

AN OVERVIEW OF RECENT SOUTHERN BLUEFIN TUNA STOCK ASSESSMENTS

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SUMMARY

Estimates of recruitment all indicate a long-term declining trend since the 1960s. Recent CPUE, tagging and aerial survey results indicate that recruitment continued to be low for the 1993 to 1995 cohorts. Estimates of spawning stock biomass indicate that the current SSB is well below the 1980 level (the target minimum rebuilding level established by the CCSBT). Any indications of a recent increase in the VPA estimates of SSB are predicated on an assumption that the age of maturity is 8. Recent studies and sampling from the spawning grounds are inconsistent with such an assumption. VPA estimates, which suggest that there may have been some increase in recent years if age 8 maturity is assumed, are not consistent with nominal or standardized CPUE trends.

Projection results for two of the three national delegations indicate a low probability of recovery, while those for a third suggest a relatively high one. Projection results appear to consistently be upwardly biased (i.e. overly optimistic).

The Scientific Committee of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) and its predecessor under the SBT Trilateral Agreement have been conducting annual stock assessments of the southern bluefin tuna (SBT) resource since 1982. In 1998, the CCSBT established a technical stock assessment group (SAG) to undertake the technical aspects of the assessment. The results from the SAG meetings are reviewed by the Scientific Committee and summarised in order to provide advice to the CCSBT on current stock status and management implications. The most recent meeting of the CCSBT Scientific Committee was held in July and August of 1998. In total, 23 representatives from Australia, Japan and New Zealand attended either one or both meetings. Scientists from Indonesia, Korea and Taiwan were also present. Both the SAG and Scientific Committee produced agreed reports of their meetings (Anon. 1998a, b). However, since the annual meeting of the Commission has not yet been held, these reports are not yet publicly available.

Extensive documentation relevant to SBT stock assessment was presented at these meetings, particularly in recent years. For example, 36 scientific papers were specially prepared and presented to the 1998 SAG and Scientific Committee Meetings. In addition, a further 8 information papers were considered (Appendix 2).

Scientific advice on the status and recovery probabilities for the SBT stock is based on information on catch per unit effort (CPUE), qualitative fishery indicators (e.g. presence or absence of fish in areas where they were abundant historically), virtual population analyses (VPA) and stochastic projection under constant-catch scenarios. The analytical assessment is based on VPA using the ADAPT framework (Garvaris 1988). The catch-at-age matrix is estimated from size-frequency data converted to age based on estimates of length-at-age derived from tagging data using a cohort slicing method (Preece *et al.* 1998). The main information used for tuning the VPA are age-specific CPUE indices derived from longline data. Recent tag return data and juvenile aerial survey indices are also used in some analyses. The structure of the VPA estimation models and associated software has been undergoing extensive development in recent years (Anon. 1994, Polacheck and Preece 1998, Tsuji *et al.* 1998; Hilborn *et al.* 1998). These developments have been needed to accommodate the increase in data and to

reconcile inconsistencies in the data, particularly in the temporal trends among the age-specific CPUE indices (Anon. 1994, Polacheck *et al.*, 1998). The VPA assessment is complicated by problems associated with the estimation of the plus group and the fact that the plus group constitutes a substantial proportion of the spawning stock.

The CCSBT has established the rebuilding of the parental biomass to at least the 1980 level as an initial recovery target for the stock, and has set 2020 as the target date for achieving recovery to this level.

Within the quantitative VPA and projection assessments, a large number of alternative VPA and projections are considered, reflecting a range of hypotheses for the major uncertainties (Polacheck *et al.*, 1998, in press; Tsuji *et al.* 1998; Anon. 1997, 1998 a, b). Weighted means of the results are used to provide estimates of the current stock status and the probability of recovery under constant-catch scenarios. Separate weights for the various hypotheses have been developed by the different national scientific delegations, and there are large disparities in these weights (Anon. 1998 a, b). Nevertheless, the different weightings tend to provide similar results on current stock status. However, they do yield disparate estimates of future stock levels 22 years in the future under constant catches at the current level.

The following is a brief synopsis of the agreed results and conclusions from the last CCSBT Scientific Committee about recruitment trends, current spawning stock levels and projections from the analyses presented there. Based on these results and conclusions, implications for management were derived and included in the Scientific Committee's report. The agreed implications are presented in Appendix 1.

Recruitment Trends

Similar recruitment trends were seen in all VPAs presented at the 1998 CCSBT Scientific Committee meeting. The trends were very robust to the differences in model structures and uncertainties considered in the various analyses. The assessments suggest that recruitment has declined markedly from the late 1960s to the mid-1990s. The most recent estimates from the VPA are about one-third of the late 1960s level. The VPA models do not provide estimates of recruitment for cohorts born after 1992. However, analyses of recent

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CPUE, tagging and aerial survey results in the Great Australian Bight indicate that the recruitment continued to be low for the 1993 to 1995 cohorts.

Current Spawning Stock Levels

All VPA results continue to show that the current SBT stock is substantially below the 1980 level. Three different VPA analyses were presented at the 1998 CCSBT meeting. The weighted mean of the current spawning stock biomass (SSB) relative to the 1980 SSB ranged from 25 to 53 % across the different analyses and weightings for the uncertainties considered.

There is uncertainty about the age of maturity for SBT. Traditionally, little data was available on the reproductive biology of SBT, and the age of maturity was assumed to be around 8 years old. Recently collected data suggests that the age of maturity is greater. Very few fish less than 10 years old occurred in the Indonesian catch from the spawning ground in 1994-95 and 1996-97, the two seasons for which direct age estimates are available. At the 1998 CCSBT Scientific Committee, three options for the age of maturity were considered. These were that SBT are sexually mature at age 8 and older (8+), age 10 and older (10+), or age 12 and older (12+).

VPA results based on age 8 showed a long-term decline in the SSB, but estimates of the most recent trends are variable. Some results showed an upturn since 1994, while others continued to decline. These trends depend greatly on the method used for estimating the size of the plus group and on which CPUE indices were used for tuning. In those results with an apparent increase, the increase is driven by recent large increases in the estimated numbers of 8- to 11-year-olds. However, this increase is not consistent with the recent trends seen in the CPUE series. It was noted that this inconsistency could be a consequence of changes in targeting, and some analyses suggest this may have occurred.

With the 10+ or 12+ maturity options, all VPA results suggest that parental biomass has continued to decline.

The VPA assessments indicate that parental biomass is considerably less than the pre-exploitation levels. Two of the three 1998 VPA assessments included estimates that extended back to 1960. For these two, the estimates of the 1997 SSB relative to 1960 ranged from 7 % to 15 %.

Projections

Stochastic projections under constant current catches yield a wide range of estimates for the probabilities of recovery of the parental biomass to the 1980 level by 2020. The results ranged from 6 % to 87 % depending upon which uncertainties were included, the hypotheses used to represent them, and the weights given to the different hypotheses. Projection results for two of the three national delegations indicate a low probability of recovery, while those for a third suggest a relatively high one. Most of the differences arose from the different weightings assigned by each delegation to the different hypotheses used to account for uncertainties. These weightings are based on an evaluation of alternative hypotheses using all known information and VPA results. Because these weights were partially subjective, there is still considerable doubt as to their absolute reliability.

Differences in the methods used for estimating the size of the plus group and in the interpretations of CPUE indices had major impacts on the estimates of the recovery probability. Of these two factors, the plus group treatment had the greatest effect.

Retrospective projection analyses based on a consistent set of VPAs indicate that the estimates of the probability of recovery decrease when the analyses are updated with an additional year's catch and effort data. This was true for all delegations' weightings. In addition, the projections produced by the Scientific Committee between 1982 and 1993 have been shown to be consistently biased upwards and hence have been overly optimistic.

The 1998 Scientific Committee noted that use of the probability of recovery to the 1980 level by 2020 as a single reference point might not be appropriate, and suggested that consideration should also be given to shorter-term projections and current stock status. Given the current range of uncertainties in the data available for assessing the SBT stock and its population dynamics, the Scientific Committee recognized that the range and uncertainty about predicted future stock size over a 20-year time interval are likely to be very wide.

References

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- Anon. 1997. Report of the Third Scientific Committee Meeting of the CCSBT. 28 July - 8 August 1997, Canberra.
- Anon. 1998a. Report of the 1998 Stock Assessment Group Meeting. 23-31 July 1998. Shimizu, Japan
- Anon. 1998b. Report of the 1998 Scientific Committee meeting. 3-6 August 1998. Tokyo, Japan.
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- Preece, A., Polacheck, T., Klaer, N., Hearn, B. 1998. Estimation of the Historical Catch and its Age Distribution for Southern Bluefin Tuna. CSBT/9807/36.
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- Tsuji, S., Takeuchi, Y. 1998. Stock Assessment and future projection of southern bluefin tuna - 1998-07-22. CCSBT/9807/27.

APPENDIX 1 – AGREED IMPLICATIONS FOR MANAGEMENT

(Taken Directly From Anon 1998b)

Although there were some differences of opinion regarding the degree to which implications for management should refer to specific management actions, the following four management implications were agreed by the SC:

1. Management measures were successful in reducing catches by 1990 but non-member catches, which have shown an increasing trend over the 1990s, have contributed to the erosion of benefits over this period;
2. As noted by the Scientific Committee in the past, the continued low abundance of the SBT parental biomass is cause for serious biological concern. The parental biomass in 1997 remains at historically low levels while catches on the spawning ground have increased since 1989,

largely due to the expanding Indonesian longline fishery;

3. The recent increase in the fishing mortality rates on juvenile fish (age 5 and younger) will lead to lower recruitment from these cohorts to the parental biomass. Also the increasing pressure on the parental biomass, particularly on the spawning ground, is contributing to the continuing low parental biomass; and
4. The Commission should pay particularly close attention to recruitment indicators in the immediate future, given indications that recruitment has dropped in the last few years.

APPENDIX 2 –

LIST OF DOCUMENTS TABLED AT THE 1998 CCSBT SCIENTIFIC COMMITTEE MEETING

Working Papers:

1. Draft Agenda for SC
2. Draft List of Participants for SC
3. List of Documents Considered at the Scientific Committee Meeting
4. Australia's 1996-98 Southern Bluefin Tuna Fishing Seasons - Robins, C.M., Caton, A.E., Ward, P.J., Williams, K.F.
5. Size Partitioning by Depth of Southern Bluefin Tuna on the Spawning Grounds - Davis, T.L.O., Farley, J.H., Bahar, S.
6. Catch Monitoring of The Fresh Tuna Caught by the Bali-Based Longline Fishery - Davis, T.L.O., Bahar, S., Naamin, N., Le, D.
7. Report on Japanese/Australian Review of SBT Catch Monitoring in Bali, 8-10 January 1998 - Davis, T.L.O.
8. Data Analysis of the Aerial Surveys (1991-1998) for Juvenile Southern Bluefin Tuna on the Great Australian Bight - Cowling, A., Millar, C.
9. Otolith analyses suggest that the growth rate of juvenile SBT began to increase in the late 1970's and that growth rates have continued to increase through the 1980's and 1990's. - Gunn, J., Farley, J.
10. Spatial Analysis of Southern Bluefin Tuna Catch Per Unit Effort Data: A Best Linear Unbiased Predictor Approach - Toscas, P., Thomas, M.
11. Preliminary Estimates of the Size Distribution of SBT Caught by Taiwanese SBT Longliners in the Indian Ocean, Based on Data Collected From Transshipments in Mauritius, October 1997. - Gunn, J., Farley, J.
12. Sample of Otoliths from the Australian Surface fisheries and New Zealand Joint Venture Longline Fishery, and Transfer of CSIRO Methods for Estimating SBT Age to the Japan NRIFSF - John, G., Farley, J., Clear, N.
13. Estimation of abundance indices of southern bluefin tuna (*Thunnus maccoyii*) based on the coarse scale Japanese longline fisheries data (1969-97) - Nishida, T., Tsuji, S.
14. Observation of SBT catch monitoring survey conducted by CSIRO/BPPL (RIMF) in Benoa fishing port, Bali, Indonesia - Nishida, T.
15. Southern Bluefin Tuna catch by Japan -1998. - Itoh, T., Nishida, T., Tsuji, S.
16. Models for Southern Bluefin Tuna in the New Zealand EEZ - Richardson, K., Murray, T., Dean, H.
17. Assessment of the Status of the Southern Bluefin Tuna Stock Using Virtual Population Analyses - 1998 - t Polacheck, A Preece and Neil Klaer
18. Spatio-Temporal Analysis of Southern Bluefin Tuna Catch Per Unit Effort Data - Ellis, N., Thomas, M., Polacheck, T.
19. Trends in Catch, Effort and Nominal Catch Rates in the Japanese SBT Longline Fisheries, 1998 - Polacheck, T., Bailey, R.
20. Updated Estimates of Mortality Rates for Juvenile SBT from Multi-Year Tagging Cohorts - Polacheck, T., Hearn, B., Millar, C., Stanley, C.
21. Applying General Linear Models to CPUE to Estimate Indices of SBT Abundance-1998 - Hearn, W.S., Polacheck, T.
22. Comments on a robust fitting procedure for the Beverton-Holt stock-recruitment curve - Hiramatsu, K.
23. Review of Estimates of Tag Reporting Rates and Mortality Rates for Southern Bluefin Tuna from Tagging Experiments - Hiramatsu, K.
24. Description of the Current Process of Data Preparation and Stock Assessment - Tsuji, S.
25. Progress in the development of a routine sampling and age estimation program - Tsuji, S.
26. Estimation of Southern bluefin tuna (*Thunnus maccoyii*) recruitment (Age 1) off Esperance in Western Australia based on the sonar information (1996-98) - Nishida, T., Miyashita, K.
27. Stock Assessment and future projection of southern bluefin tuna - 1998-07-22 - Tsuji, S., Takeuchi, Y.
28. No Paper
29. Japanese proposal for basis rules to incorporate new information to assessment process -

30. Pilot plan for experimental fishing programme for southern bluefin tuna - NRIFSF, JFA
31. A Statistical Time-Series Model for Stock Assessment of Southern Bluefin Tuna - Hilborn, R., Butterworth, D.S., Ianelli, J.N.
32. Comparisons of abundance indices estimated between Japan and Australia based on the coarse scale Japanese longline catch and effort data - Nishida, T.
33. Rebuilding and overview of historical size frequency of southern bluefin tuna, *Thunnus maccoyii*, caught by Taiwan longliners - Chang, SK.
34. Status of Taiwan longline fishery on southern bluefin tuna, 1997 - Chang, SK.
35. The method of the weight determination by ABIC - Shono, H.
36. Estimation of the Historical Catch and its Age Distribution for Southern Bluefin Tuna - Preece, A., Polacheck, T., Klaer, N., Hearn, B.
37. Documentation of the Virtual Population Analysis Methods and Model Inputs used for Estimating Current and Historical Stock Sizes of Southern Bluefin Tuna: Updates and Modifications 1998 - Polacheck, T., Preece, A.
38. Southern Bluefin Tuna Stock and Recruitment Projections
39. The Age Distribution and Relative Strength of Cohorts of SBT on the Spawning Grounds - Gunn, J., Farley, J., Clear, N.
40. Fishery Indicators for the SBT Stock: An update of 12 indicators first used in 1988 plus additional indicators from the 1990's - Gunn, J., Polacheck, T., Davis, T., Klaer, N., Cowling, A., Farley, J., Caton, A., Williams, K., Hearn, W., Preece, A., Clear, N.
41. Korean Longline Fishery for Southern Bluefin Tuna - Moon, DY., Hwang, SJ.

Information papers:

1. Treatment of Data and Model Uncertainties in the Assessment of Southern Bluefin Tuna Stocks - Polacheck, T., Preece, A., Betlehem, A., Klaer, N.
2. A Proposed Index for Weighting Results in Catch at Age Models based on Diagnostic Tests for Lack of Fit - Polacheck, T., Haskard, K.A., Klaer, N., Betlehem, A., Preece, A.
3. Request for Foreign Research Vessel to Conduct Marine Scientific Research in Australian Waters
4. Report on 1996 research cruise of the R/V *Shoyo-maru* – The research in southern bluefin tuna spawning ground, December 1996 – March 1997 - NRIFSF
5. Verification document submitted to the CCSBT on 1/4/98 - Preece, A., Takeuchi, Y.
6. Reproductive dynamics of southern bluefin tuna, *Thunnus maccoyii* - Farley, J.H., Davis, T.L.O.
7. On the Relationship Between Nominal (Raw) and Constant Squares - Butterworth, D.S.
8. On the Need to Replace the Habitat Selection Model of Appendix A of SC/9807/21 - Butterworth, D.S.

Reports:

1. Report of the Third Meeting of the Ecologically Related Species Working Group
2. Report of the First Stock Assessment Group Meeting.