Suggestions for Simulation Testing of Adaptive Management Procedures for Horse Mackerel

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Introduction

Juvenile horse mackerel are caught as bycatch in the small pelagic fishery. Therefore, in years of high horse mackerel recruitment, it can be difficult for the pelagic industry to meet their directed catch targets for anchovy in particular while simultaneously remaining within the Precautionary Upper Catch Limit for juvenile horse mackerel. This difficulty occurred in 2011 and led to lengthy closures (and losses of potential anchovy catches) while analyses were performed to investigate the impact of an *ad hoc* increase in the PUCL. Accordingly, we seek to develop an adaptive rule which can adjust the PUCL timeously should there be an indication of high horse mackerel recruitment. November pelagic acoustic surveys could serve as such an indicator; however, results thus far suggest that pelagic survey results may only be weakly correlated with horse mackerel recruitment.

A further difficulty in managing this resource is that demersal swept area surveys, which currently provide the best absolute estimates of horse mackerel abundance, are believed to be negatively biased, but to an unknown extent. However, precautionary management must at this stage consider the conservative assumption that these abundance estimates are unbiased. Consequently, it is possible that the resource is being under-utilised. To improve utilisation, an adaptive policy is planned which will gradually increase the mid-water catch limit until such time that resource monitoring indices indicate the need to cease or reverse this.

A management procedure approach is envisaged to test candidate adaptive rules, with suggestions for the basic elements of this set out below.

Operating model

The operating model will be an age-structured production model (ASPM) that is fitted using demersal survey results and a mid-water CPUE series as abundance indices, and catch-at-length data from the pelagic, demersal and mid-water fisheries. Key uncertainties to include in the robustness tests as there are difficulties in estimating the associated parameters for the operating model are: the bias in demersal abundance estimates, the “steepness” of the stock-recruitment relationship, the variance in fluctuations about expected recruitment, natural mortality, and the age-specific fishing selectivity of the fleets. The operating model proposed is that used for the assessment, which is described in full detail in Furman and Butterworth (2011).

Generating future data

At this stage of the MP process it would seem that only survey and CPUE data need to be generated, as it is unlikely that first stage rules will be based on anything other these abundance indices. Noise will be added to generated survey and CPUE data by assuming that future generated values are log-normally distributed about their expected values, where these log-normal distributions have CVs as estimated when fitting the operating model. Further, it will be necessary to check historic data for autocorrelation between years for each index, and also for correlations between different indices. These correlations will be taken into consideration when generating the noise in future indices.

Because horse mackerel are caught as bycatch in the pelagic fishery, it will be necessary to model the extent of pelagic under-catch. At this initial stage, it will probably be adequate to treat the horse mackerel bycatch in the demersal trawl fishery as fixed at its average over recent years.

Performance statistics

A suggestion is to start with a standard set which calculates the following for the next twenty years:

- average mid-water catch,
- average pelagic catch,
- B^{sp}/K^{sp} at the end of the period,
- the minimum B^{sp}/K^{sp} during the period, and
- the average annual variation in mid-water catch.

Nature of rules

The adaptive rule for the pelagic PUCL will probably be based on the November pelagic survey index of the previous year, or, to smooth out noise, the average of that index over the previous two years. The PUCL rule could be of the form:

5 000 tons for index < I_1
Linear increase from 5 000 tons to *X* tons for I_1 < index < I_2
X tons for index > I_2

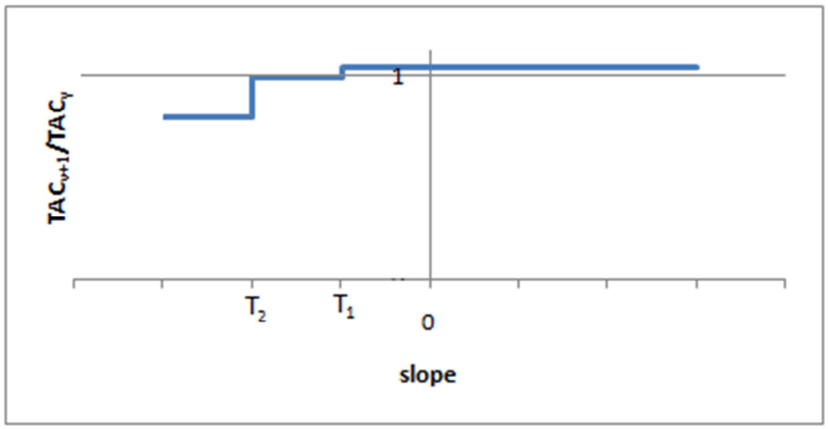
where I_1 and I_2 are selected thresholds, and an appropriate value for *X* might be in the range of 10 000 to 15 000 tons.

The adaptive rules for the mid-water TAC could be of the form:

$$TAC_{y+1} = \begin{cases} TAC_y(1+x) & slope > T_1 \\ TAC_y & T_2 < slope < T_1 \\ TAC_y(1-y) & slope < T_2 \end{cases}$$

where *slope* is the average of the slope (as provided by a log-linear regression) over the last five years for some combination of the survey and CPUE indices, T_1 is an upper threshold in terms of the

average slope, T_2 is a lower threshold in terms of that slope, and x and y are fixed positive numbers. The figure below is a graphical representation of this rule might look.



Reference

Furman, L.B. and Butterworth, D.S. 2011. An assessment of the horse mackerel resource including projections and an evaluation of the reliability of a potential index of juvenile abundance. Paper MARAM IWS/DEC11/P/HM/P1 presented at the MARAM International Stock Assessment Workshop 2011