NAFO Sci. Coun. Studies, 13: 53-58

Distribution and Biology of Common Grenadier (*Nezumia bairdi*) from Trawl Surveys in the Northwest Atlantic, 1969-83

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Abstract

Distribution of catches by area, depth and in relation to water temperature are described for the common grenadier (*Nezumia bairdi*, Goode and Bean). Biological data are also given on length and sex composition, feeding and fatness characteristics on the basis of data collected on demersal fish trawl surveys in 1972-83 and on catches taken by research vessels in 1969-83.

Common grenadier was taken as by-catch with commercial fish in the deep waters of the shelf and the adjacent continental slope areas. The catches increased with depth, and peak catches were taken in the day-time. The average length of fish in the northern Newfoundland area was larger than that in the southern Newfoundland area. The females were more abundant and larger than the males. The length-weight relationship of males and females of equal length was similar. Amphipods, shrimps, bivalves and ophiurae most often made up the food. Food content varied with growth of fish. Relative liver weight (fatness) of females was higher than that of males and it sharply increased with growth in length of the grenadier. No directed fishery is conducted for the species.

Introduction

The common grenadier (*Nezumia bairdi*, Goode and Bean) inhabit the Northwest Atlantic waters off Labrador and Newfoundland, the deep waters of Gulf of St. Lawrence and Bay of Fundy, and range southward of Georges Bank on the western side, while on the eastern side they have been caught off the Azores (Parr, 1946). They have been caught at depths from 16 to 2,250 m, but are most abundant from 90 to 180 m (Leim and Scott, 1966).

The species is abundant in areas off Labrador and Newfoundland. Houston (MS 1983) reports that the common grenadier, like the closely related species roughhead grenadier (*Macrourus berglax*), are abundant in waters off Newfoundland. Similarly, tens of thousands of *Nezumia bairdi* have often been taken in the Soviet bottom trawl fishery for cod, redfish and flounders in the areas off Labrador and Newfoundland. The catch rates in the Canadian research vessels on the southwestern slope of the Grand Bank constitute, on the average, 36 kg per 30 min of trawling (Parsons, 1976). However, there is no directed fishery for the common grenadier.

Information about the biology of common grenadier in literature is almost absent. The aim of this paper is to summarize the results from many years of observations in the Northwest Atlantic and to review information in literature on the ecology and possibilities of commercial use of this fish.

Materials and Methods

The data were collected by research vessels during the period 1969-83 in waters off Newfoundland and Labrador (Fig. 1). Data were also collected on trawl surveys for abundance assessment of demersal fish, conducted annually in the summer during 1972-83 on the Grand Bank and in the South Labrador area. These surveys consisted of occupying stations in a grid pattern on the shelf and a part of the continental slope. The trawl was modified with a small-meshed (mesh size 10-12 mm) net insertion which was 19 m long. The duration of valid trawls was 1 hr. The average catches were estimated in quads 20′ latitude by 30′ longitude distributed within 100 m depth ranges. The estimations took into account near-bottom water temperature and time of day.

The following analyses were carried out on the fish: (i) total (zoological) length of fish was measured to the nearest centimeter; (ii) sexes were determined; and (iii) in the feeding study, only non-everted stomachs were analyzed. The invertebrates and fish found in stomachs were identified where possible to the genus

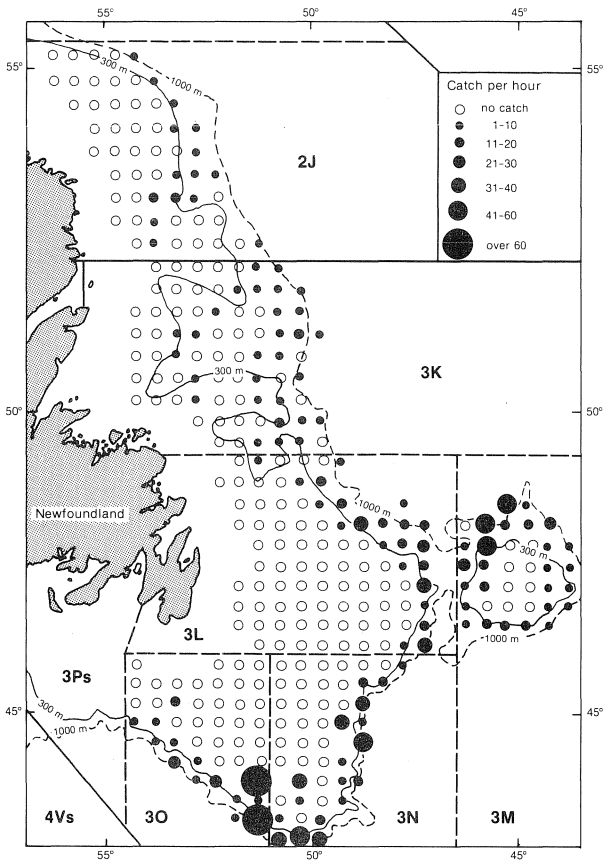

Fig. 1. Distribution of common grenadier average catches taken in bottom trawl surveys for abundance assessment of demersal fish in 1972-83.

level, but more often they could be only identified to family, order or class. The occurrence frequency expressed as a percentage, of various food components in stomachs was estimated as the ratio of number of stomachs (%) containing any one food component, to the total number of all stomachs analyzed, excluding the empty ones; (iv) the degree of stomach fullness was estimated visually using a 5-point scale: 0 = empty, 1 = small amounts of food, 2 = partially full, 3 = full stomach, 4 = extended stomach. The mean degree of stomach fullness was found as the arithmetic average, from the scale of fullness of the analyzed stomachs. The coefficient of food similarity was estimated by the method suggested by Yanulov (1963). The fatness was determined in 458 specimens, and is given as the liver weight in relation to fish weight, expressed as a percentage.

The length-weight relationship of common grenadier is expressed by the formula $W = aL^b$, where W = the fish weight (g), L = total length (cm) and a and b are constants.

The length frequencies and relative liver weight curves in the figures are smoothed. The smoothing was made by the formula $B = \frac{a + 2b + c}{4}$, where a, b and c represent preceding average and subsequent members respectively of frequency and B is the estimated value.

Results

Distribution of catches by area and depth

During the demersal fish trawl surveys in areas off Newfoundland and Labrador, the common grenadier occurred in catches everywhere near the continental slope and deepwaters of the shelf. The largest catches were taken in the southern part of the Grand Bank (Fig. 1).

The catches in depths less than 300 m were smaller than 10 specimens-per-hour of trawling. Catches increased with greater depth of trawling (Fig. 2).

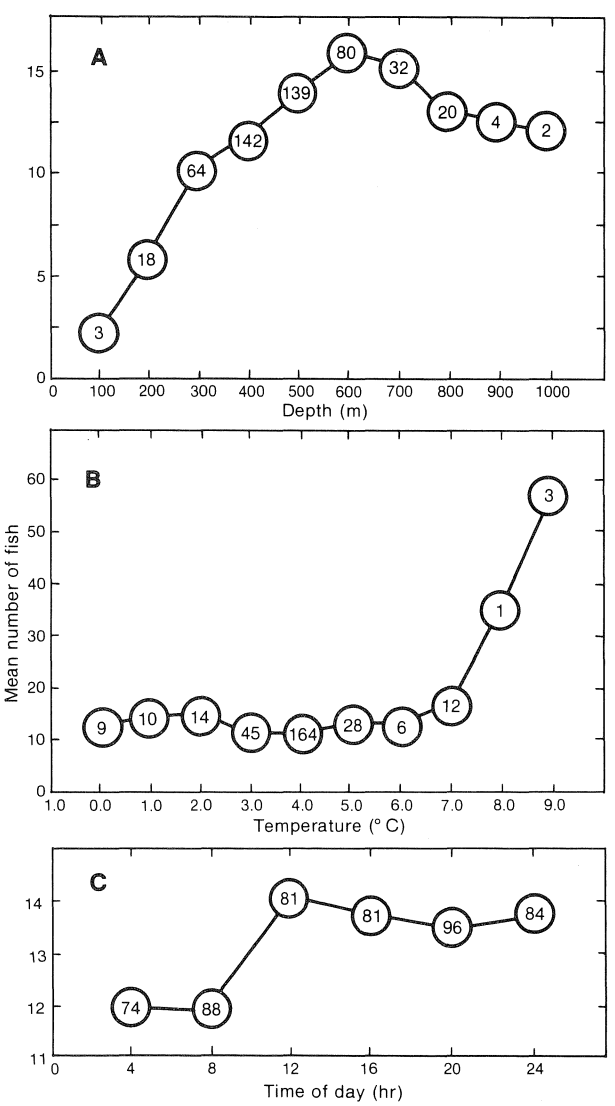

Fig. 2. Common grenadier mean catches with a bottom trawl per hour trawling by (**A**) depth, (**B**) near bottom water temperature, and (**C**) time of day, 1972-83 (smoothed curves, figures in circles = number of catches).

Common grenadier were caught at near-bottom water temperatures ranging from -1° to 9° C. They were taken in greatest numbers at water temperatures of 7° to 8° C and peaked in the day-time between 0800-1200 hrs.

Length composition of catches

Data were mainly collected on the Grand Bank. Length compositions of catches in NAFO Divisions were unequal. The largest fishes were taken in Div. 2J, 3K and 3L (Table 1). The mean length of the common grenadier in each division was generally observed to progressively decrease from north to south (Fig. 3) although Div. 3P and 4W appeared to show a reversal to this trend.

A total of 2,555 specimens were measured and separated by sex. An average of 34.6% males and 65.4% females were found in the catches. The females were considerably larger (Fig. 4). Mean length of males was 29.6 cm, and females was 31.7 cm. No variations in the length composition of catches or the sex ratio of fish were observed with increase of trawl depth.

TABLE 1. Average length of common grenadier in NAFO Divisions, 1969-83.

Division	Average length (cm)	No. of fish
2J	36.3	437
3K	35.4	206
3L	31.9	1,211
3M	28.8	1,523
3N	28.4	1,495
3O	25.7	1,663
3P	28.7	365
4W	31.4	40
All Div.	29.2	6,940

Length-weight relationship

Only scant data on length-weight relationship are available. Table 2 shows data collected in 1969 and 1979 in Div. 3LNOP. The comparison of length-weight relationships of common grenadier caught in different divisions did not show any patterns. Therefore, the measurements were combined to obtain the total characteristics of change in fish weight in relation to increase in length. Table 3 and Fig. 5 where estimated data are given, show that there are no differences in the length-weight relationship of males and females at equal lengths.

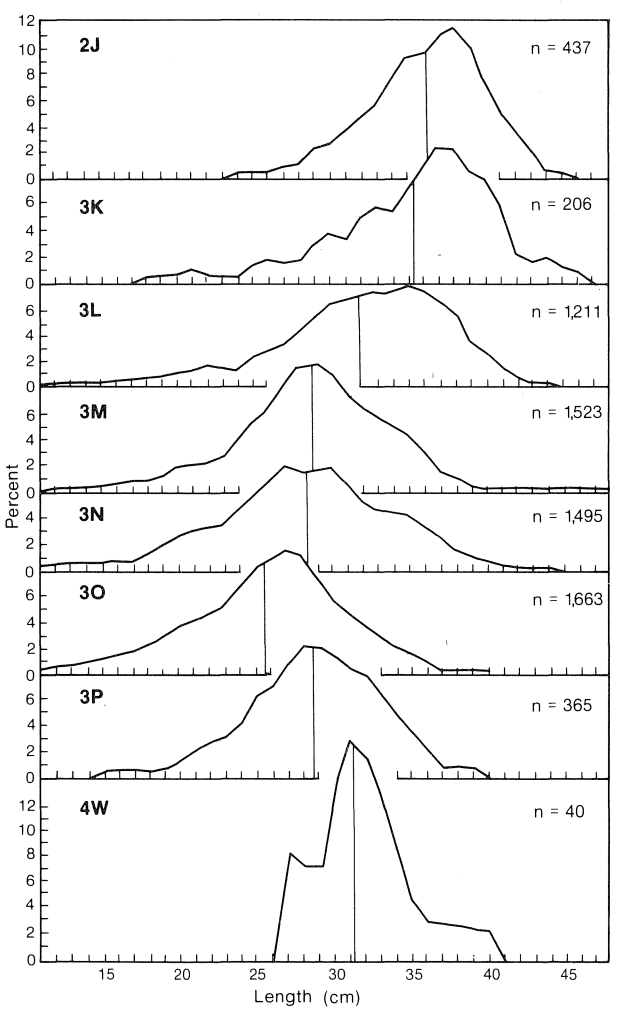

Fig. 3. Length composition of common grenadier catches taken in NAFO Divisions, 1969-83 (smoothed curves, mean fish length is shown by vertical lines).

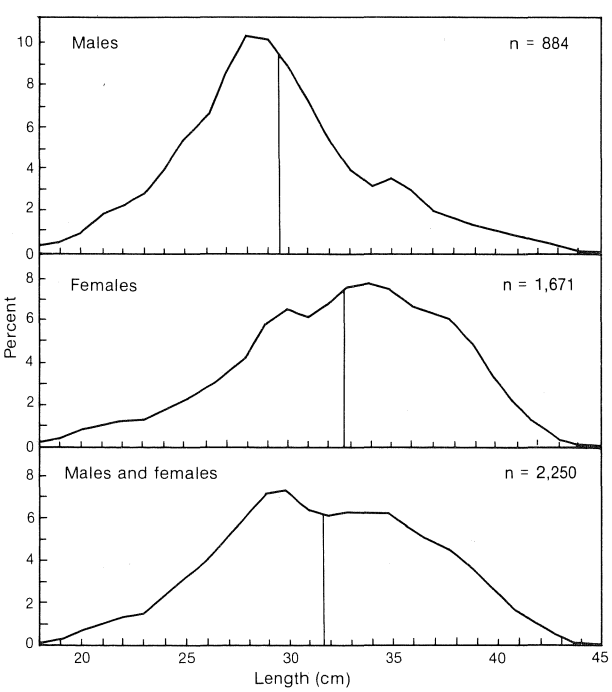

Fig. 4. Length composition of male and female common grenadier in the areas off Newfoundland and southern Labrador, 1969-83 (smoothed curves, mean fish length is shown by vertical lines).

TABLE 2. Number of males and females measured and weighed in Div. 3LNOP, 1969-79.

Sex	Division 3L	3N	3O	3P	Total
Males	26	4	39	60	129
Females	69	9	68	183	329
Total	95	13	107	243	458

TABLE 3. Length-weight relationship of common grenadier in Div. 3LNOP, 1969-79.

Length (cm)	Males Average weight (g)	Males No. of fish	Females Average weight (g)	Females No. of fish
19	—	—	18.0	1
20	—	—	26.5	7
21	25.0	2	25.3	6
22	30.0	2	27.4	5
23	39.0	5	31.0	2
24	41.3	II	36.4	5
25	42.7	13	45.6	5
26	50.1	15	44.5	15
27	58.8	15	51.6	12
28	63.7	29	62.6	17
29	76.4	13	71.2	37
30	75.6	10	83.0	28
31	92.8	7	91.1	25
32	91.7	3	93.8	34
33	110.0	1	108.7	41
34	111.7	3	119.4	29
35	—	—	132.8	28
36	—	—	144.6	12
37	—	—	153.3	9
38	—	—	170.0	6
39	—	—	174.2	4
40	—	—	195.0	1

Age and growth

Age was determined on 60 males and 183 females of common grenadier caught in the Cabot Strait in October 1969. The specimens 20-38.5 cm in length and weighing 22.9-193.5 g were from 3 to 11 years in age. According to the estimations, males at age 6 were 27 cm long and 55 g by weight, and the females were 29 cm and 70 g. During the sixth year, the males increased in length by 1.9 cm and in weight by 11.5 g, the females by 2.5 cm and 18.5 g respectively (Savvatimsky, 1975).

Sex ratio, feeding and fatness

The catches in all divisions were predominantly females (average of 65.4%) with the greatest relative number of females registered in Div. 2J, 3K, 3P (Table 4).

Only two references are known in published literature that indicate the food types of common grenadier.

TABLE 4. Relative number of females in total catches of common grenadier in NAFO Divisions, 1969-83.

	Division 2J	3K	3L	3M	3N	3O	3P	4W	All Div.
Total	428	157	396	661	386	239	243	45	2,555
% females	73.4	75.2	65.7	61.0	51.3	69.5	75.3	64.4	65.4

Euphausiids and amphipods were reported by Leim and Scott (1966) while Houston (MS 1983) reported that the food is more varied: cumaceans (35.6%), amphipods (23.9%), polychaets (17.0%), euphausiids (10.5%) and bivalves (7.5%) dominate, and also mysids, echinoderms, isopods, copepods, tanaids, ostracods and decapod crustaceans occur in small numbers. In the present study, 269 specimens of common grenadier (excluding 189 specimens with everted stomachs, or 41.3% of the sample) from the Newfoundland area in September-October 1969 and in May 1979, were taken for qualitative feeding analysis. Different demersal, near-bottom and pelagic organisms composing the food found in the stomachs are listed in Table 5.

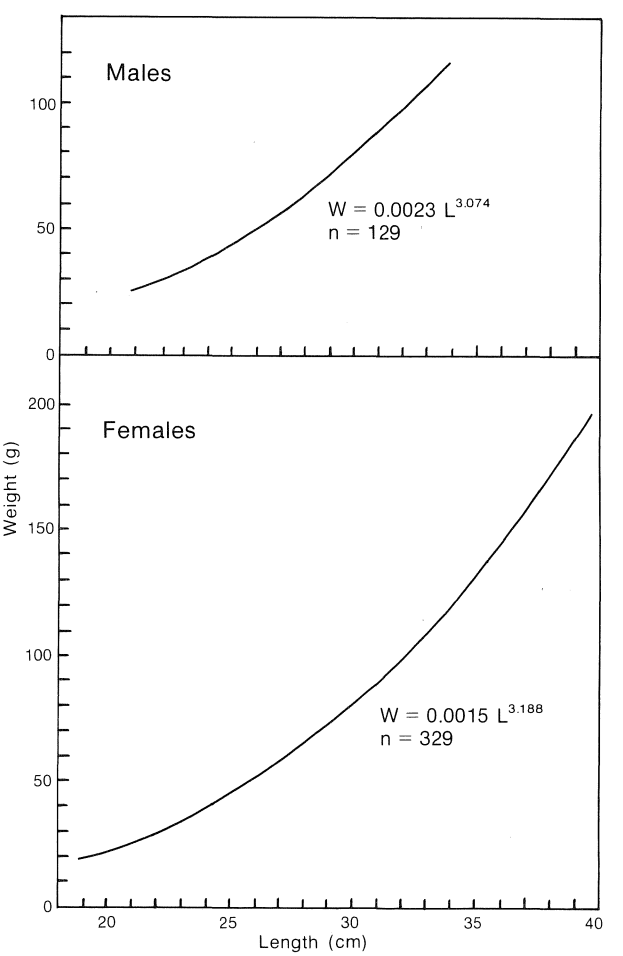

Fig. 5. Length-weight relationship for common grenadier in the Newfoundland Area in 1969, 1979 (W = weight (g); L = length (cm); n = number of fish).

TABLE 5. Occurrence frequency (%) of various food types in the stomachs of common grenadier (males and females) in Div. 3LNOP in 1969 and 1979.

Food type	Males	Females	Sexes combined
Polychaets	20.0	28.0	25.7
Other worms	1.7	3.3	2.9
Calanus	—	0.7	0.5
Amphipods	20.0	16.7	17.6
Euphausids	3.3	2.0	2.4
Cumaceans	1.7	—	0.5
Themisto	16.7	1.3	5.7
Sagitta	—	1.3	0.9
Shrimps	10.0	14.7	13.3
Hermit crabs	1.7	6.0	4.8
Ophiura	8.3	6.7	7.1
Bivalves	1.7	11.3	8.6
Gastropods	—	0.7	0.5
Digested food	40.0	36.7	37.6
Digested fish	3.3	2.0	2.4
Ground	1.7	0.7	0.9
Number of stomachs excluding the empty ones	60	150	210
Number of empty stomachs	20	39	59
Average degree of stomach fullness	1.3	1.5	1.4

Amphipods (17.6%), shrimps (13.3%), bivalves (8.6%) and ophiura (7.1%) occurred in the food most often. The females were larger than males, and the larger food types were more available to them, as shown in the higher occurrences of shrimp (14.7%), hermit crabs (6.0%) and bivalves (11.3%). In males these components occurred less often in the stomach contents (10.0%, 1.7% and 1.7% respectively). The coefficient of food similarity between males and females was 62.9%.

Common grenadier is often caught together with the closely related species, roughhead grenadier. The distributions by area and depth of these two species in the Newfoundland area is almost coincidental. In spite of their similar food contents, there are some observed differences. Notably the occurrence frequency of amphipods in common grenadier was 17.6%, while in roughhead grenadier it was 9.6%, of ophiura it was 7.1% and 26%, of shrimps it was 13.3% and 8.9% respectively. Consequently, the coefficient of food similarity between these fishes was low at 23.7%.

Only fragmentary data on common grenadier fatness were collected together with age samples, in the Newfoundland area in 1969 and 1979. The average fatness in the total sample (458 specimens) was 9.1%. The average fatness for the females (9.3%) was higher than that for males (8.3%), and at equal lengths of fish, the fatness of the males was higher compared to that of females. Both for males and females, the fatness sharply increased with growth in length (Table 6, Fig. 6).

Discussion

The present data confirm that the common grenadier is a fairly abundant fish in the areas off Labrador and Newfoundland, inhabiting deeper parts of the shelf and adjacent areas on the continental slope. The distribution of the catches and differences in length compositions of the catches in the northern and southern parts of the area surveyed were generally similar to the results of investigations carried out by Parsons (1976), however, the results must be considered preliminary yet because of scanty data in this study.

The largest catches taken by the Canadian research vessel were taken at near-bottom water temperatures ranging from 3.0° to 4.0° C (Parsons, 1976), while increases in catches were observed by the Soviet specialists at water temperatures of 7° to 8° C. The increase in the catches taken with bottom trawl in the day-time and the decrease at night, apparently was the consequence of partial migration of the grenadier at night into the upper strata.

The variations in fatness and also the length-weight relationship for males and females with their growth are similar to those of the closely related species, roughhead grenadier. Their food mainly consisted of the demersal organisms of various types. Houston (MS 1983) stated that benthic organisms for common grenadier constituted 86.0% while in roughhead grenadier it was 91.6%. In spite of the fact that the

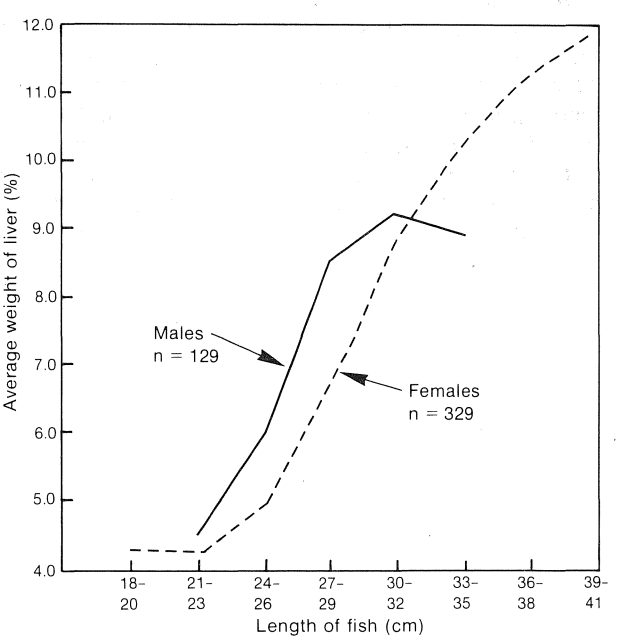

Fig. 6. Average fatness of common grenadier by length groups caught in September-October 1969 and May 1979 in NAFO Divisions (smoothed curves, n = number of fish).

TABLE 6. Fatness (%) of common grenadier caught in September-October 1969 and May 1979 in NAFO Divisions.

Division	Sex	Length ranges (cm) 18-20	21-23	24-26	27-29	30-32	33-35	36-38	39-41	18-41	No. of fish
3L	Males	—	3.8	6.3	7.6	10.3	8.7	—	—	8.4	26
3N	Males	—	—	7.9	14.9	—	12.6	—	—	12.9	4
3O	Males	—	4.2	4.2	8.6	8.1	2.5	—	—	6.6	39
3P	Males	—	4.0	5.9	9.9	10.0	—	—	—	8.8	60
3L	Females	—	4.6	4.7	6.0	9.5	8.5	10.0	11.8	8.9	69
3N	Females	—	—	—	—	3.3	10.4	13.1	—	10.4	9
3O	Females	2.9	3.3	5.0	5.4	6.3	7.9	16.1	9.2	7.1	68
3P	Females	5.9	3.8	4.6	7.0	10.2	11.8	12.5	13.7	10.2	183
All Div.	Males	—	4.0	5.4	9.4	9.7	8.5	—	—	8.3	129
	Females	4.5	3.9	4.8	6.4	9.3	10.2	11.3	12.0	9.3	329
All Div.	Combined	4.5	4.0	5.1	7.8	9.4	10.1	11.3	12.0	9.1	458

areas and distribution range by depth of these two species are to a great extent coincidental, there was apparently no food competition between them or it was insignificant. This was illustrated by the low coefficient of food similarity (23.7%). The wide food spectrum and variations in food content with growth of common grenadier was considered to be the adaptation of this species to inhabit conditions at great depths, where the food resources were limited.

Common grenadier was most abundant in the southern part of the Grand Bank. It was Parsons' (1976), opinion that the abundance of this species is not high, and because of the relatively small sizes of this fish, it is not available for commercial use. It should be noted that his investigations were conducted only within the upper part of the range of vertical distribution of the common grenadier, and therefore, the data obtained are not enough for final conclusions on their commercial use. Nevertheless, it should be noted that this fish sometimes constitute a great by-catch in the bottom trawl fisheries of traditional fish, and they probably can be used for fish meal and other food products.

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