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An Assessment of Greenland Halibut *(Reinhardtius hippoglossoides)* in NAFO Subarea 2 and Divisions 3KLMNO

by

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Abstract

Using catch history and fishery independent surveys to 2010, the status of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO is updated. An overview of catches, catch sampling and survey data are provided and the consistency of the signals within the available survey data is compared and discussed. Estimates of stock status of Greenland Halibut in Subarea 2 and Divisions 3KLMNO are produced using Extended Survivors Analysis. Estimated stock biomass has shown decreases over 2008-2011 and is currently estimated at about 84 000 tons. Estimated fishing mortality in recent years has generally decreased and the 2010 estimate is 0.37. Age 1 recruitment is estimated to be well-below average over 2004-2008, with preliminary indications of improved recruitment in 2009 and 2010, which are several years from contributing to the exploitable biomass.

Introduction

Analytical assessments of the status of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO using Extended Survivors Analysis (XSA, Shepherd, 1999) have been undertaken since 2000. Healey (2009) provides a full chronology of the XSA-based assessments over 2000-2008 with description of input data and model settings used as well as conclusions drawn from each of the annual assessments.

Results of the 2010 NAFO Scientific Council assessment of this stock (Healey et *al*., 2010) indicated that the exploitable (ages 5+) biomass decreased over 2008-2010, as weaker year-classes have recruited to the biomass. The level of recent biomass estimated in the previous assessment was higher than that reported in previous assessments, as a result of modifications to the assessment formulation and input data sets. Specifically, these were addition of the deep-water information from the EU survey (available since 2004 only) to the calibration data and altering the XSA shrinkage assumptions. The 10+ biomass peaked in 1991 and although it remains well below that peak, it has tripled over 2006-2010, becoming a larger fraction of the total 5+ biomass. Average fishing mortality (over ages 5-10) decreased from 0.49 to 0.26 over 2004 - 2009 under the Fisheries Commission Rebuilding Plan. The Scientific Council recommended (NAFO, 2010a, p. 21) that "*fishing mortality in 2011 be no higher than the F0.1 level (median catch of 14 500 t in 2011)*".

In 2003, Fisheries Commission established a fifteen year rebuilding plan for this stock (NAFO, 2003a), with the intent to: "*take effective measures to arrest the decline in the exploitable biomass and to ensure the rebuilding of this biomass to reach a level that allows a stable yield of the Greenland halibut fishery over the long term*". The plan states that "the objective of this programme shall be to attain a level of exploitable biomass 5+ of 140,000 tonnes on average", and in an attempt to improve the rebuilding prospects for this stock, TACs were set at 20, 19, 18.5, 16 ('000 tons), respectively, for the years 2004-07 (Figure 1). Subsequent TAC levels "*may be adjusted by the Scientific Council advice*" but "*shall not be set at levels beyond 15% less or greater than the TAC of the preceding year*".

In 2010, Fisheries Commission adopted a harvest control rule (HCR) as the basis for managing this stock for at least the next four years. The HCR is a survey-based rule that was simulation tested within a Management Strategy Evaluation framework (NAFO, 2010b). Initial application of this rule yielded a 2011 TAC of 17,185t.

Input Data

Catches

Catches increased from low levels in the early-1960s when the fishery began to over 36 000 tons in 1969, ranged from 18 000 tons to 39 000 tons until 1990 (Table 1, Figure 1), when an extensive fishery developed in the deep water of the NAFO Regulatory Area (Bowering and Brodie, 1995). The total catch estimated by STACFIS for 1990-94 was in the range of 47 000 to 63 000 tons annually, although estimates in some years were as high as 75 000 tons. Beginning in 1995, TACs for the resource were established for the entire stock unit by the Fisheries Commission (previous TACs were set autonomously by Canada), and the catch declined to just over 15 000 tons in 1995. Catches increased through the late 1990's into the early part of the 2000's, but decreased considerably as a result of reduced effort under the FC rebuilding plan. Estimated catches have averaged 24 000t over 2004-2010 under the FC rebuilding plan. The estimated total catch for 2010 is 26,170 tons, exceeding the TAC by 64%. Under this rebuilding plan, STACFIS estimated catches have exceeded the TAC in each year, with the over-run ranging from 22% - 64%.

Catch-at-age

Length sampling for otter trawl fisheries in the NAFO Regulatory Area (NRA) provided by EU-Portugal (Vargas et *al*., 2011), EU-Spain (González et *al*., 2011), and Russia (Skryabin et *al*., 2011) for 2010 otter trawl fisheries are generally similar (Figure 2), though modal catch length ranges from about 42cm for Portugal to 48cm for Russia. Sampling data also indicate a shift to smaller individuals compared to 2009 fisheries. Additional sampling is available from Lithuanian (total removals of just 6 tons; Statkus, 2011) and Canadian (refer to Brodie et *al.*, 2011) catches. Available age-length keys indicate a difference between Spanish and Canadian age interpretations (see Alpoim et al., 2002; Darby et al., 2003). At a given age, the Spanish data have greater mean lengths than Canadian data. Until the differences can be resolved, the length samples from all fishing are converted to catch-at-age using Canadian age length keys. Recent research suggests that in addition to these inconsistencies, the Canadian, EU and Russian age determination methods may be underestimating ages (Treble et al., 2005). Workshops on age determination methods for Greenland Halibut have been held in both 2011 and 2006 (ICES, 2011, Treble and Dwyer, 2006), but consensus on age-readings for this species has not been attained and much research on this problem continues.

Computation of Canadian catch-at-age is described by Brodie et al (2011). Samples from the Canadian fishery were used to derive catch-at-age independently for each gear. The 2002 and 2003 year-classes - ages 8 and 7 in 2010 - dominated the Canadian catch; with 78% of the catch (in numbers) from these two cohorts. In several recent years, the proportion of older individuals in the catch has was much lower than typical, primarily attributable to reductions in the longline catches and changes to gillnet mesh size regulations by depth range within the Canadian EEZ. Although longline catches remain insignificant, the Canadian gillnet catch in depths greater than 732m more than doubled from 2009 to 2010 and catches in this area typically include additional older individuals. This increase resulted from another change to management regulations regarding gillnet mesh-size.

No sampling data are available for 2010 catches taken by EU-Estonia, St. Pierre and Miquelon (France) and the Faroe Islands (Denmark) (771 t combined catch), all operating in the NAFO Regulatory Area (NRA). Catch-at-age was developed for these fleets under the assumption that the age-composition was similar to that of the combined Spanish, Portuguese and Russian fisheries operating within the NRA. Though limited sampling is available for the 7

t of catch by EU-Lithuania (Statkus, 2011), this catch was also disaggregated using the overall length distribution from Spanish, Portuguese and Russian fisheries.

Total catch numbers-at-age for 1975-2010 are given in Table 2. As in the recent past, in 2010 the modal catch was at age 7, i.e. the 2003 year-class. Catch weights at age (Table 3) are computed as weighted means of the values from national sampling, and have generally been stable over time. However, at older ages (10+), there is evidence of a slight decrease in mean weights at age over the past decade. Ages 6-8 dominate the catch throughout the entire time period and at present comprise 85% of annual catch numbers. Age groups 10+ currently contribute about 9% to the total annual landed weight, less than half of the long-term average. To illustrate the recent age composition of the catch, annual C@A over 2007-2010 is plotted in Figure 3. The overall sum-of-products (product of vectors of catch numbers and catch weights at age divided by the estimated total catch) is 0.98 for the 2010 data.

Survey Data

Abundance Indices

At present, there is no synoptic survey which covers the entire distribution range of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO. Results of annual surveys by the EU on the Flemish Cap, and by Canada covering NAFO Divs. 3LNO during spring and NAFO Divs. 2J3KLMNO in autumn provide the best sources of information for this stock. Of importance for this resource, the EU survey was extended to cover depths down to 1400m in 2004 (maximum depth covered prior to 2004 was 732m). We note that the survey information available have variable temporal, and also spatial, coverage (depth and also NAFO Divisions), with full details described by Casas and González-Troncoso (2011) for the EU survey and Healey (2011) for Canadian surveys. Information on Greenland Halibut is also available from Spanish surveys of the NRA in Divs. 3NO, but this survey covers a very small portion of the stock area and is only partially considered here.

Healey et *al.* (2010) analyzed the newly available deep water age-disaggregated results from EU surveys in Div. 3M and considered how best to incorporate these data into the analytical assessment. Following the arguments applied during the previous assessment, we consider the following data set to calibrate the assessment of this stock (Table 4):

a) EU 3M (0-700m) - European Union summer survey in Division 3M from 1995–2003, ages 1 – 12 (Casas and González-Troncoso, 2011),
b) EU 3M (0-1400m) - European Union summer survey in Division 3M from 2004–2010, ages 1 – 13 (Casas and González-Troncoso, 2011),
c) Canadian autumn survey in Divisions 2J3K from 1996 - 2010, ages 1 to 13 (Healey, 2011), and,
d) Canadian spring survey in Divisions 3LNO from 1996 - 2010, ages 1 to 8 (Healey, 2011).

During the 2003 assessment, STACFIS agreed (NAFO, 2003b; Darby et *al.*, 2003) to exclude survey data from 1978-1994 from the calibration dataset as changes in survey catchability were apparent. Retrospective patterns in biomass, fishing mortality and recruitment were less severe when the 1978-1994 data were excluded. Darby et *al.* (2003) also reported improved within survey correlations for the shortened time series. The 1995 and 2008 Canadian fall survey as well as the 2006 Canadian spring survey results have also been excluded as the survey coverage in these years was incomplete.

Results and Discussion

Exploratory Analysis of Survey Data

Prior to modeling the survey and catch data, some exploratory analyses were conducted to evaluate the internal consistency in each survey index series, the consistency of the contribution of each year-class to the total survey index, and the consistency of the age-specific information across the survey series.

Pair-wise plots of the each of the survey indices (by cohort on the log-scale) are presented in Figure 4. Data points compare the logarithm of survey data at different ages for a common cohort. The solid line in each panel is the linear

least squares regression line. Numeric values in the panels above the diagonal provide the correlation coefficient between the survey data at these ages. The p-values for testing whether or not the correlation is significantly different than 0 in each panel is indicated by the key shown on the right hand side. Regression and correlations are only computed if there are at least 5 points (i.e. cohorts) available for a given pair of ages. The scatter plots reveal that some of the low correlation values noted in previous assessments are partially due to one or two outlying points (e.g. ages 6 to 7 in Canadian fall Division 2J3K index) whereas other problems appear to be systematic.

A comparison of the correlation coefficients between successive ages in indices is presented in Figure 5. The relatively low correlation in some age-groups noted in previous assessments remains a cause for concern.

To evaluate consistency across surveys, a comparison of standardized indices for all age disaggregated indices (Figure 6a) and also the dataset currently used to calibrate the analytical assessment (Figure 6b) is provided. Each survey-age time-series is standardized to have mean 0 and variance 1 and are hence directly comparable. The survey data used to calibrate the XSA appears to be fairly consistent through time over a majority of age groups, though with less consistency for the oldest ages. There are also some differences in the recent period across many ages. The increases in the Canadian Div. 2J3K fall survey described in Healey (2010) are evident at ages 6-9. In addition, recent data from the Canadian Div. 3LNO survey at ages 6-8 are relatively large (discussed further below). The EU survey data from 0-700m does not generally reflect such increases.

Plots of the standardized proportions by age across years (SPAY) provide additional perspective on the cohort consistency within each of the survey indices (Figure 7). In the SPAY plots, the annual index proportions were standardized at each age to have a mean of 0 and a variance of 1. (Cohorts are identified with text labels in the margin.) As noted in previous assessments, there are indications of continued difficulties in tracking cohorts in these surveys; particularly in the 2002-2007 data in the Canadian fall 2J3K survey index.

Overall, these evaluations suggest that the patterns across surveys are reasonably consistent, but this is not to say that the tuning dataset is without problems, as demonstrated in the pair-wise scatter plots. Nonetheless, we rely on the assertion of Healey and Mahé (2006) that as XSA uses within cohort information to produce estimates of survivors, such analyses for this stock are still considered appropriate.

Assessment Results

Update Run

Survey data over 1995-2010 and catch information from 1975-2010 were used to estimate numbers at age using the final XSA formulation applied during the previous assessment (Healey et *al.*, 2010). The calibration data set includes the Canadian spring and fall survey data and also the EU survey data (0-700m data from 1995-2003; 0-1400m over 2004-2010). In tables and figures of results, we refer to this analysis as the “update run”. Detail on the XSA settings, diagnostics and results can be found in Table 5. Estimated numbers at age and fishing mortality at age are presented in Tables 6 and 7, with a summary of the estimates presented in Table 8. Figure 8 illustrates the exploitable (ages 5+) biomass, average fishing mortality, recruitment at age and age 10+ biomass. Estimates of 2011 survivors from the XSA are used to compute 2011 biomass assuming the 2011 stock weights at age are equal to the 2008-2010 average.

The strong recruiting year-classes of the mid-1980’s, coupled with relatively low fishing mortalities contributed to a substantial increase in the exploitable biomass over 1985-1991. Subsequently, intense fishing pressure and poor recruitment contributed to significant stock declines (approximately 65% lower) in the early 1990’s. The large 1993-1995 year-classes lead to improvements in the exploitable biomass around the turn of the millennium. Biomass increased over 2004-2008 with decreases in fishing mortality. However, it has shown decreases over 2008-2011, as weaker year-classes have recruited to the biomass. The 2011 5+ biomass is estimated to be about 84 000 tons. The 10+ biomass peaked in 1991 and although it remains well below that peak, it has tripled over 2006-2011.

From 1975-1990, average fishing mortality over ages 5-10 (Fbar(5-10)), although variable, generally declined to a low of about 0.13 during the late 1980’s. Subsequent trends in Fbar closely mirror the trends in total landings. Estimates of fishing mortality since the imposition of the rebuilding plan have decreased due to substantial

reductions in effort. However, absolute estimates of fishing mortality remain relatively high; Fbar(5-10) in 2010 has increased over the 2009 level and is estimated to be 0.37.

Historical estimates of recruitment indicate two periods with relatively strong year-classes, one during the mid-1980's and another during the mid-1990's, each consisting of multiple year-classes. More recently, age 1 recruitment is estimated to be well-below average in 2004-2008 (fish are aged 4 to 8 in 2011), with preliminary indications of improved recruitment in 2009 and 2010, with the 2010 estimate above the long-term average. However, the recruitment information for 2009 and 2010 is not consistent across surveys (refer to age 1 and age 2 estimates by survey, Table 5b).

The XSA estimated catchabilities (Q), the standard error of Log(Q), and also the scaled weights used to compute the estimates of survivors at each age of the estimated population are presented in Figure 9. Darby and Flatman (1994) suggest that Log(Q) standard errors in excess of 0.5 are indicative of poor fit. In this analysis, the Log(Q) standard errors exceed 0.5 for 26 of the 46 index-ages, even exceeding 1 in some instances. The scaled weights indicate a dominance of the Canadian fall 2J3K survey over most ages, with increasing influence of the EU deep water index at older ages.

Selection patterns of the recent past are plotted in Figure 10 and reflect a peak ranging across ages 7-9 in all but the terminal year. The shift in selection in 2010 is consistent with a shift towards smaller lengths as seen in the sampling information (Figure 2). In addition, the absolute fishing mortality on age 7 (2003 year-class) is higher than it has been in several years (Table 7), as the weaker year-classes noted above are of the modal ages taken in the fishery. A combination of increasing abundance at older ages (ages 10+) and changes to gillnet fishing regulations within the Canadian EEZ have contributed to a dramatic decline of the relative F at the oldest ages.

Residual graphics from the XSA analysis are presented in Figures 11 a-c. The trends and patterns are similar to those described in previous assessments of this stock: there are trends in the residuals along the cohorts, plus evidence of year-effects in some of the surveys. The mean squared residual (Figure 11a) is largest for ages 7 and 8 in the Canadian spring survey, and ages 1-4 in the EU (0-1400m) index. Temporal trends in the residuals as well as evidence of year-effects in the various surveys are of concern (Figure 11b). Residual bubble plots (Figure 11c) further illustrate the problematic trends – evidence of cohort tracking and year effects, each of which indicate poor model fit.

Retrospective Analysis, Updated Run

A four-year retrospective analysis was conducted to examine the influence of removing successive years' data on the terminal estimates of biomass, fishing mortality and recruitment (Figure 12). Retrospective patterns in stock size and fishing mortality estimates have been problematic in earlier assessments of this stock (see Darby et *al*. 2003; Healey and Mahé, 2008). The retrospective results indicate exploitable biomass appears to have been over-estimated in the previous assessment. The direction of the retrospective pattern has varied over several recent assessments. For example, the 2009 assessment of this stock indicated that exploitable biomass appeared to be under-estimated (Healey and Mahé, 2009). Recruitment estimates for 2004 and 2005 have been revised upwards as additional data is included in the model. Further, revisions of recruitment over the 2000-2002 period are apparent. It is uncommon to have such revisions to cohorts for which several years of index data are available, and this feature highlights some of the inconsistencies in the index data. There are differences in the one-year retrospective estimates of fishing mortality, suggesting an under-estimation of fishing mortality. However, estimates from the one-year to three-year retrospective results are more consistent. The relative difference of the estimated numbers at age and fishing mortality at age (Tables 9 and 10) from the one-year retrospective results give some insight into the structure of the revisions, with substantial change in the estimates at the oldest ages over a series of years in addition to changes evident in several recent cohorts. Values are computed as $(\tau_Y - \tau_{Y-1}) / \tau_{Y-1}$, where $\tau = N_{a,y}$ or $F_{a,y}$ for any age ($1 \leq a \leq 14$) and year ($1975 \leq y \leq 2010$). τ_Y represents estimates from the analysis using all data, and τ_{Y-1} refers to the one-year retrospective estimate, i.e. final year of catch and survey data are excluded.

Robustness - Sensitivity to each tuning index

To evaluate the consistency in estimated stock trends from each survey series, we compare the estimated 5+ biomass, age 1 recruitment and average fishing mortality (Figure 13) from a suite of XSA analyses calibrated using only one survey series. To avoid estimation problems using the 2004-2010 EU 0-1400m series, we produce stock size estimates for the "both EU" run by using both the 0-700m data over 1995-2003, and the 0-1400m data for 2004-2010. Observe that the estimated 5+ biomass from the analysis which includes only the Canadian fall index is almost identical to the results using all data series. This occurs as the ages which make up the majority of the 5+ biomass receive greatest weight from this survey in the "all data" run. There are major differences in the estimated recruitment in the most recent period. The exploitable biomass of the most recent five years is similar for analyses which use only the Canadian spring index or the EU data, because the estimated recruitments over 2000-2004 in these cases are consistent. A comparison of 2011 5+ biomass and 2010 average fishing mortality from these single-index runs is also provided (Figure 14) to highlight the differences at the end of the estimation period.

Run 2 – Excluding ages 1-4 from EU 0-1400m index

There are problems in the residuals for ages 1-4 of the EU 0-1400m index over the duration of this time series, with a continuous shift from large positive to large negative residuals. Consequently, these exacerbate the mean annual residual (refer to Figure 11b) and the mean square residual for these indices is relatively large. Hence we evaluate a second run which excludes these data.

All outputs and diagnostics (Tables 11 -14 and Figures 15 - 18) are also quite similar, though obviously the problematic residual pattern for ages 1-4 the EU 0-1400m index is removed (Figure 18b). Stock trends are virtually identical to results from the update run, with only differences in recruitment over 2007-2010.

A four-year retrospective analysis was also conducted using this set of index data, and results (Tables 15-16 and Figure 19) show the same patterns described in the update run. Though there is some signal of improved recruitment, these will not contribute to the exploitable biomass for another 3 to 4 years. The year-classes which are about to recruit to the exploitable biomass in the next few years are below average and if catches persist at current levels, the stock is likely to decline. The structure of the retrospective pattern (Tables 15-16) is also identical to that from the previous analysis.

As in recent assessments, the XSA diagnostics reveal serious problems in the model fit. The standard errors of the log-scale survey catchability parameters exceed 0.5 at most survey-ages. Further, the survey-specific estimates of survivors indicate some inconsistencies. Residual patterns indicate severe model fit issues, including year and cohort effects, as well as evidence of the conflicting signals in some of the survey information. Retrospective patterns have been poor in recent assessments and although improved with the new data and model settings, the revisions to recruitment estimates from over a decade ago in the last year of the retrospective analysis are also cause for concern. Should these problems continue the reliability of this assessment must be reconsidered. Noting that the XSA provides a way to derive a signal from sometimes conflicting data, this assessment was considered acceptable noting that careful attention must continue to be paid to model diagnostics in future assessments.

Mahé (2011) compares results from XSA with those from a statistical catch at age model (ASAP; from NOAA assessment toolbox) and found that ASAP residuals from the survey index showed similar pattern of conflicting trends as in the XSA, though less pronounced. This was due to predicted catches which showed very high deviations from the observed catch (e.g. up to 60% in the early 2000s).

Yield per Recruit

A yield per recruit analysis using three year averages of weights at age and fishery selection at age was conducted, and $F_{0.1}$=0.22 with F_{max}=0.41. These are quite similar to values computed in the previous assessment (0.21 and 0.39, respectively).

Management Advice

Projections of stock status using assumptions about catches or fishing mortality levels in coming years have typically been conducted as the basis for management advice. For 2012, management advice was provided directly from the HCR adopted by the Fisheries Commission in 2010 (NAFO, 2010b). Full details are provided within the Scientific Council Report (NAFO, 2011).

Conclusion

Estimated stock biomass has shown decreases over 2008-2011, as weaker year-classes have recruited to the biomass, and is currently estimated at about 84 000 tons. The 10+ biomass peaked in 1991 and although it remains well below that peak, it has tripled over 2006-2011, becoming a slightly larger fraction of the total 5+ biomass. Estimates of fishing mortality since the imposition of the rebuilding plan have decreased due to substantial reductions in effort. However, absolute estimates of fishing mortality remain relatively high; Fbar(5-10) in 2010 has increased over the 2009 level and is estimated to be 0.37.

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Table 1. Landings and Total Allowable Catches (all in 000 tons) for Greenland Halibut in Sub-area 2 and Div. 3KLMNO. TACs were set autonomously by Canada until 1994. Since 1995, the TAC has been established by NAFO's Fisheries Commission.

Year		TAC - Canada	TAC - FC	Landings
1960				0.9
1961				0.7
1962				0.6
1963				2
1964				4
1965				10
1966				19
1967				27
1968				32
1969				37
1970				37
1971				25
1972				30
1973				29
1974		40		28
1975		40		28.814
1976		30		24.611
1977		30		32.048
1978		30		39.070
1979		30		34.104
1980		35		32.867
1981		55		30.754
1982		55		26.278
1983		55		27.861
1984		55		26.711
1985		75		20.347
1986		100		17.976
1987		100		32.442
1988		100		19.215
1989		100		20.034
1990		50		47.454
1991		50		65.008
1992		50		63.193
1993		50		62.455
1994		25		51.029
1995			27	15.272
1996			27	18.840
1997			27	19.858
1998			27	19.946
1999			33	24.226
2000			35	34.177
2001			40	38.232
2002			44	34.062
2003			42	35.151
2004	*		20	25.486
2005	*		19	23.255
2006	*		18.5	23.531
2007	*		16	22.747
2008	*		16	21.180
2009	*		16	23.156
2010	*		16	26.174
2011	♦		17.185	

* TAC specified under FC Rebuilding Plan (FC Doc. 03/13).
♦ TAC from Harvest Control Rule (FC Doc. 10/13).

Table 2. Catch numbers at age matrix (in thousands) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total
1975	0	0	0	0	334	2819	5750	4956	3961	1688	702	135	279	288	20912
1976	0	0	0	0	17	610	3231	5413	3769	2205	829	260	101	53	16488
1977	0	0	0	0	534	5012	10798	7346	2933	1013	220	130	116	84	28186
1978	0	0	0	0	2982	8415	8970	7576	2865	1438	723	367	222	258	33816
1979	0	0	0	0	2386	8727	12824	6136	1169	481	287	149	143	284	32586
1980	0	0	0	0	209	2086	9150	9679	5398	3828	1013	128	53	27	31571
1981	0	0	0	0	863	4517	9806	11451	4307	890	256	142	43	69	32344
1982	0	0	0	0	269	2299	6319	5763	3542	1684	596	256	163	191	21082
1983	0	0	0	0	701	3557	9800	7514	2295	692	209	76	106	175	25125
1984	0	0	0	0	902	2324	5844	7682	4087	1259	407	143	106	183	22937
1985	0	0	0	0	1983	5309	5913	3500	1380	512	159	99	87	86	19028
1986	0	0	0	0	280	2240	6411	5091	1469	471	244	140	70	117	16533
1987	0	0	0	0	137	1902	11004	8935	2835	853	384	281	225	349	26905
1988	0	0	0	0	296	3186	8136	4380	1288	465	201	105	107	129	18293
1989	0	0	0	0	181	1988	7480	4273	1482	767	438	267	145	71	17092
1990	0	0	0	95	1102	6758	12632	7557	4072	2692	1204	885	434	318	37749
1991	0	0	0	220	2862	7756	13152	10796	7145	3721	1865	1216	558	422	49713
1992	0	0	0	1064	4180	10922	20639	12205	4332	1762	1012	738	395	335	57584
1993	0	0	0	1010	9570	15928	17716	11918	4642	1836	1055	964	401	182	65222
1994	0	0	0	5395	16500	15815	11142	6739	3081	1103	811	422	320	215	61543
1995	0	0	0	323	1352	2342	3201	2130	1183	540	345	273	251	201	12141
1996	0	0	0	190	1659	5197	6387	1914	956	504	436	233	143	89	17708
1997	0	0	0	335	1903	4169	7544	3215	1139	606	420	246	137	89	19803
1998	0	0	0	552	3575	5407	5787	3653	1435	541	377	161	92	51	21631
1999	0	0	0	297	2149	5625	8611	3793	1659	623	343	306	145	151	23702
2000	0	0	0	271	2029	12583	21175	3299	973	528	368	203	129	104	41662
2001	0	0	0	448	2239	12163	22122	5154	1010	495	439	203	156	75	44504
2002	0	0	0	479	1662	7239	17581	6607	1244	659	360	224	126	81	36262
2003	0	0	0	1279	4491	10723	16764	6385	1614	516	290	144	76	85	42367
2004	0	0	0	897	4062	8236	10542	4126	1307	529	289	184	87	75	30334
2005	0	0	0	534	1652	5999	10313	3996	1410	444	244	114	64	46	24816
2006	0	0	0	216	1869	6450	12144	4902	1089	372	136	47	32	40	27295
2007	0	0	0	88	570	3732	11912	5414	1230	472	163	80	41	29	23731
2008	0	0	0	29	448	3312	10697	5558	1453	393	115	46	26	15	22092
2009	0	0	0	61	476	3121	8801	7276	1949	508	206	67	31	34	22530
2010	0	0	0	146	825	5077	11202	6171	2134	520	214	64	22	21	26396

Table 3. Catch weights-at-age (kg) matrix for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1975	0.000	0.000	0.126	0.244	0.609	0.760	0.955	1.190	1.580	2.210	2.700	3.370	3.880	5.764
1976	0.000	0.000	0.126	0.244	0.609	0.760	0.955	1.190	1.580	2.210	2.700	3.370	3.880	5.144
1977	0.000	0.000	0.126	0.244	0.609	0.760	0.955	1.190	1.580	2.210	2.700	3.370	3.880	5.992
1978	0.000	0.000	0.126	0.244	0.609	0.760	0.955	1.190	1.580	2.210	2.700	3.370	3.880	5.894
1979	0.000	0.000	0.126	0.244	0.609	0.760	0.955	1.190	1.580	2.210	2.700	3.370	3.880	6.077
1980	0.000	0.000	0.126	0.244	0.514	0.659	0.869	1.050	1.150	1.260	1.570	2.710	3.120	5.053
1981	0.000	0.000	0.126	0.244	0.392	0.598	0.789	0.985	1.240	1.700	2.460	3.510	4.790	7.426
1982	0.000	0.000	0.126	0.244	0.525	0.684	0.891	1.130	1.400	1.790	2.380	3.470	4.510	7.359
1983	0.000	0.000	0.126	0.244	0.412	0.629	0.861	1.180	1.650	2.230	3.010	3.960	5.060	7.061
1984	0.000	0.000	0.126	0.244	0.377	0.583	0.826	1.100	1.460	1.940	2.630	3.490	4.490	7.016
1985	0.000	0.000	0.126	0.244	0.568	0.749	0.941	1.240	1.690	2.240	2.950	3.710	4.850	7.010
1986	0.000	0.000	0.126	0.244	0.350	0.584	0.811	1.100	1.580	2.120	2.890	3.890	4.950	7.345
1987	0.000	0.000	0.126	0.244	0.364	0.589	0.836	1.160	1.590	2.130	2.820	3.600	4.630	6.454
1988	0.000	0.000	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	0.000	0.000	0.126	0.244	0.400	0.561	0.767	1.082	1.657	2.237	2.997	3.862	4.919	6.370
1990	0.000	0.000	0.090	0.181	0.338	0.546	0.766	1.119	1.608	2.173	2.854	3.731	4.691	6.391
1991	0.000	0.000	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	0.000	0.000	0.175	0.289	0.430	0.577	0.793	1.234	1.816	2.462	3.122	3.972	5.099	6.648
1993	0.000	0.000	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	0.000	0.000	0.080	0.196	0.330	0.514	0.788	1.179	1.701	2.268	2.990	3.766	4.882	6.348
1995	0.000	0.000	0.080	0.288	0.363	0.531	0.808	1.202	1.759	2.446	3.122	3.813	4.893	6.790
1996	0.000	0.000	0.161	0.242	0.360	0.541	0.832	1.272	1.801	2.478	3.148	3.856	4.953	6.312
1997	0.000	0.000	0.120	0.206	0.336	0.489	0.771	1.159	1.727	2.355	3.053	3.953	5.108	6.317
1998	0.000	0.000	0.119	0.228	0.373	0.543	0.810	1.203	1.754	2.351	3.095	4.010	5.132	6.124
1999	0.000	0.000	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	0.000	0.000	0.000	0.254	0.346	0.524	0.787	1.192	1.774	2.279	2.895	3.645	4.486	5.531
2001	0.000	0.000	0.000	0.249	0.376	0.570	0.830	1.168	1.794	2.367	2.950	3.715	4.585	5.458
2002	0.000	0.000	0.217	0.251	0.369	0.557	0.841	1.193	1.760	2.277	2.896	3.579	4.407	5.477
2003	0.000	0.000	0.188	0.247	0.389	0.564	0.822	1.199	1.651	2.166	2.700	3.404	4.377	5.409
2004	0.000	0.000	0.180	0.249	0.376	0.535	0.808	1.196	1.629	2.146	2.732	3.538	4.381	5.698
2005	0.000	0.000	0.252	0.301	0.396	0.564	0.849	1.247	1.691	2.177	2.705	3.464	4.264	5.224
2006	0.000	0.000	0.129	0.267	0.405	0.605	0.815	1.092	1.495	1.874	2.396	3.139	3.747	4.701
2007	0.000	0.000	0.000	0.276	0.389	0.581	0.833	1.137	1.500	1.948	2.607	3.057	3.869	4.954
2008	0.000	0.000	0.000	0.278	0.404	0.617	0.891	1.195	1.605	2.038	2.804	3.247	4.232	4.721
2009	0.000	0.000	0.000	0.279	0.390	0.599	0.862	1.158	1.611	2.099	2.549	3.118	3.432	4.431
2010	0.000	0.000	0.000	0.250	0.347	0.567	0.844	1.212	1.650	2.101	2.605	3.305	4.181	5.217

Table 4. Survey data (mean numbers per tow) used to calibrate XSA analyses of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO.

2J3K Fall	1	2	3	4	5	6	7	8	9	10	11	12	13
1996	98.68	47.82	32.01	9.54	6.28	2.47	0.84	0.19	0.18	0.04	0.02	0.01	0.02
1997	28.05	58.62	43.61	21.13	10.37	5.01	2.00	0.64	0.20	0.06	0.03	0.02	0.01
1998	23.35	25.07	31.19	21.87	10.86	4.45	2.07	0.57	0.13	0.06	0.03	0.02	0.01
1999	15.99	34.42	24.07	28.28	20.04	10.53	3.81	0.70	0.14	0.07	0.02	0.01	0.03
2000	38.57	21.94	16.43	13.20	13.76	7.21	2.16	0.50	0.06	0.03	0.02	0.00	0.00
2001	43.90	22.72	17.00	14.07	9.77	7.59	3.40	0.69	0.11	0.02	0.01	0.00	0.01
2002	40.67	24.08	12.50	9.68	6.03	1.97	0.72	0.19	0.04	0.01	0.00	0.00	0.00
2003	45.70	26.67	11.69	9.49	6.39	2.27	0.89	0.27	0.04	0.02	0.01	0.01	0.00
2004	32.49	32.93	13.89	12.31	9.21	2.68	1.20	0.36	0.08	0.03	0.01	0.00	0.01
2005	16.06	16.15	8.56	13.84	10.98	6.85	3.96	0.66	0.12	0.03	0.03	0.01	0.01
2006	32.34	17.98	8.50	17.60	13.03	9.11	4.18	1.15	0.18	0.03	0.02	0.01	0.00
2007	32.61	14.51	12.81	18.77	9.57	10.35	6.17	2.14	0.34	0.08	0.04	0.02	0.01
2008	**Survey not completed**												
2009	50.62	19.15	11.40	8.42	9.89	5.40	3.59	1.39	0.25	0.08	0.02	0.01	0.01
2010	50.94	39.25	14.81	9.45	6.74	3.77	2.20	1.02	0.18	0.07	0.04	0.02	0.01

EU 3M (0-700m)	1	2	3	4	5	6	7	8	9	10	11	12
1995	12.41	2.54	2.23	1.91	2.66	5.10	3.77	2.12	1.31	0.26	0.07	0.02
1996	5.84	7.97	2.42	3.04	4.20	5.82	2.49	1.62	0.42	0.09	0.03	0.04
1997	3.33	3.78	6.00	6.50	7.11	8.46	4.99	2.15	0.66	0.22	0.03	0.02
1998	2.74	2.13	7.69	11.00	12.33	11.30	7.84	2.62	0.75	0.20	0.03	0.01
1999	1.06	0.70	3.01	10.47	13.41	12.58	5.55	1.82	0.35	0.10	0.01	0.00
2000	3.75	0.29	0.60	2.17	7.09	14.10	5.40	2.32	0.45	0.11	0.05	0.00
2001	8.03	1.43	1.81	0.99	2.79	7.79	6.63	3.21	0.18	0.05	0.01	0.00
2002	4.08	2.94	2.80	1.67	3.79	5.59	5.73	1.28	0.13	0.06	0.02	0.01
2003	2.20	1.00	0.61	1.51	2.48	2.94	1.93	0.47	0.13	0.10	0.02	0.01

EU 3M (0-1400m)	1	2	3	4	5	6	7	8	9	10	11	12	13
2004	1.40	2.19	2.92	1.54	6.80	9.16	4.95	1.46	0.73	0.37	0.26	0.16	0.15
2005	0.36	0.53	2.09	1.73	5.28	6.79	3.42	0.98	0.26	0.41	0.23	0.13	0.06
2006	0.45	0.26	0.44	0.91	5.85	8.56	4.68	1.39	0.42	0.36	0.30	0.15	0.05
2007	0.25	0.05	0.39	0.29	3.84	9.09	8.57	2.88	0.72	0.59	0.30	0.17	0.07
2008	0.13	0.07	0.10	0.16	2.03	9.00	12.53	3.18	1.14	0.87	0.44	0.25	0.13
2009	0.05	0.01	0.03	0.08	1.13	6.80	11.43	3.54	0.93	1.03	0.36	0.28	0.25
2010	0.03	0.01	0.02	0.11	2.00	6.01	7.83	2.50	0.98	0.83	0.31	0.17	0.12

3LNO Spr	1	2	3	4	5	6	7	8
1996	1.62	4.24	4.60	2.18	0.83	0.28	0.06	0.00
1997	1.16	3.92	5.16	3.23	1.46	0.51	0.10	0.01
1998	0.22	0.81	3.85	6.19	4.96	1.24	0.33	0.07
1999	0.29	0.55	1.15	1.98	3.39	1.09	0.24	0.05
2000	0.79	1.07	1.07	1.51	1.95	2.04	0.56	0.03
2001	0.57	0.71	0.74	0.68	0.80	0.72	0.28	0.02
2002	0.64	0.57	0.60	0.58	0.61	0.21	0.05	0.01
2003	0.93	2.14	1.66	1.57	1.06	0.21	0.05	0.01
2004	0.66	0.57	1.18	1.18	1.16	0.26	0.04	0.02
2005	0.35	0.31	1.09	0.95	1.37	0.82	0.21	0.03
2006	**Survey not completed**							
2007	1.60	0.52	0.80	0.40	1.41	1.49	1.12	0.18
2008	0.44	0.77	0.96	0.71	1.25	0.75	0.64	0.28
2009	0.27	0.22	0.19	0.39	0.45	0.26	0.13	0.07
2010	0.77	0.66	0.52	0.40	0.84	1.08	0.35	0.14

Table 5a. XSA Settings, update run.

Lowestoft VPA Version 3.1
4/06/2011 10:37

Extended Survivors Analysis

G. halibut SA2+3KLMNO Index file: (Combined sexes with plus group).

CPUE data from file GhalTUN2011.txt

Catch data for 36 years. 1975 to 2010. Ages 1 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU3M_0_	1995	2010	1	12	0.5	0.6
F2J3K	1996	2010	1	13	0.8	1
S3LNO	1996	2010	1	8	0.3	0.45
EU3M_0_	2004	2010	1	13	0.5	0.6

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 :

Terminal year survivor estimates shrunk towards the mean F of the final 3 years.
S.E. of the mean to which the estimates are shrunk = 1.000

Oldest age survivor estimates for the years 1975 to 2010
shrunk towards1.000 * the mean F of ages 10 - 12

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population estimates from each cohort age = .500

Individual fleet weighting not applied

Tuning converged after 56 iterations

Table 5b. XSA diagnostics and results, update run.

Fleet : EU3M_0_700

Age	1995	1996	1997	1998	1999	2000
1	0.85	0.24	-0.13	-0.19	-1.19	0
2	0.29	1.24	0.63	0.26	-0.73	-1.64
3	0.39	-0.06	0.66	1.04	0.3	-1.18
4	0.02	0.32	0.55	0.89	0.97	-0.4
5	-0.38	0.26	0.62	0.64	0.52	0.02
6	0.01	-0.01	0.54	0.67	0.21	0.17
7	0.24	-0.46	0.15	0.75	0.36	-0.06
8	0.22	-0.02	0.14	0.3	0.14	0.38
9	1.07	-0.03	0.47	0.61	-0.12	0.31
10	0.55	-0.51	0.47	0.44	-0.1	0.06
11	0.81	-0.14	-0.02	0.23	-1.12	1
12	0.03	0.77	0.22	-0.91	-1.53	99.99
13	No data for this fleet at this age					

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.77	0.07	-0.42	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	-0.13	0.59	-0.51	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	-0.12	0.24	-1.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	-1.05	-0.57	-0.74	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-0.71	-0.27	-0.71	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	-0.27	-0.44	-0.86	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	-0.01	-0.04	-0.93	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	0.64	-0.44	-1.34	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	-0.62	-0.83	-0.86	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10	-0.76	-0.43	0.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
11	-1.09	0.13	0.2	99.99	99.99	99.99	99.99	99.99	99.99	99.99
12	99.99	-0.06	-0.53	99.99	99.99	99.99	99.99	99.99	99.99	99.99
13	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9	10
Mean Log	-10.2824	-10.9124	-10.4162	-9.8361	-9.0484	-8.2875	-7.9998	-8.0173	-8.8339	-9.4647
S.E(Log q	0.6136	0.8616	0.7817	0.7319	0.5421	0.4787	0.4831	0.5838	0.6761	0.4803

Age	11	12
Mean Log	-10.5549	-10.5549
S.E(Log q	0.7264	0.8282

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.27	2.369	11.34	0.6	9	0.13	-10.28
2	0.18	3.446	11.45	0.72	9	0.1	-10.91
3	0.43	0.977	10.93	0.3	9	0.34	-10.42
4	0.5	1.108	10.46	0.41	9	0.36	-9.84
5	0.84	0.27	9.32	0.3	9	0.49	-9.05
6	1.84	-0.925	6.42	0.15	9	0.89	-8.29
7	1.97	-1.195	6.04	0.18	9	0.92	-8
8	-1.32	-1.681	10.46	0.07	9	0.69	-8.02
9	0.22	2.26	8.35	0.54	9	0.12	-8.83
10	0.56	0.827	8.65	0.34	9	0.28	-9.46
11	0.9	0.089	10.21	0.1	9	0.7	-10.55
12	0.73	0.37	9.69	0.27	7	0.6	-10.84

Table 5b. XSA diagnostics and results, update run (cont.).

Fleet : F2J3K

Age	1995	1996	1997	1998	1999	2000
1	99.99	0.66	-0.4	-0.45	-0.88	-0.07
2	99.99	0.1	0.43	-0.22	0.23	-0.26
3	99.99	0.4	0.52	0.32	0.26	0.01
4	99.99	-0.1	0.17	0.01	0.4	-0.16
5	99.99	0	0.33	-0.14	0.25	0.01
6	99.99	-0.44	0.44	0.17	0.43	-0.06
7	99.99	-0.8	0	0.16	0.8	-0.02
8	99.99	-1.1	0.04	-0.11	0.36	0
9	99.99	0.14	0.36	-0.03	0.09	-0.59
10	99.99	-0.37	0.04	0.2	0.54	-0.3
11	99.99	-0.2	0.13	0.06	-0.14	-0.23
12	99.99	-0.37	0.28	0.16	-0.76	-1.23
13	99.99	0.26	-0.12	0.2	0.87	99.99

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.06	-0.04	0.21	0.09	-0.39	0.35	0.25	99.99	0.42	0.2
2	-0.3	-0.24	-0.16	0.18	-0.32	0.03	-0.15	99.99	0.23	0.46
3	0	-0.38	-0.45	-0.3	-0.65	-0.44	0.2	99.99	0.02	0.49
4	0.04	-0.38	-0.46	-0.21	-0.11	0.25	0.53	99.99	0	0.01
5	-0.12	-0.48	-0.4	-0.11	0.01	0.16	-0.05	99.99	0.44	0.1
6	0.15	-1.06	-0.64	-0.53	0.23	0.46	0.49	99.99	0.17	0.17
7	0.25	-1.23	-0.78	-0.4	0.63	0.49	0.77	99.99	0.04	0.1
8	0.35	-1.07	-0.6	-0.31	0.38	0.8	1.12	99.99	0.24	-0.1
9	-0.05	-0.9	-0.88	-0.09	0.27	0.65	1.14	99.99	0.28	-0.39
10	-0.46	-0.94	-0.46	0.2	0.25	0	1.02	99.99	0.3	-0.02
11	-0.14	-1.35	-0.38	-0.56	0.89	0.51	0.97	99.99	0.2	0.24
12	-0.85	99.99	-0.3	-0.5	0.58	0.3	0.93	99.99	-0.3	0.13
13	0.5	-0.27	-0.36	0.68	0.73	99.99	0.61	99.99	0.03	-0.48

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9	10
Mean Log	-7.8065	-7.9049	-8.2221	-8.1998	-8.2968	-8.5701	-8.5006	-8.8737	-9.6844	-10.235
S.E(Log q	0.4095	0.2721	0.3854	0.2755	0.2541	0.4821	0.6129	0.6321	0.563	0.4881

Age	11	12	13
Mean Log	-10.378	-10.378	-10.378
S.E(Log q	0.5887	0.6318	0.5155

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.01	-0.013	7.78	0.26	14	0.43	-7.81
2	0.99	0.043	7.94	0.56	14	0.28	-7.9
3	0.95	0.141	8.37	0.4	14	0.38	-8.22
4	1.04	-0.13	8.09	0.47	14	0.3	-8.2
5	1.31	-0.987	7.52	0.46	14	0.33	-8.3
6	1.1	-0.18	8.37	0.21	14	0.55	-8.57
7	1.23	-0.284	8.13	0.11	14	0.78	-8.5
8	0.77	0.448	8.95	0.23	14	0.5	-8.87
9	1.15	-0.205	9.9	0.13	14	0.67	-9.68
10	1.25	-0.365	10.91	0.15	14	0.63	-10.23
11	1.67	-0.754	12.7	0.09	14	1	-10.38
12	2.87	-1.406	18.35	0.05	13	1.69	-10.53
13	0.95	0.151	9.95	0.49	12	0.46	-10.16

Table 5b. XSA diagnostics and results, update run (cont.).

Fleet : S3LNO

Age	1995	1996	1997	1998	1999	2000
1	99.99	0.59	0.46	-1.08	-0.84	0.09
2	99.99	1.14	1.2	-0.18	-0.43	0.18
3	99.99	1.08	1.01	0.85	-0.16	-0.1
4	99.99	0.93	0.79	1.25	0.25	0.17
5	99.99	-0.01	0.39	1.09	0.51	0.09
6	99.99	-0.51	0.26	0.99	0.3	0.75
7	99.99	-0.88	-0.42	0.93	0.56	0.92
8	99.99	-3.14	-0.73	0.94	0.75	0.29
9	No data for this fleet at this age					
10	No data for this fleet at this age					
11	No data for this fleet at this age					
12	No data for this fleet at this age					
13	No data for this fleet at this age					

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	-0.25	-0.14	0.35	0.24	-0.16	99.99	1.28	0.2	-0.79	0.05
2	-0.29	-0.51	0.78	-0.4	-0.81	99.99	-0.02	0.28	-0.77	-0.16
3	-0.51	-0.79	0.22	-0.14	-0.09	99.99	0.05	0.27	-1.45	-0.24
4	-0.5	-0.69	0.23	-0.05	-0.3	99.99	-0.82	0	-0.58	-0.66
5	-0.6	-0.74	-0.21	-0.18	-0.04	99.99	0.08	0.18	-0.61	0.06
6	-0.15	-1.2	-1.02	-0.81	0.23	99.99	0.72	0.14	-0.71	1
7	0.1	-1.51	-1.3	-1.31	0.2	99.99	1.63	0.9	-0.58	0.76
8	-0.13	-1.64	-1.26	-0.19	0.09	99.99	1.68	1.97	0.32	1.05
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									
13	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8
Mean Log	-11.9546	-11.4788	-10.9485	-10.8073	-10.4513	-10.8886	-11.4868	-12.3883
S.E(Log q	0.6211	0.6491	0.6873	0.6475	0.4813	0.7445	1.0022	1.3633

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.54	-0.514	12.18	0.07	14	0.98	-11.95
2	0.44	2.497	11.41	0.62	14	0.24	-11.48
3	0.49	1.984	11.06	0.55	14	0.3	-10.95
4	0.46	2.156	10.9	0.57	14	0.27	-10.81
5	0.67	1.111	10.55	0.48	14	0.32	-10.45
6	1.22	-0.229	10.97	0.08	14	0.94	-10.89
7	0.87	0.138	11.32	0.09	14	0.91	-11.49
8	0.32	1.624	10.24	0.32	14	0.41	-12.39

Table 5b. XSA diagnostics and results, update run (cont.).

Fleet : EU3M_0_1400

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	99.99	99.99	99.99	1.88	0.75	1.01	0.33	-0.12	-1.59	-2.27
2	99.99	99.99	99.99	2.86	1.66	1.18	-0.46	-0.28	-2.17	-2.79
3	99.99	99.99	99.99	2	1.8	0.46	0.57	-0.78	-1.97	-2.08
4	99.99	99.99	99.99	1.12	1.21	0.7	-0.22	-0.57	-1.22	-1.02
5	99.99	99.99	99.99	0.56	0.27	0.35	0.04	-0.38	-0.73	-0.12
6	99.99	99.99	99.99	0.2	-0.23	-0.06	-0.06	0.03	-0.03	0.16
7	99.99	99.99	99.99	-0.04	-0.54	-0.41	0.1	0.29	0.27	0.32
8	99.99	99.99	99.99	0	-0.33	-0.14	0.33	0.26	0.12	-0.23
9	99.99	99.99	99.99	0.41	-0.61	-0.14	0.26	0.36	-0.02	-0.26
10	99.99	99.99	99.99	-0.2	-0.09	-0.24	0.24	0.4	0.14	-0.25
11	99.99	99.99	99.99	0.15	0	0.1	0.06	0.42	-0.05	-0.69
12	99.99	99.99	99.99	0.14	0.22	0.07	-0.03	0.25	0.34	-0.38
13	99.99	99.99	99.99	0.56	-0.13	-0.18	-0.35	0.06	0.59	-0.16

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9	10
Mean Log	-12.8149	-13.3605	-12.1482	-11.6797	-9.3753	-8.2459	-7.7887	-8.1138	-8.3049	-7.6452
S.E(Log q	1.4654	2.0433	1.6635	1.0086	0.4495	0.1462	0.3508	0.2495	0.3737	0.2596

Age	11	12	13
Mean Log	-7.5942	-7.5942	-7.5942
S.E(Log q	0.3386	0.257	0.3793

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	-0.36	-1.874	10.76	0.28	7	0.44	-12.81
2	0.22	0.915	11.58	0.21	7	0.45	-13.36
3	0.16	3.558	11.11	0.78	7	0.15	-12.15
4	0.21	10.251	11	0.97	7	0.05	-11.68
5	0.41	3.322	10.14	0.87	7	0.11	-9.38
6	1.66	-1.415	6.74	0.48	7	0.23	-8.25
7	0.54	0.904	8.89	0.44	7	0.19	-7.79
8	0.78	0.804	8.39	0.73	7	0.2	-8.11
9	1.12	-0.224	8.31	0.41	7	0.46	-8.3
10	1.05	-0.127	7.66	0.57	7	0.3	-7.65
11	-65.36	-4.331	-51.08	0	7	11.12	-7.59
12	2.17	-1.322	9.2	0.2	7	0.49	-7.51
13	0.64	1.059	6.81	0.64	7	0.24	-7.54

Table 5b. XSA diagnostics and results, update run (cont.). Note estimates are for 2010, which are projected forward to 2011 using 2010 catch-at-age.

Age 1 Catchability constant w.r.t. time and dependent on age

Year class = 2009

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	122653	0.5	0	0	1	0.586	0
S3LNO	105687	0.643	0	0	1	0.354	0
EU3M_0_	10416	1.567	0	0	1	0.06	0
F shrinka	0	1				0	0

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
100426	0.38	0.41	3	1.063	0

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 2008

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	102008	0.354	0.022	0.06	2	0.604	0
S3LNO	40332	0.465	0.313	0.67	2	0.35	0
EU3M_0_	8967	1.273	0.568	0.45	2	0.047	0
F shrinka	0	1				0	0

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
65845	0.27	0.29	6	1.073	0

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 2007

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	47442	0.354	0.13	0.37	2	0.515	0
S3LNO	25709	0.389	0.289	0.74	3	0.425	0
EU3M_0_	9572	1.035	0.701	0.68	3	0.06	0
F shrinka	0	1				0	0

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
33210	0.25	0.22	8	0.849	0

Table 5b. XSA diagnostics and results, update run (cont.).

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	36609	0.289	0.08	0.28	3	0.508	0.004
S3LNO	31072	0.336	0.588	1.75	4	0.374	0.004
EU3M_0_	15097	0.747	0.442	0.59	4	0.076	0.009
F shrinka	84125	1				0.042	0.002

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
33352	0.21	0.22	12	1.068	0.004

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	25704	0.25	0.106	0.42	4	0.481	0.029
S3LNO	22577	0.31	0.169	0.54	4	0.313	0.033
EU3M_0_	18596	0.415	0.265	0.64	5	0.174	0.039
F shrinka	51992	1				0.031	0.014

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
23842	0.17	0.1	14	0.567	0.031

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	17475	0.224	0.136	0.61	5	0.461	0.233
S3LNO	14681	0.285	0.255	0.89	5	0.283	0.272
EU3M_0_	12959	0.32	0.235	0.74	6	0.226	0.303
F shrinka	41810	1				0.03	0.104

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
15959	0.15	0.12	17	0.76	0.253

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	9036	0.211	0.147	0.7	6	0.429	0.752
S3LNO	7249	0.273	0.246	0.9	6	0.255	0.875
EU3M_0_	9432	0.27	0.19	0.71	7	0.27	0.73
F shrinka	15964	1				0.046	0.492

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
8869	0.14	0.11	20	0.736	0.762

Table 5b. XSA diagnostics and results, update run (cont.).

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	4940	0.647	0	0	1	0.036	0.756
F2J3K	7364	0.204	0.12	0.59	7	0.399	0.564
S3LNO	7835	0.272	0.152	0.56	7	0.212	0.538
EU3M_0_	8150	0.246	0.173	0.7	7	0.309	0.522
F shrinka	5727	1				0.044	0.681

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
7507	0.13	0.08	23	0.574	0.556

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	3464	0.527	0.272	0.52	2	0.038	0.443
F2J3K	3660	0.213	0.109	0.51	8	0.406	0.424
S3LNO	4968	0.293	0.193	0.66	7	0.132	0.328
EU3M_0_	4083	0.249	0.145	0.58	7	0.37	0.387
F shrinka	3096	1				0.055	0.485

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
3923	0.14	0.07	25	0.503	0.4

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	2109	0.444	0.64	1.44	3	0.03	0.201
F2J3K	1965	0.247	0.093	0.38	9	0.409	0.215
S3LNO	2196	0.272	0.296	1.09	7	0.091	0.194
EU3M_0_	1775	0.256	0.095	0.37	7	0.416	0.235
F shrinka	1118	1				0.053	0.351

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1850	0.16	0.07	27	0.469	0.227

Table 5b. XSA diagnostics and results, update run (cont.).

Age 11 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	898	0.385	0.207	0.54	4	0.027	0.195
F2J3K	1303	0.263	0.111	0.42	10	0.377	0.139
S3LNO	1073	0.267	0.239	0.89	7	0.063	0.166
EU3M_0_	928	0.246	0.187	0.76	7	0.483	0.19
F shrinka	682	1				0.051	0.25

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1047	0.16	0.09	29	0.52	0.17

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	191	0.319	0.226	0.71	5	0.022	0.264
F2J3K	557	0.295	0.148	0.5	11	0.334	0.099
S3LNO	297	0.256	0.157	0.61	7	0.037	0.178
EU3M_0_	415	0.244	0.125	0.51	7	0.553	0.131
F shrinka	312	1				0.054	0.17

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
437	0.18	0.08	31	0.444	0.124

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	130	0.27	0.161	0.6	6	0.017	0.142
F2J3K	249	0.272	0.18	0.66	12	0.324	0.077
S3LNO	133	0.268	0.156	0.58	8	0.021	0.139
EU3M_0_	289	0.231	0.106	0.46	7	0.484	0.067
F shrinka	105	0.5				0.154	0.174

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
228	0.16	0.1	34	0.597	0.076

Table 6. XSA estimated numbers at age (000s), updated run.

	Age													
N@A(XSA)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**
1975	112301	126284	110156	66817	53823	31895	23092	14337	9312	3931	1773	415	720	735
1976	116683	91945	103393	90188	54705	43765	23562	13703	7254	4040	1691	816	218	113
1977	107538	95532	75278	84651	73839	44773	35280	16368	6321	2529	1313	635	433	311
1978	82406	88044	78215	61632	69306	59971	32122	19114	6754	2521	1154	876	402	459
1979	99060	67468	72085	64037	50460	54045	41486	18183	8794	2937	763	290	385	756
1980	130190	81103	55238	59018	52429	39154	36352	22362	9335	6142	1970	365	103	52
1981	131941	106591	66402	45225	48320	42736	30169	21483	9551	2758	1565	696	183	292
1982	131269	108024	87269	54365	37027	38780	30902	15828	7228	3922	1453	1050	441	512
1983	146782	107474	88443	71450	44510	30072	29670	19583	7744	2712	1688	650	628	1031
1984	153922	120175	87992	72411	58498	35808	21402	15424	9234	4264	1595	1193	464	795
1985	167467	126021	98391	72042	59285	47078	27214	12235	5678	3862	2352	937	847	834
1986	187194	137110	103177	80556	58983	46744	33741	16931	6850	3400	2699	1782	678	1129
1987	156208	153262	112256	84474	65954	48038	36244	21824	9255	4279	2357	1989	1332	2055
1988	128625	127892	125480	91908	69162	53874	37609	19717	9783	5012	2732	1582	1374	1651
1989	112774	105310	104709	102734	75248	56357	41226	23430	12180	6844	3683	2055	1201	586
1990	107643	92332	86220	85729	84112	61444	44342	26985	15316	8631	4909	2619	1441	1047
1991	94360	88131	75595	70591	70103	67868	44191	24875	15255	8856	4631	2930	1344	1004
1992	71202	77256	72155	61892	57596	54806	48548	24280	10597	6025	3883	2104	1299	1092
1993	83968	58295	63252	59076	49710	43373	34988	21072	8835	4756	3338	2264	1055	474
1994	142586	68747	47728	51786	47453	32040	21099	12616	6469	3034	2233	1779	981	653
1995	172346	116740	56285	39076	37517	23922	11922	7193	4231	2508	1486	1094	1074	855
1996	150489	141105	95578	46082	31701	29493	17466	6864	3962	2394	1565	904	649	401
1997	123428	123210	115527	78253	37557	24453	19445	8521	3888	2378	1504	887	529	341
1998	108192	101054	100876	94586	63765	29027	16248	9094	4067	2153	1399	851	504	278
1999	113066	88580	82736	82590	76941	48972	18873	8067	4140	2032	1273	804	551	570
2000	121956	92570	72523	67739	67350	61049	35005	7660	3172	1888	1100	732	382	305
2001	121681	99849	75790	59377	55214	53306	38597	9500	3287	1717	1068	567	416	198
2002	124158	99624	81749	62052	48208	43180	32638	11584	3114	1777	958	477	281	178
2003	108918	101652	81565	66931	50370	37966	28803	10813	3506	1424	859	458	188	208
2004	87723	89174	83226	66780	53641	37176	21381	8413	3076	1410	699	441	245	209
2005	69466	71822	73010	68140	53863	40242	22985	7967	3155	1336	676	311	194	138
2006	66960	56874	58802	59775	55305	42605	27519	9487	2907	1307	692	332	151	188
2007	74520	54822	46564	48143	48745	43589	29046	11543	3332	1395	733	443	230	162
2008	60512	61012	44884	38124	39337	39393	32310	13002	4551	1615	715	453	291	167
2009	98229	49543	49952	36748	31187	31801	29255	16775	5616	2412	966	481	329	360
2010	122659	80423	40563	40897	30032	25103	23212	15989	7150	2835	1515	605	333	317
2011		100426	65845	33210	33352	23842	15959	8869	7507	3923	1850	1047	437	494

Table 7. XSA estimated fishing mortality at age, updated run. (Average fishing mortality is computed over ages 5-10.)

	Age														
F@A(XSA)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**	**Fbar(5-10)**
1975	0	0	0	0.000	0.007	0.103	0.322	0.481	0.635	0.644	0.576	0.446	0.560	0.560	0.365
1976	0	0	0	0.000	0.000	0.016	0.164	0.574	0.854	0.924	0.780	0.434	0.720	0.720	0.422
1977	0	0	0	0.000	0.008	0.132	0.413	0.685	0.719	0.585	0.205	0.257	0.351	0.351	0.424
1978	0	0	0	0.000	0.049	0.169	0.369	0.576	0.633	0.995	1.179	0.622	0.943	0.943	0.465
1979	0	0	0	0.000	0.054	0.197	0.418	0.467	0.159	0.200	0.537	0.837	0.529	0.529	0.249
1980	0	0	0	0.000	0.004	0.061	0.326	0.651	1.019	1.167	0.840	0.490	0.841	0.841	0.538
1981	0	0	0	0.000	0.020	0.124	0.445	0.889	0.690	0.441	0.199	0.256	0.300	0.300	0.435
1982	0	0	0	0.000	0.008	0.068	0.256	0.515	0.780	0.643	0.604	0.314	0.525	0.525	0.378
1983	0	0	0	0.000	0.018	0.140	0.454	0.552	0.397	0.331	0.147	0.138	0.207	0.207	0.315
1984	0	0	0	0.000	0.017	0.074	0.359	0.799	0.672	0.395	0.331	0.142	0.291	0.291	0.386
1985	0	0	0	0.000	0.038	0.133	0.275	0.380	0.313	0.158	0.078	0.124	0.121	0.121	0.216
1986	0	0	0	0.000	0.005	0.054	0.236	0.404	0.271	0.166	0.105	0.091	0.121	0.121	0.189
1987	0	0	0	0.000	0.002	0.045	0.409	0.602	0.413	0.249	0.199	0.170	0.207	0.207	0.287
1988	0	0	0	0.000	0.005	0.068	0.273	0.282	0.157	0.108	0.085	0.076	0.090	0.090	0.149
1989	0	0	0	0.000	0.003	0.040	0.224	0.225	0.144	0.132	0.141	0.155	0.143	0.143	0.128
1990	0	0	0	0.001	0.015	0.130	0.378	0.370	0.348	0.423	0.316	0.468	0.405	0.405	0.277
1991	0	0	0	0.004	0.046	0.135	0.399	0.653	0.729	0.624	0.589	0.614	0.614	0.614	0.431
1992	0	0	0	0.019	0.084	0.249	0.635	0.811	0.601	0.390	0.340	0.491	0.410	0.410	0.462
1993	0	0	0	0.019	0.239	0.521	0.820	0.981	0.869	0.556	0.430	0.636	0.545	0.545	0.664
1994	0	0	0	0.122	0.485	0.789	0.876	0.892	0.747	0.514	0.513	0.304	0.447	0.447	0.717
1995	0	0	0	0.009	0.041	0.115	0.352	0.396	0.370	0.272	0.297	0.323	0.299	0.299	0.257
1996	0	0	0	0.005	0.060	0.217	0.518	0.368	0.310	0.265	0.368	0.335	0.279	0.279	0.290
1997	0	0	0	0.005	0.058	0.209	0.560	0.540	0.391	0.331	0.369	0.366	0.337	0.337	0.348
1998	0	0	0	0.007	0.064	0.231	0.500	0.587	0.494	0.325	0.354	0.235	0.226	0.226	0.367
1999	0	0	0	0.004	0.031	0.136	0.702	0.733	0.585	0.414	0.354	0.546	0.343	0.343	0.434
2000	0	0	0	0.004	0.034	0.259	1.104	0.646	0.414	0.370	0.462	0.366	0.468	0.468	0.471
2001	0	0	0	0.008	0.046	0.291	1.004	0.915	0.415	0.384	0.605	0.503	0.536	0.536	0.509
2002	0	0	0	0.009	0.039	0.205	0.905	0.995	0.583	0.527	0.537	0.731	0.685	0.685	0.542
2003	0	0	0	0.021	0.104	0.374	1.031	1.057	0.711	0.512	0.467	0.426	0.591	0.591	0.631
2004	0	0	0	0.015	0.087	0.281	0.787	0.781	0.634	0.536	0.611	0.619	0.498	0.498	0.518
2005	0	0	0	0.009	0.035	0.180	0.685	0.808	0.681	0.458	0.509	0.520	0.453	0.453	0.474
2006	0	0	0	0.004	0.038	0.183	0.669	0.846	0.535	0.378	0.245	0.170	0.266	0.266	0.441
2007	0	0	0	0.002	0.013	0.099	0.604	0.731	0.524	0.469	0.282	0.222	0.220	0.220	0.407
2008	0	0	0	0.001	0.013	0.098	0.456	0.640	0.435	0.313	0.196	0.119	0.104	0.104	0.326
2009	0	0	0	0.002	0.017	0.115	0.404	0.653	0.484	0.265	0.269	0.167	0.110	0.110	0.323
2010	0	0	0	0.004	0.031	0.253	0.762	0.556	0.400	0.227	0.170	0.124	0.076	0.076	0.371

Table 8. Stock summary table from XSA update run.

	RECRUITS Age 1	5+ BIO	10+ BIO	LANDINGS	YIELD/S	FBAR 5-1(
1975	112301	132746	21901	28814	1.3157	0.3652
1976	116683	134517	17670	24611	1.3928	0.422
1977	107538	156971	14818	32048	2.1628	0.4237
1978	82406	167784	15905	39070	2.4564	0.465
1979	99060	162577	15620	34104	2.1833	0.2489
1980	130190	130960	12404	32867	2.6498	0.538
1981	131941	115334	14028	30754	2.1923	0.4349
1982	131269	121382	19879	26278	1.3219	0.3784
1983	146782	122849	24164	27861	1.153	0.3153
1984	153922	115349	24291	26711	1.0996	0.3862
1985	167467	148333	29023	20347	0.7011	0.2161
1986	187194	138337	33583	17976	0.5353	0.1893
1987	156208	164987	42355	32442	0.766	0.2867
1988	128625	169575	44359	19215	0.4332	0.1488
1989	112774	182788	43919	20034	0.4562	0.128
1990	107643	206756	55987	47454	0.8476	0.2772
1991	94360	225451	63528	65008	1.0233	0.4311
1992	71202	193289	49196	63193	1.2845	0.4616
1993	83968	149149	38123	62455	1.6383	0.6644
1994	142586	103824	29192	51029	1.7481	0.7172
1995	172346	78049	26007	15272	0.5872	0.2575
1996	150489	77859	20093	18840	0.9376	0.2896
1997	123428	74719	18560	19858	1.0699	0.348
1998	108192	87870	17089	19946	1.1672	0.3669
1999	113066	103160	16901	24226	1.4334	0.4335
2000	121956	111153	13552	34177	2.5219	0.4711
2001	121681	112480	12308	38232	3.1064	0.509
2002	124158	99331	10743	34062	3.1708	0.5422
2003	108918	92349	8913	35151	3.9439	0.6314
2004	87723	81166	8760	25486	2.9094	0.5177
2005	69466	86173	7363	23225	3.1542	0.4745
2006	66960	91909	6601	23531	3.5649	0.4414
2007	74520	94276	7673	22747	2.9646	0.4066
2008	60512	100613	8784	21178	2.4109	0.3256
2009	98229	96652	11750	23156	1.9708	0.3229
2010	122659	90370	14949	26174	1.7509	0.3715

Table 9. One-year retrospective comparison of numbers at age; update run. Refer to text for computational details. Shaded entries highlight changes in excess of +/- 10%.

Relative Diff (%)	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	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	-1	0	0	-1	0	0
1992	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
1993	0	0	0	0	0	0	0	0	-1	-1	-2	-1	-1	-1
1994	0	0	0	0	0	0	0	-1	-1	-2	-2	-2	-2	-2
1995	0	0	0	0	0	0	-1	-1	-2	-3	-3	-4	-3	-3
1996	0	0	0	0	0	0	0	-1	-1	-3	-3	-4	-5	-5
1997	-1	0	0	0	0	0	0	0	-1	-2	-3	-5	-6	-6
1998	-2	-1	0	0	0	0	0	0	-1	-2	-2	-5	-6	-6
1999	-2	-2	-1	0	0	0	0	0	0	-1	-3	-3	-6	-6
2000	-5	-2	-2	-1	0	0	0	-1	-1	-1	-2	-4	-5	-5
2001	-7	-5	-2	-2	-1	0	0	-1	-1	-2	-1	-3	-5	-5
2002	-12	-7	-5	-2	-2	-1	-1	-1	-1	-2	-2	-2	-5	-5
2003	-6	-12	-7	-5	-2	-2	-1	-1	-2	-2	-3	-4	-5	-5
2004	8	-6	-12	-7	-5	-2	-3	-3	-4	-4	-4	-4	-6	-6
2005	15	8	-6	-12	-7	-5	-3	-6	-7	-7	-7	-6	-8	-8
2006	10	15	8	-6	-12	-7	-6	-6	-12	-13	-11	-11	-11	-10
2007	-8	10	15	8	-6	-12	-8	-11	-13	-19	-18	-14	-13	-13
2008	16	-8	10	15	8	-6	-13	-14	-21	-20	-28	-22	-16	-17
2009	25	16	-8	10	15	8	-6	-20	-24	-29	-26	-32	-24	-24
2010		25	16	-8	10	15	9	-9	-32	-34	-35	-32	-36	-54

Table 10. One-year retrospective comparison of fishing mortality at age; update run. Refer to text for computational details. Shaded entries highlight changes in excess of +/- 10%; box highlights age range over which average fishing mortality is computed.

Relative Diff (%)	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
1976					0	0	0	0	0	0	0	0	0	0
1977					0	0	0	0	0	0	0	0	0	0
1978					0	0	0	0	0	0	0	0	0	0
1979					0	0	0	0	0	0	0	0	0	0
1980					0	0	0	0	0	0	0	0	0	0
1981					0	0	0	0	0	0	0	0	0	0
1982					0	0	0	0	0	0	0	0	0	0
1983					1	0	0	0	0	0	0	0	0	0
1984					0	0	0	0	0	0	0	0	0	0
1985					0	0	0	0	0	0	0	0	0	0
1986					0	0	0	0	0	0	0	0	0	0
1987					0	0	0	0	0	0	0	0	0	0
1988					0	0	0	0	0	0	0	0	0	0
1989					0	0	0	0	0	0	0	0	0	0
1990				0	0	0	0	0	0	0	0	0	0	0
1991				3	0	0	0	1	1	1	1	1	1	1
1992				1	0	0	0	1	1	1	1	1	1	1
1993				1	0	0	1	1	1	2	2	2	2	2
1994				0	0	0	1	1	2	3	3	3	3	3
1995				0	0	0	1	1	2	3	4	5	4	4
1996				0	0	0	0	1	1	3	4	6	6	6
1997				0	0	0	0	1	2	2	4	6	8	8
1998				0	0	0	0	0	1	2	3	6	8	8
1999				0	0	0	0	1	1	2	3	4	8	8
2000				0	1	0	0	1	1	1	2	5	7	7
2001				2	1	1	1	1	1	2	2	4	8	8
2002				2	2	1	1	1	2	2	3	3	7	7
2003				5	2	2	2	3	3	3	4	5	6	6
2004				8	5	3	4	5	6	6	5	6	8	8
2005				13	7	6	5	10	11	10	10	9	11	11
2006				5	14	8	9	10	18	18	14	14	13	13
2007				-9	6	15	12	19	20	30	25	18	17	17
2008				-20	-7	6	20	23	33	30	42	30	21	21
2009				-10	-13	-8	8	34	40	47	40	51	34	34

Table 11a. XSA Settings, Run2; XSA settings unchanged from update run, but age 1-4 data from EU 0-1400m survey index excluded from input data.

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Lowestoft VPA Version 3.1
7/06/2011 13:13
Extended Survivors Analysis

G. halibut SA2+3KLMNO Index file: (Combined sexes with plus group).

CPUE data from file GhalTUN2011.txt

Catch data for 36 years. 1975 to 2010. Ages 1 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
EU3M_0_	1995	2010	1	12	0.5	0.6
F2J3K	1996	2010	1	13	0.8	1
S3LNO	1996	2010	1	8	0.3	0.45
EU3M_0_	2004	2010	5	13	0.5	0.6

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 :

Terminal year survivor estimates shrunk towards the mean F of the final 3 years.
S.E. of the mean to which the estimates are shrunk = 1.000

Oldest age survivor estimates for the years 1975 to 2010
shrunk towards1.000 * the mean F of ages 10 - 12

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population estimates from each cohort age = .500

Individual fleet weighting not applied

Tuning converged after 56 iterations

Table 11b. XSA diagnostics and results, run2.

Fleet : EU3M_0_700

Age	1995	1996	1997	1998	1999	2000
1	0.85	0.23	-0.13	-0.2	-1.19	0
2	0.29	1.24	0.63	0.26	-0.73	-1.65
3	0.39	-0.06	0.66	1.04	0.3	-1.18
4	0.02	0.32	0.55	0.89	0.97	-0.4
5	-0.38	0.26	0.62	0.64	0.52	0.02
6	0.01	-0.01	0.54	0.67	0.21	0.17
7	0.24	-0.46	0.15	0.75	0.36	-0.06
8	0.22	-0.02	0.14	0.3	0.14	0.38
9	1.07	-0.03	0.47	0.61	-0.12	0.31
10	0.55	-0.51	0.47	0.44	-0.1	0.06
11	0.81	-0.14	-0.02	0.23	-1.12	1
12	0.03	0.77	0.22	-0.91	-1.53	99.99
13	No data for this fleet at this age					

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.76	0.07	-0.4	99.99	99.99	99.99	99.99	99.99	99.99	99.99
2	-0.13	0.59	-0.5	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	-0.12	0.24	-1.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
4	-1.05	-0.57	-0.74	99.99	99.99	99.99	99.99	99.99	99.99	99.99
5	-0.71	-0.27	-0.71	99.99	99.99	99.99	99.99	99.99	99.99	99.99
6	-0.27	-0.44	-0.86	99.99	99.99	99.99	99.99	99.99	99.99	99.99
7	-0.01	-0.04	-0.93	99.99	99.99	99.99	99.99	99.99	99.99	99.99
8	0.64	-0.44	-1.34	99.99	99.99	99.99	99.99	99.99	99.99	99.99
9	-0.62	-0.83	-0.86	99.99	99.99	99.99	99.99	99.99	99.99	99.99
10	-0.76	-0.43	0.28	99.99	99.99	99.99	99.99	99.99	99.99	99.99
11	-1.09	0.13	0.2	99.99	99.99	99.99	99.99	99.99	99.99	99.99
12	99.99	-0.06	-0.53	99.99	99.99	99.99	99.99	99.99	99.99	99.99
13	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9	10
Mean Log	-10.2796	-10.9115	-10.4161	-9.8361	-9.0484	-8.2875	-7.9998	-8.0173	-8.8338	-9.4646
S.E(Log q	0.6125	0.8611	0.7815	0.732	0.5422	0.4787	0.4831	0.5838	0.6761	0.4803

Age	11	12
Mean Log	-10.5547	-10.5547
S.E(Log q	0.7264	0.8281

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.28	2.342	11.33	0.6	9	0.14	-10.28
2	0.18	3.459	11.45	0.72	9	0.1	-10.91
3	0.43	0.981	10.93	0.3	9	0.34	-10.42
4	0.5	1.108	10.46	0.41	9	0.36	-9.84
5	0.84	0.27	9.32	0.3	9	0.49	-9.05
6	1.84	-0.925	6.42	0.15	9	0.89	-8.29
7	1.97	-1.195	6.04	0.18	9	0.92	-8
8	-1.32	-1.681	10.46	0.07	9	0.69	-8.02
9	0.22	2.259	8.35	0.54	9	0.12	-8.83
10	0.56	0.827	8.65	0.34	9	0.28	-9.46
11	0.9	0.089	10.21	0.1	9	0.7	-10.55
12	0.73	0.37	9.69	0.27	7	0.6	-10.84

Table 11b. XSA diagnostics and results, run2 (cont.).

Fleet : F2J3K

Age	1995	1996	1997	1998	1999	2000
1	99.99	0.68	-0.37	-0.43	-0.85	-0.04
2	99.99	0.11	0.45	-0.2	0.25	-0.25
3	99.99	0.41	0.53	0.33	0.27	0.02
4	99.99	-0.09	0.17	0.02	0.41	-0.15
5	99.99	0.01	0.34	-0.14	0.25	0.01
6	99.99	-0.45	0.44	0.17	0.43	-0.06
7	99.99	-0.81	0	0.16	0.8	-0.02
8	99.99	-1.11	0.04	-0.11	0.36	0
9	99.99	0.14	0.35	-0.03	0.08	-0.59
10	99.99	-0.37	0.04	0.2	0.54	-0.3
11	99.99	-0.2	0.13	0.06	-0.14	-0.23
12	99.99	-0.37	0.28	0.16	-0.76	-1.23
13	99.99	0.26	-0.12	0.2	0.87	99.99

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.09	0	0.25	0.12	-0.36	0.34	0.19	99.99	0.32	0.05
2	-0.29	-0.23	-0.14	0.21	-0.29	0.04	-0.18	99.99	0.14	0.35
3	0.01	-0.37	-0.44	-0.28	-0.62	-0.42	0.21	99.99	-0.06	0.39
4	0.05	-0.37	-0.46	-0.2	-0.1	0.28	0.55	99.99	-0.03	-0.07
5	-0.12	-0.47	-0.4	-0.11	0.01	0.17	-0.03	99.99	0.44	0.06
6	0.15	-1.06	-0.64	-0.53	0.23	0.46	0.5	99.99	0.18	0.17
7	0.24	-1.23	-0.78	-0.41	0.63	0.48	0.76	99.99	0.06	0.12
8	0.34	-1.08	-0.61	-0.31	0.38	0.79	1.11	99.99	0.26	-0.06
9	-0.05	-0.9	-0.88	-0.09	0.26	0.65	1.14	99.99	0.28	-0.35
10	-0.46	-0.94	-0.46	0.2	0.25	0	1.02	99.99	0.3	-0.01
11	-0.14	-1.35	-0.38	-0.56	0.89	0.51	0.97	99.99	0.2	0.24
12	-0.85	99.99	-0.3	-0.5	0.58	0.3	0.93	99.99	-0.3	0.13
13	0.5	-0.27	-0.36	0.68	0.73	99.99	0.61	99.99	0.03	-0.48

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8	9	10
Mean Log	-7.8348	-7.9217	-8.2338	-8.2068	-8.2981	-8.5688	-8.4969	-8.8687	-9.6811	-10.2342
S.E(Log q	0.391	0.2537	0.3729	0.279	0.253	0.4832	0.6136	0.6323	0.5614	0.488

Age	11	12	13
Mean Log	-10.3779	-10.3779	-10.3779
S.E(Log q	0.5886	0.6318	0.5158

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.89	0.269	8.25	0.33	14	0.36	-7.83
2	0.88	0.557	8.35	0.63	14	0.23	-7.92
3	0.83	0.541	8.74	0.46	14	0.32	-8.23
4	1	0.007	8.21	0.45	14	0.29	-8.21
5	1.29	-0.911	7.58	0.46	14	0.33	-8.3
6	1.11	-0.191	8.36	0.21	14	0.56	-8.57
7	1.23	-0.285	8.12	0.11	14	0.78	-8.5
8	0.74	0.516	8.95	0.24	14	0.48	-8.87
9	1.1	-0.143	9.83	0.14	14	0.64	-9.68
10	1.24	-0.357	10.89	0.15	14	0.63	-10.23
11	1.67	-0.754	12.7	0.09	14	1	-10.38
12	2.87	-1.406	18.35	0.05	13	1.69	-10.53
13	0.95	0.149	9.95	0.49	12	0.46	-10.16

Table 11b. XSA diagnostics and results, run2 (cont.).

Fleet : S3LNO

Age	1995	1996	1997	1998	1999	2000
1	99.99	0.62	0.49	-1.04	-0.8	0.12
2	99.99	1.16	1.22	-0.15	-0.41	0.21
3	99.99	1.1	1.02	0.86	-0.15	-0.09
4	99.99	0.93	0.8	1.26	0.25	0.18
5	99.99	0	0.39	1.09	0.51	0.09
6	99.99	-0.51	0.26	0.98	0.3	0.75
7	99.99	-0.88	-0.42	0.93	0.56	0.92
8	99.99	-3.14	-0.73	0.93	0.74	0.28
9	No data for this fleet at this age					
10	No data for this fleet at this age					
11	No data for this fleet at this age					
12	No data for this fleet at this age					
13	No data for this fleet at this age					

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	-0.22	-0.1	0.4	0.28	-0.13	99.99	1.22	0.13	-0.88	-0.09
2	-0.27	-0.49	0.81	-0.36	-0.78	99.99	-0.04	0.21	-0.85	-0.26
3	-0.5	-0.78	0.24	-0.12	-0.06	99.99	0.07	0.25	-1.52	-0.33
4	-0.49	-0.68	0.24	-0.04	-0.28	99.99	-0.8	0	-0.62	-0.74
5	-0.6	-0.74	-0.21	-0.18	-0.04	99.99	0.09	0.19	-0.61	0.02
6	-0.15	-1.21	-1.02	-0.81	0.23	99.99	0.72	0.15	-0.7	1
7	0.1	-1.51	-1.3	-1.31	0.19	99.99	1.62	0.9	-0.56	0.77
8	-0.13	-1.64	-1.26	-0.2	0.09	99.99	1.68	1.97	0.33	1.08
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									
12	No data for this fleet at this age									
13	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	1	2	3	4	5	6	7	8
Mean Log	-11.9874	-11.502	-10.9638	-10.8156	-10.4524	-10.8862	-11.4832	-12.3842
S.E(Log q	0.6187	0.6586	0.7042	0.6568	0.4817	0.7444	1.0031	1.3661

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	1.46	-0.441	12.18	0.07	14	0.93	-11.99
2	0.39	2.926	11.43	0.66	14	0.2	-11.5
3	0.45	2.046	11.09	0.54	14	0.29	-10.96
4	0.45	2.174	10.91	0.56	14	0.26	-10.82
5	0.66	1.161	10.56	0.49	14	0.31	-10.45
6	1.22	-0.227	10.96	0.08	14	0.94	-10.89
7	0.88	0.135	11.32	0.09	14	0.91	-11.48
8	0.31	1.649	10.21	0.33	14	0.4	-12.38

Table 11b. XSA diagnostics and results, run2 (cont.).

Fleet : EU3M_0_1400

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	0.56	0.28	0.36	0.06	-0.37	-0.73	-0.16
6	99.99	99.99	99.99	0.2	-0.24	-0.06	-0.06	0.04	-0.03	0.15
7	99.99	99.99	99.99	-0.05	-0.55	-0.42	0.1	0.3	0.29	0.33
8	99.99	99.99	99.99	-0.01	-0.34	-0.15	0.32	0.25	0.13	-0.2
9	99.99	99.99	99.99	0.41	-0.62	-0.15	0.26	0.36	-0.02	-0.23
10	99.99	99.99	99.99	-0.2	-0.09	-0.24	0.24	0.4	0.14	-0.25
11	99.99	99.99	99.99	0.15	0	0.1	0.06	0.42	-0.05	-0.69
12	99.99	99.99	99.99	0.14	0.22	0.07	-0.03	0.25	0.34	-0.38
13	99.99	99.99	99.99	0.56	-0.13	-0.18	-0.34	0.06	0.59	-0.16

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	5	6	7	8	9	10	11	12	13
Mean Log	-9.3765	-8.2408	-7.7809	-8.1049	-8.2994	-7.6439	-7.5942	-7.5942	-7.5942
S.E(Log q	0.4521	0.1455	0.3584	0.2461	0.3699	0.258	0.3389	0.2572	0.3793

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.39	4.107	10.17	0.9	7	0.09	-9.38
6	1.65	-1.386	6.77	0.48	7	0.22	-8.24
7	0.55	0.822	8.86	0.4	7	0.2	-7.78
8	0.74	1.005	8.42	0.75	7	0.18	-8.1
9	1.08	-0.15	8.3	0.42	7	0.44	-8.3
10	1.04	-0.098	7.65	0.57	7	0.29	-7.64
11	-64.94	-4.336	-50.7	0	7	11.05	-7.59
12	2.17	-1.324	9.21	0.2	7	0.49	-7.51
13	0.64	1.058	6.81	0.64	7	0.24	-7.54

Table 11b. XSA diagnostics and results, run2 (cont.).

Age 4 Catchability constant w.r.t. time and dependent on age
Year class = 2006

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	37195	0.289	0.086	0.3	3	0.555	0.004
S3LNO	32348	0.34	0.594	1.75	4	0.399	0.004
EU3M_0_	1	0	0	0	0	0	0
F shrinka	85129	1				0.046	0.002

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
36556	0.21	0.26	8	1.208	0.004

Age 5 Catchability constant w.r.t. time and dependent on age
Year class = 2005

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	26076	0.25	0.109	0.43	4	0.512	0.028
S3LNO	22827	0.313	0.168	0.54	4	0.327	0.032
EU3M_0_	21287	0.5	0	0	1	0.128	0.034
F shrinka	51606	1				0.033	0.014

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
24880	0.18	0.09	10	0.495	0.03

Age 6 Catchability constant w.r.t. time and dependent on age
Year class = 2004

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	17680	0.224	0.131	0.59	5	0.482	0.231
S3LNO	14818	0.287	0.256	0.89	5	0.293	0.27
EU3M_0_	11990	0.354	0.442	1.25	2	0.194	0.324
F shrinka	41285	1				0.031	0.106

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
15993	0.16	0.13	13	0.826	0.253

Age 7 Catchability constant w.r.t. time and dependent on age
Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	1	0	0	0	0	0	0
F2J3K	9015	0.211	0.146	0.69	6	0.444	0.753
S3LNO	7270	0.274	0.245	0.9	6	0.263	0.873
EU3M_0_	8610	0.289	0.205	0.71	3	0.245	0.778
F shrinka	15755	1				0.048	0.497

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
8653	0.15	0.11	16	0.737	0.775

Table 11b. XSA diagnostics and results, run2 (cont.).

Age 8 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	4770	0.646	0	0	1	0.037	0.775
F2J3K	7230	0.204	0.12	0.59	7	0.408	0.572
S3LNO	7710	0.274	0.154	0.56	7	0.215	0.545
EU3M_0_	7268	0.257	0.107	0.42	4	0.295	0.57
F shrinka	5671	1				0.046	0.685

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
7151	0.14	0.07	20	0.49	0.577

Age 9 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	3351	0.526	0.271	0.52	2	0.038	0.455
F2J3K	3595	0.214	0.107	0.5	8	0.412	0.43
S3LNO	4896	0.296	0.191	0.65	7	0.13	0.332
EU3M_0_	3798	0.257	0.116	0.45	5	0.363	0.411
F shrinka	3088	1				0.057	0.486

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
3775	0.15	0.07	23	0.451	0.413

Age 10 Catchability constant w.r.t. time and dependent on age
Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	2089	0.443	0.639	1.44	3	0.031	0.203
F2J3K	1963	0.247	0.092	0.37	9	0.412	0.215
S3LNO	2208	0.274	0.294	1.07	7	0.09	0.193
EU3M_0_	1735	0.259	0.085	0.33	6	0.413	0.24
F shrinka	1119	1				0.054	0.351

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1832	0.16	0.07	26	0.461	0.229

Table 11b. XSA diagnostics and results, run2 (cont.).

Age 11 Catchability constant w.r.t. time and dependent on age
Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	898	0.384	0.206	0.54	4	0.027	0.195
F2J3K	1306	0.263	0.109	0.41	10	0.377	0.138
S3LNO	1090	0.269	0.237	0.88	7	0.062	0.163
EU3M_0_	926	0.246	0.187	0.76	7	0.483	0.19
F shrinka	682	1				0.051	0.25

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
1047	0.16	0.08	29	0.518	0.17

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	191	0.319	0.227	0.71	5	0.023	0.265
F2J3K	558	0.295	0.146	0.5	11	0.334	0.099
S3LNO	300	0.258	0.156	0.61	7	0.036	0.177
EU3M_0_	414	0.244	0.125	0.51	7	0.553	0.131
F shrinka	312	1				0.054	0.17

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
438	0.18	0.08	31	0.443	0.124

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 11
Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
EU3M_0_	130	0.27	0.161	0.6	6	0.017	0.142
F2J3K	249	0.272	0.18	0.66	12	0.325	0.077
S3LNO	134	0.27	0.155	0.58	8	0.021	0.139
EU3M_0_	289	0.231	0.106	0.46	7	0.484	0.067
F shrinka	104	0.5				0.154	0.175

Weighted prediction :

Survivors at end of y	Int s.e	Ext s.e	N	Var Ratio	F
228	0.16	0.1	34	0.598	0.076

Table 12. XSA estimated numbers at age (000s), run 2.

	Age													
N@A(XSA)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**
1975	112301	126284	110155	66817	53823	31895	23092	14337	9312	3931	1773	415	720	735
1976	116683	91945	103393	90188	54705	43765	23562	13703	7254	4040	1691	816	218	113
1977	107537	95532	75278	84651	73839	44773	35280	16368	6321	2529	1313	635	433	311
1978	82406	88044	78215	61632	69306	59971	32122	19114	6754	2521	1154	876	402	459
1979	99060	67468	72085	64037	50460	54045	41486	18183	8794	2937	763	290	385	756
1980	130190	81103	55238	59018	52429	39154	36352	22362	9335	6142	1970	365	103	52
1981	131941	106591	66402	45225	48320	42736	30169	21483	9551	2758	1565	696	183	292
1982	131269	108024	87269	54365	37027	38780	30902	15828	7228	3922	1453	1050	441	512
1983	146781	107474	88442	71450	44510	30072	29670	19583	7744	2712	1688	650	628	1031
1984	153921	120174	87992	72411	58498	35808	21402	15424	9234	4264	1595	1193	464	795
1985	167466	126020	98391	72042	59285	47078	27214	12235	5677	3862	2352	937	847	834
1986	187193	137110	103176	80555	58983	46744	33740	16931	6850	3400	2699	1782	678	1129
1987	156206	153261	112256	84474	65953	48038	36244	21823	9255	4279	2357	1989	1332	2055
1988	128624	127891	125479	91908	69161	53874	37609	19717	9783	5012	2732	1582	1374	1651
1989	112773	105309	104708	102734	75248	56357	41225	23430	12180	6844	3683	2055	1201	586
1990	107643	92330	86219	85728	84111	61444	44342	26984	15316	8631	4909	2619	1441	1047
1991	94360	88130	75594	70590	70102	67867	44191	24874	15255	8855	4631	2930	1343	1004
1992	71200	77255	72155	61891	57596	54805	48547	24280	10597	6025	3883	2104	1299	1092
1993	83967	58294	63251	59076	49709	43373	34988	21072	8835	4756	3338	2264	1055	474
1994	142586	68746	47727	51786	47453	32039	21099	12616	6469	3033	2233	1779	981	653
1995	172345	116739	56285	39076	37517	23921	11922	7192	4231	2508	1486	1094	1074	855
1996	150488	141104	95578	46082	31700	29493	17466	6864	3961	2394	1565	904	649	401
1997	123428	123209	115526	78253	37557	24453	19444	8521	3888	2378	1504	887	529	341
1998	108191	101054	100875	94585	63765	29027	16248	9094	4067	2153	1399	851	503	278
1999	113067	88579	82736	82590	76940	48971	18873	8066	4140	2032	1273	804	551	570
2000	121962	92572	72523	67739	67350	61049	35005	7660	3172	1888	1100	732	381	305
2001	121548	99854	75791	59376	55214	53306	38597	9499	3287	1717	1068	567	415	198
2002	123263	99515	81754	62053	48208	43180	32637	11584	3114	1777	958	477	281	178
2003	107154	100919	81476	66934	50371	37966	28803	10813	3506	1424	859	458	188	208
2004	86850	87731	82626	66707	53644	37177	21381	8413	3076	1410	699	441	245	209
2005	69578	71106	71828	67648	53803	40244	22985	7966	3154	1336	676	311	194	138
2006	69784	56966	58217	58808	54903	42556	27521	9487	2907	1307	692	332	151	188
2007	81651	57134	46639	47664	47952	43259	29005	11544	3332	1394	733	443	230	162
2008	67158	66850	46777	38185	38944	38744	32041	12969	4553	1615	715	453	291	167
2009	110972	54985	54732	38298	31237	31480	28724	16554	5589	2413	967	481	329	360
2010	145897	90856	45018	44811	31301	25144	22949	15554	6969	2812	1516	605	333	317
2011		119451	74387	36858	36556	24880	15993	8653	7151	3775	1832	1047	438	494

Table 13. XSA estimated fishing mortality at age, run 2. (Average fishing mortality is computed over ages 5-10.)

	Age														
F@A(XSA)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14+**	**Fbar(5-10)**
1975	0	0	0	0.000	0.007	0.103	0.322	0.481	0.635	0.644	0.576	0.446	0.560	0.560	0.365
1976	0	0	0	0.000	0.000	0.016	0.164	0.574	0.854	0.924	0.780	0.434	0.720	0.720	0.422
1977	0	0	0	0.000	0.008	0.132	0.413	0.685	0.719	0.585	0.205	0.257	0.351	0.351	0.424
1978	0	0	0	0.000	0.049	0.169	0.369	0.576	0.633	0.995	1.179	0.622	0.943	0.943	0.465
1979	0	0	0	0.000	0.054	0.197	0.418	0.467	0.159	0.200	0.537	0.837	0.529	0.529	0.249
1980	0	0	0	0.000	0.004	0.061	0.326	0.651	1.019	1.167	0.840	0.490	0.841	0.841	0.538
1981	0	0	0	0.000	0.020	0.124	0.445	0.889	0.690	0.441	0.199	0.256	0.300	0.300	0.435
1982	0	0	0	0.000	0.008	0.068	0.256	0.515	0.780	0.643	0.604	0.314	0.525	0.525	0.378
1983	0	0	0	0.000	0.018	0.140	0.454	0.552	0.397	0.331	0.147	0.138	0.207	0.207	0.315
1984	0	0	0	0.000	0.017	0.074	0.359	0.799	0.672	0.395	0.331	0.142	0.291	0.291	0.386
1985	0	0	0	0.000	0.038	0.133	0.275	0.380	0.313	0.158	0.078	0.124	0.121	0.121	0.216
1986	0	0	0	0.000	0.005	0.054	0.236	0.404	0.271	0.166	0.105	0.091	0.121	0.121	0.189
1987	0	0	0	0.000	0.002	0.045	0.409	0.602	0.413	0.249	0.199	0.170	0.207	0.207	0.287
1988	0	0	0	0.000	0.005	0.068	0.273	0.282	0.157	0.108	0.085	0.076	0.090	0.090	0.149
1989	0	0	0	0.000	0.003	0.040	0.224	0.225	0.144	0.132	0.141	0.155	0.143	0.143	0.128
1990	0	0	0	0.001	0.015	0.130	0.378	0.370	0.348	0.423	0.316	0.468	0.405	0.405	0.277
1991	0	0	0	0.004	0.046	0.135	0.399	0.653	0.729	0.624	0.589	0.614	0.614	0.614	0.431
1992	0	0	0	0.019	0.084	0.249	0.635	0.811	0.601	0.390	0.340	0.491	0.410	0.410	0.462
1993	0	0	0	0.019	0.239	0.521	0.820	0.981	0.869	0.556	0.430	0.636	0.545	0.545	0.664
1994	0	0	0	0.122	0.485	0.789	0.876	0.893	0.747	0.514	0.513	0.304	0.447	0.447	0.717
1995	0	0	0	0.009	0.041	0.115	0.352	0.396	0.370	0.272	0.297	0.323	0.299	0.299	0.257
1996	0	0	0	0.005	0.060	0.217	0.518	0.368	0.310	0.265	0.368	0.335	0.279	0.279	0.290
1997	0	0	0	0.005	0.058	0.209	0.560	0.540	0.391	0.331	0.369	0.366	0.337	0.337	0.348
1998	0	0	0	0.007	0.064	0.231	0.500	0.587	0.494	0.325	0.354	0.235	0.226	0.226	0.367
1999	0	0	0	0.004	0.031	0.136	0.702	0.733	0.585	0.414	0.354	0.546	0.344	0.344	0.434
2000	0	0	0	0.004	0.034	0.259	1.104	0.646	0.414	0.370	0.462	0.366	0.468	0.468	0.471
2001	0	0	0	0.008	0.046	0.291	1.004	0.915	0.415	0.384	0.605	0.503	0.536	0.536	0.509
2002	0	0	0	0.009	0.039	0.205	0.905	0.995	0.583	0.527	0.537	0.731	0.685	0.685	0.542
2003	0	0	0	0.021	0.104	0.374	1.031	1.057	0.711	0.512	0.467	0.427	0.591	0.591	0.631
2004	0	0	0	0.015	0.087	0.281	0.787	0.781	0.634	0.536	0.611	0.619	0.498	0.498	0.518
2005	0	0	0	0.009	0.035	0.180	0.685	0.808	0.681	0.458	0.509	0.520	0.453	0.453	0.474
2006	0	0	0	0.004	0.038	0.183	0.669	0.846	0.535	0.378	0.245	0.170	0.266	0.266	0.442
2007	0	0	0	0.002	0.013	0.100	0.605	0.731	0.524	0.469	0.282	0.223	0.220	0.220	0.407
2008	0	0	0	0.001	0.013	0.099	0.460	0.642	0.435	0.313	0.196	0.119	0.104	0.104	0.327
2009	0	0	0	0.002	0.017	0.116	0.413	0.665	0.487	0.265	0.269	0.167	0.110	0.110	0.327
2010	0	0	0	0.004	0.030	0.253	0.775	0.577	0.413	0.229	0.170	0.124	0.076	0.076	0.379

Table 14. Stock summary table from XSA run 2.

	RECRUITS Age 1	5+ BIO	10+ BIO	LANDINGS	YIELD/SS	FBAR 5-1
1975	112301	132746	21901	28814	1.3157	0.3652
1976	116683	134517	17670	24611	1.3928	0.422
1977	107537	156971	14818	32048	2.1628	0.4237
1978	82406	167784	15905	39070	2.4564	0.465
1979	99060	162577	15620	34104	2.1833	0.2489
1980	130190	130960	12404	32867	2.6498	0.538
1981	131941	115334	14028	30754	2.1923	0.4349
1982	131269	121382	19879	26278	1.3219	0.3784
1983	146781	122849	24164	27861	1.153	0.3153
1984	153921	115348	24291	26711	1.0996	0.3862
1985	167466	148333	29023	20347	0.7011	0.2161
1986	187193	138336	33583	17976	0.5353	0.1893
1987	156206	164987	42355	32442	0.766	0.2867
1988	128624	169574	44359	19215	0.4332	0.1488
1989	112773	182787	43919	20034	0.4562	0.128
1990	107643	206754	55986	47454	0.8476	0.2772
1991	94360	225449	63528	65008	1.0233	0.4311
1992	71200	193287	49195	63193	1.2845	0.4616
1993	83967	149146	38121	62455	1.6383	0.6644
1994	142586	103821	29190	51029	1.7481	0.7173
1995	172345	78046	26005	15272	0.5873	0.2575
1996	150488	77855	20090	18840	0.9378	0.2896
1997	123428	74716	18558	19858	1.0701	0.348
1998	108191	87867	17086	19946	1.1674	0.3669
1999	113067	103156	16898	24226	1.4337	0.4335
2000	121962	111150	13550	34177	2.5222	0.4711
2001	121548	112478	12306	38232	3.1068	0.509
2002	123263	99329	10741	34062	3.1711	0.5423
2003	107154	92347	8912	35151	3.9444	0.6314
2004	86850	81165	8758	25486	2.9101	0.5177
2005	69578	86149	7362	23225	3.1548	0.4745
2006	69784	91717	6600	23531	3.5655	0.4415
2007	81651	93744	7672	22747	2.965	0.4069
2008	67158	99776	8784	21178	2.411	0.3271
2009	110972	95725	11752	23156	1.9704	0.3272
2010	145897	89743	14904	26174	1.7561	0.3794

Table 15. One-year retrospective comparison of numbers at age; run 2. Refer to text for computational details. Shaded entries highlight changes in excess of +/- 10%.

Relative Diff (%)	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	0	0	0	0
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	-1	0	0	-1	-1	0
1992	0	0	0	0	0	0	0	0	-1	-1	-1	-1	-1	-1
1993	0	0	0	0	0	0	0	0	-1	-1	-2	-1	-1	-1
1994	0	0	0	0	0	0	0	-1	-1	-2	-2	-2	-2	-2
1995	0	0	0	0	0	0	-1	-1	-2	-3	-3	-4	-3	-3
1996	0	0	0	0	0	0	0	-1	-1	-3	-3	-4	-5	-5
1997	-1	0	0	0	0	0	0	0	-1	-2	-3	-5	-6	-6
1998	-2	-1	0	0	0	0	0	0	-1	-2	-2	-5	-7	-6
1999	-2	-2	-1	0	0	0	0	-1	0	-1	-3	-3	-6	-6
2000	-5	-2	-2	-1	0	0	0	-1	-1	-1	-2	-4	-5	-5
2001	-6	-5	-2	-2	-1	0	0	-1	-1	-2	-1	-3	-5	-5
2002	-11	-6	-5	-2	-2	-1	-1	-1	-1	-2	-2	-2	-5	-5
2003	-5	-11	-6	-5	-2	-2	-1	-1	-2	-2	-3	-4	-5	-5
2004	9	-5	-11	-6	-5	-2	-3	-3	-4	-4	-4	-4	-6	-6
2005	14	9	-5	-11	-7	-5	-3	-6	-7	-7	-7	-6	-8	-8
2006	4	14	9	-5	-11	-7	-6	-6	-12	-13	-11	-11	-11	-10
2007	-11	4	14	9	-5	-11	-8	-11	-13	-19	-18	-14	-13	-13
2008	11	-11	4	14	9	-5	-13	-14	-21	-21	-28	-22	-16	-17
2009	13	11	-11	4	14	9	-5	-19	-23	-29	-26	-32	-24	-24
2010		13	11	-11	4	14	11	-8	-31	-33	-35	-32	-36	-54

Table 16. One-year retrospective comparison of fishing mortality at age, run 2. Refer to text for computational details. Shaded entries highlight changes in excess of +/- 10%; box highlights age range over which average fishing mortality is computed.

Relative Diff (%)	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
1976					0	0	0	0	0	0	0	0	0	0
1977					0	0	0	0	0	0	0	0	0	0
1978					0	0	0	0	0	0	0	0	0	0
1979					0	0	0	0	0	0	0	0	0	0
1980					0	0	0	0	0	0	0	0	0	0
1981					0	0	0	0	0	0	0	0	0	0
1982					0	0	0	0	0	0	0	0	0	0
1983					1	0	0	0	0	0	0	0	0	0
1984					0	0	0	0	0	0	0	0	0	0
1985					0	0	0	0	0	0	0	0	0	0
1986					0	0	0	0	0	0	0	0	0	0
1987					0	0	0	0	0	0	0	0	0	0
1988					0	0	0	0	0	0	0	0	0	0
1989					0	0	0	0	0	0	0	0	0	0
1990				0	0	0	0	0	0	0	0	0	0	0
1991				3	0	0	0	1	1	1	1	1	1	1
1992				1	0	0	0	1	1	1	1	1	1	1
1993				1	0	0	1	1	1	2	2	2	2	2
1994				0	0	0	1	1	2	3	3	3	3	3
1995				0	0	0	1	1	2	3	4	5	4	4
1996				0	0	0	0	1	1	3	4	6	6	6
1997				0	0	0	0	1	2	2	4	6	8	8
1998				0	0	0	0	0	1	2	3	6	8	8
1999				0	0	0	0	1	1	2	3	4	8	8
2000				0	1	0	0	1	1	1	2	5	7	7
2001				2	1	1	1	1	1	2	2	4	8	8
2002				2	2	1	1	1	2	2	3	3	7	7
2003				5	2	2	2	3	3	3	4	5	6	6
2004				7	5	3	4	5	6	6	5	6	8	8
2005				13	7	6	5	10	11	10	10	9	11	11
2006				5	13	8	9	10	19	18	14	14	13	13
2007				-9	5	14	12	19	20	30	25	18	17	17
2008				-20	-9	5	18	22	33	30	42	30	21	21
2009				0	-12	-9	7	32	39	47	40	51	34	34

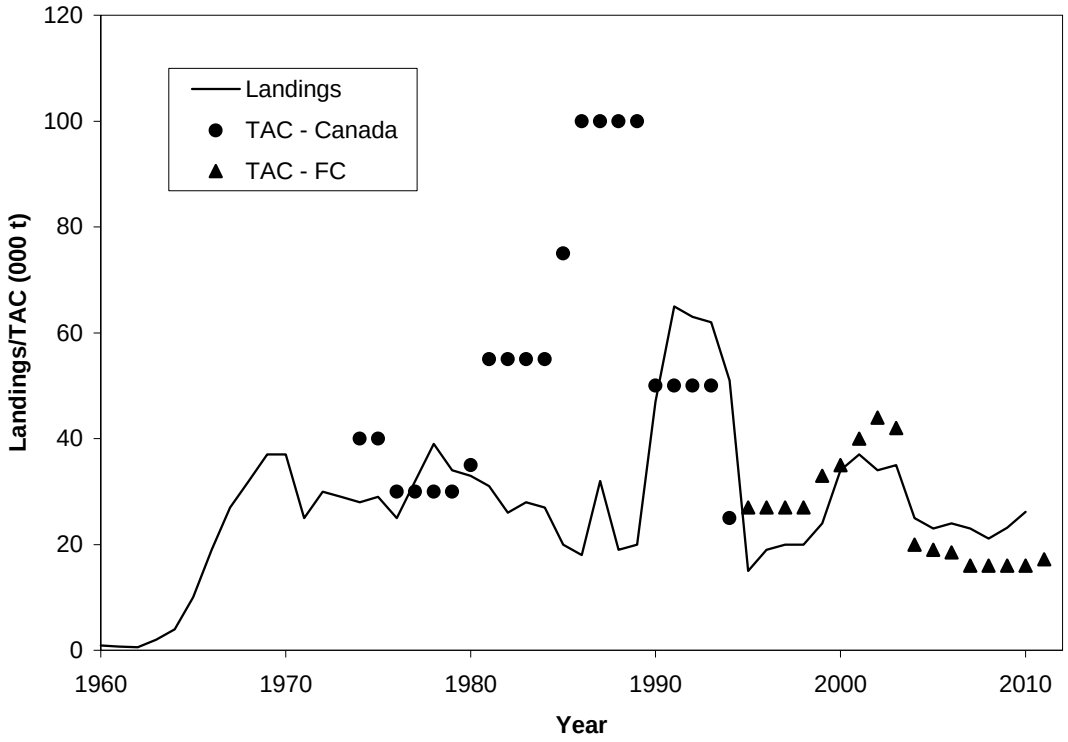


Figure 1 – Catches (line) and TAC (triangle) of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO. TACs were set autonomously by Canada prior to 1995.

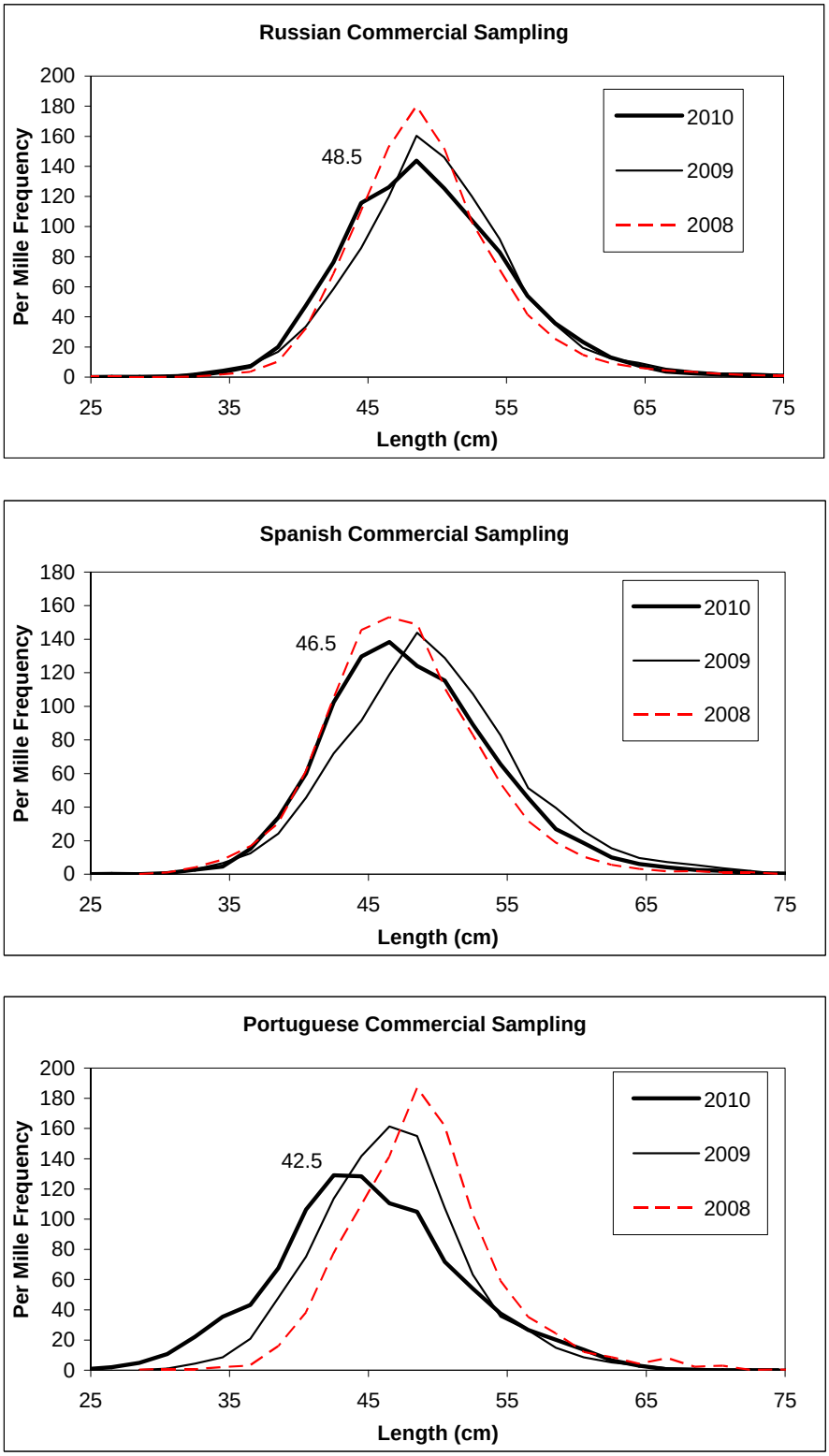


Figure 2 – Available Length Sampling over 2008- 2010 for fisheries within the NRA. Text labels indicate modal length during 2010.

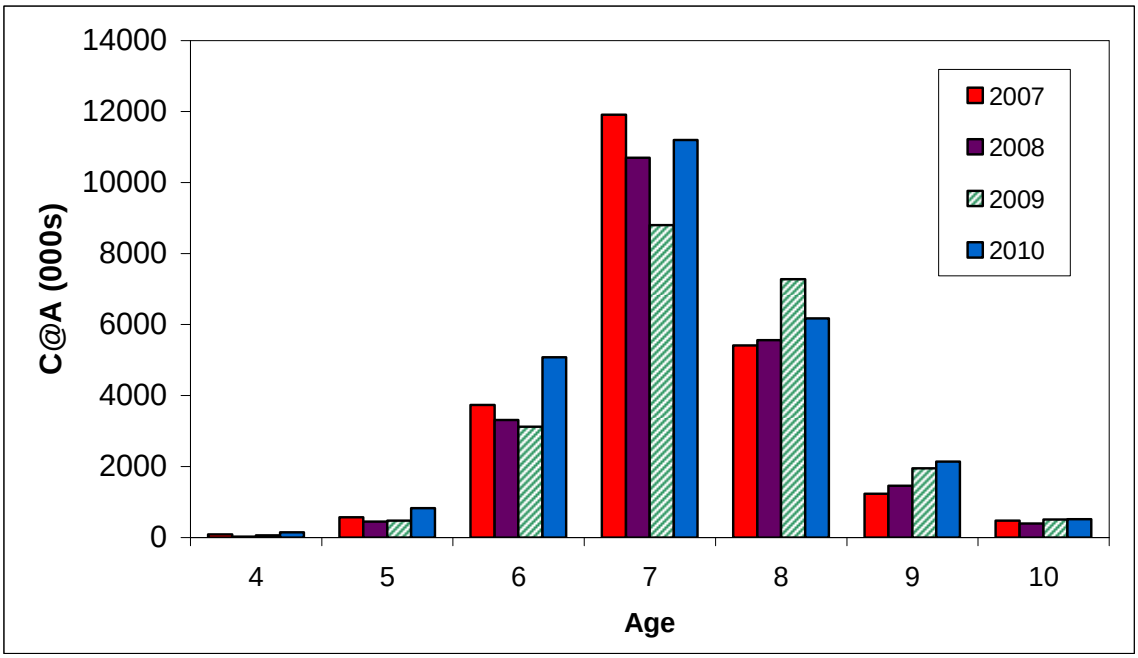


Figure 3 – Total catch at age, in thousands, for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO in recent years (2007-2010) over ages 4-10.

Figure 4a: Pair-wise scatter plot of age-disaggregated survey data (log-scale) from Canadian fall survey in Divs. 2J3K (1996-2010). Refer to text for details.

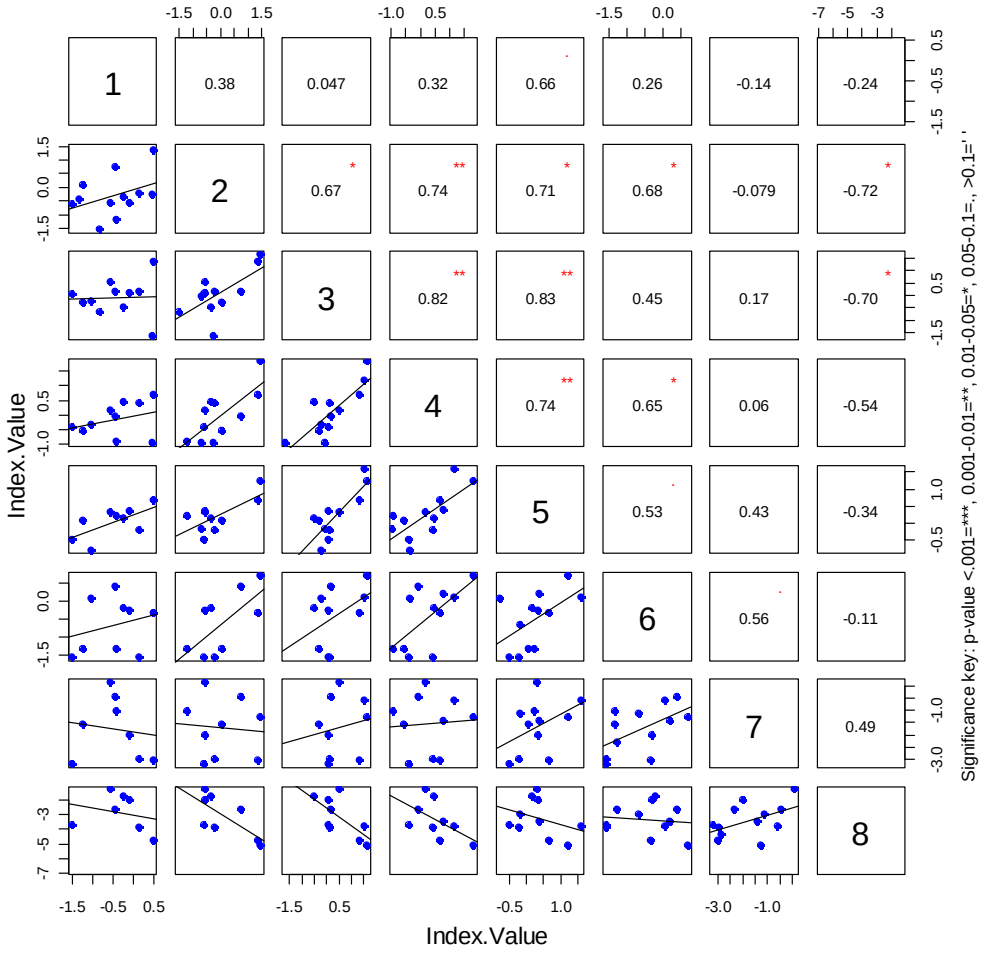


Figure 4b: Pair-wise scatter plot of age-disaggregated survey data (log-scale) from Canadian spring survey in Divs. 3LNO (1996-2010). Refer to text for details.

Figure 4c: Pair-wise scatter plot of age-disaggregated survey data (log-scale) from EU Flemish Cap survey (0-700m only; 1995-2003). Refer to text for details.

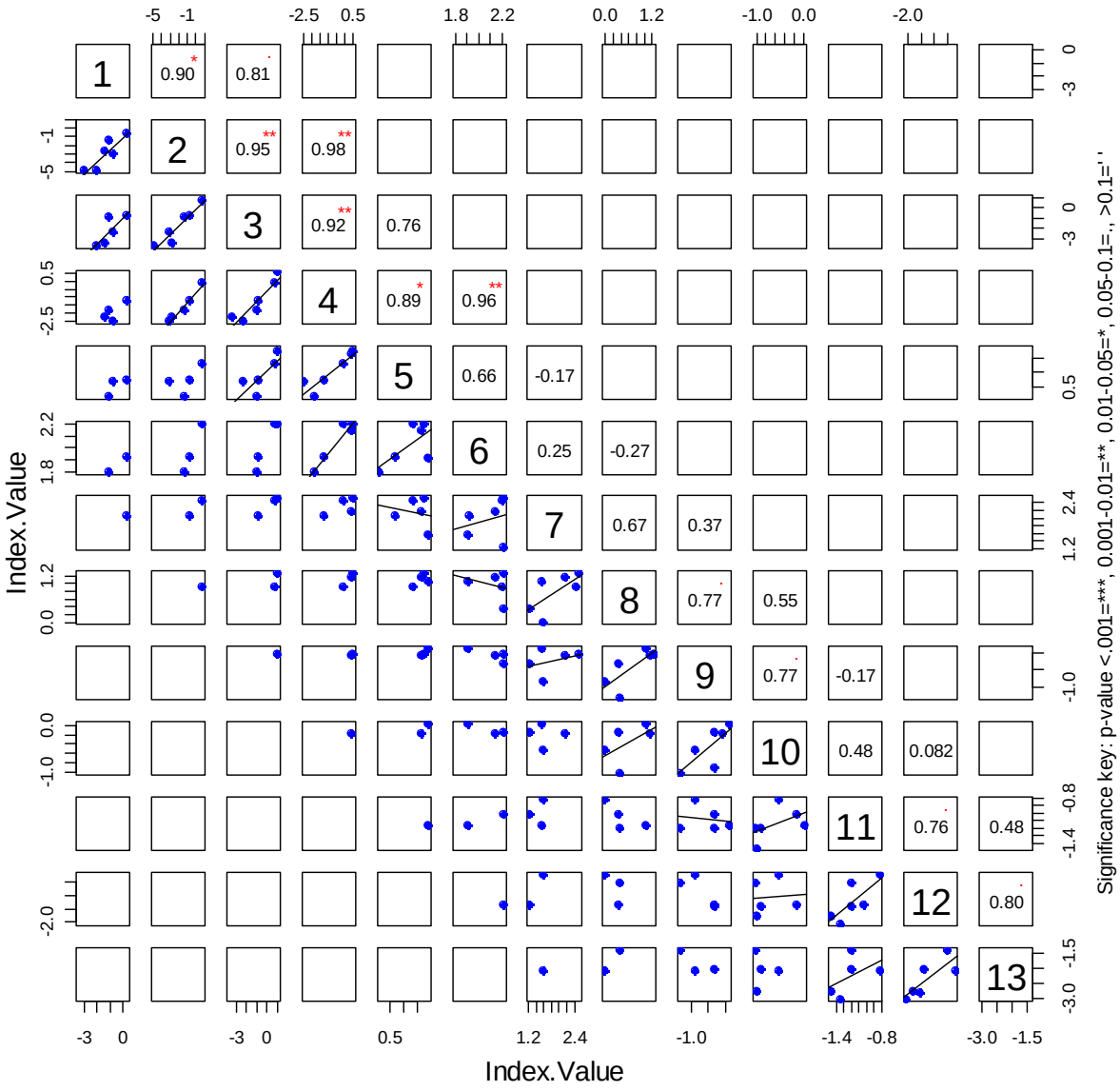


Figure 4d: Pair-wise scatter plot of age-disaggregated survey data (log-scale) from EU Flemish Cap survey (0-1400m only; 2004-2010). Refer to text for details.

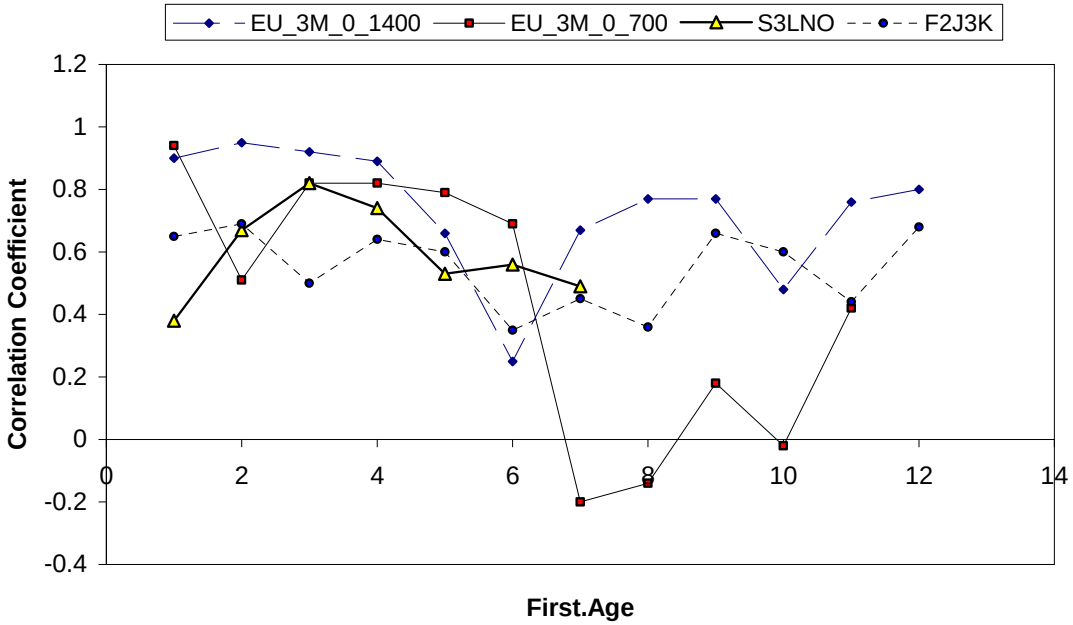


Figure 5. Correlation coefficients computed between successive age groups from each survey series. “First Age” identifies the youngest age being considered, correlations were computed on logged index data included in the XSA input dataset.

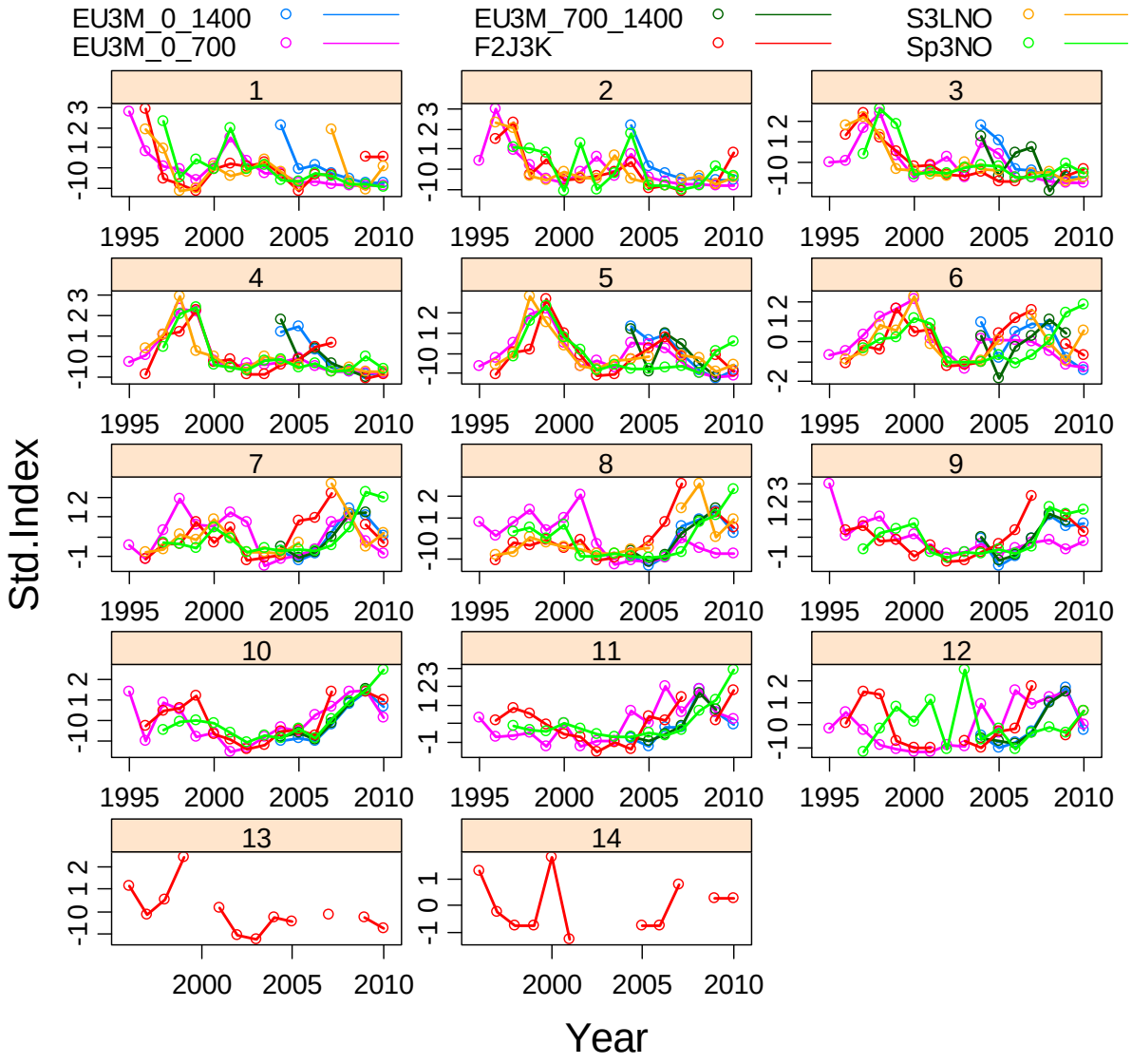


Figure 6a. Standardized age-disaggregated Greenland Halibut survey indices.

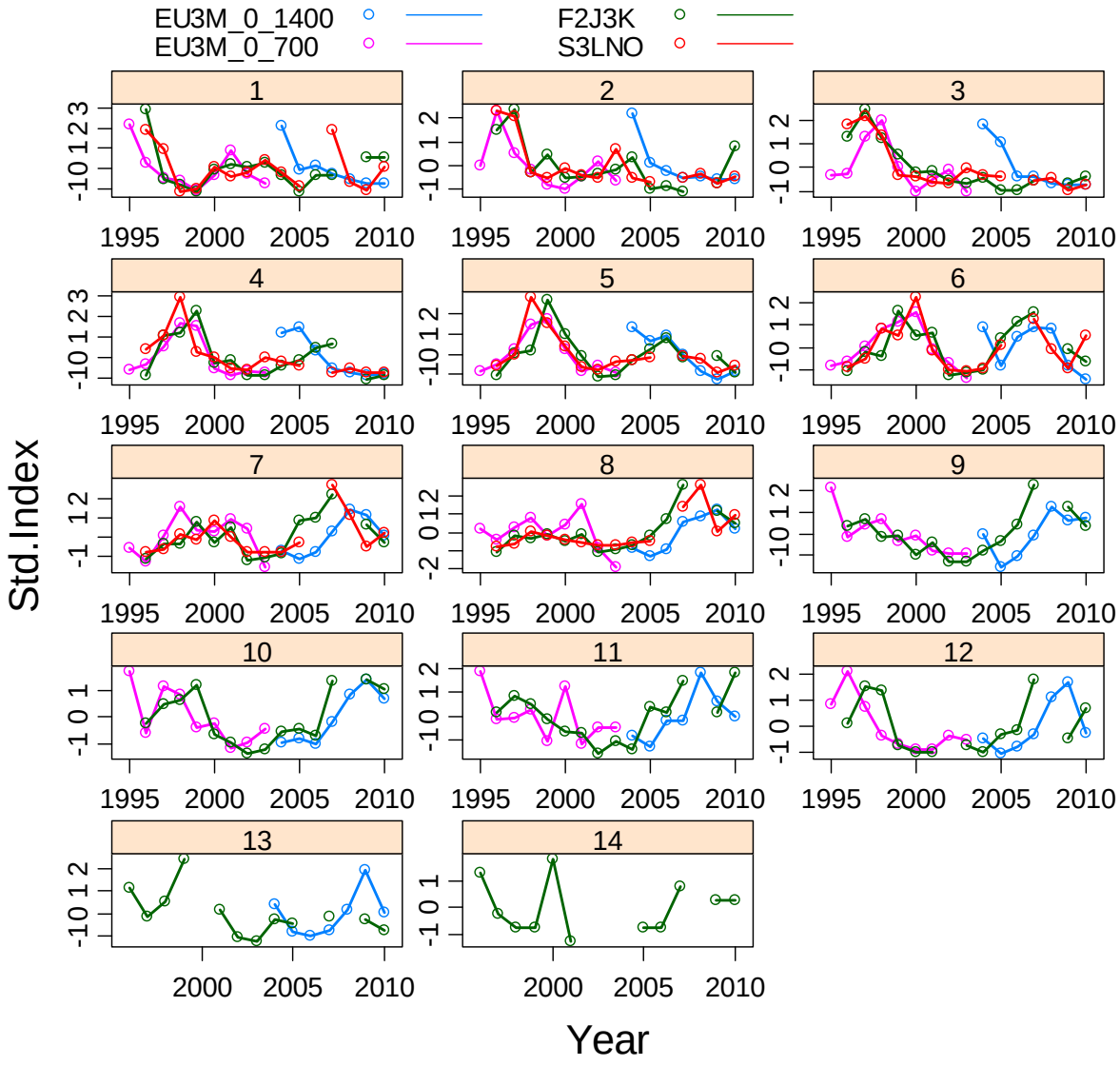


Figure 6b. Standardized age-disaggregated Greenland Halibut survey indices – includes only the surveys used to calibrate the previous analytical assessment.

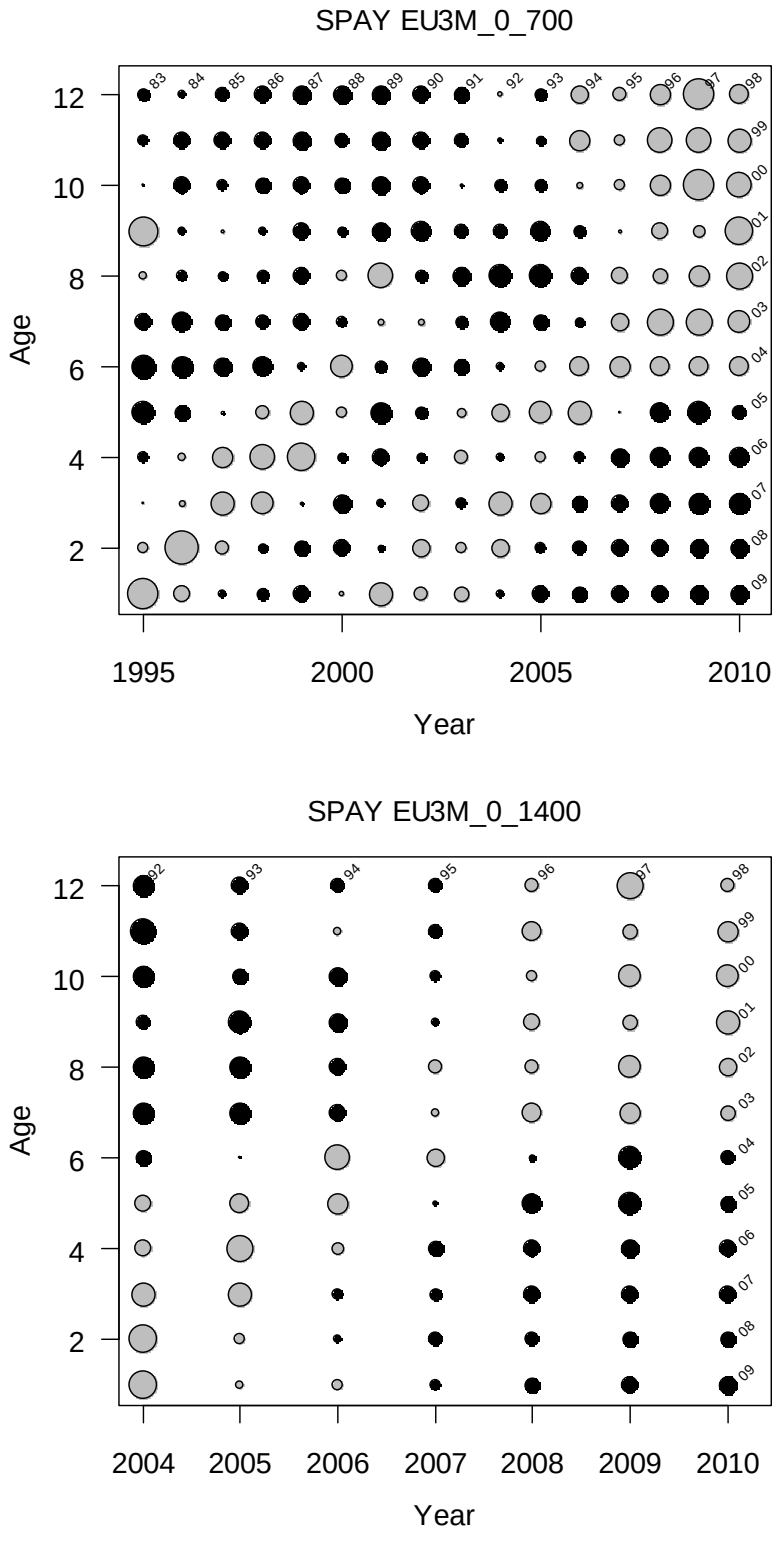


Figure 7a. Plot of standardized proportions by age across years (SPAY). Refer to text for computational details.

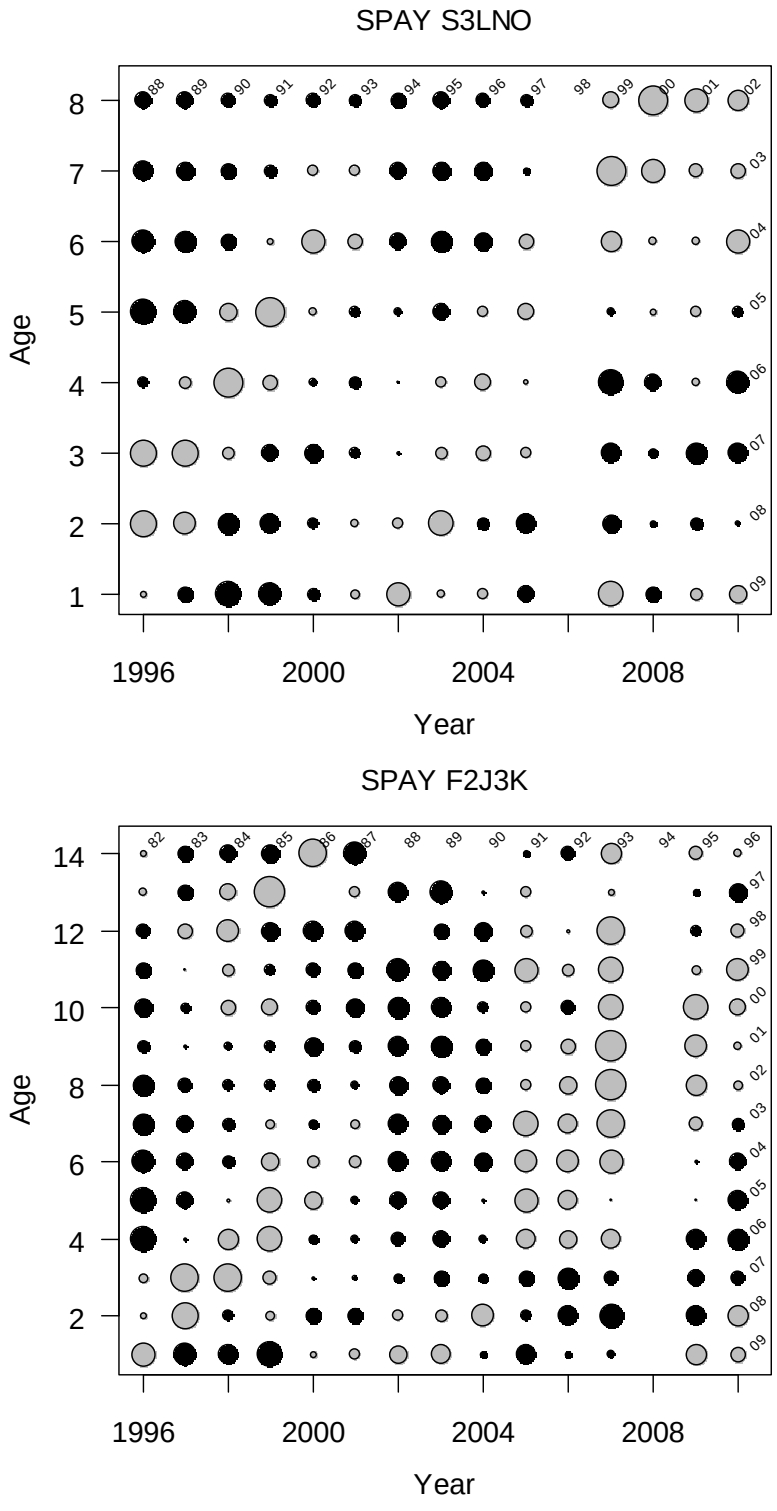


Figure 7b. Plot of standardized proportions by age across years (SPAY). Refer to text for computational details.

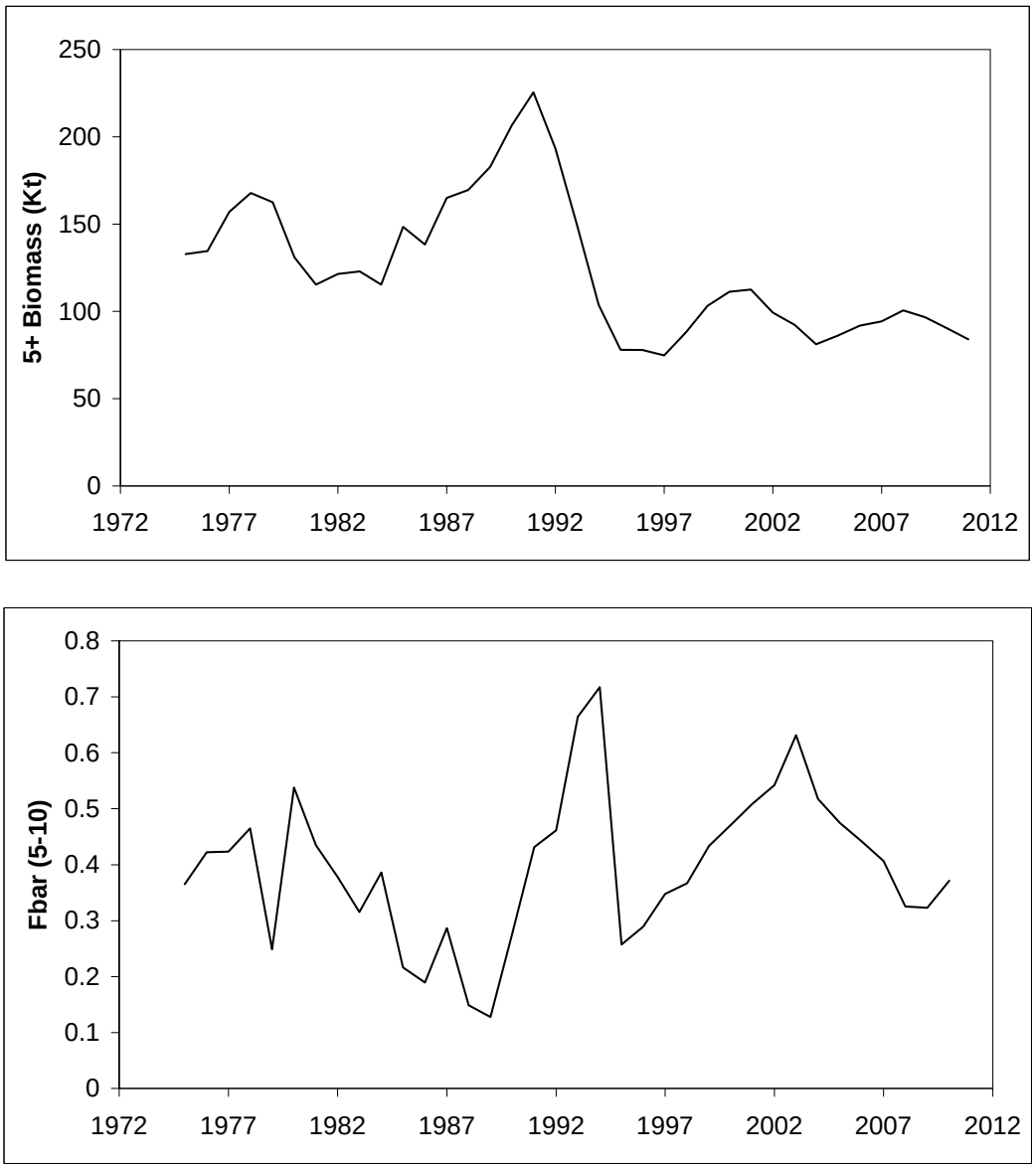
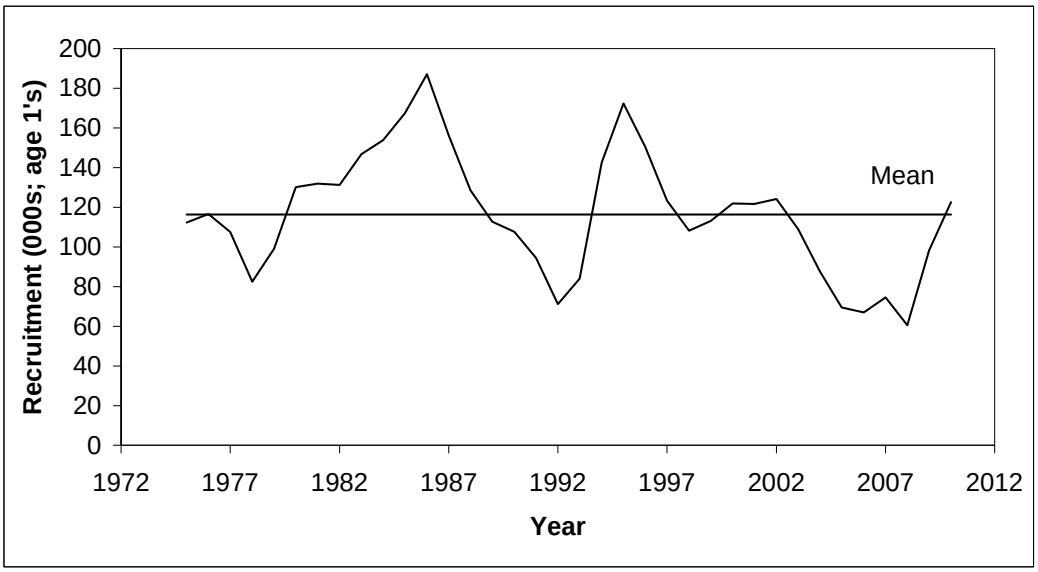


Figure 8a. XSA update run estimates of exploitable biomass (ages 5+ in tons), and average fishing mortality (ages 5-10) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO.



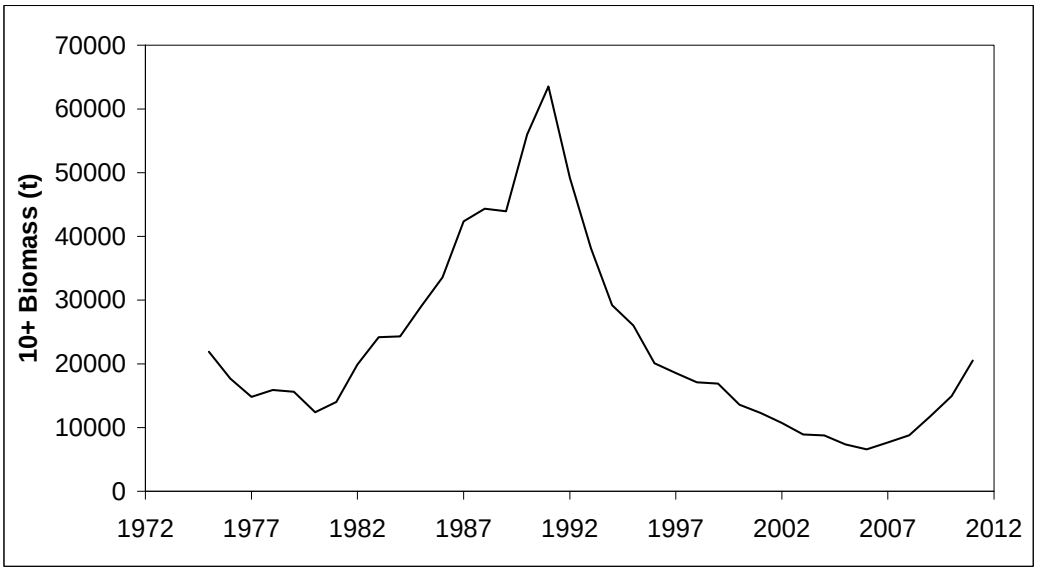
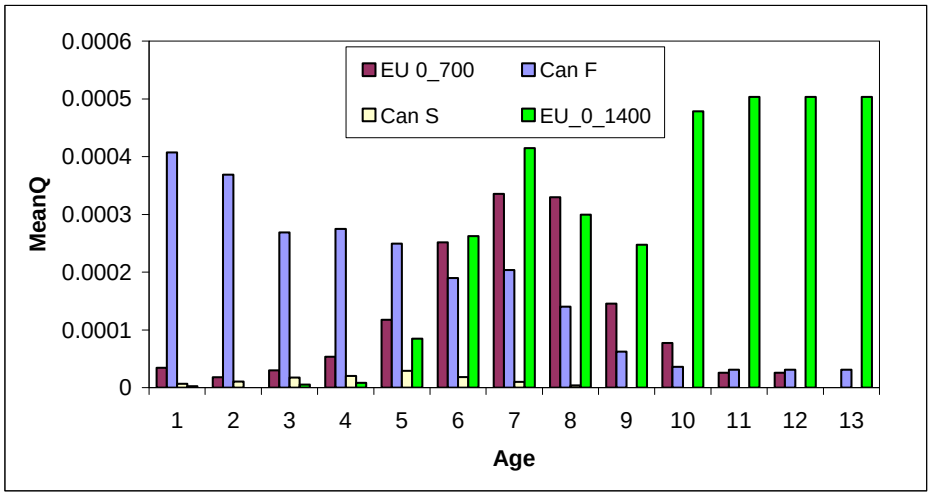
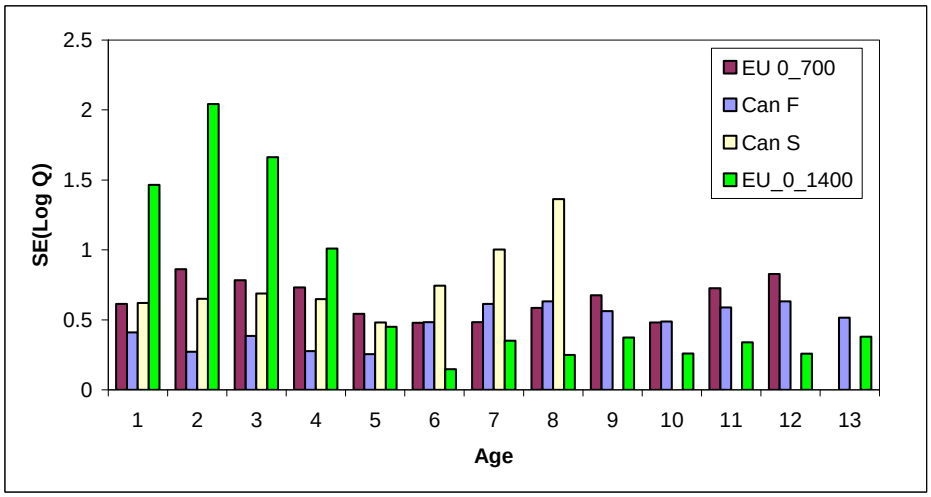


Figure 8b. XSA update run estimates of age 1 recruitment (000's) and age 10+ biomass (tons) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO.

Catchabilities



SE(Log q)



Shrinkage Scaled Weights

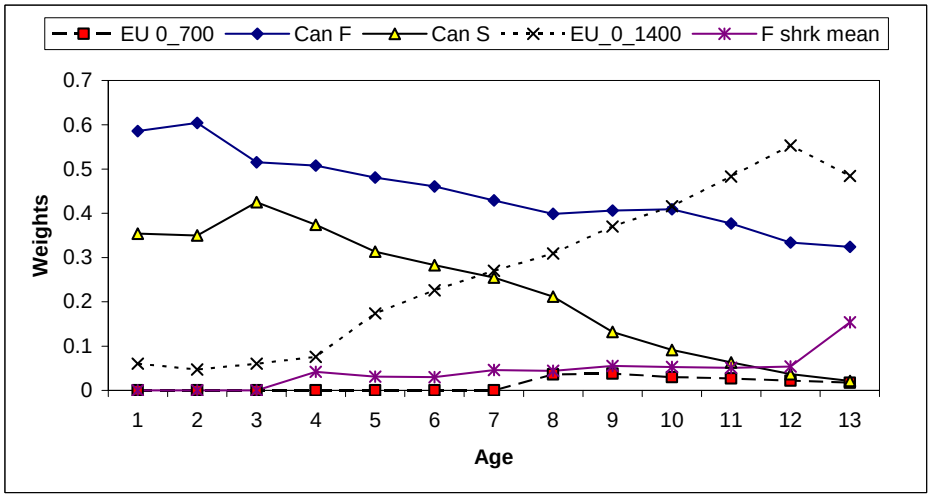


Figure 9. XSA update run estimated catchabilities, associated standard errors, and the scaled weights used to estimate survivors in the terminal year.

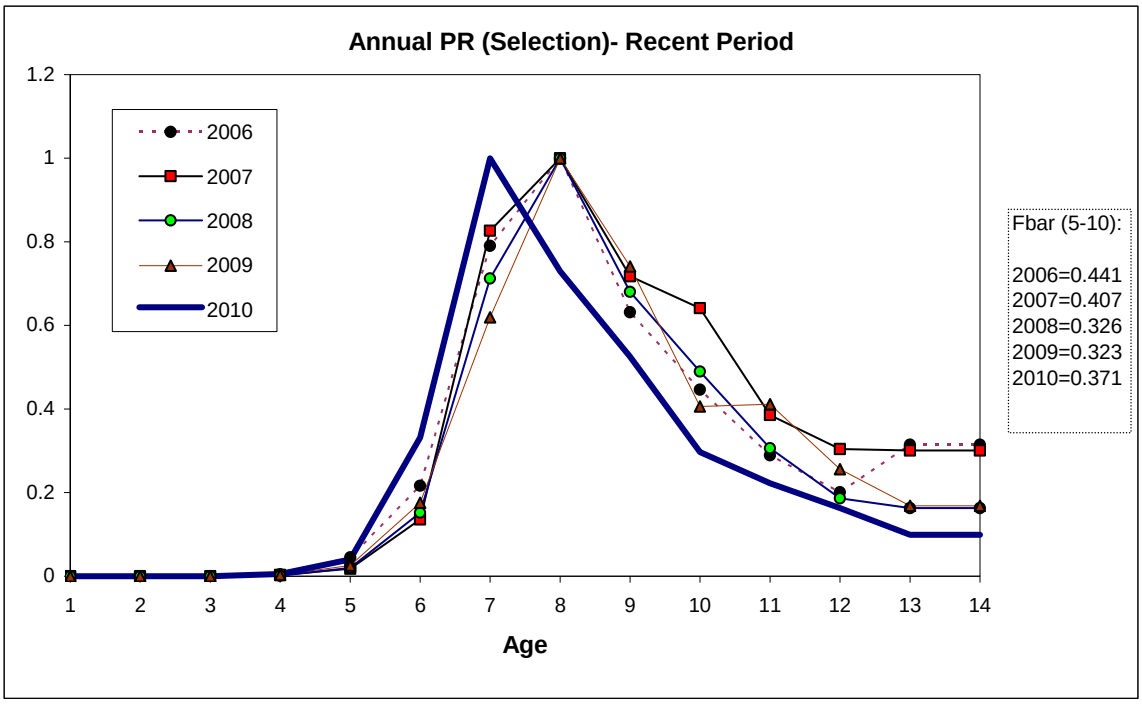


Figure 10. XSA update run estimated selection pattern in the most recent five years.

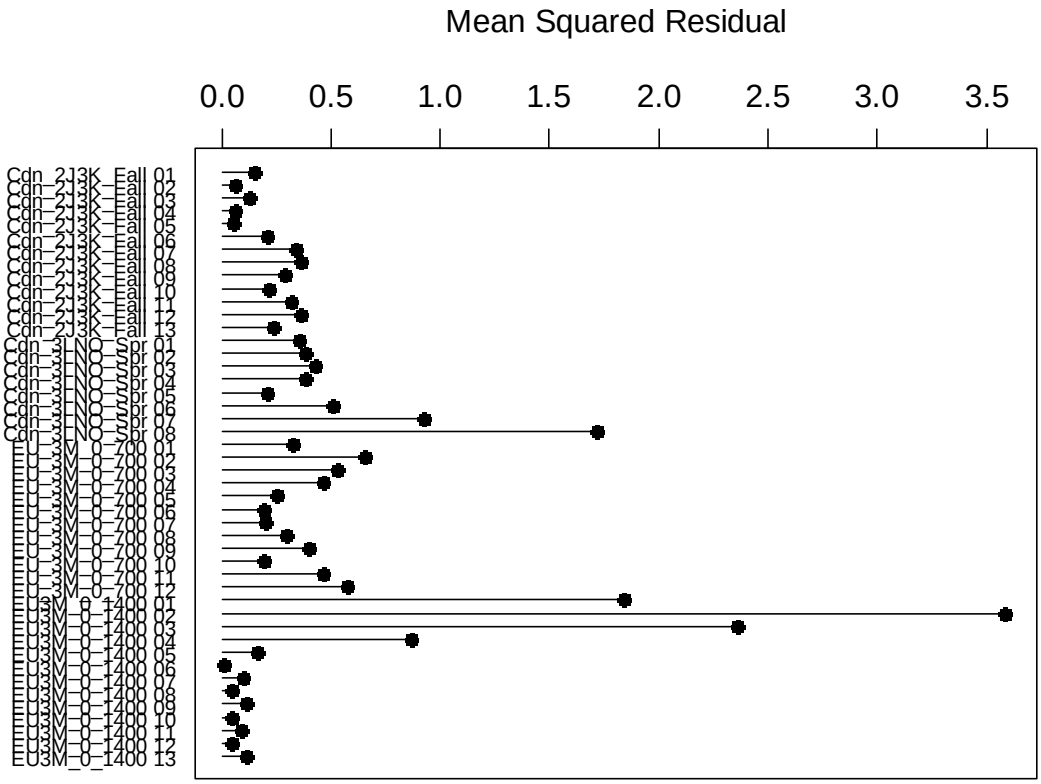


Figure 11a. Mean square residuals from XSA update run for each survey-age.

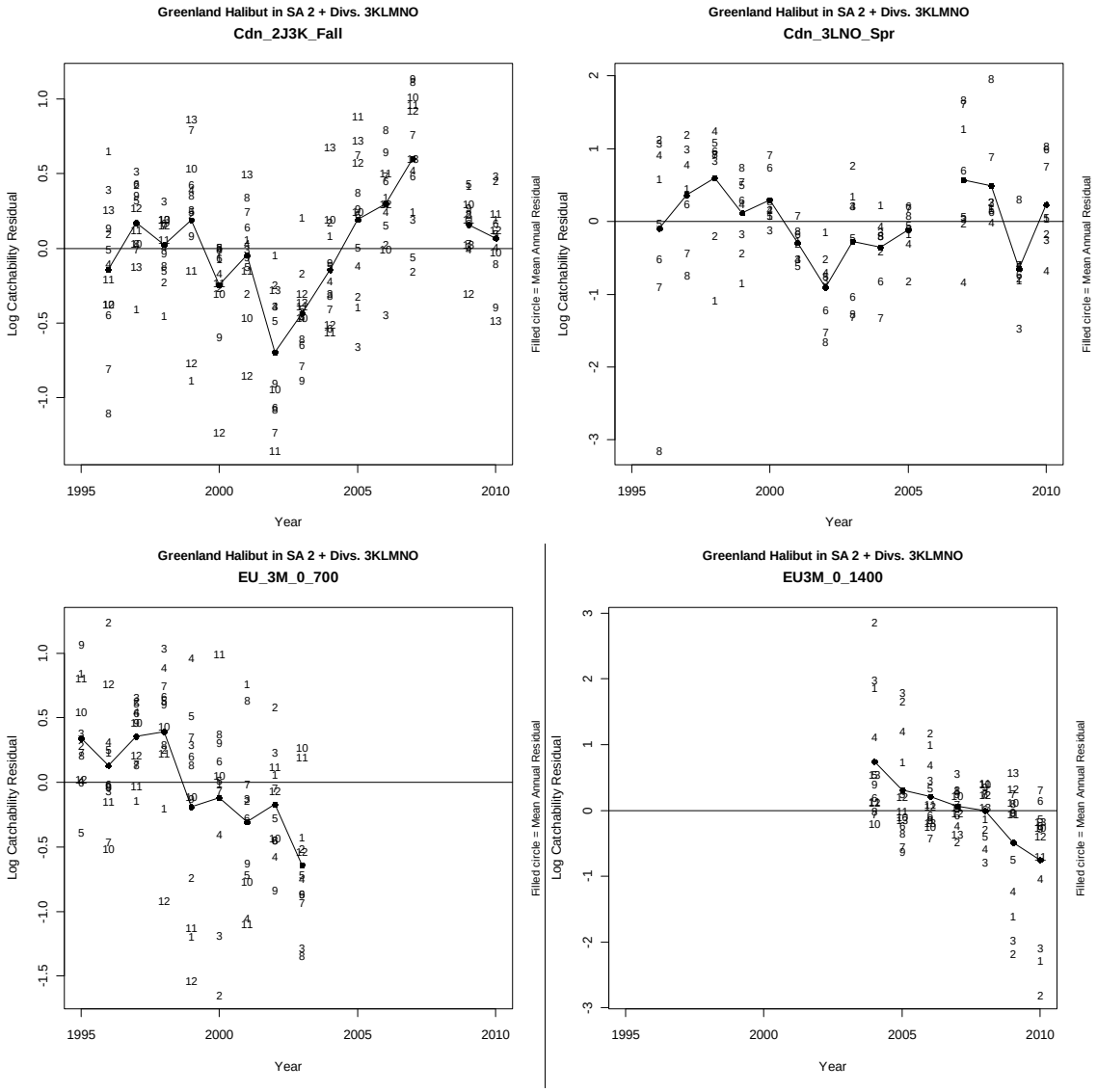


Figure 11b. XSA update run residuals by survey, age and year. Symbol=age, solid circle=mean annual residual.

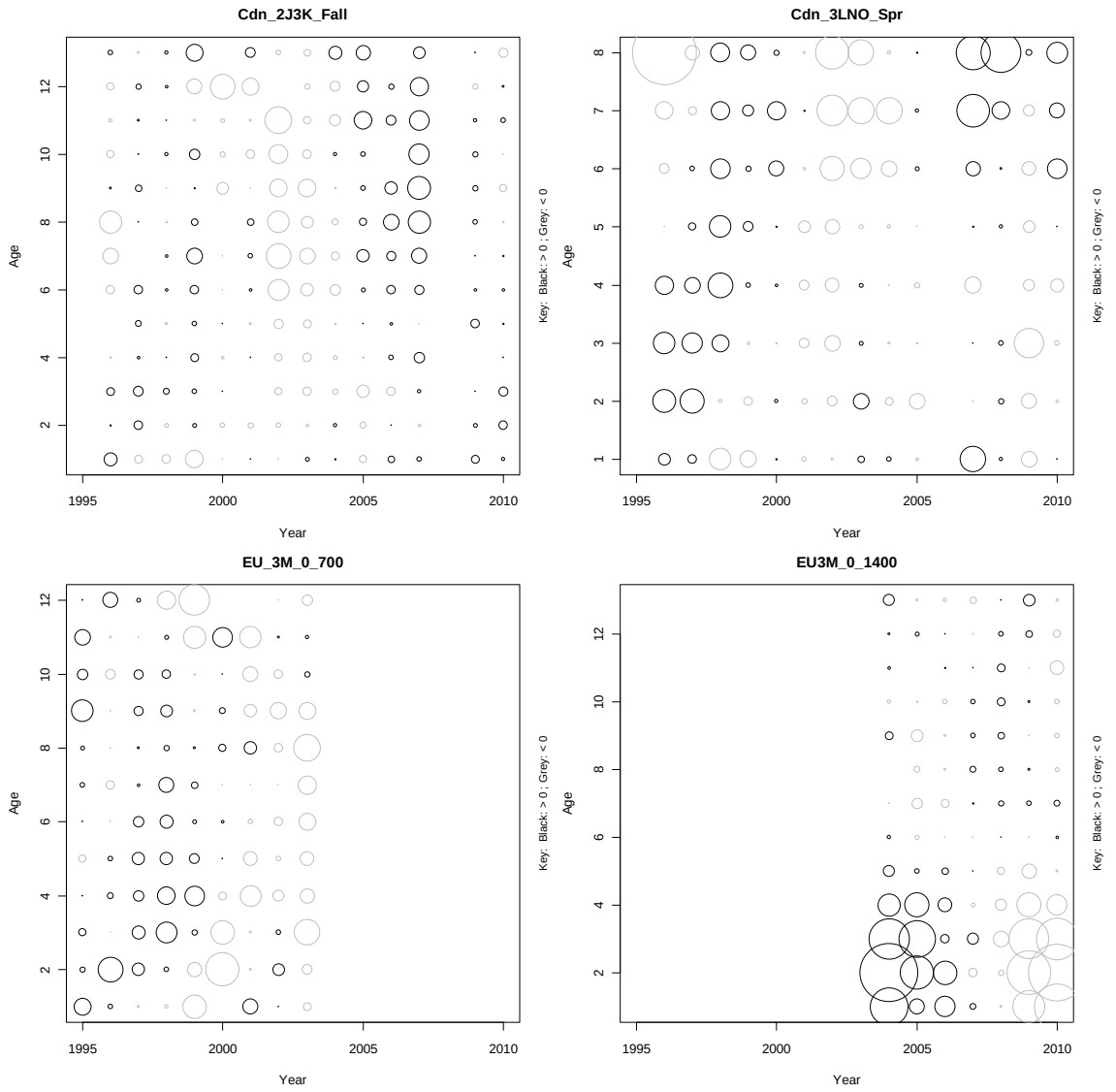


Figure 11c. XSA Residuals update run; cont. Black=positive residual; grey=negative residual. Symbols are scaled to the overall maximum residual to permit comparisons across survey series.

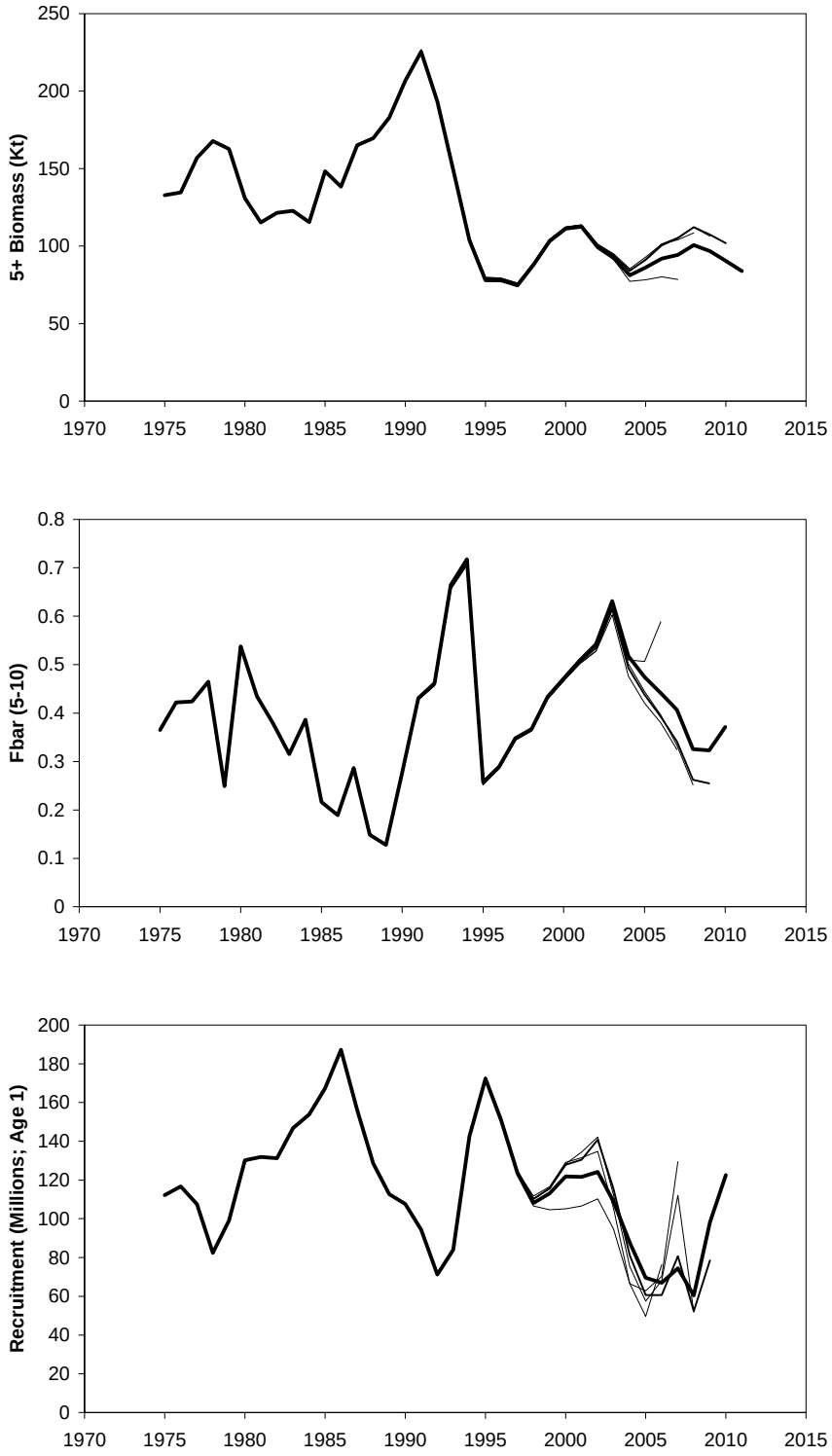


Figure 12. Retrospective Analysis, update run – 5+ biomass (t), Age 1 recruitment (000s) and average fishing mortality (ages 5-10). Bold lines highlight the current assessment.

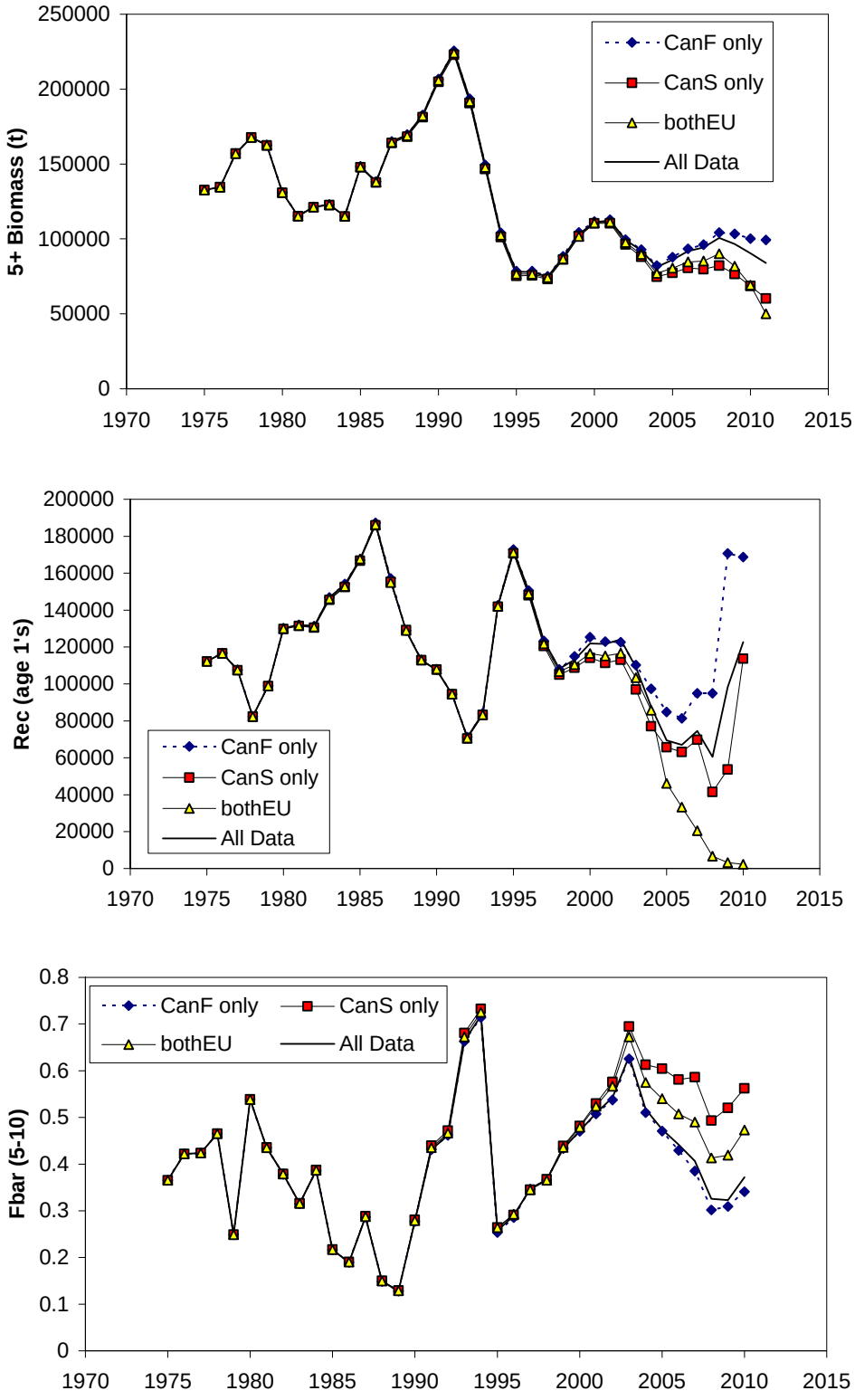


Figure 13. Biomass (5+; tons), Recruitment (age 1; 000s), and average fishing mortality (ages 5-10) from XSA analyses which ***include*** only the survey series identified by the series label. The "All Data" series results use all of the data series.

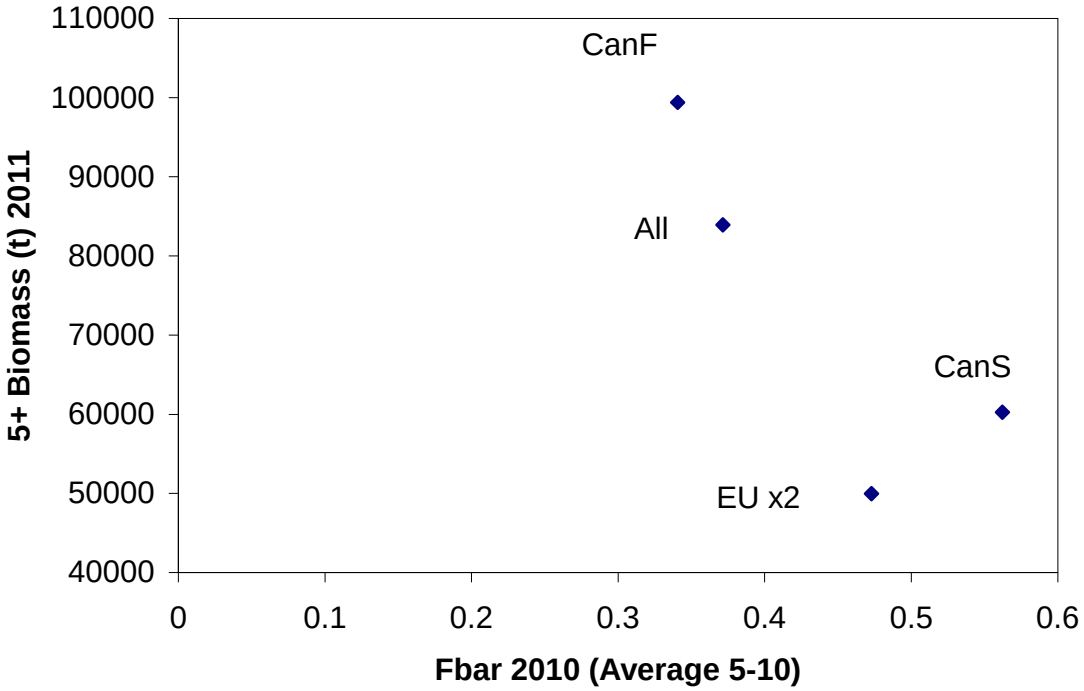


Figure 14. Comparison of exploitable biomass in 2011 and fishing mortality in 2010 for XSA results produced by ***including*** only the named survey series in the analysis. "All" refers to the analysis which includes all four data series.

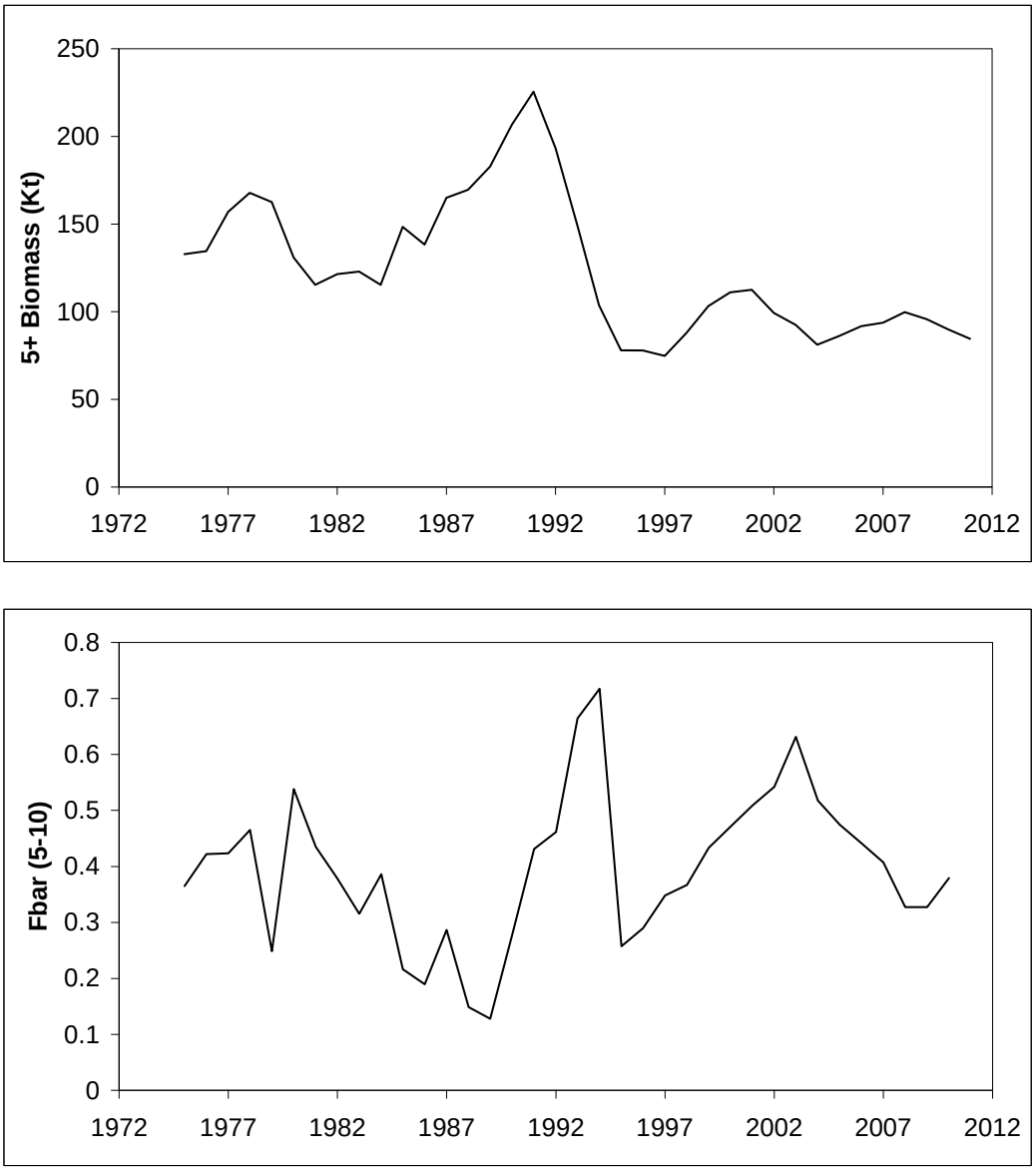


Figure 15a. XSA estimates of exploitable biomass (ages 5+ in tons), and average fishing mortality (ages 5-10) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

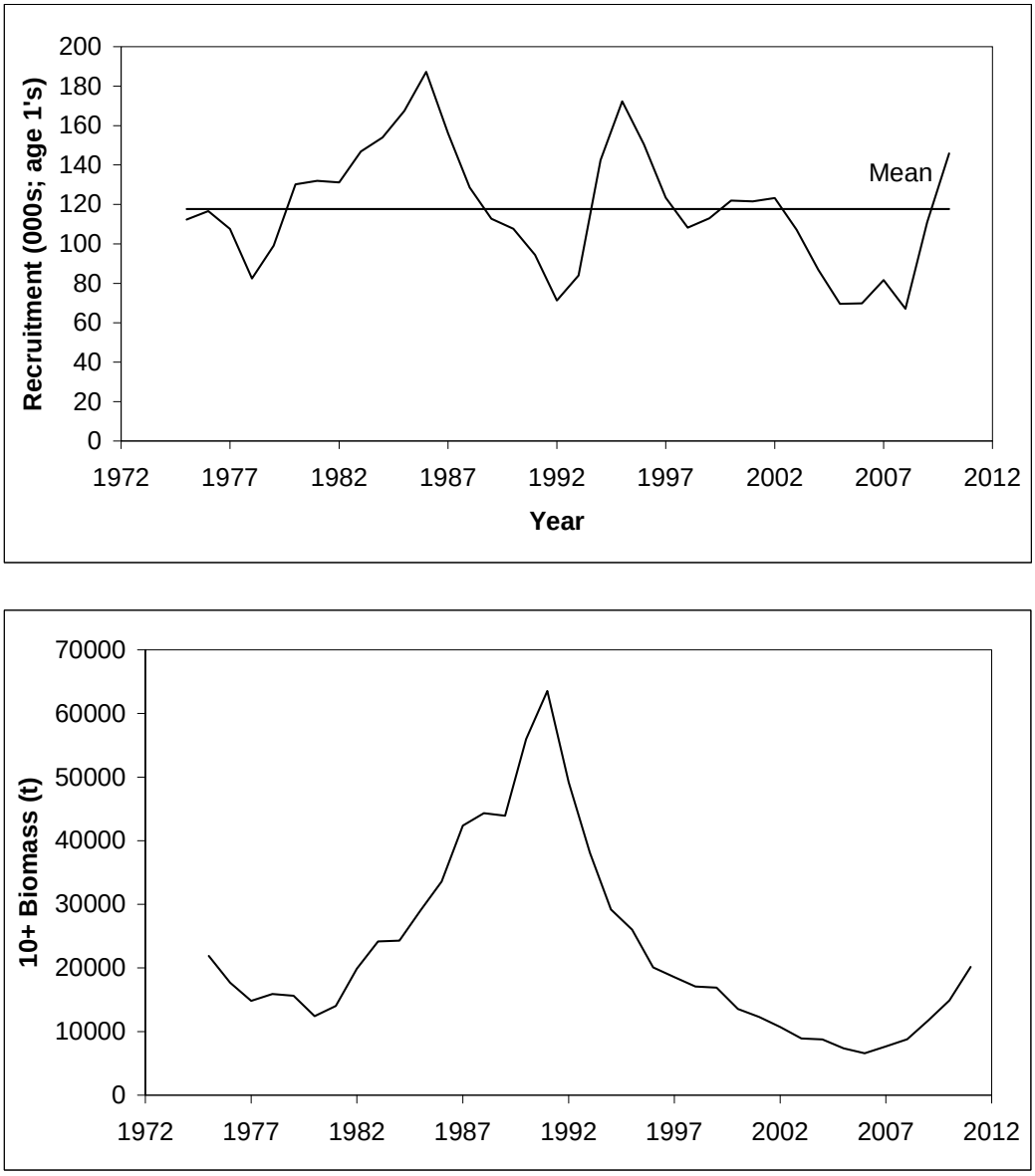
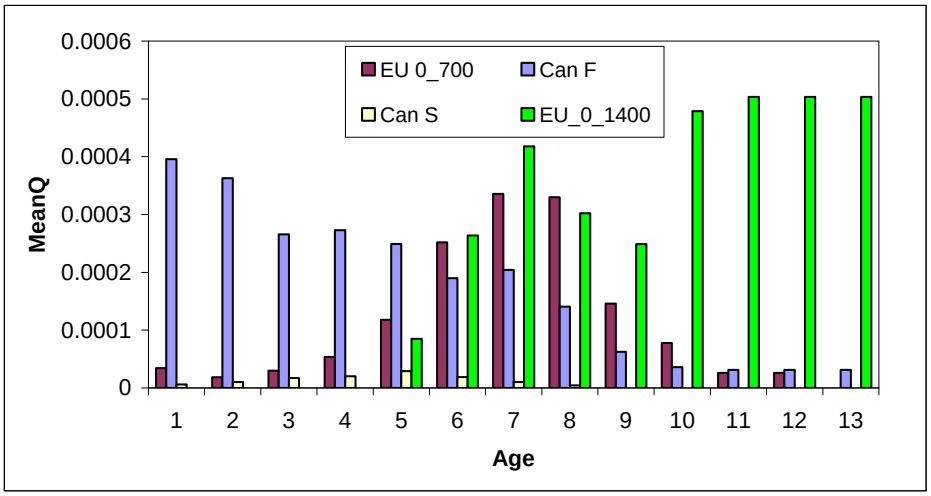
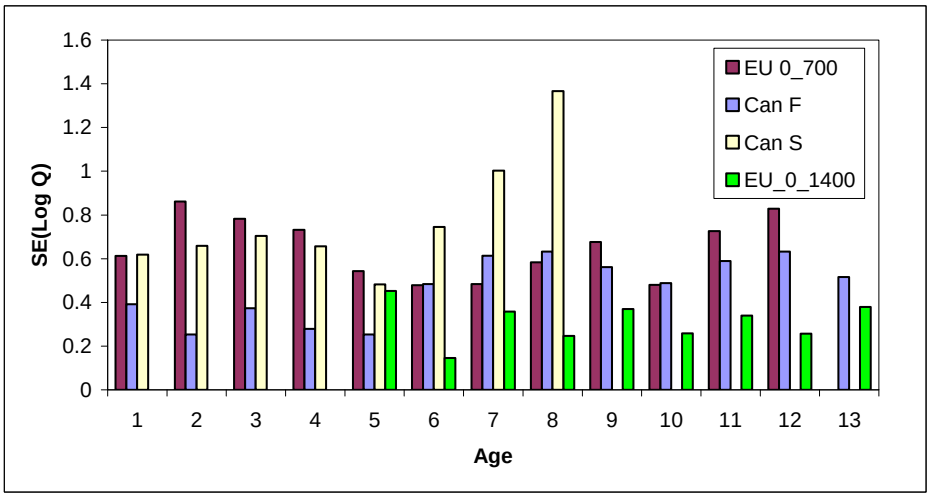


Figure 15b. XSA estimates of age 1 recruitment (000's) and age 10+ biomass (tons) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

Catchabilities



SE(Log q)



Shrinkage Scaled Weights

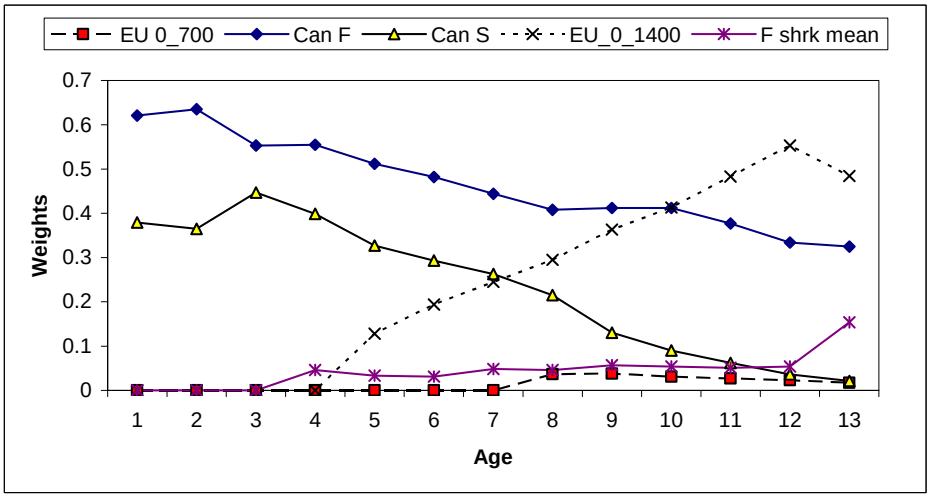


Figure 16. XSA estimated catchabilities, associated standard errors, and the scaled weights used to estimate survivors in the terminal year. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

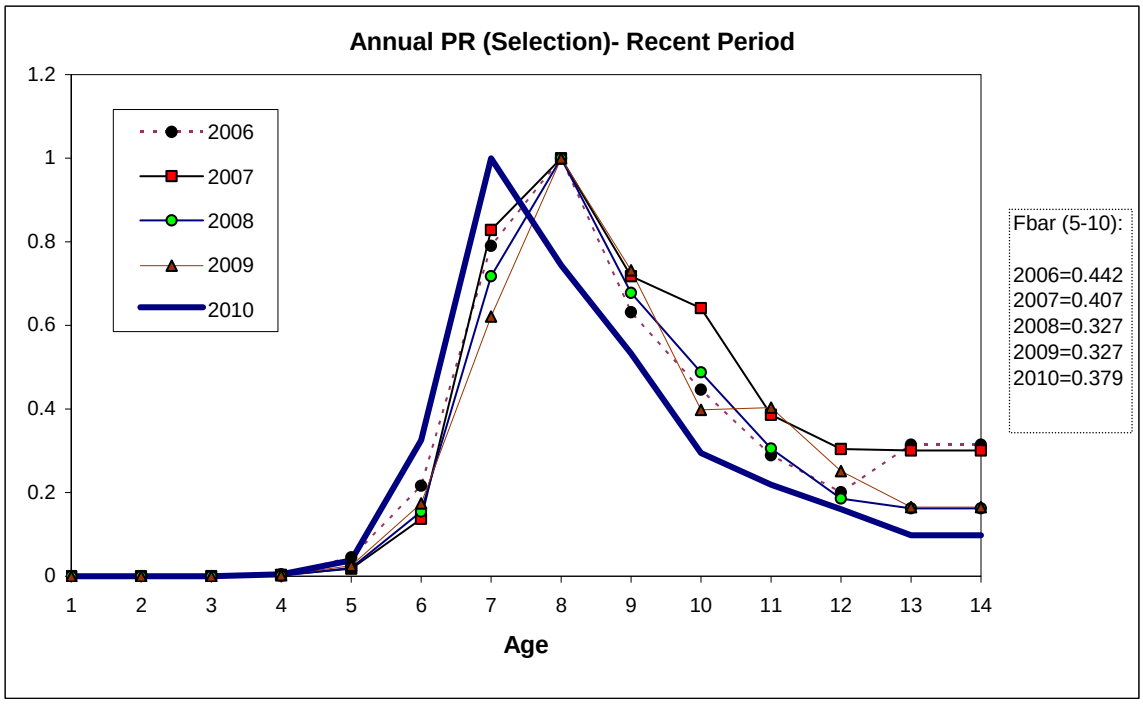


Figure 17. XSA estimated selection pattern in the most recent five years. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

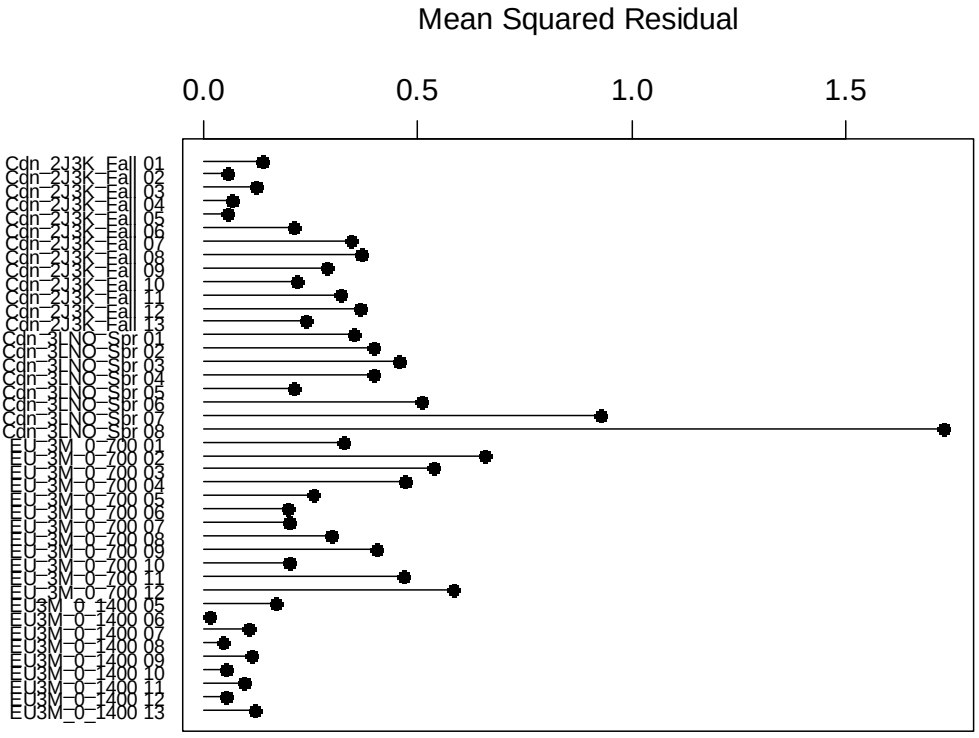


Figure 18a. Mean square residuals from XSA for each survey-age. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

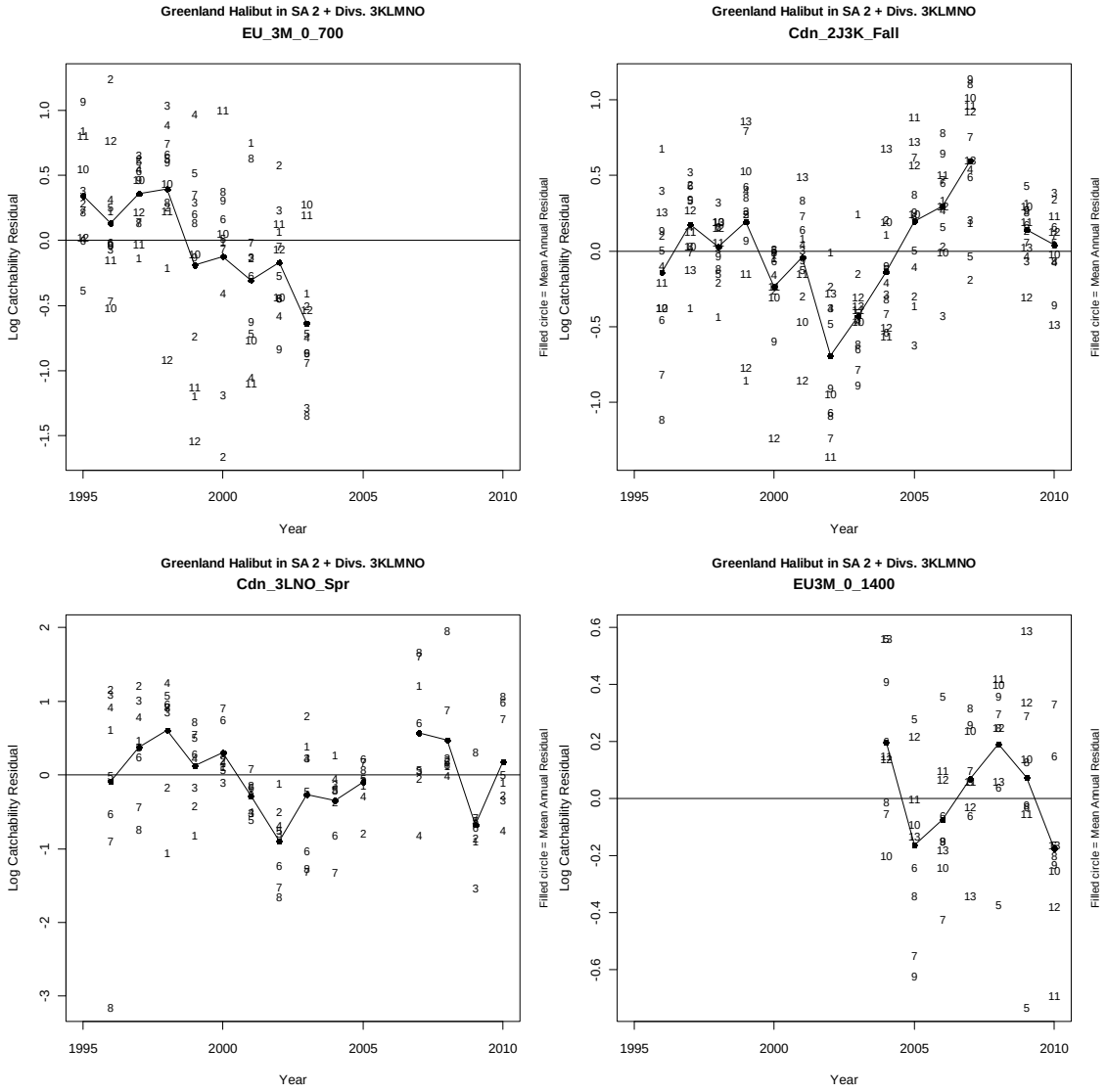


Figure 18b. XSA residuals by survey, age and year. Symbol=age, solid circle=mean annual residual. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

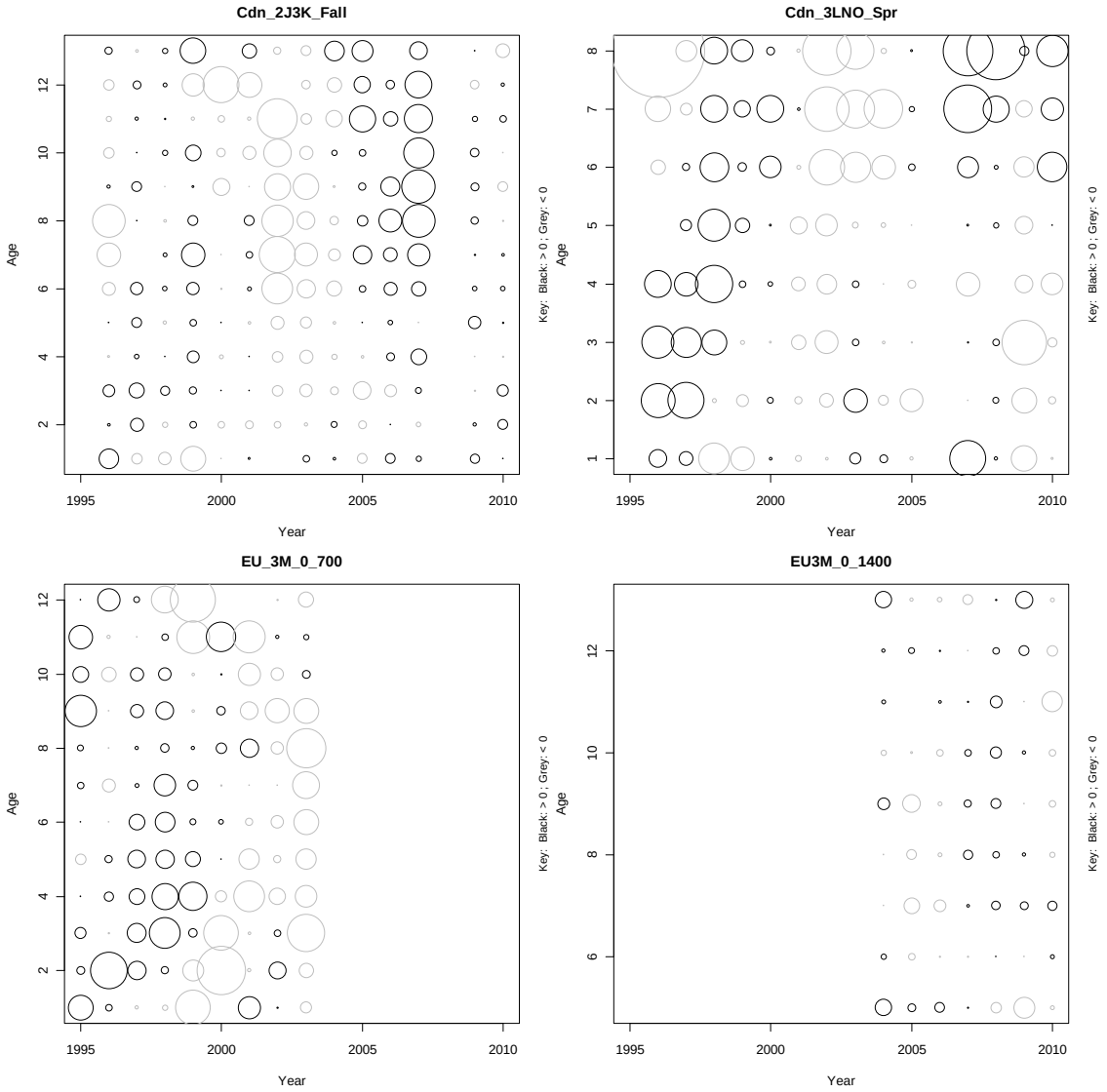


Figure 18c. XSA Residuals; cont. Black=positive residual; grey=negative residual. Symbols are scaled to the overall maximum residual to permit comparisons across survey series. Age 1 - 4 data from EU 0-1400m survey index excluded from analysis.

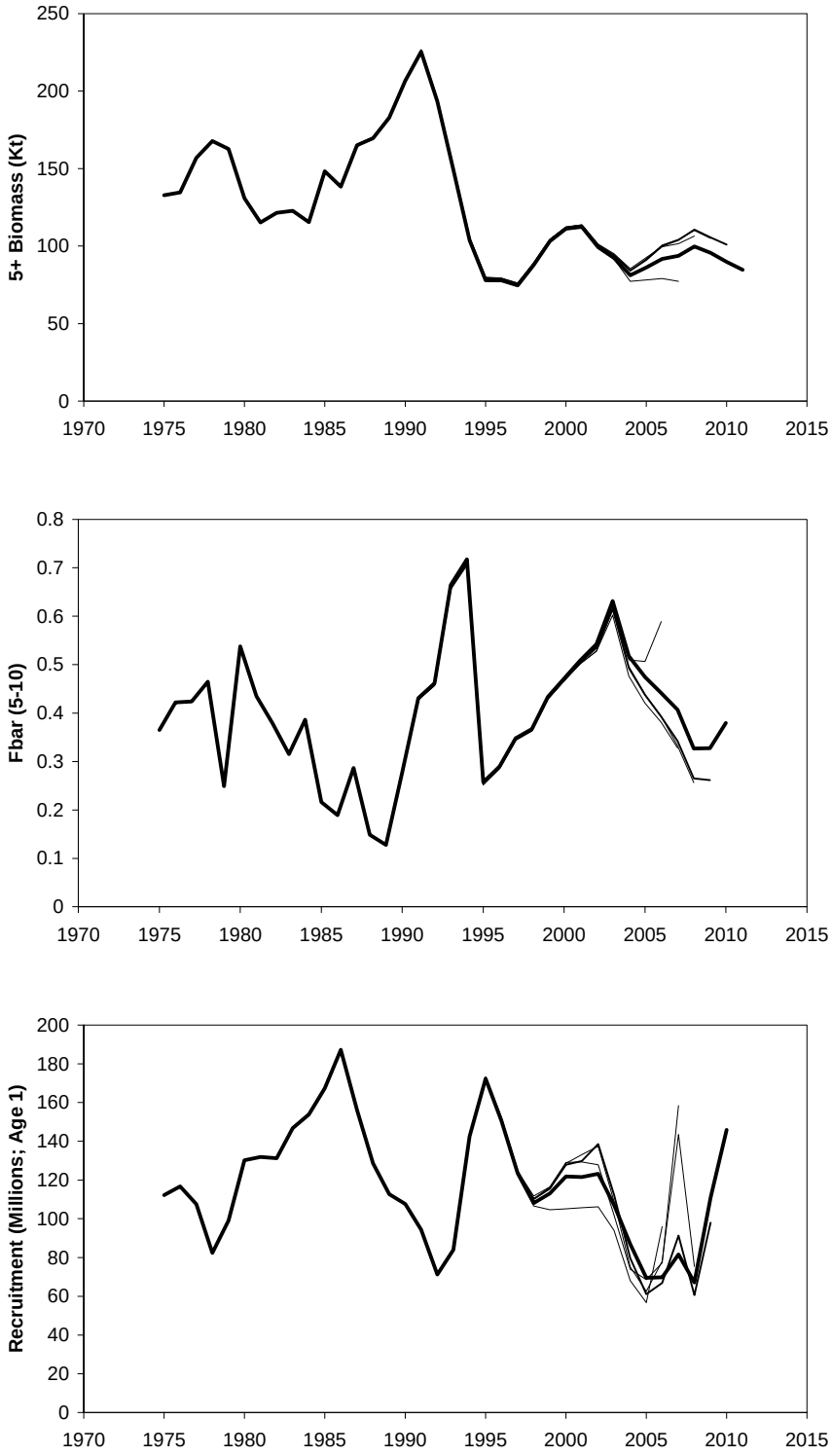


Figure 19. Retrospective Analysis, run 2 – 5+ biomass (t), Age 1 recruitment (000s) and average fishing mortality (ages 5-10). Bold lines highlight the current assessment. Age 1- 4 data from EU 0-1400m survey index excluded from analysis.