NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N5123 **NAFO SCR Doc. 05/37**

SCIENTIFIC COUNCIL MEETING – JUNE 2005

Quality of the Tuning Series in the Assessment of Greenland Halibut Subarea 2 and Divisions 3KLMNO

by

F. González Costas, D. González

Instituto Español de Oceanografía,
P.O. Box 1552. Vigo, Spain.
Fernando.gonzalez@vi.ieo.es

Abstract

The aim of this paper is to provide a deep study of the quality of the tuning series apply in the Greenland halibut assessment of the NAFO Subarea 2 and Divisions 3KLMNO, as well as to study the feasibility of including the Spanish 3NO survey as tuning fleet in future assessments of this stock.

Our results may indicated that the Canadian autumn survey have a clear year effect in the 1995 data for ages older than 6 and that this could be due to the lowest depth coverage of the survey in 1995 compared to 1996-2003. Therefore, shortening the Canadian autumn survey index to 1996-2003 the fit of the data improve and, consequently, we propose to eliminate the 1995 data of this survey in the assessment.

The Canadian spring survey showed a big trend in the log q errors of ages 7 and 8, so it could be convenient to study the possibility of shortening the age range of this tuning indices to ages 1 to 6.

The study also showed that the fit of the Spanish 3NO survey is not very good for ages less than 5 years old, being the information given good for ages between 5 and 12 and, thus, it could be feasible to include this information in future assessments.

The within, between surveys abundance correlations and the correlations between surveys and XSA abundance showed that surveys have many difficulties to track the ages 7, 8 and 9. This lack o tracking could be due related to age reading problems.

Introduction

The aim of this paper is to provide a detailed study of the quality of the tuning series applied in the Greenland halibut assessment of the NAFO Subarea 2 and Div. 3KLMNO. To carry out this study, the last Greenland halibut assessment approved by NAFO Scientific Council in 2004 (Chris Darby *et al*., 2004) was used as a base. This assessment was realised with the Extended Survivors Analysis (XSA, Shepherd, 1999; Darby and Flatman, 1994). Although the Spanish 3NO survey was not include in the assessment as tuning fleet, we have included it in the study to test the possibility to use this new series in futures assessments of this stock.

Materials and Methods

The XSA inputs (total catches, catches by age mean weights, maturity, natural mortality, etc.) used in last assessment approved by NAFO SC in 2004 are presented in Table 1 (a-f).

The Extended Survivors Analysis stock assessment model was fitted to the stock data for the Greenland halibut in NAFO Subarea 2 and Div. 3KLMNO. The model was calibrated with three trawl survey data (Flemish Cap, Canadian autumn and Canadian spring). Table 2 shows the characteristics of these surveys used in the calibration and table 3 (a-d) presents the inputs for calibration. In both these tables we have added the information of the Spanish 3NO survey.

Results

Tuning fleets Log q errors by age

The XSA approved in 2004 assume that log *q* for each age in all fleets is constant with time. To examine the trend of the errors in time, one XSA without tapered time, with high SE for shrinkage (2.5) and with prior weighting applied for each fleet 0-1 was run. Table 4 shows the set up of this XSA.

Observing the log q errors it can be seen how each age of each tuning fleet fit the assumption of constant log *q* in time. Fig. 1 (a-b) shows these errors, and the results for the different fleets are the following:

Flemish Cap Survey (Div. 3M): The errors for all ages do not show any trend and the fit is good for most of the ages.

Canadian autumn survey (CO): In this case we can observe a year effect (1995) in the data for ages older than 6 years. For these ages the errors for 1995 are very high and always negative. The reason of this year effect could be that in 1995 the survey coverage in depth was not the same than in the period 1996-2005, and this depth difference are much pronounced for older ages. To analyze the influence of this year effect, one XSA as the last year assessment but with the Canadian fall survey series between 1996-2003 was run and compare with the last year assessment. The outcome SE of the log *q* by age for Canadian autumn survey in the two run are shown in Fig. 2. It can be observed that SE of the ages older than 6 years diminishes considerably when removing the 1995 data from the Canadian autumn survey tuning fleet.

Canadian spring survey (CS). For ages older than 6 years old the fit are very poor and ages 7 and 8 have a big trend between 1998 and 2002.

Spanish 3NO survey (3NO): The fit of ages less than 5 years and more than 11 years is not good, the estimator of *q* is the bad quality, but the errors for these ages don’t show a clear trend with time.

Consistency of different indices

In the following sections consistency is analyzed as suggested by Bare *et al*. (2003) in EVAREST project.

- ***Within surveys consistency***

Annual abundance indices have been log transformed, because common assessment techniques refer to such transformed variables. $U_{a,y,f}$ is the (logarithmic) abundance index for age *a*, year *y*, and survey. Correlation coefficients calculated over years between the $U_{a,y,f}$ and $U_{a+1,y+1,f}$ offer a first indication of the ability of survey *f* to track year class strength effects. To allow for zeros, the log of (U+1) was used.

Figure 3 (a-d) present the regressions and R^2 between ages for the different surveys and Fig. 4 shows the coefficient of correlation between ages for all surveys.

Flemish Cap survey (Div. 3M): The correlation and R^2 is quite good (>0.7) for ages less than 7 years old, for ages older than 7 the correlation is weak and R^2 is close to 0 and the correlation between ages 7-8 and 8-9 is even negative.

Canadian autumn survey (CO): More or less is similar as the Flemish Cap survey, for ages less than 7 years old the correlation is quite good, R^2 is about 0.55 for these ages, for ages 8-9 the correlation is negative and for ages more than 9 is better than in the Flemish Cap survey, the value of R^2 is about 0.20.

Canadian spring survey (CS): The correlation and R^2 is quite good for all ages, except in ages 7-8 where is almost zero.

Spanish 3NO survey (Div. 3NO): The correlation is very bad for ages less than 8 years and the value of R^2 is less than 0.25 for these ages, for ages 6-7 and 7-8 R^2 is close to 0. For ages more than 9 years old the correlation and the R^2 is not bad, more than 0.20, in these ages this survey have the better R^2 values.

In Fig. 4, it can appreciate that for all surveys the correlation coefficients are quite good for ages less than 6, except for Spanish 3NO survey. For the ages 6-7, 7-8 and 8-9 these coefficients decrease considerably for all survey. For ages older than 9 years old the coefficient increase again and in the case of the Canadian autumn survey it is better considering the new series 1996-2003 than the previous one 1995-2003. The best correlations for older ages are found in the Spanish 3NO and Canadian autumn surveys, since these surveys are those that showed a deeper coverage. For Div. 3M and 3NO surveys the minimum is found in the correlation between ages 7-8 and for Canadian autumn survey the minimum is found in ages 8-9, this could be related with the problems between the readers as shows Alpoim *et al*., 2002.

- ***Between Surveys Consistency***

In this case, we examine the correlation for a given age between abundance indices of different surveys.

$$X1_y = U_{a,y,f1} \text{ and } X2_y = U_{a,y,f2}$$

A review of the corresponding correlation coefficients makes it possible to assess the consistency between surveys for each age. Figure 5 shows the results and it can be observed that Flemish Cap survey (Div. 3M) have a good correlation with the others surveys for ages less than 7 years, for older ages the correlation decrease considerably. The Canadian autumn survey have a good correlation for younger ages (less than 7) with Canadian Spring and Flemish Cap survey, and the correlation is smaller for these ages with the Spanish 3NO survey, but is quite good for older ages. The ages where the correlation is smaller between surveys are ages 7 and 8.

- ***Consistency between Survey Indices and XSA stock abundance***

Figure 6 presents the results of the correlation coeficient between the surveys abundance indices ($U_{a,y,f}$) and the abundance of 2004 assessment. For ages less than 7 the correlation is high (more than 0.6) for all surveys, but for ages 6, 7 and 8 the correlation decrease substantially; being the minimum in age 8 in all cases. Then the correlation between ages 8, 9 and 10 increase again and the correlation is stabilized around 0.6 for ages more than 10 years for all surveys. In the case of the Canadian autumn survey for ages older than 9 years all the correlation are much better considering the period 1996-2003 (taking out 1995 data).

When examining the reasons of the low correlation for age 8 (Fig. 7), we found that the low correlation mainly come from the data of the two last years, where the results of the XSA give us higher abundances than those observed by all the surveys. For previous years, the regression among the abundances of XSA and those observed by all the surveys for age 8 is quite good.

Discussion

The results indicated that the Canadian autumn survey have a clear year effect in 1995 data for ages older than 6 and it could be related with depth coverage of this survey in 1995. We propose to eliminate the 1995 data of the tuning indices of this survey in the assessment, witch in turn, it will improve the quality of the log q estimated for this survey in the assessment and, hence, the assessment itself. If this is so, in our opinion the “Minimum standard error for population estimates derived from each fleet” in the assessment should be change to a lower value to allow the new information weighting more in the assessment.

The Canadian spring survey showed a big trend in log q errors of ages 7 and 8. Therefore, in our opinion the assessment would be improve using only the indices from ages 1 to 6 of this survey in the tuning. Alternatively, giving less value to the “Minimum standard error for population estimates derived from each fleet” setting of XSA, it would not be necessary to eliminate ages 7 and 8 of this tuning indices since the weight on the final assessment of these ages of this survey would be diminished as they showed a high standard error.

The tuning quality of the Spanish 3NO survey was not very good for ages less than 5 years, they had a high standard error and were very noisy; however, the log *q* errors did not show any trend. For ages between 5 and 12 the information was as good as for other surveys and, consequently, it could be advisable to include this information in future assessments.

The surveys abundance correlation within surveys, between surveys and XSA showed that the surveys had many difficulties to track ages 7, 8 and 9. The lack of tracking of these ages could be due to different reasons, on one hand, to age reading inconsistencies; on the other hand, to changes in catchability of these ages in all surveys and, lastly, to an overestimation of the abundances in the XSA for these ages.

Acknowledgements

Brian Healey and Hilario Murua for the revision and contribution with their ideas to this document.

References

Alpoim, R., E. Roman, B. Greene, R. Burry, and W. R. Bowering. 2002. Greenland halibut (*Reinarhtius hippoglossoides*) otoliths exchange between Spain, Canada and Portugal. NAFO SCR Doc., No. 141, Serial No.4763, 14 p.

Beare, Castro, Cotter, van Keeken, Kell, Laurec, Mahé, Moura, Munch-Petersen, Nielsen, Piet, Simmonds, Skagen, and Sparre, 2003. EVALUATION OF RESEARCH SURVEYS INRELATION TO MANAGEMENT ADVICE (EVARES - FISH/2001/02 - Lot 1) Final Report to European Commission Director-General Fisheries

Darby, C. D., B. Healey, J. C. Mahe, and W. R. Bowering. 2004. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 2 and Divisions 3KLMNO: an Assessment of Stock Status Based on upon Extended Survivors Analysis, ADAPT, and ASPIC Analyses, with Stochastic Projections of Potential Stock Dynamics. NAFO SCR Doc., No. 55, Serial No. N5008, 53 p.

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): 85 p.

Shepherd, J. G. 1999. Extended survivors analysis: An improved method for the analysis of catch-at-age data and abundance indices *ICES J. Mar. Sci*., **56**(5): 584-591

.

Table 1a.- Catch Numbers (.000) by age and year used in the 2004 assessment of Greenland Halibut Subarea 2 and Div. 3KLMNO.

Catch Numbers (.000) by Age and Year														
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**
1975	0	0	0	0	334	2819	5750	4956	3961	1688	702	135	279	288
1976	0	0	0	0	17	610	3231	5413	3769	2205	829	260	101	53
1977	0	0	0	0	534	5012	10798	7346	2933	1013	220	130	116	84
1978	0	0	0	0	2982	8415	8970	7576	2865	1438	723	367	222	258
1979	0	0	0	0	2386	8727	12824	6136	1169	481	287	149	143	284
1980	0	0	0	0	209	2086	9150	9679	5398	3828	1013	128	53	27
1981	0	0	0	0	863	4517	9806	11451	4307	890	256	142	43	69
1982	0	0	0	0	269	2299	6319	5763	3542	1684	596	256	163	191
1983	0	0	0	0	701	3557	9800	7514	2295	692	209	76	106	175
1984	0	0	0	0	902	2324	5844	7682	4087	1259	407	143	106	183
1985	0	0	0	0	1983	5309	5913	3500	1380	512	159	99	87	86
1986	0	0	0	0	280	2240	6411	5091	1469	471	244	140	70	117
1987	0	0	0	0	137	1902	11004	8935	2835	853	384	281	225	349
1988	0	0	0	0	296	3186	8136	4380	1288	465	201	105	107	129
1989	0	0	0	0	181	1988	7480	4273	1482	767	438	267	145	71
1990	0	0	0	95	1102	6758	12632	7557	4072	2692	1204	885	434	318
1991	0	0	0	220	2862	7756	13152	10796	7145	3721	1865	1216	558	422
1992	0	0	0	1064	4180	10922	20639	12205	4332	1762	1012	738	395	335
1993	0	0	0	1010	9570	15928	17716	11918	4642	1836	1055	964	401	182
1994	0	0	0	5395	16500	15815	11142	6739	3081	1103	811	422	320	215
1995	0	0	0	323	1352	2342	3201	2130	1183	540	345	273	251	201
1996	0	0	0	190	1659	5197	6387	1914	956	504	436	233	143	89
1997	0	0	0	335	1903	4169	7544	3215	1139	606	420	246	137	89
1998	0	0	0	552	3575	5407	5787	3653	1435	541	377	161	92	51
1999	0	0	0	297	2149	5625	8611	3793	1659	623	343	306	145	151
2000	0	0	0	271	2029	12583	21175	3299	973	528	368	203	129	104
2001	0	0	0	448	2239	12163	22122	5154	1010	495	439	203	156	75
2002	0	0	0	479	1662	7239	17581	6607	1244	659	360	224	126	81
2003	0	0	0	1279	4491	10723	16764	6385	1614	516	290	144	76	85

Table 1b.-Catch Weights (kg) by age and year used in the 2004 assessment of Greenland Halibut Subarea 2 and Div. 3KLMNO.

Catch Weights (kg) by Age and Year														
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**
1975	0	0	0.126	0.244	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.764
1976	0	0	0.126	0.244	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.144
1977	0	0	0.126	0.244	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.992
1978	0	0	0.126	0.244	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.894
1979	0	0	0.126	0.244	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	6.077
1980	0	0	0.126	0.244	0.514	0.659	0.869	1.05	1.15	1.26	1.57	2.71	3.12	5.053
1981	0	0	0.126	0.244	0.392	0.598	0.789	0.985	1.24	1.7	2.46	3.51	4.79	7.426
1982	0	0	0.126	0.244	0.525	0.684	0.891	1.13	1.4	1.79	2.38	3.47	4.51	7.359
1983	0	0	0.126	0.244	0.412	0.629	0.861	1.18	1.65	2.23	3.01	3.96	5.06	7.061
1984	0	0	0.126	0.244	0.377	0.583	0.826	1.1	1.46	1.94	2.63	3.49	4.49	7.016
1985	0	0	0.126	0.244	0.568	0.749	0.941	1.24	1.69	2.24	2.95	3.71	4.85	7.01
1986	0	0	0.126	0.244	0.35	0.584	0.811	1.1	1.58	2.12	2.89	3.89	4.95	7.345
1987	0	0	0.126	0.244	0.364	0.589	0.836	1.16	1.59	2.13	2.82	3.6	4.63	6.454
1988	0	0	0.126	0.244	0.363	0.569	0.805	1.163	1.661	2.216	3.007	3.925	5.091	7.164
1989	0	0	0.126	0.244	0.4	0.561	0.767	1.082	1.657	2.237	2.997	3.862	4.919	6.37
1990	0	0	0.09	0.181	0.338	0.546	0.766	1.119	1.608	2.173	2.854	3.731	4.691	6.391
1991	0	0	0.126	0.244	0.383	0.592	0.831	1.228	1.811	2.461	3.309	4.142	5.333	7.081
1992	0	0	0.175	0.289	0.43	0.577	0.793	1.234	1.816	2.462	3.122	3.972	5.099	6.648
1993	0	0	0.134	0.232	0.368	0.547	0.809	1.207	1.728	2.309	2.999	3.965	4.816	6.489
1994	0	0	0.08	0.196	0.33	0.514	0.788	1.179	1.701	2.268	2.99	3.766	4.882	6.348
1995	0	0	0.08	0.288	0.363	0.531	0.808	1.202	1.759	2.446	3.122	3.813	4.893	6.79
1996	0	0	0.161	0.242	0.36	0.541	0.832	1.272	1.801	2.478	3.148	3.856	4.953	6.312
1997	0	0	0.12	0.206	0.336	0.489	0.771	1.159	1.727	2.355	3.053	3.953	5.108	6.317
1998	0	0	0.119	0.228	0.373	0.543	0.81	1.203	1.754	2.351	3.095	4.01	5.132	6.124
1999	0	0	0.176	0.253	0.358	0.533	0.825	1.253	1.675	2.287	2.888	3.509	4.456	5.789
2000	0	0	0	0.254	0.346	0.524	0.787	1.192	1.774	2.279	2.895	3.645	4.486	5.531
2001	0	0	0	0.249	0.376	0.57	0.83	1.168	1.794	2.367	2.95	3.715	4.585	5.458
2002	0	0	0.217	0.251	0.369	0.557	0.841	1.193	1.76	2.277	2.896	3.579	4.407	5.477
2003	0	0	0.188	0.247	0.389	0.564	0.822	1.199	1.651	2.166	2.7	3.404	4.377	5.409

Table 1c.-Catch weights (kg) by age and year used in the 2004 assessment of Greenland Halibut Subarea 2 and Div. 3KLMNO.

Stock Weights (kg) by Age and Year

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1975	0	0	0	0	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.764
1976	0	0	0	0	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.144
1977	0	0	0	0	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.992
1978	0	0	0	0	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.894
1979	0	0	0	0	0.609	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	6.077
1980	0	0	0	0	0.514	0.659	0.869	1.05	1.15	1.26	1.57	2.71	3.12	5.053
1981	0	0	0	0	0.392	0.598	0.789	0.985	1.24	1.7	2.46	3.51	4.79	7.426
1982	0	0	0	0	0.525	0.684	0.891	1.13	1.4	1.79	2.38	3.47	4.51	7.359
1983	0	0	0	0	0.412	0.629	0.861	1.18	1.65	2.23	3.01	3.96	5.06	7.061
1984	0	0	0	0	0.377	0.583	0.826	1.1	1.46	1.94	2.63	3.49	4.49	7.016
1985	0	0	0	0	0.568	0.749	0.941	1.24	1.69	2.24	2.95	3.71	4.85	7.01
1986	0	0	0	0	0.35	0.584	0.811	1.1	1.58	2.12	2.89	3.89	4.95	7.345
1987	0	0	0	0	0.364	0.589	0.836	1.16	1.59	2.13	2.82	3.6	4.63	6.454
1988	0	0	0	0	0.363	0.569	0.805	1.163	1.661	2.216	3.007	3.925	5.091	7.164
1989	0	0	0	0	0.4	0.561	0.767	1.082	1.657	2.237	2.997	3.862	4.919	6.37
1990	0	0	0	0	0.338	0.546	0.766	1.119	1.608	2.173	2.854	3.731	4.691	6.391
1991	0	0	0	0	0.383	0.592	0.831	1.228	1.811	2.461	3.309	4.142	5.333	7.081
1992	0	0	0	0	0.43	0.577	0.793	1.234	1.816	2.462	3.122	3.972	5.099	6.648
1993	0	0	0	0	0.368	0.547	0.809	1.207	1.728	2.309	2.999	3.965	4.816	6.489
1994	0	0	0	0	0.33	0.514	0.788	1.179	1.701	2.268	2.99	3.766	4.882	6.348
1995	0	0	0	0	0.363	0.531	0.808	1.202	1.759	2.446	3.122	3.813	4.893	6.79
1996	0	0	0	0	0.36	0.541	0.832	1.272	1.801	2.478	3.148	3.856	4.953	6.312
1997	0	0	0	0	0.336	0.489	0.771	1.159	1.727	2.355	3.053	3.953	5.108	6.317
1998	0	0	0	0	0.373	0.543	0.81	1.203	1.754	2.351	3.095	4.01	5.132	6.124
1999	0	0	0	0	0.358	0.533	0.825	1.253	1.675	2.287	2.888	3.509	4.456	5.789
2000	0	0	0	0	0.346	0.524	0.787	1.192	1.774	2.279	2.895	3.645	4.486	5.531
2001	0	0	0	0	0.376	0.57	0.83	1.168	1.794	2.367	2.95	3.715	4.585	5.458
2002	0	0	0	0	0.369	0.557	0.841	1.193	1.76	2.277	2.896	3.579	4.407	5.477
2003	0	0	0	0	0.389	0.564	0.822	1.199	1.651	2.166	2.7	3.404	4.377	5.409

Table 1d.-Maturity Ogive by age and year used in the 2004 assessment of Greenland Halibut Subarea 2 and Div. 3KLMNO.

Maturity Ogive by Age and Year

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1975	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1976	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1977	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1978	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1979	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1980	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1981	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1982	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1983	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1984	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1985	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1986	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1987	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1988	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1989	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1990	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1991	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1992	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1993	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1994	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1995	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1996	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1997	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1998	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
1999	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
2000	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
2001	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
2002	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86
2003	0	0	0	0	0	0	0	0	0	0.01	0.04	0.13	0.32	0.86

Table 1e.-Total Catch (ton) by year used in the 2004 assessment of Greenland Halibut Subarea 2 and Div. 3KLMNO.

Year	Catch (ton)
1975	28814
1976	24611
1977	32048
1978	39070
1979	34104
1980	32867
1981	30754
1982	26278
1983	27861
1984	26711
1985	20347
1986	17976
1987	32442
1988	19215
1989	20034
1990	47454
1991	65008
1992	63193
1993	62455
1994	51029
1995	15272
1996	18840
1997	19858
1998	19946
1999	24226
2000	34177
2001	38232
2002	34062
2003	35151

Table 1f.- Natural mortality and proportion of the Fishing and natural mortality before the spawning used in the 2004 assessment of Greenland Halibut Subarea 2 and Div. 3KLMNO.

	Ages	Value
Natural Mortality	1-14+	0.2
PF	1-14+	0
PM	1-14+	0

Table 2.- Characteristic of the tuning surveys.

Survey	Gear	Depth range (m)	Divisions	Month	Years	Ages (XSA)
Flemish Cap	Trawl	<750	3M	July	1995-2003	1-12
Canadian Fall	Trawl	<1500	2J3KL	Sep-Dec	1995-2003	1-13
Canadian Spring	Trawl	<730	3LNO	Mar-May	1996-2003	1-8
Spanish 3NO	Trawl	<1450	3NO	May	1997-2003	1-13

Table 3a.- Mean numbers per Trawl (MNPT) of the Flemish Cap survey used as tuning in the 2004 assessment of Greenland halibut Subarea 2 and Div. 3KLMNO.

Mean Number per Trawl Flemish Cap Survey (UE Survey)												
Year	1	2	3	4	5	6	7	8	9	10	11	12
1995	7.66	1.74	1.70	1.55	2.13	4.72	3.76	2.15	1.41	0.32	0.08	0.03
1996	3.57	5.74	1.90	2.57	3.82	5.46	2.51	1.71	0.49	0.10	0.04	0.04
1997	1.98	2.63	5.46	6.41	6.49	7.51	4.83	2.12	0.74	0.25	0.04	0.03
1998	1.79	1.58	6.40	9.75	11.40	10.97	7.88	2.91	0.87	0.25	0.04	0.01
1999	0.65	0.53	2.37	8.93	12.21	11.94	5.45	1.92	0.40	0.12	0.01	-1.00
2000	1.99	0.18	0.39	1.75	6.91	14.41	5.09	2.11	0.44	0.12	0.06	-1.00
2001	5.17	1.04	1.43	0.85	2.54	7.37	6.93	3.70	0.21	0.06	0.01	-1.00
2002	2.44	2.04	2.01	1.37	3.40	5.18	5.85	1.24	0.16	0.07	0.02	0.01
2003	2.10	1.38	0.98	2.54	4.12	4.81	2.96	0.71	0.18	0.13	0.02	0.01

Table 3b.- Mean numbers per trawl (MNPT) of the Canadian autumn survey used as tuning in the 2004 assessment of Greenland halibut Subarea 2 and Div. 3KLMNO.

Mean Number per Trawl Canadian Autumn True Campelen (CAN RV4)													
Year	1	2	3	4	5	6	7	8	9	10	11	12	13
1995	30.320	31.180	9.691	3.624	4.526	1.547	0.293	0.071	0.011	0.006	0.003	-1.000	-1.000
1996	59.310	29.080	20.850	6.588	4.616	2.031	0.831	0.182	0.131	0.041	0.018	0.011	0.012
1997	17.100	34.250	26.660	15.300	7.780	3.745	1.750	0.601	0.167	0.051	0.030	0.021	0.013
1998	13.190	15.500	18.820	14.010	10.160	3.997	1.780	0.474	0.134	0.043	0.026	0.018	0.008
1999	8.647	20.620	15.960	15.870	12.830	7.758	2.495	0.476	0.089	0.042	0.015	0.007	0.023
2000	23.210	13.910	9.738	7.681	8.749	5.447	1.832	0.351	0.055	0.023	0.016	0.006	0.005
2001	25.960	12.850	10.050	9.749	6.109	5.612	2.493	0.494	0.087	0.019	0.010	0.008	0.012
2002	23.870	14.560	7.639	6.291	4.368	1.626	0.726	0.233	0.034	0.011	0.006	0.003	0.005
2003	27.440	15.880	8.125	6.809	4.487	1.677	0.714	0.188	0.032	0.014	0.007	0.003	0.004

Table 3c.- Mean numbers per trawl (MNPT) of the Canadian spring survey used as tuning in the 2004 assessment of Greenland halibut Subarea 2 and Div. 3KLMNO.

	Mean Number per Trawl Canadian Spring True Campelen (CAN RV5)							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1996	1.621	4.241	4.599	2.183	0.827	0.284	0.057	0.001
1997	1.162	3.924	5.160	3.227	1.461	0.507	0.099	0.013
1998	0.220	0.814	3.847	6.186	4.955	1.238	0.326	0.072
1999	0.292	0.552	1.149	1.982	3.388	1.090	0.242	0.050
2000	0.793	1.069	1.068	1.506	1.954	2.037	0.556	0.031
2001	0.565	0.714	0.739	0.676	0.796	0.716	0.279	0.023
2002	0.642	0.572	0.603	0.581	0.608	0.208	0.049	0.006
2003	0.926	2.137	1.663	1.569	1.055	0.206	0.051	0.008

Table 3d.- Mean numbers per trawl (MNPT) of the Spanish 3NO survey.

	Mean Number per Trawl 3NO Spanish Survey (3NO)												
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1997	4.958	3.379	1.835	1.432	0.928	1.013	0.783	0.501	0.135	0.292	0.238	0.152	0.070
1998	1.149	4.556	6.932	5.536	3.285	1.855	0.802	0.556	0.230	0.188	0.146	0.233	0.188
1999	1.689	2.945	4.367	5.402	3.657	1.763	0.510	0.385	0.214	0.098	0.135	0.317	0.306
2000	0.955	0.245	0.417	0.545	1.507	1.820	1.151	0.403	0.192	0.081	0.100	0.162	0.287
2001	4.337	3.516	0.725	0.500	1.316	1.955	0.849	0.146	0.048	0.035	0.094	0.263	0.280
2002	2.839	0.736	1.262	0.765	1.158	0.906	0.427	0.217	0.016	0.013	0.019	0.019	0.006
2003	4.084	3.378	2.252	2.362	1.660	0.829	0.657	0.218	0.049	0.035	0.014	0.049	0.007

Table 4.- XSA inputs used to see the log *q* errors by fleet.

Catch data for 29 years. 1975 to 2003. Ages 1 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU Survey(MNPT)	1995	2003	1	12	0,5	0,6
CAN RV4(MNPT)	1995	2003	1	13	0,8	1
CAN RV5(MNPT)	1996	2003	1	8	0,3	0,45
3NO Spanish Survey	1997	2003	1	13	0,4	0,5

Time series weights : Tapered time weighting not applied
Catchability analysis :
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 11

Terminal population estimation :
Survivor estimates shrunk towards the mean F of the final 5 years or the 3 oldest ages.
S.E. of the mean to which the estimates are shrunk = 2.500
Minimum standard error for population estimates derived from each fleet = .300

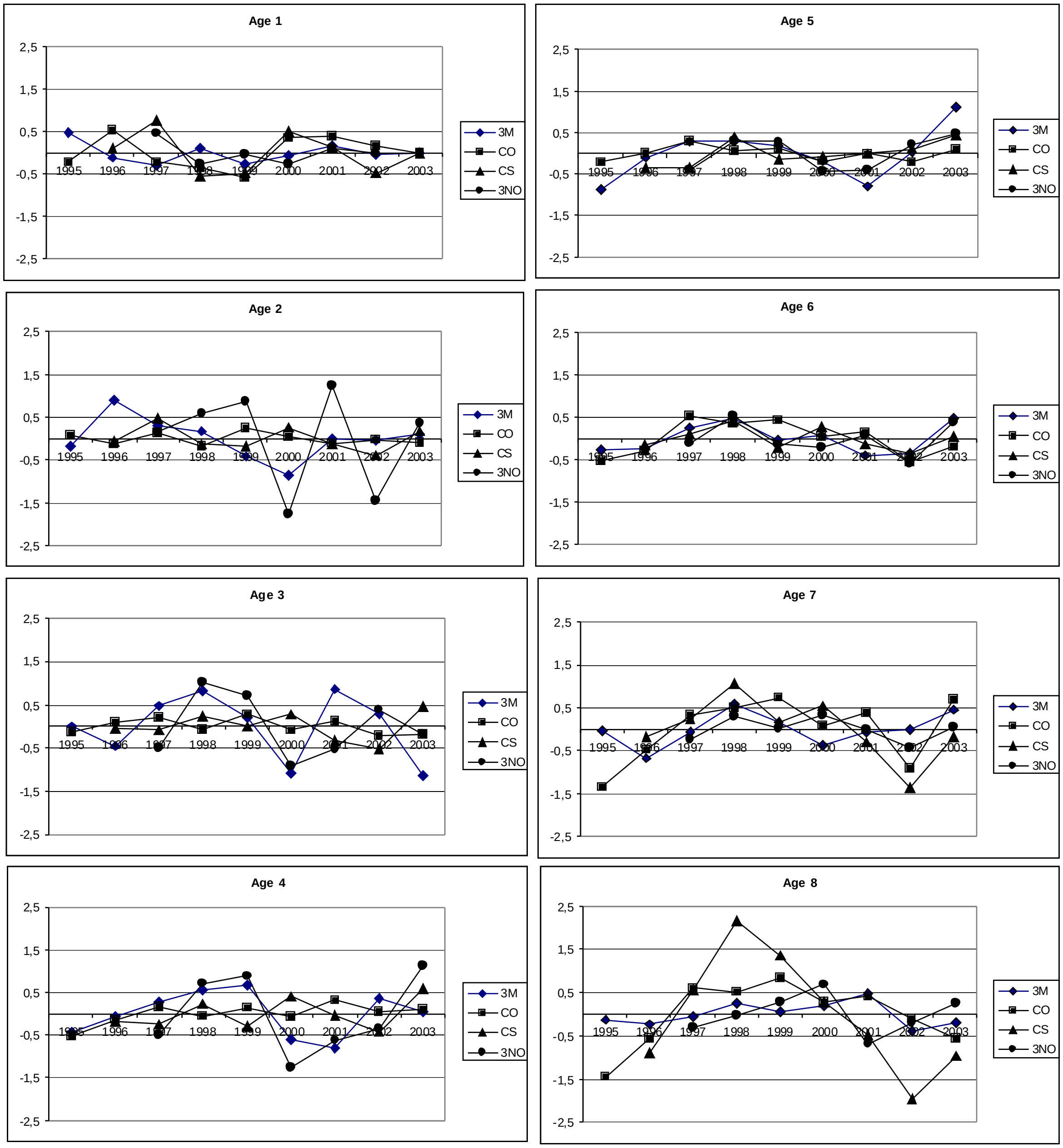


Fig. 1a.- Log *q* errors (SE) by age and fleet.

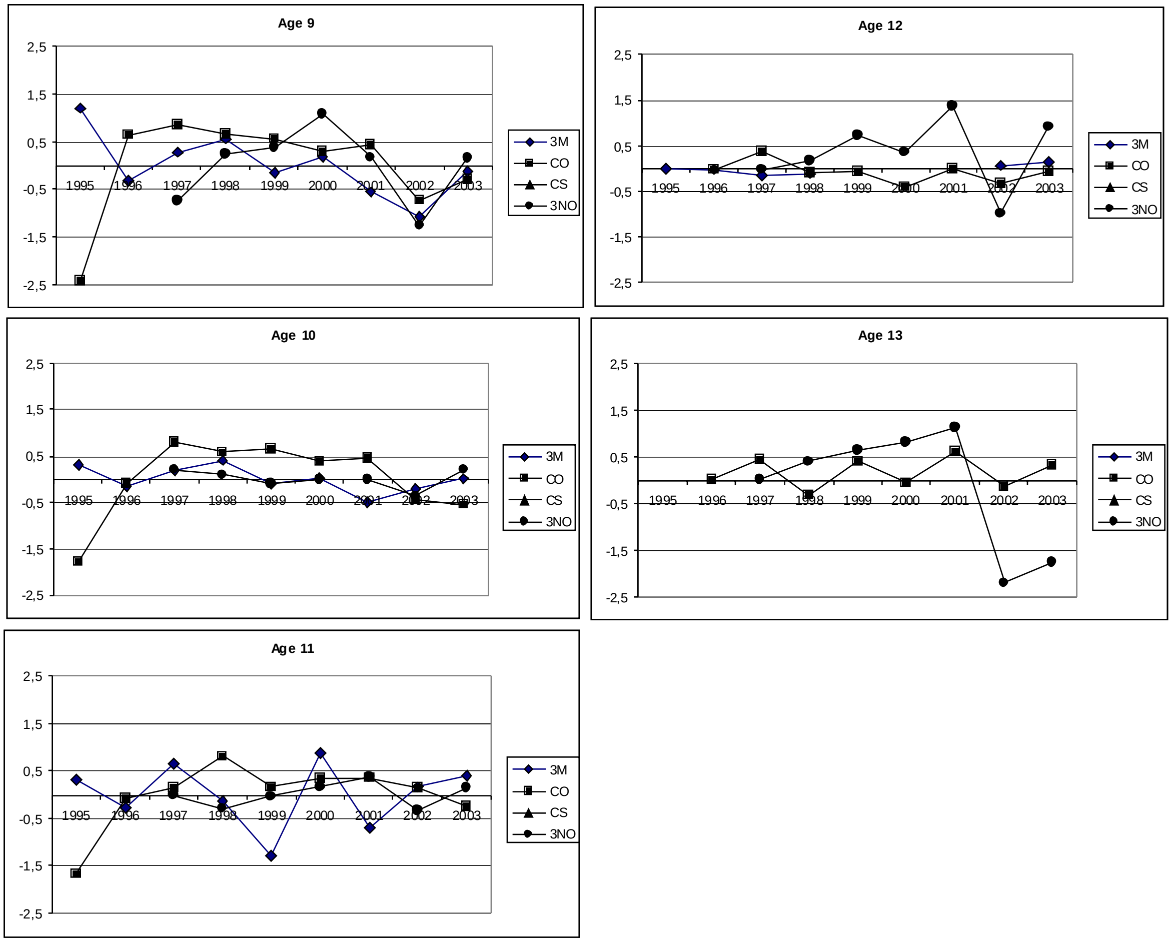


Fig. 1b.- Log *q* errors (SE) by age and fleet.

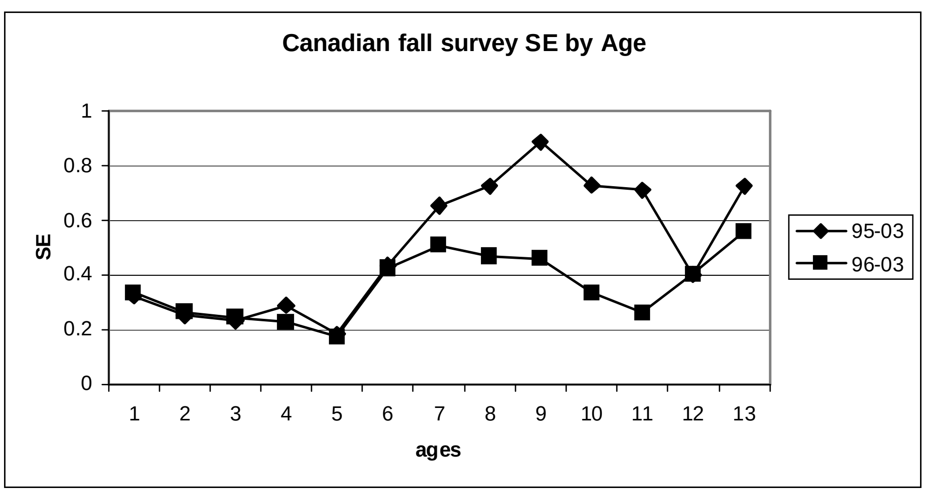


Fig. 2.- Log *q* errors (SE) by age for Canadian autumn survey. The series used in 2004 assessment is (1995-2003) and the alternative is (1996-2003).

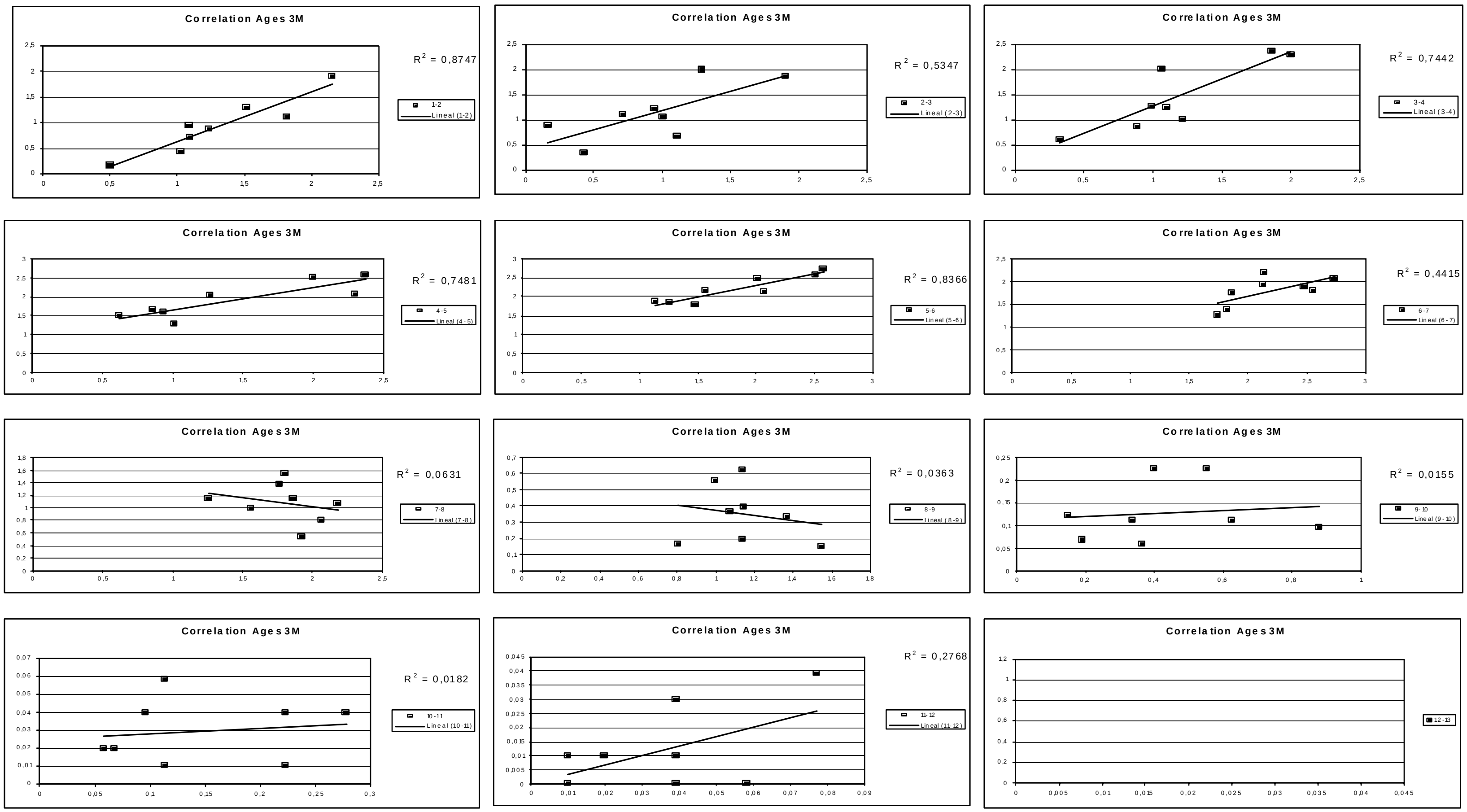


Fig. 3a.- Correlation and R^2 between ages in the Flemish Cap survey.

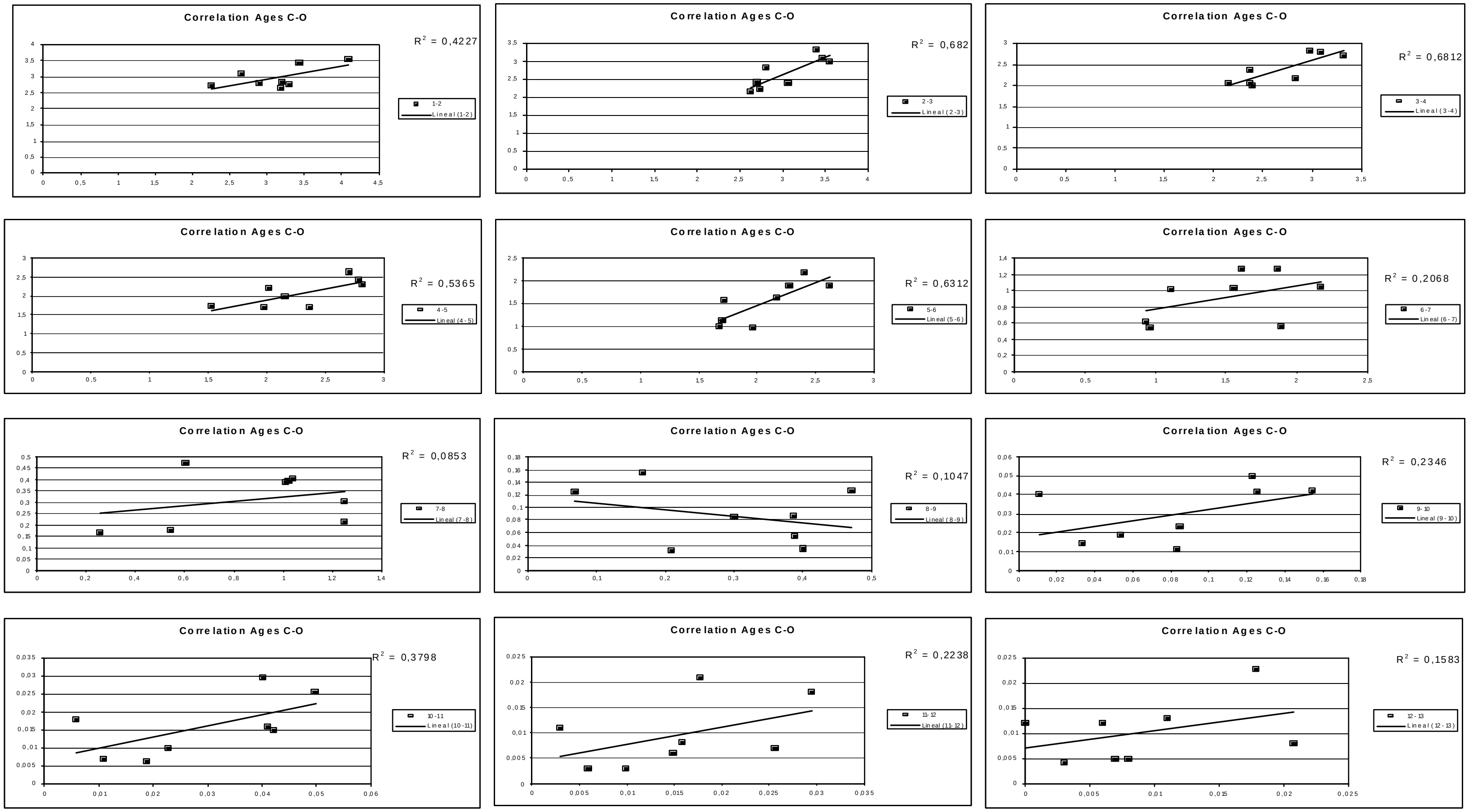


Fig. 3b.- Correlation and R^2 between ages in the Canadian autumn survey.

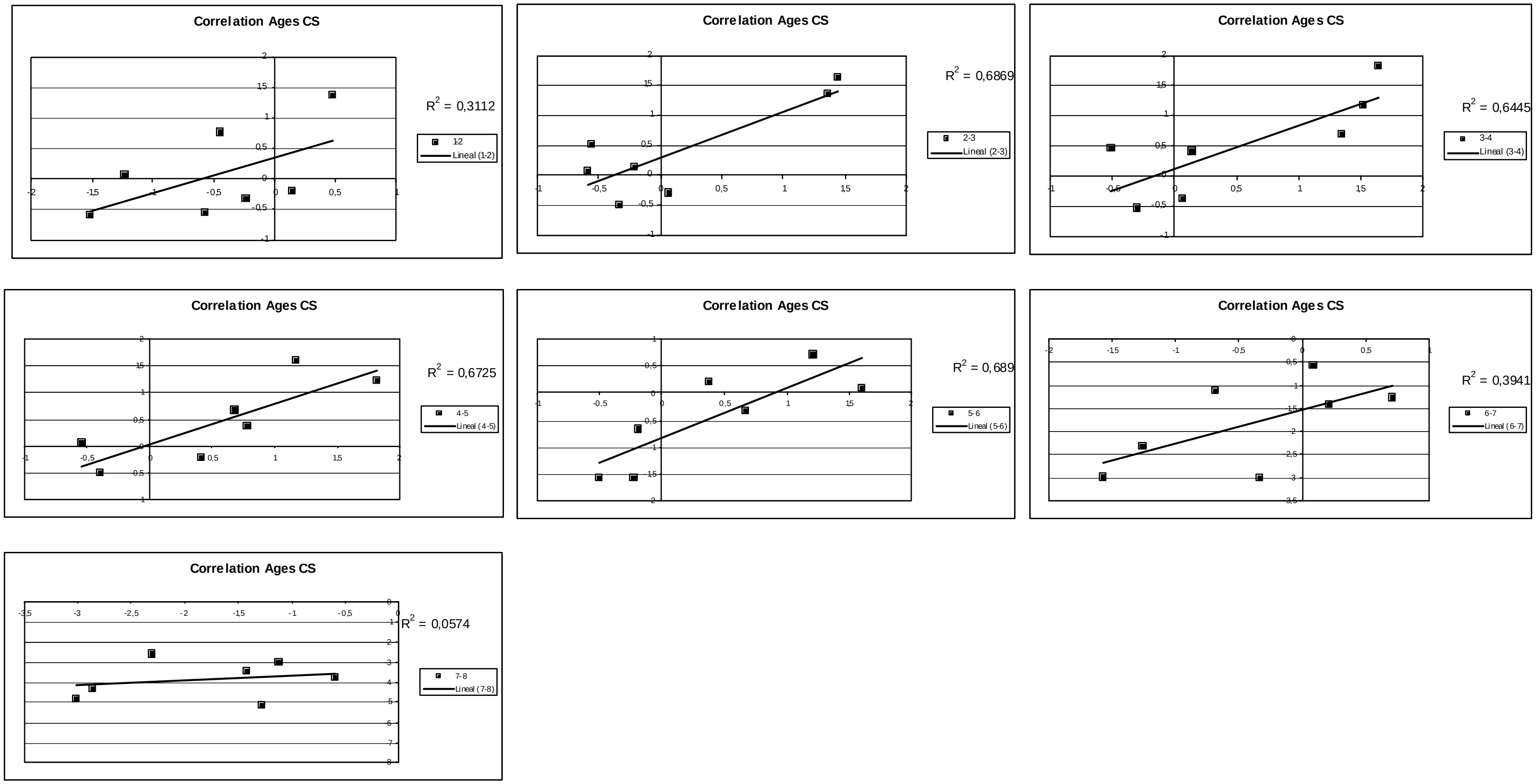


Fig. 3c.- Correlation and R^2 between ages in the Canadian spring survey.

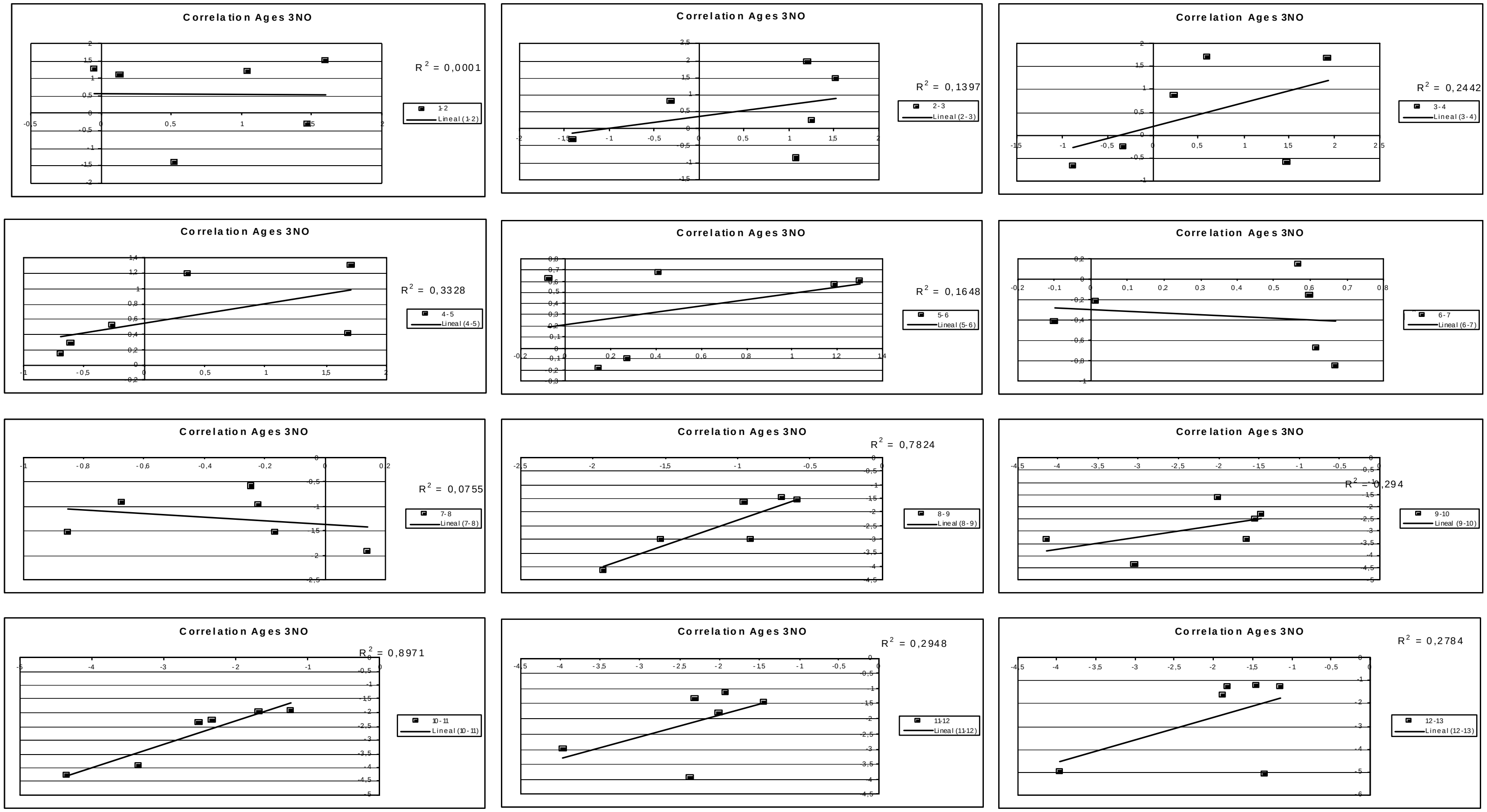


Fig. 3d.- Correlation and R^2 between ages in the Spanish 3NO survey.

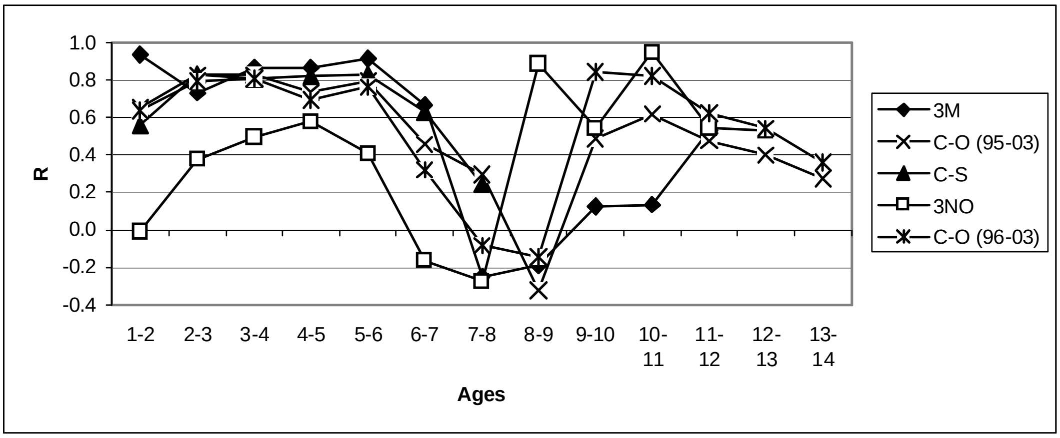
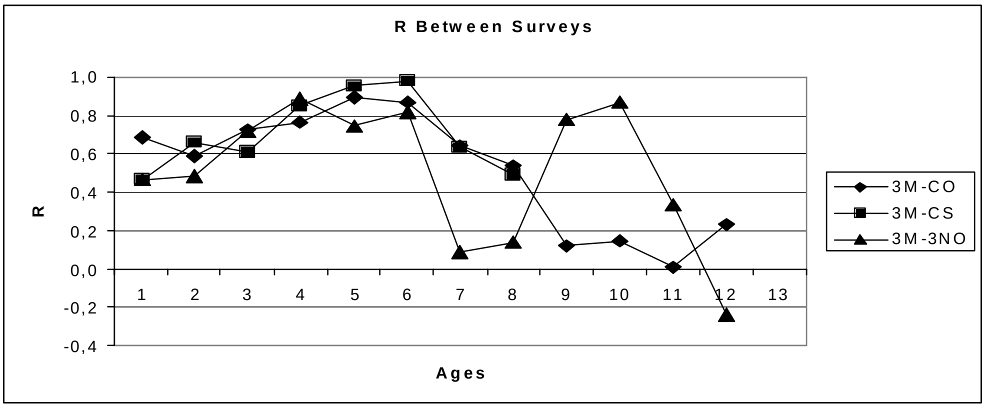


Fig. 4.- Correlation coefficient between ages abundance of the each survey.



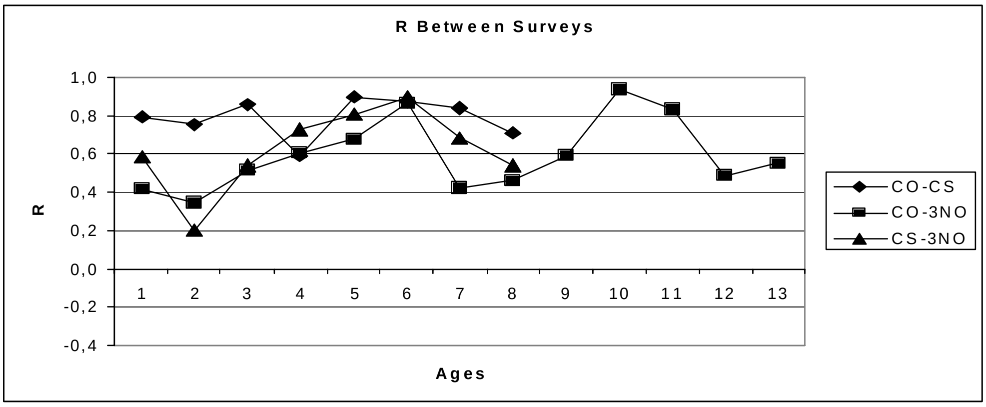


Fig. 5.- Correlation coefficient between the abundances of same ages of the different surveys.

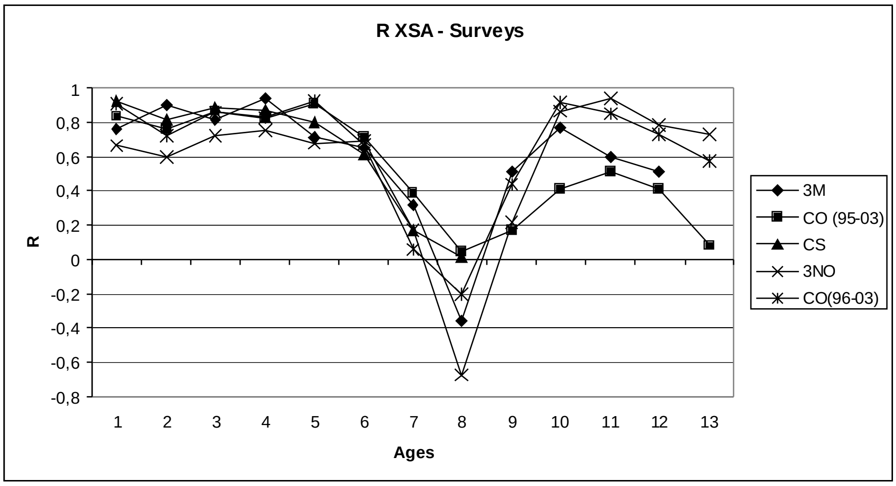


Fig. 6.- Correlation coefficient between ages abundance in the surveys and the final XSA abundance results.

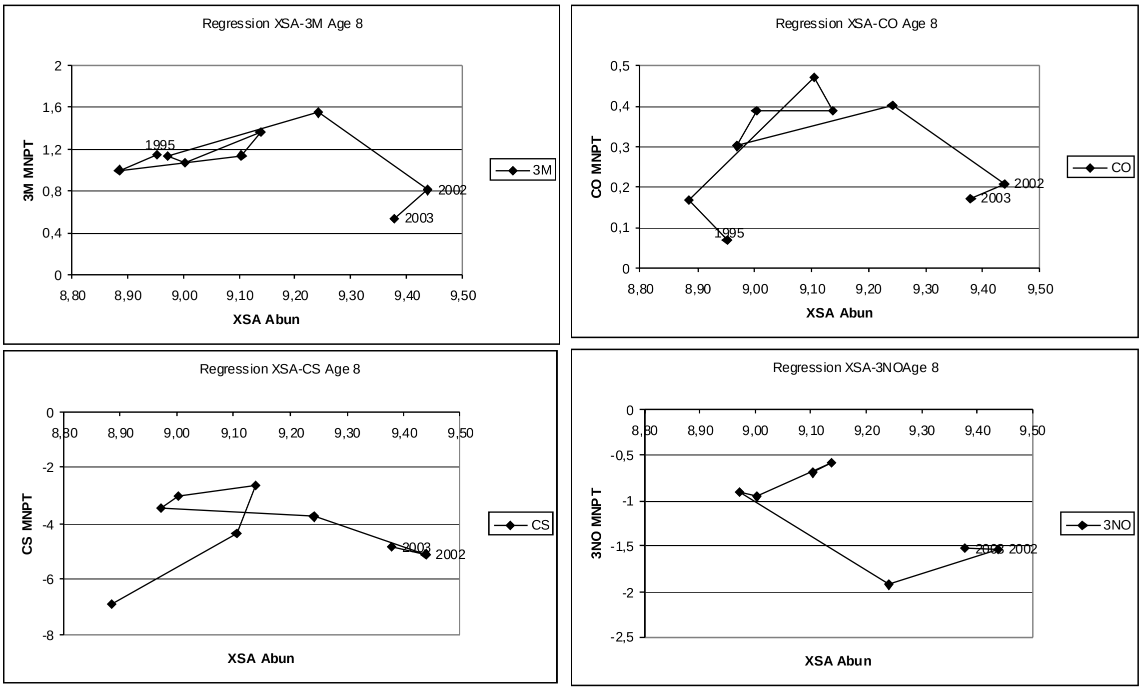


Fig. 7.- Graph of Dispersion between surveys abundance and XSA abundance for age 8.