Calculations of the tagged population and recaptures during the mixing period

Rationale

The US delegation asserted that the mixing period assumptions applied in the MULTIFAN-CL assessment models resulted in a “one-sided” treatment of this as a source of uncertainty, therefore biasing the structural uncertainty analysis. The SSP has put together the following technical observations on this issue and provided them to the US delegation on the 15th August. For transparency, we are making this response available to all CCMs. In our response to the US delegation, we noted that - as we understand it - a feature of the US’s proposed approach is that it may imply that additional parameters need to be estimated; i.e. the requirement for a more complex model, with unknown consequences during the fitting process. This is an area that could be considered within the proposed tagging workshop and represents an area for future research that, consistent with the discussion around previous assessments, can usefully be captured in the meeting report.

MULTIFAN-CL assumptions regarding reporting rates (RR) in the mixing periods

Assessment options for the assumptions.

Option 1: exclude the reporting rates adjustment of the tag recaptures in mixing periods, such that the recaptures that are removed from the tagged population are as were observed, i.e., RR = 1 during the mixing period – this is effectively the lower bound on the adjustment of recaptures.

Option 2: include the reporting rates adjustment of the tag recaptures in mixing period, i.e. RR < 1 – this is the upper bound.

This approach was deemed to span the uncertainty because: RR > 1 are not plausible (this effectively “creates” tag recaptures which are fewer than were observed); or, applying RR that are lower than as estimated in seeding trials, or as estimated in the model, seems unreasonable.

Alternative approach used for tag recaptures during the mixing periods

An alternative approach may apply the following method.

1. Using the model parameters of F, M, RR, etc. to model the tagged population from the time of release onwards.

2. Estimate N_tag_release_groups "availability" parameters, essentially as F multipliers, for the tagged population within a defined mixing period.

3. Observed and predicted tag recaptures from all periods, including the mixing period, go into the tagging likelihood.

Comments on the two approaches

The two approaches differ primarily in respect of how the assumptions for tag recaptures during the mixing period influence the tag data likelihood term via the calculation of the tagged population. At the time of release, the tagged population is that input from the tagging study as the empirical value of surveyed tagged fish released.

In MULTIFAN-CL, the intent of the mixing period calculation for the tagged population was to avoid allowing parameters estimated from the tag likelihood to influence the post-mixing period tagged population abundance (the n1 parameter), which in turns affects the tag likelihood. In other words, to avoid "circularity" in parameter estimation.

MULTIFAN-CL assumption option 1 – none of the parameters estimated from the tag likelihood fit (i.e., RR, F, M, etc.) influence the tagged population abundance (n1) at the end of the mixing period. The n1 is then subsequently used to derive predictions of tag recaptures post-mixing, which then go into the likelihood term. This assumption option is not ideal as it assumes 100% reporting of tag recaptures during the mixing periods.

MULTIFAN-CL assumption option 2 – the estimated RR parameters are permitted to influence the tagged population abundance (n1) at the end of the mixing period, and hence in turn affect the likelihood, and therefore the RR parameter estimation. This assumption option 2 entails some potential for "circularity" in the estimation of the tagged population and hence RRs, that may affect the influence of the tagging likelihood term in the integrated model fit.

The alternative approach - the estimated F, M, RR, etc. parameters modify the tagged population abundance (n1) through all the tagged population time periods, including the mixing periods, but with additional "availability" parameters being estimated in the mixing periods. All tagged population time periods from the point of release are included in the tag likelihood. Hence, the "availability" parameters influence the tagged population abundance at the end of the mixing period, and in turn may affect the RR parameter estimation via the likelihood. The estimation of additional "availability" parameters may account for mixing period processes. However, this may result in fewer recaptures being calculated than were observed during the mixing period, which is implausible.

In principle, estimating an availability parameter indexed by tag release group to operate as an F-multiplier during the mixing period only could potentially desensitise the estimation of RR to the recaptures in the mixing period. This is desirable. There are however, a couple of details to be considered in how this would be implemented:

1. One would need to filter more strongly which tag release groups are to be included, both to minimise the number of availability parameters to be estimated and to ensure as far as possible that availability can be estimated.
2. Note that as proposed in Nicholas' GitHub contribution [made available to the SSP], availability is indexed by tag release group and not by fishery. On the other hand, RR has a fishery dimension and by convention its variation by tag release group is limited to tag release groups grouped by "tagging programs" - RTTP, PTTP and JPTP. This effectively means that the availability multiplier would need to be applied to all fisheries equally and could therefore impact estimation of fisheries-specific RR indirectly, e.g. a large availability is estimated because of a large number of PS recaptures occurs that could not be predicted given the RR and F for PS. However, that large availability multiplier is also applied to fisheries that catch few tags, which would cause the model to reduce the RR for those fisheries, exactly the effect we are trying to avoid. I'm not sure if this would be important but it does cause some uncertainty.

<u>Conclusions</u>

As such, none of the above approaches are ideal, and an evaluation of their relative biases and imprecision would be beneficial, e.g., through simulation analysis.

Despite this, the two options for the MULTIFAN-CL mixing period assumptions are not necessarily "one-sided", but may under-estimate mixing period effects that produce reporting rates lower than estimated via seeding trials or in the model.