Further CPUE-based Assessments of the Greenland Halibut Resource using SCAA

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Summary

Earlier CPUE-based SCAA assessments of the 2+3KLMNO Greenland halibut resource by Butterworth and Rademeyer are updated by taking account of some data adjustments and adjusting methodology for consistency with refinements of the SCAA methodology now applied to survey based. Results are qualitatively unchanged, indicating a resource currently at an intermediate level of depletion, and increasing over recent years in line with recent increases in CPUE.

Introduction

The assessments presented in this paper for the Greenland halibut resource are based on the New Baseline (Butterworth and Rademeyer, 2009a) methodology, except that instead of fitting to survey indices of abundance and survey catch-at-age information, the model is fit to CPUE series treated as indices of relative abundance. The fits continue to take account of commercial catch-at-age data.

The open-ended depth ranges for certain depth strata in the analyses of Brandão *et al.* (2009) have been reduced to finite ranges for which it can reasonably be assumed that fishing effort extends throughout such revised strata. Table 1 describes the factors levels and highlights the areas that have changed from the Brandão *et al.* (2009) analysis. Table 2 gives the updated GLM results, while Fig. 1 compares the trends of the GLM analyses with the old and new area weights (it is evident that the changes to the weights make little difference).

The model is therefore fit to three sets of CPUE series:

a) five CPUE series available from the Canadian (Brodie *et al*., 2008), Spanish (Gonzáles, pers. commn) and Portuguese (Vargas *et al*. 2008) fleets (with the three Portuguese CPUE series each given a weight of 1/3 relative to the Spanish and Canadian series), Table 3;

b) three CPUE series for GLM model 4 (with Division*year interactions) (from Brandão *et al.* (2009) with new area-weights (Table 2); and

c) three CPUE series for GLM model 5 (with Depth*year interactions) from Brandão *et al.* (2009) with new area-weights (Table 2).

Methods

The specifications used for the models in this paper are as that for the New Baseline (Butterworth and Rademeyer, 2009a), except that instead of fitting to survey indices of abundance and survey catch-at-age information, the model is fit to CPUE series treated as indices of relative abundance, as was done in Butterworth and Rademeyer (2009b). The contribution by the CPUE series to the log-likelihood is described in Appendix B of Butterworth and Rademeyer (2009c). Five CPUE series are available from the Canadian, Spanish and Portuguese fleets (see Appendix A, Table A1). Serial correlation is estimated for the CPUE series, but not for the commercial CAA (as for the New Baseline).

Results and Discussion

The steepness parameter h is fixed to 0.9 as initial model fits treating h as an estimable parameter led to estimates approaching the upper boundary set close to 1

Fig. 2 compares the biomass trajectories for the three SCAA fitting to CPUE series and the XSA results. Fig. 3 shows the average commercial selectivity estimated (note that this is subject to inter-annual variability governed by σ_Ω = 2 as in Butterworth and Rademeyer (2009b)). Fig. 4 shows diagnostics for the fits to the CPUE series, and Fig. 5 similarly for that to the commercial CAA. Note that there is no obvious indication of pattern in the CAA residuals.

Broadly speaking these updated results are very similar to those in Butterworth and Rademeyer (2009b). The resource is estimated to be at an intermediate level of depletion, and increasing over recent years in line with recent increases in CPUE.

Ideally this analysis should be conducted using fleet-specific selectivity patterns, but we understand that the fleet-disaggregated catch and CAA data that would be required for this are not available.

References

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Vargas J, Alpoim R, Santos E and Avila de Melo M. 2008. Portuguese Research Report for 2007. NAFO SCS Doc. 08/5, Ser. No N5495.

Table 1: Description of the factor levels for the Canadian, Spanish and Portuguese data. For the Division and Depth factors, the values in parentheses represent the size of the corresponding open ocean area in $n.m^2$, these have been updated (shaded cells, Power, pers. commn) to reflect the fished areas rather than total areas.

	Canada		Spain		Portugal	
α_{Year}	1998-2008		1992-2008		1998-2007	
β_{Month}	12 months		12 months		12 months	
γ_{Vessel}	6 "CGT" levels: "3123": Otter Trawl, 50-149t "3124": Otter Trawl, 150-499t "3125": Otter Trawl, 500-999t "3126": Otter Trawl, 1000-1999t "3127": Otter Trawl, >2000t "3857": Twin Otter Trawl, >2000t		58 vessels		4 vessels	
$\delta_{Division}$	4 levels:		4 levels:		4 levels:	
	2H	(2234)	3L	(3647)	3L	(1902)
	2J	(2840)	3M	(5430)	3M	(3494)
	3K	(3700)	3N	(1296)	3N	(805)
	3L	(4451)	3O	(1136)	3O	(729)
ϕ_{Depth}	6 levels (in fathoms):		6 levels (in meters):		6 levels (in meters):	
	350-399	(1768)	701-799	(1791)	701-799	(1791)
	400-449	(3748)	800-899	(1767)	800-849	(887)
	450-499	(3748)	900-999	(1955)	850-899	(887)
	500-549	(1136)	1000-1099	(1993)	900-949	(948)
	550-599	(939)	1100-1199	(2566)	950-999	(1017)
	600-649	(1687)	1200-1299	(2295)	1000-1099	(1993)
θ_{Lat}	7 levels: "2Hb": Div.2H, N of 56°30'N "2Hc": Div.2H, S of 56°30'N "2Ja": Div.2J, N of 53°50'N "2Jc": Div.2J, S of 53°50'N "3Kb": Div.3K, N of 50°50'N "3Kd": Div.3K, S of 50°50'N "3La": Div.3L		6 levels: "3Lb": Div.3L, N of 47°40' "3Ld": Div.3L, S of 47°40' "3Ma": Div.3M "3Nb": Div.3N, N of 44°30' "3Nd": Div.3N, S of 44°30' "3Od": Div.3O, S of 44°30'		6 levels: "3Lb": Div.3L, N of 47°40' "3Ld": Div.3L, S of 47°40' "3Ma": Div.3M "3Nb": Div.3N, N of 44°30' "3Nd": Div.3N, S of 44°30' "3Od": Div.3O, S of 44°30'	

Table 2: Standardized CPUE for Greenland halibut from Canadian, Spanish and Portuguese fleets for the GLMs models 4 and 5 with interaction with updated area-weights.

	Model 4 (Div*Year interaction)			Model 5 (Depth*Year interaction)		
	Canada 2HJ3K	Spain 3MNO	Portugal 3LMNO	Canada 2HJ3K	Spain 3MNO	Portugal 3LMNO
1992		0.8646			0.9856	
1993		0.7220			0.8733	
1994		0.7336			0.7671	
1995		0.8216			0.9496	
1996		0.9228			1.0032	
1997		0.8601			1.0060	
1998	0.8183	0.7566	1.0000	0.8155	0.8243	1.0000
1999	1.2549	0.5320	1.0298	0.8171	0.6262	1.1801
2000	1.7263	1.0000	0.9466	1.3473	1.0000	1.0938
2001	1.7343	0.7721	0.7958	1.5574	0.8424	0.8489
2002	1.3737	1.1091	0.7494	1.3583	1.1073	0.8633
2003	1.0000	0.6449	0.7240	1.0000	0.8256	0.8372
2004	1.5149	0.5842	0.4541	0.9989	0.6517	0.5141
2005	1.2343	0.6919	0.9079	1.1214	0.7563	0.9681
2006	2.2160	0.8626	0.8150	2.5716	0.9733	1.1235
2007	3.0572	1.7362	1.2039	2.6470	2.0088	1.4436
2008	4.1784	1.6522		2.7869	1.7906	

Table 3: Standardized CPUE for Greenland halibut from Canadian otter trawl fleet, Div. 2HJ3KL (Brodie *et al*., 2008), from Spanish fleet, Div. 3LMNO (González, pers. commn) 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	0.830	0.058		0.144
1994	0.397	0.774	0.109		0.148
1995	0.454	0.837	0.168	0.164	0.148
1996	0.406	1.013	0.222	0.198	0.182
1997	0.583	0.936	0.227	0.260	0.164
1998	0.463	0.770	0.269	0.190	0.181
1999	0.426	0.697	0.300	0.304	0.228
2000	0.525	0.923	0.311	0.302	0.309
2001	0.637	0.844	0.252	0.226	0.213
2002	0.421	1.001	0.222	0.215	0.277
2003	0.383	0.795	0.231	0.210	0.221
2004	0.394	0.616	0.126	0.109	0.154
2005	0.391	0.735	0.218	0.241	
2006	0.642	0.975	0.270	0.262	
2007	0.925	1.920	0.501	0.178	
2008		1.645			

Table 1: Results of fits of three SCAA variants (see text for details) to the commercial catch and CPUE data Biomass-related quantities are given in '000 tons. Values fixed on input rather than estimated are shown in **bold**.

	1) Original CPUE series (Table 3)		2) CPUE with Division*Year interaction (Table 2)		3) CPUE with Depth*Year interaction (Table 2)	
No of parameters	158		158		158	
No of data points						
'-lnL:overall	-296.3		-252.4		-255.6	
-lnL:CPUE	-90.3		-40.0		-43.3	
'-lnL:CAA	-234.2		-236.7		-236.5	
'-lnL:CAAsurv	-		-		-	
'-lnL:RecRes	18.3		15.0		15.0	
'-lnL:SelPen	9.9		9.3		9.2	
h	**0.90**		**0.90**		**0.90**	
θ	**1**		**1**		**1**	
ϕ	**0**		**0**		**0**	
ρ - CPUE	0.36		0.06		0.18	
K^{sp}	566		507		511	
B^{sp}_{2008}	324		228		231	
B^{sp}_{2008}/K	0.57		0.45		0.45	
$MSYL^{sp}$	0.17		0.17		0.17	
B^{sp}_{MSY}	96		86		87	
MSY	41		38		38	
σ_{comCAA}	0.07		0.06		0.06	
CPUE	q'sx10^6	σ_{cpue}	q'sx10^6	σ_{cpue}	q'sx10^6	σ_{cpue}
Canada	3.49	0.25	15.14	0.31	12.84	0.28
Spain	6.97	0.12	7.81	0.18	8.64	0.16
Portugal 3L	1.64	0.36	8.14	0.18	9.21	0.19
Portugal 3M	1.64	0.31				
Portugal 3O	1.64	0.23				
σ_R_out	0.17		0.16		0.16	

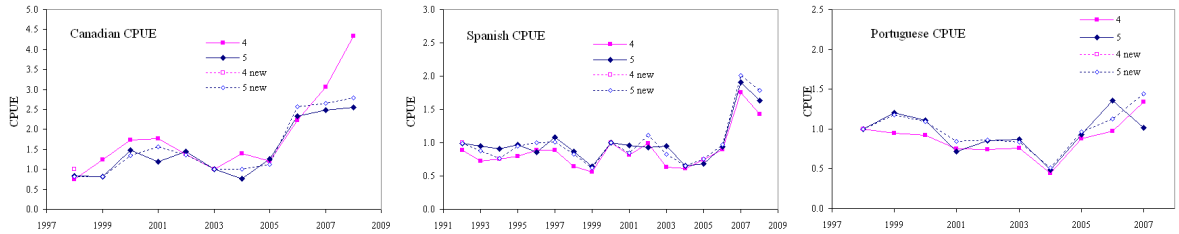

Fig. 1: Standardised CPUE for the GLMs models 4 and 5 with interactions from Brandão *et al.* (2009) and with the new area-weights.

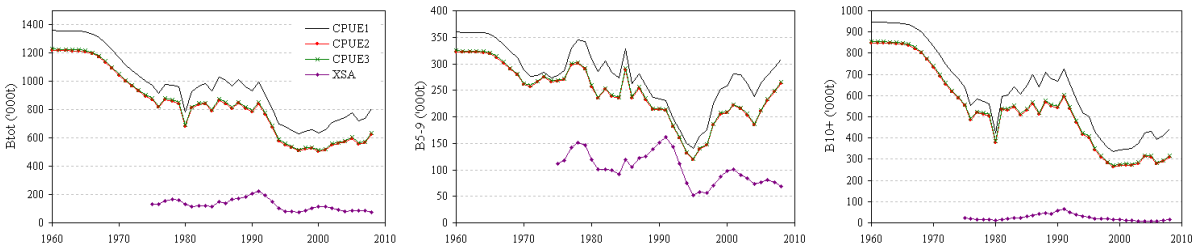

Fig. 2: Total, exploitable (5-9) and spawning (10+) biomass trajectories for the three SCAA fits to CPUE series and the commercial proportions-at-age data.

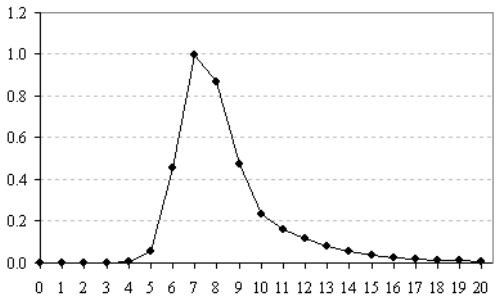

Fig. 3: Commercial selectivity-at-age as estimated for case 1.

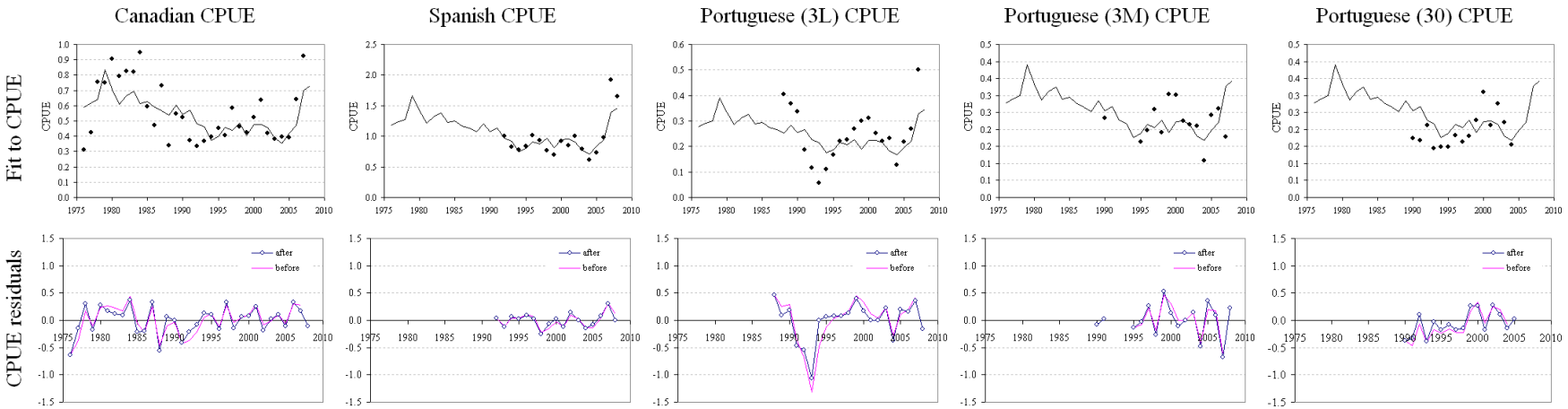

Fig. 4: Fit to the CPUE and CPUE residuals for CPUE model 1. Residuals are shown both before and after adjustment for serial correlation.

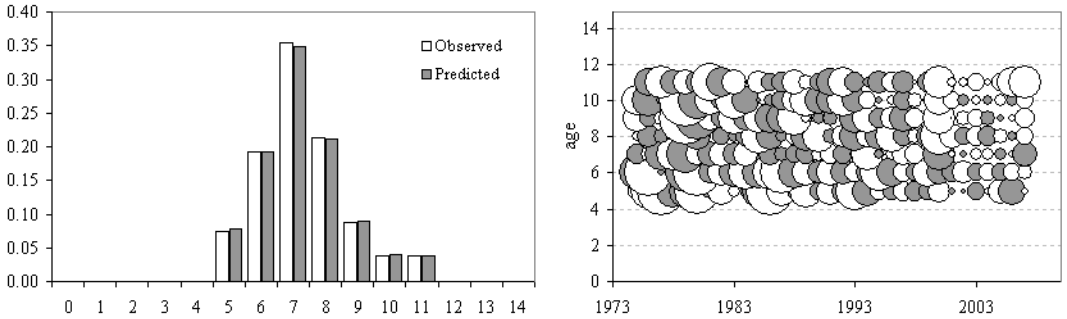

Fig. 5: Fit to the commercial CAA for CPUE model 1, first averaged over all years and then with residuals shown in the standard bubble plot format.