

## Inaccessible CMP results

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### Summary

This document provides results for new OMP candidates to be considered in the development of a revised OMP for the Tristan rock lobster fishery at Inaccessible island. These OMPs take into account both the commercial CPUE and the biomass survey data in the TAC setting formula. A choice of  $I_{tar}=5.0$  kg/trap remains the preferred choice for this revised OMP for Inaccessible.

### Introduction

An OMP was first developed and agreed upon for Inaccessible island in 2014, and used to set the TAC for *Jasus tristani* at this island for the first time in that season and again for the following 2015-2017 seasons<sup>1</sup>. Johnston and Butterworth (2014) provides details of this OMP. The Inaccessible OMP was updated in 2018 (Johnston and Butterworth 2018). Both these OMPs were target-based, with the TAC setting formulae having the form:

$$TAC_{y+1} = TAC_y + \alpha(I_y^{rec} - I^{tar}) \quad (1)$$

where

- $I_y^{rec}$  is the average of the GLMM standardized CPUE over the last three seasons ( $y-2$ ,  $y-1$ ,  $y$ ),
- $I^{tar}$  is the CPUE target (OMP-2018  $I^{tar} = 5.0$  kg/trap and OMP-2014  $I^{tar} = 4.0$  kg/trap ),
- and
- $\alpha$  is the tuning parameter (OMP-2018 value =2.5).

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<sup>1</sup> The split season is referenced by the first year, i.e. 2015 refers to the 2015/16 season

A rule to control the inter-season TAC variation was also applied. Normally the percentage TAC change relative to the previous season for the OMPs for the lobster fisheries at the Tristan group of islands has been restricted to a maximum of either up 5% down 5%, i.e.:

$$\text{If } TAC_{y+1} < 0.95TAC_y \quad \text{then } TAC_{y+1} = 0.95TAC_y$$

$$\text{If } TAC_{y+1} > 1.05TAC_y \quad \text{then } TAC_{y+1} = 1.05TAC_y$$

However, in addition, an Exceptional Circumstances metarule for Inaccessible (as for the other islands) was to be applied under certain circumstances, where the 5% TAC decrease constraint could be widened to as much as 20% if the (catch rate) index dropped below a threshold level. This metarule allows for the TAC to be reduced further than the usual inter-annual maximum 5% decrease, as shown in Figure 1. For the Inaccessible OMP 2018 the Ilim value was set at 3.0 kg/trap.

Since the updated Inaccessible assessment reported in MARAM/TRISTAN/2021/MAY/05 updates to the commercial CPUE and Catch information for the 2020 season have become available. This information is used in the OMP predictions reported here.

#### **Candidate OMPs (CMPs) considered here**

Three CMPs are considered here:

- 1) CMP1: This is identical to current OMP-2018 (Itar=5.0 kg/trap), except that now biomass survey data are also included in the inputs.
- 2) CMP2: Same as CMP1 but Itar=4.5 kg/trap.
- 3) CMP3: Same as CMP1 but Itar=4.0 kg/trap.

Note that as there was a 1.2 MT overcatch in the 2020 season, the model assumes that the actual catch allowed for 2021 will be the TAC less than 1.2 mt.

The CMPs reported here include both the commercial CPUE and biomass survey data as input into the OMP. As for the other islands, the biomass survey data receive less weight than the commercial CPUE data.

#### **Summary statistics**

A number of summary statistics have been developed in order to compare the trade-offs and performances of alternate revised CMPs. Again, these are very similar to those used for the previous selection of prior OMPs.

- CR(2032) = catch rate expected in 2032 (in kg/gear/hour) in terms of the standardised GLMM.

- $CR(2022)$  = catch rate expected in 2022 (in kg/gear/hour) in terms of the standardised GLMM.
- $TAC(2021)$  = the TAC for the 2021 season.
- $C_{ave\ 5}$  = average annual catch (in MT) over the next 5 years (2021-2025).
- $C_{ave\ 10}$  = average annual catch (in MT) over the next 10 years (2021-2030).
- The  $Bsp(2033)/K$  = the spawning biomass at the start of 2033 relative to the pristine level ( $K$ ).  
The median and lower 5%ile values are reported.

Each candidate CMP has been run for 100 simulations. The medians, and the 5<sup>th</sup> and 95<sup>th</sup> percentiles, of various management quantities of interest are reported.

### Addition of survey data

It is clearly desirable, now that biomass survey indices in conjunction with the standard CPUE index have been available for some time, to include not only the commercial CPUE as input into the TAC-setting equation, but also the biomass survey index. The current Tristan OMP and new Gough OMPs take into account not only commercial CPUE, but also the Edinburgh/Geo searcher CPUE (in the case of Tristan) and the biomass survey indices. To repeat this for Inaccessible, the following steps have been taken (similarly to those for Tristan and Gough):

STEP 1: Rescale the biomass survey series such that the average survey 2010-2012 values equal the average commercial CPUE 2010-2012 values (and both series have units of kg/trap). Figure 1b provides plots of these series.

STEP 2: Calculate the  $I_y^{rec}$  value for each series ( $I_y^{rec,comm}$  and  $I_y^{rec,survey}$ ) as the average of the values over the last three years ( $y-2, y-1, y$ ).

STEP 3: Calculate a combined  $J_y^{rec}$  from using both of the  $I_y^{rec}$  values.

$$J_y^{rec} = \frac{w_1 I_y^{rec,comm} + w_2 I_y^{rec,survey}}{w_1 + w_2}, \text{ i.e. uses commercial CPUE and biomass survey index}$$

where the weights  $w_1$  and  $w_2$  are the inverse variances of the residuals from the updated RC fits to these data in the underlying assessments, so that:

$$\begin{aligned} w_1 &= \frac{1}{\sigma_{comm}^2} = \frac{1}{0.185^2} = \mathbf{29} \\ w_2 &= \frac{1}{\sigma_{survey}^2} = \frac{1}{0.251^2} = \mathbf{16} \end{aligned} \quad (1)$$

(effectively then, the ratio of weight given to the commercial CPUE data and biomass survey indices is about 1:0.55).

STEP4: Calculate the TAC.

$$TAC_{y+1} = TAC_y + \alpha(J_y^{rec} - I_{tar}) \quad (2)$$

where  $I_{tar}$  and  $\alpha$  are control parameters whose values are to be selected.

Figure 2 shows the OMP-2018 catch rate predictions (for 2018+): medians with 5<sup>th</sup> and 95<sup>th</sup> percentiles are shown. The 2018-2020 actual CPUE values are shown as red squares.

Tables 2 and 3 report the summary statistics results of the three CMP candidates. Figure 3 compares the Catch, Bsp/K and CR trajectories for the three CMP candidates.

### Stochastic results

In recent documentation, only the median trajectories of Bsp/K, catch and CR (catch rate) have been presented. This document now presents the 5<sup>th</sup> and 95<sup>th</sup> percentile trajectories in order to assess the level of uncertainty (and hence also the resource conservation risk) associated with these results. Stochastic results are presented for the VAR5.5 kg/trap CMP. Figure 4 shows plots of these stochastic trajectories for VAR5.5.

### Robustness tests

A series of robustness models are then run to explore the robustness of CMP1 (Itar=5.0 kg/trap) to these uncertainties. These are:

ROB1:  $h$  prior mean = 0.90

ROB2:  $h$  prior mean = 0.80

ROB3a:  $h$  prior mean = 0.70

ROB3b:  $h$  prior mean = 0.50

ROB4a:  $M=0.1$

ROB4b:  $M=0.3$

ROB5:  $d = 0.2$

ROB6:  $F(2009)=0.4$

ROB7:  $F(2009)=0.5$

ROB8: No once-off mortality of lobsters aged 1,2, and 3 years during the 2011 due to OLIVA event.

The model fits for each of these robustness tests can be found in MARAM/TRISTAN/2021/MAY/05.

Figure 5 compares the expected results of the application of CMP1 (Itar=5) for a range of ten robustness tests. Figure 6 shows the expected TAC and Bsp/K trajectories for CMP1 for the RC and ten different robustness tests.

## Discussion

Table 2 reports comparisons of **Inaccessible** candidate OMPs expected performance results. All statistics reported below are median values unless otherwise stated. The OMP-2014 and OMP-2018 performance results as evaluated in 2014 and 2018 respectively are given in the two top rows. Figure 2 shows the catch, Bsp/K and catch rate (CR) trajectories for each of the CMPs considered here. Table 3 reports the predicted median TAC values (MT) for the first 10 seasons (2021-2030) for the different CMPs. Some summary points:

- Expected TAC(2021) values range from 101-104 MT for the three CMPs considered. Similar CMPs for which only the commercial CPUE is used as input result in slightly more optimistic TAC values (as the survey data do not show a recent increasing trend in CPUE, at least to the same extent as the commercial data do).
- All the CMPs considered will result in Bsp/K(2033) median values of 0.87 and larger, and the lower 5<sup>th</sup> percentile values are 0.54 and larger; these lower percentile values are all slightly larger than calculated for OMP-2018 at the time this was accepted (i.e. these new CMPs have lower resource risks than was the case for OMP-2018).
- Expected catch rates are expected to have stabilised to between 4.90-5.30 kg/trap by the time of the 2032 season, though actual annual values could vary in the range of about 3-11 kg/trap.

Figure 3 shows the OMP-2018 TAC (or catch) and catch rate predictions (for 2018+) (medians with 5<sup>th</sup> and 95<sup>th</sup> percentiles are shown). The 2018-2020 actual Catch and CPUE values are shown as red squares on the same plot; it is clear that the 2018 and 2019 CPUE values are within the range predicted by the 2018 assessment, whilst the most recent 2020 CPUE value is well above the range forecast. The 2021 updated assessment was not however fit to this high 2020 CPUE value as the GLM standardised analysis of the CPUE data was not completed at the time that assessment was conducted. This is positive in suggesting that the actual situation is better still than these results indicate.

CMP1 performs well for all ten robustness trials, producing median Bsp(2032/K) values of at least 0.80 (and above 0.50 at the lower 5<sup>th</sup> percentile).

It is recommended that CMP1 (Itar=5 kg/trap) would be a suitable new OMP for Inaccessible island.

## References

- Johnston, S.J. and Butterworth, D.S. 2014. Initial OMP candidates for the Inaccessible and Gough rock lobster fisheries. MARAM document, MARAM/Tristan/2014/FEB/03.
- Johnston, S.J. and Butterworth, D.S. 2018. Initial updated 2018 OMPs for the Inaccessible and Gough islands. MARAM document, MARAM/Tristan/2018/JUL/09.

Table 1: Candidate OMPs (CMPs) presented here.

<b>CMP1</b> (ompi21.tpl)	ltar= <b>5.0</b> kg/trap As for OMP-2018
<b>CMP2</b> (ompi21.tpl)	ltar= <b>4.5</b> kg/trap
<b>CMP2</b> (ompi21.tpl)	ltar= <b>4.0</b> kg/trap

Table 2: Comparison of the expected performance results for **Inaccessible** candidate OMPs. All statistics reported below are median values unless otherwise stated. The OMP-2014 and OMP-2018 performance results, as evaluated in 2014 and 2018 respectively, are given in the two top rows.

CMP	$I^{tar}$ (kg/trap)	$\alpha$	Inter-annual max TAC constraint	l <sub>lim</sub> value (kg/trap)	CR(2022) (kg/trap)	CR(2032) (kg/trap)	TAC(2021) (MT)	C <sub>ave</sub> 5 (MT)	C <sub>ave</sub> 10 (MT)	Lower 5%ile C <sub>ave</sub> 10	Median and Lower 5%ile Bsp(2033/K)
OMP-2014 <sup>#</sup>	4.0	2.5	+5%,-5 to -20%	4.0	5.62	4.51	-	-	84	78	0.91 (0.56)
OMP-2018 <sup>#</sup>	5.0	2.5	+5%,-5 to -20%	3.0	5.96	4.75	104	-	110	107	0.86 (0.51)
<b>CMP1</b> I <sub>tar</sub> =5.0	<b>5.0</b>	2.5	+5%,-5 to -20%	3.0	6.02	5.29	101	105	109	102	0.88 (0.55)
<b>CMP2</b> I <sub>tar</sub> =4.5	<b>4.5</b>	2.5	+5%,-5 to -20%	3.0	6.00	5.10	102	109	125	109	0.88 (0.54)
<b>CMP3</b> I <sub>tar</sub> =4.0	<b>4.0</b>	2.5	+5%,-5 to -20%	3.0	6.00	4.92	104	112	122	125	0.87 (0.54)

# as evaluated in 2014 and 2018 respectively

Table 3: Predicted median TAC values (MT) for the first 10 seasons (2021-2030) for the different CMPs.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<b>CMP1</b> I <sub>tar</sub> =5.0	101	103	106	107	108	109	111	112	113	114
<b>CMP2</b> I <sub>tar</sub> =4.5	102	106	110	112	114	116	119	122	123	124
<b>CMP3</b> I <sub>tar</sub> =4.0	104	108	113	117	120	122	127	130	133	137

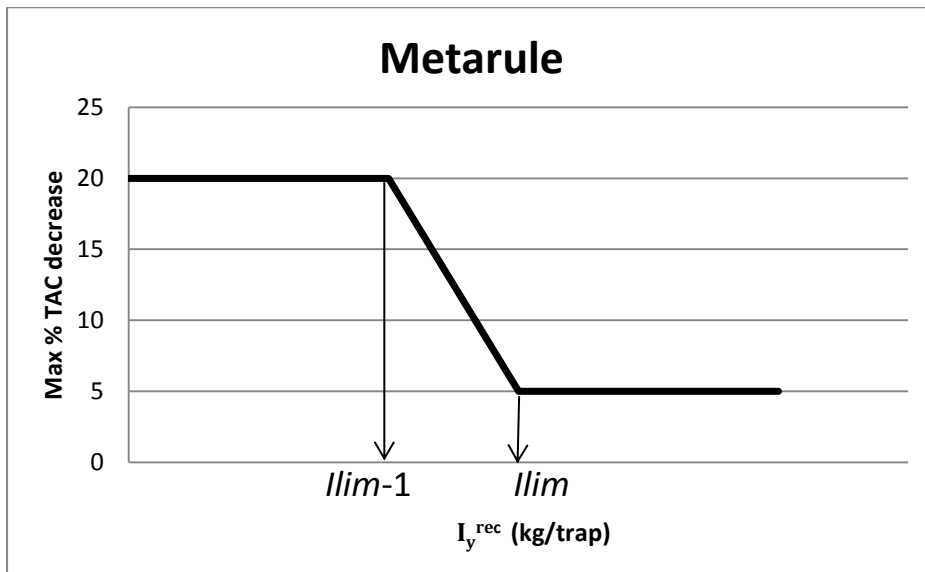


Figure 1a: The metarule used as part of the CMPs.

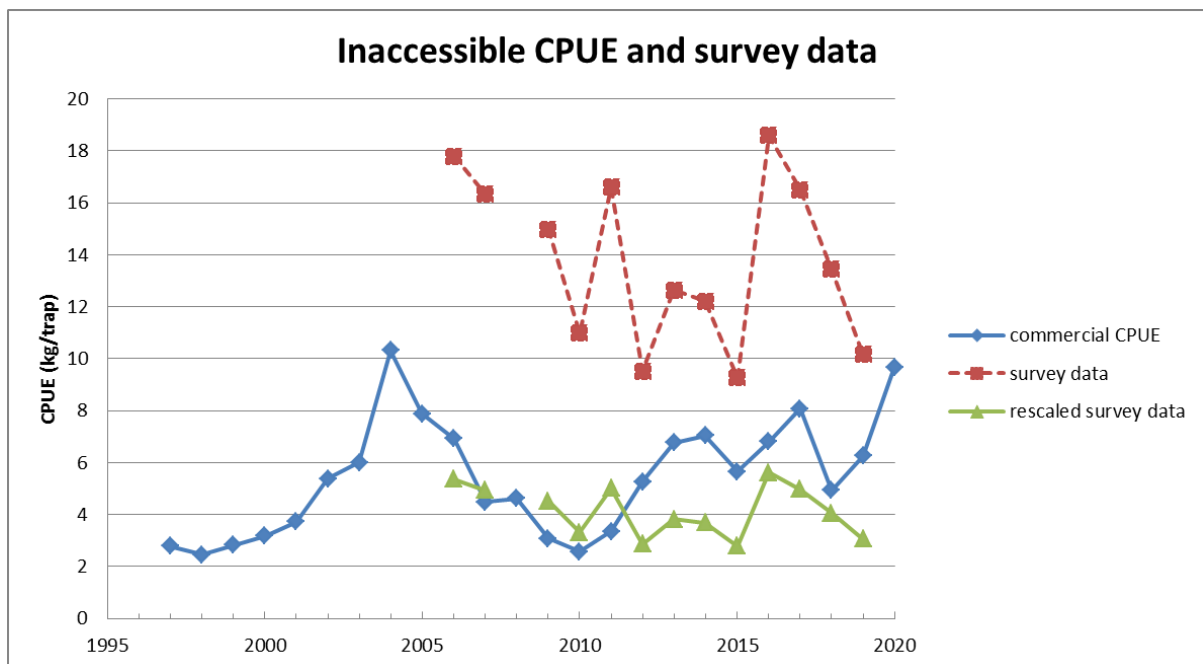


Figure 1b: The commercial CPUE data (blue), and the rescaled biomass survey data (green – original in red) used as input to the OMP.



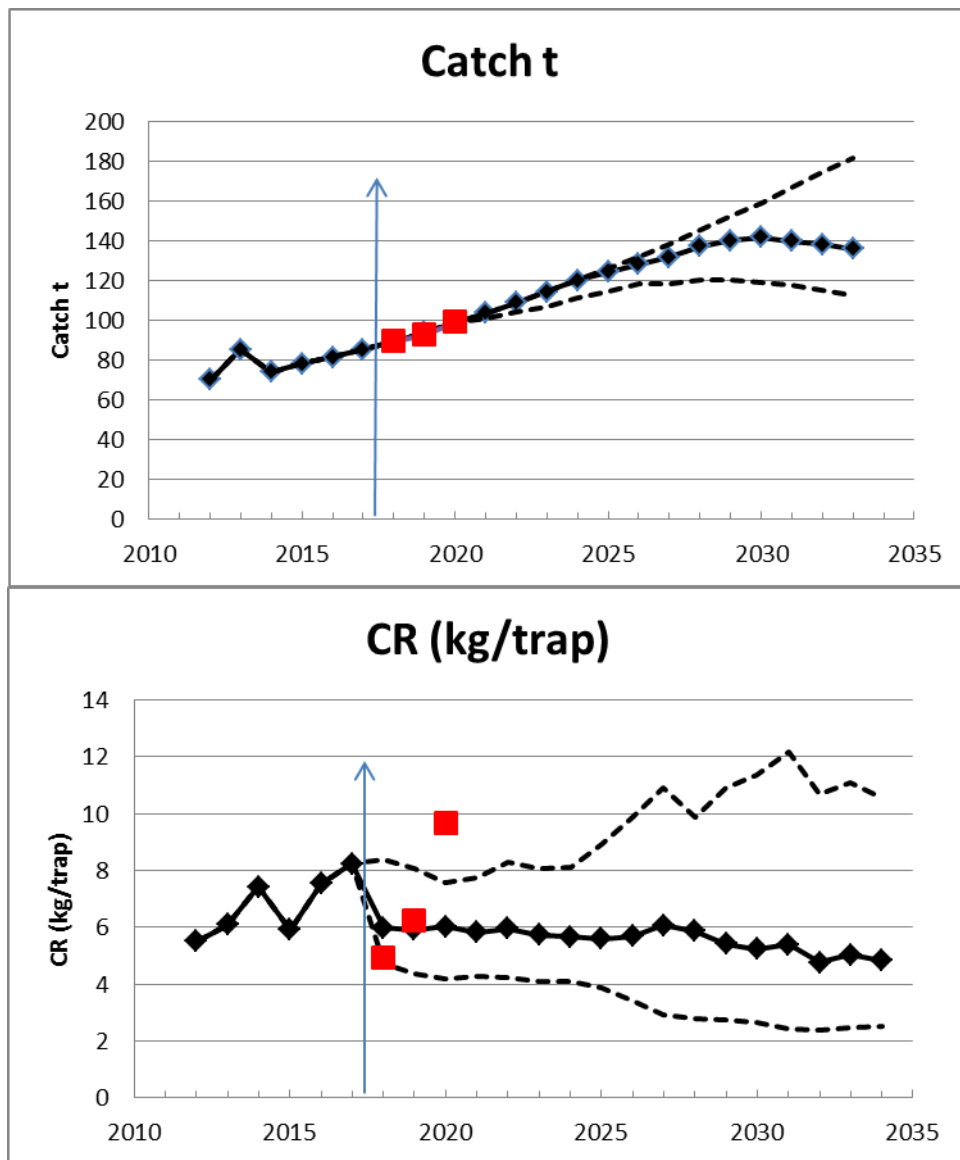


Figure 2: OMP-2018 TAC (or catch) and catch rate predictions (for 2018+) as provided in 2018: medians with 5<sup>th</sup> and 95<sup>th</sup> percentiles are shown. The subsequent 2018-2020 actual catches and CPUE values are shown as red squares.

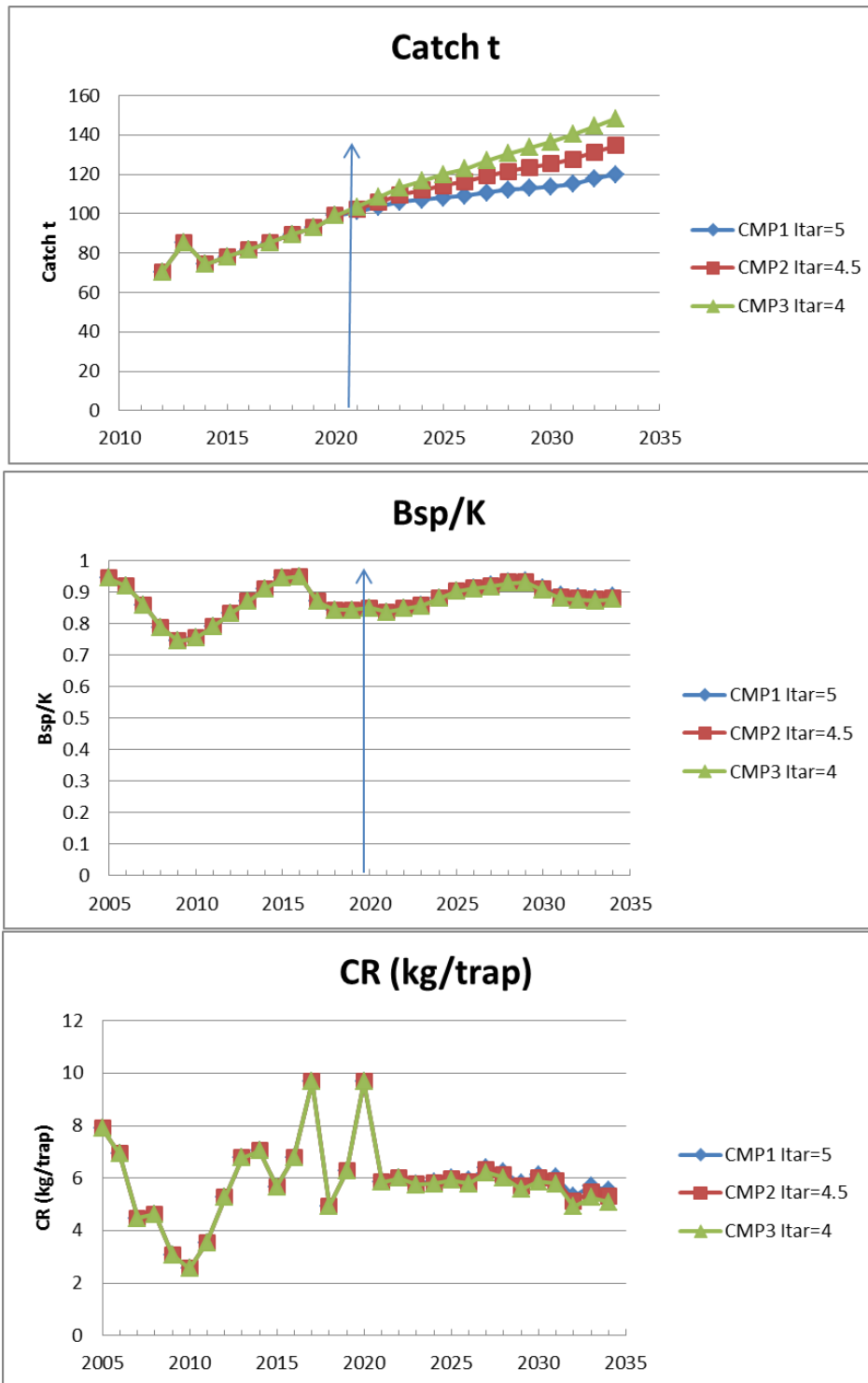


Figure 3: The Catch (MT), Bsp/K and catch rate (kg/trap) trajectories for each of the three CMPs.

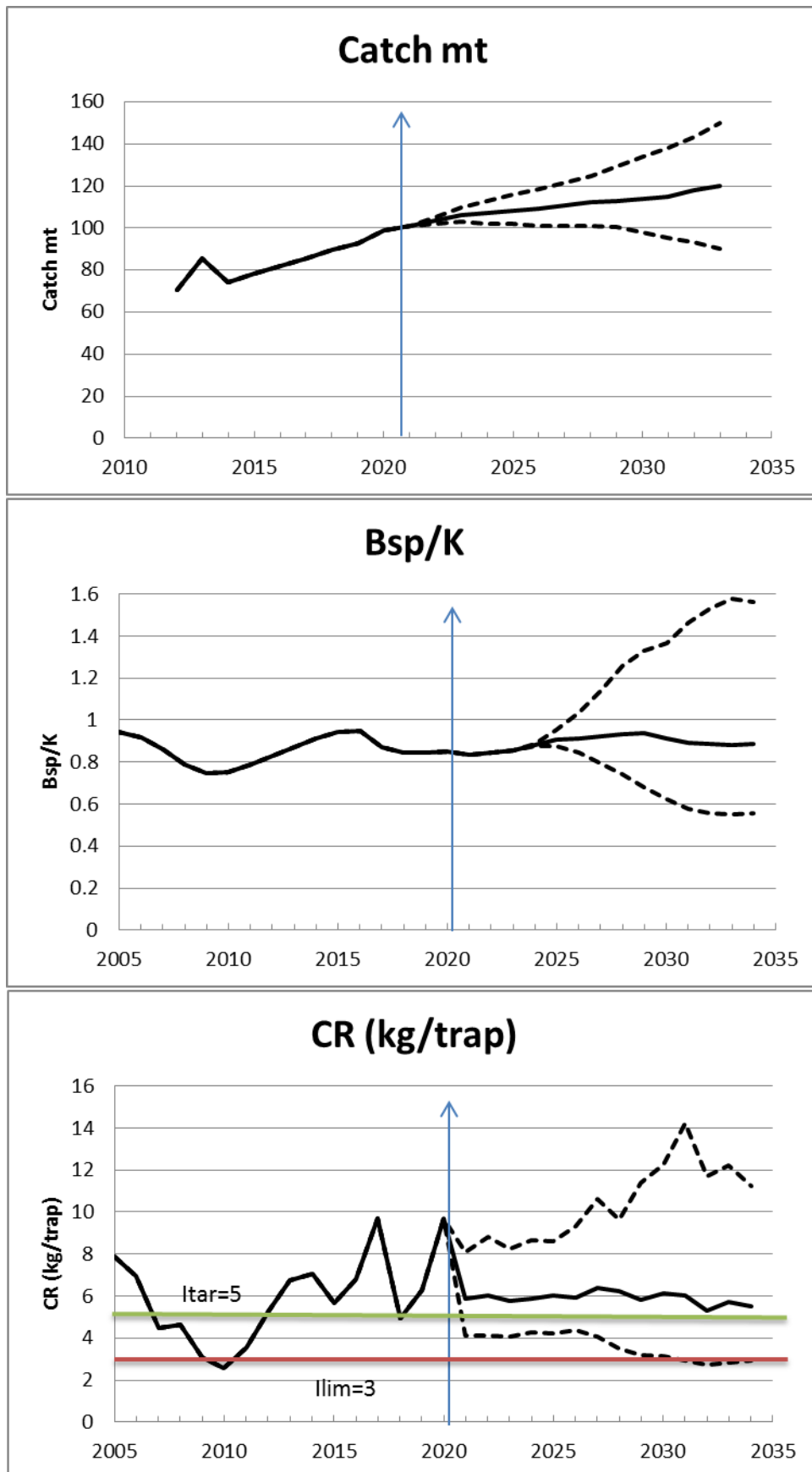


Figure 4: Stochastic trajectories for CMP1 ( $I_{tar}=5$ ). The solid line is the median, with the dashed lines representing the 5<sup>th</sup> and 95<sup>th</sup> percentiles.

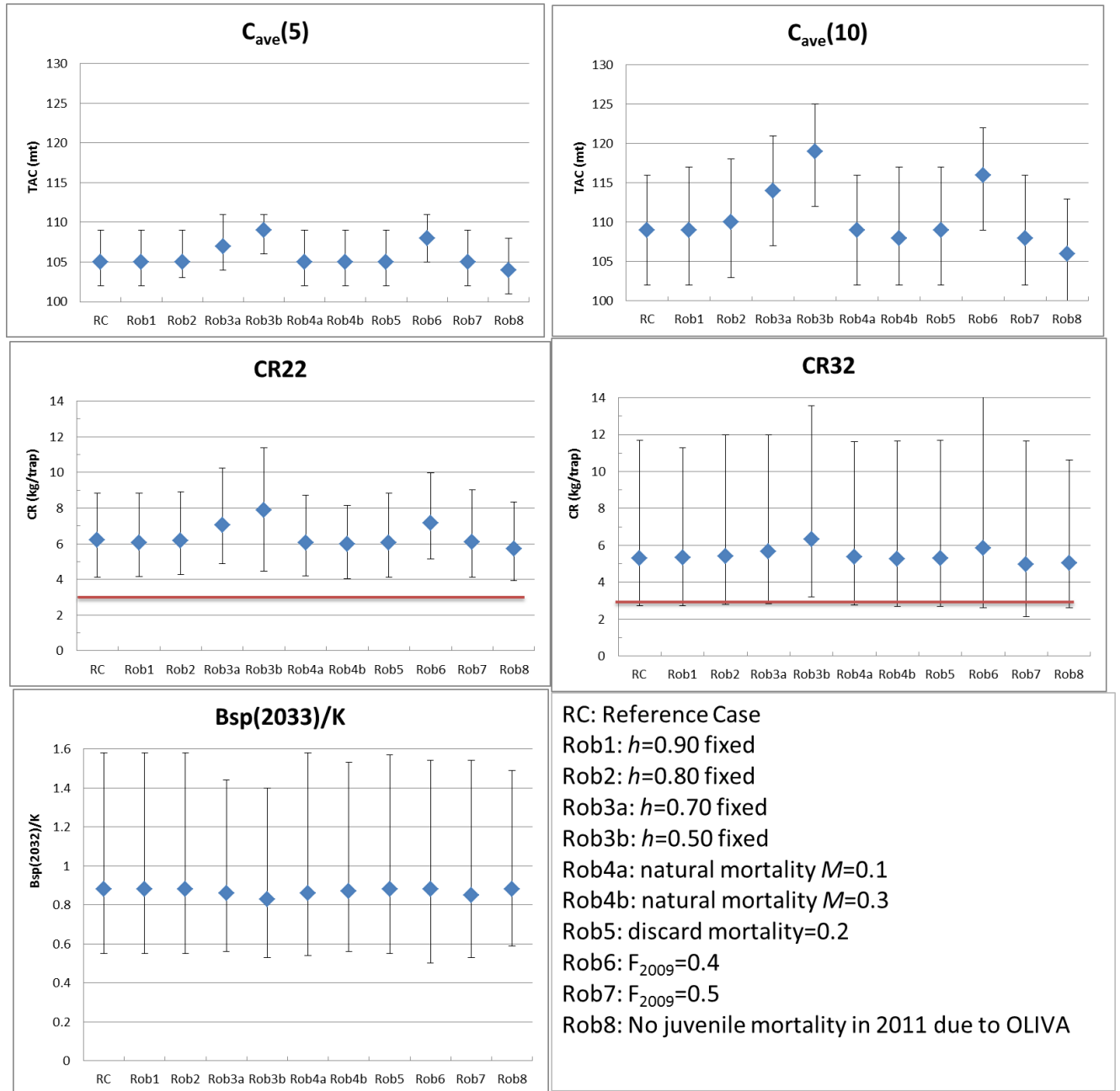


Figure 5: Robustness performance plots for CMP1 (Itar=5). The icons represent the median values, with the vertical bars showing the 5<sup>th</sup> and 95<sup>th</sup> percentiles.

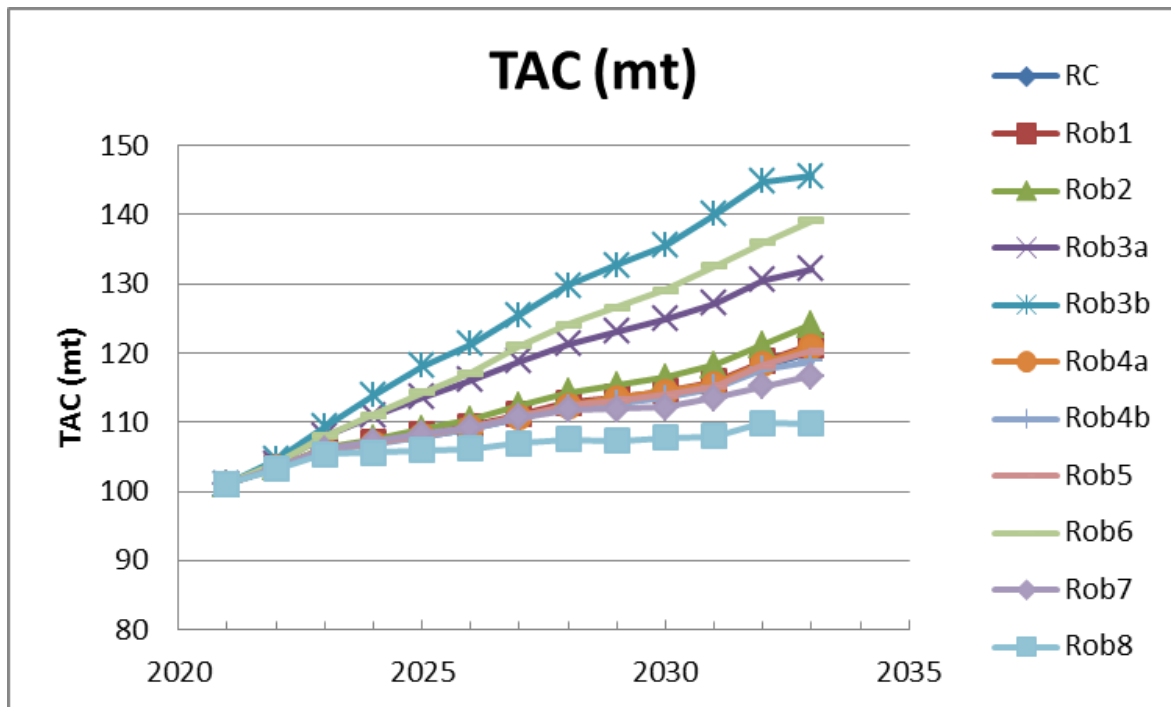


Figure 6: The expected TAC trajectories for CMP1 for the RC and ten different robustness tests.