Responses to IWS 2018 workshop recommendations made with respect to West Coast rock lobster

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EXTRACTS ARE FROM THE INTERNATIONAL REVIEW PANEL REPORT FOR THE 2018 INTERNATIONAL FISHERIES STOCK ASSESSMENT WORKSHOP 26 -30 November 2018, UCT. [Sean Cox[1], Sarah Gaichas[2], Malcolm Haddon[3], and André E Punt[4]]

Responses are shown in *italics*.

General West Coast Rock Lobster commentary

The analysis of trends in poaching catches has been much improved by compliance data that recently became available and that link policing effort type to confiscations (the 'new' database) (though these are somewhat limited in number). Interestingly, the trend in poaching (taken to be indexed by the ratio of confiscations per unit of policing effort) over time using the revised data and analyses is similar to that computed last year for both super-areas 3+4+5+6+7 and super-area 8+. Nevertheless, this estimate of trend in poaching is more reliable given the availability of the 'new' database. The Panel recommends that, to enable more detailed analyses, this database be improved further by recording cases in which no confiscations occurred rather than only those cases in which there was a confiscation.

Response: This is to be followed up within DAFF/DEA for future data collection/recording.

The estimates of poaching are based on the compliance data and data from TRAFFIC. However, these data sources do not account for domestic sales of illegal catches. The Panel encourages efforts to obtain data on local sales to better estimate total poaching catches, and hence to better evaluate the impact on this resource.

Response: A Task Group has met to discuss this issue. A project to be funded by TRAFFIC is being developed to collect data on local sales.

The latest stock assessment indicates that the WCRL resource has been at low levels since about 1968 and is now down to 1.8% the estimated 1910 biomass[5]. This pattern of long-term decline implies low resilience to historical removals (legal and illegal) combined with environmental shocks and periods of low recruitment. Poaching is now at high levels irrespective of how it is estimated.

Response: The current depletion estimate is now 1.7%, but there have been indications of a reduction in poaching (see for example MARAM/IWS/2019/WCRL/P1)

The projections used to select WCRL TACs consistent with avoiding further decline were implemented by projecting poaching at current levels and the central tendency of recent recruitment (given by the geometric mean) forward through to 2025. These projections could be improved in several ways: (a)

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[5] More specifically, the metric used is the male biomass above the lowest legal size of 75 mm carapace length.

bias-correct the geometric mean assuming log-normality, (b) use an arithmetic mean recruitment, (c) use bootstrap samples of the empirical distribution of recruitment values in the projections, or (d) preferably by re-parameterizing the 1975-2017 recruitment parameters via an estimated mean level ($\bar{R}$) multiplied by annual recruitment deviates. This last parameterization would enable projections via randomly selecting recruitment values from their estimated distribution. Even so, further potential declines are predicted without a substantial reduction in both catch and poaching.

Response: See related responses below.

Assuming that poaching continues at current levels, a 244 t TAC is needed to achieve a male WCRL harvestable biomass 7% above the baseline 2006 level by year 2025. The TAC for the current season has already been reduced from 1,924 t to 1,084 t, with another reduction down to 244 t proposed for the following season. While the increase in male harvestable biomass is 30% over the estimated level in 2018, the predicted harvestable biomass in 2015 will still be only 2.31% of the estimated 1910 level. Improvements in recruitment projection methods, as suggested above, may result in a lesser TAC decrease than currently indicated for the 2019/2020 season.

Response: See MARAM/IWS/2019/WCRL/P2 ~~later~~ for detailed response and updated results.

Q1: Have the Panel's 2017 recommendations about the analysis of the compliance data to estimate poaching trends been appropriately addressed?

The Panel's evaluation of the analyses in MARAM/IWS/WCRL/P1 focused on whether the compliance data had been re-analysed as recommended during IWS 2017 and not (as requested) on how the poaching scenarios used in assessments and projections were developed. The revised analysis was based on a small 'new' database that includes data on confiscations and the associated effort type, which hence addresses the recommendation from IWS 2017. The analysis in MARAM/IWS/WCRL/P1 of the 'new' database led to fairly imprecise estimates owing to low sample size. An alternative analysis that uses both datasets simultaneously (and propagates uncertainty of the estimates of effort type efficiency factors better) would be:

$$C^{new}_{y,m,t} \sim E^{new}_{y,m,t}\,\text{Negative\_binomial}(\exp(\mu^{new}+\alpha_m+\delta_y+\beta_t),\delta)$$
$$C^{old}_{y,m} \sim \text{Negative\_binomial}(\sum_t Q_t e^{\beta_t} E^{old}_{y,m,t}\exp(\mu^{old}+\alpha_m+\delta_y),\delta)$$

where Q_t is the factor to account for the fact that the new database does not include zero catches (pre-specified based on Table 1 of MARAM/IWS/WCRL/P1). One disadvantage of this approach is that the information in the 'new' database is included in the old database. However, the overlap is likely small given the low number of observations in the new database, and this disadvantage is likely outweighted by the benefits of estimating common month and year factors, and propagating the uncertainty in the estimates of efficiency factors.

Response: See MARAM/IWS/2019/WCRL/P1 for an application of this approach.

Q2: Have updated assessments of the resource been carried out appropriately?

There is only one major change to the assessment methodology since the 2010 assessment, which is the estimation of the recruitment for 2010. However, many of the data sources have been updated based on recent data. The Panel did not detect any reasons that the updated assessment could not be used for management purposes.

The Panel strongly recommends that the assessment model be re-coded in ADMB to facilitate easier model diagnostic analyses such as assessing parameter sensitivity via the gradient, likelihood profiling, parameter correlation and possibly Bayesian MCMC simulation, once model structure and parameterization is adequate to provide convergence.

Response: Due to various constraints (unavailability of analyst for a period and lack of clarity over funding) the assessment model has not yet been re-coded in ADMB. As a simpler first step, implemenation using other FORTRAN software which also provides Hessians (e.g. use of MINIM) is planned. Focus has first concentrated on modifying assessment and projections of recruitment as suggested by IWS panel.

Q3: How could these assessments be improved, with prioritised suggestions related to data and to analysis methodology?

1. The Panel notes with concern that no length-frequency data have been collected from the fishery catches since 2008. These data are important to allow recruitments to be estimated more precisely. The Panel recommends that DAFF scientists and managers work to re-initiate collection of these data. In other regions of the world (e.g. New Zealand) length-frequency data are collected at low cost by industry with some observer validation. A similar approach in South Africa would enhance future assessments and should be discussed.

   Response: No progress has been made on this issue due to lack of resources.

2. Possible use of a stock-recruitment relationship relies on the estimation of egg production. Calculation of egg production should account for changes over time in maturity-at-length. If there is to be an increased focus on egg production, additional tagging to estimate recent somatic growth rates for females should take place.

   Response: No progress has been made on the additional tagging suggested due to funding constraints.

3. The fits to the data should be annotated with measures of uncertainty and bubble plots provided for the fits to the composition data to help assess whether the model fits the data adequately.

   Response: This will be done for future assessments.

4. The assessment assumes that somatic growth prior to 1968 equals the average from 1968 onwards. This assumption may have been appropriate when the assessment was first developed, but should be reviewed by the DAFF WCRL SWG, and the alternative assumption that pre-1968 somatic growth equals the average over some of the first years for which estimates of somatic growth are available examined.

   Response: Future (2019+) somatic growth is now assumed equal to the 1989-2018 average somatic growth level (1989 was the initial year when somatic growth reductions were detected). Note that the 2018 somatic growth rate is the lowest on record so that no sign of recovery to historical higher levels has been evident.

5. The assessment is coded in FORTRAN, which means that exploration of scenarios is slow and measures of uncertainty cannot be produced easily. The model should be recoded in ADMB – perhaps with a prior on the recruitment in 1910 (unless recruitment is re-parameterized as per below).

Response: See response to Q2 above.

6. The assessment does not fit some of the average (over time) length-composition data sets, especially those for females. Alternative selectivity assumptions should be explored to assess whether the fits can be improved. However, care should be taken to avoid overly and unrealistically complex selectivity patterns (a recommendation from IWS 2010).

   Response: No further progress on this issue as yet because of resource constraints.

7. Explore whether the data currently available are sufficient to construct models that split some of the super-areas into inshore and offshore components. Such models will likely have to estimate movement between the two components, which will require tagging data.

   Response: No further progress on this issue as yet because of resource constraints.

8. Inclusion of environmental covariates in the GLM may explain some of the variance in catch rates, but such inclusions often do not change the results and should only be considered if there is a plausible biological mechanism for the relationship between the covariate and catchability. There may be value in including depth as a covariate in the GLM (assuming the necessary data are collected).

   Response: No progress has been possible on this issue as no depth (nor other environmental covariates) are currently recorded.

9. Conduct sensitivity tests in which catch-rate is assumed to be non-linearly related to abundance.

   Response: See MARAM/IWS/2019/WCRL/P3 for recent results.

Q4: Have updated resource projections under alternative future levels of catch (both legal and illegal/poaching) been carried out appropriately and how might such projections be best improved methodologically in future, including in particular taking account of stock-recruitment effects?

Key assumptions underlying the methodology used for future projections are that (a) somatic growth for males is the average of the estimates for 1989-2018, and (b) future recruitment is equal to the simple geometric mean from 1975-2010. Although assuming constant recruitment is common in some circumstances where resource abundance is relatively high, there is concern that projected recruitment and abundance will not adequately reflect impacts of fishing, especially under a constant TAC plus poaching on the very low abundance stocks in all the WCRL super areas. Figures 1 and 2 plot somatic growth rates and recruitment spatially, and all of these are clearly suggestive of variation among years.

Future projections should consider uncertainty in recruitment, somatic growth, and resource abundance.

- Recruitment processes are poorly understood for many invertebrate stocks, mainly because of uncertainty about spatial and reproductive dynamics (e.g. role of males, male-female ratios). In the absence of clear hypotheses for reproductive dynamics, the Panel recommends two parsimonious assumptions about future recruitment: (1) sampling from recruitment values – this approach makes the fewest assumptions about the form and distribution of recruitment, and simply relies on the best-estimated historical pattern though at the cost of assuming that future recruitment is independent of abundance, and (2) sampling recent recruitment rates (i.e., recruits/egg production) from the stock assessment – this approach would additionally create feedback between egg production (and hence link to legal and illegal catch) and future recruitment. As in (1), process error could be bootstrapped from residuals about the mean recruitment rate.

Response: A variant of (1) was applied (MARAM/IWS/2019/WCRL/P2). Calculation to take account of possible recruitment versus egg production relationships are underway.

The recruitment estimates for 2007 and 2010 each had a penalty to constrain their values and prevent their estimates being unrealistically large or small. The penalties should be calculated without including the recruitment values for 2007 and 2010. Projections of recruitment, which are currently based on the geometric mean, need to be adjusted to better reflect the production from the resource which is the most likely in the future. There are various ways that merit consideration to do this, which the DAFF WCRL SWG will need to evaluate: for example, bias-correct the geometric mean assuming log-normality; use an arithmetic mean; use bootstrap samples of the empirical distribution of recruitment values in the projections, although these would best be set up as recruitment residuals (deviates) from some measure of central tendency ($\bar{R}$) (see below).

Response: These suggestions have been taken into account in the updated assessment (see MARAM/IWS/2019/WCRL/P2 for details).

- The estimation of $\bar{R}$ would permit the generation of a likelihood profile on $\bar{R}$ as a means of characterizing uncertainty around recent recruitment.

  Response: See MARAM/IWS/2019/P3 for likelihood profile on $\bar{R}$ for super-area A8+.

- Somatic growth has changed over time, which leads to two scenarios: (1) somatic growth remains low, and (2) somatic growth increases back to historical levels. Projections should be conducted for both scenarios, with weights assigned by the DAFF WCRL SWG.

  Response: Given that there has been no indication of a recovery in the low somatic growth rates to historical levels (the 2018 somatic growth rates are the lowest on record), the SWG have decided the most appropriate scenario for future somatic growth rate is that the somatic growth rate remains low.

- Previously, uncertainty in historical and projected resource abundance was dependent on uncertainty in R_{2010}, which, unfortunately, does not fully quantify uncertainty. Another way to represent resource uncertainty is to re-parameterize recruitment (after 1975) as multiplicative deviations about a mean level ($\bar{R}$). Projections could then be conducted by repeatedly selecting a value of $\bar{R}$ based on its probability from a likelihood profile. A range of options for conducting projections from these $\bar{R}$ values should be considered by the DAFF WCRL SWG, including basing these on the full set of parameter estimates corresponding to each selected $\bar{R}$ and resampling from the associated recruitment deviations.

  Response: This level of complexity has not been fully taken into account yet, but the approach adopted (see MARAM/IWS/2019/WCRL/P2) did incorporate some of these suggestions.

- The results of projections should be shown for each scenario regarding somatic growth and not for the weighted result alone.

  Response: Not currently taken into account yet, given the decision (for immediate purposes) to focus on only one future somatic growth option.

- In addition to showing projection envelopes, the probability of dropping below the current and the 2006 biomass should be reported to include in the basis for selecting future TACs.

  Response: These probabilities can be approximately inferred from Figure 8 of MARAM/IWS/2019/WCRL/P2.

The stock-recruitment plots in MARAM/IWS/WCRL/P5 were hard to interpret because (a) no account was taken of time-varying maturation schedules, and (b) the data points do not exhibit compensatory dynamics, which preclude fitting standard (e.g. hockey-stick) stock-recruitment relationships. Some of the projections lead to reductions in biomass below previously observed levels. It is plausible that recruitment would be expected to decline if this occurs, but the current data provide little quantitative basis for specifying expected recruitment at egg production levels lower than have been observed historically. Given the current stock status, any decline in egg production should be considered to reflect a large increase in risk to the resource.

Response: Followed up in document MARAM/IWS/2019/WCRL/P3, which includes past S/R plots.

Q5: In the current situation, what schedule would be appropriate to return to an OMP basis for management recommendations, and how should future data/indices on poaching best be treated in this process?

The Panel emphasizes that OMP-based management remains the preferable way to provide scientific management advice for marine renewable resources. However, the Panel does not recommend that an OMP development process be re-initiated until there is more clarity regarding the future management structure (e.g. the allocation among sectors) and also future data collection strategies. Given the likely changes in allocation, the Panel strongly recommends that the small-scale sector be monitored at least for both total (landed) catch, discards and catch-rate.

Response: Management of the resource has not yet returned to an OMP basis, with recommendations based on various constant catch scenarios. This will be revisited during the coming year, inter alia once the issue of the future spatial aspect of allocations has been finalised.