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An Update on the Status of Roundnose Grenadier in NAFO Subareas 0+1 and 2+3

by

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Introduction

Since 1980, nominal catches of roundnose grenadier have been below 1000 t in SA 0+1 (Table 1, Figure 1). In 1987 and 1988 there were no reported landings by Denmark (G) (Table 2a) but Japan took about 300 t in 1987 and the USSR reported 120 t taken in 1988. In both of these years, catches were taken in the second half of the year (Table 3a). A general production analysis was carried out in 1985 (Atkinson MS 1985), but the lack of sufficient data has precluded any updates.

Prior to 1979, catches of roundnose grenadier in SA 2+3 exceeded 20,000 t in most years (Table 1, Figure 2), but declined to as low as 2000 t in 1982. After 1984, catches increased somewhat and exceeded 8000 t in 1987, but declined slightly to about 6300 t in 1988. The increases in recent years are due to increased catches by both the German Democratic Republic and USSR (Table 2b). In 1987 Portugal reported 1000 t taken, and the 1988 catch by the EEC (perhaps Portugal again?) was about 900 t. Catches continue to be greatest in the second half of the year when ice is not a problem (Table 3b). There are insufficient data available to conduct an analytical assessment of this stock, and recent attempts at general production analyses have been unsuccessful (Atkinson and Power MS 1988). This document updates the available information concerning the commercial fishery on roundnose grenadier.

For the past number of years, it has been stated that the 10% by-catch limitation for Greenland halibut in the roundnose grenadier fishery (imposed by Canada) has restricted the location of the grenadier fishery. This restriction was felt to be adversely affecting the catch rates for roundnose grenadier and as a result, questions were raised as to whether the catch rates may be artificially depressed and not indicative of stock status. Beginning in 1987, the by-catch restriction was changed to 30% for the German Democratic Republic fishing in depths >800 m, and this same change was allowed for the USSR fleet for 1988. STACFIS, in 1988, recommended (NAFO Scientific Council Reports, 1988, p. 70) that the Canadian observer (FOP) database be examined in detail to determine if the change in the regulation had any effect on the catch rates for roundnose grenadier. This paper also presents the results of these analyses.

Methods and Results

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 1987, and the second is that compiled by Canadian observers (FOP) for 1978-1988. 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. In addition, two new category types were created: the first based on percentage catch, and the second based on depth of fishing. For the percent category type, five categories were chosen representing the percent of the total catch made up of roundnose grenadier (50.1-60 %; 60.1-70%; 70.1-80%; 80.1-90%; and 90.1-100%). The depth category type could be created using the FOP database only, and fishing was divided to ≤ 800 m and > 800 m. Initial analyses carried out to investigate the interaction between year and percent, and year and depth indicated that the trends in catch rates for the different categories were the same over time: the assumption of proportionality, required by the multiplicative model (Gavaris 1980) is not violated by the inclusion of these new category types. Although the FOP data were first categorized on a set by set basis, they were aggregated by month before input into the analyses. For the FOP data, for depths >800 m, the by-catch was almost totally Greenland halibut (pers. Comm., D.W. Kulka, Department of Fisheries and Oceans, St. John's, Newfoundland).

Both datasets were then 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 4) indicate that the regression is significant, explaining about 60% of the variation in the data. There were not significant differences between months. The percent category type itself explained about 40% of the variation as without it, although the trends in the year coefficients are the same, the regression only explains about 20% of the variation (similar to last year's results (Atkinson and Power MS 1988)). This indicates that depending on the percent of roundnose grenadier in the catch, catch rates are very different. This is confirmed by examination of the coefficients for the percent category type (Table 4, Figure 3): as the percent roundnose grenadier increases, so does the catch rate. Examination of the coefficients also indicates that catch rates are greater in depths $\leq$800 m. Examination of the residuals (Figure 4) did not reveal any outliers.

The catch rates (Table 5, Figure 5) suggest two cycles although the reasons for this are not clear. It is not felt that these reflect any change in the stock status, and examination of the standard errors of the estimates suggests that statistically, there is no real trend in the catch rates over time. Standardized effort (Table 5, Figure 6) has gradually increased in recent years, similar to the increases in catches.

Initial analysis using the NAFO database indicated the presence of a few outliers (Figure 7). Those circled were deleted and the analysis redone. The results (Table 6) indicate that the regression explained about 67% of the variation. As with the FOP data, differences between months were not significant. The percent category type explained about 25% of the variation as analysis without it, while giving the same trends in catch rates over time, only explained about 45% of the variation (similar to last year (Atkinson and Power MS 1988)). Examination of the coefficients for the percent categories (Table 6, Figure 8) again indicates that the higher the proportion of roundnose grenadier in the catch, the higher the catch rate. The step-wise increase in catch rate with percent observed with the FOP data is not so evident with these data. The 55 and 65 % categories are not significantly different, nor are the 75, 85 or 95 % categories. These differences may be the result of the different aggregation procedures used with the two datasets. Since the NAFO data were aggregated by month prior to percent classification, these data may not be as sensitive to differences. Examination of the residuals from the final analysis (Figure 9) did not reveal any outliers.

Standardized catch rates (Table 7, Figure 10) declined from the early 1970's until around 1981 then remained fairly stable. There was an increase in 1984 which was also noted from the FOP data. Except for 1971, standardized effort (Table 7, Figure 11) fluctuated between about 8000 and 15,000 hr from 1967 to 1979 then declined to about 1500 hours in 1980. Effort has gradually increased from 1984.

When compared, the two catch rate series show similar overall trends with time although the results using observer data show more inter-annual fluctuations than do those from the ICNAF/NAFO data (Fig. 12). Last year (Atkinson and Power MS 1988) one increase in catch rate with the FOP data was in 1980. Analysis of the revised dataset indicates an increase in 1979. This difference is due to an error in the database used previously.

General production analyses were not carried out on the data as it was felt that the addition of one more point would not yield results different from those in the past.

Commercial length frequencies were available for 1979-1988 from the FOP (Figures 13-22). There has been insufficient time to carry out any detailed examination of them.

As noted above, over the 1978-1988 period, the coefficients for percent of roundnose grenadier in the catch (Table 4, Figure 3) indicate that catch rates increase as the percent grenadier increases. These results are contrary to the point of view that an increased by-catch allowance would result in increase catch rates for roundnose grenadier.

Beyond 800 m, the by-catch in the roundnose grenadier fishery is almost exclusively Greenland halibut. If a relaxation of the Greenland halibut by-catch restrictions allows fishing on denser concentrations of roundnose grenadier resulting in increased catch rates, then examination of residuals from the multiplicative model for catches in depths >800 m for the German Democratic Republic and the USSR should reveal a shift starting in 1987 and 1988 respectively, corresponding to increases in catch rates caused by changes to the regulations. Such examination however (Figure 14), does not suggest a shift. What can be seen is that the residuals fluctuate (especially for the USSR data) but do not increase as expected after the regulations were changed.

Discussion

The fishery for roundnose grenadier in SA 0+1 continues at a low level, and it is still not possible to update the assessment of this stock. There are no data available to indicate any change in the previously advised catch at 2/3 f_{MSY} of 8000 t.

General production analyses can still not be carried out for roundnose grenadier in SA 2+3. Standardized catch rates have remained stable during the 1980's when catches have averaged about 4500 t.

It has been noted in the past that by-catch limitations of Greenland halibut may be restricting this fishery and thus catch rates in the most recent period may not be reflective of stock status. Analyses presented here suggest that catch rates are lower when the percentage of roundnose grenadiers in the catches decreases. This is examined in more detail by Atkinson (MS 1989). The modal length of fish has decreased from 1979 to 1988. There are, however, insufficient data available to suggest any change in the TAC in SA 2+3 for 1990 from the present level of 11,000 t.

The available data do not indicate that catch rates increase either when a lower percent of roundnose grenadier is caught, or when the by-catch restrictions were changed from 10 to 30 %. On the contrary, catch rates appear to decline.

References

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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	56	7,222	32	7,427	11,000
1987*	-	319	319	8,000	80	254	204	6,682	1,059	8,279	11,000
1988*	-	-	120	8,000						6,337	11,000
1989				8,000							11,000

* Provisional.

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

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986*	1987*	1988*
Denmark (G)	10	32	21	-	39	37	22	25	36	81	-	-
GDR	61	-	-	-	-	-	-	-	14	-	-	-
FRG	519	5,807	6,794	1,721	353	11	-	-	-	-	-	-
USSR	2,345	-	106	32	87	43	46	25	2	1	-	120
Japan	-	-	-	-	-	-	-	-	3	4	319	-
TOTAL	2,935	5,839	6,921	1,753	479	91	68	50	55	86	319	120

* Provisional.

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

Country	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986*	1987*	1988*
Canada (M)+	-	2	-	-	-	-	-	-	-	9	-	-
Canada (N)	15	7	4	-	-	-	-	-	-	-	-	-
FRG	174	973	-	32	-	-	-	-	178	13	-	1
GDR	613	1,801	480	898	1,407	1,640	2,586	3,650	3,740	4,571	4,469	3,438
Poland	-	51	96	36	18	15	50	51	12	17	1	17
Romania	7	108	-	-	-	-	-	-	-	-	-	-
USSR	14,577	17,760	7,201	1,087	5,660	2,689	933	147	1,018	2,801	2,725	1,890
Japan	-	-	-	-	-	-	-	2	-	13	79	72
EEC	-	-	-	-	-	-	-	-	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	3	1,001	919
Cuba	-	-	-	-	-	-	-	-	-	-	4	-
TOTAL	15,386	20,702	7,781	2,053	7,085	4,344	3,569	3,873	4,948	7,427	8,275	6,337

* 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
1977	464	94	20	14	2	5	58	1,094	1,089	38	18	39	2,935
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	319
1988*	-	-	-	-	-	-	-	-	-	-	118	2	120

a includes catch of 7 t from month 'unknown'; b includes catch of 6 t from month 'unknown'.
c includes catch of 1 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
1977	44	8	12	45	13	6	1,776	5,698	3,411	1,973	1,681	719	15,386
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	2,817	2,093	1,555	494	336	7,426
1987*	71	111	45	96	75	5	22	2,722	1,627	1,558	1,319	628	8,279 a
1988*	415	33	37	-	8	74	993	836	736	1,443	1,484	278	6,337

* Provisional.

Table 4: Regression of multiplicative model for roundnose grenadier in SA 2+3 using FOP data.

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multiple r..............    0.783
multiple r squared.....    0.613
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analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	4.116e1	4.116e1	
regression	27	7.813e1	2.894e0	18.773
CGT 1	4	2.781e0	6.952e⁻1	4.510
Div. 2	3	8.305e0	2.768e0	17.959
Month 3	5	7.586e⁻1	1.517e⁻1	0.984
Depth 4	1	4.384e0	4.384e0	28.441
Percent 5	4	5.437e1	1.359e1	88.185
Year 6	10	6.500e0	6.500e⁻1	4.217
residuals	320	4.933e1	1.541e⁻1	
total	348	1.686e2		

Table 4: continued.

regression coefficients

category	code	variable	coefficient	std. error	no. obs.
1	20127	intercept	‾0.030	0.133	348
2	31				
3	9				
4	2				
5	95				
6	78				
1	11125	1	‾0.178	0.069	90
	11126	2	0.085	0.084	45
	11127	3	‾0.003	0.066	71
	20157	4	‾0.563	0.190	5
2	21	5	0.612	0.093	28
	22	6	0.393	0.080	46
	23	7	0.223	0.148	17
3	7	8	‾0.056	0.124	18
	8	9	‾0.049	0.068	70
	10	10	‾0.006	0.067	81
	11	11	0.092	0.068	77
	12	12	‾0.043	0.103	21
4	1	13	0.388	0.073	52
5	55	14	‾1.285	0.078	55
	65	15	‾1.008	0.074	72
	75	16	‾0.782	0.070	83
	85	17	‾0.373	0.071	79
6	79	18	0.480	0.208	5
	80	19	0.285	0.169	20
	81	20	0.185	0.124	54
	82	21	0.239	0.138	31
	83	22	‾0.046	0.144	29
	84	23	0.561	0.150	22
	85	24	0.293	0.136	35
	86	25	0.334	0.135	47
	87	26	0.225	0.133	50
	88	27	0.071	0.131	39

Table 5: Standardized catch rate and effort for roundnose grenadier in SA 2+3 based on FOP data.

standards used   variable numbers: 20127   31   9   2   95

predicted catch rate

	ln transform		retransformed			
year	mean	s.e.	mean	s.e.	catch	effort
78	‾0.0302	0.0178	1.039	0.138	20702	19925
79	0.4589	0.0442	1.672	0.348	7781	4654
80	0.2545	0.0231	1.378	0.208	2053	1490
81	0.1545	0.0088	1.255	0.118	7085	5644
82	0.2086	0.0104	1.324	0.135	4344	3281
83	‾0.0760	0.0128	0.995	0.112	3569	3587
84	0.5307	0.0145	1.824	0.219	3873	2124
85	0.2624	0.0100	1.397	0.140	4948	3541
86	0.3040	0.0088	1.458	0.136	7426	5094
87	0.1953	0.0095	1.307	0.127	8279	6334
88	0.0408	0.0115	1.119	0.120	10000	8937

average c.v. for the retransformed mean: 0.120

Table 6: Regression of multiplicative model for roundnose grenadier in SA 2+3 using NAFO data.

multiple r............ 0.821
multiple r squared..... 0.674

analysis of variance

source of variation	df	sums of squares	mean squares	f-value
intercept	1	6.866e0	6.866e0	
regression	41	4.929e1	1.202e0	10.032
CGT 1	7	2.524e0	3.606e⁻1	3.009
Month 2	7.	9.304e⁻1	1.329e⁻1	1.109
Div. 3	3	1.226e0	4.086e⁻1	3.410
Percent 4	4	1.112e1	2.779e0	23.193
Year 5	20	2.396e1	1.198e0	9.996
residuals	199	2.385e1	1.198e⁻1	
total	241	8.000e1		

regression coefficients

category	code	variable	coefficient	std. error	no. obs.
1	20127	intercept	0.687	0.269	241
2	10				
3	31				
4	95				
5	67				
1	11115	1	⁻0.451	0.203	5
	11116	2	⁻0.583	0.213	5
	11125	3	⁻0.065	0.108	22
	11126	4	⁻0.187	0.158	6
	11127	5	0.110	0.081	35
	20126	6	⁻0.182	0.107	16
	20157	7	0.099	0.083	34
2	1	8	⁻0.062	0.165	6
	6	9	0.171	0.171	5
	7	10	⁻0.062	0.106	17
	-8	11	0.063	0.079	37
	9	12	⁻0.085	0.070	54
	11	13	0.073	0.078	48
	12	14	0.047	0.101	19
3	21	15	⁻0.070	0.070	68
	22	16	0.160	0.073	54
	23	17	0.022	0.106	20
4	55	18	⁻0.683	0.097	32
	65	19	⁻0.672	0.099	37
	75	20	⁻0.154	0.082	55
	85	21	⁻0.060	0.079	66
5	68	22	0.145	0.259	15
	69	23	0.180	0.362	2
	70	24	0.240	0.280	10
	71	25	⁻0.045	0.267	18
	72	26	⁻0.183	0.285	8
	73	27	0.255	0.294	6
	74	28	0.331	0.284	10
	75	29	0.254	0.285	11
	76	30	⁻0.228	0.276	11
	77	31	⁻0.165	0.269	16
	78	32	⁻0.212	0.266	29
	79	33	⁻0.517	0.263	26
	80	34	⁻0.424	0.274	14
	81	35	⁻0.638	0.268	17
	82	36	⁻0.709	0.272	12
	83	37	⁻1.058	0.309	4
	84	38	⁻0.258	0.374	2
	85	39	⁻0.890	0.292	8
	86	40	⁻0.772	0.290	9

Table 7: Standardized catch rate and effort for roundnose grenadier in SA 2+3 based on NAFO
data.

standards used   variable numbers: 20127   10   31   95

predicted catch rate

	ln transform		retransformed			
year	mean	s.e.	mean	s.e.	catch	effort
67	0.6871	0.0726	2.036	0.540	17304	8500
68	0.8319	0.0263	2.408	0.389	31263	12982
69	0.8671	0.0703	2.440	0.637	12333	5055
70	0.9267	0.0189	2.658	9.365	22864	8603
71	0.6420	0.0151	2.003	0.246	75445	37667
72	0.5043	0.0229	1.738	0.262	24386	14027
73	0.9425	0.0326	2.681	0.482	17564	6550
74	1.0177	0.0244	2.903	0.452	28416	9789
75	0.9408	0.0253	2.687	0.426	27425	10208
76	0.4595	0.0195	1.665	0.232	20593	12368
77	0.5221	0.0168	1.775	0.230	15386	8667
78	0.4751	0.0119	1.698	0.185	20702	12194
79	0.1703	0.0159	1.249	0.157	7781	6228
80	0.2631	0.0175	1.370	0.181	2053	1499
81	0.0488	0.0168	1.106	0.143	7085	6407
82	⁻0.0221	0.0186	1.029	0.140	4344	4221
83	⁻0.3708	0.0371	0.719	0.138	3569	4961
84	0.4288	0.0785	1.568	0.432	3873	2471
85	⁻0.2033	0.0247	0.856	0.134	4948	5781
86	⁻0.0844	0.0225	0.965	0.144	7427	7695
87	⁻0.2759	0.0234	0.797	0.121	8279	10393

average c.v. for the retransformed mean: 0.163
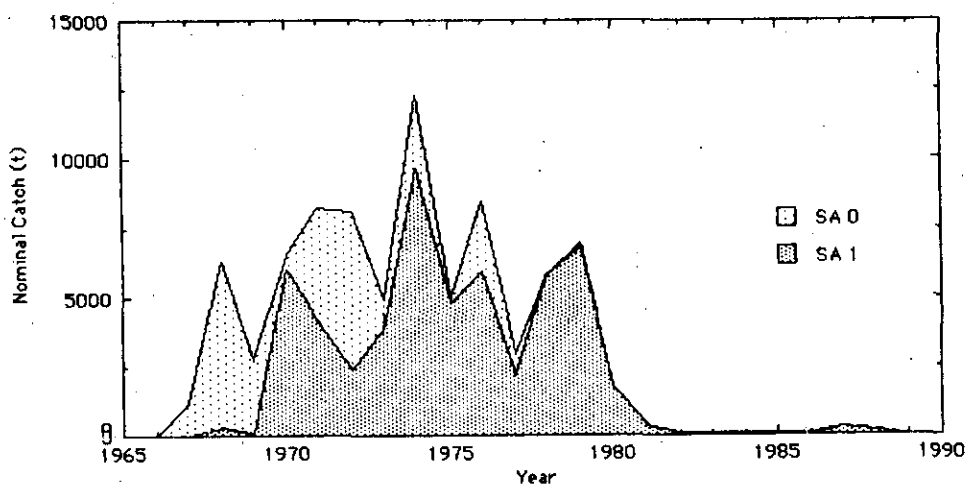
Figure 1 : Nominal catches of roundnose grenadier in SA 0+1 , 1967-1987 (1986 - 1988 are provisional).
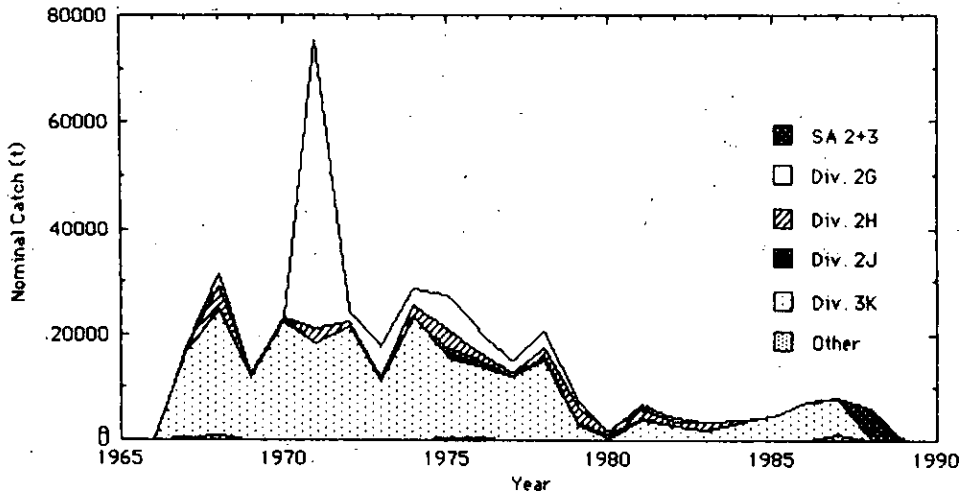
Figure 2: Nominal catches of roundnose grenadier in SA 2+3, 1967-1987 (1986 - 1988 are provisional).
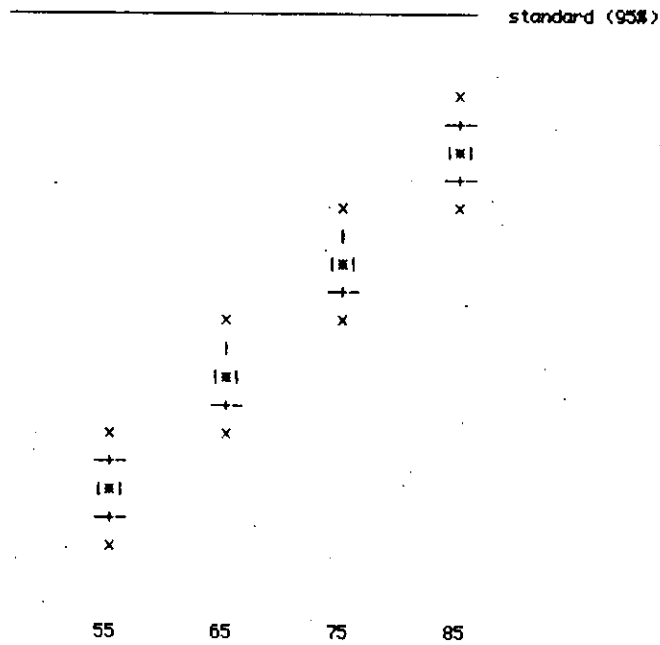
Figure 3: Boxplots of coefficients from the multiplicative model of the percent categories for roundnose grenadier in SA 2+3 using FOP data.
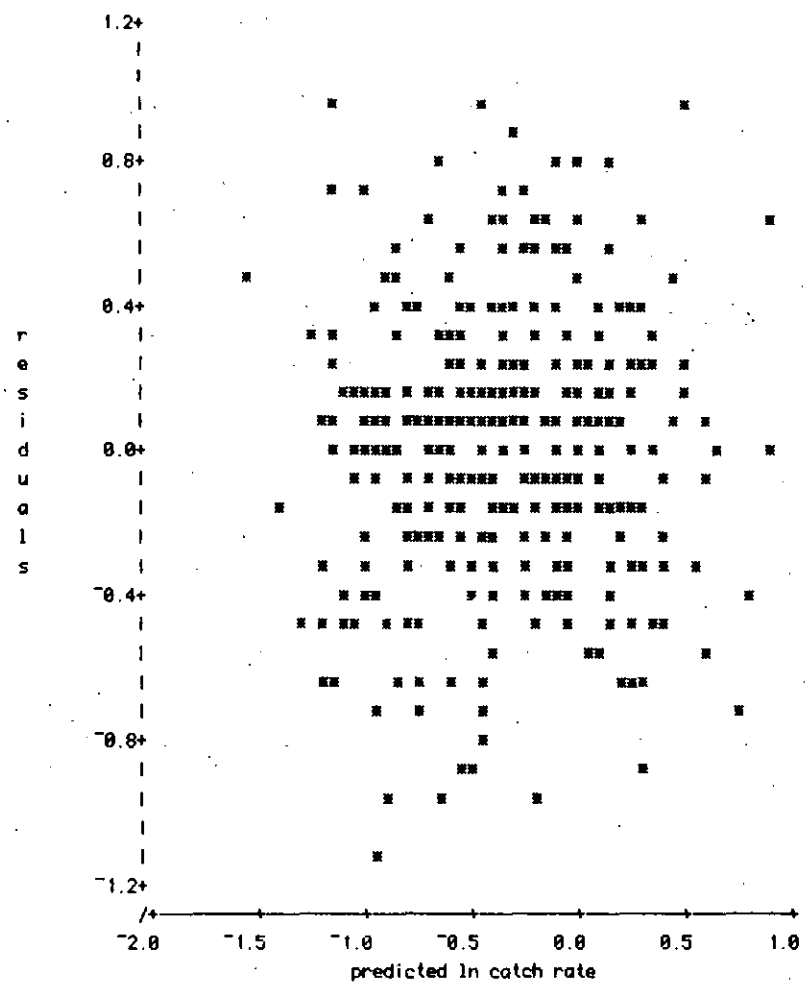
Figure 4: Residuals from initial multiplicative analysis using FOP data for roundnose
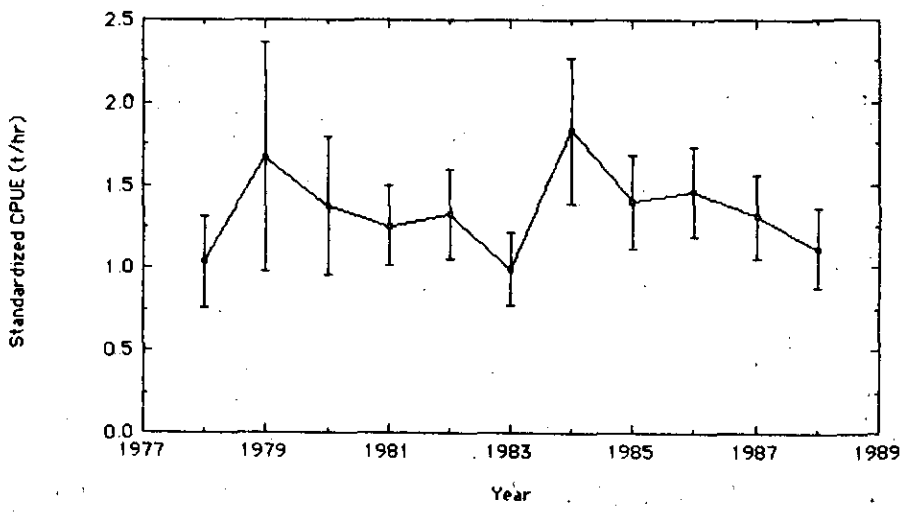grenadier in SA 2+3.
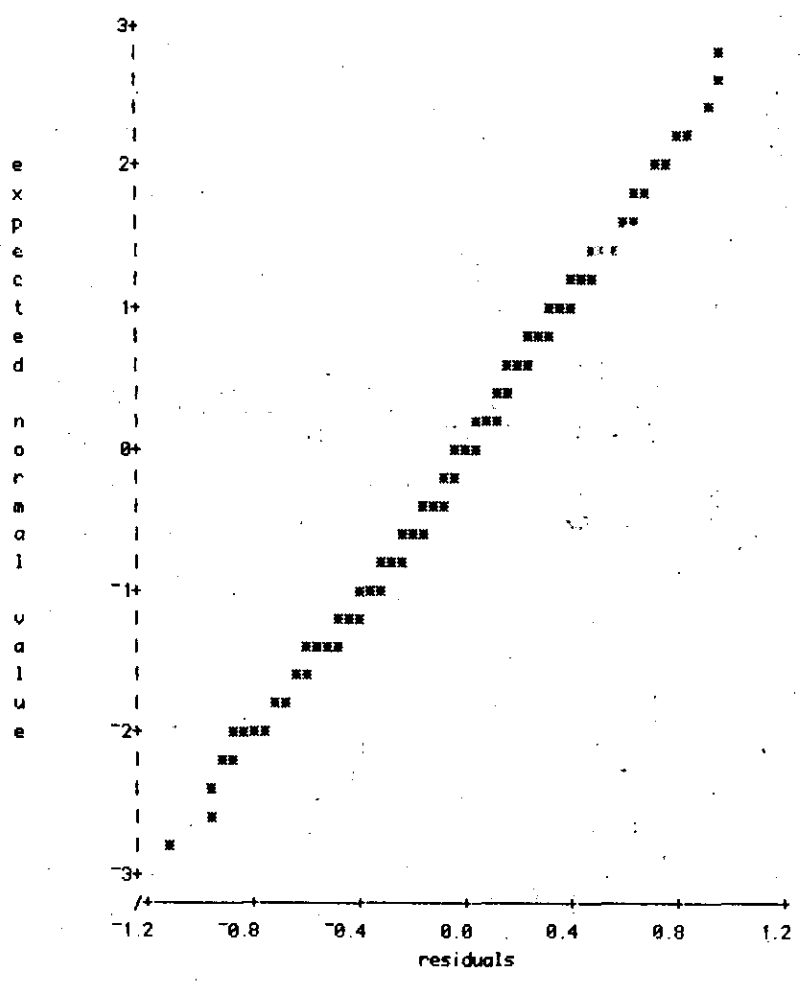
Figure 4: Continued.

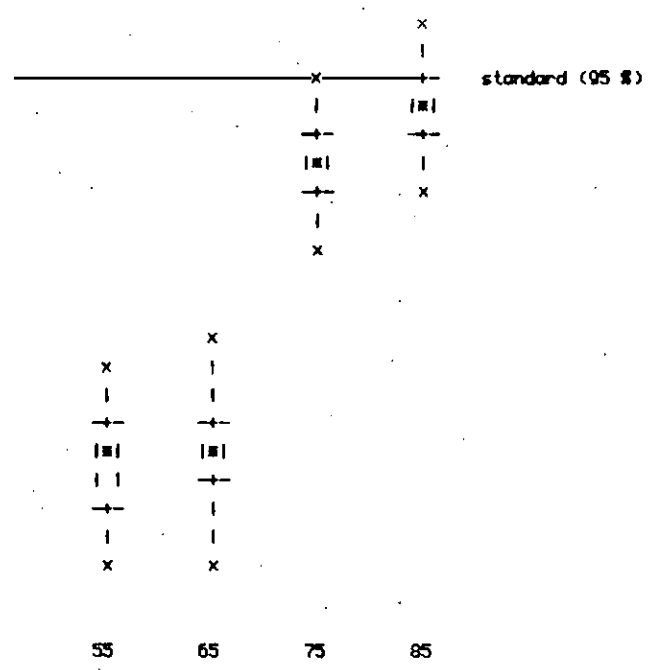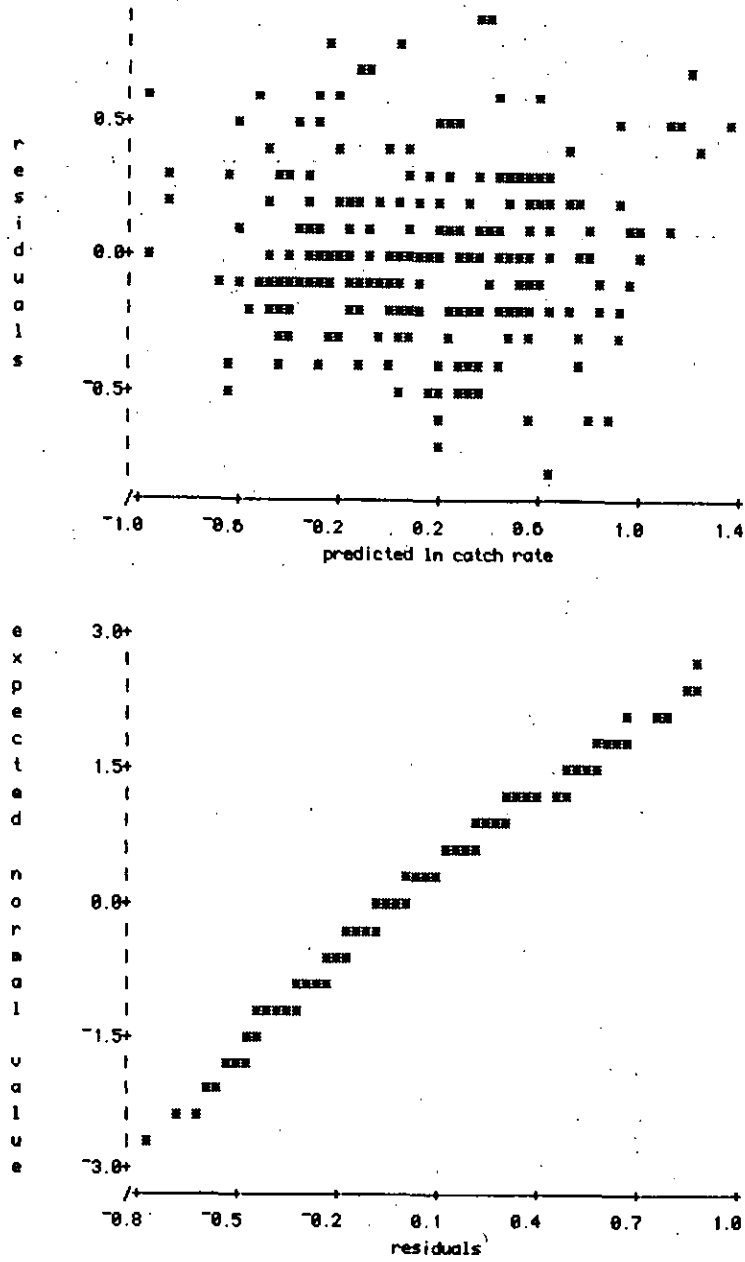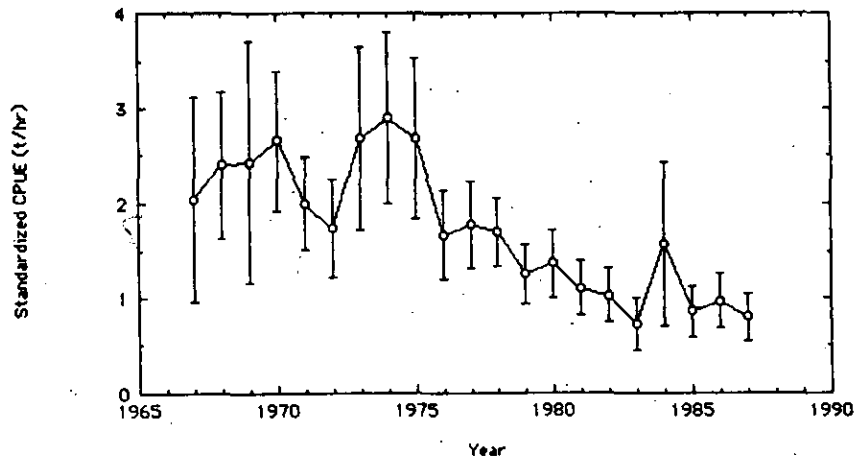Figure 5: Standardized catch rates for roundnose grenadier in SA 2+3 from the multiplicative analysis of FOP data (error bars are ± 2 s.e.)
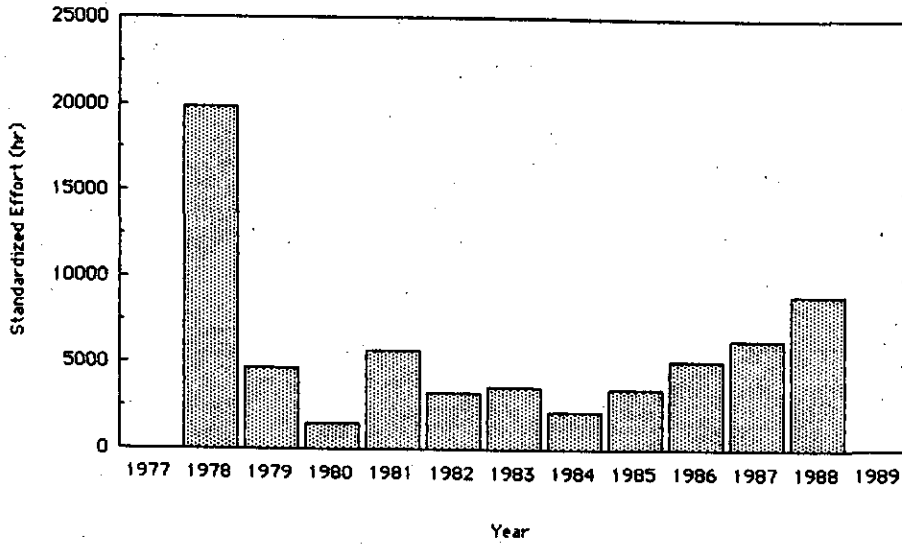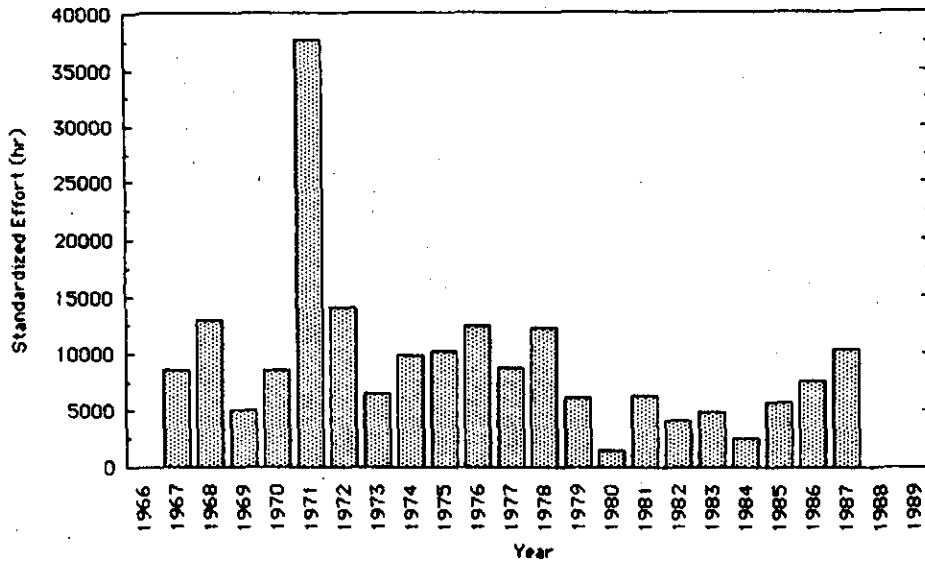
Figure 6: Standardized effort for roundnose grenadier in SA 2+3 from the multiplicative analysis of FOP data.
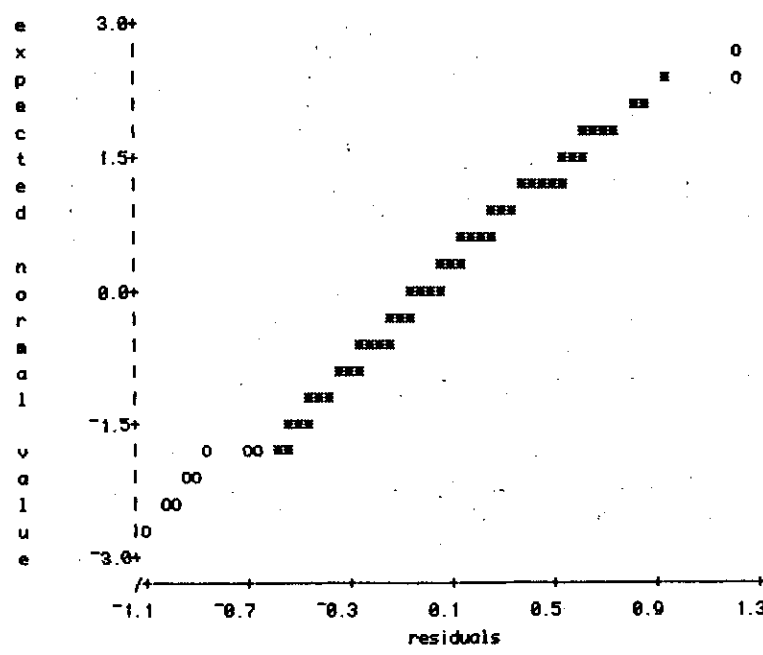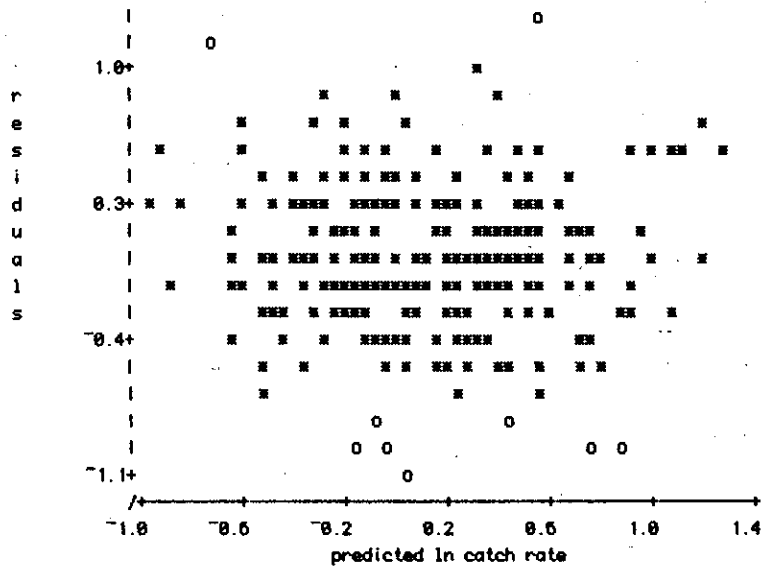
Figure 7: Residuals from initial multiplicative analysis using NAFO data for roundnose grenadier in SA 2+3 (points shown as 'O' were deleted).

```
                                            x
                                            |
        ──────────────────────────────x───────────+─  standard (95 %)
                                       |         |x|
                                      ─+─        ─+─
                                      |x|          |
                                      ─+─          x
                                       |
                                       x


                               x
           x                   |
           |                   |
          ─+─                 ─+─
          |x|                 |x|
          | |                 ─+─
          ─+─                  |
           |                   |
           x                   x


          55        65        75        85
```

Figure 8: Boxplots of coefficients from the multiplicative model of the percent categories
for roundnose grenadier in SA 2+3 using NAFO data.

Figure 9: Residuals from final multiplicative analysis using NAFO data for roundnose grenadier in SA 2+3.

Figure 10 Standardized catch rates for roundnose grenadier in SA 2+3 from the multiplicative analysis of NAFO data (error bars are ± 2 s.e.)

Figure 11: Standardized effort for roundnose grenadier in SA 2+3 from the multiplicative analysis of NAFO data.
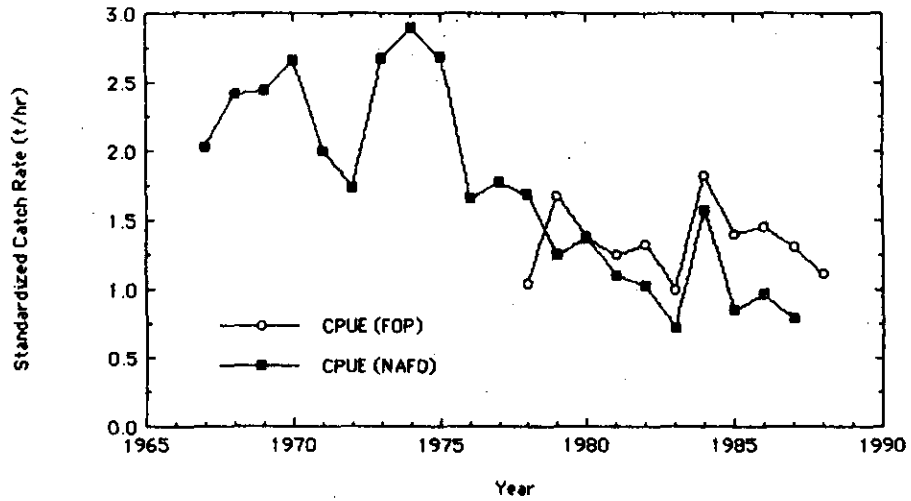
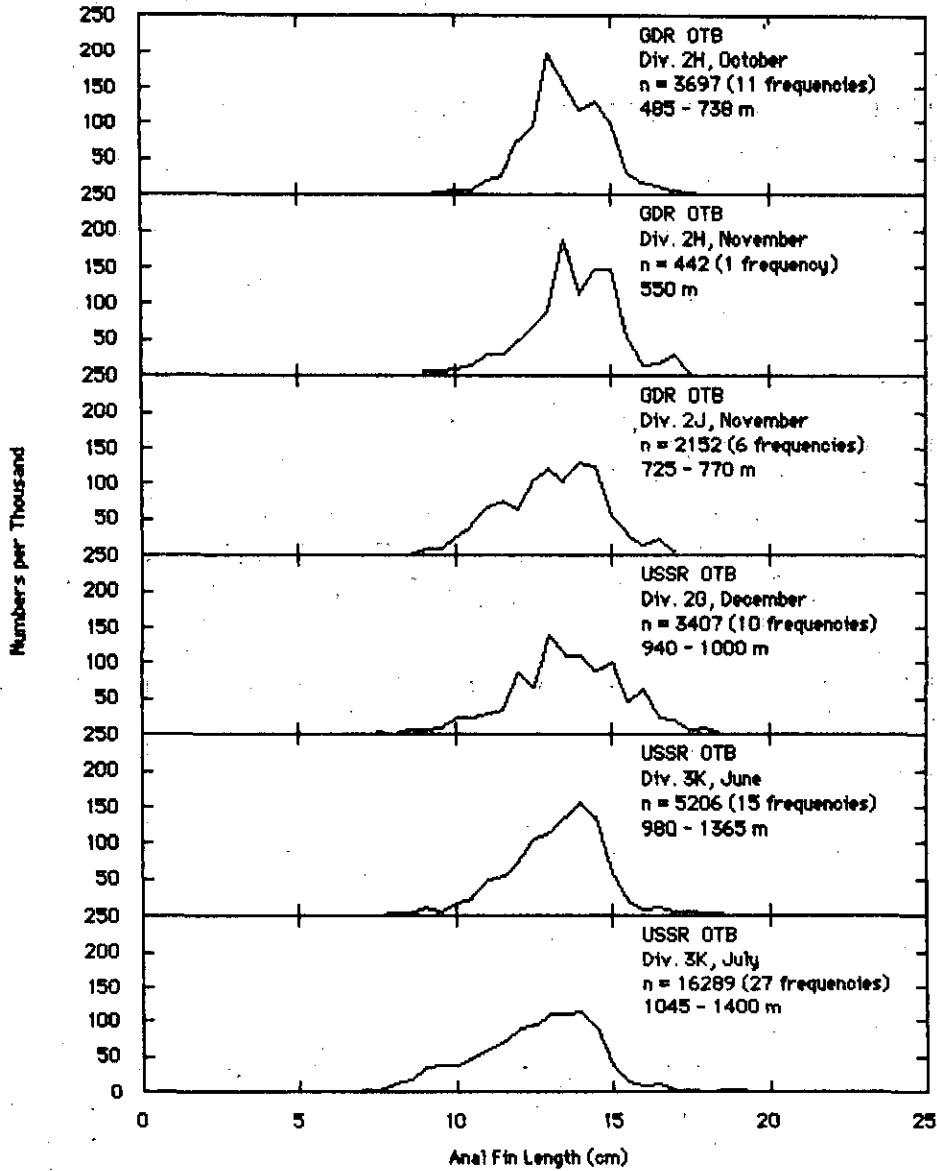Figure 12: Comparison of standardized catch rates derived from ICNAF/NAFO statistics, and observer data (FOP).

GDR OTB
Div. 2H, October
n = 3697 (11 frequencies)
485 - 738 m

GDR OTB
Div. 2H, November
n = 442 (1 frequency)
550 m

GDR OTB
Div. 2J, November
n = 2152 (6 frequencies)
725 - 770 m

USSR OTB
Div. 2G, December
n = 3407 (10 frequencies)
940 - 1000 m

USSR OTB
Div. 3K, June
n = 5206 (15 frequencies)
980 - 1365 m

USSR OTB
Div. 3K, July
n = 16289 (27 frequencies)
1045 - 1400 m

Anal Fin Length (cm)

Numbers per Thousand

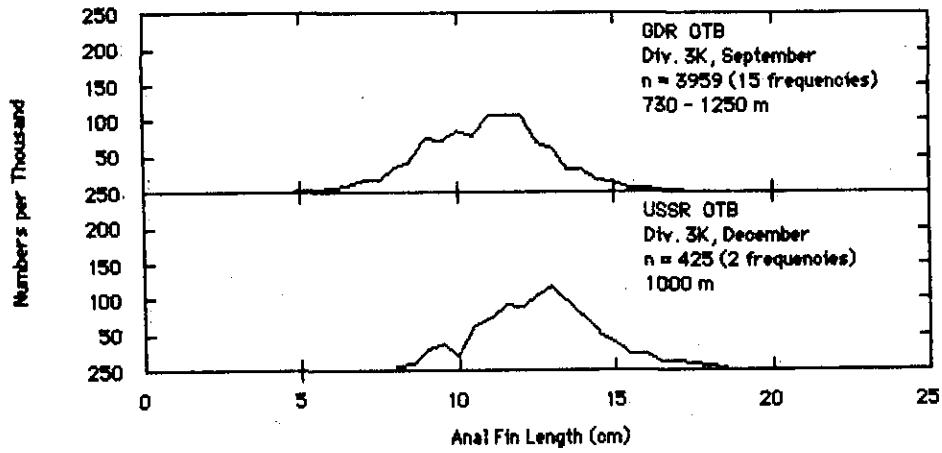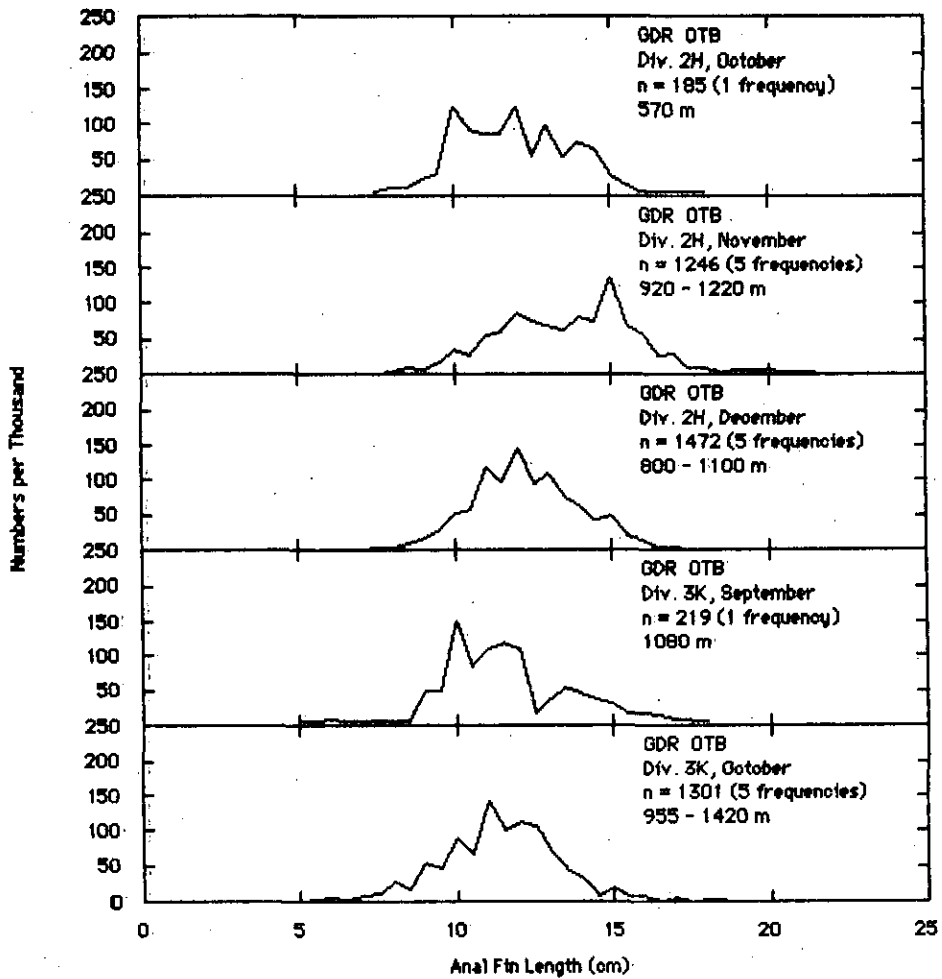Figure 13 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1979 as collected Canadian observers.

GDR OTB
Div. 2J, November
n = 2997 (10 frequencies)
555 - 913 m

GDR OTB
Div. 2J, December
n = 306 (1 frequency)
590 m

Numbers per Thousand
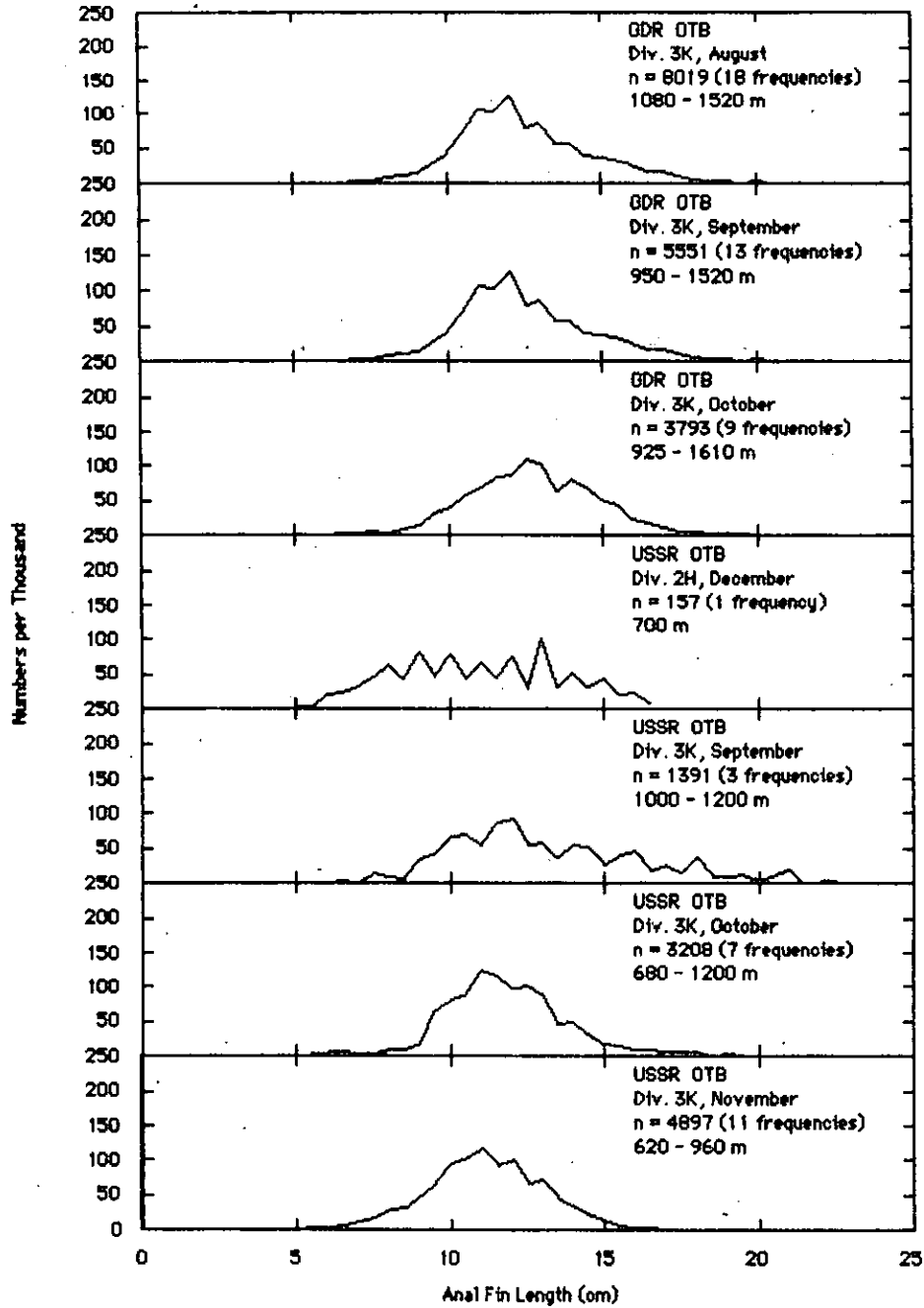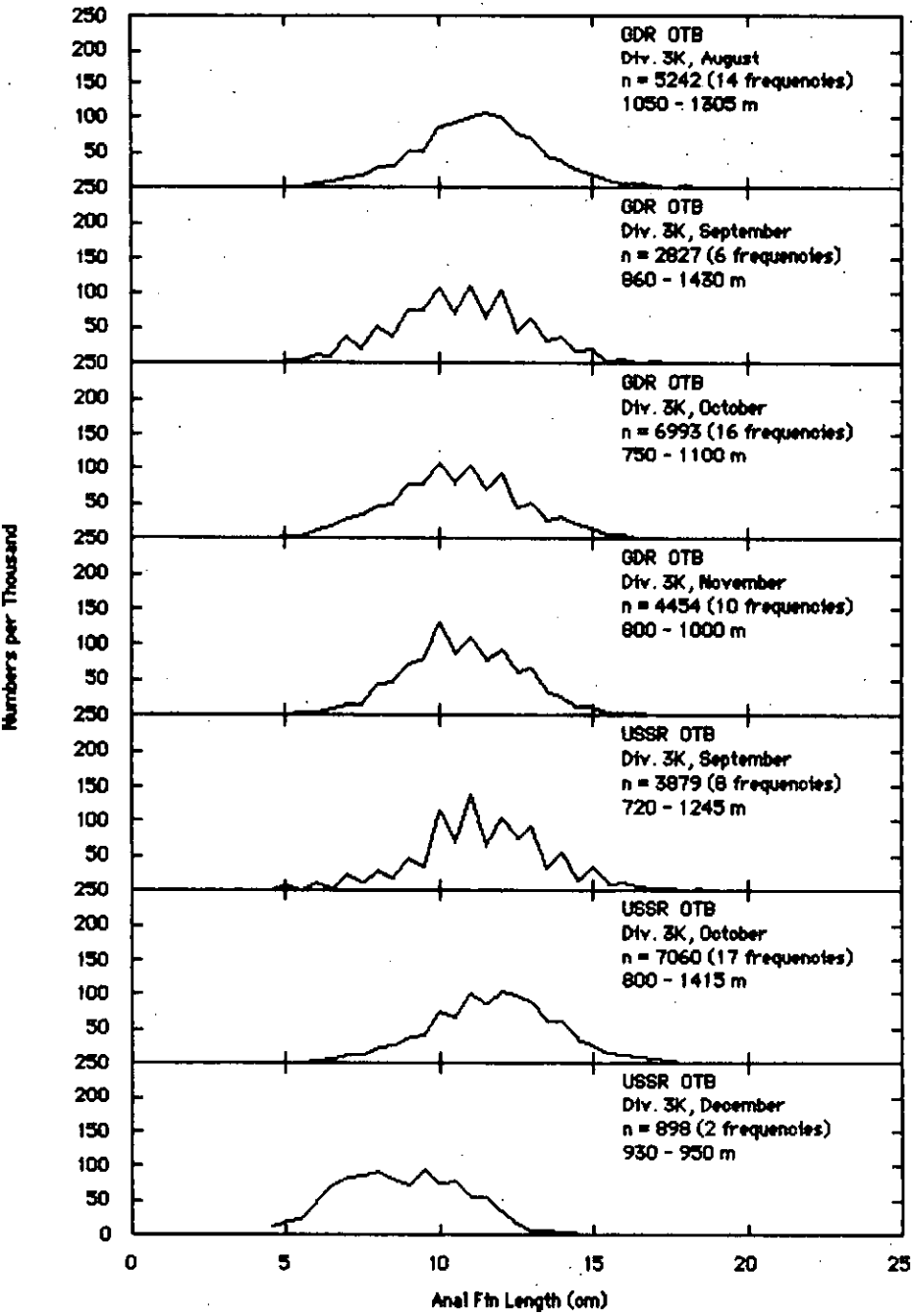
Anal Fin Length (cm)
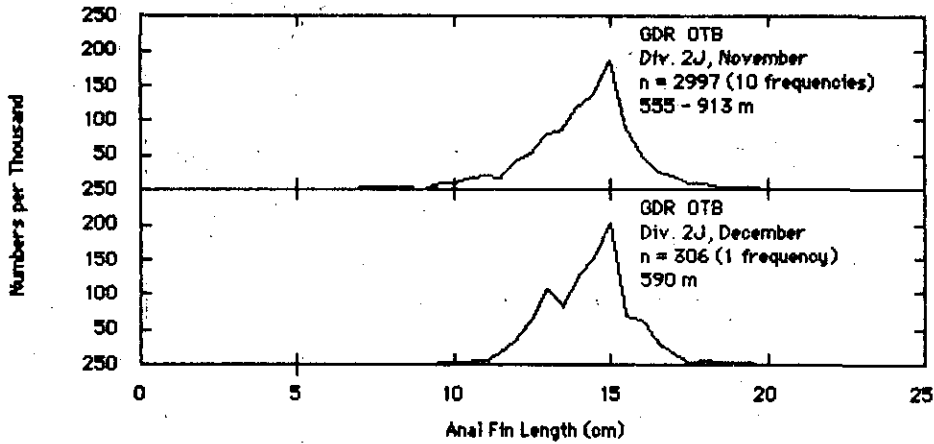
Figure 14 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1980 as collected Canadian observers.
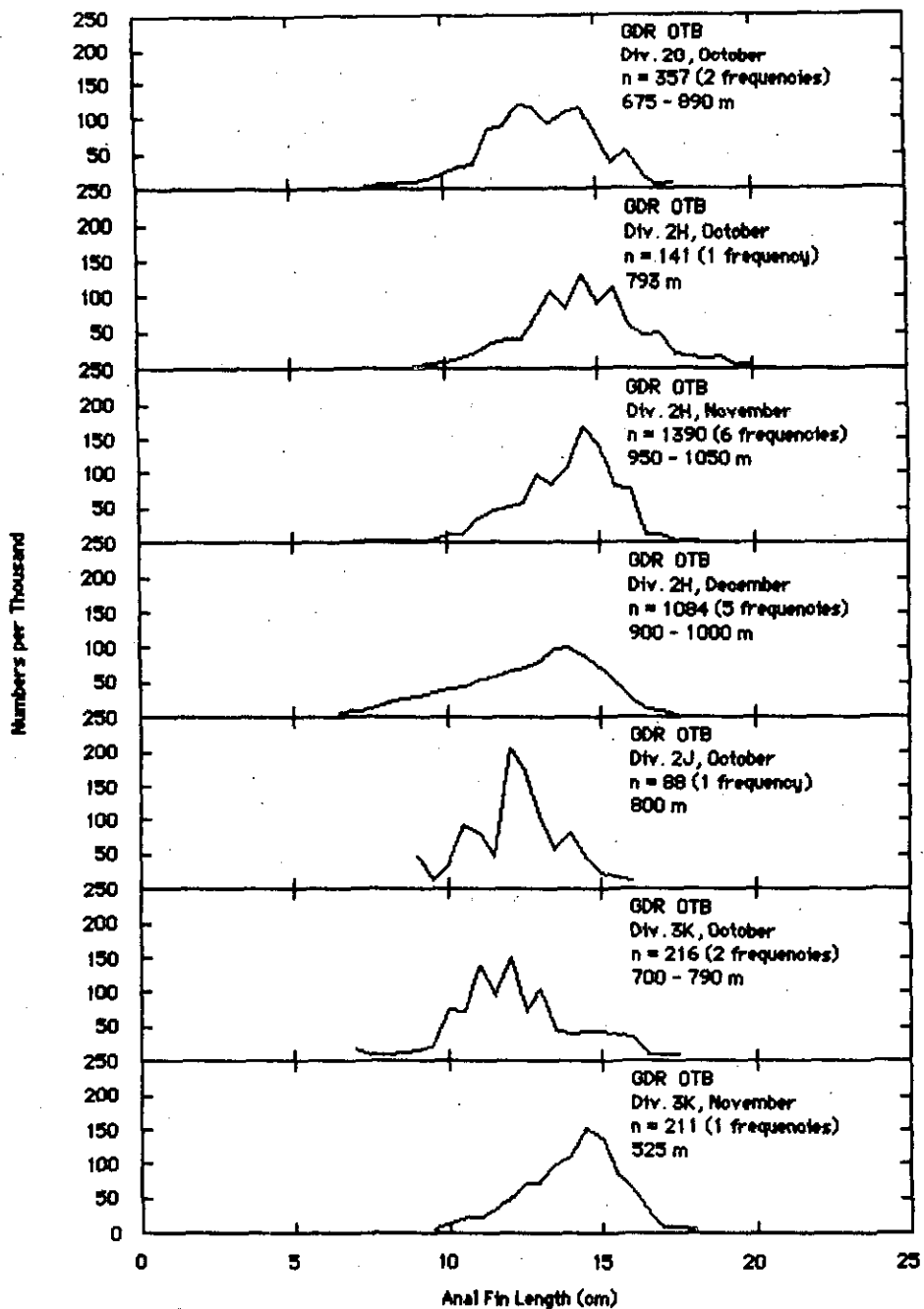
Figure 15: Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1981 as collected Canadian observers.

USSR OTB
Div. 2O, August
n = 1862 (10 frequencies)
824 - 1060 m

USSR MWT
Div. 2O, August
n = 186 (1 frequency)
900 m

USSR OTB
Div. 2O, September
n = 285 (3 frequencies)
560 - 700 m

USSR OTB
Div. 2H, August
n = 9243 (46 frequencies)
400 - 1100 m

USSR MWT
Div. 2H, August
n = 369 (2 frequencies)
750 - 1000 m

USSR OTB
Div. 2H, September
n = 76 (1 frequency)
1000 m

USSR OTB
Div. 2H, October
n = 164 (2 frequencies)
600 - 750 m

USSR OTB
Div. 3K, July
n = 138 (1 frequency)
800 m

USSR OTB
Div. 3K, August
n = 434 (2 frequencies)
1050 - 1100 m

USSR OTB
Div. 3K, September
n = 3302 (11 frequencies)
820 - 1020 m

USSR OTB
Div. 3K, November
n = 249 (2 frequencies)
810 - 1000m

Numbers per Thousand

Anal Fin Length (cm)

Figure 15: Continued

Figure : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1982 as collected Canadian observers.

Figure 17 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1983 as collected Canadian observers.
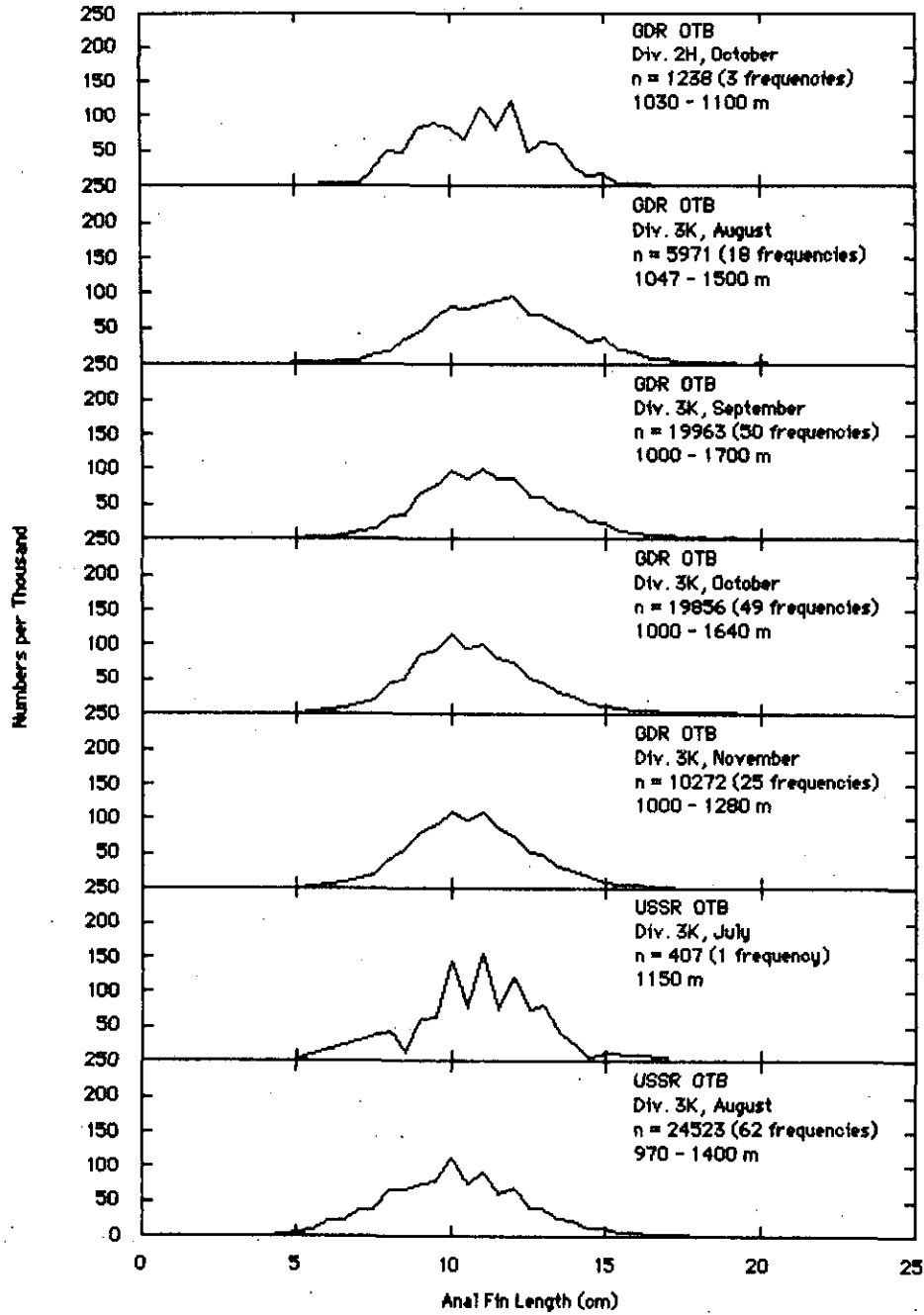

Figure 18 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1984 as collected Canadian observers.
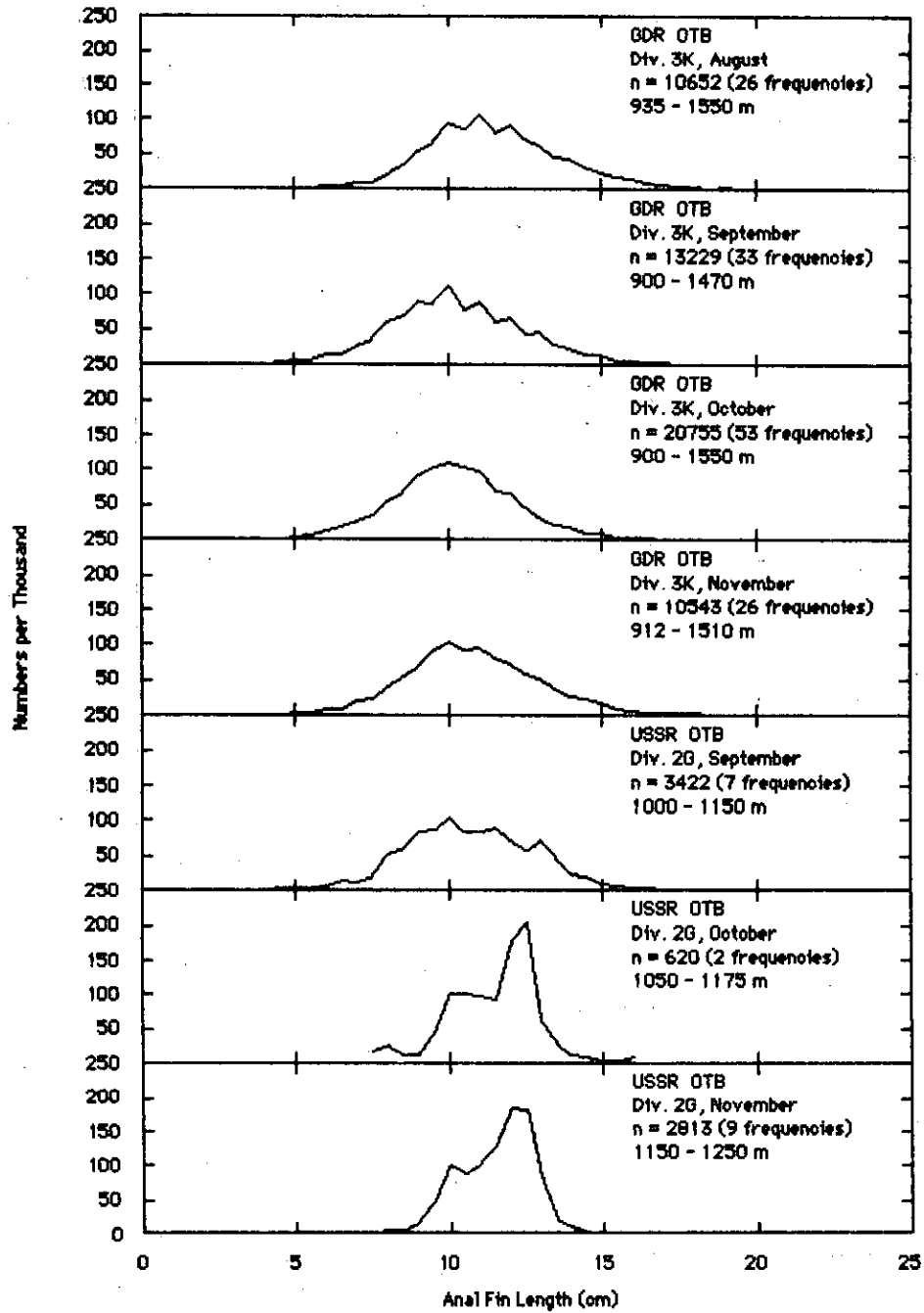
Figure 19: Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1985 as collected Canadian observers.
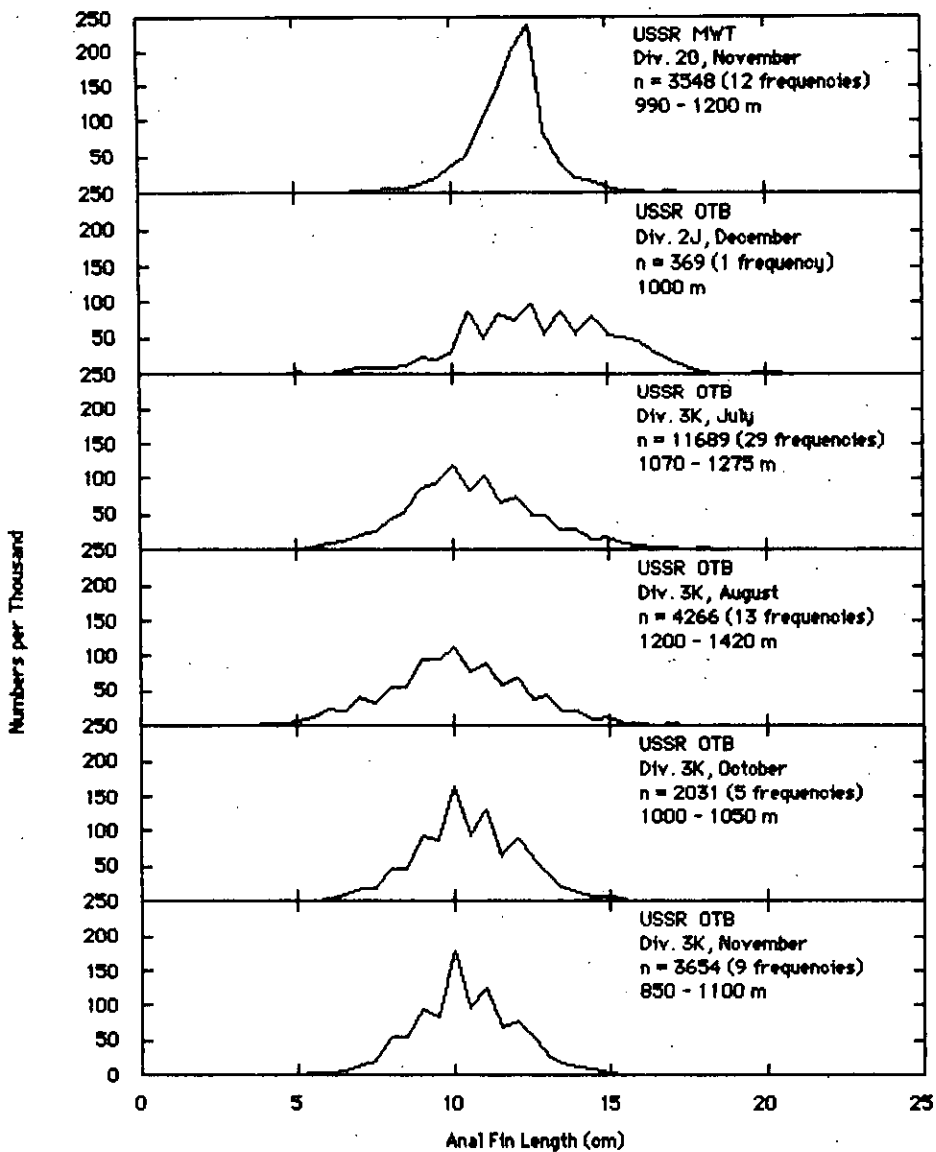
Figure 20 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1986 as collected Canadian observers.

Figure 21 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1987 as collected Canadian observers.

Figure 22 : Commercial length frequencies of roundnose grenadiers caught in SA 2+3 in 1988 as collected Canadian observers.

USSR MWT
Div. 2O, November
n = 3548 (12 frequencies)
990 - 1200 m

USSR OTB
Div. 2J, December
n = 369 (1 frequency)
1000 m

USSR OTB
Div. 3K, July
n = 11689 (29 frequencies)
1070 - 1275 m

USSR OTB
Div. 3K, August
n = 4266 (13 frequencies)
1200 - 1420 m

USSR OTB
Div. 3K, October
n = 2031 (5 frequencies)
1000 - 1050 m

USSR OTB
Div. 3K, November
n = 3654 (9 frequencies)
850 - 1100 m

Numbers per Thousand

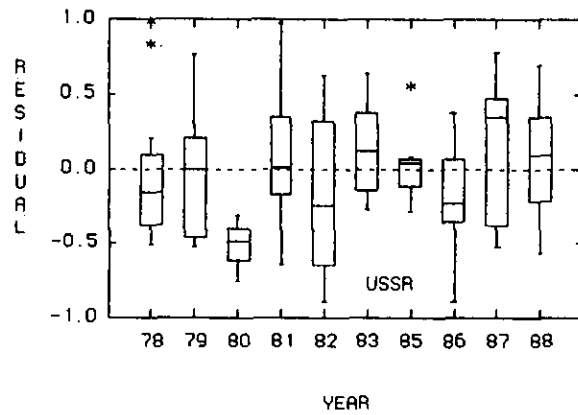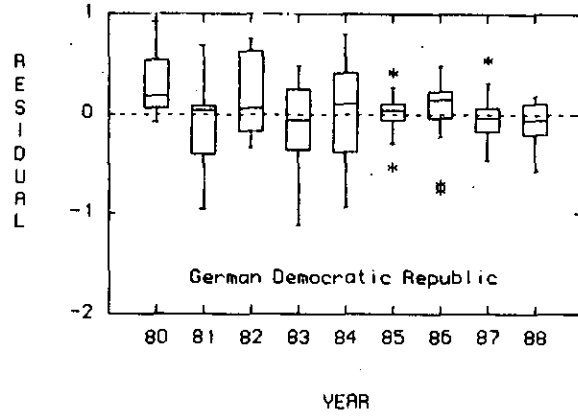Anal Fin Length (cm)

Figure 22: Continued

Figure 23 : Boxplots (quartiles) of residuals from the multiplicative analysis
of FOP data for roundnose grenadier in SA 2+3 for the USSR and
German Democratic fisheries in depths >800 m.