Northwest Atlantic Fisheries Organization

Serial No. N4375 **NAFO SCR Doc. 01/9**

SCIENTIFIC COUNCIL MEETING – JUNE 2001

By-catch of Grenadiers in Directed Fishery for Greenland Halibut in Divisions 3LMN and Size, Age and Sex Composition of Roughhead Grenadier in 2000

by

P.I.Savvatimsky, K.V.Gorchinsky

Polar Research Institute of Marine Fisheries and Oceanography
(PINRO), 6 Knipovich Street, Murmansk 183763 Russia

Abstract

In 2000 Greenland halibut fishery by Russian vessels took place in Div. 3L – in January-May, 3M – in April-May and July, 3N – in March. Three species of grenadier occurred as a steady by-catch: roughhead, roundnose and common rat-tail. By-catch of roundnose grenadier and common rat-tail was insignificant and these species are of no commercial value. By-catch was composed primarily of roughhead grenadier, although on the average it was small. Greatest by-catches were taken from depth of about 1000 m and accounted for 6%. However, individual by-catches of this species were as large as 2 and even 3 t per haul.

The catch of roughhead grenadier was dominated by individuals of 18-98 cm. Size composition of grenadier was similar in all divisions; it did not differ between months either. In general, caches from Div. 3LMN contained fish at age from 1 to 21 years with males and females at age 6 prevailing. Size and age of fish increased with depth of fishing from 800 to 1 300 m, relative number of females declined. A general regularity is that females of grenadier have a longer life cycle therefore the catches virtually did not contain males larger than 54-56 cm and older than 9-10 years.

Introduction

In a directed fishery for Greenland halibut in the Flemish Pass by-catch contains three most numerous species of grenadier, which live in this area: roundnose (*Coryphaenoides rupestris*), common rat-tail (*Nezumia bairdi*) and roughhead grenadier (*Macrourus berglax*).

The by-catch is known to be dominated by roughhead grenadier. There is no directed fishery for this species, however it is taken as by-catch in the Greenland halibut fishery, which can be quite big. In 1992 it was 6.7 thou. t, from 1993 to 1997 – about 4 thou. t and in 1998-1999 provisional catch was 6.7 thou. t. There are no statistical data available on by-catch of other species of grenadier in the Greenland halibut fishery.

Variations in the total catch of grenadiers are not directly related to the dynamics of their abundance and biomass in the Flemish Pass, since the catch is dependent on the intensity of Greenland halibut fishery. Assessment of abundance and biomass of grenadiers by trawl surveys and investigation of their biology are hampered by the large depth where they live. It is known that roundnose grenadier dwells in depth to 2500 m (Atkinson *et al*., 1981) and even to 3000 m (Sahrhage, 1986). Roughhead grenadier can be found between 100 m and up to 2740 m (Wheeler, 1969). Common rat-tail was fished in the depth range from 16 to 2285 m (Scott W.B. and M.G.Scott, 1988). Commercial and research fishing gears can fish only upper part of the grenadier distribution range by depth, therefore trawl surveys are not much effective.

The purpose of this paper is to review the by-catch of the above species of grenadier taken at various depths and to assess its commercial value.

Material and Methods

Materials collected by NAFO obSerialvers on Russian fishing vessels in Div. 3LMN in January-May and July 2000 are used. By-catch of most plentiful species of grenadiers: roughhead (*Macrourus berglax*), roundnose (*Coryphaenoides rupestris*) and common rat-tail (*Nezumia bairdi*) were averaged by 100 m depth intervals. The number of catches is given in Fig.1. In these divisions an age sample of roughhead grenadier was taken and the age of fish was read (330 males and 568 females) to establish size-age keys and to further determine the size-age composition of catch by division and 100 m depth interval. Data from age reading were applied to length frequency distribution (3 887 males and 4 118 females).

The age was read from scales by using polarized transmitted light. In the analysis of sex ratio of fish in catch from various depth length and age distributions of roughhead grenadier in Divs 3K, OB, and 2GH for 1969-1989 and age sample (459 males and 745 females) taken in these divisions in October-December 1985 (Savvatimsaky, 1994) were also used.

A table and figures show the number of fish in samples by division, month and depth.

Some curves given in the figures are smoothed, which is specified in figure legends.

Frequencies were smoothed by applying the formula $B = \frac{a + 2b + c}{4}$

where a, b, c – preceding, average and subsequent members, B – computed value.

Total (zoological) length of fish was measured from tip of snout to tip of tail to the nearest 1 cm. For convenience of statistical processing measurements were classified into 3 cm groups (e.g.18-20, 21-23 etc.).

Results and Discussion

Grenadiers are major by-catch in the Greenland halibut fishery. In examined catches from above 500 m Greenland halibut accounted for less than 10% of the total catch. With the depth increasing from 500 to 800 m the relative amount of halibut in catch increased rapidly to 80% and in depth 1 200-1 300 m Greenland halibut accounted for 90% of the catch (Fig.1).

Similar distribution of Greenland halibut catch by depth was noted for northern part of Flemish Pass during Russian trawl survey in February 1996. Greenland halibut dominated the catch from 700 to 1 400 m (no hauls were done deeper). Maximum proportion of this species in catch was noted for depth 800-1 200 m, deeper it declined to 60-62% (Gorchinsky, Savvatimsky, 1996).

We did not find any differences between divisions with respect to distribution of catch by depth in 2000, therefore, it was considered possible to pool all the data from Div. 3LMN together.

By-catch of grenadier

The proportion of roughhead grenadier in catch amongst other grenadier species under review was small, amounting on the average up to 5% at about 1 000 m. Such a low estimate of the proportion of this species in catch was likely due to under-reporting of by-catch by fishing vessels. Results provided by research vessels in deep-water bottom trawl surveys were much more accurate. For example, in trawl survey in the northern part of Flemish Pass (depth: 732-1 463 m) the proportion of roughhead grenadier was on the average 9-13% in depth 800-1 200 m and 24-25% in depth 1 200-1 400 m. (Gorchinsky, Savvatimsky, 1996). According to the data from Spanish surveys (Paz and

Casas, 1995) the biomass of roughhead grenadier in catch from hauls done deeper than 600 m accounted for about 16%.

It should also be noted that in 2000 the proportion of roughhead grenadier in commercial catch from about 1 000 m depth was sometimes as much as 50-90%. For example, by-catch of roughhead grenadier from a haul done in 1 040 m depth at positions 48°18' N, 46°35' W was 1 750 kg in the total catch of 2 912 kg, in 980 m depth at positions 46°34'N, 46°28"W – 2 898 kg in the total catch of 2 960 kg, in 1 050 m depth at positions 48°09'N, 47°00'W – 3 490 kg in the total catch of 5500 kg.

Catches of roughhead grenadier were distributed along the eastern slope of Div. 3L, eastern and southern slopes of Div. 3N. Largest catches were taken in the northern part of Flemish Pass and one catch in its southern part (Fig. 2). Catches were small on slopes of Flemish Cap. In bottom trawl surveys in 1971-1983 catches taken in Div. 3N were larger than in Div. 3M and 3L (Savvatimsky, 1988; 1989).

Large long-line catches by research vessel "Langust" from depth 310-1 000 m in May-July 1982 were also indicative of a considerable abundance of roughhead grenadier in the Newfoundland area. Roughhead grenadier catch was on the average 66% in number and 49% by weight of the total catch. The largest catches were taken in the southern part of Div. 3L and in Div. 3N (Savvatimsky, 1984).

Deep-water long-line survey conducted by European Union (Spain and Portugal) in Div. 3LMN in 1995, which covered the depth of 562-3 028 m, showed that roughhead grenadier was most plentiful species in catch and accounted for about 32% of the total catch. Catches were taken from above 2 039 m, the largest – in depth 1 000-1 600 m. The size of fish increased with depth (De Cardenas *et al*., 1996).

Evidence given suggests that roughhead grenadier form powerful concentrations at some localities over the continental shelf of Newfoundland, which can be fished commercially.

There are a lot of references in scientific literature to the potentials of the fishery for roughhead grenadier. As far back as 1962 it was noted that bottom catch of this species near Newfoundland was often 2 t and more (Yanulov, 1962). Largest catches in trawl surveys (up to 540 kg per 30 min. haul) were taken deeper than 500 m along the eastern and northern slopes of the Grand Bank in Div. 3L and 3N from July to September (Parsons, 1975; 1976). K. A. Houston (1983) also reported high abundance of roughhead grenadier near Newfoundland as well as of another grenadier species – common rat-tail.

By-catch of roundnose grenadier and common rat-tail in commercial fishery in 2000 was very small. By-catch of roundnose grenadier was less than 0.1% above 700 m and increased to 0.4% with depth of hauls increasing to 1300 m (Fig. 1). In trawl survey in the northern part of Flemish Pass in February 1996 by-catch of roundnose greanadier was also very small – about 0.1%. The largest by-catch was fished only in the depth interval 1 300-1 400 m – 5.0% (Gorchinsky, Savvatimsky, 1996).

Results were absolutely different in the Canadian deep-water survey in Div. 3L, and 3M in 1991 when the amount of this species in catch from depth 951-1 300 m was considerable (Brodie *et al*., 1992). According to other data, the biomass of roundnose grenadier during survey (523, depth 701-800 m) was as much as 50% of the total catch in individual strata (Yokawa, Koga, 1995).

These contradictory data suggest that the distribution of grenadiers by depth and area near Newfoundland are not well studied.

In 2000 common rat-tail was found in commercial catch everywhere over the Newfoundland area, its by-catch was small – less than 0.2% above 600 m and about 0.8% in depth 900-1 400 m. In 1969-1983 the catch of this species according to data from research vessels was the largest (up to 60 fish per hour haul) in depth 500-800 m primarily on the north-western slope of Flemish Cap and southern slope of the Grand Bank (Savvatimsky, 1989). A trawl survey in the northern part of Flemish Pass in February 1996 showed that this species of grenadier made up a small by-catch (from 1.6 to 8%) in depth 700-1 000 m. The by-catch declined with depth.

In the three instances referred to above there was not even a single large catch of this species reported, and it could hardly be of interest from the commercial point of view.

Size composition of roughehead grenadier was similar in all divisions, except Div. 3N, where it was much smaller (mean length – 43.7 cm), which was presumably due to a small amount of fish examined – only 278 individuals (Table 1, Fig.3).

Table 1. Mean length of roughhead grenadier from bottom trawl catch in Div.3 LMN in 2000

Division	Males		Females		Males and females		Number of females, %
	L, cm	N	L, cm	N	L, cm	N	
3 L	40.9	3633	46.9	3687	43.9	7320	50.4
3 M	41.6	171	45.2	252	43.7	423	59.6
3 N	39.2	87	43.5	191	42.2	278	68.7
3 LMN	40.9	3891	46.6	4130	43.8	8021	51.5

It should be noted that roughhead grenadier from research catch in 1967-1983 was much larger in Div. 3N than in Div. 3 KLMO (Savvatimsky, 1988; 1989). The analysis of size composition of grenadier by month, from January to May, in Div.3L, where the largest amount of materials was collected, showed no difference (Fig. 4). No significant difference was also found in age composition of roughhead grenadier from different divisions. On the whole the catch in Div.3 LMN contained fish at age from 1 to 21 years, with males and females at age 6 prevailing (Fig. 3). Age composition and growth rate of roughhead grenadier in Div. 3 KLMNO in 2000 and 1996, (Gorchinsky, Savvatimsky, 1996), and in Div. OB, 2 GHI and 3K in 1985 (Savvatimsky, 1994) were similar.

References can often be found in scientific literature concerning the change of mean length of grenadier with depth – its increase or decrease in various areas. The analysis of abundant evidence for 1969-1989 showed that in SA 0, 2, 3 mean length of males and females of roughhead grenadier in catch from depth 100 m to 401-500 m decreased from 57-67 cm to 45-52 cm. The mean length of males and females did not change above 800-900 m, but deeper, down to 1400-1500 m; it increased (Savvatimsky, 1992). Relative number of females in catch decreased from depth 1 100-1 200 m. In commercial catch from Div. 3 LMN in 2000 the mean length of males and females increased, and a relative number of females of roughhead grenadier decreased between 800 m and 1 400 m (Fig. 5,6).

Similar changes of the mean length with depth are also typical of roundnose grenadier in SA 0, 2 and Div. 3 K (Savvatimsky, 1992a). The mean length of males and females decreased from depth 300-400 m and down to 600-700 m, it then gradually increased up to the depth of 1 300-1 400 m. Such a change of fish length with depth is possibly a feature typical of these two species of grenadier.

A general regularity is that females have a longer life cycle than males. Therefore, no males of roughhead grenadier larger than 54-56 cm and older than 9-10 years were found in catch. Sex ratio for this species is close to 50% before the fish reach the limits indicated above. At age 12 and older (length more than 50 cm) only females are found in catch while males occur rarely. This regularity was established on the basis of abundant evidence collected by research vessels in SA OB, Div. 2GH, 3K in 1969-1989 and confirmed by data collected in Div. 3LMN in 2000 (Fig.7, 8). It should be noted that a relative number of females of the same length and age was similar in SA OB, Div. 2GH, 3K and Div. 3LMN. Taking into account that the size-age composition of this species in these divisions was also similar, it could be hypothesised that roughhead grenadier in these divisions form a single stock. However, having regard to a huge extent of the area between the Baffin Land and Flemish Cap with differing climatic conditions the question of population structure of roughhead grenadier remains open and needs to be studied specifically.

References

ATKINSON, D. B., W. R. BOWERING, SV. A. HORSTED, J. P. MINET, and D. G. PARSONS, 1981. A review of the biology and fisheries of Roundnose grenadier (Macrourus rupestris), Greenland halibut (Reinhardtius hippoglossoides) and Shrimp (Pandalus borealis) in Davis Strait (NAFO Subareas 0 and 1). *NAFO SCR Doc*. 81/22, Serial No. 290, 58 pp.

BRODIE, W. B., J. W. BAIRD, and D. POWER, 1992. Analysis of data from deepwater surveys in Div. 0B, 2GHI and 3KLM in 1991. *NAFO SCR Doc*. 92/82, Serial. No. N2137, 8 pp.

DE CARDENAS, E., J. M. CASAS, R. ALPOIM, and H. MURUA., 1996. Preliminary resulys of the European long-line survey in the NAFO Regulatory area. *NAFO SCR Doc*. 96/34, Serial. No. 2709, 6 pp.

GORCHINSKY, K. V. and P. I. SAVVATIMSKY. 1996. Composition of catches in the northern Flemish Pass from data of Russian trawl survey in February, 1996 and some information on the biology of roughhead grenadier. *NAFO SCR Doc*. 96/39 Serial. No. N 2714, 6 pp.

HOUSTON, K. A., 1983. Food sources for deep-sea fishes of the Newfoundland continental slope. *NAFO SCR. Doc*. No. 89, Serial. No. 755, 19 pp.

LEIM A. H., and SCOTT W. B., 1966. Fishes of the Atlantic coast of Canada. *Bull. Fish. Res. Bd. Canada,* No. 155, Ottawa, 485 pp.

PARSONS, L. S., 1975. Distribution and relative abundance of roundnose, roughhead and common grenadiers in the Northwest Atlantic. *ICNAF Res. Doc*. No. 26, 19 pp.

PARSONS, L. S., 1976. Distribution and relative abundance of roundnose, roughhead and common grenadiers in the Northwest Atlantic. *ICNAF Sel. Pap*. 1, p. 73-88.

PAZ, J., and J. M. CASAS., 1995. Zonation and association of dominant fish fauna in Flemish Cap. *NAFO SCR Doc*. 95/45, Serial. No. 2556, 12 pp.

PINHORN A. T. 1976. Living Marine Resources of Newfoundland – Labrador: Status and Potential. *Bull. Fish. Res. Bd. Canada*. No. 194. Ottawa. 65 pp.

SAHRHAGE, D., 1986. Wirtchaftlich wichtige Grenadierfishe des Nordatlantiks. *Mitteilungen Inst. Seefischerei,* No. 37, 81 S.

SAVVATIMSKY, P. I., 1983. Distribution, biological characteristics and percentage of Roughhead grenadier in the catches from the Grand Newfoundland area in May-July 1982. *NAFO SCR Doc*. 45/83, Serial. No. 702, 21 pp.

SAVVATIMSKY, P. I. 1984. Biological aspects of Roughhead grenadier (*Macrourus berglax*) from long-line catches in the eastern Grand Bank area, 1982. *NAFO Sci. Coun. Studies*, 7, p. 45-51.

SAVVATIMSKY, P. I., 1988. Investigations of Roughhead grenadier (*Macrourus berglax* L) in the Northwest Atlantic in 1967-83. *NAFO SCR Doc*. 88/17, Serial. No. 1453, 41 pp.

SAVVATIMSKY, P. I., 1989. Investigations of Roughhead grenadier (*Macrourus berglax* L) in the Northwest Atlantic in 1967-83. *NAFO Sci. Coun. Stud*., 13, p. 59-75.

SAVVATIMSKY, P. I., 1989a. Distribution and biology of Common grenadier (*Nezumia bairdi*) from trawl surveys in the Northwest Atlantic, 1969-83. NAFO Sci. Coun. Studies, 13, p. 53-58.

SAVVATIMSKY, P. I., 1992. Roughhead grenadier (*Macrourus berglax* L) – potential object for trawl and long-line fisheries in the North Atlantic. Research on biological resources in the North Atlantic. *Selected papers, PINRO* – Murmansk, p. 45-67.

SAVVATIMSKY, P. I., 1992a. Distribution and biological characteristics of Rock grenadier (*Coryphaenoides rupestris*) as shown by trawl surveys in Northwest Atlantic in 1989-1991. *NAFO SCR Doc*. 92/9 Serial. No. 2051, 12 pp.

SAVVATIMSKY, P. I., 1994. Age structure of Roughhead grenadier *(Macrourus berglax*) in the Northwest Atlantic,1985. *NAFO Sci. Coun. Studies*, 20, p. 53-64.

SCOTT W. B., and M. G. SCOTT. 1988. Atlantic Fishes of Canada. *Can. Bull. Fish. Aquat. Sci*. 219, 731 pp.

WHEELER, A., 1969. Anacanthini. The fishes of the British Isles and North-West Europe. London-Melbourne-Toronto, p. 255-259.

YANULOV K. P., 1962. On the reproduction of the Roughhead grenadier (*Macrourus berglax* Lacepede*). J. Zoolog*., 41 (8), p. 1259-1262 (in Russian).

YOKAWA K., and J. KOGA., 1995. Results of deepwater survey in NAFO Regulatory area in the spring of 1995 with emphasis on Greenland halibut. *NAFO SCR Doc*. 95/48, Serial. No. 2559, 12 p.

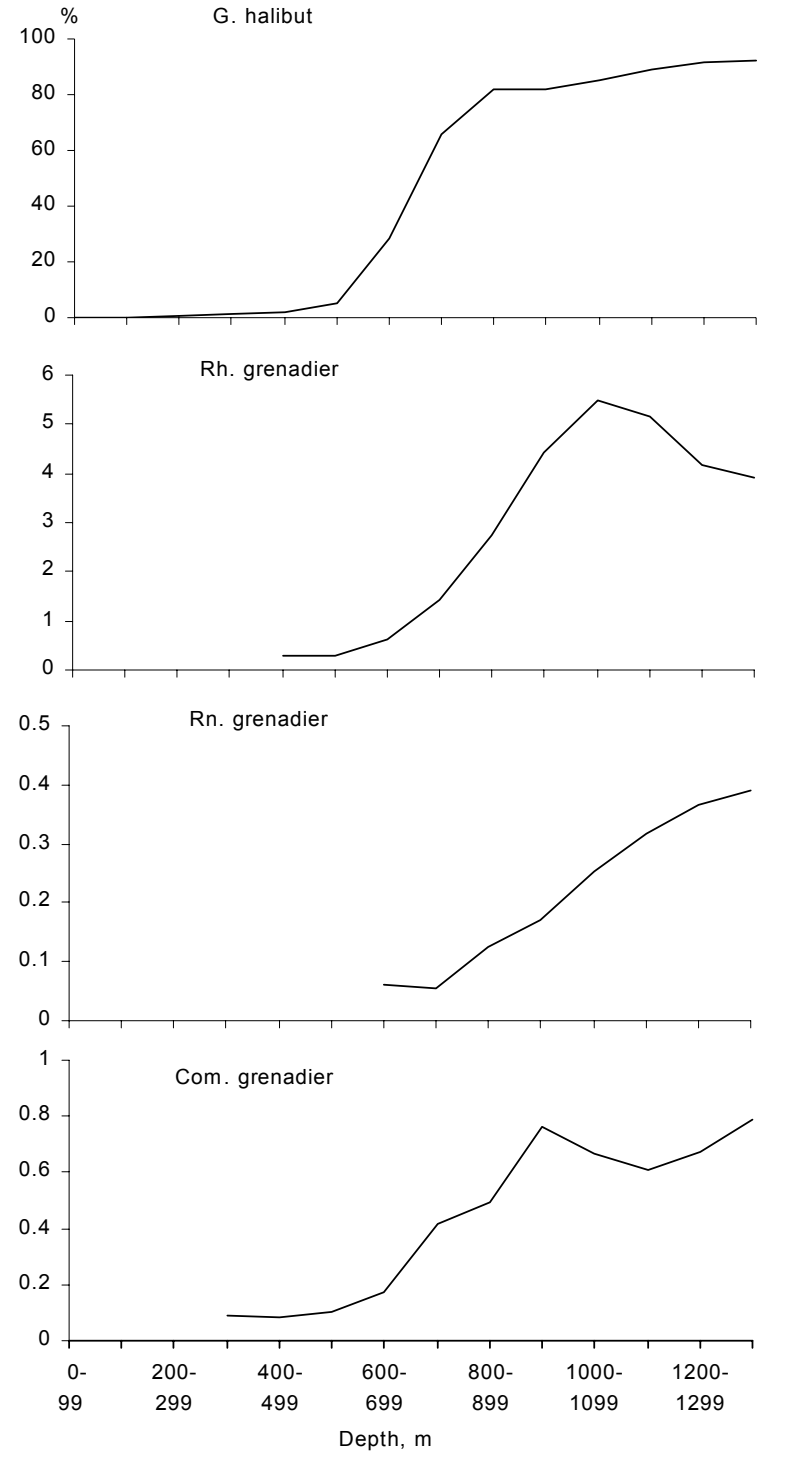

Fig. 1. Some groundfishes bycatches (%) by depths on Greenland halibut target fishery in Div. 3LMN, 2000 (smoothed curves).

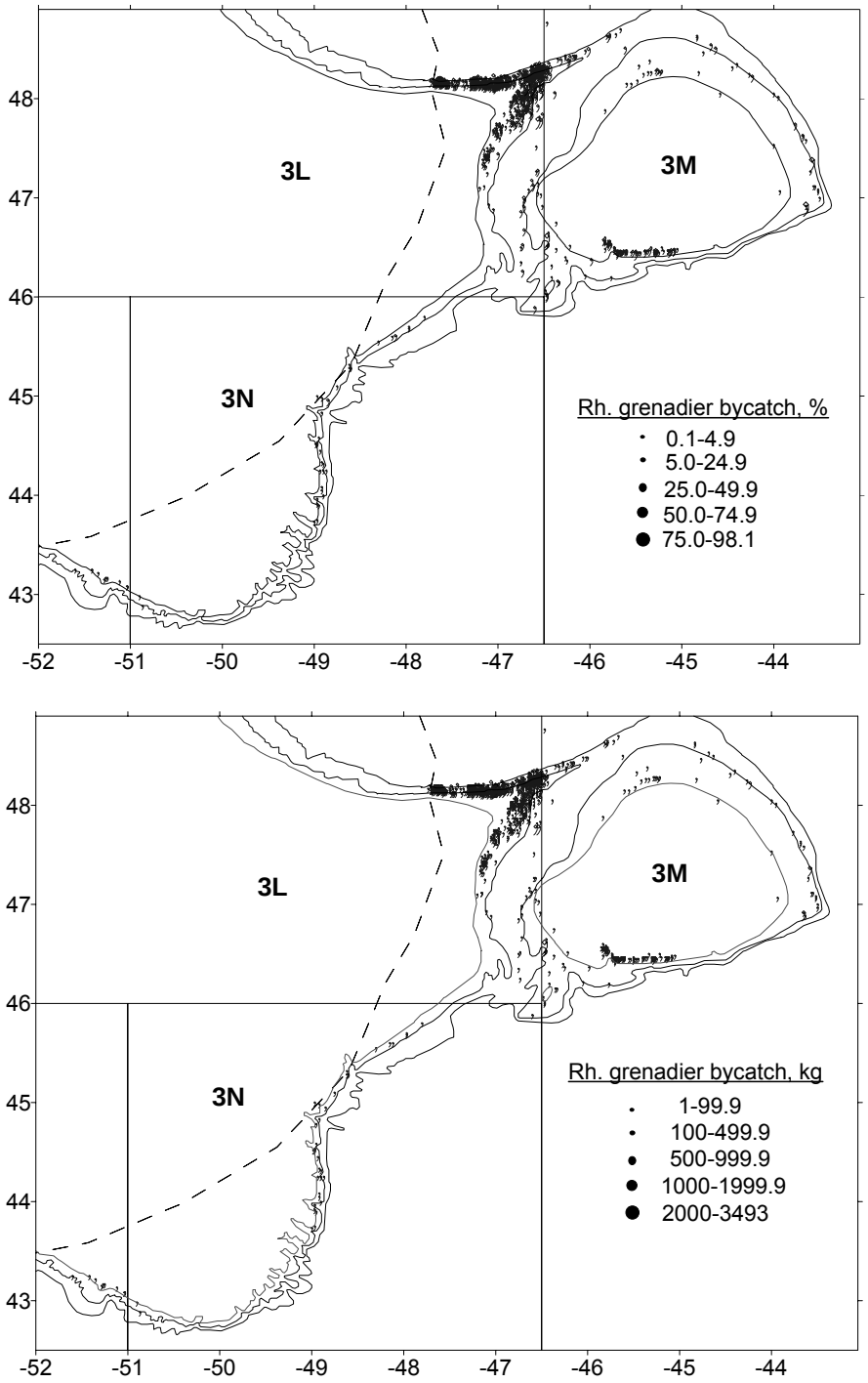

Fig. 2. Roughhead grenadier bycatch distribution in percent (above) and kg (below) in 2000.

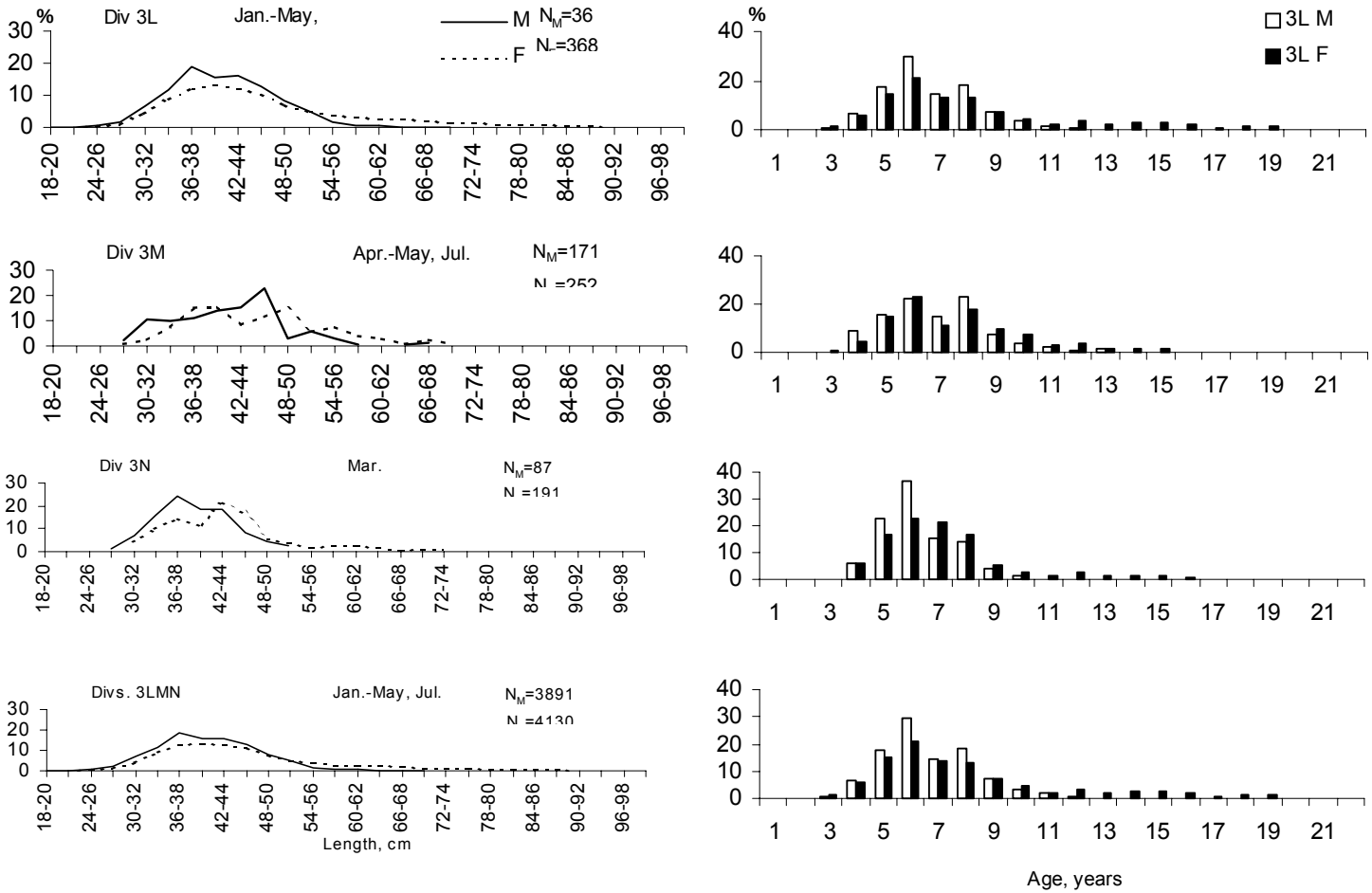

Fig. 3. Age-length composition of Roughhead grenadier in Div. 3LMN in 2000.

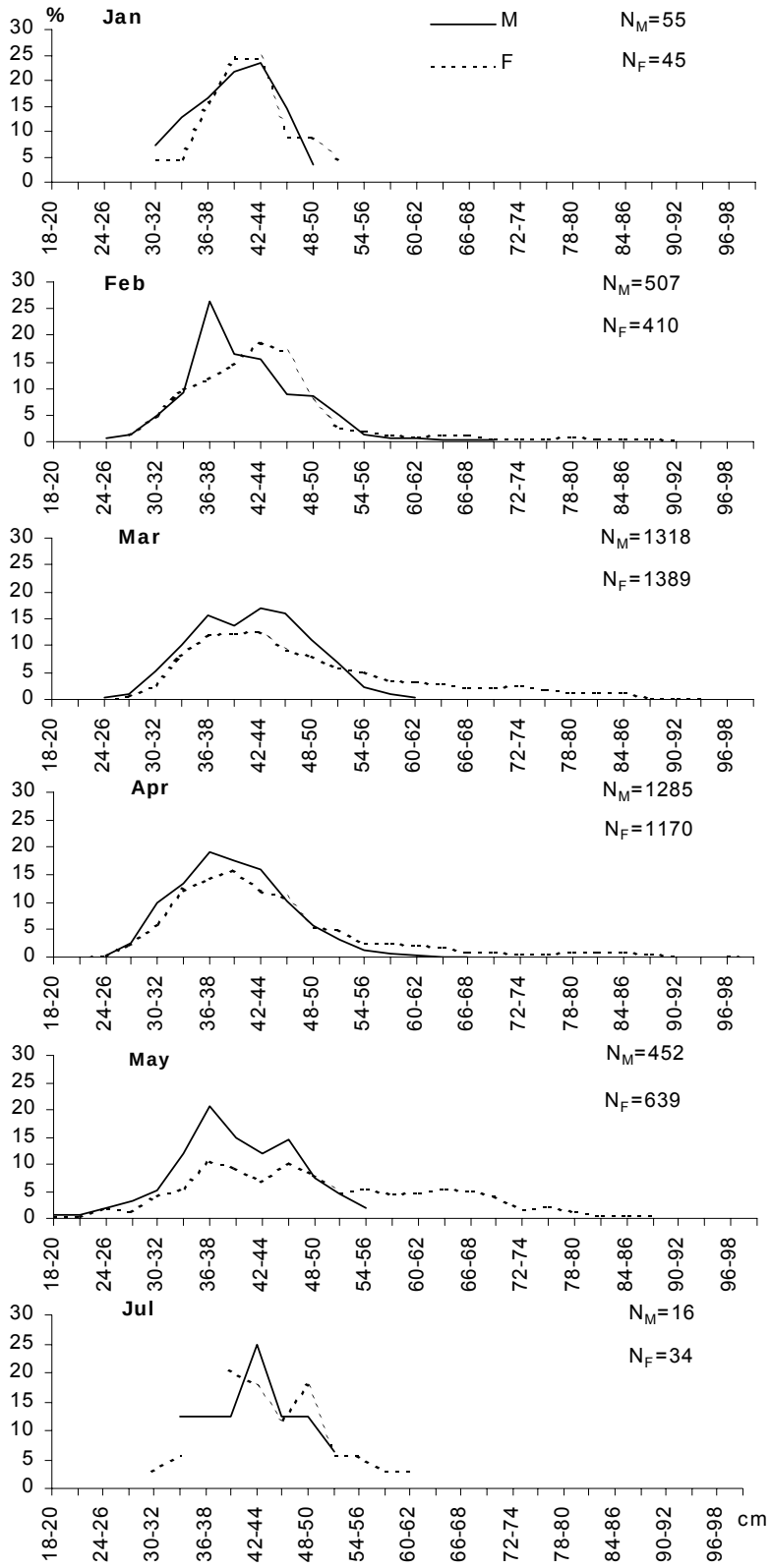

Fig. 4. Length distribution of Roughhead Grenadier in Div. 3L by months in January-July, 2000.

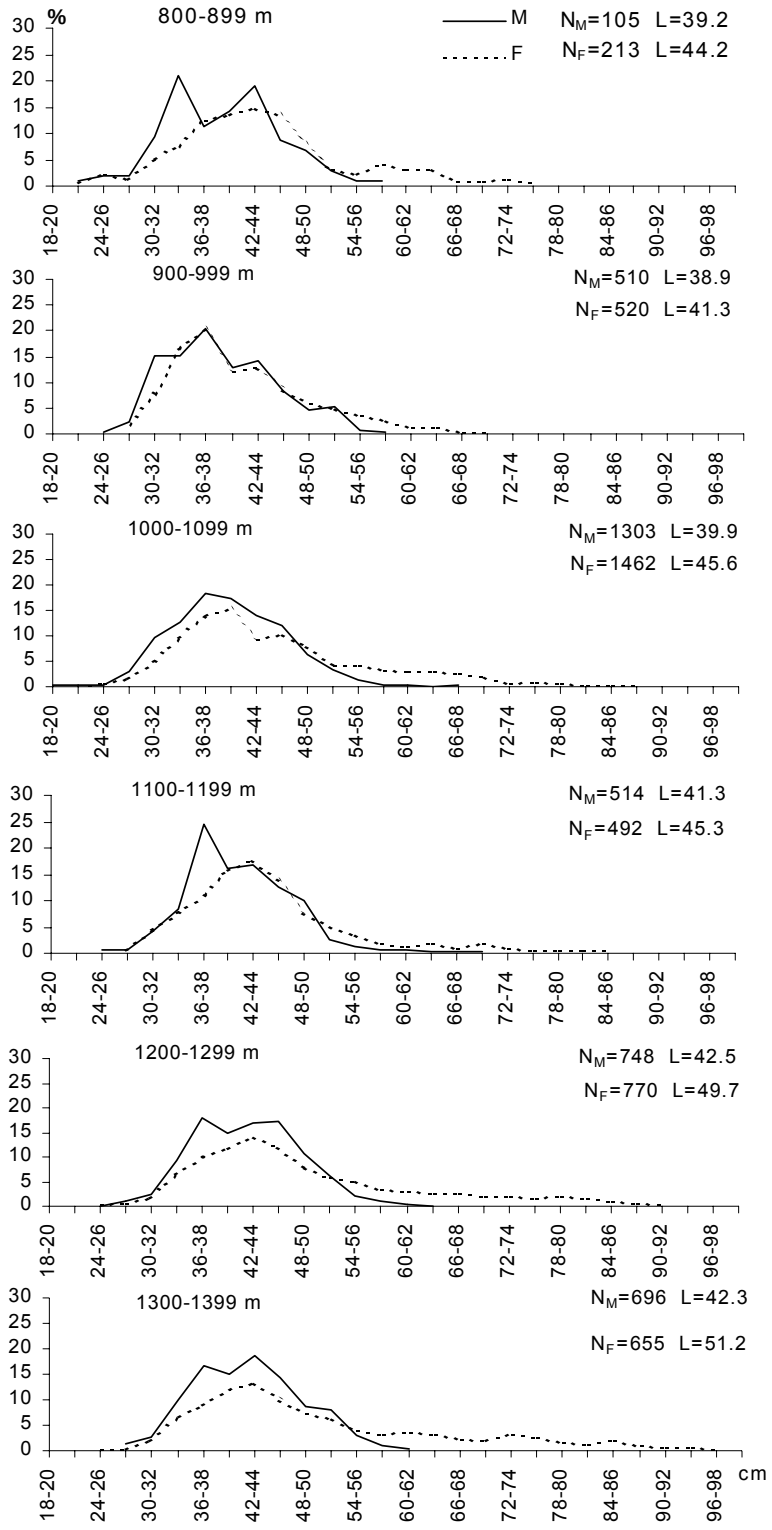

Fig. 5. Length distribution of Roughhead Grenadier in Divs. 3LMN by depth in January-July, 2000.

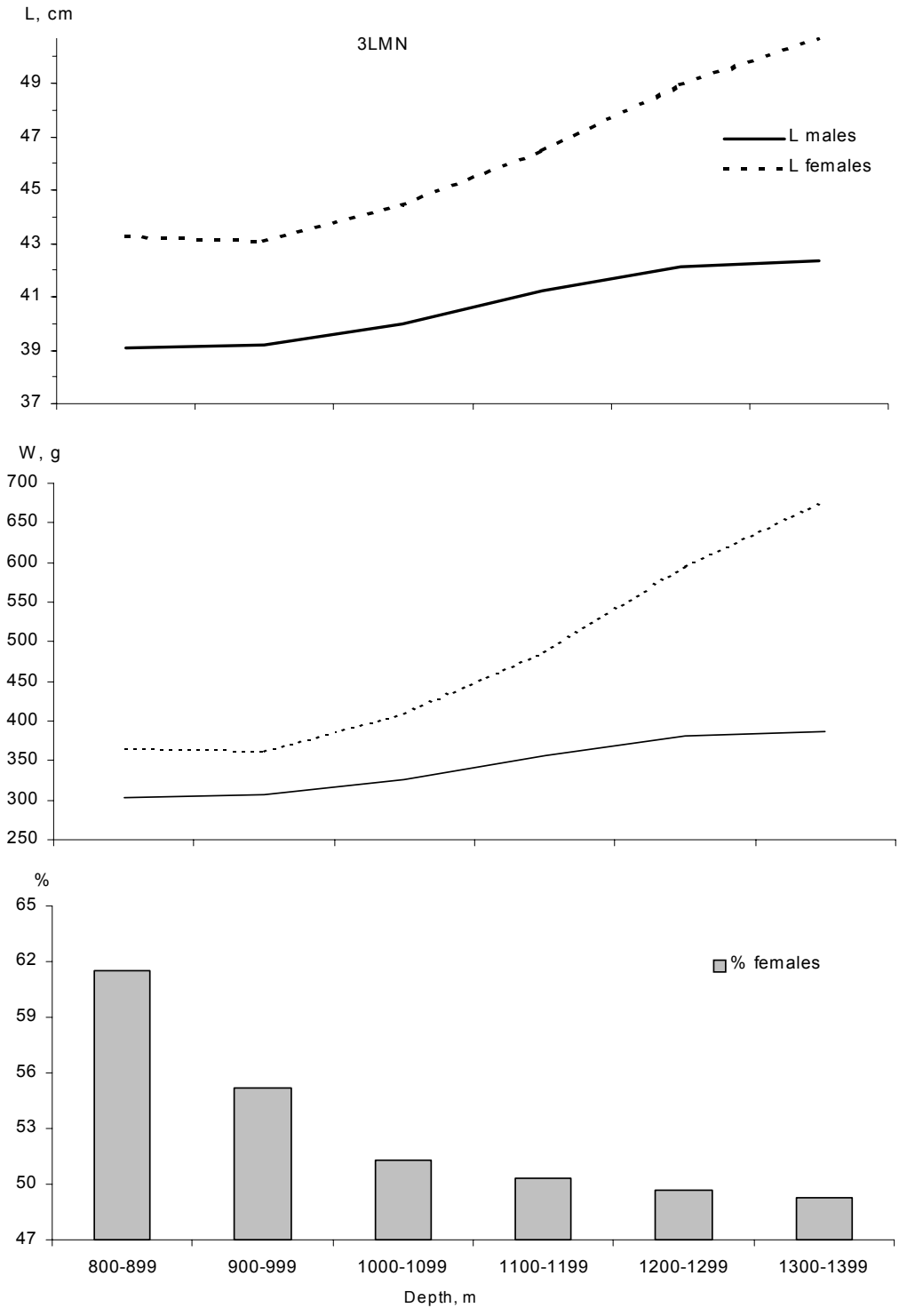

Fig. 6. Roughhead grenadier changes in males and females average length, weight and females proportion by depth in 2000.

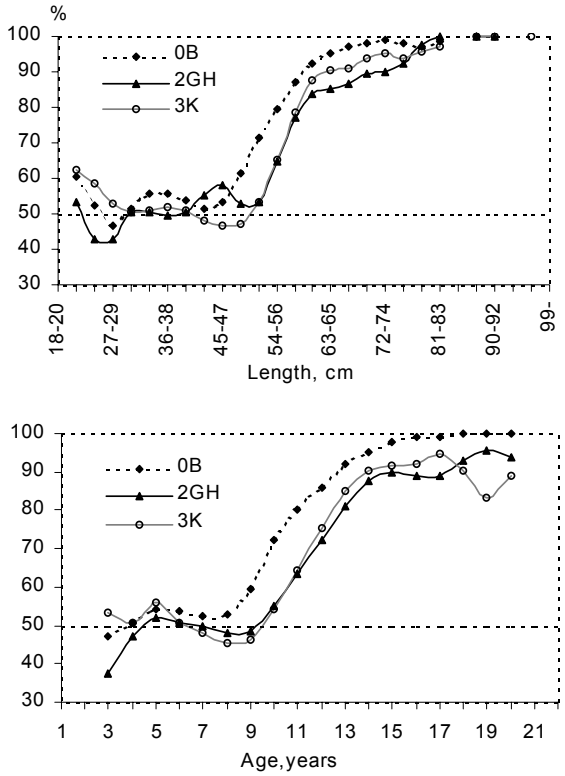

Fig. 7. Percentage of Roughhead grenadier females at length and age in bottom trawl catches in Divs. 0B,2GH, 3K, 1969-89 (smoothed curves).

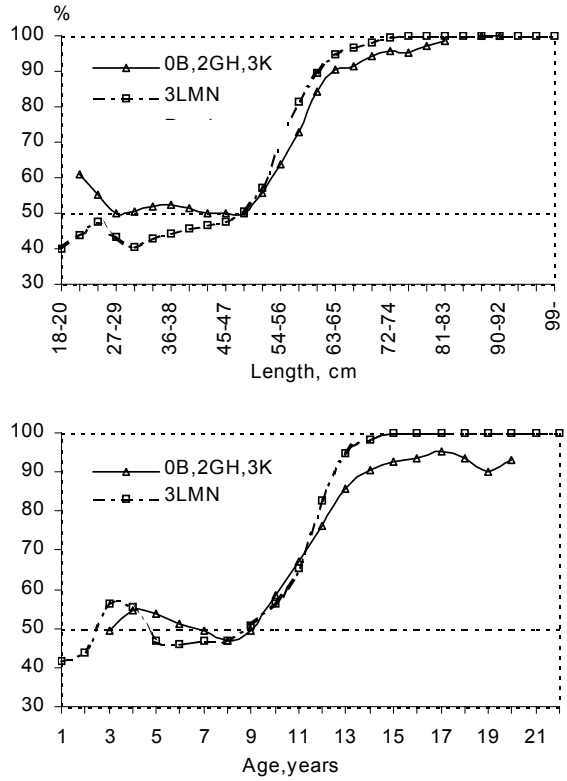

Fig. 8. Percentage of Roughhead grenadier females at length and age in bottom trawl catches in Divs. 0B,2GH, 3K (combined), 1969-89 and 3LMN, 2000 (smoothed curves).