Results for the abalone spatial- and age-structured assessment model for Zones A, B, C and D in 2012

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Abstract

The 2011 assessment of abalone in Zones A-D is updated to take new data into account. Projections are shown for different scenarios for the future commercial and poaching catches in Zone A and Zone B. Current poaching levels (average of 2011 and 2012) if continued, would not be sustainable.

Introduction and Data

This document provides results from fitting the Reference spatial- and age-structured production model (ASPM) for abalone for Zones/Subareas A, B, CNP, CP and D in combination using new data that have become available since the previous assessment (Brandão and Butterworth, 2011).

The series that have been updated compared to those used in Brandão and Butterworth (2011) for the analyses that follow are (note that throughout this document the convention is that, for example, the year 2008 refers to the Model-year running from October 2007 to September 2008.):

- CPUE: new values from updated GLM standardisation for Zones A and B only for 2011 (Brandão and Butterworth, 2012a)
- Commercial catches for Zones A and B for 2011 (TAC assumed taken in 2012)
- Poaching confiscations for all Zones (2010 updated for Zones A and B, 2011 updated for all Zones and 2012 extrapolated to a full Model-year for all Zones)
- Commercial catch-at-age data: for Zones A and B for 2011
- Poaching catch-at-age data: Zones A and B (2010 and 2011 revised and 2012) and Zones C and D (2011 revised and 2012).

Methodological Changes

The full details of the spatial- and age-structured production model used for assessing abalone are provided in Brandão and Butterworth (2009) as well as in Plagányi and Butterworth (2010). The Reference case model described in those two documents has been modified by some generally slight adjustments that are described in Brandão and Butterworth (2011). The model applied this year is identical to that applied last year in including those adjustments, and for simplicity will be referred to as the Reference case model.

The main difference arising from the adjustments is that the method for calculating the CPUPE (catch per unit of policing effort) index, which serves as an index of the numbers of abalone poached in a Zone, has been changed for the most recent years. Previously the number of abalone confiscated (or abandoned) which were collected by all MCM/DAFF-associated policing operations and which could be assigned to a Zone within Zones A-D was used. This annual value for each Zone was divided by an estimate of overall policing effort for that year (relative to previous years) as advised by a senior member of MCM/DAFF's compliance section, hence providing a CPUPE index time series for each Zone.

Continuation of this coarse approach to estimating policing effort trends was, however, undesirable in circumstances where the recovery plan adopted for abalone in 2010 specified an annual 15% reduction in the extent of poaching, which in turn begged the development of a more objectively based measure. This measure has been provided by an analysis of the detailed records on confiscations and policing effort which has been maintained over recent years by DAFF's compliance section, and Brandão and Butterworth (2012b) use these data for Zones A-D combined to develop a new CPUPE index for the 2008-2012 period. This new index is used here in preference to the previous approach because of its more objective basis and the fact that the confiscations considered correspond exactly to the policing effort measures utilised. In implementing this change in the assessment model, the previous measure of CPUPE in each of Zones A-D has been used until 2007, and thereafter replaced by the new index from Brandão and Butterworth (2012b). This requires a calibration factor (k) for each Zone, as the two CPUPE indices have different units. For the Reference case model, this was fixed on input by dividing the sum of the CPUPE index for the Zone concerned for 2008 and 2009 under the old approach, by the sum of the corresponding values for the new approach. Note that this approach makes the tacit assumption that the distribution of abalone poached across Zones A-D has remained the same over the period from 2008.

Results

Results have been obtained for the Reference case model for the updated data. These are reported in Tables 1-2 for some key statistics, and in terms of fits to CPUE for Zones A and B in Figure 1, FIAS data for Zones A to D in Figure 2, spawning biomass with projections for all Zones in Figures 3, and annual poaching estimates (by number) for Zones A and B in Figure 4.

These Tables and Figures include comparisons with the results of the previous assessment of Brandão and Butterworth (2011), referenced as “Previous”.

Figure 5 shows spawning biomass projections for the Reference case model for five scenarios for future commercial and poaching catches:

- Poaching only (average of 2011 and 2012 levels)
- 50t commercial catch only
- Both poaching and commercial catches at the above levels
- A 3 year phase-down of commercial catches to zero
- 50t commercial catch for the next two years and then no commercial catch afterwards
- Poaching reduction necessary to keep the biomass at its current level

Results for some of these scenarios are also shown assuming that an Allee effect operates (Figure 6).

Figure 7 shows future poaching levels, as assumed to remain at the current estimated level (average of 2011 and 2012), and the actual removals made by the model because of the model restriction that does not allow the fully selected fishing proportion to be greater than 95%. Thus the model builds in a factor to allow for the fact that as abundance declines, it could not be possible to sustain current poaching removals.

Discussion

The Reference case results are similar to those from the previous assessment conducted in 2011 (Previous), but results do show that the abalone stock is further reduced than thought previously in all Zones (Table 1 and Figure 3).

Fits to the CPUE data for Zones A and B (Figure 1) and fits to the FIAS data (Figure 2) are reasonable.

Future trends are unsurprisingly more pessimistic under the Allee effect (Figure 6).

Although there has been an estimated drop in poaching levels in the last season for both Zones A and B (Figure 4), the current level of poaching (the average of 2011 and 2012) is still not sustainable in the future (Figures 5 and 6).

Figure 5 shows that in relative terms, the differences amongst the predicted effects of stopping the commercial catch immediately, phasing it out over three years, or stopping it after two more years, are slight. This is because the effects of future poaching dominate the projections.

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Plagányi, É.E. and Butterworth, D.S. 2010. A spatial- and age-structured assessment model to estimate the impact of illegal fishing and ecosystem change on the South African abalone *Haliotis midae* resource. African Journal of Marine Science, 32(2):207-236.

Table 1. Best fit estimates for the pre-exploitation spawning biomass B_0^{sp}, current depletion and the depletion at the end of the projection period for the Reference case. Projections assume future poaching levels at their current estimated values (average of 2011 and 2012). For comparison, results for the previous Reference case ("Previous") of the assessment of Brandão and Butterworth (2011) are also given.

	B_0^{sp}					$\left(B_y^{sp}/B_0^{sp}\right)$						$\left(B_y^{sp}/B_0^{sp}\right)$					
Model	**A**	**B**	**CNP**	**CP**	**D**	**y**	**A**	**B**	**CNP**	**CP**	**D**	**y**	**A**	**B**	**CNP**	**CP**	**D**
Previous	9478	6364	3366	4812	10325	2011	0.374	0.292	0.145	0.072	0.282	2031	0.173	0.155	0.034	0.012	0.070
Reference case	9334	5979	2981	4725	9140	2011	0.355	0.283	0.112	0.071	0.251	2031	0.148	0.134	0.023	0.009	0.055
						2012	0.286	0.228	0.085	0.046	0.227	2032	0.146	0.132	0.022	0.008	0.052

Table 2. Estimates of the current (2012) poaching levels (in terms of biomass), the average of the last five years of the proportion of confiscations to estimated poaching numbers and the minimum values of the negative of the log-likelihood function (-*ln* L) for the Reference case. For comparison, results for the "Previous" 2011 assessment are also given (the poaching estimates given for that assessment are those for 2011). Note that all contributions from catch-at-age data to -*ln* L have been multiplied by 0.1 as an *ad hoc* adjustment to compensate for likely positive correlation in these data. The log-likelihood values are not comparable (because the data fitted differ from the current Reference case) and are given within square brackets.

	Poaching (2012) MT					***Average proportion of confiscation to poaching over the last 5 years***					***-ln L***					
Model	**A**	**B**	**CNP**	**CP**	**D**	**A**	**B**	**CNP**	**CP**	**D**	**A**	**B**	**CNP**	**CP**	**D**	**Total**
Previous	691.3	408.4	81.0	102.3	158.6	(22.5%	28.4%	7.8%		10.6%)†	**[**-77.17	-77.5	-52.3	-47.90	-52.76	**-307.6]**
Reference case	449.5	257.3	49.4	58.0	118.9	15.4%	25.1%	6.0%		7.6%	-77.96	-83.8	-55.9	-50.1	-54.6	**-322.3**

† Note that these averages given in Brandão and Butterworth (2011) were calculated over the wrong period. The values reported in this Table are the correct ones.

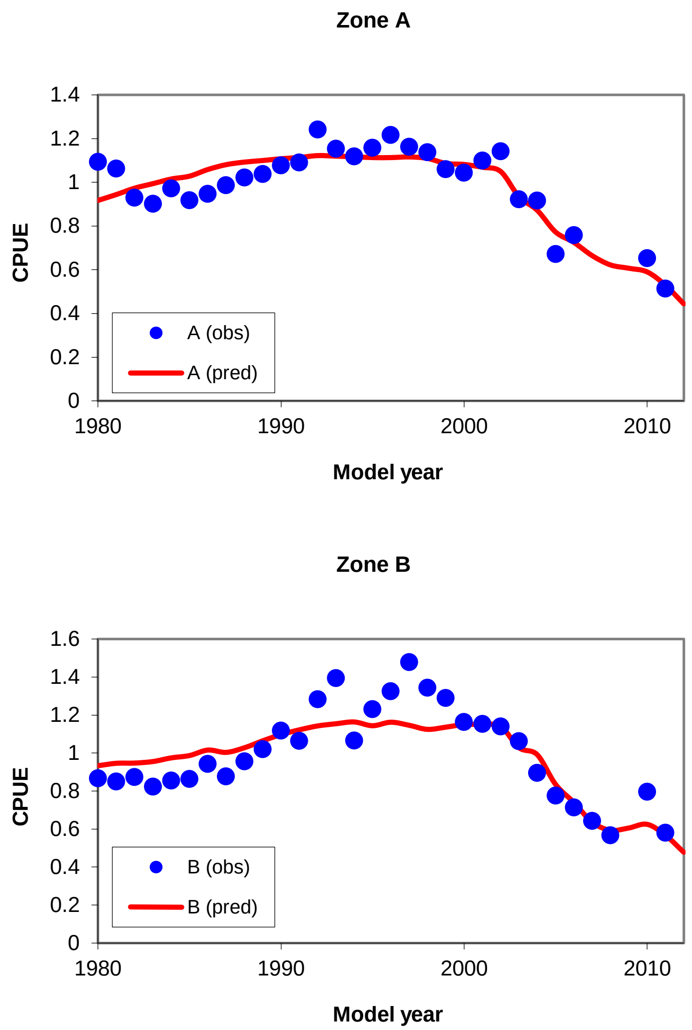

Figure 1. Comparisons between the standardised CPUE (obs) and model-predicted CPUE values for the Reference case for Zones A and B.

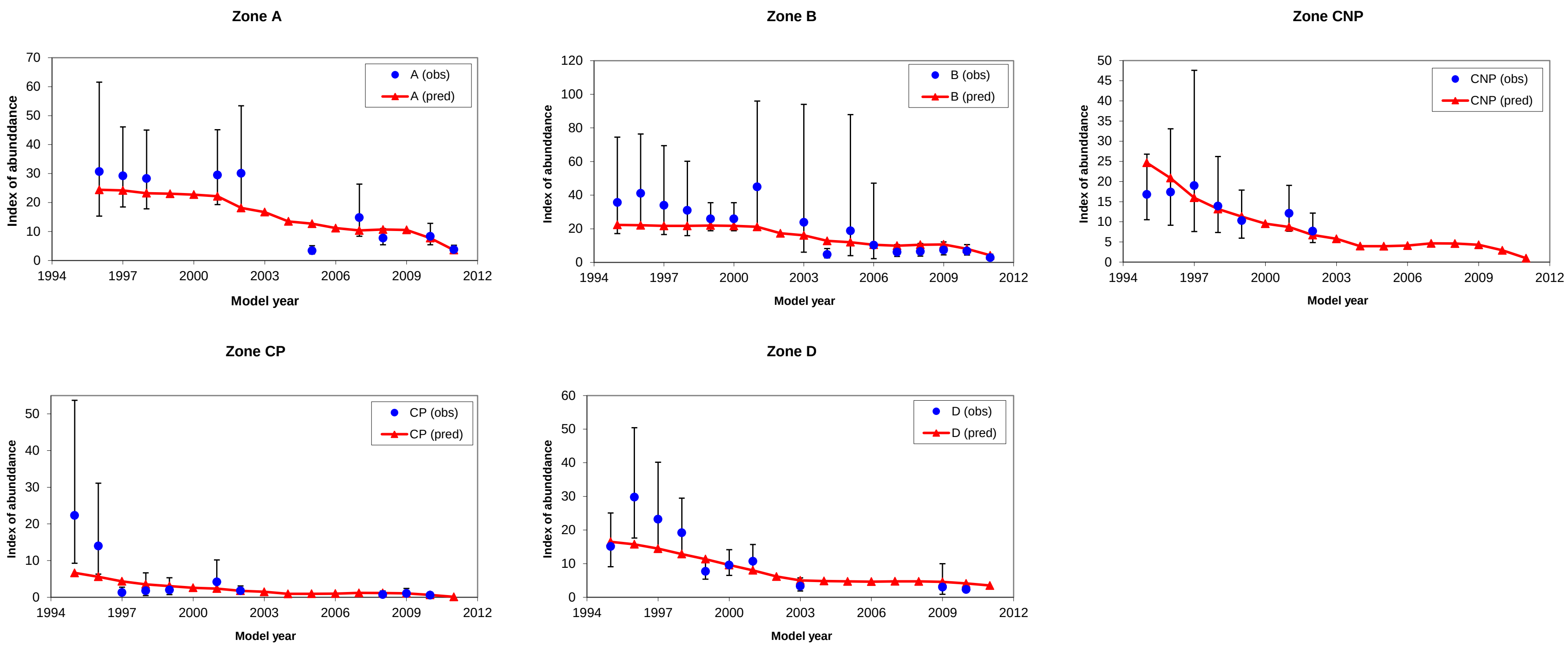

Figure 2. Comparison of observed FIAS and model-predicted trends for the Reference case Zones A to D. Note that 95% confidence intervals have been computed as estimate*exp(±1.96*CV).

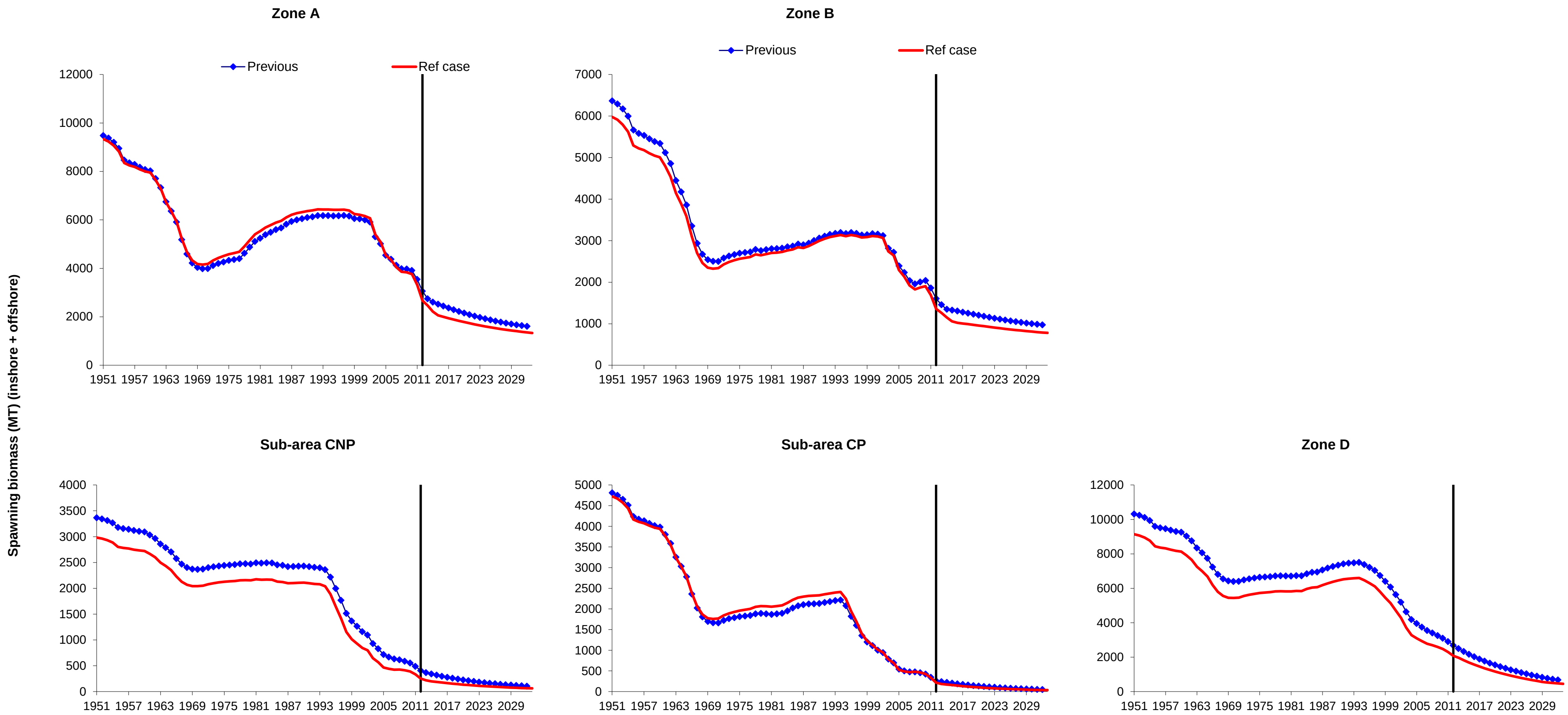

Figure 3. Total (inshore + offshore) spawning biomass trajectories shown for Zones A to D for the Reference case model compared to the "Previous" one obtained in the 2011 assessment. Note that the 20-yr projections shown (after the vertical bar) represent scenarios under which future poaching levels are assumed to remain at the current estimated level (average of 2010 and 2011 for the "Previous" model and the average of 2011 and 2012 for the "Ref case") and future commercial catches are set to zero.

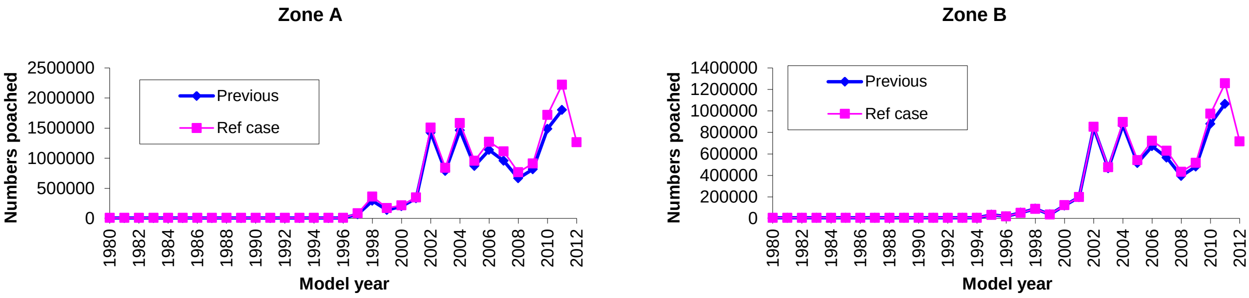

Figure 4. Comparison of model-predicted numbers of abalone poached for Zones A and B for the Reference case model and those obtained in the 2011 assessment ("Previous").

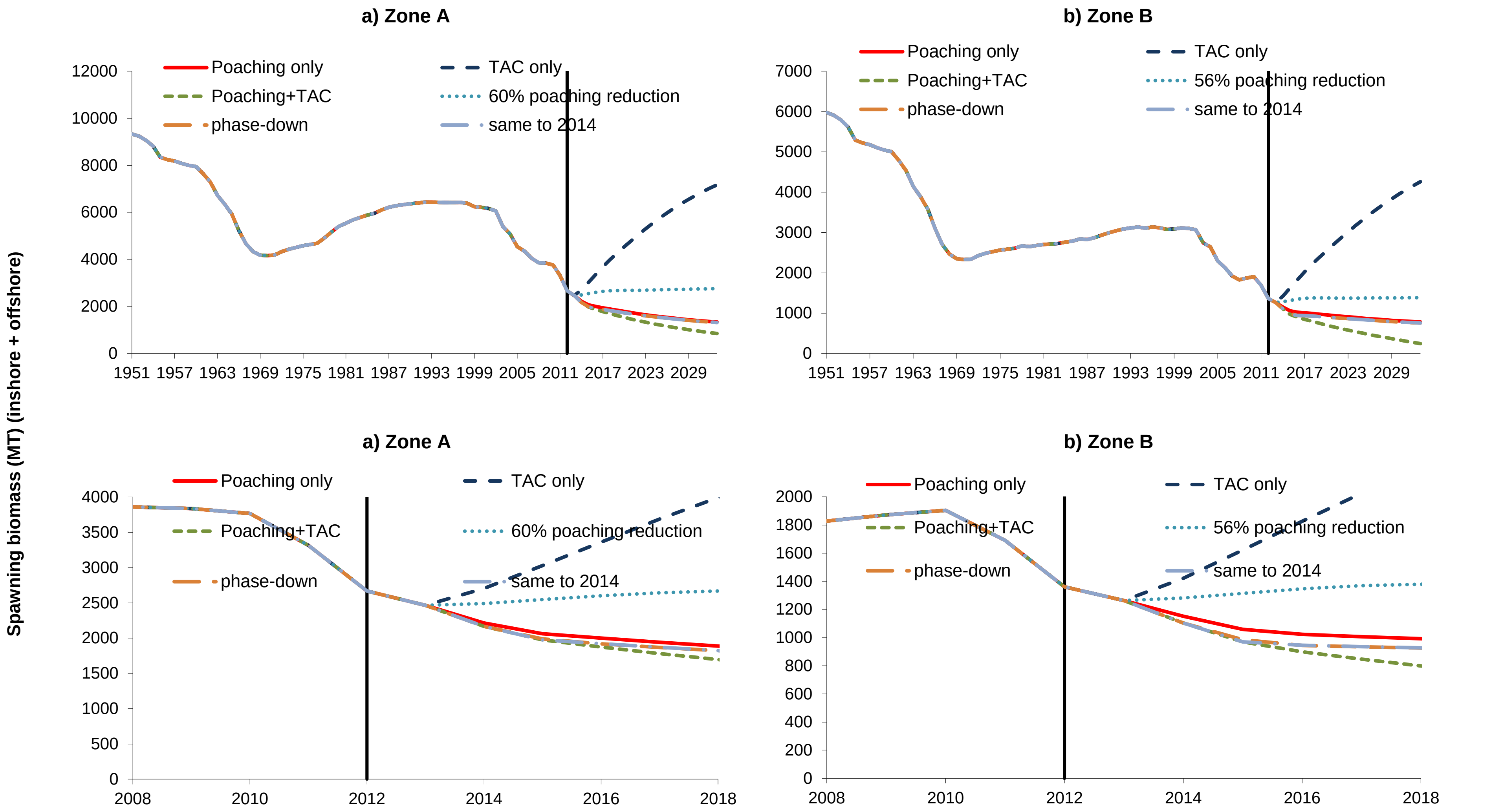

Figure 5. Total (inshore + offshore) spawning biomass trajectories shown for Zones A and B for the Reference case model. The 20-yr projections shown (after the vertical bar) represent five different scenarios for future commercial and poaching catches. Unless a zero amount is assigned, future poaching levels are assumed to remain at the current estimated level (average of 2011 and 2012) and future commercial catches are set to the current TAC of 50 tons. The bottom plots zoom in a shorter period to be able to distinguish the plots more clearly. In each plot, the required reduction in poaching necessary to keep the resource stable at its present level under the current TAC is also shown, with the required reduction shown in the legend.

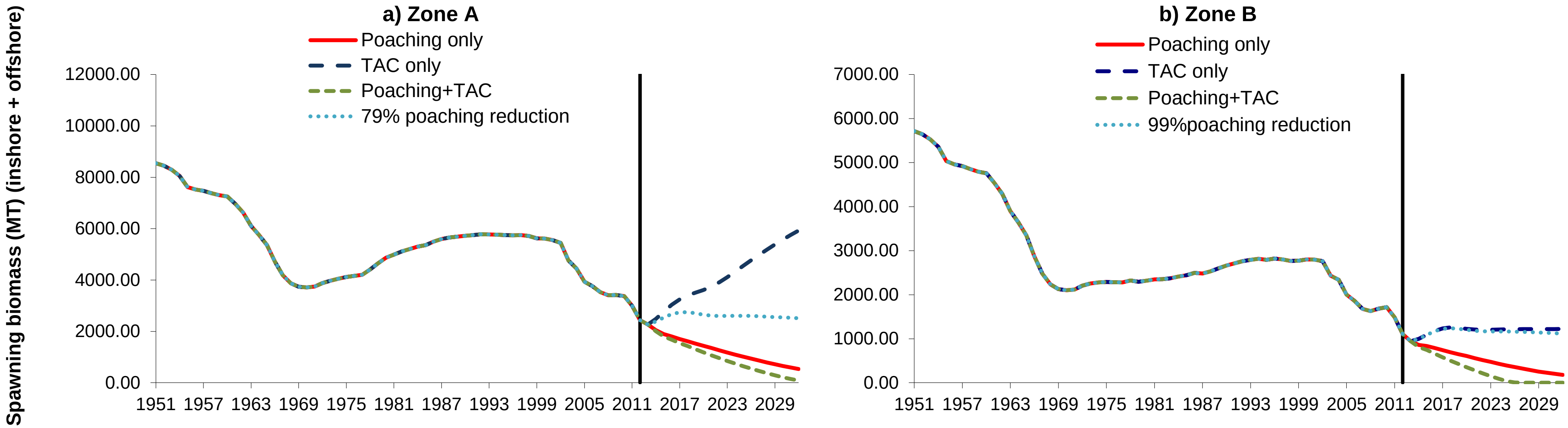

Figure 6. Total (inshore + offshore) spawning biomass trajectories shown for Zones A and B for the Reference case model taking an Allee effect into account. The 20-yr projections shown (after the vertical bar) represent three different scenarios for future commercial and poaching catches. Unless a zero amount is assigned, future poaching levels are assumed to remain at the current estimated level (average of 2011 and 2012) and future commercial catches are set to the current TAC of 50 tons. In each plot, the required reduction in poaching necessary to keep the resource stable at its present level under the current TAC is also shown, with the required reduction shown in the legend.

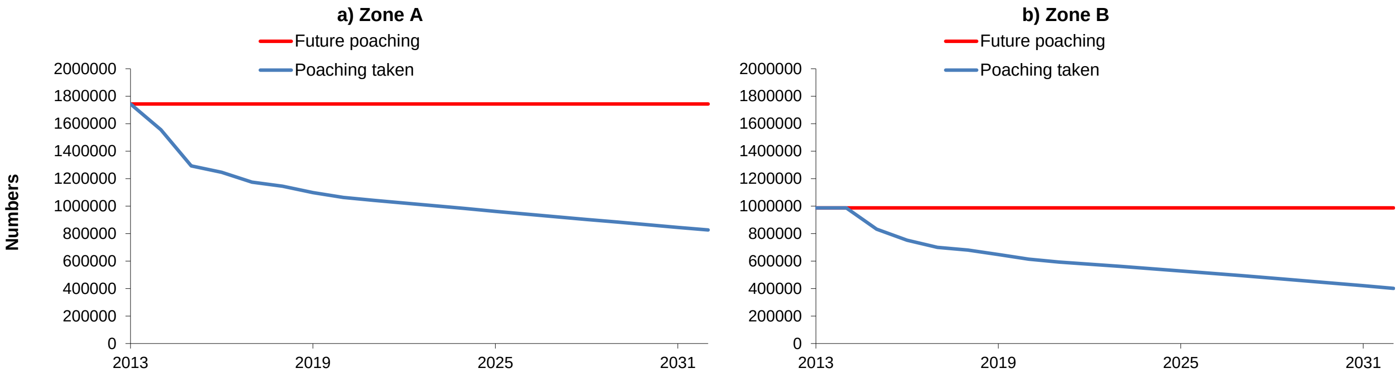

Figure 7. Future poaching levels, as assumed to remain at the current estimated level (average of 2011 and 2012), and the actual removals made by the model because of the model restriction that does not allow the fully selected fishing proportion to be greater than 95%. Thus the model builds in a factor to allow for the fact that as abundance declines, it could not be possible to sustain current poaching removals.