Impacts of assumptions about the natural mortality schedule and the Indonesian fishery selectivity on the SBT stock assessment

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This document examines the impacts of some specifications for the age-specific natural mortality schedule and the selectivity curve for Indonesian fishery on the SBT stock assessment, which is scheduled for an update in 2014.

ミナミマグロの資源評価における選択率と自然死亡率の影響

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この文書は年齢別の自然死亡率とインドネシア漁業の選択率の仮定が 2014 年に更新予定の資源評価に与える影響を調べた。

1. Introduction

The Fourth Operating Model and Management Procedure Technical Meeting (OMMPTM), which was held in Portland Maine in July 2013, discussed technical issues concerning the Operating Model (OM) with a view towards the full stock assessment update which is scheduled for 2014 (CCSBT 2013). An important outcome of those discussions was that the incorporation of close-kin data led to higher preference for low M10 values, an increase in the doming of the selectivity function for the Indonesian fishery and an increase in the size of the plus group. One of the recommendations made by the OMMPTM for the coming ESC meeting in September 2013 was to evaluate the influence on Indonesian selectivity and the plus group when lower M10 values (0.03 and 0.04) were included.

This issue of close interaction between age-specific natural mortality schedule and Indonesian selectivity curve for fish of older ages was first addressed in the First OMMPTM held in Seattle in July 2009 (CCSBT 2009). After evaluating model sensitivities, this Seattle meeting agreed to make the assumptions that (1) natural mortality of fish between age 10 and age 25 is constant and starts to increase above age 25 due to senescence and (2) the selectivity for SBT over the age of 25 in the Indonesian fishery is constant.

The additional new M10 values proposed at the 2013 Portland meeting are lower than those considered in the 2009 Seattle meeting. For this reason this document evaluates model performance when using the updated input data and including these low M10 values, and in particular revisits the issues of the age-specific schedule for natural mortality and Indonesian selectivity.

2. Methods

OM programs and data files (e.g., sbtdata2012_0813.dat) downloaded on 7 August were used. A preliminary analysis showed a preference for higher M0 values along with lower M10. Therefore a high M0 (=M1) value (0.5) was added to the grid as well as the low M10 values (0.03 and 0.04). The following grid was used for this analysis:

	Levels	Cumul N	Values	Prior	Simulation Weights
Steepness (h)	5	5	0.55 0.64 0.73 0.82 0.9	Uniform	Prior
M_0 (=M_1)	5	25	0.30 0.35 0.40 0.45 0.50	Uniform	Objective function
M_{10}	6	150	0.03 0.04 0.05 0.075 0.1 0.125	Uniform	Objective function
Omega	1	150	1.0	NA	NA
CPUE series	2	300	w.5 w.8	Uniform	Prior
q age-range	2	600	4-18 8-12	0.67, 0.33	Prior
Sample Size	1	600	Sqrt	NA	NA

Four runs (**M25-IS25**, **M20-IS25**, **M25-IS20**, **M20-IS20**) with different combinations of the "transition" ages for the natural mortality schedule and the Indonesian selectivity curve were examined. For example, if "base case" (M25-IS25) refers to the assumptions used at present, then "M20-IS20" corresponds to those same base case assumptions except that the increase of natural mortality starts at age 20, and constant selectivity applies to all fish over age 20. All runs assumed no auto-correlation of recruitment in the conditioning process.

3. Results

M25-IS25 (Figure 1)

The new low M10 values (0.03 and 0.04) were sampled to some extent under the grid weighting. For these samples, more marked dome-shaped selectivity and a larger size of plus-group were evident as expected, though it is difficult to judge from this analysis alone whether or not the overall results for this scenario should be considered unrealistic.

M20-IS25 (Figure 2)

The extent of the selectivity doming was less marked and the plus-group smaller compared to the results for the base case. In addition, greater preference for lower M10 values was evident. The value of the total likelihood was almost the same as for the base case.

M25-IS20 (Figure 3)

The fit to the Indonesian catch-at-age data and, with that, the total likelihood was much worse when compared to the base case. The highest M10 value was very heavily sampled. The selectivity for older fish varied considerably from year to year. This suggests that the assumptions for this scenario are questionable, though this might reflect the need for an M10 range that includes higher values than included in the current grid.

IS20-M20 (Figure 4)

As was evident for M25-IS20, the selectivity for older fish varies considerably from year to year. Nevertheless, the fit to Indonesian catch-at-age data was reasonable except for the lowest M10 value. The middle values of the M10 range were preferred.

The trajectories of spawning stock biomass in absolute terms were different amongst the four runs (Figure 5). However, trends relative to SSB0 (the unfished spawning stock biomass) hardly differed except from the mid-1960s to the mid-1980s (though the precise reason for this difference is unclear at this stage). When M25-IS25 was examined in detail, the two low M10 values showed larger spawning stock biomass compared to the original high M10 values, as was to be expected given the different natural mortality schedules (Figure 6). However, the relative trends were broadly similar except from the mid-1960s to the mid-1980s.

4. Discussion

Though the extent of the exploration in this analysis is limited, the M20 scenarios seem to be as reasonable as the M25 scenarios in terms of overall model diagnostics, and might be regarded as better if the marked domed-shape of Indonesian selectivity as seen in the M25-IS25 runs is seen as problematic in the context of bluefin biology and fishery. M20 scenarios were also explored during the 2009 Seattle meeting, and although the differences in model results between M20 and M25 were acknowledged to be minor, the M20 scenarios were finally dropped because they were considered to have less biological realism compared to M25 (CCSBT 2009). Nevertheless we suggest that it might be valuable to revisit the issue of age-specific natural mortality and Indonesian selectivity at this stage, because of the new information (close-kin data) that is now available.

Several technical issues regarding the OM development will be discussed in 2013 and 2014 in the process of finalizing the stock assessment update scheduled for 2014. In general, it is important to evaluate the impacts of changes in model formulations and assumptions on the overall stock assessment results (such as the stock biomass trajectory over a long period and the SSB0 estimate), and to check the realism of the results before the final specifications for the assessment are agreed.

5. References

CCSBT (2009) Report of the Operating Model and Management Procedure Technical Meeting. 13-17 July 2009. Seattle, USA.

CCSBT (2013) Report of the Fourth Operating Model and Management Procedure Technical Meeting. 23-26 July 2013. Portland, Maine, USA.

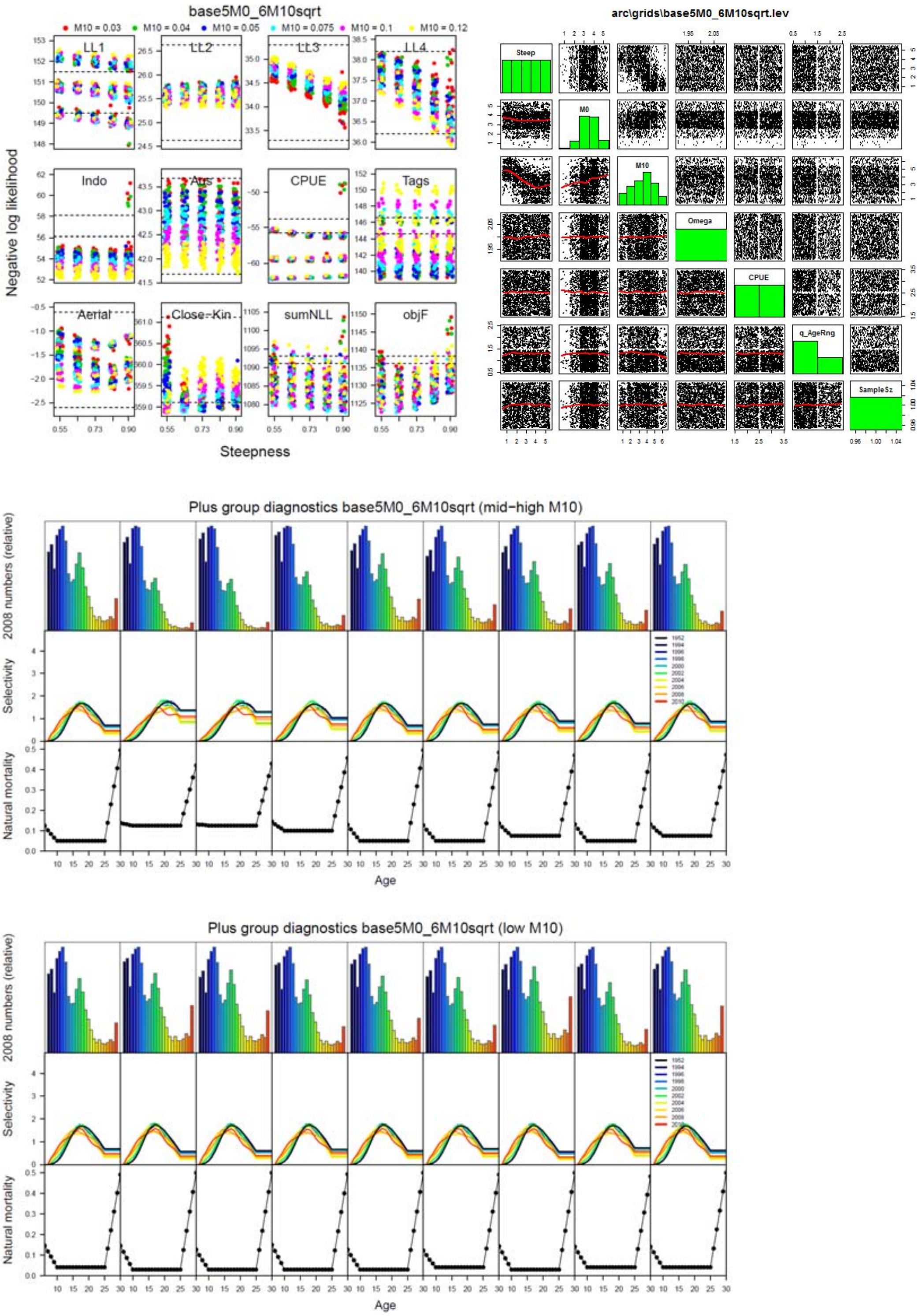

Figure 1. Likelihood profile (upper left panel), level plot (upper right panel) and age structure in 2008, Indonesian fishery selectivity and natural mortality for randomly-chosen scenarios with the high M10 values (0.05-0.125; middle panel) and the low M10 values (0.03, 0.04; lower panel) for the **M25-IS25** run.

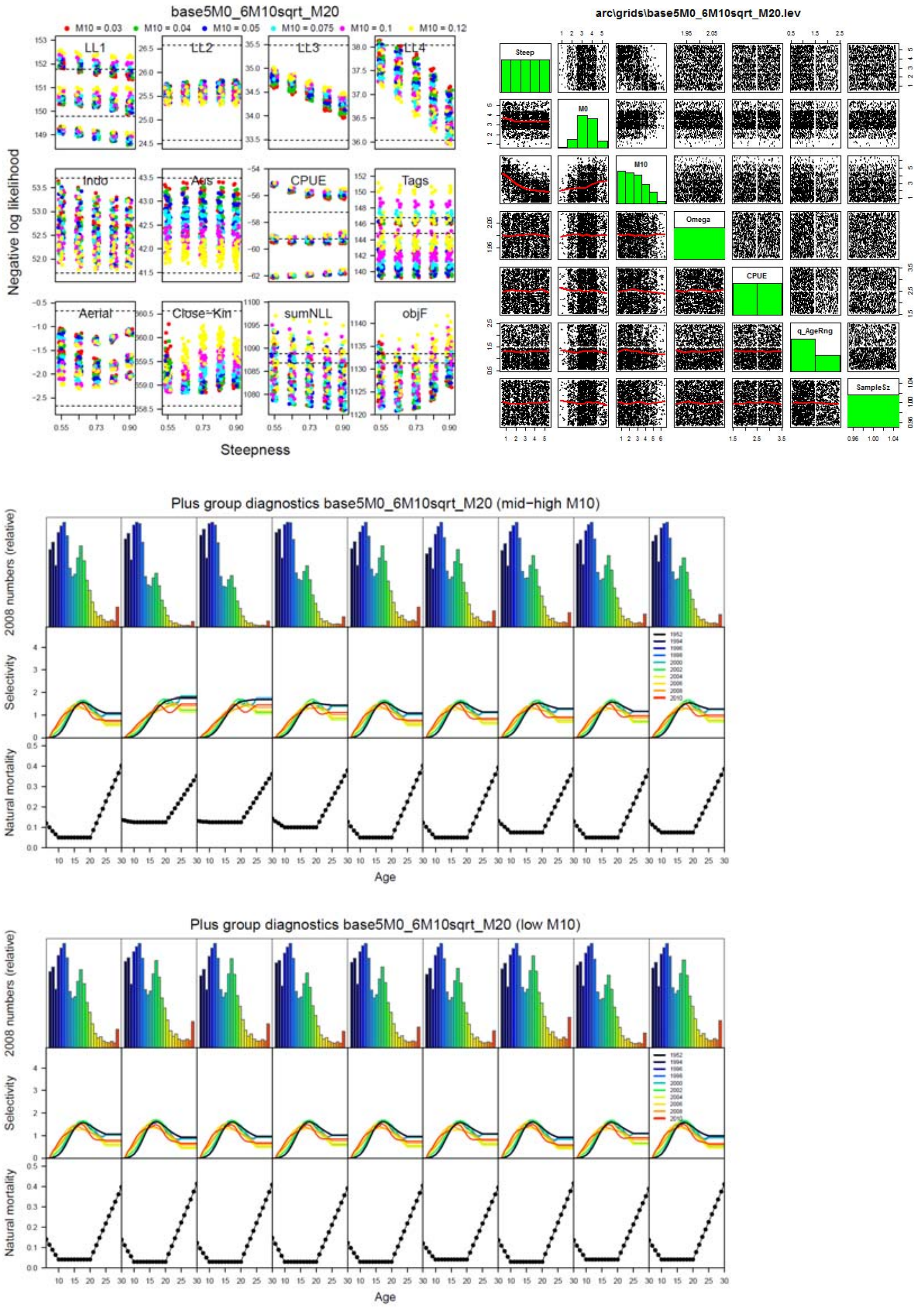

Figure 2. Likelihood profile (upper left panel), level plot (upper right panel) and age structure in 2008, Indonesian fishery selectivity and natural mortality for randomly-chosen scenarios with the high M10 values (0.05-0.125; middle panel) and the low M10 values (0.03, 0.04; lower panel) for the **M20-IS25** run.

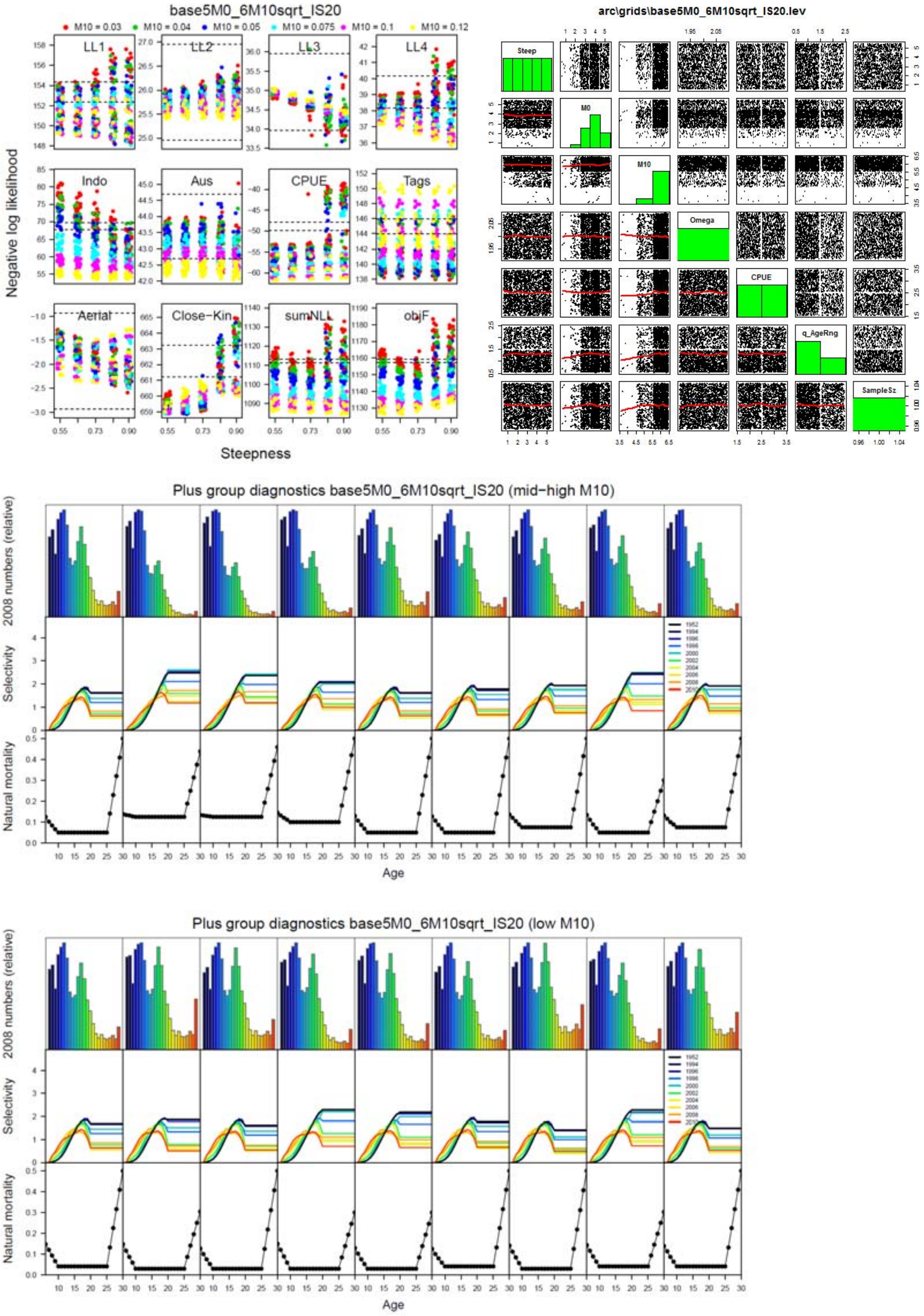

Figure 3. Likelihood profile (upper left panel), level plot (upper right panel) and age structure in 2008, Indonesian fishery selectivity and natural mortality for randomly-chosen scenarios with the high M10 values (0.05-0.125; middle panel) and the low M10 values (0.03, 0.04; lower panel) for the **M25-IS20** run. Note that the three lowest M10 values were not sampled due to the poor fit to the data.

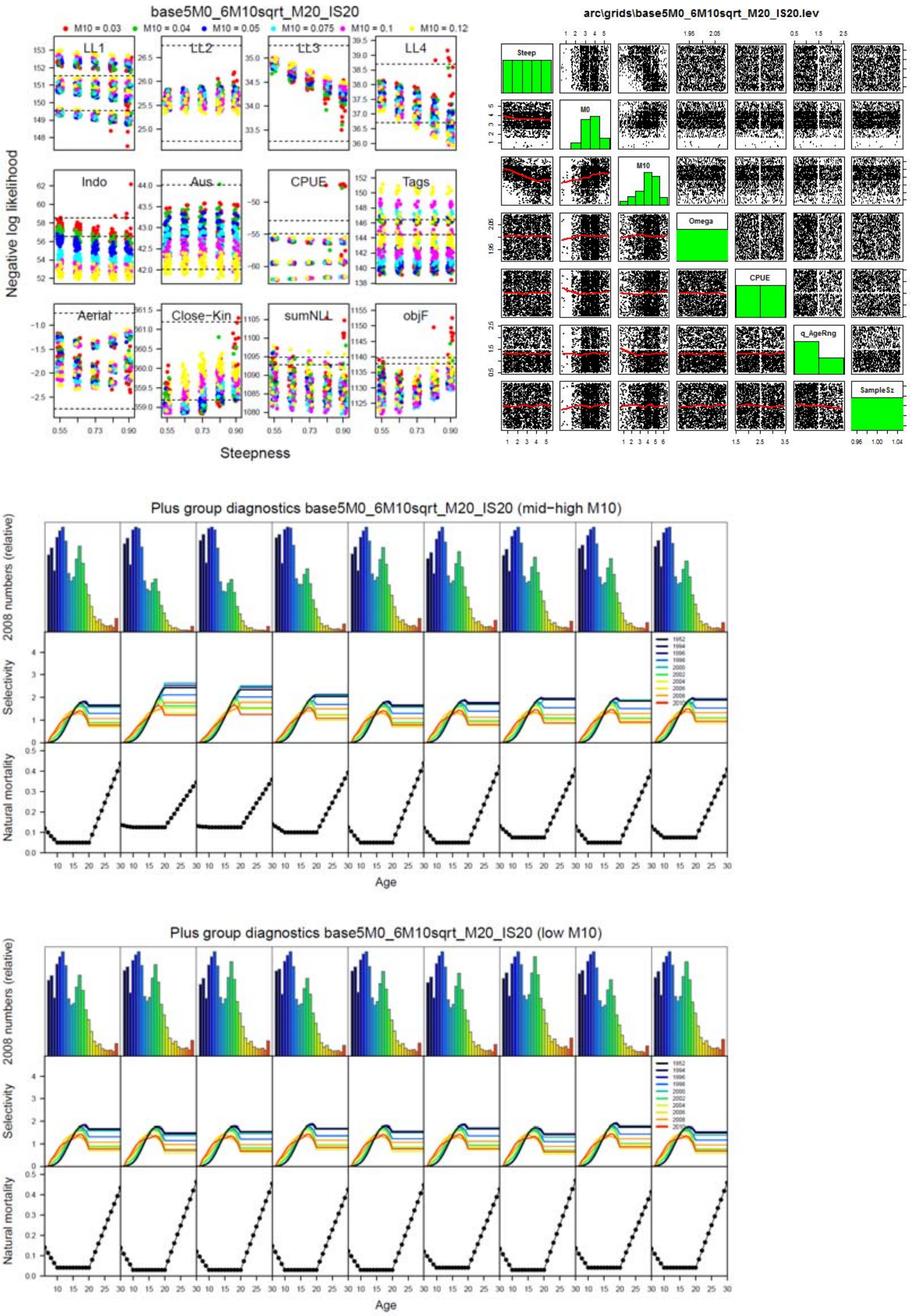

Figure 4. Likelihood profile (upper left panel), level plot (upper right panel) and age structure in 2008, Indonesian fishery selectivity and natural mortality for randomly-chosen scenarios with the high M10 values (0.05-0.125; middle panel) and the low M10 values (0.03, 0.04; lower panel) for the **M20-IS20** run.

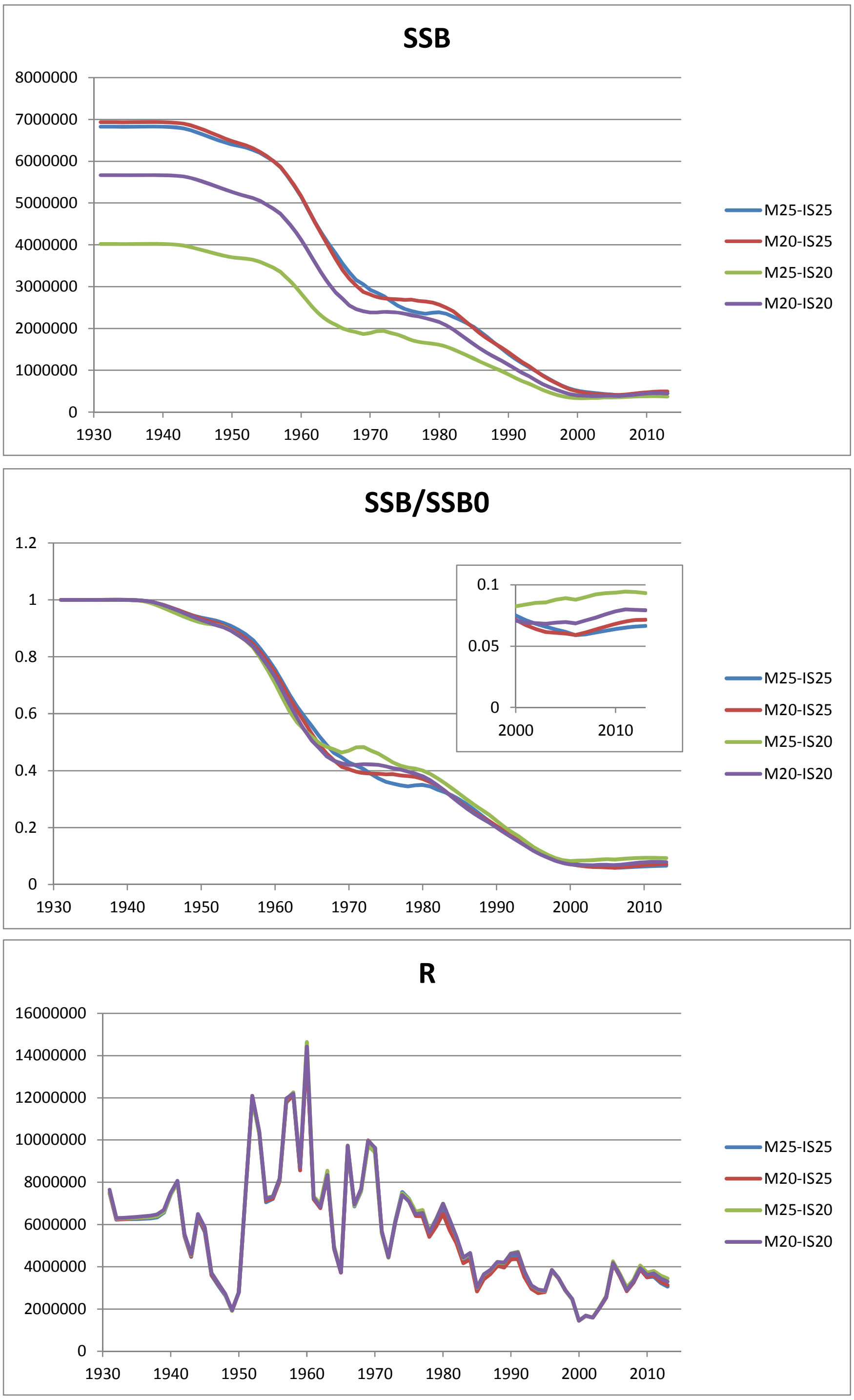

Figure 5. Trajectories (represented by the median of 2000 samples) of spawning stock biomass in absolute terms (upper panel) and relative terms (middle panel) and recruitment (lower panel) for the four runs.

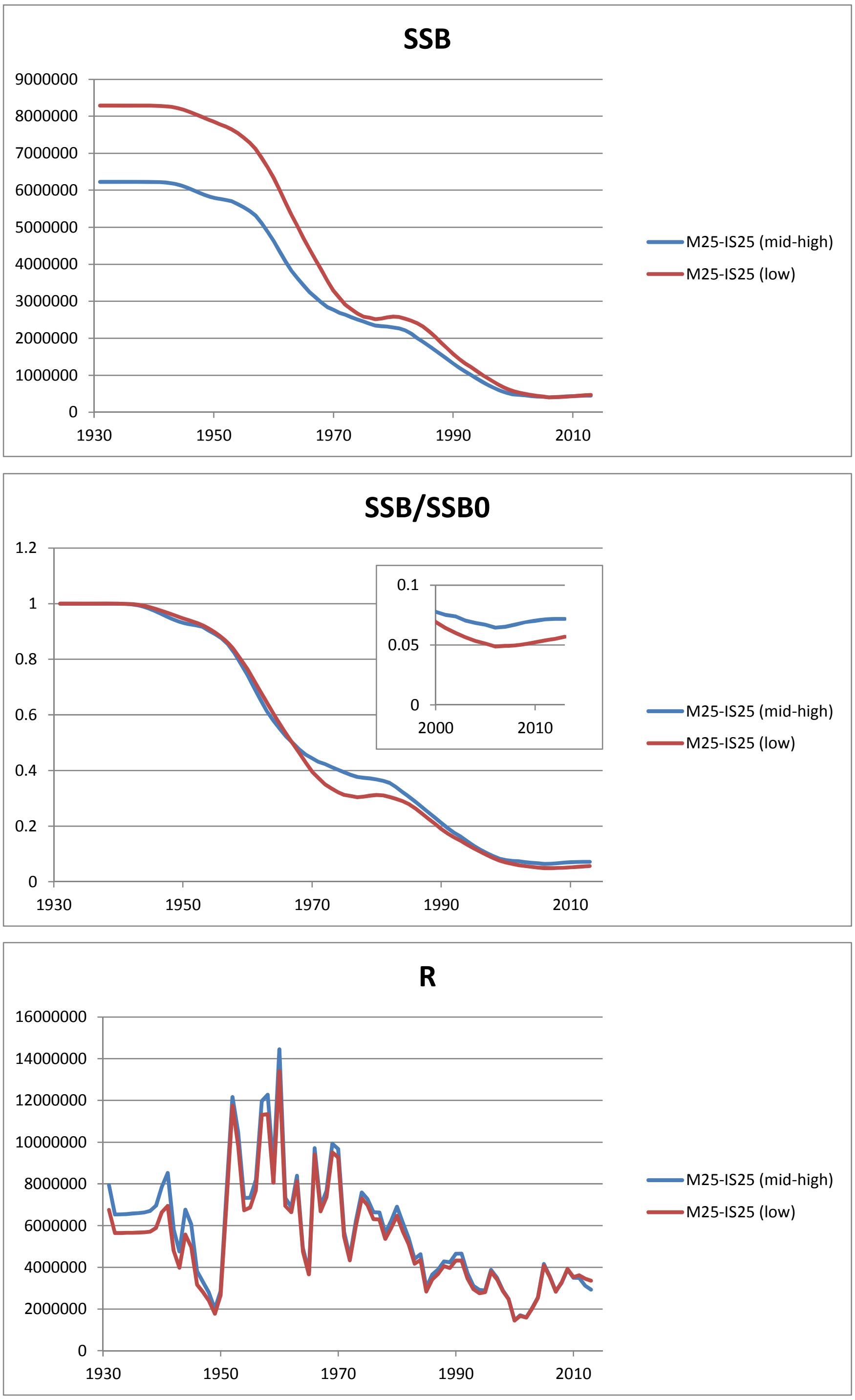

Figure 6. Trajectories (represented by the median of 2000 samples) of spawning stock biomass in absolute terms (upper panel) and relative terms (middle panel) and recruitment (lower panel) for the high M10 values (0.05-0.125) and the low M10 values (0.03, 0.04) in M25-IS25.