Report of the 23rd Session of the IOTC Working Party on Tropical Tunas, Data Preparatory Meeting

Microsoft Teams Online, 10 - 14 May 2021

DISTRIBUTION:

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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_{MSY}	Biomass which produces MSY
CE	Catch and effort
CI	Confidence Interval
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
ENSO	El Niño–Southern Oscillation
EU	European Union
F	Fishing mortality; F_{2011} is the fishing mortality estimated in the year 2011
FAD	Fish aggregating device
FOB	Floating object
F_{MSY}	Fishing mortality at MSY
GLM	Generalised linear model
HBF	Hooks between floats
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 23rd Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT), Data Preparatory Meeting was held online using the Microsoft Teams online platform from 10 - 14 May 2021. The meeting was opened by the Chairperson, Dr Gorka Merino (EU, Spain) who welcomed participants and Vice-Chair, Dr M. Shiham Adam (Maldives). A total of 80 participants attended the Session (cf. 62 in 2020, 68 in 2019, 57 in 2018, and 49 in 2017). The list of participants is provided at Appendix I.

The report of the 23rd Session of the Working Party on Tropical Tunas Data Preparatory Meeting (IOTC–2021–WPTT23(DP)–R) was ADOPTED intersessionally via correspondence

1. Opening of the Meeting

1. The 23rd Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Tropical Tunas (WPTT), Data Preparatory Meeting was held online using the Microsoft Teams online platform from 10 - 14 May 2021. The meeting was opened by the Chairperson, Dr Gorka Merino (EU, Spain) who welcomed participants and Vice-Chair, Dr M. Shiham Adam (Maldives). A total of 80 participants attended the Session (cf. 62 in 2020, 68 in 2019, 57 in 2018, and 49 in 2017). 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 WPTT23(DP) are listed in Appendix III.

3. The IOTC Process: Outcomes, Updates and Progress

3.1 Outcomes of the 23rd Session of the Scientific Committee (IOTC Secretariat)

3. The WPTT **NOTED** paper IOTC–2021–WPTT23(DP)–03 on the Outcomes of the 23rd Session of the Scientific Committee.

4. The WPTT **NOTED** that in 2020, the SC made a number of observations in relation to the WPTT22 report (noting that updates on Recommendations of the SC23 are dealt with under Agenda item 3.4 below). Those observations are provided here for reference.

> ***7.4.1 Skipjack tuna stock assessment***
>
> - *(Para 69) The SC **NOTED** that the 2020 skipjack tuna assessment (using Stock Synthesis) concluded that the stock is not overfished and is not subject to overfishing. The SC further **NOTED** that the estimated stock status is more optimistic compared to the previous assessment, despite that the catches have increased in the last three years (the catches in 2018 exceeded the catch limit by as much as 30%).*
> - *(Para 70) The SC **DISCUSSED** the possible reasons for the improved stock status, e.g. favourable environment conditions which may have resulted in increased recruitment and productivity, as reflected in the recent CPUE trends. The SC **AGREED** that it is important to explore and understand the underlying ecological and environmental drivers that underpin the stock trend to ensure that the recent overshooting of TAC did not undermine the sustainability of the stock.*
> - *(Para 71) The SC also **NOTED** that the 2020 skipjack tuna stock assessment captured structural uncertainty through a grid of 24 models covering alternative assumptions on spatial structure, tag data weighting, steepness, and technological effort creep. Statistical uncertainty from individual models was incorporated into the estimates of stock status. The SC further **NOTED** that several uncertainty axes included in the grid differed to what was considered in the previous assessment, following detailed revisions of the data and model structure.*
> - *(Para 72) The SC **NOTED** paper IOTC–2020–SC23–INF04 which provided a review by the invited scientific expert to WPTT22 of the 2020 skipjack tuna stock assessments.*
> - *(Para 73) The SC **NOTED** that the report by the invited expert provides guidance on how future assessments for skipjack might be improved. The SC **REQUESTED** the Secretariat to work with the Chair of the WPTT and the relevant assessment modellers to consider the salient points raised in the expert review for use in the next assessment.*
> - *(Para 74) The SC **NOTED** that there were considerable deliberations on the technology effort creep that might have accrued over time in the Purse Seine fleet, and how they should be incorporated into the assessment. The SC **NOTED** that the 1.25% annual effort*

*creep assumption included in the model grid was based on a study that evaluates the difference in catchability trends between Purse Seine and Longline CPUE using the yellowfin and bigeye assessment models, which suggested an effort creep about 1.25–4% annually since 1990. The SC also **NOTED** disagreement between WPTT scientists as to whether a scenario of 0% effort creep should have been part of the assessment grid.*

- *(Para 75) The SC **AGREED** that the technological effort creep represents a key source of uncertainty although in case of skipjack tuna it is influential, but not a main driver of the assessment results. The SC NOTED similar debate is likely to occur for other species if the PS CPUE is going to be applied, and therefore urge the scientists to undertake additional analysis to fully understand the extent of the effort creep to the PS fleet and to resolve the issue quickly.*
- *(Para 76) The SC **NOTED** that for skipjack tuna target and limit reference points for unfished spawning biomass level have been agreed, in accordance with the HCR (16/02), which differ considerably to the MSY based reference points defined in Resolution 15/10. The SC further **NOTED** that when the skipjack tuna stock is maintained to fluctuate around its target, there is still a very large probability for the stock to be classified as being overfished, despite that the biomass is well above BMSY.*
- *(Para 77) The SC discussed the plausibility of the provision of both depletion based as well as MSY based stock status plots for skipjack tuna. The SC **NOTED** the ad hoc reference point working group is mandated to review the definition of overfished and overfishing stock status, and possible revisions of the Kobe plots, and therefore provides a better forum on how to best present the stock status for skipjack.*
- *(Para 78) The SC **NOTED** that the reference points for skipjack tuna are defined with respect to unfished spawning biomass only in resolution 16/02; nonetheless the notation is in terms of B (total exploitable biomass) instead of SB (spawning biomass). Although the resolution also specified Etarg (annual equilibrium exploitation rate associated with the unfished target spawning biomass), it was intended as a control parameter for the harvest control rule, rather than as an explicit target. Meanwhile Resolution 16/02 did not define a limit exploitation rate (Elim). The SC further NOTED that resolution 15/10 had specified a default depletion-based target and limit fishing mortality rate but it was discussed whether these are appropriate for skipjack tuna (the default values are defined only when MSY-based reference points cannot be estimated robustly according to 15/10). As such the SC **RECOMMENDED** that the skipjack MSE project to revisit these reference points, including to investigate the plausibility of establishing a limit reference point for fishing mortality (or exploitation rate) and to evaluate the .differences on the catch forecasts by using total biomass instead of spawning biomass in the HCR.*
- *(Para 79) The SC **RECALLED** that the first iteration of the skipjack HCR was implemented in 2017 and an annual Catch Limit was established for 2018-2020. The SC **ENDORSED** the 2020 skipjack tuna assessment results for updating the catch limit for the period 2021-2023 using the Harvesting Control Rule stipulated by the Resolution 16/02.*

7.4.2 Yellowfin tuna assessment update

- *(Para 80) The SC **RECALLED** that the yellowfin stock assessment conducted in 2018 concluded that the stock is overfished and is subject to overfishing. The SC further **RECALLED** that the assessment was not used to provide management advice due to the insufficient uncertainty considered, as well as the poor predictive capability of the model. Consequently, a yellowfin workplan was initiated to reduce the uncertainty and improve the predictive capability of the model.*
- *(Para 81) The SC **NOTED** that the yellowfin modelling team has made considerable progress in addressing the array of tasks under the workplan, which were scrutinized in more details during the WPTT, including: the investigation of alternative (annual)*

temporal structure; the development of an objective procedure towards the selection of models based on diagnostics scores; a close examination of the issues in the projections.

- *(Para 82) The SC **NOTED** there is a structure issue in the projection which is related to how the regional recruitment distribution is propagated through the projection period. The SS3 software has assumed the long-term average values for the regional recruitment distribution parameters in the projection, which differed considerably to the recent values in case of yellowfin tuna. Consequently, this would have imposed a constraint on available biomass in regions with large catches and led to biomass collapse for some of the more pessimistic modes, resulting in biased estimates of K2SM probabilities.*
- *(Para 83) The SC **NOTED** that the yellowfin modelling team is working collaboratively with the SS3 developer to resolve this issue by allowing for more flexible options in configuring time-varying parameters for the projections. The SC AGREED that until a solution is provided, the estimated K2SM probabilities should be not used for providing management advice for yellowfin tuna in order to avoid confusions.*
- *(Para 84) The SC commended the yellowfin modelling team for their efforts and excellent contributions to identify the issues in the yellowfin assessment model. The SC **NOTED** that the work will continue in 2021 to provide a model that is sufficiently improved to justify its use for providing new management advice on catch limit. The SC NOTED that the work is expected to be complete in time for the WPTT meeting in 2021 and any progress made intersessionally will be reported to the special session of the Commission scheduled in March 2021.*

7.4.3 Status of Yellowfin catches

- *(Para 85) The SC **NOTED** Para. 24 of Resolution 19/01 states that "The IOTC Secretariat, under advice of the Scientific Committee, shall prepare and circulate a table of allocated catch limits disaggregated as per the conditions set out in paragraphs 5 – 10 for preceding year, in December of the current year." As such, the table of allocated catch limits was presented to the SC and is contained in Appendix 33.*
- *(Para 86) The SC **NOTED** that the intention of Res 19/01 is to reduce catch levels to allow the yellowfin tuna stock to rebuild. The SC **NOTED**, however that according to Appendix 33, catches have actually increased by 5.22% since 2014. The SC further **NOTED** that increases in catches by CPCs not bound by Res 19/01 have offset the reductions in catches by CPCs bound by the Resolution. This has led to the overall increase in catches from 2014 – 2019.*

7.4.4 Other Matters

- *(Para 87) The SC **NOTED** the WPTT Program of work, with high priorities being given to stock assessment model data review, fishery-independent monitoring including acoustic FAD monitoring, and MSE, CPUE standardisations, Biological sampling, Historical data review, and Target and limit reference points review.*

3.2 Outcomes of the 24th Session of the Commission and 4th Special Session of the Commission (IOTC Secretariat)

5. The WPTT(DP) **NOTED** paper IOTC–2021–WPTT23(DP)–04 on Outcomes of the 24th Session of the Commission and the 4th Special Session of the Commission.
6. The WPTT(DP) **NOTED** that due to the shortened nature of the meeting, as well as its virtual format, Members agreed not to discuss or adopt any new management measures in 2020.
7. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2019, which have relevance for the WPTT (details as follows: paragraph numbers refer to the report of the Commission (IOTC–2020–

S24–R) as well as the report of the Special Session of the Commission IOTC-2021-SS4-R), the WPTT **AGREED** that any advice to the Commission would be provided in the relevant sections of this report, below.

The 24th Session of the Commission

Report of the 22nd Session of the Scientific Committee (SC22)

- *(Para. 20): The Commission **SUPPORTED** the ongoing Management Strategy Evaluation work and **NOTED** the revised workplan endorsed by the Scientific Committee in Appendix 6 of the 2019 Scientific Committee Report. The Commission particularly **NOTED** the importance of the work to specify the skipjack tuna harvest control rule as a full Management Procedure (MP) as well as the need to finalise the MP development for yellowfin tuna to provide sound management advice for this species.*
- *(Para 23): The Commission **NOTED** with concern the current status of yellowfin tuna. The Commission also **ACKNOWLEDGED** that six other IOTC species are also listed as being overfished and subject to overfishing and that measures should be taken to address this problem.*

On the status of tropical and temperate tunas

- *(Para. 24) The Commission **NOTED** that the current status of tropical and temperate tunas is as follows (full details are provided in Appendix 6):*

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. The stock status determination changed qualitatively in 2019 to not overfished but subject to overfishing.*
Yellowfin tuna *No new stock assessment was carried out for yellowfin tuna in 2019, thus, stock status is determined on the basis of the 2018 assessment and other indicators presented in 2019. On the weight-of-evidence available in 2018 and 2019, the yellowfin tuna stock is determined to remain overfished and subject to overfishing.*
Skipjack tuna *No new stock assessment was carried out for skipjack tuna in 2019, thus, stock status is determined on the basis of the 2016 assessment and other indicators presented in 2019. On the weight-of-evidence available in 2019, the skipjack tuna stock is determined to be not overfished and is not subject to overfishing.*

- *(Para. 25) Due to its strong concern regarding the status of the yellowfin tuna stock, the Commission **REITERATED** the urgency for the Scientific Committee to produce an assessment of the yellowfin tuna stock as a priority in 2021.*
- *(Para. 26) The Commission **NOTED** the considerable use of estimated data in the yellowfin tuna assessment due to the unavailability of data from CPCs, as is the case for all species. The Commission **URGED** all CPCs to improve their data collection and reporting.*
- *(Para. 27) The Commission **NOTED** that total catches of skipjack in 2018 (607,701 t) were 30% higher than the catch limit generated by the Harvest Control Rule (470,029 t) which applies to the years 2018–2020, and that catches have increased over the past 3 years. The Commission further **NOTED** that a new catch limit for skipjack will be calculated by the Scientific Committee in 2020 using the Harvest Control Rule (in accordance with Resolution 16/02).*

Scientific Committee Recommendations

- *(Para. 32) The Commission **ENDORSED** the Scientific Committee's 2019 list of recommendations as its own. The Commission **AGREED** to interpret Recommendation 22.22 as a request and **NOTED** that any purse seine fleets reporting effort as fishing hours or fishing days should begin to submit this information as 'number of sets', in accordance with the reporting requirements of Resolutions 15/01 and 15/02.*
- *(Para. 33) Japan stated that it would not oppose the endorsement of the recommendations on the understanding that many of the recommendations require the Commission to note the advice provided by the Scientific Committee and endorsement of the recommendations would not imply that the Commission shall strictly follow them.*

The 4th Special Session of the Commission

- *(Para. 7) The Commission **NOTED** the report on yellowfin stock status (IOTC–2021–SS4–INF12) which was presented by the Scientific Committee Chair, Dr Toshihide Kitakado (Japan).*
- *(Para. 8) The Commission **NOTED** the current status of the yellowfin tuna stock as determined by the Scientific Committee. Currently the stock is assessed to be in the red zone of the Kobe diagram i.e. overfished and subject to overfishing.*
- *(Para. 9) The Commission **NOTED** that critical errors in the projections and estimations for computing probabilities in the K2SM developed from 2016 - 2018 has led to the Scientific Committee not accepting these projections nor the use of the K2SM for providing management advice. The Commission also NOTED that F2017 was 20% above the target reference point. As such, in 2020, the Scientific Committee's advice on the current status of the resource is that from 2018, based on 2017 data.*
- *(Para. 10) The Commission **NOTED** that the Scientific Committee recommended that yellowfin tuna catches be reduced to a level at least below the CMSY estimate (403,000 t) from the 2018 assessment until new information based on the 2021 stock assessment and its associated projections becomes available.*
- *(Para. 11) The Commission **NOTED** that in the 2018 Scientific Committee a workplan was developed to address the issues identified, aimed at increasing the Committee's ability to provide more concrete and robust advice. This workplan will culminate in the 2021 assessment, at which point updated advice based on revised projections and an improved K2SM is expected to be provided to the Commission.*

Discussion on possible target reduction levels for yellowfin

- *(Para. 21) The Commission **NOTED** the importance of using the best available data in the calculations and stock assessments and encouraged those Members who need to improve their data submissions, to work with the Secretariat.*

On a way forward

- *(Para 34: 3rd bullet point) Yellowfin tuna catch data for 2020 (provisional when appropriate) will be submitted earlier than usual, by 1 May, for the consideration at the WPTT (DP) meeting, 10-14 May.*

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

8. The WPTT **NOTED** paper IOTC–2021–WPTT23(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 WPTT23(DP) to review the existing CMMs relevant to tropical tunas.

3.4 Progress on the recommendations of WPTT22 (IOTC Secretariat)

9. The WPTT **NOTED** paper IOTC–2021–WPTT23(DP)–06 on the Progress made on the recommendations of WPTT22. 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 WPTT23(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

10. The WPTT **NOTED** paper IOTC–2021–WPTT23(DP)–07 which provided a review of the statistical data and fishery trends for tropical tunas received by the IOTC Secretariat, in accordance with IOTC Resolution 15/02 on Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs), for the period 1950–2019. The paper also provided a range of fishery indicators, including catch and effort trends for fisheries catching tropical tunas in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, size-frequency and other data, in particular mark-recapture (tagging) data. A summary of supporting information for the WPTT is provided in Appendix IV.

11. The WPTT **CONGRATULATED** the authors for the standardization work conducted to improve and facilitate the process of data synthesis and dissemination, and **ACKNOWLEDGED** that the same paradigm will progressively be applied to the data papers specific to each of the IOTC working parties.

12. The WPTT **NOTED** the steady increase in catches from handline fisheries recorded in the years between 2015 and 2019, to the point that these now provide the highest contribution to total catches reported for the species in 2019, and **ACKNOWLEDGED** that this might be explained by several factors, including the transitioning from gillnets towards costal longlines (currently categorized under the "handline" fishery group in the IOTC) that was known to occur in recent years in countries such as I.R. Iran, Oman and Pakistan (to a lesser extent).

13. The WPTT **ACKNOWLEDGED** that the classification used for this group of fisheries is heterogeneous in terms of vessel attributes and gear configuration (e.g., current handline fisheries can operate with a mix of trolling and handline during the same fishing trip), potentially resulting in different size selectivities.

14. The WPTT **NOTED** that information on operational aspects of several handline fisheries are limited or missing, and **ENCOURAGED** CPCs to report such information through their National Reports, to assess the pertinence of the classification of the gears currently appearing under the "handline" fishery group in use in the IOTC.

15. The WPTT **NOTED** that information on the type of school association (e.g. anchored vs. drifting FADs coming from the purse seine fishery) is not collected and recorded for handline fisheries in the Maldives, but **ACKNOWLEDGED** that such information might not be pertinent for a fishery in which over 90% of the catches of yellowfin tuna are taken on free-swimming and dolphin-associated schools.

16. The WPTT **NOTED** that georeferenced monthly catch-and-effort data for artisanal fisheries are not consistently reported to the Secretariat by several countries (e.g., Oman, Yemen, India, Indonesia) and **URGED** all concerned CPCs to take the necessary steps to collect and report this important information in agreement with the requirements of Resolution 15/02.

17. **NOTING** that little data on fishing effort is available for several handline and trolling fisheries, the WPTT **ACKNOWLEDGED** that alternative evaluations of the increase in fishing capacity for these fisheries could be derived from the IOTC fishing crafts database.

18. At the same time, the WPTT **RECALLED** that the provision of data to the IOTC fishing crafts database is made on a voluntary basis (through form IOTC forms 2FC) and that for this reason the content of the database is incomplete and potentially inconsistent with the information provided through National Reports.

19. The WPTT **CONSIDERED** that the voluntary nature of the fishing crafts data submissions limits the possibility of using this information to assess, among other things, whether the increasing trends observed in yellowfin tuna catches from handline fisheries are the result of an overall increased capacity or on the contrary due to other factors such as an increase in fishing efficiency.

20. The WPTT **NOTED** that a coastal longline fishery targeting tuna and tuna-like species has begun to develop in Pakistan, and that information on this fishery will eventually be submitted to the Secretariat once proper data collection and curation processes will be in place.

21. The WPTT **ACKNOWLEDGED** the need of improving the general understanding of the procedures adopted by the Secretariat to re-estimate, from the data officially submitted by CPCs, species and gear compositions for several important fisheries which are known to present outstanding issues in terms of data collection and reporting.

22. The WPTT **RECALLED** that these re-estimations, which introduce differences between the originally provided time series and those included in the IOTC best scientific estimates, are always made in collaboration with national scientists and captured by documents describing the rationale and methodology adopted for the re-estimation, which are in turn presented to the IOTC Working Parties (e.g. IOTC-2018-WPB16-22) and eventually to the Scientific Committee for its endorsement.

23. The WPTT **ACKNOWLEDGED** that the Secretariat is in the process of introducing a revised workflow to increase the amount of feedback and the timeliness of its reporting to CPCs that submit information to the IOTC, and **NOTED** that additional tools to improve interactive access to all IOTC statistical data sets are about to be released to the IOTC Scientific Community.

24. The WPTT **NOTED** that while there might be a certain degree of variability between the types and configuration of driftnets used in the Indian Ocean (e.g., length, mesh size, etc.) they are all classified under the "gillnet" gear type, and therefore **ENCOURAGED** all concerned CPCs to report information on the technical and operational aspects of their gillnet fisheries through the National Reports, to help assessing whether a better discrimination of this gear could be made available and used for scientific analysis.

25. **RECALLING** that longline fisheries are steadily reducing their operations in the Indian Ocean over time, while they continue to provide the main time series of abundance indices for the assessments of yellowfin and bigeye tuna stocks, the WPTT **ACKNOWLEDGED** that alternative indices of abundance from other fisheries might be urgently needed to support the development of population dynamics models.

26. The WPTT **NOTED** that the quality of the catch-effort data used to derive time series of abundance indices is very important and that clear criteria based on minimum thresholds of sample size should be defined to assess the trade-off between data quantity (e.g., spatio-temporal coverage) and data quality.

27. The WPTT **NOTED** how the comparison of average weights of yellowfin tuna derived from the size-frequency and catch-and-effort data (in both weight and numbers) reported by the deep-freezing longline fisheries of Taiwan,China is in strong contrast for all years from 2002 onwards,

and for this reason **REQUESTED** that the quality of the catch-and-effort data from the fleet be further analyzed to determine whether it shall continue to be used to produce the inputs for the stock assessment of the species during the years concerned.

28. The WPTT **ACKNOWLEDGED** that little to no information on the breakdown of catches of yellowfin tuna by vessel size categories for small-scale fisheries have been reported to the Secretariat following the request made at the 4th Special Session of the Commission (see also IOTC Circular 2021-15), and **NOTED** that the few reported datasets generally cover only the year 2019.

29. The WPTT **NOTED** the abrupt changes in the catch levels of tropical tunas by Pakistani fisheries between 2016 and 2020, with an increase of total catch to more than 30,000 t supported by a high demand and high prices in 2017, followed by a decrease to about 20,000 t in 2018, to 7,500 t in 2019 and to less than 6,000 t in 2020, and **ACKNOWLEDGED** that this is likely due to a combination of factors that include: reduced market demand, poor environmental conditions (high sea temperatures and jellyfish bloom), and high fuel prices.

30. The WPTT **NOTED** with concern that no official updates have yet been provided by the EU to explain the exceptional composition of part of their purse seine catches following a change in estimation methodology reported by EU,Spain in 2018, and **RECALLED** that in lack of upcoming updates, the original catch data from the EU will continue to be used in the assessments of the stock to be performed during 2021.

31. The WPTT **RECALLED** the Scientific Committee's request that both unraised (raw) and raised (catch-at-size) size frequency data should be reported to the IOTC, and **REQUESTED** all concerned CPCs to liaise with the Secretariat to ensure that historical and new submissions of size data including both types of information are provided for incorporation into the IOTC databases.

32. The WPTT also **REQUESTED** that, in agreement with the recommendation of the Scientific Committee, all CPCs having industrial purse seine fleets operating in the Indian Ocean begin to consistently report their efforts primarily as number of sets, and eventually liaise with the Secretariat to guarantee the re-submission of historical effort data with the same unit.

33. The WPTT **NOTED** the apparent bimodality shown by the size data of yellowfin tuna caught with purse seine on free swimming schools for EU,Spain (2019), EU,France (2018), Mauritius (2017), and Seychelles (2017, 2018, 2019), and **ACKNOWLEDGED** that this might be due to two distinct types of tuna school associations: (i) schools essentially composed of large (>70 cm or >10 kg) yellowfin and bigeye tunas and (ii) schools of small and medium-sized yellowfin tunas mixed with skipjack tuna and bigeye tuna to a lesser extent.

34. The WPTT further **NOTED** that the inter-annual variability observed in the average weights of yellowfin tuna caught on free-swimming schools might depend on the relative contribution of each of these different types of school association to the total catches on free-swimming schools, and therefore **SUGGESTED** that further analysis be performed to take into account other factors such as the spatial origin of the data to validate this hypothesis.

35. The WPTT **ACKNOWLEDGED** that the decrease in average weights of yellowfin tuna on free swimming schools observed in recent years might also be due to the expansion of the fishery further towards the North Arabian sea and in the Mozambique Channel, where yellowfin tunas caught on free schools are relatively smaller than in other regions, combined with the purposeful avoidance of catches of free schools comprising large individuals.

36. The WPTT **NOTED** that depredation could be a substantial cause of uncertainty in longline catch estimates as information presented at a technical workshop in 2007 showed that it may affect around 5% of the total longline catches in the Indian Ocean on average, with a large variability

in species, time and space, and the extent of the effects varying with the type of predator (sharks vs. cetaceans).

37. **NOTING** that part of the depredated catch can be monitored through the provision of information on discards at sea, the WPTT **RECALLED** that this type of data is still very limited in longline fisheries, and therefore **URGED** CPCs to make the necessary steps to comply with IOTC Res. 11/04 and reach the minimum level of coverage of 5% of all fishing operations through scientific observers.

38. The WPTT **NOTED** paper IOTC-2021-WPTT23(DP)-17 giving an Introduction to the IOTC tuna factory purchases data flow and database including the following abstract written by the authors:

> *"Tuna factory purchases data constitute a complementary source of independent information in support of IOTC tuna fisheries analyses. This novel data source is aimed to be used routinely for future assessment and to cross verify and reduce uncertainties in the currently available statistical data (in particular for what concerns species composition). A total of 45 companies have been submitting tuna quarterly reports to IOTC secretariat since 2010. Here, we present the IOTC tuna factory purchase data flow and database, including the different steps of data harmonization, compilation and preliminary curation undertaken on the quarterly reports to improve the overall data quality and traceability to the original information source. Between 2010 and 2020, 72% of the total number of purchases records received at the Secretariat came from the Indian Ocean, and the rest from the Atlantic and Pacific Oceans. The Indian Ocean 2010-2020 reports revealed that purse-seine and pole-and-line represented the majority of the total number of records (63% and 21%, respectively), and were dominated by skipjack (37%), followed by yellowfin (31%), bigeye (15%), and albacore (14%) tunas. Moreover, around 75% of purchases data from the Indian Ocean reports were harmonized into four species-specific commercial weight categories for each of the four major tuna species. Next project steps aim to finalize data curation and conduct analyses including comparisons of the tuna purchases data against the IOTC fisheries statistics by species and gear."*

39. The WPTT **CONGRATULATED** the authors for the study and ENCOURAGED them to pursue the work and present further results at the WPDCS, NOTING the interest of such ancillary and independent sources of information to cross-check and validate official data submissions, as well as to provide benchmark levels of catches in absence of other information.

40. The WPTT **NOTED** that the catches from ISSF-affiliated processing factories may cover about 60-70% of all Indian Ocean tuna and tuna-like catches purchased by factories.

41. The WPTT **NOTED** that the commercial weight categories of the factory purchase data are defined by ISSF according to a reporting template which aims to provide minimum breakdowns and reflect commercial gradings used by the processors.

42. The WPTT **NOTED** that data made available from processing factories are private commercial data that may be biased to some extent, **RECALLING** the importance of scientific sampling.

43. The WPTT **NOTED** that while the factory purchase data do provide information on the fishing vessel, the fishing period and the ocean of catch, a more detailed traceability to the origin may be challenging given the level of details available in the datasets, and also that these do not include information on the fishing set and type of school association (with the latter that has been introduced only recently).

44. The WPTT also **NOTED** that the most recent ISSF data requirements for the provisions of cannery data can accommodate the reporting of the component of fish purchased and rejected

by the factories due to factors such as the fish being damaged or too small in size, and that this information is sometimes provided by the factories.

45. The WPTT **NOTED** that part of the retained purse seine catch (including some bycatch species) may be sold to local companies in Port Victoria (Seychelles) for processing or re-export, and that this data flow, which is not covered by the exchange of cannery data, is instead partially monitored through the landing information provided by the industry.

46. The WPTT **ACKNOWLEDGED** that the WCFPC has adopted a resolution stating that non-ISSF affiliated processing factories may voluntarily report the data on purchase of fish caught in the WCPFC convention area, and **CONSIDERED** with favour the possibility of this same approach being implemented by IOTC as well.

47. The WPTT(DP) **NOTED** that in the report of the 4th Special Session (IOTC-2021-SS4-R) the following request was made:

> *"Para. 27: It became apparent that a clear difference among Members as to the scope of application, i.e., whether it should continue to exclude vessels under 24 m operating in EEZs, would be a fundamental point to be resolved. The Commission noted that it could not consider intermediate points between continuation of the current exemption and inclusion of the catches not covered by the current Resolution because there is a lack of information on the catches of vessels <24 m LOA. In order to better understand the small-scale fisheries for yellowfin and possibly explore a new threshold at which the percentage of exemption would be smaller than the current level while exempting artisanal fishing vessels, the Commission **ENCOURAGED** Members to submit information on the catches from these vessels, in particular those under 10 m and under 15 m LOA for 2019 and other years if possible. The Commission **REQUESTED** the Secretariat to coordinate this activity by 1 May 2021. The Commission confirmed that launching this work does not prejudice the position of any Member on the application."*

48. The Secretariat clarified that in response to this request, five CPCs provided the information required (with different degrees of temporal coverage) as of May 10th 2021. The WPTT(DP) **AGREED** that there was insufficient data provided to be able to conduct any analysis or draw conclusions on the information received.

5. New Information on Fisheries and Associated Environmental Data Relating to Yellowfin Tunas

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

- *Catch at size*

49. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-08 containing a review of size data from Indian Ocean longline fleets, and its utility for stock assessment. Including the following abstract provided by the authors:

> "*This is an incomplete draft report on a project to review the procedures used to collect and process longline size data for use in IOTC stock assessments. Further work will be carried out after the WPTT data preparation meeting and the report updated for presentation at the WPTT stock assessment meeting. This draft report is provided to help inform discussion about data preparation for the 2021 yellowfin stock assessment. All conclusions and recommendations expressed herein should be regarded as preliminary*"

50. The WPTT **NOTED** that the annual trend of yellowfin and bigeye tuna size data from Seychelles and Taiwanese longliners follow the same trend which is unexpected and, thus, could reflect

sampling bias. Conversely, Japan and Korea longliner size data trends for yellowfin and bigeye are different which is more in line with expectations.

51. The WPTT **NOTED** that pre-1962 Japanese longliners yellowfin average size is consistently larger than the post-1962 period. Therefore, the stock assessment model cannot fit the size composition of both periods using the same selectivity. Conflicts are created in the stock assessment as the size reduction between both periods is too large to be explained by fishing mortality at a time when removals were low and, hence, producing unrealistic depletion and high fishing mortality in that period. This change in size between periods also creates conflict in the Japanese longline CPUE. Thus, to cope with those inconsistencies, the WPTT **SUGGESTED** to use only Japanese size data post-1965.

52. The WPTT **QUESTIONED** whether the decrease in size data of the Japanese longline catch is observer homogeneously throughout the area, or if it is mostly focused in a particular zone that may provide a good justification not to use this data. The WPTT WAS **INFORMED** that this analysis was not done yet but that it is planned for the stock assessment meeting which could inform the decision whether to include pre-1965 Japanese size data or not.

53. The WPTT **NOTED**, however, that the reduction of size in the early period of the fishery may be a plausible scenario as larger fish are removed from the population at the beginning of the fishing activity. The WPTT **NOTED** that there would be other options to address the change of fish size at catch during selected periods, such as changing the selectivity of the Japanese longline within the stock assessment, different catchabilities, having different fisheries for both periods, and/or standardizing the size information before including it into the stock assessment.

54. Finally, the WPTT **REQUESTED** that the stock assessment modellers investigate different options to address the change in size of the catch observed for the Japanese longliners between pre- and post-1962 with the preferred option of using only size data for the Japanese longliners post-1965, as in the case of bigeye, in the stock assessment.

55. The WPTT **NOTED** that under IOTC Resolution 11-04 on a Regional Observer Program there are also templates to provide size data in addition to the trip reports. Moreover, minimum data requirements for the Regional Observer Scheme were agreed by the IOTC Commission and, hence, CPCs should collect and submit size data following those standards. As such, there is a possibility to submit size data, and other observer information, without modifying Res 11-04. The IOTC Secretariat is in the process of liaising with Taiwan,China for them to submit the actual observer data.

56. The WPTT **NOTED** that there is lack of size data for some areas and also large spatial differences in catch at size which may affect the CPUE but also the regional CPUE scaling factor and movement among regions used in the stock assessment. The WPTT **NOTED** that the spatial distribution of catch at size may affect the model and, therefore, size data should be standardized before use in the stock assessment as spatial changes in size may misinform the model potentially resulting in a reduction of population when a size decrease by area is observed.

57. The WPTT **NOTED** that the stock assessment areas, or fisheries, need to have similar sizes. Should this not be the case, it may necessitate standardising the size data. The selectivity (and the catchability) is assumed to be the same between different areas and, thus, there could be problems to fit size data in different regions when using a single selectivity if there is a spatial distribution of sizes. Thus, the WPTT **NOTED** that different longline selectivities among regions should be used as the average sizes appear to show a spatial pattern. Because spatial growth variation is not included in the stock assessment, the spatial variation on sizes should be modelled using different selectivities among regions.

58. The WPTT **QUESTIONED** whether the size trends in the Taiwanese size frequencies are comparable, and whether they are explained by changes in the trends of CPUE due to targeting. The WPTT **DISCUSSED** whether the trends are sufficient to justify the removal of the Taiwanese size frequency data from the stock assessment. The WPTT **NOTED** that the collection of size data in the Taiwanese fleet has not been done following a consistent protocol therefore this data should be further investigated before they are used in the stock assessment (See discussions under paper IOTC-2021-WPTT23(DP)-11).

59. The WPTT WAS **INFORMED** that Taiwanese size data post-2003 was not included in the last stock assessment and, thus, the positive size residual obtained in the models in the most recent years could be due to other fisheries (mainly Seychelles but with possible minor contributions from South Africa/Australia) so the effect of those fleet sizes should also be explored.

60. The WPTT **NOTED** that the residuals for the size data in the most recent years of the stock assessment have larger confidence intervals than the previous period which may affect size data reliability but also has an effect on the CPUE. Hence, the WPTT **AGREED** that different weights for the size data in the assessment should be considered depending on the time period.

61. The WPTT **NOTED** that the decrease in sizes between pre- and post-1962 for the Japanese longliners is similar to the decrease in CPUE (due to possible hyperdepletion effect) over the same period. This has been explored by eliminating the pre-1965 CPUE data in the stock assessment (e.g. bigeye). Thus, the WPTT **AGREED** that the decrease in CPUE and size data around 1962 are related and, thus, the WPTT **REQUESTED** investigating the possibility to remove pre-1965 size data but also CPUE from the yellowfin stock assessment.

62. The WPTT **NOTED** that changes in Taiwanese size data (e.g. larger in the most recent period) are observed in all Oceans and **QUESTIONED** the reasons behind this change. Various reasons have been advanced to explain the change; from an increasing rate of discards due to recent management regulations, to changes in the operations of the longliners which enables them to catch larger fish. The WPTT further **NOTED** that the treatment of Taiwanese size data for the most recent period has been different in each tuna RFMOs (e.g. including/excluding the most recent Taiwanese data). Therefore, the WPTT **NOTED** that this issue requires further attention and that different scenarios (including/excluding most recent Taiwanese size data) should be explored and stock assessment diagnostics/fits investigated.

63. The WPTT also **NOTED** that there is a large heterogeneity of size data completeness and accuracy between fleets and this has changed over time. For example, Taiwanese size data is more complete and widely distributed in most recent years but there are some caveats about its reliability. Thus, the WPTT **NOTED** that size data should be standardized before use in the stock assessment. The WPTT **ENCOURAGED** those longline CPCs to collect more representative size data.

64. The WPTT **DISCUSSED** how the quality of size data could be assessed, i.e. if the data is inaccurate or reliable for use in the stock assessment and whether clear guidance can be developed to evaluate size data accuracy for stock assessment inclusion. For example, it could be explored if purse seine size data are congruent with longliners size data. Thus, the WPTT **REQUESTED** that IOTC Secretariat liaise with interested scientists to develop criteria for size data to be included in the stock assessment.

65. For the yellowfin stock assessment, and depending on the results of further analysis and discussions, the WPTT initially **REQUESTED** that for the assessment, modellers should:

    - remove Japanese size data pre-1965,
    - remove size data for Taiwanese and Seychelles,
    - use different longline selectivity by regions,

- investigate the possibility of including seasonal selectivity, noting this will be more difficult to implement.
- Use fleets as areas is preferable.

- *Biological indicators, including age-growth curves and age–length keys*

66. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-09 on the Reproductive Biology of Yellowfin Tuna (*Thunnus albacares* Bonnaterre, 1788) from Southern Part of Indonesian Waters and its Application as Limit Reference Point (Lm50) Including the following abstract provided by the authors.

"*A large area, diverse fishing gear, different landing models, and data collection problems are some issues that caused the difficulty to control over the yellowfin tuna catch allowance. The research was conducted to explore the biological aspects of yellowfin tuna reproduction, including the development of oocytes, egg diameter, histological classification, and its application as one of the models of fishery management in the form of a minimum size limit allowed to be caught. Ovaries were collected from March to November 2018, from Benoa and Kedonganan fishing port, Bali. A total of 79 ovaries with length ranged between 30-157 cm FL collected from longline and handline/troll line catch. Samples were fixed in 10% buffered formalin and embedded in paraffin then stained with Harris-Haemotoxylin and Eosin. The average length at which 50% of mature individuals were calculated using Bayesian model-based logistics analysis is contained in the sizeMat module in R software version 3.5.2.*" – see document for full abstract.

67. The WPTT **ACKNOWLEDGED** the work on the reproductive biology of yellowfin and considering the low sample size to estimate the length at first maturity the WPTT **ENCOURAGED** the authors to continue the sampling so as to present an updated document with more samples covering a larger size distribution. The authors **INFORMED** that a biological sampling program is currently in place that they will be able to collect more samples.

68. The WPTT **QUESTIONED** the use of term "Limit Reference Point" and the inference of a Limit Reference Point from the maturity ogive.

69. The WPTT **NOTED** that the maturity ogive obtained in this work is in between of the maturity ogives tested in previous stock assessment, which did not resulted in differences in the stock assessment results, and slightly larger than the one used in the final grid of the yellowfin stock assessment.

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

6.1 Review of Fishery Dynamics by fleet

70. The WPTT **NOTED** paper IOTC-2021-WPTT23(DP)-10 on Status of tuna resources (oceanic & neritic) & some biological aspects of selected tuna species in India including the following abstract provided by the authors:

"The present status of the tuna fishery (oceanic & neritic) in Indian waters is discussed with special reference to biological details of Thunnus albacares, Thunnus obesus, Katsuwonus pelamis,Thunnus tonggol, Euthynnus affinis, Auxis rochei and Auxis thazard.. The data collected during the exploratory tuna longline fishing survey in the Indian exclusive economic zone by the Fishery Survey of India (FSI) and the data on the tuna landings by the coastal fisheries collected by the Central Marine Fisheries Research Institute (CMFRI), the Andaman & Nicobar Administration and Lakshadweep Administration are also discussed. The landings of tuna stands at 1,07,375 tonnes during 2019 which is 18% lesser than the tuna landings (1,32,474 tonnes) during 2018.The oceanic tunas contribute 56.2% followed by neritic tunas

(43.7%) to the total tuna catch in India during 2019. Biological studies carried out during the past 10 years till 2019 shows significant variation in L∞, growth coefficient (K) and mortality is imperative."

71. **NOTING** how the government of India is emphasizing the importance of improving their data collection procedures at national and local level (e.g., by requesting the compilation of data forms prior to the commencement of a fishing trip), the WPTT **ACKNOWLEDGED** that this would constitute an important step forward to ensure that spatialized catch-and-effort data for the artisanal fisheries of the country are submitted in agreement with Resolution 15/02 in the future.

72. The WPTT **NOTED** the length-weight data collected by Indian scientists, and expressed interest in including this information in an Indian Ocean-wide database currently under development. However, India stated that these data are taken at landing sites from gillnet and handline fisheries and that it is difficult to extract these data from the overall dataset in order to provide them to the Secretariat. The Secretariat will liaise with the authors to ascertain whether it will be possible to obtain the information.

73. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)-11 on an Exploratory analysis of tropical tuna longline selectivity and its implications for stock assessment, including the following abstract provided by the authors:

"Different approaches to modelling fishing selectivity can have a profound impact on stock assessments. This exploratory work considers how this selectivity might be better modelled. Interest in this subject was inspired by the length composition changes observed in longlines over 2003/4 and how these changes may be best accounted for. Data used were the longline length frequencies for yellowfin and bigeye tunas within the tropical region (+/- 15 degrees latitude) covering the period from 1952 to 2018 and Regional Observer Program data. All the data are available to the public on IOTC's website. Results showed that there is a clear break in length frequency patterns around 2003/4, most apparent for yellowfin although a similar pattern occurs for bigeye. This pattern is solely found in the Taiwanese fleet length frequencies that makes up most of the data. It was originally hypothesized that the change in length compositions in 2003/4 could be due to change in discard practices. However, this appears to be inconsistent with the available data which does not show length frequency truncation that might result from size-specific discarding. The data are more consistent with some other cause such as a change in vessel operations which have affected the underlying selectivity. What this change might have been and how these changes may impact yellowfin and bigeye stock assessments remain unclear to date. Ways to proceed with this analysis that may provide further insight are discussed."

74. The WPTT **CONGRATULATED** the authors for the analysis and **NOTED** the interest of clustering approaches to explore factors driving variability in the longline size data.

75. The WPTT **NOTED** that a prior distribution on fishing mortality will likely be required to improve the fitting of the selectivities and that different variables will be tested to determine their impact on the selectivity curves.

76. The WPTT **NOTED** that the fishing strategy corresponding to each of the selectivity curves was unknown.

77. The WPTT **NOTED** that a robust way to select and process the information is required to ensure that the results are informative and focused on the key elements of interest and will help to identify those factors that are most influential.

78. The WPTT **NOTED** that data from Taiwan,China are thought to be driving the changes in the length-frequency distribution and that without these data the distribution is much more

homogenous. The WPTT **NOTED** that these data issues are thought to be the result of sampling bias by Taiwan,China as discussed in relation to paper IOTC-2021-WPTT23(DP)-08. The WPTT **NOTED** that these data are not thought to be very reliable due to the sampling issues and **SUGGESTED** that further efforts to try to understand these data are unlikely to be productive.

79. The WPTT **NOTED** that issues with size frequency data from around 2003 may relate to the issue of bigeye tuna "laundering" between the Atlantic and Indian Oceans that was thought to be occurring at that time. Another suggestion was that the issue may have been related to the misidentification of species or to the "golden years" (2003-2005) when environmental conditions in the Indian Ocean substantially increased purse seine productivity, with very high catches of large yellowfin tuna during this period. The WPTT **SUGGESTED** that the group provides an explanation for this issue so that it does not require any further investigation.

80. The WPTT **NOTED** that at this stage the fleets are being clustered in the analyses as the focus has been on clustering the length frequency data rather than separating out the gears.

81. The WPTT **NOTED** that it could be useful to use categorical variables to test out clusters. This may help to identify potential size-frequency overlaps in gears although these are likely to relate more to the spatial distribution of fishing activities rather than the different gear types (several gears may catch the same size distribution). The WPTT **NOTED** that the model could be arranged in a different form in order to alleviate issues and try alternative scenarios. The WPTT **SUGGESTED** that selectivites from different fleets could be compared in relation to different regions and periods. The WPTT **NOTED** that the IATTC has been doing similar work on their size data in relation to identifying spatial boundaries and **SUGGESTED** that it would be useful to apply their cluster approach to these analyses.

82. The WPTT **NOTED** that different targeting practices and gear configurations of the various fleets within the longline component are likely to be influencing the overall size distribution but that these differences may not be reflected. The WPTT **NOTED** that analysing catch composition from different fleets could lead to conclusions about the capacity of certain fleets such as Taiwan,China to catch smaller tuna. The WPTT **NOTED** that at this stage the focus is on trying to process all the data to identify any problems but that it may be useful in the future to incorporate other species into the analysis to investigate the capacity of fleets to catch certain size frequencies of yellowfin tuna.

83. The WPTT **NOTED** that currently the Secretariat does not have access to reliable data required to provide a breakdown of different targeting types and would require this information to be provided by CPCs to ensure accuracy.

84. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-12 on the Status of Tropical Tuna Fisheries of Pakistan with Special Reference to Yellowfin Tuna, including the following abstract provided by the authors:

> *"Tropical tuna is represented by two species in Pakistan; of these yellowfin tuna (Thunnus abacares) contributed 5,219 tons during 2020. Annual landings of skipjack tuna (Katsuwonus pelamis) during 2020 were recorded to be 712 m. tons. Tropical tuna is contributed about 22.62 % in total landings of tuna during 2020. Tropical tuna landing in 2020 was 21.03 % lower than 2019 which is mainly because of operation of tuna fleet for only 8 months as compared to a normal fishing year of about 10 months. A change in marketing pattern was also noticed as major part of the fleet has shifted their operational base from Karachi to Gwadar (near Iranian border) where higher prices for tropical tuna was prevailing as compared to Karachi Fish Harbour."*

85. The WPTT **NOTED** large variability in catches of tropical tunas between 2016-2020 and **NOTED** that this variability is thought to be due mostly to changes in prices and the markets rather than other factors such as environmental conditions.

86. The WPTT **NOTED** that the CPUE data presented by Pakistan are randomly selected from observer data rather than being derived directly from overall catch data.

87. The WPTT **NOTED** that Pakistan is willing to share the presented length-frequency data with any scientists who would like access to them. However, the WPTT **NOTED** that the Secretariat have encountered issues with trying to incorporate these data into their database and are offering support to Pakistan to help to restructure the information so it can be made available to the scientific community. The WPTT **NOTED** that Pakistan is working to enter its data into a new software which should help to deal with issues encountered with the length-frequency and other data.

6.2 Nominal and standardised CPUE indices

88. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-13 on Bayesian Skipjack and Yellowfin Tuna CPUE Standardisation Model for Maldives Pole and Line 1970-2019, including the following abstract provided by the authors:

> *"An abundance index for skipjack and juvenile yellowfin tuna from 1970 to 2018 has been developed from Maldives pole and line catch and effort data. The index was derived from multiple datasets with differing level of detail over the period. Solutions for missing data were a random effects component used to account for missing mechanization information on the fleet 1974-1979 (Medley et al. 2017a) and the reconstruction of vessel length information using a vessel survival regression (described in Medley et al. 2017c). Fishing power effects related to vessel length are explained using a segmented regression that accounts for different classes of vessel. Both skipjack and yellowfin are combined into a single multivariate model, with skipjack and yellowfin catch rates standardized through a compound poisson-gamma (Tweedie) regression model. Additional fishing power effects which have not been recorded in the data have been estimated using subjective priors based on an expert meeting, and these effects could be included. The model was fitted obtaining a MCMC approximation to the Bayes posterior for the abundance indices using Stan software. Remaining issues include poor estimation of catch rates for the smallest vessels which has only been partially resolved and unaccounted for differences among landing atolls, as the reasons for these differences are not understood. Also, declines in data reporting, which coincided with the introduction of the logbooks, are a cause for concern, although reporting rates are improving. The analysis is fully reproducible and have been made available for peer review."*

89. The WPTT **NOTED** that all recent stock assessments have used longline CPUE indices and that the intention is to continue using these for the 2021 assessment but that these Maldivian indices could be considered for inclusion. The WPTT **NOTED** that the Maldivian pole and line CPUE indices should only be considered as an abundance estimate for juvenile yellowfin tunas.

90. The WPTT **NOTED** that the indices will start from 2004 as prior to this year there were several changes to the power and efficiency of the fleet which have not been well recorded. 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.

91. The WPTT **NOTED** a recent change in the collection of data through the introduction of a logbook system and that there was an initial reduction in reported catches during the transition to this system until it was fully rolled out.

92. The WPTT **CLARIFIED** that drifting FADs discussed in the paper have been deployed by vessels operating outside of the Maldives EEZ and are fished opportunistically by the Maldivian pole and line fleet when passing through the EEZ.

93. The WPTT **NOTED** that the indices produced by this approach show a very flat level of yellowfin tuna abundance since the 1990s which contradicts the declining abundance indices seen in other fisheries and **NOTED** that due to the high catches of small, juvenile yellowfin tuna by pole and line, these could be considered as indices of recruitment rather than overall stock abundance. The WPTT further **NOTED** potential issues with the limited spatial extent of this analysis as well as issues with the misidentification of yellowfin tuna caught together with skipjack tuna, especially in the initial years.

94. The WPTT **NOTED** that the initial steep decline seen in the indices is thought to be a result of the overestimation of changes in fishing power which may be driving an increase in the estimated index during this period. The WPTT further **NOTED** that the interpretation of the indices in the earlier time periods is difficult.

95. The WPTT **NOTED** that it was not possible to fit a delta lognormal distribution to the early data so a poisson-gamma regression was used instead. The advantages of using this distribution are the ability to interpret results in a variety of ways and the faster speed of running the model but it can be difficult to fit this distribution as it is not available in standard R packages.

96. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-14: Report of trilateral collaborative study among Japan, Korea and Taiwan for producing joint abundance indices for the yellowfin tunas in the Indian Ocean using longline fisheries data up to 2019, including the following abstract from the authors:

"Three distant-water tuna longline countries, Japan, Korea and Taiwan, have started a collaborative study since December 2019 for producing the joint abundance indices using integrated fishery data of these fleets to contribute to the upcoming stock assessments of yellowfin tuna in the Indian Ocean. The intention is to produce reliable indices by increasing the spatial and temporal coverage of fishery data. In this paper, some preliminary results using data up to 2019 fisheries were provided to update the WPTT on the progress of this activity.

As an underlying analysis, a clustering approach was utilized to account for the inter-annual changes of the target in each fishery in each region. Due to high dimensionality of fishery data with species composition, a two-step procedure was employed. A "K-means clustering" method with a pre-specified large number of initial clusters was firstly applied to fine scale fishery data in order to reduce the dimension of data, and then the aggregated data based on the first step were used in the subsequent "hierarchical clustering". The whole process was repeated through a certain number of iterations with different random initial clusters to seek a set of the smallest sum of within-cluster variation. The outputs of the finalized cluster were then used to assign the cluster label on fishery target to each catch-effort data. (See document for full abstract)

97. The WPTT **NOTED** that the plan is to complete the analysis by the end of July after all CPCs should have submitted their datasets for 2020.

98. The WPTT **NOTED** the regional split of R2 into North and South within the model and **NOTED** that the stock assessment does not consider these as separate regions so suggested that these are aggregated in the future for when they are used in the assessment.

99. The WPTT **NOTED** that aggregated rather than operational level data were incorporated into the model due to the restriction of the data sharing protocol among the three countries with only the remote access to the data.

100. The WPTT **NOTED** the suggestion to exclude data from Taiwan,China prior to 2005 due to quality issues with these data which have been discussed for past assessments but for which a proper cause has not been found.

101. The WPTT **NOTED** the concern of some participants of using clustering as a covariate in the model in equatorial regions due to the difficulty in distinguishing between different targeting approaches (targeting of yellowfin or bigeye tuna) in this region which differs from other regions such as the south where it is clear that fleets are targeting bluefin tuna and swordfish separately. The WPTT **NOTED** issues found when using clusters in equatorial regions in past analyses was the tendency for the clusters to lead to the removal of the trend and changes in the species composition model were thought to be explained in the model as a change in targeting rather than a change in abundance. The WPTT stressed the need to identify the real trends in abundance and suggested to merge yellowfin and bigeye into a single category when conducting the cluster analysis (see Para 138).

102. The WPTT **NOTED** the suggestion to replace the cluster with hooks between floats as targeting indicator variables to deal with this issue (as was done in the previous analysis). The WPTT **NOTED** one issue with taking this approach is the change in gear material in the 1990s which would need to be accounted for. The WPTT **NOTED** that as well as hooks between floats, the depth of hooks may also vary which could influence the species composition of catches. The WPTT **NOTED** that these issues have been discussed in the past in relation to the operating model and that both options should be investigated to discern their impacts on the assessment.

103. The WPTT **NOTED** that if the same stock assessment model that has been used in the past can be used again successfully, an estimated regional scaling factor will not be required for these indices.

104. The WPTT **NOTED** the use of statistical weighting in past models assigning equal weight to each area to standardise CPUE series across the regions which can avoid issues with moving effort which can bias the indices.

105. The WPTT **NOTED** that there appear to be a lot of discrepancies between the data from Taiwan,China and Japan and expressed concern that including both datasets together may result in some bias in the trend. The WPTT **NOTED** that these discrepancies may be a result of slightly different selectivity curves and different modes of operation in the various regions which could be overcome with size-based CPUE indices in the future. The WPTT **NOTED** that this is not considered to be a big issue for yellowfin tuna so the current approach can be continued.

106. The WPTT **NOTED** the suggestion of using effort as a spline factor if data are consistent with little variation between datasets.

107. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-16 on European purse seine CPUE standardization: methodology and framework for the YFT stock assessment, including the following abstract provided by the authors:

> *"Purse seine CPUE standardization is thought on a combination of fishing mode and commercial size categories of species basis, i.e., large fish in free schools (FSC) sets on one side and small fish under floating objects associated sets on the other side. However, while FSC sets are randomly encountered, FOB sets can either be randomly encountered, e.g., foreign drifting fish aggregating devices (dFADs) or natural log not instrumented, or not randomly encountered, i.e., vessels have access to buoys and/or echosounder data equipping the dFAD. The non-randomness of encounter leads to different statistical approaches and different impact on effort creep. On one hand, the standardization approach using an extension of the Delta-lognormal GLMM to three components, i.e., the product of the number of schools detected (summing positive and null sets) (number of schools) by spatiotemporal strata, the proportion of positive sets with the species/category of interest and the catch per positive set with it (school size), is appropriate to randomly encountered schools. We propose to apply this methodology to FSC sets as well as to FOB sets randomly encountered. On the*

other hand, for FOB sets not randomly encountered, we propose to use, as classical approaches, the product of the third component, i.e., school size, by a fishing efficiency rate per set calculated with a methodology quantifying the increase in fishing efficiency due to the use of FOB equipped with echosounders (Wain et al. 2020). This framework would allow to homogenized standardization of CPUE based on fisheries-dependant data and provide several time series, i.e., on randomly encountered FSC (> and < 10kg) and FOB sets separately and on not randomly encountered FOB sets, here of EU purse seine fleet catches per unit effort (CPUE) of yellowfin tuna (YFT) from the Indian Ocean."

108. The WPTT **NOTED** the plan to explore standardized PS CPUE in this year's assessment as it has improved since the previous assessment due to the inclusion of echosounders in the analyses.

109. The WPTT **NOTED** concerns regarding the inclusion of the floating object (FOB) index based on non-randomly encountered FOBs as the element of searching is changed. The WPTT further **NOTED** the concern that there appears to be an upward trend in the CPUE series which contradicts most of the other CPUE indices for the Indian Ocean and that the reason for this is currently unknown.

110. The WPTT **NOTED** the difficulty in accounting for competition or collaboration between vessels on the same FOBs and that any increases in the indices may not be increases in abundance but increases in catchability.

111. The WPTT **NOTED** that this analysis includes three components each with a separate model which have a year and quarter effect applied with and some specific variables such as the effect of piracy. The authors clarified that the approach taken is the same as the delta lognormal approach with two components with the addition of a third component and noted that this approach allows for some adjustments in each model which gives more flexibility.

112. The WPTT **NOTED** that there is no reason to expect a correlation between the impact of a factor on the number of schools and the number of fish in each school. The WPTT further **NOTED** that the component on the proportion of successful sets does provide information on the presence of yellowfin tuna in the catch while non-positive sets are included in the first model component.

113. The WPTT **NOTED** the difficulties associated with trying to account for the effect of vessels sharing the locations of FOBs in terms of capturing the increasing catchability trends, particularly those where the captains have communicated the locations by phone. The WPTT **NOTED** that it is common for vessels of several companies and CPCs to share information on schools, associated and free, and that sharing is not thought to be consistent over time due to changes in skippers, companies, etc.

114. The WPTT **NOTED** that there is thought to be a cascade effect where a null set on a school may end up as a positive set in a second or third attempt either by the same vessel or by other vessels. The WPTT **NOTED** that a procedure to deal with the issue of null sets has been developed ensuring that null sets are only counted when not followed by a positive set. The WPTT **NOTED** that zero catches are classed as such when fish were caught during a set but no species of interest were in the catch.

115. The WPTT **NOTED** the difficulties in distinguishing between non-randomly and randomly encountered FOBs and **NOTED** the need to incorporate the probability of vessels encountering a tuna school.

116. The WPTT **NOTED** that the Gulland index was included in the last analysis as an index of effort concentration but this was considered to be largely redundant with the addition of spatial factors in this analysis. The WPTT further **NOTED** that the Gulland index was initially included in the model to downweight the influence of high CPUEs due to large tuna concentrations which

mainly reflect local but not total abundance, and **SUGGESTED** that simulations could be used to explore and better interpret the effect of this covariate on the results.

117. The WPTT **NOTED** the differences between the current and previous models including the use of the number of 1x1 grid squares as spatial covariate instead of the Gulland index, and spatial factors being treated as offsets so they do not account for variance.

6.3 Other abundance indices

118. The WPTT **NOTED** paper IOTC-2021-WPTT(DP)23-15 on Associative Behavior-Based abundance Index (ABBI) for yellowfin tuna (Thunnus albacares) in the Western Indian Ocean, including the following abstract provided by the authors:

> "This paper presents an associative behavior-based *abundance index (ABBI) providing direct estimates of the abundance of yellowfin tuna (Thunnus albacares) based on their associative behavior around floating objects (FOBs). Considering the associative dynamics of small yellowfin tuna individuals (<10 kg) at FOBs through residence and absence times at FOBs, together with acoustic data obtained from fisher's echosounder buoys, the ABBI index is derived for yellowfin tuna in the western Indian Ocean over the period 2013-2019. This index accounts for both the FOB-associated and free-swimming components of the tuna populations, as well as for the effects of increasing numbers of FOBs on each component."*

119. The WPTT **NOTED** that estimates of the proportion of yellowfin tuna in FOB-associated catches were derived from the T3 data processing which relies on scientific samples that are aggregated over large areas over a quarterly basis and **ENCOURAGED** the authors to assess the sensitivity of the results by directly estimating the proportions from the samples in smaller spatio-temporal strata.

120. The WPTT **NOTED** that sensitivity analyses related to electronic tagging and FAD resident times were not performed but that the index was based on the best available science of this factor (6 days residency time based on an average of information taken from the Mozambique Channel and Seychelles). The WPTT **NOTED** that there is some debate as to the stability of resident time estimates in the Indian Ocean and that with current data from drifting FADs it is difficult to assess the variability of resident times as this could depend on factors such as region and environmental conditions.

121. The WPTT **NOTED** that the purse seine fleet underwent operational changes in 2019 to attempt to avoid FADs with large concentrations of yellowfin tuna due to the catch limits set on this species in particular in the region considered for the study, and that this would likely impact the indices produced by these analyses. The WPTT **NOTED** that these operational changes were accounted for using spatial data and the authors found that there was a gradient with more yellowfin tuna in the western rather than the central Indian Ocean.

122. The WPTT **NOTED** the move towards the use of buoys by the purse seine fleet which are able to discriminate between the species in the school below them and that in the future, data from these buoys may help to improve the accuracy of species composition estimates for buoys that are not yet able to do so. The WPTT **NOTED** however, that these data are likely to add additional uncertainties due to the catch rate and operational changes that are likely to occur as a result of vessels knowing the species composition beneath buoys such as vessels avoiding areas with high densities of yellowfin tuna.

7. YELLOWFIN STOCK ASSESSMENT

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

123. The WPTT **NOTED** the presentation that summarised the progress of the yellowfin assessment, including the revisions of model parameterizations and the recent development of the model configurations that addresses the main issues identified. The WPTT thanks the yellowfin modelling team for their effort devoted to improve the yellowfin assessment

124. The WPTT **NOTED** that a few improvements have been made to the current model and will be incorporated in the 2021 assessment, including (1) transformation of the model into the SS3.30 platform; (2) a better parameterization of the recruitment and movement rates that eliminates redundant variables; (3) the change of the Purse seine selectivity from an age- to a length-based selectivity that can improve the fits the length composition data.

125. The WPTT **NOTED** that in the 2018 assessment, the size data after 2014 were excluded in the final models to improve the retrospective trend. Given the proposed revisions to the modelling of size data, the treatment of the recent size data will be revisited in the 2021 assessment.

126. The WPTT **NOTED** a number of diagnostics proposed for evaluating model performance, including the Runs test that evaluated whether the residuals distributions were normally distributed or/and had time trends, hindcasting that evaluates model prediction skill of the CPUE, and Retrospective and forecast analysis that reveals potential systematic bias in the model estimation. The WPTT also **NOTED** that these diagnostics have been implemented in R package *ssdiag* and it is proposed that these methods be used for selecting models within a model grid.

127. The WPTT **NOTED** that preliminary translation of the model into a seasonal model and the results are promising but the model still needs more work before using it for assessment. The WPTT **NOTED** some of the advantages of the seasonal model over the quarter-as-year model, including better clarity and the ability to explicitly estimate seasonal effects. The WPTT further **NOTED** that the main concern about the seasonal model historically was the limited flexibility to assign tag releases to the correct seasonal cohorts, such that it will be essential to compare the seasonal tag releases with the traditional approach (in addition to the tag recoveries). The WPTT also noted that currently the SSdiag package only works with the seasonal model.

128. The WPTT **RECALLED** the structure issue in the projection which is related to how the regional recruitment distribution assumption is the projection period. The WPTT **NOTED** that the modelling team is working collaboratively with the SS3 developer to resolve this issue by allowing for more flexible options in configuring time-varying parameters for the projection. The WPTT **NOTED** a number of solutions were developed (1) White Noise, (2) Random walk, and (3) White noise with time block. WPTT Noted that Options (3) time block is the best option available for projection with the average proportion of recruitment in the last time block is assumed and in this case in the historical part when the recruitment deviates it does not come back to the initial value.

129. The WPTT discussed in general how recruitment is handled in projection and noted there are some recent improvements in SS3 that allows more flexibility in future recruitment assumptions. The WPTT **NOTED** the suggestion that if the projection is conducted over a short period of time, then a random walk may be appropriate for future recruitment, and if the projection is conducted over a longer period then an average or constant recruitment assumption is perhaps more suitable.

130. The WPTT suggested a number of alternative models to be developed in parallel with the SS3 model, including ASPIC, JABBA, and SCAS. The WPTT **NOTED** that SCAS (Statistical Catch At Size) will be similar to the SS3 model in the sense that it admits the same CPUE and size data. The WPTT further **NOTED** that the SCAS will be an area aggregated and annual model without tagging data.

131. The WPTT **NOTED** that the Indian Ocean Yellowfin tuna population was used as a case study for the Spatial Stock Assessment Methods Workshop, which aims to compare the decision process that different analysts undertake in formulating spatial stock assessments models, using a number of different modelling platforms (including SS3). The OM was conditioned with the Indian Ocean yellowfin tuna data.

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

Catch data

132. The WPTT **NOTED** the expected timelines for the availability of the data inputs for the stock assessment and further requests to data providers. In particular, preliminary catch data is expected to be received in late August, but delays may be expected due to the COVID pandemic. Further reviews to the catch data may be made after September.

Size data

133. The WPTT **NOTED** further tasks for the size frequency review (WPTT-2021-23-08):
    - Improve the format of the section in the report describing the practices of data collection by CPC.
    - Document how data from each CPC have been rounded, stratified, and converted (e.g. weight to length).
    - Document the availability of other sources of data that can be used to estimate mean sizes and catch weight & numbers.
    - Further explore Taiwan,China and Seychelles data and better understand patterns in the data to identify issues that may have occurred in different periods.
    - Comparisons of datasets between flags and data types, e.g., the Japanese operational and research vessel data. These explorations will focus on two groups of data: a) the Japanese data, where the data are generally of good quality, but with minor issues (e.g. rounding, and issues reported in other oceans); b) datasets by various fleets available since the early 2000s.
    - Examine size data from the piracy area ((e.g. by Seychelles) after recovery of fishing effort, and check for possible declining trends in mean size, as seen at the start of the Japanese time series.

134. The WPTT **NOTED** the recommendations for this year's yellowfin assessment provided as part of the size data review project, and agreed that intersessional collaboration with the stock assessment modelers and the consultant responsible for the size frequency data review will be the way forward to inform any further recommendations for the stock assessment

Tagging data

135. The WPTT **RECALLED** the requests from previous WPTT and SC meetings for a review of tagging data to recommend for its optimal use in the stock assessment. The WPTT re-emphasized the importance of reviewing and improving how tagging data should be modelled within the stock assessments of the three tropical tuna species.

Abundance indices

136. The WPTT **NOTED** the current yellowfin assessment relies on the Joint Longline index only. The WPTT **AGREED** other abundance indices could potentially explain relevant fishery trends. As such, the assessment should assess the impact of the inclusion of other indices in the model. The WPTT **NOTED** that final versions of all available indices will be presented to the WPTT meeting in October with further diagnostics and suggest a correlation study be carried out to enable the comparison of different abundance indices. However, the WPTT also **NOTED**

that the effect of differing selectivity needs to be taken into account when comparing CPUE trends, and this might be difficult to achieve outside of a stock assessment model.

137. The WPTT **DISCUSSED** options for the improvement of analysis on individual abundance indices, and suggested additional work to the analysts responsible of their analysis

138. The WPTT **NOTED** the Maldivian pole and line index will be available after updated catch and effort data is included (until June or July). It is suggested that the early part of the series is removed and dropping IPTP aggregated data from the analysis could be explored.

139. The WPTT **NOTED** that the Joint LL index will be available at the end of July. The WPTT requested following analyses with assigned priorities

- Apply the statistical area weighting in the standardisation (Low).
- Consider using Hooks Between Floats (HBF) instead of clusters in tropical regions (if possible), or re-run cluster analysis with a compound BET and YFT species group (High).
- Consider using fastcluster for hierarchical clustering (low).
- Omit data from Taiwan,China before 2005 (inclusive) for both clustering and standardization analysis.
- Consider extending the time series to 1972 by including 1972-1975 indices from the previous analysis as an extension of the new time series.
- Consider developing alternative criteria for data selection to improve model convergence (e.g. number of sets per vessel).
- Consider Including effort as a predictor in delta-model..
- Fix parameters for vessels or explore other approaches to avoid convergence failure when vessel id is included. Explore other R packages (e.g. mgcv) to make the standardisation more efficient.
- Produce indices for 4,2,1 areas and in both yearly and quarterly time steps (High priority).

140. The WPTT **NOTED** that the final indices for EU purse seine FOB and free school will be available at the end of June. The WPTT requested following analyses:

- The WPTT **NOTED** that the final indices for EU purse seine FOB and free school will be available at the end of June.
- The WPTT **NOTED** that alternative approaches to account for spatio-temporal variations using VAST models or GAMs (including a tensor product of longitude and latitude) will be explored in the next months but that the results will not be ready for this year's yellowfin assessment.
- The WPTT **NOTED** that the issue of effort creep will be discussed once after the index is finalised and compared to other abundance indices. However, the WPTT **NOTED** that the standardization has already aimed to include the effect of the technological improvement related to the use of echo-sounder buoys.
- The WPTT **NOTED** that the Gulland index was used to account for the level of fisheries concentration and for downweighing the influence of large tuna concentrations but that the effect of the covariate is not well understood and could be further explored with simulations.
- The WPTT **NOTED** that adding "fishing company" as a covariate could be explored to represent homogeneous behavior and possibly for collaboration (including buoy sharing) within each company.
- The WPTT **NOTED** that collaborative behavior among vessels could be explored with clustering methods based on vessel spatio-temporal co-occurrence, **NOTING** that such patterns might also reflect competitive behavior with vessels following each other.

141. The WPTT **NOTED** that the final index of the ABBI (Associative Behavior-Based abundance Index) will be available at the end of June. The WPTT requested following analyses:

- Correct species composition on 10 degree scale based on sampling data.
- Run sensitivity analysis on the continuous residence time (CRT) values to evaluate how the abundance index varies with the CRT.

8. OTHER MATTERS

Spatial modelling workshop

142. The WPTT **NOTED** the plan for an upcoming spatial modelling workshop which aims to improve knowledge of the development of spatial models. The WPTT **NOTED** that several different modelling platforms will be used and will be focused on Indian Ocean yellowfin tuna as well as Antarctic toothfish fisheries. Interested scientists were **ENCOURAGED** to take part in the analysis exercise and to participate in the workshop planned for 2022.

Data dissemination tools

143. The WPTT **NOTED** the development by the Secretariat of an online portal to make IOTC data and statistics easily available to the wider scientific community. The WPTT **NOTED** that the tool is still in the testing phases and the Secretariat requested help from scientists in testing the features of the tool as it is being finalised.

144. The WPTT **NOTED** that updated catch datasets including data for 2020 should be available from the Secretariat around the end July 2020, at least one month after the end of June deadline for CPCs to submit their data. The WPTT **NOTED** however, that there may be some delays in the submission of data due to the Covid-19 pandemic.

Covid-19 impacts

145. The WPTT **NOTED** the impacts of the Covid-19 pandemic on data collection and submissions to the Secretariat. The WPTT **NOTED** that there is thought to have been a major reduction in sampling operations in Seychelles (around 40% of 2019 levels), a reduction in the boarding of observers, interruption of several research projects involving operations at sea and delays in data entry and curation in several CPCs due to reduced working activities.

146. The WPTT **NOTED** that these issues are likely to impact the quality and quantity of data available in 2021 from 2020, including data required for stock assessments. The WPTT **NOTED** that the IATTC made the decision to suspend stock assessments which would have included the terminal year of 2020 or 2021 as a result of these projected issues which would likely have an undue influence on the assessment results. The WPTT further **NOTED** that modellers working on the Indian Ocean yellowfin tuna stock assessment will need to consider these issues as they have done in the past with issues such as the effect of piracy and the introduction of new management measures. The WPTT **NOTED** that a final decision on how to deal with these issues may be taken by the Scientific Committee.

147. The WPTT **NOTED** that many NGOs are using these issues related to data collection during the pandemic to push for the introduction of electronic monitoring systems to ensure that data continue to be provided. The WPTT **NOTED** that the Commission is yet to endorse the recommendation of the Scientific Committee to create a working group on electronic monitoring but that an online meeting can likely be organised before the end of 2021 once this recommendation has been endorsed.

9. Review of the draft, and adoption of the Report of the 23rd Session of the WPTT

148. The report of the 23rd Session of the Working Party on Tropical Tunas Data Preparatory Meeting (IOTC–2021–WPTT23(DP)–R) was **ADOPTED** intersessionally via correspondence.

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APPENDIX II
AGENDA FOR THE 22ND WORKING PARTY ON TROPICAL TUNAS DATA PREPARATORY MEETING

Date: 10 - 14 May 2021

Location: Microsoft Teams

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 23rd Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 24th 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 WPTT22 (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 ENVIRONMENAL DATA RELATING TO YELLOWFIN TUNAS** (Chair)

5.1 Review new information on the biology, stock structure, their fisheries and associated environmental data for yellowfin 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 YELLOWFIN TUNAS** (Chair)

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

7 **YELLOWFIN STOCK ASSESSMENT** (Chair)

7.1 Discussion on yellowfin assessment models to be developed and their specifications
7.2 Identification of data inputs for the different assessment models and advice framework

8 **OTHER MATTERS** (Chair)

9 **REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 23rd SESSION OF THE WORKING PARTY ON TROPICAL TUNAS (DATA PREPARATORY)** (Chair)

APPENDIX III
LIST OF DOCUMENTS FOR THE 22ND WORKING PARTY ON TROPICAL TUNAS DATA PREPARATORY MEETING

Document	Title
IOTC–2021–WPTT23(DP)–01a	Draft: Agenda of the 23rd Working Party on Tropical Tunas (DP)
IOTC–2021–WPTT23(DP)-01b	Draft: Annotated agenda of the 23rd Working Party on Tropical Tunas (DP)
IOTC–2021–WPTT23(DP)-02	Draft: List of documents for the 23rd Working Party on Tropical Tunas (DP)
IOTC–2021–WPTT23(DP)-03	Outcomes of the 23rd Session of the Scientific Committee (IOTC Secretariat)
IOTC–2021–WPTT23(DP)–04	Outcomes of the 24th Session of the Commission and the 4th Special Session of the Commission (IOTC Secretariat)
IOTC–2021–WPTT23(DP)-05	Review of Conservation and Management Measures relevant to tropical tuna (IOTC Secretariat)
IOTC–2021–WPTT23(DP)-06	Progress made on the recommendations of WPTT22 (IOTC Secretariat)
IOTC–2021–WPTT23(DP)–07	Review of the statistical data and fishery trends for tropical tunas (IOTC Secretariat)
IOTC–2021–WPTT23(DP)–08	Review of size data from Indian Ocean longline fleets, and its utility for stock assessment (Hoyle S, Chang S-T, Fu D, Geehan J, Itoh T, Lee SI, Matsumoto T, Yeh Y-M and Wu R-F)
IOTC–2021–WPTT23(DP)–09	Reproductive Biology of Yellowfin Tuna (Thunnus albacares Bonnaterre, 1788) from Southern Part of Indonesian Waters and its Application as Limit Reference Point (Lm50). (Setyadji, B and Hartaty H)
IOTC–2021–WPTT23(DP)–10	Status of tuna resources (oceanic & neritic) & some biological aspects of selected tuna species in India (Ramachandran S, Kar AB and Tiburtius A)
IOTC–2021–WPTT23(DP)-11	Exploratory analysis of tropical tuna longline selectivity and its implications for stock assessment (Medley P, Defaux V and Huntington T)
IOTC–2021–WPTT23(DP)–12	Status of Tropical Tuna Fisheries of Pakistan with Special Reference to Yellowfin Tuna (Moazzam M)
IOTC–2021–WPTT23(DP)–13	Bayesian Skipjack and Yellowfin Tuna CPUE Standardisation Model for Maldives Pole and Line 1970-2019 (Medley P and Ahusan M)
IOTC–2021–WPTT23(DP)–14	Report of trilateral collaborative study among Japan, Korea and Taiwan for producing joint abundance indices for the yellowfin tunas in the Indian Ocean using longline fisheries data up to 2019 (Kitakado T, Wang S-P, Satoh K, Lee SI, Tsai W-P, Matsumoto T, Yokoi H, Okamoto K, Lee MK, Lim J-H, Kwon Y, Su N-J, Chang S-T and Chang F-C)
IOTC–2021–WPTT23(DP)–15	Associative Behavior-Based abundance Index (ABBI) for yellowfin tuna (Thunnus albacares) in the Western Indian Ocean. (Baidai Y, Dagorn L, Gaertner D, Denebourg J-L, Duparc A and Capello M)
IOTC–2021–WPTT23(DP)–16	European purse seine CPUE standardization: methodology and framework for the YFT stock assessment (Guéry L, Kaplan D, Grande M, Merino G, Marsac F, Abascal F, Báez J-C and Gaertner D)
IOTC–2021–WPTT23(DP)–17	Introduction to the IOTC tuna factory sales data flow and database (Bodin N, Pierre L and Fiorellato F)
IOTC–2021–WPTT23(DP)-INF01	Review of Japanese fisheries and tropical tuna catch in the Indian Ocean (Matsumoto T)
IOTC–2021–WPTT23(DP)-INF02	Japanese longline CPUE for yellowfin tuna in the Indian Ocean standardized by generalized linear model which includes cluster analysis (Matsumoto T et al.)
IOTC–2021–WPTT23(DP)-INF03	CPUE standardization of yellowfin tuna caught by Korean tuna longline fishery in the Indian Ocean, 1977-2019 (Lee SI)
IOTC–2021–WPTT23(DP)-INF04	On-going investigation of Japanese longline CPUE for yellowfin tuna in the Indian Ocean standardized by vector-autoregressive spatiotemporal model (Satoh K, Matsumoto T, Yokoi H, Okamoto K and Kitakado T)
IOTC–2021–WPTT23(DP)-INF05	Yellowfin tuna Synopsis

APPENDIX IV
MAIN STATISTICS FOR YELLOWFIN TUNA
(Extracts from IOTC–2021–WPTT23(DP)–07)

Trends in nominal catches

Nominal catches of yellowfin tuna show an increasing trend over the last seven decades with some variability between years (**Fig. 1**). Since 2012, catches have steadily increased from 400,000 t to an average of 430,000 t between 2015 and 2019, and a maximum close to 450,000 t in 2019.

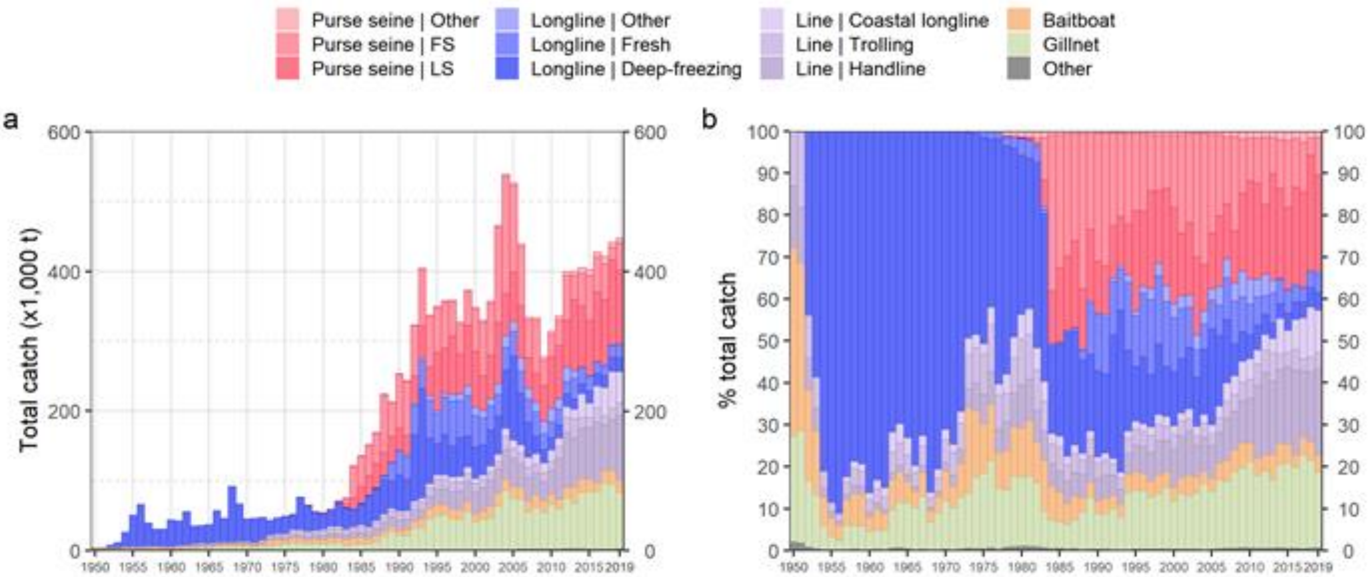

Fig. 1. Annual time series of cumulative nominal absolute (a) and relative (b) catches of yellowfin tuna in metric tons (t) by fishery for the period 1950-2019. LS = schools associated with floating objects; FS = free-swimming schools. Data source: yellowfin tuna raised time-area catches

Main fishery features

Yellowfin tuna is caught by a large diversity of fisheries from many fleets operating all over the Indian Ocean. Contrary to other oceans, the artisanal fishery component of yellowfin catches in the Indian Ocean has always been substantial, accounting annually for more than 40% of the total catches from the mid-1970s to the early 1980s and since 2007. Between 2015 and 2019, the mean annual catches of artisanal fisheries were close to 200,000 t (47% of total catches) when the industrial fisheries caught more than 227,000 t every year.

Catch trends by fishery group in the period 2015-2019 show a slight decrease in catches from purse seiners since 2015, a relatively stable trend in catches from longliners and baitboats (as well as from vessels using all other gears), a return to 2015 catch levels for gillnetters after two years of higher-than-average catches and a marked increasing trend in catches reported from line fisheries, that in 2019 recorded the peak in catches since the beginning of the period considered (**Fig. 2**).

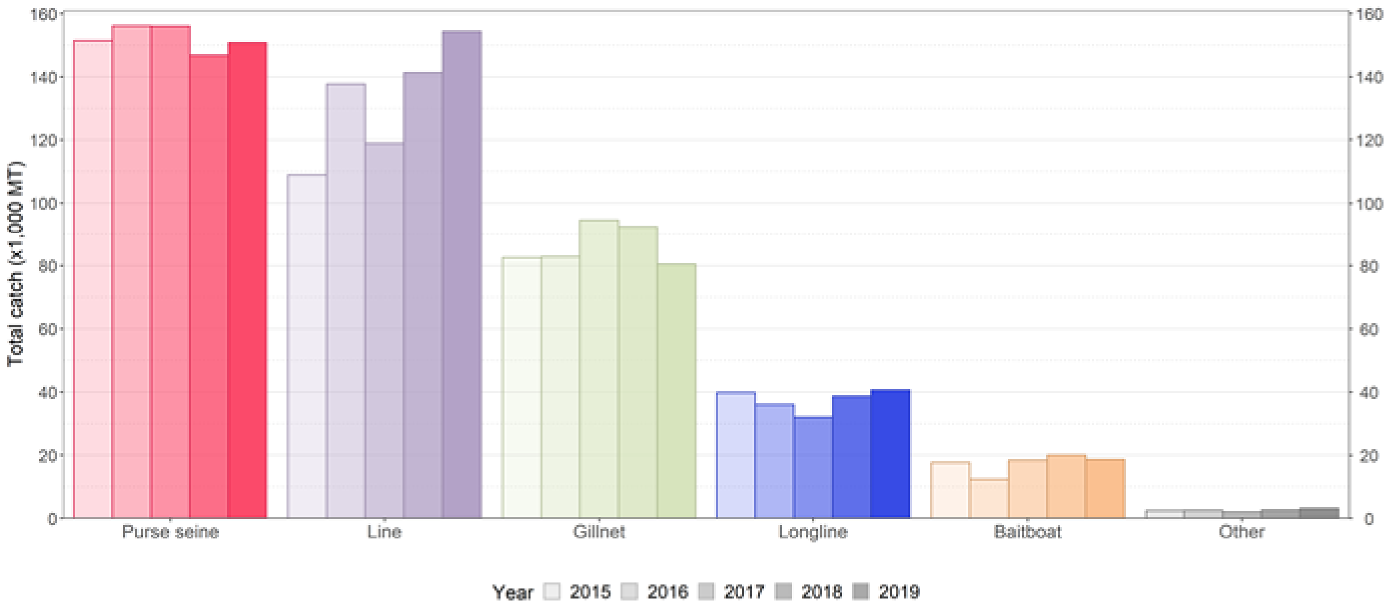

Fig. 2. Annual catch trends of yellowfin tuna by fishery group in metric tons (t) between 2015 and 2019. Data source: latest best scientific estimate of nominal catches

Uncertainties in nominal catch data

The overall quality of the nominal catches of yellowfin tuna shows some large variability between 1950 and 2019 (**Fig. 3**). In some years, a large portion of the nominal catches of yellowfin tuna had to be estimated through the breakdown of catches reported using species or gear aggregates. The data quality was particularly poor between 1994 and 2002 when less than 70% of the nominal catches were fully or partially reported, with most reporting issues coming from coastal fisheries.

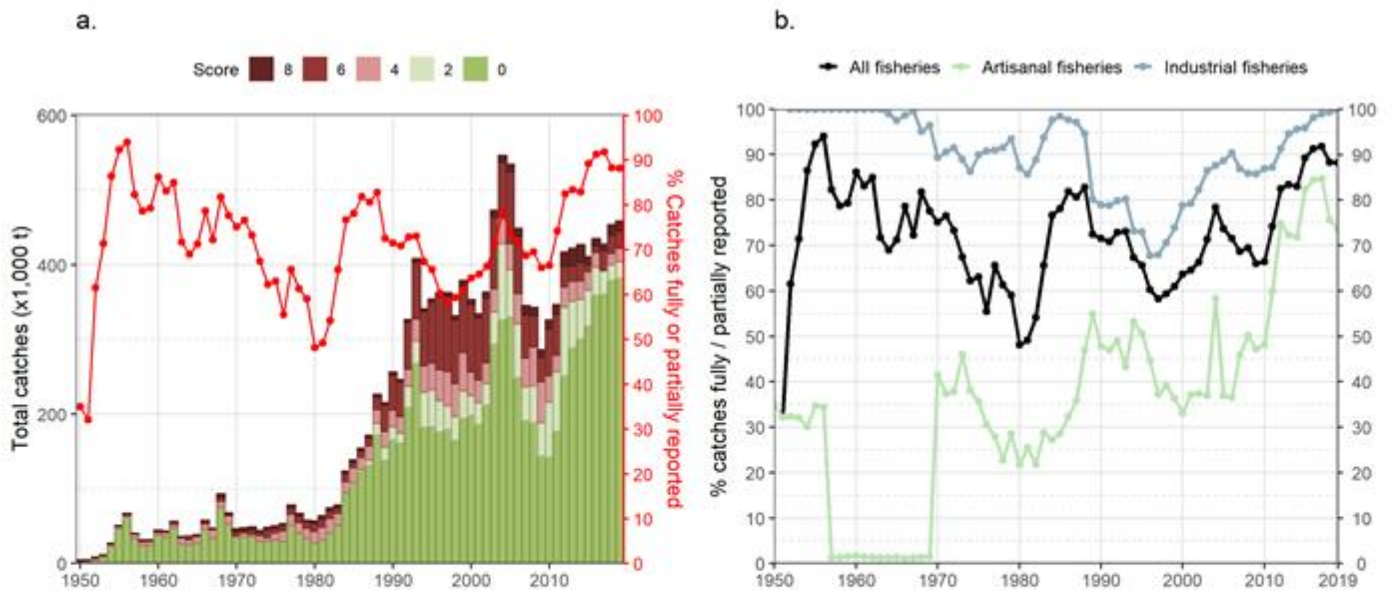

Fig. 3. Annual nominal catches of yellowfin tuna in metric tons (t) estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2019

The quality has steadily improved over the last decade, to the point that around 83% of the catches was fully available from CPC submissions in 2019. Nevertheless, more than 35,000 t of nominal catches of yellowfin tuna (8% of the total catches) were scored between 6 and 8 and required to be mostly estimated by the Secretariat. In particular, the handline catches of Yemen were repeated from previous years at levels of about 18,000 t, based on information retrieved from the FAO global capture production database. Also, catches from the coastal longline fishery of India and gillnet fisheries of Tanzania and Pakistan contributed the most to the catch estimates.

Discard levels

The total amount of yellowfin tuna discarded at sea remains unknown for most fisheries and time periods despite the obligation to report these data as per IOTC Res. 15/02. Furthermore, and except for very specific situations (i.e., the fish caught is considered unfit for human consumption or there is insufficient storage capacity following the final set of a trip), all tropical tunas caught with purse seine have to be retained onboard since 2013 (IOTC Res. 19/05).

Discarding of tropical tuna is thought to be small in coastal fisheries and negligible in baitboat fisheries. Besides, data collected by observers at sea have shown that the level of discarding of tropical tunas is low in the Indian Ocean purse seine fishery, and mostly occur in schools associated with floating objects. Purse seine discards of yellowfin tuna are mainly composed of fish smaller than 50 cm (~1.3 kg) although a few larger fish may be discarded when damaged. Estimates for the main component of the Indian Ocean purse seine fleet showed they amount to a few hundred tons annually.

Discarding may also occur in tropical longline fisheries, mainly due to depredation by sharks and cetaceans. There is currently little information in the ROS database on discarding practices in longline fisheries except for a small sample of fish observed in French and Japanese longliners during 2009-2018. Recently, the practice of high grading in longline fisheries has been suggested to occur in some pelagic longline fisheries operating in the South of the Indian Ocean. Preliminary analysis conducted on size data of retained yellowfin tuna caught in Indian Ocean longline fisheries does not seem to support the hypothesis of major changes in discarding practice, e.g. linked to high grading in relation with the implementation of Res. 17/01.

Geo-referenced catches

Estimated geo-referenced catches show the spatial expansion and major changes that took place in the fisheries targeting yellowfin tuna over the last decades (**Figs. 4-5**). As early as the 1950s, yellowfin tuna was caught by large-scale longline fisheries across most of the Indian Ocean while coastal gillnet and line fisheries were active in the Arabian Sea and baitboats in the Maldives and off the south-western coast of India (**Fig. 4**).

Throughout the 1960s and 1970s, the longline fisheries expanded in the south-western part of the Indian Ocean, including in the Mozambique Channel. From the 1980s, the purse seine fishery developed in the western Indian Ocean, with a majority of the yellowfin tuna caught in free-swimming schools.

During the 1990s and 2000s, the purse seine fishery increased its catches and expanded its fishing grounds in the western Indian Ocean while the coastal fisheries of the northern countries of the Indian Ocean grew substantially in importance and a large fresh longline fishery developed in the north eastern Indian Ocean.

The overall annual distribution of yellowfin tuna catches by fishery has changed little over the period 2014-2019 (**Fig. 5**). Most yellowfin tuna catches are located in the central and western Indian Ocean, with important catches also reported around Sri Lanka and along the coasts of Indonesia. Purse seine largely dominates in the western Indian Ocean around the Seychelles archipelago (between 20°S and 10°N), and the fishery showed an expansion towards the north between 2014 and 2019.

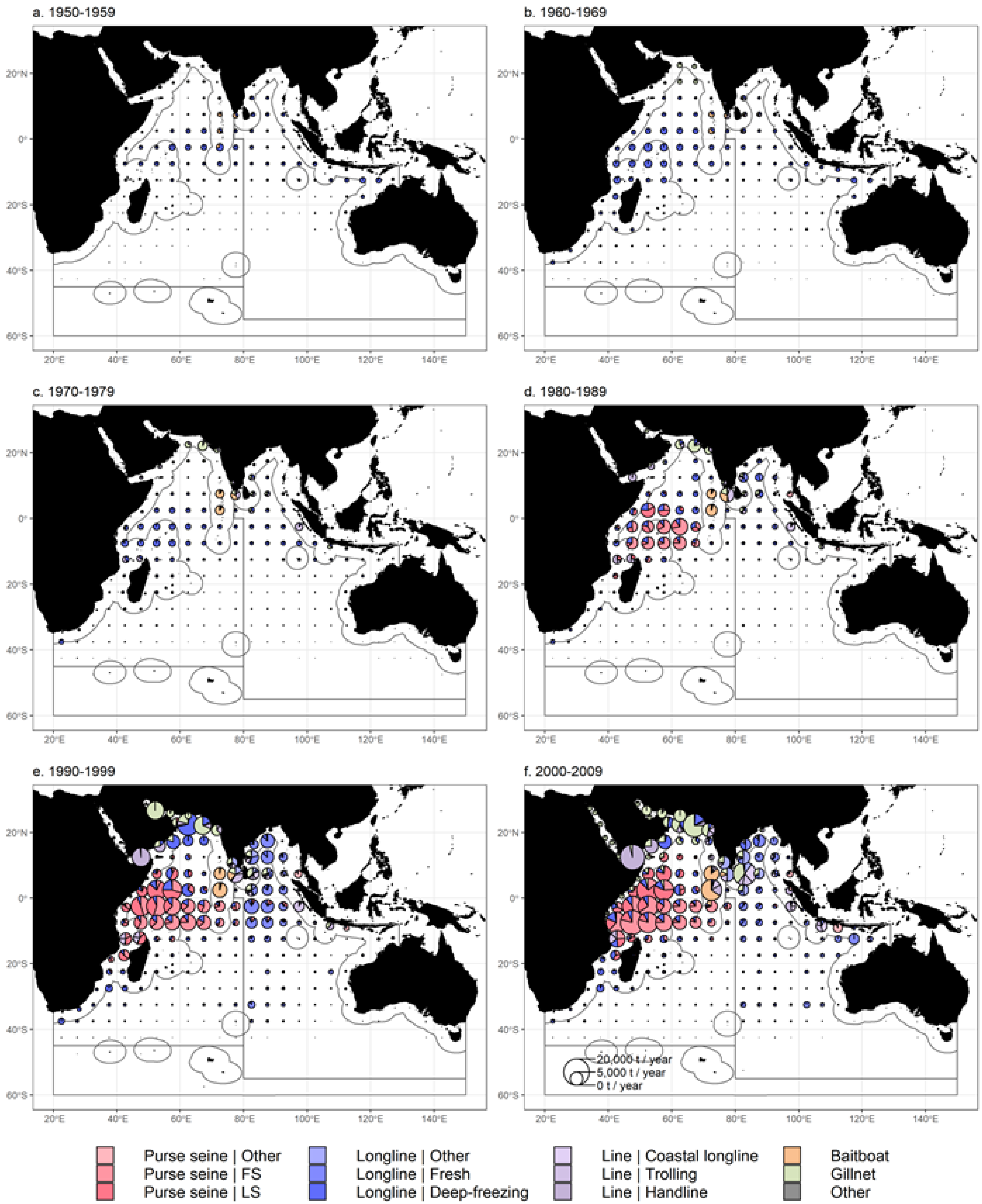

Fig. 4. Estimated average annual time-area catches of yellowfin tuna in metric tons (t) for the period 1950–2009 by decade and fishery. Data source: yellowfin tuna raised time-area catches

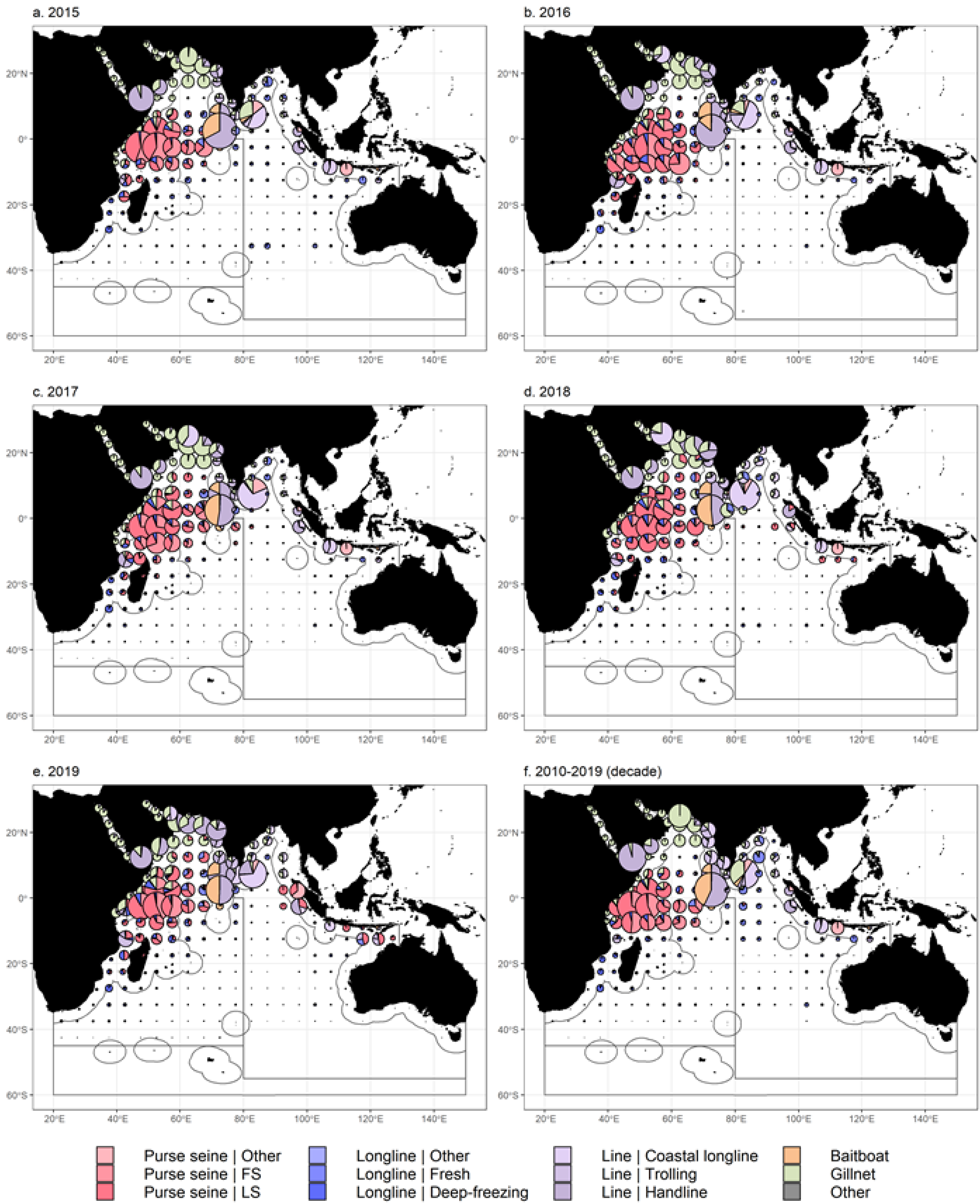

Fig. 5. Estimated average annual time-area catches of yellowfin tuna in metric tons (t) for the last decade and for the period 2015–2019 by year and fishery. Data source: yellowfin tuna raised time-area catches

Uncertainties in catch-and-effort data

Catch-and-effort series are available for most industrial fisheries and some important artisanal fisheries. However, for many artisanal fisheries, these data are either not available or are considered to be of poor quality. Consequently, the trend in quality of the catch-effort data is driven to some extent by the relative contribution of artisanal fisheries to the total catches of yellowfin tuna (**Fig. 6**).

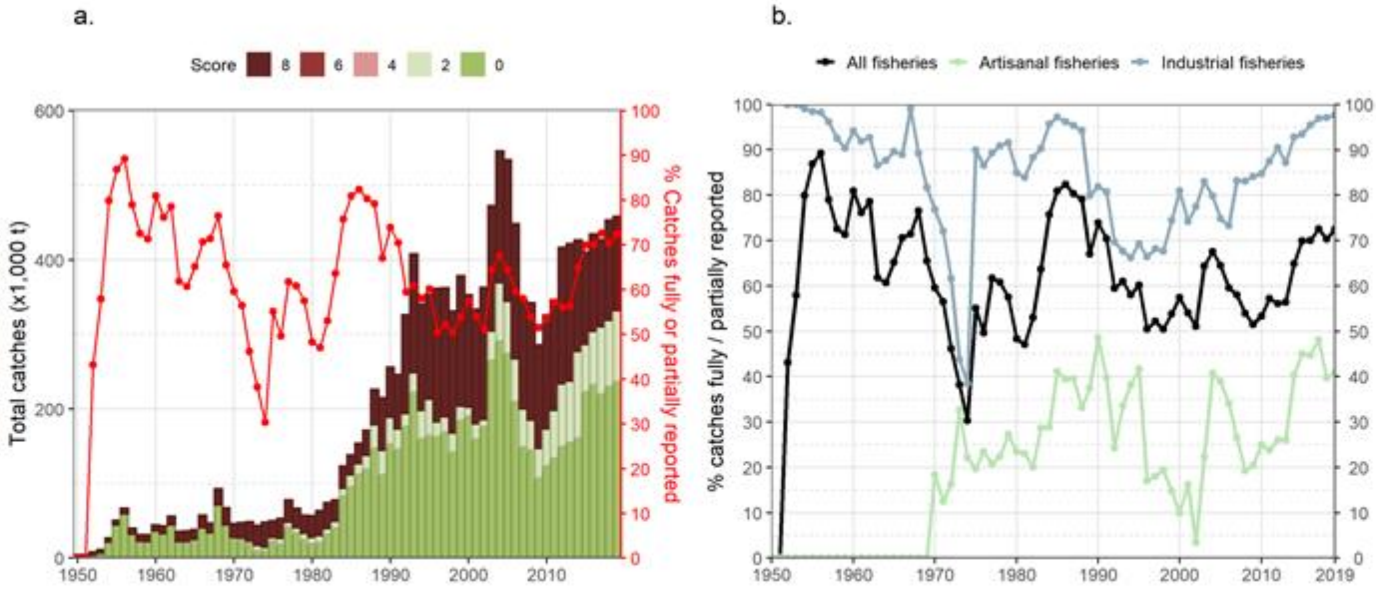

Fig. 6. Annual nominal catches (t) of yellowfin tuna estimated by quality score (barplot) and percentage of geo-referenced catches reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2019

The percentage of data considered of good quality (scores of 0-2) varied between 50%-70% during the 1990s and 2000s, and has stabilized over the last decade showing an increasing trend from 51% in 2009 to 72% in 2019 (**Fig. 6**). In particular, catch-effort data have progressively become available for some important fisheries such as coastal and fresh longline as well as hand line from Sri Lanka since 2014, coastal longline from I.R. Iran since 2016, small-scale purse seine and fresh longline from Indonesia since 2018, and some smaller fisheries such as trolling from Indonesia and hand line from Kenya since 2018.

Nevertheless, geo-referenced catch-effort data were not available for about 30% (i.e. more than 125,000 t) of the total nominal catches of yellowfin tuna in 2019. In particular, no information was available for several major coastal fisheries, in particular:

- the handline fisheries of Oman (~25,000 t), Yemen (~18,000 t), and India (~5,700 t);
- the gillnet fisheries of Oman (~11,500 t), Pakistan (~9,300 t), India (~6,800 t), and Tanzania (~3,800 t);
- the coastal longline and trolling fisheries of India.

In addition, no spatial information has been provided by a few industrial purse seine fisheries such as EU,Italy (since 2016) and I.R. Iran (since the beginning of the time series), with the two fleets accounting in 2019 for relatively low total catch levels of yellowfin tuna of ~2,300 t and ~3,400 t, respectively.

Estimated average weights of yellowfin tuna caught in Indian Ocean fisheries

Trends in average weights of yellowfin tuna can be derived from the raised time-area catches in weight and numbers. While they can be estimated for the entire time series and for each fishery, due to the lack of original samples for several strata (especially in the early periods of the fisheries) they are considered accurate only for those periods for which actual samples are available and cover strata that correspond to at least 50 t of retained catches per year.

Considering the limitations in the original data and in the process that produces this estimation, it shall be noted that the average weights estimated for the longline fisheries of Japan and Taiwan,China are pretty stable at around 40-50 kg / fish (**Fig. 7**). On the contrary, average weights estimated for the log-associated school component of the purse seine fisheries show a declining trend from the mid 1990s onward, and the resulting estimated average weight of yellowfin tuna caught by this fishery is now as low as 5 kg / fish.

Trends in average weight for all other fisheries (baitboat, gillnet and all other gears) are more difficult to assess due to the inherently artisanal nature of several of them, which in turn implies a lower number of available samples which are often of lower quality compared to those provided by industrial fleets (recorded through logbooks or collected by scientific observers, in several cases).

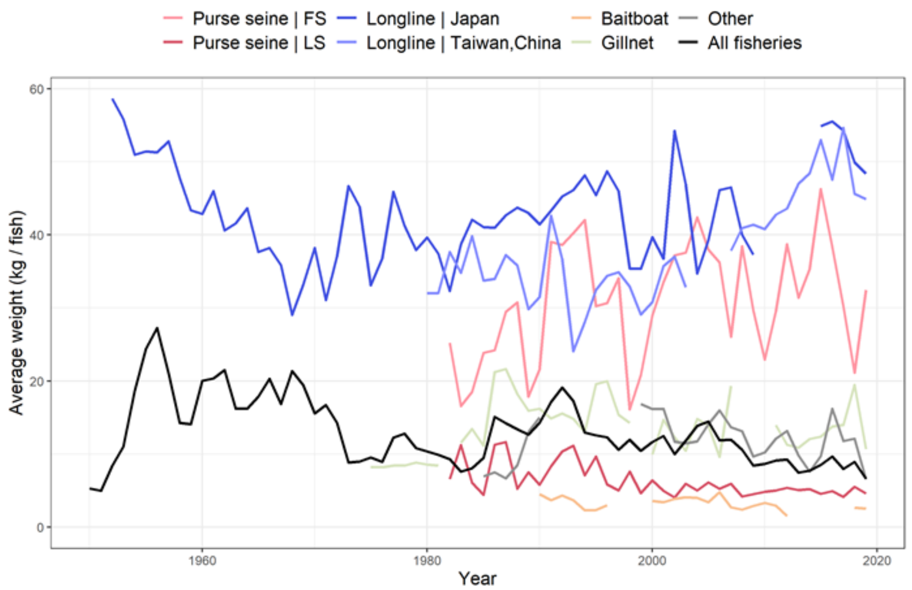

Fig. 7. Combined estimated yellowfin tuna average weight (kg/fish) by fishery and year. Data are only shown for those years for which the original size samples cover strata with reported catches (by year and fishery) higher than 50 t. LS = schools associated with floating objects; FS = free-swimming schools. Longline | Japan = includes data from longlines flagged by Japan, Rep. of Korea and Thailand; Longline | Taiwan = includes data from longlines flagged by Taiwan,China and all other flags not otherwise mentioned. Data source: yellowfin tuna raised time-area catches

Uncertainties in size-frequency data

The overall quality – as measured by the percentage of nominal catches with size data of quality scores between 0-2 – of size data available for yellowfin tuna in IOTC databases is poor, particularly for artisanal fisheries. Almost no size data are available prior to the 1980s and the general quality has varied around 50% (range 36-63%) since 1984 (**Fig. 8**). Following an increase in quality from about 40% in 2006-2007 to more than 60% in 2017, the quality substantially decreased to 52% in 2018 and 40% in 2019.

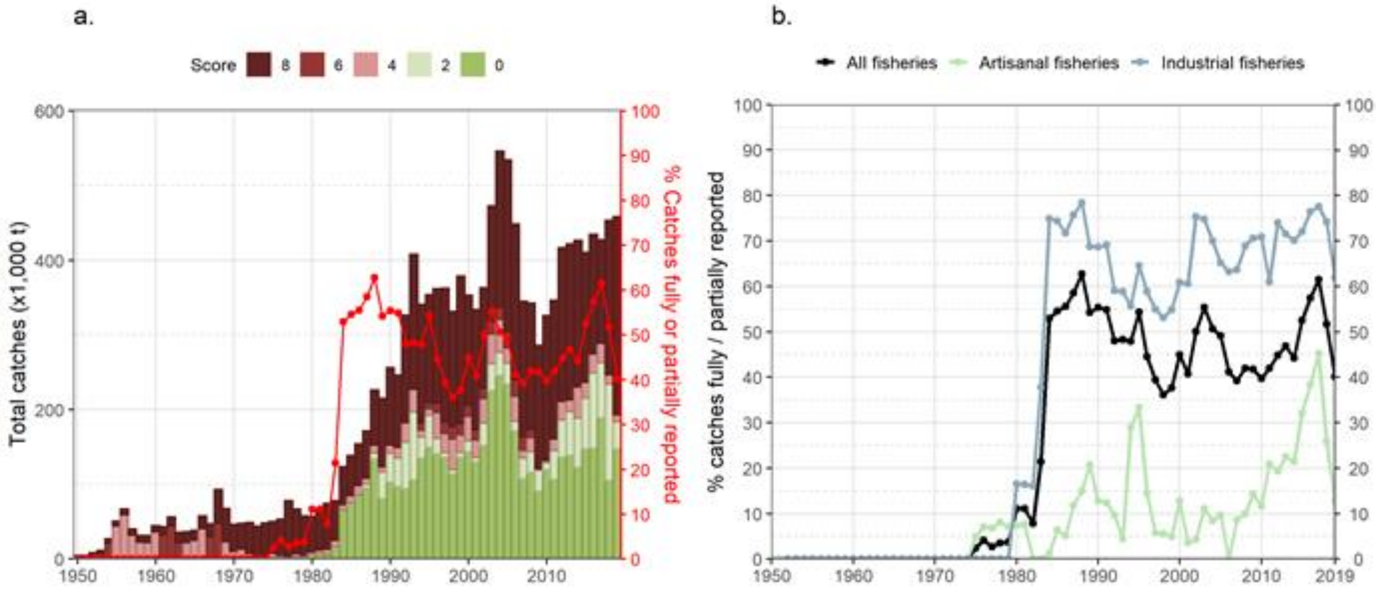

Fig. 8. Annual nominal catches (t) of yellowfin tuna estimated by quality score (barplot) and percentage of geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2019