

Northwest Atlantic



Fisheries Organization

Serial No. N344

NAFO SCR Doc. 81/VI/60

SCIENTIFIC COUNCIL MEETING - JUNE 1981

Assessment of Roundnose Grenadier in NAFO Subareas 2+3

by

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INTRODUCTION

With the exception of the work by Borrmann (1976, 1978) analytical assessment techniques have not been used to assess this stock. Instead, the general production model has been used. This paper presents the results of an updated general production model as well as a cohort analysis of this stock.

MATERIALS AND METHODS

The multiplicative model was reexamined to arrive at revised standardized catch rates. The data were weighted by effort and the standards were USSR OTB2 tonnage class 7, month of September, and Div. 3K.

These standardized data were applied to the Schaefer general production model (Schaefer 1954) and were not lagged. The 1971 point was not used in the regression.

From commercial frequencies and age/length keys submitted to NAFO, a catch matrix was produced for the years 1972-78 inclusive. For those years in which A/L keys were missing the numbers at length were applied to the keys of both the previous and following years, then averaged. Natural mortality was set at 0.15 (between cod and redfish) and a partial recruitment vector was derived by averaging the F's at  $M = 0.1$  and  $M = 0.2$  as presented by Borrmann (1978). Fully recruited age was set at 15 (Borrmann 1978). Weights at age were determined

from the A/L keys and the W/L relationship  $W = 0.0094L^{2.6593}$ . Regressions were run for biomass on CPUE and F on effort at a series of terminal F's from 0.05 to 0.30. Also, it was assumed that similar catch rates reflected similar biomass levels and so the 10+ biomass for the years 1978 and 1974 were compared for runs at the above terminal F's.

A best terminal F was selected and the results of cohort projected to 1982 inputting the actual catches for 1979 and 1980, the TAC in 1981 and  $F_{0.1}$  in 1982. Recruitment was set at the geometric mean of 3 year olds from cohort. The yield per recruit curve was determined using the method of Thompson and Bell (1934).

#### RESULTS AND DISCUSSION

Trends in catch, effort (standardized) and catch per unit effort (standardized) can be seen in Table 1 and Fig. 1. Except for 1971 when 75,000 MT were caught, catches averaged in the range of 20,000 MT until 1979 when the catch dropped to 7750 MT and 1980 when a further drop to 3000 MT occurred. Effort (standardized) has fluctuated considerably during the period of this fishery but the oscillations do not seem to be as great in recent years. Catch per unit effort (standardized) has also fluctuated a great deal but the general trend since 1970 has been downwards.

Figure 2 shows the regression of CPUE on effort (1971 point excluded) and the resulting yield curve. The correlation coefficient is very poor ( $r = -0.381$ ) and the model suggests an MSY of 32,000 MT and a yield at  $2/3 f_{MSY}$  of 28,500 MT.

The derived catch matrix for the years 1972-78 can be seen in Table 2 and the partial recruitment vector and weights at age used are shown in Table 3. All regressions of biomass on CPUE and F on effort were poor with the correlation coefficients giving no indication of a best terminal F. In all cases the regressions of biomass on CPUE gave negative slopes. Regressions of F on effort from 1972-77 (for 10+ and 14+ F), when used to predict the 1978 F, suggested a terminal F in the range of 0.2 to 0.25. A comparison of the 1974 and 1978 10+ biomass also indicated a terminal F in this range so a run was carried out at terminal F of 0.225 and then projected to 1982. The results of

the cohort run are shown in Table 4 and the projections in Table 6. Table 5 and Fig. 3 show the derived yield per recruit curve. Fishing at  $F_{0.1}$  suggests a catch of 28,000 MT in 1982. These results agree quite closely with the results of the general production model as well as those of Borrmann (1978) which suggested  $F_{0.1}$  catches between 26,000 MT and 31,000 MT at M's of 0.1 and 0.2. It is therefore suggested that the 1982 TAC remain at the present level of 27,500 MT.

#### REFERENCES

- Borrmann, H. 1978. Stock assessment of roundnose grenadier in the Northwest Atlantic. ICNAF Res. Doc. 78/VI/54, Ser. No. 5220.
1976. Roundnose grenadier stocks in ICNAF Subareas 0+1 and 2+3. ICNAF Res. Doc. 76/VI/57, Ser. No. 5397.
- Schaefer, M. B. 1954. Some aspects of the dynamics of populations important to the management of commercial marine fisheries. Bull. Inter-Amer. Trop. Tuna Comm. 1: 26-56.

Table 1. Catch, effort (standardized) and catch per unit effort (standardized) for roundnose grenadier in NAFO Subareas 2+3.

Year	Catch	Effort (hr)	CPUE
1967	17,304	9194	1.882
1968	31,263	25,212	1.240
1969	12,333	9749	1.265
1970	22,864	9298	2.459
1971	75,445	32,717	2.306
1972	24,386	14,336	1.701
1973	17,564	7522	2.335
1974	28,416	20,011	1.420
1975	27,425	16,763	1.636
1976	20,593	10,965	1.878
1977	15,386	13,275	1.159
1978	20,699	14,374	1.440
1979	7763	7897	0.983
1980 <sup>1</sup>	2961		

<sup>1</sup>Provisional

Table 2. Catch matrix for roundnose grenadier from NAFO Subareas 2+3, 1972-78.

C A T C H   M A T R I X

AGE/YEAR	1972	1973	1974	1975	1976	1977	1978
3	1.	10.	9.	1.	180.	1.	3.
4	7.	42.	31.	11.	1179.	1.	23.
5	104.	72.	99.	63.	1449.	1.	29.
6	211.	139.	295.	155.	2387.	10.	140.
7	344.	174.	499.	333.	2586.	76.	343.
8	2193.	1005.	1081.	578.	1744.	157.	526.
9	387.	153.	2001.	1115.	1239.	273.	780.
10	3427.	1305.	3680.	2197.	1697.	739.	1484.
11	3829.	1470.	4942.	3074.	3222.	1321.	1904.
12	1030.	344.	5562.	4307.	5212.	2886.	3043.
13	13726.	5133.	6049.	4216.	4549.	2385.	3847.
14	2751.	1473.	6797.	5204.	5467.	4706.	7889.
15	3883.	1636.	4666.	3972.	4851.	4007.	5241.
16	3958.	2249.	3348.	3116.	3720.	5289.	8069.
17	5400.	3880.	2285.	3107.	4541.	2835.	2374.
18	3558.	2080.	3364.	4730.	4480.	2353.	2102.
19	2269.	1650.	1146.	2521.	2372.	1351.	1221.
20	7092.	7882.	2104.	4263.	2121.	897.	1521.
21	1.	1.	1.	238.	83.	161.	517.
22	1.	1.	1.	33.	11.	18.	50.
23	1.	1.	1.	32.	8.	7.	47.

Table 3. Mean weight (gm) at age and partial recruitment vector used in cohort runs and projections.

AGE MEAN WEIGHT PROPORTION RECRUITED

3	15.	.0004
4	30.	.0012
5	50.	.002
6	76.	.002
7	106.	.007
8	142.	.010
9	182.	.027
10	226.	.080
11	273.	.119
12	324.	.190
13	377.	.371
14	432.	.630
15	489.	1.000
16	547.	1.000
17	606.	1.000
18	666.	1.000
19	726.	1.000
20	786.	1.000
21	845.	1.000
22	905.	1.000
23	963.	1.000

NATURAL MORTALITY RATE IS .150

Table 4a. Fishing mortalities of roundnose grenadier in Subareas 2+3 from cohort runs at terminal F = 0.225.

2+3 GRENADEIER

FISHING MORTALITIES

AGE/YEAR	1972	1973	1974	1975	1976	1977	1978
3	.000	.000	.000	.000	.002	.000	.000
4	.000	.000	.000	.000	.004	.000	.000
5	.001	.000	.000	.000	.005	.000	.000
6	.001	.001	.002	.001	.007	.000	.001
7	.003	.001	.004	.002	.015	.000	.002
8	.013	.009	.008	.005	.015	.001	.002
9	.004	.001	.020	.009	.013	.003	.006
10	.026	.014	.030	.026	.017	.009	.018
11	.057	.013	.066	.030	.046	.016	.027
12	.017	.006	.059	.072	.061	.051	.043
13	.289	.105	.134	.055	.096	.034	.083
14	.065	.043	.107	.154	.089	.129	.142
15	.141	.048	.175	.151	.199	.083	.225
16	.201	.108	.123	.160	.195	.328	.225
17	.387	.292	.144	.153	.349	.211	.225
18	.522	.238	.417	.466	.324	.289	.225
19	.220	.461	.189	.600	.424	.144	.225
20	4.833	4.869	2.020	2.281	1.624	.264	.225
21	.317	.021	.019	1.962	.222	.445	.225
22	.639	.568	.025	1.363	.398	.065	.225
23	4.833	4.869	2.020	2.281	1.624	.445	.225

Table 4b. Population numbers of roundnose grenadier in Subareas 2+3 from cohort runs at terminal F = 0.225.

2+3 GRENADEIER

POPULATION NUMBERS

AGE/YEAR	1972	1973	1974	1975	1976	1977	1978
3	343246	560070	406700	421937	117314	106594	35897
4	226526	295434	482047	350042	363163	100806	91746
5	197564	194966	254243	414873	301274	311484	86763
6	202347	169948	167742	218737	357026	257964	268096
7	148260	173966	146147	144104	188125	305081	222023
8	186474	127296	149572	125327	123722	159522	262515
9	114077	158465	108632	127735	107334	104871	137156
10	146412	97828	136250	91644	108908	91233	90010
11	74874	122839	82990	113058	76841	92164	77840
12	65473	60892	104365	66845	95146	63148	78101
13	58990	55398	52091	84667	53539	77058	51675
14	46958	38039	42919	39223	68962	41861	64112
15	31805	37865	31374	30635	28932	54285	31664
16	23470	23773	31073	22675	22683	20404	43006
17	18119	16529	18375	23639	16626	16072	12653
18	9431	10586	10627	13695	17463	10097	11203
19	12393	4816	7182	6026	7400	10875	6508
20	7706	8562	2615	5118	2048	4168	8107
21	4	53	57	298	450	483	2755
22	2	2	45	48	36	310	266
23	1	1	1	37	11	21	250

Table 4c. Summary of F's, population biomass and population numbers for roundnose grenadier in Subarea 2+3 from cohort runs at terminal F = 0.225.

POPULATION BIOMASS AGES 3 TO 23

YEAR	1972	1973	1974	1975	1976	1977	1978
BIOMASS	278139.	276837.	285877.	292393.	294585.	293303.	295896.

POPULATION BIOMASS AGES 10 TO 23

YEAR	1972	1973	1974	1975	1976	1977	1978
BIOMASS	177981.	171551.	183352.	181875.	182688.	179424.	182118.

POPULATION BIOMASS AGES 15 TO 23

YEAR	1972	1973	1974	1975	1976	1977	1978
BIOMASS	60713.	58860.	57910.	59559.	56294.	66049.	68044.

FISHING MORTALITY-WINTERS METHOD AGES 3 TO 21

YEAR	1972	1973	1974	1975	1976	1977	1978
TOTAL F	.031	.015	.023	.020	.028	.018	.029

FISHING MORTALITY-WINTERS METHOD AGES 10 TO 21

YEAR	1972	1973	1974	1975	1976	1977	1978
TOTAL F	.117	.068	.096	.093	.096	.067	.094

FISHING MORTALITY-WINTERS METHOD AGES 15 TO 21

YEAR	1972	1973	1974	1975	1976	1977	1978
TOTAL F	.320	.229	.198	.264	.285	.170	.225

TOTAL POPULATION NUMBERS AGES 3 TO 23

YEAR	1972	1973	1974	1975	1976	1977	1978
TOTAL N	1914140.	2157327.	2235047.	2301164.	2057802.	1828498.	1582344.

TOTAL POPULATION NUMBERS AGES 10 TO 23

YEAR	1972	1973	1974	1975	1976	1977	1978
TOTAL N	495639.	477182.	519962.	498409.	499844.	482176.	478149.

TOTAL POPULATION NUMBERS AGES 15 TO 23

YEAR	1972	1973	1974	1975	1976	1977	1978
TOTAL N	102932.	102187.	101347.	102171.	96448.	116712.	116412.

Table 5. SUMMARY OF YIELD PER RECRUIT CALCULATED FROM  
PARTIAL RECRUITMENT AND AVERAGE WEIGHT AT AGE  
OVER AGES 3 TO 23

F	Y/R (KG)
.001	.0007
.050	.0262
.100	.0428
.150	.0534
.200	.0603
.250	.0648
.300	.0679
.350	.0700
.400	.0715
.450	.0726
.500	.0733
.550	.0739
.600	.0744
.650	.0747
.700	.0750
.750	.0752
.800	.0754
.850	.0756
.900	.0757
.950	.0758
1.000	.0759
1.050	.0759
1.100	.0760
1.150	.0760
1.200	.0760
1.250	.0760
1.300	.0760
1.350	.0761
1.400	.0761
1.450	.0760
1.500	.0760
1.550	.0760
1.600	.0760
1.650	.0760
1.700	.0760
1.750	.0759
1.800	.0759
1.850	.0759
1.900	.0758
1.950	.0758
2.000	.0758

F0.1 IS .2660 AT A Y/R OF .0659  
AND FMAX IS 1.354 AT A Y/R OF .0761

Table 6a. Catch projections for Subarea 2+3 grenadier from cohort runs at terminal F = 0.225 - catch in 1979.

2+3GRENADEIER

CATCH PROJECTION FOR 1979

AGE	POPULATION NUMBERS	POPULATION WEIGHT	FISHING MORTALITY	CATCH NUMBERS	CATCH WEIGHT	RESIDUAL NUMBERS	RESIDUAL WEIGHT
3	204208	3063	.000	6	0	175758	2636
4	30894	927	.000	3	0	26588	798
5	78945	3947	.000	10	0	67940	3397
6	74651	5673	.000	14	1	64240	4882
7	230622	24446	.001	130	14	198378	21028
8	190779	27091	.001	140	20	164075	23299
9	225461	41034	.002	469	85	193622	35239
10	117328	26516	.007	710	160	100328	22674
11	76097	20774	.010	685	187	64863	17708
12	65233	21136	.016	940	304	55276	17209
13	64403	24280	.030	1794	676	53770	20271
14	40915	17675	.052	1917	828	33440	14446
15	47883	23415	.082	3507	1715	37966	19565
16	21762	11904	.082	1594	872	17255	9438
17	29557	17912	.082	2165	1312	23436	14202
18	8696	5792	.082	637	424	6895	4592
19	7700	5590	.082	564	409	6105	4432
20	4473	3515	.082	328	258	3546	2787
21	5572	4708	.082	408	345	4418	3733
22	1894	1714	.082	139	126	1502	1359
23	355	342	.082	26	25	282	271
TOTAL	1527429	291454		16185	7763	1299680	243668

Table 6b. Projections (cont.) - catch in 1980.

2+3GRENADEIER

CATCH PROJECTION FOR 1980

AGE	POPULATION NUMBERS	POPULATION WEIGHT	FISHING MORTALITY	CATCH NUMBERS	CATCH WEIGHT	RESIDUAL NUMBERS	RESIDUAL WEIGHT
3	204208	3063	.000	2	0	175761	2636
4	175758	5273	.000	5	0	151271	4538
5	26588	1329	.000	1	0	22884	1144
6	67940	5163	.000	4	0	58472	4444
7	64240	6809	.000	12	1	55280	5860
8	198378	28170	.000	49	7	170700	24239
9	164075	29862	.001	116	21	141114	25683
10	193622	43759	.002	397	90	166284	37580
11	100328	27389	.003	307	84	86069	23497
12	64863	21016	.005	318	103	55533	17993
13	55276	20839	.010	527	199	47088	17752
14	53770	23228	.018	868	375	45476	19645
15	33440	16352	.028	852	417	27993	13688
16	37966	20767	.028	967	529	31781	17384
17	17255	10457	.028	440	266	14444	8753
18	23436	15608	.028	597	398	19618	13066
19	6895	5006	.028	176	128	5772	4190
20	6105	4799	.028	156	122	5111	4017
21	3546	2997	.028	90	76	2969	2508
22	4418	3998	.028	113	102	3698	3347
23	1783	1717	.028	45	44	1493	1438
TOTAL	1503888	297600		6042	2961	1288810	253403

Table 6c. Projections (cont.) - TAC in 1981.

**B+3 GRENADIER  
CATCH PROJECTION FOR 1981**

AGE	POPULATION NUMBERS	POPULATION WEIGHT	FISHING MORTALITY	CATCH NUMBERS	CATCH WEIGHT	RESIDUAL NUMBERS	RESIDUAL WEIGHT
3	204208	3063	.000	19	0	175746	2636
4	175761	5273	.000	48	1	151234	4537
5	151271	7564	.000	56	3	130149	6507
6	22884	1739	.001	13	1	19684	1496
7	58472	6198	.002	99	11	50235	5325
8	55280	7850	.002	122	17	47467	6740
9	120700	31067	.007	1067	194	145934	26560
10	141114	31892	.020	2556	578	112090	26214
11	166284	45395	.029	4466	1219	130984	37943
12	86069	27886	.047	3679	1192	70672	22898
13	55533	20936	.092	4527	1707	43607	16440
14	47088	20342	.156	6327	2733	34676	14980
15	45476	22238	.247	9293	4539	30564	14946
16	27993	15312	.247	5714	3126	18814	10291
17	31781	19260	.247	6487	3931	21360	12244
18	14444	9620	.247	2948	1964	9708	6465
19	19618	14243	.247	4005	2907	13135	9572
20	5772	4537	.247	1178	926	3879	3049
21	5111	4318	.247	1043	882	3435	2902
22	2969	2687	.247	606	540	1995	1806
23	5191	4999	.247	1060	4020	3489	3360
TOTAL	1493018	306418		55303	27500	1233906	238312

Table 6d. Projections (cont.) - F<sub>0.1</sub> in 1982.

**B+3 GRENADIER  
CATCH PROJECTION FOR 1982**

AGE	POPULATION NUMBERS	POPULATION WEIGHT	FISHING MORTALITY	CATCH NUMBERS	CATCH WEIGHT	RESIDUAL NUMBERS	RESIDUAL WEIGHT
3	204208	3063	.000	20	0	175745	2636
4	175746	5272	.000	52	2	151218	4537
5	151234	7562	.000	60	3	130113	6506
6	130149	9891	.001	80	6	111945	6508
7	19684	2087	.002	36	4	16909	1792
8	50235	7133	.003	119	17	43128	6124
9	47467	8639	.007	319	58	40560	7382
10	145934	32981	.021	2840	642	122975	27792
11	112090	32512	.032	3436	938	99318	27114
12	130984	45031	.051	6378	2066	113717	36844
13	70672	26643	.099	6175	2328	55112	20777
14	43607	18838	.168	6265	2707	31737	13711
15	34676	16957	.266	7546	3690	22875	11186
16	30564	16718	.266	6651	3638	20162	11029
17	18814	11401	.266	4094	2481	12411	7521
18	21360	14226	.266	4648	3096	14091	9384
19	9708	7048	.266	2413	1534	6404	4649
20	13105	10363	.266	2869	2255	8698	6837
21	3879	3278	.266	844	713	2559	2162
22	3435	3108	.266	747	676	2266	2051
23	5484	5281	.266	1193	1149	3618	3484
TOTAL	1438114	288033		56485	28003	1185561	222026

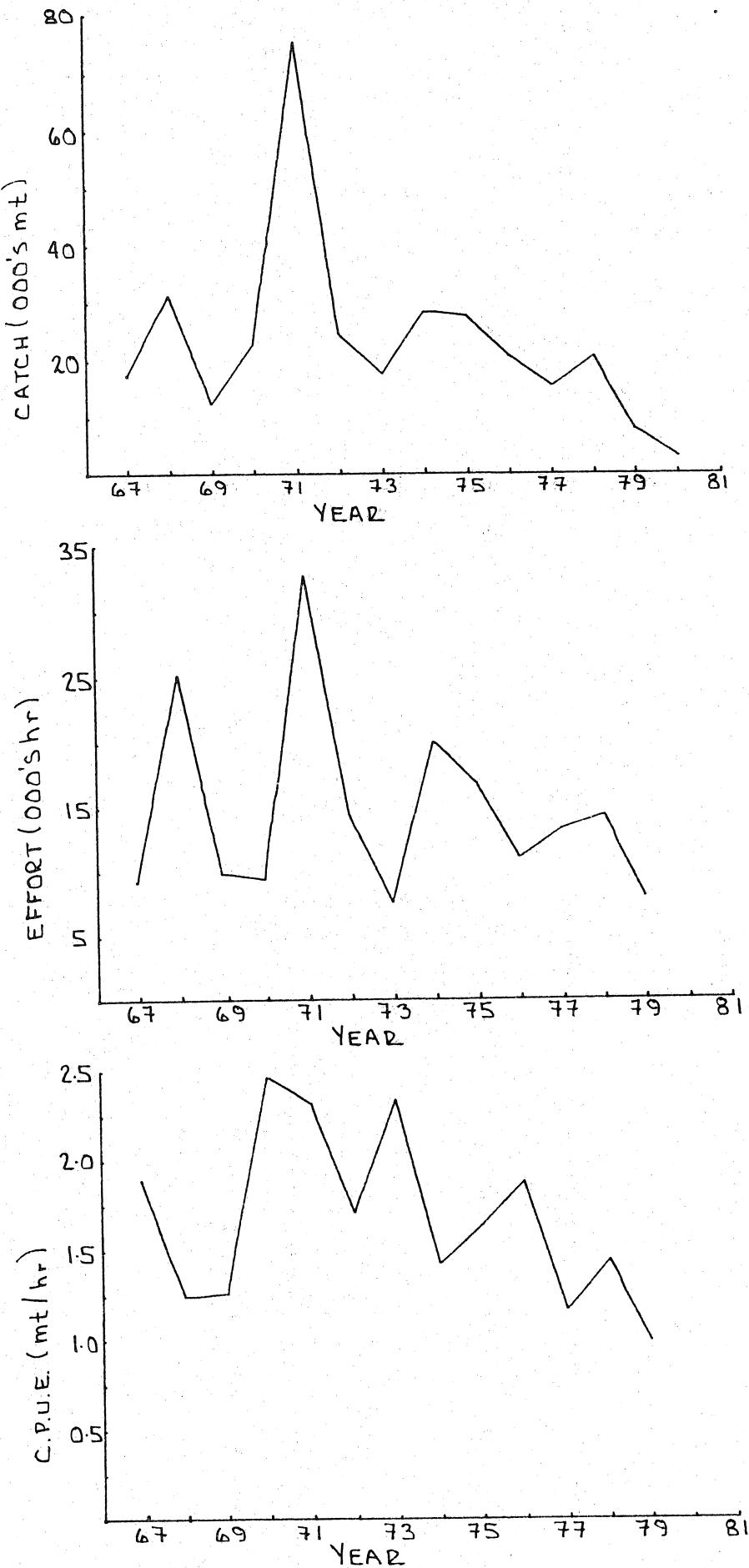


Fig. 1. Catch, effort (standardized) and CPUE (standardized) for roundnose grenadier in NAFO Subareas 2+3.

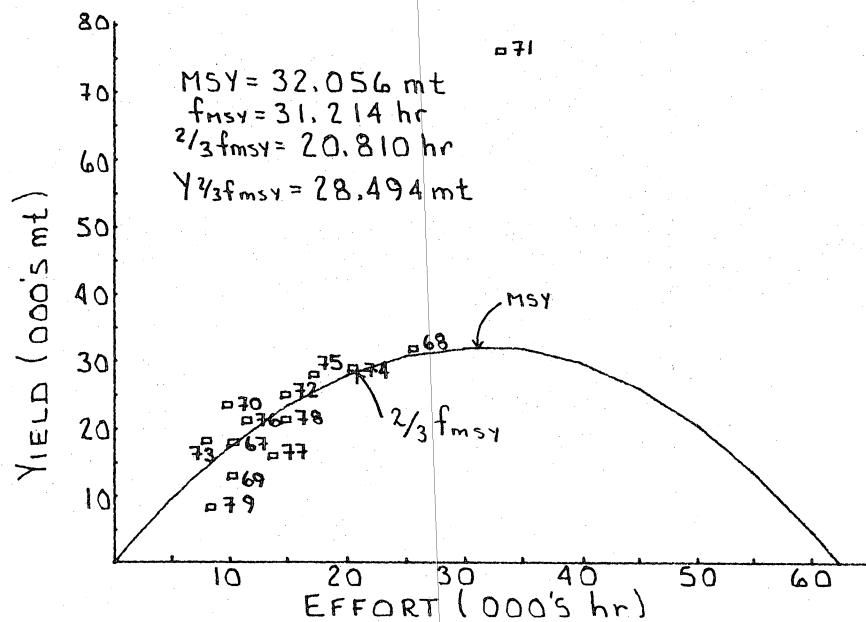
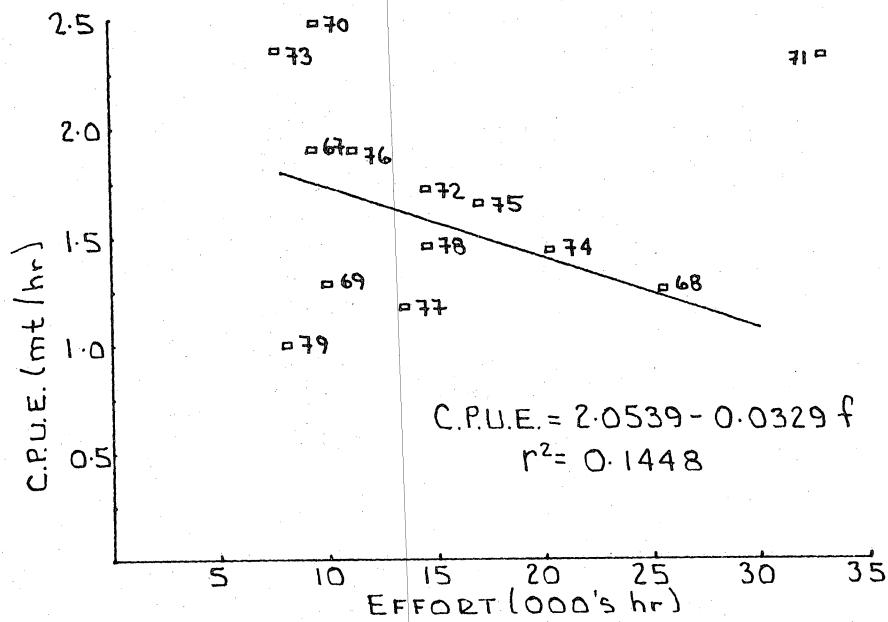


Fig. 2. Regression of CPUE on effort and resulting yield curve for grenadier from NAFO Subareas 2+3.

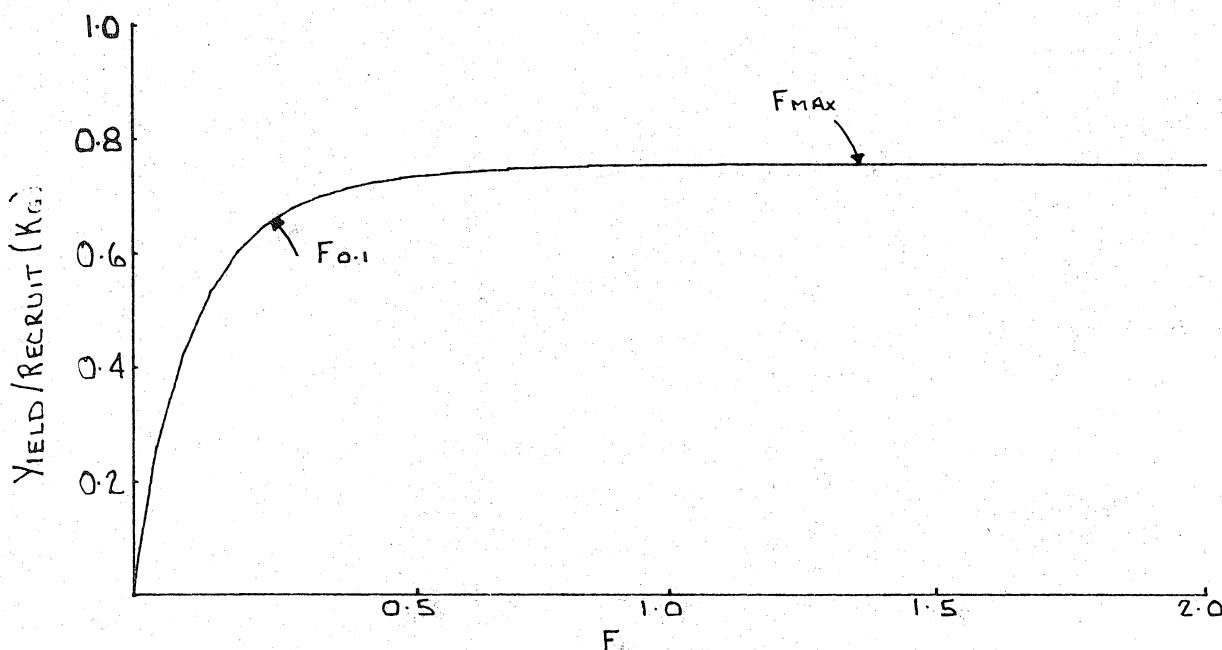


Fig. 3. Yield per recruit curve for roundnose grenadier from NAFO Subareas 2+3 (Thompson and Bell, 1934).