Commission for the Conservation of
Southern Bluefin Tuna

みなみまぐろ保存委員会

Report of the Fourth Meeting of the Stock Assessment Group

25-29 August 2003
Christchurch, New Zealand

Report of the Fourth Meeting of the Stock Assessment Group

25-29 August 2003

Christchurch, New Zealand

Agenda Item 1. Opening

1.1 Introduction of participants

1. The independent chair, Dr. John Annala, opened the meeting and welcomed participants from Australia, Japan, Korea, New Zealand and Fishing Entity of Taiwan.
2. Participants were introduced and the list of participants is at Attachment **A**.

1.2 Administrative matters

3. Administrative arrangements for the meeting were presented by the Deputy Executive Secretary

Agenda Item 2. Appointment of rapporteurs

4. Each member appointed rapporteurs to produce the text of the report relating to technical discussions.

Agenda Item 3. Adoption of agenda

5. The draft agenda was adopted. The agreed agenda is at Attachment **B**.

Agenda Item 4. Admission of documents and finalisation of document list

6. The draft list of documents for the meeting was considered. The agreed list is at Attachment **C**.
7. The meeting assigned individual documents from the list to relevant agenda items.

Agenda Item 5. Review of fisheries indicators analysis results

5.1 Review of fishery indicators

8. Papers CCSBT-ESC/0309/44, CCSBT-ESC/0309/34, CCSBT-ESC/0309/26 were tabled and discussed.

5.2 Status of the SBT stock

9. The range of stock status indicators exchanged in May 2003 contained a mixture of signals, on balance more positive than negative. The results suggest that there has been no dramatic change in the stock since the model-based assessment undertaken in 2001 and hence there is no reason to change the advice provided at that time.
10. Based on new information provided in CCSBT-ESC/0309/34, the group noted an absence of fish under 115cm (<4yrs) in the Japanese longline catch in Apr-Jul 2003.

This result is in marked contrast from catch-at-age data from previous years. In addition, results of the acoustic survey in 2000, CPUE data from the Australian surface fishery in 2002 and the Japanese longline CPUE for 3yr olds in 2002, are all consistent with a marked decline in recruitment in 1999 and 2000.

11. Results of the acoustic survey (2001 & 2002), Australian surface fishery CPUE (2002 & 2003) and aerial survey (2003) (CCSBT-ESC/0309/24) suggest that markedly lower recruitment may have continued in the 00/01 and 01/02 spawning seasons. If marked declines in recruitment since 1999 are confirmed, it will have major implications for the stock and its' potential to rebuild. However, analysis of Japanese longline data for 2004 (and possibly 2005) will be required before recent recruitment can be properly assessed. Recent recruitment remains a key uncertainty in provision of scientific advice on stock status.

Agenda Item 6. Management procedure

6.1 Terms of Reference

12. The terms of reference for the management procedure development were noted.

6.2 Consultation with Industry and Managers

13. Dr Hilborn presented paper CCSBT-ESC/0309/7 which summarised the outcome of individual consultations with members on the development of a CCSBT management procedure.

14. There was general agreement on a number of broad issues during the consultation, in particular:

- Industries of all members were sensitive to price and all members expressed concern that increases in global TAC could result in lower prices;
- All participants in the consultation recognised the global nature of the fishery and that it is the single Japanese market that makes bluefin tuna fishing profitable;
- Industries of longlining members were concerned that longlining at present is also dependant on catch rates and is sensitive to changes in catch rates. They indicated that if catch rates declined there may be reductions in catch even without reductions in the TAC;
- All participants in the consultation agreed that a period of stable harvest for the next 5 years would be highly desirable.

15. In summary, for the purposes of building a management procedure, Dr Hilborn suggested that:

- The objectives of the management procedure should be asymmetric with very slow increases in TAC in high productivity scenarios, and provide for decreases in low productivity scenarios;
- In low productivity scenarios an ideal management procedure would have a gradual decrease in TAC with substantial notification in advance.

16. In the light of the importance of economic issues revealed in the consultations, Dr Hilborn raised the possibility of incorporating economic considerations into the

development of a management procedure. The SAG considered economic issues, but felt that the uncertain and variable nature of the industry's economics (e.g., changes in price of both SBT and other species) made incorporation of explicit economic concepts infeasible within the operating model. It was noted that the consultations in Australia were intended primarily to elicit views from industry.

6.3 Performance of initial candidate management procedures from trials to date

17. Paper CCSBT-ESC/0309/23 updating the graphics used to evaluate the performance of candidate Management procedures was briefly reviewed. Clarification was sought as to why the *A* statistic had been excluded and it was determined that this was a judgment of the developer based on the observation that it is uninformative if an MP simply holds constant for the first three years. It was suggested that this statistic should describe magnitude as well as direction and hence, needs revision.

18. Changes in the Fox model-based Management Procedure (CCSBT-ESC/0309/37) and the performance of five associated candidate Management Procedures were reviewed. The main changes include:

    - Parameterising the relationship between CPUE and abundance to permit nonlinear relationships.
    - Reducing the extent of TAC changes in inappropriate directions in the first few years of management action (i.e., avoid changing the TAC in one direction and then the opposite direction in a short time period).

19. The "base case" MP (CCSBT-ESC/0309/37) showed improved performance for the $h = 0.3$ scenarios with declines in abundance stopping within the next 20 years. Performance, however, was poor where CPUE was proportional to the square root of abundance, and attempts to rectify this achieved little success, though some success was realised in dampening TAC changes albeit at the expense of greater reductions in abundance. It was noted that for all candidate procedures examined there was a trade off between the magnitude of future TACs and future stock size. It was also noted that for the least productive scenario none of the MPs in this paper pass the criterion of allowing the stock to increase.

20. CCSBT-ESC/0309/29 presented a set of 11 second stage candidate MPs. As with the previous paper, within a given MP there was a trade off between the future catch taken from the stock and the stock status after 20 years. It was also found that within a specific MP it was possible to achieve a wide range of performance in terms of this trade off by varying the tuning parameters. It was also possible to achieve similar average performance from alternate MPs; however, performance differed substantially among MPs for specific operating models despite similar average performance. It was further noted that it will be important for managers to specify the performance measures that best reflect their objectives because the consequences are, for example, quite different for different MPs depending upon whether one is considering the performance relative to the median or the lower 10^{th} percentile. As with the preceding paper it was clear that under current catches there is a low probability of realising the existing management objective of recovery to the 1980 level by 2020.

21. MP developers used different and arbitrary definitions of "good" performance. The characteristic they had in common was general agreement that attaining a similar biomass objective across scenarios (with a corresponding increase in catch variability across OMs) was desirable in the sense that it demonstrates the capacity for effective feedback control with respect to conservation objectives. It was suggested that if managers are unable to clearly specify objectives for the MPs to be evaluated against, then scientists might need to identify a set of evaluation criteria. For example it might be possible to look at how procedures perform along two axes (catch and biomass) to see if something like a Pareto frontier[1] could be identified so that those procedures along the frontier were kept and others eliminated. However, it was suggested that the utility of such an approach might be limited as procedures already might tend to be placed close to this frontier.

22. One MP (termed ASCURE, CCSBT-ESC/0309/29) was examined in greater detail to illustrate that unrealistically informative data were available that might be used to "reverse engineer" the MP and hence achieve deceptively good performance. Some problems, both philosophical and technical, were raised and it was not clear to what extent this approach should be pursued. It was noted that high information content was available to all MPs. The current set of operating models allows one to recognise current depletion very reliably from very few observations (and stock recruitment productivity to a lesser extent). These were deemed to be operating model characteristics that needed further investigation.

23. CPUE-based MPs were explored in CCSBT-ESC/0309/38. This paper explored a wider parameter space, contrasted the use of CPUE based on number and on weight, used absolute values in addition to the trend in CPUE, introduced an index of recruitment and attempted to develop a composite model. Factors considered important in evaluating performance included: catch should stabilize, TAC changes should be gradual and smooth, and the direction of changes in stock and TAC should be the same. One feature of the analysis was that in some MPs stock status improved over the next 20 years but subsequently declined. It was proposed that stock projections to 50 years should be included as a final check to identify those MPs that exhibit long term declines in stock status. A number of suggestions were made to deal with this issue ranging from eliminating some scenarios to using "worm plots" of CPUE and recruitment to explore reasons for such behaviour. In future it was thought that other types of information might be incorporated, but due to time constraints procedures based only on CPUE-based approaches were currently being considered.

[1] A Pareto frontier is a boundary between the region of feasible outcomes and not feasible outcomes. For instance, when plotting average catch against average stock size, it would be desirable to have high catch and high stock size, but biological constraints make some combinations not feasible. If we plot the performance of all management plans examined, we find that some combinations of catch and stock size can be achieved, and some cannot. In Attachment **E**, the X axis is the ratio of the stock size in 2020 to the stock size in 2002, and the Y axis is the average catch between 2002 and 2020. It would be best if we could be in the upper right hand corner, high catch and high stock recovery, but the points plotted are the outcomes of a series of management procedures examined. For any level of catch, the MP that has the highest stock recovery is considered to be at the "Pareto Frontier" that is it is one of the best possible MP's depending upon how one trades catch for stock recovery.

24. Principal Component Analysis was used in CCSBT-ESC/0309/42 to demonstrate that MP performance for robustness trials can be represented by the reference tests, except for Omega and M05 scenarios. It also demonstrated that results from Q0 and Q1 scenarios were quite similar. This approach was considered to be potentially useful but further clarification was requested as to what factors contributed to the two PC axes.

25. CCSBT-ESC/0309/40 also presented results from alternative MPs showing regardless of relative stock productivity, that under current catches the SBT stock is unlikely to rebuild. It was noted that under current catches short term abundance declines are evident that under H55 scenarios stay relatively steady in the long term, while for H30 scenarios continue to decline and for H80 scenarios improve.

6.4 Process for testing management procedures and for synthesizing results across operating models

6.4.1 Process for synthesizing results across scenarios

26. CCSBT-ESC/0309/42 considered issues for further development of management procedures. The issue relevant to this agenda item is the relative plausibility and weighting of scenarios. It was suggested that scenarios with low plausibility should not dominate the development and evaluation of management procedures, and that results from such scenarios should not be heavily focused upon.

27. An approach for synthesising results over scenarios was presented (CCSBT-ESC/0309/27). The process involves ranking the scenarios for relative plausibility by first ranking the different individual factors (or uncertainty axes, such as M, h, etc.) independently, and then deriving an overall ranking (high, medium, low) for each scenario. The first step in the synthesis is then to identify MPs with 'acceptable' performance in terms of biomass performance measures (i.e. stock status). Acceptability is determined by a different criterion for each rank of scenarios. In the second phase, only those MPs with 'acceptable' performance are evaluated with regard to catch performance measures. During the verbal presentation it was emphasised that rules can be tuned so that their behaviour is 'acceptable' under the biomass criteria, and in that sense the first step of the synthesis process does not eliminate rules. A number of advantages of this approach were noted.

28. Two other approaches were identified during discussion: integrative and 'by inspection'. The integrative approach uses a method to weight different scenarios and form weighted performance statistics over all scenarios. The 'by inspection' approach is feasible when there are a small number of scenarios to consider because performance measures are considered separately for each scenario.

29. The group agreed that it would be important to tune the MP rules before comparing their performance. This is because each rule can be 'tuned' (by changing the control parameters) to fall almost anywhere on the catch-biomass trade-off curve. If rules are tuned to perform similarly in terms of, say, one biomass performance measure, then a comparison in terms of their catch performance would be fair.

30. A small group was tasked to further develop a process for tuning and synthesising results and to report back. It was emphasised that these processes are crucial for the further development of management procedures (MPs) by national scientists intersessionally and for the planned MP workshop in early 2004. The report from the small group was further discussed in the larger technical group, agreed and is incorporated below.

Synthesis

31. The group agreed that the integrative approach would be preferable and that performance statistics would be integrated over the reference set of scenarios, defined in 6.5, using the defined weights (see Attachment **D**). The desire and need to look at individual scenarios separately was also recognised.

Tuning

32. With regard to tuning, it was noted that the details of (a) which scenario or scenarios are tuned to and (b) which measure is tuned to are important. With regard to the scenarios, it was agreed that only the reference set would be used in the tuning process. Within this, several options were identified:

    1. tuning to a single scenario;
    2. tuning to all scenarios with equal weighting;
    3. tuning to all scenarios but weighted by scenario weights;
    4. tuning high ranked scenarios to a minimum performance criterion.

    It was agreed that the 3rd option (a weighted tuning to all scenarios) is the preferred approach. This is in keeping with the integrative approach to synthesizing results.

33. With regard to what to tune to, it was considered that it is preferable, and easier in practice, to tune to the median of a measure. The median would be a more stable quantity than the 10th percentile, for example. It was agreed to tune MPs to three different levels of the ratio B2022/B2002: 0.7, 1.1, and 1.5. The choice of the levels is meant to reflect a wide range of the catch-biomass trade-off space. There are many different options for a measure to tune to and the choice of B2022/B2002 does not imply that other performance statistics are not important. The three levels should be explored and if they are found to cause problems, national scientists should communicate the problem to the panel (Ana Parma) to allow for revision of the levels prior to the March meeting. The level of accuracy for tuning should be + or - 0.005 of the absolute value of the tuning statistic.

34. The group noted that developers are unlikely to have strong guidance from the Commission about the relative importance of different aspects such as catch level, catch variability and biomass level before the March MP workshop meeting. This makes it more difficult for developers to come up with a very small number of "best" MPs, because there is limited guidance about what "best" means.

35. Several issues were identified as important to the evaluation of MPs. One key issue that has been identified in industry consultations is the short-term stability of catch. It was agreed to address this issue by defining two options for which each MP has to be run for the Reference case (see Attachment **D**):

Option a: annual TACs

For any management procedure (say, Rule 1a), tune it to each of the 3 levels of B2022/B2002 (i.e. 3 versions of Rule 1a, with median B2022/B2002 equal to 0.7, 1.1 and 1.5 respectively).

The TAC should be kept at the current catch (produced by the operating model for 2001) for 2002 to 2004, with the first year for a change in TAC being 2005.

The maximum and minimum changes in TAC are as before: 3000t and 100t respectively.

Option b: 3-year blocks of TAC

Define a variant of Rule 1a (say, Rule 1b), which has the additional constraint that the TAC is fixed at the current catch up to 2006 and after that the TAC is set every three years for a block of 3 years during which the annual TAC remains the same (i.e. the first possibility for a change in TAC being 2007, set for the three years 2007, 2008 and 2009).

Tune this MP to each of the 3 levels of B2022/B2002 (i.e. 3 versions of Rule 1b, with median B2022/B2002 equal to 0.7, 1.1 and 1.5 respectively).

The maximum and minimum changes in TAC are: 5000t and 100t. The larger maximum change is in recognition of the longer time-period of fixed catches.

Other issues

In addition to the main axes (i.e., catch and biomass) and the above-mentioned short-term catch stability, the following list of performance issues, considered important by some or all participants for the evaluation of MPs (prior to and at the March meeting) was identified:

- the minimum biomass (lower confidence level and median of Min(By/B2002);
- the lower confidence level of B2022/B2002;
- variability in catch (the AAV statistic);
- a measure of the 'wrong direction' as expressed by the modified A-statistic and deltaS-deltaTAC statistic (Section 6.6, equations 11 and 13);
- how does the abundance increase achieved compare with the maximum possible? (consider B2022/B2022 under zero catch);
- for the lowest productivity scenario (lowest steepness range and omega=0.75) within the reference case set, the median and lower confidence level of the minimum biomass statistic (Min(By/B2002));
- results from the robustness scenarios can be used to discriminate between MPs which perform similarly on the reference set;
- projections extending to 50 years.

6.4.2 Process for assigning weights to alternative scenarios

36. The process of synthesising across scenarios requires relative weights of plausibility for each scenario in the reference set. It was agreed that the scenarios in the

robustness trials do not need quantitative weights, but would benefit from qualitative weights.

37. It was agreed to treat the key axes of uncertainty as independent, and then multiply the relevant weights and normalise, to obtain an overall weight for each scenario in the reference set. Given that natural mortality (*M*) and its age dependence will be handled by an MCMC approach, the only factors for which quantitative weights are required, are steepness (*h*) and the parameter which governs the relationship between CPUE and biomass (ω).

Weighting for steepness

38. Following on from the approach of using three values of steepness in the reference set of scenarios (h=0.3, 0.55 and 0.8 as specified in the report of the Second Management Procedure Workshop), the group decided to base scenarios on MCMCs over three ranges of steepness: 0.3-0.467; 0.467-0.633; 0.633-0.8 (see section 6.5). A weight for each range is required.

39. Two sources of information for deciding on weights were considered, namely the likelihood and knowledge from other resources. Knowledge about productivity from other fish resources, would suggest putting most of the weight on the high steepness bin (0.633-0.8). However, considering the SBT stock, some weight should also be accorded to the other two bins. This is because, based on the likelihood, none of the steepnesses in the lower and higher ranges appear to be incompatible with the data. Reservations about the reliability of the likelihood as a good indicator of relative plausibility, particularly for steepness, have already been noted (CCSBT - Report of the 2nd meeting of the MPW).

40. Work presented in CCSBT-ESC/0309/30 suggests that the data are not incompatible with relatively high productivity, but there is some lack of fit between the data and the choice of a Beverton-Holt stock-recruitment curve which leads to a poorer fit (to high steepness) in the conditioning model. There was general agreement that in qualitative terms, based on current data and knowledge, the highest weight would be on the middle range of steepness and lower weights on the low and high steepness ranges.

Weighting for the CPUE-abundance parameter

41. The second key factor is the parameter, ω, which reflects the relationship between CPUE and stock size. Two values have been chosen for the new reference set:

- ω=1, implying a linear relationship; and
- ω=0.75, which implies a non-linear relationship (slower change in CPUE than in abundance at high abundance)

42. It was noted that analyses have been done for trawl fisheries, suggesting a power of 0.5 on average, but that this may not have great relevance for longline fisheries. The rapid initial decline in longline CPUE (early 1950's), associated with very low catch levels may suggest a value greater than 1. Nonetheless, it was considered that the relationship between CPUE and stock size, i.e., the value of ω, may change as stock size changes. Although the model uses a single value of ω this only applies to the

period from 1969 onwards, which is after the early period of rapid decline. Some participants argued that analyses on fine scale catch and effort data done in the past (CCSBT/SC/96/16) provide support that the stock had become spatially more concentrated in smaller geographical areas since 1969. This tends to suggest that an ω less than 1.0 is a plausible hypothesis.

43. On the basis of the likelihood, the assumption of a linear relationship gives a better fit (2 likelihood points) than the curvilinear assumption, which would suggest a much higher weight on ω=1 than on ω=0.75. However, the absolute likelihood values should be interpreted with caution. On balance there was little basis for choosing relative weights for the two hypotheses about this parameter.

Weighting for steepness and ω factors

44. Quantitative weights for two factors (steepness and ω) were obtained by asking participants to suggest quantitative weights. Eighteen participants submitted written sets of weights which were summarised by the panel. Results are given in Attachment **D**.

Weighting for robustness scenarios

45. The robustness scenario associated with the age range over which CPUE is related to abundance was first considered. The default has been to use ages 4-30, and the chosen robustness trials (for low and medium steepness ranges) are based on ages 8-12. The two age ranges was considered to be equally plausible, and therefore a high weight or plausibility was given to this robustness scenario.

46. The robustness scenario associated with a change in carrying capacity was afforded a medium plausibility, on the basis that there is currently no strong evidence from independent sources for a regime shift.

47. The third category of robustness scenarios consider a sudden change in catchability (which could occur, for example, as a result of changes in targeting practices or advances in equipment). These scenarios were given a medium plausibility.

6.5 Reconsideration of operating models

6.5.1 Review of results of model fits done by national scientists using the generalized conditioning code distributed after April 2003 (i.e. sbtmod4.tpl)

48. Concerns arising from the exploration of operating model conditioning as prescribed at the second CCSBT MP Workshop were presented (CCSBT-ESC/0309/27). It was illustrated that the imposition of different levels of stock productivity in the form of a Beverton-Holt stock-recruitment relationship (i.e., steepness of 0.3, 0.55 and 0.8) actually resulted in very similar individual estimates of recruitment (in the informative part of the time series, assuming the same natural mortality vector), while biomass was essentially re-scaled. This results in a very linear relationship between stock and recruitment in all cases, differing primarily in the slope. Most components of the likelihood were similar across the three cases, with the exception of the stock recruitment relationship likelihood, which supports low steepness. This illustration suggests that the preference for low steepness is mostly driven by a

preference for a linear relationship, rather than low productivity (i.e. the Beverton Holt functional form is essentially linear only at low steepness, while higher steepness fits always suffer from systematic lack of fit). Thus there was a general feeling that the SAG can confidently defend the plausibility of higher productivity with the recognition that the customary assumption of a Beverton-Holt functional form of the stock recruitment relationship may be inappropriate.

49. The option for exploring other functional forms for the stock recruitment relationship was discussed. In particular, a double linear "hockey stick" relationship was suggested, but some concerns were noted including: 1) the effects of estimating early dynamics (and the bending point of the hockey stick) and the corresponding implications for management reference points were uncertain, and 2) it was not clear that the simulated future behaviour would be substantially different from that resulting from the traditional stock-recruit assumptions given the different productivity levels imposed. It was also recognized that the current systematic lack of fit gives rise to recruitment projections that rapidly gravitate toward the stock-recruitment curve. This may produce unrealistically optimistic scenarios in the high productivity cases (and unrealistically informative data for the MPs to exploit). The alternative suggestion of adopting a linear relationship for projections was considered unfeasible to implement at this time. It was recognized that further work on this issue is required.

50. There was also a discussion of the mechanistic plausibility of some of the implied selectivity estimates generated by the operating models, most of which had been recognized in previous SAG discussions. The dome-shaped nature of the longline fisheries selectivity and the differences among spawning ground fleets was questioned. However, no new insight was provided so that no changes were made.

6.5.2 Reconsideration of specific assumptions made about different model components

51. MCMC exploratory trials and results of the first stage reference and robustness testing were considered in formulating the next set of operating model scenarios.

52. The exploratory MCMC runs suggested that many sources of uncertainty could be adequately integrated into posterior distributions in the next phase of testing. Some of the important factors were represented well by the baseline estimated posteriors (eg M), while other factors could only be adequately represented by merging several MCMC runs. In the latter case, steepness was represented by three approximately uniform distributions spanning the range of low, medium and high. Attaining a uniform distribution required over each of these ranges an increased recruitment variance (and manipulation of steepness priors). Other uncertainties (e.g., Q0, Q1) could only be represented by merging different MCMC runs with different point specifications for the quantity of interest. It was recognised that Q0 and Q1 scenarios did not show substantial differences in results and decided to converge into one scenario with Q=0.005.

53. The following describes the inferences from the first round of robustness "tick tests":

- H30M10Q0_psi and H55M10Q0_psi – (psi in the abundance/CPUE relationship) not very sensitive.
- H30M10Q0_A18; H55M10Q0_A18; H30M10Q0_A12; and H55M10Q0_A12. The age range selected for these tests resulted in some sensitivity. It was decided that only an extreme case (i.e., A12) would be retained for low and medium productivity scenarios.
- H30M10Q0_Omega and H55M10Q0_Omega, H30M10Q1_q1Omega and H55M10Q0Q1_q1Omega, H30M10Q1_q1 and H55M10Q1_q1 (CPUE / abundance hyperstability and increasing catchability trend historical and future) – results were particularly sensitive to omega but the current value of omega seemed too extreme. It was agreed that the scenarios with modified omega value would be included into the new reference set.
- H30M10Q0_q20 and H55M10Q0_q20 (20% shift in catchability historically) – results were not particularly sensitive.
- H30M10Q0_Fec and H55M10Q0_fec – results were very robust to these trials. However, it was noted that the robustness tests were an ad hoc representation of the likely relationship between size and fecundity, and this relationship should be revisited at some future date beyond the current MP development plan when a better analysis has been conducted.
- H30M05Q0_Mo3 and H55M10Q0_Mo3, H30M05Q0_Mo5 and H55M10Q0_Mo5 (alternative mortality vectors) – there was considerable sensitivity to these specifications. However, the likelihood suggested that some of the M specifications were very implausible. It was decided that MCMC representation would be used to reflect uncertainty in juvenile M in the next phase.
- H_M10Q0_CC – (carrying capacity shift) this was recognized as a plausible and potentially sensitive scenario worth including in subsequent trials for illustrative purposes.
- H30M05Q0_G2 and H55M10Q0_G2 – (length-class plus-group on longline selectivity) – these robustness tests attempted to admit the possible effects of a change in length-at-age prior to 1970. This was an ad hoc solution to a problem that could be revisited in a more systematic fashion at some subsequent date beyond the current MP development plan.
- H30M05Q0_SC and H55M10Q0_SC – (constant future selectivity) – MPs were very robust to this specification, and it was not deemed worth pursuing further.

6.5.3 Selection of final operating models and robustness tests

54. The list of operating model specifications for the next phase of MP testing is described in Attachment **D**. Relevant discussions that led to these decisions are summarized in Attachment **D** and in the previous sections.

55. The group considered the potential for underestimation of fishing mortality in the current data and noted that there are a range of possible sources of such errors. Potential sources include under-reporting of catch by non-members, predation on

hooked fish (such as by sharks), unreported discards (e.g., damaged, low value and small fish) and potential impacts on reporting following the introduction of quotas.

56. The group agreed that robustness trials should include trials of raised global catch to take into account the potential for underestimation of fishing mortality in the past and in the future. For the purpose of robustness testing, the group agreed to the following raising factors being applied to global catch inputs to the operating model:

Period 1969-1990

- Global catch raised by 5%

Period 1991-current and in projections

- Global catch raised by 15%

57. Although noting that Indonesian and other non-member catches of SBT are currently unregulated, the group considered that these catches should be included under the TAC outputs generated by management procedures. Non-member catches were not separated from member catches in recognition of the commitment of the CCSBT to manage all global catch.

6.6 Reconsideration of performance statistics and robustness criteria

58. CCSBT 41 presented several approaches for reducing the number of performance statistics either by dropping some statistics with similar behaviours or by unifying the set of statistics. One potential method (AHP) showed some promise for synthesizing results.

59. The following performance statistics were retained from the first-stage of trials:

Maximizing catches:

Let *Y* represent the first year of the simulations, *Cy* the total catch in year *y* and *Csurface y* the surface fishery catch in year *y*

(1) $\frac{\sum_{Y}^{Y+4} C_y}{5}$ (2) $\frac{\sum_{Y}^{Y+19} C_y}{20}$ (3) $\frac{1}{20}\sum_{Y}^{Y+19} \frac{C_{surface,y}}{C_y}$

Biomass (*S*: spawning biomass)

(4) $\frac{S_{Y+5}}{S_Y}$ (5) $\frac{S_{Y+20}}{S_Y}$ (6) $\frac{S_{2020}}{S_{1980}}$

Inter-annual variations in catches:

(7) $AAV = \frac{1}{20}\sum_{Y-1}^{Y+18} \frac{\left|C_{y+1} - C_y\right|}{C_y + 1^{-6}}$

60. The following performance statistic was retained to evaluate minimum spawning biomass relative to current:

(8) $Min\left\{\frac{S_y}{S_Y}\right\}$ over 20-year projections.

61. Two performance measures relating to MSY concepts were also retained: one related to spawning biomass, and one related to exploitation rate.

(9) $\frac{S_{2020}}{S_{MSY}}$

(10) Catch-to-total biomass ratio:

$$\frac{1}{5}\sum_{y=2018}^{2022} \frac{C_y}{\text{Total Biomass }_y} \quad \text{relative to} \quad \frac{C_{MSY}}{\text{Total Biomass at MSY}}$$

The latter is formulated in terms of the ratio between catch and total biomass (age 2 and older) over the last 5 years in the simulation versus the ratio of MSY catch to biomass (age 2 and older) to avoid the difficulties associated with the appropriate definition of fishing mortality when selectivity's are changing. The group also noted that there are potential difficulties with regard to interpretation of these measures when selectivities change greatly, and/or if the split between the surface and longline catch changes from the values used in the MSY calculations. Note that the above implies computing the MSY and the total biomass (age 2 and older) at MSY for the different conditioning scenarios. This would be done using the most recent weights at age and selectivities at age.

62. The following three TAC-related performance measures were retained. The first is intended to reflect whether the TAC trajectories change direction in the early years, with the notion that one did not want the TAC to first increase and then decrease or vice versa over the first 6 years.

$$A = 1 - \Pr\begin{Bmatrix} TAC_{2003} < TAC_{2006} < TAC_{2009} \\ TAC_{2003} > TAC_{2006} > TAC_{2009} \end{Bmatrix}$$

i.e., avoid situations where TAC_{2006} lies outside the range of TAC_{2003} and TAC_{2009} (low *A* desired). Discussion identified the fact that this measure indicated the probability of TAC going in the "wrong" direction but did not incorporate a measure of the extent of such changes. It was decided to modify this measure to incorporate extent as well as probability of TAC going in the "wrong" direction as follows:

If *n* replicates of a trial are conducted:

(11) $$A = \frac{1}{n}\sum_{i=1}^{n} (\Delta TAC)_i I_i$$

$$where\ \Delta TAC_i = modulus\left[TAC_{2008} - TAC_{2004}\right]$$

$$I_i = \begin{cases} 0 & TAC_{2005} < TAC_{2008} < TAC_{2011} \\ 0 & TAC_{2005} > TAC_{2008} > TAC_{2011} \\ 1 & otherwise \end{cases}$$

lower values of *A* are desired.

Note that the year ranges were changed given the decision that 2005 rather than 2003 is now the first year for a possible TAC change.

The second addressed issues about stability of TACs

(12) Number of years when $\lfloor \Delta TAC_{y-1} \times \Delta TAC_y < 0 \rfloor$ ($\Delta TAC_y = TAC_y - TAC_{y-1}$)

where all years with no change in TAC are ignored. This statistics evaluated the number of time TAC changes go in opposite direction in consecutive years.

The last statistic addresses consistency in the trends in biomass with those in the TACs:

(13) Number of years when $\lfloor \Delta S_y \times \Delta TAC_y < 0 \rfloor$

It was acknowledged that this performance statistic would be difficult to interpret and would have to be viewed in conjunction with other performance statistics.

63. Four new performance statistics were proposed for the next set of trials, one to measure the spawning stock biomass in 2022 relative to what it would have been in the absence of fishing:

(14) S_{2022}/S^{*}_{2022}

where S^{*}_{2022} is the spawning biomass in 2022 under a no catch scenario.

NOTE: This statistic will not be part of the summary output produced by Vivian Haist, but will be computed as part of the new graphics package.

another to measure the maximum decrease in TAC:

(15) $Min\lfloor \Delta TAC_y \rfloor$

and for low *h* scenarios:

(16) Pr[(the slope of the regression of S_y versus time over the last five years[2])>0].

To take into account industry concerns,

(17) $\text{Min}(\text{CPUE}_y)/\text{CPUE}_{2002}$

Summary statistics (median, 10^{th} and 90^{th} quantiles) will be provided for statistics: (1)-(10), (12), (13), (15), and (17). In addition, a new output file will contain values for each realization for statistics (1) – (17) and the following: B_{MSY}, B_0, *MSY*, R_0, α, and β.

64. Robustness criteria (CCSBT 2nd MPWS report) will be dropped from the next round of MP trials because they had proven to be uninformative as defined. However, the concept may be considered as part of the selection process at the next MP workshop.

6.7 Mechanics for conducting tests and evaluating results

6.7.1 Coding issues arising from users experience with simulation code

65. The decision to follow an integrative approach for the evaluation of management procedures implies that only one input file will be produced for the reference set. The file will contain MCMC results for all scenarios in the reference set, sampled in proportion to the weights defined in item 6.4. The importance of being able to look at management procedure results for the integrated set, as well as for individual

[2] i.e. S_{2018}, S_{2019}, S_{2020}, S_{2021}, S_{2022}

scenarios, means that the output file will contain a code to enable the extraction of results by scenario.

66. Although it is difficult to know apriori what the ideal sample size would be, it was agreed that a sample of 2000 should be used for each version of a management procedure. It was noted that a smaller number, e.g. 500 can be used in the initial stages of tuning to speed computations up, but that the final tuning should be to 2000. The input file will be randomised relative to the weights for each scenario within blocks of 500. The full file will contain 4000 entries to allow for tests on the sensitivity of results to sample size. It was noted that there will now only be one hierarchy, namely, hierarchy 4 (MCMC).

67. With regard to the robustness scenarios, the input files will contain 2000 rows. The robustness scenarios should be run on a default sample size of 200.

68. The standard code will produced the set of performance measures (see 6.6) only for the integrated set.

6.7.2 Consolidate results obtained by scientists into a database

69. It was agreed that a database was not required, but instead output files for candidate MPs should be kept by the secretariat. To facilitate this and to avoid confusion, each MP should be given a unique name which also reflects tuning details. A naming convention was agreed on (see Attachment **D**)

6.8 Workplan and timetable

Task	Date
- Consultant estimate model parameters by conditioning to historical data	19/09/2003
- Consultant distributes final simulation code and data/parameter sets to National Scientists	19/09/2003
- National Scientists evaluate performance of candidate MPs	
- Consultant consolidates documentation for operating models and process used for testing MP during final trials	
- National Scientists conduct trials of MPs and document results	
- Exchange results and consolidate them into a database	Immediately before MPWS III
- Hold MP Workshop III	April 2004

6.9 SBT management objectives

70. It was noted that the scientists have been seeking clarification as to the management objectives to guide the development of MPs from the Commission. The SC plans to develop a series of questions related to possible management objectives related to 1) optimizing catch, 2) optimizing biomass, and 3) stability of TACs to present to the managers in order to clarify a possible range of management objectives. In discussing this item, the meeting decided that it would be sufficient at this point for

scientists to encompass a range of MPs that will cover the likely range of management objectives of interest to the Commission.

71. It was decided that Ray Hilborn would convene a small technical group that will meet during the SC to identify graphical ways to present the trade-offs between catch and biomass to managers. The results of this group would be directed at developing some very simple presentations that would:

- Help the managers determine if the scientists have adequately bounded the range of MPs that they wish to evaluate.
- Provide national scientists with a tool that would enable them to explore the behaviour of MPs as a way of making managers more familiar with the consequences of various trade offs between catch and biomass.

Agenda Item 7. Assessment approach to be used in 2004

72. The SAG discussed the issues surrounding the work schedule for completing the management procedure work as well as performing a stock assessment in 2004. It was noted that the plan set out by the Commission is to complete the substantial part of the MP work by the April workshop and to conduct a stock assessment for the SAG/SC meeting in September.

73. It was noted that the outcome from the April WS would not be a single MP, but a final set of MPs from which the Commission would be asked to choose. Following the April meeting, additional work with regard to the final set of MPs would need to be conducted to produce the final results and graphics to present to the Commission at their meeting in 2004.

74. The SAG agreed that there was no reason to change the original work plan, and therefore agreed to proceed with MP work for the April 2004 management procedure workshop and to conduct a stock assessment for the SAG/SC meeting in September 2004.

75. The importance of considering a range of alternative assessment models was emphasised.

76. Data exchange and issues relating to data aggregation will be discussed at the SC meeting and reported in the SC report.

Agenda Item 8. Indonesian catch monitoring

77. The meeting reviewed the results of three papers (CCSBT-ESC/0309/19, CCSBT-ESC/0309/20, and CCSBT-ESC/0309/31) prepared at the request of the March 2003 Indonesian Catch Monitoring Workshop. These papers explore the impact of different raising factors of DINAS export data on the estimates of Indonesian catch and contrast the difference in estimates from the former CSIRO/RIMF with the IOTC procedures now available. It was noted that this work confirmed results from the March workshop that the IOTC procedure provides an improved basis for estimating Indonesian catch of SBT. The meeting recognised the uncertainty in Indonesian catch estimates and decided it would be worthwhile including high and

low estimates of Indonesian catch as sensitivity tests in future stock assessments. How to implement this would be left to individuals but will not be part of operating models used in the development of MPs. Biases beyond those dealing with the choice of DINAS raising factors should also be considered. The meeting concluded that these papers adequately addressed the outstanding issues from the March workshop and further work on this issue was not warranted.

Agenda Item 9. Other business

78. There was no other business.

Agenda Item 10. Adoption of report

79. The report of the meeting was adopted.

Agenda Item 11. Close of meeting

80. The meeting was closed at 6:30pm, 29 August 2003

List of Attachments

Attachment

A	List of Participants
B	Agenda
C	List of Documents
D	Specification of Final Reference Set
E	Pareto frontier Example

Attachment A

List of Participants
CCSBT
4th Stock Assessment Group Meeting
25 – 29 August 2003
Christchurch, New Zealand

CHAIR

Dr John ANNALA
Science Policy Manager
Ministry of Fisheries
PO Box 1020
Wellington
New Zealand
Phone: +64 4 470 2661
Fax: +64 4 470 2669
Email: annalaj@fish.govt.nz

ADVISORY PANEL

Dr Ana PARMA
Centro Nacional Patagonico
Pueto Madryn, Chubut
Argentina
Phone: +54 2965 451024
Fax: +54 2965 451543
Email: parma@cenpat.edu.ar

Dr James IANELLI
REFM Division
7600 Sand Pt Way NE
Seattle, WA 98115
USA
Phone: +1 206 526 6510
Fax: +1 206 526 6723
Email: jim.ianelli@noaa.gov

Dr John POPE
The Old Rectory
Burgh St Peter
Norfolk, NR34 0BT
UK
Phone: +44 1502 677377
Fax: +44 1502 677377
Email: PopeJG@aol.com

Professor Ray HILBORN
School of Fisheries Box 355020
University of Washington
Seattle, WA 98195
USA
Phone: +1 206 543 3587
Fax: +1 206 685 7471
Email: rayh@u.washington.edu

SCIENTIFIC COMMITTEE CHAIR

Mr Andrew PENNEY
Pisces Environmental Services (Pty) Ltd
22 Forest Glade
Tokai Road, Tokai 7945
South Africa
Phone: +27 21 7154238
Fax: +27 21 7154238
Email: apenney@pisces.co.za

CONSULTANT FOR MP

Ms Vivian HAIST
6224 Groveland Drive
Nanaimo, B.C. V9V1B1
Canada
Phone: +1 250 7560518
Email: haistv@shaw.ca

AUSTRALIA

Mr Jay HENDER
Policy Officer
Fisheries & Aquaculture Branch
Dept. of Agriculture, Fisheries & Forestry
PO Box 858, Canberra ACT 2601
Phone: +61 2 6272 3608
Fax: +61 2 6272 4875
Email: jay.hender@affa.gov.au

Dr James FINDLAY
Senior Research Scientist
Fisheries & Marine Science program
Bureau of Rural Sciences
Dept. of Agriculture, Fisheries & Forestry
PO Box E11, Kingston ACT 2604
Phone: +61 2 6272 5534
Fax: +61 2 6272 3882
Email: james.findlay@brs.gov.au

Mr Andy BODSWORTH
Manager
Southern Bluefin Tuna Fishery
Australian Fisheries Management Authority
PO Box 7051, Canberra Mail Centre ACT 2610
Phone: +61 2 6272 5290
Fax: +61 2 6272 4614
Email: Andy.Bodsworth@afma.gov.au

Dr Tom POLACHECK
Senior Principal Research Scientist
Pelagic Ecosystems Sub-Program
Division of Marine Research
CSIRO P.O. Box 1538
Hobart, TAS 7001
Phone: +61 3 6232 5312
Fax: +61 3 6232 5012
Email: tom.polacheck@csiro.au

Dr Marinelle BASSON
Senior Research Scientist
Pelagic Ecosystems Sub-Program
Division of Marine Research
CSIRO P.O. Box 1538
Hobart, Tas 7001
Phone: +61 3 6232 5336
Fax: +61 3 6232 5012
Email: marinelle.basson@csiro.au

Dr Dale KOLODY
Research Scientist
Pelagic Ecosystems Sub-Program
Division of Marine Research
CSIRO P.O. Box 1538
Hobart, Tas 7001
Phone: +61 3 6232 5121
Fax: +61 3 6232 5012
Email: dale.kolody@csiro.au

JAPAN

Dr Sachiko TSUJI
Section Chief
Temperate Tuna Section
National Research Institute of Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka, Shizuoka 424-8633
Phone: +81 543 36 6042
Fax: +81 543 35 9642
Email: tsuji@fra.affrc.go.jp

Dr Norio TAKAHASHI
Senior Resercher
Temperate Tuna Section
National Research Institute of Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka, Shizuoka 424-8633
Phone: +81 543 36 6043
Fax: +81 543 35 9642
Email: norio@affrc.go.jp

Dr Hiroyuki KUROTA
Temperate Tuna Section
National Research Institute of Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka, Shizuoka 424-8633
Phone: +81 543 36 6043
Fax: +81 543 35 9642
Email: kurota@affrc.go.jp

Dr Kazuhiko HIRAMATSU
Section Chief
Mathematical Biology Section
National Research Institute of
Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka,
Shizuoka 424-8633
Phone: +81 543 36 6014
Fax: +81 543 35 9642
Email: hira@affrc.go.jp

Mr Hiroshi SHONO
Mathematical Biology Section
National Research Institute of
Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka,
Shizuoka 424-8633
Phone: +81 543 36 6039
Fax: +81 543 35 9642
Email: hshono@affrc.go.jp

Prof Doug BUTTERWORTH
Department of Mathematics and Applied
Mathematics
University of Cape Town
Rondebosch 7701
South Africa
Phone: +27 21 650 2343
Fax: +27 21 650 2334
Email: dll@maths.uct.ac.za

Mr Hajime TAGUCHI
Section Chief
Fisheries Agency
1-2-1 Kasumigaseki, Chiyoda-ku
Tokyo 100-8907
Phone: +81 3 3501 5098
Fax: +81 3 3502 1682
Email: hajime_taguchi@nm.maff.go.jp

Mr Yuji NISHIMOTO
Section Chief
Fisheries Agency
1-2-1 Kasumigaseki, Chiyoda-ku
Tokyo 100-8907
Phone: +81 3 3502 8479
Fax: +81 3 3591 5824
Email: yuji_nishimoto@nm.maff.go.jp

NEW ZEALAND

Dr Talbot MURRAY
Pelagic Project Leader
National Institute of Watr & Atmospheric
Research Ltd
PO Box 14-901, Kilbirnie, Wellington
Phone: +64 4 386 0300
Fax: +64 4 386 0574
Email: t.murray@niwa.cri.nz

FISHING ENTITY OF TAIWAN

Dr Shui Kai CHANG(Eric)
Associate Researcher
Deep Sea Fisheries Research and
Development Center
Fisheries Agency
Council of Agriculture
No. 2, Chaochow St.
Taipei 100, Taiwan
Tel: +886 2 33436133
Fax: +886 2 33436268
Email: skchang@msl.fa.gov.tw

Dr Shu-Hui WANG
Assistant Researcher
Overseas Fisheries Development
Council of the Republic of China
19, Lane 113, Roosevelt Road
Sec. 4, Taipei, Taiwan
Tel: +886 2 2738 1522
Fax: +886 2 2738 4329
Email: Jessica@ofdc.org.tw

REPUBLIC OF KOREA

Dr Dae-Yeon MOON
Senior Scientist
Distant-water Fisheries Research Div.
National Fisheries R & D Institute
408-1 Shirang-ri, Kijang-gun
Pusan 619-902
Tel: +82 51 720 2320
Fax: +82 51 720 2337
Email: dymoon@nfrda.re.kr

Dr Kyu-Jin SEOK
Research Scientist
International Cooperation Office
Ministry of Maritime Affairs and Fisheries
50 Chungjeong-Ro 3, Seodaemoon-Gu
Seoul 120-715
Phone: +82 2 3148 6994
Fax: +82 2 3148 6996
Email: pisces@momaf.go.kr

CCSBT SECRETARIAT

PO Box 37, Deakin West ACT 2600
AUSTRALIA
Phone: +61 2 6282 8396
Fax: +61 2 6282 8407

Mr Brian MACDONALD
Executive Secretary
Email: bmacdonald@ccsbt.org

Mr Yukito NARISAWA
Deputy Executive Secretary
Email: ynarisawa@ccsbt.org

Mr Robert KENNEDY
Database Manager
Email: rkennedy@ccsbt.org.

INTERPRETERS

Ms Saemi BABA
Ms Kumi KOIKE

Attachment B

Fourth Stock Assessment Group Meeting
Christchurch, New Zealand
25-29 August 2003

AGENDA

1. **Opening**

   1.1 Introduction of participants
   1.2 Administrative matters

2. **Appointment of rapporteurs**

3. **Adoption of agenda**

4. **Admission of documents and finalisation of document list**

5. **Review of fisheries indicators analysis results**

   5.1 Review of fishery indicators

   5.2 Status of the SBT stock

6. **Management Procedure**

   6.1 Terms of Reference
   - Evaluate performance of candidate Management Procedures (MP) tested to date.
   - Produce final specification of operating models and robustness tests to be used for the final evaluations of MPs.
   - Specify process for evaluating performance of candidate MPs across operating models.
   - Define workplan and timetable.

   6.2 Consultation with Industry and Managers

   6.3 Performance of initial candidate Management Procedures from trials to date

   6.4 Process for testing Management Procedures and for synthesizing results across Operating Models

   6.4.1 Process for synthesizing results across scenarios.
   6.4.2 Process for assigning weights to alternative scenarios.
   - Feasibility of MCMC to approximate posterior distributions of state variables and model parameters. [*discuss results of MCMC trials done by Vivian Haist using different prior distributions for M and h*]
   - Expert judgment.

6.4.3. Others

6.5 Reconsideration of Operating Models

6.5.1 Review of results of model fits done by national scientists using the generalized conditioning code distributed after April 2003 (i.e. sbtmod4.tpl).
6.5.2 Reconsideration of specific assumptions made about different model components.
6.5.3 Selection of final operating models and robustness tests.

6.6 Reconsideration of Performance Statistics and Robustness criteria

6.7 Mechanics for conducting tests and evaluating results

6.7.1 Coding issues arising from users experience with simulation code.
6.7.2 Consolidate results obtained by National Scientists into a database.
6.7.3 Define a protocol to facilitate comparison of results (tables, graphic output, etc.).
6.7.4 Other issues.

6.8 Workplan and timetable

- Further changes to conditioning and simulation codes introduced and code distributed.
- Consultant estimate model parameters by conditioning to historical data.
- Consultant distributes final simulation code and data/parameter sets to National Scientists.
- National Scientists evaluate performance of candidate MPs.
- Consultant consolidates documentation for operating models and process used for testing MP during final trials.
- National Scientists conduct trials of MPs and document results.
- Exchange results and consolidate them into a database.
- Hold Workshop III.

6.9 SBT management objectives

7. Assessment approach to be used in 2004

8. Indonesian catch monitoring

9. Other business

10. Adoption of report

11. Close of meeting

Attachment C

List of Documents
Extended Scientific Committee for 8th Scientific Committee (SC)
and 4th Stock Assessment Group (SAG)

(CCSBT-ESC/0309/)

01. Draft Agenda of 4th SAG
02. List of Participants of 4th SAG
03. Draft Agenda of the Extended SC for 8th SC
04. List of Participants of the Extended SC for 8th SC
05. List of Documents－The Extended SC for 8thSC&4th SAG
06. (Secretariat) 4.Review of SBT Fisheries
07. Consultation with Industry and Managers: Hilborn, R. (to be prepared at SAG)
08. (Secretariat) 6.1. Characterization of SBT Catch
09. (Secretariat) 6.3. Scientific Observer Program Standards
10. (Secretariat) 6.4. CCSBT Scientific Research Program Tagging Program
11. (Secretariat) 6.5 Direct Age Estimation
12. (Secretariat) 6.6. Other SRP components
13. (Secretariat) 7.1. Review of CCSBT datebase development
14. (Secretariat) 7.2. CCSBT Collaboration with FIRMS/FIGIS systems
15. (Secretariat) 8.1. Suggsstion to Ecologically Related Speacies Working Group
16. (Secretariat) 9. Data exchange requirements for 2004
17. (Australia) The catch of SBT by the Indonesian longline fishery operating out of Benoa, Bali in 2002.: T.L.O. Davis and Andamari, R.
18. (Australia) Length and age distribution of SBT in the Indonesian longline catch on the spawning ground.: Farley, J.H. and Davis, T.L.O.
19. (Australia) The effect of alternate raising factors on the estimated catch of SBT by the Indonesian longline fishery.: Davis, T.L.O. and Polacheck, T.
20. (Australia) Estimates of SBT catches in Bali based on the CSIRO/RIMF estimation procedure and sub-samples of the data collected by the IOTC coordinated monitoring program.: Polacheck, T. and Davis, T.L.O.
21. (Australia) An update on Australian Otolith Collection Activities: 2002/03.: Stanley, C. and Polacheck, T.
22. (Australia) Exploring the Trade-off between Tag Releases and Observer Coverage in the Estimation of Mortality Rates through an Integrated Brownie and Peterson Mark-Recapture Estimation Approach.: Polacheck, T., J. P. Eveson and G. M. Laslett.

23. (Australia) An update of the graphics used for evaluating the performance of candidate management procedures for southern bluefin tuna.: Eveson, P.
24. (Australia) Aerial survey indices of abundance: comparison of estimates from line transect and "unit of spotting effort" survey approaches.: Farley, J. and S. Bestley.
25. (Australia) Report from a Pilot Tag Seeding Program for Estimating Tag Reporting Rates from the Australian Surface fishery.: Stanley, C.A. and T. Polacheck.
26. (Australia) Trends in catch, effort and nominal catch rates in the Japanese longline fishery for SBT – 2003 update.: Hartog, J., D. Ricard, T. Polacheck and S. Cooper.
27 (Australia) Issues in the selection of final trials for testing SBT management procedures and for the process of synthesizing results from the simulation testing.: Polacheck, T., D. Kolody and M. Basson.
28. (Australia) An update on estimating a CPUE series for southern bluefin tuna using enhanced tree-based modelling methods.: Venables, B., P. Toscas, M. Bravington and T. Polacheck.
29. (Australia) Results from further testing of candidate management procedures for southern bluefin tuna.: T. Polacheck, D. Ricard, P. Eveson, M. Basson, D. Kolody and J. Hartog.
30. (Australia) Issues related to setting rebuilding objectives for southern bluefin tuna.: Polacheck, T.
31. (Australia) A Description of the Distribution System for export and reject quality tuna landed at Port of Benoa.: Proctor, C.H., A. Andmari, G.S. Merta, and S. Simorangkir.
32. (Australia) Estimation of age profiles of southern bluefin tuna.: Morton, R. and MV Bravington.
33. (Australia) An Overview of the Australian Southern Bluefin Tuna Purse Seine Pilot Observer Programme (02/03) and Observed Longline Operations 2002.: Stanley, R, and M. Scott.
34. (Japan) Interpretation of fisheries indicators by in 2003. (S.Tsuji)
35. (Japan) Report of 2002/2003 results and proposal for 2003/2004 activities on CCSBT tagging by Japan.: Itoh., Takahashi., Tsuji. and Hosogaya.
36. (Japan) Interpretation of second evaluation results of otolith aging. (T.Itoh and S.Tsuji)
37. (Japan) Further investigations of a Fox model based Management Procedure for Southern Bluefin Tuna. (D.S.Butterworth and M.Mori)
38. (Japan) Further exploration of CPUE-based management procedures. (S.Tsuji et al)
39. (Japan) Report of the 2002/2003 RMA utilization and application for the 2003/2004 RMA. (JFA)
40. (Korea) Preliminary results of testing on the candidate management procedures for southern bluefin tuna.: Moon, D.Y, An, D.H and Koh, J.R.

41. (Japan) Some consideration toward the selection of a management procedure.: H.Kurota, H.Shono, N.Takahashi, K.Hiramatsu and S.Tsuji.
42. (Japan) Issues to be considered for further development of MP.: K.Hiramatsu, H.Kurota, H.Shono, N.Takahashi and S.Tsuji.
43. (Japan) Comments by Japan's fisheries administrators regarding management procedure.: JFA.
44. (Advisory Panel) Overview of Indicators of SBT stock status.: R. Hilborn, A. Parma, J. Ianelli and J. Pope.
45. (Australia) Results of the second year of a pilot program to examine the feasibility of tagging mature SBT in the western Tasman Sea.: J. Gunn, J. Hender and M. Scott.HH
46. (New Zealand) Within EEZ movements of southern bluefin tuna.: New Zealand.

(CCSBT-ESC/0309/SBT Fisheries)

Australia	Australia's 2001-02 Southern Bluefin Tuna Fishing Season.: J. Findlay.
Japan	Review of Japanese SBT Fisheries in 2002.: Itoh. and Nishimoto.
Fishing Entity of Taiwan	Review of Taiwanese SBT Fishery of 2001/2002.: Fishing Entity of Taiwan.
New Zealand	Trends in the New Zealand southern bluefin tuna fishery to 2002.: T. Murray.
Republic of Korea	Korean SBT longline fishery.: Moon, D.Y, Koh, J. R and An, D.H.

(CCSBT-ESC/0309/Info)

01. (Australia) Size at first maturity and recruitment into egg production of southern bluefin tuna. Final Report FRDC Project No. 1999/106.: Davis, T., Farley, J., Bravington, M, and Andamari, M.
02. (Australia) A pilot study to examine the potential for using pop-up satellite transmitting archival tags (PATs) to examine the migrations and behavior of adult Southern Bluefin Tuna (SBT).: Gunn, J., and T. Patterson.
03. (Australia, Japan) Southern Bluefin Tuna Recruitment Monitoring and Tagging Program: Report of the Fifteenth Workshop.
04. (Australia) Global Spatial Dynamic Project for Juvenile SBT.: Polacheck, T., J. Gunn, and A. Hobday.
05. (Japan) Proposal for Shoyo-maru spawning ground survey.: JFA
06. (Nature) Rapid worldwide depletion of predatory fish communities.: Ransom A. Myers and Boris Worm

07. (Japan) Proposal for Number 2 Taikei-maru spawning ground survey.: JFA

(CCSBT-ESC/0309/Rep)

01. Report of the Sixth Meeting of the Scientific Committee (August 2001)
02. Report of Tagging Program Workshop (October 2001)
03. Report of the Eighth Annual Commission Meeting (October 2001)
04. Report of the Fourth Meeting of Ecologically Related Species Working Group (November 2001)
05. Report of the First Meeting of Management Procedure Workshop (March 2002)
06. Report of the CPUE Modeling Workshop (March 2002)
07. Report of Direct Age Estimation Workshop (June 2002)
08. Report of the Third Stock Assessment Group Meeting (September 2002)
09. Report of the Seventh Meeting of the Scientific Committee (September 2002)
10. Report of the Ninth Annual Commission Meeting (October 2002)
11. Report of the Second Meeting of the Management Procedure Workshop (April 2003)
12. Report of the Indonesian Catch Monitoring Review Workshop (April 2003)

Attachment D

Specification of final reference set

It was agreed that MCMC runs with Steepness specified to be uniformly distributed with even splits (3) between 0.3 and 0.8. I.e., with the following ranges in steepness:

Low	0.300 - 0.467
Med	0.467 - 0.633
High	0.633 - 0.800

Since (for efficiency) the MCMC runs require estimates of covariance matrix, the point estimates must be assured to fall away from the bounds. Technically, the conditioning code will be modified to ensure that a "relatively" uniform distribution of steepness within the bounds will result.

Q1 dropped but proposal to set q-change parameter to 0.005 (to be half way between Q0 and Q1). A change from MPWS2 is to include this in both the conditioning and in the projections (previously it appeared only in the projection model). A preferred approach would be to do both 0.0 and 0.01 and combine them as part of the expression of uncertainty. The workshop concluded that this may be an alternative for future consideration.

Another change to be applied to the reference set was set to σ_R = 0.6. This was done to approximate a desired uniform distribution of steepness within the specified bins for the different scenarios specified below. Also, autocorrelation in the recruitment residuals was set to the empirical estimate over the period 1965-1995 and used as part of the likelihood from 1998-2002.

Experimental runs

Run 1

Test an *h*=0.55, *M10=0.1* with omega set at 0.7 and 0.8 and look at LL results before proceeding. Based on these results we will decide whether to include omega in the reference sets. Omega set to 0.5 was found to be too unlikely. The results for these runs are presented in the last two columns of the following table:

	Name	H55M10	H55M10_Omega	h55m10_omega7	H55m10_omega8
ρ	1931-2001	0.637	0.648	0.651	0.646
	1965-1995	0.520	0.573	0.566	0.547
σ_R	Model SigR	0.400	0.400	0.400	0.400
	1931-2001	0.391	0.394	0.396	0.394
	1965-1995	0.300	0.318	0.312	0.306
CPUE Autocorr.	1969-2000	0.468	0.811	0.571	0.496
	1990-2000	0.584	0.533	0.554	0.565
σ_{CPUE}	1969-2000	0.153	0.267	0.176	0.160
	1990-2000	0.216	0.201	0.210	0.212
	Steepness	0.55	0.55	0.55	0.55
Like-lihoods	Total	770.29	786.53	775.012	771.450
	LL1	255.61	255.20	256.587	256.323
	LL2	50.02	49.96	49.951	49.966
	LL3	102.20	101.97	102.174	102.187
	LL4	191.82	190.48	189.748	190.296
	IND	39.72	39.19	39.511	39.406
	SURF	99.81	99.53	99.658	99.714
	CPUE	-44.12	-26.26	-39.569	-42.607
	Tags	11.71	11.35	11.335	11.383
	Sel.Ch	37.53	38.71	38.602	38.181
	Sel.sm	57.14	57.02	57.237	57.241
	Sg.R	-31.15	-30.62	-30.223	-30.640
	Prior on h	0.00	0.00	0.00	0.00

The ensuing discussion of these results concluded that a value of omega=0.75 be used as an added cross to the final reference set.

The final reference model runs are thus:

Model Name	Steepness	Steepness mid-pt	Omega
Low1	0.300 - 0.467	0.3835	1.00
Med1	0.467 - 0.633	0.5500	1.00
High1	0.633 - 0.800	0.7165	1.00
Low75	0.300 - 0.467	0.3835	0.75
Med75	0.467 - 0.633	0.5500	0.75
High75	0.633 - 0.800	0.7165	0.75

Robustness tests

The full set of robustness tests specified in the last MP workshop were re-evaluated and either moved into the reference case specified above or evaluated for sensitivity. The following two cases were retained.

Catchability/CPUE model

Retain the trial setting $a_1 = 8,\ a_2 = 12$, (A12). Noting that not much difference was seen using A18. The default for the reference case was $a_1 = 4,\ a_2 = 30$. These age ranges are used to standardize selectivity for the CPUE predictions. This specification is to be considered for low and medium *h* values models and omega = 1.0. The models are named:

Low1_A12

Med1_A12

Carrying capacity

Retain this for middle group of steepness with omega set to 1.0 (model Med1). In this scenario, estimate two values for R_0, one for $y \leq 1977$ and the other for $y > 1977$.

Med1_cc

Additional trials

The workshop proposed a new robustness test where future catchability changes one time by 20% between 2005 and 2006. The tests will include one version where it increases by 20% and another where it decreases by the same proportion. These will be done for the low and medium *h* range scenarios.

Low1_up20

Med1_up20

Low1_down20

Med1_down20

Another robustness test dealing with uncertainty in catches was proposed and accepted by the workshop. The group agreed that robustness trials should include trials of raised global catch to take into account the potential for underestimation of fishing mortality in the past and in the future. The MPs would not know the “true” catches. For the purpose of robustness testing, the group agreed to the following raising factors being applied to global catch inputs to the operating model:

Period 1969-1990

- Global catch raised by 5%

Period 1991-current and in projections

- Global catch raised by 15%

Low1_CU

Med1_CU

Results from weighting

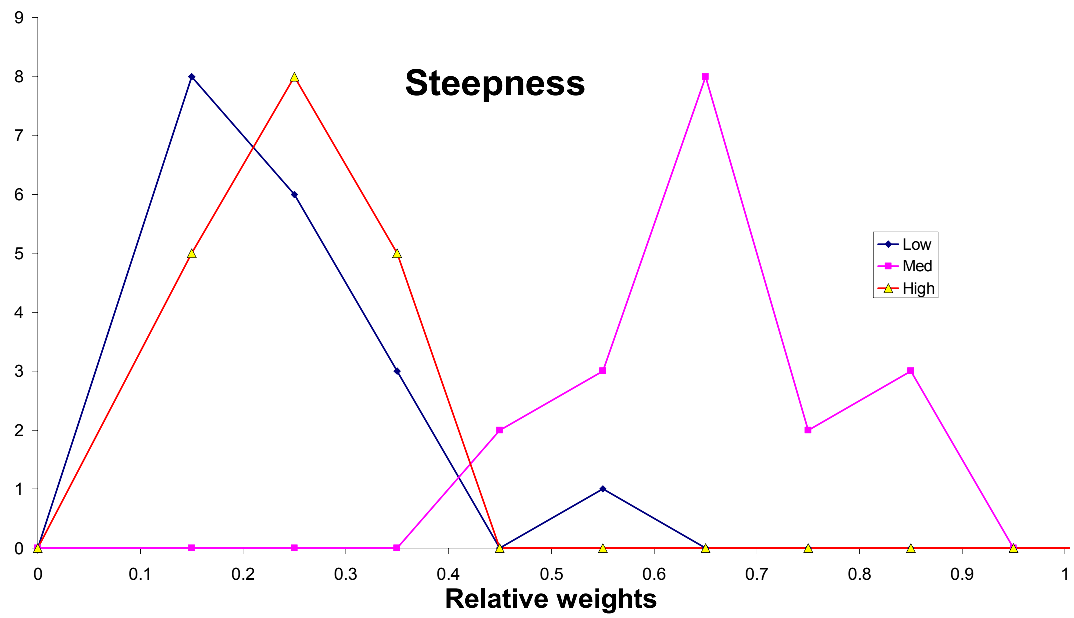
The individuals in attendance provided their individual weightings for the range of steepness bins (productivity) and on the value for omega (CPUE relationship relative to actual abundance).

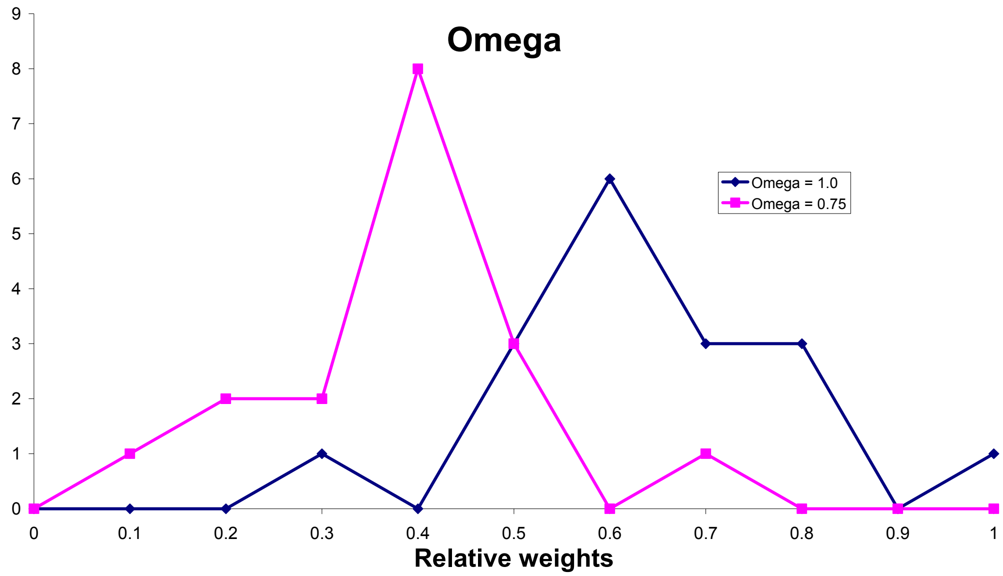
A total of 18 individuals participated with the following results (relative weights):

Steepness	Low	Med	High
Average	0.19	0.60	0.21
Median	0.20	0.60	0.20

	Omega = 1.0	Omega = 0.75
Average	0.63	0.37
Median	0.60	0.40

The distributions of these results were as follows (note that the values represent the upper bound of arbitrary bins):





Based on these results, the workshop concluded that the median values for relative weights among the factors should be used for weighting the different scenarios. These final relative weights are detailed in the following table:

Model Name	Steepness	Steepness mid-pt	Omega	Final Relative weights
Low1	0.300 - 0.467	0.3835	1.00	0.12
Med1	0.467 - 0.633	0.5500	1.00	0.36
High1	0.633 - 0.800	0.7165	1.00	0.12
Low75	0.300 - 0.467	0.3835	0.75	0.08
Med75	0.467 - 0.633	0.5500	0.75	0.24
High75	0.633 - 0.800	0.7165	0.75	0.08

Issues for the projection model

Rho

For the projection model, all reference scenarios will use empirical estimates of rho from each trial.

Catchability increase of 0.5% per year to be in both the operational model and the projection.

Naming conventions

A proposal for a naming convention is to have a unique three-letter prefix (user's choice but unique to CCSBT MP workshop), a 2-digit serial number (user's choice), and a tuning level (either 1, 2, or 3) suffixed with *a* or *b*:

PRE_01_1a

PRE_01_1b

PRE_01_2a

PRE_01_2b

…

Options for addressing the issue of short term stability in catch

For option b, three-year blocks with fixed catch levels will be specified the year prior to the change.

	Year of availability			Option a (new default)		Option b	
Decision year	Catch Data from operating model	Anticipated catches from TACs	CPUE Data from operating model	MP TAC Year	TAC Change allowed?	MP TAC Year	TAC Change allowed?
2001	2000	2001	2000	2002	no	2002	no
2002	2001	2002	2001	2003	no	2003	no
2003	2002	2003	2002	2004	no	2004	no
2004	2003	2004	2003	2005	Yes	2005	no
2005	2004	2005	2004	2006	Yes	2006	no
2006	2005	2006	2005	2007	Yes	2007	Yes
2007	2006	2007	2006	2008	Yes	2008	no
2008	2007	2008	2007	2009	Yes	2009	no
2009	2008	2009	2008	2010	Yes	2010	Yes
2010	2009	2010	2009	2011	Yes	2011	no
2011	2010	2011	2010	2012	Yes	2012	no
2012	2011	2012	2011	2013	Yes	2013	Yes
2013	2012	2013	2012	2014	Yes	2014	no
2014	2013	2014	2013	2015	Yes	2015	no
2015	2014	2015	2014	2016	Yes	2016	Yes
2016	2015	2016	2015	2017	Yes	2017	no
2017	2016	2017	2016	2018	Yes	2018	no
2018	2017	2018	2017	2019	Yes	2019	Yes
2019	2018	2019	2018	2020	Yes	2020	no
2020	2019	2020	2019	2021	Yes	2021	no
2021	2020	2021	2020	2022	Yes	2022	Yes
2022	2021	2022	2021	2023	Yes	2023	no

Attachment E

Pareto frontier Example