Food and Agriculture Organization of the United Nations

Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
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IOTC–2022–WPTmT08(AS)–R[E]

# Report of the Eighth Session of the IOTC Working Party on Temperate Tunas: Assessment Meeting

Online, 25–29 July 2022

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## ACRONYMS

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

## STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

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

## HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

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

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

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

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

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**EXECUTIVE SUMMARY**

The 8th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas: Assessment Meeting (WPTmT08(AS)) was held online, from 25 to 29 July 2022. A total of 42 participants (23 in 2019) attended the Session.

The WPTmT **RECALLED** the recommendations contained in the Working Party on Temperate Tunas: Data Preparatory Meeting (WPTmT08(DP)) Report.

The following are a subset of the complete recommendations from the WPTmT08(AS) to the Scientific Committee,

**Stock synthesis III (SS3)**

WPTMT08.01 (para 71) **NOTING** the absence of small albacore (<75 cm fork length) in the sample used for estimating the current growth curve and the fact that most samples were collected in the southwestern Indian Ocean while spatial variability in growth has been observed in albacore in the Pacific Ocean, the WPTmT **RECOMMENDED** to the SC that the collection and analysis of otolith samples is expanded to cover the whole Indian Ocean, with a particular focus on obtaining a broad range of sizes and locations, including fish from the eastern part of the ocean.

**Revision of the WPTmT Program of Work**

WPTmT08.02 (Para 92) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2023–27), as provided at Appendix V.

**Date and place of the 8th and 9th Sessions of the WPTmT**

WPTmT08.03 (para 101) The WPTmT **RECOMMENDED** that a data preparatory meeting (DP) and stock assessment meeting (AS) be held in the same year, with the data preparatory meeting being held between April and June and the assessment meeting in July or August. This would facilitate the provision of CPUE series using data from the previous year to the data preparatory meeting, while ensuring catch data for 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 the stock assessments. The exact dates and meeting locations will be confirmed and communicated by the IOTC Secretariat to the SC for its consideration.

i. WPTmT09(DP): Host to be decided. Meeting to be held in April 2025 (TBC).
ii. WPTmT09(AS): Host to be decided. Meeting to be held in July 2025 (TBC).

**Review of the draft, and adoption of the Report of the 8th Session of the WPTmT**

WPTmT08.04 (para 102) The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT08(AS), provided at Appendix VI, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix IV).

## 1. OPENING OF THE MEETING

1. The 8th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Temperate Tunas (WPTmT08(AS)) was held online from 25 to 29 July 2022. A total of 42 participants (23 in 2019) attended the Session. The list of participants is provided at Appendix I. The meeting was opened by the Chairperson, Dr Jiangfeng Zhu (China), 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 WPTmT08 (AS) are listed in Appendix III.

3. The WPTmT **NOTED** a summary from the Chair on the parameters, configuration and results of the stock assessment conducted in 2019 and the changes that were agreed to for this year's assessment during the data preparatory meeting.

4. The WPTmT **NOTED** that in the 2019 assessment, estimates of reference points (including F and B ratios) were obtained by combining the estimates from the three final models which were adopted, with the median derived from the range estimates across the three models.

## 3. UPDATE OF ANY NEW DATA AVAILABLE AT THE SECRETARIAT FOR ALBACORE TUNA SINCE THE DATA PREPARATORY MEETING

5. The WPTmT **NOTED** the main discussion points and recommendations arising from the report of the WPTmT Data Preparatory meeting (IOTC-2022-WPTmT08(DP)-R), held online in April 2022.

6. The WPTmT **NOTED** the relatively minor updates to the IOTC datasets since the WPTmT Data Preparatory meeting and that the latest data available for the stock assessment of albacore include catches up to 2020, although incomplete data for the statistical year 2021 were received by the Secretariat around the deadline of June 30th 2022.

7. The WPTmT **NOTED** the increasing trends in albacore catches from the beginning of the time series, and how these became more stable in recent years, with annual catch levels oscillating around 35 thousand metric tons since 2006.

8. The WPTmT **ACKNOWLEDGED** that albacore is generally caught by industrial fisheries, with the notable exception of 2020 when around 20% of total catches were accounted for by artisanal fisheries, mostly from Indonesia.

9. The WPTmT **ACKNOWLEDGED** the existence of a large-scale driftnet fishery from Taiwan,China, operating between the mid-1980s and mid-1990s in the northern Arabian sea and in the southern Indian Ocean, that eventually disappeared following the UN ban on large-scale pelagic driftnet fishing.

10. The WPTmT **NOTED** how longline fisheries are the main industrial fisheries targeting albacore, and **ACKNOWLEDGED** that, starting from the beginning of the 2000s, the 'fresh' component of these fisheries became preponderant in terms of catches for the species, and caused a shift of core fishing grounds towards the southwestern Indian Ocean.

11. The WPTmT **ACKNOWLEDGED** that the so called 'fresh tuna longliners operate smaller vessels (average length overall of 28 m) than deep-freezing longliners (average length overall of 41 m) and mostly target albacore that are kept at subfreezing temperatures for the canning market.

12. The WPTmT also **NOTED** how this definition is not always correctly reflected in the fishery code used to report catches to the IOTC Secretariat, and that therefore a revision of the classification might be performed (in collaboration with concerned CPCs) to properly account for the distinct components of the industrial longline fisheries.

13. The WPTmT **NOTED** that the vast majority (~ 60%) of albacore catches in recent years (2016-2020) is accounted for by the longline fisheries of Taiwan,China, followed by Indonesia (catches equally split between industrial longline and artisanal line fisheries), then China, Japan, Malaysia and all other CPCs.

14. The WPTmT **NOTED** that trends in annual catches of albacore reported by artisanal fisheries show a threefold increase between 2016 and 2020, and that this increase is mostly driven by the levels of catches estimated by the IOTC Secretariat for the coastal longline fishery of Indonesia.

15. In light of the above, the WPTmT **ACKNOWLEDGED** that the Secretariat has recently delivered a data compliance and support mission to Indonesia, and that the purposes of this mission also included the assessment of the current state-of-play in terms of national catch data statistics, **NOTING** that Indonesia will present a proposal for the revision of their official catches to the next IOTC Working Party on Data Collection and Statistics.

16. The WPTmT **NOTED** the improvement in the estimated quality of nominal catches for albacore, which went from around 60% of total annual catches assessed to be of 'good' level in the mid-2000s, to over 80% in 2020.

17. The WPTmT **ACKNOWLEDGED** that these improvements are mainly driven by the reduction of catches attributed to longline NEI fleets, which were particularly common during the 2000s but gradually disappeared as a consequence, among others, of the introduction of Port State Measure controls in the Indian Ocean.

18. Nevertheless, the WPTmT **ACKNOWLEDGED** that uncertainties regarding the quality of recorded longline catches from the Philippines, India and Oman still remain for the years that these fisheries were known to operate, and **REMINDED** concerned CPCs to collaborate with the IOTC Secretariat to clarify any outstanding issues on this matter.

19. The WPTmT **NOTED** that information on discards of albacore are almost exclusively available through the IOTC Regional Observer Scheme database, and that for this reason they remain partial and cover only a fraction of all fisheries targeting the species. At the same time, the WPTmT **ACKNOWLEDGED** that discard levels are expected to be small due to the high commercial value of the species, and that it is likely that mostly damaged fish might be discarded when caught (e.g., due to depredation), even by those fisheries (e.g., industrial purse seines) which do not explicitly target albacore.

20. The WPTmT **NOTED** that the quality of geo-referenced catch and effort data for albacore fisheries is on par with the quality of nominal catches and that this is a direct consequence of the fisheries being mainly of industrial nature and therefore well sampled.

21. Furthermore, the WPTmT **NOTED** the increased levels of catch and effort information reported by some coastal fisheries of Indonesia in recent years (2018-2020), which are a consequence of the implementation of national policies on the use of logbooks, and **ACKNOWLEDGED** that the coverage of the data available to the IOTC Secretariat is still low as it seldom reaches 5% of total catches by species, gear and year.

22. The WPTmT also **NOTED** the different patterns and fishing grounds exploited by the fisheries catching albacore as emerging from the available georeferenced catch and effort data, and in particular how catches from industrial purse seines are generally localised in the tropical waters in the northwestern Indian Ocean, while catches from industrial longliners are now mostly localised in the southwestern Indian Ocean and in waters southeast of Madagascar.

23. Regarding available size-frequency data, the WPTmT **ACKNOWLEDGED** that their quality is generally lower than all other statistical datasets, due to a combination of factors that also includes (for some fleets and years) sampling levels of less than the one fish per metric ton requested by Res. 15/02.

24. Additionally, the WPTmT **NOTED** that a) size-frequency data for Taiwanese deep-freezing and fresh-tuna longliners have very good coverage (above 1 fish / t), although data for the latter are only available from 2010 onwards, b) size-frequency data for longliners from Japan, China, Republic of Korea and Seychelles are scattered and not always reaching the minimum level of coverage, and c) size-frequency data from Indonesian fisheries are not available for several years.

25. The WPTmT **NOTED** in particular the fluctuations in the number of samples available for Japanese longliners, that show a decline in the number of samples recorded from the late-1980s as well as several years of low sampling, and also **NOTED** the large number of samples available for Taiwanese longliners since the early-1980s, with marked changes in estimated average weight starting from 2003, alongside what has already been detected for yellowfin and bigeye tuna.

26. The WPTmT **NOTED** the estimated average weights calculated for the main fisheries, and in particular the strong variability detected among longline fisheries until the mid-1990s, as well as the generally decreasing trend in

average weight of fish caught by purse seine fisheries, but further **NOTED** the larger size of fish caught on free schools by this fishery.

27. The WPTmT **ACKNOWLEDGED** that the average weight calculated for all fisheries combined follows a similar trend to that estimated for the fresh-tuna longlines, due to the preponderance of this fishery in recent years, and further **NOTED** that the average weight of individuals caught by all fisheries combined oscillates between 15 and 17 kg.

28. Finally, the WPTmT **NOTED** the geospatial plots showing the estimated average weight by 5x5 degrees grids in the years 2010-2019 and how these highlight the larger size of fish caught around the equator.

## 4. ALBACORE STOCK ASSESSMENT

### *4.1 Review new information on albacore biology, stock structure, fisheries and associated environmental data since the data preparatory meeting*

29. The WPTmT **NOTED** paper IOTC-2022-WPTmT08-07 which provided Length-weight relationship for Indian Ocean albacore including the following abstract provided by the authors:

> *"We collated a data set of almost half a million observations of fork length and round weight for albacore spanning more than two decades and spreading across the fishing grounds of albacore over the whole Indian Ocean. Most data were collected on fresh fish at sea on large-scale longliners. First, we fitted generalized additive models that showed that the relationship between length and weight varied with sex, space, and time while the fleet and fishery also had an effect on morphometric parameters of Indian Ocean albacore. Secondly, we used linear models to develop statistical relationships between fork length and round weight for operational use and showed that the large areas used for deriving albacore abundance indices for the assessment had a significant effect to explain the observed variability in weights, although the percentage of variation was very small. Weights predicted in the northeastern part of the Indian Ocean were found to be higher than in other regions. Finally, fitting a univariate linear model only considering fork length as covariate showed that the relationships used for the assessments conducted in 2019 and 2022 overestimated albacore's weight."*

30. The WPTmT **THANKED** the authors and **NOTED** that the analysis is based on the collation of different data sources available from a range of fisheries catching albacore across the whole Indian Ocean that represent nearly half a million observations, **ACKNOWLEDGING** the contribution of the Overseas Fisheries Development Council, the Shanghai Ocean University, the University of Mauritius, and the French national Institut de Recherche pour le Développement and Ifremer (Délégation Océan Indien).

31. The WPTmT **NOTED** that the factors affecting the variability in weight measurements were assessed with Generalised Additive Models (GAM) showing that the relationship between fork length and round weight varies with sex, space, and time while the fleet and fishery also have an effect on morphometric parameters of Indian Ocean albacore. The WPTmT also **NOTED** some seasonal variations with the highest values of weight estimated in February-March and the lowest values in August.

32. The WPTmT **NOTED** the discontinuity between December and January in the monthly effects of the GAM analysis and **ENCOURAGED** the authors to further explore the reasons for this and improve the way of accounting for the non-linear effects of month in the model.

33. The WPTmT **NOTED** that mean linear regression models were used to derive a univariate relationship for predicting round weight from observations of fork length and then assess the influence of other factors on weight predictions, indicating capture area as the most important effect explaining weight.

34. The WPTmT **NOTED** that the length-weight relationships generated from these data were compared with Penney (1994) which was calculated for the Atlantic Ocean but has been used for albacore stock assessments in the Indian Ocean. The WPTmT **NOTED** that this comparison suggested that the Penney (1994) relationship overestimates the weight of albacore for a given length.

35. The WPTmT **NOTED** some issues with some of the datasets including rounding applied by observers and the difficulties in collecting length and weight data by observers onboard vessels as well as some measurements

which were conducted visually. The WPTmT also **NOTED** the unbalanced nature of the samples as 99.7% of the data were collected by scientific observers deployed on commercial large-scale longliners as well the lack of sex information for most of the data collected.

36. The WPTmT **NOTED** that some of the length-weight data were collected in the southeastern area of the Atlantic Ocean (i.e., under ICCAT's mandate) and may not be needed in the final estimation regarding the large size of the data set.

37. The WPTmT **NOTED** some patterns in the models' residuals and **SUGGESTED** the use of heavy tailed distribution to account for the noise in the data in future analysis.

38. The WPTmT **ENCOURAGED** the continuation of this work to improve the data available and the understanding of the length-weight relationships of Indian Ocean albacore for potential use in future assessments. The WPTmT also **ENCOURAGED** CPCs to collaborate with the Secretariat on this work to explore other effects and derive a set of relationships based on area, sex, fleet and/or other parameters, **NOTING** that all data, programs and results are available on Github.

39. The WPTmT **NOTED** that the Secretariat currently holds few length-weight relationships based on good quality data and **AGREED** on the need to improve the relationships used in the preparation of national fisheries data sets as well as in stock assessments. The WPTmT **ENCOURAGED** all CPCs to share their morphometric data with the Secretariat in order to improve the quality of the IOTC reference relationships (e.g., through increased coverage) and increase the transparency of the data processing procedures used by the CPCs.

40. The WPTmT **NOTED** paper IOTC-2022-WPTmT08-07 which examined Albacore tuna larval occurrence in the Southwest Indian Ocean and associated species including the following abstract provided by the authors:

    "*Improving our knowledge about albacore tuna reproduction biology is critical for stock management for sustainable fisheries of this presumed to be overfished species. While most of the stock assessment data are from commercial fisheries landed adults, here we present preliminary results of distribution and abundances of larval Albacore tuna (Thunnus. albacares) from Southwestern Indian Ocean near Reunion Island. Surface and subsurface tows were conducted in the spawning habitat of albacore and collected tuna larvae were quantified, measured, visually identified, and genetically confirmed using multiplex PCR using primers for six tuna species: kawakawa (Euthynnus affinis), skipjack (Katsuwonus pelamis), albacore (Thunnus alalunga), yellowfin tuna (Thunnus albacares), bigeye (Thunnus obesus), and Atlantic bluefin tuna (Thunnus thynnus). Albacore larvae were the most numerous and most abundant from our collection (N = 214, 68.21% of total tuna density). Using the reported age-length relationship for T. alalunga from the Mediterranean Sea, our specimens are estimated to be 0–6 days post hatch. Further early life history research is needed to determine larval indices to better estimate larval survival and recruitment into fisheries*"

41. The WPTmT **CONGRATULATED** the authors for successfully conducting larval surveys in 36 stations located between Tromelin and Reunion island during January-February 2022, **NOTING** that eDNA samples were also taken during the cruise.

42. The WPTmT **NOTED** that most of the scombrid larvae collected during the survey were underdeveloped and in preflexion stage due to the small mesh size of the nets (333-500 µm) used.

43. The WPTmT **NOTED** the historical sampling of larvae undertaken by Japan and recently published as an open data set through Zenodo, **NOTING** that these data are considered to be reliable as the surveys used larger gears so the larvae collected were large enough to correctly identify to species level. However, the WPTmT **NOTED** that now the best way to identify individuals to species level is through genetics which allows for larvae of all sizes to be analysed.

44. The WPTmT **NOTED** the need to expand the sampling coverage of such studies, especially in the eastern Indian Ocean and further **NOTED** that the authors are planning to conduct a study off the west coast of Australia to expand the coverage and help to cover this region.

45. The WPTmT **NOTED** paper IOTC-2022-WPTmT08-08 which examined Sex identification of Albacore using a low cost genetic method including the following abstract provided by the authors:

    *"Sex identification of animal species is a critical piece of information to derive parameters for population dynamic models. In the context of stock assessment (SA) for marine population, sex identification provides information about the sex-ratio of the population which is subsequently used to calculate the stock*

*spawning biomass. In these SA models, sex-ratio can be set to a constant value throughout the lives of individuals (e.g. 0.5) or age-structured to account for changes linked to the physiology of individuals (e.g. females may live longer and represent a larger proportion of the population) or the selectivity of the fishery (e.g. a gender may be more accessible to the fishery at specific stages). The most common methods to identify sex are derived from direct observation of gonads. However, scientists must access the whole fish, which is rarely the case for large pelagic species in the IOTC fishery as fish that are landed have been gutted. Here we show the preliminary results of sex identification of albacore (Thunnus alalunga) using a genetic method: Amplified Fragment Length Polymorphism (AFLP). This polymerase chain reaction (PCR)-based genetic tool is a highly sensitive method for detecting polymorphisms in DNA. We tested the hypothesis that male and female albacore present a genetic polymorphism linked to sex. Using a multiplexing technique (i.e. a combination of different restriction enzymes and PCR primers), we identified potential locations in the albacore genome where polymorphism could occur. Comparing results between 3 males and 3 females of albacore, we were able to identify 1 marker over 64 combinations of primers that led to potential sex-specific polymorphism identification. Higher sampling (40 males and 40 females) will be performed to confirm these results. This method has the advantage of being low cost, simple to develop, requires few genetic laboratory analysis or preparation (DNA extraction, PCR, electrophoresis and a capillary sequencer for DNA fragment analysis) and the genetic material required is minimal and can be taken from a living or dead animal.''*

46. The WPTmT **THANKED** the authors for the paper and **WELCOMED** the approach regarding the sexual size dimorphism in growth observed for Indian Ocean albacore (Farley et al. 2019) and in other albacore populations (e.g., Williams et al. 2012).

47. The WPTmT **NOTED** that while the results from this study are promising as it appears that a potential genetic marker has been identified for females, the results are very preliminary as very few samples were analysed. The WPTmT further **NOTED** that this work will be continued with 40 male and 40 female samples and the authors will experiment with taking samples from fins as well as from muscle to see if this method may make sample collection easier while still obtaining samples that can be analysed adequately.

48. The WPTmT **NOTED** that the method could be applied to larvae as well as adults which could be useful for determining sex ratios in spawning locations.

### *4.2 Updated Nominal and standardised CPUE indices*

49. The WPTmT **NOTED** the different time series of CPUE indices presented and discussed at the Data Preparatory meeting of the WPTmT held in April 2022, including the joint CPUE indices considered for the stock assessment (see section 6 of IOTC-2022-WPTmT08DP-RE).

50. The WPTmT **RECALLED** that some major concerns were raised during the Data Preparatory meeting over the reliability of the Taiwanese component in the northeast region (Region 2) while the target effect in the southeast (Region 4) for the Japanese catch effort series remained unsolved.

### *4.3 Stock assessments*

51. The WPTmT **NOTED** that two quantitative modelling methods as detailed below (SCAS and SS3) were applied to the assessment of albacore in 2022. The different assessments were presented to the WPTmT in documents IOTC-2022-WPTmT08-INF01_Rev1 and IOTC-2022-WPTmT08-09. Each model is summarised in the sections below.

**Summary of stock assessment models in 2022: albacore**

52. The WPTmT **NOTED** Table 1 which provides an overview of the key features of each of the stock assessments presented in 2022 (2 model types).

**Table 1.** Summary of final stock assessment model features as applied to the Indian Ocean albacore resource in 2022.

| Model feature | SCAS (Doc #17_Rev1) | SS3 (Doc# 11_Rev1) |
|---|---|---|
| Software availability | Nishida & Rademeyer | NMFS toolbox |
| Population spatial structure / areas | 1 | 1 |
| Number CPUE Series | 4 | 4 (2 used in final model options); |
| Uses Catch-at-length/age | Yes | Yes |
| Age-structured | Yes | Yes |
| Sex-structured | No | Yes |
| Number of Fleets | 8 | 23 |
| Stochastic Recruitment | Yes | Yes |

***Statistical-Catch-At-Size (SCAS)***

53. The WPTmT **NOTED** paper IOTC-2022-WPTmT08-INF01_Rev1 which provided a stock assessment for albacore in the Indian Ocean using Statistical-Catch-At-Size (SCAS), including the following abstract provided by the authors:

    "*Using the SCAS software, a preliminary stock assessment was attempted with the following specification, i.e., four scenarios incorporating nine different variants for the model uncertainties…*" see the paper for the full abstract

54. The WPTmT **NOTED** that the SCAS model is based on catch-at-size and uses the length composition dataset in a similar way to the Stock Synthesis model. The primary distinction between SCAS and Stock Synthesis is that SCAS is an annual model that does not take into account seasonal, spatial or sex structures. SCAS differs from the earlier model (Statistical-Catch-At-Age) (SCAA) which is based on catch-at-age data.

55. The WPTmT **NOTED** that the SCAS assessment implemented four scenarios as a combination of two alternative assumptions about each of the two issues: (a) CPUE based on Western Indian Ocean only (R1+R3) or Whole IO (R1+R2+R3+R4); and (b) the relative weights of CAS versus CPUE (0.05 and 0.1). Each scenario was run on a set of models based on three levels of sigmaR and three steepness values (9 models). Based on the respective analyses, the 2CPUE_CASW (Western IO CPUE and CAS relative weight of 0.05) was considered to be the more stable and plausible option.

56. The WPTmT **NOTED** that the SCAS assessment provided estimates of stock status using MCMC from model options 2CPUE_CASW. The WPTmT **NOTED** that although probabilities indicate that the stock is most likely to be in the red quadrant, the median of the MCMC estimates is in the orange Kobe quadrant. The WPTmT **REQUESTED** the authors to investigate this.

57. The WPTmT **NOTED** that the length composition data from the "Other" fishery category (mainly small artisanal, or coastal fishing gears, such as trolling) has resulted in some convergence issues in the model. This highlights how important the length composition is to such a model. Particularly poor quality length data from coastal fisheries might significantly affect the stock status estimate, even though catches may have been small.

58. The WPTmT **THANKED** the authors for their good work in creating the SCAS tool, which represents a significant improvement over the initial SCAA model. The SCAS can be very complementary to the more complex stock assessment models, even though it is designed as a simpler model to allow efficient assessment. The WPTmT **ENCOURAGED** the authors to evaluate the performance of SCAS with other stock assessment platforms, such as SS3, to further improve the SCAS model's transparency and reliability.

**Stock Synthesis III (SS3)**

59. The WPTmT **NOTED** paper IOTC–2022–WPTmT08(AS)–09 which provided a stock assessment for albacore in the Indian Ocean by Stock Synthesis III (SS3) model, including the following abstract provided by the author:

    *"This paper presents a stock assessment of albacore tuna in the Indian Ocean using Stock Synthesis (version 3.30.19.01 http://nft.nefsc.noaa.gov/Download.html). The 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 from longline fisheries were considered for this analysis. 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.*

*Albacore tuna are most often caught in long line fisheries in the Indian Ocean tuna fisheries, though some bycatch occurs in the purse seine fisheries as well as other mixed gear fisheries.*
*This analysis was developed based on the 2019 assessment along with updates to the data and parameterization. A the diagnostic case, is referred to in the main text when presenting the model parametrization and diagnostics. The upcoming 8th meeting of the Indian Ocean Tuna Commission Working Party on Temperate Tuna and Bycatch (WPTmT08) will recommend the final parameterization as a base case model for the provision of stock status. Initial analysis based on the sensitivity analysis done with SS3 indicated that the stock is not over fished nor experiencing overfishing"*

60. The WPTmT **NOTED** that the author was not able to attend the meeting in person and so the IOTC Secretariat presented the stock assessment. The WPTmT **THANKED** the author for his great effort and made note of the important findings for the preliminary SS3 models. Based on the results outlined in the paper, the WPTmT **NOTED** the below with respect to the modelling approach presented at the meeting.

61. The WPTmT **NOTED** that the assessment's main approach is to create an internally consistent model, to which end a variety of diagnostic tools were used to evaluate model performance. The diagnostic procedures used include (but are not limited to) profile likelihood, retrospective analysis, goodness of fit, residual analysis, and hindcasting cross validation. The WPTmT also **NOTED** that additional sensitivity model runs were carried out afterwards to investigate additional alternative parameters and CPUE choices.

62. The WPTmT **NOTED** that the diagnostics case configuration was based on the previous assessment's reference case, and the model was fitted to the CPUE index from the southwestern region (R3). The longline fisheries in each region are separated by season, with independent selectivity and catchability in each quarter, which is a significant change from the previous assessment. This enables the model to better account for seasonal variation in length compositions and catch rates, which may previously have been less accurately reflected by the modelled population dynamics.

63. The WPTmT **NOTED** that the variation in length-at-age used in the assessment was parameterised as a function of age with a coefficient of variation (CV) of 0.06 for the younger age classes and decreasing to 0.025 for the older age classes. The magnitude of variation had been derived from the individual ageing observations from the growth study and may have underestimated the true variability of the growth curve due to the relatively small sample size and limited sampling of the population. The WPTmT **NOTED** that a higher CV (0.10 across all ages) was examined in a model sensitivity.

64. The WPTmT **NOTED** that the assessment has separated males and females due to differential growth by sex. The WPTmT further **NOTED** that the sex split can make the model more complex. However, the WPTmT **RECALLED** that the sex distinction was initially examined in the 2014 assessment and shown to significantly affect model outcomes.

65. The WPTmT clarified that SigmaR of 0.6 was used in all models including the diagnostic case and sensitivities. The WPTmT discussed various practices for choosing sigmaR and **NOTED** that as a general rule sigmaR should be based on the assumed variability in recruitment deviations. The WPTmT **NOTED** that Indian Ocean albacore tuna fisheries are primarily focused on large fish, resulting in a lack of information in the size data to inform recruitment variability. As such the model should avoid using too small a value to overly constrain the estimation of recruitment deviation.

66. The WPTmT **NOTED** that the mirroring of selectivity for fishery F16 (LL 4, quarter 4) to F8 (LL 2, quarter 4) may not be appropriate because the catch-at-size distributions are very different between the southern and northern fisheries. The WPTmT **SUGGESTED** that F16 should be mirrored to F15 (LL4, Quarter 3).

67. The WPTmT **NOTED** that the model is very sensitive to changes/updates in length composition data (particularly LL 3), indicating some model instability. As a result, the longline size data has been significantly down-weighted by limiting the input sample size to a maximum of 5 and reducing its likelihood weight to 0.1. Furthermore, the

length composition data for fisheries other than the longline fishery (driftnet, purse seine, and all other small artisanal fisheries) have been given a weight of 0 or are excluded from the model (the associated selectivity parameters are thus fixed) to reduce the influence of these data on the estimate of population scaling parity (i.e., R0).

68. The WPTmT **NOTED** that albacore tuna length composition data are generally not very informative of population age structure because albacore approach the asymptotic length at a relatively young age. As a result, poor-quality length data (even from a small-catch fishery) could significantly bias population age structure and, consequently, abundance estimation. The WPTmT **SUGGESTED** that the weighting of length composition data for individual fisheries should be given careful consideration.

69. The WPTmT **NOTED** that there are some well-known methods for weighting length composition data for individual fisheries (such as the Francis' method or McAllister' approach), but they do not seem to work well for most tuna assessments, where data are weighted more subjectively in practice. The WPTmT **NOTED** that for tuna assessment, particularly when there is no tagging data and CPUE data provide limited information on scaling, the model must rely on size data for this purpose. Therefore, it is critical to use more reliable length composition data and for the model to fit those data well.

70. The WPTmT **NOTED** the length composition data in the northern fishery are fitted poorly (there are obvious large positive residuals in the upper size range), which may indicate that the variance of size-at-age is not sufficient. The WPTmT **NOTED** that while the sensitivity run which increases CV of the size-at-age to 10% could improve the residual patterns (in the upper size range), it appears to have caused the selectivity in Q2 and Q3 fisheries in LL1 fisheries to be poorly estimated, resulting in a large bias in the predicted mean length for these two fisheries. This suggests that there may be some complicated interactions between growth and selectivity, as well as length composition data, that need to be investigated further. For example, the double normal selectivity in the southern fishery has been constrained to be asymptotic, which may be inconsistent with the albacore population's vulnerability to this fishery.

71. **NOTING** the absence of small albacore (<75 cm fork length) in the sample used for estimating the current growth curve and the fact that most samples were collected in the southwestern Indian Ocean while spatial variability in growth has been observed in albacore in the Pacific Ocean, the WPTmT **RECOMMENDED** to the SC that the collection and analysis of otolith samples is expanded to cover the whole Indian Ocean, with a particular focus on obtaining a broad range of sizes and locations, including fish from the eastern part of the ocean.

72. The WPTmT **AGREED** that the final set of model options should include alternative models based on the CPUE indices for the northwest and southwest. The two indices effectively monitor different components of the albacore stock. At this time, the CPUE in the western area (LL1+3) may best represent the abundance of albacore. The western area also contains a significant proportion of the Indian Ocean's albacore biomass. Changes in targeting have an impact on the eastern indices (LL2+4). Both sets of western indices indicated a significant difference in biomass trend between 1990 (**Fig. 1**) and now, highlighting the uncertainty in model estimates of recent biomass trends.

73. The WPTmT also **NOTED** that the current assessment used the new joint CPUE series, which shows some differences from the previous assessment. These differences are primarily due to changes in standardisation methodology, which were in part caused by restricted operational data access for Joint CPUE analysis, and it is unclear whether these changes result in more representative indices. In comparison to the previous assessment, the CPUE index in the southwestern fishery (LL 3) has a somewhat flatter overall trend, while the CPUE index in the northwestern fishery (LL 1) has significantly higher variability.

74. Based on the above discussions the WPTmT **SUGGESTED** final model options:

    i. Based on NW CPUE regional CPUE indices (LL1)

    ii. Based on SW CPUE regional CPUE indices (LL3)

    The above model runs are based on configurations of the diagnostic model in the document except that the selectivity of fishery F16 was mirrored to that of F15.

75. The WPTmT **NOTED** the key assessment results for the Stock Synthesis III model (SS3) as shown below (**Tables 2-3**; **Fig. 2 & 3**).

**Table 2.** Key management quantities from the SS3 assessment for Indian Ocean albacore. Values are based on the median of the combined outputs of 3 model options: Models 1, 2 and 3

| Management Quantity | Indian Ocean |
|---|---|
| 2021 catch estimate (t) | 41 073 |
| Mean catch from 2017–2021( t) | 39 414 |
| MSY (1000 t) (95% CI) | 45 (35–55) |
| Data period used in assessment | 1950–2020 |
| $F_{MSY}$ (95% CI) | 0.18 (0.15–0.21) |
| $SB_{MSY}$ (1000 t) (95% CI) | 27 (21 – 33) |
| $F_{2021}/F_{MSY}$ (95% CI) | 0.68 (0.42–0.94) |
| $SB_{2021}/SB_{MSY}$ (95% CI) | 1.56 (0.89–2.24) |
| $SB_{2021}/SB_{1950}$ (95% CI) | 0.36 (0.26–0.45) |

* For SS3 SB is defined as mature female biomass.

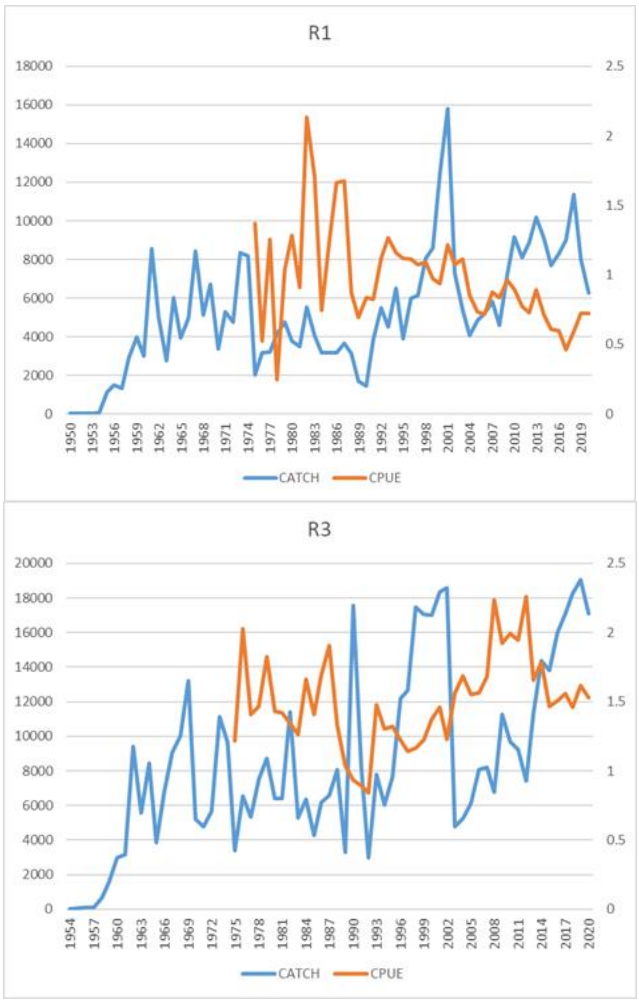


**Fig. 1.** Albacore: Time series of CPUE indices (orange) and catches (blue) for the northwestern region (R1) and southwestern region (R3) (tonnes)

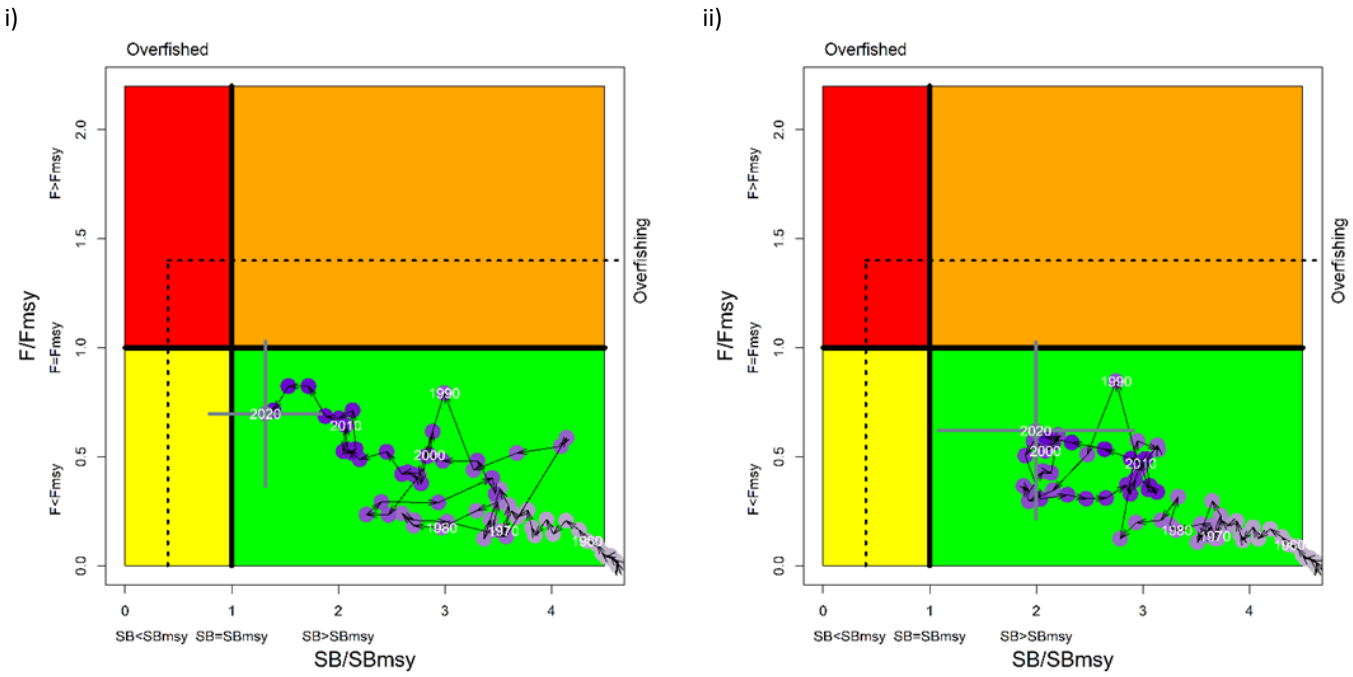


**Fig. 2.** Albacore: SS3 Indian Ocean assessment Kobe plot for the two model options: (i) Model NW_CPUE (ii) Model SW_CPUE. Purple circles indicate the trajectory of the point estimates for the spawning biomass (SB) ratio and fishing mortality (F) ratio for each year 1950–2020 (the grey lines represent the 95 percentiles of the 2020 estimate). Target ($F_{target}$ and $SB_{target}$) and limit ($F_{lim}$ and $SB_{lim}$) reference points are shown.

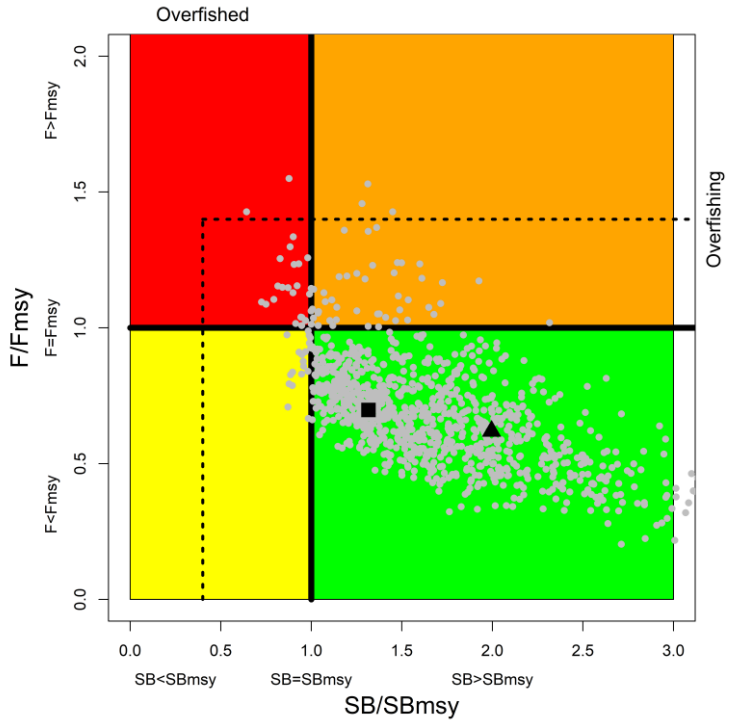


**Fig. 3.** Albacore: SS3 Indian Ocean assessment Kobe plot for the final two model options combined: current stock status relative to $SB_{target}$ (x-axis) and $F_{target}$ (y-axis) reference points. Black symbols represent Maximum posterior density (MPD) estimates from individual models: square represents NW_CPUE model and triangle represents SW_CPUE model. Grey dots represent uncertainty from individual models.

**Table 3.** Albacore: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix based on the model options (i) Model 1 (ii) Model 2 (Estimates including uncertainty from the two models are combined with equal weighting). Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for constant catch projections (2020 catch level, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

| **Reference point and projection timeframe** | **Alternative catch projections (relative to the catch level for 2020) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 60% (24,644) | 70% (28,751) | 80% (32,858) | 90% (36,966) | 100% (41,073) | 110% (45,180) | 120% (49,288) | 130% (53,395) | 140% (57,502) |
| $SB_{2023} < SB_{MSY}$ | 0.006 | 0.016 | 0.022 | 0.036 | 0.045 | 0.069 | 0.097 | 0.123 | 0.154 |
| $F_{2023} > F_{MSY}$ | 0 | 0 | 0.003 | 0.029 | 0.1 | 0.204 | 0.326 | 0.434 | 0.529 |
| $SB_{2030} < SB_{MSY}$ | 0.03 | 0.047 | 0.087 | 0.135 | 0.19 | 0.28 | 0.395 | 0.505 | 0.603 |
| $F_{2030} > F_{MSY}$ | 0 | 0 | 0.001 | 0.037 | 0.141 | 0.3 | 0.453 | 0.565 | 0.618 |
| **Reference point and projection timeframe** | **Alternative catch projections (relative to the catch level for 2020) and probability (%) of violating MSY-based target reference points ($SB_{Lim} = 0.4*SB_{MSY}$; $F_{Lim} = 1.4*F_{MSY}$)** | | | | | | | | |
| | 60% (24,644) | 70% (28,751) | 80% (32,858) | 90% (36,966) | 100% (41,073) | 110% (45,180) | 120% (49,288) | 130% (53,395) | 140% (57,502) |
| $SB_{2023} < SB_{Lim}$ | 0 | 0 | 0 | 0 | 0.001 | 0.002 | 0.005 | 0.006 | 0.012 |
| $F_{2023} > F_{Lim}$ | 0 | 0 | 0 | 0 | 0.001 | 0.011 | 0.056 | 0.117 | 0.213 |
| $SB_{2030} < SB_{Lim}$ | 0.004 | 0.009 | 0.022 | 0.042 | 0.074 | 0.118 | 0.169 | 0.243 | 0.344 |
| $F_{2030} > F_{Lim}$ | 0 | 0 | 0 | 0 | 0.008 | 0.073 | 0.21 | 0.374 | 0.496 |

### *4.4 Selection of Stock Status indicators*

76. The WPTmT **NOTED** the following with respect to the various modelling approaches used in 2022:

    i. The Joint CPUE standardisation was based on a unified, well documented procedure which has been evolving over time. It is currently considered as the best practice in standardising the operational level data from the main longline fleets (i.e. Japanese, Taiwanese, and Korean fleets). Combining observations across fleets in a single analysis also provides a time series with better spatial and temporal coverage.

    ii. The reliability and representativeness of the Joint CPUE indices were extensively discussed at the WPTmT. At this time, the CPUE in the western area (LL1+3) may best represent the abundance of albacore tuna. The western area also contains a significant proportion of the Indian Ocean's albacore biomass. The CPUE in the eastern area, on the other hand, is more likely to be problematic: there are serious concerns about the reliability of the Taiwanese component in the northeast region (R2), and the target effect in the southeast (R4) for the Japanese catch effort series remains unresolved.

    iii. It was agreed that all the stock assessment modelling approaches would use the joint standardized CPUE for southwest area as well as northwest region

    iv. The WPTmT **NOTED** that there is still significant uncertainty due to: changes in the CPUE series that are not well understood; model instability in response to updated data; growth variability; and poor fits to the size data. It should be noted that neither the CPUE series nor the other model assumptions account for changes in catchability/effort creep over time.

77. The WPTmT **NOTED** significant progress in SCAS model development. For example SCAS is able to incorporate CPUE and Catch-at-size data and define the fleet structure in a similar way to the SS3 model. The WPTmT **ENCOURAGED** CPC scientists to explore the utility of SCAS in assessing the albacore stock.

78. The WPTmT **NOTED** a thorough and in-depth analysis of SS3 was presented with a complete set of diagnostics, in comparison with other stock assessments for which some key diagnostics were not provided. Therefore, the

WPTmT **AGREED** that albacore stock status should be determined by the results of the SS3 stock assessments undertaken in 2022 and that the results of the SCAS models should be presented for informative purposes supporting the results of the SS3.

### *4.5 Update on Management Strategy Evaluation Progress (OM formulation)*

79. The WPTmT **NOTED** paper IOTC-2022-WTmT08(AS)-05 which provided an update on the ALB OM conditioning included the following abstract by the authors:

*"This document presents the process of conditioning and the current state of the Operating Model (OM) for Indian Ocean albacore. The OM is being used for the initial evaluation of Management Procedures for the stock following the guidelines providing by recent meetings of the TCMP (IOTC 2021b). The OM is based on a grid of alternative runs based on the stock assessment for albacore (Langley 2019) carried out and accepted by WPTmT in 2019. Three system characteristics of the Operating Model and the Observation Error Model are likely to have the greatest in_uence in the performance of an MP: scale, noise and trend. The strategy for development of an MP described here tries to ensure that a realistic range of options for those three quantities are present in the OM set. Model runs have been selected based on four criteria related to their _t to the data, prediction skill, and ability to explain recent catches. A large proportion of model runs did not pass these tests. Finally, the remaining runs were resampled using sampling weights based on their prediction skill for the two CPUE indices to be used in future projections."*

80. The WPTmT **WELCOMED** the presentation and **AGREED** to further discuss possible ways for building an updated OM for this stock. The WPTmT **NOTED** the problems identified by the developer with the current OM and the effect these could have on the suitability of the OM as a basis for the evaluation of alternative MPs.

81. The WPTmT **NOTED** that the choice of selection criteria is an important element in the method employed for building the current OM for this stock. Although the current methodology was presented and endorsed by the WPM in its 2021 session, the WPTmT **REQUESTED** WPM to revisit the selection and weighting criteria and suggest a set of guidelines for application across different stocks.

82. The WPTmT **DISCUSSED** whether the catches in the last three years (those used to extend the OM to its current status) had increased sufficiently for so many models to be unable to explain them. Catches in the Indonesian fisheries have grown considerably over that period, and a large proportion of those catches are being estimated by the Secretariat. Although there is no reason to doubt the procedure, the WPTmT **NOTED** that some work needs to be carried out to validate those estimates, given that they have become a larger proportion of the total catch for this stock.

83. The WPTmT **NOTED** paper IOTC-2022-WTmT08(AS)-10 which introduce a new method for conditioning of the OM, and included the following abstract by the authors:

*"IOTC has been conditioning various OMs based on a grid of alternative stock assessment runs. A complimentary approach is outlined here that attempts to separate the stock assessment and operating models given their different intentions. A suite of possible prior states for past dynamics and current status are combined with available data using the Approximate Bayesian Computation (ABC) paradigm. A relatively simple example is provided on how this methodology could be used to construct a flexible OM for Indian Ocean albacore."*

84. The WPTmT **NOTED** that this approach has been proposed initially for stocks in which the stock assessment fails to provide a robust basis for constructing the OM. Given the problems with the current albacore OM, as presented in document IOTC-2022-WPTmT08-05, this alternative approach was discussed for its use on albacore.

85. The WPTmT **NOTED** that the example presented in the document is a simple proof of concept, and that several methodological developments will have to take place before it can be applied fully to the albacore stock, for example, on the validation of this type of models.

86. The WPTmT **NOTED** the need for robustness tests on the main assumptions and inputs of the presented methodology. These should include at least the choice of distance metrics that are used to evaluate the fit to the input data, and the prior distributions employed by the algorithm.

87. The WPTmT **NOTED** that the further separation of stock assessment and operating model will require the interaction between the two processes to be defined. The WPTmT **ACKNOWLEDGED** the discussion on these

issues that took place during TCMP05, as well as the SC guidelines on exceptional circumstances, and how they would apply to the albacore stock.

88. The WPTmT **AGREED** to support the proposed methodology as the basis for the update of the albacore Operating Model and **REQUESTED** the WPM to further discuss the technical details of this method. The WPTmT **NOTED** that a potential new OM, either based on this method or the current one, would only be available for review by the WPM session in 2023.

### *4.6 Development of technical advice on the status of the albacore tuna stock*

89. The WPTmT **ADOPTED** the management advice developed for albacore as provided in the draft Executive Summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for albacore with the latest 2020 catch data:
    - Albacore (*Thunnus alalunga*) – Appendix IV

## 5. RESEARCH RECOMMENDATIONS AND PRIORITIES

### *5.1 Revision of the WPTmT Program of Work*

90. The WPTmT **NOTED** paper IOTC–2022–WPTmT08(AS)–03 which provided an opportunity to consider and revise the Program of Work for 2023–27 to align with the requests and directives from the Commission and Scientific Committee.

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

92. The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2023–27), as provided at Appendix V.

### *5.2 Development of priorities for an Invited Expert at the next WPTmT meeting*

93. The WPTmT **NOTED** with thanks the contributions of Dr Iago Mosquiera and Dr Richard Hillary, IOTC consultants, who presented the results of the MSE and alternative approaches to MSE for albacore, respectively. The WPTmT also **NOTED** the critical work carried out by Mr Joel Rice, IOTC Consultant, who conducted the SS3 assessment.

94. 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:
    i. Expertise: experience with CPUE analysis and standardisation for albacore.
    ii. Expertise: stock assessment experience, particularly with fully integrated models.

## 6. OTHER BUSINESS

### *6.1 Election of a Chairperson and Vice-Chairperson of the WPTmT for the Next Biennium*

95. The WPTmT **NOTED** that the second term of the current Chairperson, Dr JiangFeng Zhu, is due to expire at the end of the current WPTmT meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Chairperson for the next biennium.

96. The WPTmT **THANKED** Dr Zhu for his Chairmanship over the past six years and looked forward to his continued engagement in the activities of the WPTmT in the future.

97. **NOTING** the Rules of Procedure (2014), the WPTmT **CALLED** for nominations for the newly vacated position of Chairperson of the IOTC WPTmT for the next biennium. Dr Toshihide Kitakado was nominated, seconded and elected as Chairperson of the WPTmT for the next biennium.

98. The WPTmT **NOTED** that the second term of the current Vice-Chairperson, Dr Toshihide Kitakado, is due to expire at the closing of the current WPTmT meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Vice-Chairperson for the next biennium.

99. **NOTING** the Rules of Procedure (2014), the WPTmT **CALLED** for nominations for the position of the Vice Chairperson of the IOTC WPTmT for the next biennium. Dr JiangFeng Zhu was nominated, seconded and elected as Vice-Chairperson of the WPTmT for the next biennium.

### *6.2 Date and place of the 9th and 10th Sessions of the WPTmT*

100. Following a discussion on who would host the 9th and 10th 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.

101. The WPTmT **RECOMMENDED** that a data preparatory meeting (DP) and stock assessment meeting (AS) be held in the same year, with the data preparatory meeting being held between April and June and the assessment meeting in July or August. This would facilitate the provision of CPUE series using data from the previous year to the data preparatory meeting, while ensuring catch data for 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 the stock assessments. The exact dates and meeting locations will be confirmed and communicated by the IOTC Secretariat to the SC for its consideration.
    i. WPTmT09(DP): Host to be decided. Meeting to be held in April 2025 (TBC).
    ii. WPTmT09(AS): Host to be decided. Meeting to be held in July 2025 (TBC).

## 7. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 8TH SESSION OF THE WPTMT(AS)

102. The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT08(AS), provided at Appendix VI, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix IV).

103. The report of the 8th Session of the Working Party on Temperate Tunas (*IOTC–2022–WPTmT08(AS)–R*) was **ADOPTED** intersessionally.

# APPENDIX I
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# APPENDIX II

## AGENDA FOR THE 8TH WORKING PARTY ON TEMPERATE TUNAS (AS)

**Date:** 25 - 29 July 2022

**Location:** Online (Zoom)

**Time:** 12:00 – 16:00 daily (Seychelles time)

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

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

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

3. **UPDATE OF ANY NEW DATA AVAILABLE AT THE SECRETARIAT FOR ALBACORE TUNA SPECIES SINCE THE DATA PREPARATORY MEETING (**IOTC Secretariat**)**

4. **ALBACORE STOCK ASSESSMENT** (Chair)
   - 4.1 Review new information on albacore biology, stock structure, fisheries and associated environmental data since the data preparatory meeting (all)
   - 4.2 Updated nominal and standardised CPUE indices
   - 4.3 Stock assessments
     - Stock Synthesis (SS3)
     - Statistical-Catch-at-Size (SCAS)
     - Others
   - 4.4 Selection of Stock Status indicators for albacore
   - 4.5 Update on Management Strategy Evaluation Progress (OM formulation)
   - 4.6 Development of management advice for albacore tuna (all)
   - 4.7 Update of albacore tuna Executive Summary for the consideration of the Scientific Committee (all)

5. **WPTmT PROGRAM OF WORK**
   - 5.1 Revision of the WPTmT Program of Work (2023–2027)
   - 5.2 Development of priorities for an Invited Expert at the next WPTmT meeting

6. **OTHER BUSINESS**
   - 6.1 Election of a Chairperson and a Vice-Chairperson for the next biennium (IOTC Secretariat)
   - 6.2 Date and place of the 9th and 10th Sessions of the WPTmT (Chair and IOTC Secretariat)

7. Review of the draft, and adoption of the Report of the 8th Session of the WPTmT(AS) (Chair)

# APPENDIX III
## LIST OF DOCUMENTS

| Document | Title |
|---|---|
| IOTC–2022–WPTmT08–01a | Draft Agenda of the 8th Working Party on Temperate Tunas |
| IOTC–2022–WPTmT08–01b | Draft Annotated agenda of the 8th Working Party on Temperate Tunas |
| IOTC–2022–WPTmT08–02 | Draft List of documents |
| IOTC–2022–WPTmT08–03 | Revision of the WPTmT Program of Work (2020–2024) (IOTC Secretariat) |
| IOTC–2022–WPTmT08–04 | Overview of Indian Ocean albacore fisheries (Secretariat) |
| IOTC–2022–WPTmT08–05 | Conditioning an operating model for Indian Ocean albacore (Mosqueira I) |
| IOTC–2022–WPTmT08–06 | Preliminary analysis of the variability in the length-weight relationship of Indian Ocean albacore (Secretariat) |
| IOTC–2022–WPTmT08–07 | Albacore tuna larval occurrence in the Southwest Indian Ocean and associated species (Shiroza A, Chevrier T, Brisset B, Chanut J, Derridj O, Evano H, Julien M, Grondin E, Nieblas A-E, Rouyer T, Bernard S, Kerzerho V, Bonhommeau S) |
| IOTC–2022–WPTmT08–08 | Sex identification of Albacore using a low cost genetic method Helary L, Chevrier T, Roumagnac M, Chanut J, Nieblas A-E, Dominique C, Padron M, Brisset B, Evano H, Bernard S, Kerzerho V, Rouyer T, Bonhommeau S.) |
| IOTC–2022–WPTmT08–09 | Stock assessment of albacore tuna (*Thunnus alalunga*) in the Indian Ocean using Stock Synthesis (Rice J) |
| IOTC–2022–WPTmT08–10 | Exploring a wider approach to OM conditioning in IOTC MSE work (Hillary R and Mosqueira I) |
| INFO Papers | |
| IOTC–2022–WPTmT08-INF01 | Preliminary stock assessment of albacore in the Indian Ocean using Statistical-Catch-At-Size (SCAS) (Nishida T and Kitakado T) |

# APPENDIX IV
## DRAFT RESOURCE STOCK STATUS SUMMARY – ALBACORE

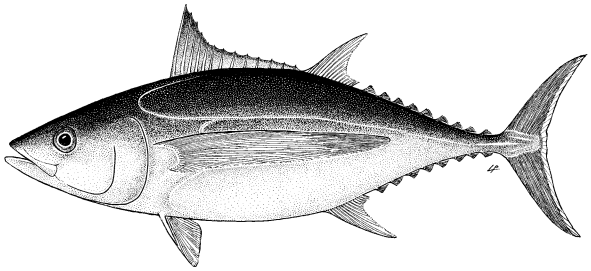

**TABLE 1**. Albacore: Status of albacore (*Thunnus alalunga*) in the Indian Ocean.

| Area | Indicator | Value | Status[3] |
|---|---|---|---|
| Indian Ocean[1] | Catch (2020) (t)[2] | 41,051 | |
| | Mean annual catch (2016-2020) (t) | 39,397 | |
| | MSY (x1,000 t) (95% CI) | 45 (35-55) | |
| | $F_{MSY}$ (80% CI) | 0.18 (0.15-0.21) | |
| | $SB_{MSY}$ (x1,000 t) (80% CI) | 27 (21-33) | |
| | $F_{2020}$ / $F_{MSY}$ (80% CI) | 0.68 (0.42-0.94) | |
| | $SB_{2020}$ / $SB_{MSY}$ (80% CI) | 1.56 (0.89-2.24) | |
| | $SB_{2020}$ / $SB_0$ (80% CI) | 0.36 (0.26-0.45) | |

[1]Stock boundaries defined as the IOTC area of competence; [2]Proportion of catch fully or partially estimated for 2020: 20.2%; [3]Status relates to the final year data are available for assessment

Table 2: Probability of stock status with respect to each of four quadrants of the Kobe plot. Percentages are calculated as the proportion of model terminal values that fall within each quadrant with model weights taken into account

| | Stock overfished ($SB_{2020}$ / $SB_{MSY}$<1) | Stock not overfished ($SB_{2020}$ / $SB_{MSY}$≥ 1) |
|---|---|---|
| Stock subject to overfishing ($F_{2020}$ / $F_{MSY}$≥ 1) | 1% | 9% |
| Stock not subject to overfishing ($F_{2020}$ / $F_{MSY}$≤ 1) | 5% | 85% |
| Not assessed / Uncertain | | |

### Indian Ocean stock – Management Advice

***Stock status***. A new stock assessment was carried out for albacore in 2022 to update the assessment undertaken in 2019. The stock assessment was carried out using Stock Synthesis III (SS3), a fully integrated model that is currently also used to provide scientific advice for the three tropical tunas stocks in the Indian Ocean. The model used in 2022 is based on the model developed in 2019 with a series of revisions that were noted during the WPTmT data preparatory meeting held in April 2022. There are some noticeable changes compared to the previous assessment data set, mainly related to how the fisheries are structured, and how the CPUE indices and length composition data are treated within the assessment model.

The current assessment has utilised the new joint CPUE series that shows some differences compared with the last assessment. This is mainly related to changes in standardisation methodology, which were partly caused by limited operational data access for joint CPUE analysis. Compared to the last assessment, the CPUE index in the southwestern fishery (LL3) shows a somewhat flatter overall trend, the CPUE index in the northwestern fishery (LL1) also exhibited considerably larger variability. Further, the size composition data are significantly down-weighted within the assessment model, and length samples from fisheries other than longline fisheries are effectively given a zero weight. This is to reduce the bias that can be introduced by potentially unrepresentative or problematic length samples.

The final set of model options included alternative models using the northwest and southwest CPUE indices. Both sets of indices suggested a considerable difference in biomass trend between 1990 and now which highlights the uncertainty with respect to the model estimates of recent biomass trends. The two sets of indices effectively monitor different components of the albacore stock. The CPUE in the western area (LL1+3) may best represent the abundance of albacore at this time. The western area also represents a significant proportion of the albacore biomass in the Indian Ocean. The eastern indices are affected by changes in targeting.

Trends in the northwest CPUE series suggest that the biomass vulnerable to longline has declined to around 45-50% of the levels observed in 1980-82, whereas a much smaller decline was observed in the southwest CPUE series for the same period. Prior to 1980 there were 20 years of moderate fishing, after which total catches of albacore tuna in the Indian Ocean have more than doubled (**Fig. A1**). Catches have also increased substantially since 2007 for some fleets (i.e., Indonesian and Taiwan,China longline fisheries), although there is substantial uncertainty regarding the reliability of the catch estimates. Catches in 2020 were marginally below the MSY level estimated by the SS3 model. Fishing mortality represented as $F_{2020}/F_{MSY}$ is 0.68 (0.42–0.94). Biomass is estimated to be above the $SB_{MSY}$ level (1.56 (0.89–2.24)) from the SS3 model (**Table A1**, **Fig. A3**). These changes in stock status since the previous assessment are mainly due to changes in the CPUE. Thus, the stock status in relation to the Commission's interim $B_{MSY}$ and $F_{MSY}$ target reference points indicates that the stock is **not overfished** and is not **subject to overfishing** (**Table A1**).

***Outlook***. The impacts of piracy in the western Indian Ocean 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. However, in recent years the effort distribution in the Indian Ocean has been rather dynamic. Projections indicate that current catch appears to be sustainable in the short term although the projections are based on model assumptions that may be associated with high levels of uncertainty (see management advice below for more detail). It should be noted with caution that the short-term projections are more influenced by the recent low recruitment levels, whereas the long-term projections are more determined by the assumptions of average recruitment levels over the longer-term period.

***Management advice***. Although considerable uncertainty remains in the SS3 assessment conducted in 2022, particularly due to the conflicts in key data inputs, a precautionary approach to the management of albacore should be applied. The K2SM indicates that there is little risk of violating the target and limit reference points with current and moderate increases in catch in the short term. Current catches are just below the estimated level of MSY (41,051t for the statistical year 2020; **Table A3**).

There remains considerable uncertainty resulting from changes in the CPUE series which are not well understood, model instability in response to updated data, growth variability and poor fits to the size data. It should be noted that neither CPUE series or other model assumptions account for any change in catchability/effort creep over the time series.

The following should be noted:

- The primary sources of data that drive the assessment, total catches, CPUE and length data, are highly uncertain and should be developed further as a priority;
- The catch estimates for 2020 (41,051 t) are above the current estimated MSY levels (**Table A1**);
- A Kobe 2 Strategy matrix was calculated to quantify the risk of different future catch scenarios, using the projections from the SS3 model (**Table A3**);
- Provisional reference points: noting that the Commission in 2015 adopted Resolution 15/10 *On interim target and limit reference points and a decision framework*, the following should be noted:
  - **Fishing mortality**: current fishing mortality is considered to be below the interim target reference point of $F_{MSY}$, and therefore below the interim limit reference point of $1.4*F_{MSY}$ (**Fig. A3**)
  - **Biomass**: current spawning biomass is considered to be above the target reference point of $SB_{MSY}$, and therefore above the limit reference point of $0.4*SB_{MSY}$ (**Fig. A3**)

- **Main fisheries (mean annual catch 2016-2020)**: albacore are caught using longline (87.1%), followed by line (10.3%) and purse seine (1.4%). The remaining catches taken with other gears contributed to 1.2% of the total catches in recent years (**Fig. A1**).
- **Main fleets (mean annual catch 2016-2020)**: the majority of albacore catches are attributed to vessels flagged to Taiwan,China (57.7%) followed by Indonesia (18.6%) and China (8.8%). The 28 other fleets catching albacore contributed to 14.8% of the total catch in recent years (**Fig. A2**).

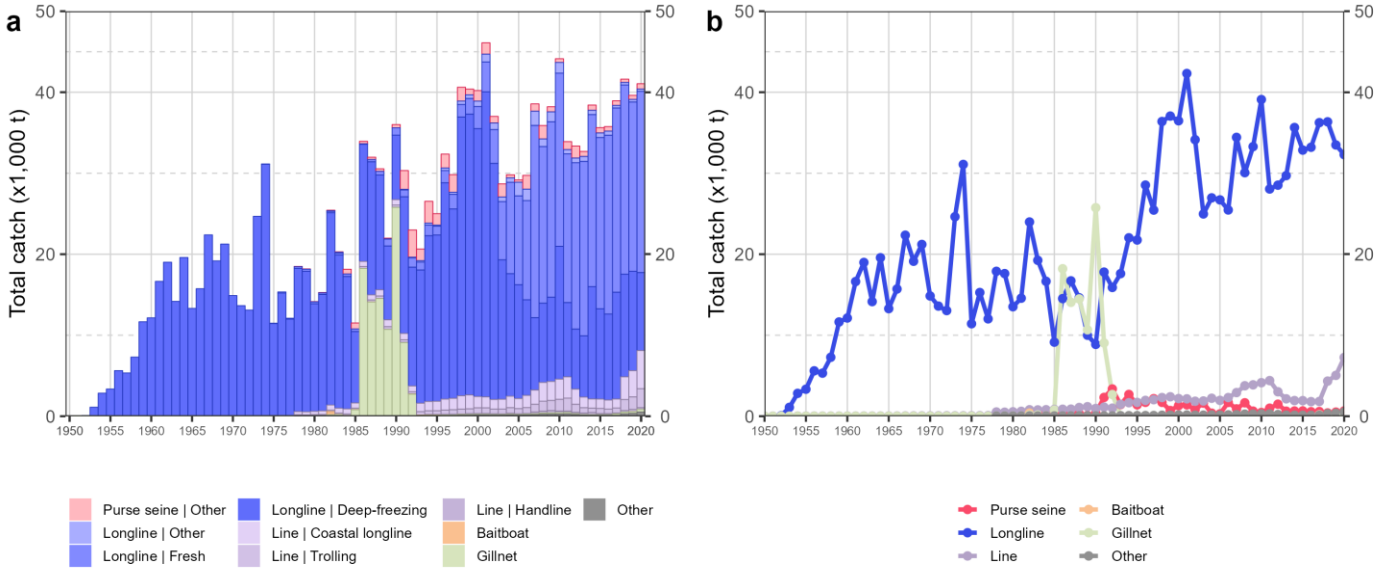


**Figure A1:** Annual time series of (a) cumulative nominal catches (t) by fishery and (b) individual nominal catches (t) by fishery group for albacore during 1950-2020

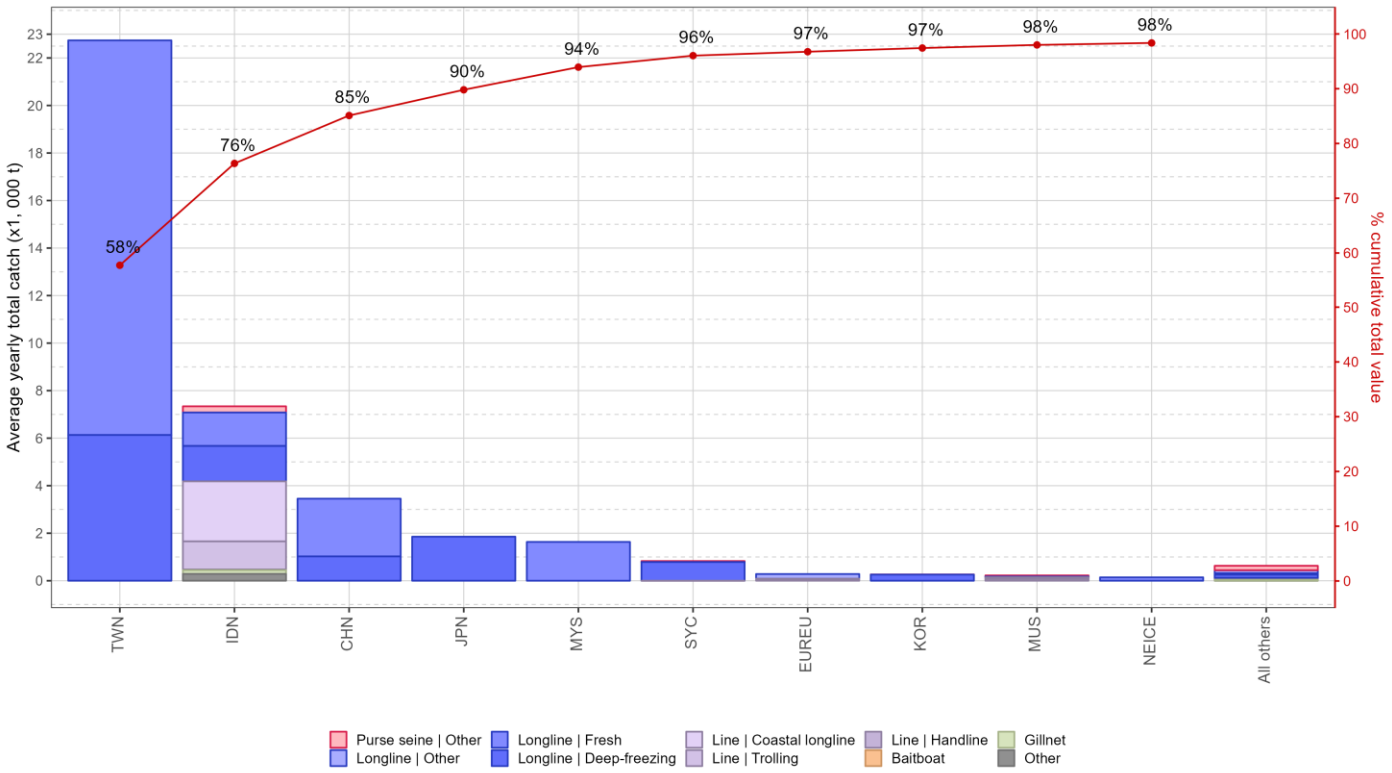


**Figure A2:** Mean annual catches (t) of albacore by fleet and fishery between 2016 and 2020, with indication of cumulative catches by fleet

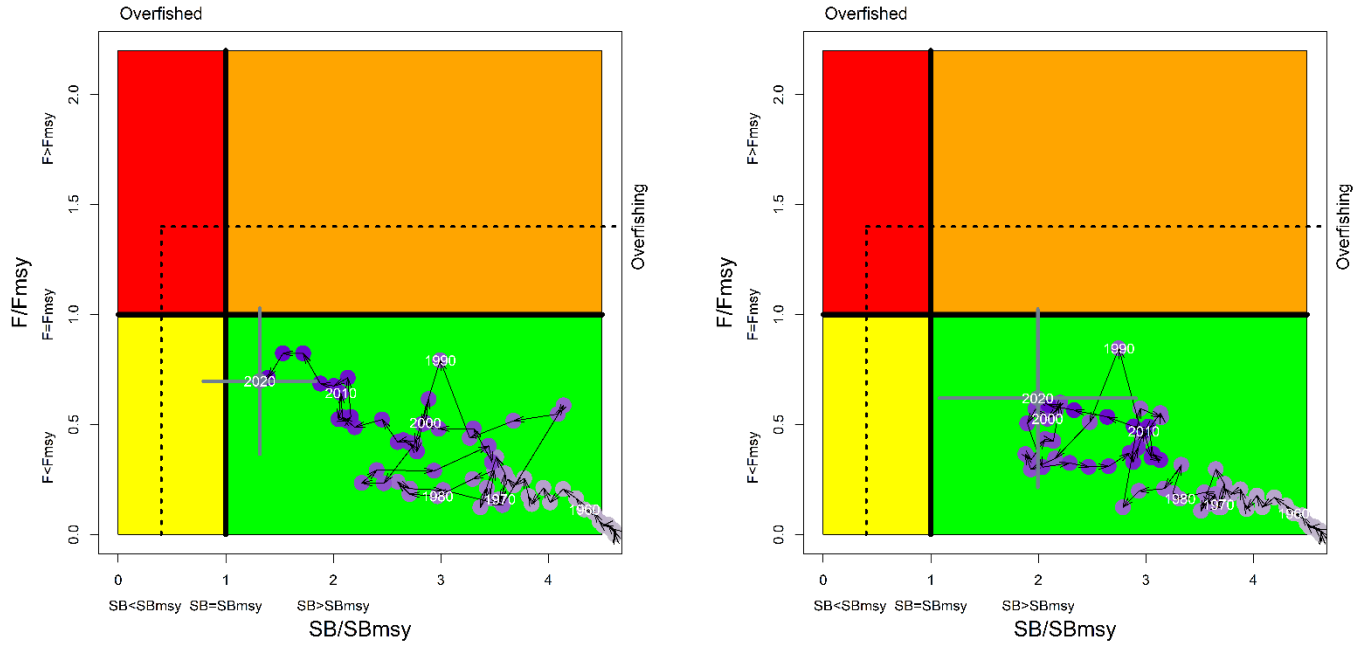


**Fig. A3.** Albacore: SS3 Indian Ocean assessment Kobe plot for the two model options considered: (i) Model fitted to the North-western CPUE; (ii) Model fitted to the South-western CPUE. Purple circles indicate the trajectory of the point estimates for the spawning biomass (SB) ratio and fishing mortality (F) ratio for each year 1950–2020 (the grey lines represent the 95 percentiles of the 2020 estimate). Target ($F_{target}$ and $SB_{target}$) and limit ($F_{lim}$ and $SB_{lim}$) reference points are shown

**Table A2.** Albacore: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix based on the model options (i) Model 1 and (ii) Model 2. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for constant catch projections (2020 catch level, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years

| **Reference point and projection timeframe** | **Alternative catch projections (relative to the catch level for 2020) and probability (%) of violating MSY-based target reference points ($SB_{targ}$ = $SB_{MSY}$; $F_{targ}$ = $F_{MSY}$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 60% (24,644) | 70% (28,751) | 80% (32,858) | 90% (36,966) | 100% (41,073) | 110% (45,180) | 120% (49,288) | 130% (53,395) | 140% (57,502) |
| $SB_{2023} < SB_{MSY}$ | 0.006 | 0.016 | 0.022 | 0.036 | 0.045 | 0.069 | 0.097 | 0.123 | 0.154 |
| $F_{2023} > F_{MSY}$ | 0 | 0 | 0.003 | 0.029 | 0.1 | 0.204 | 0.326 | 0.434 | 0.529 |
| $SB_{2030} < SB_{MSY}$ | 0.03 | 0.047 | 0.087 | 0.135 | 0.19 | 0.28 | 0.395 | 0.505 | 0.603 |
| $F_{2030} > F_{MSY}$ | 0 | 0 | 0.001 | 0.037 | 0.141 | 0.3 | 0.453 | 0.565 | 0.618 |
| **Reference point and projection timeframe** | **Alternative catch projections (relative to the catch level for 2020) and probability (%) of violating MSY-based target reference points ($SB_{Lim}$ = 0.4*$SB_{MSY}$; $F_{Lim}$ = 1.4*$F_{MSY}$)** | | | | | | | | |
| | 60% (24,644) | 70% (28,751) | 80% (32,858) | 90% (36,966) | 100% (41,073) | 110% (45,180) | 120% (49,288) | 130% (53,395) | 140% (57,502) |
| $SB_{2023} < SB_{Lim}$ | 0 | 0 | 0 | 0 | 0.001 | 0.002 | 0.005 | 0.006 | 0.012 |
| $F_{2023} > F_{Lim}$ | 0 | 0 | 0 | 0 | 0.001 | 0.011 | 0.056 | 0.117 | 0.213 |
| $SB_{2030} < SB_{Lim}$ | 0.004 | 0.009 | 0.022 | 0.042 | 0.074 | 0.118 | 0.169 | 0.243 | 0.344 |
| $F_{2030} > F_{Lim}$ | 0 | 0 | 0 | 0 | 0.008 | 0.073 | 0.21 | 0.374 | 0.496 |

# APPENDIX V
# WORKING PARTY ON TEMPERATE TUNAS PROGRAM OF WORK (2023–2027)

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**: Stock assessment schedule.

**Table 1**. Priority topics for obtaining the information necessary to develop stock status indicators for albacore in the Indian Ocean (2023–2027)

| Topic | Sub-topic and project | Priority | Est. budget and/or potential source | Timing | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2023 | 2024 | 2025 | 2026 | 2027 |
| 1. Stock structure (connectivity and diversity) | 1.1 Genetic research to determine the connectivity of albacore throughout its distribution and the effective population size. | Low (5) | 1.3 m Euro: European Union | | | | | |
| 2. Biological information (parameters for stock assessment) | 2.1 Biological research (collaborative research to improve understanding of spatio-temporal patterns in age and growth and reproductive parameters) | High (1) | TBD | | | | | |
| | 2.1.1 Age and growth studies: Uncertainty about the growth curve is a primary source of uncertainty in the stock assessment. A preliminary growth curve was developed in 2019, but there is substantial work to be done to ensure that growth curves include data from smaller size classes, and that spatio-temporal patterns in growth are quantified for use in the stock assessment. Collaborative sampling programs, involving a combination of observer- and port-based sampling, are required to ensure that adequate samples are collected. | | TBD | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2..1.2 Quantitative biological studies are necessary for albacore throughout its range to determine spatio-temporal patterns in key reproductive parameters including sex ratio; female length- and age-at-maturity; spawning location, periodicity and frequency; batch fecundity at length and age; spawning fraction and overall reproductive potential, to inform future stock assessments. | | TBD | | | | | |
| 3 | CPUE standardisation | 3.1 Continue the development of standardized CPUE series for each albacore fishery for the Indian Ocean, with the aim of developing appropriate CPUE series for stock assessment purposes. | High (3) | CPUE Workshop (TBD) | | | | | |
| | | 3.1.1 Spatio-temporal structure and target changes need to be considered carefully, as fish density and targeting practices can vary in ways that affect CPUE indices. Developments may include changes to fishery spatial structure, new approaches for area weighting, time-area interactions in the model, and/or indices using VAST. | | CPCs directly | | | | | |
| 4 | Size frequency data | 5.1 Further investigate the size information provided by CPCs in order to better understand the stock dynamics and inputs into the assessment models. This is particularly necessary for the purse seine data. | High (2) | TBD | | | | | |
| 5 | Management strategy evaluation | 6.1 Continue to collaborate with the WPM on input to the Management Strategy Evaluation (MSE) process. | High (4) | TBD | | | | | |

**Table 2.** Assessment schedule for the IOTC Working Party on Temperate tuna 2023-2027.

| ***Working Party on Temperate Tunas*** | | | | | |
|---|---|---|---|---|---|
| **Species** | **2023** | **2024** | **2025** | **2026** | **2027** |
| Albacore | – | | Data preparatory Meeting (4 days) (April/May/June) Stock assessment meeting (5 days) (July/August) | – | – |

# APPENDIX VI
# CONSOLIDATED RECOMMENDATIONS OF THE 8TH SESSION OF THE WORKING PARTY ON TEMPERATE TUNAS: ASSESSMENT MEETING

The following are the complete recommendations from the WPTmT08(AS) to the Scientific Committee.

**Stock synthesis III (SS3)**

WPTMT08.01 (para 71) **NOTING** the absence of small albacore (<75 cm fork length) in the sample used for estimating the current growth curve and the fact that most samples were collected in the southwestern Indian Ocean while spatial variability in growth has been observed in albacore in the Pacific Ocean, the WPTmT **RECOMMENDED** to the SC that the collection and analysis of otolith samples is expanded to cover the whole Indian Ocean, with a particular focus on obtaining a broad range of sizes and locations, including fish from the eastern part of the ocean.

**Revision of the WPTmT Program of Work**

WPTmT08.02 (Para 92) The WPTmT **RECOMMENDED** that the SC consider and endorse the WPTmT Program of Work (2023–27), as provided at Appendix V.

**Date and place of the 8th and 9th Sessions of the WPTmT**

WPTmT08.03 (para 101) The WPTmT **RECOMMENDED** that a data preparatory meeting (DP) and stock assessment meeting (AS) be held in the same year, with the data preparatory meeting being held between April and June and the assessment meeting in July or August. This would facilitate the provision of CPUE series using data from the previous year to the data preparatory meeting, while ensuring catch data for 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 the stock assessments. The exact dates and meeting locations will be confirmed and communicated by the IOTC Secretariat to the SC for its consideration.

i. WPTmT09(DP): Host to be decided. Meeting to be held in April 2025 (TBC).
ii. WPTmT09(AS): Host to be decided. Meeting to be held in July 2025 (TBC).

**Review of the draft, and adoption of the Report of the 8th Session of the WPTmT**

WPTmT08.04 (para 102) The WPTmT **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPTmT08(AS), provided at Appendix VI, as well as the management advice provided in the draft resource stock status summary for albacore (Appendix IV).