Report of the 17th Session of the IOTC Working Party on Billfish

La Réunion, EU, France, 9–12 September 2019

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Acronyms

ABF	African Billfish Foundation
ASPIC	A Stock-Production Model Incorporating Covariates
B	Biomass (total)
B_{MSY}	Biomass which produces MSY
BLM	Black marlin (FAO code)
BSP-SS	Bayesian Surplus Production Model – State-Space
BUM	Blue marlin (FAO code)
CE	Catch and effort
CI	Confidence Interval
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
EU	European Union
EEZ	Exclusive Economic Zone
F	Fishing mortality; F_{2010} is the fishing mortality estimated in the year 2010
FAO	Food and Agriculture Organization of the United Nations
F_{MSY}	Fishing mortality at MSY
GLM	Generalized linear model
HBF	Hooks between floats
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
JABBA	Just Another Bayesian Biomass Assessment (a generalized Bayesian State-Space Surplus Production Model)
LL	Longline
M	Natural Mortality
MSY	Maximum sustainable yield
n.a.	Not applicable
NGO	Non-governmental organization
PS	Purse-seine
q	Catchability
r	Intrinsic rate of population increase
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
SFA	Indo-Pacific sailfish (FAO code)
SS3	Stock Synthesis III
STM	Striped marlin (FAO code)
SWO	Swordfish (FAO code)
Taiwan,China	Taiwan, Province of China
WPB	Working Party on Billfish of the IOTC
WPEB	Working Party on Ecosystems and Bycatch of the IOTC

STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

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

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

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

Level 2: From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:
REQUESTED: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalize 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 Billfish (WPB) was held in La Réunion, France from 9th to 12th September 2019. A total of 25 participants (20 in 2018) attended the Session. The list of participants is provided at Appendix I. The meeting was opened by the Vice Chairperson, Dr Evgeny Romanov (EU, France), who welcomed participants to La Réunion, France.

The following are the complete recommendations from the WPB17 to the Scientific Committee, which are also provided at Appendix XII:

WPB 17.01 (para 6): **RECALLING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the WPB reiterated it's previous **RECOMMENDATION** that the Scientific Committee consider requesting the Commission to include it in the list of species to be managed by the IOTC.

Revision of the WPB Program of work (2020–2024)

WPB 17.02 (para 133): The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2020–2024), as provided at Appendix XII.

Review of the draft, and adoption of the Report of the 17th Session of the Working Party on Billfish

WPB17.03 (para. 141): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB17, provided at Appendix XII, as well as the management advice provided in the draft resource stock status summary for each of the five billfish species under the IOTC mandate, and the combined Kobe plot for the five species assigned a stock status in 2019 (Fig. 9):

- Swordfish (*Xiphias gladius*)– Appendix VI
- Black marlin (*Makaira indica*) – Appendix VII
- Blue marlin (*Makaira nigricans*) – Appendix VIII
- Striped marlin (*Tetrapturus audax*) – Appendix IX
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix X

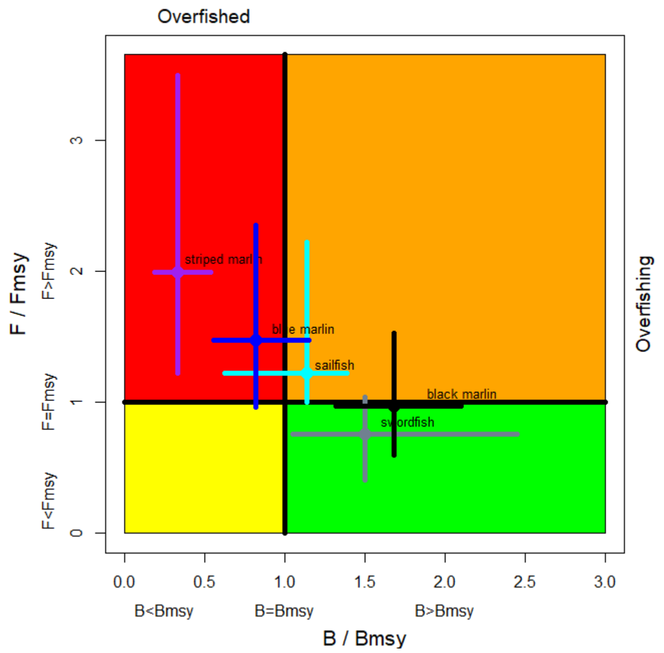

Fig. 7. Combined Kobe plot for swordfish (grey), indo-pacific sailfish (cyan), black marlin (black), blue marlin (blue) and striped marlin (purple) showing the 2017, 2018, and 2019 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

Table 1. Status summary for billfish species under the IOTC mandate.

Stock	Indicators	2015	2016	2017	2018	2019	Advice to the Scientific Committee
Swordfish *Xiphias gladius*	Catch 2017: 33,352 t Average catch 2013–2017: 31,154 t MSY (1,000 t) (80% CI): 31.59 (26.30–45.50) F_{MSY} (1000 t) (80% CI): 0.17 (0.12–0.23) SB_{MSY} (80% CI): 43.69 (25.27–67.92) F_{2015}/F_{MSY} (80% CI): 0.76 (0.41–1.04) SB_{2015}/SB_{MSY} (80% CI): 1.50 (1.05–2.45) SB_{2015}/SB_{1950} (80% CI): 0.31 (0.26–0.43)						***Stock status.*** No new stock assessment was carried out for swordfish in 2019, thus, the stock status is determined on the basis of the 2017 assessment and other indicators presented in 2019. In 2017 a stock synthesis assessment was conducted, with fisheries catch data up to 2015. The assessment uses a spatially disaggregated, sex explicit and age structured model. The SS3 model, used for stock status advice, indicated that MSY-based reference points were not exceeded for the Indian Ocean population (F_{2015}/F_{MSY}< 1; SB_{2015}/SB_{MSY}> 1). Most other models applied to swordfish also indicated that the stock was above a biomass level that would produce MSY. Spawning stock biomass in 2015 was estimated to be 26%–43% of the unfished levels. There are some uncertainties in the catch estimates from the Indonesian fresh tuna longline; an alternative catch history was used in the base case stock assessment. Most recent catches are above the MSY level (31,590 t). On the weight-of-evidence available in 2019, the stock is determined to be ***not overfished*** and ***not subject to overfishing***. ***Management advice***. The most recent catches (33,352 t in 2017) are above the MSY level (31,590 t). However, given the uncertainty of recent catches from Indonesian fresh tuna longline fisheries there is a possibility that total catches could be higher. Therefore catches should not be increased beyond the MSY level (31,590 t). Click here for full stock status summary: Appendix VI
Black marlin *Makaira indica*	Catch 2017: 14,644 t Average catch 2013–2017: 17,352 t MSY (1000 t) (80% CI): 12.93 (9.44-18.20) F_{MSY} (80% CI): 0.18 (0.11-0.30) B_{MSY} (1000 t) (80% CI): 72.66 (45.52-119.47) F_{2017}/F_{MSY} (80% CI): 0.96 (0.77-1.12) B_{2017}/B_{MSY} (80% CI): 1.68 (1.32-2.10) B_{2017}/B_{1950} (80% CI): 0.62 (0.49-0.78)						***Stock status.*** No new stock assessment was carried out for black marlin in 2019, thus, the stock status is determined on the basis of the 2018 assessment and other indicators presented in 2019. In 2018 a stock assessment based on JABBA was conducted for black marlin. This assessment suggests that the point estimate for the stock in 2017 is in the green zone in the Kobe plot with F/F_{MSY}=0.96 (0.77-1.12) and B/B_{MSY}=1.68 (1.32-2.10). The Kobe plot (Fig. 2) from the JABBA model indicated that the

							stock is not **subject to overfishing** and is currently not **overfished**, however these status estimates are subject to a high degree of uncertainty. As such, the results should be interpreted with caution. ***Management advice.*** The current catches (>14,600 t in 2017) are higher than MSY (12,930 t). Projections were not carried out due to the poor predictive capabilities identified in the assessment diagnostics. Click here for full stock status summary: Appendix VII
Blue marlin *Makaira nigricans*	Catch 2017: 12,796 t Average catch 2013–2017: 11,761 t MSY (1000 t) (80% CI): 9.98 (8.18 –11.86) F_{MSY} (80% CI): 0.21 (0.13 – 0.35) B_{MSY} (1,000 t) (80% CI): 47 (29.9 – 75.3) F_{2015}/F_{MSY} (80% CI): 1.47 (0.96 – 2.35) B_{2015}/B_{MSY} (80% CI): 0.82 (0.56 – 1.15) B_{2015}/B_{1950} (80% CI): 0.41 (0.28 – 0.57)						***Stock status.*** A new stock assessment of blue marlin was conducted in 2019. The stock status is based on the Bayesian State-Space Surplus Production model JABBA that suggests that there is an 87% probability that the Indian Ocean blue marlin stock in 2017 is in the red zone of the Kobe plot, indicating the stock is ***overfished*** and ***subject to overfishing*** (B_{2017}/B_{MSY}=0.82 and F_{2017}/F_{MSY}=1.47). The most recent catch exceeds the estimate of MSY (catch2017 = 12,029; MSY = 9,984). The previous assessment of blue marlin (Andrade 2016) concluded that in 2015 the stock was subject to overfishing but not overfished. The change in stock status can be attributed to increased catches for the period 2015-2017 as well as improved standardisation of CPUE indices, which includes the area disaggregation of JPN and TWN indices to account for fleet dynamics. ***Management advice.*** The current catches of blue marlin (average of 11,761 t in the last 5 years, 2013-2017) are higher than MSY (9,984 t) and the stock is currently overfished and subject to overfishing. In order to achieve the Commission objectives of being in the green zone of the Kobe Plot by 2027 ($F_{2027} < F_{MSY}$ and $B_{2027} > B_{MSY}$) with at least a 60% chance, the catches of blue marlin would have to be reduced by 35% compared to the average of the last 3 years, to a maximum value of approximately 7,800 t. Click here for full stock status summary: Appendix VIII
Striped marlin *Tetrapturus audax*	Catch 2017: 3,020 t Average catch 2013–2017: 3,574 t MSY (1,000 t) (JABBA): 4.73 (4.27–5.18) F_{MSY} (JABBA): 0.26 (0.20–0.34) B_{MSY} (1,000 t) (JABBA): 17.94 (14.21–23.13) F_{2017}/F_{MSY} (JABBA): 1.99 (1.21–3.62) B_{2017}/B_{MSY} (JABBA): 0.33 (0.18–0.54) SB_{2017}/SB_{MSY} (SS3): 0.373 B_{2017}/B_{1950} (JABBA): 0.12 (0.07–0.20)						***Stock status:*** No new stock assessment was carried out for black marlin in 2019, thus, the stock status is determined on the basis of the 2018 assessment and other indicators presented in 2019. The stock assessment for striped marlin carried out in 2018, based on two different models: JABBA, a Bayesian state-space production model; and SS3, an integrated length-based model. Both models were very consistent and confirmed the results from 2012, 2013, 2015 and 2017 assessments, indicating that the stock is subject to overfishing ($F>F_{MSY}$) and overfished, with the biomass for at least the past ten years is

	SB_{2017}/SB_{1950} (SS3): 0.13 (0.09–0.14)						below the level which would produce MSY ($B<B_{MSY}$). On the weight-of-evidence available in 2018, the stock status of striped marlin is determined to be ***overfished*** and ***subject to overfishing***. ***Management advice.*** Current or increasing catches have a very high risk of further decline in the stock status. Current 2017 catches are lower than MSY (4,730 t) but the stock has been overfished for more than two decades and is now in a highly depleted state. If the Commission wishes to recover the stock to the green quadrant of the Kobe plot with a probability ranging from 60% to 90% by 2026, then the maximum annual catches have to be set to between 1,500 t – 2,200 t. Click here for full stock status summary: Appendix IX
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2017: 33,136 t Average catch 2013–2017: 29,843 t MSY (1,000 t) (80% CI): 23.9 (16.1 – 35.4) F_{MSY} (80% CI): 0.19 (0.14 - 0.24) B_{MSY} (1,000 t) (80% CI): 129 (81–206) F_{2017}/F_{MSY} (80% CI): 1.22 (1 – 2.22) B_{2017}/B_{MSY} (80% CI): 1.14 (0.63 – 1.39) B_{2017}/B_{1950} (80% CI): 0.57 (0.31 – 0.70)						***Stock status:*** A new stock assessment was carried out for Indo-Pacific sailfish in 2019 using the C-MSY model. The data poor stock assessment techniques indicated that F was above F_{MSY} (F/F_{MSY}=1.22) and B above B_{MSY} (B/BMSY=1.14). Another alternative model using the Stock Reduction Analysis (SRA) techniques produced similar results. The stock appears to show a continued increase catches which is a cause of concern, indicating that fishing mortality levels may be becoming too high. However both assessment models rely on catch data, which is considered to be highly uncertain. In addition aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are also a cause for concern. On the weight-of-evidence available in 2019, the stock status cannot be assessed and is determined to be uncertain. ***Management advice***: Given the uncertainty in the catch estimates, the management advice is unchanged from 2018 (i.e., that catches should be below the current MSY level of 23,900 t). Click here for full stock status summary: Appendix X

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

1. OPENING OF THE SESSION

1. The 17th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in La Réunion, France from 9th to 12th September 2019. A total of 25 participants (20 in 2018) attended the Session. The list of participants is provided at Appendix I. The meeting was opened by the Vice Chairperson, Dr Evgeny Romanov (EU, France), who welcomed participants to La Reunion, France. Opening remarks were also given by Mr. Sylvain Bonhommeau, from l'Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), La Réunion, France.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

2. The WPB ADOPTED the Agenda provided at Appendix II. The documents presented to the WPB17 are listed in Appendix III.

3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

3.1 Outcomes of the 21th Session of the Scientific Committee

3. The WPB **NOTED** paper IOTC–2019–WPB17–03 which describes the main outcomes of the 21th Session of the Scientific Committee (SC21), specifically related to the work of the WPB:

- ***Review of the statistical data available for billfish***
  [Para 46] The SC noted the IOTC Secretariat has re-estimated the catches for Indonesia's fresh longline fleet and provided the WPB16 meeting with an alternative catch series (IOTC–2018–WPB16–DATA03b). The total catches mostly affect catches of swordfish, blue marlin, and striped marlin to a lesser extent, which have been revised downwards by as much as 30%. The SC further noted that these estimates have been reviewed by WPDCS14.
- ***Revision of catch levels of Marlins under Resolution 18/05***
  [Para 68] The SC noted that Resolution 18/05 On management measures for the conservation of billfish, striped marlin, black marlin, blue marlin and Indo-Pacific sailfish encourages CPCs to "…ensure that the overall catches, of the Indian Ocean Striped Marlin, Black Marlin, Blue Marlin and Indo Pacific Sailfish in any given year do not exceed either the MSY level or, in its absence, the lower limit of the MSY range of central values as estimated by the Scientific Committee…". Moreover, Resolution 18/05 also requires the SC to "…annually review the information provided and assess the effectiveness of the fisheries management measures reported by CPCs on striped marlin, black marlin, blue marlin and Indo-Pacific sailfish and, as appropriate, provide advice to the Commission".

4. The WPB **NOTED** that catches in recent years for Black Marlin, Blue Marlin, Striped Marlin and Indo-Pacific Sailfish have all exceeded the catch limits set by Resolution 18/05, and that current catch trends for all four species show no clear signs of decline in line with meeting the catch limits by 2020.

5. The WPB **ACKNOWLEDGED** and **REITERATED** the request from the Scientific Committee for full compliance with Resolutions 15/01 and 15/02 and **REQUESTED** that all involved CPCs take immediate action to overcome any issues preventing the timely and complete reporting of all mandatory statistical data to the IOTC Secretariat.

6. **RECALLING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the WPB reiterated it's previous **RECOMMENDATION** that the Scientific Committee consider requesting the Commission to include it in the list of species to be managed by the IOTC.

3.2 Outcomes of the 23st Session of the Commission

7. The WPB **NOTED** paper IOTC–2019–WPB17–04 which provided the main outcomes of the 23st Session of the Commission specifically related to the work of the WPB and **AGREED** to consider how best to provide the Scientific Committee with the information it needs, in order to satisfy the Commission's requests, throughout the course of the current WPB meeting.

8. The WPB **NOTED** the 7 Conservation and Management Measures (CMMs) adopted at the 23st Session of the Commission (consisting of 7 Resolutions and 0 Recommendations) as listed below:

IOTC Resolutions

- Resolution 19/01 On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock in the IOTC Area of competence.
- Resolution 19/02 Procedures on a fish aggregating devices (FADs) management plan, including a limitation on the number of fads, more detailed specifications of catch reporting from fad sets, and the development of improved fad designs to reduce the incidence of entanglement of non-target species.
- Resolution 19/03 On the conservation of mobulid species caught in association with fisheries in the IOTC Area of Competence.
- Resolution 19/04 Concerning the IOTC Record of Vessels Authorised to operate in the IOTC Area of Competence.
- Resolution 19/05 On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna, and non-targeted species caught by purse seine vessels in the IOTC Area of Competence.
- Resolution 19/06 On establishing a programme for transhipment by large-scale fishing vessels.
- Resolution 19/07 On vessel chartering in the IOTC Area of Competence

9. The WPB **NOTED** that pursuant to Article IX.4 of the IOTC Agreement, the above mentioned Conservation and Management Measures shall become binding on Members, 120 days from the date of the notification communicated by the IOTC Secretariat.

10. Participants to WPB17 were **ENCOURAGED** to familiarise themselves with the adopted Resolutions, especially those most relevant to the WPB.

11. The WPB **NOTED** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2018, which have relevance for the WPB (details in the report of the Commission - IOTC–2019–S23–R).

12. The WPB **AGREED** that any advice to the Commission would be provided in the Management Advice section of each stock status summary.

3.3 Review of Conservation and Management Measures relevant to billfish

13. The WPB **NOTED** paper IOTC–2019–WPB17–05 which aimed to encourage participants at the WPB17 to review some of the existing Conservation and Management Measures (CMM) relevant to billfish, noting the CMMs referred to in document IOTC–2019–WPB17–05, and - as necessary - to 1) provide recommendations to the Scientific Committee on whether modifications may be required and 2) recommend whether other CMMs may be required.

14. The WPB **NOTED** that the Commission **EXPRESSED** concern that catches for all billfish species (except striped marlin in 2017) in both 2016 and 2017 were higher than the limits outlined in Resolution 18/05.

3.4 Progress on the recommendations of WPB16 and SC21

15. The WPB **NOTED** paper IOTC–2019–WPB17–06 which provided an update on the progress made in implementing the recommendations from the previous WPB meeting which were endorsed by the Scientific Committee, and **AGREED** to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress.

16. The WPB **RECALLED** that any recommendations developed during a Session, must be carefully constructed so that each contains the following elements:

    - a specific action to be undertaken (deliverable);
    - clear responsibility for the action to be undertaken (i.e., a specific CPC of the IOTC, the IOTC Secretariat, another subsidiary body of the Commission or the Commission itself);
    - a desired time for delivery of the action (i.e., by the next Working Party meeting, or other date);
    - if appropriate, an approximate budget for the activity, so that the IOTC Secretariat may be able to use it as a starting point for developing a proposal for the Commission's consideration.

17. The WPB **NOTED** that the requests included in Appendix I of the document IOTC–2019–WPB17–06 are only taken from the report of the previous year. Requests that are not addressed directly in the subsequent year are not carried over and therefore often neglected. As such, unresolved or pending requests still relevant are included in a table in the body of the report so that they may be addressed the following year. The revised list of requests are therefore included in table 2 below:

Table 2: Review of requests requiring further attention

WPB16 Report reference	WPB16 REQUESTS	Update/Progress
Para. 8	The WPB **ACKNOWLEDGED** and **REITERATED** the request from the Scientific Committee for full compliance with Resolutions 15/01 and 15/02 and REQUESTED that all involved CPCs take immediate action to overcome any issues preventing the timely and complete reporting of all mandatory statistical data to the IOTC Secretariat	Update: Ongoing.
Para. 25	The WPB **NOTED** that the IOTC Secretariat is continuing to implement a number of revisions to the nominal catches that impact current estimates for billfish, including Comoros, Indonesia's fresh longline catches, as well as incorporating improvements in the catch-and-effort reported by I.R. Iran, and changes to the species composition submitted by Taiwan,China, and **REQUESTED** that an update is provided during the next WPB meeting	Update: The IOTC Secretariat to provide an update during the WPB meeting.
Para. 28	The WPB **NOTED** the main billfish data issues, by type of dataset and fishery, that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, which are provided in Appendix V, and **REQUESTED** that the CPCs listed in the Appendix make efforts to remedy to the identified data issues and report back to the WPB at its next meeting	Update: CPCs to provide an update during the WPB meeting.
Para. 29	Taiwan,China: While number of Taiwanese fresh (small-scale) longline vessels has decreased by around 30% in recent years (from 307 vessels in 2013, to 2012 vessels in 2016), longline catches remained at similar levels, raising average longline catches per vessel from 100 t in 2013 to around 175 t in 2016. Over the same period, the proportion of swordfish reported by Taiwanese flesh longline vessels increased from around 8% to over 30%, due to improvements in data collection and the estimation of catches by species, rather than changes in targeting. To avoid discontinuities in the estimates of catches by species, the WPB **REQUESTED** that Taiwan,China provide the IOTC Secretariat with revisions to the species composition of historical catches prior to the WPB meeting in 2019	Update: Taiwan,China to provide an update during the WPB meeting.
Para. 31	The WPB **REQUESTED** that the IOTC Secretariat clarify with both India and I.R. Iran the reasons for the sudden increase in catches of black marlin; specifically whether the increases are the result of the development of a new fishery, or alternatively improvements in data collection and reporting in order to assess whether catches in earlier years may have been underestimated and require adjustments in order to maintain continuity with latest (higher) catches of black marlin	Update: The IOTC Secretariat to provide an update during the WPB meeting, based on a review of the existing documents/data submitted to IOTC. A Data Compliance and Support mission was also planned for India in June – to address a range of issues regarding increases in a number IOTC species, including billfish and tropical tunas - but postponed until a later date due to logistical issues. Clarification was also provided by I.R. Iran who indicated that, while catches have increased in the short term, this is mostly the result of gillnets vessels returning to the north-western Indian Ocean previously impacted by piracy – and that over the longer term catches have not increased sharply as previously suggested.

Para. 32	The WPB **REQUSTED** that for the next WPB meeting in 2019, the IOTC Secretariat provide an information document to provide background information on the increase in catches of marlins in recent years, including revisions to the official data provided by CPCs, and any changes in the methodology for estimating catches conducted by the IOTC Secretariat.	Update: The IOTC Secretariat to provide an update during the WPB meeting.
Para. 44	The WPB **NOTED** that information on Kenya's longline fleet, including nominal catches and time-area catch-and-effort, has not been reported to the IOTC Secretariat since 2010 and **REQUESTED** that Kenya submit these data to the IOTC Secretariat as a matter of priority.	Update: In progress. In 2019 Kenya did report catch-and-effort, but not nominal catches. The IOTC Secretariat has requested Kenya submit all mandatory datasets required by Resolution 15/02.
Para. 50	The WPB **CONSIDERED** the results of the alternative catch series and **REQUESTED** that the WPDCS consider endorsing the catch series.	Update: The WPDCS **ACKNOWLEDGED** that the methodologies adopted and the results obtained by the IOTC Secretariat in collaboration with national scientists for the revision of Indonesian fresh-tuna longliners best scientific estimates have been presented under agenda item 4.3 and endorsed by the WPDCS
Para. 95	The WPB **AGREED** that the systematic deviations in the retrospective analysis provide little confidence in the predictive capabilities of the model, and as such the resultant fishery reference points for black marlin should be treated with caution. The WPB **REQUESTED** that the catch and effort data provided for this species be discussed by the WPDCS in 2018 and revised information be submitted to the secretariat by CPCs that have catches of black marlin, prior to the next assessment of the species	Update: As above.
(WPB15) Para. 26	***African Billfish Foundation*** The WPB **ACKNOWLEDGED** the evidence of known quality issues related to the African Billfish Foundation tag data, and **REQUESTED** that a full assessment of the information be performed before this could effectively be used and disseminated to a broader audience.	No progress.
(WPB15) Para. 207	***Development of options for alternative management measures (including closures) for billfish in the IOTC area of competence*** The WPB **ACKNOWLEDGED** the difficulties in finding a proper agreement among CPCs with respect to quota allocation criteria that would otherwise represent a potentially effective and alternative output control measure. For this reason, the WPB **REQUESTED** to keep this agenda item open until WPB16 and beyond, **ACKNOWLEDGING** that alternative and practical measures should be explored in the near future.	No progress to date: A study on spawning locations and periods was prioritized in the program of Work and some funds requested. Such information could provide important information to address this request by the Commission.
(WPB15) Para. 212	**ACKNOWLEDGING** the importance of correct species identification to improve the quality of data submitted to the IOTC Secretariat, the WPB **REQUESTED** to further discuss the potential development of identification guides for dressed billfish, and the completion of preliminary studies on this same matter.	No progress to date.

4. NEW INFORMATION ON FISHERIES AND ASSOCIATED ENVIRONMENTAL DATA FOR BILLFISH

4.1 Review of the statistical data available for billfish

18. The WPB **NOTED** paper IOTC–2019–WPB17–07 which summarises the standing of a range of data and statistics received by the IOTC Secretariat for billfish, in accordance with IOTC Resolution 15/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2017. The paper also provided a summary of important reviews to series of historical catches for billfish species; a range of fishery indicators, including catch and effort trends, for fisheries catching billfish in the IOTC area of competence; and the range of equations used by the IOTC Secretariat to convert billfish measurements between non-standard and standard measurements used for each species. A summary of the supporting information for the WPB is provided in Appendix IV.

19. The WPB **NOTED** the main billfish data issues, by type of dataset and fishery, that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, which are provided in Appendix V, and **REQUESTED** that the CPCs listed in the Appendix make efforts to remedy to the identified data issues and report back to the WPB at its next meeting.

20. The WPB **NOTED** the persistent problems of the lack of data available for many species of billfish - in particular Indo-Pacific Sailfish and Black marlin which are caught predominantly by gillnet fisheries in coastal waters – and reiterated its **REQUEST** that CPCs fully comply with the data collection and reporting standards specified by Resolution 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)*.

21. The WPB also strongly **ENCOURAGED** CPCs to ensure catches of billfish are reported at species level, in accordance with Resolution 15/02, or alternatively that null catches of billfish are also reported as per the requirements of Resolution 18/05 *On Management Measures for the Conservation of the Billfishes*.

22. The WPB **NOTED** a brief introduction of the taxonomy of billfish species given by the Chairperson, Dr Evgeny Romanov. The WPB **REITERATED** its advice to use the taxonomy for billfish as detailed in the IOTC species ID cards for presentation at the WPB meeting and also for data submissions to the IOTC Secretariat.

23. The WPB **RECALLED** that most billfish are non-target species and may be subject to widespread under-reporting, particularly in earlier years, and also in the case of industrial fisheries where catches are considered to be relatively minor; and that the overall trend of increasing catches of most billfish species may reflect improvements in reporting combined than a real increase in actual catches. The WPB also **RECALLED** that the general trend in billfish catches in the Indian Ocean appears contrary to many other fisheries whose catches peaked in the 1990's, rather than 2010's as in the case of IOTC billfish species, which suggests further evidence of possible under-reporting.

24. The WPB **NOTED** that the IOTC Secretariat is currently finalizing a review of the revised historical catch series submitted to IOTC by the Government of Pakistan, and which will be presented at the WPDCS meeting later in 2019. The WPB **REQUESTED** than an update also be provided to the WPB meeting in 2020, including a summary of any major changes to the catches of billfish.

4.2 Review new information on fisheries and associated environmental data

I.R. Iran billfish fishery

25. The WPB NOTED paper IOTC–2019–WPB17–09 which summarises billfish landings in I.R. Iran made by Iranian industrial gillnet fishery during 2012–2018, including the following abstract provided by the authors:

> *"The total production of large pelagic species (including by-catch) was 314000 Mt in 2018, which 275000 Mt belongs to tuna and tuna-like fishes in the Indian Ocean. This amount of catch contains 70% (220000 Mt) of Tunas, 11.1% (35000 Mt) of Seerfish, 6.5% (21000Mt) of Billfish, 0.9% (2900 Mt) different species of shark and 11.5% (36000 Mt) other species. Also around 92.2% of tuna and tuna like species catch comes from gillnet gear, while around 1.9% of catch belong to purse seiners and 1.6% comes from trolling vessels and 4.3% comes from small artisanal gillnetter as a seasonal and temporal long-liner where they are fish in coastal waters" (see paper for full abstract).*

26. The WPB **NOTED** that Iranian gillnetters include a total of 6,545 of vessels and account for over 90% of Iran's billfish catches, of which 1220 actively fish in the Oman sea and offshore waters. The WPB further **NOTED** that a number of these vessels operate multi-gear gillnet-longline, targeting tropical and neritic tunas, which will have some impact on the incidental catches of billfish which are considered as a non-target species.

27. The WPB **NOTED** that catches blue marlin are often processed on-board, which causes issues of identification when catches are landed. Currently catches of blue marlin reported to the IOTC Secretariat are included in the species aggregate of 'other billfish', which include a number of other billfish species; the WPB therefore **REQUESTED** that I.R. Iran advise the IOTC Secretariat on how best to disaggregate catches of 'other billfish' to ensure catches of blue marlin are accurately reported for Iran's gillnet fisheries.

Thailand billfish fishery

28. The WPB **NOTED** paper IOTC–2019–WPB17–10 which summarises billfish landings in Phuket by foreign vessels in 2018, including the following abstract provided by the authors:

"In 2018, billfish was unloaded at Phuket, Thailand equal 475.29 tons (46.52% of total catch). All of them were caught by foreign tuna longline fishing vessels those operated in the Indian Ocean. From the recorded data, there were six species of billfish included swordfish (Xiphias gladius) which was the highest proportion as 61.55%, followed by blue marlin (Makaira mazara) 14.58%, sailfish (Istiophorus spp.) 11.40%, black marlin (M. indica) 6.62%, strip marlin (Tetrapturus audax) 5.21% and short bill spearfish (T. angustirostris) 0.64%."

29. The WPB **ENCOURAGED** the scientists from Thailand to cross check the information on billfish landings composition collected by port samplers with the data reported in logbooks; also that scientists from Thailand explore the possibility of collecting genetic samples and develop barcoding identification that could be used for checking species identification, especially for dressed billfish.

Pakistan billfish fishery

30. The WPB **NOTED** paper IOTC–2019–WPB17–11 which summarises bycatch in tuna drifting gillnet fisheries off Pakistan in the Arabian sea, including the following abstract provided by the authors:

"Billfish form important part of the landings of tuna and tuna like fishes from Pakistan. Its landings during 2018 was reported to be about 3,521 m. tons which is about 17.93 % less than 2017. The decrease is attributed to a much longer closed season observed by the tuna gillnet fisheries in 2018. Fishing in 2018 was stopped in the late April or beginning of May and initiated only in last week of August i.e. almost no fishing for four months as against normal 2 month ban of June and July" (see paper for full abstract).

31. The WPB **NOTED** the importance of the gillnet fishery active in coastal and offshore waters of Pakistan (inside EEZ) and the collaboration with WWF-Pakistan to provide the data analysing the impact of subsurface gillnetting.

32. The WPB **NOTED** the large decrease of CPUE from 6107 kg/month in 2013 to 3337 kg/month in 2017 is largely attributed to the deployment of subsurface gillnet instead of the classical gillnet gear. The WPB **REQUESTED** Pakistan to explore the species composition of landings during the fishing seasons to highlight whether the reduction in catches is impacting all billfish species or selected species.

33. The WPB **NOTED** that as a result of discussions between FAO and the Government of Pakistan, 50 gillnetters will be converted to longline and handline.

Malaysian billfish fishery

34. The WPB NOTED paper IOTC–2019–WPB17–12 which summarises billfish catch trends by Malaysian tuna longliners in the Indian Ocean, including the following abstract provided by the authors:

"Malaysian tuna longline vessels were fishing in waters off Madagascar and southwards since the 3rd quarter of 2011. The primary target of these vessels was Albacore and all catches were landed in Mauritius. From 2013 to 2017, catches of billfish (comprised of marlins and swordfish) by Malaysian tuna longliners ranged from 0.68 to 47.22 tonnes with the average 10.35 ± 9.03 tonnes. In 2017, landing of marlin was four times over from 2013, showing an increase about 40% compare to 2013, meanwhile for swordfish, 15% greater than 2013 landing. This showed the demand of these fishes will make them as an attractive by-catch due to its high value, although billfishes are not the primary target of tuna longliners"

35. The WPB **NOTED** the seasonal trend in CPUE with a drop in April and September. Information on fishing positions are also available which has shown a shift from southeast to northeast (within the South Western part of the Indian Ocean).

36. The WPB **NOTED** that marlins are currently reported to the IOTC Secretariat at the level of an aggregated species group – mostly as the longline fishery targets albacore tuna and billfish are considered a non-target bycatch – and **ENCOURAGED** Malaysia to improve the capacity for the identification of marlin species by distributing IOTC Billfish ID cards onboard their national pelagic longline fleet.

37. The WPB further **NOTED** that Malaysia are currently in the process of developing a national Regional Observer Scheme for the longline fishery – which may also improve the reporting of data by species of marlins – however, the date of its implementation is still to be confirmed.

Kenyan billfish fishery

38. The WPB **NOTED** paper IOTC–2019–WPB17–13 which summarises size frequency distribution of billfish caught by Kenyan longliners in the Kenyan EEZ, including the following abstract provided by the authors:

"Scientific Fisheries observers' data on billfish catches from Kenyan Lonliners caught in the Kenyan EEZ from April to October, 2018 was analyzed for their size frequency distribution. The catch composed of five billfish species which included Xiphias gladius (Swordfish), Istiophorus platypterus (Indo-Pacific sailfish) Tetrapturus audax (Striped marlin), Makaira nigricans (Blue Marlin) and Makaira indica, with a sample size of 3608, 37, 16, 4 and 3 individuals respectively giving a total of 3668 individuals. The Total length (TL) was measured for Istiophorus platypterus (Sailfish) while Lower Jaw Fork Length (LJFL) was measured for Xiphias gladius (Swordfish) Tetrapturus audax (striped marlin), Makaira indica (Black marlin) and Makaira nigricans (Blue marlin). Ten (10) cm length class intervals were used to group the length measurements for the five species. For the species X.gladius, the lengths ranged between 80 and 260 cm and the model class was 130-139 cm class interval. For Istiophorus platypterus (Sail fish) the largest frequency was for the class 210-219 cm class interval. The species Tetrapturus audax (Striped marlin) lengths ranged from between 150 and 203 cm with 190-199 cm being the modal class. Makaira nigricans (Blue marlin) recorded only four individuals measuring 140, 194, 200 and 240 cm while Makaira indica (Black marlin) had three individuals which measured 193, 203 and 208 cm. Istiophorus platypterus recorded lowest total length (TL) of 115 cm and highest total length (TL) of 298 cm while Xiphias gladius recorded the lowest, Lower Jaw Fork length (LJFL) length of 80 cm and highest length of 260 cm."

39. The WPB **NOTED** that while Kenya has implemented a national observer program related to the pelagic longline fishery, which is composed of three longliners, not all observers are fully trained or collect biological information according to the mandatory data requirements of the IOTC Regional Observer Scheme. The WPB therefore **ENCOURAGED** Kenya to equip observers with IOTC billfish species ID cards and also facilitate follow-up observer training to ensure the collection of biological data on all billfish species.

Indian billfish fishery

40. The WPB **NOTED** paper IOTC–2019–WPB17–27 which summarises the distribution of billfish caught by Indian longliners in the Indian EEZ, which included the following abstract provided by the authors:

"Distribution, abundance of bill fishes of the family Xiphiidae (Sword fish- Xiphias gladius) and Istiophoridae (Indo-Pacific sailfish-Istiophorus platypterus, Black marlin-Istiompax indica and Blue marlin-Makaira nigricans) in the Indian seas were investigated by analyzing the data collected during the exploratory tuna longline fishing conducted by the Fishery Survey of India. There are four Tuna long line fishing vessels (M.F.V. Blue marlin, M.F.V Yellow fin, M.F.V Matsya Vrushti and M.F.V Matsya Drushti) were involved for this survey cruises during the period from 2009 – 2018. The targeted Tuna and other bycatch details were excluded for this analysis and only bill fish catches during the survey were furnished in this report. The data from East coast of India including Andaman waters (FAO area 57) and West coast of India (FAO area 51) were divided in to 5 degree Latitude / Longitude grid. Seasonal and temporal variation of bill fish abundance during the study period of 10 years were given in this report. The abundance of Xiphias gladius revealed a diminishing trend from the 2009 to 2018 in Andaman waters but in area Lat7-12°N/Long.89-94°E the cpue was moderate and stable throughout the study period. However, X. gladius was dominated among the bill fish catches (54.6%) by an average catch per unit effort of 0.13 nos. per 100 hooks in Andaman waters. In general Istiophorus platypterus was dominated in the catches of East coast of India by 57% among the Bill fish catches during the past 10 years period from 2009-2018. Interestingly in west coast also the Indo pacific sail fish dominated in the catches by 49% during the study period, whereas the catch per unit effort was between 0.051 and 0.54 nos. per 100 hooks during 2009-2018. The length (LJFL) range of X.gladius occurred in Indian seas was between 65cm and 316cm, the length weight relationship

was 0.000002 L 3.28 during the year 2018, whereas the length range of I.platyperus was 53-289cm (LJFL) and the length weight relationship was 0.00009 L 2.2"

41. The WPB **NOTED** some gaps in the data where identified and **ENCOURAGED** Indian scientists to present more detailed information at the next meeting, especially changes to the fishing strategy which may impact the derived CPUE.

4.3 New information on sport fisheries

42. The WPB **NOTED** that despite a Sports Fisheries pilot project conducted a few year ago, which aimed to develop tools to facilitate CPCs to collect and report data on sports and recreational fisheries, there has been no significant improvements in the availability of data for sports fisheries due to a number of reasons, including:

    - Lack of human and financial resources to support the long-term data collection for sports fisheries by developing coastal states, which in some cases may be considered a low priority given their relatively minor contribution to the total catches across *all species and fisheries* within a CPC.
    - In some cases, limited opportunities for engagement or poor relations between national and local fisheries agencies and sport fishing clubs and operators within CPCs.
    - Lack of awareness by CPCs of their mandatory obligations to report catches from sports and recreational fisheries as part of Resolution 15/02.

43. The WPB **REQUESTED** that CPCs improve efforts to collect and report data on sports and recreational fisheries to the IOTC Secretariat as a matter of priority, given their importance in terms of their contribution to total billfish catches.

5. MARLINS

5.1 Review of new information on marlin biology, stock structure, fisheries and associated environmental data

44. The WPB **NOTED** that no papers were presented under this standing agenda item during the WPB17 meeting.

5.2 Review of any biological data in support of retention and transhipment bans for specimen below a minimum size, as per recent IOTC Resolutions

Billfish biology from Chinese longline observer data

45. The WPB **NOTED** paper IOTC–2019–WPB16–14 which compared the biology of four billfish species in the Indian Ocean based on Chinese longline observer data, including the following abstract provided by the authors:

    "Billfish are commercially important by-catch species in tuna longline fishery. In the latest stock assessments in WPB16, the stock status of striped marlin in the Indian Ocean is determined to be overfished and subject to overfishing, while black marlin is considered not be overfished, but overfishing is occurring. Considering that the biology of some billfishes is different between the sexes, sex-specific model was suggested to develop in the future. WPB encouraged more collection of biological information (e.g. from observer) to make those key parameters available for the model. On this account, based on the new supplementary data from four observers sampling aboard tuna longliner in 2018, this paper made an update on the length at maturity of four billfish species in the IO. Relatively sufficient data for blue marlin (254 samples for male and 160 for female) and striped marlin (86 samples for male and 88 for female) allowed the development of sex-specific maturity curves. Calculation results showed 50% & 95% maturity length for blue marlin are 179.6 & 221.1 for male, and 178.0 & 207.8 for female, while for striped marlin are 183.7 & 222.9 for male, and 169.0 & 211.0 for female. Gender-mixed maturity length for black marlin (sample size ~90) and Indo-Pacific sailfish (sample size ~112) are 179.1 & 208.5, and 195.8 & 239.6, respectively"

46. The WPB **NOTED** the work represents an update of the size-at-maturity study for billfish, with supplementary data from four additional observers in 2018. The WPB **NOTED** that on average the sample size doubled for each of the four main marlin species, and sex specific estimates are also available in response to the request from the previous WPB meeting.

47. The WPB **NOTED** the 6-stage maturity scale used in the study and differences in their definitions can occur. The WPB **AGREED** that the interpretations of the results should be homogenized to be consistent between studies.

48. WPB **NOTED** the size distribution of the samples was generally skewed towards large individuals, and **SUGGESTED** that there was the possibility of bias in the sampling conducted by observers. The WPB **NOTED** observers identify small specimens as immature and that the different maturity scale for maturity has been used for male and female specimens.

49. WPB **ACKNOWLEDGED** the importance of the study and **ENCOURAGED** further collection of biological data (e.g. length information, weight of gonads) and the identification of the maturity stage for small fish. The WPB also **ENCOURAGED** China to analyse and present their observer data from the Chinese longline fishery to relevant IOTC Working Party meetings.

Billfish size-at-maturity from the Western Indian Ocean

50. The WPB **NOTED** paper IOTC–2019–WPB17–15 which provides estimates of length at maturity marlin species from the Western Indian Ocean, and included the following abstract provided by the authors:

"Billfish are caught as bycatch in tropical fisheries. Most billfish species stocks are evaluated by RFMOs and stock assessment models generally require reproductive biology parameters such as the size-at-maturity. However, the reproductive biology of billfish species in the Indian Ocean is poorly known. The objective of this study is to fit maturity curves by sex for billfish species such as the black marlin, the blue marlin, the striped marlin, the shortbill spearfish, the Indo-Pacific sailfish, and the swordfish, and to determine the L50 (size at which 50% of the individuals are mature). We used 1480 samples from scientific cruises carried out by YugNIRO (1969-1989) and IRD (2003-2015) in the Indian Ocean to test and compare two methods for fitting maturity curves. The method that is commonly used consists in building the maturity curve from proportions of mature individuals by size class intervals with a logistic curve. The alternative method that we propose here is a Binomial regression that directly fits a logistic curve from binary immature/mature data. We showed that the Binomial regression method is the better method. We were able to fit maturity curves and determine L50, including a confidence interval, for most species by sex. For the black marlin, the L50 is 185 cm (LJFL) for males and none could be found for females. The L50 for striped marlins is 232 cm for females and could be determined for males. The sailfish reaches maturity at 203 and 210 cm for females and males respectively. Finally, swordfish females and males have a L50 of 152 and 129 cm."

51. The WPB **NOTED** that EU,France has presented an alternative method that is more reliable to estimate the maturity curve and length at maturity for billfish.

52. The WPB **NOTED** the potential differences in the maturity stage compared with the Chinese longline observations, and the size at maturity is found to be for larger fish than for the Chinese longline observations. The WPB **NOTED** that both studies used macroscopic observations and **SUGGESTED** that EU,France and China collaborate on developing the same maturity staging standard for the billfish species, and **ENCOURAGED** these studies to be continued further.

53. The WPB **NOTED** that the Gonado Somatic Index (GSI) could be used to improve the current analysis. Maturity for female striped marlin is found to be very large (for stage 2) and GSI could then be used to reclassify some of the individuals. As a result the L50 maturity of striped marlin appears to be overestimated and no stage 6 were found in the sample while large fish were found in stage 2 and suggested that this may be related to maturity stage identification issues.

5.3 Review of new information on the status of marlins (all)

Blue marlin

Indonesia longline CPUE

54. The WPB **NOTED** paper IOTC–2019–WPB17–16 providing a standardised CPUE indices for blue marlin from 2006 to 2017 for the Indonesia tuna longline fisheries in the Indian Ocean, which included the following abstract provided by the authors:

"Blue marlin (Makaira nigricans) is usually caught as frozen by-catch in by Indonesian tuna longline fleets. Its contribution estimated around 31% (~4,000 tons) from of total catch in Indian Ocean. Relative abundance indices as calculated based on commercial catches are the input data for several to run stock assessment analyses that provide models to gather information useful information for decision making and fishery management. In this paper a Generalized Linear Model (GLM) was used to standardize the catch per unit effort (CPUE) and to calculate estimate relative abundance indices based on the Indonesian longline dataset. Data was collected from January 2006 to December 2018 through scientific observer program (2005-2018). Most of the vessels monitored

were based in Benoa Port, Bali. On overall, the Delta-gamma performs better on data with high proportion of zeros compared to other traditional models. CPUE trend relatively stable, despite the fluctuation over the years of estimation. Catch rates are likely affected by temporal trend rather than operational or environmental effects. However, the final model also leaves high range of uncertainty, which leave room for further improvement in the future"

55. The WPB **THANKED** the authors for work and **ACKNOWLEDGED** the different models used to derive standardized CPUE for Blue marlin.

56. WPB **NOTED** that while the data combine information from Indonesia's scientific observers and also the Regional Observer Program, these two sets of data are very similar as they both collect the same types of information.

57. WPB **ACKNOWLEDGED** the data screening is appropriate and does not result in a dramatic reduction in the proportion of zero catches. The WPB **SUGGESTED** that alternative methods are explored to exclude areas with minimum catches of blue marlin, as 85-90% of zero catches is still considered to be very high.

58. The WPB **NOTED** that the CPUE standardisation has considered models with and without area effects, and the model without area effects tends to give more stable results. The WPB **SUGGESTED** further analyses examine whether there are different trends amongst areas, or if there are changes in the distribution of effort. If changes in distribution over time occurred, it would be important to add this component to the model to improve the CPUE standardisation.

59. WPB **NOTED** that the positive anomaly in 2012 is not consistent with other years. This may be linked to the data screening procedure which excluded trips without any blue marlin catches and which may have a large effect on 2012 given its low effort and high catches. No further conclusions can be drawn as to whether the positive spike is related to an actual increase in abundance. WPB **AGREED** that the increase in CPUE by more than two-fold in such a short time-frame may not be biologically plausible.

Spanish longline CPUE

60. The WPB **NOTED** paper IOTC–2019–WPB17–17, which provided standardised CPUE indices for blue marlin from 1980 to 2017 for the Spanish tuna longline fisheries in the Indian Ocean, and which included the following abstract provided by the authors:

*"Standardized yields of blue marlin were obtained from 1,914 recorded trips (65.1*106 hooks) by the surface longline fleet targeting swordfish in the fishing areas of the Indian Ocean during the period 2003-2017. The observations represent about 90% of the total fishing effort of this fleet during this combined period. Roughly 7% of the trips recorded during this period showed a positive catch of these species (at least one fish). However a part of the observation analyzed were obtained during scientific surveys done in warmer areas where occurrence of this species is more likely but in which the fishing activity was sporadic and it is not currently carried out. Because of the low occurrence and prevalence of this species in this fishery, the standardized yields were calculated using a Generalized Linear Mixed Model, assuming a delta-lognormal error distribution. An overall flat trend was predicted for the whole period considered, with some annual fluctuations. Some other considerations are also discussed"*

61. The WPB **NOTED** that the CPUE was based on longline vessels that mostly targeted swordfish and blue sharks, with the majority of data coming from the southwest Indian Ocean. The WPB **NOTED** that the fishing operations typically occurred during night time and used shallow sets, and catch rates of blue marlins were expected to be very low.

62. The WPB **NOTED** the CPUE shows no obvious trend, and that preliminary investigations suggested that it is not very informative from a modelling perspective. For this reason the WPB **AGREED** not to include the Spanish CPUE indices in the 2019 assessment of blue marlin**.**

Taiwanese longline CPUE

63. The WPB **NOTED** paper IOTC–2019–WPB17–18 which provided the standardised CPUE indices for blue marlin from 1980 to 2017 for the Taiwanese tuna longline fisheries in the Indian Ocean, and which included the following abstract provided by the authors:

"This paper described the historical patterns of blue marlin catches of Taiwanese large scale longline fishery in the Indian Ocean. The cluster analysis was adopted to explore the targeting of fishing operations. In addition, the CPUE standardizations were conducted using delta-gamma generalized linear models because blue marlin were the bycatch of Taiwanese longline fishery and large amount zero catch existed in the data sets. The results indicate

that the effects of targeting (clusters) provided most significant contributions to the explanation of the variance of CPUEs of blue marlin for the models with positive catches, but the catch probability of blue marlin might be mainly influenced by temporal and spatial effects".

64. The WPB **THANKED** the authors for the update to the Taiwanese CPUE series, which is an integral input into the stock assessment models.

65. The WPB **NOTED** that there is a trend of increasing hooks between floats over time by the Taiwanese longline fleets, indicating a shift toward deeper sets.

66. The WPB **NOTED** the large spike of CPUE index in 2011–12 in the northwest regions coincided with a period of substantial redistribution of fishing effort as a result of a number of longline vessels returning to the fishing grounds previously impacted by piracy during the mid to late-2000s. During this period of 2011-12 catches of swordfish and billfish species increased substantially, in addition to significant increases in the catch rates for tropical tuna species, which were observed by the WPTT. The WPB **AGREED** that the link between abundance and CPUE may be complicated due to changes in the fishing grounds and relocation of vessels during this period and the associated impact on catchability.

67. WPB **NOTED** the Taiwanese CPUE index has a substantial impact on the assessment. WPB further **NOTED** that during the last meeting of the group, it was proposed to split the time series to take into account changes in fishing operations (e.g., to account for the changes in catchability pre and post 2010/11). The WPB therefore **SUGGESTED** removing the CPUE time series after 2010 for both the northwest and northeast regions when including these in the stock assessment.

68. The WPB **NOTED** that in the southern region of the Indian Ocean, where the Taiwanese longline fleet mostly target albacore tuna with shallow sets, encounter rates of marlins are significantly lower. As the indices presented for the southern regions were probably less credible for blue marlin, the WPB **AGREED** to use the Taiwanese indices from northwest and northeast for the stock assessment.

69. The WPB **NOTED** a number of additional suggestions to improve the future standardisation analysis, including the inclusion of fishing operation characteristics (e.g. branch line length, if available), and to use temporal and spatial modelling approach to better account for spatial effects.

Japanese longline CPUE

70. The WPB **NOTED** paper IOTC–2019–WPB17–19 which provided standardised CPUE indices for blue marlin from 1994 to 2018 for the Japanese tuna longline fisheries in the Indian Ocean, and which included the following abstract provided by the authors:

"We addressed to standardize CPUE of blue marlin (Makaira nigricans) caught by Japanese longline fishery in the Indian Ocean. The time-period of this study limits between 1994 and 2018 due to large uncertainties such as species discrimination in the earlier period logbook data. We used the three core areas (Northwest, Southwest and Central east) with high density of blue marlin caught for the analysis following the approach by Yokoi et al. (2016). We applied the zero-inflated Poisson GLMM for the CPUE standardization (catch number) of blue marlin. To evaluate the shrink of Japanese longliner operations, we calculated different period standardized CPUE (1994-2010 and 1994-2018 (1994-2014 for the Northwest)). There was no substantial difference between the two CPUEs for all core areas. The standardized CPUE typically decreased from mid-1990s to mid-2000s for all core areas, although the trend was different from that of nominal CPUE in the Southwest. There was little significant difference of standardized CPUE between four quarters as well as between two gear depths for each core area, but the zero-catch rate during April-September always rose close to 100% in the Southwest. In the model diagnosis, we checked Pearson residuals corresponding the explanatory variables. There are little clear trends against the explanatory variables, but Pearson residual showed some time-spatial patterns for all core areas. Considering this result, it might need to address the geostatistical model in the future study".

71. WPB **NOTED** the CPUE standardisation from Japan has used a zero-inflated model. This explains why residuals of the model are not evenly distributed around zero.

72. The WPB **NOTED** the core areas approach (NW, CE, and SW) would allow the analysis to focus on areas with high blue marlin density, and reduce the proportion of zero sets in the dataset and define a fishery that is more consistent in terms of catches and occurrences of blue marlin.

73. The WPB **NOTED** the similar trend for the standardised indices from the three core areas. However there is very large uncertainty after 2010 in the northwest region due to lack of data. The WPB therefore **SUGGESTED** remove the CPUE time series after 2010 for the northwest region when including this index in the stock assessment.

74. The WPB further **NOTED** the catch rates of blue marlin were extremely low in quarters 2 and 3 in the southern regions. This may be due the absence of fish in the area during the Austral winter season, and the WPB **AGREED** to include only the CPUEs from NW and CE in the stock assessment models.

75. Regarding the availability of indices prior to 1994, the WPB **NOTED** there were potential issues in the dataset before 1979 (i.e., vessel ID was missing) but data after 1979 are available. The WPB therefore **REQUESTED** that the standardized indices be extended back to 1979 for use in the current stock assessment.

CPUE Summary discussion

76. The WPB **NOTED** the different trends seen in the longline CPUE series and discussed which might be considered more reliable. The WPB **AGREED** to consider the updated Japanese longline for NW (up to 2010) and CE regions, and Taiwanese indices for the NW and NE, and Indonesian indices for the blue marlin stock assessment model (**Figure 1**). The WPB **THANKED** Japan for providing the updated CPUE during the meeting.

77. The WPB discussed whether there is merit to use the same method for standardisations, for the purposes of consistency. The WPB **AGREED** that the methods should depend on the data available in each case, which may vary by country or fleet. The **WPB SUGGESTED** that a joint CPUE analysis between CPCs (e.g., Japan and Taiwan,China) would be useful to develop indices for marlin species and **ENCOURAGED** the national scientists to collaborate in order to achieve this.

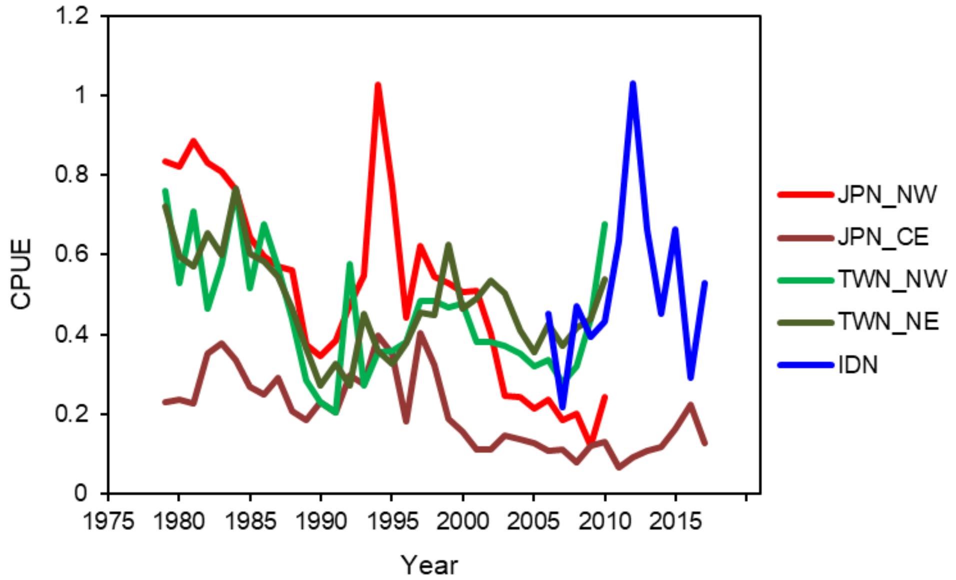

Figure 1. Standardized CPUE series of blue marlin in the Indian Ocean
These series have been scaled to the mean for comparison.

5.3.1 Stock assessments

Blue marlin: Summary of stock assessment models in 2019

Bayesian State Space Surplus Production Model (JABBA)

78. The WPB **NOTED** paper IOTC–2019–WPB17–20a which provided continuity runs of the Andrade (2016) Bayesian state-space surplus production model assessment of Indian Ocean blue marlin stock using JABBA, which included the following abstract provided by the authors:

"*Continuity between consecutive stock assessments is fundamental to tracking stock status over time. Here we attempt to create a continuity assessment of the 2016 Bayesian State-Space Surplus Production Model assessment of the Indian Ocean blue marlin (Makaira nigricans) documented in Andrade (2016) using the open-source stock assessment tool JABBA. All JABBA scenarios produced B/BMSY trajectories that steadily declined from the mid 1970's to around 2008 before increasing to the 2015 B/BMSY estimates and all scenarios produced F/FMSY trends that steadily increased from 1980 to 2015. The Schaefer informative JABBA scenario indicated that the stock was "subject to overfishing" in 2015 but not overfished - the WPB14 decided that the equivalent Andrade (2016) scenario would be used to provide management advice. The point estimates between the models were comparable B/BMSY: JABBA = 1.13; Andrade = 1.11 and F/FMSY: JABBA = 1.26; Andrade = 1.18. Thus, JABBA was able to accurately recreate the Andrade (2016) assessment* *of Indian Ocean blue marlin. Notwithstanding severe data conflict in recent years (2016-2018), a 2019 blue marlin assessment using JABBA should provide results comparable to projections from previous assessments. This is important to evaluate the efficacy of previous management recommendations to the IOTC Commission"*

79. The WPB **THANKED** the authors for providing the continuity run. This approach was to ensure comparability of models used in-between assessments, thus increasing the confidence of model results to be used for management advice.

80. The WPB **RECALLED** that the last stock assessment used for management advice, conducted in 2016 using the *Bayesian State-Space Surplus Production Model*, estimated the stock of blue marlin in 2015 was not overfished but was subject to overfishing.

81. The WPB **NOTED** the continuity runs of the four model configurations (i.e., two types of surplus production functions and two types of priors) produced very similar results to the previous assessment except for the B_{MSY} estimates, which may have been related to the approach of treating the informative prior (as a range prior was used in previous assessment, while a log normal prior was used for JABBA).

82. In view of the continuity runs, the WPB **AGREED** to use base scenarios from the previous assessment (informative prior and Schaefer model) as the basis for the 2019 JABBA assessment. The Schaefer model was selected for continuity with the previous assessment conducted in 2016.

83. Based on the preliminary investigation, The WPB **AGREED** to consider the following model runs with various configurations of CPUE:

    - S1:JPN_hist+JPN_NW+JPN_CE+IDN
    - S2:JPN_hist+JPN_NW+JPN_CE+TWN_NW+IDN
    - S3:JPN_hist+JPN_NW+JPN_CE+TWN_NW+TWN_NE+IDN
    - S4:JPN_NW+JPN_CE+TWN_NW+TWN_NE+IDN

    [JPN_hist is the CPUE time series provided by Japan in 2016 (Yokoi, et al 2016); subset 1971-1993]

84. The WPB **NOTED** the 'Run' tests suggested S1 has less data conflict (and which has the least CPUE indices). The WPB also **NOTED** models with both Japanese and Taiwanese indices also perform reasonably well, although data conflicts persist to various degrees.

85. The WPB **NOTED** the consensus to use a base case model which included the JPN indices (NW and CE), Taiwanese indices (NW and NE), and Indonesian indices. The WPB also **AGREED** to extend the JPN indices (both NW and CE) back to 1979, and **REQUESTED** a sensitivity run be conducted using a Fox production model for comparison with the SS3 assessment .

86. The WPB **NOTED** the key assessment results for JABBA assessment for blue marlin as shown below (**Table 3; Figure 2**), and that the retrospective analysis produced generally consistent stock status estimates (**Figure 3**).

87. WPB **NOTED** that in the initial scenarios of the JABBA model the Kobe plot suggested that the stock was overfished before overfishing has occurred, and that this issue was also raised during the last time stock assessment. However this is not the case in the final model runs with the updated CPUE time series.

88. WPB **NOTED** the final model runs conducted during the meeting will be fully documented in paper IOTC -2019-WPB17-20b.

Table 3. Stock status summary table for the blue marlin assessment base case model (JABBA)

Management Quantity	JABBA (base)
Current catch	12,029
Mean catch over last 5 years	11,608
MSY (1000 t)	9.98 (8.18 –11.86)
F_{MSY}	0.21 (0.13 – 0.35)
Current Data Period	1950 – 2017
F_{2017}/F_{MSY}	1.47 (0.96 – 2.35)
B_{2017}/B_{MSY}	0.82 (0.56 – 1.15)
SB_{2017}/SB_{MSY}	n.a.
B_{2017}/B_0	0.41 (0.28 – 0.57)

SB_{2017}/SB_0	n.a.

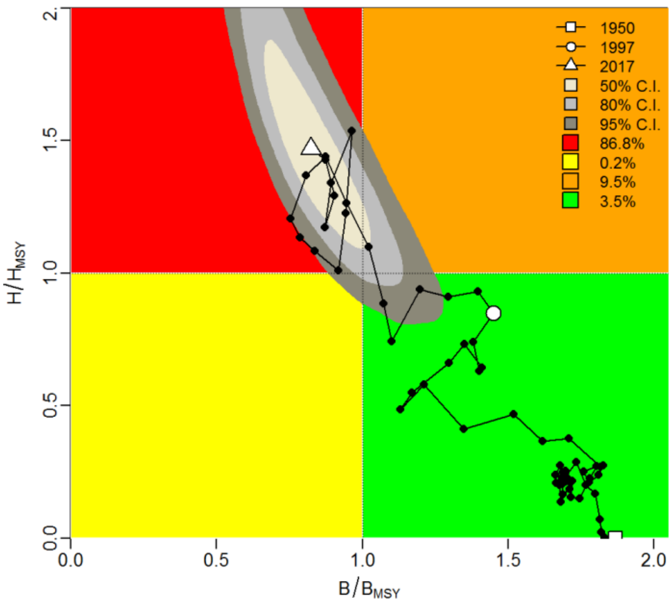

Figure 2. JABBA: Kobe stock status plot for the Indian Ocean for blue marlin, from the final JABBA base case. The black line traces the trajectory of the stock over time. Contours represent the smoothed probability distribution for 2018 (isopleths are probability relative to the maximum).

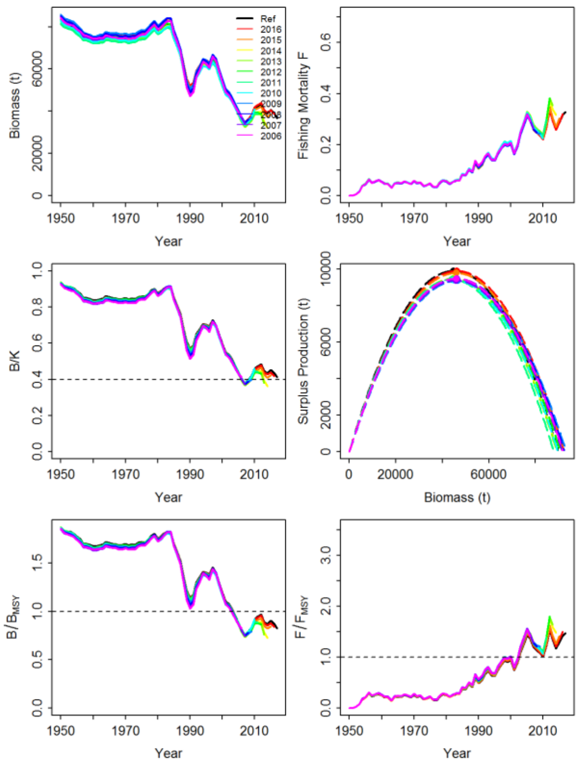

Figure 3: Retrospective analysis for stock biomass (t), surplus production function (maximum = MSY), B/B_{MSY} and F/F_{MSY} for the Indian Ocean blue marlin JABBA base model.

Stock synthesis (SS3)

89. The WPB **NOTED** paper IOTC–2019–WPB17–21 which provided a stock assessment of blue marlin in the Indian Ocean using Stock Synthesis 3, and which included the following abstract provided by the authors:

"Paper IOTC–2019–WPB17–21 described the stock assessment for blue marlin in the Indian Ocean using Stock Synthesis (SS), which was conducted the by incorporating historical catch, standardized CPUE series, length-frequency data and life-history parameters. The results of most scenarios indicated that the current spawning biomass is higher than the MSY level but the fishing mortality may be either lower or higher the MSY level depending on the adoption of CPUE series. Based on the results of the scenario selected by the WPB (S5), the current stock status of blue marlin in the Indian Ocean may probably be subject to overfishing but not overfished, while there was also a possibility that the stock was overfished. However, most of the life-

history parameters used in this study were based on the values of blue marlin in the Pacific Ocean. These may lead to the uncertainties in the evaluation of the stock status of blue marlin in the Indian Ocean"

90. The WPB **NOTED** the SS3 model for blue marlin was configured as a single area, sex specific model (due to sexual dimorphic growth), and that the fisheries were grouped into four fleets: Taiwanese longline, Japanese longline, Indonesian longline, and others. The observational data included the standardised CPUE indices for the Taiwanese fleet (1979-2017, NW and NE series combined), Japanese fleet (1994-2017), and Indonesian fleet (2008-2017), and size frequency data. The WPB further **NOTED** that the life history parameters were fixed at known estimates from the Pacific Ocean.

91. The WPB **NOTED** that as spawning stock biomass is calculated from female fish only, the male maturity at length is not required for the SS3 model.

92. The WPB **NOTED** that the model assumed a dome-shaped, time-invariant selectivity for the Taiwanese and Japanese longline. The selectivity for the Indonesian and "other" fleets was assumed to be same as the Taiwanese fleet. The WPB **NOTED** standardized CPUE series revealed different patterns by fleets and areas, and six model scenarios were implemented corresponding to different combinations of area-specific standardized CPUE series of Taiwanese and Japanese fleets as follows:
    - TNWJCE (TWN_NW+JPN_CE+IDN).
    - TNWJNW (TWN_NW+JPN_NW+IDN).
    - TNWJSW (TWN_NW+JPN_SW+IDN).
    - TNEJCE (TWN_NE+JPN_CE+IDN).
    - TNEJNW (TWN_NE+JPN_NW+IDN)
    - TNEJSW (TWN_NE+JPN_SW+IDN)

93. The WPB **NOTED** the model cannot appropriately fit the CPUE series of Taiwanese and Japanese fleets between the early 1990s and the mid-1990s due to conflicting CPUE trends obviously between these two fleets. The WPB further **NOTED** that the models cannot adequately fit the length-frequency data before the early-2000s when high proportions of small fishes were observed, and that the model fits also deteriorated for Japanese length-frequency data after the early-2000s due to the low sample size numbers.

94. The WPB **NOTED** the conflict between the Taiwanese and Japanese indices cannot be easily resolved, and suggested conducting models runs with the following CPUE scenarios to cover possible abundance trend (as in the JABBA model).
    - S1:JPN_hist+JPN_NW+JPN_CE+IDN
    - S2:JPN_hist+JPN_NW+JPN_CE+TWN_NW+IDN
    - S3:JPN_hist+JPN_NW+JPN_CE+TWN_NW+TWN_NE+IDN
    - S4:JPN_NW+JPN_CE+TWN_NW+TWN_NE+IDN

95. The WPB **NOTED** that the results are broadly similar between the models but conflicts between CPUE indices persist which influence estimates of the biomass trend. The WPB further **NOTED** including the historical Japanese indices (prior to 1994) allows the model to better determine biomass in the early years and also fit the recent Japanese CPUE indices (NW and CE) better.

96. In view of the analysis above, the WPB **AGREED** on a base model (S5) which replaced JPN indices (NW and CE, both extended back to 1979), Taiwanese indices (NW and NE), and Indonesian indices. The WPB also **AGREED** to conduct a sensitivity analysis using an asymptotic selectivity for the JPN longline fleet ensure that the model did not to produce cryptic biomass (S6).
    - S5:JPN_NW(updated to 1979)+JPN_CE(updated to 1979)+TWN_NW+TWN_NE+IDN
    - S6: same as S5 with asymptotic selectivity

97. The WPB **NOTED** that it is a good practice to start the model in the year close to the time when CPUE becomes available. However, for blue marlin, the catches in the early years were high, and there is lack of data to allow the model to estimate initial population structure. While it is possible to start the model in 1970 when abundance data are available, the WPB **AGREED** to start the model in the 1950s. The WPB **NOTED** the key assessment results for SS3 for blue marlin as shown below (**Table 4; Figure 4**).

Table 4. Stock status summary table for the blue marlin SS3 assessment (model S5).

Management Quantity (model S5)	Aggregate Indian Ocean
2017 catch estimate	12,029
Mean catch from 2013–2017	11,608
MSY (1000 t) (80% CI)	9.108 (8.669, 9.666)
Data period (catch)	1950–2017
F_{MSY} (80% CI)*	5.962 (5.420, 6.531)
SB_{MSY} (1,000 t) (80% CI)	16.902 (15.958, 17.928)
F_{2017}/F_{MSY} (80% CI)	1.050 (0.944, 1.185)
SB_{2017}/SB_{MSY} (80% CI)	1.055 (0.874, 1.253)
SB_{2017}/SB_{1950} (80% CI)	0.183 (0.151, 0.227)

* *Fishing mortality was estimated based on the approach of hybrid methods of SS3.*

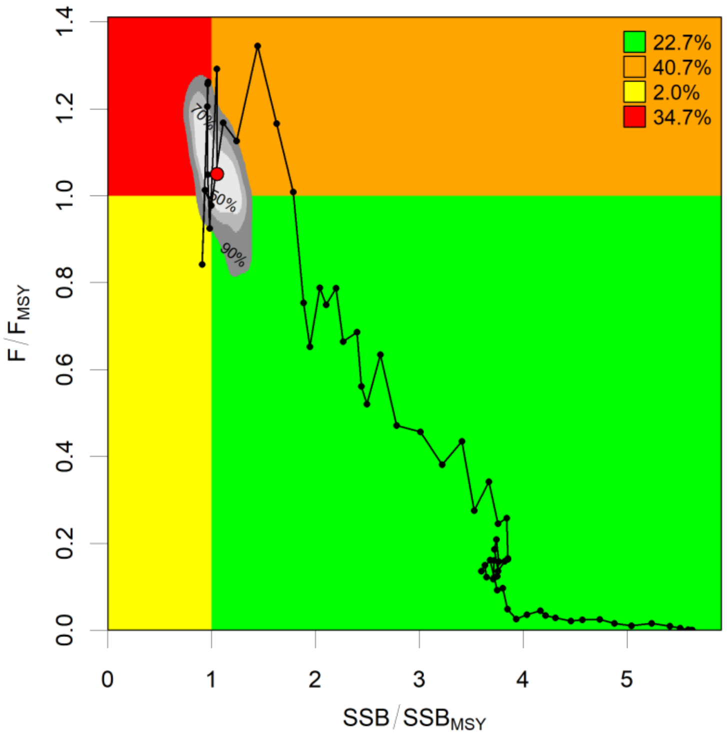

Figure 4. Stock synthesis: Kobe stock status plot for the Indian Ocean for blue marlin (model S5). The black line traces the trajectory of the stock over time.

5.4 Development of management advice for marlins and update of marlin species Executive Summaries for the consideration of the Scientific Committee including discussion on current catch limits as per standing IOTC Resolutions

Blue marlin

98. The WPB **NOTED** the overall consistent biomass trend estimated by the JABBA and SS3 models, and that the differences in estimated management quantities are likely to be attributed to different production functions inherent in these models. The sensitivity run of JABBA using a fox-type model also produced very similar results to the SS3 model and the WPB therefore **AGREED** that the JABBA model be used for management advice for blue marlin.

99. The WPB **ACKNOWLEDGED** the ability of JABBA to accurately recreate the results of the previous blue marlin assessment (Andrade 2016), as documented in IOTC-2019-WPB17-20a. The JABBA model is therefore likely to provide a suitable continuity assessment in 2019. Furthermore, the WPB **NOTED** the dependence of the SS3 model on biological input parameters which have been taken from the Pacific Ocean as a consequence of paucity of biological information on blue marlin derived from the Indian Ocean.

100. The WPB **NOTED** that almost all the biological parameters for blue marlin in the SS3 model are derived from the Pacific Ocean, and strongly **ENCOURAGED** CPCs to collect biological information for marlin species to

help reduce the potential uncertainty of future stock assessments inherent in the current limited range of biological parameters available.

101. The WPB **NOTED** the JABBA assessment model estimated the current stock biomass is below B_{MSY}, and the current fishing mortality is higher F_{MSY}.

102. The WPB also **NOTED** that there were no systematic deviations in the retrospective analysis from the JABBA model, which provides some confidence in the predictive capabilities of the model.

103. The WPB **NOTED** the management advice developed for blue marlin (executive summary) at WPB17 :

"The current catches of blue marlin (average of 12,008 t in the last 3 years, 2015-2017) are higher than MSY (9,984 t) and the stock is currently overfished and subject to overfishing. In order to achieve the Commission objectives of being in the green zone of the Kobe Plot by 2027 (F2027 < FMSY and B2027 > BMSY) with at least a 60% chance, the catches of blue marlin would have to be reduced by 35% compared to the average of the last 3 years, to a maximum value of approximately 7,800 t."

- Blue marlin (*Makaira indica*) – Appendix VIII

6. INDO-PACIFIC SAILFISH

6.1 Review of new information on Indo-Pacific Sailfish biology, stock structure, fisheries and associated environmental data

104. The WPB **NOTED** paper IOTC–2019–WPB17–22 which summarises the distribution of Indo-Pacific Sailfish in Pakistan waters, and which included the following abstract provided by the authors:

"*Billfish form important part of the landings of tuna and tuna like fishes from Pakistan. Its landings during 2018 were reported to be about 3,521 m. tons. Indo-Pacific sailfish (Istiophorus platypterus) contributed 2,154 m. tons. Contribution of Indo-Pacific sailfish in total billfish landings was 61.18 %, therefore, this species is considered to be most important billfish species. This species is harvested by tuna gillnets vessels from continental shelf and slope area during August and November whereas in winter it is mainly harvested from central Arabian Sea (in the EEZ of Pakistan and beyond). Indo-Pacific sailfish is one of the highly migratory and oceanodromous species which is regularly being fished in all countries of the Arabian Sea. High value of E max= 0.575 is indicative that there are symptoms of over-exploitation of the stocks of Indo-Pacific sailfish by Pakistani tuna fleets. Because of high demand Istiophorus platypterus is sent to neighbouring country where it fetches comparatively higher prices"*

105. The WPB **ACKNOWLEDGED** the efforts of WWF-Pakistan and **THANKED** the Government of Pakistan for this important study, and **REQUESTED** Pakistan to officially report the size frequency data to the IOTC Secretariat used in the analyses presented in the paper.

6.2 Review of new information on the status of IP sailfish

6.2.1 Nominal and standardized CPUE indices

Spanish longline CPUE

106. The WPB **NOTED** paper IOTC–2019–WPB17–23 which provided standardised CPUE indices for Indo-Pacific Sailfish of the Indian Ocean from the Spanish tuna longline fishery, and which included the following abstract provided by the authors:

"*Standardized yields of sailfish were obtained from 1,914 recorded trips (65.1*106 hooks) by the surface longline fleet targeting swordfish in the fishing areas of the Indian Ocean during the period 2003-2017. The observations represent about 90% of the total fishing effort of this fleet during this combined period. Roughly 50% of the trips recorded during this period showed a positive catch of these species (at least one fish). Because of the relatively low prevalence of this species in this fishery, the standardized yields were calculated using a Generalized Linear Mixed Model, assuming a delta-lognormal error distribution. An overall flat trend was predicted for the whole period considered, with some annual fluctuations. Some other considerations are also discussed"*

107. The WPB **THANKED** EU,Spain for conducting the analysis, but **NOTED** that additional details are needed on the distribution of catch-and-effort, as it was not clear how the standardisation has changed the raw catch rates. For this reason the WPB **AGREED** not to use the indices in the stock assessment this year.

6.2.2 Stock assessments

Indo-Pacific Sailfish: Summary of stock assessment models in 2019

108. The WPB **NOTED** paper IOTC–2019–WPB17–24 which details two assessment methods for IP-sailfish marlin in the Indian Ocean using catch-only methods, which included the following abstract provided by the authors:

"*Assessing the status of the stocks of billfish species in the Indian Ocean is challenging due to the paucity of data. There is lack of reliable information on stock structure, abundance and biological parameters. Data poor stock assessments were conducted for Indo-Pacific Sailfish (Istiophorus platypterus) in 2015 (Sharma 2015). This paper provides an update to that assessments based on the most recent catch information reported to the IOTC, using a revised Catch-MSY method (Froese et al. 2016). An additional method, stochastic stock reduction analysis, was also used to explore the potential to include the length frequency data in the assessment"*

C-MSY method

109. The WPB **RECALLED** that the last stock assessment conducted in 2015, using the Catch-MSY model of Indo-Pacific Sailfish, estimated that the stock was not overfished, but was subject to overfishing.

110. The WPB **NOTED** the C-MSY method included a number of modifications to the previous version of Catch-MSY method. Both methods rely on only a catch time series, prior ranges of *r* and *K*, and possible ranges of stock sizes in the initial and terminal years. The WPB **NOTED** that the following prior range was assumed for the I.P. sailfish: r (0.16 – 0.5); K (62-760); Initial B/K (0.5–0.9); Final B/K (0.3 – 0.7)

111. The WPB **NOTED** that the assessment results are highly sensitive to assumptions regarding productivity and final depletion. For C-MSY the choice of a high r from the range of plausible r values is poorly justified but has a noticeable effect on estimates of F_{MSY}.

112. The WPB **NOTED** that estimates of MSY are more stable than estimates of F_{MSY} or B_{MSY}, and Catch/MSY may be a more suitable indicator for management than B/B_{MSY} or F/F_{MSY}.

113. The WPB **NOTED** the results from the C-MSY assessment method:

Table 5. Stock status summary table for the IP sailfish assessment (C-MSY)

Management Quantity	C-MSY
Most recent catch estimate (year)	33 320 t (2017)
Mean catch – most recent 5 years	29 880 t (2013 – 2017)
MSY (95% CI)	23 900 (16 100 – 35 400)
Data period used in assessment	1950 – 2017
F_{MSY} (95% CI)	0.19 (0.14 - 0.24)
B_{MSY} (95% CI)	129 000 (81 000 – 206 000)
F_{2017}/F_{MSY} (95% CI)	1.22 (1 – 2.22)
B_{2017}/B_{MSY} (95% CI)	1.14 (0.63 – 1.39)
B_{2017}/B_0 (95% CI)	0.57 (0.31 – 0.70)

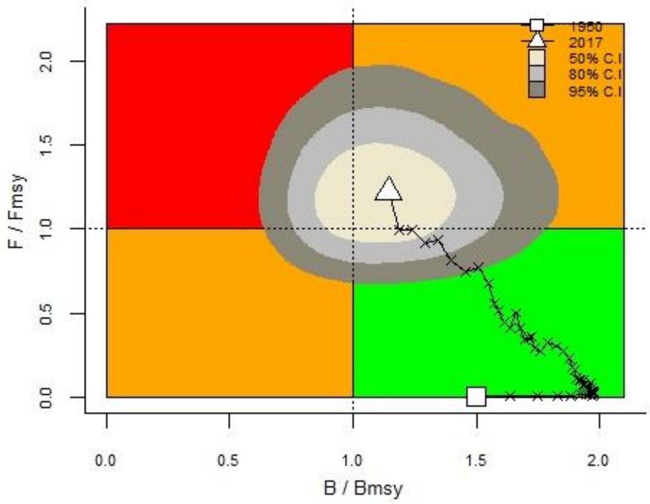

Figure 5. C-MSY: Kobe stock status plot for the Indian Ocean for Indo Pacific Sailfish, from the final C-MSY model. The black line traces the trajectory of the stock over time. Contours represent the smoothed probability distribution for 2017 (isopleths are probability relative to the maximum).

Stochastic Stock reduction analysis

114. The WPB **NOTED** that the stochastic SRA approach provides an exploration of alternative methods that utilise other types of data, but may not be well supported by data currently available. In this situation it might be preferable to develop a CPUE index and then apply the surplus production modelling approach, rather than apply a more complicated model which requires more data support.

115. The WPB **NOTED** the results from the Stochastic SRA assessment method**.**

Table 6. Stock status summary table for the black marlin assessment (Stochastic SRA)

Management Quantity	**C-MSY**
Most recent catch estimate (year)	33 320 t (2017)
Mean catch – most recent 5 years	29 880 t (2013 – 2017)
MSY (95% CI)	0.36 (0.08 – 0.90)
Data period used in assessment	1950 – 2017
F_{MSY} (95% CI)	0.36 (0.08 – 0.90)
B_{MSY} (95% CI)	114 415 t (39 550– 248 618)
F_{2017}/F_{MSY} (95% CI)	1.25 (0.14 – 4.00)
B_{2017}/B_{MSY} (95% CI)	1.52 (0.54 – 2.68)
B_{2017}/B_0 (95% CI)	0.46 (0.16 – 0.82)

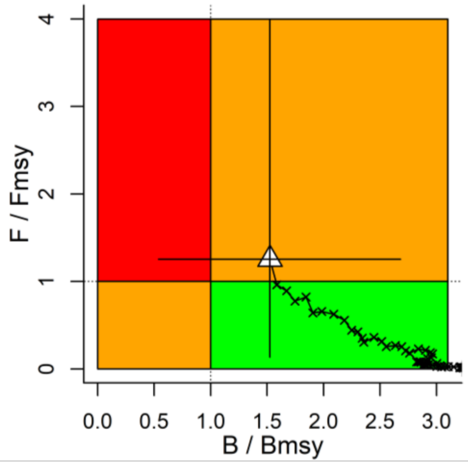

Figure 6. Stochastic SRA: Kobe stock status plot for the Indian Ocean for Indo-Pacific sailfish, from the Stochastic SRA. The black line traces the trajectory of the stock over time.

116. The WPB **NOTED** the consistency in the assessment results between all models with respect to MSY and stock status which suggest that Indo-Pacific Sailfish is currently being fished above the optimal rate of fishing mortality (F_{MSY}) and that catches are currently below the estimated MSY

6.3 Development of management advice for Indo-Pacific Sailfish and update of species Executive Summaries for the consideration of the Scientific Committee, including discussion on current catch limits as per standing IOTC Resolutions

Indo-Pacific Sailfish

117. The WPB **NOTED** the C-MSY assessment model estimated that the current stock biomass is above B_{MSY}, and the current fishing mortality is below F_{MSY}.

118. The WPB **NOTED** that the catch only method relies on accurate catch data. However the historic catch estimates in particular are considered highly uncertain, with around 29% of catches in recent years also partially or fully estimated by the Secretariat. In addition, the biological parameters were poorly known (with most parameter values for the assessment sourced from Fishbase). The WPB **NOTED** the management advice based on the catch-only model therefore needs to be treated with caution.

119. The WPB **NOTED** the management advice developed for Indo-Pacific Sailfish (executive summary) at WPB17:

"The catch limits as stipulated in Resolution 18/05 have been exceeded. The Commission should provide mechanisms to ensure that catch limits are not exceeded by all concerned fisheries. Research emphasis on further developing possible CPUE indicators from gillnet fisheries, and further exploration of stock assessment approaches for data poor fisheries are warranted. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps. The lack of catch records in the Persian Gulf should also be examined to evaluate the degree of localised depletion in Indian Ocean coastal areas."

- Indo-Pacific Sailfish (Istiophorus platypterus) – Appendix X

7. SWORDFISH

7.1 Review of new information on Swordfish biology, stock structure, fisheries and associated environmental data

120. The WPB **NOTED** that no papers were presented under this standing agenda item during the WPB17 meeting.

7.2 Review of new information on the status of swordfish

7.2.1 Nominal and standardized CPUE indices

121. The WPB **NOTED** paper IOTC–2019–WPB17–25 which provided Swordfish catch rates in relation to Sea Surface Temperature and Chlorophyll-A concentration within EEZ of Sri Lanka, and which included the following abstract provided by the authors:

"*Swordfish (Xiphias gladius) is one of the important bill fish species landed as a by catch of tuna- longline fishery. In 2018, the production of swordfish in the longline fishery within EEZ was 5795mt which contributes about 42% of the total bill fish catch. Remarkable changes of the monthly catch rates of sword fish can be observed from different zones of the country and may probably influenced by the monsoon driven temperature and chlorophyll fluctuations. Therefore, the present study was undertaken to understand temperature and chlorophyll a effects in the CPUE variations of swordfish within EEZ, Sri Lanka. The values of Sea Surface Temperature (SST) and Sea Surface Chlorophyll a (SSC) were obtained from remote sensing data while catch rates were based on 2016longline fishery data of log books. A Generalized Additive Model (GAM) was fitted for describing the relationships between oceanographic parameters and sword fish catch rates. The result of GAM shows that the relationships between swordfish catch rates and two oceanographic parameters are significant at 0.05 level (p<0.01). The higher catch rates of swordfish were observed from the areas where SST varied between 28.8-30.6 °C and SSC ranged from 0.11-0.16mgm-3.However the strongest relationship was observed between SST and swordfish CPUE. The GAM results show that space-time factor also has more influence on swordfish catch rates where high catch rates are primarily associated in productive areas of Sri Lankan EEZ"*

122. The WPB **NOTED** that the main targeted species by the longline fishery from Sri Lanka are yellowfin and bigeye tuna.

123. The WPB **ENCOURAGED** Sri Lanka to follow up this study on the swordfish habitat based on fishery dependent data by collecting individual length data in their habitat model, in addition to collecting biological data on the reproduction of swordfish.

124. The WPB **ENCOURAGED** the Sri Lankan scientist to include zero catch sets in their analysis since both null and positive catch are necessary in predicting the presence/absence of swordfish. It was also suggested to consider investigating fronts and strong gradients in oceanographic data such as altimetry (SSH) and temperature (SST).

South African longline CPUE

125. The WPB **NOTED** paper IOTC–2019–WPB17–26 was withdrawn and not presented during the meeting.

8. DEVELOPMENT OF OPTIONS FOR ALTERNATIVE MANAGEMENT MEASURES (INCLUDING CLOSURES) FOR BILLFISH IN THE IOTC AREA OF COMPETENCE

8.1 Review of new information on the status of other billfishes (other marlins) (all)

126. The WPB **NOTED** that no new information was presented during WPB17 meeting and currently there is no adequate biological information that allows management advice to be developed on this agenda item.

Striped marlin

127. The WPB **AGREED** that, as no new information was presented for striped marlin, the previous indicators, as well as the most recent catch estimates would be used to update the management advice from last year.

Black marlin

128. The WPB **AGREED** that, as no new information was presented for black marlin, the previous indicators, as well as the most recent catch estimates would be used to update the management advice from last year.

9. PROGRESS ON THE SWORDFISH MANAGEMENT STRATEGY EVALUATION

129. The WPB **NOTED** paper IOTC–2019–WPB17–INFO1 which provided an update of the MSE work for swordfish in the Indian Ocean. The paper was presented by the IOTC Secretariat on behalf of the author.

10. WPB PROGRAM OF WORK

10.1 Revision of the WPB Program of work (2020–2024)

130. The WPB **NOTED** paper IOTC–2019–WPB17–08 which provided an opportunity to consider and revise the WPB Program of Work (2020–2024), by taking into account the specific requests of the Commission, Scientific Committee, and the resources available to the IOTC Secretariat and CPCs.

131. The WPB **RECALLED** that the SC, at its 18th Session, made the following request to its Working Parties:

> "*The SC **REQUESTED** that during the 2016 Working Party meetings, each group not only develop a Draft Program of Work for the next five years containing low, medium and high priority projects, but that all High Priority projects are ranked. The intention is that the SC would then be able to review the rankings and develop a consolidated list of the highest priority projects to meet the needs of the Commission. Where possible, budget estimates should be determined, as well as the identification of potential funding sources.*" (SC18. Para 154).

132. The WPB **NOTED** that in response to the request from WPB16 and SC, additional samples of billfish species have been collected in the second phase of the IOTC stock structure project. The WPB **REQUESTED** an update of the study regarding the billfish species to be provided to the next WPB meeting.

133. The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2020–2024), as provided at Appendix XI.

10.2 Development of priorities for an Invited Expert at the next WPB meeting

134. The WPB **NOTED** that an Invited Expert may be required to support the next WPB meeting and **AGREED** that the decision for the selection of the candidate for the WPB18 be considered inter-sessionally. Once decided,

the selection will be performed by advertising the position through the IOTC science list (as a priority channel) and finalized after receipt and assessment of résumés and supporting information for potential candidates, according to the deadlines set forth by the rules and procedures of the Commission.

135. The WPB **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPB in 2020 by an Invited Expert:

- **Expertise**: Stock assessment, including from regions other than the Indian Ocean; SS3 assessment approaches.
- **Priority areas for contribution**: Refining the information base, historical data series and indicators for billfish species for stock assessment purposes (species focus: Swordfish).

11. OTHER BUSINESS

11.1 Election of a Chairperson and Vice-Chairperson for the WPB for the next biennium

136. The WPB **NOTED** that Dr. Denham Parker (South Africa) was nominated as Chairperson of the WPB for the next biennium (2020–2021), and this nomination was **ENDORSED** by the WPB. The WPB **CONGRATULATED** Dr. Parker on his election as Chairperson and expressed gratitude for the acceptance of his nomination.

137. Dr Jie Cao was nominated as vice-Chairperson of the WPB for the next biennium, and this nomination was **ENDORSED** by the WPB. The WPB **CONGRATULATED** Dr. Cao on his election as vice-Chairperson.

11.2 Date and place of the 18th and 19th Sessions of the Working Party on Billfish

138. The WPB **THANKED** La Réunion, France (IFREMER) for hosting the 17th Session of the WPB and **COMMENDED** La Réunion, France on the warm welcome, the excellent facilities and assistance provided for the organisation and running of the Session.

139. The WPB **AGREED** on the importance of having IOTC Working Party meetings within key CPCs catching IOTC species of relevance to the Working Party, in this case billfish. Following a discussion on who would host the 18th and 19th sessions of the WPB in 2020 and 2021 respectively, the WPB **ACKNOWLEDGED** the offer from China to host the 18th session in conjunction with the Working Party on Ecosystems and Bycatch. The meeting locations and dates will be confirmed and communicated by the IOTC Secretariat to the SC for its consideration at its next session to be held in December 2019 (**Table 7**).

140. The WPB **NOTED** the importance of having a degree of stability in the participation of CPCs to each of the Working Party meetings and **ENCOURAGED** participants to regularly attend each meeting to ensure as much continuity as possible.

Table 7. Draft meeting schedule for the WPB (2020 and 2021).

	2020			**2021**		
Meeting	**No.**	**Date**	**Location**	**No.**	**Date**	**Location**
Working Party on **Billfish** (WPB)	18th	1-5 September (4d)	China (TBC)	19th	(TBC)	(TBC)
Working Party on **Ecosystems and Bycatch** (WPEB)	17th	7-11 September (5d)	China (TBC)	18th	(TBC)	(TBC)

11.3 Review of the draft, and adoption of the Report of the 17th Session of the Working Party on Billfish

141. The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB17, provided at Appendix XII, as well as the management advice provided in the draft resource stock status summary for each of the five billfish species under the IOTC mandate, and the combined Kobe plot for the five species assigned a stock status in 2019 (Fig. 7):

- Swordfish (*Xiphias gladius*)– Appendix VI
- Black marlin (*Makaira indica*) – Appendix VII
- Blue marlin (*Makaira nigricans*) – Appendix VIII
- Striped marlin (*Tetrapturus audax*) – Appendix IX
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix X

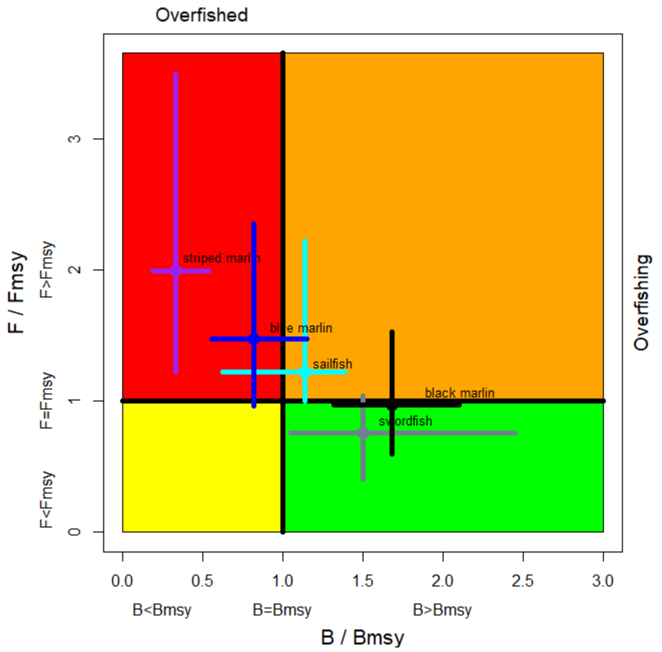

Fig. 7. Combined Kobe plot for swordfish (grey), indo-pacific sailfish (cyan), black marlin (black), blue marlin (blue) and striped marlin (purple) showing the 2017, 2018, and 2019 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

142. The report of the 17th Session of the Working Party on Billfish (IOTC–2019–WPB17–R) was **ADOPTED** on the 12th of September 2019.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
AGENDA FOR THE 17TH WORKING PARTY ON BILLFISH

Date: 9–12 September 2019
Location: La Réunion, EU,France
Venue: TAMARUN Seminar venue
Time: 09:00 – 17:00 daily
Chair: Dr Rui Coelho (EU,Portugal); **Vice-Chair**: Dr Evgeny Romanov (EU,France)

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

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

3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS**
   - Outcomes of the 21th Session of the Scientific Committee (IOTC Secretariat)
   - Outcomes of the 23nd Session of the Commission (IOTC Secretariat)
   - Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat)
   - Progress on the recommendations of WPB16 (IOTC Secretariat)
4. **NEW INFORMATION ON FISHERIES AND ASSOCIATED ENVIRONMENTAL DATA FOR BILLFISH**
   - Review of the statistical data available for billfish (IOTC Secretariat)
   - Review new information on fisheries and associated environmental data (general CPC papers)
   - New information on sport fisheries (all)
5. **MARLINS (Priority species for 2019: Blue marlin)**
   - Review new information on marlin biology, stock structure, fisheries and associated environmental data (all)
   - Review of any biological data in support of retention and transhipment bans for specimen below a minimum size, as per recent IOTC Resolutions (all)
   - Review of new information on the status of marlins (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for marlins
   - Development of management advice for marlins and update of marlin species Executive Summaries for the consideration of the Scientific Committee, including discussion on current catch limits as per standing IOTC Resolutions (all)
6. **INDO-PACIFIC SAILFISH (Priority species for 2019)**
   - Review new information on marlin biology, stock structure, fisheries and associated environmental data (all)
   - Review of any biological data in support of retention and transhipment bans for specimen below a minimum size, as per recent IOTC Resolutions (all)
   - Review of new information on the status of I.P Sailfish (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for I.P. Sailfish
   - Development of management advice for I.P. Sailfish and update of species Executive Summaries for the consideration of the Scientific Committee, including discussion on current catch limits as per standing IOTC Resolutions (all)
7. **SWORDFISH (new information for informing the 2020 scheduled assessment)**
   - Review of new information on swordfish biology, stock structure, fisheries and associated environmental data (all)
   - Review of new information and indicators on the status of swordfish (all)
     - Nominal and standardised CPUE indices
     - Other indicators

8. DEVELOPMENT OF OPTIONS FOR ALTERNATIVE MANAGEMENT MEASURES (INCLUDING CLOSURES) FOR BILLFISH IN THE IOTC AREA OF COMPETENCE

9. PROGRESS ON THE SWORDFISH MANAGEMENT STRATEGY EVALUATION

10. WPB PROGRAM OF WORK

- Revision of the WPB Program of Work (2020–2024) (Chairperson and IOTC Secretariat)
- Development of priorities for an Invited Expert at the next WPB meeting (Chairperson)

11. OTHER BUSINESS

- Election of a Chairperson and Vice-Chairperson for the WPB for the next biennium (IOTC Secretariat)
- Date and place of the 18th and 19th Sessions of the Working Party on Billfish (Chairperson and IOTC Secretariat)
- Review of the draft, and adoption of the Report of the 17th Session of the Working Party on Billfish (Chairperson)

APPENDIX III
LIST OF DOCUMENTS FOR THE 17TH WORKING PARTY ON BILLFISH

Last updated: 4th September 2019

Document	Title	Availability
IOTC-2019- WPB17-01a	Agenda of the 16th Working Party on Billfish	August 26 2019
IOTC-2019- WPB17-01b	Annotated agenda of the 16th Working Party on Billfish	August 26 2019
IOTC-2019- WPB17-02	List of documents of the 16th Working Party on Billfish	August 26 2019
IOTC-2019- WPB17-03	Outcomes of the 20th Session of the Scientific Committee (IOTC Secretariat)	August 26 2019
IOTC-2019- WPB17-04	Outcomes of the 22nd Session of the Commission (IOTC Secretariat)	August 26 2019
IOTC-2019- WPB17-05	Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat)	August 26 2019
IOTC-2019- WPB17-06	Progress made on the recommendations and requests of WPB15 and SC20 (IOTC Secretariat)	August 26 2019
IOTC-2019- WPB17-07	Review of the statistical data and fishery trends for billfish species (IOTC Secretariat)	August 26 2019
IOTC-2019- WPB17-08	Revision of the WPB Program of Work (2019-2023) (IOTC Secretariat)	August 26 2019
IOTC-2019- WPB17-09	Fishery in Iran and analysis of billfish landings made by industrial gillnet fishery during 2012–2018	August 26 2019
IOTC-2019- WPB17-10	Billfishes landings in Phuket Ports by foreign vessel, 2018	August 19 2019
IOTC-2019- WPB17-11	Bycatch in tuna drift gillnet fisheries off Pakistan (Arabian sea)	September 3 2019
IOTC-2019- WPB17-12	Catch Trends of Billfishes by Malaysian Tuna Longliners in the Indian Ocean	August 9 2019
IOTC-2019- WPB17-13	Size frequency distribution of billfish caught by Kenyan longliners in the Kenyan EEZ	August 19 2019
IOTC-2019- WPB17-14	Length at maturity of four billfish species in the Indian Ocean based on Chinese longline observer data	August 19 2019
IOTC-2019- WPB17-15	Billfish size-at-maturity in the western Indian Ocean	August 26 2019
IOTC-2019- WPB17-16	Standardized CPUE indices for blue marlin (*makaira nigricans*) caught by Indonesian tuna longline fishery in eastern Indian ocean	August 26 2019
IOTC-2019- WPB17-17	Standardized yields of the blue marlin (*makaira nigricans*) caught as bycatch of the Spanish surface longline fishery targeting swordfish (*xiphias gladius*) in the Indian ocean	August 22 2019
IOTC-2019- WPB17-18	CPUE standardization of blue marlin caught by Taiwanese large-scale longline fishery in the Indian Ocean	August 26 2019
IOTC-2019- WPB17-19	Standardized CPUE of blue marlin (Makaira mazara) caught by Japanese longline fishery in the Indian Ocean: Analysis between 1994 and 2018	August 19 2019
IOTC-2019- WPB17-20a	Continuity runs of the Andrade (2016) Bayesian state-space surplus production model assessment of Indian ocean blue marlin (makaira nigricans) stock using JABBA	August 26 2019
IOTC-2019- WPB17-20b	Stock assessment of blue marlin in the Indian Ocean using JABBA	
IOTC-2019- WPB17-21	Stock assessment of blue marlin in the Indian Ocean using Stock Synthesis	September 3 2019
IOTC-2019- WPB17-22	Some observations on distribution, abundance and biology of Indo-Pacific sailfish (*Istiophorus platypterus*) along the coast of Pakistan	August 31 2019
IOTC-2019- WPB17-23	Standardized yields of the sailfish (*istiophorus platypterus*) caught as bycatch of the Spanish surface longline fishery targeting swordfish (*xiphias gladius*) in the Indian ocean	August 22 2019
IOTC-2019- WPB17-24	Assessment of Indian Ocean Indo-Pacific sailfish using catch-only methods	August 26 2019
IOTC-2019-WPB17-25	Sword fish catch rates in relation to Sea Surface Temperature and Chlorophyll-A concentration within EEZ Sri Lanka	August 26 2019
IOTC-2019- WPB17-26	Standardization of the catch per unit effort for swordfish (*xiphias gladius*) for the South African longline fishery	

Document	Title	Availability
IOTC-2019- WPB17-27	Distribution, Abundance and some biological aspects of Bill fish species under the family *Xiphiidae *(*Xiphias gladius*) and *Istiophoridae* (*Istiophorus platypterus, Istiompax indica Makaira nigricans*) in Indian EEZ"	August 26 2019
Information papers		
IOTC-2019- WPB17-INFO01	Updates on the IOTC swordfish Management Strategy Evaluation	✓(1 September 2019)
Data sets		
IOTC-2019-WPB17-DATA03	Nominal Catches per Fleet, Year, Gear, IOTC Area and species	✓(23 July 2019)
IOTC-2019-WPB17-DATA04	Catch and effort data - vessels using drifting longlines	✓(23 July 2019)
IOTC-2019-WPB17-DATA05	Catch and effort data - surface fisheries	✓(23 July 2019)
IOTC-2019- WPB17-DATA06	Catch and effort data - vessels using other gears (e.g., gillnets, lines and unclassified gears)	✓(23 July 2019)
IOTC-2019- WPB17-DATA07	Catch and effort data - all gears	✓(23 July 2019)
IOTC-2019- WPB17-DATA08	Catch and effort data - reference file	✓(23 July 2019)
IOTC-2019- WPB17-DATA09_Rev1	Size frequency data - billfish species	✓(30 July 2019)
IOTC-2019- WPB17-DATA10_Rev1	Size frequency - reference file	✓(30 July 2019)
IOTC-2019- WPB17-DATA11	Equations used to convert from fork length to round weight for billfish species	✓(23 July 2019)
IOTC-2019- WPB17-DATA12	Standardization of Blue marlin CPUE by Taiwanese longline fishery in the Indian Ocean (1979-2017)	✓(5 August 2019)
IOTC-2019- WPB17-DATA13_Rev1	ROS regional database data sets	✓(19 August 2019)
IOTC-2019- WPB17-DATA14	Standardization of Blue marlin CPUE by Japanese longline fishery in the Indian Ocean (1994-2017)	✓(20 August 2019)
IOTC-2019- WPB17-DATA15	Standardization of Blue marlin CPUE by Indonesian longline fishery in the Indian Ocean (2006-2018)	August 26 2019

APPENDIX IVA
MAIN STATISTICS OF BILLFISH

(*Extract from IOTC–2019–WPB17–07_Rev1*)

Fisheries and catch trends for billfish species

- Main species: Swordfish and Indo-Pacific sailfish account for around two thirds of total catches of billfish species in recent years, followed by black marlin, blue marlin and striped marlin (**Fig. 1d**).

  The importance of individual species of billfish – as a proportion of the total catches of billfish – has changed over time, mostly as a result of changes to the number of longline vessels active in the Indian Ocean (**Fig. 1c**). Catches of swordfish in particular increased during the 1990s as a result of changes in targeting by Taiwan,China, and the arrival of European longline fleets, increasing the swordfish share of total billfishes catch from 20–30% in the early 1990s to around 50% by the early-2000s. By the late-2000s catches of swordfish declined to around a third of total billfish catches, largely as a result of the decline in the number of longline vessels operated by Taiwan,China. However since 2012 catches of swordfish have shown an increasing trend, which may be partly due to improvements in the estimation of catch-by-species reported by Taiwan,China.

  Relatively large catches of marlins have also been recorded since 2012 – possibly from a combination of improvements in reporting as well as increased activities by longliners in waters of the western central and northwest Indian Ocean as a consequence of improvements in security in the area off Somalia.

- Main fisheries: Up to the early-1980s longline vessels accounted for over 90% of the total billfish (largely as non-targeted catch); in the last 20 years the proportion has fallen to between 50% to 70% as billfish catches from offshore gillnet fisheries have become increasingly important for a number of fleets, such as I.R. Iran and Sri Lanka (**Fig. 2b-c**).

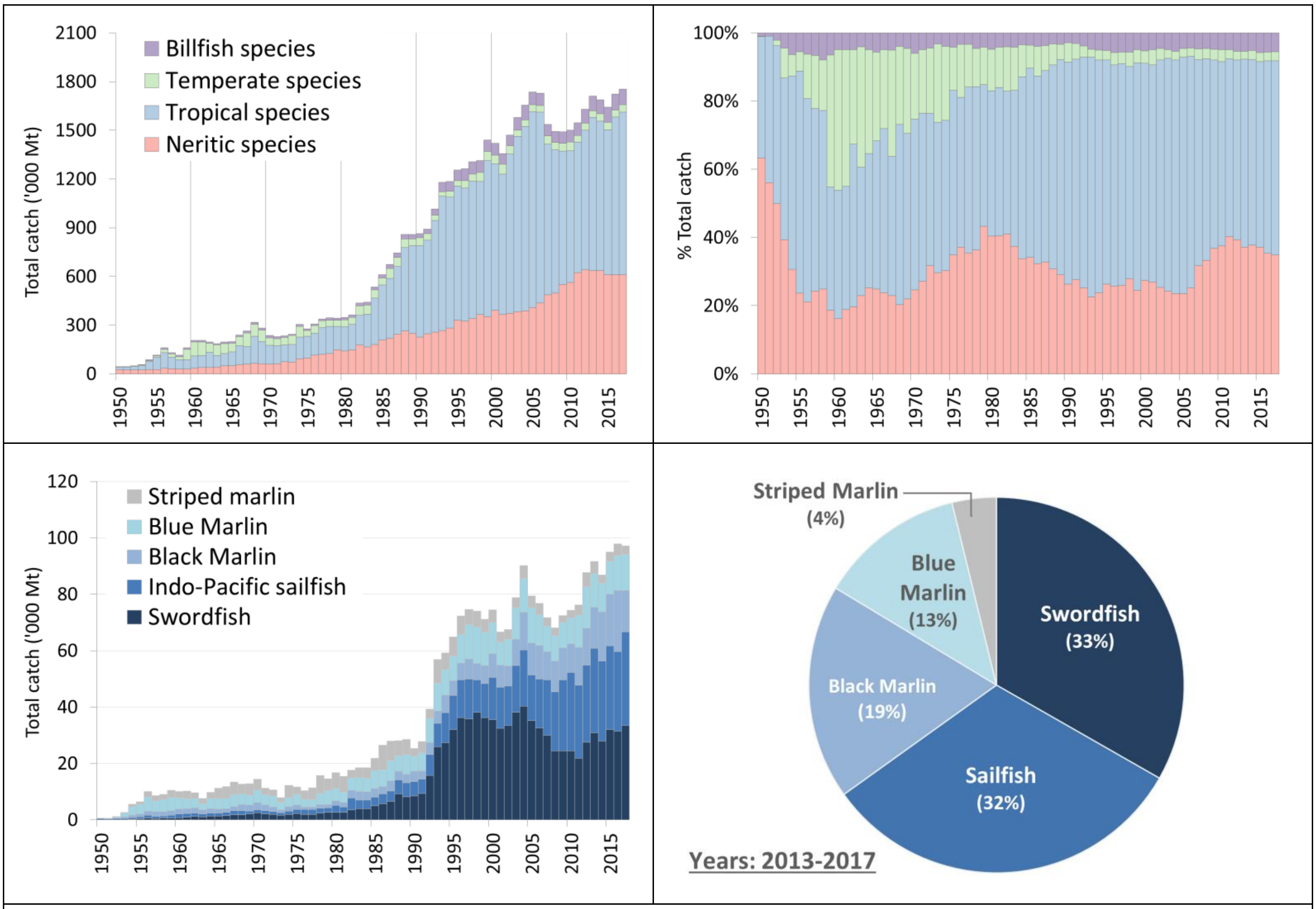
  In addition the number of longline vessels has also declined in recent years in response to the threat of Somali piracy in the western tropical Indian Ocean. Nevertheless, billfish catches are still dominated by a small number of longline fleets – namely Taiwan,China and European fleets[1] – that now appear to be resuming fishing activities in their main fishing grounds.

- Main fleets (i.e., highest catches in recent years):
  In recent years four fleets (I.R. Iran, India, Sri Lanka, and Taiwan,China) have reported around 60% of the total catches of billfish species from all IOTC fleets combined (Fig. 2a).

- Retained catch trends:
  The importance of catches of billfish species to the total catches of IOTC species in the Indian Ocean has remained relatively constant over the years (**Figs. 1a-b**) at between 5% – 7% of the total catch of IOTC species.

  Total catches of billfish species have generally increased in line with other species groups under the mandate of IOTC, increasing from around 25,000 t in the early 1990s to nearly 75,000 t in the mid-1990s. Since then, average catches per year have remained relatively stable at between 70,000 t and 75,000 t. However since 2012 catches over 85,000 t have been reported, with the largest increases reported by I.R. Iran, Pakistan, and Taiwan,China (**Fig. 2a**).

[1] EU,Spain, EU,Portgual, EU,France(La Réunion), and EU,UK.



Figs. 1a-d. Billfish (all species):

Top: Contribution of the five billfish species under the IOTC mandate to the total catches of IOTC species in the Indian Ocean, over the period 1950–2017 (a. Top left: total catch; b. Top right percentage, same colour key as Fig. 1a).

Bottom: Contribution of each billfish species to the total combined catches of billfish (c. Bottom left: nominal catch of each species, 1950–2017; d. Bottom right: share of billfish catch by species, 2013–17 average catch)**.**

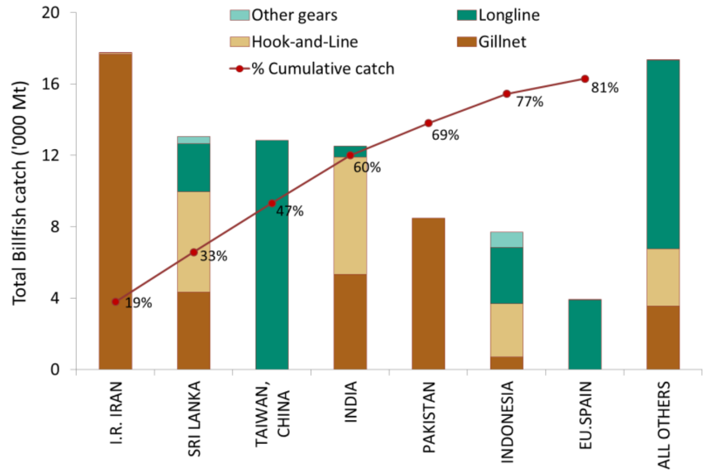
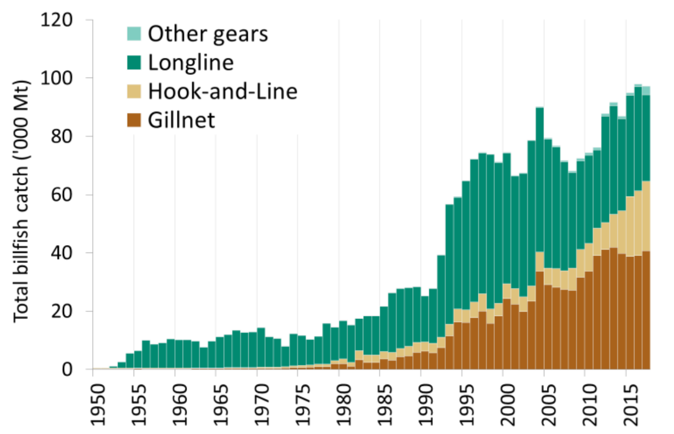


Fig. 2a: Billfish (all species): average catches in the Indian Ocean over the period 2013–17, by fleet and gear.

Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of all billfish species for the fleets concerned, over the total combined catches reported from all fleets and gears.



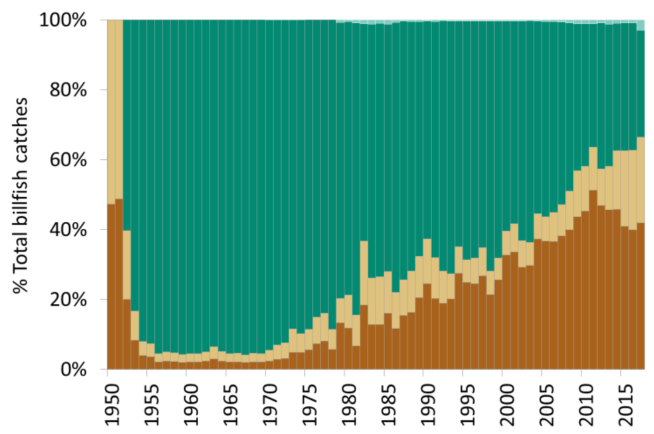


Fig. 2b-c: Billfish (all species): catches in the Indian Ocean over the period 1950–17, by gear. Fig 2b. Left: nominal catch of all billfish species, by gear; Fig. 2c. Right: percentage share of all billfish species catches, by gear**.**

APPENDIX IVB
MAIN STATISTICS OF SWORDFISH

(*Extract from IOTC–2019–WPB17–07_Rev1*)

Fisheries and main catch trends

- Main fishing gear (2013–17): Longline catches[2] currently comprise around 70% of total swordfish catches in the Indian Ocean. (**Table 2; Fig. 3**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–17):
  Over 50% of swordfish catches are accounted for by three fleets:
  Taiwan,China (longline): 21%; Sri Lanka (longline-gillnet): 18%; EU,Spain (swordfish targeted longline): 12% (**Fig. 4**).
- Main fishing areas: Primary: Western Indian Ocean, in waters off Somalia, and the southwest Indian Ocean. In recent years (i.e., 2009 – 2011) the fishery has moved eastwards due to piracy, a decrease in fish abundance, or a combination of both. Secondary: Waters off Sri Lanka, western Australia and Indonesia.
- Retained catch trends:
  Before the 1990s, swordfish were mainly a non-targeted catch of industrial longline fisheries; catches increased relatively slowly in tandem with the development of coastal state and distant water longline fisheries targeting tunas.

  After 1990, catches increased sharply (from around 8,000 t in 1991 to 36,000 t in 1998) as a result of changes in targeting from tunas to swordfish by part of the Taiwan,China longline fleet, along with the development of longline fisheries in Australia, France(La Réunion), Seychelles and Mauritius and arrival of longline fleets from the Atlantic Ocean (EU,Portugal, EU,Spain the EU,UK and other fleets operating under various flags[3]).

  Since the mid-2000s annual catches have fallen steadily, largely due to the decline in the number of Taiwanese longline vessels active in the Indian Ocean in response to the threat of piracy; however since 2012 catches appear to show signs of recovery as a consequence of improvements in security in the area off Somalia.
- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners.

***Changes to the catch series*:** Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia (IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.
Estimates for all three billfish species have been reduced significantly for Indonesia's fresh longline fleet in recent years, while total catches across all fleets have also been revised downwards by as much as 30% for each species. Further details on the estimation methodology can be found in paper IOTC-2018-WPB16-22, but in the case of swordfish catches have been revised down in recent years from over 50,000 t to less than 35,000 t directly as a result of the revision to Indonesia's catches. Since the WPB-16 meeting, the catches have been endorsed by the WPDCS and incorporated into the IOTC database.

TABLE 2. Swordfish: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2019.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ELL	-	-	-	9	1,841	9,736	7,655	7,637	9,031	6,835	7,643	7,876	7,420	6,618	6,257	6,153
LL	260	1,301	1,920	4,313	22,692	20,085	13,511	13,810	12,419	10,976	15,762	17,617	12,581	15,742	14,136	13,696
OT	37	39	186	807	1,989	2,819	3,261	3,019	3,033	4,061	4,069	5,290	7,961	9,696	11,042	13,683
Total	**297**	**1,340**	**2,106**	**5,130**	**26,521**	**32,640**	**24,427**	**24,466**	**24,483**	**21,872**	**27,474**	**30,783**	**27,963**	**32,055**	**31,436**	**33,532**

[2] Including deep freezing longline (LL), exploratory longline (LLEX), fresh longline (FLL), longlines targeting sharks (SLL), and swordfish targeted longline (ELL).

[3] E.g., Senegal, Guinea, etc.

Definition of fisheries: Swordfish targeted longline (**ELL**); Longline (**LL);** Other gears (includes longline-gillnet, handline, gillnet, gillnet-longline, coastal longline, troll line, sport fishing, and all other gears) (**OT**).

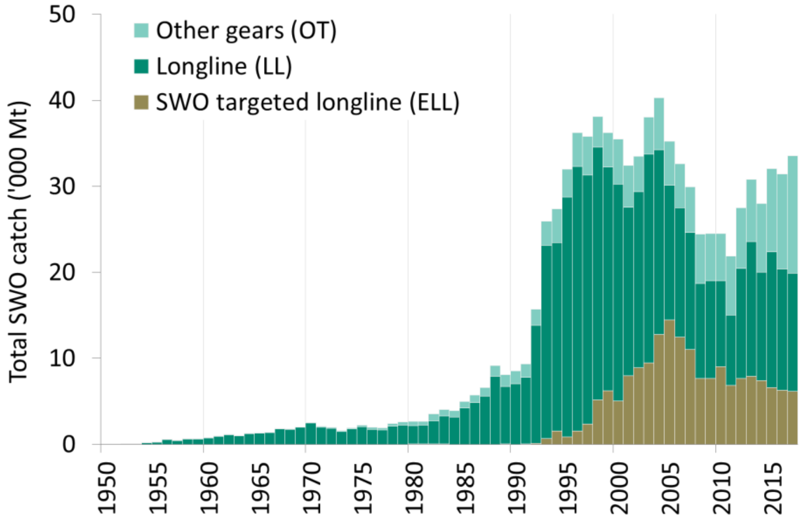


Fig. 3. Swordfish: catches by gear and year recorded in the IOTC Database (1950–2017).
Other gears includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.

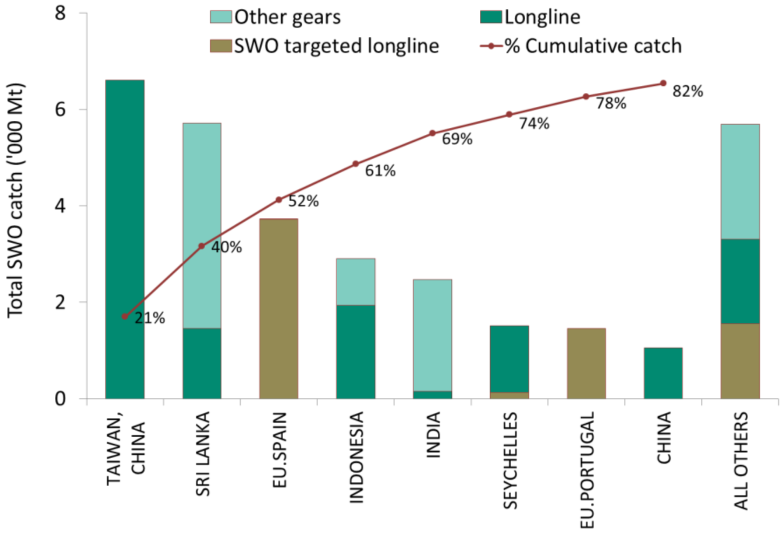


Fig. 4: Swordfish: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of swordfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

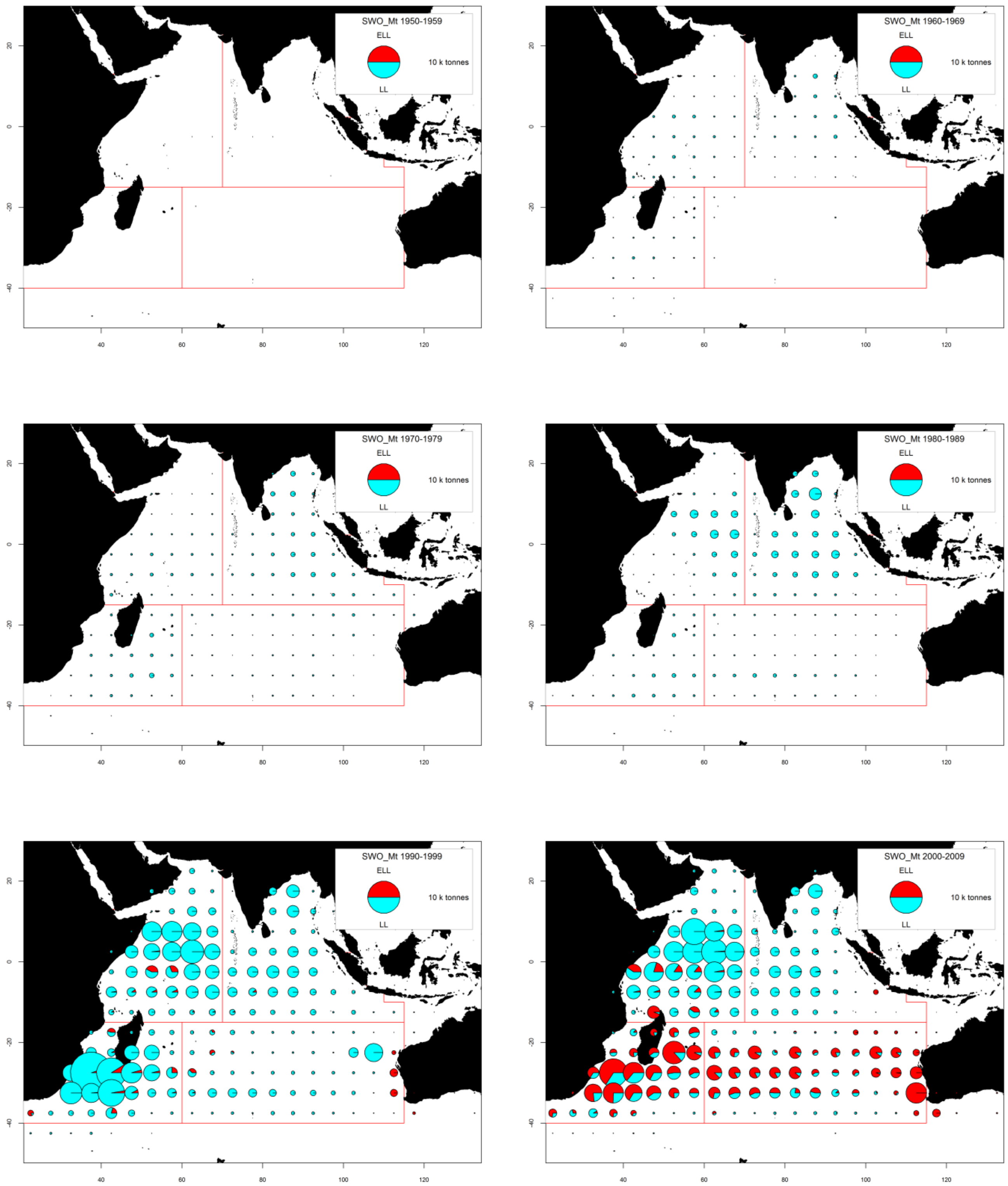


Fig. 5a-f: Swordfish: Time-area catches (total combined in tonnes) as reported for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), for the period 1950-2009, by decade and type of gear. Red lines represent the areas used for the assessments of swordfish.

Source: IOTC catch-and-effort data. Does not include catches from fleets not reporting catch-and-effort data.

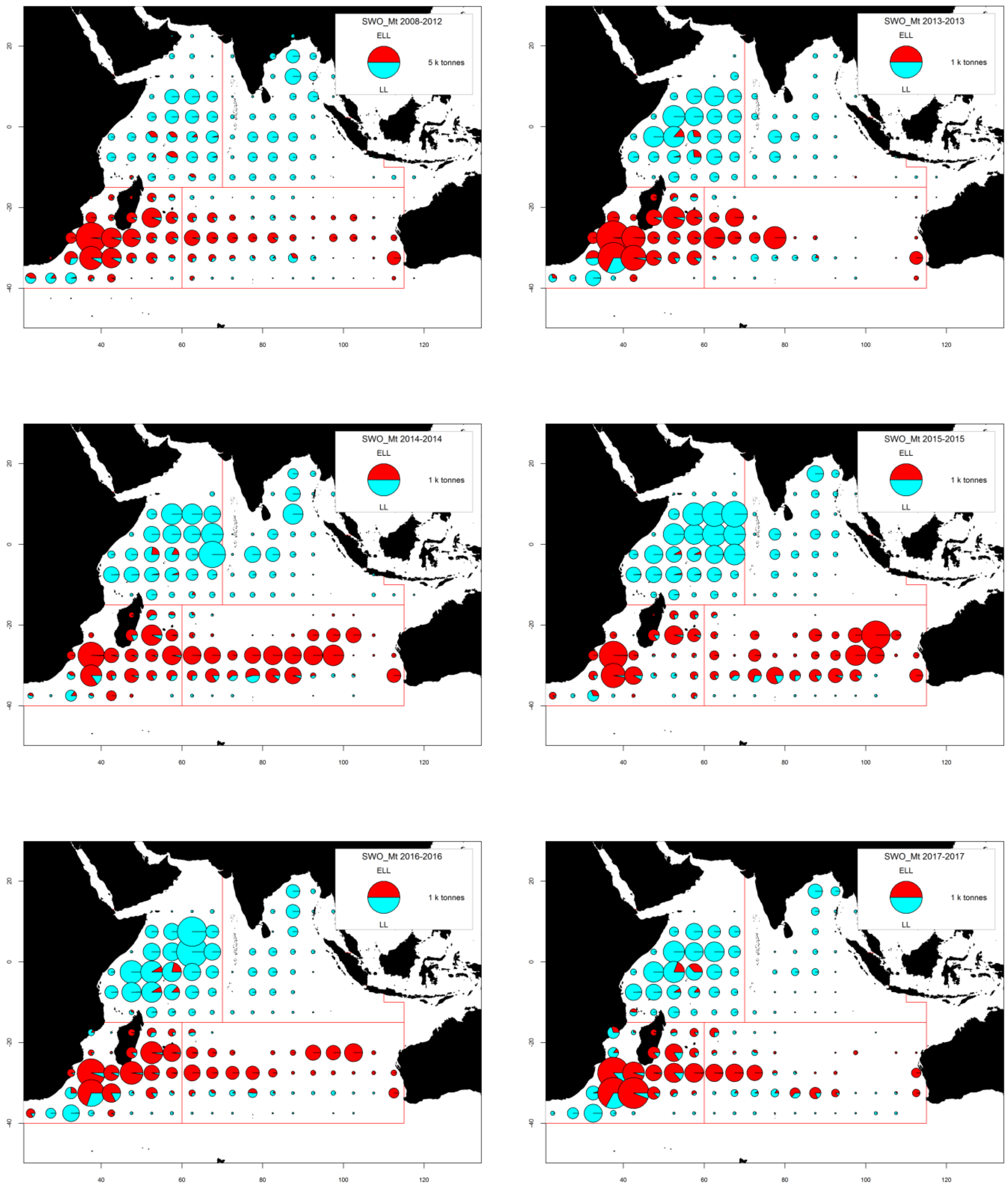


Fig. 6a-f: Swordfish: Time-area catches (total combined in tonnes) for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), gillnet fisheries (**GI**), and for all other fleets combined (**OT**), for the period 2008-2012 by type of gear and for 20013-17, by year and type of gear. Red lines represent the areas used for the assessments of swordfish.

Source: IOTC catch-and-effort data. Does not include catches from fleets not reporting catch-and-effort data.

Swordfish: estimation of catches – data related issues

Retained catches – while the proportion of catches estimated, or adjusted, by the IOTC Secretariat are relatively low (**Fig.7a**), there are uncertainties for the following fisheries/fleets:

- I.R. Iran and Pakistan (Gillnet): the IOTC Secretariat used the catches of swordfish and marlins reported by I.R. Iran for the years 2012 and 2013 to rebuild historical catch series of billfish for this fishery. However, catch rates and species composition for the Iranian and Pakistani gillnet fisheries differ significantly from each other in terms of the species composition, and in the case of Pakistan, the catches by species and are also in contradiction with other estimates derived from WWF funded sampling conducted Pakistan in recent years.

  In 2017 Pakistan also submitted a revised catch series, dating back to the 1980s, and which are significantly lower than current estimates for billfish for Pakistan in the IOTC database, including swordfish. A review of the revised historical data is currently being undertaken by the IOTC Secretariat, and which will be presented to the WPDCS meeting in 2019, before changes are made to Pakistan's current catch estimates in the IOTC database.
- India (Longline): Incomplete catches and catch-and-effort data, especially for its commercial longline fishery. Catches in recent years represent less than 4% of the total catches of swordfish.
- Non-reporting fleets (NEI) (Longline): Catches estimated by the IOTC Secretariat, however the proportion of total catches associated with this fishery are thought to be low and do not have a significant impact on the overall catch series.

Swordfish – Catch-per-unit-effort (CPUE) trends

- Availability: Catch-and-effort series are available for some industrial longline fisheries (**Fig. 7b**).

For most other fisheries, catch-and-effort are either not available (e.g., longline fisheries of Indonesia, drifting gillnet fisheries of Pakistan), or they are considered poor quality – especially since the early-1990s (e.g., gillnet and longline fisheries of Sri Lanka, Taiwan,China fresh-tuna longliners, Non-reporting longliners (NEI)).

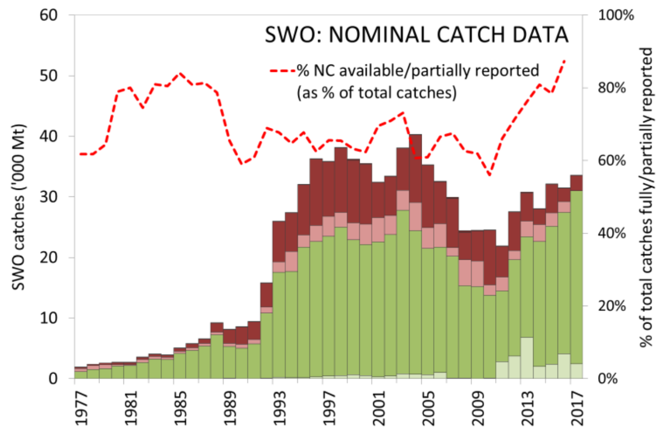
Swordfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

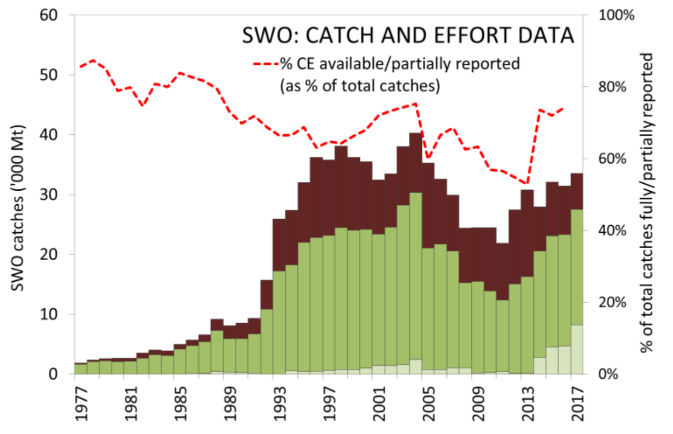
In general, the amount of catch for which size data for the species are available before 2005 is still very low and the number of specimens measured per stratum has been decreasing in recent years (**Fig. 7c**)

- Average fish weight: can be assessed for several industrial fisheries, although they are incomplete or poor quality for most fisheries before the early-80s and also in recent years (due low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend. (**Appendix I**).

- Catch-at-Size (Age) table: data are available but the estimates are thought to have been compromised for some years and fisheries due to:
  i. Uncertainty in the length frequency data recorded for longliners of Japan and Taiwan,China, in which average weights of swordfish derived from length frequency and catch-and-effort data are very different.
  ii. Uncertainties in the catches of swordfish for the drifting gillnet fisheries of I.R. Iran and the longline fishery of Indonesia.
  iii. The lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (e.g., Pakistan, India, Indonesia).
  iv. The paucity of size data available from industrial longliners since the early-1990s (e.g. Japan, Philippines, India and China).
  v. The lack of time-area catches for some industrial fleets (e.g. Indonesia, India, NEI fleets).
  vi. The paucity of biological data available, notably sex-ratio and sex-length-age keys.

- Sex ratio data: have not been provided to the Secretariat by CPCs.





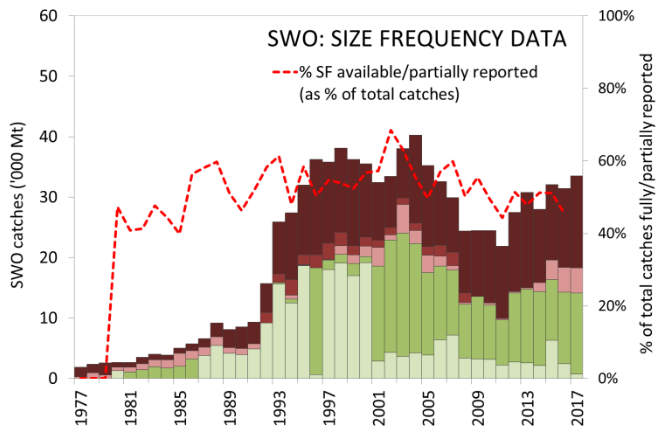


Fig. 7a-c. Swordfish: data reporting coverage (1978–2017).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

Data as of August 2019.

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

APPENDIX IVC
MAIN STATISTICS OF STRIPED MARLIN

(*Extract from IOTC–2018–WPB16–07_Rev1*)

Fisheries and main catch trends

- Main fishing gear (2013–17): striped marlin are largely considered to be a non-target species of industrial fisheries. Longlines account for around 56% of total catches in the Indian Ocean, followed by gillnets (34%), with remaining catches recorded under troll and handlines. (**Table 5, Fig. 18**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–15):
  Around 75% of the total catches of striped marlin are accounted for by four fleets:
  Taiwan,China (longline): 24%; Indonesia (longline): 21%; I.R. Iran (gillnet): 20%; and Pakistan (gillnet): 10% (**Fig. 19**).
- Main fishing areas: The distribution of striped marlin catches has changed since the 1980's with most of the catch now taken in the north-west Indian Ocean (**Table 6**), although between 2007 – 2011 catches in this area have dropped markedly, in tandem with a reduction of longline effort due to piracy.

  Changes in fishing grounds and catches are thought to be related to changes in access agreements to the EEZs of coastal countries in the Indian Ocean, rather than necessarily changes in the distribution of the species over time. Between the early-50s and the late-80s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported relatively high catches of striped marlin in the area, in particular in waters off northwest Australia, as well in the Bay of Bengal. Catches by Japan has since declined dramatically.
- Retained catch trends:
  Catch trends are variable, ranging from 2000 t to 8000 t per year, which may reflect the level of reporting and the status of striped marlin as a non-target species.

  Similarly, catches reported under drifting longlines are highly variable, with lower catch levels between 2009 and 2011 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners. Since 2012, catches of striped marlin have fluctuated between 3000 t – 5000 t per year.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners.

Changes to the catch series**:** Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia. The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia.
In the case of striped marlin, catches have been revised downwards to between 3000 and 5000 t from 2012 onwards.

TABLE 5: Striped marlin: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2019.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	1,028	3,104	3,458	5,144	5,120	2,939	2,196	1,679	2,123	2,308	3,756	2,864	1,357	1,720	2,633	1,345
GN	5	8	16	22	161	541	389	407	331	900	978	1,183	1,245	1,271	1,113	1,247
HL	3	5	10	32	72	137	198	273	282	292	288	334	319	301	329	342
OT	0	0	0	6	10	20	29	41	42	44	43	49	45	44	44	86
Total	**1,036**	**3,117**	**3,485**	**5,204**	**5,362**	**3,637**	**2,812**	**2,400**	**2,777**	**3,544**	**5,066**	**4,431**	**2,966**	**3,336**	**4,119**	**3,020**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

TABLE 6: Striped marlin: best scientific estimates of catches by fishing area for the period 1950–2017 (in metric tons). Data as of August 2019.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NW	335	1,859	1,516	2,073	2,713	1,815	1,211	840	756	1,357	3,138	2,558	1,318	1,272	2,449	1,521
SW	9	124	159	162	661	248	138	219	312	510	300	237	128	135	304	176
NE	551	810	1,542	2,752	1,609	1,339	1,375	1,266	1,521	1,570	1,592	1,590	1,485	1,803	1,328	1,285
SE	141	324	159	218	380	235	88	75	188	108	35	46	35	126	38	38
Total	**1,036**	**3,117**	**3,375**	**5,204**	**5,362**	**3,637**	**2,812**	**2,400**	**2,777**	**3,544**	**5,066**	**4,431**	**2,966**	**3,336**	**4,119**	**3,020**

Areas: Northwest Indian Ocean (**NW**); Southwest Indian Ocean (**SW**); Northeast Indian Ocean (**NE**); Southeast Indian Ocean (**SE**); Southern Indian Ocean (**OT**).

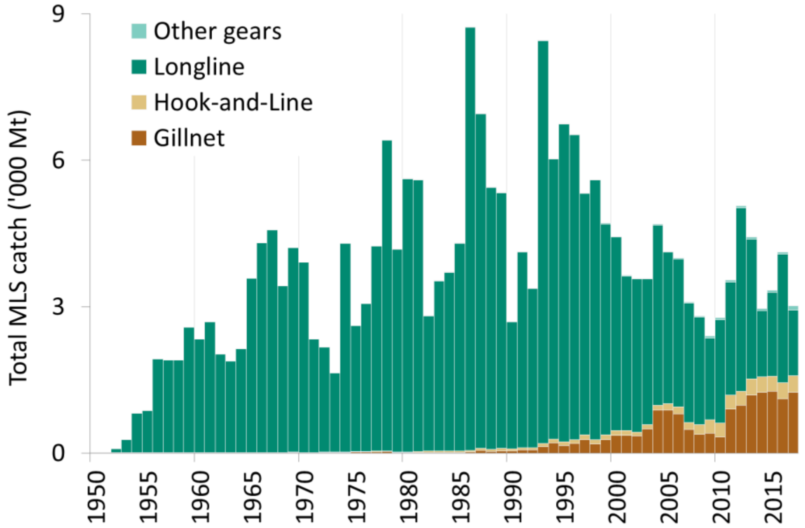


Fig. 18. Striped marlin: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

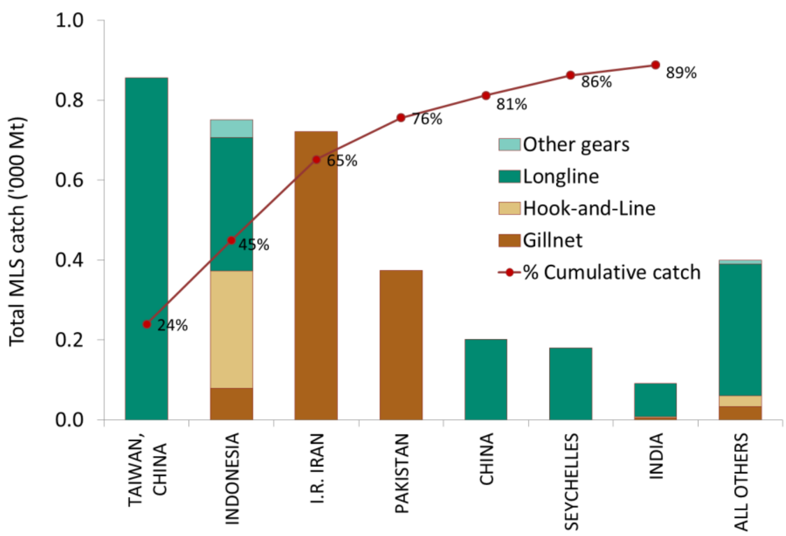


Fig. 19: Striped marlin: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

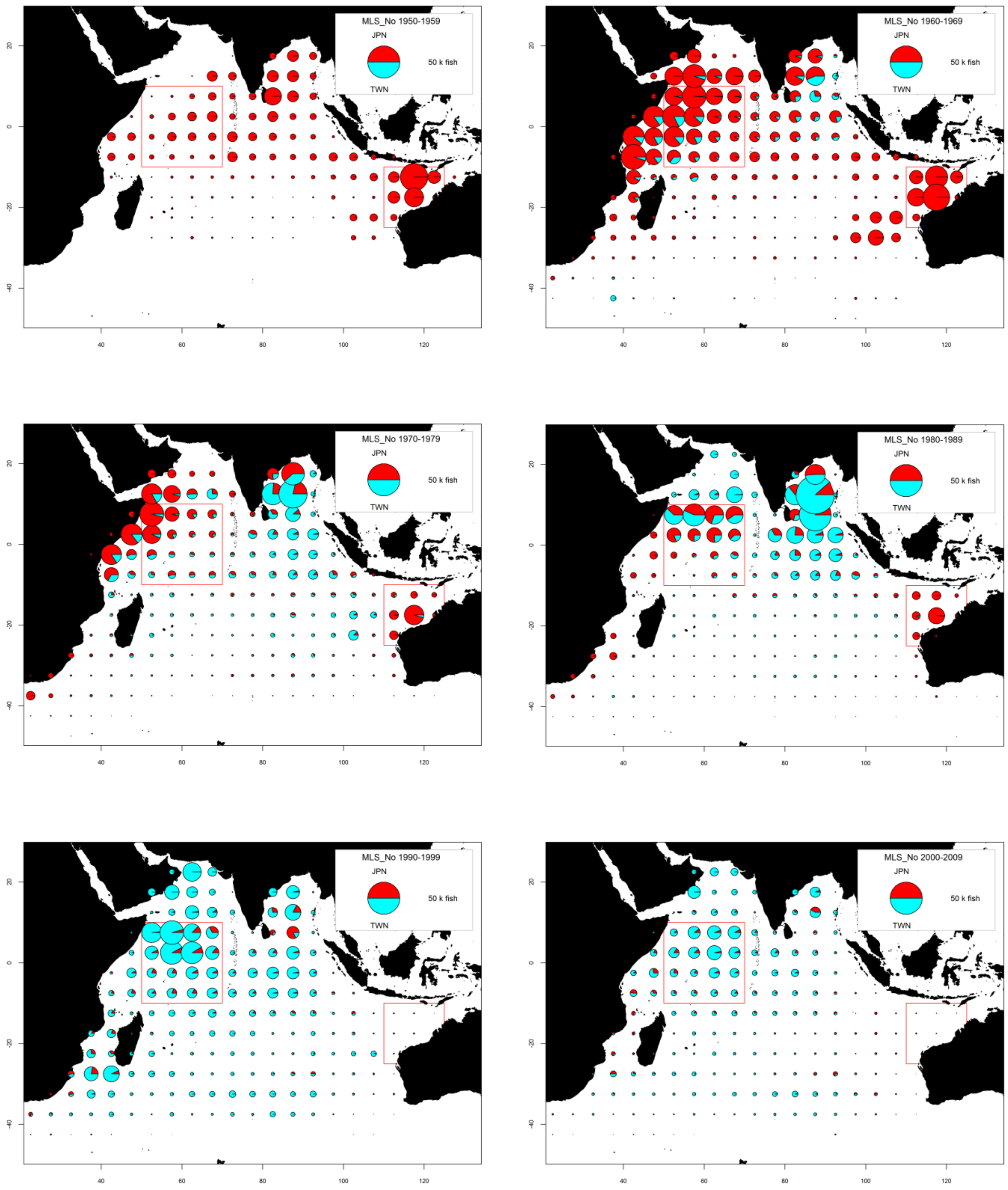


Fig. 20a-f. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include fleets not reporting catch-and-effort data.

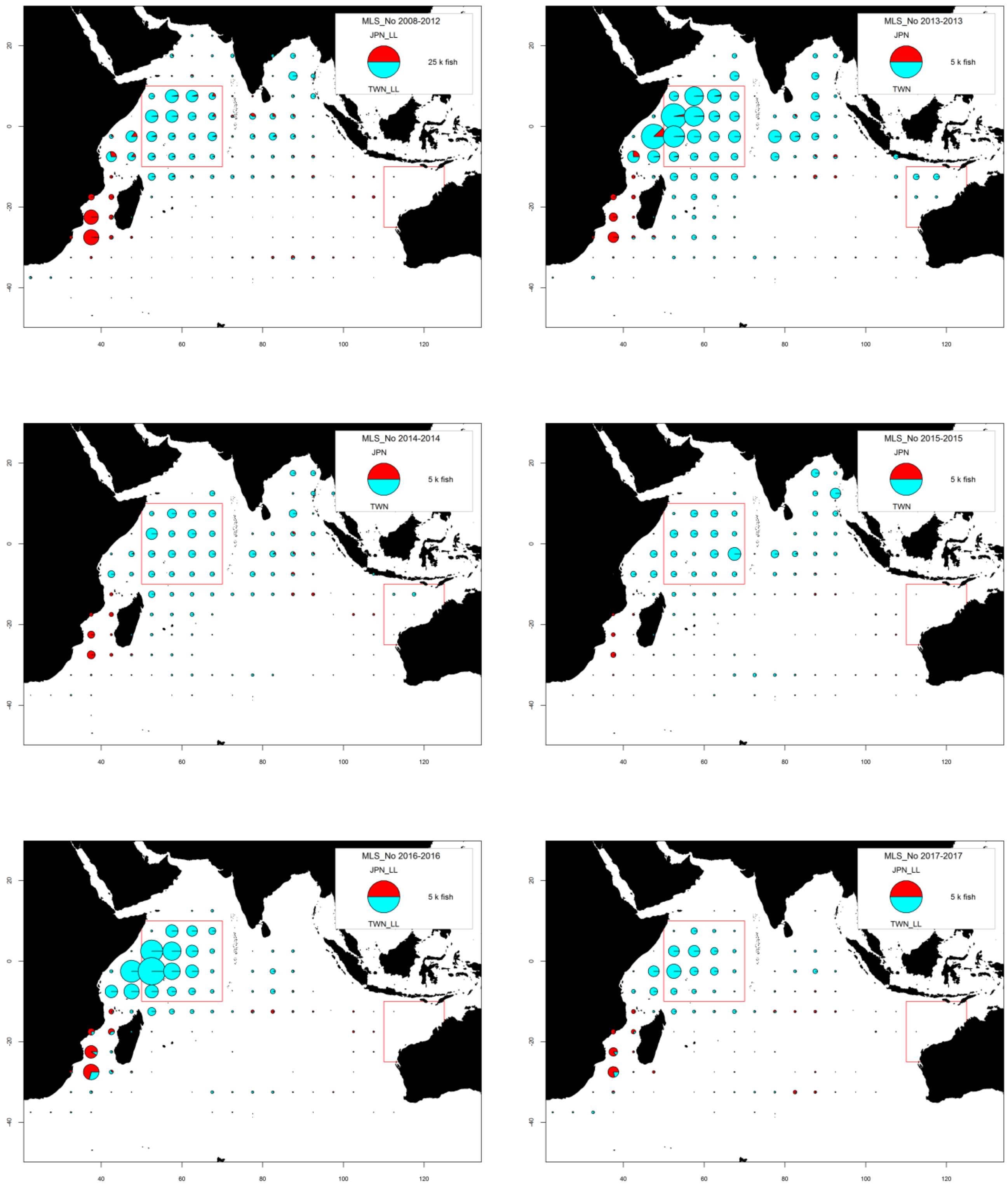


Fig. 21a-f. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2006–10 by fleet and for 2011–15, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include fleets not reporting catch-and-effort data.

Striped marlin: estimation of catches – data related issues

Retained catches – while the proportion of catches estimated, or adjusted, by the IOTC Secretariat are relatively low compared to other species of marlins (**Fig.22a**), there are a number of uncertainties in the catches:

- Species aggregates: catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which striped marlin is not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of striped marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.

  There are also conflicting catch reports for the drifting gillnet fishery of Pakistan, with very high catches of striped marlins reported by alternative sources (i.e., WWF funded sampling) derived from sampling in different locations in Pakistan. These relatively high catch levels are in contradiction to a revised catch series submitted by the Government of Pakistan to the IOTC in 2017, which estimates much lower catches of billfish based on the results of a separate WWF-funded crew based observer scheme. A review of the revised historical data submitted by Pakistan is currently being undertaken by the IOTC Secretariat, and which will be presented to the WPDCS meeting in 2019, before changes are made to Pakistan's current catch estimates in the IOTC database.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of striped marlin available to the Secretariat.

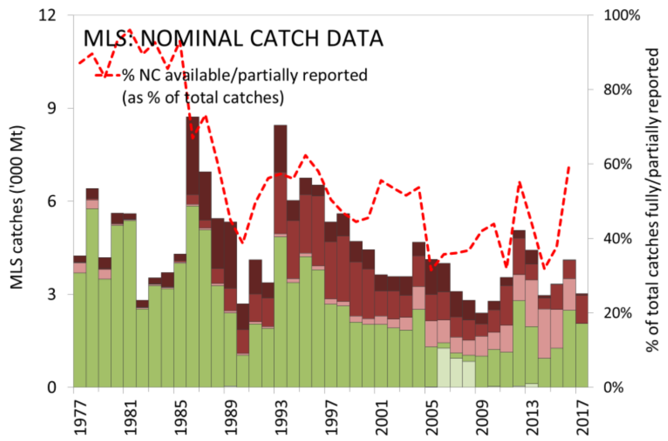
Striped marlin – Nominal catch-per-unit-effort (CPUE) trends

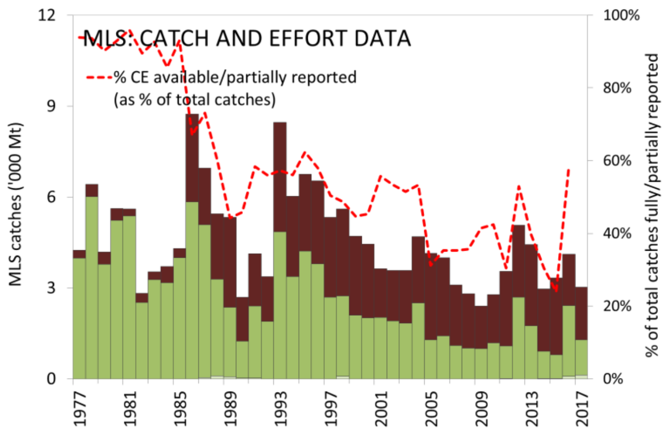
- Availability: Standardized CPUE series have been developed for the Japanese and Taiwanese longline fleets. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (e.g., gillnet fisheries of Pakistan and Indonesia) or other industrial fisheries (NEI longliners and all purse seiners). Unreliable data from gillnet/longlines of Sri Lanka.
- Main CPUE series available: Japanese and Taiwanese longline fleet.

Striped marlin – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low. Also mis-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery. Thirdly, the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan.
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





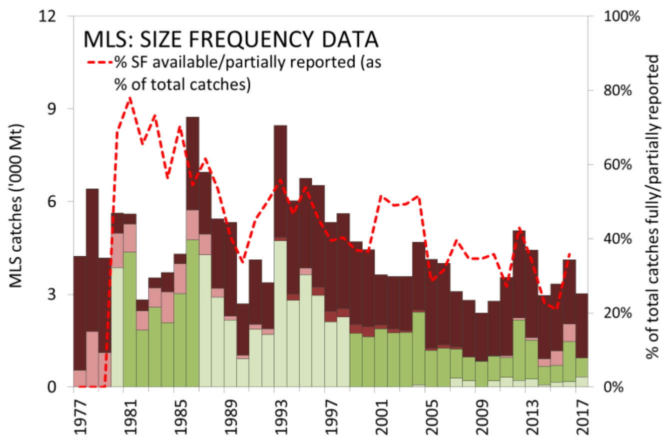


Fig. 22a-c. Striped marlin: data reporting coverage (1978–2017).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

Data as of August 2019.

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

APPENDIX IVD
MAIN STATISTICS OF BLACK MARLIN

(*Extract from IOTC–2018–WPB16–07_Rev1*)

Fisheries and main catch trends

- Main fishing gear (2013–17): black marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for around 50% of total catches in the Indian Ocean, followed by longlines (17%), with remaining catches recorded under troll and handlines. (**Fig. 13**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–17):
  Around 70% of the total catches of black marlin are accounted for by three fleets:
  India (gillnet and trolling): 28%; I.R. Iran (gillnet): 27%; Sri Lanka (gillnet and fresh longline): 19%.
- Main fishing areas:

  Primary: between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches in that area, in particular in waters off northwest Australia.

  Secondary: in recent years, deep-freezing longliners from Japan and Taiwan,China have reported catches of black marlin off the western coast of India and the Mozambique Channel.
- Retained catch trends:
  Since the 1990s catches have increased steadily, from 2,800 t in 1991 to over 10,000 t in 2004. In recent years catches have further increased sharply from around 15,000 t in 2013 to over 21,000 t in 2016 and 2017 – the highest catches recorded in the Indian Ocean for the species (**Table 4**) – largely due to increases reported by the offshore gillnet fisheries of I.R. Iran.

  Catches in Sri Lanka have also risen steadily since the mid-1990's as a result of the development of the fishery using a combination of drifting gillnets and longlines, from around 1,000 t in the early 1990s to over 3,000 t in recent years.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Negligible levels of discards have also been reported for some purse seine fleets. Discards may also occur in some gillnet fisheries.

Changes to the catch series**:** Catch estimates for black marlin have been largely unaffected by the recent revisions to Indonesia's fresh longline fleet (as opposed to other species such as swordfish and blue marlins), mostly as black marlins are generally more associated with gillnets operating in more coastal waters.

TABLE 4. Black marlin: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2019.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	862	1661	1391	1728	1571	1987	3041	1839	1895	2034	1828	2204	2648	2296	3007	1867
GN	26	31	44	439	2761	6917	6226	6935	6070	8957	8495	8569	9700	8905	10266	7340
HL	24	27	45	486	736	1017	1274	2147	1629	1864	2261	3094	4630	6625	7981	4660
OT	0	0	5	82	112	226	329	460	472	490	484	702	503	507	480	776
Total	**912**	**1,719**	**1,485**	**2,735**	**5,181**	**10,147**	**10,870**	**11,380**	**10,066**	**13,345**	**13,067**	**14,570**	**17,482**	**18,333**	**21,733**	**14,644**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

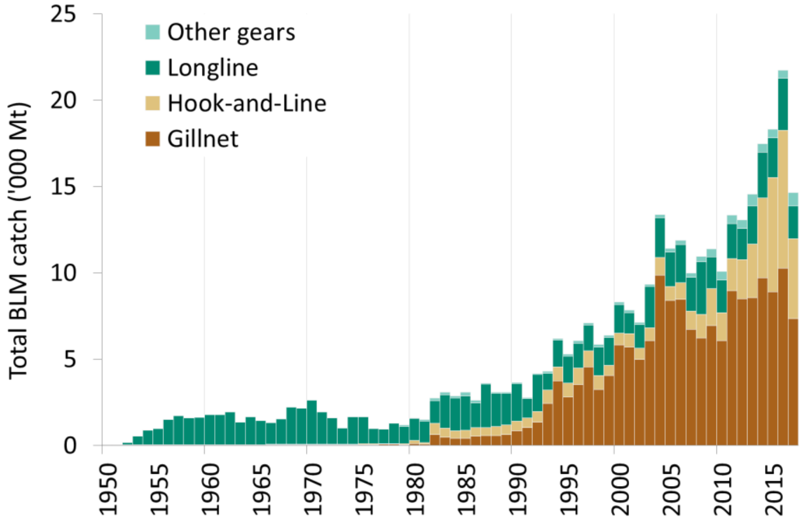


Fig. 13. Black marlin: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

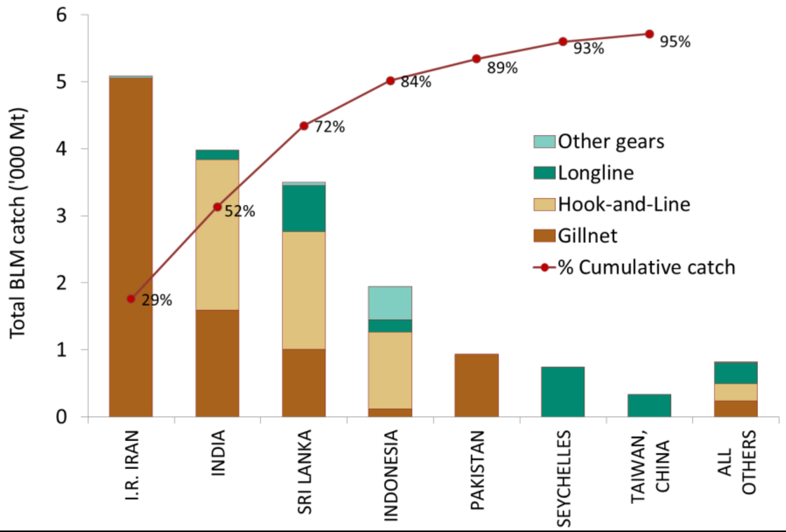


Fig. 14: Black marlin: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of black marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

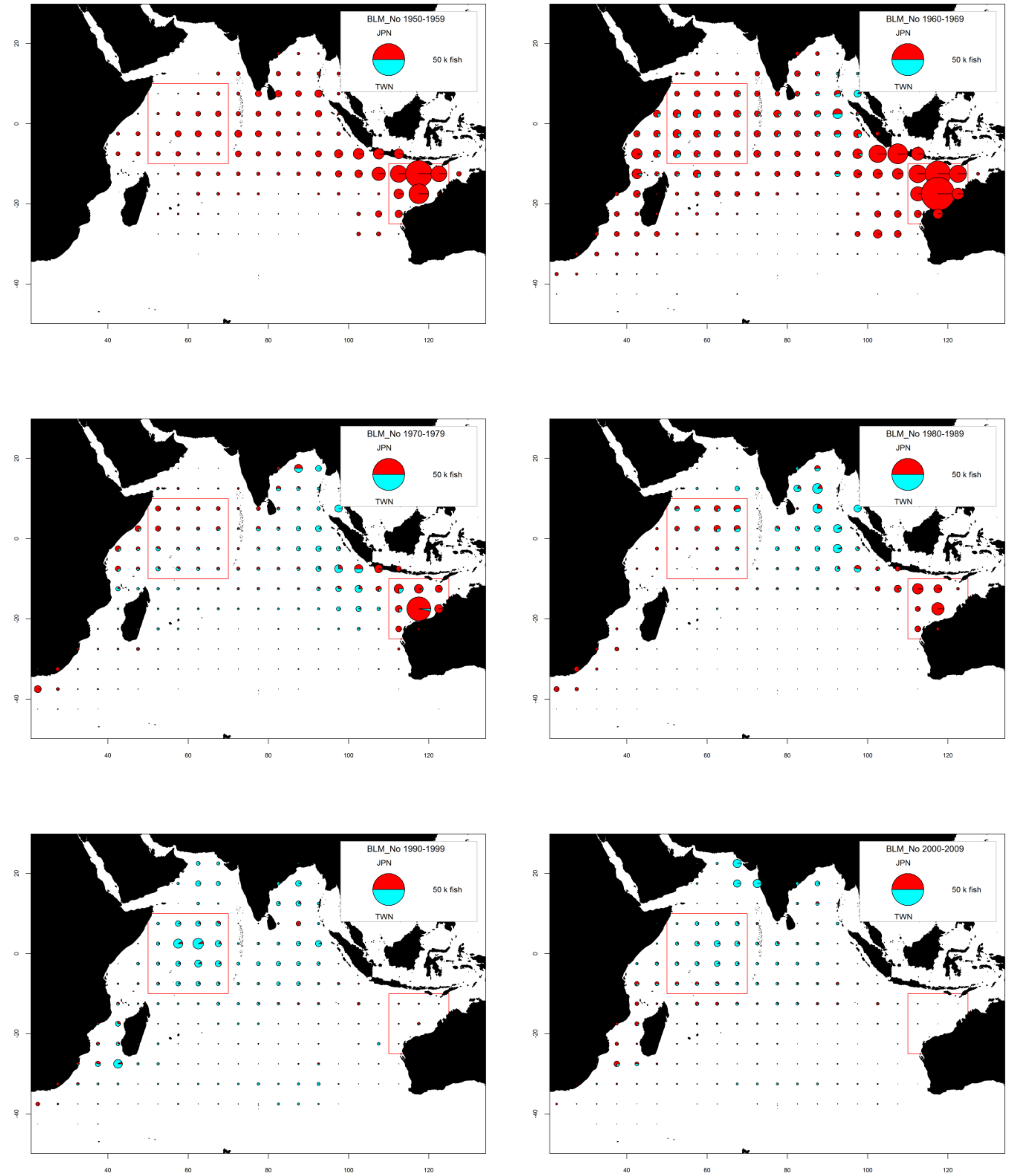


Fig. 15a-f. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include catches from fleets not reporting catch-and-effort data.

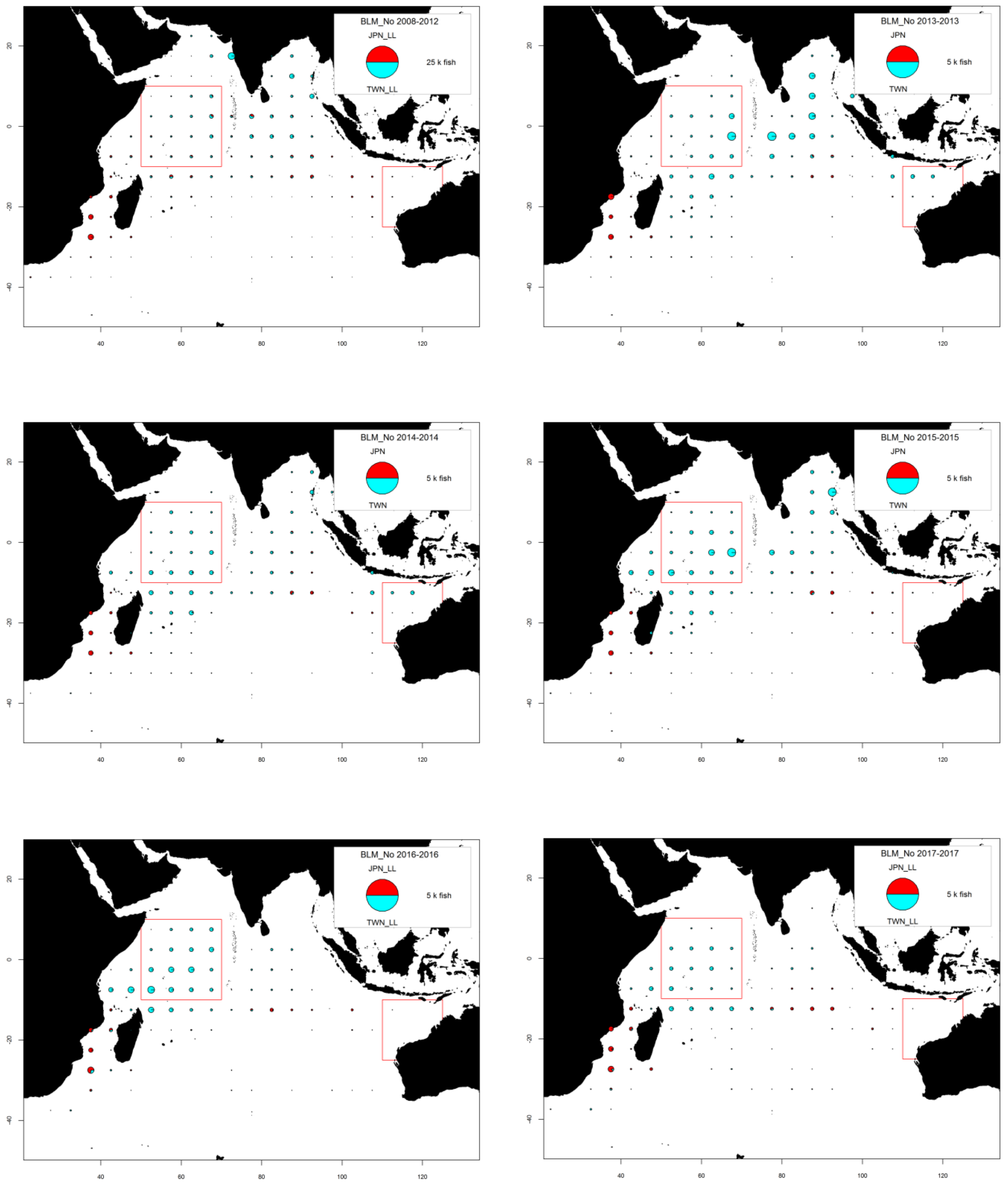


Fig. 16a-f. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2008–12 by fleet and for 2013–17, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include catches from fleets not reporting catch-and-effort data.

Black marlin: estimation of catches – data related issues

Retained catches – a very high proportion of the catches of black marlin are estimated, or adjusted, by the IOTC Secretariat (**Fig.17a**), due to a number of uncertainties in the catches:

- Species aggregates: catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species; catches by species are estimated by the Secretariat for some years and artisanal fisheries (e.g., gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. Iran and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI fleets) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which black marlin is not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- General lack of catch data for most sport fisheries, particularly in the Western Indian Ocean.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of black marlin available to the Secretariat.

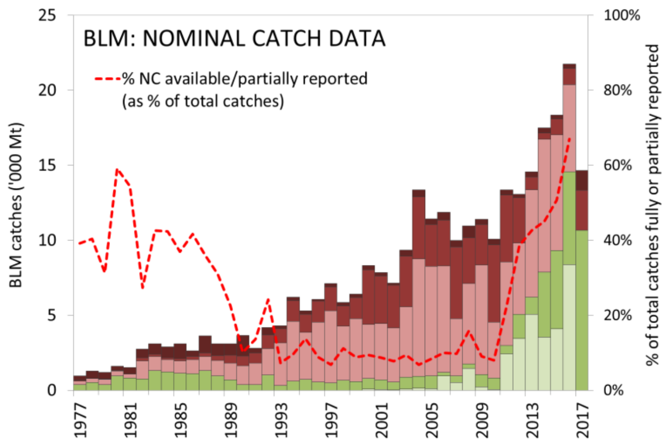
Black marlin – Nominal catch-per-unit-effort (CPUE) trends

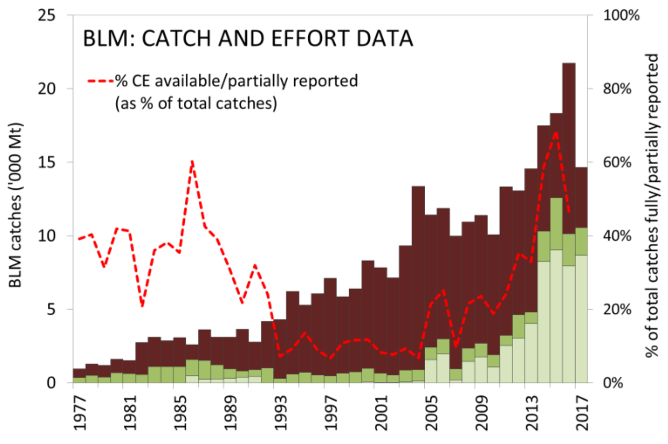
- Availability: Standardized CPUE series have been developed for Japanese and Taiwanese fleets. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (e.g., gillnet fisheries of Iran, Indonesia and Pakistan).
- Main CPUE series available: Japanese and Taiwan,China longline fleet.

Black marlin– Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low. Also the length frequency distributions derived from samples collected by fishermen on Taiwanese longliners are also likely to be biased.
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish sizes are derived from various length and weight information, however the reliability of the size data is uncertain for some fleets, particularly when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





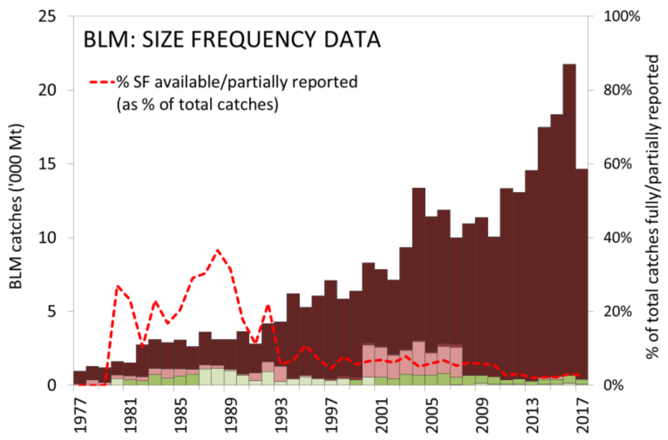


Fig. 17a-c. Black marlin: data reporting coverage (1978–2017).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

Data as of August 2019.

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

(green)	Total score is 0 (or average score is 0-1)
(light green)	Total score is 2 (or average score is 1-3)
(pink)	Total score is 4 (or average score is 3-5)
(red)	Total score is 6 (or average score is 5-7)
(dark red)	Total score is 8 (or average score is 7-8)

APPENDIX IVE
MAIN STATISTICS OF BLUE MARLIN

(*Extract from IOTC–2018–WPB16–07_Rev1*)

Fisheries and main catch trends

- Main fishing gear (2013–17): Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches[4] account for around 70% of total catches in the Indian Ocean, followed by gillnets (24%), with remaining catches recorded under troll and handlines. (**Table 3; Fig. 8**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  Around 80% of the total catches of blue marlin are accounted for by four fleets:
  Taiwan,China (longline): 41%; Pakistan (gillnet): 15%; I.R. Iran (gillnet): 13%, and Sri Lanka (10%) (**Fig. 9**).
- Main fishing areas: Western Indian Ocean, in the main fishing areas operated by longliners.
- Retained catch trends:
  Catch trends are variable, which may reflect the level of reporting and the status of blue marlin as a non-target species.

  Catches reported by drifting longliners were more or less stable until the late-70's, at around 3,000 t to 4,000 t, and have steadily increased since then to reach values between 8,000 t and to over 10,000 t since the early 1990's. Some of the highest catches of blue marlin reported by longliners have been recorded since 2012, and are likely to be the consequence of higher catch rates by some longline fleets which appear to have resumed operations in the western tropical Indian Ocean.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Negligible levels of discards have also been reported for some purse seine fleets. Discards may also occur in some gillnet fisheries.

Changes to the catch series**:** Catches have been revised in recent years (i.e., since 2015) when catches estimates for blue marlin were revised substantially following new reports of catches-by-species for Iran's drifting gillnet fleet[5].

In addition, following issues with the reliability of catch estimates of Indonesia's fresh longline fleet, the IOTC Secretariat provided the WPB-16 meeting with an alternative catch series based on a new estimation methodology developed in collaboration with Indonesia. The revised catch series mostly affects catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat for Indonesia. In the case of blue marlin, catches have been revised down by around 5,000 t per year from 2012 onwards.

TABLE 3: Blue marlin: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2019.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	2,567	3,535	3,409	4,545	6,982	7,384	6,272	6,664	6,689	7,280	9,630	7,447	6,066	7,229	7,858	5,633
GN	1	2	124	761	2,357	2,687	2,410	2,049	2,198	3,919	4,828	4,064	3,545	3,675	3,581	4,419
HL	5	9	17	105	168	150	195	277	303	269	265	337	522	711	867	1,962
OT	0	0	0	2	4	7	11	15	15	16	16	18	16	21	55	781
Total	**2,574**	**3,546**	**3,550**	**5,413**	**9,511**	**10,228**	**8,887**	**9,004**	**9,205**	**11,484**	**14,739**	**11,865**	**10,149**	**11,636**	**12,361**	**12,796**

[4] Including deep freezing longline (LL), exploratory longline (LLEX), fresh longline (FLL), longlines targeting sharks (SLL), and swordfish targeted longline (LLEX).

[5] Prior to 2013 I.R. Iran reported aggregated catches for all billfish species, which were estimated by species and gear by the IOTC Secretariat. Iran has provided catches by billfish species for the first time, from 2012 onwards, which significantly revised the catch-by-species previously estimated by the Secretariat: the main change being the higher proportions of black marlin, rather than blue marlin reported by I.R. Iran, assigned to the offshore gillnet fishery. As a result of changes in the catch series total catches of black marlin for I.R. Iran were revised upwards by as much as 30% to 50% for a number of years around the mid-2000's.

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

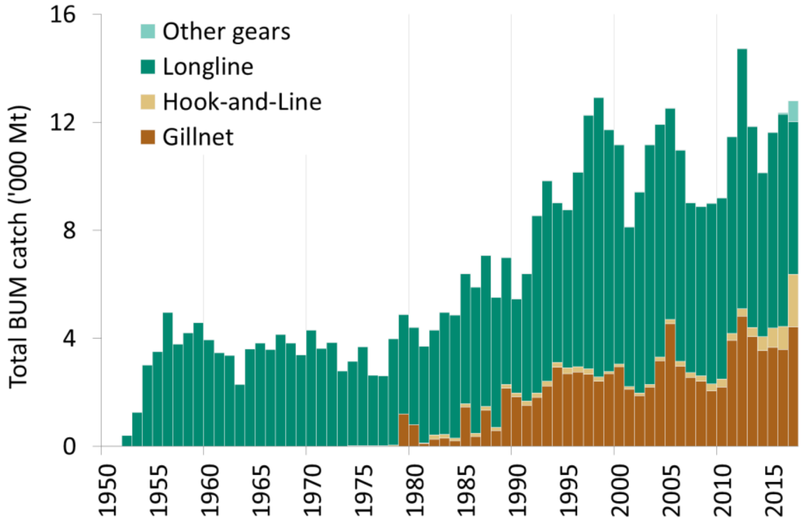


Fig. 8. Blue marlin: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

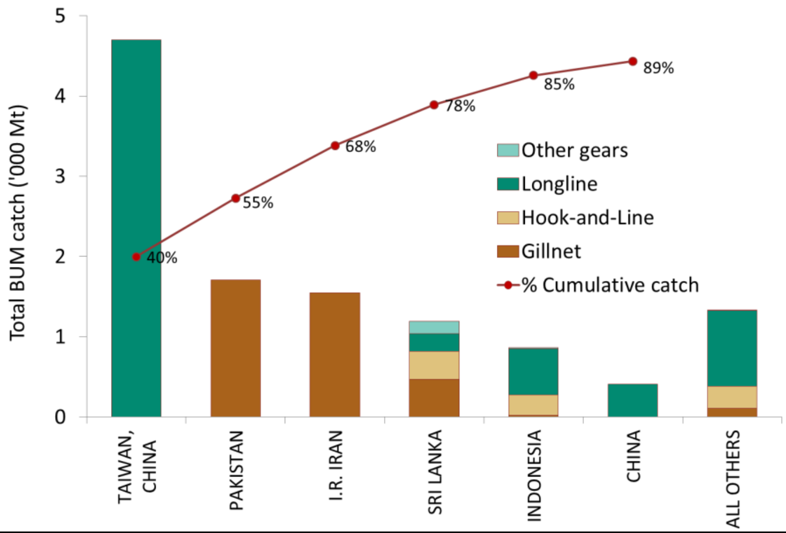


Fig. 9: Blue marlin: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of blue marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

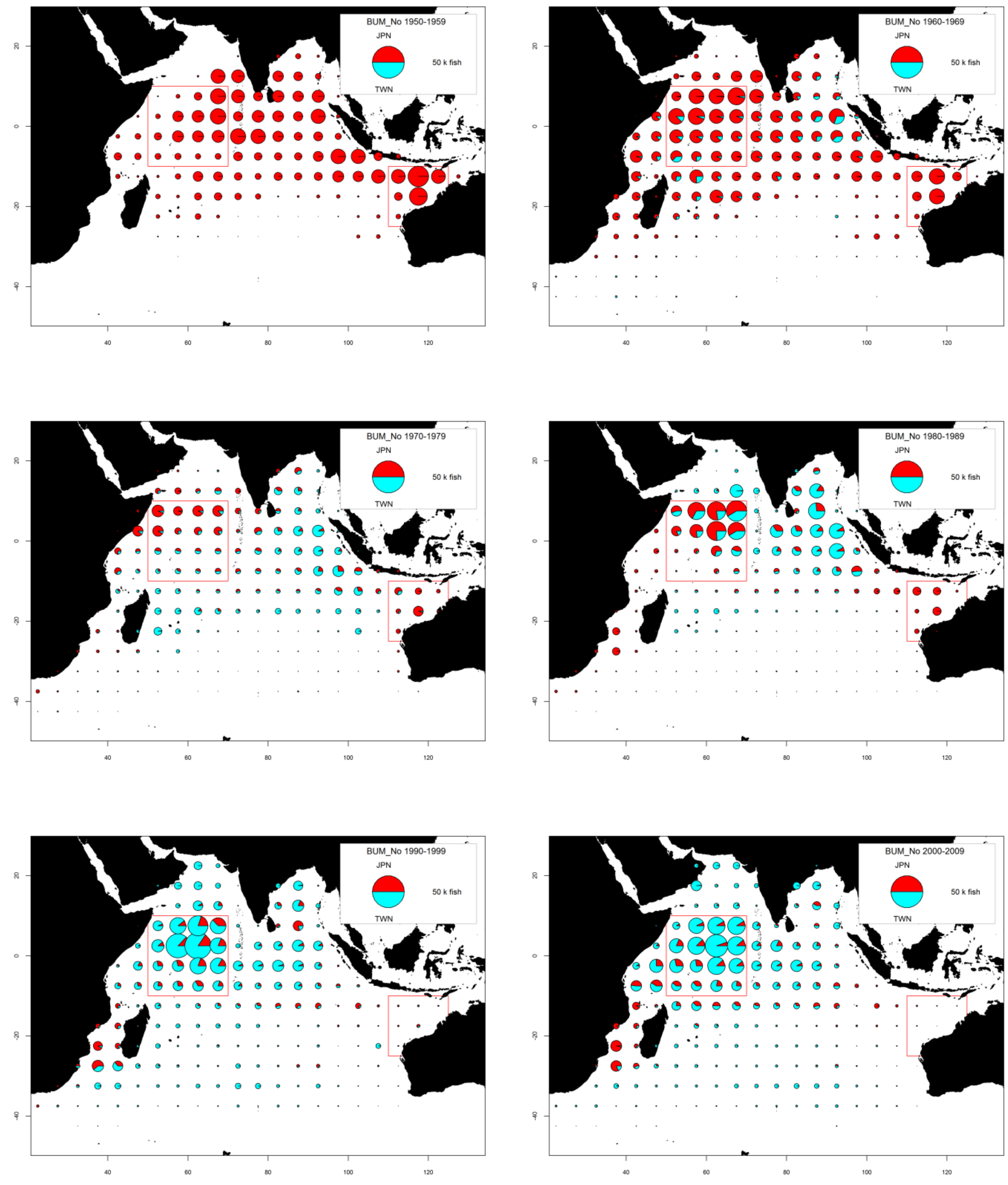


Fig. 10a-f. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950-2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include catches from fleets from not reporting catch-and-effort data.

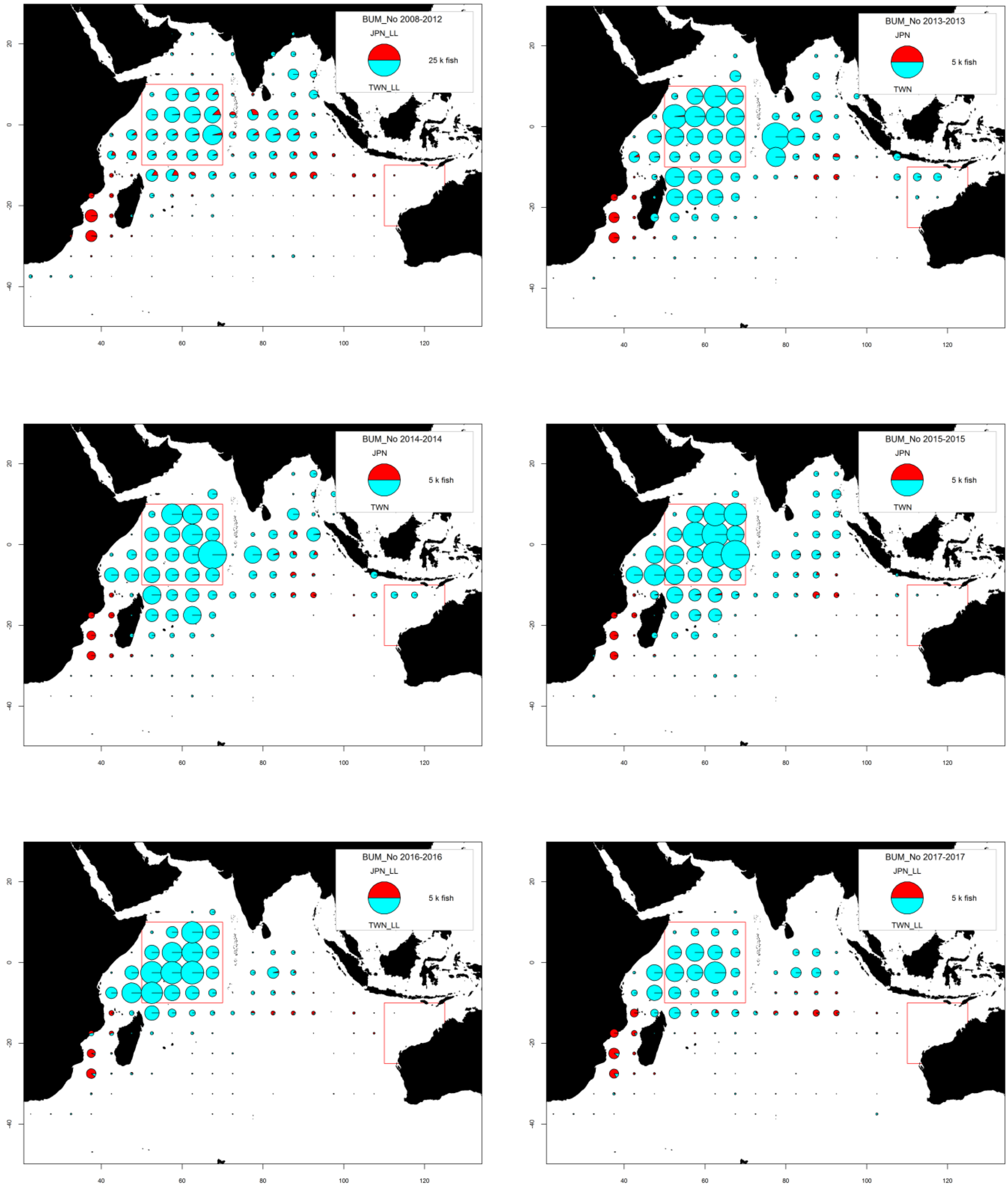


Fig. 11a-f. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2008–12 by fleet and for 2013–17, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch-and-effort data. Does not include catches from fleets from not reporting catch-and-effort data.

Blue marlin: estimation of catches – data related issues

Retained catches – a high proportion of the catches of blue marlin are estimated, or adjusted, by the IOTC Secretariat are (**Fig.12a**), due to a number of uncertainties in the catches:

- Species aggregates: catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species. Catches-by-species are estimated by the IOTC Secretariat for some years and artisanal fisheries (e.g., gillnet-longline fishery of Sri Lanka, artisanal fisheries of India and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which blue marlin is not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea reported as nominal catches, and catch and effort are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- Lack of catch data for most sport fisheries.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of blue marlin.

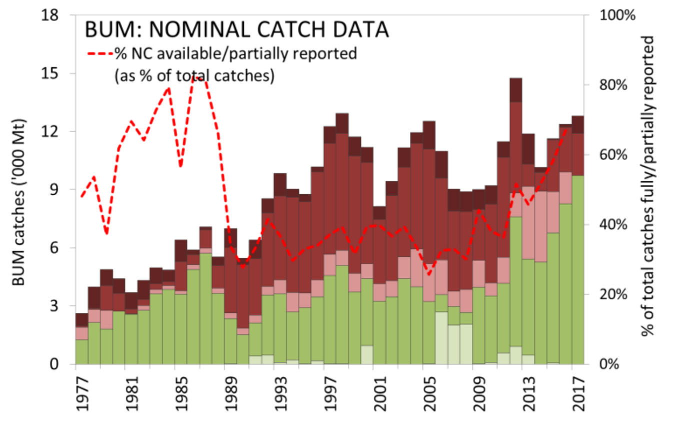
Blue marlin – Nominal catch-per-unit-effort (CPUE) trends

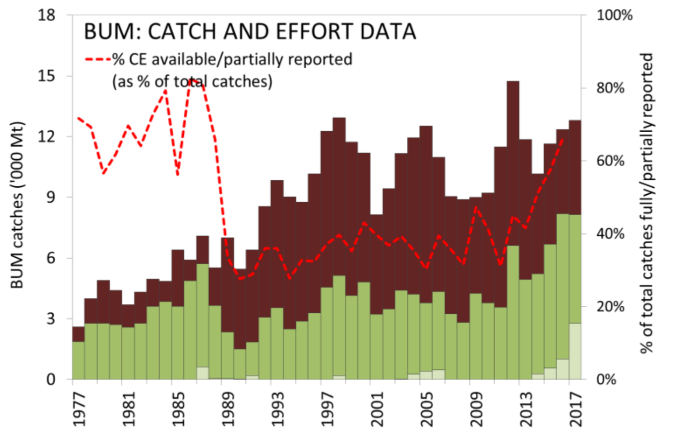
- Availability: Standardized CPUE series have not yet been developed. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (gillnet fisheries of Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or other industrial fisheries (NEI longliners and all purse seiners).
- Main CPUE series available: Japanese longline fleet and Taiwanese longline fleet.

Blue marlin– Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and mis-identification of striped and blue marlin may occur in some longline fisheries. Also the length frequency distributions derived from samples collected by fishermen on Taiwanese longliners may not be representative of the total catches.
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





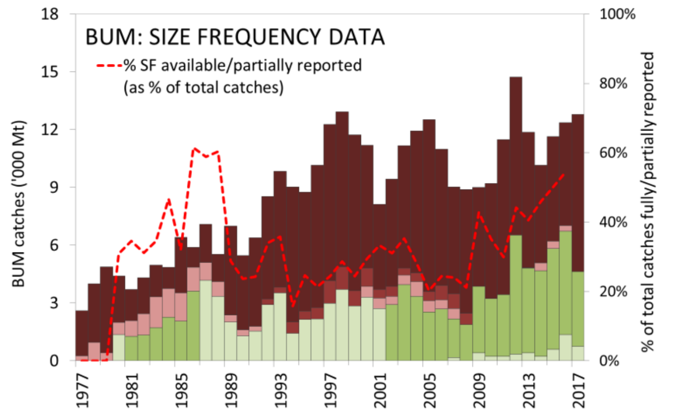


Fig. 12a-c. Blue marlin: data reporting coverage (1978–2017).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

Data as of August 2019.

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

APPENDIX IVF
MAIN STATISTICS OF INDO-PACIFIC SAILFISH

(*Extract from IOTC–2018–WPB16–07_Rev1*)

Fisheries and main catch trends

- Main fishing gear (2013–2017): gillnets account for around 70% of total catches in the Indian Ocean, followed by troll and hand lines (21%), with remaining catches recorded under longlines and other gears (**Fig. 23**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2013–17):
  Three quarters of the total catches of Indo-Pacific sailfish are accounted for by four countries situated in the Arabian Sea: I.R. Iran (gillnets): 32%; India (gillnets and trolling): 20%; Pakistan (gillnets): 16%; and Sri Lanka (gillnets and fresh longline): 9% (**Fig. 24**).

  This species is also a popular catch for sport fisheries (e.g. Kenya, Mauritius, and Seychelles).
- Main fishing areas: Primary: north-west Indian Ocean (Arabian Gulf).
- Retained catch trends:
  Catches have increased sharply since the mid-1990's (from around 5,000 t in the early 1990s to nearly 30,000 t from 2011 onwards) (**Table 7**), largely due to the development of a gillnet/longline fishery in Sri Lanka and, especially, the extension of Iranian gillnet vessels operating in areas beyond the EEZ of I.R. Iran. In the case of I.R. Iran, gillnet catches have increased from less than 1,000 t in the early 1990's to between 7,000 t and 11,000 t since 2013. Catches from drifting longline fleets have also likely increased, but have been under reported as the species has little commercial value. In recent years, deep-freezing longliners from Japan have also reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel.
- Discard levels**:** Moderate to high, however discard levels are largely unknown for most industrial fisheries (i.e., mostly longliners).

Changes to the catch series**:** Catch estimates for Indo-Pacific sailfish have been largely unaffected by the recent revisions to Indonesia's fresh longline fleet (as opposed to other species such as swordfish and blue marlins), mostly as sailfish are generally more associated with gillnet fisheries.

TABLE 7: Indo-Pacific sailfish: best scientific estimates of catches by type of fishery for the period 1950–2017 (in metric tons). Data as of August 2019.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
LL	297	804	385	256	1,400	1,419	2,544	1,257	586	335	927	1,193	1,530	1,121	1,790	1,095
GN	165	181	504	1,774	6,055	12,493	13,863	18,205	21,037	19,920	21,230	22,964	21,768	21,488	19,242	23,045
HL	171	213	456	1,427	2,470	3,937	4,445	5,510	5,999	5,477	5,049	5,591	4,790	6,759	7,009	8,600
OT	-	-	2	24	41	85	134	171	175	184	180	279	191	187	178	396
Total	**633**	**1,197**	**1,347**	**3,480**	**9,966**	**17,934**	**20,986**	**25,143**	**27,797**	**25,915**	**27,385**	**30,026**	**28,279**	**29,556**	**28,218**	**33,136**

Fisheries: Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

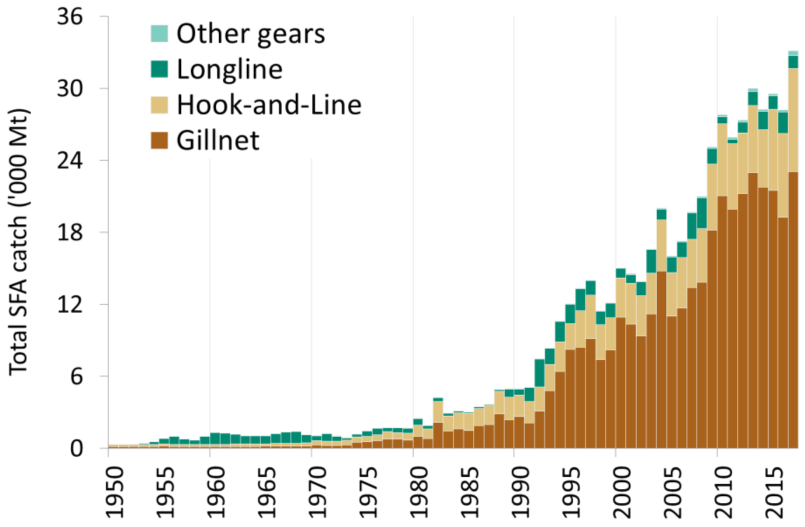


Fig. 23. Indo-Pacific sailfish: catches by gear and year recorded in the IOTC Database (1950–2017). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

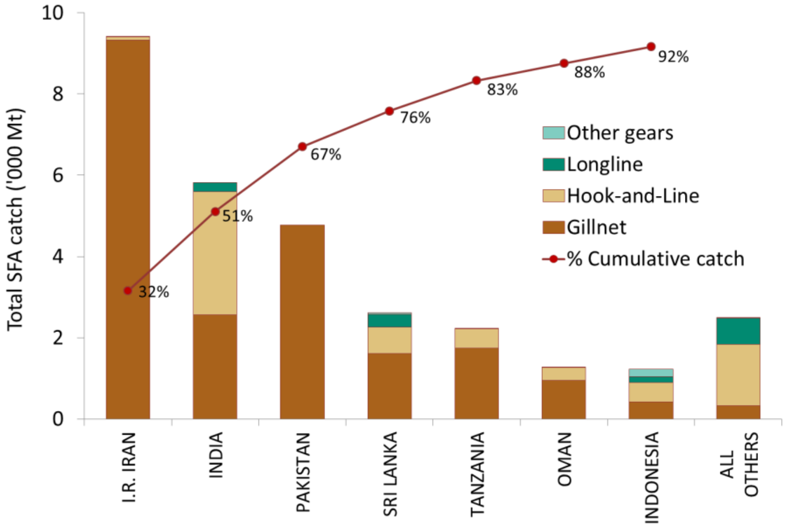


Fig. 24: Indo-Pacific sailfish: average catches in the Indian Ocean over the period 2013–17, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported.

The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

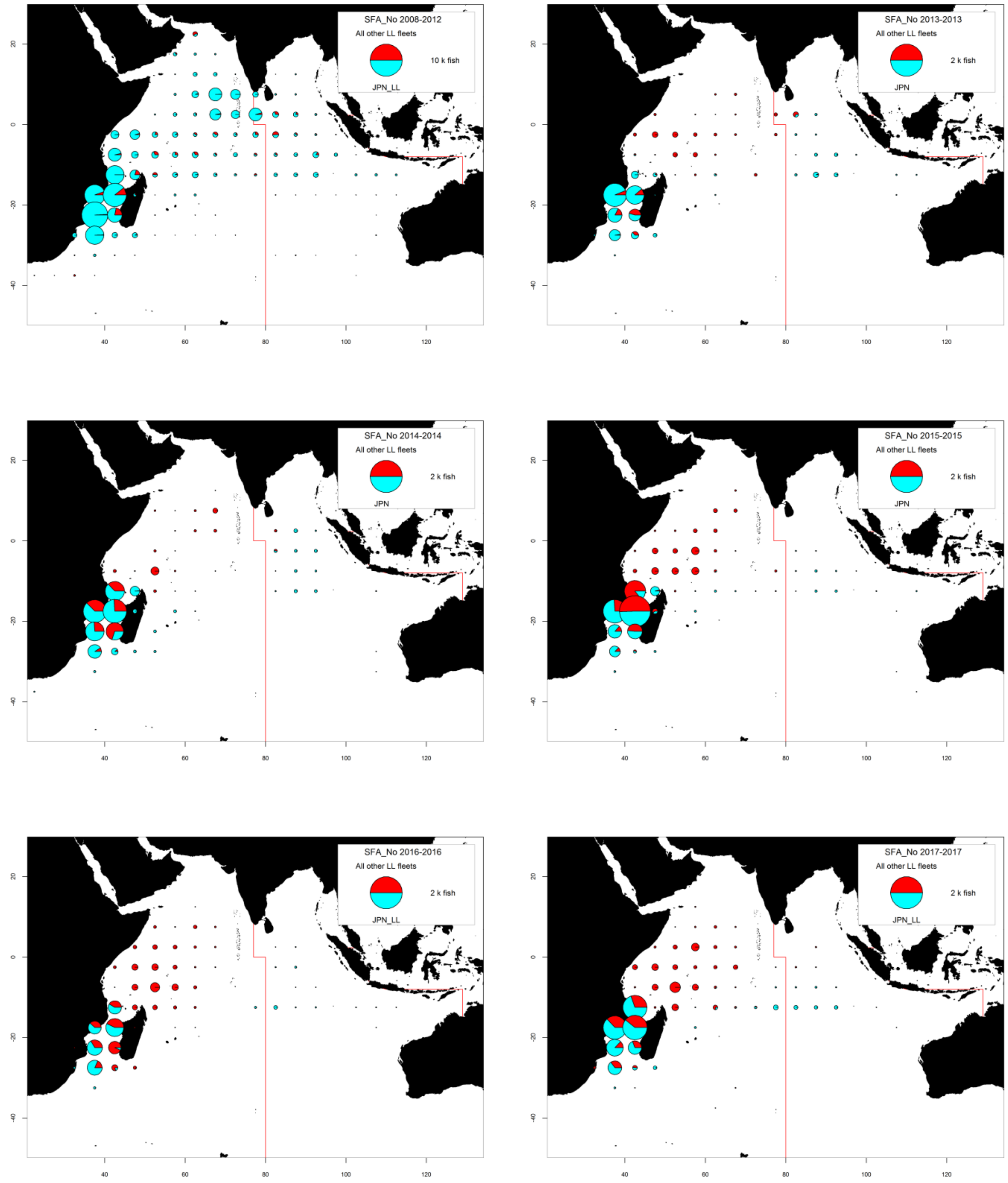


Fig. 25a-f. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and all other longline fleets for the period 2008–12, by fleet and for 2012–17, by year and fleet. Red lines represent the IOTC Areas.

Source: IOTC catch-and-effort data. Does not include catches from fleets notreporting catch-and-effort data.

Indo-pacific sailfish: estimation of catches – data related issues

Retained catches – a very high proportion of the catches of Indo-Pacific sailfish are estimated, or adjusted, by the IOTC Secretariat are (**Fig.26a**), due to a number of uncertainties in the catches listed below. However, unlike the other billfish species, Indo-Pacific sailfish are more reliably identified because of the large and distinctive first dorsal fin that runs most of the length of the body:

- Species aggregates: catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the Secretariat for some artisanal fisheries (e.g., gillnet/longline fishery of Sri Lanka and artisanal fisheries of India and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).

  Catches of Indo-Pacific sailfish reported for some fisheries may also refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (i.e., in the case of coastal fisheries).
- Conflicting reports: In 2017 Pakistan also submitted a revised catch series, dating back to the 1980s, and which are significantly lower than current estimates for billfish for Pakistan in the IOTC database, and particularly catches of Indo-Pacific sailfish. The data are currently pending upload to the IOTC database until further clarifications have been received regarding the catch revision estimation methodology, and particularly the scale of revisions for some billfish species.
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI fleets) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which Indo-Pacific sailfish is not a target species.
- Missing or incomplete catches: catches are likely to be incomplete for some artisanal fisheries (e.g., Pakistan gillnets, Maldives pole-and-line) due to under-reporting.

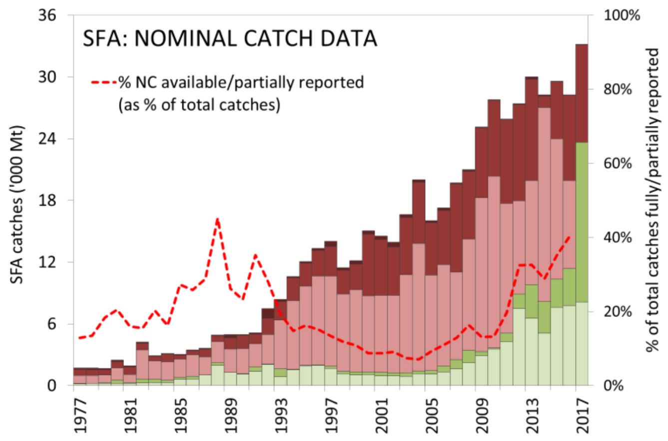
  There is also a lack of catch data for most sport fisheries.

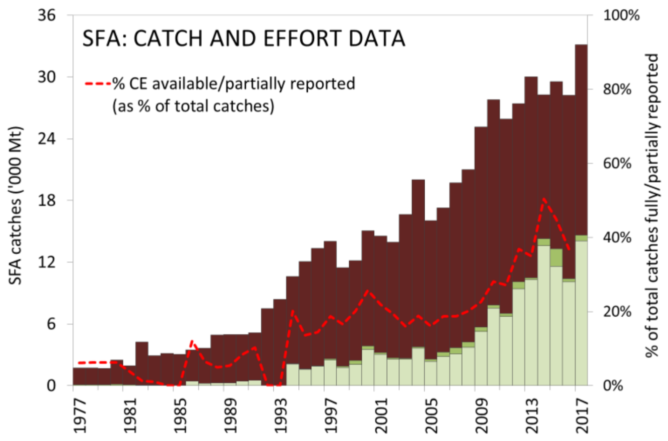
Indo-Pacific sailfish – Nominal catch-per-unit-effort (CPUE) trends

- Availability: Standardized and nominal CPUE series have not yet been developed. No catch and effort data are available from sports fisheries, other than partial data from the sports fisheries of Kenya; or other artisanal fisheries (e.g., Pakistan (gillnet), Sri Lanka (gillnet-longline), Indonesia (gillnet)) or industrial fisheries (NEI longliners and all purse seiners).

Indo-Pacific sailfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s. The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (leading to possible bias of existing samples).
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.
- Sex ratio data: have not been provided to the Secretariat by CPCs.





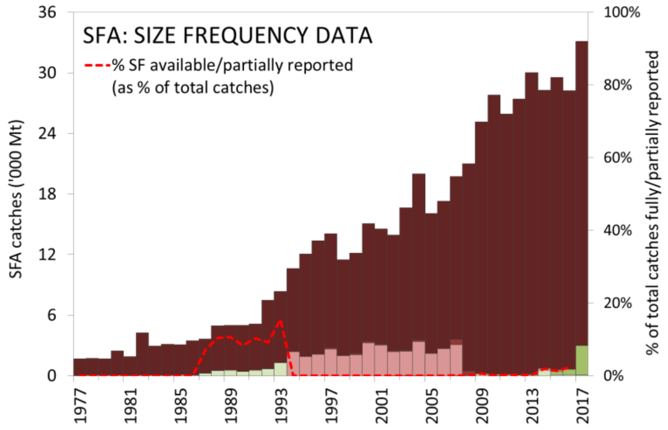


Fig. 26a-c. Indo-Pacific sailfish: data reporting coverage (1978–2017).

Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

Data as of August 2019.

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

- Total score is 0 (or average score is 0-1)
- Total score is 2 (or average score is 1-3)
- Total score is 4 (or average score is 3-5)
- Total score is 6 (or average score is 5-7)
- Total score is 8 (or average score is 7-8)

APPENDIX V
MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF BILLFISH

(*Extract from IOTC–2018–WPB16–07_Rev1*)

The following section provides a summary of the main issues that the IOTC Secretariat considers to negatively affect the quality of billfish statistics available at the IOTC, by type of dataset, for the consideration of the WPB.

Nominal (retained) catches

Artisanal fisheries (including Sports Fisheries)

- Sri Lanka (gillnet/longline): In recent years, Sri Lanka has been estimated to catch over 15% of catches of marlins in the Indian Ocean. Although catches of marlins by species have been reported for it's gillnet/longline fishery, the catch ratio of blue marlin to black marlin has changed dramatically in recent years. This is thought to be a sign of frequent mis-identification rather than the effect of changes in catch rates or species composition for this fishery. Although the IOTC Secretariat has adjusted the catches of marlins using proportions derived from years known to have reliable data, the estimated catches remain uncertain.
- Indonesia (coastal fisheries): Catches of billfish reported by Indonesia for its artisanal fisheries in recent years are considerably higher than those reported in the past, at around 5% of the total catches of billfish in the Indian Ocean. In 2011 the Secretariat revised the nominal catch dataset for Indonesia, using information from various sources, including official reports. While Indonesia is implementing a number of improvements to the collection and validation of data for artisanal fisheries – including electronic logbooks and complete enumeration of catches at key landing sites – catches are considered to be uncertain for the small-scale fisheries.
- Sport fisheries of Australia, France(La Réunion), India, Indonesia, Madagascar, Mauritius, Oman, Seychelles, Sri Lanka, Tanzania, Thailand and United Arab Emirates: Data has either never been submitted, or is available for only a limited number of years for sports fisheries in each of the referred CPCs. Sport fisheries are known to catch billfish species, and are particularly important for catches of blue marlin, black marlin and Indo-Pacific sailfish. Although some data are available from sport fisheries in the region (e.g., Kenya, Mauritius, Mozambique, South Africa), the information cannot be used to estimate levels of catch for other fisheries.

  In 2017 the IOTC Secretariat commissioned a pilot project to develop tools and training materials for CPCs to improve the collection and reporting of catch-and-effort and size frequency from sports fisheries in the Western Indian Ocean. The Project focused on trialling the data collection tools on a small number of CPCs, including La Réunion, Kenya, Mauritius and Seychelles – however data reporting continues to be an on-going issue for sports and recreational fisheries.
- Drifting gillnet fisheries of I.R. Iran and Pakistan:

  The gillnet fisheries of I.R. Iran and Pakistan are estimated to account for around 25,000 t of catches of billfish (equivalent to over 20% of the total billfish catches in the Indian Ocean). However catches for this component remain uncertain:

  - I.R. Iran**:** In recent years I.R. Iran has reported catches of marlins and swordfish for their gillnet fishery (from 2012 onwards) which significantly revises the catch-by-species previously estimated by the IOTC Secretariat. While the IOTC Secretariat has used the new catch reports to re-build the historical series (pre-2012) for its offshore gillnet fishery, estimates for the historical series remain highly uncertain.
  - Pakistan: In 2017 Pakistan submitted revised catches dating back to the 1980s. However the catches are significantly different for a number of species reported by WWF-Pakistan funded sampling in 2012, and also compared to previous official data reported by Pakistan to the IOTC Secretariat. In the case of billfish, there are large differences particularly for catches of swordfish, striped marlin and Indo-Pacific sailfish. Current IOTC catch estimates for Pakistan account for around 6% of the total catches of billfish in the Indian Ocean - however, based on the latest data submitted by Pakistan, catches are estimated to be much significantly lower. A review of the revised historical data is currently being undertaken by the IOTC Secretariat, and which will be presented to the WPDCS meeting in 2019, before changes are made to Pakistan's current catch estimates in the IOTC database.

Industrial (longline) fisheries

- Indonesia (fresh longline): Following issues with the reliability of catch estimates of Indonesia's fresh longline fleet in recent years, in 2018 the IOTC Secretariat provided the WPB-16 meeting with an alternative catch series, based on a new estimation methodology developed in collaboration with Indonesia (see IOTC-2018-WPB16-DATA03b available on the WPB meeting webpage). The revised catch series mostly affects Indonesia's catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat.

The revised catches are significantly lower for Indonesia's fresh longline fleet in recent years compared to previous IOTC estimates, while total catches across all fleets have also been revised downwards by as much as 30% for each species as a consequence of the new estimation methodology. Further details on the alternative catch series can be found in paper IOTC-2018-WPB16-22[6].

- Taiwan,China (fresh longline): Recent issues with IOTC Secretariat's estimates of billfish for Indonesia relate to changes in the Taiwanese fresh-longline fleet, which in previous years has been used as a proxy fleet by the Secretariat to estimate the total catches and species composition (due to separate and unrelated issues with the reliability of Indonesia's officially reported catches).

  Despite a decrease in the number of Taiwanese fresh-longline vessels of around 30% between 2013-2016, catches have remained at similar levels, or even marginally increased as average catches per vessel have risen from 100 t per vessel in 2013 to around 175 t per vessel in 2016. Over the same period, the proportion of swordfish reported by the Taiwanese flesh longline fleet has risen from around 8% to over 30% - due to improvements in the estimation of catches by species, according to official sources.

  Both these issues (i.e., the sharp increase in average catches per vessel, and also changes to the species composition) require further clarification to ensure that the recent increase in average catches is valid.

Catch-and-effort and CPUE series

For a number of fisheries important for billfish catches listed below, catch-and-effort remains either unavailable, incomplete (i.e., missing catches by species, gear, or fleet), or only partially reported according to the standards of IOTC Resolution 15/02, and therefore of limited value in deriving indices of abundance:

- EU,Spain (longline)**:** Incomplete catch-and-effort data is reported for the longline fishery of EU-Spain, which reports nominal catches for all billfish, but only time-area catches for swordfish.
- India (longline): In recent years, India has reported very incomplete catches and catch-and-effort data for its commercial longline fishery. The IOTC Secretariat has estimated total catches for this period using alternative sources, and the final estimated catches are significantly higher than those officially reported to the Secretariat.
- Republic of Korea (longline): The nominal catches and catch-and-effort data series for billfish for the longline fishery of Korea are conflicting, with nominal catches of swordfish and marlins lower than the catches reported as catch-and-effort for some years. Although in 2010 the IOTC Secretariat revised the nominal catch dataset to account for catches reported as catch-and-effort, the quality of the estimates remains unknown. However, the catches of longliners of the Republic of Korea in recent years are very small.

Size data from (all fisheries)

Size data for all billfish species is generally considered to be unreliable and insufficient to be of use for stock assessment purposes, as the numbers of samples for all species are below the minimum sampling coverage of one fish per tonne of catch recommended by IOTC. Also the quality of many of the samples collected by fishermen on commercial boats cannot be verified.

- Taiwan,China (longline): Size data have been available since 1980; however, the IOTC Secretariat has identified issues in the length frequency distributions, in particular fish recorded under various types of size class bins (e.g. 1cm, 2cm, 10cm, etc.) that are reported under identical class bins (e.g. 2cm, with all fish between 10-20 cm reported as 10-12cm). For this reason, the average weights estimated for this fishery are considered unreliable.
- I.R. Iran and Pakistan (gillnet): no size data reported for billfish species for gillnet fisheries since the 1980s.
- Sri Lanka (gillnet/longline)**:** Although Sri Lanka has reported length frequency data for swordfish and marlins in recent years, the lengths reported are considered highly uncertain, due to mis-identification of marlins and likely sampling bias (large specimens of swordfish and marlins are highly processed and not sampled for lengths, while small specimens are sampled).
- India and Oman (longline)**:** To date, India and Oman have not reported size frequency data for billfish from their commercial longline fisheries.

[6] https://www.iotc.org/documents/revision-iotc-scientific-estimates-indonesias-fresh-longline-catches-0

- Indonesia (longline): size frequency data has been reported for its fresh-tuna longline fishery in recent years. However, the samples cannot be fully disaggregated by fishing area (i.e., 5 degree square grid) due to being sampled in port (rather than on-board). For this reason the quality of the samples in the IOTC database are considered to be of limited value.
- Taiwan,China (fresh-tuna longline)**:** Taiwan,China recently submitted size frequency data for the fresh tuna longline for marlins and swordfish. In the case of data available for marlins, the data are considered uncertain due to the small number of samples for some species, or discrepancies in the size frequency distributions.
- India and Indonesia (artisanal fisheries): To date, India and Indonesia have not reported any billfish size frequency data for their artisanal fisheries.

Biological data (all billfish species)

The IOTC Secretariat has previously used length-age keys, length-weight keys, and processed weight-live weight keys for billfish species from other oceans due to the general lack of biological data, and length frequency data by sex, available from the fisheries indicated below:

- Industrial longline fisheries: in particular Taiwan,China, Indonesia, EU(all fleets), China and the Republic of Korea.

Data issues: priorities and suggested actions

The IOTC Secretariat suggests the following actions as key to improving the quality of datasets for the assessment of billfish, with a focus on fleets considered important for catches of billfish and for which issues have been identified with the data reported or currently estimated by the IOTC Secretariat (as detailed above).

i. I.R. Iran (gillnet fisheries): In previous years I.R. Iran has reported aggregated catches for all billfish species, which were estimated by species and gear by the IOTC Secretariat. Since 2012 Iran has now begun to report catches by billfish species, and which significantly revise the catches-by-species previously estimated by the IOTC Secretariat. The main changes are higher proportions of black marlin, rather than blue marlin reported by I.R. Iran, assigned to the offshore gillnet fishery. As a result of changes in the catch series total catches of black marlin for I.R. Iran were revised upwards by as much as 30% to 50% during the mid-2000's.

   Following an IOTC Data Compliance and Support mission to Iran in late-2017, the IOTC Secretariat has begun to receive detailed time-area catches (i.e., catch-and-effort) in accordance with the reporting requirements of Resolution 15/02. Data is also expected to be reported for the historical time series, which in turn will be used to inform the recent revisions to the billfish catches reported by Iran, and whether catches need to be revised for years prior to 2012.

ii. Pakistan (gillnet fisheries): In 2017 Pakistan submitted a revised catch series, dating back to the 1980s, and which significantly reduces estimates for billfish for Pakistan in the IOTC database – particularly for Indo-Pacific sailfish. A review of the revised historical data is currently being undertaken by the IOTC Secretariat, and which will be presented to the WPDCS meeting in 2019, before changes are made to Pakistan's current catch estimates in the IOTC database.

iii. Indonesia (fresh longline): Due to issues with the reliability of catch estimates of Indonesia's fresh longline fleet in recent years, the IOTC Secretariat provided the WPB-16 meeting with an alternative catch series, based on a new estimation methodology developed in collaboration with Indonesia. The revised catch series mostly affects Indonesia's catches of swordfish, striped marlin, and blue marlin estimated by the IOTC Secretariat.

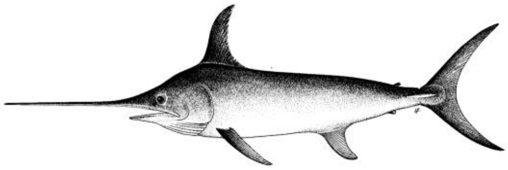
   While the new catch series is considered to be an improvement compared to the previous estimates, catches for Indonesia's fresh longline fleet remain uncertain and should be revisited as new information becomes available.

iv. Taiwan,China (fresh longline): Despite a decrease in the number of Taiwanese fresh-longline vessels of around 30% between 2013-2016, catches have remained at similar levels, or even marginally increased, as average catches per vessel have risen from 100 t per vessel in 2013 to around 175 t per vessel in 2016. Over the same period, the proportion of swordfish reported by the Taiwanese flesh longline fleet has risen from around 8% to over 30% due to improvements in the estimation of catches by species, according to official sources.

Both these issues (i.e., the sharp increase in average catches per vessel, and also changes to the species composition) require further clarification to ensure that the recent increase in average catches are valid.

APPENDIX VI
[DRAFT] RESOURCE STOCK STATUS SUMMARY – SWORDFISH

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

TABLE 1. Swordfish: Status of swordfish (*Xiphias gladius*) in the Indian Ocean.

Area[1]	Indicators		2019 stock status determination
Indian Ocean	Catch 2017[2]: Average catch 2013-2017:	33,352 t 31,154 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2015}/F_{MSY} (80% CI): SB_{2015}/SB_{MSY} (80% CI): SB_{2015}/SB_{1950} (80% CI):	31.59 (26.30–45.50) 0.17 (0.12–0.23) 43.69 (25.27–67.92) 0.76 (0.41–1.04) 1.50 (1.05–2.45) 0.31 (0.26–0.43)	

[1] Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2] Proportion of catch estimated or partially estimated by IOTC Secretariat in 2017: 29%

Colour key	Stock overfished (SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment was carried out for swordfish in 2019, thus, the stock status is determined on the basis of the 2017 assessment and other indicators presented in 2019. In 2017 a stock synthesis assessment was conducted, with fisheries catch data up to 2015. The assessment uses a spatially disaggregated, sex explicit and age structured model. The SS3 model, used for stock status advice, indicated that MSY-based reference points were not exceeded for the Indian Ocean population (F_{2015}/F_{MSY}< 1; SB_{2015}/SB_{MSY}> 1). Most other models applied to swordfish also indicated that the stock was above a biomass level that would produce MSY. The spawning stock biomass in 2015 was estimated to be 26%–43% of the unfished levels. The latest year's catches are higher than the MSY level (31,590 t). On the weight-of-evidence available in 2019, the stock is determined to be ***not overfished*** and ***not subject to overfishing***.

Outlook. The decrease in longline catch and effort from 2005 to 2011 lowered the pressure on the Indian Ocean stock, and despite the recent increase in total catches, current fishing mortality is not expected to reduce the population to an overfished state over the next decade. There is a very low risk of exceeding MSY-based reference points by 2026 if catches are maintained at 2015 levels (<1% risk that SB_{2026}< SB_{MSY}, and <1% risk that F_{2026}> F_{MSY}) (Table 2).

Management advice. The most recent catches (33,352 t in 2017) are higher than MSY (31,590 t) and should be reduced to the MSY level.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the Indian Ocean is 31,590 t.
- **Provisional reference points**: Noting that the Commission in 2015 agreed to Resolution 15/10 *on target and limit reference points and a decision framework*, the following should be noted:
  a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY} and below the provisional limit reference point of 1.4*F_{MSY} (**Fig. 2**).

b. **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of 0.4*SB_{MSY} (**Fig. 2**).

- **Main fishing gear (average catches 2013-17)**: Longline catches are currently estimated to comprise approximately 70% of total swordfish catches in the Indian Ocean (Fig. 1).
- **Main fleets (average catches 2013-17):**
Taiwan,China (longline): 21%; Sri Lanka (longline-gillnet): 18%; EU,Spain (swordfish targeted longline): 12%**;** Indonesia (fresh longline): 9%.

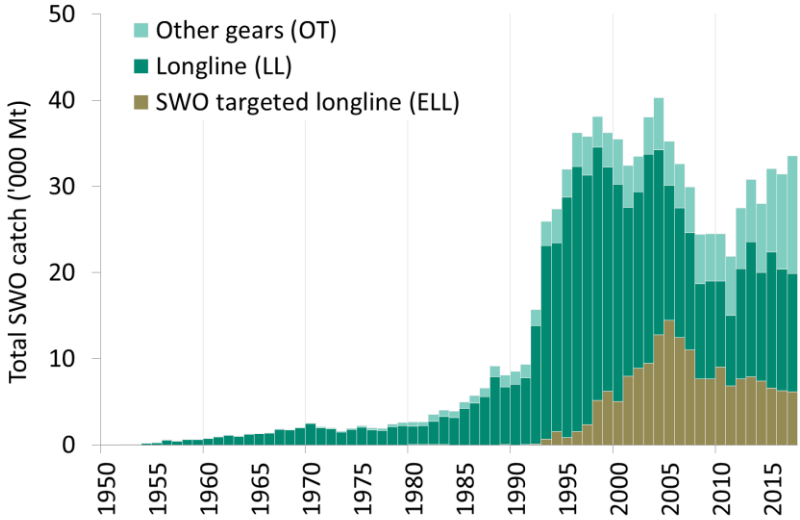


Fig. 1. Swordfish catches by gear and year recorded in the IOTC database (1950–2017);
Note: *Other gears (OT) includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.*

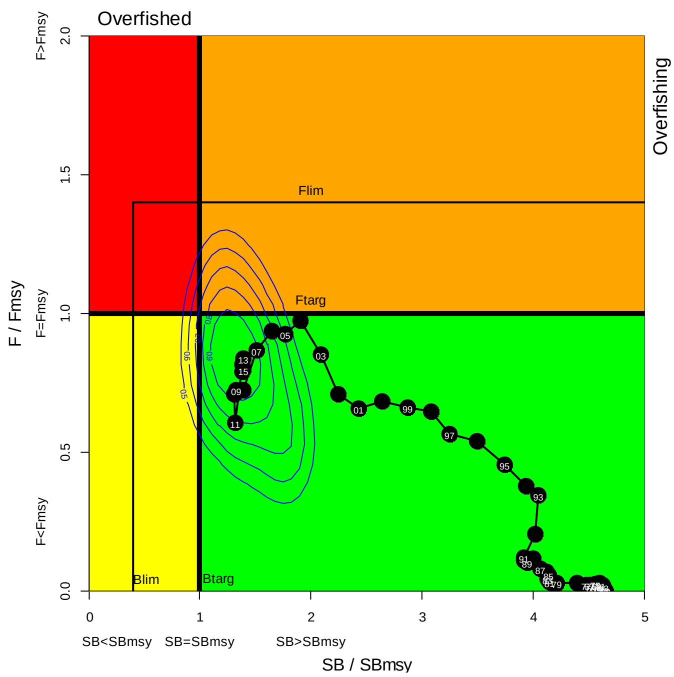


Fig. 2. Swordfish: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 60, 70, 80 and 90 percentiles of the 2015 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2015. Interim target (F_{targ} and SB_{targ}) and limit (F_{lim} and SB_{lim}) reference points, as set by the Commission, are shown.

TABLE 2. Swordfish: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for nine constant catch projections relative to 2015* catch level (32,129 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

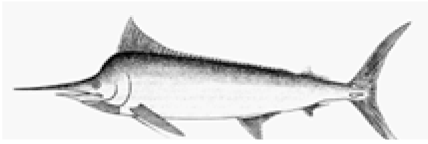
Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2015* (32,129 t) and probability (%) of violating MSY-based target reference points (SBtarg = SBMSY; Ftarg = FMSY)**								
	60% (19,278 t)	**70%** (22,491 t)	**80%** (22,704 t)	**90%** (28,917 t)	**100%** (32,129 t)	**110%** (35,343 t)	**120%** (38,556 t)	**130%** (41,769 t)	**140%** (44,982 t)
$SB_{2018} < SB_{MSY}$	0	0	0	0	0	0	0	8	13
$F_{2018} > F_{MSY}$	0	0	0	0	13	33	42	58	71
$SB_{2025} < SB_{MSY}$	0	0	0	0	8	33	46	63	75
$F_{2025} > F_{MSY}$	0	0	0	4	38	54	71	83	88

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2015* (32,129 t) and probability (%) of violating MSY-based limit reference points (SB_{lim} = 0.4 SB_{MSY}; F_{Lim} = 1.4 F_{MSY})**								
	60% (19,278 t)	**70%** (22,491 t)	**80%** (22,704 t)	**90%** (28,917 t)	**100%** (32,129 t)	**110%** (35,343 t)	**120%** (38,556 t)	**130%** (41,769 t)	**140%** (44,982 t)
$SB_{2018} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2018} > F_{Lim}$	0	0	0	0	0	0	0	13	33
$SB_{2025} < SB_{Lim}$	0	0	0	0	0	0	0	0	21
$F_{2025} > F_{Lim}$	0	0	0	0	0	21	42	63	75

** 2015 catches, at the time of the last swordfish assessment conducted in 2017.*

APPENDIX VII
[DRAFT] RESOURCE STOCK STATUS SUMMARIES – BLACK MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien



Status of the Indian Ocean black marlin (BLM: *Makaira indica*) resource

TABLE 1. Black marlin: Status of black marlin (*Makaira indica*) in the Indian Ocean.

Area[1]	Indicators		2019 stock status determination
Indian Ocean	Catch 2017[2]: Average catch 2013–2017:	14,644 t 17,352 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2017}/F_{MSY} (80% CI): B_{2017}/B_{MSY} (80% CI): B_{2017}/B_0 (80% CI):	12.93 (9.44-18.20) 0.18 (0.11-0.30) 72.66 (45.52-119.47) 0.96 (0.77-1.12) 1.68 (1.32-2.10) 0.62 (0.49-0.78)	

[1] Boundaries for the Indian Ocean = IOTC area of competence;
[2] Proportion of catch fully or partially estimated by IOTC Secretariat in 2018: 27%

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment for black marlin was carried out in 2019, thus, the stock status is determined on the basis of the 2018 assessment based on JABBA and other indicators presented in 2019. This assessment suggests that the point estimate for the stock in 2017 is in the green zone in the Kobe plot with F/F_{MSY}=0.96 (0.77-1.12) and B/B_{MSY}=1.68 (1.32-2.10). The Kobe plot (Fig. 2) from the JABBA model indicated that the stock is not **subject to overfishing** and is currently not **overfished** (Table 1; Fig. 2), however these status estimates are subject to a high degree of uncertainty. The recent sharp increases in total catches (e.g., from 13,000 t in 2012 to over 21,000 t by 2016), and conflicts in information in CPUE and catch data lead to large uncertainties in the assessment outputs. This caused the point estimate of the stock status to change from the red to the green zones of the Kobe plot without any evidence of a rebuilding trend. **As such, the results of the assessment are uncertain and should be interpreted with caution.**

Outlook. While the recent high catches seem to be mainly due to developing coastal fisheries operating in the core habitat of the species, the CPUE indicators are from industrial fleets operating mostly offshore on the edges of the species distribution. However, the recent increases in catches are much higher than MSY and are a cause for concern and will likely continue to drive the population towards overfished status.

Management advice. Current catches (>14,600 t in 2017) (Fig. 1) are higher than MSY estimate (12,930 t), which is likely to associate with high uncertainty. The catch limits as stipulated in Resolution 18/05 have also been exceeded. The Commission should provide mechanisms to ensure that catch limits are not exceeded by all concerned fisheries. Projections were not carried out due to the poor predictive capabilities identified in the assessment diagnostics.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 12,930 t.
- **Provisional reference points**: Although the Commission adopted reference points for swordfish in Resolution 15/10 *on target and limit reference points and a decision framework*, no such interim reference points nor harvest control rules have been established for black marlin.
- **Main fishing gear (average catches 2013-17)**:
  Black marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for around 50% of total catches in the Indian Ocean, followed by longlines (17%), with remaining catches recorded under troll and handlines (Fig. 1).
- **Main fleets (average catches 2013-17):**
  Around 70% of the total catches of black marlin are accounted for by three fleets:
  I.R. Iran (gillnet): 29%; India (gillnet and trolling): 23%; Sri Lanka (gillnet and fresh longline): 20%.

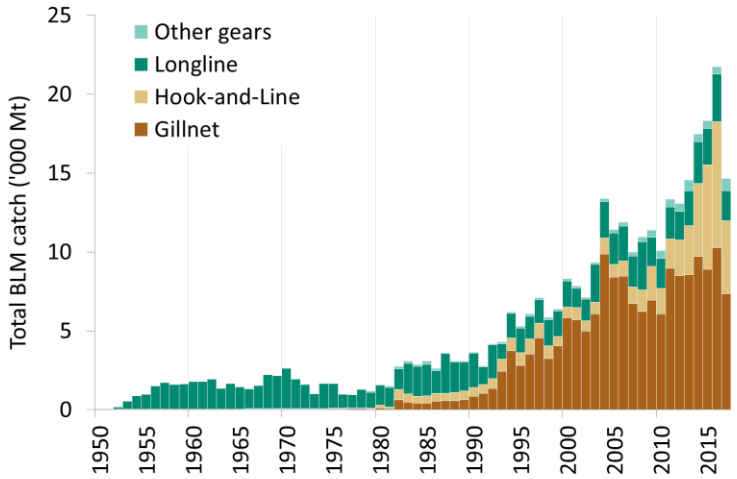


Fig. 1a-b. Black marlin catches by gear and year recorded in the IOTC database (1950–2017):
Notes: *Other gears (OT) includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.*

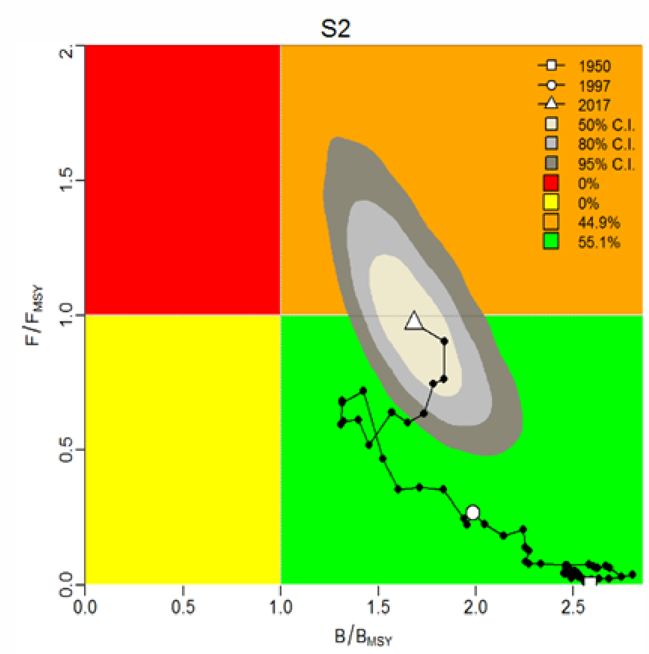
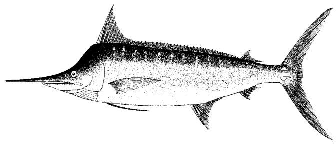


Fig. 2. Black marlin: JABBA Indian Ocean assessment Kobe plots for black marlin (contours are the 50, 80 and 95 percentiles of the 2017 estimate). Black line indicates the trajectory of the point estimates for the total biomass (B) ratio and F ratio for each year 1950–2017.

APPENDIX VIII
[DRAFT] RESOURCE STOCK STATUS SUMMARIES – BLUE MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean blue marlin (BUM: *Makaira nigricans*) resource

TABLE 1. Blue marlin: Status of blue marlin (*Makaira nigricans*) in the Indian Ocean.

Area[1]	Indicators		2019 stock status determination
Indian Ocean	Catch 2017[2]:	12,796 t	87%*
	Average catch 2013-2017:	11,761 t	
	MSY (1,000 t) (80% CI):	9.98 (8.18 –11.86)	
	F_{MSY} (80% CI):	0.21 (0.13 – 0.35)	
	B_{MSY} (1,000 t) (80% CI):	47 (29.9 – 75.3)	
	H_{2017}/H_{MSY} (80% CI):	1.47 (0.96 – 2.35)	
	B_{2017}/B_{MSY} (80% CI):	0.82 (0.56 – 1.15)	
	B_{2017}/B_0 (80% CI):	0.41 (0.28 – 0.57)	

[1] Boundaries for the Indian Ocean = IOTC area of competence.
[2] Proportion of catch estimated or partially estimated by IOTC Secretariat in 2017: 27%.
* Estimated probability that the stock is in the respective quadrant of the Kobe plot (shown below), derived from the confidence intervals associated with the current stock status.

Colour key	Stock overfished($B_{year}/B_{MSY} < 1$)	Stock not overfished ($B_{year}/B_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	**87%**	**10%**
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	**0%**	**3%**
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Stock status based on the Bayesian State-Space Surplus Production model JABBA suggests that there is an 87% probability that the Indian Ocean blue marlin stock in 2017 is in the red zone of the Kobe plot, indicating the stock is **overfished** and **subject to overfishing** (B_{2017}/BMSY=0.82 and F_{2017}/FMSY=1.47) as shown in Table 1 and Figure 1. The most recent catch exceeds the estimate of MSY ($catch_{2017}$ = 12,796; MSY = 9,984). The previous assessment of blue marlin (Andrade 2016) concluded that in 2015 the stock was subject to overfishing but not overfished. The change in stock status can be attributed to increased catches for the period 2015-2017 as well as improved standardisation of CPUE indices, which includes the area disaggregation of JPN and TWN indices to account for fleet dynamics.

Outlook. The B_{2017}/B_{MSY} trajectory declined from the mid 1980s to 2008 and a steady increase of F/F_{MSY} since the mid-1980s has continued unabated. Periodic data conflict between the CPUE indices included in the assessment, particularly JPN and TWN, inflate uncertainty in B_{2017}/B_{MSY} and F_{2017}/F_{MSY} point estimates. However, a 'drop one' sensitivity analysis indicated that omitting any of the CPUE time-series would not alter the stock status.

Management advice. The current catches of blue marlin (average of 11,761 t in the last 5 years, 2013-2017) are higher than MSY (9,984 t) and the stock is currently overfished and subject to overfishing. In order to achieve the Commission objectives of being in the green zone of the Kobe Plot by 2027 ($F_{2027} < F_{MSY}$ and $B_{2027} > B_{MSY}$) with at least a 60% chance, the catches of blue marlin would have to be reduced by 35% compared to the average of the last 3 years, to a maximum value of approximately 7,800 t.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the Indian Ocean blue marlin stock is 9,980 t (estimated range 8,180–11,860 t).

- **Provisional reference points**: Although the Commission adopted reference points for swordfish in Resolution 15/10 *on target and limit reference points and a decision framework*, no such interim reference points, nor harvest control rules have been established for blue marlin.
- **Main fishing gear (average catches 2013-17)**: Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches account for around 70% of total catches in the Indian Ocean, followed by gillnets (24%), with remaining catches recorded under troll and handlines (Fig. 1).
- **Main fleets (average catches 2013-17):**
  Around 80% of the total catches of blue marlin are accounted for by four fleets:
  Taiwan,China (longline): 40%; Pakistan (gillnet): 15%; I.R. Iran (gillnet): 13%, and Sri Lanka (10%) (**Fig.1**).

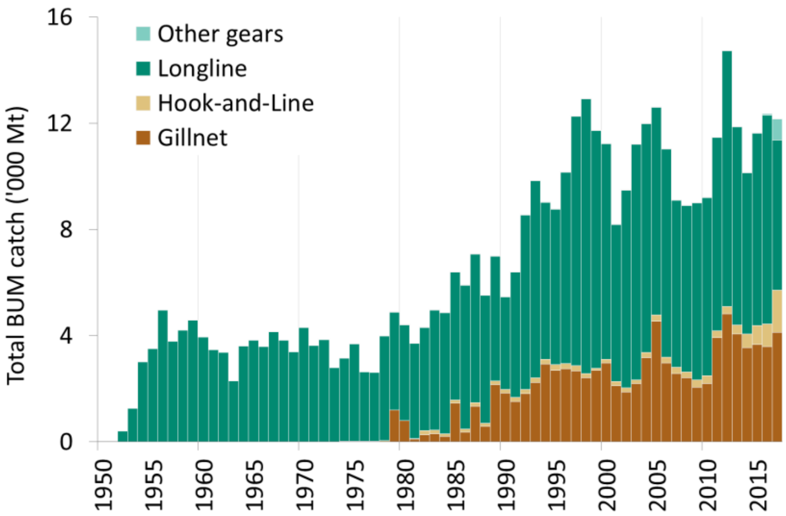


Fig. 1. Blue marlin catches by gear and year recorded in the IOTC database (1950–2017).
Notes: *Other gears (OT) includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.*

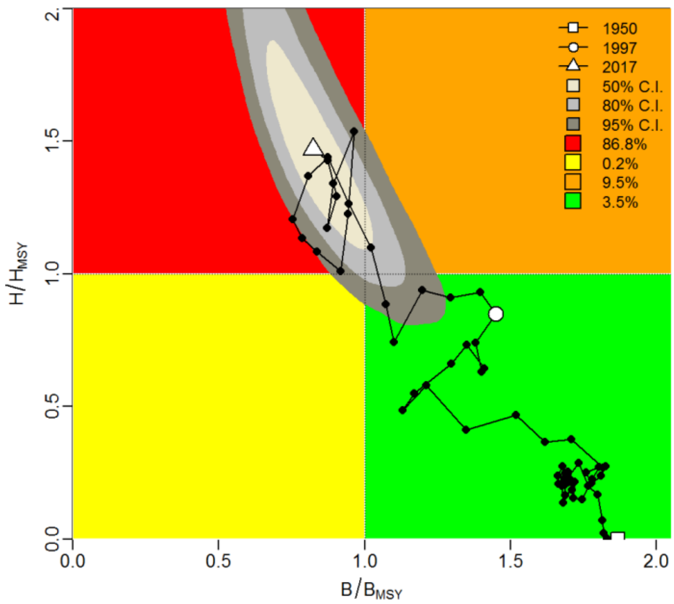


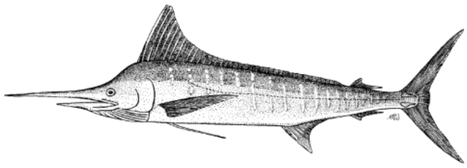
Fig. 2. Blue marlin: Kobe stock status plot for the Indian Ocean for black marlin, from the final JABBA base case (the black line traces the trajectory of the stock over time. Contours represent the smoothed probability distribution for 2018 (isopleths are probability relative to the maximum)).

Table 2. Blue Marlin: Indian Ocean JABBA Kobe II Strategy Matrix. Probability (percentage) of achieving the green quadrant of the KOBE plot nine constant catch projections, with future catch assuming to be 30–110% (in increments of 10%) of the 2017 catch level (12,029 t).

TAC | Year	2019	2020	2021	2022	2023	2024	2025	2026	2027
30% (3609)	20	39	58	71	81	87	91	93	95
40% (4812)	20	36	51	63	72	79	83	87	90
50% (6014)	21	33	44	54	62	68	73	77	81
60% (7217)	20	29	38	45	51	56	60	64	67
70% (8420)	20	26	32	37	41	45	47	50	52
80% (9623)	20	23	26	28	30	31	33	34	35
90% (10826)	17	18	19	19	20	20	20	20	20
100% (12029)	11	11	11	10	10	10	10	9	9
110% (13232)	7	6	6	6	5	5	4	4	4

APPENDIX IX
[DRAFT] RESOURCE STOCK STATUS SUMMARIES – STRIPED MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource

TABLE 1. Striped marlin: Status of striped marlin (*Tetrapturus audax*) in the Indian Ocean.

Area[1]	**Indicators**		**2019 stock status determination**
Indian Ocean	Catch 2017[2]:	3,020 t	**99.8%***
	Average catch 2013-2017:	3,574 t	
	MSY (1,000 t) (JABBA):	4.73 (4.27–5.18)[5]	
	F_{MSY} (JABBA):	0.26 (0.20–0.34)	
	B_{MSY} (1,000 t) (JABBA):	17.94 (14.21–23.13)	
	F_{2017}/F_{MSY} (JABBA):	1.99 (1.21–3.62)	
	B_{2017}/B_{MSY} (JABBA):	0.33 (0.18–0.54)	
	SB_{2017}/SB_{MSY} (SS3)[6]:	0.373	
	B_{2017}/K(JABBA):	0.12 (0.07–0.20)	
	SB_{2017}/SB_{1950} (SS3):	0.13 (0.09–0.14)	

[1] Boundaries for the Indian Ocean = IOTC area of competence
[2] Proportion of catch estimated or partially estimated by IOTC Secretariat in 2017: 32%
[5] JABBA estimates are the range of central values shown in Figure 2.
[6] SS3 is the only model that used SB/SB_{MSY}, all others used B/B_{MSY}.
* Estimated probability that the stock is in the respective quadrant of the Kobe plot (shown below), derived from the confidence intervals associated with the current stock status.

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)	**99.8%**	**0.0%**
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	**0.2%**	**0.0%**
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new stock assessment for striped marlin was carried out in 2019, thus, the stock status is determined on the basis of the 2018 assessment and other indicators presented in 2019. In 2018 a stock assessment was conducted based on two different models: JABBA, a Bayesian state-space production model; and SS3, an integrated length-based model. Both models were very consistent and confirmed the results from 2012, 2013, 2015 and 2017 assessments, indicating that the stock is subject to overfishing ($F>F_{MSY}$) and overfished, with the biomass for at least the past ten years below the level which would produce MSY ($B<B_{MSY}$). On the weight-of-evidence available in 2019, the stock status of striped marlin is determined to be ***overfished*** and ***subject to overfishing*** (**Table 1**; **Fig. 2**)

Outlook. The decrease in longline catches and fishing effort in the years 2009–11 reduced the pressure on the Indian Ocean stock. However, given the increase in catches reported since 2011 (mostly from coastal fisheries), combined with the results obtained from the last stock assessments conducted in 2012, 2013, 2015, 2017 and 2018, the outlook is pessimistic. As requested by IOTC Resolution 18/05, K2SM probabilities are provided with options to reduce fishing mortality with a view to recover the stocks to the green zone of the Kobe Plot with levels of probability ranging from 60% to 90% by 2026 at latest (Table 2).

Management advice. Current or increasing catches have a very high risk of further decline in the stock status. Current 2017 catches (Fig. 1) are lower than MSY (4,730 t) but the stock has been overfished for more than two decades and is now in a highly depleted state. If the Commission wishes to recover the stock to the green quadrant of the Kobe plot with a probability ranging from 60% to 90% by 2026, it needs to provide mechanisms to ensure the maximum annual catches remain between 1,500 t – 2,200 t (Table 3).

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY)**: estimates for the Indian Ocean stock are highly uncertain and estimates range between 4,270 t – 5,180 t. However, the current biomass is well below the B_{MSY} reference point and fishing mortality is in excess of F_{MSY} at recent catch levels.
- **Provisional reference points**: Although the Commission adopted reference points for swordfish in Resolution 15/10 *on target and limit reference points and a decision framework*, no such interim reference points have been established for striped marlin.
- **Main fishing gear (average catches 2013-17)**: Striped marlin are largely considered to be a non-target species of industrial fisheries. Longlines account for around 56% of total catches in the Indian Ocean with remaining catches recorded gillnets, and troll and handlines (Fig. 1).
- **Main fleets (average catches 2013-17):**
  Taiwan,China (drifting longline): 24%; Indonesia (longline): 21%; I.R. Iran (gillnet): 20%; and Pakistan (gillnet): 10%.

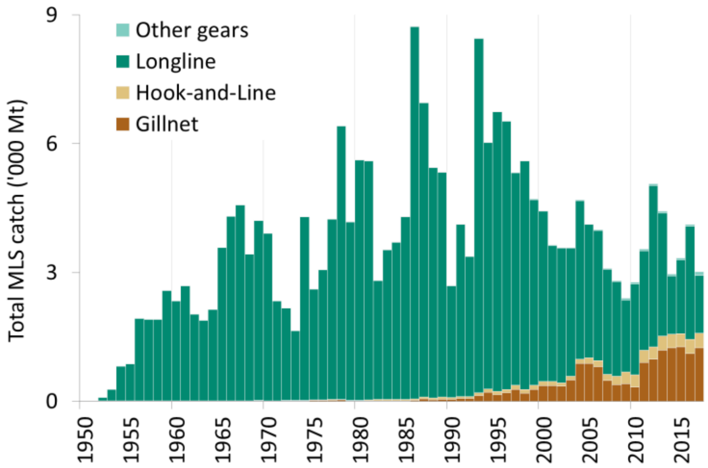


Fig. 1. Striped marlin catches by gear and year recorded in the IOTC database (1950–2017).
Notes*: Other gears (OT) includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.*

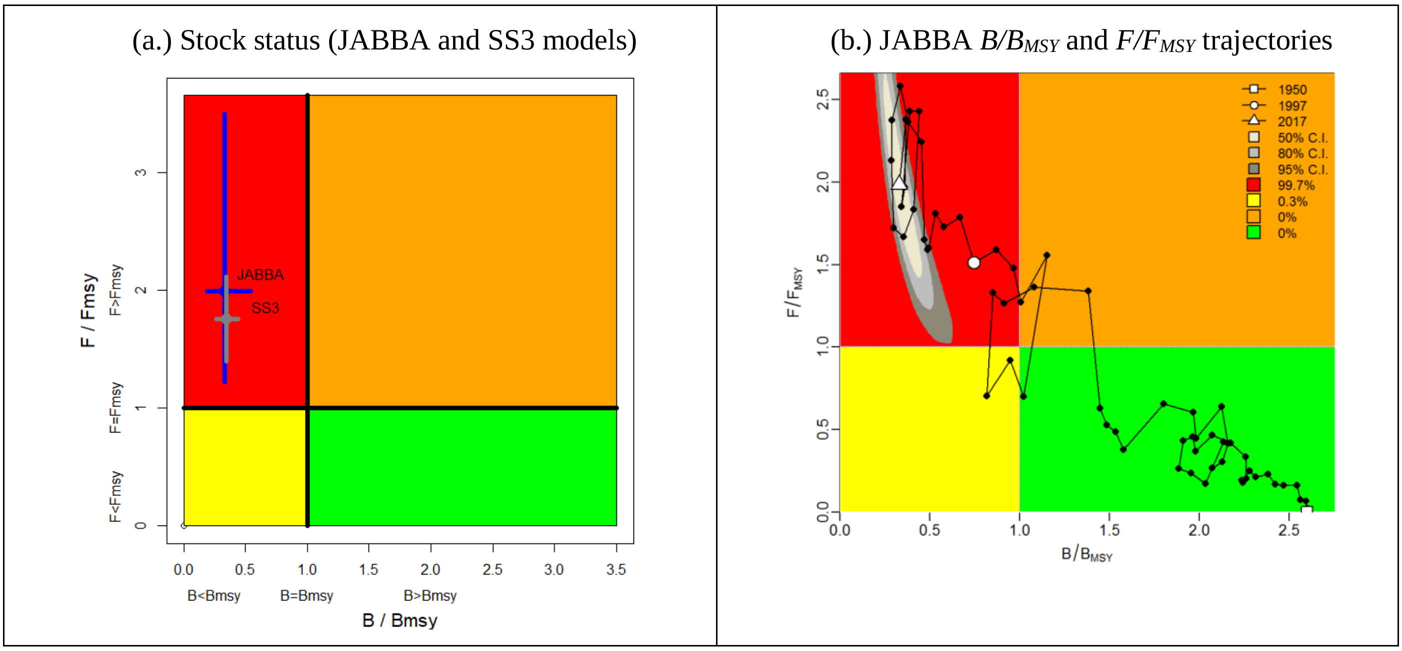


Fig. 2. (a): Striped marlin: Stock status from the Indian Ocean assessment JABBA (Bayesian State Space Surplus Production Model) and SS3 models with the confidence intervals (left); (b): Trajectories (1950-2017) of B/B_{MSY} *and* F/F_{MSY} from the JABBA model. NB: SS3 refers to SB/SB_{MSY} while the JABBA model correspond to B/B_{MSY}.

TABLE 2. Striped marlin: JABBA Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections relative to the average 2015-2017 catch level (3,512 t)*, ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2015-2017* (3,512 t)) and probability (%) of violating MSY-based target reference points (SBtarg = SBMSY; Ftarg = FMSY)**								
	60% (2,107 t)	**70%** (2,459 t)	**80%** (2,810 t)	**90%** (3,161 t)	**100%** (3,512 t)	**110%** (3,864 t)	**120%** (4,215 t)	**130%** (4,566 t)	**140%** (4,917 t)
$SB_{2020} < SB_{MSY}$	99	100	100	100	100	100	100	100	100
$F_{2020} > F_{MSY}$	48	70	87	95	99	100	100	100	100
$SB_{2027} < SB_{MSY}$	25	43	64	81	92	97	99	100	100
$F_{2027} > F_{MSY}$	9	21	40	63	83	94	99	100	100

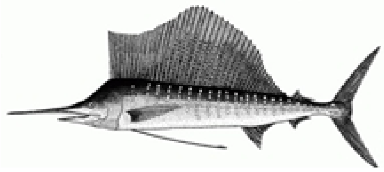
** 2015-2017 average catches, based on low catch scenario (IOTC-2018-WPB16-DATA03b).*

TABLE 3. Striped marlin: Probability (percentage) of achieving the KOBE green quadrat from 2018-2027 for a range of constant catch projections (JABBA).

TAC | Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
1500	0	0	2	11	29	51	70	83	90	94
1600	0	0	2	10	25	47	66	79	87	92
1700	0	0	2	8	23	42	61	75	84	90
1800	0	0	1	7	20	38	56	71	81	87
1900	0	0	1	6	17	34	52	66	77	84
2000	0	0	1	5	15	30	48	62	73	80
2100	0	0	1	4	13	26	42	56	68	76
2200	0	0	1	4	11	23	38	52	62	71
2300	0	0	1	3	9	20	33	46	57	66
2400	0	0	1	3	8	17	29	41	52	61
2500	0	0	1	3	7	15	25	36	47	55

APPENDIX X
[DRAFT] RESOURCE STOCK STATUS SUMMARY – INDO-PACIFIC SAILFISH

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Indo-Pacific sailfish (SFA: *Istiophorus platypterus*) resource

TABLE 1. Indo-Pacific sailfish: Status of Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean.

Area[1]	**Indicators**		**2019 stock status determination**
Indian Ocean	Catch 2017[2]: Average catch 2013-2017:	33,136 t 29,843 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2017}/F_{MSY} (80% CI): B_{2017}/B_{MSY} (80% CI): B_{2017}/B_0 (80% CI):	23.9 (16.1 – 35.4) 0.19 (0.14 - 0.24) 129 (81–206) 1.22 (1 – 2.22) 1.14 (0.63 – 1.39) 0.57 (0.31 – 0.70)	

[1] Boundaries for the Indian Ocean = IOTC area of competence.
[2] Proportion of catches estimated or partially estimated by IOTC Secretariat in 2017: 29%.

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)	17%	60%
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	5%	16%
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. A new stock assessment was carried out for Indo-Pacific sailfish in 2019 using the C-MSY model. The data poor stock assessment techniques indicated that F was above F_{MSY} (F/F_{MSY}=1.22) and B is above B_{MSY} (B/B_{MSY}=1.14). Another alternative model using the Stock Reduction Analysis (SRA) techniques produced similar results. The stock appears to show a continued increase catches which is a cause of concern (**Fig. 1**), indicating that fishing mortality levels may be becoming too high (**Fig. 2**). However both assessment models relies on catch data, however the catch series is highly uncertain. In addition aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are also a cause for concern. On the weight-of-evidence available in 2019, the stock status cannot be assessed and is determined to be uncertain.

Outlook. Catches since 2009 have exceeded the estimated MSY, and have also increased by 58% between 2008 and 2017. This increase in coastal gillnet catches and fishing effort in recent years is a substantial cause for concern for the Indian Ocean stock, however there is not sufficient information to evaluate the effect this will have on the resource. It is also noted that 2017 catches (33,136 t) exceed the catch limit prescribed in Resolution 18/05 (25,000 t).

Management advice. The catch limits as stipulated in Resolution 18/05 have been exceeded. The Commission should provide mechanisms to ensure that catch limits are not exceeded by all concerned fisheries. Research emphasis on further developing possible CPUE indicators from gillnet fisheries, and further exploration of stock assessment approaches for data poor fisheries are warranted. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps. The lack of catch records in the Persian Gulf should also be examined to evaluate the degree of localised depletion in Indian Ocean coastal areas.

The following key points should also be noted:

- **Maximum Sustainable Yield (MSY):** estimate for the Indian Ocean stock is 23,900 t.

- **Provisional reference points:** Although the Commission adopted reference points for swordfish in Resolution 15/10 on target and limit reference points and a decision framework, no such interim reference points have been established for I.P. sailfish.
- **Main fishing gear (average catches 2013-17)**: gillnets account for around 70% of total catches in the Indian Ocean, followed by troll and hand lines (21%), with remaining catches recorded under longlines and other gears (Fig. 1).
- **Main fleets (average catches 2013-17):**
  Three quarters of the total catches of Indo-Pacific sailfish are accounted for by four countries situated in the Arabian Sea: I.R. Iran (gillnets): 32%; India (gillnets and trolling): 20%; Pakistan (gillnets): 16%; and Sri Lanka (gillnets and fresh longline): 9%.

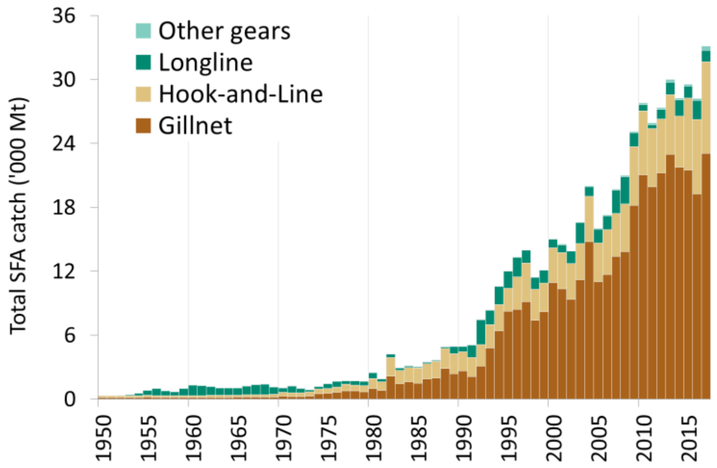


Fig. 1. Indo-Pacific sailfish: catches by gear and year recorded in the IOTC Database (1950–2017).
Notes*: Other gears (OT) includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears*

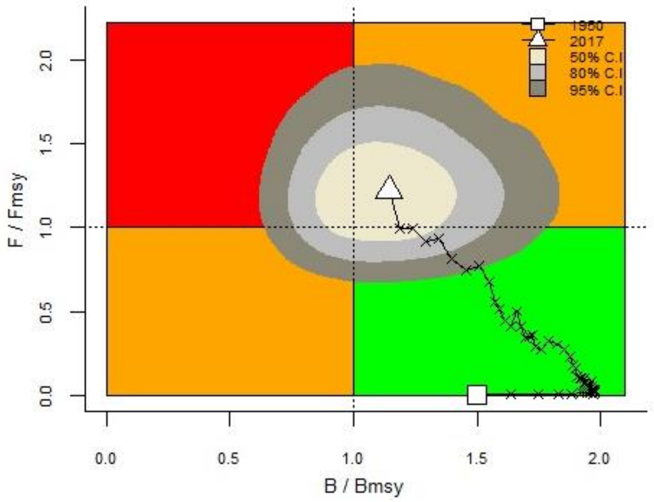


Fig.2. Indo-Pacific sailfish: Stock reduction analysis (C-MSY Method) of aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2017 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the B ratio and F ratio for each year 1950–2017.

APPENDIX XI
WORKING PARTY ON BILLFISH PROGRAM OF WORK (2020–2024)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

- **Table 1**: High priority topics for obtaining the information necessary to develop stock status indicators for billfish in the Indian Ocean; and
- **Table 2**: Stock assessment schedule.

Table 1. Priority topics for obtaining the information necessary to develop stock status indicators for billfish in the Indian Ocean

Topic	Sub-topic and project	Priority ranking	Est. budget and/or potential source	Timing				
				2020	**2021**	**2022**	**2023**	**2024**
1. Stock structure (connectivity and diversity)	1.1 Genetic research to determine the connectivity of billfish throughout their distribution (including in adjacent Pacific and Atlantic waters as appropriate) and the effective population size.		1.3 m Euro: (European Union)					
	1.1.1 Next Generation Sequencing (NGS) and nuclear markers (i.e. microsatellites) to determine the degree of shared stocks for billfish within the Indian Ocean and with the southern Atlantic Ocean and Pacific Ocean, as appropriate. Population genetic analyses to decipher inter- and intraspecific evolutionary relationships, levels of gene flow (genetic exchange rate), genetic divergence, and effective population sizes. Highest priority species: blue, black, striped marlin and sailfish.	High (15)						
	1.1.2 Initiate discussion (e.g., small workshop for CSIRO or request to present results in WPB) on the possibility to develop a close-kin mark recapture method (see *Bravington et al.* 2016) on marlins to estimates population size and other important demographic parameters..	High (14)						

	1.2 Tagging research (PSAT tags) to determine connectivity, movement rates and mortality estimates of billfish (Priority species: swordfish). Similar projects have been partially funded by EU, with a focus on epipelagic species. More tags are needed for swordfish.	High (1)	US$400,000					
2. Biological and ecological information (incl. parameters for stock assessment and provide answers to the Commission)	2.1 Age and growth research	High (3)						
	2.1.1 CPCs to provide further research on billfish biology, namely age and growth studies including through the use of fish otolith or other hard parts, either from data collected through observer programs, port sampling or other research programs. (Priority: all billfishes: swordfish, marlins and sailfish)		(CPCs: age & growth study = 50,000)					
	2.2 Reproductive biology study	High (2)						
	CPCs to conduct reproductive biology studies, which are necessary for billfish throughout its range to determine key biological parameters including length-at-maturity, age-at-maturity and fecundity-at-age, which will be fed into future stock assessments, as well as provide advice to the Commission on the established Minimum Retention Sizes (Res 18-05, paragraphs 5 and 14c). (Priority: marlins and sailfish). Propose to have a two-day workshop to discuss the standard of billfish maturity staging intersessionally prior to the next WPB. Funding are needed to support the workshop participation of CPCs and expert(s) on billfish reproduction (expecting to have confirmation from the host organization).		(CPCs: Maturity study = 30,000)					
	2.3 Spawning time and locations	High (4)						
	2.3.1 Collect gonad samples from billfish to confirm the spawning time and location of the spawning area that are presently hypothesized for each billfish species. This will also provide advice to the Commission on the request for alternative management measures (Res. 18-05, paragraph 6). Partially		(CPCs: Spawning study =30,000)					

		supported by EU, on-going support and collaboration from CPCs are required.							
3.	Historical data review	3.1 Changes in fleet dynamics							
		3.1.1 Continue the work with coastal countries to address recent changes and/or increases of marlins catches especially in some coastal fleets. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data and very high increases in some species (e.g., black marlin mainly due to very high catches reported by India in recent years). The possibility of producing alternative catch histories should also be explored. Priority countries: India, Pakistan, Iran, I.R., Indonesia.	High (5)	WPDCS					
		3.2 Species identification							
		3.2.1 The quality of the data available at the IOTC Secretariat on marlins (by species) is likely to be compromised by species miss-identification. Thus, CPCs should review their historical data in order to identify, report and correct (if possible) potential identification problems that are detrimental to any analysis of the status of the stocks. Consider the application of DNA-Barcoding technology for billfish species identification.	High	(CPCs directly)					
4.	CPUE standardization	4.1 Develop and/or revise standardized CPUE series for each billfish species and major fisheries/fleets for the Indian Ocean.							
		4.1.1 Swordfish: Priority LL fleets: Taiwan,China, EU(Spain, Portugal, France), Japan, Indonesia, South African	High	(CPCs directly)					
		4.1.2 Striped marlin: Priority fleets: Japan, Taiwan,China	High	(CPCs directly)					
		4.1.3 Black marlin: Priority fleets: Longline: Taiwan,China; Gillnet: I.R. Iran, Sri Lanka, Indonesia	High	(CPCs directly)					

		4.1.4 Blue marlin: Priority fleets: Japan, Taiwan,China, Indonesia	High	(CPCs directly)					
		4.1.5 I.P. Sailfish: Priority fleets: Priority gillnet fleets: I.R. Iran and Sri Lanka; Priority longline fleets: EU(Spain, Portugal, France), Japan, Indonesia;	High	(CPCs directly)					
		4.1.6 Joint analysis of operational catch and effort data from Indian Ocean longline fleets as recommended by WPM	High	Consultant/ US$40K					
5.	Stock assessment / Stock indicators	5.1 Workshops on techniques for assessment including CPUE estimations for billfish species in 2019 and 2020. Priority fleets: Gillnet fisheries	High	Consultant US$11,750					
6	Target and Limit reference points	6.1 To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High						
		6.1.1.Assessment of the interim reference points as well as alternatives: Used when assessing the Swordfish stock status and when establishing the Kobe plot and Kobe matrices.		WPM					
7	Management measure options	7.1 To advise the Commission, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process.	High						
		7.1.1 These management measures will therefore have to ensure the achievement of the conservation and optimal utilization of stocks as laid down in article V of the Agreement for the establishment of the IOTC and more particularly to ensure that, in as short a period as possible and no later than 2020, (i) the fishing mortality rate does not exceed the fishing mortality rate allowing the stock to deliver MSY and (ii) the spawning biomass is maintained at or above its MSY level.		WPM					

Table 2. Assessment schedule for the IOTC Working Party on Billfish (WPB)

Working Party on Billfish					
Species	**2020**	**2021**	**2022**	**2023**	**2024**
Black marlin		**Full assessment**			**Full assessment**
Blue marlin			**Full assessment**		
Striped marlin		**Full assessment**			**Full assessment**
Swordfish	**Full assessment**		**Indicators****	**Full assessment**	
Indo-Pacific sailfish			**Full assessment***		

* Including data poor stock assessment methods; Note: the assessment schedule may be changed depending on the annual review of fishery indicators, or SC and Commission requests.
** Including biological parameters, standardized CPUE, and other fishery trend.

APPENDIX XII
CONSOLIDATED RECOMMENDATIONS OF THE 17TH SESSION OF THE WORKING PARTY ON BILLFISH

Note: Appendix references refer to the Report of the 17th Session of the Working Party on Billfish (IOTC–2019–WPB17–R)

The following are the complete recommendations from the WPB17 to the Scientific Committee,:

WPB 17.01 (para 6): **RECALLING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the WPB reiterated it's previous **RECOMMENDATION** that the Scientific Committee consider requesting the Commission to include it in the list of species to be managed by the IOTC.

Revision of the WPB Program of work (2020–2024)

WPB 17.02 (para 133): The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2020–2024), as provided at Appendix XI.

Review of the draft, and adoption of the Report of the 17th Session of the Working Party on Billfish

WPB17.03 (para. 141): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB17, provided at Appendix XII, as well as the management advice provided in the draft resource stock status summary for each of the five billfish species under the IOTC mandate, and the combined Kobe plot for the five species assigned a stock status in 2019 (Fig. 9):

- Swordfish (*Xiphias gladius*)– Appendix VI
- Black marlin (*Makaira indica*) – Appendix VII
- Blue marlin (*Makaira nigricans*) – Appendix VIII
- Striped marlin (*Tetrapturus audax*) – Appendix IX
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix X

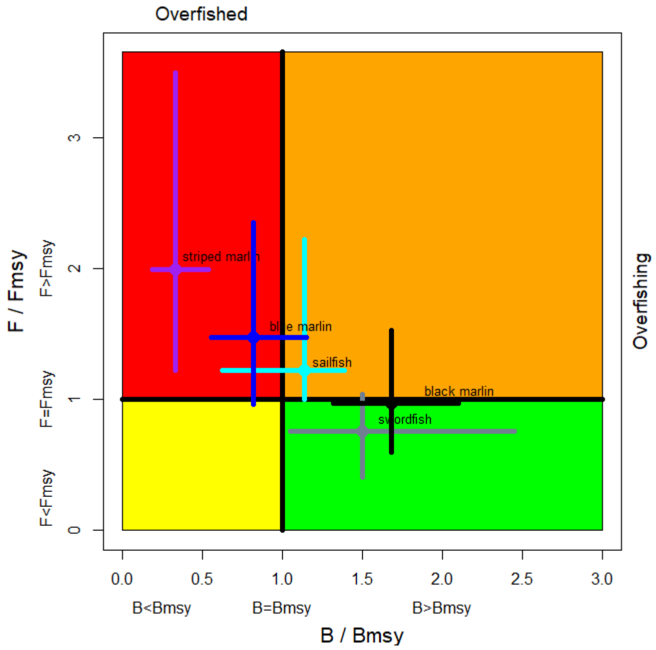


Fig. 9. Combined Kobe plot for swordfish (grey), indo-pacific sailfish (cyan), black marlin (black), blue marlin (blue) and striped marlin (purple) showing the 2017, 2018, and 2019 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.