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An Extended Survivors Analysis (XSA) of the Greenland Halibut in NAFO Divisions 0+1

by

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Abstract

An assessment of the Greenland halibut in NAFO Divisions 0+1 was carried out using Extended Survivors Analysis (XSA). Although the assessment results are considered to be provisional due to problems with the catch at age data, the assessment is considered to reflect the dynamics of the stock. The results indicate that the stock increased during 1987-1990 and has since remained stable. The rate of exploitation has been increasing in recent years after a period of relatively stability.

Methods

The Extended Survivors Analysis (XSA, Shepherd, 1999; Darby and Flatman, 1994) stock assessment model was fitted to the stock data for the Greenland halibut in Div. 0+1. The model was calibrated with trawl survey data for the years 1997-2002 at ages 5-15. Catchability was assumed to be constant in time at all ages and constant with age after age 10. Shrinkage to the mean fishing mortality was applied over the final three years and oldest two ages using a c.v. of 1.0. The minimum permitted value for the survey catchability standard error at each age was set to 0.3.

Results

The assessment data, fitted model diagnostics and estimated population abundance and exploitation rates are presented in Tables 1- 8.

The log catchability residuals of the model fit to the survey data show that there is good agreement between the estimated population numbers and the survey data at the majority of ages. There are no trends or patterns indicating departures from the model assumptions.

Figure 1 illustrates average fishing mortality for ages 7-13, Fig. 2 the estimated biomass series and Fig. 3 recruitment. Retrospective analysis was carried out and the time series of estimates for assessments terminating in 2001 and 2000 are also plotted. The retrospective series indicate good agreement between years in the assessment results with no systematic bias.

Fishing mortality is estimated to have increased in proportion to the levels of catches. Spawning stock and total biomass are estimated to have increased throughout the period for which assessment data is available.

Discussion

There are concerns with regard to the availability of the length distributions and the frequent inconsistencies between years and between SA1 and SA0 in the age-length-keys used to derive the catch-at-age data for this stock. Therefore the assessment results are considered to be representative of the overall trends in the stock and exploitation dynamics.

References

Darby, C.D. and Flatman, S. 1994. Virtual Population Analysis: version 3.1 (Windows/DOS) user guide. MAFF Information Technology Series No 1. Directorate of Fisheries Research, Lowestoft

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

Table 1. The proportion of fishing and natural mortality prior to spawning and the maturity at age ogive used in the assessment of Greenland halibut in NAFO Div. 0 and 1.

Proportion of F before spawning		0.0										
Proportion of M before spawning		0.0										
Natural mortality	0.2											
Proportion mature at age	5	6	7	8	9	10	11	12	13	14	15	+gp
	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 2. The catch per unit effort at age data, for the years 1997 – 2002, used in the asessment of Greenland halibut in NAFO Div. 0 and 1.

Survey												
1997	2002											
1	1	0.5	0.6									
5	16											
1	9961295	15370847	13558728	5436358	1200931	948950	584382.0	466433	187646	96503	262704	187646
1	14760362	19057854	14083592	5766084	1515966	1211419	764751.0	527881	351921	155657	236870	115051
1	11291344	15893794	19759852	4786548	859124	920490	613660.0	675026	429562	429562	184098	61366
1	15090231	16838191	14711646	5026106	3214208	1040152	717770.0	350292	318336	122157	230208	128241
1	20601616	26595603	17922784	4674899	2550178	780082	705656.0	369836	345397	195607	225277	91540
1	11779876	26697300	18561065	6201987	1857799	1340261	905723.0	166242	257412	143024	263139	178780

Tables 3 and 4. The catch numbers, catch and stock weights at age used in the assessment of Greenland halibut in NAAFO Div. 0 and 1.

Catch numbers at age (thousands)

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE																
5	2	1	1	4	20	53	241	254	152	151	41	71	262	415	69	570
6	31	29	36	87	318	678	651	862	552	530	311	372	1092	1106	987	1975
7	182	190	244	592	1742	2967	2242	2472	1628	1818	1556	677	1759	1677	3212	4252
8	296	354	409	1711	2679	4311	2356	1692	940	1575	2110	1187	1174	1144	1802	1791
9	193	245	212	1356	1418	2604	1048	954	558	660	1042	900	672	772	1154	617
10	77	115	75	711	533	951	590	294	259	306	438	572	375	501	776	476
11	40	80	47	359	221	398	224	183	228	160	232	422	234	443	503	347
12	18	61	48	195	144	231	130	160	188	127	118	205	184	291	273	149
13	10	58	44	189	108	158	72	125	104	64	96	153	172	178	101	209
14	9	46	42	115	60	85	59	58	80	57	21	98	95	68	50	75
15	6	35	26	67	36	45	37	55	85	39	13	19	61	75	21	168
+gp	9	20	13	20	8	24	32	51	69	71	12	4	62	27	18	146
TOTALNUM	873	1234	1197	5406	7287	12505	7682	7160	4843	5558	5990	4680	6142	6697	8966	10775
TONSLAND	1295	2605	2207	10540	10982	18070	11423	10144	8270	8982	9101	8693	9691	10689	13184	15136
SOPCOF %	101	100	101	104	103	100	99	101	100	100	100	100	100	100	100	100

Catch and stock weights at age (kg)

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE																
5	0.289	0.29	0.29	0.33	0.338	0.33	0.58	0.43	0.49	0.52	0.36	0.5	0.54	0.53	0.48	0.48
6	0.508	0.51	0.51	0.54	0.538	0.56	0.72	0.62	0.66	0.69	0.55	0.74	0.7	0.72	0.67	0.7
7	0.739	0.74	0.74	0.79	0.794	0.8	0.96	0.91	0.94	0.94	0.86	1	0.98	1	0.91	0.96
8	1.078	1.08	1.08	1.1	1.124	1.13	1.26	1.26	1.34	1.38	1.27	1.24	1.28	1.29	1.3	1.3
9	1.41	1.42	1.42	1.52	1.57	1.59	1.8	1.72	1.81	1.91	1.83	1.54	1.66	1.71	1.76	1.85
10	1.965	2.05	2	2.11	2.27	2.28	2.43	2.19	2.37	2.48	2.38	2.22	2.25	2.26	2.29	2.2
11	2.582	2.8	2.68	2.94	3.22	3.02	3.25	2.73	2.89	3.18	3.01	3.08	2.74	2.84	2.91	2.82
12	3.522	3.88	3.73	3.9	4.24	4.02	4.1	3.43	3.62	4.04	3.84	3.84	3.68	3.59	3.51	3.32
13	4.643	5.01	4.87	4.96	5.5	5.33	5.26	4.48	4.44	5.05	4.93	4.74	4.73	4.23	4.31	3.93
14	5.789	6.16	6.2	6.26	6.82	6.76	6.17	5.75	5.61	5.95	5.69	6.04	5.58	5.19	5.6	5.2
15	6.605	7.44	7.65	7.96	8.33	7.76	7.42	6.58	6.65	7.34	6.79	6.6	6.68	5.85	6.09	5.383
+gp	9.4286	9.1987	9.3903	10.2023	9.8263	8.7338	8.3281	8.2841	8.8694	9.5011	8.0256	13.3927	8.5144	7.883	8.2867	8.5962
SOPCOFAC	1.0093	1.0017	1.0061	1.0363	1.0251	1.0007	0.9852	1.0107	0.9988	0.999	1.002	0.9992	1.0002	1.0007	1.0001	1.0025

Table 5a. The specification for the model structure of the XSA fitted to the data for the Greenland halibut in NAFO Div. 0 and 1.

Lowestoft VPA Version 3.1

11/06/2003 21:19

Extended Survivors Analysis

GREENLAND HALIBUT NAFO SUBAREAS 0+1

CPUE data from file tun.dat

Catch data for 16 years. 1987 to 2002. Ages 5 to 16.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Survey	1997	2002	5	15	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 >= 10

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 2 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 96 iterations

Regression weights

1	1	1	1	1	1

Table 5b. Fishing mortality and population numbers at age estimated by fitting XSA to the data for Greenland halibut in NAFO Div. 0 and 1.

Fishing mortalities

Age	1997	1998	1999	2000	2001	2002
5	0.002	0.004	0.013	0.017	0.002	0.029
6	0.027	0.027	0.082	0.071	0.052	0.084
7	0.213	0.075	0.169	0.175	0.304	0.328
8	0.342	0.25	0.181	0.158	0.289	0.277
9	0.277	0.239	0.219	0.174	0.236	0.151
10	0.153	0.241	0.148	0.252	0.266	0.144
11	0.14	0.216	0.147	0.261	0.432	0.182
12	0.084	0.176	0.137	0.274	0.255	0.218
13	0.16	0.149	0.22	0.191	0.144	0.316
14	0.071	0.244	0.13	0.127	0.075	0.151
15	0.036	0.085	0.236	0.144	0.052	0.385

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XSA population numbers (Thousands)

	AGE										
YEAR	5	6	7	8	9	10	11	12	13	14	15
1997	1.92E+04	1.29E+04	8.96E+03	8.05E+03	4.75E+03	3.42E+03	1.97E+03	1.62E+03	7.18E+02	3.37E+02	4.08E+02
1998	1.88E+04	1.57E+04	1.03E+04	5.93E+03	4.68E+03	2.95E+03	2.40E+03	1.40E+03	1.22E+03	5.01E+02	2.57E+02
1999	2.20E+04	1.53E+04	1.25E+04	7.82E+03	3.78E+03	3.02E+03	1.90E+03	1.58E+03	9.61E+02	8.62E+02	3.21E+02
2000	2.69E+04	1.78E+04	1.15E+04	8.67E+03	5.34E+03	2.49E+03	2.13E+03	1.34E+03	1.13E+03	6.32E+02	6.20E+02
2001	3.30E+04	2.16E+04	1.35E+04	7.93E+03	6.06E+03	3.67E+03	1.58E+03	1.34E+03	8.35E+02	7.65E+02	4.56E+02
2002	2.24E+04	2.70E+04	1.68E+04	8.17E+03	4.87E+03	3.92E+03	2.31E+03	8.42E+02	8.52E+02	5.92E+02	5.81E+02

Estimated population abundance at 1st Jan 2003

0.00E+00	1.78E+04	2.03E+04	9.91E+03	5.07E+03	3.43E+03	2.78E+03	1.57E+03	5.55E+02	5.09E+02	4.17E+02

Taper weighted geometric mean of the VPA populations:

1.95E+04	1.52E+04	1.12E+04	7.35E+03	4.46E+03	2.72E+03	1.73E+03	1.13E+03	7.77E+02	5.27E+02	3.64E+02

Standard error of the weighted Log(VPA populations) :

0.2071	0.2367	0.2135	0.2071	0.1995	0.2368	0.2471	0.2774	0.2857	0.288	0.311

Table 5c. The log catchability residuals, estimates of average log catchability and catchability regression diagnostics from an XSA model fitted to the data for Greenland halibut in NAFO Div. 0 and 1.

Log catchability residuals.

Fleet : Survey

Age	1997	1998	1999	2000	2001	2002
5	-0.12	0.3	-0.12	-0.03	0.07	-0.09
6	0.07	0.08	-0.04	-0.14	0.11	-0.09
7	0.11	-0.06	0.13	-0.08	0.03	-0.14
8	0.04	0.35	-0.15	-0.22	-0.13	0.12
9	-0.29	-0.06	-0.43	0.52	0.2	0.05
10	-0.17	0.27	-0.07	0.3	-0.37	0.04
11	-0.11	0.01	-0.02	0.09	0.46	0.2
12	-0.17	0.15	0.25	-0.16	-0.12	-0.47
13	-0.22	-0.13	0.35	-0.13	0.23	0.01
14	-0.18	0	0.41	-0.54	-0.29	-0.31
15	0.61	1	0.6	0.12	0.36	0.45

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
Mean Log q	6.4816	7.1405	7.4344	6.7781	6.083	5.9859	5.9859
S.E(Log q)	0.1622	0.1018	0.1096	0.2117	0.3421	0.2595	0.2324

Age	12	13	14	15
Mean Log q	5.9859	5.9859	5.9859	5.9859
S.E(Log q)	0.2748	0.2264	0.3659	0.6442

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	1.05	-0.137	-7.38	0.61	6	0.19	6.48
6	1.13	-0.605	-9.26	0.85	6	0.12	7.14
7	1.32	-1.09	-12.74	0.75	6	0.14	7.43
8	-3.42	-2.793	62.68	0.09	6	0.47	6.78
9	0.37	2.505	3.11	0.8	6	0.09	6.08
10	-14.18	-1.879	207.38	0	6	3	5.99
11	3.26	-1.213	-37.12	0.07	6	0.63	6.09
12	0.55	2.276	-0.01	0.86	6	0.1	5.9
13	1.1	-0.165	-7.32	0.39	6	0.28	6
14	0.8	0.536	-3.37	0.64	6	0.28	5.83
15	4.55	-4.132	-51.07	0.25	6	0.65	6.51

Table 5d. The esitmates of estimated survivors in 2003 and the breakdown of the contribution from the fleet and shrinkage constrint for the Greenland halibut in NAFO Div. 0 and 1.

Terminal year survivor and F summaries :

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

Year class = 1997

Fleet	I $	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	16276	0.3	0	0	1	0.915	0.031
F shrinkage mean	46828	1				0.085	0.011

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17801	0.29	0.31	2	1.071	0.029

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

Year class = 1996

Fleet	I $	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	20083	0.212	0.076	0.36	2	0.953	0.085
F shrinkage mean	25166	1				0.047	0.069

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20296	0.21	0.06	3	0.303	0.084

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

Year class = 1995

Fleet	I $	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	9712	0.173	0.073	0.42	3	0.958	0.334
F shrinkage mean	15878	1				0.042	0.217

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9913	0.17	0.08	4	0.479	0.328

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

Year class = 1994

Fleet	I $	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	5011	0.152	0.063	0.41	4	0.963	0.28
F shrinkage mean	6923	1				0.037	0.21

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5071	0.15	0.06	5	0.408	0.277

Table 5e. The esitmates of estimated survivors in 2003 and the breakdown of the contribution from the fleet and shrinkage constrint for the Greenland halibut in NAFO Div. 0 and 1.

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

Year class = 1993

Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
Survey	3466	0.142	0.074	0.52	5	0.968	0.149
F shrinkage mean	2382	1				0.032	0.211

Weighted prediction :

Survivors		Int	Ext	N	Var	F
at end of year	s.e	s.e			Ratio	
3425	0.14	0.07	6		0.509	0.151

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

Year class = 1992

Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
Survey	2813	0.13	0.062	0.48	6	0.974	0.142
F shrinkage mean	1726	1				0.026	0.223

Weighted prediction :

Survivors		Int	Ext	N	Var	F
at end of year	s.e	s.e			Ratio	
2777	0.13	0.06	7		0.503	0.144

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1991

Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
Survey	1597	0.131	0.122	0.93	6	0.972	0.179
F shrinkage mean	966	1				0.028	0.282

Weighted prediction :

Survivors		Int	Ext	N	Var	F
at end of year	s.e	s.e			Ratio	
1574	0.13	0.12	7		0.882	0.182

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1990

Fleet		Int	Ext	Var	N	Scaled	Estimated
		s.e	s.e	Ratio		Weights	F
Survey	555	0.14	0.182	1.3	6	0.964	0.217
F shrinkage mean	539	1				0.036	0.223

Weighted prediction :

Survivors		Int	Ext	N	Var	F
at end of year	s.e	s.e			Ratio	
555	0.14	0.16	7		1.167	0.218

Table 5f . The esitmates of estimated survivors in 2003 and the breakdown of the contribution from the fleet and shrinkage constrint for the Greenland halibut in NAFO Div. 0 and 1.

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1989

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	498	0.135	0.032	0.24	6	0.965	0.322
F shrinkage mean	926	1				0.035	0.186

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
509	0.14	0.06	7	0.409	0.316

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1988

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	413	0.138	0.1	0.73	6	0.97	0.152
F shrinkage mean	579	1				0.03	0.111

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
417	0.14	0.09	7	0.68	0.151

Age 15 Catchability constant w.r.t. time and age (fixed at the value for age) 10

Year class = 1987

Fleet	I S	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Survey	316	0.142	0.098	0.69	6	0.96	0.393
F shrinkage mean	575	1				0.04	0.235

Table 6. The XSA estimated fishing mortality at age for Greenland halibut in NAFO Div. 0 and 1.

Run title : GREENLAND HALIBUT NAFO SUBAREAS 0+1
At 11/06/2003 21:23

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR / AGE	1987	1988	1989	1990	1991	1992
5	0.0001	0.0001	0.0001	0.0002	0.0013	0.0033
6	0.0035	0.0025	0.0026	0.0059	0.0213	0.0559
7	0.0288	0.0269	0.026	0.0543	0.1552	0.2817
8	0.0781	0.0719	0.0745	0.2552	0.3691	0.7085
9	0.0786	0.0857	0.056	0.3757	0.3485	0.7551
10	0.0549	0.0614	0.034	0.2694	0.2471	0.4179
11	0.0436	0.0743	0.0321	0.2262	0.1248	0.2952
12	0.0314	0.0866	0.0582	0.1808	0.1328	0.186
13	0.023	0.1343	0.0831	0.3399	0.1439	0.2112
14	0.0268	0.1404	0.136	0.3236	0.1707	0.1611
15	0.025	0.1379	0.1099	0.3338	0.158	0.187
+gp	0.025	0.1379	0.1099	0.3338	0.158	0.187
FBAR 7-13	0.0484	0.0773	0.052	0.2431	0.2174	0.4079

YEAR / AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR 00-02
5	0.015	0.0151	0.0119	0.0105	0.0024	0.0042	0.0133	0.0172	0.0023	0.0286	0.016
6	0.0507	0.0684	0.0413	0.0521	0.027	0.0265	0.0821	0.0713	0.0518	0.0844	0.0692
7	0.2641	0.2763	0.1783	0.186	0.213	0.0754	0.1686	0.175	0.3043	0.328	0.2691
8	0.3791	0.3265	0.1599	0.2622	0.3423	0.2499	0.1814	0.1577	0.289	0.2773	0.2413
9	0.3654	0.2588	0.1691	0.161	0.2774	0.2391	0.2186	0.174	0.2363	0.151	0.1871
10	0.3742	0.1639	0.1031	0.1317	0.1527	0.2413	0.1479	0.2516	0.2658	0.1442	0.2205
11	0.1616	0.1886	0.1847	0.0855	0.1396	0.2159	0.1466	0.2613	0.4321	0.1818	0.2917
12	0.1473	0.1661	0.3018	0.1485	0.0838	0.1764	0.1373	0.2742	0.2545	0.2176	0.2488
13	0.081	0.2063	0.1549	0.1584	0.16	0.149	0.2203	0.1911	0.1436	0.3161	0.2169
14	0.1134	0.0867	0.1974	0.1189	0.0713	0.2438	0.1299	0.1267	0.075	0.1508	0.1175
15	0.0976	0.1471	0.1769	0.1392	0.0358	0.0851	0.2355	0.1436	0.0523	0.385	0.1936
+gp	0.0976	0.1471	0.1769	0.1392	0.0358	0.0851	0.2355	0.1436	0.0523	0.385	
FBAR 7-13	0.2533	0.2266	0.1788	0.1619	0.1955	0.1924	0.1744	0.2121	0.2751	0.2309	

Table 7. The XSA estimated population nukmbers at age for Greenland halibut in NAFO Div. 0 and 1.

Run title : GREENLAND HALIBUT NAFO SUBAREAS 0+1
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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1987	1988	1989	1990	1991	1992
AGE						
5	15741	18504	20093	20362	16865	17820
6	9684	12886	15149	16450	16667	13790
7	7092	7901	10524	12370	13389	13358
8	4352	5642	6297	8395	9592	9386
9	2820	3295	4299	4785	5325	5429
10	1593	2134	2476	3328	2691	3077
11	1037	1235	1644	1959	2081	1721
12	643	813	938	1303	1279	1504
13	485	510	610	725	890	917
14	377	388	365	460	423	631
15	269	300	276	261	272	292
+gp	403	171	139	78	61	155
TOTAL	44495	53778	62809	70476	69536	68081

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 87-00	AMST 87-00
AGE													
5	17864	18683	14258	15955	19240	18775	21970	26863	33019	22372	0	18569	18785
6	14542	14408	15066	11536	12926	15715	15307	17750	21618	26972	17801	14259	14420
7	10677	11317	11016	11836	8965	10301	12530	11544	13532	16806	20296	10748	10916
8	8252	6713	7029	7546	8045	5932	7822	8667	7934	8173	9913	7251	7405
9	3784	4624	3965	4904	4753	4678	3783	5341	6061	4866	5071	4341	4413
10	2089	2150	2923	2741	3418	2949	3015	2489	3675	3918	3425	2596	2648
11	1659	1176	1494	2159	1967	2402	1897	2129	1584	2306	2777	1706	1754
12	1049	1155	798	1017	1623	1401	1585	1341	1343	842	1574	1134	1175
13	1022	741	801	483	718	1222	961	1131	835	852	555	768	801
14	608	772	494	562	337	501	862	632	765	592	509	509	529
15	440	444	579	332	408	257	321	620	456	581	417	347	362
+gp	379	410	468	602	379	55	325	222	389	501	603		
TOTAL	62364	62593	58890	59671	62780	64188	70377	78730	91211	88781	62941		

Table 8. The time series of management indices derived from an XSA model fitted to catch data for the Greenland halibut in NAFO Div. 0 and 1.

Run title : GREENLAND HALIBUT NAFO SUBAREAS 0+1

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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 5	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 7-13
1987	15741	41457	18080	1295	0.0716	0.0484
1988	18504	48295	19738	2605	0.132	0.0773
1989	20093	55751	21506	2207	0.1026	0.052
1990	20362	69090	27207	10540	0.3874	0.2431
1991	16865	73321	28881	10982	0.3803	0.2174
1992	17820	74563	31035	18070	0.5823	0.4079
1993	17864	78607	30318	11423	0.3768	0.2533
1994	18683	69640	25964	10144	0.3907	0.2266
1995	14258	72344	28464	8270	0.2905	0.1788
1996	15955	78865	31703	8982	0.2833	0.1619
1997	19240	72224	31563	9101	0.2883	0.1955
1998	18775	76456	30579	8693	0.2843	0.1924
1999	21970	83230	32081	9691	0.3021	0.1744
2000	26863	88802	29926	10689	0.3572	0.2121
2001	33019	95250	31621	13184	0.4169	0.2751
2002	22372	97160	31781	15136	0.4763	0.2309
Arith. Mean	19899	73441	28153	9438	0.3202	0.1967
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

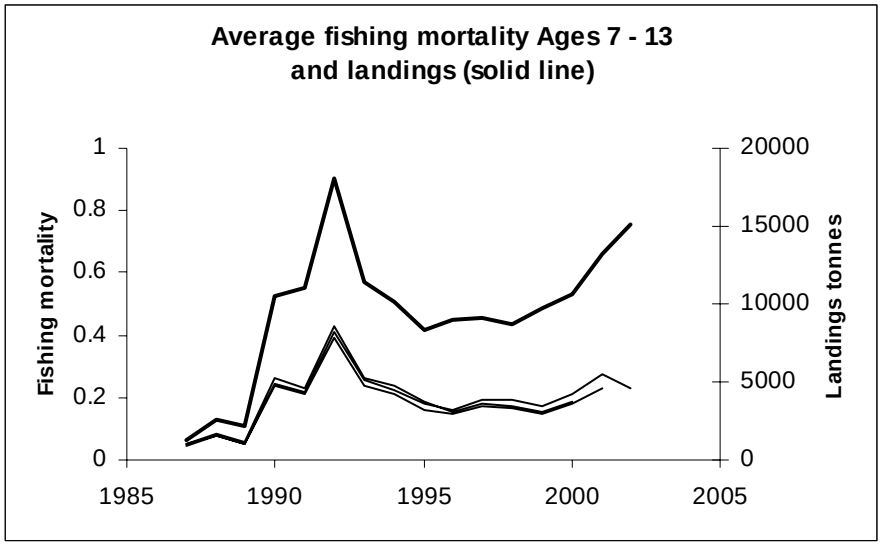

Fig. 1. The landings and estimated fishing mortality for Greenland halibut in NAFO Div. 0-1. Fishing mortalities estimated from retrospective assessments for 2001 and 2000 are also plotted.

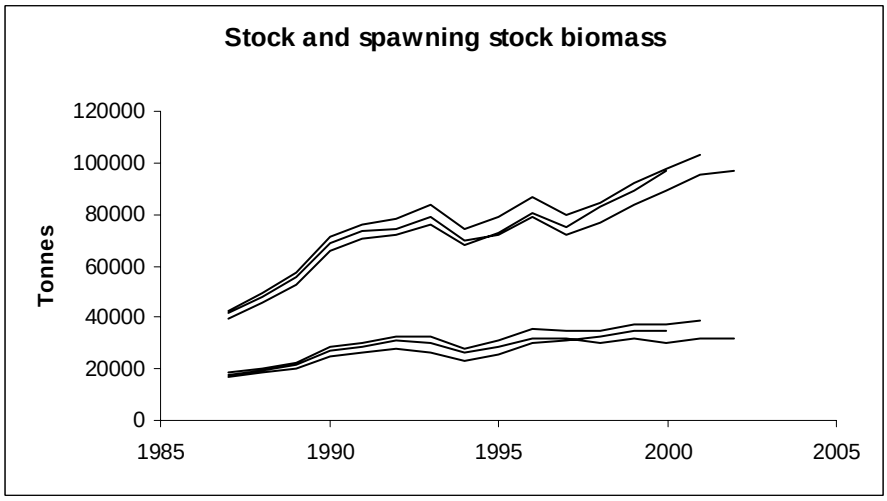

Fig. 2. The estimated stock and spawning stock biomass for Greenland halibut in NAFO Div. 0-1. The estimates derived from retrospective assessments for 2001 and 2000 are also plotted.

Fig. 3. The estimated recruitment for Greenland halibut in NAFO Div. 0-1. The estimates derived from retrospective assessments for 2001 and 2000 are also plotted.