Report of the 17th Session of the IOTC Working Party on Ecosystems and Bycatch

Microsoft Teams Online, 12 - 14 April 2021

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ACRONYMS

ABNJ	Areas Beyond National Jurisdiction
ACAP	Agreement on the Conservation of Albatrosses and Petrels
BPUE	Bycatch Per Unit of Effort
BSH	Blue shark
CITES	Convention on International Trade in Endangered Species
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CMS	Convention on Conservation of Migratory Species of Wild Animals
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
ERA	Ecological Risk Assessment
ETP	Endangered, Threatened and Protected Species
EU	European Union
EU-DCF	European Union Data Collection Framework
F	Fishing mortality; F_{2015} is the fishing mortality estimated in the year 2015
FAD	Fish Aggregation Device
FAO	Food and Agriculture Organization of the United Nations
FOB	Floating Object
F_{MSY}	Fishing mortality at MSY
GAM	Generalised Additive Model
GLM	Generalised liner model
HBF	Hooks between floats
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IOSEA	Indian Ocean - South-East Asian Marine Turtle Memorandum
IO-ShYP	Indian Ocean Shark multi-Year Plan
IPOA	International Plan of Action
IUU	Illegal, Unreported and Unregulated, fishing
IWC	International Whaling Commission
LL	Longline
LSTLV	Large-scale tuna longline vessel
MoU	Memorandum of Understanding
MPF	Meeting Participation Fund
MSY	Maximum sustainable yield
n.a.	Not applicable
NDF	Non Detriment Finding
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
NPOA	National Plan of Action
PSA	Productivity Susceptibility Analysis
ROS	Regional Observer Scheme
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SMA	Shortfin mako shark
Taiwan,China	Taiwan, Province of China
UN	United Nations
WPDCS	Working Party on Data Collection and Statistics, of the IOTC
WPEB	Working Party on Ecosystems and Bycatch, of the IOTC
WWF	World Wildlife Fund

KEY DEFINITIONS

Bycatch	All species, other than the 16 species listed in Annex B of the IOTC Agreement, caught or interacted with by fisheries for tuna and tuna-like species in the IOTC area of competence.
Discards	Any species, whether an IOTC species or bycatch species, which is not retained onboard for sale or consumption.
Large-scale driftnets	Gillnets or other nets or a combination of nets that are more than 2.5 kilometres in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column.

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 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - Data Preparatory Meeting (WPEB(DP)) was held Online on Microsoft Teams from 12 - 14 April 2021. A total of 68 participants (108 in 2020, 41 in 2019, 40 in 2018 and 39 in 2017) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Sylvain Bonhommeau from Ifremer, France, who welcomed participants and formally opened the meeting.

Table 1. Status summary for key shark species caught in association with IOTC fisheries for tuna and tuna-like species.

Stock	Indicators	2015	2016	2017	2018	2019	2020	Advice to the Commission
Sharks: Although sharks are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with fisheries targeting IOTC species. Some fleets are known to actively target both sharks and IOTC species simultaneously. As such, IOTC Contracting Parties and Cooperating Non-Contracting Parties are required to report information at the same level of detail as for the 16 IOTC species. The following are the main species caught in IOTC fisheries, although the list is not exhaustive								
Blue shark *Prionace glauca*	Reported catch 2018: 22,385t Estimated catch 2015: 54,735 t Not elsewhere included (nei) sharks 2018: 19,768 t Average reported catch 2014–18: 27,566 t Average estimated catch 2011–15: 54,993 t Ave. (nei) sharks[2] 2012–16: 50,677 t MSY (1,000 t) (80% CI): 33.0 (29.5 - 36.6) F_{MSY} (80% CI): 0.30 (0.30 - 0.31) SSB_{MSY} (1,000 t) (80% CI): 39.7 (35.5 - 45.4) F_{2015}/F_{MSY} (80% CI): 0.86 (0.67 - 1.09) SSB_{2015}/SSB_{MSY} (80% CI): 1.54 (1.37 - 1.72) SSB_{2015}/SSB_0 (80% CI): 0.52 (0.46 - 0.56)			**72.6%**	**72.6%**	**72.6%**	**72.6%**	Even though the blue shark in 2017 is assessed to be not overfished nor subject to overfishing, current catches are likely to result in decreasing biomass and making the stock become overfished and subject to overfishing in the near future. If the Commission wishes to maintain stocks above MSY reference levels ($B>B_{MSY}$ and $F<F_{MSY}$) with at least a 50% probability over the next 10 years, then a reduction of 20% in catches is advised. The stock should be closely monitored. Mechanisms need to be developed by the Commission to improve current statistics, by ensuring CPCs comply with their recording and reporting requirement on sharks, so as to better inform scientific advice in the future. Click below for a full stock status summary: ● Blue sharks – Appendix IX
Oceanic whitetip shark *Carcharhinus longimanus*	Reported catch 2018: 35 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 201 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							
Scalloped hammerhead shark *Sphyrna lewini*	Reported catch 2018: 45 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 62 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							

Shortfin mako *Isurus oxyrinchus*	Reported catch 2018: 1,499 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 1,582 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority. Click below for a full stock status summary: ● Oceanic whitetip sharks – Appendix X ● Scalloped hammerhead sharks – Appendix XI ● Shortfin mako sharks – Appendix XII ● Silky sharks – Appendix XIII ● Bigeye thresher sharks – Appendix XIV ● Pelagic thresher sharks – Appendix XV
Silky shark *Carcharhinus falciformis*	Reported catch 2018: 1,815 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 2,442 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							
Bigeye thresher shark *Alopias superciliosus*	Reported catch 2018: 2 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 1 t Not elsewhere included (nei) sharks 2014-2018: 38,511 t							
Pelagic thresher shark *Alopias pelagicus*	Reported catch 2018: 401 t Not elsewhere included (nei) sharks: 19,768 t Average reported catch 2014–2018: 348 t Not elsewhere included (nei) sharks 2014-2018: 38,511t							

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

1. Opening of the meeting

1. The 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - Data Preparatory Meeting (WPEB(DP)) was held Online on Microsoft Teams from 12 - 14 April 2021. A total of 68 participants (108 in 2020, 41 in 2019, 40 in 2018 and 39 in 2017) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Sylvain Bonhommeau from Ifremer, France, who welcomed participants and formally opened the meeting.

2. Adoption of the Agenda and arrangements for the Session

2. The WPEB **ADOPTED** the Agenda provided in Appendix II . The documents presented to the WPEB are listed in Appendix III.

3. The IOTC process: outcomes, updates and progress

3.1 Outcomes of the 24th Session of the Commission

3. The WPEB **NOTED** paper IOTC–2021–WPEB17(DP)–03 which outlined the main outcomes of the 24th Session of the Commission, specifically related to the work of the WPEB.

4. The WPEB **NOTED** that there was very little discussion related to the WPEB, due to the shortened format of the Commission meeting and that the main items were the endorsement by the Commission of the SC information on stock status as well as the agreement in principle to a letter of intent to continue a collaborative arrangement with the Agreement on the Conservation of Albatrosses and Petrels (ACAP).

4. Review of data available on ecosystems and bycatch

4.1 Review of the statistical data available for ecosystems and bycatch species

5. The WPEB **NOTED** paper IOTC–2021–WPEB17(DP)–04 which provided an overview of the data received by the IOTC Secretariat for bycatch species for the period 1950–2019. A summary for shark and ray species is provided in Appendix IV.

6. The WPEB **RECALLED** that with the term "bycatch species" the IOTC refers to all those species other than the 16 managed species, regardless of their being targeted or incidentally caught by the fisheries.

7. The WPEB **NOTED** that artisanal fisheries contributed to the majority of reported nominal catches of shark and ray species during 1950-2019, reaching more than 80% of the average total reported nominal catches in recent years (2015-2019).

8. At the same time, the WPEB **NOTED** that the contribution of artisanal fisheries to the reporting of geo-referenced catches of shark and ray species is very low, with about 5% of the nominal catches reported with spatial information between 2015 and 2019.

9. Also, the WPEB **ACKNOWLEDGED** that while the fraction of shark catches reported to the species level has increased in recent years, to the point of reaching around 50% of total annual catches for the species group, it still is subject to frequent oscillations that might reflect long-standing issues in reporting.

10. In particular, the WPEB **NOTED** with concern a sudden drop (around 30,000 t) in total shark catches reported during 2018 compared to 2017 and 2019, and **ENCOURAGED** all concerned CPCs (India, Indonesia and Mozambique, among others) to liaise with the IOTC Secretariat and identify the causes of this issue.

11. More in general, the WPEB **NOTED** with concern that data for all bycatch species (including raised catches and discards, time-area catches and size-frequency data) are often incomplete or not reported according to IOTC standards, and **RECALLED** that this has an adverse impact on the ability of the group to undertake its work.
12. The WPEB **NOTED** that the species-specific time series of nominal catches for sharks and rays presented in the paper (Fig. 9) mostly represent the statistics reported at species level, i.e. they did not account for any reallocation process of aggregate shark catches except for a few fisheries for which the estimation of shark and ray catches was made by the Secretariat (i.e.., Indonesia and Madagascar).
13. **RECALLING** that in 2013 a Resolution entered in force to prevent the retention of Oceanic whitetip shark, the WPEB **CONSIDERED** the possibility of further exploring the effects of this retention ban on the level of reporting for the species.
14. The WPEB **NOTED** that EU,France did report data to the Secretariat indicating that seabird interactions with the Reunion-based longline fishery targeting swordfish were nil during 2005-2019 which is now specified as "0" in the IOTC forms instead of a blank as before.
15. The WPEB **NOTED** that Sri Lanka has a wealth of information available on bycatch species and **THANKED** Sri Lanka for their kind offer of sharing this information with the Secretariat at their earliest availability.
16. The WPEB **NOTED** that despite the recent improvements in data reporting for sharks and rays (e.g., increased number of reporting CPCs, better coverage, and improved species level resolution), the overall quality of the data remains low and the time series of catches are considered to be highly incomplete.
17. The WPEB **NOTED** that the ROS data offer an appropriate resolution to identify hotspots of shark and ray bycatch species (as a preliminary study showed for mobulid rays; IOTC-2020-WPEB16-19) and that this could be useful to consider some area-based management measures in the future.
18. The WPEB also **NOTED** that the records of retained marine turtles reported in the ROS database by the coastal longline fleet of La Réunion are due to the protocols for the conservation of the species established at local level by EU,France, which require fishermen to bring back wounded individuals to the Kelonia turtles recovery center in Saint Leu (La Réunion).

5. New Information on Biology, Ecology, Fisheries and Environmental Data Relating to Blue Sharks

5.1 Review new information on the biology, stock structure

Best practices onboard French purse seiner vessels

19. The WPEB **NOTED** paper IOTC–2021–WPEB17(DP)–16 on the size, sex and reproductive biology of seven pelagic sharks in the eastern Arabian sea, including the following abstract provided by the authors

> *"Studies on reproduction in sharks are important for their management, since the attainment of sexual maturity has a substantial impact on their distribution, behaviour and biology. However, reproductive biology of large oceanic sharks is poorly studied in the Indian seas. In this study, the size structure, sex and maturity of pelagic thresher (Alopias pelagicus), bigeye thresher (A. superciliosus), oceanic whitetip shark (Carcharhinus longimanus), tiger shark (Galeocerdo cuvier), shortfin mako (Isurus oxyrinchus), longfinmako (I. paucus) and blue shark (Prionace glauca) in the eastern Arabian Sea are described based on 1449 specimens collected from gillnet-cum-longline landings at the Cochin fisheries harbour during 2013 – 2014."* - (See document for full abstract)

20. The WPEB **THANKED** the authors for this presentation and **NOTED** the importance of this study in terms of understanding the biology of these seven species caught in the IOTC region of competence. The WPEB **NOTED** the extensive sampling undertaken in this study in terms of number of sharks per species sampled.

6. Review of New Information on the Status of Blue Sharks

6.1 Review of fishery dynamics by fleet

21. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-05 providing an update of Japanese annual catches of pelagic sharks between 1964 and 1993 by changing the species composition, including the following abstract provided by the authors:

    "Japanese catch data of three pelagic sharks (blue shark, shortfin mako, and porbeagle) and the other sharks between 1964 and 1993 in the IOTC area was updated by using the FAO capture statistics and species composition of the main pelagic sharks calculated from current Japanese observer data. The update was conducted because the IOTC secretariat used unproved species composition of pelagic sharks to estimate Japanese catch data between 1964 and 1993 as the IOTC capture statistics. Japan requests that the IOTC secretariat replace the Japanese annual catches of three pelagic sharks in this period estimated by the IOTC secretariat with the catch data updated in this paper, as the official IOTC capture statistics. Also, the updated catch data of three pelagic sharks can be used in the stock assessments."

22. The WPEB **NOTED** the current use of shark species composition based on regional FAO statistics due to the lack of species-specific catch data prior to 1994 (no observer data), as well as the issues relating to the quality of logbook data including the lack of information on discards.

23. The Secretariat **THANKED** the Japanese scientists for providing revised data on shark catches by species to overcome these issues as requested during the last WPEB, and **ACKNOWLEDGED** that this information should be considered as official data for the fleet, species and years concerned and will be used for stock assessment purposes.

24. The WPEB **NOTED** that the use of shark species composition derived from Japanese observer data from 1994 to 2020 is due to the lack of other means to re-estimate species-specific catch data prior to 1994, as well as to issues related to the quality of logbook data (including the lack of information on discards).

25. The WPEB further **NOTED** that while there are potential issues when using species composition derived from observer data after 1994 for the entire time series, this is the most reliable source of data for estimating species composition data which are otherwise lacking.

26. The WPEB **NOTED** that the average species composition calculated over such a long period (1994-2020) may not be indicative of the true annual catch trend and will not reflect any temporal changes (i.e., variations in fishing grounds over decades, changes in fishing behaviour as a result of shark-directed catch regulations and CMMs, differences in species abundance and gear configuration) which could affect the estimated species composition.

27. The WPEB **NOTED** that the revised catch series provided by Japan is aggregated at the level of the entire Indian Ocean, and therefore **REQUESTED** Japan to provide a version of this same catch series that splits yearly catches by species and Indian Ocean sub-area (Eastern / Western), as required by IOTC Resolution 15/02, to allow its incorporation in the IOTC databases.

28. The WPEB **NOTED** that it may not be possible to look further into the effect of any historical changes in gears configurations on species composition in a future study using the logbook data before 1994 as there is no information about species of sharks before 1994).

6.2 Nominal and standardised CPUE indices

29. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-06 providing an update on the CPUE standardization of the blue shark caught by the Indonesian longline fishery in the eastern Indian Ocean, including the following abstract provided by the authors:

"The blue shark or BSH (Prionace glauca) is commonly caught as bycatch in tuna longline fishery. It is vulnerable as a consequence of the increasing intensity of tuna harvesting. Despite this species categorized as well-studied compared to other shark species, an update on its abundance is essential for stock assessment and fishery management. This study provided an update on the CPUE standardization of the blue shark as a proxy of relative abundance by removing possible factors that influence the CPUE using a Generalized Linear Model (GLM). The fishery-independent data was gathered through the Indonesian onboard scientific observers program operated in the eastern Indian Ocean from August 2005 to December 2019. Due to the large proportion of the zero catch of blue shark (~62%), the CPUE was standardized using a delta-lognormal model. In general, an increase-fluctuated trend of the CPUE was observed in the last decade. The standardized CPUE of the blue shark as a proxy of its relative abundance decreased during 2006 and to 2011 and showed an increasing trend thereafter and peaked in 2018. The positive catch of blue shark was significantly affected by the variables of year, quarter, and latitude, where the blue shark is more abundant in high latitude waters."

30. The WPEB **NOTED** that the chair presented this paper on behalf of Indonesia.

31. The WPEB **REQUESTED** that Indonesian scientists provide information on the yearly and spatial coverage of the observed fishing effort.

32. The WPEB **NOTED** the relatively low observer coverage, limited area (i.e., tropical areas in the north eastern Indian Ocean), large fluctuations in annual sample sizes, insufficient statistical analyses (e.g. not taking into consideration the high zero catch ratio) for the Indonesian longline fishery and **AGREED** to consider the presented standardized CPUE for sensitivity analysis in the stock assessment work to be carried out this year.

33. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-07 on Updated standardized catch rates for blue shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean, including the following abstract provided by the authors:

"The catches and efforts of the blue shark in the Indian Ocean were estimated based on the observers' records (2004-2019) of Taiwanese tuna longline fisheries. To cope with the large percentage of zero shark catch, the catch per unit effort (CPUE) of blue shark, as the number of fish caught per 1,000 hooks, was standardized using a two-step delta-lognormal model (DLN) that treats the proportion of positive sets and the CPUE of positive catches separately. The standardized CPUE showed a stable increasing trend for blue sharks from 2008 to 2014 (the peak), although decreased in 2015, it increased again in 2016. Overall, the standardized CPUE series of the blue shark caught by Taiwanese longline fishery showed a stable trend. The stable trend suggested that blue shark stocks in the Indian Ocean seems at the level of optimum utilization."

34. The WPEB **NOTED** the value of influence plots in understanding the effect of each covariate, specifically a shift in fishing strategy in 2013 regarding the decrease in number of hooks deployed. The WPEB further **NOTED** that the positive influence of the number of hooks seems to drive high nominal catch rates in the latter part of the time series resulting in flattening the CPUE trend. This result is counterintuitive and the WPEB **REQUESTED** that the authors confirm that the influence plot axes are correct.

35. The WPEB **NOTED** that the effect of vessel was not included in the standardisation process, and **SUGGESTED** that some attempt to quantify vessel behaviour would be beneficial. This can be done, for example, by introducing vessel targeting using species catch composition or the number of hooks

per basket. The WPEB **NOTED** that it is possible to include these targeting effects using the observer data.

36. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-08 on Updated standardized CPUE of blue shark bycaught by the French Reunion-based pelagic longline fishery (2007-2020), including the following abstract provided by the authors:

"The blue shark Prionace glauca is the main bycatch species of the French swordfish-targeting longline fishery operating in the south-west Indian Ocean. Using observer and self-reported data collected aboard commercial longliners between 2007 and 2020, we propose a standardized CPUE series for blue shark for this fishery estimated with a lognormal generalized linear mixed model (GLMM) to be used for stock assessment. We propose to use the standardized CPUE for the period comprised between 2011 and 2020 where the monitoring effort has been consequent in comparison with previous years. Throughout 2011-2020, the standardized CPUE for the blue shark shows a significant decreasing trend."

37. The WPEB **THANKED** the authors for the presentation and **ACKNOWLEDGED** that the statistical applications were robust and appropriate, and that the model diagnostics showed no signs of misspecification.

38. The WPEB **NOTED** the limited spatial area of the study and, therefore, whether the results are indicative of abundance indices in the entire Indian Ocean. Despite the limited distribution, the WPEB **AGREED** that the data may still be important (e.g. if the fishery catches large productive females).

39. The WPEB **NOTED** that some length-frequency data are available from this fishery, however, as blue sharks are almost always discarded and often not brought onboard for measurements, there is not a lot of size data for blue sharks. The WPEB **NOTED** that the existing length-frequency data should be examined to better inform the WPEB of the size structure of blue sharks caught by the French Reunion-based pelagic longline fishery.

40. **ACKNOWLEDGING** the low observer coverage before 2011, the WPEB **AGREED** that removing the early years of the time series (2007-2010) would be appropriate given the rationale provided by the authors that the standardization model fitted on data from the period 2011-2020 produced similar results.

41. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-09 on Updated Standardized Catch Rates in Biomass for the Blue Shark (*Prionace glauca*) Caught by the Spanish Surface Longline Fleet in the Indian Ocean During the 2001-2019 Period, including the following abstract provided by the authors:

*"This paper provides an update of standardized catch rates in weight of blue shark using a Generalized Linear Model (GLM) from a total of 2,301 trips carried out by the Spanish surface longline fleet targeting swordfish in the Indian Ocean during the 2001-2019 period. The criteria used to define explanatory variables were similar to those used in previous papers. The main factors considered in the analysis were year, quarter, area, ratio, gear and the interaction quarter*area. The results indicate that the ratio factor (an indicator of target criteria of the skippers) defined as the ratio between the two most prevalent species caught -swordfish and blue shark- was the most important factor which explained the CPUE variability. The GLM results explained 80% of CPUE variability in weight. The index showed a stable trend over time."*

42. The WPEB **NOTED** that Spanish scientists used a ratio of catch rates (SWO/SWO+BSH) to account for the effect of targeting and that this covariate explains a lot of the variance in the standardization model. The WPEB **DISCUSSED** the circularity of this process and whether this ratio may artificially account for variability that may otherwise be allocated to interannual variation in blue shark abundance, resulting in a hyperstable standardised CPUE index.

43. The WPEB **SUGGESTED** considering trimming northern locations with very low effort levels from the dataset and focusing on the core fishing area which might help with outliers.

44. The WPEB **NOTED** that data from the southern areas of the Indian Ocean were derived from pilot surveys conducted in areas where commercial fishing activity is unusual or minor which could explain the apparent trend of high CPUEs but low effort in this region, rather than this being related to a localised depletion.

45. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-10 on Updated Blue shark catches and standardized CPUE for the Portuguese pelagic longline fleet in the Indian Ocean between 1998 and 2019, including the following abstract provided by the authors:

"The Portuguese pelagic longline fishery in the Indian Ocean started in the late 1990's, targeting mainly swordfish in the southwest region. This working document analyses catch, effort and standardized CPUE trends for blue shark captured by this fishery. Nominal annual CPUEs were calculated in biomass (kg/1000 hooks), and were standardized with Generalized Linear Mixed Models (GLMMs) using year, quarter, season and targeting as fixed effects, and vessel as random effects. The standardized CPUE trends shows a general decrease in the initial years between 2000 and 2005, followed by a more stable period with some oscillations until 2019. These results present an updated annual index of abundance for the blue shark captured by the Portuguese pelagic longline fleet in the Indian Ocean that can now be considered for utilization in the 2021 IOTC blue shark stock assessment."

46. The WPEB **NOTED** that the significant inter-annual variation in number of sets is not reflected in the confidence intervals of the standardized CPUE time series that are constant throughout the period. The authors confirmed that the coefficient of variation does vary though between years in relation to the number of sets.

47. **ACKNOWLEDGING** that the catch ratio (SWO/SWO+BSH) and clusters used to account for the targeting effect produced very similar results, the WPEB **EXPRESSED** concerns regarding this way of considering targeting due to the issue of redundancy. The WPEB **REQUESTED** that authors run the model without targeting for sensitivity analysis purposes. However, the invited scientist **ADVISED** that there is no need to run the model without considering the targeting effects.

48. The WPEB **CONFIRMED** the method of area stratification (i.e., GLM tree).

49. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-11 on Available shark assessment data from South Africa: Standardization of blue shark (Prionace glauca) observer catch per unit effort data from the IOTC region, including the following abstract provided by the authors:

"The blue shark Prionace glauca is caught as bycatch in the large pelagic longline fishery in South Africa. The fleet includes a domestic component with varying but increasing degree of observer coverage, and a foreign-flagged component of Japanese vessels that operate under joint venture agreements with South African Right Holders. Japanese flagged vessels have been operating under a mandatory 100% observer coverage since 2007. The catch and effort data include consistent records of bycatch species in numbers caught per set. We investigated blue shark abundance by standardising the Catch per Unit Effort (CPUE) in numbers from Observer data for the time series 2007 to 2019. To do this, we applied a Generalised Additive Mixed Model (GAMM) with a Poisson error distribution. Explanatory variables of the final model included year, month, grid (lat, long) with the number of blue shark caught in a set offset by the number of hooks set, so as to maintain a count distribution. Vessel was included as a random effect. Despite a period of relatively low catch rates (2009-2012) followed by a period of relatively high catch rates (2015-2017), the results indicate that blue shark CPUE in the southwestern IOTC area has been stable overall. Our dataset is unique in that the joint-venture Japanese flagged vessels have required 100% observer coverage since 2007. Given the increasing stricter catch regulation on shark species, our observer dataset may be the most appropriate dataset to accurately represent trends in abundance of blue sharks in the southwestern IOTC region."

50. The WPEB **NOTED** that blue shark catches in the ICCAT area (west of 20°E) were not considered and questioned whether they should be included in the analysis since they might hide some patterns of abundance in the final standardized CPUE for the IOTC area. The authors indicated that the omission of ICCAT data may result in high inter-annual variation in reported catches, but since space is accounted for in the standardization process it is less likely to influence the standardised CPUE index.

51. The WPEB **NOTED** that the effect of gear configuration (e.g., number of hooks per basket) was not considered in the model as it is believed to be relatively stable throughout the years and the inclusion of vessel as a random effect should sufficiently account for this.

6.3 Other abundance indices

52. The WPEB **CONCLUDED** that all abundance indices except for the CPUE of Indonesia are candidates for the base case model. The WPEB thanked Indonesia for the provision of valuable data and **ACKNOWLEDGED** the improvements to the CPUE standardization. The WPEB expressed **CONCERN** regarding the issue of limited area coverage of two CPUEs from La Reunion and South Africa but **NOTED** that these abundance indices have high data coverage (i.e., approximately 20% and 100% respectively) and there are no issues with the statistical methods, so **SUGGESTED** that they could be explored as candidates for a base case model. The WPEB **SUGGESTED** that CPUEs for the base case model could be determined after the WPEB has scrutinized the outputs of the model fitting to these data.

7. Blue Shark Stock Assessment

7.1 Discussion on blue shark assessment models to be developed and their specifications

53. The WPEB-DP **NOTED** paper IOTC-2021-WPEB17(DP)-12, which provided a review of the data availability, model configuration and catch estimation for the 2017 blue shark stock assessment in the Indian Ocean, with the summary provided by the author:

> *"This paper presents a review of the 2017 stock assessment of blue shark in the Indian Ocean using Stock Synthesis. This paper is largely based on the assessment document (IOTC–2017–WPEB13–33 Rev_1), as well as the catch estimation document (IOTC-2017-WPEB13-23). Herein the "assessment" refers the blue shark assessment model is an age structured (25 years), spatially aggregated (1 region) and two sex model. The catch, effort, and size composition of catch are grouped into 8 fisheries covering the time period from 1950 through 2015. Seven indices of abundance, all from longline fisheries, were available as well as three alternative time series of total catch. The base case model is parameterized using indices of abundance from the Portugal (2000-2015), Reunion (2007-2015) and the Japanese late (1992-2015) series, along with estimates of catch generated via a generalized additive model. The estimated abundance trend is decreasing throughout the time frame of the model, and spawning stock abundance has decreased to approximately 1.503 times SSBMSY, (80% CI is 1.33-1.63). The fishing mortality has increased steadily over the model time frame with F2015/FMSY= 0.904 (80% CI =0.68 to 1.13)"*

54. The WPEB **DISCUSSED** the plan for the 2021 blue shark assessment and agreed to adopt an overall consistent approach to the 2017 assessment given that there are no major changes in key input data and parameters. It was agreed that a continuity run be conducted where data are sequentially updated to evaluate their impact on the assessment, followed by explorations of alternative data and sensitivity runs to the main model assumptions.

55. The WPEB **NOTED** the 2021 blue shark assessment shall adopt the following model structure:

- Years: 1950-2019
- Two Sex
- Age classes 1-25+

- Beverton Holt Spawner Recruit Curve
- Fleet specific catch (8 Fleets)
- Fleet specific CPUE index
- Sex specific selectivity where available

56. The WPEB **NOTED** that the model separates males and females. The WPEB-DP further NOTED that male and female blue sharks have very similar growth and natural mortality parameters, and the sex partition is not expected to have a major impact on the model. However, the two-sex model structure allows the incorporation for sex-specific size composition from observer programs, and any other potential sex-explicit data when they become available. This might be particularly important for blue shark, a species that are known to aggregate by size and sex. If there was a fleet particularly targeting large females, the information should be incorporated in the model

57. The WPEB **AGREED** that the biological parameters for BSH are generally well known compared to other data (e.g. CPUE). The WPEB **NOTED** the following initial parameters values proposed for the base model (Table 2). Morphometric relationships from IOTC-2021-WPEB17(DP)-INF05_Rev1, were recommended (Table 3).

58. The WPEB **NOTED** that several length-length or length-weight relationships may be available from the literature for some species and that the combination of the raw data sets would increase sample size and coverage and eventually improve the accuracy and precision of the conversions. Therefore, the WPEB **REQUESTED** the WPDCS to explore the possibility of collating raw morphometric data from CPCs to improve the quality and management of conversion factors and relationships at the IOTC Secretariat.

59. The WPEB **AGREED** that it is important to keep track of the reasoning behind the choices of all biological parameters with associated sources and that this could also help for the identification of priority research to reduce uncertainties.

60. The WPEB **NOTED** that the study used for the age specific mortality had a miscalculation and a corrected version is now available. Further current natural mortality estimates are based on the growth estimates of blue sharks from the Pacific Ocean, and suggested the estimates be updated using the available growth information from the Indian Ocean (Andrade et al. 2019).

61. The WPEB **NOTED** that there is also a new paper showing a breeding frequency cycle of 1 year year in the North Pacific (Fujinami et al. 2017), which corresponds with what was used in the previous assessment model.

62. The WPEB **NOTED** that steepness is often difficult to estimate, but with sharks it is possible to actually count the numbers of pups. Many studies have estimated similar values, so the confidence in this value is high. The WPEB also **NOTED** that the proposed steepness of 0.79 for blue shark was derived from length-based fecundity, and the estimates were corroborated by several other studies. The WPEB further **NOTED** a study using the Leslie matrix approach estimated the distribution of the steepness for blue shark and suggested sensitivity on alternative values of steepness to be conducted based on the estimated parameter and its distribution.

63. The WPEB **NOTED** that most uncertainty of the blue shark assessment were from the CPUE and catch data, and suggested alternative surplus production biomass dynamic models be considered in parallel (e.g. JABBA). The WPEB also **NOTED** that that an age structured production model can also be run easily and is planned to be carried out within the SS3 framework.

64. The WPEB **AGREED** that additional diagnostics based on likelihood profile, one-off sensitivity, retrospective analysis be conducted to evaluate model performance.

Table 2 Initial parameterization for the Indian Ocean Blue Shark stock assessment. Parameters and sources discussed at the 2021 WPEB Data Prep meeting.

Parameter	Value			Citation
Length at birth	45 cm FL			Pratt 1979
Length at 50% maturity	M: 201.4cm (TL)			Jolly *et al*. 2013
	F: 194.4cm (TL)			Jolly *et al*. 2013
Maximum length	M: 270 (FL)			Compagno 2001
	F: 361 (FL)			
Age at 50% maturity	M: 4~7 years F: 5~7 years			Jolly et al. 2013
Longevity	25 (maximum vertebral			Andrade et al. 2019
Litter size	38 (average)			Mejuto & Garcia-Cortés 2005
Gestation	9-12 months			Cailliet & Bedford 1983, Pratt 1979
Breeding frequency	1 year			Joung, Hsu, Liu and Wu 2011, Fujinami et al. 2017
Parturition	Variable among studies, spring to fall			
Growth (VBGF)	**Sex**	**Linf**	***k***	Andrade et al. 2019
	C	285.2	0.14	
	M	283.8	0.15	
	F	290.6	0.13	
Natural Mortality				
	Age Specific by sex	To be updated, Indian Ocean specific estimates.		
Stock Recruitment Relationship				
Beverton-Holt	Steepness = 0.8			Rosa and Coelho (2017)
Data Inputs				
Catch				
GAM estimates	To be updated, 1950-2019			Martin et al 2017
CPUE and Length Composition				
CPUE series recommended for inclusion	**Time Frame**	**Area**	**Length Data?**	
JPN Late	1992-2019	Mostly SW IO and	Yes	IOTC-2020-WPEB16-20
REU	2007-2020	SW IO near REU	Yes	IOTC-2021-WPEB17(DP)-08_Rev1
TWN	2004-2019	Throughout the I	Yes	IOTC–2021–WPEB17(DP)-07
ESP	2001-2019	Throughout the I	Yes	IOTC-2021-WPEB17(DP)-09
POR	2000-2019	Throughout the I	Yes	IOTC-2021-WPEB17(DP)-10
ZAF	2007-2019	ZAF EEZ	Yes	IOTC-2021-WPEB17(DP)-11
CPUE Series not recommended	**Reason**			
Indonesian	Small sample size, inconsistent spatial domain, low observer coverage, high variability of BSH catch reported			

Table 3. Morphometric relationships from IOTC-2021-WPEB17(DP)-INF05.

Source measure	**Target measure**	**Equation type**	**a**	**b**	**N**	**Source**
Fork length FL	Total length TL	$TL = a \times FL + b$	1.1681	5.3197	6,485	Ariz et al. 2007

Fork length	Round weight RW	$RW = a \times FL^{b}$	2.7968e-6	3.1697	2,279	Ariz et al. 2007
Total length	Round weight RW	$RW = a \times TL^{b}$	1.3307e-6	3.2043	2,311	Ariz et al. 2007
Fork length	Dressed weight PD	$PD = a \times FL^{b}$	4.0189e-7	3.362	2,129	Ariz et al. 2007
Total length	Dressed weight PD	$PD = a \times TL^{b}$	1.6877e-7	3.4163	2,137	Ariz et al. 2007
Fork length	Round weight RW	$RW = a \times FL^{b}$	1.59e-5	2.84554	2,842	Romanov & Romanova 2009

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

65. The WPEB **NOTED** the three methods for estimating blue shark catch histories used in the 2017 assessment: ratio-based, species-disaggregated, and GAM (recommended for the final model). The WPEB **NOTED** that both ratio-based and species disaggregated are based on assumptions that were less reliable, whereas the GAM method (based on nominal catch where BSH were caught) is considered to be relatively robust. The WPEB **AGREED** that the GAM estimates be updated and used for the 2021 assessment. The WPEB further **NOTED** that IOTC nominal catch dataset has not undergone any major revisions in the past few years, as such repeating the previous analysis is unlikely to change the results.

66. The WPEB **NOTED** the Japanese catch series from 1967 to 1993 was updated due to issues regarding the lack of species composition information, but the total catch of pelagic sharks has not changed. For the previous assessment, Japan provided the corrected historic series that included logbook and discards information, but the WPEB decided not to use it. Therefore, for this current assessment, Japan only provided the catch series starting from 1994. This issue has been debated during the previous assessment and does not require further discussion. The WPEB **NOTED** the revision to the historic Japanese data has not been incorporated into the IOTC database yet and **REQUESTED** the Secretariat to update the IOTC database when the information is provided by Japan disaggregated by FAO area.

67. The WPEB **AGREED** that the following CPUE indices be included in the assessment (Fig. 1):

- Deep-freezing longline of Japan (JPN), 1992 – 2019
- Swordfish-targeted longline fishery of Portugal (EUPRT), 2000 – 2019
- Swordfish-targeted longline fishery of Spain (EUESP), 2001 – 2019
- Deep-freezing longline fishery of Taiwan,China (TWN), 2004 – 2019
- Swordfish-targeted longline fishery of Reunion (EUREU), 2007 – 2019
- Swordfish-targeted longline fishery of South Africa (ZAF), 2007 – 2019)
- Longline fishery of Indonesia (IDN), 2005 – 2019 (sensitivity)

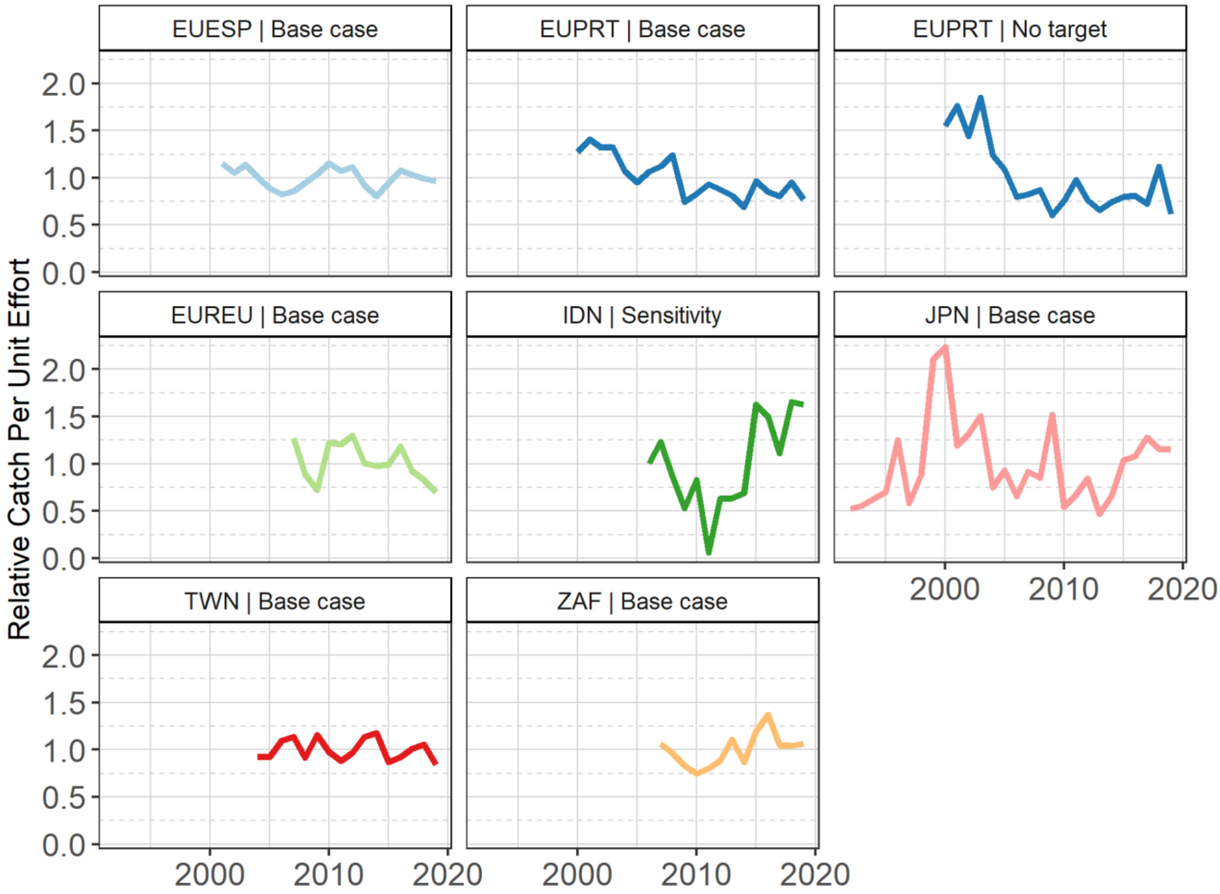

Fig. 1. Annual time series of relative Catch Per Unit Effort of blue shark considered for the 2021 stock assessment

68. The WPEB **AGREED** the Japanese early CPUE indices (pre-1994) should not be included in the assessment, as the change of the estimation method for the Japanese longline species composition (see IOTC-2021-WPEB17(DP)-05) may have invalidated the underlying methodology of the early CPUE indices. The WPEB also **AGREED** that the Indonesian CPUE should be included in a sensitivity analysis only due to the small sample size, inconsistent spatial distribution, low observer coverage and high variability of blue shark catches.

69. The WPEB **AGREED** that adequate considerations should be given to the representativeness of the CPUE indices in terms of their spatial and temporal coverage of the fishery and the stock. The WPEB **NOTED** that there is no spatial weighting in the assessment and all CPUE indices are treated equally (as the model has no spatial structure). It was suggested that CPUE from fleets with more questionable data (e.g. species compositions, catch reporting, etc.) should be weighted less. A hierarchical clustering analysis (similar to the one conducted for the 2017 assessment) is proposed to identify groupings of CPUE series which have consistent trends, with the aim to eliminate potential conflicting trends and obtain an internally consistent model.

70. The WPEB **AGREED** that the alternative Portuguese indices standardized without the proxy targeting variable (species ratio/cluster) to be considered as a sensitivity analysis in the 2021 assessment. The WPEB **NOTED** that the index showed a slightly larger decline.

71. The WPEB **AGREED** that size composition data to be included in the 2021 assessment shall be provided by the CPCs directly and **REQUESTED** the secretariat to also provide data that are available in the IOTC databases. The WPEB **NOTED** for some fleets the size composition data may contain additional information (e.g. sex ratio) which is not available in the IOTC databases. The WPEB **AGREED** that a data template be provided (by the stock assessment consultant) detailing the format and information of the data required (e.g. spatial resolution). If possible, CPCs are encouraged to

assure that all size data provided and used in the stock assessment are also made available to the Secretariat, to ensure that models are reproducible in the future. The WPEB further **NOTED** that that some CPCs may require prior permission for releasing such data (the data can only be used for stock assessment and cannot be used for other purposes without permission of the CPC scientists).

8. Review Information on Biology, Ecology, Fisheries, and Environmental Data Related to Silky Sharks

8.1 Presentation of new information available on silky sharks

72. The WPEB(DP) **NOTED** paper IOTC-2021-WPEB17(DP)-13 which provided an estimation of bycaught silky shark post-release survival in the Indian Ocean tuna purse seine fishery. The following abstract was provided by the authors:

> *"A tagging experiment for Carcharhinus falciformis post-release survival assessment was conducted in a trip on-board the tuna purse seiner Jai Alai from Echebastar company in the Indian Ocean. Twenty-eight sharks were tagged with 24 SPATs and 4 MiniPATs and blood samples were collected in 45 sharks for lactate concentration measurement to be used as an indicator of shark survival. A vitality index based on state and behavior at release was also assigned to all the sharks caught accidentally. The overall predicted survival of silky shark in this trip was estimated to be 43%, both using survival rate by vitality index derived from tagged sharks and survival rate predicted using lactate concentration threshold. Shark survivorship decreased as the fishing operation advanced and vitality index declined. This information is essential to ensure the conservation of this vulnerable species and for a proper management of the fishery."*

73. The WPEB **ACKNOWLEDGED** the update of silky shark post-release mortality following best practices for safe and release and **ENCOURAGED the** authors to continue the planned experiment tagging more sharks so as to increase the sampling numbers and accuracy of the estimation.

74. The WPEB **NOTED** that an overall survivorship of 43% was obtained which is larger from previous studies on silky shark in the Indian Ocean. The author explained that this can be due to the application of improved best practices of handling and release, the use of the bycatch conveyor belt in the lower deck and more experience of the crew when applying the handling and best practices of release.

75. The WPEB **ASKED** whether the effect on survivorship of different size of tagged shark was investigated as previous studies have shown a larger survivorship of the larger sharks. The authors showed the size frequency of tagged fish and the survivorship rate based on size and no major differences were observed. The authors also informed the WPEB that a new tagging experiment is planned for the end of the year that will allow investigating this matter further.

76. The WPEB **NOTED** that the increase in lactate is due to entanglement/stress which is mainly related to the time from catch to release, which is the major factor affecting survivorship.

77. The WPEB **NOTED** that 4 minipats and 24 survivorship-PATs were deployed and **REQUESTED** the authors to further analyse data on minipats that could provide very valuable information on silky shark migration, including vertical migration, and behavior of the tagged sharks.

78. The WPEB **NOTED** that there have been different tagging projects using satellite tags on various shark species, some of them partly funded by IOTC, that can provide a large amount of information of migration, behavior and other questions to inform shark scientific management advice. The WPEB **NOTED** that it would be beneficial to compile and centralize this information scattered in different research institutes into a regional IOTC database. Therefore, the WPEB **REQUESTED** that the WPDCS in conjunction with the IOTC Secretariat develop the concept of an IOTC regional database containing satellite tagging information on shark (and other species) including data use and confidentiality agreements and explore the possibility to compile tagging data from research institutes. For

example, the WPEB WAS **INFORMED** that about 30 data series of tag information of various sharks collected under EU project MADE were already published and that they can be incorporated into an IOTC regional database of large pelagics biologging information.

79. The WPEB was **INFORMED** that a similar project on post-release mortality on oceanic white-tip shark is being currently being carried out and that the results will be presented during the next WPEB meeting.

80. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-14 which presented information on Silky Shark (*Carcharhinus falciformis*) captured in the Tuna Gillnet Fisheries of Pakistan. The following abstract was provided by the author:

> *"Sharks form important part of bycatch of the tuna gillnet operations in Pakistan. Silky shark (Carcharhinus falciformis) was observed to the most dominating species in commercial landings of oceanic sharks at Karachi Fish Harbour Pakistan followed by mako shark. This species is considered as commercially important, as it meat is locally consumed whereas fins are exported despite restrictions because this species is included in Appendix-II of CITES. During the present study it was observed that large sized specimens (161 cm to 191cm TL) were not caught during 2017 and 2018 whereas in 2016, silky shark of these size classes were caught by tuna gillnetters as bycatch indicating overfishing of shark in general and silky shark in particular."*

81. The WPEB **ACKNOWLEDGED** the information on silky shark capture in the gillnet fishery of Pakistan and **ENCOURAGED** the authors to continue with the sampling of sharks in Pakistan harbors.

82. The WPEB **NOTED** that the revised Pakistan catch series (1987-2018) endorsed by the IOTC Scientific committee in 2019 brought yearly shark catches from around 30,000 t before 1985 to lower than 1,000 t in the most recent years which the authors explained by the change in fisheries practices, with shark-targeting fisheries responsible for major past catches not being anymore operative.

83. The WPEB **NOTED** that the discrepancies between Pakistan officially submitted shark catch data and the data presented in the document are due to the inclusion, in the latter, of catches from fisheries that do not target tuna but incidentally capture marketable shark species as bycatch.

84. The WPEB **NOTED** that some catches in the study were reported by gillnetters from areas beyond national jurisdiction (ABNJ) and **ACKNOWLEDGED** that these were gillnetters operating close to the limit of the EEZ, sporadically drifting into areas beyond national jurisdictions, or double registered in two or more countries that are operating in the ABNJ.

85. The WPEB **NOTED** that size frequency data for shark species are collected but not submitted officially to IOTC and **ENCOURAGED** the authors to submit these data to IOTC as soon as possible.

86. The WPEB **NOTED** paper IOTC-2021-WPEB17(DP)-17 which reviewed biological parameters, such as growth and reproductive parameters, of silky shark *Carcharhinus falciformis* caught in the eastern Arabian Sea. The following abstract was provided by the author:

> *"Reproduction, diet and growth of silky shark Carcharhinus falciformis in the eastern Arabian Sea are described based on 473 specimens collected from the gillnet-cum-longline landings at the Cochin fisheries harbour during 2012–2014. The reproductive biology of 215 males and 258 females was examined while 113 stomachs were sampled to study the diet. The von Bertalanffy growth parameters estimated using length-based models were asymptotic length (L1). 309.80 cm, growth coefficient (K). 0.10 year21 and age at zero length (t0). 22.398 year. The sex ratio was significantly skewed to females. Seasonality in reproduction was not evident and in males, sexual maturity was attained at 201–223 cm total length (LT) with the size at maturity (LT50) occurring at 217.0 cm, whereas in females sexual maturity was attained at 224–231 cm LT and LT50 occurs at 226.5 cm".* - See document for full abstract.

87. The WPEB **ACKNOWLEDGED** the work as biological information is key for planned silky shark stock assessment and **ENCOURAGED** authors to continue with the sampling to increase the sampling size, specially for large species, that can improve the estimates.

9. Other Matters

9.1 Collaboration with the IWC

88. The WPEB **NOTED** a document provided by the International Whaling Commission (IOTC-2021-WPEB17(DP)-INF03. The document provided a draft Letter of Intent for collaboration between the IOTC and IWC. The WPEB **NOTED** that participants had not had time to review the contents of the document and therefore discussion would not be productive during the current meeting. As such, the WPEB **SUGGESTED** this letter be presented during the next WPEB meeting in September.

9.2 Climate Change

89. The WPEB **NOTED** document IOTC-2021-WPEB17(DP)-15 on Modeling the impacts of climate change on global tuna fisheries to support development and implementation of climate adaptive EAFM plans, including the following abstract provided by the authors:

> *"The current paper summarizes (1) the work completed in 2018 as part of the FAO-implemented Common Oceans I Program, which focused on modeling the impacts of climate change on the productivity and distribution of tuna fisheries in the Pacific Ocean, and (2) the new work that is being proposed under the second phase of the Common Oceans Program. The primary objectives of the newly proposed work are to improve our current understanding of climate change impacts on global tuna resources by RFMOs and member states, and to increase global, regional and national commitment to development and implementation of climate adaptive EAFM plans for tuna fisheries. With the submission of this paper, we hope to receive feedback from IOTC on how best to proceed with projecting Climate Change impacts on global tuna fisheries using methods similar to those developed in the Pacific. We specifically wish to integrate the proposed activities into the normal scientific committee peer review processes at IOTC with the eventual aim of advising the Commission on potential actions needed to mitigate against adverse impacts."*

90. The WPEB **ACKNOWLEDGED** the advances in ecosystem modeling using the SEAPODYM model in the Western Pacific and **SUPPORTED** this initiative for potential application to IOTC fisheries.

91. The WPEB **NOTED** that WWF Pakistan highlighted the impacts of climate change on local fisheries and the need to forecast these impacts in order for local economies to adapt. The WPEB also **NOTED** that Australian scientists support this approach and that this work should be continued in the Indian Ocean.

10. Review of the draft, and adoption of the report of the 17th session of the IOTC

92. The WPEB **NOTED** that the report would be adopted via correspondence:

APPENDIX I
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APPENDIX II

AGENDA FOR THE 17TH WORKING PARTY ON ECOSYSTEMS AND BYCATCH DATA PREPARATORY MEETING

Date: 12 - 14 April 2021

Location: Microsoft Teams

Venue: Virtual

Time: 12:00 – 16:00 (Seychelles time)

Chair: Dr Sylvain Bonhommeau (European Union); **Vice-Chairs**: Dr Mariana Tolotti (EU, France)/Mr Mohammed Koya (India)

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 24th Session of the Commission (IOTC Secretariat)

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

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

   1.1. Review new information on the biology, stock structure, their fisheries and associated environmental data for Blue sharks:

   - 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 BLUE SHARKS** (Chair)

   6.1. Review of fishery dynamics by fleet (CPCs)

   6.2. Nominal and standardised CPUE indices

   6.3 Other abundance indices

7. **BLUE SHARK STOCK ASSESSMENT** (Chair)

   7.1. Discussion on blue shark assessment models to be developed and their specifications

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

8. **REVIEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO SILKY SHARKS** (Chair)

8.1. Presentation of new information available on silky sharks

8.2. Review of all data available on silky sharks

8.3. Review of indicators for silky sharks

9. OTHER MATTERS (Chair)

9.1. Collaboration with the IWC

9.2. Climate Change

10. REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 17th SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH (DATA PREPARATORY) (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
Document	**Title**
IOTC-2021-WPEB17(DP)-01a	Agenda of the 17th Working Party on Ecosystems and Bycatch Data Preparatory Meeting
IOTC-2021-WPEB17(DP)-01b	Annotated agenda of the 17th Working Party on Ecosystems and Bycatch Data Preparatory Meeting
IOTC-2021-WPEB17(DP)-02	List of documents of the 17th Working Party on Ecosystems and Bycatch Data Preparatory Meeting
IOTC-2021-WPEB17(DP)-03	Outcomes of the 24th Session of the Commission (IOTC Secretariat)
IOTC-2021-WPEB17(DP)-04	Review of the statistical data and fishery trends for ecosystems and bycatch species (IOTC Secretariat)
IOTC-2021-WPEB17(DP)-05	Update of Japanese annual catches of pelagic sharks between 1964 and 1993 by changing the species composition (Kai M)
IOTC-2021-WPEB17(DP)-06	Updated on the CPUE standardization of the blue shark caught by the Indonesian longline fishery in the eastern Indian Ocean (Wujdi A, Setyadji B, Fahmi Z)
IOTC-2021-WPEB17(DP)-07	Updated standardized catch rates for blue shark caught by the Taiwanese large-scale tuna longline fishery in the Indian Ocean (Wu XH and Tsai WP)
IOTC-2021-WPEB17(DP)-08	Updated standardized CPUE of blue shark bycaught by the French Reunion-based pelagic longline fishery (2007-2020) (Sabarros P, Coelho R, Romanov E, Guillon N, Bach P)
IOTC-2021-WPEB17(DP)-09	Updated Standardized Catch Rates in Biomass for the Blue Shark (*Prionace glauca*) Caught by the Spanish Surface Longline Fleet in the Indian Ocean During the 2001-2019 Period (Fernández-Costa J, Ramos-Cartelle A and Mejuto J)
IOTC-2021-WPEB17(DP)-10	Updated Blue shark catches and standardized CPUE for the Portuguese pelagic longline fleet in the Indian Ocean from 1998 to 2019 (Coelho R, Santos C, Rosa D, Lino P)
IOTC-2021-WPEB17(DP)-11	Standardization of Blue Shark *Prionace glauca* Catch Rates of the Japanese-Flagged Component of the South African Large Pelagic Longline Fleet Based on Observer Records (da Silva C, Parker D and Kerwath S)
IOTC-2021-WPEB17(DP)-12	A review of the data availability, model configuration and catch estimation for the 2017 blue shark (*Prionace glauca*) stock assessment in the Indian Ocean (Rice J)
IOTC-2021-WPEB17(DP)-13	New assessment on accidentally captured silky shark post-release survival in the Indian Ocean tuna purse seine fishery (Onandia I, Grande M, Galaz JM, Uranga J, Lezama-Ochoa N, Murua J, Ruiz J, Arregui I, Murua H, Santiago J)
IOTC-2021-WPEB17(DP)-14	Some Observation on the Silky Shark (*Carcharhinus falciformis*) in the Tuna Gillnet Fisheries of Pakistan (Moazzam M)
IOTC-2021-WPEB17(DP)-15	Modeling the impacts of climate change on global tuna fisheries to support development and implementation of climate adaptive EAFM plans (Obregon P, Senina I, Bell J, Nicols S, Phillips JS, Lehodey P, Kittinger J)
IOTC-2021-WPEB17(DP)-16	Size, sex and reproductive biology of seven pelagic sharks in the eastern Arabian Sea (Varghese S, Unnikrishnan N, Gulati D and Ayoob A
IOTC-2021-WPEB17(DP)-17	Biological aspects of silky shark *Carcharhinus falciformis* in the eastern Arabian Sea (Varghese S, Gulati D, Unnikrishnan N and Ayoob A)
Information papers	
IOTC-2021-WPEB17(DP)-INF01	Demographic and harvest analysis for blue shark (*Prionace glauca*) in the Indian Ocean (Geng Z, Wang Y, Kindong R, Zhu J, Dai X
IOTC-2021-WPEB17(DP)-INF02	On the dangers of including demographic analysis in Bayesian surplus production models: A case study for Indian Ocean blue shark (Geng Z, Punt A, Wang Y, Zhu J, Dai X)
IOTC-2021-WPEB17(DP)-INF03	Proposed letter of intent between the Indian Ocean Tuna Commission and the International Whaling Commission (Anon)
IOTC-2021-WPEB17(DP)-INF04	Silky shark synopsis (IOTC Secretariat)
IOTC-2021-WPEB17(DP)-INF05	Blue shark synopsis (IOTC Secretariat)
IOTC-2021-WPEB17(DP)-INF06	Age and growth of the blue shark (*Prionace glauca*) in the Indian Ocean (Andrade I, Rosa D, Muñoz-Lechuga R, Coelho R)
IOTC-2021-WPEB17(DP)-INF07	Update of Age and sex specific Natural mortality of the blue shark (*Prionace glauca*) in the North Pacific Ocean (Semba Y and Yokoi H)

Document	**Title**
IOTC-2021-WPEB17(DP)-INF08	Reproductive biology of the blue shark (*Prionace glauca*) in the western North Pacific Ocean (Fujinami Y, Semba Y, Okamoto H, Ohshimo S and Tanaka S)
IOTC-2021-WPEB17(DP)-INF09	Increasing Abundance of Silky Sharks in the Eastern Indian Ocean: Good News or a Reason to be Cautious? (Simeon BM, Muttaqin E, Mardhiah, Ichsan M, Dharmadi, Prasetyo AP, Fahmi and Yulianto I)