Northwest Atlantic Fisheries Organization

Serial No. N5655 **NAFO SCR Doc. 09/21**

SCIENTIFIC COUNCIL MEETING – JUNE 2009

Roughhead Grenadier subarea 2 and 3 XSA model configuration

by

Fernando González-Costas

e-mail: fernando.gonzalez@vi.ieo.es
Instituto Español de Oceanografìa, Vigo, Spain

ABSTRACT

STACFIS recommended in 2007 to explore the eXtended Survivors Analysis (XSA) configuration of the analytical assessment presented (definition of the plus group, catchability model and the shrinkage options), as well as the incorporation of the new survey information into the model. This document tries to respond this recommendation with the following suggestions.

To establish the plus group in 17+ because the percentage of maturity (93%) as well as the percentage in biomass (10%) and abundance (2%) would be reasonably and the stability of the model would improve appreciably compare with the 19+ plus group used in the 2007 XSA.

To define the Fbar age range between 6 and 13 years because this range is representative of the most important ages in the catches and avoid most of the problems of the partial recruitment and the plus group assumptions.
To consider all ages with catchability independent of the year class strength and to use a mean model to determine the relationship between the log CPUE and the Log VPA abundance and setup q constant for ages older than 15 years.

To use the last two ages (14-15) and the last two years (2005-2006) as range for the shrinkage with a standard error of 1.0 for the F shrinkage means.

INTRODUCTION

The aim of this document is to answer the 2007 STACTFIS recommendation about the Roughhead grenadier Subarea 2 and 3 analytical assessment presented by González-Costas and Murua in the SCR 07/34. STACFIS recommended to explore the eXtended Survivors Analysis (XSA) configuration of the analytical assessment presented (definition of the plus group, catchability model and the shrinkage options), as well as the incorporation of the new survey information into the model.

This document do not try to present a new Roughhead grenadier Subarea 2 and 3 analytical assessment, we only try to found the best model configuration with the available input data. Most of the new configuration was compared with the following model set up used in the 2007 document.

Input data

Catch-at-age data from 1992 to 2005 for ages 3 to 19, last age as plus group.

Tuning fleets: EU Flemish Cap survey indices from 1994 to 2005 for ages 3 to 16. Survey month June.

Spanish 3NO research survey indices from 1997 to 2005 for ages 3 to 18. Survey month May.

Natural mortality (M) at age was assumed to be constant and was set at 0.1 for all years.

Model specifications

Not taper time was applied.

Catchability analysis: A mean model is used to describe the relationship between catchability and abundance for all ages, and it was defined catchability independent of age (constant) above age 17.

Terminal population estimation: A shrink age for the last 4 years and the oldest 3 ages were used. A weight of 1.0 has been given for the F shrinkage means.

A minimum value of 0.3 has been set for the log catchability standard errors used as weights estimating survivors. Prior weighting was not applied.

MATERIAL AND METHODS

The available data presented by González-Costas and Murua (2007) has been updated with the 2006 and 2007 data (Table 1). The eXtended Survivors Analysis (XSA, Shepherd, 1999; Darby and Flatman 1994) was applied with different model formulations to the updated commercial catch-at-age data for Roughhead grenadier in NAFO Subarea 2 and 3 from 1992-2007. The analysis has been calibrated using the Flemish Cap and Spanish 3NO survey update.

RESULTS AND DISCUSSION

Plus Group

To determine which it would be the best plus group with available data, different information have been examined. Table 2 presents the number of otoliths from Spanish commercial catches by age and year read to make the Age Length Key (ALK), as we can see, the number of read otoliths for ages older than 20 years and younger than 4 years are very scarce and this problem can cause that abundance for ages older than 20 years and younger than four years in the catch at age matrix could be not very well determined. For the younger ages this can be solve in part with the survey otoliths but for the older ages the problem is not easy to solve. Figure 1 shows the log catch cohorts abundance by age. In general it can be appreciated that the younger and older ages of every cohort are difficult to track. The difficulty in tracking the younger ages are probably due to the otoliths availability and to the selectivity of the gear, i.e. they are not fully recruited to the trawl. For the older ages, this can be due to the otoliths availability and to the difficulty in age determination. Figure 2 shows the mean weight by age and year for ages 1 to 24 years old. For ages older than 20 years old, the mean weight of the different ages are very variable and for some of these ages and years there are not information or the values cross between ages. To avoid all this problems with the younger and older ages it was decided in the SCR 07/34 fitted the XSA model with the catch data for ages 3 to 19, the last age as plus group.

Figure 3 and 4 present the absolute and the relative catch proportion in abundance at age by year for ages 1 to 24 years old. In both figures, it is possible to observe that the most important ages, in abundance, present in the catches are ages between 5 and 14 years old. Figure 5 shows for catches (1992-2007) the mean percentage of abundance and biomass of the plus group for different ages with their Standard Deviation (SD). The plus group in 15+ represents the 5% of the total catch abundance and 17% in biomass, these percentages decrease when the plus group increase as we can expected. If we observe the maturity ogive used in this assessment (Figure 6), the percentage of maturity for age 15 is only 33% and increase with the age as is normal, being 1 for ages older than 19 years all. It would be recommended having a plus group with a high percentage of maturity to have a certain kind of measure of the SSB. To highlight that the XSA model work with abundance and the abundance percentage for 15+ plus group is not very high but the biomass percentage grouped in the plus group is important and it would be very difficult measure the SSB because most of them will be in the plus group. It has also examined the stability of the model for different plus groups. To do that we have compared the XSA iterations for different plus groups runs with the same setup used in the SCR 07/34 (Figure 7). The number of iterations decreases appreciably when the plus group decrease from 19+ to 17+ but is more or less stable when the plus group change from 17+ to 15+. With all these information one solution could be establish the plus group in 17+ because the percentage of maturity (93%) as well as the percentage in biomass (10%) and abundance (2%) would be reasonably and the stability of the model would improve appreciably compare with the 19+ plus group used in the 2007 XSA.

F bar

Other aspect that it would be necessary revised is the Fbar age range. In the previous assessment, Fbar was defined as the mean F for ages 11 to 16 years old. There are two principals reason to revised Fbar: the first reason is that the Fbar mean should be made with the F of the principal ages present in catches to be representative of the stock F trend. The other reason is that if we change the range of the catches at age matrix to 3-17+ It should be necessary to change the Fbar range because the upper level of Fbar (16) is very close to the new plus group (17) and it is recommended that F bar mean do not include ages with partial recruitment to the fishery (younger ages) and ages close to the plus group to avoid the model assumptions made in the older ages and to profit from the VPA convergence property. If we revise the Figures 3 and 4, it is possible to observe that the most important ages, in abundance, present in the catches are ages between 5 and 14 years old and it should be reasonably that most of these ages would be present in the Fbar range. To explore the Fbar range, it was run an XSA with the update data (1992-2007) and the same set up of the 2007 XSA to calculate Fbars with different age ranges. Figure 8 presents these results for seven different ranges. We can observe two different groups of Fbar: one with the ranges where we have the principal ages present in catches (more or less ages between 5 and 14) and other group with the ranges where only participate the older ages (9 to 16) more similar to the old Fbar range (11-16). Both group present very similar trends in the most recent period but the trends are different before 2001. One of the choice for Fbar age range it could be a range between 6 and 13 because this range is representative of the most important ages in the catches and avoid most of the problems of the partial recruitment and the plus group assumptions.

Catchability (q) model

In the XSA model there are two settings relate with the catchability, one is to determine the ages at which catchability is independent of the year class strength and the other is to determine the age above which catchability is independent of the age (constant).

The first setting allows the use of a power model to describe the relationship between catchability of the younger ages and their abundance (Shepherd, 1994). For the other ages, catchability will be treated as independents of the year class strength. To select the age at which catchability is independent of the year class we need to examine the regression statistics for ages with catchability dependent on year class strength, especially the slope, the R square and the overall standard error. The slopes should be tested to see whether they are significantly different from 1.0, if not then catchability will be constant with respect to population abundance (Darby et al, 1994). Table 3 present the regression statistics for all survey ages of the update 2007 XSA and Table 4 the regression statistics for the XSA made with ages between 3 and 17 plus group. In table 3, only the age 3 of the 3NO Survey has the slope significantly different from 1 (tStuden column less than 0.05), the other slopes of young ages of this survey and all the slopes of the Flemish Cap survey are not significantly different from 1. The R square for the regression of the age 3 of the 3NO survey is very low (0.01) and his Standard Error is very high. In Table 4 it can be observed that the slopes for all the ages for both surveys are not significantly different from 1. With these results we think that the best solution should be to consider all ages with catchability independent of the year class strength and to use a mean model to determine the relationship between the log CPUE and the Log VPA abundance.

The second setting is to determine the age above which catchability is independent of the age (constant). In the XSA the catchability for the oldest assessment age is under-determined. “In order to overcome this uncertainty, the XSA makes the assumption that catchability is constant above a specific, user-defined age. A default constrain is imposed to ensure that, at very least, the catchability of the older true age is fixed to that of the preceding age. (Darby and Flatman, 1994)”. Figure 9 presents the XSA Log q estimation by age for the Flemish Cap Survey and their standard error for different ages at which q is independent of age (constant). Values of the age 17 (q17) at which q is independent of the age come from the update 2007 assessment (1992-2007 years; 3-19+ ages), the other values for ages (q15, q14 and q13) at which q is independent of the age come from the new assessment (1992-2007 years; 3-17+ ages) without shrinkage. Figure 10 shows the same for the 3NO Survey. In both Figures it can be observed a domo shape for the q values by age for q constant for ages equal or older than 17 years, the maximum allowed by the model when we have a catch-age matrix between 3 and 19+ years old, it seems that for ages older than 10 years the catchability decrease with age. If we take the age matrix between 3 and 17+, we only observe the domo shape when the catchability is constant for age older than 15 years, the shape and the values are very similar in both cases but when we choose for q constant a younger ages the catchability shape by age is different and the values are more or less constant for ages older than 10 years. In all cases the quality (Standard Error SE) of the q estimates are more or less similar. With these results, probably the best option would be to setup q constant for ages older than 15 years if the catch-age-matrix is reduced to 3-17+.

Shrinkage options

In this case due to the catch-at-age matrix started before the tuning data it is recommended that XSA is used with F shrinkage. If the shrinkage is not selected, the terminal population seed value of cohorts without tuning data will not change. There are two F shrinkage parameters, for the last year, for each age, a mean of the F values for the years that precede the final year is calculated, we need to say how many years. And for the years prior to the final year the survivors are shrunk to a terminal population derived from an average of the F values of ages that proceed the oldest true age, we need to say how many ages.

A weight of 1.0 has been given for the F shrinkage means. This weight is the same for all years and ages and it allows the shrinkage values not to have a large influence in the parameter estimates in the period where there is tuning information. As the fishing mortality shows a declining trend during the last years (Figure 13), applying shrinkage to the mean F leads to overestimation of F in the final year and, consequently, the survivors and biomass will be underestimated. In order to avoid biomass underestimation it has been considered that a high standard error (1.0) is a good choice for F-shrinkage in this stock.

To determine how many ages in the shrinkage we need to observe the exploitation pattern to select the age range before the last true age where the exploitation pattern is more or less constant to estimate the F of the last true age as a mean of the F of the ages before. Figure 11 shows the relative (to age 10) exploitation patterns estimate by the XSA without shrinkage (1992-2007 ; ages 3-17+) for different periods. We show three time periods; the first (1992-1993) is the period where there are catch information but there are not survey information, the second (1994-1996) is the period more close to the first and where we could assume that the exploitation pattern is the same or similar for both periods and the their period (2004-2006) is the most recent period. In Figure 11 it can be observed that the exploitation pattern for the older ages between the first and second period are very different and this is due to the seed value of cohorts without tuning data did not change. To avoid this problem and to try that the exploitation patterns between these two consecutive periods been more similar we use the shrinkage. Figure 12 shows relative (to age 10) exploitation patterns estimate by the XSA with shrinkage (1992-2007 ; ages 3-17+) for the three different periods. In this case it have been chosen a survivor estimates shrunk towards the mean F of the final 2 years and the 2 oldest ages. The reason to choose the last two ages (14-15) is a compromise solution with the most recent exploitation pattern (2004-2006) and the exploitation pattern of the second period (1994-1996), if we observe the Figure 11, in the most recent period the F of the age 16 are in the level of the F of ages 14 and 15, in the second period the F level decrease for ages older than 14. As this shrinkage age is applied to all years except the last year we think that the best age range for the shrinkage could be the last two ages (14-15).

In the terminal year, for each age, a mean of the F value for the two years that proceed the final year is calculated. Figure 13 presents the Fbar trend with and without shrinkage. It can be seen that both trends are very similar and since 1998 there is a clear decrease trend and in the period 2005-2006 this decrease trend was less accentuate. This time period (two years before the last year) has been selected to the shrinkage to avoid the clear F trends and to estimate a robust mean F value. In this case the shrinkage estimations have not a large influence because the weight of these estimations is very low in the final results.

New survey information

No new surveys information is available at this moment to use as tuning information in the model.

CONCLUSION

After the analysis of the results our conclusion is that the best configuration of the eXtended Survivors Analysis (XSA) for the NAFO Subarea 2+3 Roughhead grenadier analytical assessment is the following:

Plus group: To establish the plus group in 17+ because the percentage of maturity (93%) as well as the percentage in biomass (10%) and abundance (2%) would be reasonably and the stability of the model would improve appreciably compare with the 19+ plus group used in the 2007 XSA.

Fbar: To define the Fbar age range between 6 and 13 years because this range is representative of the most important ages in the catches and avoid most of the problems of the partial recruitment and the plus group assumptions.

Catchability (q) model : To consider all ages with catchability independent of the year class strength and to use a mean model to determine the relationship between the log CPUE and the Log VPA abundance and setup q constant for ages older than 15 years.

Shrinkage options: The best range for the shrinkage could be the last two ages (14-15) and the last two years (2005-2006) with a Standard Error of 1.0.

REFERENCES

Darby, C.D., and S. Flatman. 1994. Virtual Population Analysis: Version 3.1 (Windows/Dos) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, (1): 85pp.

González-Costas, F. and H. Murua (2007). An analytical assessment of NAFO roughhead grenadier Subareas 2 and 3 stock. NAFO SCR Doc. 07/34.

González-Costas, F. and H. Murua (2008). An Analytical Assessment of the Roughhead Grenadier Stock in NAFO Subareas 2 and 3. American Fisheries Society Symposium 63:319–342, 2008.

Shepherd, J. G., 1994. Prediction of year class strength by calibration regression analysis of multiple recruit index series. ICES J. Mar. Sci.

Shepherd, J. G., 1999. Extended survivors analysis: An improved method for the analysis of catch-at-age data and abundance indices. ICES Journal of Marine Science Vol. 56, No. 5, October 1999, pp 584-591.

Table 1.- Available Roughhead grenadier NAFO Subarea 2 and 3catch and survey data.

Data	Period	Ages
Catch data	1992-2007	1-24
Flemish Cap Survey	1994-2007	3-16
3NO Spanish Survey	1997-2007	3-18

Table 2.- Number of Roughhead grenadier otoliths read from Spanish commercial catch by year and age to make the annuals Age Length Key (ALK).

	Age																										
Year	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**28**	**Total**
1999	2	8	24	54	74	85	99	65	49	56	46	67	71	45	22	15	26	18	25	15	10	9	2	5	1		893
2000	17	37	42	59	93	66	79	104	79	57	66	56	64	52	32	17	19	26	16	15	10	7	5			1	1019
2002	2	17	29	41	56	39	47	42	32	41	44	34	31	21	24	28	29	21	16	10	7	6	4	1			622
2003		14	20	15	19	30	40	31	29	31	31	18	15	15	25	20	6	7	4		1						371
2004		26	43	62	49	50	60	50	51	35	57	43	28	22	21	18	13	7	6	4	1	1	2				649
2005			1	9	32	68	70	96	103	65	73	47	26	16	4	9	5	4	3	2							633
2006		4	10	41	63	84	64	71	58	73	42	35	39	21	11	21	4	2	1								644
2007				8	14	27	22	19	25	31	21	10	8	4	4	2	6	6	2	1		3					213
Total	21	106	169	289	400	449	481	478	426	389	380	310	282	196	143	130	108	91	73	47	29	26	13	6	1	1	5044

Table 3.- Regression statistics for all tuning ages for the update 2007 XSA (years 1992-2007 and ages 3-19+)

Flemish Cap Survey

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q	tStudent
3	4.06	-1.95	14.44	0.03	14	4.54	-10.82	0.08
4	0.9	0.14	10.81	0.14	14	0.92	-10.93	0.89
5	-3.86	-1.238	6.3	0.01	14	3.07	-10.55	0.24
6	-0.8	-3.719	9.12	0.26	14	0.36	-10.09	0.00
7	5.68	-1.478	11.65	0.01	14	2.54	-9.77	0.17
8	1.07	-0.103	9.66	0.14	14	0.56	-9.62	0.92
9	0.6	1.812	9.36	0.63	14	0.18	-9.65	0.10
10	0.67	1.223	9.21	0.53	14	0.3	-9.49	0.25
11	0.75	0.799	9.32	0.46	14	0.44	-9.65	0.44
12	1.27	-0.591	10.06	0.29	14	0.78	-9.62	0.57
13	1.06	-0.197	9.86	0.45	14	0.57	-9.72	0.85
14	0.72	1.083	9.07	0.55	14	0.47	-9.79	0.30
15	1.22	-0.464	10.83	0.27	14	0.92	-10.11	0.65
16	0.86	0.538	9.74	0.57	13	0.49	-10.26	0.60

3NO Survey

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q	tStuden
3	-12.56	-3.604	10.2	0.01	11	10.58	-9.48	0.01
4	1.55	-0.589	9.53	0.11	11	1.15	-9.59	0.57
5	0.63	0.61	9.3	0.24	11	0.44	-9.09	0.56
6	1.97	-0.719	7.84	0.06	11	0.86	-8.7	0.50
7	1.68	-0.997	7.76	0.2	11	0.43	-8.44	0.35
8	0.89	0.182	8.46	0.23	11	0.39	-8.36	0.86
9	0.62	1.575	8.67	0.66	11	0.17	-8.48	0.16
10	0.57	2.605	8.49	0.81	11	0.17	-8.33	0.04
11	0.59	2.326	8.54	0.78	11	0.23	-8.63	0.05
12	0.82	0.726	8.57	0.64	11	0.38	-8.67	0.49
13	0.78	0.75	8.55	0.55	11	0.45	-8.79	0.48
14	0.75	1.298	8.49	0.74	11	0.29	-8.87	0.24
15	2.37	-1.829	11.81	0.16	11	1.23	-9.03	0.11
16	1.26	-0.697	9.73	0.44	11	0.64	-9.09	0.51
17	0.9	0.323	8.74	0.52	11	0.53	-9.03	0.76
18	4.81	-1.923	20.93	0.03	11	2.91	-9.02	0.10

Table 4.- Regression statistics for all tuning ages for the new XSA (years 1992-2007 and ages 3-17+)

Flemish Cap Survey

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q	tStudent
3	1.56	-0.433	11.67	0.05	14	1.73	-11.01	0.67
4	0.53	0.606	10.44	0.12	14	0.54	-11.01	0.56
5	-1.18	-1.621	8.67	0.04	14	0.92	-10.57	0.13
6	-0.67	-4.524	9.19	0.38	14	0.27	-10.09	0.00
7	7.6	-1.565	12.38	0	14	3.4	-9.75	0.14
8	1.06	-0.089	9.61	0.15	14	0.55	-9.59	0.93
9	0.64	1.543	9.34	0.6	14	0.2	-9.6	0.15
10	0.75	0.838	9.22	0.49	14	0.35	-9.42	0.42
11	0.82	0.59	9.33	0.46	14	0.48	-9.57	0.57
12	1.38	-0.838	10.13	0.29	14	0.84	-9.52	0.42
13	1.31	-0.826	10.23	0.38	14	0.74	-9.58	0.42
14	0.83	0.678	9.17	0.56	14	0.52	-9.6	0.51
15	1.37	-0.837	11.08	0.3	14	1.01	-9.88	0.42
16	1	-0.015	9.94	0.71	13	0.44	-9.93	0.99

3NO Survey

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q	tStudent
3	-10.33	-1.712	10.33	0	11	8.72	-9.73	0.12
4	0.47	1.264	9.74	0.38	11	0.29	-9.69	0.24
5	0.48	0.987	9.43	0.29	11	0.32	-9.12	0.35
6	2.7	-0.865	7.2	0.03	11	1.2	-8.7	0.41
7	1.84	-1.043	7.58	0.15	11	0.48	-8.42	0.32
8	0.85	0.264	8.46	0.26	11	0.37	-8.33	0.80
9	0.68	1.149	8.6	0.58	11	0.21	-8.44	0.28
10	0.63	2.304	8.41	0.81	11	0.18	-8.26	0.05
11	0.65	1.873	8.48	0.76	11	0.26	-8.55	0.09
12	0.87	0.569	8.5	0.7	11	0.37	-8.57	0.58
13	0.92	0.24	8.58	0.51	11	0.55	-8.66	0.82
14	0.91	0.399	8.56	0.7	11	0.38	-8.69	0.70
15	3.95	-2.556	14.76	0.08	11	2.17	-8.82	0.03
16	1.52	-1.664	10.06	0.53	11	0.66	-8.79	0.13

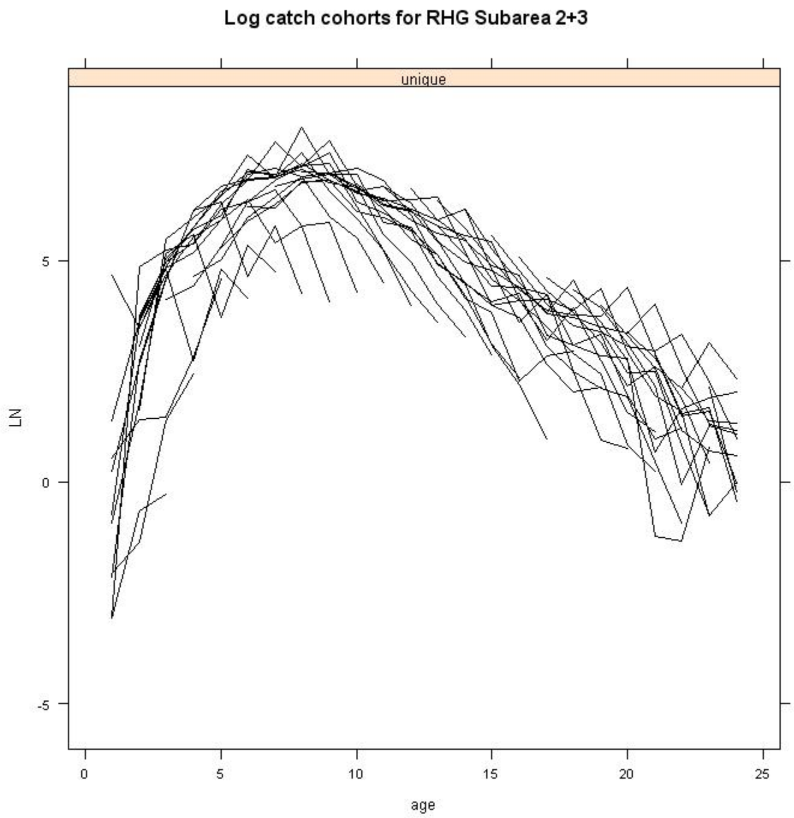

Figure 1.- Log catch cohorts abundance by age of the Roughhead grenadier Subarea 2 and 3 stock.

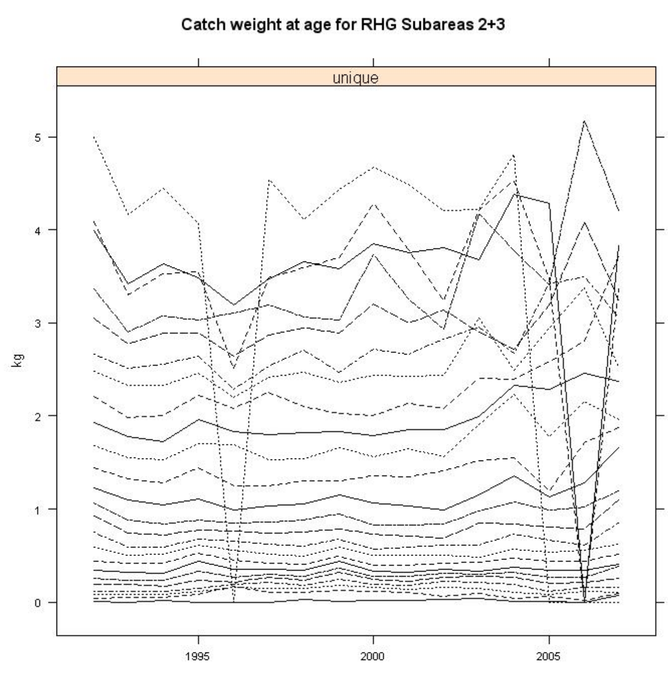

Figure 2.- Roughhead grenadier Subarea 2 and 3 catch Mean Weights by age and year.

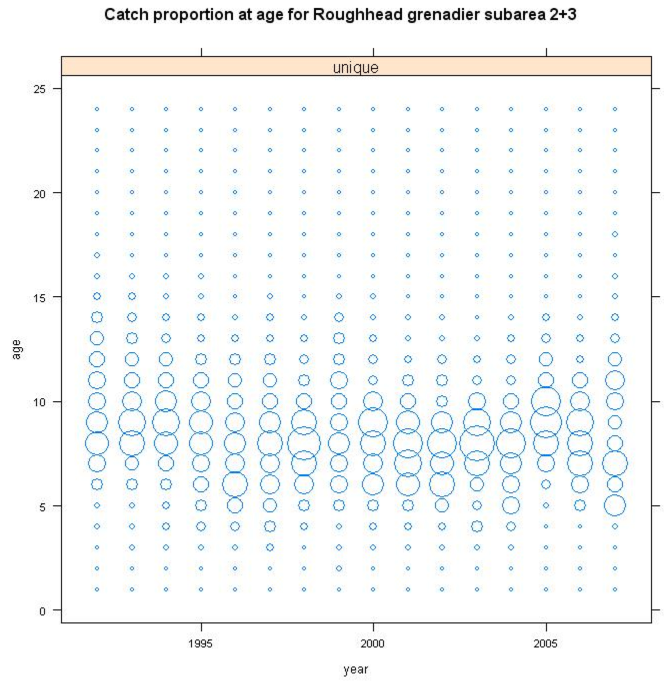

Figure 3.- Absolute catch proportion at age by year for Roughhead grenadier Subarea 2+3.

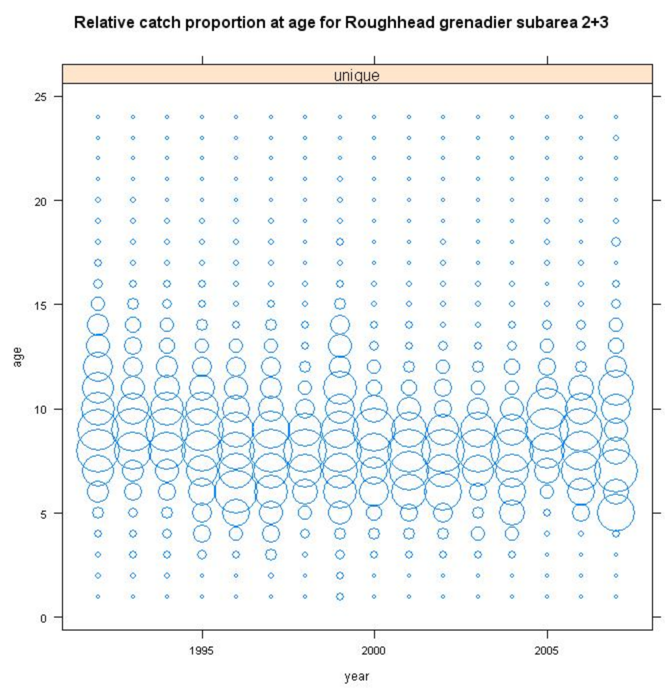

Figure 4.- Relative catch proportion at age by year for Roughhead grenadier Subarea 2+3.

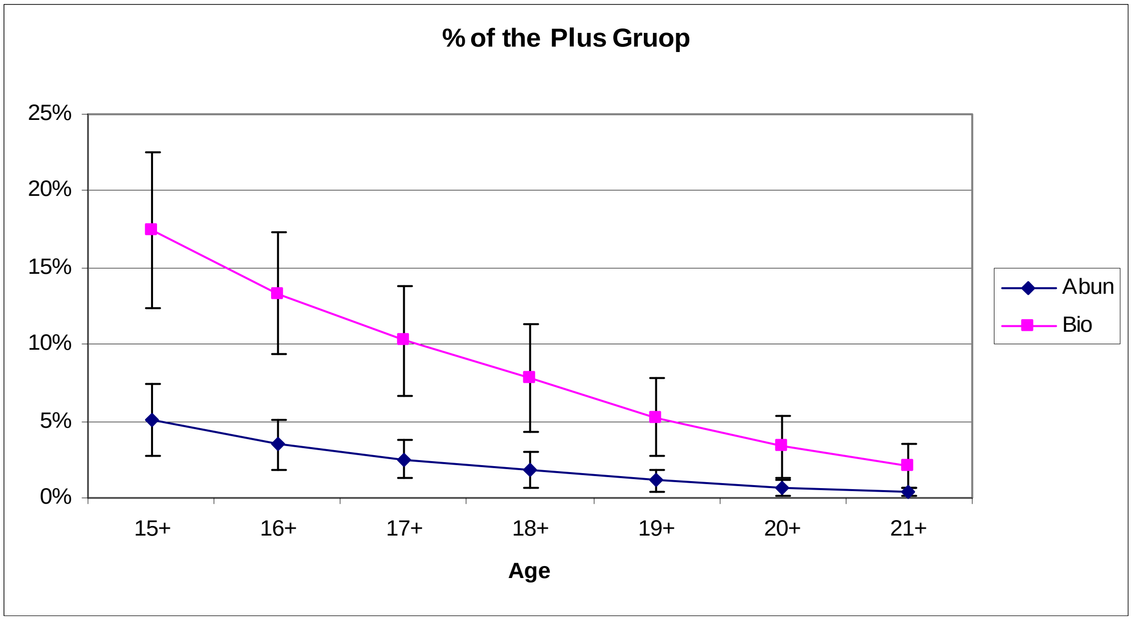

Figure 5.- Mean percentage (1992-2007) of catch abundance and biomass for different plus groups with their Standard Deviation (SD).

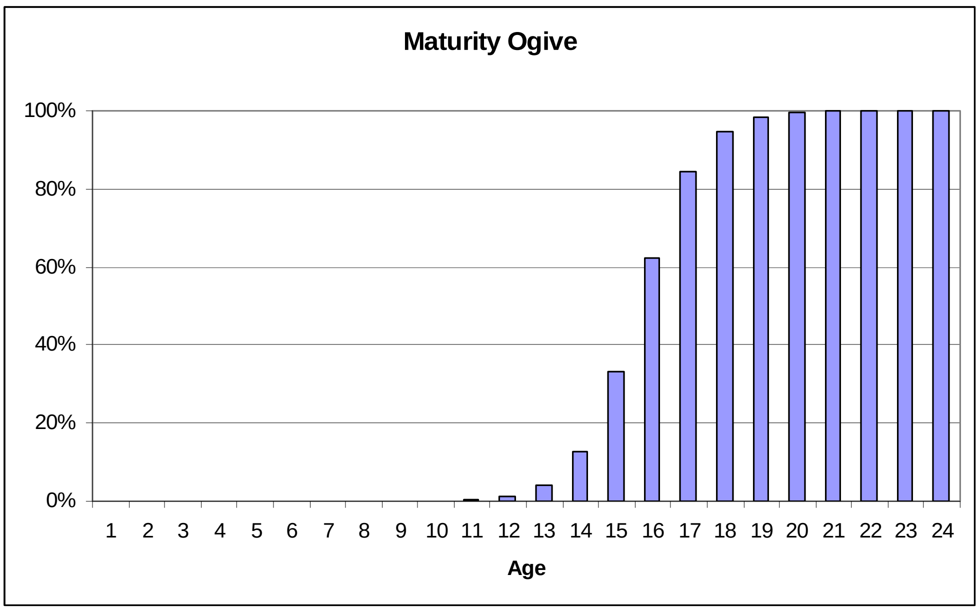

Figure 6.- Roughhead grenadier Subarea 2+3 Maturity Ogive by age.

Figure 7.- Number of the XSA iterations for different plus groups runs with the same setup used in the SCR 07/34.

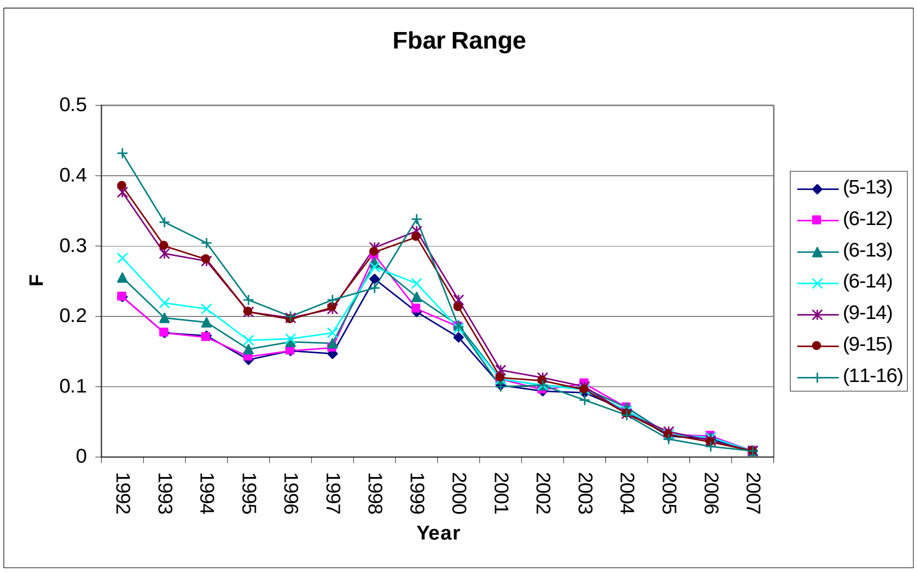

Figure 8.- Roughhead grenadier Subarea 2+3 XSA Fbar results for different ages ranges.

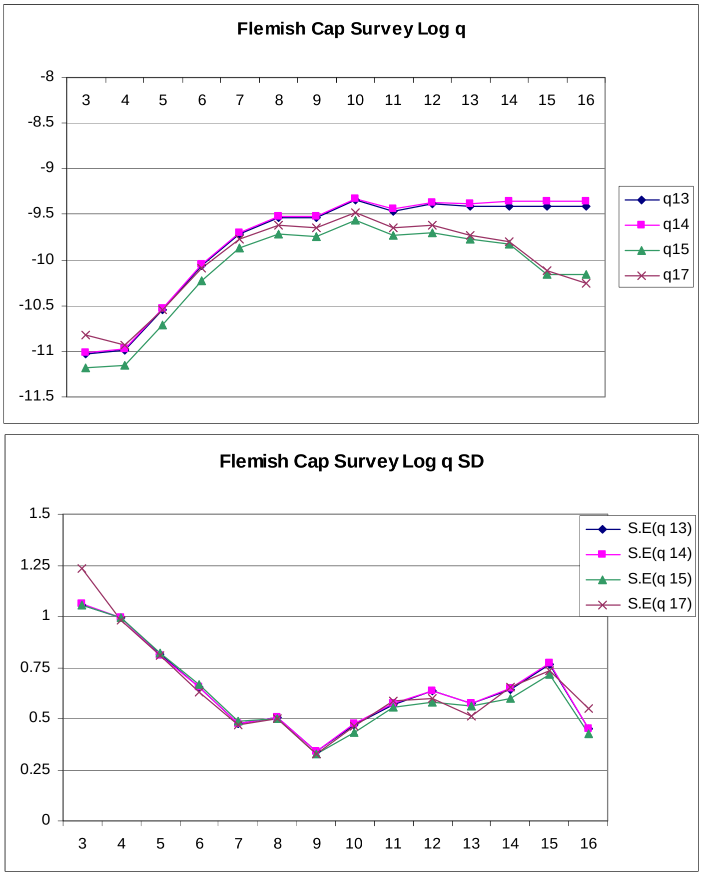

Figure 9.- XSA Flemish Cap Survey Log q estimations by age and their standard error for different ages at which q is independent of age (constant).

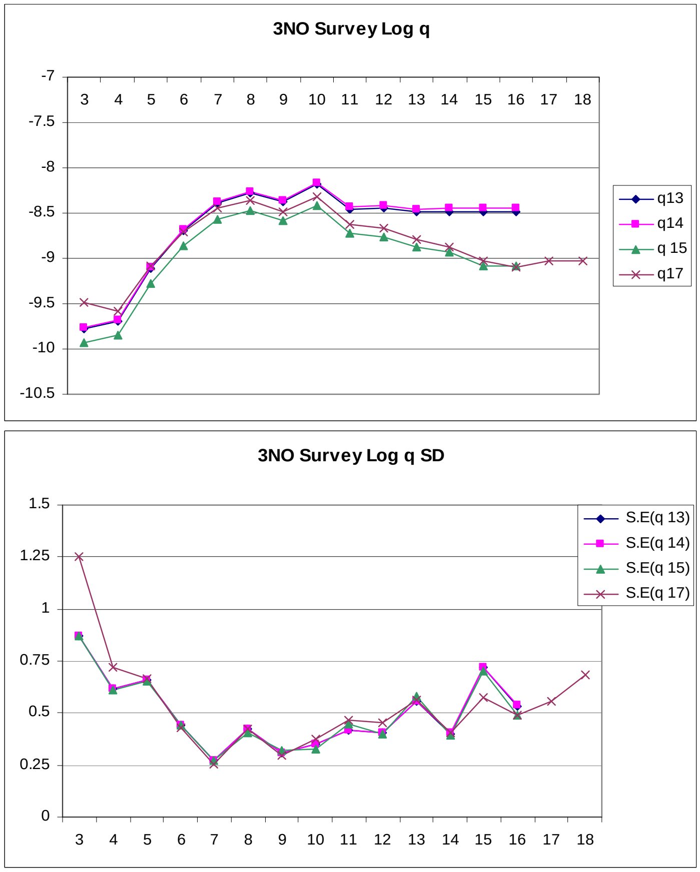

Figure 10 .- XSA 3NO Survey Log q estimations by age and their standard error for different ages at which q is independent of age (constant).

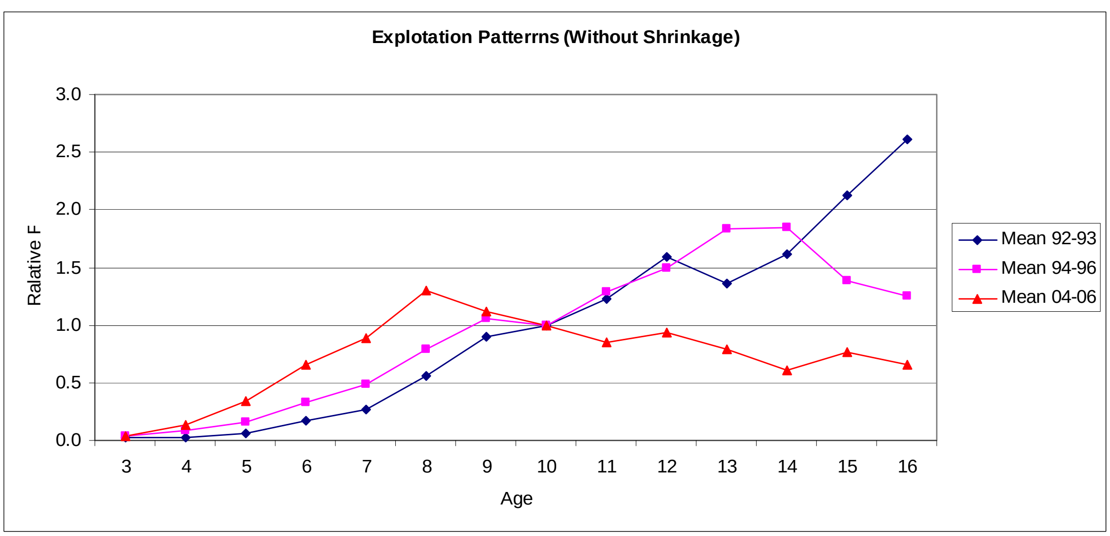

Figure 11.- Relative (to age 10) exploitation pattern for different periods without shrinkage.

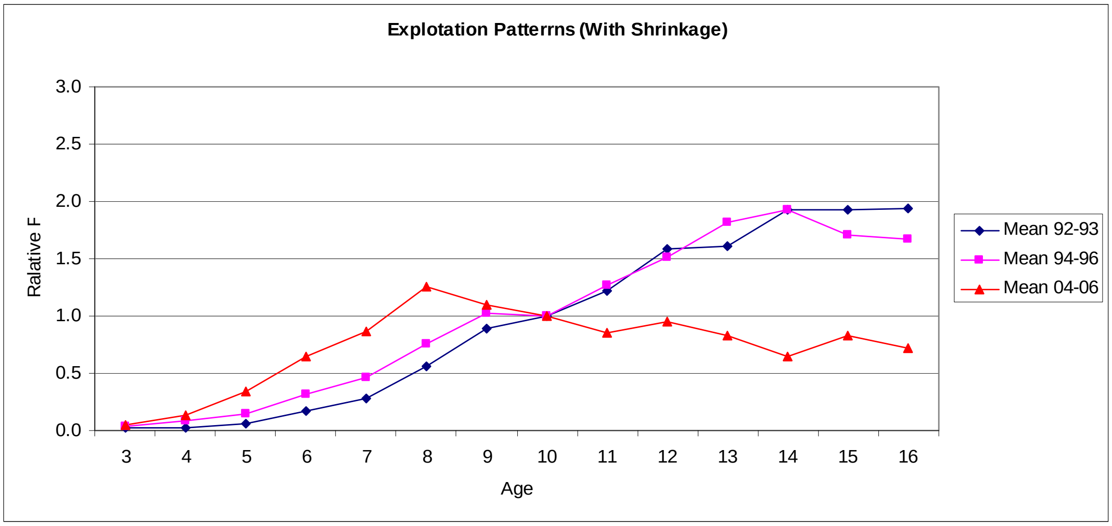

Figure 12.- Relative (to age 10) exploitation pattern for different periods with survivor estimates shrunk towards the mean F of the final 2 years and the 2 oldest ages.

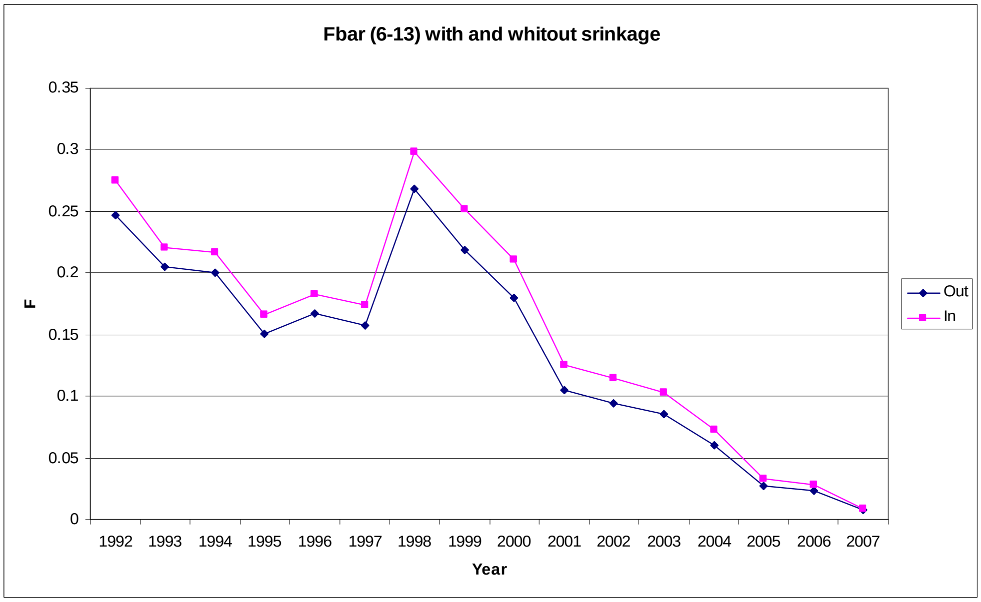

Figure 13.- Fbar (6-13) with and with out Shrink age (mean F of the final 2 years or the 2 oldest ages)