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Roundnose Grenadier (*Coryphaenoides rupestris*) in NAFO Subareas 0+1 and 2+3

PART A

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PART B

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Introduction

The roundnose grenadier fishery began in 1967 in Div. 3K with subsequent expansion to waters off Labrador, Baffin Island and West Greenland. Prior to 1979, nominal catches of roundnose grenadier in SA 2+3 were greater than 20,000 t in most years (Table 1, Figure 1), but declined to only about 2000 t in 1980. Catches have increased somewhat in recent years, fluctuating around 6,000-8,000 t during 1986-1989. The increases in recent years are due to increased catches by the USSR, and to some extent, moderate increases by GDR (Table 2b). Portugal has reported catches in recent years, primarily from Div. 3L. Catches continue to be greatest in the second half of the year (Table 3b).

Attempts to assess the roundnose grenadier stocks through use of trawl surveys has not been successful because the surveys do not cover the entire range of the distribution of these fish. The present work attempts to assess the stock and potential catch of roundnose grenadier in subareas 2+3 using combined fisheries data from the USSR and GDR fisheries. In addition, updated catch information for subareas 0+1 is presented.

PART A

MATERIALS AND METHODS

Abundance and biomass of the exploited part of the roundnose grenadier stock in Subareas 2+3 are estimated using VPA. Numbers and mean weights in catches by age group and years of fishing (Table 4) are obtained from combined data of USSR and GDR for 1979-1988. For 1989 the USSR data were taken as basic which were recalculated using the preliminary estimate of the international catch. The quantitative composition of the catches and mean weights by age group and year of fishing were estimated using combined

age-length key for 1969-1988. The rationale of using this combined key for roundnose grenadier in Subareas 2+3 is the consistency in linear and weight growth rates of roundnose grenadier in those years.

The stock status analysis and TAC estimation use natural mortality rate of $M_{0.15}$ which is constant for all age groups.

To find the start rates of fishing mortality, VPA tuning techniques described in Pope and Shepherd (1983) were applied. This or that technique was selected based on maximum coefficients of correlation between fishing mortality and effort by age group as well as minimum error provided by tuning technique calculated on dependent and independent parts of data.

The stock status and TAC for 1991 are predicted with coefficients of partial recruitment calculated using Rivard method (1983) taken into account.

Optimum exploitation parameters for the roundnose grenadier stock in Subareas 2+3 are obtained using Thompson-Bell method described in Ricker (1975) (Fig. 2).

RESULTS AND DISCUSSION

The stock has been estimated for age groups 2 to 19 years. The more realistic estimates of abundance by age group and their dynamics in the preceding years were derived when tuning by "i"-method (Table 5) which consists in setting the below regression equation:

$$\ln \bar{N}(a,y) = L(a) + \beta(a) \ln G(a,y)$$

where $\bar{N}(a,y)$ - mean abundance of fish at age a in year y;
$G(a,y)$ - CPUE index of age group a in year y;

This equation is written for each age group without taking into account the data on the terminal year. Knowing the equation parameters and CPUE index in the last year (y_{max}) allows estimation of $\bar{N}$ in the last year, and therefore, calculation of Fs in that year by formula:

$$\bar{F}(a,y_{max}) = \frac{G(a,y_{max})}{\bar{N}(a,y_{max})}$$

The calculations are done by way of iteration to an accuracy of 0.01. F values estimated this way were taken as start values for the terminal year (Table 6). Table 7 shows the biomass estimates by age group and year of fishing.

In case of using VPA, the abundance estimate of the initial age group of the population commercial part in the terminal year (1989 two-year-olds) is most unstable. Therefore, in case of stock status prediction and TAC estimation, the value of recruitment to commercial part of the population (abundance of age 2

group) in the terminal, first, and second year under prediction is the mean for this group for 1985-1988.

The stock status prediction and TAC for 1991 with partial recruitment coefficients (Table 8) taken into account are presented in Table 9.

Abundance - 236.9×10^6 fish, biomass - 48.1×10^3 t

TAC at $F_{0.1} = 0.24$ amounts to 3.5×10^3 t

$F_{max} = 0.42$ - 5.6×10^3 t

$F_{1991} = F_{1989}$ - 6.0×10^3 t

Fig. 2 shows variations in the total catch, TAC and VPA-estimated biomass of grenadier for a number of recent years in Subareas 2 and 3. The estimated biomass is very low and, in our view, do not reflect the actual stock status of this species. This may be corroborated by comparing our estimates of the roundnose grenadier stock to those from the Japan trawl survey in Subarea 1 in 1987-1988 (see the text table below).

Biomass of roundnose grenadier estimated through VPA and by the 1987-1988 trawl survey, 10^3 tonnes

Estimating technique (country)	Subareas	Biomass	
		1987	1988
VPA (USSR)	0+1+2+3	74.8	81.6
VPA (USSR)	2+3	51.7	50.7
VPA (USSR)	0+1	23.1	30.9
Trawl survey (Japan) (Yatsu, Jorgensen, 1988)	1	43.6	45.7

Using VPA we derived some preliminary biomass estimates in Subareas 0, 1, 2, 3 for a number of years. All of them are not cited in the present paper. In 1987 the grenadier biomass was 74.8×10^3 t, and 81.6×10^3 t in 1988. The grenadier biomass in Subareas 0+1 for these years was estimated as the difference between the biomass values in Subareas 0,1,2,3 and Subareas 2,3.

It is apparent from the text table above that the roundnose grenadier biomass in Subareas 0+1 was lower than in Subarea 1 as estimated in the trawl survey (Yatsu, Jorgensen, 1988). Moreover, the authors themselves note that the biomass in Subarea 1 is underestimated because the survey did not cover the whole of the grenadier vertical distribution.

Size composition and the percentage of roundnose grenadier in catches taken from various depths differ between years and vary greatly within one year which appears to be related to the year-

to-year and seasonal vertical migrations. Availability of the roundnose grenadier concentrations for fishing gear seems to be governed by migration rates and times.

The USSR trawl surveys in Subareas 2 and 3 did not cover the greater depths (mainly down to 1000-1100 m) and, therefore, are not indicative of the actual age-length structure of the population. The trawl surveys also indicate an abrupt increase in size of roundnose grenadier with increasing depth of fishery (Savvatimsky, 1986,1987,1988,1989). Taking into account the fact that the roundnose grenadier live, according to some authors, at depths down to 2500 m (Atkinson et al., 1981), and according to others, down to 3000 m (Sahrhage,1986), it may be stated that the commercial and research fishing gear only cover the upper part of the vertical distribution of this species and our knowledge about its way of life and distribution is limited. How large is the portion of the grenadier biomass distributed at depths out of reach of the fishing gear remains unknown.

The roundnose grenadier is known to be distributed and to form concentrations not only in the Northwest Atlantic but also in the Northeast and central North Atlantic (Savvatimsky, Shibanov, 1987). Providing reliable stock estimates of roundnose grenadier as well as rationalization of the fishery are impossible unless its populational structure, which has not been studied as yet, is allowed for. The roundnose grenadier fishery off Labrador and Newfoundland has been mainly supported by immature fish coming from the spawning grounds in the central North Atlantic and Northeast Atlantic and on the Nova Scotia continental slope. In recent years a hypothesis has become common about the transport of grenadier eggs and larvae in a current system from the spawning grounds over the whole of the North Atlantic (Savvatimsky, Shibanov, 1987). This idea is corroborated by capture of 3.5 mm larvae in the Northeast Atlantic (Johnsen, 1927; Merrett, 1978) off Greenland (Jensen,1948) and of juveniles of 7-8 cm in length all along the Canada continental slope (Grigoryev, 1972).

The existing opinion suggests that the whole of the roundnose grenadier range is broken down into a number of local groups between which a large-scale exchange occurs at early life stages. Statistically reliable differences were found in roundnose grenadier living in various areas of the North Atlantic on many indications such as the form and relative size of otoliths, relative weight of brain and its sections, some morphological features, frequencies of esterase phenotypes, stability of size and sex structure of the catches, parasitofauna features (Savvatimsky, Shibanov,1987; Savvatimsky, 1982; Dushchenko, Savvatimsky, 1987; Dushchenko, 1988; Szuks,1975,1980). The North Atlantic cyclonic current circulation (the North Atlantic, Irminger, West Greenland, and Labrador Currents) make for passive westward transfer of eggs and larvae.

It is quite probable that the offspring of the roundnose grenadier living in the central North Atlantic contribute to the Northwest Atlantic population. It is also fairly plausible that eggs and larvae are transported in the Gulf Stream northwestwards, i.e. these populations are interrelated to a certain extent. That suggests that providing right stock estimates of roundnose grenadier and development of rational fishery require allowance for the extent of population insulation and amount of recruitment from eggs and larvae transported in the oceanic currents.

The above said suggests that conventional mathematical methods do not always fit the roundnose grenadier stock assessment and may lead to errors. The vertical distribution of fish and populational structure features should be taken into account when estimating the stocks.

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PART B

Subareas 0+1

Since 1980, nominal catches of roundnose grenadier have been below 1000 t in SA 0+1 (Table 1, Figure 4). In 1988 there were no reported landings by Denmark (G) (Table 2a) but Japan took about 300 t in 1987 and 250 t in 1988, and the USSR reported 120 t taken in 1988. In both years, the majority of the catch was taken in the second half of the year (Table 3a), but some landings were reported in April-June in 1988.

A general production analysis was carried out in 1985 (Atkinson MS 1985), but the lack of sufficient data has precluded any updates. Based on the results of a Canadian Survey conducted in 1986 the current TAC level of 8,000 t represents an exploitation rate of about 10%, whereas it is almost 20% based on the results of 1987 and 1988 surveys carried out by Japan and Greenland in Subarea 1 (*NAFO Sci. Coun. Rep.*, 1987, page 71; 1988, page 96).

Subareas 2+3

Methods and Results

As in previous assessments, two sets of catch and effort data exist for roundnose grenadier in SA 2+3. The first is that contained in the NAFO database for the years 1967 (start of the fishery) to 1988, and the second is that compiled by Canadian observers (FOP) for 1978-1989. The NAFO database is aggregated on a monthly basis whereas the FOP data are available on a set by set basis. For both datasets, only those catches where roundnose grenadier comprised >50% of the total catch were selected. As in the past, the category types of country-gear-tonnage class (CGT), NAFO division, month and year were used. The two new category types created for last year's assessment (the first based on percentage catch, and the second based on depth of fishing) were not used again this year. The depth category was only created to address a special issue, and the trends, over time, of the different percent levels was not different. Although the FOP data were first categorized on a set by set basis, they were aggregated by trip before input into the analyses.

Both datasets were analysed using the multiplicative model (Gavaris 1980) to derive standardized catch rates. To reduce bias associated with rounding of low values of catch and effort, all catch/effort <10 units were removed from the datasets. In addition, any category types with <5 points (except years) were removed prior to analyses. The data were not weighted.

The results of the analysis using the FOP data (Table 10) indicate that the regression is significant, explaining about 42% of the variation in the data. All of the categories were significant. Examination of the residuals (Figure 5) did not reveal any problematic outliers. The regression explained about 47% of the variation in the NAFO data (Table 11). Using these data, the month category was not significant. No outliers were detected (Figure 6).

The catch rates from the two series (Table 12, Figure 7) suggest a gradual decline over time, particularly with the longer NAFO based series. Both indicate an increase in 1984, more noticeably with the FOP data, followed by further declines. Standardized effort (Table 12, Figure 8) has gradually increased in recent years, similar to the increases in catches, and reflective of a gradual decline in catch rates.

General production analyses were not carried out on the data as these have not been successful in the recent past, and it was felt that the addition of one more point would not suddenly give meaningful results.

Commercial length frequencies for 1979-1988 from the FOP were presented last year (Atkinson and Power MS1989). Additional information, available for 1989 (Figure 9), indicates a gradual decrease in the size of fish taken over the year in both the GDR and USSR fisheries.

Estimates of the catch- and weight-at-age for 1979 through 1989 were also available this year (Table 4). In most years, there appears to be a normal distribution of ages in the catch, with the mode at about age 9 (Figure 10).

These data were input into various formulations of ADAPT. Catch rate-at-age was calculated using the FOP standardized effort series. Calibrations were attempted using all ages, and assuming both flat topped and dome shaped partial recruitment (PR) (Annex I). Results from a run assuming a domed PR are presented. Differences between this and a run assuming flat topped PR were small, the estimates only differing for ages 16-19. The parameter estimates (except age 2) were all significant (Table 13). Some of the calculated F's were very high, particularly on the older ages. Since these ages represent only a relatively small proportion of the total catches, this was not considered to be problematic. Examination of the correlation matrix (Table 14) does not reveal any serious problems. The residuals (Table 15) tend to reflect some of the inter-annual variability that exists in the catch rate series. Plots of the predicted vs. actual population data points (Fig. 11) indicate reasonable fits for many of the ages. It does appear, however, that those ages which are dominant in the catches (ages 8-13) are not fit as well.

Because of the above observation, the model was re-formulated (Annex II) so that only ages 6-13 were used for calibration. The results (Table 16, 17 and 18) indicate that the parameters were once again well estimated. The estimates of population size for ages 6-13 are lower for ages 6-9, but quite close for ages 10-13. Differences occur for other ages because the PR for these was fixed. Age by age, the estimates do not appear to be greatly improved (Fig. 12).

Annual partial recruitment was calculated from the F matrix derived from the formulation including all ages (Table 19). From this, the annual exploitable biomass (beginning of year)was calculated (Table 20). Comparison of the overall CPUE from the multiplicative model with age 6+ exploitable biomass indicates a good fit (Fig. 13). The estimates of exploitable biomass do, however, appear low. When plotted with the annual reported landings (Fig.14), it can be seen that the catch exceeded age 2+ exploitable biomass in 1986, 1987 and 1989. Based on this, the population estimates from ADAPT are thought to be too low, and are not useful as the basis for the provision of management advice.

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Final Discussion and Summary

Researchers in different laboratories have applied SPA techniques in an attempt to determine the population size of roundnose grenadier in SA 2+3. Comparison of the results for 1989 (Fig. 15) show some differences, particularly for ages 2 through 8. This is probably a result of the different calibration techniques used. The respective estimates of 1989 biomass (48.7×10^3 t in Part A, and 57.7×10^3 t in Part B) are quite close. However, both parts A and B note that the estimates of population size are low and is not representative of the stock size. An unknown portion of the population is distributed in depths greater than those presently fished, and movements between deeper and shallower areas is not well understood. From Fig. 14, it may be inferred that in recent years some changes have occurred in the distribution of the fish in relation to the fishery. Less fish may be available than in earlier years.

In conclusion, SPA does not appear to be an appropriate tool in its present form to assess roundnose grenadier in SA 2+3. Also, survey data available do not provide reasonable estimates of the stock size because all depths are not covered and the proportion of grenadier in deeper water is not known. If there is a trend in recent years for grenadier to be distributed deeper, then the decline in catch rates may reflect this movement rather than stock status.

Given the above, there are not data available upon which to base an assessment. The precautionary TAC of 11,000 t should remain in place until more information is available.

Table 1: Summary of nominal catches (t) of roundnose grenadier by Subarea and Division.

Year	0	1	Total	TAC	2G	2H	2J	3K	Other	2+3	TAC
1967	1,129	6	1,135		-	868	217	16,009	210	17,304	
1968	5,996	284	6,280		2,536	4,089	479	23,553	606	31,263	
1969	2,642	68	2,710		387	-	264	11,682	-	12,333	
1970	545	5,980	6,525		-	-	468	22,267	129	22,864	
1971	4,172	4,132	8,304		54,179	2,738	81	18,392	55	75,445	
1973	5,783	2,311	8,094		2,161	655	293	21,122	155	24,386	
1972	1,054	3,830	4,884		5,880	232	632	10,655	165	17,564	
1974	2,661	9,657	12,318		3,220	2,007	333	22,816	40	28,416	32,000
1975	204	4,749	4,953	10,000	6,489	3,536	1,754	15,388	258	27,425	32,000
1976	2,610	5,893	8,503	14,000	3,841	1,460	1,381	13,636	275	20,593	32,000
1977	721	2,214	2,935	8,000	2,597	525	206	11,935	123	15,386	35,000
1978	-	5,839	5,839	8,000	3,112	1,412	913	15,250	15	20,702	35,000
1979	106	6,815	6,921	8,000	1,035	3,090	438	3,200	18	7,781	35,000
1980	32	1,721	1,753	8,000	279	493	726	451	104	2,053	30,000
1981	87	392	479	8,000	967	1,693	463	3,920	42	7,085	27,000
1982	43	48	91	8,000	719	734	182	2,709	-	4,344	27,000
1983	46	22	68	8,000	140	1,390	36	1,916	87	3,569	11,000
1984	25	25	50	8,000	107	289	3	3,362	112	3,873	11,000
1985	16	39	55	8,000	-	80	13	4,642	213	4,948	11,000
1986	1	85	86	8,000	-	117	53	7,222	32	7,424	11,000
1987	-	377	377	8,000	80	254	213	6,682	1,069	8,298	11,000
1988*	260	120	380	8,000	329	226	9	4,658	1,069	6,291	11,000
1989*	-	-	2	8,000	-	-	-	-	-	5,240	11,000
1990				8,000							11,000

* Provisional.

Table 2a: Nominal catches (t) of roundnose grenadier in Subarea 0+1 by country and year.

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988*	1989*
Denmark (G)	32	21	-	39	37	22	25	36	81	58	-	-
GDR	-	-	-	-	-	-	-	14	-	-	-	-
FRG	5,807	6,794	1,721	353	11	-	-	-	-	-	-	-
USSR	-	106	32	87	43	46	25	2	1	-	120	1
Norway	-	-	-	-	-	-	-	-	-	-	-	1
Japan	-	-	-	-	-	-	-	3	4	319	260	-
TOTAL	5,839	6,921	1,753	479	91	68	50	55	86	377	380	2

*Provisional.

Table 2b: Nominal catches (t) of roundnose grenadier in Subarea 2+3 by country and year.

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988*	1989*
Canada (M)+	2	-	-	-	-	-	-	-	9	10	-	-
Canada (N)	7	4	-	-	-	-	-	-	-	-	-	-
FRG	973	-	32	-	-	-	23	178	13	-	8	-
GDR	1,801	480	898	1,407	1,640	2,586	3,650	3,740	4,571	4,469	3,380	2,352
Poland	51	96	36	18	15	50	51	12	17	1	17	17
Romania	108	-	-	-	-	-	-	-	-	-	-	-
USSR	17,760	7,201	1,087	5,660	2,689	933	147	1,018	2,801	2,725	1,890	2,552
Japan	-	-	-	-	-	-	2	-	13	79	85	2
EEC	-	-	-	-	-	-	-	-	-	-	-	290
Portugal	-	-	-	-	-	-	-	-	3	1,001	911	-
Faroes	-	-	-	-	-	-	-	-	-	9	-	-
Norway	-	-	-	-	-	-	-	-	-	-	-	27
Cuba	-	-	-	-	-	-	-	-	-	4	-	-
TOTAL	20,702	7,781	2,053	7,085	4,344	3,569	3,873	4,948	7,427	8,298	6,291	5,240

*Provisional.

+Maritimes and Quebec were combined prior to 1979.

Table 3a: Nominal catches (t) of roundnose grenadier in Subarea 0+1 by month and year

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	
1978	139	130	723	2,554	1,943	343	4	2	1	-	-	-	5,839	
1979	605	759	348	626	1,658	1,122	123	118	1	185	545	831	6,921	
1980	686	385	-	-	-	-	-	418	117	118	23	6	1,753	
1981	1	4	13	12	1	2	-	-	170	245	17	8	479	b
1982	1	3	9	6	4	11	1	3	-	14	25	7	91	a
1983	-	3	6	5	1	-	-	-	7	5	21	14	68	b
1984	-	2	6	8	1	1	-	14	14	2	-	2	50	
1985	1	6	8	6	3	1	-	-	5	2	19	4	55	
1986	3	3	8	44	11	2	4	1	2	2	2	3	86	c
1987	-	-	-	-	-	-	-	48	180	-	87	4	377	d
1988*	-	-	-	3	45	18	-	173	2	134	4	1	380	
1989*	-	-	-	-	-	-	-	-	2	-	-	-	2	

a includes 7 t from month 'unknown'; b includes 6 t from month 'unknown'.

c includes 1 t from month 'unknown'; d includes 58 t from month 'unknown'; * Provisional

Table 3b: Nominal catches (t) of roundnose grenadier in Subarea 2+3 by month and year

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	
1978	264	467	13	45	7	405	6,416	3,963	1,814	3,964	1,478	1,866	20,702	
1979	103	32	44	6	136	683	1,169	1,612	1,691	611	745	949	7,781	
1980	3	4	48	13	2	-	-	130	376	794	577	106	2,053	
1981	40	14	1	2	4	1	168	1,636	1,391	759	1,751	1,318	7,085	
1982	4	-	3	5	3	4	559	563	410	698	1,465	630	4,344	
1983	3	18	4	-	3	1	1	74	1,292	861	866	446	3,569	
1984	31	13	6	19	-	5	-	45	460	3,018	123	153	3,873	
1985	44	7	1	96	73	-	54	873	1,869	1,361	537	33	4,948	
1986	9	5	-	-	-	-	117	2,818	2,093	1,555	494	336	7,427	
1987	71	111	45	96	75	5	22	2,732	1,633	1,561	1,319	628	8,298	
1988*	415	33	37	-	8	87	841	837	690	1,484	1,608	251	6,291	
1989*	76	23	24	6	1	51	574	1,593	704	1,083	1,002	71	5,283	a

a includes 75 t from month 'unknown'; * Provisional.

Table 4. Catch- and weight-at-age for roundnose grenadiers in SA 2+3, 1979-1989.

A. Catch-at-age

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	38	41	58	41	140	19	235	235	65	15	82
3	45	35	207	77	195	70	326	453	519	161	455
4	63	44	285	147	239	129	425	530	1170	466	788
5	135	89	456	319	409	255	767	890	1973	995	1294
6	274	164	613	504	506	436	959	1054	2196	1360	1370
7	545	282	924	815	661	695	1411	1595	2629	1826	1662
8	981	375	1205	1102	773	896	1616	1958	3142	2366	2037
9	1282	423	1352	1169	759	958	1547	1955	2921	2295	1992
10	1559	473	1527	1119	704	914	1403	1929	2537	2026	1722
11	1681	479	1607	989	638	799	1061	1604	1837	1502	1345
12	1714	445	1544	858	620	699	897	1435	1381	1143	1104
13	1267	298	1069	543	447	462	607	1018	770	634	711
14	992	211	782	368	350	338	324	591	400	324	433
15	595	115	421	185	224	203	184	383	192	147	247
16	356	68	236	98	139	126	99	226	96	69	139
17	203	35	124	44	86	81	54	140	59	40	90
18	57	7	27	6	27	36	9	36	12	4	19
19	28	3	12	3	23	23	9	24	7	1	11

B. Weight-at-age

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.052	0.049	0.052	0.049	0.050	0.052	0.051	0.051	0.062	0.065	0.073
3	0.089	0.086	0.092	0.104	0.087	0.100	0.089	0.086	0.108	0.112	0.099
4	0.142	0.135	0.130	0.143	0.134	0.140	0.134	0.132	0.141	0.148	0.132
5	0.192	0.190	0.180	0.188	0.181	0.188	0.176	0.173	0.185	0.199	0.177
6	0.266	0.262	0.253	0.256	0.247	0.257	0.243	0.242	0.230	0.242	0.230
7	0.330	0.316	0.314	0.319	0.310	0.315	0.292	0.294	0.278	0.288	0.281
8	0.420	0.400	0.400	0.394	0.387	0.394	0.352	0.358	0.346	0.355	0.349
9	0.482	0.470	0.471	0.455	0.452	0.456	0.406	0.419	0.403	0.410	0.408
10	0.562	0.554	0.558	0.536	0.537	0.534	0.474	0.492	0.460	0.467	0.472
11	0.646	0.632	0.639	0.621	0.635	0.621	0.560	0.578	0.545	0.548	0.563
12	0.730	0.714	0.720	0.706	0.726	0.710	0.641	0.658	0.598	0.600	0.626
13	0.815	0.795	0.798	0.784	0.815	0.799	0.705	0.731	0.688	0.685	0.726
14	0.892	0.875	0.873	0.855	0.897	0.885	0.806	0.839	0.768	0.760	0.817
15	1.006	0.994	0.988	0.967	1.027	1.021	0.920	0.975	0.905	0.877	0.943
16	1.050	1.044	1.033	1.011	1.074	1.073	1.011	1.052	0.976	0.940	1.008
17	1.165	1.142	1.141	1.106	1.193	1.219	1.024	1.113	1.034	0.977	1.070
18	1.353	1.257	1.315	1.222	1.365	1.425	1.290	1.346	1.326	1.113	1.292
19	1.460	1.332	1.433	1.335	1.538	1.545	1.408	1.434	1.495	1.454	1.476

Table 5. Abundance of roundnose grenadier by age group and year of fishery, 10^6 fish

Age group	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	44.21	46.29	46.54	45.79	45.69	45.86	46.75	47.16	47.02	46.96	46.52
3	35.09	38.02	39.80	40.01	39.38	39.20	39.45	40.02	40.38	40.41	40.40
4	27.22	30.16	32.69	34.06	34.36	33.71	33.67	33.65	34.03	34.27	34.63
5	21.02	23.37	25.92	27.87	29.18	29.35	28.90	28.59	28.48	28.20	28.06
6	16.40	17.97	20.03	21.89	23.69	24.74	25.03	24.16	23.78	23.68	23.35
7	12.74	13.86	15.32	16.67	18.37	19.92	20.89	20.65	19.82	19.44	18.21
8	10.44	10.46	11.67	12.33	13.66	15.20	16.51	16.67	16.30	14.63	14.18
9	8.86	8.08	8.66	8.93	9.59	10.99	12.25	12.71	12.54	11.13	10.40
10	7.29	6.44	6.56	6.20	6.60	7.55	8.57	9.12	9.13	8.09	7.46
11	5.53	4.84	5.10	4.24	4.36	5.03	5.65	6.08	6.06	5.52	5.10
12	4.21	3.21	3.72	2.91	2.73	3.11	3.59	3.89	3.75	3.52	3.36
13	2.70	2.05	2.35	1.78	1.71	1.78	2.04	2.26	2.02	1.96	1.98
14	1.76	1.16	1.49	1.04	1.03	1.06	1.11	1.19	1.01	1.03	1.09
15	1.00	0.61	0.80	0.56	0.56	0.57	0.60	0.65	0.48	0.50	0.52
16	0.48	0.32	0.42	0.31	0.31	0.27	0.30	0.35	0.21	0.24	0.30
17	0.25	0.09	0.21	0.14	0.17	0.14	0.12	0.17	0.09	0.09	0.14
18	0.07	0.03	0.04	0.07	0.08	0.07	0.05	0.05	0.02	0.03	0.04
19	0.04	0.01	0.02	0.01	0.05	0.04	0.03	0.03	0.01	0.00	0.02
Total	199.3	207.0	221.3	224.8	231.4	238.6	245.5	247.4	245.1	237.7	236.9

Table 6. Fishing mortality rates of roundnose grenadier

Age group	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.0009	0.0010	0.0013	0.0010	0.0033	0.0004	0.0054	0.0054	0.0015	0.0005	0.0016
3	0.0014	0.0010	0.0056	0.0021	0.0053	0.0019	0.0089	0.0123	0.0139	0.0043	0.0122
4	0.0025	0.0016	0.0094	0.0047	0.0075	0.0041	0.0137	0.0171	0.0377	0.0147	0.0248
5	0.0069	0.0041	0.0191	0.0124	0.0152	0.0094	0.0290	0.0341	0.0775	0.0387	0.0491
6	0.0182	0.0099	0.0335	0.0251	0.0233	0.0192	0.0421	0.0481	0.1046	0.0667	0.0652
7	0.0471	0.0221	0.0671	0.0540	0.0395	0.0383	0.0754	0.0867	0.1538	0.1126	0.1030
8	0.1065	0.0393	0.1177	0.1011	0.0631	0.0655	0.1113	0.1350	0.2319	0.1909	0.1677
9	0.1691	0.0580	0.1836	0.1517	0.0890	0.0985	0.1458	0.1806	0.2876	0.2503	0.2212
10	0.2607	0.0824	0.2874	0.2154	0.1218	0.1394	0.1934	0.2577	0.3536	0.3126	0.2845
11	0.3944	0.1126	0.4117	0.2883	0.1735	0.1871	0.2251	0.3326	0.3925	0.3450	0.3327
12	0.5714	0.1615	0.5866	0.3800	0.2790	0.2755	0.3118	0.5030	0.5008	0.4267	0.4331
13	0.6946	0.1701	0.6658	0.3957	0.3285	0.3263	0.3851	0.6548	0.5232	0.4262	0.4851
14	0.9166	0.2171	0.8231	0.4768	0.4514	0.4174	0.3772	0.7529	0.5494	0.4103	0.5466
15	0.9951	0.2280	0.8166	0.4351	0.5649	0.4850	0.3970	0.9799	0.5533	0.3758	0.5947
16	1.5504	0.2593	0.9296	0.4204	0.6438	0.6841	0.4368	1.1664	0.6665	0.3700	0.6916
17	1.9346	0.5605	0.9725	0.4069	0.7562	0.9406	0.6715	2.1432	1.1172	0.6142	1.1162
18	1.7710	0.2768	1.1064	0.0981	0.4429	0.7971	0.2273	1.3304	1.4081	0.1789	0.6311
19	1.7300	0.3612	0.9935	0.3062	0.6091	0.7965	0.4395	1.5088	0.9971	0.3604	0.9674
2-19	0.0813	0.0196	0.0724	0.0444	0.0350	0.0351	0.0565	0.0809	0.1089	0.0778	0.0783

Table 7. Biomass of roundnose grenadier by age group and year of fishery, 10^3 t

Age group	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	2.30	2.27	2.42	2.24	2.28	2.38	2.38	2.41	2.92	3.05	3.46
3	3.12	3.27	3.66	4.16	3.43	3.92	3.51	3.44	4.36	4.53	4.09
4	3.87	4.07	4.25	4.87	4.60	4.72	4.51	4.44	4.80	4.57	4.57
5	4.04	4.44	4.67	5.24	5.25	5.52	5.09	4.95	5.27	5.07	5.14
6	4.36	4.71	5.07	5.60	5.85	6.36	6.08	5.85	5.47	5.61	5.37
7	4.21	4.38	4.81	5.32	5.70	6.28	6.10	6.07	5.51	5.49	5.13
8	4.38	4.19	4.67	4.86	5.26	5.99	5.81	5.97	5.64	5.31	5.35
9	4.27	3.80	4.08	4.06	4.33	5.01	4.98	5.33	5.05	5.19	4.95
10	4.10	3.57	3.66	3.32	3.55	4.03	4.06	4.48	4.20	4.56	4.24
11	3.57	3.06	3.26	2.63	2.79	3.12	3.17	3.51	3.30	3.78	3.52
12	3.07	2.29	2.68	2.05	1.96	2.21	2.30	2.56	2.24	3.02	2.87
13	2.20	1.63	1.87	1.40	1.46	1.42	1.43	1.65	1.39	2.11	2.11
14	1.57	1.02	1.30	0.89	0.93	0.94	0.89	1.00	0.78	1.34	1.44
15	1.01	0.60	0.79	0.54	0.57	0.58	0.55	0.64	0.44	0.78	0.90
16	0.50	0.33	0.43	0.31	0.34	0.29	0.30	0.37	0.21	0.44	0.56
17	0.29	0.10	0.24	0.16	0.21	0.17	0.12	0.19	0.10	0.22	0.30
18	0.10	0.04	0.06	0.08	0.11	0.10	0.06	0.07	0.02	0.08	0.15
19	0.05	0.01	0.03	0.02	0.08	0.07	0.04	0.05	0.02	0.01	0.06
Total	47.0	43.8	47.9	47.8	48.6	53.1	51.4	53.0	51.7	50.7	48.7

Table 8. Partial recruitment coefficients of round-nose grenadier by age group

Age group	Partial recruitment coefficient
2	0,2872
3	0,1004
4	0,2960
5	0,1198
6	0,3258
7	0,1687
8	0,3136
9	0,2670
10	0,5198
11	0,3934
12	0,6006
13	0,5529
14	0,8187
15	0,6544
16	0,8395
17	1,0000
18	0,7884
19	0,7016

Table 9. Roundnose grenadier stock status and TAC prediction for 1991 in Subareas 2+3 at a constant natural mortality rate (M=0.15)

Age group	1989		1990			1991				
	Abund., 10^6 fis	F	Abund., 10^6 fish	Biomass 10^3t	TAC, 10^3t F_{1989}	Abund., 10^6 fish	Biomass 10^3 t	TAC, 10^3 t F_{1989}	TAC, 10^3 t $F_{max=0.42}$	TAC 10^3t $F_{0.1}$= 0.24
2	46.97	0.0019	46.97	3.43	0.01	46.97	3.43	0.01	0.36	0.21
3	40.40	0.0122	40.35	3.99	0.04	40.35	3.99	0.04	0.14	0.08
4	34.63	0.0248	34.35	4.53	0.10	34.31	4.53	0.10	0.48	0.28
5	29.06	0.0491	29.08	5.15	0.23	28.84	5.11	0.23	0.21	0.13
6	23.35	0.0652	23.82	5.48	0.32	23.83	5.48	0.32	0.65	0.39
7	18.26	0.1030	18.83	5.29	0.48	19.21	5.40	0.49	0.32	0.20
8	14.18	0.1677	14.18	4.95	0.71	14.62	5.10	0.73	0.60	0.37
9	10.40	0.2212	10.32	4.21	0.78	10.32	4.21	0.78	0.43	0.27
10	7.46	0.2848	7.18	3.39	0.78	7.12	3.36	0.78	0.68	0.43
11	5.10	0.3327	4.83	2.72	0.72	4.65	2.62	0.69	0.40	0.26
12	3.36	0.4331	3.15	1.97	0.65	2.98	1.86	0.61	0.46	0.30
13	1.98	0.4851	1.88	1.36	0.49	1.76	1.27	0.46	0.29	0.20
14	1.10	0.5466	1.05	0.86	0.34	0.99	0.81	0.32	0.28	0.19
15	0.59	0.5947	0.55	0.52	0.22	0.52	0.49	0.21	0.14	0.09
16	0.30	0.6916	0.28	0.28	0.13	0.26	0.26	0.12	0.10	0.07
17	0.14	1.1162	0.13	0.14	0.09	0.12	0.13	0.08	0.06	0.04
18	0.04	0.6311	0.04	0.05	0.02	0.04	0.05	0.02	0.02	0.02
19	0.02	0.9674	0.02	0.03	0.02	0.02	0.03	0.02	0.01	0.01
	237.4		237.0	48.3	6.1	236.9	48.1	6.0	5.6	3.5

Table 10. Regression of the multiplicative model for roundnose grenadiers in SA 2+3 using the FOP data, 1978-1989.

MULTIPLE R..... 0.651
MULTIPLE R SQUARED..... 0.424

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.315E1	2.315E1	
REGRESSION	22	3.691E1	1.678E0	10.470
CGT	3	1.419E0	4.731E-1	2.953
Division	3	1.390E0	4.633E-1	2.891
Month	5	4.110E0	8.220E-1	5.130
Year	11	2.325E1	2.113E0	13.188
RESIDUALS	313	5.015E1	1.602E-1	
TOTAL	336	1.102E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	20127	INTERCEPT	-0.252	0.135	336
2	31				
3	10				
4	78				
1	11125	1	-0.116	0.083	92
	11126	2	-0.104	0.079	67
	11127	3	-0.222	0.076	58
2	21	4	0.246	0.110	19
	22	5	0.120	0.089	41
	23	6	-0.175	0.152	13
3	7	7	0.342	0.130	16
	8	8	0.059	0.073	71
	9	9	-0.063	0.065	87
	11	10	0.143	0.072	62
	12	11	-0.318	0.126	13
4	79	12	0.164	0.317	2
	80	13	0.671	0.197	12
	81	14	0.273	0.144	35
	82	15	0.263	0.151	23
	83	16	-0.271	0.170	21
	84	17	0.714	0.175	22
	85	18	0.027	0.152	34
	86	19	0.178	0.144	41
	87	20	0.022	0.137	46
	88	21	-0.312	0.138	42
	89	22	-0.432	0.133	45

Table 11. Regression of the multiplicative model for roundnose grenadiers in SA 2+3 using the NAFO data, 1967-1988.

MULTIPLE R..... 0.686
MULTIPLE R SQUARED..... 0.470

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.868E0	3.868E0	
REGRESSION	38	4.222E1	1.111E0	5.187
CGT	7	4.162E0	5.946E-1	2.776
Month	7	1.134E0	1.620E-1	0.756
Division	3	1.664E0	5.547E-1	2.590
Year	21	2.448E1	1.166E0	5.443
RESIDUALS	222	4.755E1	2.142E-1	
TOTAL	261	9.365E1		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	20127	INTERCEPT	0.447	0.341	261
2	10				
3	31				
1	11115	1	-0.367	0.266	5
	11116	2	-0.557	0.280	5
	11125	3	-0.175	0.129	27
	11126	4	-0.255	0.209	6
	11127	5	0.135	0.103	37
	20126	6	0.055	0.139	16
	20157	7	0.247	0.099	36
2	1	8	-0.298	0.211	6
	6	9	0.108	0.209	6
	7	10	0.035	0.136	18
	8	11	0.091	0.100	40
	9	12	-0.045	0.089	56
	11	13	0.032	0.095	54
	12	14	-0.066	0.126	21
3	21	15	-0.031	0.086	75
	22	16	0.151	0.093	56
	23	17	-0.169	0.134	21
4	68	18	-0.308	0.331	16
	69	19	-0.231	0.465	2
	70	20	0.339	0.368	10
	71	21	0.044	0.351	18
	72	22	-0.204	0.374	8
	73	23	0.325	0.389	6
	74	24	-0.014	0.367	11
	75	25	0.090	0.363	14
	76	26	-0.216	0.364	11
	77	27	-0.327	0.355	17
	78	28	-0.183	0.348	29
	79	29	-0.610	0.347	28
	80	30	-0.407	0.360	14
	81	31	-0.763	0.352	17
	82	32	-0.661	0.358	12
	83	33	-0.675	0.393	5
	84	34	-0.506	0.451	3
	85	35	-0.837	0.382	8
	86	36	-0.691	0.380	9
	87	37	-0.845	0.376	10
	88	38	-0.929	0.368	10

Table 12. Standardized CPUE and effort for roundnose grenadiers in SA 2+3 from the multiplicative model.

A. From the FOP data.

STANDARDS USED VARIABLE NUMBERS: 20127 31 10

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
78	-0.2517	0.0183	0.835	0.113	20702	24798
79	-0.0877	0.0973	0.945	0.288	7781	8230
80	0.4194	0.0252	1.628	0.257	2053	1261
81	0.0214	0.0120	1.100	0.120	7085	6438
82	0.0109	0.0111	1.089	0.115	4344	3987
83	-0.5231	0.0170	0.637	0.083	3569	5605
84	0.4620	0.0151	1.707	0.210	3873	2269
85	-0.2244	0.0107	0.861	0.089	4948	5745
86	-0.0742	0.0082	1.002	0.091	7427	7412
87	-0.2300	0.0085	0.857	0.079	8279	9657
88	-0.5636	0.0100	0.614	0.061	6337	10326
89	-0.6833	0.0081	0.545	0.049	5240	9615

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.128

B. From the NAFO data.

STANDARDS USED VARIABLE NUMBERS: 20127 10 31

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
67	0.4470	0.1162	1.642	0.545	17304	10535
68	0.1385	0.0320	1.259	0.224	31263	24838
69	0.2157	0.1094	1.308	0.422	12333	9430
70	0.7860	0.0277	2.410	0.400	22864	9486
71	0.4906	0.0198	1.801	0.253	75445	41895
72	0.2428	0.0318	1.397	0.248	24386	17455
73	0.7721	0.0481	2.353	0.511	17564	7466
74	0.4333	0.0293	1.692	0.288	28416	16790
75	0.5367	0.0277	1.878	0.311	27425	14600
76	0.2312	0.0288	1.383	0.233	20593	14888
77	0.1205	0.0206	1.243	0.178	15386	12376
78	0.2644	0.0167	1.439	0.186	20702	14391
79	-0.1630	0.0170	0.938	0.122	7781	8295
80	0.0400	0.0220	1.146	0.169	2053	1791
81	-0.3158	0.0205	0.804	0.115	7085	8816
82	-0.2140	0.0246	0.888	0.139	4344	4892
83	-0.2280	0.0498	0.865	0.191	3569	4128
84	-0.0592	0.0914	1.002	0.297	3873	3863
85	-0.3898	0.0349	0.741	0.138	4948	6677
86	-0.2443	0.0321	0.858	0.153	7427	8653
87	-0.3977	0.0320	0.736	0.131	8279	11245
88	-0.4818	0.0297	0.678	0.116	6337	9351

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.187

Table13: Parameter, population and fishing mortality estimates from ADAPT analysis (all ages) of roundnose grenadier in SA 2+3.

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.013012
MEAN SQUARE RESIDUALS 0.263734

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
2	ABUNDANCE	3.79528E4	2.08395E4	1.82120E0	0.55
3	ABUNDANCE	1.95108E4	7.67404E3	2.54244E0	0.39
4	ABUNDANCE	3.03310E4	9.86413E3	3.07488E0	0.33
5	ABUNDANCE	5.19958E4	1.48313E4	3.50581E0	0.29
6	ABUNDANCE	4.88199E4	1.27162E4	3.83918E0	0.26
7	ABUNDANCE	2.64199E4	6.61710E3	3.99267E0	0.25
8	ABUNDANCE	2.07828E4	5.07085E3	4.09848E0	0.24
9	ABUNDANCE	1.22486E4	3.17457E3	3.85834E0	0.26
10	ABUNDANCE	6.73722E3	1.97733E3	3.40723E0	0.29
11	ABUNDANCE	4.94528E3	1.52888E3	3.23457E0	0.31
12	ABUNDANCE	2.09230E3	7.46135E2	2.80418E0	0.36
13	ABUNDANCE	1.01283E3	3.63471E2	2.78654E0	0.36
14	ABUNDANCE	5.52200E2	1.78778E2	3.08874E0	0.32
15	ABUNDANCE	3.05243E2	9.25490E1	3.29818E0	0.30
16	ABUNDANCE	1.65637E2	4.42298E1	3.74492E0	0.27
17	ABUNDANCE	1.01512E2	1.76904E1	5.73824E0	0.17
18	ABUNDANCE	2.69259E1	9.66507E0	2.78590E0	0.36
19	ABUNDANCE	1.43938E1	4.63468E0	3.10567E0	0.32
2	CE SLOPE	2.27799E-7	4.43479E-8	5.13663E0	0.19
3	CE SLOPE	7.04834E-7	1.29329E-7	5.44995E0	0.18
4	CE SLOPE	1.27240E-6	2.24195E-7	5.67543E0	0.18
5	CE SLOPE	2.83996E-6	4.85089E-7	5.85450E0	0.17
6	CE SLOPE	5.16919E-6	8.62701E-7	5.99187E0	0.17
7	CE SLOPE	1.02742E-5	1.68538E-6	6.09605E0	0.16
8	CE SLOPE	1.77013E-5	2.86911E-6	6.16960E0	0.16
9	CE SLOPE	2.55722E-5	4.12118E-6	6.20507E0	0.16
10	CE SLOPE	3.53494E-5	5.68193E-6	6.22138E0	0.16
11	CE SLOPE	4.50240E-5	7.21201E-6	6.24291E0	0.16
12	CE SLOPE	6.27243E-5	1.00895E-5	6.21680E0	0.16
13	CE SLOPE	7.05102E-5	1.14164E-5	6.17621E0	0.16
14	CE SLOPE	7.92519E-5	1.28709E-5	6.15747E0	0.16
15	CE SLOPE	8.04945E-5	1.30753E-5	6.15624E0	0.16
16	CE SLOPE	8.54756E-5	1.38765E-5	6.15972E0	0.16
17	CE SLOPE	1.00341E-4	1.64269E-5	6.10834E0	0.16
18	CE SLOPE	5.38600E-5	9.00195E-6	5.98315E0	0.17
19	CE SLOPE	5.07611E-5	8.51091E-6	5.96424E0	0.17

Table 13: Continued

POPULATION NUMBERS (000S) 6/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	38521	45700	44118	51000	61839	63036	93043	93023	41161
3	30790	33120	39296	37919	43858	53096	54238	79365	71240
4	24811	26459	28474	33630	32566	37568	45635	46380	68320
5	19805	21296	22733	24243	28809	27808	32215	38884	39428
6	15862	16921	18247	19143	20570	24417	23698	27016	32642
7	12607	13399	14412	15137	16009	17236	20611	19507	22275
8	10420	10345	11271	11547	12272	13166	14190	16431	15310
9	8887	8058	8557	8583	8916	9846	10501	10714	12326
10	7346	6460	6543	6110	6303	6970	7586	7603	7408
11	5590	4876	5121	4215	4221	4772	5151	5227	4754
12	4280	3252	3753	2917	2711	3041	3366	3449	3011
13	2770	2093	2386	1798	1715	1758	1969	2065	1638
14	1875	1209	1525	1062	1043	1061	1084	1132	833
15	1119	693	844	587	572	573	600	633	426
16	517	411	490	336	334	285	305	345	189
17	307	115	291	203	199	158	128	171	88
18	87	76	66	135	134	91	61	60	17
19	76	22	59	32	111	90	45	44	19
2+	185668	194505	208186	218598	242183	264972	314427	342552	321087

	1988	1989
2	22656	37916
3	35368	19486
4	60836	30292
5	57718	51929
6	32106	48755
7	26058	26372
8	16734	20734
9	10263	12208
10	7899	6704
11	4023	4919
12	2388	2069
13	1310	995
14	695	540
15	346	298
16	188	161
17	74	98
18	21	26
19	4	14
2+	278685	263517

FISHING MORTALITY 6/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.001	0.001	0.001	0.001	0.002	0.000	0.003	0.003	0.002	0.001	0.002
3	0.002	0.001	0.006	0.002	0.005	0.001	0.006	0.006	0.008	0.005	0.025
4	0.003	0.002	0.011	0.005	0.008	0.004	0.010	0.012	0.019	0.008	0.028
5	0.007	0.005	0.022	0.014	0.015	0.010	0.026	0.025	0.055	0.019	0.027
6	0.019	0.011	0.037	0.029	0.027	0.019	0.045	0.043	0.075	0.047	0.031
7	0.048	0.023	0.072	0.060	0.046	0.044	0.077	0.092	0.136	0.079	0.070
8	0.107	0.040	0.122	0.109	0.070	0.076	0.131	0.137	0.250	0.165	0.112
9	0.169	0.058	0.187	0.159	0.096	0.111	0.173	0.219	0.295	0.276	0.193
10	0.260	0.082	0.290	0.220	0.128	0.152	0.222	0.319	0.461	0.324	0.322
11	0.392	0.112	0.413	0.292	0.178	0.199	0.251	0.402	0.539	0.515	0.347
12	0.565	0.160	0.586	0.381	0.283	0.285	0.339	0.595	0.682	0.726	0.841
13	0.679	0.167	0.660	0.394	0.330	0.333	0.404	0.758	0.707	0.737	1.413
14	0.845	0.208	0.804	0.468	0.449	0.421	0.389	0.828	0.729	0.698	1.866
15	0.851	0.197	0.771	0.415	0.548	0.481	0.402	1.057	0.666	0.613	2.057
16	1.356	0.196	0.732	0.377	0.595	0.648	0.430	1.222	0.791	0.502	2.349
17	1.245	0.399	0.615	0.266	0.629	0.801	0.604	2.149	1.294	0.877	3.116
18	1.230	0.104	0.579	0.049	0.246	0.555	0.173	1.030	1.404	0.234	1.430
19	0.498	0.160	0.246	0.107	0.252	0.320	0.242	0.860	0.518	0.351	1.736

Table 14: Log residuals from ADAPT formulation (all ages) for roundnose grenadier in SA 2+3.

LOG RESIDUALS FOR CPUE INDEX 6/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	-0.630	1.151	-0.097	-0.109	0.585	-0.527	0.670	0.529	-0.319	-1.255
3	-1.366	0.186	0.162	-0.312	0.131	-0.181	0.408	0.095	0.081	-0.456
4	-1.404	0.048	0.214	-0.136	0.042	0.186	0.256	0.206	0.346	-0.526
5	-1.219	0.167	0.107	0.164	-0.101	0.366	0.393	0.098	0.618	-0.517
6	-0.887	0.410	0.025	0.260	-0.149	0.434	0.326	0.034	0.317	-0.215
7	-0.654	0.500	-0.013	0.291	-0.316	0.564	0.167	0.091	0.197	-0.396
8	-0.415	0.501	-0.041	0.323	-0.436	0.546	0.137	-0.072	0.216	-0.230
9	-0.351	0.505	-0.013	0.315	-0.501	0.539	0.030	-0.007	-0.004	-0.131
10	-0.281	0.516	0.062	0.293	-0.550	0.517	-0.062	0.007	0.054	-0.313
11	-0.164	0.570	0.126	0.305	-0.485	0.523	-0.194	-0.038	-0.061	-0.164
12	-0.194	0.574	0.080	0.207	-0.394	0.516	-0.261	-0.049	-0.209	-0.229
13	-0.169	0.497	0.054	0.117	-0.376	0.537	-0.227	0.017	-0.299	-0.335
14	-0.126	0.588	0.084	0.144	-0.231	0.619	-0.376	-0.035	-0.393	-0.492
15	-0.137	0.520	0.038	0.028	-0.084	0.714	-0.364	0.115	-0.477	-0.606
16	0.104	0.457	-0.060	-0.113	-0.078	0.891	-0.366	0.147	-0.409	-0.825
17	-0.107	0.927	-0.352	-0.577	-0.196	0.888	-0.252	0.289	-0.244	-0.563
18	0.508	0.323	0.223	-1.562	-0.369	1.233	-0.717	0.500	0.426	-1.024
19	-0.077	0.789	-0.442	-0.745	-0.283	0.836	-0.344	0.448	-0.205	-0.600

	1989
2	0.000
3	1.252
4	0.769
5	-0.077
6	-0.555
7	-0.431
8	-0.528
9	-0.381
10	-0.241
11	-0.418
12	-0.040
13	0.183
14	0.219
15	0.253
16	0.257
17	0.222
18	0.459
19	0.627

SUM OF RV 1 RESIDUALS : 0.0464241579 MEAN RESIDUAL : 0.0002344554439

Table 15: Parameter correlation matrix from ADAPT formulation (all ages) for roundnose grenadier in SA 2+3.

Parameter Correlation Matrix 6/ 6/90

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.112	0.106	0.102	0.098	0.094	0.090	0.084	0.076	0.069
2	0.112	1.000	0.142	0.136	0.131	0.126	0.120	0.113	0.101	0.092
3	0.106	0.142	1.000	0.158	0.153	0.146	0.140	0.131	0.117	0.107
4	0.102	0.136	0.158	1.000	0.168	0.160	0.154	0.144	0.129	0.117
5	0.098	0.131	0.153	0.168	1.000	0.172	0.164	0.153	0.138	0.125
6	0.094	0.126	0.146	0.160	0.172	1.000	0.172	0.161	0.144	0.131
7	0.090	0.120	0.140	0.154	0.164	0.172	1.000	0.168	0.150	0.136
8	0.084	0.113	0.131	0.144	0.153	0.161	0.168	1.000	0.157	0.140
9	0.076	0.101	0.117	0.129	0.138	0.144	0.150	0.157	1.000	0.145
10	0.069	0.092	0.107	0.117	0.125	0.131	0.136	0.140	0.145	1.000
11	0.051	0.068	0.079	0.087	0.093	0.097	0.101	0.103	0.106	0.115
12	0.020	0.033	0.041	0.047	0.051	0.055	0.057	0.060	0.062	0.066
13	0.011	0.014	0.020	0.024	0.027	0.029	0.032	0.033	0.035	0.037
14	0.006	0.008	0.009	0.012	0.014	0.016	0.018	0.019	0.021	0.022
15	0.003	0.004	0.005	0.005	0.007	0.008	0.009	0.010	0.011	0.012
16	0.001	0.002	0.002	0.002	0.003	0.003	0.004	0.005	0.005	0.006
17	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003	0.004
18	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002
19	-0.354	-0.316	-0.300	-0.288	-0.277	-0.265	-0.254	-0.238	-0.213	-0.193
20	-0.105	-0.306	-0.291	-0.280	-0.270	-0.258	-0.247	-0.231	-0.208	-0.189
21	-0.087	-0.116	-0.276	-0.266	-0.256	-0.245	-0.234	-0.220	-0.197	-0.179
22	-0.072	-0.097	-0.113	-0.249	-0.241	-0.231	-0.220	-0.206	-0.185	-0.168
23	-0.060	-0.080	-0.093	-0.102	-0.226	-0.220	-0.207	-0.194	-0.173	-0.158
24	-0.049	-0.066	-0.076	-0.084	-0.090	-0.209	-0.200	-0.184	-0.164	-0.148
25	-0.040	-0.054	-0.063	-0.069	-0.074	-0.077	-0.194	-0.185	-0.161	-0.143
26	-0.033	-0.045	-0.052	-0.058	-0.061	-0.064	-0.067	-0.193	-0.177	-0.148
27	-0.027	-0.037	-0.043	-0.048	-0.051	-0.053	-0.056	-0.058	-0.204	-0.170
28	-0.021	-0.028	-0.033	-0.037	-0.039	-0.041	-0.043	-0.044	-0.046	-0.203
29	-0.014	-0.020	-0.024	-0.027	-0.029	-0.030	-0.031	-0.033	-0.033	-0.036
30	-0.007	-0.011	-0.013	-0.015	-0.017	-0.018	-0.019	-0.020	-0.021	-0.022
31	-0.004	-0.005	-0.007	-0.008	-0.009	-0.010	-0.011	-0.012	-0.012	-0.013
32	-0.002	-0.003	-0.003	-0.004	-0.005	-0.005	-0.006	-0.007	-0.007	-0.008
33	-0.001	-0.001	-0.002	-0.002	-0.002	-0.003	-0.003	-0.003	-0.004	-0.004
34	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002
35	-0.000	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002
36	-0.000	-0.000	-0.000	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001

Table 15: Continued

	11	12	13	14	15	16	17	18	19	20
1	0.051	0.020	0.011	0.006	0.003	0.001	0.001	0.000	-0.354	-0.105
2	0.068	0.033	0.014	0.008	0.004	0.002	0.001	0.001	-0.316	-0.306
3	0.079	0.041	0.020	0.009	0.005	0.002	0.001	0.001	-0.300	-0.291
4	0.087	0.047	0.024	0.012	0.005	0.002	0.001	0.001	-0.288	-0.280
5	0.093	0.051	0.027	0.014	0.007	0.003	0.002	0.001	-0.277	-0.270
6	0.097	0.055	0.029	0.016	0.008	0.003	0.002	0.001	-0.265	-0.258
7	0.101	0.057	0.032	0.018	0.009	0.004	0.002	0.001	-0.254	-0.247
8	0.103	0.060	0.033	0.019	0.010	0.005	0.003	0.002	-0.238	-0.231
9	0.106	0.062	0.035	0.021	0.011	0.005	0.003	0.002	-0.213	-0.208
10	0.115	0.066	0.037	0.022	0.012	0.006	0.004	0.002	-0.193	-0.189
11	1.000	0.074	0.040	0.023	0.013	0.007	0.005	0.003	-0.143	-0.140
12	0.074	1.000	0.051	0.028	0.015	0.008	0.005	0.004	-0.057	-0.082
13	0.040	0.051	1.000	0.043	0.022	0.010	0.007	0.006	-0.030	-0.030
14	0.023	0.028	0.043	1.000	0.039	0.017	0.011	0.009	-0.016	-0.016
15	0.013	0.015	0.022	0.039	1.000	0.030	0.021	0.015	-0.008	-0.008
16	0.007	0.008	0.010	0.017	0.030	1.000	0.044	0.032	-0.004	-0.004
17	0.005	0.005	0.007	0.011	0.021	0.044	1.000	0.130	-0.002	-0.002
18	0.003	0.004	0.006	0.009	0.015	0.032	0.130	1.000	-0.001	-0.001
19	-0.143	-0.057	-0.030	-0.016	-0.008	-0.004	-0.002	-0.001	1.000	0.296
20	-0.140	-0.082	-0.030	-0.016	-0.008	-0.004	-0.002	-0.001	0.296	1.000
21	-0.133	-0.079	-0.046	-0.016	-0.008	-0.004	-0.002	-0.001	0.245	0.239
22	-0.125	-0.076	-0.045	-0.027	-0.008	-0.004	-0.002	-0.001	0.204	0.199
23	-0.117	-0.072	-0.043	-0.027	-0.015	-0.004	-0.002	-0.001	0.168	0.165
24	-0.110	-0.069	-0.041	-0.026	-0.015	-0.008	-0.002	-0.002	0.138	0.135
25	-0.105	-0.066	-0.041	-0.026	-0.015	-0.008	-0.005	-0.002	0.113	0.111
26	-0.108	-0.066	-0.041	-0.027	-0.016	-0.008	-0.005	-0.003	0.094	0.093
27	-0.119	-0.072	-0.043	-0.028	-0.017	-0.009	-0.006	-0.004	0.077	0.077
28	-0.157	-0.087	-0.049	-0.031	-0.019	-0.011	-0.007	-0.005	0.059	0.059
29	-0.238	-0.131	-0.067	-0.038	-0.022	-0.012	-0.009	-0.007	0.041	0.043
30	-0.025	-0.268	-0.116	-0.061	-0.030	-0.016	-0.012	-0.010	0.019	0.025
31	-0.014	-0.018	-0.280	-0.112	-0.057	-0.024	-0.017	-0.014	0.010	0.010
32	-0.008	-0.010	-0.015	-0.283	-0.107	-0.047	-0.028	-0.023	0.005	0.006
33	-0.005	-0.005	-0.007	-0.013	-0.285	-0.085	-0.061	-0.040	0.003	0.003
34	-0.003	-0.003	-0.004	-0.007	-0.012	-0.294	-0.130	-0.096	0.001	0.001
35	-0.002	-0.002	-0.003	-0.005	-0.009	-0.019	-0.325	-0.231	0.001	0.001
36	-0.002	-0.002	-0.003	-0.004	-0.008	-0.017	-0.176	-0.361	0.001	0.001

Table 15: Continued

	21	22	23	24	25	26	27	28	29	30
1	-0.087	-0.072	-0.060	-0.049	-0.040	-0.033	-0.027	-0.021	-0.014	-0.007
2	-0.116	-0.097	-0.080	-0.066	-0.054	-0.045	-0.037	-0.028	-0.020	-0.011
3	-0.276	-0.113	-0.093	-0.076	-0.063	-0.052	-0.043	-0.033	-0.024	-0.013
4	-0.266	-0.249	-0.102	-0.084	-0.069	-0.058	-0.048	-0.037	-0.027	-0.015
5	-0.256	-0.241	-0.226	-0.090	-0.074	-0.061	-0.051	-0.039	-0.029	-0.017
6	-0.245	-0.231	-0.220	-0.209	-0.077	-0.064	-0.053	-0.041	-0.030	-0.018
7	-0.234	-0.220	-0.207	-0.200	-0.194	-0.067	-0.056	-0.043	-0.031	-0.019
8	-0.220	-0.206	-0.194	-0.184	-0.185	-0.193	-0.058	-0.044	-0.033	-0.020
9	-0.197	-0.185	-0.173	-0.164	-0.161	-0.177	-0.204	-0.046	-0.033	-0.021
10	-0.179	-0.168	-0.158	-0.148	-0.143	-0.148	-0.170	-0.203	-0.036	-0.022
11	-0.133	-0.125	-0.117	-0.110	-0.105	-0.108	-0.119	-0.157	-0.238	-0.025
12	-0.079	-0.076	-0.072	-0.069	-0.066	-0.066	-0.072	-0.087	-0.131	-0.268
13	-0.046	-0.045	-0.043	-0.041	-0.041	-0.041	-0.043	-0.049	-0.067	-0.116
14	-0.016	-0.027	-0.027	-0.026	-0.026	-0.027	-0.028	-0.031	-0.038	-0.061
15	-0.008	-0.008	-0.015	-0.015	-0.015	-0.016	-0.017	-0.019	-0.022	-0.030
16	-0.004	-0.004	-0.004	-0.008	-0.008	-0.008	-0.009	-0.011	-0.012	-0.016
17	-0.002	-0.002	-0.002	-0.002	-0.005	-0.005	-0.006	-0.007	-0.009	-0.012
18	-0.001	-0.001	-0.001	-0.002	-0.002	-0.003	-0.004	-0.005	-0.007	-0.010
19	0.245	0.204	0.168	0.138	0.113	0.094	0.077	0.059	0.041	0.019
20	0.239	0.199	0.165	0.135	0.111	0.093	0.077	0.059	0.043	0.025
21	1.000	0.189	0.157	0.129	0.106	0.088	0.073	0.057	0.042	0.026
22	0.189	1.000	0.148	0.121	0.100	0.083	0.069	0.054	0.040	0.026
23	0.157	0.148	1.000	0.115	0.094	0.078	0.065	0.051	0.038	0.025
24	0.129	0.121	0.115	1.000	0.089	0.074	0.061	0.048	0.036	0.024
25	0.106	0.100	0.094	0.089	1.000	0.073	0.060	0.046	0.034	0.023
26	0.088	0.083	0.078	0.074	0.073	1.000	0.063	0.047	0.035	0.023
27	0.073	0.069	0.065	0.061	0.060	0.063	1.000	0.053	0.038	0.025
28	0.057	0.054	0.051	0.048	0.046	0.047	0.053	1.000	0.049	0.030
29	0.042	0.040	0.038	0.036	0.034	0.035	0.038	0.049	1.000	0.043
30	0.026	0.026	0.025	0.024	0.023	0.023	0.025	0.030	0.043	1.000
31	0.015	0.015	0.015	0.015	0.015	0.015	0.016	0.018	0.023	0.040
32	0.006	0.009	0.009	0.009	0.009	0.009	0.010	0.011	0.013	0.021
33	0.003	0.003	0.005	0.005	0.005	0.005	0.006	0.007	0.008	0.011
34	0.001	0.001	0.001	0.003	0.003	0.003	0.003	0.004	0.005	0.007
35	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.004	0.006
36	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.003	0.004	0.005

Table 15: Continued

	31	32	33	34	35	36
1	-0.004	-0.002	-0.001	-0.000	-0.000	-0.000
2	-0.005	-0.003	-0.001	-0.001	-0.000	-0.000
3	-0.007	-0.003	-0.002	-0.001	-0.001	-0.000
4	-0.008	-0.004	-0.002	-0.001	-0.001	-0.000
5	-0.009	-0.005	-0.002	-0.001	-0.001	-0.001
6	-0.010	-0.005	-0.003	-0.001	-0.001	-0.001
7	-0.011	-0.006	-0.003	-0.001	-0.001	-0.001
8	-0.012	-0.007	-0.003	-0.002	-0.001	-0.001
9	-0.012	-0.007	-0.004	-0.002	-0.001	-0.001
10	-0.013	-0.008	-0.004	-0.002	-0.002	-0.001
11	-0.014	-0.008	-0.005	-0.003	-0.002	-0.002
12	-0.018	-0.010	-0.005	-0.003	-0.002	-0.002
13	-0.280	-0.015	-0.007	-0.004	-0.003	-0.003
14	-0.112	-0.283	-0.013	-0.007	-0.005	-0.004
15	-0.057	-0.107	-0.285	-0.012	-0.009	-0.008
16	-0.024	-0.047	-0.085	-0.294	-0.019	-0.017
17	-0.017	-0.028	-0.061	-0.130	-0.325	-0.176
18	-0.014	-0.023	-0.040	-0.096	-0.231	-0.361
19	0.010	0.005	0.003	0.001	0.001	0.001
20	0.010	0.006	0.003	0.001	0.001	0.001
21	0.015	0.006	0.003	0.001	0.001	0.001
22	0.015	0.009	0.003	0.001	0.001	0.001
23	0.015	0.009	0.005	0.001	0.001	0.001
24	0.015	0.009	0.005	0.003	0.001	0.001
25	0.015	0.009	0.005	0.003	0.002	0.001
26	0.015	0.009	0.005	0.003	0.002	0.002
27	0.016	0.010	0.006	0.003	0.002	0.002
28	0.018	0.011	0.007	0.004	0.003	0.003
29	0.023	0.013	0.008	0.005	0.004	0.004
30	0.040	0.021	0.011	0.007	0.006	0.005
31	1.000	0.038	0.019	0.010	0.008	0.007
32	0.038	1.000	0.036	0.018	0.013	0.011
33	0.019	0.036	1.000	0.034	0.026	0.022
34	0.010	0.018	0.034	1.000	0.057	0.050
35	0.008	0.013	0.026	0.057	1.000	0.122
36	0.007	0.011	0.022	0.050	0.122	1.000

Table16: Parameter, population and fishing mortality estimates from ADAPT analysis (ages 6-13) of roundnose grenadier in SA 2+3.

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.000257
MEAN SQUARE RESIDUALS 0.134494

AGE	PARAMETER	ESTIMATE	STD. ERR.	T-STATISTIC	C.V.
6	ABUNDANCE	2.43713E4	9.38522E3	2.59677E0	0.39
7	ABUNDANCE	1.68850E4	4.76663E3	3.54233E0	0.28
8	ABUNDANCE	1.47532E4	3.62041E3	4.07502E0	0.25
9	ABUNDANCE	9.70629E3	2.31147E3	4.19919E0	0.24
10	ABUNDANCE	6.30304E3	1.53591E3	4.10379E0	0.24
11	ABUNDANCE	3.86778E3	9.88750E2	3.91179E0	0.26
12	ABUNDANCE	2.07419E3	5.49690E2	3.77338E0	0.27
13	ABUNDANCE	1.12219E3	3.01903E2	3.71707E0	0.27
6	CE SLOPE	5.96115E-6	7.45559E-7	7.99555E0	0.13
7	CE SLOPE	1.11651E-5	1.33608E-6	8.35661E0	0.12
8	CE SLOPE	1.85541E-5	2.17329E-6	8.53732E0	0.12
9	CE SLOPE	2.60840E-5	3.02468E-6	8.62370E0	0.12
10	CE SLOPE	3.54100E-5	4.08345E-6	8.67159E0	0.12
11	CE SLOPE	4.49282E-5	5.16698E-6	8.69525E0	0.12
12	CE SLOPE	6.04352E-5	6.94440E-6	8.70272E0	0.11
13	CE SLOPE	6.60780E-5	7.56138E-6	8.73887E0	0.11

Table 16: Continued

POPULATION NUMBERS (000S) 7/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	38439	41542	42677	43739	47021	42868	48536	79866	91161
3	31286	33050	35718	36678	37609	40342	36879	41557	68523
4	26182	26887	28414	30551	31498	32189	34658	31440	35348
5	20610	22476	23101	24191	26159	26889	27586	29436	26569
6	15298	17614	19263	19460	20526	22136	22907	23032	24510
7	12846	13774	15008	16011	16282	17197	18648	18826	18846
8	10521	10551	11593	12060	13025	13401	14157	14741	14724
9	8957	8145	8734	8861	9358	10493	10703	10686	10871
10	7342	6520	6618	6263	6542	7350	8143	7777	7384
11	5591	4873	5173	4280	4352	4978	5479	5707	4904
12	4338	3253	3750	2961	2766	3154	3543	3731	3424
13	2719	2143	2387	1795	1753	1805	2066	2217	1880
14	1815	1165	1568	1062	1041	1094	1125	1215	964
15	1030	642	807	624	573	572	628	668	498
16	480	335	446	304	366	285	304	370	220
17	271	82	225	165	171	186	129	170	109
18	71	45	38	78	101	67	85	61	16
19	75	8	32	8	62	62	24	65	19
2+	188870	193105	205551	209093	219204	225068	235599	271564	309970

	1988	1989
2	81336	38939
3	78403	69993
4	58497	67333
5	29339	49916
6	21038	24329
7	19059	16846
8	13782	14710
9	9758	9667
10	6647	6270
11	4001	3842
12	2517	2051
13	1666	1106
14	904	846
15	459	477
16	250	258
17	100	151
18	39	49
19	3	30
2+	327797	306812

Table 16: Continued

FISHING MORTALITY 7/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.001	0.001	0.001	0.001	0.003	0.000	0.005	0.003	0.001	0.000	0.002
3	0.002	0.001	0.006	0.002	0.006	0.002	0.010	0.012	0.008	0.002	0.007
4	0.003	0.002	0.011	0.005	0.008	0.004	0.013	0.018	0.036	0.009	0.013
5	0.007	0.004	0.022	0.014	0.017	0.010	0.030	0.033	0.083	0.037	0.028
6	0.018	0.010	0.035	0.028	0.027	0.021	0.046	0.051	0.102	0.072	0.063
7	0.047	0.022	0.069	0.056	0.045	0.045	0.085	0.096	0.163	0.109	0.112
8	0.106	0.039	0.119	0.104	0.066	0.075	0.131	0.155	0.261	0.205	0.161
9	0.168	0.058	0.183	0.153	0.091	0.104	0.169	0.220	0.342	0.292	0.250
10	0.260	0.081	0.286	0.214	0.123	0.144	0.205	0.311	0.463	0.398	0.349
11	0.392	0.112	0.408	0.286	0.172	0.190	0.234	0.361	0.517	0.519	0.470
12	0.555	0.160	0.587	0.374	0.277	0.273	0.319	0.535	0.570	0.673	0.853
13	0.698	0.162	0.659	0.395	0.321	0.323	0.381	0.683	0.582	0.528	1.149
14	0.889	0.217	0.771	0.467	0.450	0.405	0.372	0.743	0.593	0.488	0.790
15	0.975	0.214	0.827	0.385	0.547	0.482	0.380	0.962	0.537	0.424	0.802
16	1.611	0.247	0.845	0.427	0.527	0.646	0.433	1.075	0.637	0.353	0.852
17	1.644	0.612	0.902	0.339	0.784	0.634	0.602	2.207	0.881	0.564	1.000
18	2.020	0.183	1.410	0.086	0.339	0.866	0.121	1.019	1.635	0.118	0.537
19	0.506	0.506	0.506	0.506	0.506	0.506	0.506	0.506	0.506	0.506	0.506

Table 17: Log residuals from ADAPT formulation (ages 6-13) for roundnose grenadier in SA 2+3.

LOG RESIDUALS FOR RV INDEX 1 7/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
6	-1.057	0.227	-0.172	0.101	-0.289	0.390	0.217	0.052	0.463	0.068	0.000
7	-0.756	0.389	-0.137	0.151	-0.417	0.483	0.185	0.044	0.284	-0.164	-0.063
8	-0.472	0.434	-0.117	0.232	-0.543	0.481	0.092	-0.009	0.209	-0.080	-0.227
9	-0.379	0.474	-0.054	0.263	-0.569	0.455	-0.009	-0.024	0.106	-0.099	-0.163
10	-0.282	0.505	0.048	0.266	-0.589	0.461	-0.136	-0.018	0.056	-0.136	-0.173
11	-0.162	0.573	0.118	0.291	-0.514	0.482	-0.255	-0.127	-0.091	-0.156	-0.159
12	-0.171	0.611	0.118	0.228	-0.377	0.515	-0.277	-0.095	-0.309	-0.249	0.007
13	-0.084	0.538	0.119	0.183	-0.334	0.574	-0.212	0.005	-0.382	-0.527	0.120

SUM OF RV 1 RESIDUALS : 7.582341596E-8 MEAN RESIDUAL : 8.616297268E-10

Table 18: Parameter correlation matrix from ADAPT formulation (ages 6-13) for roundnose grenadier in SA 2+3.

Parameter Correlation Matrix 7/ 6/90

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.081	0.068	0.058	0.048	0.039	0.029	0.020	-0.323	-0.046
2	0.081	1.000	0.095	0.080	0.066	0.054	0.040	0.028	-0.251	-0.257
3	0.068	0.095	1.000	0.098	0.081	0.065	0.048	0.033	-0.210	-0.219
4	0.058	0.080	0.098	1.000	0.096	0.076	0.055	0.038	-0.178	-0.181
5	0.048	0.066	0.081	0.096	1.000	0.090	0.063	0.042	-0.149	-0.150
6	0.039	0.054	0.065	0.076	0.090	1.000	0.077	0.049	-0.122	-0.121
7	0.029	0.040	0.048	0.055	0.063	0.077	1.000	0.063	-0.090	-0.090
8	0.020	0.028	0.033	0.038	0.042	0.049	0.063	1.000	-0.063	-0.063
9	-0.323	-0.251	-0.210	-0.178	-0.149	-0.122	-0.090	-0.063	1.000	0.143
10	-0.046	-0.257	-0.219	-0.181	-0.150	-0.121	-0.090	-0.063	0.143	1.000
11	-0.033	-0.046	-0.227	-0.195	-0.155	-0.123	-0.089	-0.062	0.102	0.104
12	-0.025	-0.034	-0.042	-0.219	-0.181	-0.134	-0.095	-0.064	0.077	0.077
13	-0.019	-0.026	-0.031	-0.036	-0.220	-0.169	-0.110	-0.071	0.058	0.058
14	-0.014	-0.019	-0.023	-0.026	-0.031	-0.227	-0.155	-0.089	0.043	0.042
15	-0.009	-0.013	-0.015	-0.018	-0.020	-0.024	-0.244	-0.135	0.029	0.029
16	-0.005	-0.007	-0.009	-0.010	-0.011	-0.013	-0.016	-0.257	0.016	0.016

	11	12	13	14	15	16
1	-0.033	-0.025	-0.019	-0.014	-0.009	-0.005
2	-0.046	-0.034	-0.026	-0.019	-0.013	-0.007
3	-0.227	-0.042	-0.031	-0.023	-0.015	-0.009
4	-0.195	-0.219	-0.036	-0.026	-0.018	-0.010
5	-0.155	-0.181	-0.220	-0.031	-0.020	-0.011
6	-0.123	-0.134	-0.169	-0.227	-0.024	-0.013
7	-0.089	-0.095	-0.110	-0.155	-0.244	-0.016
8	-0.062	-0.064	-0.071	-0.089	-0.135	-0.257
9	0.102	0.077	0.058	0.043	0.029	0.016
10	0.104	0.077	0.058	0.042	0.029	0.016
11	1.000	0.081	0.059	0.043	0.029	0.016
12	0.081	1.000	0.066	0.046	0.030	0.016
13	0.059	0.066	1.000	0.056	0.035	0.018
14	0.043	0.046	0.056	1.000	0.047	0.023
15	0.029	0.030	0.035	0.047	1.000	0.035
16	0.016	0.016	0.018	0.023	0.035	1.000

Table 19: Annual partial recruitment derived from the F matrix from the ADAPT run (all ages) for roundnose grenadier in SA 2+3.

ANNUAL PARTIAL RECRUITMENT 7/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	0.001	0.002	0.002	0.002	0.004	0.000	0.005	0.001	0.001	0.001	0.001
3	0.001	0.003	0.007	0.005	0.008	0.002	0.011	0.003	0.006	0.006	0.008
4	0.002	0.004	0.013	0.010	0.013	0.005	0.017	0.006	0.013	0.009	0.009
5	0.005	0.011	0.027	0.031	0.025	0.012	0.043	0.012	0.039	0.021	0.009
6	0.014	0.026	0.046	0.062	0.043	0.024	0.074	0.020	0.054	0.053	0.010
7	0.035	0.057	0.089	0.128	0.072	0.055	0.127	0.043	0.097	0.090	0.023
8	0.079	0.100	0.152	0.232	0.112	0.095	0.217	0.064	0.178	0.189	0.036
9	0.125	0.146	0.232	0.339	0.153	0.138	0.286	0.102	0.210	0.315	0.062
10	0.192	0.206	0.360	0.470	0.204	0.190	0.368	0.149	0.328	0.369	0.103
11	0.289	0.280	0.513	0.623	0.283	0.249	0.415	0.187	0.384	0.587	0.111
12	0.417	0.400	0.729	0.815	0.450	0.355	0.560	0.277	0.486	0.827	0.270
13	0.501	0.417	0.820	0.842	0.524	0.416	0.668	0.353	0.503	0.841	0.454
14	0.623	0.522	1.000	1.000	0.713	0.525	0.643	0.385	0.519	0.796	0.599
15	0.627	0.493	0.958	0.887	0.871	0.600	0.664	0.492	0.474	0.699	0.660
16	1.000	0.492	0.911	0.806	0.946	0.809	0.712	0.569	0.564	0.573	0.754
17	0.918	1.000	0.765	0.570	1.000	1.000	1.000	1.000	0.922	1.000	1.000
18	0.907	0.261	0.720	0.105	0.390	0.693	0.285	0.479	1.000	0.267	0.459
19	0.367	0.400	0.306	0.228	0.400	0.400	0.400	0.400	0.369	0.400	0.557

Table 20. Annual beginning of year exploitable biomass derived from the ADAPT run (all ages) for roundnose grenadier in SA 2+3.

ANNUAL EXPLOITABLE BIOMASS 7/ 6/90

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
2	2	5	4	5	12	1	21	6	3	1	2
3	3	8	26	18	29	9	52	20	43	22	16
4	7	16	50	49	55	24	102	35	128	85	36
5	21	46	111	139	128	65	244	78	288	246	80
6	58	117	212	302	217	152	425	131	403	414	111
7	146	243	403	617	359	301	763	246	600	672	167
8	345	413	686	1056	531	493	1082	376	943	1120	259
9	534	553	936	1326	616	621	1220	458	1043	1323	308
10	791	737	1315	1540	690	708	1323	556	1118	1361	327
11	1043	864	1680	1632	758	737	1198	565	994	1295	308
12	1302	928	1969	1679	885	768	1209	628	875	1185	350
13	1131	694	1561	1187	733	584	928	532	567	755	328
14	1042	552	1332	908	668	493	562	366	332	420	264
15	706	340	800	504	512	351	367	303	183	212	185
16	543	211	461	274	339	247	220	207	104	101	122
17	329	131	254	128	237	193	131	190	83	72	105
18	107	25	63	17	71	90	23	39	23	6	16
19	41	12	26	10	68	56	25	25	10	2	12
2+	8149	5895	11887	11388	6908	5895	9894	4762	7741	9294	2997
3+	8148	5890	11883	11384	6896	5894	9872	4756	7738	9293	2995
4+	8145	5882	11857	11365	6867	5884	9820	4736	7694	9271	2979
5+	8138	5866	11807	11317	6812	5860	9718	4701	7566	9186	2942
6+	8117	5820	11696	11177	6684	5795	9475	4623	7278	8940	2862

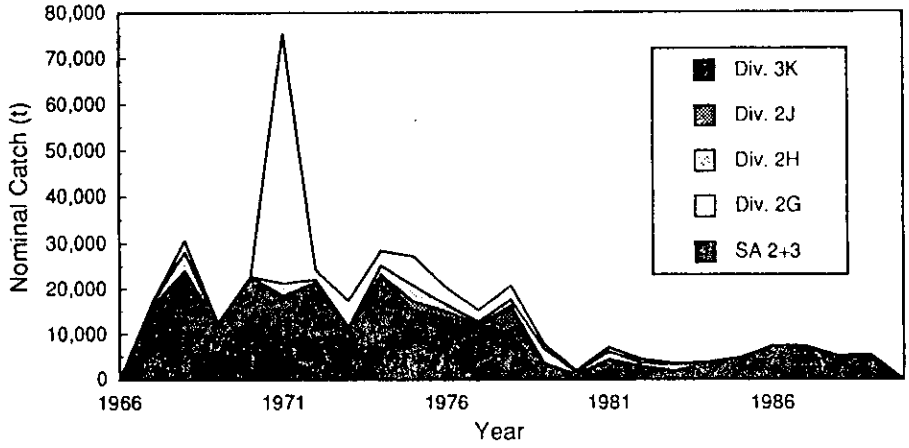


Fig. 1. Nominal catches of roundnose grenadiers in SA 2+3, 1967-1989 (1988 and 1989 are provisional).

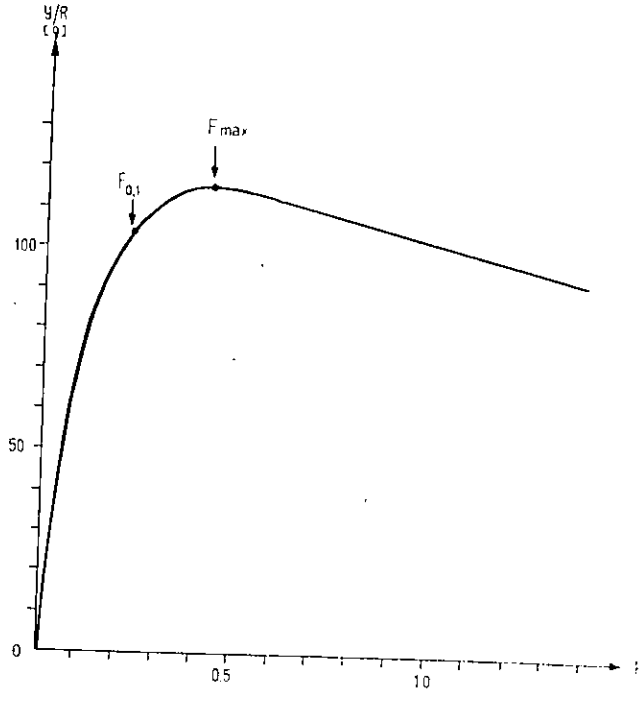


Fig. 2. Roundnose grenadier catch per recruit in Subareas 2+3.

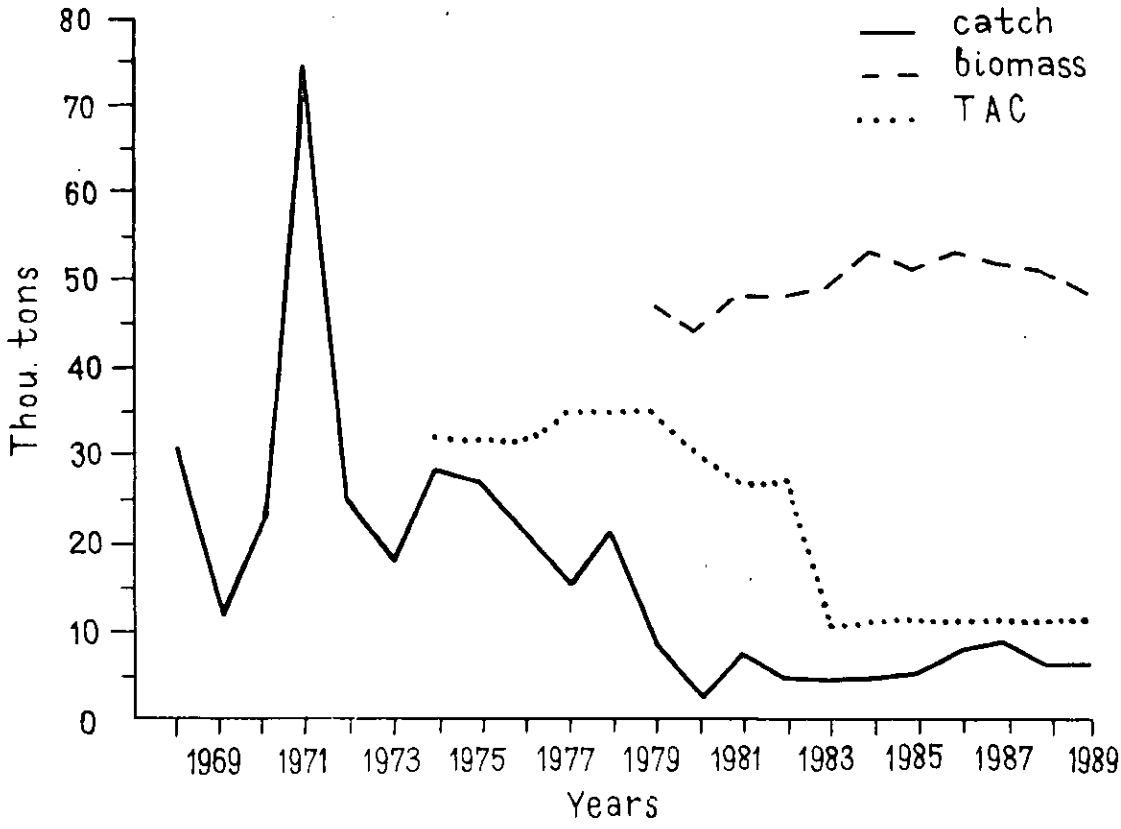


Fig. 3. Actual total catch, TAC, and VPA-estimated biomass of roundnose grenadier in NAFO Subareas 2+3.

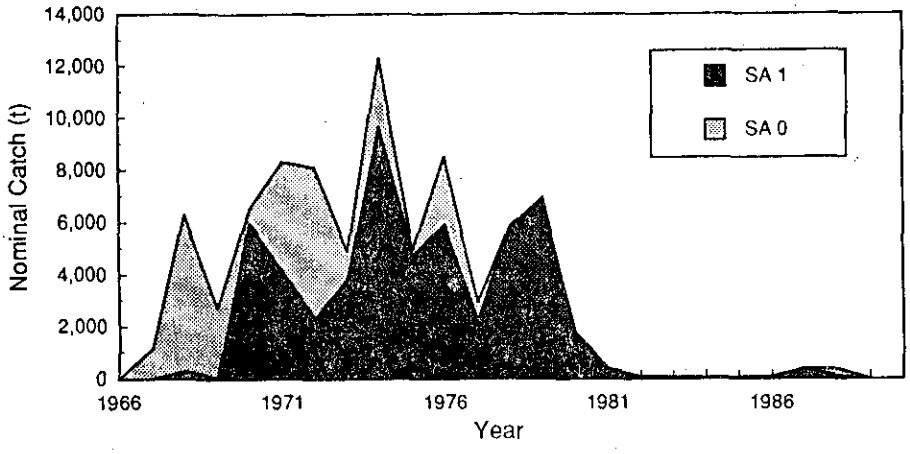


Fig. 4. Nominal catches of roundnose grenadiers in SA 0+1, 1967-1989 (1988 and 1989 are provisional).

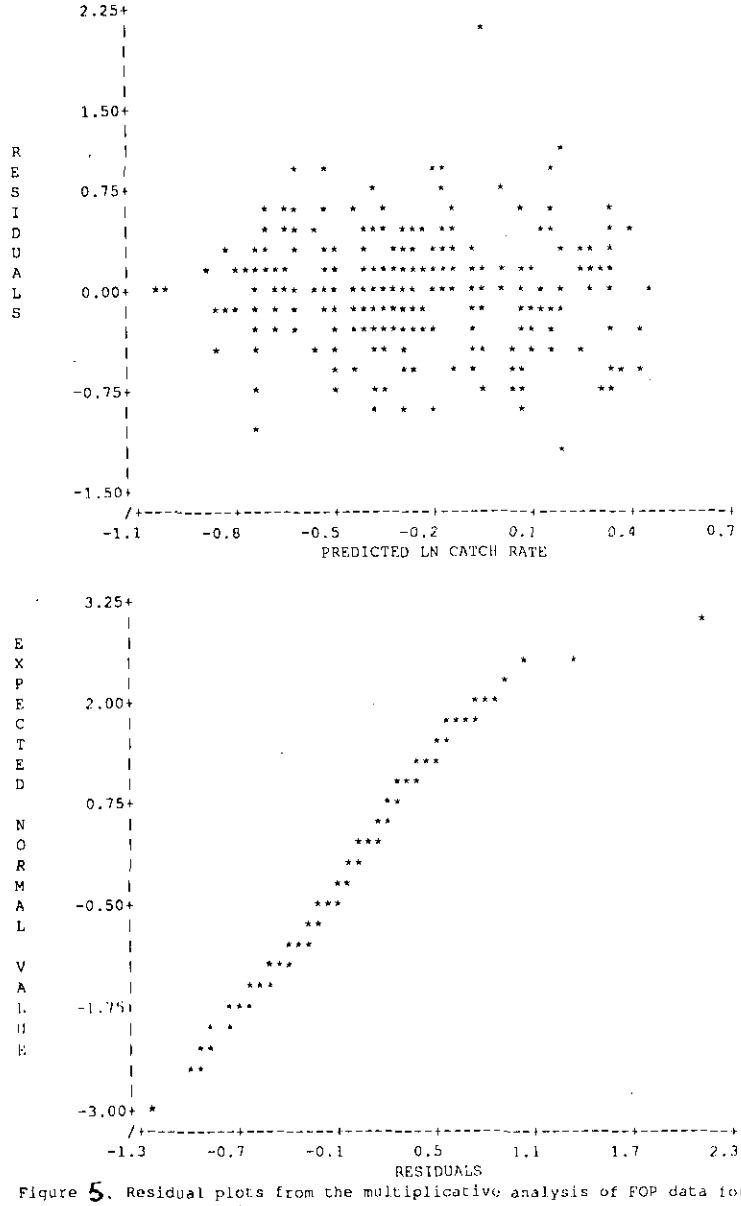
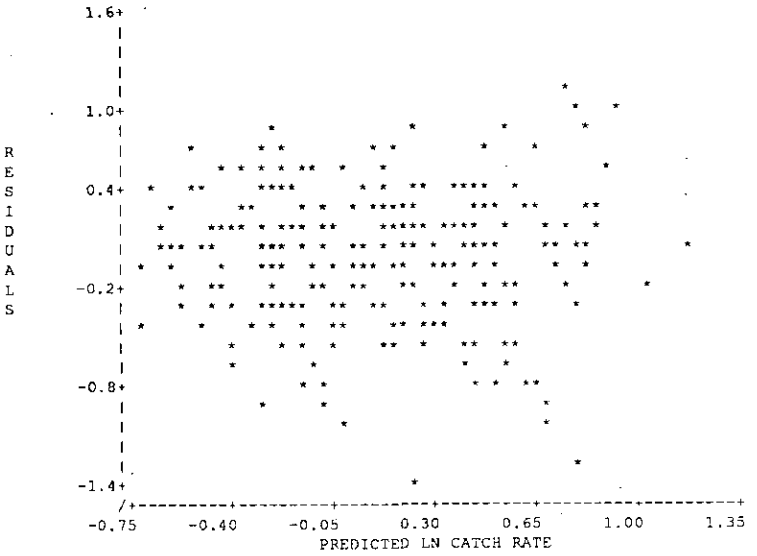


Figure 5. Residual plots from the multiplicative analysis of FOP data for roundnose grenadiers in SA 2+3.



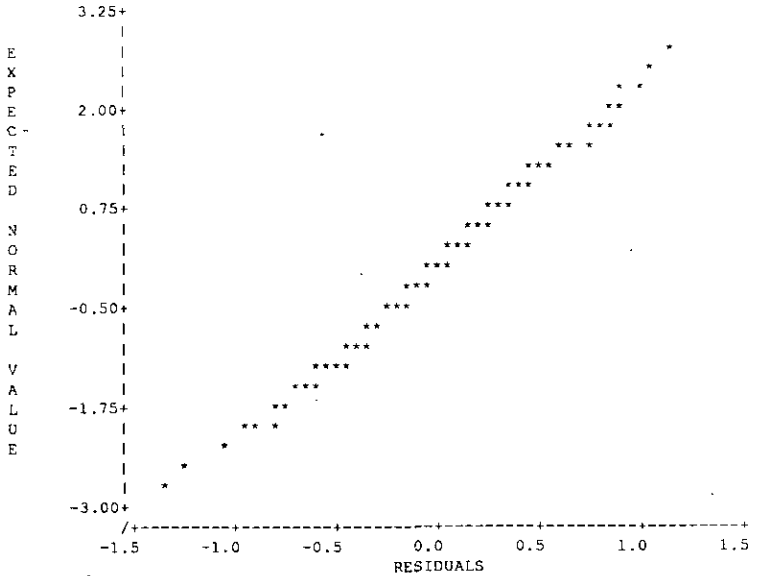
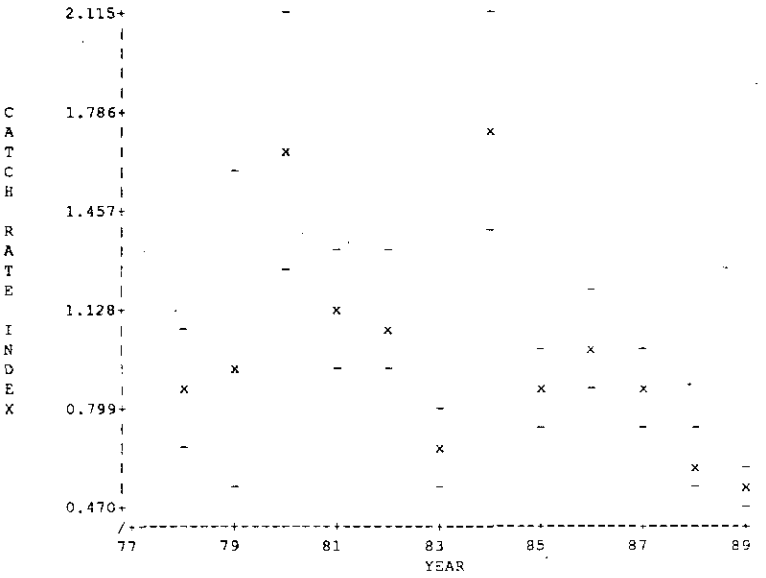


Figure 6. Residual plots from the multiplicative analysis of NAFO data for roundnose grenadiers in SA 2+3.

A. From the FOP data.



B. From the NAFO data.

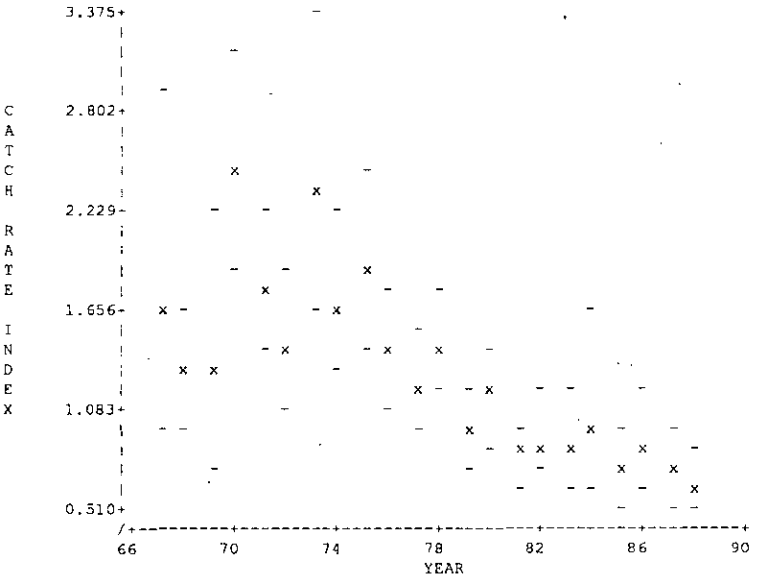


Figure 7. Standardized catch rates for roundnose grenadiers in SA 2+3 derived from the multiplicative model.

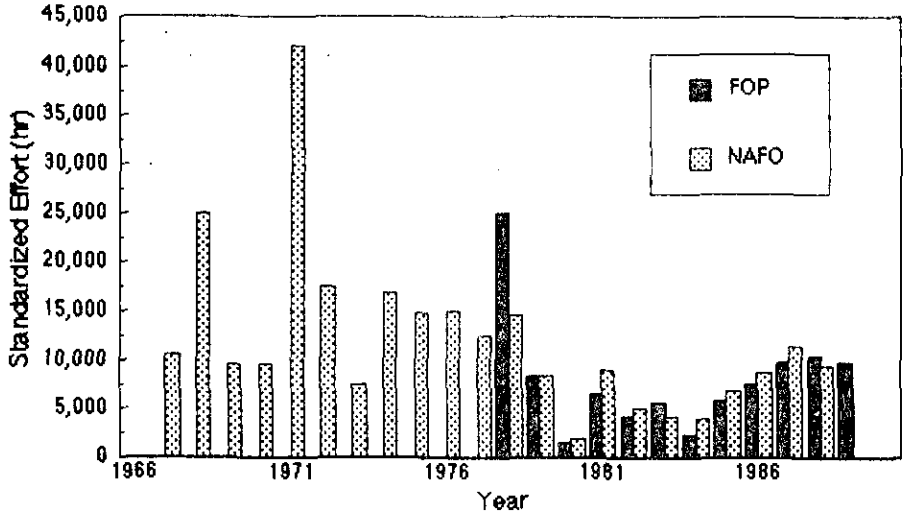


Fig. 8: Standardized effort (hr) for roundnose grenadiers in SA 2+3 from multiplicative analyses of FOP and NAFO data.

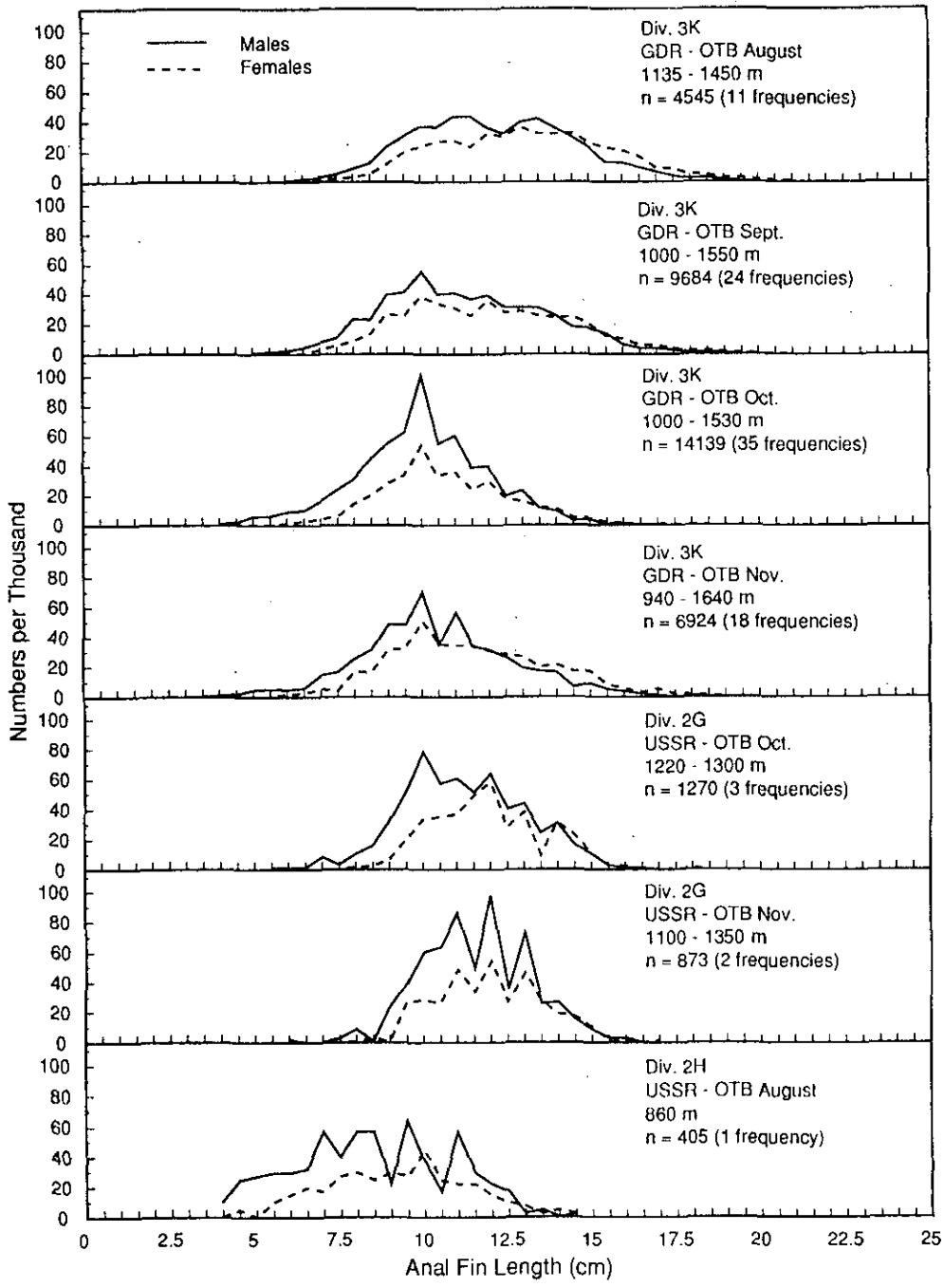


Fig. 9. Length frequencies of roundnose grenadier from the commercial fishery in SA2+3 in 1989.

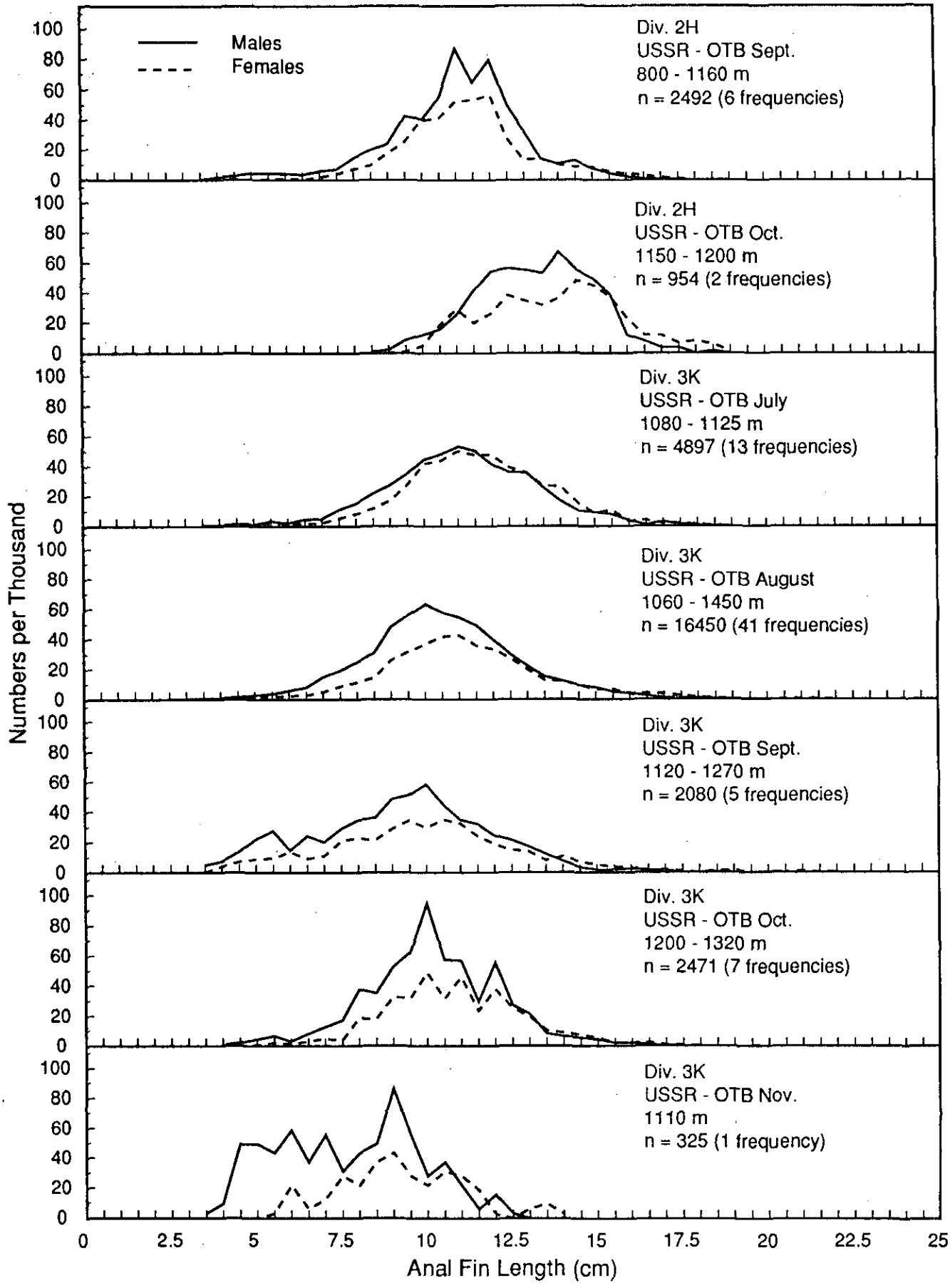


Fig. 9. Continued.

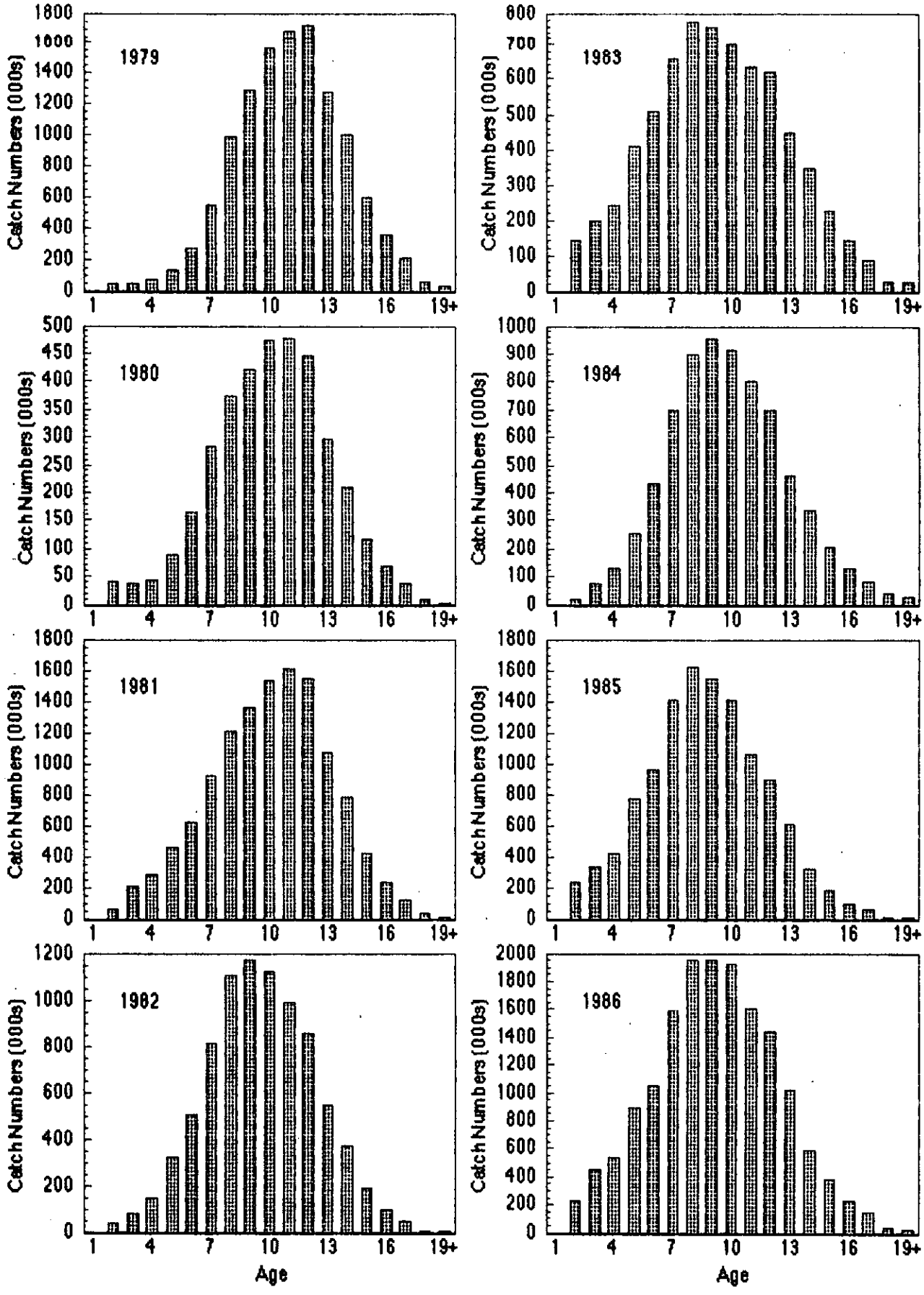


Figure 10: Catch-at-age of roundnose grenadiers in SA2+3, 1979 - 1989.

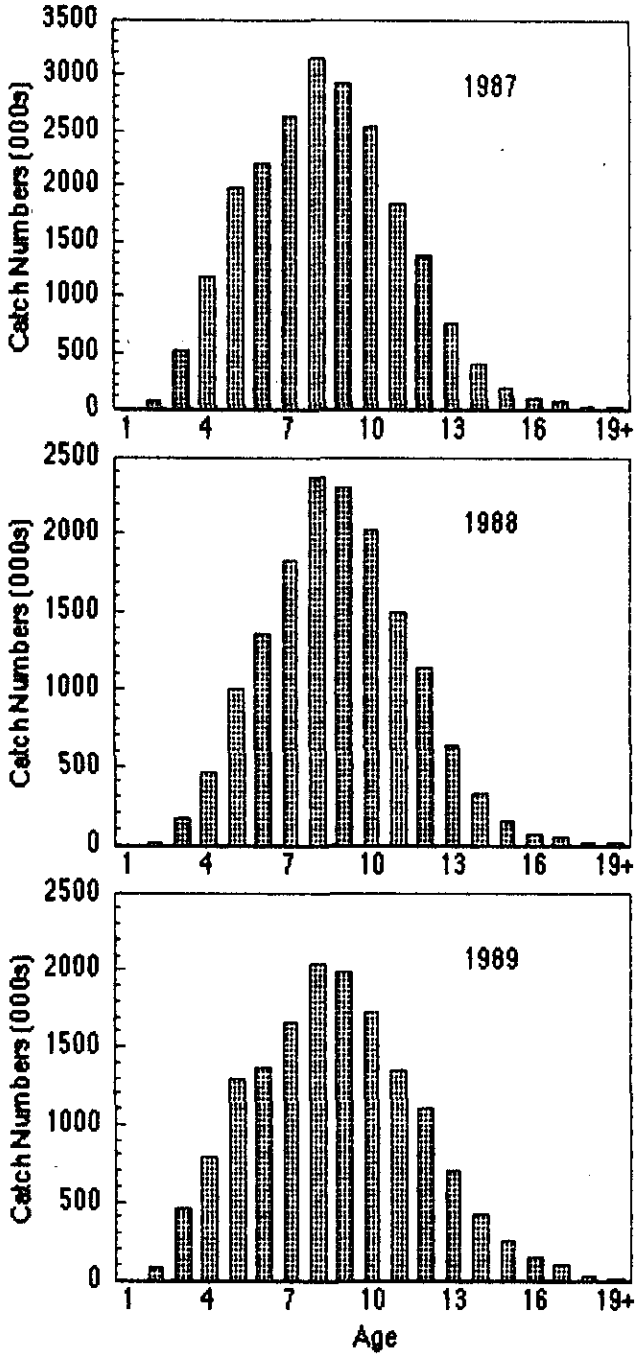
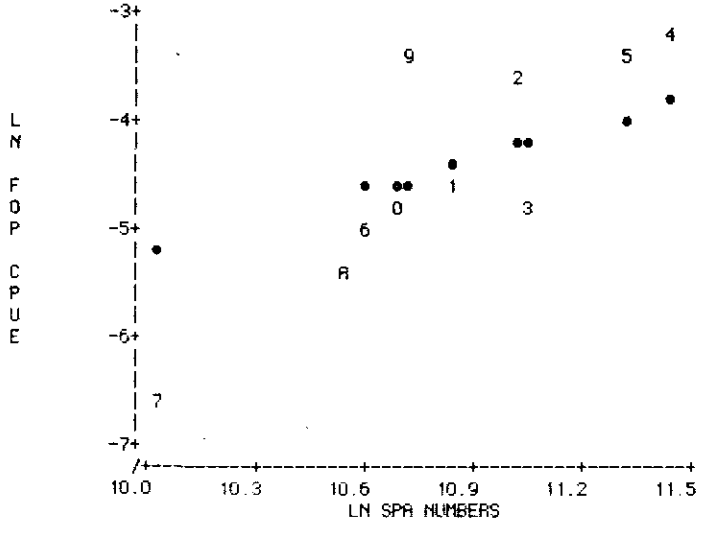


Fig. 10: Continued.

Figure 11. Calibration plots from ADAPT for roundnose grenadier in SA2+3. (all ages)



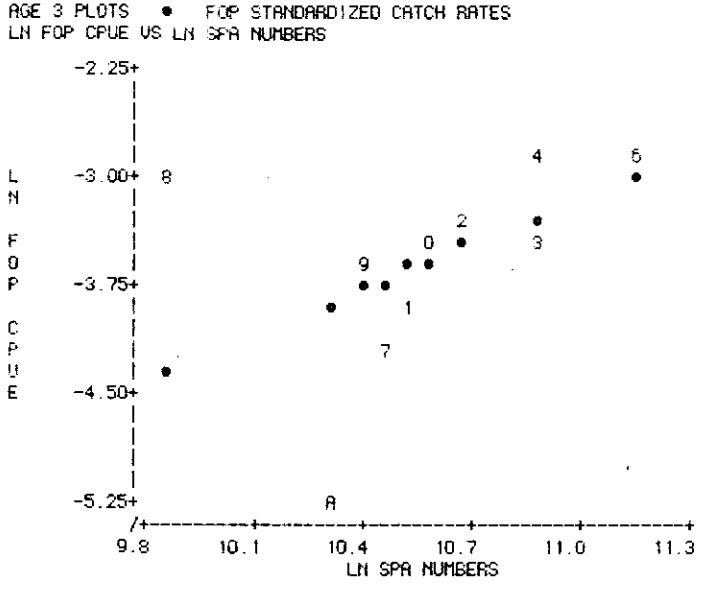
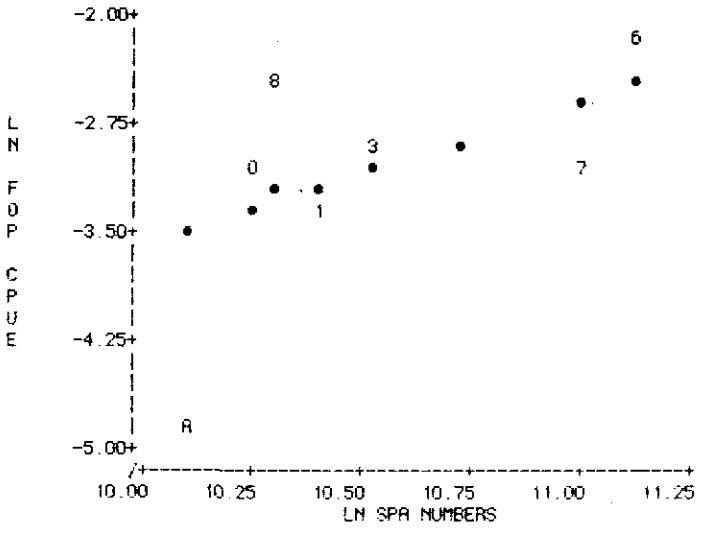


Figure 11: Continued.



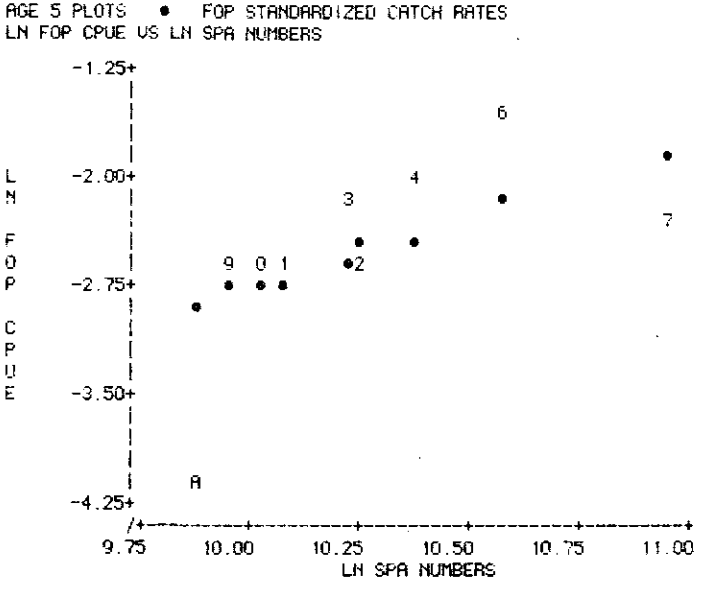
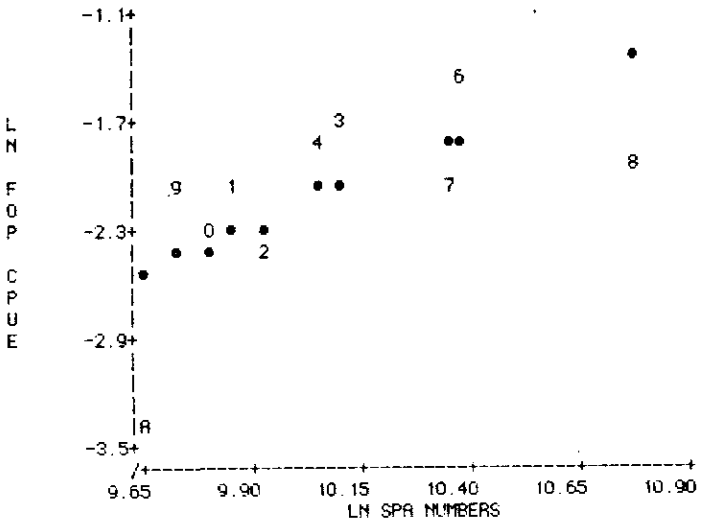


Figure11:Continued.

AGE 6 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 7 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

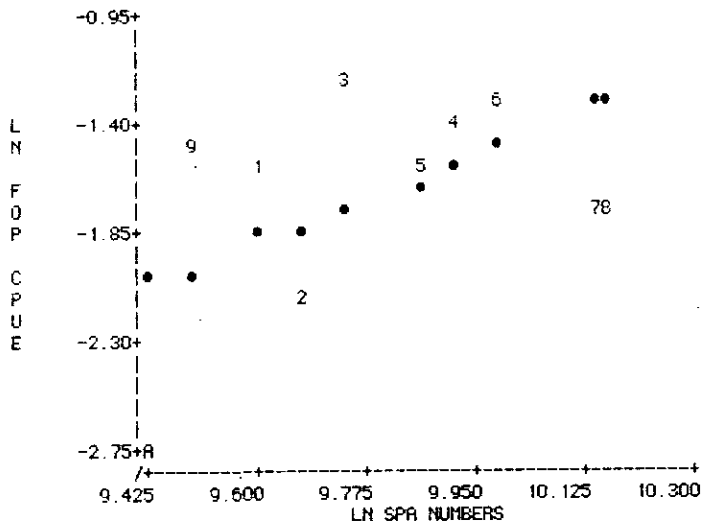
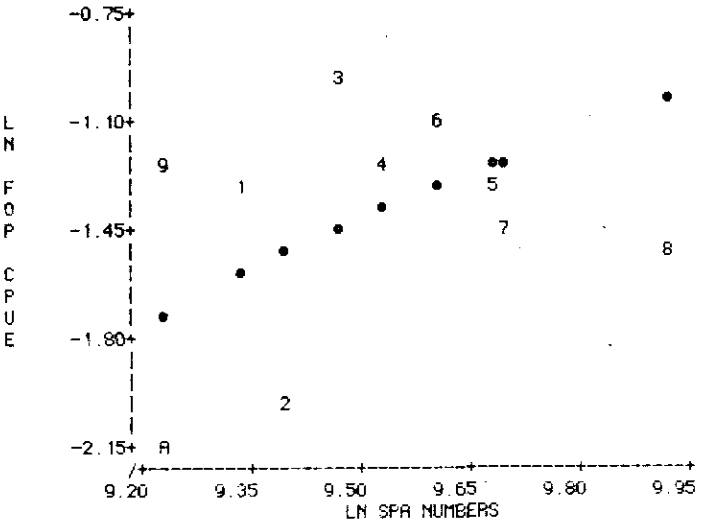


Figure11:Continued.

AGE 8 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 9 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

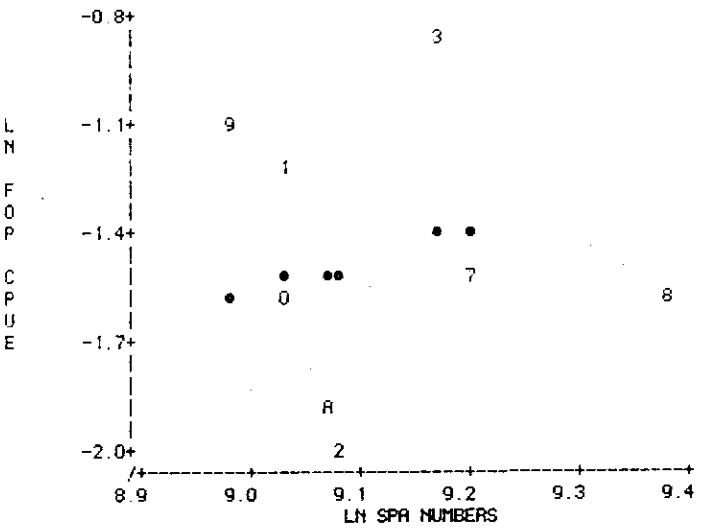
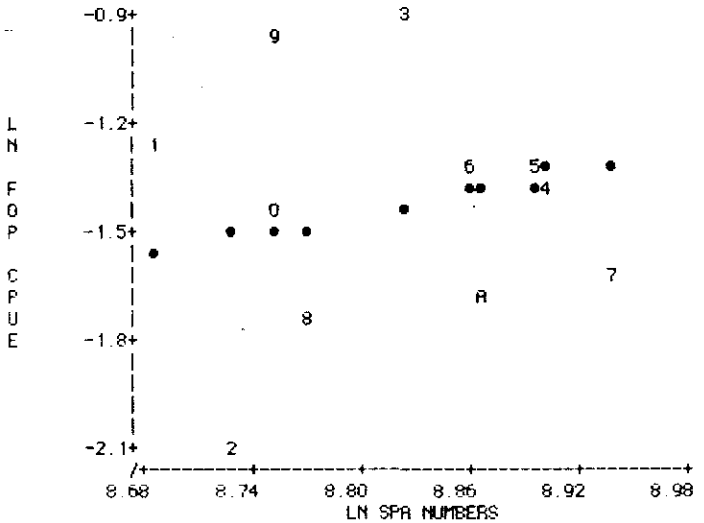


Figure11:Continued.

AGE 10 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 11 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

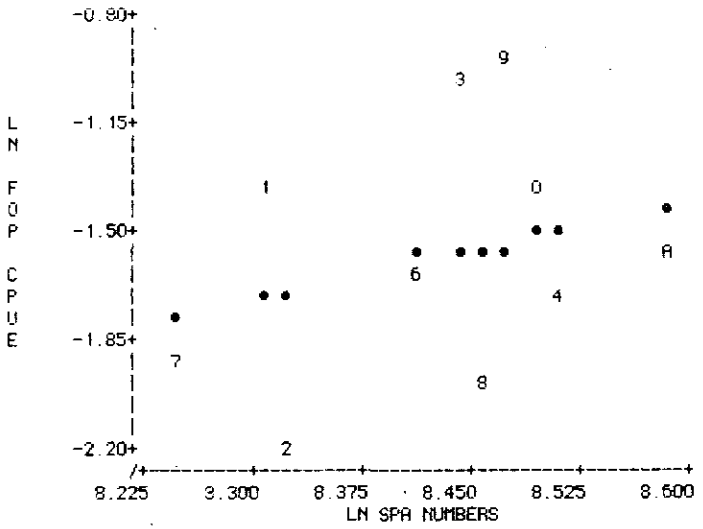
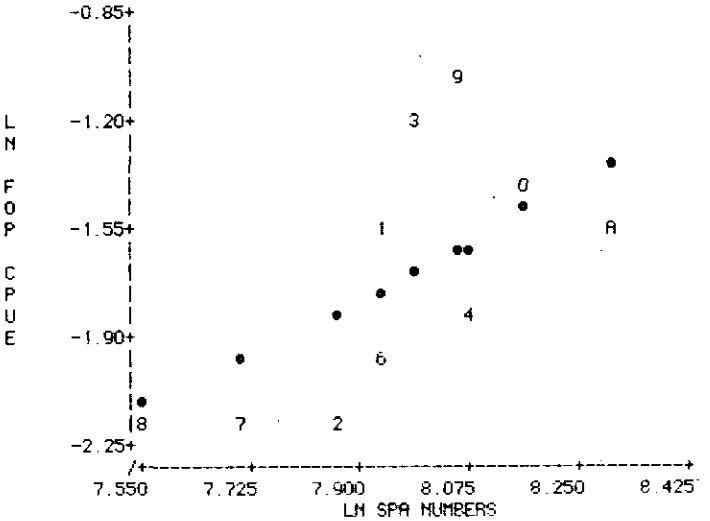


Figure11:Continued.

AGE 12 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 13 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

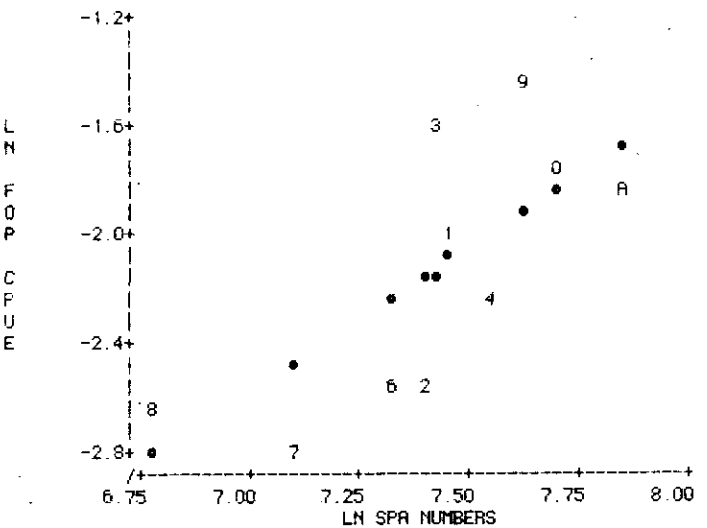
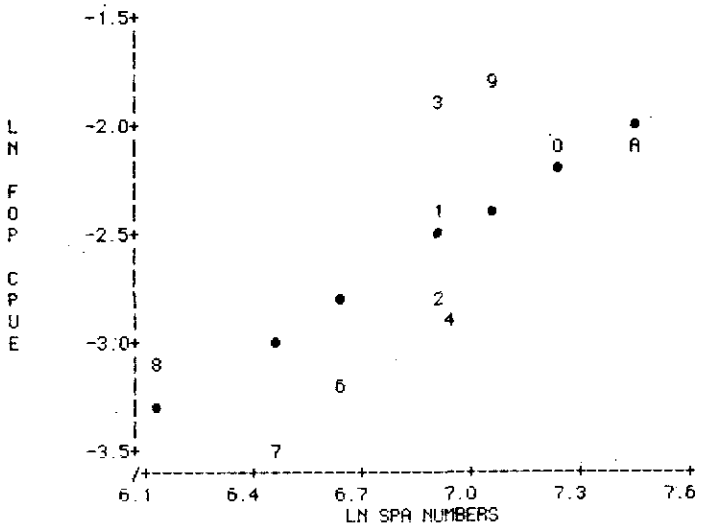


Figure 11:Continued.

AGE 14 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 15 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

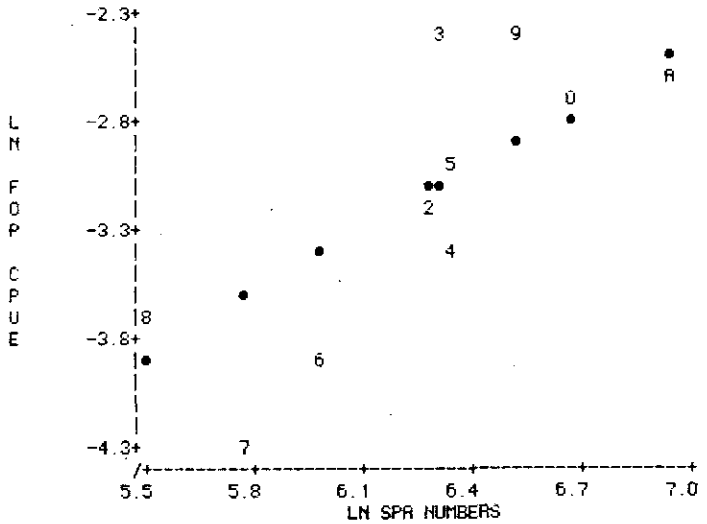
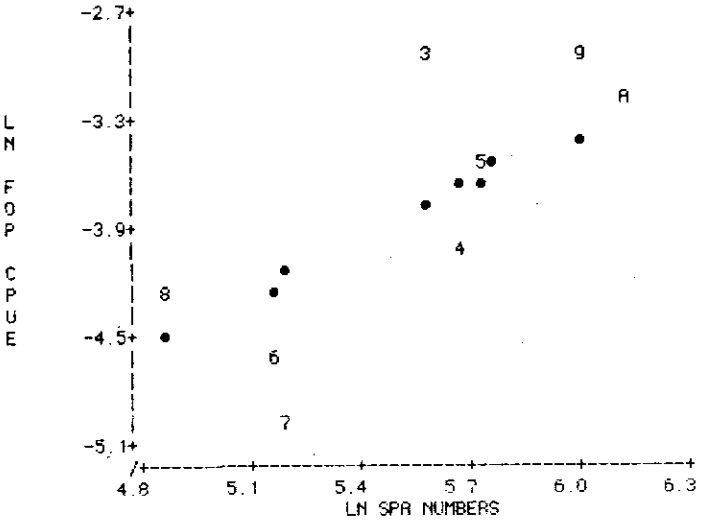


Figure 11:Continued.

AGE 16 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 17 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

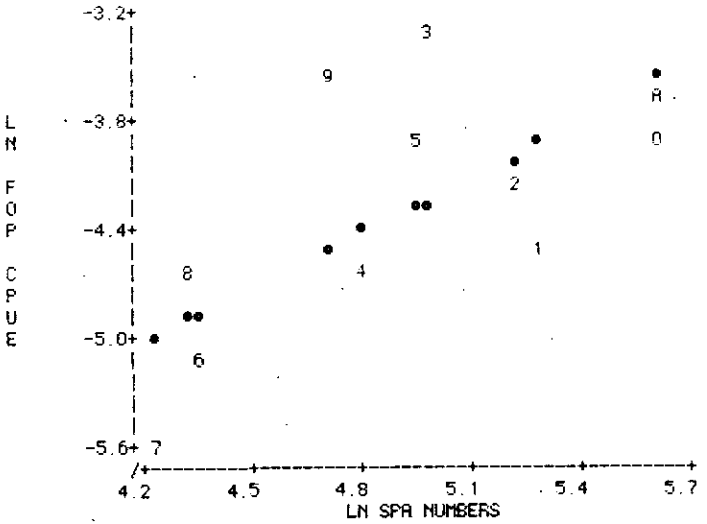
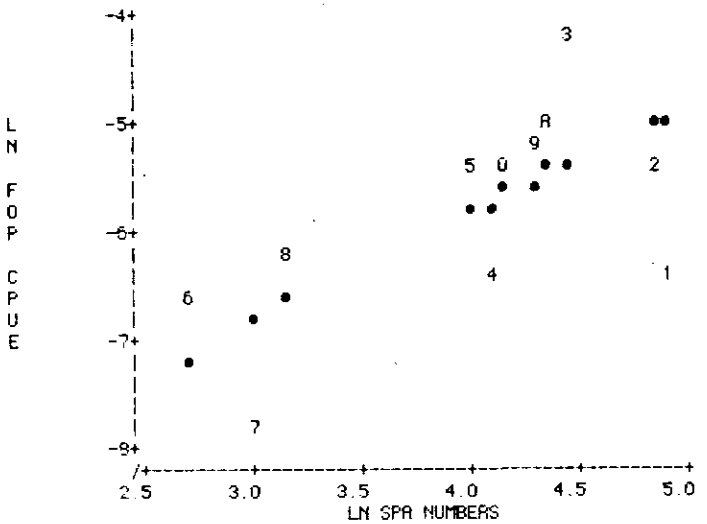


Figure11:Continued.

AGE 18 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 19 PLOTS • FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

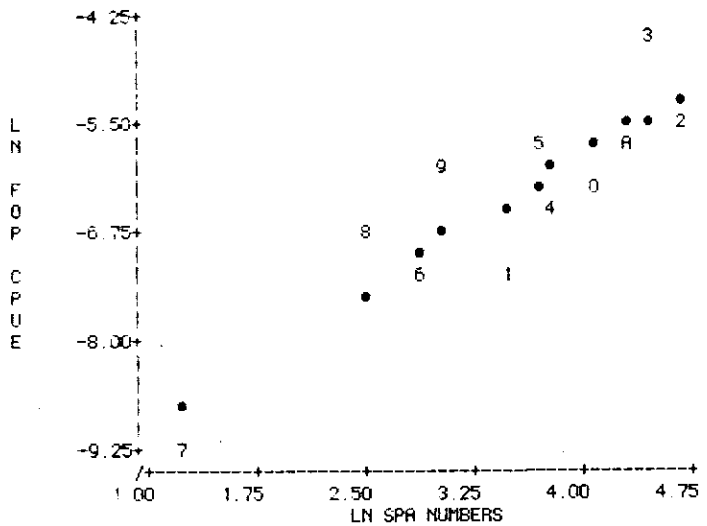
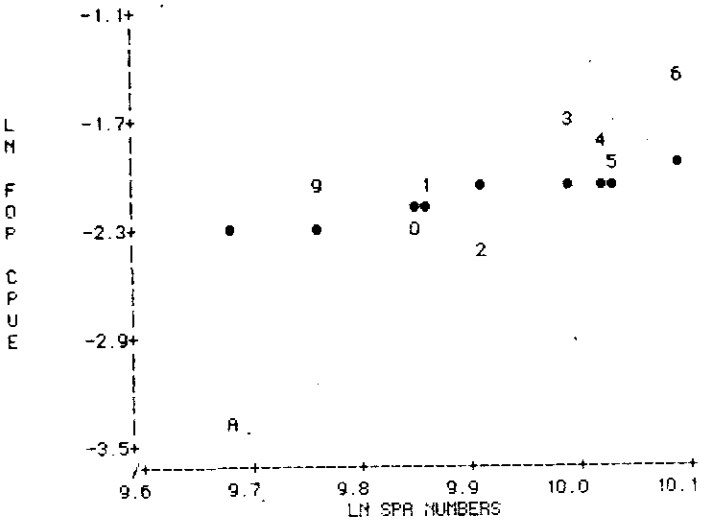


Figure 12: Calibration plots from ADAPT formulation (ages 6-13) for roundnose grenadier in SA2+3.

AGE 6 PLOTS - FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 7 PLOTS - FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

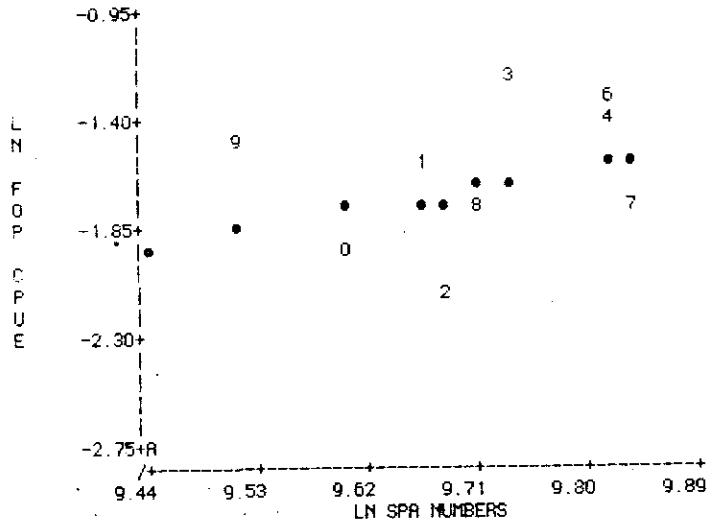
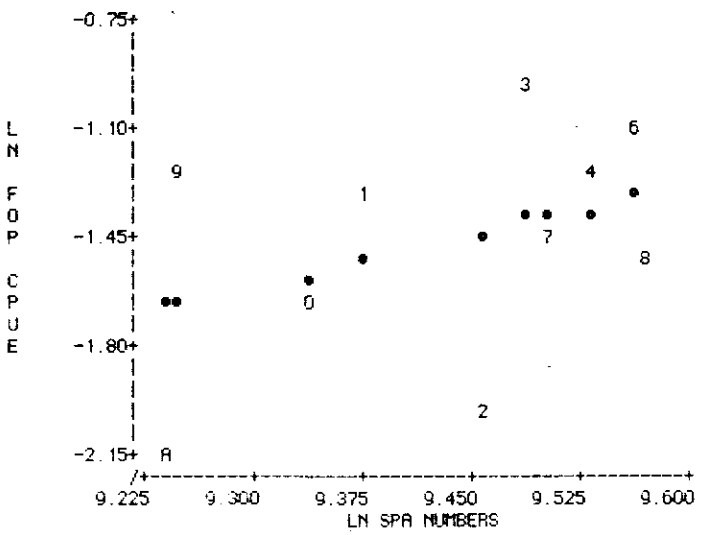


Figure 12: Continued

AGE 8 PLOTS - FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 9 PLOTS - FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

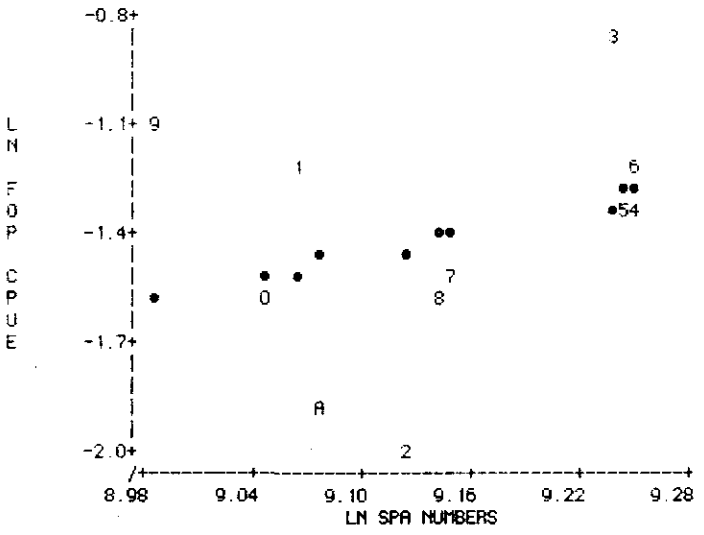
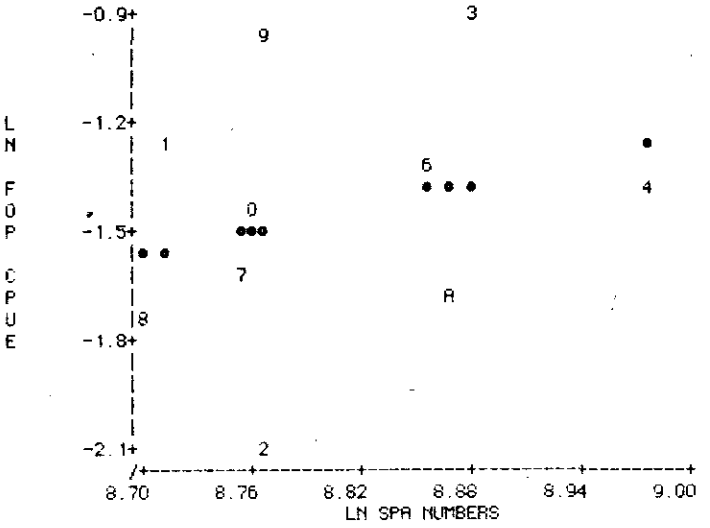


Figure 12: Continued

AGE 10 PLOTS - FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS



AGE 11 PLOTS - FOP STANDARDIZED CATCH RATES
LN FOP CPUE VS LN SPA NUMBERS

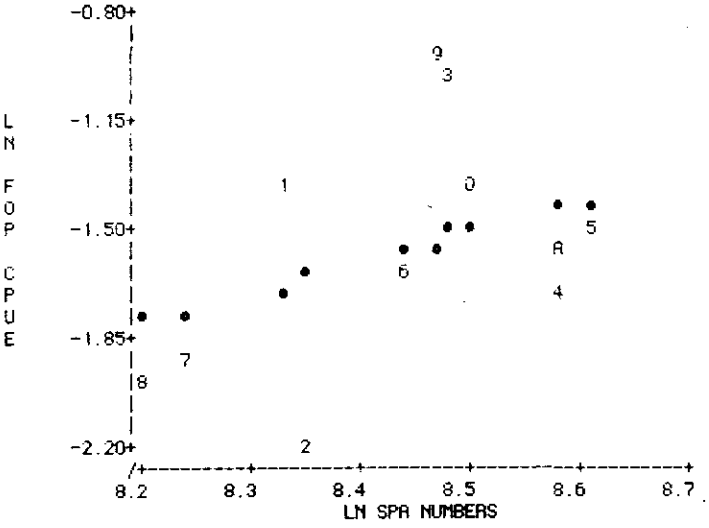
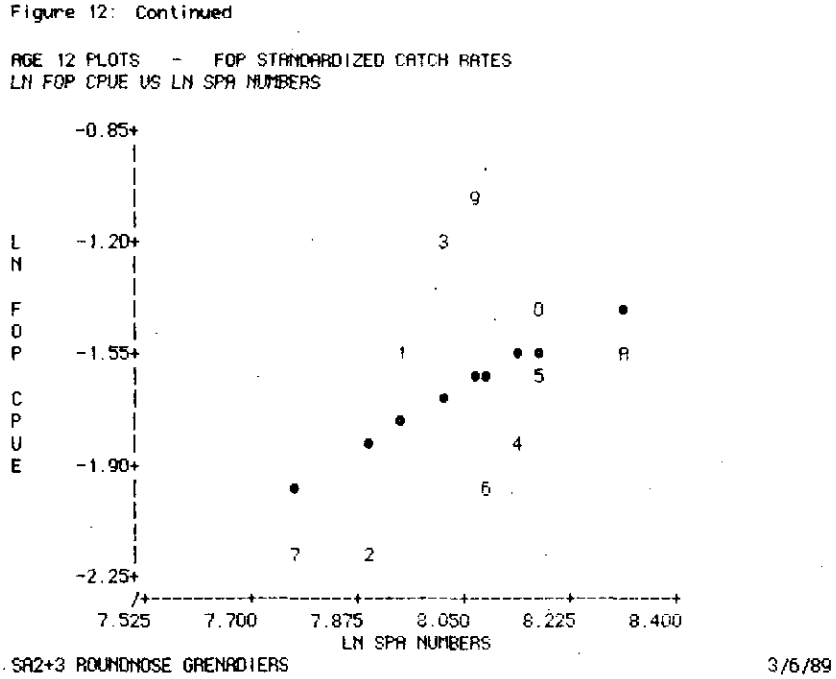
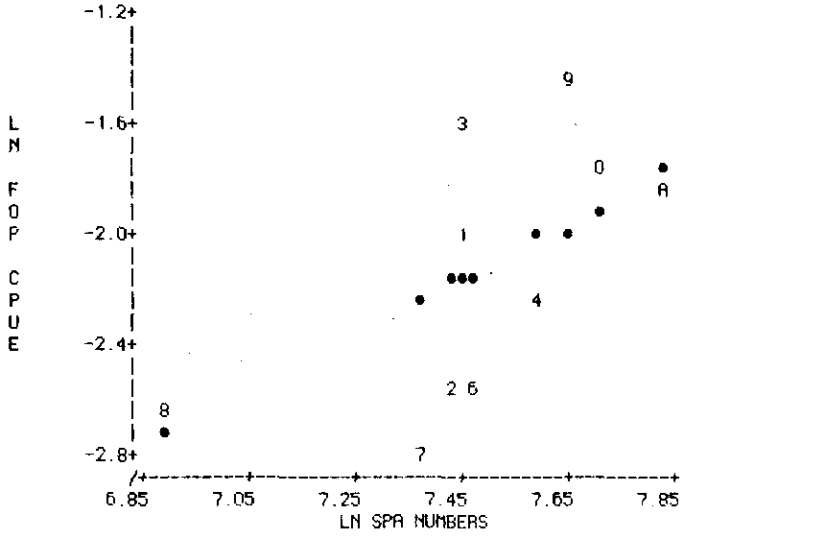


Figure 12: Continued





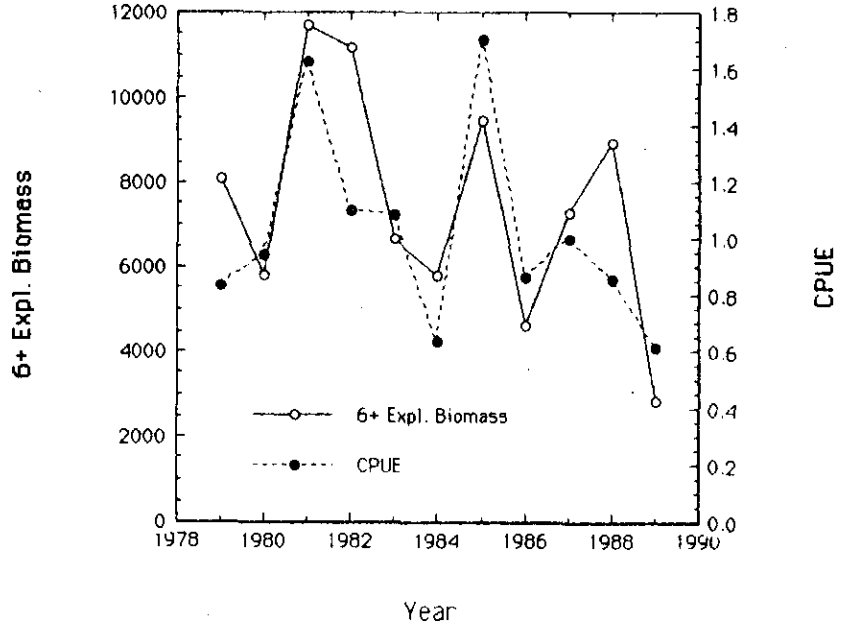


Figure 13. Comparison of standardized CPUE (t/hr) and exploitable biomass of roundnose grenadiers in SA 2+3 from ADAPT.

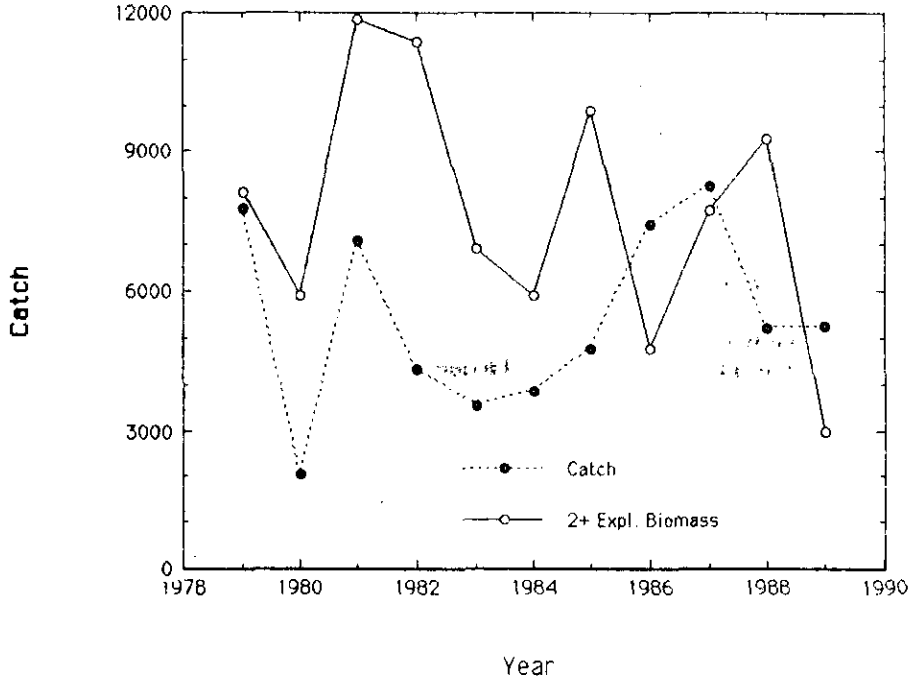


Figure 14: Comparison of catches and exploitable biomass from ADAPT for roundnose grenadier in SA 2+3.

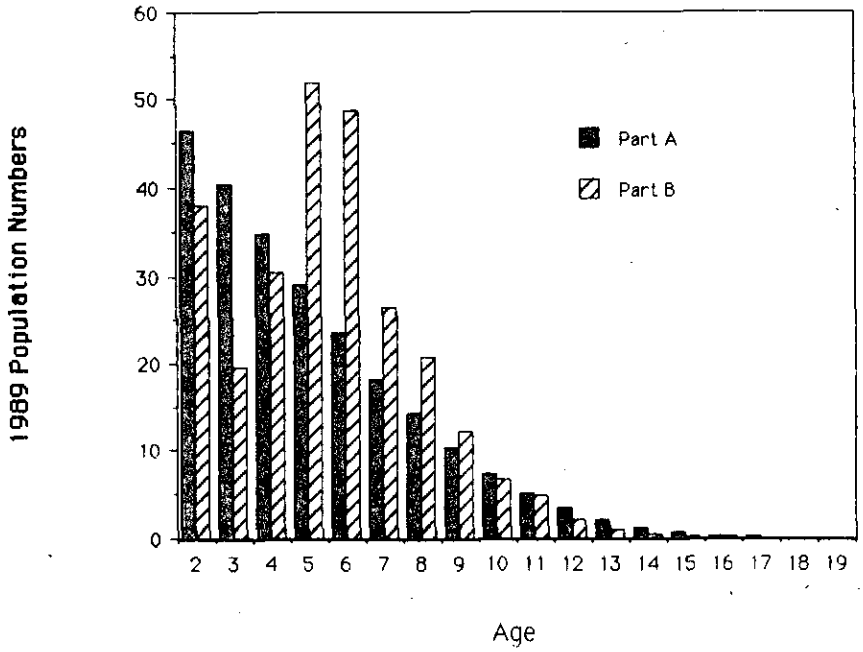


Figure 15: Population numbers at age in 1989 for roundnose grenadiers in SA 2+3 as estimated by SPA in Part A and Part B.

ANNEX I: Summary of ADAPT formulation using all ages for roundnose grenadiers in SA 2+3.

Parameters:

- year-class estimates: $N_{i,1989}$ i=2-19
- calibration constants: q_i i=2-19
- number of parameters: 36

Structure:

- F for oldest age-group (19) = 0.4 x F at age 17
- error in catch-at-age assumed to be negligible
- model did not include an intercept term (assumed to be non-significant)
- natural mortality assumed to be 0.15

Input:

- Catch at age: $C_{i,t}$ i=2-19; t=1979-89
- FOP catch rates: $CPUE_{i,t}$ i=2-19; t=1979-89
- number of observations: 198

Objective function:

- minimize

$$\sum_{it}\sum \{\text{obs}\,(\ln CPUE_{i,t}) - \text{pred}\,(\ln CPUE_{i,t})\}^2$$

ANNEX II: Summary of ADAPT formulation using ages 6-13 for roundnose grenadiers in SA 2+3.

Parameters:

- year-class estimates: $N_{i,1989}$ i=6-13
- calibration constants: q_i i=6-13
- number of parameters: 16

Structure:

- F for oldest age-group (19) = 0.4 x F at age 17
- error in catch-at-age assumed to be negligible
- model did not include an intercept term (assumed to be non-significant)
- natural mortality assumed to be 0.15

Input:

- Catch at age: $C_{i,t}$ i=2-19; t=1979-89
- FOP catch rates: $CPUE_{i,t}$ i=6-13; t=1979-89
- number of observations: 88

Objective function:

- minimize

$$\sum_{it}\sum \{\text{obs}\,(\ln CPUE_{i,t}) - \text{pred}\,(\ln CPUE_{i,t})\}^2$$