	20079.9 11/3373.4		20488.6 7/4785.9	4054.0 8/912.3	3887.1 9/683.1	6814.7 10/2666.5	7625.6 14/1531.0
	1001-1200	**4464.1** **/982.1**	1128.6 2/675.1	900.3 2/60.5	969.9 2/53.0	1907.7 2/254.3	1786.1 2/202.5		1061.4 2/186.7	1276.9 2/607.9	1921.4 2/445.0	2014.3 2/261.5	1771.0 2/711.0
1D	0-200	0.0 5/0.0											
	201-400	12.7 3/9.9											
	401-600	**372.4** **/81.9**	**237.4** **/52.2**	214.6 2/145.0	125.0 2/5.5	249.7 **1/54.9**	27.8 2/27.8		295.1 2/254.9	147.5 **1/32.5**	334.3 2/27.2	**127.6** **/28.1**	**176.6** **/38.9**
	601-800	3748.5 **1/824.7**	**1843.4** **/405.5**	272.9 **1/60.0**	1933.6 3/124.9	2370.7 **1/521.6**	1220.7 3/170.5		714.4 3/268.5	417.7 2/270.7	**1370.8** **/301.6**	646.4 2/146.2	**1395.4** **/307.0**
	801-1000	7340.6 6/1303.8	5735.6 7/684.6	2015.2 3/560.4	8155.9 4/3242.2	4189.5 7/955.9	8910.0 5/3369.0		6326.1 4/2472.8	2285.3 3/531.2	3213.2 7/500.6	2624.1 4/298.7	4098.0 8/1034.9
	1001-1200	**29794.4** **/6554.8**	12834.5 17/1428.5	26886.3 14/3468.2	18816.7 14/2394.9	15523.2 20/1830.2	16863.3 15/1979.3		16658.6 16/2134.2	19846.9 12/4066.4	11967.9 19/1272.8	11129.3 14/1550.3	11550.2 15/1415.9
	1201-1400	**12333.4** **/2713.3**	8676.4 11/485.3	17636.1 14/4885.5	5447.5 9/1613.6	5520.6 4/2200.5	5084.5 10/1758.7		6679.1 11/1349.0	17748.8 5/4615.8	5123.3 11/1101.4	5211.0 13/935.1	4129.0 13/928.7
	1400-1500	**2029.0** **/446.4**	1886.4 **1/415.0**	9911.9 3/2746.7	1782.0 3/676.5	1158.1 2/325.5	1626.5 2/652.8		89.5 **1/19.7**		0 1/0	943.9 3/341.0	2024.1 2/1258.4
	Sum 1B-1D 401-1500	115158.5 31/25366.9	58647.2 83/9133.9	69085.6 61/13855.4	66320.3 75/14116.2	51744.3 81/9296.7	81746.4 83/15360.1		72588.6 84/15883.2	50863.1 49/11571.2	40759.8 87/7108.0	33958.5 80/7537.6	43408.5 87/9446.8

Table 4. Abundance (.000) and Standard Error (S.E.) by NAFO Division, depth stratum, year and cruise number. Abundance figures in **bold** are estimated from an two-way ANOVA and S.E. in **bold** are estimated from a regression between abundance and S.E. (see text).

	Year	1987	1988	1989	1990	1990	1991	1991	1992	1992	1993	1994	1995
Div	Depth (m)				1	2	1	2	1	2			
1AS	0-200						149.7 115.1	1317.6 326.1					
	201-400	10476.2 3555.7					3761.6 835.1	6148.0 1868.6					
	401-600	861.1 352.6	455.5 **109.3**			770.8 585.5	722.3 196.2		276.1 135.2				
	601-800						2478.2 **594.8**		1521.9 **365.3**				
	801-1000		5222.7 565.0			1984.6 785.8	2918.9 **700.5**		3734.8 **8964**				332.1 52.0
	1001-1200					1465.2 **351.6**							217.7 156.6
	1201-1400		742.3 105.0			553.2 **132.8**	613.2 519.1		1984.2 **476.2**				
	1400-1500								111.5 **26.8**				
1B	0-200						631.8 492.5	24330.6 14077.1					
	201-400	32574.5 8422.9					20171.7 6216.1	49413.8 10802.1					
	401-600	13688.2 2992.4	19532.2 8271.5		9852.2 2561.2	9799.4 1707.0	23014.7 5368.9	29300.2 4325.7	35306.8 11588.2		19797.9 5578.5	8114.4 2314.7	26689.7 8538.4
	601-800	5497.5 1127.4	4134.8 1765.0			5072.6 1027.5	6601.2 1290.1	5324.0 1385.0	6749.4 988.8		2711.7 631.7	843.2 466.7	2896.4 1017.3
	801-1000	**2664.6** **639.5**	570.2 **136.8**			788.1 **189.1**	1337.4 **321.0**		**4208.4** **1010.0**		**671.4** **161.1**	**239.7** **57.5**	**805.7** **193.4**
1C	201-400	238.1 131.3											
	401-600	911.6 279.2	342.0 130.1	771.2 204.5	2091.0 310.2	713.6 190.8	938.4 231.7		1882.0 1264.3	827.6 271.7	1007.1 341.5	278.3 212.1	331.1 175.6
	601-800	24976.0 4610.9	13446.4 2017.5	6175.1 617.9	11824.9 1576.8	9290.4 1613.3	16235.2 1604.5		8428.8 862.3	8777.5 839.4	7219.4 940.4	2784.7 508.0	6716.6 598.0
	801-1000	15491.5 3610.9	7688.9 1125.7	7000.8 1419.4	9395.2 2776.5	6105.4 945.9	16331.5 2431.7		19443.5 4375.3	5717.6 1232.6	4164.0 692.1	6862.6 2576.3	7259.2 1280.2
	1001-1200	**3536.4** **848.7**	660.9 361.9	851.4 18.3	744.6 56.5	1635.3 279.7	1088.1 70.8		918.4 171.1	1606.3 711.6	1891.7 426.3	1205.6 147.0	1303.6 676.6
1D	401-600	**1105.1** **265.2**	**550.7** **132.2**	233.5 145.8	169.9 9.2	292.7 **70.2**	82.1 82.1		874.6 779.7	218.5 **52.4**	1116.1 102.9	**272.9** **65.5**	**411.3** **98.7**
	601-800	**3544.6** **850.7**	**1766.5** **424.0**	352.1 **84.5**	1663.6 145.5	2013.4 **483.2**	1307.7 124.6		928.6 386.6	532.5 365.4	**1417.6** **340.2**	636.7 116.8	**1319.2** **316.6**
	801-1000	6896.0 1667.9	4604.0 456.0	2325.5 584.0	7034.5 3347.6	3816.4 964.2	7245.2 2262.3		6328.9 2562.8	2994.3 539.4	2984.1 433.0	2413.5 174.3	3682.6 868.1
	1001-1200	**27076.8** **6498.4**	8039.7 1069.1	23889.4 3014.0	14355.2 1866.70	10694.7 1194.8	11658.8 1395.5		12355.0 1582.6	20039.9 3973.8	9220.4 1134.7	8136.1 1228.5	8275.4 1203.6
	1201-1400	**10304.6** **2473.1**	5335.6 458.5	11544.6 2625.7	3199.5 1102.7	2920.7 1381.3	3459.8 1154.3		4818.2 990.4	17381.4 4229.5	3510.6 837.6	3743.1 817.7	2604.1 719.3
	1400-1500	**1413.1** **339.1**	1449.2 **347.8**	4382.1 2402.7	731.7 271.6	468.8 13.4	674.7 270.7		83.3 **20.0**		0 0	322.8 57.4	1121.4 766.5
	Sum 1B-1D 401-1500	149918.6 34757.6	68121.1 16696.1	57525.7 11116.8	61062.3 14024.5	53611.5 10060.4	89974.8 16608.2		102325.8 26582.1	58095.6 12215.8	55712.0 11620.0	35853.6 8742.5	63416.2 16452.3

Table 5. Biomass (tons), number of hauls / Standard Error in NAFO Division 1E and 1F by depth stratum in 1987. (No abundance data).

Div.	Depth (m)	Biomass
1E	1-200	5.0
		3/5.0
	201-400	35.9
		2/29.5
1F	1-200	0.0
		5/0.0
	201-400	0.0
		2/0.0
	401-600	10.8
		2/1.14

Table 6. Biomass (tons), number of hauls and Standard Error (S.E) and abundance (.000) and S.E. in Division 1AN in 1988 by, depth stratum. S.E. in **bold** are estimated from a regression between biomass (or abundance) and S.E. (see text).

Depth (m)	Biomass	Abundance
201-500	5502.4	59136.8
	9/2197.8	2335.0
501-1000	10017.8	35604.3
	11/1657.8	7483.5
1001-1500	3815.0	3315.7
	1/839.3	**795.8**

Table 7. Sex ratio (percent males) by NAFO Division and depth. All surveys combined. n=number of fish sexed

Div.	Depth (m)	Percent males	n
1AN	200-500	51.8	1056
	501-1000	54.7	2207
	1001-1500	45.8	83
1AS	0-200	49.3	2
	201-400	44.1	372
	401-600	51.5	398
	601-800	57.0	637
	801-1000	62.4	2616
	1001-1200	60.9	191
	1201-1400	55.6	670
	1400-1500	46.9	32
1B	0-200	39.9	29
	201-400	47.4	4610
	401-600	48.0	18120
	601-800	61.5	4205
	801-1000	65.0	516
1C	401-600	60.0	1524
	601-800	67.9	11977
	801-1000	74.4	18297
	1001-1200	74.2	4796
1D	401-600	50.2	758
	601-800	73.9	1224
	801-1000	77.4	8269
	1001-1200	74.9	22865
	1201-1400	70.0	10186
	1400-1500	53.8	752

Table 8. Mean temperature (°C), range (°C), number of observations and Standard Error by NAFO Division and depth stratum (m). All surveys combiened. Div. 1AN: See foot note.

Div./ Depth	1AS	1B	1C	1D	1E	1F
1-200	-0.12 -1.3-1.1 14 / 0.23	1.58 -0.9-4.1 32 / 0.23	0.79 -2.1-1.5 10 / 0.34	0.94 0.4-1.6 5 / 0.19	2.57 1.8-3.2 3 / 0.41	2.92 2.3-3.7 5 / 0.29
201-400	1.32 0.1-2.6 32 / 0.13	2.35 0.3-4.5 52 / 0.13	3.00 1.6-3.9 6 / 0.42	3.77 3.1-4.5 3 / 0.41	4.55 4.2-4.9 2 / 0.35	4.55 4.5-4.6 2 / 0.05
401-600	2.03 1.6-2.3 10 / 0.09	2.82 0.9-4.1 58 / 0.10	3.94 3.3-4.9 34 / 0.05	3.85 2.7-4.6 8 / 0.22		4.70 4.6-4.8 2 / 0.10
601-800	1.80 1.7-1.8 2 / 0.10	1.43 0.9-3.8 23 / 0.16	3.38 1.1-4.3 145 / 0.05	3.67 3.4-4.0 15 / 0.04		
801-1000	1.07 0.8-1.5 7 / 0.08	1.67 0.9-1.4 3 / 0.15	3.48 3.2-4.0 85 / 0.02	3.48 3.0-3.9 49 / 0.03		
1001-1200	0.73 0.7-0.8 3 / 0.03		3.36 3.1-3.6 14 / 0.05	3.26 2.9-3.6 117 / 0.01		
1201-1400	0.30 0.1-0.4 5 / 0.05			3.19 2.9-3.9 82 / 0.02		
1401-1500	0.00 0.0-0.0 1 /			3.14 3.0-3.3 13 / 0.03		

1AN 201-500 m: Mean=1.59, Range=1.0-2.2, n= 7, S.E.= 0.19. 501-1000 m: Mean= 1.67, Range=1.1-2.0, n=11, S.E.= 0.09. 1001-1500 m: Mean 0.1, Range 0.1-0.1, n=1, S.E. -.

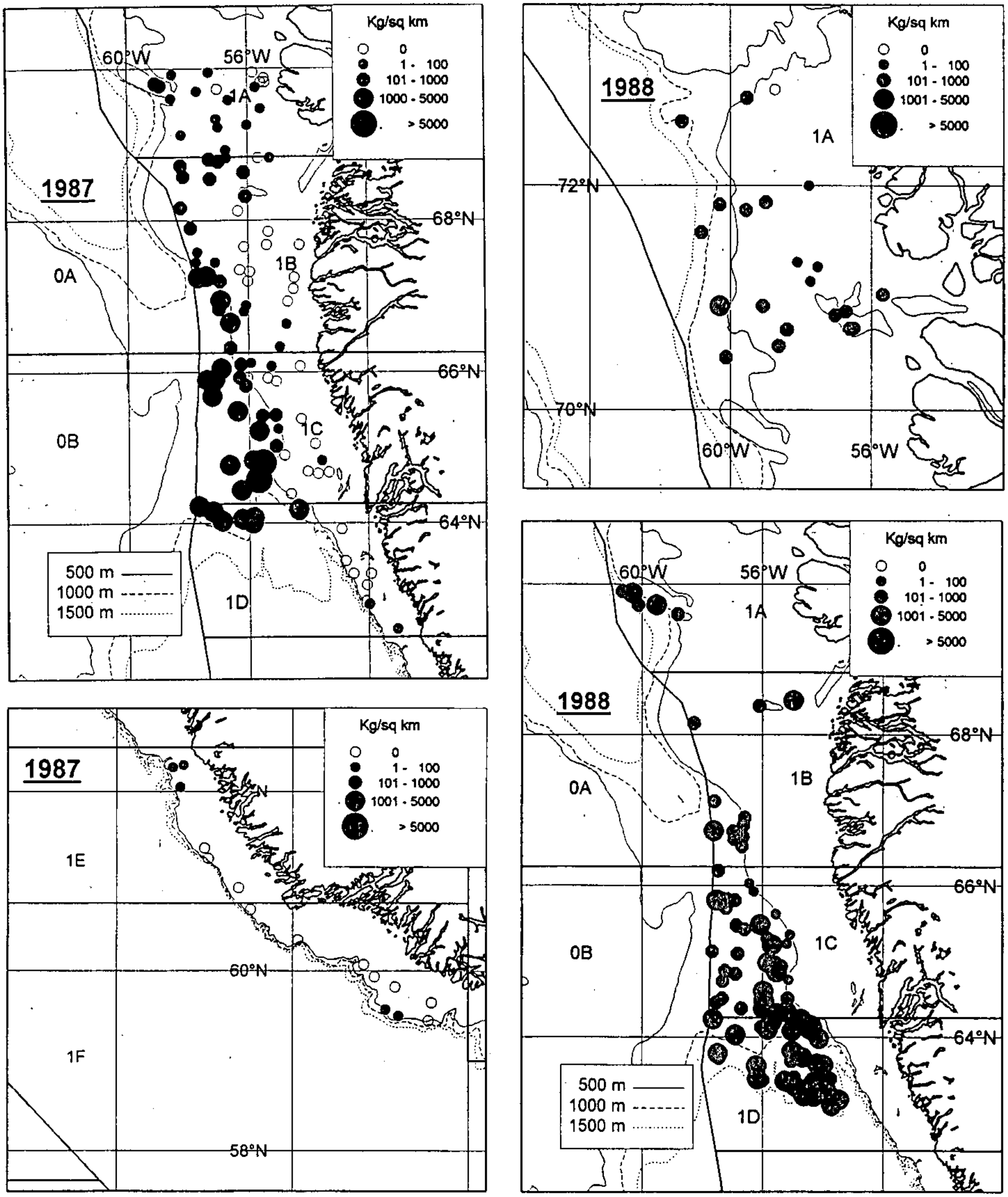

Fig. 1. Distribution of catches in kg per km^2 swept in the 12 joint Japan Greenland surveys conducted 1987-1995.

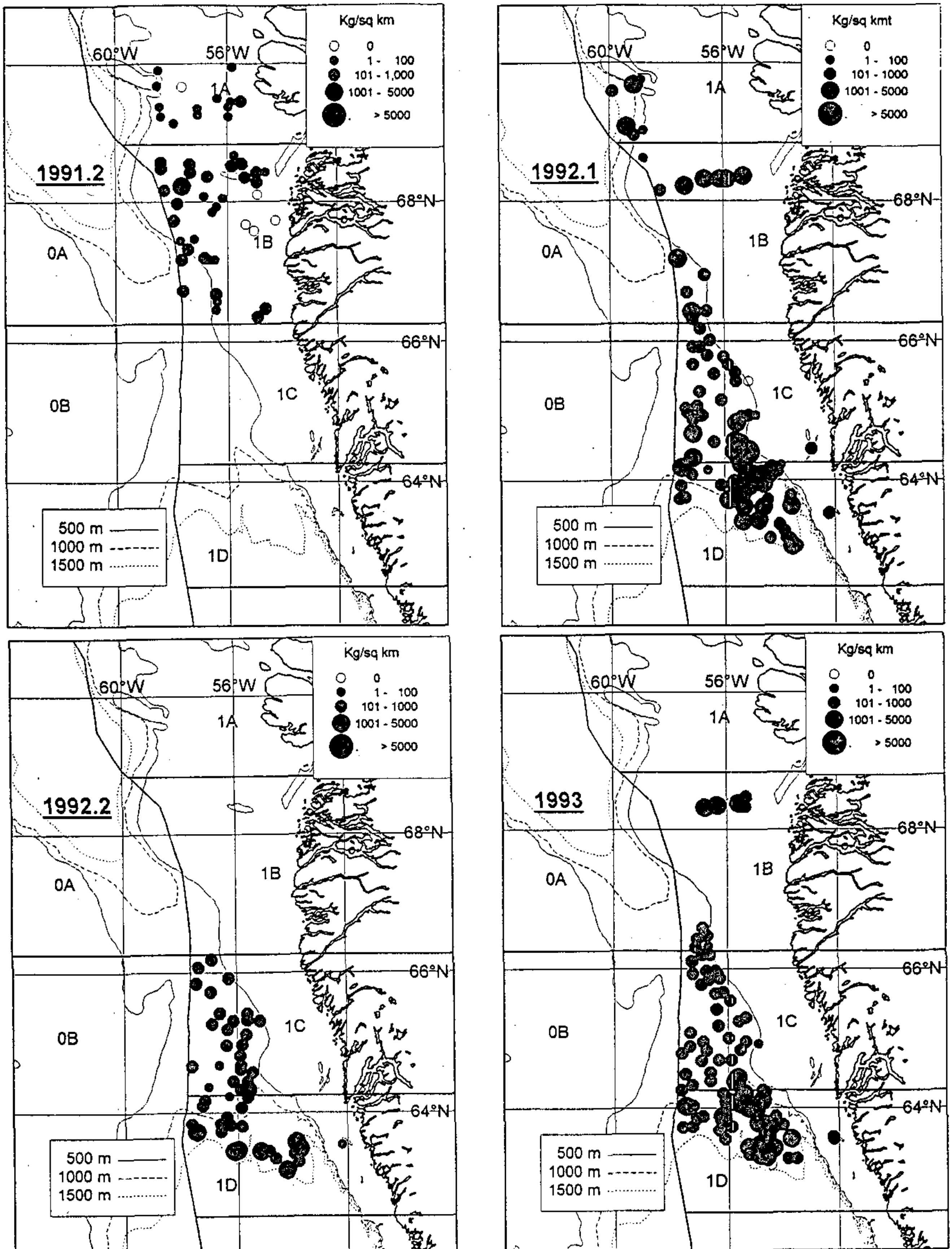

Fig. 1. Distribution of catches in kg per km^2 swept in the 12 joint Japan Greenland surveys conducted 1987-1995 (Cont.).

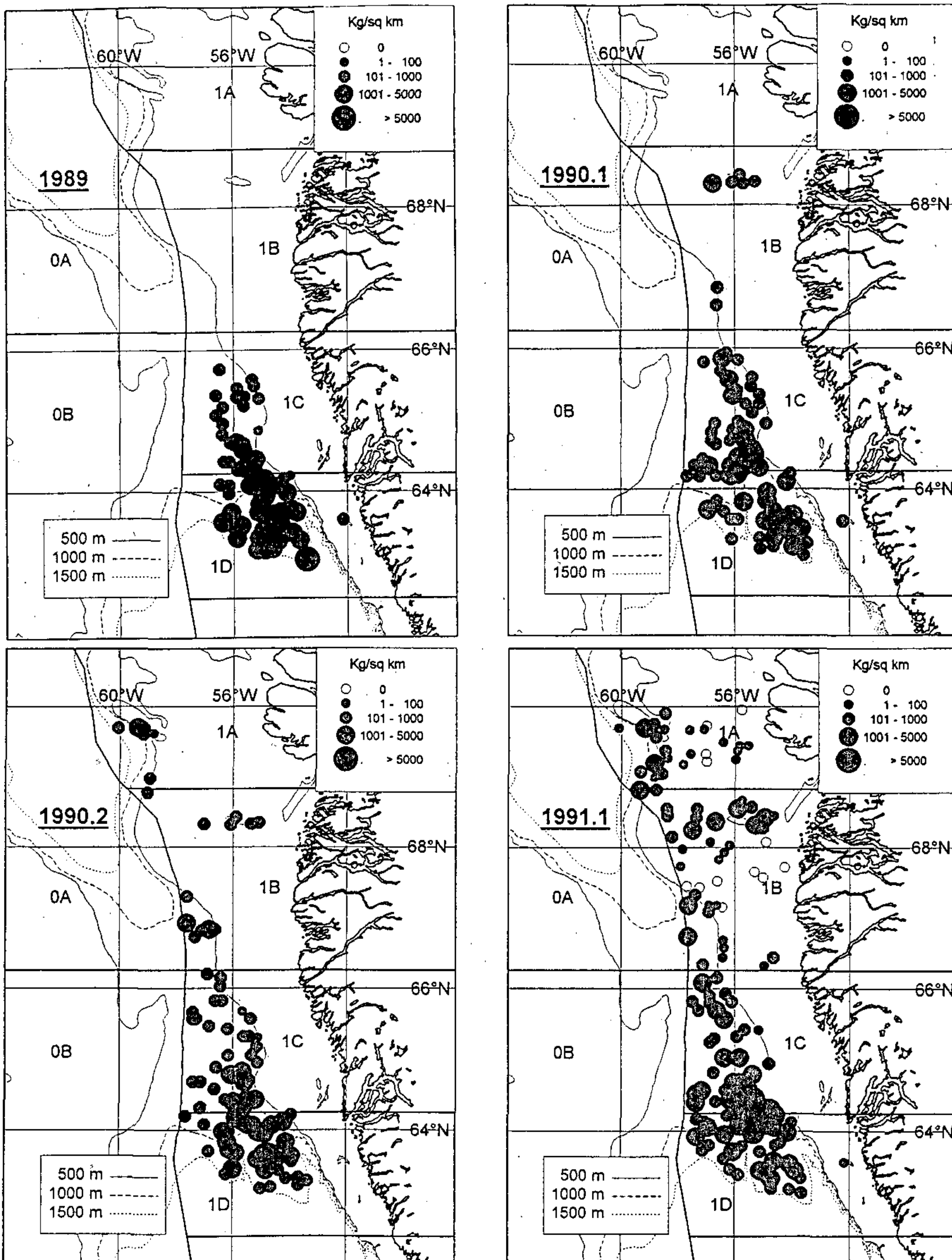

Fig. 1. Distribution of catches in kg per km² swept in the 12 joint Japan Greenland surveys conducted 1987-1995 (Cont.).

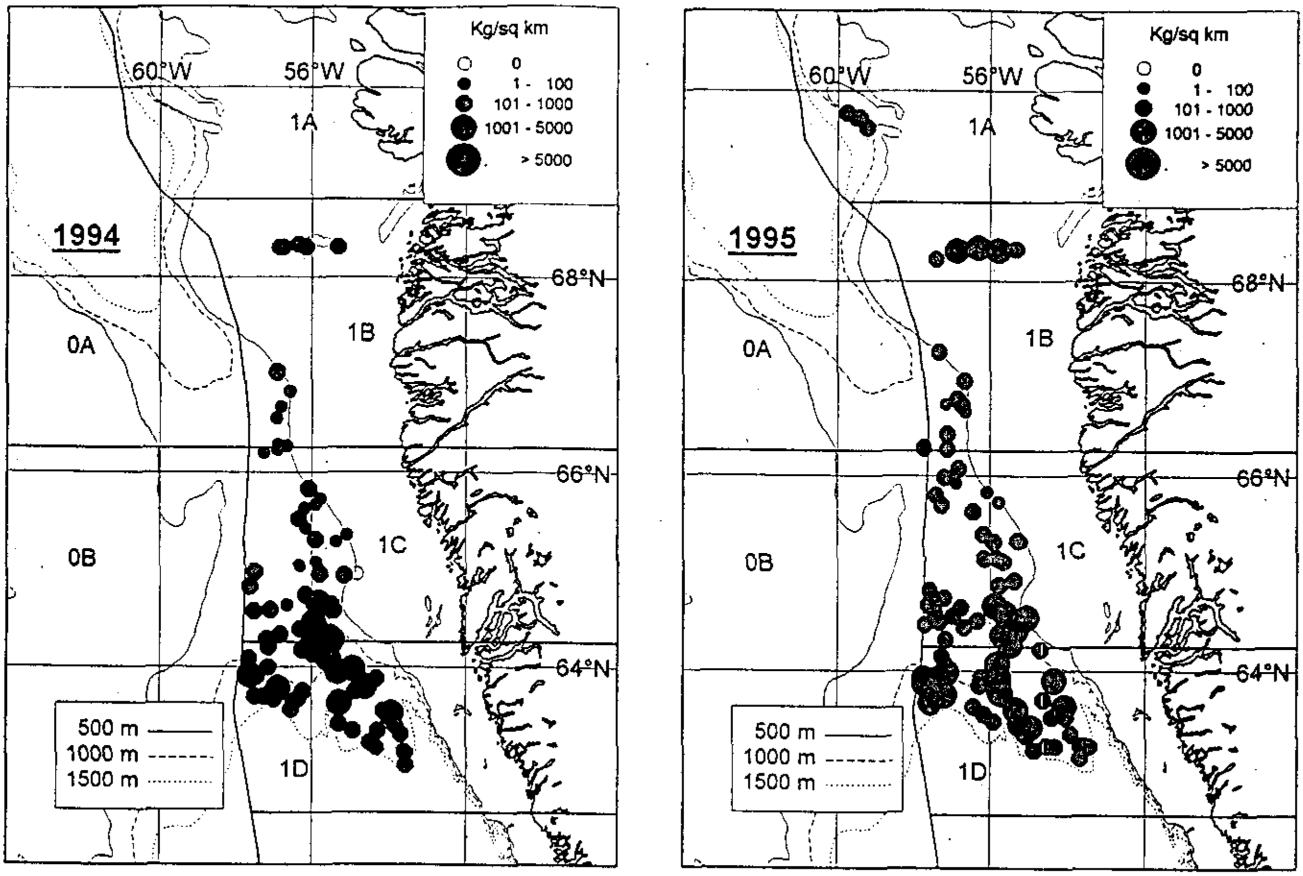

Fig. 1. Distribution of catches in kg per km^2 swept in the 12 joint Japan Greenland surveys conducted 1987-1995 (Cont.).

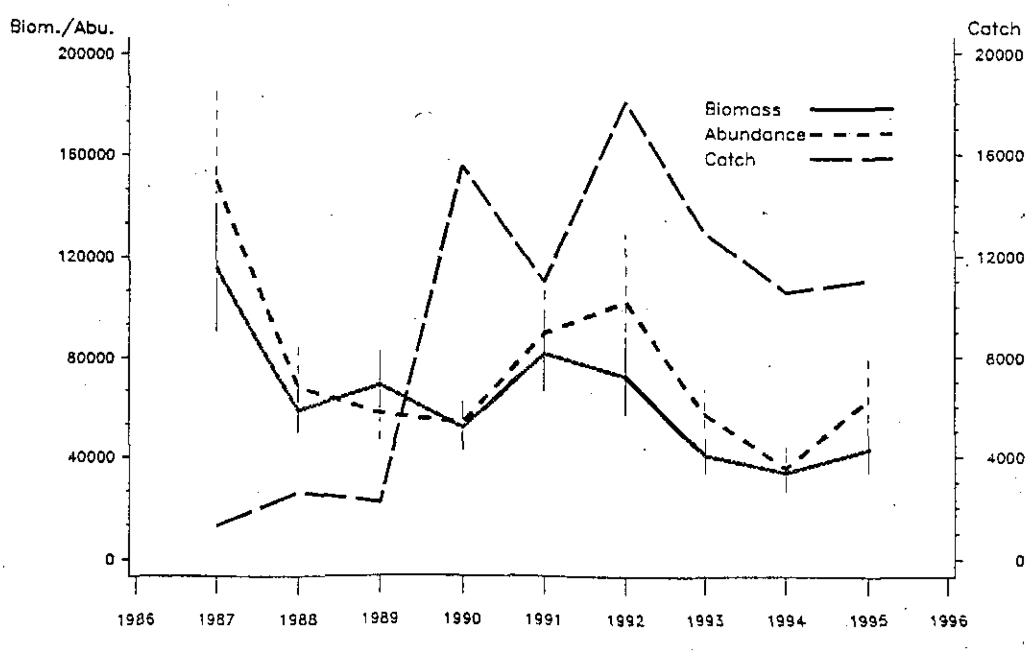

Fig. 2. Estimated biomass (tons) and abundance (.000) in Div. 1B-1D at depths between 401 and 1500 m in the period 1987-1995 with +/- Standard Error. The survey in 1989 covered 1C-1D only and was conducted in May, all other surveys were conducted in July - October. Further, the offshore catches (tons) in Subarea 0B and 1 are shown .

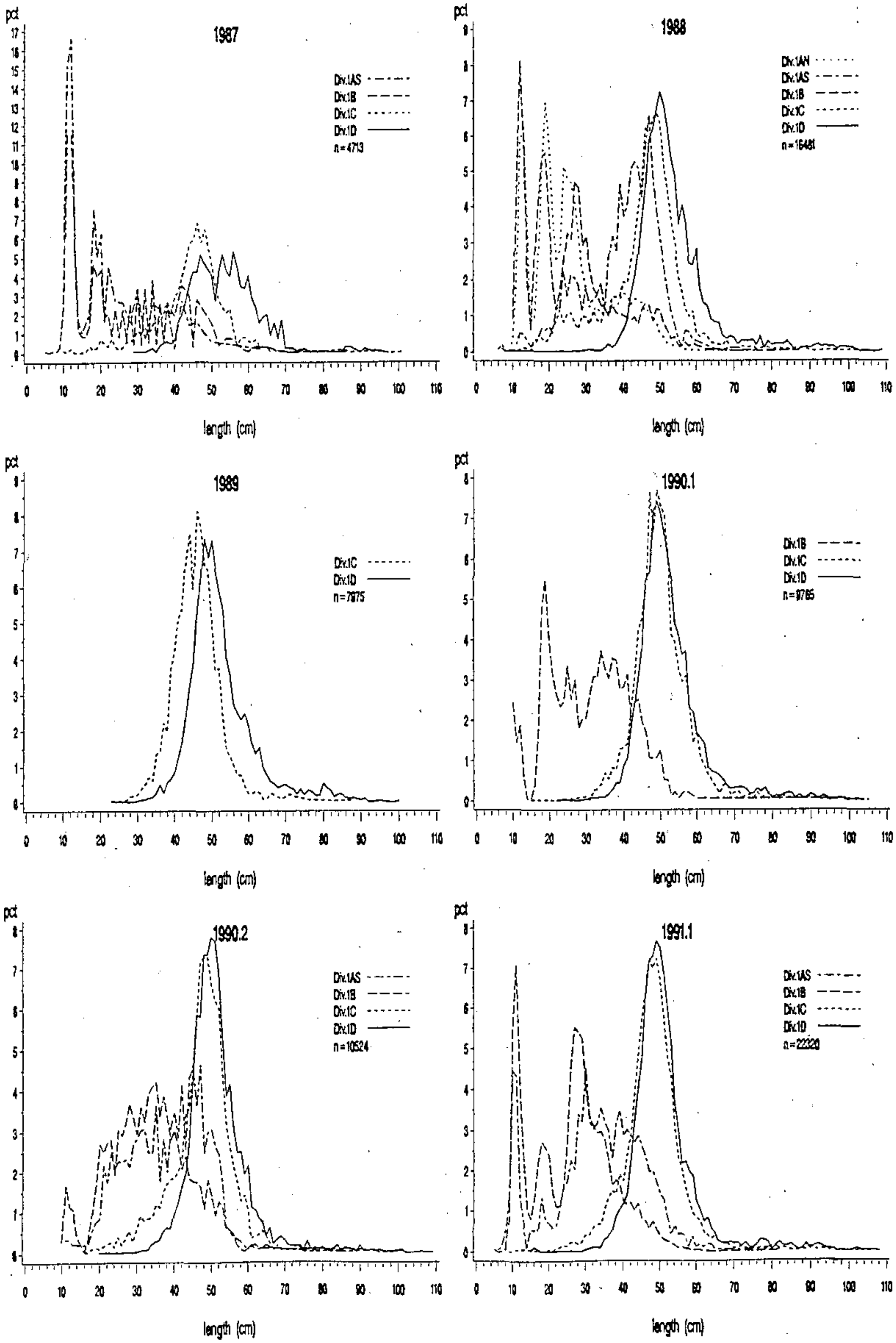

Fig. 3. Length frequencies by survey and NAFO Division.

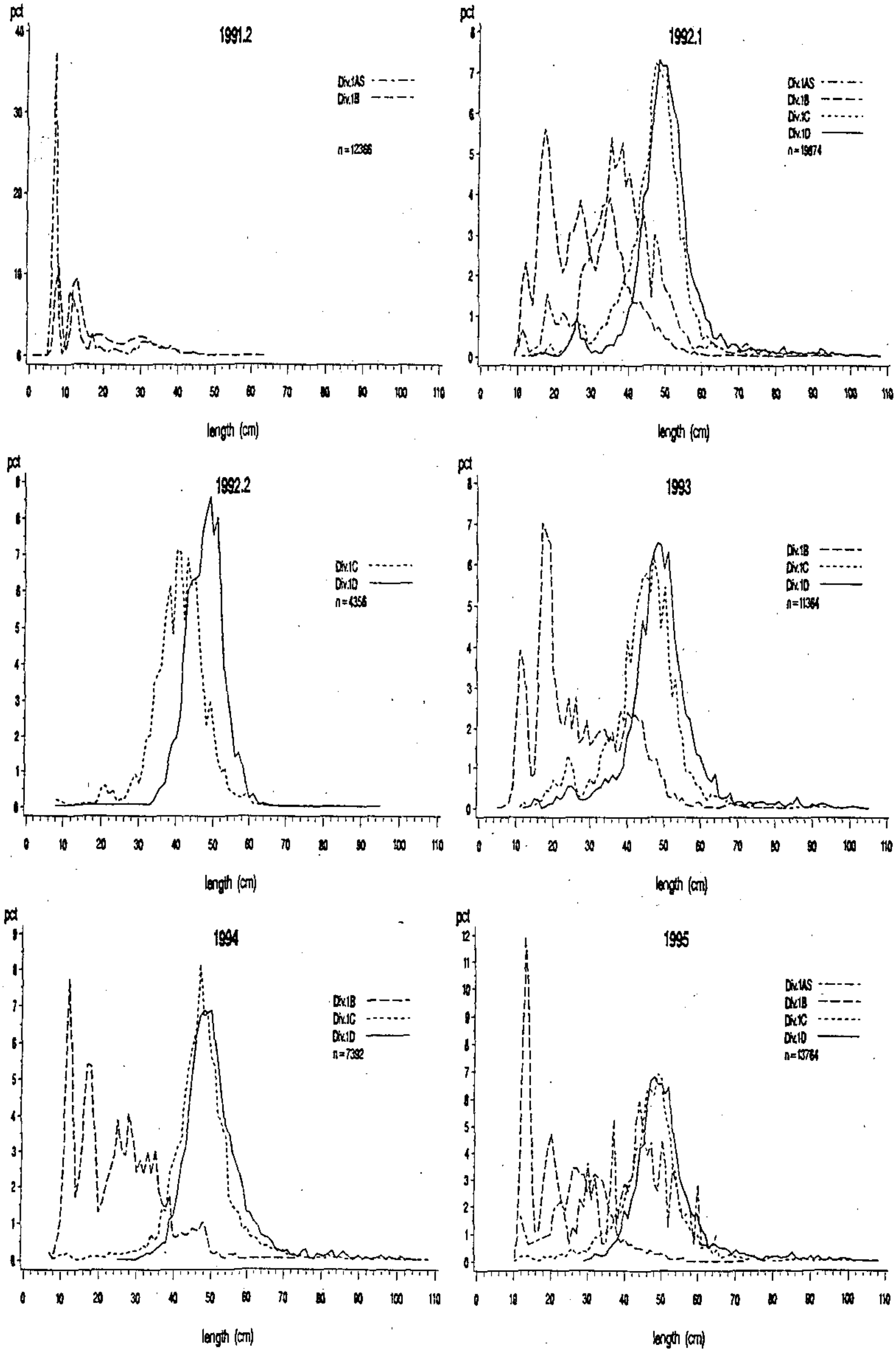

Fig. 3. Length frequencies by survey and NAFO Division (cont.).

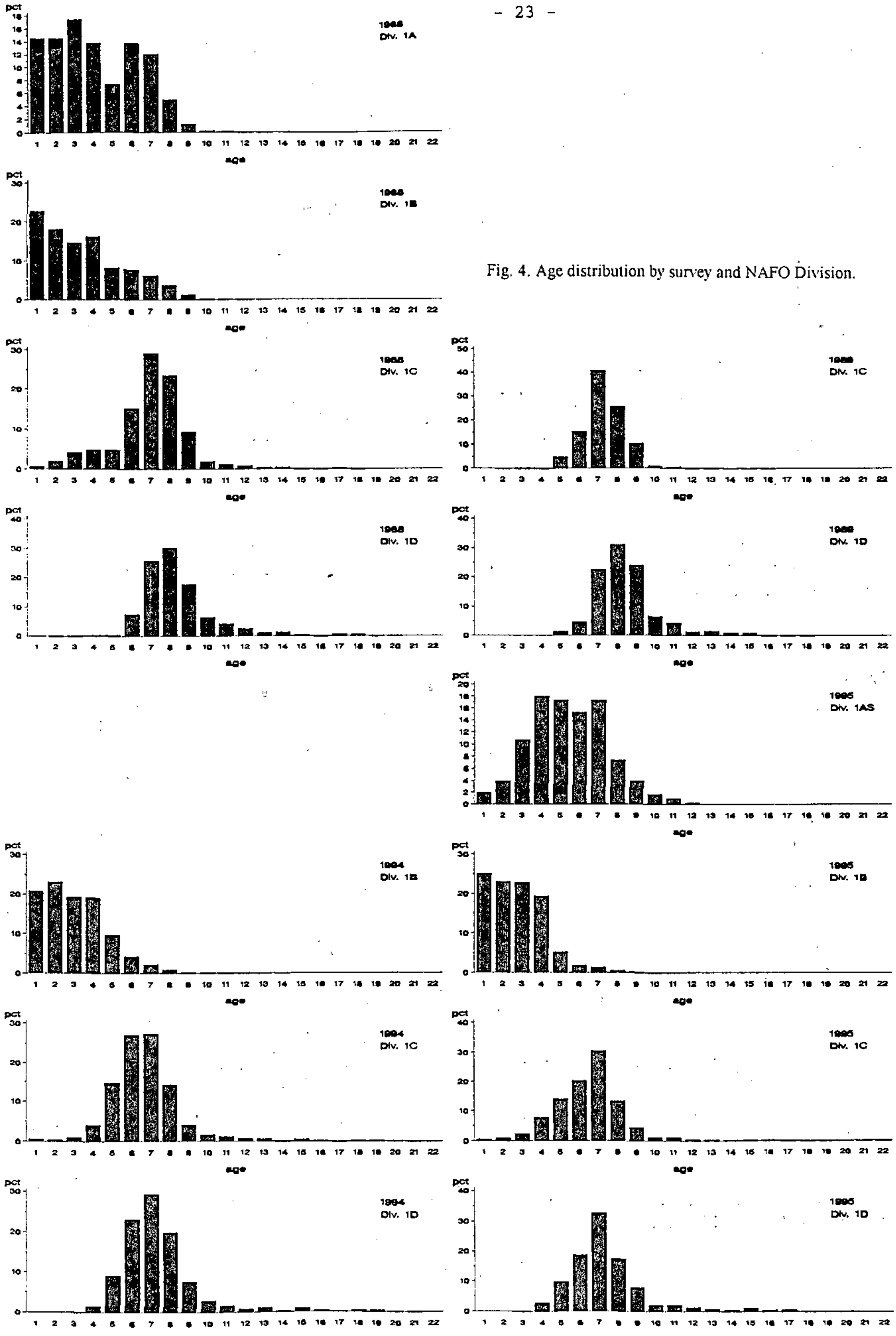

Fig. 4. Age distribution by survey and NAFO Division.

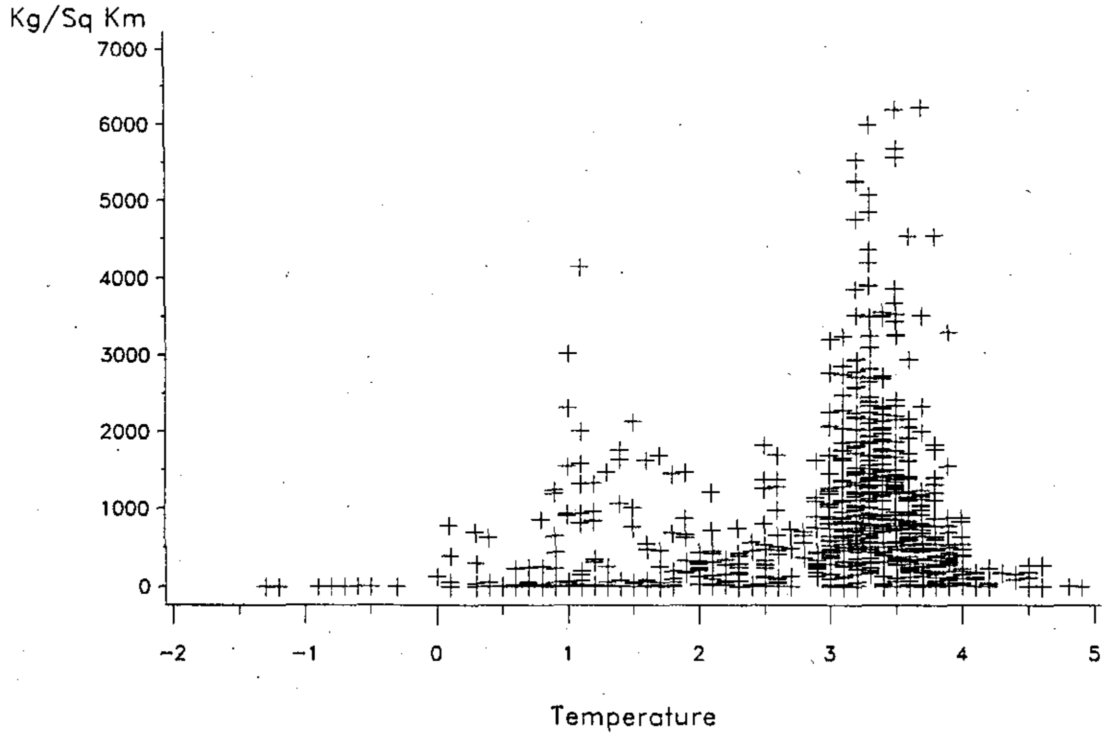

Fig. 5. Relation between catch in kg per swept km^2 and bottom temperature (C°). Two catches on 1.8 kg at - 2.1 °C and 12700.2 kg at 3.1 °C, respectively, have been excluded.

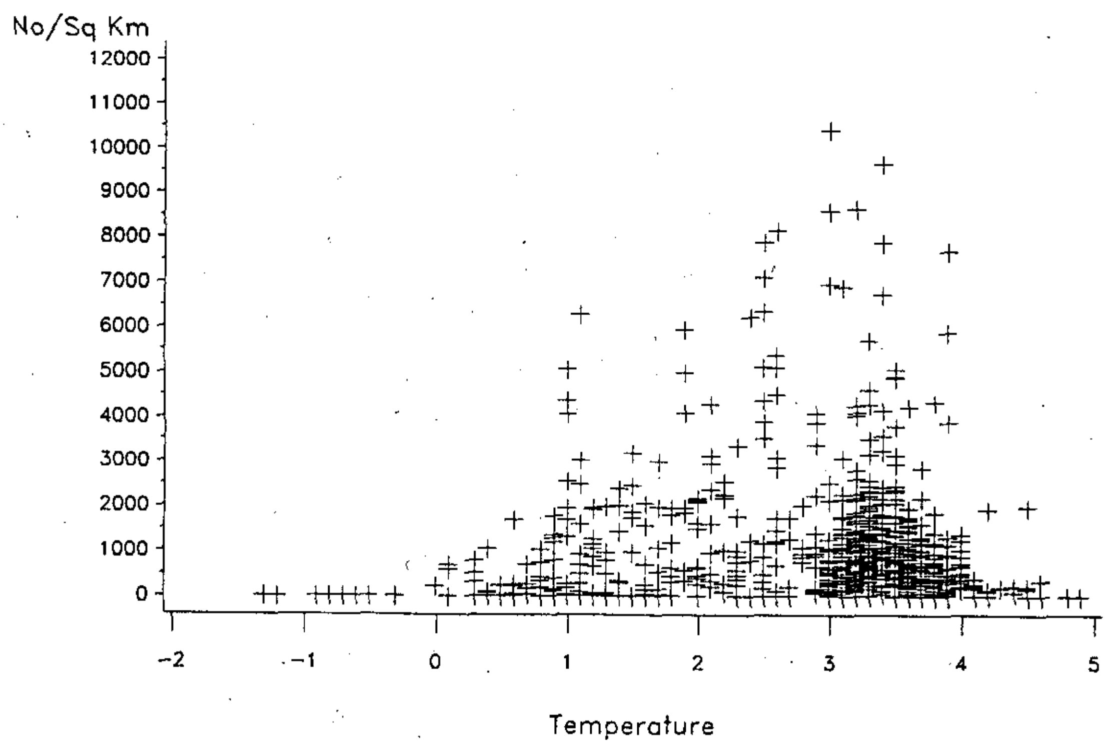

Fig. 6. Relation between catch in numbers per swept km^2 and bottom temperature (C°). Two catches on 13511.4 specimens at 3.2 °C and 19743.7 specimens at 3.0 °C, respectively, have been excluded.