Summary of Actual and Potential Stock Assessment Inputs for Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO, and Current Assessment Results

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Note: This document intends neither to be comprehensive nor definitive. Rather it lists a selection of material that seeks to provide some pertinent information to facilitate a discussion of alternative approaches to the assessment of this halibut population. These potentially include both simpler "index-based" approaches and more complex spatially-disaggregated approaches.

Table 1: Total catches
Table 2: Commercial catches-at-age (all catches)
Table 3: Commercial catch weights-at-age (all catches)
Table 4: Survey data by age
Table 5: Survey biomass
Table 6: Standardised CPUE series
Table 7: Canadian CPUE standardisation including year*division interactions
Tables 8-10: XSA results

Note: The "new" Canadian CPUE standardisation analyses in Table 7 are based on the data used in the 2008 standardisation (and kindly forwarded by D Power), and on the following GLM assuming a normal error structure:

$$\ln(CPUE) = \mu + \alpha_{year} + \beta_{month} + \gamma_{CGT} + \eta_{division} + \theta_{year*division} + \varepsilon \quad (1)$$

where

μ is the intercept,
year is a factor with 32 levels associated with the years 1976 – 2007,
month is a factor with 12 levels (January – December),
CGT is a factor with 7 levels associated with a combination of vessel country, gear and tonnage class,
division is a factor with 4 levels (2H, 2J, 3K and 3L),
year*division is the interaction between year and division, and
ε is the error term assumed to be normally distributed.

Figure 1: Comparative survey, CPUE and biomass trends
Figure 2: Percentage effort by division and year for the Canadian fleet
Figure 3: Standardised Canadian CPUE with no year*division interaction
Figure 4: Standardised Canadian CPUE with year*division interaction
Figure 5: Moving average of standardised Canadian CPUE by division

References

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Table 1: Landings (tons) for Greenland Halibut in Sub-area 2 and Div. 3KLMNO (Healey and Mahé, 2008).

Year	Landings (t)	Year	Landings (t)
1960	938	1984	26711
1961	741	1985	20347
1962	588	1986	17976
1963	1621	1987	32442
1964	4252	1988	19215
1965	10069	1989	20034
1966	19276	1990	47454
1967	26525	1991	65008
1968	32392	1992	63193
1969	37275	1993	62455
1970	36889	1994	51029
1971	24834	1995	15272
1972	30038	1996	18840
1973	29105	1997	19858
1974	27588	1998	19946
1975	28814	1999	24226
1976	24611	2000	34177
1977	32048	2001	38232
1978	39070	2002	34062
1979	34104	2003	35151
1980	32867	2004	25486
1981	30754	2005	23255
1982	26278	2006	23531
1983	27861	2007	22747

Table 2. Catch at age matrix (000s) for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO (Healey and Mahé, 2008).

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

Table 3. Catch weights-at-age (kg) matrix for Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO (Healy and Mahé, 2008).

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

Table 4. Survey data (mean numbers per tow) used to calibrate XSA assessment of Greenland Halibut in Sub-Area 2 and Divisions 3KLMNO. Decimalized year reflects the timing of each survey series (e.g. EU Summer survey). (Healey and Mahé, 2008)
Note: 1978-1994 survey data have been excluded because of apparent changes in survey catchability.

2J3K - Fall

	1	2	3	4	5	6	7	8	9	10	11	12	13
1996.9	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
1997.9	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
1998.9	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
1999.9	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
2000.9	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
2001.9	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
2002.9	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
2003.9	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
2004.9	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
2005.9	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
2006.9	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
2007.9	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

EU Survey

	1	2	3	4	5	6	7	8	9	10	11	12
1995.6	12.41	2.54	2.23	1.91	2.66	5.10	3.77	2.12	1.31	0.26	0.07	0.02
1996.6	5.84	7.97	2.42	3.04	4.20	5.82	2.49	1.62	0.42	0.09	0.03	0.04
1997.6	3.33	3.78	6.00	6.50	7.11	8.46	4.99	2.15	0.66	0.22	0.03	0.02
1998.6	2.74	2.13	7.69	11.00	12.33	11.30	7.84	2.62	0.75	0.20	0.03	0.01
1999.6	1.06	0.70	3.01	10.47	13.41	12.58	5.55	1.82	0.35	0.10	0.01	0.00
2000.6	3.75	0.29	0.60	2.17	7.09	14.10	5.40	2.32	0.45	0.11	0.05	0.00
2001.6	8.03	1.43	1.81	0.99	2.79	7.79	6.63	3.21	0.18	0.05	0.01	0.00
2002.6	4.08	2.94	2.80	1.67	3.79	5.59	5.73	1.28	0.13	0.06	0.02	0.01
2003.6	2.20	1.00	0.61	1.51	2.48	2.94	1.93	0.47	0.13	0.10	0.02	0.01
2004.6	2.19	3.29	4.37	1.97	6.97	7.80	2.54	0.64	0.29	0.13	0.08	0.05
2005.6	0.54	0.81	3.18	2.50	6.89	7.59	2.92	0.61	0.11	0.12	0.06	0.02
2006.6	0.68	0.40	0.65	1.17	5.98	7.46	3.31	0.77	0.22	0.18	0.13	0.06
2007.6	0.42	0.09	0.57	0.34	3.44	7.37	5.76	1.51	0.31	0.21	0.08	0.05

3LNO - Spr

	1	2	3	4	5	6	7	8
1996.4	1.62	4.24	4.60	2.18	0.83	0.28	0.06	0.00
1997.4	1.16	3.92	5.16	3.23	1.46	0.51	0.10	0.01
1998.4	0.22	0.81	3.85	6.19	4.96	1.24	0.33	0.07
1999.4	0.29	0.55	1.15	1.98	3.39	1.09	0.24	0.05
2000.4	0.79	1.07	1.07	1.51	1.95	2.04	0.56	0.03
2001.4	0.57	0.71	0.74	0.68	0.80	0.72	0.28	0.02
2002.4	0.64	0.57	0.60	0.58	0.61	0.21	0.05	0.01
2003.4	0.93	2.14	1.66	1.57	1.06	0.21	0.05	0.01
2004.4	0.66	0.57	1.18	1.18	1.16	0.26	0.04	0.02
2005.4	0.35	0.31	1.09	0.95	1.37	0.82	0.21	0.03
2006.4	Survey not completed							
2007.4	1.60	0.52	0.80	0.40	1.41	1.49	1.12	0.18

Table 5: Survey data in terms of weight for ages combined: 2J3K Fall (Healey, 2008), EU survey (Vázquez and González-Troncoso, 2008), and 3LNO Spr obtained from the product of Tables 3 and 4.

Year	2J3K Fall Mean weight (kg)/tow	EU survey Biomass (tons)	3LNO - Spr Mean weight (kg)/tow
1978	38.4		
1979	28.1		
1980	30.0		
1981	32.1		
1982	35.6		
1983	36.9		
1984	37.2		
1985	27.5		
1986	35.4		
1987	25.5		
1988	23.6	6926	
1989	25.4	4472	
1990	21.2	5799	
1991	11.5	8169	
1992	8.2	8728	
1993	15.3	6529	
1994	10.8	8037	
1995	14.1	10875	
1996	21.6	11594	1.77
1997	24.8	16098	2.11
1998	23.8	24229	4.74
1999	32.5	21207	2.76
2000	23.9	16959	2.60
2001	22.7	13872	1.14
2002	14.1	12100	0.67
2003	15.3	6214	1.28
2004	17.5	12292	1.14
2005	20.3	11698	1.78
2006	25.7	11706	
2007	29.1	13040	2.66

Table 6: Standardized CPUE for Greenland halibut from Canadian otter trawl fleet, Div. 2HJ3KL (Brodie *et al*., 2008), from Spanish fleet, Div. 3LMNO (Fernández *et al*., 2007) and from Portuguese fleet, by Division, for Div. 3LMN (Vargas *et al*., 2008).

	Canadian standardised CPUE	Spanish standardised CPUE	Portuguese standardised CPUE		
	Div. 2HJ3KL	Div. 3LMNO	Div. 3L	Div. 3M	Div. 3N
1976	0.311				
1977	0.426				
1978	0.756				
1979	0.748				
1980	0.904				
1981	0.794				
1982	0.827				
1983	0.823				
1984	0.949				
1985	0.593				
1986	0.471				
1987	0.731				
1988	0.338		0.404		
1989	0.546		0.367		
1990	0.524		0.338	0.233	0.175
1991	0.374		0.187		0.168
1992	0.333	1.000	0.115		0.213
1993	0.37	0.828	0.058		0.144
1994	0.397	0.774	0.109		0.148
1995	0.454	0.836	0.168	0.164	0.148
1996	0.406	1.041	0.222	0.198	0.182
1997	0.583	0.938	0.227	0.260	0.164
1998	0.463	0.744	0.269	0.190	0.181
1999	0.426	0.680	0.300	0.304	0.228
2000	0.525	0.955	0.311	0.302	0.309
2001	0.637	0.873	0.252	0.226	0.213
2002	0.421	1.024	0.222	0.215	0.277
2003	0.383	0.743	0.231	0.210	0.221
2004	0.394	0.590	0.126	0.109	0.154
2005	0.391	0.700	0.218	0.241	
2006	0.642	0.949	0.270	0.262	
2007	0.925		0.501	0.178	

Table 7. Standardized CPUE for Greenland halibut from Canadian otter trawl fleet, Div. 2HJ3KL, with no interaction (Model.1) and with year*division interactions (Model.2). (Model. 2 results are "new".)

	Model. 1	Model.2 (with year*division interaction)			
	Div. 2HJ3KL	Div. 2H	Div. 2J	Div. 3K	Div. 3L
1976	0.809		1.045	0.696	
1977	1.098			0.955	2.001
1978	1.911			1.582	2.759
1979	1.928			1.869	2.251
1980	2.287	1.857	1.954	2.790	2.214
1981	2.010	1.628	2.476	1.987	2.271
1982	2.113	2.655	2.159	1.417	
1983	2.082	2.688	2.036	1.902	
1984	2.404	2.318	2.933	2.169	
1985	1.499	2.529	1.587	0.912	
1986	1.199	0.873	1.226	4.220	
1987	1.849		1.805	1.935	
1988	0.857		0.725	1.870	
1989	1.381		1.215	1.620	
1990	1.173	0.507	1.326	1.262	1.683
1991	0.958		1.229	0.682	0.585
1992	0.846	0.691	1.152	0.886	0.764
1993	0.951		0.871	1.015	0.913
1994	1.031			1.018	
1995	1.185			1.142	
1996	1.032		0.885	1.244	
1997	1.496		1.006	1.554	
1998	1.215		1.102	1.369	
1999	1.124		1.180	1.098	
2000	1.341		1.273	1.429	1.328
2001	1.605		1.327	1.682	1.898
2002	1.066		0.986	1.139	1.029
2003	1.000	1.000	1.000	1.000	1.000
2004	1.015	1.182	3.325	0.913	0.827
2005	1.058	0.812	1.300	0.929	0.678
2006	1.816	0.788	0.834	2.470	
2007	2.637		2.878	2.570	

Table 8. XSA estimated numbers at age (000s) (Healey and Mahé, 2008).

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1975	112289	126280	110151	66815	53822	31894	23091	14337	9312	3931	1773	415	720	735
1976	116668	91934	103389	90184	54704	43764	23562	13703	7254	4040	1691	816	218	113
1977	107522	95520	75270	84648	73837	44772	35279	16367	6321	2529	1313	635	433	311
1978	82385	88032	78205	61625	69304	59969	32121	19113	6754	2521	1154	876	402	459
1979	99031	67451	72074	64029	50455	54043	41484	18182	8794	2937	763	290	385	756
1980	130137	81079	55225	59009	52422	39150	36350	22361	9334	6142	1969	365	103	52
1981	131878	106547	66382	45214	48313	42731	30166	21482	9550	2758	1565	696	183	292
1982	131159	107972	87233	54349	37018	38774	30898	15825	7226	3921	1453	1050	441	512
1983	146631	107384	88400	71420	44497	30064	29666	19579	7742	2712	1687	650	628	1031
1984	153784	120051	87919	72376	58474	35797	21396	15421	9231	4262	1594	1192	464	795
1985	167248	125908	98290	71982	59257	47058	27205	12230	5674	3860	2350	937	847	834
1986	187148	136931	103085	80473	58934	46721	33724	16923	6846	3397	2697	1780	677	1128
1987	156283	153224	112109	84399	65886	47997	36225	21810	9249	4276	2355	1987	1331	2054
1988	128757	127954	125449	91787	69100	53819	37576	19702	9772	5007	2729	1581	1373	1650
1989	112950	105417	104760	102709	75149	56306	41180	23403	12167	6835	3679	2052	1199	585
1990	107712	92476	86308	85770	84091	61363	44301	26947	15294	8621	4902	2616	1439	1045
1991	94449	88188	75713	70663	70137	67851	44125	24841	15225	8837	4622	2924	1341	1002
1992	71040	77329	72202	61988	57655	54833	48534	24226	10569	6000	3869	2097	1294	1088
1993	84255	58163	63311	59114	49789	43422	35011	21061	8791	4734	3318	2252	1049	471
1994	143006	68982	47619	51835	47484	32105	21139	12635	6459	2997	2214	1762	971	647
1995	173619	117083	56478	38988	37557	23947	11975	7225	4247	2501	1456	1079	1061	844
1996	151487	142147	95860	46240	31628	29526	17487	6908	3988	2406	1559	880	636	394
1997	124090	124027	116380	78483	37686	24394	19471	8538	3924	2400	1514	882	510	329
1998	110643	101597	101545	95284	63953	29133	16200	9116	4081	2182	1417	860	499	275
1999	112062	90586	83180	83138	77513	49126	18960	8027	4158	2043	1297	819	558	577
2000	117558	91749	74166	68102	67799	61517	35131	7731	3140	1903	1109	751	394	314
2001	112024	96249	75117	60722	55512	53673	38981	9603	3345	1690	1080	575	432	205
2002	111402	91717	78802	61501	49310	43424	32938	11898	3199	1825	936	487	287	182
2003	84400	91208	75092	64517	49919	38867	29002	11060	3763	1493	898	441	196	217
2004	49258	69101	74675	61480	51665	36807	22119	8576	3277	1620	756	472	230	197
2005	50750	40329	56575	61139	49524	38624	22683	8571	3288	1501	848	357	220	157
2006	49376	41551	33018	46320	49573	39052	26195	9239	3402	1416	827	473	189	235
2007	81438	40425	34019	27033	37728	38896	26137	10458	3129	1800	823	554	345	243
2008	66676	33098	27852	22053	30374	28468	10621	3664	1449	1046	526	381	418	

Table 9. XSA estimated fishing mortality at age. (Average fishing mortality is computed over ages 5-10.) (Healey and Mahé, 2008)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Fbar(5-10)
1975	0	0	0	0	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	0	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	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	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	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	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	0.020	0.124	0.445	0.890	0.690	0.441	0.199	0.256	0.300	0.300	0.435
1982	0	0	0	0	0.008	0.068	0.256	0.515	0.780	0.644	0.604	0.314	0.525	0.525	0.378
1983	0	0	0	0	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	0.017	0.075	0.359	0.800	0.672	0.395	0.332	0.142	0.291	0.291	0.386
1985	0	0	0	0	0.038	0.133	0.275	0.380	0.313	0.159	0.078	0.124	0.121	0.121	0.216
1986	0	0	0	0	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	0.002	0.045	0.409	0.603	0.414	0.249	0.199	0.170	0.207	0.207	0.287
1988	0	0	0	0	0.005	0.068	0.274	0.282	0.157	0.108	0.085	0.076	0.090	0.090	0.149
1989	0	0	0	0	0.003	0.040	0.224	0.225	0.145	0.132	0.141	0.155	0.143	0.143	0.128
1990	0	0	0	0.001	0.015	0.130	0.379	0.371	0.349	0.423	0.317	0.468	0.406	0.406	0.278
1991	0	0	0	0.003	0.046	0.135	0.400	0.655	0.731	0.626	0.591	0.615	0.616	0.616	0.432
1992	0	0	0	0.019	0.084	0.249	0.635	0.814	0.603	0.392	0.341	0.493	0.412	0.412	0.463
1993	0	0	0	0.019	0.239	0.520	0.819	0.982	0.876	0.560	0.433	0.641	0.549	0.549	0.666
1994	0	0	0	0.122	0.485	0.786	0.874	0.890	0.749	0.522	0.519	0.308	0.453	0.453	0.718
1995	0	0	0	0.009	0.041	0.114	0.350	0.394	0.368	0.273	0.304	0.328	0.303	0.303	0.257
1996	0	0	0	0.005	0.060	0.216	0.517	0.366	0.308	0.263	0.370	0.346	0.286	0.286	0.288
1997	0	0	0	0.005	0.057	0.209	0.559	0.538	0.387	0.327	0.366	0.369	0.353	0.353	0.346
1998	0	0	0	0.006	0.064	0.230	0.502	0.585	0.492	0.320	0.348	0.232	0.228	0.228	0.365
1999	0	0	0	0.004	0.031	0.135	0.697	0.739	0.582	0.411	0.346	0.533	0.338	0.338	0.432
2000	0	0	0	0.004	0.034	0.256	1.097	0.638	0.419	0.366	0.457	0.355	0.450	0.450	0.468
2001	0	0	0	0.008	0.046	0.288	0.987	0.899	0.406	0.391	0.596	0.495	0.510	0.510	0.503
2002	0	0	0	0.009	0.038	0.204	0.891	0.951	0.562	0.510	0.554	0.709	0.664	0.664	0.526
2003	0	0	0	0.022	0.105	0.364	1.018	1.016	0.643	0.481	0.442	0.448	0.558	0.558	0.604
2004	0	0	0	0.016	0.091	0.284	0.748	0.759	0.581	0.448	0.549	0.563	0.540	0.540	0.485
2005	0	0	0	0.010	0.038	0.188	0.698	0.724	0.642	0.396	0.383	0.435	0.387	0.387	0.448
2006	0	0	0	0.005	0.043	0.202	0.718	0.883	0.437	0.343	0.201	0.116	0.207	0.207	0.437
2007	0	0	0	0.004	0.017	0.112	0.701	0.849	0.570	0.342	0.247	0.174	0.141	0.141	0.432

Table 10. Total and spawning biomass (t) from XSA analysis. (Healey and Mahé, 2008)

	Total biomass	Spawning biomass (10+)
1975	132745	21901
1976	134515	17670
1977	156967	14817
1978	167779	15905
1979	162567	15619
1980	130949	12403
1981	115319	14026
1982	121359	19874
1983	122816	24154
1984	115307	24279
1985	148263	29003
1986	138252	33558
1987	164862	42319
1988	169413	44314
1989	182583	43867
1990	206522	55914
1991	225176	63402
1992	193014	49008
1993	148926	37916
1994	103612	28899
1995	77875	25695
1996	77778	19899
1997	74714	18439
1998	88131	17210
1999	103716	17119
2000	111918	13791
2001	113461	12424
2002	100779	10872
2003	93844	9191
2004	81929	9342
2005	85460	8558
2006	88165	7938
2007	85516	9885

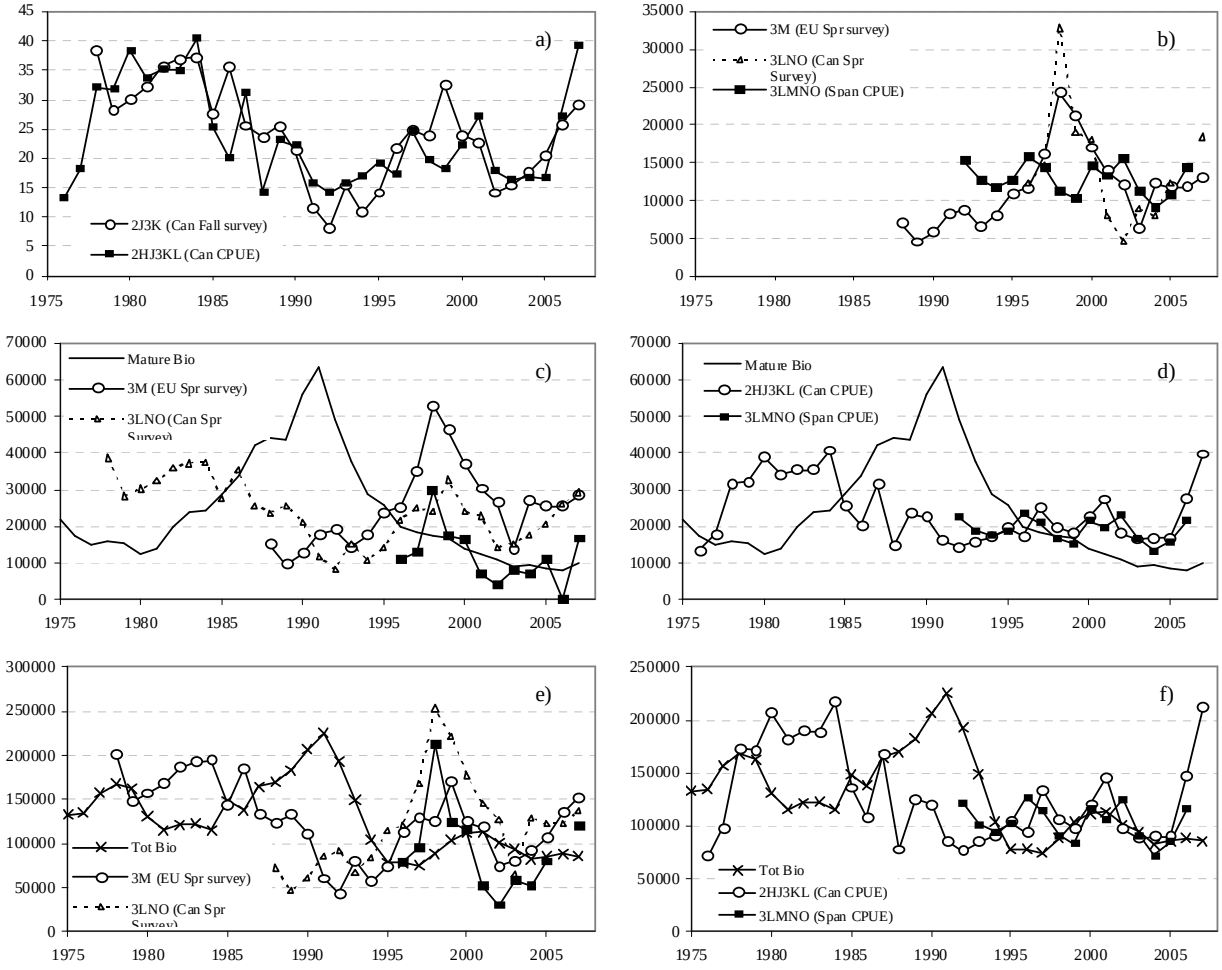

Figure 1: Comparison of normalised time series of survey and CPUE indices in a) and b), together with comparisons to the 2008 XSA mature biomass in c) and d), and the XSA total biomass in e) and f). The normalisation is to the average of the Can Fall survey and EU Spr survey in a) and b) respectively and of the XSA series in c) - f), over the same time period.

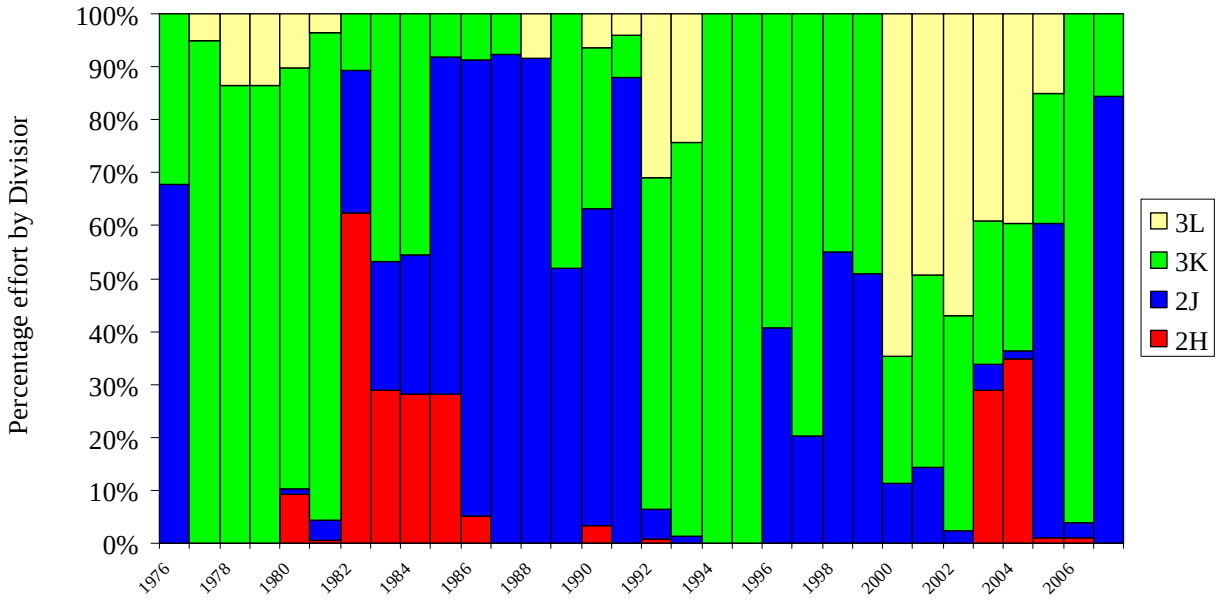

Figure 2: Percentage effort by division and year of the Canadian fleet.

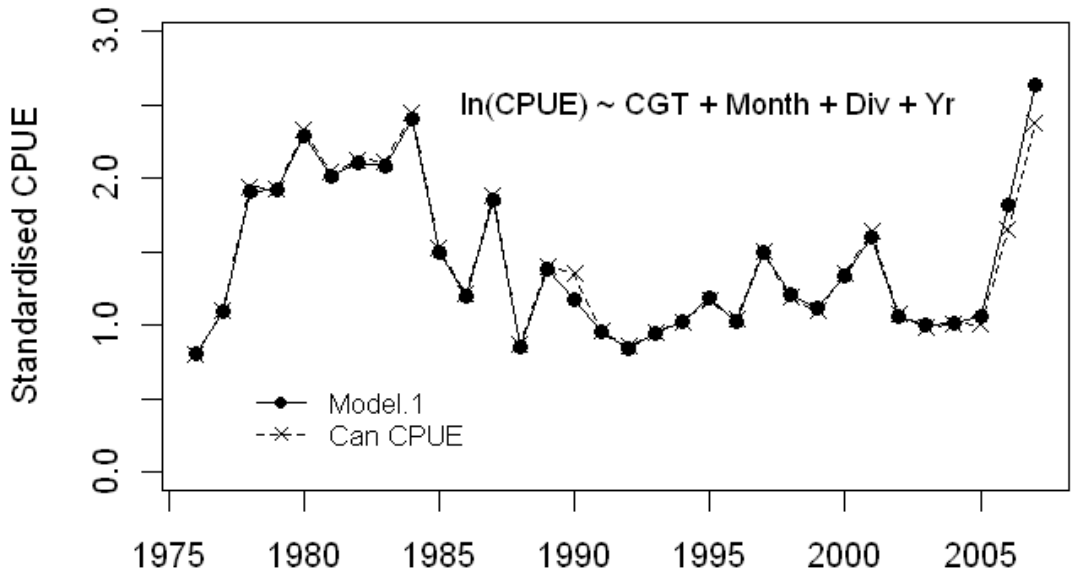

Figure 3: Standardised Canadian CPUE for Model.1 (no year*division interaction). The standardised CPUE series of Healy and Mahé (2008) is also plotted for comparison (after renormalisation to the average of Model.1).

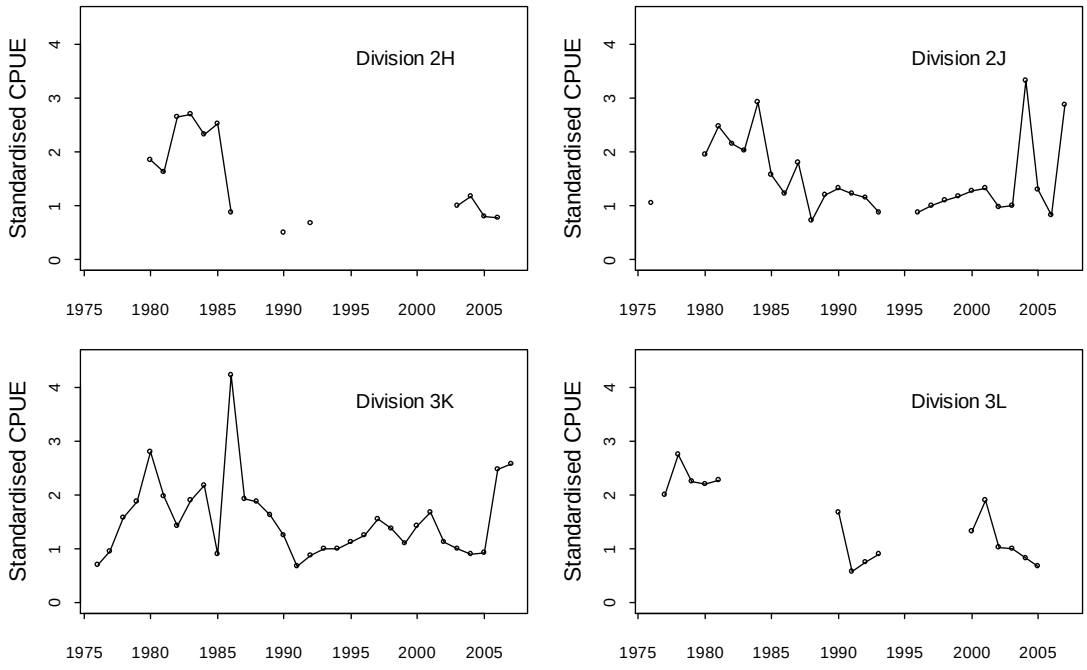

Figure 4a: Standardised Canadian CPUE by division for Model.2 (with year*division interactions).

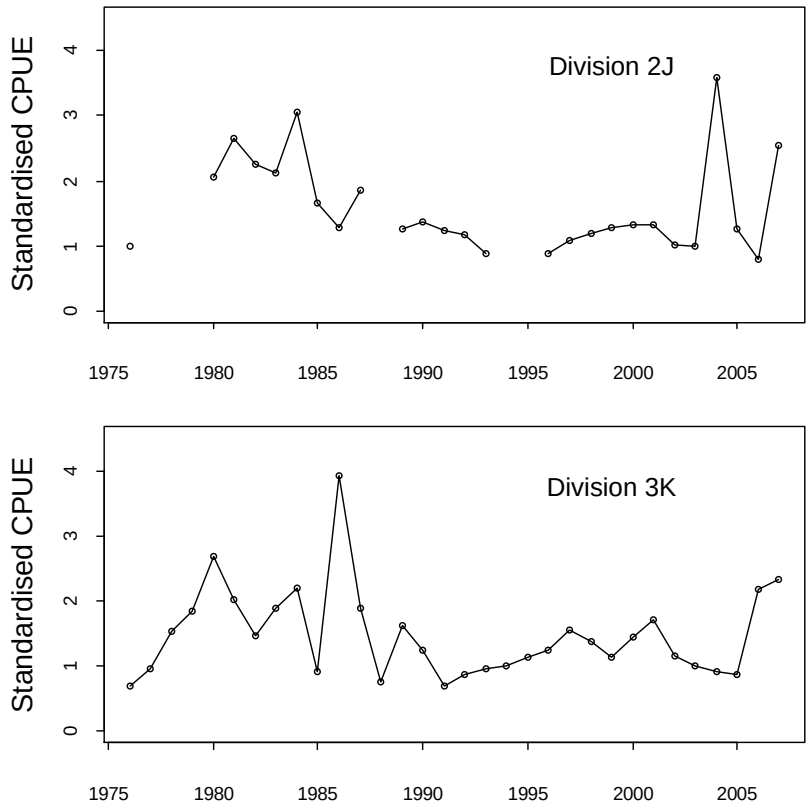

Figure 4b: Standardised Canadian CPUE for Divisions 2J and 3K *only* for Model.2 (with year*division interactions).

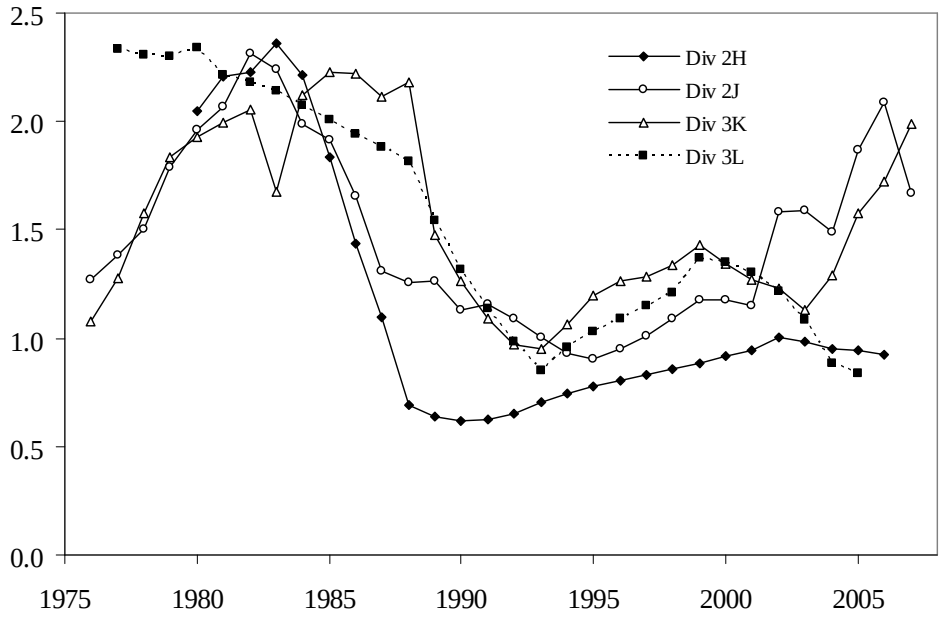

Figure 5a: Moving averages of standardised CPUE by division for Model.2. Note: where there were gaps, a linear trend was taken between the closest two points. Where possible, the averages are averages of 5 points (2 before, 2 after).

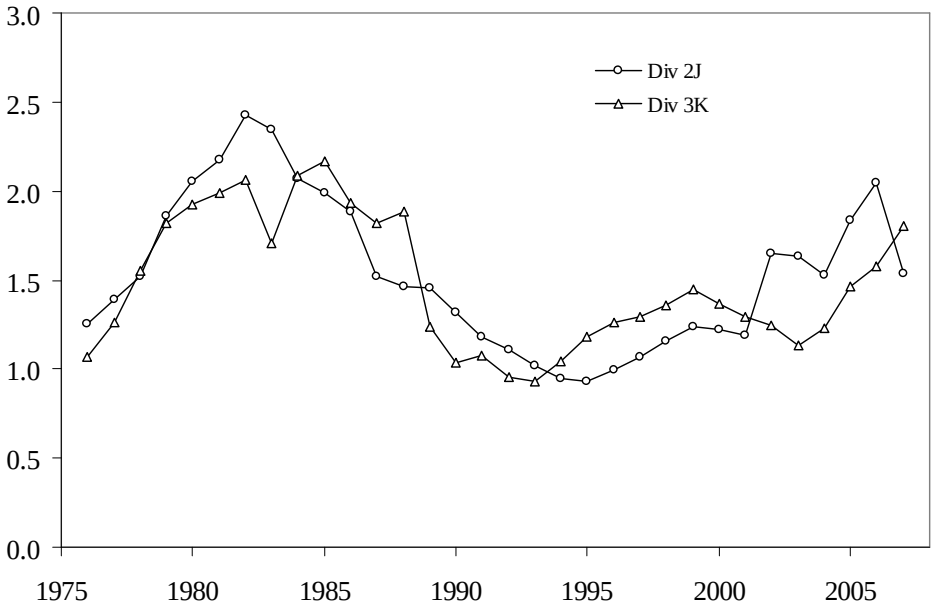

Figure 5b: As Figure 4a for Divisions 2J and 3K *only*, for Model.2.