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Updates to the CCSBT Operating Model including new data sources, data weighting and re-sampling of the grid

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Abstract

The CCSBT intends to undertake a full stock assessment in 2014. The recent OMMP meeting held in Portland Maine discussed the key technical and operational details relating to updating the OM for new data sources and key data weighting and parameter re-sampling schemes. This paper will detail how the key outcomes from this meeting relate to current OM structure and diagnostics, and the steps required in relation to undertaking the stock assessment in 2014.

1 Background

With the adoption of the CCSBT Management Procedure (MP), TAC decisions are no longer based on the CCSBT Operating Model (OM). However, the OM is still a key tool in tracking the status of the population under the action of the MP. As per the agreed timeline the CCSBT ESC intends to undertake a full stock assessment in 2014, with the OM updated for the most recent - and any new and agreed - data sources.

This paper details the key technical and operational details relating to the upcoming 2014 assessment. Key issues are:

- How data sets are weighted within the OM
- How key parameters and variables in the grid are resampled
- How will new data sources - primarily the close-kin data - be included in the OM

2 Data weighting

Focussing first on the established OM data sets - catch composition, tagging, abundance indices - this section outlines the data weighting schemes as discussed and developed over the years, and detailed in [1]

2.1 Catch composition

These data, whether catch-at-length or catch-at-age, are modelled with the same multinomial likelihood in the OM. For this likelihood an *effective sample size* is required, which essentially defines in some way the "true" number of random samples given the data and the model. In previous years iterative approaches have been suggested, in terms of estimating this effective sample size and this is detailed in [2].

In practice, given some of the issues relating to the relative influence of the early long-line composition data, the flexibility of the selectivity has also been altered over time. The rationale being that we want to account for these catches in the past, but effectively down-weight any influence these data have on other key parameters (such as M or steepness). We should, therefore, be wary of strictly adhering to some kind of iterative re-weighting for the effective sample sizes. Freeing selectivity will generally mean we fit the data better, but that will suggest our effective sample size should be higher and we should up-weight these data. This would be a somewhat circular mechanism as up-weighting the data would increase their influence, which was the main reason for freeing up the selectivities in the first place.

One suggestion is to not commit to a rigid scheme for weighting the catch composition data but simply continue the approach used in previous years: Monitor how well these data are fitted and their influence on key parameters (via the likelihood profiles) and discuss and agree appropriate sample sizes and selectivity regimes.

2.2 Tagging data

In the OM the tagging data are modelled at a reasonably low level of aggregation:

- Tagger group (from 1 to 6)

- Cohort (1989-1994)
- Release age (1-3)
- Recapture age (1-7)

For each tagger group, cohort and release age the subsequent recaptures-at-age are modelled using the Dirichlet-multinomial distribution. This flexible approach allows for the inclusion of over-dispersion (variability beyond that expected by the multinomial) due to factors like schooling or individual variation in recapture probabilities and so on.

In previous years, the variance inflation/over-dispersion factor was calculated by balancing the variation in the standardised recapture residuals. This should equal 1 if our assumptions are correct, so this over-dispersion factor is simply increased until this is the case. This calculation has been done over the whole tagging data set, but in [2] some more detailed diagnostics were done at the level of aggregation of the tag data as they appear in the OM.

For the grid estimated for the initial inclusion of the close-kin data [3] there were no obvious issues at these lower aggregation levels. We suggest that similar diagnostics be performed alongside the more aggregated over-dispersion calculations for the 2014 assessment.

2.3 Abundance indices

The two main abundance indices currently included in the reference set of OMs are the standardised Japanese long-line CPUE and the scientific aerial survey data. For the CPUE data a log-normal distribution is assumed with a minimum CV of 0.2 assumed for the total variation (i.e. both observation and process). For the aerial survey data the full observation covariance matrix (across years) derived in the standardisation is included, with a fixed diagonal process error term of around CV 0.18 included as well.

In [2] a predictive approach, similar to that used in Bayesian analyses, is outlined that assesses both how well the OM is fitting to these data *and* how well it is predicting the variation in the observed data across the full grid. This simple approach can be applied to all abundance indices that could be used and provides a readily interpretable way of assessing how the OM handles the abundance indices.

3 Grid resampling

Although there are a number of elements within the grid, we focus on the natural mortality and the steepness here as only these grid elements were the focus of the most recent OMMP meeting. No suggested changes to other grid elements are being envisaged at this stage.

3.1 Natural mortality

In previous OM conditionings the natural mortality grid elements, M_0 and M_{10}, have been resampled using objective function weighting. The recommendation of the last OMMP meeting was to continue this approach [1]. One issue that needs to be addressed is the apparent preference for low values of M_{10} given the inclusion of the close-kin data [1, 3]. The recommendation was that two extra low levels of $M_{10} = 0.03, 0.04$ be added to a sensitivity grid run to explore how low the preference for this parameter might be. These results will be presented and discussed at this meeting for final agreement on the grid structure for 2014.

3.2 Steepness

The steepness parameter has also been recently resampled using objective function weighting. With the inclusion of the close-kin data it has become apparent that the only clear information on steepness is now coming from the recruitment deviation penalty [1, 3], and the clear preference is for lower values. While the OMMP group agreed that this was not in principle necessarily spurious information, the fact that such a key parameter is being forced only by its prior is of concern because we must then be sure that our specification for the prior is valid.

This concern led the OMMP group to explore how including the strong, temporally varying levels of auto-correlation in the recruitment residuals influenced the prior weighting for steepness. The story is a complex one, with different time periods in the recruitment history having far stronger influence on steepness than others [1]. The main message was that the inclusion of first order auto-correlation did notably decrease the recruitment penalty's preference for low steepness, and seemed to shift to weaker preference for intermediate steepness levels.

The general view of the OMMP was that, although there was still some weaker information coming from the adjusted steepness penalty, uniform weighting on steepness should be used for the updated grid re-sampling scheme. This did mean that, to define a usable range for the steepness, the potential preference (or otherwise) for lower levels of steepness than those currently in the reference grid needed to be explored. The current range in the grid is between 0.55 and 0.9, but two lower values of 0.38 and 0.3 were included in a sensitivity run at the OMMP workshop. The close-kin data in particular but also the CPUE data showed very little preference for the low steepness values and so it was agreed that the current 5 steepness values would be maintained, but that prior weighting would be used to resample steepness not objective function weighting.

4 New data sources

4.1 Close-kin data

The general format of the close-kin data (in terms of their inclusion in the OM) are the same as already outlined in [3]. Also, the likelihood model for the detected parent-offspring pairs (POPs) is also unchanged from that explained last year [3], which itself closely mirrors that used in the standalone close-kin analysis [4].

While the OMMP group agreed that the biomass of animals age 10+ should remain the reporting variable for stock status, it acknowledged that including the close-kin data means redefining the currency of the OM from SSB 10+ to effective reproductive output [1]. Key processes involved are residence time and vulnerability on the spawning grounds, as well as the size and age-at-maturity.

Given no direct information on spawning ground residency, and the fact that the primary observations of maturity come from animals caught on the spawning grounds, some additional assumptions and calculations needed to be made. Attachment 4 of [1] summarises the detailed definitions required to explain how all the factors influence our definition of effective spawning population.

The OMMP group agreed that residence time and fishery vulnerability were the two key - and with present information inseparable - uncertainties. To cover a plausible range of options relating to residency/vulnerability/maturity four specifications were defined; to cover a plausible range of options relating to the proportion of immature animals that visit the spawning ground four options were defined. From this set of 16 possible combinations 7 were chosen that would best span the range. The overall effect of these different scenarios, in relation to SSB and relative recruitment depletion, were negligible; as a result, option 4 from Table 4 of [1] (logistic profile) was chosen with the $\lambda = 0.5$ immature/mature spawning ground scenario.

5 Discussion

This paper summarises the key issues to be addressed for the upcoming stock assessment in 2014: data weighting, grid configuration of the reference set of OMs, the inclusion new data sources.

In relation to data weighting, for the catch composition data the suggestion is to maintain the previous approach: monitor the influence of these data on key OM parameters like steepness and natural mortality and adjust selectivity and/or sample sizes after any discussion and agreement. For the tag data, previous approaches to calculating the over-dispersion factor should be continued but with the addition of some finer-scale analysis that reflects the disaggregated nature of these data in the OM. For the abundance indices, a quasi-Bayesian predictive approach is outlined that can simply assess the explanatory performance of the OM relative to these types of data.

For the grid configuration of the reference set the recommendation of the OMMP group was to continue with objective function weighting for the two natural mortality parameters M_0 and M_{10}. One issue that must be addressed before agreement here is how far does the inclusion of the close-kin data push the preference for low M_{10} values. For steepness given the previous penalty was now the only informant on this key parameter, and the assumption of no auto-correlation was not true and complicated over time, objective function weighting was not thought to be the best way forward. The data themselves show very little support for values of steepness lower than the range already defined in the grid, so the recommendation was to proceed with prior weighting for steepness.

In relation to including the close-kin data, it was agreed that there is no current information available that could effectively unravel the effects of residence time, fishery vulnerability and the dynamics of mature and immature fish. A range of plausible options were explored and the OM was found to be very robust to this range, in relation to relative depletion in both SSB and recruitment. Given this robustness, the default scenario chosen to define the effective reproductive output represents an intermediate choice given the plausible options explored, in terms of the relative output of younger vs. older fish.

6 Acknowledgements

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