REPORT OF THE NINTH SESSION OF THE IOTC WORKING PARTY ON TEMPERATE TUNAS (DATA PREPARATORY SESSION)

Online, 27 February 2025

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ACRONYMS

ALB	Albacore
ASAP	Age structured assessment program
ASPIC	A Stock-Production Model Incorporating Covariates
ASPM	Age-structured production model
B	Biomass (total)
BBDM	Bayesian biomass dynamics model
B_{MSY}	Biomass which produces MSY
BSPM	Bayesian State-Space Production Model
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
EEZ	Exclusive Economic Zone
F	Fishing mortality; F_{2011} is the fishing mortality estimated in the year 2011
F_{MSY}	Fishing mortality at MSY
HBF	Hooks between floats
HCR	Harvest control rule
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
LL	Longline
LRP	Limit reference point
M	Natural mortality
MPF	Meeting participation fund
MSE	Management strategy evaluation
MSY	Maximum sustainable yield
n.a.	Not applicable
PS	Purse seine
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SS3	Stock Synthesis III modelling platform
SST	Sea surface temperature
TAC	Total allowable catch
TRP	Target reference point
VB	Von Bertalanffy (growth function)
WPTmT	Working Party on Temperate Tuns 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 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 readers of IOTC reports the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

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EXECUTIVE SUMMARY

The 9th Session (Data Preparatory) of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPTmT09(DP)) was held was held online using Zoom on 27 February 2025. A total of 24 participants (51 in 2022, 19 in 2019, 29 in 2016) attended the Session.

The meeting was initially planned to discuss the standardized CPUE indices for albacore tunas in preparation for the upcoming stock assessment. However, the Joint CPUE Workshop, held just before this meeting, prioritized bigeye tuna. The workshop will reconvene in late April to continue work on albacore tuna. Discussions on the Joint index for albacore tuna have been postponed to the assessment meeting in July 2025.

Additionally, the meeting discussed the best scientific estimates of catch data, along with other relevant data such as length frequency and catch effort for albacore tuna, and associated issues. Spatially raised, geo-referenced catch data for assessment will be compiled after this meeting.

The meeting extensively discussed model specifications and agreed on an initial specification (Table 1) to guide the modeler in developing preliminary models. The meeting agreed that the assessment may explore alternative configurations where appropriate, based on further examination of the data and model diagnostics.

1. Opening of the meeting

1. The 9th Session (Data Preparatory) of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPTmT09(DP)) was held online using the Zoom platform, 27 February 2025. A total of 24 participants (51 at the DP meeting in 2022, 19 in 2019, 29 in 2016 and 27 in 2014) attended the Session. The list of participants is provided at Appendix 1. The meeting was opened by the Chairperson, Dr Toshihide Kitakado (Japan), who welcomed participants.

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 WPTmT09 are listed in Appendix III.

3. The IOTC Process: outcomes, updates, and progress

3.1. Outcomes of *the 27th Session of the IOTC Scientific Committee*

3. The WPTmT **NOTED** paper **IOTC–2025–WPTmT09(DP)–03** which outlined the main outcomes of the 25th, 26th and 27th Sessions of the Scientific Committee, specifically related to the work of the WPTmT.

4. The WPTmT **NOTED** that in 2022, the SC made a number of observations in relation to the WPTmT08 report. Those observations are provided in the document and have not been reproduced here. Due to the absence of WPTmT meetings in 2023 and 2024, the SC meetings during these years did not include further discussions on albacore tuna, except for updates on the progress of the albacore MSE.

3.2. *Outcomes of the 28th Session of the Commission*

5. The WPTmT **NOTED** paper **IOTC–2025–WPTmT09(DP)–04** which outlined the main outcomes of the 28th 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.

6. The WPTmT **NOTED** the 11 Conservation and Management Measures (CMMs) adopted at the 28th Session of the Commission, consisting of 10 Resolutions and 1 Recommendation (the list of CMMs is provided in the document).

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

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

8. The WPTmT **NOTED** paper **IOTC–2025–WPTmT09(DP)–05** which aimed to encourage participants at the WPTmT09(DP) to review existing CMMs related to temperate tunas, noting the CMMs contained in document IOTC–2025–WPTmT09(DP)–04; and as necessary to 1) provide recommendations to the SC on whether modifications may be required; and 2) recommend whether other CMMs may be required.

3.4. *Progress on the recommendations of WPTmT08*

9. The WPTmT **NOTED** paper **IOTC–2025–WPTmT09(DP)–06** which provided an update on the progress made in implementing the recommendations from the previous WPTmT meeting which were endorsed by the SC and AGREED to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress.

10. 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 SC and endorsed by the Commission.

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

11. The WPTmT **NOTED** paper **IOTC-2025-WPTmT09(DP)-07** with the following summary provided by the authors:

    - *"The Indian Ocean (IO) represents ~15% of the global catch of albacore (Thunnus alalunga)*
    - *Annual catches of IO albacore have steadily increased since the 1950s to reach ~40,000 t in recent years*
    - *Industrial longline fisheries contribute to the bulk of albacore catch in the IO*
    - *Longline fisheries are dominated by Taiwan,China, followed by China, Indonesia, Malaysia, Japan and Seychelles*
    - *Longline catches are distributed all over the IO with high concentrations in the southwest in recent years*
    - *Catches from artisanal fisheries have increased over time, reaching about 20% of all albacore catch in 2023*
    - *Overall levels of albacore discards are considered to be small or negligible in most fisheries*
    - *Information available on fishing grounds and size composition is considered to be of good quality*
    - *Size data show that smaller fish are found at high latitudes while larger individuals occur in tropical areas*
    - *Albacore average weight in the catch has decreased from >20 kg in the 1950s to ~15 kg in the late 1990s."*

12. The WPTmT **NOTED** the materials and methods used by the Secretariat to produce the best scientific estimates of annual retained catches for the 16 IOTC species. The WPTmT **NOTED** that this process comprises three components: i) estimation of catches for non-reporting CPCs and non-CPCs, ii) disaggregation of catches reported for gear and species aggregates, and iii) re-estimation of catches for key artisanal fisheries where data quality and accuracy issues persist. The WPTmT **AGREED** that the uncertainties introduced by this process should be duly considered when using these estimates for assessment purposes.

13. The WPTmT **ACKNOWLEDGED** that the geo-referenced catches, raised to the total retained catches, have not been updated to include 2023 due to technical issues. The WPTmT **REQUESTED** the Secretariat to complete the processing and provide the data by the end of April 2025 to enable the stock assessment to be conducted.

14. The WPTmT **NOTED** that trolling line and driftnet fisheries are aggregated under the 'other' fishery category in the assessment model, despite differences in the expected size composition of their catch. The WPTmT further **NOTED** that trolling lines are expected to catch larger fish, whereas the model currently assumes that these fisheries, which are dominated by Indonesia, primarily catch smaller fish.

15. The WPTmT **QUERIED** the quality of the sources of information on size data available for the Indonesian trolling line fishery, **NOTING** that its albacore catches were estimated to exceed 2,000 t during the 2000s and early 2010s, reaching more than 4,000 t in 2015, equivalent to over 10% of the total stock catch.

16. The WPTmT **ACKNOWLEDGED** the large uncertainties associated with the catches of Indonesia's trolling line fisheries, **NOTING** that these catches were recently re-estimated following a methodology endorsed by the SC at its 27th session held in December 2024 (see IOTC-2024-WPDCS20-16_Rev1).

17. More generally, the WPTmT **NOTED** that the re-estimation of Indonesia's catch time series resulted in substantial changes in albacore catches compared to the previous Working Party in 2022, with catches increasing to over 17,000 tonnes in 2013.

18. The WPTmT also **NOTED** that albacore catches from coastal line fisheries of the Western Indian Ocean may be uncertain, as they come from multi-gear fisheries that use a combination of handlines and trolling lines, as seen in Reunion island (EU,France), Mauritius, and Comoros. The WPTmT **NOTED** that such aggregated catches are

disaggregated by individual gear in the estimation process of the best scientific catch data. However, the WPTmT **NOTED** that these fisheries represent a small contribution to the total catches of albacore compared to Indonesia's line fisheries.

19. The WPTmT **NOTED** the spatial patterns in the size distribution of albacore, **NOTING** that larger albacore are predominantly found in the North, while smaller ones are less common. The WPTmT **NOTED** that the presence of small-sized albacore in the North could be attributed to sampling errors or species identification issues, considering the albacore life cycle. Furthermore, the WPTmT **NOTED** that the lack of samples from small-sized fish could affect the assessment model.

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

20. The WPTmT **NOTED** paper **IOTC-2025-WPTmT09(DP)-08** which describes Spatial and temporal effects on albacore growth and reproduction, with the following abstract provided by the authors:

"Biological parameters for Indian Ocean albacore are relatively poorly understood. Better estimates of these parameters are required, because they are influential for the stock assessment. In this report, literature on albacore growth and reproductive parameters in all oceans is reviewed. Representative estimates of growth require the sampling of fish from a range of sizes, and across potential sources of variation such as longitude. Similarly, representative estimates of reproductive parameters require sampling across potential sources of variation, which include latitude and seasons, and may also include longitude" (see the document for the full abstract)

21. The WPTmT **ACKNOWLEDGED** the challenges in sampling variables that influence growth, **NOTING** that the skew towards larger estimates is due to the limited number of small fish in the samples and the fact that the fish are not large enough to be captured by longline fisheries.

22. The WPTmT **ACKNOWLEDGED** the results of albacore standardisation, **NOTING** the increase in fish length around 1970 in certain regions, where at same time a decline in CPUE was recorded. This could be attributed to either changes in sampling protocols or an increase in fish growth.

23. The WPTmT **NOTED** the lack of samples data from small pole-and-line fisheries which operated in South Africa's Indian Ocean waters, **NOTING** that a similar fishery that provided information to ICCAT operated in a same manner in the Indian Ocean.

24. The WPTmT **NOTED** the uncertainty surrounding the Taiwanese longline fisheries data prior to 2007, **NOTING** that scientists were advised not to consider these data for assessment due to incomplete datasets and the scattered nature of the fishery's operations in the Indian Ocean.

6. Review of new information on the status of temperate tunas

25. The WPTmT **NOTED** that the paper **IOTC–2022–WPTmT08(DP)–10,** which provided the Joint CPUE indices for the albacore tuna in the Indian Ocean based on Japanese, Korean and Taiwanese longline fisheries, was withdrawn by the authors, as there was not sufficient time to produce the index for this meeting.

26. The WPTmT **NOTED** that the Joint CPUE workshop was held February 6-12 to develop standardised CPUE indices for bigeye and albacore tunas, with the priority being given to the former. The Joint CPUE workshop will be reconvened in later April to continue to work on the albacore tuna. The WPTmT **AGREED** that the discussions of the Joint index shall take place in the assessment meeting in July 2025.

7. Albacore stock assessment

7.1. *Discussion on albacore assessment models to be developed and their specifications*

27. The WPTmT **NOTED** paper **IOTC–2025–WPTmT09(DP)–09** which provided a review of the data availability, model configuration and parameterization of the 2022 Indian Ocean albacore tuna (Thunnus alalunga), stock assessment in the Indian Ocean, including the following abstract provided by the authors:

"*This paper presents a review of the 2022 stock assessment of albacore tuna in the Indian Ocean. The 2022 albacore tuna assessment model is an age structured (14 years), spatially aggregated (1 region) and two sex model. The catch, effort, and size composition of catch are grouped into 23 fisheries covering the time period from 1950 through 2020. Fifteen indices of abundance, fourteen of which are derived from longline fisheries were considered for the analysis. The results of the 2022 assessment were that the estimated abundance trend is decreasing throughout the time frame of the model, and spawning stock abundance has decreased to approximately 2 times SSBMSY. The fishing mortality has increased over the model time frame with F2020/FMSY= 0.6. For a detailed description of the methods, data, model assumptions, and diagnostics the reader is referred to the 2022 assessment and the Assessment meeting report*" (see the document for the full abstract).

28. The WPTmT **ACKNOWLEDGED** that one of the main objectives of the current data preparatory meeting is to discuss and determine the model specifications to be used for the assessment.

29. The WPTmT **NOTED** the assumptions used in the previous assessment with regards to the input data as well as the assumed parameters. Taking into account updated studies and information, the WPTmT **AGREED** on initial parameter values and advisory model specifications as defined in Table 1.

30. The WPTmT **NOTED** that the previous assessment was run as an internally consistent model using the 'cookbook' methodology in Carvalho et al. (2020) and **AGREED** that this approach should be used in the 2025 model, particularly with regards to the diagnostic outputs that will be reviewed prior to the Stock Assessment meeting in July.

31. The WPTmT **DISCUSSED** the changes to model specification from the 2019 model, that have made the model more complex and **NOTED** that this allowed for more flexibility to allow for changes to selectivity and catchability between season and **NOTED** that this approach provided better fits to data.

32. The WPTmT **NOTED** that the main change to the model specification in the 2022 assessment was the re-structuring of the model into four seasons as well as four regions meaning that there are effectively 16 longline fleets represented in the model.

33. The WPTmT also **NOTED** the option of splitting the model into two sexes which was suggested due to the slight variations in the growth curves estimated for each sex and **NOTED** that these led to improvement to the fits to the size data.

34. The WPTmT **DISCUSSED** the potential conflict between the CPUE and length composition data and **NOTED** the importance of including only good quality length frequency data. The WPTmT **DISCUSSED** the length-frequency data to be included in the model and **AGREED** that only data that improves the model should be included.

35. The WPTmT **NOTED** that the CPUE data will be available following the joint CPUE workshop which will be held at the end of April, and that catch data for model inputs will be available in March. To facilitate model development, an informal stock assessment meeting will be held in May (exact dates to be decided) with relevant experts online, prior to the WPTmT Assessment Meeting that will be held in-person in July in Seychelles.

36. The WPTmT **AGREED** that the model will be run in Stock Synthesis III (following the 2022 model). As the Management Strategy Evaluation process may use different models e.g. simple production models, the WPTmT **NOTED** that biomass dynamics models may also be run separately to compare outputs with the SS3.

37. The WPTmT **NOTED** that the model specifications in Table 1 aim to provide guidance to the modeller for creating the initial models, further **NOTING** that the modeller may explore alternative configurations where appropriate, to allow for a consistent model configuration. These configurations will be based on further examination of the data, model fits to data, and model diagnostics.

Table 1. Summary of agreed stock structure and seven biological parameters (base case) to be used for 2025 ALB stock assessments in the Indian Ocean.

Parameters	Initial Parameterization 2025
Model structure	Single stock, two sex, quarterly time step, 1950-2023
Sex ratio at birth	1:1
Length-Weight relationship	Use length-weight parameters from Kitakado et al. (2019) a = 1.3718 e^{-5} b = 3.0973
Length-at-Age	Increase variation in length-at-age for males and females as in 2022 base case. CV_young = 0.06 CV_old = 0.025
Growth equation	Farley et al (2019) based on Von Bertalanffy ♂ $L(t)=110.06 [1-e^{-0.34 (t+0.87)}]$ ♀ $L(t)=103.80 [1-e^{-0.38 (t+0.86)}]$
Age classes	Plus group at age 14+ (equivalent quarterly age for SS3)
Natural Mortality (M)	Age-specific M, using Lorenzen function. M for age 4+ = average of 0.3
Fecundity	Fecundity is proportional to female weight-at-age (by individual)
Maturity	Use maturity a length from recent western Indian Ocean study (Dhurmeea et al. 2016, PLoS ONE).
Recruitment (and steepness parameter, h)	Occurs at the start of fourth quarter as 0 age fish. Recruitment is a function of Beverton-Holt stock-recruitment relationship (SRR). h=0.8, Sigma r = 0.6 Temporal recruitment deviates (44) from stock recruitment relationship, 1975-2020.
Catchability	No seasonal variation in catchability for LL CPUE (note the use of quarterly CPUE). LL CPUE indices have a mean CV of 0.3. 1 base parameter estimated per CPUE
Selectivity	Length based selectivity, parameterised with double normal function. All LL Fisheries (except F16_LL4_Q4, which is mirrored to F8_LL2_Q4) are independently estimated. LL3 and LL4 fisheries (and CPUE) share a common double normal selectivity. **LL3 and LL4 NOT** constrained to approximate full selectivity for the largest length classes. LL1 and LL2 fisheries share a common double normal selectivity constrained to approximate full selectivity for the largest length classes. Drift net fisheries have common selectivity. Double normal.

	Purse seine fisheries: double normal selectivity. Other (1-4) fisheries: fixed selectivity, equivalent to double normal.

8. Other business

8.1. *Review of information relevant to the Albacore management strategy evaluation process*

38.   The WPTmT **NOTED** a brief update on the progress and status of the albacore management strategy evaluation, as provided by the Chair. Additionally, the WPTmT **NOTED** that the MSE developers organised an intersessional meeting in December 2024, during which they discussed the albacore MSE process with WPTmT participants and received feedback.

39.   Furthermore, the WPTmT **NOTED** that the WPM has agreed to the operating models proposed by the developers, with the current focus being on conducting simulation testing of candidate management procedures. It was also **NOTED** that there are plans to compare the operating models to the assessment during the WPTmT meeting in July 2025, to determine if the operating model requires reconditioning.

9. Review of the draft, and adoption of the Report of the 9th Session of the WPTmT (Data Preparatory)

40.   Report of the 9th Session of the Working Party on Temperate Tuna (IOTC–2025–WPTmT09(DP)–R) was **ADOPTED** by correspondence.

APPENDIX I

LIST OF PARTICIPANTS

Chairpersons

Title	First name	Last name	Affiliation	Country	E-mail
Dr.	Toshihide	Kitakado	Tokyo University of Marine Science and Technology	JPN	kitakado@kaiyodai.ac.jp

Participants from national institutions

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Participants from international organisations

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Secretariat Staff

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APPENDIX II

AGENDA FOR THE 9ᵀᴴ WORKING PARTY ON DATA COLLECTION AND STATISTIC

Date: 27 February 2025

Location: Online

Time: 12:00 – 16:00 Seychelles time daily

Chair: Dr Toshihide Kitakado (Japan); **Vice-Chair:** Dr Dr Jiangfeng Zhu (People's Republic of China)

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

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

3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS**

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

5. **NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENAL DATA RELATING TO TEMPERATE TUNAS** (Chair)

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

6. **REVIEW OF NEW INFORMATION ON THE STATUS OF TEMPERATE TUNAS** (Chair)

   6.1 Review of fishery dynamics by fleet (CPCs)
   6.2 Nominal and standardised CPUE indices

7. **ALBACORE STOCK ASSESSMENT** (Chair)

   7.1 Discussion on albacore assessment models to be developed and their specifications
   7.2 Identification of data inputs for the different assessment models and advice framework
   7.3 Other data or priorities relevant to the albacore stock assessment and preparation of the WPTmT09 stock assessment meeting

8. **OTHER BUSINESS** (Chair)

   8.1 Review of information relevant to the Albacore management strategy evaluation process
   8.2 Any other matters

9. **REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 9th SESSION OF THE WORKING PARTY ON TEMPERATE TUNAS (DATA PREPARATORY)** (Chair)

APPENDIX III

LIST OF DOCUMENTS

Document	Title
IOTC-2025-WPTmT09(DP)-01a	Draft Agenda of the 9th Working Party on Temperate Tunas (DP)
IOTC-2025-WPTmT09 (DP)-01b	Draft Annotated agenda of the 9th Working Party on Temperate Tunas (DP)
IOTC-2025-WPTmT09 (DP)-02	Draft List of documents
IOTC-2025-WPTmT09 (DP)-03	Outcomes of the 27th Session of the Scientific Committee (IOTC Secretariat)
IOTC-2025-WPTmT09 (DP)-04	Outcomes of the 28th Session of the Commission (IOTC Secretariat)
IOTC-2025-WPTmT09 (DP)-05	Review of Conservation and Management Measures relevant to temperate tuna (IOTC Secretariat)
IOTC-2025-WPTmT09 (DP)-06	Progress made on the recommendations of WPTmT08 (IOTC Secretariat)
IOTC-2025-WPTmT09(DP)-07	Review of the statistical data and fishery trends for albacore (IOTC Secretariat)
IOTC-2025-WPTmT08(DP)-08	A review of the 2022 Albacore Assessment in the Indian Ocean (Rice J)
IOTC-2025-WPTmT08(DP)-09	Spatial and temporal effects on albacore growth and reproduction (Hoyle S)