

## Conditioning of the SBT operating model to inform projection specifications

### ミナミマグロの将来予測の様式を決めるための オペレーティングモデルの条件設定

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#### Abstract

The effects of updates on the operating model are examined. Because of the new growth schedule and the most recent two years' data, the operating model prefers somewhat higher steepness compared to the previous version. This difference has little influence on the historical trajectories of spawning stock biomass, but it leads to more optimistic projection results.

#### 概要

オペレーティングモデルの更新の影響を検討した。新たな成長式の導入と2年分のデータの更新により、高いスティープネスが選択される傾向がみられた。これは、歴史的な産卵親魚バイオマスの推定にはほとんど影響しないが、将来予測を非常に楽観的にする。

## Introduction

Since the 15<sup>th</sup> CCSBT Extend Scientific Committee (ESC) meeting, the conditioning process for the Operating Model (OM) to be used in evaluation of candidate SBT Management Procedures (MPs) has been updated in primarily two respects: (1) the inclusion of further two years' data, and (2) a change to using the new growth schedule. The two further years' data include SBT catch information (e.g. catch weight and length frequencies) for each fishery in 2009-2010, LL1 CPUE series in 2009-2010, and the aerial survey index in 2010-2011. The addition of a new growth schedule was agreed at the previous ESC (Report of SC15; para 115), and tentative updating and trials have already been conducted in spring 2011 (e.g. CCSBT-SFMWG/1103/Info2). In this document, we show conditioning and projection results assuming a constant future catch, and examine the impact by these recent data updates.

To check the robustness of candidate MPs, the ESC will also be considering the scenarios covered by some robustness trials. Hence conditioning and projection results are also shown for these robustness scenarios.

## Data and model specification

In this analysis, we have used the conditioning program "sbtmod23.exe" with "sbtdata2008.dat" (distributed on 31 Jan. 2011) for the previous growth schedule calculations, "sbtmod24.exe" with "sbtdata2008growth.dat" (distributed on 23 Jan. 2011) for the new growth schedule calculations, and "sbtmod24.exe" with "sbtdata2010.dat" (distributed on 15 June 2011) for the inclusion of the new growth schedule and the most recent two years' data (this being the most recent version). In these conditioning calculations, the "c1s11" scenario with the following grid specification was used (**basehup**): five steepness values (0.55, 0.64, 0.73, 0.82, 0.90), four  $M_1$  values (0.30, 0.35, 0.40, 0.45), and three  $M_{10}$  values (0.07, 0.10, 0.14), all with uniform priors (Table 1). The same grid specification has been used for the robustness scenarios. For the constant catch projections, we used the projection program "sbtprojv119.exe" (distributed on 3 July 2011).

## Results and Discussion

### Impact of data update:

The fits of the operating model (OM) using the new growth schedule indicate that higher values of steepness are more likely compared to previous growth schedule version (Fig. 1-a, 1-b). Moreover, inclusion of the most recent two years' data also sees the conditioning results prefer somewhat higher steepness (Fig. 1-c). Although the likelihood profiles do not show any distinct difference

among these three sets of results, the higher steepness preference under the new growth schedule seems to arise as a result of the fit to the catch composition data of LL3 (Japanese LL in Area 2) (Fig. 2-a, 2-b). Furthermore, the higher steepness preference given the inclusion of the recent two years' data seems to arise as a result of the fit to the aerial survey index (Fig. 2-c). The penalty terms for selectivity change over time and stock-recruitment residual also influence steepness preference.

There were no substantial differences in the historical trajectories for spawning stock biomass among these three sets of results (Fig. 3), which indicate that the current spawning stock biomass remains at a very low level; typically about 5% or less of  $SSB_0$ . However, historical trajectories for recruitment over the last decade were higher for the most recent version of OM compared to the previous version; with SBT recruitments for several recent years being as strong as those during the 1990s for this most recent OM.

Retrospective analysis:

To measure the influence of recent stock index (LL1 CPUE and Aerial survey) for the OM, especially for its “steepness”, we conducted retrospective analyses using the following settings:

- [1] Removal of the most recent 2 years LL1 CPUE index (2009-2010);
- [2] Removal of the most recent 4 years LL1 CPUE index (2007-2010);
- [3] Removal of the aerial survey index;
- [4] Removal of the aerial survey index and the most recent 2 years CPUE: i.e. combine [1] and [2].

The [1] – [4] trials above indicated similar results to “**basehup**” scenario. The higher steepness values tended to be preferred in all these trials; however some relatively-low steepness values were selected in all these trials compared to “**basehup**” scenario. Furthermore, the removal of the most recent two CPUE values and the aerial survey index reduced the preference for higher steepness (Fig. 4). This suggests that the update of the stock indexes (LL1 CPUE and aerial survey index) was one of the causes of the preference for higher steepness for the most recent OM.

Constant catch projection:

Constant catch projections were conducted using the conditioning results under the most recent version of OM for the “**basehup**” scenario. The projection for a constant catch of 9449t, corresponding to the average TAC for 2010 and 2011, indicates that the future SSB will decline to a minimum in 2012 and then recover rapidly after the mid-2010s (Fig. 5). For this projection, the year when SSB would exceed 120% of  $SSB_{2009}$  with 50% probability is estimated to be 2015. Projections assuming different constant catch levels indicate that a future constant catch level of about 17000t or lower would meet the interim rebuilding target (20% of  $SSB_0$ ) in 2035 with 70% probability (Fig. 6). The replacement yield, which is the catch that maintains the spawning stock biomass at its current level, is estimated at about 28000t, which is double of the previous result

calculated for the 2010 OMMP meeting (Kurota et al. 2010). These results show clearly that the most recent version of the OM provides more optimistic projections compared to the previous OM.

Scenarios in the robustness trials:

Projection results for the robustness scenarios under the 9449t constant catch assumption indicate that these scenarios cover a range of current spawning biomass, but all show increases in the longer term future (Fig. 7). However, this current range is rather narrow compared to the results under the previous OM (Kurota et al. 2010). “Laslett” and “troll” are typical optimistic scenarios. For these scenarios, higher steepness values are preferred. On the other hand, “omega75” and “STwindow” are typical pessimistic scenarios, and they prefer relatively somewhat lower steepness values. The scenario “regime shift” also gave an estimate of a relatively low spawning stock biomass in the constant catch projections; however, it preferred higher steepness values as for the optimistic scenarios (Fig. 8). Furthermore, lower  $M_{10}$  values were preferred in the “Laslett” and “STwindow” scenarios. These scenarios do show individual differences, so that it might be helpful to use them for the examination of the performance of candidate MPs.

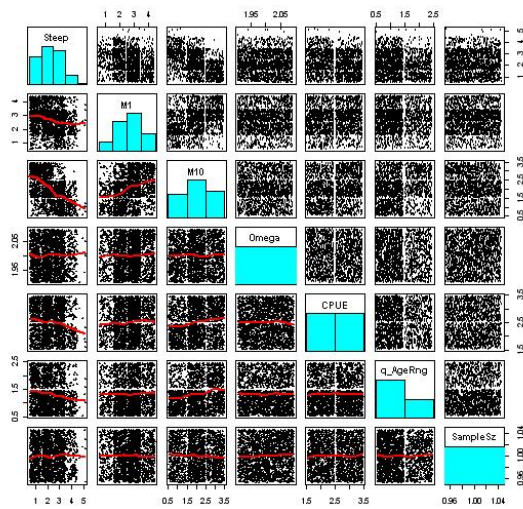
## References

- CCSBT 2010. Report of the Extended Scientific Committee for the Fifteenth Meeting of the Scientific Committee. 4 - 9 September 2010, Taipei, Taiwan.
- Kurota H., O. Sakai, and D. S. Butterworth 2010 Brief examination of conditioning results of the SBT operating model for management procedure evaluation. CCSBT-OMMP/1006/12
- Sakai, O., N. Takahashi, and H. Kurota 2011 Provisional comparison of conditioning results of the SBT operating model: sbtmod23 and sbtmod24. CCSBT-SFMWG/1103/Info2

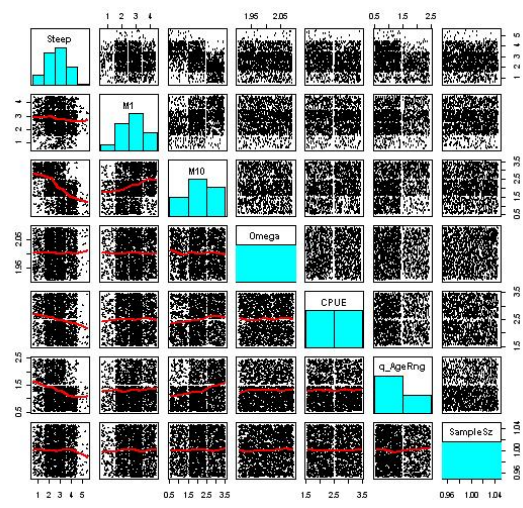
Table 1. Grid specifications used for this analysis.

	Levels	Cumul N	Values					Prior	Simulation Weight
Steepness (h)	5	5	0.55	0.64	0.73	0.82	0.90	Uniform	Likelihood
M1	4	15	0.30	0.35	0.40	0.45		Uniform	Likelihood
M10	3	45	0.07	0.1	0.14			Uniform	Likelihood
Omega	1	45	1					NA	NA
CPUE series	2	90	W0.5	W0.8				Uniform	Prior
q-age-range	2	180	4-18	8-12				0.67, 0.33	Prior
Sample size	1	180	Sqrt					NA	NA

(a)  
 Previous growth schedule version.  
 (result of the "sbtmod23.exe" with "sbtdata2008.dat" under the "basehup" scenario)



(b)  
 New growth schedule version.  
 (result of the "sbtmod24.exe" with "sbtdata2008growth.dat" under the "basehup" scenario)



(c)  
 Most recent version.  
 New growth schedule and recent two years data were included.  
 (result of the "sbtmod24.exe" with "sbtdata2010.dat" under the "basehup" scenario)

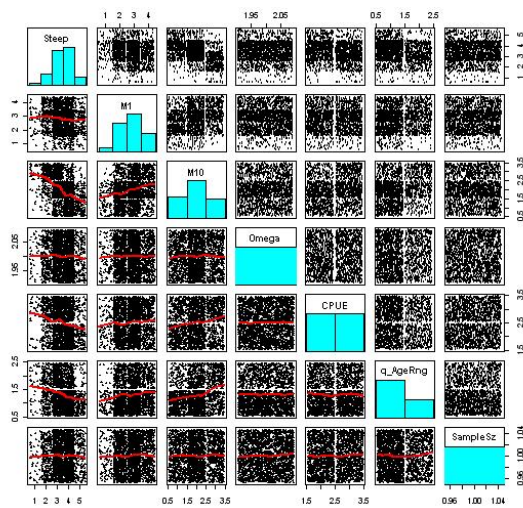
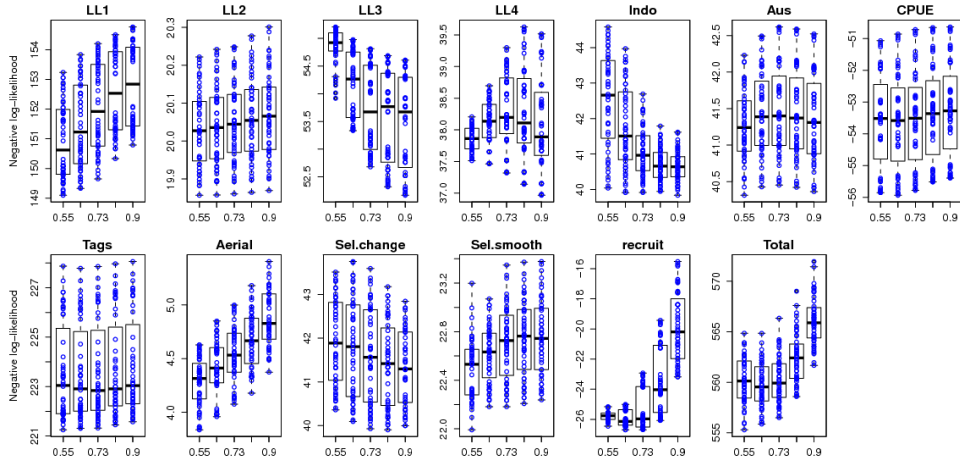
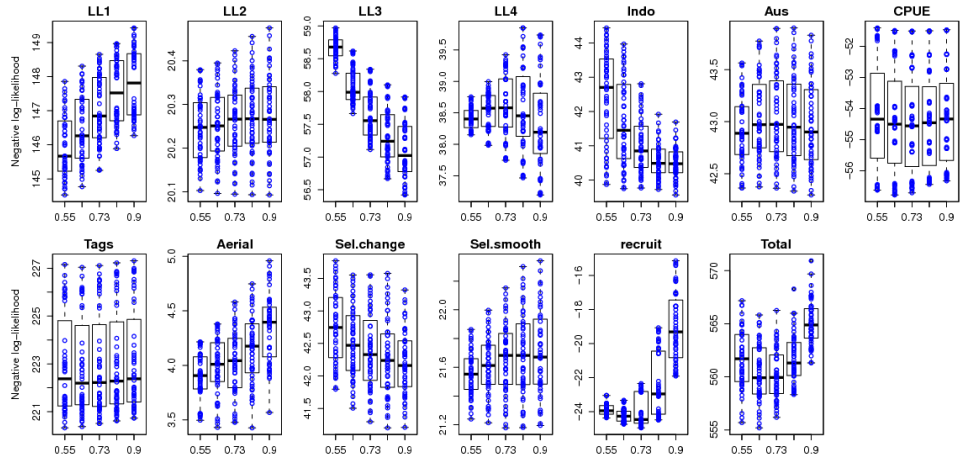


Fig. 1. Likelihood weighted shade plots for the conditioning results under the "basehup" scenario using the previous and recent OMs; (a) previous growth schedule version, (b) new growth schedule version, and (c) most recent version (inclusion of new growth schedule and recent data).

(a) Previous growth schedule version. (result of the "sbmod23.exe" with "sbdata2008.dat")



(b) New growth schedule version. (result of the "sbmod24.exe" with "sbdata2008growth.dat")



(c) Most recent version. (result of the "sbmod24.exe" with "sbdata2010.dat")

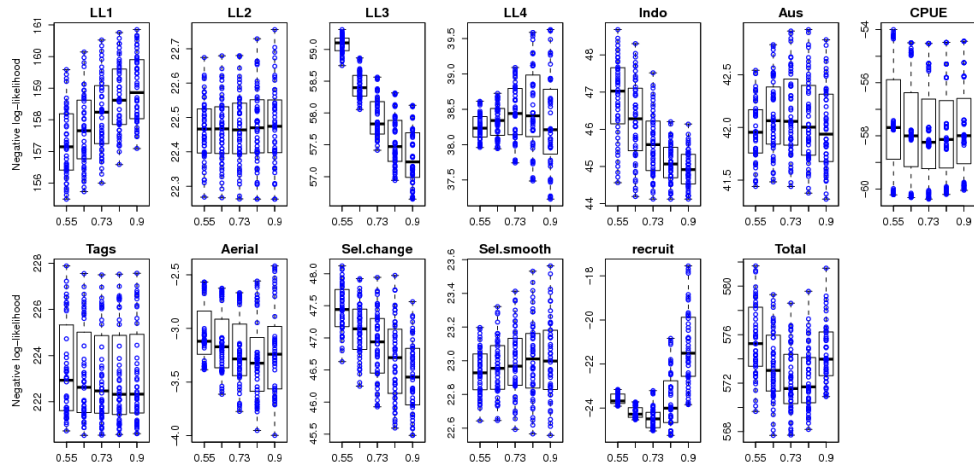
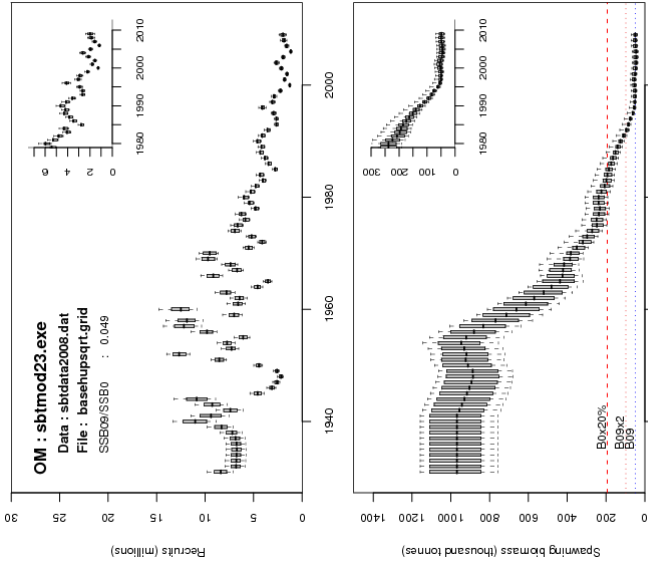
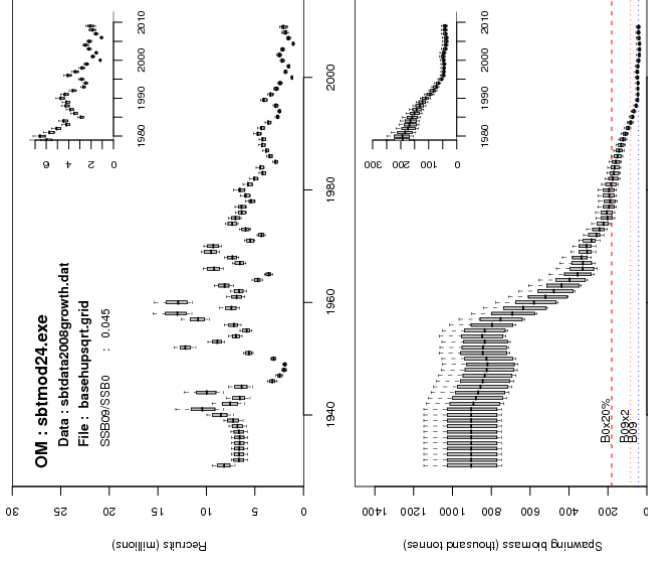


Fig. 2. Likelihood profiles in each stepness value for data components and total (lower right) for the "basehup" scenario using the previous and recent OMs; (a) previous growth schedule version, (b) new growth schedule version, and (c) most recent version (inclusion of new growth schedule and recent data).

(a) Previous growth schedule version.



(b) New growth schedule version.



(c) Most recent version.

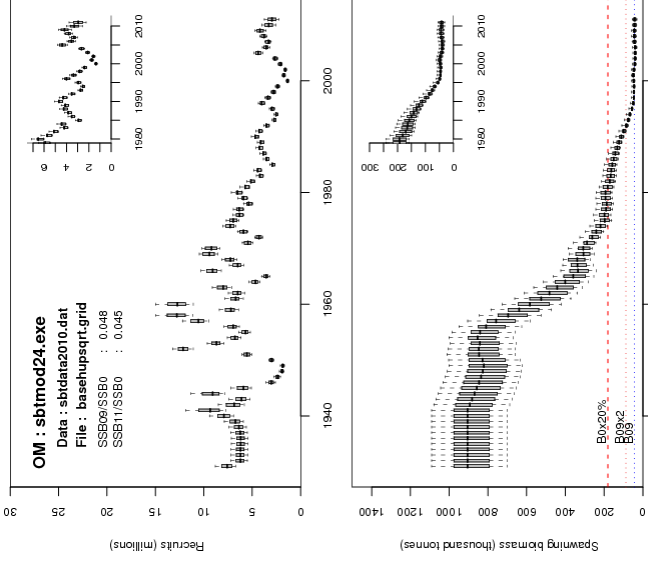


Fig. 3. Recruitment and spawning stock biomass, showing the median, quartiles, and 90th percentiles. Calculations were based on the "basehup" scenario using the previous and recent OMs; (a) previous growth schedule version, (b) new growth schedule version, and (c) most recent version (inclusion of new growth schedule and recent data).



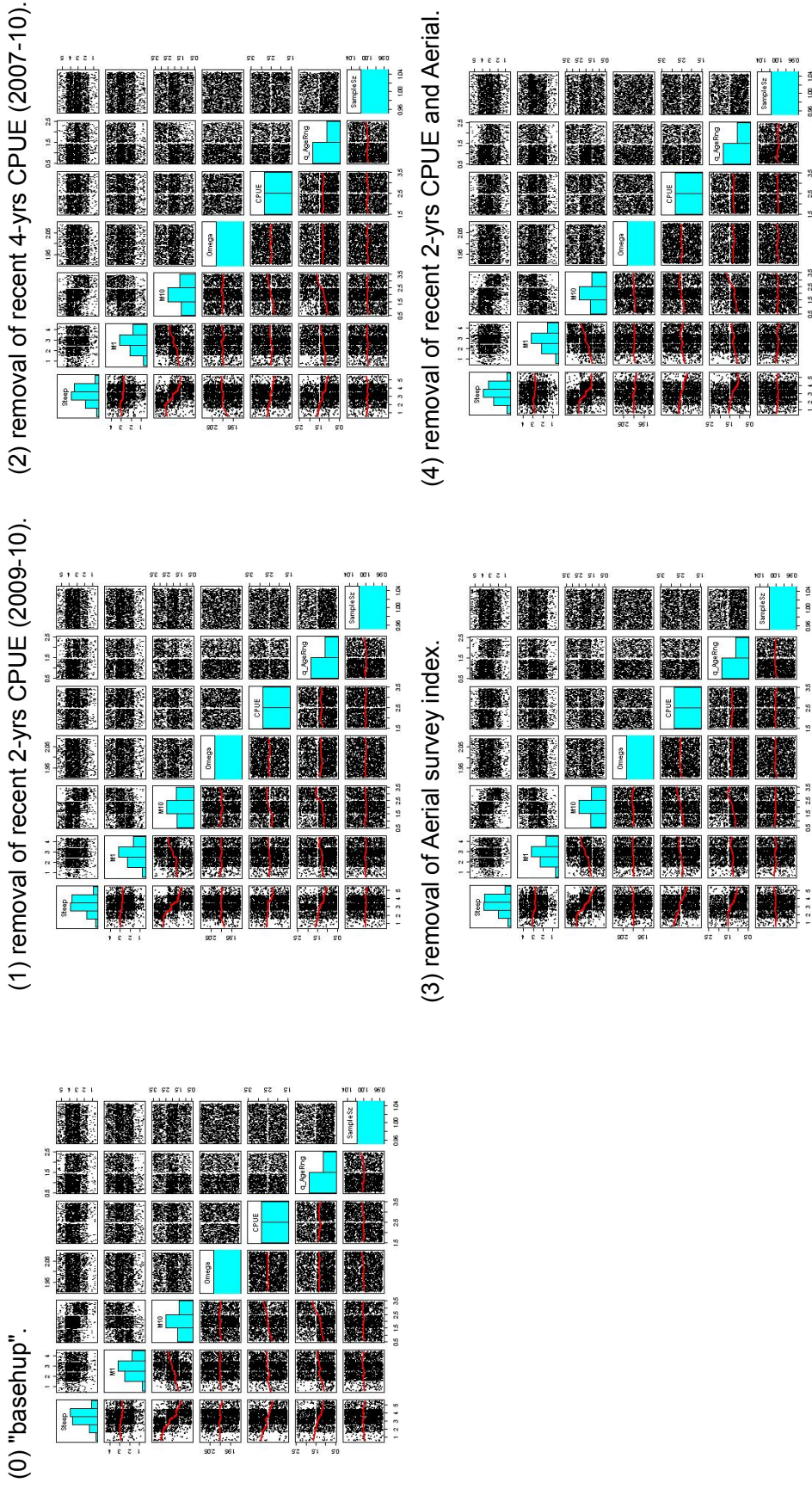


Fig. 4. Likelihood weighted shade plots of the retrospective analysis under the "basehup" scenario; (0) "basehup" scenario as the base case, (1) remove 2009-10 CPUE from base case, (2) remove 2007-10 CPUE from base case, (3) remove aerial survey index from base case, and (4) remove 2009-10 CPUE and aerial survey index from base case.

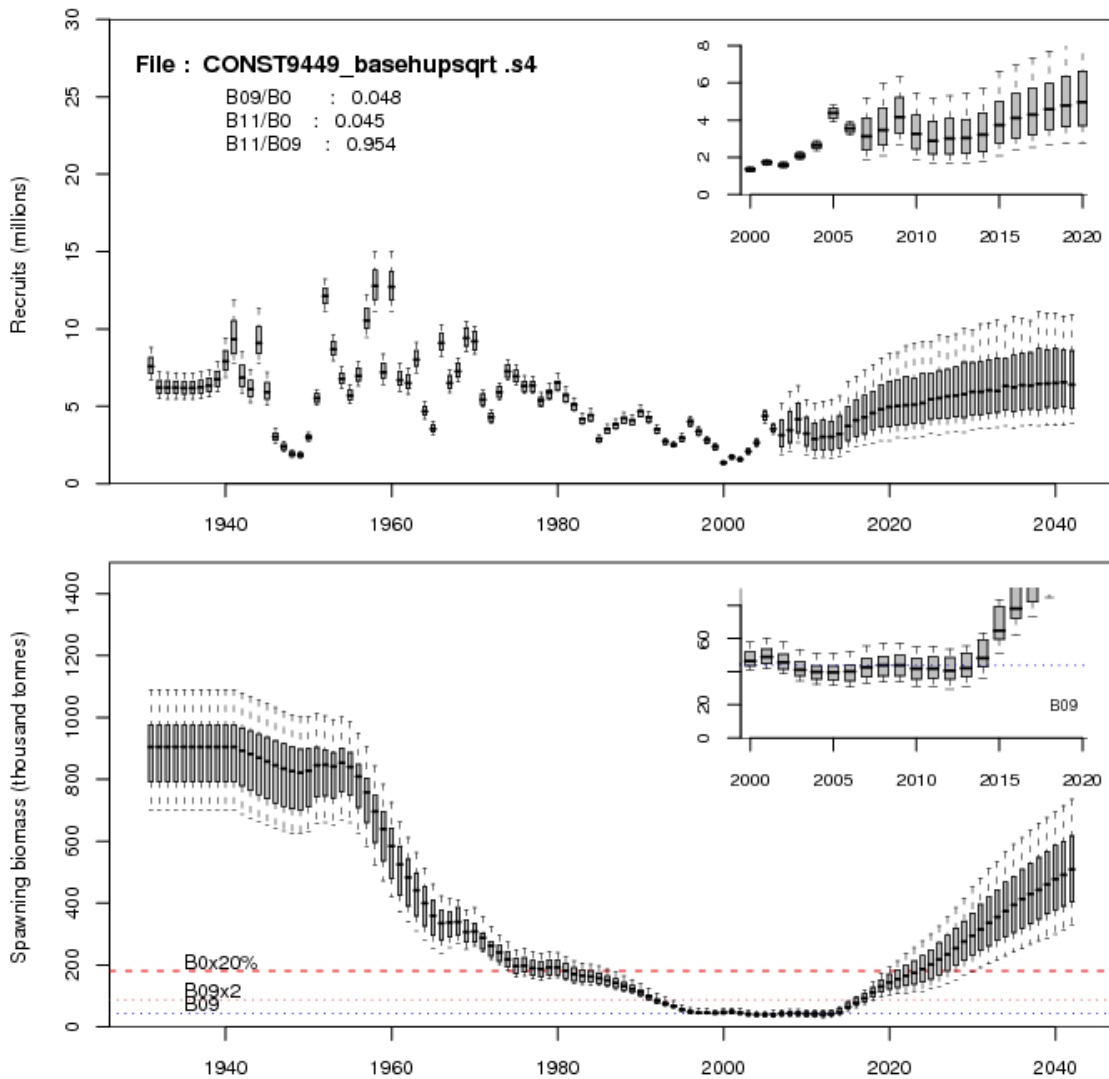


Fig. 5. Recruitment and spawning stock biomass, showing the medians, quartiles and 90th percentiles. Projections of future spawning stock biomass and recruitments assume a constant catch of 9449t which corresponds to the average TAC in 2010 and 2011. Blue dot-line indicates the spawning stock biomass level in 2009 (SSB2009), red dot-line indicates double the amount of SSB2009, and red dash-line indicates 20% of the original spawning stock biomass level.

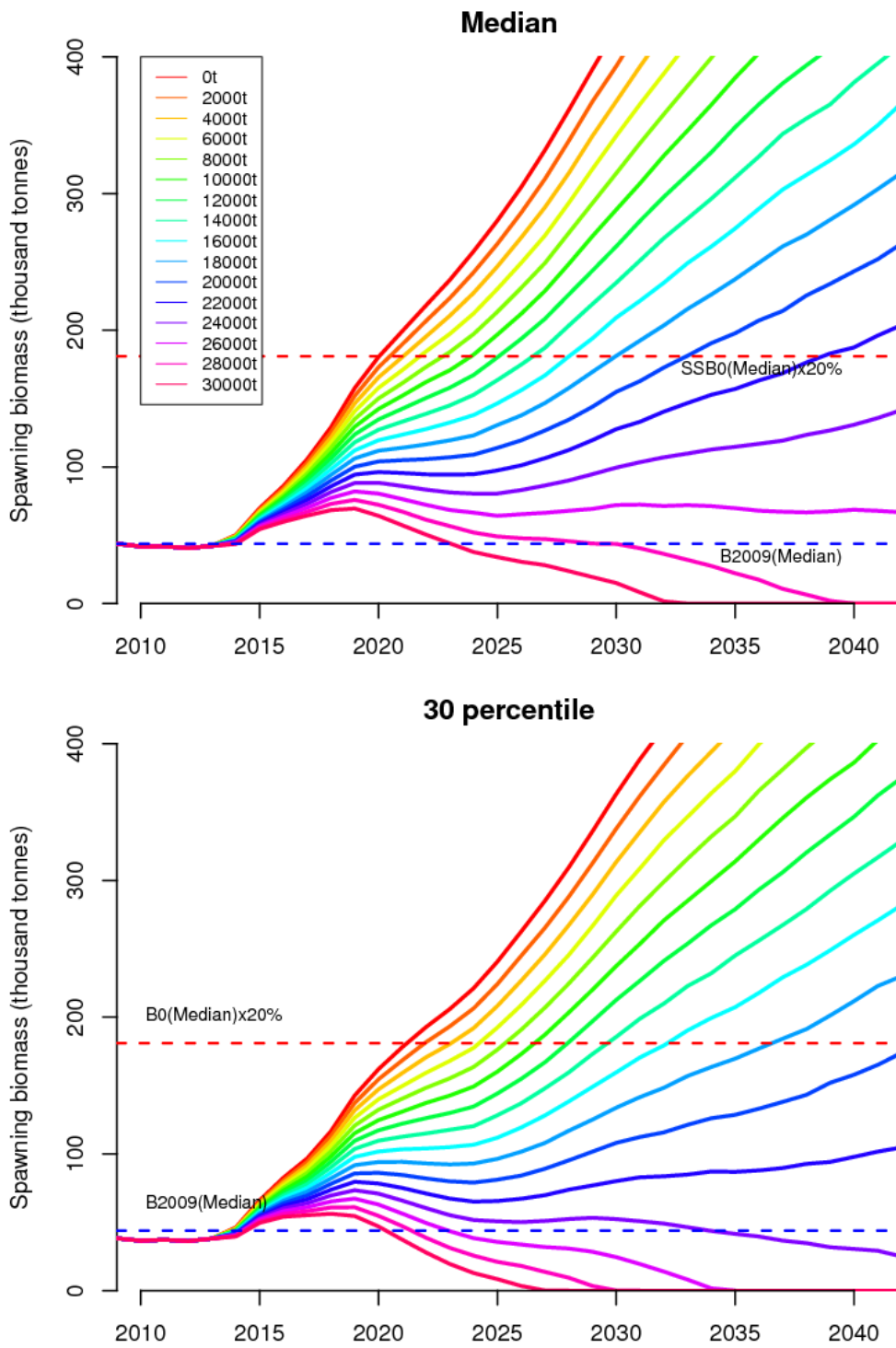


Fig. 6. Median (upper) and 30 percentile (bottom) spawning stock biomass projected for a variety of levels of constant future catches.

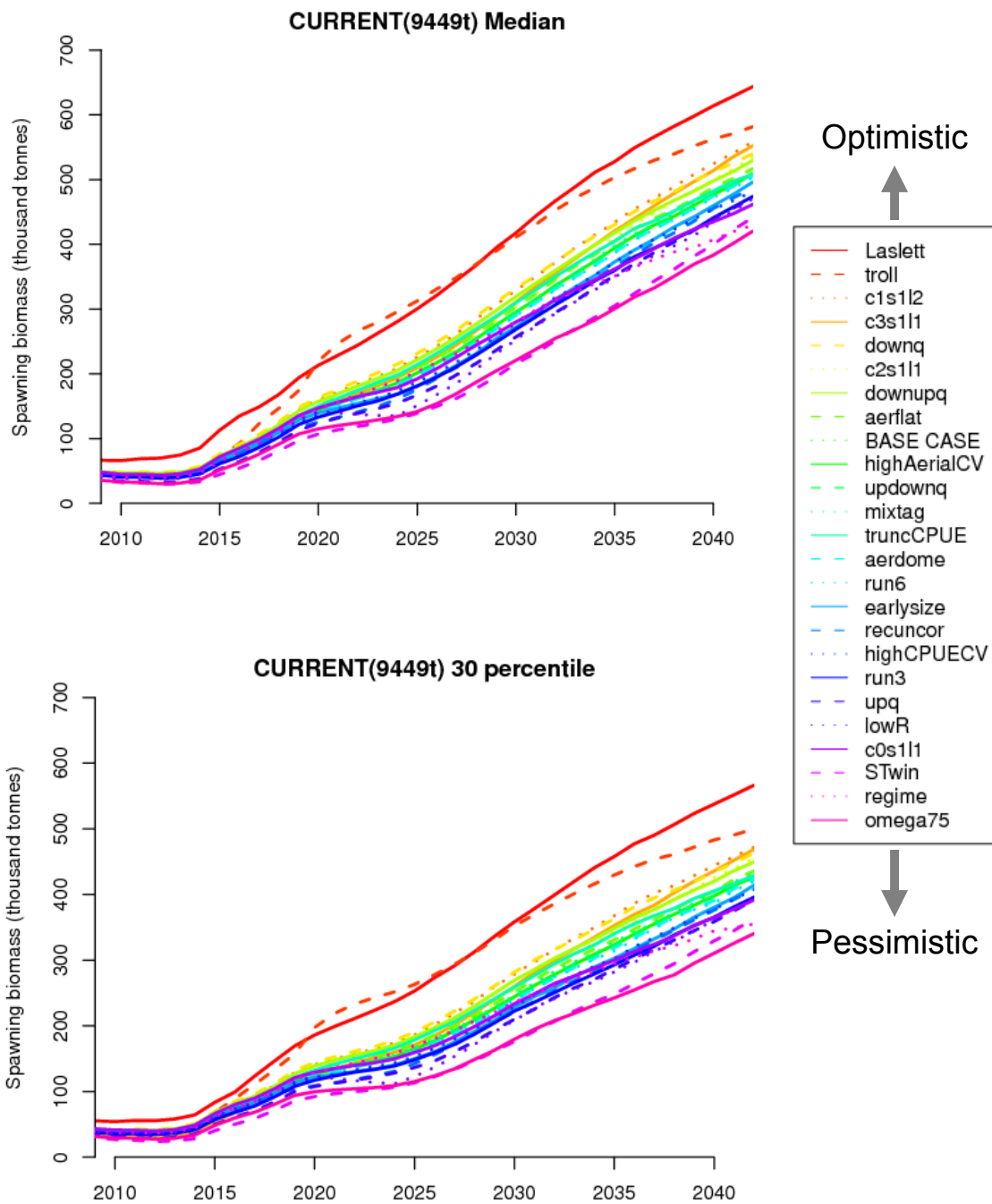
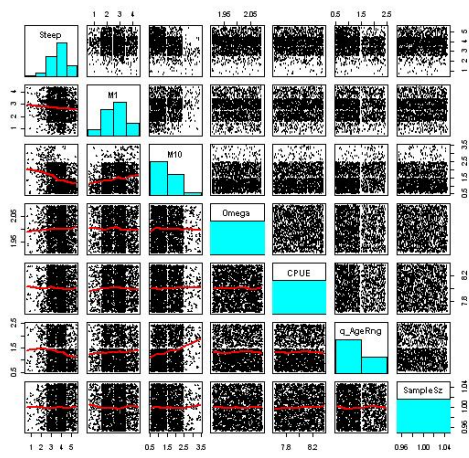


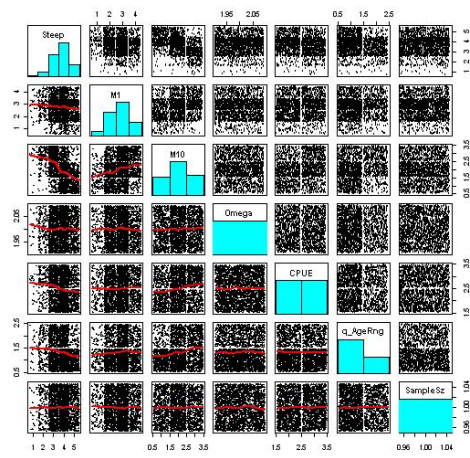
Fig. 7. Median (upper) and 30 percentile (bottom) spawning stock biomass projected for each robustness scenario, assuming a constant future catch of 9449t.



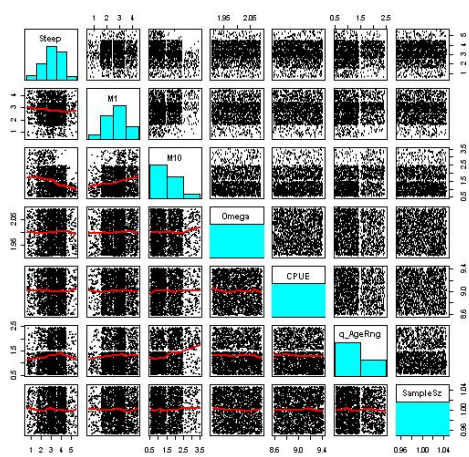
(a) Laslett



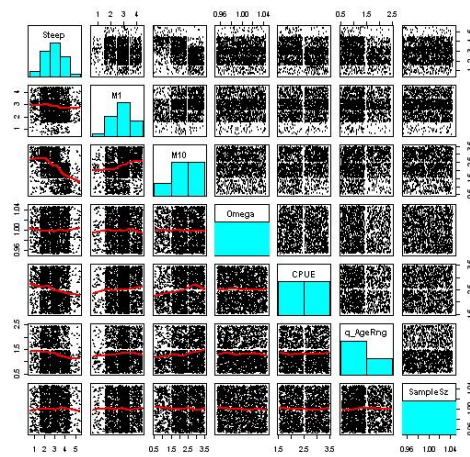
(b) Troll



(c) STwindow



(d) omega75



(e) regime shift

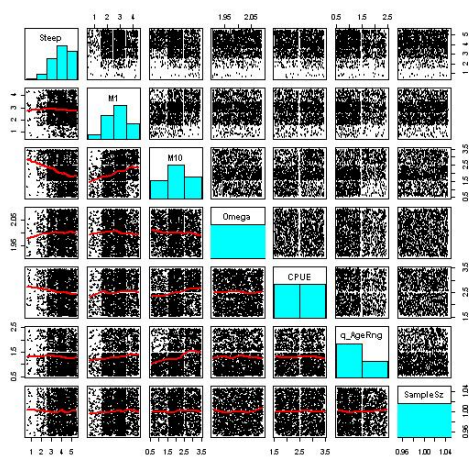


Fig. 8. Likelihood weighted shade plots for the robustness scenarios.