Sensitivity of abalone assessment model to having no recent commercial data

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ABSTRACT

The consequences of absence of availability of commercial data for the assessment of abalone in zones A and B are examined by assuming an absence of commercial data over the past five years. This results in the extent of uncertainty about current resource size roughly doubling, and of about current poaching levels roughly increasing by a factor of 1.5 for Zone A and 2.5 (i.e. more than double) for Zone B. These results point towards a substantial deterioration in ability to assess the abalone resource with reasonable precision in the next few years in the absence of trend information previously provided by CPUE data.

INTRODUCTION

The 2007 abalone assessment model (Plagányi 2007 a,b) is used to investigate the effect on model predictions given a scenario in which inshore FIAS data are assumed available, but it is assumed that no commercial CPUE or size structure data are available for the past five years. This was done as a rough initial check as to possible problems to be encountered in assessing abalone over the next few years given that the fishery has been closed (and hence no further commercial data will become available), but assuming that FIAS data will continue to be collected as in the past.

METHODS

The 2007 abalone stock assessment model Reference Case was used, with results compared with a scenario in which it is assumed that there were no commercial CPUE or size structure data available for the past five years. Available data over this period included the FIAS data and size structure information from confiscated samples of illegal catch. The recent trends in CPUE and FIAS have been similar.

In order to realistically test the effect of assuming no commercial data are available, it was necessary to first make an adjustment to the 2007 assessment model to account for the assumption of unrealistically high precision associated with the FIAS survey data. The sampling variance estimates available for FIAS are used as inputs in the model, but these estimates fail to include all sources of variability. To take this into account an additional variance component is added to the variance estimates, with a single additional variance parameter, assumed to be the same for each zone, estimated in the minimisation process. This is effected subject to the constraint that the overall variance must be greater than or the same as its externally input component.

The FIAS catchability coefficient q^s is thus estimated by its maximum likelihood value which, for the case of a log-normal error distribution, is given by:

$$\ln \hat{q}^s = \frac{\sum_y 1 \big/ \left(\sigma_y^s\right)^2 \left(\ln I_y^s - \ln \hat{B}_y^{exp,s}\right)}{\sum_y 1 \big/ \left(\sigma_y^s\right)^2}$$

where $\left(\sigma_y^{FS}\right)^2 = \left(\sigma_{Add}\right)^2 + \ln\left(1+\left(CV_y\right)^2\right)$ and the coefficient of variation (CV_y) of the resource abundance estimate for year *y* is input.

The estimated additional variance parameter σ_{Add} is shown in Table 1, and its 90% confidence interval (normal approximation) shown in Table 2. The Tables show Hessian-based CVs, whereas the Figures give the Hessian-based 90% probability intervals.

Results presented here focus on Zones A and B. Projection results together with their associated uncertainties are also provided for a scenario in which it is assumed that future commercial catches remain set at zero but future poaching catches are half the current estimated level.

RESULTS AND DISCUSSION

Figures 1a,b illustrate the large increase in uncertainty associated with model predictions that results under a scenario with no commercial data available for a 5 year period. This is particularly evident for Zone A for which the spawning biomass estimate also increases substantially in the absence of recent CPUE information (Table 2; Fig 1a). In addition to the estimates of pre-exploitation biomass, there is a much larger uncertainty associated with estimates for the current spawning biomass (Table 2) – for example, the 90% confidence interval associated with the Reference Case current estimate of spawning biomass in Zone A is 1640-4040 tonnes, which widens to 1080-6500 tonnes under the scenario with no recent commercial data. In broad terms, had no commercial data been available for the past five years, the uncertainty associated with current estimates of resource status would be roughly double.

The estimates of poaching in the model are key. Fig. 2 highlights the large increase in uncertainty associated with these estimates when no commercial data are available. For the poaching estimates for 2007, without commercial data for the last five years uncertainty roughly increased by a factor of 1.5 for Zone A and 2.5 (ie more than double) for Zone B.

Overall the results presented here point towards a substantial deterioration in ability to assess the abalone resource with reasonable precision in the next few years in the absence of additional resource trend information such as that previously provided by the commercial CPUE data.

Literature cited

Plagányi, É.E. 2007a. A summary of the assessment and management approach applied to South African abalone in Zones A-D. Marine and Coastal Management document WG/AB/07/Jun/01: 20 pp

Plagányi, É.E. 2007b. Projection results for Zones A, B, C and D in 2007. Marine and Coastal Management document: WG/AB/07/Aug/27: 11 pp.

Table 1. Comparison of selected model results when using the full 2007 Reference Case assessment model as compared to a scenario in which the commercial CPUE and catch-at-age information from the last five years are excluded when fitting the model.

Model	a) Ref. case					b) Scenario with no recent CPUE				
No. parameters			30					30		
Zone	**A**	**B**	**CNP**	**CP**	**D**	**A**	**B**	**CNP**	**CP**	**D**
Ave confiscation %	14%	45%	7%		5%	11%	53%	10%		6%
$B(0)^{sp}$	7385	5754	2606	4385	9173	9038	5900	2209	4371	10778
ρ	0.033	0.033	0.033	0.017	0.033	0.055	0.055	0.055	0.027	0.055
r^I	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Cpmax (no.)	1283760	7.85E+05		561607	800613	1576380	6.75E+05		560332	745288
Cpmax (MT)	440	356		269	394	545	310		267	352
Cpmax (YEAR)	2006	2002		1995	2002	2006	2002		1995	2002
CP(2007) (MT)	524	243		0	97	632	220		10	88
M_0			0.324					0.324		
M_{15}			0.137					0.137		
a(CS)			8.99892					8.99894		
a(RS)			8.99951					8.99942		
a(PS)			4.52556					4.09957		
a(FS)			6.72678					6.18446		
a(OS)			4.55789					4.9432		
a(IS)			-					-		
μ(CS)			0.000331					0.000479		
μ(RS)			0.001219					0.000885		
μ(PS)			0.000185					0.000186		
μ(FS)			0.001692					0.001393		
μ(OS)			4.74E-12					0.000169		
μ(IS)			-					-		
δ(CS)			477.913					313.251		
δ(RS)			617.99					608.691		
δ(PS)			1.45491					35.9951		
δ(FS)			0.779493					0.880385		
δ(OS)			0.668497					0.676621		
δ(IS)			-					-		
Model	a) Ref. case					b) Sensitivity				
	A	**B**	**CNP**	**CP**	**D**	**A**	**B**	**CNP**	**CP**	**D**
-*ln* L CPUE	-44.402	-50.722	-35.323	-44.862	-34.480	-41.450	-39.067	-34.492	-44.380	-26.724
-*ln* L FIAS	0.630	-4.472	-3.394	4.724	-4.038	0.673	-4.154	-4.764	4.886	-4.195
-*ln* L age CS	-17.044	-18.464	-8.483	-10.540	-11.797	-14.161	-14.464	-7.155	-10.517	-9.700
-*ln* L age RS	-1.642	-8.002	-6.819	-0.006	-8.854	-1.645	-8.090	-7.179	-0.018	-8.705
-*ln* L age PS	-2.777	-3.299		-1.803	-3.751	-2.789	-2.624		-1.937	-3.230
-*ln* L age FIAS	-1.934	-9.925	-3.913	-0.352	-5.395	-2.818	-9.924	-4.777	-0.245	-5.054
-*ln* L age OS inshore	-3.463	-1.060		-1.269	-0.945	-3.230	-1.117		-1.412	-1.100
-*ln* Lage OS offsh.	-3.618	-1.689		-0.810	-1.855	-3.128	-1.320		-0.995	-2.158
-*ln* L age IS insh+offsh.		-1.004	-0.735				-0.872	-0.780		
-*ln* L zone subtotal	-74.251	-98.637	-113.585		-71.115	-68.548	-81.631	-113.764		-60.866
-*ln* L TOTAL			-357.588					-324.809		
σ CPUE	0.119	0.094	0.151	0.064	0.172	0.092	0.103	0.120	0.066	0.180
σ age CS	0.079	0.073	0.114	0.094	0.097	0.076	0.075	0.117	0.089	0.099
σ age RS	0.114	0.057	0.061	0.201	0.059	0.114	0.057	0.058	0.198	0.061
σ age PS	0.122	0.131		0.153	0.098	0.121	0.142		0.150	0.108
σ age FIAS	0.132	0.070	0.093	0.132	0.086	0.114	0.070	0.080	0.136	0.091
σ OS insh.	0.036	0.063		0.053	0.073	0.040	0.060		0.047	0.064
σ OS offsh.	0.038	0.043		0.082	0.035	0.046	0.057		0.071	0.028
σ IS		0.036	0.071				0.042	0.067		
Additional variance	0.402					0.381				
q CPUE	0.00033	0.000645	0.003734	0.00098	0.000272	0.000248	0.000612	0.003095	0.001024	0.00022
Depletion statistics										
$B^{sp}(2007)/K$ (Insh. + Offsh)	0.38	0.31	0.05	0.06	0.15	0.42	0.36	0.14	0.08	0.22
$B^{sp}(2007)/K$ (Insh.)	0.29	0.27	0.00	0.00	0.03	0.27	0.32	0.01	0.00	0.06
$B^{sp}(2007)/K$ (Offsh.)	0.57	0.39	0.16	0.26	0.38	0.61	0.41	0.29	0.25	0.42
$B^{total}(2007)/K$	0.43	0.35	0.05	0.05	0.13	0.46	0.41	0.12	0.07	0.20
$B^{commercial}(2007)/K$	0.33	0.22	0.07	0.07	0.19	0.39	0.28	0.16	0.09	0.28
FIAS N_{2007}/N_{1951}	0.28	0.33	0.00	0.00	0.01	0.22	0.39	0.00	0.00	0.02

Table 2. Comparison of the uncertainty associated with key model results when using the full 2007 Reference Case assessment model as compared to a scenario in which the commercial CPUE and catch-at-age information from the last five years are excluded when fitting the model.

	a) Reference Case with CPUE			b) No recent CPUE		
Parameter	Value	90% Confidence Interval		Value	90% Confidence Interval	
M_0	0.32	0.31	0.34	0.32	0.31	0.34
M_{15}	0.14	0.12	0.15	0.14	0.12	0.16
$B(0)^{sp}$ (A)	7385	5384	9387	9038	4491	13585
$B(0)^{sp}$ (B)	5754	5347	6161	5900	5328	6473
$B(0)^{sp}$ (C)	6991	6472	7510	6579	5969	7190
$B(0)^{sp}$ (D)	9173	6533	11814	10778	6146	15410
$B(current)^{sp}$ (A)	2842	1638	4045	3803	1085	6521
$B(current)^{sp}$ (B)	1757	1371	2143	2145	1287	3003
$B(current)^{sp}$ (C)	405	0	2089	629	394	863
$B(current)^{sp}$ (D)	1353	0	7453	2356	549	4162
AddvarSTD σ_{Add}	0.40	0.29	0.52	0.38	0.26	0.50

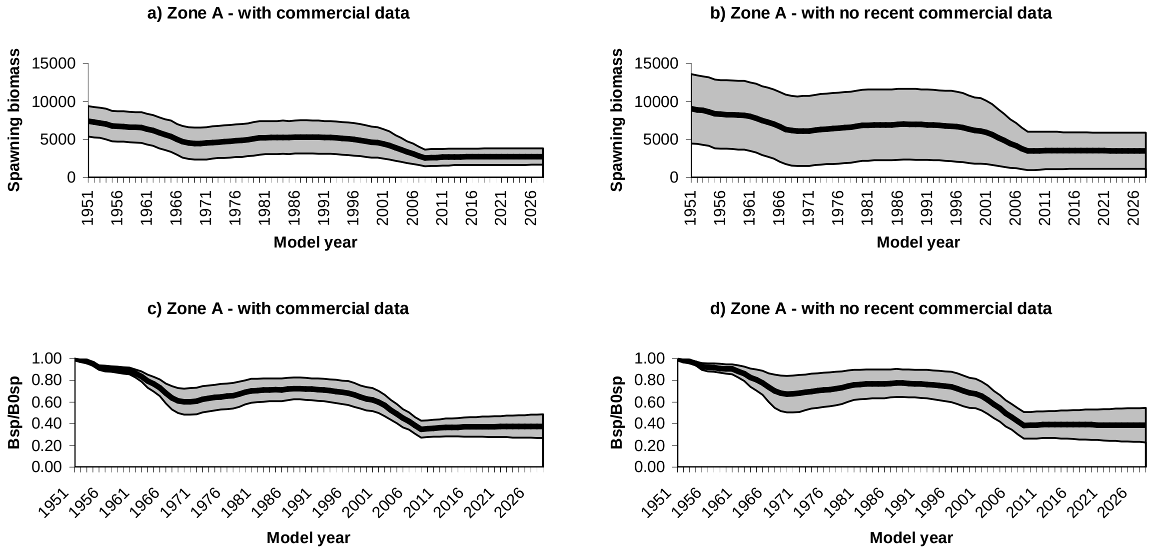

Fig. 1a. Total spawning biomass trajectories (inshore and offshore combined and shown in both absolute terms (top) and as a proportion of the pre-exploitation level (bottom)) for Zone A when a) **using the 2007 Reference Case model and b) when using a version of the model that assumes no commercial data were available for the past five years**. The shaded areas represent the associated Hessian-based 90% probability intervals. Projections assume future commercial catches are set to zero and that poaching levels in the future are fixed at half the current estimated level.

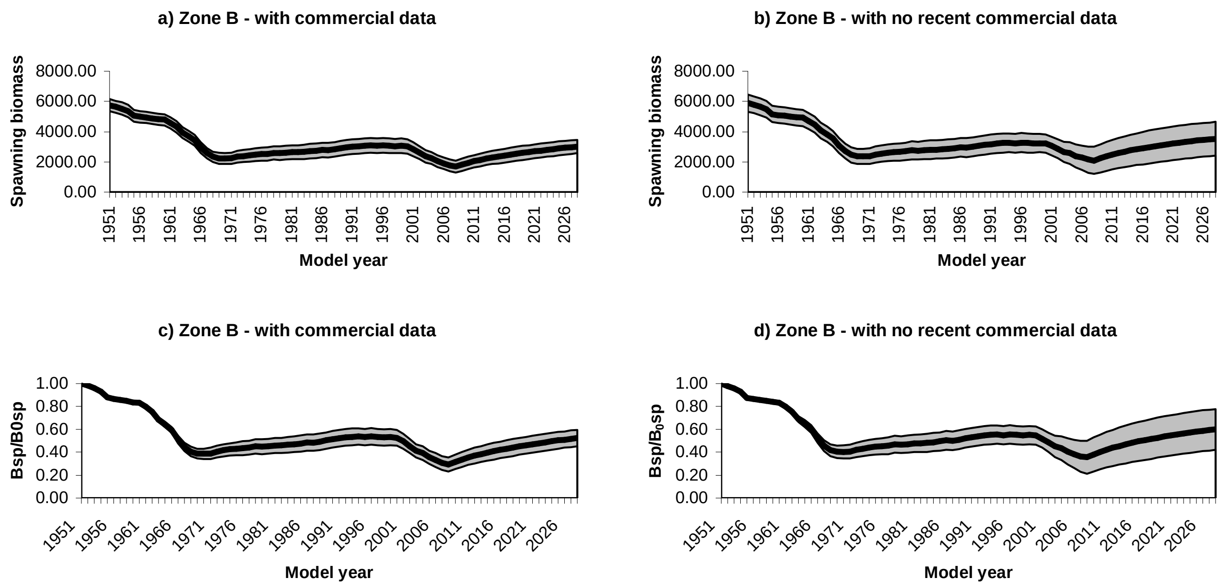

Fig. 1b. Total spawning biomass trajectories (inshore and offshore combined and shown in both absolute terms (top) and as a proportion of the pre-exploitation level (bottom)) for Zone B when a) **using the 2007 Reference Case model and b) when using a version of the model that assumes no commercial data were available for the past five years**. The shaded areas represent the associated Hessian-based 90% probability intervals. Projections assume future commercial catches are set to zero and that poaching levels in the future are fixed at half the current estimated level.

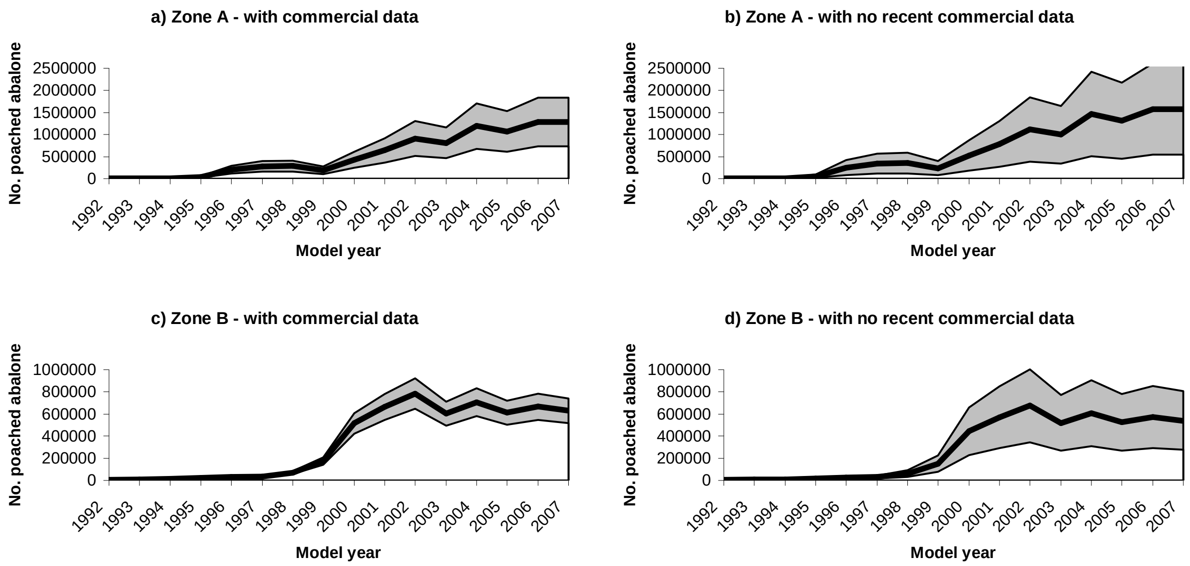

Fig. 2. Illustrative model results showing the uncertainty associated with estimates of the total numbers of abalone poached for years as shown for a-b) Zone A and c-d) Zone B when using the 2007 Reference Case model (left panels) and when using a version of the model that assumes no commercial data were available for the past five years (right panel). The shaded areas represent the associated Hessian-based 90% probability intervals.