

Commission for the Conservation of  
Southern Bluefin Tuna



みなまぐろ保存委員会

## **Report of the Sixth Meeting of the Stock Assessment Group**

**29 August - 3 September 2005  
Taipei, Taiwan**

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**Agenda Item 1. Opening**

1. The Director General of the Taiwan Fisheries Agency, Mr Shieh, opened the meeting and welcomed participants.
2. Participants introduced themselves and the list of participants is at **Attachment 1**.

**Agenda Item 2. Appointment of rapporteurs**

3. The independent panel were appointed as the rapporteurs for agenda item 5. Each member appointed rapporteurs to produce the text of the report relating to technical discussions of the other agenda items.

**Agenda Item 3. Adoption of agenda**

4. The draft agenda was adopted. The agreed agenda is at **Attachment 2**.

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

5. The draft list of documents for the meeting was considered. The agreed list is at **Attachment 3**.
6. The meeting assigned individual documents from the list to relevant agenda items.

**Agenda Item 5. Stock Assessment**

***5.1 Analysis of fisheries indicators***

7. The following documents were identified under agenda item 5 on stock assessment: CCSBT-ESC/0509/12, 13, 15, 16, 17, 20, 21, 22, 23, 24, 25, 32, 38, 39, 40 and CCSBT-ESC/0509/SBT fisheries country reports.
8. CCSBT-ESC/0509/17 presents preliminary summaries of data on SBT catch and effort from training programs of Indonesian Fisheries Training Schools. Several caveats regarding the interpretation of the data were noted, including: the commercial longline vessels taking part in the program are probably not a random selection of the fleet, coverage over time is not consistent, the dataset has not yet been fully checked or analysed, and CPUE has not yet been standardised. Given

these qualifications, there appears to be an increase in fishing effort in Area 2, particularly in the southern part of that area. The apparent increase in nominal CPUE (in numbers) in area 2 is most likely related to the expansion of the fleet, and is still based on a relatively small number of sets compared to Area 1. In Area 1, there appears to have been a drop of possibly as much as 50% between 2000/01 and 2004/05 in the nominal CPUE of vessels observed that fished during the spawning months. Most of this decrease occurred in the first two spawning seasons in the dataset (2000/01 and 2001/02), and the index seems to have been relatively stable over the most recent three spawning seasons (2002/03 – 2004/05). The data from Area 1 were further explored for changes in catch rates of other species or in the depth of fishing (using the ratio of bigeye to bigeye plus yellowfin catch as a proxy) which could explain the drop in catch rates of SBT. The preliminary analyses did not find any such clear signals.

9. CCSBT-ESC/0509/22 presents results of the scientific line-transect aerial survey for juvenile SBT which was conducted in the Great Australian Bight in 2005. The survey followed similar surveys conducted in 1993-2000, and resumes a time-series of abundance indices for juvenile SBT. Because of bad weather, the 2005 survey flew very few transects in March and this month was omitted from the analyses for all years. Results from the survey suggest that the abundance of 2-4 year olds in the GAB in 2005 was lower than it was in the mid-1990s, but perhaps higher than in 1999. Since the efficiency of the observer teams in 1999 and 2000 is very uncertain, the comparison of the 2005 index with the mid-1990s is considered more reliable.
10. CCSBT-ESC/0509/23 discusses results from commercial spotting data in the GAB over four fishing seasons (December to March of 2001-02 to 2004-05). The commercial spotting data were used to produce nominal and standardised fishery-dependent indices of SBT abundance (surface abundance per unit effort – a SAPUE index). The SAPUE indices declined substantially after the first of the four seasons, but increased again for the last. Interpretation of the results, however, is difficult as there is a strong indication of an interaction between the company/spotter and season. The document notes that the line-transect aerial survey remains preferable as an approach, since it is based on a consistent design and set of protocols which also greatly facilitates standardisation and improves consistency of the index.
11. CCSBT-ESC/0509/20 provides an update on tag seeding activities in 2004/05 in the surface fishery and estimates of reporting rates based on past tag seeding activities. Estimates of tag reporting rates are essential for the estimation of fishing mortality rates from the SRP tagging and the tag seeding results provide a direct estimate of this for the surface fishery. In 2004/05, tag seeding took place for 34 of the 36 tow cages. Preliminary estimates of the reporting rates for both 2002/2003 and 2003/2004 (0.66 and 0.63 respectively) are consistent in magnitude and suggest that only about two thirds of the tags are returned. These estimates take into account tag shedding rates. The document notes that there are a number of unresolved statistical issues related to the estimation of reporting rates, in particular there is a need to develop appropriate error models for the reporting rate estimates.
12. CCSBT-ESC/0509/21 presents an initial analysis of the release and recapture data from the CCSBT SRP tagging program. A tag attrition model was used to estimate

cohort and age specific fishing mortality rates for different groups of tag releases conditional on estimates of natural mortality, tag shedding and reporting rates (the last three derived from separate analyses). The estimated fishing mortality rates are independent of the catch and catch-at-age data. There appear to be some substantial tagger and age of release effects in the return data. The results suggest high fishing mortality rates for 3 and 4 year old fish in 2003 and 2004 for those fish tagged at age 2 and above. However, rates based on age 1 releases, which primarily occurred in Western Australia, tend to be lower. High rates of recovery were obtained from age 3 fish released in December in the Great Australian Bight (GAB) during the same season they were released. Overall the results suggest high fishing mortality rates generally greater than 0.4 in 2003 and 2004 for fish of ages 3 and 4 in the GAB, but it is not clear to what extent the fish in the GAB represents the overall juvenile population. CCSBT-ESC/0509/21 noted that the number of returns from age 1 releases from the 2000 and 2001 cohorts were disproportionately low relative to the returns from releases from other age classes and also relative to returns from the 1990s tagging experiments. This suggests either higher tagging mortality or natural mortality or changes in the spatial dynamics for age 1 fish. The spatial distribution of longline returns also suggest a possible change in spatial dynamics with few tagged fish moving into the Tasman Sea. In addition, estimates of fishing mortality rates from the tag attrition model at age 2 were very close to zero for the 2000 and 2001 cohorts, which appears inconsistent with the catch data from the surface fishery. Estimates of the number of tags returned per 1000 fish caught in the surface and longline fisheries also suggest possible inconsistencies with the catch-at-age estimates.

13. Document CCSBT-ESC/0509/25 presented a summary of several fishery indicators, with emphasis on the newest data that were unavailable to the 2004 SAG. The indicators were extracted mostly from other, more detailed SAG/ESC 2005 documents and were presented primarily in the context of evaluating the strength of recent cohorts, with a lesser emphasis on the most recent biomass trends. Indicators included CPUE by fleet (including the new Indonesian training fishery indices), total catches, catch age composition, the age 1 acoustic survey from Western Australia, aerial survey in the Great Australia Bight, commercial spotting data (SAPUE) in the GAB, SRP tag returns (described above) and Australian fishing industry comments. Overall, the document concluded that there have probably been between 2 and 4 weak cohorts spawned between 1999 and 2002, with at least one cohort between 2002 and 2004 that is more abundant than the recent weak cohorts. CPUE trends suggest that the spawning stock biomass may have decreased slightly in the last two years, while the age structure suggests that young spawners are recruiting to the spawning population. The major change in the perception of the stock status from the 2004 assessment relates to the recruitment estimates, and the confirmation that there has almost certainly been more than one very weak cohort in the recent past.
14. CCSBT-ESC/0509/38 presented recruitment information obtained from the Recruitment Monitoring Program in Western Australia, representing age-1 abundances in the survey area. All indices showed that recruitment dropped markedly in 1999 and stayed at extremely low levels since then. The 2005 survey data indicated that the 2004 year class was slightly stronger than 2000 and 2001 year

classes but about the same level as 1999 year class, i.e. still substantially lower than the average 1990's level.

15. CCSBT-ESC/0509/39 reviewed various fisheries indicators exchanged. Longline CPUE indicated that the component of the stock exploitable by longline fisheries has stayed stable with slight increase from the late 1990s to 2002. Cohorts recruited during 1999 and after were virtually absent in the Japanese longline catch in Areas 4-7 and in the New Zealand fishery. The preliminary size composition of the 2005 Japanese longline catch indicated that the 2002 cohort was stronger than 2000 and 2001 cohorts but still weaker than the average of the late 1990s cohorts. Attention was drawn to CCSBT-ESC/0509/37 (Figure 1) which shows very little difference between the Japanese observer and vessel logbook data. It was also stated that observers report no discards other than badly damaged fish. These two sources of information support the reliability of Japanese longline size composition data.
16. CCSBT-ESC/0509/40 examined various recruitment information in conjunction with Operating Model recruitment scenarios. Information examined consistently showed that the 2000 and 2001 recruitments were markedly low as was the 1999 cohort. The 2002 recruitment seemed slightly higher than 2000 and 2001 but still lower than recruitments in the late 1990s. The information currently available was considered to be reasonably consistent with the reference set recruitment scenario of the operating model (OM).
17. CCSBT-ESC/0509/Taiwanese SBT Fisheries provides brief information on the nominal CPUE and catch at length of the Taiwanese longline fleet. The CPUE series were calculated from logbooks of vessels that have caught SBT in that year, except the most recent year (2004) which was estimated from weekly reports. The CPUE shows a generally stable trend during 1996-2004. Further studies are needed to exclude data from fishing vessels during periods when they are not involved in the SBT fishery and to separate target and non-target fishing data. The catch at length shows that the catch was dominated by 85-130cm fish in 2001 and by fish with a length of 100-145 cm from 2002 to 2004.
18. CCSBT-ESC/0509/SBT Fisheries – New Zealand was presented. Both areas of the New Zealand fishery have shown declines in catch per unit effort in recent years, with a steady decline of 55-70% in the northeast fishery and a 60% reduction in the southwest fishery since 2001. There has been a very clear reduction in the range of sizes of southern bluefin tuna taken in the New Zealand fishery since 2001. The proportion of fish less than 140 cm in length has declined rapidly since that time. The lack of small fish reflected in the length data corresponds to a series of weak cohorts in the proportional ageing data for the New Zealand fishery. Overall, the data suggest three consecutive weak year classes from 2000 to 2002 and that the 1999 cohort is also low. Preliminary data for the 2005 fishing year (the fishery is still underway) indicate a continuation of the lack of small fish observed in the data for the 2004 fishing year. In response to a question about observer size frequency data in the New Zealand fishery, it was noted that observers reported only two discards from the charter fleet (which had 100% observer coverage) in 2004.

19. The following is a summary of the fishery indicators evaluated and Attachment 5 shows some of the key indicators.

*#1 CPUE Trends Over Time in Japanese LL fishery*

20. The nominal CPUE index for Japanese LL vessels in Areas 4-9 over April to September for ages 4+ in 2004 was down slightly from 2003, and is currently at about the same level as it was in the late 1990s (CCSBT-ESC/0509/25 and CCSBT-ESC/0509/40). For the same Areas and months, nominal CPUE for ages 4, 5, 6&7, and 8-11 were all down from 2003. (CCSBT-ESC/0509/39, figure 1-1).

*#2 CPUE Trends by year-class in Japanese LL fishery*

21. The nominal CPUE for the 2000 and 2001 year classes is very low relative to the historical average, which is consistent with the low numbers of small fish in the LL catch in recent years (CCSBT-ESC/0509/25, figure 9).

*#3 CPUE trends in other fisheries*

22. The Korean CPUE (CCSBT-ESC/0509/25) shows a small increase between 2002 and 2003 (no data were available for 2004 at the time of writing). Taiwanese LL fisheries (CCSBT-ESC/0509/Taiwanese SBT fishery) show no trend in CPUE from 2003 to 2004. The NZ LL fishery showed a decrease in CPUE in the fisheries in the southwest and northeast areas with three weak year classes from 1999 to 2001.

*#4 & #5 Indonesian catch and age composition*

23. Total catches estimated from Indonesia (Benoa sampling program) indicated that total SBT longline catches have declined from 2002 through 2004, but it is unclear how this relates to stock status, given the non-target nature of the SBT fishery, and the difficulties in effort quantification. In 2000/01, the age distributions shifted towards a larger proportion of young spawners compared to the late 1990s. The size distribution suggests a similar pattern in 2005. These data may provide an indication that cohorts spawned since catch limits were introduced in 1984 have survived to reach spawning age in substantial proportions. However, in the absence of reliable effort data it is impossible to determine the degree to which the greater proportion of young fish reflects more recruiting young spawners or the disappearance of old spawners.

*#7 Acoustic estimates of age 1 off Western Australia*

24. The Japanese acoustic survey of 1 year old SBT off Western Australia recorded some fish in 2005, but the numbers are a small fraction of what had been seen prior to 2000 (CCSBT-ESC/0509/25 and CCSBT-ESC/0509/39). An intensive review held in 2004 indicated a low detection power of SBT by sonar devices and a non-linear relationship between the acoustic index and age 1 abundance in the survey area. The low recruitment indicated by the acoustic index is consistent with a lower level of juveniles from the Japanese longline CPUE in Areas 4 and 7 and the NZ longline catch.

*#8 Tagging data*

25. Estimates of fishing mortality rates based on the SRP conventional tagging program suggest high rates for ages 3 and 4 fish in 2003 and 2004, in particular for age 3 fish in 2004 (i.e. the 2001 cohort). Estimates based on age 1 releases tend to be lower than those for age 2 and 3 releases. Such differences were not seen in the tagging results in the 1990s. These changes in the fishing mortality rate estimates when combined with the low level of longline returns from the Tasman Sea area suggest possible changes in juvenile spatial dynamics.
26. Fishing mortality rates for age 2 fish were consistently estimated to be very low. High recovery rates within season were obtained from age 3 and 4 fish tagged in December in the GAB, particularly in 2004 in which 37-40% of the tags were estimated to have been caught. This indicates high exploitation rates for fish of those ages that were in the GAB in 2003 and 2004.

*#9 Size distribution*

27. Data were presented showing the size distribution of catch as an indication of year class strength. There was a striking lack of small fish (<140 cm) in the New Zealand longline data, and this was confirmed by direct aging of samples of the New Zealand catch (CCSBT-ESC/0509/New Zealand SBT fishery, Figure 8). Whereas previously ages 3-5 fish were common in the NZ LL catch, they are almost totally absent in 2004 and 2005 (the 2000, 2001, and 2002 cohorts). Furthermore, the 1999 cohort was also weak. The Japanese longline data continued to indicate a lack of fish from the 2000 and 2001 cohorts (CCSBT-ESC/0509/25 and CCSBT-ESC/0509/39) especially in the areas around Australia. There were indications in the Japanese LL data that the 1999 year class may also have been weak. The preliminary RTMP data indicated that the 2002 cohort is slightly stronger than the 2000 and 2001 cohorts, but still lower than the average of the 1990s cohorts.

*#10 GAB Aerial survey indices*

28. In 2005 Australia re-introduced the aerial transect survey of tuna in the Great Australian Bight (CCSBT-ESC/0509/22). The index of abundance in 2005 was about 80% of the values averaged from the previous years in which the survey had been conducted (1993-2000). No survey data were available for the years when the 2000 and 2001 cohorts would have been 3 years old.
29. Australia also conducted an analysis of the commercial aerial spotting data and obtained indices for 2002-2005 (CCSBT-ESC/0509/23). The years 2003 and 2004 (when the 2000 and 2001 cohorts would have been 3 years old) were considerably lower than the 2002 and 2005 estimates, which were similar to each other.

*Other indices*

30. A preliminary view of how Indonesian nominal CPUE has changed in recent years in area 1 is presented in CCSBT-ESC/0509/17 based on data from Indonesian fisheries training schools. These data are available from 2000 to 2005, which is after the more dramatic changes in the size composition of the SBT catch. The data indicate that numbers of SBT per set have declined somewhat over the period. Much of this decline occurred from 2000 to 2002, and CPUE has been relatively stable since. Given the lack of CPUE data from the spawning area, these data sets are especially

valuable and the SAG encourages its further analysis, as well as attempts to characterise how representative these data are of the Indonesian fleet.

## ***Discussion***

### *Interpretation of Indicators of Recruitment*

31. The indicators presented in 2005 reinforce the evidence available in 2004 that the 2000 and 2001 year classes were considerably smaller than previous years and the sum of the evidence is now convincing that there have been at least two very low recruitments. There are four primary data sources to indicate this poor recruitment: acoustic survey, size frequency, commercial spotting (SAPUE), and tagging data. The acoustic data indicated markedly low recruitment after 1999. The size distribution data in the Japanese LL fishery show a marked reduction in the number of fish from the 2000 and 2001 year classes. The charter fishery in New Zealand also shows a near total absence of fish recruited since 1999. The Australian commercial aerial spotting data (CCSBT-ESC/0509/23 Figure 8) show lower abundance in 2003 and 2004. The tagging data show that the exploitation rates on the 2000 and 2001 year classes are high, and hence are consistent with estimates of low recruitments to these year classes.
32. In summary, the indicators of recruitment suggest markedly lower recruitment in at least 2000 and 2001 with some indication that recruitment in 1999 was also weak.

### *Spawning stock biomass*

33. Catch rates of fish aged 12 and older in the Japanese LL indicate a drop in spawning stock biomass in about 1995. Recent Indonesian catch has remained low and the majority of the catch has been relatively young spawners. The data from the Indonesian fishery training schools from 2000 to 2005 is consistent with a declining spawning stock biomass.

### *Exploitable biomass for the longline fishery*

34. Japanese LL CPUE of SBT for all ages combined suggests that the exploitable biomass for these gears has remained fairly constant during the past 10 years, though this level is low compared to historical values. Results indicate increases in the CPUE of ages 8-11 since about 1992, but there is a slight decline in 2003 which continued into 2004. CPUE of fish aged 4-7 has increased since the mid 1980s and remained broadly constant over the last 10 years.
35. In summary, these CPUE indicators generally suggest stable exploitable biomass over the last 10 years. However, recent low recruitments are likely to lead to declines in future exploitable biomass trends.

## ***5.2 Overall assessment of stock status***

36. The current assessments through the operating model (using data available from the 2004 SAG/ESC) suggest the SBT spawning biomass is at a low fraction of its original biomass and well below the 1980 level. The stock is estimated to be well below the level that could produce maximum sustainable yield. Rebuilding the



spawning stock biomass would almost certainly increase sustainable yield and provide security against unforeseen environmental events. Recruitments in the last decade are estimated to be well below the levels in the period 1950-1980. Assessments estimate that recruitment in the 1990s fluctuated with no overall trend. Analysis of several independent data sources and the operating model indicate very low recruitments in 2000 and 2001. There is some evidence that the 1999 cohort is relatively weak and that the 2002 cohort is unlikely to be as strong as those estimated during the 1990s. Other indicators show that the Indonesia LL fishery on spawning fish catches fewer older individuals. One plausible interpretation is that the spawning stock has declined in average age and may have declined appreciably in abundance. The decline in average age may be due to the disappearance of older fish, a pulse of younger fish entering the spawning stock, or a combination of the two factors. A pulse of younger fish entering the spawning stock is consistent with the assessment model output which suggests that the spawning stock has been largely stable over the last decade and increased slightly over the last four years.

37. Given all the evidence, it seems highly likely that current levels of catch will result in further declines in spawning stock and exploitable biomass, particularly because of recent low recruitments..

## **Agenda Item 6. Management procedure**

### ***6.1 Reconsideration of final operating models in the light of the overall assessment of stock status***

38. CCSBT-ESC/0509/14 was used as the basis for considerations for this item along with the outputs from a range of analyses conducted during the meeting (some figures are shown in **Attachment 4**).
39. The existing reference set (Cfull2) used to produce the results in CCSBT-ESC/0509/14 was conditioned to the data available at MPWS4. Since then further data have become available. As agreed at MPWS4 the need to extend the reference set by taking weighted averages of the reference set and some of the alternative recruitment scenarios was considered. The motivation for making adjustments to the reference set was to make it as far as possible a good reflection of the current status of the stock and particularly of recent recruitments. The SAG agreed that the choice of an MP could proceed without modifying the operating model. However, the evaluation of short-term risks to the stock and the impact of alternative levels of immediate catch reductions are very dependent on recent trends in recruitment and therefore should be based upon most current information.
40. In general, the existing reference set matched the new data reasonably well and adequately represented the state of the stock. Some, however, felt that the somewhat more optimistic scenario, called “expl” (CCSBT-ESC/0509/14) fitted the spotting data equally well (CCSBT-ESC/0509/23) and there might be benefit in making a 50:50 weighting of this scenario and the reference set. Others were concerned that the “expl” set inflated the estimates of the 1998 and 1999 year classes and that the exploitation rates were low compared to the tagging results (CCSBT-ESC/0509/21),

while the reference set exploitation rates were considered more consistent, although marginally higher. After considerable discussion, it was agreed that the existing reference set provided the best available basis to evaluate short-term risks and the effects of alternative initial catch reductions and Candidate Management Procedures (CMPs) with their associated tuning level. Notwithstanding the above, the SAG agreed that it remained necessary to consider the results for the “lowR4” and “expl” robustness tests.

***6.2 Evaluation of projection results obtained using the four chosen management procedures (tuned to 1.1 and 1.3) in combination with different TAC-changing schedules and quota cuts in 2006.***

41. The SAG agreed to use the reference set as the Operating Model, and the Robustness trials as sensitivity analyses, as the basis for evaluating the Candidate Management Procedures (CMPs). In doing so, it was noted that at the Special Consultation in May 2005 the Commission had asked the SAG and the Extended Scientific Committee (ESC) for advice on the “best” MP, but no specific criteria had been provided to determine this. In the context of the current estimated very low level of the stock, confirmation of recent low recruitment and the Commission’s rebuilding objective, the combination of initial catch reductions and an MP should address both short-term risk to stock and the long-term objectives of the Commission for stock rebuilding, average catch and catch stability.
42. The evaluation process needs to consider the combination of the number of CMPs (1-4), initial catch reductions (0, 2500, 5000), schedule of catch reductions and MP implementation (initial cut in 2006 and MP commencement in 2008, initial catch reduction in 2007 and MP commencement in 2009) and tuning levels (1.1, 1.3). However, this results in a large number of potential combinations to be evaluated.
43. In order to focus the evaluation the SAG agreed on the following process:
  - i. Evaluate the implications of the different initial reduction options in the annual assumed global catch of 14,930 tonnes for 2004 and 2005 in the OM in terms of short-term risks for the spawning biomass (all specifications of assumed catch relate to the annual assumed global catch of 14,930 tonnes in the OM).
  - ii. Agree on a recommendation on the size for the initial reduction in the annual assumed global catch to be implemented in 2006 if at all.
  - iii. Evaluate the performance of CMPs conditioned on the recommended catch reduction in 2006 and assuming MP implementation would commence in 2008 (schedule b).
  - iv. Agree on a recommendation on the combination of immediate catch reduction and MP.
  - v. Evaluate the combination of catch reduction and CMP tuning parameters that would achieve similar rebuilding objectives if catch reductions were delayed until 2007 under schedule e.
44. It was noted that the first two steps above relate to the immediate concern arising from the confirmation of very low recent recruitments, and the following three steps

relate to the relative performance of candidate management procedures in meeting the Commission's objectives in the long-term.

45. To evaluate the implications of different sizes and schedules of initial catch reductions, a series of calculations assuming constant current catches were made to estimate the catch that would result in a estimated probability of 50% that the spawning biomass (SSB) would be above the 2004 level in 2014 (the year in which the SSB is estimated to reach a minimum). The results are presented in **Attachment 4**. These indicate that a reduction of 5000 tonnes would be required to meet the criterion adopted by the SAG. In terms of the implications of the timing of the catch reductions, postponing any initial catch reduction until 2007 would require a reduction of 7160 tonnes to meet the same criterion.
46. The SAG noted that it was not possible to provide reliable estimates of risks associated with possible further stock decline which could jeopardise recovery prospects. This is because of the lack of empirical evidence with the stock at this low level, and the potential for environmental effects to result in further stock declines. Nevertheless, while it was not possible to provide a quantitative estimate of the risk associated with the further stock decline, the SAG agreed that a decision not to reduce current catches in the immediate future was a high risk option given the recent low recruitments and the current low stock status.
47. The relative performance of each CMP is outlined in CCSBT-ESC/0509/14, and was considered and discussed in light of the alternative recommendations for immediate catch reductions. Their relative behaviour is summarised below.
48. CMP\_1 uses Japanese LL CPUE, indices of recruitment and a simple "Fox" model. It proved to be the most responsive to stock trends and productivity of the CMPs, also reducing catches early on to stabilize the stock and then, in scenarios when the stock was rebuilding strongly, it was the most aggressive MP in increasing catches in later years. However it produced quite variable TACs.
49. CMP\_2 also uses Japanese LL CPUE, indices of recruitment and a simple "Fox" model. It was responsive to stock trends and productivity but less so than CMP\_1, but provided a generally smoother and less variable catch series than CMP\_1. It was slow to reduce TAC in early years, but when combined with a 2006 catch reduction CMP\_2 performed well in preventing stock decline.
50. CMP\_3 used Japanese LL CPUE and indices of recruitment in an empirical rule to adjust TACs. It provided the most stable catches of the CMPs, and when combined with catch reductions in 2006 provided good stock stabilization and rebuilding. However, this CMP was unresponsive to stock increases, so that even when the stock was growing rapidly in later years, catch increases were limited to 3% per year by design.
51. CMP\_4 relied on Japanese LL CPUE only. Its strengths were a very simple structure that could be easily understood by all parties, responded to stock trends but less so than CMP\_1, and its long-term performance in the trade off between catch and stock recovery which was good. However, CMP\_4 did not use recruitment data and produced quite variable TACs.

### *6.3 Selection of preferred management procedures*

52. At the Management Procedure Special Consultation (May 2005), CCSBT had requested the SAG to provide specific recommendations about management procedures. Given the stock rebuilding objectives of the Commission, the SAG has interpreted this request to mean that CCSBT wants the ESC to recommend specific management actions sufficient to prevent further declines in the stock.
53. When choosing a MP, it was agreed that generally desirable features are to protect against further reduction of the spawning stock in the short and long term, to keep short term TAC fluctuations small, and to respond by increasing TACs in the longer term if the stock shows signs of rebuilding strongly.
54. The report of SC9 highlighted concern about stock status and suggested that catch reductions might be required in addition to adoption of an MP. Given the stock status described in the previous section, particularly the low recruitments of 2000 and 2001 and the ongoing low SSB, the SAG considers that there is an urgent need to reduce catches to prevent further stock decline. It is recommended that the global SBT catch should be reduced to 9,930 tonnes for 2006, which corresponds to a 5,000 tonne reduction in the assumed global catch of 14,930 tonnes. This level of catch reduction was chosen so that, when coupled with the implementation of an MP, it would provide an estimated 50% probability that the spawning stock biomass in 2014 (when a minimum is forecast) would be no lower than 2004 spawning stock biomass which is currently the lowest estimated.
55. In the event that the catch is not reduced until 2007, in order to maintain the same estimated 50% probability that 2014 biomass will be no lower than the estimated 2004 biomass, the catch would need to be reduced to 7,770 tonnes in 2007 (this corresponds to a reduction of 7,160 tonnes in the annual assumed global catch of 14,930 tonnes).
56. In the event that it is determined that the global catches are higher, and, or, the characteristics of the catch (e.g. the age, and size composition, distribution among sectors) are substantially different than those assumed in the operating model, then the total catch reduction required to achieve the same stock stabilization would need to be recalculated. It is expected that the catch reduction required would be approximately an equivalent percentage of total removals under most circumstances. Therefore, in the absence of a calculation, the SAG recommended a catch reduction equivalent in percentage of total removals.
57. The SAG judged that all MPs showed reasonable feedback behaviour and made different tradeoffs between the objectives of CCSBT when combined with catch reductions in 2006. The SAG also noted that many of the weaknesses identified could probably be remedied with additional modification. However, the Commission had asked the ESC to recommend a single MP for implementation at the current meeting without further opportunity for MP modification.
58. The SAG also recognized that a 5,000 tonne reduction in 2006 will be highly disruptive to fishing industries but is considered essential to achieve an estimated

50% probability that spawning stock biomass in 2014 will be above the SSB in 2004. Accepting the need for this catch reduction, CMP\_1 and CMP\_4 produced more year-to-year variability in the TAC. These changes would add additional disruption to all fishing industries. CMP\_3 was less responsive to stock increases and failed to take advantage of the potential for TAC increases following stock rebuilding.

59. Thus the SAG recommends that the Commission accepts CMP\_2 as its procedure, combined with a corresponding reduction in the annual assumed global catch specified for 2006 (5,000 tonnes) or 2007 (7160 tonnes).
60. In the event that the recommended 2006 or 2007 catch reductions do not occur, then the conservation risk of CMP\_2 would be higher and would not meet the same objectives. Additional measures would then be required to prevent further stock decline, and these measures could include additional catch reductions, retuning of CMP\_2 or adoption of another MP.
61. The MP workshop in May 2005 outlined a process by which the selected MP would be re-tuned after the selection. SAG considered alternative tuning levels in the context that one of the prime objectives of CCSBT is to rebuild the spawning stock, which requires minimizing the probability of the further decline of the SBT stock to minimize conservation risk.
62. Thus the SAG recommends that CMP\_2 be tuned so that there is an estimated 90% probability that the 2022 biomass will be at or above the 2004 biomass. This means, in effect, that there is an estimated 10% chance that the stock will be below the 2004 level in 2022. This would lead to a higher estimated median biomass in 2022 than that examined at MPWS4 but lower than either the 1980 or 1989 stock levels. Associated tabular and graphical results are given in **Attachment 4**, together with those for an alternative tuning which corresponds to an estimated 20% chance that the stock will be below the 2004 level in 2022.
63. Once the MP is implemented, the performance of the MP and the management system should be reviewed periodically following the process outlined in Attachment 9 of the MPWS4 report or any subsequent revision thereof.

#### **6.4 Metarules**

64. The meeting agreed that there was a need to document the metarules process that had commenced at the Fourth Meeting of the Management Procedure Workshop. The report from this workshop, and in particular Attachments 8 and 9 to the report, form a good basis for documenting the metarules process.
65. The documentation of the metarules process should be based on and address at least the following components:
  - The agreed Management Procedure (based on summaries given in CCSBT-ESC/0509/14).
  - The Report of the Fourth Meeting of the Management Procedure Workshop, and in particular Attachments 8 and 9.

- Issues related to Management Procedure Implementation.
  - The Management Procedure review and revision process.
66. The Chair of the ESC agreed to chair a small group in the margins of the SAG and ESC to develop a draft document on the metarules process to report to the ESC.

***6.5 Specification of input data and procedures for the implementation of the management procedure***

67. The Data Manager presented document CCSBT-ESC/0509/43 which raised four main issues with respect to input data for the management procedure:
- Process for provision of data for the MP and for running the MP;
  - Options for validating and improving the reliability of data;
  - The meaning of “catch” and “years” in the MP; and
  - Whether changes made to historical data should be used by the MP.
68. A small working group was formed to discuss these issues and this group will report its findings to the ESC.

***6.6 Specification of input data for operation of metarules***

69. The meeting agreed that except for identifying broad circumstances that may invoke the metarules process, it is not possible to pre-specify the data that may trigger the metarule. If a Member or the independent panel is to propose an exceptional circumstances review, then that member or the panel must outline the reasons why they believe exceptional circumstances exist and must either indicate where the data are found supporting the review or they must supply those data in advance of the SAG/ESC meeting. This matter will be taken up by the metarules small group being chaired by the ESC Chair in the margins of the SAG/ESC meeting.

**Agenda Item 7. Research and technical requirements for future stock assessments and management procedure operations**

70. Detailed discussion of the research and technical requirements for future stock assessments and management procedure operations was deferred until the ESC. The meeting was referred to Attachment 8 of the Report of the Fourth Meeting of the Management Procedure Workshop which specifies in the metarules process that every year the SAG will review stock and fishery indicators, and any other relevant data or information on the stock and fishery; and that every three years (not coinciding with years when a new TAC is calculated from the MP) the SAG will conduct an in depth stock assessment. The year in which the latter process will commence needs to be specified.

**Agenda Item 8. Other business**

71. There was no other business.

**Agenda Item 9. Finalisation and adoption of meeting report**

72. The report of the meeting was adopted.

**Agenda Item 10. Close of meeting**

73. The meeting was closed at 7:00pm, 3 September 2005.

## **List of Attachments**

### Attachment

- 1 List of Participants
- 2 Agenda
- 3 List of Documents
- 4 Figures and Tables for the 6th meeting of the Stock Assessment Group
- 5 A selection of relevant indicators considered by the CCSBT-SAG



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**29 August - 3 September 2005**  
**Taipei, Taiwan**

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**Agenda**  
**Sixth Meeting of the Stock Assessment Group**  
**29 August – 3 September 2005**  
**Taipei, Taiwan**

1. Opening  
Introduction of participants and administrative matters
2. Appointment of rapporteurs
3. Adoption of agenda
4. Admission of documents and finalisation of document list
5. Stock assessment
  - 5.1 Analysis of fisheries indicators
  - 5.2 Overall assessment of stock status
6. Management procedure
  - 6.1 Reconsideration of final Operating Models in the light of the overall assessment of stock status.
  - 6.2 Evaluation of projection results obtained using the four chosen management procedures (tuned to 1.1 and 1.3) in combination with different TAC-changing schedules and quota cuts in 2006.
  - 6.3 Selection of preferred management procedures.
  - 6.4 Metarules
  - 6.5 Specification of input data and procedures for the implementation of the management procedure.
  - 6.6 Specification of input data for operation of metarules
7. Research and technical requirements for future stock assessments and management procedure operations
8. Other business
9. Finalisation and adoption of meeting report
10. Close of meeting

**List of Documents**  
**Sixth Meeting of the Stock Assessment Group**

**(CCSBT-ESC/0509/ )**

01. Draft Agenda of 6th SAG
02. List of Participants of 6th SAG
03. Draft Agenda of the Extended SC for 10th SC
04. List of Participants of the 10th SC and Extended SC
05. List of Documents - The Extended SC for 10<sup>th</sup> SC & 6th SAG
06. (Secretariat) 4. Review of SBT Fisheries
07. (Secretariat) 7.1. Characterisation of SBT Catch
08. (Secretariat) 7.4. SBT Tagging Program
09. (Secretariat) 8. Data Exchange
10. (Secretariat) 9. Indonesian Catch Monitoring
11. (Secretariat) Catch calculations for the management procedure
12. (New Zealand) Catch at age of Southern bluefin tuna in the New Zealand longline fishery, 2001-2004.: K. Krusic-Golub.
13. (New Zealand) Preparation of New Zealand catch and effort data for the CCSBT data exchange.: S. Harley, T. Murray, and L. Griggs.
14. (Panel) Performance of the final candidate management procedures selected at the 4<sup>th</sup> Management Procedure Workshop.: Branch, T.A. and A.M. Parma
15. (Australia) The catch of SBT by the Indonesian longline fishery operating out of Benoa, Bali in 2003.: R. Andamari, T.L.O. Davis, B. Iskandar, D. Rentowati, M. Herrera, C.H. Proctor and S. Fujiwara.
16. (Australia) Update on the length and age distribution of SBT in the Indonesian longline catch on the spawning ground.: Farley, J.H. and Davis, T.L.O.
17. (Australia) Indonesian fishery school data on Southern Bluefin tuna: summary and preliminary analyses.: M. Basson, D. Bromhead, T.L.O. Davis, R. Andamari, G.S. Mertha and C. Proctor.
18. (Australia) An update on Australian Otolith Collection Activities: 2003/04.: Stanley, C. & Polacheck, T.
19. (Australia) Estimates of proportions at age in the Australian surface fishery catch from otolith ageing and size frequency data.: M. Basson, M. Bravington, S. Peel and J. Farley.
20. (Australia) Tag Seeding Activities in 2004/2005 and Preliminary estimates of reporting rate from the Australian surface fishery based on previous tag seeding experiments.: Tom Polacheck and Clive Stanley.

21. (Australia) Initial analyses of tag return data from the CCSBT SRP tagging program.: T. Polacheck, P. Eveson.
22. (Australia) The Aerial survey index of abundance, updated to include the 2005 survey.: M. Bravington, P. Eveson, J. Farley.
23. (Australia) Commercial spotting in the Australian surface fishery, updated to include the 2004/5 fishing season.: M. Basson, J. Farley.
24. (Australia) Trends in catch, effort and nominal catch rates in the Japanese longline fishery for SBT-2005 update.: Hartog, J., T. Polacheck and S. Cooper.
25. (Australia) Fishery indicators for the SBT stock 2004/05.: D. Kolody, J. Hartog, M. Basson and T. Polacheck.
26. (Australia) Proposal for continued monitoring of southern bluefin tuna recruitment via aerial survey of juveniles in the Great Australian Bight.: C.R. Davies, J. Farley, P. Eveson, M. Basson, M. Bravington.
27. (Australia) A Proposal for Multi-lateral Co-ordination and Co-Operation in Electronic Tag Deployment under the CCSBT Scientific Research Programme.: T. Polacheck, J. Gunn and A. Hobday
28. (Australia) Post-processing of data from the 2005 data exchange.: A. Preece, S. Cooper.
29. (Australia) Movement and residency of adult SBT in the Tasman Sea and on their spawning grounds south of Indonesia using pop-up archival tags: a summary of results for 2004.: T. Patterson, J. Gunn, K. Evans, T. Carter.
30. (Australia/Taiwan) Update on the Global Spatial dynamics Archival Tagging project.: T. Polacheck, S.K. Chang, Chien-Ho Liu, A. Hobday, G. West, J. Gunn.
31. (Australia) Proposal for work requiring RMA/SRP allowance.: T. Polacheck, J. Gunn.
32. (Australia) Updated estimates of growth rates for juvenile SBT using tag-recapture and otolith direct ageing data up to 2005.: P. Eveson, T. Polacheck and J. Farley.
33. (Taiwan) Age and size composition of southern bluefin tuna (*Thunnus maccoyii*) caught by Taiwanese longliners in the central Indian Ocean.:
34. (Taiwan) Tracing the life history of southern bluefin tuna (*Thunnus maccoyii*) using otolith chemical fingerprints.:
35. (Taiwan) A preliminary study on the stomach content of southern bluefin tuna *Thunnus maccoyii* caught by Taiwanese longliner in the central Indian Ocean.:
36. (Taiwan) Investigation on Taiwanese longline fishing condition of Southern Bluefin Tuna in the Central Indian Ocean and its relationship with ocean temperature variability.:
37. (Japan) Report of Japanese scientific observer activities for southern bluefin tuna fishery in 2004.: T. Itoh and K. Miyauchi
38. (Japan) Review of recruitment indices obtained from the Recruitment Monitoring Program.: T. Itoh and S. Tsuji



39. (Japan) Summary of fisheries indicators in 2005.: N. Takahashi, T. and S. Tsuji.
40. (Japan) Comparison among various recruitment indices.: S. Tsuji
41. (Japan) Report of the 2004/2005 RMA utilization and application for the 2005/2006 RMA.: Fisheries Agency of Japan.
42. (Australia) Metarules: update of status of a “Metarule Process” document.: M. Basson, T. Polacheck.
43. (Secretariat) Intersessional Discussion on Management Procedure Implementation Issues
44. (Japan) Consideration on metarules, implementation issues and MP performance monitoring.: Hiroyuki KUROTA, Norio TAKAHASHI and Sachiko TSUJI.
45. (Japan) Preliminary analysis on effect of changes in fishing pattern on CPUE.: Norio TAKAHASHI.
46. (Japan) Possible application of finite normal mixture distribution with a structural model to estimate SBT catch composition from otolith direct aging data.: Hiroshi SHONO and Tomoyuki ITOH.
47. (Japan) Quick consideration toward future Scientific Research Program under the CCSBT and preferable management actions under low recruitments.: Sachiko TSUJI.

**(CCSBT-ESC/0509/SBT Fisheries)**

New Zealand	The New Zealand southern bluefin tuna fishery in 2004.: T. Kendrick, T. Murray, S. Harley, and A. Hore
Republic of Korea	Korean longline fishery for southern bluefin tuna in 2004.: Dae-Yeon Moon, Jeong-Rack Koh and Soon –Song Kim
Fishing Entity of Taiwan	Review of Taiwanese SBT Fishery of 2003/2004
Australia	Australia CCSBT Season Report
Japan	Review of Japanese SBT Fisheries in 2004. T. Itoh and K. Miyauchi

**(CCSBT-ESC/0509/Info)**

01. (Australia) Investigating the timing of annual growth zones in otoliths of southern bluefin tuna (*Thunnus maccoyii*): Naomi P. Clear, J. Paige Eveson and Tom Polacheck. Appendix 11 of Final Report for FRDC Project 1999/104
02. (Australia) withdrawn
03. (Australia) Estimation of mortality rates and abundance for southern bluefin tuna (*Thunnus maccoyii*) using tag-return and catch data from 1991 to 1997.: J. Paige Eveson, Tom Polacheck and Geoff M. Laslett. Appendix 15 of FRDC Project No. 2002/015 (as listed above)

04. (Japan) Proceedings of SBT Recruitment Monitoring Review Workshop: The role and constraints of scientific monitoring for stock management - brain storming using southern bluefin tuna experiences as an example.
05. (Japan) Southern bluefin tuna recruitment monitoring and tagging program

**(CCSBT-ESC/0509/Rep)**

01. Report of Tagging Program Workshop (October 2001)
02. Report of the First Meeting of Management Procedure Workshop (March 2002)
03. Report of the CPUE Modeling Workshop (March 2002)
04. Report of Direct Age Estimation Workshop (June 2002)
05. Report of the Third Stock Assessment Group Meeting (September 2002)
06. Report of the Seventh Meeting of the Scientific Committee (September 2002)
07. Report of the Second Meeting of the Management Procedure Workshop (April 2003)
08. Report of the Indonesian Catch Monitoring Review Workshop (April 2003)
09. Report of the Fourth Meeting of the Stock Assessment Group (August 2003)
10. Report of the Eight Meeting of the Scientific Committee (September 2003)
11. Report of the Tenth Annual Meeting of the Commission (October 2003)
12. Report of the Fifth Meeting of the Ecologically Related Species Working Group (February 2004)
13. Report of the Third Meeting of the Management Procedure Workshop (April 2004)
14. Report of the Special Meeting of the Commission (April 2004)
15. Report of the Fifth Meeting of the Stock Assessment Group (September 2004)
16. Report of the Ninth Meeting of the Scientific Committee (September 2004)
17. Report of the Eleventh Annual Meeting of the Commission (October 2004)
18. Report of the Special Management Procedure Technical Meeting (February 2005)
19. Report of the Fourth Meeting of the Management Procedure Workshop (May 2005)
20. Report of the Management Procedure Special Consultation (May 2005)

## Figures and Tables for the Sixth meeting of the Stock Assessment Group

The following documents the final set of figures and tables produced during the SAG in support of the SAG report to the SC. While the captions are intended to be self explanatory, please refer to paper CCSBT-ESC/0509/14 from the SAG and Table 1 for added detail and explanations of naming conventions.

### List of figures

Figure 1 Comparison of the reference-set spawning biomass trajectories for the schedules with catch reductions in 2006 (upper pair) and 2007 (lower pair) for cases where the catch once reduced remains constant thereafter. In the plots on the left the catch is reduced from the assumed level in the operating model (14930 t for 2004 and 2005) by 2500 t and by 5000 t for the plots on the right.....	4
Figure 2 Same as for Figure 1 but for the lowR4 case (four years of poor recruitment following those of 2000 and 2001). .....	5
Figure 3. The effect of different catch-reductions (followed by constant catches) based on median and 10 <sup>th</sup> -percentiles of the 2014 biomass relative to 2004 for catch schedules “b” (reduction from 2006) and “e” (reduction from 2007) for the recommended MP.....	6
Figure 4 Statistics comparing CMPs for the reference set based on the 1.1 tuning parameters (CMPs were tuned using the previous Cfull2 reference set from the MPWS4). The catch schedules are grouped from left to right as in the figure title—for explanation of symbols please see Table 1. ....	10
Figure 5 Tradeoff plots between the 10 <sup>th</sup> percentile of spawning biomass in 2014 (relative to 2004) and the median 10-year average catch. The top plot is for 1.1 tuning level and catch schedule “b”. Lines join the catch reductions (0, 2500 and 5000 t). Different symbols represent each CMP. Please see table 1 for additional explanation detail on schedules.....	11
Figure 6 Tradeoff plots between the 50 <sup>th</sup> percentile of spawning biomass in 2022 (relative to 2004) and the median 20-year average catch. The top plot is for 1.1 tuning level and catch schedule “b”. Lines join the catch reductions (0, 2500 and 5000 t). Different symbols represent each CMP. Please see table 1 for additional explanation detail on schedules.....	12
Figure 7 Plots showing 1.3 tuning level for CMP_1 compared with the 1.1 tuning level for the other CMPs for the b5000 catch schedule for the reference set. Please see Table 1 for additional explanation detail on schedules.....	13
Figure 8 Plots showing 1.3 tuning level for CMP_1 compared with the 1.1 tuning level for the other CMPs for the b5000 catch schedule for the lowR4 recruitment scenario. Please see Table 1 for additional explanation detail on schedules. ....	14
Figure 9 Comparison of the performance of the two catch schedules under different tuning levels for the recommended management procedure (as noted in the figure title). Please see Table 1 for additional explanation detail on schedules. ....	15
Figure 10. Cumulative probability of the spawning biomass ratios of 2022:2004 and 2020:1980 for the two catch schedules under different tuning levels for the recommended management procedure. Please see Table 1 for additional explanation detail on schedules.....	16
Figure 11. Recent past and future spawning biomass under the two catch schedules with different tuning levels for the recommended management procedure. Please see Table 1 for additional explanation detail on schedules. ....	17
Figure 12. As for Figure 11 but for the expl robustness case, which constrains the surface fishery’s exploitation rate to be less than 80% of the average estimated for age 2 and 3 for 1984-1988. ....	18
Figure 13. As for Figure 11 but for the lowR4 robustness case (four years of low recruitment subsequent to 2000 and 2001). ....	19

Figure 14 Plots of the spawning biomass and catch for the re-tuned CMP\_2 procedure. The “4” tuning level ensures that there is a 10% probability that  $B_{2022} < B_{2004}$ . The “7” tuning level is the 20% probability that  $B_{2022} < B_{2004}$ . The “e” catch schedule is based on a catch reduction in 2007 that produces an equivalent effect on  $B_{2014:2004}$  to a 5000 t catch reduction in 2006. .... 20

Figure 15 As for Figure 14 but for the expl robustness case (surface fishery’s exploitation rate constrained to be less than 80% of the average estimated for age 2 and 3 for 1984-1988). .... 21

Figure 16 As for Figure 14 but for the lowR4 robustness case (four years of low recruitment subsequent to 2000 and 2001). .... 22

Figure 17. Historic and projected spawning biomass under the recommended management procedure with the 4b5000 catch schedule. Lines indicate the median spawning biomass in 1989 and in 2004. .... 23

Figure 18. Historical (solid line) and projected CPUE (relative to the median value in 2004) for the recommended management procedure with catch schedule 4b and the 5000 t catch reduction below 14930 tones (as assumed for 2004 and 2005 in the operating model) in 2006. .... 24

Figure 19. The effect of different catch reductions followed by the recommended MP for schedule “b” (2006 catch-reduction and CMP\_2 in 2008 and every three years thereafter) and schedule “e” (2007 catch reduction and CMP\_2 in 2009, 2011 and every three years thereafter) on the median of the 2014 biomass relative to 2004 for the reference set. .... 25

Figure 20. The effect of different catch reductions followed by the recommended MP under schedule “b” (2006 catch-reduction and CMP\_2 in 2008 and every three years thereafter) on the median of the 2014 biomass relative to 2004 for the reference set and robustness trials expl (constraint on the surface fishery’s exploitation rate to be less than 80% of the average estimated for age 2 and 3 for 1984-1988) and LowR4 (four years of low recruitment subsequent to 2000 and 2001). .... 26

## List of Tables

Table 1. Explanation of catch schedule naming convention (left column). Note that schedules beginning with “4” or “7” are tuned to objectives related to the probability of the spawning biomass in 2022 being below the 2004 level (see paragraph 62 of the SAG6 report). .... 3

Table 2. Median ratio of spawning biomass in 2014 to that in 2004 for different catch schedules under the assumption of a catch reduction in either 2006 or 2007 followed by constant catches thereafter. .... 6

Table 3. 10<sup>th</sup> percentile of  $B_{2014}$  (relative to 2004). Results shown here and in subsequent tables (except for Tables 7 and 10) are for the four candidate management procedures (CMPs) where ZERO means no catch from the first decision period (2008 for the “b” schedules and 2009 for the “e” schedules), MAXDEC reflects reductions of 5000 t on each possible future TAC-change occasion subsequent to the control reduction; and CONST means maintain the catch of 14930 t assumed for 2004 and 2005. .... 7

Table 4. As for Table 1 but showing the 50<sup>th</sup> percentile of  $B_{2014}$  (relative to 2004). .... 7

Table 5. As for Table 1 but showing the 50<sup>th</sup> percentile of  $B_{2022}$  (relative to 2004) using the 1.1 tuning parameters (for the old Cfull2 reference set). Note that if the CMPs were tuned to 1.1 for the new reference set then all of their values would be 1.1 here. .... 7

Table 6. As for Table 3 but showing the 50<sup>th</sup> percentile of  $B_{2022}$  (relative to 2004) using the 1.3 tuning parameters (for the old Cfull2 reference set). Note that if the CMPs were tuned to 1.3 for the new reference set then all of their values would be 1.3 here. .... 8

Table 7. 10<sup>th</sup> percentile of CPUE in 2009 (relative to that in 2004) using the 1.1 tuning parameters. .... 8

Table 8. 50<sup>th</sup> percentile of CPUE in 2009 (relative to that in 2004) using the 1.1 tuning parameters. .... 8

Table 9. The 10<sup>th</sup> percentile of spawning biomass in 2022 relative to that in 2004. Under the proposed new tuning level (see paragraph 62 in SAG6 report), these values would be 1.00. .... 8

Table 10 As for Table 3 but showing the median  $B_{2022:B2004}$ . .... 9

Table 11. Statistics of interest for the reference set. Tuning “4b” parameters were chosen so that there is a 10% probability that  $B_{2022} < B_{2004}$ , “4e” so that the short term risk (2014) was the same as for “4b”, and

tuning “7” parameters so that there was a 20% probability that  $B_{2022} < B_{2004}$ . The relevant tuning criteria are denoted in grey. ....27

Table 12 Statistics of interest for the expl and lowR4 robustness cases. Expl places a limit on the maximum exploitation in the surface fishery (80% of the average for age 2 and 3 from 1984-1988), while in lowR4 it is assumed that the low recruitment in 2000 and 2001 continues for an additional four years. Please see Table 1 for additional explanation of the schedules. ....27

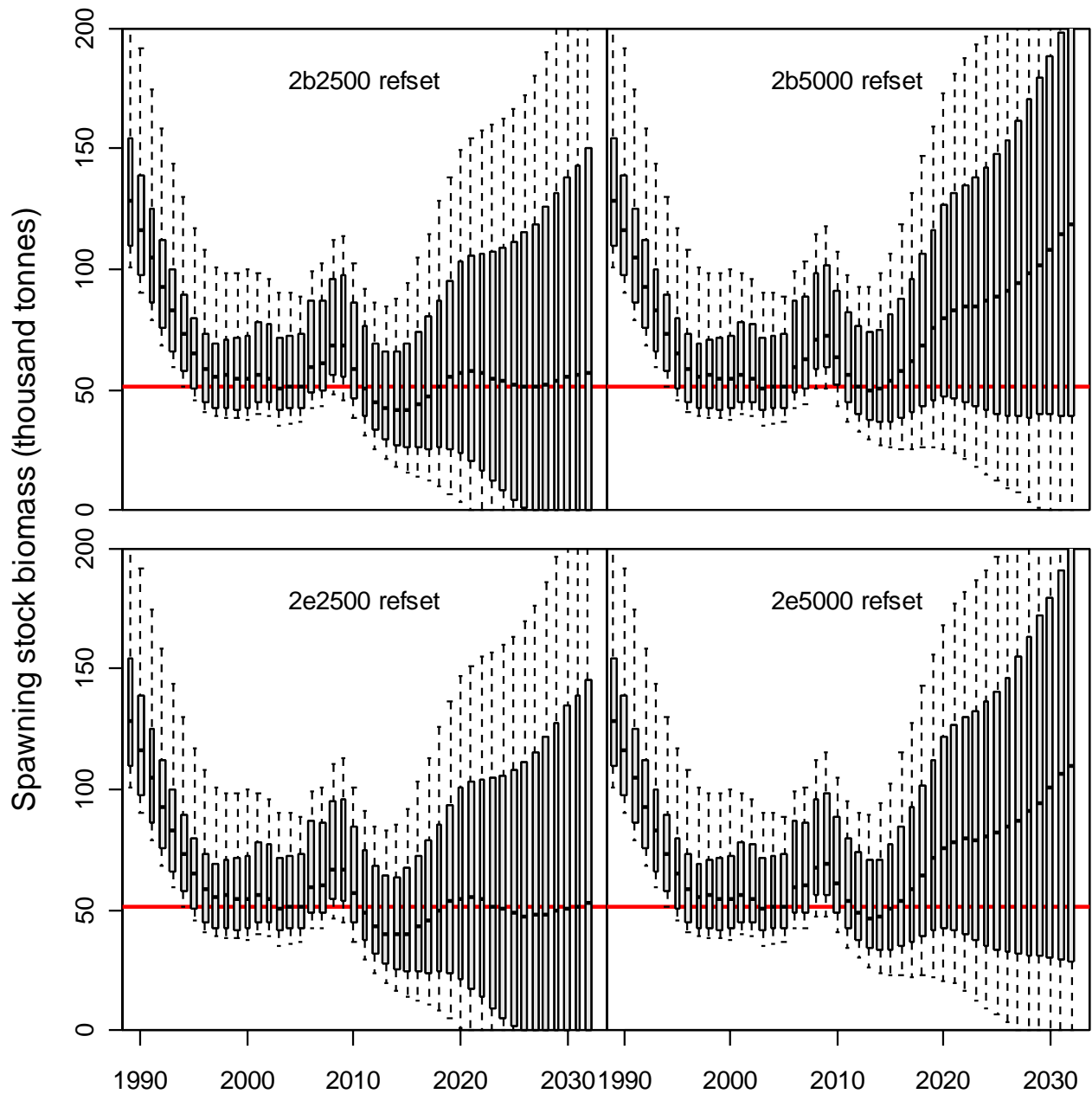
## Naming conventions

**Table 1.** Explanation of catch schedule naming convention (left column). Note that schedules beginning with “4” or “7” are tuned to objectives related to the probability of the spawning biomass in 2022 being below the 2004 level (see paragraph 62 of the SAG6 report).

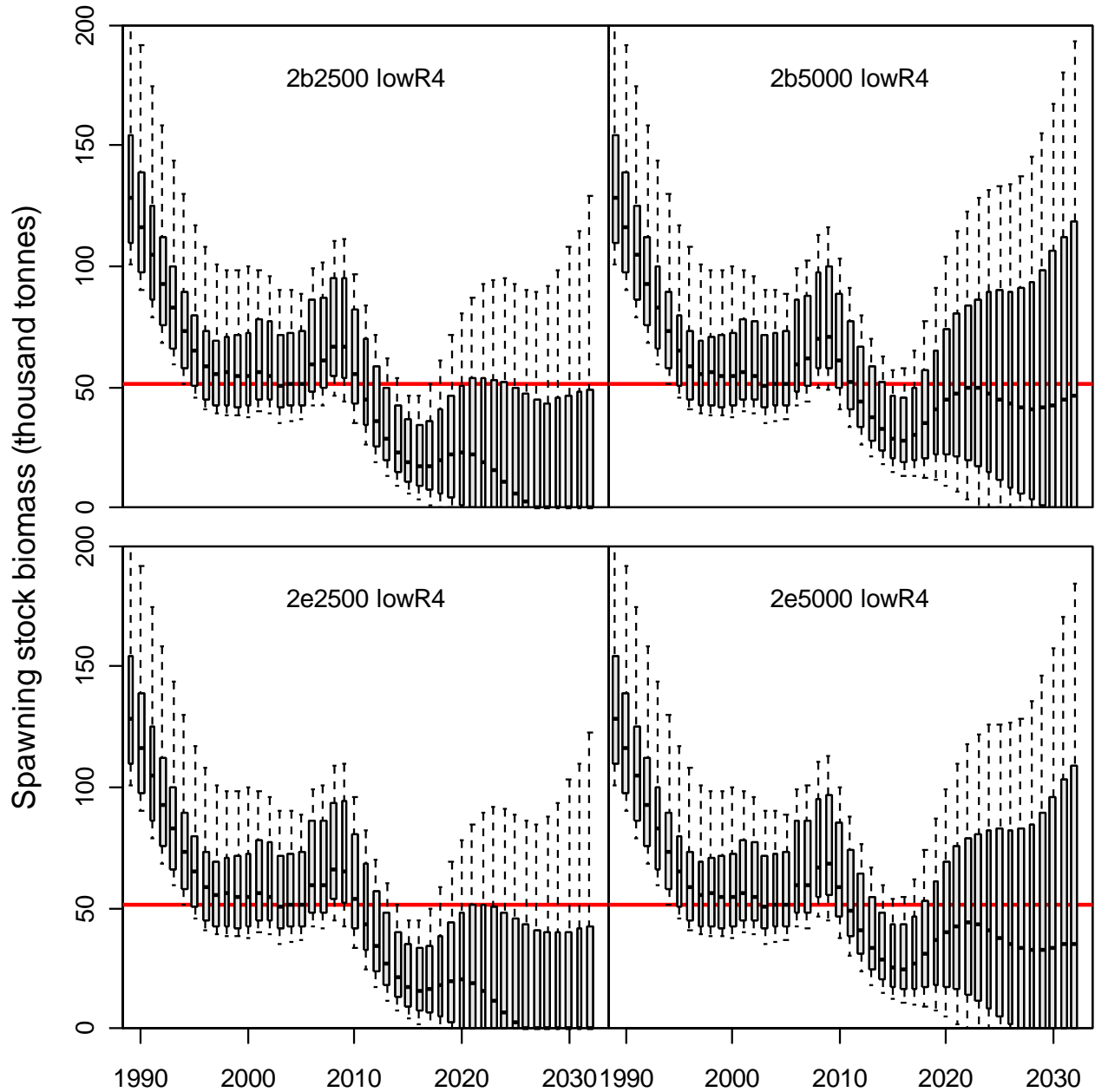
Schedules	Start MP year	Catch reduction		Tuning*	Probability $B_{2022} < B_{2004}$
		2006	2007		
2b	2008	0	0	1.1	-
2b2500	2008	2500	0	1.1	-
2b5000	2008	5000	0	1.1	-
2e	2009	0	0	1.1	-
2e2500	2009	0	2500	1.1	-
2e5000	2009	0	5000	1.1	-
3b	2008	0	0	1.3	-
3b2500	2008	2500	0	1.3	-
3b5000	2008	5000	0	1.3	-
3e	2009	0	0	1.3	-
3e2500	2009	0	2500	1.3	-
3e5000	2009	0	5000	1.3	-
4b5000	2008	5000	0	-	0.10
4e7160	2009	0	7160	-	~0.10
7b5000	2008	5000	0	-	0.20
7e7160	2009	0	7160	-	0.20

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

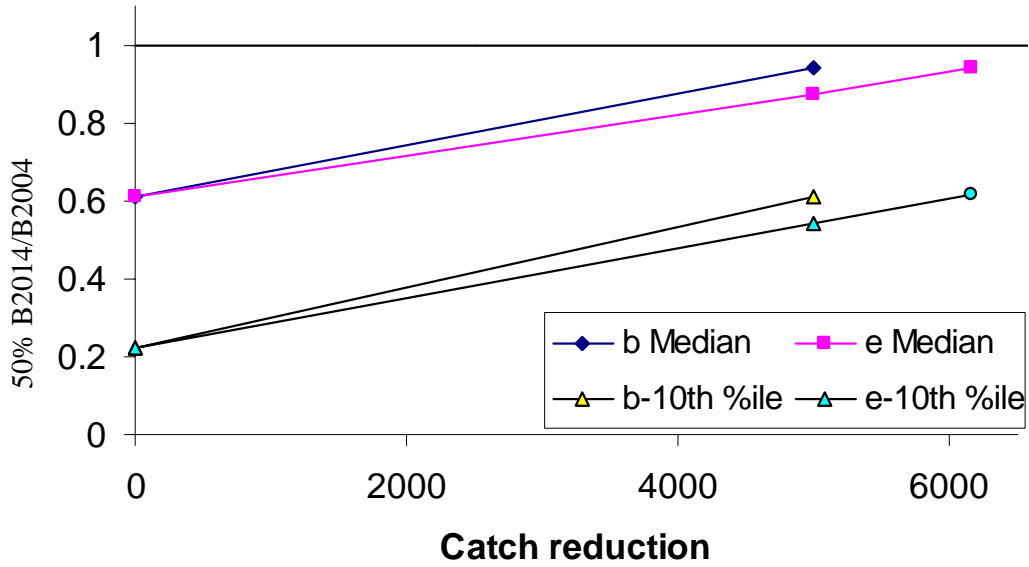
## Effect of alternative initial catch reductions



**Figure 1** Comparison of the reference-set spawning biomass trajectories for the schedules with catch reductions in 2006 (upper pair) and 2007 (lower pair) for cases where the catch once reduced remains constant thereafter. In the plots on the left the catch is reduced from the assumed level in the operating model (14930 t for 2004 and 2005) by 2500 t and by 5000 t for the plots on the right.



**Figure 2** Same as for **Figure 1** but for the lowR4 case (four years of poor recruitment following those of 2000 and 2001).



**Figure 3.** The effect of different catch-reductions (followed by constant catches) based on median and 10<sup>th</sup>-percentiles of the 2014 biomass relative to 2004 for catch schedules “b” (reduction from 2006) and “e” (reduction from 2007) for the recommended MP.

**Table 2.** Median ratio of spawning biomass in 2014 to that in 2004 for different catch schedules under the assumption of a catch reduction in either 2006 or 2007 followed by constant catches thereafter.

Schedules	Catch reduction year		Median B <sub>2014:2004</sub>
	2006	2007	
2b5000	5000	0	0.94
2e6150	0	6150	0.94



## Comparisons of the four CMPs

**Table 3.** 10<sup>th</sup> percentile of B2014 (relative to 2004). Results shown here and in subsequent tables (except for Tables 7 and 10) are for the four candidate management procedures (CMPs) where ZERO means no catch from the first decision period (2008 for the “b” schedules and 2009 for the “e” schedules), MAXDEC reflects reductions of 5000 t on each possible future TAC-change occasion subsequent to the control reduction; and CONST means maintain the catch of 14930 t assumed for 2004 and 2005.

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
2b	1.1	0	0	0.92	0.58	0.22	0.50	0.43	0.41	0.38
2b2500	1.1	2500	0	0.98	0.77	0.22	0.58	0.58	0.58	0.54
2b5000	1.1	5000	0	1.04	0.94	0.22	0.69	0.72	0.74	0.72
2e	1.1	0	0	0.80	0.53	0.22	0.46	0.33	0.42	0.42
2e2500	1.1	0	2500	0.85	0.69	0.22	0.54	0.46	0.55	0.56
2e5000	1.1	0	5000	0.91	0.83	0.22	0.64	0.60	0.68	0.69

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 4.** As for Table 1 but showing the 50<sup>th</sup> percentile of B2014 (relative to 2004).

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
2b	1.1	0	0	1.24	0.90	0.61	0.81	0.74	0.75	0.70
2b2500	1.1	2500	0	1.32	1.08	0.61	0.88	0.87	0.89	0.85
2b5000	1.1	5000	0	1.39	1.26	0.61	0.97	1.01	1.04	1.00
2e	1.1	0	0	1.11	0.86	0.61	0.77	0.66	0.75	0.74
2e2500	1.1	0	2500	1.17	1.00	0.61	0.83	0.77	0.86	0.85
2e5000	1.1	0	5000	1.22	1.15	0.61	0.92	0.90	0.97	0.97

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 5.** As for Table 1 but showing the 50<sup>th</sup> percentile of B2022 (relative to 2004) using the 1.1 tuning parameters (for the old Cfull2 reference set). Note that if the CMPs were tuned to 1.1 for the new reference set then all of their values would be 1.1 here.

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
2b	1.1	0	0	3.03	2.34	0.49	1.23	1.23	1.29	1.17
2b2500	1.1	2500	0	3.11	2.67	0.49	1.29	1.51	1.63	1.50
2b5000	1.1	5000	0	3.20	2.98	0.49	1.46	1.81	1.99	1.83
2e	1.1	0	0	2.77	2.24	0.49	1.18	1.01	1.33	1.34
2e2500	1.1	0	2500	2.86	2.53	0.49	1.26	1.28	1.63	1.62
2e5000	1.1	0	5000	2.95	2.80	0.49	1.40	1.60	1.94	1.91

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 6.** As for Table 3 but showing the 50<sup>th</sup> percentile of B2022 (relative to 2004) **using the 1.3 tuning parameters** (for the old Cfull2 reference set). Note that if the CMPs were tuned to 1.3 for the new reference set then all of their values would be 1.3 here.

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
3b	1.3	0	0	3.03	2.34	0.49	1.44	1.48	1.48	1.42
3b2500	1.3	2500	0	3.11	2.67	0.49	1.55	1.75	1.79	1.73
3b5000	1.3	5000	0	3.20	2.98	0.49	1.64	2.02	2.11	2.03
3e	1.3	0	0	2.77	2.24	0.49	1.40	1.24	1.51	1.56
3e2500	1.3	0	2500	2.86	2.53	0.49	1.49	1.48	1.80	1.83
3e5000	1.3	0	5000	2.95	2.80	0.49	1.58	1.78	2.07	2.09

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 7.** 10th percentile of CPUE in 2009 (relative to that in 2004) using the 1.1 tuning parameters.

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
2b	1.1	0	0	0.44	0.39	0.36	0.37	0.37	0.37	0.36
2b2500	1.1	2500	0	0.47	0.43	0.36	0.40	0.40	0.41	0.40
2b5000	1.1	5000	0	0.50	0.47	0.36	0.44	0.44	0.45	0.44
2e	1.1	0	0	0.37	0.36	0.36	0.36	0.36	0.36	0.36
2e2500	1.1	0	2500	0.39	0.39	0.36	0.39	0.39	0.39	0.39
2e5000	1.1	0	5000	0.42	0.42	0.36	0.41	0.41	0.42	0.42

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 8.** 50<sup>th</sup> percentile of CPUE in 2009 (relative to that in 2004) using the 1.1 tuning parameters.

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
2b	1.1	0	0	0.72	0.65	0.61	0.63	0.63	0.63	0.62
2b2500	1.1	2500	0	0.76	0.70	0.61	0.68	0.68	0.68	0.67
2b5000	1.1	5000	0	0.80	0.76	0.61	0.72	0.73	0.73	0.73
2e	1.1	0	0	0.62	0.61	0.61	0.61	0.61	0.61	0.61
2e2500	1.1	0	2500	0.66	0.65	0.61	0.65	0.65	0.65	0.65
2e5000	1.1	0	5000	0.69	0.68	0.61	0.68	0.68	0.68	0.68

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 9.** The 10<sup>th</sup> percentile of spawning biomass in 2022 relative to that in 2004. Under the proposed new tuning level (see paragraph 62 in SAG6 report), these values would be 1.00.

Schedules	Tuning*	Catch reduction year								
		2006	2007	ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
2b5000	1.1	5000	0	1.77	1.61	0.00	0.65	0.96	0.97	0.97
2e5000	1.1	0	5000	1.60	1.49	0.00	0.62	0.80	0.94	1.03
3b5000	1.3	5000	0	1.77	1.61	0.00	0.81	1.03	1.06	1.09
3e5000	1.3	0	5000	1.60	1.49	0.00	0.77	0.87	1.04	1.13

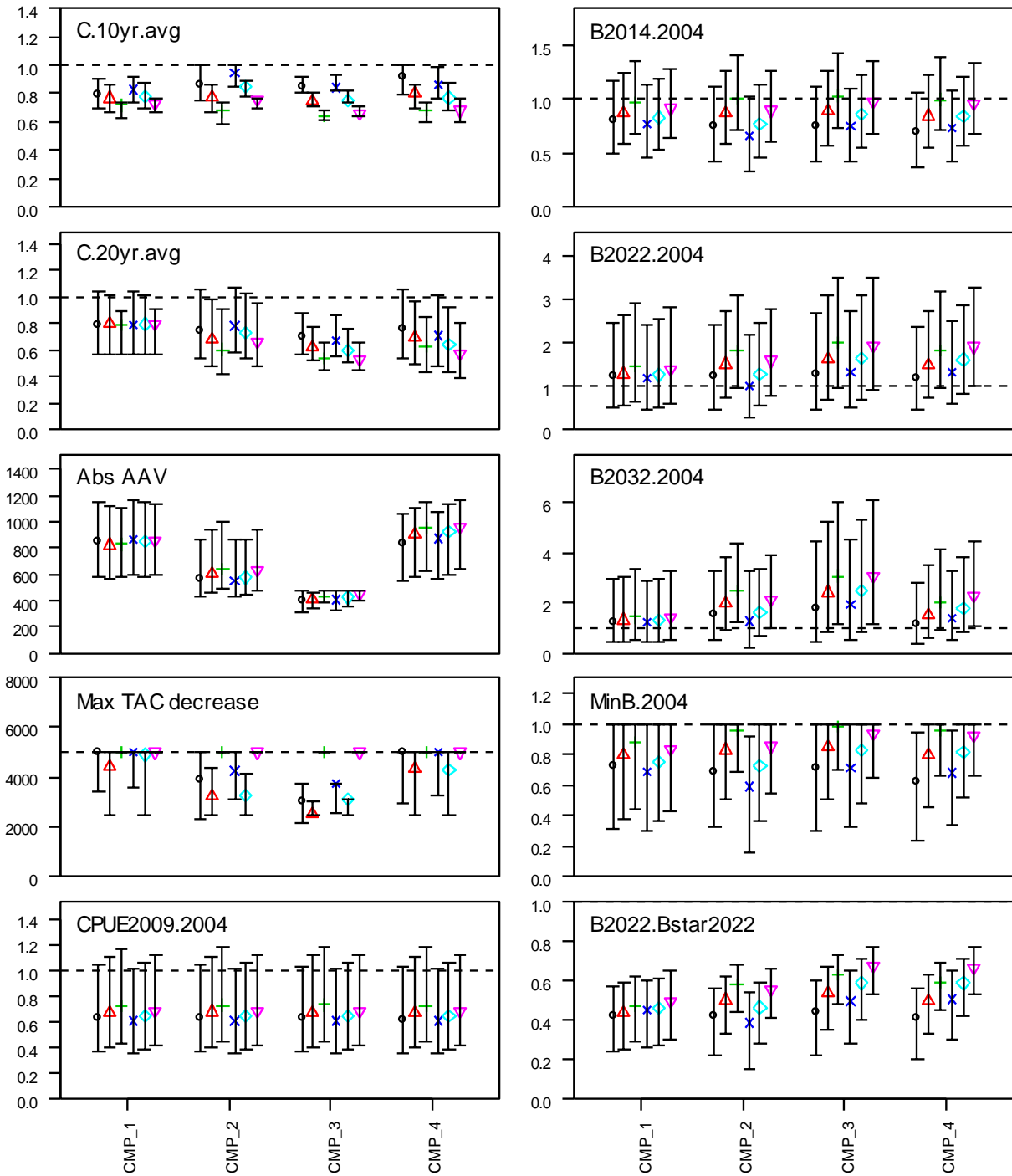
\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

**Table 10** As for Table 3 but showing the median B2022:B2004.

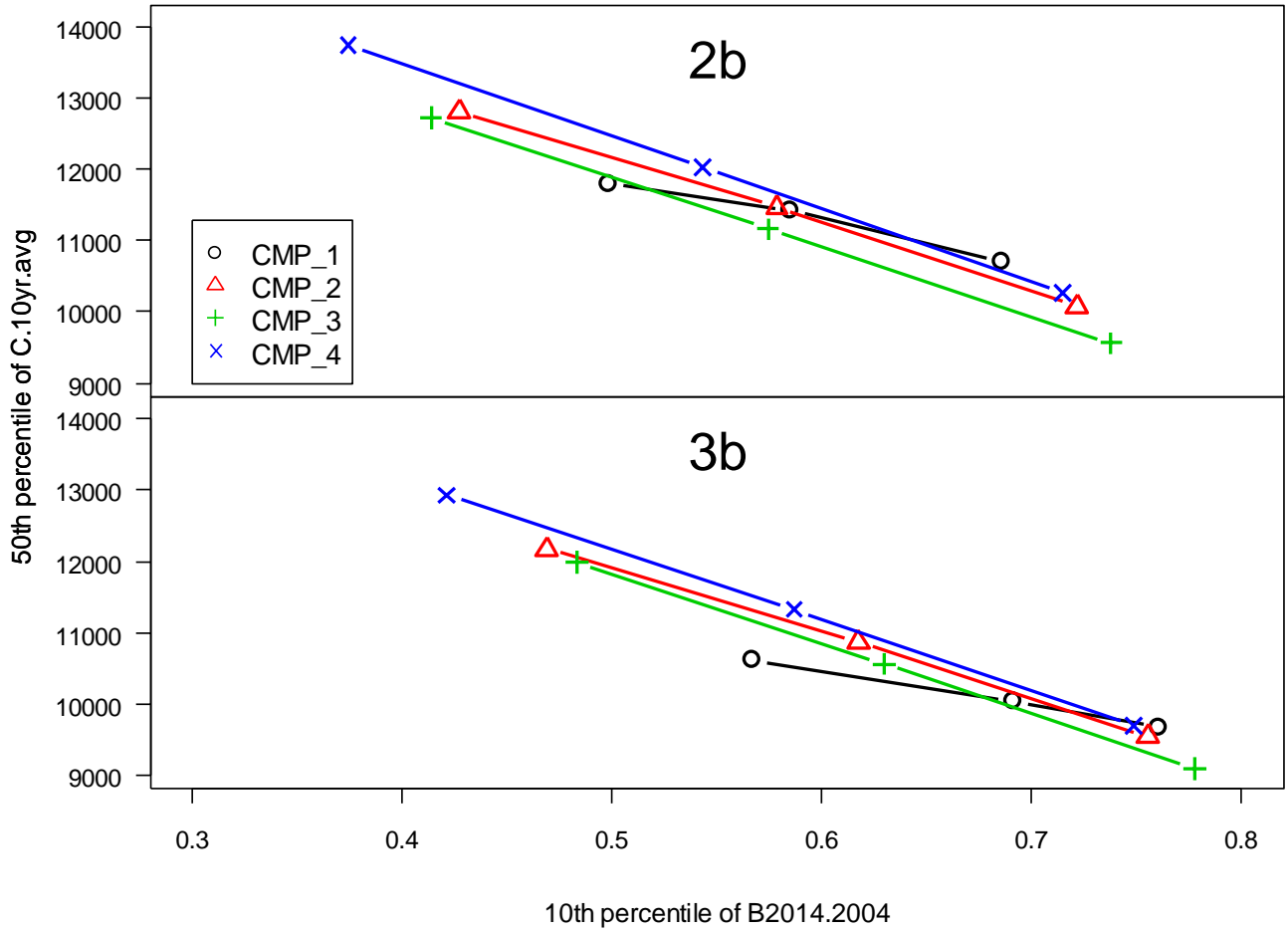
Schedules	Tuning*	Catch reduction year		ZERO	MAXDEC	CONST	CMP_1	CMP_2	CMP_3	CMP_4
		2006	2007							
2b5000	1.1	5000	0	3.20	2.98	0.49	1.46	1.81	1.99	1.83
2e5000	1.1	0	5000	2.95	2.80	0.49	1.40	1.60	1.94	1.91
3b5000	1.3	5000	0	3.20	2.98	0.49	1.64	2.02	2.11	2.03
3e5000	1.3	0	5000	2.95	2.80	0.49	1.58	1.78	2.07	2.09

\*Tuning parameters based on the previous Cfull2 reference set from the MPWS4.

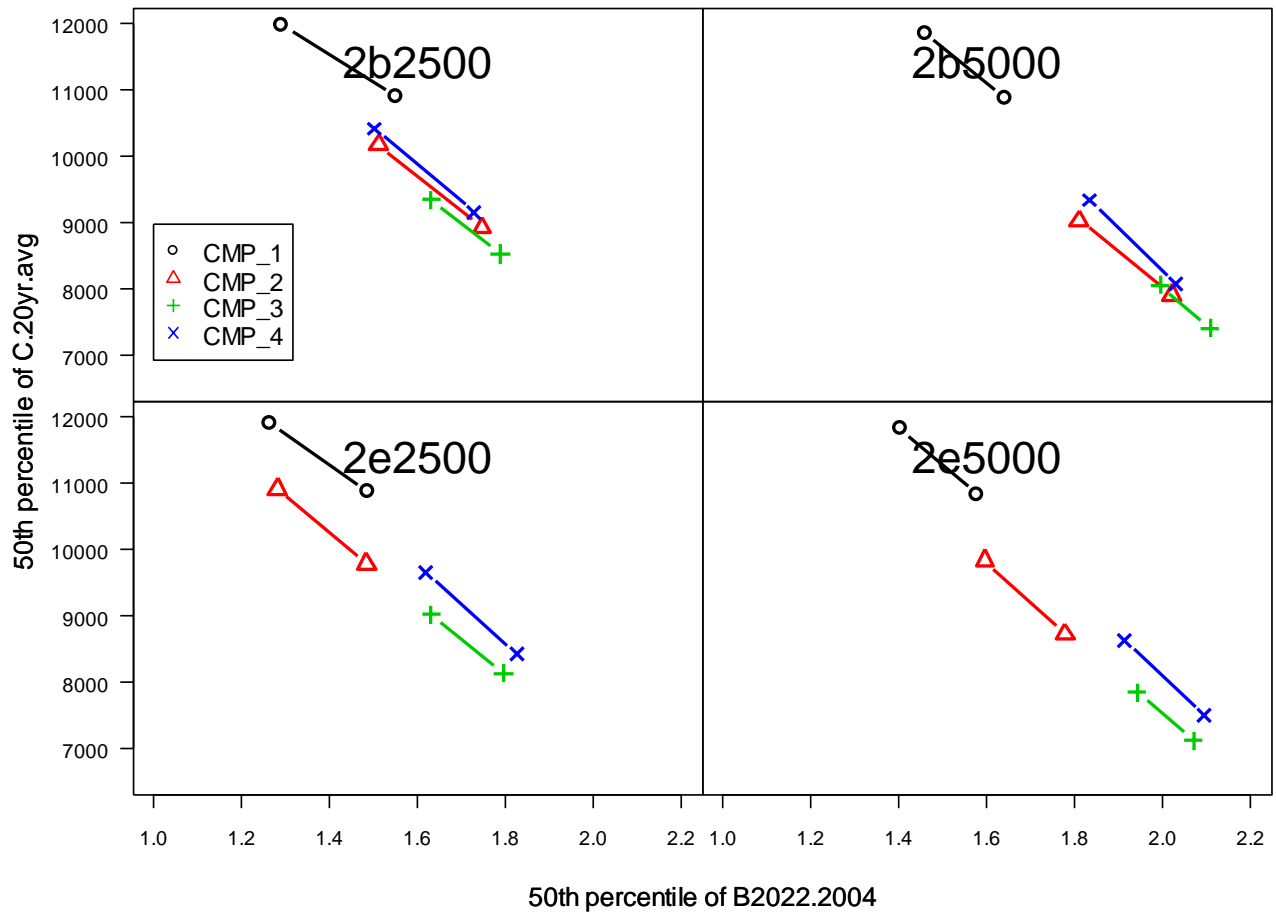
Compare schedules 2b, 2b2500, 2b5000, 2e, 2e2500, and 2e5000 w ith model refset



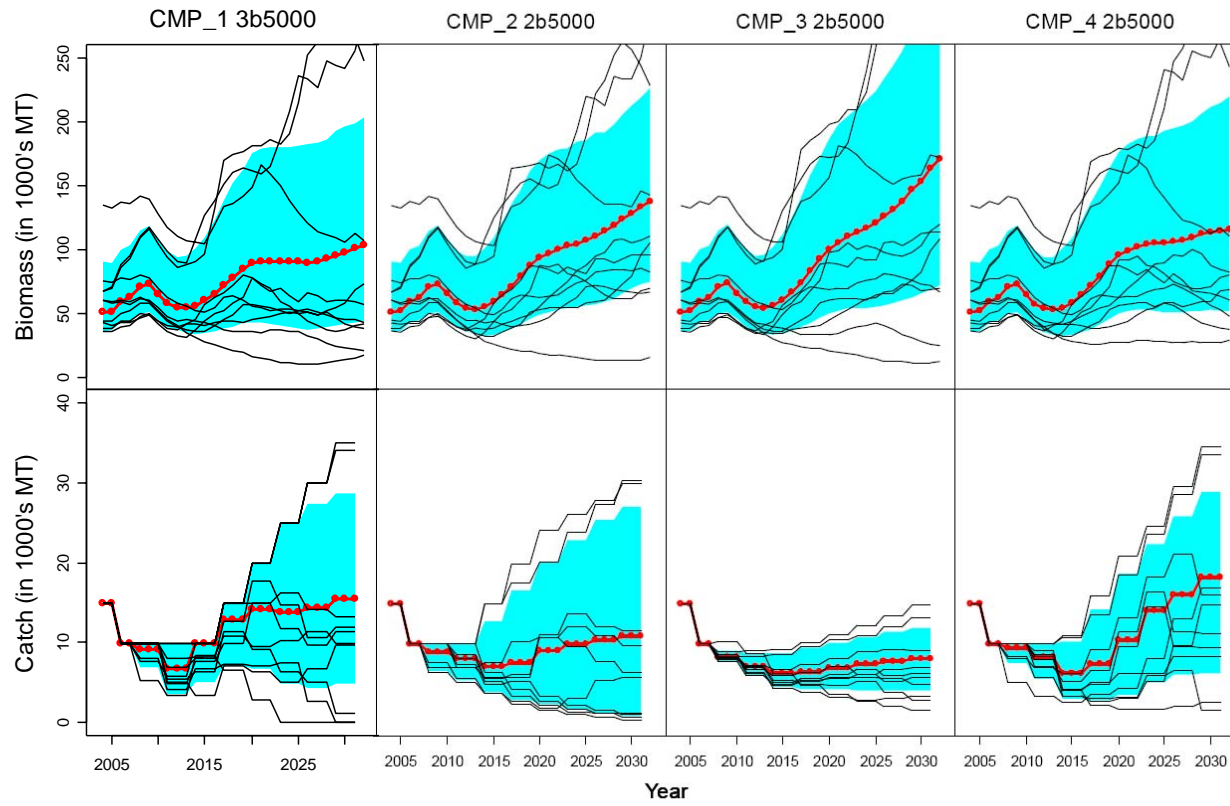
**Figure 4** Statistics comparing CMPs for the reference set based on the 1.1 tuning parameters (CMPs were tuned using the previous Cfull2 reference set from the MPWS4). The catch schedules are grouped from left to right as in the figure title—for explanation of symbols please see Table 1.



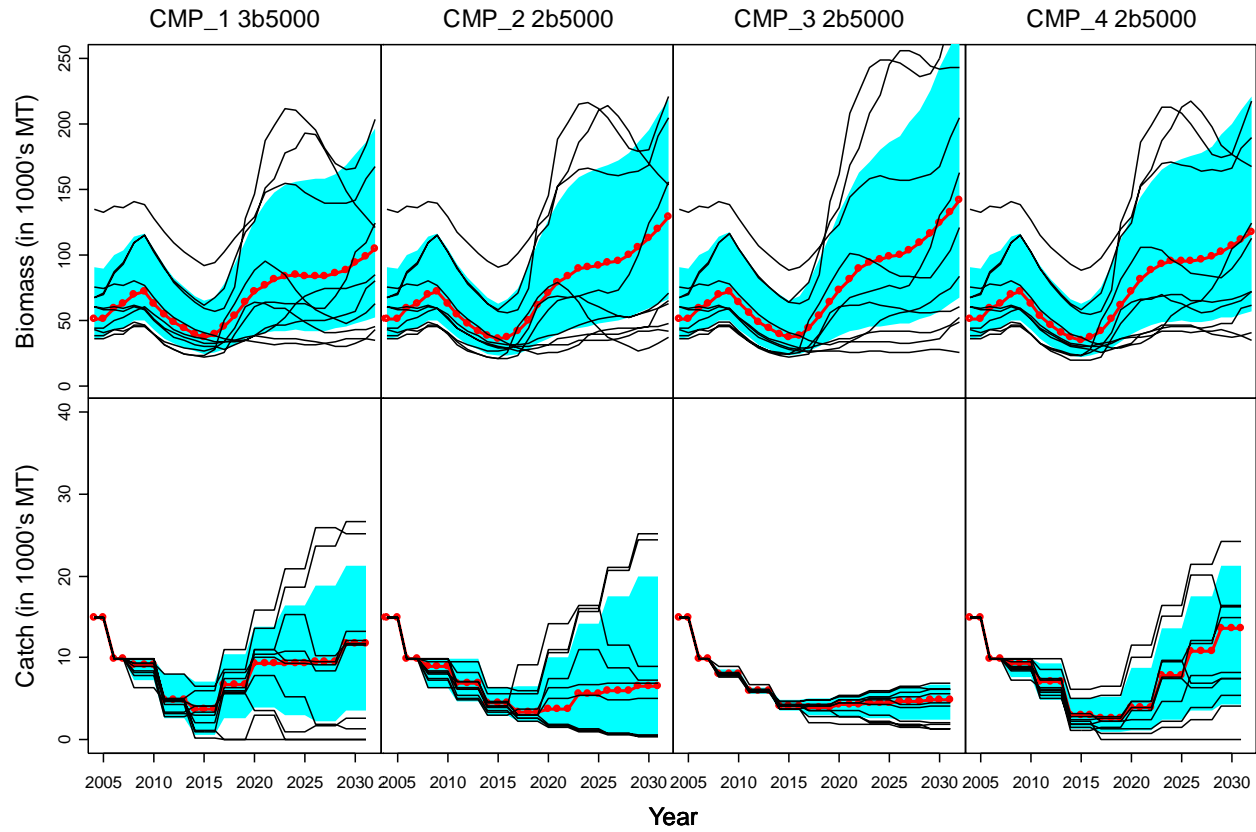
**Figure 5** Tradeoff plots between the 10<sup>th</sup> percentile of spawning biomass in 2014 (relative to 2004) and the median 10-year average catch. The top plot is for 1.1 tuning level and catch schedule “b”. Lines join the catch reductions (0, 2500 and 5000 t). Different symbols represent each CMP. Please see table 1 for additional explanation detail on schedules.



**Figure 6** Tradeoff plots between the 50<sup>th</sup> percentile of spawning biomass in 2022 (relative to 2004) and the median 20-year average catch. The top plot is for 1.1 tuning level and catch schedule “b”. Lines join the catch reductions (0, 2500 and 5000 t). Different symbols represent each CMP. Please see table 1 for additional explanation detail on schedules.



**Figure 7** Plots showing 1.3 tuning level for CMP\_1 compared with the 1.1 tuning level for the other CMPs for the b5000 catch schedule for the reference set. Please see Table 1 for additional explanation detail on schedules.

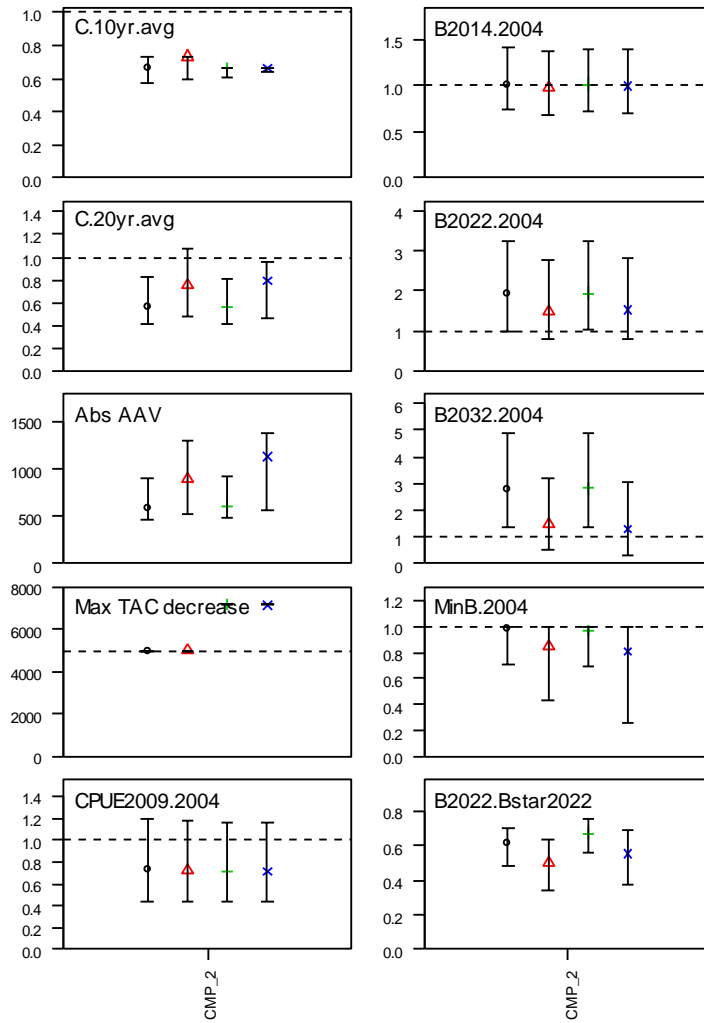


**Figure 8** Plots showing 1.3 tuning level for CMP\_1 compared with the 1.1 tuning level for the other CMPs for the b5000 catch schedule for the lowR4 recruitment scenario. Please see Table 1 for additional explanation detail on schedules.

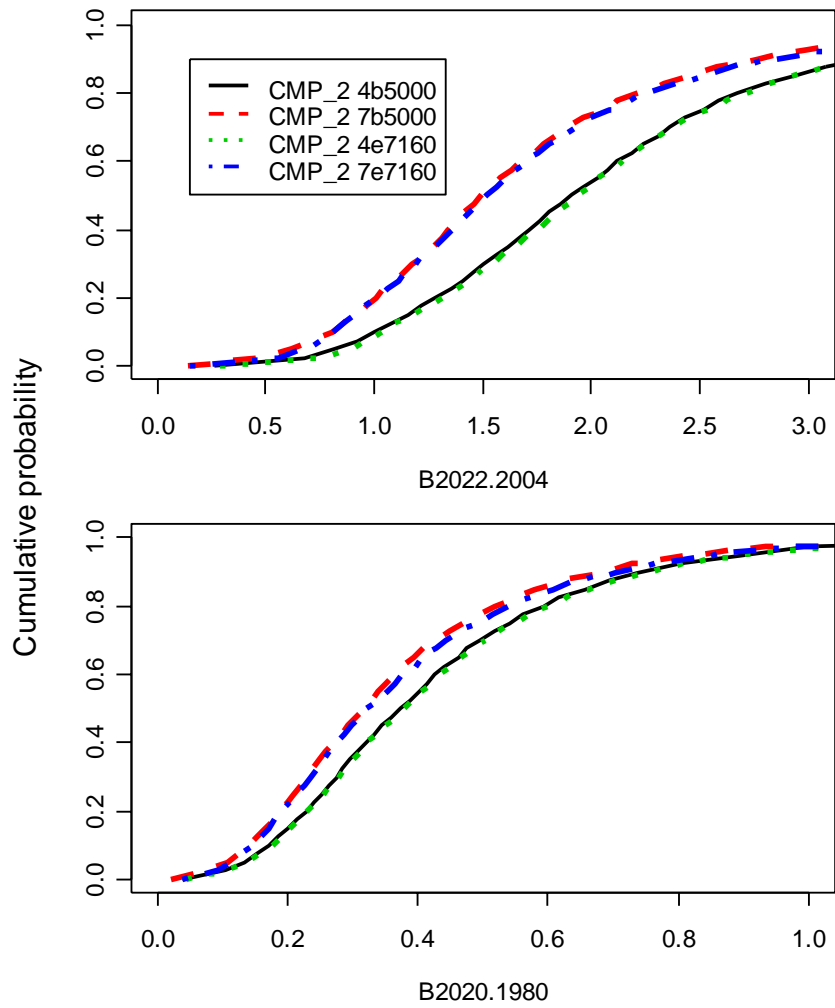


# Results for recommended CMP and alternative tuning thereof

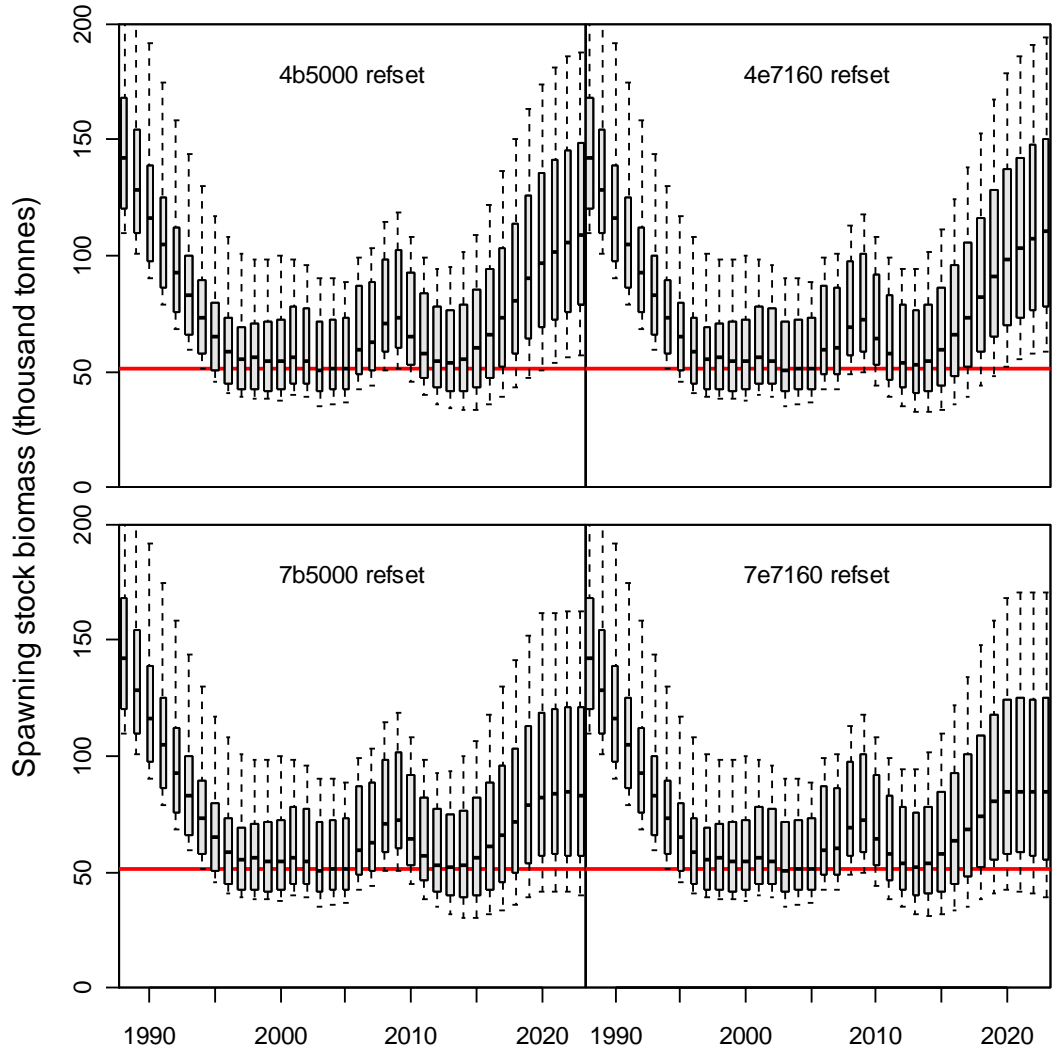
Compare schedules 4b5000, 7b5000, 4e7160, and 7e7160 w ith model refset



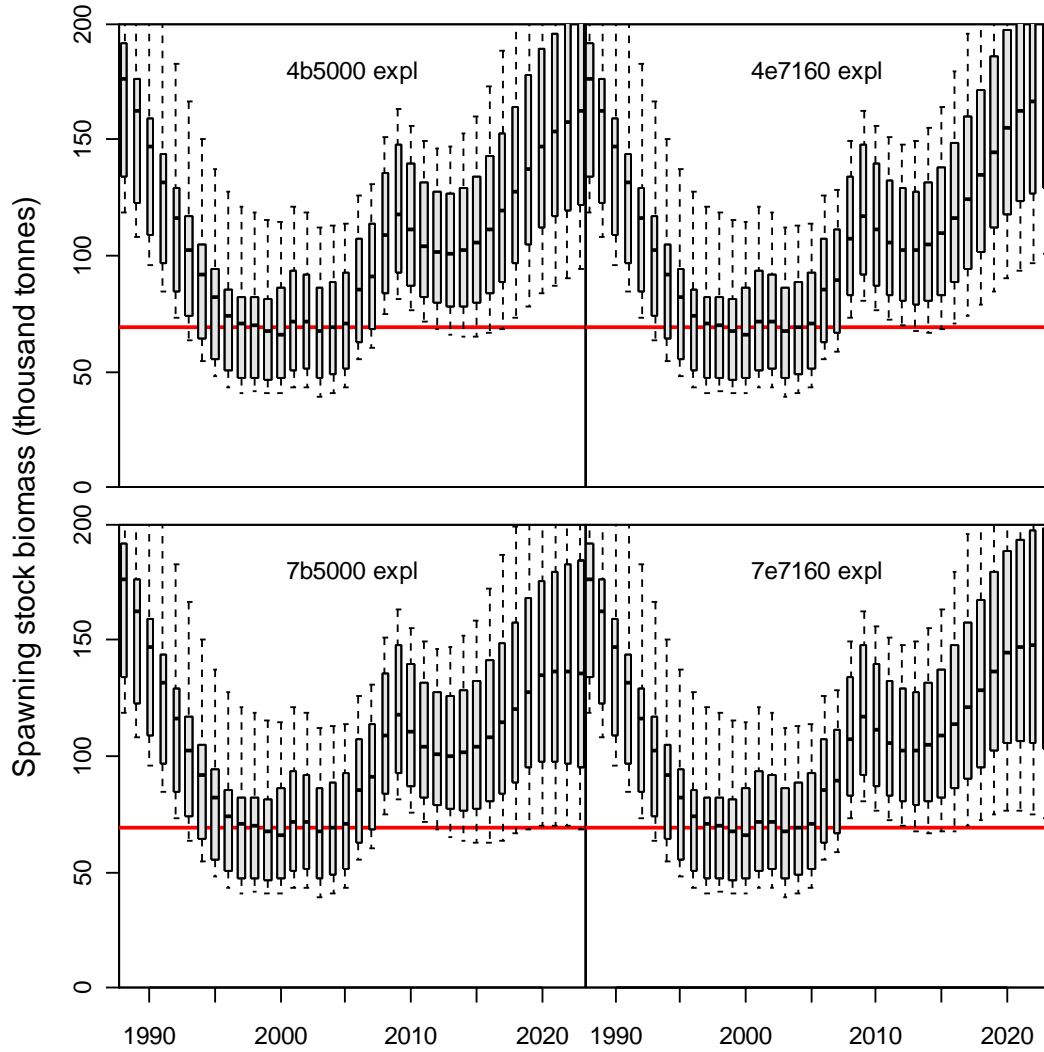
**Figure 9** Comparison of the performance of the two catch schedules under different tuning levels for the recommended management procedure (as noted in the figure title). Please see Table 1 for additional explanation detail on schedules.



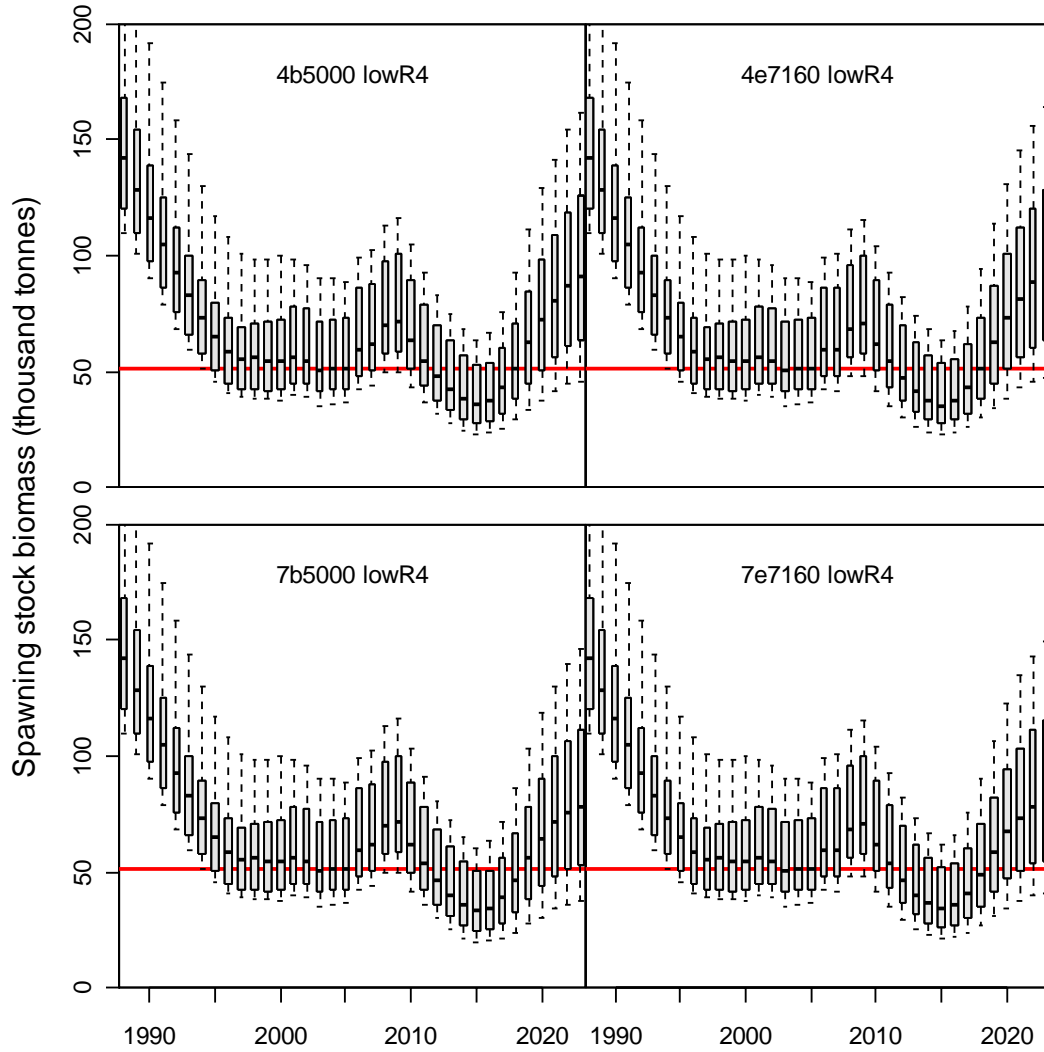
**Figure 10.** Cumulative probability of the spawning biomass ratios of 2022:2004 and 2020:1980 for the two catch schedules under different tuning levels for the recommended management procedure. Please see Table 1 for additional explanation detail on schedules.



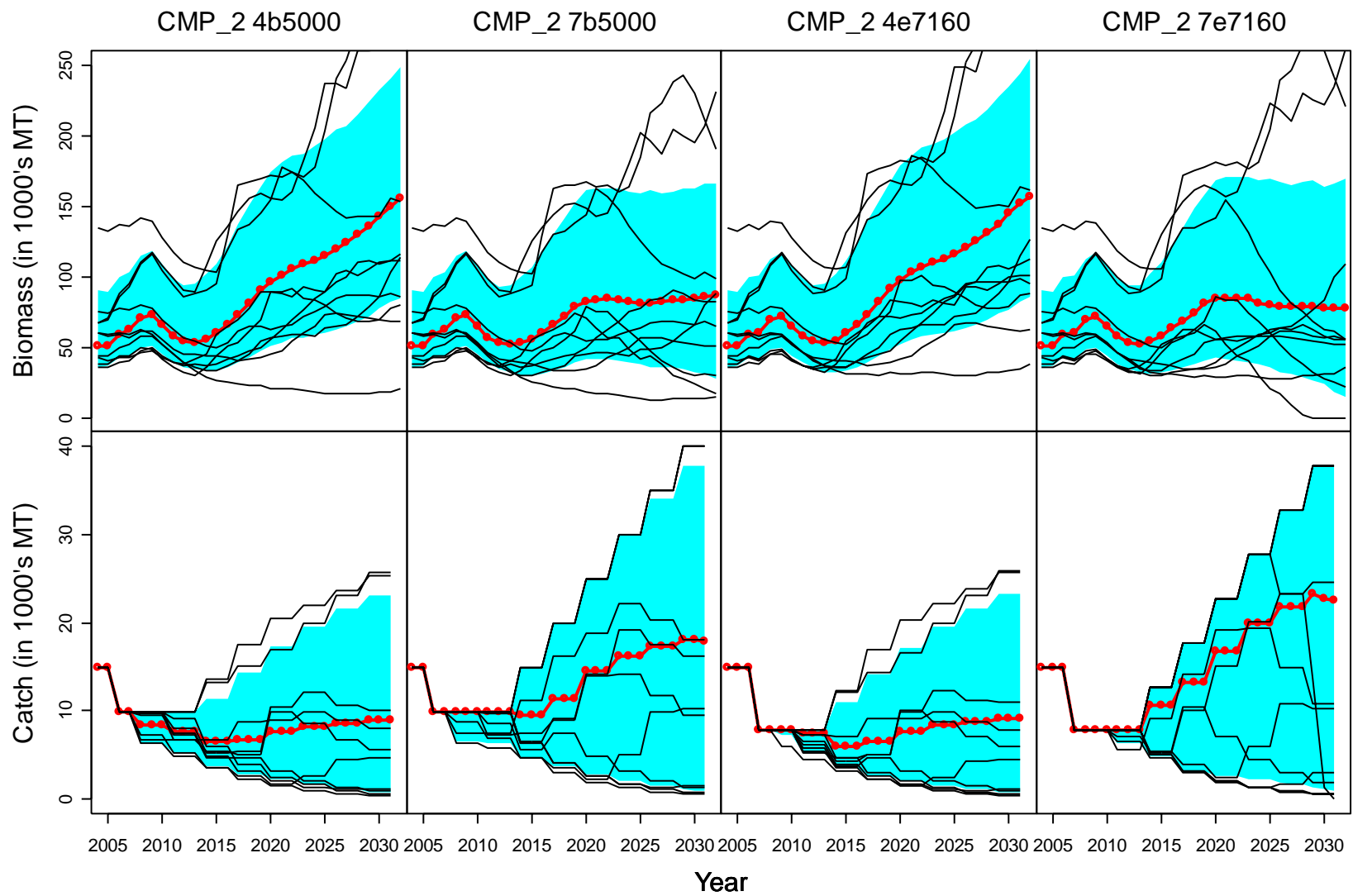
**Figure 11.** Recent past and future spawning biomass under the two catch schedules with different tuning levels for the recommended management procedure. Please see Table 1 for additional explanation detail on schedules.



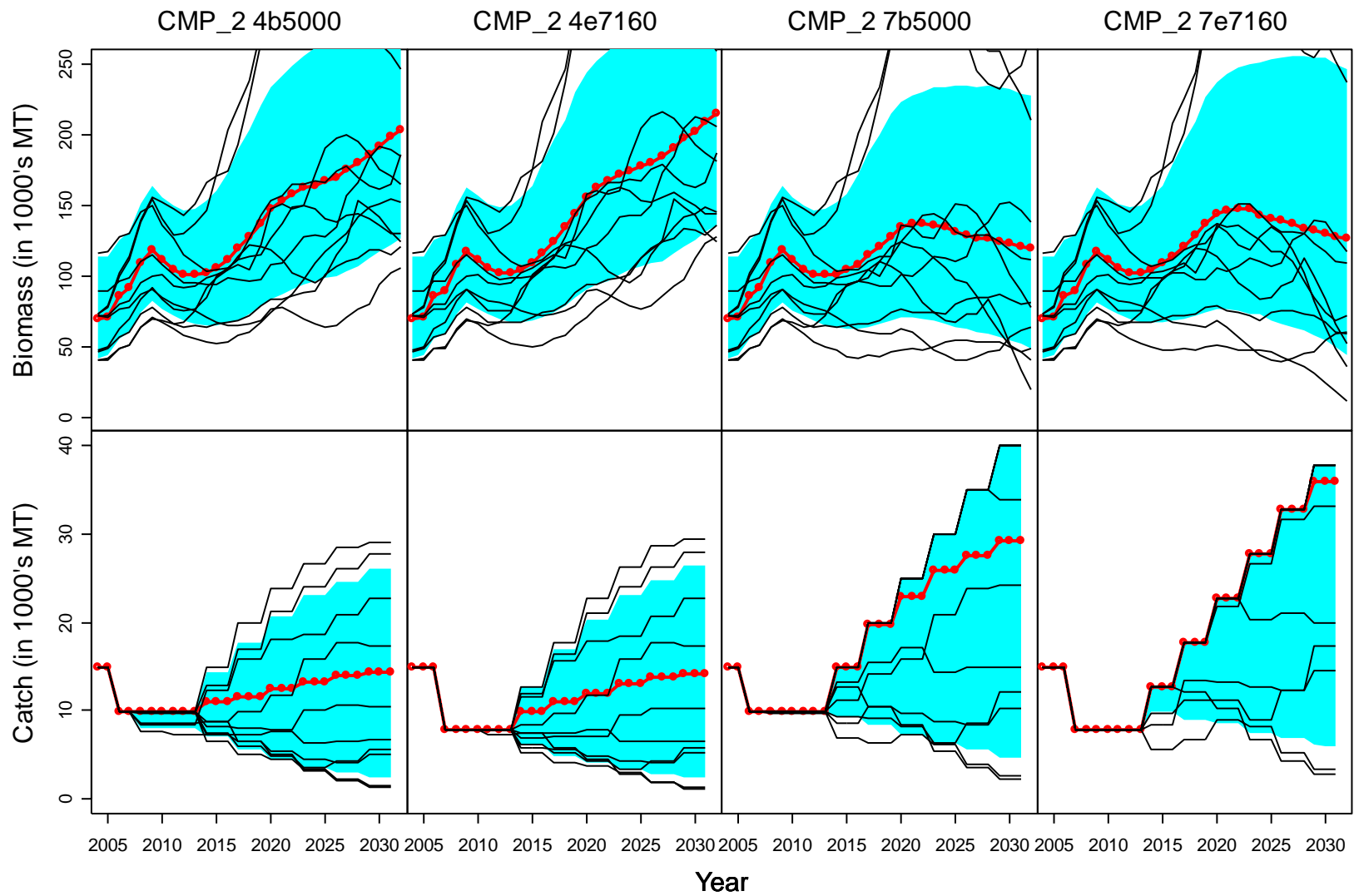
**Figure 12.** As for **Figure 11** but for the expl robustness case, which constrains the surface fishery's exploitation rate to be less than 80% of the average estimated for age 2 and 3 for 1984-1988.



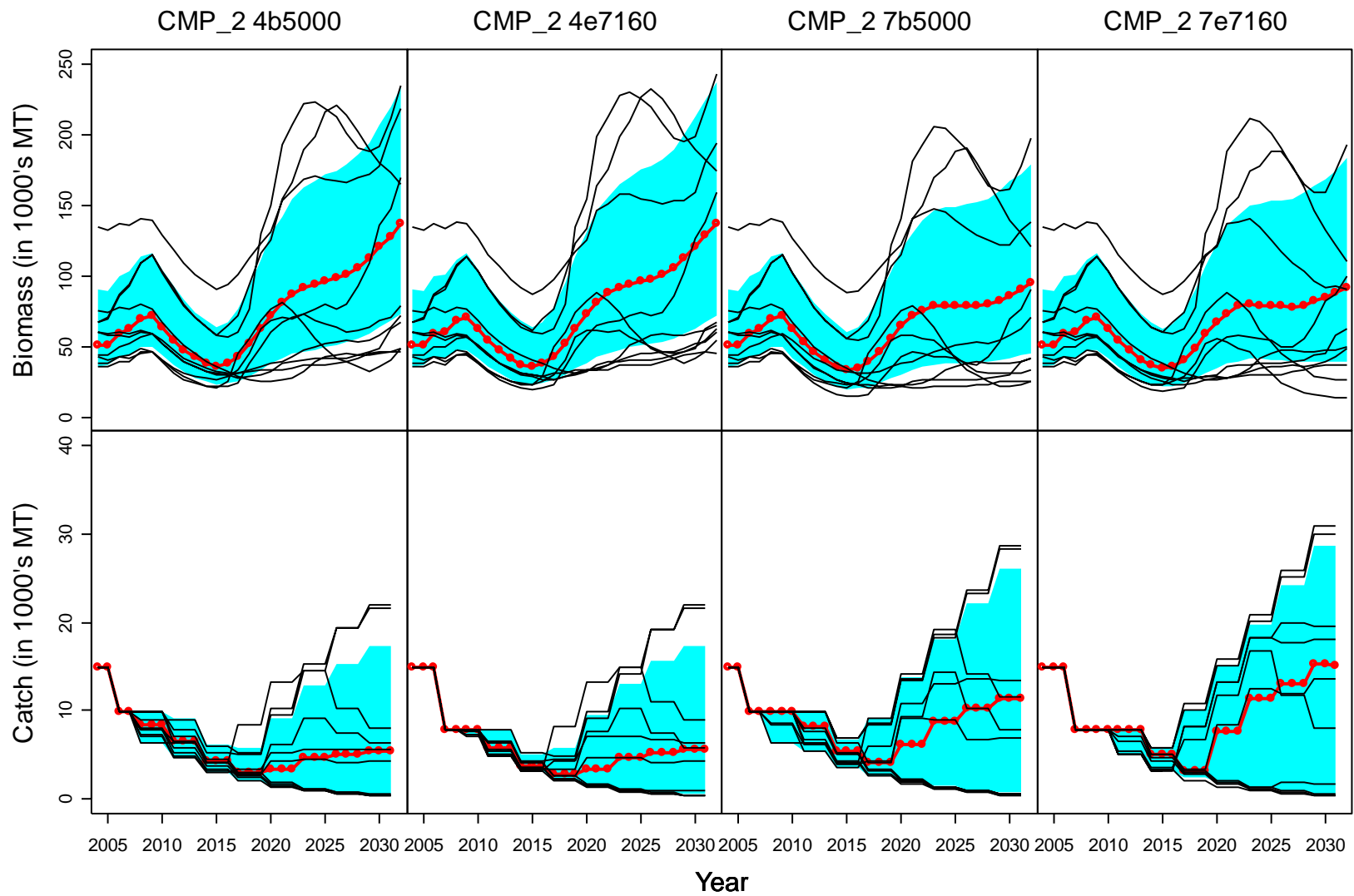
**Figure 13.** As for **Figure 11** but for the lowR4 robustness case (four years of low recruitment subsequent to 2000 and 2001).



**Figure 14** Plots of the spawning biomass and catch for the re-tuned CMP\_2 procedure. The “4” tuning level ensures that there is a 10% probability that  $B_{2022} < B_{2004}$ . The “7” tuning level is the 20% probability that  $B_{2022} < B_{2004}$ . The “e” catch schedule is based on a catch reduction in 2007 that produces an equivalent effect on  $B_{2014}:2004$  to a 5000 t catch reduction in 2006.

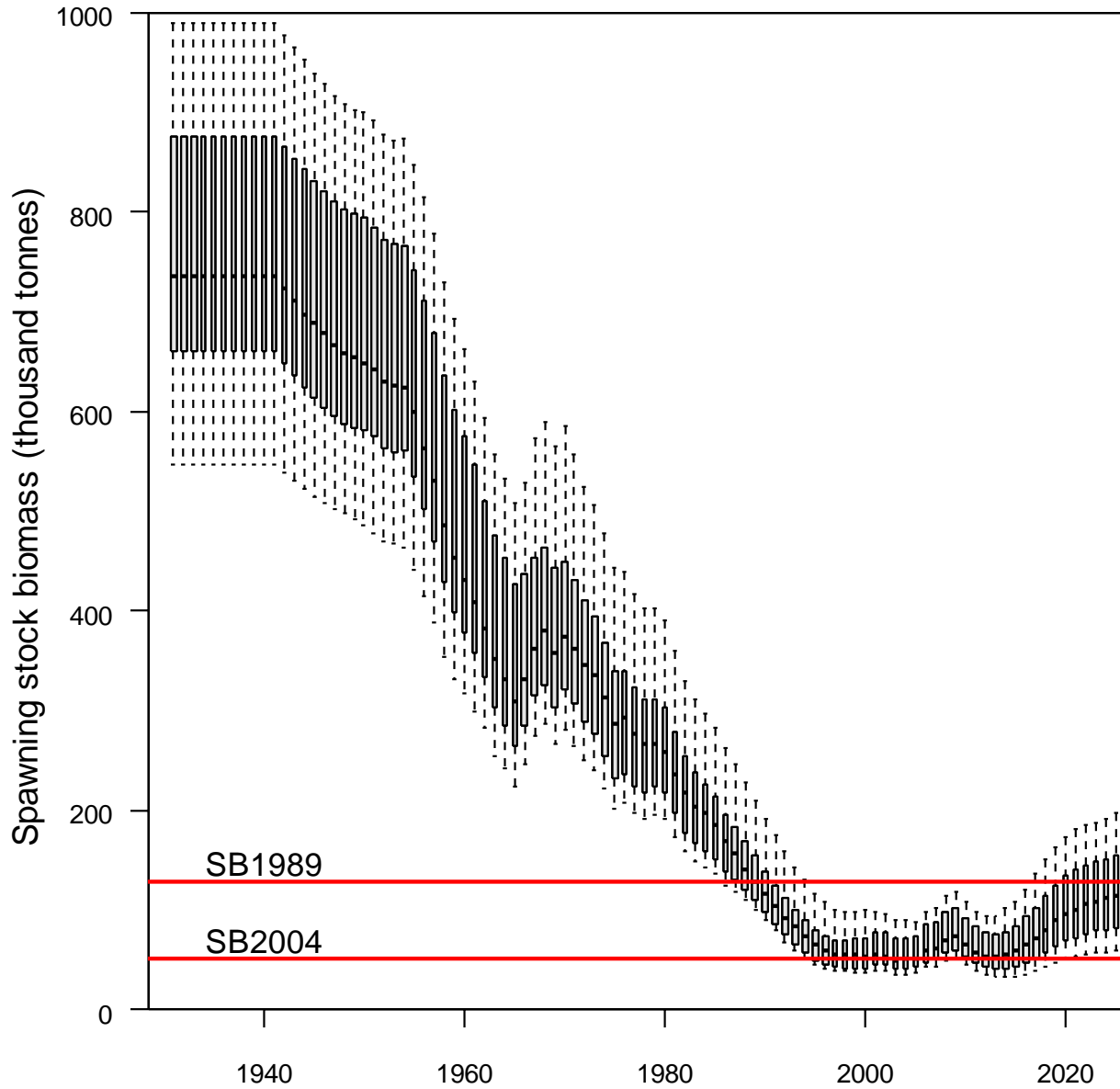


**Figure 15** As for **Figure 14** but for the expl robustness case (surface fishery's exploitation rate constrained to be less than 80% of the average estimated for age 2 and 3 for 1984-1988).

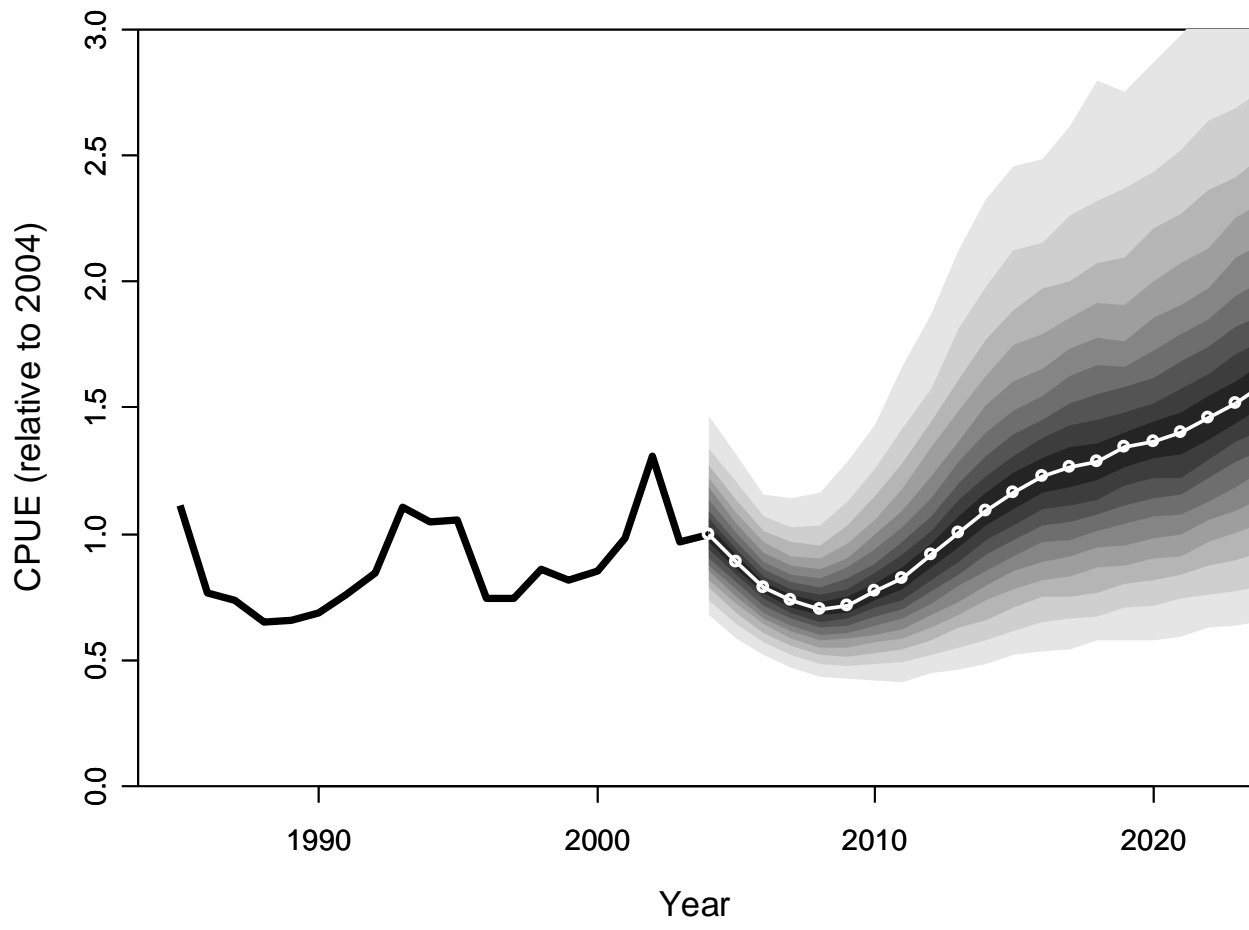


**Figure 16** As for **Figure 14** but for the lowR4 robustness case (four years of low recruitment subsequent to 2000 and 2001).

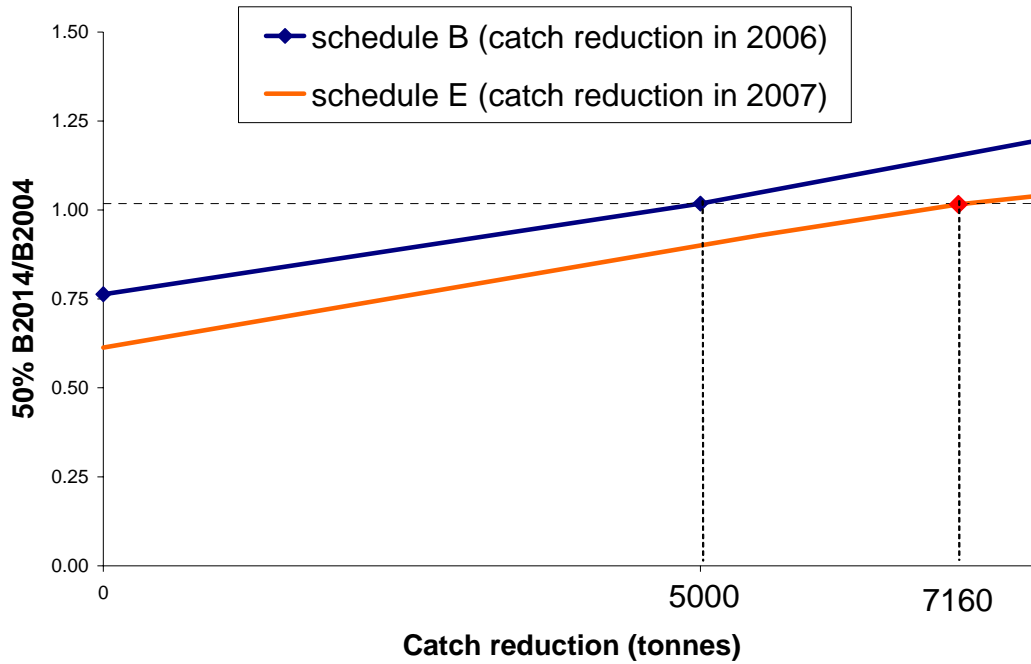




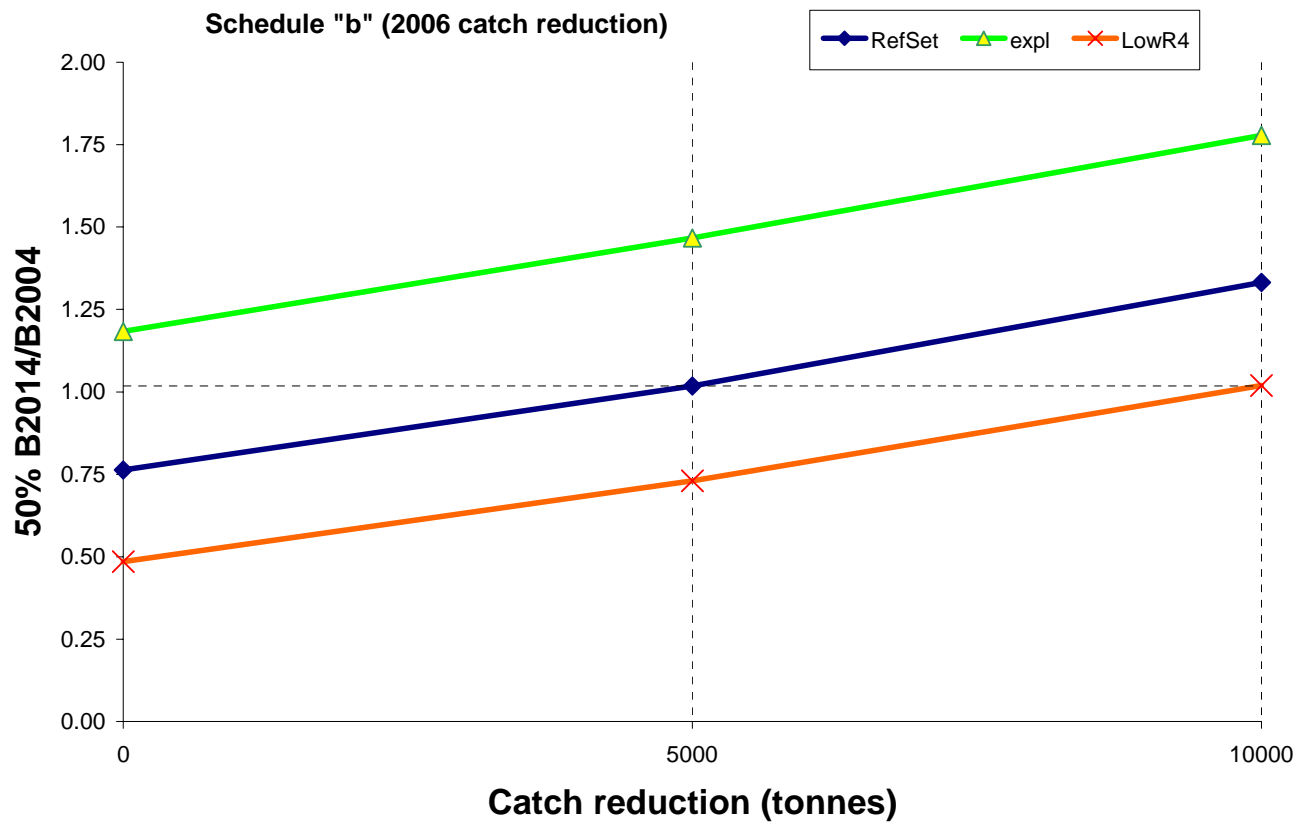
**Figure 17.** Historic and projected spawning biomass under the recommended management procedure with the 4b5000 catch schedule. Lines indicate the median spawning biomass in 1989 and in 2004.



**Figure 18.** Historical (solid line) and projected CPUE (relative to the median value in 2004) for the recommended management procedure with catch schedule 4b and the 5000 t catch reduction below 14930 tonnes (as assumed for 2004 and 2005 in the operating model) in 2006.



**Figure 19.** The effect of different catch reductions followed by the recommended MP for schedule “b” (2006 catch-reduction and CMP\_2 in 2008 and every three years thereafter) and schedule “e” (2007 catch reduction and CMP\_2 in 2009, 2011 and every three years thereafter) on the median of the 2014 biomass relative to 2004 for the reference set.



**Figure 20.** The effect of different catch reductions followed by the recommended MP under schedule “b” (2006 catch-reduction and CMP\_2 in 2008 and every three years thereafter) on the median of the 2014 biomass relative to 2004 for the reference set and robustness trials expl (constraint on the surface fishery’s exploitation rate to be less than 80% of the average estimated for age 2 and 3 for 1984-1988) and LowR4 (four years of low recruitment subsequent to 2000 and 2001).

**Table 11.** Statistics of interest for the reference set. Tuning “4b” parameters were chosen so that there is a 10% probability that  $B_{2022} < B_{2004}$ , “4e” so that the short term risk (2014) was the same as for “4b”, and tuning “7” parameters so that there was a 20% probability that  $B_{2022} < B_{2004}$ . The relevant tuning criteria are denoted in grey.

Model	Schedules	Tuning	Catch reduction (year)		10%-ile	Median	10%-ile	Median	Probability	Median	Median
			2006	2007	$B_{2014:2004}$	$B_{2014:2004}$	$B_{2022:2004}$	$B_{2022:2004}$	$B_{2022}<B_{2004}$	$B_{2020:1980}$	$B_{2022:1989}$
Refset	4b5000	4	5000	0	0.74	1.00	1.02	1.91	0.10	0.37	0.78
Refset	7b5000	7	5000	0	0.69	0.81	0.98	1.50	0.20	0.32	0.61
Refset	4e7160	4	0	7160	0.73	1.03	1.02	1.94	0.09	0.38	0.80
Refset	7e7160	7	0	7160	0.70	0.81	1.00	1.52	0.20	0.32	0.63

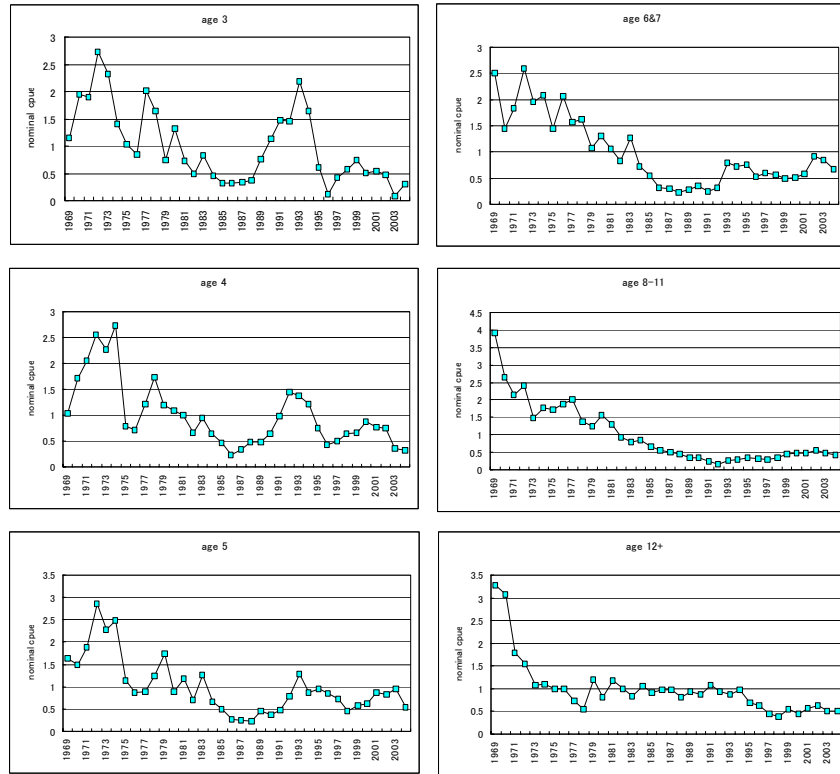
**Table 12** Statistics of interest for the expl and lowR4 robustness cases. Expl places a limit on the maximum exploitation in the surface fishery (80% of the average for age 2 and 3 from 1984-1988), while in lowR4 it is assumed that the low recruitment in 2000 and 2001 continues for an additional four years. Please see Table 1 for additional explanation of the schedules.

Model	Schedules	Tuning	Catch reduction (year)		10%-ile	Median	10%-ile	Median	Probability	Median	Median
			2006	2007	$B_{2014:2004}$	$B_{2014:2004}$	$B_{2022:2004}$	$B_{2022:2004}$	$B_{2022}<B_{2004}$	$B_{2020:1980}$	$B_{2022:1989}$
Expl	4b5000	4	5000	0	1.08	1.26	1.47	2.26	0.04	0.48	1.01
Expl	7b5000	7	5000	0	1.07	1.02	1.45	1.91	0.09	0.44	0.85
Expl	4e7160	4	0	7160	1.10	1.34	1.50	2.40	0.02	0.51	1.06
Expl	7e7160	7	0	7160	1.10	1.10	1.50	2.07	0.07	0.47	0.91
LowR4	4b5000	4	5000	0	0.60	0.84	0.73	1.55	0.17	0.27	0.63
LowR4	7b5000	7	5000	0	0.54	0.72	0.69	1.35	0.27	0.25	0.56
LowR4	4e7160	4	0	7160	0.59	0.87	0.72	1.55	0.15	0.28	0.64
LowR4	7e7160	7	0	7160	0.56	0.80	0.70	1.37	0.22	0.26	0.57

A selection of relevant indicators considered by the CCSBT-SAG

# 1 CPUE trends over time in Japanese longline fishery

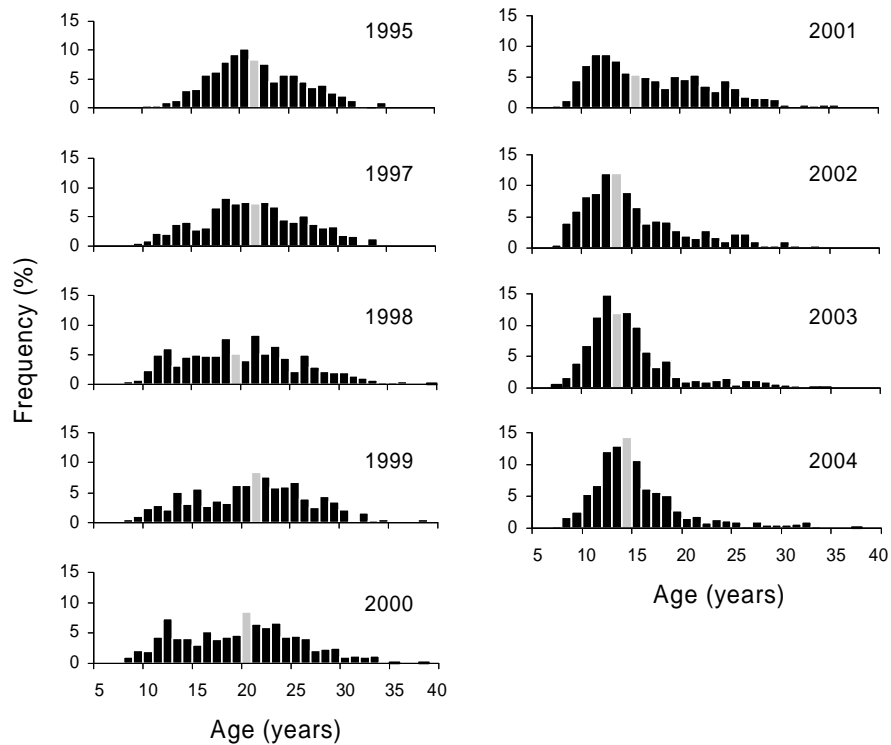
Figure 1. Nominal CPUE from the Japanese longline fishery by age groups.(from CCSBT– ESC/0509/37, Fig 1.1)





#### #4 & #5 Indonesian catch and age composition

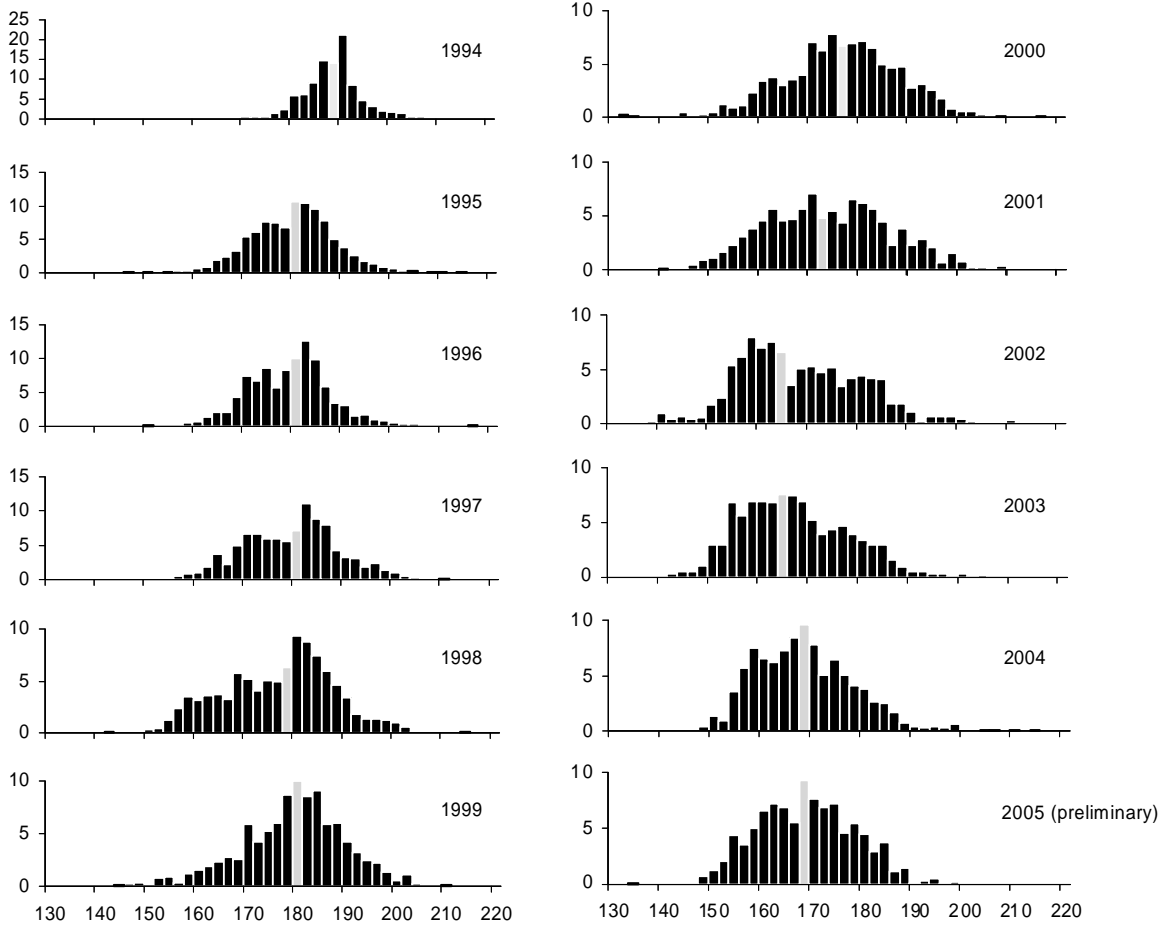
Figure 3. Age distribution (based on direct aging) of SBT by spawning season from the Indonesian spawning grounds longline fishery. A spawning season is defined as July 1 of the previous year to June 30 of the given year. Age could not be assigned to 22 (2%) fish with length measured in the 2002 season. The pale bar represents the median age. (from CCSBT–ESC/0509/25, Fig 25)





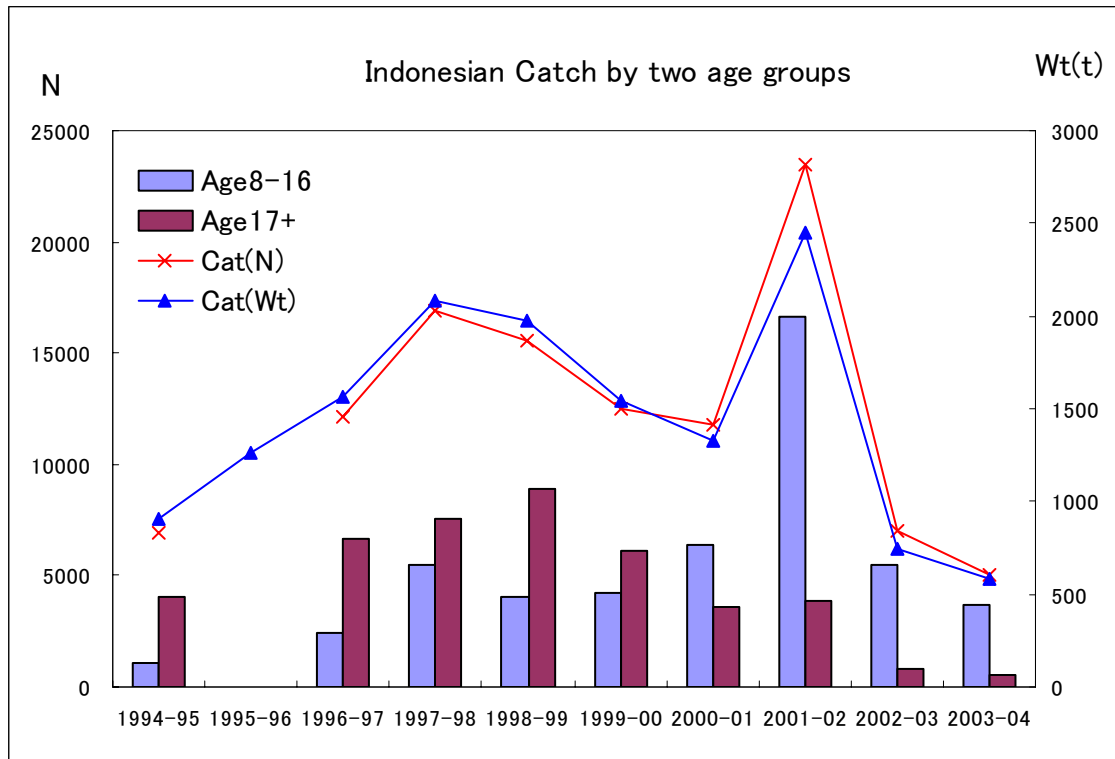
#### #4 & #5 Indonesian catch and age composition

Figure 4. Length frequency (2 cm intervals) of SBT by spawning season from the Indonesian spawning grounds longline fishery. The grey bar shows the median length class. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The pale bar represents the median length. (from CCSBT- ESC/0509/25, Fig 27)



#### #4 & #5 Indonesian catch and age composition

Figure 5. Trends in the Indonesian catch by number and catch by weight for two sets of combined age groups (from CCSBT- ESC/0509/39, Fig 4.1)



## #7 Acoustic estimates of age 1 off Western Australia

Figure 6. Relative values of four abundance indices for age one SBT off southern Western Australia. (from CCSBT- ESC/0509/38, Fig 1).

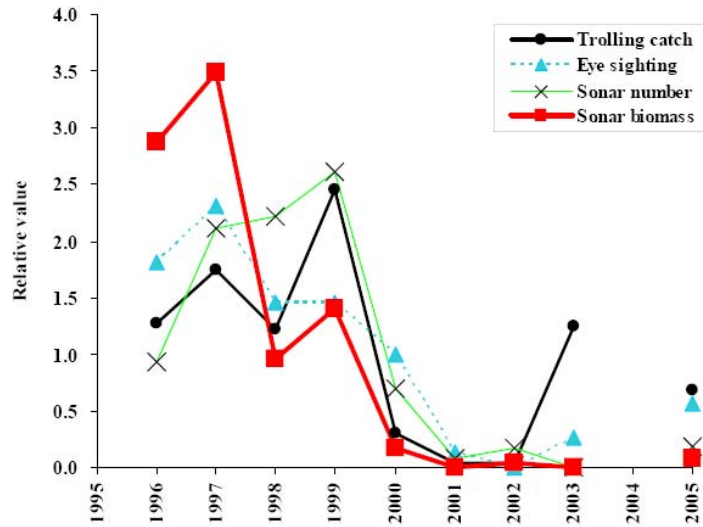
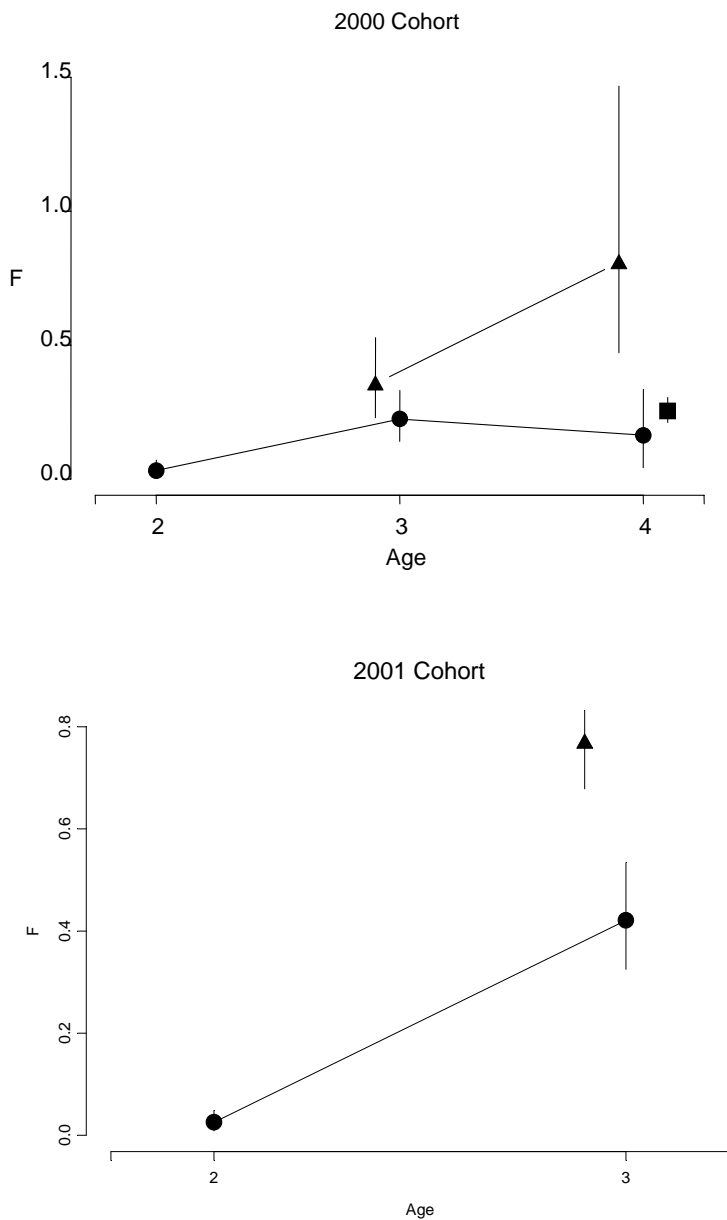


Fig. 1 Relative values of four indices for age one SBT recruitment in southern Western Australia

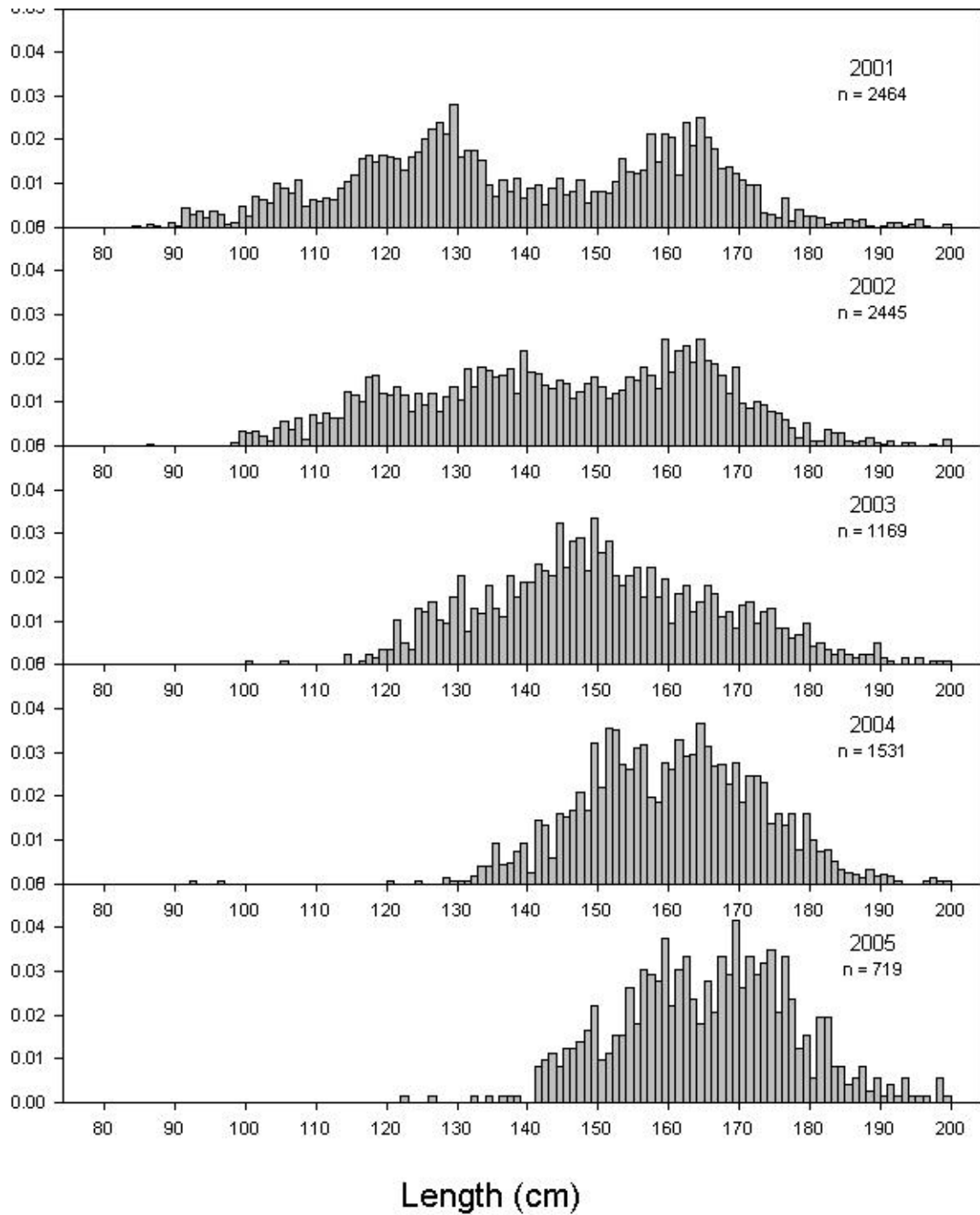
## # 8 Tagging data

Figure 7. Comparison of estimates of age specific mortality rates for different release ages and cohorts for tagger group 1 (defined in CCSBT-ESC/0509/21). All estimates are for natural mortality rate vector 1 and reporting rate option 2 (defined in CCSBT-ESC/0509/21). Circles are for releases at age 1, triangles are for releases at age 2, and squares are for releases at age 3. Note no results are shown for the 1999 cohort as it only had usable estimates for one release year. Error bars are 90% bootstrap confidence intervals conditional on the estimates of mortality, shedding and reporting rates. (from CCSBT-ESC/0509/21, Fig 13)



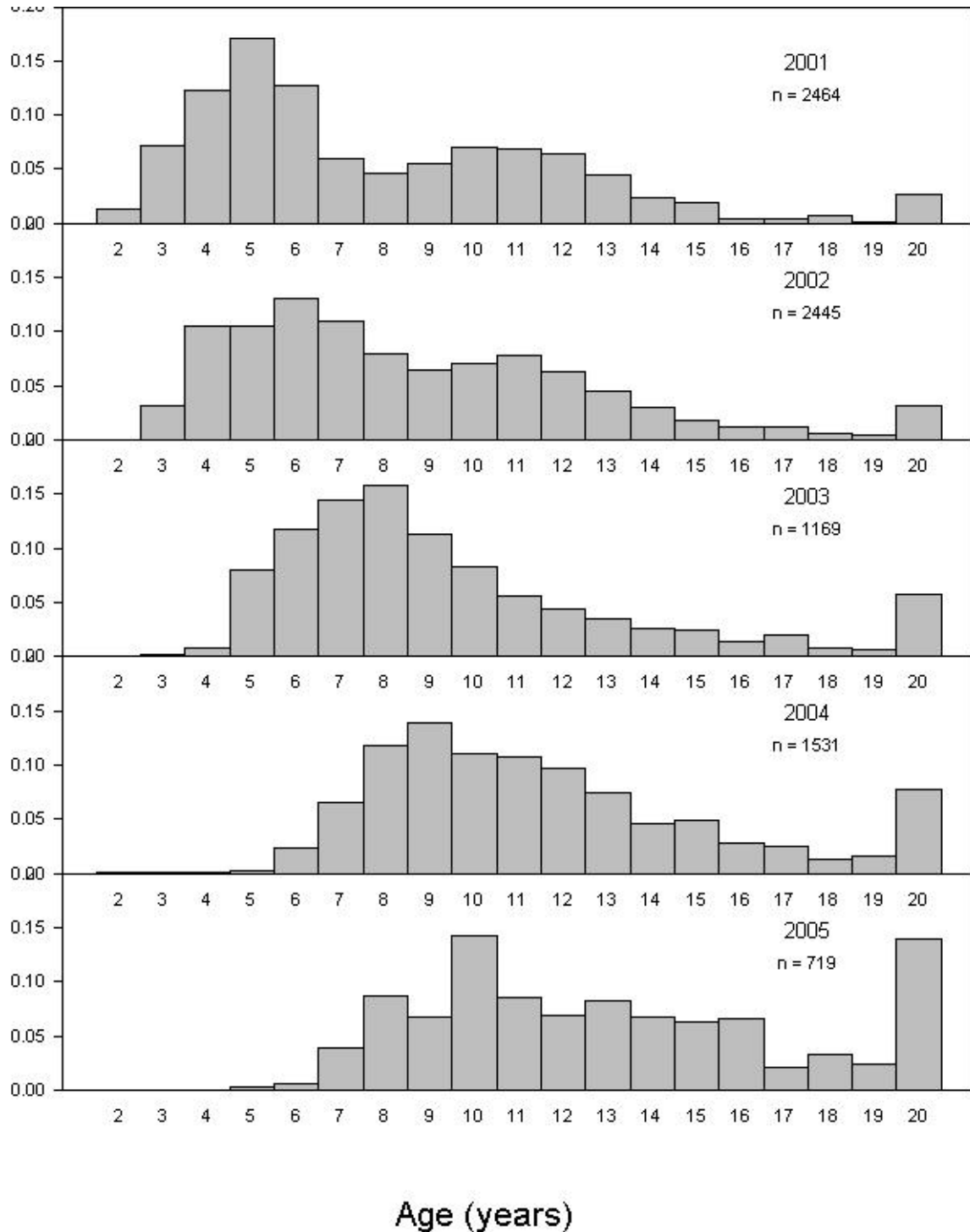
## # 9 Size distribution

Figure 8. Proportion at length of SBT from the New Zealand charter fleet for 2001 to 2005. Data for 2005 is based on about 75% of the catch.



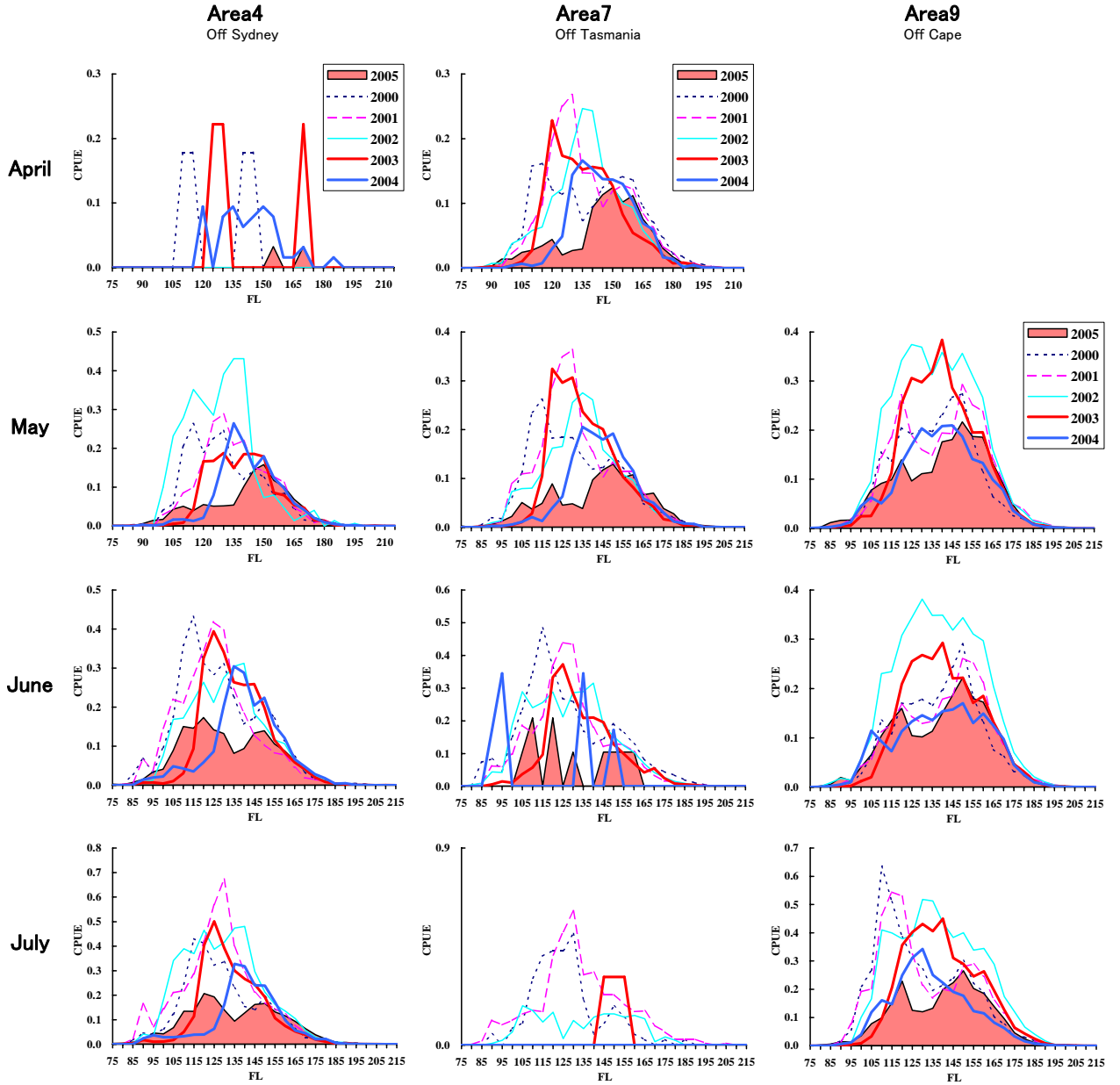
## # 9 Size distribution

Figure 9. Proportion at age of SBT from the New Zealand charter fleet for 2001 to 2005 based on cohort slicing using the SC(2001) growth curve. Data for 2005 is based on about 75% of the catch.



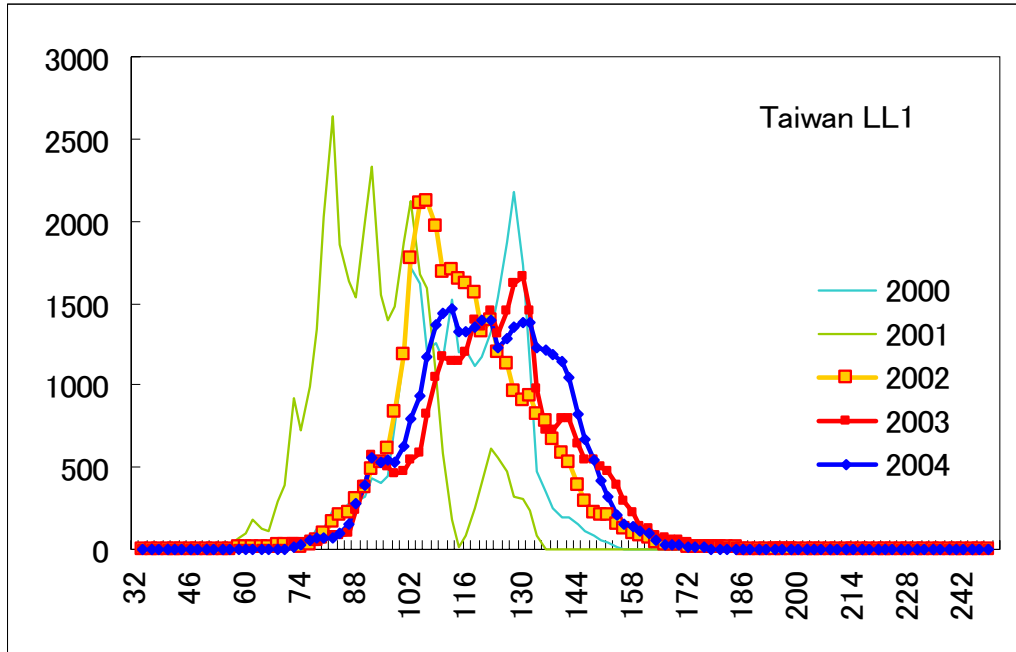
## # 9 Size distribution

Figure 10. Size composition of nominal CPUE of RTMP data for five recent years by month and areas (from CCSBT- ESC/0509/39, Fig 1.4)



## # 9 Size distribution

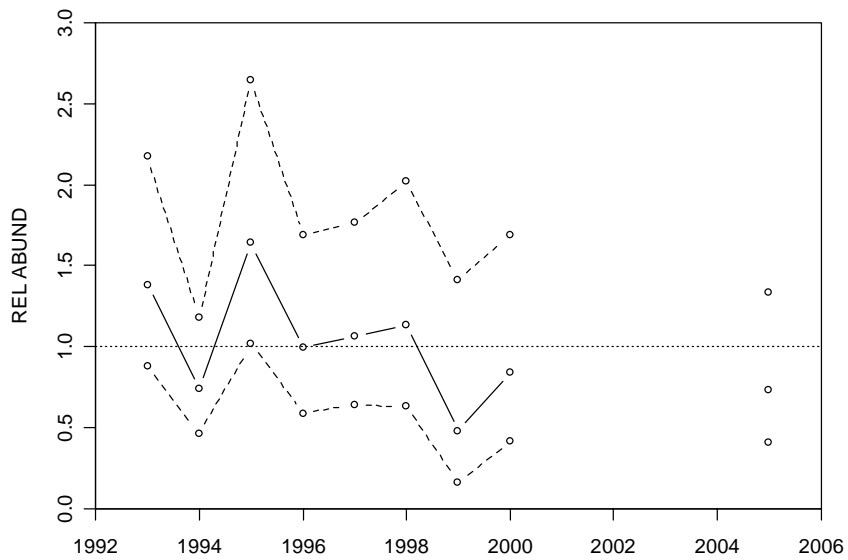
Figure 11. Changes in the size composition of the Taiwanese LL1 fishery. Note: The definition of Taiwanese LL1/LL2 was on targeting/bycatch criteria. It is recommended that the separation should be based on size selectivity and therefore the figure may be revised accordingly. (from CCSBT– ESC/0509/39, Fig 1.7 d)





## #10 GAB aerial survey indices

Figure 12. Time series of relative abundance estimates based on January and February (not March) aerial line transect survey sightings data with 90% confidence intervals. This index is a composite index of primarily ages 2-4 SBT in the Great Australian bight. Surveys were not conducted in 2001-04. (from CCSBT- ESC/0509/22, Fig 6)



## #10 GAB aerial survey indices

Figure 13. Standardized estimates of SAPUE (surface abundance in terms of weight per unit effort) from commercial spotter pilot data for companies 1,3, and 6 in each of the 4 past seasons. The median and exp(predicted value + or - 2 standard deviations) are shown. (from Basson and Farley 2005). This index is a composite index of primarily ages 2-4 SBT in the Great Australian Bight. (from CCSBT- ESC/0509/25, Fig 31)

