Extended CMP results for VAR6, VAR5.5 and Var5 for Gough island lobster

S. Johnston

Key Words: Tristan rock lobster, Gough island, CMPs

Summary

This document provides extended CMP results for OMPs currently being developed and considered for the management of Tristan rock lobster at Gough island, following the addition of survey data into the TAC setting formula. Stochastic results and sensitivity results for a range of robustness tests are also provided. The CMP Var5.5 is shown to be robust to a wide range of uncertainties.

Introduction

Three CMP variants are presented here which differ only with regards to the Itar level. The three levels of Itar are considered:

> **VAR6**: Itar=6.0 kg/trap
>
> **VAR5.5**: Itar=5.5 kg/trap and
>
> **VAR5**: Itar=5.0 kg/trap.

For each CMP the following applies:

1) 15 mt are added over the first three years (5 mt for 2021[1], 2022 and 2023 each) reflecting rollovers from 2020.
2) The TAC in 2021 is limited to 100 mt (with an extra 5 mt rollover = 105 mt in total).
3) A value of the tuning parameter α is set equal to 4 (this provides for a series of flatter TAC trajectories).
4) Both commercial longline standardised CPUE as well as biomass survey data are used as input into the TAC setting formula.
5) The underlying operating model used to assess these CMPs is as described in MARAM/TRISTAN/2021/JUL/12 (i.e. the slightly revised assessment model that takes into account 2020 CPUE, discard % and catch values, as well as having a lower limit of 0.15 on the σ value when fitting to commercial CPUE and survey abundance).

---

[1] The split season is referenced by the first year, for example 2021 refers to the 2021/22 season

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 current takes into account not only commercial CPUE, but also the Edinburgh/Geo searcher CPUE and the biomass survey indices. To do this, the following steps have been taken:

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 1 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 from the "revised RC" model (where the CPUE and survey σ values are constrained to be >=0.15) fits to these data in the underlying assessments., so that:

$$w_1 = \frac{1}{\sigma_{commn}^2} = \frac{1}{0.15^2} = \mathbf{44}$$

$$w_2 = \frac{1}{\sigma_{survey}^2} = \frac{1}{0.272^2} = \mathbf{13} \tag{1}$$

(effectively then, the ratio of weight given to the commercial CPUE data and biomass survey indices is about 1:0.3).

STEP4: Calculate the TAC.

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

where I_{tar} and α are control parameters whose values are to be selected.

Tables 1 and 2 report the summary statistics results of the three CMP candidates. Figure 2 compares the Catch, Bsp/K and CR trajectories between 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 5th and 95th percentile trajectories in order to assess the level of uncertainty associated with these results. Stochastic results are presented for the VAR5.5 kg/trap CMP. Figure 3 shows plots of these stochastic trajectories for VAR5.5.

Robustness tests

A series of robustness models are then run to explore the robustness of CMP VAR5.5 kg/trap to these uncertainties. These are:

ROB1: fix h = 0.90

ROB2: fix h = 0.80

ROB3: fix h = 0.70

ROB3b: fox h=0.50

ROB4: M=0.2

ROB5: d = 0.2

ROB6: F_{2009}=0.3

ROB7: CPUE and survey index σ constraint increased to ≥ 0.20 (from 0.15)

ROB8: Juvenile lobsters (ages 1, 2 and 3) suffer a 35% mortality in 2020 due to the result of oil spillage from the sinking of the Geo Searcher.

The model fits for each of these robustness test can be found in MARAM/TRISTAN/2021/JUL/12.

Figure 4 compares the expected results of the application of VAR5.5 for a range of eight robustness tests. Figure 5 shows the expected TAC trajectories for Var5.5 for the RC and eight different robustness tests.

Of particular interest is Rob8, the robustness tests that assumes 35% of juvenile lobsters die in 2020 (due to oil from Geo Searcher sinking). Figure 6 compares the RC and the robustness trial Rob8 trajectories of spawning biomass, catch rate and TAC. It is clear that the TAC will be modified downwards in response to a reduction in catch rates as the smaller juvenile cohorts move through the population. This OMP (Var5.5) will therefore perform very well by adjusting the TAC if such an event has occurred. The final Bsp/K(2033) will hardly be affected (due to the decrease in TAC), as indicated in Figure 6.

Table 1: Comparison of **Gough** candidate MP variants' expected performance results. All statistics reported below are median values unless otherwise stated.

CMP	I^{tar} (kg/trap)	α	CR(2022) (kg/trap)	CR(2032) (kg/trap)	TAC(2021)* (MT)	C_{ave} 5* (MT)	C_{ave} 10* (MT)	Lower 5%ile C_{ave} 10*	Median and Lower 5%ile Bsp(2033/K)
OMP-2018#	6.0	10	3.86	4.28	95	82	89	89	0.66 (0.33)
VAR6	**6.0**	4	**6.04**	**5.00**	**100+5=105***	**101+3=104***	**101+1.5=102.5***	**99+1.5=101.5***	**0.79 (0.46)**
VAR5.5	**5.5**	4	**6.02**	**4.53**	**100+5=105***	**105+3=108***	**109+1.5=110.5***	**101+1.5=102.5***	**0.77 (0.46)**
VAR5	**5.0**	4	**6.00**	**4.05**	**100+5=105***	**109+3=112***	**116+1.5=117.5***	**109+1.5=110.5***	**0.75 (0.45)**

*Here the first figure is the OMP TAC, the second is the rollover amount, the final is the combination of the two.

Table 2: Predicted median TAC values (MT) for the first 10 seasons (2021-2030) for the different CMP variants.

	2021*	2022*	2023*	2024	2025	2026	2027	2028	2029	2030
VAR6	100+5= 105	100+5= 105	102+5= 107	103	103	103	102	101	101	98
VAR5.5	100+5= 105	102+5 =107	106+5 =111	108	111	112	113	113	111	111
VAR5	100+5= 105	104+5 =109	109+5 =114	114	118	121	122	124	125	124

*Here the first figure is the OMP TAC, the second is the rollover amount, the final is the combination of the two.
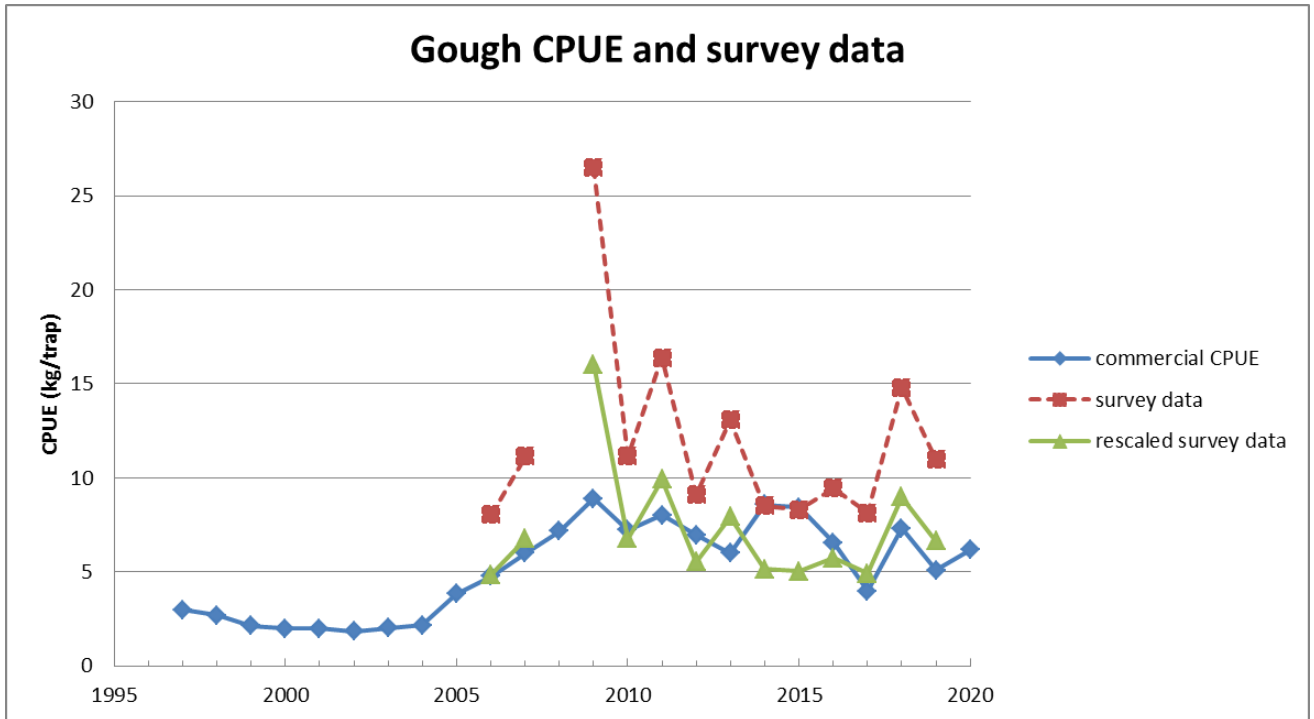
Figure 1: Commercial CPUE data, along with the survey data and the rescaled survey data.
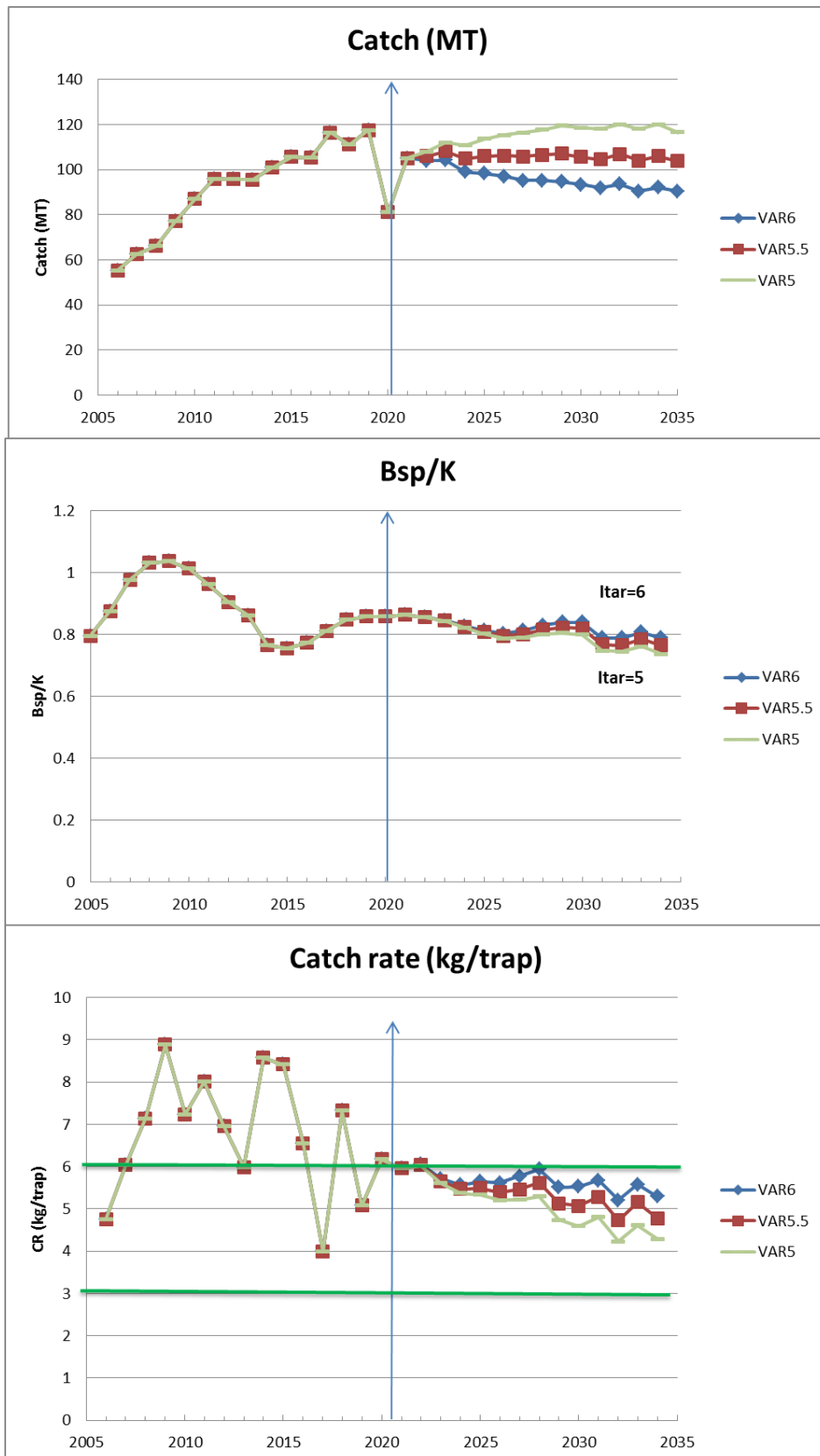
Catch (MT)

Bsp/K

Catch rate (kg/trap)

Figure 2: The Catch (MT), Bsp/K and catch rate (kg/trap) trajectories for each of the CMP variants. (Note that the Catch of 81MT taken in 2020 is reflected in the catch plot, but the CMP algorithm uses TAC and hence an initial input value of TAC(2020)=100 MT.) The top plot of Catches also INLCUDES a 5t rollover for 2021-2023 seasons.
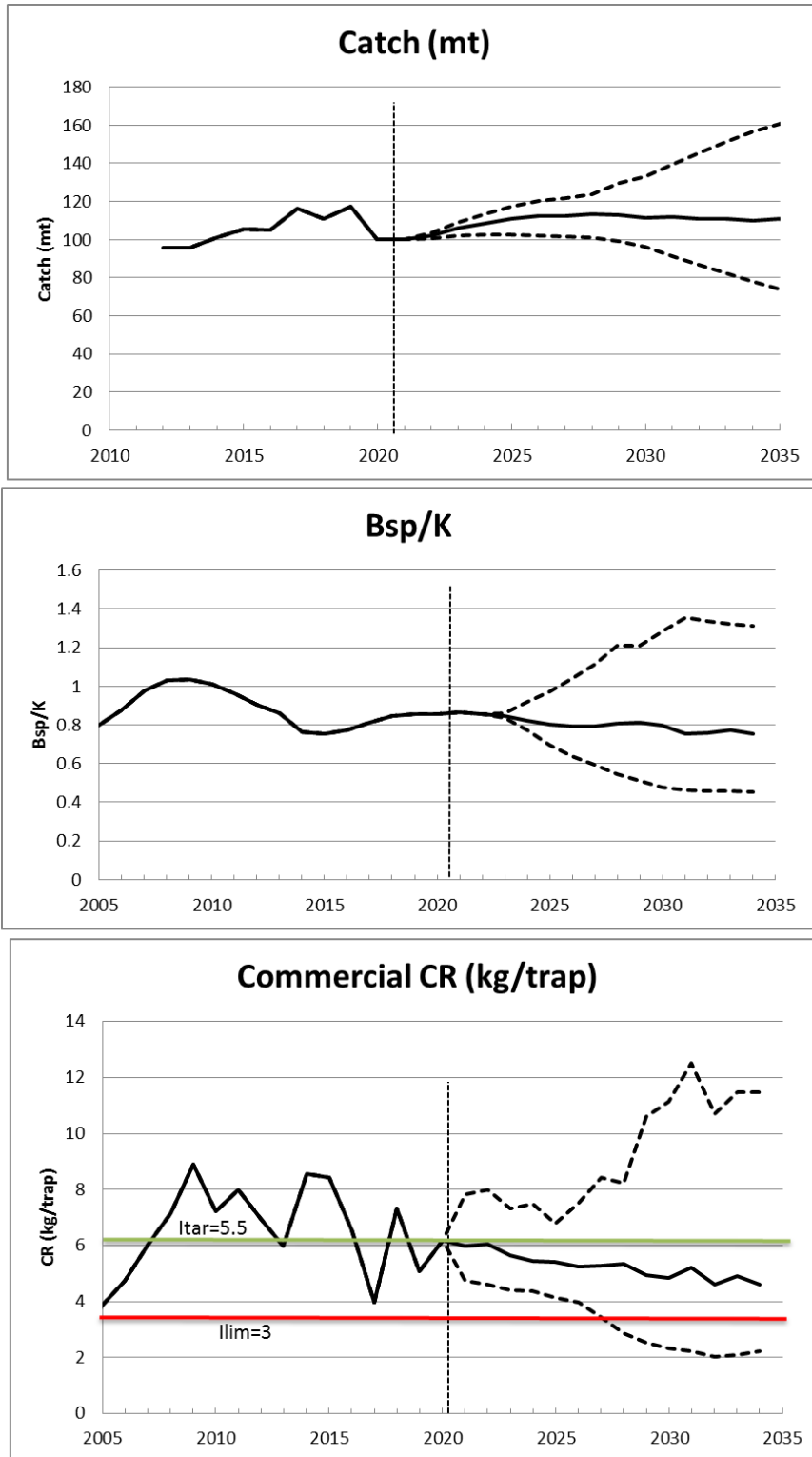
Figure 3: Stochastic trajectories for VAR5.5. The solid line is the median, with the dashed lines representing the 5th and 95th percentiles.
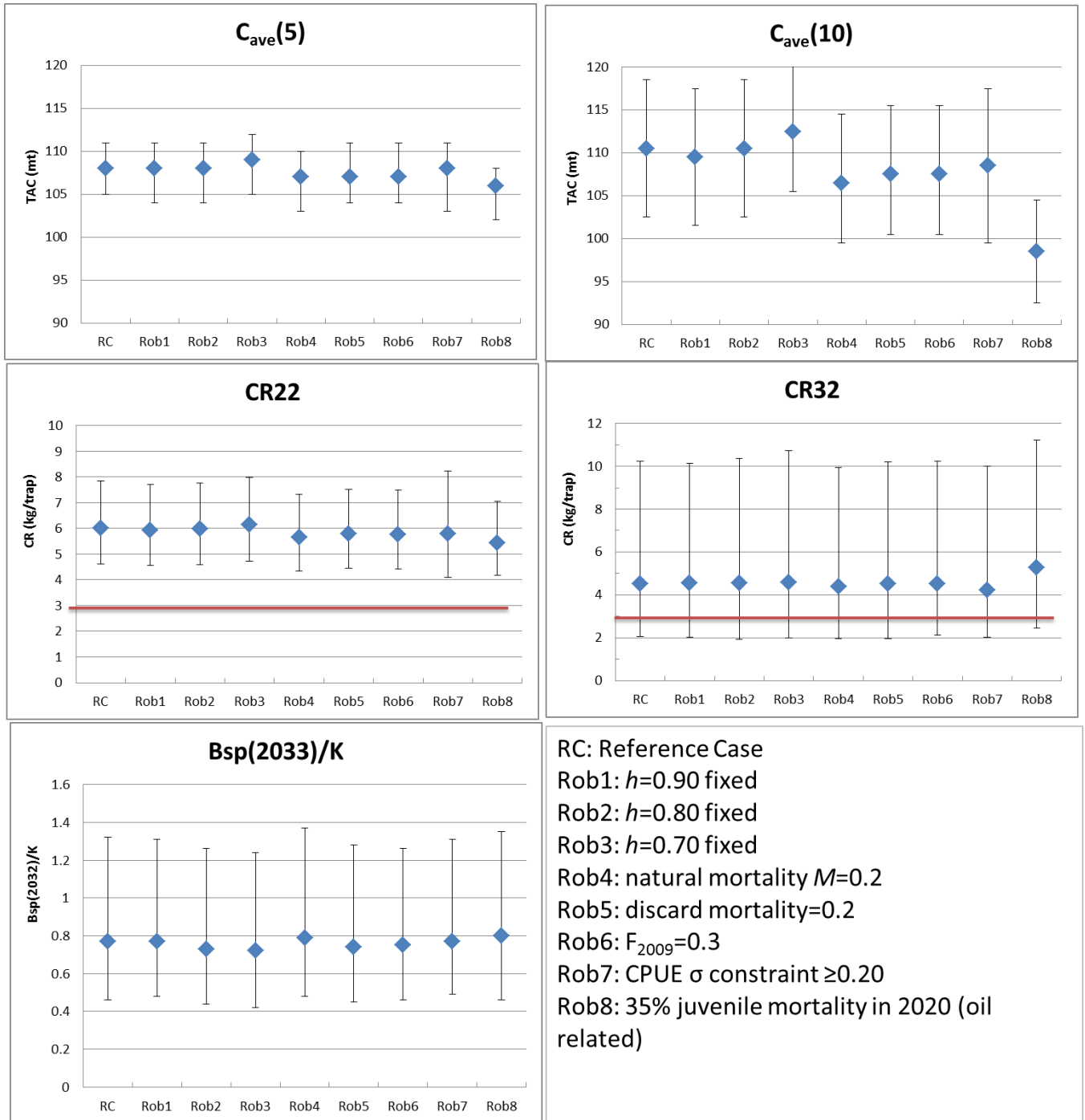
Figure 4: Robustness performance plots for VAR5.5. The icons represent the median values, with the vertical lines representing the 5th and 95th percentiles.

RC: Reference Case
Rob1: h=0.90 fixed
Rob2: h=0.80 fixed
Rob3: h=0.70 fixed
Rob4: natural mortality M=0.2
Rob5: discard mortality=0.2
Rob6: F_{2009}=0.3
Rob7: CPUE σ constraint ≥0.20
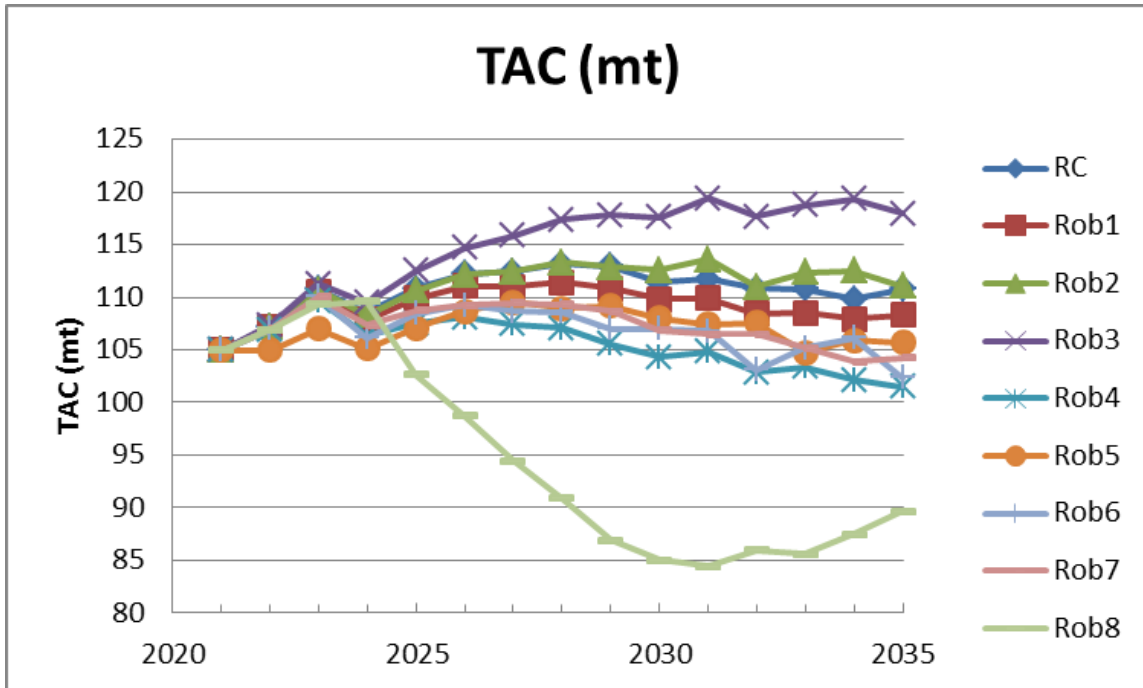Rob8: 35% juvenile mortality in 2020 (oil related)

Figure 5: The expected TAC trajectories for Var5.5 for the RC and eight different robustness tests.
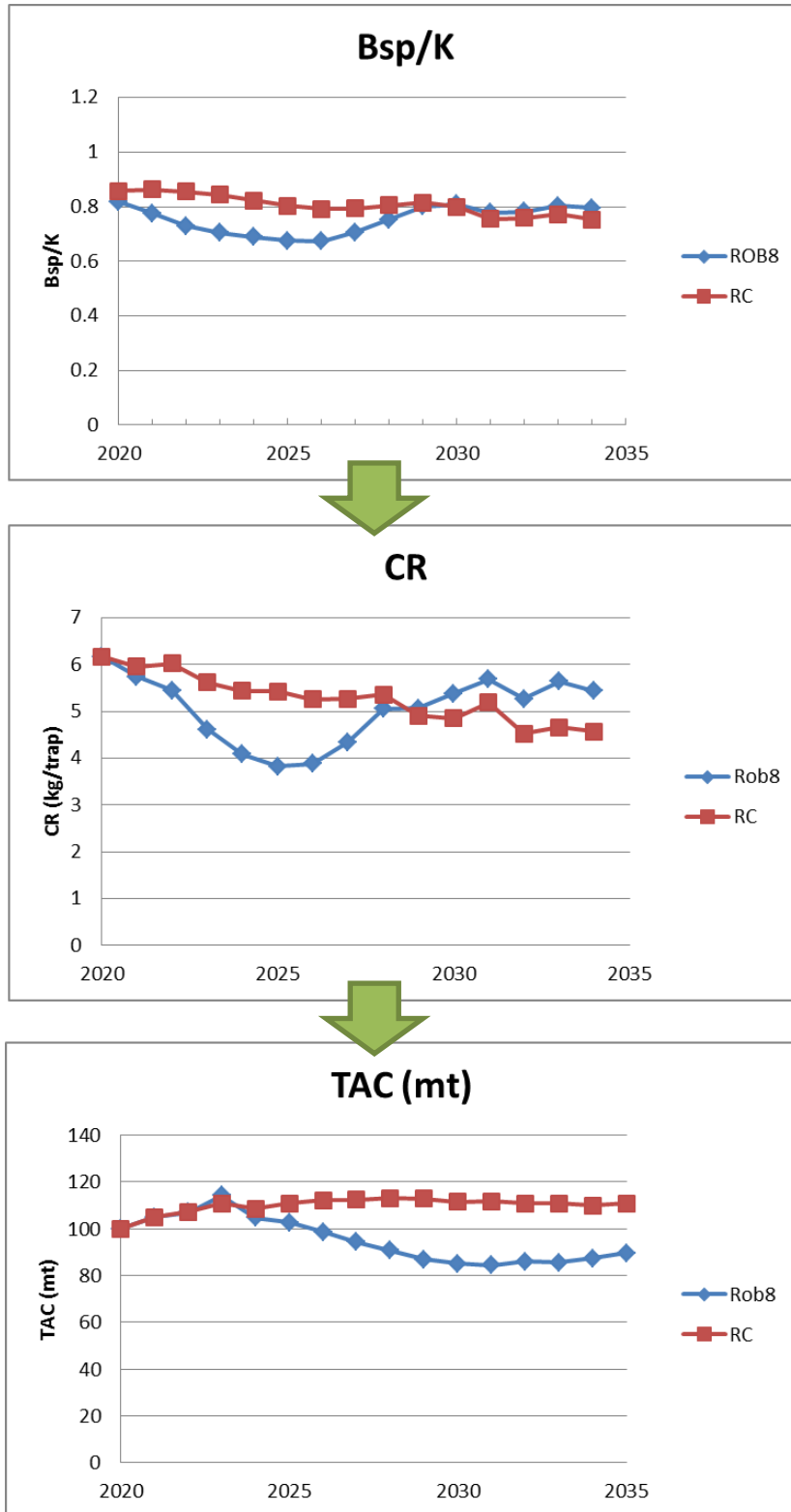
Figure 6: Comparison between the RC and the robustness trial Rob8 (which assumes 35% of juveniles die in 2020). The green arrows indicate the flow of information.