

## On options for the basis for future West Coast Rock Lobster TAC advice

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### Summary

In 2016, scientific recommendations for management of the west coast rock lobster (WCRL) resource changed to fall under the Exceptional Circumstances provisions of the then OMP, because of marked reductions in resource abundance and increases in poaching. At present, primarily for reasons of limited time, these scientific recommendations for TACs are being based on deterministic projections of a “best” assessment. This approach needs to be expanded to provide, at the very least, probability envelopes about these projections to take account of major uncertainties. Following that, decisions will be required on when to move back to an OMP as the basis for TAC recommendations. The main matters needing consideration in this process are discussed; these include whether or not poaching index values for future years should be input to harvest control rules.

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### Background

Until the 2016 season<sup>1,2</sup>, TAC recommendations (disaggregated by super-area) for the west coast rock lobster (WCRL) resource were generated from the OMP in place at the time. During 2016 the updated assessment conducted indicated a substantial reduction in abundance to have occurred over the preceding five years in super-area A8+, and furthermore revised estimates of poaching in this super-area indicated an appreciable recent increase. These results took the situation outside the range covered in the simulation testing of the then OMP, with Exceptional Circumstances consequently being declared and a larger TAC decrease than would have applied under the OMP being recommended, based on deterministic projections under the “best assessment” at that time.

The decision subsequently made by government was not to decrease the TAC. Stated briefly, effectively this sequence of events was repeated in 2017, in circumstances where continuation of the then current TAC was indicated not to be sustainable by deterministic projections.

In 2018 the poaching estimates and assessments from 2016 were updated, with advice given by the WCRL Scientific Working Group again being for a TAC reduction to minimally restore sustainability. Concurrently litigation initiated by WWF was in progress, which culminated in a judgement to the effect that future TAC decisions must be consistent with sustainability as indicated by scientific analyses. The TAC decision that followed for the 2018 season was

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<sup>1</sup> With one exception a few years earlier, with an adjustment being made subsequently to cater for the deviation.

<sup>2</sup> The split season is indexed by the first year, thus the 2016/17 season is referenced by 2016.

consistent with a preferred WCRL SWG TAC recommendation for a reduction over two years leading to a 7% increase in the male exploitable biomass (B75m) over the baseline 2006 level by 2025 as indicated by a deterministic projection of the best assessment. However, government is currently seeking leave to appeal this judgement.

### **Why immediately give advice on a “best deterministic assessment” basis?**

There were three reasons why this approach was used by the WCRL SWG for providing advice for the 2018 season.

- 1) Time limitations precluded finalisation of further analyses, including an evaluation of the uncertainties associated with the deterministic projections.
- 2) Even more so, such time limitations precluded a revision of and return to an OMP basis for such TAC advice.
- 3) Furthermore, the large time investment required for an OMP revision had to be weighed against longer term uncertainties associated with outcome from litigation and a current process of transfer of some harvesting rights from the existing commercial sector to co-operatives established in coastal communities for a “small scale” sector (the calculations required would become clearer/less extensive once these issues were resolved).

### **Taking account of uncertainties when projecting**

Even under “best assessment” (let alone OMP) based management, developing decisions from deterministic projections alone is questionable, as no account is taken of uncertainty, and its consequences for the risk to which the resource will be exposed.

In previous OMP evaluations, the primary axes of uncertainty taken into account were current abundance, and future recruitment and somatic growth. The associated specifications are detailed in Appendix A.

In moving forward, these uncertainties as well as those associated with the **past** extent and trends in poaching need to be taken into account. Obviously, there is also uncertainty about **future** trends in poaching, but the approach taken to date has been to assume that poaching continues at the level estimated for the current year, with changes to be made only following the provision of clear evidence that this has changed.

Discussion is needed on whether the general approach used in the past (Appendix A) for integrating over the various uncertainties to estimate some overall risk (e.g. lower 10% probability envelope for projections) should be continued, though possibly with a revision of the weighting factors allocated to the options considered along each uncertainty axis, and the introduction of such for weights for alternative poaching scenarios. Alternatively, at least for estimated resource status, if the current minimisation approach could be changed to one which (at least in principle) could provide a Hessian, a more comprehensive approach to take account of assessment-related uncertainties could be pursued.

## Moving on from a probability envelope about a deterministic projection to an OMP

The particular advantage of the OMP approach is that it evaluates risk taking the feedback effects from future data into account, effectively shrinking the probability envelopes about deterministic projections compared to those from the approach above. Thus, larger TACs become possible for the same perceived risk.

Certainly such shrinkage likely for harvest control rules<sup>3</sup> based on abundance index and somatic growth data, as in past OMPs for this resource. However, an important question arises about estimates of future poaching in this context. There are two ways this might be addressed which merit further discussion.

- a) Whenever in the future poaching is re-estimated and is found to be non-trivially different from the existing estimate, retune the OMP.
- b) Include the annual index of poaching for future years, given future data, as an input to the OMP itself, so as to impact the TAC recommendation directly; the key question that then arises though, is whether this index is as yet sufficiently reliably estimated to do so (see MARAM/IWS/2018/WCRL/P1).

## Other aspects

Further aspects meriting consideration are:

- i) How best are the trade-offs between resource growth with associated higher TACs in the future, and lower TACs in the short term, best summarised for decision makers?
- ii) In addition to the major axes of uncertainty listed above, robustness to other uncertainties also needs evaluation (see Appendix B for robustness tests considered in past OMP evaluations).
- iii) How best might potential stock-recruitment effects be taken into account (e.g. perhaps by use of hockey-stick relationships with hinge points at the lowest historical level of egg production).

## In Summary

To single out what are probably the major issues at this stage (at a framework level, without encroaching on policy-related choices, such as an acceptable specific probability level for risk within a biologically feasible space) which require decisions by local scientists, these might be the following.

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<sup>3</sup> Of note also is that if in future any form of ecolabel is to be sought for this fishery, adoption of a harvest control rule is likely to be a minimal requirement to be met.

- I) Whether there is any reason not to move from deterministic projections at this stage to ones also taking uncertainties into account so as to instead provide probability envelopes about projections to inform TAC recommendations.
- II) What are the major axes of uncertainty, which factors on each of those axes should be considered, and how is it best to integrate over them to develop probability envelopes about future projections under various future TACs?
- III) When to move back from a best assessment to an OMP based approach for TAC recommendations?
- IV) Whether to retune any approach (either best assessment or OMP based) each time another year's poaching estimate becomes available, or rather to include such a poaching index directly into a harvest control law?

## Appendix A

### Previous projection prescriptions to take account of uncertainties

Baseline future scenarios, which result as combinations of uncertainties regarding future recruitment, future somatic growth, and current abundance have been specified in the past. The following are the various possible options for each scenario, with the associated probabilities (or relative weights, WT) agreed at the last occasion. The three factors were treated as independent, so that the probability of any combination was given simply by the product of their individual probabilities.

[The prescriptions below include “obvious” extensions to update to the current assessment.]

#### Recruitment

##### Median future recruitment

	<b>WT</b>
• FRM: Geometric Mean of $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$	0.60
• FRH: Maximum of $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$	0.30
• FRL: Minimum of $R_{75}, R_{80}, R_{85}, R_{90}, R_{95}, R_{98}, R_{01}, R_{04}$	0.10

Note however that on the last occasion the FRL option excluded certain extremely low estimates which were  $R_{01}$  and  $R_{04}$  for super-area A12 and  $R_{80}$  for A7. [Decisions regarding such exclusions will need to be revised given the 2018 updated assessment results.]

These specifications are readily extended to include  $R_{07}$  and  $R_{10}$ .

##### Future recruitment

For FRM future  $R_y$ : where  $y = 2013, 2018+$ ; linearity between these two years (and between 2010 and 2013).

Stochastic:  $R_y$  randomly selected from  $\bar{R} e^{\varepsilon_y}$ , where,

$$\ln \bar{R} = \frac{1}{10} (\ln R_{75} \dots \ln R_{10})$$

$$\sigma = \text{SD of } (\ln R_{75} \dots R_{10})$$

$$\varepsilon_y \sim N(0, \sigma^2)$$

Or for FRH and FRL, the  $\bar{R}$  is replaced by either the maximum or minimum  $R$  from  $R_{75} \dots R_{10}$  (with the exceptions noted above).

##### Future Somatic growth (2018+)

	<b>WT</b>
• FSGL: = the 1989-2017 average	0.80
• FSGM: $\uparrow$ linearly to the 1968-2017 average by 2020	0.20

[The above applied previously to the growth rates for super-areas A34, A56, A7 and A8+. The somatic growth rate for Area 12 is assumed to remain constant in the future at the 1989-2017 average level for all scenarios.]

### Current Abundance levels

- For the RC model  $R_{10}$  is an estimable parameter, although it is estimated with low precision. Alt1 and Alt2 models correspond almost exactly to the RC best fit parameter values except for  $R_{10}$  which is fixed at the (approximate) upper and lower 25%iles of this distribution as follows:

$$\ln R_{10}^{alt1} = \ln \hat{R}_{10}^{RC} + \sigma \alpha \quad (\text{A.1})$$

and

$$\ln R_{10}^{alt2} = \ln \hat{R}_{10}^{RC} - \sigma \alpha \quad (\text{A.2})$$

where  $\sigma$  is from equation (4) below, and the  $\alpha$  value (0.706) corresponds to the 25%iles of a  $t$ -distribution with the appropriate number of degrees of freedom:

$$\ln \bar{R} = \frac{1}{10} \sum_{y=1975}^{y=2010} \ln R_y \quad (\text{A.3})$$

$$\sigma^2 = \frac{1}{9} \sum_{y=1975}^{y=2010} (\ln \bar{R} - \ln R_y)^2 \quad (\text{A.4})$$

- |   | <b>WT</b> |
|---|-----------|
| • RC: Best Estimate of $R_{10}$             | 0.50      |
| • ALTL: Estimated lower 25%ile for $R_{10}$ | 0.25      |
| • ALTH: Estimated upper 25%ile for $R_{10}$ | 0.25      |

## Appendix B

### Robustness Tests

The following table (developed in 2007) provides an initial list of robustness tests to be used to test the robustness of the underlying operating models to various model assumptions (Category A tests) and to evaluate the performance of various candidate OMPs (Category B tests). Suggested priorities of each test is given, where I is the highest priority.

**CATEGORY A:** One (or several) of the assumptions of the underlying operating model itself, or the data to which it was fitted, are altered, thus requiring the model to be re-fitted to the data by maximising the likelihood function.

**CATEGORY B:** These tests examine the robustness to assumptions relating to the future of the resource and monitoring data. During the OMP testing, it is assumed that the OMP is not “aware” of these changes.

<b>CATEGORY A TESTS</b>	<b>Description</b>	<b>Suggested Priority</b>
<b>HC</b>	Examine alternate inter-areal split of historic catches	II
<b>SEL</b>	Alternate selectivity functional forms	I
<b>MOD</b>	Start model in 1970	II
<b>NS1</b>	Male natural survivorship = 0.88 (RC = 0.90)	I
<b>NS2</b>	Male natural survivorship = 0.92	I
<b>NS3</b>	Alter natural survivorship function so that maximum survivorship occurs at 80mm (not 60mm)	II
<b>D2</b>	Discard mortality = 0.2 (RC = 0.1)	II
<b>D3</b>	Discard mortality increases 5 yrs prior to min size change in 1993	II
<b>SG1</b>	Adult growth is 0.5mm more than thought	II
<b>SG2</b>	1870-1967 growth = 68-88 average (i.e. historic growth excludes low growth period in average)	I
<b>SG3</b>	Pre-1990 growth shifted down to 1990+ average level	II
<b>SG5</b>	Adult somatic growth rate smaller at large sizes	III
<b>W1</b>	1990+ 225 MT walkout each yr	III
<b>W2</b>	Once every decade 1870-1990 500 MT walkout	III
<b>P</b>	Poaching has increased linearly in the last five years by 10% p.a.	I
<b>CATEGORY B TESTS</b>		
<b>C1</b>	Future TAC levels are over caught by 5%	II
<b>E1</b>	Recruitment drops 50% for a 3 year period, once in 1995-2010	I
<b>E3</b>	25% all lobsters die once 2003-2016	II
<b>P1</b>	Poaching reduced next 5 years from 500 to 200 MT	III

<b>P2</b>	Poaching increased next 5 years from 500 to 1000 MT	I
<b>TH1</b>	Future trap:hoop 60:40 (RC: 80:20)	II
<b>B2</b>	Future adult somatic growth 0.5mm than thought	III
<b>B3</b>	Future adult somatic growth 0.5mm less than thought	II
<b>W1 future</b>	Future walkouts continue at 1990s rate	I
<b>W3</b>	W1 above, but 400 MT walk-out annually 2006+	III
<b>M1</b>	FIMS index missing	III
<b>M2</b>	Somatic growth index missing	III
<b>COMP</b>	Hard combination of tests	I
<b>RECR</b>	Recreational implementation error	I
<b>IR</b>	Interim relief error	I