OMP 2020 candidates for the Nightingale rock lobster fishery

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Summary

The performances of a number of OMP candidates for the fishery for rock lobster at Nightingale are reported. These performances do not show much variation amongst the various candidates. For this and other reasons it is recommended that CMP9 be adopted as the new OMP for Nightingale. This CMP has a TAC ceiling of 100 MT. Very little further resource protection (which is in any case already certainly adequate) is provided by a CMP with a lower TAC ceiling. All the CMPs have appropriate feedback, so that if the resource declines in the future, the future TAC will do so too. An added precautionary feature defines an Ilim catch rate below which the TAC can decline faster than the baseline constraint of 5% pa given the occurrence of specified "Exceptional Circumstances"; this feature is built into the CMPs.

Introduction

In 2017, the first OMP (OMP 2017) was developed for the Nightingale island rock lobster fishery (Johnston and Butterworth 2017). This OMP has been used to set TACs for the island for the 2017-2019 seasons[1]. A new OMP (OMP 2020) is to be developed for the Nightingale fishery this year.

This document reports performances of CMPs (Candidate Management Procedures) for the Nightingale rock lobster fishery, with the intention that the final selected OMP will be used for setting the TAC at Nightingale for the 2020 and the following two seasons.

The stock assessment for the rock lobster population at Nightingale has recently been updated (Johnston and Butterworth 2020) to take data from the most recent (2019) fishing season into

[1] The split season is referenced by the first year, i.e. season 2017 refers to season 2017/18.

account. This assessment includes updated data from both the commercial fishery and the biomass surveys. The continued relatively high GLM standardised CPUE values (and biomass survey index values) at the island suggest that the impact of the OLIVA on adults may have been overestimated initially. These high CPUEs indicate that any additional adult mortality in 2011 due to the OLIVA incident was much less than originally assumed. The 2020 RC assessment thus now assumes zero additional adult mortality in 2011 due to the OLIVA incident, but continues to assume a 20% additional juvenile mortality in 2011 due to this incident. The current spawning biomass (*Bsp*) relative to the pristine level (*K*) for Nightingale is currently estimated to be at a healthy value of 84% pristine. This suggests that this population is well above the level at which maximum sustainable yield would be expected to be harvestable (usually a value of around 50% of *K* or lower). As populations approach their carrying capacity (*K*), the productivity of the resource diminishes. For this reason, it is usually recommended that populations at high levels of spawning biomass relative to *K* can be more heavily harvested to reduce their abundances to lower and more productive levels.

As with the Tristan, Inaccessible and Gough OMPs, the management target for Nightingale island is linked to the target catch rates which are considered to be the most desirable in the future. The ultimate aim of using an OMP to manage a resource is to try to reach such a management goal as closely as possible, no matter what eventuates in the future. If the resource declines in the future, this will be evident from diminished catch rates so that TACs will be reduced, and more quickly should those rates fall below some threshold level. For the analyses that follow, TACs are constrained not to increase or decrease by any large amount from one season to the next – here the baseline constraint is 5%. Rules that allow for a TAC decrease of greater than 5% if catch rates decline appreciably (below a defined Ilim level) are also incorporated in the OMP for implementation in such Exceptional Circumstances. Unlike the OMPs for the other three islands, the Nightingale OMP also includes an upper "ceiling" for the future annual TACs. Here the range of 85MT to 100 MT is considered for this ceiling.

Candidate OMPs (CMPs)

The CMPs presented here are based on the same structure as that for the current Tristan, Inaccessible and Gough OMPs as well as the current Nightingale OMP (Johnston and Butterworth 2017). This is 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 value, and

α is a tuning parameter which is varied here between 2.5 to 5. The larger the α value, the more "responsive" the OMP will be to changes in the catch rate in the future.

A rule to control the inter-annual TAC variation is also applied. The baseline % TAC change relative to the previous year ("max V%") is restricted to a maximum of either up 5% down 5% (although a maximum of either up 3% down 3% is also explored):

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

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

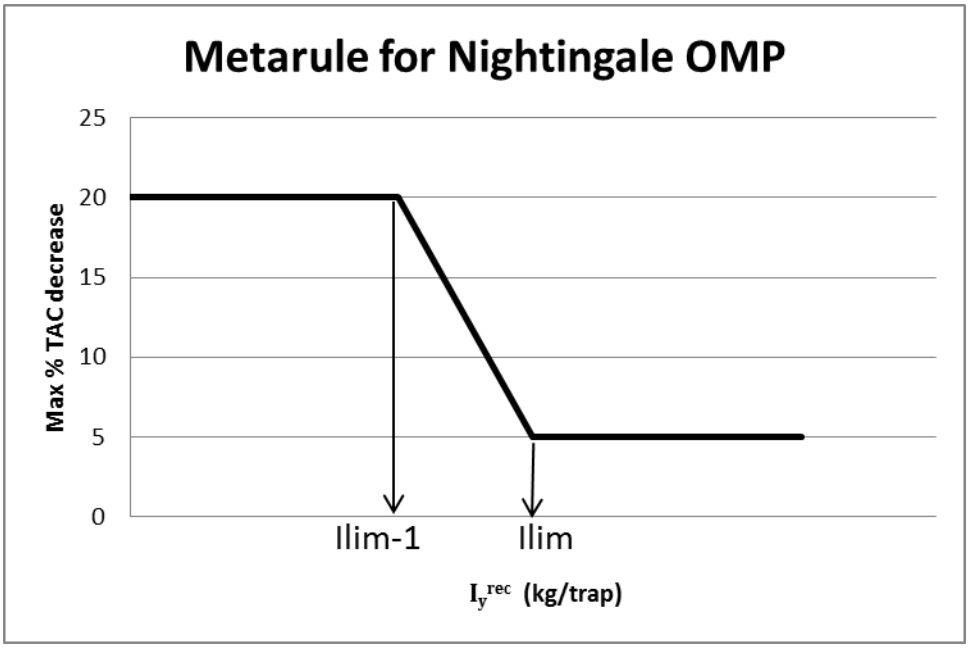
Furthermore a ceiling (upper bound) applies to the TAC:

If $TAC_{y+1} > TAC_{ceiling}$ then $TAC_{y+1} = TAC_{ceiling}$

As for the other OMPs that have been developed, the addition of a precautionary metarule rule is also incorporated into the OMP, whereby the 5% TAC decrease constraint is increased by up to 20% if the (catch rate) index drops below a threshold (Ilim) level. Here the baseline Ilim level is set at 3.0 kg/trap. The Ilim is considered as the CPUE level below which "Exceptional Circumstances" would apply.

Metarule

A metarule that allows for the TAC to decrease further than the usual maximum 5% TAC decrease, under "Exceptional Circumstances", is shown in the figure below. "Ilim" is the threshold catch rate level below which the metarule would be invoked. The baseline Ilim level is 3.0 kg/trap. Sensitivity to this value may be explored at a later stage.



Robustness trials

The idea is to develop "difficult" robustness trials in order to test how well the OMP is able to adjust the TACs appropriately in response to a drop abundance and hence in CPUE values.

ROB1: At the start of 2020, 10% of all lobsters die (or are removed from the system).

ROB2: At the start of 2020, 30% of all lobsters die (or are removed from the system).

ROB3: At the start of 2020, 50% of all lobsters die (or are removed from the system).

Future TAC=0 scenario

Simulation results are produced assuming future TACs are set equal to zero. The results reflect the highest abundance which the resource could achieve.

Summary statistics

A number of summary statistics have been developed in order to compare the trade-offs and performances of the alternate CMPs. These are similar to those used for the selection of the Tristan, inaccessible and Gough OMPs.

- CR(2035) = catch rate expected in 2035 (in kg/trap)
- CR(2025) = catch rate expected in 2025 (in kg/trap)
- C_{ave} 5 = average annual catch (in MT) over the next 5 years (2020^2-2024)
- C_{ave} 10 = average annual catch (in MT) over the next 10 years (2020-2029)
- V10 = average percentage TAC change from the previous year over next 10 years
- The median of *Bsp*(2036)/*K* which is the spawning biomass at the start of 2036 relative to the pristine level (*K*)
- The lower 5%ile of *Bsp*(2036)/*K* which is the spawning biomass at the start of 2036 relative to the pristine level (*K*)

Each candidate CMP was run for 100 simulations. The medians, and the 5^{th} and 95^{th} percentiles of various management quantities of interest are reported.

CPUE 2019

Note that at the time of these CMP developments, the Nightingale standardized CPUE value for the 2019 season had been calculated (7.124 kg/trap), and this value is used in the CMP simulated projections into the future.

Results

Table 1 compares simulation results of various initial CMPs expected performance results for the Reference Case (RC) assessment model (assumes a 20% additional juvenile mortality in 2011 due to the OLIVA incident). All statistics reported are median values unless otherwise stated, and values **bolded** indicate changes from the current CMP1 control parameter value selections, which are listed below.

- **Itar**: The target CPUE level set at a baseline level of 5 kg/day, and an Itar value of 4.0 kg/day is also explored.
- **α**: a tuning parameter is set to either 2.5 or 5. The larger the α value, the more "responsive" the CMP will be to changes in the catch rate in the future.
- **$TAC_{ceiling}$**: the maximum annual TAC value allowed (values of 85 - 100 MT are explored)
- **Ilim**: the threshold catch rate level below which the metarule for Exceptional Circumstances is invoked (and TAC may fall more than 5% per annum). Here the value is kept at a 3 kg/day as for the current OMP 2017.
- **Max V%:** The % TAC change relative to the previous year ("max V%") is restricted to a maximum of either up 5% down 5% (as for OMP 2017 and OMPs for other islands).

Table 2 reports CMP9 (TAC ceiling of 100 MT, Itar=5) expected performance results for the robustness tests (which assume either 10%, 30% or 50% of all lobsters die at start of 2020).

Figure 1a shows the standardized Nightingale CPUE, and also indicates Itar=5 kg/day and Ilim = 3 kg/trap levels. Figure 2a plots the catches taken at Nightingale.

Figure 2 shows the simulation results for CMP1, CMP5, CMP7, CMP9 and TAC=0. Median values only are shown.

Figure 3a shows simulation results of CMP9 for the updated Reference Case model where not only is the median shown, but also the 5^{th} and 95^{th} percentile values. The median for future TAC=0 scenario is shown in red.

Figures 3b-d show simulation results of CMP9 where either a) ROB1 assumptions hold (10% of all lobsters die in 2020), b) ROB2 assumptions hold (30% of all lobsters die in 2020) or c) ROB3 assumptions hold (50% of all lobsters die in 2020). Again, the medians for future TAC=0 scenarios are shown in red.

Discussion

The Nightingale resource is currently at a healthy state with a current spawning biomass at 84% of K (see Johnston and Butterworth 2020).

The Table and Figures reported here show clearly that the Nightingale resource is able to accommodate a TAC ceiling of more than 85 MT in the future. There is little difference in performance over most of the CMPs reported. Under CMP9, the final median Bsp(2036/K) is still at a healthy 81% of K, with the lower 5^{th} %ile at 53%.

Should the resource start to decline, the OMPs will reduce the TACs (by up to 5% per annum), and if the resource were to drop suddenly to yield catch rates below Ilim=3 kg/day, then the metarule above would make much faster TAC reductions possible. Table 2 and Figure 3 indicate that CMP9 reduces the TACs appropriately in these circumstances: after first falling to a level not much lower than would have occurred even had there been no catch, the resource then recovers back to a healthy level.

Management Recommendation

Given that the current TAC is 85 MT and the catch rates at Nightingale continue to be high, is seems that there should be allowance for the TAC to be able to increase if these good conditions continue into the future. This will require an increase in the current TAC ceiling of 85 MT. The MARAM recommended OMP is CMP9, which allows for a TAC ceiling of 100 MT in the future if the resource continues to produce higher than pre-OLIVA catch rates, and involves no meaningful increase in conservation risk to the resource. The annual 5% TAC increase constraint still applies. The Itar value is set at 5 kg/day (the same as the current OMP 2017). The value chosen for α results in little difference in performance for the scenarios considered here; α=5 is recommended.

An alternate possibility is that CMP7 be considered the preferred OMP; this allows for a TAC ceiling of 95 MT.

References

Johnston, S.J. and Butterworth, D.S. 2017. Initial OMP candidates for the Nightingale rock lobster fishery MARAM/TRISTAN/2017/JUL/08.

Johnston, S.J. and Butterworth, D.S. 2020. Updated 2020 Nightingale island assessment. MARAM/TRISTAN/2020/MAR/05.

Table 1: Comparison of expected performance results for initial Nightingale CMPs (for the updated 2020 assessment model which assumes a 20% additional juvenile mortality in 2011 due to the OLIVA event). All statistics reported below are median values unless otherwise indicated. Values **bolded i**ndicate changes from CMP1 selections (where CMP1 is identical to OMP 2017, but the results shown labelled OMP 2017 are those which were reported in 2017 based on the Reference Case assessment at that time). The **red** indicates CMPs for which I^{tar} is set equal to 5.0.

CMP	I^{tar} (kg/trap)	α	$TAC_{ceiling}$ (MT)	Ilim (kg/trap)	Max V%	CR(2025) (kg/trap)	CR(2035) (kg/trap)	C_{ave} 5 (MT)	C_{ave} 10 (MT)	V10 (%)	Median *Bsp*(2036/K)	Lower 5%ile *Bsp*(2036/K)
OMP 2017	5	2.5	85	3	+5%,-5%	7.06	7.92	84	84	1.14	0.832	0.522
CMP1	5	2.5	85	3	+5%,-5%	6.21	6.22	85	85	0.08	0.817	0.552
CMP2	**4**	2.5	85	3	+5%,-5%	6.21	6.20	85	85	0.08	0.817	0.548
CMP3	5	**5**	85	3	+5%,-5%	6.21	6.23	85	85	0.08	0.817	0.553
CMP4	**4**	**5**	85	3	+5%,-5%	6.21	6.20	85	85	0.08	0.816	0.551
CMP5	5	**5**	**90**	3	+5%,-5%	6.06	6.06	90	90	0.67	0.813	0.547
CMP6	**4**	**5**	**90**	3	+5%,-5%	6.06	6.03	90	90	0.67	0.810	0.544
CMP7	5	**5**	**95**	3	+5%,-5%	5.93	5.90	94	94	1.23	0.809	0.541
CMP8	**4**	**5**	**95**	3	+5%,-5%	5.93	5.87	94	94	1.23	0.805	0.537
CMP9	5	**5**	**100**	3	+5%,-5%	5.81	5.74	96	98	1.75	0.805	0.533
TAC=0	-	-	-	-	-	8.62	8.75	0	0	0	0.898	0.622

Table 2: CMP9 expected performance results for the robustness tests (which assume that either 10%, 30% or 50% of all lobsters die at start of 2020). All statistics reported below are median values unless otherwise indicated.

CMP	I^{tar} (kg/trap)	α	$TAC_{ceiling}$ (MT)	Ilim (kg/trap)	Max V%	CR(2025) (kg/trap)	CR(2035) (kg/trap)	C_{ave} 5 (MT)	C_{ave} 10 (MT)	V10 (%)	Median *Bsp*(2036/K)	Lower 5%ile *Bsp*(2036/K)
Reference Case No 2020 deaths	5	**5**	**100**	3	+5%,-5%	5.81	5.74	96	98	1.75	0.805	0.533
ROB1 (10% die 2020)	5	**5**	**100**	3	+5%,-5%	5.07	5.74	96	97	2.53	0.809	0.532
ROB2 (30% die 2020)	5	**5**	**100**	3	+5%,-5%	3.69	6.06	91	83	4.42	0.825	0.534
ROB3 (50% die 2020)	5	**5**	**100**	3	+5%,-5%	2.19	6.37	88	79	4.91	0.822	0.544

Figure 1a: The standardized Nightingale CPUE showing Itar = 5.0 kg/trap and Ilim = 3 kg/trap values.

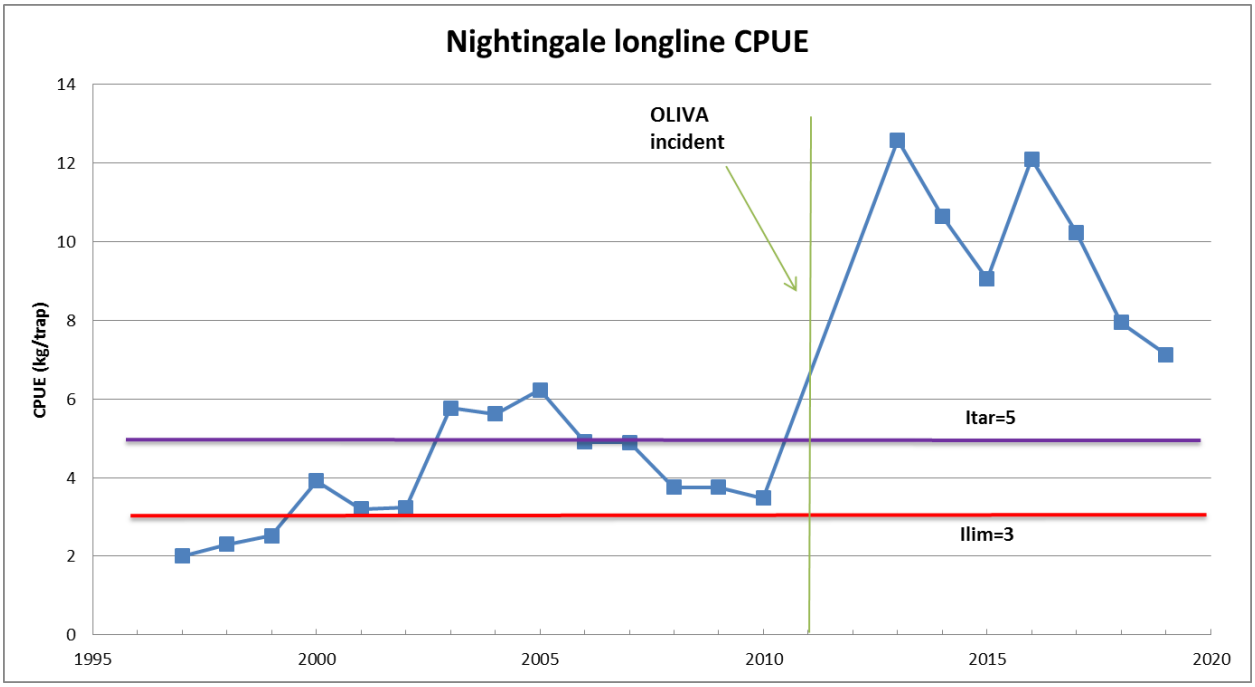


Figure 1b: Catches (MT) taken at Nightingale island each season. The green vertical line indicates the OLIVA incident in 2011.

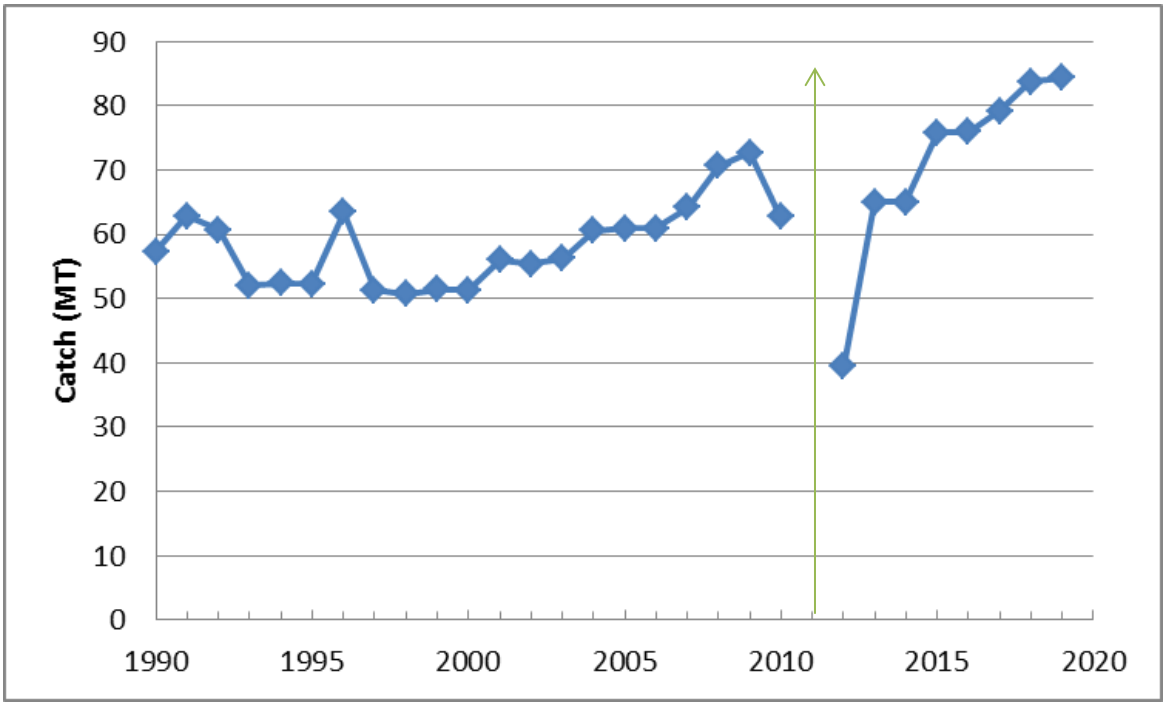


Figure 2: Simulation results for CMP1, CMP5, CMP7 and CMP9 for the updated 2020 Reference Case assessment. Median values only are shown.

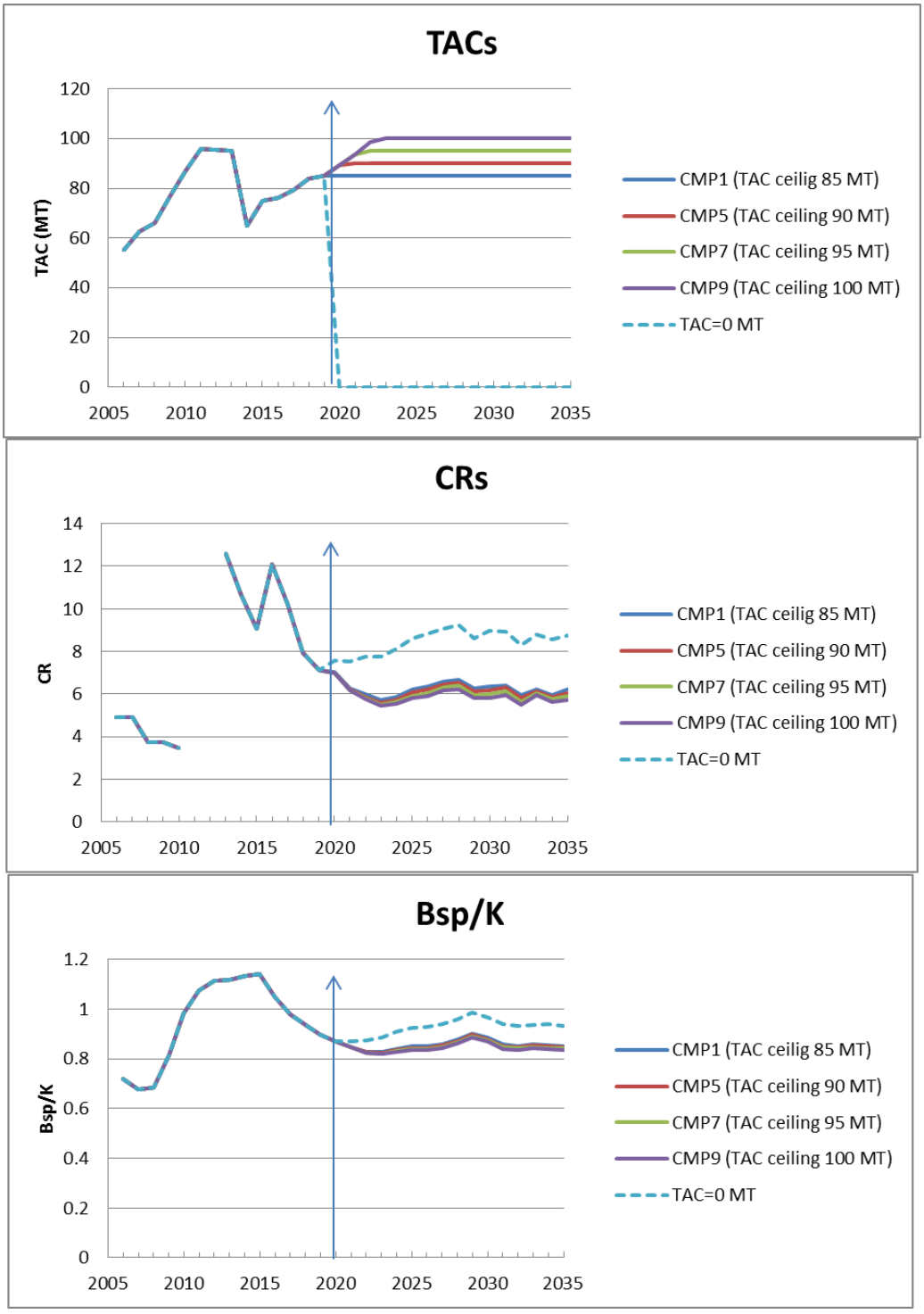


Figure 3a: Simulation results for CMP9 (TAC ceiling of 100 MT, Itar = 5) for the updated 2020 Reference Case assessment where the median, 5th and 95th percentiles values are shown. The median trajectories for a TAC=0 scenario are also indicated in red.

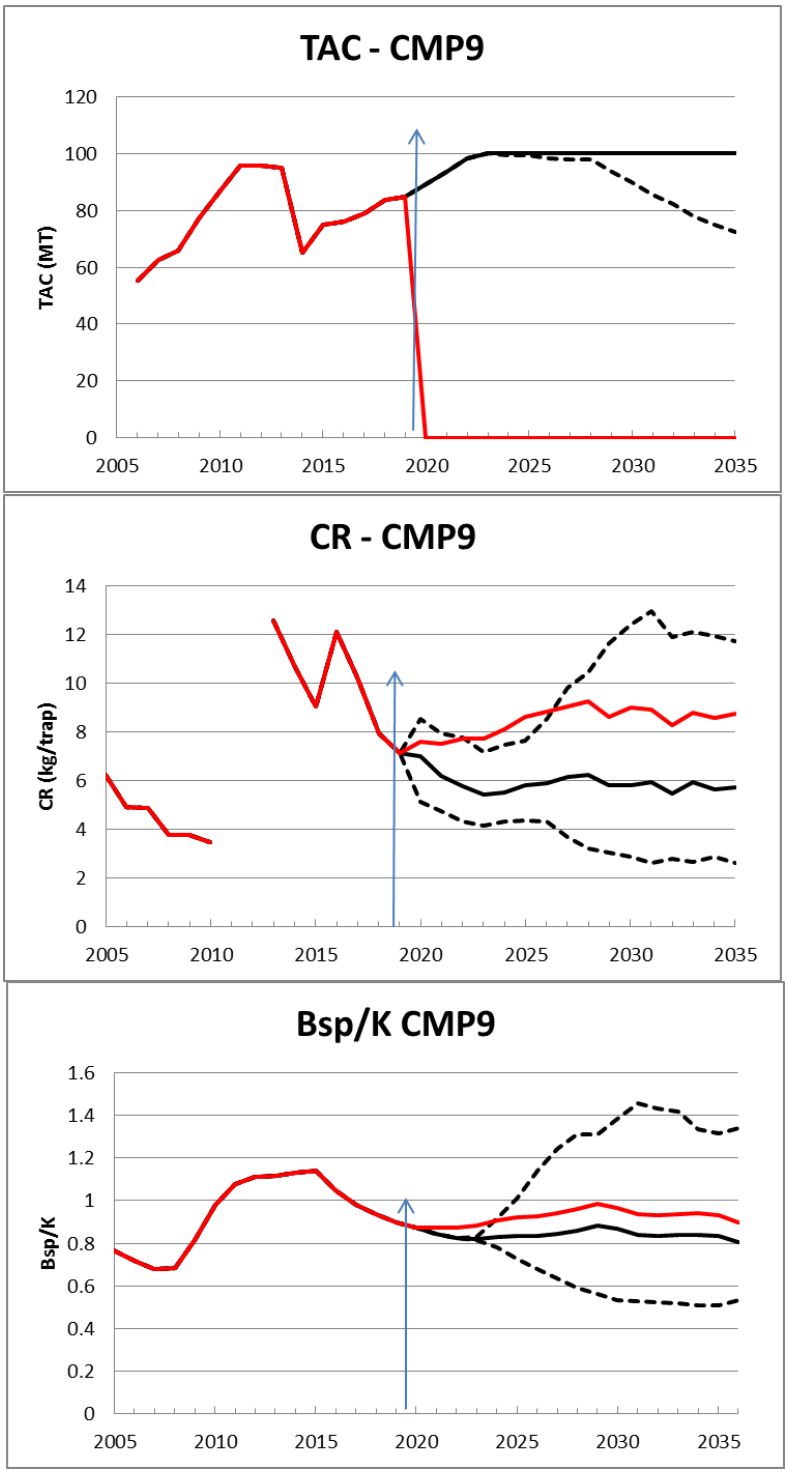


Figure 3b: Simulation results of the **ROB1** (10% of all lobsters die in 2020) robustness tests under CMP9 (TAC ceiling of 100 MT, Itar = 5) where the median, 5th and 95th percentiles values are shown. The median trajectories for a TAC=0 scenario are also indicated in red.

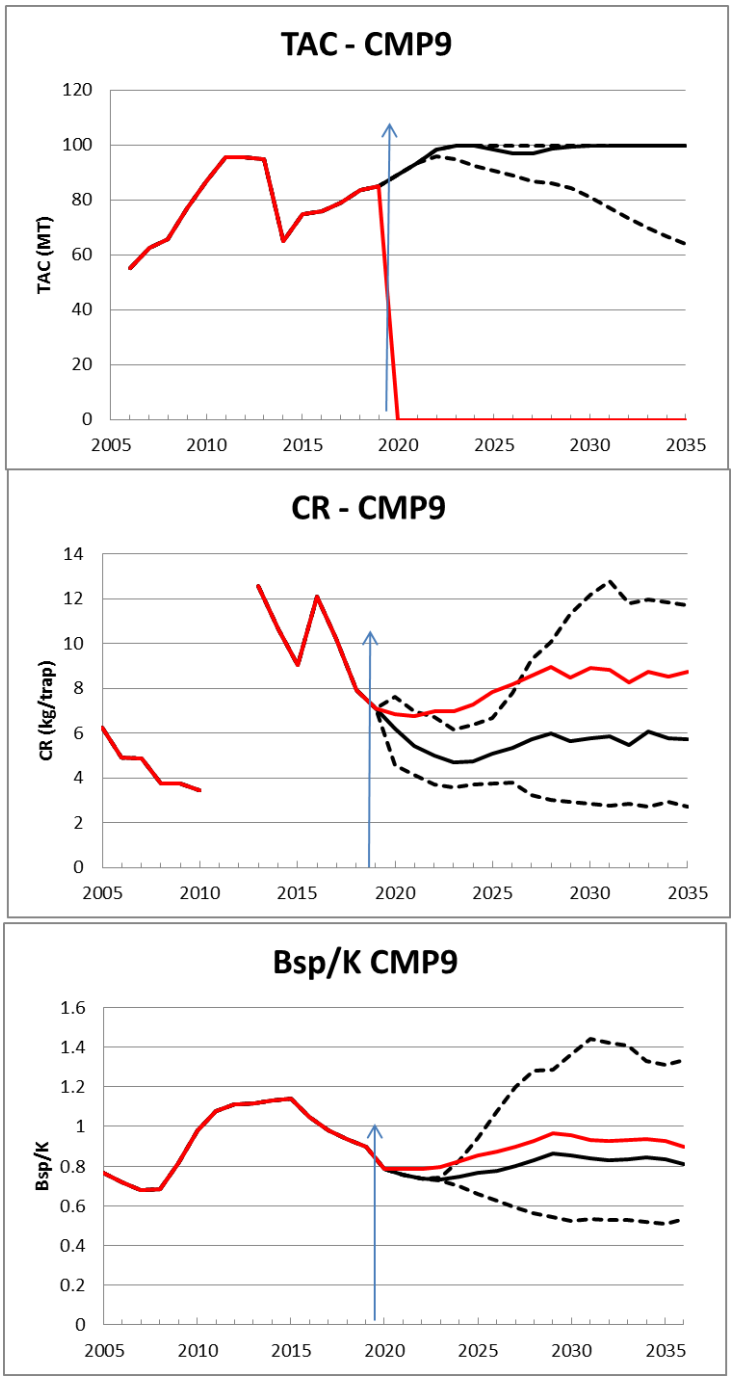


Figure 3c: Simulation results of the **ROB2** (30% of all lobsters die in 2020) robustness tests under CMP9 (TAC ceiling of 100 MT, Itar = 5) where the median, 5th and 95th percentiles values are shown. The median trajectories for a TAC=0 scenario are also indicated in red.

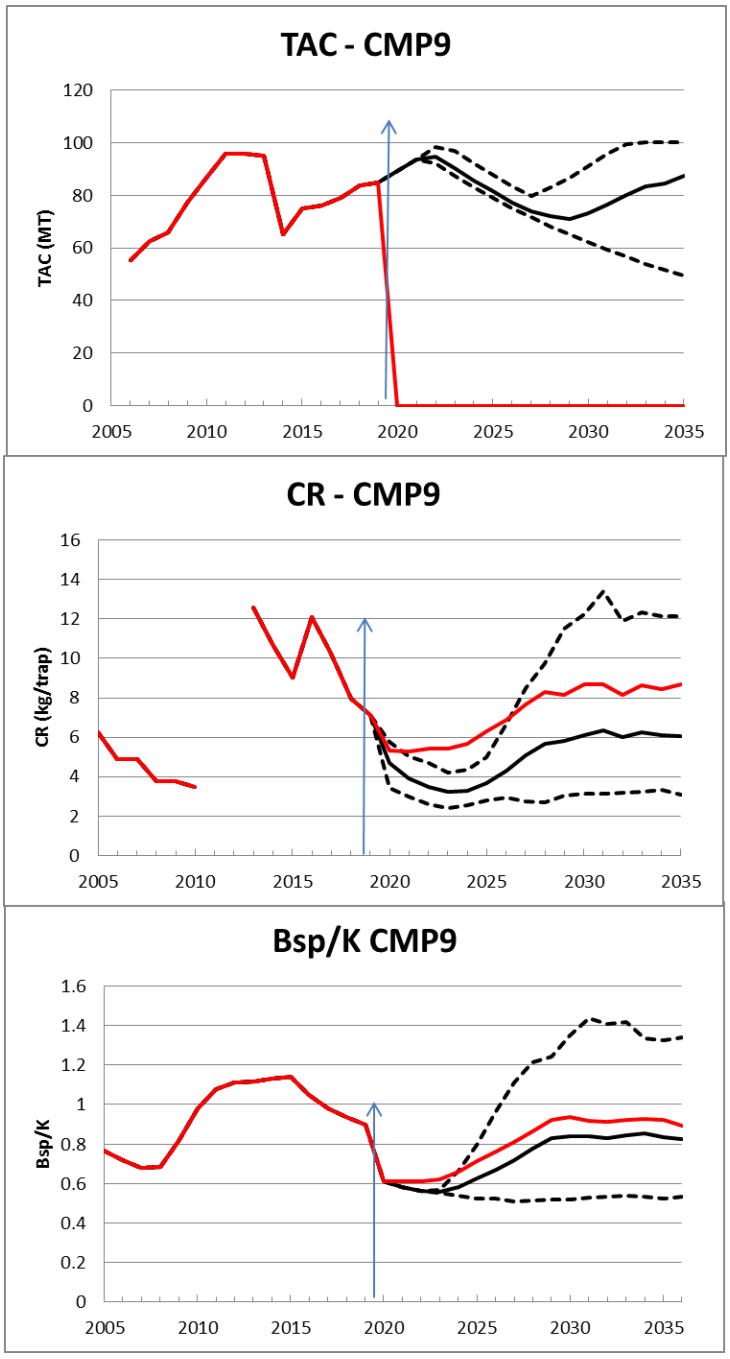


Figure 3d: Simulation results of the **ROB3** (50% of all lobsters die in 2020) robustness tests under CMP9 (TAC ceiling of 100 MT, Itar = 5) where the median, 5th and 95th percentiles values are shown. The median trajectories for a TAC=0 scenario are also indicated in red.