

International Commission for



the Northwest Atlantic Fisheries

Serial No. 5055
(D.c.9)

ICNAF Res.Doc. 77/VI/30

ANNUAL MEETING - JUNE 1977

Prospects of roundnose grenadier fishery in the Northwest Atlantic

by

P.I. Savvatimsky
The Polar Research Institute of Marine Fisheries and Oceanography (PINRO)
Murmansk, USSR

Abstract

In the present paper on the basis of the analysis of the size, age and sex composition of catches in 1967 - 1976 is considered the possibility to commercially fish for the round nose grenadier in sub areas 0 and 1 and in ICNAF divisions 3K and 2G. From 1967 to 1971 in div. 3K the heavy fishery brought about the change in the size and sex composition of the catches. Catch per unit effort decreased. In subsequent years when the fishery was shorter and less intensive these indices again increased to the previous level. The size and sex composition of the catches changed somewhat in div. 2G in the year when the total removal reached the maximum - 54 000 tons. The optimum annual removal in div. 3K must be 18 - 20 000 tons. It seems that the removal of round nose grenadier off Northern Labrador, Baffin Island and West Greenland can be increased compared with the present one without any fears of the subsequent decline in grenadier abundance.

Introduction

At present in the Northern Atlantic many countries are engaged in developing the fisheries for new species (including roundnose grenadier *Macrurus rupestris* Gunn.) using the new deep water fishing techniques. This has been necessitated by the intensification of the fisheries for traditional species.

The fishery for roundnose grenadier started on the Northern Newfoundland Bank (div.3K) in 1967 when 16 000 tons of grenadier were taken (table 1).In subsequent years grenadiers were also fished off the Northern Labrador (div.2G),Baffin Island (subarea O) and West Greenland (subarea 1).At present the fishery for grenadier is conducted by 3 countries: USSR,Polish People's Republic and German Democratic Republic.The total annual removal in the ICNAF area amounts to tens of thousands of tons (table 1).

The roundnose grenadier occur in the eastern and western North Atlantic along the continental slope as well as on separate banks away from it.They are distributed from the Greenland - Canadian Ridge to Cape Hatteras,in the waters washing Greenland and Iceland,along the Scandinavian coast southwards up to Scagerrak.The roundnose grenadiers inhabit depths from 180 to 2 000 m and deeper (Leim and Scott,1966) and are a benthicpelagic fish (Marshall,1965)*.They are caught in quantity at depths 600 - 1 300 m.

Sometimes the grenadier concentrations in midwater may have a vertical extension of 300 - 500 m.Such concentrations take up a large area.For example,in August 1967 a large refrigerator trawler " VSPOLOKH " while scouting for fish off Baffin Island found dense grenadier concentrations over the area of 350 square miles(Savvatimsky,1969).Taking account of this as well as of the extensive vertical and horizontal distribution of grenadier by depths we may assume that this species is abundant in the Northern Atlantic.In connection with this assumption the question arises as to how great the removal of this valuable fish can be?.

It is known that an intensive fishery to a larger extent affects those populations which consist of a large number of age groups.Dementieva,(1953,1976) and Nikolsky (1965,1974)

*It would be more correct to call the roundnose grenadier a bathypelagic fish as do Konstantinov,K.G and Podrazhanskaya,S.G. (Konstantinov,Podrazhanskaya,1972,Konstantinov,1976) for this species is but slightly connected with the bottom,builds up its concentrations in midwater although near the bottom and feeds mainly on plankton crustaceans and shrimps.

hold that the species with a long life cycle and a late maturation are most sensitive to the effect of the fishery whereas the species with a quick renewal of a stock are less subject to the effect of the fishery. Usually the overfishing causes to change the size - age composition of the catches, the sex composition of the catches (if selectivity in favor of males or females exists) and catch per unit effort.

The roundnose grenadier has a long life cycle, the structure of its populations is many - aged (Savvatinsky, 1969, 1971, 1972, Kosswig, 1974) and it attains maturity late (Grigoriev, 1972). Judging by age determinations the abundances of the separate year - classes do not differ markedly.

Material and methods

In the attempt to determine the optimum removal of the roundnose grenadier in the various areas of the Northwest Atlantic we have analysed the annual total removal from the ICNAF Statistical Bulletins (Statistical Bulletins, ICNAF, 1969 - 1976), the size and sex composition for the period 1966 - 1976 and the age composition of the catches in div. 3K in 1967 - 1970. All these data are season dependent and therefore only the data for July - December were considered.

Grenadiers were taken mainly by bottom and only sometimes by midwater trawls. As the size composition of the catches by bottom and midwater trawls was almost the same (table 2) the length frequency distributions of the midwater and bottom catches were combined.

The length of the fishes was measured to within 1 cm and subsequently to simplify the further calculations the lengths were combined in 3 cm groups (30 - 32, 33 - 35, 36 - 38 cm and so on). In figures (1, 3 - 5) the smoothed length distributions are given. They were smoothed according to the formula:
$$B = \frac{a + 2b + c}{4}$$
 where a, b, c - previous, middle and subsequent terms of the distribution and B is a term to be determined. In the right

side of the figures the size composition of the catches is presented as the departures from the long term mean values.

The age of the fishes was read from scales placed in the polarized passing light according to the technique described earlier (Savvatimsky, 1971).

On the prospects of grenadier fishery

Gulland estimated that approximately as much as 10 000 tons of grenadier can be taken in the Northern Atlantic (Ann.Meet. ICNAF, 1968). However, since the development of the fishery for this species (from 1967) on the Northern Newfoundland Bank alone (div.3K) the annual catch has been almost twice as much as Gulland's figure (table 1). In the subsequent years no attempts to determine the optimum removal of the roundnose grenadier were made as the available commercial and research fishing gears could not cover the entire range of grenadier vertical distribution. Grenadier migrations, spawning grounds, age composition and localities of the stocks being unknown the size of the commercial stock could not be established. And only as late as 1974 Pinhorn (1974) a Canadian ichthyologist using the method of Bertalanfy as well as that of Beverton and Holt on the basis of age determinations found that the optimum grenadier removal in subareas 2 and 3 should not exceed 30 000 tons. In 1976 Borrman (1976) on the basis of calculations relating to the age and size composition of the catches for some years showed that the present fishery does not affect adversely the grenadier stocks and that the average annual removal of 34 000 tons in subareas 2 - 3 and of 8 000 tons in subareas 0 - 1 are within the limits of the calculated possible sustainable catches.

The estimates of the grenadier removal given by Pinhorn and Borrman are not final as the techniques used presuppose the constant annual recruitment to the commercial stock and do not allow for the variations in the year - classes' abundance.

Table 1 shows that the greatest grenadier catches every year are taken by the fishing fleet in div.3K with the exception of 1971 when in div.2G 54 179 tons were taken.Lesser grenadier catches in the northern part of the ICNAF area in 1972 compared with those of 1971 are explained by the fact that the fleet was mainly engaged in the fishery for Greenland halibut whose concentrations appeared in 1972 off Baffin Island following the hydrological conditions favourable for this arctic fish.

In div.3K the grenadier annual catches are approximately equal (table 1).In 1967 - 1970 the fishery in this division was concentrated within a limited area extending for 40 - 50 miles along the continental slope.Grenadiers in this period were heavily fished, the number of large refrigerator trawlers sometimes being as great as 20.The fishery was of a short duration and the fishing fleet in this area operated only in October and November.

The fishery in 1967 - 1969 over a limited area of the slope in div.3K seems to have influenced the grenadier abundance.In the above period there decreased the catch per unit effort, changed the size,age and sex composition of the catches which was not the case in the other ICNAF divisions where a commercial removal of grenadier was small (Savvatimsky,1972).

In Fig.1 is shown the size composition of grenadier catches by years in div.3K.From the left side of the figure it can be seen that from 1967 to 1971 the dominant length of fishes in catches decreased.From the right side of the figure where are given yearly departures from the long term mean values it can be seen that during these years a relative number of large fishes in the catches also decreased.The age composition of the catches also changed.If in the catches in 1967 dominated fishes at the age of 9 - 14 years,in 1970 dominated fishes at the age of 6 - 7 years (Fig.2).

Since 1971 the fishery area in div.3K has increased.If during the first years the fishery in this division was intensive and of short duration in the subsequent years the fishery was conducted during summer and autumn months.In 1972,for example,

the fishery lasted from May to November (Stat.Bull.ICNAF,1974). In 1972 and later when the fishery was conducted over a large area, at various depths and in different seasons the size composition of the catches was restored (Fig.1).The sex composition was also restored (table 3).Apparently these changes can be attributed to the recruitment of fishes from the adjacent sectors of the continental slope.

From the above a conclusion can be drawn that an annual removal of 18 - 20 000 tons of grenadier in div.3K which is the average annual removal for 8 years will not affect adversely the grenadier stocks but,however, to exceed this figure would be to all appearances unreasonable.

In div.2G the annual commercial removal of grenadier is small with the exception of 1974 when the catch amounted to 54 000 tons (table 1).In the period from 1966 to 1970 the grenadiers in the catches were larger than in subsequent years.As it can be quite clearly seen in Fig.3 , especially in its right side, before 1970 in the catches there was an excess of large and a lack of small fishes compared with the long term mean distribution but from 1971 and on the opposite was the case - the excess of small and a lack of large fishes,Analysing the left side of Fig.3 and table 4 one can not say that the change in the size composition was very considerable, such as it was, for example,in div.3K from 1967 to 1971.The portion of females in catches by years practically did not change (table 3).However, it may be that the annual catch of 54 000 tons in div.2G caused changes in the size composition of the catches in subsequent years.

On subarea 0 (Baffin Island) we unfortunately have no data for 1975 and 1976 but we can state that from 1967 to 1974 no changes in the size and sex composition of catches took place in this area (Fig.4,tables 3,4).The grenadiers in this subarea are taken in relatively small quantities.

Nothing is either known about the effect of the fishery on

the grenadier stocks in subarea 1 (West Greenland).From 1969 to 1972 the average length of the fishes in catches somewhat increased while 1973 to 1976 the average length somewhat decreased (Fig.5,table 4).These changes,probably,were not connected with the fishery.The catches of grenadiers in these two subareas compared with the present ones can be increased.

Conclusion

The presented data show that in general the fishery in 1967 - 1976 did not affect substantially the grenadier stocks in the ICNAF area.Judging by the year to year trends in the size,sex and age composition of the grenadier catches the optimum catch in div.3K must be 18 - 20 000 tons.The removal of 54 000 tons in div.2G in 1971 probably caused changes in the size composition of the catches in subsequent years and therefore the optimum catch in this division must be less than this figure.

Taking into account that the grenadier concentrations off Labrador,Baffin Island and West Greenland distribute over a considerably larger area than on the Northern Newfoundland Bank it seems that the catches in these subareas can be increased without any fear that the fishery may reduce the grenadier abundance in subsequent years.

The grenadier fishery in the Northwest Atlantic is supported by the concentrations of the immature foraging grenadiers.While fishing with bottom trawls the by- catch of Greenland halibut may often reach as much as 30% and over.Halibut build up their concentrations in the same localities and approximately in the same range of depths as the feeding grenadiers.Index of food similarity between these fishes is very small(Konstantinov, Podrazhanskaya,1972) and they practically do not compete for food.Grenadiers,however, are one of the main food items in the halibut diet, especially off Labrador and Baffin Island. Field analyses of the halibut feeding show that sometimes the halibut stomachs are filled full with grenadiers.In

the mentioned subareas halibut occur in great abundance and are exploited by the fishery. The quantity of grenadiers eaten out by halibut is considerable and therefore the existing removal of halibut makes available some additional resources for the development of the grenadier fishery.

References

- ANON, 1968. Area reviews on living resources of the World's Ocean Northwest Atlantic (compiled by Gulland, J.A.). Annu. Meet. ICNAF, June 1968. Res. Doc. 68/75, p.1 - 22.
- BORRMANN, H., 1976. Preliminary stock assessments of roundnose grenadier in ICNAF Subareas 0 + 1 and 2 + 3. ICNAF, Res. Doc. No. 76/VI/27. Serial No. 3807, p.1 - 12.
- DEMENTIEVA, T.F., 1953. Regularities in variations of abundance of the main commercial species and methods of fishery forecasts. Trudy Vsesoyuznoi konferentsii po voprosam rybnogo khozyaistva. Izdatelstvo Akademii Nauk, Moskva, p.1 - 19
- DEMENTIEVA, T.F., 1976. Biological substantiation of fishery forecasts. Moskva, izdatelstvo " Pishchevaya promyshlennost ", p.1 - 239.
- GRIGORIEV, G.V., 1972. On reproduction of roundnose grenadier in the Northern Atlantic. Trudy PINRO, vyp. 28, Murmansk, p.107 - 115.
- KONSTANTINOV, K.G., PODRAZHANSKAYA, S.G., 1972. Feeding and food relations between grenadier (*Macrurus rupestris*) and other deep water fishes of the Northwest Atlantic. Trudy PINRO, vyp. 28, Murmansk, p.96 - 106.
- KONSTANTINOV, K.G., 1976. Morphological and functional peculiarities of Greenland halibut and grenadiers connected with swimming and feeding. Biology and fishery for the bottom fishes of the Northern Basin. Trudy PINRO, vyp. 37, Murmansk, p.26 - 34.
- KOSSWIG, K., 1974. Alter und Wachstum des Grenadierfische im Nordatlantic. Informationen für die Fischwirtschaft, No.1, p.6 - 7, Lit:p.6.

- LEIM ,A.H. and SCOTT,W.B.,1966.Fishes of the Atlantic coast of Canada.Ottawa,p.1 - 485.
- MARSHALL,N.B.,1965.Systematic and biological studies of the Macrourid fishes (Anacanthini - Teleostii).Deep - Sea Research,vol.12,No.3.
- NIKOLSKY,G.V.,1965.Theory of a fish stock dynamics as a biological basis of a rational exploitation and reproduction of fish resources.Izdatelstvo " Nauka ",Moskva,p.1 - 382.
- NIKOL'SKY,G.V.,1974.Theory of a fish stock dynamics as a biological basis of a rational exploitation and reproduction of fish resources.Moskva,izdatelstvo " Pishchevaya promyshlennost ", p.1 - 447.
- PINHORN,A.T.,1974.Preliminary estimates of sustainable yield for roundnose grenadiers (*Macrurus rupestris*)in ICNAF Subareas 2 and 3.ICNAF,Annu.Meet.vol.1,Res.Doc.74/6,p.1 - 5.
- SAVVATIMSKY,P.I.,1969.Grenadiers of the Northern Atlantic. Murmansk,p.1 - 72.
- SAVVATIMSKY,P.I.,1971.On determination of grenadiers age.(Order Macruriformes)." Voprosy ikhtiologii ",tom II,vyp.3 (68), p.495 - 501.
- SAVVATIMSKY,P.I.,1972.About the age of the roundnose grenadier of the Northwest Atlantic and possible effect of fishery on its abundance.Trudy PINRO,vyp.28,Murmansk,p.116 - 127.
- STATISTICAL BULLETIN,ICNAF,1974.Vol.22 for year 1972.Dartmouth, Canada.
- STATISTICAL BULLETIN,ICNAF,1969 - 1976.Vol.17 - 24 for years 1967 - 1974.Dartmouth,Canada.

Table 1. Total grenadier removal according to statistical bulletin of ICNAF for 1967 - 1975 (in tons)

Subareas and div.	1967	1968	1969	1970	1971	1972	1973	1974	1975
Subarea 0							1054	2661	
Subarea 1	6	284	68	5980	4132	2311	3830	9657	
Subarea 2	1085	7104	651	468	56998	3109	6744	5660	
Division 2G		2536	387		54179	2161	5880	3220	
Subarea 3	16219	24159	11682	22396	18447	21277	10820	22856	
Division 3K	16009	23553	11682	22267	18392	21122	10655	22816	
ICNAF area	17310	31547	12401	28844	79577	26697	22448	40734	

Note: before 1973 the removal in subarea 0 was not included in Statistical Bulletin

Table 2. Size composition of grenadier catches taken by bottom and midwater trawls in div.2G in 1976

Trawls	Length of fishes, cm																				Total				
	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-44	45-47	48-50	51-53	54-56	57-59	60-62	63-65	66-68	69-71	72-74	75-77	78-80		81-83	84-86	87-89	90-92
Bottom	1	1	48	120	129	128	132	259	305	659	1171	1263	1176	1315	1436	937	746	556	233	176	100	43	13	4	10951
%	0,4	1,1	1,2	1,2	1,2	1,2	2,4	2,8	6,0	10,7	11,6	10,8	12,0	13,1	8,5	6,8	5,1	2,1	1,6	0,9	0,4	0,1			100
Midwater		2	20	28	45	77	192	252	404	542	507	516	522	623	449	377	299	121	110	56	27	6	1	5176	
%		0,4	0,5	0,9	1,5	3,7	4,9	7,8	10,5	9,8	10,0	10,1	12,0	8,7	7,3	5,8	2,3	2,1	1,1	0,5	0,1			100	

Table 3. Number of females of roundnose grenadier in catches by years and areas in August - December

Year	Div 3K		Div.2G		Subarea 0		Subarea 1	
	Months	Number of females	Months	Number of females	Months	Number of females	Months	Number of females
1967	VIII-XI	$\frac{691}{36,4}$	XI	$\frac{618}{35,1}$	VIII-X	$\frac{1106}{31,0}$		
1968	X-XII	$\frac{164}{31,3}$	X-XI	$\frac{1438}{39,8}$		-		
1969	XI	$\frac{791}{30,6}$	X	$\frac{142}{40,5}$	VIII-X	$\frac{2597}{29,1}$	VIII-IX	$\frac{2107}{32,2}$
1970					VIII-IX	$\frac{2543}{30,2}$	VIII	$\frac{785}{29,6}$
1971	VIII	$\frac{349}{35,6}$	X-XII	$\frac{3293}{45,9}$	IX-X	$\frac{1001}{25,5}$	IX-X	$\frac{2140}{35,1}$
1972	X	$\frac{201}{31,8}$	VIII-X	$\frac{3449}{37,4}$	VIII-X	$\frac{2198}{32,8}$	VIII-XI	$\frac{6631}{38,9}$
1973	X-XI	$\frac{3187}{41,7}$	VIII-X	$\frac{3866}{39,3}$	VIII-X	$\frac{662}{27,0}$	VIII-XII	$\frac{6071}{38,3}$
1974	VIII	$\frac{693}{46,8}$	VIII-XII	$\frac{4956}{36,4}$	VIII-X	$\frac{2708}{28,2}$	VIII-XII	$\frac{7033}{38,8}$
1975			VI-XI	$\frac{7484}{41,6}$			VI-XII	$\frac{9441}{39,7}$
1976			VIII-X	$\frac{6389}{38,1}$			VII-XI	$\frac{9665}{32,4}$

Numerator - number of females (in specimens)

Denominator - number of females (in %)

Table 4. Average length of roundnose grenadier from various areas of the Northern Atlantic by years

Subareas, div:	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	for all years
Subarea 0	$\frac{63.45}{15486}$	$\frac{70.23}{14351}$	$\frac{61.50}{14500}$	$\frac{62.91}{16511}$	$\frac{61.98}{17664}$	$\frac{63.63}{9450}$	$\frac{62.13}{2522}$	$\frac{63.24}{9562}$				$\frac{63.78}{100046}$
Subarea 1			$\frac{56.28}{12537}$	$\frac{59.55}{3092}$	$\frac{60.51}{11412}$	$\frac{62.79}{37249}$	$\frac{60.06}{14708}$	$\frac{54.00}{23819}$	$\frac{56.76}{23754}$	$\frac{54.55}{28218}$		$\frac{57.96}{154789}$
Div. 2G	$\frac{67.62}{3286}$	$\frac{67.68}{1764}$	$\frac{67.71}{6594}$	$\frac{67.17}{2851}$	$\frac{63.27}{327}$	$\frac{63.27}{44253}$	$\frac{62.43}{9383}$	$\frac{62.37}{16253}$	$\frac{63.15}{24136}$	$\frac{62.76}{17984}$	$\frac{59.31}{16127}$	$\frac{63.03}{142958}$
Div. 3K	$\frac{62.10}{6971}$	$\frac{55.47}{22619}$	$\frac{53.22}{10132}$	$\frac{47.01}{1606}$	$\frac{48.56}{2892}$	$\frac{56.31}{1446}$	$\frac{60.12}{7881}$	$\frac{62.19}{693}$				$\frac{56.07}{54040}$

Note: numerator - average length of a fish, cm
denominator - number of measured fishes,

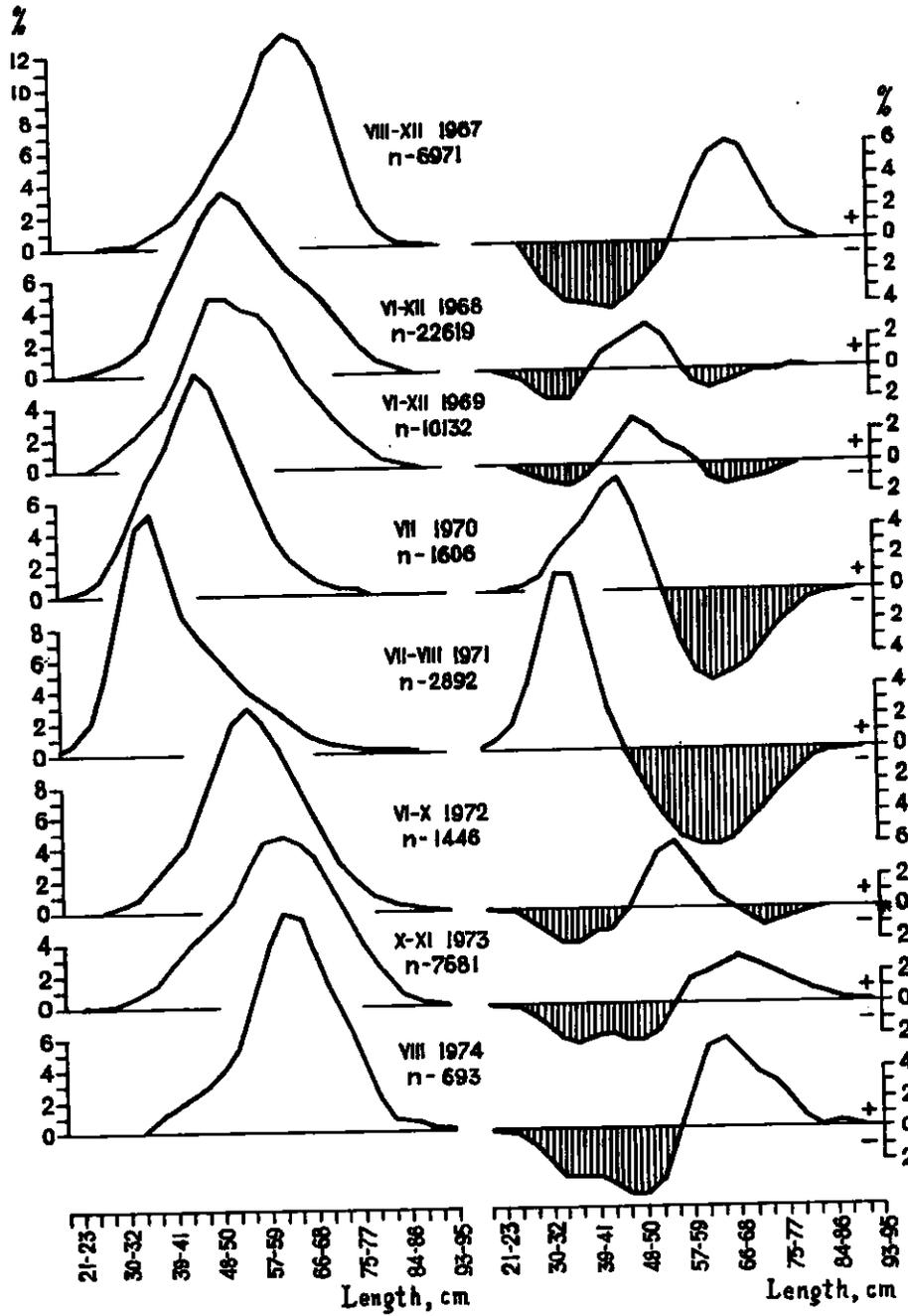


Fig. 1. Size composition of the roundnose grenadier catches by years in Div. 3K.

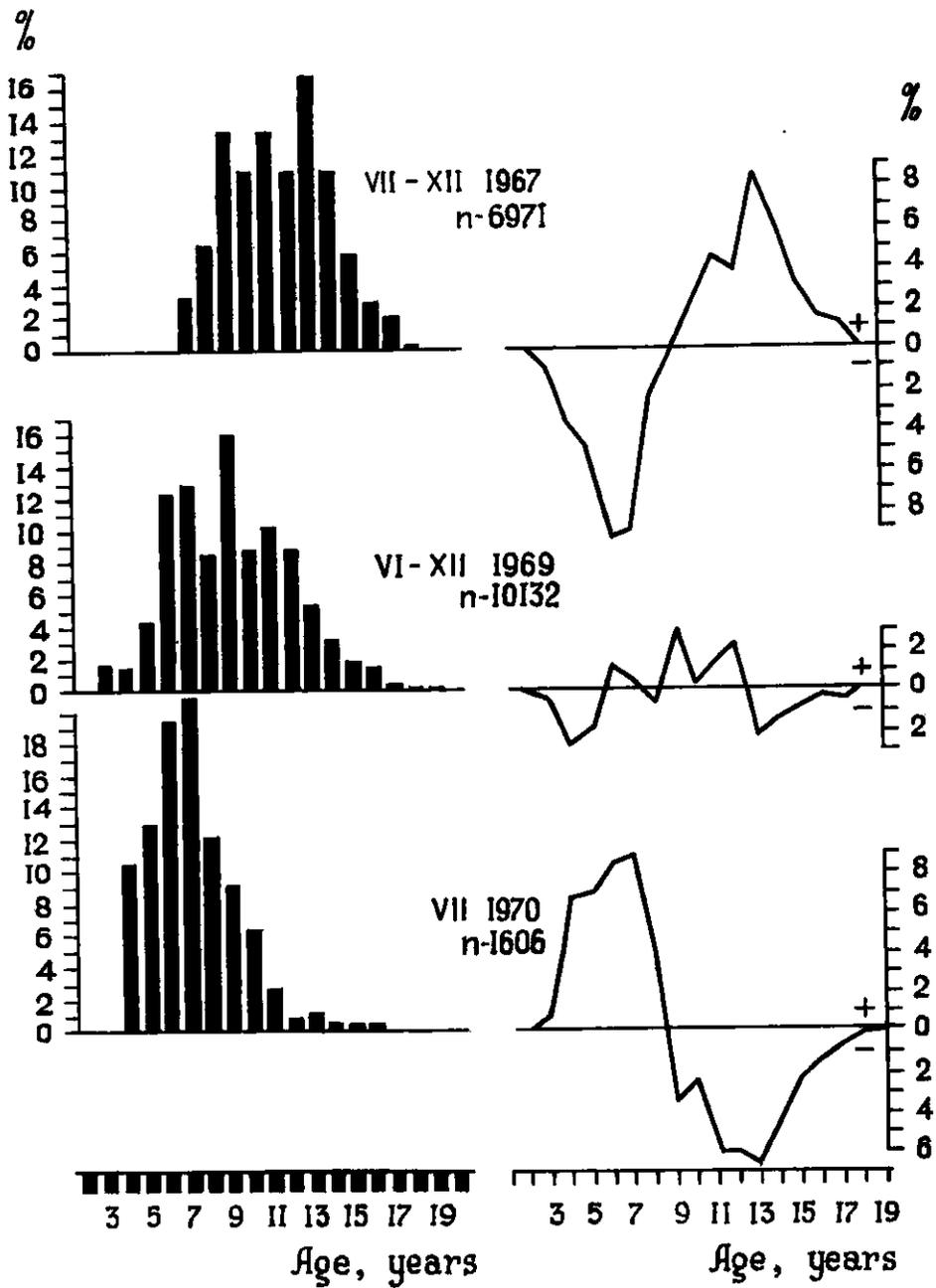


Fig. 2. Age composition of the roundnose grenadier catches by years in Div. 3K.

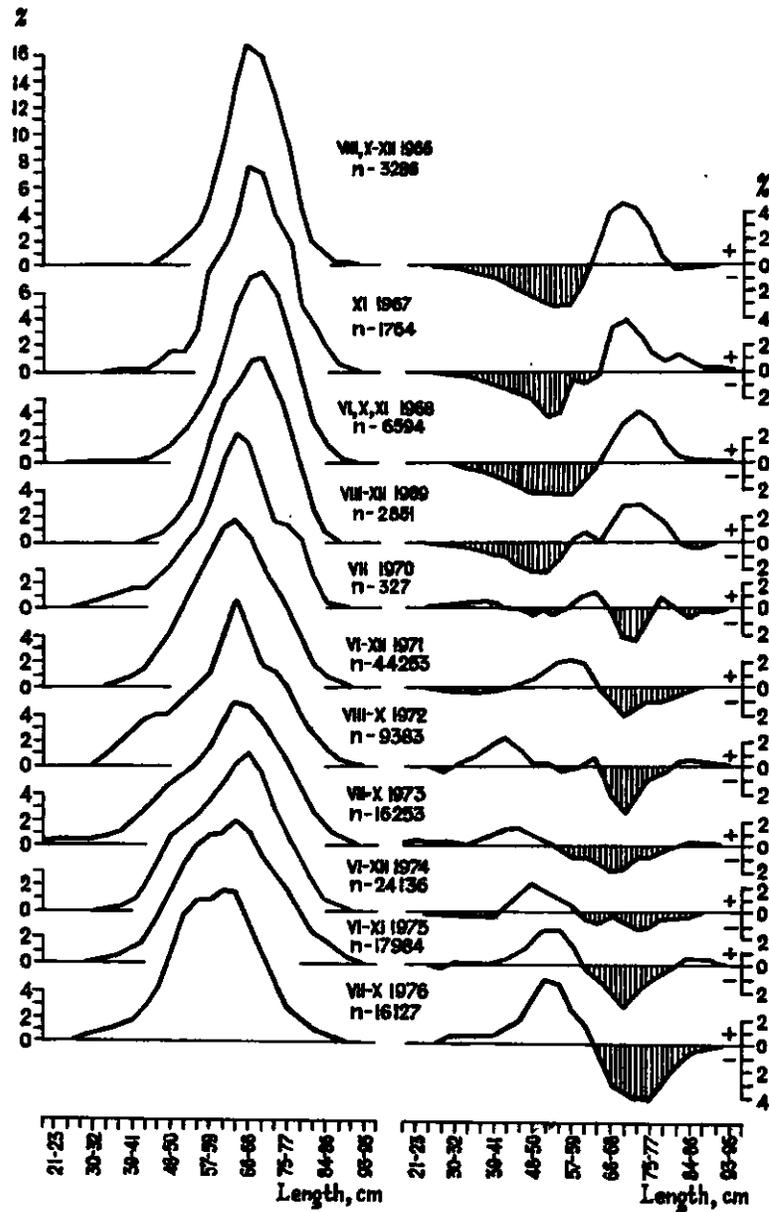


Fig. 3. Size composition of the roundnose grenadier catches by years in Div. 2G.

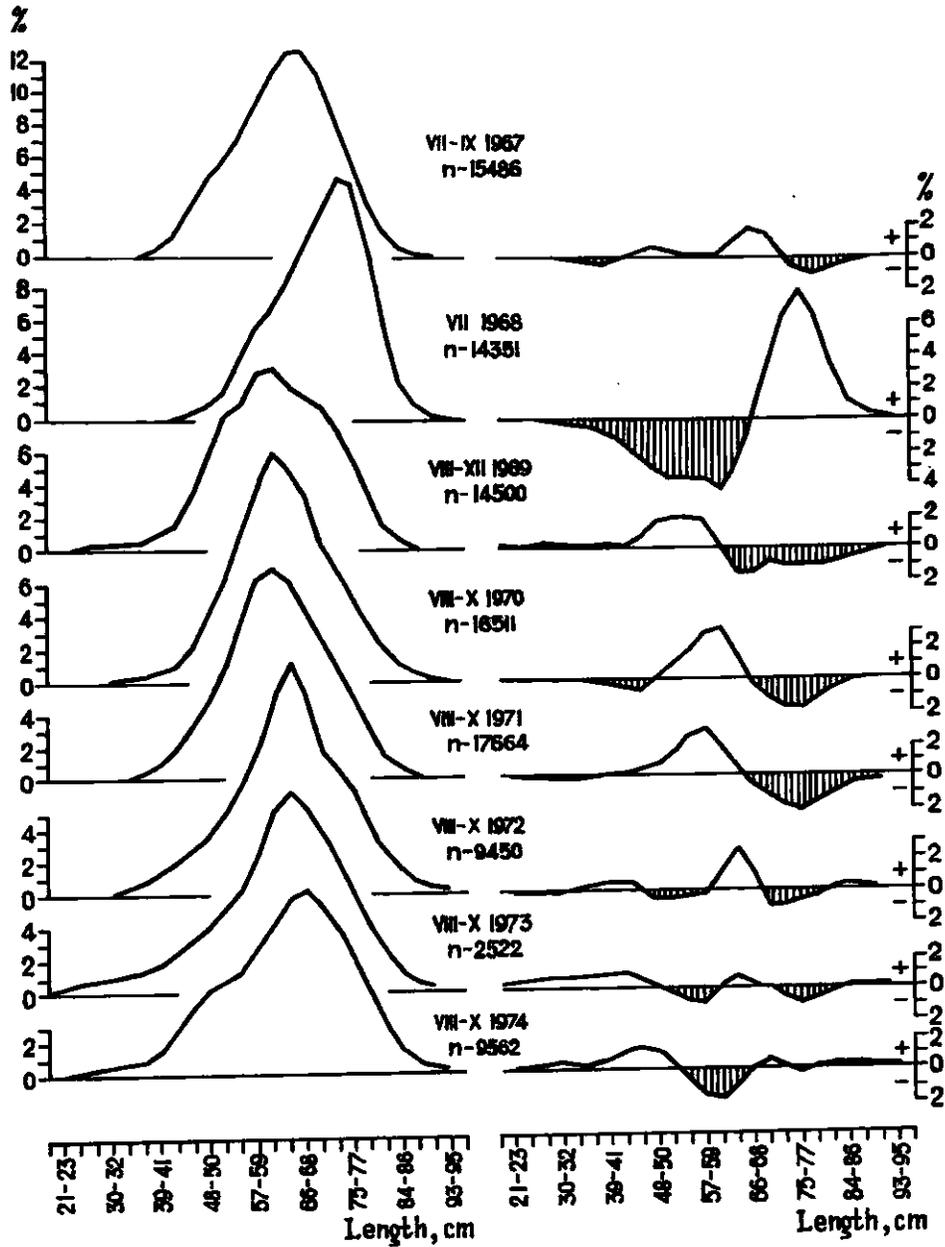


Fig. 4. Size composition of the roundnose grenadier catches by years in Statistical Area 0.

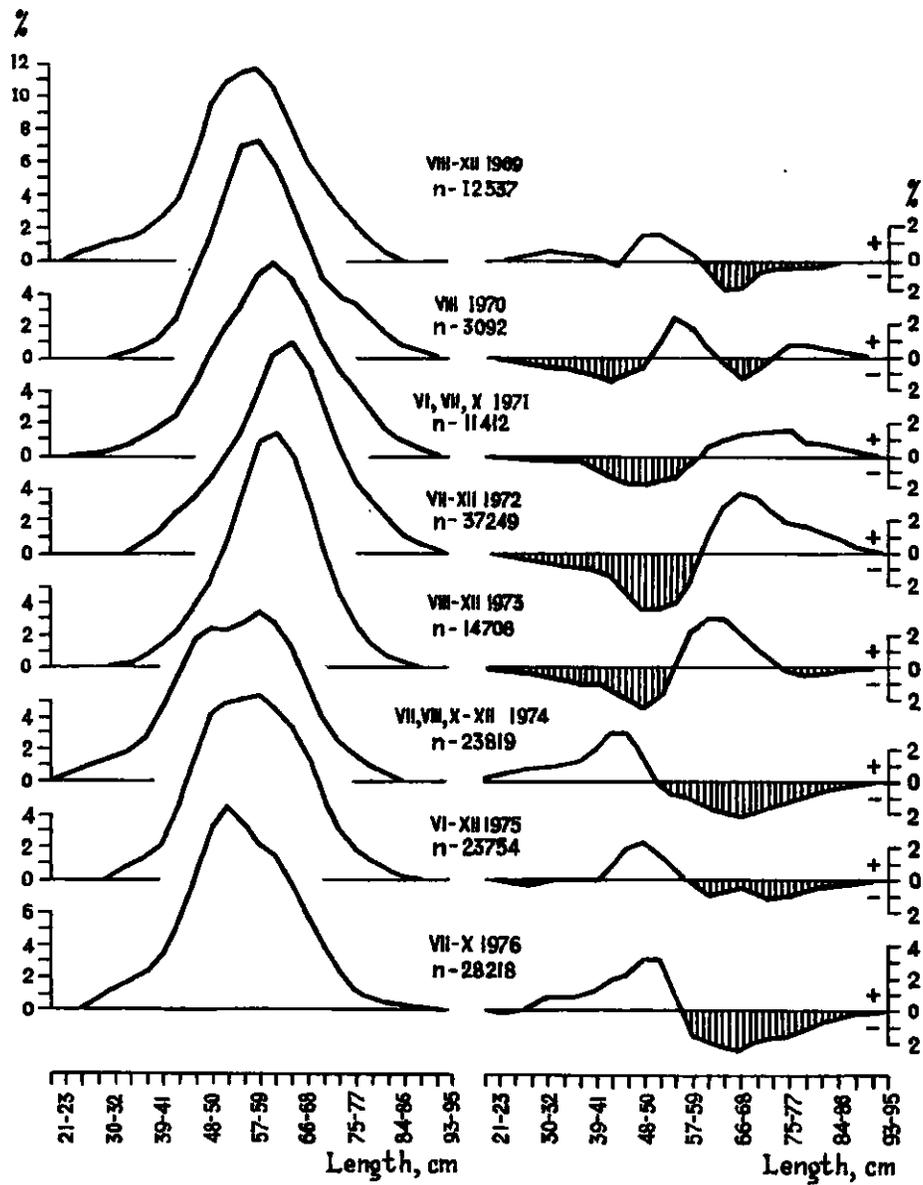


Fig. 5. Size composition of the roundnose grenadier catches by years in Subarea 1.

