



The need for an aerial survey to provide a fishery independent index of recruitment for SBT

**A Hobday
J Farley
J Gunn
T Polacheck
M Basson
M Bravington (CMIS)**

**Prepared for the CCSBT 5th Meeting of the Stock Assessment Group (SAG5)
and the 9th Meeting of the Scientific Committee (SC9)
6-11 and 13-16 September 2004, Seogwipo KAL Hotel in Jeju, Korea**

Abstract

Monitoring recruitment of exploited fish species is often considered important for sustainable management and to monitor potential stock status/recovery/collapse. The CCSBT has consistently highlighted the need for a fishery-independent recruitment index for Southern Bluefin Tuna (SBT). Recruitment indices are important as they can provide information about stock status some years before CPUE trends in longline fisheries can provide reliable measure of a cohorts' strength. Recent trends in longline CPUE suggest that changes in recruitment may be occurring, but interpretation of CPUE alone is ambiguous because of possible changes in selectivity. The collaborative Recruitment Monitoring Program (RMP) has been supported by Australia and Japan for over 10 years; the main goal has been to develop a fishery-independent index of abundance. The indices derived from the RMP are some of the indicators considered by the CCSBT SC in assessing the stock status. Efforts are underway to improve the manner in which the RMP results (other than tagging) could be used in the analytical assessment process (e.g. CCSBT/0509/ForInfo 2).

One of the RMP fishery-independent indices was based on an aerial survey of juvenile SBT (ages 2-4) in the Great Australian Bight (GAB) between January and March. This full scientific aerial survey ran in consistent fashion from 1993-2000. In 2001, the survey was halted due to logistical difficulties with access to trained tuna spotters and planes, and to evaluate the usefulness of the index. Since then, substantial effort has been devoted to analysis of the survey results, and showed that the index was comparable to other recruitment indices around the world (CV~ 30%). A reduced aerial survey has been conducted over the period 2002-2004 relying on industry support and availability of spotters during the commercial harvest. The voluntary nature of the survey has meant that it is both reduced and ad-hoc in terms of the timing, location and number of transects flown. It is apparent that this reduced ad-hoc survey does not provide a reliable indicator of abundance, due in part to high variability in estimates resulting from reduced effort (CV ~45-154%). Nevertheless, it may be possible to refine the design of the original dedicated survey to produce satisfactory CVs while reducing the overall cost, and CSIRO is exploring alternative designs.

Trends in recruitment will be a critical indicator for the CCSBT over the coming years, and so the findings from the RMP remain vital for improving the scientific basis for advising management. Current concerns about recruitment suggest urgency to implementing a fishery-independent survey of recruitment. The aerial survey index of juvenile SBT (age 2-4) in the GAB is a potential solution that can be implemented soon (e.g. in 2005 fishing season provided funding and logistic issues can be resolved). It is important to decide the future of the aerial survey as soon as possible. Delays to the implementation of a new survey will severely impact on its value as a long time series of recruitment, as a short-term indicator of recruitment failure, and on the ability to cross-calibrate between the old and a new survey. CCSBT SC's advice and guidance on the relative priority of this index and the ways in which long-term support can be established will be important in the decision making process for the future of the aerial survey. We believe that a fishery-independent recruitment index based on a long time series of aerial surveys has the potential to provide significant improvements to the SBT stock assessments and thus would be of substantial benefit to the CCSBT SC and the member nations.

Background

Current concern around the status of the southern bluefin tuna (SBT) stock suggests that early warning of recruitment failure could be crucial. The CCSBT has consistently highlighted the need for a fishery-independent recruitment index for SBT. Recruitment indices for SBT are important as they can provide information about stock status several years before CPUE trends in the SBT longline fisheries can provide reliable measure of a cohorts' strength.

Fishery-dependent measures have some utility, but are often confounded by changes in fishing practices or other factors. There are clear advantages in having well designed fishery independent indices that are at least consistent in the way they are conducted. In recent years, a variety of indicators have suggested that recruitment and/or adult spawning biomass may be declining:

- longline CPUE for age 3 and 4 fish on the high seas in 2003,
- longline catch for adult fish on the Indonesian spawning grounds
- the Recruitment Monitoring Program (RMP) Acoustic Survey Index for age-1 SBT in southern Western Australia,
- the number of size classes in the age-1 cohort observed in conventional tagging in southern Western Australia

Some of the above and several other indicators are used by the CCSBT to assess the status of the stock. Some are used directly in the stock assessment, others are used as indicators. Interpretation of these measures is, however, problematic. All have different time scales, spatial coverage and varying assumptions and caveats regarding interpretation. For example, recent trends in longline CPUE for juvenile fish suggest that changes in recruitment may be occurring, but interpretation of CPUE alone is ambiguous because of possible changes in selectivity and retention practices. The RMP has been working towards developing usable fishery-independent indices of recruitment for many years now. Results from past work under this program, together with current concerns about recruitment, suggest that refinement and implementation of one of the recruitment indices should be considered

The Recruitment Monitoring Program

The collaborative Recruitment Monitoring Program (RMP) has been supported by Australia and Japan for over 10 years. The main goal has been to develop a fishery-independent index of juvenile abundance. Much effort in the RMP has been directed at development of a juvenile SBT abundance index based on two approaches: a scientific aerial survey and an acoustic survey. Validation of survey assumptions has also been a major research focus, including archival tagging to study the surfacing behaviour of SBT, and acoustic tracking projects to study the movement patterns of SBT in the area where the acoustic survey has taken place. Efforts are underway to improve the manner in which the RMP results (other than the conventional tagging data, which has since become a CCSBT tagging program) could be used in the analytical assessment process.

Aerial Survey for Juvenile SBT

An aerial survey for juvenile SBT (mixed schools of age 2-4) in the Great Australian Bight was conducted based on line-transects using dedicated tuna spotters and aircraft between 1993-2000. The data formed the basis of a fishery-independent juvenile SBT index of abundance. In the year 2000, it seemed that the ability to detect changes in juvenile SBT abundance using this index was limited and there were major logistic difficulties in

continuing the aerial survey. A recommendation from an aerial survey workshop, held to address some of the concerns, was to suspend the survey for a year (2001) and complete analysis and synthesis of existing data. A decision to continue or end the scientific aerial survey could then be made on the merits of the data, in particular the ability to detect changes in abundance. A significant amount of effort has been directed at decreasing index uncertainty by incorporating information from the supporting RMP projects, such as archival tag-derived surfacing behaviours with regard to environmental conditions. The analysis of the 1993-2000 aerial survey data has now been completed and concluded that the scientific aerial survey can provide a suitable indicator of SBT abundance in the GAB (CV ~ 30%). It has also been recognized that the level of uncertainty is similar to that found in other fishery-independent surveys carried out around the world.

Between 2002-2004, an alternate approach was conducted to examine the feasibility of using experienced commercial spotters to collect data on SBT sightings in the GAB. This new "aerial survey" comprised two parts:

- (1) a 'commercial' spotting component based on SBT sighted per unit of searching effort (a SAPUE index), and
- (2) a reduced ad-hoc line-transect component based on the transects in the 2000 scientific aerial survey design (Cowling, 2000).

As noted in Cowling et. al. (2003), the commercial data offers two possibilities for integration with aerial surveys: calibration of patch size measurements and improved estimation of the effects of environmental factors on sightability. Although standardised indices have been estimated for the commercial spotting data, they suffer from many potentially serious problems, particularly ones related to dense coverage of small areas, which could lead to substantial bias. The reduced ad-hoc line transect component is called this because the transects (taken from the 2000 scientific aerial survey design) were being flown only when spotters were available and not required for commercial spotting, and when the weather was suitable. This tended to lead to very few transects being flown compared to the scientific survey. It also meant that most transects were flown towards the end of the season when SBT may already be leaving the GAB, as seems evident from the data collected over the 7 years of the scientific aerial survey. It is now apparent that a reduced ad-hoc survey will not provide a reliable estimate of abundance, due in part to high variability in estimates resulting from reduced and variable effort (CV ~45-152%), and in part because of the most likely timing of transects at the end of the season. Retrospective analyses of the full aerial survey, however, showed that a temporally reduced (2 month) survey conducted during January and February are likely to provide CVs at a level similar to the full survey (35% compared to 30%).

Based on these results, and the logistical problems encountered when using spotters ad-hoc to conduct a line-transect survey, we propose to re-establish a scientific aerial survey in the GAB. Either a 2- or 3-month survey, including experiments to calibrate the previous 1993-2000 aerial survey with the new one, would be sufficient. Given the importance of calibration experiments and their expected ability to retrospectively improve the variance of previous estimates (Bravington, 2002), we believe these should be conducted if a scientific aerial survey proceeds in 2004/05.

The resulting index can be used as an additional input to the assessment models for the SBT stock. The aerial survey results (1993-1997) have been used in some SBT stock assessments in the past (e.g. Butterworth et. al. 2003). In 2004, an assessment of the SBT stock will be

conducted by the CCSBT SAG. Attempts will be made to do some assessment runs which include the aerial survey index (CCSBT-ESC/0409/23). Work is also underway to examine consistency between the aerial survey index and the stock assessment (or essentially the other data inputs to the assessment) (CCSBT-ESC/0409/Info 2). This index is recognized as a potentially critical early-warning tool of recruitment failure.

We are fully aware of the fact that there are some remaining issues with the aerial survey. One of the most important questions is whether a fixed or highly variable proportion of recruits go to the GAB each year. What would be more problematic of course is if the proportion that goes to the GAB is related to the recruitment strength in some way. This would affect the interpretation of the index relative to the overall recruitment. The work on consistency is a first attempt to start getting a clearer picture of what the situation might be. In any case, the index is still likely to be a highly relevant indicator of 'local' recruitment to the GAB. The need for research associated with the aerial survey to address the outstanding issues remains.

The acoustic index for juvenile SBT

A second fishery-independent index based on an acoustic survey of age-1 SBT has also been a focus in the RMP. This survey was suspended in 2003/4 to allow full consideration of the effectiveness and biases in this approach. There were identified problems with detection and validation of SBT schools, as well as issues regarding migration timing and pathways. The results of these analyses have not yet been completed, and so the ability of this approach to provide an index of abundance in the near future is unclear.

Conclusion

Trends in recruitment will be a critical indicator for the CCSBT over the coming years, and so a fishery-independent index of recruitment remains vital for improving the scientific basis for advising management. Current concerns about recruitment suggest urgency to implementing a fishery-independent survey of recruitment. The aerial survey index of juvenile SBT (age 2-4) in the GAB is a potential solution that can be implemented soon (e.g. in 2005 fishing season provided funding and logistic issues can be resolved). The aerial survey came to a halt because of logistical and analytical concerns, which we now believe can be overcome. It is important to decide the future of the aerial survey as soon as possible. It has value as both a long time series of recruitment, and also as a short-term indicator of recruitment failure. Delays to the implementation of a new survey will severely impact on both values. Moreover, the longer the delays the more difficult it may be to cross calibrate the previous one with a re-implemented aerial survey. CCSBT SC's advice and guidance on the relative priority of this index and the ways in which long-term support can be established will be important in the decision making process for the future of the aerial survey. We believe that a fishery-independent recruitment index based on a long time series of aerial surveys has the potential to provide significant improvements to the SBT stock assessments and thus would be of substantial benefit to the CCSBT SC and the member nations.

References

Bravington, M. 2002. CSIRO. Further considerations on the analysis and design of aerial surveys for juvenile SBT in the Great Australian Bight. Report of the Third CCSBT Stock Assessment Group Meeting, Canberra, Australia (+ Extended Scientific Committee for 7th Scientific Committee). 2002. CCSBT-ESC/0209/Info11

- Butterworth.D.S., J.N. Ianelli and R. Hilborn. 2003. A statistical model for stock assessment of southern bluefin tuna with temporal changes in selectivity. *African Journal of Marine Science* 25: 331-361
- Cowling, A. 2000. Data analysis of the aerial surveys (1992-2000) for juvenile southern bluefin tuna in the Great Australian Bight. Southern bluefin tuna recruitment monitoring and tagging program. Report of the twelfth workshop. RMWS/00/03
- Cowling, A., A. Hobday, Gunn, J. (2003). 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 96/118 & 99/105