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Stock assessment of roundnose grenadier in the Northwest Atlantic

by

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Introduction

This paper intends to present the latest estimates of fishing mortalities, stock sizes and sustainable yields for fishing mortality levels of $F_{0.1}$ and $F_{max.}$ of roundnose grenadier in Subareas 2 and 3 and Statistical Area 0 and Subarea 1. Opposite to the assessment in 1976 (Borrmann, 1977) this estimates are based on more complete and suitable data.

Materials and Methods

The mean fishing mortalities and stock sizes were calculated by means of the cohort analysis (Pope, 1972) of age compositions.

Yield calculations were made using the Beverton and Holt (1957) yield equation, solved by the incomplete Beta function.

All assessments were made using two values of natural mortality, M = 0.1 and M = 0.2.

The catch by number and age group was calculated in the following way: First, the calculation was made for every year, where age compositions were available (the age compositions for SA 2 and 3 consisted of data of SA 2 for 1969, 1971, 1973, 1974 and 1976 and for Statistical Area 0 and SA 1 of data for 1969, 1971, 1973, 1974, 1975 and 1976). The mean weights of the catch were calculated by using length compositions and mean weights per length group as used in 1976. After that the mean age compositions of the catch by number of the available years were calculated and raised to the mean catch of the years 1967-1976 for SA 2 and 3 and of the years 1968-1976 for Statistical Area 0 and SA 1, in order to take into consideration all years with catch.

As terminal fishing mortalities F = 0.3 and F = 0.2 were used according to the natural mortalities and the results of the cohort analysis carried out 1976.

Calculations of yield per recruit were made using values of W_∞, K and t_o as determined from mean weight-at-age data from the years 1969, 1971, 1976 and for SA 1 additionally from 1975. The growth parameters are as follows:

Area	W_∞ (kg)	K	t_o
Subarea 2	2.392	0.0512	-3.094
Stat. Area 0 + Subarea 1	8.958	0.0263	-1.934

(The corresponding growth curves are in Fig. 1). The mean age of recruitment to the fishery (t_p') was obtained from the expression given in Beverton and Holt (1957), using the F values from the cohort analysis:

$$t_\rho' \approx \bar{t}_s \cdot \sum_{y=1}^{z} t_y \cdot \Delta F_y \Big/ \sum_{y=1}^{z} \Delta F_y$$

It was 13.5 years in SA 2 and 3 and 12,0 years in Statistical Area 0 and SA 1 where the age of full recruitment to the fishery was 15 and 14 years respectively. The age of recruitment to the stock (t_p) was taken as 3 years and the maximum age (t_λ) as 25 and 27 respectively as these ages comprise the range of the available age composition data.

The sustainable yields of $F_{0.1}$ and F_{max} for each management area were estimated by multiplying the number of age 3 fish in the stock (as determined from cohort analysis) by the corresponding Y/R values of the yield-per-recruit curves.

Results

Subareas 2 and 3

The mean total catch by number was 48.494 million fish at a mean catch of 27,960 tons in 1967-1976. The catch composition and the results of the cohort analysis are given in Table 1. The calculated stock sizes are 1,357 million for M = 0.1 and 3,611 million fish for M = 0.2. The mean F-values at M = 0.1 are 0.042 and 0.334 for the stock as a whole and for the fully-recruited stock (ages 15^+) respectively. The corresponding values at M = 0.2 are 0.016 and 0.255.

The yield-per-recruit curves for M = 0.1 and M = 0.2 (Fig. 3) are both flat-topped with $F_{max.}$ at 1.2 and greater than 2.0 respectively. In the latter case $F_{max.}$ = 2.0 was used. The results of the yield calculations are as follows:

	Natural mortality (M)	Fishing mortality (F)	Yield per recruit (Y/R) (kg)	Sustainable yield (Y) (000 t)
Fishing at $F_{0.1}$	0.1	0.3	0.149	26.1
	0.2	0.4	0.044	30.7
Fishing at $F_{max.}$	0.1	1.2	0.158	27.7
	0.2	2.0[a)]	0.053	37.0

a) $F_{max.}$ actually>2.0

Statistical Area 0 and Subarea 1

The mean total catch by number was 18.835 million fish at a mean catch of 6,942 tons in 1968-1976.

The catch composition and the results of the cohort analysis are given in table 2. The calculated stock sizes are 427 million fish for M = 0.1 and 1,053 million fish for M = 0.2. The mean F-values at M = 0.1 are 0.052 and 0.330 for the stock as a whole and for the fully-recruited stock (ages 14^+) respectively. The corresponding values at M = 0.2 are 0.021 and 0.239.

The yield-per-recruit curves (Fig. 4) for M = 0.1 and M = 0.2 have a maximum at 0.3 and greater than 2.0 respectively. In the latter case F_{max} = 2.0 was used. The results of the yield calculations are as follows:

	Natural mortality (M)	Fishing Mortality (F)	Yield per recruit (Y/R) (kg)	Sustainable yield (Y) (000 t)
Fishing at $F_{0.1}$	0.1	0.2	0.118	6.9
	0.2	0.3	0.036	7.5
Fishing at F_{max}	0.1	0.3	0.120	7.0
	0.2	2.0 a)	0.042	8.7

a) F_{max} actually > 2.0

Discussion

The results of the cohort analysis are not very different from those of 1976 (Borrmann, 1977). The fishing mortalities are nearly the same. The stock sizes for Subareas 2 and 3 are somewhat lower and for Statistical Area 0 and Subarea 1 higher. The differences may be due to different age compositions of the catch where the compositions used now are the more realistic ones (Fig. 2 a and b). Moreover, the total number of the catch changed because for this analysis all years with catch were considered whereas in the past only those years were taken into account where biological data were available. The used mean catch per year diminnished from 31,726 tons to 27,960 tons for Subareas 2 and 3 and increased from 6,609 tons to 6,942 tons for Statistical Area 0 and Subarea 1.

The values of fishing mortalities are still on the level of $F_{0.1}$ though they are somewhat higher and the values of $F_{0.1}$ are lower with the exeption of one value. The reason for the changed shape of the yield-per-recruit curves and the lower yield-per-recruit values is related mainly with the new growth parameters which are more suitable because they are derived from growth in weight data and from more data.

According to the lower yield-per-recruit values and the changed number of age 3 fish in the stock (Table 1 and 2) the sustainable yields at $F_{0.1}$ and $F_{max.}$ decreased. But nevertheless the anual average catches of 27,960 tons in Subareas 2 and 3 and of 6,942 tons in Statistical Area 0 and Subarea 1 are in the range of the sustainable yields at $F_{0.1}$, which amount to 26,100 tons - 30,700 tons and 6,900 tons - 7,500 tons respectively in dependence on the value of natural mortality.

Though the size of the biological material has been increased, it was not sufficient to carry out a VPA in order to get fishing mortalities and stock sizes by the year and to make a catch prognosis related to the actual stock condition. Besides the results for Subdivisions 2 and 3 are only preliminary, because biological data from Subdivision 3 were not available and there are some indications obtained by comparing length compositions and mean lengths (Savvatimsky, 1977) that the stock is different from that in Subdivision 2.

Acknowlegement

I am grateful to Mrs. S. Möller for the age-readings and the preliminary analysis of former samples.

References

Beverton, R.J.H.., and S.J. Holt 1957. On the dynamics of exploited fish populations. Fish. Invest., Lond.(2) 19: 533 p.

Borrmann, H. 1977. Stock Assessment of Roundnose Grenadier in the Northwest Atlantic. Int. Comm. Northw. Atlant. Fish. Sel. Pap., No. 2, p.45-53

Pope, J.G. 1972. An investigation of the accuracy of virtual population analysis using cohort analysis. Res. Bull. int. Comm. Northw. Atlant. Fish., No. 9, p. 65-74

Savvatimsky, P.I. 1977. Prospects of roundnose grenadier fishery in the Northwest Atlantic. Ann. Meet. int. Comm. Northw. Atlant. Fish. 1977, Res. Doc. No. 30, Serial No. 5055 (mimeographed).

Table 1: Roundnose grenadier in Subareas 2 and 3 stock size and fishing mortality (F) for two of natural mortality (M) from cohort analysis

	M = 0.1			M = 0.2	
Age group	Catch (10^{-3})	Stock (10^{-6})	F	Stock (10^{-6})	F
3	30.0	175.255	.00015	698.448	.00004
4	59.9	158.545	.0004	571.815	.00016
5	79.8	143.396	.0006	468.109	.00016
6	109.8	129.671	.0009	383.184	.00028
7	272.8	117.224	.0025	313.626	.0010
8	318.0	105.806	.0031	256.529	.0014
9	780.0	95.432	.0087	209.741	.0041
10	1 959.9	85.607	.0244	171.016	.0127
11	2 470.0	75.594	.0350	138.243	.0199
12	3 528.6	66.049	.0509	110.949	.0358
13	5 194.6	56.405	.1019	87.645	.0678
14	6 785.9	46.095	.168	67.057	.119
15	7 724.4	35.252	.262	48.762	.192
16	5 649.5	24.549	.277	32.933	.210
17	4 596.8	16.838	.338	21.851	.264
18	3 588.0	10.863	.427	13.731	.341
19	1 886.5	6.416	.370	7.995	.302
20	1 540.1	4.011	.517	4.839	.433
21	1 009.5	2.164	.674	2.568	.570
22	694.7	0.998	1.317	1.189	1.037
23	121.0	0.242	.747	0.345	.491
24	33.5	0.104	1.868	0.173	.762
25	10.9	0.014	.3	0.066	.2
3^+	48 494.2	1 356.530	.042[a]	3 610.814	.016[a]
15^+		101.452	.334[a]	134.453	.255[a]

a) Average F weighted by stock size

Table 2: Roundnose grenadier in Subarea 1 and Statistical Area 0: Stock size and fishing mortality (F) for two values of natural mortality (M) from cohort analysis

	M = 0.1			M = 0.2	
Age group	Catch (10^{-3})	Stock (10^{-6})	F	Stock (10^{-6})	F
3	21.7	58.558	.0005	207.890	.00016
4	43.6	52.963	.0009	170.187	.00028
5	94.0	47.880	.0021	139.298	.00077
6	121.1	43.233	.0030	113.963	.0011
7	644.5	39.003	.0175	93.196	.0076
8	732.9	34.677	.0225	75.719	.0107
9	976.9	30.679	.0341	61.330	.0178
10	1 406.8	26.830	.0568	49.329	.0321
11	1 297.9	22.938	.0613	39.115	.0374
12	1 658.4	19.520	.0936	30.850	.0612
13	2 637.0	16.084	.189	23.757	.131
14	2 948.4	12.045	.297	17.065	.212
15	1 885.9	8.094	.281	11.304	.204
16	1 493.2	5.529	.334	7.548	.247
17	1 053.4	3.583	.370	4.829	.276
18	693.4	2.240	.393	3.000	.295
19	476.8	1.367	.457	1.829	.340
20	287.6	0.784	.488	1.066	.354
21	124.6	0.435	.358	0.612	.254
22	125.6	0.276	.653	0.389	.442
23	51.7	0.130	.544	0.205	.327
24	40.1	0.068	.961	0.121	.457
25	11.2	0.024	.691	0.063	.221
26	3.0	0.011	.353	0.041	.0853
27	5.1	0.007	.3	0.031	0.2
3^+	18 834.8	426.958	.052[a]	1 052.737	.021[a]
14^+		34.591	.330[a]	48.101	.239[a]

[a]Average F weighted by stock size

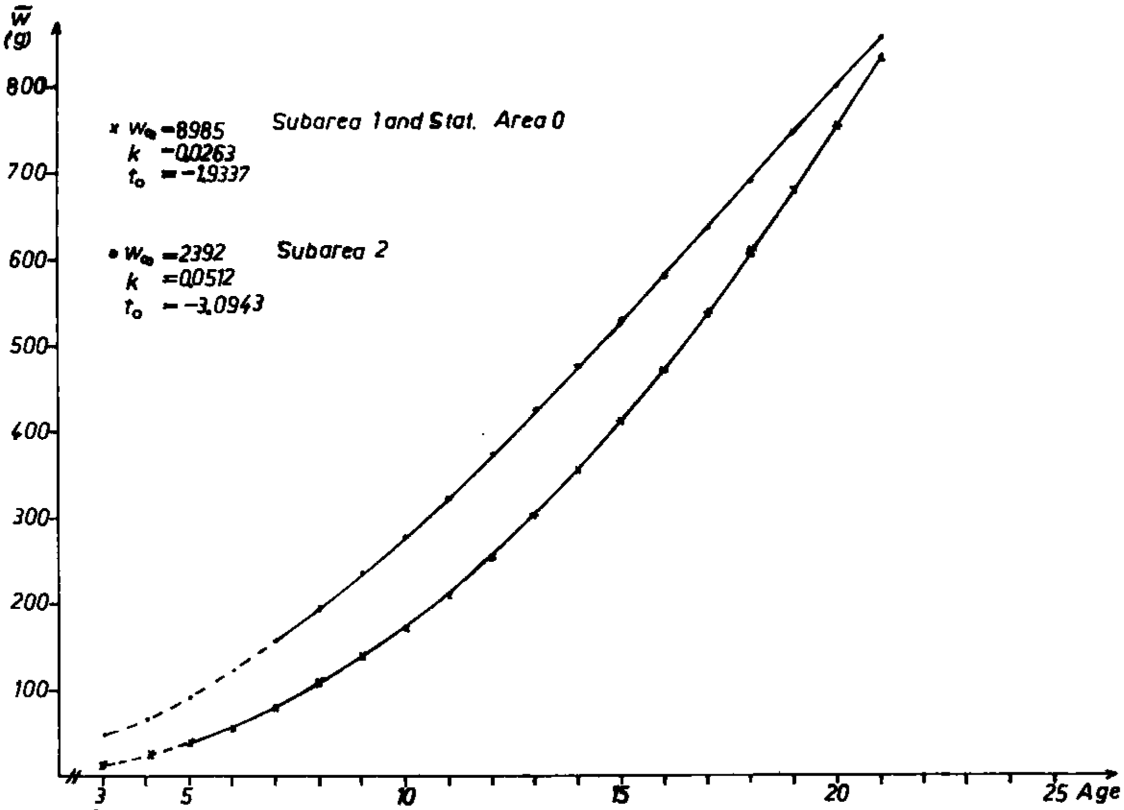

Fig.1. Growth curves for roundnose grenadier

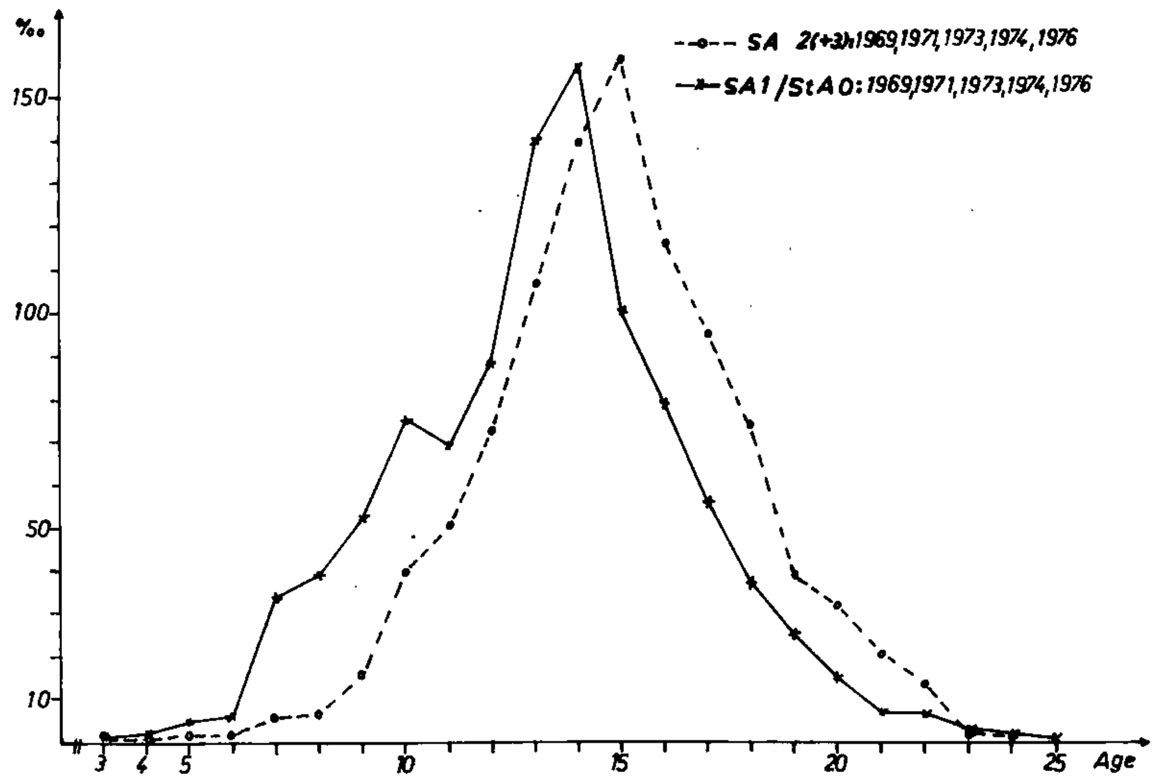

Fig. 2a. Mean age composition of roundnose grenadier catches (weighted mean)

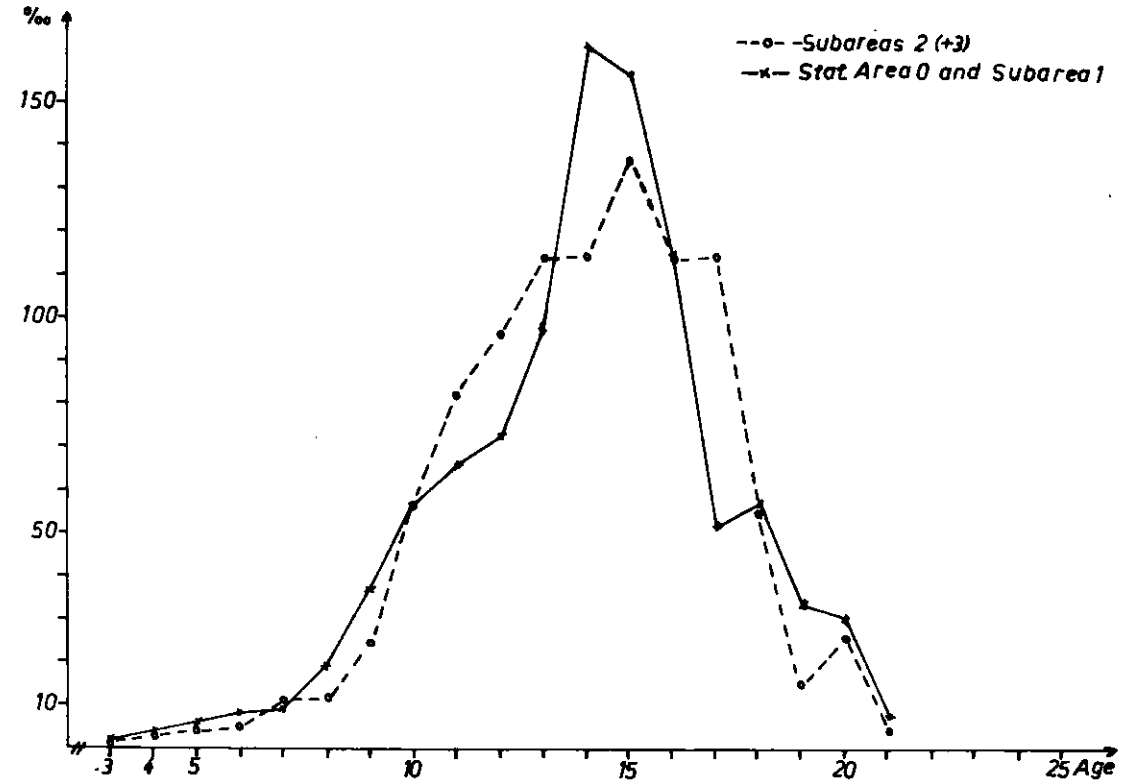

Fig. 2b. Mean age composition of roundnose grenadier catches in 1973 and 1974 (unweighted mean)

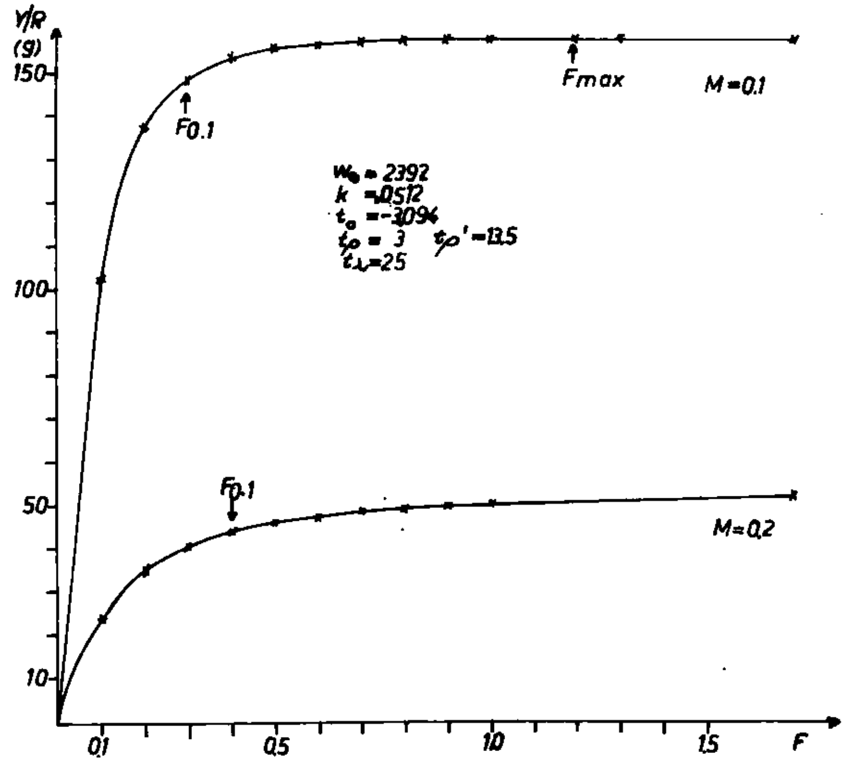

Fig. 3. Yield-per-recruit curves for roundnose grenadier in Subareas 2 and 3

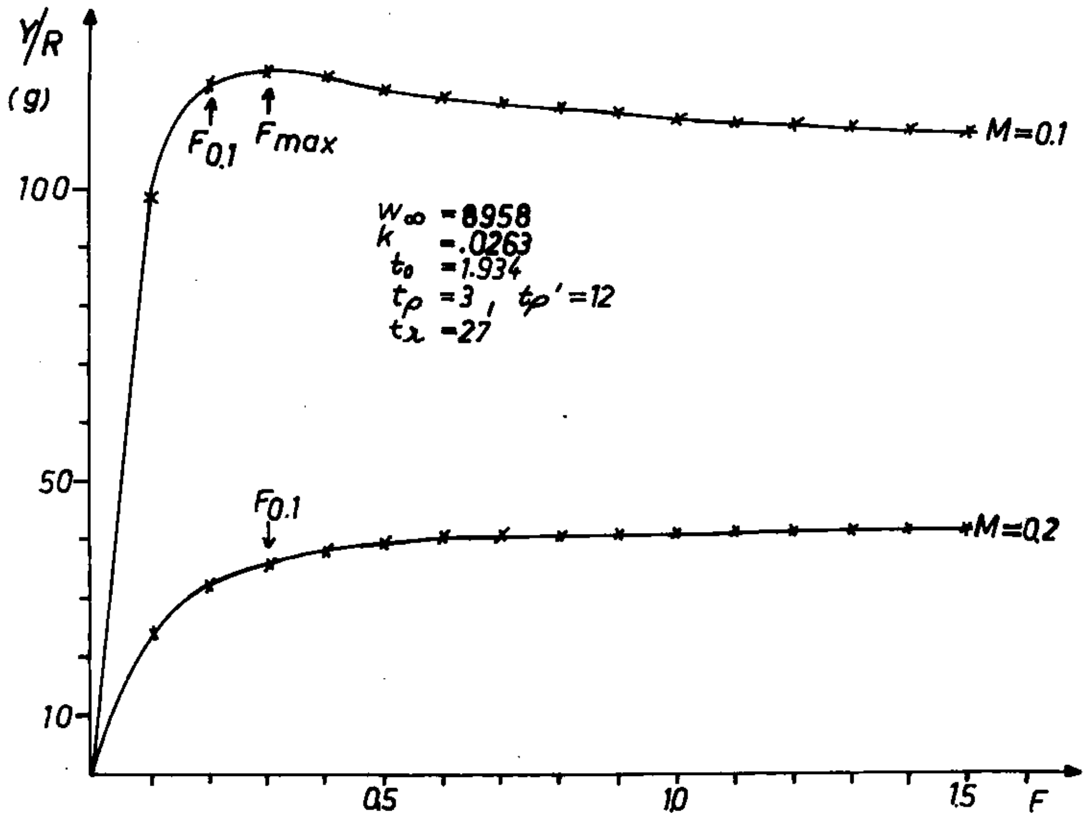

Fig. 4 Yield-per-recruit curves for roundnose grenadier in Subarea 1 and statistical area 0