CCSBT-ESC/2108/15
(ESC Agenda item 11)

Australia's National
Science Agency

Developing a new SRP – review and priorities

Campbell R Davies and Ann L Preece
August 2021

CCSBT-ESC/2108/15

Report to the Commission for the Conservation of Southern Bluefin Tuna

Acknowledgements

This work is funded by The Australian Fisheries Management Authority and CSIRO.

1 Summary

The CCSBT Scientific Research Program has been central to improving the data and methods available for stock assessment and the provision of robust management advice for rebuilding the SBT stock. While the original review was due in 2019, the selection and adoption of a new MP and the scheduled stock assessment took priority, and COVID-19 impacts have made collaborative development of the SRP challenging. In addition, the issues identified with the Base CPUE, used for stock assessment and MP purposes, has resulted in a focus on improving methods for CPUE standardisation in the short term. However, there are a range of other issues to address specific aspects of SBT biology, monitoring systems and spatial dynamics to resolve key uncertainties in the current monitoring and stock assessment. This report summaries short and medium-term priorities for potential inclusion in the SRP, based on discussions at SC25, and outlines a process for collaborative development of the SRP. If possible, we propose this be done with the addition of extra days to the OMMP and, if necessary, the ESC, to allow for a comprehensive review of past activities and development of proposals under the next phase of the SRP.

2 Introduction

The CCSBT Scientific Research Program (SRP) has been central to improving the data and methods available for stock assessment and the provision of robust management advice for rebuilding the SBT stock. An in-depth review of the SRP was scheduled for 2019 and 2020, however, the priority for adoption of the new Management Procedure (MP), and scheduled stock assessment, delayed detailed consideration. Impacts of COVID-19 have made development of cross-member proposals more challenging. Now that the Cape Town Procedure (CTP) has been adopted and the 2020 stock assessment is complete, further review of the 2014-2018 SRP and development of specific priorities, work program and detailed project proposals needs to be a priority for the ESC.

As noted in the annotated agenda for ESC26:

The 2020 meeting of the ESC noted that a comprehensive review and planning for the SRP was not possible at that meeting due to the priority accorded to reviewing the stock assessment and to running the Management Procedure (MP) for TAC setting. A comprehensive review of and planning for the SRP needs to be revisited at the 2021 meeting of the ESC, and Members are encouraged to discuss potential research priorities and develop proposals intersessionally. The ESC should note that the 2020 Finance and Administration Committee (FAC) and the EC did not support the e-tagging program which the ESC recommended and that the FAC recommended that future requests from the ESC for new research be accompanied by additional information to allow the FAC to have a better understanding on the relative importance and priority of the work in relation to other scientific expenses.

Unfortunately, the broad impacts of the COVID-19 pandemic have continued to impact on the capacity of members to engage in the detailed discussions required for the development of a consolidated work program agreed priorities for the next 5 year phase of the SRP and individual proposals for recommendation to the EC. Based on the initial review and discussion at SC25 (Anon 2020), we summarise short and medium-term priorities and associated rationale and outline a process for collaborative development of more detailed proposals over the coming year.

3 Initial 2020 Review of SRP

The initial 2020 review of the 2014-2018 SRP (Anon 2020, Davies and Preece 2020) demonstrated that an extensive amount of research had been completed and that this has substantially improved the monitoring and management of the SBT stock.

The research programs undertaken fit within 5 broad categories of research:

1. Characterisation of Catch
2. Abundance Indices
3. Biological Parameters
4. MP implementation
5. Stock Assessment (OM development)

A number of the research activities included in the 2014-2018 SRP, and member's research programs, are on-going: CPUE working group, close kin data collection, gene-tagging program, trolling survey, tag deployments.

The 2020 ESC review identified outstanding activities that have either not been addressed or remain incomplete. While a comprehensive review and development of a new program was not possible, initial progress was made on the following three categories and activities:

1. Characterisation of Catch
    - Quantifying different sources of UAM, in particular, methods for determining the plausibility of estimates of non-member UAM to include in i) future stock assessments; and ii) regular evaluation of exceptional circumstances for the MP.
2. Abundance Indices
    - Exploration and refinement of CPUE monitoring series.
    - Resolving issues identified with Base series in 2020.
3. Spatial dynamics of SBT stock
    - Design study to examine the relative costs and benefits of alternative e-tagging in addressing questions associated with environmental change and potential changes in spatial dynamics of different components of the stock.

3.1 Immediate priorities identified from ESC25

The ESC discussed three main priority areas for the SRP from the categories above: i) estimation of non-Member UAM; ii) progression of CPUE analyses and iii) a design study for an e-tagging project.

3.1.1 Estimation of non-Member UAM

Estimation of non-member UAM remains a priority. Updated estimates are important for two purposes: i) as an input to the next assessment of stock status and ii) and as part of the regular evaluation of exceptional circumstances for the implementation of the CTP (in the short-term) and the review of the CTP (in the longer-term).

For stock assessment purposes, the ESC needs to agree on a specific level of UAM that is considered the "best available estimate", which is used as an input to the stock assessment to provide advice on stock status.

In the case of the implementation of the MP, the CTP has been evaluated to be robust to a specified range of UAM, that was considered plausible by the ESC. The ESC will regularly (annually) assess whether the "best estimate" of total removals in any year/TAC block is within the plausible range used to evaluate the performance and robustness of the CTP. In the longer term, it will be important to have consolidated estimates of total removals (and the uncertainty associated with different sources) since the implementation of the MP for consideration in the first review of the MP and the extent of rebuilding achieved, which is scheduled for 2025.

The ESC agreed that further work needs to be conducted to examine the sources of potential bias in the current methods used to estimate non-member UAM for MP testing and stock assessment purposes so that they could be reviewed in 2022 and the estimate based on these refined methods be incorporated in the 2023 stock assessment. This work has not been advanced in 2021 so there is no updated estimate.

Also, while the current methods are the best information available to the ESC, the ESC does not have current information to demonstrate that the estimated catches are actually *being taken*. Hence, the priority given to examining the potential sources of bias in the current methods (ESC25, para 179) and the potential value of recommencing market surveys both for the Japanese market (CCSBT-ESC/2008/23), but also more broadly (e.g. CCSBT- ESC/1609/37), for improving estimates of non-member catches (ESC25, para 182). Ongoing advances in genetic and micro-elemental methods to identify species and provenance of product in the supply chain should be considered in this context.

3.1.2 Improved standardisation of longline CPUE for stock assessment and MP

Improving the standardisation methods for longline CPUE has been and remains a high priority, given the issues identified with the Base CPUE standardisation and the need for a new series for stock assessment and MP purposes. This has been progressed within the CPUE WG with the appointment of a consultant, inter-sessional work and meetings of the CPUE working group (see papers submitted to this meeting and report of CPUE Working Group). Identifying a new series to be used in the MP for the next TAC recommendation (2022) and the next scheduled stock assessment (2023) is the immediate priority. However, it is unlikely that in this timeframe all the issues identified at ESC25 (Anon, 2020, para 186-187) will have been addressed. The ESC will need to revisit the relative priority and schedule for short and medium-term activities and how they interact with activities identified in other categories of the SRP, in particular, spatial dynamics of SBT and fishing fleets and estimation of non-member UAM using the current "member-CPUE" based methods.

3.1.3 Design study for an e-tagging project

The ESC strongly supported the e-tagging design study proposal (CCSBT-ESC/2008/35) in 2020 and recommended that it be funded. The EC declined to fund the design study and the FAC has requested:

…that future requests from the ESC for new research be accompanied by additional information to allow the FAC to have a better understanding on the relative importance and priority of the work in relation to other scientific expenses.

CCSBT-ESC/2108/16 provides an update proposal for an e-tagging design study. The purpose of the design study is to complete detailed analyses to provide more specific guidance on the required sampling design, tag types, deployment schedule and costs and logistics associated with the different categories of questions on the spatial dynamics of SBT (see below). The priority and support from the ESC for the e-tag design study is based on the importance of understanding the interaction between spatial dynamics of the stock and key monitoring programs for the stock assessment and MP in the short, medium and longer term. Given the request from the FAC/EC, it will be important to for the ESC to clarify and emphasise the need to complete the design study before the ESC can provide the EC with detailed costed proposal(s) to address the different questions relating to the spatial dynamics of the SBT stock.

The e-tagging proposal welcomes collaboration. To facilitate this, we recommend convening of an informal group of interested members to participate in discussions between ESC26 and 27. This group could then use results of the design study to develop detailed e-tagging proposal(s) for consideration by the ESC in 2022.

3.2 Additional priorities for consideration

There are a number of other outstanding and new activities that the ESC did not have time to consider in detail at ESC25. The list from Davies and Preece (2020) is provided in Appendix 1 for convenience.

We consider the following activities short and medium-term priorities, in addition to those outlined in 3.1, that the ESC should consider for inclusion in the next phase of the SRP.

1. Characterisation of Catch
    - Consideration of the potential to move from cohort slicing to catch at age in OM.
    - Review of sampling design for otolith collection and standardised ageing methods.
    - Use of epigenetic ageing for SBT as an alternative/complementary source of age data.
    - Addressing the current uncertainty in the level and fate of discards by fishery for both estimating total removals.
2. Spatial dynamics of SBT stock
    - Great Australian Bight (GAB): related to the timing and rate of migration 2-3 year old fish within the GAB and implications for recruitment monitoring (i.e. gene-tagging).
    - Short to medium-term changes in the spatial and temporal distribution across the current range of the stock in response to changing environmental conditions and the distribution of fishing effort, which relates to CPUE as an index of stock abundance.

- Medium to longer-term changes in the distribution of the stock as it rebuilds and the extent to which different life-history stages expand into areas they previously occupied (e.g. juveniles in SE Australia).

3. Biological Parameters
    - Completion of the independent estimate of size/age at maturity, which has been agreed by the ESC as a high priority.
    - Age validation review workshop; agreed at ESC18, but yet to be completed
    - Understanding within season spawning behaviour, which could also potentially be addressed through e-tagging studies designed to also address questions on spatial dynamics
    - Updating estimates of rates of growth and variation in size at age as the stock rebuilds.
    - Review of observer protocols and standard operating procedures for collection of additional biological samples – e.g. tissue samples, for determining sex and age via DNA
4. MP implementation
    - Review timing and terms of reference for formal MP review.
5. Stock Assessment (OM development)
    - Strategic review and design specifications for future OM code.
    - Reducing uncertainty in selectivity of the fishery on the spawning grounds.
    - Incorporation of SRP tagging data from 2000s
    - Potential costs and benefits of a spatially explicit stock assessment; noting this will be conditional on availability of suitable tagging data series.

4 Process for further review and development of detailed work program and proposals

The experience of the last 3 years has demonstrated that it has been difficult for ESC members to engage in a comprehensive review of the 2014-2018 SRP and to consider priorities and develop proposals for the future SRP. This reflects the priority and time involved with the finalisation and adoption of the CTP and completion of the 2020 stock assessment and the impact on COVID-19. COVID-19 has impacted on members in different ways and extents, but we consider common factors to include: lack of face-to-face meetings meaning less opportunity for in effective discussion that is central to building collective understanding and collaboration; time pressures associated with responding to the multi-facetted impacts of COVID-19; and, for many members, participation in web-meetings over extended periods for multiple RFMOs that has actually reduced the time and positive energy for creative thinking.

Given this, we consider the priority for the SRP at ESC26 should be to focus on identifying small task groups to lead completing the review of each component of the 2014-2018 SRP and preparing papers for consideration the 2022 OMMP and ESC meetings. As was proposed and agreed in 2020 and assuming that it is possible to meet in person, the OMMP meeting could be extended (formally/informally) to include an additional two days to complete the review of SRP 2014-2018 and discuss proposals for inclusion in the SRP beyond 2022. Papers (ideally developed collaboratively) should be submitted a month prior to the meeting to provide time for substantive consideration and consultation prior to and at the OMMP. As proposed previously, having the additional dedicated time at the OMMP would allow for focussed technical discussion on the merits of proposals and the development of a draft work program for members to further develop and refine prior to formal consideration by the ESC and recommendations to the EC in 2022.

5 Conclusions

The CCSBT Scientific Research Program has been central to the achievements of the CCSBT in improving the monitoring and management of the stock and the fishery. The 2014-2018 SRP delivered major improvements in monitoring of the stock and the development and adoption of the new CTP. The delivery of the CTP and 2020 stock assessment, combined with the impacts of COVID-19, have delayed the completion of review of the 2014-2018 program and the development of a comprehensive work program. The issues identified with the Base CPUE, used for stock assessment and MP purposes, has necessitated a short-term focus on methods for CPUE standardisation. However, there are a range of other important research areas, to address specific aspects of the SBT biology, monitoring systems and spatial dynamics to resolve key uncertainties in the current monitoring and stock assessment, which will be important to address in the short and longer term. It will be important to develop this next phase of the SRP collaboratively, as has been done in the past. If COVID circumstances allow, we propose this be done with the addition of extra days to the OMMP and, if necessary, the ESC and the identification of small teams to lead review of past activities and development of proposals under the next phase of the SRP.

6 References

Anon 2020. Report of the Extended Scientific Committee for the Twenty Fifth Meeting of the Scientific Committee, 31 August – 7 September 2020, Online

Davies CR and Preece AL. 2020. CCSBT Scientific Research Program: A brief review (2014-2018). CCSBT-ESC/2008/15

Davies C, J Farley, P Hill, M Lansdell and P Grewe. 2016. Interim Report to the CCSBT and TRAFFIC International: Genetic species identification – SBT market presence in China. CCSBT-ESC/1609/37

Morita Y and Itoh T. 2020. Proposal on monitoring of SBT distribution in Japan to verify catch of all Members. CCSBT-ESC/2008/23

Patterson T, Eveson P, Hartog J, Preece A. 2020. Proposal for a design study to evaluate potential electronic tagging programs to understand implications of changes in migration. CCSBT-ESC/2008/35

Patterson T, Eveson P, Hartog J, Preece A. 2021. Proposal for a design study to evaluate potential electronic tagging programs to understand implications of changes in migration of SBT. CCSBT-ESC/2108/16

Appendix A: Summary of activities, progress and achievements for SRP:2013-2018 from Davies and Preece (2020).

Table 1: Summary of progress with research activities identified under the CCSBT Scientific Research Program: 2014-2018. Preliminary suggestions on future activities noted in *blue italic text in Progress/Status column*.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
i. Characterization of catch (Future)					
Catch amount					
Unaccounted catch mortality - Unreported or uncertainty in retained catch by Members		2014 Extended Commission request, OM and annual status advice	Ongoing; potentially with more work for MP Review and OM revision (High for all categories)	EC21. Para 50-53, Table 1	"Attributable Catch" defined by Commission.
Unaccounted catch mortality - Mortality from releases and/or discards				EC21. Para 50-53, Table 1	Discards included in definition of attributable catch. *Address uncertainty in discard rates by fishery.*
Unaccounted catch mortality - Recreational fisheries				ESC 21 CCSBT-ESC/1609/Info 02 EC21. Para 50-53, Table 1	Recreational catch accounted for in definition of attributable catch for members.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Unaccounted catch mortality - Catches by non-members				ESC 21 CCSBT- ESC/1609/32 CCSBT- ESC/1609/7	Trade and market reviews for presence of SBT in non-members markets.
				ESC 21 CCSBT- ESC/1609/BGD-3	UAM included in OMs for MP testing.
				ESC 21 CCSBT-ESC/1609/BGD 02 ESC22 CCSBT-ESC/1509/10 ESC24 CCSBT-ESC/1909/33 ESC 25 CCSBT-ESC/2008/BGD04	Method developed for constructing scenarios for potential scale of non-member catch
Any other sources of unaccounted mortality			-	-	-
Size structure					
Value of using the CDS data as a comprehensive sample of the size structure of removals		OM and annual status advice	As soon as possible then ongoing (High)	ESC17. Para. 112 ESC18, Para. 69	Pending agreement by all members.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Age structure					
Review of sampling design for otolith sampling		Current sampling too sparse to be representative		ESC17. Para.120	Limited by distribution of observers on LL vessels to collect otoliths. *Future review and design exercise pending outcomes of epigenetic ageing.*
Calibration of age estimation (workshop)		Long time since previous workshop and relatively low cost	2016 (High)	ESC17 CCSBT-ESC/1409/24 ESC18	Agreed at ESC18, but yet to be completed.
Instigate moves towards catch at age data rather than using cohort slicing in the OM.		Improved estimates of recruitment and selectivity from the longline fisheries, OM and annual status advice.	Cost and logistic implications (Low – outside current timeframe, post 2018)	ESC17. Para. 76-79 & 120 CCSBT-ESC/2008/Info04	See above. Currently limited by reliance on observer coverage to collect otoliths at sea. See potential for epigenetic ageing.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
ii. Abundance indices					
a) **Recruitment**					
Proportion of juvenile population that move into the Great Australian Bight		Stock structure for the OM and assumptions for recruitment indices and close-kin analysis.	(Medium)	Para. 81-83 ESC (2012) CCSBT-ESC/1409/22 CCSBT-ESC/2008/35	Design/feasibility study completed for the potential of using otolith microchemistry to examine movement. Unsuccessful. Design study proposed for E-tagging project.
Migration of age 1 SBT (electronic tagging during troll survey)			Ongoing (Medium)	CCSBT-ESC/1708/22 CCSBT-ESC/1909/25 CCSBT-ESC/1809/26	Substantial e-tag deployments by Japan as part of 1+ troll survey
Design study on alternative measures of absolute juvenile recruitment (gene-tagging approaches)		Estimates of absolute abundance of cohorts for the OM	Design study 2015 (High)	ESC18 Report of ESC 20 CCSBT-ESC/1509/18	Complete. Gene-tagging recommended by ESC20 and funded by Commission.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Pilot gene-tagging program: Absolute abundance estimates of juvenile recruitment		Demonstration feasibility obtaining absolute abundance estimates of cohorts via gene-tagging for use in the OM	Pilot gene-tagging 2016 and 2017 (High, dependent on outcomes of design study)	ESC18 Report of ESC20 CCSBT-ESC/1509/18	Complete. Design study
				ESC22 & 23 and OMMP9 CCSBT-OMMP/1806/06 CCSBT-ESC/1709/7 CCSBT-ESC/1809/06 Report of ESC24 & OMMP10 and 11 CCSBT-OMMP/1906/06 CCSBT-ESC/1909/10 CCSBT-ESC/1909/11 CCSBT-ESC/2008/6	Complete. Large scale pilot study (2016). Complete 2 full cycles (2017, 2018). Adopted as input to OMs and MP (See MP implementation and Stock Assessment sections below).

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Environmental interactions with the scientific aerial survey		Improved relative recruitment index; MP implementation	Partly underway in the Australian GAB project (Medium)	Para. 29 ESC17 See Evans et al 2017 for final report of SBT component of GAB program. Patterson et al 2018a for large-scale migration. Patterson et al 2018b for GAB habitat use. Eveson et al 2018a for surfacing behaviour. Evans et al 2018 for interaction with seismic	Not explicitly addressed, but see results of archival tag analysis, including juvenile migration and fine-scale GAB dynamics.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Review scientific aerial survey standardisation; Previous papers provide the details of calibration and model selection		OM and MP	(High) Members review previous papers and discuss at ESC 2015.	ESC17 CCSBT-ESC/1809/26 Eveson et al 2018b	Complete. Methodology sound. Issues with logistic frailty of survey due to availability of experienced spotters and need/expense associated with calibration between spotters. Aerial Survey discontinued in 2017. Gene-tagging initiated as alternative recruitment monitoring series.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Standardised CPUE series for Taiwanese longline fleet		Annual status advice	Ongoing, CPUE working group (High)	ESC17, Para. 54-56 & 60	Outstanding issues around E-W grounds and targeting.
				OMMP4 ESC20 CCSBT-ESC/1509/23	New approach using cluster analysis to select sets for inclusion in SBT standardisation.
				ESC21 CCSBT-ESC/1609/33	Possible inter-annual shifts catchability associated with changes in targeting remain a challenge.
				ESC23 Para. 53 CCSBT-ESC/1809/39	
				ESC24 CCSBT-ESC/1909/37	

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
b) **Sub-adults**					
Exploration and refinement of alternative CPUE monitoring series		MP implementation	Ongoing, CPUE working group (High)	ESC18, Para. 50-53 & 60 ESC19 CCSBT-ESC/1409/36 CCSBT-ESC/1409/42 ESC21 CCSBT-ESC/1609/12 ESC23 CCSBT-ESC/1809/BGD02 CCSBT-ESC/1809/BGD03 OMMP11 Para. 11-24 CCSBT-OMMP/2006/10 CCSBT-OMMP/2006/11 CCSBT-OMMP/2006/12 CCSBT-OMMP/2006/15	Ongoing exploration of methods to address spatial and temporal interaction of fleets and SBT stock. Initial application of GAMM. Core Series Exploration of potential use of LL1 for recruitment index. Issues identified with Base series in 2020 will require dedicated work program

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Monitoring and exploration of changes in fleet operations over time		MP implementation and OM	Ongoing, CPUE working group (Essential)	ESC18, Para. 58-60 ESC 23, para. 48-49, Att CCSBT-ESC/1809/BGD04	Regular papers on monitoring spatial/temporal patterns and changes in fleet. Issues identified with Base series in 2020 will require dedicated work program
Standardised CPUE series for Korean longline fleet		Annual status advice	Ongoing, CPUE working group (High)	ESC17, Para. 54-56 & 60 OMMP4	Ongoing.
				ESC22 para. 31-41 and Att.6. ESC/1708/34 CCSBT-ESC/1708/BGD10	Detailed review of data and application of alternative data selection and standardisation approaches.
				ESC23 CCSBT-ESC/1809/41	
				OMMP11 CCSBT-OMMP/2006/13	

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
c) **Spawning biomass**					
Close-kin abundance estimation (revise after further discussion, possibly refer to a more detailed document)	Design study provide costs and benefits of a time series of close- kin data collection for the OM	(2013-14, High)	ESC17 Para. 114 ESC18 Para.129-134. Att.10 CCSBT-ESC/1309/17 CCSBT-ESC/1409/44	Completed. Initial cost-benefit study recommended shift to SNP markers and approximate sample size requirements. ESC2014, para 125. ESC requested external review of technical details of sequencing approach for kin identification (see below).
Continued close-kin sample collection	Need to take advantage of present opportunity	2014 and ongoing (High)	ESC18 Para.129-134	Completed/Ongoing Annual collection of samples of adults (Benoa, Indonesia) and juveniles (Pt Lincoln, Australia: 2006-2020
Further work (some laboratory, some desk top) on the potential genetics approach to inform an expert review/workshop	Further work on genotyping approaches to inform the decision on long-term approach.	2015 (High)	ESC19 Para.131 ESC/1509/36 ESC/1509/19	Completed.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Expert review workshop (ESC and experts familiar with the techniques and their use in this context)		This will review and decide on the long-term approach to genotyping	2015 (High)	ESC20, paras 126-131. CCSBT-ESC/1509/19 CCSBT-ESC/1509/36	Completed. Both reviewers endorse the change to DArT sequencing method and the value of extending CKMR to the POPs +HSPs approach. ESC noted potential for CKMR data to be used in CMPs
Follow-up to review process and dependent on review outcome.		Further locus development, and validation Timing for 2017 assessment may be advantageous given uncertainties generated by unaccounted mortality scenarios (Option 1)	(High) Option 1: 2015 Option 2: 2016	OMMP8 CCSBT-OMMP/1706/12 ESC22 CCSBT-ESC/1708/Rep01 CCSBT-ESC/1708/36	Complete. Locus (SNP), kin identification confirmed for 2017 Stock Assessment.
Medium term: process the accumulated back catalogue of samples (4-6 years of accumulated samples)		Timing for 2017 assessment may be advantageous given uncertainties generated by unaccounted mortality scenarios (Option 1)	Option 1: 2016 to input to the 2017 assessment. Option 2: 2017 to input to the 2020 assessment.	OMMP8 and ESC 2017 CCSBT-OMMP/1706/12 CCSBT-ESC/1708/36	Completed. 10 year time series of samples sequenced and analysed for inclusion in stand-alone CKMR model, 2017 stock assessment and CMP development.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Long-term time series		Fishery independent index of spawning stock, information on fecundity, adult selectivity and mortality	Ongoing, once previous stages are completed	OMMP and ESC20 OMMP8 and ESC22, Para. 52-53, 87-88. CCSBT-OMMP/1706/4 CCSBT-OMMP/1706/5 CCSBT-ESC/1708/Rep01 CCSBT-ESC/1708/12 CCSBT-ESC/1809/12	Complete. Adopted as part of MP development process in 2017. Full report to ESC23.
Associated OM refinement/development associated with incorporating close-kin time series etc.		This requires discussion and further consideration at 2015 ESC		OMMP8 and ESC20 OMMP8 and ESC22 CCSBT-OMMP/1706/4 CCSBT-ESC/1809/14 CCSBT-ESC/1809/19 Davies et al 2020	Complete. OMs modified to include CKMR POP and HS data and associated diagnostics (See below under MP Implementation and Stock Assessment).

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
iii. Biological parameters					
Independent estimate of maturity schedule		Defining effective reproductive contribution in the OM, MSY estimation	Sample collection, 2015 and ongoing (High)	OMMP4 ESC18	Proposal to ESC19.
			Processing & analysis prior to 2017? (Medium)	ESC20 CCSBT-ESC/1509/15	Partially Complete.
				ESC21 CCSBT-ESC/1708/32 ESC22 Para.136-138	Samples collected from non-spawning ground fish by members. Maturity workshop completed in 2019.
				ESC24 Para. 21-22 CCSBT-ESC/1909/07 CCSBT-ESC/1909/36 CCSBT-ESC/1909/41 CCSBT-ESC/1909/42	*Final analysis in progress.*

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Understanding within season spawning behaviour and skip spawning behaviour (e.g. electronic tagging approaches and otolith microchemistry for spawning frequency). Note this may draw on close-kin future work (if half-sibling pairs are identified)		Defining effective reproductive contribution in the OM	Reconsider in 2015 (Medium)	Para. 118 ESC 2012 ESC23 CCSBT-ESC/1809/14 CCSBT-ESC/1809/19 Bravington et al 2016 Davies et al 2020 ESC19 CCSBT-ESC/1409/22	Partially complete. Effective reproductive contribution redefined via CKMR POP data as TRO, which is now used in the OM. POP data provided evidence of skip spawning in younger adults (Davies et al 2020). Otolith microchemistry not successful for this purpose.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
2. MP Implementation					
Terms of reference for formal MP review [Indicators of MP performance/improvement]	Preparation for first formal review of the MP (2017).		2015 ESC – substantive agenda item to discuss what should be done before 2017 (High)	Para145 ESC 2013; Att10 ESC 2013 CCSBT-ESC/1509/12 CCSBT-ESC/1509/38	Incomplete. Initial suggestions at 2015 ESC. Not progressed due to need to develop new MP. Should be revisited as part of reviewing Meta-Rules and schedule of implementation for the CapeTown Procedure.
Feasibility of alternative indices for input to the MP (estimated trends from the stand-alone close kin assessment, gene-tagging)	For revised MP		Longer term (Medium)	ESC 2013 Para 155 and 156 ESC 2015, CCSBT/1509/18	Completed. GT adopted.
				Para 38 ESC 2016, CSBT-ESC/1509/19	CKMR POPS & HSP adopted.
				CCSBT-ESC/1609/BGD06 ESC 2019 CCSBT-ESC/1909/16	Developed and used in development of CMPs.

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
3. Stock Assessment (OM development)					
Selectivity of the fishery on the spawning grounds (note potential link to close-kin). Potentially informed by the collation and analysis of existing data on fleet operations (shifts in targeting, spatial temporal distributions in effort, species composition, hook setting depth)	OM – basis for domed selectivity and defining effective reproductive contribution	Prior to 2017 (High)	Para. 115 ESC 2012, OMMP4, attachment 4 CCSBT- OMMP/1307/5, CCSBT-ESC/1809/14 CCSBT-ESC/1809/19 CCSBT-ESC/1909/9 Davies et al 2020	Partially complete. Indonesian selectivity and mortality schedule for adult fish reviewed and refined with the incorporation of CKMR POP data. Has been reviewed with the incorporation of HSP in OM and with stand-alone CKMR model. *A longer time series of CKMR data will help test the current assumptions.*

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
Mortality estimates for mature fish (10+ years old) (Note the potential through close kin)		Current OM does not have data sources that provide substantial information on M10.	Longer term, potentially high cost (Medium)	ESC 2013 CCSBT-ESC/1809/14 CCSBT-ESC/1809/19	HSP CKMR data provides information on total mortality of adults in OM and stand-alone CKMR model.
Improved information on cohort abundance, fishing mortality and natural mortality (e.g. gene-tagging approaches)		OM – mortality estimates	Design/feasibility study for gene-tagging could consider cohort abundance 2015 (High) Longer term (Medium)	Para. 88-89, 117, OMMP workshop CCSBT-OMMP/2006/5, CCSBT-ESC/2008/12	Implementation of gene-tagging is providing precise estimates of 2 year old cohort abundance.
Potential costs and benefits of a spatially explicit stock assessment		OM, review in light of otolith microchemistry and gene-tagging results	Longer term (Low)	Para. 89 ESC 2012	Not progressed. *May become a higher priority in the medium term to address spatial dynamics of fleets and stock, but will be conditional on availability of suitable tagging data series.*
Strategic review and refinement of operation of the OM code		Update and improve efficiency of code	Before 2017? (Medium)	ESC 2013	Limited progress. Development of shiny

Activity	Potential research	Relevance	Original Timeframe (Priority)	Reference	Progress/Status
				Para 50, OMMP 2018	app (2018) which allows members to see model results in standard figures and tables Some progress on making Hessian calculation functional for including within-cell uncertainty estimation.
				Para 31-32, OMMP 2017	
Evaluating possible changes in the OM (model structure)			High 2015 ESC Discussion or jointly with review meeting of close-kin	CSBT–OMMP/1706/04 CCSBT-ESC/1809/19	OM structure has been revised to incorporate the CKMR (POP and HSP) and GT data for stock assessment and to allow for data generation (in projections) for these data series for CMP testing
Incorporation of SRP tagging data from 2000s		Related to spatially explicit model	Longer term (medium)	ESC 2013	Not progressed

References for Non CCSBT paper citations from appendix

Bravington, M.V., Skaug, H.J. and Anderson, E.C. (2016). Close-Kin Mark-Recapture. Statistical Science. Volume 31(2), 259-274.

Bravington, M.V., Grewe, P.M. and Davies, C.R. (2016b). Absolute abundance of southern bluefin tuna estimated by close-kin mark-recapture. Nature Communications 7:13162. https://doi.org:10.1038/ncomms13162

Davies, C.R., Bravington, M.V., Eveson, J.P., Lansdell, M., Aulich, J., and P.M. Grewe 2020. Next-generation Close-kin Mark Recapture: Using SNPs to identify half- sibling pairs in Southern Bluefin Tuna and estimate abundance, mortality and selectivity. Final Report (Project No: 2016-044) to the Fisheries Research and Development Corporation, 52 pp.

Evans, K., Patterson, T., Eveson, P., Hobday, A., Lansdell, M., Cooper, S., Davies, C.R. 2017. Southern bluefin tuna: spatial dynamics and potential impacts of noise associated with oil and gas exploration. Great Australian Bight Research Program. Great Australian Bight Research Report Number 18, CSIRO Oceans and Atmosphere, Hobart, 94 pp. https://www.misa.net.au/__data/assets/pdf_file/0011/326909/GABRP_Research_Report_Series_Number_18_02082018.pdf

Toby Patterson, Paige Eveson, Jason Hartog, Karen Evans, Scott Cooper, Matt Lansdell, Alistair J. Hobday, Campbell Davies. (2018a). Migration dynamics of juvenile southern bluefin tuna. Scientific Reports 8:145-53. https://doi.org/10.1038/s41598-018-32949-3

Toby Patterson, Alistair J. Hobday, Paige Eveson, Karen Evans, Campbell Davies. (2018b). Southern bluefin tuna habitat use and residence patterns in the Great Australia Bight. Deep Sea Research Part II: Topical studies on Oceanography. Volumes 157–158, November–December 2018, Pages 169-178, https://doi.org/10.1016/j.dsr2.2018.07.00

Karen Evans, Rob McCauley, Paige Eveson Toby Patterson. (2018). A summary of oil and gas exploration in the Great Australia Bight with particular reference to Southern bluefin tuna. Deep Sea Research Part II: Topical studies on Oceanography. Volumes 157–158, November–December 2018, Pages 190-202, https://doi.org/10.1016/j.dsr2.2018.05.024

Paige Eveson Toby Patterson, Jason Hartog, Karen Evans. (2018a). Modelling surfacing behaviour of Southern bluefin tuna in the Great Australia Bight. Deep Sea Research Part II: Topical studies on Oceanography. Volumes 157–158, November–December 2018, Pages 179-189, https://doi.org/10.1016/j.dsr2.2018.03.007

Eveson JP, Bravington MV, Farley JH (2018b) Accounting for environmental and observer effects in estimating abundance of southern bluefin tuna from aerial survey data. PLoS ONE 13(11): e0207790. https://doi.org/10.1371/journal. pone.0207790.

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us

1300 363 400
+61 3 9545 2176
csiroenquiries@csiro.au
www.csiro.au

For further information

O**ceans and Atmosphere**
Ann Preece
+61 3 6232 5336
Ann.preece@csiro.au
csiro.au/