Initial Results in the Development of a new OMP 2016 for Tristan da Cunha island rock lobster

S.J. Johnston and D.S. Butterworth

MARAM

Department of Mathematics and Applied Mathematics

University of Cape Town

An OMP for setting the TAC for the rock lobster fishery at Tristan da Cunha island was developed and implemented in 2013 (Johnston and Butterworth 2013). The operating model (i.e. the underlying stock assessment model used to simulation test the candidate OMPs) at the time was fitted to GLM standardized CPUE for the period 1994-2012. This OM (OM-2013) predicted catch rates for the fishery into the future (2013+) for the final selected OMP (OMP 2013).

Recently, an updated GLM CPUE analysis (Johnston and Butterworth 2016) has provided updated GLM standardised CPUE values for 2013 and 2014 (which are outside the 90% CI predicted by OM-2013 – see MARAM/TRISTAN/2015/OCT/12). Table 1 and Figure 1 (top plot) of MARAM/TRISTAN/2015/OCT/12 report this mis-match. This constitutes “Exceptional Circumstances”, and requires initiation of a revision of OMP 2013.

To initiate this process, results of a new OMP (OMP 2016) and variants thereof are reported here for the OM (developed recently in 2016), which fits to the powerboat GLM standardized CPUE data which have been rescaled to allow for changes in fishing efficiency over recent times. The CPUE analyses are described fully in MARAM/TRISTAN/2016/MAR/05, and the most recent updated assessment model as described in MARAM/Tristan/2016/FEB/01 is used.

A range of OMPs are assessed here to set the TACs for the 2016+ period and project the resource dynamics forwards. Note that the TAC of 120 tons for 2015 is assumed to be the catch for the 2015 season.

OMP 2016

The OMP is again a target-based rule based on the recent commercial CPUE, *viz.*

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

where

I_y^{rec} is the average of the GLM standardized CPUE over the last three years (*y*-2, *y*-1,*y*),

I^{tar} is the CPUE target index of either

- The **Baseline** three-year average GLM standardised 2010-2012 CPUE = 1.257
- An alternate which is the three-year average GLM standardised 2012-2014 CPUE=1.007.

$\alpha = 25$

A rule to control the inter-annual TAC variation is also applied. The % TAC change relative to the previous year is restricted to a maximum of either 5% up or 5% down, i.e.:

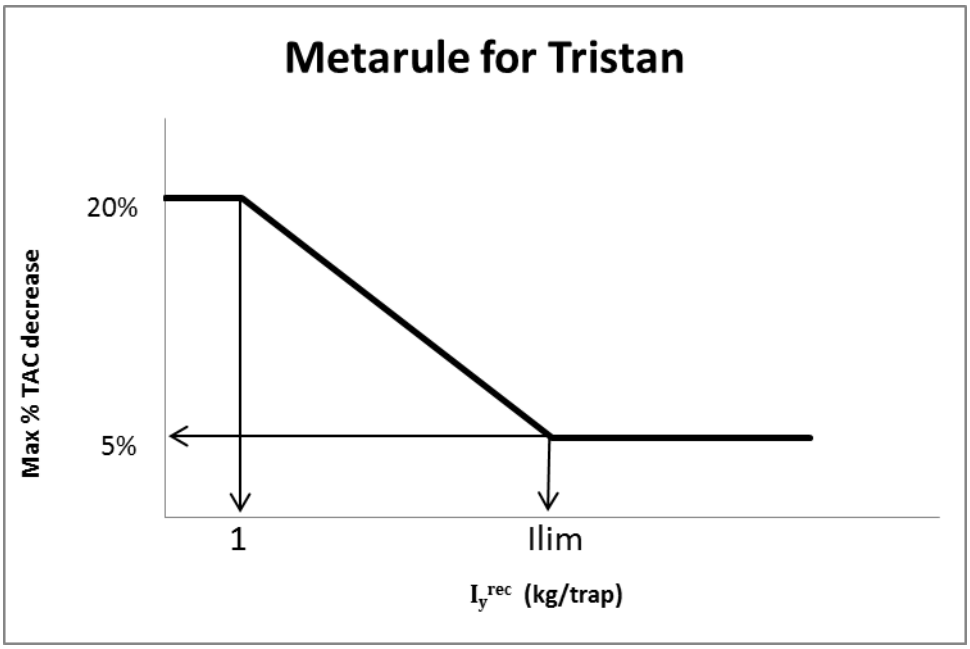
If $TAC_{y+1} < 0.95TAC_y$ then $TAC_{y+1} = 0.95TAC_y$ (2)

If $TAC_{y+1} > 1.05TAC_y$ then $TAC_{y+1} = 1.05TAC_y$ (3)

A further NEW rule is that:

If $TAC_{y+1} < 120t$ then $TAC_{y+1} = 120t$ (3)

Thus a “floor” of 120 tons is set, BUT there must be a lower limit in the observed recent CPUE 3-yr average below which this 120t floor rule is over-ruled due to Exceptional Circumstances occurring, and the diagram below indicates how this further rule operates.



If the recent catch rate I_y^{rec} value drops below a threshold level (**Ilim**), the TAC may decrease by more than the usual maximum 5% decrease. The Figure above shows how the maximum % the TAC may be reduced from year to year may change from the default of 5% to a value of 20%, depending on the value of I_y^{rec}. OMP results for various values of Ilim are reported here.

OMP variants

A number of variants of OMP 2016 are reported here - see Table 1 for details.

Robustness trials

The idea is to develop a "difficult" robustness trial in order to test how well the OMP is able to successfully adjust the TACs in response to decline CPUE values.

ROB1: At the start of 2016, 10% of all lobsters die (or are removed from the system).

ROB2: At the start of 2016, 20% of all lobsters die (or are removed from the system).

ROB3: At the start of 2016, 50% of all lobsters die (or are removed from the system).

Results

Table 2 reports key simulation results for a number of OMP variants. All statistics reported below are median values unless otherwise stated. Note "Current OMP" refers to the OMP as developed and simulation tested in 2013. Figure 2a and b illustrates the median, 5th and 95th percentile trajectories for of TAC, Bsp/K and CR values for the RC and Alt1 OMPs respectively (these two OMPs differ with respect to their Itarg values). Figure 3 compares the TAC trajectories for four OMPs which differ with respect to the Ilim value (the level at which EC Kick in and the Floor value of 120 may be over ridden). Figure 3b compares the TAC trajectories between the RC OMP (which has the Floor of 120tons) and OMP Alt5 which has no Floor. Finally Table 3 and Figure 4 report on robustness tests results.

Discussion

The decision maker is required to make some decisions regarding the parameters of the OMP presented in this document. Essentially a value for Itarg, Ilim and whether a Floor of 120tons is required need to be decided upon in order to define the final OMP 2016 for the Tristan resource, which will be used to set the TACs at Tristan for a three year period (2016-2018).

The authors recommend the "RC" OMP presented here which has an Itar of the average 2010-2012 CPUE (as in the current OMP), has an Ilim value of 0.80 and incorporates a TAC floor of 120tons (which can be over ridden if Irec drops below the Ilim value).

The choice of Ilim 0.80 is recommended as it is high enough to have some meaning, but low enough that it would definitely not be hit in the first year (2016) and very unlikely to be hit in the next two years under baseline projections.

The RC OMP is shown however to be able to adjust sufficiently quickly in the case of a severe catastrophe (e.g. ROB3 where 50% of all lobsters die). Table 3 and Figure 4 show that the average TACs in the next 10 years ($C_{ave}10(16\text{-}25)$) drops from 122tons (no lobster mortality) to an average of 108tons (50% lobster mortality in 2016). The lower 5th percentile of Bsp(2033/K) remains at 0.55 even under the ROB3 scenario.

Future Work

Future extensions to the OMP rule could be to include Edinburgh CPUE as well.

References

Johnston, S.J and Butterworth, D.S. 2013. An operational management procedure for the Tristan da Cunha rock lobster fishery. MARAM document, MARAM/Tristan/2013/OCT/14.

Johnston, S.J. and Butterworth, D.S. 2016. Rescaled Tristan GLM-standardised lobster CPUE to take account of fishing efficiency changes. MARAM document, MARAM/Tristan/2016/MAR/05.

Table 1: Details of the various OMPs presented here. For all OMPs the inter-annual TAC constraint is 5%.

OMP	Itar	Ilim	Floor of 120t
RC	CR1012=1.257	0.8	Yes
Alt1	**CR1214=1.007**	0.8	Yes
Alt2	CR1012=1.257	**0.6**	Yes
Alt3	CR1012=1.257	**0.7**	Yes
Alt4	CR1012=1.257	**0.9**	Yes
Alt5	CR1012=1.257	0.8	**No**

Table 2: Simulation results for a number of OMPs. All statistics reported below are median values unless otherwise stated. Note Current OMP refers to the OMP as developed and simulation tested in 2013.

OM	**OMP**	Itar	Ilim	Floor 120t	CR(2022) (kg/gear/hour)	CR(2025) (kg/gear/hour)	CR(2032) (kg/gear/hour)	C_{ave} 10 (13-22) (MT)	C_{ave} 10 (16-25) (MT)	Lower 5%ile B_{sp}(2033/K)
(**2015 OM** no rescaling of CPUE)	**Current OMP**	**CR1012=1.016**	**-**	**-**	**1.38**	**1.39**	**1.24**	**171**	**181**	**0.57**
Updated 2016 assessment with rescaled CPUE	**Current OMP**	**CR1012=1.016**	**-**	**-**	**1.47**	**1.51**	**1.35**	**117**	**105**	**0.56**
Updated 2016 assessment with rescaled CPUE	**RC**	CR1012=1.257	0.8	Yes	1.39	1.43	1.27	129	122	0.55
Updated 2016 assessment with rescaled CPUE	**Alt1**	**CR1214=1.007**	0.8	Yes	1.34	1.35	1.16	133	133	0.53
Updated 2016 assessment with rescaled CPUE	**Alt2**	CR1012=1.257	**0.6**	Yes	1.39	1.43	1.27	129	122	0.55
Updated 2016 assessment with rescaled CPUE	**Alt3**	CR1012=1.257	**0.7**	Yes	1.39	1.43	1.27	129	11	0.55
Updated 2016 assessment with rescaled CPUE	**Alt4**	CR1012=1.257	**0.9**	Yes	1.39	1.43	1.27	129	122	0.55
Updated 2016 assessment with rescaled CPUE	**Alt5**	CR1012=1.257	0.8	**No**	1.47	1.51	1.36	117	105	0.56

Table 3: Robustness trials ROB1 (10% of lobsters die in 2016) ,ROB2 (20% of all lobsters die in 2016) and ROB3 (50% of lobsters die in 2016) simulation results for two OMPS: the RC (Ilim=0.80) and Alt4 (Ilim=0.90). All statistics reported below are median values unless otherwise stated.

OM	**OMP**	CR(2022) (kg/gear/hour)	CR(2025) (kg/gear/hour)	CR(2032) (kg/gear/hour)	C_{ave} 10 (13-22) (MT)	C_{ave} 10 (16-25) (MT)	Lower 5%ile B_{sp}(2033/K)
RC (0% die in 2016)	RC (Ilim=0.80)	1.39	1.43	1.27	129	122	0.55
ROB1 (10% die 2016)	RC (Ilim=0.80)	1.21	1.37	1.30	129	120	0.55
ROB2 (20% die in 2016)	RC (Ilim=0.80)	1.03	1.28	1.32	129	120	0.55
ROB3 (50% die in 2016)	RC (Ilim=0.80)	0.52	1.06	1.33	121	108	0.55
RC (0% die in 2016)	Alt4 (Ilim=0.90)	1.39	1.43	1.27	129	122	0.55
ROB1 (10% die 2016)	Alt4 (Ilim=0.90)	1.21	1.38	1.30	128	119	0.55
ROB2 (20% die in 2016)	Alt4 (Ilim=0.90)	1.04	1.29	1.32	126	117	0.55
ROB3 (50% die in 2016)	Alt4 (Ilim=0.90)	0.53	1.06	1.33	120	107	0.55

Figure 1: The CPUE series underlying the OM (i.e. the rescaled CPUE taking into account changes in fishing efficiency). The baseline Itar value (average of 2010-2012 CPUE) and the alternate Itar value (average of 2012-2014 CPUE) are indicated as horizontal lines.

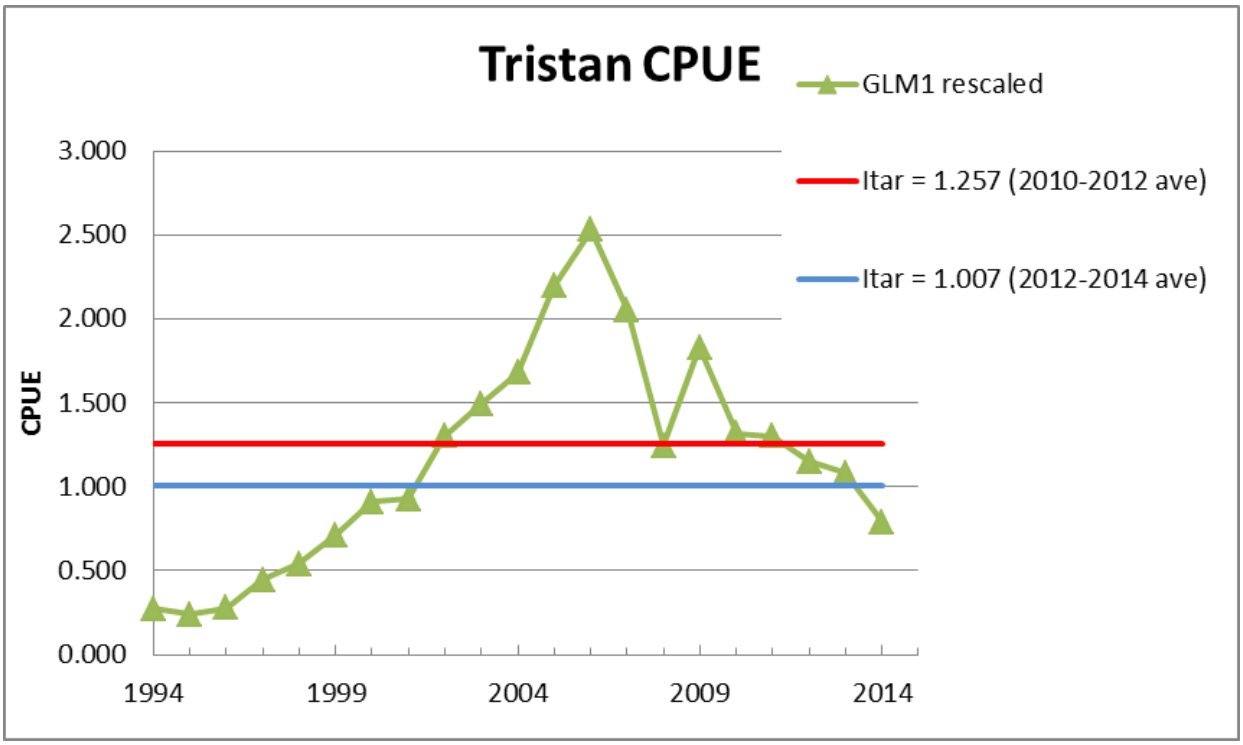


Figure 2a: TACs, Bsp/K and CR trajectories for the RC OMP. In each plot the median with 5th and 95th percentiles are plotted.

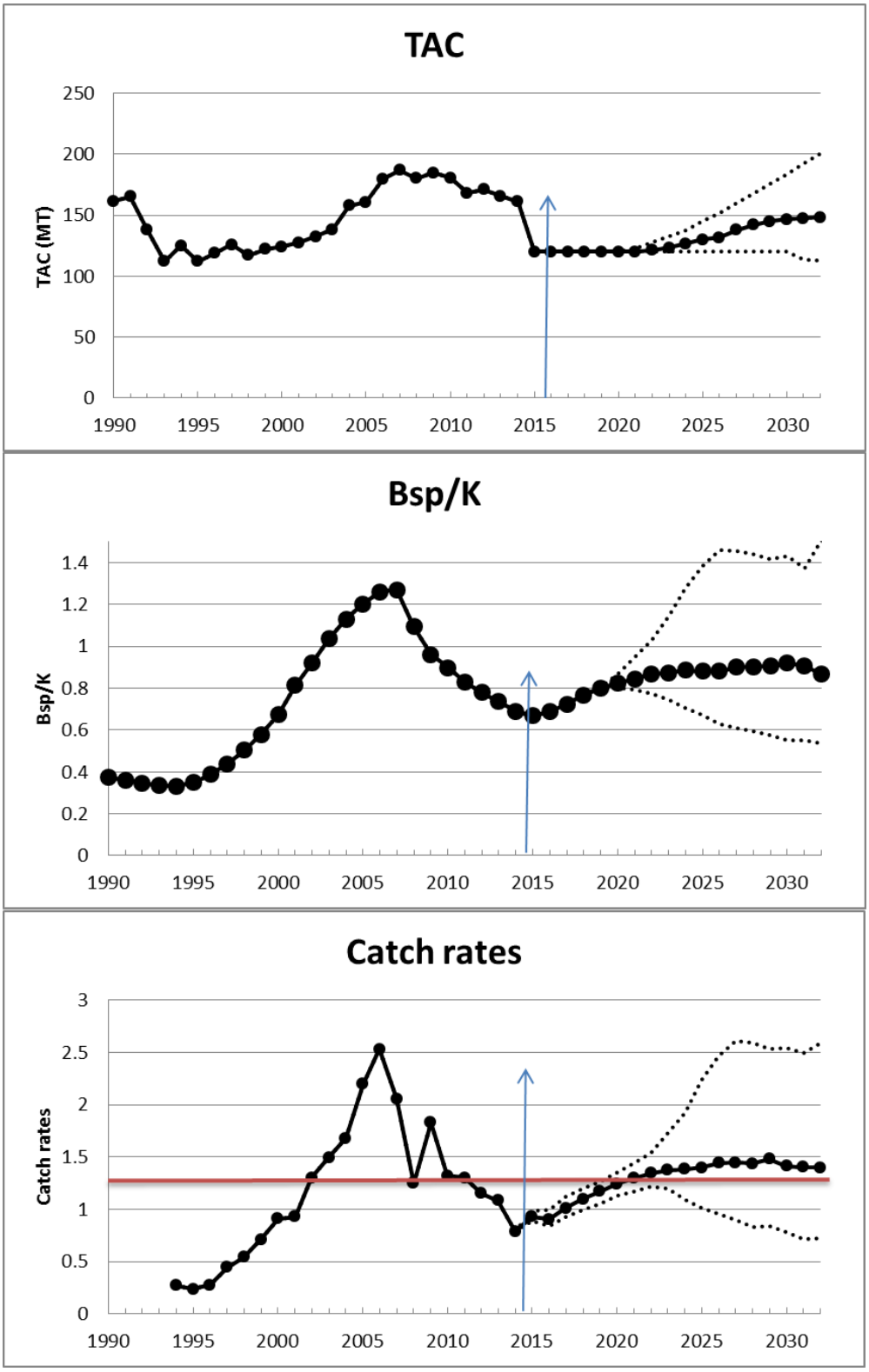


Figure 2b: TACs, Bsp/K and CR trajectories for the Alt1 OMP (Itar = 2012-2014 ave of 1.007). In each plot the median with 5th and 95th percentiles are plotted.

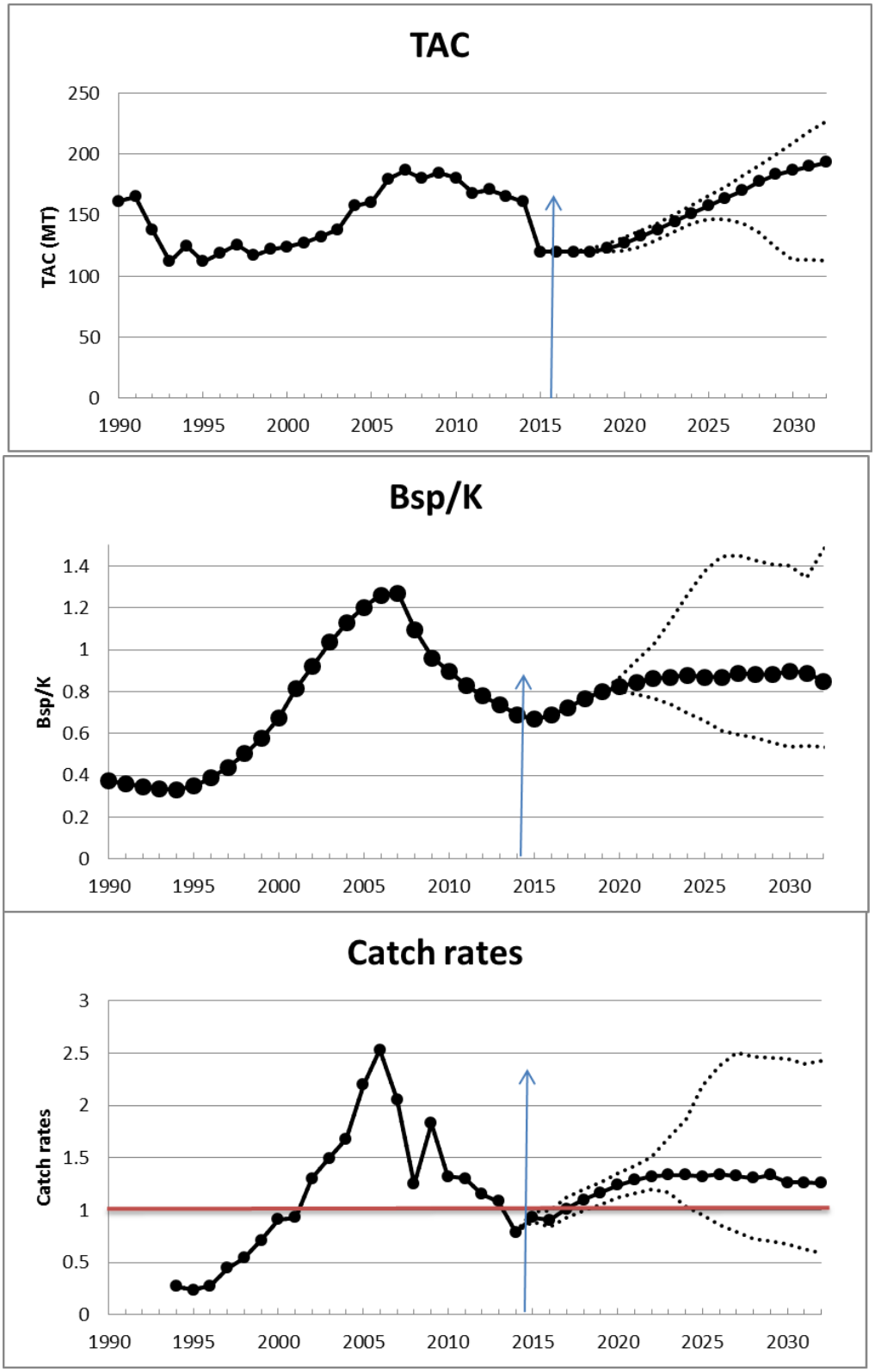


Figure 3a: TAC trajectories (medians and 5th and 95th %iles) comparing OMP with four different Ilim values.

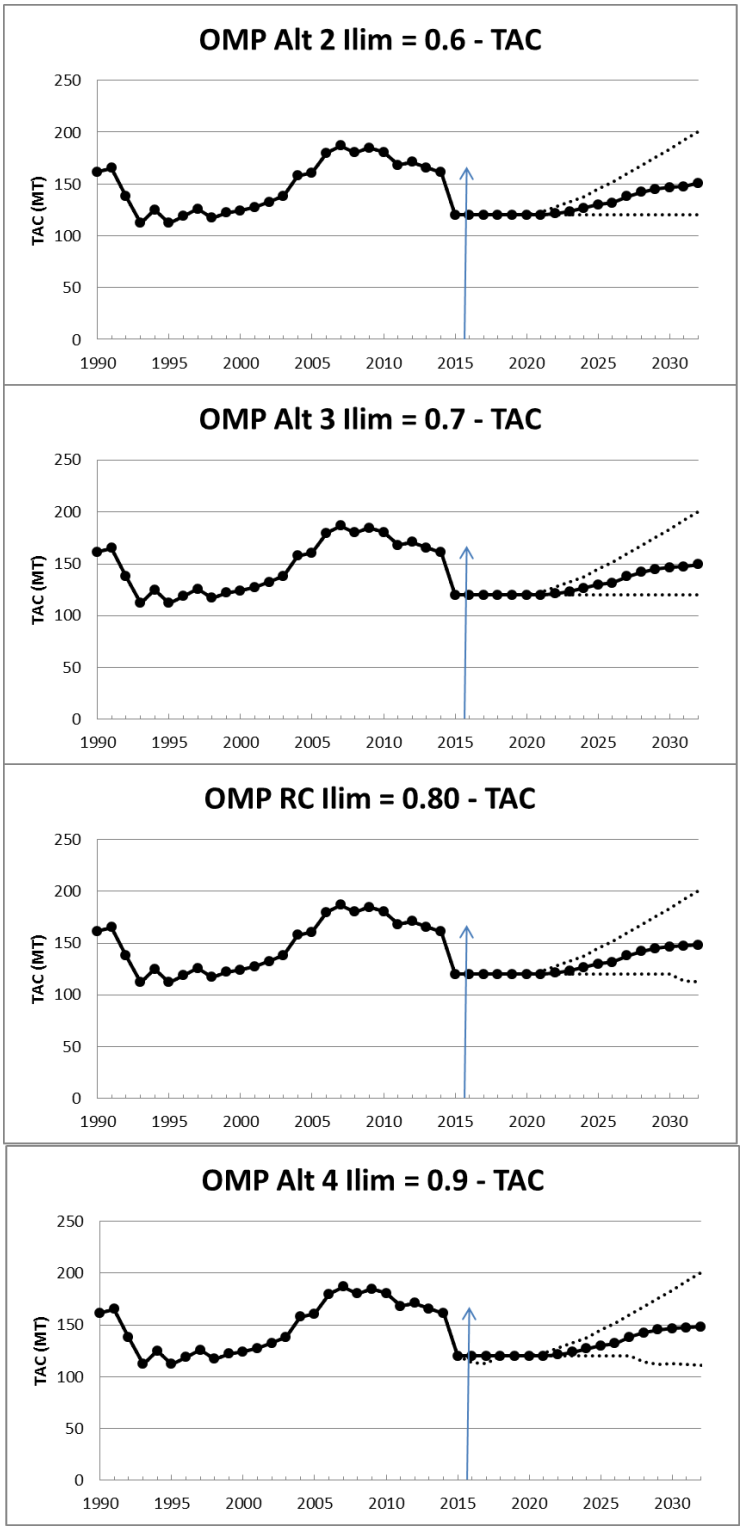
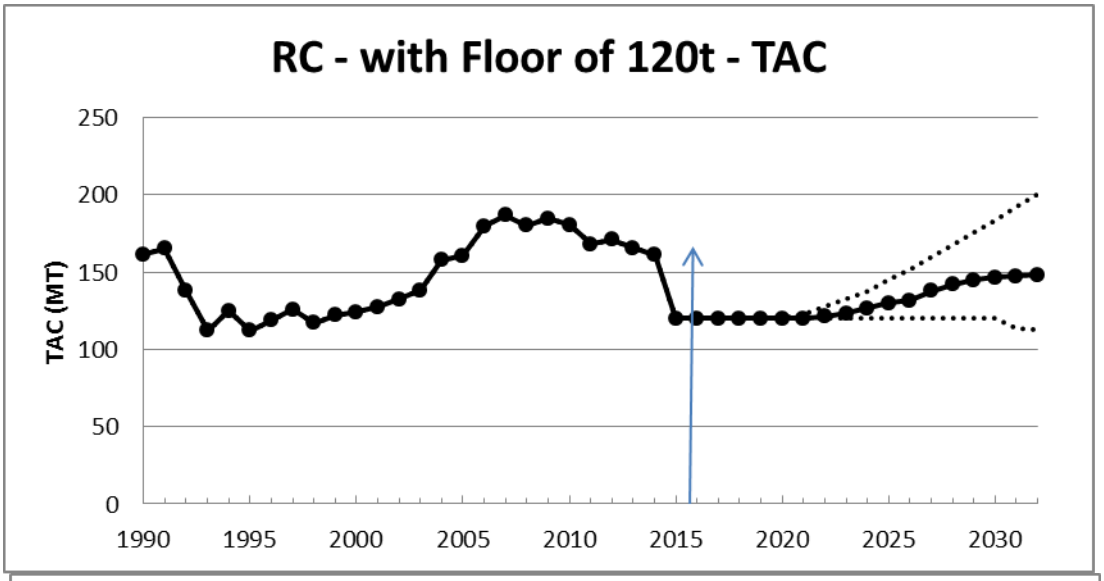


Figure 3b: TAC trajectories (medians and 5th and 95th %iles) comparing OMPs with and without a Floor of 120tons.



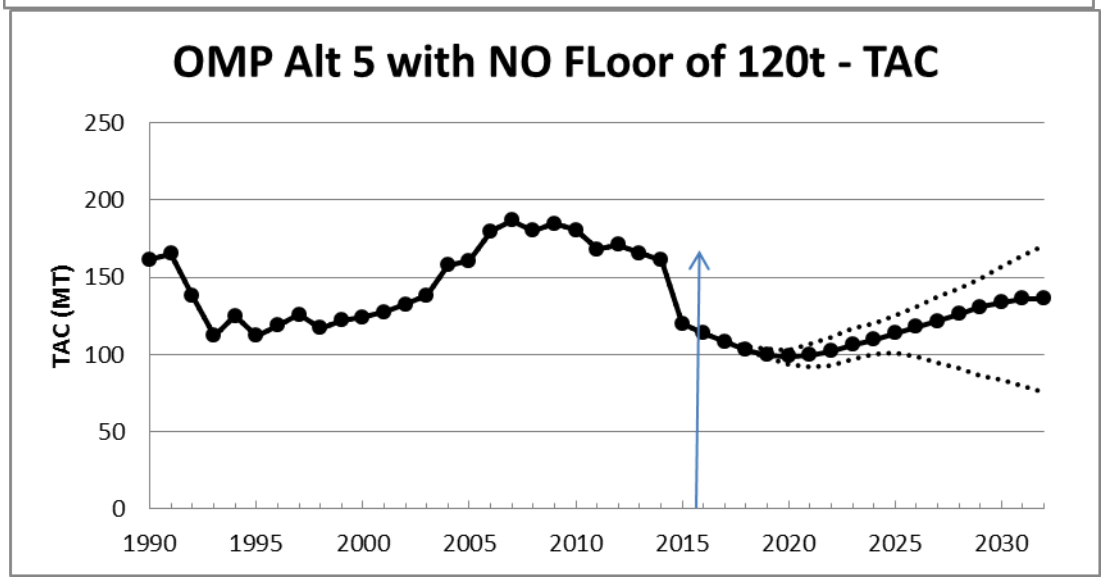


Figure 4: Comparison of the RC OMP (Ilim=0.80) for the baseline scenario (0% lobsters die in 2016) and Robustness trial ROB3 (50% lobsters die in 2013). Simulation results of TACs, Bsp/K and CR trajectories are shown. In each plot the median with 5th and 95th percentiles are plotted.

Baseline (0% lobster die in 2016) ROB3 (50% lobsters die in 2016)