Report of the 25th Session of the IOTC Working Party on Tropical Tunas, Data Preparatory Meeting

Virtual Meeting, 31 May – 02 June 2023

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ACRONYMS

aFAD	anchored Fish aggregating device
ASAP	Age-Structured Assessment Program
ASPIC	A Stock-Production Model Incorporating Covariates
ASPM	Age-Structured Production Model
B	Biomass (total)
BDM	Biomass Dynamic Model
BET	Bigeye tuna
B_0	The estimate of the unfished spawning stock biomass
B_{curr}	The estimate of current spawning stock biomass
B_{MSY}	Biomass which produces MSY
B_{thresh}	Threshold level, the percentage of B0 below which reductions in fishing mortality are required
CE	Catch and effort
CI	Confidence Interval
C_{max}	Maximum catch limit
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.
D_{max}	Maximum change in catch limit
EEZ	Exclusive Economic Zone
ENSO	El Niño–Southern Oscillation
E_{targ}	The estimate of the equilibrium exploitation rate associated with sustaining the stock at B_{targ}.
EU	European Union
F	Fishing mortality; F_{2011} is the fishing mortality estimated in the year 2011
FAD	Fish aggregating device
FOB	Floating Object (or Fish aggregating devices FADs)
F_{MSY}	Fishing mortality at MSY
GLM	Generalised linear model
HBF	Hooks between floats
I_{max}	Maximum fishing intensity
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IWC	International Whaling Commission
K2SM	Kobe II Strategy Matrix
LL	Longline
M	Natural Mortality
MSC	Marine Stewardship Council
MSE	Management Strategy Evaluation
MSY	Maximum sustainable yield
n.a.	Not applicable
PS	Purse seine
q	Catchability
ROS	Regional Observer Scheme
RTTP-IO	Regional Tuna Tagging Project in the Indian Ocean
RTSS	RTTP-IO plus small-scale tagging projects
SC	Scientific Committee, of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY (sometimes expressed as SSB_{MSY})
SCAA	Statistical-Catch-At-Age
SKJ	Skipjack tuna
SS3	Stock Synthesis III
Taiwan, China	Taiwan, Province of China
VB	Von Bertalanffy (growth)
WPTT	Working Party on Tropical Tunas of the IOTC
YFT	Yellowfin tuna

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 25th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT), Data Preparatory Meeting was held online using the Zoom online platform from 31 May - 2 June 2023. The meeting was opened by the Chairperson, Dr Gorka Merino (EU, Spain) who welcomed participants and Vice-Chair, Dr M. Shiham Adam (IPNLF). A total of 76 participants attended the Session (cf. 67 in 2022, 80 in 2021 and 62 in 2020). The list of participants is provided at Appendix I

1. OPENING OF THE MEETING

1. The 25th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT), Data Preparatory Meeting was held online using the Zoom online platform from 31 May - 2 June 2023. The meeting was opened by the Chairperson, Dr Gorka Merino (EU, Spain) who welcomed participants and Vice-Chair, Dr M. Shiham Adam (IPNLF). A total of 76 participants attended the Session (cf. 67 in 2022, 80 in 2021 and 62 in 2020). The list of participants is provided at Appendix I.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

2. The WPTT **ADOPTED** the Agenda provided in Appendix II. The documents presented to the WPTT25(DP) are listed in Appendix III.

3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

3.1 Outcomes of the 25th Session of the Scientific Committee

3. The WPTT **NOTED** paper IOTC–2023–WPTT25(DP)–03 on the Outcomes of the 25th Session of the Scientific Committee.

4. The WPTT **NOTED** that in 2022, the SC made a number of observations in relation to the WPTT24 report (noting that updates on Recommendations of the SC25 are dealt with under Agenda item 3.4 below). Those observations are provided in the document and have not been reproduced here as they are extensive.

3.2 Outcomes of the 6th Special Session and 26th Session of the Commission (IOTC Secretariat)

5. The WPTT(DP) **NOTED** paper IOTC–2023–WPTT25(DP)–04 on Outcomes of the 6th Special Session and 26th Session of the Commission.

6. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2021, which have relevance for the WPTT (details as follows: paragraph numbers refer to the report of the Commission (IOTC–2022–S26–R), the WPTT **AGREED** that any advice to the Commission would be provided in the relevant sections of this report, below.

*(Para 29) The Commission **NOTED** that the current status of tropical and temperate tunas are as follows:*

Bigeye tuna *In 2019 a new stock assessment was carried out for bigeye tuna in the IOTC area of competence to update the stock status undertaken in 2016. On the weight-of-evidence available in 2019, the bigeye tuna stock is determined to be not overfished but subject to overfishing.*
Yellowfin tuna *A new stock assessment was carried out for yellowfin tuna in 2021. The model used in 2021 is based on the model developed in 2018 with a series of revisions that were noted during the WPTT in 2018, 2019 and 2020. On the weight-of-evidence available since 2018, the yellowfin tuna stock is determined to remain overfished and subject to overfishing*
Skipjack tuna

A new stock assessment was carried out for skipjack tuna in 2020 using Stock Synthesis with data up to 2019. On the weight-of-evidence available in 2020, the skipjack tuna stock is determined to be: (i) above the adopted biomass target reference point; (ii) not overfished ($SB_{2019}>SB_{40\%SB0}$); (iii) with fishing mortality below the adopted target fishing mortality, and; (iv) not subject to overfishing ($E_{2019}<E_{40\%SB0}$)
Albacore tuna *A new stock assessment was carried out for albacore in 2019 to update the assessment undertaken in 2016. The stock status in relation to the Commission's BMSY and FMSY target reference points indicates that the stock is not overfished but is subject to overfishing.*

*(Para 31) The Commission **REITERATED** its concern over the status of the yellowfin tuna stock and **NOTED** the SC observation that some of the fisheries subject to catch reductions have achieved a decrease in catches in 2020 in accordance with the levels of reductions specified in the Resolution; however, these reductions were offset by increases in the catches of yellowfin tuna by some CPCs, including some that were subject to limitations.*
*(Para 32) The Commission **NOTED** that different fishing gears and fleets have differing impacts on the yellowfin tuna population. The Commission **REQUESTED** that the SC conduct a fisheries impact assessment to determine the individual gear/fleet effects on the yellowfin tuna stock status, and productivity.*

*(Para 33) The Commission **NOTED** the TORs and Workplan endorsed by the SC for an external Peer review process for the yellowfin tuna stock assessment. One CPC requested clarification on the timelines provided in the workplan and whether these could be reduced in order to provide advice in a shorter timeframe. Other CPCs expressed their opinion that the current timeline was necessary to provide a thorough review of the yellowfin tuna stock assessment and that reducing the timeframe could be detrimental. The SC Chair explained that the availability of experts, the logistics in organising a face-to-face review meeting and the time required for the SC to review and discuss the outputs of the review were taken into account when developing the presented workplan and that a shortened timeframe will need to be discussed by the SC to determine its feasibility. The Executive Secretary informed the Commission that, the Secretariat will endeavour to expedite the procedure to appoint the reviewers.*

7. The WPTT **NOTED** that the SS6 adopted two new management measures for FADs that are of interest to the WPTT, however the report from that meeting has yet to be adopted. The WPTT further **NOTED** that the S27 meeting report was also yet to be adopted although there were several management measures adopted during that meeting that were also of interest to the WPTT. As such the outcomes from those meeting could not be considered by the WPTT at this stage, but the new management measures are listed below:

SS6

- Resolution 23/01 *On management of Anchored Fish Aggregating Devices (AFADs)*
- Resolution 23/02 *On Management of Drifting Fish Aggregating Devices (DFADs) in the IOTC area of competence*

S27

- Resolution 23/3 *On Establishing a Voluntary Fishing Closure in the Indian Ocean for the Conservation of Tropical Tunas*

- Resolution 23/4 *On Establishing Catch Limits for Bigeye Tuna in the Area of IOTC Competence*
- Resolution 23/5 *On Establishing a Programme for Transhipment by Large-scale Fishing Vessels*
- Resolution 23/6 *On the Conservation of Cetaceans*
- Resolution 23/7 *On Reducing the Incidental Bycatch of Seabirds in Longline Fisheries*
- Resolution 23/8 *On Electronic Monitoring Standards for IOTC Fisheries*
- Resolution 23/9 *On a Fish Aggregating Devices (FADs) Working Group*
- Resolution 23/10 *Terms of Reference for a Working Party on Socio-Economics*
- Recommendation 23/11 *To Enhance Cooperation in the Indian Ocean Tuna Commission Decision Making Process*

8. The WPTT **NOTED** that there are several requests to the SC that need to be addressed in 2023. Most of these requests are being addressed by the WGFAD and will be reported back to the WPTT at its meeting in October/November.

3.3 Review of Conservation and Management Measures relevant to tropical tuna (IOTC Secretariat)

9. The WPTT **NOTED** paper IOTC–2023–WPTT25(DP)–05 containing a Review of Conservation and Management Measures relevant to tropical tuna. The aim of this document was to encourage participants at the WPTT25(DP) to review the existing CMMs relevant to tropical tunas.

3.4 Progress made on the recommendations of WPTT24 (IOTC Secretariat)

10. The WPTT **NOTED** paper IOTC–2023–WPTT25(DP)–06 on the Progress made on the recommendations of WPTT24. The WPTT **AGREED** to consider and revise as necessary, its previous recommendations, and for these to be combined with any new recommendations arising from the WPTT25(DP), noting that these will be provided to the SC for its endorsement.

4. REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR TROPICAL TUNA SPECIES

11. The WPTT **NOTED** papers IOTC–2023–WPTT5(DP)–07.1 and IOTC–2023–WPTT25(DP)–07.2 which provide a review of the statistical data and fishery trends for tropical tunas and skipjack tuna (respectively), as received by the IOTC Secretariat for the period 1950–2021. The papers cover data on nominal catches, catch and effort, size-frequency, and observations at sea performed by scientific observers, and provide a range of fishery indicators, including catch and effort trends and (estimated) average weights for fisheries catching skipjack tuna in the IOTC area of competence.

12. The WPTT **ACKNOWLEDGED** that the information presented does not yet include data for the statistical year 2022, as these will become available after June 2023 in agreement with the IOTC data reporting cycle.

13. The WPTT also **NOTED** the annual changes in nominal catches of skipjack tuna compared to those provided at the last WPTT meeting in October 2022, including the origins of these changes, which are manifold, and their magnitude.

14. In this regard, the WPTT **RECALLED** how the species composition of tropical tuna catches from the Spanish component of the EU fleet (2018) has been reverted to what originally provided by the data owner and is therefore no longer estimated by the Secretariat.

15. The WPTT further **NOTED** that official revisions of EU data are still pending submissions and that no further updates have been provided by the data provider since the last WPTT meeting in 2022.

16. The WPTT **NOTED** the overall trends in tropical tuna catches by fishery group in recent years and **ACKNOWLEDGED** the marked increases in tropical tuna catches for 2021 when compared to 2020.

17. More specifically, the WPTT **NOTED** that purse seines (several fleets), handline (Oman), and gillnet (I.R. Iran) are the fisheries that contributed the most to the recently recorded increase in total catches of tropical species.

18. The WPTT **NOTED** that two types of morphometric information are generally available from the Secretariat, i.e., *raised* and *raw* size-frequency data, depending on the fisheries**.**

19. **NOTING** how size-frequency data currently published on the IOTC website are a combination of these two types of information, and that the datasets do not include a flag to split the information according to its source, the WPTT **ACKNOWLEDGED** that only raw size data are generally used for stock assessment purposes, and that therefore this limits the amount of information included for some industrial purse seine fleets (e.g., EU and comparable fleets such as Seychelles, which historically provided *raised* data only).

20. The WPTT **NOTED** the importance of having access to both types of information and **ACKNOWLEDGED** that the Secretariat will ensure publication of both types of size-frequency datasets (raw and raised) in the future.

21. The WPTT **NOTED** the efforts undertaken by some industrial purse seine fleets to also give access to raw size-frequency data covering all years from mid-1980s onwards and **ACKNOWLEDGED** that informal exchanges between the Secretariat and national institutions from all concerned fleets (IRD, IEO) are ongoing to further progress on this issue in the shortest time possible.

22. The WPTT **NOTED** the annual trends in estimated average weight of skipjack tuna by fishery group, which clearly indicates a declining trend overall, and marked fluctuations and declining trends for some fisheries, and particularly those of artisanal nature.

23. The WPTT **ACKNOWLEDGED** that the presented average weights are calculated from the geo-referenced monthly catches estimated both in number and weight by the Secretariat for all fisheries concerned, and that this estimation requires using data from proxy fleets as well as a substitution scheme to account for all those fisheries which lack comprehensive geo-referenced catch and effort and size frequency data, or whose coverage is sub-optimal.

24. Also, the WPTT **NOTED** how the intensity of the presented average weight plots reflects the availability of the original data for a given year / fishery group, and that this is particularly poor for several artisanal fisheries including those that are known for catching great quantities of the species.

25. The WPTT **ACKNOWLEDGED** that the re-estimation producing the average weight by fishery type also excludes size-frequency data from some strata that are known (or considered) to be affected by issues with data quality and consistency, including recent data submitted by Maldives for their baitboat fisheries that present marked changes when compared with size distributions reported for years prior to 2015.

26. For this reason, the WPTT **ACKNOWLEDGED** that the very low (< 1.5 kg) average weight estimated for skipjack tuna caught by baitboat fisheries in 2021 might indeed reflect the size-frequency records from other fleets but Maldives which are used by the estimation process, and that might not really be representative of the fishery in its entirety.

27. The WPTT also **NOTED** that the Secretariat will liaise with Maldives to understand the nature of the changes in recent size-frequency distributions from their baitboat fisheries, and eventually confirm (or not) if these data should be kept and used for stock assessment purposes.

5. NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO TROPICAL TUNAS

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

28. The WPTT **NOTED** paper IOTC-2023-WPTT25(DP)-08 on the report of the International Workshop on the Ageing of Skipjack Tuna from Indian Ocean, including the following abstract written by the authors:

> *"A recent study found differences in age estimates of skipjack (Katsuwonus pelamis) (SKJ) based on otoliths and dorsal fin spines obtained from the same fish caught in the Indian Ocean. This difference highlighted the need to develop standardized and validated aging criteria for both hard structures. In response, an international workshop was conducted in February 2023, with the objective of discussing and reviewing preparation protocols, reading criteria, validation methods to ensure consistent and comparable age data across laboratories. This document summarizes the key points of discussion and the progress achieved during the workshop on the following topics: 1) what constitutes annual growth zones in both the spine and otolith sections, 2) where are the inconsistencies between otoliths and fin spines readings, 3) assessment and adoption of edge type criteria for fin spine and otolith readings, and 4) age interpretation differences between readers."* – see document for full abstract.

29. The WPTT **THANKED** the authors for the organization of the workshop and the update on the progress made on estimating the skipjack growth to be included in the stock assessment and **ENCOURAGED** the authors to continue the work on skipjack growth validation using otoliths and fin-spines, if possible, considering the limitations found in the workshop.

30. The WPTT **NOTED** that one of the main difficulties in aging fin-spines is identifying the wide opaque band followed by the narrow translucent band in spines (i.e., the annulus bipartite structure) as they do not form very clear opaque/light annulus.

31. The WPTT **NOTED** that skipjack age is overestimated when using fin-spines in comparison to otoliths when the readers do not have information on fish sizes.

32. The WPTT **SUGGESTED** that the authors continue with the experiments and age readings using oxytetracycline (OTC) marked skipjack otoliths as this could be used to validate skipjack annual growth increments and reading with otoliths.

33. The WPTT **NOTED** that very few smaller specimens were collected for these analyses with the smallest specimen studied being between age 0 and 1 (the smallest analysed was 28cm FL). The WPTT **NOTED** that it is particularly difficult to read the age using either otoliths or spines at these smaller sizes with daily aging techniques.

34. The WPTT **NOTED** that the growth curve used in the stock assessment using tagging data and otoliths fixed age 0 at 20 cm but the current analysis assumed a one-year fish at around 30 cm. The WPTT **NOTED** that there is not a clear reason for the discrepancy but **NOTED** that daily ageing could ascertain when the first annuli is formed in both otoliths and spines.

35. The WPTT **SUGGESTED** that the authors continue with the daily age analysis and otolith daily growth increment measurements in otoliths of skipjacks sized 28-30 cm, which is the assumed size of one year individuals, to determine the first annual growth and **NOTED** that it would be important to compare those daily ageing reading with fin-spines daily rings of matching otoliths. The WPTT **NOTED** that continuing this work should help to improve the estimate of size at age zero.

36. The WPTT **NOTED** the potential to use Artificial Intelligence (AI) to estimate age automatically as long as more validated aging information that can be used as training data to inform AI algorithms is available. However, the WPTT **NOTED** that for training the AI algorithm a large dataset with validated daily and annual age readings with images of aged otoliths/spines is needed which still is not possible and was the objective of the workshop.

37. The WPTT **NOTED** that the systematic absence/presence of multiple opaque and translucent pair growth bands could be affected by environmental factors, however the growth bands, particularly in fin-spines, are mainly thought to be affected by physiology rather than environment, with potentially large individual variability, and that this pattern is also observed in temperate tunas such as bluefin and albacore.

38. The WPTT **NOTED** paper IOTC-2023-WPTT25(DP)-09 on an environmental signal in skipjack tuna recruitment in the Indian Ocean, including the following abstract written by the authors:

    "*Skipjack is a tuna species that is known to respond quickly to environmental changes. The active search of prey is a requirement for this species which needs to sustain high metabolic rates. The ocean productivity is driven by physical processes that exhibit inter-annual fluctuations and cycles. Phytoplankton biomass at the sea surface is measured in routine from the space by specific sensors, whereas the secondary production which composes the diet of larvae, is only measured in situ, or is derived through biogeochemical coupled models. Here, we use the satellite-measured sea surface chlorophyll as a proxy of ocean productivity and we examine its relationship from 1998 to 2018 with annual recruitment deviates estimated by the SS3 assessment model run at the last skipjack stock assessment of the IOTC in 2020. We show 1) that multi-year oscillations occur in both series; 2) that these oscillations occur in synchrony; and 3) that the Indian Ocean dipole appears to play a leas a key environmental driver of the system.*"

39. The WPTT **THANKED** the authors for this interesting analysis which related the ocean productivity (Sea Surface Chlorophyl) and climate descriptor (IO Dipole) with skipjack recruitment derived from the most recent skipjack stock assessment.

40. The WPTT **ACKNOWLEDGED** the review of oceanographic conditions and climate descriptors that can affect skipjack recruitment and, hence, population biomass, and inform the trend in skipjack catches.

41. The WPTT **NOTED** that there seems to be a relationship/correlation between ocean productivity and climate predictor in the Western Indian Ocean and the recruitment deviates from the stock assessment.

42. The WPTT **SUGGESTED** investigating possible spatial effects on productivity, and how this will affect recruitment, within the Western Indian Ocean.

43. The WPTT **NOTED** that there is a perspective of favourable skipjack recruitment conditions due to enhanced productivity in 2021-2022 which should be considered during the stock assessment to explain possible trend in catches and the fishery. The WPTT **NOTED** the positive Indian Ocean Dipole forecast for June-October 2023 which could affect negatively skipjack recruitment.

44. The WPTT **SUGGESTED** expanding the analysis to other productivity indicators, such as integrated chlorophyll concentration in the water column, and/or focusing on the sub-areas with maximum environmental variability to check if the relationships are maintained.

45. The WPTT **NOTED** that the recruitment deviate from the reference case in the skipjack stock assessment was used for the analysis and that the other scenarios of the stock assessment grid have a similar recruitment trend.

46. The WPTT **NOTED** that this analysis will be updated by the WPTT in October with the updated recruitment deviates from the preliminary skipjack stock assessment working document that will be available before the WPTT meeting.

47. The WPTT **NOTED** the possibility of including Indian Ocean Dipole and/or Sea Surface Chlorophyll time series as an index of recruitment (age 0) in the upcoming SS3 assessment to test the influence of oceanic and environmental indicators on recruitment estimations and see if the diagnostics of the stock assessment are improved. However, their inclusion could affect other components that inform the recruitment within the stock assessment model (CPUE, catch and size composition indices). Therefore, the WPTT **AGREED** that the combined trend of Sea Surface Chlorophyll and Indian Ocean Dipole should be used only in the discussion of the management advice, to support the outcomes of the stock assessment, therefore outside the assessment model.

6. REVIEW OF NEW INFORMATION ON THE STATUS OF TROPICAL TUNAS

6.1 Review of fishery dynamics by fleet

48. The WPTT **NOTED** that paper IOTC-2023-WPTT25(DP)-10 on the implementation of technology on the tropical tuna purse seine fishery was withdrawn.

6.2 Nominal and Standardized CPUE Indices

49. The WPTT **NOTED** paper IOTC-2023-WPTT25(DP)-11 on CPUE standardization for skipjack tuna (*Katsuwonus pelamis*) of the EU purse-seine fishery on floating objects (FOB) in the Indian Ocean, including the following abstract provided by the authors:

> *"Abundance indices for Katsuwonus pelamis (SKJ) in the Indian Ocean were derived from the European purse seiner CPUE series (2010-2021) for fishing operations made on floating objects (FOBs). GAMM and GLMM approach were used to standardize the SKJ catch per floating object set. The GLMM approach has been applied to compare the outputs when using an alternative modelling approach and both approaches have been compared to nominal annual CPUE time series. To account for the effort creep, additional explanatory variables have been included in the models. FOB sets have been classified to non-followed FOBs (i.e., randomly encounter FOBs for which the purse seiner has no previous information) and followed- FOBs (dFADs for which the purse seiner is likely to have previous information and therefore the dFAD was not randomly encounter). Densities of instrumented buoys at the 1°×1°-month scale and vessel capacity have also been included as explanatory variables. The time of the set relative to local sunrise has been estimated by comparing logbook catch-effort data with VMS vessel trajectory data and this variable has been integrated in the analysis to account for changes in fish aggregations around the FOBs over the course of the day."*

50. The WPTT **CONGRATULATED** the authors for the progress made on the model since the last assessment, including the addition of new predictor variables, the use of both GLMMs and GAMMs, and the prediction strategies based on both spatially weighted and unweighted estimates.

51. The WPTT **NOTED** that the time series covers the period 2010-2021 and that the setting time could not be determined for about 9,000 operations, in particular due to partial VMS coverage during 2010-2012, further **NOTING** that work was ongoing to address the issue and complement the data set for this period.

52. The WPTT **NOTED** that the spatial DFAD density index included in the model was combining buoy data from EU, Seychelles, and Mauritius purse seine fleets, further **NOTING** that the data

coverage has been very good for most of the time series and that the standardisation process applied to the data has now been harmonized across fleets.

53. The WPTT further **NOTED** that past analyses showed a high correlation in spatial buoy density between French and Spanish fleets although with some variability, and that it would be desirable to include the buoy data available at IOTC for all purse seine fleets in future model runs.

54. The WPTT **NOTED** the decline in both nominal and standardised CPUE in 2020 which may be attributed to a change in the behaviour of the purse seine fleet due to the COVID pandemic. The WPTT **NOTED** that the changes in spatio-temporal distribution of the fleet were accounted for by the model but that other factors may have affected the operations of the fleets in that year, with some potential effect on the CPUE.

55. The WPTT **NOTED** that all covariates were highly significant in the model, with the catch of skipjack tuna per FOB set showing a continuous increase with vessel capacity and a continuous decrease with DFAD density and time elapsed since time of sunrise during about 10 hours.

56. The WPTT **NOTED** that there was no major difference between the temporal trends in the standardised indices derived from GAMM and GLMM approaches, and that both indices were quite close to the nominal CPUE, except for the year 2020. The WPTT **NOTED** that the purse seine fishery is homogenous in space and time and that the main uncertainty is whether the standardization accounts for all the factors that may impact the catch rates.

57. The WPTT **NOTED** that the previous time series started in 1990 and **REQUESTED** the authors to run the model for the full time series 1990-2021 for the assessment, **NOTING** that the model will not include some of the covariates (e.g., DFAD density) which are only available since the early 2010s.

58. The WPTT **QUERIED** whether the catch of tuna per set is a good index of fish abundance as it mainly reflects the ability of finding tuna schools associated with FOBs (mostly through the information collected by the buoys) and the ability of encircling and catching the tuna aggregation. The approach assumes that the size of tuna aggregations associated with FOBs is proportional to the whole abundance of the population in the ocean, when the drivers of aggregation processes are unknown and when density-dependent processes could also occur and affect the numbers and magnitude of aggregations.

59. The WPTT further **NOTED** that the model might not properly account for increasing fishing efficiency due to technical improvements of the buoys, increased ability of the fishers to use them, and better selection of the FOBs (see Wain et al. 2020). The WPTT further **NOTED** that the resulting trend from the CPUE standardisation which suggests a two-fold increase in relative abundance between 2011 and 2021, seems inconsistent with the trend of increasing fishing effort and decreasing average weight of skipjack tuna during that period.

60. The authors **ACKNOWLEDGED** that the model does not include the numbers of schools at sea as the information is not available but that information available from echo-sounders on the presence/absence of tuna associated with the FOBs monitored in each stratum might be a way of improving the model. The WPTT **NOTED** comments from industry participants that there have not been major technological improvements in the purse seine fishery over the last decade and NOTED also that some key factors of change (i.e., DFAD density and ownership of the buoy) have already been included in the model.

61. The WPTT **NOTED** that some improvements on echo-sounder buoys occurred in recent years, with multi-frequency buoys providing better species discrimination than single frequency buoys, **ENCOURAGING** the authors to include the models of buoys in the future in the standardisation process..

62. The WPTT **NOTED** that the VAST approach (Thorson 2019), which has been previously used for modelling the CPUE of bigeye tuna caught in the EU purse seine fishery (IOTC-2022-WPTT24-12), could be interesting to consider in future work (especially for bigeye and yellowfin tunas) but **AGREED** that GAMMs are efficient and flexible tools to analyse the sources of CPUE variability, further **NOTING** that GAMMs offer the opportunity to explore the interannual variability in seasonal patterns of the CPUEs.

63. The WPTT **NOTED** that the authors encountered some technical issues to generate influence plots for the GAMMs which combine both fixed and random effects and **ENCOURAGED** the authors to explore this further in the future, **NOTING** that GAM marginal effects provide useful information on the role of the different factors.

64. The WPTT **NOTED** that the estimates of catch of skipjack tuna on FOBs are outputs of a model which smooths the composition of the catch over quarters and large spatial areas and fails to account for the uncertainty in species composition. The WPTT **NOTED** that skipjack tuna is generally well reported in the logbooks and that it would be interesting to apply the model to the raw data reported by fishers, further **NOTING** that this approach would not be suited for yellowfin and bigeye tunas.

65. The WPTT **ENCOURAGED** the authors to pursue the development of a two-component model focusing on the total catch in a first step and the species composition in a second step to better reflect the processes of data collection and uncertainties in the estimation of relative proportions of each species in the catch.

66. The WPTT **NOTED** paper IOTC-2023-WPTT25(DP)-12 on an Associative Behavior-Based abundance Index (ABBI) for western Indian Ocean skipjack tuna (*Katsuwonus pelamis*) obtained from echosounder buoys data, including the following abstract provided by the authors:

    "This paper presents the abundance estimates of skipjack tuna (Katsuwonus pelamis) using the Associative Behavior-Based abundance Index (ABBI). By taking advantage of the associative behavior of species around floating objects (FOBs) and acoustic data collected by echosounder buoys used in the tropical tuna purse seine fishery, the ABBI approach provides direct and effort-independent estimates of tropical tuna abundance. Its implementation in the western Indian Ocean for skipjack has shown that the decline in abundance of this species observed since 2018 is shifting towards a stabilization trend of abundance around 2013 levels from 2020 onwards."

67. The WPTT **THANKED** the authors for the work which was initially developed for skipjack tuna (IOTC-2020-WPTT22(DP)-13) and has also been applied to juveniles of yellowfin tuna (IOTC–2021–WPTT23(DP)–15) and bigeye tuna (IOTC-2022-WPTT24(DP)-13_Rev1) caught on FOBs.

68. The WPTT **NOTED** that the approach based on biomass estimated derived from acoustic indices aims to provide direct, effort-independent indices of abundance that are not affected by issues of effort creep.

69. The WPTT **NOTED** that the species composition used for estimating the catch of skipjack tuna on FOBs was derived from the T3 outputs aggregated at a lower spatial resolution (10x10 degree-grid squares) and restricted to the main DFAD purse seine fishing grounds of the western Indian Ocean.

70. The WPTT **NOTED** that no standardisation process was performed on the CPUE to account for spatio-temporal variability in the observations and **ENCOURAGED** the authors to explore the effect of such standardisation on the results.

71. The WPTT **NOTED** that the average tuna biomass per occupied FOB which is derived from DFAD catch data could be biased upwards due to the selection of the "best" FOBs by the fishers, and **ENCOURAGED** the authors to consider how the information on buoy ownership could be included

in the model to account for such selection process which has been shown to result in a ~10% increase in catch on FOBs (Wain et al. 2020).

72. The WPTT **NOTED** that the values of CAT and CRT parameters are currently fixed in space and time in the model but that some work is ongoing to improve their estimates. The WPTT further **NOTED** that the CAT parameter is assumed to depend on FOB density, its value decreasing with increasing FOB densities.

73. The WPTT further **NOTED** that the average value of CRT used in the model was based on measurements taken on individual tunas sampled in the field in the Mozambique Channel and in the Seychelles and found to be in the range of values observed in other oceans. Also, the WPTT **NOTED** that CRTs have been shown to follow an exponential distribution function which is independent of time.

74. The WPTT **NOTED** that the sensitivity of the model was explored with a range of values of CAT drawn from a uniform distribution and **ENCOURAGED** the authors to consider a process where the aggregation process would be size-dependent since size is correlated with fish speed. The WPTT **NOTED** that this would be relevant for yellowfin and bigeye tunas but may be less important for skipjack tunas which are mostly composed of fish in the size range 40-60 cm fork length when caught on FOBs.

75. The WPTT **AGREED** that CRT might be influenced by environmental conditions around the FOBs and **NOTED** that the authors are exploring such effects which can be very complex, and that they aim to remain parsimonious in the number of hypotheses made for producing the CPUE index.

76. The WPTT **NOTED** that the current approach is deterministic and lacks some diagnostics to assess the robustness of the model, e.g., to evaluate how new data included in the model may influence historical estimates. The WPTT **ENCOURAGED** the authors to further explore the consistency in model results through retrospective analysis and comparison of the ABBI with the outputs of the SS3 without the index.

77. The WPTT **NOTED** paper IOTC-2023-WPTT25(DP)-13 which provided diagnostics for a revised Skipjack CPUE Standardisation Model for Maldives Pole and Line, including the following summary points provided by the authors:

    - *The model explains changes in fishing power for pole and line catch effort data 1995 2022 from the Maldives*
    - *The model accounts for differences in vessel length, regional location within the Maldives chain (west, central, east) and the data source (island reporting vs logbooks) as main effects*
    - *The model structure is a legacy from the previous model using early data. Optional "expert offset" now excluded*
    - *The Maldives chain effect is fitted separately for skipjack and yellowfin*
    - *No development work since 2019.*

78. The WPTT **CONGRATULATED** the authors for the progress made in the development of the abundance index time series for skipjack and yellowfin tuna from the Maldivian pole and line fishery including the work to extend to time series back to the 1970s. The WPTT **NOTED** that the Maldivian pole and line CPUE is essential for the skipjack tuna assessment which could benefit from a longer time series to reduce model uncertainty.

79. The WPTT **NOTED** that prior to 2004 there were several changes to the power and efficiency of the fleet which have not been well recorded.

80. The WPTT **NOTED** that experts on the fishery were consulted to estimate the influences of these different historical changes in the fishery on fishing power and so catch rates to be considered in the model. However, the WPTT **NOTED** that model diagnostics were worse when including prior

information derived from expert judgment, likely because they tend to exaggerate the impacts of the changes in the fishery. Consequently the "expert offset" was excluded from the final model.

81. The WPTT **QUERIED** whether the increasing trend observed in the CPUE since 2015 could be due to increased fishing on FOBs and **ENCOURAGED** the authors to assess the contribution of FOBs to the catches of the pole and line fishery.

82. The WPTT **NOTED** the similarity of the standardised CPUEs for skipjack tuna from two separate analyses IOTC-2023-WPTT25(DP)-11 and IOTC-2023-WPTT25(DP)-13 from different fisheries.

83. The WPTT **NOTED** that a delta-lognormal distribution (under a maximum likelihood approach) did not work to account for zero CPUE data, and that instead the authors decided to use a Tweedie distribution in a Bayesian framework because of its advantages of interpreting results in different ways as a mixture distribution and its stable computation. However, the WPTT **NOTED** that the Tweedie model underestimated zero probabilities and therefore **ENCOURAGED** the authors to explore the potential applications of delta type distribution even in a Bayesian framework as well as the use of simpler GAM models to look at the zero component.

84. The WPTT **NOTED** that vessel effects, which are important in explaining the observed CPUE, were included in the analysis.

85. The WPTT **NOTED** that the analysis of the Maldivian PS CPUE data was jointly performed for skipjack and yellowfin tunas to account for the zero catches, as previously done. It was questioned whether the covariates in the regression model would be shared between the two species and improve the fitting. This warranted an additional analysis for each species separately, rather than integrating the two species.

86. The WPTT **NOTED** that the time series of standardised CPUE for skipjack tuna showed a rapid increase while that for yellowfin tuna showed a decreasing trend in that period. For the investigation of the reasons that are beyond the changes of biomasses of stocks, questions were raised whether the catchability has been changing using recent technology such as long-whole mobile communications, bird radar, satellite information etc. and whether size composition has changed. The WPTT further **NOTED** that increased communication between fishers might impact their strategy, particularly changes in target species, which influences the catchability for each species, and effort allocation.

87. The WPTT **NOTED** that observer data collected in the Maldivian pole and line fishery may be useful to investigate the possible dynamics further, including the collection of information on the development and extent of bird radar use in the fishery.

88. The WPTT **NOTED** that the fishery was initially a multi-gear fishery in which the fishers could use a combination of handline (to target yellowfin tuna) and pole and line (to mostly target skipjack tuna) during the same trip, and that the effort exerted for each gear could not be disentangled in absence of logbooks in the past. The WPTT **QUERIED** whether this could affect the CPUE analysis as the zero catch could represent a different type of fishing activity.

89. The WPTT **NOTED** that the handline and pole and line fisheries are very distinct fisheries with almost no overlap in the sizes of the yellowfin tuna caught and different landing ports, further **NOTING** that less than 1% of the logbooks available for 2020-2021 in the fishery showed that both gears could be used during a same fishing trip.

90. Additionally, the WPTT **NOTED** that some DFADs used in the western Indian Ocean purse seine fishery may drift in the Maldivian waters and be randomly encountered in the pole and line fishery, and that data observer data available from 2015-2019 indicated that it concerned only about 5% of all fishing operations.

91. Following the discussions, the WPTT **REQUESTED** the authors to conduct the following additional analyses for the WPTT(AS):
    - Explore improvements before September:
        - Impact of fishing on purse seine DFAD encounters
        - Incorporate variables on technological changes
        - Run models for skipjack and yellowfin tunas separately
        - Separate fishing effort between handline and pole and line and investigate zero catches for some specific trips
    - Include vessel identifier as explanatory variable for next year.

7. SKIPJACK STOCK ASSESSMENT

7.1 Discussion on skipjack assessment models to be developed and their specifications

92. The WPTT **NOTED** the presentation that summarizes the configuration and parameters of the assessment model for skipjack tuna. The WPTT **NOTED** a few of the changes made to the fishery structure to better account for the size structure differences between gears. The assessment would continue to investigate the model's sensitivity to important assumptions including new estimates of biological parameters and may decide to revise some of uncertainty axes included in the final model assemble.

7.2 Identification of data inputs for the different assessment models and advice framework

93. The WPTT **NOTED** that the standardized CPUE indices from the Pole and Line and Purse Seine FAD fisheries, as well as the index based on the skipjack tuna's associated behavior with the floating objects, are the main updates of the assessment inputs. The WPTT further **NOTED** that the acoustic buoyant Index, which was considered in the last assessment has not been updated.

94. The WPTT **NOTED** the assessment output (if endorsed by the Scientific Committee) will be used by the skipjack harvest control regulation (Res. 16/02) as input parameters to determine the catch limit for 2024–2026.

7.3 Fishery indicators

95. The WPTT **NOTED** that other assessment models, such as biomass dynamic models, may be developed to supplement the stock synthesis model.

8. OTHER MATTERS

8.1 CAPAM's Tuna Stock Assessment Good Practices Workshop

96. The WPTT **NOTED** document IOTC-2023-WPTT25(DP)-14 which provided a presentation on the CAPAM tuna stock assessment good practices workshop that was held in Wellington, New Zealand from the 7 – 10 March 2023.

97. The workshop discussed and updated the adopted Good Practices for tuna stock assessments, with a particular focus on the large, high-value, complex, and data-rich stocks of bigeye, yellowfin, bluefin, skipjack, and albacore tuna. Topics such as data input and modelling, biology, model structure and close-kin mark recapture studies were covered.

98. The WPTT **NOTED** that the workshop has addressed the utility of tagging data in stock assessments. The workshop had found that in many stock assessments, tagging data was of limited use due to the model structure. The WPTT **NOTED** the workshop's finding that fine-scale temporal/spatial models are required to fully utilize the information from the tagging studies as

these models don't require assumptions to be made about mixing. The WPTT **FURTHER NOTED** the advice from the workshop that simulation models should be utilized to inform the most effective tagging methodology before expensive tagging programmes are initiated.

99. The WPTT **NOTED** the advice that if multiple CPUEs are available for a particular stratum (temporal/spatial) and if these CPUEs have contrasting trends, they should not be used in an assessment model simultaneously. The CPUEs effectively represent different plausible "realities" rather be included in separate models in the assessment model grid.

100. The WPTT **NOTED** that discussions are progressing on taking into account long term climate change effects on stocks in assessment models. Other tRFMOs are recommending the inclusion of models that consider climate driven non-stationary changes in the assessment model grids.

9. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 25TH SESSION OF THE WPTT(DP) (CHAIR)

101. The report of the 25th Session of the Working Party on Tropical Tunas Data Preparatory Meeting (IOTC–2023–WPTT25(DP)–R) was **ADOPTED** by correspondence.

Appendix I
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Appendix II
Agenda for the 25th Working Party on Tropical Tunas, Data Preparatory Meeting

Date: 31 May - 2 June 2023

Location: Online

Venue: Virtual

Time: 12:00 – 16:00 (Seychelles time)

Chair: Dr Gorka Merino (European Union); **Vice-Chair:** Dr Shiham Adam (IPNLF)

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**
   - 3.1 Outcomes of the 25th Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 6th Special Session and 26th Session of the Commission (IOTC Secretariat)
   - 3.3 Review of Conservation and Management Measures relevant to tropical tunas (IOTC Secretariat)
   - 3.4 Progress on the recommendations of WPTT24 (IOTC Secretariat)
4. **REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR TROPICAL TUNA SPECIES** (IOTC Secretariat)
5. **NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO TROPICAL TUNAS** (Chair)
   - 5.1 Review new information on the biology, stock structure, their fisheries and associated environmental data for skipjack tuna:
     - Catch and effort
     - Observer data
     - Catch at size
     - Catch at age
     - Biological indicators, including age-growth curves and age–length keys
6. **REVIEW OF NEW INFORMATION ON THE STATUS OF SKIPJKACK TUNA** (Chair)
   - 6.1 Review of fishery dynamics by fleet (CPCs).
   - 6.2 Nominal and standardised CPUE indices.
7. **SKIPJACK STOCK ASSESSMENT** (Chair)
   - 7.1 Discussion on skipjack assessment models to be developed and their specifications.
   - 7.2 Identification of data inputs for the different assessment models and advice framework.
   - 7.3 Fishery indicators.
8. **OTHER MATTERS** (Chair)
   - 8.1 CAPAM's Tuna Stock Assessment Good Practices Workshop.
9. **REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 25th SESSION OF THE WORKING PARTY ON TROPICAL TUNAS (DATA PREPARATORY)** (Chair)

Appendix III
List of Documents for the 25th Working Party on Tropical Tunas, Data Preparatory Meeting

Document	Title
IOTC–2023–WPTT25(DP)–01a	Draft: Agenda of the 25th Working Party on Tropical Tunas (DP)
IOTC–2023–WPTT25(DP)-01b	Draft: Annotated agenda of the 25th Working Party on Tropical Tunas (DP)
IOTC–2023–WPTT25(DP)-02	Draft: List of documents for the 25th Working Party on Tropical Tunas (DP)
IOTC–2023–WPTT25(DP)-03	Outcomes of the 25th Session of the Scientific Committee (IOTC Secretariat)
IOTC–2023–WPTT25(DP)–04	Outcomes of the 6th Special Session and 26th Session of the Commission (IOTC Secretariat)
IOTC–2023–WPTT25(DP)-05	Review of Conservation and Management Measures relevant to tropical tuna (IOTC Secretariat)
IOTC–2023–WPTT25(DP)-06	Progress made on the recommendations of WPTT24 (IOTC Secretariat)
IOTC–2023–WPTT25(DP)–07.1 IOTC–2023–WPTT25(DP)–07.2	Overview of Indian Ocean tropical tuna fisheries Review of Indian Ocean skipjack tuna statistical data
IOTC–2023–WPTT25(DP)–08	Report of the International Workshop on the Ageing of Skipjack Tuna from Indian Ocean (Luque P, Krusic-Golub K, Farley J, Artetxe-Arrate I, Grande M, Fraile I, Agnissan R, Serrano N, Zudaire I, Merino G.)
IOTC–2023–WPTT25(DP)–09	Environmental signal in skipjack tuna recruitment in the Indian Ocean (Marsac F)
IOTC–2022–WPTT25(DP)–10	Withdrawn
IOTC–2023–WPTT25(DP)-11	CPUE standardization for skipjack tuna (Katsuwonus pelamis) of the EU purse-seine fishery on floating objects (FOB) in the Indian Ocean (Kaplan D, Lourdes Ramos M, Báez JC, Grande M, Santiago J)
IOTC–2023–WPTT25(DP)-12	Associative Behavior-Based abundance Index (ABBI) for western Indian Ocean skipjack tuna (Katsuwonus pelamis) obtained from echosounder buoys data. (Baidai Y, Dupaix A, Dagorn L, Deneubourg JL, Duparc A, Capello M)
IOTC–2023–WPTT25(DP)-13	Diagnostics for a revised Skipjack CPUE Standardisation Model for Maldives Pole and Line (Medley P and Ahusan M)
IOTC–2023–WPTT25(DP)-14	Tuna Stock Assessment Good Practices Workshop (Maunder M, Hoyle S)
Information documents	
IOTC–2023–WPTT25(DP)-INF01	Review of Indian Ocean bigeye tuna statistical data (IOTC Secretariat)
IOTC–2023–WPTT25(DP)-INF02	Review of Indian Ocean yellowfin tuna statistical data (IOTC Secretariat)
IOTC–2023–WPTT25(DP)-INF03	Schooling in habitats with aggregative sites: The case of tropical tuna and floating objects (Capello M, Rault J, Denebourg J-L, Dagorn L)
IOTC–2023–WPTT25(DP)-INF04	Behavior of skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), and bigeye (*T. obsesus*) tunas associated with drifting fish aggregating devices (dFADs) in the Indian Ocean, assessed through acoustic telemetry (Govinden R, Capello M, Forget F, Filmalter J, Dagorn L)