Commission for the Conservation of
Southern Bluefin Tuna

みなみまぐろ保存委員会

Report of the Ninth Meeting of the Stock Assessment Group and Fifth Meeting of the Management Procedure Workshop

2 - 10 September 2008
Rotorua, New Zealand

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Agenda Item 1. Opening

1.1 Introduction of participants and administrative matters

1. The Independent Chair, Dr. Joseph Powers, opened the meeting and welcomed participants.
2. Participants were introduced and the list of participants is at **Attachment 1**.

Agenda Item 2. Appointment of rapporteurs

3. Australia, Japan and New Zealand assigned rapporteurs to produce and review the text of the substantive agenda items.

Agenda Item 3. Terms of reference and 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. CPUE modelling work

5.1 CPUE Working Group report

7. CCSBT-ESC/0809/09 was presented. This report summarises the analyses and recommendations from a series of seven web meetings held by the CPUE Working Group. After discussing paper CCSBT-ESC/0809/09 and the report of the CPUE Working Group (see **Attachment 4**) the SAG made the following recommendations:

    - That the two proposed series (**Attachment 5**) be adopted for use in 2008 conditioning of the operating model (OM) (CCSBT-ESC/0809/09 Figure 7).

- The Working Group should consider the effect of the market anomalies on longline CPUE. There has been no appreciable progress in analyses or further data provided to assist in building a CPUE series.
- Further consideration should be given to the appropriate incorporation of potential sources of sampling and process error that may improve the characterisation of uncertainty in the relationship between CPUE and abundance.
- The 2007 CPUE estimate not be included in the series used in conditioning the OM in 2008, given the potential uncertainties due to changes in the TAC, IQs and targeting that have occurred commencing 2006.
- The performance and behaviour of the series needs to be monitored closely into the future, with particular attention to be paid to relevant analyses of shot by shot and bycatch data which nevertheless retain their confidentiality. Further joint analyses of these data will be specified by the CPUE Working Group and included in the 2009 work program. Continued efforts to be made to respect confidentiality issues but enable joint analyses to occur, e.g. CPUE Modelling Group.
- Discussions on the alternative approaches to the calibration of the pre and post 1986 CPUE series be continued.
- Hooks per basket, main line material and configuration, and other information on changes in fishing practices (e.g. gear characteristics) should be monitored for changes in fishing behaviour.
- Further work should be conducted to find better ways to account for the effects of targeting on CPUE.

8. The work proposed above will be facilitated by three intersessional web meetings.

5.2 Selection of CPUE time series

9. CCSBT-ESC/0809/19 was presented. The paper focused on the choice and use of the historical CPUE series and the issues associated with using it as an index of abundance. Revelations of large market anomalies had substantially undermined the confidence of the Scientific Committee and Commission in the use of longline CPUE as: i) the primary index of stock abundance for conditioning the OM and ii) a data input into any Management Procedure (MP) adopted by the Commission. In light of these issues a summary of data and information requirements to improve evaluation of implications of unreported catches agreed by the ESC was provided (Table 1, CCSBT-ESC/0809/19) and comments on the implications for future development and evaluations of MPs for SBT were made. The paper concludes that the ESC has little substantive data, or information, on which to provide improved evidence-based advice on the impacts of the unreported catches on CPUE beyond those provided in 2006. The paper recommended: i) that alternative approaches to the provision of management advice in the short-term, and development and evaluation of MPs in the medium-term, based on fisheries-independent data be pursued, and: ii) that this be done in conjunction with the development and

implementation of systems which would lead to reliable and verifiable CPUE data in future.

10. Notwithstanding these conclusions, the paper recognises the utility of both historical and future catch and effort data and provides a summary of a range of issues that need to be considered in the future use of CPUE. These include:

    - the potential for range contraction of the stock and reduction in the area fished by the fishing fleets;
    - distinguishing targeting practices and potential changes over time;
    - the development of new, more appropriate statistical approaches and software for CPUE standardisation;
    - the impacts of changes in management arrangements and operational and market conditions on fishing practices; and
    - the need to continue to take account of model uncertainty associated with the use of CPUE. This has previously been incorporated through the use of multiple CPUE series derived using alternative models with different underlying assumptions about the relationship between CPUE and overall stock abundance.

11. In light of these issues, paper CCSBT-ESC/0809/19 recommends that CPUE should be used as an index of local stock density, instead of total stock abundance as has been the case in the past. Such CPUE should be used in combination with other indicators in future MPs, rather than the only or primary index of abundance. It also emphasises the continued need for implementation of monitoring and verification systems to provide accurate catch and effort data for future use.

12. The SAG noted that there is still value in using CPUE data in conditioning the OM and providing a vehicle for evaluating likely MPs. In doing so, it will be important to capture the full uncertainty in the relationship between CPUE and abundance. The SAG agreed that this will be done by including a range of scenarios used to incorporate the effects of the unreported catches and using sensitivity trials incorporating the previous five CPUE series. However, it would be remiss of the SAG to proceed with MPs based solely on CPUE indices. The SAG noted the need to emphasize the requirement for fishery-independent data, such as recruitment monitoring and tag-based estimates, to provide more confidence in the CPUE series in the future and, potentially, a basis for non-CPUE based indices and alternative MPs.

13. CCSBT-ESC/0809/37 was presented. This paper shows the change in operation pattern of Japanese SBT longliners in 2007 resulting from the introduction of the individual quota system for individual fishing vessels in 2006. While the number of operations per 5x5 degree square in a month decreased to 39.9% of the 2001-2005 average, the spatio-temporal range covered in 2007 remained similar to that in 2006. It noted that changes observed in 2007 were due not only to the change of the fishery regulation system but also to changes in the SBT stock and complex socio-economical factors.

14. The SAG noted that these issues need to be taken into consideration in calculating and evaluating Japanese longline (LL1) CPUE series. The SAG discussed the

15. The SAG noted the changes in size composition of fish caught by the LL1 fleet through time shown in CCSBT-ESC/0809/37. These changes were considered by the author to be related to a change in the length frequency distribution of the stock rather than a change in the spatial distribution of fishing effort.

16. CCSBT-ESC/0809/38 was presented. This paper provides detail on scientific observer coverage by time and area, and length frequency comparisons between observed and non-observed operations. The paper also considered the difference between non-fisher observers and ex-fisher observers and concluded that there was no substantial difference between nominal CPUE for these two types of scientific observers. However, it was noted by some participants that there was a statistically significant observer effect within the model (Table 4 of paper CCSBT-ESC/0809/38).

17. The question was raised about how the set of observed vessels compared to the core fleet. The SAG noted the importance of determining what proportion of the core fleet was observed in the past and how this changes with time.

18. The SAG was advised that from 2007 onwards longline shots that do not catch SBT are not required to be reported in the RTMP data due to changes in reporting arrangements. However, these new reporting requirements do not affect the logbook data, which continue to report zero catches. The group noted that an analysis of the trend in the number of zeros over time would give an indication of the magnitude of the effect of this change in reporting on the CPUE analyses and the extent to which there may be a trend with the magnitude of CPUE. The SAG noted that a decision would need to be made as to whether RTMP data would be included in the OM (so there would be data input to the model for the most recent year). If RTMP data for the most recent year were included, a correction would be needed to account for the proportion of zero shots. It was agreed that this should be considered by the CPUE Modelling Group and reported back to the SAG.

5.3 Implications for conditioning of operating model

19. The SAG agreed that the two CPUE series recommended by the CPUE Working Group be used in the conditioning of the OM. The SAG discussed the issues associated with including the 2007 data point in the CPUE series, given the lack of

reporting on null SBT sets in the RTMP data in 2007 and agreed not to include 2007 and 2008 RTMP data for the conditioning of the OM.

20. The SAG noted that the range of market anomaly assumptions with respect to CPUE and reported catch scenarios previously used to condition the OM would be applied to the new CPUE series.

Agenda Item 6. Basis for providing management advice in 2008-09

6.1 Using indicators for basis of management advice

21. CCSBT-ESC/0809/30 was presented. It was noted that this paper should be considered in conjunction with the issues identified in CCSBT-ESC/0809/19. The paper proposes a shift away from relying on catch and CPUE as the primary inputs in an MP, and the development and testing of MPs using indicators based on fisheries-independent data. The paper addresses two pressing issues for the SAG, ESC and Commission: i) the basis for short-term management advice, and ii) alternative approaches to the development and testing of MPs. One of the main reasons for this suggested shift in focus are concerns about the scientific credibility of work based on the catch (and associated CPUE) scenarios and the lack of the required information on the characteristics of the unreported catches (see CCSBT-ESC/0809/19).

22. The first section of the paper describes the rationale for adopting an alternative approach (to constant catch projections based on a reconditioned OM) to providing short-term management advice in light of the historically low level of the spawning biomass, recent low recruitments and large uncertainty in the impacts of the unreported catches on the LL1 catch and effort data. The general form of a suggested decision rule is given below:

Catch in year$_{(t+1)}$ = Catch in year$_{(t)}$[1] , unless:

- one or more indicator shows a decline or has a value below a pre-agreed level (‘reference point’) in which case the recommended catch should be decreased, or;
- if all indicators have values above some pre-agreed level (or ‘reference point’) or show increases, then an increase in catch can be considered though unless a rebuilding target has been reached, this will reduce the speed of rebuilding and imply a higher risk to the stock.

23. The second part of CCSBT-ESC/0809/30 outlined an approach to the development and testing of a MP based on fisheries independent data, largely focussed on different tagging approaches.

24. The paper acknowledges that there would be important issues that would need to be resolved and time involved in developing and evaluating this form of MP. Not the least of these would be the development and conditioning of an appropriate testing framework, which would necessarily be spatial. However, this would be likely to result in a more robust MP.

[1] where Catch is assumed to be equal to the TAC

25. The SAG supported the concept for broadening future decision rules in the MP to include other indicators and to further discuss how these may be used in conjunction with CPUE.

26. The SAG discussed improving the existing OM by including some of the available indicators. It was agreed that a small set of indicators is preferred to many.

27. A new MP was not expected to be able to be developed, tested in a conditioned OM and adopted before the 2010 meeting. Some participants questioned the need to test an empirical decision rule for use in the immediate future if it was designed to be appropriately conservative.

28. The management advice that the ESC in 2007 agreed to provide in 2009 is constant catch projections run on a conditioned OM. The amount of work required to make modifications to the existing OM to include some indicators was discussed, and was considered feasible.

Review of Indicators

29. The summary papers on the indicators were presented (CCSBT-ESC/0809/16 and 36), followed by presentations of individual papers on details of the indicators, methods and results.

30. Paper CCSBT-ESC/0809/16 summarises recent trends and cohort strength for the set of indicators that are considered to be unaffected by the unreported catch issues identified in the Japanese Market Review and Australian Farm Review. The unaffected indicators include: 1) aerial survey index, 2) commercial spotting (SAPUE) index, 3) conventional tagging estimates of fishing mortality and indirect archival tag information on return rates, 4) acoustic survey and trolling index, 5) NZ Joint Venture and domestic CPUE, 6) Indonesian high school observers' CPUE, 7) Catch at size and age from NZ fisheries, 8) Indonesian spawning ground age and size composition, and 9) Indonesian total catch.

31. The interpretation of the indicators provided by CCSBT-ESC/0809/16 is that there have been 2-5 very weak cohorts in 1999-2003. Subsequent cohorts may be stronger, but still appear to be weak when compared with the cohorts in the mid 1990s. There is limited information on the trends for fish fully recruited to the fishery and for the spawning components of the stock, but what is available suggests little change in recent years. These results do not differ markedly from 2007.

32. Paper CCSBT-ESC/0809/36 also presents a summary of the fisheries indicators. The Japanese longline fishery CPUE indicators generally supported a view that current stock levels for 4, 5, 6 & 7 age classes are the same as, or lower than, those observed in the late 1980s, which are the historically lowest levels. When looking at the most recent six years, the indices for these age classes show steadily declining trends. Other age classes (3, 8-11, and 12+) tend to increase or stay at the same level after 2003. Current stock levels for these age groups, however, are still at low levels similar to those observed in the recent past. Many indicators suggest some recent low recruitments but differ in indication of how low they were. The acoustic indices suggest continuous low recruitments for six years (1999-2002 cohorts, 2004 and

2005 cohorts). The longline fishery-related indicators similarly suggest low recruitments in 1999, 2000, 2001, and 2002 cohorts. However, the troll survey provides more optimistic results which suggest increases in recruitment for the most recent three cohorts. Indices on spawning stock are difficult to interpret and thus no specific conclusion was drawn.

33. The details of the methods and results for each of the indicators were presented and discussed. These are summarised below.

Scientific Aerial Survey

34. CCSBT-ESC/0809/24 provides an update on the scientific aerial survey for juvenile SBT in the Great Australian Bight (GAB). Table 1 of the document gives a summary of the search effort and sightings data for all years of the survey. While total search effort declined steadily from 1994 to 2007, it increased in 2008 due primarily to good weather conditions in March. The sightings rate was among the highest of all survey years, but the average patch (i.e. school) size was the lowest. The methods used to estimate the relative index of juvenile abundance were updated from the previous year to include some random effects, which can better handle year/month/area combinations where there was little or no sampling effort. The point estimates obtained using the random effects model are similar to those obtained using the previous fixed effects model, but the precision achieved for most estimates is higher. The point estimate for 2008 is higher than the estimates for 2005 to 2007, but remains appreciably below the average level in the mid-1990s. Furthermore, the 90% confidence interval on the 2008 estimate overlaps with the confidence intervals for the 2005 to 2007 estimates, so the increase cannot be considered statistically significant.

35. In discussion of the scientific aerial survey index, it was clarified that the aerial survey provides a relative biomass index, and is calculated from estimates of school biomass not numbers of fish.

36. The SAG noted that the spatial distribution of the scientific aerial survey is much broader than the area fished in the GAB and also much broader than the commercial spotting survey area (see Fig 1 of paper CCSBT-ESC/0809/25).

37. There was a request for the authors to check the model diagnostics to examine whether there were systematic trends in factors treated as random effects, and to check if covariance estimates are small.

38. The reliability and regularity of the aerial survey relative abundance estimates was raised in the context of earlier (1990s) concerns about the aerial survey methods and analysis. The authors expressed confidence that the design, field logistics and analysis methods are stable and sound. The question of the proportion of the population in the GAB remains unresolved. A future concern is the potential for changes in spotters and the reduction from two spotters to one on each plane Additional work has been carried out to address these issues. Nevertheless, given the importance of this work for the assessment of the status of the stock and in the ESC's work, it is a high priority item.

39. The question was raised of whether the commercial spotting index and the scientific aerial survey index could be combined. It was explained that there are substantial differences between the area and nature of the aerial survey and commercial spotting operations. The aerial survey is broad, and designed to cover the whole GAB, whereas the commercial spotters' index is focused on a smaller area where catches are taken. Notwithstanding this, it is useful to be able to compare the two indices, though still keeping them quite separate. Paper 30 shows the two indices scaled to the same level. While there is close agreement in the trend of the two indices, it is important to recall that the period of overlap is relatively short and stable, so that it is too early to judge how the two series will behave under future changes in abundance of juveniles in the GAB. The SAG confirmed that the scientific aerial survey index is preferred over the commercial spotting index.

40. In response to a question about the possibility of obtaining abundance estimates in absolute terms, rather than as a relative index only, from the scientific aerial survey, advice was given that more work would first be required on potential bias in estimation of school size and age composition, and on analyses of archival tag data to estimate the proportion of time a tuna was sightable from the air.

Conventional tagging estimates of fishing mortality

41. CCSBT-ESC/0709/22 presents an updated analysis of the release and recapture data from the CCSBT SRP tagging program. A tag attrition model was again 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 latter three derived from separate analyses). The results continue to show very high estimates of fishing mortality rates for ages 3 and above (many over 0.5) over the past four years based on fish tagged at age 2 and older, although the age 3 estimate for 2007 is somewhat lower (0.26). The same general results hold true for a range of alternative reporting rate vectors and natural mortality rate vectors. Comparison with fishing mortality estimates obtained from the 1990s RMP tagging data indicates that the fishing mortality on tagged fish has increased substantially. Even the age 3 estimate for 2007 remains above levels experienced in the 1990s.

42. Also noted in CCSBT-ESC/0709/22 is that there continues to be a marked lack of returns, and thus lower estimates of fishing mortality, from fish tagged at age 1 compared to those tagged at ages 2 and above. This phenomenon was not observed in the tag returns from the 1990s releases, and suggests that 1-year-old fish found in WA (where the majority of age 1 fish are tagged) are no longer entering the GAB in substantial numbers in subsequent years. It appears that these same 1-year-old fish may not be entering the longline fisheries either. Furthermore, the longline returns continue to show a much smaller percentage of tagged fish moving into the Tasman Sea in recent years compared to the 1990s. These spatial changes have now been observed in five consecutive years of release and recapture data, suggesting that they are not simply outliers.

43. The SAG discussed potential hypotheses for the spatial changes since the 1990s that have been observed in the last five years. These include: 1) that the distribution and movement of tagged one year old fish have changed, or 2) there has been extremely

high natural mortality that has changed since the 1990s tagging. It is not possible to discern whether tag recaptures from the longline fishery are down because there are no estimates of reporting rates for the longline fishery.

44. Differences between F’s presented in paper 22 and 36 were noted. The F calculations in paper 36 were derived from a simplified analysis, and do not consider reporting rates.

45. It was suggested that average fishing mortality by year and age could be useful if considered as an index of effort and then used to calculate a relative abundance index (CPUE) by applying these F’s to the catch in the surface fishery. This would make it easier to compare with other indices for these age classes. The idea was suggested for further consideration.

46. The high F’s from these analyses were discussed. The possibility of effects from site fidelity and emigration were suggested for further consideration.

Reporting rates

47. CCSBT-ESC/0809/21 provides updated estimates of the tag reporting rate for the Australian surface fishery for 2003 to 2007 based on tag seeding experiments. Analyses of the data, which incorporates tag shedding estimates and variances, indicate that reporting rates decreased substantially from 64.0% in 2003 to 30.3% in 2006, then increased to 42.5% in 2007. The CVs range from 7.3% to 17.8%. The estimate for 2006 excluded data from an inexperienced tagger with a very low return rate, suspected to be due to high levels of dependent tag shedding. Dependent tag shedding is a potential factor that would downward bias the reporting rate estimates, and an experimental design that allows for testing of this is outlined. Given the importance of the reporting rate estimates in interpreting results from the analyses of fishing mortality rates (document CCSBT-ESC/0809/22), a range of alternative reporting rate vectors are provided for robustness testing. Three of these are based on the tag seeding data, and two are based on return rates of wild tagged fish that were found during the 40-fish sampling and then re-released into the farm cages.

Trolling survey

48. The results of the trolling survey off Western Australia for age one SBT in 2007/2008 were presented in CCSBT-ESC/0809/41. In January 2008, the trolling research survey was carried out for 13 days by chartering an Australian vessel and the straight research line (piston line) off Bremer Bay was repeatedly surveyed for five days. The adjacent area of the piston-line and the area between Esperance and Albany were also surveyed. The trolling index, the number of SBT age one school per 100 km searched, was higher for the 2005-2007 cohorts than the 1995-1998 cohorts when taking account of both the trolling survey and the trolling catch data in the acoustic survey.

49. It was clarified that the trolling index is the number of schools per unit of searching effort (100km searched). The question was asked whether school size could be estimated during the survey, and/or whether the aerial survey could be used to convert school size to numbers or biomass. It was noted that in the aerial survey the numbers of schools increased in the most recent year, but school sizes decreased

substantially. It was not considered possible to estimate school size for the current trolling method. It was proposed that there be further discussions about collaborative research on the distribution and abundance of juvenile SBT and ways in which the Members' efforts could be co-ordinated to address the question of monitoring recruitment and in particular the proportion of juvenile SBT present in south western Australia and whether or not this is likely to be consistent over time.

50. Questions were asked about the local hydrography and potential for there to be spatial and inter-annual trends in habitat preference. The area covered is quite complex in terms of bathymetry, and effects from the south flowing Leeuwin Current and Southern Ocean currents and frontal structure. Oceanographic models can provide fine-scale, hind-cast information of the oceanography. These could be used to define habitat preferences for SBT, and potential covariates for use in CPUE models.

51. Concerns were raised about the coverage of the survey, whether the survey slices through the middle or either end of the distribution of juveniles in the south west of Australia, and the fraction of the fish moving around to the south of Australia. In this regard, it was noted that few of the age 1 fish tagged with sonic tags on the west coast were detected by the listening stations along the south coast (see CCSBT-ESC/0809/44). The author thought that the trolling survey was possibly not covering all age 1 fish, but thought that the index off Bremer Bay reflects the fish going to the south coast. The proportion of fish at the western versus southern coast is unknown and an important question to address in the context of the available indices of recruitment.

Commercial Spotting SAPUE index

52. CCSBT-ESC/0809/25 presents an update for the commercial spotting SAPUE index. Data on the sightings of SBT schools by experienced tuna spotters during commercial spotting operations in the GAB were again collected between December 2007 and March 2008, resulting in seven consecutive seasons of data which can potentially be standardised to obtain an index of juvenile abundance (ages 2-4 primarily) in the GAB.. The index values for 2003 and 2004 are somewhat sensitive to the choice of spotters included in the model, though the general temporal patterns, particularly in recent years, are not sensitive. The index is lowest in 2003 and 2004, close to average in 2006 and 2007, and highest in 2008. It is important to consider these results, especially the 2008 estimate, in the context of the much longer scientific aerial survey index of abundance (CCSBT-ESC/0809/24). This aerial survey index, which shows a similar pattern for the period of overlap (2005-2008) with the SAPUE index, still estimates the 2008 index as being below the long term average over 1993-2008.

53. While it is encouraging that the overall patterns of the two indices are similar in the years of overlap, direct comparisons need to be made with caution. The SAG confirmed that the scientific aerial survey index is preferred over the commercial spotting index.

54. A suggestion was made that the season-observer interaction that was left out of this year's analysis could be added as a random effect.

Archival tagging returns

55. CCSBT-ESC/0809/23 provides an update of the archival tagging activities that have been undertaken as part of the collaborative Global Spatial Dynamics project between Australia, New Zealand and Taiwan, which aims at archival tagging 2-4 year old SBT throughout their range (from South Africa to New Zealand) in order to better understand movement patterns, migration rates and residency times. To date, 558 tags have been released in: South Australia (122), Western Australia (175), the central Indian Ocean (160), the Tasman Sea (75) and South Africa (26). A large percentage of the Tasman Sea releases and all except one of the South Africa releases took place since last year's report. The number of returns to date has been 53. Of the 2004 releases, 25% have been recaptured so far, including the first recoveries ever from archival tags released in the central Indian Ocean and New Zealand. Of the 2005 and 2006 releases, 15% and 12% respectively have been returned to date. These proportions are substantially lower than for the 2004 releases after the same amount of time, and suggest that reporting rates may have declined (noting that none of the returns have come from the Japanese or Korean longline fleets). The movement patterns seen in the archival tag returns to date differ in the extent of their eastward and westward movements from the archival tag returns from the 1990s releases. In particular, only one of the recaptured fish from tags released off South Australia has moved into the Tasman Sea, and movement into the Indian Ocean has been restricted to the more central and eastern areas.

56. Clarifications were sought regarding the age classes tagged in the global spatial tagging program (the aim of the project was to tag ages 2-4), and the potential for getting information on stock structure, particularly alternative locations for migration of very young fish. The SAG was informed about the additional tags being released off South Africa in collaboration with Taiwan, a new project looking for stock structure information from otolith micro-chemistry and a new generation of archival tags that are very small and can be placed on much smaller fish. It is hoped that these future initiatives will provide more information on very young SBT movement and migration patterns and also an opportunity for co-operation and greater coordination among members' field programs.

NZ Joint venture CPUE

57. CCSBT-ESC/0809/SBT Fisheries – New Zealand and CCSBT-ESC/0809/16 present information on NZ Joint venture CPUE trends. The NZ fleets fish a relatively small portion of the stock, such that the interpretation of catch rates might be particularly sensitive to inter-annual variability in SBT spatial distribution. Catch rates in both the northern and southern fishery decreased in 2007. The catch rates for the southern fishery in 2006 and 2007 are an improvement over the very low catch rates between 2003 and 2005, but are still low when compared with the decade prior to this. Observer coverage has been very high for this fleet.

NZ domestic longline fishery CPUE

58. CCSBT-ESC/0809/SBT Fisheries – New Zealand and CCSBT-ESC/0809/16 present information on the NZ domestic longline fishery CPUE trends. The NZ domestic longline fleet shows a 2007 catch rate that has more than doubled since 2006. There

has been a general increasing trend in catch rates since 2003. The 2006 catch rate is down on the 2005 level, which is different from the results seen in the New Zealand joint venture catch rates. The 2007 catch rate is similar to the 1998-2001 catch rates (apart from 1995 which is higher). This is also the reverse of what is seen in the NZ joint venture catch rates. Management arrangements changed in 2004 from an "Olympic" system, and the trends from the domestic CPUE are not thought to provide reliable information on trends in vulnerable biomass (CCSBT-ESC/0809/SBT Fishery – New Zealand).

Indonesian CPUE (data from Students from the Indonesian Fishery School - FHS).

59. There is no updated index from these data this year. A thorough analysis of the FHS data is considered worthwhile to extract useful CPUE information once concerns about data reliability have been addressed. This work is being pursued through a PhD program and an update is available in paper CCSBT-ESC/0809/Info 1.

New Zealand longline fishery catch size composition

60. The New Zealand longline fishery catch size composition data are presented in CCSBT-ESC/0809/SBT Fisheries – New Zealand and CCSBT-ESC/0809/16. The size composition of the NZ catch shows that small fish, up to and including age 5, had almost completely disappeared from the NZ domestic and charter (joint venture) fisheries in 2004 and 2005, and had been in decline since 2001. The 2006 and 2007 data for the charter fishery show a reversal of this trend; however the contribution of these fish to the total catch is still very small. The 2006 catch of small fish in the domestic fishery is high, but drops back to almost zero in 2007. NZ presented preliminary size data for the charter fleet for 2008 (from CCSBT-ESC/0809/SBT Fisheries – New Zealand, figure 8) that show a substantial increase in the proportion of the catch under 120 and 140 cm in 2008.

Indonesian Spawning Ground Age/Size composition

61. CCSBT-ESC/0809/27 was presented. The SBT catch composition from the Indonesian longline fishery on the spawning ground has been estimated for 15 spawning seasons. These data are considered to be an important source of information about the spawning population, predicated on the assumption that fishery selectivity is reasonably constant over time. Data from one processing plant were from Indonesian fishing vessels believed to be fishing south of the SBT spawning grounds. These data were excluded from the analyses of the spawning population age and size composition for the 2004/5, 2005/6 and 2006/7 seasons, and were reported separately.

62. The trends observed for the spawning population reported in the paper were:

- The mean size distribution declined from 188.1 to 166.8 cm between 1993/94 and 2002/03, and has remained between 168 and 170 cm for the last 5 years.
- In 2007/08 the relative abundance of SBT < 165 cm declined slightly but has remained between 27-34% of the catch for the last five seasons. The relative abundance of SBT>190 cm has declined since the mid-1990s, but has remained between 1.4 - 3.1% of the catch for the last five seasons.

- Age estimates for the 2006/07 season are preliminary because an age bias in the estimates was detected for this season's data only, and this is being further examined. This only affects the 2006/07 age estimates.
- The median of the age distribution declined from 19-21years in mid and late 1990s down to 13-14 years in 2001/02 to 2005/06.
- The proportion of young fish < 11 years increased in 2006/07. The average age of SBT greater than 20 years has remained relatively stable over time, but has shown a slight decline over the last 3 seasons.
- The sex ratio of SBT in the Indonesian catch continues to be skewed towards females. This dominance of females has gradually declined over the past 8 seasons from 72% in 1999/00 to 55.6% in 2007/08.

63. The point was raised that these data may need further investigation to ascertain whether selectivity is changing or there are different cohort strengths evident in the Indonesian catches when examining the conditioning of the OM.

64. The SAG noted that the catches from the area south of the spawning ground were excluded from the analysis of the spawning population age and length distributions.

Indonesian Spawning Ground Total Catch

65. CCSBT-ESC/0809/18 was presented. Total catches by year indicate that total Indonesian SBT longline catches increased from 1993-1999 and have generally declined from 1999-2007. It is unclear how total catches relate to stock status given the non-target nature of the SBT fishery, the difficulty in effort standardisation and marked changes in fleet behaviour over recent years.

Review of fisheries indicators

66. There are a range of indices that may reflect abundance of SBT at different ages. All indices were converted by the appropriate time lag to reflect year class strength (see Attachment 6), although each index can be affected by differential vulnerability to the sampling method/area and previous exploitation. Using these indices as representing year class strength the SAG agreed to the following:

Recruitment indices

67. The indicators continue to support the previous conclusion of poor 2000 and 2001 year classes. The evidence is stronger now that the 2002 year class was also poor. The status of the 2003 year class is unclear, but there are indications of a better year class in 2004 for a number of the indicators (Table 1). Overall recruitment levels remain lower than the 1990s and considerably lower than the 1980 estimates.

68. The size distribution in the New Zealand charter longline fishery and in the Japanese longline fishery both indicate poor 1999, 2000, 2001 and 2002 year classes (though the latter indicator is subject to potential bias due to the catch anomaly). The Australian scientific aerial survey fluctuates without trend from 1994 to 2005, however year class strength in terms of this index was on average three times higher for the period 1990-1993. The commercial spotting (SAPUE) index shows

particularly low year class strength for 2000 and 2001 (these were 2 of the 4 years when the scientific aerial survey did not take place). The high fishing mortality rate estimates for age 3 and 4 from recent SRP tagging suggest low year class strengths between 2001 and 2003. Trends in CPUE at ages from the Japanese longline fleet show poor strength of the 1999-2001 year classes, but preliminary indications are that the 2003 and 2004 year classes may be larger. This is also shown in the New Zealand longline and the trolling indices. The trolling index shows similar trends to other indices for year classes 1995-2001, with a rapid increase since then (however this is confounded by a design change in 2005) The acoustic index shows a decline in year class strength since 1996, followed by low year classes from 1999 (see Table 1).

69. The base case of the OM is broadly consistent with the indicators described above. The model indicates year class strengths since 1991 have been lower than in previous decades and that the 2000-2002 year classes were the lowest on record.

Trends in stock biomass

70. Reported catch rates of fish aged 12 and older in the Japanese longline indicate a drop in spawning stock biomass between 1993 and 1998; since 1998 this index has been stable. The catch anomalies make interpretation of CPUE less certain. The increase in tonnage of the Indonesian catch in 2004-2005, as well as the increase in proportion of SBT in a component of the Indonesian catch, was associated with a possible shift in the behaviour of the Indonesian fleet to target SBT south of the spawning ground. The average age in the Indonesian catch declined from about 21 years prior to 1998/1999 to about 15 since 2001/2002 and has remained the same since then.

71. Reported Japanese longline CPUE of SBT for all ages combined suggests that the exploitable biomass for this fleet has remained fairly constant during the past 10 years, though this level is low compared to historical values. Confidence in this indicator has diminished considerably due to the uncertainty associated with catch anomalies. Reported CPUE indicate increases in the CPUE of ages 8-11 since about 1992, but there is a slight decline in 2003 and 2004, with a slight increase in 2005, and 2006 is similar to 2005. Reported CPUE of fish aged 4-7 has increased since the mid 1980s but has been declining in recent years.

Table 1. Normalized year class indices (average for 1999-2004 set to 1.0) for year classes 1990-2007 and where available averages from 1990-1998.

Year Class	Japan Longline	New Zealand Longline	SRP Tagging	Aerial Survey	Commercial Spotting	Trolling	Acoustic Survey	Model
1990-1998	1.41	2.48	N/A	2.14	N/A	2.58	2.42	1.77
1990	2.05	2.73	N/A	3.96	N/A	N/A	N/A	2.22
1991	1.50	0.86	N/A	2.28	N/A	N/A	N/A	2.21
1992	1.10	1.16	N/A	3.43	N/A	N/A	N/A	1.87
1993	0.91	1.95	N/A	2.77	N/A	N/A	N/A	1.38
1994	1.15	2.88	N/A	1.38	N/A	N/A	N/A	1.68
1995	1.22	2.80	N/A	1.65	N/A	2.22	3.19	1.65
1996	1.63	4.58	N/A	0.62	N/A	1.90	3.87	2.44
1997	1.52	3.59	N/A	1.03	N/A	2.78	1.06	1.49
1998	1.61	1.79	N/A	N/A	N/A	3.41	1.56	1.51
1999	0.87	0.07	2.52	N/A	1.23	0.65	0.19	1.13
2000	0.68	0.02	1.08	N/A	0.62	0.18	0.00	0.64
2001	0.65	0.20	0.49	N/A	0.61	0.00	0.04	0.93
2002	0.63	0.76	0.50	1.29	1.46	1.85	0.00	0.75
2003	1.07	0.93	0.28	0.89	0.98	N/A	N/A	1.14
2004	2.09	4.03	1.13	0.82	1.10	2.33	0.09	1.40
2005	N/A	N/A	N/A	1.51	1.57	5.25	0.00	0.69
2006	N/A	N/A	N/A	N/A	N/A	8.34	N/A	
2007	N/A	N/A	N/A	N/A	N/A	9.58	N/A	

6.2 Reconditioning operating model and constant catch projections for management advice

72. The SAG agreed that the basis for management advice at this time would be the reconditioned operating model, in conjunction with an evaluation of current stock status and recent recruitment based on indicators. The conditioning of the operating model would be broadened to include some of the available indicators. The indicators that were evaluated for inclusion in the operating model at the SAG included the aerial survey and trolling index. The development of methods and code for inclusion of information from recent (SRP) tagging data was considered a high priority for the intersessional period.

73. It was agreed that management advice in 2009 could be based on constant catch projections from the reconditioned operating model, and an evaluation of current stock status and recent recruitment based on indicators in contrast to a fully developed Management Procedure.

6.3 TAC options and criteria for constant catch projections for SAG/SC 2009

74. Options for constant catch projections were discussed. Five alternative future constant catch options were suggested: 1) TAC in 2009, 2) TAC 2009 + 2000 t, 3) TAC 2009 - 2000 t, 4) TAC 2009 + 4000 t, and 5) TAC 2009 - 4000 t. The ESC should seek advice from the Extended Commission on these choices for constant

catch projections. The year in which TAC would change for future catch projections is 2010.

75. The reference points to be reported from constant catch projections were suggested to include:

- probability of B2014 > B2004,
- probability of B2014 > B2008[2],
- medians and lower 10th percentiles of B2014/B2004, B2014/B2008[2], B2022/B2004, B2022/B2008,
- medians of B2008/B1980, B2008/B0[3],

where B is spawning biomass.

76. Intersessional work to examine the linearity of outputs to catch changes was requested.

77. The SAG drew the attention of the ESC to its previous caution on the interpretation of constant catch predictions for the medium to long term, in the absence of feedback decision rules (i.e. an MP), the low level of spawning stock biomass and low recent recruitments.

Agenda Item 7. Reconsideration of operating models and MP development

7.1 Inputs to the Conditioning Model

7.1.1 Historical catches and size compositions: further examination of issues related to the Japan Market Review and Australian Farm Review Reports

78. CCSBT-ESC/0809/40 presented an examination of the time lag between catching SBT and selling at the Tsukiji Fish Market, based on records of the management tag attached to SBT caught by Japanese longliners. The research was carried out once a month from October 2007 to August 2008, and data on 829 individuals were collected. The mean annual proportions of fish sold in year *i* were calculated as 7% caught in *i* year, 86% of caught in year *i*-1, 7% of caught in year *i*-2. The paper stated that the lag was indicative of 2007-08 only and that simply applying the lag to years before 2007 was questionable.

79. Participants noted that these proportions were calculated from 2007-08 data, so that it was questionable whether they could be applied to earlier years, given the potential for temporal trends in the proportions through different marketing and fishing practices. Some participants considered that given the current business logic of holding SBT longer in a rising market, the lag in SBT sales would have been shorter in earlier years. However, as these were the only available data to calculate market lag proportions, they were adopted as the basis to calculate catch scenarios to recondition the OM. The method of calculating the 2007-08 lag was considered to be

[2] To reflect previous advice on risk of further short term decline in spawning stock biomass and therefore possible future declines in recruitment.
[3] To reflect current stock status relative to historic reference point and unfished biomass

more appropriate than the approach used in 2006 to calculate the lag as 70% in year *i*-1 and 30% in year *i*-2.

80. The SAG agreed that if and when new information was provided on the unreported catch estimates it would be examined. If the new information is more reliable than the current information, the new information will be used in conditioning the OM.

7.1.2 CPUE scenarios

81. At the SAG meeting in 2006, certain market anomaly assumptions with respect to CPUE and reported catch scenarios were used to condition the OM. These included:

    i. 25% of the unreported catch associated with reported effort;
    ii. 50% of the unreported catch associated with reported effort;
    iii. 75% of the unreported catch associated with reported effort.

82. The SAG discussed the merit of excluding the 75% unreported catch assumption. Some participants considered that the differences in standardised CPUE of longline vessels with and without observers was broadly too small to support the possibility that as much as 75% of the unreported catches could have come from the vessels and period used to calculate CPUE (see Figure 7, CCSBT-ESC/0809/38). However, other participants disagreed, pointing out that for certain years upper confidence limits were consistent with a high extent of under reporting from vessels without observers, and hence considered that 75% was within the bounds of plausibility. There were also disagreements as to whether the extent of reported overcatch for 2005 under stricter inspections provided a basis to choose between these scenarios.

83. The SAG discussed the inclusion of the 2007 CPUE estimate in the conditioning of the OM to be conducted during the meeting as outlined in paragraph 19.

7.1.3 Consideration of possible new data inputs, potential for integration of direct age in the OM

84. The SAG discussed the merits of adding the following information sources to the OM. Including:

    - Aerial survey index
    - Commercial spotting (SAPUE) index
    - Trolling survey index
    - NZ CPUE index
    - 2001-2007 conventional tagging data

85. Given the time constraints of the meeting, only the aerial survey, SAPUE and trolling survey indices were incorporated into the OM code. The NZ CPUE index and 2001-2007 conventional tagging data were discussed briefly and recommended for further consideration during inter-sessional work. Pending the results of inter-sessional work, particularly on the tagging data, the OM may be updated in 2009 to incorporate this additional information.

86. The group also noted that further consideration should be given to the way that the earlier tagging data had been incorporated in the model as it is likely that improvements to the methodology could be made.

7.2 Reconsideration of Operating Models

7.2.1 Review of inter-sessional analyses conducted by national scientists

87. CCSBT-ESC/0809/35 was presented. In this paper stock assessments and constant catch projections under several overcatch scenarios, conducted using the Operating Model (OM) developed by the ESC, are described. This analysis shows that (1) the existence of overcatch and (2) CPUE adjustments to longline overcatch are key factors as noted by the SAG/ESC meetings in 2006. In general, current stock status in both absolute and relative terms is somewhat better than past perceptions due to incorporating overcatch in the assessment model and to recruitment returning to its recent average level as indicated from recent data. It is, however, noted that future projections become more pessimistic as the degree of CPUE adjustments increased. The authors consider that if these overcatch effects could be incorporated reasonably (likely as further uncertainty axes), the current framework of OM conditioning and projections based on the grid approach could be applied for the update of OMs used for the development of new management procedures.

7.2.2 Consideration of additional estimation trials evaluated during the meeting

88. The MP Working Group discussed a range of exploratory scenarios for evaluating goodness of fit in the OM (details discussed in Attachments 7 and 8). The estimation trials conducted were combinations of the following changes to the OM:

- The inclusion of the aerial survey index assuming that age groups 2, 3 and 4 are equally available to sighting (selectivities of 1, 1, 1).
- The inclusion of the aerial survey assuming that age groups 2 and 4 are less available to sighting than age group 3 (selectivities of 0.33, 1, 0.33).
- The inclusion of the aerial survey assuming that age group 2 is less available to sighting than age groups 3 and 4 (selectivities of 0.5, 1, 1).
- Estimating an additional process error (τ_{aerial}) for the aerial survey.
- Increasing the minimum CV constraint on the longline *CPUE* index from 0.1 to 0.2 and to 0.3.
- The inclusion of the Japanese trolling survey index.
- Changing the values of the CVs used to constrain changes in selectivities between blocks of years in the Indonesian fishery from 0.5 to 0.2.
- Changing the selectivity block CVs in the Australian surface fishery from 2 to 0.5.
- Estimating separate selectivities for the main longline fishery (*LL1*) in 2006 and 2007.

- Replacing the assumption of constant selectivity in the Taiwanese fishery (*LL2*) by the use of three blocks of selectivities (pre 2002, 2002-2005, 2006-2007), using a CV = 0.5.
- Truncating the *CPUE* series at 1992.

89. The main changes in model fit were obtained through the inclusion of the trolling data, truncating the *CPUE* series at 1992 and changing *LL2* selectivity. Models were evaluated in terms of goodness of fit.

Incorporating trolling data

- If *LL2* selectivity is unchanged over time, the results were inconsistent with the *LL2* length frequencies for the smaller fish in recent years. However, consistency was improved if variability in *LL2* selectivity is introduced.
- Lead to poorer fits to aerial survey data and 1990's tagging data.
- Recruitment is very high for the most recent years. The SAG noted that estimates in the most recent years are highly uncertain in this sort of modelling approach especially given concerns about this particular index.

Truncated CPUE data

- Poorer fit to the *LL1 CPUE* in most recent years with predicted *CPUE* falling below the data for the period after 1993.
- Fit to aerial survey improved.
- Fit to 1990's tagging data improved.

Changing LL2 selectivity

- Improved fit to LL2 size data when selectivity was estimated in blocks (pre 2002, 2002-2005, 2006-2007).

90. Other results of exploratory analyses were:

- When the minimum CV constraint on the CPUE was increased the OM still fitted closely to this series.
- The OM predicted the trolling data reasonably well prior to 2005 but not for the most recent 3 years.

91. After detailed discussions of the results of these exploratory runs, a base case model was selected to be used in further robustness testing. This base case was agreed to be:

- *LL1* overcatch scenario based on Case 1 of the market review report.
- Surface fishery overcatch scenario of 20%.
- *CPUE* scenario S = 25% (25% of the unreported catch attributed to the *LL1* reported effort).
- *CPUE* data up to and including 2006.
- Lower bound on *CPUE* CV=0.20.
- OM fitting to the aerial survey with selectivity 0.5/1/1 for ages 2/3/4.
- *LL1* selectivity blocks changed in 2006 and 2007, and every 4 years prior to that with CV = 0.5.

- *LL2* selectivity blocks: pre 2002, 2002-2005, 2006-2007.
- Other assumptions retained as in previous OM.

92. It was agreed that over the explorations considered above, the following span the plausible range of uncertainties about the associated base case model, given the currently available information:

- Include troll survey data;
- Increase the CV on CPUE to 0.30 and set the additional process error estimated for the aerial survey (τ_{aerial}) to 0.

93. The agreed base case was then used to test the following further sensitivities:

- *S* = 50%: change the proportion of overcatch attributed to LL1 effort in calculating *CPUE* from 25% to 50%.
- *S = 75%*: change the proportion of overcatch attributed to *CPUE* from 25% to 75%.
- Low *M*: change natural mortality from 0.4 to 0.3 for *M0* and 0.1 to 0.07 for *M10*
- *High M*: change natural mortality from 0.4 to 0.5 for *M0* and 0.1 to 0.14 for *M10*
- *Low M0 high M10:* change to *M0*=0.3 and *M10*=0.14
- Low steepness *h*: change stock recruitment steepness from 0.55 to 0.385
- High steepness *h*: change stock recruitment steepness from 0.55 to 0.73

94. The main conclusions drawn from these sensitivities were:

- The high *M* scenarios did not fit well to the tagging data.
- The fit to the CPUE became progressively worse as *S* was increased (based on the negative log likelihood and residual components for the *LL1 CPUE*). However, it was noted that this may be influenced by the large spike in the CPUE series in the mid 1990s which the OM is unable to fit well.
- The low *M0* and high *M10* showed improvements to the negative log likelihood over the low *M* and high *M* cases.

7.2.3 Definition of changes in the structure/parameterization of the conditioning model, including new data inputs and likelihood assumptions

95. The SAG agreed that the assumptions specified for the base case in 7.2.2 would be used for conditioning the OM in 2009. In particular, the aerial survey would be included in the base case, and the two CPUE series estimated by the CPUE working group including data only to 2006. The SAG also agreed that the trolling index and SAPUE index would not be incorporated in the OM conditioning for the base case.

96. As noted in 7.1, exploration of methods for the inclusion of the 2001-2007 conventional tagging data and reconsideration of the 1990s tagging data were agreed by the SAG as a high priority for inter-sessional work. The OM code may be revised

in 2009 to incorporate these new methods. In addition, new information may also be incorporated in reconditioning the OM in 2009.

7.2.4 *Possible changes in the structure/parameterization of the projection model*

97. The structure/parameterization of the projection model was discussed. The SAG agreed that the projection model remain the same as the model used in 2006 except for a minor change to the selectivity of LL1 (selectivity based on the average of the last three years – 2006 and 2007-2008) (see Attachment 7). A number of sensitivity runs were proposed, as specified in 7.2.6. In terms of the projection model, the effect of the autocorrelation assumed to generate recruitments from 2006 and onwards (when the last year of data is 2007) was discussed. It was noted that because point estimates from the different grid cells are used for projections (instead of a full Bayesian approach) this method would tend to propagate the 2005 recruitment deviate into the future, without properly reflecting its uncertainty. To address this problem, a sensitivity test was included in which the recruitment deviate for 2007 will not be correlated to the previous deviate.

7.2.5 *Selection of a new candidate reference set, including specification of axes of uncertainty and weights to be used for constant-catch projections in 2009*

98. Based on the analyses outlined in 7.2.2, the SAG agreed that the OM conditioning to be conducted in preparation for the 2009 SAG meeting should be conducted using the base model and the revised 2006 OM grid (Table 2). The SAG also discussed whether to base the weights of the grid cells on priors or posteriors for each axis.

99. Results presented in paper CCSBT-ESC/0809/35 indicate that when the overcatch scenario was added to the reported *LL1* catch, the use of likelihood-based weights in the grid integration gave very little weight to the high and mid values of *M0*, the low value of *M10* and the $\varpi = 0.75$. The SAG agreed to use fixed weights equal to the prior in the base case and evaluate sensitivity to the use of likelihood-based weights. The structure of the resultant new grid is as follows:

Table 2. Specification of axes to be considered for the new "grid."

	Levels	Cumul N	Values			Prior	Simulation Weights
Steepness (*h*)	3	3	0.385	0.55	0.73	0.2, 0.6, 0.2	Prior
M0	3	9	0.30	0.40	0.50	Uniform	Prior
M10	3	27	0.07	0.1	0.14	Uniform	Prior
Omega	2	54	0.75		1	0.4, 0.6	Prior
CPUE (w.5, w.8)	2	108				Uniform	Prior
q age-range	2	216	4-18		8-12	0.67, 0.33	Prior
Sample Size	2	432	Sqrt		Original/2	Uniform	Prior

7.2.6 Initial discussion of robustness trials for MP evaluation

100. The following cases were suggested for evaluation of the constant catch projections:

- Effects of overcatch on *CPUE*: S = 50% and S = 75%.
- *LL1* overcatch scenario based on Case 2 of Market Report.
- Projected recruitment deviates uncorrelated to historical estimates from conditioning.
- Include troll survey data.
- Truncate *CPUE* series in 1992.
- Use 5 historical CPUE series (i.e. incorporate 3 more series in addition to w.5 and w.8).
- Break *CPUE* into two time series, the second starting in 1986 [*note this one was added at the request of the CPUE Modelling Group*].
- Use likelihood-based weights for M0, M10 and ω for grid integration.
- Increase the CV on *CPUE* to 0.30 and set the additional process error estimated for the aerial survey (τ_{aerial}) to 0.

101. The SAG discussed incorporating some of the above to the OM grid, but recommended that all would remain as trials at this stage. These trials will be considered further at the 2009 SAG meeting after appropriate inter-sessional work has been conducted.

7.3 Possible MP options and modelling implications

7.3.1 MP data inputs

102. The SAG agreed to the concept of broadening future decision rules and the MP to include indicators and/or fishery independent data, as described in CCSBT-ESC/0809/30. This work would be considered after 2009.

7.3.2 Schedule of TAC changes

103. Options for a TAC change in 2010 for consideration in constant catch projections to be presented in 2009 are detailed under item 6.3. Further than that, TAC change schedules for a formal MP were not discussed.

7.4 Performance criteria for MP evaluation

104. As noted in 7.2 and 7.3 a formal MP was not discussed during the SAG meeting.

7.5 Workplan and timetable

105. This agenda item was deferred for discussion to the ESC.

Agenda Item 8. Other business

106. There was no other business.

Agenda Item 9. Next meeting

107. The date and time of the next meeting will be recommended by the ESC.

Agenda Item 10. Finalisation and adoption of meeting report

108. The report of the meeting was adopted.

Agenda Item 14. Close of meeting

109. The meeting was closed at 11:30am, 10 September 2007.

List of Attachments

Attachment

1 List of Participants
2 Agenda
3 List of Documents
4 Report of the CPUE Modeling Group
5 Future CPUE series for use in the OM and MP
6 Summary of recruitment indices
7 Details about model specification
8 Evaluations of alternative conditioning configurations for the operating model

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Attachment 2

Agenda
Ninth Meeting of the Stock Assessment Group
and Fifth Meeting of the Management Procedure Workshop
2 – 7 September 2008
Rotorua, New Zealand

1. Opening

1.1. Introduction of participants and administrative matters

2. Appointment of rapporteurs

3. Terms of reference and adoption of agenda

4. Admission of documents and finalisation of document list

5. CPUE modelling work

5.1. CPUE working group report

5.2. Selection of CPUE time series

5.3. Implications for conditioning of operating model

6. Basis for providing management advice in 2008-09

6.1. Using indicators for basis of management advice

6.2. Reconditioning operating model and constant catch projections for management advice

6.3. TAC options and criteria for constant catch projections for SAG/SC 2009.

7. Reconsideration of Operating Models and MP development

7.1 Inputs to the Conditioning Model

7.1.1 Historical catches and size compositions: further examination of issues related to the Japan Market Review and Australian Farm Review Reports.

7.1.2 CPUE scenarios

7.1.3 Consideration of possible new data inputs, potential for integration of direct age in the OM

7.2 Reconsideration of Operating Models

7.2.1 Review of inter-sessional analyses conducted by national scientists.

7.2.2 Consideration of additional estimation trials to be performed/evaluated during the meeting.

7.2.3 Definition of changes in the structure/parameterization of the conditioning model, including new data inputs and likelihood assumptions.

7.2.4 Possible changes in the structure/parameterization of the projection model

7.2.5 Selection of a new candidate reference set, including specification of axes of uncertainty and weights to be used for constant-catch projections in 2009.

7.2.6 Initial discussion of robustness trials for MP evaluation

7.3 Possible MP options and modelling implications

7.3.1 MP data inputs

7.3.2 Schedule of TAC changes

7.3.3 Other

7.4 Performance criteria for MP evaluation

7.5 Workplan and timetable

7.5.1 Update code of OM / grid for constant-catch projections and associated graphics files.

7.5.2 Update agreed input data sets to include data up to 2008.

7.5.3 Distribution of simulation code and data/parameter sets to National Scientists.

7.5.4 Scientists conduct Scenario modelling.

7.5.5 Need for an intersessional technical meeting to decide on final grid structure for constant-catch projections?

7.5.6 SAG10 /SC14 (2009)

8 Other business

9 Next meeting

10 Finalisation and adoption of meeting report

11 Close of meeting

Attachment 3

List of Documents
Ninth Meeting of the Stock Assessment Group
and Fifth Meeting of the Management Procedure Workshop
and Extended Scientific Committee for the Thirteenth Meeting of the Scientific Committee

(CCSBT-ESC/0809/)

1. Draft Agenda of the 9th SAG and 5th MPWS
2. List of Participants of the 9th SAG and 5th MPWS
3. Draft Agenda of the ESC for the 13th SC
4. List of Participants of the 13th SC and ESC
5. List of Documents - The ESC for the 13th SC and 9th SAG / 5th MPWS
6. (Secretariat) Secretariat Review of Catches (ESC agenda item 4.2)
7. (Secretariat) Surface Fishery Tagging Program (ESC agenda item 13.4)
8. (Secretariat) Data Exchange (ESC agenda item 15.1)
9. (CPUE Modelling Group) The development of new agreed CPUE series for use in future MP work. Itoh, T., Lawrence, E. and Pope, J.G.
10. (New Zealand) Scientific evaluation of a catch balancing scheme
11. (Australia) Preparation of Australia's southern bluefin tuna catch and effort data submission for 2008. Hobsbawn, P.I., and Sahlqvist, P.
12. (Australia) Assessing the accuracy and precision of stereo-video and sonar length measurements of southern bluefin tuna (Thunnus maccoyii). Phillips, K., Rodriguez, V., Harvey, E., Ellis, D., Seager, J., Begg, G., Honda, N., Shibata, K., and Hender, J.
13. (Australia) Report on the potential and feasibility of genetic tagging of SBT. Davies, C., Moore, A., Grewe, P., and Bradford, R.
14. (Australia/New Zealand) Using passive integrated transponder (PIT) technology to improve performance of CCSBT's conventional tagging program. Harley, S., Bradford, R., and Davies, C.
15. (Australia) Report on the potential of spawning ground surveys. Phillips, K., and Begg, G.
16. (Australia) Fishery indicators for the SBT stock 2007/08. Hartog, J., and Preece, A.
17. (Australia) Estimating Australia's Recreational Catch of Southern Bluefin Tuna.

Rowsell, M., Moore, A., and Sahlqvist, P., and Begg, G.

18. (Australia) The catch of SBT by the Indonesian longline fishery operating out of Benoa, Bali in 2007. Prisantoso, B.I., Andamari, R., and Proctor, C.
19. (Australia) Choice, use and reliability of historic CPUE. Davies, C., Lawrence, E., Basson, M., , and Preece, A.
20. (Australia) A summary of progress with a trial observer program for Indonesia's tuna longline fishery in the Indian Ocean. Sadiyah, L., Andamari, R., Prisantoso, B.I., Proctor, C., and Retnowati, D.
21. (Australia) Estimates of reporting rate from the Australian surface fishery based on previous tag seeding experiments and tag seeding activities in 2007/2008. Hearn, B., Polacheck, T., and Stanley, S.
22. (Australia) Analyses of tag return data from the CCSBT SRP tagging program - 2008. Eveson, P., and Polacheck, T.
23. (Australia) Update on the Global Spatial dynamics Archival Tagging project – 2008. Polacheck, T., Chang, K.S., Hobday, A., West, G., Eveson, P., and Chung, K.N.
24. (Australia) The aerial survey index of abundance: updated analysis methods and results. Eveson, P., Bravington, M., and Farley, J.
25. (Australia) Commercial spotting in the Australian surface fishery, updated to include the 2007/8 fishing season. Farley, J., and Basson, M.
26. (Australia) An update on Australian otolith collection activities, direct ageing and length-at-age in the Australian surface fishery. Farley, J., and Clear, N.
27. (Australia) Update on the length and age distribution of SBT in the Indonesian longline catch. Farley, J., Andamari, R., and Proctor, C.

~~28. (Australia) Recent market data for SBT. Jeffriess, B.~~ (withdrawn)

29. (Australia) Update on SBT close-kin abundance estimation, 2008. Bravington, M., and Grewe, P.
30. (Australia) The potential use of indicators as a basis for management advice in the short term. Basson, M., and Davies, C.
31. (Australia) Proposed use of CCSBT Research Mortality Allowance to facilitate electronic tagging of adult SBT as part of Australia's contributions to the CCSBT SRP in 2008/09. Evans, K., and Davies, C.
32. (Japan) Report of Japanese scientific observer activities for southern bluefin tuna fishery in 2007/2008. Osamu SAKAI, Tomoyuki ITOH, Shingo Fukui and Toshiyuki TANABE
33. (Japan) Activities of otolith collection and age estimation and analysis of the age data by Japan in 2007. Tomoyuki ITOH, Akio HIRAI and Kenichiro OMOTE

34. (Japan) Report of activities for conventional and archival tagging and recapture of southern bluefin tuna by Japan in 2007/2008. Osamu SAKAI and Tomoyuki ITOH
35. (Japan) Further examinations of the SBT operating model under overcatch scenarios to select critical uncertainty factors for the update. Hiroyuki Kurota and Doug S Butterworth
36. (Japan) Summary of Fisheries Indicators in 2008. Norio TAKAHASHI and Tomoyuki ITOH
37. (Japan) Change in operation pattern of Japanese SBT longliners in 2007 resulting the enforce of the individual quota system. Tomoyuki ITOH
38. (Japan) Comparison between observer data and data reported by fishermen. Osamu SAKAI and Tomoyuki ITOH
39. (Japan) Analysis on age compositions of southern bluefin tuna used for farming. Tomoyuki ITOH, Hiroshi SHONO and Takaaki SAKAMOTO
40. (Japan) Report of the time lag of southern bluefin tuna caught by Japanese longline between catch and sold at market. Tomoyuki ITOH, Osamu SAKAI and Hirohide MATSUSHIMA
41. (Japan) Report of the piston-line trolling survey in 2007/2008. Tomoyuki ITOH and Osamu SAKAI
42. (Japan) Interannual variation in habitat use by juvenile Southern Bluefin Tuna in southern Western Australia during the summers of 2005 – 2007: implication for recruitment index estimates. K. Fujioka, A. Hobday, R. Kawabe, K. Miyashita, T. Itoh, and Y, Takao
43. (Japan) Proposal for the recruitment monitoring survey in 2008/2009. Tomoyuki ITOH
44. (Japan) Preliminary report on migration paths of juvenile southern bluefin tuna determined by acoustic tagging in Western Australia 2007 - 08. Hobday, Alistair J., Kawabe, Ryo., Takao, Yoshimi, Miyashita, Kazushi, and Itoh, Tomoyuki
45. (Japan) Report of the 2007/2008 RMA utilization and application for the 2008/2009 RMA. Fisheries Agency of Japan
46. (Japan) Advance technique for measuring the length of fish during transfer by the acoustic camera (DIDSON) system. Naoto Honda, Koji Shibata, Takurou Hotta, Akira Asada

(CCSBT-ESC/0709/SBT Fisheries)

New Zealand	Annual Review of National SBT Fisheries for the Scientific Committee
Australia	Australia's 2006-07 Southern Bluefin Tuna Fishing Season. Hobsbawn, P.I., Phillips, K., and Begg, G.
Japan	Review of Japanese SBT Fisheries in 2007. Osamu SAKAI, Tomoyuki ITOH and Shingo Fukui
Korea	Review of Korean SBT Fishery of 2006/2007. Doo-Hae An, Seon-Jae Hwang, Dae-Yeon Moon, Soon-Song Kim, Kyu-Jin Seok
Taiwan	Review of Taiwanese SBT Fishery of 2006/2007.
Indonesia	Review of Indonesian SBT Fishery

(CCSBT-ESC/0709/Info)

1. (Australia) A preliminary evaluation of Indonesia's Indian Ocean tuna and bycatch longline fisheries, based on historical and newly established sources of CPUE information: a project overview. Sadiyah, L., Proctor, C., and Dowling, N.
2. (Australia) Correction factors derived from acoustic tag data for a juvenile southern bluefin tuna abundance index in southern Western Australia. Hobday, A.J., Kawabe, R., Takao, Y., Miyashita, K., and Itoh, I.

(CCSBT-ESC/0809/Rep)

1. Report of Tagging Program Workshop (October 2001)
2. Report of the CPUE Modeling Workshop (March 2002)
3. Report of the Special Management Procedure Technical Meeting (February 2005)
4. Report of the Fourth Meeting of the Management Procedure Workshop (May 2005)
5. Report of the Management Procedure Special Consultation (May 2005)
6. Report of the Special Meeting of the Commission (July 2006)
7. Report of the Seventh Meeting of the Stock Assessment Group (September 2006)
8. Report of the Eleventh Meeting of the Scientific Committee (September 2006)
9. Report of the Second CPUE Modelling Workshop (May 2007)
10. Report of the Eighth Meeting of the Stock Assessment Group (September 2007)
11. Report of the Twelfth Meeting of the Scientific Committee (September 2007)
12. Report of the Fourteenth Annual Meeting of the Commission (October 2007)

Attachment 4

Future CPUE series for use in the Operating Model and Management Procedure

The final CPUE model recommended by the CPUE Working Group was:

$$\log(CPUE+0.2) = Intercept + Year + Month + Area + Lat5 + BET\_CPUE + YFT\_CPUE + (Month*Area) + (Year*Lat5) + (Year*Area) + Error,$$

where *Error* $\sim N(0,\sigma^2)$, *Area* is the CCSBT Statistical Area, *Lat5* is latitude in five degree bands, *BET_CPUE* is the CPUE of Bigeye tuna and *YFT_CPUE* is the CPUE of Yellowfin tuna.

The data were aggregated at the 5x5 degree level and limited to a set of 63 vessels chosen as part of a core vessel set operating in Area's 4-9 and months 4-9 (see CCSBT-ESC/0809/09 Section 2.5). If hooks in a 5x5 degree and month cell were less than 10,000, the records were deleted. Area 5 and Area 6 were combined due to a lack of data. In addition, records of anomalously high CPUE (>120) were deleted after aggregating to 5x5 data.

As there was a null category (no records of operation in the category) in *Month*Area* in April Area8, the SAS computing package could not provide annual standardized CPUE. However, the CPUE was calculated manually by using R (ver. 2.7.1 for Windows) assuming the missing parameter value was same as that in May Area8.

Attachment 5

Report of the CPUE Modeling Working Group

Intersessional work conducted

Between SAG 2007 and SAG 2008 the CPUE Modeling Group held 7 web based meetings. These meetings facilitated the work of providing agreed CPUE series for use in reconditioning the Operating Model. This resulted in 20 working papers being produced which are available on the CCSBT web-site and listed in CCSBT-ESC\0809\9. The hard work of their authors was greatly appreciated by the CPUE Modeling Group. CCSBT-ESC\0809\9 provides a summary of this work and provides the specification of the CPUE series that was suggested be used for conditioning the Operating Model. CCSBT-ESC\0809\9 was presented in draft form (but modified and agreed during the course of the 2008 SAG).

Agreement on CPUE series for MP work

During the course of the SAG meeting the results of CCSBT-ESC\0809\9 were discussed and it was agreed that a CPUE series based upon the GLM and weighting procedures in CCSBT-ESC\0809\9 be accepted for OM conditioning.

The statistical CPUE series is specified as follows

Data used: Data were limited to the core vessels (about 100 vessels chosen as being those whose catches were amongst the highest 63 in any 3 year period in Areas 4-9, in Months 4-9, between 1986 and 2006. Data were aggregated by 5x5 degree squares for each month. If the number of hooks used in a 5x5 degree square/month was less than 10,000, the records were deleted. Area 5 and Area 6 were combined as Area 56. Records from 5x5 degree square-months with anomalously high CPUE (>120 fish per 1000 hooks) were deleted.

GLM runs: The calculation was performed using the GLM procedure of the SAS package (SAS. Ver. 9.1.3). The full model is.

$$\log(CPUE+0.2) = Intercept + Year + Month + Area + Lat5 + BET\_CPUE + YFT\_CPUE + (Month*Area) + (Year*Lat5) + (Year*Area) + Error,$$

where $Error \sim N(0,\sigma^2)$, *Area* is the CCSBT statistical area, *Lat5* is latitude in five degree bands, *BET_CPUE* is the nominal CPUE of bigeye tuna and *YFT_CPUE* is the nominal CPUE of yellowfin tuna. Note that *BET_CPUE* and *YFT_CPUE* were used as continuous variables. All the effects were significant ($p < 0.01$).

CPUE series: From the standardized CPUE using the method described in Takahashi (2006), CPUE series based upon constant square area weighting and variable square area weighting were first produced. In turn these were combined as two weighted mean series (w0.5 and w0.8) to provide the two “new” 1986-2006 series.

An overall unweighted CPUE series was also considered by the CPUE Modeling WG for simple comparison between possible models. Because there was a null category (no records of operation in the category) in *Month*Area* in April Area8, the SAS statistical package could not provide this. Instead the annual unweighted CPUE was calculated manually using R (ver. 2.7.1 for Windows), assuming that the missing parameter value was the same as that in May for Area 8. Estimates of the confidence intervals for CPUE are not available at the present time.

To provide data prior to 1986 two equivalent series were calculated using the above statistical model but with the by-catch terms omitted (as these are not available for data prior to 1986). These were fitted to all Japanese vessels between 1969 and 2006 in the CCSBT data base to provide two "old" 1969-2006 series.

The two CPUE series were combined for w0.5 and w0.8 as follows

> CPUE 1969-1985: As in the "old" 1969-2006 series.
>
> CPUE 1986-2006: As in the "new" 1986-2006 series*constant, where constant={average "old" series (1986-2006)}/ {average "new" series(1986-2006)}.

The adjusted and combined CPUE series are shown in Fig. 3.1.1. of CCSBT-ESC\0809\9. CPUE series values were made available to the SAG.

A remaining problem to resolve is how to add results for the most recent year to the series (2007 for the current series). This must be based upon the RTMP data. A suitable adjustment needs to be developed to account for sets with zero SBT which are unreported and thus not available in the RTMP data set. This correction will need to be carefully specified.

Proposals for follow up work to the MP CPUE series.

Five issues were noted which follow on from the above choice of CPUE series. All will require inter-sessional work between SAG 2008 and SAG 2009. These are:

1. Specifying how to correct the RTMP estimate of CPUE in the last year of the series. This correction is required to account for sets with zero SBT which are unreported and thus not included in the RTMP data set.

2. Providing robustness tests and monitoring the future performance of the chosen series (e.g. shot by shot analyses).

3. The effect of market anomalies on longline CPUE.

4. Alternative approaches to the calibration of the pre and post 1986 CPUE series.

5. Possible effects of discarding/fish release on longline CPUE results.

Approaches to addressing these questions inter-sessionally are considered in the following report sections. Actions are highlighted by bullets and responsible people indicated by initial as follows (Pope JGP, T. Itoh TI, H. Shono HS, E. Lawrence EL, C. Davies CD, R. Hillary RH, D. Butterworth DB). For convenience, actions are also drawn together in an action list at the end of the report. It is proposed to hold about 3 web meetings in the inter-sessional period, with the first to be tentatively scheduled in either December 2008 or January 2009.

Specifying how to correct the RTMP estimate of CPUE in the last year of the CPUE series.

Logbook data are used to fit the proposed CPUE model but these only become available about two years after the fishing operations. Thus the CPUE for the last data year (current year-1) must be based upon RTMP data rather than logbook data. It was noted that the RTMP data will provide results from sets with positive SBT catches, but unlike logbook data they do not include information on sets with zero SBT catch in the months and areas used to estimate the SBT CPUE series. These unreported zero SBT catch sets require that an appropriate correction be made to avoid a small upward bias occurring in the last data year of the CPUE series. To correct for this bias it is proposed to make additional fits to the logbook data omitting zero sets. Overall absolute CPUE estimates from this series will be compared to the agreed series and used to establish an appropriate correction to the CPUE for the last data year (i.e. that based on RTMP data). The logbook data also need to be monitored for the number of sets with positive and zero SBT catch each year to see if the proportion of sets with zero catches changes through time. Actions:

- Conduct GLM with the standard model on 5x5 degree data (1996-2006) omitting zero sets, weight results to get w0.5 and w0.8 series and compare these series with agreed CPUE series to provide a correction factor for RTMP based CPUE. (TI)
- Provide historic series of the proportion of sets with zero SBT. (TI)

Providing robustness tests for CPUE series and monitoring the future performance of the chosen series.

CPUE series are used to provide an index of population abundance. The use of any CPUE series implies that its link to population abundance through time remains constant or at least predictable. The proportional relationship between CPUE and stock abundance is called catchability. Systematic changes in catchability may obviously undermine the usefulness of CPUE series.

Management procedure work will require that plausible alternative CPUE series are used in robustness tests. The CPUE Modeling Group will also continue to monitor how adequately the proposed series may reflect stock biomass in the future particularly when the behaviour of the fishery might change or there is evidence of substantial shifts in the distribution of the stock. Both requirements are best met by considering alternative interpretations of the existing data sets and carrying these forward as monitoring tools. It is therefore proposed to investigate those aspects of catchability that might cause the relationship between CPUE and population abundance to vary through time. In turn, those that capture the more extreme behaviour should provide alternative CPUE series from those recommended for use in robustness trials of MPs.

The aspects of catchability considered most worth investigating are:

1. Size distribution by time and area.
2. Trends in concentration of fisheries at the fine spatial scale (e.g. shot by shot).
3. Adjusting for non-SBT targeting.
4. Environmental effects that may influence stock distribution.
5. Vessel effects.
6. Approaches for accounting for the effects of zero catch operations.

Size distribution

SBT are not homogeneously distributed over the months and areas used in the analysis for the agreed series. Both as a check on the proposed series and as an aid to improving stock indicators it was considered that it would be useful to investigate if size distribution by time and area caused changes to CPUE indices. The CPUE Modeling Group noted that it would be straightforward to compute CPUE indices for different size groups of SBT to compare with the aggregated indices.

It is proposed that a preliminary analysis is made for each of the length groups defined by the approximate quartiles of the aggregate size composition between 1986 and 2006 (TI).

It was noted that changes in growth rates may need to be accounted for in the interpretation of results in terms of CPUE at age. It was suggested that size data be binned each year into size ranges corresponding to ages 2-4, 5-12 and 12+. Action:

- clarify age-size ranges by year and indicate possible analyses. (CD)

Trends in concentration of fisheries on the fine scale

Changes in the concentration of fishing through time (e.g. increased or decreased focus of fishing in areas of high abundance) can change catchability and size structure of the catch. Broad scale changes are taken into account in the recommended model (if they are uniformly distributed) but fine scale effects are aggregated in the 5x5 degree squares used in the analysis. This problem has been considered in detail in the past (Campbell et al 1996). These investigations lead to the proxy B-ratio (w0.5) and proxy geostatistical (w0.8) approaches proposed. Concentration is an important issue for catchability and merits further consideration.

- The CPUE Modeling Group recommended examining the concentration issue along the lines of the "B-ratio" (from Campbell *et al* 1996, and subsequently implemented by Tsuji (2001)). Rather than go through a full analysis it was suggested that evaluation should start by simply examining patterns within 5x5 degree grids. The statistic would be the number of 1x1 degree squares that are fished within each 5x5 degree square within a month. Investigations in specific subareas would be an appropriate first step. (CD & EL)

<u>Adjusting for non-SBT targeting.</u>

Future changes in targeting in the SBT fishery may cause changes in the catchability of SBT and thus bias the CPUE as an index of abundance. The agreed CPUE series uses catch rates of yellowfin and bigeye tuna as covariates in the GLM to adjust CPUE estimates in each 5x5 degree square. Several alternatives to this were considered. Some are definite proposals while others require further development. Where proposals require further development it was thought it would be helpful to develop methodology and computer code on subsets of the longline data (AU and NZ) before attempting analysis of the full data set.

Definite proposals for analysis were:

- To include abundance indices of bycatch species abundance estimated from stock assessment models in the analysis. (DB indicated a possible methodology to use - see annex 1. RH will provide trends of by-catch species and if possible TI will run model).

- To include a measure of the Poisson excess as a covariate (proposed by JGP). The method uses the ratio of the estimated excess zero SBT sets seen in a 5x5 degree square compared to that which would be expected under a Poisson distribution given the mean catch numbers of SBT in positive sets. (JGP to provide formula to TI to run model)

Proposals requiring further development were:

- Using fishing effort as an offset and by-catch biomass as predictors in GLMs as an alternative to using bycatch CPUE. (RH and EL to consider),

- Further consideration of the theory behind the use of the zero % covariate method (JGP to develop),

- Propose GAM analyses of SBT and by-catch distributions. (EL and CD)

It was considered that checking the residuals of annual CPUE estimates from Operatng Model conditioning runs in those years where the largest non-targeting adjustments occurred might help detect problems and indicate if the corrections were coherent with other data. Furthermore, it would be useful to monitor factors such as trends in relative market prices of bycatch species relative to SBT, or relative price by size of SBT, since these might influence targeting behavior in the future.

CPUE patterns relative to the environment

The effect of environmental factors on the geographic patterning of CPUE would be useful to evaluate. The archival and acoustic tag data may help indicate appropriate covariates. Australia and Japan have ongoing research on this (CCSBT-ESC/0809/23, 42, 44.) and environmental data are available at resolutions that could be useful as covariates. Action:

- Investigate the potential to develop suitable covariates and if possible supply these at the appropriate (e.g. 1x1 degree or wider) area and time cells used in the CPUE analysis. (CD)

Vessel effects

The fishing power of vessels is often a key component of catchability. The use of the core fleet was an attempt to standardize for this factor. Action:

- This should be checked by adding a vessel factor as a fixed (or alternatively a random-effect) to the standard model using the core fleet and shot-by-shot data, and examining the parameter estimates and standard errors obtained from the GLM. (JGP, TI, EL)

Zero catch adjustments

While not strictly a catchability issue the adjustment used on zero catches (the addition of a small constant) can influence the CPUE series. Presently zero-catches are adjusted by adding 0.2 to CPUE expressed as catch in number per thousand hooks to allow the use of the logarithmic transform. This can cause distortion to the distribution of residuals. A possible solution is to replace the logarithmic distribution with the Tweedie distribution in the GLM. Action:

- The use of the Tweedie distribution should be examined (based on a recommendation from HS) for zero-correction and to correct for clear patterns in the Q-Q plots seen in some model results. (EL, HS to investigate)

The effect of market anomalies on longline CPUE

Market anomalies might distort longline CPUE. This concern gives rise to a major uncertainty axis in the Operating Model. Thus work which can help define this range is required. CCSBT-ESC\0809\38 addressed this problem by considering CPUE series fitted respectively to data from unobserved vessels and from vessels with two types of observer. While significant differences in CPUE were indicated between the three series with the GLM, these differences were thought to result at least in part from small fish being released in 1995 and 1996 and differences in spatial coverage between observed and unobserved sets. This latter difference results from some vessels being allowed to fish within national EEZ's only when an observer was present. Analyses therefore need to be made which as far as possible eliminate these differences between observed and unobserved sets. Action:

- Evaluate GLMs with data from observed and unobserved sets for SBT separately for SBT larger and smaller than 25 kg. Include appropriate factors for sets within and outside national EEZ's. Examine the parameter values and their standard errors to give upper and lower bounds for the effect of market anomaly on the CPUE series. (JGP, TI, EL)

Alternative approaches to the calibration of the pre and post 1986 CPUE series

The CPUE series proposed for use in tuning the Operating Model (see above) are formed from an "old" pre 1986 series and a "new" 1986 onward series which is calibrated to the "old series". Currently the Operating Model treats these as if they were one series but this raises questions of the compatibility of the two series. While in fact these appear very similar it would be wise to check if treating them as one series gives more weight to the combined series than is appropriate. It was considered this could be checked by fitting the two parts as separate series in the Operating Model as a robustness check. Action:

- Examine the effect of including both the old and new CPUE series separately (MPWG).

Possible effect of discarding/fish release on long-line CPUE results.

The release of small fish and the discarding of fish have the potential to distort CPUE series, particularly when these are used as indicators of recruitment. Parts of CCSBT-ESC\0809\32 relevant to this question were presented and it was noted that the size distribution of observed and unobserved catches differed particularly in Area 8 (Jul-Nov) during 2007. It was also noted from CCSBT-ESC\0809\38 that this had occurred in the past and might need to be taken account when CPUE series are used for tuning the Operating Model and as indicators of recruitment. Appropriate GLMs which consider SBT size from both observed and unobserved sets seem the best approach to correcting CPUE series for fish release/discarding problems. Action:

- GLM studies of observed and unobserved sets are proposed above (under the effect of market anomalies on longline CPUE) and these should be extended to quantify the effects of the release of small fish and any discarding. (JGP, TI, EL)

ACTION LIST

Specifying how to correct the RTMP estimate of CPUE in the last year of the CPUE series.
Conduct GLM with the standard model on 5x5 degree data (1996-2006) omitting zero sets, weight results to w0.5 and w0.8 and compare these series with agreed CPUE series to provide a correction factor for RTMP based CPUE. (TI). Provide historic series of the proportion of sets with zero SBT. (TI).

Providing robustness tests for CPUE series and monitoring the future performance of the chosen series.
<u>*Size distribution*</u> A preliminary analysis is made for each of the length groups defined by the approximate quartiles of the aggregate size composition between 1986 and 2006(TI). Clarify age-size ranges by year and indicate possible analyses. (CD).
<u>*Trends in concentration of fisheries on the fine scale*</u> The CPUE modeling working group recommended examining the concentration issue along the lines of the "Bratio" (from Campbell *et al*. 1996 and subsequently implemented by Tsuji (2001)). Rather than go through a full analysis it was suggested that evaluation should start by simply examining patterns within 5x5 degree grids. The statistic would be the number of 1x1 degree squares that are fished within each 5x5 square within a month. Investigations in specific subareas would be an appropriate first step. (CD & EL).
<u>*Adjusting for non-SBT targeting.*</u> To include abundance indices of bycatch species abundance estimated from stock assessment models in the analysis. (DB indicated a possible methodology to use - see annex 1. RH will provide trends of by-catch species and if possible TI will run model.) To include a measure of the Poisson excess as a covariate. (proposed by JGP). The method uses the ratio of the estimated excess zero SBT sets seen in a 5x5 degree square compared to those which would be expected under a Poisson distribution given the mean catch numbers of SBT in positive sets. (JGP to provide formula to TI to run model) Using fishing effort as an offset and by-catch biomass as predictors in GLMs models as an alternative to using bycatch CPUE. (RH and EL to consider) Further consideration of the theory behind the use of the zero % covariate method (JGP to develop). Propose GAM analyses of SBT and by-catch distributions (EL and CD)
<u>*CPUE patterns relative to the environment*</u> Investigate the potential to develop suitable covariates and if possible supply these by the 5x5 degree (or wider) area and time cells used in the CPUE analysis. (CD)
<u>*Vessel effects*</u> This should be checked by adding a vessel factor as a fixed (or alternatively a random-effect) to the standard model using the core fleet and shot-by-shot data, and examining the parameter estimates and standard errors obtained from the GLM. (JGP, TI, EL).
<u>*Zero catch adjustments.*</u> The use of the Tweedie distribution should be examined (based on a recommendation from Shono) for zero-correction and to correct for clear patterns in the Q-Q plots seen in some model results. (EL , HS to investigate).

Action list continued

The effect of market anomalies on longline CPUE
Make GLMs with data from observed and unobserved sets for SBT separately for SBT larger and smaller than 25Kg. Include appropriate factors for sets within and outside national EEZ's. Examine the parameter values and their standard errors to give upper and lower bounds to the effect of market anomaly on the CPUE series. (JGP, TI, EL).
Alternative approaches to the calibration of the pre and post 1986 CPUE series
Examine the effect of include both old and new series separately. (MPWG)
Possible effect of discarding/fish release on long-line CPUE results
GLM studies of observed and unobserved sets are proposed above (under the effect of market anomalies on longline CPUE.) and these should be extended to quantify the effects of the release of small fish and any discarding. (JGP, TI, EL)

Abbreviations used in table:-John Pope JGP, T. Itoh TI, H. Shono HS, E. Lawrence EL, C. Davies CD, R. Hillary RH, D. Butterworth DB Management Procedures Working Group.

References

Campbell, Tuck,Tsuji, Nishida (1996), Indices of abundance for SBT from analysis of fine - scale catch and effort data. CCSBT/96/16

Tsuji, S. Takahashi, N and Itoh, T. 2001. Quick examination of Japanese longline CPUE data in the light of SRP development. CCSBT-SC/0103/14.

Annex 1

Technical Annex to CPUE Modelling Working Group

By D. Butterworth.
Using by-catch CPUE and independent bycatch species abundance index to correct for non-targeting for SBT.

Variable List
$C_{b,\,y}$ = Bluefin catch in year y
$C_{o,\,y}$ = Catch of some other species in year y
$E_{b,\,y}$ = Bluefin directed effort in year y
$E_{o,\,y}$ = Other species directed effort in year y
$E_{t,\,y} = E_{b,\,y}+E_{o,\,y}$ = Total effort in year y
$C_{b,\,y}/E_{b,\,y} = q_bB_{b,\,y}$ $\quad C_{o,\,y}/E_{o,\,y} = q_oB_{o,\,y}$

If $E_{o.y} \ll E_{b,\,y}$ then

$$\ln(C_{b,\,y}/E_{t,\,y}) \approx \ln(q_b)+\ln(B_{b,\,y}) - \{1/(q_oB_{o,\,y})\}C_{o,\,y}/E_{t,\,y}$$

$$\ln(CPUE(b,\,y)) \approx \mu+\alpha_y - \beta{*}CPUE(o,\,y) \qquad \text{(I)}$$

i.e. conduct a GLM of ln(CPUE(b, y) with a year factor and linear CPUE(o, y) in the other species as covariates ($\beta = 1/(q_oB_{o,\,y})$)

BUT
This requires β = constant independent of y, i.e. $B_{o,\,y}$ steady.

ALTERNATIVE.

From another assessment obtain $B^*_{o,\,y}$ which is the index of abundance of the other species THEN

conduct the GLM: $\ln(CPUE(b,\,y)) \approx \mu'+\alpha'_y-\beta'{*}CPUE(o,\,y)/B^*_{o,\,y}$ (II)

where $\beta' = 1/q_o$

Attachment 6

Summary of recruitment indices

(R. Hilborn)

Japanese LL data

The nominal Japanese LL CPUE for ages 3, 4 and 5 for years 1969 to 2007 were the input to this analysis. These provided estimates of year classes 1964 to 2004. I then fit a model of the form

$$I_{ya} = Y_y A_a \tag{1}$$

where

I_{ya} is the CPUE index for year class y at age a

Y_y is a year class factor

A_a is an age of capture effect

I set A_3=1 as a standardized age effect and then estimated by least squares the values of the Y's and A for ages 4 and 5. The Y is the index of year class strength.

It is important to note, especially with reference to year classes 1980 to 1986 that the Japanese LL data does not index true year class strengths, but escapement from the Australian fishery to the LL fishery. The strong dip in the index for year classes 1980 to 1986 may be due to high surface fishery exploitation rates over that period rather than low initial year class strengths.

New Zealand charter fleet LL data

The data used were the proportion of the catch in the NZ charter LL fleet that were in size classes classified as age 3 (86-102 cm), age 4 (102-114 cm) and age 5 (114-126 cm) from 1986 to 2007 (with 1996 missing). In most cases these proportions were very small, but as an indicator of year class strength using such a proportion has obvious limitations as the fraction in other sizes is not constant.

As with the Japanese LL data, I fit a model with least squares with year class effects and age at capture effects, and used the year class effect as an index of the year class strength.

SRP Tagging

The SRP tagging estimates of for year classes 1999 to 2004 were analyzed using data based on both age at release, and age of capture.

$$F_{yra} = Y_y R_r A_a \qquad (2)$$

where

F_{yra} is the estimated F for year class *y*, released at age *r*, and recovered at age *a*

Y_y is a year class factor

R_r is an age of release effect

A_a is an age of capture effect

Again least squares was used to find the value of year class effects.

Earlier Australian tagging data for cohorts 1989-1994 are also available for ages 1-5. I used these data in the same analysis, but fixing the age at release factor to age 2.

Again least squares was used to find the value for all parameters including year class effects. An index of year class strength was calculated by dividing the Australian surface fishery catch in tonnes in the year the cohort was age 3 by the estimated value of F_{yra}.

Scientific Aerial Survey

The scientific aerial survey index was taken directly from the Australian data files. The index was available for years 1993 to 2000 and 2005 to 2008. It was assumed to represent the 3 year old abundance and thus covered year classes 1990-1997 and 2002-2005.

Commercial Spotting (SAPUE) Index

The Commercial spotting (SAPUE) index was available for 2002-2008 and was assumed to represent the 3 year old abundance, thus covering the 1999-2005 year classes.

Trolling Index

The trolling indices were available as a estimated number of schools per 100 square km. Prior to 2003 only troll catches made during the acoustic surveys were available. For 2005 and 2006, troll catches from both acoustic and piston line surveys were available. For 2006 to 2008 piston line trolling indices were available. Where multiple indices were available an average was taken. It was assumed that the index reflected 1 year old SBT. Thus there are indices for year classes 1995-2002 and 2004-2007.

Standardization of Indices

Each index was then standardized to have an average of 1.0 over the year classes 1999 and 2004. These standardized indices are shown in Table 1.

Variances

Each of the papers presenting results for tagging, aerial survey, spotting and trolling provided variances, CV's or confidence intervals. No variance estimates are available for the two LL indices. It does not seem that these estimates of precision have much relevance to the actual reliability of these indices as representing recruitment. It would be useful to attempt to estimate the reliability of each index.

Summary of Tables and Figures.

Table 1 shows the standardized indices and the base case model run for year class 1964 to 2007. Prior to 1983 only the JPN LL and model estimates are available, and the model does not show the decline in year class strength in the early 1980s that the JPN LL index does. This is presumably because the JPN LL index declines due to the large surface fishery over this period and the model accounts for the removals from the surface fishery. Figure 1 shows all of the indices plotted against time, and Figure 2 shows recent years in more detail.

Table 1: Indices of year class strength standardized to an average of 1.0 between 1999 and 2004.

	JPN LL	NZ LL	SRP Tagging	Air Survey	Spotting	Trolling	Model
1964	3.21	#N/A	#N/A	#N/A	#N/A	#N/A	2.39
1965	2.34	#N/A	#N/A	#N/A	#N/A	#N/A	1.78
1966	3.44	#N/A	#N/A	#N/A	#N/A	#N/A	4.93
1967	4.64	#N/A	#N/A	#N/A	#N/A	#N/A	3.51
1968	4.55	#N/A	#N/A	#N/A	#N/A	#N/A	3.83
1969	4.52	#N/A	#N/A	#N/A	#N/A	#N/A	4.97
1970	3.75	#N/A	#N/A	#N/A	#N/A	#N/A	4.75
1971	1.58	#N/A	#N/A	#N/A	#N/A	#N/A	3.06
1972	1.52	#N/A	#N/A	#N/A	#N/A	#N/A	2.26
1973	2.28	#N/A	#N/A	#N/A	#N/A	#N/A	2.46
1974	3.29	#N/A	#N/A	#N/A	#N/A	#N/A	3.24
1975	2.05	#N/A	#N/A	#N/A	#N/A	#N/A	3.10
1976	2.13	#N/A	#N/A	#N/A	#N/A	#N/A	2.75
1977	1.62	#N/A	#N/A	#N/A	#N/A	#N/A	3.08
1978	1.81	#N/A	#N/A	#N/A	#N/A	#N/A	2.23
1979	1.54	#N/A	#N/A	#N/A	#N/A	#N/A	2.55
1980	1.08	#N/A	#N/A	#N/A	#N/A	#N/A	2.77
1981	0.69	#N/A	#N/A	#N/A	#N/A	#N/A	2.33
1982	0.45	#N/A	#N/A	#N/A	#N/A	#N/A	2.18
1983	0.55	#N/A	#N/A	#N/A	#N/A	#N/A	1.86
1984	0.89	0.81	#N/A	#N/A	#N/A	#N/A	1.96
1985	0.81	1.25	#N/A	#N/A	#N/A	#N/A	1.37
1986	1.05	2.87	#N/A	#N/A	#N/A	#N/A	1.60
1987	1.68	5.56	#N/A	#N/A	#N/A	#N/A	1.75
1988	2.60	3.52	#N/A	#N/A	#N/A	#N/A	2.07
1989	2.14	3.93	1.35[1]	#N/A	#N/A	#N/A	2.02
1990	2.05	2.73	1.27[1]	3.96	#N/A	#N/A	2.22
1991	1.50	0.86	1.31[1]	2.28	#N/A	#N/A	2.21
1992	1.10	1.16	1.16[1]	3.43	#N/A	#N/A	1.87
1993	0.91	1.95	0.76[1]	2.77	#N/A	#N/A	1.38
1994	1.15	2.88	0.84[1]	1.38	#N/A	#N/A	1.68
1995	1.22	2.80	#N/A	1.65	#N/A	2.22	1.65
1996	1.63	4.58	#N/A	0.62	#N/A	1.90	2.44
1997	1.52	3.59	#N/A	1.03	#N/A	2.78	1.49
1998	1.61	1.79	#N/A	#N/A	#N/A	3.41	1.51
1999	0.87	0.07	2.52	#N/A	1.23	0.65	1.13
2000	0.68	0.02	1.08	#N/A	0.62	0.18	0.64
2001	0.65	0.20	0.49	#N/A	0.61	0.00	0.93
2002	0.63	0.76	0.50	1.29	1.46	1.85	0.75
2003	1.07	0.93	0.28	0.89	0.98	#N/A	1.14
2004	2.09	4.03	1.13	0.82	1.10	2.33	1.40
2005	#N/A	#N/A	#N/A	1.51	1.57	5.25	0.69
2006	#N/A	#N/A	#N/A	#N/A	#N/A	8.34	

[1] These years were calculated before the over catch scenarios had been run and are therefore not included in Table 1 of the SAG Report.

2007	#N/A	#N/A	#N/A	#N/A	#N/A	9.58

Figure 1. Year class strength for each year class from 1964 to 2007.

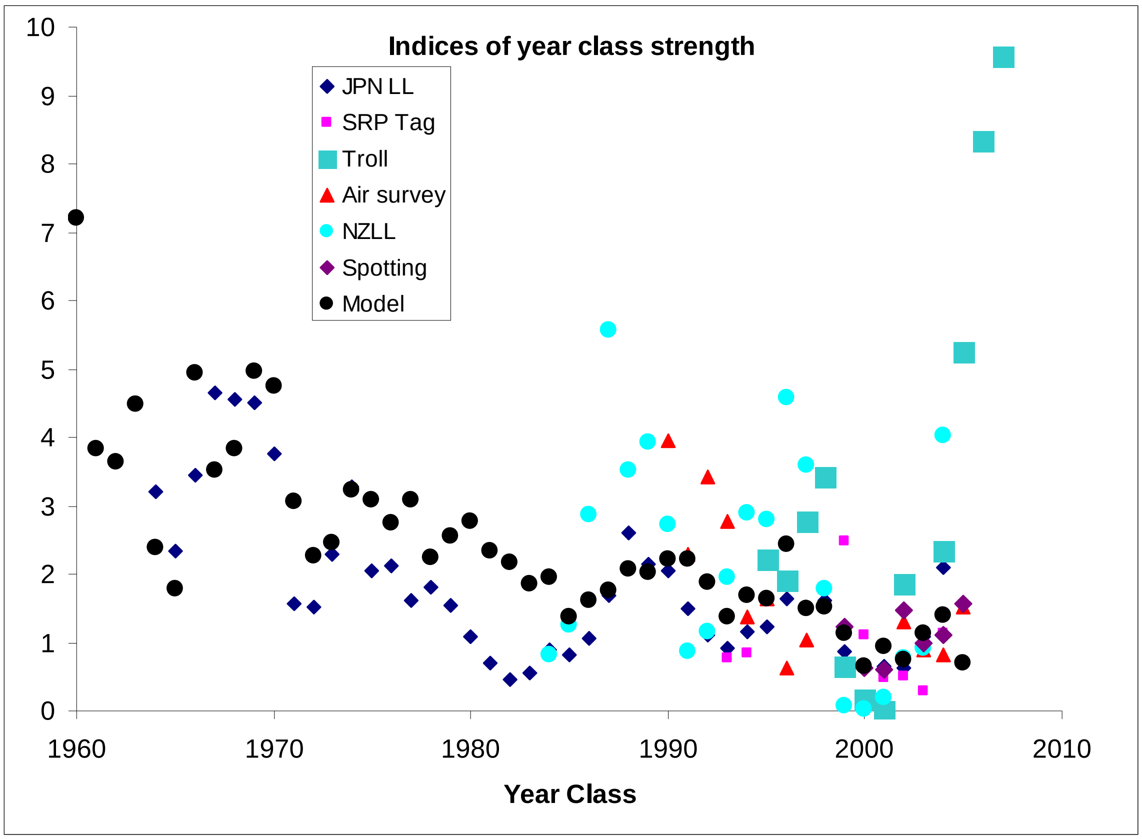
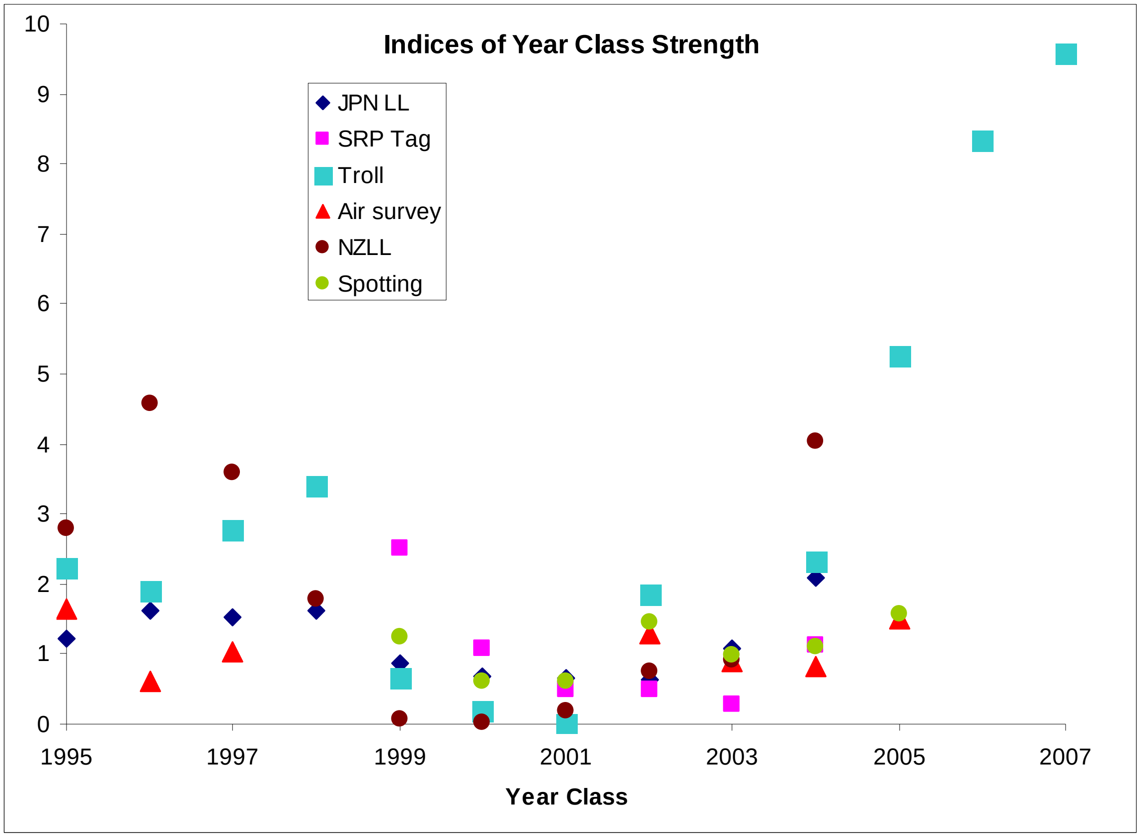


Figure 2. Year class strength for 1995 to 2007



Attachment 7

Details about model specification

Catch and CPUE scenarios

The report of SAG8 states that "The SAG agreed that the set of base case scenarios to be used in future analysis would be based on the same assumptions as scenarios "b", "c" and "d" defined in the report of SAG7 (Table 6, page 17). Where new information becomes available, these various hypotheses would be modified as appropriate."

The three scenarios selected as default differ in the extent of the effect of the unreported catch (UC) on the CPUE; other assumptions were identical (see report from SAG7 for further details):

		Scenarios from SAG7		
		a	B	c
CPUE	Effect of unreported catch on CPUE	25%	50%	75%
Surface fishery	Farm age composition	shifted for 20% increase in average weight		
LL1	Assumed lag from *LL1* catch to fish appearing in market	$M_y = 0.3C_{y-1} + 0.7C_{y-2}$		
	LL1 unreported catch in 2005	assumed equal to 2004		
	Market estimates	based on Case 1 from Market Report		
	Overcatch prior to 1989	assumed to be zero		

The following changes were considered:

LL1 scenarios

The meeting supported the use of information in paper CCSBT-ESC/0809/40 to recalculate the market anomalies and corresponding *LL1* unreported catch scenarios. Caveats related to the inappropriateness of applying information collected in 2007-2008 to previous years given many changes in the fishery were acknowledged, but the information was still considered better than that used to justify the previous (0.30-0.70) assumption. A new scenario for unreported *LL1* catches was produced by solving for the catches that minimized the differences between the market estimates M_y for each year *y* and the expected overall market volume $\hat{M}_y$ predicted from the lagged catches C_y according to

$$\hat{M}_y = 0.07C_{y-1} + 0.86C_{y-2} + 0.07C_{y-3} \qquad (1)$$

where C_y are the total *LL*1 catches (reported + UC). The M_y were set at the Case 1 market estimates for 1985-2005 (by Lou and Hidaka, pages 97-98 of Market report), same as used to compute scenarios "b", "c" and "d" at SAG7. Also, the UC for 2005 was set equal to the UC of 2004. The "Solver" tool of Excel was used to minimize the sum of squared differences between M_y and $\hat{M}_y$.

It was noted that prior to 1990 the market anomalies (i.e., the difference between the market estimates and those predicted from lagged reported catches) were small on average and some were negative (Figure 1). The sum of the calculated UC_y prior to 1989 was small (less than 250 mt). Considering the uncertainties in the market estimates and the small cumulative UC estimated over this period, the meeting decided to maintain the assumption of zero UC prior to 1989 made by SAG7 to compute scenarios "b", "c" and "d".

CPUE

The two CPUE series estimated in paper CCSBT-ESC/0809/9 based on w0.5 and w0.8 will be used in conditioning. Given the changes in management commencing in 2006, only data up to 2006 will be used in the base case (exclude 2007).

New data used for conditioning

Aerial survey

The meeting decided to fit the conditioning model to the aerial survey data treated as a relative index of biomass (note that spotters estimate biomass) of age classes 2 to 4, predicted as

$$\hat{I}_i = \sum_{a=2}^{a=4} s_a w_{y_i,a} N_{y_i,a} \,,$$

where s_a indicate selectivities-at-age and w_{y_i} are weights at age for season 1 in year *y*. An initial attempt to estimate the selectivity parameters produced unrealistic results (selectivity estimated close to 1 for age 4 and cero to ages 2 and 3). The meeting concluded that the parameters were un-estimable given that the time series does not go back far in time and abundances at age of the involved cohorts are uncertain. Three selectivity scenarios were considered:

Option	s_2	s_3	s_4
1	1	1	1
2	0.5	1	1
3	0.33	1	0.33

A log-normal likelihood with added process error was used:

$$-\ln L_{\text{aerial}} = \sum_{i=1}^{n_{\text{aerial}}} \ln(\sigma_i) + 0.5 \sum_{i=1}^{n_{\text{aerial}}} \left(\frac{\ln(I_i) - \ln \hat{q}_{\text{aerial}} - \ln(\hat{I}_i)}{\sigma_i^2} \right)^2$$

with $\sigma_i^2 = s_{i,\text{aerial}}^2 + \tau_{\text{aerial}}$, where $s_{i,\text{aerial}}^2$ is the empirical sampling variance (set equal to the square of the estimated survey cv) and τ_{aerial} is an estimated parameter representing added process error (which would impact projections for MP considerations). The MLE estimate of the log-catchability was used:

$$\ln \hat{q}_{\text{aerial}} = \frac{\sum_{i=1}^{n_{\text{aerial}}} \left(\frac{\ln(I_i) - \ln(\hat{I}_i)}{\sigma_i^2} \right)}{\sum_{i=1}^{n_{\text{aerial}}} \left(\frac{1}{\sigma_i^2} \right)}.$$

Commercial spotter data

There were concerns that this index depends on the fishery and lacks proper survey design. Since the OM is fitted to the aerial survey, the commercial spotter data will not be included in the fit and only used as an indicator. The consistency of this indicator with model predictions will be examined.

Trolling (Piston line)

The SRP review noted that the range is narrow in both time and space and presently may be of limited value for formal inclusion. However, it may be useful for qualitative comparisons and as a consistency check since it seems to capture trends in recruitment as seen in other indices. Whether this index is proportional to true abundance is unknown and how it should be modeled requires careful consideration.

The meeting proposed as a first cut, assume strictly proportional and use the data from 1996 onwards, assume a constant σ^2_{piston}, and model as an index of one-year olds that follows a normal distribution.

NZ CPUE

This index has potentially limited value since the fishery operates in areas at the extreme of the range for juvenile SBT. While the data quality is very high (due to observer coverage), environmental effects may affect inter-annual distribution patterns leading to high variability of this index. The archival tag data may provide insight on how distribution patterns change over time. Nonetheless, area 6 may provide some information. The possibility of evaluating its consistency with model predictions (as proposed for the commercial spotter data) was seen as desirable, but is given a low priority.

Newer tag data

The "new" conventional tag releases began in 2000-2001 and recoveries are continuing. The application of this is considered important in both conditioning and for future projections. In 2007, issues related to reporting rates were seen as problematic.

Ideally, the dynamics of the different tag releases should be modeled as separate cohorts. The current model formulation used to fit the old tag data aggregates the tagged cohorts, and therefore does not make full use of the information contained in the data, in particular with regard to natural mortality. The implementation of a new formulation for the analysis of tag data requires programming and analyses that could not be completed during the meeting. The Sag recommended that further examination of alternative ways to incorporate the old and new tagging data be conducted

A proposal was made for converting estimates as presented in ESC0908 (as *Fs*) into effort effectively creating age-specific CPUE indices.

Model assumptions

The model conditioning will be from 1931-2007 with the first catch data year in 1952 and the last in 2007, and use CPUE data from 1969-2006.

The following options were maintained from previous years when the input data were updated to include 2007:

Item:	**Structure for update to sbtmod20 with data to 2007:**
Autocorrelation (AC) of S-R residuals	Empirical AC based on 1965-2002 estimates applied from 2006 onward
Catchability (*LL1*) scalar	Hardwired 0.5% increase in catchability per year
selectivity changes for *LL1*	every 4 yrs, with last change in 2005 (last block is 3 yrs)
Selectivity of *LL2* (Taiwanese)	Constant selectivity
selectivity changes for Indo	Every other year with CV= 0.5
Selectivity changes for Aus	Every year since 1997 (CV=2), every 4 years before 1997
Tag reporting rates	Based on option 8 corrected for overcatch scenarios
Penalty on high Aus harvest rates	2003 and 2004 Catch(3)/N(3) penalized if > 0.6

Some possible changes were considered and a series of exploratory runs were conducted to evaluate fits under alternative assumptions (details in Attachment 8).

LL1 selectivity

The meeting agreed to allow changes in selectivity in 2006 and 2007 to accommodate the effects of management changes commencing in 2006. The assumption of selectivity changes in 4-year blocks will be retained for years prior to 2006.

LL2 selectivity

The assumption of constant selectivity led to poor fit of the *LL2* size composition for recent years. Under constant selectivity the data are incompatible with an increase in recruitment in recent years. The lack of small fish could be due to continuing low recruitment or to a change in selectivity of the fleet. Although the *LL2* data have comparatively little weight in the fit (small sample sizes assumed), the meeting recommended evaluating the sensitivity of recent recruitment estimates to changes in selectivity.

Surface fishery selectivity assumption

Presently CV on time-variability is quite high. The fit to the size composition of the surface fishery deteriorated considerably when the CV on time-variability was reduced. The meeting decided to retain the high CVs.

Indonesian Selectivity

The effect of constraining selectivity changes over time was discussed and one exploratory run was conducted, but priority was given to other issues.

LL1 catchability

There was debate on whether the *LL1* fleet had improvements in technology that effectively increased effort by a rate of 0.5% per year (beyond the standardizations already accounted for in the CPUE analyses). Search time has not appeared to have changed in the last 3 or 4 years. The meeting agreed, for this interim, to keep this effective change in effort as used in previous scenarios.

Tag reporting rates

Tag reporting rates need to be recomputed based on the new *LL1* scenarios. Because the catch scenario based on the new lags was very similar to the one used in 2006, the meeting decided to proceed with the analyses to be conducted during the SAG using the reporting rates computed in 2006. Reporting rates will be recomputed for 2009.

Autocorrelation in stock-recruitment

The following assumptions are made in the current code:

Conditioning

The likelihood assumes no autocorrelation except for 2006-2008 (when the last year of data is 2007). The empirical autocorrelation of recruitment residuals estimated over the period 1965-2002 is applied from 2006 onward. Let τ_y represent the lognormal recruitment deviate in year *y* and $\hat{\tau}_y$ its MPD estimate. The initial abundances passed to the projection code (when troll data are not included) correspond to

$\hat{\tau}_{2005}$ estimated from model fit

$$\hat{\tau}_{2006} = \rho\hat{\tau}_{2005}$$
$$\hat{\tau}_{2007} = \rho^2\hat{\tau}_{2005}$$
$$\hat{\tau}_{2008} = \rho^3\hat{\tau}_{2005}$$

where $\hat{\rho}$ is the empirical estimate of autocorrelation based on recruitments for years 1965-2002.

Projection

Lognormal autocorrelated error is added to the initial abundances (numbers at age 0 through 2 in 2008) within the projection code.

$$N_{2008,4} = \hat{N}_{2008,4} \exp\{0.4z - 0.08\}$$
$$N_{2008,3} = \hat{N}_{2008,3} \exp\{0.4z - 0.08\}$$
$$N_{2008,2} = \hat{N}_{2008,2} \exp\{\varepsilon_{2006}\}$$
$$N_{2008,1} = \hat{N}_{2008,1} \exp\{\hat{\rho}\varepsilon_{2006} + \varepsilon_{2007}\}$$

$$N_{2008,0} = \hat{N}_{2008,0} \exp\{\hat{\rho}^2 \varepsilon_{2006} + \hat{\rho}\varepsilon_{2007} + \varepsilon_{2008}\}$$

where $z \sim N(0,1)$ and $\varepsilon_y \sim N\left(0,(1-\hat{\rho}^2)\sigma_R^2\right)$, where σ_R=0.6. Note that log-normal error with s.d.=0.4 has been added to account for uncertainty around $\hat{N}_{2004,0}$ and $\hat{N}_{2005,0}$.

These equations imply that:

$$\tau_{2008} = \hat{\tau}_{2008} + \hat{\rho}^2 \varepsilon_{2006} + \hat{\rho}\varepsilon_{2007} + \varepsilon_{2008}$$

which is used to generate $\tau_{2009} = \hat{\rho}\tau_{2008} + \varepsilon_{2009}$ and so on.

This formulation amounts to assuming autocorrelated recruitment starting in 2006. It was noted that because point estimates from the different grid cells are used for projections (instead of a full Bayesian approach) this method would tend to propagate the 2005 recruitment deviate into the future, without properly reflecting its uncertainty. To address this problem, an evaluation was included in which the recruitment deviate for 2007 will be uncorrelated to the previous deviates.

Grid integration and sensitivity trials

Grid used in 2006:

	Levels	Cumul N	Values			Prior	Simulation Weights
Steepness (*h*)	3	3	0.385	0.55	0.73	0.2, 0.6, 0.2	Prior
M_0	3	9	0.30	0.40	0.50	Uniform	Posterior
M_{10}	3	27	0.07	0.1	0.14	Uniform	Posterior
ϖ	2	54	0.75		1	0.4, 0.6	Posterior
CPUE	5	270				Uniform	Prior
q age-range	2	540		4-18	8-12	0.67, 0.33	Prior
Sample Size	2	1080		Sqrt	Original/2	Uniform	Prior

The old OM used likelihood-based weights to sample the grid cells along the M_0, M_{10} and ω axes. An alternative method for sampling the grid was considered in 2006 which involved assigning fixed weights to the three M_0 levels (0.4 for M_0=0.3, 0.4 for M_0=0.4 and 0.2 for M_0=0.5). Results presented in paper CCSBT-ESC/0809/35 indicate that when the overcatch scenario was added to the reported *LL1* catch, the use of likelihood-based weights in the grid integration gave very little weight to the high and mid values of M_0, the low value of M_{10} and the $\varpi = 0.75$. The meeting decided to use fixed weights equal to the prior in the base case and evaluate sensitivity to the use of likelihood-based weights. The structure of the new proposed grid is as follows:

Specification of axes to be considered for the new "grid."

	Levels	Cumul N	Values			Prior	Simulation Weights
Steepness (h)	3	3	0.385	0.55	0.73	0.2, 0.6, 0.2	Prior
M_0	3	9	0.30	0.40	0.50	Uniform	Prior
M_{10}	3	27	0.07	0.1	0.14	Uniform	Prior
ϖ	2	54	0.75		1	0.4, 0.6	Prior
CPUE (w.5, w.8)	2	108				Uniform	Prior
q age-range	2	216	4-18		8-12	0.67, 0.33	Prior
Sample Size	2	432	Sqrt		Original/2	Uniform	Prior

The following cases were retained for sensitivity evaluation:

1) Effects of overcatch on CPUE: 50% and 75%.
2) *LL1* overcatch scenario based on Case 2 of Market Report
3) Projected recruitment deviates uncorrelated to historical estimates from conditioning.
4) Include troll survey data.
5) Truncate CPUE series in 1992.
6) Use 5 historical CPUE series (i.e. incorporate 3 more series – nominal, Laslett and St window– in addition to w.5 and w.8).
7) Break *CPUE* into two time series, the second starting in 1986.
8) Use likelihood-based weights for M_0, M_{10} and ω for grid integration.
9) Increase the CV on CPUE to 0.30 and set the additional process error estimated for the aerial survey (τ_{aerial}) to 0

Other Projection issues

Fishery-biology:

LL1 Selectivity: Random-walk processes as assumed in conditioning are not appropriate because they may result in the selectivities wandering off into implausible regions. Instead, the current projection model starts with most recent estimates of selectivity and adds autocorrelated process error according to:

$$s_{1,a,y+1} = s_{1,a,y} \exp\{\varepsilon_{a,y}\} \quad \text{for} \quad a_1^{\min s} \geq a \geq a_1^{\max s} \quad \text{where} \quad a_1^{\min s} = 2,\ a_1^{\max s} = 17$$

$$\varepsilon_{2,y} = \eta_{2,y}$$

$$\varepsilon_{a+1,y} = \rho_{\text{sel1}}\, \varepsilon_{a,y} + \sqrt{1-\rho_{\text{sel1}}^{\ 2}}\, \eta_{a,y}, \qquad \text{where} \quad \eta_{a,y} \sim N(0, 0.2^2) \quad \text{and} \quad \rho_{\text{sel1}} = 0.7$$

(note that first subscript corresponds to fishery f=1). Selectivities only change every four years so that $s_{1,a,y+3} = s_{1,a,y+2} = s_{1,a,y+1} = s_{a,y}$.

It was note that the current model specification results in a bimodal selectivity in 2006 and 2007. Before the end-year selectivity was from a 4-year block. The meeting concluded that given the changes in management, the use of the average of the last 3 years (2006-2008) will be more appropriate.

Weight-at-age (by season from growth curve): constant as in last year of data. The group recommended that further research be conducted on the variability in mean weights-at-age within different fisheries (using real data).

M at age: constant at values in scenario

Projection outputs:

1) From grid integration:
    a. Time series of medians and $\underline{+}$ CI of recruitment,
    b. spawning biomass
    c. *LL1* effort
    d. Median of B2008/B1980
2) Medium-term (where xx=2004 and 2008):
    a. probability of B2014 > Bxx
    b. median B2014/Bxx
    c. lower 10th-percentile B2014/Bxx
3) Longer-term performance (where xx=1980, 2004, and 2008)
    a. median B2022/Bxx
    b. lower 10th-percentile B2022/Bxx

Evaluations of alternative conditioning configurations for the operating model

Introduction

During SAG9 a number of model runs were completed for evaluation and exploration. After a preliminary set of model runs (not presented here) the MP working group arrived at a preliminary base case configuration from which to contrast alternative data and model configurations. The purpose of these model runs was to evaluate possible future axes within the grid set or for an alternative base model. The process and carryover of model specifications from previous years was presented in the SAG9 report.

The following options were maintained from previous years:

Item:	Structure for update to sbtmod20 with data to 2007:
Autocorrelation (AC) of S-R residuals	Empirical AC based on 1965-2002 estimates applied from 2006 onward
Catchability (*LL1*) scalar	Hardwired 0.5% increase in catchability per year
Selectivity changes for *LL1*	every 4 yrs, with last change in 2005 (last block is 3 yrs)
Selectivity changes for Indo	Every other year with CV= 0.5
Selectivity changes for Aus	Every year since 1997 (CV=2), every 4 years before 1997
Tag reporting rates	Based on option 8 corrected for overcatch scenarios (May change w/ different overcatch?)
Penalty on high Aus harvest rates	2003 and 2004 Catch(3)/N(3) penalized if > 0.6

The preliminary base-case (BASE) contains the following elements:
- The selectivity for the Taiwanese fleet (LL2) was blocked such that constant selectivity was assumed prior to 2002, then selectivity separate values estimated for the periods from 2002-2005, and 2006-2007.
- Aerial survey included (w/ τ estimated and age 2, 3, 4 selectivity set to values of 0.5, 1.0, and 1.0)
- Lower bound on CV for CPUE is 20% (previously the CV had a lower bound of 10%)
- CPUE scenario overcatch impact 25%

From these, an initial set of model explorations were specified (Table 1).

A second batch of model alternatives evaluated the impact of over-catch assumptions on the CPUE data and also extracted some of the grid variables done from previous analyses (i.e., the assumptions on natural mortality and stock recruitment steepness). These models were done to evaluate possible inclusion as future grid axes and for further explorations (Table 2).

Results

Exploratory set 1

Summary statistics for the impact of the different model results indicate that the range of stock size relative to theoretical unfished levels spanned 3.3% to 8.4% with the three lowest levels of stock size attributed to models where the CPUE data were ignored after 1992 (Table 3).

While total –ln(Likelihoods) contrasted across these models will vary due to different levels of data (i.e., including troll information or omitting part of the longline CPUE series), it is useful to evaluate how the separate data components interact (Table 4). For example, truncating the CPUE series generally improves the fit to other components, in particular the tagging data and the aerial survey.

Trends in results and estimates of stock-recruitment relationship for the initial batch of model runs are shown in Figures 1-6 while the fits to the different series are shown in Figures 7-12 (Note that not all data presented in these figures were used in the fitting—in all cases the commercial spotter information (SAPUE) was omitted from model fitting. From these, the largest impact on recent recruitment estimates was from models which included the troll survey data which provides an index of age-1 recruitment (Fig. 13). This increase is partly attributed to the lack of other information in the most recent year. From Fig. 13, it was noted that the large degree of uncertainty of year-class strength in the most recent year was due to the lack of any data on their magnitudes and is based expected values from the stock recruitment relationship. For projection purposes, these most recent year-classes were modelled following specifications described in Attachment 7.

The SAG9 meeting noted that there was in impact of assuming constant selectivity for the Taiwanese selectivity and this was evident in comparing the Base model fits with the constant-selectivity model (Fig. 14)

Exploratory set 2

Alternative models were drawn from different CPUE overcatch impacts and from past grid specifications and showed that the higher impact of overcatch allowed on the CPUE index resulted in worse overall fits and that lower values of M_0 were favoured (Table 5). The range of stock sizes ranged more broadly from 7.1% to 13.2% of unfished stock size estimated for 2008 (Table 6).

These models resulted in a broad range of stock size estimates and recruitment (Fig 15). The fit to the CPUE data generally degrades as the magnitude of overcatch impact increases (Fig. 16).

Tables

Table 1. Description of model alternatives evaluated that were brought forward during SAG9 (with changes relative to the base case highlighted)

Scenario	CPUE end year	τ_{aerial}	Troll data included?	Taiwanese Selectivity
Base	2006	Estimated	No	Varies 3-periods
Truncate CPUE	1992	Estimated	No	Varies 3-periods
Truncate CPUE, $\tau_{aerial} = 0$	1992	Fixed at 0	No	Varies 3-periods
With troll	2006	Estimated	Yes	Varies 3-periods
Truncate CPUE with troll	1992	Estimated	Yes	Varies 3-periods
Constant Taiwanese selectivity	2006	Estimated	No	Constant

Table 2. Description of the second set of model alternatives that were evaluated during SAG9.

Alternative	Description relative to base model
CPUE 50%	Overcatch impact on CPUE from 25% to 50%
CPUE 75%	Overcatch impact on CPUE from 25% to 75%
Low *M*	Change M_0/M_{10} from 0.4/0.1 to 0.3/0.07
High *M*	Change M_0/M_{10} from 0.4/0.1 to 0.5/0.14
Low M_0, **High** M_{10}	Set $M_0 = 0.3$, $M_{10} = 0.14$
Low steepness *h*	Change stock recruitment steepness from 0.55 to 0.385
High steepness *h*	Change stock recruitment steepness from 0.55 to 0.73

Table 3. Summary outputs from model scenarios (listed in Table 1). SSB refers to spawning stock biomass.

Scenario	Unfished SSB (SSB_0)	SSB_{2008}	SSB_{2008}/SSB_0
Base	1,041,240	74,144	0.071
Truncated CPUE	1,016,880	37,469	0.037
Truncated CPUE, $\tau_{aerial} = 0$	1,014,410	33,885	0.033
With troll	1,063,200	88,781	0.084
Truncated CPUE with troll	1,047,620	72,197	0.069
Constant Taiwanese selectivity	1,039,000	76,285	0.073

Table 4. Negative log-likelihood values for the main components of the conditioned operating model by alternative scenarios (listed in Table 1).

	Length frequency				Age composition						
Scenario	LL1	LL2	LL3	LL4	Indon.	Surface	CPUE	Tags	Aerial	Troll	Total
Base	165.1	47.7	52.8	102.5	50.0	29.0	-53.0	6.7	-3.5	0.0	446.2
Truncate CPUE	165.5	47.4	52.7	102.4	49.9	29.3	-57.7	5.3	-4.4	0.0	439.6
Truncate CPUE, $\tau_{aerial} = 0$	166.1	47.5	52.7	102.5	49.5	29.3	-57.7	5.2	-1.7	0.0	442.7
With troll	166.8	48.8	52.9	102.1	49.8	28.8	-52.9	7.3	-2.2	-1.8	453.3
Truncate CPUE with troll	166.5	48.7	53.0	101.8	49.9	28.8	-57.5	6.4	-2.7	-1.7	447.7
Const. Taiwanese selectivity	166.8	61.7	52.7	102.5	50.2	29.1	-53.2	6.9	-3.8	0.0	458.7

Table 5. Negative log-likelihood values for the main components of the conditioned operating model by second set of alternative configurations (as listed in Table 2).

	Length frequency				Age composition					
Scenario	LL1	LL2	LL3	LL4	Indon.	Surface	CPUE	Tags	Aerial	Total
Base	165.1	47.7	52.8	102.5	50.0	29.0	-53.0	6.7	-3.5	446.2
CPUE 50%	165.3	47.9	52.7	103.0	50.2	29.1	-49.9	7.2	-3.6	451.0
CPUE 75%	165.5	48.0	52.6	103.4	50.6	29.2	-45.9	7.7	-3.6	457.5
Low *M*	165.4	47.6	52.9	101.6	51.2	29.0	-52.3	5.7	-2.9	449.4
High *M*	163.8	48.3	53.0	102.2	49.4	29.1	-50.7	20.1	-3.5	460.3
Low M_0, **High** M_{10}	163.3	47.9	53.4	102.5	49.0	28.9	-52.3	6.0	-3.4	442.8
Low steepness *h*	164.6	47.8	53.4	102.7	50.7	29.0	-52.5	7.8	-3.6	449.3
High steepness *h*	165.7	47.7	52.3	102.2	49.4	29.0	-53.2	6.3	-3.2	445.6

Table 6. Summary outputs from second batch of model evaluations (listed in Table 2). SSB refers to spawning stock biomass.

Scenario	Unfished SSB (SSB_0)	SSB_{2008}	SSB_{2008}/ SSB_0
Base	1,041,240	74,144	0.071
CPUE 50%	1,041,650	79,970	0.077
CPUE 75%	1,043,140	88,560	0.085
Low *M*	1,708,550	225,323	0.132
High *M*	651,982	56,943	0.087
Low M_0, **High** M_{10}	779,301	71,012	0.091
Low steepness *h*	1,286,120	108,906	0.085
High steepness *h*	862,864	56,607	0.066

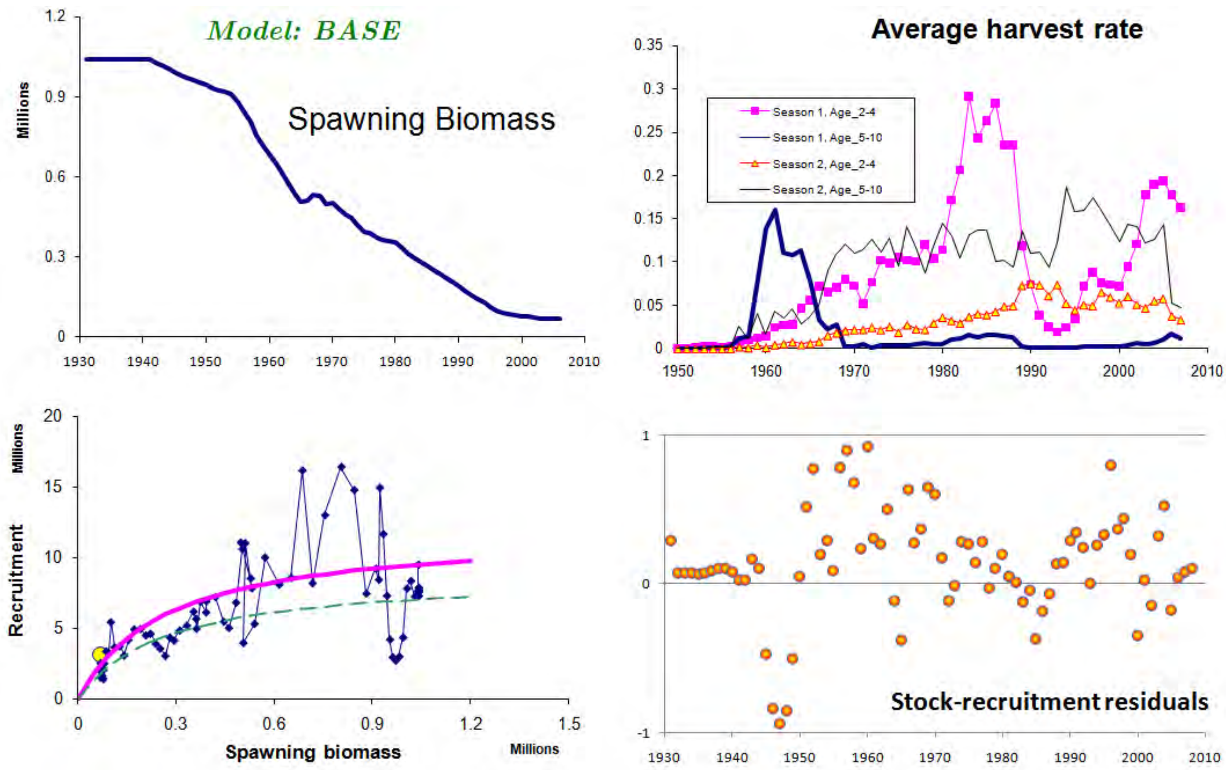


Figure 1. Conditioned SBT model trends in (clockwise from top left) spawning biomass, harvest rates by age group and season, stock-recruitment residuals (log-scale), and stock-recruitment relationship for the **base** model (described in Table 1).

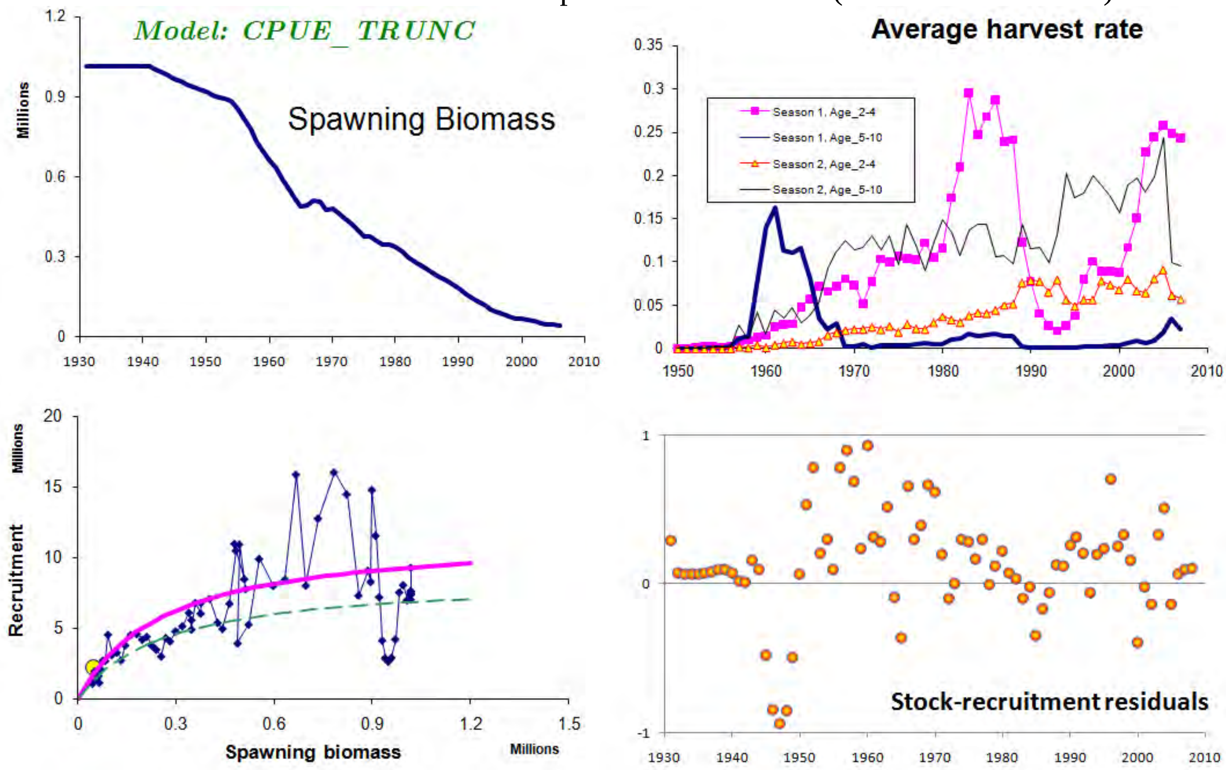


Figure 2. Conditioned SBT model trends in (clockwise from top left) spawning biomass, harvest rates by age group and season, stock-recruitment residuals (log-scale), and stock-recruitment relationship for the **CPUE data truncated** model (described in second row of Table 1).

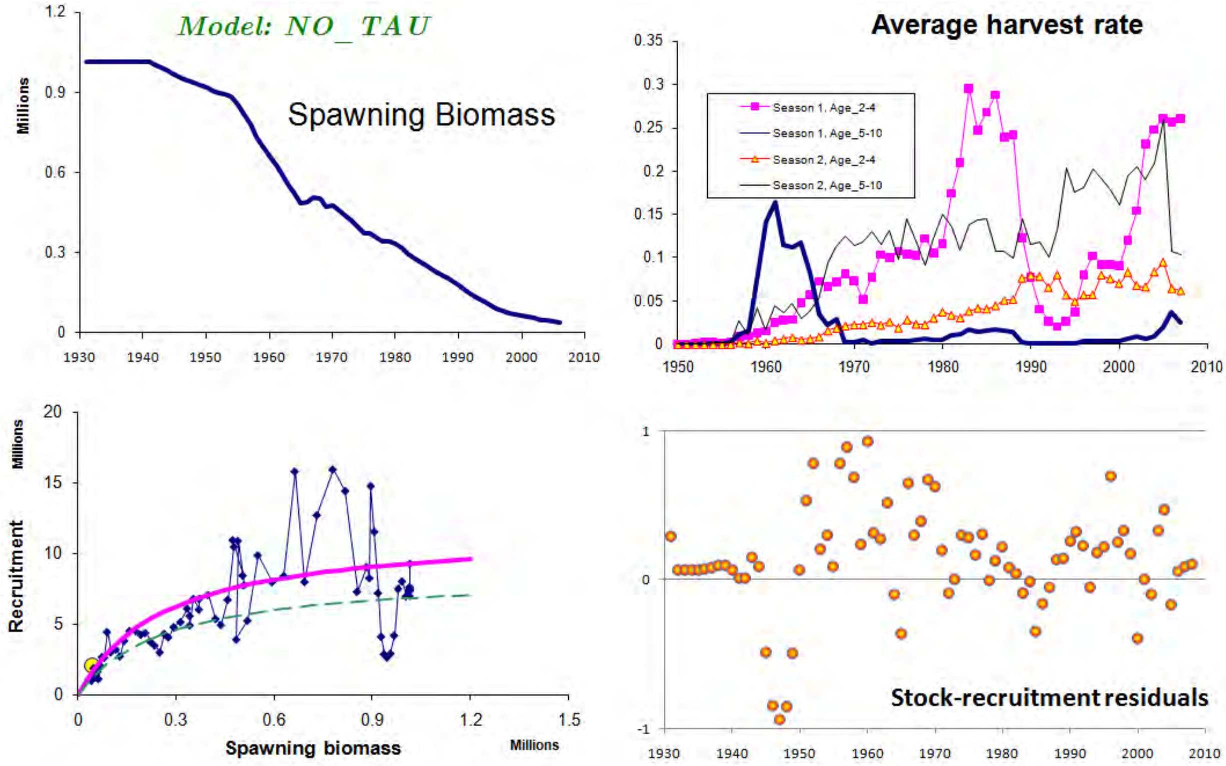


Figure 3. Conditioned SBT model trends in (clockwise from top left) spawning biomass, harvest rates by age group and season, stock-recruitment residuals (log-scale), and stock-recruitment relationship for the τ_{aerial} **set to zero** model (described in the third row of Table 1).

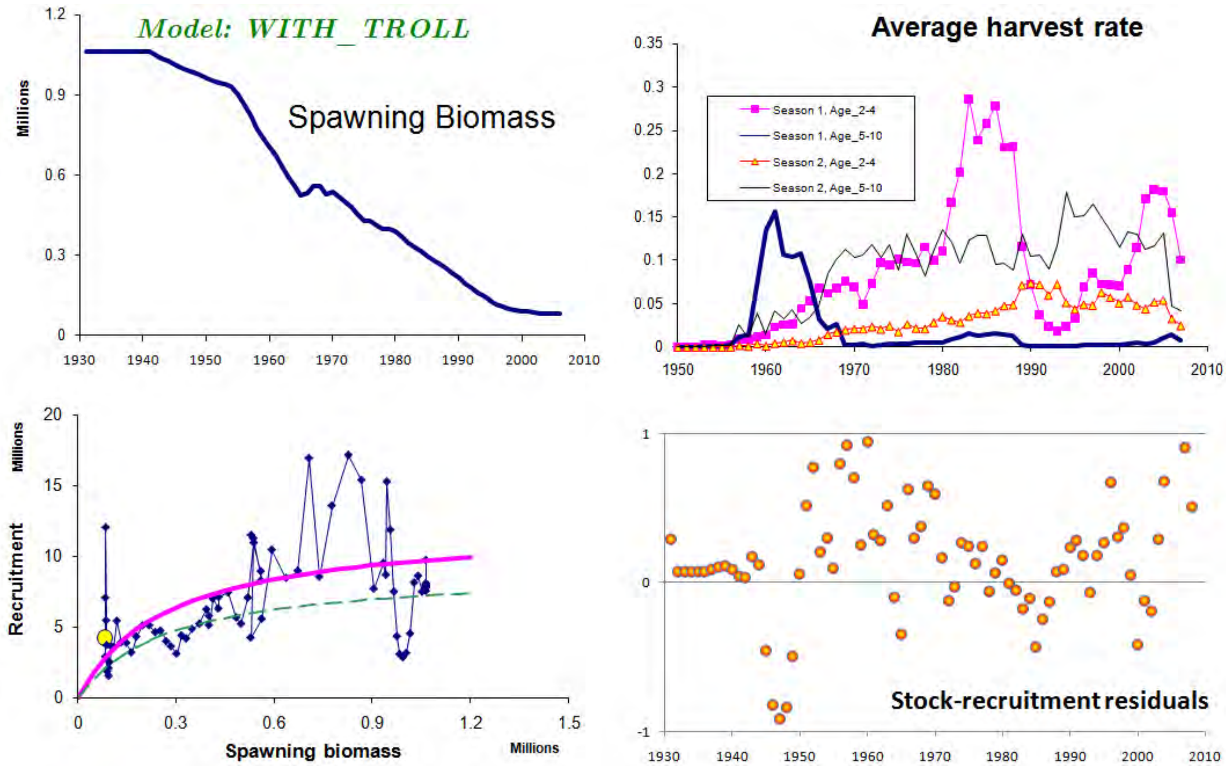


Figure 4. Conditioned SBT model trends in (clockwise from top left) spawning biomass, harvest rates by age group and season, stock-recruitment residuals (log-scale), and stock-recruitment relationship for the model **with troll survey data included** (described in Table 1).

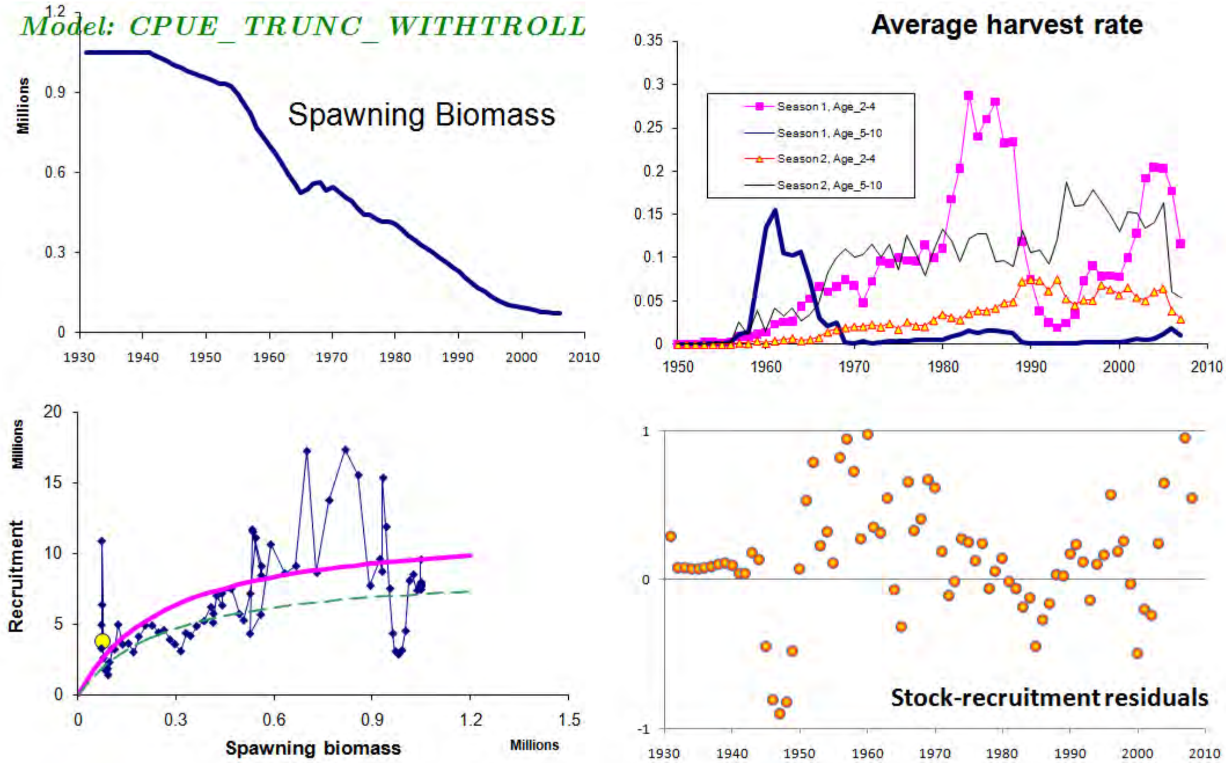


Figure 5. Conditioned SBT model trends in (clockwise from top left) spawning biomass, harvest rates by age group and season, stock-recruitment residuals (log-scale), and stock-recruitment relationship for the model **with troll survey data included and CPUE data truncated** (as described in Table 1).

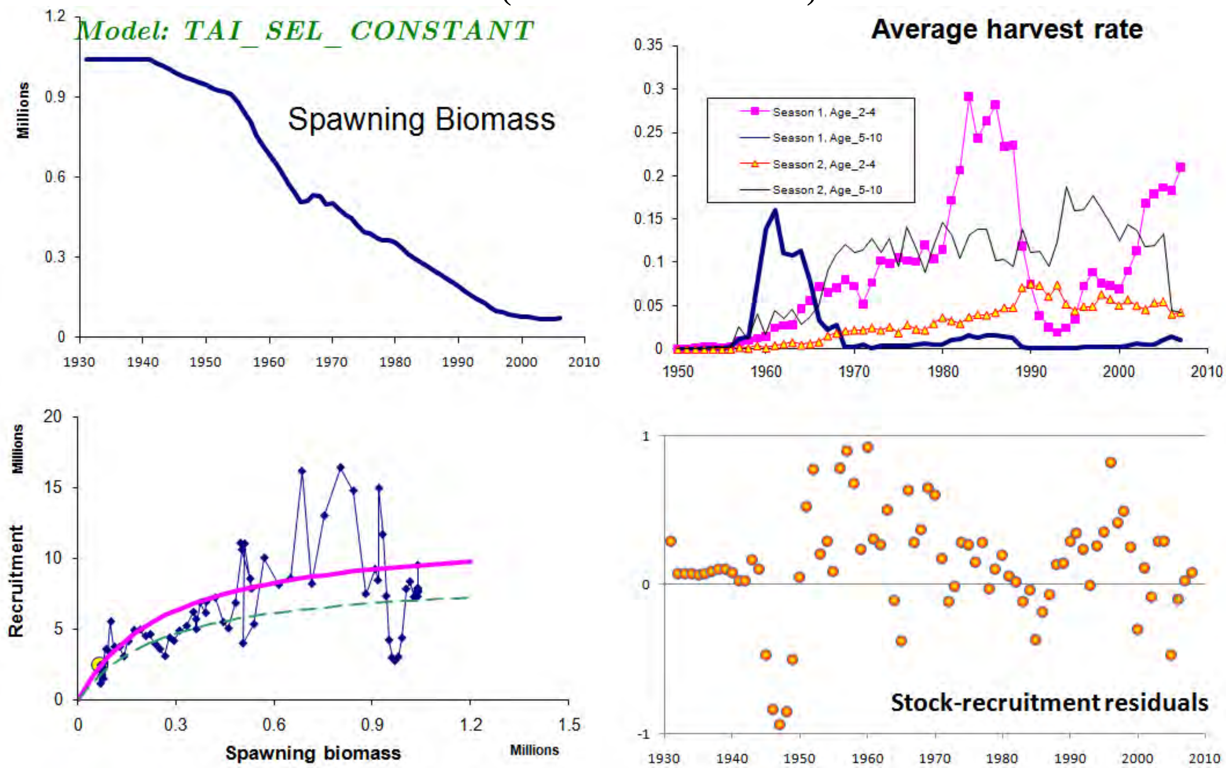


Figure 6. Conditioned SBT model trends in (clockwise from top left) spawning biomass, harvest rates by age group and season, stock-recruitment residuals (log-scale), and stock-recruitment relationship for the **constant-Taiwanese longline selectivity** model (described in Table 1).

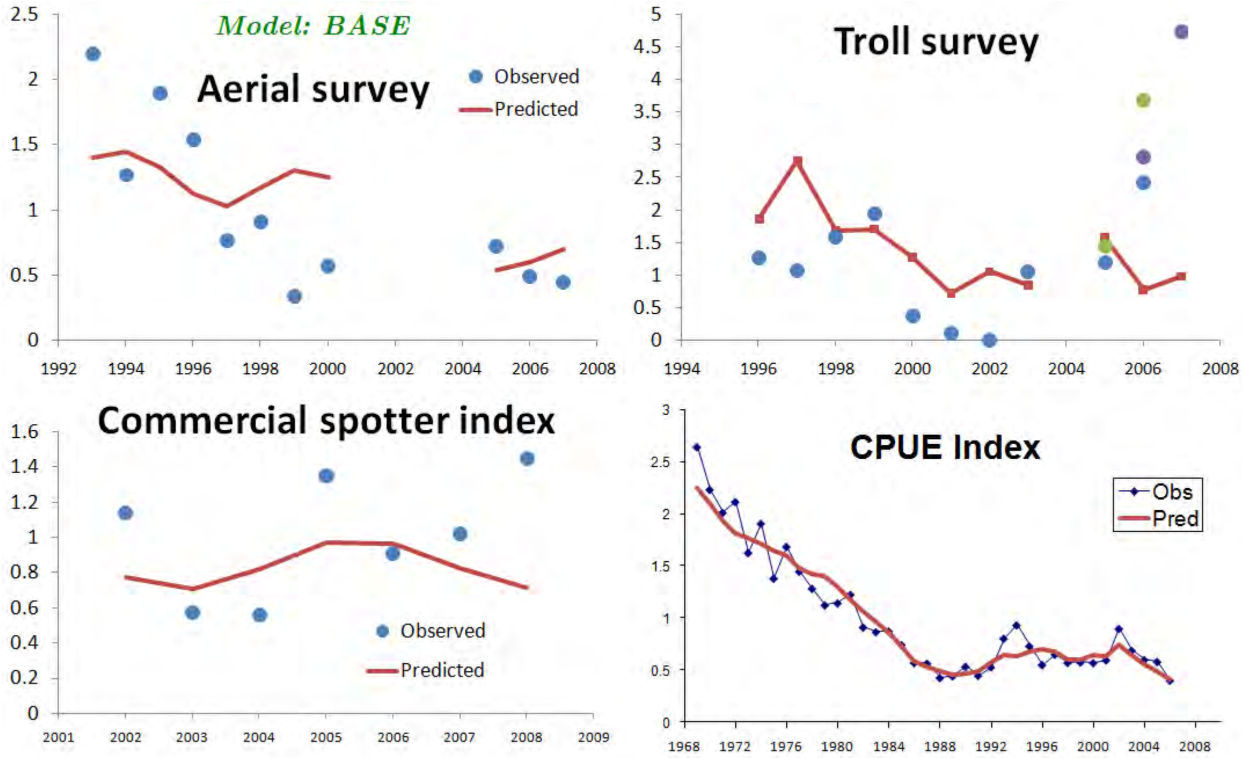


Figure 7. Conditioned SBT model fits to (clockwise from top left) the aerial survey, the troll survey, the commercial spotter index (SAPUE) and the Japanese longline CPUE for the **base** model (described in Table 1).[1]

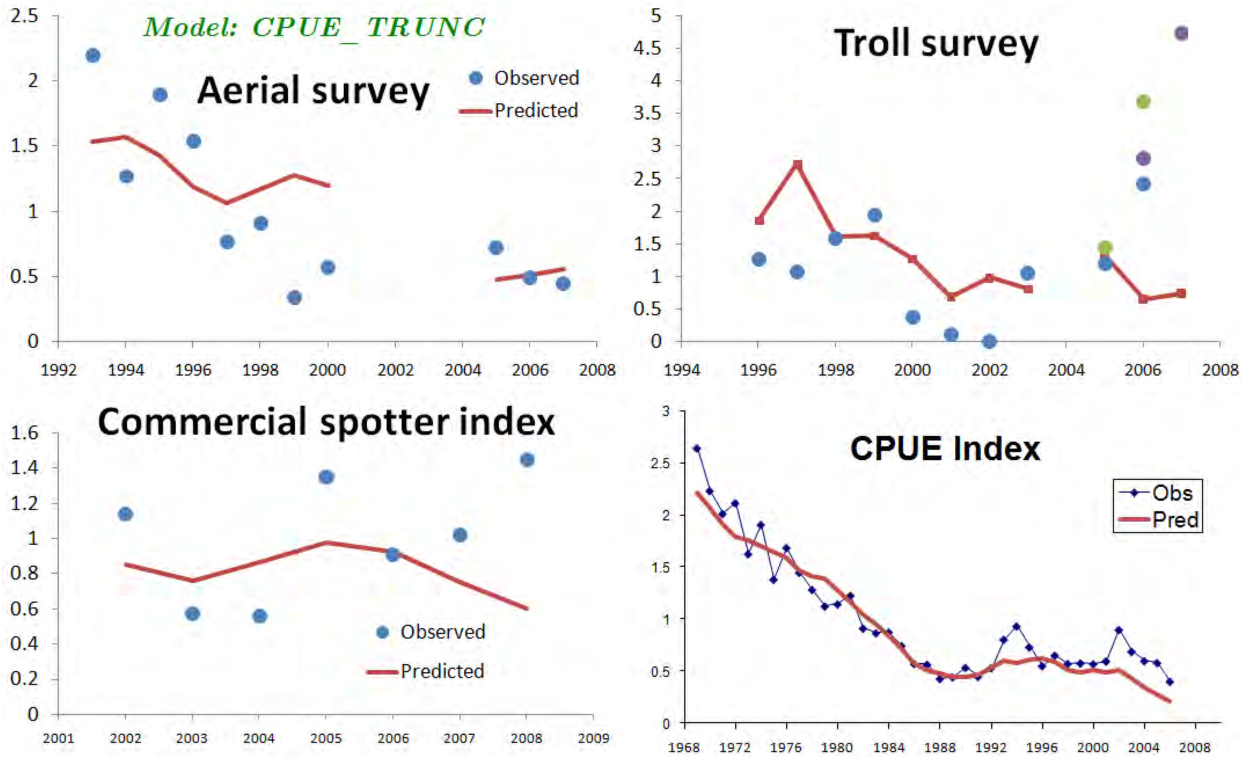


Figure 8. Conditioned SBT model fits to (clockwise from top left) the aerial survey, the troll survey, the commercial spotter index (SAPUE) and the Japanese longline CPUE for the **CPUE data truncated** model (described in second row of Table 1).

[1] Note that figures indicate "fit" to the data whether or not the data were used in tuning (conditioning) the operating model.

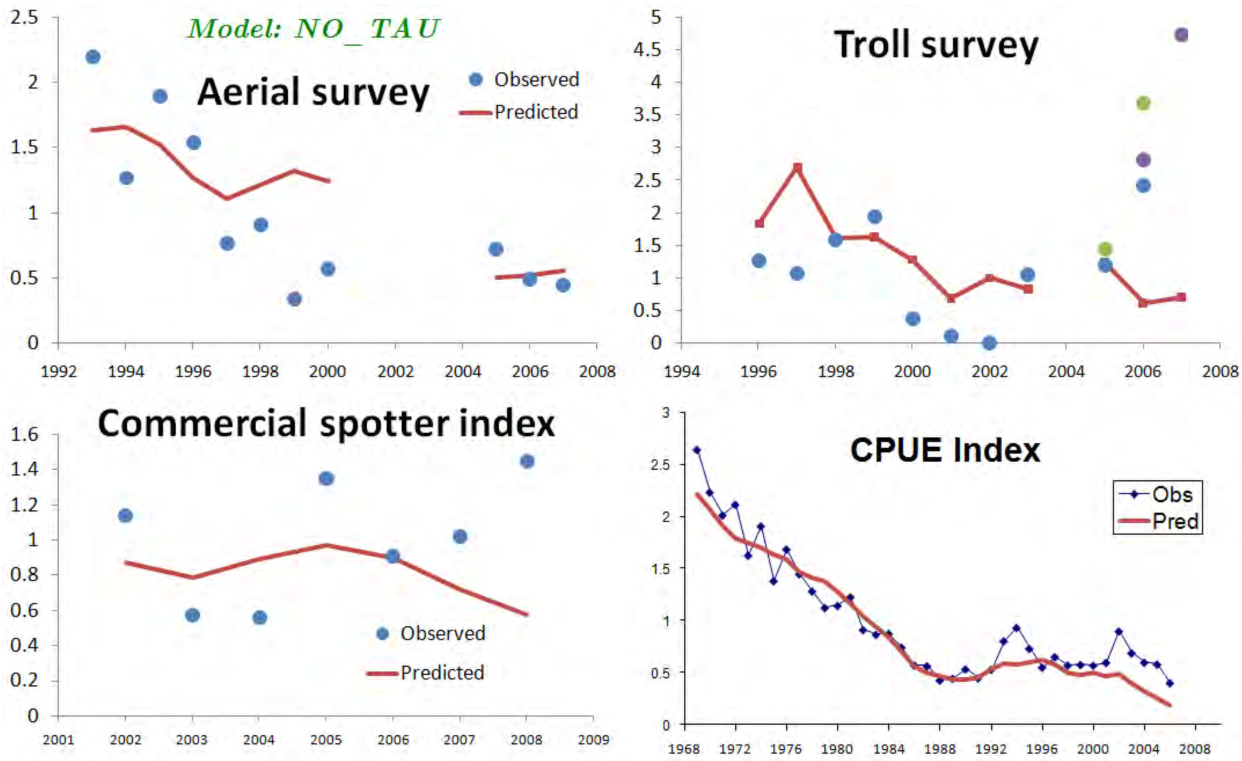


Figure 9. Conditioned SBT model fits to (clockwise from top left) the aerial survey, the troll survey, the commercial spotter index (SAPUE) and the Japanese longline CPUE for the τ_{aerial} **set to zero** model (described in the third row of Table 1).

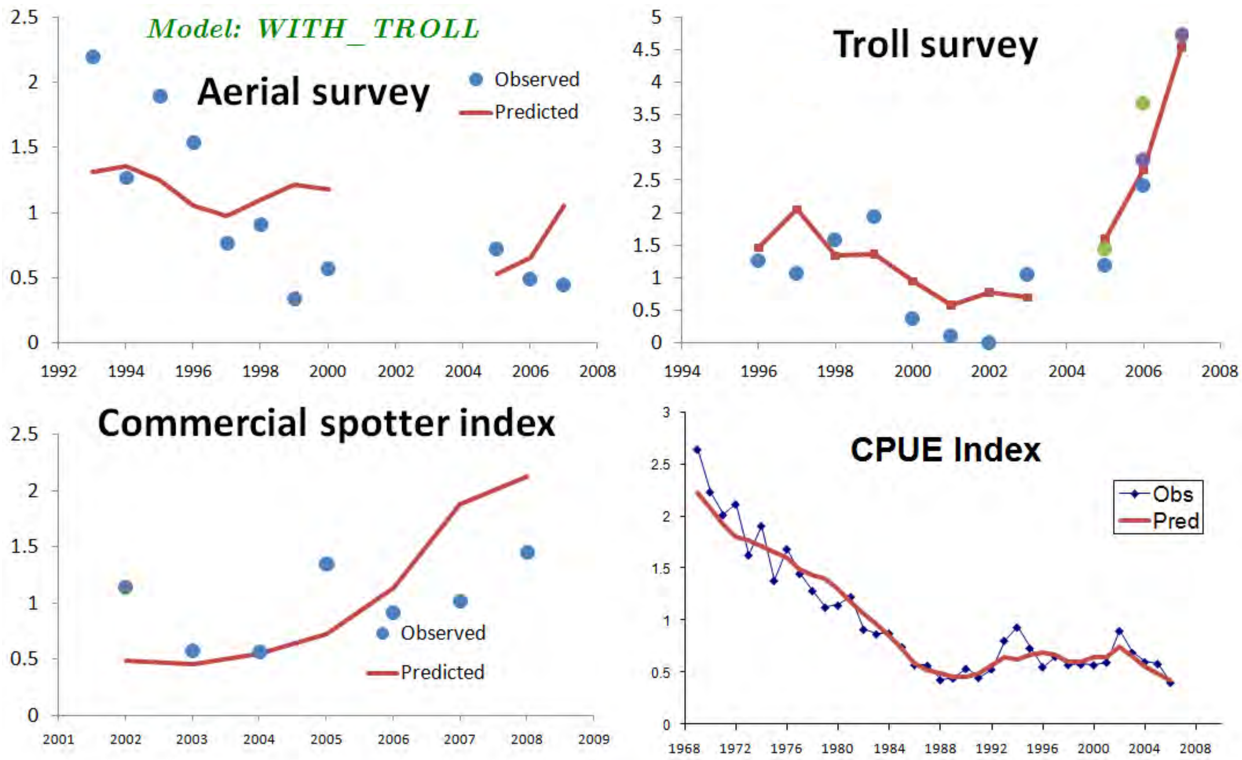


Figure 10. Conditioned SBT model fits to (clockwise from top left) the aerial survey, the troll survey, the commercial spotter index (SAPUE) and the Japanese longline CPUE for the model **with troll survey data included** (described in Table 1).

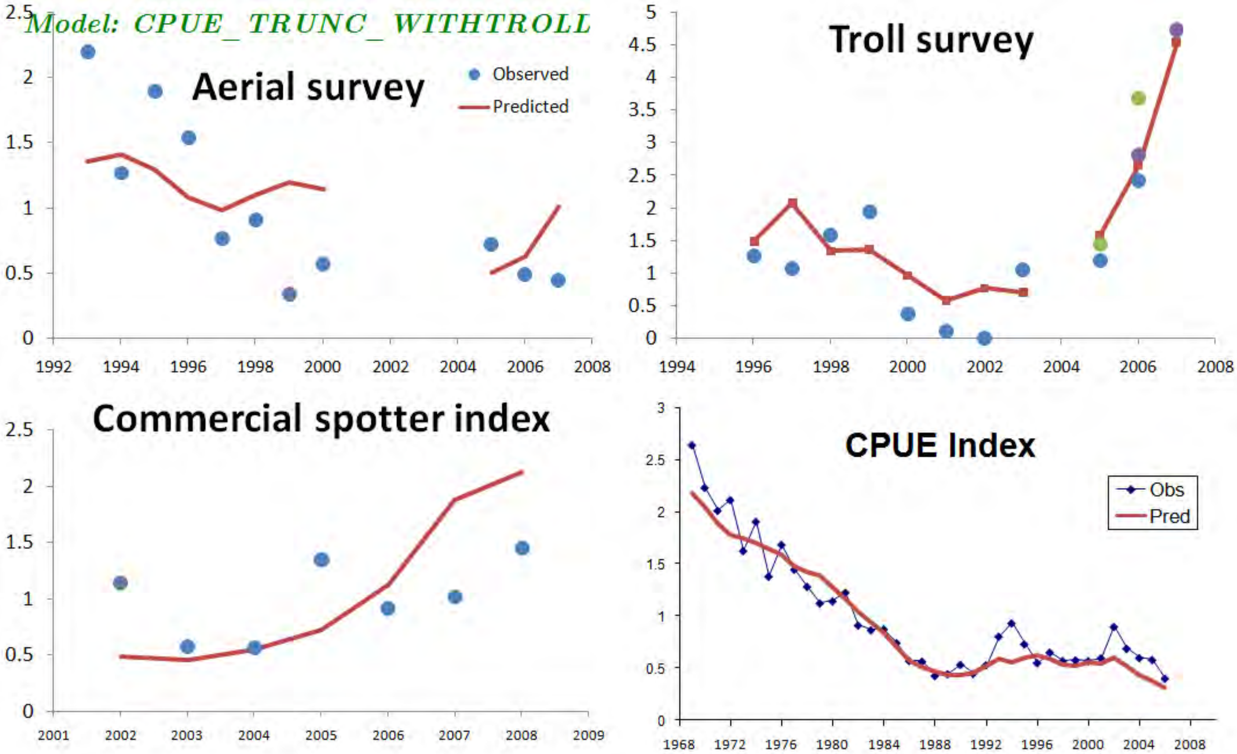


Figure 11. Conditioned SBT model fits to (clockwise from top left) the aerial survey, the troll survey, the commercial spotter index (SAPUE) and the Japanese longline CPUE for the model **with troll survey data included and CPUE data truncated** (as described in Table 1).

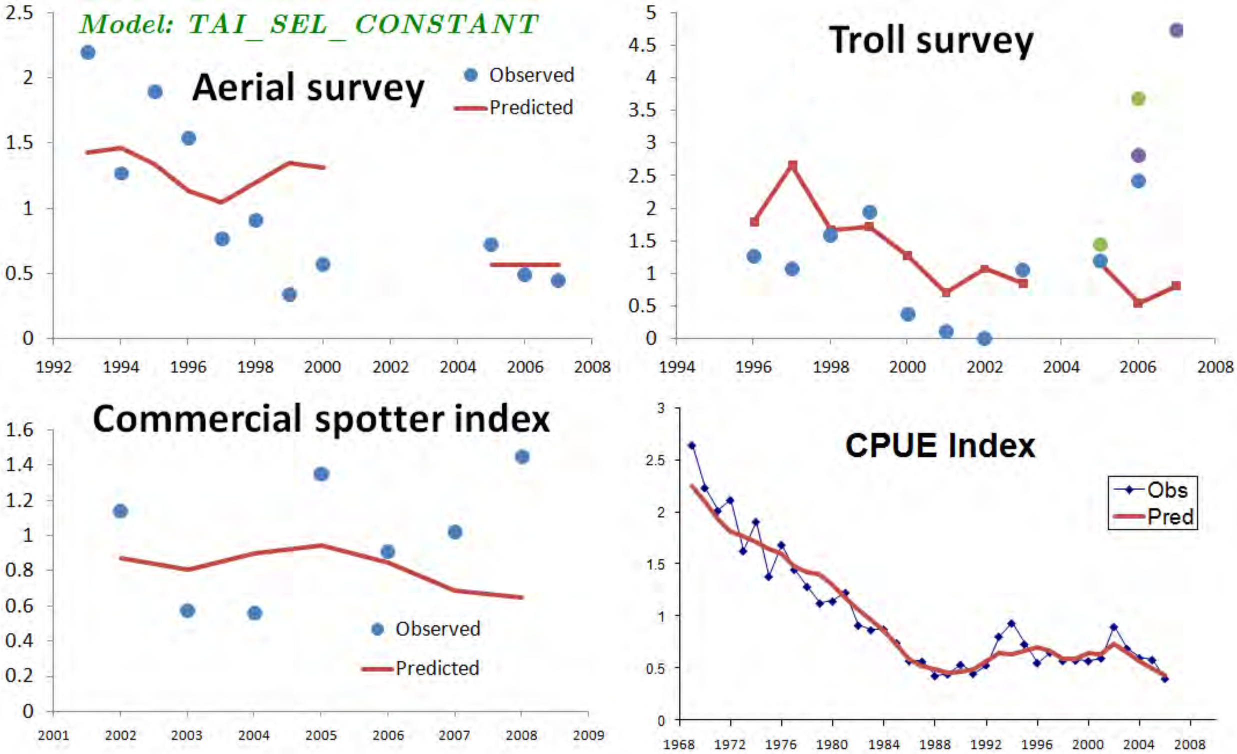


Figure 12. Conditioned SBT model fits to (clockwise from top left) the aerial survey, the troll survey, the commercial spotter index (SAPUE) and the Japanese longline CPUE for the **constant-Taiwanese longline selectivity** model (described in Table 1).

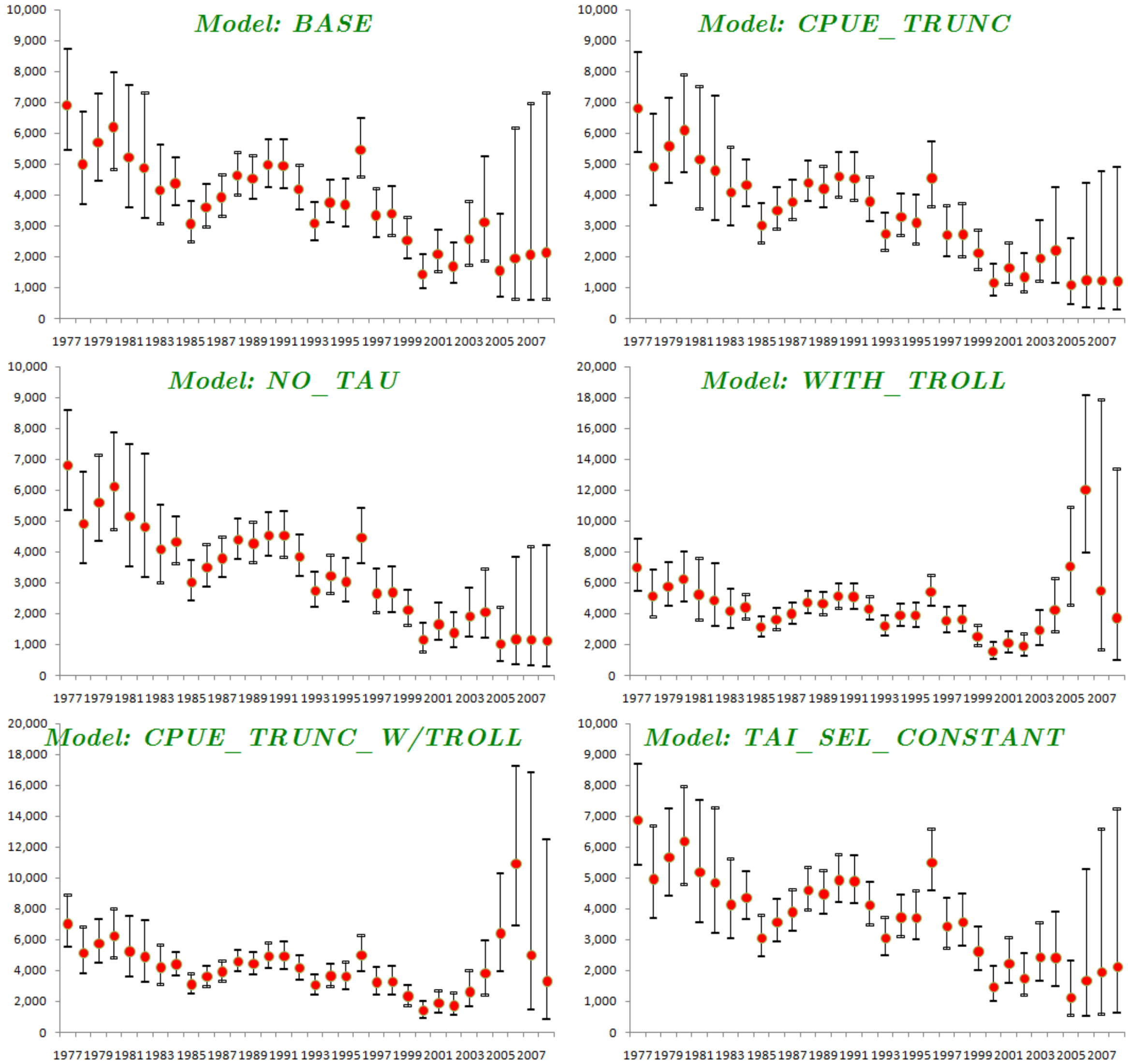


Figure 13. Conditioned SBT model recruitment estimates and approximate 95% confidence bounds for the different models presented in Table 1.

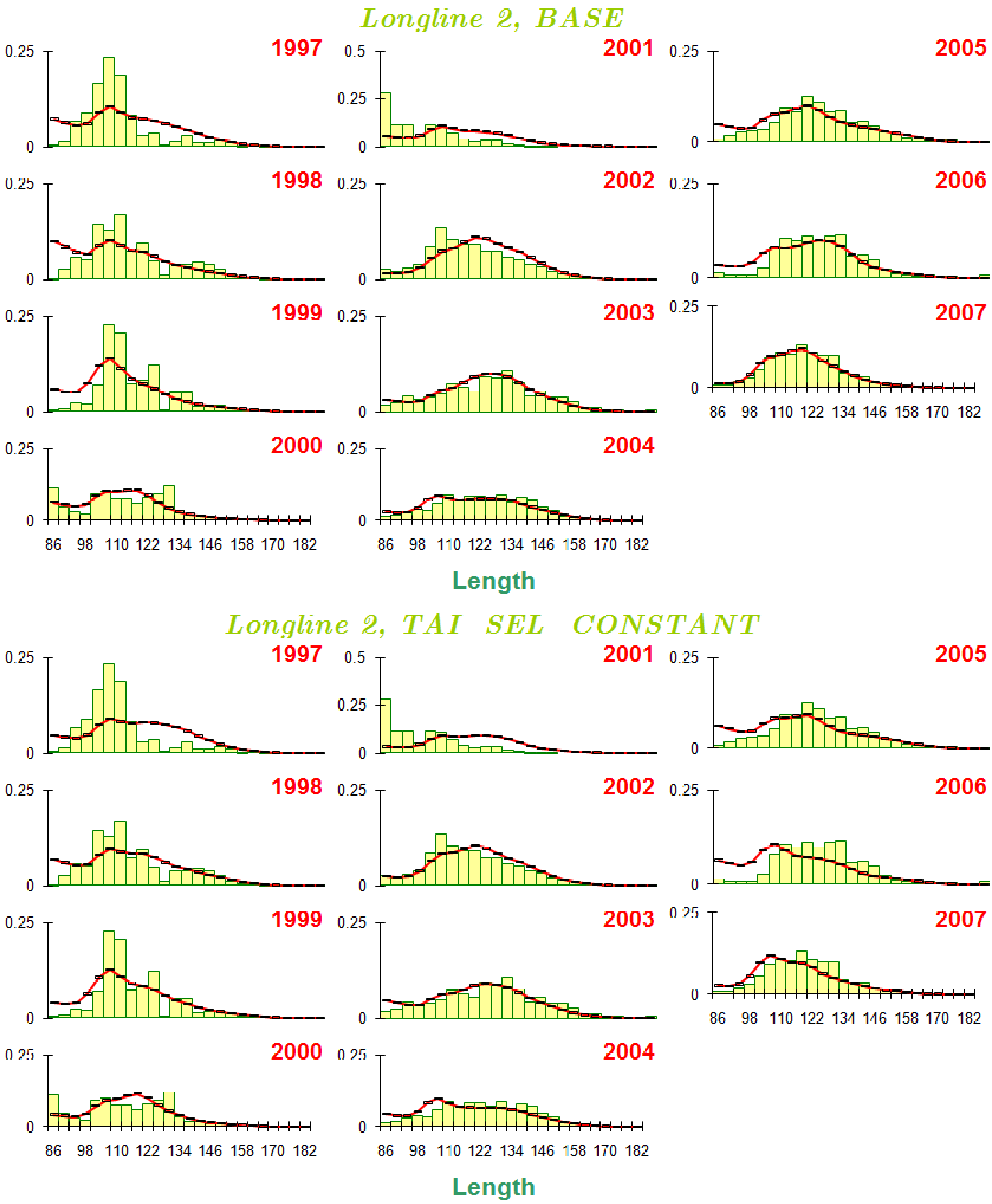
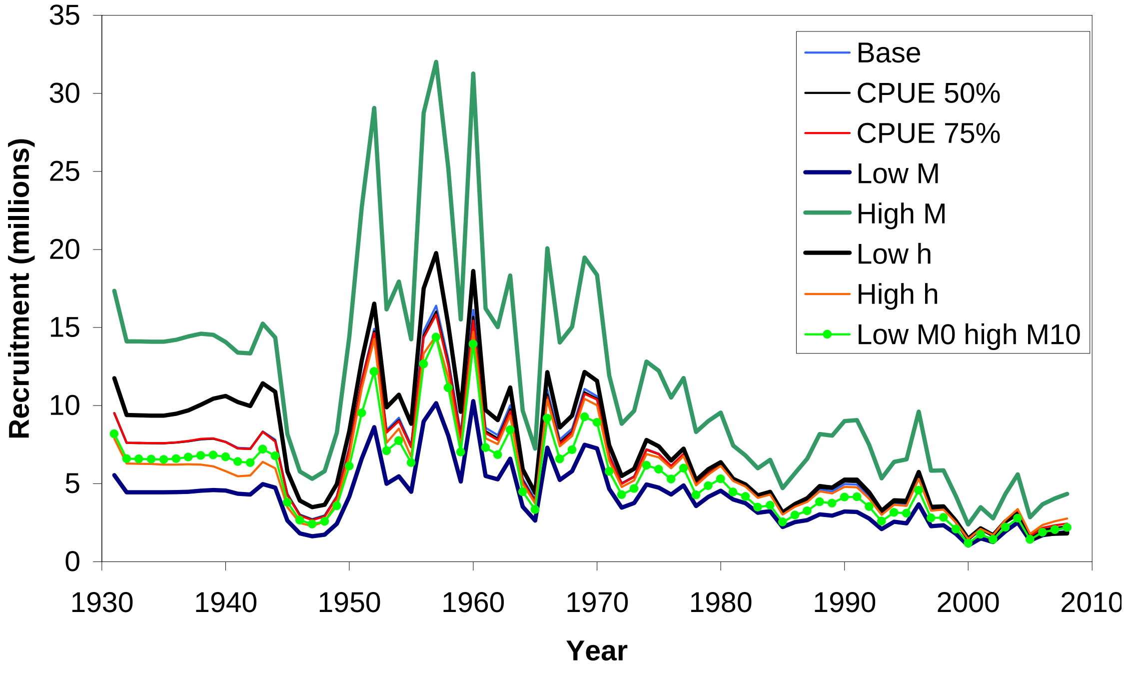


Figure 14. Conditioned SBT model fit to Taiwanese length frequency data under the base case (top set) and with constant selectivity (bottom set).



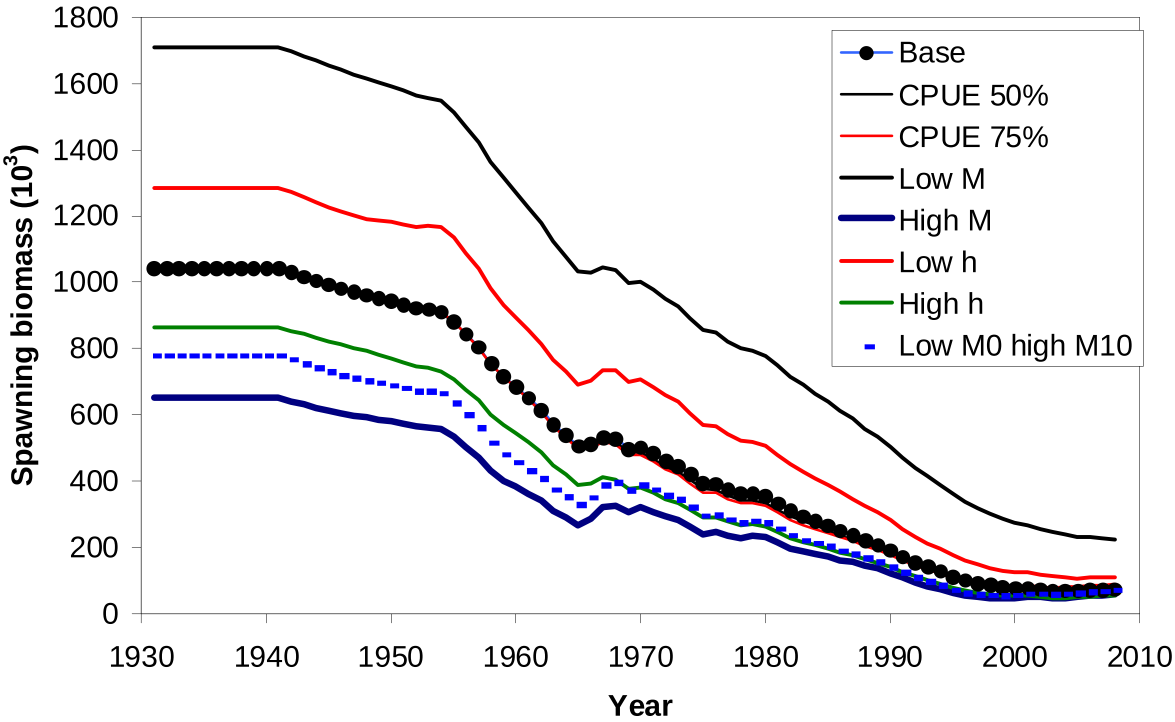


Figure 15. Conditioned SBT model recruitment (top) and spawning biomass (bottom) for the second set of exploratory models presented in Table 2.

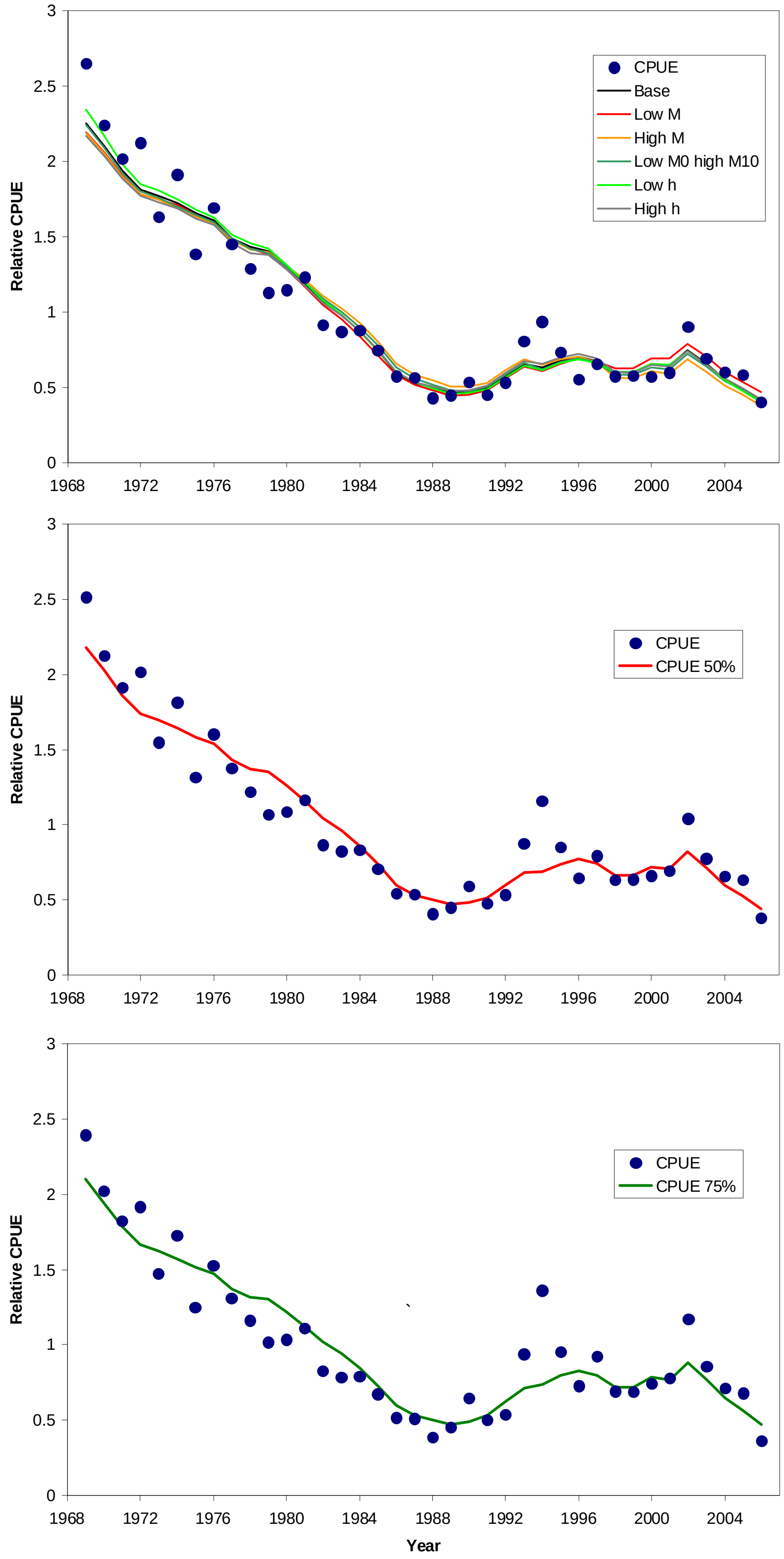


Figure 16. Conditioned SBT model fits to the CPUE data for the second set of exploratory models presented in Table 2.

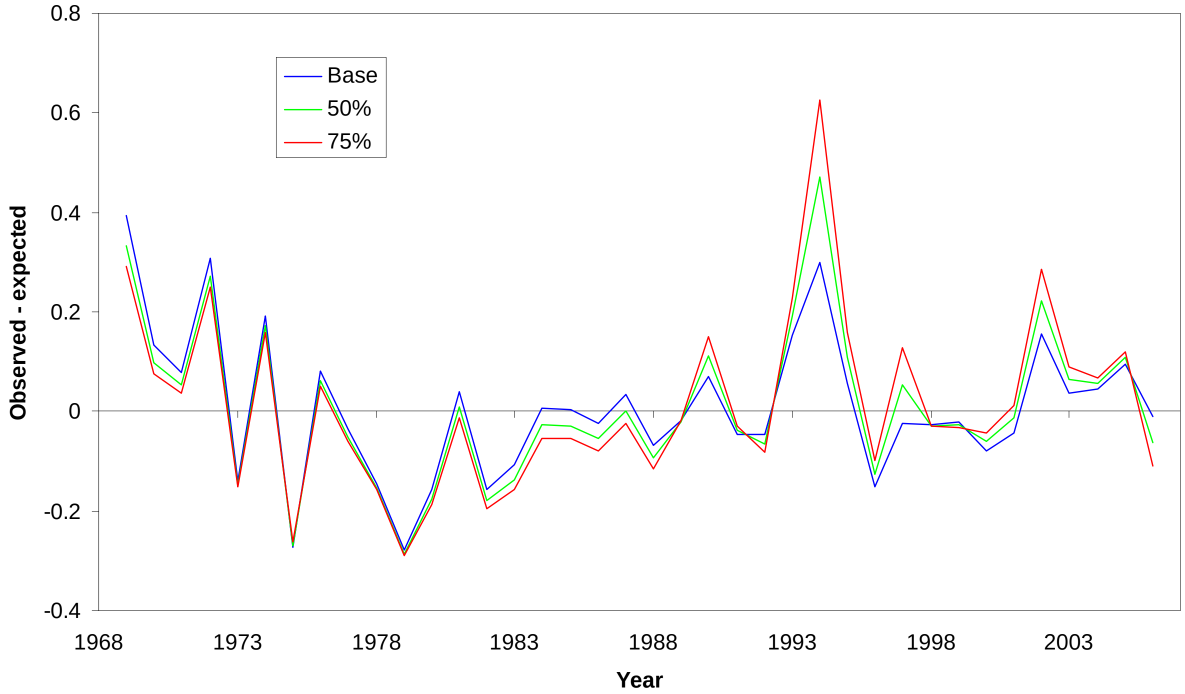


Figure 17. Conditioned SBT model residuals of CPUE data for the second set of exploratory models presented in Table 2 comparing the different impacts of the overcatch scenarios.