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

Busan, Rep. of Korea, 28–31 July 2014

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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
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
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**).

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The 5th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPNT05) was held in Busan, Rep. of Korea, from 28 to 31 July 2014. A total of 27 participants (26 in 2012) attended the Session.

The following are a subset of the complete recommendations from the WPTmT05 to the Scientific Committee, which are provided at Appendix VIII.

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

WPTmT05.01 (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.

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.

Albacore management strategy evaluation (MSE) process

WPTmT05.03 (para. 113) The WPTmT **RECALLED** para. 3 of Resolution 13/10 which states:

> "*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.

Revision of the WPTmT Program **of Work**

WPTmT05.04 (para. 119) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2015–19), as provided at Appendix VII.

Review of the draft, and adoption of the Report of the 5th Session of the WPTmT

WPTmT05.05 (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).

Stock Status table

A summary of the stock status for temperate tuna species under the IOTC mandate is provided in Table 1.

Table 1. Status summary for species of tuna and tuna-like species under the IOTC mandate, as well as other species impacted by IOTC fisheries.

Stock	Indicators		Prev[1]	2010	2011	2012	2013	2014	Advice to the Commission
Albacore *Thunnus alalunga*	Catch 2012: 33,863 t Average catch 2008–2012: 37,090 t		2007						Trends in the Taiwan,China CPUE series suggest that the longline vulnerable biomass has declined to about 47% of the level observed in 1980–82. It is considered that recent catches have been above the MSY level for one of the models (ASPIC) examined and approaching MSY levels for the other model (SS3). 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**, although considerable uncertainty remains in the SS3 and ASPIC assessments, indicating that a precautionary approach to the management of albacore should be applied by reducing fishing mortality or capping total catch levels to those taken in 2012 (34,000 t). There is a high risk of exceeding MSY-based reference points by 2015 if catches increase further (above 2012 levels) (50% risk that $SB_{2015}<SB_{MSY}$, and 39% risk that $F_{2015}>F_{MSY}$). • Click here for full stock status summary: Appendix VI
		SS3	ASPIC*						
	MSY (1000 t) (80% CI):	47.6 (26.7–78.8)	34.7 (28.8–37.4)						
	F_{MSY} (80% CI):	0.31 (0.21–0.42)	0.50 (n.a.)						
	SB_{MSY} (1000 t) (80% CI):	39.2 (25.4–50.7)	68.6 (n.a.)						
	F_{2012}/F_{MSY} (80% CI):	0.69 (0.23–1.39)	0.94 (0.68–1.61)						
	$SB_{current}/SB_{MSY}$ (80% CI):	1.09 (0.34–2.20)	1.05 (0.73–1.35)						
	$SB_{current}/SB_{1950}$ (80% CI):	0.21 (0.11–0.33)	0.43 (n.a.)						

*Total Biomass (B)

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		
Not assessed/Uncertain		

1. OPENING OF THE MEETING

1. The 5th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPTmT05) was held in Busan, Rep. of Korea, from 28–31 July 2014. A total of 27 participants (26 in 2012) attended the Session. The list of participants is provided at Appendix I. The meeting was opened by the Chairperson, Dr Zang Geun Kim (Rep. of Korea), who welcomed participants to Busan, Rep. of Korea.

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 WPTmT05 are listed in Appendix III.

3. OUTCOMES OF THE 16TH SESSION OF THE SCIENTIFIC COMMITTEE

3. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–03 which outlined the main outcomes of the 15th and 16th Sessions of the Scientific Committee, specifically related to the work of the WPTmT.

4. **NOTING** 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), the WPTmT **AGREED** that the terminology (which is provided in the opening pages of this WPTmT05 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).

6. The WPTmT **NOTED** that in 2012, the SC made a number of requests in relation to the WPTmT04 report. Those requests and the associated responses from the WPTmT05 are provided below for reference:

- ***Data available at the IOTC Secretariat for temperate tuna species***
  - *The SC **EXPRESSED** concern on the lack of information regarding the landing ports of the Indonesian longline fleet operating in the high seas and **REQUESTED** Indonesia to provide detailed information, with cooperation from the port countries, to the WPTmT at its next session.* (para. 43 of the SC15 Report)
  - **Indonesia**: At present, the available data for albacore is from Indonesia's largest landing port (Benoa-Bali). It is estimated that 50% of the total Indonesian catch of albacore is landed at Benoa. Indonesia indicated that intersessionally, the data for albacore landed at other ports would be provided to the IOTC Secretariat.
- ***Indonesian longline fishery for albacore***
  - ***NOTING** the ongoing review of Indonesian catches of albacore being carried out by the IOTC Secretariat in consultation with the Directorate General of Capture Fisheries (DGCF) of Indonesia, and that current catch estimates for Indonesia are derived from reports of albacore imports into canning factories cooperating with the ISSF, the SC **REQUESTED** that the IOTC Secretariat and Indonesia continue cooperation to finalise the review and report final estimates of catches of albacore to the next meeting of the WPTmT.* (para. 45 of the SC15 Report)
  - **Indonesia:** A detailed summary of the work undertaken is provided in paper IOTC–2014–WPTmT05–INF02 *Indian Ocean tuna fisheries of Indonesia albacore catch estimation workshop: Review of issues and considerations*.
- ***Chinese longline fishery for albacore***
  - *The SC **NOTED** that in recent years, the reported catches of albacore from longliners flagged to China fishing in the Indian Ocean have increased markedly and although this may originate from a*

*change in targeting by some vessels, it may also be the consequence of some fishing companies over-reporting catches of albacore in the logbooks during those years. In this regard, the SC **REQUESTED** that China assess the reliability of statistics of albacore available since 2010 for its fleet and report findings to the next meeting of the WPTmT, including new estimates, where require, in particular in the south-west Indian Ocean where the specific composition of the catch appears unrealistic.* (para. 46 of the SC15 Report)

- **China**: Since 2010, because of piracy in the northwest Indian Ocean, some Chinese deep freezing longliners moved to the southern Indian Ocean to target albacore, which resulted in high catches. In addition, in the recent couple of years, deep freezing longliners have returned to the tropical Indian Ocean to target bigeye tuna, and seasonally moved south to target albacore. There may be some over-reporting of albacore catches by industry, most probably due to frequent shifts of fishing grounds. The different pattern in catch composition from the southwest Indian Ocean might be a result of the different fishing strategies employed by vessels, that is, some vessels periodically go to the southwest Indian Ocean to target other species (e.g. escolar and oilfish). In this regard, China will revise the historical albacore catch and submit it to the IOTC Secretariat prior to the next WPTmT meeting.

- ***Stock structure of albacore***
  - *The SC **REQUESTED** that the WPTmT assess the feasibility of implementing a tagging Project in the future and present results to the next meeting of the SC, **NOTING** that such a project would require the support of ICCAT as the southern stocks of albacore could be shared across the boundaries of the IOTC and ICCAT.* (para. 55 of the SC15 Report)
  - **WPTmT05**: This could be incorporated into the stock structure project, outlined in para 7.

7. The WPTmT **NOTED** that in 2013, the SC made an additional recommendation on stock structure research. That recommendation and a brief update are provided below:

- ***Stock structure of albacore***
  - *The SC **RECOMMENDED** that the IOTC Secretariat act in a project coordination role, as well as to seek funding for stock structure projects in the Indian Ocean. Initially, this would require the establishment of an intersessional discussion group with participants from the WPNT, and experts in the field of stock structure differentiation. CPCs with current or planned stock structure studies are encouraged to circulate project proposals to the wider group for comment that may be considered for submitting to prospective funding partners with support from the IOTC Secretariat*. (para. 36 of the SC16 Report)
  - **IOTC Secretariat**: At the request of the EU, a concept note was developed to examine if there is population structure of neritic, tropical and temperate tunas of interest to the IOTC throughout the Indian Ocean. The project was subsequently funded by the EU and will run for at least two years. 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. A revised concept note and subsequent project outline will be made publically available in the near future.

4. OUTCOMES OF SESSIONS OF THE COMMISSION

4.1 Outcomes of the 18th Session of the Commission

8. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–04 which outlined the main outcomes of the 18th 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 7 Conservation and Management Measures (CMMs) adopted at the 18th Session of the Commission (consisting of 6 Resolutions and 1 Recommendation):

IOTC Resolutions

- Resolution 14/01 *On the removal of obsolete Conservation and Management Measures*
- Resolution 14/02 *For the conservation and management of tropical tunas stocks in the IOTC area of competence*
- Resolution 14/03 *On enhancing the dialogue between fisheries scientists and managers*

- Resolution 14/04 *Concerning the IOTC record of vessels authorised to operate in the IOTC area of competence*
- Resolution 14/05 *Concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 14/06 *On establishing a programme for transhipment by large-scale fishing vessels*

IOTC Recommendations

- Recommendation 14/07 *To standardise the presentation of scientific information in the annual Scientific Committee report and in Working Party reports*

10. The WPTmT **ACKNOWLEDGED** the importance of standardising the way in which the subsidiary bodies of the Commission provide advice. Recommendation 14/07, newly 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.

11. The WPTmT **AGREED** that while the current species Executive Summaries already comply with most of the suggestions contained in Recommendation 14/07, there was always room for improvement.

12. **NOTING** that the Commission also made a number of general comments on the recommendations made by the Scientific Committee in 2013, which have relevance for the WPTmT (detailed as follows: paragraph numbers refer to the report of the Commission (IOTC–2014–S18–R)), the WPTmT **AGREED** that any advice to the Commission would be provided in the Management Advice section of the stock status summary for albacore, detailed in Section 9 of this report.

> Para 12. *The Commission **NOTED** that there remains considerable uncertainty about the relationship between abundance and the standardised CPUE series for albacore in the IOTC area of competence, and about the total catches over the past decade. The most recent assessment was carried out in 2012 and the next assessment is scheduled for 2014. Revisions to the catch history in 2013 indicated that reported landings in 2012 (33,960 t), and those from 2011 (33,605 t) are only slightly above the MSY estimates from the 2012 stock assessment. Maintaining or increasing effort in the core albacore fishing grounds is likely to result in further declines in albacore biomass, productivity and CPUE*.
>
> Para. 13. *The Commission **AGREED** that pending the results of the 2014 albacore stock assessment, it should take a precautionary approach to the management of albacore and consider, at its 19th Session, proposals for Conservation and Management Measure to reduce fishing pressure for albacore; including the consideration of zone-based management of fishing effort.*

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

13. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–05 which aimed to encourage participants at the WPTmT05 to review some of the existing Conservation and Management Measures (CMM) relating to temperate tunas, noting the CMMs contained in document IOTC–2014–WPTmT05–04; 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.

14. 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.

15. **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 WPTmT05 **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 December 2014.

16. The WPTmT **NOTED** that Resolution 13/10 *On interim target and limit reference points and a decision framework*, establishes the general principles that would guide the application of the precautionary approach in the context of IOTC, including the adoption of provisional reference points that would apply until such time as the Commission decides to update the reference points after considering the advice of the Scientific Committee

following the management strategy evaluation exercise. The Resolution also considers a decision framework to facilitate management measures that are currently being undertaken by the Commission.

17. The WPTmT **AGREED** that it would consider proposing modifications for improvement to the existing CMMs following discussions held throughout the current WPTmT meeting.

5. PROGRESS ON THE RECOMMENDATIONS OF WPTMT04

18. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–06 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 to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress.

19. 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.

6. REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR TEMPERATE TUNA SPECIES

20. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–07 which summarises the standing of a range of information received by the IOTC Secretariat for albacore, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2012. 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 IV.

21. 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 V, 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.

22. The WPTmT **NOTED** the large increase in catches reported from the Taiwan,China longline fleet operating in the IOTC area of competence from 2012 (33,864 t) to 2013 (~43,000 t). Reasons for this ~21% increase where discussed, with scientists from Taiwan,China indicating that one possible reason may include improved logbook reporting by small scale longline vessels landing catches in local ports (e.g. Indonesia), rather than an actual increase in catches. It was also considered whether the increases may be market driven, although no information was available to confirm this possibility.

23. The WPTmT **REQUESTED** that both Taiwan,China and Indonesia examine the reasons for the large increases in catches reported for 2013 from those taken in 2012, and to provide a detailed response intersessionally, and at the next SC and WPTmT meetings.

24. The WPTmT **NOTED** the response from Taiwan,China regarding why there was a markedly different range of sizes of fish being caught by its driftnet fisheries in the Indian Ocean and Pacific Ocean (mean weights: 9 kg and 6 kg respectively). Specifically, it was indicated that the reason was primarily due to the fact that its driftnet fisheries operating in the Pacific Ocean operate primarily in the southern Pacific Ocean, in comparison to the ocean-wide operation in the Indian Ocean.

25. The WPTmT **NOTED** that the Taiwan,China gillnet fleet historically caught juvenile albacore during the 1980's and that this information would be provided to the IOTC Secretariat.

26. The WPTmT **NOTED** that the Taiwan,China gillnet fleet historically caught juvenile albacore during the 1980's and that some size data may be held in research collections. If such data can be recovered it will be provided to the IOTC Secretariat.

27. **NOTING** the comment from Taiwan,China that there was a change in the longline size data collection protocol in 2003, at the same time as the change in the distribution of Taiwan,China longline length frequency data, the WPTmT **REQUESTED** that Taiwan,China confirm if these sampling changes are responsible for the change in the size data distribution and report back to the next WPTmT meeting.

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.

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.

7. NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO TEMPERATE TUNAS

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

Indonesian port-based monitoring (Benoa, Bali)

30. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–26 which provided an overview of the port-based monitoring of catch and effort information for albacore by Indonesia's Indian Ocean tuna longline fishery based at Benoa fishing port, including the following abstract provided by the author:

"*The aim of this study is to provide the information about albacore catch in Indian Ocean which was landed in Benoa Port Bali in 2013. This information consist of enumeration achievement, catch composition, albacore size distribution, length at the first capture, and the estimation on population of albacore in the Indian Ocean which was landed in Benoa port. According to this study, albacore was the third highest production after yellowfin tuna and bigeye tuna with the percentage 10.35%. The albacore was from industrial longliners with size distribution from 62-122 cmFL (median=93 cmFL, mode=86 cmFL and mean=90.81 cmFL). Length at the first capture was 91.15 cmFL. The population parameter using FISAT II obtained that L∞ was 128.50 cmFL, the growth coefficient (K) was 1.5 (Year-1)and (t0) was 0.10652. The estimation on the total mortality (Z)=6.68 (year-1), the natural mortality (M) at 28°C=1.55 (year-1), the capture mortality=5.13 (year-1) and the exploitation rate (E)= 0.77 (year-1).*"

31. The WPTmT **NOTED** that growth can be estimated from length frequency data when cohorts can be seen growing through the fishery, but observing such cohorts for albacore requires sampling from a small-fish fishery (e.g. troll fishery or pole-and-line) rather than longline. The observed modes in the longline data may represent selectivity variation rather than age classes. Sampling otoliths from captured fish would provide opportunities in future to develop improved growth curves.

Indonesian longline fishery for albacore

32. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–09 which provided information from the Indonesian observer scheme on albacore, as well as some life history parameters collected, including the following abstract provided by the authors:

"*This study highlighted the occurrence of the Indonesian tuna longline fishery targeting albacore (Thunnus alalunga) caught in the Eastern Indian Ocean based in Benoa through observer program from 2010–13. This paper also presents the current information on Catch Per Unit of Effort (CPUE), size distribution, length-weight relationship, swimming layer and feeding periodicity of albacore. Total albacore samples that could be analyzed were 3152 which were taken from scientific observer data from 2010–13. The study area of albacore was between 0°65'S–33°68'S and 75°79'E–131°47'E. Albacore length (cm FL) distributed from 7–196 cm FL (median=93 cm FL, mode=100 cm FL, mean=92.12 cm FL) and dominated at size 95 cm FL. The higher percentage length of albacore > 90 cm (L50) occured in the area between (30-35°S and 80-95°E) and (10-15°S and 120-125°E). The length weight relationship was determined to be* $W=0.0045\ FL^{1.8211}$ *(W in kg, FL in cm).*" – see paper for full abstract

33. The WPTmT **NOTED** the results of the review of catches of albacore carried out by the IOTC Secretariat in consultation with the DGCF of Indonesia, via the catch estimation workshop carried out in mid-2013 (see IOTC–2014–WPTmT05–INF02). The Workshop identified various issues concerning the estimation of catches of albacore, which Indonesia will work towards resolving in coming years.

34. **NOTING** that Indonesian catches represent ~33% of the total albacore catches in the Indian Ocean, determined from the revised catch history developed by the IOTC Secretariat, the WPTmT **REQUESTED** that Indonesia further strengthen sampling efforts on its coastal and off-shore fisheries and liaise with the IOTC Secretariat in order to continue to improve the catch estimates of albacore by the Indonesian longline fleet.

35. **NOTING** that port samplers from Indonesia's observer scheme have been collecting length-weight samples from landings at Benoa, Bali, the WPTmT **AGREED** that length-weight relationships from a restricted area may not be representative of broader catches for a fish with seasonal movement and size segregation. It was suggested that combining biological data with other CPCs in the region would permit analyses at a broad spatial scale with large sample sizes.

36. The WPTmT **NOTED** that outliers due to errors in the data used to calculate the length-weight relationship appeared to be affecting the slope of the regression, and suggested removing them would improve the analysis.

37. The WPTmT **NOTED** that the truncation of the size distribution at 70 cm was very abrupt and did not show any decline in numbers before being cut off. It would be useful to check whether some smaller fish may have been caught but not measured.

Malaysia longline fishery

38. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–10 which provided an overview of the catches of albacore tuna by Malaysian longline vessels in the Indian Ocean during 2005–13, including the following abstract provided by the author:

"*A total of four Malaysian tuna longliners plus one carrier began to fish for albacore in the vicinity of southern Mauritius since the 3rd quarter of 2011. This paper was based on the data extracted from fishing log sheets which were sent to Department of Fisheries, Malaysia. During 2005–13, the highest total catch was recorded in 2007 with 3983.28 tonnes followed by 2005, 2008 and 2009, respectively (3436.40, 3288.88 and 2706.09 tonnes). CPUE value was calculated for the year 2013 and it was found that the highest CPUE was in October with 57.82 fish/1,000 hooks followed by January (57.34 fish/1,000 hooks) and June (39.74 fish/1,000 hooks). The lowest catch by weight and number is in March (2.74 tonnes and 141 fishes) and its CPUE was reduced to 8.81 fish/1,000 hooks. The catch of albacore in 2013 showed a slight increase with 946.60 tonnes compared to previous years (732.12 tonnes). In addition, the average composition by number of this species increased tremendously from 5.1% (2007–11) to 78.3% in 2013.*"

39. **NOTING** that in 2012 there was a change in targeting from tropical tunas to albacore by the Malaysian longline fleet, the WPTmT **SUGGESTED** that the catch composition data for 2012 and 2013 be separated from those of previous years and presented at the next WPTmT meeting so as to allow a better understanding of how the change in targeting has impacted catch composition over time.

Thailand longline fishery for albacore

40. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–11 which provided an overview of the catch and effort by the Thailand flagged fleet, including the following abstract provided by the authors:

"*This report was based on the data extracted from fishing logsheets by two Thai tuna longliners namely, "Mook Andaman 018" and "Mook Andaman 028", which declared to Department of Fisheries, Thailand. Data from their logsheets displayed important information of their fishing operation and effort. During 2009-2013, fishing grounds were mainly in the Western coast of Indian Ocean, fishing operations were recorded 2,096 fishing day. The highest total catch was in 2010 with 607.69 tonnes followed by 2012, 2011, 2013 and 2009 respectively (470.41, 373.44, 344.77 and 295.23 tonnes). The highest CPUE was found in 2010 with 13.62 fish/1,000 hooks followed by 2012 and 2013, respectively (10.83 and 9.50 fish/1,000 hooks). During 2009–13, the albacore tuna (Thunnus alalunga) caught by number and weight were 13,145 fish and 303.43 tonnes. The average percentage composition by number and weight of albacore tuna were 24.31% and 14.51%, respectively. In 2013, albacore tuna was lowest catch by number and weight (99 fish and 2.29 tonnes) and its CPUE were 0.12 fish/1,000 hooks and 2.78 kg/1,000 hooks. The percentage composition of albacore tuna by number and weight were 1.27% and 0.66%, respectively.*"

41. The WPTmT **NOTED** that the decrease of albacore CPUE in 2011 was probably due to a change in targeting with the fishing vessels operating more in the equatorial area since that time.

Reunion Island longline fishery

42. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–12 Rev_1 which characterises the Reunion Island pelagic longline fishery, including the following abstract provided by the authors:

"*This document presents a characterization of the Reunion Island pelagic longline fishery, with a first description of the albacore catches, catch-at-size, and the standardized catch per unit of effort (CPUE) series for the period 1992-2013. The spatial catch and effort analysis revealed the major areas of operation of the fishery, and the identification of the fishery core region closer to the Reunion Island area. The trends in the albacore catch-at-size were analyzed annually, and compared between the seasons and regions of operation of the fishery. The albacore nominal CPUEs were calculated as number of fish per 1000 hooks, and were standardized using Generalized Linear Models (GLMs). Four different modeling approaches were used (including Tweedie, lognormal, Negative Binomial and Delta-method models) and compared in a sensitivity analysis. The models were compared with goodness-of-fit measures, and validated with residual analysis. The results presented in this paper, in particular the proposed albacore annual index of abundance, is a further contribution by the European Union to contribute for the assessment of the species in the Indian Ocean.*"

43. The WPTmT **NOTED** that the La Reunion longline fishery CPUE analysis currently compared among the three regions of operation of the fishery 1) Mozambique channel, 2) Seychelles region, and 3) the core of the fishery near Reunion. However, the analysis did not account for area differences in CPUE between north and south in the core region. The authors were encouraged to examine the possibility of accounting for fine scale area effects for the next WPTmT meeting.

44. The WPTmT **NOTED** that the analysis would also benefit by an examination of the level of targeting of albacore in the time series used. This could be investigated using a range of methods including cluster analysis to identify targeting.

Short review on biology, structure, and migration of Thunnus alalunga in the Indian Ocean

45. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–13 which provides a short review on biology, structure, and migration of *Thunnus alalunga* in the Indian Ocean, including the following abstract provided by the authors:

"*The most comprehensive contribution to our understanding of albacore tuna, Thunnus alalunga, comes from studies in the Pacific and Atlantic Ocean. In the Indian Ocean, there is little information about this species in the literature. In the present paper, we propose a short review on albacore in the Indian Ocean with a particular attention on the biology, the structure, and the migration. We focused on these fields because they are key components of stock assessment undertaken by Regional Fishery Management Organization. This work is part of an ongoing work on a global review of albacore tuna in the world.*"

46. The WPTmT **AGREED** that there although there may be evidence for separate stocks, the size distribution of fish did not show eastern and western separation. The main spatial size structure pattern was the north-south division with smaller fish found to the south. The higher catches in the west of fish at spawning size could be explained by the higher fishing effort in the western spawning areas.

47. The WPTmT **AGREED** that research to better understand albacore biology, movements and stock structure was necessary, and that the work would benefit from applying multiple approaches at once with comprehensive studies on the same fish. These may include studies of otolith microchemistry, genetics (with sufficient resolution to apply approaches such as genetic tagging and effective population size), parasites and ageing.

China longline fishery: Size data

48. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–14 which provided size composition data from albacore measured from the Chinese longline fishery observer scheme, including the following abstract provided by the authors:

"*Albacore (Thunnus alalunga) is a highly migratory tuna species. This paper presents the current information on length frequency of Albacore (Thunnus alalunga) caught in the Indian Ocean based Chinese longline fishery scientific observer program from 2008–13(no observer for 2011) with five trips in all. The average fork length of albacore is the shortest in 2010. In the five years, length of albacore caught distributed from 71–120 cm and the dominant FL class mostly at 102–104 cm. The length distribution from 2008 to 2013 was mainly at 98–116 cm (98.4%) in the first quarter, which suggested that larger fish tends to appear in the north part of Indian Ocean, while smaller fish were likely limited in the area south of Lat. 36º S. Details on length frequency by year, by quarter and by area were also presented.*"

Japanese longline fishery for albacore

49. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–15 which provided an overview of the Japanese longline fishery and its albacore catch in the Indian Ocean, including the following abstract provided by the author:

"*Status of effort, albacore catch, CPUE and body size 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 pirates. 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 pirates. 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. Size data of albacore has been almost constantly collected from on-board measurement, observer program and so on, although sample size was usually not large. Changes in fish size by season, area and period were observed, for example, the fish south of 30°S was smaller than those in the north of 30°S.*"

50. The WPTmT **NOTED** the increased contribution of scientific observer data in comparison to previously important training vessel and commercial vessel size data collection activities. Given the increased reliance on scientific observers to collected size data, it is even more important to ensure a representative sampling program of all areas fished is undertaken.

51. The WPTmT **NOTED** that in recent years many Japanese longline vessels are actively targeting albacore for several reasons including piracy activity in traditional tropical tuna fishing areas, the improving fish price for sashimi grade albacore in Japan, and the declining quota allocation for southern bluefin tuna.

Albacore parameters for stock assessments

52. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–16 which provided a review of potential albacore life history parameters for potential use in stock assessments, including the following abstract provided by the author:

"*We reviewed seven albacore (ALB) parameters for stock assessments including (1) stock structure, (2) sex ratio, (3) growth equation, (4) natural mortality (M), (5) LW relations, (6) maturity-at-age and (7) life span and plus group age. In the review, we investigated those used in tuna RFMOs (ISC, ICCAT, WCPFC and IOTC). Then we suggested the most feasible parameters for ALB stock assessment in the Indian Ocean.*"

53. The WPTmT **CONSIDERED** a range of potential life history parameters for use in albacore stock assessments, and **AGREED** to the following five parameters, i.e. 1) a single stock hypothesis, 2) same sex ratio (1:1), 3) LW relation by Penney (1994), 4) Maturity-at-age by Farley (2012) and 5) Age 15 as the plus group age. Two other parameters were also discussed i.e., 1) growth equations which have two options, i.e., sex based one by Chen et al (2012) and sex aggregated one by Wells et al. (2013) and 2) M (natural motality) which has four options, i.e., constant M(0.2, 0.3 and 0.4) and the hybrid one by Lee and Liu (1992)(M=0.22) and M=0.4. These two options should also be used as options for growth equations and M(natural mortality) vectors. A summary of the parameters for current and future analysis is provided in Section 8.3, Table 12 below.

Rep. of Korea longline fishery for albacore

54. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–17 which provided a review of catch and effort for albacore tuna by Korean tuna longline fishery in the Indian Ocean (1965–2013), 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 2013. The number of active fishing vessels had showed the highest in the mid-1970s, since then it has sharply decreased and reduced to 7 vessels in 2011 and 2012. In 2013 it showed a slight increasing, which was 9 vessels. The albacore tuna catch peaked at about 10 thousand mt in 1974 and decreased sharply thereafter. Since the mid-2000s it has increased, which was 582 mt in 2013. The CPUE of albacore tuna showed a steady trend from 1977 to 2002 except a jump in 1978, and has been increasing thereafter. In the 1970s and 1980s, the fishing ground of albacore tuna by Korean longline fishery was formed between 10°N and 40°S of the western and eastern Indian Oceans, but it moved gradually to the southern of the Indian Ocean thereafter, and was formed mainly between 20°S and 40°S of the western and eastern Indian Oceans in recent years.*"

55. The WPTmT **NOTED** the clear pattern of catch and effort having moved out of the area in the north-west Indian Ocean by the Rep. of Korea's longline fleet since 2010, which is considered to be a direct result of the impacts of piracy activities in this region.

56. The WPTmT **NOTED** that the reported increase in the catches of albacore, which have been combined with a decrease in the catches of bigeye tuna in recent years by the Rep. of Korea's longline fleet, was most likely related to the Rep. of Korea's southern bluefin tuna fishery pattern, and due to the increasing piracy activity in the western Indian Ocean which result in the displacement of longline vessels towards the southern Indian Ocean which are now opportunistically targeting albacore.

57. The WPTmT **NOTED** the Rep. of Korea's efforts to review the historical data series in the eastern and western Indian Ocean and that they would compare their data sets with those held in the IOTC Secretariat's databases.

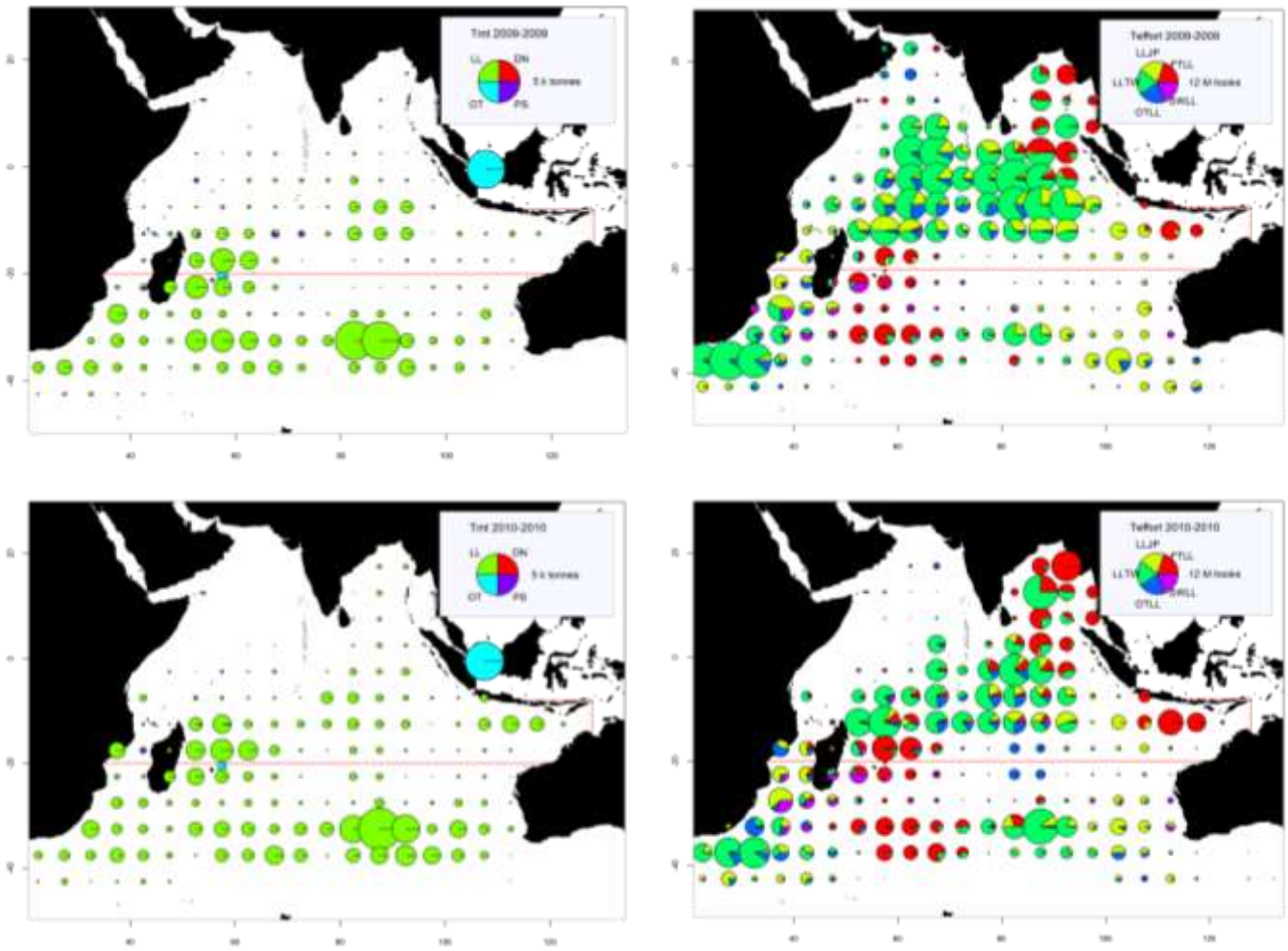
7.2 Effect of piracy on temperate tuna catches

58. The WPTmT **NOTED** that, although no specific analysis of the impacts of piracy on fisheries in the Indian Ocean were presented at this meeting, several papers presented continue to highlight the substantial displacement of effort into traditional albacore fishing areas, thereby increasing fishing pressure on this species. Political instability led to industrial fisheries to abandon fishing activities in the undeclared Somali EEZ in 2005. Piracy has substantially altered fishing activity in the rest of the western Indian Ocean since 2007, and has

altered the spatial distribution of fishing throughout the entire Indian Ocean. As the spatial distribution of fishing effort has varied substantially from year to year, these events provide insight into fishing effort relocation and catch. In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia, where catch rates of albacore are higher (Fig. 1).

59. The WPTmT **NOTED** that the number of active vessels from the Rep. of Korea has decreased from 26 in 2006 to 7 in 2011 and 2012 (73% reduction) and 9 in 2013. Since 2007, the Rep. of Korea tuna longline fleet has moved fishing grounds to south of 20°S in the Indian Ocean, especially to the waters off the western Australian coastline, where some targeting of albacore has occurred since 2010. This has resulted in an increase in catch despite an overall reduction of fishing effort (Fig. 1).

60. The WPTmT **NOTED** reports from Thailand, China and Taiwan,China that longline vessels from some fleets appear to be moving back towards the central Indian Ocean in 2013, as a direct result of increased CPUE being recorded in these areas. The WPTmT **AGREED** that this movement back into the area vacated due to piracy activities should be closely monitored and reported at the SC and the next WPTmT meeting.



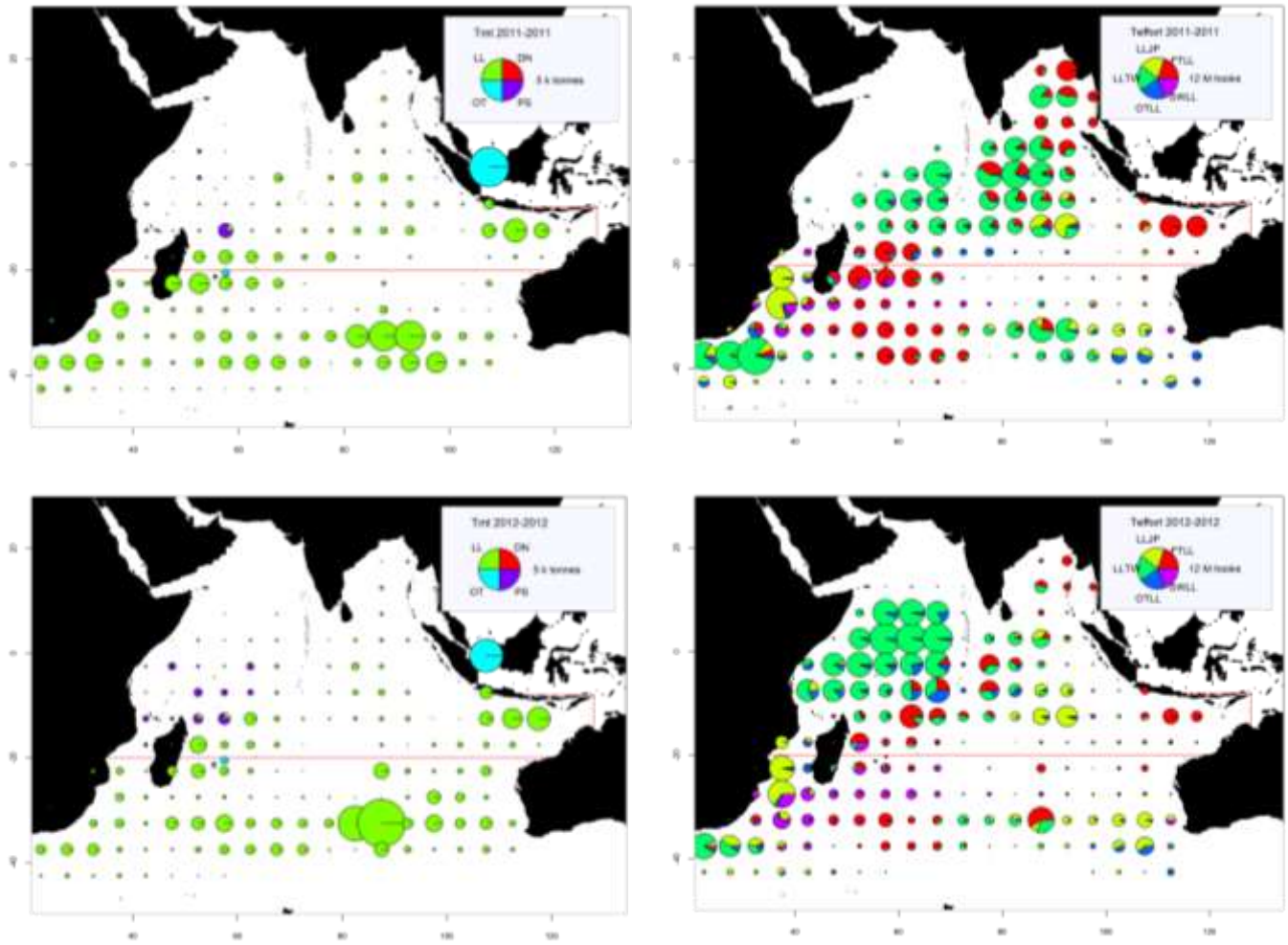


Fig. 1. The geographical distributions of catches by gear (tonnes; left column) and effort by the main longline fleets (millions of hooks; right column) for albacore caught in the IOTC area of competence, 2009–12.

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

Effort: LLJP (light green): deep-freezing longliners from Japan; LLTW (dark green): deep-freezing longliners from Taiwan,China; SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets); FTLL (red): fresh-tuna longliners (China, Taiwan,China and other fleets; OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets).

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

8.1 Nominal and standardised CPUE indices

CPUE Standardisations

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

61. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–18 Rev_1 which provided a standardised CPUE series for albacore based on Japanese longline catch and effort statistics from 1975 to 2012, including the following abstract provided by the authors:

    "*Standardization of albacore CPUE by Japanese longline fishery in the Indian Ocean during 1975–2012 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 north and south area, of which the latter is regarded as core area. CPUE in the south area was comparatively constant until 2003 and then rapidly increased and decreased. CPUE in the north area increased with fluctuation between 1975 and 1993, and slightly decreased or kept similar level after that. Quarterly CPUE indicated strong seasonality. The effect of each factor in standardization usually differed by area.*"

62. The WPTmT **NOTED** the explanation provided by the authors that the starting point for the series was changed from 1966 in the previous analysis (2012) to 1975 in this years' analysis due to a targeting shift from albacore to

bigeye tuna occurred during late 1960s to early 1970s, and so the CPUE in this period may not reflect an actual abundance index.

63. The WPTmT **NOTED** the updated CPUE series, covering the period up to 2013, was presented during the meeting (included in paper IOTC–2014–WPTmT05–18 Rev_1).

64. The WPTmT **NOTED** the use of 5 degree squares in the standardisation model which was a request from the previous WPTmT meeting. The inclusion of environmental variables into the standardisation was also considered, although they may mask actual changes in abundance. Including 5 degree squares in the standardisation accounts for some of the effects of environmental variation. However, the author explained that the seasonality of environmental variable (sea surface temperature) can't be explained only by 5 degree squares.

65. The WPTmT **NOTED** that there had been a change in targeting in recent years, as well as in the early period of the fishery (late 1960s to early 1970s). In recent years, higher commercial value for albacore and a reduced TAC for southern bluefin tuna had resulted in a shift in targeting to albacore. As for the latter, that period is regarded as a transitional period from a period of targeting to bycatch. The period between the two is considered as a bycatch period.

66. The WPTmT **AGREED** that the change in targeting poses a substantial problem in the utility of the Japanese longline CPUE series representing abundance. The authors were encouraged to consider methods to resolve or minimise this problem when the series is next analysed. Such methods are based on species composition rather than gear configuration such as hooks between floats, though there is research under way on methods to consider both data types in combination. If these methods are successful, a time series could be estimated from the Japanese longline data that would cover the period from 1976 to the present, and there is also the potential to go back to 1966 if vessel identities could be assigned to sets before 1976. Such a long time series would greatly improve the stock assessments for albacore.

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

67. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–19 which provided a standardised CPUE for albacore based on Taiwan,China longline catch and effort statistics from 1980 to 2013, including the following abstract provided by the authors:

"*Because of disharmonious CPUE trends, using generalized linear models without the effect of fishing gears interventions, were observed during recent assessments on Indian Ocean albacore, an attempt of identification the'Core albacore Area' was recommended to rectify this problem. This study was thus to propose the'Core albacore Area' and to standardize its corresponding albacore abundance indices based on Taiwanese longline fisheries data series. Two areas were proposed by Taiwan as the core albacore area, namely South area 2a (S15°-45°, E55°-100°) and South area 2b (S20°-40°, E20°-70°) respectively. For Taiwanese longline fishery, both proposed core areas do have own characteristics and represented meaning. South area 2a is always the most dominate fishing ground of albacore by Taiwanese longline fishery. Although South area 2b is also an important fishing ground of albacore, it reflects the shift of fishing composition since 2000. Standardized yearly and quarterly CPUE series of both areas' albacore, dating from 1980 to 2013, based on Taiwanese longline catch and effort statistics by using Generalized Liner Model (GLM) procedure were carried out in present study."* – See paper for full abstract

68. **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 CPUE series.

69. The WPTmT **AGREED** that addressing the impact of changes in targeting on the CPUE standardised series is a high priority for the Taiwan,China time series, and that including the CPUE of other species in the model is usually not appropriate when trying to account for targeting as changes in the abundance of the other species will likely mask the abundance estimates of albacore. Cluster analyses has been used to address changes in targeting in the Taiwan,China longline fleet in the south Pacific, with some success, in areas with a variety of fishing strategies.

70. The WPTmT **REQUESTED** that Taiwan,China examine a model that incorporates the effect of hooks per basket for the period 1995 to current, and results to be presented at the next WPTmT meeting.

Rep. of Korea – Catch-per-unit-of-effort (CPUE)

71. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–20 which provided a standardised CPUE for albacore based on the Rep. of Korea's longline catch and effort statistics from 1977 to 2013, including the following abstract provided by the authors:

"*In this study, CPUE (catch per unit effort) standardization for albacore tuna of Korean longline fishery in the Indian Ocean was conducted by Generalized Linear Model (GLM) using operational (set by set) data to assess the proxy of the abundance index. Albacore tuna CPUE by Korean tuna longline fishery was standardized for the whole area and for the core areas (2 cases). For the core area, the CPUE standardization was conducted as considering followed two ways. Firstly, to explore the core area where vessels have mainly operated to fish for albacore tuna, we analyzed the frequency of fishing year when there was 1 SBT or more caught in each 5° ×5° area. Therefore, the core area was defined as the area where fishing for albacore tuna had occurred more than 15 times in the same area during 1977–2013. Secondly, the area of 0°-15°S between 40°E-100°E was chosen as the core area based on the operational patterns of Korean tuna longline fishery. All of standardized CPUE had had a steady trend at low level until 2006 and started to increase in 2007, since then, however, those show different trends among each model.*"

72. **NOTING** that the analysis divided the Indian Ocean into two subareas which are likely to be too large to address the problem of effort relocation to areas of improved catch rates, the WPTmT **RECALLED** that the approach recommended by the IOTC CPUE workshop is to use 5 degree squares when standardising CPUE series.

73. The WPTmT **AGREED** that the use of individual vessel effects in the standardisation model would likely improve it as a measure of abundance. The author explained that it was not possible to use fishing master identities in the standardisation. Consideration should be given to using consistent vessel identifiers such as the vessel call sign, as with Japanese longline, if available.

74. The WPTmT **NOTED** that the most likely cause of the change in targeting in recent years, which caused a large change in the catch rate, is likely due to piracy activities and the TAC for southern bluefin tuna.

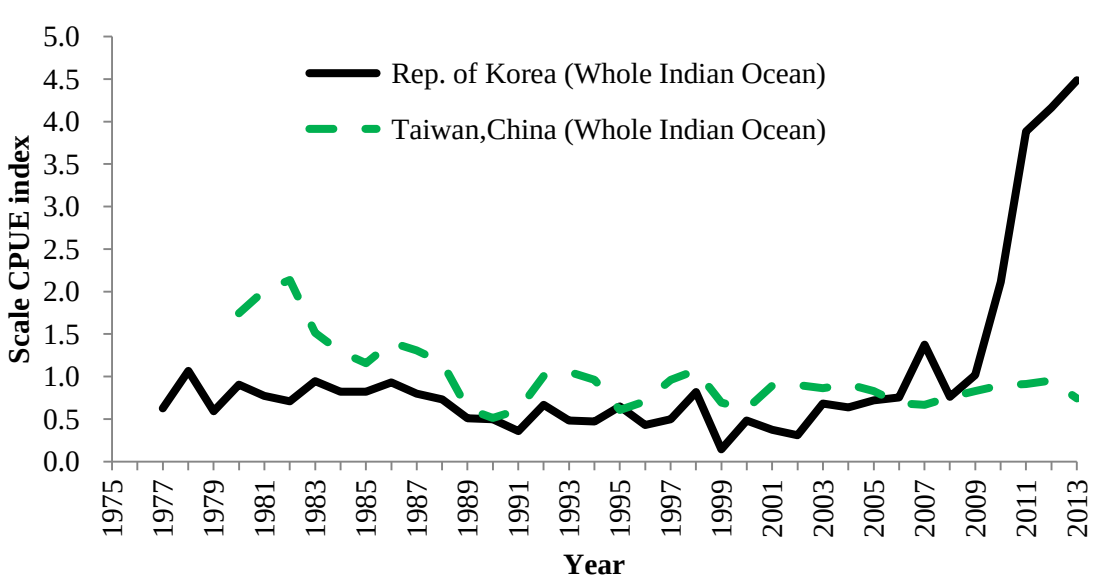
75. The WPTmT **NOTED** that the diagnostics indicated a poor model fit and that it may be better to use a different distribution.

CPUE discussion summary

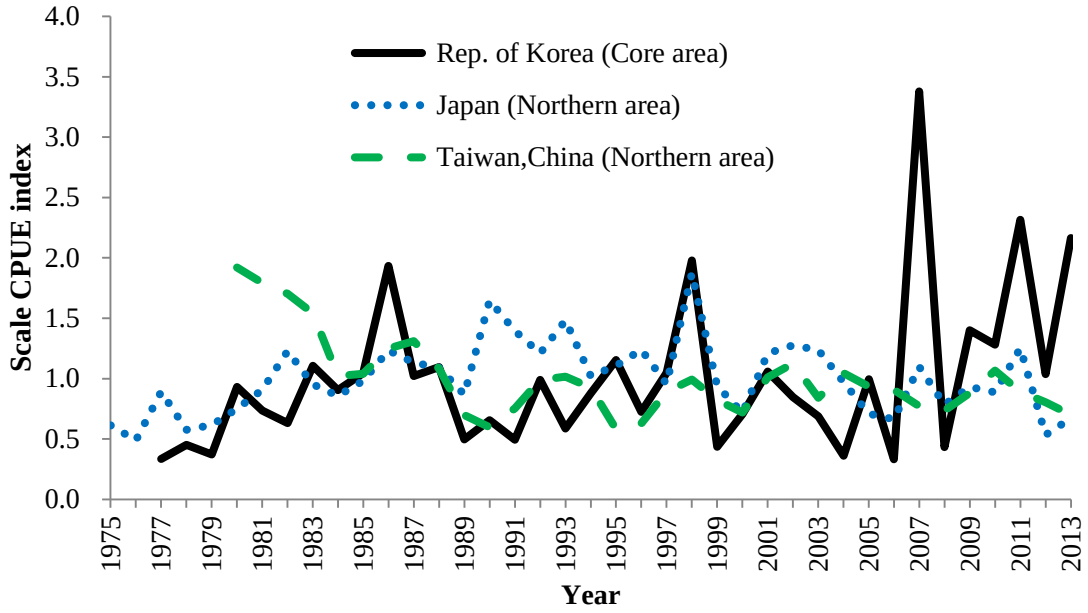
76. The WPTmT **AGREED** that there was merit in exploring the option of using all data from the three main fleets (Japan, Taiwan,China and Rep. of Korea) together in a combined CPUE analysis with a common area definition, to avoid missing combinations (area/quarter/other factors), by incorporating a "fleet effect". This may lead to a single standardised CPUE series which would avoid the need for CPUE series weighting.

77. The WPTmT **NOTED** that of the CPUE series available for assessment purposes, listed below, the Taiwan,China series (Southern area 1 and Southern area 2a; Fig. 2c) were used in the final stock assessment models for management advice purposes, for the reasons discussed above (shown in Fig. 2).
    - Japan data (1975–2012): 2 series from document IOTC–2014–WPTmT05–18 Rev_1
    - Taiwan,China data (1980–2013): 4 series from document IOTC–2014–WPTmT05–19
    - Rep. of Korea data (1977–2013): 2 series from document IOTC–2014–WPTmT05–20 Rev_1

a)



b)



c)

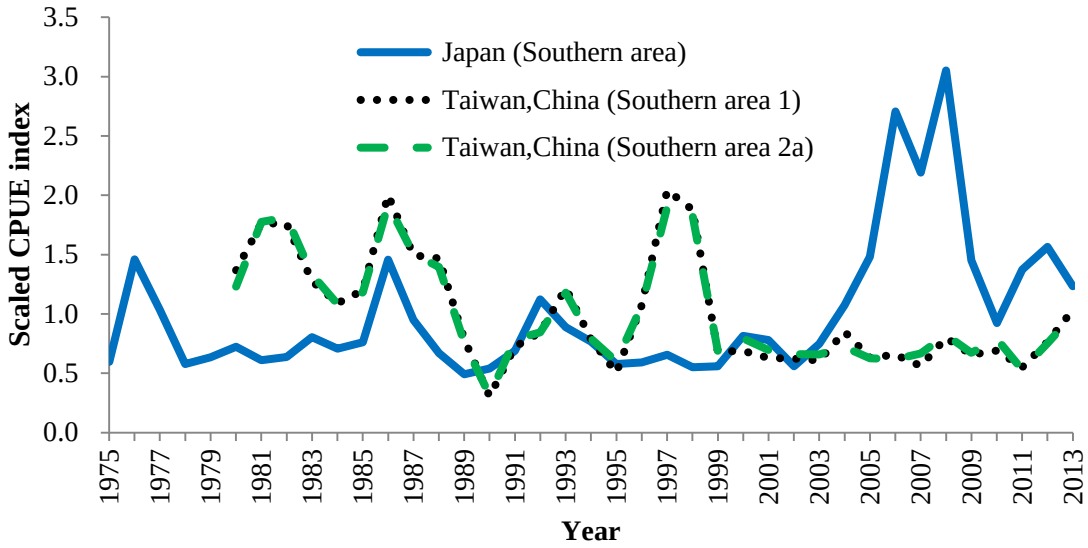


Fig. 2. Comparison of the CPUE series for longline fleets fishing for albacore in the IOTC area of competence. a) Whole Indian Ocean b) Northern area and c) Southern area. Series have been rescaled relative to their respective means from 1975–2013.

8.2 Stock assessments

78. The WPTmT **NOTED** that a range of quantitative modelling methods as detailed below (BBDM, ASAP, ASPIC, ASPM and SS3) were applied to the assessment of albacore in 2014, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. The different assessments were presented to the WPTmT in documents IOTC–2014–WPTmT05–21, 22, 23, 24 and 25. Each model is summarised in the sections below.

Summary of stock assessment models in 2014: albacore

79. The WPTmT **NOTED** Table 2 which provides an overview of the key features of each of the stock assessments presented in 2014 (5 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 2014.

Model feature	BBDM (Doc# 21)	ASPIC (Doc #22)	ASPM (Doc #23)	SS3 (Doc# 24)	ASAP (Doc# 25)
Software availability	W. Guan	NMFS toolbox	Nishida & Rademeyer	NMFS toolbox	NMFS toolbox
Population spatial structure / areas	1	1	1	1	1
Number CPUE Series	1(TWN,CHN)	1 or 2	1	1 (TWN,CHN);	2(TWN,CHN)
Uses Catch-at-length/age	No	No	Yes	Yes	Yes
Age-structured	No	No	Yes	Yes	Yes
Sex-structured	No	No	No	Yes	No
Number of Fleets	1	3	5	7	7
Stochastic Recruitment	No	No	Yes	Yes	Yes

80. The WPTmT **RECALLED** the value in undertaking a number of different modelling approaches to facilitate comparison, and **AGREED** that spatially structured integrated models, which are capable of more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simpler production models, be carried out for the next WPTmT, as data and resources permit.

Table 3. Summary of key management quantities from the assessments undertaken in 2014.

Management quantity	BBDM (Doc# 21)	ASPIC (Doc #22)	ASPM (Doc #23)**	SS3 (Doc# 24)	ASAP (Doc# 25)
Most recent catch estimate (t) (2012)	33,863				
Mean catch over last 5 years (t) (2008–2012)	37,090				
h (steepness)	n.a.	n.a.	n.a.	0.8	0.7 (base case)
MSY (1,000 t) (80% CI) [plausible range of values]	35.8 (33.3–38.8)	34.7 (28.8–37.4)	n.a.	47.6 (26.7–78.8)	26.6
Data period (catch)	1980–2012	1950–2012	n.a.	1950–2012	1980–2012
CPUE series	LL: Taiwan,China	LL: Taiwan,China (Southern 2a)	n.a.	LL: TWN,CHN, (Southern 1)	LL: Taiwan,China
CPUE period	1980–2012	1980–2012	n.a.	1981–2012	1980–2012
F_{MSY}	0.42	0.50	n.a.	0.31 (0.21–0.42)	0.18
SB_{MSY} or $*B_{MSY}$ (1,000 t)	87.4*	68.6*	n.a.	39.2 (25.4–50.7)	115.7
$F_{current}/F_{MSY}$ (80% CI) [plausible range of values]	0.84 (0.61,1.10)	0.94 (0.68-1.61)	n.a.	0.69 (0.23–1.39)	1.28
B_{2012}/B_{MSY} (80% CI) [plausible range of values]	1.17 (0.93,1.43)	1.05* (0.73-1.35)	n.a.	n.a.	n.a.
SB_{2012}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.	1.09 (0.34–2.20)	1.01
B_{2012}/B_{1950} (80% CI)	n.a.	0.43 (n.a.)	n.a.	0.43 (0.26–0.58)	n.a.
SB_{2012}/SB_{1950} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.	0.21 (0.11–0.33)	n.a.
$SB_{2012}/SB_{current, F=0}$	n.a.	n.a.	n.a.	n.a.	n.a.

**ASPM results were withdrawn (see para. 92 for details); LL = longline; n.a. = not available

Bayesian biomass dynamics model

81. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–21 which analysed population dynamics of Indian Ocean albacore (*Thunnus alalunga*) using Bayesian biomass dynamics model, including the following abstract provided by the authors:

> "*Two continuous biomass dynamics models (i.e. Logistic-form and Fox-form biomass dynamics models) were developed based on WinBUGS to assess the stock status of Indian Ocean albacore (Thunnus alalunga) using 33 years of fishery data (1980–2012). The results showed that for the Logistic-form biomass dynamics model, the mean of Maximum sustainable yield (MSY) was estimated to be 32798 t, and the mean of B_{2012}/B_{MSY} and F_{2012}/F_{MSY} was 0.93 and 1.18, respectively. For the Fox-form biomass dynamics model, the mean of MSY was 35796 t, and the mean of B_{2012}/B_{MSY} and F_{2012}/F_{MSY} was 1.17 and 0.84, respectively. The risk assessments suggested that for the Fox-form biomass dynamics model, the current catch level in 2012 (33,864 t) was lower than MSY (mean value) and this level can introduce lower risk for the fishery to exceed F_{MSY} and B_{MSY}. However, for Logistic-form biomass dynamics model, the result was more pessimistic, i.e., the current catch level was higher than MSY (mean value) and this level can introduce higher risk for the fishery to exceed F_{MSY} and B_{MSY}. There were high uncertainties in both models; however, the Fox-form biomass dynamics model was fitted little better than the Logistic-form model.*"

82. The WPTmT **NOTED** the key assessment results for the Bayesian biomass dynamics model (BBDM) as shown below (Tables 4 and 5; Fig. 3).

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

Management Quantity	Indian Ocean
2012 catch estimate	33,863
Mean catch from 2008–2012	37,090
MSY (1000 t) (80% CI)	35.8 (33.3–38.8)
Data period used in assessment	1980–2012
F_{MSY} (80% CI)	0.42 (n.a.)
B_{MSY} (1000 t) (80% CI)	87.4 (n.a.)
F_{2012}/F_{MSY} (80% CI)	0.84 (0.61–1.10)
B_{2012}/B_{MSY} (80% CI)	1.17 (0.93–1.43)
SB_{2012}/SB_{MSY}	n.a.
B_{2012}/B_{1980} (80% CI)	n.a.
SB_{2012}/SB_{1980}	n.a.
$B_{2012}/B_{1980,\ F=0}$	n.a.
$SB_{2012}/SB_{1980,\ F=0}$	n.a.

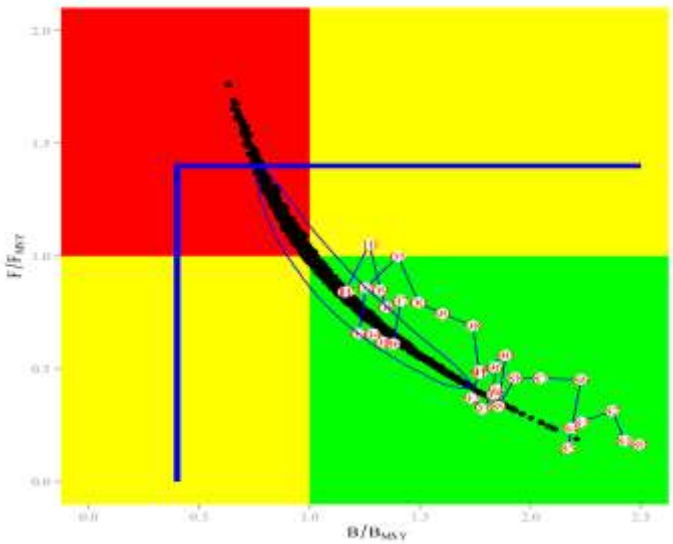


Fig. 3. Albacore: BBDM aggregated Indian Ocean assessment Kobe plot (The horizontal blue line represents F_{LIM} and the vertical blue line represents B_{LIM}). The results are from a preferred model option: Model 10 (IOTC–2014–WPTmT05–21).

Table 5. 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 2011–13, ± 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 2012–13) and probability (%) of violating MSY reference points								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2015} < B_{MSY}$	<1		3	8	19	36	55	–	82
$F_{2015} > F_{MSY}$	0		<1	5	20	45	69	–	92
$B_{2022} < B_{MSY}$	0		0	2	20	60	85	–	98
$F_{2022} > F_{MSY}$	0		0	2	20	61	87	–	98

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels associated with the interim target and limit reference points on a stock by stock basis, the Scientific Committee could prepare and include, in the annual report, the Kobe II strategy matrices using colour coding corresponding to these thresholds.

83. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - The use of an informative prior on r from a previous analysis done by Hillary (2008) could be problematic, as it has a circular argument. Using sources from other areas would be a better choice.
    - The surplus production model has an optimal yield target that occurs at 50% of B_0 (in case of the Schaefer model) or near 40% of B_0 (in case of the Fox model).
    - The r (intrinsic rate of growth) or a surrogate for productivity is stationary over time, and this can be a problem with Surplus production models. In addition these models don't capture selectivity changes in the fishery over time.
    - Model 10 is very similar to models 14, 15 and 16 in the paper and can have very different conclusions. As such, the authors need a better justification for Model 10.
    - The 90% CI is very narrow on the trajectory of the population and this is contrary to the large uncertainty in r and K.
    - In the future using a depletion of 1, i.e. B_0=K in 1952 would be a better assumption to proceed so fewer parameters would need to be estimated.

A Stock-Production Model Incorporating Covariates (ASPIC)

84. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–22 which provided a stock assessment for albacore in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC) which incorporates some of the improvements agreed at the previous WPTmT meeting, including the following abstract provided by the authors:

    "Assessment of albacore stock in the Indian Ocean based on ASPIC was conducted using latest data. Catch (Japanese and Taiwanese longline including similar longline fisheries, and other fisheries, 1950-2012) and standardized CPUE (Japanese and/or Taiwanese longline) were incorporated. Convergence and reasonable results were obtained for the scenarios with only Taiwanese CPUE or both Taiwanese and Japanese CPUE, and fixed B1/K (0.9). The scenario with both Taiwanese and Japanese CPUE in main fishing area was selected as reference case. As a result, MSY was estimated to be 35,600 tons, and TB (total biomass) ratio and F ratio (ratio of 2013 and 2012 level, respectively, to MSY level) was 1.19 and 0.80, respectively. The recent catch level is about 33,900 tons, which is about 2,000 tons lower than the MSY level. Hence the albacore stock is considered to be neither overfishing nor overfished. The Kobe plot 1 shows large confidential surface, which implies that ASPIC analyses include large uncertainties. According to KOBE II (risk assessments), if current catch level will be maintained, TB will exceed TB (MSY) by 48% of probability in 2023 and F(MSY) by 43% in 2022. Therefore, future catch with current catch level may keep the stock around the MSY level. The results in the present study were a bit more optimistic than those for the last assessment."

85. The WPTmT **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below (Tables 6 and 7; Fig. 4).

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

Management Quantity	Indian Ocean
2012 catch estimate	33,863
Mean catch from 2008–2012	37,090
MSY (1000 t) (80% CI)	34.7 (28.8–37.4)
Data period used in assessment	1950–2012
F_{MSY} (80% CI)	0.50 (n.a.)
B_{MSY} (1000 t) (80% CI)	68.6 (n.a.)
F_{2012}/F_{MSY} (80% CI)	0.94 (0.68–1.61)
B_{2012}/B_{MSY} (80% CI)	1.05 (0.73–1.35)
SB_{2012}/SB_{MSY}	n.a.
B_{2012}/B_{1950} (80% CI)	0.43 (n.a.)
SB_{2012}/SB_{1950}	n.a.
$B_{2012}/B_{1950, F=0}$	n.a.
$SB_{2012}/SB_{1950, F=0}$	n.a.

n.a. not availalbe

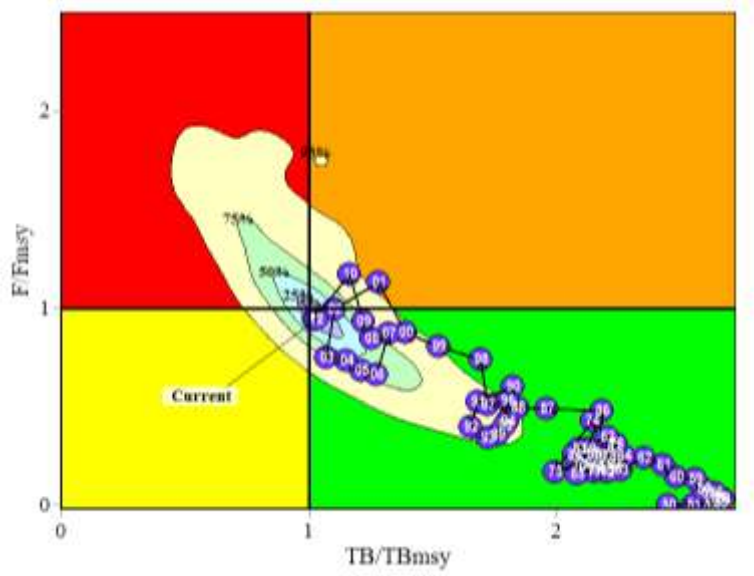


Fig. 4. Albacore: ASPIC aggregated Indian Ocean assessment Kobe plot (Base case scenario 3 from IOTC–2014–WPTmT05–22).

Table 7. 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 2011 to 2013, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY reference points								
	60%	70%	80%	90%	100%	110%	120%	130%	140%
$B_{2015} < B_{MSY}$*	56	56	56	56	56	56	56	56	56
$F_{2015} > F_{MSY}$	21	29	42	59	58	64	70	74	78
$B_{2022} < B_{MSY}$	8	14	30	65	73	82	87	89	92
$F_{2022} > F_{MSY}$	8	11	18	66	73	83	89	92	94

* Fixed 2013 and 2014 catch was used, and ASPIC estimates B-ratio at the beginning of the year. So the probability for all the scenarios becomes the same. **Note**: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels associated with the interim target and limit reference points on a stock by stock basis, the Scientific Committee could prepare and include, in the annual report, the Kobe II strategy matrices using colour coding corresponding to these thresholds.

86. The WPTmT **NOTED** that the ASPIC analysis used a combined CPUE series from Japan and Taiwan,China longline fisheries in addition to a sole series of Taiwan,China CPUE. However, those two series are not synchronised but rather conflicting, and therefore the authors were encouraged to use the two CPUE series not jointly, but separately if they intend to see that influence on the analysis.

87. The WPTmT **NOTED** an additional analysis with a Pella-Tomlinson model estimated the MSY level as 40% of the carrying capacity, which is similar to that of author's preferred Fox model (36.8% of K).

88. The WPTmT **NOTED** that the ASPIC model cannot take in account a possible change in selectivity over years, which indirectly effects the estimate of MSY as well over time.

89. The WPTmT **NOTED** the assessment used data (catch, catch-at-age or catch-at size, and CPUEs) up to 2012. However, an interim report of catch in 2013 was made available just before the meeting, and the level of catch is approximately 22% higher than the 2012 catch level. This warranted an additional analysis by adding data of the most recent year (2013). Taking a feature of the ASPIC, which does not require size data, the authors conducted an analysis with extended data set up 2013. The results indicate that the current Bratio (1.06) using 2013 data was similar to the base case scenario using data up to 2012, However the Fratio (1.09) using 2013 data was higher than the 2012 estimate.

90. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - That the Taiwan,China CPUE standardisation should be used over the Japanese CPUE series because the Japanese CPUE demonstrates strong targeting shifts away from albacore (1960s) and toward albacore in recent years (as a consequence of piracy in the western Indian Ocean), that was not accounted for in the standardization analysis.
    - The Fox model had problems converging to a sensible solution when the Japanese CPUE were given substantial weight, and/or when the initial biomass was constrained to be less than or equal to the carrying capacity.

Age-structured production model (ASPM)

91. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–23 which provided a stock assessment for albacore in the Indian Ocean by an Age-Structured Production Model (ASPM), including the following abstract provided by the authors:

    "*Indian Ocean Albacore stock assessment was attempted by ASPM. Because of large uncertainties in extremely large number of drift gillnet CAA (catch-at-age) matrix (1982-1992) (max 10 million fish) caused by the fundamental problem (no size data), we could not obtain the plausible and realistic results. To overcome this type of situation, we plan to develop additional option to the current ASPM software that can handle original size or CAS (catch-at-size) data, so that ASPM can conduct stock assessment when no or not enough size data situation (NB: when no size data, that option can use substituted size data from other areas and conduct assessments).*"

92. The WPTmT **NOTED** that the authors withdrew the assessment results as ASPM could not obtain a realistic result due to a critical problem (no size data) in high juvenile catch (maximum 25,000 t) of the drift gillnet fishery (1982–92).

Stock Synthesis III (SS3)

93. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–24 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 included catch data from 1952 to 2012. A Stock Synthesis assessment was run in 2012, and this assessment makes a number of changes and documents their effects on the results. Size data were analyzed and the spatial structure of the fisheries was changed to improve the consistency of sizes within the fisheries. Sensitivity runs were carried out with alternative parameters for natural mortality, growth, selectivity, steepness, and spatial structure. Alternative values of biological parameters were explored, given that the different tuna-RFMOs use different assumptions in their stock assessments, in some cases with little evidence, and there are substantial data gaps for Indian Ocean albacore. We examined conflicts among different sources of data and assumptions by down-weighting the different data sources. The sensitivity of management advice to the above explorations was used to identify priority areas for further research. The inferred structural uncertainty, including interactions, was included in the management advice. The assessment incorporates projections for 10 years and provides a Kobe II Strategy Matrix decision table. The stock status using a reference case assessment indicates that the stocks is not experiencing overfishing or is in an overfished status. However there is considerable uncertainty, and*

scenarios that contradict this conclusion are those with low steepness value, or a low natural mortality rate."

94. The WPTmT **NOTED** the key assessment results for the Stock Synthesis III model (SS3) as shown below (Tables 8 and 9; Fig. 5).

Table 8. Albacore: Key management quantities from the SS3 assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2012 catch estimate	33,863
Mean catch from 2008–2012	37,090
MSY (1000 t) (80% CI)	47.6 (26.7–78.8)
Data period used in assessment	1950–2012
F_{MSY} (80% CI)	0.31 (0.21–0.42)
SB_{MSY} (1000 t) (80% CI)	39.2 (25.4–50.7)
F_{2012}/F_{MSY} (80% CI)	0.69 (0.23–1.39)
B_{2012}/B_{MSY} (80% CI)	n.a.
SB_{2012}/SB_{MSY} (80% CI)	1.09 (0.34–2.20)
B_{2012}/B_{1950} (80% CI)	0.43 (0.26–0.58)
SB_{2012}/SB_{1950} (80% CI)	0.21 (0.11–0.33)
$B_{2012}/B_{1950,\ F=0}$	n.a.
$SB_{2012}/SB_{1950,\ F=0}$	n.a.

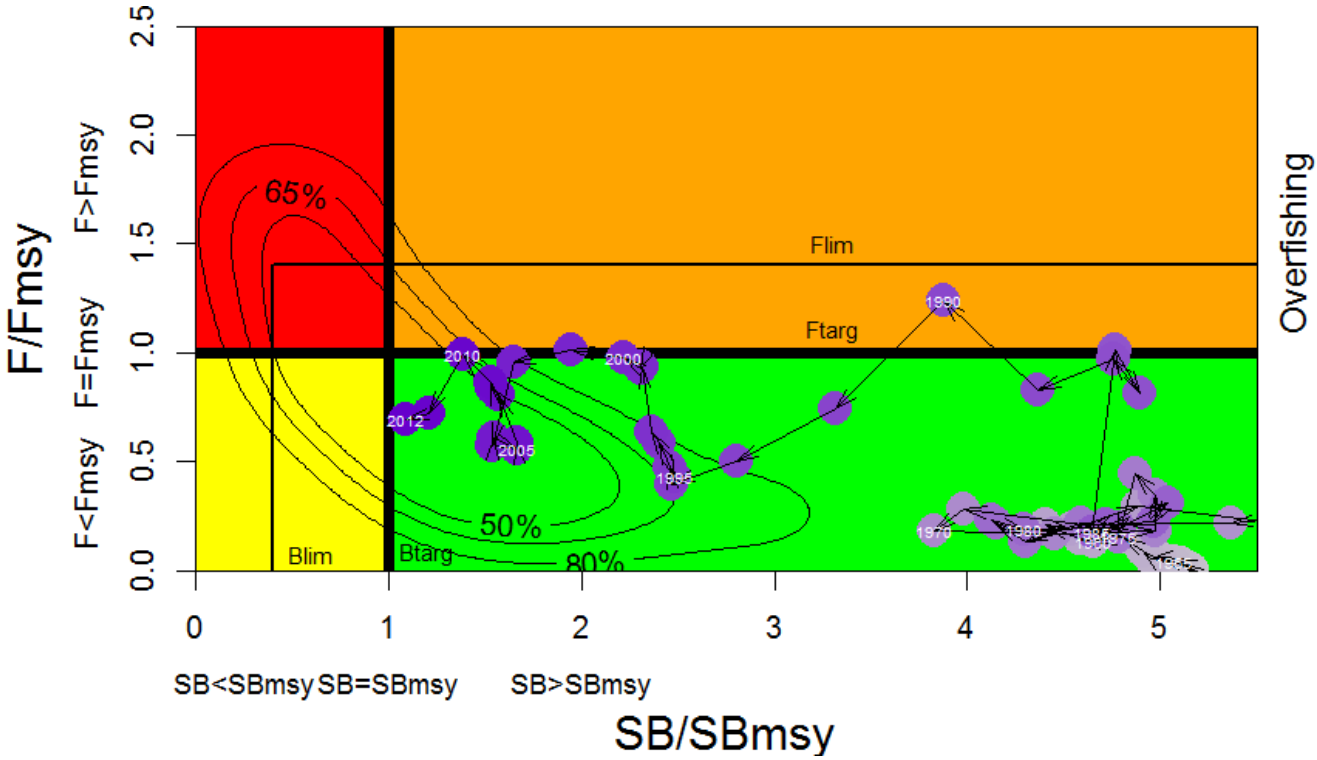


Fig. 5. Albacore: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2012 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2012. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

Table 9. 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 nine constant catch projections (average catch level from 2011–013, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2015} < SB_{MSY}$	31	33	39	42	50	50	50	53	61
$F_{2015} > F_{MSY}$	11	19	22	36	39	44	50	53	56
$SB_{2022} < SB_{MSY}$	11	19	22	33	39	44	47	53	56
$F_{2022} > F_{MSY}$	6	11	22	31	36	44	47	53	56
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2015} < SB_{Lim}$	0	0	6	8	17	22	28	33	33
$F_{2015} > F_{Lim}$	0	6	14	19	25	31	39	42	44
$SB_{2022} < SB_{Lim}$	0	6	14	19	28	33	36	42	47
$F_{2022} > F_{Lim}$	0	6	14	22	31	36	42	44	50

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels associated with the interim target and limit reference points on a stock by stock basis, the Scientific Committee could prepare and include, in the annual report, the Kobe II strategy matrices using colour coding corresponding to these thresholds.

95. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - The fits to the CPUE data from 1997 and 1998 were problematic and issues identified for this should be considered. This could directly be attributed to a few vessels which knew where to catch albacore and thus having a higher catch rate with the rest of the fleet, with unrealistically low Confidence intervals.
    - Recruitment trends in recent years showing a downward trend is problematic and more time investigating this structural uncertainty in the assessment is required.
    - Problems with the forecasting need to account for the declining trends in recruitment and the high values of optimal yield estimated in the model.
    - With respect to the large discrepancy in optimal yield estimates between ASPIC and SS3, some time needs to be spent to account for these differences.
    - A grid accounting for natural mortality (0.2, 0.3, 0.4), steepness (0.7, 0.8 and 0.9) and effort creep (1% or none) would be used to examine a weighted outcome on the analysis (this would use equal weight and a weight giving the natural mortality of 0.2, double the weight of the other runs, i.e. 6 cases where this would occur).

Age structured assessment program (ASAP)

96. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–25 which provided a stock assessment for albacore in the Indian Ocean by age structured assessment program (ASAP), including the following abstract provided by the authors:

    "*This study conducted a stock assessment for Indian Ocean Albacore (ALB; Thunnus alalunga) using Age Structured Assessment Program (ASAP), based on fishery-specific catch and catch-at-age data (1980-2012). The assessment considered that the ALB stock were subject to 7 fisheries, i.e., Longline fishery of Japan in northern Indian Ocean (LLJPNnorth), Longline fishery of Japan in southern Indian Ocean (LLJPNsouth), Longline fishery of Taiwan,China in northern Indian Ocean (LLTWNnorth), Longline fishery of Taiwan,China in southern Indian Ocean (LLTWNsouth), Driftnet fishery (DF), Purse seine fishery (PS), and Other fishery (Other). Standardized catch-per-unit-effort (CPUE) series from longline fisheries of Taiwan, China were used as abundance indices for fitting the model. In addition to base case model, sensitivity analysis was conducted as to two key parameters (i.e., steepness of Beverton-Holt stock-recruitment relationship and natural mortality). The assessment results, including MSY and related biological reference points, were sensitive to the steepness and natural mortality assumptions. However,*

both the base case and sensitivity analyses suggested that the Indian Ocean albacore be not overfished, but overfishing was probably occurring in 2012."

97. The WPTmT **NOTED** the key assessment results for the Age structured assessment program (ASAP) as shown below (Table 10; Fig. 6).

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

Management Quantity	Indian Ocean
2012 catch estimate	33,863
Mean catch from 2008–2012	37,090
MSY (1000 t) (80% CI)	26.6 (n.a.)
Data period used in assessment	1980–2012
F_{MSY} (80% CI)	0.18 (n.a.)
SB_{MSY} (1000 t) (80% CI)	115.7 (n.a.)
F_{2012}/F_{MSY} (80% CI)	1.28 (n.a.)
B_{2012}/B_{MSY} (80% CI)	n.a.
SB_{2012}/SB_{MSY} (80% CI)	1.01 (n.a.)
B_{2012}/B_{1980}	n.a.
SB_{2012}/SB_{1980} (80% CI)	n.a.
$B_{2012}/B_{1980,\ F=0}$	n.a.
$SB_{2012}/SB_{1980,\ F=0}$	n.a.

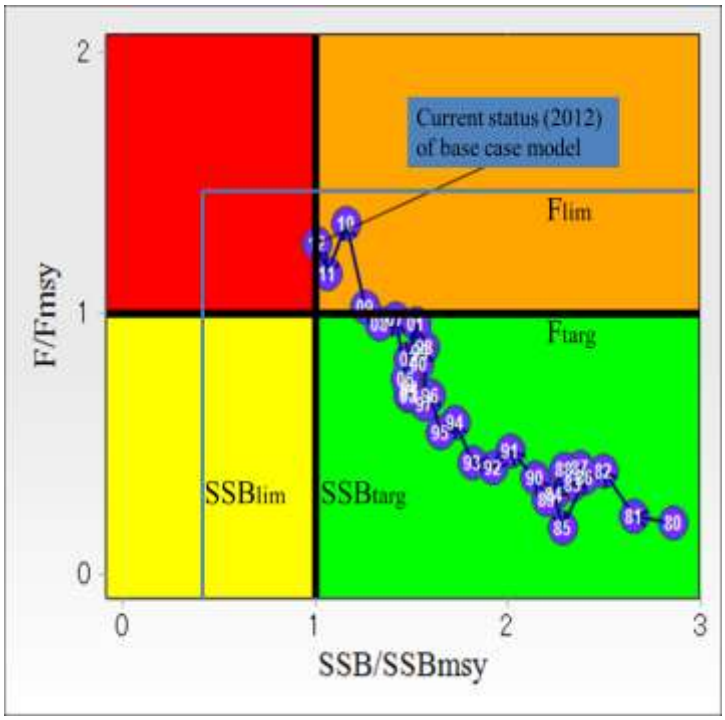


Fig. 6. Albacore: ASAP aggregated Indian Ocean assessment Kobe plot. Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1980–2012. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

98. The WPTmT **NOTED** that the Kobe II Strategy Matrix could not be estimated, as stochastic projections are not possible using the ASAP software.

99. The WPTmT **NOTED** the following with respect to the modelling approach presented at the meeting:
    - The driftnet fishery without much age structured information was creating some problems in estimation in the model.
    - The model failed to converge if extended back to 1950's.
    - Fitting to the age composition data had a very high likelihood, and should be down-weighted in the future. The iterative reweighting procedure gave too much emphasis to the age composition data. In order for the model to capture the biomass trends lower weight should be given to the age-composition data, and more to the CPUE data.

- Profile likelihood is a useful manner to assess what is the effect of the age-composition data on R_0.
- Asymptotic selectivity when you are missing the larger fish may not be appropriate for the Southern fisheries. In this case using a non-asymptotic selectivity would be appropriate for the southern fishery.

8.3 Selection of Stock Status indicators

100. The WPTmT **NOTED** the following with respect to the various modelling approaches used in 2014:
    - There was more confidence in the abundance indices this year due to the additional CPUE analyses from Japan and Taiwan,China, and the exploration of the Rep. of Korea catch and effort data. This has led to improved confidence in the overall assessments.
    - The Taiwan,China CPUE is more likely to closely represent albacore abundance at this time, because a substantial part of the Taiwan,China fleet has always targeted albacore in the southern area (2a) as identified by Taiwan,China.
    - Conversely, the Japanese CPUE seems to demonstrate very strong targeting shifts away from albacore (1960s) and back towards albacore in recent years (as a consequence of piracy in the western Indian Ocean, reduced or increased TAC for southern bluefin tuna, and increased commercial value for albacore). Similar trends are seen in the Rep. of Korea CPUE series.
    - CPUE series should not be average across series with different trends as this is likely to result in spurious trends. Thus, only series which are considered to be most representative of abundance, in this case the Taiwan,China series, should be used in stock assessments while further work is carried out on the Japanese and Rep. of Korea longline series.
    - It was recognised that the deterministic production models were only able to explore a limited number of modelling options. The structural rigidity of these simple models causes numerical problems when fit to long time series for some cases. This was also apparent in the ASPM Model approach pursued in WPTmT 2014.

101. 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 lot of uncertainties in 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, sometimes the ASPIC model can have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

102. The WPTmT **NOTED** that the stock structure of the Indian Ocean albacore resource is under investigation, but currently uncertain. The south-west region was identified as an area of interest, as it is likely that there is stock connectivity with the southern Atlantic albacore population.

103. The WPTmT **AGREED** that albacore stock status should be determined by qualitatively integrating the results of the ASPIC and SS3 stock assessments undertaken in 2014. The WPTmT treated the two analyses as equally informative, and focussed on the features common to all of the results.

104. **NOTING** the discussion around how to decide upon the most appropriate way to present the integrated stock assessment results to the Scientific Committee, the WPTmT **AGREED** that the output of the ASPIC and SS3 models were most likely to numerically and graphically represent the current status of albacore in the Indian Ocean.

105. The WPTmT **AGREED** that this does not represent an endorsement of the SS3 or ASPIC over the other models used in 2014, as there are still substantial problems with the ASPIC and SS3 on some of the model runs pursued, and the WPTmT considers all of the models to be informative of stock status.

Parameters for future analyses: CPUE standardization and stock assessments

106. The WPTmT **AGREED** that in order to obtain comparable CPUE standardisations, the analyses shall be conducted with similar parameters and resolutions. Table 11 provide a set of parameters, discussed during the WPTmT05, that shall give guidelines, if available, for the standardisation of CPUE in preparation for the next WPTmT meeting to be used as indices of abundance for the stock assessments.

Table 11. A set of parameters for the standardisation of CPUE series in preparation for the next WPTmT meeting.

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, HBF, vessel + interactions, 5x5 block effect
All fleet	*Combine data for all fleets with the above effects + fleet*

107. The WPTmT **AGREED** that CPUE standardisation should account for targeting effects as it is one of the main reasons for differential nominal CPUE trends.

108. The WPTmT **AGREED** that a global CPUE standardisation could be undertaken by pooling all the data available for the main longline fleets in one analyses.

109. The WPTmT **AGREED** that the model parameters contained in Table 12 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 12. Model parameters agreed to 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	1:1
Age (longevity)	15+ years (may need to re-examine this assumption for age-based assessments)
Natural mortality	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). N. Pacific values of M=0.3 were also appropriate for examining. Sensitivity to M=0.2 and 0.4 should also be examined.
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=0.7, sigma_R=0.6 (alternative h=0.8, and 0.8 are also appropriate)
Other parameters	
Fisheries	7 (Jpn LL N & S, Twn LL N & S, DN, PS, Other)
Abundance indices	JPN, TWN,CHN, KOR (combined datasets if available)
Selectivity	Fishery specific. Dome-shaped double-normal

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

8.4 Albacore management strategy evaluation (MSE) process

110. The WPTmT **NOTED** the presentation and update of the on-going process of the albacore Management Strategy Evaluation (MSE), given on behalf of the MSE informal work group by the Vice-Chairperson of the Working Party on Methods. The MSE process is in general a simulation framework for assessing the performance of management procedures for wildlife, and the usual questions are if goals/objectives are achieved or not by proposed "management procedures", which include some "harvest control rules". The MSE can handle various types of uncertainty such as uncertainty in data and input parameters; process uncertainty (e.g. process errors); estimation uncertainty; model uncertainty; and implementation uncertainty in its framework.

111. The WPTmT **NOTED** that the MSE process consists of the following:
    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 focus of the WPM is to develop OM's (item 3), and then to condition them. Currently, the OMs have been conditioned using the previous albacore SS3 assessment (2012). However, given availability of the updated albacore SS3 assessment (2014), it was **AGREED** that the updated results now be used in the albacore MSE processes. The difference between previous and new specification of OMs is summarised in the Table 13.

113. The WPTmT **RECALLED** para. 3 of Resolution 13/10 which states:

> "*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.

Table 13. The difference between the previous and new specification for the albacore Operating Model

MSE for albacore	**Reference specification trials**	**New specifications**
Population dynamics	Age-structured (0-8 yr; sex ratio 1:1)	Age-structured (0-14+; sex ratio at birth 1:1)
#Areas	1 (aggregated)	
Conditioning	SS3: Kitakado et al. (2012)	SS3: Hoyle et al. (2014)
3.1 OMs: Population dynamics		
Natural mortality (external)	M=0.2, 0.3, 0.4 (/year)	A hybrid version added (Nishida et al. 2014). A total of 4 assumptions
Growth formula (external)	VB: Lee and Yeh (2007)	Chen et al. (2012), Wells et al.(2013)
Weight-Length (external)	Lee and Kuo (1988)	Penney (1994)
Age-at-maturity (age-specific, external)	0 (Age<=3), 0.25 (Age=4), 0.5 (Age =5), 0.75 (Age=6) and 1 (Age>=7)	Farley et al. (2012)
S-R (B-H)	h=0.65, 0.8, 0.95	h=0.7, 0.8, 0.9
Recruitment deviations	SD: sigmaR=0.2, 0.4, 0.6 Auto-correlation: rho=0, 0.5?	sigmaR=0.4, 0.6 (rho=0) Robustness: sigmaR=0.6(rho=0.5) Robustness: smaller recruitment
Selectivity	As estimated in SS3 Two options (logistic, double normal)	As estimated in SS3 Two options (logistic, double normal) for TWN,CHN LL
MSE for ALB	Reference trials	Change
3.2 OMs: Fishery (to generate future data)		
#Fisheries (quarterly)	5 (JPN LL, TWN,CHN LL, KOR LL, PS)	7 fisheries (N and S for two LLs and rest the same)
Catch (implementation)	Random but unbiased error (?)	Exact or 10% uncertainty
Catch (report)	Exact	
#Surveys (CPUE)		

STD_CPUE	Random and unbiased error for TWN,CHN LL (CV=0.1, 0.2, 0.3)	Only TWN,CHN LL (CV=0.2, 0.3, 0.4)
#Other observations		
Length data & Catch-at-age	Not used at this stage.	

9. DEVELOPMENT OF TECHNICAL ADVICE ON THE STATUS OF THE ALBACORE TUNA STOCK

114. 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 2013 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 VI

10. RESEARCH RECOMMENDATIONS AND PRIORITIES

10.1 Revision of the WPTmT Program of Work

115. The WPTmT **NOTED** paper IOTC–2014–WPTmT05–08 which provided the WPTmT to further develop and refine its Program of Work for 2015–19 to align with the requests and directives from the Commission and Scientific Committee.

116. 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 of 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.

117. 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, 2014.

118. The WPTmT **NOTED** 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 VII).

119. The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2015–19), as provided at Appendix VII.

11. OTHER BUSINESS

11.1 Southern Bluefin tuna

120. 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 1–6 September, 2014. The Summary would be provided to the IOTC SC meeting in December, 2014.

11.2 Date and place of the 6th and 7th Sessions of the WPTmT

121. The WPTmT participants were unanimous in thanking the Rep. of Korea for hosting the 5th Session of the WPTmT and commended the Rep. of Korea on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

122. Following a discussion on who would host the 6th and 7th 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 late August or 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 2014.
    - WPTmT06: Host to be decided. Meeting to be held in late August/early September 2016
    - WPTmT07: Host to be decided. Meeting to be held in late August/early September 2018

123. The WPTmT **AGREED** that alternative to the options proposed above, the IOTC Secretariat should liaise with ICCAT to determine if the next Sessions of the WPTmT could be held in conjunction with the ICCAT southern Atlantic albacore meeting.

Meeting participation fund

124. **NOTING** that the IOTC Meeting Participation Fund (MPF), detailed in the IOTC Rules of Procedure (2014) was used to fund the participation of 3 national scientists (from Indonesia, Malaysia and Thailand) to the WPTmT05 meeting (3 at the WPTmT04), 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.

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

125. 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: Stock assessment for albacore.

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

126. The WPTmT **CONSIDERED** candidates for the positions of Chairperson and Vice-Chairperson of the WPTmT for the next biennium. Dr Zang Guen Kim (Rep. of Korea) was nominated and re-elected as Chairperson of the WPTmT, for the next *biennium*. As the WPTmT currently meets only once every two years, and the current Vice-Chairperson has served for one meeting during the last biennium, the WPTmT **AGREED** that Dr Takayuki Matsumoto (Japan) shall continue in his current role as Vice-Chairperson of the WPTmT for another year as part of his first-term.

11.5 Review of the draft, and adoption of the Report of the 5th Session of the WPTmT

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).

128. The report of the 5th Session of the Working Party on Temperate Tunas (IOTC–2014–WPTmT05–R) was **ADOPTED** on the 31 July 2014.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE 5TH WORKING PARTY ON TEMPERATE TUNAS

Date: 28–31 July 2014
Venue: Novotel Hotel Busan Ambassador, 1405-16, Jung-dong, Haeundae-gu
Location: Busan, Rep. of Korea
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. **OUTCOMES OF THE 16th SESSION OF THE SCIENTIFIC COMMITTEE** (Secretariat)

4. **OUTCOMES OF SESSIONS OF THE COMMISSION** (Secretariat)

5. **PROGRESS ON THE RECOMMENDATIONS OF WPTmT04** (Chair and Secretariat)

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

7. **NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENAL DATA RELATING TO TEMPERATE TUNAS** (Chair)
   - 7.1 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
   - 7.2 Effect of piracy on temperate tuna catches

8. **REVIEW OF NEW INFORMATION ON THE STATUS OF ALBACORE TUNA**
   - 8.1 Nominal and standardised CPUE indices
   - 8.2 Stock assessments
   - 8.3 Selection of Stock Status indicators
   - 8.4 Albacore management strategy evaluation process

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

RESEARCH RECOMMENDATIONS AND PRIORITIES
   - 10.1. Revision of the WPTmT Program of Work (Chair)

10. **OTHER BUSINESS**
    - 11.1 Southern bluefin tuna (Secretariat)
    - 11.2 Date and place of the 6th Session of the WPTmT (Chair and Secretariat)
    - 11.3 Development of priorities for an Invited Expert at the next WPTmT meeting (Chair)
    - 11.4 Election of a Chairperson and Vice-Chairperson of the WPTmT for the next biennium (Chair)
    - 11.5 Review of the draft, and adoption of the Report of the 5th Session of the WPTmT (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2014–WPTmT05–01a	Draft Agenda of the 5th Working Party on Temperate Tunas	✓(29 April 2014)
IOTC–2014–WPTmT05–01b	Draft Annotated agenda of the 5th Working Party on Temperate Tunas	✓(13 July 2014)
IOTC–2014–WPTmT05–02	Draft List of documents	✓(9 July 2014)
IOTC–2014–WPTmT05–03	Outcomes of the 16th Session of the Scientific Committee (IOTC Secretariat)	✓(13 July 2014)
IOTC–2014–WPTmT05–04	Outcomes of the 18th Session of the Commission (IOTC Secretariat)	✓(13 July 2014)
IOTC–2014–WPTmT05–05	Review of Conservation and Management Measures relating to temperate tuna (IOTC Secretariat)	✓(13 July 2014)
IOTC–2014–WPTmT05–06	Progress made on the recommendations of WPTmT04 (IOTC Secretariat)	✓(13 July 2014)
IOTC–2014–WPTmT05–07	Review of the statistical data and fishery trends for albacore (IOTC Secretariat)	✓(11 June 2014)
IOTC–2014–WPTmT05–08	Revision of the WPTmT Program of Work (2014–2018) (IOTC Secretariat)	✓(13 July 2014)
IOTC–2014–WPTmT05–09	Indonesian tuna longline fishery for albacore (*Thunnus alalunga*) in eastern Indian Ocean (F. Rochman, D. Novianto & B. Nugraha)	✓(11 July 2014)
IOTC–2014–WPTmT05–10	Catches of Albacore tuna by Malaysian longline vessels in the Indian Ocean during 2005–2013 (E.M. Faizal, S. Basir, S. Jamon & R. Rumpet)	✓(13 July 2014)
IOTC–2014–WPTmT05–11	Catches of albacore tuna by Thai tuna longliners in the Indian Ocean during 2009–2013 (P. Luesrithawornsin & A. Wongkeaw)	✓(14 July 2014)
IOTC–2014–WPTmT05–12 Rev_1	Reunion Island pelagic longline fishery characterization and standardization of albacore catch rates (R. Coelho, N. Nikolic, H. Evano, M.N. Santos & J. Bourjea)	✓(30 June 2014) ✓(28 June 2014)
IOTC–2014–WPTmT05–13 Rev_2	Short review on biology, structure, and migration of *Thunnus alalunga* in the Indian Ocean (N. Nikolic, A. Fonteneau, L. Hoarau, G. Morandeau, A. Puech & J. Bourjea)	✓(13 July 2014) ✓(24 July 2014) ✓(29 July 2014)
IOTC–2014–WPTmT05–14	Size composition of Indian Ocean albacore based on Chinese longline fishery (L. Zou, X. Dai & J. Zhu)	✓(13 July 2014)
IOTC–2014–WPTmT05–15	Review of Japanese longline fishery and its albacore catch in the Indian Ocean (T. Matsumoto)	✓(11 July 2014)
IOTC–2014–WPTmT05–16	Consideration of albacore parameters for stock assessments in the Indian Ocean (T. Nishida, T. Kitakado, T. Matusmoto, J. Zhu & L.-K. Lee)	✓(12 July 2014)
IOTC–2014–WPTmT05–17 Rev_1	Review of catch and effort for albacore tuna by Korean tuna longline fishery in the Indian Ocean (1965–2013) (S.I. Lee, Z.G. Kim, J.E. Ku, M.K. Lee, H.W. Park, S.C. Yoon & D.W. Lee)	✓(15 July 2014) ✓(27 July 2014)
IOTC–2014–WPTmT05–18 Rev_1	Standardization of albacore CPUE by Japanese longline fishery in the Indian Ocean (T. Matsumoto, T. Kitakado & T. Nishida)	✓(11 July 2014) ✓(31 July 2014)
IOTC–2014–WPTmT05–19	Albacore (*Thunnus alalunga*) CPUE trend from Indian Ocean core albacore areas based on Taiwanese longline catch and effort statistics dating from 1980 to 2013 (L.-K. Lee, C.-C. Hsu & and F.-C. Chang)	✓(12 July 2014)
IOTC–2014–WPTmT05–20 Rev_1	CPUE standardization of albacore tuna caught by Korean tuna longline fishery in the Indian Ocean (S.I Lee, Z.G. Kim, M.K Lee, J.E. Ku & D.W. Lee)	✓(15 July 2014) ✓(27 July 2014)
IOTC–2014–WPTmT05–21	Analyzing population dynamics of Indian Ocean albacore (*Thunnus alalunga*) using Bayesian biomass dynamics model (W. Guan, J. Zhu & L. Xu)	✓(13 July 2014)
IOTC–2014–WPTmT05–22	Stock and risk assessments of albacore in the Indian Ocean based on ASPIC (T. Matsumoto, T. Nishida & T. Kitakado)	✓(11 July 2014)
IOTC–2014–WPTmT05–23 Rev_1	Stock assessments of albacore albacore (*Thunnus alalunga*) in the Indian Ocean by Age-Structured Production Model (ASPM) (T. Nishida, T. Matsumoto & T. Kitakado)	✓(20 July 2014) ✓(30 July 2014)
IOTC–2014–WPTmT05–24 Rev_2	Stock assessment of albacore tuna in the Indian Ocean for 2014 using Stock Synthesis (S.D. Hoyle, R. Sharma & M. Herrera)	✓(13 July 2014) ✓(22 July 2014) ✓(27 July 2014)
IOTC–2014–WPTmT05–25	Stock assessment of Indian Ocean albacore (*Thunnus alalunga*) using age structured assessment program (ASAP) (J. Zhu, W. Guan & L. Xu)	✓(13 July 2014)

Document	Title	Availability
IOTC–2014–WPTmT05–26	Port-based monitoring report of albacore (*Thunnus alalunga*) Benoa Port, Bali-Indonesia 2013 (F. Rochman)	✓(11 July 2014)
Information papers		
IOTC–2014–WPTmT05–INF01	IOTC SC – Guidelines for the Presentation of Stock Assessment Models	✓(9 July 2014)
IOTC–2014–WPTmT05–INF02	Indian Ocean tuna fisheries of Indonesia albacore catch estimation workshop: Review of issues and considerations	✓(22 July 2014)
IOTC–2014–WPTmT05–INF03	Report of the 3rd IOTC WPM Small Working Group on Management Strategy Evaluation	✓(22 July 2014)
IOTC–2014–WPTmT05–INF04	Project GERMON (N. Nikolic & J. Bourjea)	✓(31 July 2014)

APPENDIX IV
SUMMARY OF DATA AVAILABLE AT THE IOTC SECRETARIAT

Extracts from IOTC–2014–WPTmT05–07

Albacore

Albacore – Catch trends

Albacore are currently caught almost exclusively using drifting longlines (over 90% of the total catches) (Table 1; Fig. 1), and South of 20°S (Table 2) with remaining catches recorded using purse seines and other gears. The catches increased markedly during the mid-1980's due to the use of drifting gillnets by Taiwan,China (Fig. 2), with total catches in excess of 30,000 t. The drifting gillnet fleet targeted 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 drifting gillnet fleets, catches dropped to less than 21,000 t by 1993 (Fig. 1). However, catches more than doubled over the period from 1993 (<21,000 t) to 2001 (46,000 t), the year in which the highest catches of albacore were reported. Since 2001, catches have been almost exclusively taken by drifting longlines. Catches for both 2011 and 2012 are estimated to be approximately 34,000 t (Table 1), 10,000 t lower than the catches recorded in 2010 (44,000 t), the second highest catches recorded. In 2013, current estimated catches are around 43,000 t. The majority of the catches of albacore are sold to international markets, mostly for canning. A component of the catches of albacore may not go for export, be sold in local markets or retained by the fishermen for direct consumption.

Catches of albacore in recent years have come almost exclusively from vessels flagged to Indonesia and Taiwan,China. The catches of albacore reported for the fresh tuna longline fishery of Indonesia have increased considerably since 2003, ranging between 8,000 t and 15,000 t during those years, which represents approximately 31% of the total catches of albacore in the Indian Ocean.

Longliners from Japan and Taiwan,China have been operating in the Indian Ocean since the early 1950s. 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.

In contrast to the Japanese longliners, 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. Between 2005 and 2012 the albacore catches by Taiwan,China longliners have been between 1,500 and 6,000 t, with the lowest catches recorded in 2012.

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. In recent years, the catches of fresh-tuna longliners of Taiwan,China have represented 75% of the total catches of Taiwan,China longliners during 2010–12.

While most of the catches of albacore have traditionally come from the southwest Indian Ocean, in recent years a larger proportion of the catch has come from the southern and eastern Indian Ocean (Table 2; Fig. 3). 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 (Fig. 3) which has led to an increased contribution of albacore to the total catches of some longline fleets.

Fleets of oceanic gillnet vessels from I.R. Iran and Pakistan and gillnet and longline vessels from Sri Lanka have extended their area of operation in recent years, to operate on the high seas closer to the equator. 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.

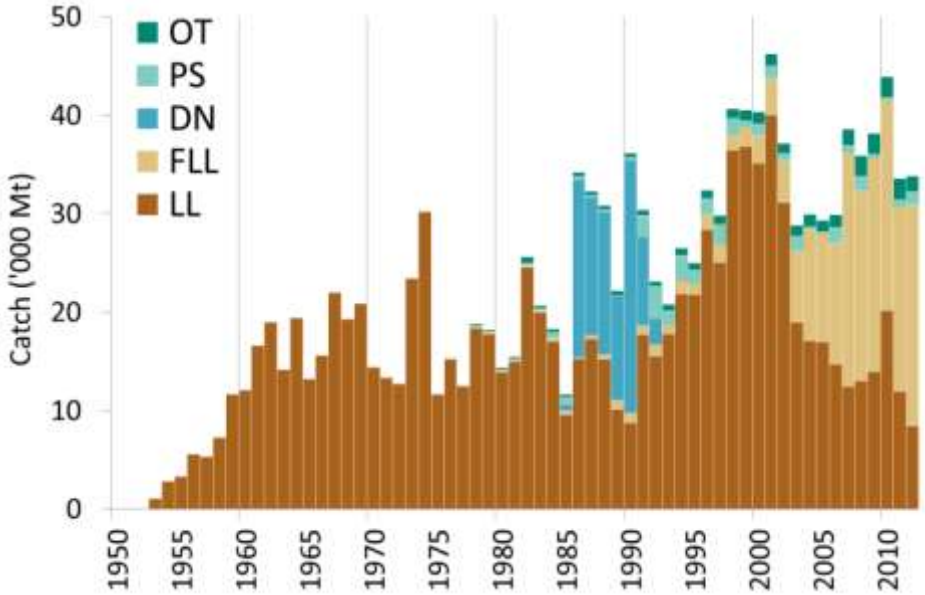


Fig. 1. Albacore: Catches of albacore by gear. Driftnet (DN; Taiwan,China); Freezing-longline (LL); Fresh-tuna longline (FLL); Purse seine (PS); Other gears NEI (OT). (Data as of May 2014)

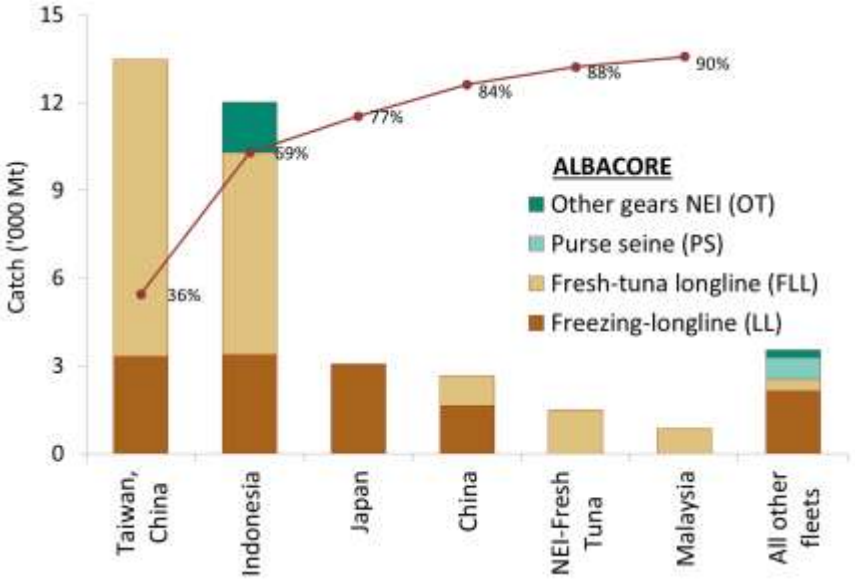


Fig. 2. Albacore: average catches in the Indian Ocean over the period 2010–12, ordered from left to right, according to the importance of catches of albacore reported. The red line indicates the (cumulative) proportion of catches of albacore for the countries concerned, over the total combined catches of albacore reported from all fisheries.

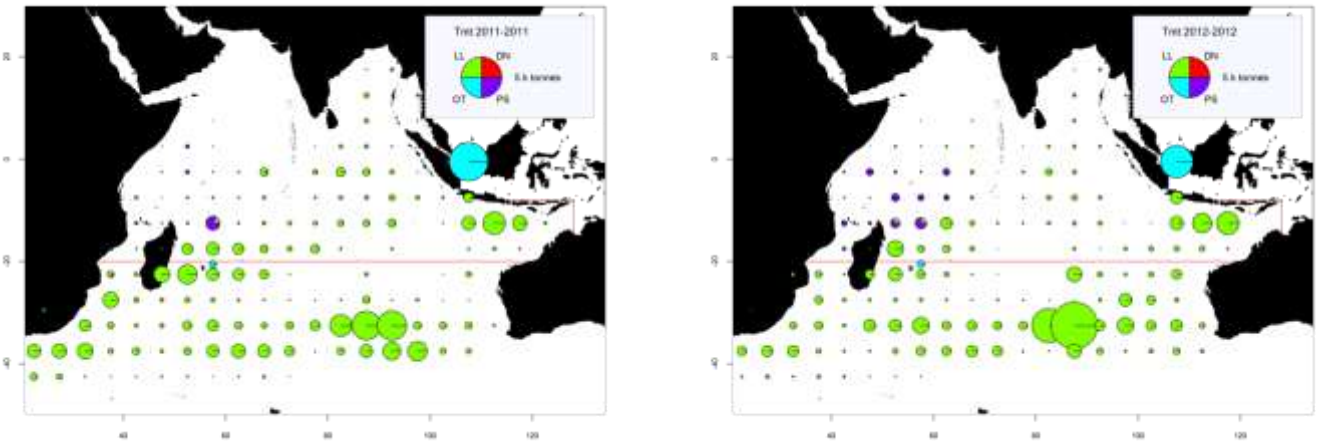


Fig. 3a–b. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for 2011 (left) and 2012 (right) by year and type of gear. Longline (LL, green), Driftnet (DN, red), Purse seine (PS, purple), Other fleets (OT, blue). Time-area catches are not available for all fleets; catches for those were assigned by 5x5 square and month using information from other fleets. (Data as of May 2014)

TABLE 1. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by gear and main fleets [or type of fishery] by decade (1950s–2000s) and year (2004–2013), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not used for all years. (Data as of July 2014)

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*
DN				5,823	3,735											
LL	3,715	17,230	16,971	15,828	23,039	21,370	17,115	17,018	14,766	12,473	13,024	13,974	20,193	11,993	8,466	8,206
FLL			80	314	1,325	11,718	11,299	10,971	12,250	23,736	19,332	21,662	21,399	18,696	22,451	29,506
PS				194	1,683	912	232	164	1,548	725	1,424	392	207	725	1,296	501
OT	20	33	94	406	764	1,436	1,288	1,147	1,307	1,653	2,137	2,105	2,119	2,203	1,650	4,724
Total	**3,735**	**17,263**	**17,145**	**22,565**	**30,546**	**35,436**	**29,934**	**29,300**	**29,871**	**38,587**	**35,917**	**38,133**	**43,918**	**33,617**	**33,863**	42,937

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

TABLE 2. Albacore: Best scientific estimates of the catches of albacore (*Thunnus alalunga*) by fishing area by decade (1950s–2000s) and year (2003–2012), in tonnes. The areas used are shown in Fig. 5. (Data as of July 2014)

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*
1-North	2,904	6,742	6,439	5,004	7,388	10,983	8,501	8,605	11,985	17,358	15,420	10,734	16,082	12,212	11,433	15,838
2-South	831	10,521	10,706	17,561	23,159	24,453	21,434	20,695	17,887	21,229	20,498	27,399	27,836	21,405	22,431	27,099
Total	**3,735**	**17,263**	**17,145**	**22,565**	**30,547**	**35,436**	**29,935**	**29,300**	**29,872**	**38,587**	**35,918**	**38,133**	**43,918**	**33,617**	**33,864**	**42,937**

Areas: North of 10ºS (**N**); South of 10ºS (**S**). * estimate based on the breakdown of catches by area in 2012, by type of fishery.

Albacore – Uncertainty of catches

While retained catches were fairly well known until the early-1990s (Fig. 4), the quality of catch estimates since that time has been compromised due to poor catch reports from some fleets, in particular:

- Longliners of Indonesia: The catches of albacore for the longline fleet of Indonesia were revised in 2013 by the DGCF and the IOTC Secretariat, using previous reports from Indonesia and information obtained from canning factories cooperating with the International Seafood Sustainability Foundation (ISSF). While the new catch estimates are considered more reliable than the previous, the lack of catch-and-effort data and insufficient monitoring of albacore landings in Indonesia makes it difficult to validate such estimates. According to the new estimates Indonesia has been catching 32% (around 12,000 t in average over the period 2008–12) of the total catches of albacore in the Indian Ocean.
- Longliners of Malaysia: To date, Malaysia has reported incomplete catches of albacore for its longline fleet, as monitoring by Malaysia does not cover the large component of the longline fleet that is based in ports outside Malaysia (in particular in Mauritius). In recent years Malaysia has reported between 5 and 59 active longliners in the Indian Ocean, with catches of albacore ranging between nil and 2,000 t for the same period. An additional 500–2,000 t of albacore were estimated for Malaysian longliners not based in Malaysia.
- Fleets using gillnets on the high seas, in particular I.R. Iran, Pakistan and Sri Lanka: Catches are likely to be less than 1,000 t.
- Non-reporting industrial longliners (NEI): Refers to catches from longliners operating under flags of non-reporting countries. While the catches were moderately high during the 1990s, they have not exceeded 3,000 t in recent years.

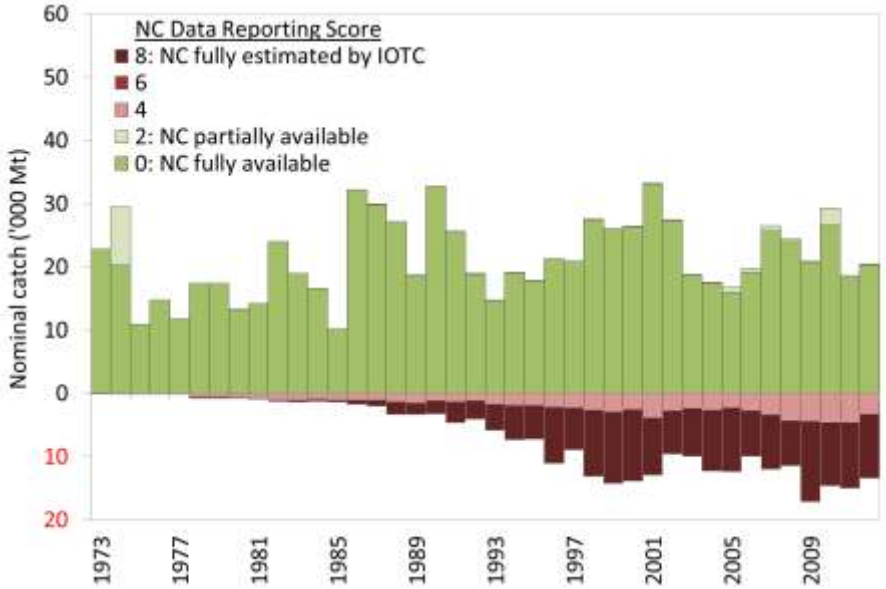


Fig. 4. Albacore: Uncertainty of nominal annual catch estimates (1950–2012). (Data as of May 2014) Catches are assessed against IOTC reporting standards, where a score of 0 indicates catches that are fully reported according to IOTC standards; catches assigned a score of between 2 – 6 do not report catch data fully by gear and/or species (i.e., partially adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; catches with a score of 8 refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat).

- Levels of discards are believed to be low although they are unknown for industrial fisheries other than European (EU) purse seiners (2003–07).
- Changes to the catch series: The catches of albacore have changed for some years since the WPTmT in 2012, including:
  - Minor to moderate increase in estimates of catches of albacore recorded for the period 1950-2003, following a review of the catches of albacore by coastal longliners in Indonesia.
  - Moderate decrease in estimates of catches of albacore in 2007 (11%) and marked decrease in 2008 (24%), following the review of catches of albacore by all fleets conducted for this period.
  - Minor changes in estimates of catches of albacore for other years.
- CPUE Series: Catch-and-effort series are available from various industrial fisheries. Nevertheless, catch-and-effort are not available from some fisheries or they are considered to be of poor quality, especially during the last decade, for the following reasons:

- Uncertain data from significant fleets of longliners, including India, Indonesia, Malaysia, Oman, and Philippines;
- No data for fresh-tuna longliners flagged in Taiwan,China during 1990–2006;
- Non-reporting by industrial purse seiners and longliners (NEI).

Albacore – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid for 2011 and 2012 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for 2011 and 2012 are provided in Fig. 6.

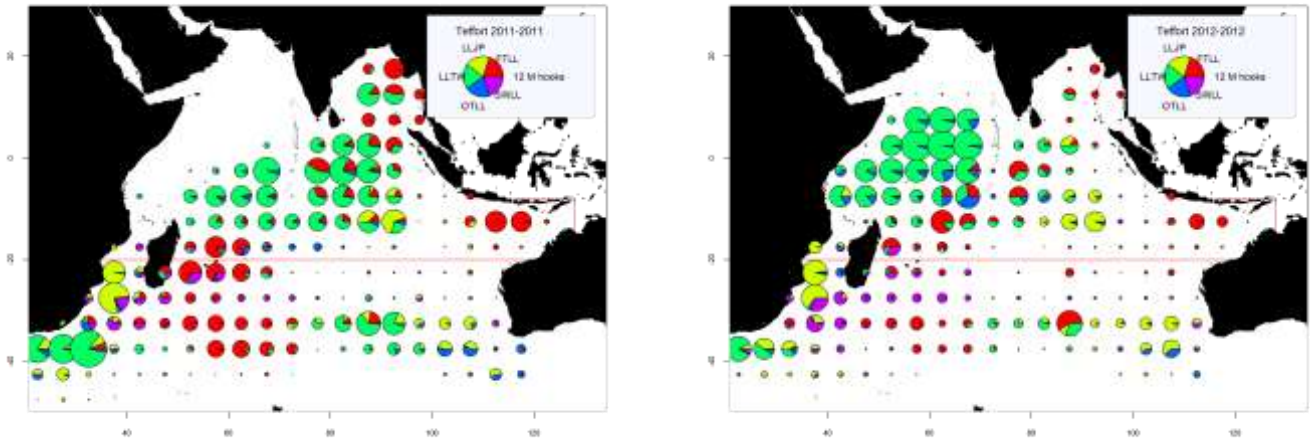


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right). (Data as of May 2014)
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets)

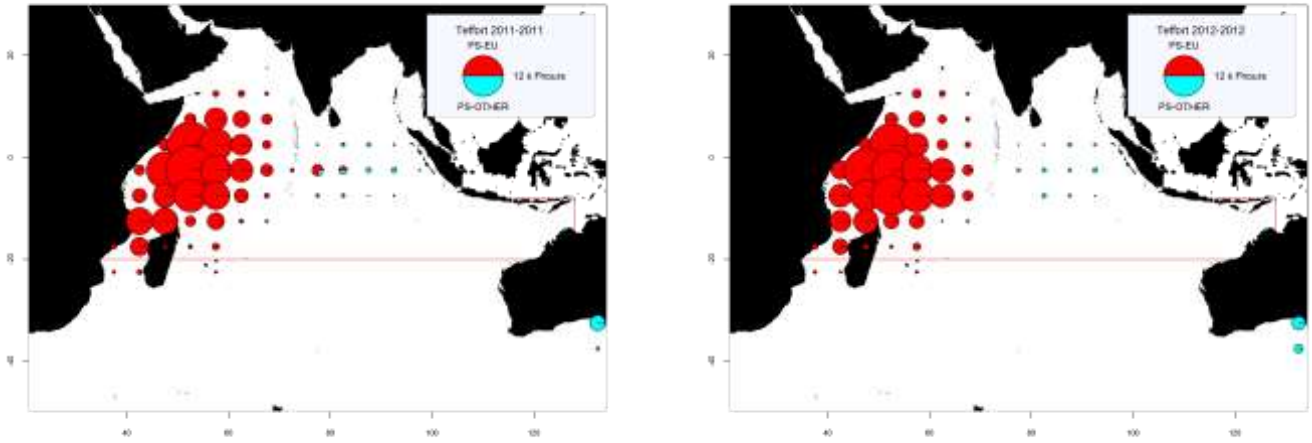
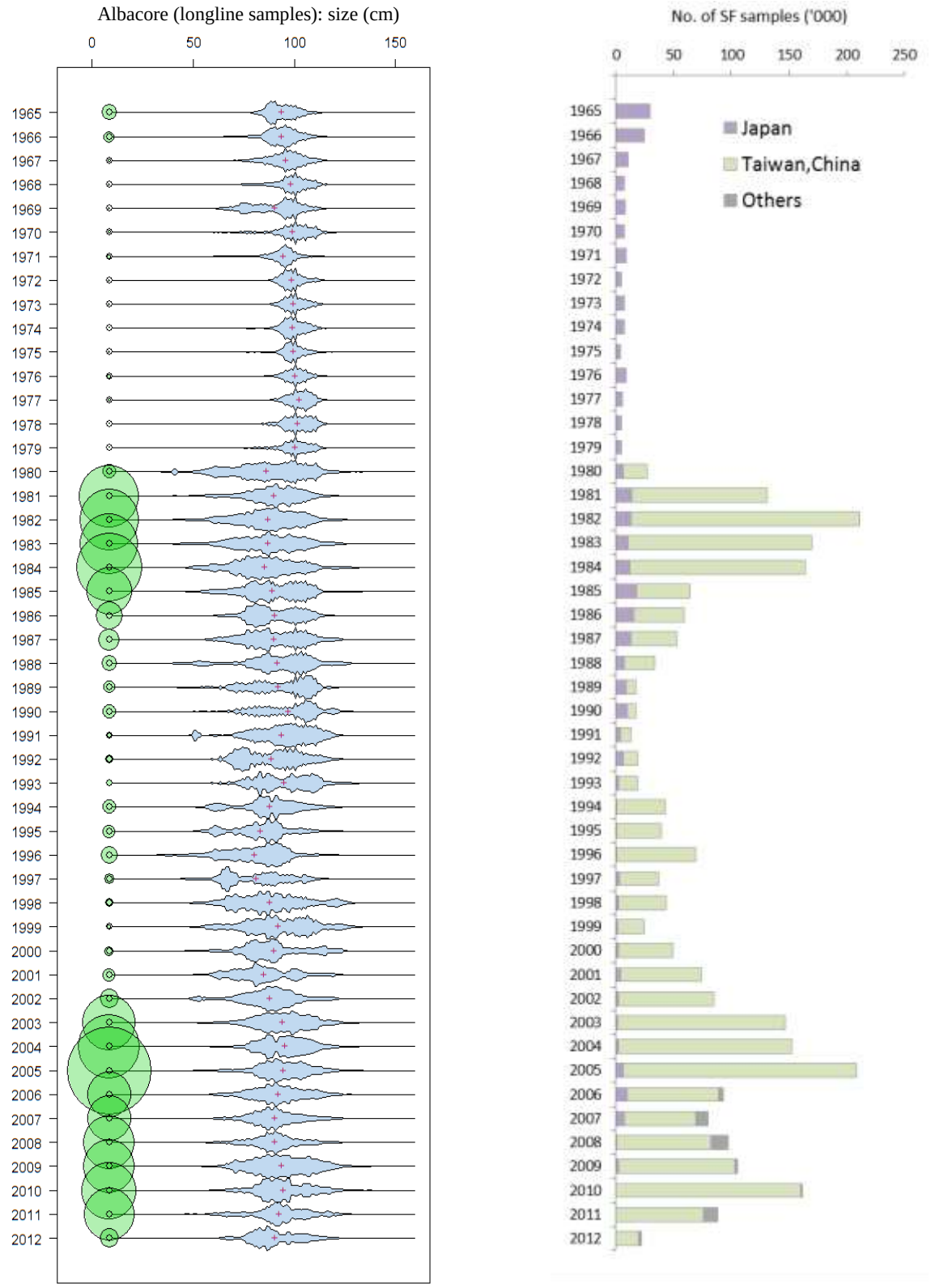


Fig. 6. Number of hours of fishing(Fhours in thousands: k) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right). (Data as of May 2014)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

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

The size frequency data for the Taiwan,China deep-freezing longline fishery for the period 1980–2012 is available. However, the lengths of albacore available for Taiwan,China since 2003 are very different from those available for earlier years and length data and catch-and-effort data for the same time-periods and areas are conflicting over most of the time series (Figs. 7a, b). In general, the amount of catch for which size data for the species are available before 1980 is still very low. The data for the Japanese longline fleet is available; however, the number of specimens measured per stratum has been decreasing in recent years. Size data are also available for industrial purse seiners flagged in EU countries and the Seychelles. Few data are available for the other fleets.

- Trends in average weight can be assessed for several industrial fisheries although they are incomplete or of poor quality for some fisheries due to the issues identified above.
- Catch-at-Size(Age) tables are available but the estimates are highly uncertain for some periods and fisheries (Fig. 13) including:
  - 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;
  - the complete lack of size samples from the driftnet fishery of Taiwan,China over the entire fishing period (1982–92)
  - the paucity of catch by area data available for some industrial fleets (Taiwan,China, NEI, India and Indonesia).



Figs. 7a-b: **Left (a):** Albacore: Length frequency distributions (total amount of fish measured by 1 cm length class) derived from the data available at the IOTC Secretariat for freezing longline fisheries, by year. The black outline circles (to the left of each distribution) indicate the minimum sampling standard set by IOTC of one fish per metric tonne; the green proportional circles indicate the relative sampling coverage in each year (i.e., circles with areas greater than the minimum sampling standard indicate relatively high sampling coverage in a given year).

Right (b): Number of specimens sampled for lengths by main longline fleet.

APPENDIX V
MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF ALBACORE

Extract from IOTC–2014–WPTmT05–07

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. Catch-and-Effort data from Industrial Fisheries:

- Fisheries of **Indonesia**: The catches of albacore estimated for the fisheries of Indonesia, including coastal and offshore fresh-tuna longliners and deep-freezing longliners, account for 33% of the total catches of albacore in the Indian Ocean in recent years (average catch 2010–12; Fig. 2). Following a recommendation from the IOTC Scientific Committee, the Directorate General for Capture Fisheries of Indonesia (DGCF) and the IOTC Secretariat reviewed the estimates of catches of albacore for Indonesia in 2013[1]. As a result of that review Indonesia reported a revised catch series for albacore for recent years. Although the new catches reported are considered more reliable than the previous catches estimated by the DGCF, the poor quality of the catch-and-effort data available for this fishery compromises the ability of the DGCF to validate the new estimates.
- **Fresh-tuna longline** fishery of **Taiwan,China**: In recent years, the catches of albacore estimated for the fresh-tuna longline fishery of Taiwan,China account for 27% of the total catches of albacore in the Indian Ocean (average catch 2010–12). Although the Secretariat has obtained catch-and-effort data for this fishery in recent years (2007–12), and estimates of total catch since 2000, the catches of albacore before 2000 were estimated using data from alternative sources, including port sampling schemes, and information on the activities of fresh-tuna longliners in coastal countries of the Indian Ocean.
- **Longline** fisheries of **India**, **Malaysia, Oman,** and **Philippines:** The catches of albacore estimated for the longline fisheries of India, Malaysia, Oman, and Philippines are uncertain, with current estimates accounting for 3% of the total catches of albacore in the Indian Ocean in recent years (average catch 2010–12). 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**: Both I.R. Iran and Pakistan have reported nil catches of albacore for their fisheries. To date, the IOTC Secretariat has not received catch-and-effort data for these fisheries which compromises the ability of the IOTC Secretariat to assess the amount of gillnet effort exerted by these fisheries in areas where catches of albacore may occur.

2. Size data from All Fisheries:

- **Driftnet** of **Taiwan,China**: No size data available over the entire period of activity of the fishery (1982–92).
- **Longline** fishery of **Indonesia**: Indonesia has reported size frequency data for its fresh-tuna longline fishery for some years. However, data are not available for 2010–12 and, where available, the samples cannot be fully disaggregated by month and fishing area (5x5 grid) and refer mostly to the component of the catch that is unloaded fresh. The quality of the samples in the IOTC database is for this reason uncertain.
- **Fresh-tuna longline** fishery of **Taiwan,China**: While Taiwan,China has provided length frequency data of albacore since 2010, the levels of coverage remain very low, under the minimum recommended by the IOTC.
- **Longline** fishery of **Japan:** The number of samples reported and total number of fish sampled for the longline fishery of Japan since 2000 has been very low.
- Longline fisheries of **India**, **Malaysia**, **Oman**, and **Philippines:** To date, none of these countries has reported size frequency data of albacore.

3. Biological data:

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

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

APPENDIX VI
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 – 2014 assessment			2014 stock status determination 2012[2]
Indian Ocean		SS3	ASPIC*	
	Catch 2012:	33,863 t	33,863 t	
	Average catch 2008–2012:	37,090 t	37,090 t	
	MSY (1000 t) (80% CI):	47.6 (26.7–78.8)	34.7 (28.8–37.4)	
	F_{MSY} (80% CI):	0.31 (0.21–0.42)	0.50 (n.a.)	
	SB_{MSY} (1000 t) (80% CI):	39.2 (25.4–50.7)	68.6 (n.a.)	
	F_{2012}/F_{MSY} (80% CI):	0.69 (0.23–1.39)	0.94 (0.68–1.61)	
	$SB_{current}/SB_{MSY}$ (80% CI):	1.09 (0.34–2.20)	1.05 (0.73–1.35)	
	$SB_{current}/SB_{1950}$ (80% CI):	0.21 (0.11–0.33)	0.43 (n.a.)	

[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.
*Total Biomass (B)

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Trends in the Taiwan,China CPUE series suggest that the longline vulnerable biomass has declined to about 47% of the level observed in 1980–82. There were 20 years of moderate fishing before 1980, and the catch has more than doubled since 1980. Catches have increased substantially since 2007, attributed to the Indonesian and Taiwan,China longline fisheries although there is substantial uncertainty remaining on the catch estimates. It is considered that recent catches have been above the MSY level for one of the models (ASPIC) examined and approaching MSY levels for the other model (SS3). Fishing mortality of F_{2012}/F_{MSY} is between 0.70 (Median: SS3) and 0.94 (Point estimate: ASPIC). Biomass is considered to be at or very near to the SB_{MSY} level (SB_{2012}/SB_{MSY} = 1.09) from the SS3 model, and also for the B_{MSY} level (B_{2012}/B_{MSY} = 1.05) from the ASPIC model (Table 1, Fig. 1). Thus, 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 and ASPIC assessments, indicating that a precautionary approach to the management of albacore should be applied by reducing fishing mortality or capping total catch levels to those taken in 2012 (34,000 t; Table 2).

Outlook. Maintaining or increasing effort in the core albacore fishing grounds is likely to result in further declines in albacore biomass, productivity and CPUE. The impacts of piracy in the western Indian Ocean has 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. It is therefore unlikely that catch and effort on albacore will decline in the near future unless management action is taken. There is a high risk of exceeding MSY-based reference points by 2015 if catches increase further (above 2012 levels) (50% risk that $SB_{2015}<SB_{MSY}$, and 39% risk that $F_{2015}>F_{MSY}$) (Table 2). The following should be noted:

- The available evidence indicates considerable risk to the stock status at current effort levels.
- The two primary sources of data that drive the assessment, total catches and CPUE are highly uncertain and should be investigated further as a priority.
- The use of aggregated data versus fine-scale operational data in the CPUE standardisations by the main fleet (Taiwan,China) introduces substantial uncertainty.
- Current catches (33,863 t in 2012) are below the current estimated MSY levels from both models (Table 1). However, maintaining or increasing effort will likely result in further declines in biomass, productivity and CPUE.
- The preliminary catch estimates for 2013 (~43,000 t) is one of the highest catches on record, and may be a cause for concern for the long-term sustainability of the stock if it remains at these levels. Note, a preliminary ASPIC analysis accounting for the larger catches in 2013 indicted no change in stock status from 2012.

- 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). The projections indicated that there is a 50% chance of violating the biomass based reference point by 2015 is catches are maintain or increased up to 20% (i.e. below SB_{MSY}) (Table 2).
- Provisional reference points: Noting that the Commission in 2013 adopted Resolution 13/10 to *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 near the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

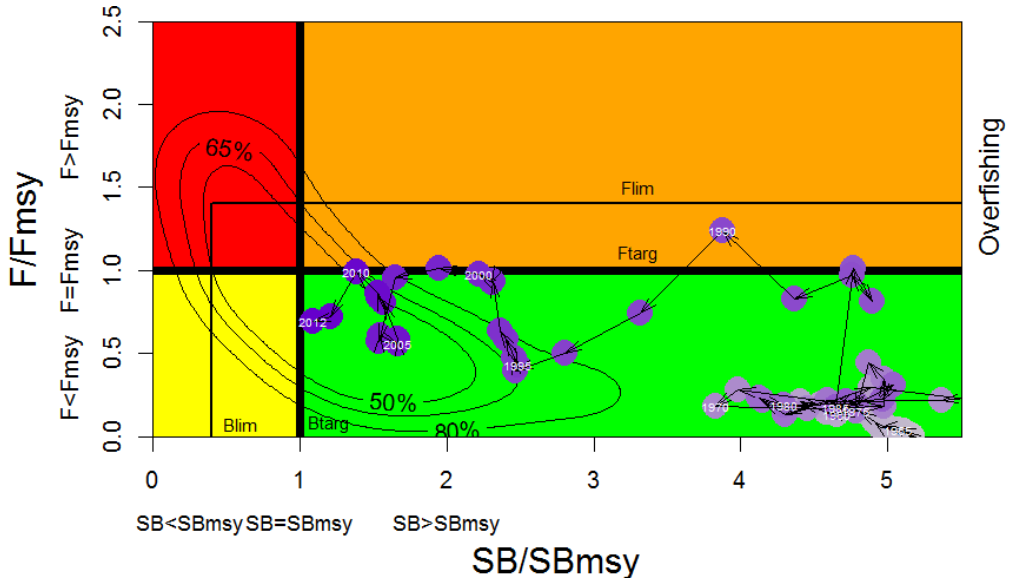


Fig. 1. Albacore: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2012 grid runs). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2012. Target (Ftarg and SBtarg) and limit (Flim and SBlim) 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 nine constant catch projections (average catch level from 2011–013, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points (SB_{targ} = SB_{MSY}; F_{targ} = F_{MSY})**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2015} < SB_{MSY}$	31	33	39	42	50	50	50	53	61
$F_{2015} > F_{MSY}$	11	19	22	36	39	44	50	53	56
$SB_{2022} < SB_{MSY}$	11	19	22	33	39	44	47	53	56
$F_{2022} > F_{MSY}$	6	11	22	31	36	44	47	53	56
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points (SB_{lim} = 0.4 B_{MSY}; F_{Lim} = 1.4 F_{MSY})**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2015} < SB_{Lim}$	0	0	6	8	17	22	28	33	33
$F_{2015} > F_{Lim}$	0	6	14	19	25	31	39	42	44
$SB_{2022} < SB_{Lim}$	0	6	14	19	28	33	36	42	47
$F_{2022} > F_{Lim}$	0	6	14	22	31	36	42	44	50

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels associated with the interim target and limit reference points on a stock by stock basis, the Scientific Committee could prepare and include, in the annual report, the Kobe II strategy matrices using colour coding corresponding to these thresholds.

APPENDIX VII
WORKING PARTY ON TEMPERATE TUNAS PROGRAM OF WORK (2015–19)

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;
- **Table 2**: High priority topics, by project for albacore in the Indian Ocean; and
- **Table 3**: Stock assessment schedule.

Table 1. Priority topics for obtaining the information necessary to develop stock status indicators for albacore in the Indian Ocean

Topic	Sub-topic	Priority
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
	1.2 Otolith microchemistry/isotope research/morphometric studies	Med
2. Biological information (parameters for stock assessment)	2.1 Age and growth research	High
	2.2 Age-at-Maturity	High
	2.3 Fecundity-at-age/length relationships	Medium
	2.4 Sex ratio at length	Medium
3. Ecological information	3.1 Spawning time and locations	High
	3.2 Feeding localisation	Medium
4. CPUE standardisation	4.1 Develop standardised 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
5. Stock assessment / Stock indicators	5.1 Develop and compare multiple assessment approaches to determining stock status for albacore.	High
6. Target and Limit reference points	6.1 To advise the Commission, by end of 2014 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High
7. Management measure options	7.1 To advise the Commission, by end of 2014 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process.	High

Table 2. High priority topics, by project for albacore in the Indian Ocean.

Topic	Sub-topic and project	Priority	Est. budget and/or potential source	Timing				
				2015	2016	2017	2018	2019
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	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	CPCs directly					
	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 assessment. Research needs to be undertaken to investigate the potential and the best approaches to be used. MSE process to look at improvement in precision of estimates given different amounts of age structure data, depending on fishery, growth curve, and effective sample sizes.		CPCs directly					
	2.2 Natural mortality (M)	High						

		2.2.1 Examine the impacts of a range of M values on stock assessments, from constant rates of 0.2, 0.3. and 0.4 over time, to M values which change with age, from 0.4 to 0.2.		CPCs directly
		2.2.2 Review evidence of currently available estimates are realistic, and whether more recent data is available on this key parameter.		CPCs directly
		2.3 Age-at-Maturity	High	
		2.3.1 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	High	
		3.1.1 Collect gonad samples from albacore to confirm the spawning time and location of the spawning area that are presently hypothesised for albacore.		CPCs directly
4.	CPUE standardisation	4.1 Develop standardised 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	CPUE Workshop (TBD)
		4.1.1 Changes in species targeting is the most important issue to address in CPUE standardisations.		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 standardisation is an ongoing research topic. Often these variables 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.		CPCs directly		
		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.	Stock assessment / Stock indicators	5.1 Develop and compare multiple assessment approaches to determining stock status for albacore (SS3, ASPIC etc).	High			
		5.1.1 A consultant be hired to assist in building capacity among the WPTmT participants by supplementing the skill set available within IOTC CPCs to further develop the SS3 model. An indicative budget is provided below:		US$26,000 in 2016 and 2018 IOTC Regular Budget	*	*
6.	Target and Limit reference points	6.1 To advise the Commission, by end of 2014 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High			
		6.1.1 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.				

Estimated budget (US$) required to hire a consultant to further develop the SS3 stock assessment model on albacore tuna in 2016 and 2018.

Description	**Unit price**	**Units required**	**2016 Total (US$)**	**2018 Total (US$)**
SS3 Stock assessment for albacore (fees)	550	40	22,000	22,000
SS3 Stock assessment for albacore (travel)	4,000	1	4,000	4,000
		Total estimate	**26,000**	**26,000**

7.	Management measure options	7.1 To advise the Commission, by end of 2014 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.		

Table 3. Assessment schedule for the IOTC Working Party on Temperate Tunas (WPTmT), 2015–19

Species	**2015**	**2016**	**2017**	**2018**	**2019**
Working Party on Temperate Tunas					
Albacore	–	**Stock assessment**	–	**Stock assessment**	–

APPENDIX VIII
CONSOLIDATED RECOMMENDATIONS OF THE 5TH SESSION OF THE WORKING PARTY ON TEMPERATE TUNAS

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

WPTmT05.01 (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.

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.

Albacore management strategy evaluation (MSE) process

WPTmT05.03 (para. 113) The WPTmT **RECALLED** para. 3 of Resolution 13/10 which states:

> "*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.

Revision of the WPTmT Program of Work

WPTmT05.04 (para. 119) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2015–19), as provided at Appendix VII.

Review of the draft, and adoption of the Report of the 5th Session of the WPTmT

WPTmT05.05 (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).