Results for the abalone spatial- and age-structured assessment model for Zones A, B, C and D in 2013

A. Brandão and D.S. Butterworth
Marine Resource Assessment & Management Group (MARAM)
Department of Mathematics and Applied Mathematics

University of Cape Town

Rondebosch 7701, Cape Town

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Abstract

The 2012 assessment of abalone in Zones A-D is updated to take new data into account and is modified to take the standard error of the estimated poaching trend 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 2012 and 2013) if continued, would not be sustainable.

Introduction

This document provides results from fitting the spatial- and age-structured production model (ASPM) for abalone for Zones/Subareas A, B, CNP, CP and D in combination, using the new data that have become available since the previous assessment (Brandão and Butterworth, 2012).

Data

The series that have been updated, compared to those used in Brandão and Butterworth (2012), 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 GLMM standardisation for Zones A and B only for 2011 and 2012 (Brandão and Butterworth, 2013a)
- Commercial catches for Zones A and B for 2012 (TAC assumed taken in 2013)
- Commercial catch-at-age data: errors in previous years have been corrected and new data provided for Zones A and B for 2012
- Poaching confiscations for all Zones (2011 updated for Zones A, B and C, 2012 updated for all Zones and 2013 extrapolated to a full Model-year for all Zones)

- Poaching trend: new values from updated analyses of policing effort and the number of confiscations for 2008 to 2013 (Brandão and Butterworth, 2013b)
- Poaching catch-at-age data: Zones A to D (2011 and 2012 revised, and 2013)
- FIAS abundance indices for 2012 and 2013 for Zones A and B
- FIAS catch-at-age data for 2012 and 2013 for Zones A and B.

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 Basecase model described in those two documents has been modified by some generally slight adjustments that are described in Brandão and Butterworth (2011).

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 (2013b) use these data for Zones A-D combined to develop a new CPUPE index for the 2008-2013 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 (2013b). This requires a calibration factor (k) for each Zone, as the two CPUPE indices have different units. For the Basecase 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.

In previous assessments, the standard errors associated with the poaching indices were not incorporated in the assessment model. Considering that the magnitude of these standard errors vary from year to year and are quite large for some indices (especially for the last year because the index is based on data from an incomplete year, see Brandão and Butterworth, 2013b), it was decided to modify the Basecase model to incorporate these standard errors. Thus, the following term has been added to the negative log-likelihood function:

$$\sum_y \left[\left(\ln X_y - \ln X_y^* \right)^2 / 2CV_y^2 \right]$$

where

X_y is the observed poaching index for year *y*

X_y^* is the estimated poaching index for year *y* (i.e. representative of the actual poaching level), and

CV_y is the *CV* of the observed poaching index for year *y*.

Results

Results have been obtained for the new Basecase model for the updated data as well as for several sensitivity tests listed below. Results for the new Basecase model are reported in Tables 1 and 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 (2012), referenced as "Previous".

Sensitivity tests

- Sensitivity 1: increase in the number of confiscations to account for the difference in the records between the Dir: Compliance and Dir: Revenue Management.
- Sensitivity 2: increase the policing effort index for 2013 by 10% to account for the possible increase in the number of tip-offs recently
- Sensitivity 3: taking an Allee effect into account.

Sensitivity 1 and Sensitivity 2 have been run on the basis of the old Basecase model (i.e. including updated data, but the standard error of the poaching trend has not been incorporated in the model) and Figure 5 shows that depletion projections for these two sensitivities scarcely differ from those for the old Basecase. Sensitivity 3 has been run on the basis of the new Basecase model and Figure 6 plots the comparison of the depletion projections for these two models.

Projections

Figure 7 shows spawning biomass projections for the new Basecase model for four scenarios for future commercial and poaching catches listed below.

- Poaching only (average of 2012 and 2013 levels)
- 50 ton commercial catch only
- Both poaching and commercial catches at the above levels
- Poaching reduction necessary to keep the biomass at its current level.

Figure 8 shows future poaching levels, as assumed to remain at the current estimated level (average of 2012 and 2013), 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 would not be possible to sustain current poaching removals.

Discussion

The new Basecase results are similar to those from the previous assessment conducted in 2012 (Previous). Results do show that the abalone stock is slightly more reduced than thought previously in some Zones and slightly higher in other Zones (Table 1 and Figure 3). The new Basecase estimates of pre-exploitation spawning biomass for Zones A, CNP and D are rather lower than previously estimated, although both the current and the 20-year projected values are quite similar.

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, as might be expected (Figure 6).

Although there has been an estimated drop in poaching levels for the 2011 and 2012 seasons for both Zones A and B (Figure 4), the estimated current (2013) level of poaching has increased again for both Zones and is higher than estimated for 2011. The current level of poaching (the average of 2012 and 2013) is not sustainable if maintained in the future (Figure 7).

References

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Brandão, A. and Butterworth, D.S. 2013a. GLMM standardisation of the commercial abalone CPUE for Zones A-D over the period 1980-2012. FISHERIES/2013/AUG/SWG-AB/11.

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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 new Basecase. Projections assume future poaching levels at their current estimated values (average of 2012 and 2013). For comparison, results for the previous Basecase ("Previous") of the assessment of Brandão and Butterworth (2012) 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	9334	5979	2981	4725	9140	2012	0.286	0.228	0.085	0.046	0.227	2032	0.146	0.132	0.022	0.008	0.052
New Basecase	7590	5911	2633	4686	7313	2012	0.270	0.243	0.094	0.054	0.200	2032	0.124	0.140	0.027	0.010	0.086
						2013	0.262	0.239	0.088	0.050	0.195	2033	0.121	0.136	0.025	0.009	0.082

Table 2. Estimates of the current (2013) 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 new Basecase. For comparison, results for the "Previous" 2012 assessment are also given (the poaching estimates given for that assessment are those estimated at that time for 2012). 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 new Basecase) and are therefore shown within square brackets.

	Poaching (2013) 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 (2012)	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]**
New Basecase (2013)	420.1	291.0	48.1	72.0	117.6	18.3%	32.4%	5.6%		6.8%	-78.09	-81.3	-56.2	-50.2	-55.3	**-317.5**

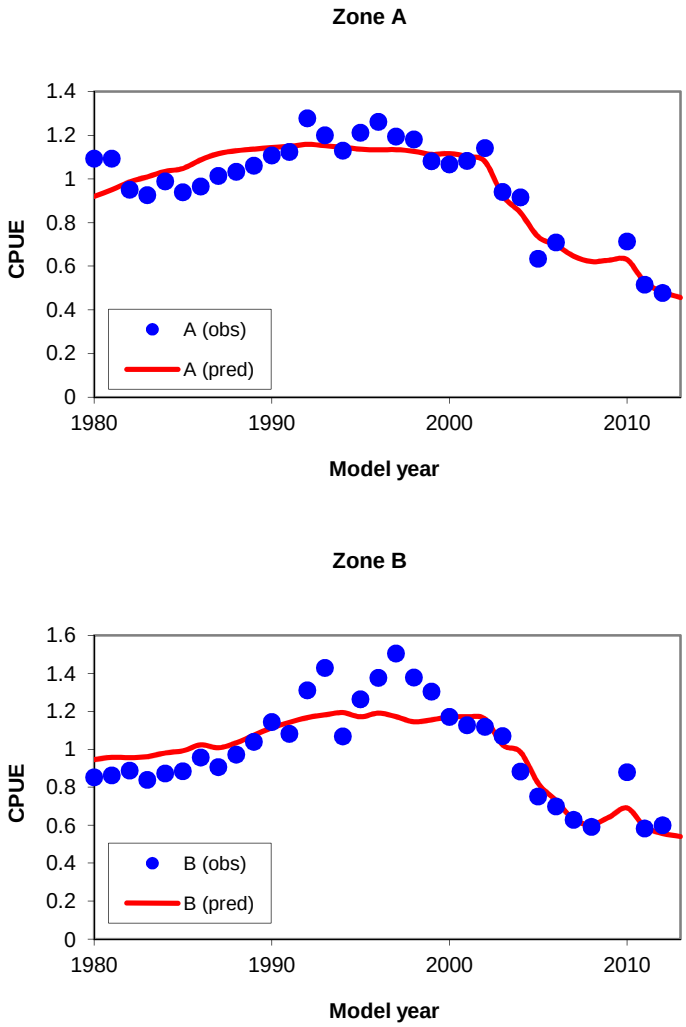

Figure 1. Comparisons between the standardised CPUE (obs) and model-predicted CPUE values for the new Basecase for Zones A and B.

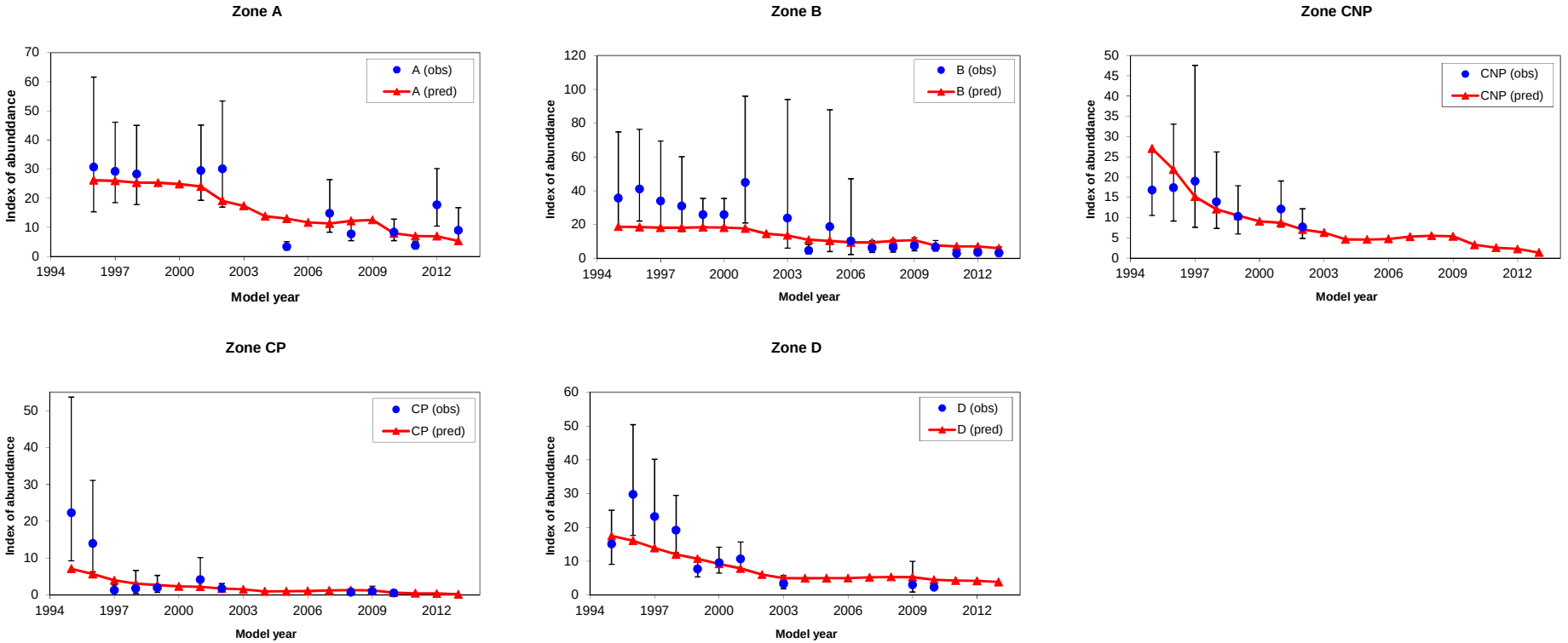

Figure 2. Comparison of observed FIAS and model-predicted trends for the new Basecase Zones A to D. Note that the 95% confidence intervals shown have been computed as: estimate*exp(±1.96*CV).

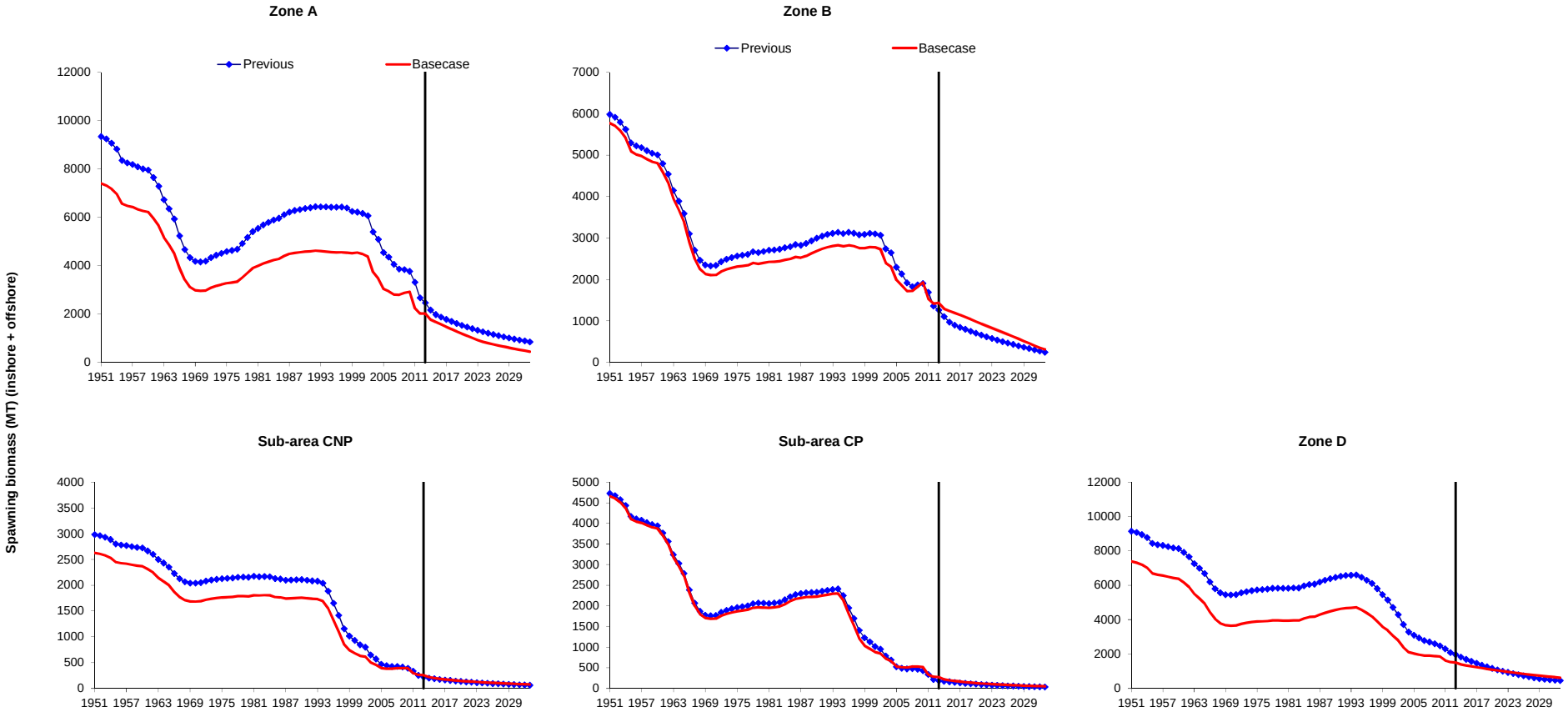

Figure 3. Total (inshore + offshore) spawning biomass trajectories shown for Zones A to D for the new Basecase model compared to the "Previous" results obtained in the 2012 assessment. Note that the 20-yr projections shown (after the vertical bar) represent scenarios under which future poaching levels are assumed to remain at the "current" estimated level (average of 2011 and 2012 for the "Previous" model and the average of 2012 and 2013 for the "Basecase") and future commercial catches are set to 50 tons in each of Zones A and B only.

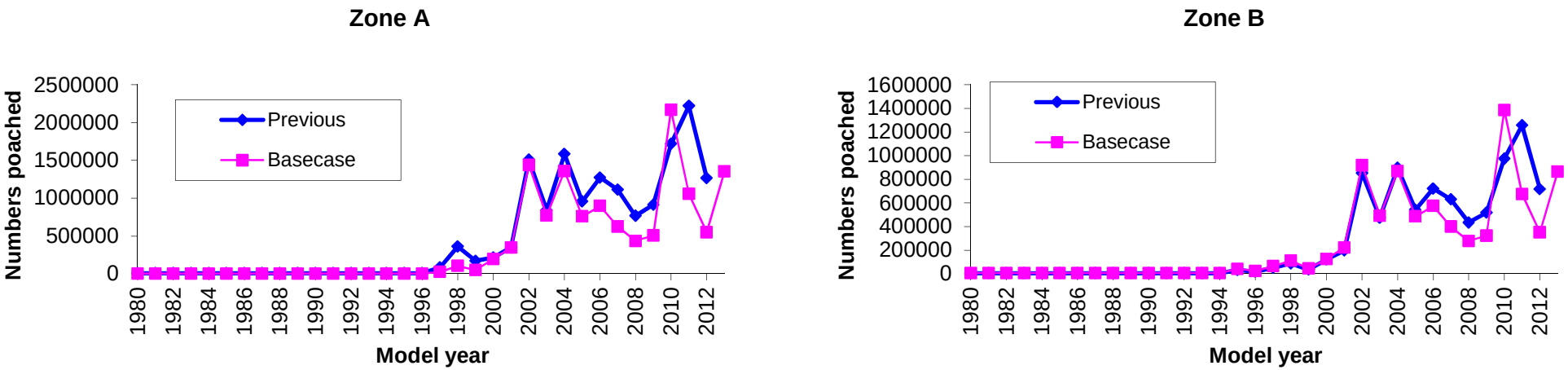

Figure 4. Comparison of model-predicted numbers of abalone poached for Zones A and B for the new Basecase model and those obtained in the 2012 assessment ("Previous").

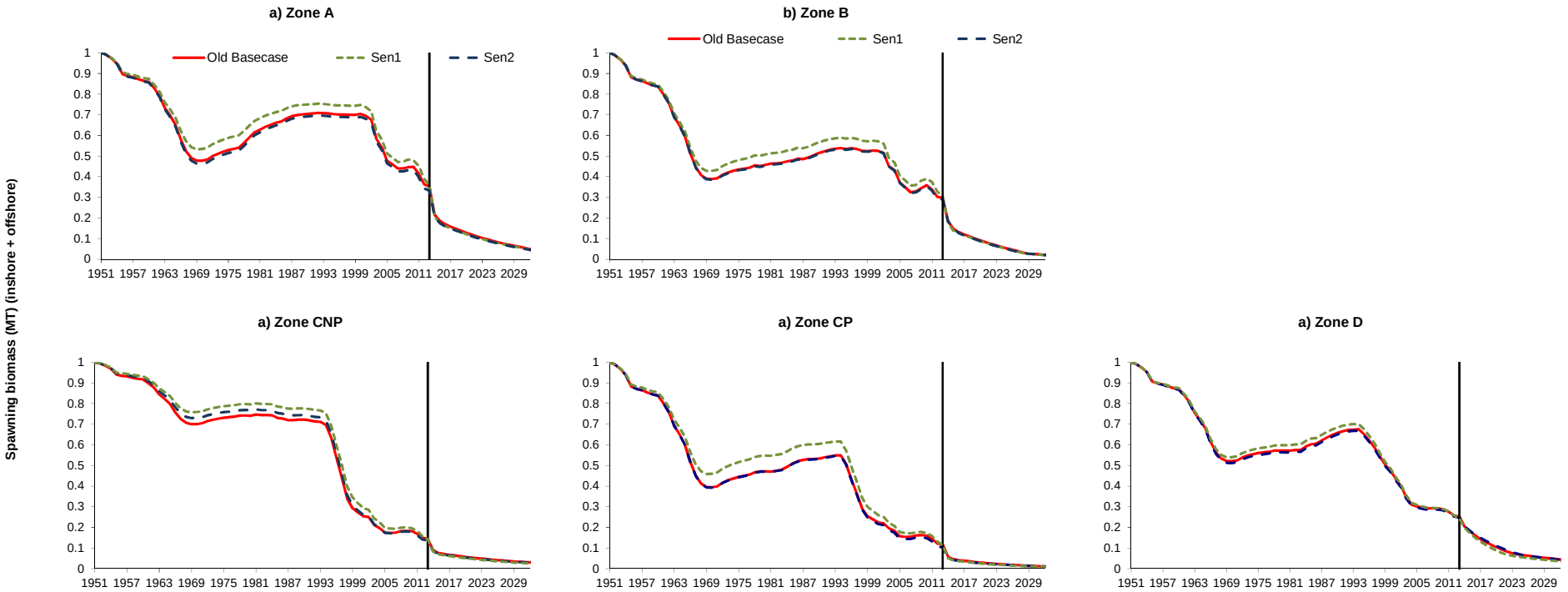

Figure 5. Total (inshore + offshore) depletion trajectories shown for Zones A to D for the old Basecase model (extended to include the further data now available, but with no incorporation of standard error) compared to sensitivity tests 1 (increase confiscations) and 2 (tip-offs). Note that the 20-yr projections shown (after the vertical bar) represent scenarios under which future poaching levels are assumed to remain at the current estimated level (average of 2012 and 2013) under this updated old Basecase model and future commercial catches are set to 50 tons in each of Zones A and B only.

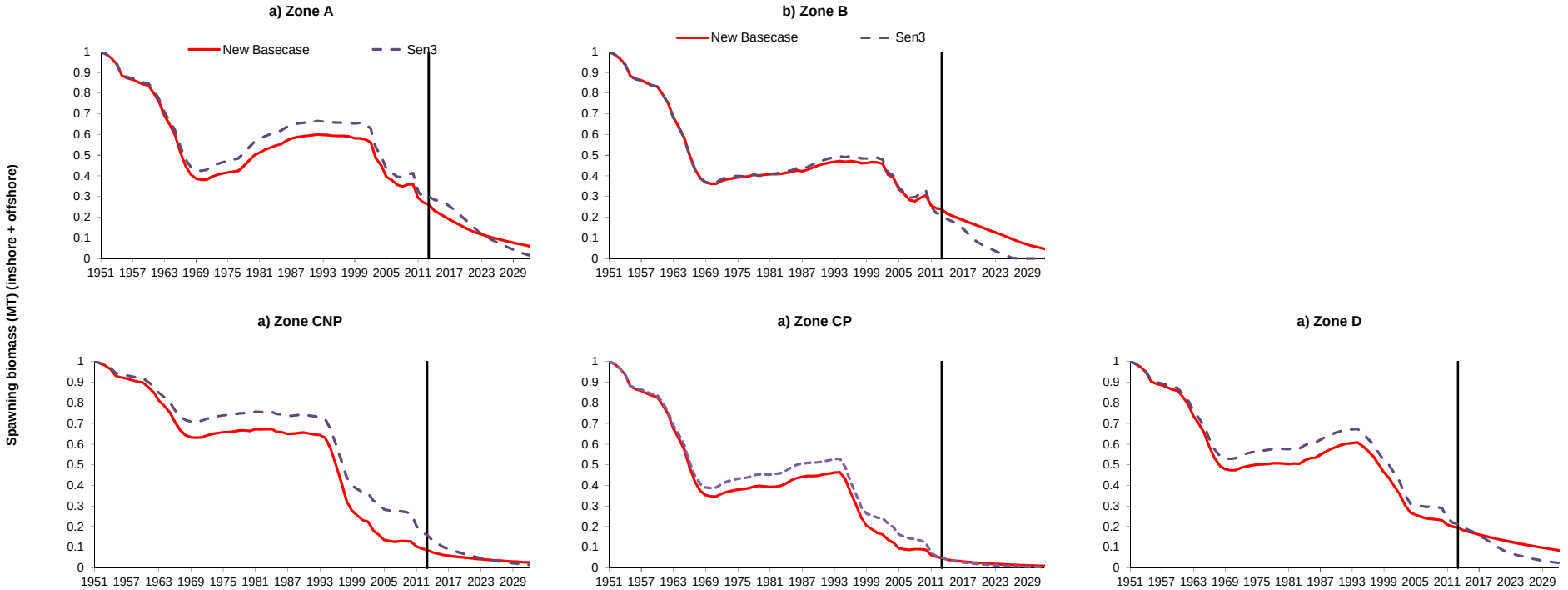

Figure 6. Total (inshore + offshore) depletion trajectories shown for Zones A to D for the new Basecase model (incorporating standard error) compared to sensitivity test 3 (Allee effect). Note that the 20-yr projections shown (after the vertical bar) represent scenarios under which future poaching levels are assumed to remain at the current estimated level (average of 2012 and 2013) and future commercial catches are set to 50 tons in each of Zones A and B only.

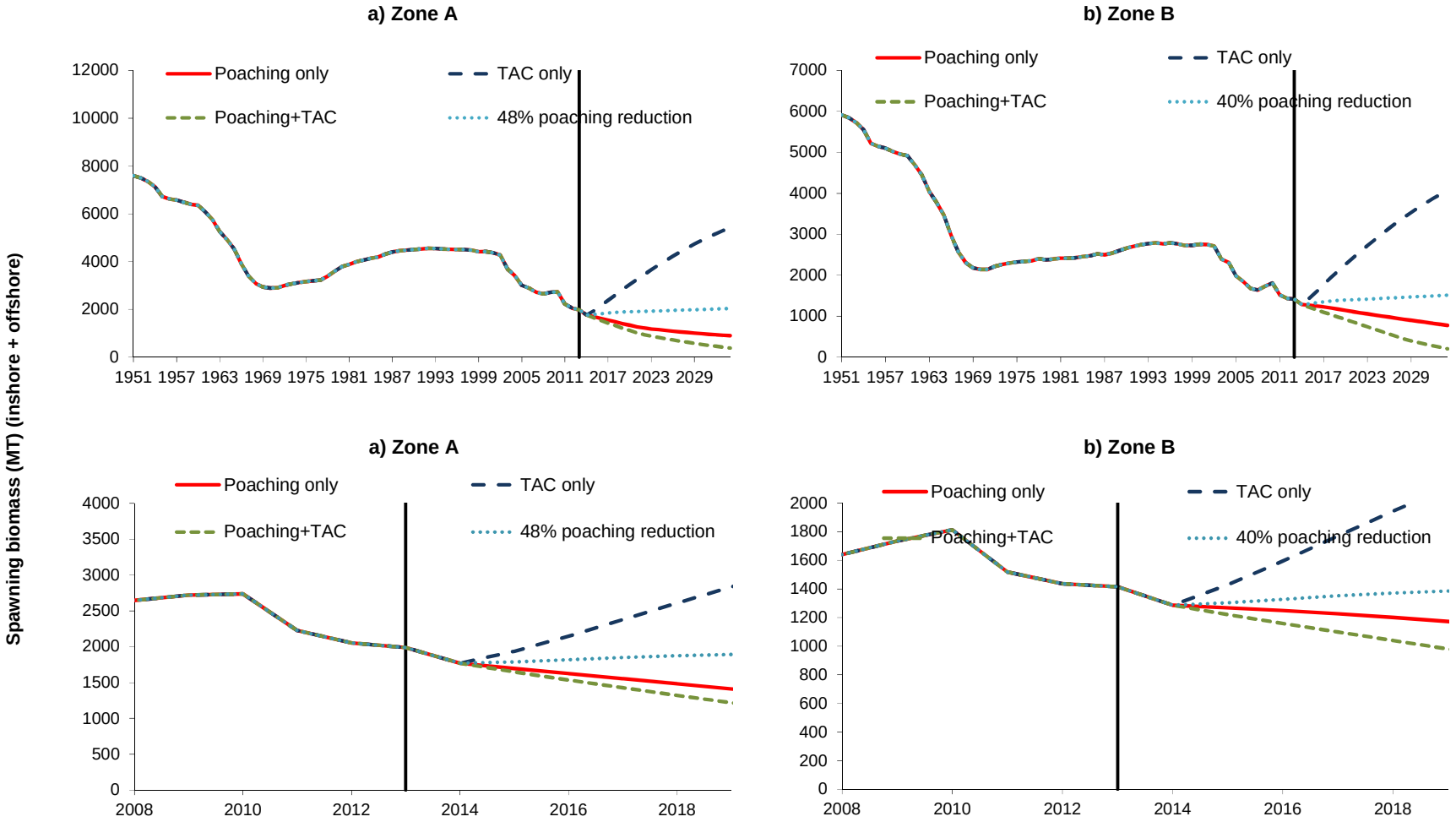

Figure 7. Total (inshore + offshore) spawning biomass trajectories shown for Zones A and B for the new Basecase model. The 20-yr projections shown (after the vertical bar) represent five different scenarios for future commercial and poaching catches. Unless a zero amount is assigned, future poaching levels are assumed to remain at the current estimated level (average of 2012 and 2013) and future commercial catches in each of these two Zones are set to the current TAC of 50 tons. The bottom plots zoom in on a shorter period to be able to distinguish the curves 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 indicated in the legend.

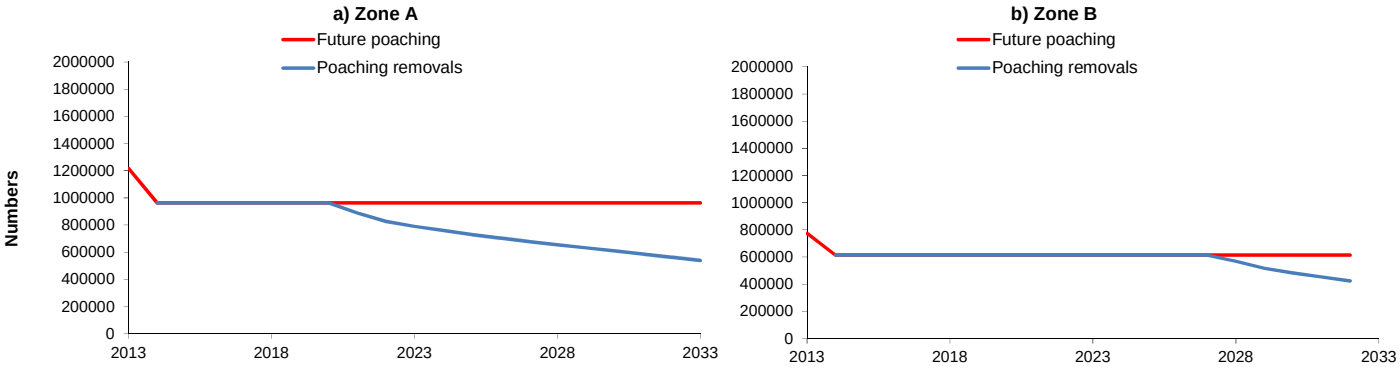

Figure 8. Future poaching levels, as assumed to remain at the current estimated level (average of 2012 and 2013), and the actual removals made by the model because of the model restriction that does not allow the fully selected fishing proportion to be greater than 95%. Thus the model builds in a factor to allow for the fact that as abundance declines, it would not be possible to sustain current poaching removals. Results shown are for the new Basecase.