Update on and summary of SRP-related work conducted by Australia over the period 2001-2007

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Abstract

This paper provides an update on the Southern Bluefin Tuna research, related to the CCSBT Scientific Research Program (SRP) that has been conducted by Australia. The paper includes a list of references to publications and documents (to this meeting), where more details about the research and results can be found.

Introduction

A wide range of projects are conducted under the umbrella of Australia's contribution to the CCSBT Southern Bluefin Tuna 'Scientific Research Program' (SRP). The Australian contribution consists of a large body of research which has been funded by the Australian Government[1], either as sole funding body, or with contributions from the Australian southern bluefin tuna (SBT) fishing industry, and/or from other organisations such as the CSIRO (Commonwealth Scientific and Industrial Research Organisation). Some activities, such as the Commission's conventional tagging program have been funded by members through the CCSBT Commission, and therefore includes a financial contribution from Australia.

This document summarises the SRP-related activities conducted by Australia over the past six years (Table 1). This paper is not intended to be an extensive review or evaluation of the work or results, although we do attempt to highlight major outcomes of the research. Most of the research under this program has been reported in many working papers, information papers, or National Reports to the CCSBT Scientific Committee (SC) and Stock Assessment Group (SAG) meetings, as well as, in project reports and peer-reviewed publications. It is beyond the scope of this document to list all relevant papers, and only a small subset is given here, primarily those working papers presented to the CCSBT, including those presented in 2007 (Table 2). For many multi-year projects, updates on research are provided annually, and titles remain similar; for these projects we present only one 'example' reference.

It is important to note that much of the research conducted over the past six years, builds on a very large body of earlier research on SBT biology, movement and behaviour, and supporting research for stock assessments. This earlier research is not covered in this document, but should be recognised.

The main topics of the CCSBT Scientific Research Program (SRP), as listed in the "Report of the SC to CCSBT on the Scientific Research Program" (Attachment D to the Report of SC5, March 2001) are:

1. Characterisation of the SBT catch
2. CPUE interpretation and analyses
3. Scientific observer program
4. Conventional tagging program
5. Direct ageing
6. Archival and pop-up tagging

[1] Government funding is mostly through bodies such as the Department of Agriculture, Fisheries and Forestry (DAFF), the Australian Fisheries and Research Development Corporation (FRDC), the Australian Centre for International Agricultural Research (ACIAR), the Australian Fisheries Management Authority (AFMA), to mention a few.

7. Recruitment monitoring program
8. Development of a spawning biomass index
9. Fisheries oceanography for improved habitat definition.

The same report also notes that: "Some of these components (items 5 through 9) represent ongoing research by member countries; the SC fully endorses these programs and encourages their continued support." Items 1-4 are, however, noted as being the areas where "additional directed initiatives by the CCSBT are most likely needed and will likely result in substantial gains in reducing uncertainty in the stock assessment in the short term".

We discuss the research under these topics in the next several sections.

1. Characterisation of the SBT catch

1.1 Indonesian SBT catch

A collaborative research program between the CSIRO Division of Marine Research and the Research Institute of Marine Fisheries of Indonesia was set up in August 1992, and started operating in 1993, to monitor the catch of SBT caught by longline fisheries operating out of Indonesia. This program was expanded when a collaborative project between Indonesia's Research Centre for Capture Fisheries/Research Institute for Marine Fisheries (RCCF/RIMF) and Directorate General for Capture Fisheries (DGCF), CSIRO, DAFF, Australian Centre for International Agricultural Research (ACIAR), Indian Ocean Tuna Commission (IOTC) and Overseas Fisheries Cooperation Foundation-Japan (OFCF), established an integrated monitoring program at three major ports where tuna and billfish (including those tuna species other than SBT) caught by longline fleets operating in the Indian Ocean are landed and processed. This expanded program started operating in July 2002 and, together with the earlier program, has provided a time-series of estimates of SBT catches by Indonesian longline vessels for the period 1993 to 2006. The most recent catch estimates for this fishery are discussed in working document CCSBT-ESC/0709/09.

The joint CSIRO/RIMF program which started in 1992 also monitored the size composition of SBT landed by the Indonesian longline fishery in Bali. In 1993, this monitoring was extended to include collecting otoliths from a representative sample of the catch for direct ageing purposes (further comments are made under 'Direct Ageing' below). Initially, the program collected data on SBT landed at the port of Benoa in Bali, but in 2002 this expanded to include the ports of Muara Baru (Jakarta) and Cilacap (south coast Central Java). The majority of targeted SBT sampling, however, still occurs at Benoa. The monitoring has been very successful and over 14,800 length measurements and 8,600 otoliths (for age estimation) have been collected.

1.2 Taiwanese SBT catch

Between 1997 and 2000 CSIRO Marine Research, in collaboration with the Overseas Fisheries Development Council in Taiwan, the Taiwan Tuna Association and the Ministry of Cooperatives, Fisheries and Marine Resources Development in Mauritius, studied the species composition and SBT size distribution of Taiwanese tuna fisheries operating in the central and SW Indian Oceans. The collaboration was established to address concerns about the accuracy of the Taiwanese catch data. Results were presented in Farley et al. (2001).

On the basis of this monitoring, the report concluded that the Taiwanese fleets operating in the Central Indian Ocean, and off south-east Africa, catch significant quantities of SBT less than 150 cm fork length. This indicated that previous assumptions (within the CCSBT Scientific Committee), that the size composition of Taiwanese catches were the same as those of the Japanese Indian Ocean catches, may not be appropriate. The report also concluded that a comparison of the official Taiwanese catch data with CSIRO's catch monitoring in Mauritius indicated that, where logbook data were available, these provided an accurate source of information on the SBT catches.

1.3 Independent reviews of Japanese and Australian catches

In 2005, Australia and Japan instigated "independent reviews of the Japanese SBT market data and of the Australian SBT farming operations to determine whether or not over-catching is occurring relative to the total allowable catch" (Agenda item 23, Report of the Twelfth Annual Meeting of the Commission). These reviews (The Japanese Market Review and the Australian Farm Review), were presented to the Commission in 2006 (both documents are currently confidential).

Discussions of the outcomes of the reviews and of implications for current stock status are partly documented in the Reports of the SAG and SC meetings in 2006 (Report of the Eleventh Meeting of the SC; Report of the Seventh Stock Assessment Group). A discussion of the implications of the reviews on the assessment of SBT stock status is provided in the document CCSBT-ESC/0709/26.

In addition to the implications for the stock assessment of SBT (and hence for stock biomass and stock trends) there are also substantial implications of the uncertainty in historic data for the development, testing and implementation of a Management Procedure (see CCSBT-ESC/0709/17 for further discussion on this).

2. CPUE interpretation and analyses

The standardisation of catch and effort data to obtain an index of population abundance is rarely straightforward. The interpretation and analyses of such data are even more challenging when there have been substantial changes in spatial distribution of the fishing fleet, as is the case for SBT for which we have a long time-series of Japanese longline logbook catch and effort data. In the late 1990s both Australia and Japan undertook additional research into alternative methods for analysing these data, given the difficulties encountered in the standardisation and interpretation of these data. Work conducted over the past six years has built on these early analyses, and in doing so has developed novel approaches to approaching standardisation problems. Some of these include using smoothing splines to estimate a CPUE index in core areas (Laslett 2001) and enhanced tree based modelling methods (Venables and Toscas 2002; Venables et al. 2003).

When testing of management procedures began in 2002, the shared objective was to decide on a single CPUE series to use in the conditioned operating model and projections. No one series could be agreed upon, so as a compromise solution, the median of five different standardised CPUE series was used in the testing. Included in these five series is the Laslett (2001) CPUE series.

3. Scientific observer program

3.1 Australian fisheries

Observers have been deployed by both AFMA and BRS in the Australian domestic purse seine fleet (targeting both purse seine fishing and tow cage operations), as well as in the Australian longline fisheries, where data are collected from SBT caught primarily as bycatch whilst fishing for other tuna and billfish species.

Observer activities for the 2002/03 season are reported in Stanley and Scott (2002) and those for the 2003/04 season onward are reported in the annual National reports (as Attachment 1 in each case; CCSBT-ESC/0409/SBT Fisheries/Australia, CCSBT-ESC/0509/SBT Fisheries/Australia, and CCSBT-ESC/0609/SBT Fisheries/Australia). These reports indicate the level of coverage (both as a percentage of effort and as a percentage of the catch) of the observer program, summarise results for catch and effort data, and comment on other data types, such as size frequencies, biological data and tag returns, for example.

3.2 Scientific observer programs in other fisheries

Australia and Indonesia, in collaboration, have set up a trial scientific observer program, operated by Indonesian observers on Indonesian longline fishing vessels operating out of the fishing port of Benoa in Bali. Although this program is aimed at obtaining information on all species being caught by the longline fishery, not just SBT, it is highly relevant. The observer trials are a key component of a project funded by ACIAR ("*Capacity development to monitor, analyse and report on Indonesian tuna fisheries" FIS/2002/074*), and the participating partners are Research Centre for Capture Fisheries (Indonesia), Directorate General of Capture Fisheries (Indonesia) and CSIRO. Activities commenced in July 2005 with training for six Indonesian and six Timor Leste trainees, provided by CSIRO scientific staff. The Indonesian observers went to sea for their first vessel assignments in early August 2005 and have since completed a total of 41 trips. Trip lengths have ranged from 20 to 103 days. The observer trials will continue within the ACIAR project until end of 2008, but Indonesia's Ministry of Marine Affairs and Fisheries have plans to develop a more formal scientific observer program to continue beyond this time. Further information is provided in CCSBT-ESC/0709/Info 04, but we note here that the program has already provided very important information about SBT being caught on fishing grounds south of the SBT spawning ground by the Indonesian Fleet.

4. Conventional tagging program

In 2002 the CCSBT conventional tagging program was initiated. Australia, together with other CCSBT members, has contributed to this program which covers tag deployment and tag recovery. The CCSBT Secretariat reports annually on these activities in documents to the SAG and SC. Here we briefly comment on additional research directly related to the CCSBT SRP conventional tagging program.

In order to provide a robust interpretation of tag return data estimates of reporting rate are required. Without reporting rate estimates for the different fishing fleets, the value of tag return data are substantially reduced. In an effort to assess reporting rates in conventional tagging programs, tag-seeding was initiated in the Australian surface fishery in 2002 on purse seine caught fish during transferral from tow cages to grow out cages. Further tag seeding

was conducted during each of the subsequent seasons (2003/04 through to 2006/07). Analyses of those data from 2002-2006, incorporating tag shedding estimates and variances yielded estimates of reporting rates which are low based on past expectations, and also progressively declining over the period of analyses. The very low estimate of the reporting rate for 2005/2006 (a value of approximately 20%) raises the question of whether the tag seeding results are providing unbiased estimates of the reporting rates.

Release and recapture information derived from the CCSBT SRP conventional tagging program have started to be used to estimate cohort and age-specific fishing mortality rates for different groups of tag releases. Associated with the development of this model has been the estimation of natural mortality, tag shedding and reporting rate, which are then used as conditional factors within the model. As noted above, decreases in reporting rates in 2005/06 have confounded quantitative interpretation of the tag return data and as a result the ability to provide useful estimates of fishing mortality rates.

5. Direct ageing

Given the longevity of SBT, the goal of direct ageing of SBT has long been recognised. The CCSBT agreed to establish an otolith collection scheme in 1997, but there was no requirement to routinely read otoliths for age determination. Australia has been collecting otoliths since the 1960s with routine collections occurring from its surface and longline fisheries since the 1990s. In 1994, Australia began formal reading of otoliths for age estimation, and research to validate age estimates derived from otolith readings. This work culminated in a CCSBT Direct Age Estimation Workshop held in 2002. In 2003 (SC Report, paragraph 95), the SC agreed that otolith collections and age-determination (in all fisheries) should begin as soon as practical.

Associated with the direct aging work conducted by Australia, has been the development of efficient statistical methods for estimating age distributions from size frequency and direct age data. Methods developed provided insights into the implications of different sample sizes of otoliths for the uncertainties in estimated quantities based on these data (Morton and Bravington, 2003). These insights helped inform the SC's recommendations for appropriate otolith sample sizes.

The collection, ageing and age validation of SBT otoliths have been discussed in detail in the many previous (annual) papers to the CCSBT SAG and SC meetings and in the Report of the Direct Age Estimation Workshop (Anon. 2002). Continued collection of otoliths and age determination of SBT caught within the Australian fisheries has been reported annually in working papers to the SAG and SC. During 2006/07, 331 otolith samples were collected from the Australian SBT surface fishery and a further 103 samples were collected from fish that died during CCSBT tagging operations in the Great Australian Bight.

As noted in Section 1.1 above, the joint programs with Indonesia to collect information on the catches of SBT by Indonesian longline vessels has also involved the collection of large quantities of length frequency data and otoliths. The development of validated methods to directly age SBT using otoliths, have allowed us to estimate the age composition of the Indonesian catch over 11 spawning seasons. These data have shown that the parental stock of SBT has undergone dramatic changes since monitoring began; the greatest change being a shift in the mode of SBT caught from 18-22 years in the mid-1990s to 12-15 years in the early-2000s (see CCSBT-ESC/0709/10).

Although the direct age data for fleets other than the Indonesian longline fleet have not yet been incorporated into an assessment model (or the operating model for MP testing), the time-series of these data are now starting to be long enough to warrant the necessary changes to the model(s) to incorporate these data.

6. Archival and pop-up Tagging

6.1 Assessment of the spatial dynamics of juvenile SBT

A project involving the archival tagging of juvenile (2–4 year old) SBT throughout their range (i.e. from South Africa to New Zealand) was initiated in 2004 with the objective of estimating movement and mixing rates, and periods of residency in different parts of this range. Further, data collected from archival tags returned will be used to provide improved knowledge of, the basis for and an understanding of the implications of incorporating spatial dynamics and habitat utilization information directly into the analyses of conventional tag return data, CPUE standardizations using habitat-based approaches, stock assessments, and management advice. Tag deployments have been implemented as a collaboration between New Zealand (NZ), Taiwan and Australia. A total of 414 tags have been released to date in NZ, Australian, central Indian Ocean and South African waters with 34 tags returned, two of which are the first tags recovered from NZ and Indian Ocean deployments. Finalisation of deployments is expected in 2008. To date, of those individuals tagged in Australian waters, movement patterns have lacked the eastward component previously recorded in juvenile SBT tagged with archival tags during the 1990s. See also Polacheck (2006) for an examination of the results from this project and CCSBT-ESC/0709/20 for an update on the most recent activities of this project.

6.2 Assessment of the spatial dynamics of large SBT

An electronic tagging program was initiated in 2001 using pop-up satellite archival tags (PSATs) to investigate (i) movements of adult sized SBT in the Australian region, (ii) fidelity of SBT caught in the eastern Australian fishery to the western Tasman Sea region and (iii) mixing with adjacent areas to the Australian Fishing Zone (see Gunn et al. 2006 for further details). In 2006, this program was extended to include tag deployments in the Indian Ocean in an effort to (i) determine movement patterns of fish caught off the eastern South African coast (ii) their fidelity to this area and (iii) their connectivity with those fish moving from the Tasman Sea to the spawning grounds south of Indonesia (see CCSBT-ESC/0709/Info-1). Deployment of PSATs rather than other forms of archival tags provided for the collection of fishery independent methods for assessing movement and habitat preferences in this species and allowed for collection of these data without the more involved surgical techniques of internal archival tags. To date, a total of 75 PSATs have been deployed (including 24 in 2006, of which three were deployed in the Indian Ocean), and data retrieved from 66 tags. In the Australian region extended residency of fish within the Tasman Sea region has been documented, with only one tag recording movements from the Tasman Sea to the area of the spawning grounds in the north-east Indian Ocean. Multiple trans-oceanic movements between the south-west Indian and the south-east Atlantic Oceans have been recorded from tags deployed in the Indian Ocean.

Collaborative efforts were initiated in 2004 with the NZ Ministry of Fisheries, culminating in the initiation of a tagging program conducted by the NZ Ministry of Fisheries in NZ waters in 2007. Continued collaboration is anticipated.

7. Recruitment monitoring program

The "Recruitment Monitoring Program" was established in June 1993 as a collaborative research program involving the (Japanese) National Research Institute for Far Seas Fisheries (NRIFSF) and CSIRO Marine Research for the purpose of monitoring the abundance of juvenile southern bluefin tuna, and developing research to provide a fishery independent index of juvenile recruitment.

Results from the joint program have been presented annually to the CCSBT through the annual reports of the meetings and workshops associated with the SBT Recruitment Monitoring Program (submitted as information papers). Here we comment on two aspects of the program, namely (i) a line transect aerial survey and (ii) commercial spotting operations. Further details on the most recent activities associated with both can be referred to in CCSBT-ESC/0709/12 and CCSBT-ESC/0709/13.

A line-transect aerial spotting survey for juvenile SBT in the Great Australian Bight (GAB) has been conducted since the early 1990's. The time-series of the aerial survey index is available for the years 1993 to 2000 and again from 2005 to 2007. The aerial survey was not conducted in 2001 to 2004, primarily due to logistic problems of finding spotter and being able to calibrate such a series, but also to re-evaluate the merits of the survey. This is discussed in detail in the many previous (annual) papers to the CCSBT SAG and SC meetings. Although it is known that the aerial survey index of abundance only represents the part of the juvenile stock which is in the GAB each summer, it is currently about the only fishery independent index of abundance available to the SAG and SC.

The commercial spotting data, which form part of the commercial fishing operations, have been collected in a systematic fashion by the CSIRO since the 2001/2002 harvesting season. A standardised index is derived (to standardise for environmental factors and differences between spotters) from the raw spotting data. These data, however, suffer from many of the problems associated with catch per unit effort data, and the designed line transect aerial survey is considered preferable to the SAPUE index of abundance.

8. Development of a spawning biomass index

As part of the process for improving our understanding of the reproductive biology of SBT, and also as a basis for developing a spawning biomass index, research on spawning adults was conducted in the late 1990s and early 2000s. The studies investigated size (and age) at first maturity, recruitment into egg production, and the relationship between adult body size and egg production. Results, reported in Davis et al. (2001) indicated an older age at 50% maturity than previously assumed. This had implications for the stock assessment-based estimates of spawning biomass. In addition, Davis et al. (2003) found that large fish contribute considerably more to egg production. This is not yet accounted for in the calculation of spawning stock biomass.

With regard to the development of an index of abundance on the spawning grounds, another collaborative project with Indonesia was established. The data being considered in this

project are somewhat unusual. Trainees from Indonesian Fisheries High Schools (FHS) have accumulated a large amount of information on daily fishing operations of the Benoa-based longline fleet, including catch and effort data, as part of their seagoing training. These data cannot be treated as robust observer data, though they may contain information on catch rates on the spawning grounds that are currently not available from other sources. In 2004, a project was therefore set up to enter fisheries data from the FHS 'Observer' program. At the time of writing (July 2007), a total of 80,528 long line sets had been entered into the database, with 6,257 sets entered during 2006/2007 (see CCSBT-ESC/0709/15 for further details). A total of 1,453 SBT were entered as catch in the database during this period. Work on developing an index of abundance from these data is ongoing. In addition, improvements to the level of training provided to the FHS students before they depart have are being made in the hope that the FHS program can become a more reliable and valuable source of observer-generated data for the Indonesian longline fleet.

It is worth noting here that new research has recently been initiated to estimate the absolute spawning stock size of SBT using close-kin genetics (CCSBT-ESC/0709/18).

9. Fisheries Oceanography for improved habitat definition.

Both projects investigating the spatial dynamics of SBT contain objectives focused on the integration of fisheries oceanography information with tag data to further improve our understanding of SBT spatial ecology, including preferred habitats (or conditions). This work is still underway and initial analyses can be referred to in Gunn et al. (2006).

10. Other Research activities

A large study on the growth and changes in growth rates of SBT was completed in 2002 (Polacheck et al. 2002). This study integrated data from many different sources (size and age frequencies, tag return data on size at release and size at recapture) to estimate time-varying growth rates of SBT. The results showed that growth rates of SBT have increased, at least between the 1970s, 1980s and 1990s as the stock has declined. These results have been incorporated into the stock assessment and the conditioned operating model as a basis for estimating catch at age distributions from the length frequency data. Although this work could be considered to be part of catch characterisation, it considerably improves our broader understanding of SBT biology and demographics.

Table 1. A summary list of Australian research activities on SBT considered in this document. Activities are listed under the main topics of the Scientific Research Program (SRP) of the CCSBT (as given in Attachment D to the Report of the Fifth Scientific Committee meeting, March 2001).

1. Catch characterisation
Indonesian catch characterisation
Taiwanese catch characterisation
Japanese Market Review
Australian Farm Review
2. CPUE standardisation
Standardisation of aggregated Japanese longline CPUE
3. Scientific observer program
Australian purse seine fishery and Australian longline fisheries
Trial Indonesian observer program
4. Conventional tagging program (CCSBT)
Conventional tagging data analyses
Tag seeding in the Australian surface fishery
5. Direct ageing
Development and validation of age reading procedure
Direct ageing of Australian catch
Direct ageing of Indonesian catch
6. Archival and pop-up tagging
Archival tagging of juveniles: 'Global Spatial Dynamics'
Pop-up satellite archival tagging of adults
7. Recruitment monitoring program
Line transect aerial survey
Commercial spotting data collection and analyses
8. Development of a spawning biomass index
Reproductive biology
Indonesian fishery High School data computerisation and analyses
9. Fisheries oceanography for improved habitat definition
Aspects of data analyses in projects under Topic 6
10. Other activities
Integrated study of SBT growth rates

Table 2. A summary of SRP-related research activities and their associated working papers to this meeting, where more details about the research and results can be found.

Research Activity	Working document number CCSBT-ESC/0709/
Catch characterisation	9, 10
Scientific observer program Australia Indonesia – trial observer program	 SBT Fisheries/Australia Info 04
Conventional tagging of juvenile SBT	19, 21
Direct ageing	10, 11
Archival and pop-up tagging	20, Info 01
Recruitment monitoring	12, 13
Development of a spawning biomass index	15
Fisheries oceanography for improved habitat definition	20, Info 01

References

This reference list is NOT a complete list of all relevant publications, reports or CCSBT working papers, but covers references made in the main text, and provides starting points for finding related documents.

1. Catch characterisation

Davis, T.L.O. and Andamari, R. 2002. Catch monitoring of the fresh tuna caught by the Bali-based longline fishery in 2001. CCSBT-SC/0209/24.

Davis, T.L.O. and Andamari, R. 2003. The catch of SBT in the Indonesian longline fishery operating out of Benoa, Bali in 2002. CCSBT-ESC/0309/17.
(and working papers with similar titles in subsequent years, 2003 – 2007)

Farley, J.H. and Davis, T.L.O. 2002. Length and age distributions of SBT in the Indonesian longline catch on the spawning ground. CCSBT-SC/0209/25.
(and working papers with similar titles in subsequent years, 2003 – 2007)

Farley, J., Chang, S-K. and Gunn, J. 2001. Taiwanese SBT catches and their size distribution in the Indian and Atlantic Oceans based on catch monitoring in Mauritius and Cape Town. CCSBT/SC/0108/17.

Proctor, C., Andamari, R., Iskandar Prisantoso, B., Retnowati, D., Poisson, F., Herrera, M. and Fujiwara, S. 2007. The catch of SBT by the Indonesian longline fishery operating out of Benoa, Bali in 2006. CCSBT-ESC/0709/09.

2. CPUE interpretation and analyses

Laslett, G. 2001. Exploratory analysis of the SBT CPUE data using smoothing splines. CCSBT-SC/0103/06.

Venables, W.N. and Toscas, P.J. 2002. Estimating a CPUE series for SBT using Enhanced Tree-based modelling methods. CCSBT-SC/0209/31.

3. Scientific Observer Program

Hobsbawn, P.I., Findlay, J.D., McLoughlin, K.J. and Curran, D. AUSTRALIA'S 2002–03 SOUTHERN BLUEFIN TUNA FISHING SEASON. 2004. CCSBT-ESC/0409/SBT Fisheries-Australia.

Hobsbawn, P.I., Williams, G.C., Findlay, J.D. and McLoughlin, K.J. 2005. AUSTRALIA'S 2003–04 SOUTHERN BLUEFIN TUNA FISHING SEASON. *CCSBT-ESC/0509/SBT Fisheries/Australia*

Hobsbawn, P.I., Hender, J., Findlay, J.D. and McLoughlin, K.J. 2006. AUSTRALIA'S 2004–05 SOUTHERN BLUEFIN TUNA FISHING SEASON. CCSBT-ESC/0609/SBT Fisheries/Australia.

Sadiyah, L., Andamari, R., Iskandar Prisantoso, B., Retnowati, D., and Proctor, C. 2007. Trial observer program for Indonesia's tuna longline fishery in the Indian Ocean. CCSBT-ESC/0709/Info 4

Stanley R. and Scott M. 2002. SBT purse seine pilot observer programme 2002–03 and observed longline operations AFMA. CCSBT-ESC/0309/33.

4. Conventional tagging program

Hearn, B., Polacheck, T. and Stanley, S. 2007. Estimates of reporting rate from the Australian surface fishery based on previous tag seeding experiments and tag seeding activities in 2006/2007. CCSBT-ESC/0709/21.
(and working papers with similar titles in 2003 to 2006)

Polacheck, T. and Eveson, P. 2007. Updated analyses of tag return data from the CCSBT SRP tagging program. CCSBT-ESC/0709/19.
(and working paper with a similar title in 2006)

5. Direct Ageing

Anon. 2002. Report of the direct age estimation workshop (June 2002). CCSBT-SC/0209/Rep 11.

Basson, M., Peel, S. and Farley, J.H. 2005. Estimates of proportions at age in the Australian surface fishery catch from otolith ageing and size frequency data. CCSBT-ESC/0509/19.
(and working paper with a similar title in 2006)

Clear, N., Stanley, C. and Polacheck, T. 2007. An update on Australian otolith collection activities: 2006/07. CCSBT-ESC/0709/11

Farley, J.H. and Davis, T.L.O. 2002. Length and age distributions of SBT in the Indonesian longline catch on the spawning ground. CCSBT-SC/0209/25.
(and working papers with similar titles in subsequent years, 2003 – 2007)

Farley, J. and Proctor, C. 2007. Update on the length and age distribution of SBT in the Indonesian longline catch. CCSBT-ESC/0709/10.

Morton, R. and Bravington, M.V. 2003. Estimation of age profiles of Southern bluefin tuna. CCSBT-ESC/0309/33.

Stanley, C. and Polacheck, T. 2003. An update on Australian otolith collection activities:2002/03. CCSBT-ESC/0309/21
(and working papers with similar titles in subsequent years)

6. Archival and pop-up tagging

Evans, K. and Patterson, T. 2007. Movements and behaviour of large SBT in the Tasman Sea and Indian Ocean regions determined using pop-up archival satellite tags: a summary of results for 2006-07. CCSBT-ESC/0709/Info 1.

Gunn, J., Evans, K., Patterson, T. and T. Carter. 2006. Examining the movement and residency of adult SBT in the Tasman Sea and on their spawning grounds south of Indonesia using pop-up archival tags. CCSBT-ESC/0609/Info 1.
(and working paper with a similar title in 2005)

Polacheck T., Chang, K.S., Hobday. A. and West, G. 2007. Update on the Global Spatial Dynamics archival tagging project. CCSBT-ESC/0709/20.
(and working papers with similar titles in 2005, 2006)

7. Recruitment monitoring program

Anon. 2002. Southern bluefin tuna recruitment monitoring and tagging program: Report of the fourteenth workshop. CCSBT-SC/0209/Info 8.
(and similar Information papers in 2003, 2005 (report of a Review workshop))

Eveson, P., Bravington, M. and Farley, J. 2007. Aerial Survey: updated index of abundance and preliminary results from calibration experiment. CCSBT-ESC/0709/12.
(and working papers with similar titles in 2005 and 2006)

Farley, J. and Basson, M. 2007. Commercial spotting in the Australian surface fishery, updated to include the 2006/7 fishing season. CCSBT-ESC/0709/13.
(and working papers with similar titles in 2005 and 2006)

8. Development of a spawning biomass index

Basson, M., Andamari, R., Sadiyah, L. and Proctor, C. 2007. An update on the use of the Indonesian Fishery school dataset to obtain a standardised CPUE series for SBT on the spawning grounds. CCSBT-ESC/0709/15.

Davis, T., Farley, J. and Gunn, J. 2001. Size and age at 50% maturity in SBT: An integrated view from published information and new data from the spawning ground. CCSBT/SC/0108/16.

Davis, T., Farley, J., Bravington, M. and Andamari, M. 2003. Size at first maturity and recruitment into egg production of southern bluefin tuna. Final Report FRDC project No. 1999/106. (Submitted to the CCSBT as CCSBT-ESC/0309/Info 01)

Bravington, M. and Grewe, P. 2007. A method for estimating the absolute spawning stock size of SBT, using close-kin genetics. CCSBT-ESC/0709/18.

Other Activities

Polacheck, T., Laslett, G.M. and Eveson, J.P. 2002. An integrated analysis of the growth rates of southern bluefin tuna for use in estimating catch at age in stock assessments (Main Report and the Appendices 9, 10). CCSBT-ESC/0209/35.