Report of the Sixth Session of the IOTC Working Party on Temperate Tunas

Shanghai, People's Republic of China, 18–21 July 2016

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ACRONYMS

ALB	Albacore
ASAP	Age structured assessment program
ASPIC	A Stock-Production Model Incorporating Covariates
ASPM	Age-structured production model
B	Biomass (total)
BBDM	Bayesian biomass dynamics model
B_{MSY}	Biomass which produces MSY
BSPM	Bayesian State-Space Production Model
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
EEZ	Exclusive Economic Zone
F	Fishing mortality; F_{2011} is the fishing mortality estimated in the year 2011
F_{MSY}	Fishing mortality at MSY
HBF	Hooks between floats
HCR	Harvest control rule
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
LL	Longline
LRP	Limit reference point
M	Natural mortality
MPF	Meeting participation fund
MSE	Management strategy evaluation
MSY	Maximum sustainable yield
n.a.	Not applicable
PS	Purse-seine
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SS3	Stock Synthesis III
SST	Sea surface temperature
TAC	Total allowable catch
TRP	Target reference point
VB	Von Bertalanffy (growth)
WPTmT	Working Party on Temperate Tunas of the IOTC

STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

SC16.07 (para. 23) The SC **ADOPTED** the reporting terminology contained in Appendix IV and **RECOMMENDED** that the Commission considers adopting the standardised IOTC Report terminology, to further improve the clarity of information sharing from, and among its subsidiary bodies.

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

Level 1: From a subsidiary body of the Commission to the next level in the structure of the Commission:
RECOMMENDED, RECOMMENDATION: Any conclusion or request for an action to be undertaken, from a subsidiary body of the Commission (Committee or Working Party), which is to be formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a Working Party to the Scientific Committee; from a Committee to the Commission). The intention is that the higher body will consider the recommended action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally this should be task specific and contain a timeframe for completion.

Level 2: From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:
REQUESTED: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

Level 3: General terms to be used for consistency:
AGREED: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.
NOTED/NOTING: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

Any other term: Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

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EXECUTIVE SUMMARY

The 6th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPTmT06) was held in Shanghai, China, from 18 to 21 July 2016. A total of 29 participants (27 in 2014) attended the Session.

The following are a subset of the complete recommendations from the WPTmT06 to the Scientific Committee, which are provided at Appendix IX.

Review of the data available at the Secretariat for temperate tuna species

WPTmT06.01 (para 21) The WTmT **NOTED** that length frequency samples for the Taiwanese driftnet fishery were collected during the 1980s and published in a former IPTP paper, and **RECOMMENDED** that the IOTC Secretariat process the information to ensure the data is available for future stock assessments.

WPTmT06.02 (para 22) **NOTING** changes in the length frequency distribution by the Taiwanese deep-freezing longline fleet since the early-2000s, and particularly the decline in the proportion of smaller sized fish sampled for lengths, the WPTmT **RECOMMENDED** that length frequency and biological data collected by Taiwanese observers be provided to the IOTC Secretariat in order to validate and better understand recent changes in the length frequencies collected by on-board sampling – including samples collected for albacore tuna, tropical tuna species, and swordfish. The WPTmT **NOTED** that all observer data submitted to the IOTC Secretariat is subject to Resolution 12/02 *Data confidentiality policy and procedures*.

WPTmT06.03 (para 23) The WPTmT **ACKNOWLEDGED** the importance of port sampling of albacore tuna unloaded in Port Louis, Mauritius, and **RECOMMENDED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. The WPTmT **NOTED** that the IOTC Secretariat has proposed a mission to Mauritius in August 2016 in support of this capacity building activity.

New information on biology, ecology, fisheries and environmental data relating to temperate tunas

WPTmT06.04 (para 47) **NOTING** the general paucity of biological indicators available from the Indian Ocean, and particularly the lack of age-specific maturity as a primary source of uncertainty in the stock assessment of albacore tuna, the WPTmT **RECOMMENDED** a study on the growth curve of albacore tuna in the Indian Ocean as a high priority in the WPTmT Program of Work.

Revision of the WPTmT Program of Work

WPTmT06.05 (para 120) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2017–21), as provided at Appendix VIII.

Date and place of the 7th and 8th Sessions of the WPTmT

WPTmT06.06 (para 125) The WPTmT **RECOMMENDED** that the SC consider rescheduling of future WPTmT meetings (currently held in July) to later in the year, e.g., August-early September, to enable the possibility of the latest years' data to be included in the assessment.

WPTmT06.07 (para 126) The WPTmT **RECOMMENDED** that future stock assessment cycle for albacore tuna should be conducted every three years (rather than two years), in line with the assessment of species covered by other IOTC Working Parties (e.g., WPTT, WPEB), and that the WPTmT should in addition convene during the year preceding the next stock assessment to focus on priority areas for improvement in the albacore assessment, such as the standardization of CPUE, or development of biological parameters (Option B, Table 15).

Review of the draft, and adoption of the Report of the 6th Session of the WPTmT

WPTmT06.08 (para 131) The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT06, provided at Appendix IX, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix VII).

Stock status table

A summary of the stock status for temperate tunas under the IOTC mandate is provided in Table 1, Appendix VII.

1. Opening of the meeting

1. The 6th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPTmT06) was held in Shanghai, China, from 18–21 July 2016. A total of 29 participants (27 in 2014) attended the Session. The list of participants is provided at Appendix I. The meeting was opened by Professor Jiale Li, vice-president of Shanghai Ocean University, and the Chairperson, Dr Zang Geun Kim (Rep. of Korea), who welcomed participants to Shanghai, China.

2. Adoption of the agenda and arrangements for the session

2. The WPTmT **ADOPTED** the Agenda provided at Appendix II. The documents presented to the WPTmT06 are listed in Appendix III.

3. The IOTC process: outcomes, updates and progress

3.1 Outcomes of the 18th Session of the IOTC Scientific Committee

3. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–03 which outlined the main outcomes of the 17th and 18th Sessions of the Scientific Committee, specifically related to the work of the WPTmT.

4. The WPTmT **RECALLED** that the SC adopted a set of standardised *IOTC Working Party and Scientific Committee reporting terminology*, contained in Appendix IV of the SC16 Report (para. 23 of the SC16 Report), and **AGREED** that the terminology (which is provided in the opening pages of this WPTmT06 Report) will provide greater clarity and remove some of the ambiguity in the way advice is provided to the next level in the Commission's structure.

5. The WPTmT **RECALLED** that the SC adopted revised '*Guidelines for the presentation of stock assessment models'* in 2012, which include the minimum requirements for presenting CPUE standardisations. All participants who undertake CPUE standardisations and/or stock assessments for temperate tunas should familiarise themselves with these guidelines (provided in paper *IOTC–2014–WPTmT05–INF01*[1]).

6. The WPTmT **NOTED** that in 2014, the SC made a number of requests in relation to the WPTmT05 report. Those requests and the associated responses from the WPTmT06 are provided below for reference:

- ***Stock structure research***
  - *The SC **RECALLED** that in 2013, it had made an additional recommendation on stock structure research, targeted primarily at neritic tunas under the IOTC mandate. Subsequently, at the request of the EU (DG-MARE), a concept note was developed to examine if there is a population structure of neritic tunas throughout the Indian Ocean. The IOTC Secretariat proposed that the list of species be expanded from only neritic tunas, to other IOTC species, including billfish, tropical, temperate tunas and sharks. The concept note has since been approved by the EU who will contribute €1.3 million and require an additional 20% co-contribution (€260,000) from either the IOTC regular budget or in combination with collaborating Institutions. The project will encourage a collaborative approach to the extent feasible to meet the needs of the Commission. The need to work collaboratively with scientists in other oceans to assess stock structure as well as with scientists within the Indian Ocean region was highlighted.*
  - **IOTC Secretariat**: funding for the Project has now been confirmed. Work is expected to commence in late-2016/early-2017, with results of the Project expected to report in either 2017 or 2018.

- ***Review of the data available at the IOTC Secretariat for temperate tuna species***
  - ***NOTING*** *that in recent years many foreign vessels have been unloading catches of albacore in Mauritius, representing around 60% of the total albacore catch, the SC* ***REQUESTED*** *that the Chair*

[1] http://www.iotc.org/documents/iotc-sc-%E2%80%93-guidelines-presentation-stock-assessment-models

of the WPTmT and the Chair of the SC contact Mauritius and indicate that they should be in attendance at all WPTmT meetings, given the high proportion of total albacore catch being landed in Mauritius, and that they should present information on its efforts to monitor albacore landings for catch and size (length) data, and to provide summaries of that data.

- **Mauritius:** is in attendance at the WPTmT06 meeting, and has also submitted paper IOTC-2016-WPTmT06-11, which includes a summary of the data collected on domestic and foreign vessel unloadings of albacore in Mauritius.
- *The SC **RECOGNISED** the value of the biological information for albacore being collected in Mauritius by port samplers and **REQUESTED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. This should occur as soon as possible in 2015.*
- **IOTC Secretariat**: a mission to evaluate the feasibility of collecting albacore tuna biological information from Port Louis, Mauritius, in addition to length frequency samples from foreign unloadings as an alternative data series for Taiwanese longline vessels, has been planned for August 2016. An update will be provided at the next meeting of the WPTmT.

7. The WPTmT **NOTED** the following extracts from the following SC18 Report in 2015, in relation to temperate tunas:

- ***Albacore MSE update***
  - *The SC **NOTED** the progress made towards management strategy evaluation (MSE) for the Indian Ocean albacore fishery. This work was primarily led by the WPM Chair and the informal MSE working group. An operating model (OM) was presented together with an initial set of Management Procedures (MP), and the platform that could be used to explore alternative control rules for the Commission.*
  - *The SC **ENDORSED** the Operating Model for albacore as the basis for the provision of advice to the Commission on the performance of alternative Management Procedures, **NOTING** that external reviewers have considered the albacore MSE work and largely endorsed the approach taken, while recommending a number of improvements to be incorporated.*
  - *The SC **NOTED** that Resolution 15/10 calls for completing the work on assessing the appropriateness of interim target and limit reference points and evaluating candidate harvest control rules as per the decision framework for skipjack tuna and albacore for presentation to the Commission in 2016.*
  - **WPTmT**: an update on the status of the MSE work for albacore tuna is provided in paper IOTC-2016-WPTmT06-26, presented by the Chair of the Working Party on Methods, who also was in attendance at the WPTmT06 meeting.

3.2 Outcomes of the 20th Session of the Commission

8. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–04 which outlined the main outcomes of the 20h Session of the Commission, specifically related to the work of the WPTmT and **AGREED** to consider how best to provide the Scientific Committee with the information it needs, in order to satisfy the Commission's requests, throughout the course of the current WPTmT meeting.

9. The WPTmT **NOTED** the 12 Conservation and Management Measures (CMMs) adopted at the 20th Session of the Commission (consisting of 12 Resolutions and 0 Recommendation):

IOTC Resolutions

- Resolution 16/01 On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock
- Resolution 16/02 On harvest control rules for skipjack tuna in the IOTC area of competence
- Resolution 16/03 On the second performance review follow-up
- Resolution 16/04 On the implementation of a Pilot Project in view of Promoting the Regional Observer Scheme of IOTC
- Resolution 16/05 On vessels without nationality
- Resolution 16/06 On measures applicable in case of non-fulfilment of reporting obligations in the IOTC
- Resolution 16/07 On the use of artificial lights to attract fish
- Resolution 16/08 On the prohibition of the use of aircrafts and unmanned aerial vehicles as fishing aids
- Resolution 16/09 On establishing a Technical Committee on Management Procedures
- Resolution 16/10 To promote the implementation of IOTC Conservation and Management Measures

- Resolution 16/11 On port state measures to prevent, deter and eliminate illegal, unreported and unregulated fishing
- Resolution 16/12 Working Party on the Implementation of Conservation and Management Measures (WPICMM)

IOTC Recommendations

- Nil

10. The WPTmT **RECALLED** the importance of standardising the way in which the subsidiary bodies of the Commission provide advice. Recommendation 14/07, adopted at the 18th Session of the Commission, details a range of options for further standardising the way in which advice may be presented in the IOTC Executive Summaries.

3.3 Review of Conservation and Management Measures (CMMs) relevant to temperate tunas

11. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–05 which aimed to encourage participants at the WPTmT06 to review existing Conservation and Management Measures (CMM) related to temperate tunas, noting the CMMs contained in document IOTC–2016–WPTmT06–04; and as necessary to 1) provide recommendations to the Scientific Committee on whether modifications may be required; and 2) recommend whether other CMMs may be required.
12. The WPTmT **NOTED** that Resolution 13/09 *On the conservation of albacore caught in the IOTC area of competence*, requires the Scientific Committee to assess the coverage and the quality of catch and effort data made available by CPCs targeting albacore, and to advise the Commission before the end of 2014 on target and limit reference points (LRPs, TRPs) which may be used when assessing the albacore stock status and when evaluating potential management measures. In addition, the Scientific Committee, through its Working Parties on Temperate Tunas (WPTmT) and on Methods (WPM), is required to examine and evaluate potential management measures which would allow the achievement of the conservation and optimal utilization of the albacore stock.
13. **NOTING** that Resolution 13/09 requires the WPTmT and SC to advise the Commission, by end of 2014 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs) used when assessing the albacore stock status and when establishing the Kobe plot and Kobe matrices, the WPTmT06 **AGREED** that until the Management Strategy Evaluation process for albacore is finalised, the WPTmT would be unable to provide the advice requested. This matter would be further discussed at the Working Party on Methods and the Scientific Committee meetings to be held in November and December 2016, respectively. The WPTmT further **NOTED** that an update on the current status of the Management Strategy Evaluation for albacore is provided in paper IOTC–2016–WPTmT06–26.
14. The WPTmT **NOTED** Resolution 15/10 *On target and reference points and a decision framework*, introduces amendments to Resolution 13/10 by including a possibility for the IOTC Scientific Committee to use possible alternatives to MSY-based reference points when they are considered as insufficiently robust. The proposal refers to B0-based reference points, where B0 is generally considered either as the historical biomass before the beginning of the fishing activities or as the biomass under the assumption of a termination of any fishing activities. In addition, considering these reference points, the Resolution introduces management objectives and a work program which would allow the IOTC Scientific Committee to discuss projections and outlooks associated to possible management options, more particularly when implementing Management Strategy Evaluations.
15. The WPTmT **AGREED** that it would consider proposing modifications for improvement to the existing CMMs following discussions held throughout the current WPTmT meeting.

3.4 Progress on the recommendations of WPTmT05

16. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–06 which provided an update on the progress made in implementing the recommendations from the previous WPTmT meeting which were endorsed by the Scientific Committee, and **AGREED** to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress. A summary of the status of the previous meeting's recommendations is provided in Appendix IV.
17. The WPTmT **REQUESTED** that the IOTC Secretariat continue to prepare a paper on the progress of the recommendations arising from the previous WPTmT, incorporating the final recommendations adopted by the Scientific Committee and endorsed by the Commission.

4. Review of the data available at the Secretariat for temperate tuna species

18. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–07 which summarises the standing of a range of information received by the IOTC Secretariat for albacore, in accordance with IOTC Resolution 15/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2014. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching albacore in the IOTC area of competence. A summary of the supporting information for the WPTmT is provided in Appendix V.

19. The WPTmT **NOTED** the main albacore data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI, and **REQUESTED** that the CPCs listed in the Appendix make efforts to remedy the data issues identified and to report back to the WPTmT at its next meeting.

20. The WPTmT **NOTED** that no size samples are available in the IOTC database for the Taiwanese driftnet fishery, which operated in the mid-1980s to early-1990s and is known to have targeted juvenile albacore. Due to the lack of alternative data from which to derive more accurate length-weight estimates, average weights for the driftnet fishery estimated by the IOTC Secretariat using size frequency distributions from proxy fleets/fisheries are thought to have been underestimated in recent stock assessments.

21. The WTmT **NOTED** that length frequency samples for the Taiwanese driftnet fishery were collected during the 1980s and published in a former IPTP paper[2], and **RECOMMENDED** that the IOTC Secretariat process the information to ensure the data is available for future stock assessments.

22. **NOTING** changes in the length frequency distribution by the Taiwanese deep-freezing longline fleet since the early-2000s, and particularly the decline in the proportion of smaller sized fish sampled for lengths, the WPTmT **RECOMMENDED** that length frequency and biological data collected by Taiwanese observers be provided to the IOTC Secretariat in order to validate and better understand recent changes in the length frequencies collected by on-board sampling – including samples collected for albacore tuna, tropical tuna species, and swordfish. The WPTmT **NOTED** that all observer data submitted to the IOTC Secretariat is subject to Resolution 12/02 *Data confidentiality policy and procedures*.

23. The WPTmT **ACKNOWLEDGED** the importance of port sampling of albacore tuna unloaded in Port Louis, Mauritius, and **RECOMMENDED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. The WPTmT **NOTED** that the IOTC Secretariat has proposed a mission to Mauritius in August 2016 in support of this capacity building activity.

24. The WPTmT **NOTED** that Indonesia's Scientific Observer program has been collecting length-weight samples from landings at Benoa, Bali, since 2005 and has begun to report data to the IOTC Secretariat following a technical assistance mission by the IOTC Secretariat in November 2015.

25. The WPTmT **RECALLED** that while samples collected by Indonesia's Scientific Observer program cover a limited range of fishing grounds, and may not be representative of broader catches for a species with seasonal movements and size segregation such as albacore tuna, combining the information collected by other CPCs in the Indian Ocean region would permit analyses at a broader spatial scale and with larger sample sizes.

26. **NOTING** the paucity of biological information available for albacore tuna in the Indian Ocean, the WPTmT **ENCOURAGED** all CPC's to report length-weight and biological information collected by observers to the IOTC Secretariat as part of the mandatory reporting requirements of Resolution 11/04 *On a regional observer **scheme***.

5. New information on biology, ecology, fisheries and environmental data relating to temperate tunas

5.1 Review new information on the biology, stock structure, their fisheries and associated environmental data

Indian Ocean albacore stock: review of its fishery, biological data and results of its 2014 stock assessment

27. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–09 which provided a review of the fishery and biological data available for albacore, as well as the results of the 2014 albacore stock assessment, including the following abstract provided by the author:

[2] Lee, Y.C. & Liu, H.S (1992), 'An updated virtual population analysis of the Indian Ocean Albacore Stock, 1980-1992', IPTP.

"*This paper makes first a review of the albacore biological and fishery data that have been used in the IOTC 2014 stock assessment. It also examines the results of the SS3 models and their correspondence with these input data. There is a severe weakness of biological data for albacore in the IO, and most basic parameters are purely hypothetical. A lower natural mortality at age estimated by the Lorenzen method is considered as being more realistic than the level used by the WG. Changes in fisheries are showing that historical Gillnet fisheries were catching medium size albacore, not the very small albacore assumed by the IOTC. The albacore habitat and its core area has been identified and discussed. Major changes in the species targeting have been observed in this area since the mid eighties. It has been concluded that changes in target species are possibly the main causes of the steady decline of the albacore CPUES since 1986. These changes have not been corrected in the today GLM albacore CPUEs. It is shown that sizes caught by the albacore fisheries have been permanently large and stable, being close to the optimal yield per recruit. The stability of total catches and of total albacore effort (and of fishing mortality estimated by SS3) since the late sixties would indicate that there was no critical changes occurring in the fisheries & stock status during the last 30 years. It is concluded that the major decline in the LL CPUE was probably the main & artificial cause producing the major decline of the SS3 modelled biomass. Improved alternate modelling based on improved data, especially improved LL GLM CPUEs, should be done again in order to evaluate better the today real condition of the albacore stock in the IO.*"

28. The WPTmT **NOTED** that the issues raised by the paper will be discussed in Section 6.2, and also are addressed in paper IOTC-2016-WPTmT06-25**.**

Albacore Tuna Unloaded at Phuket Fishing Port, Thailand

29. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–10 which provided a review of port sampling data available for albacore tuna unloading in Phuket, Thailand by foreign flagged vessels, including the following abstract provided by the authors:

"This report reviews the historical data of the albacore tuna landing in Phuket ports of Thailand as well as elaborates the data on the year of 2011 when the port sampling had been carried out. In 2011, all landing fishing vessels were longliners from Taiwan, Belize, Malaysia, India and Indonesia which the lengths of vessels were 19-40 m and their storage capacity were 20-60 tons. Their fishing ground was in the latitude of 2°S to 12°N and longitude of 77° to 95° 40´E. The total catch were 5,543,244 kg that included 4,318,743 kg of tuna, 92,351 kg of billfishes and 1,132,150 kg of other fishes. The tuna catch mainly comprised yellowfin (Thunnus albacares) and bigeye (T. obesus) for 68.77 and 9.14% while the composition of the albacore was less than 0.01%. The body weights of albacore were in the range of 8-39 kg with the average of 14.25± 3.09 kg, and the modal weights of 12 and 13 kg. Although the landing of tuna vessels in Phuket of Thailand has started since 1994, the report mostly addressed the major tuna species of yellowfin and bigeye tuna rather than albacore. Without the systematic port sampling, albacore catches may be underestimated. So, the increasing capacity of officers for identification of fish at the landing port and the port sampling program is recommend to monitoring the catch of Albacore species for assessment in the long run basis."

30. The WPTmT **NOTED** that the small number of albacore samples from port sampling was mostly due to the species composition of catches, of which albacore tuna consisted of less than 1 per cent of total catches, in addition to limited resources available for port sampling. However the WPTmT **ACKNOWLEDGED** the usefulness of collecting samples from the East Indian Ocean, in conjunction with samples collected from fishing ground in the Western Indian Ocean.

An Overview of Longline Fisheries targeting albacore tuna in Mauritius

31. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–11 which provided an overview of the data available for longline fisheries targeting albacore tuna within the Mauritius EEZ, including Mauritian and foreign flagged vessels unloading in Port Louis, Mauritius, including the following abstract provided by the authors:

"Due to its ideal geographical position, conducive port infrastructures and dry-docking facilities Mauritius is a regional hub for fishing vessels operating in the South West Indian Ocean. Tuna fishing longliners mainly targeting temperate tunas regularly call at the Port Louis harbour with an approximate of 600 calls yearly for unloading and transhipment of tuna. In 2015, 93 foreign fishing licenses were issued to tuna longliners to fish in its Exclusive Economic Zone.

The licensed foreign longline vessels are monitored through the Vessel Monitoring System (VMS). All vessels calling at Port Louis are monitored through Port State Control Measures as per the FAO model. Logbooks are collected from vessels licensed to fish in the EEZ of Mauritius and port sampling exercises for length frequency are carried out on the catch of these vessels. Logbook and length-frequency data are processed for the estimation of catch and effort and for the generation of spatial distribution maps. Moreover, transhipment *activities carried out by longline vessels are also monitored. During the year 2015, 52 586 tonnes of tuna was transhipped at Port Louis harbor, out of which 40% is represented by albacore tuna.*

Albacore represents a small percentage of the total catch obtained from the semi-industrial fishery of Mauritius which targets mainly swordfish. The catch trend of albacore tuna in the local semi-industrial longline fishery shows some variation over the last 5 years with the lowest percentage recorded in 2015 (6.2%) and the highest percentage of 15.4% in 2012.

This paper gives an overview of the length frequency, spatial distribution and catch/effort data of albacore from licensed longliners for the past five years. It also provides information on transshipment of albacore by foreign longliners calling at Port Louis."

32. The WPTmT **NOTED** the importance of Mauritius for foreign longline vessels unloading albacore tuna, which are monitored through Port State Control Measures, and which includes the collection of logbooks from vessels licensed to fish in the EEZ of Mauritius and port sampling for length frequencies, that enables the validation of catch-and-effort and size frequency data of domestic and foreign flagged vessels.

The potential fishing ground and spatial distribution pattern of albacore in Eastern Indian Ocean

33. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–12 which provided an overview of the spatial distribution of albacore using information collected by Indonesia's observer program, including the following abstract provided by the authors:

"The current work highlighted the estimation on potential fishing grounds area of Albacore (ALB) (Thunnus alalunga) in the Eastern Indian Ocean. These data used in this study were based on the Research Institute for Tuna Fisheries (RITF) observer program in Benoa from 2005-2013. The aim of this study is to give the information to the longline fisheries stake holder about the spatial distribution and the potential fishing grounds area (PFGA) of ALB in Eastern Indian Ocean. The methods used in this study is the combination of spatial distribution of CPUE and the percentage of mature ALB in Eastern Indian Ocean. Result show that the distribution and fishing grounds of ALB are influenced by spatial distribution of oceanographic variables i.e. sea surface temperature (SST), salinity, temperature at depth of 100 m, chlorophyll concentration and oxygen content at depth of 200 m. In February and March, the PFGA distribution spread out evenly in the Eastern Indian Ocean. In April and May, the PFGA distribution began to move to the area between southern coast of (Java, Bali and Nusa Tenggara) and northern coast of Australia at the coordinates (5-15°S and 110-125°E). In June and July, the PFGA spread widely in the area between south coast of Java, Bali, Nusa Tenggara and Australia with the coordinate (5-25°S and 100-125 °E). In August and September, PFGA moved to the west coast of Australia (10-35°S and 75-120 °E). In October and November, PFGA moved to southern hemisphere and far away to mid Indian Ocean."

34. The WPTmT **NOTED** that the addition of environmental indicators may help to explain some of the spatial variations in catches of albacore noted by the paper. For example the Habitat Suitability Index (HSI) may be useful for detecting potential fishing grounds for albacore, by combining information from the CPUE and environmental data to more accurately pinpoint the suitability of fishing grounds for albacore.

35. NOTING the range of data collected by Indonesia's Scientific Observer Program, the WPTmT **ENCOURAGED** Indonesia to compare information collected by observers, with data collected by logbooks, and also other sources such as VMS, to validate time-area catches and estimates of catch-by-species reported to the IOTC Secretariat.

Status of Albacore Fishing by Malaysian Tuna Longliners

36. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–13 which provided an overview of the Malaysian tuna longline vessels which shifted their targeting from tropical tuna to albacore tuna fishing, including the following abstract provided by the authors:

"Malaysian tuna fisheries began with tropical tuna fishing in 2005 to 2011. In 2012, Malaysian tuna longline vessels shifted their operation from tropical tuna to albacore tuna fishing. A total of 5 tuna longline fishing vessels and 1 carrier are currently operating under Malaysian flag and they mainly operated in the southwest of Indian Ocean. In 2015, the total catch of albacore increased significantly by 44% to 1,031 tons from 714 tons in 2014 after recording a drastic dropped from 947 tons in 2013. The fishing efforts in term of number of haul, increased from 909 hauls in 2014 to 1130 hauls in 2015. Peak period of the catches were recorded from May to August with the range of catches from 112 -165 tons/month. For the cpue (tail/100 hooks) of the albacore, the range were from 0.21 – 3.48 and the highest cpues were recorded in May and June 2015. Tuna albacore represented an average of 72% of the total catch by the tuna longliners in term of weight, followed by yellowfin

tuna 8.5%. The range of areas that covered by the fishing operation of the Malaysia tuna longliners extended from 10^{o} S in the north to 39^{o}S toward the south and longitude from 40^{o} E to 70^{o}E. All the catches were of the frozen tuna type which were exported countries such as Taiwan and Thailand."

37. The WPTmT **NOTED** that Malaysian tuna longline vessels targeting albacore tuna almost exclusively offload their catches in Port Louis, including the submission of logbook data to Mauritius port authorities, and that this may be a useful source to validate the catches of albacore reported by Malaysia to the IOTC Secretariat.

Review of Japanese longline fishery and its albacore catch in the Indian Ocean

38. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–14 which provided a summary of the Japanese longline fishery, including spatial patterns of catches and trends, including the following abstract provided by the authors:

"Status of effort, albacore catch and CPUE was summarized for Japanese longline fishery operating in the Indian Ocean including recent trends. Japanese longline vessels had been targeting albacore until late 1960s, albacore became non-target after that, but it has become one of target species in recent years. Fishing effort fluctuated and it sharply decreased in recent years due to the effects of piracy activities. Albacore catch was high in 1960s, sharply decreased in 1970s, and then gradually increased with fluctuation. In the early period, the effort was deployed mainly in the tropical area, and then expanded to the south. Fishing effort in the northwestern part (around Somalia) sharply decreased after 2009 due to piracy activities. During 1960s albacore was main component of the catch in the western part between 10˚S and 35˚S, and is recently main component in the southern part including west off Australia and around Madagascar."

39. The WPTmT **NOTED** that fishing activities of the Japanese longline fleet have still not returned to the traditional fishing grounds in the north-west Indian Ocean, due to the continued assessment of the threat of piracy.

40. The WPTmT **NOTED** that the increase in catches of albacore by the Japanese longline fleet in recent years are likely to be associated with the declining quota allocation for southern bluefin tuna and the change in targeting to bigeye tuna, rather than targeting of albacore, which is generally considered to be a bycatch species by longline vessels.

Review of catch and effort for albacore tuna by Korean tuna longline fishery in the Indian Ocean (1965-2015)

41. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–29 which provided a summary of the characteristics of the Korean tuna longline fishery, including catch series, main fishing grounds, and nominal CPUE, including the following abstract provided by the authors:

"This paper describes the fishing characteristics of Korean tuna longline fishery and its catch and CPUE trend for albacore tuna in the Indian Ocean from 1965 to 2015. The number of active fishing vessels showed the highest in the mid-1970s, and then it sharply decreased and reduced to 7 vessels in 2011 and 2012. In recent years, it is showing a slight increasing, which was 14 vessels in 2015. Albacore catch had increased from the mid-1960s to 1974 when showed the highest of about 10 thousand mt, but it sharply decreased thereafter. During the 1990s, it had remained in the lowest level below 200 mt, and since 2009 it has increased and showed over 600 mt in 2013 and 2014. The CPUE of albacore was relatively higher in 1970s, and then it decreased and showed a low level to 2002. Since then it has increased and showed a dramatic increasing during 2011-2014. In the 1970s and 1980s, the fishing ground of albacore by Korean longline fishery had been formed between 10°N and 40°S of the western and eastern Indian Oceans, but it moved gradually to the south of 20°S, and has been formed mainly between 20°S and 40°S of the western and eastern Indian Oceans in recent years."

42. The WPTmT **NOTED** that the Korean and Japanese longline fleet share the same fishing grounds and, like the Japanese fleet, fishing effort in the north-west Indian Ocean has declined as a direct result of piracy activities in this region.

43. The WPTmT **NOTED** that the increase in the catches of albacore in recent years by the Rep. of Korea longline fleet – combined with a decrease in the catches of bigeye tuna – was likely related to the Rep. of Korea's southern bluefin tuna fishery pattern, and the displacement of fishing effort of longline vessels towards the southern Indian Ocean which are now opportunistically targeting albacore due to the effects of piracy in the western Indian Ocean.

Reproductive biology of albacore tuna (Thunnus alalunga) in the Western Indian Ocean

44. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–27 which provided an overview of a study of the reproductive biology of albacore tuna, based on characteristics such as the sex ratio, spawning season and

location, length at maturity, and fecundity, in the western Indian Ocean and Mozambique Channel, including the following abstract provided by the authors:

"Information on the biology of albacore tuna, Thunnus alalunga, in the Indian Ocean is scarce and little new information on the population is available. Scientific advice on the status of fish stocks relies on indicators that are based on strong assumptions on biological parameters such as condition, maturity and fecundity. Currently, reproductive parameters used in stock assessment models for Indian Ocean albacore originate largely from other studied stocks or species of tuna. Differences that may exist in the population biology of other albacore stocks from different regions may exert a great impact on the Indian Ocean albacore stock assessment, the fishery and management advice. Maturity, fecundity, sex ratio, condition and reproductive history are the fundamental factors that affect fish population productivity and are thus used for estimating the reproductive potential. They not only incorporate changes that occur in the reproductive success of a population into stock assessments but also allow estimation of Spawning Stock Biomass (SSB).

In this work, the reproductive biology of albacore tuna from the Western Indian Ocean was examined through analysis of the sex ratio, spawning season, length-at-maturity (L50), spawning frequency and fecundity. From 2013 to 2015, a total of 923 female and 867 male albacore caught by different fishing gears were sampled. A bias in sex-ratio was found in favour of females with fork length <100 cm. Using histological analyses and gonadosomatic index, spawning was found to occur between 10°S and 30°S, mainly on the east of Madagascar from October to January. Large females contributed more to reproduction through their longer spawning period compared to small individuals. The L50 of female albacore was estimated at 85.3±0.7cm. Albacore spawn on average every 2.2 days during the peak spawning months in November and December. Batch fecundity ranged between 0.26 and 2.09 million eggs and the mean relative batch fecundity was estimated at 53.4 (±23.2) oocytes g-1 of somatic weight. The study provides new information on the reproductive development and classification of albacore in the Western Indian Ocean. The reproductive parameters will in turn significantly benefit its stock assessment by enhancing the confidence of the state and productivity estimates, especially taking into consideration the bias in sex ratio."

45. The WPTmT **NOTED** that while some of the reproductive characteristics share similar characteristics with stocks in the South Pacific, length at maturity (L_{50}), appears to be smaller than in other oceans, although additional samples are needed over a longer a time period to confirm the findings of the study, as well as the extent of temporal variation in the data.

46. **NOTING** the short period over which sampling was conducted, between 2013-2015, the WPTmT **CONGRATULATED** the project on the collection of biological information for albacore tuna from the Indian Ocean.

47. **NOTING** the general paucity of biological indicators available from the Indian Ocean, and particularly the lack of age-specific maturity as a primary source of uncertainty in the stock assessment of albacore tuna, the WPTmT **RECOMMENDED** a study on the growth curve of albacore tuna in the Indian Ocean as a high priority in the WPTmT Program of Work.

Morphometrics of albacore tuna (Thunnus alalunga) in the Western Indian Ocean

48. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–28 which provides an overview of length-length (fork-length, FL with pectoral length, PL and first dorsal length, LD1) and length-weight relationships of albacore tuna (*Thunnus alalunga*) in five regions of the Western Indian Ocean, including the following abstract provided by the authors:

"This paper provides information on the length-length (fork-length, FL with pectoral length, PL and first dorsal length, LD1) and length-weight relationships of albacore tuna (Thunnus alalunga) in five regions of the Western Indian Ocean. Data were obtained for a total of 923 female and 867 male albacore, caught by different fishing gears, and sampled from 2013 to 2015. The regression coefficients of the different relationships are presented. Possible causes of variations in length-weight, including tissue weights (gonad, liver and the rest of the viscera), sex and region are assessed using analysis of covariance (ANCOVA) and linear regressions on log-transformed equations of length and weight. There were significant differences in the relationships FL-PL ($F_{(5,1054)}$ = 5553, P<0.001) and FL-LD1 ($F_{(5,921)}$ = 307.2, P<0.001) between regions but no significant differences were found between sex. Significant interactions were also found between log(FL) and region ($F_{(4,1637)}$ = 25.3, P<0.001), and log(FL) and sex ($F_{(1,1512)}$ = 7.62, P<0.01). For the relationship of somatic gutted weight with length, significant interactions were observed between FL and region ($F_{(4,1509)}$ = 71.43, P<0.001) but not with sex ($F_{(1,1515)}$ = 0.062, P>0.05). The study shows that fixed values of a and b for the entire region may be misleading. To minimise fluctuations in length-weight relationships, it is suggested to use somatic-gutted weight instead of

whole fish weight and to use separate relationships for the northern part of the Western Indian Ocean (where albacore may be in a fattening stage at their feeding ground) and the southern part, particularly between 10 and 30°S where spawning occurs."

49. The WPTmT **NOTED** the results of the study, which suggest that to minimise fluctuations in length-weight relationships it is necessary to use the SW region instead of W region, and separate relationships for the northern part of the western Indian Ocean (where albacore may be in a fattening stage at their feeding ground) and the southern part where spawning occurs between 10 and 30°S, reflecting accumulation and depletion of energy stores (i.e. fat).

50. The WPTmT also **NOTED** that fixed values of *a* and *b* for the entire region may be misleading, given that estimates of *a* and *b* are dependent on each other and are linked to ecological processes and the life history of the fish.

51. The WPTmT **NOTED** that fitting the LW relationship using an integrated approach, such as GLM or GLMM, enables other factors such as region, time of the year, and maturity to be incorporated. Additionally, a GLM (or GAM, or GLMM) using a cubic spline instead of the traditional W=a.L^b may improve the fit to the data. Fish growth and morphology may change through the life cycle, and additional flexibility allows this to be estimated with a large high-quality dataset. Better fits at all sizes may help to estimate covariates such as regional and seasonal effects, particularly since size distributions vary in different regions.

6. REVIEW OF NEW INFORMATION ON THE STATUS OF ALBACORE TUNA

6.1 Nominal and standardised CPUE indices

CPUE Standardisations

Japanese – Catch-per-unit-effort (CPUE)

52. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–15 which provided a standardised CPUE series for albacore based on Japanese longline catch and effort statistics from 1954 to 2014, including the following abstract provided by the authors:

> "*Standardization of albacore CPUE by Japanese longline fishery in the Indian Ocean was conducted using the Generalized Linear Model (GLM) with log-normal error structure (LN model). Original (operational level) catch and effort data as well as environmental factor (sea surface temperature) were used for standardization. CPUE was standardized as for several areas. All CPUEs sharply declined in the early period (until around 1970). CPUE in the north area was comparatively constant after that. CPUE in the south area increased after early 2000s. The effect of each factor in standardization usually differed between north and south.*"

53. The WPTmT **NOTED** the explanation provided by the authors that the first year of the Japanese longline CPUE series was changed from 1975 (i.e., as presented in WPTmT05 meeting in 2014), to 1954 for the WPTmT06 meeting to enable comparisons with the joint CPUE presented in document IOTC-2016-WPTmT06-19; despite the fact the Japanese longline fleet shifted targeting from albacore to bigeye tuna during the late-1960s to early-1970s and, therefore, the CPUE during these years are not intended to provide a representative abundance index for albacore.

54. The WPTmT further **NOTED** the steep decline of the Japanese longline CPUE in the early period, similar to the yellowfin and bigeye CPUE, is not realistic as it occurred when the longline fishery was operating in a very localized area and with low fishing effort before the expansion of the fishery. Thus, during the early period between 1954 until the mid-60's, the CPUE is not considered to be representative of population abundance.

55. The WPTmT **NOTED** the substantial differences between Japanese longline CPUE and the joint CPUE presented in IOTC-2016-WPTmT06-19, which can be explained by the joint CPUE's inclusion of operational data from different longline fleets (i.e., Taiwanese, Japanese, and Korean), use of cluster analysis to select targeting of the different fleets, and the inclusion of vessel identities in the standardization process.

56. The WPTmT **NOTED** differences in the relative effect of the sea surface temperature (SST) in the standardization process in the southeast region compared to the other regions (i.e., southwest, northwest, and northeast). This could be explained because albacore tuna in this area could be distributed deeper, as supported by the use of larger number of hooks between floats (HBFs) in this area. The WPTmT **NOTED** that it would be better to use the temperature at different depths (e.g., temperature at 200 meters) in this area as a factor rather than SST.

57. The WPTmT **NOTED** that paper IOTC–2016–WPTmT06–09 shows that dissolved oxygen is related to the catch rates of albacore and suggested exploring the use of oxygen as a factor in the albacore standardization in the next iteration of the Japanese longline CPUE.

Taiwan,China – Temporal and spatial patterns of Nominal Albacore CPUE

58. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–16 which provided information on temporal and spatial patterns of Taiwanese, Japanese and Rep. of Korea Nominal Albacore CPUE distributions in the Indian Ocean from 1979 to 2014, including the following abstract provided by the authors:

    "*At the IOTC 17th WPTT NOTED the updated CPUE analysis and encouraged the CPCs to continue the analysis as part of the multi-nation collaborative effort to improve CPUE standardizations. While some progress has been made, additional joint analyses of Taiwanese, Japanese, and Korean operational level longline fishery data are needed….*" – See paper for full abstract.

59. The WPTmT **NOTED** that, as expected, there were differences in nominal catch rates between fleets in different 5 degree squares, and requested the authors to further investigate the possible reasons for such differences in the future through joint CPUE standardization.

60. The WPTmT **NOTED** that the differences in nominal catch rates between 5 degree squares, as well as temporal trends of those differences between 5 degree squares, should be accounted for during the standardization process. The WPTmT **RECALLED** that the approach recommended by the IOTC CPUE workshop is to use 5 degree squares when standardising the CPUE series. Temporal trends in the spatial distribution of the CPUE could be investigated by analysis of the residuals from the CPUE models.

Taiwan,China – Catch-per-unit-of-effort (CPUE)

61. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–17 which provided a standardised CPUE for albacore based on Taiwan,China longline catch and effort statistics from 1980 to 2014 with simultaneous nominal portion from observer data, including the following abstract provided by the authors:

    "*Albacore is one of the main target species of Taiwanese longline fishery in the Indian Ocean. It is essential to provide faithful CPUE for the albacore resource assessment and management need, to ensure the sustainable exploitation of this resource. In this paper, first we constructed temporal and spatial distributions of albacore nominal CPUE, which independently reported by fishing logbook and observer in the Indian Ocean, for quickly and comprehensively reviewing. And then, factors including year, quarter, subarea, code of CPUE and relative interactions, etc. were used to standardize the CPUEs of albacore caught by Taiwanese longliners in Indian Ocean from 1980 to 2014, by whole area and IOTC core area, respectively.*" – See paper for full abstract.

62. **NOTING** that the sub-area used for the area effect seems to be too large to address the problem of changes in fishing locations to areas with improved catch rates, the WPTmT **RECALLED** that the approach recommended by the IOTC CPUE workshop is to use 5 degree squares when standardising the CPUE series.

63. The WPTmT **NOTED** that the CPUE is used as the response variable, but also as explanatory categorical variable in the GLM equation which could affect the results of the analysis. The WPTmT **NOTED** that further analysis is required to understand the effect in the standardization process.

64. **NOTING** the importance of how data is distributed through the temporal and spatial scale, the WPTmT **REQUESTED** that Taiwan,China examine a model that incorporates the interaction between areas and years in subsequent analysis, and results should be presented at the next WPTmT meeting.

Taiwan,China – Impact of CPUEs on reference points

65. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–18 which provided an analysis of the impact of selection of abundance indices on estimates of biological reference points for Indian Ocean Albacore, including the following abstract provided by the authors:

    "*Stock assessment models using ASPIC platform were run to examine the impacts of alternative modeling components on parameter estimates and biological reference points (BRPs). The preliminary findings from this study were that the initial value of B1/K was less influential than the production models and model fitting criteria. However, considering the unrealistic BRP estimates derived from the models with Least Absolute Values (LAV) criteria, it needs to be cautious in using this method for ASPIC model for the albacore. It seems that using whole-area based Taiwanese CPUE index combining Fox production model with SSE criteria provides relatively reasonable parameters estimates and BRPs for Indian Ocean albacore. This study suggests that the production model shapes and model fitting criteria are also important and influential components when assessing Indian Ocean albacore stocks.*"

66. The WPTmT **NOTED** the interest of the exercise to investigate the sensitivity of the stock assessment model and, hence, status of the stock in relation to different CPUEs, however, the WPTmT **NOTED** that different starting values of B1/K are given identical results, which can be explained by the lack of convergence of the production model used.

Taiwan,China; Japan; Rep. of Korea – joint Catch-per-unit-of-effort (CPUE)

67. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–19 which provided a joint standardised CPUE for albacore based on Taiwan,China; Japan; Rep. of Korea longline catch and effort operational data from 1952 to 2014, including the following abstract provided by the authors:

No abstract available at the time of writing.

68. The WPTmT **ACKNOWLEDGED** the analysis presented, the excellent progress of the workshop carried out in 2016 toward attaining reliable abundance indices for albacore tuna, as well as the continuation of the work started in 2015 for yellowfin and bigeye tuna for the stock assessment processes.

69. The WPTmT **NOTED** that operational data should be collected and analysed wherever possible, and the scope of the studies should be expanded to include other fleets (e.g. Seychelles industrial longline and Indian survey data), and applied to other species of relevance to IOTC working parties (e.g. billfishes).

70. **NOTING** that the main objective of the analysis/clustering is to integrate all the data in a joint CPUE and that there seem to be different trends among clusters/fleets, the WPTmT **NOTED** that it would be worthwhile to explore separate standardisation models by cluster as well as by fleet. The comparison of those indices would allow better understanding of the processes and improve the joint CPUE standardization.

71. The WPTmT **SUGGESTED** inclusion of interactions between cluster-year and/or fleet/year in the joint standardization to explore the effect of temporal trends in clusters/fleets.

72. The WPTmT **NOTED** that the CPUE time series between areas/fleets are comparable with the joint CPUE, except for the Japanese CPUE in recent years (especially in the southeast area) which is different from the rest of the fleets that compose the joint CPUE indices. This issue requires further investigation as it seems that a change in targeting of the Japanese fleet away from southern bluefin tuna and towards fishing methods that catch higher proportions of albacore may have occurred around the mid-2000s.

CPUE discussion summary

73. The WPTmT **AGREED** that there is a merit in using operational data from the three main fleets (Japan, Taiwan,China and Rep. of Korea) together in a joint CPUE standardization with a common area definition, and common cluster analysis to select targeting, incorporating vessel effects to avoid different standardization procedures (i.e., combinations of area/quarter, and other factors) when analysing each country's CPUE separately.

74. The WPTT **NOTED** that combining observations across fleets in a single analysis provides a time series with better spatial and temporal coverage.

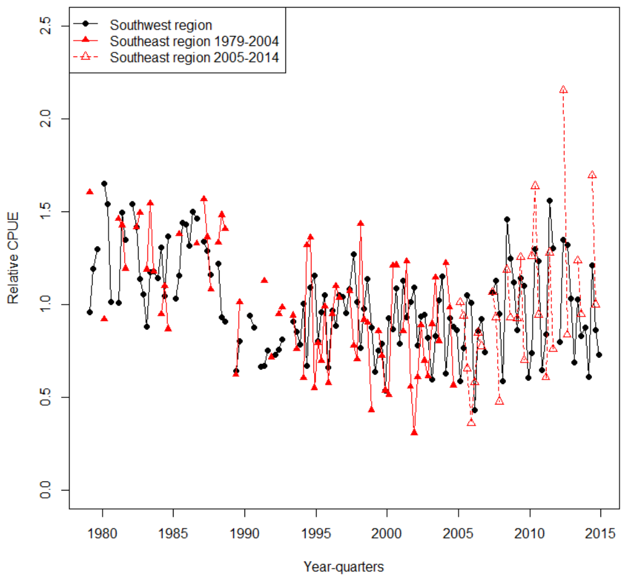
75. **NOTING** that the Taiwanese longline CPUE in southern regions, especially in the southwest region, is affected by the rapid recent increase of the oilfish fishery, and that this is a new fishery with substantially lower catchability for tunas, it is important for CPUE indices to adjust for this change in catchability. Thus, the WPTmT **AGREED** with the cluster analysis performed to identify targeting to oilfish in the joint analysis which removed the effort exerted by this fishery in the Albacore CPUE standardization process.

76. The WPTmT **NOTED** that the Japanese CPUE index has some targeting issues in the most recent years, especially since 2006 (i.e., from southern Bluefin tuna to albacore tuna) which gives less confidence in the use of the Japanese CPUE or Japanese data in the joint CPUE analysis from that period onwards. This is particularly true for the southeast Japanese CPUE index from 2006 onwards, since the importance of the Japanese fleet activity was minor in other areas. Therefore the WPTmT **AGREED** to either exclude the recent Japanese southeast indices from the assessment model, or account for differences between the two sets of CPUE indices by estimating catchability deviates for the recent south-eastern CPUE indices, thereby down weighting the influence of these indices.

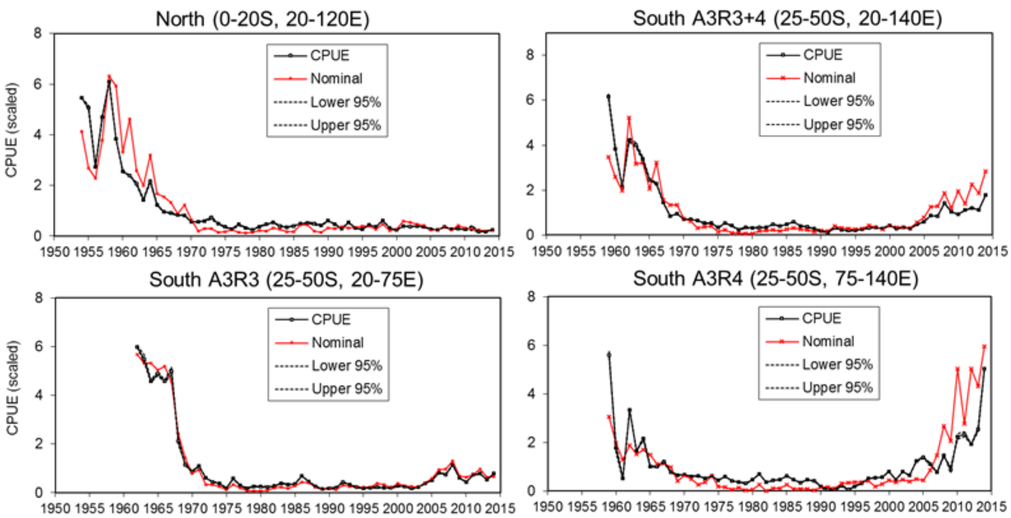
77. The WPTmT **NOTED** the CPUE series available for assessment purposes, listed below (**Fig.1** & **Table 1**):
    - Joint Taiwan, China; Japan, Rep. of Korea CPUE (1954-2014, and 1979-2014).
    - Japan (1954–2014): 4 series from document IOTC–2016–WPTmT06–15.
    - Taiwan,China (1980–2014): 2 series from document IOTC–2016–WPTmT06–17.

The WPTmT **AGREED** that the joint series (southwest and southeast area; Fig.1a) should be used in the final stock assessment models for management advice purposes, for the reasons discussed above.

a)



b)



c)

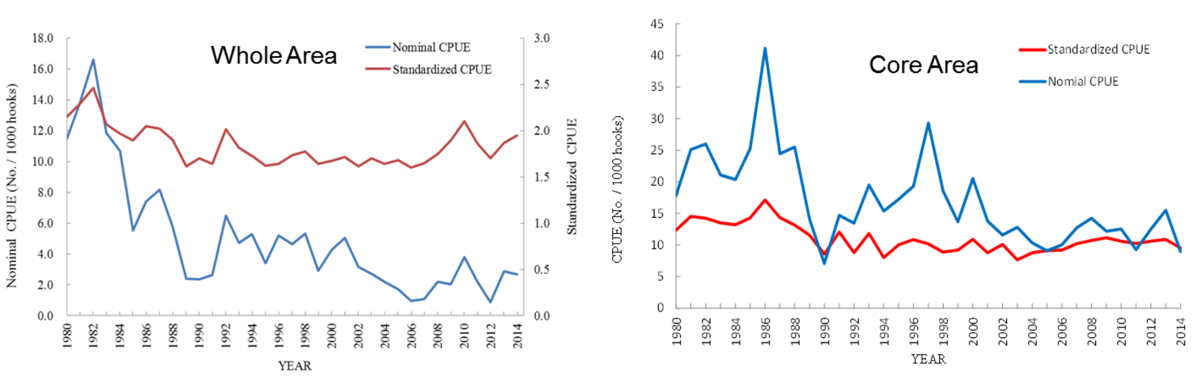


Fig.1. Comparison of the CPUE series for longline fleets fishing for albacore in the IOTC area of competence:
a) Joint CPUE (southwest (1979-2014), southeast (1979-2005), southeast (2006-2014));
b) Japanese CPUE (Areas: North, South A3R3+4, South A3R3, South A3R4);
c) Taiwan,China CPUE (whole Indian Ocean area, and Core Area).
Series have been rescaled relative to their respective means (time period varies according to each CPUE).

Table 1. Summary of CPUE series used by the albacore assessment models.

	BBDM (Doc# 22)	**BSPM (Doc# 24)**	**ASPIC (Doc# 20)**	**SCAA (Doc #21)**	**SS3 (Doc# 25)**
CPUE series	LL: Taiwan,China (core)	Joint Southwest: R3; Joint Southeast: R4	Joint Southwest: R3	LL: Taiwan,China (core)	Joint Southwest: R3; Joint Southeast: R4
CPUE period	1980–2012	R3 (1979–2014) R4 (1979-2005)	1979–2005	1980-2005	1979–2014

6.2 Stock assessments

78. The WPTmT NOTED that a range of quantitative modelling methods as detailed below (BBDM, ASPIC, SCAA, BSPM, and SS3) were applied to the assessment of albacore in 2016, ranging from the ASPIC surplus production model to the age and sex-structured SS3 analysis. The different assessments were presented to the WPTmT in documents IOTC–2016–WPTmT06–20, 21, 22, 24 and 25. Each model is summarised in the sections below.

Summary of stock assessment models in 2016: albacore

79. The WPTmT **NOTED** Table 2 which provides an overview of the key features of each of the stock assessments presented in 2016 (4 model types) and Table 3, which provides a summary of the assessment results.

Table 2. Summary of final stock assessment model features as applied to the Indian Ocean albacore resource in 2016.

Model feature	**BBDM (Doc# 22)**	**BSPM (Doc# 24)**	**ASPIC (Doc #20)**	**SCAA (Doc #21)**	**SS3 (Doc# 25)**
Software availability	W. Guan	B. Li et. al	NMFS toolbox	Nishida & Rademeyer	NMFS toolbox
Population spatial structure / areas	1	1	1	1	1
Number CPUE Series	1 (TWN,CHN)	2	1	1	2 (combined logsheet);
Uses Catch-at-length/age	No	No	No	Yes	Yes
Age-structured	No	No	No	Yes	Yes
Sex-structured	No	No	No	No	Yes
Number of Fleets	1	1	1	4	11
Stochastic Recruitment	No	No	No	Yes	Yes

80. The WPTmT **RECALLED** the value in undertaking a number of different modelling approaches to facilitate comparison across model structure and results, and **AGREED** that more complex models such as integrated age-structured population models, which are capable of more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research, cannot be considered at the same level of simpler production models.

Table 3. Summary of key management quantities from the assessments undertaken in 2016.

Management quantity	**BBDM (Doc# 22)**	**BSPM (Doc# 24)**	**ASPIC (Doc# 20)**	**SCAA (Doc #21)**	**SS3 (Doc# 25)**
Most recent catch estimate (t) (2014)	40,233				
Mean catch over last 5 years (t) (2010–2014)	36,855				
h (steepness)	n.a.	n.a.	n.a.	0.8	0.8
MSY (1,000 t) (80% CI)	44.0 (39.2–53.5)	48.4 (20.36–85.98)	41.2 (30.2–49.6)	59.0 (n.a.)	38.8 (34.0–43.6)
Data period (catch)	1950–2014	1950–2014	1950–2014	1952-2014	1950–2014
F_{MSY}	0.34	0.24	0.43	0.37	n.a.
SB_{MSY} or $*B_{MSY}$ (1,000 t)	132.8*	250*	96.5*	106	30.0 (26.1–34.0)
$F_{current}/F_{MSY}$ (80% CI)	0.53 (0.38-0.66)	0.51 (0.22–1.85)	0.64 (0.45-1.26)	0.65	0.85 (0.57–1.12)
B_{2014}/B_{MSY} (80% CI)	1.74 (1.55-1.96)	1.49 (0.85-2.01)	1.53 (1.07-1.81)	n.a.	n.a.
SB_{2014}/SB_{MSY} (80% CI)	n.a.	n.a.	n.a.	1.14	1.80 (1.38–2.23)
B_{2014}/B_{1950} (80% CI)	n.a.	n.a.	0.62	n.a	n.a.
SB_{2014}/SB_{1950} (80% CI)	n.a.	n.a.	n.a.	0.26	0.37 (0.28–0.46)
$SB_{2014}/SB_{current, F=0}$	n.a.	n.a.	n.a.	n.a.	n.a.

LL = longline; n.a. = not available. For SS3 SB is defined as mature female biomass.

A Stock-Production Model Incorporating Covariates (ASPIC)

81. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–20 which provided a stock assessment for albacore in the Indian Ocean using A Stock-Production Model Incorporating Covariates (ASPIC), including the following abstract provided by the authors:

"An assessment for the Indian Ocean stock of albacore was conducted based on ASPIC. A time series of catch (1950-2014) and that of standardized CPUE (Taiwanese longline or longline 'joint') were used for the analysis. Convergence and reasonable results were obtained for the scenarios which incorporated Taiwanese CPUE and/or joint longline CPUE. The scenario with only Taiwanese CPUE in main fishing area was selected as a reference case in this paper. According to the reference case, the stock status was estimated to be in the green zone of Kobe plot. Kobe II (risk assessments) indicated that the risk of B and F exceeding MSY level is lower than 50% if future catch is up to 40% and 30% higher than current level, respectively. On the whole, the results in the present study were more optimistic than those for the last assessment."

82. The WPTmT **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below (**Tables 4** & **5**; **Fig.2**).

Table 4. Albacore: Key management quantities from the ASPIC assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2014 catch estimate	40,233
Mean catch from 2010–2014	36,855
MSY (1000 t) (80% CI)	41.2 (30.2–49.6)
Data period used in assessment	1950–2014

FMSY (80% CI)	0.43 (n.a.)
BMSY (1000 t) (80% CI)	96.5 (n.a.)
F2014/FMSY (80% CI)	0.64 (0.45-1.26)
B2014/BMSY (80% CI)	1.53 (1.07-1.81)
SB2014/SBMSY	n.a.
B2014/B1950 (80% CI)	0.62

n.a. not available

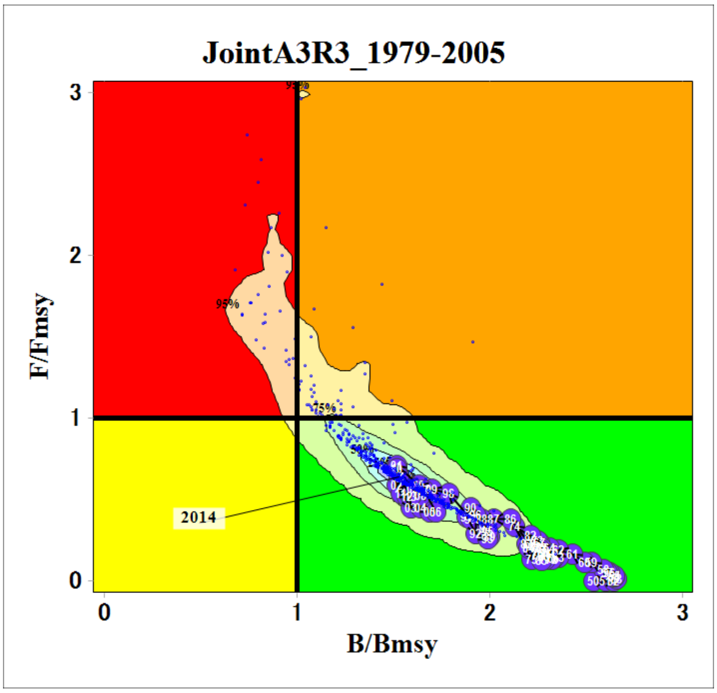


Fig. 2. Albacore: ASPIC aggregated Indian Ocean assessment Kobe plot (base case scenario during the WPTmT06 meeting).

Table 5. Albacore: ASPIC aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2012 to 2014, ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2012–14) and probability (%) of violating MSY reference points								
	60% (21,248)	70% (24,789)	80% (28,330)	90% (31,872)	100% (35,413)	110% (38,954)	120% (42,496)	130% (46,037)	140% (49,578)
$B_{2017} < B_{MSY}$*	27	27	27	27	27	27	27	27	27
$F_{2017} > F_{MSY}$	0	1	4	10	18	24	31	37	42
$B_{2024} < B_{MSY}$	8	10	16	21	27	38	46	53	62
$F_{2024} > F_{MSY}$	0	0	0	6	20	33	49	60	71

* Fixed 2015 and 2016 catches were used, and ASPIC estimates B-ratio at the beginning of the year in order that the probability for all the scenarios becomes the same.

83. The WPTmT **NOTED** that the assumption to fix initial biomass (B1/K) at 0.9 can affect the results and, therefore, the WPTmT **REQUESTED** further analysis to investigate the sensitivity of stock assessment to changes in the initial biomass values. The result of this analysis showed that while the MSY reference points (Bcurrent/Bmsy and Fcurrent/Fmsy) do not change, there are differences in the depletion level (Bcurrent/B0) as changes in the initial biomass are observed.

84. The WPTmT **NOTED** that ASPIC analysis that separate runs were conducted using:
    (i.) a joint CPUE (combining Taiwan,China, Japan and Rep. of Korea) for region 5 (core area) truncated up to 2005 or 2007, to take account of recent changes in targeting by the Japanese fleet;
    (ii.) the Taiwanese standardized CPUE, as used in the previous assessment conducted in 2014.

    The WPTmT **AGREED** to run different scenarios using the joint CPUE for the southwest and southeast areas, truncated to 2005, in order that the results of ASPIC are comparable to the other stock assessment models.

85. Due to the changes in targeting since 2006 by the Japanese longline fleet in the joint CPUE for the southern area, the author was requested to rerun as a sensitivity case three additional models, using:
    i. southwest joint CPUE (1979-2014);
    ii. southeast joint CPUE (1979-2005); and
    iii. a third model using the southwest and southeast joint CPUE (1979-2005).

    The results for each of the three scenarios either did not converge, produced too optimistic results, or were not possible using ASPIC, so were not considered feasible to conduct using the ASPIC software. The model had difficulties incorporating into the standardized CPUE changes in fishing strategy, which appear to affect the Japanese longline fishery since 2006 operating in the southeast. For this reason, the southwest CPUE for 1979-2005 was selected as the base model.

86. The WPTmT **NOTED** that it is desirable to examine any retrospective patterns in the CPUE, as a form of sensitivity analysis. Analysis conducted during the meeting indicated that almost no retrospective patterns were observed when removing data for the last 8 years. The reason this was considered, was that the base case scenario does not use the CPUE indices for the most recent period (i.e., 2006-2014).

87. The WPTmT **NOTED** that the ASPIC model was unable to take into account changes in selectivity over time, which indirectly affects the estimate of MSY.

88. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - That there is a trend in the residuals of CPUE fit which should be considered when projecting the population forward.
    - That the joint CPUE standardisation for southwest and southeast areas truncated to 2005 should be used as the base case, as it takes into account during the standardisation process the recent changes in targeting of the Japanese CPUE.

Statistical-Catch-At-Age (SCAA)

89. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–21 which provided a stock assessment for albacore in the Indian Ocean using Statistical-Catch-At-Age (SCAA), including the following abstract provided by the authors:

    "*The SCAA run with Taiwan standardized LL CPUE (core area) likely produces plausible results, i.e., (a) SB/SBmsy=1.14 and F/Fmsy=0.65. This indicates that albacore stock in the Indian Ocean is in the healthy condition as the spawning stock biomass is 14% higher than its MSY level and F is 35% lower than the MSY level. However, SCAA runs with joint CPUE (Rep. of Korea, Japan and Taiwan) produced implausible results, i.e., the stock status is too optimistic. These discrepancies need to be elucidated and the plausible standardized CPUE need to be used in the stock assessments in the future.*"

90. The WPTmT **NOTED** the key assessment results for the SCAA as shown below (**Table 6; Fig.3**).

Table 6. Albacore: Key management quantities from the SCAA assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2014 catch estimate	40,233
Mean catch from 2010–2014	36,855
MSY (1000 t) (80% CI)	59.0 (n.a.)
Data period used in assessment	1952–2014
F_{MSY} (80% CI)	0.37 (n.a.)

B_{MSY} (1000 t) (80% CI)	106 (n.a.)
F_{2014}/F_{MSY} (80% CI)	0.65 (n.a)
B_{2014}/B_{MSY} (80% CI)	(n.a.)
SB_{2014}/SB_{MSY}	1.14
B_{2014}/B_{1950} (80% CI)	0.26 (n.a.)

n.a. not available

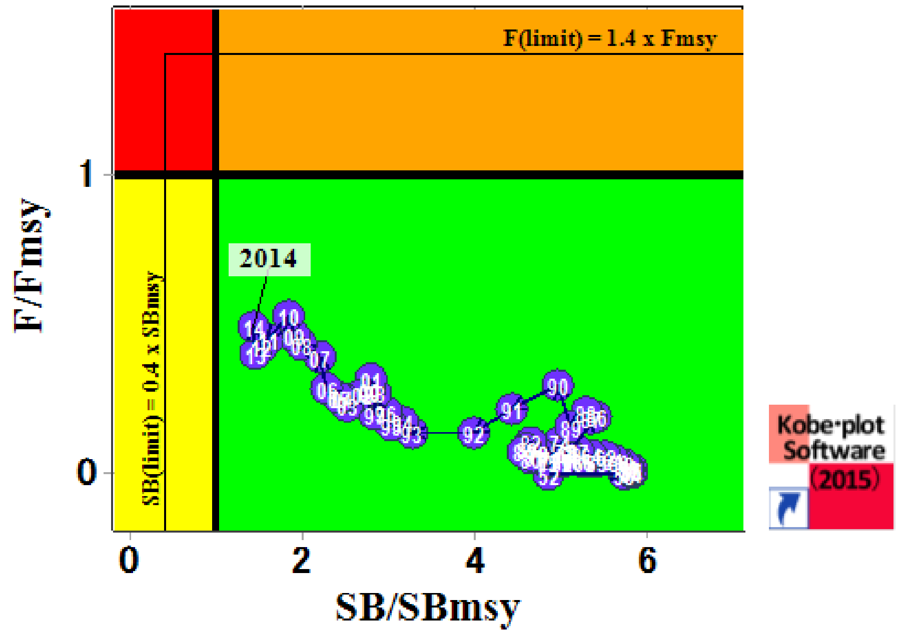


Fig.3. Albacore: SCAA aggregated Indian Ocean assessment Kobe plot (Scenario 3 from IOTC–2016–WPTmT06–21). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1952–2014.

91. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - While the model fit is improved using a lower M, the issue needs further clarification.
    - Taking into account issues with the reliability of size data, particularly the low number of samples from the Japanese longline fleet, and lack of age-length-key for albacore in the Indian Ocean, the general opinion is that the Catch-at-age matrix is quite uncertain and raises some concerns with the capacity of this model platform to assess the status of the albacore tuna stock.
    - Full selectivity is fixed based on the CAA matrix but it would be better to allow the model to estimate the time variant selectivity to check the sensitivity of the model to changes in selectivity.
    - The longline fleet is considered as one fleet but there are spatial/temporal differences between longline activities which are not taking into account. The longliners fishing in the earlier period in the northern area caught larger individuals than recent longliners catching smaller fish in the southern area. This should be further examined separating the LL fleet into two components.

92. The WPTmT **REQUESTED** to run SCAA with different scenarios using the joint Taiwan,China, Japan and Rep. of Korea southwest CPUE and southeast CPUE (truncated to 2005), in order compare the results to the other stock assessment models. The inclusion of the CPUEs did not lead to any improvement in the model, and the results were estimated to be unrealistic.

93. The WPTmT **NOTED** that the authors withdrew the assessment results as SCAA could not obtain a realistic result due to uncertain CAA matrix and CPUE used for tuning the stock assessment.

Bayesian biomass dynamics model (BBDM)

94. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–22 which analysed population dynamics of Indian Ocean albacore (*Thunnus alalunga*) using Bayesian biomass dynamics model (BBDM) including the following abstract provided by the authors:

"*A Fox-form Bayesian biomass dynamics model was developed to assess the stock status of Indian Ocean albacore (Thunnus alalunga) in the Indian Ocean (1950-2014). Because the r and K tends to be negatively correlated due to the poor quality of the observed data, we used the life-history parameters to estimate the prior* *for r and the estimation of the median and the CV of r was 0.30 and 0.42. According to the different standardized CPUEs and the assumption of B_0, there were 12 scenarios were evaluated. Based on an uninformative uniform distribution, the estimation of B_0 seemed questionable. The value fixed for B_0 as 0.90 was not enough large, but its impacts on the estimation were small. For all the scenarios, the goodness of fit for scenario S8 is best. According to the S8, the results showed that the median of Maximum sustainable yield (MSY) was 44,000 t, and the medians of B_{2014}/B_{MSY} and F_{2014}/F_{MSY} were 1.74 and 0.53, respectively. Thus, the stock was neither subject to overfishing nor overfished at the end of 2014.*"

95. The WPTmT **NOTED** the key assessment results for the Bayesian biomass dynamics model (BBDM) as shown below (**Tables 7** & **8**; **Fig.4**).

Table 7. Albacore: Key management quantities from the BBDM assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2014 catch estimate	40,233
Mean catch from 2010–2014	36,855
MSY (1000 t) (80% CI)	44.0 (39.2–53.5)
Data period used in assessment	1950-2014
F_{MSY} (80% CI)	0.34 (0.22-0.51)
B_{MSY} (1000 t) (80% CI)	132.8 (87.5-211.7)
F_{2014}/F_{MSY} (80% CI)	0.53 (0.38,0.66)
B_{2014}/B_{MSY} (80% CI)	1.74 (1.55,1.96)
SB_{2014}/SB_{MSY}	n.a.
B_{2014}/B_{1950} (80% CI)	0.67 (0.60-0.76)
SB_{2014}/SB_{1950}	n.a.
$B_{2014}/B_{1950,\ F=0}$	n.a.
$SB_{2014}/SB_{1950,\ F=0}$	n.a.

n.a. not available

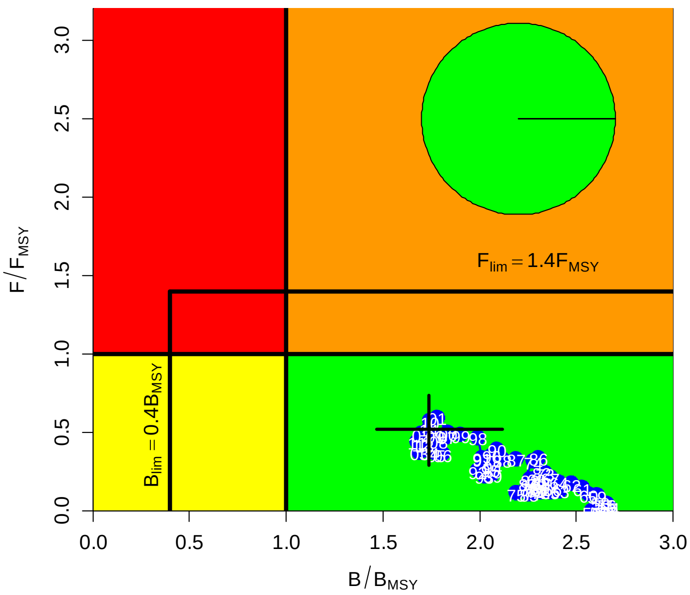


Fig.4. Albacore: BBDM aggregated Indian Ocean assessment Kobe plot (The horizontal black line represents F_{LIM} and the vertical black line represents B_{LIM}). The results are from a preferred model option: Scenario8 (IOTC–2016–WPTmT06–22 Rev1).

Table 8. Albacore: BBDM aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2012–13 ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection	Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY reference points

timeframe									
	60% (24,140)	70% (28,163)	80% (32,186)	90% (36,210)	100% (40,233)	110% (44,256)	120% (48,280)	130% (52,303)	140% (56,326)
$B_{2017} < B_{MSY}$	0.0	0.0	0.0	0.0	0.0	0.0	0.7	3.1	8.8
$F_{2017} > F_{MSY}$	0.0	0.0	0.0	0.0	0.1	1.1	6.6	20.3	38.5
$B_{2024} < B_{MSY}$	0.0	0.0	0.0	0.0	0.5	8.4	30.0	53.8	70.8
$F_{2024} > F_{MSY}$	0.0	0.0	0.0	0.0	1.2	14	40.4	63.8	79.1

96. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - Although observation and process errors were included in the Bayesian model approach, only process errors were shown as their inclusion did not improve the convergence of the model.
    - The authors were suggested to present the Bayesian *p* values for the process errors in order to justify the selection of a Bayesian model approach.
    - That the CPUE series used goes from 1952 to 2014, however, the steep decline of the CPUE in the early period, similar to yellowfin and bigeye CPUE, is not realistic as it occurred when the fishery was fishing in a very localized area and with low fishing effort before the expansion of the fishery. During the early period between 1954 and the mid-1960's, the CPUE is not representative of population abundance, and therefore it would be better to use a CPUE series starting from the mid/late 1960s (e.g., 1968) in the next update of this model.

Bayesian state-space production model (BSPM)

97. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–24 which provided a stock assessment for albacore in the Indian Ocean by an Bayesian State-Space Production Model (BSPM), including the following abstract provided by the authors:

    "A Bayesian state-space production model was developed to assess the stock status of Indian Ocean albacore (Thunnus alalunga) using fishery data from 1950 to 2014. The first scenario (S1) used total catch and two standardized CPUE from the Southwest region 3 (1978-2014) and the Southeast region 4 (1978-2005). The second scenario (S2) used total catch and one CPUE from the Southwest region 3 to model the population dynamics of Indian Ocean albacore. The results from the S1 showed that the mean of Maximum Sustainable yield (MSY; 1000 t), B2014/BMSY, and F2014/FMSY were 4841, 1.49, and 0.51. The results from the S2 indicated that the mean of Maximum Sustainable yield (MSY; 1000 t), B2014/BMSY, and F2014/FMSY were 48.66, 1.47, and 0.50. The estimated parameters from S1 and S2 showed well convergence. A continued exploration of sensitivity analyses, risk assessment, and retrospective analyses may improve the uncertainty of current models."

98. The WPTmT **NOTED** that the *q* parameter is one of the easiest parameter to converge and that, irrespective of the assumption on *q*, changing the prior for *q* will make this parameter to converge.

99. The WPTmT **REQUESTED** to run BSPM with different scenarios using the joint Taiwan,China, Japan and Rep. of Korea southwest CPUE and southeast CPUE (truncated to 2005), in order compare the results to the other stock assessment models. By including those CPUEs the BSPM model also converged, and the final model results were similar to the results provided by other stock assessment model (e.g., SS3).

100. The WPTmT **NOTED** the key assessment results for the Bayesian state biomass model (BSBM) as shown below (**Table 9**; **Fig.5**).

Table 9. Albacore: Key management quantities from the BSPM assessment scenario 1, for the Indian Ocean.

Management Quantity	**Indian Ocean**
2014 catch estimate	40,233
Mean catch from 2010–2014	36,855
MSY (1000 t) (95% CI)	48.4 (20.36–85.98)
Data period used in assessment	1950–2014
F_{MSY} (95% CI)	0.24 (0.06, 0.49)
B_{MSY} (1000 t) (95% CI)	250 (137.2-450.1)
F_{2014}/F_{MSY} (95% CI)	0.51 (0.22–1.85)
B_{2014}/B_{MSY} (95% CI)	1.49 (0.85-2.01)
SB_{2014}/SB_{MSY}	n.a.
B_{2014}/B_{1980} (95% CI)	n.a.
SB_{2014}/SB_{1980}	n.a.
$B_{2014}/B_{1980,\ F=0}$	n.a.
$SB_{2012}/SB_{1980,\ F=0}$	n.a.

n.a. not available

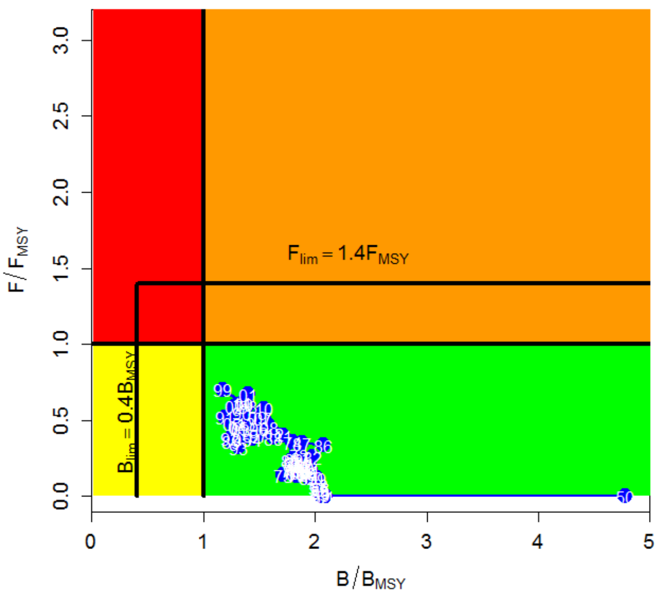


Fig.5. Albacore: BSPM aggregated Indian Ocean assessment Kobe plot. The results are from a preferred model option: Scenario 1 (IOTC–2016–WPTmT06–24).

Stock Synthesis III (SS3)

101. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–25 Rev_1 which provided a stock assessment for albacore in the Indian Ocean by Stock Synthesis III (SS3) model, including the following abstract provided by the authors:

“*A stock assessment for albacore tuna in the Indian Ocean was developed using Stock Synthesis version 3. The model represents an update and revision of the SS assessment conducted in 2014. The model included catch data from 1952 to 2014. A wide range of model options were investigated during the model development phase. The final model options were configured with a single model region, although fisheries were defined by dividing the Indian Ocean into quadrants. The main longline fisheries operate in the two southern areas and the CPUE indices derived for these fisheries (from combined fleet logsheet data) provided were incorporated as the primary abundance indices in the assessment model. These longline fisheries were assumed to have a double normal selectivity, while the two northern longline fisheries were assumed to full select the large size classes. Longline length composition data sets were configured to* *represent the sampling data from the main area of each longline fishery. The other main fisheries included in the model were the historical drift-net fishery and the purse seine fishery in the north-western quadrant.*

The recent increasing trend in the CPUE indices from the south-eastern quadrant was moderated by the estimation of catchability deviates for the recent years (2006-2014). This gave a greater emphasis to the recent trend in the CPUE indices from the south-western quadrant. Additional model sensitivities were also conducted that excluded each of the two sets of CPUE indices. Limited biological information is available from the Indian Ocean albacore stock and most of the key biological parameters are adopted from the albacore stocks in other oceans. The appropriateness of these parameters to the Indian Ocean stock is unknown, introducing considerable uncertainty into the assessment results. A range of model sensitivity analyses were undertaken to investigate the assumptions regarding key productivity parameters (natural mortality and SRR steepness), although alternative growth assumptions were not evaluated.

Overall, the range of assessment models indicated that there is considerable uncertainty in the estimates of stock status related to the treatment of the CPUE indices and the assumed productivity parameters. Nonetheless, the point estimates from the range of plausible model options indicate that the stock is not over fished (SB_{2014}/SB_{MSY} 1.35–2.40) and most model options indicate overfishing is not occurring (F_{2014}/F_{MSY} 0.66–0.99), with the exception of the lower M options for which fishing mortality is estimated to be slightly higher than the F_{MSY} level (F_{2014}/F_{MSY} 1.07 and 1.09). The MSY based reference points correspond to a low level of stock biomass relative to unexploited conditions (SB_{MSY} approximately 20% SB_0). The recent level of catch (2010–2014 average of 36,200 t) approximates the range of estimates of MSY for the stock (MSY 33,000–41,000 t).

A single model option was adopted as the base case model. This model was used to provide the summary estimates of stock status and used in model projections to determine the probability of breaching the interim reference points for the albacore stock."

102. The WPTmT **NOTED** the key assessment results for the Stock Synthesis III model (SS3) as shown below (**Tables 10** & **11**; **Fig. 6**).

Table 10. Albacore: Key management quantities from the SS3 assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2014 catch estimate	40,233 t
Mean catch from 2010–2014	36,855 t
MSY (1000 t) (80% CI)	38.8 (34.0–43.6)
Data period used in assessment	1950–2014
F_{MSY} (80% CI)	n.a
SB_{MSY} (1000 t) (80% CI)	30.0* (26.1–34.0)
F_{2014}/F_{MSY} (80% CI)	0.85 (0.57–1.12)
B_{2014}/B_{MSY} (80% CI)	n.a.
SB_{2014}/SB_{MSY} (80% CI)	1.80 (1.38–2.23)
B_{2014}/B_{1950} (80% CI)	n.a.
SB_{2014}/SB_{1950} (80% CI)	0.37 (0.28–0.46)
$B_{2014}/B_{1950, F=0}$	n.a.
$SB_{2014}/SB_{1950, F=0}$	n.a.

n.a. not available
* For SS3 SB is defined as mature female biomass.

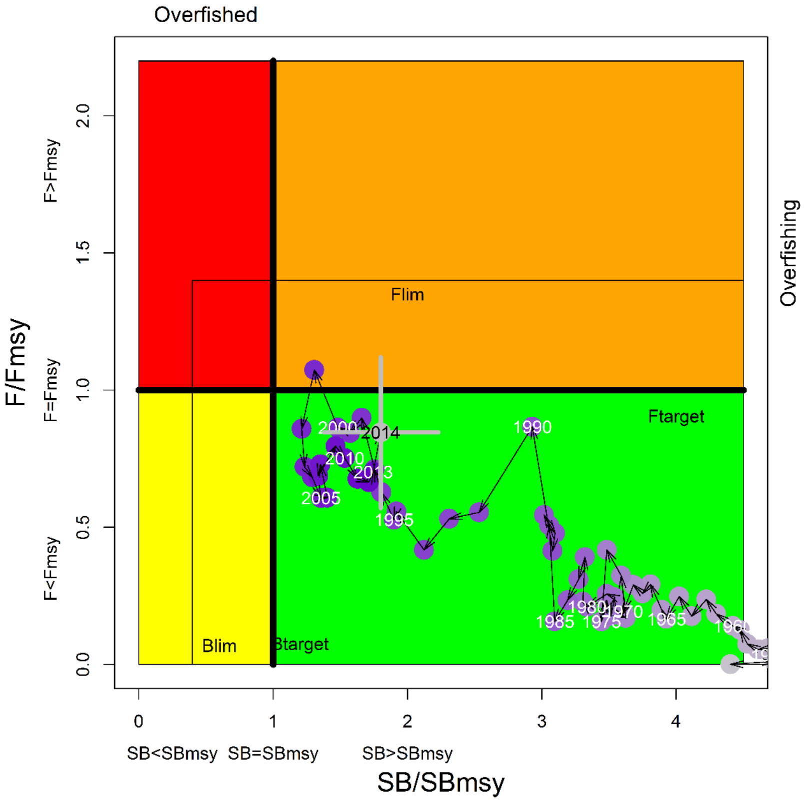


Fig. 6. Albacore: SS3 Aggregated Indian Ocean assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2014 (the grey lines represent the 80 percentiles of the 2014 estimate). Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

Table 11. Albacore: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for constant catch projections (2014 catch level, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the catch level for 2014) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (23,821)	70% (27,791)	80% (31,761)	90% (35,731)	100% (39,701)	110% (43,671)	120% (47,641)	130% (51,611)	140% (55,581)
$SB_{2017} < SB_{MSY}$	1	2	4	7	14	19	24	33	44
$F_{2017} > F_{MSY}$	0	1	5	18	33	47	59	71	77
$SB_{2024} < SB_{MSY}$	4	8	9	31	42	50	62	NA	92
$F_{2024} > F_{MSY}$	0	0	3	NA	39	56	66	70	100
Reference point and projection timeframe	**Alternative catch projections (relative to the catch level for 2014) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (23,821)	70% (27,791)	80% (31,761)	90% (35,731)	100% (39,701)	110% (43,671)	120% (47,641)	130% (51,611)	140% (55,581)
$SB_{2017} < SB_{Lim}$	0	0	0	0	0	0	1	1	4
$F_{2017} > F_{Lim}$	0	0	0	0	2	10	20	34	46
$SB_{2024} < SB_{Lim}$	0	0	1	13	20	24	30	NA	65
$F_{2024} > F_{Lim}$	0	0	0	NA	10	27	48	60	100

103. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:

- The time variant *q* for southeast CPUE since 2006 down-weights the influence of this CPUE series from 2006 onwards, where the issues with changing targeting of the Japanese, and to a minor extent the Rep. of Korea fleets were observed. Using the joint CPUE for the southeast area before 2006 instead of using only the Taiwanese CPUEs makes sense because the use of Japanese and Korean data allows filling some strata with no information.

- The growth was fixed externally because there is no size information, especially for the smallest age classes, to allow the model to estimate the growth curve from the data. This was done in the past to avoid producing unrealistic results.
- A single value of F_{1990}/F_{MSY} larger than 1, which shows that overfishing was occurring in that year, in the Kobe plot trajectory was due to a large increase of driftnet catch during that year. However, it is also because the estimation of the Kobe plot trajectory has been produced using a time-invariant MSY. When the Kobe plot is redone using time-variant MSY levels the observed peak remains but at lower level ($F_{1990}/F_{MSY} < 1$), and MSY was estimated to be much lower during the period of driftnet fishing.
- The selectivity of the driftnet gillnet fishery is fixed using data from the Pacific. However, there is data available from the Taiwanese gillnet fishery from the Indian Ocean that can be used in the current SS3 modelling approach. The authors ran, as a sensitivity case, the base model including size data from the Taiwanese gillnet fishery. The results of this model sensitivity analysis were very similar to the base case.
- Due to the problems of changing targeting since 2006 of the Japanese longline fleet in the joint CPUE for the southern area, the authors were requested to rerun as a sensitivity case two additional models: (i) one using only the joint southwest CPUE and (ii) another using the joint southwest CPUE plus the joint southeast CPUE truncated to 2005. The results of these sensitivity analysis yielded very similar results as the base case.
- Sensitivity analysis accounting for natural mortality (base, low, hybrid), steepness (0.7, 0.8 and 0.9) and effort creep (1% or none) are also used to investigate the robustness of this modelling approach. The sensitivity analysis gave similar results to the base case. The range of plausible model options indicate that the stock is not over fished (SB_{2014}/SB_{MSY} 1.35–2.40) and most model options indicate overfishing is not occurring (F_{2014}/F_{MSY} 0.66–0.99), with the exception of the lower M options for which fishing mortality is estimated to be slightly higher than the F_{MSY} level (F_{2014}/F_{MSY} 1.07 and 1.09).

6.3 Selection of Stock Status indicators

104. The WPTmT **NOTED** the following with respect to the various modelling approaches used in 2016:
   - There was more confidence in the abundance indices this year due to the joint CPUE analyses using operational data from Taiwan,China, Japan and Rep. of Korea. This in turn led to improved confidence in the range of stock assessment models overall.
   - The joint CPUE in the southwest area and southeast area, truncated to 2005, are most likely to represent the abundance of albacore tuna at this time, as the cluster analysis used to identify targeting allows the identification of fleet that have always targeted albacore in the southern area.
   - Conversely, the Japanese CPUE seems to demonstrate very strong targeting shifts away from albacore (i.e., during the 1960s) and back towards albacore in recent years since 2006 (e.g., as a consequence of piracy in the western Indian Ocean, reduced or increased TAC for southern bluefin tuna, and increases in the commercial value for albacore). Similar trends are seen in the Rep. of Korea CPUE series. However, cluster analysis using operational data to identify targeting in the standardization process has to some extents accounted for this problem.
   - It was agreed that all the stock assessment modelling approaches use the joint standardized CPUE for southwest area as well as southeast area truncated to 2005.

105. The WPTmT **NOTED** the value of comparing different modelling approaches. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a number of uncertainties in the basic albacore biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, the ASPIC model can sometimes have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

106. The WPTmT **NOTED** a thorough and in-depth analysis of SS3 was presented with a complete set of diagnostics, in comparison to other stock assessments for which some key diagnostics were not provided. Therefore, the WPTmT **AGREED** that albacore stock status should be determined by the results of the SS3 stock assessments undertaken in 2016 and that the results of the other models should be presented for informative purpose supporting the results of the SS3.

Parameters for future analyses: CPUE standardization and stock assessments

107. The WPTmT **AGREED** that in order to obtain comparable CPUE standardisations, the analyses shall be conducted with similar parameters and resolutions. Table 12 provide a set of parameters, discussed during the WPTmT06, that shall give guidelines, if available, for the standardisation of the CPUE in preparation for the next WPTmT meeting to be used as indices of abundance for the stock assessments.

CPUE standardisation parameters	Value for next CPUE standardisation
Area	*To be defined.* Explore core area(s)
CE Resolution	Operational data
GLM Factors	Year, Quarter, Area, vessel + interactions, 5x5 block effect, cluster, cluster/year, cluster/fleet
Fleets	*Combine data for all fleets with the above effects + fleet* *Taiwan,China CPUE using fine-scale data*

Table 12. A set of parameters for the standardisation of CPUE series in preparation for the next WPTmT meeting.

108. The WPTmT **AGREED** that a joint CPUE standardisation analysis should be continued in the future by combining the data available for the main longline fleets in one analysis. In addition, Taiwan,China CPUE should be analysed for comparison. Specifically the WPTmT **AGREED** that the following issues are considered in the joint analysis of CPUE standardization:

- Clustering approaches and other ways to define targeting should be further explored. Also the effect of these analyses in defining a subset of operational data (sets/hauls) and its effects on the standardization be tested.
- Time-area interactions within regions requires further examination.
- A subset of vessels to examine Vessel-Year interactions over time would be important to understand vessel-dynamics, and their reasons for their change in efficiency over time.

109. The WPTmT **AGREED** that the model parameters contained in **Table 13** should be used for applicable stock assessments for the next WPTmT meeting, with appropriate sensitivity runs, unless modifications to the parameters are agreed to by the WPTmT participants following intersessional work to be undertaken under the guidance of the Chair and Vice-Chair.

Table 13. Model parameters agreed by the WPTmT for use in base case stock assessment runs for the next WPTmT meeting.

Biological parameters	**Value for assessments**
Stock structure	Single
Sex ratio at birth	1:1
Age (longevity)	15+ years (may need to re-examine this assumption for age-based assessments)
Natural mortality	M=0.3 (/year) constant over ages (based on North Pacific). Sensitivities for M to be considered, for example: M=0.2207 (/year) constant over ages[1] (or M=0.4 for immature and 0.22 for mature fish). Hybrid approach was recommended of M=0.4 for juveniles that declines to M=0.22 for adult (age 5).
Growth formula	$L(t)=124.10\ [1-e^{-0.164\ (t+2.2390)}]$; Wells et al. (2013) (N. Pacific)[2] Chen et al. (2012) Sex based growth curve
Weight-length allometry	$W=aL^b$ $a=1.3718 \times 10^{-5}$, $b=3.0973$ common to sex[3]
Maturity	Age (0-15):0, 0, 0, 0, 0.09, 0.47, 0.75, 0.88, 0.94, 0.97, 0.99, 0.99, 1, 1, 1 Farley et al. (2012) (S. Pacific)
Fecundity	Proportional to the spawning biomass
Stock-recruitment	B&H, h=0.8, sigma_R=0.6 (alternative h=0.7 and 0.9 are also appropriate)
Other parameters	
Fisheries	11 (LL NW, NE, SW, S; DN West and East, PS, Other (4))
Abundance indices	CPUE: Taiwan,China; Japan; Rep. of Korea longline combined indices 1979-2014 A3 Region3 (southwest) and Region4 (southeast)
Selectivity	Fishery specific. Dome-shaped double-normal southern LL

[1] Lee and Liu 1992; [2] Wells et al. 2013 (Chen et al. 2012 was also appropriate and sex specific); [3] Penney 1994

6.4 Albacore management strategy evaluation (MSE) process

110. The WPTmT **NOTED** paper IOTC-2016-WTmT06-26, provided an update on the recent development and current status of the work on Management Strategy Evaluation for Indian Ocean albacore being conducted under the remit of the Working Party on Methods, and included the following abstract by the authors:

“*The operating model currently in place has incorporated the feedback of the WPTmT 2014 and the WPM 2015. Two management procedures have been tested and initial results are being finalized. The second version of the simulation platform allows testing of many alternative procedures. A complete set of MP runs will be presented to WPM and SC.*”

111. The WPTmT **RECALLED** that the MSE process consists of the following components, of which the focus of the WPM is to develop OMs (item 3), and then condition them:
    1. Specification and prioritization of management objectives
    2. Translation of the management objectives to performance measures and risk indicators
    3. Construction of Operating Models (OMs)
    4. Proposition of management procedures (MPs) or harvest control rules (HCRs)
    5. Implementation of simulation trials
    6. Comparison of performance for various procedures
    7. Advice of MPs or HCRs which meet management objectives.

112. The WPTmT **NOTED** that the current OMs used in the albacore MSE are based on the outcomes of previous stock assessment, conducted in 2014 (Hoyle 2014), as well as a broad range of variants to take into account of uncertainties in models, stochasticity and data. The MSE is a system or framework to evaluate management procedures, and therefore the OMs do not necessarily reflect real population dynamics perfectly, but are instead covered by the range of OMs. Nevertheless, the OMs should capture important features of population dynamics, and the best assessment result could represent the base case as a centre of range of OMs.

113. The WPTmT **NOTED** the discussion on the extent to which the current OMs are appropriate in light of the new assessment result. While the albacore SS3 stock assessments conducted in 2016 and 2014 are not considered to be substantially different in terms of overall stock status, the main driver of the differences in the model results

are the standardized CPUE series used in assessments, which may have implications not only for OMs but also for the Management Procedures, and which are partly CPUE-based.

114. The WPTmT **DISCUSSED** if the current OMs are appropriate in light of the new assessment results. Taking into account the limited time available before the next meetings of the WPM, SC and COM, the WPTmT **AGREED** that the decision as to whether the existing set of OMs should be replaced with a new set by re-conditioning based on the new assessment result should be guided intersessionally by the Chair/vice-Chair of the WPM and with the participation of scientists of the WPM and WPTmT who should report back their conclusions to the next WPM and SC

7. Development of technical advice on the status of the albacore tuna stock

115. The WPTmT **ADOPTED** the management advice developed for albacore as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for albacore with the latest 2015 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Albacore (*Thunnus alalunga*) – Appendix VII

8. Research Recommendations and Priorities

8.1 Revision of the WPTmT Program of Work

116. The WPTmT **NOTED** paper IOTC–2016–WPTmT06–08 which requested that the WPTmT further develop and refine its Program of Work for 2017–21 to align with the requests and directives from the Commission and Scientific Committee.

117. The WPTmT **RECALLED** that the SC, at its 16th Session, requested that all Working Parties provide their work plans with items prioritised based on the requests of the Commission or the SC. (SC16. para. 194). Similarly, at the 18th Session of the Commission, the Scientific Committee was requested to provide its Program of Work on a multi-year basis, with project priorities clearly identified. In doing so, the SC should consider the immediate and longer term needs of the Commission.

118. The WPTmT **NOTED** the range of research projects on albacore, currently underway, or in development within the IOTC area of competence, and reminded participants to ensure that the projects described are included in their National Reports to the SC, which are due in early November 2016.

119. The WPTmT **RECALLED** paper IOTC–2014–WPTmT05–INF04 that outlined a project (GERMON) currently being led by IFREMER, in partnership with a range of other institutions in the region. The key elements of which have been incorporated into the WPTmT Program of Work (2015–19) (Appendix VIII).

120. The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2017–21), as provided at Appendix VIII.

Consultants

121. **NOTING** the excellent work done by IOTC consultants in the past and for the WPTmT, the WPTmT **RECALLED** that the Commission has pre-approved a consultant to undertake an albacore stock assessment in 2018, by the inclusion of funds in the 2018 budget (or alternatively 2019, if a three year stock assessment cycle for albacore tuna is approved, according the timetable in Table 15, Option B, below). The budget (2018) is provided in Table 14 for implementation by the IOTC Secretariat.

Table 14. Budget for an IOTC consultant to conduct SS3 stock assessments on albacore tuna in 2018.

Description	Unit price	Units required	Total
Albacore Stock Assessment (fees) 2018	US$550	40	22,000
Albacore tuna Stock Assessment (travel) 2018	US$5,000	1	5,000
Total estimate (US$)			**27,000**

9. Other Business

9.1 Southern Bluefin tuna

122. The WPTmT **NOTED** that a summary report on the biology, stock status and management of southern bluefin tuna would be provided to the IOTC Secretariat following the CCSBT scientific working group which is due to

meet from 5 - 10 September, 2016. The summary would be provided to the IOTC SC meeting in December, 2016.

9.2 Date and place of the 7th and 8th Sessions of the WPTmT

123. The WPTmT participants were unanimous in thanking China for hosting the 6th Session of the WPTmT and **COMMENDED** the Shanghai Ocean University on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

124. Following a discussion on who would host the 7th and 8th Sessions of the WPTmT, the WPTmT **AGREED** that the IOTC Secretariat should liaise with CPCs to determine where it would be feasible to hold the next two meetings, preferably in early September so that data from the previous year, which is due to be submitted to the IOTC Secretariat by the end of June each year, is available for use in stock assessments. The exact dates and meeting locations will be confirmed and communicated by the IOTC Secretariat to the SC for its consideration at its next session to be held in December 2016.
    - WPTmT07: Host to be decided. Meeting to be held between July-September 2018 (TBC).
    - WPTmT08: Host to be decided. Meeting to be held between July-September 2020 (TBC).

125. The WPTmT **RECOMMENDED** that the SC consider rescheduling of future WPTmT meetings (currently held in July) to later in the year, e.g., August-early September, to enable the possibility of the latest years' data to be included in the assessment.

126. The WPTmT **RECOMMENDED** that future stock assessment cycle for albacore tuna should be conducted every three years (rather than two years), in line with the assessment of species covered by other IOTC Working Parties (e.g., WPTT, WPEB), and that the WPTmT should in addition convene during the year preceding the next stock assessment to focus on priority areas for improvement in the albacore assessment, such as the standardization of CPUE, or development of biological parameters (Option B, Table 15).

Table 15. Assessment schedule for the IOTC Working Party on Temperate Tunas (WPTmT), 2017-21.
Option A: current WPTmT tuna stock assessment and meetings schedule

Species	**2017**	**2018**	**2019**	**2020**	**2021**
Albacore	–	WPTmT: Stock assessment	–	WPTmT: Stock assessment	–

Option B: Proposed changes to the WPTmT stock assessment and meetings schedule

Species	**2017**	**2018**	**2019**	**2020**	**2021**
Albacore	–	WPTmT: Data preparatory meeting*	WPTmT: Stock assessment	–	WPTmT: Data preparatory meeting*

* Data preparatory meetings to focus of specific issues identified as a priority to improve the availability and quality of data inputs in the stock assessment, e.g.:

- standardization of CPUE series;
- development of Indian Ocean specific data for biological indicators (including length-weight conversion factors, length-age keys, age-at-maturity, growth curve analysis);
- revision of nominal catch series, and/or country specific issues related to core IOTC datasets.

9.3 Meeting participation fund

127. **NOTING** that the IOTC Meeting Participation Fund (MPF), detailed in the IOTC Rules of Procedure (2014) was used to fund the participation of 4 national scientists (from Indonesia, Malaysia, Mauritius and Thailand) to the WPTmT06 meeting (3 at the WPTmT05), all of which were required to submit and present a working paper relevant to the Program of Work of the WPTmT, the WPTmT **REQUESTED** that this fund be maintained into the future and that Mauritius attend the next meeting, funded via the MPF.

9.4 Development of priorities for an Invited Expert at the next WPTmT meeting

128. The WPTmT **NOTED** with thanks the outstanding contributions of Dr. Simon Hoyle, IOTC consultant, who presented the results of the CPUE standardization (funded by ISSF and the IOTC Secretariat), and Mr. Adam Langley, IOTC Consultant, who conducted the SS3 assessment (also co-authored by Dr. Hoyle).

129. The WPTmT **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPTmT, should an Invited Expert be necessary:
    - Expertise: experience with CPUE analysis and standardisation for albacore.
    - Priority areas for contribution: CPUE standardization, and biological indicators.

9.5 Election of a Chairperson and Vice-Chairperson of the WPTmT for the Next Biennium

130. The WPTmT **CONSIDERED** candidates for the position of Chairperson and Vice-Chairperson of the WPTmT for the next *biennium*. Dr. Jiangfeng Zhu was nominated and elected as Chairperson of the WPTmT for the next *biennium*, while Dr Toshihide Kitakado was elected as Vice-Chairperson of the WPTmT.

9.6 Review of the draft, and adoption of the Report of the 6th Session of the WPTmT

131. The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT06, provided at Appendix IX, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix VII).

132. The report of the 6th Session of the Working Party on Temperate Tunas (*IOTC–2016–WPTmT06–R*) was **ADOPTED** on the 21 July 2016.

APPENDIX I
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APPENDIX II
AGENDA FOR THE 6TH WORKING PARTY ON TEMPERATE TUNAS

Date: 18–21 July 2016
Venue: Paradise Hotel
Location: Shanghai, China
Time: 09:00 – 17:00 daily
Chair: Dr. Zang Geun Kim (Rep. of Korea); **Vice-Chair**: Dr. Takayuki Matsumoto (Japan)

1. **OPENING OF THE MEETING** (Chair)

2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chair)

3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS** (Chair)
   3.1 Outcomes of the 18th Session of the Scientific Committee (IOTC Secretariat)
   3.2 Outcomes of the 20th Session of the Commission (IOTC Secretariat)
   3.3 Review of Conservation and Management Measures relevant to temperate tunas (IOTC Secretariat)
   3.4 Progress on the recommendations of WPTmT05 (IOTC Secretariat)

4. **REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR TEMPERATE TUNA SPECIES** (IOTC Secretariat)

5. **NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENAL DATA RELATING TO TEMPERATE TUNAS** (Chair)
   Review new information on the biology, stock structure, their fisheries and associated environmental data
   - Catch and effort
   - Catch at size
   - Growth curves and age–length key
   - Catch at age

6. **REVIEW OF NEW INFORMATION ON THE STATUS OF ALBACORE TUNA**
   6.1 Nominal and standardised CPUE indices
   6.2 Stock assessments
   6.3 Selection of Stock Status indicators
   6.4 Albacore management strategy evaluation process

7. **DEVELOPMENT OF TECHNICAL ADVICE ON THE STATUS OF THE ALBACORE TUNA STOCK**
   7.1 Indian Ocean albacore management advice (Chair)
   7.2 Update of species Executive Summary for the consideration of the Scientific Committee (Chair)

8. **RESEARCH RECOMMENDATIONS AND PRIORITIES**
   8.1 Revision of the WPTmT Program of Work (Chair)
   8.2 Development of priorities for an Invited Expert at the next WPTmT meeting (Chair)

9. **OTHER BUSINESS**
   9.1 Date and place of the 7th Session of the WPTmT (Chair and IOTC Secretariat)
   9.2 Election of a Chairperson and Vice-Chairperson of the WPTmT for the next biennium (Chair/Vice-Chair)
   9.3 Review of the draft, and adoption of the Report of the 6th Session of the WPTmT (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2016–WPTmT06–01a	Draft Agenda of the 6th Working Party on Temperate Tunas	✓(1 June 2015)
IOTC–2016–WPTmT06–01b	Draft Annotated agenda of the 6th Working Party on Temperate Tunas	✓(1 July 2016)
IOTC–2016–WPTmT06–02	Draft List of documents	✓(1 July 2016)
IOTC–2016–WPTmT06–03	Outcomes of the 18th Session of the Scientific Committee (IOTC Secretariat)	✓(1 July 2016)
IOTC–2016–WPTmT06–04	Outcomes of the 20th Session of the Commission (IOTC Secretariat)	✓(1 July 2016)
IOTC–2016–WPTmT06–05	Review of Conservation and Management Measures relevant to temperate tuna (IOTC Secretariat)	✓(1 July 2016)
IOTC–2016–WPTmT06–06	Progress made on the recommendations of WPTmT05 (IOTC Secretariat)	✓(1 July 2016)
IOTC–2016–WPTmT06–07	Review of the statistical data and fishery trends for albacore (IOTC Secretariat)	✓(10 July 2016)
IOTC–2016–WPTmT06–08	Revision of the WPTmT Program of Work (2017–2021) (IOTC Secretariat)	✓(1 July 2016)
IOTC–2016–WPTmT06–09	Indian Ocean albacore stock: review of its fishery, biological data and results of its 2014 stock assessment (A. Fonteneau)	✓ (1 June 2015)
IOTC–2016–WPTmT06–10	Albacore tuna unloaded at Phuket Fishing Port, Thailand (S. Panjarat, S. Rodpradit & W. Singtongyam)	✓ (4 July 2016)
IOTC–2016–WPTmT06–11	An overview of longline fisheries targeting albacore tuna in Mauritius (L. Mootoosamy, et al.)	✓ (4 July 2016)
IOTC–2016–WPTmT06–12	The potential fishing ground and spatial distribution pattern of albacore (*Thunnus alalunga*) in Eastern Indian Ocean (F. Rochman, et al.)	✓ (4 July 2016)
IOTC–2016–WPTmT06–13	Status of albacore fishing by Malaysian Tuna Longliners (S. Basir, S. Jamon & E.M. Faizal)	✓ (4 July 2016)
IOTC–2016–WPTmT06–14	Review of Japanese longline fishery and its albacore catch in the Indian Ocean (T. Matsumoto)	✓ (4 July 2016)
IOTC–2016–WPTmT06–15	Standardization of albacore CPUE by Japanese longline fishery in the Indian Ocean (T. Matsumoto, T. Kitakado & T. Nishida)	✓ (4 July 2016)
IOTC–2016–WPTmT06–16	Temporal and spatial patterns of Taiwanese, Japanese and Korean Nominal Albacore CPUE distributions in the Indian Ocean (Y. Chang, T. Matsumoto & S.I. Lee)	✓ (4 July 2016)
IOTC–2016–WPTmT06–17	Standardized CPUE of Indian Albacore caught by Taiwanese longliners from 1980 to 2014 with simultaneous nominal CPUE portion from observer data (Y. Chang, L.K. Lee and S.Y. Yeh)	✓ (4 July 2016)
IOTC–2016–WPTmT06–18	Impact of selection of abundance indices on estimates of biological reference points for Indian Ocean Albacore (*Thunnus alalunga*) (L. Ma, J. Zhu)	✓ (18 July 2016)
IOTC–2016–WPTmT06–19	Collaborative study of albacore tuna CPUE from multiple Indian Ocean longline fleets (S. Hoyle, et al.)	
IOTC–2016–WPTmT06–20	Stock and risk assessments of albacore in the Indian Ocean based on ASPIC (T. Matsumoto)	✓ (11 July 2016)
IOTC–2016–WPTmT06–21	Stock assessment of albacore (*Thunnus alalunga*) in the Indian Ocean using Statistical-Catch-At-Age (SCAA) (T. Nishida, T. Matsumoto & T. Kitakado)	✓ (16 July 2016)
IOTC–2016–WPTmT06–22 Rev1	Using Bayesian biomass dynamic model to assess Indian Ocean Albacore (*Thunnus alalunga*) (W. Guan)	✓ (4 July 2016) & (26 July 2016)
IOTC–2016–WPTmT06–23	Evaluating MSY-based harvest strategy for Indian Ocean Albacore (*Thunnus alalunga*) (J. Zhu, Y. Zhang)	Withdrawn
IOTC–2016–WPTmT06–24 Rev1	Assessing population dynamics of Indian Ocean albacore using Bayesian state-space production model (B. Li et al.)	✓ (16 July 2016) & (24 July 2016)
IOTC–2016–WPTmT06–25	Stock assessment of albacore tuna in the Indian Ocean using Stock Synthesis (A. Langley & S. Hoyle)	✓(16 June 2016)
IOTC–2016–WPTmT06–26	Status of development of the Management Strategy Evaluation work for Indian Ocean albacore tuna (I. Mosqueira)	✓ (4 July 2016)
IOTC–2016–WPTmT06–27	Reproductive biology of albacore tuna (Thunnus alalunga) in the Western Indian Ocean (Z. Dhurmeea)	✓ (4 July 2016)

Document	Title	Availability
IOTC–2016–WPTmT06–28_Rev1	Morphometrics of albacore tuna (Thunnus alalunga) in the Western Indian Ocean (Z. Dhurmeea)	✓ (4 July 2016) & (15 July 2016)
IOTC–2016–WPTmT06–29	Review of catch and effort for albacore tuna by Korean tuna longline fishery in the Indian Ocean (1965-2015)	✓ (11 July 2016)
Information papers		
IOTC–2016–WPTmT06–INF01		✓(14 June 2016)

APPENDIX IV

Progress made on the recommendations of WPTmT05

Extracts from IOTC–2016–WPTmT06–06

WPTmT05 Rec. No.	Recommendation from WPTmT05	SC17 Rec. No.	Recommendation adopted by the SC17 (2014)	Progress / Comments
WPTmT05.01	***Review of the data available at the Secretariat for Temperate Tuna Species*** (para. 28) NOTING that in recent years many foreign vessels have been unloading catches of albacore in Mauritius, representing around 60% of the total albacore catch, the WPTmT **RECOMMENDED** that the Chair of the WPTmT contact Mauritius and indicate that they should be in attendance at all WPTmT meetings, given the high proportion of total albacore catch being landed in Mauritius, and that they should present information on its efforts to monitor albacore landings for catch and size (length) data, and to provide summaries of that data.	SC17 (Para. 32)	The **NOTED** that in recent years many foreign vessels have been unloading catches of albacore in Mauritius, representing around 60% of the total albacore catch, the SC **REQUESTED** that the Chair of the WPTmT and the Chair of the SC contact Mauritius and indicate that they should be in attendance at all WPTmT meetings, given the high proportion of total albacore catch being landed in Mauritius, and that they should present information on its efforts to monitor albacore landings for catch and size (length) data, and to provide summaries of that data.	Nil.
WPTmT05.02	(para. 29) The WPTmT **RECOGNISED** the value of the biological information for albacore being collected in Mauritius by port samplers and **RECOMMENDED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. This should occur as soon as possible, but at the latest in 2015.	SC17 (Para. 33)	The SC **RECOGNISED** the value of the biological information for albacore being collected in Mauritius by port samplers and **REQUESTED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. This should occur as soon as possible in 2015.	*Progress: The IOTC Secretariat is proposing a mission to Mauritius in August 2016 (TBC) to assess the status of current length frequency and biological data collected, and provide additional technical assistance in terms of the collection and reporting of data, as required.*
WPTmT05.03	***Albacore management strategy evaluation (MSE) process*** (para. 113) The WPTmT **RECALLED** para. 3 of Resolution 13/10 which states:	SC17 (Paras. 100-106)	• The SC **NOTED** that a lot of progress was made towards management strategy evaluation (MSE) for the Indian Ocean albacore fishery. This work was primarily led by the WPM Chair and the informal MSE working group. An operating model (OM) was	*Progress: An update on the Albacore MSE process will be presented during WPTmT06 meeting (see paper IOTC-2016-*

	"The IOTC Scientific Committee shall assess, as soon as possible and more particularly through the management strategy evaluation process (MSE) process, the robustness and the performance of the interim reference points, specified under paragraph 1 and other reference points based on the guidelines of International agreements taking into account: i) the nature of these reference points – target or limits, ii) the best scientific knowledge on population dynamics and on life-history parameters, iii) the fisheries exploiting them, and iv) the various sources uncertainty." and **RECOMMENDED** that the current MSE work being undertaken on albacore, be expanded to include the assessment of not only the interim target and limit reference points contained in Table 1 of Resolution 13/10, but also other target and limit reference points.		presented with some hypothetical Management Procedures (MP) to suggest alternative control rules could be evaluated using the approach developed by WPM for the Commission. Further refinements of the OM and MP's need to be conducted before final models would be evaluated by the Commission in 2016. • The SC **NOTED** that Resolution 13/10 *On interim target and limit reference points and a decision framework*, requires that the SC assess and further review the interim reference points and advise the Commission of its findings. • The SC **NOTED** the difficulties with accurately estimating the MSY-based interim reference points within Resolution 13/10 in cases where there is uncertainty in our knowledge of stock dynamics. • The SC **RECOMMENDED** the Commission consider an alternative approach to identify biomass limit reference points, such as those based on biomass depletion levels, when the MSY-based reference points are difficult to estimate. In cases where MSY-based reference points can be robustly estimated, limit reference points may be based around MSY. • The SC **RECOMMENDED** that in cases where MSY-based reference points cannot be robustly estimated, biomass limit reference points be set at 20% of unfished levels ($B_{LIM} = 0.2B_0$) • **NOTING** that the interim target reference points contained in Resolution 13/10 are also MSY-based and subject to the same difficulties with robust estimation, the SC **RECOMMENDED** that the Commission consider that stock biomass depletion levels equivalent to B_{MSY} are expected to lie in the range of 30% to 40% of unfished levels ($0.3B_0$ to $0.4B_0$), when MSY-based levels cannot be accurately estimated. The Commission may wish to	*WPTmT06-26).*

			consider a value of $0.4B_0$ or higher, if a precautionary buffer against reaching a biomass limit is desirable. • **NOTING** that the approach described in para. 105 is similar to what is currently taking place in other RFMOs such as WCPFC, the SC **RECOMMENDED** that the use of this type of reference point is adopted by the Commission. In considering target reference points, guidance will be required from the Commission on tolerable risks of exceeding limit reference points.	
WPTmT05.04	***Revision of the WPTmT Program of Work*** (para. 119) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2015–19), as provided at Appendix VII.	Nil	Nil	*Progress: Considered by the SC. High priority activities Incorporated into the SC work plan.*
WPTmT05.05	***Review of the draft, and adoption of the Report of the 5th Session of the WPTmT*** (para. 127) The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT05, provided at Appendix VIII, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix VI).	Nil	Nil	*Progress: Considered by SC.*

APPENDIX V
SUMMARY OF DATA AVAILABLE AT THE IOTC SECRETARIAT

Extracts from IOTC–2016–WPTmT06–07

Albacore Fisheries and main catch trends

- Main fisheries: albacore tuna are currently caught almost exclusively using drifting longlines (accounting for over 90% of the total catches) (**Table 1; Fig.3**), with remaining catches recorded using purse seines and other gears. Catches from the longline fisheries are split between deep-freezing longliners, and fresh-tuna longliners:

  Deep-freezing longline fishery:

  - Deep-freezing longliners from Japan and Taiwan,China have been operating in the Indian Ocean since the early 1950s (Fig.3). Although the Japanese albacore catch ranged from 8,000 t to 18,000 t in the period 1959 to 1969, in 1972, catches rapidly decreased to around 1,000 t due to a change in the target species, mainly to southern bluefin tuna and bigeye tuna. Albacore became a bycatch species for the Japanese fleet with catches between 200 t and 2,500 t. In recent years the Japanese albacore catch has been around 2,000 to 4,000 t.
  - Catches by Taiwan,China deep-freezing longliners increased steadily from the 1950's to average around 10,000 t by the mid-1970s. Between 1998 and 2002 catches ranged between 20,000 t to 26,000 t, equating to just over 55% of the total Indian Ocean albacore catch. Since 2006 albacore catches by Taiwan,China deep freezing longliners have been between 1,500 and 5,000 t, with the lowest catches recorded in 2012.

  Fresh-tuna longline fishery:

  - Unlike deep-freezing longliners, the catch levels of albacore for the fresh-tuna longline fishery of Taiwan,China have increased in recent years, leading to a shift in the proportion of catches of albacore by deep-freezing and fresh-tuna longliners. Catches by fresh-tuna longliners currently account for between 80% - 90% of catches by Taiwanese longliners.
  - Catches of albacore reported for the fresh tuna longline fishery of Indonesia have also increased considerably since 2003, ranging over 9,000 t in recent years.

- Main fleets (i.e., highest catches in recent years):

  In recent years nearly three-quarters of the total catches of albacore in the Indian Ocean are accounted for by Taiwan,China and Indonesia, followed by Japan – with the majority of catches reported by fresh-tuna longline, and deep-freezing fisheries by each fleet. (**Fig.2**).

- Main fishing grounds:

  While most of the catches of albacore have traditionally come from the southwest Indian Ocean (i.e., South of 20°S), in recent years a larger proportion of the catch has come from the southern and eastern Indian Ocean (**Table 2; Figs.4, 6 & 7**). The relative increase in catches in the eastern Indian Ocean since the early 2000's is mostly due to increased activity of fresh-tuna longliners from Taiwan,China and Indonesia.

  In the western Indian Ocean, the catches of albacore mostly result from the activities of deep-freezing longliners and purse seiners. One consequence of Somali maritime piracy in the western tropical Indian Ocean in recent years has been the movement of part of the deep-freezing longline fleets from this area, for which the target species were tropical tunas or swordfish, to operate in southern waters of the Indian Ocean which has led to an increased contribution of albacore to the total catches of some longline fleets.

  Offshore gillnet vessels from I.R. Iran and Pakistan, as well as gillnet-longline vessels from Sri Lanka have extended their area of operation in recent years, and are now thought to operate on the high seas closer to the equator. However the lack of catch-and-effort data from these fleets makes it impossible to assess whether they are operating in areas where catches of juvenile albacore are likely to occur.

- Retained catch trends:

  Between the early 1960s until the mid-1980s, catches of albacore remained relatively stable at around 15,000 – 20,000 t, except for high catches recorded in 1973 and 1974 (**Table 1, Fig.3**). From the mid-1980s catches increased markedly due to the use of drifting gillnets by Taiwan,China, with total catches over 30,000 t, mostly targeting juvenile albacore in the southern Indian Ocean (30°S to 40°S). In 1992 the United Nations worldwide ban on the use of drifting gillnets effectively closed this gillnet fishery. Following the removal of the Taiwanese drifting gillnet fleet, catches dropped to less than 21,000 t by 1993 (**Fig.5**).

From 1993 catches increased to 46,000 t (in 2001) – the year in which the highest catches of albacore were reported – mostly as a result of increased fishing effort by the Taiwanese deep-freezing longline fleet. Since 2001, catches have been almost exclusively taken by deep-freezing longlines and fresh-tuna longlines.

- Discard levels**:** are thought to be very low, although estimates of discards are unknown for most fisheries.

TABLE 1. Albacore: Best scientific estimates of the catches of albacore by gear and main fleets (or type of fishery) by decade (1950s–2000s) and year (2005–2014), in tonnes. Catches by decade represent the average annual catch. Data as of June 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
DN				5,823	3,735		0	0	0	0	0	0	0	0	0	0
LL	3,715	17,230	16,971	15,828	23,039	21,370	16,983	14,776	12,451	13,043	13,971	20,211	12,318	9,855	9,474	15,499
FLL			80	314	1,325	11,718	10,971	12,250	23,736	19,332	21,662	21,380	18,361	20,547	21,528	23,098
PS				194	1,683	912	164	1,548	725	1,424	392	207	725	1,297	501	530
OT	20	33	94	406	764	1,436	1,059	1,218	1,649	2,091	2,181	2,338	2,498	1,653	1,152	1,106
Total	**3,736**	**17,347**	**17,310**	**22,418**	**30,472**	**35,344**	**29,177**	**29,792**	**38,561**	**35,890**	**38,205**	**44,135**	**33,902**	**33,352**	**32,655**	**40,233**

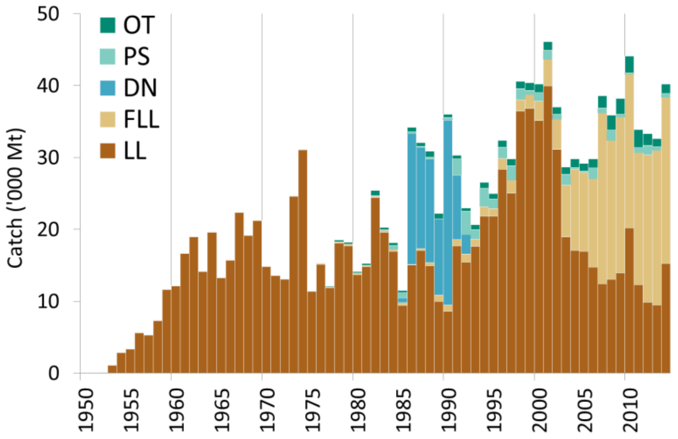
Fisheries: Driftnet (**DN**; Taiwan,China); Freezing-longline (**LL**); Fresh-tuna longline (**FLL**); Purse seine (**PS**); Other gears nei (**OT**).

TABLE 2[3]. Albacore: Best scientific estimates of the catches of albacore by (stock assessment) fishing area by decade (1950s–2000s) and year (2005–2014), in tonnes. Data as of June 2016.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1-NORTHWEST	1,421	8,855	6,000	4,486	7,482	10,293	7,407	7,459	7,204	5,187	8,284	11,591	8,959	7,693	9,644	8,251
2-NORTHEAST	2,239	3,830	3,738	2,942	4,319	8,157	6,785	8,157	18,002	14,954	6,279	9,213	4,986	4,110	2,673	2,428
3-SOUTHWEST	73	4,201	5,863	6,277	10,969	8,456	3,966	6,262	7,124	6,963	10,770	8,138	8,995	8,955	12,316	15,154
4-SOUTHEAST	1	457	1,689	8,444	7,423	7,939	10,636	7,451	5,664	8,067	12,090	14,417	10,084	11,953	7,563	13,874
Total	**3,734**	**17,343**	**17,290**	**22,149**	**30,193**	**34,845**	**28,794**	**29,329**	**37,994**	**35,171**	**37,423**	**43,359**	**33,024**	**32,711**	**32,196**	**39,707**

Areas: 1-NORTHWEST (North of 25S, West of 75 E); 2-NORTHEAST (North of 25S, East of 75 E); 3-SOUTHWEST (South of 25S, West of 75 E); 4-SOUTHEAST (South of 25S, East of 75 E)

[3] Catches exclude a small number of (artisanal) fisheries that were not included due to the paucity of information available in the IOTC database.



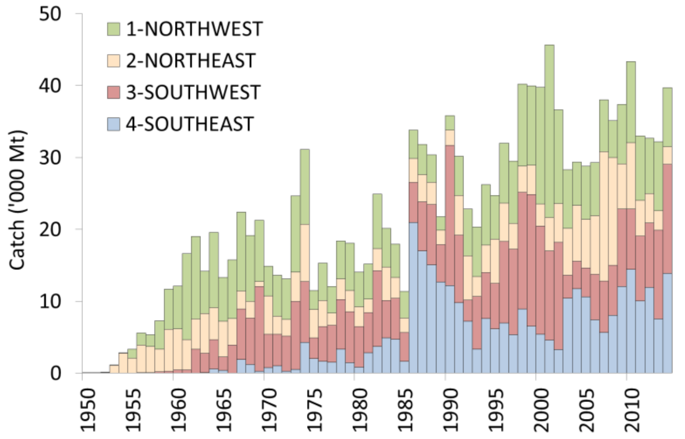


Fig.3. Albacore: catches by gear. Driftnet (DN; Taiwan,China); Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears NEI (OT). Data as of June 2016.

Fig.4. Albacore: catches recorded in assessment areas 1-4. Data as of June 2016.

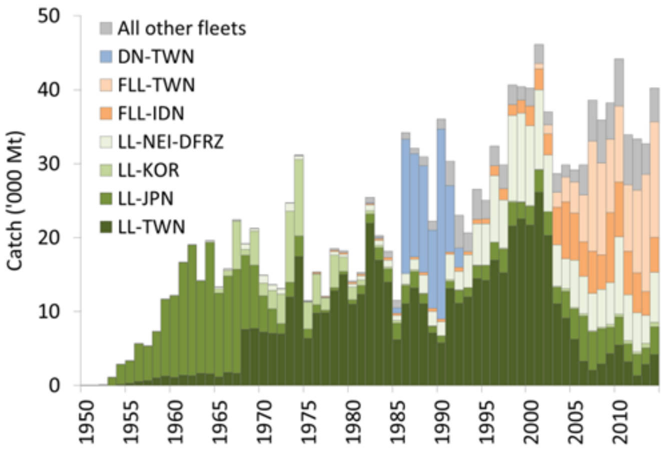


Fig.5. Albacore: Catches by fleet recorded in the IOTC Database (1950–2014). Data as of June 2016.

Freezing Longlines of Taiwan,China (LL-TWN), Japan (LL-JPN), Rep. of Korea (LL-KOR), and other nei fleets (LL-NEI-DFRZ); Fresh-tuna longlines of Indonesia (FLL-IDN), and Taiwan,China (FLL-TWN); Driftnets of Taiwan,China (DN-TWN); all other fleets combined (Other Fleets).

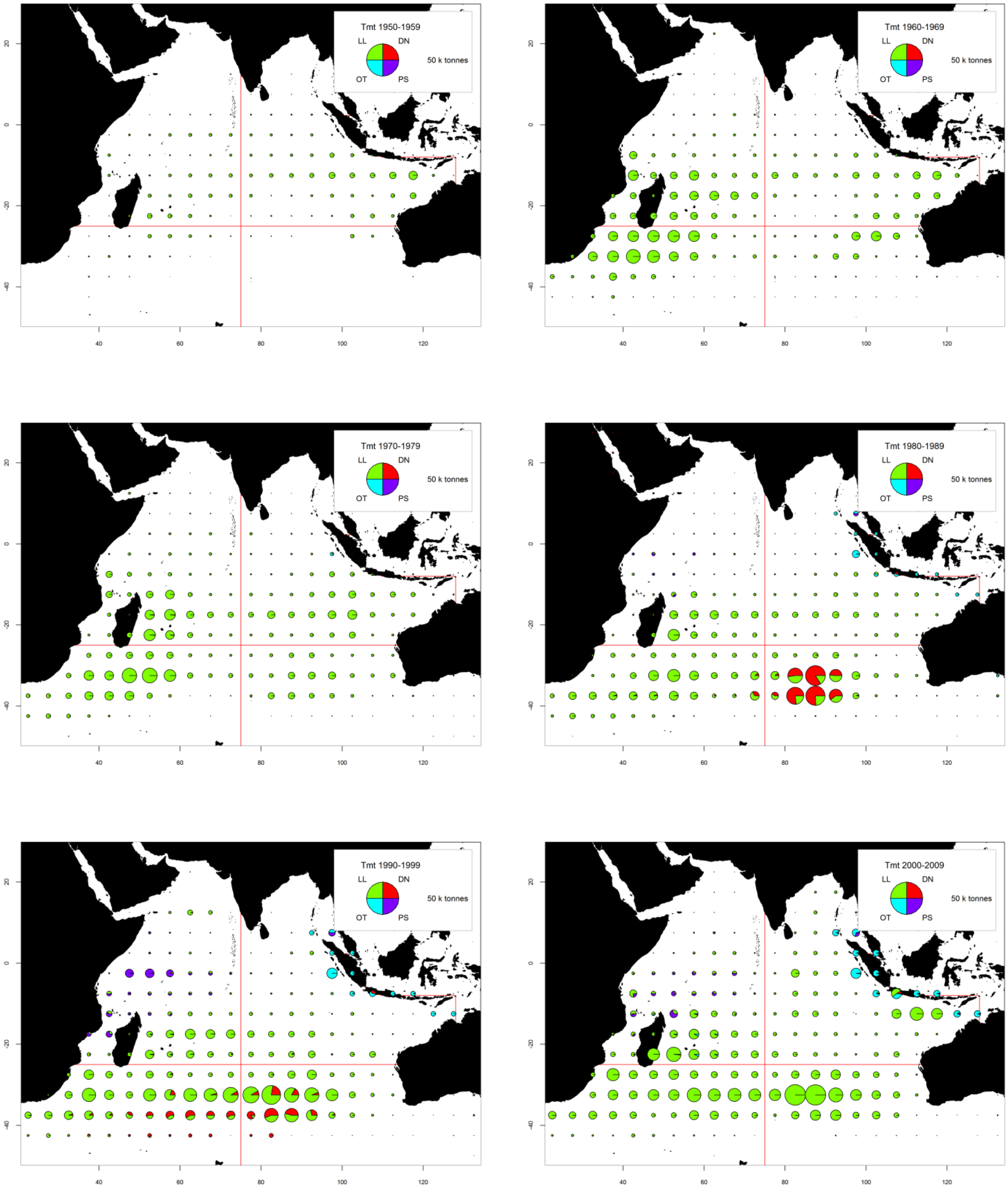


Fig.6a–f. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for the period 1950-2009, by decade and type of gear. Albacore stock assessment areas shown in red.

Longline (**LL**, green), Driftnet (**DN**, red), Purse seine (**PS**, purple), Other fleets (**OT**, blue)

Time-area catches are not available for all fleets; catches for those were assigned by 5x5 square and month using information from other fleets. Data as of June 2016. Source: Catch-and-effort, raised to total nominal catches.

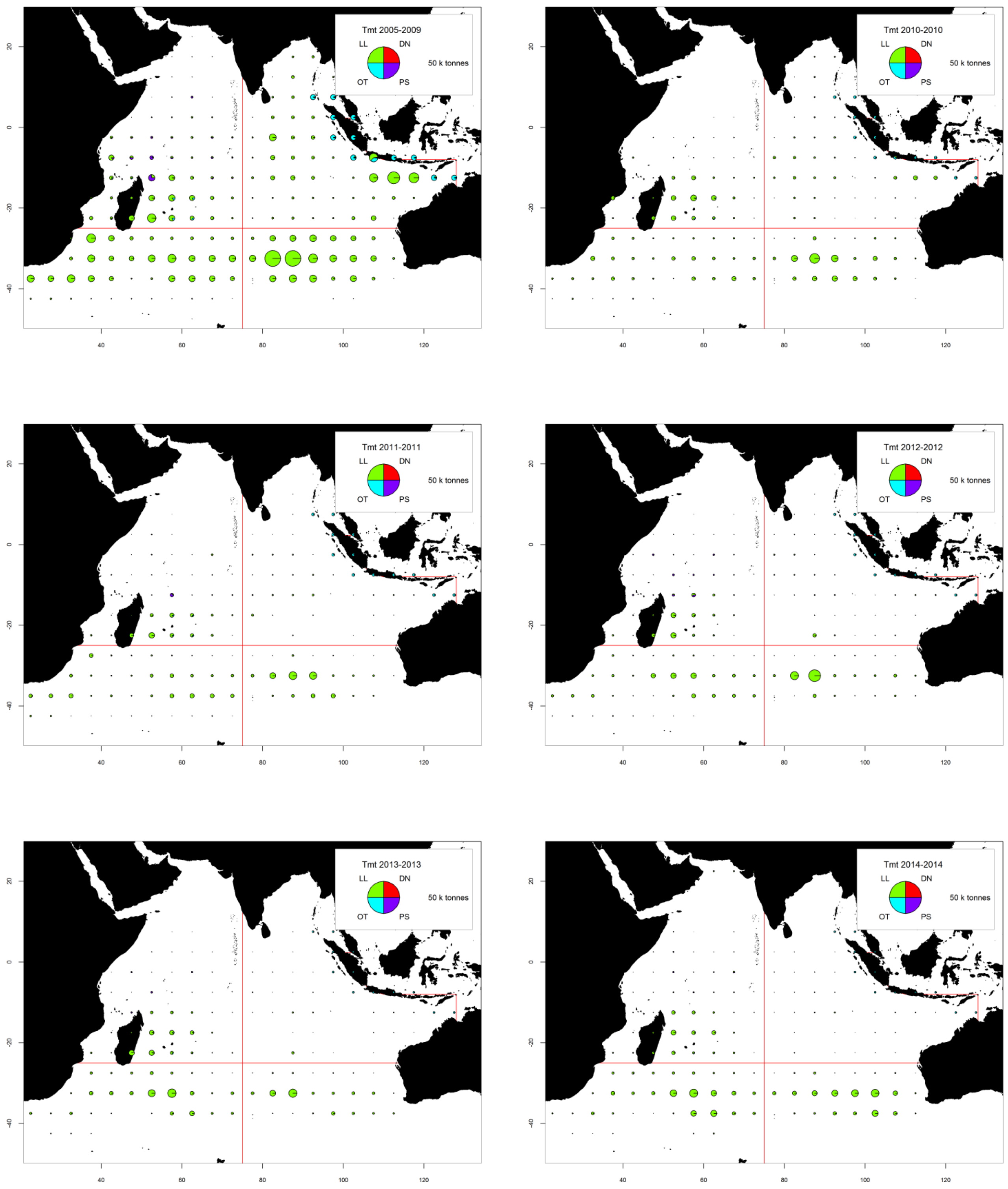


Fig.7a–f. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for the period 2005–09 by type of gear and for 2010–14, by year and type of gear. Albacore stock assessment areas shown in red.

Longline (**LL**, green), Driftnet (**DN**, red), Purse seine (**PS**, purple), Other fleets (**OT**, blue)

Time-area catches are not available for all fleets; catches for those were assigned by 5x5 square and month using information from other fleets. Data as of June 2016. Source: Catch-and-effort, raised to total nominal catches.

- Discard levels: are thought to be low, although they are unknown for industrial fisheries other than European (EU) purse seiners (2003–07).

Changes to the catch series**:** no major changes to the estimates of total catches of albacore tuna since the WPTmT meeting in 2014.

Albacore tuna – Catch-per-unit-effort (CPUE) trends

- Availability: Standardized catch-and-effort series are available from the various industrial fisheries (see below). Nevertheless, catch-and-effort reported to the IOTC Secretariat are not available from some fisheries or are considered to be of poor quality, especially during the last decade, for the following reasons (**Fig.8**):
    - uncertain data from significant fleets of longliners, including: India, Indonesia, Malaysia, Oman, and Philippines;
    - no catch-and-effort data for fresh-tuna longliners flagged as Taiwan,China, from 1990 (i.e., the start of the fishery) up to 2009;
    - non-reporting by industrial purse seiners and longliners (NEI).
- Main CPUE series available: Rep. of Korea (longline), Japan (longline), Taiwan,China (longline).

Albacore tuna – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: In general, the amount of catch for which size data is available for albacore before 1980 is very low. The deep-freezing longline fleets account for the majority of size data for albacore in the IOTC database. Size data are also available for industrial purse seiners flagged in EU countries and the Seychelles, however few data are available for all other fleets.

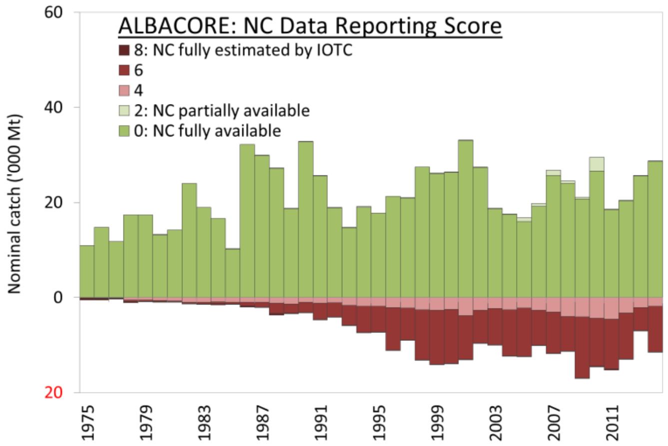
  Average fish weights can be assessed for several industrial fisheries although they are incomplete or of poor quality due to the issues identified below:

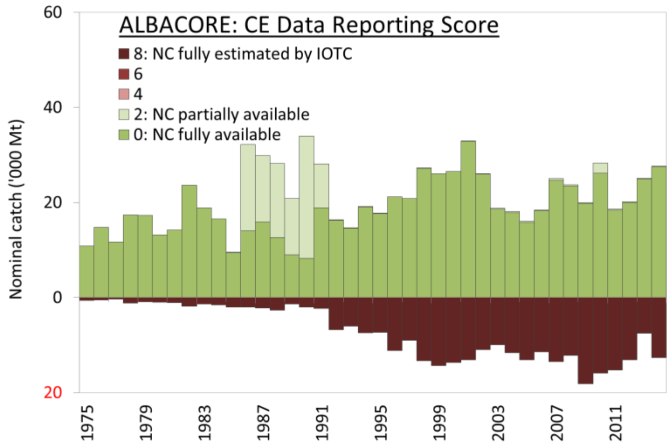
  i. Tawain,China longliners: size frequency data is available for the period 1980–2014. However, the length distributions of albacore available for Taiwan,China since 2003 are different than compared to earlier years (**Fig.9**). In addition, since 2003 higher average weights derived from length data have also been reported, compared to average weights from catch-and-effort (for the same time-periods and areas), which suggests changes in the sampling protocols of specimens measured for lengths – particularly the proportion of smaller sized fish measured for lengths.
  ii. Japan longliners: data for the Japanese longline fleet is available; however, the number of specimens measured per stratum has been decreasing since the early-1990s.

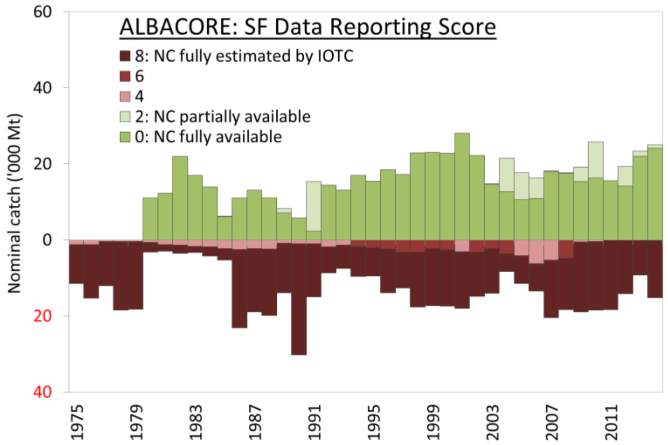
  In 2010, the IOTC Scientific Committee noted several issues concerning the reliability size frequency statistics available for Japan and Taiwan,China, and which remain unresolved. In 2013 the IOTC Secretariat presented a paper to the Working Party on Tropical Tunas documenting the current data quality issues and inconsistences between the length frequency data and catch-and-effort reported in particular by Taiwan,China since the mid-2000s[4].

- Catch-at-Size(Age) table: are available but estimates are highly uncertain for some periods and fisheries, including:
    i. all industrial longline fleets before the mid-60s, from the early-1970s up to the early-1980s and most fleets in recent years, in particular fresh-tuna longliners;
    ii. no size samples from the driftnet fishery of Taiwan,China over the entire fishing period (1982–92);
    iii. lack of size data for some industrial fleets (Taiwan,China (fresh longline), NEI, India, Indonesia, and NEI fleets).

[4] See IOTC Secretariat, IOTC-2013-WPTT15-41 Rev_1, for more details.







Figs.8a-c. Albacore tuna: data reporting coverage (1975–2014).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available.

Data as of June 2016.

IOTC Data reporting score:

Nominal Catch	By species	By gear
Fully available according the minimum reporting standards	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*E.g., Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Fully available according to the minimum reporting standards	0	0
Partially available according to the minimum reporting standards*	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

* E.g., Catch-and-effort not fully disaggreaged by species, gear, area, or month.

Size frequency data	Time-period	Area
Fully available according to the minimum reporting standards	0	0
Patially available according to the minimum reporting standards*	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

* E.g., Size data not fully available by species, gear, gear, month, or recommended size interval.

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

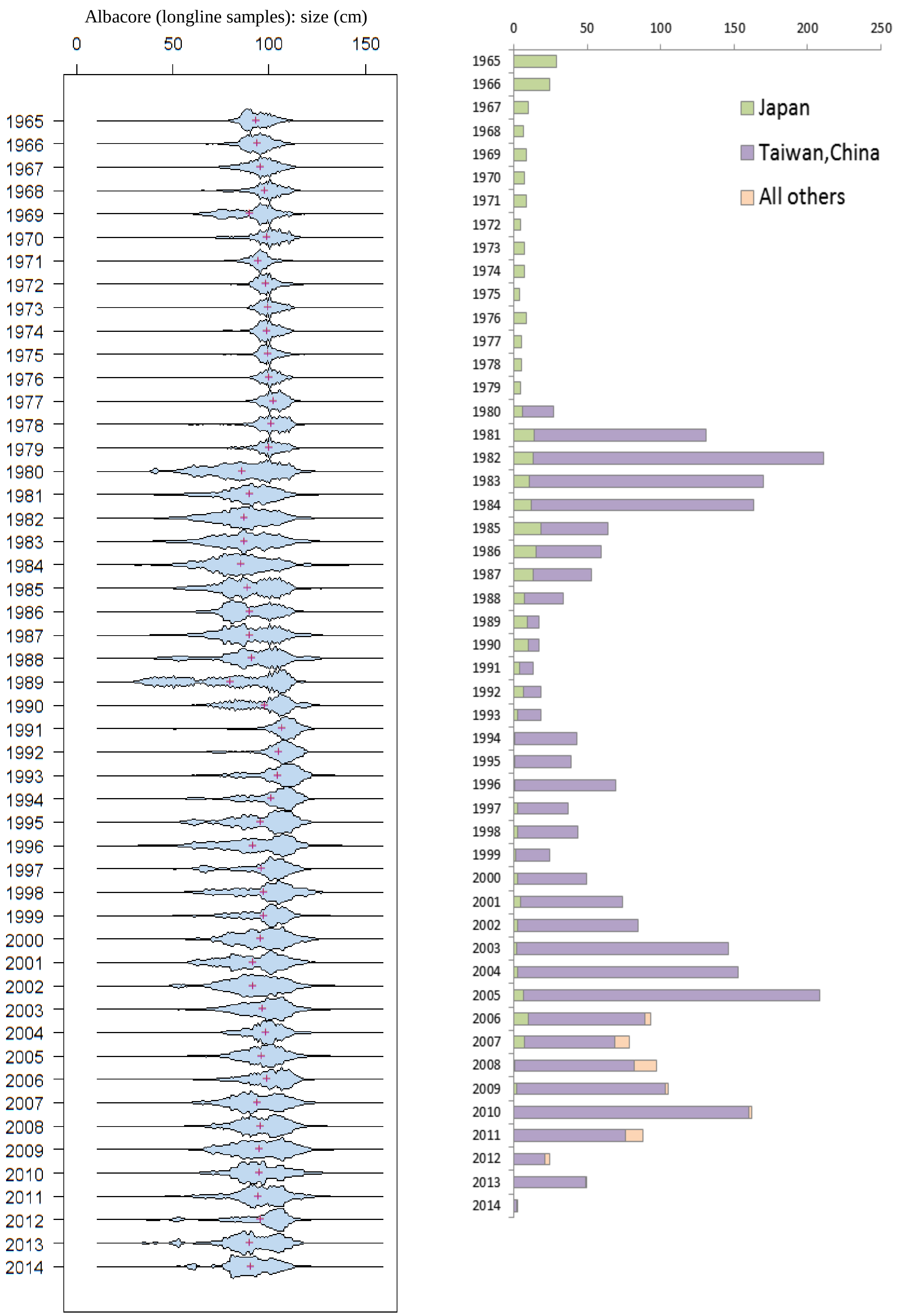


Fig.9: **Left:** Albacore: Length frequency distributions (total amount of fish measured by 1cm length class) derived from the data available at the IOTC Secretariat for freezing longline fisheries, by year.
Right: Number of specimens sampled for lengths by main longline fleet.

APPENDIX VI
MAIN DATA ISSUES IDENTIFIED RELATING TO THE STATISTICS OF ALBACORE

Extract from IOTC–2016–WPTmT06–07

The following list is provided by the Secretariat for the consideration of the WPTmT. The list covers the main issues which the Secretariat considers to negatively affect the quality of the statistics available at the IOTC, by type of dataset and fishery.

1. Nominal (retained) catches

Retained catches are considered to be fairly reliable until the early-1990s; since then the quality of catch estimates has been compromised due to poor catch reports from some fleets, in particular:

- Fisheries of Indonesia: Catches of albacore tuna for the fisheries of Indonesia – including fresh-tuna longliners and deep-freezing longliners and coastal fisheries – are estimated to account for around 26% of total catches of albacore in the Indian Ocean in recent years. However the quality of the catch estimates is generally considered of poor quality.

  Following a recommendation from the IOTC Scientific Committee, in 2013 the Directorate General for Capture Fisheries of Indonesia (DGCF) and the IOTC Secretariat reviewed the estimates of albacore catches for Indonesia[5]. As a result of the review Indonesia submitted a revised catch series for albacore for the most recent years. While the new estimates are considered more reliable than previous catches reported by DGCF, the lack of catch-and-effort data available for the longline fishery and issues with the monitoring of albacore landings in Indonesia compromises the ability of DGCF (and the IOTC Secretariat) to validate the new estimates which are still considered to be uncertain.

  Large fluctuations in total catches of albacore continued to be reported by Indonesia to the IOTC Secretariat, in addition to relatively large revisions between provisional and final catch estimates. Also the number of active longline vessels reported by Indonesia do not correspond to the expected average catch per vessel of comparable fleets (e.g., Tawian,China). For this reason, in recent years the IOTC Secretariat has compared catches reported by Indonesia with reports from canning factories cooperating with the International Seafood Sustainability Foundation (ISSF) to help with the validation of total catches of albacore reported by Indonesia.

- Malaysia (longliners): In previous years, Malaysia has reported incomplete catches of albacore for its longline fleet, as monitoring of the fishery by Malaysia did not include the large component of the longline fleet that is based in ports outside Malaysia (e.g., in particular unloadings of albacore in Port Louis, Mauritius). In recent years Malaysia has reported around 5 longliners in the Indian Ocean, while catches of albacore range between nil and 2,000 t for the same period. To compensate the under-reporting of catches, an additional 500–2,000 t of albacore have been estimated in previous years for Malay longliners not based in Malaysia, unloaded in foreign ports (with catches instead reported as NEI longline fleet).

- Other longline fleets (e.g., India, Oman, and Philippines)**:** The catches of albacore for the longline fisheries of India, Oman, and Philippines appear to be only partially reported (i.e., compared to the number of active vessels operating), with current estimates accounting for 3% of the total catches of albacore in the Indian Ocean in recent years.

- Non-reporting industrial longliners (NEI): catches from longliners operating under flags of non-reporting countries (e.g., Malaysia, foreign unloadings) have been estimated by the IOTC Secretariat. While the catches were moderately high during the 1990s, they have not exceeded 3,000 t in recent years.

- Offshore gillnets operating on the high seas (e.g., I.R. Iran, Pakistan and Sri Lanka): No catches for offshore gillnets have been reported to the IOTC Secretariat, although catches are thought to be less than 1000 t.

- Taiwan,China (fresh-tuna longliners): catches of albacore estimated for the fresh-tuna longline fishery of Taiwan,China are only available from 2001 onwards. Prior to 2000, catches for the Taiwanese fleet remain relatively uncertain.

[5] http://www.iotc.org/documents/report-review-catches-albacore-fisheries-indonesia

2. ***Catch-and-Effort data from Industrial Fisheries:***

- Indonesia (all fisheries): no catch-and-effort is available for either the industrial longline fishery or coastal fisheries of Indonesia. In 2015 an IOTC-OFCF mission was conducted to assist Indonesia with the reporting of catch-and-effort data, however to date, no information has been received. Submission of logbook data to DGCF data also remains very low – at around 5%, raising concerns over the level of coverage.
- Taiwan,China (fresh-tuna longliners): catch-and-effort data for this fishery is only available since 2010, compared to nominal catches from 2000. Estimates of total catches, and time-area catches, prior to these periods remains highly uncertain.
- Longline fisheries of India, Malaysia, Oman, and Philippines**:** Although catch-and-effort data are available for some of these fleets, they are usually incomplete and fall short of the IOTC standards.
- Drifting gillnet fisheries of I.R. Iran and Pakistan: To date, the Secretariat has not received catch-and-effort data for these fisheries, which compromises the ability to assess the amount of gillnet effort exerted in areas where catches of albacore may occur.

3. ***Size data from all Fisheries:***

- Driftnets of Taiwan,China: No size data available over the entire period of activity of the fishery (1982–92).
- All other offshore gillnets: No size data available for offshore gillnets (e.g., I.R. Iran, Pakistan).
- Indonesia (fresh-tuna longliners): has only reported size data for its fresh-tuna longline fishery for a limited number of years, during the mid-2000s. However samples, where available, cannot be fully disaggregated by month and fishing area (5x5 grid) and refer mostly to the component of the catch that is unloaded fresh. For this reason, the quality of the samples in the IOTC database are considered low quality.
- Taiwan,China (deep-freezing longliners): size data is available for the period 1980–2014. However, the length distributions of albacore available since 2003 are different than compared to earlier years. In addition, since 2003 higher average weights derived from length data have also been reported, compared to average weights from catch-and-effort (for the same time-periods and areas), which suggests changes in the sampling protocols of specimens measured for lengths – particularly the proportion of smaller sized fish measured for lengths.
- Taiwan,China (fresh-tuna longliners): size data of albacore has been provided since 2010, however the levels of coverage remain very low, and well below the minimum sampling coverage recommended by the IOTC (1 fish per Mt of catch).
- Japan (deep-freezing longliners): data for the Japanese longline fleet is available; however, the number of specimens measured per stratum has been decreasing since the early-1990s, and since 2000 the number of samples has been very low.
- Longline fisheries of India, Malaysia, Oman, and Philippines**:** To date, none of these countries have reported size frequency data of albacore.

4. ***Biological data*:**

- Industrial longline fisheries, in particular Taiwan,China, Indonesia, and Japan: the IOTC Secretariat has used length-age keys, length-weight keys, and processed weight-live weight keys for albacore from other oceans due to the general lack of biological data available from the fisheries indicated.

APPENDIX VII
DRAFT RESOURCE STOCK STATUS SUMMARY – ALBACORE

DRAFT: STATUS OF THE INDIAN OCEAN ALBACORE (*THUNNUS ALALUNGA*) RESOURCE

TABLE 1. Status of albacore (*Thunnus alalunga*) in the Indian Ocean.

Area[1]	Indicators – 2016 assessment		2016 stock status determination 2014[2]
Indian Ocean		SS3	(green)
	Catch 2014:	40,233 t	
	Average catch 2010–2014:	36,855 t	
	MSY (1000 t) (80% CI):	38.8 (33.9–43.6)	
	F_{MSY} (80% CI):	-	
	SB_{MSY} (1000 t) (80% CI):	30.0 (26.1–34.0)	
	F_{2014}/F_{MSY} (80% CI):	0.85 (0.57–1.12)	
	$SB_{current}/SB_{MSY}$ (80% CI):	1.80 (1.38–2.23)	
	$SB_{current}/SB_{1950}$ (80% CI):	0.37 (0.28–0.46)	

[1] Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] The stock status refers to the most recent years' data used for the assessment.
SB refers to mature female biomass.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)	(red)	(orange)
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Trends in the CPUE series suggest that the longline vulnerable biomass has declined to around 65% of the levels observed in 1980–82. Prior to 1980 there was 20 years of moderate fishing, after which total catches of albacore tuna in the Indian Ocean have more than doubled in subsequent years. Catches have also increased substantially since 2007, mostly attributed to Indonesian and Taiwan,China longline fisheries, although there is substantial uncertainty regarding the reliability of the catch estimates. Catches in 2014 have been marginally above the MSY level of the SS3 model. Fishing mortality represented as F_{2014}/F_{MSY} is 0.85 (0.57–1.12). Biomass is considered to be above the SB_{MSY} level (SB_{2014}/SB_{MSY} = 1.80 (1.38–2.23)) from the SS3 model (**Table 1**, **Fig.1**). The results from the other model options were also generally consistent with these estimates of stock status. Thus, the stock status in relation to the Commission's B_{MSY} and F_{MSY} target reference points indicates that the stock is **not overfished** and **not subject to overfishing** (**Table 1**), although considerable uncertainty remains in the SS3 assessment, particularly due to the lack of biological information on Indian Ocean albacore tuna stocks, indicating that a precautionary approach to the management of albacore tuna should be applied by capping total catch levels to MSY levels (approximately 40,000 t; **Table 2**).

Outlook. Maintaining or increasing effort in the core albacore fishing grounds is likely to result in further decline in the albacore tuna biomass, productivity and CPUE. The impacts of piracy in the western Indian Ocean have resulted in the displacement of a substantial portion of longline fishing effort into the traditional albacore fishing areas in the southern and eastern Indian Ocean. With the reduction of the effects of piracy in recent years, due to increased security on-board vessels of some longline fleets (e.g., Taiwan,China, and China), it is unlikely that catch and effort on albacore will increase in the near future. There is a moderate probability of exceeding MSY-based reference points by 2017 if catches are maintained at 2014 levels (14% probability that $SB_{2017}<SB_{MSY}$, and 33% probability that $F_{2017}>F_{MSY}$) (**Table 2**).

The following should be noted:

- The two primary sources of data that drive the assessment, total catches and CPUE, are highly uncertain and should be developed further as a priority.
- Current catches (40,233 t in 2014) approximate current estimated MSY levels (**Table 1**).
- The preliminary catch estimates for 2015 (~35,000 t) are below the current estimated MSY levels.
- A Kobe 2 Strategy matrix was calculated to quantify the risk of different future catch scenarios, using the projections from the SS3 model (**Table 2**).

- Provisional reference points: Noting that the Commission in 2015 adopted Resolution 15/10 *On interim target and limit reference points and a decision framework*, the following should be noted:
    - **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and the provisional limit reference point of $1.4*F_{MSY}$ (**Fig. 1**).
    - **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (**Fig. 1**).

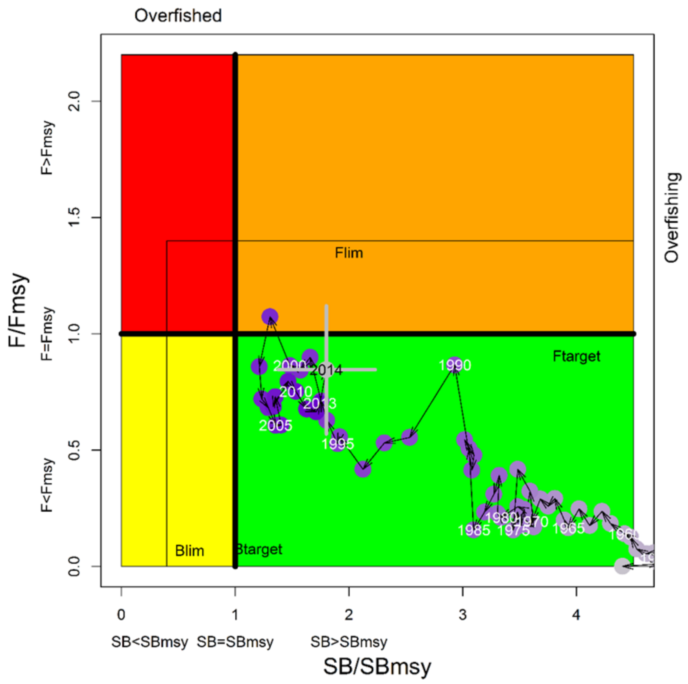


Fig. 1. Albacore: SS3 Aggregated Indian Ocean assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2014 (the grey lines represent the 80 percentiles of the 2014 estimate). Target (F_{targ} and SB_{targ}) and limit (F_{lim} and SB_{lim}) reference points are shown.

Table 2. Albacore: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for constant catch projections (2014 catch levels, ± 10%, ± 20%, ± 30%, and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the catch level for 2014) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (23,821)	**70% (27,791)**	**80% (31,761)**	**90% (35,731)**	**100% (39,701)**	**110% (43,671)**	**120% (47,641)**	**130% (51,611)**	**140% (55,581)**
$SB_{2017} < SB_{MSY}$	1	2	4	7	14	19	24	33	44
$F_{2017} > F_{MSY}$	0	1	5	18	33	47	59	71	77
$SB_{2024} < SB_{MSY}$	4	8	9	31	42	50	62	NA	92
$F_{2024} > F_{MSY}$	0	0	3	NA	39	56	66	70	100
Reference point and projection timeframe	**Alternative catch projections (relative to the catch level for 2014) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (23,821)	**70% (27,791)**	**80% (31,761)**	**90% (35,731)**	**100% (39,701)**	**110% (43,671)**	**120% (47,641)**	**130% (51,611)**	**140% (55,581)**
$SB_{2017} < SB_{Lim}$	0	0	0	0	0	0	1	1	4
$F_{2017} > F_{Lim}$	0	0	0	0	2	10	20	34	46
$SB_{2024} < SB_{Lim}$	0	0	1	13	20	24	30	NA	65
$F_{2024} > F_{Lim}$	0	0	0	NA	10	27	48	60	100

APPENDIX VIII
WORKING PARTY ON TEMPERATE TUNAS PROGRAM OF WORK (2017–2021)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

Table 1. Priority topics for obtaining the information necessary to develop stock status indicators for albacore in the Indian Ocean (2017-2021).

Topic	Sub-topic and project	Priority	Est. budget and/or potential source	Timing				
				2017	2018	2019	2020	2021
1. Stock structure (connectivity and diversity)	1.1 Genetic research to determine the connectivity of albacore throughout its distribution and the effective population size.	High (3)	1.3 m Euro: European Union					
	1.1.1 Determine albacore stock structure, migratory range and movement rates in the Indian Ocean.		TBD					
	1.1.2 Determine the degree of shared stocks for albacore in the Indian Ocean with the southern Atlantic Ocean.		Ifremer					
	1.1.3 Population genetic analyses to decipher inter- and intraspecific evolutionary relationships, levels of gene flow (genetic exchange rate), genetic divergence, and effective population sizes.		TBD					
2. Biological information (parameters for stock assessment)	2.1 Age and growth research (collaborative research to estimate ages across research facilities; stratification of sampling across fishery and stock)	High (1)	TBD					
	2.1.1 China and other CPCs to provide further research reports on albacore biology, including through the use of fish otolith studies, either from data collected through observer programs or other research programs, at the next WPTmT meeting.		CPCs directly					
	2.1.2 Growth curve analysis: Uncertainty about the growth curve is a primary source of uncertainty in the stock assessment. Depending on the shape of the growth curve, it is likely that only limited information about total mortality can be obtained from catch-at-size data. As an additional information source, data on the age structure of the catch may be very informative about total mortality and may considerably reduce uncertainty in the		TBD					

		assessment. Research needs to be undertaken to investigate the potential and the best approaches to be used. MSE process will look at improvement in precision of estimates given different amounts of age structure data, depending on fishery, growth curve, and effective sample sizes.							
		2.2 Age-at-Maturity	High (4)						
		2.2.1 Quantitative biological studies are necessary for albacore throughout its range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.		CPCs directly					
3	Ecological information	3.1 Spawning time and locations	Medium (5)						
		3.1.1 Collect gonad samples from albacore to confirm the spawning time and location of the spawning area that are presently hypothesized for albacore.		CPCs directly					
4	CPUE standardisation	4.1 Develop standardized CPUE series for each albacore fishery for the Indian Ocean, with the aim of developing a single CPUE series for stock assessment purposes (either a combined or single fleet series approved by the WPTmT).	High (2)	CPUE Workshop (TBD)					
		4.1.1 Changes in species targeting is the most important issue to address in CPUE standardizations.		CPCs directly					
		4.1.2 Appropriate spatial structure needs to be considered carefully as fish density (and targeting practices) can be highly variable on a fine spatial scale, and it can be misleading to assume that large areas are homogenous when there are large shifts in the spatial distribution of effort.		CPCs directly					
		4.1.3 If there are many observations with positive effort and zero catch, it is worth considering models which explicitly model the processes that lead to the zero observations (e.g. negative binomial, zero-inflated or delta-lognormal models). Adding a small constant to the lognormal model may be fine if there are few zero's, but may not be appropriate for areas with many zero catches (e.g. north of 10oS). Sensitivity to the choice of constant should be tested.		CPCs directly					
		4.1.4 The appropriate inclusion of environmental variables in CPUE standardization is an ongoing research topic. Often these variables		CPCs directly					

		do not have as much explanatory power as, or may be confounded with, fixed spatial effects. This may indicate that model-derived environmental fields are not accurate enough at this time, or there may need to be careful consideration of the mechanisms of interaction to include the variable in the most informative way.							
		4.1.5 It is difficult to prescribe analyses in advance, and model building should be undertaken as an iterative process to investigate the processes in the fishery that affect the relationship between CPUE and abundance.		CPCs directly					
5	Target and Limit reference points	5.1 To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High (WPM)						
		5.1.1 Assessment of the interim reference points as well as alternatives: Used when assessing the albacore stock status and when establishing the Kobe plot and Kobe matrices. Agreed to pass this task temporarily to WPM.							
6	Management measure options	6.1 To advise the Commission, by end of 2016 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process. Agreed to pass this task temporarily to WPM.	High (WPM)						

APPENDIX IX
CONSOLIDATED RECOMMENDATIONS OF THE 6TH SESSION OF THE WORKING PARTY ON TEMPERATE TUNAS

Review of data available at the Secretariat for temperate tuna species

WPTmT06.01 (para 21) The WTmT **NOTED** that length frequency samples for the Taiwanese driftnet fishery were collected during the 1980s and published in a former IPTP paper, and **RECOMMENDED** that the IOTC Secretariat process the information to ensure the data is available for future stock assessments.

WPTmT06.02 (para 22) **NOTING** changes in the length frequency distribution by the Taiwanese deep-freezing longline fleet since the early-2000s, and particularly the decline in the proportion of smaller sized fish sampled for lengths, the WPTmT **RECOMMENDED** that length frequency and biological data collected by Taiwanese observers be provided to the IOTC Secretariat in order to validate and better understand recent changes in the length frequencies collected by on-board sampling – including samples collected for albacore tuna, tropical tuna species, and swordfish. The WPTmT **NOTED** that all observer data submitted to the IOTC Secretariat is subject to Resolution 12/02 *Data confidentiality policy and procedures*.

WPTmT06.03 (para 23) The WPTmT **ACKNOWLEDGED** the importance of port sampling of albacore tuna unloaded in Port Louis, Mauritius, and **RECOMMENDED** that the IOTC Secretariat provide additional support to Mauritius on how to collect and report this information. The WPTmT **NOTED** that the IOTC Secretariat has proposed a mission to Mauritius in August 2016 in support of this capacity building activity.

New information on biology, ecology, fisheries and environmental data relating to temperate tunas

WPTmT06.04 (para 47) **NOTING** the general paucity of biological indicators available from the Indian Ocean, and particularly the lack of age-specific maturity as a primary source of uncertainty in the stock assessment of albacore tuna, the WPTmT **RECOMMENDED** a study on the growth curve of albacore tuna in the Indian Ocean as a high priority in the WPTmT Program of Work.

Revision of the WPTmT Program of Work

WPTmT06.05 (para 120) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2017–21), as provided at Appendix VIII.

Date and place of the 7th and 8th Sessions of the WPTmT

WPTmT06.06 (para 125) The WPTmT **RECOMMENDED** that the SC consider rescheduling of future WPTmT meetings (currently held in July) to later in the year, e.g., August-early September, to enable the possibility of the latest years' data to be included in the assessment.

WPTmT06.07 (para 126) The WPTmT **RECOMMENDED** that future stock assessment cycle for albacore tuna should be conducted every three years (rather than two years), in line with the assessment of species covered by other IOTC Working Parties (e.g., WPTT, WPEB), and that the WPTmT should in addition convene during the year preceding the next stock assessment to focus on priority areas for improvement in the albacore assessment, such as the standardization of CPUE, or development of biological parameters (Option B, Table 15).

Table 15. Assessment schedule for the IOTC Working Party on Temperate Tunas (WPTmT), 2017-21.

Option A: current WPTmT tuna stock assessment and meetings schedule

Species	**2017**	**2018**	**2019**	**2020**	**2021**
Albacore	–	WPTmT: Stock assessment	–	WPTmT: Stock assessment	–

Option B: Proposed changes to the WPTmT stock assessment and meetings schedule

Species	**2017**	**2018**	**2019**	**2020**	**2021**
Albacore	–	WPTmT: Data preparatory meeting*	WPTmT: Stock assessment	–	WPTmT: Data preparatory meeting*

Review of the draft, and adoption of the Report of the 6th Session of the WPTmT

WPTmT06.08 (para 131) The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT06, provided at Appendix IX, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix VII).

Stock status table

A summary of the stock status for temperate tunas under the IOTC mandate is provided in Table 1, Appendix VII