Final CMP Projections for the South African hake resource

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Summary

This document provides final CMP trial results for the revision of the SA hake OMP, following selections and requests made at the 16 September meeting of the DWG. The results cover the four CMPs identified, which are distinguished by two different target average TACs for the next decade, and by whether or not the TAC is fixed at 147 500 tons for the next two years. For the higher target average TAC (138 000 t compared to 135 000 t), *M. paradoxus* recovery would be about 5% and CPUE about 2% less, with attainment of MSYL delayed by about 2 years. For the options with a fixed TAC of 147 500 t for the next two years, recovery is briefly delayed, and later TACs drop lower, with lower CPUEs and higher effort levels over most of the next decade. Performance under the various robustness tests examined does not seem unsatisfactory.

Introduction

This document presents results for the final four CMPs selected during the DWG meeting on 16 September. The specifications selected for all four CMPs are:

- The 150 000 t "upper hard cap" is maintained.
- The interannual TAC change constraints are set at 10% (increase) and 5% (decrease).
- The default meta-rule is the "safeguard rule" option CMP5b (Rademeyer and Butterworth, 2014) ($J^{thresh1}$=0.75, $J^{thresh2}$=0.65 and x=25%).
- For the projections it is assumed that the *Africana* is available for 2015 onwards, and that for recent surveys conducted by *Andromeda*, that vessel is equivalent to *Africana* in terms of trawling efficiency (catchability coefficient *q*).

The final four CMPs represent the full cross regarding two options of tuning for the annual average catch target for the next decade (135 000t or 138 000t) and whether the TAC for the next two years (2015 and 2016) is fixed at 147 500t or not, i.e.:

	135 000t av. annual catch	138 000t av. annual catch
2015 and 2016 TACs not fixed	CMPfinal1$_{135}$	CMPfinal1$_{138}$
2015 and 2016 TACs fixed at 147 500t	CMPfinal2$_{135}$	CMPfinal2$_{138}$

Results are presented for the RS and five robustness tests. Where quoted, the probability intervals are 90 percentiles.

Reference Set

Results for these four final CMPs are given in Table1 for the RS. Medians and lower 5%iles for the TAC, B^{sp} relative to MSYL for *M. paradoxus*, CPUE (relative to 2013) and effort (relative to 2010) are compared in Figure 1. Figures 2a-d plot a number of projection statistics for each of the four CMPs.

Robustness tests

Industry vessels used for future demersal surveys

Two robustness tests have been run to evaluate the effect of using industry vessels for future demersal surveys. C.future.1a assumes a normal distribution with a standard deviation of 0.169 on the possible difference between the catchability coefficient *q* of an industry vessel compared to the *Africana*. C.future.1b is a precautionary variant which assumes that an industry vessel is more efficient than the *Africana*, as reflected by the upper half of the normal distribution above. Both these robustness tests are run under the whole RS. Results are compared in Table 2 and Figures 3, 4 and 5.

Undetected increase in CPUE q

Robustness test C.future.3 projects a 2% p.a. undetected increase in CPUE catchability coefficient *q*, for each of the OM in the RS. Results for this robustness test are compared in Table 3 and Figures 6 and 7.

Change in carrying capacity

Robustness test C.future.5 assumes a decrease in carrying capacity in the future, reflected by a 20% linear decrease in *K* for both species between 2015 and 2020, and based on the whole RS. Results for this robustness test are compared in Table 4 and Figures 8 and 9.

Robustness test B.others.2 assumes that a decrease in carrying capacity occurred in the past (30% linear decrease between 1980 and 2000 for both species). This robustness test has been run for RS1. Results for this robustness test are compared in Table 5 and Figures 10 and 11.

Discussion

Table 1 shows that by the target year a decade hence (2024), aiming for an average annual catch of 135 000 rather than 138 000 t achieves improvements of 5 and 4% in terms of the median and lower 5%-ile for *M. paradoxus*, with MSYL being reached (in median terms) by 2022 rather than 2024. CPUE is better by about 2% and effort less by about 4%, though the trajectories for these quantities do cross in complex ways during the projection period shown (Figure 1). For the options with a fixed TAC of 147 500 t for the next two years, recovery is briefly delayed, and later TACs drop lower, with lower CPUEs and higher effort levels over most of the next decade. The possibility of invoking the metarule to breach the 5% annual downward TAC change constraint, together with the magnitude of the associated TAC reduction, become slightly greater (Figure 2).

Under a symmetrical distribution for the catchability (*q*) difference between an industry vessel used for surveys and *Africana*, performance statistics hardly change (Table 2). However if one considers only the precautionary option that the industry vessel could be more efficient (as reflected by the upper half of the distribution assumed), the average TAC over the next decade would increase by about 4 000 t, at the expense of *M. paradoxus* recovery dropping by about 6 percentage points in median terms and a little more for lower 5%-iles.

An undetected increase in CPUE catchability of 2% pa would lead to an average TAC increase of about 3 000 over the next decade, with a corresponding drop of about 6% in the extent of *M. paradoxus* recovery (in median terms, though at the 5%-ile level this drop is somewhat less) (Table 3).

For the robustness tests involving a change in carrying capacity *K*, either in the future or in the past (Tables 4 and 5 respectively), the most important feature of the results is that the CMPs do eventually reflect turnarounds towards recovery. However this may take some time, and requires an appreciable reduction in TACs (effected through the metarule than can override the 5% maximum annual reduction constraint on the TAC changes).

Reference

Rademeyer, RA and Butterworth, DS. 2014. And yet further Candidate Management Procedures projections for the South African hake resource. Document FISHERIES/2014/SEPT/SWG-DEM/44. 13pp.

Table 1: Median and 90% PIs for a series of performance statistics under the **RS** for the four final CMPs.

MP:		RS: $CMPfinal1_{135}$	RS: $CMPfinal2_{135}$	RS: $CMPfinal1_{138}$	RS: $CMPfinal2_{138}$
C_{2014}		**155.3** (155.3; 155.3)	**155.3**	**155.3**	**155.3**
C_{2015}	BS	147.5 (147.5; 150.0)	**147.5**	147.5 (147.5; 150.0)	**147.5**
C_{2016}	BS	140.1 (140.1; 142.5)	**147.5**	140.1 (140.1; 145.7)	**147.5**
C_{2017}	BS	133.1 (133.1; 149.4)	140.1 (140.1; 146.0)	133.1 (133.1; 150.0)	140.1 (140.1; 150.0)
B^{sp}_{2014}/B_{MSY}	para	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)
B^{sp}_{2015}/B_{MSY}	para	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)
B^{sp}_{2016}/B_{MSY}	para	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)
B^{sp}_{2017}/B_{MSY}	para	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)
avC: 2015-2024	BS	**135.0** (120.0; 146.7)	**135.0** (122.2; 146.5)	**138.0** (122.0; 148.1)	**138.0** (123.8; 148.0)
C_{low}: 2015-2034)	BS	116.4 (96.0; 133.1)	115.5 (94.5; 133.1)	120.2 (97.8; 135.4)	119.9 (96.3; 135.4)
AAV: 2015-2034	BS	0.04 (0.02; 0.06)	0.04 (0.02; 0.06)	0.04 (0.02; 0.05)	0.04 (0.02; 0.05)
$B^{sp}_{low}/B^{sp}_{2014}$	para	0.82 (0.57; 0.99)	0.80 (0.53; 0.99)	0.80 (0.57; 0.99)	0.80 (0.53; 0.99)
$B^{sp}_{low}/B^{sp}_{2014}$	cap	1.02 (0.79; 1.09)	1.02 (0.79; 1.10)	1.02 (0.79; 1.09)	1.02 (0.79; 1.09)
$B^{sp}_{low}/B^{sp}_{2007}$	para	1.35 (0.90; 1.63)	1.32 (0.85; 1.63)	1.33 (0.89; 1.63)	1.31 (0.85; 1.63)
$B^{sp}_{low}/B^{sp}_{2007}$	cap	1.68 (1.33; 1.88)	1.68 (1.34; 1.88)	1.66 (1.33; 1.88)	1.67 (1.33; 1.88)
B^{sp}_{2024}/B_{MSY}	para	1.07 (**0.66;** 2.02)	1.06 (**0.64;** 1.96)	1.01 (**0.62;** 1.91)	1.01 (**0.61;** 1.89)
B^{sp}_{2024}/B_{MSY}	cap	3.41 (1.84; 4.86)	3.40 (1.82; 4.82)	3.37 (1.82; 4.82)	3.36 (1.81; 4.81)
B^{sp}_{2034}/B_{MSY}	para	1.15 (0.71; 2.29)	1.19 (0.74; 2.35)	1.10 (0.66; 2.18)	1.12 (0.69; 2.23)
$CPUE_{2024}/CPUE_{2013}$	BS	1.11 (0.94; 1.34)	1.11 (0.94; 1.34)	1.09 (0.91; 1.32)	1.09 (0.92; 1.32)
E_{2024}/E_{2013}	BS	0.78 (0.63; 0.96)	0.76 (0.60; 0.94)	0.81 (0.65; 0.99)	0.79 (0.64; 0.97)
Prob decl >20% (2015-2017)		0.01	0.01	0.01	0.01
Prob decl >20% (2016-2018)		0.03	0.02	0.03	0.02
Prob decl>20% (2015-2032)		0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)

Table 2: Median and 90% PIs for a series of performance statistics under the robustness tests **C.future.1a** and **C.future.1b** (symmetrical and asymmetrical distribution of *q* for industry vessel, based on the whole RS).

		C.future.1a - symmetrical prior on *q* for industry vessel				C.future.1b - asymmetrical prior on *q* for industry vessel			
MP:		CMPfinal1$_{135}$	CMPfinal2$_{135}$	CMPfinal1$_{138}$	CMPfinal2$_{138}$	CMPfinal1$_{135}$	CMPfinal2$_{135}$	CMPfinal1$_{138}$	CMPfinal2$_{138}$
C_{2014}		**155.3**	**155.3**	**155.3**	**155.3**	**155.3**	**155.3**	**155.3**	**155.3**
C_{2015}	BS	147.5 (147.5; 150.0)	**147.5**	147.5 (147.5; 150.0)	**147.5**	147.5 (147.5; 150.0)	**147.5**	147.5 (147.5; 150.0)	**147.5**
C_{2016}	BS	140.1 (140.1; 146.7)	**147.5**	140.1 (140.1; 150.0)	**147.5**	140.1 (140.1; 150.0)	**147.5**	140.1 (140.1; 150.0)	**147.5**
C_{2017}	BS	133.1 (133.1; 150.0)	140.1 (140.1; 150.0)	133.1 (133.1; 150.0)	140.1 (140.1; 150.0)	133.1 (133.1; 150.0)	140.1 (140.1; 150.0)	135.1 (133.1; 150.0)	140.1 (140.1; 150.0)
B^{sp}_{2014}/B_{MSY}	para	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)
B^{sp}_{2015}/B_{MSY}	para	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)
B^{sp}_{2016}/B_{MSY}	para	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)
B^{sp}_{2017}/B_{MSY}	para	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)	0.68 (0.52; 1.06)	0.66 (0.51; 1.06)
avC: 2015-2024	BS	**135.6** (119.0; 147.0)	**136.2** (119.9; 147.1)	**138.3** (121.0; 148.4)	**138.5** (120.9; 148.1)	**139.3** (123.1; 148.3)	**139.2** (124.8; 148.4)	**141.5** (126.3; 149.3)	**141.7** (126.3; 149.1)
C_{low}: 2015-2034)	BS	117.1 (93.3; 133.1)	116.1 (91.5; 133.1)	120.2 (95.0; 135.4)	120.1 (92.7; 135.6)	120.2 (100.6; 137.3)	120.1 (97.9; 138.4)	123.9 (103.0; 140.4)	122.7 (101.4; 140.1)
AAV: 2015-2034	BS	0.04 (0.02; 0.06)	0.04 (0.02; 0.06)	0.04 (0.02; 0.06)	0.04 (0.02; 0.06)	0.04 (0.02; 0.05)	0.04 (0.02; 0.05)	0.03 (0.01; 0.05)	0.03 (0.01; 0.05)
$B^{sp}_{low}/B^{sp}_{2014}$	para	0.81 (0.57; 0.99)	0.80 (0.54; 0.99)	0.80 (0.57; 0.98)	0.79 (0.53; 0.99)	0.80 (0.56; 0.98)	0.79 (0.53; 0.98)	0.79 (0.55; 0.98)	0.78 (0.52; 0.98)
$B^{sp}_{low}/B^{sp}_{2014}$	cap	1.02 (0.79; 1.09)	1.03 (0.79; 1.10)	1.02 (0.79; 1.09)	1.02 (0.79; 1.09)	1.01 (0.78; 1.09)	1.01 (0.79; 1.09)	1.00 (0.77; 1.09)	1.01 (0.78; 1.09)
$B^{sp}_{low}/B^{sp}_{2007}$	para	1.34 (0.90; 1.63)	1.31 (0.85; 1.63)	1.33 (0.89; 1.63)	1.30 (0.84; 1.63)	1.33 (0.87; 1.63)	1.30 (0.84; 1.63)	1.30 (0.87; 1.62)	1.29 (0.84; 1.62)
$B^{sp}_{low}/B^{sp}_{2007}$	cap	1.67 (1.33; 1.88)	1.68 (1.33; 1.88)	1.66 (1.33; 1.88)	1.67 (1.33; 1.88)	1.66 (1.33; 1.88)	1.66 (1.33; 1.88)	1.64 (1.32; 1.87)	1.65 (1.32; 1.88)
B^{sp}_{2024}/B_{MSY}	para	1.04 (**0.66;** 2.07)	1.03 (**0.63;** 2.05)	1.00 (**0.62;** 1.96)	1.00 (**0.61;** 1.94)	0.98 (**0.58;** 1.90)	0.98 (**0.58;** 1.86)	0.94 (**0.53;** 1.80)	0.93 (**0.55;** 1.81)
B^{sp}_{2024}/B_{MSY}	cap	3.37 (1.83; 4.85)	3.37 (1.83; 4.84)	3.35 (1.81; 4.83)	3.34 (1.81; 4.81)	3.34 (1.81; 4.80)	3.34 (1.80; 4.79)	3.31 (1.77; 4.77)	3.30 (1.78; 4.76)
B^{sp}_{2034}/B_{MSY}	para	1.17 (0.69; 2.06)	1.20 (0.72; 2.14)	1.11 (0.64; 1.96)	1.13 (0.66; 2.04)	1.09 (0.63; 1.92)	1.11 (0.65; 1.98)	1.03 (0.59; 1.84)	1.06 (0.61; 1.88)
$CPUE_{2024}/CPUE_{2013}$	BS	1.11 (0.93; 1.34)	1.10 (0.93; 1.34)	1.09 (0.91; 1.32)	1.09 (0.91; 1.32)	1.08 (0.90; 1.32)	1.09 (0.91; 1.31)	1.07 (0.89; 1.30)	1.07 (0.89; 1.30)
E_{2024}/E_{2013}	BS	0.78 (0.60; 0.96)	0.77 (0.58; 0.95)	0.81 (0.63; 0.98)	0.79 (0.61; 0.97)	0.82 (0.65; 1.00)	0.80 (0.64; 0.99)	0.85 (0.69; 1.03)	0.83 (0.66; 1.01)
Prob decl >20% (2015-2017)		0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00
Prob decl >20% (2016-2018)		0.03	0.02	0.03	0.02	0.01	0.01	0.01	0.01
Prob decl>20% (2015-2032)		0.00 (0.00; 0.06)	0.00 (0.00; 0.11)	0.00 (0.00; 0.06)	0.00 (0.00; 0.11)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)

Table 3: Median and 90% PIs for a series of performance statistics under the robustness test **C.future.3** (2% p.a. undetected increase in CPUE, based on the whole RS) for the four final CMPs.

		C.future.3 - undetected increase in CPUE *q*			
MP:		$CMPfinal1_{135}$	$CMPfinal2_{135}$	$CMPfinal1_{138}$	$CMPfinal2_{138}$
C_{2014}		**155.3**	**155.3**	**155.3**	**155.3**
C_{2015}	BS	147.5 (147.5; 150.0)	**147.5**	147.5 (147.5; 150.0)	**147.5**
C_{2016}	BS	140.1 (140.1; 142.5)	**147.5**	140.1 (140.1; 146.2)	**147.5**
C_{2017}	BS	133.1 (133.1; 150.0)	140.1 (140.1; 147.5)	133.1 (133.1; 150.0)	140.1 (140.1; 150.0)
B^{sp}_{2014}/B_{MSY}	para	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)	0.83 (0.63; 1.26)
B^{sp}_{2015}/B_{MSY}	para	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)	0.74 (0.60; 1.05)
B^{sp}_{2016}/B_{MSY}	para	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)	0.68 (0.55; 1.00)
B^{sp}_{2017}/B_{MSY}	para	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)	0.68 (0.52; 1.08)	0.66 (0.51; 1.06)
avC: 2015-2024	BS	**138.3** (122.6; 147.5)	**138.5** (124.6; 148.1)	**140.4** (124.8; 148.8)	**140.8** (125.9; 148.6)
C_{low}: 2015-2034)	BS	120.5 (101.9; 135.4)	120.1 (101.1; 139.9)	124.9 (103.7; 139.9)	125.2 (103.0; 140.1)
AAV: 2015-2034	BS	0.03 (0.01; 0.05)	0.03 (0.01; 0.05)	0.03 (0.01; 0.05)	0.03 (0.01; 0.05)
$B^{sp}_{low}/B^{sp}_{2014}$	para	0.79 (0.57; 0.99)	0.79 (0.53; 0.98)	0.78 (0.55; 0.98)	0.77 (0.53; 0.98)
$B^{sp}_{low}/B^{sp}_{2014}$	cap	1.01 (0.78; 1.09)	1.01 (0.78; 1.09)	1.00 (0.77; 1.09)	1.00 (0.77; 1.09)
$B^{sp}_{low}/B^{sp}_{2007}$	para	1.32 (0.87; 1.63)	1.30 (0.85; 1.63)	1.29 (0.87; 1.61)	1.28 (0.84; 1.61)
$B^{sp}_{low}/B^{sp}_{2007}$	cap	1.65 (1.32; 1.87)	1.65 (1.32; 1.87)	1.64 (1.31; 1.87)	1.64 (1.31; 1.87)
B^{sp}_{2024}/B_{MSY}	para	1.01 **(0.63;** 1.91)	1.01 **(0.61;** 1.88)	0.96 **(0.60;** 1.83)	0.96 **(0.58;** 1.81)
B^{sp}_{2024}/B_{MSY}	cap	3.38 (1.82; 4.82)	3.35 (1.81; 4.80)	3.33 (1.80; 4.77)	3.33 (1.79; 4.78)
B^{sp}_{2034}/B_{MSY}	para	1.02 (0.58; 1.97)	1.04 (0.59; 2.03)	0.97 (0.53; 1.92)	0.99 (0.55; 1.95)
$CPUE_{2024}/CPUE_{2013}$	BS	1.09 (0.91; 1.32)	1.09 (0.92; 1.32)	1.08 (0.89; 1.31)	1.07 (0.90; 1.30)
E_{2024}/E_{2013}	BS	0.83 (0.66; 1.01)	0.81 (0.65; 0.99)	0.85 (0.70; 1.04)	0.84 (0.68; 1.03)
Prob decl >20% (2015-2017)		0.01	0.00	0.01	0.00
Prob decl >20% (2016-2018)		0.03	0.02	0.03	0.02
Prob decl>20% (2015-2032)		0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)

Table 4: Median and 90% PIs for a series of performance statistics under the robustness test **C.future.5** (decrease in *K* in the future, reflected by a 20% linear decrease in *K* for both species between 2015 and 2020, and based on the whole RS) for the four final CMPs.

		C.future.5 - change in *K* in future							
MP:		$CMPfinal1_{135}$		$CMPfinal2_{135}$		$CMPfinal1_{138}$		$CMPfinal2_{138}$	
C_{2014}		**155.3**		**155.3**		**155.3**		**155.3**	
C_{2015}	BS	147.5	(147.5; 150.0)	**147.5**		147.5	(147.5; 150.0)	**147.5**	
C_{2016}	BS	140.1	(140.1; 142.5)	**147.5**		140.1	(140.1; 145.7)	**147.5**	
C_{2017}	BS	133.1	(127.0; 149.3)	140.1	(133.3; 146.0)	133.1	(127.0; 150.0)	140.1	(133.3; 150.0)
B^{sp}_{2014}/B_{MSY}	para	0.83	(0.63; 1.26)	0.83	(0.63; 1.26)	0.83	(0.63; 1.26)	0.83	(0.63; 1.26)
B^{sp}_{2015}/B_{MSY}	para	0.74	(0.60; 1.05)	0.74	(0.60; 1.05)	0.74	(0.60; 1.05)	0.74	(0.60; 1.05)
B^{sp}_{2016}/B_{MSY}	para	0.68	(0.55; 1.00)	0.68	(0.55; 1.00)	0.68	(0.55; 1.00)	0.68	(0.55; 1.00)
B^{sp}_{2017}/B_{MSY}	para	0.68	(0.52; 1.08)	0.66	(0.51; 1.06)	0.68	(0.52; 1.08)	0.66	(0.51; 1.06)
avC: 2015-2024	BS	**108.5**	(85.9; 133.7)	**109.1**	(87.2; 132.9)	**110.7**	(88.1; 135.4)	**110.9**	(89.1; 135.1)
C_{low}: 2015-2034)	BS	39.3	(21.5; 61.4)	35.1	(19.9; 57.5)	42.8	(25.6; 64.5)	39.4	(22.9; 61.7)
AAV: 2015-2034	BS	0.10	(0.08; 0.13)	0.11	(0.08; 0.13)	0.10	(0.08; 0.12)	0.10	(0.08; 0.13)
$B^{sp}_{low}/B^{sp}_{2014}$	para	0.30	(0.12; 0.55)	0.28	(0.11; 0.54)	0.28	(0.12; 0.52)	0.26	(0.11; 0.51)
$B^{sp}_{low}/B^{sp}_{2014}$	cap	0.45	(0.29; 0.65)	0.45	(0.29; 0.65)	0.44	(0.27; 0.62)	0.44	(0.28; 0.63)
$B^{sp}_{low}/B^{sp}_{2007}$	para	0.51	(0.19; 0.89)	0.47	(0.17; 0.88)	0.49	(0.18; 0.85)	0.46	(0.17; 0.84)
$B^{sp}_{low}/B^{sp}_{2007}$	cap	0.76	(0.51; 1.03)	0.75	(0.51; 1.02)	0.74	(0.48; 0.98)	0.74	(0.49; 0.99)
B^{sp}_{2024}/B_{MSY}	para	0.29	(**0.17;** 0.54)	0.27	(**0.16;** 0.53)	0.27	(**0.16;** 0.51)	0.26	(**0.15;** 0.51)
B^{sp}_{2024}/B_{MSY}	cap	1.50	(0.79; 2.10)	1.48	(0.76; 2.08)	1.44	(0.75; 2.00)	1.43	(0.75; 2.00)
B^{sp}_{2034}/B_{MSY}	para	1.66	(0.96; 4.03)	1.77	(1.05; 4.15)	1.49	(0.87; 3.79)	1.61	(0.93; 3.92)
$CPUE_{2024}/CPUE_{2013}$	BS	0.46	(0.34; 0.58)	0.45	(0.34; 0.58)	0.44	(0.32; 0.57)	0.44	(0.33; 0.57)
E_{2024}/E_{2013}	BS	0.67	(0.36; 1.45)	0.63	(0.34; 1.38)	0.74	(0.40; 1.52)	0.68	(0.38; 1.46)
Prob decl >20% (2015-2017)		0.01		0.01		0.01		0.01	
Prob decl >20% (2016-2018)		0.17		0.04		0.15		0.04	
Prob decl>20% (2015-2032)		0.22	(0.11; 0.39)	0.22	(0.17; 0.39)	0.22	(0.11; 0.33)	0.22	(0.16; 0.39)

Table 5: Median and 90% PIs for a series of performance statistics under RS1 and the robustness test **B.others.2** (decrease in *K* in the past, reflected by a 20% linear decrease in *K* for both species between 1980 and 2000, and based on RS1).

		RS1								B.others.2 - change in *K* in past, based on RS1							
MP:		CMPfinal1$_{135}$		CMPfinal2$_{135}$		CMPfinal1$_{138}$		CMPfinal2$_{138}$		CMPfinal1$_{135}$		CMPfinal2$_{135}$		CMPfinal1$_{138}$		CMPfinal2$_{138}$	
C_{2014}		**155.3**		**155.3**		**155.3**		**155.3**		**155.3**		**155.3**		**155.3**		**155.3**	
C_{2015}	BS	147.5	(147.5; 150.0)	**147.5**		147.5	(147.5; 150.0)	**147.5**		147.5	(140.3; 147.5)	**147.5**		147.5		**147.5**	
C_{2016}	BS	140.1	(140.1; 142.5)	**147.5**		140.1	(140.1; 142.5)	**147.5**		133.8	(107.8; 140.1)	**147.5**		133.8		**147.5**	
C_{2017}	BS	133.1	(133.1; 145.7)	140.1	(140.1; 142.5)	133.1	(133.1; 150.0)	140.1	(140.1; 149.4)	105.1	(80.8; 133.1)	110.6	(105.4; 140.1)	105.1	(80.8; 133.1)	110.6	(105.4; 140.1)
B^{sp}_{2014}/B_{MSY}	para	0.85	(0.85; 0.85)	0.85	(0.85; 0.85)	0.85	(0.85; 0.85)	0.85	(0.85; 0.85)	0.82	(0.82; 0.82)	0.82	(0.82; 0.82)	0.82	(0.82; 0.82)	0.82	(0.82; 0.82)
B^{sp}_{2015}/B_{MSY}	para	0.74	(0.69; 0.80)	0.74	(0.69; 0.80)	0.74	(0.69; 0.80)	0.74	(0.69; 0.80)	0.60	(0.52; 0.69)	0.60	(0.52; 0.69)	0.60	(0.52; 0.69)	0.60	(0.52; 0.69)
B^{sp}_{2016}/B_{MSY}	para	0.68	(0.60; 0.81)	0.68	(0.60; 0.82)	0.68	(0.60; 0.81)	0.68	(0.60; 0.82)	0.45	(0.38; 0.69)	0.45	(0.38; 0.69)	0.45	(0.38; 0.69)	0.45	(0.38; 0.69)
B^{sp}_{2017}/B_{MSY}	para	0.67	(0.54; 0.87)	0.66	(0.53; 0.86)	0.67	(0.54; 0.87)	0.66	(0.53; 0.86)	0.40	(0.30; 0.78)	0.36	(0.30; 0.75)	0.40	(0.30; 0.78)	0.36	(0.30; 0.75)
avC: 2015-2024	BS	**132.5**	(120.0; 143.8)	**132.5**	(123.8; 145.7)	**135.3**	(121.5; 146.1)	**135.1**	(124.4; 146.5)	**101.0**	(77.0; 135.0)	**100.4**	(78.7; 139.0)	**105.9**	(81.2; 137.9)	**104.7**	(82.0; 142.1)
C_{low}: 2015-2034)	BS	114.1	(97.7; 126.5)	113.3	(94.4; 128.7)	117.2	(96.0; 131.8)	115.9	(96.3; 133.1)	68.1	(47.3; 99.8)	63.6	(43.9; 99.5)	73.5	(52.6; 100.8)	69.8	(46.2; 99.4)
AAV: 2015-2034	BS	0.04	(0.02; 0.05)	0.04	(0.02; 0.05)	0.04	(0.02; 0.05)	0.04	(0.02; 0.05)	0.09	(0.05; 0.12)	0.09	(0.04; 0.12)	0.08	(0.05; 0.11)	0.08	(0.04; 0.11)
$B^{sp}_{low}/B^{sp}_{2014}$	para	0.77	(0.60; 0.93)	0.76	(0.56; 0.93)	0.76	(0.58; 0.93)	0.75	(0.56; 0.93)	0.45	(0.29; 0.75)	0.41	(0.25; 0.74)	0.44	(0.28; 0.73)	0.41	(0.25; 0.71)
$B^{sp}_{low}/B^{sp}_{2014}$	cap	0.97	(0.85; 1.06)	0.98	(0.83; 1.07)	0.95	(0.83; 1.06)	0.96	(0.83; 1.06)	0.95	(0.77; 1.05)	0.92	(0.67; 1.05)	0.93	(0.74; 1.05)	0.92	(0.67; 1.05)
$B^{sp}_{low}/B^{sp}_{2007}$	para	1.35	(1.05; 1.63)	1.33	(0.97; 1.63)	1.34	(1.01; 1.62)	1.30	(0.97; 1.63)	0.56	(0.36; 0.95)	0.52	(0.31; 0.93)	0.55	(0.35; 0.92)	0.52	(0.31; 0.90)
$B^{sp}_{low}/B^{sp}_{2007}$	cap	1.68	(1.47; 1.85)	1.69	(1.44; 1.85)	1.66	(1.44; 1.84)	1.67	(1.44; 1.85)	1.66	(1.35; 1.84)	1.62	(1.18; 1.84)	1.64	(1.30; 1.84)	1.62	(1.18; 1.84)
B^{sp}_{2024}/B_{MSY}	para	1.05	(**0.80**; 1.47)	1.05	(**0.77**; 1.45)	0.99	(**0.76**; 1.41)	0.99	(**0.76**; 1.41)	1.30	(**0.70**; 2.56)	1.30	(**0.63**; 2.30)	1.18	(**0.64**; 2.35)	1.16	(**0.58**; 2.13)
B^{sp}_{2024}/B_{MSY}	cap	2.36	(2.02; 2.78)	2.35	(1.99; 2.79)	2.34	(1.99; 2.74)	2.33	(1.97; 2.75)	1.96	(1.60; 2.42)	1.94	(1.55; 2.38)	1.91	(1.57; 2.40)	1.89	(1.53; 2.33)
B^{sp}_{2034}/B_{MSY}	para	1.15	(0.78; 1.59)	1.21	(0.82; 1.71)	1.09	(0.72; 1.51)	1.13	(0.75; 1.57)	1.21	(0.55; 2.82)	1.24	(0.66; 3.46)	1.09	(0.51; 2.42)	1.13	(0.59; 2.95)
$CPUE_{2024}/CPUE_{2013}$	BS	1.06	(0.93; 1.24)	1.06	(0.93; 1.23)	1.04	(0.91; 1.22)	1.04	(0.91; 1.22)	1.25	(0.98; 1.64)	1.25	(0.95; 1.63)	1.21	(0.96; 1.61)	1.21	(0.92; 1.59)
E_{2024}/E_{2013}	BS	0.80	(0.65; 0.98)	0.77	(0.62; 0.97)	0.83	(0.68; 1.01)	0.81	(0.66; 0.99)	0.51	(0.28; 0.80)	0.46	(0.25; 0.76)	0.57	(0.32; 0.85)	0.52	(0.30; 0.81)
Prob decl >20% (2015-2017)		0.00		0.00		0.00		0.00		0.70		0.64		0.70		0.64	
Prob decl >20% (2016-2018)		0.00		0.00		0.00		0.00		0.77		0.72		0.77		0.72	
Prob decl>20% (2015-2032)		0.00	(0.00; 0.00)	0.00	(0.00; 0.00)	0.00	(0.00; 0.00)	0.00	(0.00; 0.00)	0.17	(0.00; 0.22)	0.17	(0.00; 0.28)	0.17	(0.00; 0.28)	0.17	(0.00; 0.28)

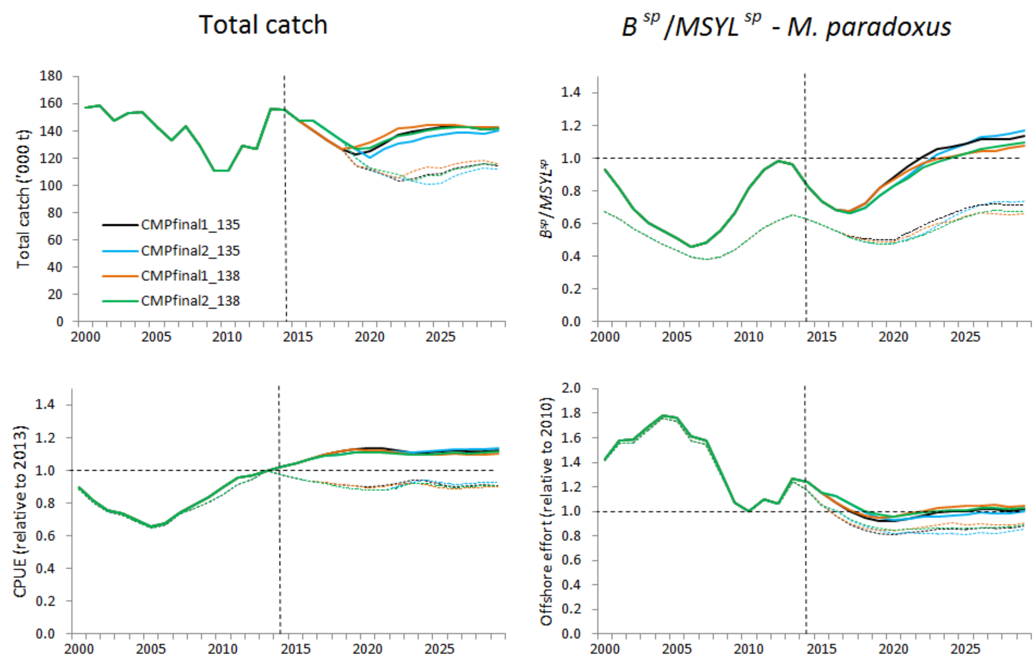

Figure 1a: Medians (full lines) and lower **5%iles** (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the **RS** under the final four CMPs.

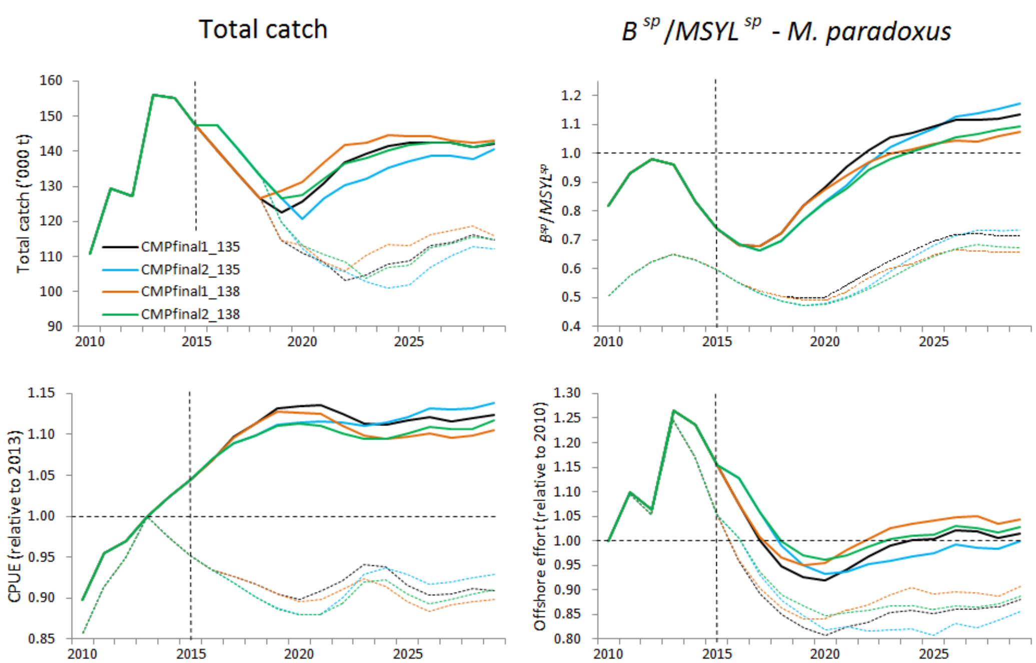

Figure 1b: as Figure 1a but with a different scale to show differences more clearly.

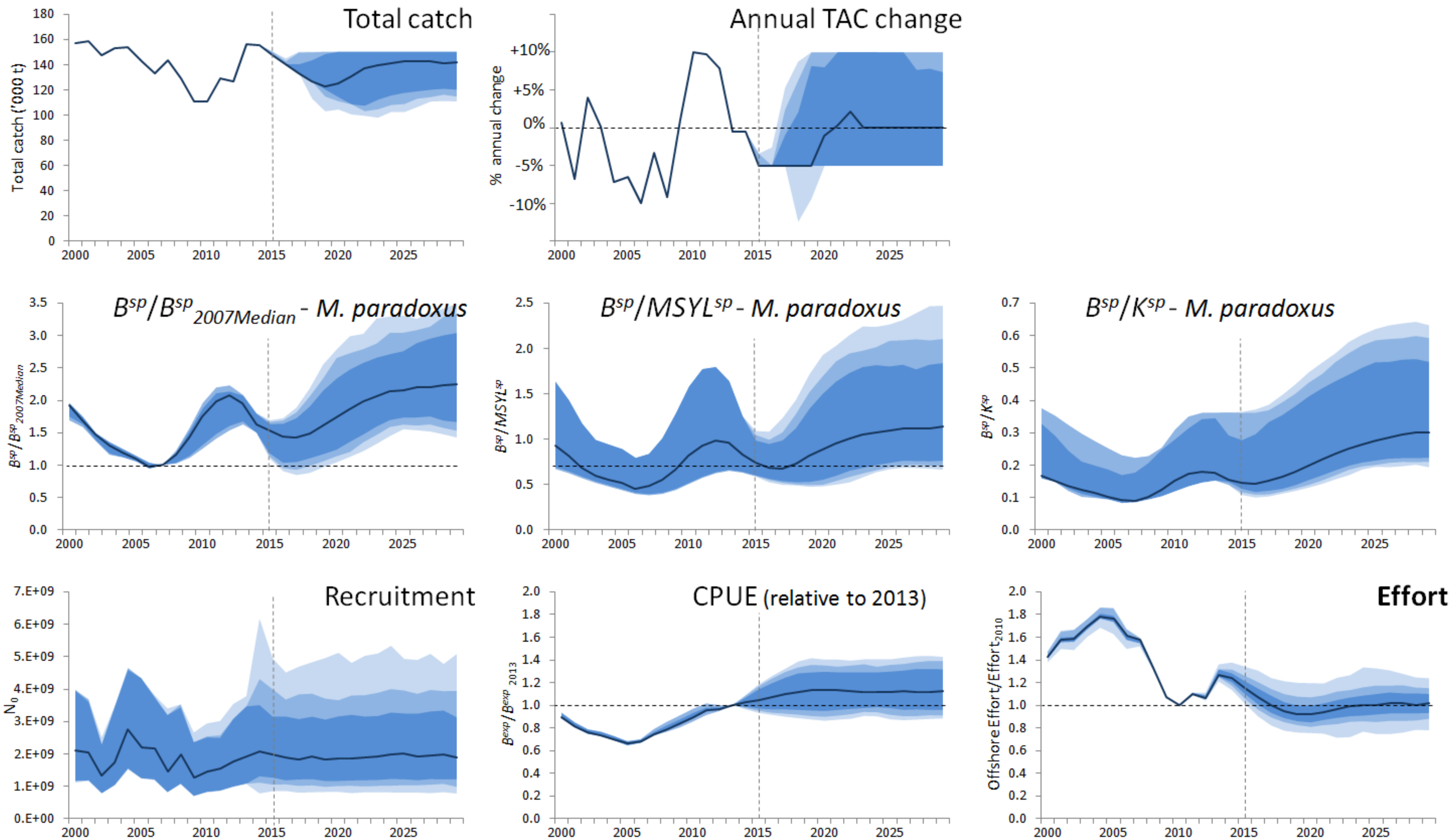

Figure 2a: 95, 90 and 80% PI and median for a series of performance statistics for **CMPfinal1**$_{135}$ under the RS.

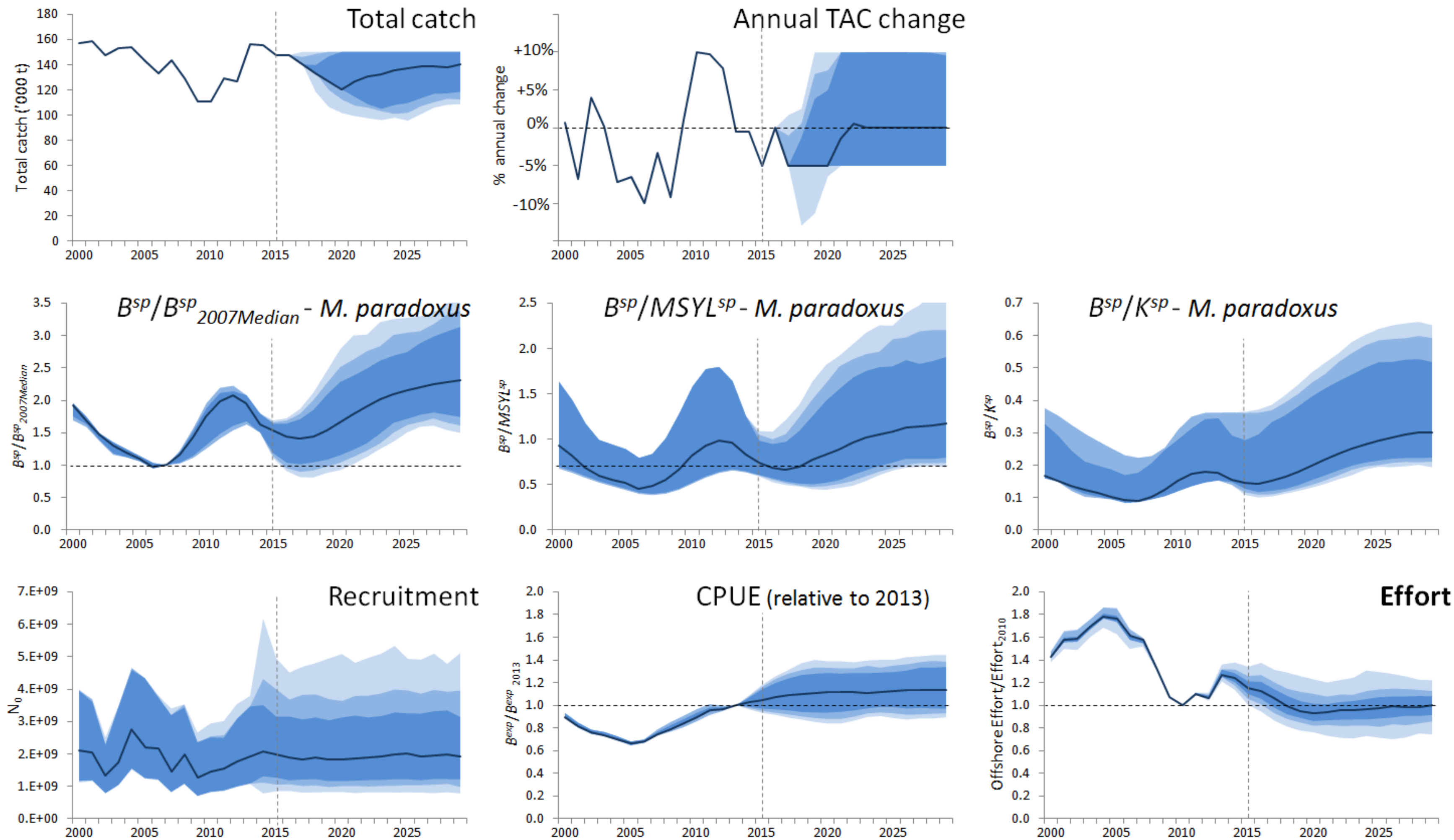

Figure 2b: 95, 90 and 80% PI and median for a series of performance statistics for **CMPfinal2**$_{135}$ under the RS.

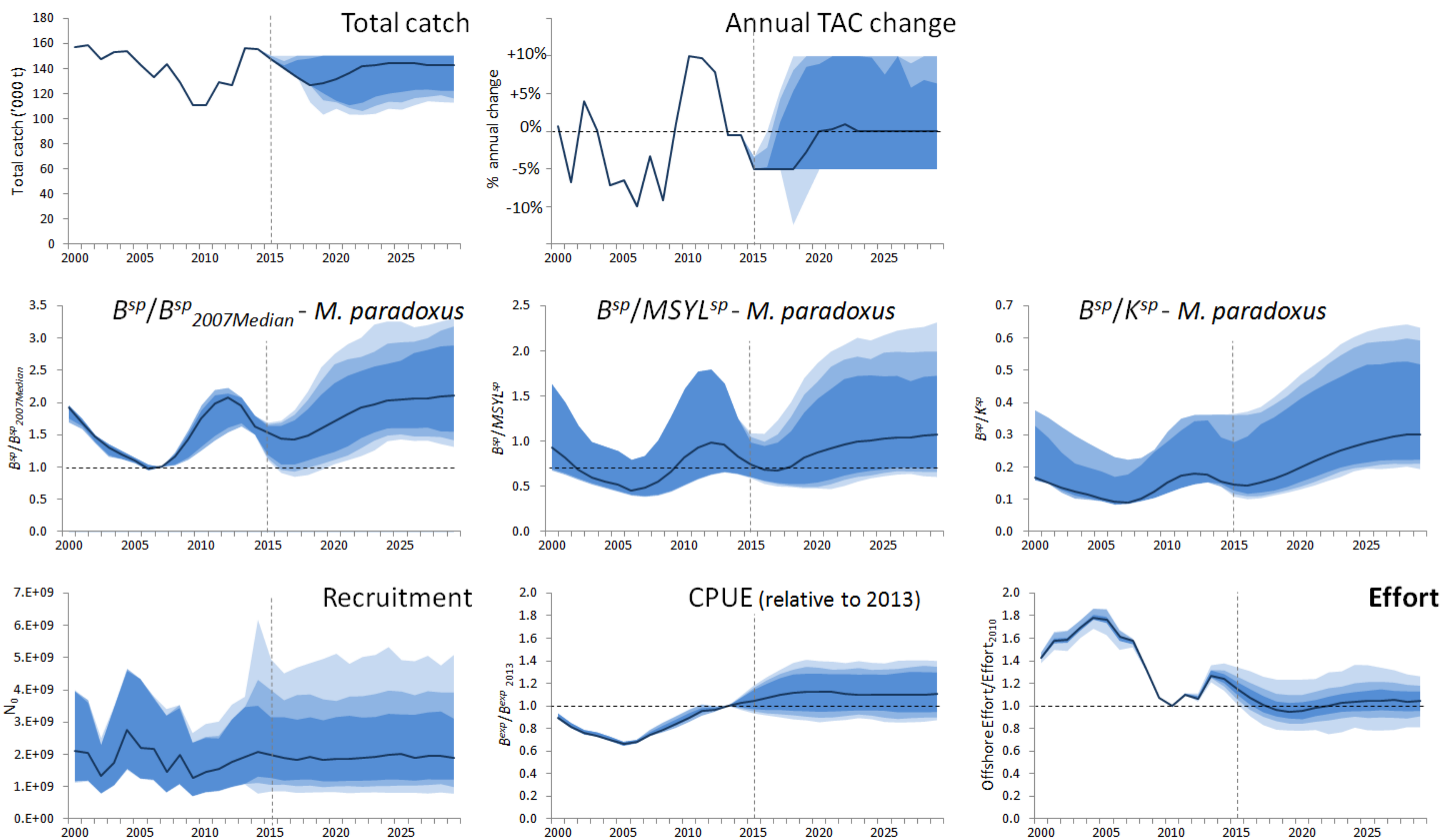

Figure 2c: 95, 90 and 80% PI and median for a series of performance statistics for **CMPfinal1**$_{138}$ under the RS.

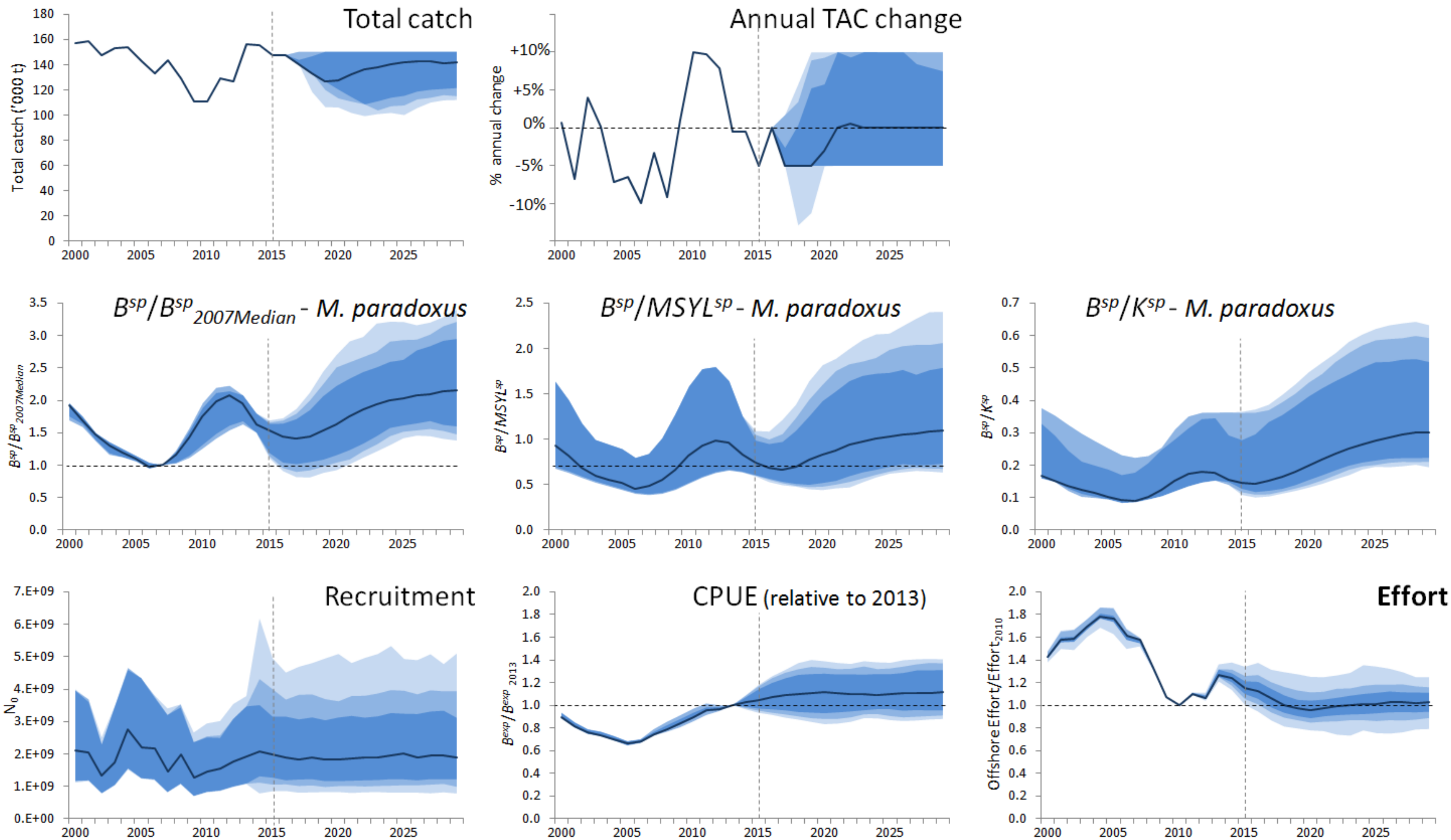

Figure 2d: 95, 90 and 80% PI and median for a series of performance statistics for **CMPfinal2**$_{138}$ under the RS.

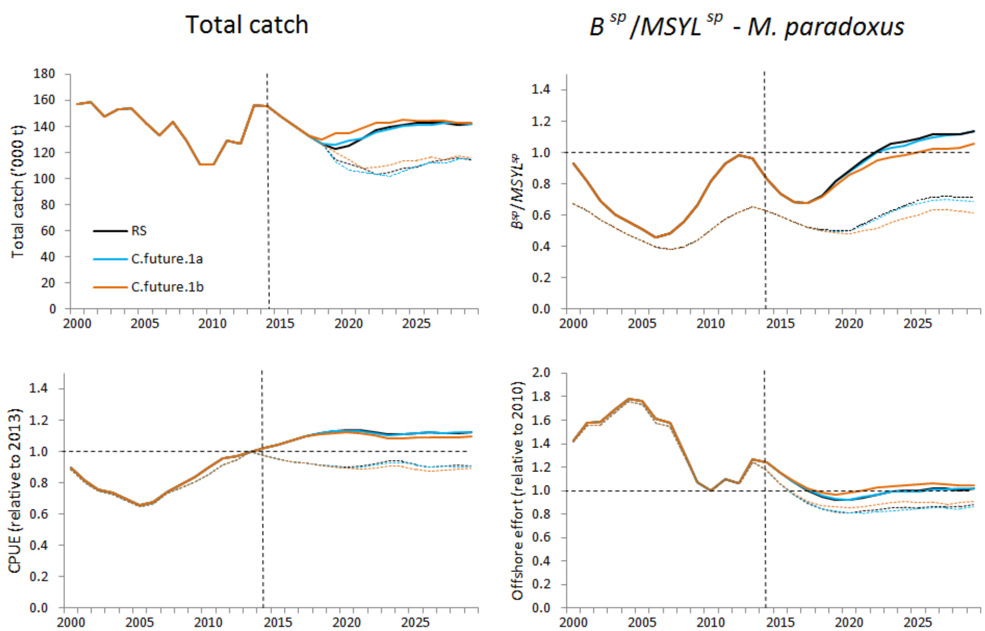

Figure 3: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the **CMPfinal1**$_{\mathbf{135}}$ under the **RS** and robustness tests **C.future.1a** (symmetrical distribution for industry vessel *q*) and **C.future.1b** (asymmetrical distribution for industry vessel *q*), both based on the whole RS.

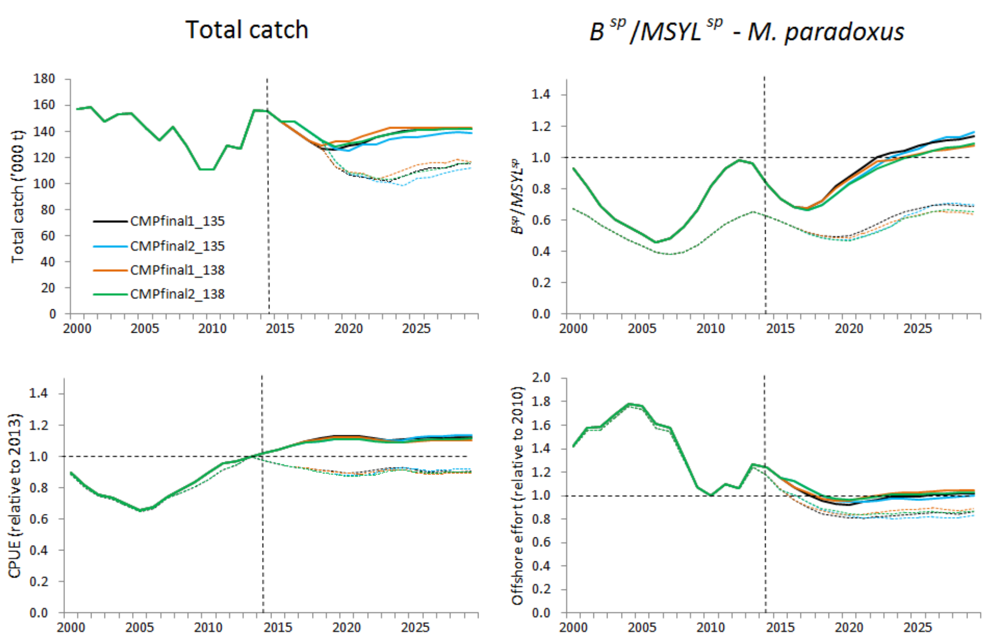

Figure 4: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the robustness test **C.future.1a** (symmetrical distribution for industry vessel *q*) under the four final CMPs.

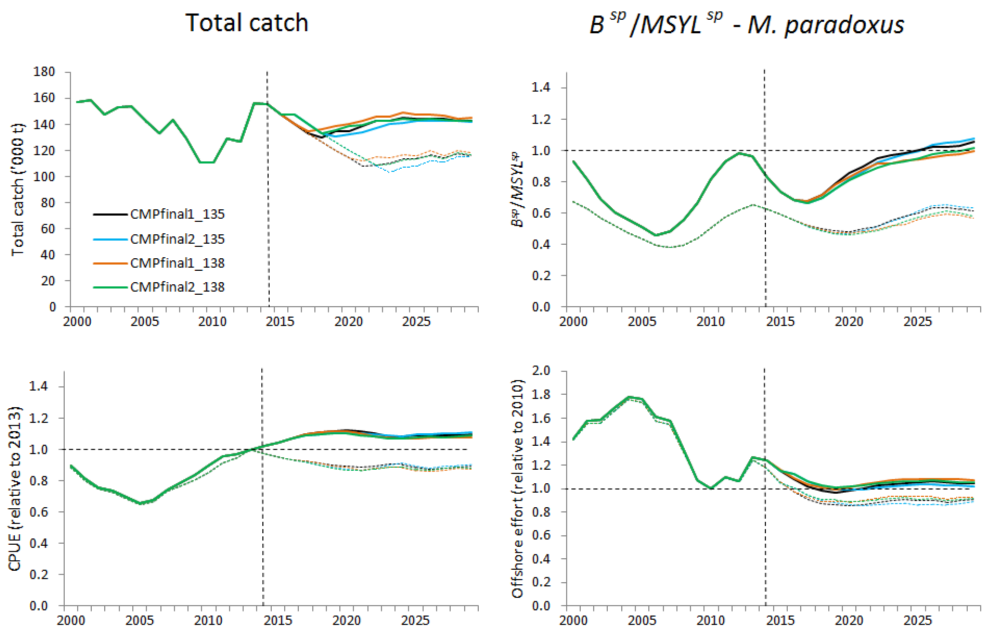

Figure 5: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the robustness test **C.future.1b** (asymmetrical distribution for industry vessel *q*) under the four final CMPs.

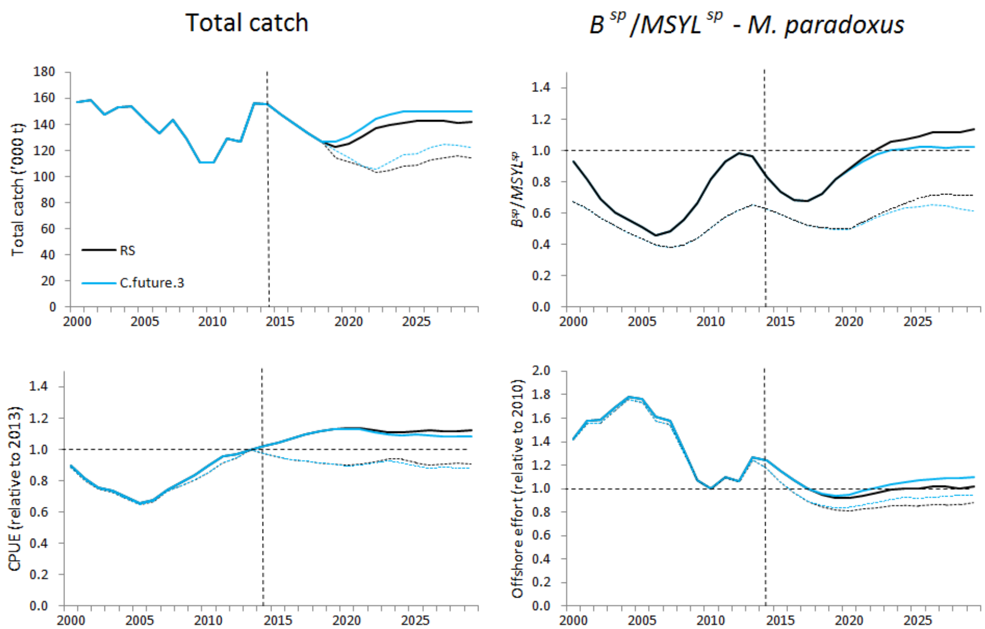

Figure 6: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the **CMPfinal1$_{135}$** under the **RS** and robustness tests **C.future.3** (2% p.a. undetected increase in CPUE *q*, based on the whole RS).

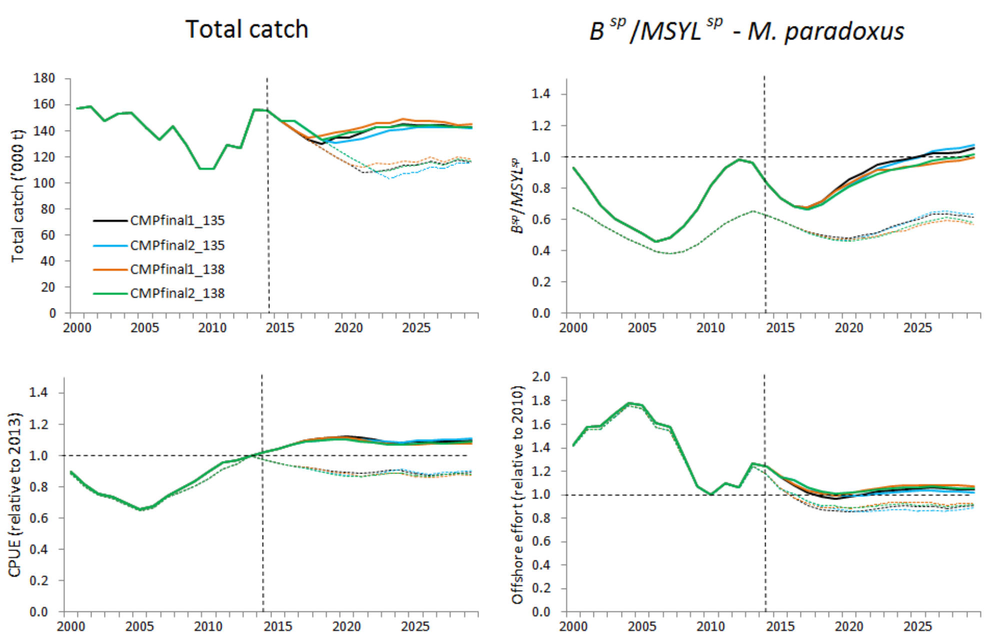

Figure 7: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the robustness test **C.future.3** (2% p.a. undetected increase in CPUE *q*, based on the whole RS) under the four final CMPs.

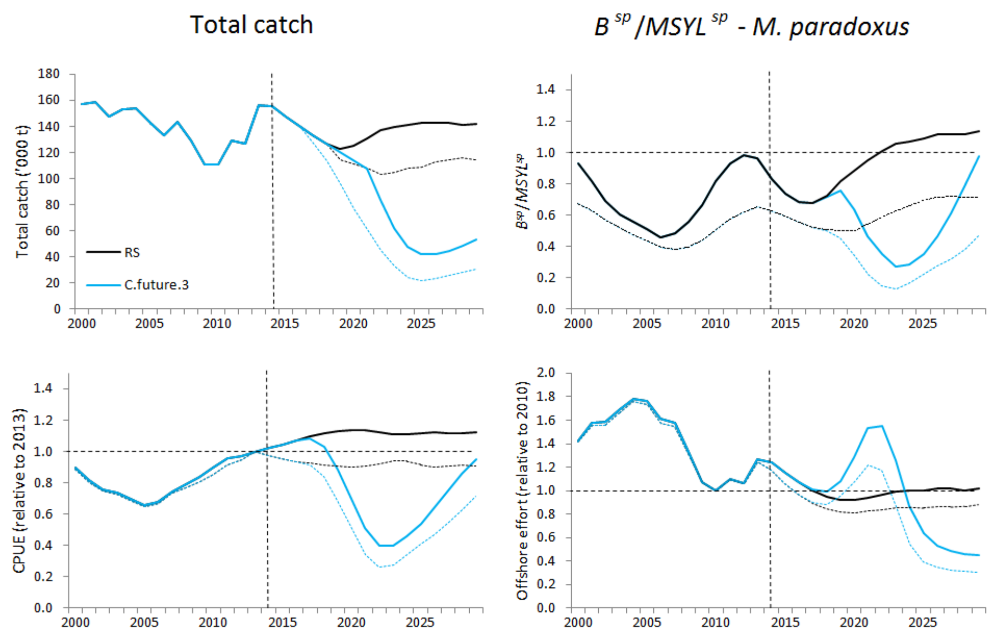

Figure 8: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the **CMPfinal1$_{135}$** under the **RS** and robustness tests **C.future.5** (decrease in *K* in the future, reflected by a 20% linear decrease in *K* for both species between 2015 and 2020, and based on the whole RS).

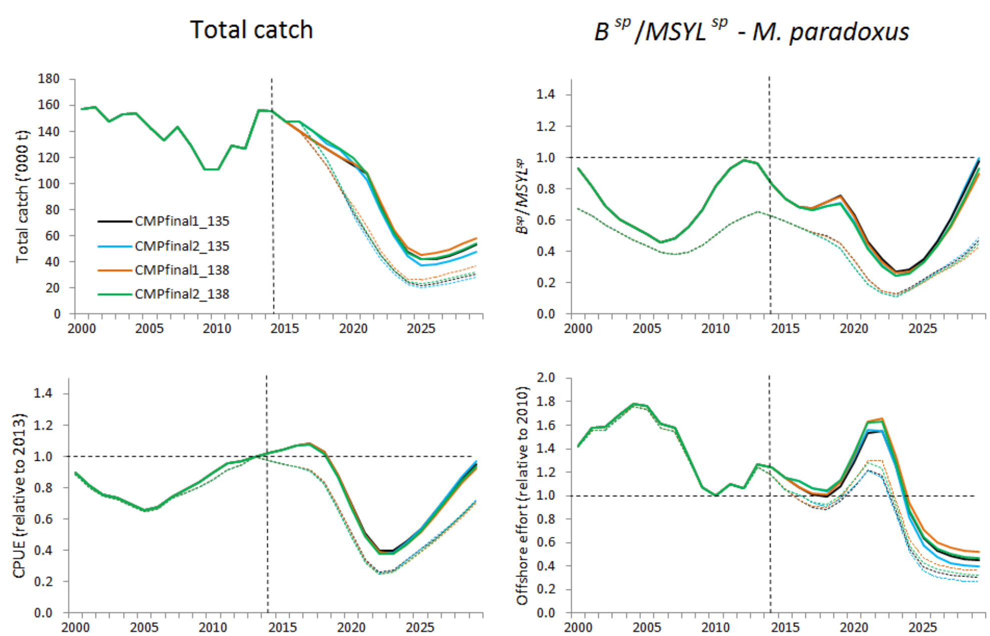

Figure 9: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the robustness test **C.future.5** (decrease in *K* in the future, reflected by a 20% linear decrease in *K* for both species between 2015 and 2020, and based on the whole RS) under the four final CMPs.

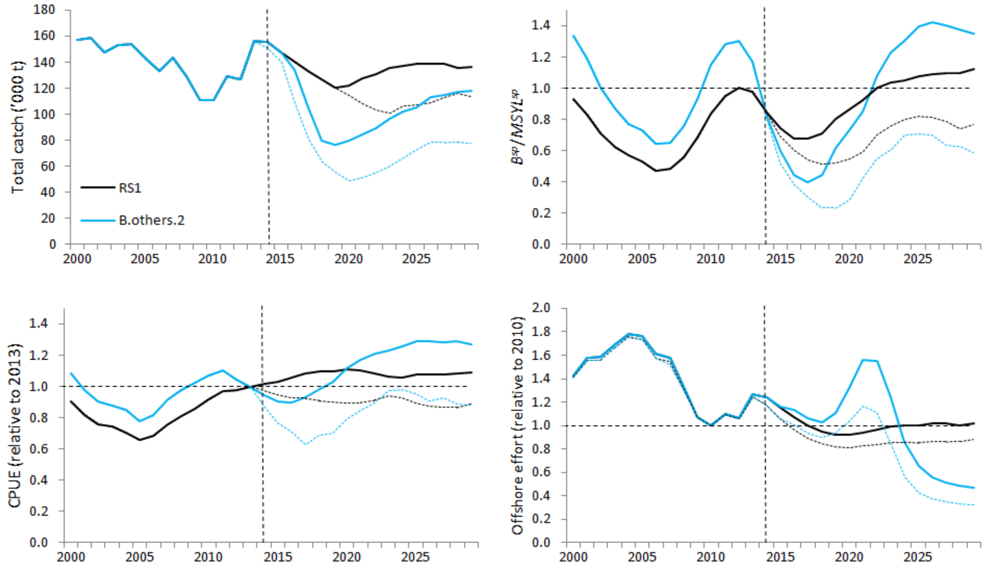

Figure 10: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the **CMPfinal1**$_{\mathbf{135}}$ under the **RS1** and robustness tests **B.others.2** (decrease in *K* in the past, reflected by a 20% linear decrease in *K* for both species between 1980 and 2000, and based on RS1).

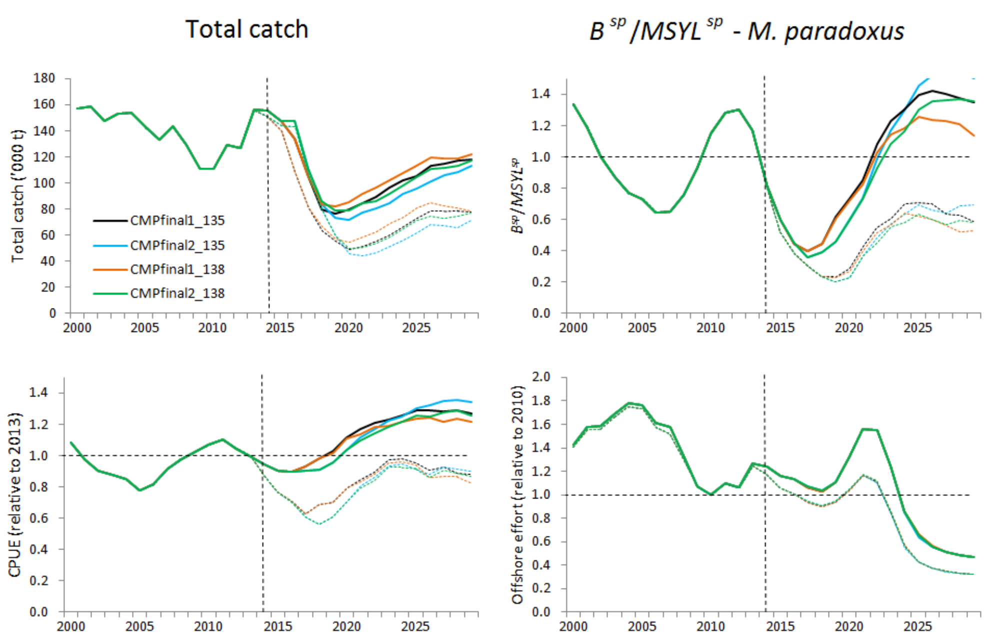

Figure 11: Medians (full lines) and lower 5%iles (dotted lines) for total catch (top row, LHS), *M. paradoxus* spawning biomass (relative to MSYL level - top row, RHS), CPUE (relative to 2013, bottom row, LHS) and effort (relative to 2010, bottom row, RHS) for the robustness test **B.others.2** (decrease in *K* in the past, reflected by a 20% linear decrease in *K* for both species between 1980 and 2000, and based on RS1 only) under the four final CMPs.