Report of the 21st Session of the IOTC Working Party on Ecosystems and Bycatch – Data Preparatory meeting

Online via Zoom, 28 – 30 April 2025

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Contact details:

Indian Ocean Tuna Commission
ABIS Center
PO Box 1011
Victoria, Mahé, Seychelles
Email: IOTC-secretariat@fao.org
Website: http://www.iotc.org

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
CKMR	Close-Kin-Mark-Recapture
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
EMS	Electronic Monitoring System
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	Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia
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
PCA	Principal Components Analysis
PSA	Productivity Susceptibility Analysis
RPOA	Regional Plan of Action
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
SWO	Swordfish
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**).

TABLE OF CONTENTS

Executive summary

The 21st Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB Data Preparatory meeting was held online via Zoom from 28-30 April 2026. A total of 42 participants (55 in 2024, 100 in 2023, 103 in 2022, 93 in 2021, and 108 in 2020) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Vice-Chairperson, Dr Chalene da Silva from South Africa, who welcomed participants and formally opened the meeting.

The WPEB **DISCUSSED** the stock assessment that will be carried out for blue shark this year. Six CPUE series were provided and reviewed by the group.

The WPEB **NOTED** that for past assessments, CPCs have provided sex specific length frequency data from observers and logbooks and so the WPEB **ENCOURAGED** CPCs to submit this information again for the 2025 assessment. The WPEB **NOTED** that a template for submitting this data will be provided (based on a template used for previous submissions) and that CPCs should aim to submit this information prior to *mid-June* to allow for these data to be incorporated into the assessment model.

The WPEB **NOTED** that the GAM model estimates of catches were adopted as the base model in the last two blue shark assessments. This method is specifically designed to address the issue of non-reporting of blue sharks and is therefore considered to be better than reported nominal catches. It is also more robust than simple ratio-based estimates, which was used a sensitivity in previous assessments. The WPEB **AGREED** to continue using this approach as the basis for providing blue shark catch estimates. However, the WPEB **EMPHASIZED** that the final output, including diagnostics, should be thoroughly examined before the estimates can be formally endorsed.

The WPEB **NOTED** that **Table 1** summarises the biological parameters proposed for the base model in the current assessment. These parameters are based on those used in the 2021 assessment, with some updates from newly available information.

The WPEB **AGREED** that the assessment should consider CPUE data from Japan, Spain, Réunion, Portugal, and South Africa. Taiwan,China intends to submit a standardized CPUE index shortly after this meeting, as there has been a delay in the availability of their observer data. This data will be included for discussion and consideration during the WPEB(AS) meeting.

The WPEB **NOTED** that alternative models, including JABBA and JABBA-select, were also proposed to support the SS3 assessment. The WPEB **SUGGESTED** that modellers coordinate with the SS3 modellers to ensure consistency in input data (e.g., CPUE, catch, and parameters) to allow meaningful comparisons between alternative models and the SS3 model.

No recommendations were provided by the WPEB21(DP).

1 Opening of the meeting

1. The 21st Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Ecosystems and Bycatch - WPEB Data Preparatory meeting was held online via Zoom from 28-30 April 2025. A total of 42 participants (55 in 2024, 100 in 2023, 103 in 2022, 93 in 2021 and 108 in 2020) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Vice-Chairperson, Dr Charlene da Silva from South Africa, 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 WPEB **NOTED** a request from the Commission contained in Resolution 24/06:

   (para. 7) *The IOTC Scientific Committee, the IOTC Working Party on Tropical Tunas, and the IOTC Working Party on Ecosystems and Bycatch shall as a matter of priority act on its recommendation in the Report of the 18th Session of the IOTC Scientific Committee and undertake work to examine the benefits of retaining non-targeted species catches, other than those prohibited via IOTC Resolution, and present its recommendations to the 29th Annual Session of the Commission. The work should take into account all species that are usually discarded on all major gears, and should look at fisheries that take place both on the high seas and in coastal countries and the feasibility of both retraining on-board and processing of the associated landings.*

4. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-12 on the data held by the Secretariat on retained, non-targeted and associated species in IOTC fisheries to aid with the request.

5. The WPEB **NOTED** that this paper does not include information on discards as those data are particularly lacking in the IOTC databases.

6. The WPEB **ENCOURAGED** the group to consider this request and report back to the WPEB assessment meeting. The WPEB **NOTED** that it may be necessary to request further clarification from the Commission on this topic as it is quite vague and exactly what is required is unclear.

3 Review of data available at the Secretariat for bycatch species

3.1 Review of the statistical data available for bycatch species

7. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-03 which provided an overview of the data managed by the IOTC Secretariat for blue sharks (BSH) for the period 1950–2023.

8. The WPEB **NOTED** that blue shark catches continue to be associated with considerable uncertainties due to changes in the data series due to the Indonesian catch re-estimation process. In recent years (period 2018-2022), the average annual catch of blue sharks in the Indian Ocean was around 24 000 tonnes, of which around 64% was taken by Indonesia. The WPEB also **NOTED,** that the application of the re-estimation methodology to Indonesian catches, resulted in around 25% reduction in blue shark catches during the same period.

9. The WPEB **NOTED** that, despite the modifications to the data series, from 2011 until 2022 there was a decreasing trend in the reported nominal blue shark catches, however, this trend was reversed in 2023 with an increase in catches mainly due to longline fisheries.

10. **NOTING** the very high catch data from Indonesia in 2023, the WPEB **NOTED** that the Secretariat has planned a mission to Indonesia to deal with the re-estimation of all their data for all species.

However, the WPEB **NOTED** that the species composition for Indonesian shark catches has mostly been derived from the average species composition found from literature and it is likely that for 2023, the average composition across the preceding 5 years will be used. The WPEB **NOTED** the possibility that this datapoint will be corrected in time for the assessment.

11. The WPEB **NOTED** that the Secretariat has started to collaborate with researchers at NOAA who are working on statistical models estimating the species composition of IOTC fisheries with a focus on sharks. The WPEB **NOTED** that this work will be of interest to the group to follow **NOTING** that species composition is a major topic of interest to the Secretariat due to the large uncertainties in the data and the amount of data that has been aggregated.
12. The WPEB **NOTED** that information on discards is inferred from observer data collected through the ROS, but limited as the main fleets catching blue sharks do not provide ROS data according to the standard. The WPEB also **NOTED** that the Secretariat is working with these fleets to reconstruct the ROS data in an appropriate format and incorporate them into the database. **NOTING** the limitations of the available information, approximately 80% of recorded interactions with blue sharks result in discards, of which 80% of individuals are discarded alive.
13. The WPEB **NOTED** that for past assessments, CPCs have provided sex specific length frequency data from observers and logbooks and so the WPEB **ENCOURAGED** CPCs to submit this information again for the 2025 assessment. The WPEB **NOTED** that a template for submitting this data will be provided (based on a template used for previous submissions) and that CPCs should aim to submit this information prior to *mid-June* to allow for these data to be incorporated into the assessment model.
14. The WPEB **NOTED** that the Secretariat needs to take steps to better keep track of the data provided for assessments in order to better monitor this for future assessments.
15. The WPEB **NOTED** that the Secretariat has been working to collate length-weight data in order to form a morphometric database which will help the group to determine suitable morphometric relationships for the shark species regularly encountered in IOTC fisheries. The WPEB **NOTED** that these relationships will need to be presented to the WPDCS and endorsed by the SC.

4 Review information on biology, ecology, fisheries and environmental data relating to blue shark

4.1 Review new information available on the biology, stock structure, their fisheries and associated environmental data for blue shark

16. The WPEB **NOTED** that no new papers or information were presented to the group on this topic and **ENCOURAGED** CPCs to provide information on this for the assessment meeting.

5 Review of new information on the status of blue shark

5.1 Nominal and standardised CPUE indices

17. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-04 on Standardised CPUE indices of abundance for pelagic sharks, mako shark (*Isurus oxyrinchus*) and blue shark (*Prionace glauca*), off South Africa, including the following abstract provided by the author:

> *"This report provides preliminary results for standardized Catch per Unit Effort indices based on catches of the large pelagic longline fishery to track abundance of two pelagic shark stocks off South Africa: blue shark (Prionace glauca) and mako sharks (Isurus oxyrinchus). Given the spatio-temporal nature of the data, the standardized index of abundance was generated based on a*

model that takes advantage of this information to learn about the long-term trend in the abundance of modelled stock, accounting both for catchability and abundance covariates. Data from both indicator vessels (former shark longline vessels that continue to catch a significant proportion of sharks) and from the entire large pelagic longline fleet were considered. This fleet targets multiple tuna species, thus, to account for changes in targeting, a multivariate index of species composition of the catch was included in the model. A spatio-temporal Generalized Linear Mixed Effect Model (GLMM) was applied, accounting both for catchability and abundance covariates. Multiple models were fitted of which the best model was selected based on information theoretic approach using the AIC. The standardized indices of abundance for both mako and blue sharks were then calculated from the best model."

18. The WPEB **NOTED** the data for the analyses extend across the IOTC and ICCAT areas of competence.
19. The WPEB **ACKNOWLEDGED** the management interventions of South Africa that may have impacted the catch and CPUE for blue shark. South Africa has implemented several conservation-based management strategies to reduce and in some cases, stop targeting pelagic sharks. However, there is a small fleet that continues to target sharks, and these are used as 'indicator' vessels within the standardisation process and catch allocation process.
20. The WPEB **NOTED** the management of shark fisheries in South Africa - both effort controlled (limited licences, no new entrants), and upper catch limits (2000 t). In particular, the WPEB **NOTED** the consolidation of the shark longline fishery into the large pelagic (tuna) longline fishery in 2011, with shark catches being limited to 10 % total landings. Between 2011 and 2015, various rulings regarding shark fins were introduced in a stepwise manner (shark fins must now be naturally attached to the body, and in 2015 shark targeting is prohibited). The WPEB also **NOTED** that if vessels catch more than 60 % of landings as shark, they are required to have 100 % observer coverage. In 2017 additional limitations were placed on thresher and hammerhead sharks, prohibiting catch and landings.
21. The WPEB **NOTED** the CPUE methods - the model is implemented in sdmTMB (an R-package using Template Model Builder that can fit spatial and spatiotemporal GLMMs to data - https://pbs-assess.github.io/sdmTMB/). Both delta-gamma and tweedie distributions were tested in scenarios.
22. The WPEB **ACKNOWLEDGED** the difficulties in identifying vessels targeting sharks as opposed to those catching them as bycatch, as the tuna data overwhelmed the Principal Components Analysis (PCA) that was used to cluster data into 'shark' and 'non-shark' vessels. The indicator vessels, however, do show different species composition to other vessels, and are truly targeting blue shark and mako sharks. The WPEB **CONSIDERED** the PCA approach to be more appropriate than the previously approach which was based on targeting factors.
23. The WPEB **NOTED** some seasonal differences in catches - between May and August, catches are higher between both the indicator and non-indicator vessels. The WPEB also **NOTED** the BSH catches declined after 2015 presumably due to management changes, and that these reductions in catches might not represent population declines.
24. The WPEB **ACKNOWLEDGED** the challenges associated with developing a CPUE for a fishery where the target species is unlikely to be directly targeted any more due to management changes. The WPEB **ACKNOWLEDGED** that the CPUE of BSH in South Africa may not be representative of the actual abundance of the species due to these challenges, however it was also **NOTED** that if fishing behaviour has not changed over time, then the CPUE would still be reflective of the BSH abundance.
25. The WPEB **DISCUSSED** whether there were any size data related to the BSH (weight and length) that cover the temporal and spatial extent of the CPUE as these data could provide evidence of any changes in weight-at-length that reflect changes in stock size. It was **NOTED** that both the indicator vessels and other vessels show a sharp decline in catch of BSH from 2015 onwards, and if there were

associated size data, it could be used to understand whether these were due to changes in management or population dynamics, while **ACKNOWLEDGING** the fishery has traditionally targeted juveniles due to the presence of a nursery for BSH presented at previous WPEB meetings.

26. The WPEB **DISCUSSED** other data that could be used to identify BSH trends in catches - for example discard data, however it was **ACKNOWLEDGED** that live release is encouraged, and discards are not permitted within the fishery, with the exception of prohibited species.

27. With respect to recent declines in the CPUE, the WPEB **NOTED** that while there have been significant changes in the fishery since 2016 (a period since which CPUE has declined), in particular the amalgamation of the tuna and shark fisheries, the methodology analyses the CPUE on a set by set basis and as such will capture changes in fishing methods to target either species where the methods (and target species) differ. As such the WPEB **NOTED** the view of the authors that the CPUE series would accurately reflect the abundance trend over the recent period. However, the WPEB **REQUESTED** that the authors check any observer data to determine if there might be temporal trends in discarding of sharks that might impact upon the retain catch CPUE over time.

28. The WPEB **DISCUSSED** the use of ICCAT data in the development of the CPUE models. It was widely **ACKNOWLEDGED** that the CPUE developed is representative of the biological stock of BSH, especially as the line delineating ICCAT and IOTC areas of competence goes directly over a BSH nursery, and individuals move across the entire modelled area, so individuals are fully mixed and it does not make sense biologically to split the index by area. The WPEB **DISCUSSED** whether the CPUE should include data for each area, and it was **SUGGESTED** that the CPUE model could be used to predict into the IOTC area of competence, to develop an IOTC-only CPUE. The WPEB **SUGGESTED** that this IOTC-only CPUE could be compared to an ICCAT-only CPUE (predicted from full model), and a joint CPUE to see if there are any major differences.

29. The WPEB **NOTED** that the inclusion of ICCAT CPUE index was feasible, however the inclusion of catch data in any stock assessment should be discussed further in the stock assessment section.

30. The WPEB **NOTED** that it would be useful to run both approaches, with the index derived from IOTC area perhaps only being used as a sensitivity run and to determine if it is consistent with the full fishery index.

31. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-05 on an Updated standardized CPUE of blue shark bycaught by the French Réunion-based pelagic longline fishery (2007-2024), including the following abstract provided by the author:

    "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 2024, we present a standardized CPUE series for blue shark bycaught in this fishery estimated with a lognormal generalized linear mixed model (GLMM) to be used for the upcoming stock assessment. We propose to use the standardized CPUE for the period comprised between 2011 and 2024 where the monitoring effort has been consequent in comparison with previous years. Throughout 2011-2024, the standardized CPUE for the blue shark shows a slight decreasing trend, more precisely a substantial decrease between 2011 and 2019 followed by a stabilization since 2019."

32. The WPEB **NOTED** that blue sharks represent the principal bycatch species in the Réunion-based drifting longline fishery, with the majority of individuals caught being discarded. Nevertheless, instances of retention by certain vessels operating in the Mozambique Channel have been reported in recent years.

33. The WPEB **NOTED** that the observer data considered in the study include information collected through the self-reporting programme implemented in the fishery since 2007 (see IOTC-2013-WPEB09-37 Rev_1 for further details). The WPEB **ACKNOWLEDGED** that these self-reported data have been validated against scientific observations conducted at sea and are regarded as being of good quality, thereby complementing logbook data and providing additional information on discards and fishing operations. The WPEB further **NOTED** that size data are not collected through the self-reporting programme, and that an Electronic Monitoring programme may be implemented in the future for this fishery, following trials conducted during 2018–2019 (see RECOLAPE report for more details).

34. The WPEB **NOTED** that the total observer coverage in the fishery was approximately 15% during the period 2011–2023. The WPEB **ACKNOWLEDGED** that the study was restricted to the core fishing grounds (based on an effort threshold) and to the period 2011–2023, due to the low observer coverage recorded during 2007–2010. The WPEB further **NOTED** that the authors do not recommend using the earlier part of the time series due to this very low level of observer coverage.

35. The WPEB **ACKNOWLEDGED** the use of Generalized Linear Mixed Models to model the CPUEs of blue sharks, incorporating a suite of fixed covariates and individual vessels as random effects. A backward stepwise selection, based on the Akaike Information Criterion (AIC), was employed to identify the best model.

36. The WPEB **NOTED** that previous analyses indicated that moon phases did not significantly explain CPUE variability, although they have been identified as a significant factor in some longline fisheries targeting swordfish in the Western-Central Pacific Ocean.

37. The WPEB **NOTED** that the number of hooks per basket was included as a covariate in the model to account for changes in gear configuration made to adapt fishing depth to lunar cycles. The WPEB further **NOTED** that soaking and hauling times may vary across operations and were therefore incorporated into the standardisation procedure.

38. The WPEB **ACKNOWLEDGED** that while some previous studies have shown sex-specific spatial disaggregation in blue sharks (Coelho et al. 2018), the ratio of mature male and female shark in the Réunion catch (which occurs in a relatively confined spatial sub-area of the IOTC) was close to 50/50. The WPEB further **NOTED** that while there is a tendency for more juveniles to occur in more temperate waters and larger sharks in more tropical areas, this pattern cannot really be seen in the relatively confined operational area of the longline fleet from Réunion Island.

39. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-06 on Updated standardized catch rates in biomass for the Indian stock of blue shark (*Prionace glauca*) from the Spanish surface longline fleet for the period 2001-2023, including the following abstract provided by the author:

> *"Standardized catch rates per unit of effort (CPUE) were updated for the Indian stock of blue shark (Prionace glauca) using Generalized Linear Models (GLM). A total of 3,189 trips of the Spanish surface longline fleet targeting swordfish, between the 2001–2023 period, were analyzed. The main factors considered were year, quarter, area, gear, and targeting criteria. The base case model explained 77% of CPUE variability in gutted weight. Most of the variability was explained by the proxy of the targeting criteria. The standardized CPUE showed a stable trend over time, with an increase over the last three years."*

40. The WPEB **DISCUSSED** the use of the targeting ratios, **NOTING** that these were computed to account for the skipper selection criteria and to identify the trips that are mostly targeting swordfish, versus

those that have a mixed targeting of swordfish (SWO) and blue shark. The WPEB **NOTED** that this was calculated for each trip and used in the model as a 10 level categorical variable. The WPEB **NOTED** that simulations were made in the past to assess the use of the ratio as covariates showed there was no correlation and that it was a good proxy for targeting. The WPEB further **NOTED** that the ratio explains most of the variance in the model.

41. The WPEB **NOTED** that the ratios could be influenced if there were changes in the blue shark discarding practices change over time, however, the authors **NOTED** that blue shark has mostly been a retained species during the entire period of the time series, which for this work starts in 2021. The WPEB **NOTED** that the situation and approach used is similar to that of the Portuguese CPUE series.

42. The WPEB also **NOTED** the sensitivities that were carried out, which was helped to further explain the influence of the targeting effects. The WPEB **NOTED** that overall, the main trends were maintained with the base case model.

43. Overall, the WPEB **AGREED** to use the base case model as suggested by the authors.

44. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-07 on Updated catch, effort and standardized CPUEs of blue shark (*Prionace glauca*) captured by the Portuguese pelagic longline fishery in the Indian Ocean, including the following abstract provided by the author:

"The Portuguese pelagic longline fishery in the Indian Ocean started in the late 1990s, 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 show an overall decrease in the initial years between 2000 and 2014, followed by a more stable period with oscillations until 2020, and a slight increase in the more recent years until 2023. A comparison is made with a standardization without the targeting effects. These results present an updated annual index of abundance for the blue shark captured by the Portuguese pelagic longline fleet in the Indian Ocean with data until 2023, that can now be considered for use in the 2025 IOTC blue shark stock assessment."

45. The WPEB **NOTED** the CPUE analyses used GLMMs to standardise the catch rates. The response variable was defined as biomass of blue shark caught per 1000 hooks, and the analysis accounted for zero catches (only 2.7 % of the catch data) by adding a constant to the CPUE to minimise bias. This allowed for a log-normal approach to be used. Targeting of blue shark was identified by both a cluster analysis and by using a ratio approach using catch data for both swordfish and blue shark. Fishing activities targeting blue shark are identified by the ratio of SWO / (SWO+BSH) catch.

46. The WPEB **NOTED** that the least square means method was used for standardisation, and **NOTED** the reasonable plots for residuals. The residual plots were improved when the 'ratio' was removed as an explanatory variable (thereby removing information on targeting), however the AIC value for the model including 'ratios' was far lower, suggesting that this model is a better representation of the data.

47. The WPEB **NOTED** that for the future it would be useful to add influence plots and sequential GLMM building processes to visualize the relative contribution of each covariate for the overall trends. The WPEB also **REQUESTED** that future explorations attempt a CPUE standardization within each target (or cluster) category and examine changes in prices and changes in BSH fins/carcass composition over time, and consider that in the standardization models.

48. The WPEB **NOTED** the general decrease in CPUE from 2000 to 2005, with a small increase in CPUE in the most recent years, however further investigations are necessary to identify whether this is a significant difference in the CPUE trend, or just a visual artefact. Additionally, the WPEB also **NOTED** that it would be interesting to compare the indices from each of the 'clusters' as it would be informative to know whether the same trend is seen within each cluster.

49. The WPEB **NOTED** some seasonal differences in CPUE, with slight increases in catch in the austral summer months.

50. The WPEB **DISCUSSED** the high CVs seen in some years (50-77% around the mean), and **NOTED** that these will be checked to confirm their accuracy. Additionally, the difference between the nominal and standardised CPUE in recent years was **DISCUSSED**, and it was **SUGGESTED** that a stepwise addition of variables into the CPUE could be used, alongside influence plots, to identify the key variables causing the divergence of the standardised CPUE from the nominal.

51. The WPEB **DISCUSSED** the potential influence of price / economic value of BSH over time, and it was **NOTED** that if the fleet is following EU rules regarding fin attachment to the body of the shark, the economic value of the fins should not have an impact on the catch or retention of BSH over time.

52. The WPEB **NOTED** the major issue in using BSH catches in both the response and explanatory variables within the CPUE standardisation process. Notwithstanding this issue, the WPEB **AGREED** to use the CPUE that uses ratios (and therefore information on 'targeting'), as this best represents the standardised CPUE. This CPUE will be used in the stock assessments for BSH in 2025.

53. Overall, the WPEB **AGREED** to use the base case model.

54. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-08 on Spatio-temporal model for CPUE standardization: Application to blue shark caught by Japanese tuna longline fishery in the Indian Ocean from 1994 to 2023, including the following abstract provided by the author:

    "Abundance indices of blue shark caught by Japanese tuna-longline fishery in the Indian Ocean were estimated using logbook data from 1994 to 2023. Since the blue sharks in this area are non-target species and frequently discarded, the data was filtered based on the reporting rate of observer data. The nominal CPUEs were standardized using the spatio-temporal generalized linear mixed model (GLMM, sdmTMB) to update the annual changes in the abundances. We focused on spatial and interannual variations of the density in the model to account for spatiotemporal changes in the fishing location due to the target changes of tuna and tuna-like species. The predicted annual CPUEs revealed a gradual increase overall. However, the recent decrease in fishing effort and reduced area and data coverage have widened the confidence intervals significantly since 2019. In 2023, the CPUE values were very high, with a notably wide confidence interval. The predicted CPUE using the spatio-temporal model with a large amount of data collected in the wide area in the Indian Ocean is very useful information about the spatiotemporal changes in the abundance."

55. The WPEB **THANKED** the authors for their paper.

56. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-09 on Historical standardized CPUEs of the blue shark from 1966 through 1989, including the following abstract provided by the author:

    "We used an historical longline survey from 1966 to 1989 in the Indian Ocean basin to calculate standardized CPUEs for the blue shark (Prionace glauca). CPUEs were generated using a zeroinflated negative binomial (ZINB) generalized additive model (GAM). These CPUEs represent

an important basin-wide baseline for blue sharks abundance at the start of industrialization of Indian Ocean fisheries."

57. The WPEB **ACKNOWLEDGED** the methods used, including using GAMs to model the CPUE, where variables were chosen using data dredging and simulation methods.
58. The WPEB **DISCUSSED** the change in mean body length seen in the data (202 cm to 162.5 cm) and **ACKNOWLEDGED** that these are likely due to the interannual variations in spatial extent of the fishery considering the strong BSH relationship of size with latitude, with the presence of larger specimens in the tropics and smaller in temperate waters. The WPEB **NOTED** that if the data are to be included in the stock assessment, the data would need to be normalised to account for sampling biases. The WPEB also **SUGGESTED** investigating decadal changes in the operational area.
59. The WPEB **DISCUSSED** the drop in CPUE over time, and whether this could be attributed to a change in biomass, and **NOTED** that the initial high biomass was likely due to the smaller fleet and constricted sampling area at the start of the fishery rather than reflecting a drop in abundance.
60. The WPEB **DISCUSSED** the data presented in the Arabian Sea, **NOTING** this is likely the limit of the species distribution, with very few individuals being observed in this area. The WPEB **NOTED** that the data presented may not represent catch, but hooks deployed.

5.2 Other abundance indices

61. The WPEB **NOTED** that no other abundance indices were presented to the group.

6 Stock assessment and indicators for blue shark

6.1 Review of indicators

62. The WPEB **NOTED** that no new indicators were presented to the group.

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

63. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-10 on A review of the 2021 blue shark assessment in the Indian Ocean, including the following abstract provided by the author:

> *"This paper presents a review of the 2021 stock assessment of blue shark in the Indian Ocean using Stock Synthesis (version 3.30.16.02 http://nft.nefsc.noaa.gov/Download.html). 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 2019. Six indices of abundance, all from longline fisheries were considered for this analysis. This assessment considered two alternative time series of total catch. The diagnostic case model is parameterized using indices of abundance from the Portugal (2000-2019), Reunion (2007-2019) and the Japanese late (1992-2019) 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 1.21 times SSBMSY, (80% CI is 1.08-1.36). The fishing mortality has increased over the model time frame with F2019/FMSY= 0.81 (80% CI =0.66 to 0.96)."* ... [see paper for full abstract]

64. The WPEB **NOTED** that the GAM model estimates of catches were adopted as the base model in the last two blue shark assessments. This method is specifically designed to address the issue of non-

reporting of blue sharks and is therefore considered to be better than reported nominal catches. It is also more robust than simple ratio-based estimates, which was used a sensitivity in previous assessments.

65. The WPEB **AGREED** to continue using this approach as the basis for providing blue shark catch estimates. However, the WPEB **EMPHASIZED** that the final output, including diagnostics, should be thoroughly examined before the estimates can be formally endorsed.

66. The WPEB **NOTED** that the latest nominal catch dataset provided by the IOTC Secretariat, which serves as the input for the GAM model, incorporates revisions and re-estimations of Indonesian catches for 2010–2022. The WPEB **ACKNOWLEDGED** that these revisions have been endorsed by the WPDCS and SC. As such, the WPEB **AGREED** that these revised estimates should form the basis for the GAM model input.

67. The WPEB **NOTED** that the revised estimates for Indonesian blue shark catches are significantly lower than previously reported numbers. This results in a nominal catch series that is significantly lower than the previous (unrevised) normal catch series. The WPEB **CONSIDERED** these lower estimates to be more reasonable, given Indonesia's restrictions on shark retention during this period and the high survival rate of blue sharks when discarded. However, the WPEB **NOTED** two remaining issues: (1) the catch data for 2023 has yet to be revised (refer to Section 3), and (2) Estimations for catches prior to 2010 have not been performed.

68. The WPEB **NOTED** that upcoming workshops in May (an internal workshop by Indonesia and a mission led by the Secretariat) would be an opportunity to examine pre-2010 catches and 2023 data. However, it was noted that very limited information or data sources are available for the period before 2010. The WPEB **SUGGESTED** that the Secretariat collaborate with Indonesia to explore potential approaches for addressing the pre-2010 data gaps.

69. The WPEB **REQUESTED** that Indonesia present their catch revisions to the WPEB, **NOTING** that this work was presented to the WPDCS in 2024 with a focus on tropical tuna. The WPEB **REQUESTED** that Indonesia also provide details on the revisions for bycatch species (e.g., sharks).

70. The WPEB **NOTED** that, in the interim, the modeller will provide a solution for Indonesian catches prior to 2010 using a back-calculation approach. This will tentatively involve applying the ratio of revised blue shark catches to target catches. The WPEB also **NOTED** the suggestion to roll over the 2022 revised catch estimate for 2023 as a reasonable interim solution.

71. The WPEB **NOTED** that subsequently, the modeller provided an analysis on the revised blue shark catches vs different target species by Indonesia. The analysis suggested it would be reasonable to use the average ratio (0.55) of the blue shark to Swordfish catches between 2020 and 2020 to for the back-calculation.

72. The WPEB **SUGGESTED** conducting a sensitivity run using the previous (unrevised) nominal dataset (combined with the unrevised catch for 2023 from Indonesia) for the GAM input. This would serve as a continuous run to assess the impact of the new catch estimates on the assessment outcomes.

73. The WPEB **NOTED** that the GAM model is used to predict unreported catches based on the modelled relationship between reported blue shark catches and target catches. Other explanatory variables include year, gear, and area.

74. The WPEB **NOTED** that target catches are a combination of tropical tuna, temperate tuna, and swordfish, which were identified as the best predictors of blue shark catches in a previous catch reconstruction project in 2016.

75. The WPEB **SUGGESTED** including southern bluefin tuna in the analysis, as it was indicated that many blue shark catches occur in Japanese southern bluefin tuna fisheries. The modeller agreed to explore this option in the reanalysis.

76. The WPEB **NOTED** that currently the GAM model included an interaction between gear and area in the GAM model without main effects. It was observed that including both main effects and interactions produced spiky estimates without improving diagnostic statistics (e.g., AIC). The modeller agreed to further explore the possibility of including main effects. It was later found this has no major impact on the final estimates.

77. The WPEB **NOTED** that the diagnostics of the GAM model looks reasonable as there is no obvious departure from model assumption in terms of the residual analysis. The total blue shark catches (reported and estimated catches) peaked around 30,000 t in the early 2000s.

78. The WPEB **NOTED** the new blue shark catches differ from the previous catch series used in the assessment (due to the revision of the Indonesian reported catch). The WPEB **AGREED** that this represents a major source of uncertainty and should be reflected in the assessment report.

79. The WPEB **NOTED** paper IOTC-2025-WPEB21(DP)-11 on Preliminary catch estimates of blue shark in the Indian Ocean in support of an assessment in 2025, including the following abstract provided by the author:

"Catch histories form an important component of stock assessments and so having a reliable and believable catch series is a key part in gauging the level of stock depletion. In data-limited situations, reported nominal catches are often not considered reliable and so reconstruction of catch histories plays an important role. The first Indian Ocean stock assessment of blue shark took place in 2015, however, due to the amount of uncertainty in the assessments, the conclusion regarding stock status remained as uncertain. The historic catch series was considered to be one of the key sources of uncertainty and the Working Party requested that participants develop approaches to reconstructing historic catches to be used as alternate series for assessment. Nominal catch of blue shark was revised in 2025 by some CPCs and this has altered the historical reported catch.

This paper uses the available nominal catch data held by the IOTC and two methods to reconstruct historic blue shark catches in the Indian Ocean, the first a generalized additive model (GAM) and the second a ratio-based estimator approach. Both estimates based on based on the reported data as of 2024 with data for 2023 supplied by the 2025 nominal catch,

The procedure used to estimate catch for both the ratio and GAM based models assumes that target catches can be used to predict the unreported catches in the case where there are zero reported catches. The accuracy of all of these methods is entirely dependent on the quality of the original data on which they are based. The underlying dataset that was used was a combination of the 2024 nominal catch and the final year from the 2025 nominal catch data. The working party is encouraged to discuss this combination of the data as well as any preferred alternatives."

80. Based on the review of the 2021 stock synthesis model, the WPEB **DISCUSSED** the plan for the 2025 assessment.

81. The WPEB **NOTED** that **Table 1** summarises the biological parameters proposed for the base model in the current assessment. These parameters are based on those used in the 2021 assessment, with some updates from newly available information.

82. The WPEB **NOTED** that information on breeding frequency and gestation is not directly used to parameterize the SS3 model but is instead used to verify the appropriateness of the annual time step.

Litter size and fecundity are used to determine recruits in the sex-specific model, and steepness values are derived from these reproductive parameters. The WPEB further **NOTED** that in a sex-specific model, it is important to use sex-specific parameters wherever appropriate (e.g., sex-specific growth).

83. The WPEB **NOTED** that age-based natural mortality was derived using biological parameters (e.g., length-age relationship and maximum age) as outlined in 2021 (IOTC-2021-WPEB17-16). This approach is similar to some studies in the Indian and Atlantic Oceans, which use life-history invariants to anchor adult mortality, with age-based mortality following a Lorenzen function.

84. The WPEB **NOTED** a recent paper by Zhu et al. (2023) on the reproductive biology of blue sharks in the Western Indian Ocean, which may provide updated estimates included in Table 1.

85. The WPEB **AGREED** that the assessment should consider CPUE data from Japan, Spain, Réunion, Portugal, and South Africa. Taiwan,China intends to submit a standardized CPUE index shortly after this meeting, as there has been a delay in the availability of their observer data. This data will be included in the assessment.

86. The WPEB **NOTED** that, at this stage, it is not necessary to be overly prescriptive about how these CPUE indices should be included in the assessment (e.g., base case vs. sensitivity). The WPEB **AGREED** that the modeller should conduct correlation analyses to examine potential conflicts between indices, which should be considered when deciding how to model these indices.

87. The WPEB **NOTED** that the blue shark assessment corresponds to a situation involving a large population area with several local/regional indices. A potential issue is that catchability may change on a local scale, which is difficult to capture in standardization using data from small areas. In such cases, local abundance indicators may not effectively monitor the wider population. Ideally, the stock assessment should be spatially configured to mitigate this effect.

88. The WPEB **NOTED** that a more practical approach would involve scoring or ranking the available indices based on their spatial and temporal coverage, sampling consistency, and the quality of the standardization process (e.g., inclusion of relevant factors). This scoring could inform how the CPUE indices are modelled in the assessment (e.g., base case or sensitivity, relative weighting). The WPEB **NOTED** that this approach is commonly used in ICCAT assessments.

89. The WPEB had an extensive discussion regarding the treatment of the South African index, which currently combines data from the Indian and Atlantic Oceans. Two divergent points of view were **NOTED**:

- One perspective was that, for the index to be used in the assessment, it should be based solely on data from the IOTC area. This approach aligns with common practices in tuna RFMOs. For example, the standardization of Japanese CPUE does not include data from the ICCAT area. It was suggested that combining data would only be appropriate in a joint tRFMO study for a straddling stock (e.g., the risk assessment of porbeagle sharks in the Southern Hemisphere).
- The opposing perspective was that South Africa presents a unique situation where blue shark fisheries span the boundary of two tRFMOs, and the blue shark population in the shelf ridge area is fully mixed. From a biological standpoint, it was considered more appropriate to include data from the entire population so that the index represents the whole population. The boundary should only be used to split the data if there is biological justification. The CPUE modeller suggested that further analysis of abundance predictions in the IOTC area using the "global" model indicated that trends in the IOTC area are similar to global trends.

90. The WPEB **AGREED** that South Africa should provide further analysis using only IOTC-area data for the next meeting in September. A decision can then be made based on a comparison of trends in the

IOTC area and global trends. The WPEB also **SUGGESTED** that South Africa share additional information on tagging studies and fine-scale size data at the next meeting to provide further evidence on the population structure of blue sharks in Southern African waters.

91. The WPEB **NOTED** that alternative models, including JABBA and JABBA-select, were also proposed to support the SS3 assessment. The WPEB **SUGGESTED** that modellers coordinate with the SS3 modellers to ensure consistency in input data (e.g., CPUE, catch, and parameters) to allow meaningful comparisons between alternative models and the SS3 model.

92. The WPEB also **NOTED** that some CPC scientists expressed interest in being involved in the assessment. The WPEB **WELCOMED** these initiatives and encouraged scientists to contact the modellers directly for collaboration. The Secretariat could assist in facilitating access to and sharing of model input files or data.

93. The WPEB also **NOTED** that CPC scientists need to provide Length-Frequency information for blue sharks by the 15th June 2025 in order to be incorporated into the assessment, in addition, outstanding CPUE indices need to be provided.

Table 1: Proposed initial biological parameter values for the blue shark SS3 model.

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) F: 361 (FL)			Compagno 2001
Age at 50% maturity	M: 4~7 years F: 5~7 years			Jolly *et al*. 2013[1]
Longevity	25 (maximum vertebral band counts)			Andrade *et al.* 2019
Litter size	38 (average)			Mejuto & García-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 (FL)**	***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	IOTC-2021-WPEB17(AS)-16		

[1] Note that some advocated for using the Andrade et al (2019) estimate for Age at 50% maturity. A sensitivity analysis will be conducted as part of the assessment to evaluate the impact of using this or the Jolly et al 2013 parameter. However, the model will be parameterised with the Length at 50% maturity rather than Age at 50% maturity.

Stock Recruitment Relationship		
Beverton-Holt	Steepness = 0.8	Rosa and Coelho (2017)

7 Review of the draft, and adoption of the Report of the 21st Session of the WPEB(DP)

94. The report of the 21st Session of the Working Party on Ecosystems and Bycatch Data Preparatory meeting (IOTC–2025–WPEB21(DP)–R) was **ADOPTED** by correspondence.

APPENDIX I
LIST OF PARTICIPANTS

Vice Chairperson					
Title	**First name**	**Last name**	**Affiliation**	**Country**	**E-mail**
Dr.	Charlene	DA SILVA	Department of Forestry, Fisheries and the Environment	SOUTH AFRICA	CDaSilva@dffe.gov.za
Title	**First name**	**Last name**	**Affiliation**	**Country**	**E-mail**
Mrs.	Eider	ANDONEGI	AZTI	EUROPEAN UNION	eandonegi@azti.es
Mr.	Isaac	BARASA	Kenya fisheries Service	KENYA	barasawafula71@gmail.com
Dr.	Sylvain	BONHOMMEAU	Ifremer	EUROPEAN UNION	sylvain.bonhommeau@ifremer.fr
Dr.	Don	BROMHEAD	ABARES	AUSTRALIA	Don.Bromhead@aff.gov.au
Mr.	Emmanuel	CHASSOT	IOTC Secretariat		Emmanuel.Chassot@fao.org
Dr.	Rui	COELHO	IPMA - Portuguese Institute for the Ocean and Atmosphere	EUROPEAN UNION	rpcoelho@ipma.pt
Ms.	Julissa	DE LA ROSA	Centro Oceanográfico de Málaga	EUROPEAN UNION	julissa.delarosa@ieo.csic.es
Dr.	Charles	EDWARDS	IOTC Consultant		cescapecs@gmail.com
Ms.	Cynthia	FERNANDEZ DIAZ	IOTC Secretariat		Cynthia.FernandezDiaz@fao.org
Mr.	Jose	FERNÁNDEZ COSTA	IEO.CSIC	EUROPEAN UNION	jose.costa@ieo.csic.es
Dr.	Carmen	FERNANDEZ LLANA	Instituto Español de Oceanografía (IEO, CSIC)	EUROPEAN UNION	carmen.fernandez@ieo.csic.es
Mr.	Dan	FU	IOTC Secretariat		Dan.Fu@fao.org
Ms	Emma	GEE	UC Santa Cruz		ekgee@ucsc.edu
Ms.	Ali	HOOD	Shark Trust		ali@sharktrust.org
Dr.	Mikihiko	KAI	Fisheries Resources Institute	JAPAN	kai_mikihiko61@fra.go.jp
Dr.	Farhad	KAYMARAM	Iranian Fisheries Science Research Institute	IRAN, ISLAMIC REPUBLIC OF	farhadkaymaram@gmail.com
Dr.	Sven	KERWATH	Department Forestry, Fisheries and the Environment	SOUTH AFRICA	SKerwath@dffe.gov.za
Mr.	Muhammad Moazzam	KHAN	WWF-Pakistan		mmoazzamkhan@gmail.com
Ms.	Yanan	LI	Shanghai Ocean University	CHINA	liyananxiada@yeah.net

Mr.	Gonzalo	LINIERS	IEO - CSIC	EUROPEAN UNION	gonzalo.liniers@ieo.csic.es
Ms.	Estibaliz	MARTINEZ DE LA-GOS GUEVARA	FIP BLUES	EUROPEAN UNION	departamentotecnico@fipblues.com
Ms	Elizabeth	MUENI	Kenya fisheries Service	KENYA	emuenibf@yahoo.com
Mr	Stephen	NDEGWA	Kenya fisheries Service	KENYA	ndegwafish@yahoo.com
Ms.	Lauren	NELSON	IOTC Secretariat		Lauren.Nelson@fao.org
Mr.	Dian	NOVIANTO	National Research and Innovation Agency	INDONESIA	dian.novianto@brin.go.id
Ms.	Aintzina	OIHENARTE ZUBIAGA	FIP BLues Spanish longline surface	EUROPEAN UNION	departamentotecnico@fipblues.com
Ms.	Lucia	PIERRE	IOTC Secretariat		Lucia.Pierre@fao.org
Mr.	Teodoro	PATROCINIO IBAR-ROLA	Instituto español de Oceanografia-CSIC	EUROPEAN UNION	teo.ibarrola@ieo.csic.es
Dr.	Genevieve	PHILLIPS	IOTC Secretariat		Genevieve.Phillips@fao.org
Mrs.	Maria Lourdes	RAMOS ALONSO	IEO.CSIC	EUROPEAN UNION	mlourdes.ramos@ieo.csic.es
Ms.	Ana	RAMOS CARTELLE	IEO-CSIC	EUROPEAN UNION	ana.cartelle@ieo.csic.es
Mr.	Stuart	REEVES	Cefas	UNITED KINGDOM	stuart.reeves@cefas.gov.uk
Mr.	Joel	RICE	Rice Marine Analytics		ricemarineanalytics@gmail.com
Dr.	Philippe	SABARROS	IRD	EUROPEAN UNION	philippe.sabarros@ird.fr
Dr.	Yasuko	SEMBA	Fisheries Resources Institute	JAPAN	yasukosemba@gmail.com
Mrs.	Chloé	TELLIER	IRD	EUROPEAN UNION	chloe.tellier@ird.fr
Mr.	Weerapol	THITIPONGTRAKUL	Department of Fisheries, Thailand	THAILAND	weerapol.t@gmail.com
Mr.	Wen-Pei	TSAI	Invited Expert		wptsai@nkust.edu.tw
Dr.	Yuji	UOZUMI	Japan Tuna Fisheries Co-operative Associa-tion	JAPAN	uozumi@japantuna.or.jp
Dr.	Arezoo	VAHABNEZHAD	Iranian fisheries research institute	IRAN, ISLAMIC RE-PUBLIC OF	avn9400@gmail.com
Dr.	Dawit	YEMANE GHEBRE-HIWET	Department Forestry, Fisheries and the Envi-ronment	SOUTH AFRICA	DGhebrehiwet@dffe.gov.za
Dr.	Iriz	ZIEGLER	Deutsche Stiftung Meeresschutz (DSM)		iris.ziegler@stiftung-meeresschutz.org

APPENDIX II
AGENDA FOR THE 21ST WORKING PARTY ON ECOSYSTEMS AND BYCATCH DATA PREPARATORY MEETING

Date: 28-30 April 2025
Location: Online
Time: 12:00 – 16:00 (Seychelles time, GMT+4)
Chair: Dr Charlene da Silva (South Africa)
Vice-Chair: Mr Mohammed Koya (India)

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

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

3. **REVIEW OF THE DATA AVAILABLE AT THE SECRETARIAT FOR BYCATCH SPECIES AND BYCATCH DATA ESTIMATION APPROACHES** (All)

4. **REVIEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO BLUE SHARK** (all)

   4.1. Review new information on the biology, stock structure, their fisheries and associated environmental data for blue shark
   - Catch and effort
   - Observer data
   - Catch at size
   - Catch at age
   - Biological indicators, including age-growth curves and age-length keys

5. **REVIEW OF NEW INFORMATION ON THE STATUS OF BLUE SHARK** (all)

   5.1. Nominal and standardised CPUE indices
   5.2. Other abundance indices

6. **STOCK ASSESSMENT AND INDICATORS FOR BLUE SHARKS** (all)

   6.1. Review of indicators (all)
   6.2. Discussion on blue shark assessment models to be developed and their specifications

7. **REVIEW OF THE DRAFT, AND ADOPTION OF THE REPORT OF THE 21st SESSION OF THE WORKING PARTY ON ECOSYSTEMS AND BYCATCH (DATA PREPARATORY)** (Chair)

APPENDIX III
LIST OF DOCUMENTS FOR THE 21ST WORKING PARTY ON ECOSYSTEMS AND BYCATCH

Document	Title
IOTC-2025-WPEB21(DP)-01a	Agenda of the 21st Working Party on Ecosystems and Bycatch Data Preparatory Meeting
IOTC-2025-WPEB21(DP)-01b	Annotated agenda of the 21st Working Party on Ecosystems and Bycatch Data Preparatory Meeting
IOTC-2025-WPEB21(DP)-02	List of documents of the 21st Working Party on Ecosystems and Bycatch Data Preparatory Meeting
IOTC-2025-WPEB21(DP)-03	Review of the statistical data and fishery trends for blue shark (IOTC Secretariat)
IOTC-2025-WPEB21(DP)-04	Standardised CPUE indices of abundance for pelagic sharks, mako shark (*Isurus oxyrinchus*) and blue shark (*Prionace glauca*), off South Africa (Yemane, D., da Silva, C. and Kerwath, S.)
IOTC-2025-WPEB21(DP)-05	Updated standardized CPUE of blue shark bycaught by the French Reunion-based pelagic longline fishery (2007-2024) (Sabarros, P. S., Tellier, C., Bach, P., Coelho, R., and Romanov, E. V.)
IOTC-2025-WPEB21(DP)-06	Updated standardized catch rates in biomass for the Indian stock of blue shark (*Prionace glauca*) from the Spanish surface longline fleet for the period 2001-2023 (Ramos-Cartelle, A., García-Cortés, B. and Fernández-Costa, J.)
IOTC-2025-WPEB21(DP)-07	Updated catch, effort and standardized CPUEs of blue shark (*Prionace glauca*) captured by the Portuguese pelagic longline fishery in the Indian Ocean (Coelho, R., Rosa D., Lino, P. G.)
IOTC-2025-WPEB21(DP)-08	Spatio-temporal model for CPUE standardization: Application to blue shark caught by Japanese tuna longline fishery in the Indian Ocean from 1994 to 2023 (Kai, M. and Semba, Y.)
IOTC-2025-WPEB21(DP)-09	Historical standardized CPUEs of the blue shark from 1966 through 1989 (Gee, E., Ferretti, F. and Romanov, E.)
IOTC-2025-WPEB21(DP)-10	A review of the 2021 blue shark assessment in the Indian Ocean (Rice, J.)
IOTC-2025-WPEB21(DP)-11	Preliminary catch estimates of blue shark in the Indian Ocean in support of an assessment in 2025 (Rice, J.)

APPENDIX IV

THE STANDING OF A RANGE OF INFORMATION RECEIVED BY THE IOTC SECRETARIAT FOR BLUE SHARK

Extract from IOTC–2025–WPEB21(DP)–03.

(Appendix references in this Appendix, refer only to those contained in this appendix)

Overall bycatch levels & trends of blue shark

Overall levels and quality of reported catches of shark and ray species have increased over time due to the development and expansion of tuna and tuna-like fisheries across the Indian Ocean. Blue shark catches remain associated with considerably uncertainties due to estimates of blue shark catches from Indonesian artisanal fisheries. In recent years (2018–2022), the average annual catch of blue sharks in the Indian Ocean was around 24,000 tonnes, around 64% of which was taken by Indonesia (IOTC-2024-SC27-ES17_BSHE). However, the application of the re-estimation methodology to Indonesian catches, presented at WPDCS20 and endorsed by SC27, resulted in a 25% reduction in blue shark catches over the same period (**Figure A 1**). Despite the modifications to the data series, blue sharks still account for the majority of reported shark catches at the species level. However, it is important to emphasise that the aggregate species account for up to 70% of the total number of sharks caught. (**Figure A 1**).

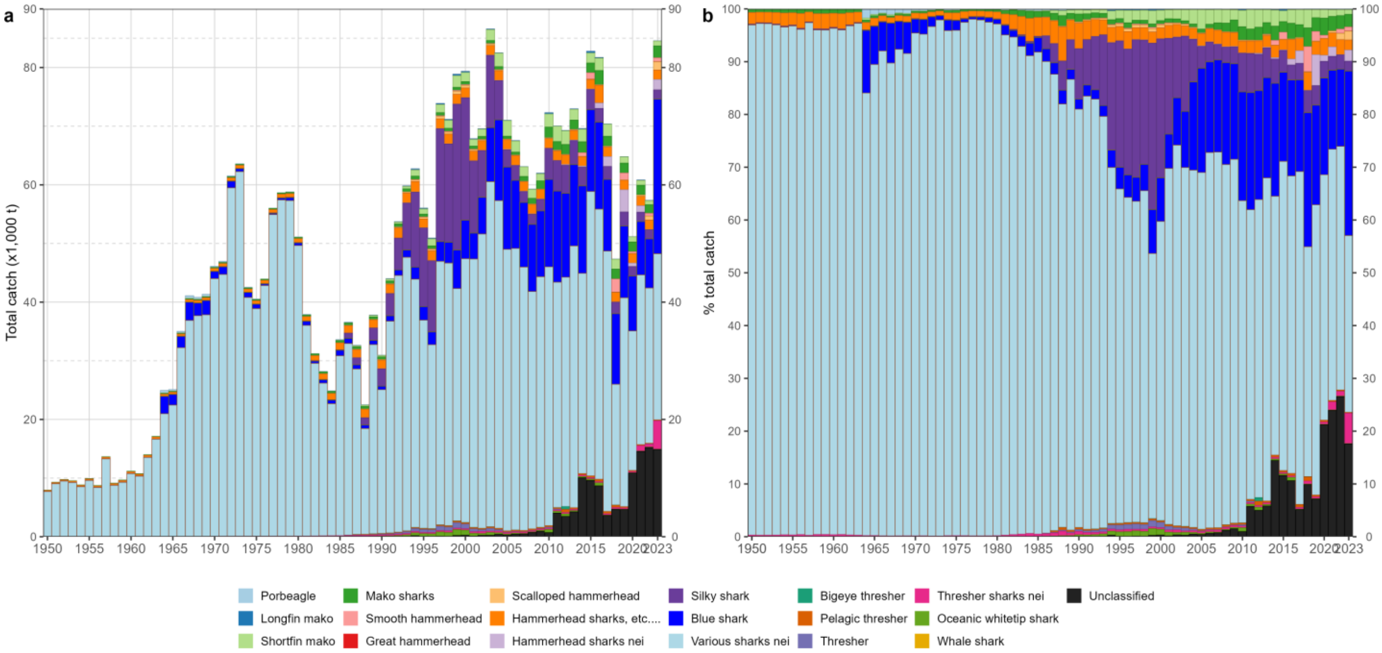

Figure A 1: Annual time series of cumulative nominal absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of shark species for the period 1950-2023

The change in the time series also implies a reordering of the contributions of blue shark catches by the three main fleets (Taiwan,China, EU,Spain, and Indonesia) until 2022. Reported catches of blue sharks by Indonesia in 2023 dominate once again, with similar values to previous reports, as the re-estimation methodology has not yet been applied to the latest data submission (Figure A 2).

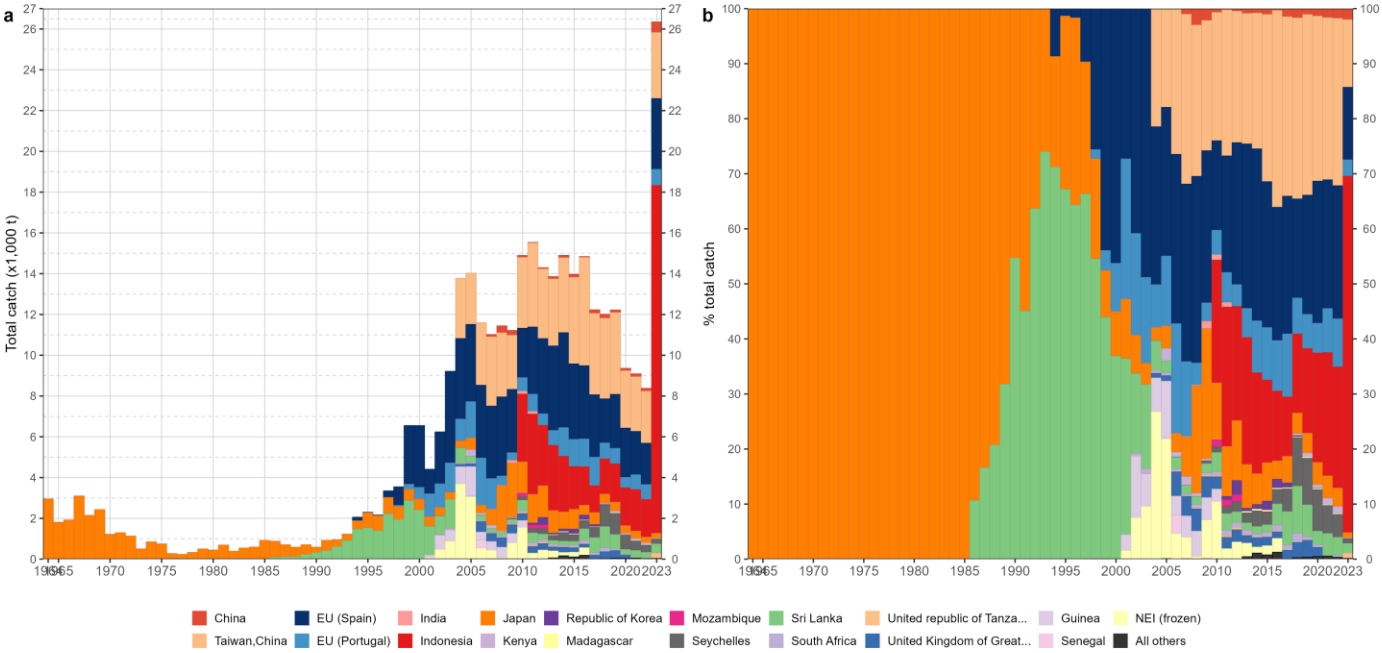

Figure A 2: Annual cumulative absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of blue shark by fleet for the period 1950-2023

Vulnerability to fisheries

Catches of blue shark have increased sharply from the mid-1990s, period in which longline and line fisheries accounted for more than 70% of total catches of these species (**Figure A 3**) and followed by a period of decrease since 2010.

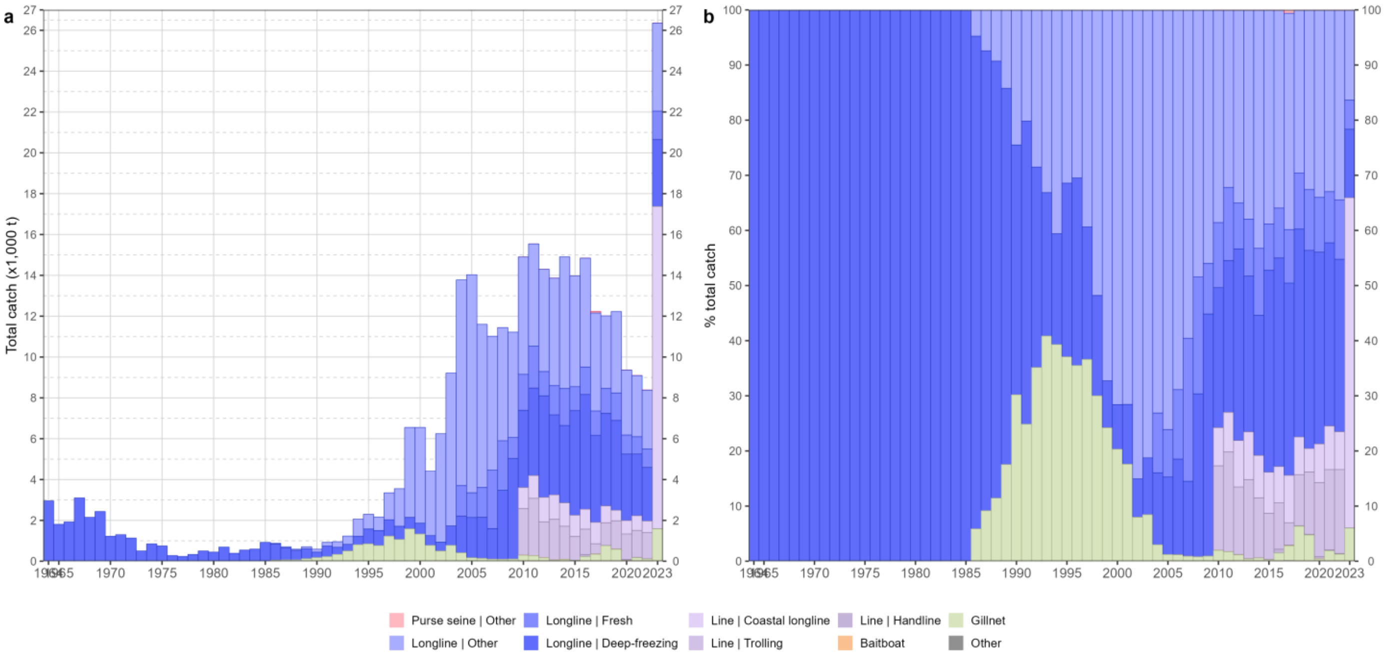

Figure A 3: Annual absolute (a) and relative (b) time series of retained catches (metric tonnes; t) of blue shark by fishery for the period 1950-2023. 'Other' corresponds to all other fisheries combined

Table A1: Blue shark catches (metric tonnes; t) by year and fishery for the period 2014 -2023.

Fishery	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Purse seine | Other	0	0	2	76	0	1	0	0	4	1
Longline | Other	6,447	5,421	5,334	4,799	3,555	3,987	3,185	2,998	2,885	4,312
Longline | Fresh	1,810	1,177	1,345	1,187	1,221	1,345	930	844	903	1,394
Longline | Deep-freezing	3,787	5,115	5,614	4,266	4,532	4,393	3,255	3,021	2,622	3,271
Line | Coastal longline	1,147	1,040	980	1,049	822	519	658	718	575	15,784
Line | Trolling	1,621	1,168	1,247	499	1,114	1,382	1,256	1,326	1,275	7
Line | Handline	3	7	102	13	9	14	41	12	11	3
Baitboat	1	0	0	2	0	1	1	0	0	0
Gillnet	80	31	217	332	761	579	30	170	103	1,582
Other	8	8	4	11	2	4	7	3	4	0
Total	14,904	13,968	14,845	12,231	12,017	12,224	9,362	9,092	8,382	26,354

Recent fishery features (2019-2023)

Until 2022, most longline fisheries reported a decline in blue shark catches. However, this trend was reversed in 2023 with blue shark catches increasing by 70% and 30% for the EU,Spain and Taiwan,China, respectively (**Figure A 4**). Although with small amounts, China, Mauritius, Sri Lanka, and Tanzania also reported considerable increases in blue shark catches.

The sharp increase in line and gillnet catches of blue sharks in 2023 is entirely dependent on Indonesia's reported catches and is subject to review (**Figure A 5**).

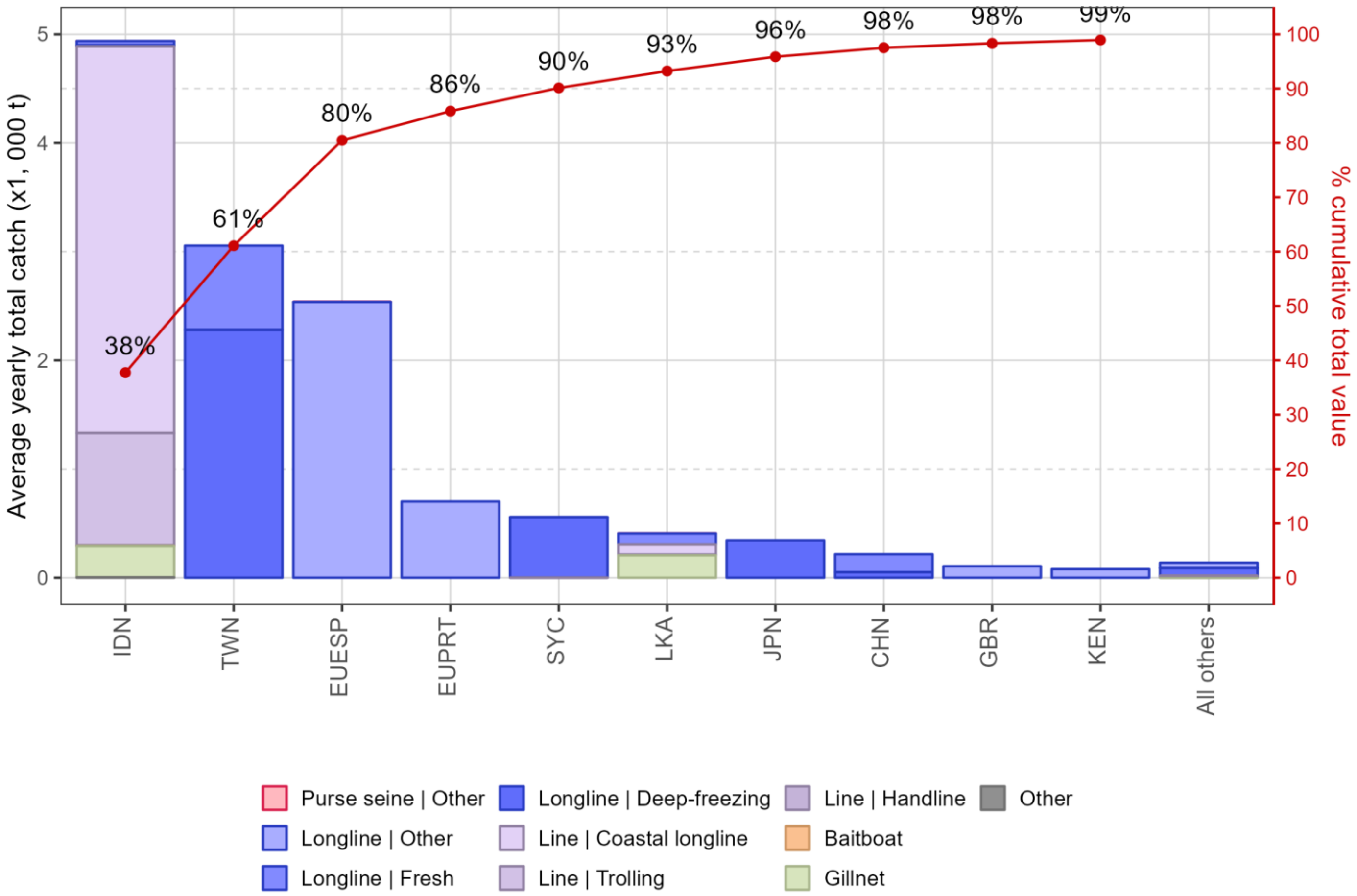

Figure A 4: Average annual catch trends (metric tonnes; t) of blue shark by fleet and fishery for the period 2019-2023

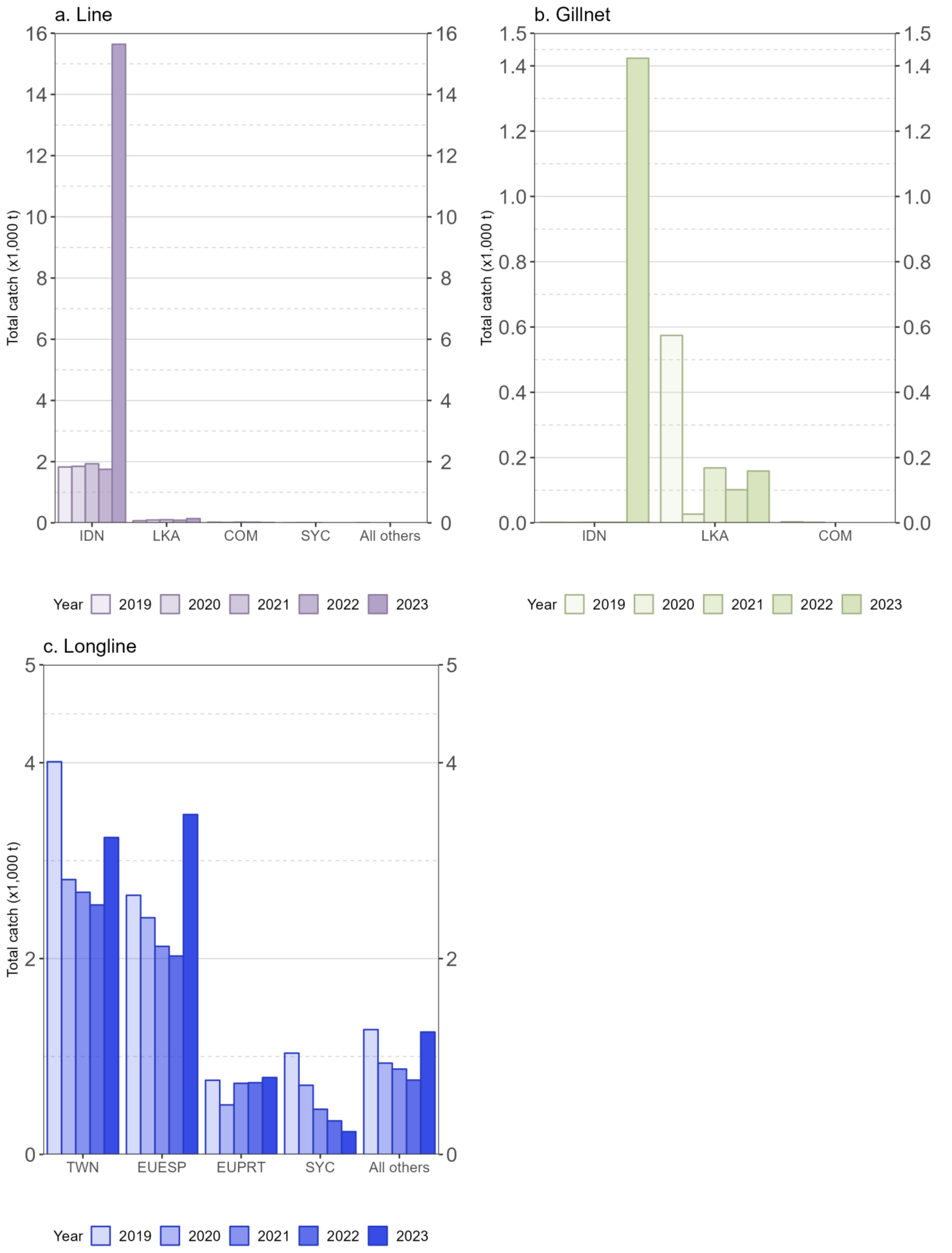

Figure A 5: Annual catch trends (metric tonnes; t) of blue shark by fishery group between for the period 2019-2023