RESULTS OF INTERSESSIONAL MANAGEMENT PROCEDURE RUNS REQUESTED BY THE SPECIAL MEETING OF THE EXTENDED COMMISSION

INTRODUCTION

The Special Meeting of the Extended Commission (August 2011) made the following request to Member Scientists:

"*Member scientists, in conjunction with the Management Procedure Coordinator, are to provide results, comprising the specific TAC recommendations for 12 different variations of the Bali Procedure, for consideration by Members in advance of CCSBT 18. The 12 management procedures will be based on the above decisions and will have the following combinations:*

- *Tuning years[1] of 2030 and 2035. The results from the latest ESC showed more optimistic rebuilding projections than in the past and enabled the slowest rebuilding option (tuning to 2040) to be eliminated as an option.*
- *Maximum TAC changes of 3,000t and 5,000t (for both TAC increases and decreases).*
- *With and without a specific rule that prevents the management procedure from allowing a TAC increase in its first TAC setting period, as well as a 1000t increase in the first TAC setting period.*"

This work was conducted and checked by Scientists from Australia and Japan, together with the Management Procedure (MP) Coordinator, who provided updated code to accommodate these requests.

RESULTS

The median projected catch and spawning stock biomass (SSB) from the 12 variations of the Bali Procedure are shown in Figures 1 and 2, respectively.

Worm plots of spawning stock biomass and catch showing the median, 10^{th} and 90^{th} percentiles with a random sample of individual trajectories for each of the 12 variations of the Bali Procedure are provided in Attachment A.

The summary performance statistics plots can be found in Attachment B.

The detailed summary performance statistics tables (for the Base, lowR and upq scenarios) can be found in Attachment C.

The median constant catch projections under the current TAC (of 9449 t) and for the zero TAC are provided in Attachment D.

[1] The "tuning year" is the year by which the spawning stock biomass (SSB) should achieve the interim rebuilding target of 20% SSB_0 with a 70% probability under the chosen management procedure.

Figure 1: TAC (median, full line; 10th percentile, dashed line) summary. Each pane represents the specific first-year increase scenario, and therein all four tuning year and maximum TAC change scenarios.

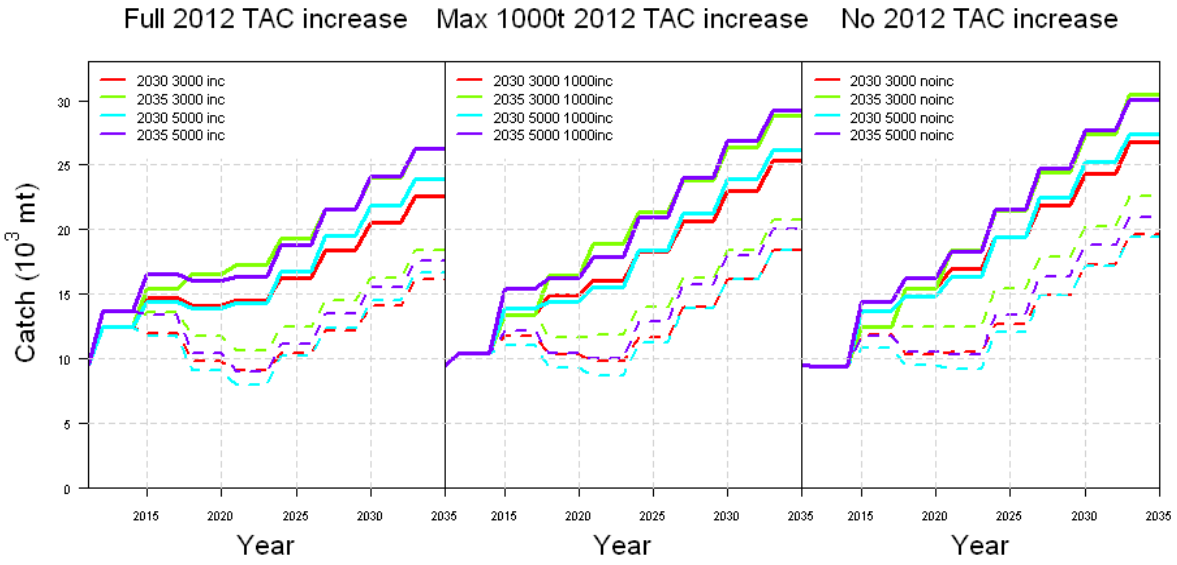
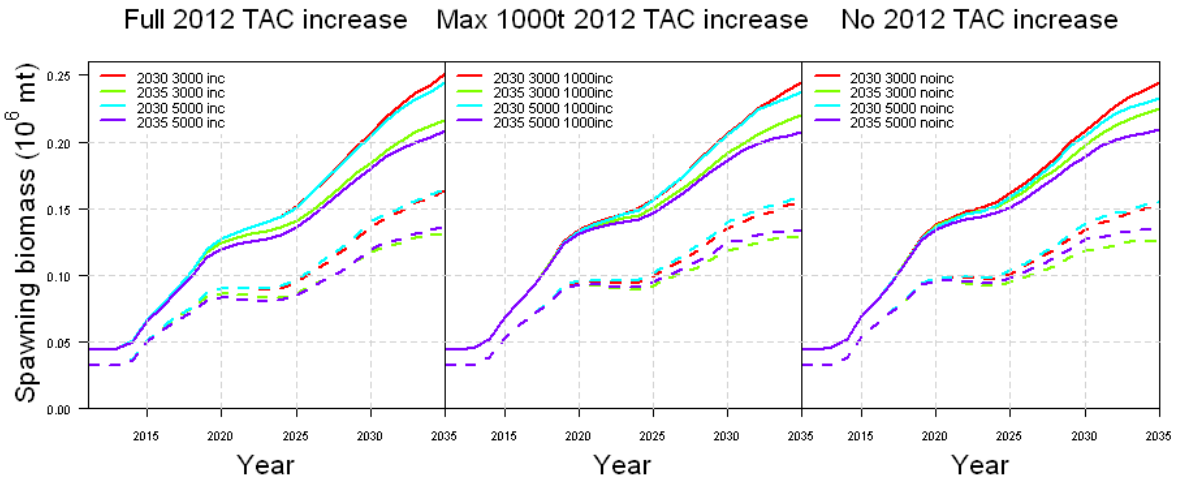


Figure 2: Spawning stock biomass (median, full line; 10th percentile, dashed line) summary. Each pane represents the specific first-year increase scenario, and therein all four tuning year and maximum TAC change scenarios.



A summary of the main trade-offs in terms of stock rebuilding and catch performance of the different variants of the Bali Procedure are shown in Table 1.

Table 1: Summary of the main trade-offs in stock rebuilding and catch performance for the Bali Procedure against rebuilding year and TAC constraints.

Rebuilding year / TAC constraint	Stock rebuilding performance	Catch performance
Tuning year (2030, 2035)	• 2030 leads to more rapid rebuilding than 2035.	• Earlier tuning means greater likelihood of lower average catches. • Earlier tuning increases up/down TAC behaviour.
Maximum TAC change (3000, 5000t)	• 3000t max change leads to more rapid rebuilding by 2022.	• 5000t max change leads to greater inter-annual variation in catch. • 5000t max change leads to higher likelihood of TAC increase followed by decrease in the first two and the first four TAC decisions. • 5000t max change leads to higher average catch between 2012-2022.
TAC increase allowed in first year of MP implementation (i.e. 2012) (No//1000t/Yes)	• Allowing TAC increase in first year does not prevent MP meeting rebuilding target. • Allowing increase slows rate of biomass rebuilding in initial period (2011-2022). • Allowing for a maximum 1000t increase in 2012 yields similar, but slightly slower rebuilding than the no increase case.	• No TAC increase reduces up/down TAC behavior between 2015-2021. • No increase reduces catch variation 2012-2022. • A 1000t maximum increase yields higher average catches (than the no increase case) but also increases the probability of future (beyond 2015) TAC up/down behaviour. • Allowing the maximum TAC increase in first year leads to higher maximum TAC decrease over remainder of evaluation period. • Allowing the maximum TAC increase leads to, on average, a 0.12 probability of a decrease in TAC in 2015. • No TAC increase generally leads to lower catches between 2012-2022.

Table 2 provides the implied TACs for 2012 to 2014 inclusive under each of the 12 variations of the Bali Procedure.

Table 2: Implied TACs for 2012 to 2014 under the 12 variations of the Bali Procedure.

Tuning Year	Max change	TAC inc	TAC
2030	3000	No	9449
2030	3000	1000t	10449
2030	3000	Yes	12449
2030	5000	No	9449
2030	5000	1000t	10449
2030	5000	Yes	12448
2035	3000	No	9449
2035	3000	1000t	10449
2035	3000	Yes	12449
2035	5000	No	9449
2035	5000	1000t	10449
2035	5000	Yes	13723

Attachment A

Figure 1: Worm plots (SSB and catch) for tuning year 2035, maximum change 3000t, and for the increase, 1000t increase and no increase in the first year scenarios.

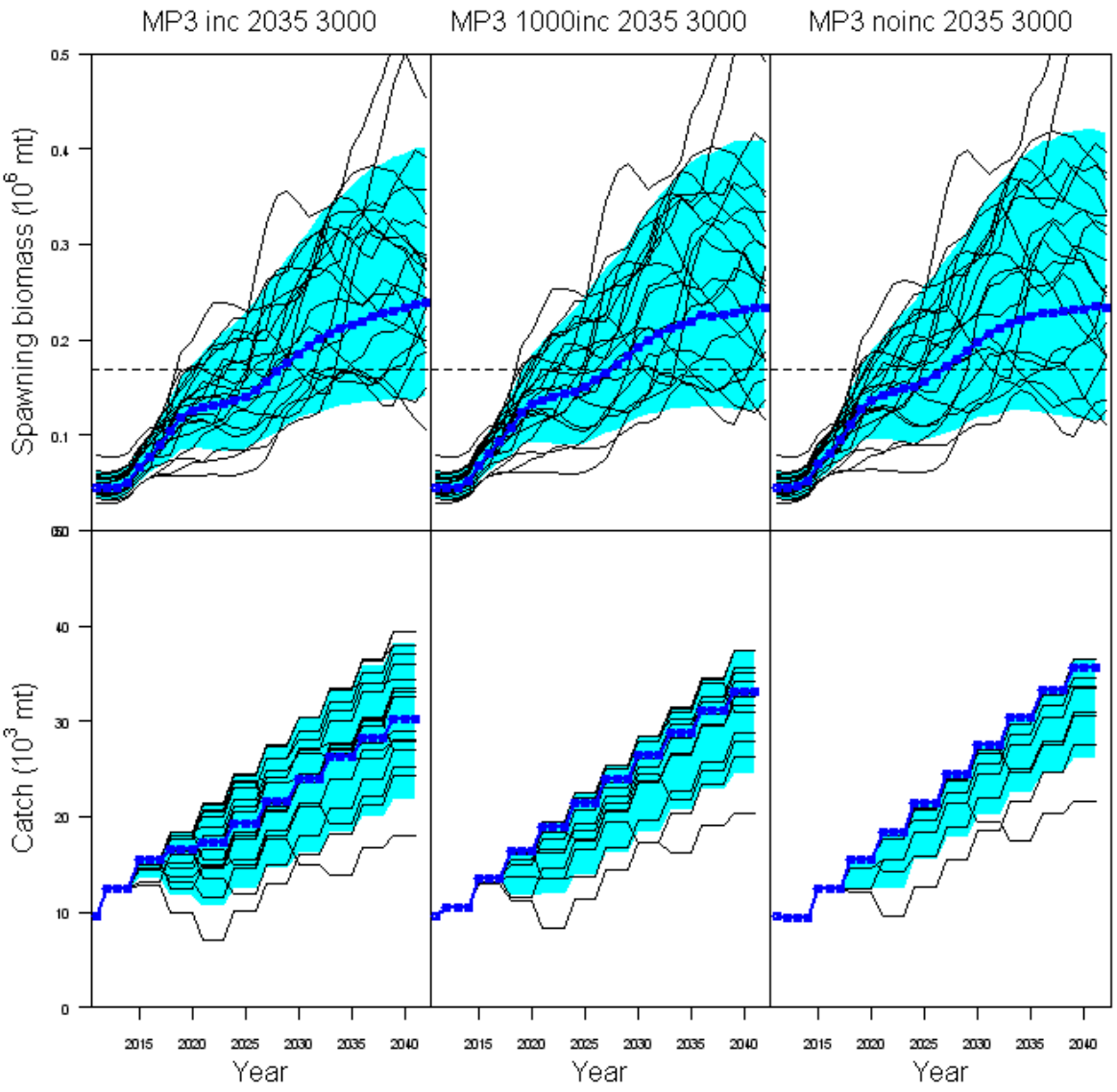


Figure 2: Worm plots (SSB and catch) for tuning year 2035, maximum change 5000t, and for the increase, 1000t increase and no increase in the first year scenarios.

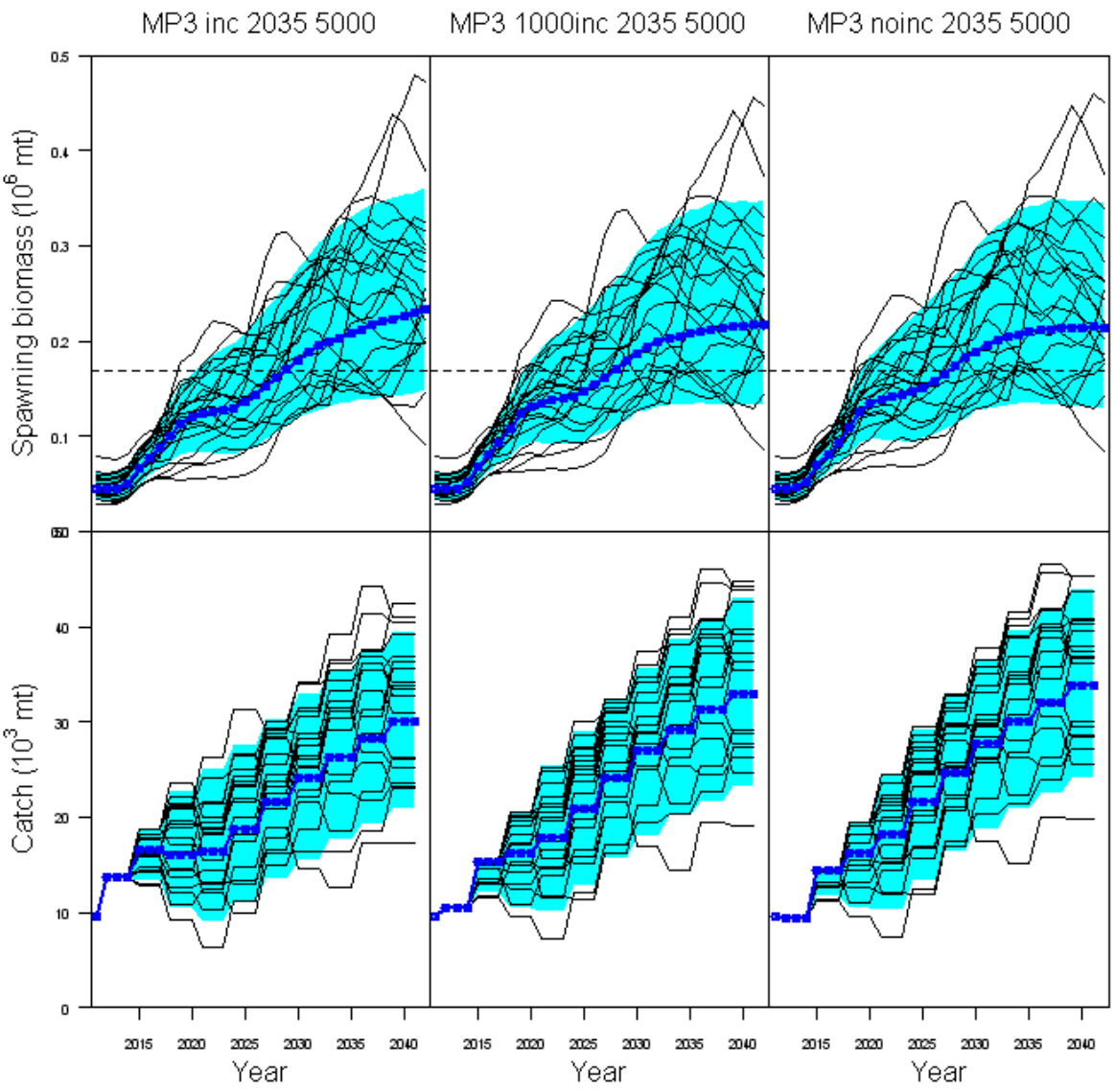


Figure 3: Worm plots (SSB and catch) for tuning year 2030, maximum change 3000t, and for the increase, 1000t increase and no increase in the first year scenarios.

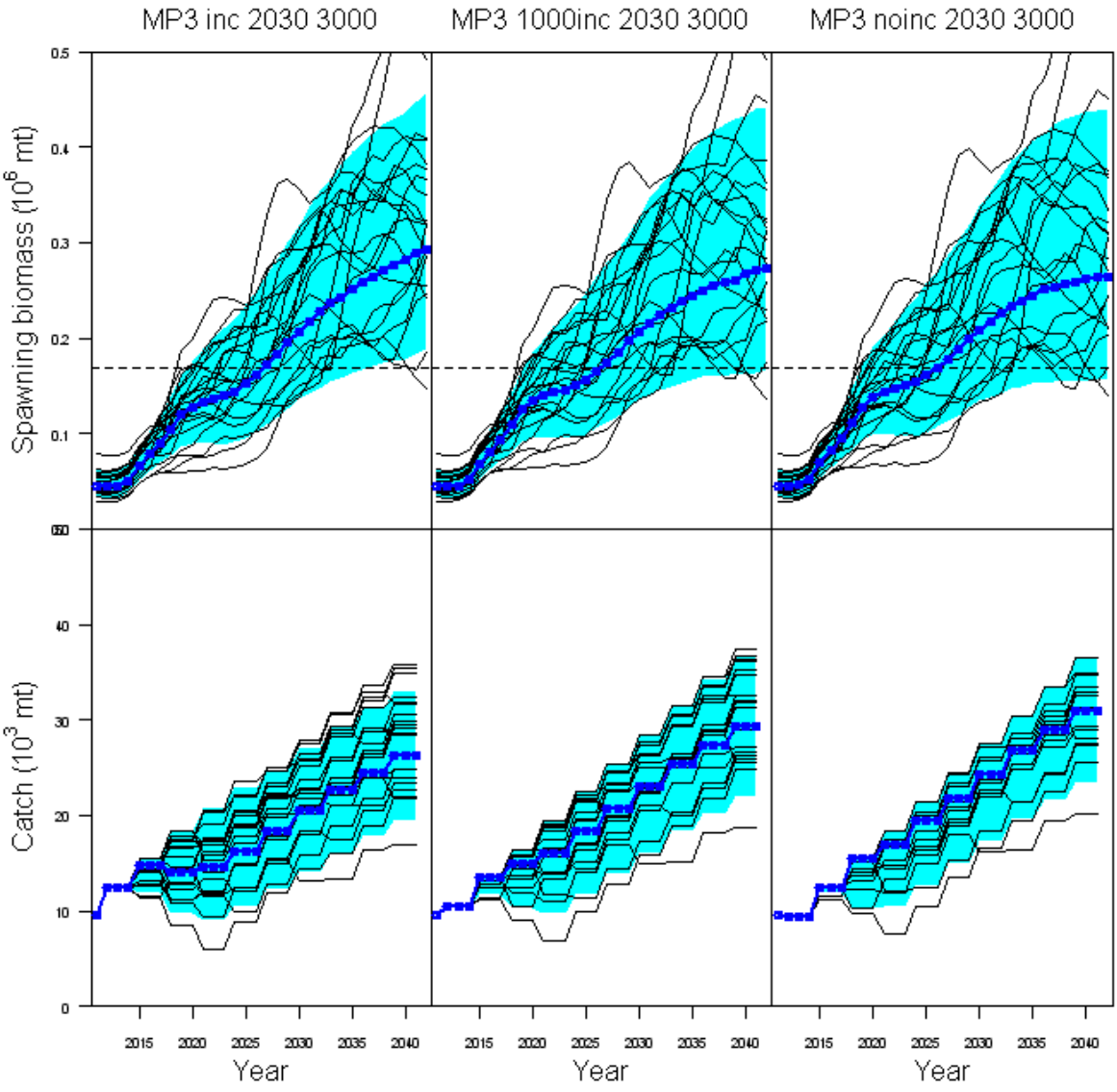
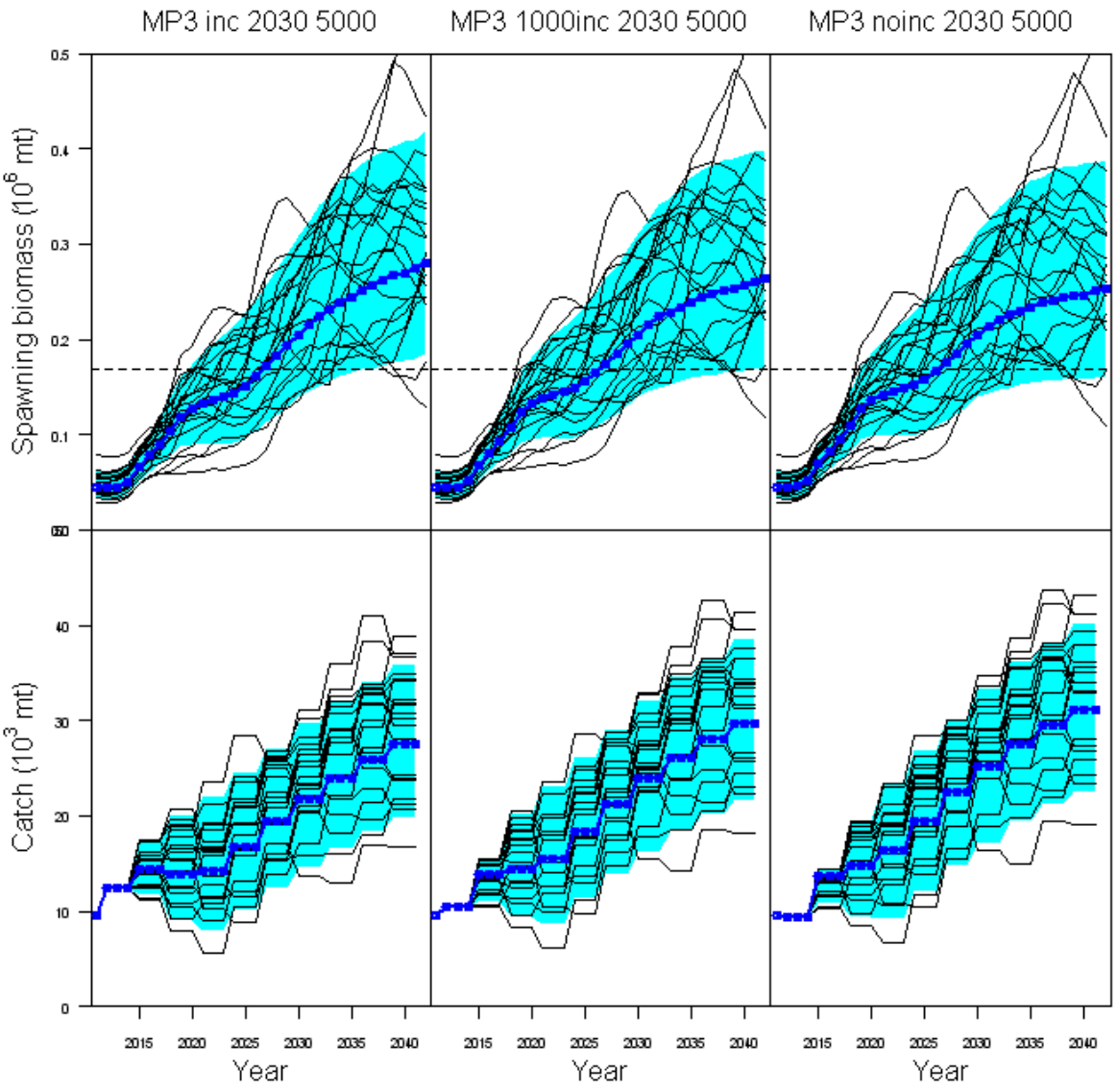


Figure 4: Worm plots (SSB and catch) for tuning year 2030, maximum change 5000t, and for the increase, 1000t increase and no increase in the first year scenarios.


MP3 inc 2030 5000
MP3 1000inc 2030 5000
MP3 noinc 2030 5000
Spawning biomass (10^6 mt)
Catch (10^3 mt)
Year
Year
Year

Attachment B

Figure 1: Summary statistics plot for tuning year 2035 across all the maximum change and first year increase scenarios.

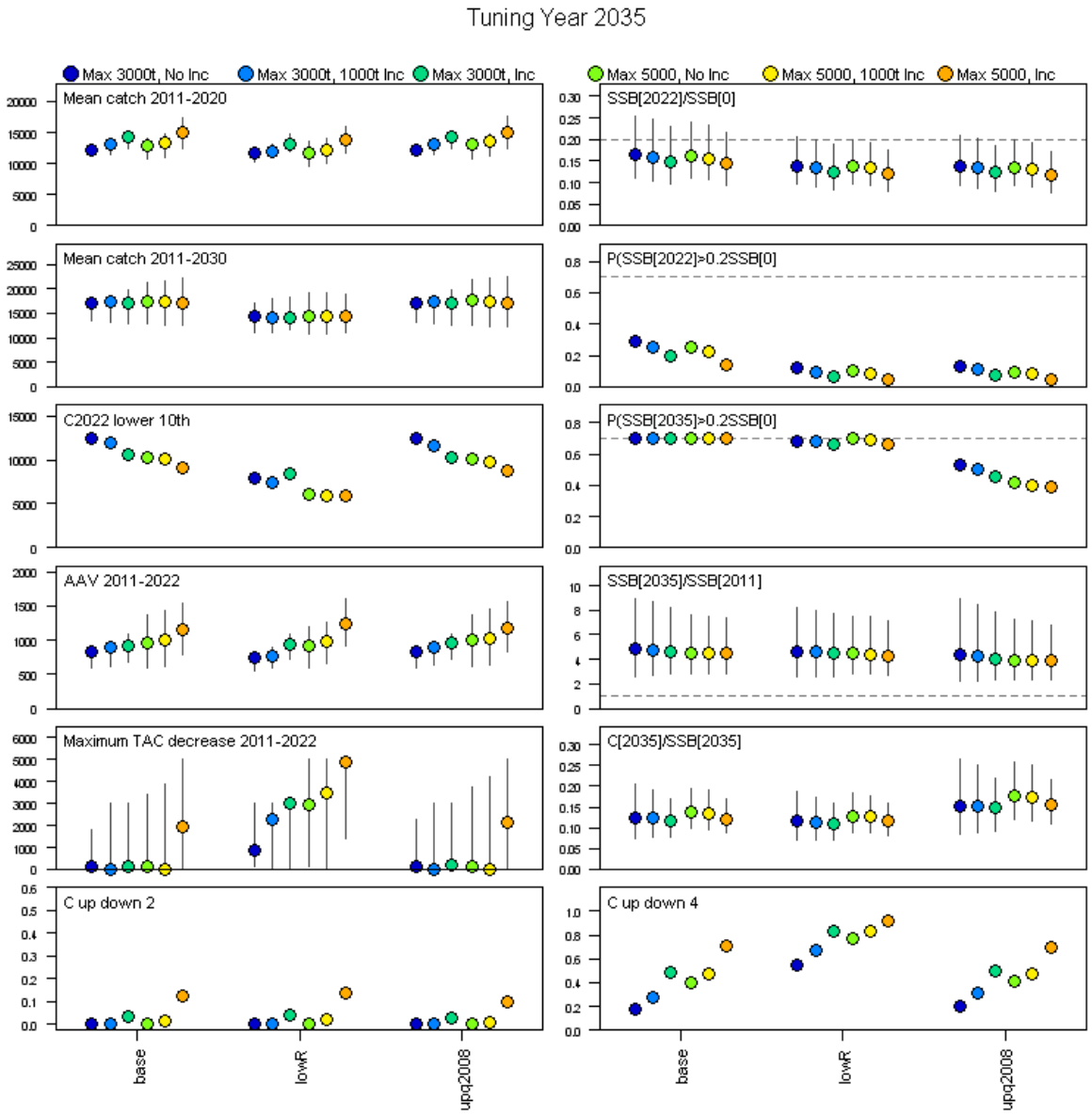
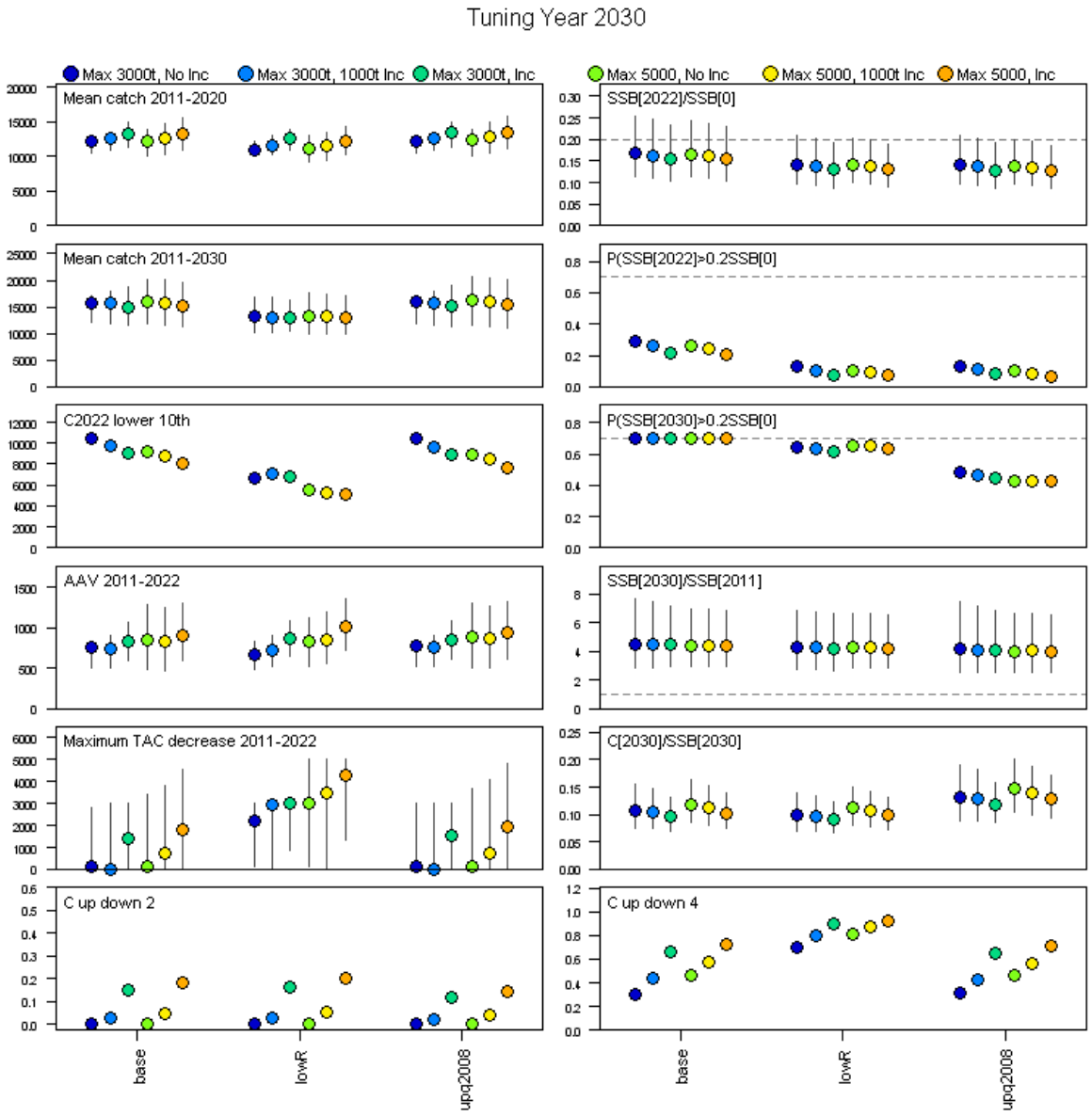


Figure 2: Summary statistics plot for tuning year 2030 across all the maximum change and first year increase scenarios.



Attachment C

Summary of Performance Statistics for 12 Variants of the Bali Procedure

Performance statistics are provided for the base model and key robustness trials (LowR and upq).

LowR represents 4 years (from 2011) where recruitment is 50% lower than predicted, uncorrelated with subsequent recruitments

upq represents a step function change in catchability (35% up between 2007 and 2008, unknown to the MP).

Legend

$B_{10th\%}$ Lower 10^{th} SSB percentile in year 2022
$C_{10th\%}$ Lower 10^{th} catch percentile in year 2022

Catch:

1) Proportion of occurrence that initial 2 changes up then down TAC (irrelevant for no increase)
2) Proportion of occurrence that initial 4 changes up then down TAC
3) Measure of TAC smoothness (through to tuning year)
4) Proportion of runs above the current catch at the tuning year

SSB:

5) Proportion of runs above the current biomass at the tuning year
6) Appearance that catch continues to increase while SSB stays low should be avoided (ratio of catch / SSB in 2030) a) lower 10^{th}, b) median, c) upper 90^{th}
7) SSB lower (10^{th}) percentile continuing to increase (no drop in period 2013-2035)

Base

Tuning Year	Max Incr	Max 1st Incr	$P[B_{2022} > 0.2B_0]$	$P[B_{2035} > 0.2B_0]$	$P[B_{2022} > 0.1B_0]$	$P[B_{2022} > 2B_{2011}]$	$\frac{B_{2022}}{B_{2011}}$	$\overline{C}_{2012-2022}$	$B_{10^{th}\%}$	$C_{10^{th}\%}$	Up then down 2x 1)	Up then down 4x 2)	TAC Smth 3)	C_{2030}/B_{2030} 10^{th} 6a)	C_{2030}/B_{2030} 50^{th} 6b)	C_{2030}/B_{2030} 90^{th} 6c)	P[B.↓] 7)
2035	3000	3000	19%	70%	89%	87%	2.76	15,200	84,800	10,600	4%	49%	0.24	0.09	0.12	0.18	0.14
2035	3000	1000	26%	70%	93%	92%	2.96	14,400	91,000	11,900	0%	28%	0.27	0.08	0.13	0.19	0.18
2035	3000	0	29%	70%	95%	93%	3.07	13,500	94,200	12,500	0%	18%	0.3	0.08	0.13	0.19	0.18
2035	5000	5000	14%	70%	86%	85%	2.65	15,600	81,700	9,100	12%	71%	0.44	0.09	0.13	0.18	0.14
2035	5000	1000	22%	70%	94%	93%	2.91	14,500	91,900	10,100	2%	48%	0.47	0.1	0.14	0.19	0.14
2035	5000	0	25%	70%	96%	94%	3.01	14,100	95,400	10,400	0%	40%	0.49	0.1	0.14	0.19	0.18
2030	3000	3000	21%	86%	92%	91%	2.88	13,800	90,100	9,100	15%	66%	0.28	0.07	0.1	0.13	0.09
2030	3000	1000	27%	83%	95%	93%	3.03	13,400	95,100	9,800	3%	44%	0.28	0.07	0.11	0.15	0.09
2030	3000	0	29%	82%	96%	95%	3.11	13,100	97,900	10,500	0%	30%	0.3	0.07	0.11	0.15	0.09
2030	5000	5000	20%	86%	93%	92%	2.89	13,800	90,600	8,000	18%	72%	0.47	0.07	0.1	0.14	0.05
2030	5000	1000	25%	84%	96%	94%	3.02	13,300	96,200	8,700	5%	57%	0.49	0.08	0.11	0.15	0.05
2030	5000	0	26%	82%	97%	95%	3.08	13,200	98,600	9,200	0%	46%	0.5	0.09	0.12	0.16	0.09

LowR

Tuning Year	Max Incr	Max 1st Incr	$P[B_{2022} > 0.2B_0]$	$P[B_{2035} > 0.2B_0]$	$P[B_{2022} > 0.1B_0]$	$P[B_{2022} > 2B_{2011}]$	$\frac{B_{2022}}{B_{2011}}$	$\overline{C}_{2012-2022}$	$B_{10^{th}\%}$	$C_{10^{th}\%}$	Up then down 2x 1)	Up then down 4x 2)	TAC Smth 3)	C_{2030}/B_{2030} 10^{th} 6a)	C_{2030}/B_{2030} 50^{th} 6b)	C_{2030}/B_{2030} 90^{th} 6c)	P[B.↓] 7)
2035	3000	3000	6%	66%	75%	69%	2.32	13,200	69,700	8,400	4%	83%	0.38	0.08	0.11	0.16	0.18
2035	3000	1000	10%	68%	82%	79%	2.50	12,400	77,200	7,500	1%	67%	0.4	0.08	0.12	0.17	0.18
2035	3000	0	12%	68%	87%	84%	2.58	12,300	81,400	8,000	0%	54%	0.36	0.08	0.12	0.18	0.23
2035	5000	5000	4%	66%	72%	65%	2.24	13,700	67,700	5,900	14%	92%	0.76	0.09	0.12	0.16	0.18
2035	5000	1000	8%	69%	85%	81%	2.50	12,300	79,600	6,000	2%	83%	0.75	0.09	0.13	0.17	0.23
2035	5000	0	10%	70%	88%	85%	2.58	11,800	82,900	6,100	0%	77%	0.75	0.09	0.13	0.18	0.23
2030	3000	3000	8%	80%	79%	75%	2.42	12,700	74,500	6,800	17%	90%	0.45	0.07	0.09	0.12	0.18
2030	3000	1000	10%	80%	86%	83%	2.57	11,600	80,500	7,100	3%	80%	0.45	0.07	0.1	0.13	0.18
2030	3000	0	13%	80%	89%	86%	2.65	11,200	83,800	6,700	0%	70%	0.45	0.07	0.1	0.14	0.18
2030	5000	5000	7%	82%	82%	78%	2.45	12,000	76,500	5,000	20%	92%	0.81	0.07	0.1	0.13	0.18
2030	5000	1000	10%	81%	88%	85%	2.58	11,400	82,600	5,300	6%	88%	0.8	0.08	0.11	0.14	0.18
2030	5000	0	11%	80%	91%	88%	2.65	11,200	85,600	5,500	0%	81%	0.79	0.08	0.11	0.15	0.18

upq

Tuning Year	Max Incr	Max 1st Incr	$P[B_{2022} > 0.2B_0]$	$P[B_{2035} > 0.2B_0]$	$P[B_{2022} > 0.1B_0]$	$P[B_{2022} > 2B_{2011}]$	$\frac{B_{2022}}{B_{2011}}$	$\overline{C}_{2012-2022}$	$B_{10^{th}\%}$	$C_{10^{th}\%}$	Up then down 2x 1)	Up then down 4x 2)	TAC Smth 3)	C_{2030}/B_{2030} 10^{th} 6a)	C_{2030}/B_{2030} 50^{th} 6b)	C_{2030}/B_{2030} 90^{th} 6c)	P[B.↓] 7)
2035	3000	3000	8%	45%	74%	79%	2.58	15,300	70,100	10,400	3%	50%	0.25	0.10	0.15	0.22	0.23
2035	3000	1000	11%	51%	81%	87%	2.80	14,500	76,400	11,600	0%	31%	0.27	0.10	0.15	0.23	0.32
2035	3000	0	13%	53%	85%	89%	2.93	13,500	79,800	12,400	0%	20%	0.30	0.09	0.15	0.24	0.27
2035	5000	5000	5%	39%	68%	75%	2.43	15,800	67,100	8,700	10%	70%	0.45	0.11	0.16	0.22	0.18
2035	5000	1000	8%	40%	81%	87%	2.73	14,700	77,500	9,700	1%	48%	0.48	0.12	0.17	0.24	0.32
2035	5000	0	10%	42%	85%	90%	2.84	14,400	80,900	10,100	0%	41%	0.49	0.12	0.17	0.24	0.32
2030	3000	3000	8%	65%	79%	85%	2.71	13,900	74,900	8,900	12%	65%	0.28	0.08	0.12	0.16	0.14
2030	3000	1000	11%	61%	84%	90%	2.87	13,500	80,700	9,600	2%	42%	0.28	0.09	0.13	0.18	0.23
2030	3000	0	13%	62%	87%	92%	2.98	13,200	83,100	10,400	0%	32%	0.30	0.09	0.13	0.19	0.18
2030	5000	5000	6%	62%	80%	86%	2.70	13,900	76,100	7,700	15%	72%	0.48	0.09	0.13	0.17	0.14
2030	5000	1000	9%	59%	85%	91%	2.86	13,600	81,500	8,500	4%	56%	0.49	0.10	0.14	0.19	0.09
2030	5000	0	10%	55%	87%	92%	2.93	13,400	84,200	9,000	0%	47%	0.51	0.10	0.15	0.20	0.14

Attachment D

Constant Catch Projections

The median constant catch projection under the current TAC (of 9449 t) for the base case show the interim rebuilding target of 0.2 SSB_0 being reached in 2024, and for the zero TAC case it is reached in 2020 (Figure 1).

The faster than previously projected recovery of the future SSB is largely driven by the higher estimates of recruitment, CPUE and steepness.

Constant catch projections make no allowance for future conditions such as poor recruitments, and hence the **ESC strongly recommends the adoption of an adaptive MP** to properly deal with such circumstances.

Figure 1: Median recruitment (top) and spawning stock biomass (bottom) projections under a constant catch equal to the current (red) TAC (9449 t) and zero (blue) TAC. Median recruitments beyond 2010 are estimated using the model stock - recruitment relationship and assume that this relationship holds for future levels of spawning stock biomass. Consequently, estimates of the future recruitment are more uncertain.