Commission for the Conservation of
Southern Bluefin Tuna

みなみまぐろ保存委員会

Report of the Fourth Operating Model and Management Procedure Technical Meeting

23 – 26 July 2013
Portland, Maine, U.S.A.

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Opening

1. The Chair of the Fourth Operating Model and Management Procedure Technical Workshop (OMMP), Dr. Ana Parma opened the meeting and welcomed participants.
2. The list of participants is shown at **Attachment 1**.
3. The draft agenda was adopted and is shown at **Attachment 2**.
4. The list of documents for the meeting is shown at **Attachment 3**.
5. Jim Ianelli agreed to co-ordinate the preparation of the report with Campbell Davies.

Agenda Item 1. Alternative approaches for applying close-kin data for stock assessment purposes.

1.1 Models developed outside of the Operating Model (OM)

6. Campbell Davies presented OMMP-Info 1, the final report for the Close-kin abundance estimation project. The presentation focused on the number and nature of the Parent-Offspring-Pairs, the form of the estimation model (Appendix 5, OMMP/1307Info-1) and the results.
7. A total of 45 POPs were found of which 20 were female and 25 male and ranged in age from 8-25. Male L_∞ was ~10 cm greater than for females. Female parents were slightly larger than other female adults. There was evidence of age related skip spawning with parents of ages 8-12, but not in older age classes. There was no evidence of temporal correlation in the dates of capture of parents, relative to other adults, that might lead the abundance estimates to be biased (e.g., we might have seen that parents of GAB juveniles always spawn early, and we might not have had equal coverage through the Indonesian fishing season) and there was no evidence of siblings or half-siblings among the ~14,000 fish processed.
8. Diagnostics of model fits for length by sex and length by sex-ratio are given in Figures 1 and 2. The fits to the length by sex data are reasonable, although there is notable lack of fit in 2002. The fits to the sex ratio at length are not as good, with a noticeable trend in data for most length classes that is not reflected in the fits.
9. Annual adult survival for the revised random-effects model was estimated at 0.77 (with 90% CI of 0.75-0.8). This is somewhat higher than the estimate from the preliminary investigations with the steady state model (0.73) but fairly close to 2011 CCSBT OM estimates, which for ages 10-20 yr-old have generally ranged between 0.75 and 0.85 since 2003, with higher survival in more recent years.

10. The estimates of numbers and biomass of 10+ yr-old SBT by year are given in Tables 1 and 2 and numbers of recruits (at age 8) in Table 3. It is important to recognize that these estimates are not directly comparable with the estimates from the 2011 CCSBT OM due to the different specifications of the estimation models, in particular, effective reproductive potential (in close-kin) and SSB in the OM.

Table 1. Estimated numbers of 10+yr-old SBT by year over the period covered by the close-kin project (Bravington et al., 2012).

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
N (millions)	1.87	1.80	1.73	1.59	1.54	1.52	1.47	1.38	1.21
CV %	16.3	16.0	15.8	15.7	15.7	15.9	16.2	16.5	16.8

Table 2. Estimated 10+ yr-old biomass of SBT by year over the period covered by the close-kin project (Bravington et al., 2012).

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Biomass (kt)	149	145	141	132	128	127	123	116	104
CV %	15.9	15.6	15.4	15.3	15.4	15.5	15.8	16.1	16.3

Table 3. Estimated annual recruitment (at age 8 in millions) and associated CVs (Bravington et al., 2012).

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Recruits	0.561	0.435	0.520	0.546	0.488	0.419	0.231	0.386	0.504
CV %	19.7	20.2	20.2	20.6	21.5	23.0	26.9	28.5	39.3

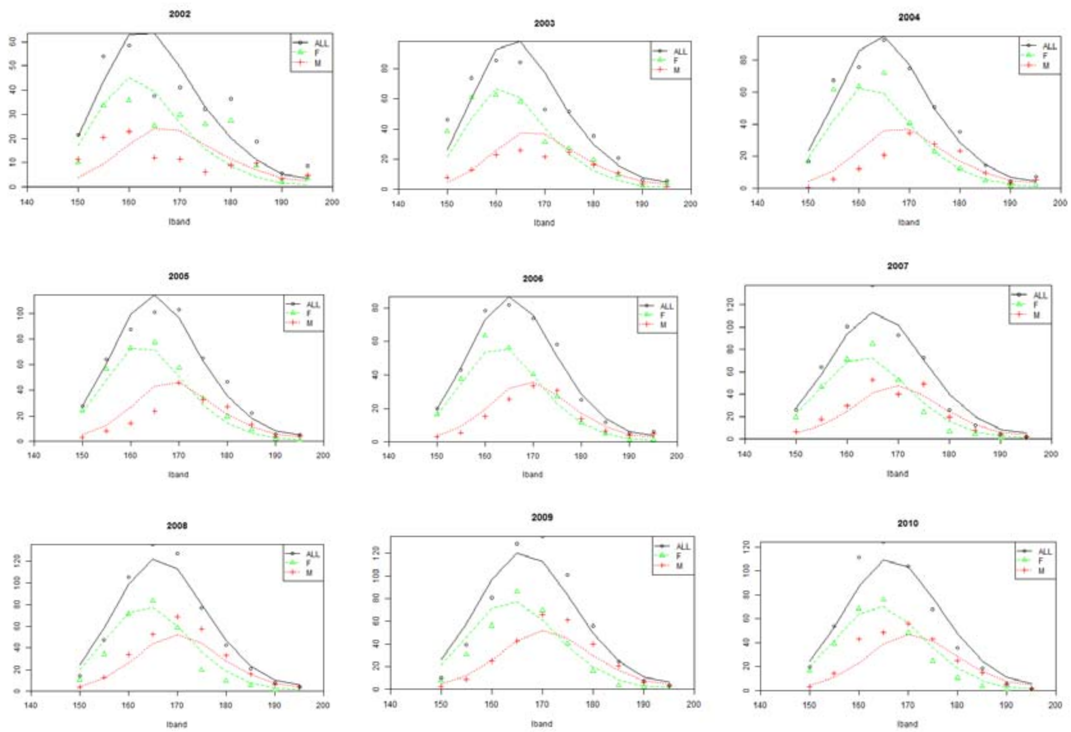

Figure 1. Fit of random effects abundance estimation model to length data from spawning grounds by year. Note Y-axis is rescaled sample sizes to reflect estimated effective sample size (see text for details) (from Bravington et al., 2012).

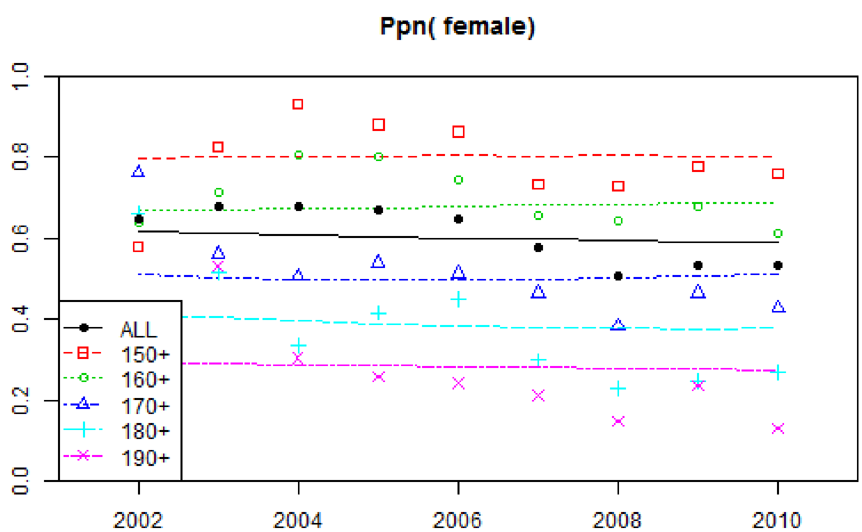

Figure 2. Diagnostic fits to sex-ratio (proportion females) by length class and year (from Bravington et al., 2012).

Sensitivity to assumptions about selectivity

11. It was noted that a number of the issues and sensitivity tests identified at SC17 had been addressed. This included allowing for variability and trend in recruitment, relaxing the equilibrium assumption for the initial age-structure and investigating the impact of changing effective sample sizes.
12. A range of different functional forms for residence time/selectivity of the Indonesian longline fishery was fitted as part of the close-kin project, with the logistic differentiated by sex providing the best fit (Figure 3). It was noted during the workshop that the comparison with the maturity assumed in the 2011 OM shown in Figure 4 (from Bravington et al., 2012) is inappropriate because of how the normalization of the OM function (i.e., spawning contribution proportional to 10+ biomass) was carried out.
13. Bravington et al. (2012) note that the form of this relationship and the extent to which it can be separated into component parts of selectivity (probability of being caught by the fishery) and residence time (time spent on the spawning ground) remains a primary source of uncertainty in estimating the spawning biomass of the stock. This is the case for both the close-kin estimation model and the approach to incorporating the close-kin data into the OM (ESC/1209/21).
14. To further investigate the sensitivity of the close-kin estimates to selectivity / residence time relationship the working group suggested that it would be useful to:

- Examine the influence of 1-2 alternative selectivities from the OM in the years corresponding to the cohorts and years covered by the close-kin, in particular those that include the 1990's tagging cohorts.
- Conduct further analyses of the catch and effort dynamics of the Indonesian longline fleet to evaluate possible effects of hook depth in connection to the depth distribution of tuna by size, and to examine whether there is evidence for substantial spatial or temporal shifts in operations over time.

15. In addition, the Working Group considered that it would be useful, in the context of improving comparability with the OM, to use one or two contrasting age compositions from the OM for the period immediately prior to that covered by the close-kin data to explore the sensitivity to initial conditions.
16. The close-kin model is coded in Pascal and R, and can be run as an R executable. It was noted that it is not in a form that can be readily explored by most members of the OMMP Working Group. The Working Group suggested that re-coding the model using a different language (e.g., ADMB or a suitable alternative that would make it generally useable by members of the OMMP working group and/or the SC) would be very useful, both as code verification and to allow wider investigation of the approach.

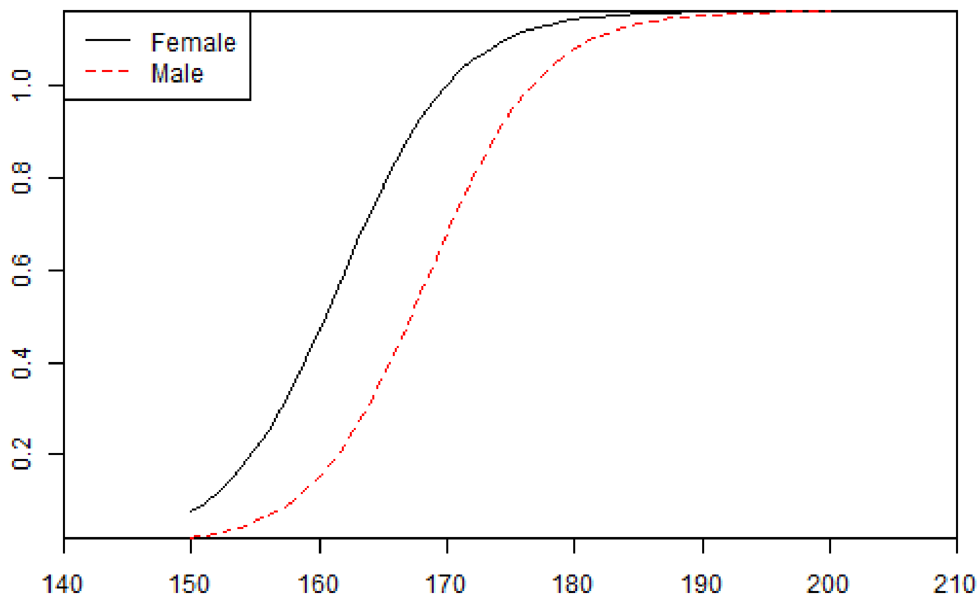

Figure 3. Estimated residence time (assumed equal to selectivity) on the spawning ground differentiated by sex and length for the close-kin mini-assessment model (from Bravington et al., 2012).

Figure 4. Relative spawning contribution as a function of female bodyweight. Average bodyweight at ages are indicated on close-kin estimate (black line). The green line corresponds to 2011 CCSBT OM assumption (from Bravington et al., 2012), but note Working Group concerns expressed in the text at paragraph 12.

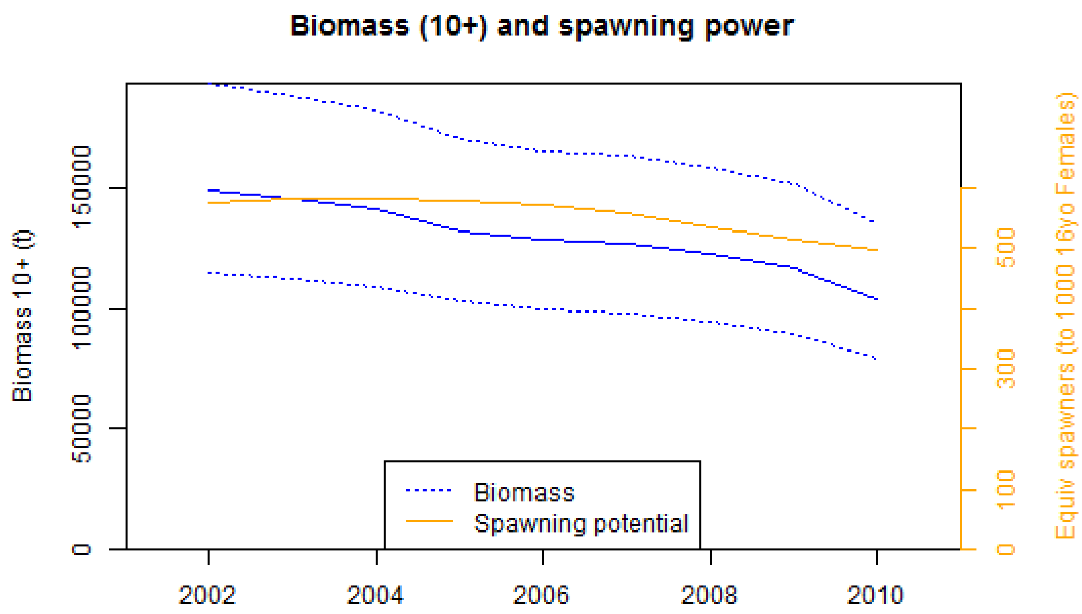

Figure 5. Estimated spawning biomass (10+ biomass as per assumption of 2011 CCSBT OM) and "spawning potential" (as estimated from the close-kin model by year, from Bravington et al., 2012).

1.2 Incorporation of close-kin data into the OM

17. The preliminary estimates of spawning biomass from the close-kin project and from the 2011 OM model (before close-kin data were included) indicated a difference of 2 to 3 times in abundance. However, a revised OM was developed in 2012 to incorporate the close-kin data, based on a proposed initial definition for the effective reproductive potential for the OM (ESC/1209/21). That model was updated prior to the workshop using data up to 2012 (2013 in the case of the scientific aerial survey). Results obtained for an intermediate grid cell run using this revised OM indicated that the estimated 10+ yr-old biomass was within one standard error of the close-kin estimate for 2010 of 104,000 t, with a CV of 16.9% (see Figure 5).

18. The Working Group agreed that, independent of the sensitivities requested for the close-kin assessment, it would be very informative to explore the influence of the CPUE, tagging data and Indonesian age frequency data on the fits and estimates of the revised OM. In the case of CPUE and tagging data, this could be done by excluding them from the fitting process, one at a time. The Indonesian age data are required for the estimation of the selectivity; hence it is not possible to exclude them. However, their relative influence could be examined by down-weighting them.

Approaches and sensitivity to alternative assumptions

19. Dr Hillary provided an overview of the approach to incorporating the close-kin data within the OM as described in ESC/1209/21. Within the close-kin assessment (Bravington et al. 2012) the assumption is made that residence time is effectively the same as the selectivity of the Indonesian fleet. The catch composition data are used to estimate the residence time/selectivity relationship, as well as aiding in the estimation of survival probabilities. Irrespective of whether or not this assumption about residence time on the spawning ground and Indonesian selectivity holds, it is not possible to replicate this assumption within the current OM structure as the Indonesian selectivity is:

- age-based
- permitted to vary among years
- domed in some years

20. The more complicated nature of the OM means that it is also necessary to specify a static effective spawning population ogive, which can be used to calculate the probability of an adult being a parent of a given juvenile in the close-kin data set.

Selectivity

21. The impact of the incorporation of the close-kin data on selectivity of the Indonesian fishery was investigated by looking at the estimates obtained including (baseCK) and excluding (basesqrt) the close-kin data for some randomly-chosen grid cells (Figure 6). The inclusion of the close-kin data resulted in a reduction in M_4, a slight increase in the doming of the selectivity and an increase in the abundance in the plus group, even though the estimates were conditioned on the value of M_{10} assumed for the selected grid cells

22. The Working Group noted that grid cells that had the most marked dome in the Indonesian selectivity were those with low M_{10} values. These cells already had a similarly dome-shaped selectivity before the close-kin data were included. Plausible mechanisms for doming of selectivity were discussed, but no evidence or independent data were available at the meeting on such mechanisms or to inform the likely shape of the Indonesian selectivity. It was recommended that the analysis of the Indonesian longline catch and effort data (distribution, hook depth, targeting) discussed at ESC17 be conducted to explore potential mechanisms for the domed selectivity pattern.

23. The Working Group noted that although the plus group increased with the inclusion of the close-kin data, its size was not inconsistent with the number of year classes in the plus group; some of the grid cells still had low abundance in the plus group.

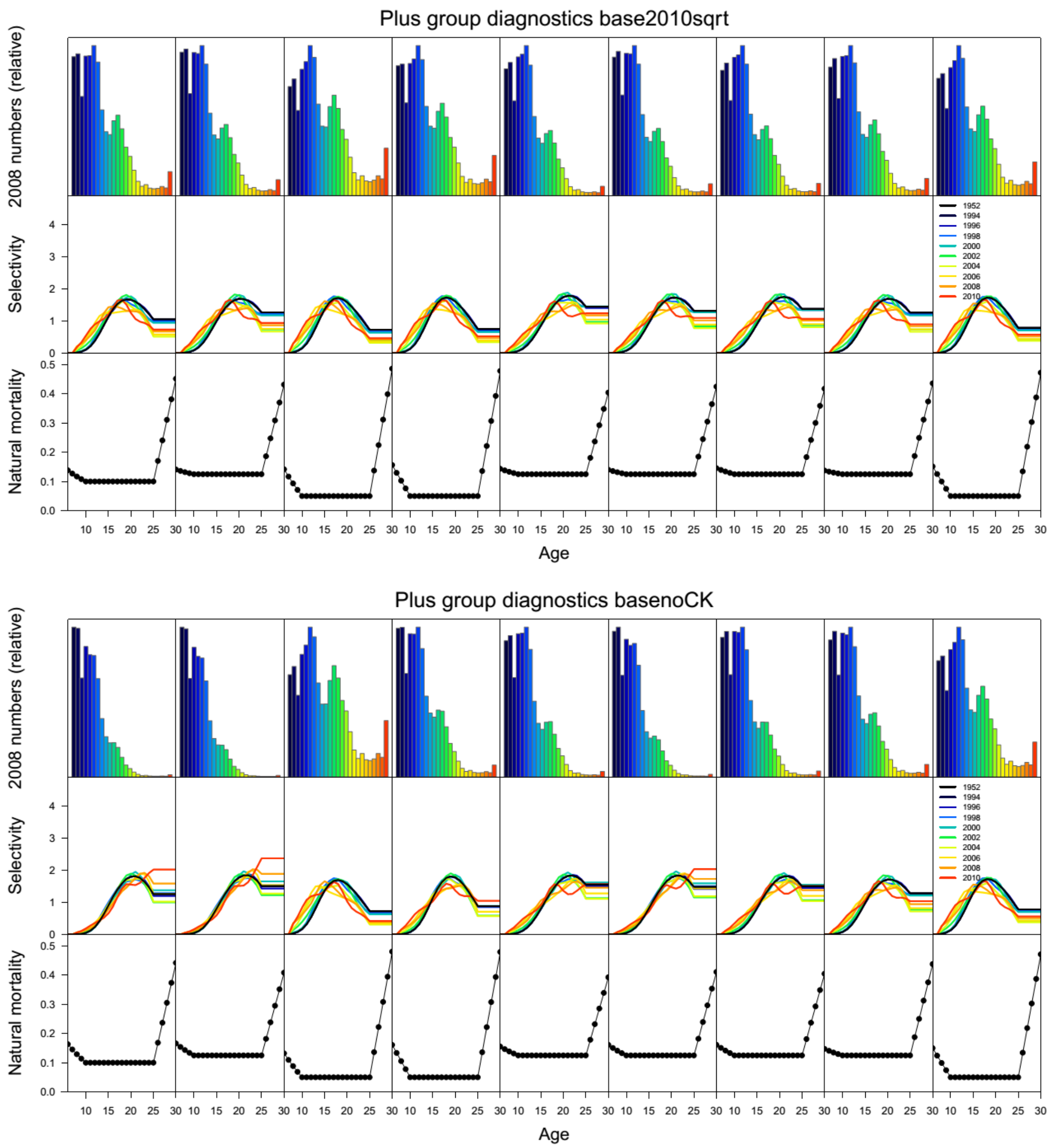

Figure 6. Population at age in 2008, Indonesian fishery selectivity, and age-specific *M* estimates for the base case with close-kin (top set) and without close-kin (bottom set).

24. ESC/1209/21 showed the effect of including the close-kin data on the OM preference for M_{10}. Figure 7, case baseCKmk3sqrt, shows an abrupt increase in the negative log-likelihood for values of M_{10} larger than 0.12. Based on these results the Working Group decided to restrict the range of M_{10} values to a maximum of 0.125.

25. The Working Group decided to retain the existing specification of selectivity for the Indonesian fishery and recommended that the preference for lower values of M_{10} be explored.

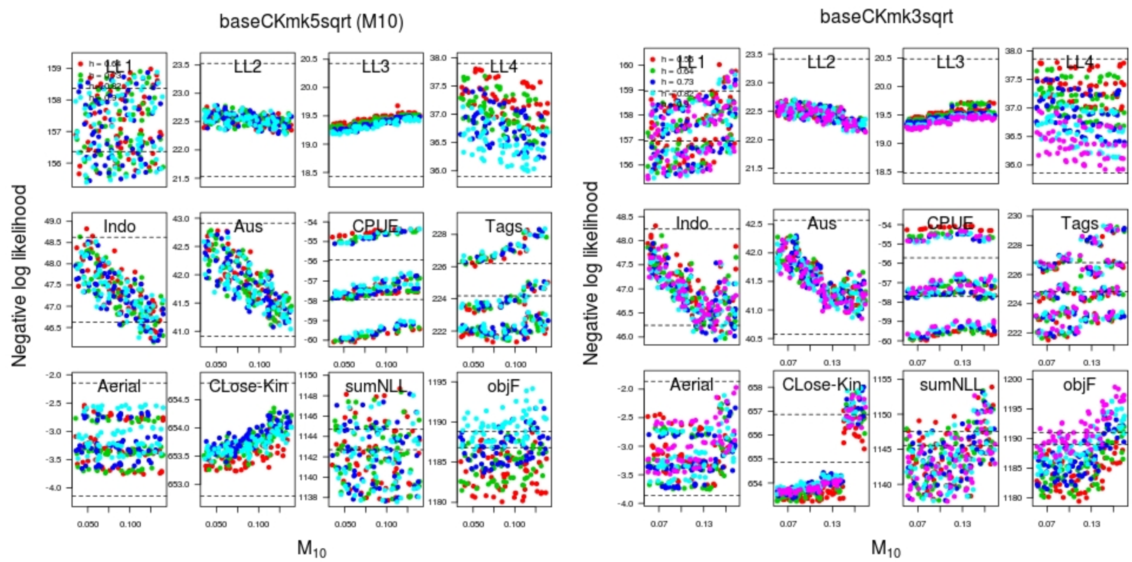

Figure 7. Negative log-likelihood profiles for the 2010 data with higher values of M_{10} omitted (left) and included (right) to show that high values are inconsistent with the close-kin data (from ESC/1209/21).

Effective reproductive output

26. ESC/1209/21 provides an initial specification for effective reproductive output for the OM, which is required to incorporate the close-kin data. It was noted that this means redefining the “currency” of the OM from SSB 10+ yr-old to effective reproductive output. The Working Group agreed that, for consistency, SSB 10+ yr-old would continue to be the basis for reporting on stock status, but that effective reproductive output of the form described in ESC/1209/21 would be used in projections.

27. The working group noted that there are several key assumptions included in this specification relating to:

- Residence time on the spawning ground
- Vulnerability on the spawning ground
- Size and age at maturity.

28. In particular, there are no direct observations of behavior on the spawning ground to inform residency time and the large majority of the data on size/age of maturity is derived from samples taken from the spawning ground. It seems likely that immature fish spend less time on the spawning grounds which would indicate that the current estimates are biased toward smaller/younger ages and sizes.

29. Given the uncertainty in each of the above, the Working Group agreed the most appropriate approach would be to develop two or more “reasonable” cases to bound the base case. The components of the initial specification of effective reproductive output provided in ESC/1209/21 were examined in considerable detail by the Working Group to clarify likely mechanisms and the available data,

parameter estimates and information available for each. Attachment 4 provides a detailed description and specification.

30. The Working Group agreed that the most influential uncertainty was related to residence time and vulnerability to the fishery on the spawning ground, and that these two processes were inseparable with the available information. Four alternatives were developed that reflected different assumptions about maturity, residence time and vulnerability, as summarised in Table 4 and illustrated in Figure 8 below. These were run for an intermediate grid cell using the 2012 data. The first alternative considered that all mature and immature SBT migrate to the spawning ground; the additional three runs assumed that an increasing proportion (λ = 0.25, 0.5 and 0.75) of immature animals migrate to the spawning ground (Figure 9. below and for the λ options).

Table 4. Four alternative specifications for the proportion of time a mature SBT spends on the spawning ground. See Attachment 4 for details.

Option	Age at Maturity	Form	Rationale
1	7+	Knife edge	Extreme case: all SBT age 7 and older stay on the spawning ground for the same period.
2	Starts with 50% at age 7, 100% by 12	Stepped	Only skip spawning (alternative years) prevents full contribution. This has been observed only for ages from 7 to 12. Assumed to decrease linearly over this range.
3	Starts with 33% at age 7, 100% at 25.	Stepped	Ad hoc allowance to increased residency with age in addition to skip-spawning effect.
4	5% at 8, 50% at 12, 95% at 16	Logistic	Approximation of close-kin

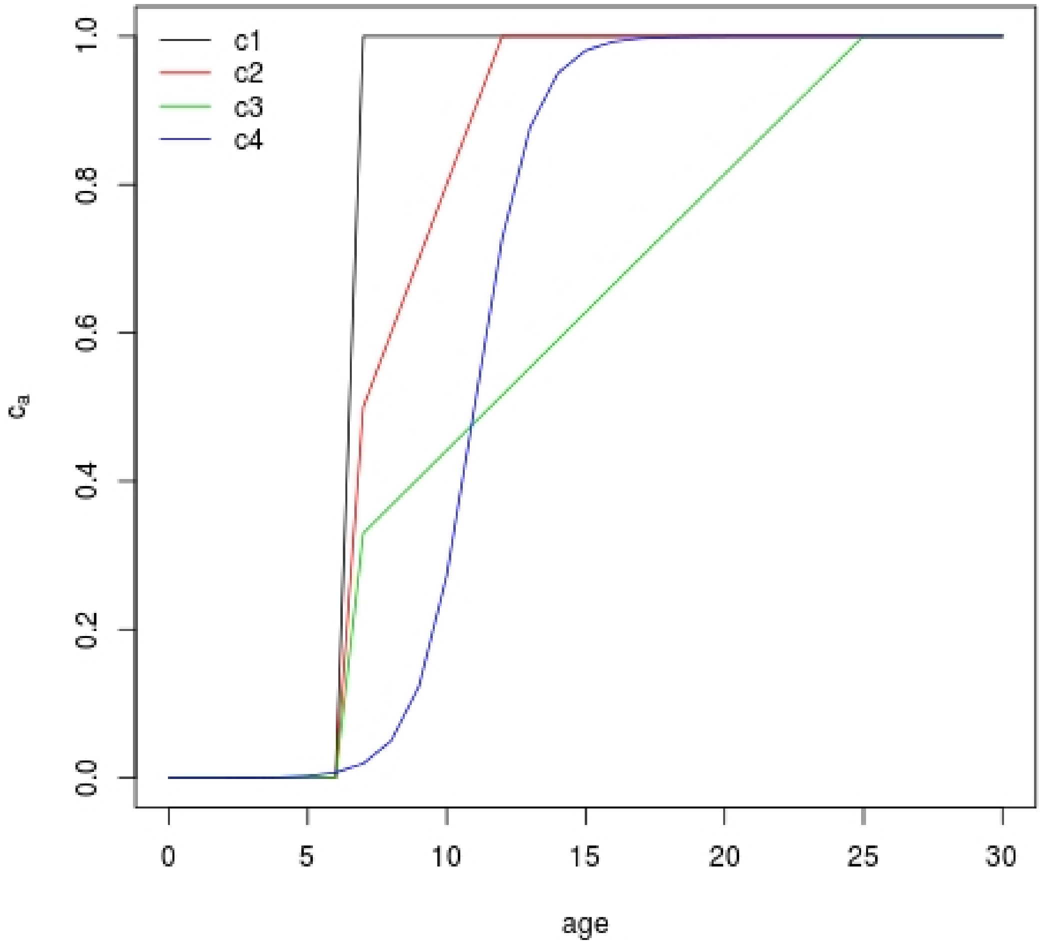

Figure 8. Four alternative specifications for the proportion of time a mature SBT spends on the spawning ground.

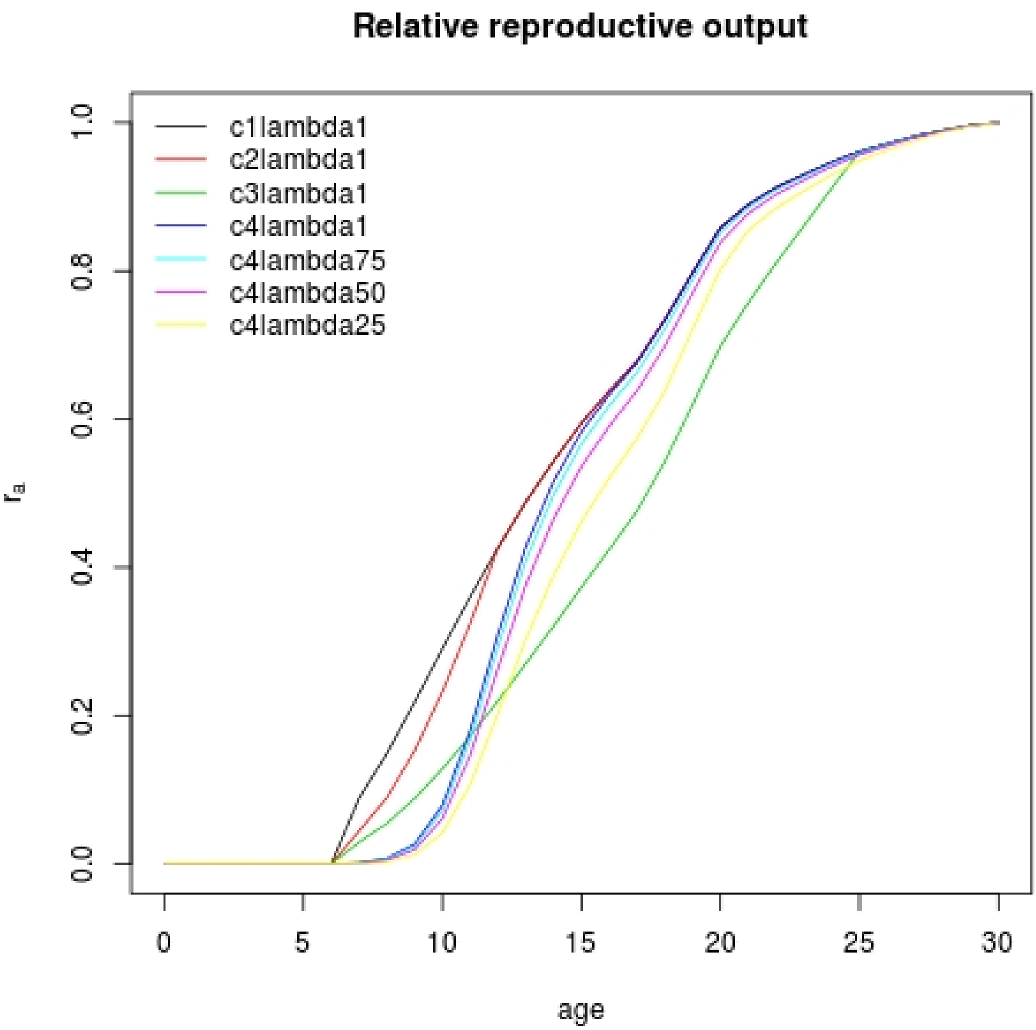

Figure 9. Relative reproductive output for four alternative assumptions about residency time for mature SBT and three values of λ (the proportion of immature SBT, relative to mature SBT, that migrate to the spawning ground).

31. The results of the seven runs indicated that the impact of different forms of reproductive output on SSB, estimated recruitment and depletion were negligible (Figure 10). Given this the Working Group agreed to use the logistic residency relationship estimated in the close-kin assessment and a λ value of 0.5 as a base-case assumption.

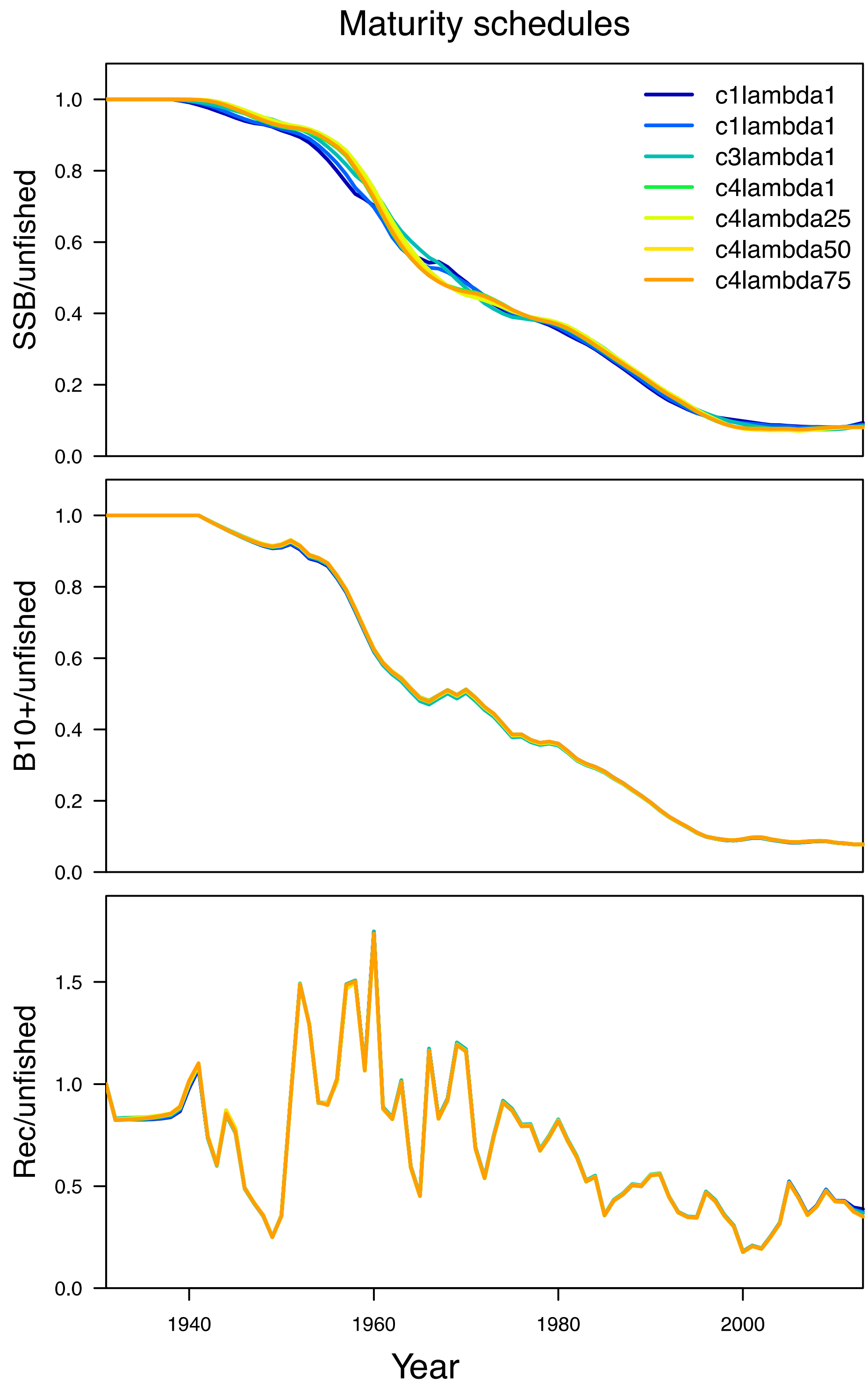

Figure 10. Relative spawning biomass, total biomass at age 10+ and recruitment estimated using four alternative assumptions about residency time for mature SBT and three values of λ (the proportion of immature SBT, relative to mature SBT, that migrate to the spawning ground).

Agenda Item 2. Reconsideration of reference set

2.1 Grid structure and associated uncertainty

32. The preliminary results of including the close-kin data for conditioning the OM (ESC/1209/21, OMMP/1307/05) showed that the addition of the close-kin likelihood component resulted in higher objective-function weights assigned to low values of steepness. The analysis demonstrated that these higher weights were determined by the penalty applied to the deviates from the stock-recruitment function.

33. With regard to the choice of variance for this penalty, currently set at 0.6^2in the OM, paper OMMP/1307/6 detailed an approach using the population and estimation model of the SBT management procedure to infer an estimate of recruitment variance (σ_r) outside of the SBT OM. While the authors cautioned that the values estimated might be over-estimates, it was acknowledged that the estimate of around 0.6 was encouraging. This suggests that we are not underestimating how variable recruitment might be and, hence, likely not under-estimating stock variability in the projections used in the MP testing.

34. A concerned was expressed, however, that the subjective penalty applied to the recruitment deviates could potentially generate a false preference for steepness, especially given the one-way trip pattern in the stock-recruitment estimates and the assumption of zero autocorrelation made for conditioning the OM.

35. To investigate this further the Working Group evaluated the extent to which the apparent preference for lower steepness values was driven by the early part of the series of recruitment estimates, which are largely not informed by data.

36. As a first step, the series of recruitment estimates was broken into four blocks of 20 years each, and the stock-recruitment penalty, auto-correlation of recruitment deviates and steepness preferences were evaluated for each period (Table 5). The estimated autocorrelation was close to 0.7 for the last two blocks, low in the1950s and 1960s, and very high in the initial period. The preference for low values of steepness was not the result of the initial period but was driven by the penalty calculated for 1950-1969 and 1990-2012 (Figure 11).

Table 5. Steepness preferences, autocorrelation and penalty ($0.5\sigma_R^{-2}\sum_{i=1}^{n}\varepsilon_i^2$ where σ_R = 0.6) applied to recruitment deviates by 20-year periods of historical series.

		1930-1949	1950-1969	1970-1989	1990-2012
NLL penalty	5%	4.804	3.587	1.067	2.213
	50%	5.793	4.305	1.317	2.981
	95%	6.233	6.819	1.554	4.732
Autocorrelation	5%	0.912	0.132	0.618	0.672
	50%	0.918	0.145	0.682	0.737
	95%	0.925	0.164	0.738	0.790
Steepness (h) preference		High h, weak	Low h, strong	No preference	Low h, strong

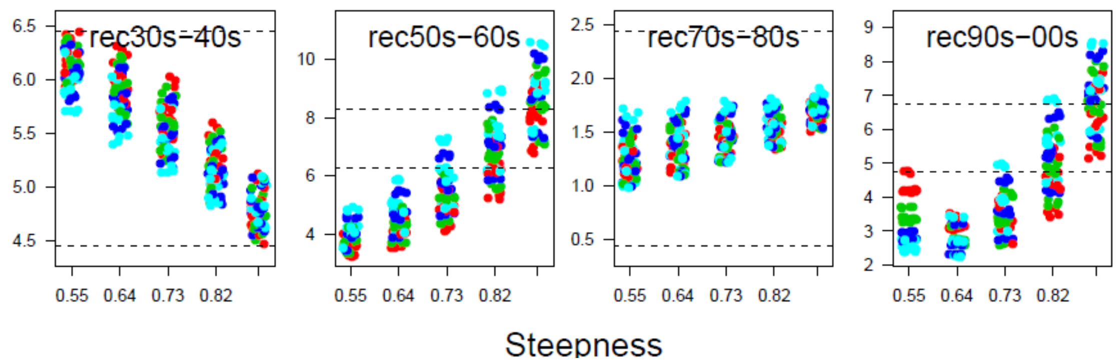

Figure 11. Preference for steepness as measured by the negative value of the penalty applied to stock-recruitment residuals, calculated for four 20-year periods assuming zero autocorrelation.

37. The relatively high values of the penalty obtained for 1930-1950 correspond to the period prior to the development of the fishery. Recruitment estimates over this period are mainly informed by the initial Japanese long-line (LL1) length frequencies starting in 1952. Historically, the recruitment estimates always showed a marked dip in the late 1940s (Figure 12), which was in part driven by the initial LL1 size compositions, and the model could not fit an abrupt shift in size composition (from larger fish to mid-size fish) observed between 1956 and 1957. It was noted that during the development of the fishery there was a shift in the Japanese fleet from initially fishing on the spawning ground (Area 1) further south to the Oki grounds and subsequently to the Tasman Sea (Area 5). In order to accommodate these changes in fleet behaviour and to improve the fits, the Working Group decided to relax the penalty applied to the change in selectivity parameters between 1956 and 1957. Increasing the variance for the penalty from 0.5 to 2 improved the fit to the initial LL1 size compositions (Figure 13) and reduced the size of the negative recruitment deviates (Figure 14) but only had a

slight effect on the preference for high steepness in this early period (Figure 15). The Working Group agreed to include this change as part of the new base model.

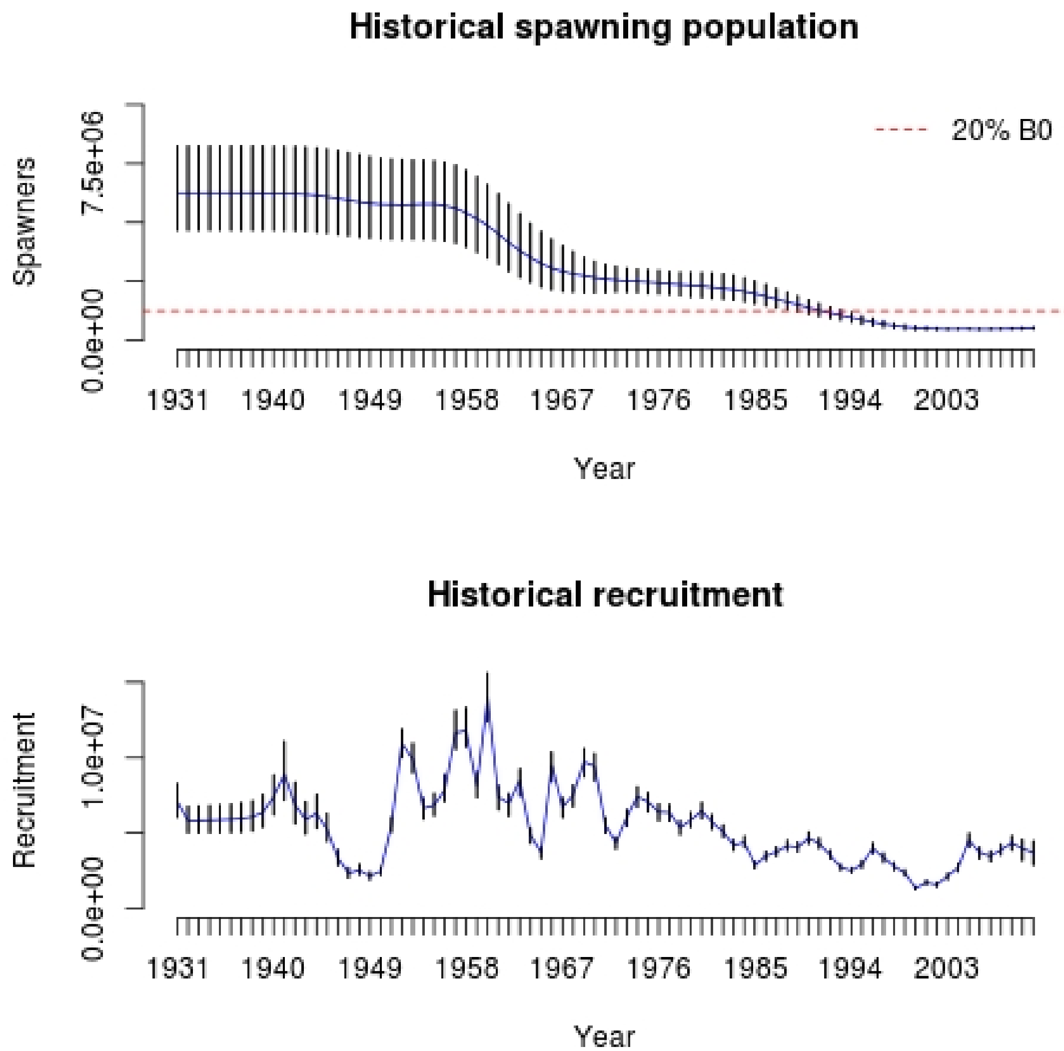

Figure 12. SSB and recruitment series from ESC/1209/21 .

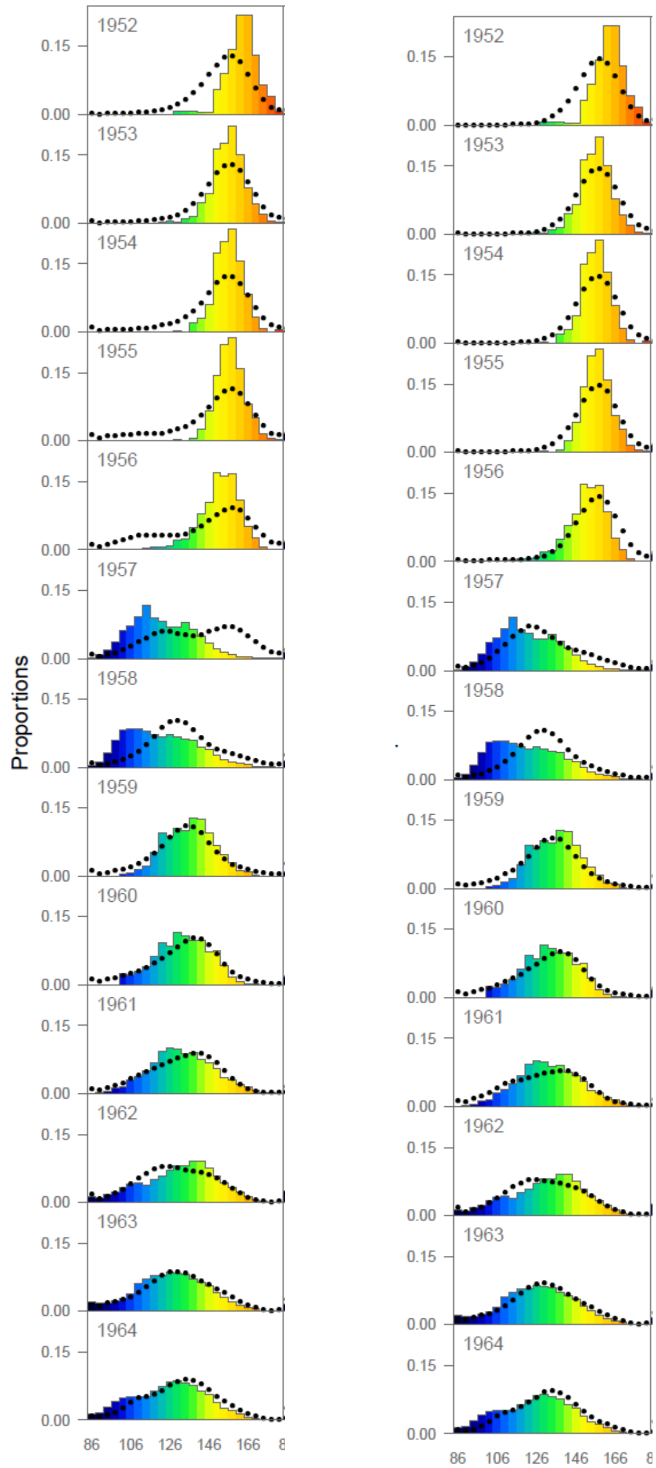

Figure 13. Fits to the initial size composition of LL1 fishery before (left) and after relaxation of the selectivity penalty.

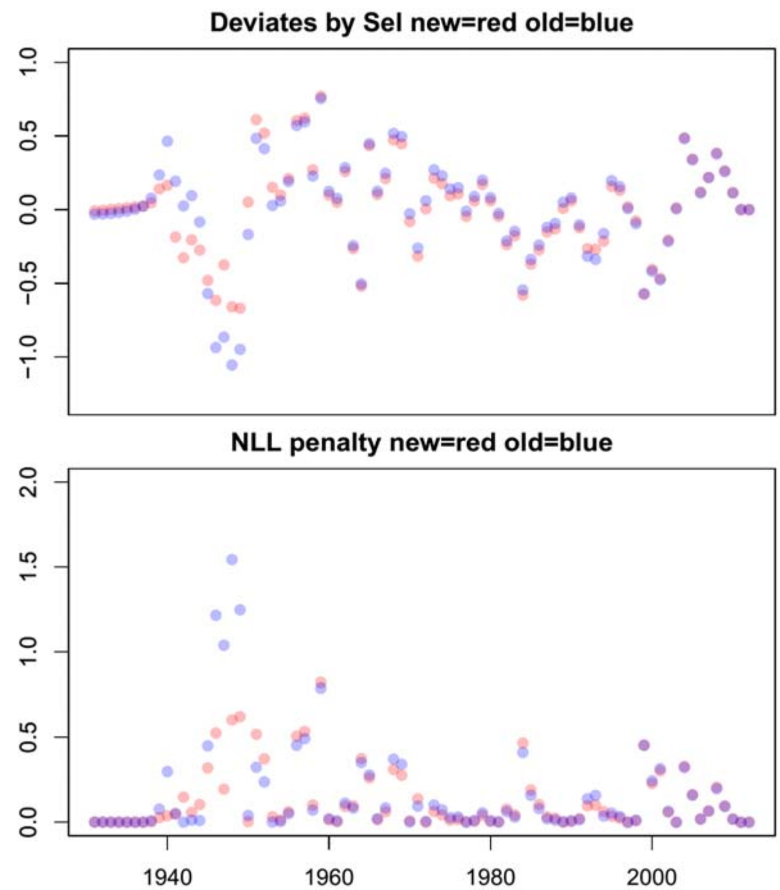

Figure 14. Recruitment deviations (top) and corresponding penalties (bottom) for a representative cell of the grid showing the impact of the modified selectivity specification.

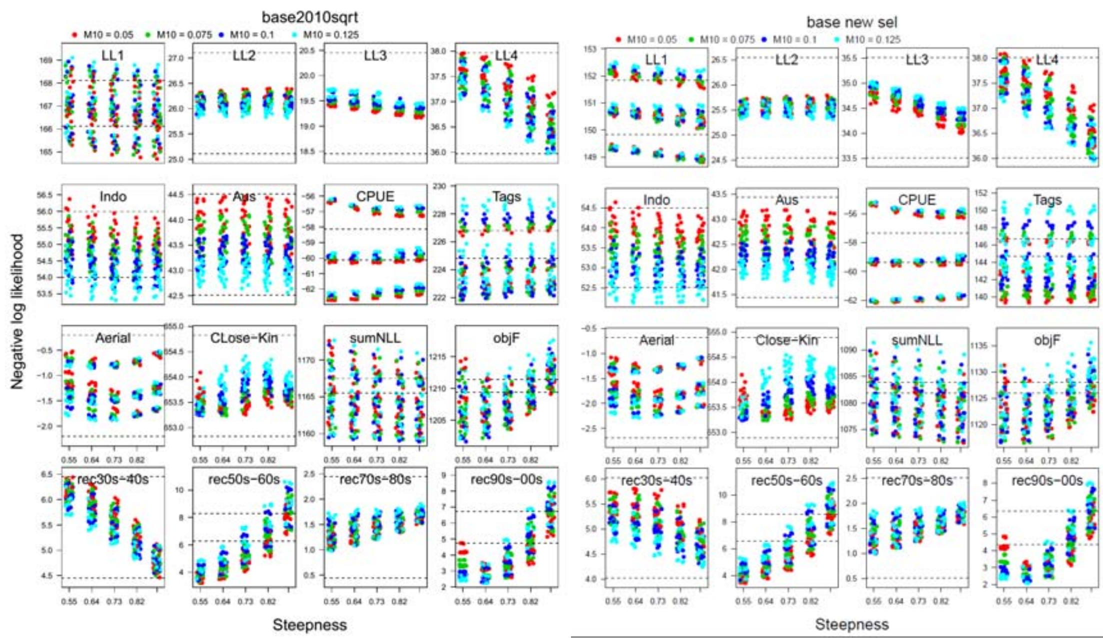

Figure 15. Negative log-likelihood profiles pre- and post-modification of the penalty applied to changing LL1 selectivity parameters between 1956 and 1957.

38. This investigation confirmed that the stock-recruitment penalty was the primary determinant of the preference for low steepness. The Working Group noted that the assumption that recruitment deviates are independent made in the conditioning of the OM might artificially increase the value of the stock-recruitment penalty and the preference for low steepness values. The impact of accounting for auto-correlation in the recruitment deviates on the stock-recruitment penalties was therefore examined.

39. Given the problems found in the past when trying to estimate the autocorrelation of recruitment residuals during the fit, the conditioning code was modified to incorporate a fixed value of autocorrelation in the last phase of the estimation. A value of autocorrelation equal to 0.7 was first tried but a large fraction of the grid cells failed to converge. Numerical performance improved when the autocorrelation coefficient was reduced to 0.5.

40. The resulting likelihood profiles showed that the strong preference for low steepness in the objective function disappeared with the inclusion of autocorrelation (Figure 16). Sampling using objective function weights showed some preference for intermediate steepness values (Figure 17). Further work is needed to improve numerical performance and examine the sensitivity to the use of higher values of autocorrelation.

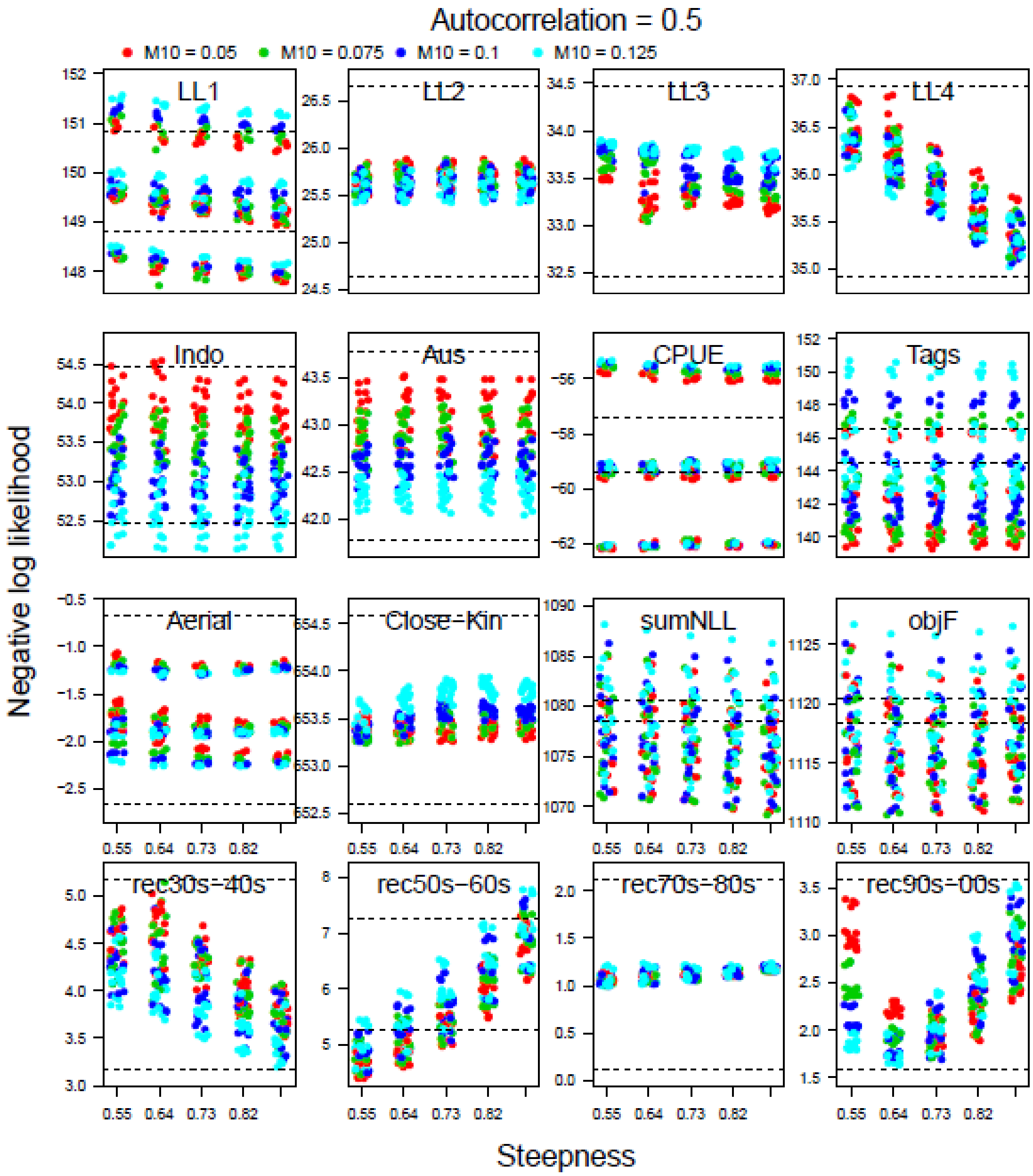

Figure 16. Profiles of negative log-likelihood, objective function and penalty on stock-recruitment deviations calculated for 20-year periods assuming auto-correlated residuals (AC = 0.5).

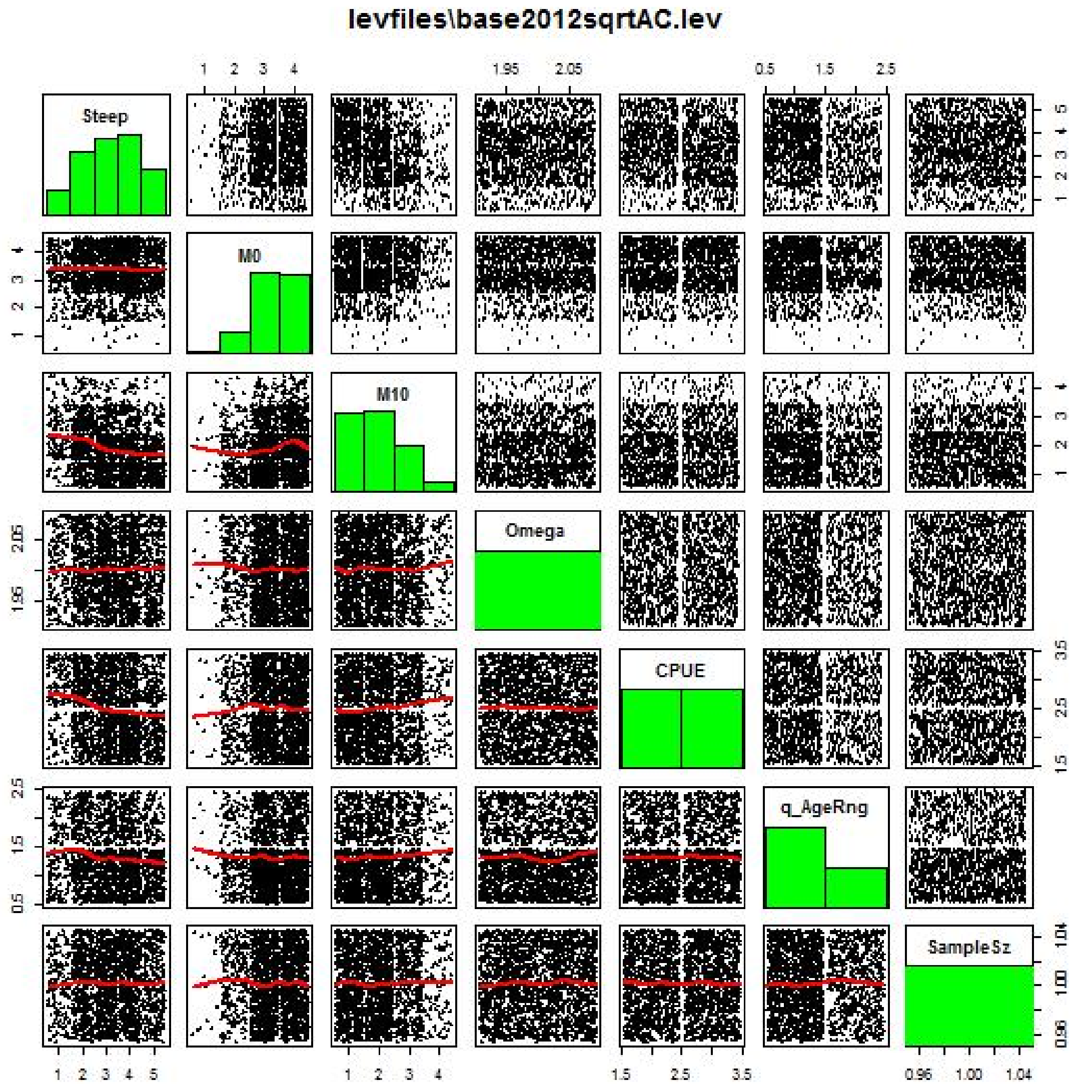

Figure 17. Levels sampled from the grid using objective-function weighting for steepness for the model that included auto-correlated stock-recruitment residuals (AC = 0.5).

41. In light of these results the Working Group concluded that is was not appropriate to use objective-function weighting for steepness when recruitment residuals are assumed to be independent, and that the OM would be improved if a fixed autocorrelation of recruitment residuals could be included in the formulation of the penalty for fitting.

42. The Working Group agreed that the most appropriate approach was to use a uniform prior on steepness in the grid.

43. The values of steepness in the grid used in 2011 ranged from 0.55 to 0.9. Lower values of steepness had been excluded because they resulted in a very low value of the objective function. However, the fact that the objective function was

uninformative when auto-correlation in recruitment residuals was incorporated, and the decision made by the Working Group to use uniform weights for steepness implied that the *h* range had to be re-considered for possible inclusion of lower values. A model run was conducted using seven values of *h* (base7h), including *h*=0.3 and *h*=0.385. The likelihood profiles obtained using this expanded grid showed a marked increase in the negative log-likelihood for the two lowest values of *h*, especially for the close-kin data (Figure 18). None of the likelihood components favoured those low *h* values.

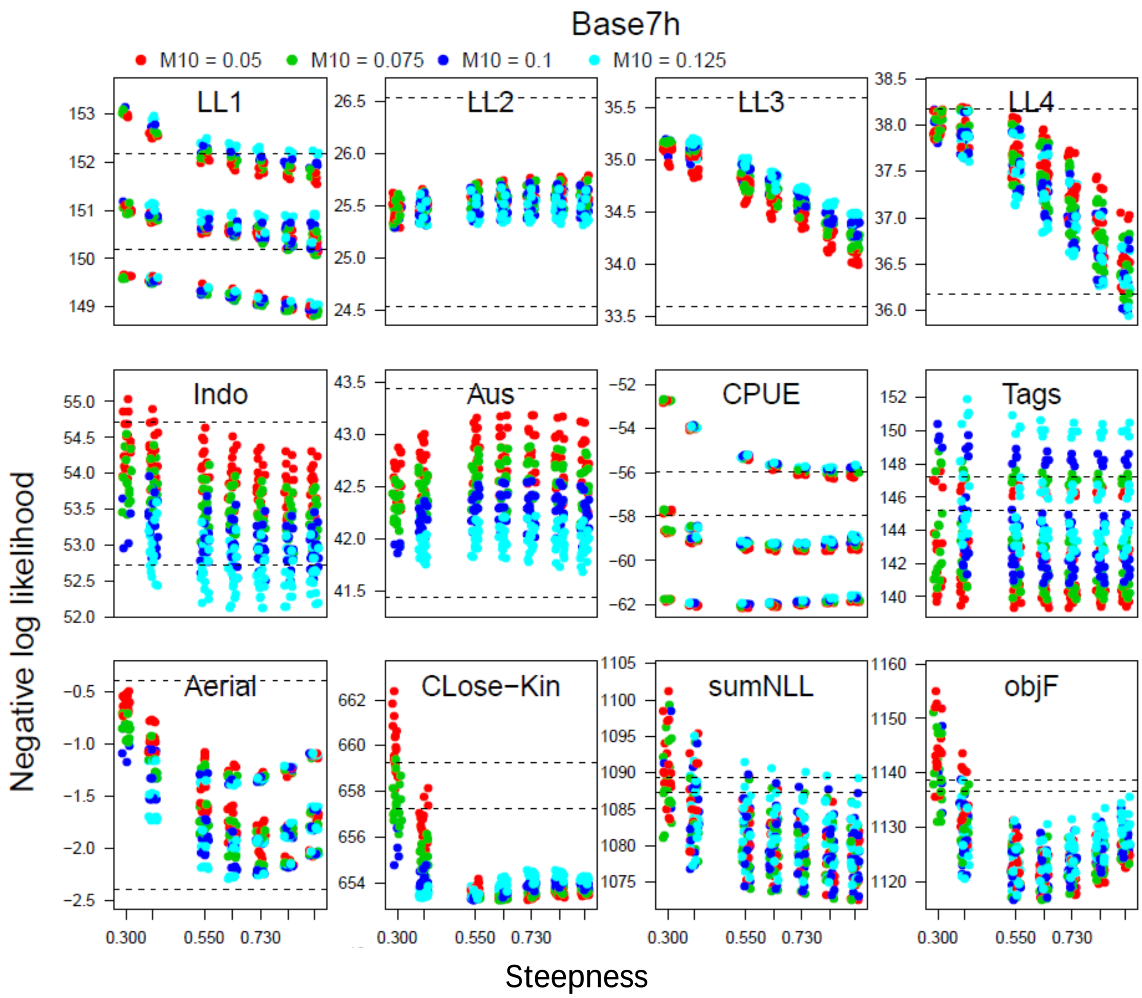

Figure 18. Negative log-likelihood profiles as a function of steepness obtained using an expanded axis on steepness, from 0.3 to 0.9, and no autocorrelation in the stock-recruitment penalty.

2.2 Treatment of within-cell uncertainty

44. Conditioning the model and estimating the within-cell uncertainty (i.e., estimation error) posed a problem during the meeting as the Hessian appeared to be non-positive definite. Efforts to resolve the issue were incomplete but there seems to

be some relationship with this behaviour and the fact that some initial size compositions for LL3 were assigned a sample size of zero in 2011.

2.3 Weighting schemes for key parameters

45. Based on the increase in negative log-likelihood obtained for steepness values of 0.3 and 0.385 (Figure 19, discussed in section 2.1) the Working Group decided to keep the same range of *h* values, from 0.55 to 0.9, as assumed for the OM grid used for MP evaluations in 2011.

46. As discussed in Section 2.1, the Working Group decided to use uniform weightings for steepness based on the results of model runs conducted using autocorrelated recruitment deviations, which showed that the objective function was uninformative about steepness over the range 0.55-0.9.

47. With regard to M_{10}, the objective-function weights obtained using the grid configuration specified above showed a preference for low values (Figure 20). The fits obtained using values of M_{10} equal to 0.03 and 0.04 should be evaluated before a final decision on the grid, with special attention to the impact on the size of the plus group and the shape of the Indonesian selectivity.

48. The base model will use an intermediate scenario for the effective reproduction contribution by age, as defined in Section 1.2. The inclusion of an additional grid axis to incorporate uncertainty around this function was considered unnecessary given the lack of sensitivity of trends in relative recruitment and spawning biomass, as well as current absolute value of spawning biomass, with respect to the alternative functions examined.

49. Based on these considerations, the workshop decided to use the grid structure for the OM specified in Table 6, pending on the results of further evaluation of the range of M_{10} values.

Table 6. Specification of the axes of reference set grid.

	Levels	Cumul N	Values	Prior	Simulation Weights
Steepness (*h*)	5	5	0.55 0.64 0.73 0.82 0.9	Uniform	Prior
M_1	4	20	0.30 0.35 0.40 0.45	Uniform	Objective function
M_{10}	4	80	0.05 0.075 0.1 0.125	Uniform	Objective function
Omega	1	80	1	NA	NA
CPUE series	2	160	w.5 w.8	Uniform	Prior
q age-range	2	320	4-18 8-12	0.67, 0.33	Prior
Sample Size	1	320	Sqrt	NA	NA

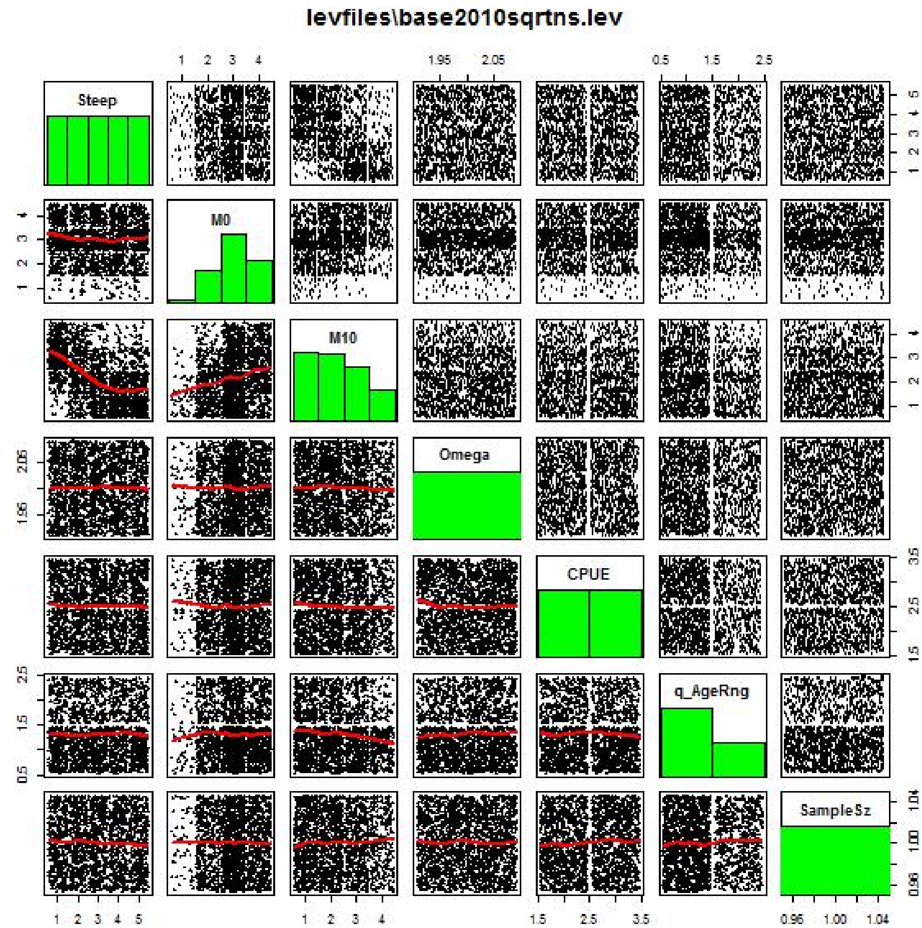

Figure 19. Level figure for the grid selected at OMMP4.

Agenda Item 3. Code refinements and version control system

50. Due to glitches with the original version control system Jim Ianelli went with a more modern and popular approach using github (which has facility to manage the content to selected members only). The versioning system allows CCSBT analysts to dispense with confusing numbering system in the program names.

51. Code refinements made during the meeting included facilitating running the OM in a variety of environments and the facility to use auto-correlation parameters in recruitment was added (since the prior on the stock-recruitment relationship appeared to have an influence on steepness—as a function of pre-set recruitment variability).

52. Outstanding issues with the OM include that some parameters may be poorly estimable, leading to a non-positive definite Hessian. As noted above, there seems to be some relationship with this behaviour and the fact that some initial size compositions for LL3 were removed in 2011.

Agenda Item 4. Considerations for the Scientific Research Program

53. Results of the analyses conducted during the meeting led to the identification of a series of modelling and data-analysis issues that require further investigation. Those are listed under Agenda Item 5. Broader discussion of priorities for the Scientific Research Program were deferred for the ESC.

Agenda Item 5. Workplan and timetable

54. Below is a list of tasks and issues to be addressed in preparation for the ESC meeting of 2014 when a full SBT stock assessment is to be conducted. These tasks were identified based on the work conducted during the workshop.

Before (or during) Canberra meeting:

55. Update input files for projections (Ana).

56. Update word documents about model specifications (Ana, Richard).

57. Update user document about assessment code (grid and projections) within Version Control (Ana & Jim).

58. Extend the grid on the M_{10} axis to include 0.03 and 0.04 and evaluate the likelihood profiles and effects on the plus group and Indonesian selectivity (Trevor).

59. Address numerical problems encountered when running the code with hardwired autocorrelated recruitment deviations. This may involve revisiting the catch equation as the problems seem to be related to hitting the bounds for the current formulation. If it is not fixed, evaluate use of empirical autocorrelation to re-compute penalty *a posteriori* (Richard)

60. Assemble information on the Indonesian fishery that is relevant to the apparent dome shaped selectivity (effort and hook depth data) (CSIRO).

During Canberra meeting:

61. With a view toward better understanding differences in spawning stock size estimates between the OM and close-kin analysis, evaluate effects of removing or modifying components of the OM (CPUE, tagging, and giving low weight to Indonesian age composition) on the OM results (technical working group during Canberra).
62. Further consider comparability of OM results with the independent close-kin assessment.
63. Evaluate implications of OM updates (including incorporation of close-kin data) on MP performance.
64. Evaluate which parameters are causing the Hessian to be non-positive definite.

For 2014 assessment:

65. Estimate initial abundance and age structure in 1950 without an initial equilibrium assumption.
66. Evaluate sensitivity to exclusion of the assumed linear increment in q over time.
67. Evaluate sensitivity of independent close-kin assessment to selectivity assumptions.
68. Evaluate OM residuals and effective sample sizes.
69. Refine use of version control for all code (MP, OM and R scripts).
70. Evaluate how to incorporate within-cell uncertainty in OM grid.

CPUE work

71. The meeting convened a sub-group to consider the CPUE indices and they provided a summary in Attachment 4.

Agenda Item 6. Close of meeting

6.1 Adoption of report

72. A draft report was prepared during the meeting and participants provided editorial comments. A final draft was circulated after the workshop and approved by email.

6.2 Close of meeting

73. The meeting closed at 4:30 PM, 26 July, 2013.

List of Attachments

Attachment

1	List of Participants
2	Agenda
3	List of Documents
4	Reproductive output computations
5	Report of the CPUE discussion

Attachment 4. Reproductive output computations

In order to run the operating model with the inclusion of close-kin data the following age-based variables need to be estimated.

(NB: a superscript of *i* indicates immature fish, *m* indicates mature fish and # indicates measured on the spawning grounds.)

1. The proportion of tuna of age *a* that are mature, ϕ_a
2. Reproductive output = r_a which will be summed over age *a*
3. Reproducers caught = RC_a - these are related to the age distribution of identified parents and can be used to compare against the observed values for this distribution

These are linked to the following variables/factors that are either known or can be estimated when fitting the model

$\phi_a^{\#}$ proportion of tuna of age a sampled on the spawning grounds that are mature

p_a^m probability that a mature tuna of age *a* goes to the spawning grounds for at least some time =1 (by assumption)

d_a daily output of spawn by a mature tuna of age *a*

N_a Numbers at age from the model

S_a Selectivity of fishery on spawning ground

and to the following variables for which presently informed assumptions need to be made.

p_a^i probability that an immature tuna of age *a* goes to the spawning ground for at least some time

g_a^m proportion of time a mature tuna of age *a* that goes to the spawning ground spends on the spawning ground

g_a^i proportion of time an immature tuna of age *a* that goes to the spawning ground spends on the spawning grounds

S_a^m probability that a mature tuna of age *a* on the spawning grounds is caught by the fishery (i.e. this includes only the gear component of selectivity, and not the availability component)

S_a^i probability that an immature tuna of age *a* on the spawning ground is caught by the fishery

Estimating ϕ_a

Note that the spawning ground measurement of proportion mature relates to the proportion mature in the whole population as:

$$\phi_a^{\#} = \frac{S_a^m g_a^m p_a^m \phi_a}{S_a^m g_a^m p_a^m \phi_a + S_a^i g_a^i p_a^i (1-\phi_a)} \qquad 1$$

We assume that $S_a^m = S_a^i = S_a^{\#}$, and define

$$c_a = g_a^m p_a^m, \qquad g_a^i p_a^i = \lambda_a c_a \,.$$

Then the S_a will cancel in equation 1 and various forms are assumed for c_a.

Thus for example if λ_a=1, equation 1 simplifies to:

$$\phi_a^{\#} = \frac{\phi_a}{\lambda_a + (1-\lambda_a)\phi_a} = \phi_a \text{ for } \lambda_a = 1$$

which can be reorganised as:

$$\phi_a = \frac{\lambda_a \phi_a^{\#}}{1-(1-\lambda_a)\phi_a^{\#}} = \phi_a^{\#} \text{ for } \lambda_a = 1$$

The Other Unknowns

With an estimate of ϕ_a it is now possible to compute the predicted age distribution of the identified parents in the POPs:

$$\begin{aligned} RC_a &= S_a N_a = S_a^{\#} c_a \left[\lambda_a + (1-\lambda_a)\phi_a\right] \\ &= S_a^{\#} c_a \qquad \text{for } \lambda_a = 1 \end{aligned}$$

and

Reproductive output: $r_a = d_a c_a \phi_a N_a$

Attachment 5 Report of the CPUE discussion at OMMP4 on 24 July 2013

John Pope presented a summary of the CPUE webinar held in April 2013 (CCSBT-OMMP/1307/10). There were two main agenda items, checking that the current base series continues to behave adequately and to develop and encourage new work on potential CPUE monitoring series.

Various possible monitoring series were proposed. It was agreed that the following series should be constructed and used to compare with the base model series. These were as follows:

1. The Base Model but without bycatch terms (i.e. with the YFT and BET terms removed)
2. John's bycatch model (as 1 but including the proportion of hauls with zero SBTa s a by-catch indicator)
3. The Base Model with all interaction terms removed (main effects only).
4. Leave interaction terms in but treat them as random effects (– Year x month, area x month).
5. Use GAM / spatio temporal splines to provide new series.

It was also noted that the 1° x 1° and the haul by haul series should also be seen as potential monitoring series.

In response to the chair, members stated that all the CPUE series except 4 above were completed or in preparation and the 1° x 1° had been completed. Itoh-san offered to construct series 2, and John asked Australia and Japan to liaise in preparing 4, Australia was preparing series 5.

Itoh presented an update of the core CPUE indices used in the Management Procedure (CCSBT- OMMP/1307/07). The base series has the following variables and interaction terms:

log(CPUE+0.2) = Intercept + Year + Month + Area + Lat5 + BET_CPUE + YFT_CPUE + (Month*Area) + (Year*Lat5) + (Year*Area) + Error

Two additional CPUE series are made for comparison with the base case:

1. Reduced base model:
   log(CPUE+0.2) = Intercept + Year + Month + Area + Lat5 + (Month*Area) + Error
2. Same variables as the base series, but the data used are shot-by-shot rather than the aggregated 5x5 monthly data.

The base model and the reduced model were very similar except for the last three years (Figure 4 in OMMP/1307/07). The cause of this difference was explored by removing terms to identify those that made the most difference. The Year*Lat5 and Year*Area interactions were found to be responsible for the difference (Figure 5 in the paper).

The base model and the shot by shot series were also very similar except for the last year 2012). An increase in effort in Area 7 was found to cause this difference.

The Working Group discussed the differences and determined that higher CPUE resulted in more effort being attracted to Area 7 in 2012. The differences seen in the CPUE series were not considered a problem but something that should be kept under review.

Itoh presented a summary of the Japanese longline operations in 2012 for comparison with earlier years (CCSBT- OMMP/1307/08). Apart from an increase in the number of hooks set in Area 7 there was little change in 2012. A feature of the length frequency data was the progression of a dominant mode from 2009 to 2012. The concentration index showed little change except an increase in Area 7 (i.e., more spread).

Conclusion: The Working Group concluded that the updated base CPUE series is suitable for the MP and there was no reason to change the model being used.

Discussion

The WG discussed other ideas and any new work that would be useful for further CPUE studies:

- To compare Taiwan CPUE by area with the Japan CPUE, Scientists from Taiwan (Wang) and Japan (Itoh and Norio) will discuss how best to achieve this and provide a joint analysis. The Taiwan CPUE may need adjusting for the by-catch of other species to make this comparison and it may be necessary for the Japanese data to be compared for a restricted size range of fish.
- To carry out an analysis of Korean CPUE data. Similar collaboration will also be needed for this to be successful. Initially it may be easiest to compare Korean and Japanese CPUE in area 9 since most overlap in fishing was thought to occur in that area.
- To consider shorter time series starting from 2006 as the new post-2006 CPUE series increases in length.
- To look at size-based indices of CPUE in order to account for changes in mean distributions by size. It was anticipated that at least in the first case a few broad splits of the data by size would be sufficient. Itoh offered to try to construct suitable data sets.
- To design experiments using longline research sets as a basis for providing consistent time/area distribution of longline CPUE. Itoh reported that he had had preliminary discussions with representatives of the Japanese Industry. They were not adverse to the idea in principle, but would need firmer ideas of the objectives of such a study, the amount of effort that would be required and the nature of any practical arrangements.

- John suggested that a long term experiment to clarify the weighting to use for constant versus variable squares might be a more possible use of research effort by commercial vessels. As a preliminary to proposing such work it would be helpful map out the squares fished or dropped out over time. He requested that Norio might produce a report that detailed the 5x5 cells and months that contributed the largest difference between constant squares and variable squares.

List of Working Papers for the July 2013 CPUE discussion

CCSBT-OMMP/1307/07 (Japan) Description of CPUE calculation from the core vessel data for southern bluefin tuna in 2013. Itoh T, Sakai O, and Takahashi N.

CCSBT-OMMP/1307/08 (Japan) Change in operation pattern of Japanese SBT longliners in 2012. Itoh T.

CCSBT-OMMP/1307/10 (Chair of CPUE modelling group) Summary Report of the CPUE web meeting held on the 25/26 April 2013.

Plan of work for developing abundance index of SBT based on Taiwanese longline CPUE

OMMP Workshop 4 in Portland

Wang, Takahashi and Itoh

1. Collect information of fishing and data collection system
   - In terms of for Catch, Effort, Size, Fleet size, gear configuration, etc.
   - For reporting system from vessel to government, actual reporting rate and those changes along with year.
   - Review of papers which were submitted to CCSBT in the past, and other papers or information relating.

2. Understanding of fishery and catch data
   - Analysis on data already submitted in CCSBT
     e.g. Spatio-temporal distribution: mapping on catch, effort, CPUE
     Various summarization
   - Analysis on data not submitted in CCSBT
     e.g. Other by-catch tunas, i.e. albacore, bigeye, yellowfin tunas. Albacore is primarily important.
     Check whether catch is zero-inflated.

3. Understanding by factor
   - How each candidate factors change along with year and other factors.
   - Correlation to each other.

4. Comparison with Japanese data
   - Understanding of difference between Japanese and Taiwanese longlines in terms of operation methods, fishing strategy, etc.
   - Specify the time-area to compare.
   - Can Japanese size data use for Taiwanese catch data?

5. Standardization of CPUE
   - Exploration of catch and effort data in terms of variables to be included in standardization models (GLM, GAM, etc)
   - Conduct standardization, examine model fits, select appropriate model

6. Abundance index
   - Consider definition of SBT distribution w/in Taiwanese fishing ground (variable squares and constant-squares?)
   - Area weighting?

Remarks:

- Data since 2002 will be used mainly for CPUE analysis. Historical data since 1981 will be used to characterize Taiwanese longline fishery. Utilization of data before

2002 may be tried in future.

- Progress on items 1 and 2 will be reported to the CPUE group in ESC18 held in September 2013.