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Overview of the Process Adopted by the Commission for the Conservation of Southern Bluefin Tuna for Provision of Management Advice Based on an Annual Review of Fishery Indicators

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INTRODUCTION

During May 2009, preceding the 7th SPRFMO meeting in Lima, Peru, the Jack Mackerel Sub-Group of the Scientific Working Group held a workshop to agree on datasets, model specifications and model inputs for jack mackerel assessments to be undertaken in 2009.

The workshop identified additional work that needs to be done to develop and test alternative integrated and joint modelling approaches before such assessments can be conducted. As a result, the subsequent meeting of the Jack Mackerel Sub-Group noted:

> "*It was recognized that the sub-group will not be in a position to provide advice on the status of Chilean jack mackerel based on the results of an agreed joint assessment model in 2009.*" (Report of the SPRFMO Jack Mackerel Sub-Group, May 2009)

Given that the SPRFMO Interim Measures for Pelagic Fisheries nonetheless require the SWG to provide advice on jack mackerel stock status in 2009 (Pelagic Fisheries IM 4), the JM Sub-Group proposed that, in the absence of a stock assessment, a review of fisheries indicators be conducted as a basis for providing stock status advice to the Negotiations in 2009:

> "*It was proposed that a meeting of the Jack Mackerel Sub-group be held later this year and that this meeting should examine indicators derived from the fishery for jack mackerel and from fishery-independent surveys.*" (Report of the SPRFMO Jack Mackerel Sub-Group, May 2009)

The purpose of this information paper is to describe the process for review of fisheries indicators adopted by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) in recent years, and to provide examples from recent CCSBT indicator reviews as a guide to how such reviews might be approached for South Pacific jack mackerel.

DESCRIPTION OF THE CCSBT FISHERY INDICATOR REVIEW PROCESS

Increasing Emphasis on Review of Fishery Indicators

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The CCSBT was formally established in 1994, replacing the preceding Informal *Trilateral Arrangements for Management of Southern Bluefin Tuna* between Japan, Australia and New Zealand. Assessments conducted by the trilateral participants in 1988 resulted in recommendations for substantial cuts in national SBT quotas. Following significant cuts in participant's SBT quotas in 1989, increasing disagreement developed between national scientists at trilateral and CCSBT Scientific Committee (SC) meetings from 1990 onwards regarding the estimated rate of stock recovery at the reduced quota levels. Over the next 10 years, opposing assessments increasingly diverged, depending on certain key assumptions and uncertainties in the different assessment models used. Some assessments indicated the need for further quota cuts, while others predicted stock recovery and indicated that catches could be increased.

In addition to conducting regular stock assessments, the CCSBT SC has conducted periodic reviews of a range of fishery indicators for SBT since at least 1988 (Polachek *et al*. 2004). Fishery indicators have been used to provide a broad perspective on recent changes in the status of the stock, independent of formal, analytical stock assessments. Even when stock assessments were conducted, evaluation of indicators allowed information that is not readily incorporated into an analytical assessment to be assessed for consistency with the results of stock assessments, providing an additional measure of robustness to the overall stock assessment process (Polachek *et al*. 2004).

The escalating scientific dispute over the conflicting results of competing national stock assessments resulted in 2001 in the appointment of independent Chairs to the CCSBT Stock Assessment Group (SAG) and Scientific Committee (SC) and an independent expert stock assessment Advisory Panel. Given the difficulties in resolving differences between competing stock assessments, this was followed by a shift in emphasis away from annual assessments towards development of a joint operating model and a management procedure tuned to achieve specific stock re-building objectives using this operating model. With most efforts being focussed on the operating model and management procedure, an annual review of fishery indicators became the principal basis for management advice after 2001, pending implementation of a management procedure.

In 2006, just as testing of candidate management procedures was completed and a management procedure was about to be implemented, reviews of SBT market data indicated the possibility of significant under-reporting of SBT catches in the period following implementation of the 1989 quota cuts. This resulted in high uncertainty regarding the validity of catch and effort data used to develop and condition the operating model and tune the candidate management procedures, and even more distrust of results of stock assessments conducted using the reported historic catch and effort data. Annual fishery indicator reviews therefore became even more important as the main source of information upon which to base SBT management advice, until uncertainties in catch and effort data can be resolved and there can be a return to either analytical stock assessments or an operational management procedure.

Similarities to the Current SPRFMO Situation

There are a number of similarities between problems experienced by the CCSBT over the past decade in conducting SBT stock assessments, and the current situation within the SPRFMO science processes regarding jack mackerel assessments. Assessments tabled by different SPRFMO participants at the July 2008 Santiago Chilean jack mackerel workshop provided conflicting results, depending on the assessment method used, key assumptions and inputs to those assessments and assumptions regarding stock structure. There have subsequently been proposals to move towards a 'joint' assessment methodology and conducting of jack mackerel stock assessments has been postponed pending further evaluation of alternate stock assessment methods.

in 2009, following reluctance by participants to submit high-resolution tow-by-tow data for use in assessments, the SPRFMO Jack Mackerel Sub-Group has advocated the development of simulated data sets for use in testing alternative stock assessment approaches. So, for similar reasons to those experienced within the CCSBT, SPRFMO must now also turn to using fishery indicators as a basis for providing advice on jack mackerel stock status in 2009 until further progress can be made towards preparing a suitable catch and effort database for use in assessments, and reaching agreement on assessment methods to use.

Key Characteristics of the CCSBT Indicators Review Process

With the increased reliance on fishery indicator reviews as a basis for providing management advice from 2001 onwards, the CCSBT Scientific Committee steadily improved and standardised the process for reviewing and reporting on these indicators. It is useful to consider the extent to which the main characteristics of the CCSBT indicators review process are worth adopting by the SPRFMO SWG.

- Particularly in the early stages, the CCSBT SC reviewed a broad range of indicators, covering virtually every indicator which might potentially provide some information on the status of various component of the stock or fisheries. Even recently, overview papers reviewing SBT fishery indicators may include more than 30 different indicators (see e.g. Kolody *et al*. 2005, provided as SP-08-SWG-JM-INF-02).
- These indicators are prepared inter-sessionally by CCSBT members and are circulated and exchanged approximately one month prior to each annual SAG meeting, in numerous papers submitted for the SAG and SC meetings. For example, 20 of the 47 papers and 5 national reports submitted to the 6th SAG Meeting in 2005 provided information on fishery indicators (see CCSBT SAG 2005, an extract of which is provided in Annex B). These papers provide detailed explanation of how the various indicators were calculated, as well as initial interpretation of what each indicator appears to show regarding stock or fishery status.
- Usually, one or more participants then prepares an overview paper summarising the key indicators presented in all circulated papers, grouping these into related indicator groups, and providing further interpretation of what these grouped indicators indicate regarding stock status. Examples of such overview papers are Polachek *et al*. (2004) and Kolody *et al*. (2005) (the latter is provided as information paper SP-08-SWG-JM-INF-02).
- Over time the CCSBT SC, assisted and guided by the independent Advisory Panel and independent Chairs, have critically reviewed these indicators in terms of validity, reliability and bias, resulting in rejection of some indicators and emphasis on others. This resulted in the adoption in 2002 of a list of agreed indicators for the 2003 review, and in 2004 of a list of previously agreed and recommended additional indicators for the 2005 review (CCSBT SAG 2004). The 2005 list of agreed and recommended indicators included nine groups of indicators agreed in 2002, ten additional recommended indicators and six additional analyses which might provide further useful indicators (see list in Annex A).
- All tabled Indicators are critically reviewed at annual CCSBT SAG meetings and a summary is provided in the annual SAG report describing the indicators reported on in that year, together with the main observations, criticisms and conclusions of participants regarding each indicator. As an example, the section of the report describing the 2005 *Analysis of Indicators* conducted at the 6th SAG meeting (from CCSBT SAG 2005) is attached in Annex B.
- Finally, in each year where fishery indicators are being used as the basis for management advice, a summary discussion on *Interpretation of Indicators* and *Overall Assessment of Stock Status* is prepared. Since 2001, this overview summary has been prepared by the independent Advisory Panel and independent Chairs in consultation with

the CCSBT SAG and SC participants. Shown in the box below is the summary for the 2005 CCSBT indicators review (from CCSBT SAG 2005).

- This final summary of interpretation of indicators and assessment of stock status, together with key figures supporting these conclusions (in this example, the key figures from CCSBT SAG 2005 shown in Annex B) then serve as the basis for the presentation of scientific and management advice to the Commission by the independent Chair of the SC. An example of the relevant section of the 2005 presentation by the CCSBT SC Chair is provided in SP-08-SWG-JM-INF-03, showing how the above process resulted in advice to the CCSBT Commission based on the review of indicators in that year.

Extract from the Report of the 6th Meeting of the Stock Assessment Group

Discussion

Interpretation of Indicators of Recruitment

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

32. In summary, the indicators of recruitment suggest markedly lower recruitment in at least 2000 and 2001 with some indication that recruitment in 1999 was also weak.

Spawning stock biomass

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

Exploitable biomass for the longline fishery

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

35. In summary, these CPUE indicators generally suggest stable exploitable biomass over the last 10 years. However, recent low recruitments are likely to lead to declines in future exploitable biomass trends.

5.2 Overall assessment of stock status

36. The current assessments through the operating model (using data available from the 2004 SAG/ESC) suggest the SBT spawning biomass is at a low fraction of its original biomass and well below the 1980 level. The stock is estimated to be well below the level that could produce maximum sustainable yield. Rebuilding the spawning stock biomass would almost certainly increase sustainable yield and provide security against unforeseen environmental events. Recruitments in the last decade are estimated to be well below the levels in the period 1950-1980. Assessments estimate that recruitment in the 1990s fluctuated with no overall trend. Analysis of several independent data sources and the operating model indicate very low recruitments in 2000 and 2001. There is some evidence that the 1999 cohort is relatively weak and that the 2002 cohort is unlikely to be as strong as those estimated during the 1990s. Other indicators show that the Indonesia LL fishery on spawning fish catches fewer older individuals. One plausible interpretation is that the spawning

> *stock has declined in average age and may have declined appreciably in abundance. The decline in average age may be due to the disappearance of older fish, a pulse of younger fish entering the spawning stock, or a combination of the two factors. A pulse of younger fish entering the spawning stock is consistent with the assessment model output which suggests that the spawning stock has been largely stable over the last decade and increased slightly over the last four years.*
>
> *Given all the evidence, it seems highly likely that current levels of catch will result in further declines in spawning stock and exploitable biomass, particularly because of recent low recruitments.* (CCSBT SAG 2005)

OBSERVATIONS REGARDING USE OF FISHERIES INDICATORS AS A BASIS FOR MANAGEMENT ADVICE

There are a number of observations to be made, and lessons to be learned by SPRFMO science processes, from the CCSBT experiences in using reviews of fishery indicators as a basis for management advice:

- The most important observation is that fishery indicators typically only provide information on changes or trends in stock status, but not on the actual status of the stock in relation to reference points. In the absence of estimates of absolute stock abundance (such as might be provided by analytical stock assessments or surveys designed to provide absolute abundance estimates), fishery indicators can only indicate whether some component of the stock is increasing or declining, but not where the stock is in relation to reference levels such as B_{MSY}.
- Even in the case of the CCSBT, where the indicators review process is well established, and where a substantial and diverse variety of indicators based on a wide range of data is reviewed annually, interpretation of indicators still requires references back to previous stock assessment estimates of the status of the stock at some point in the history of the indicator. This is particularly important where, for example, indicators might be indicating increase in some component of the stock, while the stock itself is still strongly over-exploited and well below B_{MSY}.
- Reviews of fishery indicators are therefore no replacement for formal analytical stock assessments as a basis for providing robust scientific advice on stock status and recommended management actions. Essentially the CCSBT, and currently the SPRFMO science process, has been forced to resort to reviewing fishery indicators as a result of a failure of the stock assessment process.

The first priority of the SPRFMO SWG Jack Mackerel Sub-Group must therefore be to establish an effective stock assessment process.

REFERENCES

Anon, 1988. Report of the Seventh Meeting of Australia, Japanese and New Zealand Scientists on Southern Bluefin Tuna. 15-19 August 1988. Wellington, New Zealand.

CCSBT SAG, 2004. Report of the 5th Meeting of the Stock Assessment Group, 6-11 September 2004, Seogwipo City, Jeju, Republic of Korea. 18 pp plus attachments.

CCSBT SAG, 2005. Report of the 6th Meeting of the Stock Assessment Group, 29 August - 3 September 2005, Taipei, Taiwan. 40 pp.

Kolody, D., J. Hartog, M. Basson and T. Polacheck, 2005. Fishery indicators for the SBT stock 2004/05. CCSBT-ESC_0509_25, 39 pp.

Polacheck, T., D. Kolody and M. Basson, 2004. Fishery indicators for the SBT stock 2003/4. CCSBT-ESC/0409/21, 42 pp.

Annex A

CCSBT 11th Meeting 2004, SAG 5 Report, Attachment 7
Evaluation of Fishery Indicators and Analyses for 2005

Agreed Indicators for 2003 SAG / SC

1. CPUE indices (nominal, i.e. number of fish per 1000 hooks)

Nominal CPUE of the Japanese fishery by year for the months of April – September for areas 4 – 9.

Nominal CPUE of the New Zealand charter and domestic fleets for portions of areas Area 5 and 6 within the EEZ by year for the months of May – June.

2. CPUE by cohort for Japanese longline

Nominal CPUE of the Japanese fishery by year for the months of April – September for areas 4 – 9.

3. Total catch in surface fishery and estimated age composition

Total catch in the Australian surface fishery by fishing year from 1988/89 to the most recent year. [Do we want to include duration of catching period within each fishing year?]

Age frequency histograms from 1994/95 to the most recent year. Age frequency will be derived from cohort slicing of the raised catch at length data based on the length sampling from fish going into farms and video counts of total numbers including fishing or towing mortalities.

4. Total Indonesian catch by month and % of Indonesian LL catch that is SBT

The estimated total catches of SBT by the Indonesian fleet for the period 1992 to the most recent year by financial year/spawning season and calendar year.

[The relative proportions of SBT, BET and YFT in sampling of the Indonesian catch by spawning season.]

5. Indonesian age composition

Proportional age composition of the Indonesia catch by spawning season from cohort slicing of the length data. The period shall be 1992/93 to the most recent year by spawning season/financial year.

6. Estimate of total global catch of SBT

Total weight of catch per year with subdivision by flag for CCSBT members, cooperating non-members and Indonesia.

7. Acoustic estimates of age 1 off Western Australia

Index of abundance of age 1 fish estimated from the acoustic survey.

8. Aerial spotting data in Great Australian Bight

Fishery independent surveys

Fishery independent aerial spotting data from line transects in the Great Australian Bight as a fishery independent index of aggregated 2-4 year old abundance. Analysis as in Cowling et al. (2002), with modification if required for calibration.

Cowling, A., Hobday, A. and Gunn, J. 2002. Development of a fishery independent index of abundance for juvenile southern bluefin tuna and improvement of the index through integration of environmental, archival tag and aerial survey data. FRDC Final Report 96/111 and 95/105.

Commercial spotting surveys

Index of abundance for 2-4 year olds based on commercial spotting data of sightings per unit of searching effort.

9. Tag returns

Three tables for the CCSBT surface fishery tag/recapture data providing:

- Number of releases by year (for each release age class)
- Number of recaptures (of each release age class) in the first year of release
- Number of recaptures (of each release age class) excluding those recaptured in the year of release

8 tables (one for each reporting rate option) showing the reporting rate for each year for each release age class.

Suggested Additional Indicators

1. Length frequency by fleet

Length frequency of each fleet by year and area. Areas are each of Areas 1 – 10, 11, and total. Also indices in the area north of 35°S. in the Indian Ocean.

2. Proportion of fish less than 110 and 120 cm by stat area/fleet/time

Estimates of the percent composition of the catch in two size classes (fork length <110 cm and <120 cm) by fleet, statistical area and year since 1999. Sample size should accompany estimates.

3. Age composition of catch (otolith aged)

Specifications to be provided.

4. Information of fishermen's experience and knowledge

Assuming that fishermen on board fishing vessels can usually assess changes to stock status from the results of their fishing operations, the following indicators can be used to monitor decreases in abundance – continuous decrease (at least 3 consecutive years) in the number of vessels in the fleet, in the number of months fished per vessel, in the number of sets per vessel, in the average amount of time spent locating fish.

5. Number of squares fished by fleet, including zero catches

Total number of squares fished and total number of squares in which SBT were caught in each calendar (or fishing?) year for each fleet (5^ox5^osquares for longline, 1^ox1^o squares for surface fisheries). The entire available time series shall be provided

6. Indonesian CPUE from observer data

Nominal CPUE for a subset of the Indonesian Benoa-based longline fleet derived from fishery high school and RIMF observer data.

7. Growth rates

Annual time-series of weight at age from representative areas and times. Other possible indicators might be otolith growth increment studies (Australian to add to this if considered worth while) or tagging results.

8. Price of fish by size class/grade

It would help interpretation of CPUE and catch size distributions to better understand market values of different sizes of SBT. The essential need would be an annual time series of value (or value differential) by size or relevant size group. The detailed specification would best match any series available from the past.

9. Weight/length changes over time and area from Japanese fishery

Changes in the relationship between weight and length can be an indicator of changes in condition. It is suggested that comparison of the length-relationship for each quarter and for areas 4 – 7 (combined), 8 and 9 for each year be calculated from RTMP data and be compared as indicators of SBT condition.

10. Distribution of juvenile fish around Australia

This is likely to be more dependent on qualitative records than other indicators but could be useful. Possible sources are discussed in paper 21. Possible form of indicator might be a brief statement from Australia summarising available information.

Suggested Analyses

1. Tagging data and estimates of fishing mortality

Specifications to be provided.

2. Standardised CPUE

Calculation of standardised CPUE indices assuming constant squares and variable squares.

3. Lorenz curves and GINI coefficients for analysis of distributional data

Data on the spatial and temporal extent of catch and effort can often provide important information on the exploitable biomass and provide additional information critical for the interpretation of CPUE. Several graphical and statistical approaches have been described within the fisheries literature to summarize spatial and temporal trends in fisheries data, e.g. the Lorenz curve and Gini coefficient. A range of concentration indices should be calculated to summarize longline catch and effort data (5x5 degree by month and year) and data for other fisheries where it is available.

4. Cluster analysis of major fishing grounds

The spatial and temporal distribution of catch and effort often changes between years due to changes in fleet behaviour. By analysing the 5 x 5 degree catch and effort data using cluster analysis techniques, the major fishing grounds can be identified and changes in fleet behaviour evaluated to standardise CPUE analyses between years.

5. Reproductive potential from biological samples

Mean GSI in the year of first maturity for both sexes.

6. Catch rate trends by area

[As per CPUE in earlier indicators for consistency but] divided by fleet by month/quarter by CCSBT Statistical Areas (1-9 or 4-9?)

Annex B

CCSBT 12 2005 - Extract from the Report of the 6th Meeting of the Stock Assessment Group

Agenda Item 5. Stock Assessment

5.1 Analysis of fisheries indicators

7. The following documents were identified under agenda item 5 on stock assessment: CCSBT-ESC/0509/12, 13, 15, 16, 17, 20, 21, 22, 23, 24, 25, 32, 38, 39, 40 and CCSBT-ESC/0509/SBT fisheries country reports.

8. CCSBT-ESC/0509/17 presents preliminary summaries of data on SBT catch and effort from training programs of Indonesian Fisheries Training Schools. Several caveats regarding the interpretation of the data were noted, including: the commercial longline vessels taking part in the program are probably not a random selection of the fleet, coverage over time is not consistent, the dataset has not yet been fully checked or analysed, and CPUE has not yet been standardised. Given these qualifications, there appears to be an increase in fishing effort in Area 2, particularly in the southern part of that area. The apparent increase in nominal CPUE (in numbers) in area 2 is most likely related to the expansion of the fleet, and is still based on a relatively small number of sets compared to Area 1. In Area 1, there appears to have been a drop of possibly as much as 50% between 2000/01 and 2004/05 in the nominal CPUE of vessels observed that fished during the spawning months. Most of this decrease occurred in the first two spawning seasons in the dataset (2000/01 and 2001/02), and the index seems to have been relatively stable over the most recent three spawning seasons (2002/03 – 2004/05). The data from Area 1 were further explored for changes in catch rates of other species or in the depth of fishing (using the ratio of bigeye to bigeye plus yellowfin catch as a proxy) which could explain the drop in catch rates of SBT. The preliminary analyses did not find any such clear signals.

9. CCSBT-ESC/0509/22 presents results of the scientific line-transect aerial survey for juvenile SBT which was conducted in the Great Australian Bight in 2005. The survey followed similar surveys conducted in 1993-2000, and resumes a time-series of abundance indices for juvenile SBT. Because of bad weather, the 2005 survey flew very few transects in March and this month was omitted from the analyses for all years. Results from the survey suggest that the abundance of 2-4 year olds in the GAB in 2005 was lower than it was in the mid-1990s, but perhaps higher than in 1999. Since the efficiency of the observer teams in 1999 and 2000 is very uncertain, the comparison of the 2005 index with the mid-1990s is considered more reliable.

10. CCSBT-ESC/0509/23 discusses results from commercial spotting data in the GAB over four fishing seasons (December to March of 2001-02 to 2004-05). The commercial spotting data were used to produce nominal and standardised fishery-dependent indices of SBT abundance (surface abundance per unit effort – a SAPUE index). The SAPUE indices declined substantially after the first of the four seasons, but increased again for the last. Interpretation of the results, however, is difficult as there is a strong indication of an interaction between the company/spotter and season. The document notes that the line-transect aerial survey remains preferable as an approach, since it is based on a consistent design and set of protocols which also greatly facilitates standardisation and improves consistency of the index.

11. CCSBT-ESC/0509/20 provides an update on tag seeding activities in 2004/05 in the surface fishery and estimates of reporting rates based on past tag seeding activities.

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

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

14. CCSBT-ESC/0509/38 presented recruitment information obtained from the Recruitment Monitoring Program in Western Australia, representing age-1 abundances in the survey

area. All indices showed that recruitment dropped markedly in 1999 and stayed at extremely low levels since then. The 2005 survey data indicated that the 2004 year class was slightly stronger than 2000 and 2001 year classes but about the same level as 1999 year class, i.e. still substantially lower than the average 1990's level.

15. CCSBT-ESC/0509/39 reviewed various fisheries indicators exchanged. Longline CPUE indicated that the component of the stock exploitable by longline fisheries has stayed stable with slight increase from the late 1990s to 2002. Cohorts recruited during 1999 and after were virtually absent in the Japanese longline catch in Areas 4-7 and in the New Zealand fishery. The preliminary size composition of the 2005 Japanese longline catch indicated that the 2002 cohort was stronger than 2000 and 2001 cohorts but still weaker than the average of the late 1990s cohorts. Attention was drawn to CCSBT-ESC/0509/37 (Figure 1) which shows very little difference between the Japanese observer and vessel logbook data. It was also stated that observers report no discards other than badly damaged fish. These two sources of information support the reliability of Japanese longline size composition data.

16. CCSBT-ESC/0509/40 examined various recruitment information in conjunction with Operating Model recruitment scenarios. Information examined consistently showed that the 2000 and 2001 recruitments were markedly low as was the 1999 cohort. The 2002 recruitment seemed slightly higher than 2000 and 2001 but still lower than recruitments in the late 1990s. The information currently available was considered to be reasonably consistent with the reference set recruitment scenario of the operating model (OM).

17. CCSBT-ESC/0509/Taiwanese SBT Fisheries provides brief information on the nominal CPUE and catch at length of the Taiwanese longline fleet. The CPUE series were calculated from logbooks of vessels that have caught SBT in that year, except the most recent year (2004) which was estimated from weekly reports. The CPUE shows a generally stable trend during 1996-2004. Further studies are needed to exclude data from fishing vessels during periods when they are not involved in the SBT fishery and to separate target and non-target fishing data. The catch at length shows that the catch was dominated by 85-130cm fish in 2001 and by fish with a length of 100-145 cm from 2002 to 2004.

18. CCSBT-ESC/0509/SBT Fisheries – New Zealand was presented. Both areas of the New Zealand fishery have shown declines in catch per unit effort in recent years, with a steady decline of 55-70% in the northeast fishery and a 60% reduction in the southwest fishery since 2001. There has been a very clear reduction in the range of sizes of southern bluefin tuna taken in the New Zealand fishery since 2001. The proportion of fish less than 140 cm in length has declined rapidly since that time. The lack of small fish reflected in the length data corresponds to a series of weak cohorts in the proportional ageing data for the New Zealand fishery. Overall, the data suggest three consecutive weak year classes from 2000 to 2002 and that the 1999 cohort is also low. Preliminary data for the 2005 fishing year (the fishery is still underway) indicate a continuation of the lack of small fish observed in the data for the 2004 fishing year. In response to a question about observer size frequency data in the New Zealand fishery, it was noted that observers reported only two discards from the charter fleet (which had 100% observer coverage) in 2004.

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

#1 CPUE Trends Over Time in Japanese LL fishery

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

the same Areas and months, nominal CPUE for ages 4, 5, 6&7, and 8-11 were all down from 2003. (CCSBT-ESC/0509/39, figure 1-1).

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

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

#3 CPUE trends in other fisheries

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

#4 & #5 Indonesian catch and age composition

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

 # 7 Acoustic estimates of age 1 off Western Australia

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

#8 Tagging data

25. Estimates of fishing mortality rates based on the SRP conventional tagging program suggest high rates for ages 3 and 4 fish in 2003 and 2004, in particular for age 3 fish in 2004 (i.e. the 2001 cohort). Estimates based on age 1 releases tend to be lower than those for age 2 and 3 releases. Such differences were not seen in the tagging results in the 1990s. These changes in the fishing mortality rate estimates when combined with the low level of longline returns from the Tasman Sea area suggest possible changes in juvenile spatial dynamics.

26. Fishing mortality rates for age 2 fish were consistently estimated to be very low. High recovery rates within season were obtained from age 3 and 4 fish tagged in December in the GAB, particularly in 2004 in which 37-40% of the tags were estimated to have been caught. This indicates high exploitation rates for fish of those ages that were in the GAB in 2003 and 2004.

#9 Size distribution

27. Data were presented showing the size distribution of catch as an indication of year class strength. There was a striking lack of small fish (<140 cm) in the New Zealand longline data, and this was confirmed by direct aging of samples of the New Zealand catch (CCSBT-ESC/0509/New Zealand SBT fishery, Figure 8). Whereas previously ages 3-5

fish were common in the NZ LL catch, they are almost totally absent in 2004 and 2005 (the 2000, 2001, and 2002 cohorts). Furthermore, the 1999 cohort was also weak. The Japanese longline data continued to indicate a lack of fish from the 2000 and 2001 cohorts (CCSBT-ESC/0509/25 and CCSBT-ESC/0509/39) especially in the areas around Australia. There were indications in the Japanese LL data that the 1999 year class may also have been weak. The preliminary RTMP data indicated that the 2002 cohort is slightly stronger than the 2000 and 2001 cohorts, but still lower than the average of the 1990s cohorts.

#10 GAB Aerial survey indices

28. In 2005 Australia re-introduced the aerial transect survey of tuna in the Great Australian Bight (CCSBT-ESC/0509/22). The index of abundance in 2005 was about 80% of the values averaged from the previous years in which the survey had been conducted (1993-2000). No survey data were available for the years when the 2000 and 2001 cohorts would have been 3 years old.

29. Australia also conducted an analysis of the commercial aerial spotting data and obtained indices for 2002-2005 (CCSBT-ESC/0509/23). The years 2003 and 2004 (when the 2000 and 2001 cohorts would have been 3 years old) were considerably lower than the 2002 and 2005 estimates, which were similar to each other.

Other indices

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

CCSBT 12 2005 - SAG 6 Attachment 5: A Selection of Relevant Indicators Considered by the CCSBT-SAG

1 CPUE trends over time in Japanese longline fishery

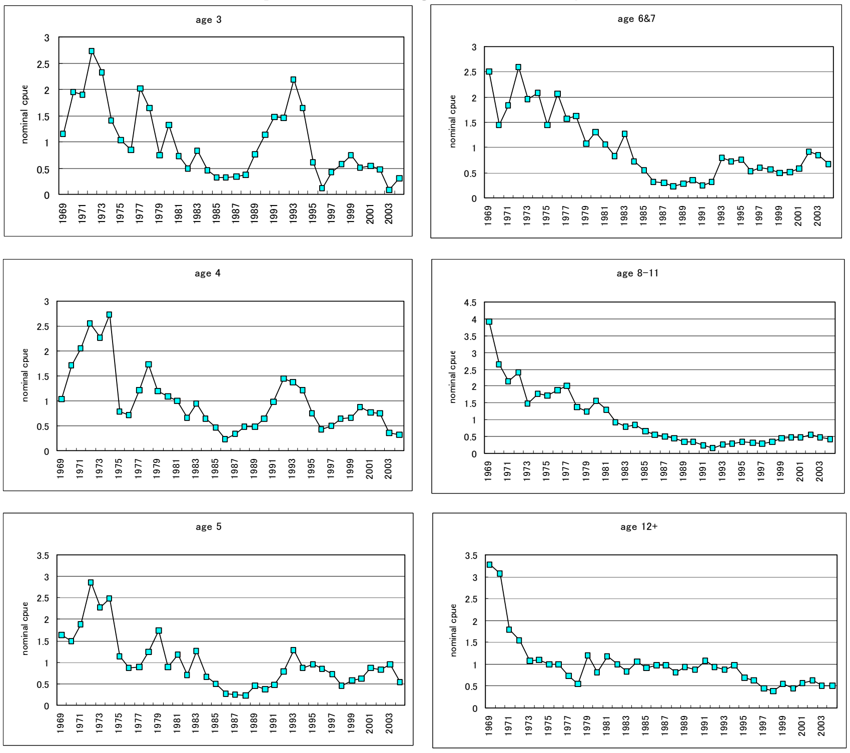


Figure 1. Nominal CPUE from the Japanese longline fishery by age groups.(from CCSBT–ESC/0509/37, Fig 1.1)

2 CPUE trends by year class in Japanese longline fishery

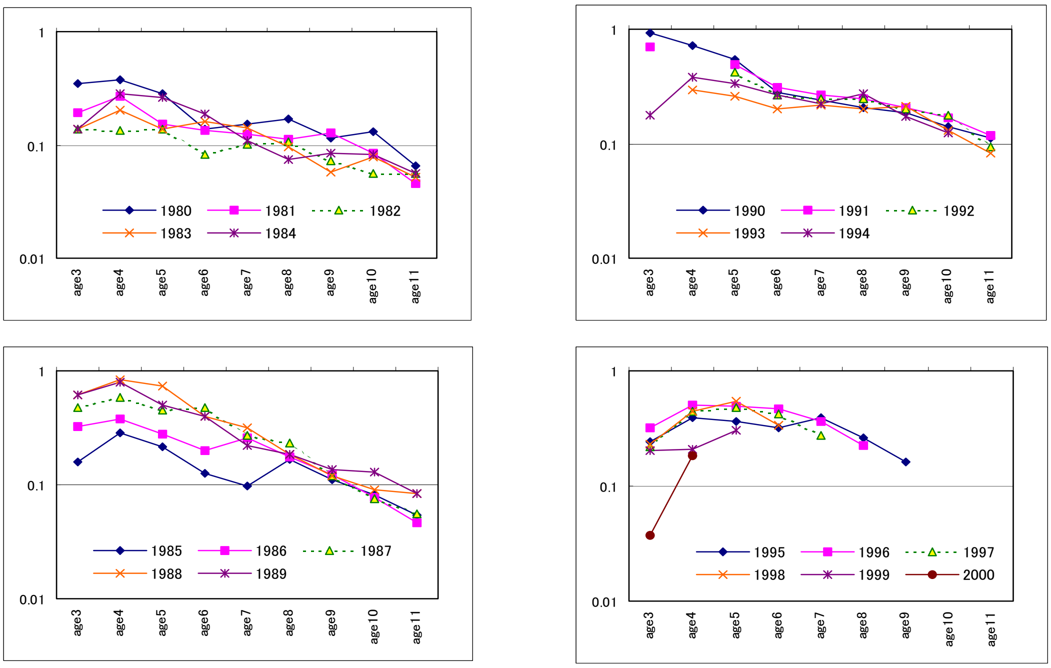


Figure 2. Nominal CPUE by cohorts in log-scale from the Japanese longline fishery. (from CCSBT–ESC/0509/39, Fig 1.3)

#4 & #5 Indonesian catch and age composition

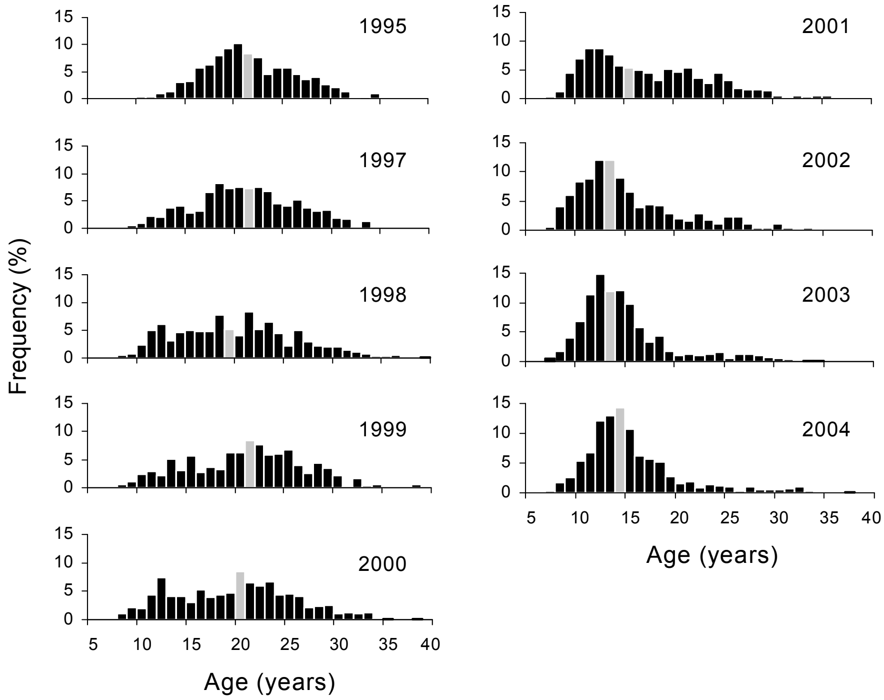


Figure 3. Age distribution (based on direct aging) of SBT by spawning season from the Indonesian spawning grounds longline fishery. A spawning season is defined as July 1 of the previous year to June 30 of the given year. Age could not be assigned to 22 (2%) fish with length measured in the 2002 season.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

#4 & #5 Indonesian catch and age composition

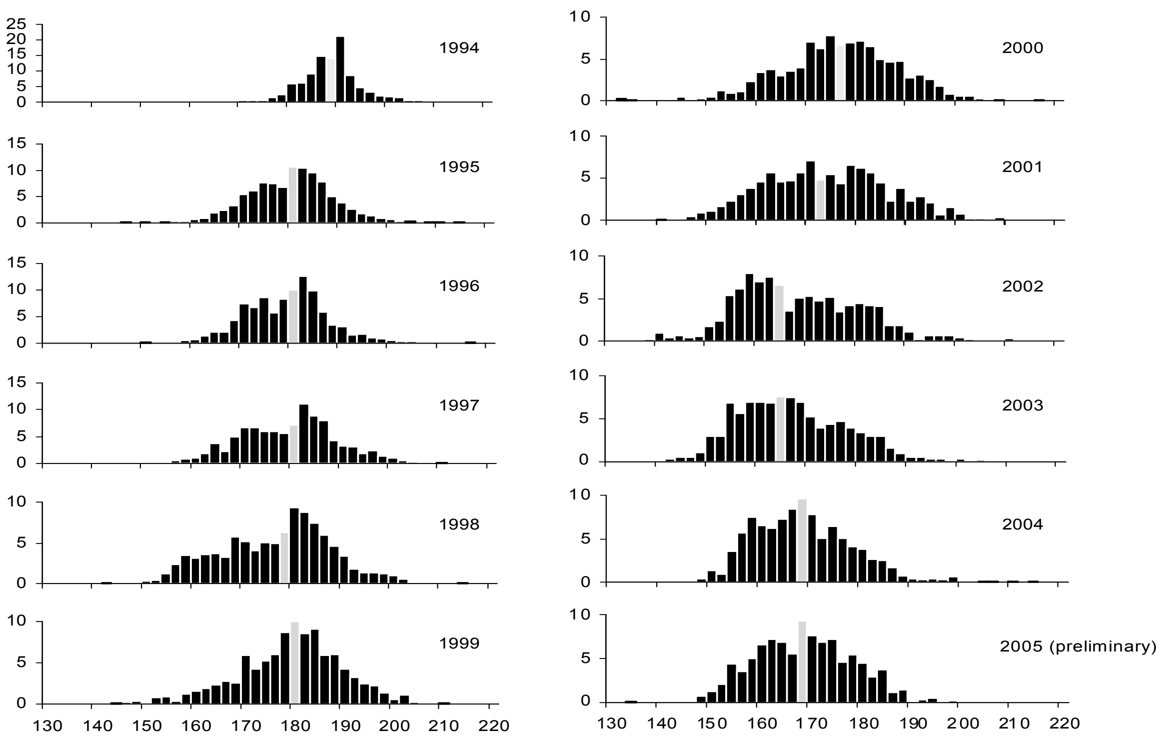


Figure 4. Length frequency (2 cm intervals) of SBT by spawning season from the Indonesian spawning grounds longline fishery. The grey bar shows the median length class. A spawning season is defined as July 1 of the previous year to June 30 of the given year. The pale bar represents the median length.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

#4 & #5 Indonesian catch and age composition

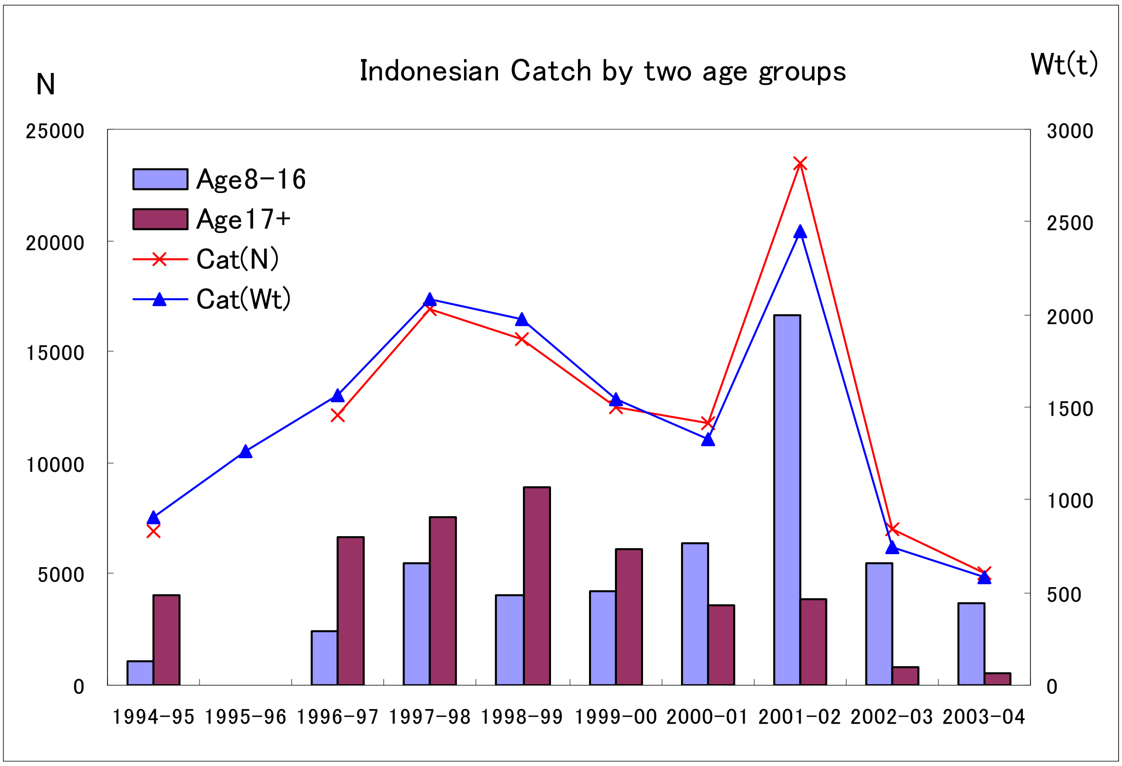


Figure 5. Trends in the Indonesian catch by number and catch by weight for two sets of combined age groups (from CCSBT– ESC/0509/39, Fig 4.1)

#7 Acoustic estimates of age 1 off Western Australia

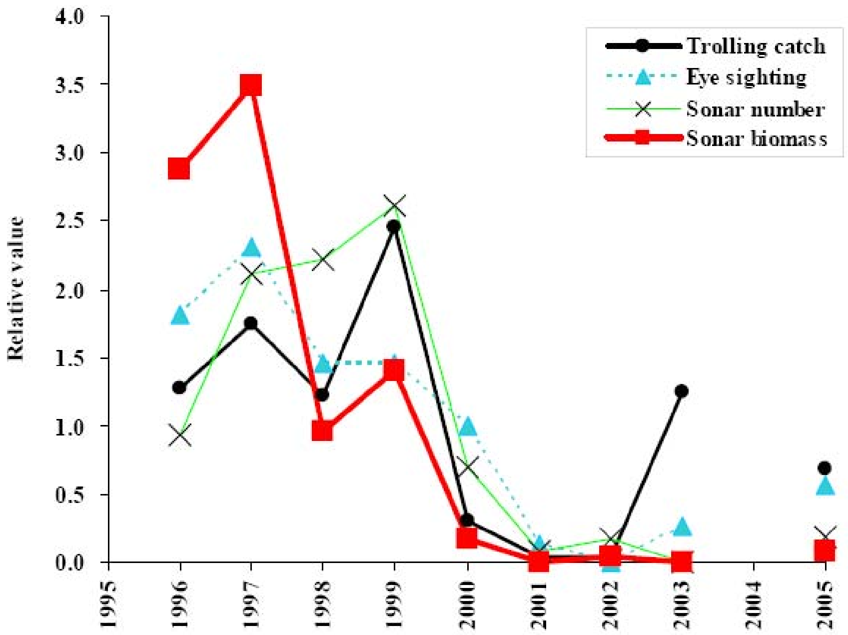
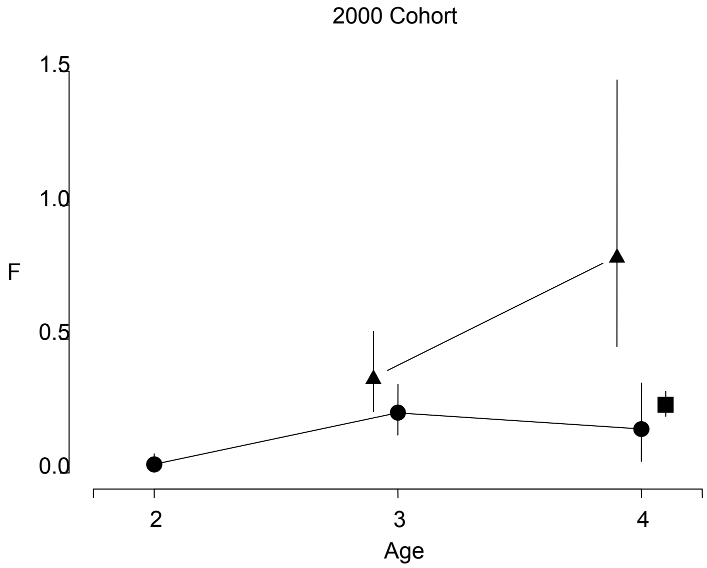


Fig. 1 Relative values of four indices for age one SBT recruitment in southern Western Australia

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

8 Tagging data



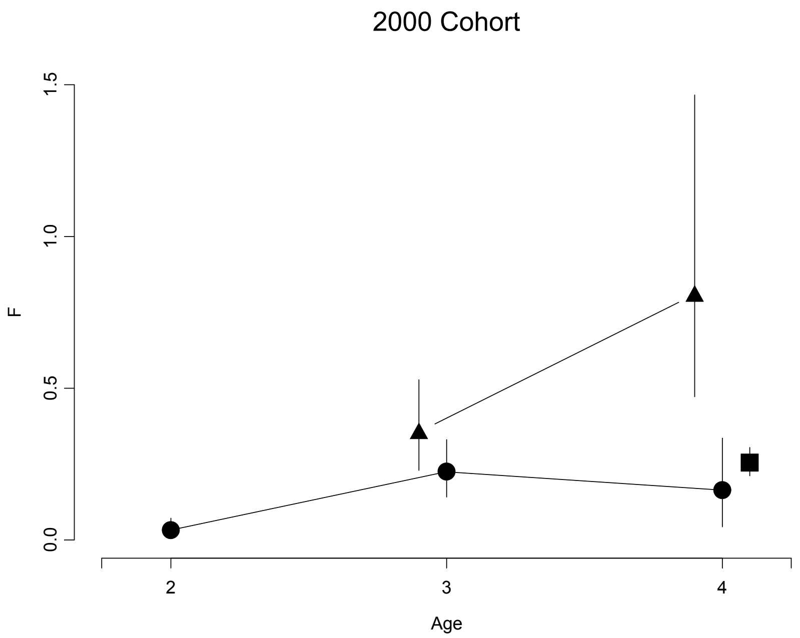


Figure 7. Comparison of estimates of age specific mortality rates for different release ages and cohorts for tagger group 1 (defined in CCSBT-ESC/0509/21). All estimates are for natural mortality rate vector 1 and reporting rate option 2 (defined in CCSBT-ESC/0509/21). Circles are for releases at age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

9 Size distribution

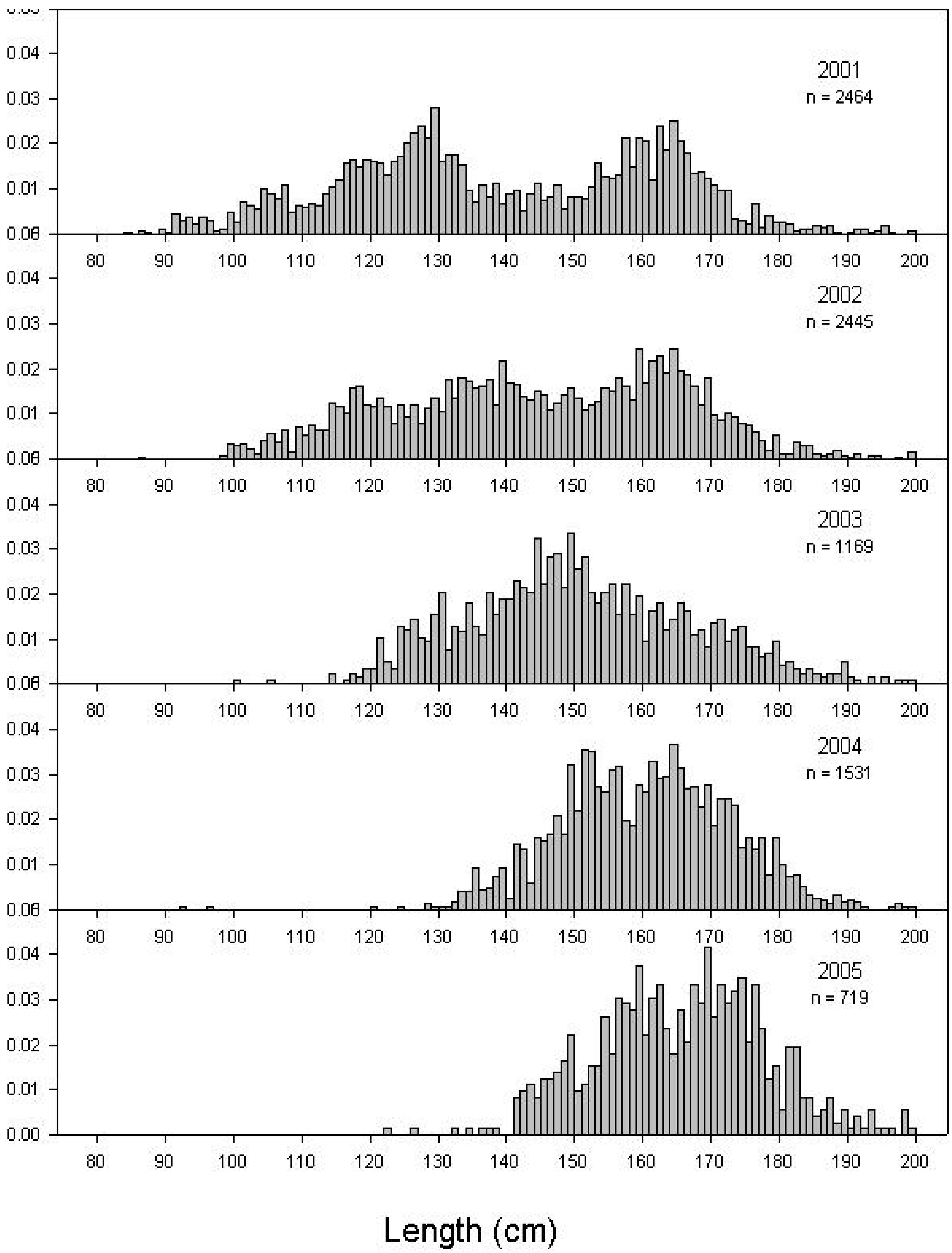


Figure 8. Proportion at length of SBT from the New Zealand charter fleet for 2001 to 2005. Data for 2005 is based on about 75% of the catch.

9 Size distribution

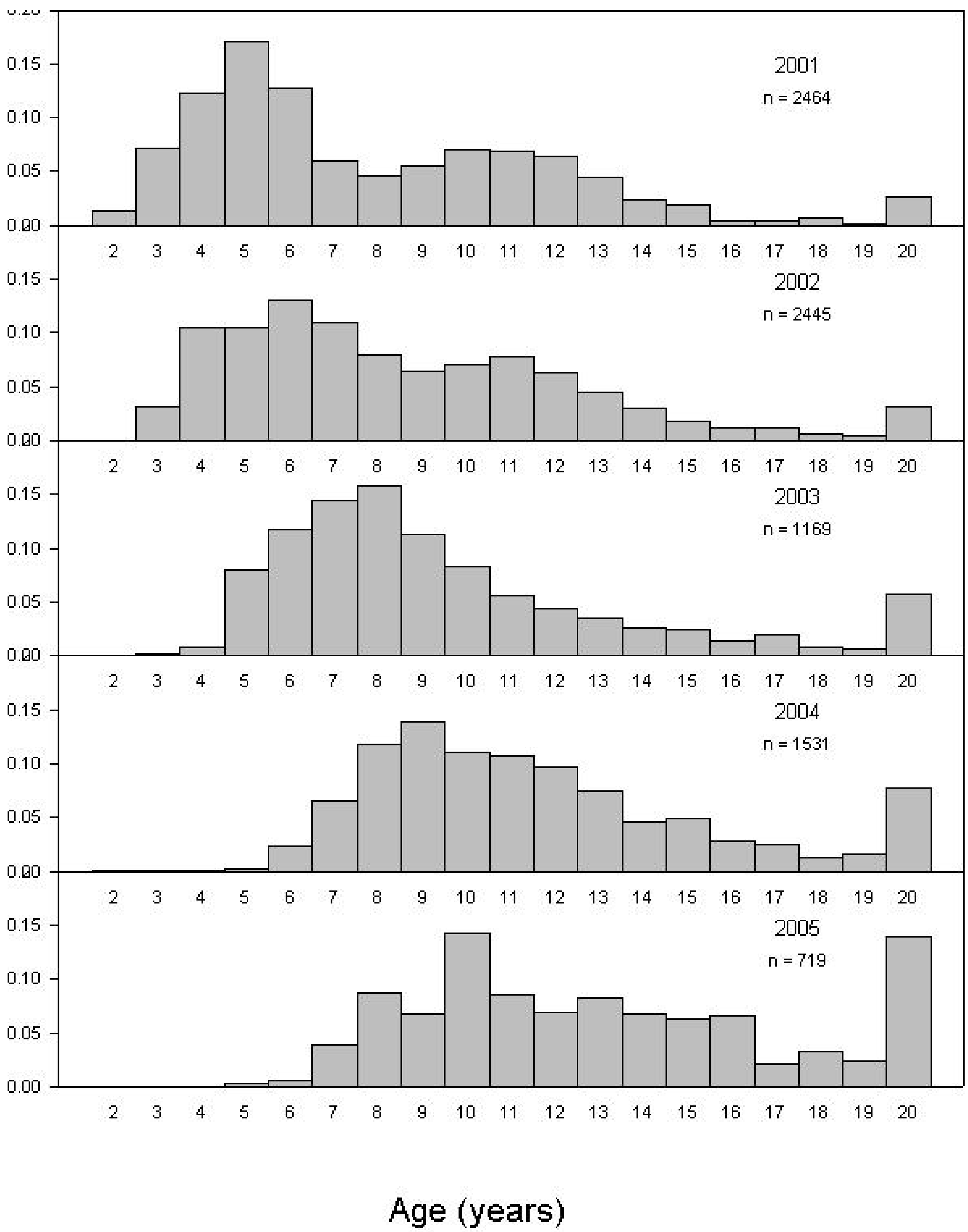


Figure 9. Proportion at age of SBT from the New Zealand charter fleet for 2001 to 2005 based on cohort slicing using the SC(2001) growth curve. Data for 2005 is based on about 75% of the catch.

9 Size distribution

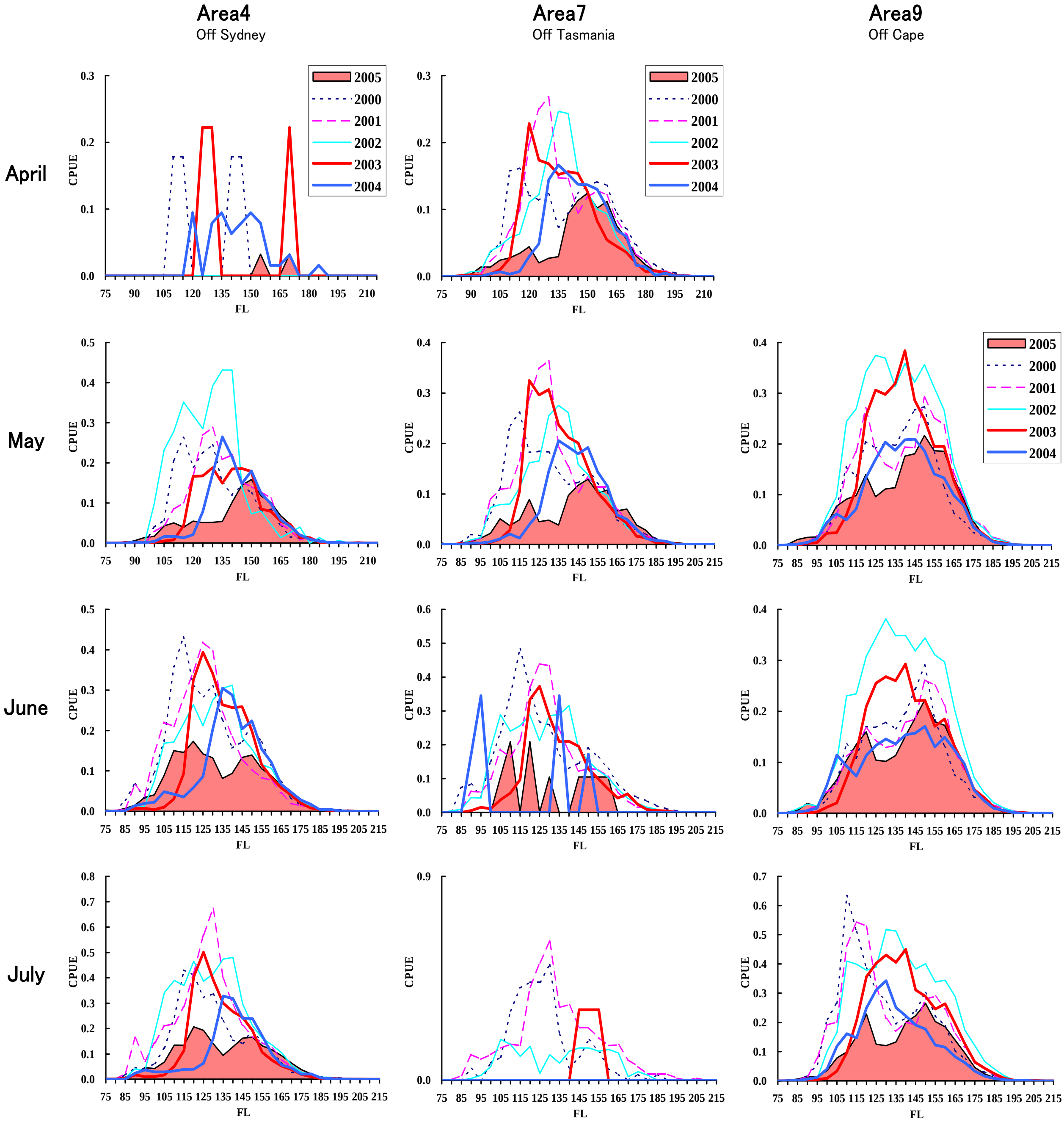


Figure 10. Size composition of nominal CPUE of RTMP data for five recent years by month and areas (from CCSBT– ESC/0509/39, Fig 1.4)

9 Size distribution

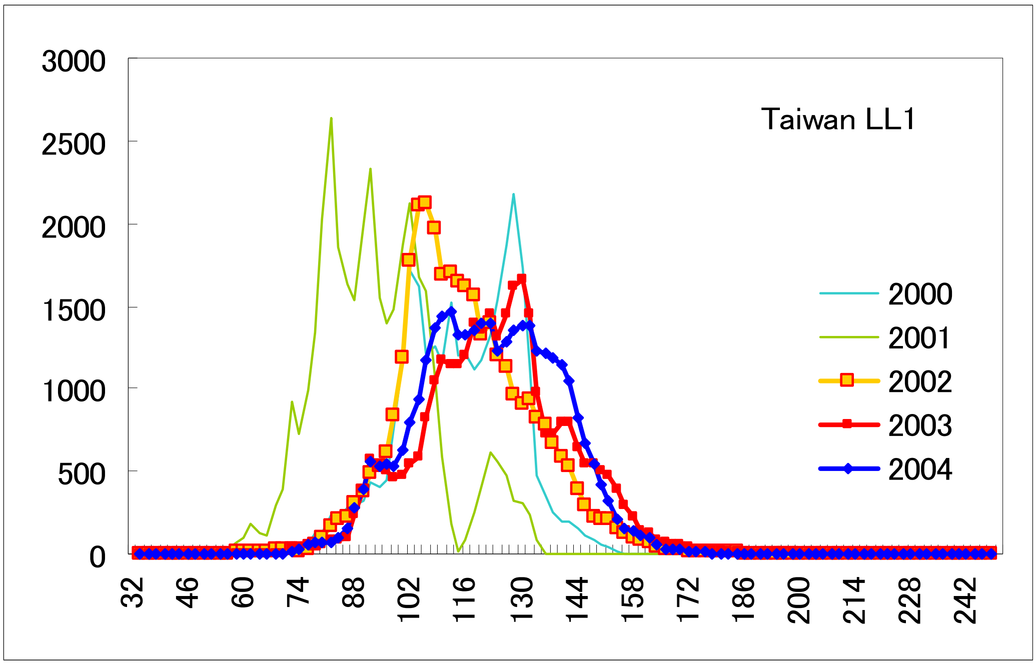


Figure 11. Changes in the size composition of the Taiwanese LL1 fishery. Note: The definition of Taiwanese LL1/LL2 was on targeting/bycatch criteria. It is recommended that the separation should be based on size selectivity and therefore the figure may be revised accordingly. (from CCSBT– ESC/0509/39,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

#10 GAB aerial survey indices

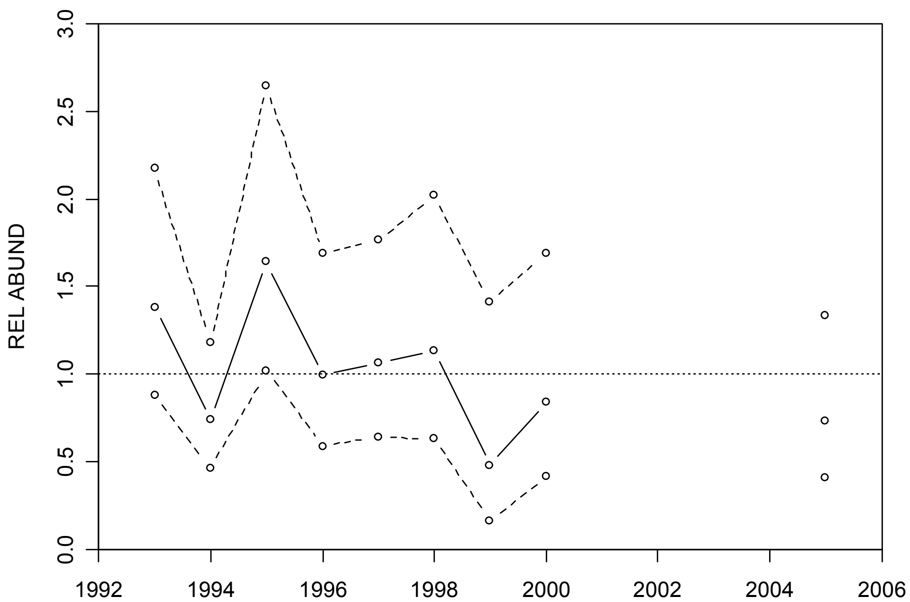


Figure 12. Time series of relative abundance estimates based on January and February (not March) aerial line transect survey sightings data with 90% confidence intervals. This index is a composite index of primarily ages 2-4 SBT in the Great Australian bight. Surveys were not conducted in 2001-04. (from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

#10 GAB aerial survey indices

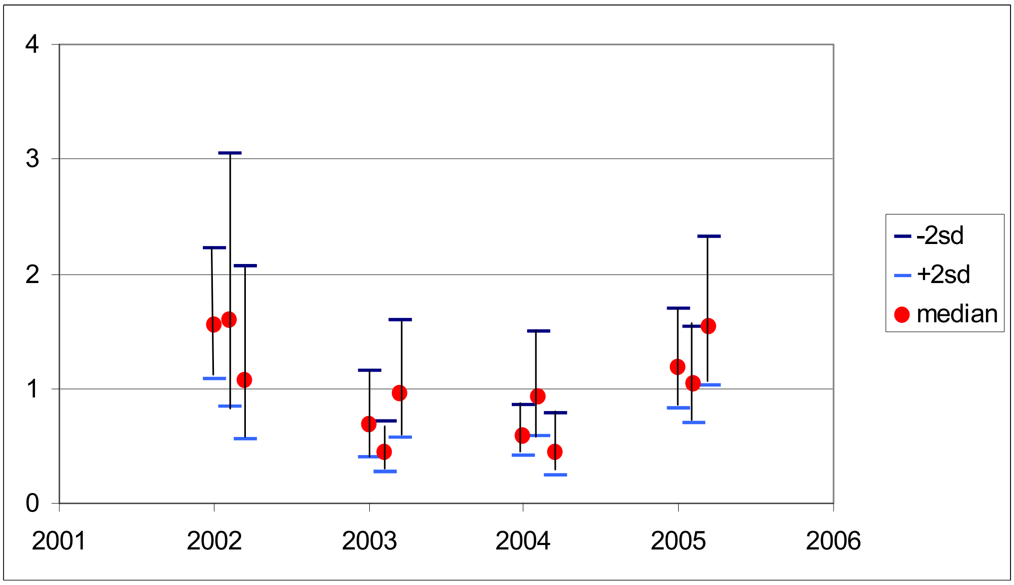


Figure 13. Standardized estimates of SAPUE (surface abundance in terms of weight per unit effort) from commercial spotter pilot data for companies 1,3, and 6 in each of the 4 past seasons. The median and exp(predicted value + or – 2 standard deviations) are shown. (from Basson and Farley 2005). This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