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An Assessment of Stock Status of the Greenland Halibut Resource in NAFO Subarea 2 and Divisions 3KLMNO based on Extended Survivors Analysis.

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Abstract

An Extended Survivors Analysis was applied to the commercial catch at age data for Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO from 1975-2001 to assess the current status of the stock. The analysis was calibrated using Canadian and European Union research vessel survey data. Stock biomass at ages 5 and older is estimated to have increased during the late 1980's and then declined rapidly during the period of high landings in the early 1990's. Estimated fishing mortality has followed the trend in landings, increasing rapidly in the early 1990's, remaining high as the stock was reduced to its historic lows and then declining to the low levels recorded during 1985–1990. The reduction in exploitation has resulted from both a decrease in the recorded landings and an increase in biomass following the better than average recruitment of the 1993-1995 year-classes. However, the assessment is considered to be very uncertain with respect to absolute estimates of stock size and it does not match the historic trends in the stock as illustrated by the longest survey series. The increasing trend in the late 1990s is believed to be reflective of the stock trajectory during that period, however, the continued increasing trend since then is inconsistent with the trends in stock size from all other major sources. Given these concerns, the assessment in its present form therefore is considered unreliable for projecting future stock trends and potential catch levels.

Data

The input commercial catch at age data sets are listed in Tables 1 and 2. The catch at age data from 1975-2000 were taken directly as calculated and presented during the 2001 assessment meeting. In the current assessment the Canadian catch-at-age data for 2001 were provided as calculated in the usual fashion (Bowering and Power 2002). In previous years, all non-Canadian catch at age data were computed using Canadian age-length keys applied to length frequency distributions provided by major participants in the fishery. For 2001, however, catch-at-age data were used as provided by EU-Spain and Russia for their respective fisheries in the NRA in 2001. These data when then applied to length frequency data provided in national research reports by countries fishing in the NRA but without age sampling data. In 2001 this applied to EU-Portugal only. The resultant age compositions were then adjusted to the agreed best estimates of total catch including countries fishing the NRA but providing no sampling data.

Table 2 shows that the catch weights at age have been increasing in 2001 for ages up to 7 while a declining trend is observed in recent years on older ages, more pronounced at ages 11 and over.

Updated Canadian and European Union (EU) survey Greenland Halibut catch per unit effort data sets were also made available at the meeting, they are presented in Tables 3 and 4. Catch weights at age and stock weight at age are the same and based on commercial data. In the absence of an agreed maturity ogive, the 10+ biomass is used as a proxy for spawning stock biomass. The 5+ biomass was used as an estimate of exploitable biomass. As in previous assessments of this stock, natural mortality was assumed to be constant at age and in all years at 0.2.

An XSA assessment of Greenland Halibut in Subarea 2 and Divisions 3KLMNO

The details of the methodology of the Extended Survivor Analysis (Shepherd, 1999; Darby and Flatman, 1994) was described in detail in the 2000 assessment document (Darby and Mahé, 2000) and therefore won't be repeated here.

A full investigation of the possible formulation was conducted in 2000 and 2001 (Darby and Mahé, 2000, Mahé and Bowering, 2001). For the 2002 assessment, a first analysis was conducted on the basis of the 2001 assessment settings. The results of this first analysis showed increases in the trends of catchability of both cpues data at older ages and an increase in the retrospective pattern of underestimating biomass and over estimating F in the last year. In view of the residuals patterns, the assessment seemed to be driven mostly by the cpue at ages 4 to 6 from the Canadian survey, less noisy and given most weight due to the inverse variance weighting. In order to balance the contribution of all fleets data, the minimum S.E. threshold used in the weighing was set to a higher value (S.E. of 1.0 instead of 0.5). The results showed some improvement in the retrospective pattern in the last year (Figure 1).

Therefore the final model was fitted with catchability constant in time at all ages, independent of age for ages 1-11 and, for each fleet, constrained at ages 12 and 13 to the value estimated at age 11. A fishing mortality shrinkage constraint was imposed such that the terminal populations in the final year were shrunk towards the average of the preceding five years and at the oldest age, to the two penultimate ages. The log standard error weight for the fishing mortality means was set at 0.5, and the minimum standard error threshold at 1.0. The tuning indices were the Canadian survey in Divisions 2J and 3K and the EU survey in division 3M. The Canadian survey was split in two periods, 1978-1988 and 1989-2001 to account for a shift in catchability observed in the previous screening analysis.

The log catchability estimates, the associated standard errors and the log catchability residuals for the two Canadian survey periods and the EU survey are given in Tables 5 b-c. The log catchability residuals are plotted in Figures 2 and 3.

The log standard errors of catchability, approximations to the coefficient of variation of the original data, are high, generally above 0.5 (50%) except for ages 4 to 6 in the Canadian survey. They are above 1.0 for ages 11 and older in the recent part of the Canadian survey and the EU survey. This indicates a poor model fit. The details of the estimation of survivors by fleet are given in tables 5d. With the high S.E. threshold value, both surveys are given equal weights in the estimation of survivors up to age 11. For most ages, the estimates are relatively consistent. At ages 4 and 5, the F shrinkage estimates are high as a consequence of the recent increase of fishing mortality at those ages in 2001.

The results of this assessment are given in tables 6, 7 and 8. There is a retrospective pattern to under estimate population size and under estimate fishing mortality (figure 1). The recent levels of exploitable biomass have been revised upward and the levels of fishing mortality downward. In view of the trends in catchability residuals, the general high standard errors of the estimates, the results of this assessment are still considered to be indicative of trends recent stock dynamics rather than providing absolute estimates of stock size and fishing mortality. Figure 4 illustrates the estimated stock trends and Figure 5, the stock and recruitment plot using the 10+ biomass as a proxy for spawning stock biomass (SSB).

Stock biomass at ages 5 and older is estimated to have increased during the late 1980's and then declined rapidly during the period of high landings in the early 1990's. Estimated fishing mortality has followed the trend in landings, increasing rapidly in the early 1990's, remaining high as the stock was reduced to its historic lows and then declining to the low levels recorded during 1985–1990. The reduction in exploitation has resulted from both a decrease in the recorded landings and an increase in biomass following the above average recruitment of the 1993-1995 year-classes.

Based on this assessment the stock biomass is estimated to be close to its historically highest level. However, the assessment is noisy and the data have been manipulated to meet model assumptions. Recent absolute point estimates are therefore uncertain.

Summary and Conclusions

The results of the XSA indicate that this resource began an increasing trend in the mid-1990s which was consistent with the commercial CPUE and most survey indices during the period. The increase was propagated by the presence of strong recruitment from the 1993-95 year-classes. Although the absolute level of fishing mortality was unknown, in recent assessments it was considered to be relatively low and at a level that would allow rebuilding. As a result these year-classes were anticipated to contribute substantially to the catches during 2000-2002 and accelerate continued improvement in the stock as they progressed through the population. In the current XSA assessment there was substantial uncertainty in the abundance of the strong year-classes, since these year-classes do not appear to have contributed to the catches in proportions expected. The continuing positive trend in the biomass from XSA after 1999 was largely inconsistent with the major stock size indicators observed. It was therefore considered imprudent to formulate any projections from this assessment. Furthermore, it is now uncertain as to whether the fishing mortality in recent years was as low as previously thought.

From this assessment, concerns are raised about the impact of the changes in the construction of the total catch at age matrix in 2001. Future investigation should be aimed at analysing the impact of the use of different age length keys in the construction of the catch at age matrix. The change in the method used for computing the 2001 catch at age could have the most important effect on the change in the estimated catch weights at age.

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Table 1. Catch numbers at age and total landings for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

	Year								
Age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	334	17	534	2982	2386	209	863	269	701
6	2819	610	5012	8415	8727	2086	4517	2299	3557
7	5750	3231	10798	8970	12824	9150	9806	6319	9800
8	4956	5413	7346	7576	6136	9679	11451	5763	7514
9	3961	3769	2933	2865	1169	5398	4307	3542	2295
10	1688	2205	1013	1438	481	3828	890	1684	692
11	702	829	220	723	287	1013	256	596	209
12	135	260	130	367	149	128	142	256	76
13	279	101	116	222	143	53	43	163	106
+gp	288	53	84	258	284	27	69	191	175
Total Nb	20912	16488	28186	33816	32586	31571	32344	21082	25125
Landings (t)	**28814**	**24611**	**32048**	**39070**	**34104**	**32867**	**30754**	**26278**	**27861**

	Year								
Age	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	95	220	1064
5	902	1983	280	137	296	181	1102	2862	4180
6	2324	5309	2240	1902	3186	1988	6758	7756	10922
7	5844	5913	6411	11004	8136	7480	12632	13152	20639
8	7682	3500	5091	8935	4380	4273	7557	10796	12205
9	4087	1380	1469	2835	1288	1482	4072	7145	4332
10	1259	512	471	853	465	767	2692	3721	1762
11	407	159	244	384	201	438	1204	1865	1012
12	143	99	140	281	105	267	885	1216	738
13	106	87	70	225	107	145	434	558	395
+gp	183	86	117	349	129	71	318	422	335
Total Nb	22937	19028	16533	26905	18293	17092	37749	49713	57584
Landings (t)	**26711**	**20347**	**17976**	**32442**	**19215**	**20034**	**47454**	**65008**	**63193**

	Year								
Age	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	41
3	0	0	0	0	0	0	0	0	201
4	1010	5395	323	190	335	552	297	271	846
5	9570	16500	1352	1659	1903	3575	2149	2029	3683
6	15928	15815	2342	5197	4169	5407	5625	12583	11931
7	17716	11142	3201	6387	7544	5787	8611	21175	15295
8	11918	6739	2130	1914	3215	3653	3793	3299	5871
9	4642	3081	1183	956	1139	1435	1659	973	1598
10	1836	1103	540	504	606	541	623	528	680
11	1055	811	345	436	420	377	343	368	573
12	964	422	273	233	246	161	306	203	375
13	401	320	251	143	137	92	145	129	287
+gp	182	215	201	89	89	51	151	104	234
Total Nb	65222	61543	12141	17708	19803	21631	23702	41662	41615
Landings (t)	**62455**	**51029**	**15272**	**18840**	**19858**	**19946**	**24226**	**34177**	**38232**

Table 2. Catch weights at age for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

	Year								
Age	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126
4	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244
5	0.609	0.609	0.609	0.609	0.609	0.514	0.392	0.525	0.412
6	0.76	0.76	0.76	0.76	0.76	0.659	0.598	0.684	0.629
7	0.955	0.955	0.955	0.955	0.955	0.869	0.789	0.891	0.861
8	1.19	1.19	1.19	1.19	1.19	1.05	0.985	1.13	1.18
9	1.58	1.58	1.58	1.58	1.58	1.15	1.24	1.4	1.65
10	2.21	2.21	2.21	2.21	2.21	1.26	1.7	1.79	2.23
11	2.7	2.7	2.7	2.7	2.7	1.57	2.46	2.38	3.01
12	3.37	3.37	3.37	3.37	3.37	2.71	3.51	3.47	3.96
13	3.88	3.88	3.88	3.88	3.88	3.12	4.79	4.51	5.06
+gp	5.764	5.144	5.992	5.894	6.077	5.053	7.426	7.359	7.061

	Year								
Age	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0.126	0.126	0.126	0.126	0.126	0.126	0.09	0.126	0.175
4	0.244	0.244	0.244	0.244	0.244	0.244	0.181	0.244	0.289
5	0.377	0.568	0.35	0.364	0.363	0.4	0.338	0.383	0.43
6	0.583	0.749	0.584	0.589	0.569	0.561	0.546	0.592	0.577
7	0.826	0.941	0.811	0.836	0.805	0.767	0.766	0.831	0.793
8	1.1	1.24	1.1	1.16	1.163	1.082	1.119	1.228	1.234
9	1.46	1.69	1.58	1.59	1.661	1.657	1.608	1.811	1.816
10	1.94	2.24	2.12	2.13	2.216	2.237	2.173	2.461	2.462
11	2.63	2.95	2.89	2.82	3.007	2.997	2.854	3.309	3.122
12	3.49	3.71	3.89	3.6	3.925	3.862	3.731	4.142	3.972
13	4.49	4.85	4.95	4.63	5.091	4.919	4.691	5.333	5.099
+gp	7.016	7.01	7.345	6.454	7.164	6.37	6.391	7.081	6.648

	Year								
Age	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0.172
3	0.134	0.08	0.08	0.161	0.12	0.119	0.176	0	0.273
4	0.232	0.196	0.288	0.242	0.206	0.228	0.253	0.254	0.377
5	0.368	0.33	0.363	0.36	0.336	0.373	0.358	0.346	0.509
6	0.547	0.514	0.531	0.541	0.489	0.543	0.533	0.524	0.681
7	0.809	0.788	0.808	0.832	0.771	0.81	0.825	0.787	0.85
8	1.207	1.179	1.202	1.272	1.159	1.203	1.253	1.192	1.05
9	1.728	1.701	1.759	1.801	1.727	1.754	1.675	1.774	1.411
10	2.309	2.268	2.446	2.478	2.355	2.351	2.287	2.279	2.007
11	2.999	2.99	3.122	3.148	3.053	3.095	2.888	2.895	2.567
12	3.965	3.766	3.813	3.856	3.953	4.01	3.509	3.645	3.065
13	4.816	4.882	4.893	4.953	5.108	5.132	4.456	4.486	3.767
+gp	6.489	6.348	6.79	6.312	6.317	6.124	5.789	5.531	4.952

Table 3. The European Union survey catch numbers at age data set for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

Start of fishing	0.5
End of fishing	0.6

		Numbers at age											
Year	**Effort**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1991	1	349	-1	235	993	1956	1253	2283	545	464	388	122	-1
1992	1	922	800	286	861	1600	1996	1793	991	473	266	139	67
1993	1	937	933	599	566	960	1574	1732	1388	905	257	141	51
1994	1	832	706	1082	1224	1365	2233	2096	1213	689	264	95	54
1995	1	6165	1394	1369	1249	1709	3793	3026	1729	1134	254	68	26
1996	1	2874	4613	1527	2066	3070	4394	2020	1378	392	75	31	35
1997	1	1597	2113	4396	5157	5216	6045	3885	1709	593	200	33	22
1998	1	1434	1268	5149	7835	9168	8821	6334	2339	703	201	27	6
1999	1	525	426	1904	7178	9818	9599	4382	1544	322	101	8	4
2000	1	1602	147	312	1405	5557	11591	4093	1701	351	98	49	-1
2001	1	4157	839	1154	687	2044	5927	5569	2978	168	49	7	-1

Table 4. The Canadian survey catch numbers at age data set for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

Start of fishing	0.8
End of fishing	1

		Numbers at age															
Year	**Effort**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1978	1	67133	315362	243378	146864	90817	68595	40908	19170	9940	7366	6469	4117	2683	992	560	365
1979	1	76275	128771	95883	50861	53099	50976	24408	9977	4777	4572	3000	2638	2193	1079	699	624
1980	1	47941	46187	43767	39304	49738	52627	32283	11102	4960	3891	4461	2882	1874	1070	411	231
1981	1	141166	158149	109462	41433	47202	49991	35482	15613	7017	4213	3349	1559	857	446	268	43
1982	1	33748	39589	88918	75651	57104	41105	43097	41244	16566	6765	4129	2714	1929	1975	1257	589
1983	1	12131	34727	71282	75711	71101	51583	50698	39418	15223	4414	3180	2291	1664	1109	495	131
1984	1	31845	50917	70143	74837	103171	61334	42301	27028	13058	6306	2602	1812	1480	1285	677	461
1985	1	192902	113558	65428	54235	66317	69541	42805	17028	7982	5296	2257	1997	874	1002	606	302
1986	1	125257	106161	112555	104606	72301	81840	71749	22142	6546	2380	1856	1668	879	542	555	318
1987	1	36234	81046	212676	99109	75271	53188	47138	25791	9434	2833	1481	1454	754	583	385	204
1988	1	74055	71555	109246	114836	119818	59218	41431	12233	3134	1105	781	463	361	327	236	149
1989	1	52954	95755	174201	174689	108472	87210	38560	9604	2847	747	568	151	35	81	103	31
1990	1	9858	39744	70539	177413	115858	70699	36649	6200	1500	746	640	389	223	155	90	21
1991	1	84583	59211	44644	103158	65701	40331	12485	2383	635	310	181	104	22	8	-1	4
1992	1	52907	188121	148380	95263	38552	22088	10472	1067	140	89	12	-1	-1	15	-1	-1
1993	1	62241	281182	497522	182333	42962	13677	5905	1967	232	32	22	94	41	24	-1	-1
1994	1	226026	164066	171549	143398	54795	10007	4606	1402	191	64	17	16	8	-1	-1	-1
1995	1	342056	397121	122856	39605	50370	15863	3513	920	266	104	49	-1	-1	-1	-1	-1
1996	1	793447	452542	267483	96568	55611	22305	7422	1920	1141	377	178	115	118	42	10	-1
1997	1	222012	486571	398365	192045	89809	40112	17321	5658	1547	493	280	151	100	54	-1	-1
1998	1	199610	216980	265730	188600	92110	38350	17250	4770	1100	580	240	150	140	20	-1	20
1999	1	93492	289040	217037	227676	162884	90149	29589	5048	1100	415	143	86	170	10	-1	-1
2000	1	322796	182144	139877	99212	111556	65480	19417	3379	670	210	165	17	20	54	-1	-1
2001	1	360130	192986	150045	130034	81596	70117	31107	5324	794	202	95	45	107	11	-1	-1

Table 5a. The parameter selections specified for the final XSA model for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

Lowestoft VPA Version 3.1

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Extended Survivors Analysis

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

CPUE data from file GhalTUN.txt

Catch data for 27 years. 1975 to 2001. Ages 1 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
CAN RV1	1978	2001	1	13	0.8	1
CAN RV2	1989	2001	1	13	0.8	1
EU Survey	1991	2001	1	12	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 vear survivor estimates shrunk towards the mean F of the final 5 vears.
S.E. of the mean to which the estimates are shrunk = 0.500

Oldest age survivor estimates for the years 1975 to 2001
shrunk towards1.000 * the mean F of ages 11 - 12

S.E. of the mean to which the estimates are shrunk = 0.500

Minimum standard error for population estimates from each cohort age = 1.000

Individual fleet weighting not applied

Tuning converged after 63 iterations

Regression weights

1 1 1 1 1 1 1 1 1 1

Table 5b. The diagnostics of the XSA fit to the Canadian survey catch per unit effort data for the years 1978 – 1987 (CAN RV1) and 1988-2001 (CAN RV2), for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

Log catchability residuals.

Fleet : CAN RV1

Age	1978	1979	1980	1981
1	0.63	0.58	-0.16	0.9
2	1.58	0.9	-0.3	0.65
3	1.05	0.19	-0.37	0.36
4	0.82	-0.27	-0.46	-0.18
5	0.05	-0.14	-0.27	-0.24
6	-0.06	-0.23	0.03	-0.04
7	-0.03	-0.73	-0.4	0.04
8	-0.14	-0.81	-0.7	-0.11
9	0.38	-1	-0.27	-0.13
10	1.15	0.01	-0.11	0.21
11	1.69	0.6	0.57	-0.05
12	1.01	1.48	1	-0.07
13	1.42	0.9	1.63	0.12

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	-0.51	-1.65	-0.74	0.96	0.42	-0.66	0.24	99.99	99.99	99.99
2	-0.75	-0.87	-0.6	0.15	-0.02	-0.4	-0.35	99.99	99.99	99.99
3	-0.12	-0.36	-0.36	-0.54	-0.05	0.48	-0.29	99.99	99.99	99.99
4	0.24	-0.04	-0.06	-0.37	0.17	0.06	0.11	99.99	99.99	99.99
5	0.16	0.21	0.3	-0.14	-0.06	-0.14	0.27	99.99	99.99	99.99
6	-0.2	0.3	0.24	0.14	0.24	-0.22	-0.21	99.99	99.99	99.99
7	0.04	0.42	0.4	0.11	0.37	0.03	-0.24	99.99	99.99	99.99
8	0.92	0.71	0.81	0.05	0.02	0.09	-0.84	99.99	99.99	99.99
9	1.09	0.72	0.72	0.35	-0.29	-0.09	-1.48	99.99	99.99	99.99
10	0.68	0.34	0.5	0.27	-0.45	-0.69	-1.9	99.99	99.99	99.99
11	0.63	0.1	0.12	-0.41	-0.65	-0.7	-1.9	99.99	99.99	99.99
12	0.15	0.38	-0.12	0.2	-0.4	-0.47	-1.55	99.99	99.99	99.99
13	0.63	0	0.33	-0.52	-0.3	-0.74	-1.52	99.99	99.99	99.99

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	11	12	13
Mean Log q	-0.6716	-0.092	0.303	0.2613	0.4449	0.5303	0.7558	0.7641	0.6184	0.6205	0.8393	0.8393	0.8393
S.E(Log q)	0.8182	0.7613	0.479	0.3503	0.2073	0.2036	0.3533	0.6246	0.7642	0.8102	0.9295	0.8488	0.9593

Regression statistics :

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

Age	Slope	t-value	Intercep	RSquar	No Pts	Reg s.e	Mean Q
1	5.24	-0.73	-46.67	0	11	4.39	-0.67
2	-1.85	-1.791	32.97	0.04	11	1.28	-0.09
3	1.49	-0.524	-6.05	0.11	11	0.74	0.3
4	0.86	0.292	1.28	0.34	11	0.32	0.26
5	0.93	0.236	0.41	0.52	11	0.2	0.44
6	2.15	-1.938	-13.43	0.24	11	0.39	0.53
7	-2.35	-3.288	36.47	0.1	11	0.59	0.76
8	-1.3	-1.9	23.6	0.07	11	0.73	0.76
9	-0.91	-2.155	17.73	0.12	11	0.59	0.62
10	-2.36	-1.713	29.07	0.03	11	1.75	0.62
11	-0.6	-3.161	12.56	0.3	11	0.41	0.84
12	-1.54	-2.994	19.14	0.13	11	0.96	0.99
13	-1.44	-3.44	17.29	0.18	11	0.94	1.02

Table 5c. The diagnostics of the XSA fit to the Canadian survey catch per unit effort data for the years 1988-2001 (CAN RV2), for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

Fleet : CAN RV2

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.52	-2.2	0.06
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.47	-1.26	-0.86
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.02	-0.71	-1.08
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.16	0.35	-0.02
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.26	0.23	-0.15
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.71	0.48	-0.18
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.67	0.67	-0.41
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.67	0.21	-0.44
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.93	0.27	-0.27
10	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.72	0.74	0.04
11	99.99	99.99	99.99	99.99	99.99	99.99	99.99	1.35	1.33	0.33
12	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.6	1.57	0.24
13	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.06	1.54	-0.56

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	-0.25	-0.32	0.34	0.39	1.13	0.34	0.23	0.23	0.66	-0.09
2	0.41	0.97	0.2	0.46	0.22	0.19	-0.13	0.15	0.45	-0.31
3	0.12	1.45	0.54	-0.02	0.13	0.16	-0.34	-0.07	-0.51	0.32
4	0	0.65	0.6	-0.61	0.04	0.11	-0.28	-0.19	-0.54	-0.27
5	-0.47	-0.14	0.27	0.06	0.23	0.47	-0.13	0.05	-0.43	-0.24
6	-0.49	-0.54	-0.46	-0.32	-0.06	0.57	0.29	0.46	-0.21	-0.26
7	-0.48	-0.62	-0.43	-0.73	-0.24	0.56	0.52	0.88	-0.13	-0.26
8	-1.14	-0.28	-0.3	-0.67	-0.07	0.83	0.66	0.66	0	-0.13
9	-1.58	-0.83	-0.87	-0.54	0.88	1.06	0.56	0.6	-0.07	-0.14
10	-1.06	-1.79	-0.95	-0.48	0.76	1.01	1	0.51	-0.15	-0.36
11	-2.38	-1.58	-1.51	-0.54	0.76	1.14	0.95	0.22	0.19	-0.26
12	99.99	0.45	-1.41	99.99	0.7	0.99	0.84	0.34	-1.6	-0.73
13	99.99	0.12	-1.4	99.99	1.29	0.91	1.23	1.31	-0.78	0.65

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	11	12	13
Mean Log q	-0.1603	0.4914	0.6244	0.5172	0.256	-0.0786	-0.3678	-1.1919	-2.1149	-2.6843	-2.9638	-2.9638	-2.9638
S.E(Log q)	0.7917	0.6003	0.619	0.3874	0.287	0.4423	0.5703	0.5924	0.8073	0.8903	1.2017	1.0232	1.0669

Regression statistics :

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

Age	Slope	t-value	Intercep	RSquar	No Pts	Reg s.e	Mean Q
1	0.6	1.713	4.93	0.63	13	0.44	-0.16
2	0.98	0.051	-0.24	0.37	13	0.61	0.49
3	1.65	-0.96	-8.58	0.17	13	1.03	0.62
4	1.42	-1.112	-5.55	0.39	13	0.55	0.52
5	1.41	-1.549	-4.93	0.57	13	0.38	0.26
6	1.02	-0.076	-0.16	0.51	13	0.47	-0.08
7	1.01	-0.026	0.27	0.4	13	0.6	-0.37
8	1.35	-0.591	-1.84	0.2	13	0.82	-1.19
9	1.95	-0.701	-4.5	0.05	13	1.61	-2.11
10	0.97	0.038	2.86	0.12	13	0.9	-2.68
11	0.93	0.054	3.31	0.06	13	1.17	-2.96
12	1.65	-0.283	-0.39	0.02	11	1.74	-2.78
13	0.82	0.136	3.4	0.06	11	0.84	-2.57

Table 5d. Diagnostics of the fit to the European Union survey data for the years 1991 - 2001, for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

Fleet : EU Survey

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.79
2	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
3	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.2
4	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.34
5	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.41
6	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.47
7	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.64
8	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-1.34
9	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	-0.51
10	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.41
11	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	0.7
12	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
13	No data for this fleet at this age									

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	0.34	0.13	-0.62	1.01	0.16	0.05	-0.06	-0.31	0	0.09
2	0.34	0.65	0.14	0.2	1.02	0.15	0.12	-0.98	-1.28	-0.35
3	-1	-0.15	0.6	0.61	0.09	0.78	0.84	0.33	-1.49	0.58
4	-0.39	-0.81	0.12	0.25	0.52	0.81	0.86	0.67	-0.48	-1.2
5	-0.41	-0.75	-0.29	-0.07	0.58	0.88	0.81	0.5	-0.17	-0.67
6	-0.75	-0.65	0.03	0.44	0.47	0.85	0.99	0.41	0.23	-0.55
7	-0.85	-0.5	0.14	0.64	-0.07	0.53	1.01	0.45	-0.26	-0.45
8	-0.68	-0.14	0.09	0.65	0.31	0.32	0.62	0.15	0.02	-0.01
9	-0.24	0.6	0.53	1.14	0.06	0.34	0.35	-0.41	-0.45	-1.43
10	0.27	0.48	0.7	0.7	-0.56	0.4	0.25	-0.59	-0.59	-1.47
11	0.91	1.1	1.02	0.68	-0.11	-0.11	-0.34	-1.76	-0.11	-1.99
12	0.78	0.59	0.67	0.25	0.4	-0.05	-1.46	-1.85	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	11	12
Mean Log q	-4.873	-4.9708	-4.5746	-3.8719	-3.081	-2.3677	-2.0439	-2.0568	-2.5054	-3.1128	-3.9898	-3.9898
S.E(Log q)	0.4793	0.6996	0.8466	0.6905	0.5909	0.7617	0.599	0.5746	0.7022	0.6961	1.0591	1.0127

Regression statistics :

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

Age	Slope	t-value	Intercep	RSquar	No Pts	Reg s.e	Mean Q
1	0.77	1.106	6.53	0.73	11	0.37	-4.87
2	0.8	0.512	6.39	0.44	10	0.58	-4.97
3	0.76	0.551	6.29	0.36	11	0.66	-4.57
4	0.7	0.897	6.17	0.49	11	0.49	-3.87
5	0.96	0.092	3.39	0.39	11	0.6	-3.08
6	2.64	-1.356	-11.67	0.07	11	1.93	-2.37
7	8.36	-3.311	-59.68	0.02	11	3.55	-2.04
8	-11.26	-3.403	95.9	0.01	11	4.51	-2.06
9	-3.81	-1.994	33.92	0.02	11	2.35	-2.51
10	1.41	-0.355	0.93	0.08	11	1.03	-3.11
11	0.69	0.32	5.25	0.1	11	0.76	-3.99
12	0.35	0.938	6.29	0.26	8	0.36	-4.07

Table 5e. The XSA estimates of survivors at the beginning of 2002 derived from each survey, their standard errors and the combined weighted average; for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	414338	1	0	0	1	0.5	0
EU Survey	496596	1	0	0	1	0.5	0
F shrinkage mean	0	0.5				0	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
453606	0.71	0.09	2	0.128	0

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

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	187579	0.707	0.483	0.68	2	0.5	0
EU Survey	131596	0.707	0.174	0.25	2	0.5	0
F shrinkage mean	0	0.5				0	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
157114	0.5	0.23	4	0.467	0

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	79782	0.577	0.062	0.11	3	0.5	0
EU Survey	40852	0.577	0.538	0.93	3	0.5	0
F shrinkage mean	0	0.5				0	0

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
57090	0.41	0.28	6	0.698	0

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	89899	0.5	0.175	0.35	4	0.332	0.008
EU Survey	39162	0.5	0.307	0.61	4	0.332	0.019
F shrinkage mean	277927	0.5				0.335	0.003

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
99539	0.29	0.36	9	1.248	0.008

Table 5e (cont). The XSA estimates of survivors at the beginning of 2002 derived from each survey, their standard errors and the combined weighted average; for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	68761	0.447	0.142	0.32	5	0.353	0.047
EU Survey	68440	0.447	0.189	0.42	5	0.353	0.048
F shrinkage mean	106278	0.5				0.295	0.031

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
78048	0.27	0.12	11	0.435	0.042

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

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	97104	0.408	0.24	0.59	6	0.363	0.105
EU Survey	114503	0.408	0.211	0.52	6	0.363	0.09
F shrinkage mean	73638	0.5				0.273	0.137

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
95596	0.25	0.14	13	0.548	0.107

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

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	55755	0.378	0.099	0.26	7	0.357	0.222
EU Survey	95673	0.378	0.207	0.55	7	0.357	0.135
F shrinkage mean	28322	0.5				0.287	0.398

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
55654	0.24	0.17	15	0.727	0.222

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

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	21355	0.364	0.092	0.25	8	0.328	0.222
EU Survey	22418	0.364	0.167	0.46	8	0.328	0.213
F shrinkage mean	14893	0.5				0.344	0.305

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19165	0.24	0.09	17	0.381	0.245

Table 5e (cont). The XSA estimates of survivors at the beginning of 2002 derived from each survey, their standard errors and the combined weighted average; for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	8251	0.353	0.118	0.34	9	0.337	0.161
EU Survey	7675	0.353	0.285	0.81	9	0.337	0.173
F shrinkage mean	6031	0.5				0.326	0.215

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7271	0.23	0.13	19	0.536	0.181

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

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	4744	0.345	0.159	0.46	10	0.345	0.122
EU Survey	4017	0.345	0.277	0.8	10	0.345	0.143
F shrinkage mean	3562	0.5				0.31	0.159

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4099	0.23	0.13	21	0.565	0.14

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

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	2991	0.361	0.143	0.4	11	0.317	0.16
EU Survey	1494	0.359	0.269	0.75	11	0.329	0.298
F shrinkage mean	2713	0.5				0.354	0.175

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2299	0.24	0.14	23	0.561	0.203

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

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	1758	0.356	0.212	0.6	12	0.36	0.176
EU Survey	1539	0.391	0.156	0.4	9	0.278	0.199
F shrinkage mean	1910	0.5				0.362	0.163

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1746	0.25	0.11	22	0.435	0.178

Table 5e (cont). The XSA estimates of survivors at the beginning of 2002 derived from each survey, their standard errors and the combined weighted average; for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	8251	0.353	0.118	0.34	9	0.337	0.161
EU Survey	7675	0.353	0.285	0.81	9	0.337	0.173
F shrinkage mean	6031	0.5				0.326	0.215

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7271	0.23	0.13	19	0.536	0.181

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

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	4744	0.345	0.159	0.46	10	0.345	0.122
EU Survey	4017	0.345	0.277	0.8	10	0.345	0.143
F shrinkage mean	3562	0.5				0.31	0.159

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4099	0.23	0.13	21	0.565	0.14

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

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	2991	0.361	0.143	0.4	11	0.317	0.16
EU Survey	1494	0.359	0.269	0.75	11	0.329	0.298
F shrinkage mean	2713	0.5				0.354	0.175

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2299	0.24	0.14	23	0.561	0.203

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

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	1758	0.356	0.212	0.6	12	0.36	0.176
EU Survey	1539	0.391	0.156	0.4	9	0.278	0.199
F shrinkage mean	1910	0.5				0.362	0.163

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1746	0.25	0.11	22	0.435	0.178

Table 5e (cont). The XSA estimates of survivors at the beginning of 2002 derived from each survey, their standard errors and the combined weighted average; for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
CAN RV1	1	0	0	0	0	0	0
CAN RV2	1005	0.355	0.269	0.76	13	0.375	0.23
EU Survey	819	0.398	0.305	0.77	9	0.244	0.275
F shrinkage mean	1232	0.5				0.381	0.191

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1033	0.25	0.16	23	0.625	0.224

Table 6. The estimates of fishing mortality at age derived from an XSA model fitted to the data for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

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Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 8 Fishing mortality (F) at age

YEAR	1975	1976	1977	1978	1979	1980	1981
AGE							
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0.0067	0.0003	0.008	0.0487	0.0553	0.0046	0.0205
6	0.0994	0.015	0.1297	0.1685	0.1965	0.0626	0.1296
7	0.3085	0.1582	0.3971	0.3604	0.4179	0.3257	0.4637
8	0.4653	0.5371	0.6464	0.5408	0.4503	0.6504	0.888
9	0.5914	0.7993	0.636	0.5671	0.1453	0.9445	0.6893
10	0.5829	0.795	0.5139	0.76	0.1702	0.9817	0.3805
11	0.4086	0.6435	0.1602	0.881	0.325	0.6486	0.1466
12	0.3363	0.2591	0.1899	0.4368	0.4397	0.2347	0.17
13	0.3749	0.4547	0.1758	0.5732	0.3021	0.2743	0.1149
+gp	0.3749	0.4547	0.1758	0.5732	0.3021	0.2743	0.1149
FBAR 5-10	0.3424	0.3842	0.3885	0.4076	0.2392	0.4949	0.4286

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0.0012	0.0032
5	0.0079	0.0173	0.017	0.037	0.0052	0.0023	0.0047	0.0026	0.0141	0.0441
6	0.0699	0.1379	0.0734	0.1312	0.0535	0.0444	0.0669	0.039	0.1249	0.1305
7	0.2699	0.4736	0.3519	0.27	0.2316	0.3998	0.2707	0.2211	0.3697	0.38
8	0.5507	0.5977	0.8673	0.3689	0.3945	0.5862	0.2731	0.2224	0.3643	0.6291
9	0.7773	0.442	0.7839	0.3608	0.2597	0.3989	0.1512	0.139	0.3424	0.7083
10	0.6422	0.3292	0.4659	0.201	0.1998	0.2361	0.1034	0.1264	0.4018	0.6084
11	0.4759	0.1468	0.3286	0.096	0.1388	0.2488	0.0797	0.1339	0.2989	0.542
12	0.2142	0.0997	0.1417	0.1228	0.1147	0.235	0.0991	0.1446	0.4362	0.5617
13	0.3007	0.1287	0.1968	0.1201	0.1198	0.2726	0.1315	0.1932	0.3695	0.5466
+gp	0.3007	0.1287	0.1968	0.1201	0.1198	0.2726	0.1315	0.1932	0.3695	0.5466
FBAR 5-10	0.3863	0.3329	0.4265	0.2281	0.1907	0.2779	0.145	0.1251	0.2695	0.4167

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-2001
AGE											
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0.0172	0.0163	0.1021	0.0068	0.0032	0.003	0.0034	0.0017	0.0025	0.0077	0.0039
5	0.0783	0.2115	0.3985	0.0335	0.0439	0.0398	0.0399	0.0164	0.014	0.0418	0.0241
6	0.2357	0.4763	0.6453	0.0887	0.1741	0.1482	0.1518	0.0815	0.1259	0.107	0.1048
7	0.6035	0.7478	0.7365	0.2538	0.3695	0.4113	0.3159	0.3839	0.4952	0.2221	0.3671
8	0.7424	0.8778	0.7274	0.2933	0.2369	0.3214	0.3579	0.353	0.2472	0.2447	0.2816
9	0.5609	0.7162	0.5866	0.2605	0.2068	0.2161	0.2315	0.2728	0.1423	0.1814	0.1988
10	0.3717	0.4933	0.3621	0.1873	0.1683	0.1959	0.1508	0.1486	0.13	0.1399	0.1395
11	0.326	0.3993	0.4216	0.1823	0.2271	0.2064	0.1796	0.1347	0.1229	0.2034	0.1536
12	0.4272	0.5951	0.2741	0.2429	0.1803	0.1932	0.1136	0.217	0.1101	0.1776	0.1682
13	0.3553	0.4366	0.4	0.2602	0.1935	0.153	0.1024	0.1419	0.1333	0.2243	0.1665
+gp	0.3553	0.4366	0.4	0.2602	0.1935	0.153	0.1024	0.1419	0.1333	0.2243	
FBAR 5-10	0.4321	0.5871	0.5761	0.1862	0.1999	0.2221	0.208	0.20937	0.19243	0.15615	

Table 7. The estimates of population numbers at age derived from an XSA model fitted to the data for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

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

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Terminal Fs derived using XSA with final year & oldest age shrinkage.

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1975	1976	1977	1978	1979	1980	1981
AGE							
1	109108	112118	104357	83640	100395	131967	134125
2	126352	89330	91794	85440	68479	82196	108045
3	110175	103448	73137	75155	69953	56066	67297
4	67978	90204	84696	59880	61532	57272	45903
5	55517	55656	73853	69344	49025	50378	46891
6	32918	45152	45552	59982	54075	37980	41057
7	23937	24400	36415	32759	41495	36377	29208
8	14721	14395	17053	20044	18705	22370	21503
9	9805	7568	6888	7315	9555	9762	9557
10	4224	4444	2786	2985	3397	6765	3108
11	2313	1931	1643	1364	1143	2346	2075
12	522	1259	831	1146	463	676	1004
13	986	306	795	562	606	244	438
+gp	1010	159	573	646	1196	124	700
TOTAL	559567	550368	540374	500264	480019	494523	510911

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
1	132278	148284	156674	173392	193157	163485	137012	125597	125511	111894
2	109812	108300	121405	128274	141961	158144	133850	112176	102830	102760
3	88460	89907	88668	99398	105022	116228	129477	109587	91842	84190
4	55098	72425	73609	72595	81380	85984	95160	106007	89722	75194
5	37582	45110	59297	60266	59436	66628	70398	77910	86791	73372
6	37610	30526	36299	47732	47548	48409	54427	57369	63624	70061
7	29527	28712	21774	27616	34276	36902	37913	41678	45171	45976
8	15040	18457	14640	12539	17260	22262	20256	23679	27355	25553
9	7244	7099	8313	5035	7099	9525	10142	12621	15520	15558
10	3927	2726	3736	3108	2874	4483	5233	7138	8992	9022
11	1739	1692	1606	1920	2081	1927	2899	3864	5150	4926
12	1468	885	1196	946	1428	1483	1230	2191	2767	3127
13	694	970	656	850	685	1042	960	912	1553	1465
+gp	807	1595	1126	837	1141	1607	1153	444	1129	1096
TOTAL	521287	556689	588999	634508	695348	718109	700109	681174	667957	624195

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 75-99
AGE												
1	95644	120417	225298	326001	358815	221755	223226	104023	234381	554024	0	145631
2	91611	78307	98589	184458	266907	293773	181558	182762	85167	191895	453606	121129
3	84133	75005	64112	80718	151022	218525	240521	148647	149633	69729	157114	97965
4	68929	68882	61409	52491	66086	123646	178913	196922	121702	122509	57090	78360
5	61365	55472	55482	45396	42684	53935	100930	145982	160957	99396	99539	61094
6	57483	46459	36757	30495	35943	33445	42436	79400	117576	129945	78048	45384
7	50344	37180	23625	15784	22848	24726	23610	29852	59917	84877	95596	30922
8	25741	22543	14410	9261	10027	12927	13417	14094	16649	29896	55654	17234
9	11152	10032	7673	5701	5655	6477	7675	7680	8107	10646	19165	8472
10	6273	5211	4013	3494	3597	3765	4273	4985	4787	5757	7271	4307
11	4020	3542	2605	2288	2372	2489	2534	3009	3518	3441	4099	2364
12	2346	2376	1945	1399	1561	1548	1658	1734	2153	2547	2299	1340
13	1460	1253	1073	1211	899	1067	1044	1211	1142	1579	1746	842
+gp	1229	564	715	964	556	690	577	1257	917	1280	1871	
TOTAL	561729	527241	597706	759660	968972	998768	1022372	921556	966606	1307521	1033098	

Table 8. The XSA summary table of population and exploitation trends.

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSE	FBAR 5-10
1975	109108	141686	26989	28814	1.0676	0.3424
1976	112118	141876	21277	24611	1.1567	0.3842
1977	104357	165460	19912	32048	1.6095	0.3885
1978	83640	174647	20135	39070	1.9404	0.4076
1979	100395	169711	21773	34104	1.5664	0.2392
1980	131967	132675	15426	32867	2.1306	0.4949
1981	134125	120218	21208	30754	1.4501	0.4286
1982	132278	124234	25331	26278	1.0374	0.3863
1983	148284	126848	30847	27861	0.9032	0.3329
1984	156674	116236	26492	26711	1.0082	0.4265
1985	173392	146151	26124	20347	0.7789	0.2281
1986	193157	136007	29436	17976	0.6107	0.1907
1987	163485	160100	35517	32442	0.9134	0.2779
1988	137012	165733	38287	19215	0.5019	0.145
1989	125597	185176	43328	20034	0.4624	0.1251
1990	125511	213300	59059	47454	0.8035	0.2695
1991	111894	234367	67027	65008	0.9699	0.4167
1992	95644	204419	52925	63193	1.194	0.4321
1993	120417	162213	41763	62455	1.4954	0.5871
1994	225298	119850	33990	51029	1.5013	0.5761
1995	326001	100074	33490	15272	0.456	0.1862
1996	358815	107120	30361	18840	0.6205	0.1999
1997	221755	112101	32392	19858	0.6131	0.2221
1998	223226	142846	33428	19946	0.5967	0.208
1999	104023	188578	38845	24226	0.6237	0.2094
2000	234381	237823	39139	34177	0.8732	0.1924
2001	554024	298126	40484	38232	0.9444	0.1561

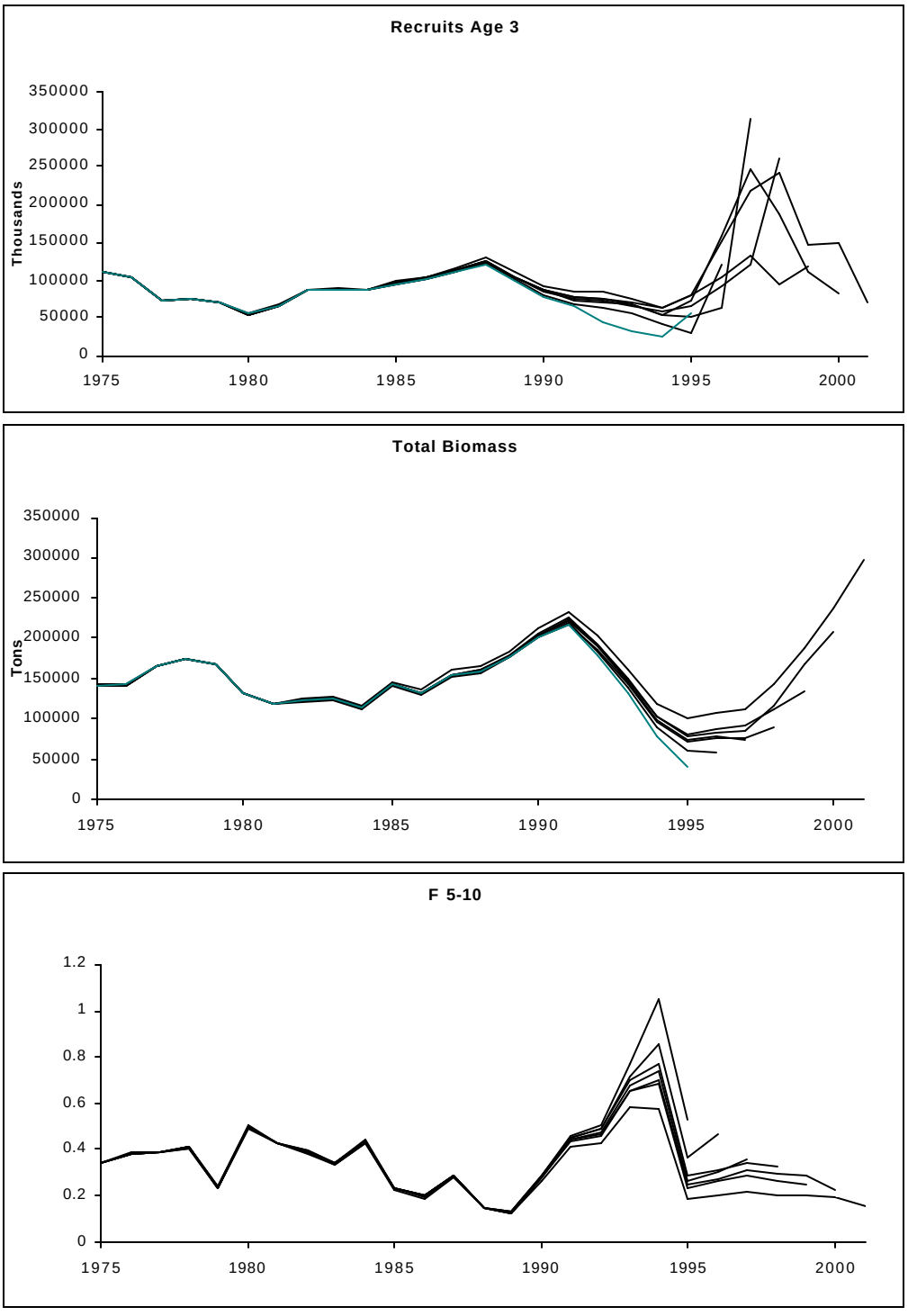

Fig. 1. XSA Retrospective analysis.

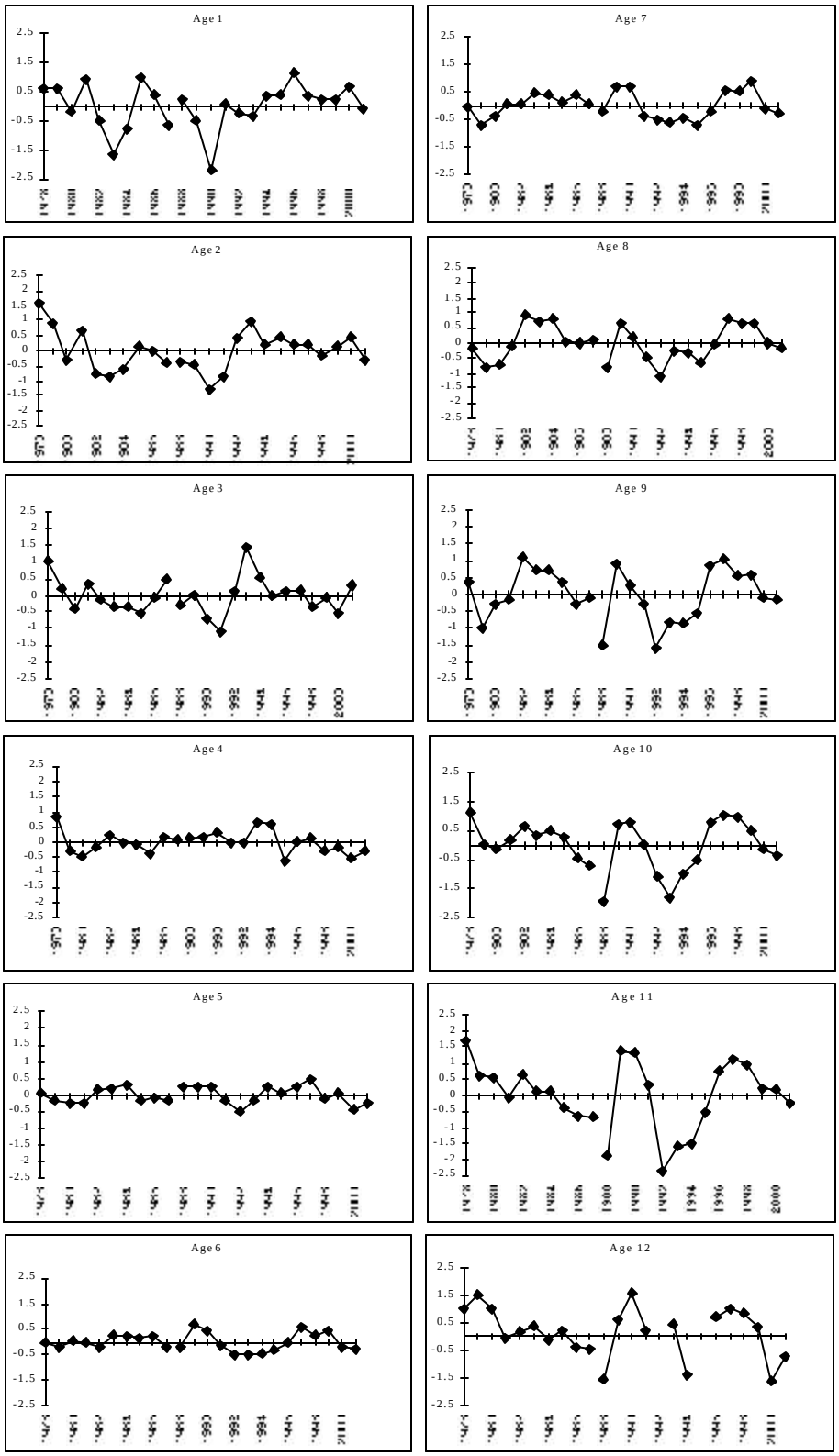

Fig. 2. The log catchability residuals for the Canadian R.V survey for the data series 1978 - 1987 and 1998 - 1999, derived from the fit of the final XSA model to the catch at age data for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

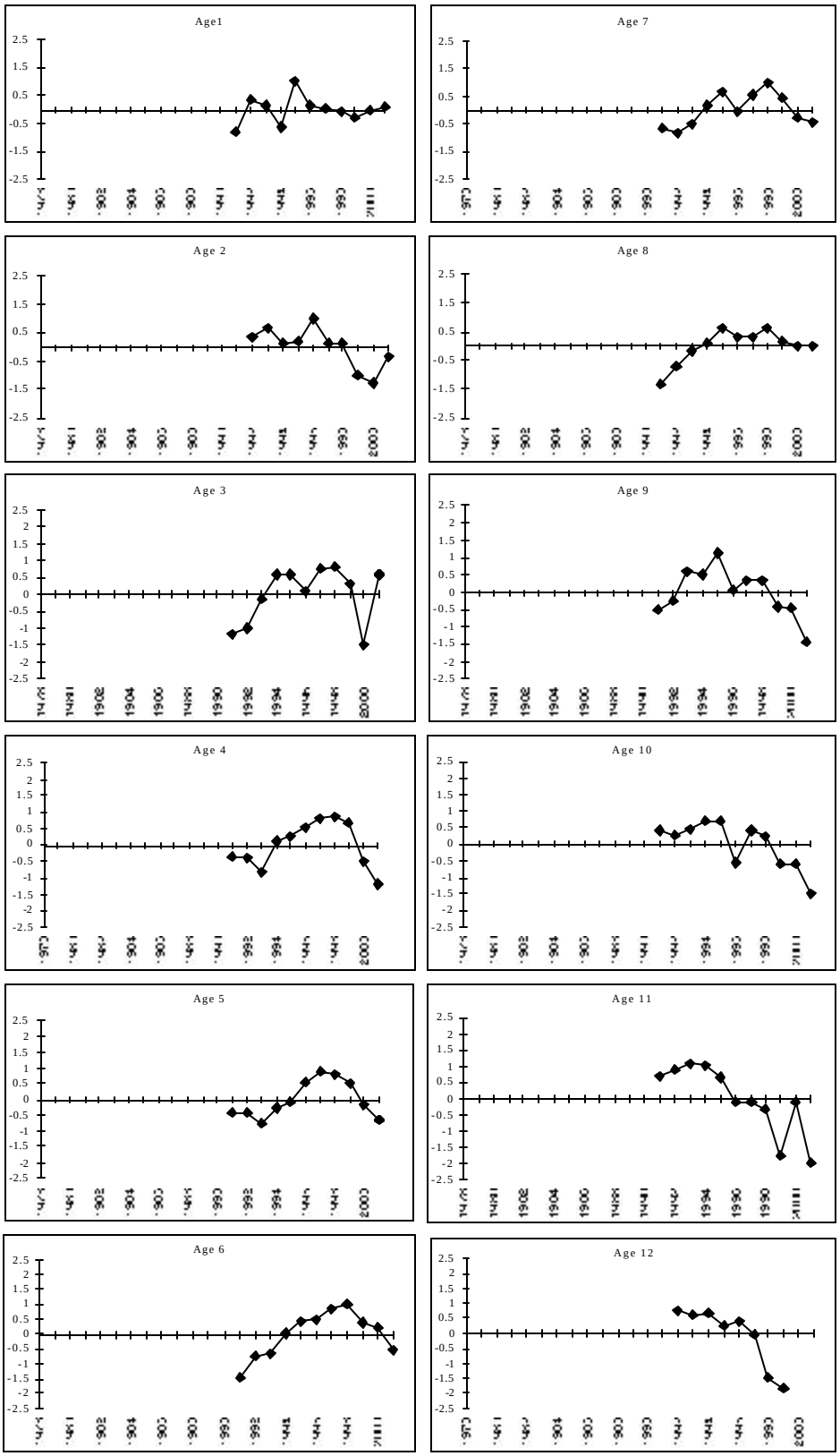

Fig. 3. The log catchability residuals for the EU R.V survey derived from the fit of the preliminary XSA based model to the catch at age data for Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

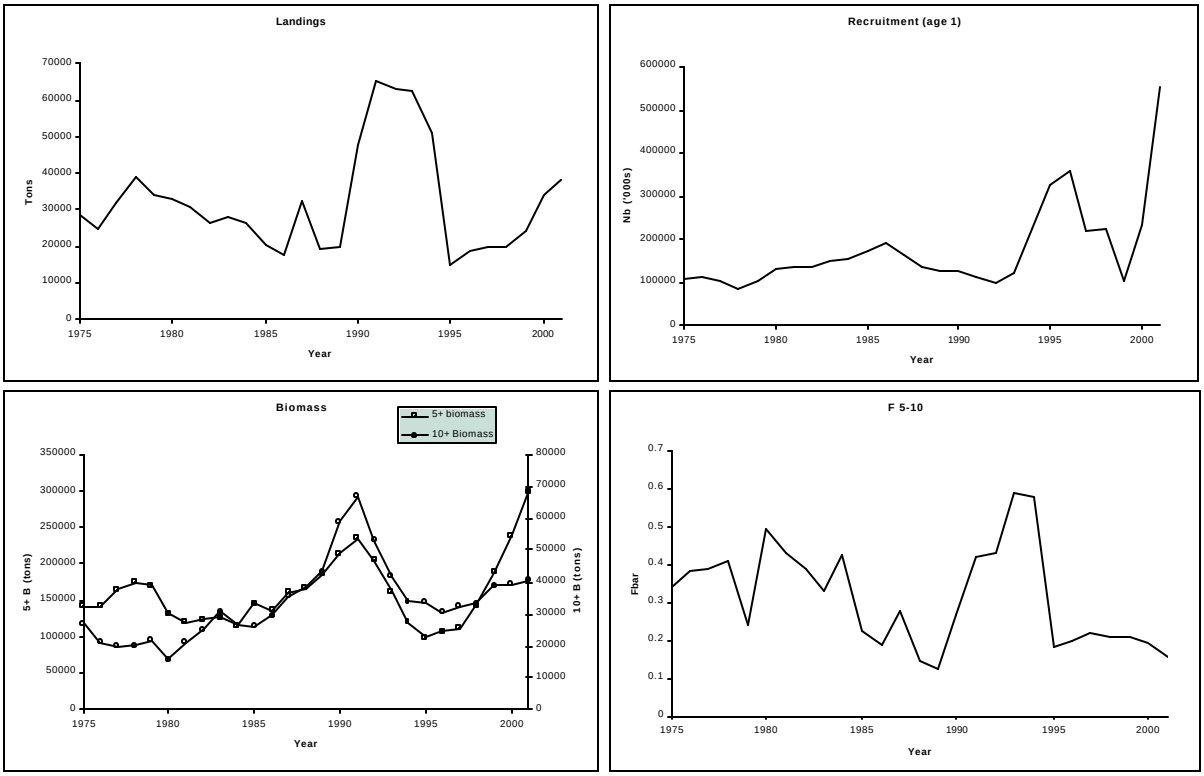

Fig. 4. The time series of stock trends for the Greenland Halibut in Subarea 2 and Divisions 3KLMNO.

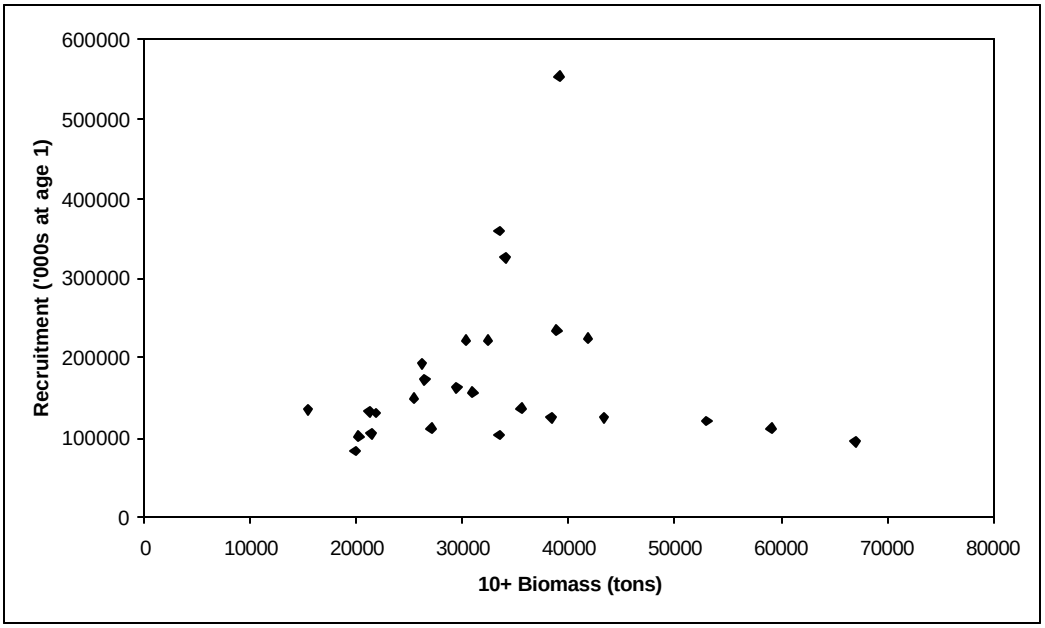

Fig. 5. The stock and recruitment plot for the Greenland Halibut in Subarea 2 and Divisions 3KLMNO.