

# **Spatial Distribution of Greenland Halibut (*Reinhardtius hippoglossoides* (Walbaum)) in the Labrador-Eastern Newfoundland Area of the Canadian Northwest Atlantic**

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## **Abstract**

Spatial distribution of Greenland halibut (*Reinhardtius hippoglossoides* (Walbaum)) in the eastern Labrador-Newfoundland area was examined using catch data from research vessel surveys directed either towards groundfish generally or Greenland halibut in particular to a maximum depth of 1 500 m. Results indicated that for Div. 2GH there was no apparent change in the spatial distribution of Greenland halibut between the late-1970s and late-1980s even though overall abundance of fish was significantly lower in the late-1980s compared to the late-1970s. For Div. 2J and 3K the spatial distribution pattern was about the same between the late-1970s and late-1980s at which time Greenland halibut rapidly disappeared from Div. 2J, followed by Div. 3K within a couple of years. It is concluded that this was a result of a significant migration southward of Greenland halibut to the deep waters of Flemish Pass in Div. 3LM. This was indicated by the occurrence of large quantities of Greenland halibut in the Flemish Pass during the deepwater survey of 1991.

*Key words:* Abundance, distribution, G. halibut, Newfoundland area

## **Introduction**

Greenland halibut (*Reinhardtius hippoglossoides* (Walbaum)) is widely distributed throughout the Northwest Atlantic from as far north as Smith Sound (78°N latitude) off the West Greenland coast to as far south as the eastern Grand Bank of Newfoundland, and eastward to the deep slopes of the Flemish Cap. A comprehensive study of the distribution of Greenland halibut throughout this area was published by Bowering and Chumakov (1989) based on combined survey data from both Canada and the former USSR collected during 1977–86. It was shown that there was no break in the continuity of the distribution throughout the range and that there was a clear trend in abundance by depth as well as a distinctive difference in the size and age structure.

It had been concluded for some time that the Greenland halibut resource from Davis Strait and West Greenland waters to the Newfoundland Grand Bank was likely a single, self-sustaining stock, with the major spawning component located in the deep waters of Davis Strait to which fish migrate as they approach maturity. It has been hypothesized that there may very well be some localized spawning along the continental slope area off Labrador and eastern Newfoundland based upon stock delineation studies (Khan *et al.*, 1982; Misra and Bowering,

1984), although fully mature fish have only been encountered on rare occasions.

The purpose of this paper is to examine in more detail the spatial distribution of Greenland halibut in the Labrador and eastern Newfoundland waters on an annual basis from Canadian survey data collected during the 1978–92 period.

## **Materials and Methods**

The spatial distribution is examined by depicting standardized survey catches as circles and subsequently plotting these circles on a geographic map of the survey area according to the position of each catch. Circle diameters were chosen to represent proportionately increasing size groups of catch weight established arbitrarily from a cursory examination of the entire database. All catches within the bounds of a particular size grouping are represented by the same circle diameter. Tows where Greenland halibut did not occur are depicted with a plus (+) symbol. Prior to plotting, catches were adjusted where necessary to correspond to a 1.75 naut. mile tow (the distance covered by a standard groundfish survey tow conducted at 3.5 knots for 30 min). The plotting was done utilizing the ACON program developed and made available by G. Black, Marine Fish Division, Bedford Institute of Oceanography, Dartmouth, Nova Scotia (Black,

1993). Four sets of survey data are considered and described below. Only successful tows were selected for plotting (tows with no gear damage or minimal damage not considered to have affected the catch). A description of the basic survey design and protocol is found in Doubleday (1981).

- 1) For Div. 2J and 3K, the data were obtained from Canadian stratified-random groundfish surveys conducted by the chartered RV *Gadus Atlantica* in autumn each year during the period 1978–92 (Fig. 1). Fishing sets were made in depths from 100 m to 1 250 m, although there were few sets conducted beyond 1 000 m, utilizing an Engels 164 ft high-lift bottom trawl (1978) or an Engels 145 ft high-lift bottom trawl (1979–92) both fitted with a one and one-eighth inch mesh liner in the codend. The data plotted for 1978 also include a survey carried out in Div. 2J and 3KL in the summer.

For Div. 3L, the data were obtained from Canadian stratified-random groundfish surveys conducted by the Department of Fisheries and Oceans RV *Wilfred Templeman* or its sister ship *Alfred Needler* in autumn each year during the period 1981–92 (Fig. 1). The net utilized was an Engels 145 ft high-lift bottom trawl fitted with a one and one-eighth inch mesh liner in the codend. Prior to 1991, the maximum depth surveyed was 200 fathoms (366 m), and during 1991–92 the coverage was extended to include the area down to 400 fathoms (732 m).

- 2) For Div. 2GH, the data were obtained from Canadian fixed station (1978–79 and 1981) and stratified-random groundfish surveys (1987–88), conducted by the chartered RV *Gadus Atlantica* generally in late summer (Fig. 2). During the fixed station surveys, sets were generally made between 90 m and 870 m except for 1978 when stations down to 1 400 m were included. The stratified-random surveys generally covered depths between 100 m and 1 200 m. An Engels 164 ft high lift trawl fitted with a one and one-eighth inch liner in the codend was utilized in 1978 and on subsequent surveys an Engels 145 ft with a similarly lined codend was used.
- 3) For Div. 0B and Div. 2GHJ, the data were obtained from a Greenland halibut directed line transect survey conducted by the *Northern Kingfisher*, a chartered commercial fishing vessel, during the summer of 1991 (Fig. 3). Transects were chosen at regularly spaced intervals and one set was planned within each of the following depth zones: 750–950 m, 951–1 055 m, 1 056–1 300 m and 1 301–1 500 m. The net utilized during the survey was a modified

Alfredo #3 bottom trawl with a one and one-eighth inch liner in the codend. Specialized otter doors and footgear were used to improve performance and success, given the bottom types and depths fished during the survey. The gear was towed for 2.0 naut. miles along the bottom maintaining a speed between 3.0 knots and 3.5 knots.

- 4) For Div. 3KLM, the data were obtained from a Greenland halibut directed line transect survey conducted by the *Cape Adair*, a chartered commercial fishing vessel, during the summer of 1991 (Fig. 4). Transects were chosen at regularly spaced intervals and depth zones fished were as described above for the *Northern Kingfisher* survey. The net consisted of an Engels 145 ft bottom trawl with a one and one-eighth inch liner in the codend. Specialized otter doors and footgear were used to improve performance and success. Each set consisted of the gear being towed for 1.7 naut. miles along the bottom at a vessel speed of between 3.0 knots to 3.5 knots. A Furuno CN 10A net sounder was attached to the trawl to allow the gear to be monitored during fishing operations.

There was no attempt to account for differences that may occur because of vessel size, gear or any other factor that may influence catchability and hence the comparability between the different survey results. Numerical results of surveys (3) and (4) above are available in Brodie *et al.* (MS 1992).

## Results and Discussion

### Regular groundfish surveys

**Divisions 2J and 3KL.** During the earlier surveys, Greenland halibut were relatively abundant in the deep channels running between the shallow fishing banks especially in Div. 2J and 3K (Fig. 1). They were also plentiful along the slope of the continental shelf of Div. 2J and the more surveyed area of Div. 3K. This distribution pattern remained fairly consistent through to about 1986–87 and any variation associated with total abundance among years was more likely to be a result of differences in year-class strengths of certain age groups as well as natural variability in survey estimates (see Bowering *et al.*, MS 1993). By 1988, for Greenland halibut in Div. 2J, a decreasing trend in abundance was clearly apparent. This was followed by a similar trend in Div. 3K by 1990. By 1992, catches in Div. 2J and 3K were extremely low; the highest catch in the area was taken in the very southeast end of Div. 3K near the edge of the continental slope.

Throughout the survey period, there were very few large catches in Div. 3L (Fig. 1), however, most

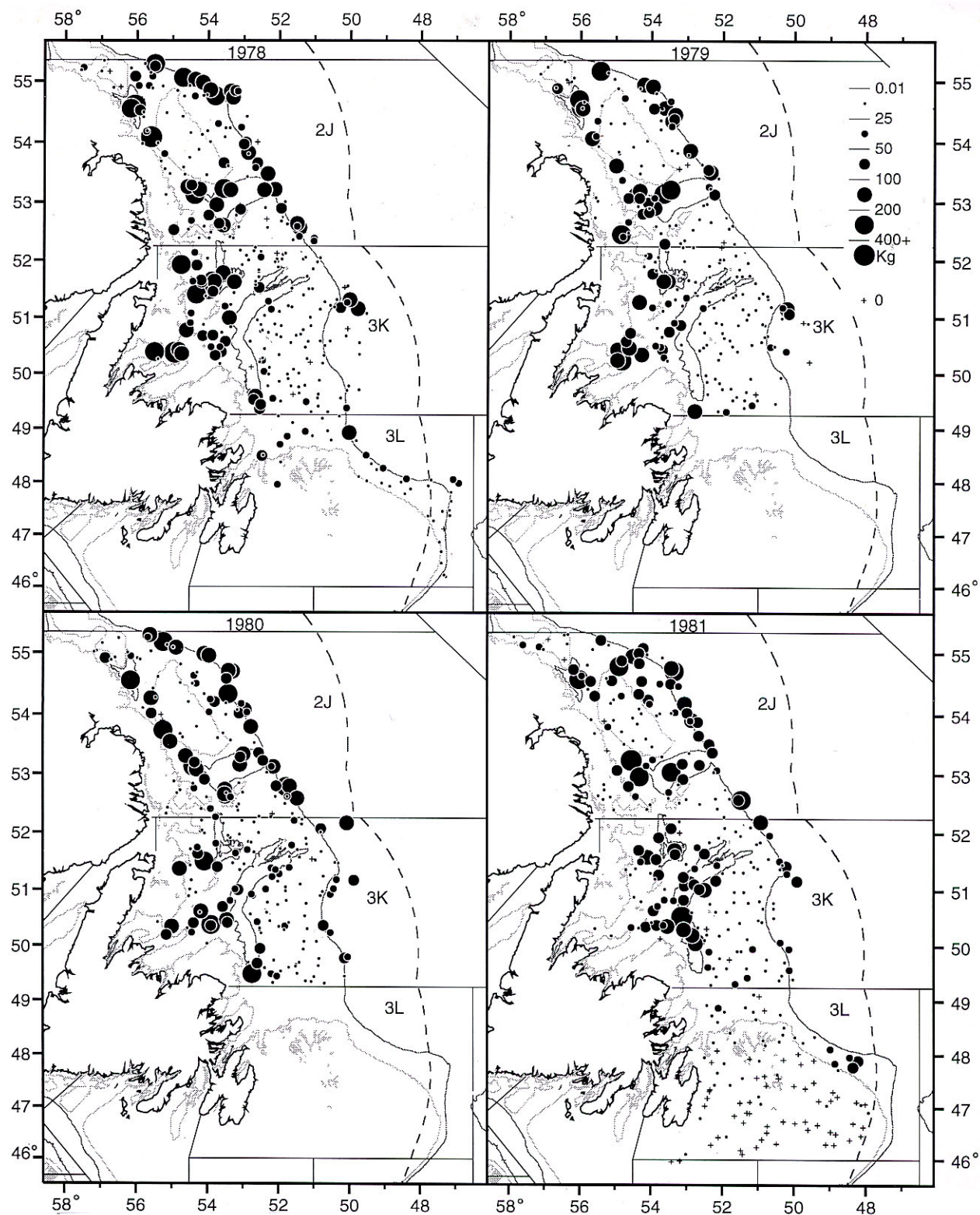


Fig. 1. Distribution of Greenland halibut catches (kg per standard tow) from 1978 to 1992 Canadian autumn surveys to Div. 2J and 3KL showing 200 m (light dotted) and 400 m (dark dotted) depth contours. Dashed line represents division between the Canadian Economic Zone and the NAFO Regulatory Area.

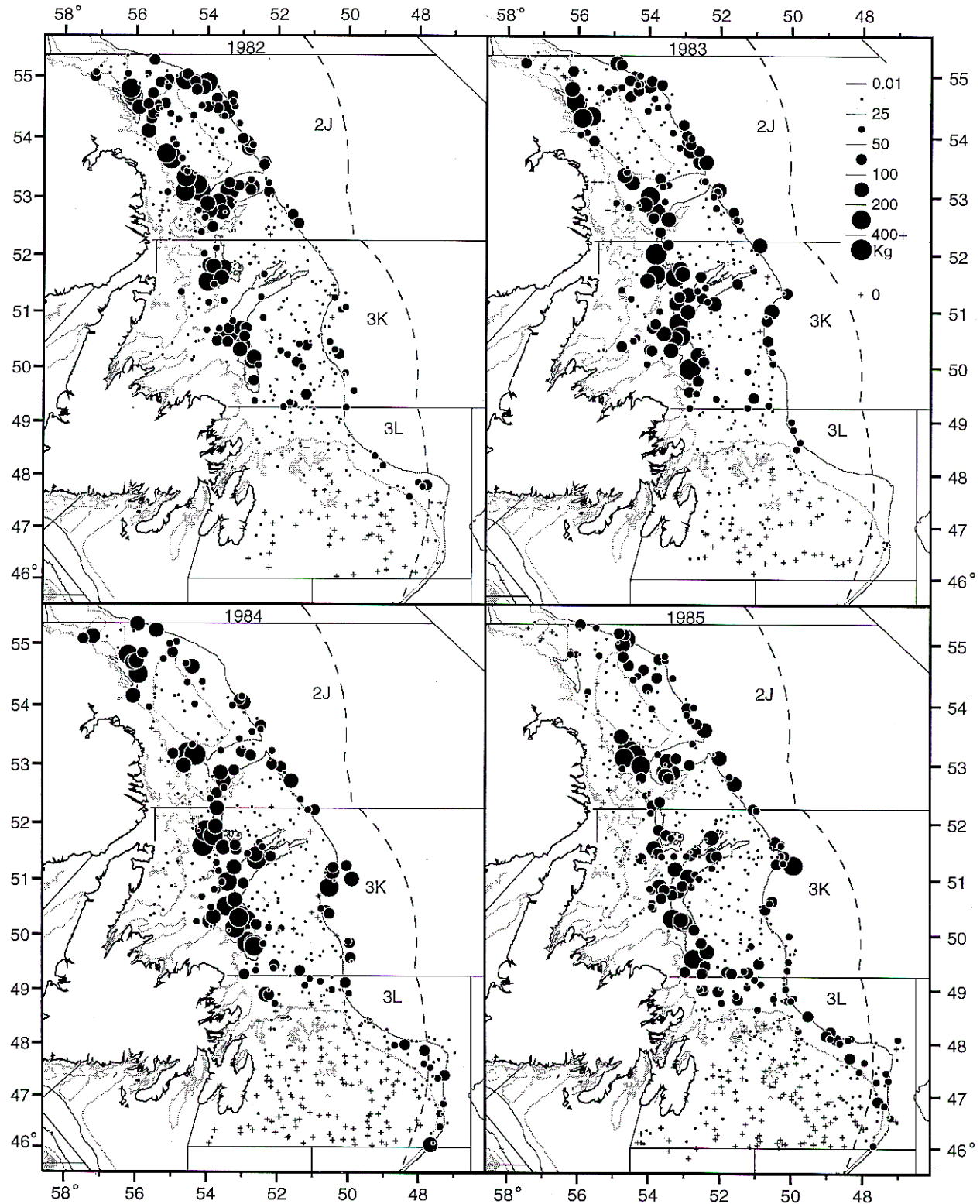


Fig. 1. (Continued). Distribution of Greenland halibut catches (kg per standard tow) from 1978 to 1992 Canadian autumn surveys to Div. 2J and 3KL showing 200 m (light dotted) and 400 m (dark dotted) depth contours. Dashed line represents division between the Canadian Economic Zone and the NAFO Regulatory Area.



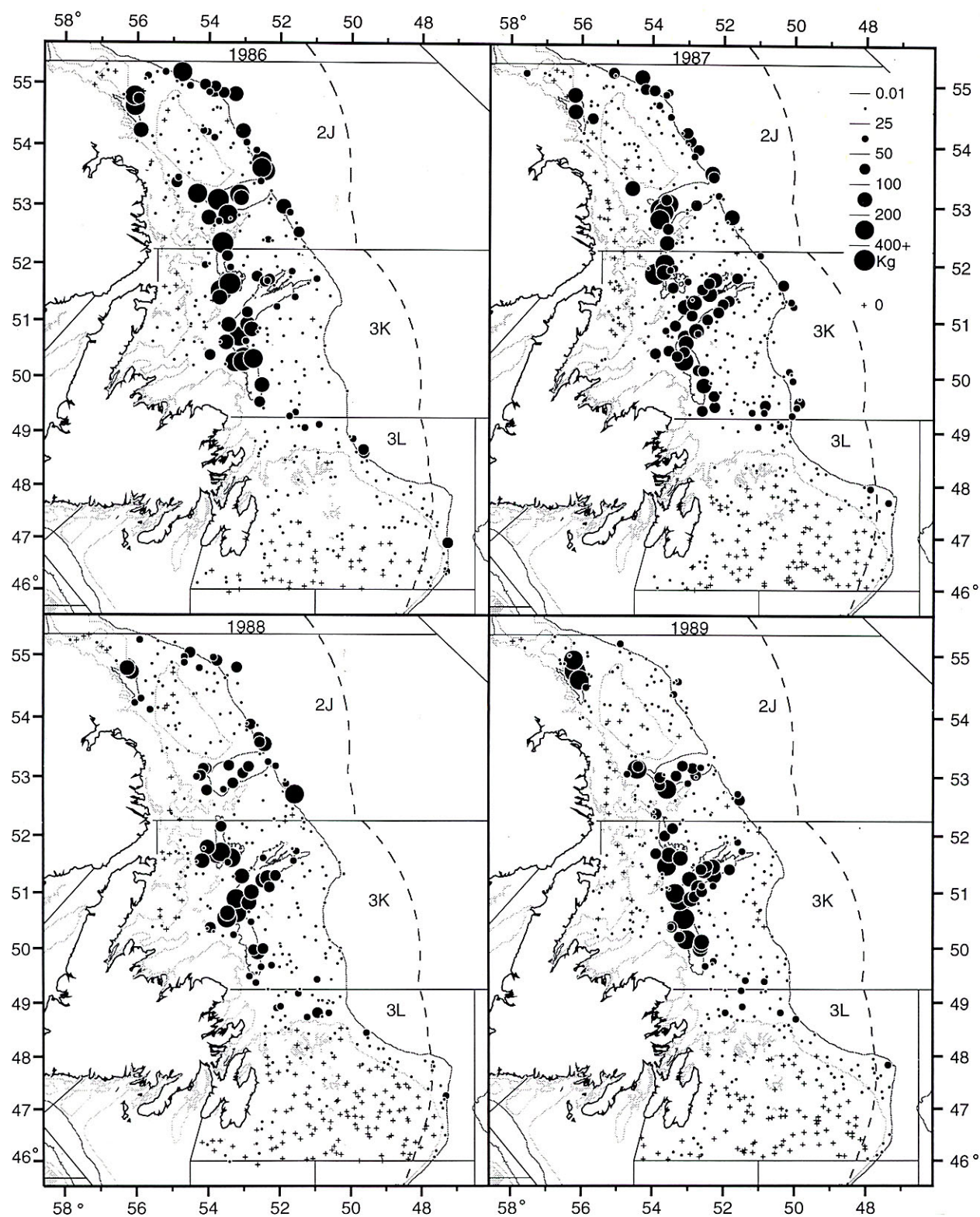


Fig. 1. (Continued). Distribution of Greenland halibut catches (kg per standard tow) from 1978 to 1992 Canadian autumn surveys to Div. 2J and 3KL showing 200 m (light dotted) and 400 m (dark dotted) depth contours. Dashed line represents division between the Canadian Economic Zone and the NAFO Regulatory Area.

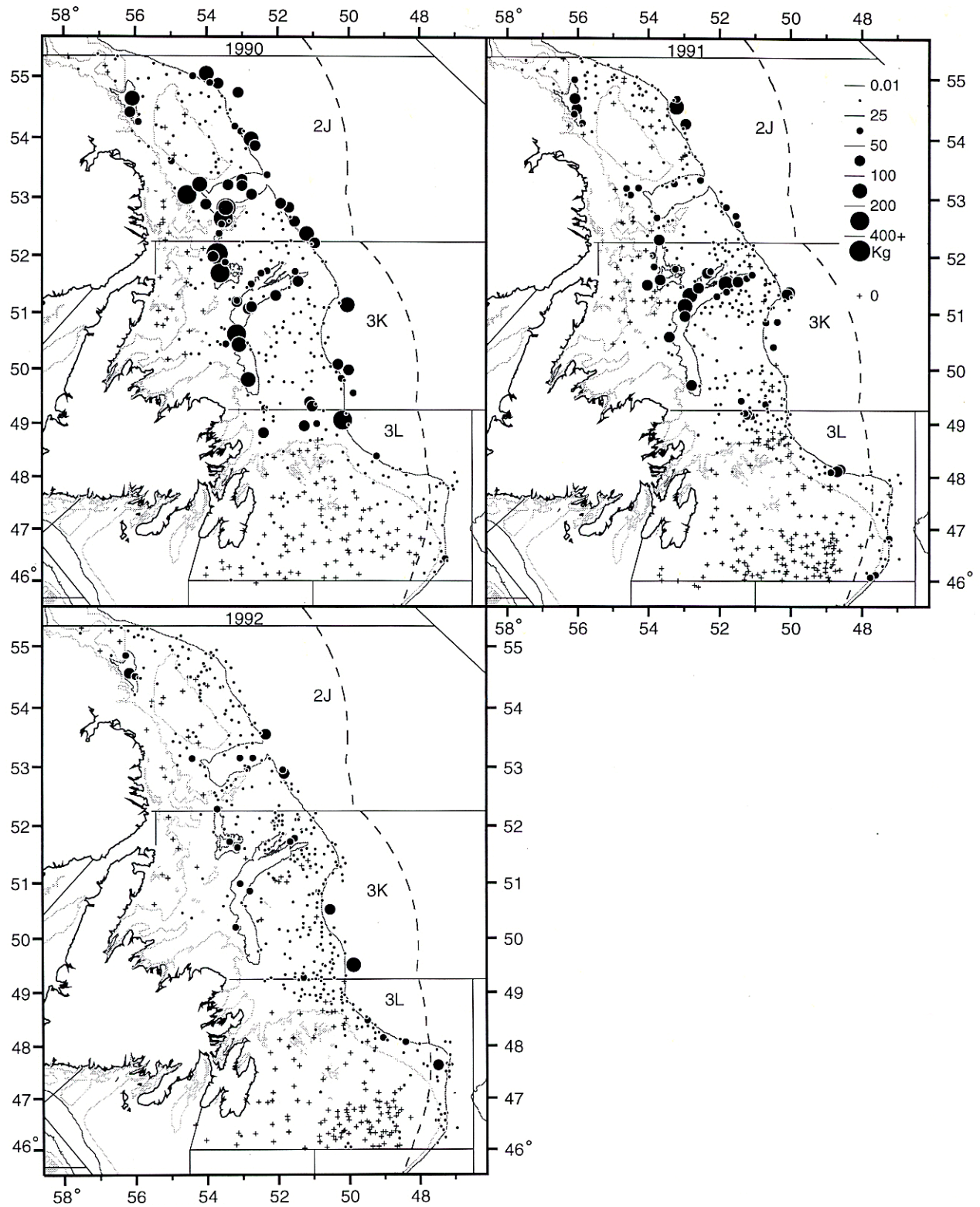


Fig. 1. (Continued). Distribution of Greenland halibut catches (kg per standard tow) from 1978 to 1992 Canadian autumn surveys to Div. 2J and 3KL showing 200 m (light dotted) and 400 m (dark dotted) depth contours. Dashed line represents division between the Canadian Economic Zone and the NAFO Regulatory Area.

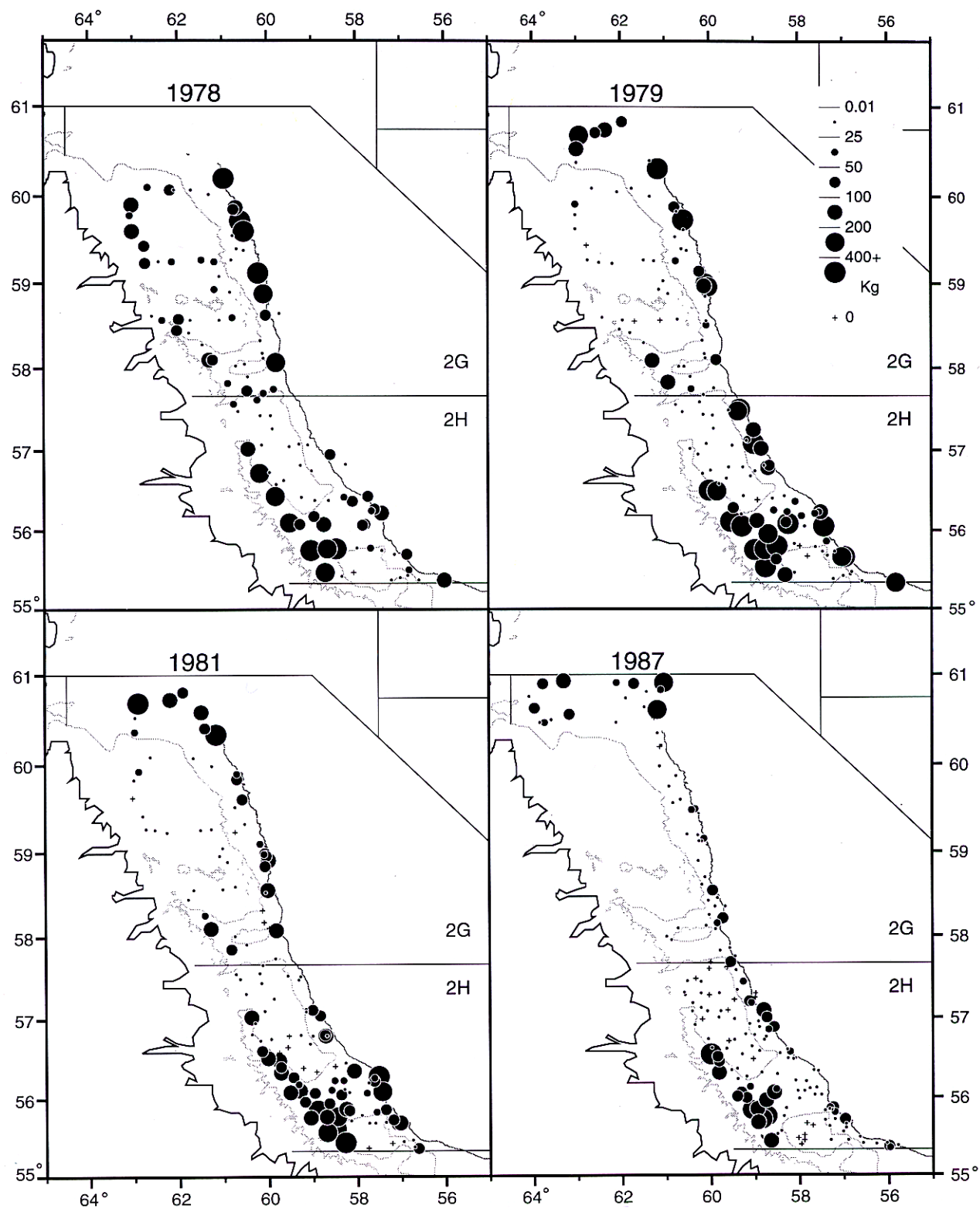


Fig. 2. Distribution of Greenland halibut catches (kg per standard tow) from periodic Canadian surveys of Div. 2GH in 1978–88 showing 200 m (light dotted) and 800 m (dark dotted) depth contours.

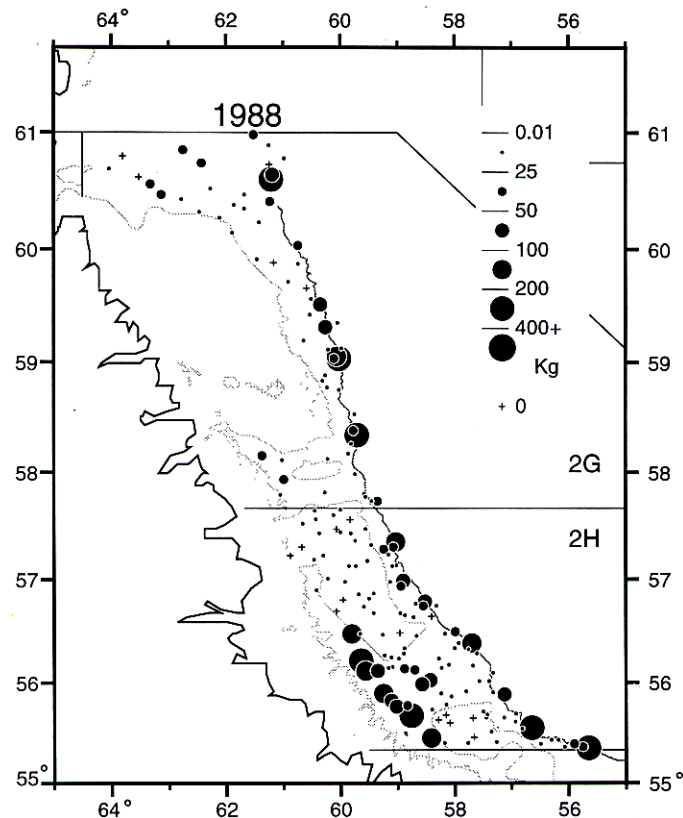


Fig. 2. (Continued). Distribution of Greenland halibut catches (kg per standard tow) from periodic Canadian surveys of Div. 2GH in 1978–88 showing 200 m (light dotted) and 800 m (dark dotted) depth contours.

incidental large catches were taken on the “nose” of the Grand Bank in the area known as the Sackville Spur. It is noteworthy that the highest catches in Div. 3L were during the 1984–85 period when surveys only covered depths of 366 m and this pattern did not change during the last two years when coverage was complete to over 700 m.

**Divisions 2GH.** The distribution pattern of Greenland halibut in Div. 2GH was remarkably consistent in both the early time series and the later time series despite differences in overall abundance (Fig. 2). Most of the larger catches were associated with the outer deep continental slope area from the northern tip of Div. 2G at the outflow of the deep waters of Hudson Strait all the way down the slope of Div. 2H. Fish were particularly abundant (in relative terms) in the Hopedale Channel area which is located in the south western part of Div. 2H. The only apparent difference between the 1979–81 and 1987–88 periods was that the overall abundance in the earlier period was clearly much higher than in the later period. Indices of abundance from these

surveys suggested that the stock size had declined at least by half (Anon., 1989).

#### Deepwater surveys, 1991

**Northern Kingfisher.** The extent of survey coverage was rather limited considering the geographic distance required to travel by the vessel (Fig. 3). Nevertheless, for the transects fished, catch levels were similar from Div. 0B south to Div. 2J. Because the fishing sets were so close together as a result of the sharp descent of the continental shelf edge, it is somewhat difficult to see clearly from the figure the variation in catches. Brodie *et al.* (MS 1993) indicated, however, that the larger catches were taken in deeper water and comprised mainly larger fish. It is unfortunate that it was not possible to survey the deep channel areas to compare catch levels with earlier surveys.

**Cape Adair.** This survey was much more intensive than that of the *Northern Kingfisher* and covered all of the deep slope area from northern Div. 3K to the deep areas on the north side of Div. 3L



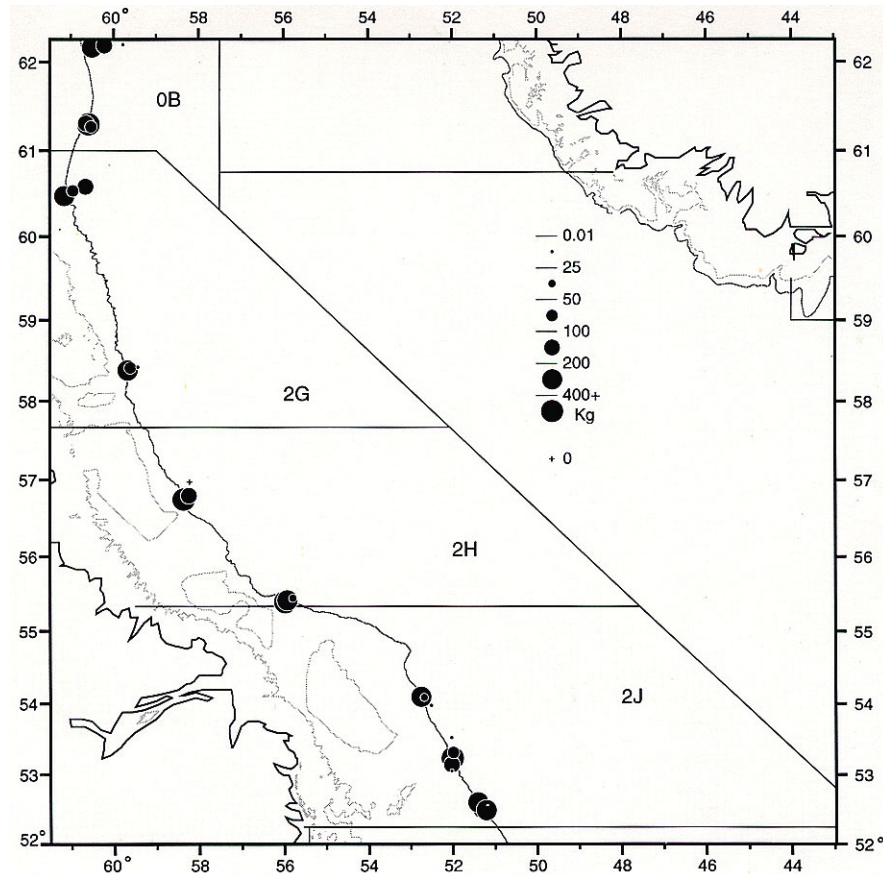


Fig. 3. Distribution of Greenland halibut catches (kg per standard tow) from a 1991 Greenland halibut directed survey in depths greater than 750 m by the *Northern Kingfisher* to Div. 0B and 2GHJ showing 200 m (light dotted) and 1 000 m (dark dotted) depth contours.

and the Flemish Cap in Div. 3M (Fig. 4). The noticeable gap in the aerial coverage along the 1 000 m contour in Div. 3L is due to very poor trawlable bottom. Nevertheless, the sets that were possible clearly indicated that there is little reason to expect a break in the continuity of the distribution from Div. 3K through Div. 3M. The higher catches experienced in the survey occurred in the northern part of Div. 3K. Catch levels were lower in the southern part of Div. 3K. Catches were, on average, quite high in the proximity of the Div. 3L and 3M boundary (Fig. 4). Notably, every set fished had some catch of Greenland halibut.

### Summary

Except that there have been substantial reductions in the biomass levels in Div. 2GH from the late-1970s to the late-1980s, there did not appear to be any significant change in the pattern of distribution throughout the area. In Div. 2J and 3K, the distribu-

tion was also rather consistent for many years, until the late-1980s when Greenland halibut began to rapidly disappear in Div. 2J, followed within a couple of years by Div. 3K. It was not readily apparent from the survey data that the fish moved progressively to deep water. However, considering the rapidity in which the events progressed, it is not inconceivable that large-scale seasonal movements may have taken place which may not have been precisely detected as a result of the 12 months between surveys.

It is also apparent that there was a continuity in the distribution of Greenland halibut along the continental shelf edge from within the Canadian fishing zone extending to the Flemish Pass and likely further south. Based on the synchrony of timing from when the Greenland halibut began to rapidly disappear from the northern divisions to the discovery of high concentrations in the Flemish Pass, the important question that has been raised is whether

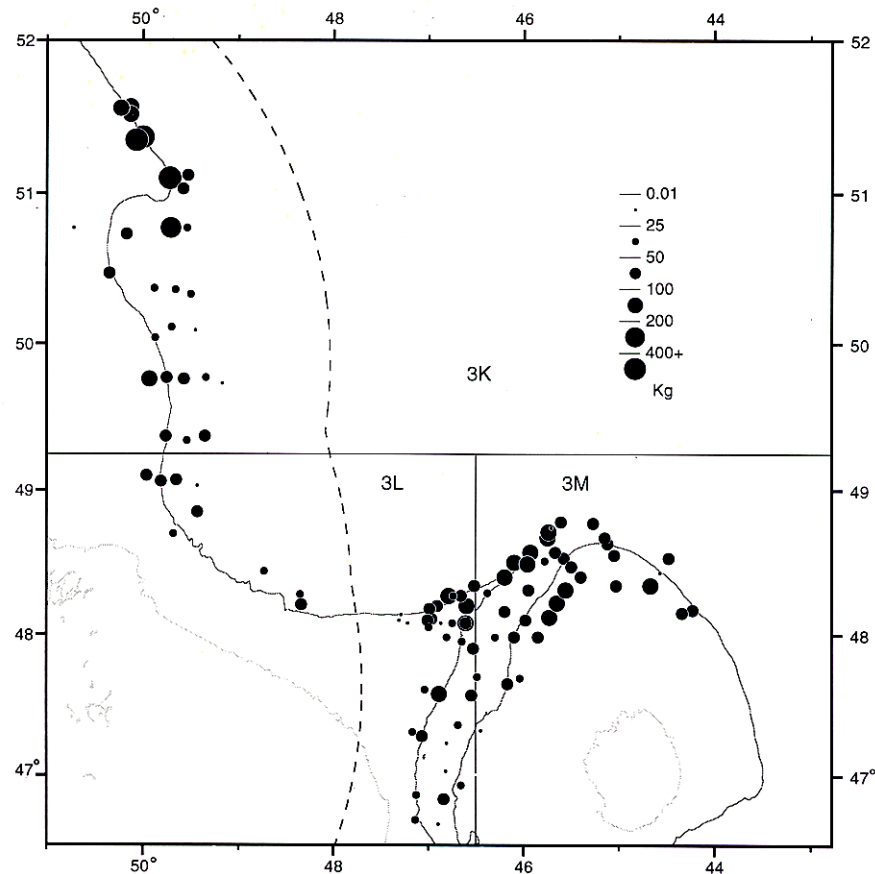


Fig. 4. Distribution of Greenland halibut catches (kg per standard tow) from a 1991 Greenland halibut directed survey in depths greater than 750 m by the *Cape Adair* to Div. 3KLM showing 200 m (light dotted) and 1 000 m (dark dotted) depth contours. Dashed line represents division between the Canadian Economic Zone and the NAFO Regulatory Area (east of dashed line).

this fish migrated to the Flemish Pass or has always been there and not detected? The NAFO Scientific Council reported at its June 1993 Meeting that "a substantial part of the stock component being exploited in the NAFO Regulatory Area of Div. 3L, 3M and 3N is likely to have originated in divisions to the north, at least from Div. 2J, 3K and 3L. This was particularly apparent in that the strong 1984–86 year-classes, which disappeared in Div. 2J and 3K in recent years, appeared as a main component of the catch in 1992 in the Regulatory Area especially the 1986 year-class" (Anon., 1993).

Furthermore, considering the extensive commercial as well as deepwater research activity that has been conducted in the area over decades, it is difficult to accept, and indeed is highly unlikely that such a large localized concentration of Greenland halibut could have gone undetected for such a long period of time.

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