Northwest Atlantic Fisheries Organization

Serial No. N2391 NAFO SCR Doc. 94/25

SCIENTIFIC COUNCIL MEETING - JUNE 1994

Analysis of the Variations in the Spacial Distribution and Spawning of the Greenland Halibut in Divisions 3LMN (1990-93)

by

Susana Junquera

Instituto Español de Oceanografia
Vigo, Spain

ABSTRACT:

In this paper the geographic, bathymetric and seasonal distribution of the adult Greenland halibut stock exploited in the Flemish Pass area (Div. 3LMN) is analysed for the period 1990 - 1993 using data collected by observers on board the commercial fleet. A southward shift of the fishing area took place and adult fish and spawning activity were recorded in unsual areas. The main areas and seasons of spawning are described. A peak time for spawning has not been found and spawning females appeared evenly represented at any time of the day.

INTRODUCTION.

The new Greenland halibut fishery developed in the NAFO Regulatory Area of Div. 3LMN since 1990 is important to understand the trends in this Northwest Atlantic resource as in 1993, a 90 % of the total catch was estimated to be taken there (Anon. 1994). STACFIS considered that catches from this area belong to the Subarea 2 and Div.3KL stock. The length frequency data are congruent, as the 1984-86 year classes were dominant in catches in Div. 3LM in 1991 and 1992, and those same year classes were reported to be dominant in catches from Subarea 2 and Div. 3KL until 1991, when they started to disappear there (Bowering et al. 1993). Also, results from Canadian surveys showed that Greenland halibut dissappeared from the traditional grounds of this species (Div. 2J, followed by Div. 3K), and that in the 1992 survey, highest abundance levels were detected in southern Div. 3K and in northern Div. 3L. The results of the EEC surveys on Flemish Cap (Vazquez 1993) show that the year class of 1986 is still important there, and the biomass indices (above 730 m. depth) do not show the declining trends observed in the northern areas.

On this basis, STACFIS agreed that there seems to have been a major redistribution of the Greenland halibut since the late 80s (Anon. 1994) and that a substantial part of the stock might be concentrated in the Regulatory Area of Div. 3LMN, moving into areas where this species was formerly considered unusual. As a result, the stock boundaries, stock structure and migration patterns are unknown, which prevents analytical assessment of the stock. To provide information on these aspects, this paper reviews the spatial and seasonal patterns of the mature fish distribution and of the spawning activity since the start of the Greenland halibut fishery in the Flemish Pass area in 1990, using data from the Spanish observers network on board commercial ships.

MATERIAL AND METHODS.

The data used here were supplied by observers on board the commercial deep-water trawlers from May 1990 to December 1993 In every trawl the position, depth, time and catch are recorded. Length frequencies are obtained by random sampling of the catch, while biological data, such as maturity stages are obtained by an stratified-by-length sampling design.

To determine the patterns of geographic distribution of mature fish in the catches, 24 squares of 30 minutes latitude by 1 degree longitude, named A to Y, have been defined (Fig. 1). Fish larger than 68 cm are considered as mature, in accordance with previous results on the 50 % maturation size in this area (Junquera and Zamarro 1984). The percentages of mature fish by square are obtained from the corresponding monthly length frequencies (both sexes included) weighted by the monthly reported catch in the same square. To analyse the bathymetric distribution of adults and the areas of maximun spawning, three depth strata are defined: 700 to 900 m , 900 to 1100 m and 1100 to 1700 m, and the squares are in this case grouped into four larger areas: eastern Flemish Cap slope (squares ABF), northern Flemish Pass (squares CDGHLIM), southern Flemish Pass (squares QRSTU) and Div. 3N (squares VXY).

The maturity stages of the fish are determined visually according to a four-point scale (Junquera and Zamarro 1994).

Only data from females are used here. The proportion of spawning females is obtained by computing the number of adult fish in the ripe stage, which means with hydrated oocytes in the ovary. The proportion of spawning females is analysed for the areas defined above, and by month and depth strata. An attempt is also made to find the peak time of spawning, by following the proportion of spawning females in the samples during the 24-hour cycle. To do this, samples are grouped into six-hour intervals, according to the mid- time of the trawl from which they came.

RESULTS AND DISCUSSION.

In 1990 and 1991 mature fish were concentrated in a very narrow area (Fig.2) at the entrance of the Flemish Pass, north to 47º 30' N. The highest proportion of adult fish in the catches were always reported in the square H, followed in abundance by the nearby slopes of northern Flemish Cap (square C) and northern Div. 3L (square I). Catches south to 47º 30'N were negligible in those years. From the second half of 1992, the fishing area spread to the south across the Flemish Pass, moving into Div. 3N. At the same time mature, fish started to appear in important proportions (up to 20 %) in southern Flemish Pass, in areas where previously only juveniles were reported. This distribution pattern matches that observed for mainly juveniles in the EEC summer survey in shallower areas of Flemish Cap in 1992, but in 1993 these areas were not properly covered in the survey (Vazquez 1993).

Data on the percentage of mature fish in the catches by month and depth strata (Fig. 3) do not reveal any regular pattern of seasonal or seasonally -linked bathymetric migrations. On the contrary, in all the time series analysed, the number of mature fish in the catches increases with depth, as was already known (Bowering and Chumakov 1989; Junquera et al. 1992). With few exceptions (July of 1992 and summer of 1993 in southern Flemish Pass), mature fish are most abundant in the 1100 - 1700 m depth strata. Their proportion in the catch is however very variable during the year in all areas and at all depths. This reflects not only the true abundance of fish, but also the suitability of their aggregations for successful fishing; this last factor may be highly variable on a short time scale.

The most remarkable feature (Fig.3) is the decline in the percentage of mature fish on the northern Flemish Pass slopes since 1992, followed by the increase first in the southern Flemish Pass and later in Div. 3N since the second half of 1992 and in 1993. Bowering et al. (1993) indicated that biomass indices of Greenland halibut in the Canadian surveys have been declining in Div. 2J since 1982, followed by Div. 3K in 1987 and in Div. 3L in 1991-92. If as Bowering and Chumakov (1989) pointed out, there is no break in the continuity of the distribution range in those areas, the results from the Canadian surveys and from fishing activity both give evidence of a general shift to the south of the stock as a whole, as not only juveniles but also a substantial proportion of adult fish and spawning activity are found there. The results of the EEC surveys on Flemish Cap are in agreement, and show in recent years areas of high concentration of juveniles in shallower waters that match with areas of mature fish concentration at greater depths (Vazquez 1993). The results presented do not support the usually assumed migration to the northern areas of the mature component before spawning. On the contrary, and at least for the last four years, the displacement is in the opposite direction. It seems more likely that mature fish move in relation to suitable environmental conditions rather than by strict migratory patterns related to spawning. Coinciding with the years analysed here, a period of very cold environmental conditions has been reported in these areas (Stein 1992; Petrie et al. 1988; Colbourne 1993; Drinkwater et al. 1994). It has been pointed that adult Greenland halibut within its boreal range of distribution requires warm conditions (Jensen 1935; Smidt 1969; Fedorov 1971) especially to attain sexual maturity. Hence the recent colder than normal environmental conditions may have caused the shift to the south.

Spawning activity as reflected by the percentage of females with ovaries in the hydrated stage was very variable during the period analysed (Fig. 4). In 1990 it was negligible, increased in 1991, declined again in 1992 and finally reached maximum levels in 1993. This increase in spawning activity in 1993 is consistent through the areas surveyed, with the exception of eastern Flemish Cap where significant spawning activity was only

detected in 1991. In agreement with previous results (Junquera and Zamarro 1994), peak spawning activity appeared regularly in summer (July - August), except in Div. 3N in 1993 where a peak in spawning has been reported in May (Fig.4). Significant spawning activity is also observed in winter (November to January) in both northern and southern Flemish Pass, and at much lower levels during the whole year. Fedorov (1971) described the same situation in the Barents Sea Greenland halibut population, and formulated a model of reproductive strategy for this species, where sexual maturity would be achieved asynchronously by small groups of spawners as a way to extend the reproductive period of the whole population. This may explain the low proportion of spawning females usually found in the catches, compared with other species with massive spawning seasons, and the existence of several spawning peaks during the year, with variable magnitude from year to year.

Months of high spawning activity sometimes coincide with months of increased proportions of mature fish in the catches, as happened in the eastern Flemish Cap area in July - August of 1991, in northern Flemish Pass in the same months of 1992-93, in southern Flemish Pass in December of 1993 and in Div. 3N in May of 1993. But this is not always the case, and nor is there a general coincidence between peak spawning months and mature fish abundance in the catches. This confirms that spawning activity is not the only factor that determines the concentrations of fish in those areas.

In northern Flemish Pass, spawning occurs in the entire depth range analysed, whereas to the east and to the south it is restricted to the deepest strata (900 to 1700 m.).

The percentage of spawning females in the catches at different times of day are remarkably constant (table 1). Differences within each year are not significant, but differences from year to year are large, as it was indicated. The lack of a peak time in spawning suggests that oocyte maturation in this species could be of the 'synchronic by groups' type (Wallace and Selman 1981), as in other Pleuronectiforms in the North Atlantic, such as American plaice (Zamarro 1992), yellow-tail flounder (Howell 1983) and turbot (Jones 1974), where maturation appears as a continuous process.

REFERENCES.

ANON. (1994).- NAFO Scientific Council Reports, 1993.

BOWERING, W.R. and A.K. CHUMAKOV (1989).- Distribution and relative abundance of Greenland halibut (Reinhardtius hippoglossoides Walbaum) in the Canadian Northwest Atlantic from Davis Strait to the northern Grand Bank. Fish. Res., 7: 301-328.

BOWERING, W.R.; W.B. BRODIE; D. POWER (1993).- An evaluation of the status of the Greenland halibut resource in NAFO Subarea 2 and Divisions 3KLMN. NAFO SCR Doc. 93/75, 29 p.

COLBOURNE, E. (1993).- Oceanographic conditions during the annual fall groundfish survey in NAFO Divisions 2J3KL. NAFO SCR Doc. 93/88. 31 p.

DRINKWATER, K.F.; B. PETRIE; S. NARAYANAN (1994).- Overview of environmental conditions in the Northwest Atlantic in 1991. Sci. Coun. Studies, 20: 19-47.

FEDOROV, K.Y. (1971).- The state of the gonads of the Barent Sea Greenland halibut (Reinhardtius hippoglossoides Walb.) in connection with failure to spawn. J.Ichthyol.11(5): 673-682.

HOWELL, H.W. (1983).- Seasonal changes in the ovaries of adult yellowtail flounder, Limanda ferruginea. Fish.Bull, 81: 341-355.

JENSEN, A.S. (1935).- The Greenland halibut (Reinhardtius hippoglossoides) its development and migrations. K. Dan. Viden. Sels. Skr., 6. 32 p.

JONES, A. (1974).- Sexual maturity, fecundity and growth of the turbot (Scophthalmus maximus L.). J.Mar.Biol.Assoc. U.K., 54: 109-125.

JUNQUERA, S.; S. IGLESIAS; E.CARDENAS (1992).- Spanish fishery of Greenland halibut (Reinhardtius hippoglossoides) in 1990-91. NAFO SCR Doc. 92/28. 14 p.

JUNQUERA, S. and ZAMARRO, J. (1992).- Sexual maturity and spawning of the Greenland halibut (reinhardtius hippoglossoides) from Flemish Pass area. NAFO SCR Doc. 92/41. 10 p.

PETRIE, B.; S. AKENHEAD; J. LAZIER; J. LODER (1988).- The cold intermediate layer on the Labrador Current and Northwest Newfoundland shelves, 1978-1986. NAFO Sci. Coun. Studies, 12: 57-69.

SMIDT, E. (1969).- The Greenland halibut (Reinhardtius hippoglossoides), biology and exploitation in Greenland waters. Medd. Dan. Fisk. Havunders. 6: 79-148.

STEIN, M. (1992).- Variability of climate - impact on cod recruitment off West Greenland?. NAFO SCR Doc. 19/92. 15 p.

VAZQUEZ, A. (1993).- Results of the bottom-trawl survey of Flemish Cap in July 1992. NAFO SCR Doc. 93/19. 22 p.

WALLACE, R.A.; K.SELMAN (1981).- Cellular and dynamic aspects of oocyte growth in teleosts. Am. Zool. 21: 325-343.

ZAMARRO, J. (1991).- Determination of fecundity in American plaice (Hippoglossoides platesoides) and its variation from 1987 to 1989, on the tail of the Grand Bank. Nether. J. Sea Res. 29 (1-3): 205-209.

TABLE 1.- Percentage of Greenland halibut spawning females by year and time intervals. N- Total number of mature females sampled.

Time intervals	1990		1991		1992		1993	
	N	%	N	%	N	%	N	%
00.00 - 06.00 h	295	3	322	13	133	1	193	39
06.01 - 12.00 h	1819	2	2524	13	1327	7	1624	39
12.01 - 18.00 h	2362	2	2466	15	1313	6	1704	38
18.01 - 00.00 h	988	2	1187	20	385	9	729	29

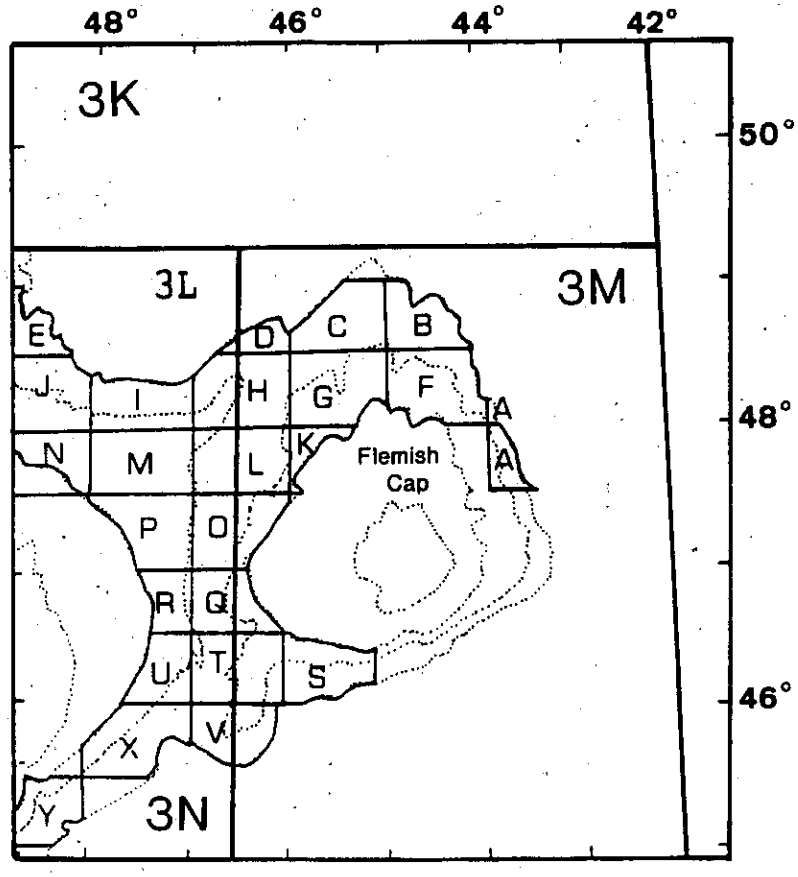


Fig. 1- Sampling squares defined to describe the pattern of distribution of adult Greenland halibut (1990-93).

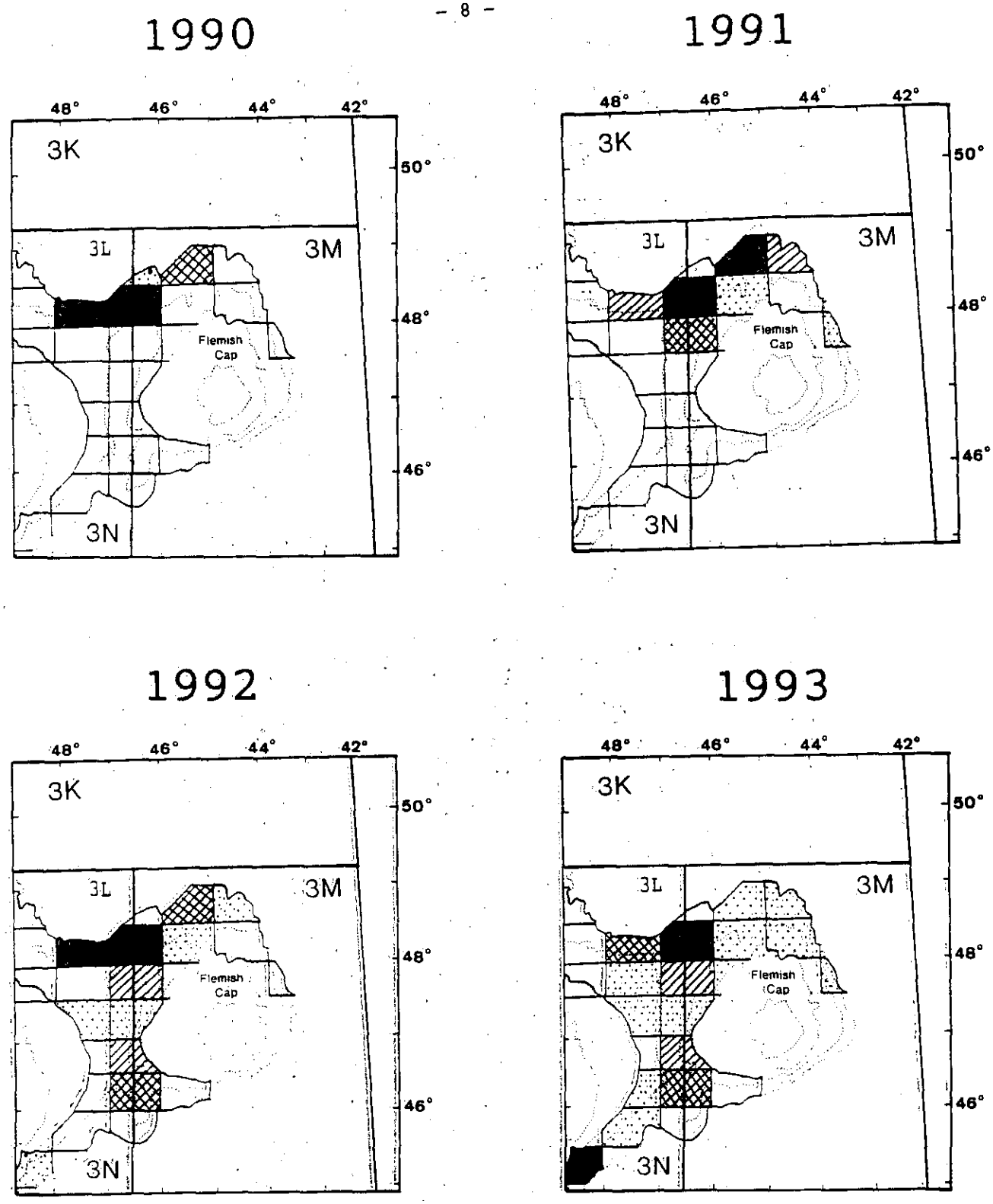
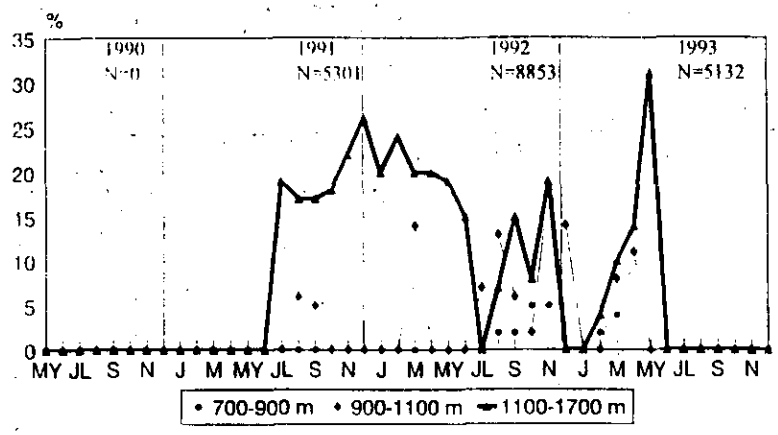


Fig. 2- Trends in mature Greenland halibut distribution (1990-93) from length distributions weighted by the catch by square.
1 - 5 % of mature fish in the catches;
6 - 10 %
11 - 19 %
more than 20 %

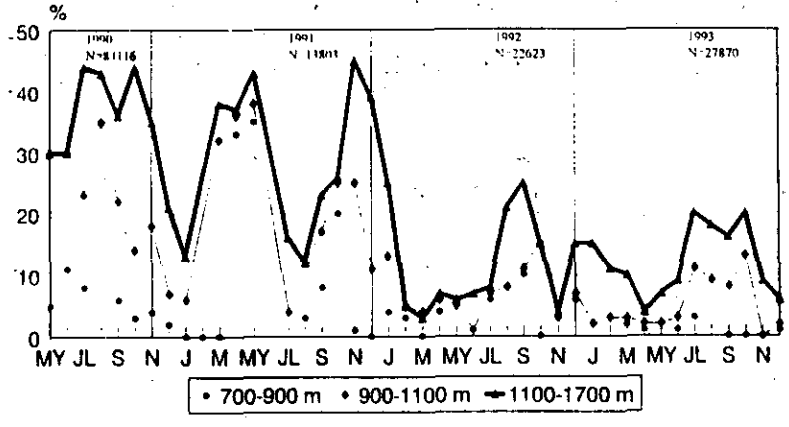
Northeast Flemish Cap

(squares ABF)



Northern Flemish Pass

(squares CDGHLMI)



Southern Flemish Pass

(squares QRSTU)

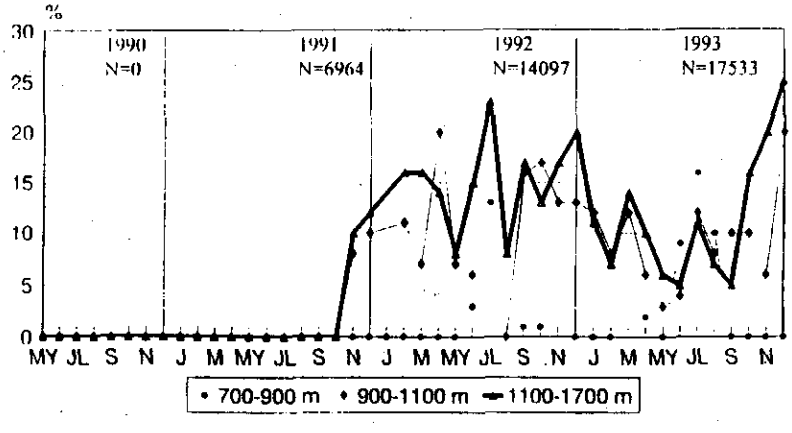


Fig. 3a- Percentage of mature fish by month and depth strata. (N- number of fish sampled).

Division 3N

(squares XY))

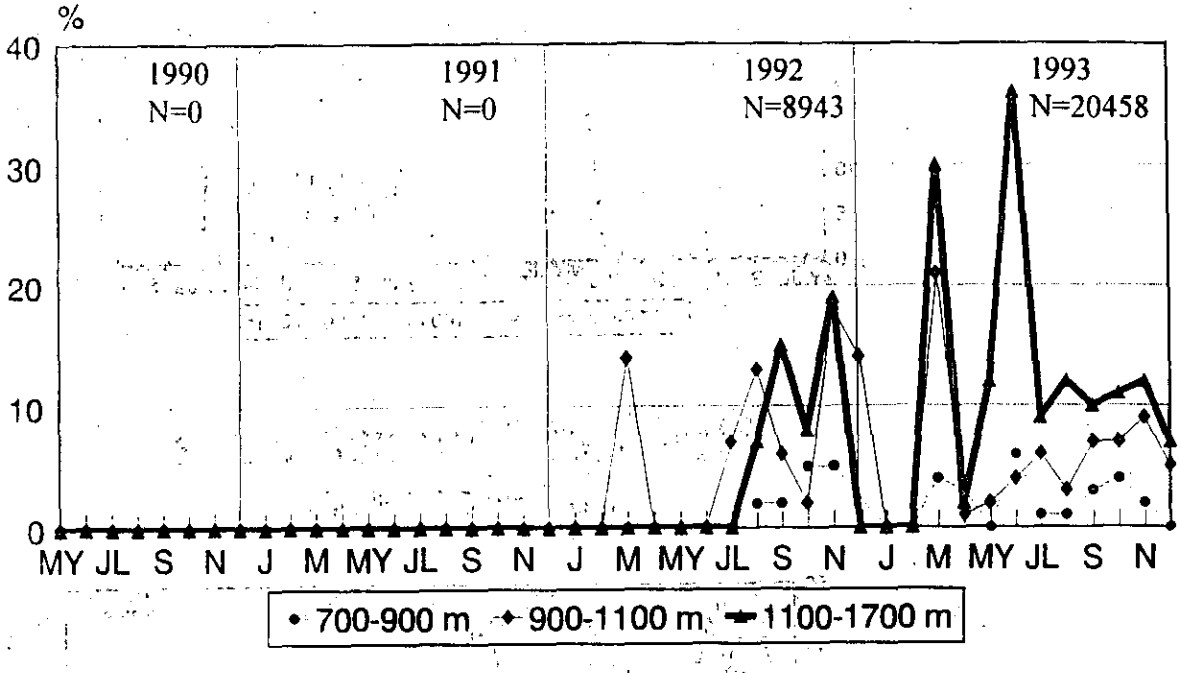
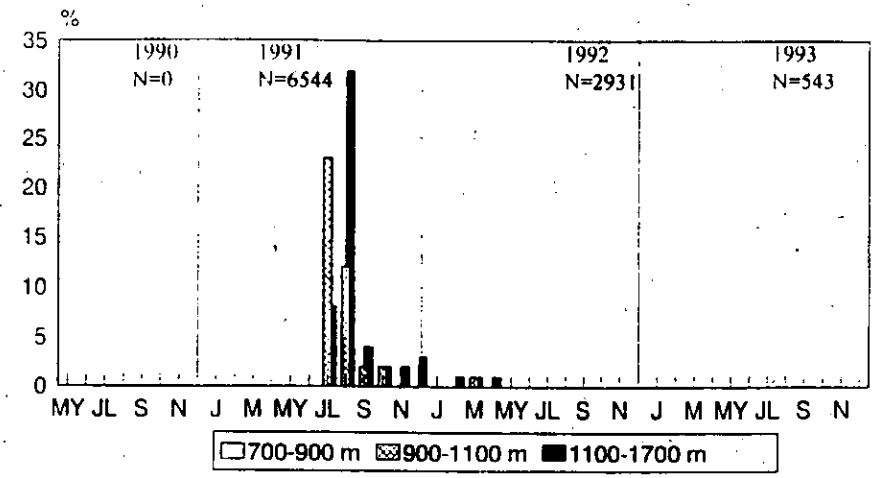


Fig. 3b- Percentage of mature fish by month and depth strata in Division 3N. (N- number of fish sampled).

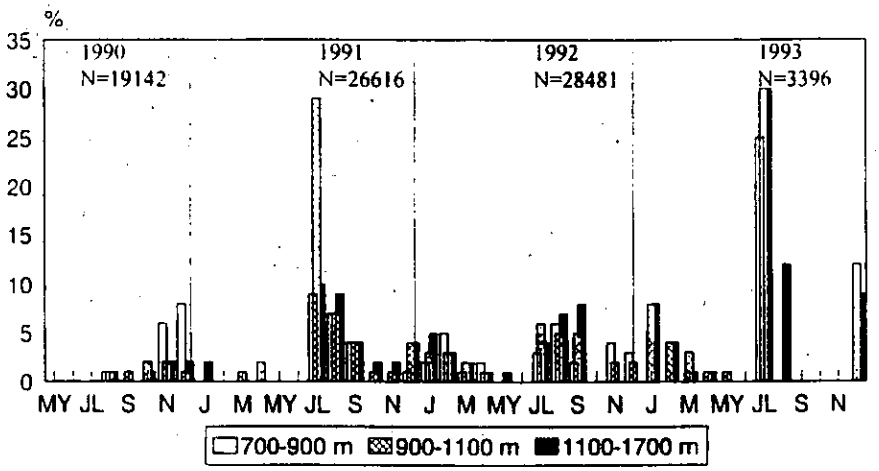
Northeast Flemish Cap

(squares ABF)



Northern Flemish Pass

(squares CDGHLMI)



Southern Flemish Pass

(squares QRSTU)

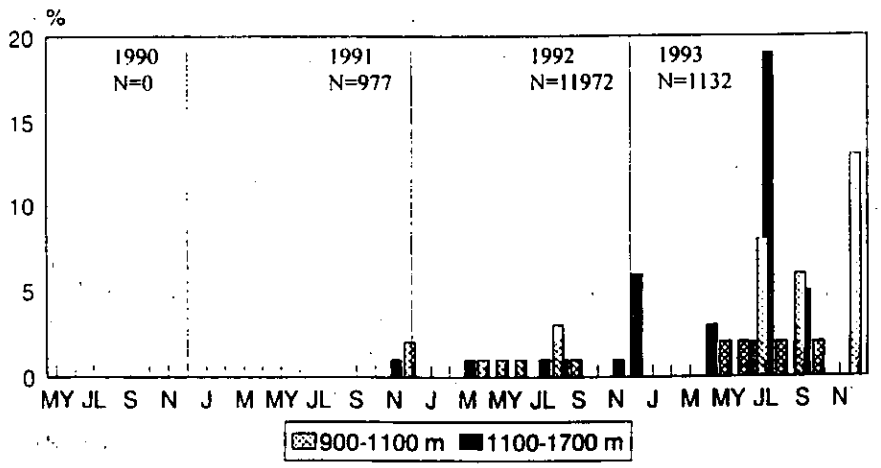


Fig.4a- Percentage of spawning females by month and depth strata. (N- number of adult females sampled)

Division 3N

(squares XY)

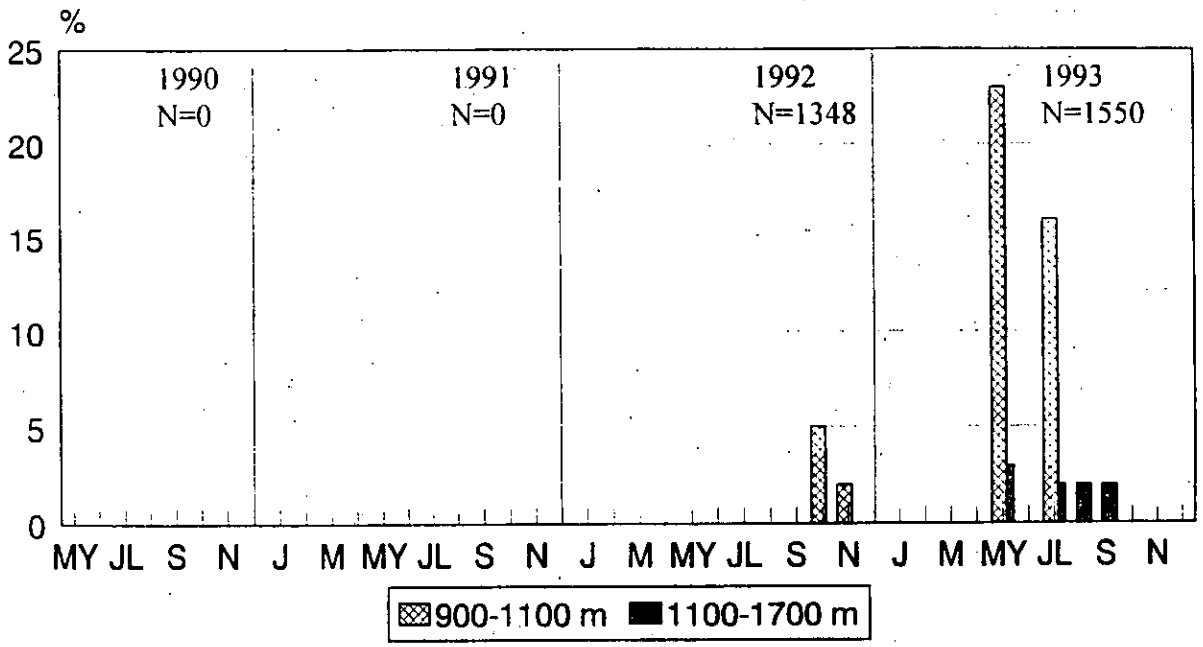


Fig.4b- Percentage of spawning females by month and depth strata in Division 3N. (N-number of adult females sampled).