

Some initial projections under the OMP2014 rules

A. Ross-Gillespie and D.S. Butterworth¹

Email: mlland028@myuct.ac.za

Summary

The Reference Case Operating Model (RS02) is projected forward under the rules of OMP2014, as well as variants of OMP2014 where the TAC cap and one of the tuning parameters are adjusted. These results suggest that there is scope for some increase in exploitation of the hake resource, but certain refinements of the methodology still need to be put in place, and similar projections for the remainder of the Reference Set need to be completed.

Introduction

The Reference Case (RC) operating model (OM) (RS02 from FISHERIES/2018/JUL/SWG-DEM/28, corresponding to the Ricker model with 1958 as the central year of catch shift) is projected forward here under the rules of OMP2014. Additionally, some modifications to OMP2014 are explored: alternatives to the TAC cap of 150 000t and adjustments to the tuning parameter b , which determines the extent to which the TAC changes in response to changes in future abundance indices. Details of OMP2014 can be viewed in FISHERIES/2017/OCT/SWG-DEM/41, but for the purposes of this document, the relevant equation is:

$$C_{y+1}^s = b^s (J_y^s - J_0^s) \quad (1)$$

where C_{y+1}^s is the TAC in year $y+1$, J_y^s is a measure of the immediate past level of the abundance indices for species s that are available for calculations in year y , and b^s and J_0^s are tuning parameters. It is the b^s parameters that have been adjusted in the results presented in this document. The values of the tuning parameters for OMP2014 are:

| | <i>M. paradoxus</i> | <i>M. capensis</i> |
|-------|---------------------|--------------------|
| J_0 | 0.132 | 0.240 |
| b | 83.83 | 33.33 |

Results

Projections were conducted for RS02 (the RC OM) for:

- the rules of OMP2014,
- a modified version of OMP2014 where the TAC cap of 150 000t is increased to 160 000t,
- a version where the cap is removed altogether,
- a variant of OMP2014 with a cap of 160 000t where the b parameters are increased by 10%,

¹ Marine Resource Assessment and Management Group, Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch.

- the OMP2014 rules (i.e. with a cap of 150 000t) where the b parameter is increased and decreased respectively by 10%, 25% and 50%, and finally
- a variant of OMP2014 where the TAC cap is removed and the b parameters are increased and decreased by these same percentages.

Table 1 lists key performance statistics for these projections and Figure 1 plots these graphically.

Figure 2a-c illustrates key results for six possible candidates for OMP2018 as described in the discussion section.

Figure 3a contrasts the projections for OMP2014 (i.e. with the 150 000t TAC cap) with a range of variants where the b parameters are increased and decreased by 10%, 25% and 50%. Figure 3b shows similar plots for OMP2014 with the TAC cap of 150 000t removed.

Discussion

Some points to aid discussion are listed below. Note that for the final OMP2018 decisions, results will be based on runs with 1000 simulations (instead of 100 as for this document) to reduce stochastic variability.

- TAC cap
 - The first block of Table 1 and the left-most column of Figure 1 show the performance statistics for OMP2014 with the TAC cap of 150 000t in place, a variant where this cap is increased to 160 000t and one where this cap is removed entirely. In all cases the final (2042) B^{par}/B_{MSY} value is well above one. However as the cap is increased to 160 000t and then removed, the lowest B^{par}/B_{MSY} value in the projection period drops and the inter-annual catch variability (AAV) increases.
 - Both 150 000t and 160 000t TAC caps seem reasonable options for consideration for OMP2018. Removing the cap entirely is probably not desirable given the marked increase in AAV.
- b parameter
 - There seems to be no benefit in decreasing the b parameters as this would result in what could be considered an overly conservative management procedure with substantial drops in TAC compared to the recent past.
 - An OMP with a TAC cap of 150 000t and b increased by 10% seems fine, and even a 25% increase could be acceptable, although the lowest B^{par}/B_{MSY} is reduced then from 1.21 (0.79, 1.72) to 1.13 (0.70, 1.60).
- The table below is an extract from Table 1 containing a selection of rows only. A TAC cap of 150 000t with b increased by 10% has similar average catch to the option of a 160 000t cap with b remaining the same, but the latter has a higher AAV (compare C and D below). Similarly, a cap of 150 000t with b increased by 25% has a similar average catch to the option of 160 000t cap with b increased by 10% (compare E and F below).

| | <i>M. paradoxus</i> | | | | (v) C_{av} | | (vi) AAV | |
|----------------------------|----------------------------|------------------------------|------|--------------|--------------|------------------|----------|--------------|
| | (i) B^{sp}/B_{MSY} final | (ii) B^{sp}/B_{MSY} lowest | | | | | | |
| (A) 150 000t cap | 2.08 | (1.29, 3.80) | 1.37 | (0.88, 1.75) | 138.58 | (125.59, 145.81) | 0.04 | (0.02, 0.06) |
| (B) No cap | 1.90 | (1.04, 3.20) | 1.10 | (0.65, 1.51) | 147.31 | (127.17, 166.37) | 0.06 | (0.05, 0.08) |
| (C) 150 cap, inc. b by 10% | 1.87 | (1.24, 3.70) | 1.21 | (0.79, 1.72) | 141.53 | (130.58, 148.27) | 0.03 | (0.01, 0.05) |
| (D) 160 000t cap | 2.01 | (1.20, 3.68) | 1.27 | (0.78, 1.71) | 141.87 | (126.63, 151.27) | 0.05 | (0.03, 0.06) |
| (E) 150 cap, inc. b by 25% | 1.77 | (1.07, 3.68) | 1.13 | (0.70, 1.60) | 145.66 | (135.11, 149.45) | 0.02 | (0.01, 0.05) |
| (F) 160 cap, inc. b by 10% | 1.84 | (1.11, 3.57) | 1.15 | (0.73, 1.61) | 146.30 | (133.03, 154.99) | 0.04 | (0.02, 0.06) |

- All of the above might be defensible candidates for OMP2018. (C) and (D) would allow for an increase in average catch over the next 25 years of roughly 3000t p.a. more than would be the case under the rules of OMP2014, while (E) and (F) estimate an increase of about 7000t. The AAV for (C)-(F) is relatively similar to what could be expected from OMP2014, but a TAC cap of 150 000t produces a lower AAV than a cap of 160 000t. Conversely, however, a cap of 160 000t seems to produce slightly more optimistic estimates for *M. paradoxus* depletion, although some caution should be exercised when interpreting the population abundance values reported as they are the most sensitive to stochastic variability. In all cases, approximate future effort is estimated to be below current effort levels (see Figure 2a-c), although the method for calculating the effort needs to be refined.
- Note that the 90% probability intervals for the lowest B/B_{MSY} reported in Table 1 will differ from the 90% probability envelopes plotted in Figure 2a-c. This is because the statistic in Table 1 is calculated by taking lowest B/B_{MSY} value for each of the 100 simulations (which may correspond to a different year for different simulations) and calculating the median and 5th and 95th percentiles, while the 90% probability envelope in Figure 2a-c is calculated by taking the 100 simulated values for each year in the projection period, and calculating the median, 5th and 95th percentiles.

Questions to the DWG

1. The decision of whether or not to increase the TAC cap to 160 000t may be influenced largely by the practical implications this would have to the fishing industry, as one can seemingly get relatively similar catch on average by keeping the cap at 150 000t but increasing the tuning parameters. What input can industry provide on this matter?
2. Would models (C)-(F) (or a subset of these) in the table above be considered suitable as a basis for further work on projecting the RS forward?
3. For future documents, would it be useful to show Bexp plots in absolute terms or relative to current value?
4. What other output would be desirable for future documents?

Further work

At the DWG meeting in August it was considered preferable to release a series of smaller documents with results as they become available, rather than delaying in order to compile a comprehensive document with all the results. Further work planned for the hake 2018 OMP review entails the following.

1. Project the remainder of the Reference Set OMs forward in a similar manner to what has been done here.
2. Robustness tests, with first priority given to survey q 's.
3. Evaluate and (if deemed necessary) conduct sensitivity testing of other rules and tuning parameters of the OMP2014 formula, which include:
 - a. other tuning parameters (see Table 1 of FISHERIES/2017/OCT/SWG-DEM/41)
 - b. maximum allowable annual change
 - c. weighting of commercial and survey CPUE indices
4. Check the assumptions made regarding autocorrelation in the stock recruitment.

5. Refine the method for adding noise to recruitment – currently a sigma of 0.4 has been assumed, but the values for the individual RS models need to be calculated from the assessment model estimates of recruitment and assessed.
6. Refine the method in which noise is added to the age 0-3 cohorts in the projections.
7. Refine the method for calculating effort.
8. Weighted (i.e. coast- and species-combined) CPUE plots need to be produced. They have not been included in this document as the species- and coast-disaggregated catch output is required from the models, which was not part of the standard output when these runs were conducted; accordingly a re-run of all the models is required.

Table 1: Table of key performance statistics as medians with 90% probability intervals in parentheses for the RC OM. The performance statistics are B^{SP}/B_{MSY} final – the value of this statistic for the final year of the projection, i.e. 2042), B^{SP}/B_{MSY} lowest – the lowest value of this statistic in the projection period), C_{av} (the average catch over the projection period) and AAV (the average inter-annual proportional change in catch over the projection period). The last two rows list the performance statistics for the constant catch projections from FISHERIES/2018/AUG/SWG-DEM/35. Note that the constant catch statistics vary slightly from what those in DEM/35 as a different set of random numbers was used to generate future errors for the runs reported in this document. For the final set of results for the OMP 2018 decision more simulations will be used to reduce the stochastic variation in the results. The Table first explores the effect of a cap on the maximum TAC, and then considers more and less aggressive procedures than OMP-2014, first with a cap of the TAC at 150 thousand tons, and then without. Catch statistics are given in thousand tons.

| | <i>M. paradoxus</i> | | | | <i>M. capensis</i> | | | | (v) C_{av} | | (vi) AAV | |
|--|----------------------------|------------------------------|------------------------------|------------------------------|--------------------|---------------------|-------------|---------------------|---------------|-------------------------|-------------|---------------------|
| | (i) B^{SP}/B_{MSY} final | (ii) B^{SP}/B_{MSY} lowest | (iii) B^{SP}/B_{MSY} final | (iv) B^{SP}/B_{MSY} lowest | | | | | | | | |
| OMP2014 (i.e. with 150 cap) | 2.08 | (1.29, 3.80) | 1.37 | (0.88, 1.75) | 2.60 | (1.86, 3.75) | 1.94 | (1.61, 2.39) | 138.58 | (125.59, 145.81) | 0.04 | (0.02, 0.06) |
| OMP2014, with 160 cap | 2.01 | (1.20, 3.68) | 1.27 | (0.78, 1.71) | 2.59 | (1.83, 3.80) | 1.91 | (1.60, 2.36) | 141.87 | (126.63, 151.27) | 0.05 | (0.03, 0.06) |
| OMP2014, no cap | 1.90 | (1.04, 3.20) | 1.10 | (0.65, 1.51) | 2.63 | (1.66, 4.00) | 1.79 | (1.23, 2.28) | 147.31 | (127.17, 166.37) | 0.06 | (0.05, 0.08) |
| OMP2014, with 160 cap, increase b by 10% | 1.84 | (1.11, 3.57) | 1.15 | (0.73, 1.61) | 2.57 | (1.80, 3.73) | 1.87 | (1.54, 2.30) | 146.30 | (133.03, 154.99) | 0.04 | (0.02, 0.06) |
| Decrease b by 50% | 3.35 | (2.45, 4.90) | 1.75 | (1.39, 1.75) | 2.86 | (2.17, 3.86) | 2.31 | (1.76, 2.39) | 98.32 | (90.54, 111.57) | 0.05 | (0.04, 0.06) |
| Decrease b by 25% | 2.66 | (1.59, 4.14) | 1.70 | (1.18, 1.75) | 2.73 | (1.93, 3.88) | 2.06 | (1.66, 2.39) | 122.57 | (109.45, 132.99) | 0.05 | (0.04, 0.06) |
| Decrease b by 10% | 2.23 | (1.44, 3.92) | 1.48 | (0.98, 1.75) | 2.64 | (1.93, 3.80) | 1.99 | (1.64, 2.39) | 133.46 | (118.59, 141.60) | 0.04 | (0.03, 0.06) |
| OMP2014 (i.e. with 150 cap) | 2.08 | (1.29, 3.80) | 1.37 | (0.88, 1.75) | 2.60 | (1.86, 3.75) | 1.94 | (1.61, 2.39) | 138.58 | (125.59, 145.81) | 0.04 | (0.02, 0.06) |
| Increase b by 10% | 1.87 | (1.24, 3.70) | 1.21 | (0.79, 1.72) | 2.56 | (1.84, 3.72) | 1.93 | (1.53, 2.34) | 141.53 | (130.58, 148.27) | 0.03 | (0.01, 0.05) |
| Increase b by 25% | 1.77 | (1.07, 3.68) | 1.13 | (0.70, 1.60) | 2.50 | (1.84, 3.69) | 1.89 | (1.44, 2.29) | 145.66 | (135.11, 149.45) | 0.02 | (0.01, 0.05) |
| Increase b by 50% | 1.64 | (0.79, 3.45) | 1.08 | (0.58, 1.59) | 2.51 | (1.72, 3.76) | 1.84 | (1.39, 2.28) | 148.67 | (140.14, 149.45) | 0.01 | (0.01, 0.04) |
| Decrease b by 50% | 3.35 | (2.45, 4.90) | 1.75 | (1.39, 1.75) | 2.86 | (2.17, 3.86) | 2.31 | (1.76, 2.39) | 98.32 | (90.54, 111.57) | 0.05 | (0.04, 0.06) |
| Decrease b by 25% | 2.55 | (1.59, 4.15) | 1.61 | (1.04, 1.75) | 2.76 | (1.92, 3.84) | 1.98 | (1.54, 2.39) | 123.73 | (109.45, 138.66) | 0.06 | (0.05, 0.07) |
| Decrease b by 10% | 2.16 | (1.24, 3.57) | 1.32 | (0.83, 1.75) | 2.66 | (1.78, 4.13) | 1.85 | (1.37, 2.39) | 138.71 | (118.94, 157.04) | 0.06 | (0.05, 0.07) |
| OMP2014, with no cap | 1.90 | (1.04, 3.20) | 1.10 | (0.65, 1.51) | 2.63 | (1.66, 4.00) | 1.79 | (1.23, 2.28) | 147.31 | (127.17, 166.37) | 0.06 | (0.05, 0.08) |
| Increase b by 10% | 1.73 | (0.85, 2.90) | 0.91 | (0.53, 1.23) | 2.62 | (1.53, 3.99) | 1.72 | (1.10, 2.18) | 155.62 | (133.83, 173.90) | 0.06 | (0.05, 0.09) |
| Increase b by 25% | 1.41 | (0.73, 2.52) | 0.74 | (0.51, 1.01) | 2.62 | (1.41, 4.06) | 1.54 | (0.86, 2.09) | 163.23 | (140.26, 183.72) | 0.07 | (0.06, 0.09) |
| Increase b by 50% | 1.01 | (0.58, 1.83) | 0.59 | (0.45, 0.85) | 2.40 | (1.32, 3.78) | 1.20 | (0.69, 1.83) | 171.95 | (149.78, 196.79) | 0.08 | (0.06, 0.10) |
| Constant catch 140 000t | 1.92 | (0.87, 3.81) | 1.27 | (0.54, 1.75) | 2.50 | (1.67, 3.79) | 1.91 | (1.40, 2.36) | 139.98 | (139.54, 139.98) | 0.00 | (0.00, 0.01) |
| Constant catch 150 000t | 1.55 | (0.47, 3.45) | 1.03 | (0.37, 1.59) | 2.40 | (1.56, 3.76) | 1.80 | (1.18, 2.28) | 149.58 | (147.82, 149.58) | 0.01 | (0.01, 0.02) |

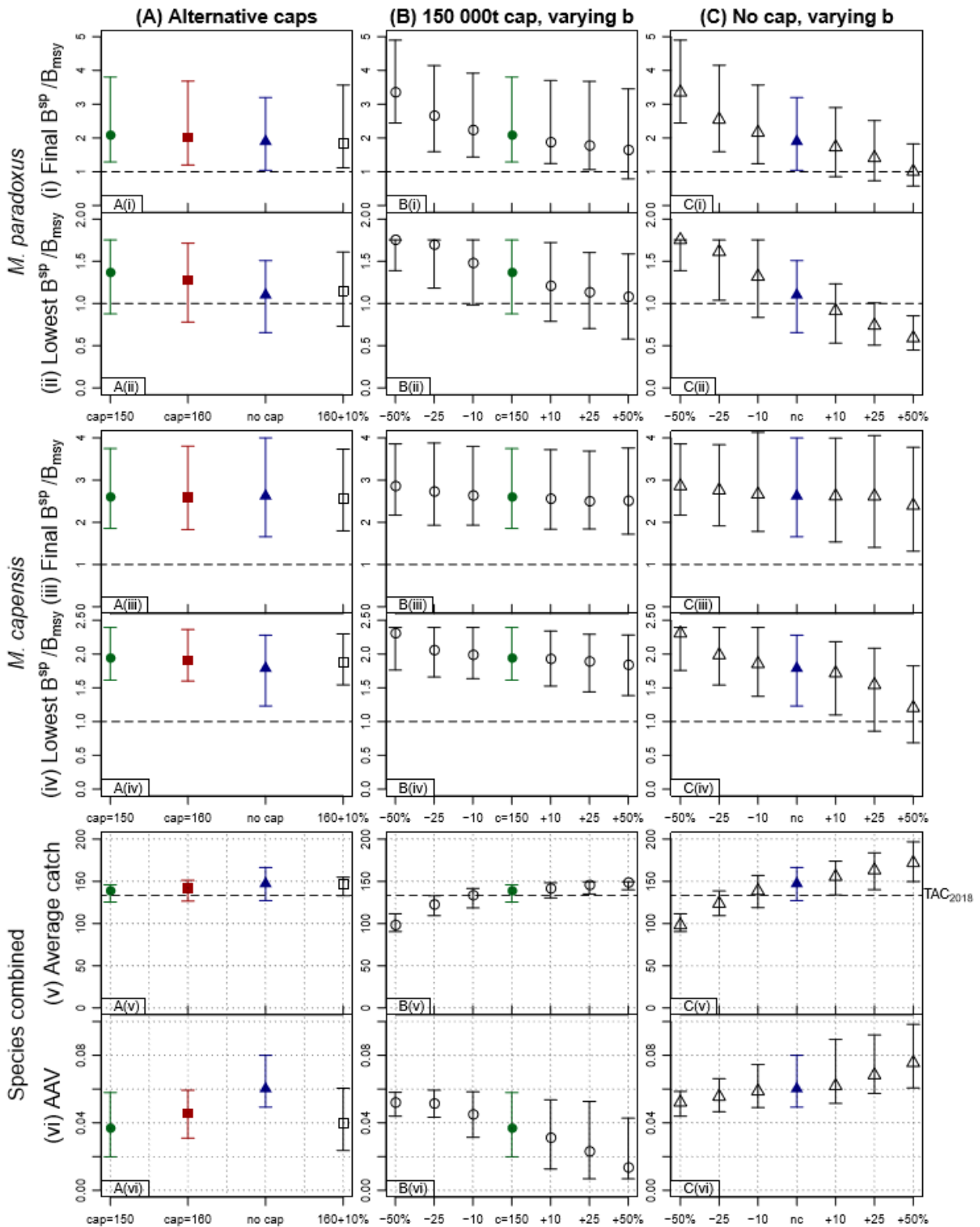


Figure 1: Zeh plots of the performance statistics in Table 1 for the RC OM, showing the median estimates and 90% probability intervals. The left most column plots the statistics for the OMP2014 rules with a 150 000t cap (green circle), 160 000t cap (red square) and no cap (blue triangle). The middle column shows the statistics for the 150 000t cap runs with the b parameters decreased and increased by set percentages, while the last column repeats this for the OMP with the cap removed. In the first four rows, the horizontal dashed line indicates $B = B_{MSY}$, while in row (v) the horizontal dashed lines indicates the 2018 TAC of 133 119t.

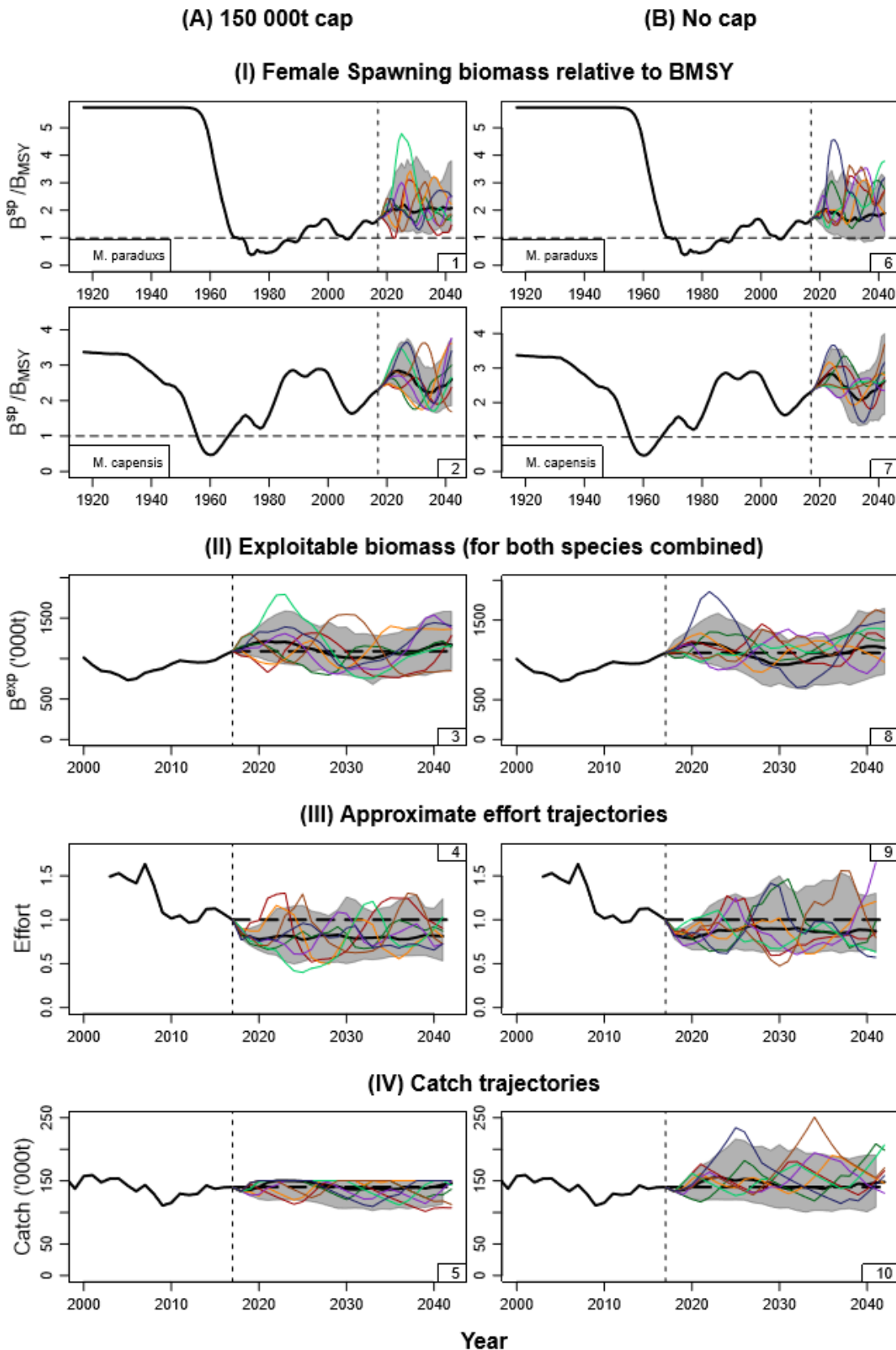


Figure 2a: Comparison of projections for the RC OM under the rules of OMP2014 **with** (left-hand plots) **and without** (right-hand plots) **the 150 000t cap**. In each subplot, “worms” (i.e. a random selection from the 100 simulations conducted) are shown by the individual lines, while the thick black line shows the median trajectory and the grey shaded area the 90% probability envelopes (Pes). For sections B, C and D the 2017 levels have been carried forward by the horizontal dashed line. Note that the number in the bottom right corner is to indicate the different subplots for ease of reference.

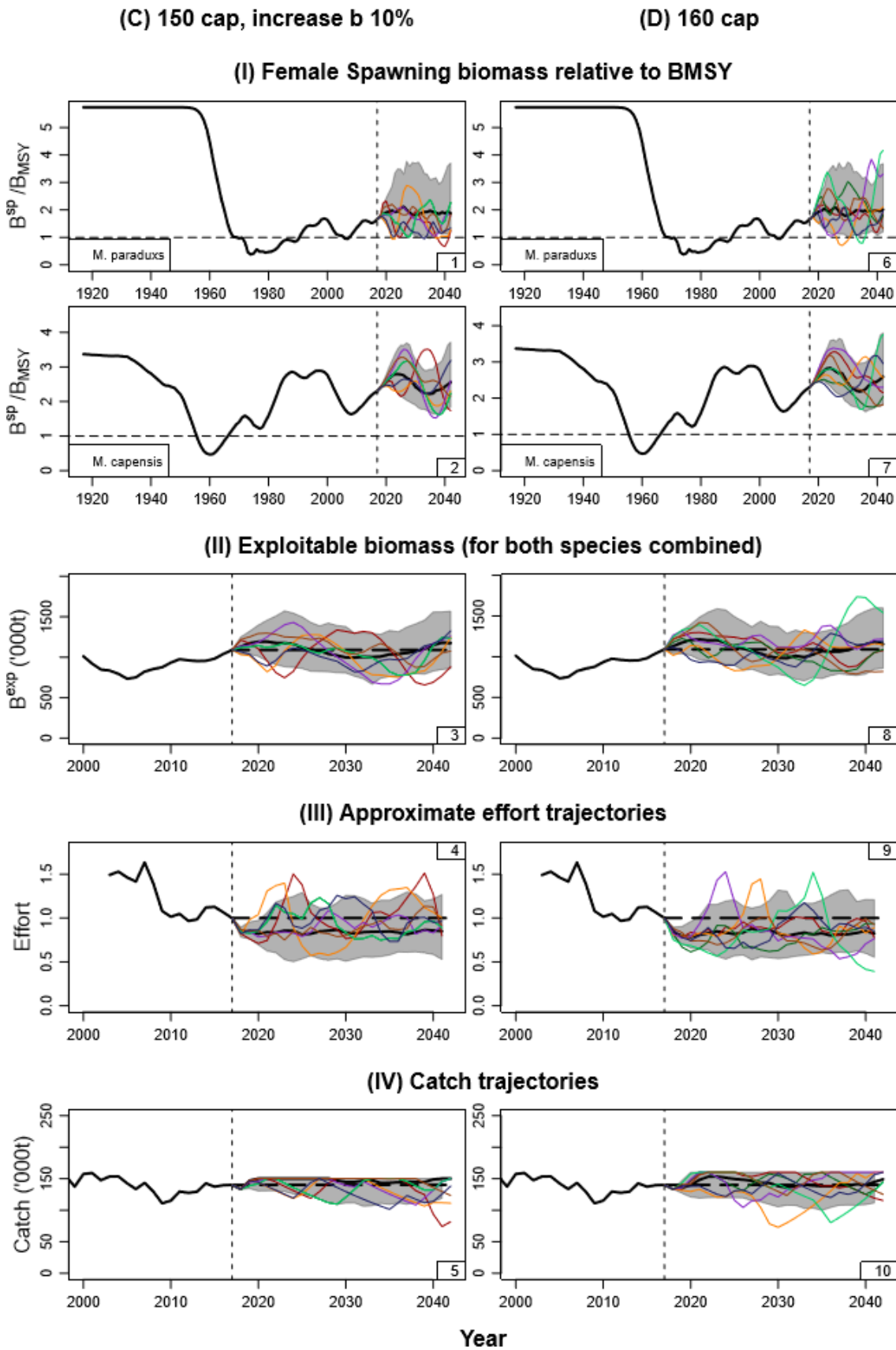
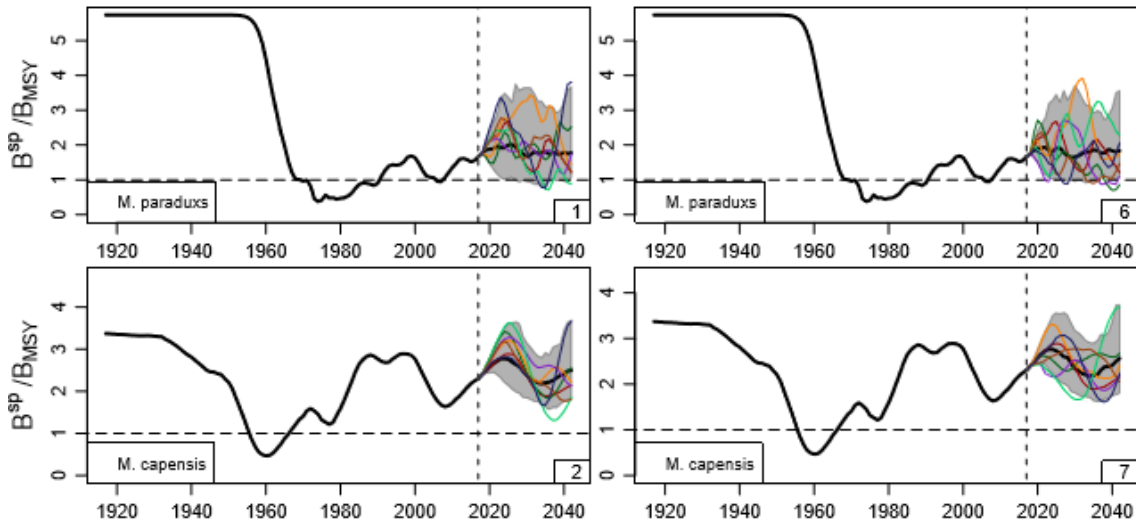


Figure 2b: Worm plots for the RC OM for (C) an upper cap of 150 000t with b increased by 10% for both species and (D) an upper cap of 160 000t with b unchanged from the OMP2014 values.

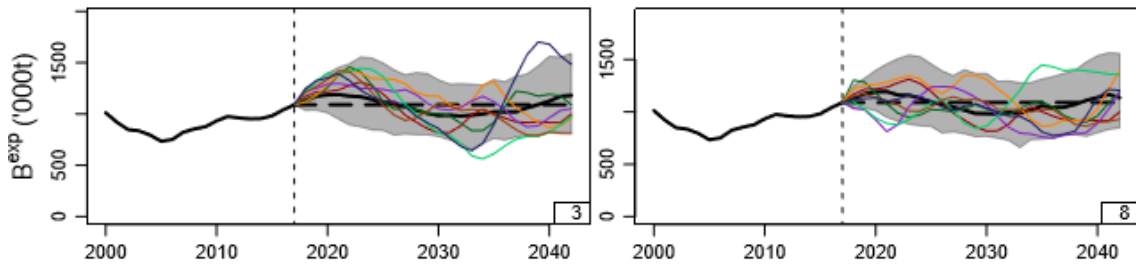
(E) 150 cap, increase b 25%

(F) 160 cap, increase b 10%

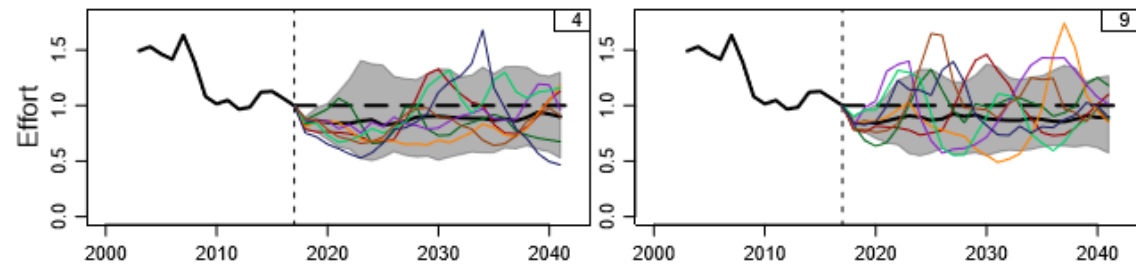
(I) Female Spawning biomass relative to BMSY



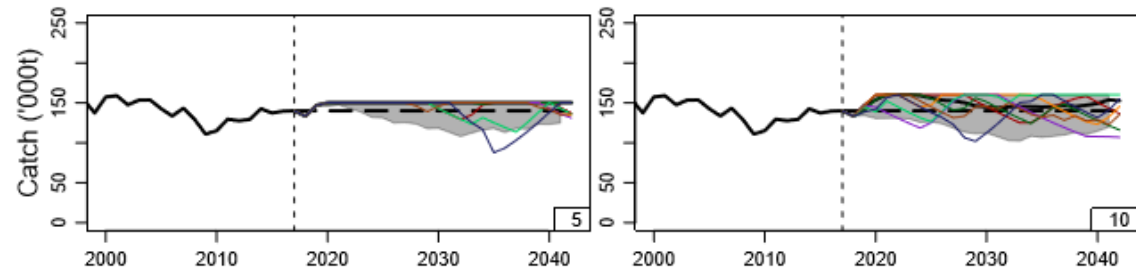
(II) Exploitable biomass (for both species combined)



(III) Approximate effort trajectories



(IV) Catch trajectories



Year

Figure 2c: Worm plots for the RC OM for (E) an upper cap of 150 000t with b increased by 25% for both species and (F) an upper cap of 160 000t with b increased by 10%.

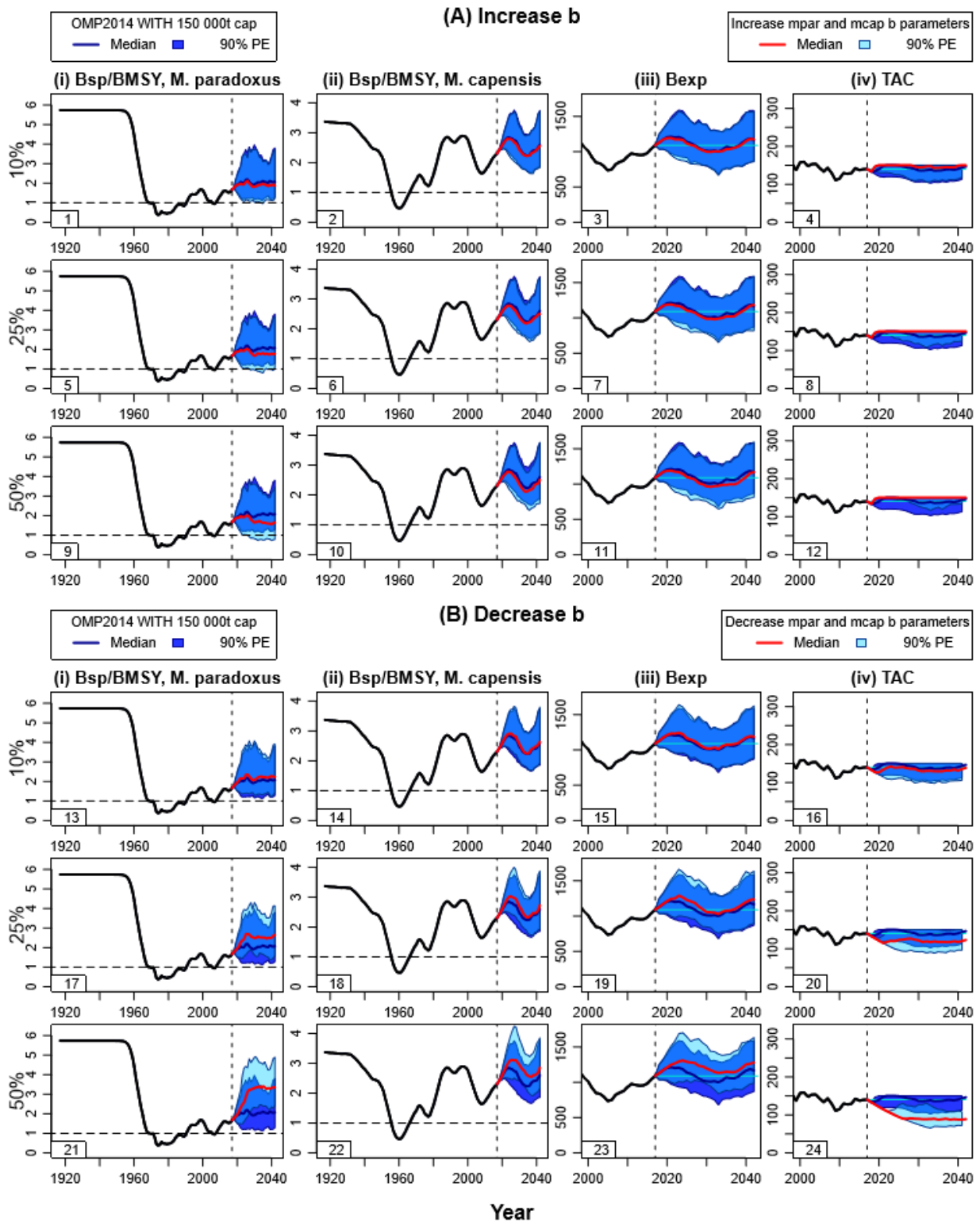


Figure 3a: Comparison for the RC OM of projections under OMP2014 with the 150 000t cap in place and variants of OMP2014 where the tuning parameter b (the parameter that determines the extent to which TAC is dependent on the simulated future survey and commercial indices) is adjusted by the same proportion for both *M. paradoxus* and *M. capensis*. Plots in section (A) contrast projections under OMP2014 with the 150 000t cap from those from variants of the OMP2014 where the b parameters are increased, while in section (B) the b parameters are decreased. Thus, in all the plots, the dark blue line (median) and dark blue shaded area (90% PE) show the projections under OMP2014 with the 150 000t cap, while the red line with the light blue area show projections under the alternative OMP with b increased or decreased as relevant per section. Areas of overlap between the two PE's are shown by an intermediate blue.

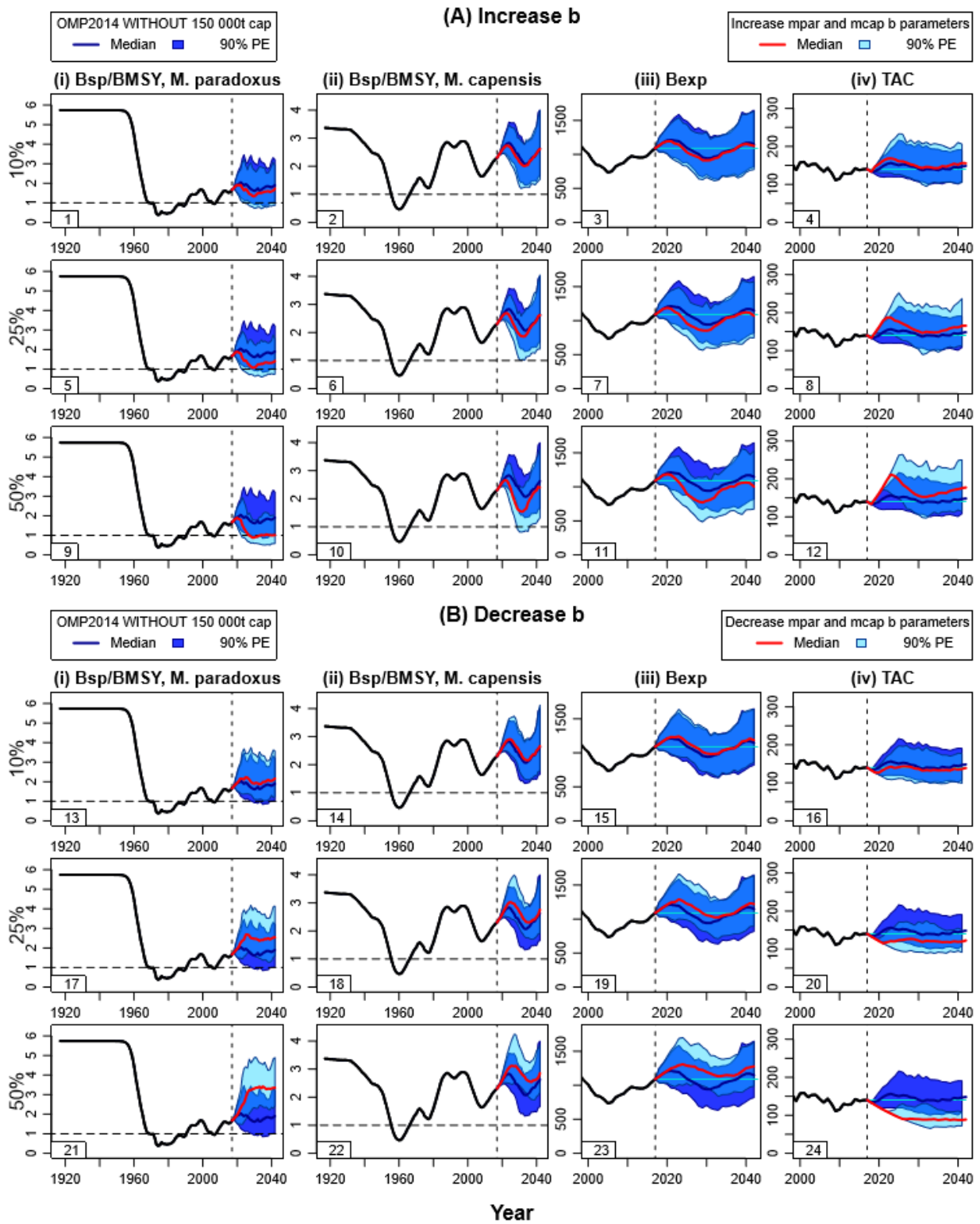


Figure 3b: Repeat of Figure 3a, but with no cap on the TAC.