Report of the 14th Session of the IOTC Working Party on Billfish

Victoria, Seychelles, 6–10 September 2016

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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
LL	Longline
M	Natural Mortality
MSY	Maximum sustainable yield
n.a.	Not applicable
NGO	Non-governmental organization
PS	Purse-seine
q	Catchability
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 14th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Victoria, Seychelles, from 6 to 10 September 2016. A total of 18 participants (23 in 2015, 21 in 2014) attended the Session. The meeting was opened on the 6th of September 2016 by the Chairperson, Dr Tsutomu Nishida (Japan), who welcomed participants to Seychelles

The following are a subset of the complete recommendations from the WPB14 to the Scientific Committee, which are provided at Appendix XII.

Billfish species identification

WPB14.02 (para. 21): The WPB **RECOMMENDED** that funds are allocated for further printing of the species ID guides so that these can be distributed amongst the sports fishing clubs for recreational activities to improve the quality of data reported from these fisheries.

Review of the statistical data available for billfish

WPB14.04 (para. 40): The WPB **NOTED** that many CPCs, responsible together for cumulative estimated billfish species catches up to 50% of total catch, do not submit to Secretariat either accurate nominal catch data and/or CPUE series (as per Res. 15/01 and 15/02). Particularly for black marlin (BLM) and Indo-Pacific sailfish (SFA) CPUE-based assessment analysis consider only gear/countries data covering less than 15% of estimated nominal catches. The WPB **NOTED** the Secretariat efforts in conjunction with CPCs (capacity building, observer training) to improve the current situation and **RECOMMENDED** CPCs to fully comply with Resolutions 15/01 and 15/02, providing detailed statistics at the required deadlines.

Stock structure project

WPB14.05 (para. 51): In light of the ongoing delays in the commencement of the EU-funded Indian Ocean stock structure project, the WPB **RECOMMENDED** that the Scientific Committee ensure that a full review is undertaken and that results from this study (and others that have taken place since the project plan was developed) are evaluated and that the work plan of the EU-funded Indian Ocean stock structure project is revised where appropriate. The projects are listed below: (…)

Swordfish habitat and behavior

WPB14.06 (para. 70): Therefore, the WPB **RECOMMENDED** that starting from this WPB14, swordfish is treated as a single stock and separate sections related to swordfish for the southwest Indian Ocean are removed from the executive summary and from the summary of available data for all billfish species.

Revision of the WPB Program of work (2017–2021)

WPB14.08 (para. 178): The WPB **RECOMMENDED** that more support is provided for the implementation of the ROS for fleets catching the majority of the billfish species (i.e. the gillnet fleets).

WPB14.09 (para. 180): The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2017–2021), as provided at Appendix XI.

Review of the draft, and adoption of the Report of the 14th Session of the Working Party on Billfish

WPB14.10 (para. 188): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB14, 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 2016 (Fig. 8):

- 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

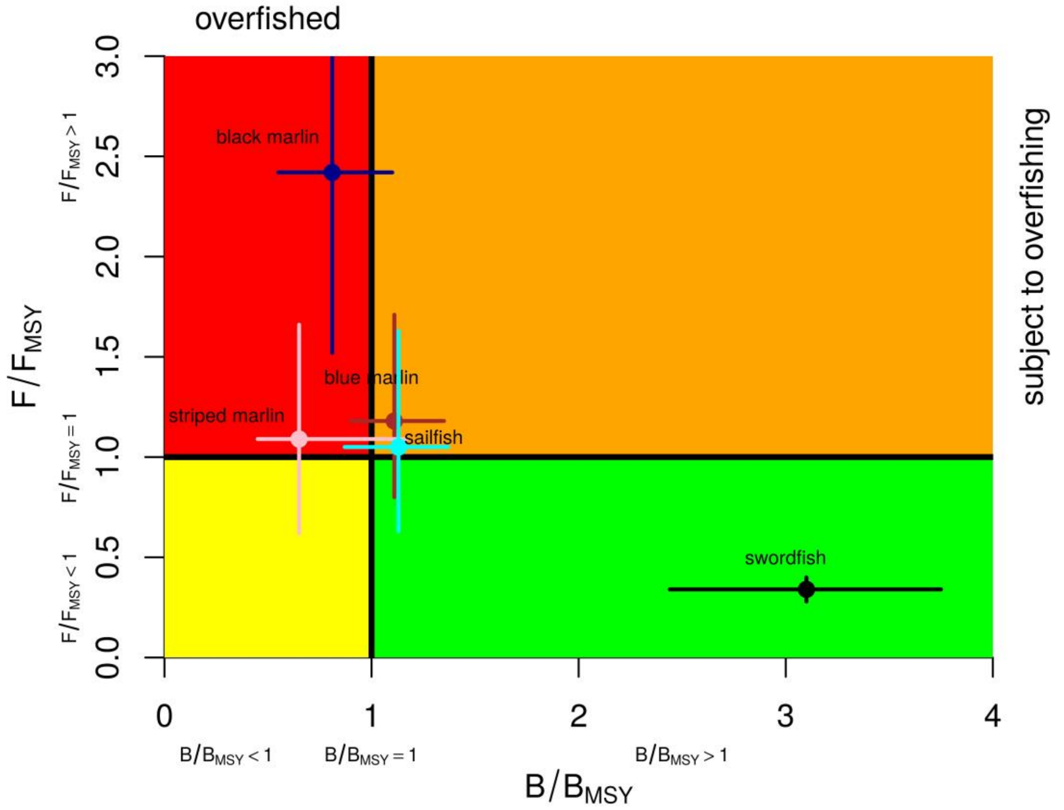

Fig. 8. Combined Kobe plot for swordfish (black), indo-pacific sailfish (cyan), black marlin (light blue), blue marlin (brown) and striped marlin (pink) showing the 2015 and 2016 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

Stock status table

A summary of the stock status for billfish species under the IOTC mandate is provided in Table 1.

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

Stock	Indicators	Prev[1]	2011	2012	2013	2014	2015	2016	Advice to the Scientific Committee
Swordfish *Xiphias gladius*	Catch 2015: 41,760 t Average catch 2011–2015: 31,900 t MSY (1,000 t) (80% CI): 39.40 (33.20–45.60) F_{MSY} (1,000 t) (80% CI): 0.138 (0.137–0.138) SB_{MSY} (80% CI): 61.4 (51.5–71.4) F_{2013}/F_{MSY} (80% CI): 0.34 (0.28–0.40) SB_{2013}/SB_{MSY} (80% CI): 3.10 (2.44–3.75) SB_{2013}/SB_{1950} (80% CI): 0.74 (0.58–0.89)	2010							No new assessment was undertaken in 2016. Thus, stock status is based on the previous assessment undertaken in 2014, as well as indicators available in 2015. The SS3 model, used for stock status advice, indicated that MSY-based reference points were not exceeded for the Indian Ocean population as a whole (F_{2013}/F_{MSY}< 1; SB_{2013}/SB_{MSY}> 1). All other models applied to swordfish also indicated that the stock is above a biomass level that would produce MSY and current catches were below the MSY level. Most recent catches (41,760 t in 2015) are 2,360 t above the MSY level (39,400 t). Spawning stock biomass in 2013 was estimated to be 58–89% of the unfished levels. On the weight-of-evidence available in 2016, catches for 2017 should be kept below MSY and the stock is determined to be ***not overfished*** and ***not subject to overfishing***. Click here for full stock status summary: Appendix VI
Black marlin *Makaira indica*	Catch 2015: 18,490 t Average catch 2011–2015: 15,276 t MSY (1000 t) (80% CI): 9.932 (6.963–12.153) F_{MSY} (80% CI): 0.211 (0.089–0.430) B_{MSY} (1000 t) (80% CI): 47.430 (27.435-100.109) F_{2015}/F_{MSY} (80% CI): 2.42 (1.52–4.06) B_{2015}/B_{MSY} (80% CI): 0.81 (0.55–1.10) B_{2015}/B_{1950} (80% CI): 0.30 (0.20–0.41)								Stock status based on BSP-SS stock assessment suggests that the stock in 2015 is in the red zone of the Kobe plot with F/F_{MSY}=2.42 and TB/TB_{MSY}=0.81. Another approach by ASPIC examined in 2016 came to similar conclusions. The Kobe plot from the BSP-SS model indicated that the stock has been ***subject to overfishing*** and ***overfished*** in recent years. Click here for full stock status summary: Appendix VII
Blue marlin *Makaira nigricans*	Catch 2015: 15,706 t Average catch 2011–2015: 14,847 t MSY (1000 t) (80% CI): 11.926 (9.232-16.149) F_{MSY} (80% CI): 0.109 (0.076-0.160) B_{MSY} (1,000 t) (80% CI): 113.012 (71.721-161.946) F_{2015}/F_{MSY} (80% CI): 1.18 (0.80–1.71) B_{2015}/B_{MSY} (80% CI): 1.11 (0.90–1.35) B_{2015}/B_{1950} (80% CI): 0.56 (0.44-0.71)								Stock status based on BSP-SS stock assessment suggests that the stock in 2015 is in the orange zone of the Kobe plot and both F and TB are close to their MSYs, i.e., F/F_{MSY}=1.18 and TB/TB_{MSY}=1.11. Two other approaches examined in 2016 came to similar conclusions, namely ASPIC and SS3. The Kobe plot from the BSP-SS model indicated that the stock has been ***subject to overfishing*** but ***not overfished*** in recent years, while the stock biomass is slightly above the BMSY level. Click here for full stock status summary: Appendix VIII

Striped marlin *Tetrapturus audax*	Catch 2015: 4,410 t Average catch 2011–2015: 4,481 t MSY (1,000 t) (80% CI): 5.22 (5.18–5.59) F_{MSY} (80% CI): 0.62 (0.59–1.04) B_{MSY} (1,000 t) (80% CI): 8.4 (5.40–8.90) F_{2014}/F_{MSY} (80% CI): 1.09 (0.62–1.66) B_{2014}/B_{MSY} (80% CI): 0.65 (0.45–1.17) B_{2014}/B_{1950} (80% CI): 0.24 (n.a.)								In 2015 an ASPIC stock assessment confirmed the assessment results from 2012 and 2013 that indicated the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two approaches examined in 2015 came to similar conclusions, namely a Bayesian Surplus Production Model, and a Stock Reduction Analysis using only catch data. The ASPIC model indicated that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. In 2016 reported catches increased to 4,410 t. On the weight-of-evidence available in 2016, the stock is determined to be ***overfished*** and ***subject to overfishing*** and catches for 2017 should be kept below 4000 t. Click here for full stock status summary: Appendix IX
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2015: 28,455 t Average catch 2011–2015: 28,543 t MSY (1,000 t) (80% CI): 25.00 (17.20–36.30) F_{MSY} (80% CI): 0.26 (0.15–0.39) B_{MSY} (1,000 t) (80% CI): 87.52 (56.30–121.02) F_{2014}/F_{MSY} (80% CI): 1.05 (0.63–1.63) B_{2014}/B_{MSY} (80% CI): 1.13 (0.87–1.37) B_{2014}/B_{1950} (80% CI): 0.57 (0.44–0.69)								In 2015, data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not yet overfished, but is subject to overfishing. Records of stock extirpation in the Gulf should also be examined to determine the degree of localised depletion in Indian Ocean coastal areas. On the weight-of-evidence available in 2016, the stock is still determined to be ***not overfished*** but ***subject to overfishing*** and the same management advice for 2016 (catches below MSY, 25,000 t) is kept for the next year (2017). Click here for full stock status summary: Appendix X

[1.] This indicates the last year taken into account for assessments carried out before 2011

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 14th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Victoria, Seychelles, from 6 to 10 September 2016. A total of 18 participants (23 in 2015, 21 in 2014) attended the Session. The list of participants is provided at Appendix I. The meeting was opened on 6 September 2016 by the Chairperson, Dr Tsutomu Nishida (Japan), who welcomed participants to Seychelles.

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 WPB14 are listed in Appendix III.

3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

3.1 Outcomes of the 18th Session of the Scientific Committee

3. The WPB **NOTED** paper IOTC–2016–WPB14–03 which outlined the main outcomes of the 18th Session of the Scientific Committee (SC18), specifically related to the work of the WPB.

3.2 Outcomes of the 20th Session of the Commission

4. The WPB **NOTED** paper IOTC–2016–WPB14–04 which outlined the main outcomes of the 20th 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.

5. The WPB **NOTED** the 12 Conservation and Management Measures (CMMs) adopted at the 20th Session of the Commission (consisting of 12 Resolutions and 0 Recommendations) which will come into force on 27th September 2016:

IOTC Resolutions

- Resolution 16/01 *On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock*
- Resolution 16/02 *On harvest control rules for skipjack tuna in the IOTC area of competence*
- Resolution 16/03 *On the second performance review follow-up*
- Resolution 16/04 *On the implementation of a Pilot Project in view of Promoting the Regional Observer Scheme of IOTC*
- Resolution 16/05 *On vessels without nationality*
- Resolution 16/06 *On measures applicable in case of non-fulfilment of reporting obligations in the IOTC*
- Resolution 16/07 *On the use of artificial lights to attract fish*
- Resolution 16/08 *On the prohibition of the use of aircrafts and unmanned aerial vehicles as fishing aids*
- Resolution 16/09 *On establishing a Technical Committee on Management Procedures*
- Resolution 16/10 *To promote the implementation of IOTC Conservation and Management Measures*
- Resolution 16/11 *On port state measures to prevent, deter and eliminate illegal, unreported and unregulated fishing*
- Resolution 16/12 *Working Party on the Implementation of Conservation and Management Measures (WPICMM)*

6. Participants to WPB14 were **ENCOURAGED** to familiarise themselves with the adopted Resolutions, especially those most relevant to the WPB.

7. The WPB **ACKNOWLEDGED** that the report of the 20th Session of the Commission is not yet finalised for download, pending agreement by correspondence.

8. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2015, which have relevance for the WPB (details as follows: paragraph numbers refer to the report of the Commission: IOTC–2016–S20–R) the WPB **AGREED** that any advice to the Commission would be provided in the Management Advice section of each stock status summary for the billfish species detailed in the relevant species sections of this report.

Para. 14. The Commission **CONSIDERED** the list of recommendations made by the SC18 (Appendix VI) from its 2015 report (IOTC–2015–SC18–R) that related specifically to the Commission. The Commission **ENDORSED** the list of recommendations as its own, while taking into account the range of issues outlined in this Report (S20) and incorporated within the Conservation and Management Measures adopted during the Session and as adopted for implementation as detailed in the approved annual budget and Program of Work. (para. 14 of the S20 report).

9. **NOTING** the comments by the FAO Legal Counsel at the 20th Session of the IOTC:

"First, the Legal Counsel informed the Members that FAO fully acknowledged that the IOTC Agreement, negotiated between 1991 and 1993, and which came into force in 1996, should be modernized, in order to reflect recent developments in the Law of the Sea and modern trends in fisheries management". (S20 Para. 94 *To be adopted*)

the WPB **RECOMMENDED** that on the next revision of the IOTC Agreement, short billed spearfish are included as an IOTC species.

On the conservation and management of IOTC species

*Para. 130. The Commission **CONSIDERED** a proposal on the conservation and management of IOTC species (IOTC–2016–S20–Prop G), which detailed two options with the main objective of decreasing the fishing pressure on Yellowfin Tuna (Thunnus albacares), and which will also benefit the status of the following overfished stocks: Striped Marlin (Tetrapturus audax), Black Marlin (Makaira indica), Blue Marlin (Makaira nigricans), Indo-Pacific Sailfish (Istiophorus platypterus), Longtail Tuna (Thunnus tonggol) and Narrow-based Spanish Mackerel (Scomberomorus Commerson) in the IOTC Area of competence. Following discussions with CPCs, the proposal was split into three individual proposals with catch reduction measures specific to the following species: Prop-G-A (Yellowfin tuna), Prop-G-B (billfish species), and Prop-G-C (neritic tunas). The proposal to reduce catches of Yellowfin tuna (Prop-A) was eventually withdrawn, in favour of the adoption of (IOTC-2016-S20-PropF); while the proposals for Prop-G-B and Prop-G-C, were deferred until the next meeting of the Commission.*

10. The WPB also **NOTED** table 2 comparing the current status of catches vs. MSY vs. catch limits as set forth by Resolution 15/05 for billfish species:

Table 2. comparison of current catches vs. MSY vs. catch limits (Res. 15/05 and EU proposal)

Species	Current catches (2015)	MSY	Catch limits	
			Resolution 15/05 (avg. catch 2009-2014) **EFFECTIVE**	EU proposal (20th session of the Commission) **DEFERRED** to 2017
Swordfish	41,760 t	39,400 t	N.A.	N.A.
Striped marlin	4,410 t	5,220 t	3,858 t	4,000 t
Blue marlin	15,706 t	11,926 t	12,786 t	11,000 t
Black marlin	18,490 t	9,932 t	13,219 t	10,000 t
I.P. sailfish	28,455 t	25,000 t	N.A.	25,000 t

3.3 Review of Conservation and Management Measures relevant to billfish

11. The WPB **NOTED** paper IOTC–2016–WPB14–05 which aimed to encourage participants at the WPB14 to review some of the existing Conservation and Management Measures (CMM) relevant to billfish – noting the CMMs referred to in document IOTC–2016–WPB14–04 – 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.

12. The WPB **AGREED** that it would consider proposing modifications for improvement to the existing CMMs following discussions held throughout the current WPB meeting.

13. The WPB **NOTED** that the 20th Session of the Commission considered a proposal specific to the conservation and management of IOTC species, namely IOTC-2016-S20-Prop-G (revised as IOTC-2016-S20-Prop-G-B for billfish), that was *not* adopted.

14. The WPB **NOTED** that the new Resolutions will come into effect 120 days from the IOTC circular, i.e. on the 27th of September 2016.

3.4 Progress on the recommendations of WPB13 and SC18

15. The WPB **NOTED** paper IOTC–2016–WPB14–06 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 from for delivery of the action (i.e. by the next working party meeting, or other date);
- if appropriate, and 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.

Regional Observer Scheme

17. The WPB **ENCOURAGED** the implementation of the pilot project to promote the regional observer scheme based on Res 16/04.

18. The WPB **NOTED** the very low staffing situation at the Secretariat and **SUGGESTED** the IOTC Secretariat outsource some of the training activities.

19. **ACKNOWLEDGING** the difficulties with the deployment of observer on board in small vessels, the WPB **AGREED** on the implementation of electronic monitoring or observation pilot project in ports, according to paragraph 7 of Res 16/04, and **NOTED** the ongoing development by the IOTC Secretariat of an e-reporting system and national observer database template for use in CPCs which have not established data collection and management procedures.

Billfish species identification

20. The WPB **NOTED** Seychelles, Mauritius, La Reunion and Kenya as countries included in the sports fishery data collection protocols project and **REQUESTED** that Mozambique is included as a priority country for a potential second phase, given the importance of its sports fisheries for billfish.

21. The WPB **RECOMMENDED** that funds are allocated for further printing of the species ID guides so that these can be distributed amongst the sports fishing clubs for recreational activities to improve the quality of data reported from these fisheries.

22. The WBP **THANKED** WWF-Mozambique for having completed the translation of species identification cards and **REQUESTED** that the final copies are sent to the IOTC Secretariat as soon as possible.

23. The WPB **CONGRATULATED** Sri Lanka (NARA) for completing the Sinhalese/Tamil translations for the IOTC billfish species identification guides and **REQUESTED** the finalised draft is sent to the IOTC Secretariat for printing.

24. The WPB **AGREED** on the importance of the hard, waterproof copies of the IOTC species identification guides for observers and port samplers in improving the quality of data collected and **RECOMMENDED** that funds continue being provided for the translation of these into the priority languages identified by the SC.

25. The WPB **RECALLED** the recommendation from WPB13, reiterated at the SC:

*Para. 98. The SC **RECOMMENDED** that the IOTC Rules of Procedure (2014), for the administration of the Meeting Participation Fund be modified so that applications are due not later than 60 days, and that the full Draft paper be submitted no later than 45 days before the start of the relevant meeting. The aim is to allow the Selection Panel to review the full paper rather than just the abstract, and provide guidance on areas for improvement, as well as the suitability of the application to receive funding using the IOTC MPF. The earlier submission dates would also assist with Visa application procedures for candidates.*

and **REQUESTED** that the Rules of Procedure are updated to include the revised deadlines so that a draft can be presented to the S21 for approval in 2017.

4. New information on fisheries and associated environmental data for billfish

4.1 Review of the statistical data available for billfish

26. The WPB **NOTED** paper IOTC–2016–WPB14–07 Rev_1 which summarised 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 1950–2015. 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.

27. 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.

28. The WPB **NOTED** the request from WPB13 (WPB13 para. 27) for the IOTC Secretariat to provide total catches for each billfish species by area (NE, NW, SE, SW, OT) on a yearly basis and not only during assessment years, and **NOTED** that while this could technically be possible, the quality of the results would be highly dependent on the quality of the data in the catch and effort database to be used for the spatial reallocation of total catches.

29. I.R. Iran **ACKNOWLEDGED** the importance of billfish catches from their fisheries and the lack of complete data submissions to the Secretariat, adding that data are collected from separate centres and that the process of collating and aggregating information to provide complete catch-and-effort estimates is complex. The WPB **NOTED** the importance of the Iranian fisheries statistics that could be used in the future for billfish assessment. However, the lack of catch-and-effort data for the Iranian driftnet fishery compromises estimates of total catch, as the species composition of marlins would vary depending on the areas and times fished. Thus, the WPB **REQUESTED** that the I.R. Iran work with the IOTC Secretariat to make every possible effort to assess the areas and times fished by its fishery and to report this information to the next meeting of the WPB, **NOTING** that this is already a mandatory reporting requirement under Resolution 15/02.

30. The WPB **NOTED** the *ObServe* database that is used by purse seine and longline vessels and **ENCOURAGED** IRD to share this software with CPCs who might find this a useful tool.

31. The WPB **NOTED** the difference in historical catches since the assessment dataset produced for WPB12, due to the revisions made in 2014. These were predominantly based on new, species-specific data submitted by I.R. Iran, Pakistan and Indonesia which led to an improvement in the disaggregation method used to estimate historical catches from aggregates such as '*billfish*' or '*marlins*'.

32. The WPB **NOTED** the conflicting information for striped marlin catches from Indonesia, with catch-and-effort distribution suggesting lower total catch level than reported.

33. The WPB **NOTED** that, due to missing or incomplete information for Indonesia longlines, IOTC estimates average catches using comparable values from known proxy fleets (Taiwan,China) and **ACKNOWLEDGED** that revisions were also made to the Indonesian data series based on the outcomes of a consultancy that led to improvements in the disaggregation procedures used by the Secretariat.

34. **NOTING** the dominance of catches of striped marlin by the longline fleet of Indonesia the WPB **REQUESTED** that Indonesia provide spatially disaggregated catch and effort information to the IOTC Secretariat as required by Resolution 15/02.

35. The WPB **NOTED** that striped marlins were not very prevalent in the observer data for Indonesia and **ENCOURAGED** Indonesian scientists to work with the IOTC Secretariat to improve the estimated historical data series.

36. The WPB **NOTED** that spatial information for Indo-pacific sailfish has been provided to IOTC by CPCs which are responsible for only 2% of catches, and **ENCOURAGED** coastal countries to submit spatial catch-and-effort information.

37. The WPB further **NOTED** the work that the IOTC Secretariat is doing with coastal countries to improve data submissions for Indo-pacific sailfish.

38. The WPB also **NOTED** that I.R. Iran have submitted data on total effort, however, this is not spatially disaggregated, so the WPB **ENCOURAGED** I.R. Iran to collect and report this information - according to the standards set forth by the Secretariat - in the future.

39. The WPB **ACKNOWLEDGED** that Sri Lanka already started submitting detailed logbook information to the Secretariat since 2015. However, due to some inconsistencies, Sri Lanka is currently working with IOTC in order to improve the status of the reported information. The WPB **NOTED** that Sri Lanka is expected to start reporting more complete data to the Secretariat starting from 2017.

40. The WPB **NOTED** that many CPCs, responsible together for cumulative estimated billfish species catches up to 50% of total catch, do not submit to Secretariat either accurate nominal catch data and/or CPUE series (as per Res. 15/01 and 15/02). Particularly for black marlin (BLM) and Indo-Pacific sailfish (SFA) CPUE-based assessment analysis consider only gear/countries data covering less than 15% of estimated nominal catches. The WPB **NOTED** the Secretariat efforts in conjunction with CPCs (capacity building, observer training) to improve the current situation and **RECOMMENDED** CPCs to fully comply with Resolutions 15/01 and 15/02, providing detailed statistics at the required deadlines.

41. The WPB **NOTED** paper IOTC-2016-WPB14-09 Rev_1 including the following abstract provided by the authors:

> *"This paper summarises the current state of the art for all the data management processes in place at the Secretariat and described the alternative, integrated system being currently developed. The paper also provided a summary of the major differences between the two systems, highlighting the benefits of the new approach especially in terms of effectiveness of operations and improved data exchange mechanism between the Secretariat and the scientific community, still within the bounds set forth by Resolution 12/02. Also, the paper presented additional details regarding the procedures currently used to disaggregate Nominal Catches, and showed a practical example of how these procedures could be used to reconstruct time series for specific species starting from data available for other aggregates."* – (see paper for full abstract)

42. The WPB **ACKNOWLEDGED** the measurable improvements in the overall efficiency and usability of the data management processes introduced by the adoption of the new Integrated System and **NOTED** that the future availability of data and services as *remote resources* might be of particular interest for the scientific community.

43. The WPB **NOTED** that one of the goals of this project is to allow users outside the Secretariat to use the database and filter data in real-time and that appropriate interfaces for this purpose will be made available as the project is completed, based on the data confidentiality agreements specified in Resolution 12/02.

44. While mandatory statistical data are currently accepted in any format, the WPB **ENCOURAGED** CPCs to submit data based on the standard templates provided by IOTC, so that their processing through the new Integrated System could be easier and more efficient.

45. The WPB **NOTED** that the key concepts in terms of data exchange formats and protocols adopted by the new Integrated System might be of interest to other tRFMOs as well.

46. The WPB **NOTED** that a process of uniform data sharing among tRFMOs may be fairly complex to design and implement and **ACKNOWLEDGED** that this feature should be further explored by the IOTC Secretariat in combination with the other tRFMOs.

47. The WPB **NOTED** that the transition from the current data management system to the new one may take some time, and **ACKNOWLEDGED** that in the transitional period the Secretariat will continue disseminating data in the currently adopted formats, ensuring a smooth and seamless transition for scientists and data consumers.

Kenyan sports fishery

48. The WPB **REQUESTED** that the catch-and-effort data for the sports fishery in Kenya from 1987–2010 be submitted to the IOTC Secretariat to assist in future assessments for sports fishery species.

African Billfish Foundation

49. **RECALLING** the excellent efforts being undertaken by the African Billfish Foundation to develop a tag and recapture database in Kenya and Tanzania, the WPB **REQUESTED** that the African Billfish Foundation continue its important work, particularly in the areas of collaborative research aimed at obtaining more information on movements of billfishes, via both conventional and archival tagging programs that will allow the collection of information on both horizontal and vertical movements as well as on population dynamics.

50. The WPB **NOTED** the importance of the African Billfish Foundation datasets but also the inconsistencies that are apparent and **WELCOMED** the attendance of the African Billfish Foundation at the next meeting, through the IOTC sports fishery consultancy they are undertaking, to explore these issues.

Stock structure project

51. In light of the ongoing delays in the commencement of the EU-funded Indian Ocean stock structure project, the WPB **RECOMMENDED** that the Scientific Committee ensures that a full review is undertaken and that results from this study (and others that have taken place since the project plan was developed) are evaluated so that the work plan of the EU-funded Indian Ocean stock structure project is revised where appropriate. The projects are listed below:

- "*Evaluating the population structure of striped marlin (Kajikia audax, i.e. Tetrapturus audax) in the Indian and Pacific oceans*" developed by the Virginia Institute of Marine Science (VIMS) USA, see report of WPB13 and IOTC–2015–WPB13–30
- "*Assessing the global genetic population structure and effective population size for the black marlin (Istiompax indica, i.e. Makaira indica)*" developed by the University of Queensland, Australia, see IOTC–2016–WPB14–18

4.2 Review new information on fisheries and associated environmental data

Sri Lanka billfish fishery

52. The WPB **NOTED** paper IOTC–2016–WPB14–10 which outlined the **billfish by-catch in the Sri Lankan tuna long line fishery ,** including the following abstract provided by the authors:

> "*Billfish are an important by-catch species in in the tuna fishery of Sri Lanka. The gillnet and longline, which are frequently used in Sri Lankan Tuna fishery mainly contribute for capturing the billfish too. The present study was undertaken to study the relative influence of three environmental parameters (sea surface temperature (SST), sea surface chlorophyll (SSC) and dynamic height of the sea surface (SSH)) on the billfish catch rates. The fisheries data in longline fishery of Sri Lanka was collected during the period 2006-2010 and used for this audit. The relevant values of above three environmental parameters were obtained from remote sensing data. A Generalized Additive Model (GAM) was fitted for describing the relationships between environment parameters and billfish catch rates.*"– (see paper for full abstract)

53. The WPB **NOTED** the partial disaggregation of billfish species in the data presented by Sri Lanka, mixing species with different biology in the analysis, and **ENCOURAGED** Sri Lanka to perform further analysis with complete species separation, developing a specific model for Swordfish first and then additional models for the remaining billfish species.

I.R. Iran billfish fishery

54. The WPB **NOTED** paper IOTC–2016–WPB14–13 which outlined the **billfish gillnet fishery in the I.R. Iran**, including the following abstract provided by the authors:

> "*Fishery for tuna and tuna-like species is a major component in large pelagic fisheries in Iran and one of the most important activities in the Persian Gulf, Oman Sea and offshore waters. There are 4 coastal provinces in those areas and more than 11 thousands vessels consist of fishing boat, dhows and vessels which are engaged in fishing in the coastal and offshore waters. There are three fishing methods targeting tuna and tuna-like species in the IOTC area which include gillnet and purse seine and also some of small boats use trolling in coastal fisheries. Gillnet is the dominant fishing gear in the IOTC area*." – (see paper for full abstract)

55. The WPB **ACKNOWLEDGED** the effort by I.R Iran to collect the catch data by EEZ and offshore fisheries, which were presented to WPB. The WPB **NOTED** that catches of billfish for I.R. Iran from IOTC nominal catches refer to two gear types, "GIOF (gillnet offshore)" and "GILL (gillnet coastal)", whereas - in terms of fishing craft statistics - the data are split into three categories of gillnet vessels by GT size class. The WPB also **NOTED** that I.R. Iran is not providing explicit information on catch rate between the EEZ and outside EEZ. WPB **ENCOURANGED** I.R Iran to report the information by fishery operation to the IOTC Secretariat.

56. The WPB **ACKNOWLEDGED** the reduction in catches of I.R. Iran due to piracy and **NOTED** that in recent years, with the decline of piracy, billfish catches outside the EEZ have markedly increased.

57. The WPB **ACKNOWLEDGED** that gillnet fisheries account for a substantial proportion of the catches and that it is important to begin estimating standardised CPUE for these fisheries. The WPB therefore **ENCOURAGED**

I.R. Iran to further liaise with the IOTC Secretariat and continue making improvements to their national reporting system.

Malaysia billfish fishery

58. The WPB **NOTED** paper IOTC–2016–WPB14–14 which outlined the **billfish catch by the Malaysian longline fishery from 2012 to 2015**, including the following abstract provided by the authors:

> "*Malaysian tuna fisheries began with tropical tuna fishing in 2005 to 2011. In 2012, Malaysian tuna longline vessels shifted their operation from tropical tuna to albacore tuna fishing. A total of 5 tuna longline fishing vessels and 1 carrier are currently operating under Malaysian flag and they mainly operated in the southwest of Indian Ocean. Billfishes are considered as by-catch by Malaysian tuna longliners and only accounted 8% of the total catch composition from 2012-2015. In 2014, landings of swordfish was more than 4-fold over that of 2013, showing an increase of more than 300% and continue to increase in 2015.*" – (see paper for full abstract)

59. **NOTING** the issues related to correct species identification, the WPB **THANKED** Malaysia for the offer to translate the IOTC species identification guides into Bahasa Malay and **REQUESTED** that these translations are provided to the IOTC Secretariat.

60. The WPB **NOTED** that there is currently only one observer monitoring supply vessels and that these species identification guides would be useful for the development of the national observer scheme.

Thailand billfish fishery

61. The WPB **NOTED** paper IOTC–2016–WPB14–15 which outlined the **billfish catch by the Thailand longline fishery from 2014 to 2015**, including the following abstract provided by the authors:

> "*Thai tuna longliners operated in the Indian Ocean since 2007. This report was based on the data extracted from fishing logsheets by six Thai tuna longliners which declared to Department of Fisheries, Thailand. Data from their logsheets displayed important information of their fishing operation and effort. Then summarized and calculated the hook rate in Catch Per Unit Effort.*" – (see paper for full abstract)

62. The WPB **NOTED** that billfish data were obtained from the logbooks submitted by commercial vessels to the Thailand Fisheries Department.

63. The WPB **NOTED** the surprising trend of sailfish catches caught only in March and **ENCOURAGED** Thailand to provide more detailed information on the matter.

64. The WPB **NOTED** the observer training that took place in 2015, with some support by the IOTC Secretariat, and the subsequent deployment of observers on trawl vessels in 2016. The WPB further **NOTED** that observers have not yet been deployed on the tuna vessels this year as there are currently no reported active tuna vessels in the IOTC area of competence (2016), however there are plans for deployment once the vessels are active again.

65. The WPB **NOTED** that IOTC does not have detailed information for Thailand billfish catches - if not for swordfish - prior to 2014 and **ACKNOWLEDGED** that the reason for this lack of information is related to Thailand having started to clearly separate billfish species in their reports only from 2014 onwards.

5. SWORDFISH

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

Swordfish habitat and behavior

66. The WPB **NOTED** paper IOTC–2016–WPB14–16 which provided an **overview of swordfish habitat and behaviour on migratory track from Reunion Island to equatorial waters**, including the following abstract provided by the authors:

> "*A swordfish, Xiphias gladius tagged with pop-up satellite tag (PSAT) off Reunion Island (southwestern Indian Ocean) demonstrated active migratory behaviour by reaching equatorial waters in 69 days of tracking. The total estimated distance travelled was 2411 nmi with average daily horizontal displacement of 34.9 nmi. This swordfish occupied the upper mixed layer at night and remained in deep layers down to 800 m depth during the day.*" – (see paper for full abstract)

67. The WPB **NOTED** the limited vertical overlap in the distribution of tuna and swordfish and that this might imply that the swordfish CPUE series generated from tuna targeting fleets may not be very informative.

68. Nevertheless, the WPB also **NOTED** that CPUE standardisation for species which are bycatch might actually be a better reflection of the relative abundance given that they are not targeted and so their incidental capture is more random than that for the target species.

69. **NOTING** the results outlined in this paper the WPB **ACKNOWLEDGED** the highly migratory nature of swordfish in the Indian Ocean.

70. Therefore, the WPB **RECOMMENDED** that starting from this WPB14, swordfish is treated as a single stock and separate sections related to swordfish for the southwest Indian Ocean are removed from the executive summary and from the summary of available data for all billfish species.

71. The WPB **NOTED** paper IOTC–2016–WPB14–INF01 which provided a **preliminary summary of billfish tagging in the Indian Ocean**, including the following abstract provided by the authors:

> "*A summary of billfish tagging experiments conducted by various research organizations in the Indian Ocean is developed as a reference documents for further considerations of WPEB and IOTC Secretariat. Research programmes are grouped in alphabetical order of names of respective institutions.*"

72. The WPB **AGREED** that the type of techniques used for this analysis would be extremely useful in the future to gather relevant knowledge on the behaviour of billfish, and **ENCOURAGED** further studies as well as the review of existing ones.

5.2 Review of new information on the status of swordfish

5.2.1 Nominal and standardized CPUE indices

73. **NOTING** that swordfish was not a priority species in 2016 (it will be assessed in 2017 as per the Program of Work - see Appendix XI), no updated CPUE indices were submitted for consideration by the WPB in 2016. However, the WPB **REQUESTED** that key CPCs (Taiwan,China, Sri Lanka, Indonesia, Japan, EU,Portugal, EU,Spain and EU,France) provide updated CPUE indices as indicators of stock status between stock assessment years.

5.2.2 Selection of Stock Status indicators for swordfish

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

5.3 Development of management advice for swordfish& update of swordfish Executive Summary for the consideration of the Scientific Committee

75. The WPB **ACKNOWLEDGED** that given the current stock status, if catch remained below the estimated MSY levels then immediate management measures to reduce catch were not required.

76. At the same time, the WPB **NOTED** that the most recent catches (41,760 t in 2015) were 2,360 t above the MSY level (39,400 t). Hence the WPB **RECOMMENDED** that catches for swordfish in 2017 should be less than MSY and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for swordfish with the latest 2015 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary for its consideration:
    - Swordfish (*Xiphias gladius*) – Appendix VI

6. MARLINS

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

Billfish bycatch in France purse-seine fishery

77. The WPB **NOTED** paper IOTC–2016–WPB14–17 Rev_1 which provided an overview on the **bycatch of billfish in French purse-seine fishery in the Western Indian Ocean, through data collected by sea-going observers between 2005 and 2015**, including the following abstract provided by the authors:

> "*French purse-seiners operating in the western Indian Ocean mainly target tuna species (yellowfin tuna - Thunnus albacares and skipjack tuna - Katsuwonus pelamis) in free schools or under FADs, and occasionally catch billfishes: black marlin (Makaira indica), blue marlin (Makaira mazara), striped marlin (Tetrapturus audax), Indo-Pacific sailfish (Istiophorus platypterus), and shortbill spearfish (Tetrapturus angustirostris). We intend in this paper to provide an overview of the data on Istiophoridae species collected by sea-going observers on French purse-seiners in the framework of DCF and OCUP programs between 2005 and 2015 in the western Indian Ocean.*" – (see paper for full abstract)

78. The WPB **CONGRATULATED** the authors for providing long awaited information on billfish bycatch in the purse seine fishery and **ACKNOWLEDGED** the importance of this analysis for a better understanding of this type of bycatch.

79. The WPB **NOTED** the higher occurrence of sailfish in the purse-seine tuna free school as compared to FAD sets, contrastingly to the other Istiophoridae species.

80. The WPB **NOTED** that the comparison in species composition by gear type could be partially misleading, due to the different environments in which specific gear operate (purse seine fleets usually catch billfish within 150 m of the surface, although vessels with large nets can fish as deep as 250 m) and **ENCOURAGED** the authors to further compare data from overlapping areas in order to confirm or reject this hypothesis.

81. The WPB **NOTED** that the there is no local market for billfish caught by the French purse seine fleet so these are either discarded or retained for crew consumption.

82. **ACKNOWLEDGING** the absence of landings of billfish in the French purse-seine fishery, the WPB **REQUESTED** that the authors provide retained billfish data (for crew consumption) to the IOTC Secretariat, given that they are likely to be the best and possibly only available estimates of nominal catches of billfish by the fleet. The WPB also **NOTED** that French purse-seiners have already been reporting, in the last two years, *dead* discard information for all species.

Global Marlin population

83. The WPB **NOTED** paper IOTC–2016–WPB14–18 which provided the results of **assessing the global genetic population structure and effective population size for the Black marlin** including the following abstract provided by the authors:

> "*Genetic data are often used to identify the population structure of commercially exploited marine species. The identification of stocks is critical for fisheries management, particularly in highly migratory species that have few barriers to dispersal. This is true for the black marlin (Istiompax indica), a valuable commercial and recreational species, whose population structure within the Indian and Pacific Oceans is unresolved. Without knowledge of how many stocks exist, the ability of fisheries managers to monitor and regulate exploitation of the species is restricted. This study will investigate the population structure for black marlin through its entire range by utilizing a suite of pre-developed microsatellite markers and next-generation DD-rad sequencing-based molecular methods.*"– (see paper for full abstract)

84. The WPB **NOTED** the importance of this study and **ENCOURAGED** other CPCs to collaborate with the authors to provide more samples to support the project.

6.2 *Review of new information on the status of marlins*

6.2.1 Nominal and standardized CPUE indices

Black marlin

Japan longline CPUE

85. The WPB **NOTED** paper IOTC–2016–WPB14–19 providing a **CPUE standardization for black marlin exploited by the Japanese tuna longline fisheries in the Indian Ocean** including the following abstract provided by the authors:

> "*We updated the standardized CPUE (catch number per 1,000 hooks) of black marlin (Istiompax indica) caught by the Japanese tuna longline vessel between 1971 and 2015. The Japanese longline set by set catch and effort statistics from 1971 to 2015 were used. Total number of operational data is 1,269,199 (unit:set) and zero catch ratio of black marlin is 93%. Since the proportion of zero catch is large, the core (hot spot) area approach based on the 1-degree area was applied by filtering Japanese longline catch and effort data. After filtering, total number of set used in the analysis decreased to 18,560 sets and zero catch ratio to 58%."*– (see paper for full abstract)

86. The WPB **NOTED** that it is appropriate to have two CPUE series because of the large difference in the percentage of zeros between the two periods (earlier and later period in the series) which is likely due to a change of gears.

87. **ACKNOWLEDGING** that the sharp increase in the first CPUE series during the 1980s is a consequence of the transition from shallow set gear types to deeper gears the WPB **REQUESTED** the authors explore the effects of dropping a few years of data from this transition phase.

88. The WPB **NOTED** that the two separate series were then joined to produce the final CPUE series to be used in the assessment models. The WPB **SUGGESTED**, as preferable, to keep the two separate series also for the

stock assessment as the big drop in the combined CPUE series just reflects the change of gear and not a real drop in abundance index.

89. The WPB **NOTED** that it is surprising that the gear effect is significant for black marlin but not for blue marlin, despite the similar ecology of the two species and **REQUESTED** the authors to further investigate and provide a possible explanation.

Taiwan,China longline CPUE

90. The WPB **NOTED** paper IOTC–2016–WPB14–20 providing a **CPUE standardization for black marlin exploited by the Taiwanese tuna longline fisheries in the Indian Ocean** including the following abstract provided by the authors:

> "*In this study, the delta-lognormal GLM was used to conduct the CPUE standardization of black marlin (Makaira indica) caught by the Taiwanese longline fishery in the Indian Ocean for 1979-2015. CPUE trends were obviously different for northern and southern Indian Ocean, while the trend of area-aggregated CPUE series was similar to the CPUE series in the northern areas. The trend of area-aggregated CPUE indicated that high CPUEs occurred before late 1980s, substantially decreased and fluctuated in the 1990s, gradually declined from the late 1990s to 2005, and slightly increased in early years."* – (see paper for full abstract)

91. The WPB **NOTED** the high number of parameters in the model, especially in the *year:area* interaction, and the difficulty in interpreting some of these, such as the interactions between the different principal components and other covariates.

92. The WPB **NOTED** that the model selection approach might be backward stepwise selection, but this is unclear from the paper.

93. The WPB **SUGGESTED** that the author consider an alternative spatial structure which might reduce the variability in the CPUE series.

94. The WPB **NOTED** that billfish were a target species group for the longline fisheries prior to ~1970, whereas tropical tunas have been targeted since, while now they're considered as bycatch.

Indonesia longline CPUE

95. The WPB **NOTED** paper IOTC–2016–WPB14–21 providing a **CPUE standardization for black marlin exploited by the Indonesian tuna longline fisheries in the Indian Ocean** including the following abstract provided by the authors:

> "*Black marlin (Makaira indica) is caught as by-catch by Indonesian tuna longline fleet. Approximately 18% (~2,500 tons) of total black marlin caught in Indian Ocean is landed in Indonesia. Relative abundance indices are the input data for several stock assessment analyses that provide 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 and to estimate relative abundance indices based on the Indonesian longline dataset. Data was collected by scientific observers from August 2005 to December 2014. Most of the vessels monitored were based in Benoa Harbour, Bali.*" – (see paper for full abstract)

96. The WPB **THANKED** the authors for having submitted for the first time CPUE series from Indonesia and **ENCOURAGED** to continue this important work in the future.

97. The WPB **NOTED** the large number of positive catches in area D, which might be better explained by the inclusion of environmental variables in the model, and **REQUESTED** the authors investigate this further.

Blue marlin

Japan longline CPUE

98. The WPB **NOTED** paper IOTC–2016–WPB14–22 which provided a CPUE standardisation for **blue marlin (*Makaira mazara*) exploited by the Japanese tuna longline fisheries in the Indian Ocean from 1971 to 2015**, including the following abstract provided by the authors:

> "*We updated the standardized CPUE (catch number per 1,000 hooks) of blue marlin (Makaira mazara) caught by the Japanese tuna longline vessel between 1971 and 2015. In past, standardization of CPUE of this stock was conducted three times (Uozumi 1998; Nishida et al. 2012; Nishida and Wang 2013). In this document, we followed the approach common (log normal GLM) with the past work. In this analysis, we focused on the period between 1971 and 2015 and did not include the data before 1970, considering the shift of target species around 1970s. In the 1950s and 60s some of the Japanese longline fishery targeted billfishes (mainly striped and black marlins) in the Indian Ocean, while after the early 1970s, it has targeted mainly*

bigeye, yellowfin, and southern bluefin (Uozumi 1998, Nishida and Wang 2013)." – (see paper for full abstract)

99. The WPB **NOTED** that NHBF has little effect in the final model and therefore **SUGGESTED** that a species targeting effect could also be included in the standardisation.

100. The WPB **NOTED** that an analysis of size-frequency information for blue marlin over time would be useful to complement the results of the CPUE analysis **ACKNOWLEDGING** that this work is based on data for fish caught by longlines, whose samples have a median size of around 170 cm LJFL.

101. The WPB **NOTED** that the nominal catch datasets held by the IOTC Secretariat are only spatially disaggregated by east and west Indian Ocean regions and that finer scale information is held in the catch-and-effort database. These complementary data could potentially be used, for further spatial disaggregation of Nominal Catches, only if further updates from CPCs improve their coverage and quality.

102. The WPB **NOTED** the high proportion of zeros in the data (36%) and **ENCOURAGED** the authors to explore different types of models such as zero-inflated models as an alternative to the inclusion of a constant.

103. The WPB **NOTED** that the effect of core-areas as a main effect was explored in previous model runs but only retained as an interaction term in the final model.

104. The WPB also **NOTED** that the [1+1] area degree factor has over 200 levels, so there is the need to estimate a great number of parameters (with these smaller spatial area that can possibly have some correlation with the main area effects) and **ACKNOWLEDGED** that the data set has enough data points to estimate the parameters.

105. The WPB **NOTED** that since 2010 catches of blue marlin by the Japanese fleet have declined to about half of previous levels and so now comprise a very low proportion of total Indian Ocean catches.

Taiwan,China longline CPUE

106. The WPB **NOTED** paper IOTC–2016–WPB14–23 which provided a CPUE standardisation for **blue marlin caught by the Taiwan,China longline fishery in IOTC area of competence**, including the following abstract provided by the authors:

"*In this study, the principle component analysis was conducted based on catch composition of Taiwanese longline fishery in the Indian Ocean. The results indicated that the principle component scores can represent the historical fishing pattern related to characteristics of targeting species. Also, there were appropriate relationships between the principle component scores and the numbers of hooks between float. The delta-lognormal GLM was used to conduct the CPUE standardization of blue marlin (Makaira nigricans) caught by the Taiwanese longline fishery in the Indian Ocean for 1979-2015 because blue marlin was bycatch species of Taiwanese longline fishery and large amounts of zero catches was recorded in the operational data sets.*" – (see paper for full abstract)

107. The WPB **NOTED** that although there are potential issues with use of blue marlin in both the response and in the explanatory variables, this did not affect the analysis as blue marlin did not contribute to any of the first three components of the PCA used in the final model.

108. The WPB **NOTED** the use of the delta-lognormal approach to accommodate the high proportion of zero catches present in the data.

109. The WPB **NOTED** the contrast between the Japanese and Taiwanese CPUE series in recent years within the same areas.

110. **NOTING** the domination of the north west area in the aggregated model results the WPB **SUGGESTED** that the standardised CPUE series for each area could be normalised, so that they have equal means, prior to averaging so that the final results are a more accurate reflection of the CPUE in all areas.

111. The WPB **NOTED** that the CPUE signal in recent years reflects changes in catchability rather than relative abundance. This was due to the spatial movement of the fleet driven by the threat of piracy within the north west region and so the large areas used in the model do not account for this behaviour.

112. The WPB **SUGGESTED** that the authors might model this effect by splitting the time series to reflect the change in catchability from 2012.

113. The WPB **NOTED** that an alternative might be to drop *year:area* interaction from the model.

CPUE Summary discussion

114. The WPB **AGREED** to use the standardized CPUE series from Japan and Taiwan,China in the blue marlin stock assessment (Fig. 1)

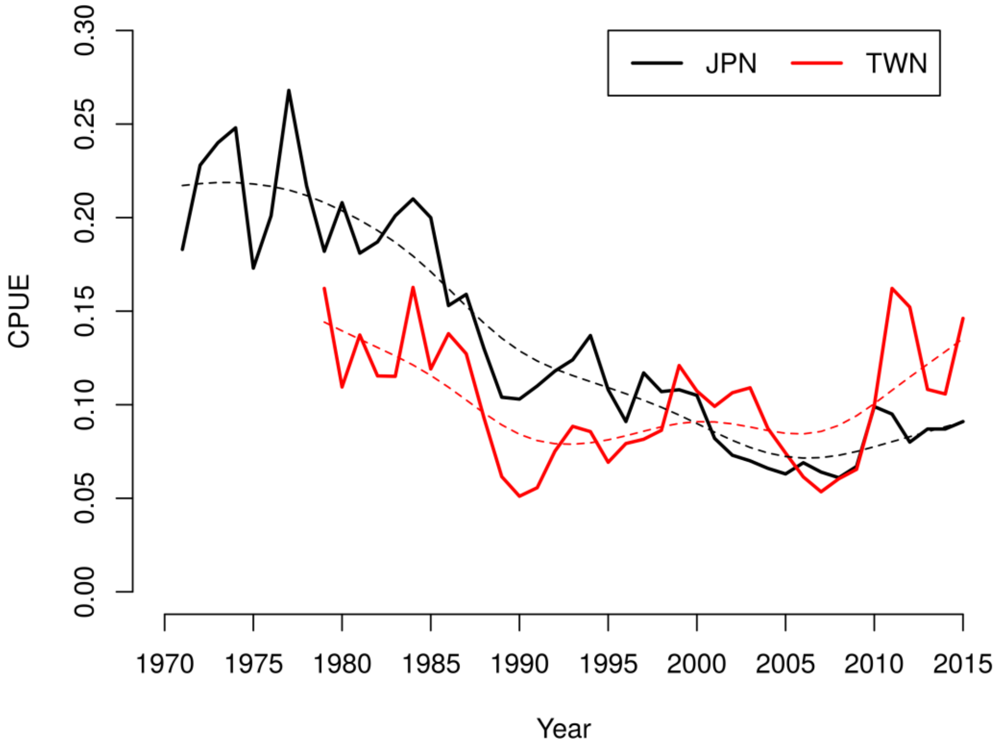

Fig 1. Standardized CPUE series used in the blue marlin stock assessment

115. The WPB **AGREED** to use the standardized CPUE series from Japan (split in earlier and later periods), Taiwan,China and Indonesia for the black marlin assessment (Fig. 2)

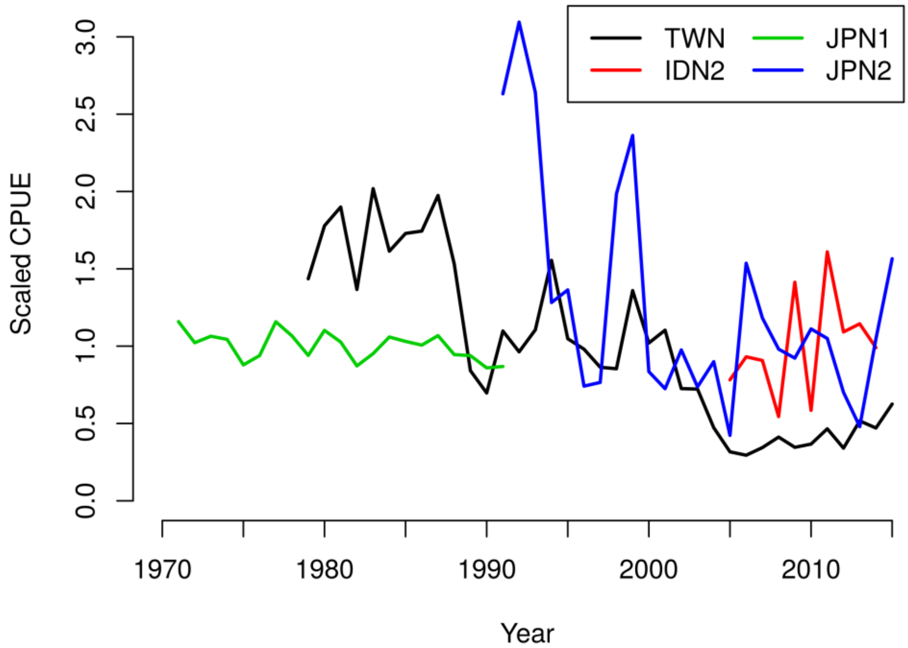

Fig 2. Standaridized CPUE series used in the black marlin stock assessment

6.2.2 Stock assessments

Blue marlin: Summary of stock assessment models in 2016

116. The WPB **NOTED** Table 3, which provides an overview of the key features of each of the blue marlin stock assessments presented in 2016 for the Indian Ocean-wide assessments (3 model types). Similarly, Table 4 provides a summary of the assessment results.

117. The WPB **AGREED** that the final advice for the executive summary should be based on the state-space Bayesian production model using informative priors and including both process and observational errors, with both CPUE series from Japan and Taiwan,China.

Table 3. Blue marlin: **Indian Ocean-wide** assessments. Summary of final stock assessment model features as applied to the Indian Ocean blue marlin resource in 2016.

Model feature	**SS3 (Doc #25 Rev1)**	**ASPIC (Doc #26)**	**BSP-SS (Doc #27)**
Software availability	NOAA toolbox	NOAA toolbox	H.A. Andrade / code at IOTC Secretariat
Population spatial structure / areas	1	1	1
Number CPUE Series	2	2	2
Uses Catch-at-length/age	Yes	No	No
Age-structured	Yes	No	No
Sex-structured	Yes	No	No
Number of Fleets	3	2	2
Stochastic Recruitment	Yes	No	No

Table 4. Blue marlin: **Indian Ocean-wide** summary of key management quantities from the assessments undertaken in 2016.

Management quantity	**SS3 (Doc #25 Rev1)**	**ASPIC (Doc #26)**	**BSP-SS (Doc #27)**
Most recent catch estimate (t) (2015)	15,706	15,706	15,706
Mean catch over last 5 years (t) (2011–2015)	14,847	14,847	14,847
h (steepness)	0.87	n.a.	n.a.
MSY (1,000 t) (80% CI) [plausible range of values]	11.206 (10.432 – 11.981)	11.980 (10.260 – 13.480)	11.926 (9.232 – 16.149)
Data period (catch)	1950 – 2015	1950 – 2015	1950 – 2015
CPUE series	JPN – TWN – OTH	JPN – TWN	JPN – TWN
CPUE period	JPN (1971 - 2015) TWN (1979 - 2015)	JPN (1971 - 2015) TWN (1979 - 2015)	JPN (1971 - 2015) TWN (1979 - 2015)
F_{MSY}	0.263 (0.259–0.268)	0.29 (0.15 - 0.49)	0.109 (0.076 – 0.160)
SB_{MSY} or $*B_{MSY}$ (1,000 t)	23.133 (21.567 – 24.698)	40.850* (27.050 – 69.760)	113.012* (71.721 – 161.946)
F_{2015}/F_{MSY} (80% CI) [plausible range of values]	1.492 (1.239 – 1.746)	1.08 (0.78 – 1.44)	1.18 (0.80 – 1.71)
B_{2015}/B_{MSY} (80% CI) [plausible range of values]	n.a.	1.17 (0.97 – 1.46)	1.11 (0.90 – 1.35)
SB_{2015}/SB_{MSY} (80% CI) [plausible range of values]	1.829 (1.532 – 2.125)	n.a.	n.a.
B_{2015}/B_{1950} (80% CI) [plausible range of values]	n.a.	0.45 (n.a.)	0.56 (0.44 – 0.71)
SB_{2015}/SB_{1950} (80% CI)	0.299 (0.250 – 0.347)	n.a.	n.a.

[plausible range of values]			
$SB_{2015}/SB_{current,\ F=0}$	n.a.	n.a.	n.a.

n.a. = not available

Stock synthesis (SS3)

118. The WPB **NOTED** paper IOTC–2016–WPB14–25_Rev1 which provided a **stock assessment of blue marlin in the Indian Ocean using Stock Synthesis (SS3)**, including the following abstract provided by the authors:

"*In this study, Stock Synthesis (SS) was adopted to conduct the stock assessment for blue marlin in the Indian Ocean by incorporating historical catch, CPUE and length- frequency data. Although the model estimates were sensitive to the assumptions related to life-history parameters and selectivity functions, the results of all sensitivity scenarios indicated that the current stock status of blue marlin in the Indian may be not overfished but be overfishing already. In addition, there are high risks of spawning biomass dropping below the MSY level and fishing mortality exceeding the MSY level if future catches are not reduced.*" – (see paper for full abstract)

119. The WPB **NOTED** the key assessment results for **Stock Synthesis** (SS3) as shown below (Tables 5 and 6; Fig. 3).

Table 5. Blue marlin: Key management quantities from the SS3 assessment, for the Indian Ocean.

Management Quantity	**Indian Ocean**
2015 catch estimate	15,706
Mean catch from 2011–2015	14,847
MSY (1000 t) (80% CI)	11.206 (10.432 – 11.981)
Data period used in assessment	1950 – 2015
F_{MSY} (80% CI)	0.263 (0.259 – 0.268)
SB_{MSY} (1000 t) (80% CI)	23.133 (21.567 – 24.698)
F_{2015}/F_{MSY} (80% CI)	1.492 (1.239 – 1.746)
B_{2015}/B_{MSY} (80% CI)	n.a.
SB_{2015}/SB_{MSY}	1.829 (1.532 – 2.125)
B_{2015}/B_{1950} (80% CI)	n.a.
SB_{2015}/SB_{1950}	0.299 (0.250 – 0.347)
$B_{2015}/B_{1950,\ F=0}$	n.a.
$SB_{2015}/SB_{1950,\ F=0}$	n.a.

Indian Ocean

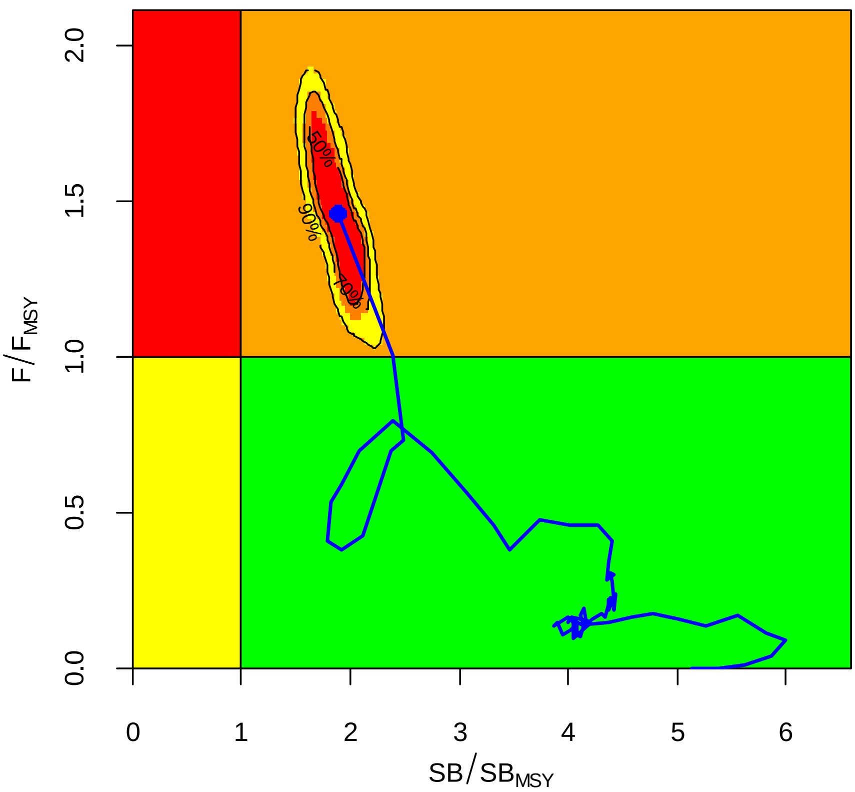

Fig. 3. Blue marlin: SS3 aggregated Indian Ocean assessment Kobe plot. The results are from the preferred base case SS3 model.

Table 6. Blue marlin: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2013–15 (15,401 t) ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2013–2015) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	9,240 t	10,780 t	12,321 t	13,861 t	15,401 t	16,941 t	18,481 t	20,021 t	21,561 t
$B_{2018}<B_{MSY}$	30	41	54	68	79	84	90	95	98
$F_{2018}>F_{MSY}$	32	57	82	98	100	100	100	100	100
$B_{2025}<B_{MSY}$	32	57	82	98	100	100	100	100	100
$F_{2025}>F_{MSY}$	6	53	80	100	100	100	100	100	100

120. The WPB **NOTED** the steepness parameter used for the base case model run (h=0.87) has been taken from the Pacific whereas the basic information on biology is limited for this stock and this value might be too high. The WPB **REQUESTED** that additional and alternative information on the biology is further explored prior to the next meeting.

121. The WPB **SUGGESTED** doing a preliminary run with no projections to obtain the biological parameters and then doing a subsequent run.

122. The WPB **NOTED** the poor fit of the model to the CPUE which may be due to large confidence intervals for the CPUE series and so the model is fitting better to the size data in recent years. The WPB **SUGGESTED** that this issue could be explored further through sensitivity analysis in which alternative weightings are applied to the CPUE and size data, giving a greater weighting to the CPUE series.

123. The WPB **NOTED** that there is a balance and a trade-off between the fit of the model to the CPUE time series and the size distribution data. As this is the first attempt to assess blue marlin using SS3, the WPB **SUGGESTED** that current results are considered to be preliminary and **ENCOURAGED** to further explore this option in the future.

A Stock-Production Model Incorporating Covariates (ASPIC)

124. The WPB **NOTED** paper IOTC–2016–WPB14–26 which provided a **stock assessment of blue marlin in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC)**, including the following abstract provided by the authors:

> "*ASPIC was used to conduct the stock assessment of blue marlin in the Indian Ocean using total nominal catch (1950-2015) and standardized CPUE of Japanese longline fleets (1971-2015). We conducted ASPIC assuming that B0/K=1 with two model scenarios (Schaefer and Fox model). Results suggest the Fox model fits to the data better based on R2 and RMS (Root Mean Square). Estimated r (intrinsic growth rate) is 0.273 is higher than 0.11 (FAO FISHBASE) and 0.19 (0.06-0.6) (IOTC, 2014), but it is considered to be the plausible value. ASPIC results suggests that the blue marlin stock is the overfished status with F/F_{MSY}=1.99 and TB/TB_{MSY}=0.67 (red zone in the Kobe plot).*" – (see paper for full abstract)

125. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below (Tables 7 and 8; Fig. 4).

Table 7. Blue marlin: Key management quantities from the ASPIC assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2015 catch estimate	15,706
Mean catch from 2011–2015	14,847
MSY (1000 t) (80% CI)	11.980 (10.260 - 13.480)
Data period used in assessment	1950 – 2015
F_{MSY} (80% CI)	0.29 (0.15 – 0.49)
B_{MSY} (1000 t) (80% CI)	40.850 (27.050 – 69.760)
F_{2015}/F_{MSY} (80% CI)	1.08 (0.78 – 1.44)
B_{2015}/B_{MSY} (80% CI)	1.17 (0.97 – 1.46)
SB_{2015}/SB_{MSY}	n.a.
B_{2015}/B_{1950} (80% CI)	0.45 (n.a.)
SB_{2015}/SB_{1950}	n.a.
$B_{2015}/B_{1950,\ F=0}$	n.a.
$SB_{2015}/SB_{1950,\ F=0}$	n.a.

Indian Ocean

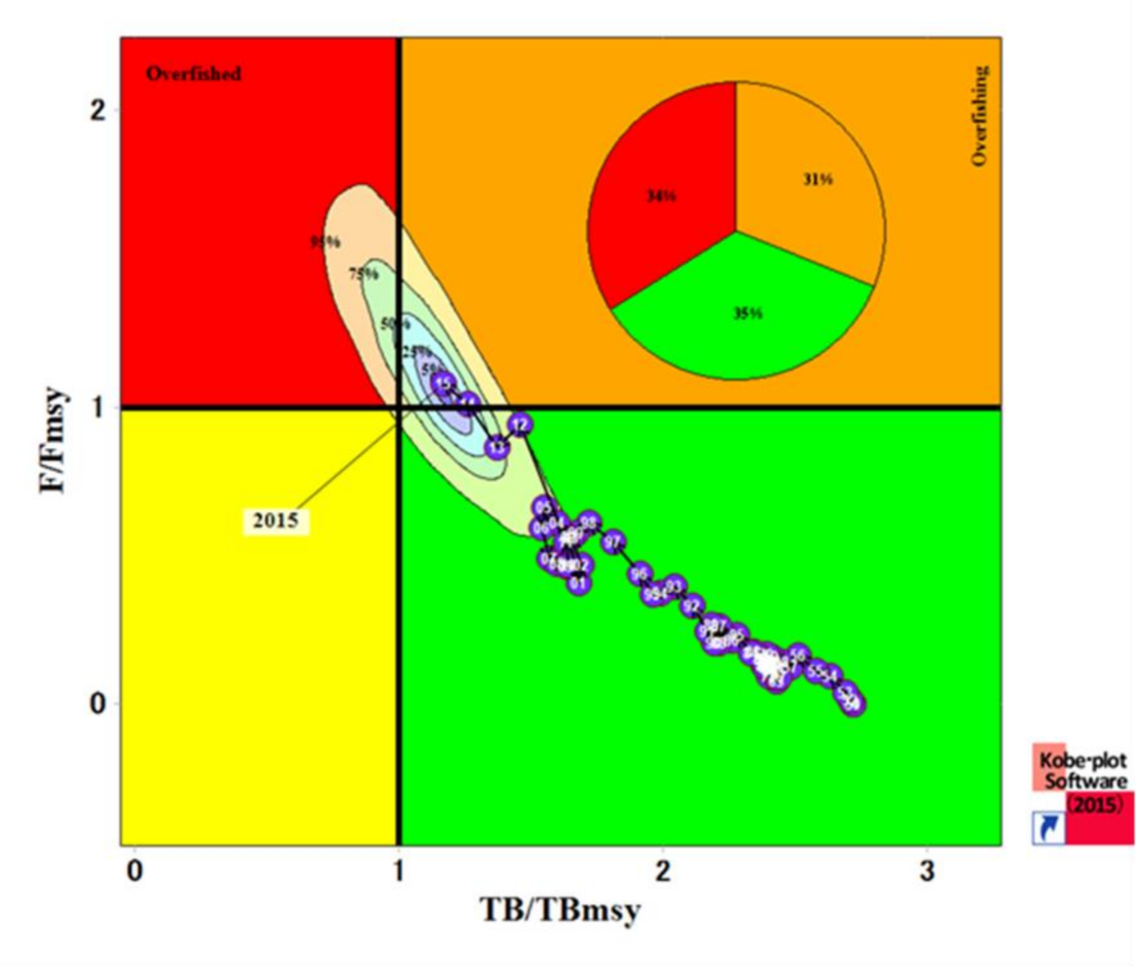

Fig. 4. Blue marlin: ASPIC aggregated Indian Ocean assessment Kobe plot. The results are from a preferred model option: Fox type model.

Table 8. Blue marlin: ASPIC aggregated Indian Ocean assessment Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2013–15 (15,401 t) ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2013–2015) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	9,240 t	10,780 t	12,321 t	13,861 t	15,401 t	16,941 t	18,481 t	20,021 t	21,561 t
$B_{2018}<B_{MSY}$	56	60	62	65	67	71	73	74	76
$F_{2018}>F_{MSY}$	30	47	65	76	85	91	95	97	98
$B_{2025}<B_{MSY}$	26	44	68	83	93	97	98	99	100
$F_{2025}>F_{MSY}$	10	35	71	90	97	99	100	100	100

126. The WPB **NOTED** the following with respect to the ASPIC modelling approach presented at the meeting:

- Japanese standardised CPUE with traditional targeting effect (NHBF) fits better to ASPIC than by swordfish cluster.
- ASPIC results by Schaefer are more conservative than by Fox.
- Schaefer fits better to CPUE series, but Fox fits better to the catch and the overall fit in the model.
- The Japanese standardized CPUE fits well to global catch trends (increased catch implies a lower CPUE).

127. The WPB **EXPRESSED** concern about the elimination of the Taiwanese CPUE series from the ASPIC model based on the poor correlation between the catch and CPUE, despite the larger proportion of catches for which the Taiwanese fleet accounts.

128. The WPB **NOTED** that if the Japanese fleets fish in the core areas of blue marlin abundance then this better quality data should be used for the analysis, whereas if the fishing only takes place in particular areas which are more peripheral to the core blue marlin fishing grounds then it may be better to use an alternative dataset which better represents the distribution of blue marlin.

129. The WPB **NOTED** that the Taiwanese aggregate CPUE series was dominated by the NW region, whereas if this is first normalised then the series will change and will affect the model results.

130. The WPB **NOTED** the poor model fit to the Japanese CPUE series, meaning that more data preparatory time may be needed to discuss and review the quality of the different CPUE series prior to running the model. However, due to the limited time available, the WPB **SUGGESTED** that sensitivity analyses could be used instead.

131. The WPB **NOTED** the changes to the historical nominal catch dataset which has also contributed to the substantial changes in the KOBE plot since previous assessments.

132. The WPB **NOTED** that in this base case (using Japan CPUE only) the Kobe plot is in the red, whereas in the results of the sensitivity analysis (including Japan and Taiwan,China CPUEs) the scenario is more optimistic and the Kobe plot trajectory ends in the orange zone.

133. The WPB **NOTED** the sensitivity run with the inclusion of a TWN CPUE series provides a more positive outlook on stock status and that there is no reason to drop the series from the assessment.

134. The WPB however **NOTED** that, although there is substantial uncertainty associated with the current status, the current catch is still much higher than MSY. Therefore, even in the more optimistic scenario, if catches remain much higher than MSY the step increase in the trajectories will likely continue into the red zone. This can also be seen in the risk matrix, with high probabilities of violating the F_{MSY} and B_{MSY} reference points in case catches remain on the same level as the last year.

135. The WPB **AGREED** that both models have the same long term outlook which is that the stock will be overexploited if catches continue at current levels with no management.

136. The WPB **NOTED** the substantial change in the KOBE trajectory since the last assessment which is due to the changes in the nominal catch series (both historical and in recent years).

Bayesian state space Surplus Production Model (BSP-SS)

137. The WPB **NOTED** paper IOTC–2016–WPB14–27 which provided a **stock assessment of blue marlin in the Indian Ocean using a Bayesian state space Surplus Production Model (BSPM)** which incorporates some of the improvements agreed at the previous WPB meeting, including the following abstract provided by the authors:

"*Blue marlin (Makaira nigricans) is a bycatch species of tuna longline and gillnet fleets operating in the Indian Ocean. Unitary stock in the Indian Ocean is assumed as the most probable hypothesis in this analysis. Indian Ocean blue marlin stock was classified as not overfished and not subject to overfishing in the last stock assessment meeting in 2013. However relative abundance indices and catch time series were updated and revised, hence new stock assessment is warranted. Bayesian state-space models (Fox and Schaefer types) were used to assess the status of blue marlin Indian Ocean stock based on estimations of total catch and standardized catch rates of Japan and Taiwan*,China*. Informative and non-informative priors were used. Likelihood function was based on log-normal density distributions. Posterior samples were calculated using Monte Carlo Markov Chains. Three chains starting on different locations of the space of parameters were calculated.*" – (see paper for full abstract)

138. The WPB **NOTED** the key assessment results for Bayesian state space Surplus Production Model (BSP-SS) as shown below (Tables 9 and 10; Fig. 5).

139. The WPB **NOTED** that authors agreed about using the Japan and Taiwan,China LL standardized CPUE, and conducted BSP-SS.

Table 9. Blue marlin: Key management quantities from the BSP-SS assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2015 catch estimate	15,706
Mean catch from 2011–2015	14,847
MSY (1000 t) (80% CI)	11.926 (9.232 – 16.149)
Data period used in assessment	1950 – 2015
F_{MSY} (80% CI)	0.109 (0.076 – 0.160)
B_{MSY} (1000 t) (80% CI)	113.012 (71.721 – 161.946)
F_{2015}/F_{MSY} (80% CI)	1.18 (0.80 – 1.71)
B_{2015}/B_{MSY} (80% CI)	1.11 (0.90 – 1.35)
SB_{2015}/SB_{MSY}	n.a.
B_{2015}/B_{1950} (80% CI)	0.56 (0.44 – 0.71)
SB_{2015}/SB_{1950}	n.a.
$B_{2015}/B_{1950,\ F=0}$	n.a.
$SB_{2015}/SB_{1950,\ F=0}$	n.a.

Indian Ocean

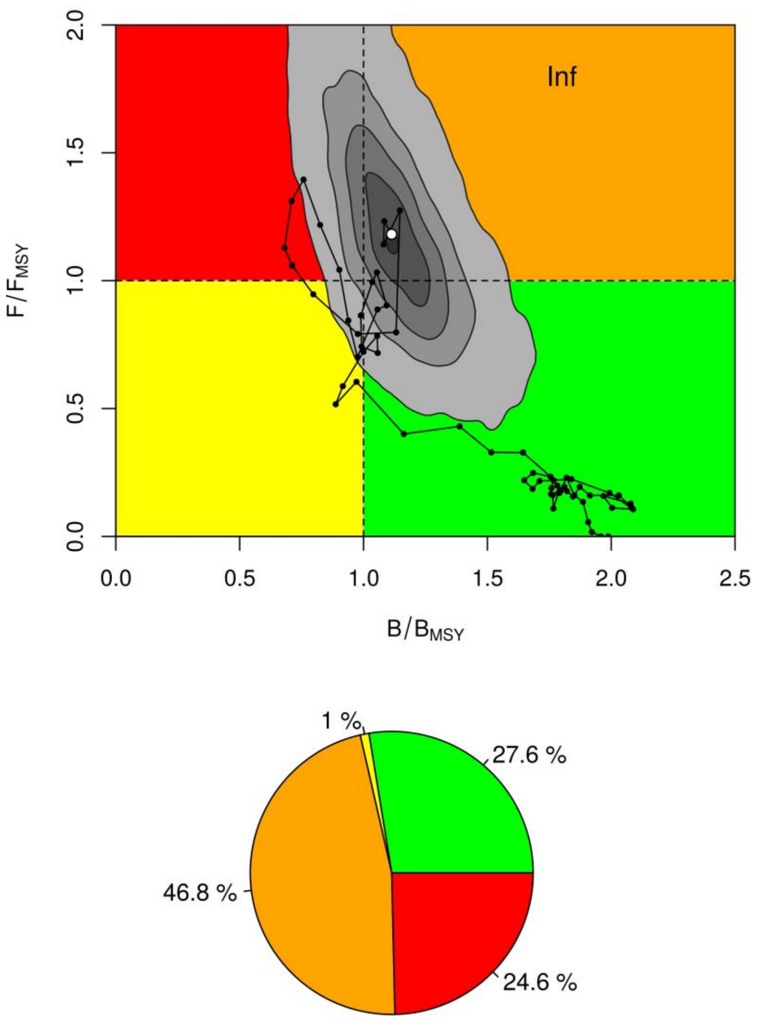

Fig. 5. Blue marlin: BSP-SS aggregated Indian Ocean assessment Kobe plot. The results are from a preferred model option: Fox type model with informative prior.

Table 10. Blue marlin: BSP-SS aggregated Indian Ocean assessment Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2013–15

(15,401 t) ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2013–2015) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	9,240 t	10,780 t	12,321 t	13,861 t	15,401 t	16,941 t	18,481 t	20,021 t	21,561 t
$B_{2018}<B_{MSY}$	26	31	37	43	48	54	59	64	69
$F_{2018}>F_{MSY}$	14	30	47	63	75	84	90	94	96
$B_{2025}<B_{MSY}$	16	30	46	60	73	82	88	93	95
$F_{2025}>F_{MSY}$	12	30	51	68	80	89	93	96	98

140. The WPB **NOTED** that while the stock status outlook differs between results of Fox and Schaefer models, they both suggest current catches (15,706 t) are above MSY.

141. The WPB **NOTED** that the limited size ranges recorded indicate that only a small fraction of the population are used for the CPUE series, which may influence the results. However this is a surplus production model approach which does not utilise size information so this has less impact than it would on an age or size structured model.

142. The WPB **NOTED** the fluctuations in the KOBE trajectory which previously entered the yellow (overfished but not subject to overfishing) and red zones, but only recently entered the orange (subject to overfishing but not overfished) zone, which is unusual. The WPB **NOTED** that this may due to the state space model assuming that the Schaefer equation does not explain well the relationship between recruitment, mortality and growth, and suggests the production model is too simple to adequately explain the data. Alternatively, the reason might be because the KOBE diagram plots the mean/median of B/B_{MSY} ratio against the mean/median of F/F_{MSY} ratio. However, as the distribution is not symmetrical, the trajectory of means/medians may not represent the data very well.

143. The WPB **ENCOURAGED** the authors to perform a sensitivity run including the Japanese CPUE only, so that it would be more comparable to the base case in the ASPIC model.

144. The WPB also **SUGGESTED** to perform a sensitivity run using observational error only. The authors conducted both analysis and presented the results to the WPB.

145. The WPB **NOTED** that the Schaefer model was producing slightly better fits, as were the informative priors. The WPB **ACKNOWLEDGED** that, in terms of error structure, the inclusion of both the process and observational errors allows for more uncertainty to be included in the model.

146. The WPB **NOTED** the results without the inclusion of process error are very similar to the ASPIC results and the uncertainty is much reduced.

147. The WPB **NOTED** the consistency in the estimates of MSY between model runs

148. The WPB **NOTED** the use of non-informative and informative priors, using information from the Atlantic, and the similarity in estimates of final *r* and *k* regardless of the priors used.

149. The WPB **AGREED** that the final model selected would be the Schaefer with the informative priors including process error, **NOTING** that the inclusion of process error in the model structure yielded an unusual stock trajectory which passed through the overfished phase before entering the overfishing phase as it considered the possibility of stock depletion for ecological reasons rather than being solely dependent on fishing-induced mortality.

Black marlin: Summary of stock assessment models in 2016

150. The WPB **NOTED** Table 11, which provides an overview of the key features of each of the blue marlin stock assessments presented in 2016 for the Indian Ocean-wide assessments (2 model types). Similarly, Table 12 provides a summary of the assessment results.

Table 11. Black marlin: **Indian Ocean-wide** assessments. Summary of final stock assessment model features as applied to the Indian Ocean black marlin resource in 2016.

Model feature	**ASPIC (Doc #24 Rev1)**	**BSP-SS (Doc #28)**
Software availability	NOAA toolbox	H.A. Andrade / code at IOTC Secretariat
Population spatial structure / areas	1	1
Number CPUE Series	4	4
Uses Catch-at-length/age	No	No
Age-structured	No	No
Sex-structured	No	No
Number of Fleets	3	3
Stochastic Recruitment	No	No

Table 12. Black marlin: **Indian Ocean-wide** summary of key management quantities from the assessments undertaken in 2016.

Management quantity	**ASPIC (Doc #24 Rev1)**	**BSP-SS (Doc #28)**
Most recent catch estimate (t) (2015)	18,490	18,490
Mean catch over last 5 years (t) (2011–2015)	15,276	15,276
h (steepness)	n.a.	n.a.
MSY (1,000 t) (80% CI) [plausible range of values]	11.940 (10.940 – 13.660)	9.932 (6.963 – 12.153)
Data period (catch)	1950 – 2015	1950 – 2015
CPUE series	TWN-JPN1-JPN2-IDN	TWN-JPN1-JPN2-IDN
CPUE period	TWN (1979-2015); JPN1 (1971-1991); JPN2 (1991-2015); IDN(2005-2014)	TWN (1979-2015); JPN1 (1971-1991); JPN2 (1991-2015); IDN(2005-2014)
F_{MSY}	0.43 (0.40 – 0.50)	0.211 (0.089 – 0.430)
B_{MSY} (1,000 t)	27.590 (n.a.)	47.430 (27.435 – 100.109)
F_{2015}/F_{MSY} (80% CI) [plausible range of values]	1.66 (1.11 – 2.45)	2.42 (1.52 – 4.06)
B_{2015}/B_{MSY} (80% CI) [plausible range of values]	0.83 (0.56 – 1.14)	0.81 (0.55 – 1.10)
SB_{2015}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.
B_{2015}/B_{1950} (80% CI) [plausible range of values]	0.34 (n.a.)	0.30 (0.20 – 0.41)
SB_{2015}/SB_{1950} (80% CI) [plausible range of values]	n.a.	n.a.
$SB_{2015}/SB_{current,\ F=0}$	n.a.	n.a.

n.a. = not available

A Stock-Production Model Incorporating Covariates (ASPIC)

151. The WPB **NOTED** paper IOTC–2016–WPB14–24 Rev1 which provided a **stock assessment of blue marlin in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC)**, including the following abstract provided by the authors:

"*ASPIC was used to conduct the stock assessment of black marlin in the Indian Ocean using total nominal catch (1950-2015) and standardized CPUE of Japanese longline fleets (1971-2015) and Taiwan longline* *fleets (1979-2015). We conducted ASPIC using 36 runs varying K values with two models (Schaefer and Fox model). Results suggest the Fox model (K=50,000) fits to the data as the best, based on R2, RMS (Root Mean Square) and B1/K values (we consider it is the virgin stock in 1950, thus we select the ASPIC run with estimated B1/K closer 1). ASPIC results suggests that the black marlin stock is the overfished status with F/F_{MSY}=2.02 and TB/TB_{MSY}=0.59 (red zone in the Kobe plot)*"– (see paper for full abstract)

152. The WPB **NOTED** the key assessment results for the ASPIC as shown below (Tables 13 and 14; Fig. 6).

Table 13. Black marlin: Key management quantities from the ASPIC assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2015 catch estimate (t)	18,490
Mean catch from 2011–2015 (t)	15,276
MSY (1000 t) (80% CI)	11.940 (10.940 – 13.660)
Data period used in assessment	1950 – 2015
F_{MSY} (80% CI)	0.43 (0.40 – 0.50)
B_{MSY} (1,000 t) (80% CI)	27.590 (n.a.)
F_{2015}/F_{MSY} (80% CI)	1.66 (1.11 – 2.45)
B_{2015}/B_{MSY} (80% CI)	0.83 (0.56 – 1.14)
SB_{2015}/SB_{MSY}	n.a.
B_{2015}/B_{1950} (80% CI)	0.34 (n.a.)
SB_{2015}/SB_{1950}	n.a.
$B_{2015}/B_{1950,\ F=0}$	n.a.
$SB_{2015}/SB_{1950,\ F=0}$	n.a.

Indian Ocean

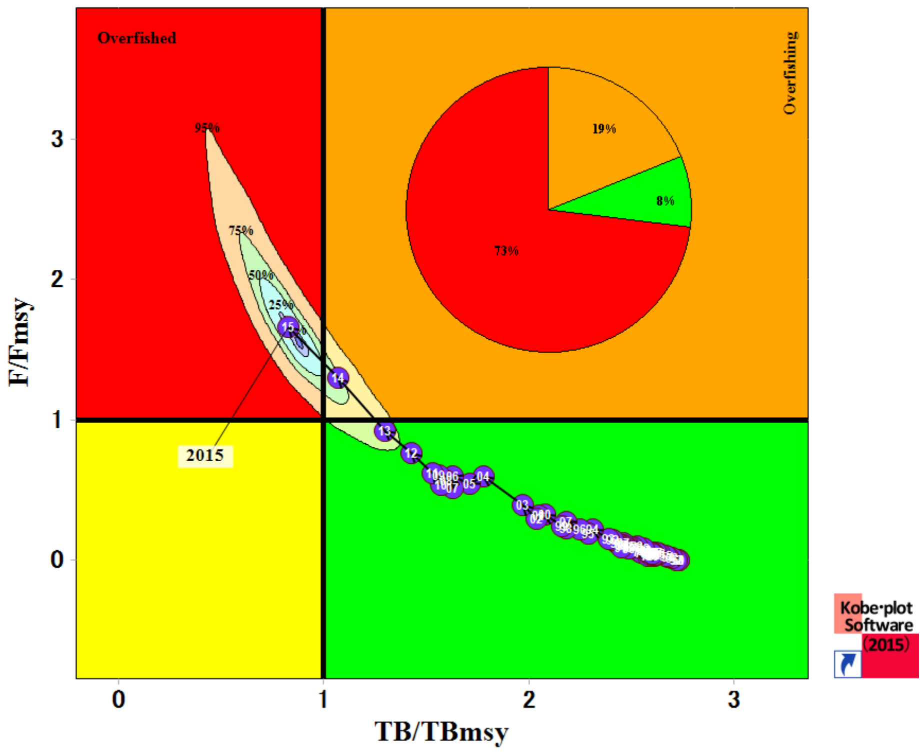

Fig. 6. Black marlin: ASPIC aggregated Indian Ocean assessment Kobe plot. The results are from a preferred model option: Fox type model.

Table 14. Black marlin: ASPIC aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2013–15 (17,171 t) ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2013–15) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	10,303 t	12,020 t	13,737 t	15,454 t	17,171 t	18,888 t	20,605 t	22,322 t	24,039 t
$B_{2018}<B_{MSY}$	82	86	90	92	94	95	97	97	98
$F_{2018}>F_{MSY}$	69	86	94	98	100	100	100	100	100
$B_{2025}<B_{MSY}$	51	76	91	96	99	99	100	100	100
$F_{2025}>F_{MSY}$	47	75	93	98	100	100	100	100	100

153. The WPB **SUGGESTED** that the fixed *k* value might be too low (50,000 t), given that current catches are approximately ~20,000 t. The WPB **NOTED** that given the negative correlation between *k* and *r*, the resulting *r* is very high for a marlin (0.68), with the authors replying that the estimated *r* value is within the plausible range from the previous black marlin assessment using a data-poor stock-reduction analysis.

154. The WPB **NOTED** the problems with model convergence which may be explained by the relatively poor correlation between catch and CPUE, with a negative correlation until catches of approximately 10,000 t after which the relationship is relatively flat.

155. **NOTING** the surprising increase in CPUE in recent years, the WPB **SUGGESTED** that a retrospective analysis might be carried out for the final model run, without the inclusion of the final few years of the CPUE series to explore the results further.

Bayesian state space Surplus Production Model (BSP-SS)

156. The WPB **NOTED** paper IOTC–2016–WPB14–28 Rev1 which provided a **stock assessment of black marlin in the Indian Ocean using a Bayesian state space Surplus Production Model (BSP-SS)**, which incorporates some of the improvements agreed at the previous WPB meeting, including the following abstract provided by the authors:

> "*Black marlin (Makaira indica) is often caught by tuna longline and gillnet fleets operating in the Indian Ocean. Unitary stock in Indian Ocean has been assumed as working hypothesis during recent years. In 2014 an Stock Reduction Analysis based only on catch data was used to assess the status of the the stock assessment which was then classified as "subject to overfishing". Catch time series was updated and revised and new relative abundance indices for Indonesia, Japan and Taiwan were calculated. In this paper this new information was analysed in an attempt to fit an Bayesian state-space production model. Informative and non- informative priors were used. Likelihood function was based on log-normal density distributions. Posterior samples were calculated using Monte Carlo Markov Chains. Three chains starting on different locations of the space of parameters were calculated.*" – (see paper for full abstract)

157. The WPB **NOTED** the key assessment results for the BSP-SS as shown below (Tables 15 and 16; Fig. 7).

Table 15. Black marlin: Key management quantities from the BSP-SS assessment, for the Indian Ocean.

Management Quantity	Indian Ocean
2015 catch estimate	18,490
Mean catch from 2011–2015	15,276
MSY (1000 t) (80% CI)	9.932 (6.963 – 12.153)
Data period used in assessment	1950 – 2015
F_{MSY} (80% CI)	0.211 (0.089 – 0.430)
B_{MSY} (1000 t) (80% CI)	47.430 (27.435 – 100.109)
F_{2015}/F_{MSY} (80% CI)	2.42 (1.52 – 4.06)
B_{2015}/B_{MSY} (80% CI)	0.81 (0.55 – 1.10)
SB_{2015}/SB_{MSY}	n.a.
B_{2015}/B_{1950} (80% CI)	0.30 (0.20 – 0.41)
SB_{2015}/SB_{1950}	n.a.
$B_{2015}/B_{1950,\ F=0}$	n.a.
$SB_{2015}/SB_{1950,\ F=0}$	n.a.

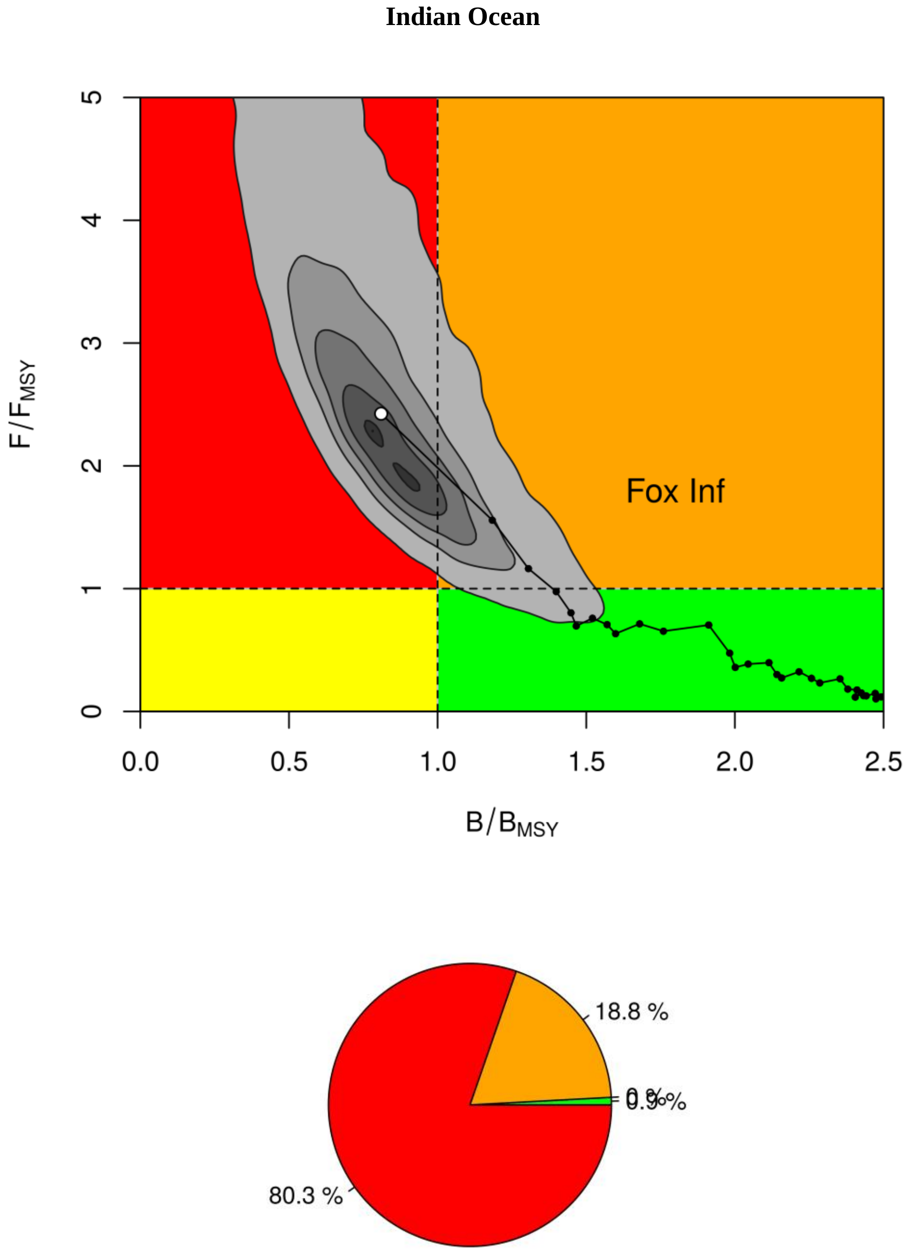

Fig. 7. Black marlin: BSP-SS aggregated Indian Ocean assessment Kobe plot. The results are from a preferred model

option: Fox type model with informative prior.

Table 16. Black marlin: BSP-SS aggregated Indian Ocean assessment Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2013–15 (17,171 t) ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from 2013–2015, 17,171 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	10,303 t	12,020 t	13,737 t	15,454 t	17,171 t	18,888 t	20,605 t	22,322 t	24,039 t
$B_{2018}<B_{MSY}$	91	94	96	97	98	98	99	99	99
$F_{2018}>F_{MSY}$	89	96	98	99	100	100	100	100	100
$B_{2025}<B_{MSY}$	98	100	100	100	100	100	100	100	100
$F_{2025}>F_{MSY}$	97	99	100	100	100	100	100	100	100

158. The WPB **NOTED** that three separate CPUE series are used (Japan, Taiwan,China and Indonesia) even if there are conflicting trends between them.

159. The WPB **NOTED** that the Indonesia CPUE series was not very influential in the model results and so it did not matter whether the negative binomial or the zero inflated negative binomial was used.

160. The WPB **NOTED** that the estimated posterior of *k* is bounded by the upper limit of the prior being used, thus putting a low confidence in the estimation of *k*. If a different prior with a higher bound was used, then the estimate of *k* could also be higher and this would also have consequences for the estimation of *r*.

161. The WPB **ENCOURAGED** that the author explores the use of a log transformation on *k* given the unusual posterior distribution with an upper limit bounded by the prior.

162. The WPB **NOTED** the large discrepancy between the *r* values used in the BSP-SS and ASPIC assessments (0.2 and 0.68 respectively).

163. The WPB **NOTED** that the estimated *r* value seems low, although results are consistent when using informative or non-informative priors, meaning that the data has indeed *some* information for calculating *r*.

164. The WPB also **NOTED** the same situation as in the case of blue marlin, with trajectories in the Kobe plot going directly from *green* to *red* without traversing the *orange* zone.

Striped marlin

165. **NOTING** that striped marlin was not a priority species in 2016 (it will be assessed in 2017 as per the Program of Work (see Appendix XI), no updated CPUE indices were submitted for consideration by the WPB in 2016.

6.3 Development of management advice for marlins and update of marlins species Executive Summaries for the consideration of the Scientific Committee

166. The WPB **ADOPTED** the management advice developed for each marlin species as provided in the draft resource stock status summaries and **REQUESTED** that the IOTC Secretariat update the draft stock status summaries for each marlin species with the latest 2015 catch data (if necessary), and for the summaries to be provided to the Scientific Committee as part of the draft Executive Summary, for its consideration:

- Black marlin (*Makaira indica*) – Appendix VII
- Blue marlin (*Makaira nigricans*) – Appendix VIII
- Striped marlin (*Tetrapturus audax*) – Appendix IX

7. INDO-PACIFIC SAILFISH

7.1 Review of new information on I.P. sailfish biology, stock structure, fisheries and associated environmental data

7.2 Review of new information on the status of I.P. sailfish

167. **NOTING** that Indo-pacific sailfish was not a priority species in 2016 (it will be assessed in 2019 as per the Program of Work (see Appendix XI), no new information or updated CPUE indices were submitted for consideration by the WPB in 2016.

7.2.2 Selection of Stock Status indicators for I.P sailfish

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

7.3 Development of management advice for sailfish and update of sailfish species Executive Summaries for the consideration of the Scientific Committee

169. The WPB **ADOPTED** the management advice developed for Indo-Pacific sailfish (*Istiophorus platypterus*), as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for Indo-Pacific sailfish with the latest 2015 catch data (if appropriate), and for the summary to be provided to the Scientific Committee as part of the draft Executive Summary, for its consideration:

- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix X

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

170. The WPB discussed possible alternatives by highlighting input (effort) and output (catch) controls.

171. The WPB **NOTED** that a potential management measure involving a quota allocation has not yet been adopted by the Commission and, as a result, the Commission has requested the Scientific Committee and relevant Working Party discuss alternative options for potential management measures.

172. The WPB also **NOTED** that references to time-area closures have been removed from Resolution 14/02 (previously: 10/01, 12/13) and that some of the key IOTC species are being over-exploited or are now fully exploited.

173. Therefore the WPB **SUGGESTED** that the Commission may consider options for time-area-closures as one alternative among others presented, such as fishery input and output controls and **NOTED** an earlier study conducted in 2012 on the effectiveness of time area closures (included in previous versions of Resolution 14/02) that indicated that this closure was not effective.

174. For these reasons, the WPB **SUGGESTED** that this agenda may not be needed unless new relevant information are available.

9. WPB PROGRAM OF WORK

9.1 Revision of the WPB Program of work (2017–2021)

175. The WPB **NOTED** paper IOTC–2016–WPB14–08 Rev_1 which provided an opportunity to consider and revise the WPB Program of Work (2017–2021), by taking into account the specific requests of the Commission, Scientific Committee, and the resources available to the IOTC Secretariat and CPCs.

176. 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)

177. The WPB **NOTED** that budget has been allocated for 2017 and 2018 for CPUE standardisation with coastal fleets and stock assessment including data-poor approaches.

178. The WPB **RECOMMENDED** that more support is provided for the implementation of the ROS for fleets catching the majority of the billfish species (i.e. the gillnet fleets).

179. The WPB **NOTED** the proposal on the development of a tagging project with the objectives of determining levels of connectivity, movement rates, mortality for billfish stocks with SWO as a priority species and **AGREED** that this will be developed intersessionally, for a presentation to the SC19.

180. The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2017–2021), as provided at Appendix XI.

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

181. The WPB **NOTED**, with thanks, the continued and outstanding contributions of the invited expert for the meeting, Dr Humber Andrade from the Universidade Federal Rural de Pernambuco in Brazil. Dr Andrade's work, both prior to and during the WPB11-14 meetings, has contributed greatly to the group's understanding of billfish data and assessment methods. Dr Andrade collaborated with the WPB, as the Invited Expert, on a voluntary basis for the past three years and his expertise has been greatly appreciated having contributed substantially to the stock status determination of billfish under the IOTC mandate.

182. 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 2017, by an Invited Expert:

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

183. The WPB **AGREED** that the selection of the invited expert for the next WPB15 would be performed by advertising the position through the IOTC science list (as a priority channel) and finalized after receipt and assessment of resumes and supporting information for potential candidates, according to the deadlines set forth by the rules and procedures of the Commission.

184. The WPB **AGREED** to nominate Dr Humber Andrade as the consultant to work on the "*billfish data poor stock assessment, including the development of CPUE series for coastal gillnet and fisheries other than industrial longline*" as outlined in table 5, page 45 of IOTC-2015-SC18-R.

10. OTHER BUSINESS

10.1 *Date and place of the 15th and 16th Sessions of the Working Party on Billfish*

185. The WPB **THANKED** the IOTC Secretariat for hosting the 14th Session of the WPB and commended the Secretariat on the warm welcome, the excellent facilities and assistance provided for the organisation and running of the Session.

186. The WPB **AGREED** on the importance of having IOTC working party meetings within key CPCs catching species of relevance to the working party, in this case on billfish. Following a discussion on who would host the 15th and 16th sessions of the WPB in 2017 and 2018 respectively, the WPB **REQUESTED** that the IOTC Secretariat will later identify candidate CPCs to determine if they would be able to host the 15th / 16th Sessions. The WPB should continue to be held in conjunction with the Working Party on Ecosystems and Bycatch: the meeting locations will be communicated by the IOTC Secretariat to the SC for its consideration at its next session to be held in December 2016 (Table 17).

Table 17. Draft meeting schedule for the WPB (2017 and 2018)

	2017			**2018**		
Meeting	**No.**	**Date**	**Location**	**No.**	**Date**	**Location**
Working Party on **Billfish** (WPB)	15th	11-15 September (5d)	Seychelles (TBC)	16th	4-8 September (5d)	To be identified
Working Party on **Ecosystems and Bycatch** (WPEB)	13th	5-9 September (5d)	Seychelles (TBC)	14th	10-14 September (5d)	To be identified

187. 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.

10.2 *Review of the draft, and adoption of the Report of the 14th Session of the Working Party on Billfish*

188. The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB14, 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 2016 (Fig. 8):

- 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

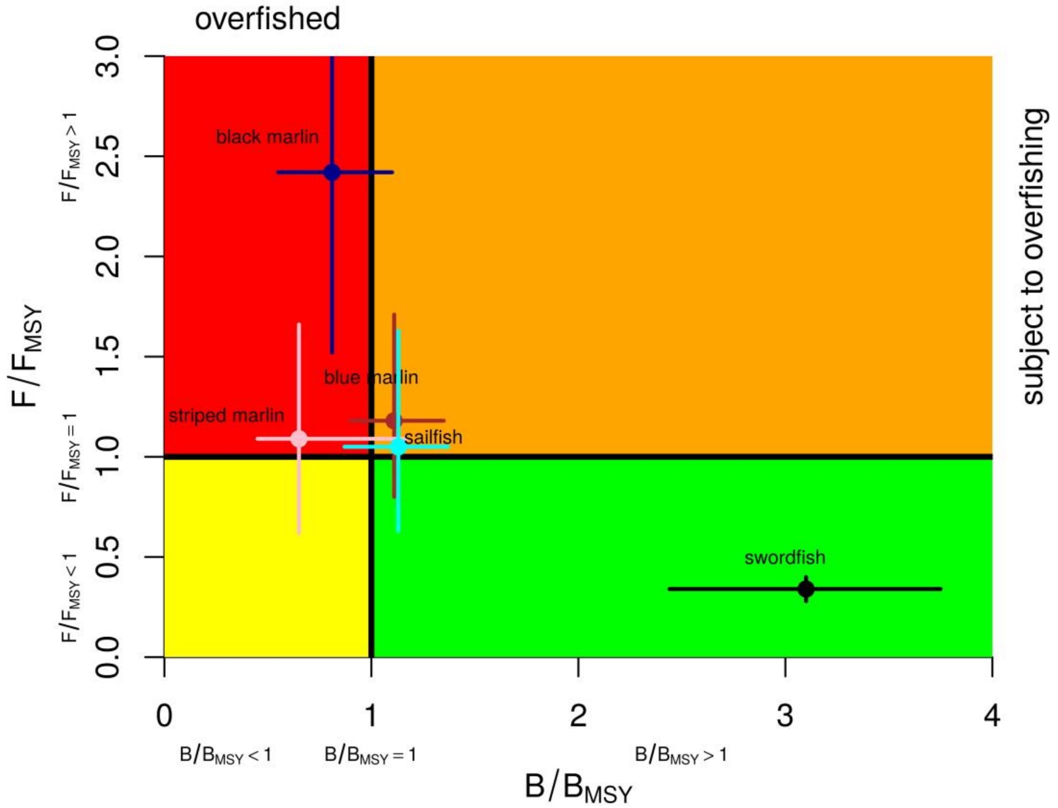

Fig. 8. Combined Kobe plot for swordfish (black), indo-pacific sailfish (cyan), black marlin (light blue), blue marlin (brown) and striped marlin (pink) showing the 2015 and 2016 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

189. The report of the 14th Session of the Working Party on Billfish (IOTC–2016–WPB14–R) was **ADOPTED** on the 10th of September 2016

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APPENDIX I
LIST OF PARTICIPANTS

Chairperson

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APPENDIX II
AGENDA FOR THE 14TH WORKING PARTY ON BILLFISH

Date: 6–10 September 2016
Location: Mahe, Seychelles
Venue: STC conference centre, Victoria
Time: 09:00 – 17:00 daily
Chair: Dr Tsutomu Nishida (Japan); **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**
   - 3.1 Outcomes of the 18th Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 20th Session of the Commission (IOTC Secretariat)
   - 3.3 Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat)
   - 3.4 Progress on the recommendations of WPB13 (IOTC Secretariat)

4. **NEW INFORMATION ON FISHERIES AND ASSOCIATED ENVIRONMENTAL DATA FOR BILLFISH**
   - 4.1 Review of the statistical data available for billfish (IOTC Secretariat)
   - 4.2 Review new information on fisheries and associated environmental data (general CPC papers)
   - 4.3 New information on sport fisheries (all)

5. **SWORDFISH**
   - 5.1 Review new information on swordfish biology, stock structure, fisheries and associated environmental data (all)
   - 5.2 Review of new information on the status of swordfish (all)
     - Nominal and standardised CPUE indices
     - Selection of Stock Status indicators for swordfish
   - 5.3 Development of management advice for swordfish and update of swordfish Executive Summary for the consideration of the Scientific Committee (all)

6. **MARLINS (Priority species for 2016: Black marlin & Blue marlin)**
   - 6.1 Review new information on marlin biology, stock structure, fisheries and associated environmental data (all)
   - 6.2 Review of new information on the status of marlins (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for marlins
   - 6.3 Development of management advice for marlins and update of marlin species Executive Summaries for the consideration of the Scientific Committee (all)

7. **INDO-PACIFIC SAILFISH**
   - 7.1 Review new information on I.P. sailfish biology, stock structure, fisheries and associated environmental data (all)
   - 7.2 Review of new information on the status of IP sailfish (all)
     - Nominal and standardised CPUE indices
     - Selection of Stock Status indicators for IP sailfish
   - 7.3 Development of management advice for IP sailfish and update of IP sailfish species Executive Summaries for the consideration of the Scientific Committee (all)

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

9. WPB PROGRAM OF WORK

9.1 Revision of the WPB Program of Work (2017–2021) (Chairperson and IOTC Secretariat)

9.2 Development of priorities for an Invited Expert at the next WPB meeting (Chairperson)

10. OTHER BUSINESS

10.1 Date and place of the 15th and 16th Sessions of the Working Party on Billfish (Chairperson and IOTC Secretariat)

10.2 Review of the draft, and adoption of the Report of the 14th Session of the Working Party on Billfish (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2016–WPB14–01a	Agenda of the 14th Working Party on Billfish	✓(10 February 2016) ✓(5 August 2016)
IOTC–2016–WPB14–01b	Annotated agenda of the 14th Working Party on Billfish	✓(5 August 2016) ✓(4 September 2016)
IOTC–2016–WPB14–02	List of documents of the 14th Working Party on Billfish	✓(5 August 2016) ✓(8 September 2016)
IOTC–2016–WPB14–03	Outcomes of the 18th Session of the Scientific Committee (IOTC Secretariat)	✓(11 August 2016)
IOTC–2016–WPB14–04	Outcomes of the 20th Session of the Commission (IOTC Secretariat)	✓(11 August 2016)
IOTC–2016–WPB14–05	Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat)	✓(11 August 2016)
IOTC–2016–WPB14–06	Progress made on the recommendations and requests of WPB13 and SC18 (IOTC Secretariat)	✓(19 August 2016)
IOTC–2016–WPB14–07_Rev1	Review of the statistical data and fishery trends for billfish species (IOTC Secretariat)	✓(23 August 2016)
IOTC–2016–WPB14–08_Rev1	Revision of the WPB Program of Work (2017–2021) (IOTC Secretariat)	✓(22 August 2016) ✓(25 August 2016)
IOTC–2016–WPB14–09_Rev1	Improvement in the core IOTC data management processes (IOTC Secretariat)	✓(22 August 2016) ✓(25 August 2016)
IOTC–2016–WPB14–10_Rev1	Environmental preferences of Billfish in Bay of Bengal: A case study in longline fishery of Sri Lanka (Rathnasuriya M.I.G., Gunasekara S.S., Haputhanthri S.S.K. and Rajapaksha J.K.)	✓(30 August 2016) ✓(2 September 2016)
IOTC–2016–WPB14–12	Update on the satellite tagging activities for billfish in Seychelles waters (Heyer G)	[Not provided]
IOTC–2016–WPB14–13	Fishery in Iran and a review on billfish by-catches of Industrial gillnet fishery (Rajaei F)	✓(21 August 2016)
IOTC–2016–WPB14–14	Catches of Billfishes by Malaysian tuna longliners in the Indian Ocean, 2012-2015 (Mohd Faizal E, Basir S and Jamon S)	✓(25 July 2016)
IOTC–2016–WPB14–15_Rev1	Catch of billfish by Thai tuna longliners during 2014 – 2015 (Wongkeaw A, Lirdwitayaprasit P and Luesrithawornsin P)	✓(20 August 2016) ✓(29 August 2016)
IOTC–2016–WPB14–16_Rev1	A preliminary analysis of swordfish (Xiphias gladius) habitat and behaviour on migratory track from Reunion Island to equatorial waters (Romanov E, Sabarros P.S., Le Foulgoc L and Bach P)	✓(22 August 2016) ✓(8 September 2016)
IOTC–2016–WPB14–17_Rev1	Bycatch of Istiophoridae species in French purse-seine fishery in the Indian Ocean (2005-2015) (Sabarros P.S., Cauquil P, Damiano A, Moec E and Bach P)	✓(23 August 2016) ✓(3 September 2016)
IOTC–2016–WPB14–18	Assessing the global genetic population structure and effective population size for the Black marlin (Williams S, Pepperell J and Ovenden J)	✓(21 August 2016)
IOTC–2016–WPB14–19_Rev1	CPUE standardization of black marlin exploited by Japanese tuna longline in the Indian Ocean (Yokoi et al.)	✓(27 August 2016) ✓(30 August 2016)
IOTC–2016–WPB14–20	CPUE standardization of black marlin (Makaira Indica) caught by Taiwanese longline fishery in the Indian Ocean using targeting effect derived from principle component analyses (Wang S-P)	✓(28 August 2016)
IOTC–2016–WPB14–21	Standardization of Catch per Unit of Effort (CPUE) of Black Marlin (Makaira Indica) Caught by Indonesian Tuna Longline Fishery in the Eastern Indian Ocean (Setyadji B and Andrade H)	✓(11 August 2016)

Document	**Title**	**Availability**
IOTC–2016–WPB14–22	CPUE standardization of blue marlin exploited by Japanese tuna longline in the Indian Ocean (Yokoi et al.)	✓(23 August 2016)
IOTC–2016–WPB14–23	CPUE standardization of blue marlin (*Makaira nigricans*) caught by Taiwanese longline fishery in the Indian Ocean using targeting effect derived from principle component analyses (Wang S-P)	✓(28 August 2016)
IOTC–2016–WPB14–24_Rev1	Stock assessments of black marlin in the Indian Ocean using ASPIC (Yokoi et al)	✓(28 August 2016) ✓(31 August 2016)
IOTC–2016–WPB14–25_Rev1	Stock assessment of blue marlin (*Makaira nigricans*) in the Indian Ocean using Stock Synthesis (Wang S-P and Huang B-Q)	✓(31 August 2016) ✓(1 September 2016)
IOTC–2016–WPB14–26	Stock assessments of blue marlin in the Indian Ocean using ASPIC (Nishida et al)	✓(22 August 2016)
IOTC–2016–WPB14–27	Preliminary stock assessment of blue marlin (*Makaira nigricans*) caught in the Indian Ocean using a Bayesian state-space production model (Andrade H.A.)	✓(4 September 2016)
IOTC–2016–WPB14–28	Preliminary stock assessment of black marlin (*Makaira indica*) caught in the Indian Ocean using a Bayesian state-space production model	✓(6 September 2016)
Information papers		
IOTC–2016–WPB14–INF01	A preliminary summary of billfish tagging in the Indian Ocean (Romanov E)	✓(8 September 2016)
Data sets		
IOTC–2016–WPB14–DATA01	Billfish datasets available	✓(1 August 2016) ✓(8 August 2016) ✓(11 August 2016) ✓(16 August 2016)
IOTC–2016–WPB14–DATA02	IOTC Species data catalogues – availability of datasets	✓(2 August 2016)
IOTC–2016–WPB14–DATA03	Data for Stock Assessment of Blue and Black Marlins	✓(1 August 2016)
IOTC–2016–WPB14–DATA04	Standardization of Blue marlin CPUE by Taiwanese longline fishery in the Indian Ocean	✓(1 August 2016)
IOTC–2016–WPB14–DATA05	Standardization of Black marlin CPUE by Taiwanese longline fishery in the Indian Ocean	✓(8 August 2016)
IOTC–2016–WPB14–DATA06	Standardization of Blue marlin CPUE by Japanese longline fishery in the Indian Ocean	✓(3 August 2016)
IOTC–2016–WPB14–DATA07	Standardization of Black marlin CPUE by Japanese longline fishery in the Indian Ocean	✓(8 August 2016)
IOTC–2016–WPB14–DATA07b	Standardization of Black marlin CPUE by Indonesian longline fishery in the Indian Ocean	✓(8 August 2016)
IOTC–2016–WPB14–DATA08	Nominal Catches per Fleet, Year, Gear, IOTC Area and species	✓(1 August 2016)
IOTC–2016–WPB14–DATA09	Catch and Effort - Longline	✓(1 August 2016)
IOTC–2016–WPB14–DATA10	Catch and Effort - vessels using pole and lines or purse seines	✓(1 August 2016)
IOTC–2016–WPB14–DATA11	Catch and Effort - Coastal	✓(1 August 2016)
IOTC–2016–WPB14–DATA12	Catch and Effort - all vessels	✓(1 August 2016)
IOTC–2016–WPB14–DATA13	Catch and Effort - reference	✓(1 August 2016)

APPENDIX IVA
MAIN STATISTICS OF BILLFISH

(*Extract from IOTC–2016–WPB14–07 Rev_1*)

Fisheries and catch trends for billfish species

- Main species:

  Indo-Pacific sailfish and swordfish 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 some billfish species – in terms of share of total catches of billfish – has changed over time (**Fig. 1c**), mostly as a result of changes to the number of longline vessels active in the Indian Ocean. 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 as much as 50% by the early-2000s. Catches of swordfish over the last decade have since declined back to around a third of total billfish catches, largely as a result of declines in the number of longline vessels operated by Taiwan,China. However in recent years the catches of swordfish are showing increasing trend.

  Large catches of marlins have also been recorded since 2012 from 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 number of longline fleets – namely Taiwan,China and European fleets[1] that now seem to be resuming fishing activities in their main fishing grounds.

- Main fleets (i.e., highest catches in recent years):

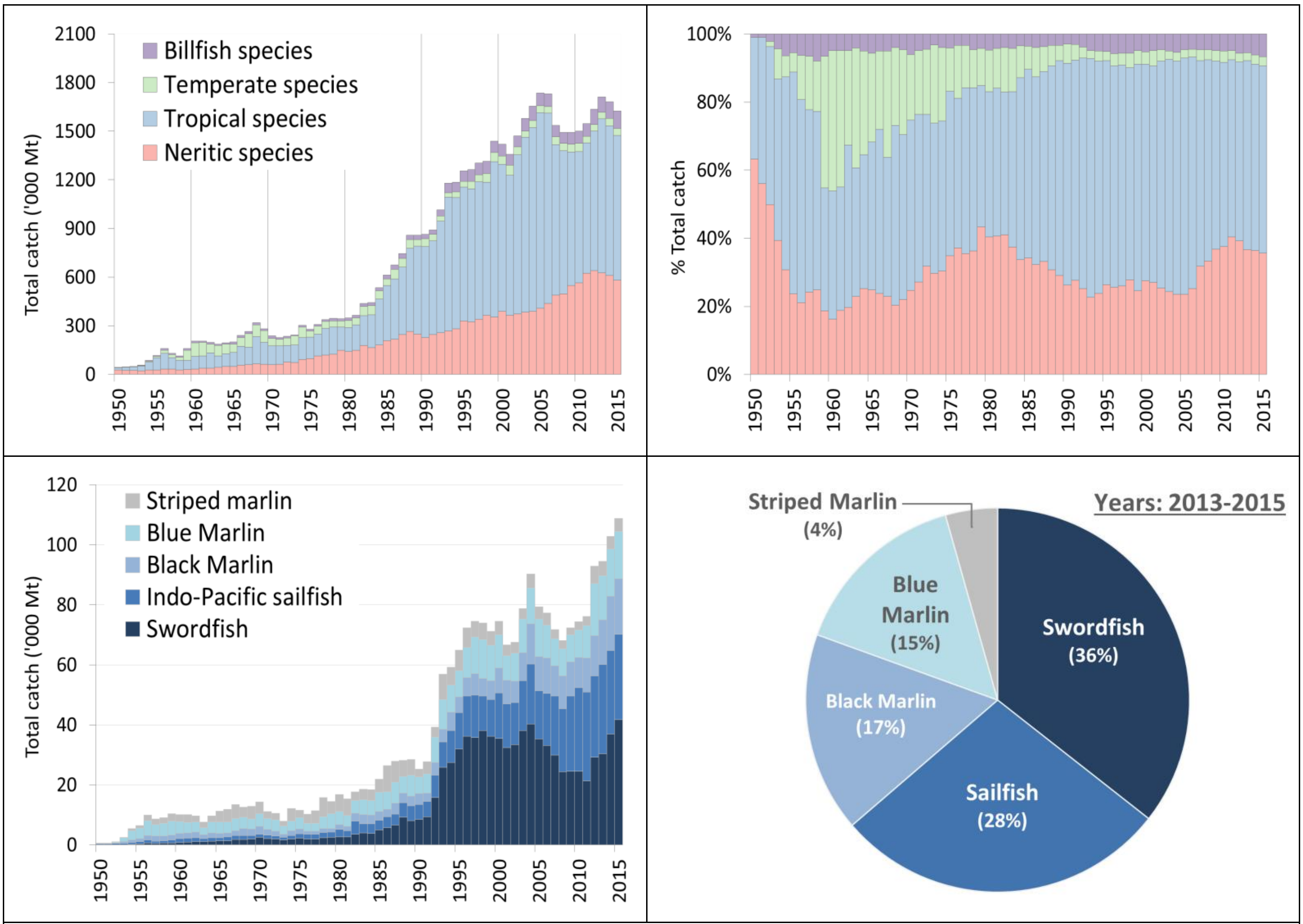
  In recent years six fleets (Indonesia, I.R. Iran, Taiwan,China, Sri Lanka, India and Pakistan) have reported over 75% of the total catches of billfish species from all IOTC fleets combined (Fig. 2a).

- 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 around 5% 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 annum have remained relatively stable at between 70,000 t and 75,000 t, however since 2012 catches over 90,000 t have been reported, with the highest catch of over 108,000 t in 2015 (with the largest increases reported by Indonesia, 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 1950–2015 (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, 1950–2015; d. Bottom right: share of billfish catch by species, 2013–15 average catch).

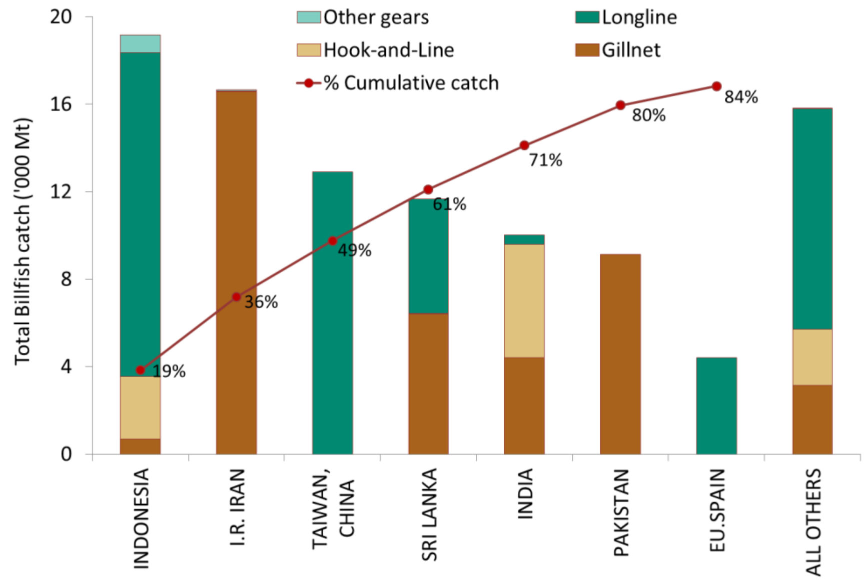


Fig. 2a: Billfish (all species): average catches in the Indian Ocean over the period 2013–15, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of all billfish species for the fleets concerned, over the total combined catches reported from all fleets and gears.

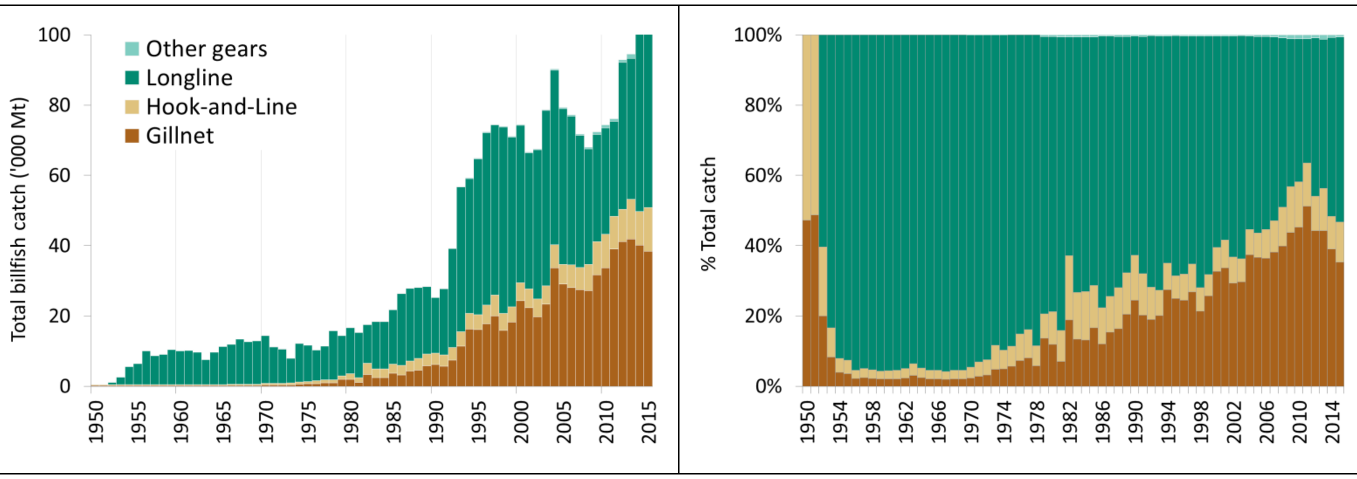


Fig. 2b-c: Billfish (all species): catches in the Indian Ocean over the period 1950–15, by gear. Fig 2b. Left: nominal catch of all billfish species, by gear; Fig. 2c. Right: percentage share of all billfish species catches, by gear.

APPENDIX IVB
MAIN STATISTICS OF BLACK MARLIN

(*Extract from IOTC–2016–WPB14–07 Rev_1*)

Fisheries and main catch trends

- Main fishing gear (2012–15): black marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for around 51% of total catches in the Indian Ocean, followed by longlines (27%), with remaining catches recorded under troll and handlines. (**Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15): Iran (gillnet): 29%; India (gillnet and troll): 20%; Sri Lanka (gillnet and fresh longline): 19%; Indonesia (fresh longline and hand lines): 15% (**Fig. 2**).
- 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: Catches have increased steadily since the 1990s, from 2,800 t in 1991 to over 10,000 t since 2004. The highest catches were recorded in 2015, at over 18,000 t (**Table 1**) – 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. Discards may also occur in some gillnet fisheries.

Changes to the catch series**:** no major changes to the catch series since the WPB meeting in 2014, when catches were revised substantially following new reports of catches-by-species for drifting gillnet fleets by Iran[2].
Any differences in the data series since the last WPB are changes to the nominal catch as a result of reallocation of catches reported as other billfish species or as aggregated billfish species groups reported by, e.g., Sri Lanka, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates for black marlin.

TABLE 1. Black marlin: best scientific estimates of catches by type of fishery for the period 1950–2015 (in metric tons). Data as of August 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
LL	862	1661	1391	1727	1571	1985	2174	1921	3033	1839	1871	1978	2180	2641	4962	5349
GN	26	31	44	439	2761	6917	8458	6738	6227	6936	6071	7115	8495	8556	9735	8962
HL	24	27	42	447	745	1033	983	1060	1362	2146	1630	1865	2260	3031	2944	3745
OT	0	0	4	65	112	226	237	257	329	460	472	490	483	693	461	434
Total	**912**	**1,719**	**1,480**	**2,679**	**5,189**	**10,162**	**11,852**	**9,976**	**10,951**	**11,381**	**10,044**	**11,447**	**13,418**	**14,920**	**18,103**	**18,490**

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**).

[2] 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.

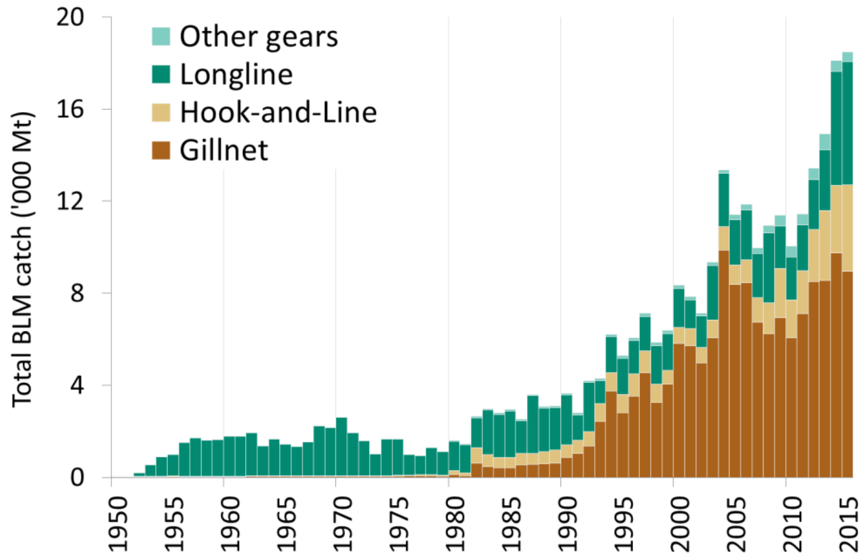


Fig. 1. Black marlin: catches by gear and year recorded in the IOTC Database (1950–2015). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

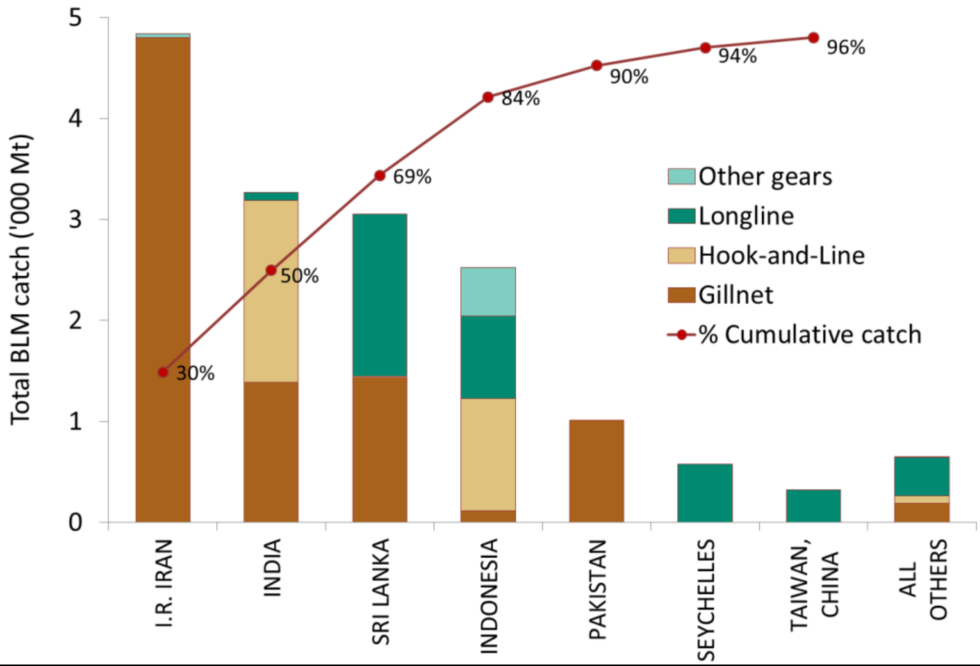


Fig. 2: Black marlin: average catches in the Indian Ocean over the period 2012–15, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of black marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

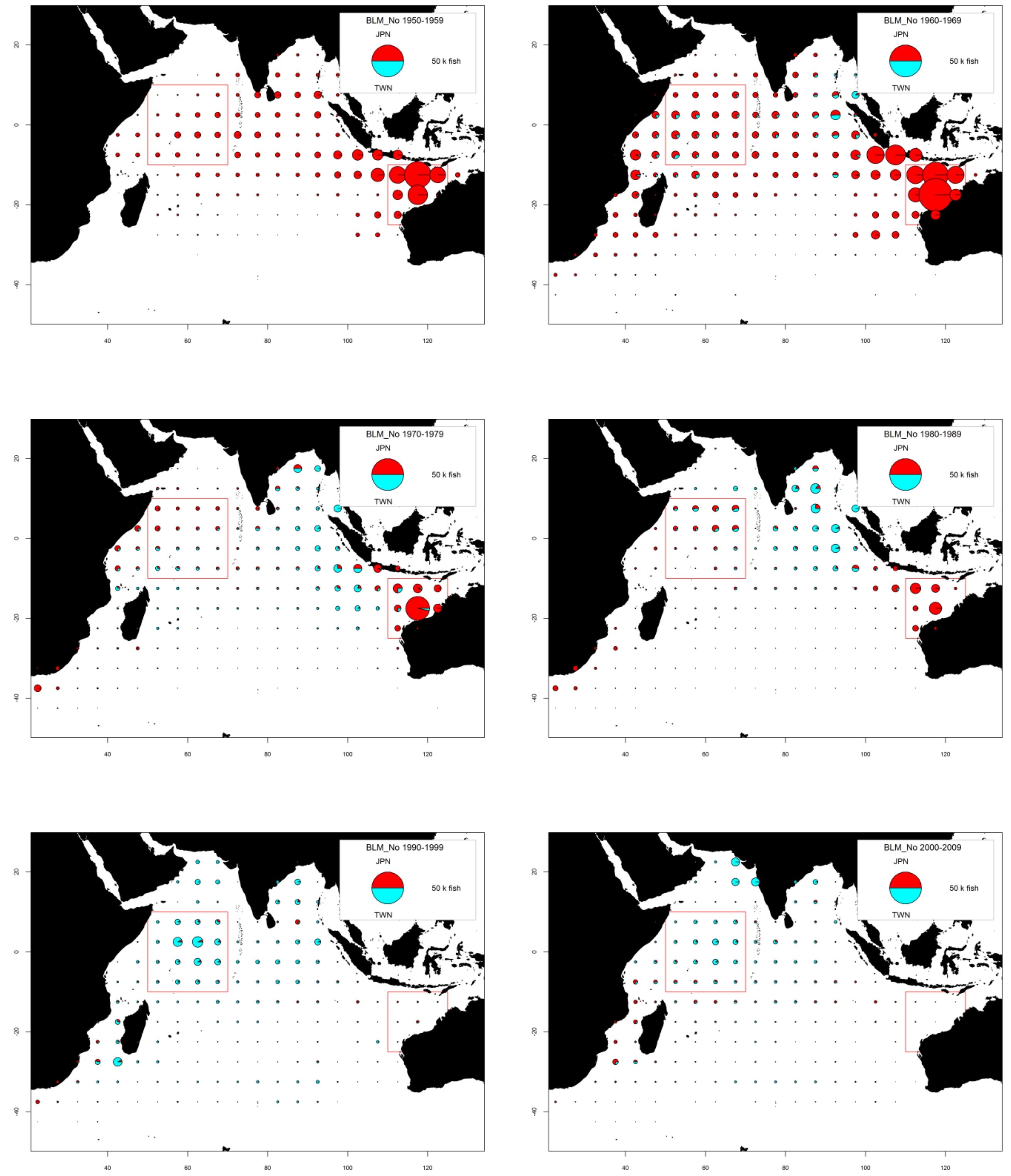


Fig. 3a-f. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch and effort data (unraised).

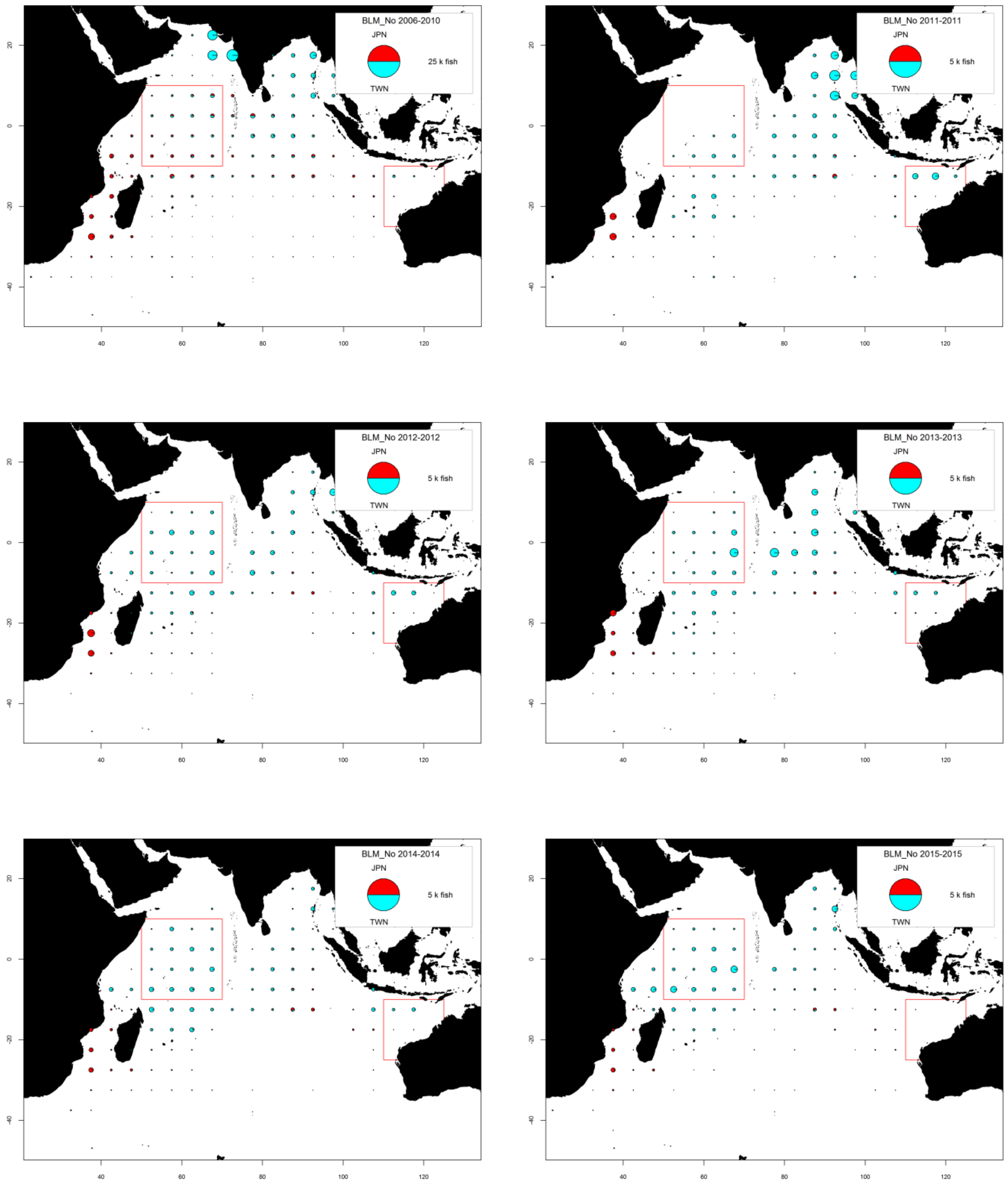


Fig. 4a-f. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2006–10 by fleet and for 2011–15, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch and effort data (unraised).

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 are (**Fig.5a**), 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, 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) 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.
- 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 black marlin available to the Secretariat.

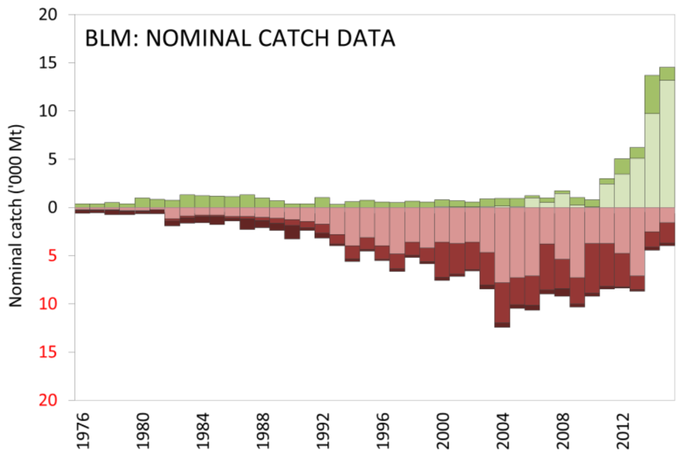
Black marlin – Nominal catch-per-unit-effort (CPUE) trends

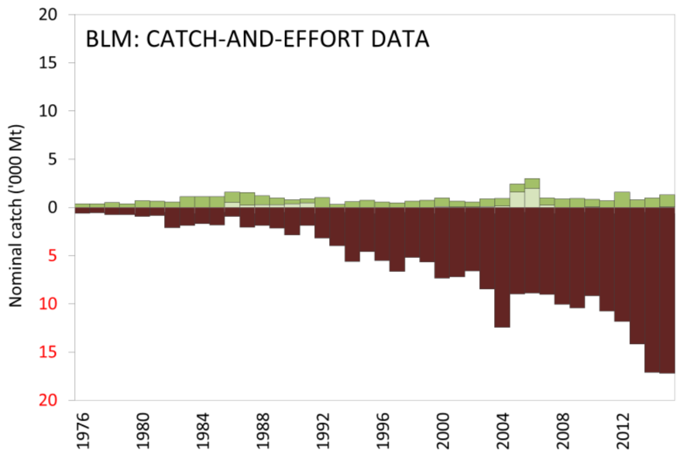
- Availability: Standardized CPUE series have not yet been developed for black marlin. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  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 Iran, Indonesia and Pakistan). Unreliable data from gillnet/longlines of Sri Lanka) or other industrial fisheries (NEI longliners and all purse seiners).
- 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 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 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.





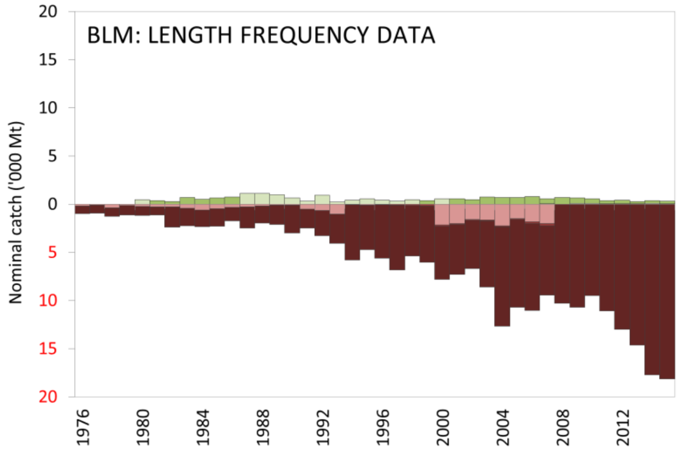


Fig. 5a-c. Black marlin: data reporting coverage (1976–2015).

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 2016.

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 BLUE MARLIN

(*Extract from IOTC–2016–WPB14–07 Rev_1*)

Fisheries and main catch trends

- Main fishing gear (2012–15): Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches[3] account for around 74% of total catches in the Indian Ocean, followed by gillnets (23%), with remaining catches recorded under troll and handlines. (**Table 1; Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15): Taiwan,China (longline): 33%; Indonesia (fresh longline): 28%; Pakistan (gillnet): 12%; I.R. Iran (gillnet): 9%, and Sri Lanka (6%) (**Fig. 2**).
- 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. The highest catches 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. Discards may also occur in some gillnet fisheries.

***Changes to the catch series*:** no major changes to the catch series since the WPB meeting in 2014, when catches were revised substantially following new reports of catches-by-species for drifting gillnet fleets by Iran[4].
Any differences in the data series since the last WPB are changes to the nominal catch as a result of reallocation of catches reported as other billfish species or as aggregated billfish species groups reported by, e.g., Sri Lanka, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates for blue marlin.

TABLE 1: Blue marlin: best scientific estimates of catches by type of fishery for the period 1950–2015 (in metric tons). Data as of August 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
LL	2,567	3,535	3,409	4,545	6,982	7,406	7,859	6,407	6,369	6,664	6,669	7,276	12,216	10,215	11,913	11,686
GN	1	2	124	760	2,357	2,687	2,977	2,559	2,410	2,049	2,198	3,148	4,828	4,059	3,539	3,671
HL	5	9	17	105	157	144	153	167	193	276	303	268	264	360	377	336
OT	0	0	0	2	4	7	8	8	11	15	15	16	16	17	15	14
Total	**2,574**	**3,546**	**3,550**	**5,412**	**9,500**	**10,245**	**10,996**	**9,142**	**8,982**	**9,004**	**9,185**	**10,708**	**17,324**	**14,652**	**15,844**	**15,706**

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**).

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

[4] 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.

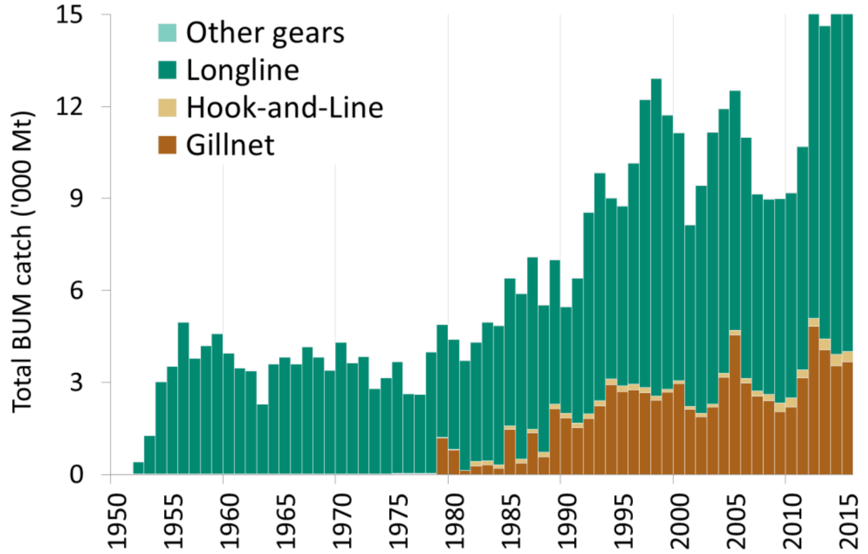


Fig. 1. Blue marlin: catches by gear and year recorded in the IOTC Database (1950–2015). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

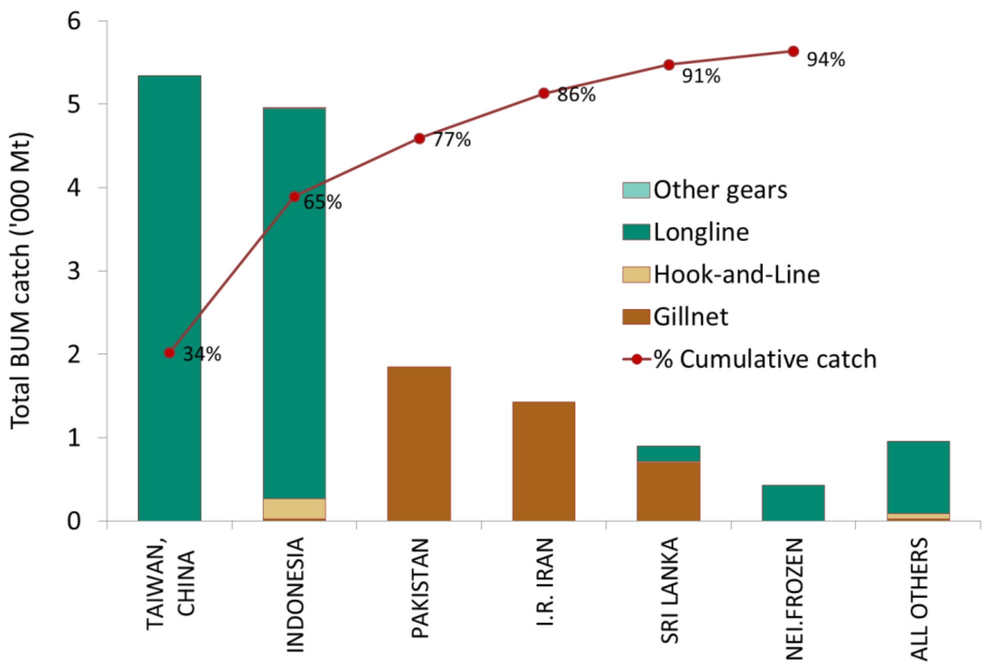


Fig. 2: Blue marlin: average catches in the Indian Ocean over the period 2012–15, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

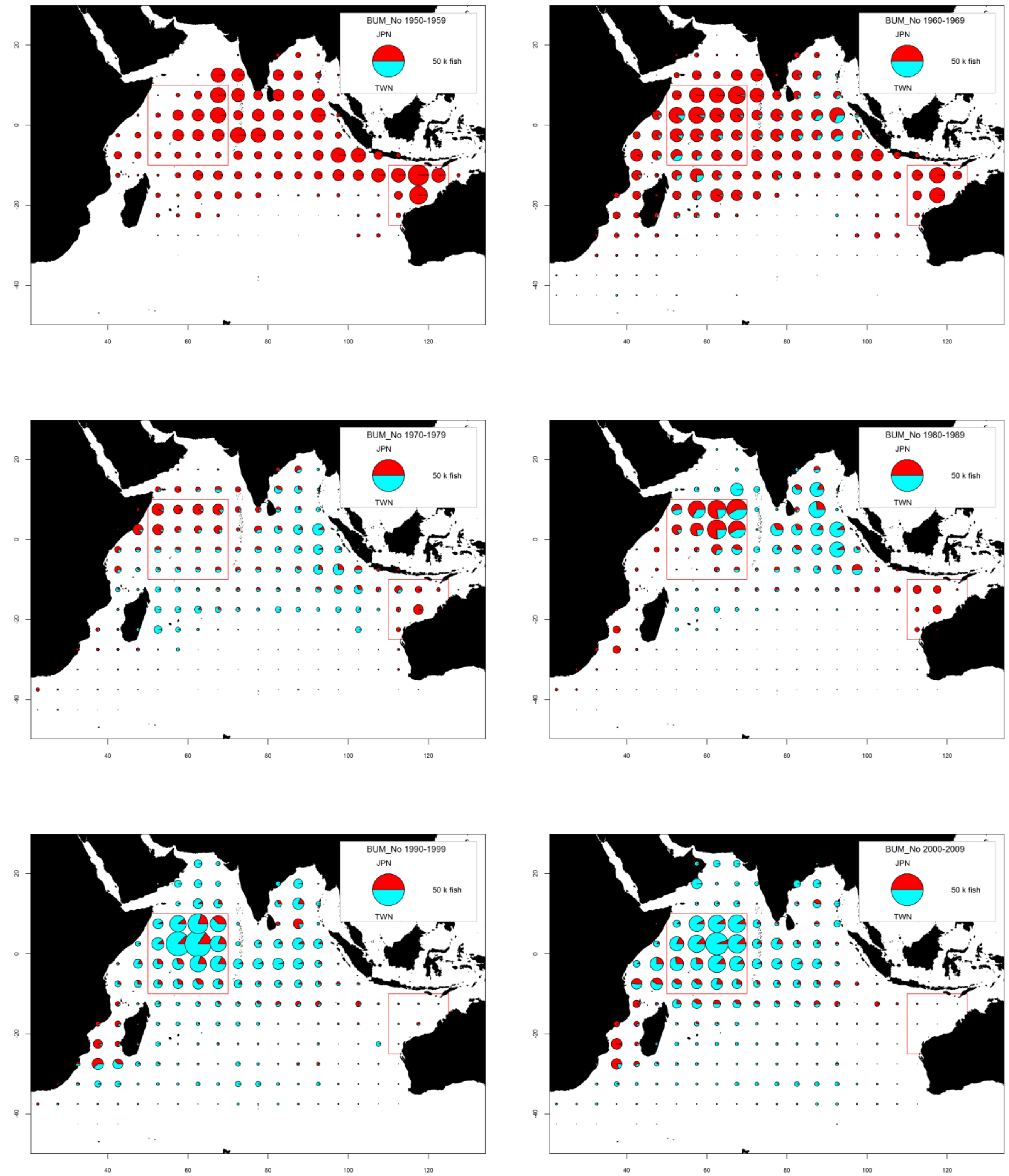


Fig. 3a-f. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950-2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch and effort data (unraised).

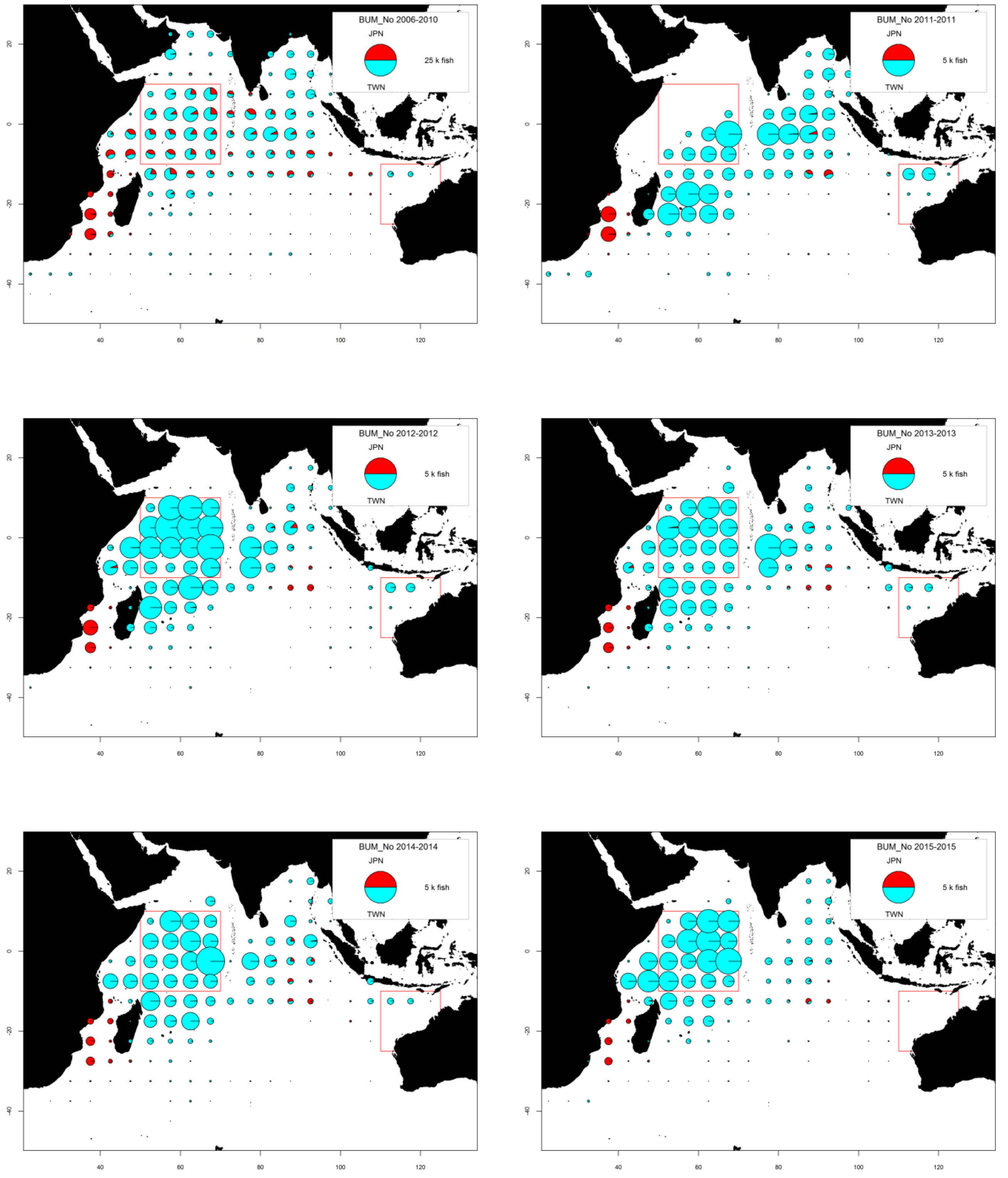


Fig. 4a-f. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2006–10 by fleet and for 2011–15, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch and effort data (unraised).

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.5a**), 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, 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) 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.

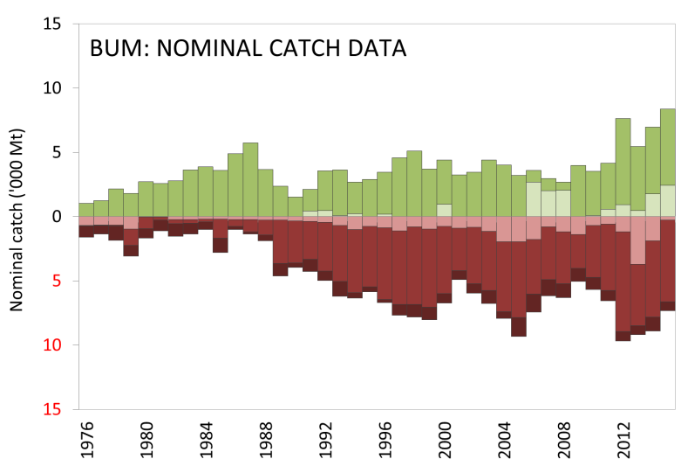
Blue marlin – Nominal catch-per-unit-effort (CPUE) trends

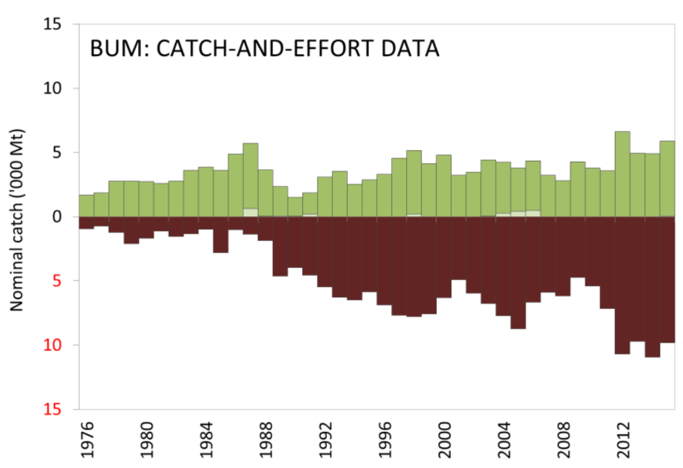
- Availability: Standardized CPUE series have not yet been developed. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  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 Iran and 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 are likely to be.
- 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.





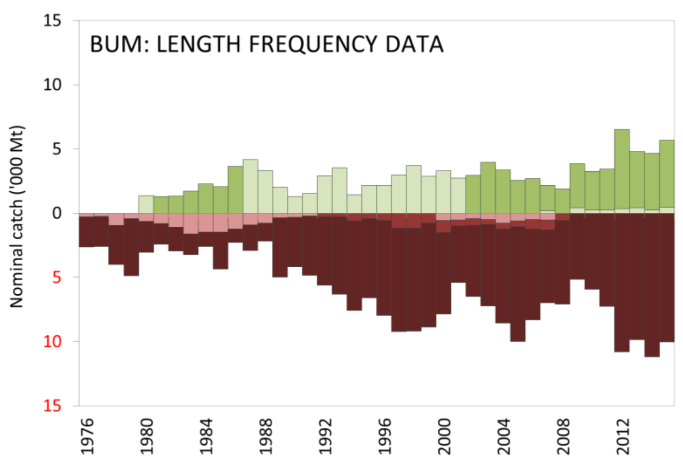


Fig. 5a-c. Blue marlin: data reporting coverage (1976–2015).

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 2016.

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

(dark 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 IVD
MAIN STATISTICS OF STRIPED MARLIN

(*Extract from IOTC–2016–WPB14–07 Rev_1*)

Fisheries and main catch trends

- Main fishing gear (2012–15): striped marlin are largely considered to be a non-target species of industrial fisheries. Longlines account for around 69% of total catches in the Indian Ocean, followed by gillnets (24%), with remaining catches recorded under troll and handlines. (**Table 1, Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  Indonesia (drifting longline and coastal longline): 36%; Taiwan,China (drifting longline): 24%; I.R. Iran (gillnet): 14%; and Pakistan (gillnet): 8% (**Fig. 2**).
- 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 2**), 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. Catches of striped marlin have since increased in 2012 and 2013, as longline vessels have resumed operations in the north-west Indian Ocean.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Discards may also occur in the driftnet fishery of the I.R of Iran, as this species has no commercial value in this country.

***Changes to the catch series*:** no major changes to the catches series since the WPB meeting in 2015.

TABLE 1: Striped marlin: best scientific estimates of catches by type of fishery for the period 1950–2015 (in metric tons). Data as of August 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
LL	1,028	3,104	3,458	5,144	5,120	2,922	3,038	2,356	2,117	1,679	2,096	2,253	4,539	3,242	2,640	2,843
GN	5	8	16	22	161	541	807	479	389	407	331	542	978	1,182	1,241	1,262
HL	3	5	10	32	70	136	142	152	196	273	282	292	288	333	290	266
OT	0	0	0	6	10	20	21	23	29	41	42	44	43	48	41	39
Total	**1,036**	**3,117**	**3,485**	**5,204**	**5,360**	**3,618**	**4,008**	**3,010**	**2,731**	**2,400**	**2,751**	**3,131**	**5,848**	**4,806**	**4,212**	**4,410**

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 2: Striped marlin: best scientific estimates of catches by fishing area for the period 1950–2014 (in metric tons). Data as of August 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NW	335	1,859	1,516	2,073	2,713	1,803	2,147	1,968	1,310	1,174	828	741	962	3,589	2,800	2,101
SW	9	124	159	162	659	244	177	199	157	124	224	299	557	363	309	181
NE	551	810	1,542	2,758	1,617	1,334	1,471	1,625	1,444	1,335	1,265	1,491	1,534	1,826	1,728	1,723
SE	141	324	268	211	372	230	317	199	88	80	71	178	101	37	46	45
Total	**1,036**	**3,117**	**3,485**	**5,204**	**5,361**	**3,612**	**4,112**	**3,990**	**2,999**	**2,714**	**2,389**	**2,708**	**3,154**	**5,815**	**4,882**	**4,049**

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

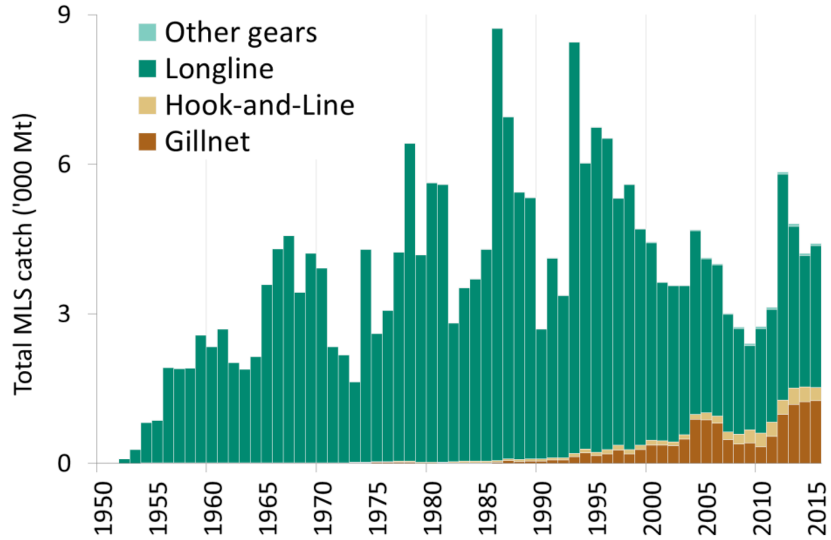


Fig. 1. Striped marlin: catches by gear and year recorded in the IOTC Database (1950–2015). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

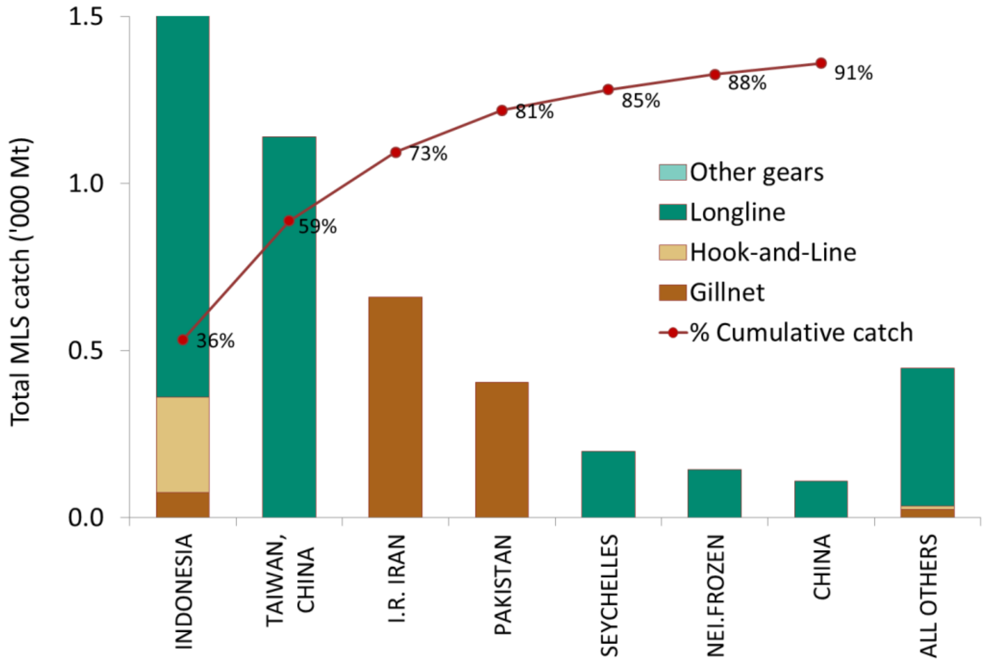


Fig. 2: Striped marlin: average catches in the Indian Ocean over the period 2012–15, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

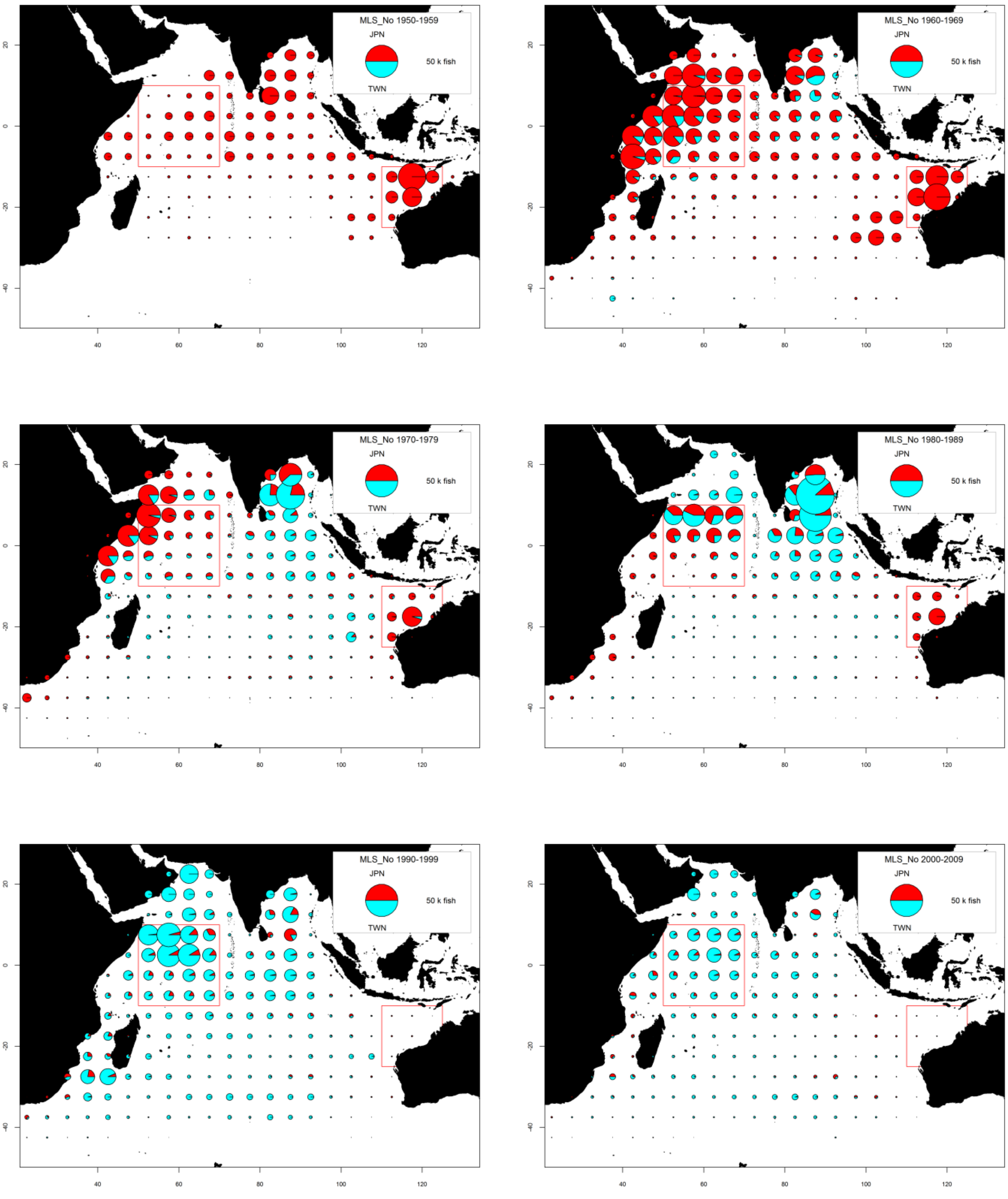


Fig. 3a-f. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch and effort data (unraised).

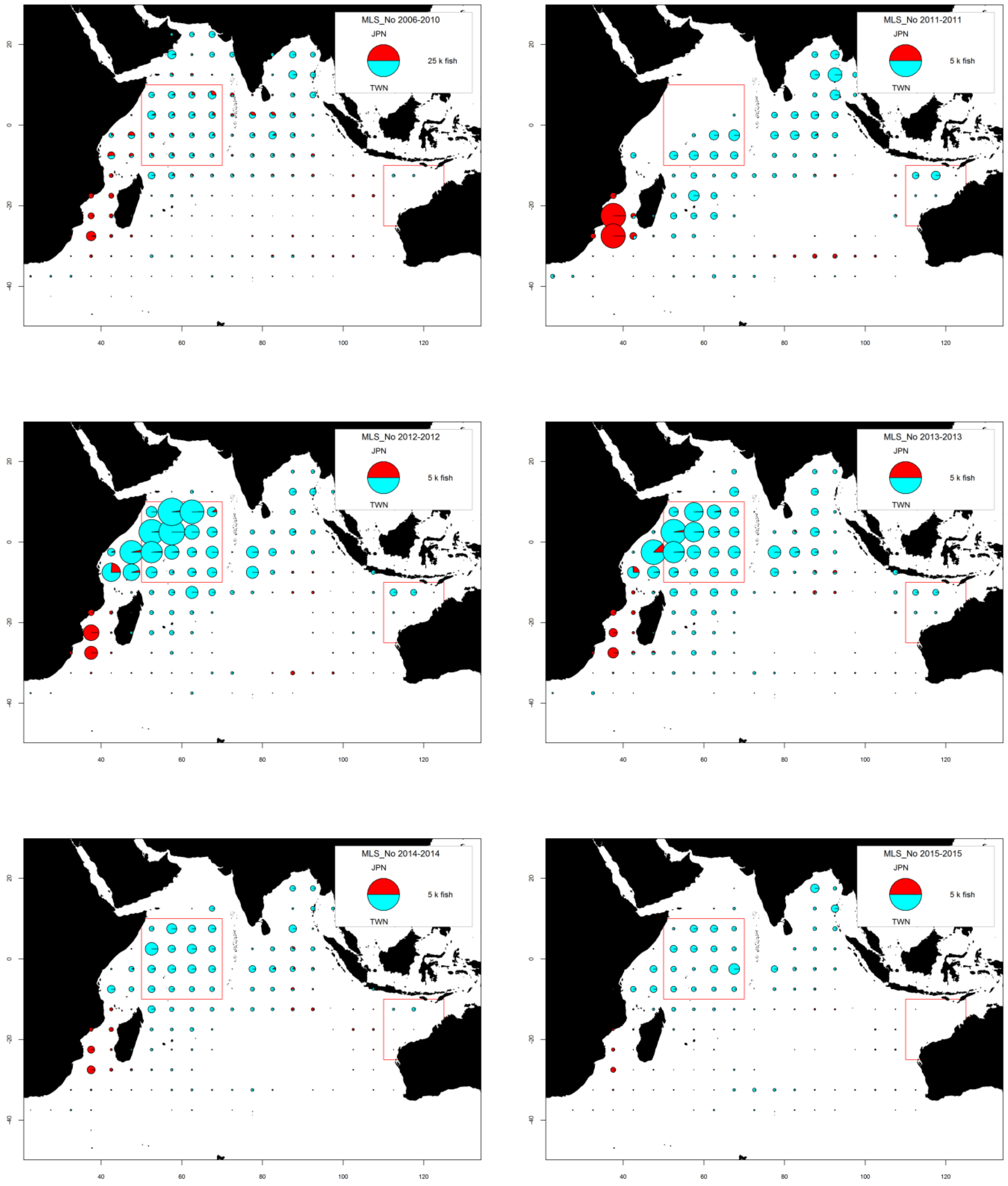


Fig. 4a-f. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2006–10 by fleet and for 2011–15, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

Source: IOTC catch and effort data (unraised).

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.5a**), 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 (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. Catches of striped marlin reported by fleets using gillnets have been relatively low over the entire time-series (i.e., between 500 t and 1,400 t in recent years); however the recent data appears to indicate that gillnet catches of striped marlin in Pakistan may be much higher than those officially reported – although a comprehensive review of the catch series is required to confirm the catch levels for this species.
- Species mis-identification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of striped marlin available to the Secretariat.

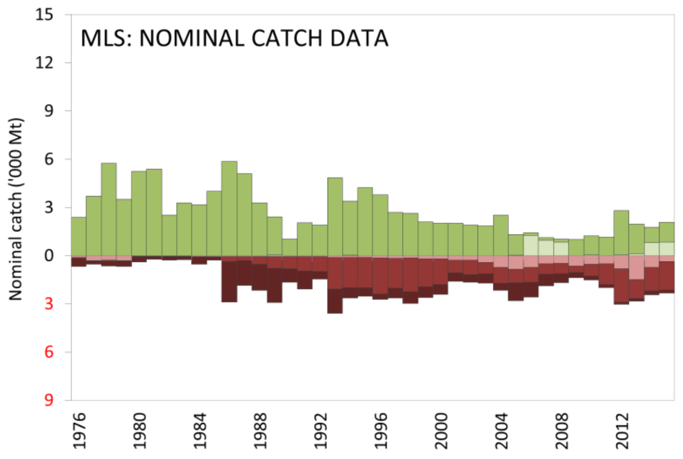
Striped marlin – Nominal catch-per-unit-effort (CPUE) trends

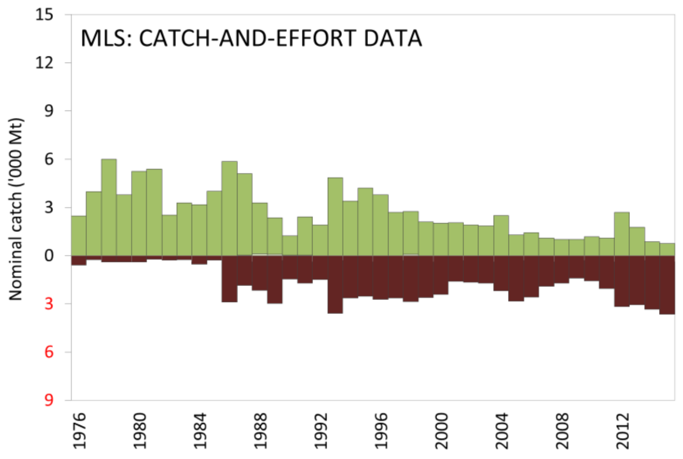
- Availability: Standardized CPUE series have been developed for the Japanese and Taiwanese longline fleets. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  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 (gillnet fisheries of Iran and Pakistan, gillnets of 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.





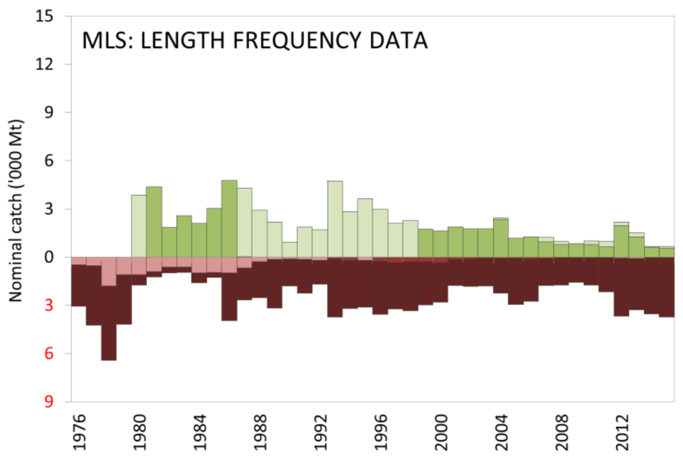


Fig. 5a-c. Striped marlin: data reporting coverage (1976–2015).

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 2016.

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

(light green)	Total score is 0 (or average score is 0-1)
(pale 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 INDO-PACIFIC SAILFISH

(*Extract from IOTC–2016–WPB14–07 Rev_1*)

Fisheries and main catch trends

- Main fishing gear (2012–2015): gillnets account for around 75% of total catches in the Indian Ocean, followed by troll and hand lines (18%), with remaining catches recorded under longlines and other gears (**Fig. 1**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  Three quarters of the total catches of Indo-Pacific sailfish are accounted for by four countries situated in the Arabian Sea: Iran (gillnet): 31%; Pakistan (gillnet): 18%; India (gillnet and troll): 17%; and Sri Lanka (gillnet and fresh longline): 10% (**Fig. 2**).

  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 Sea).
- 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 1**) – 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 over 11,000 t since 2014.

  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 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, mainly longliners.

Changes to the catch series**:** no major changes to the catch series since the WPB meeting in 2015[5].

TABLE 1: Indo-Pacific sailfish: best scientific estimates of catches by type of fishery for the period 1950–2015 (in metric tons). Data as of August 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
LL	297	804	385	257	1,400	1,417	1,309	2,165	2,534	1,257	656	449	698	903	1,806	1,476
GN	165	181	508	1,827	6,056	12,503	11,712	13,417	13,863	18,305	21,037	23,393	21,229	22,988	21,961	20,815
HL	171	213	456	1,427	2,477	3,930	4,197	4,024	4,445	5,410	5,999	5,477	5,048	5,579	3,920	6,004
OT	-	-	2	26	41	85	88	95	134	171	175	184	180	275	171	161
Total	**633**	**1,197**	**1,351**	**3,537**	**9,974**	**17,936**	**17,306**	**19,701**	**20,976**	**25,143**	**27,867**	**29,502**	**27,155**	**29,745**	**27,858**	**28,455**

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**).

[5] Any differences in the data series since the last WPB are changes to the nominal catch as a result of reallocation of catches reported as other billfish species or as aggregated billfish species groups reported by, e.g., Sri Lanka, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates for Indo-Pacific sailfish.

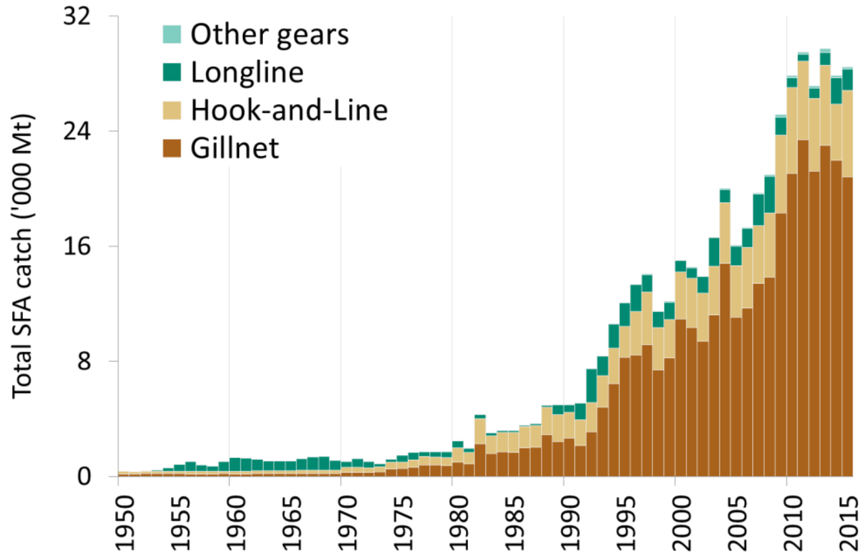


Fig. 1. Indo-Pacific sailfish: catches by gear and year recorded in the IOTC Database (1950–2015). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

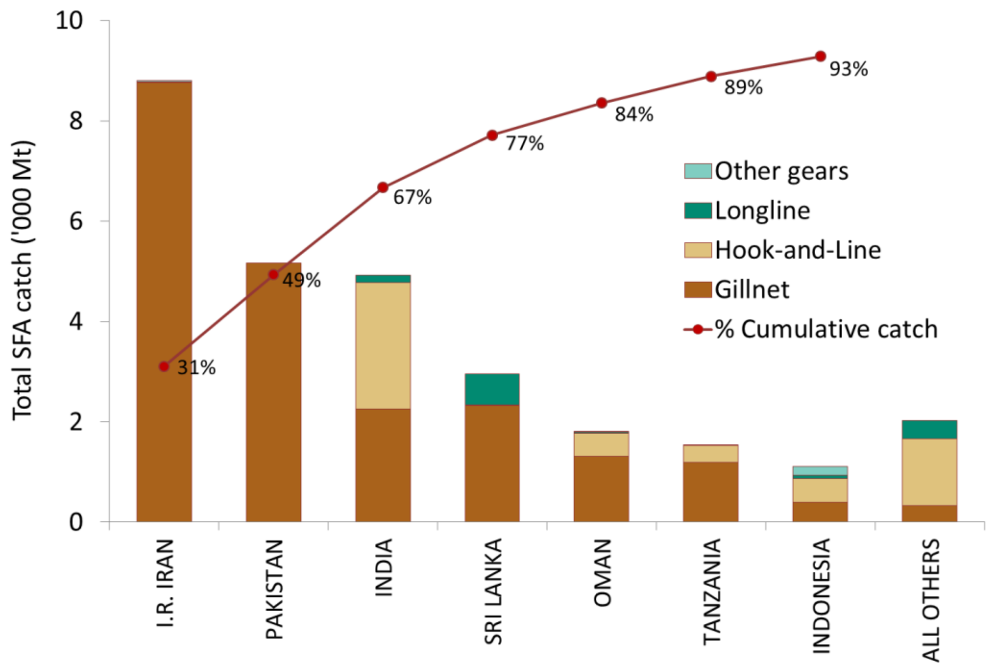


Fig. 2: Indo-Pacific sailfish: average catches in the Indian Ocean over the period 2012–15, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

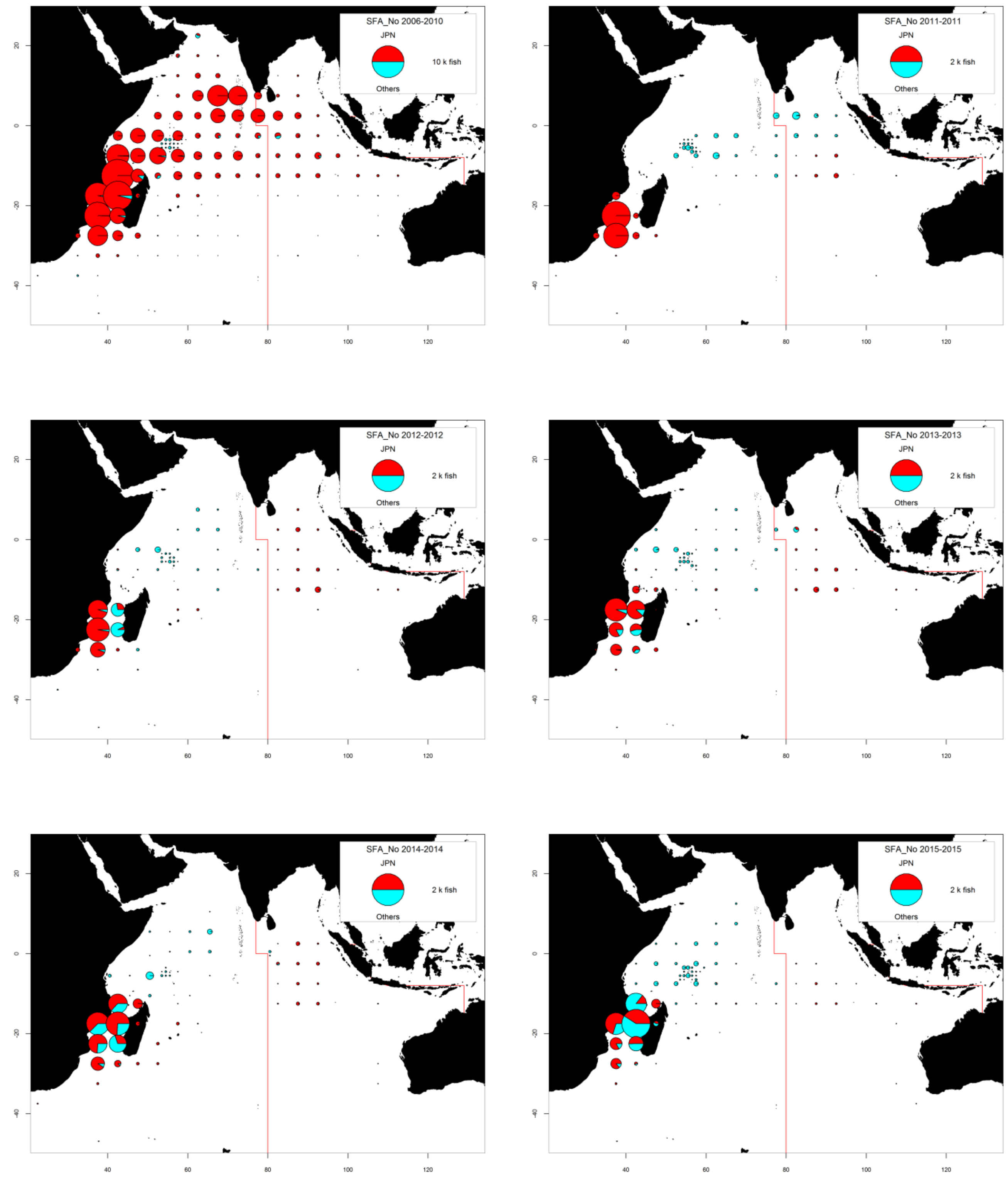


Fig. 3a-f. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2006–10, by fleet and for 2011–15, by year and fleet. Red lines represent the IOTC Areas.

Source: IOTC catch and effort data (unraised).

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.4a**), 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).

- 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 Indo-Pacific sailfish is not a target species.

- Missing or incomplete catches: catches are likely to be incomplete for some artisanal fisheries (e.g. gillnets of Pakistan, pole and lines of Maldives) 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

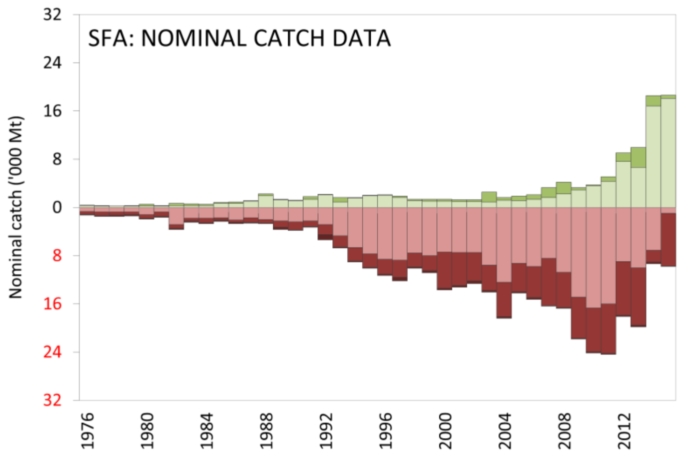
- Availability: Standardized and nominal CPUE series have not yet been developed. No catch and effort data are available from sports fisheries, other than partial data from the sports fisheries of Kenya; or other artisanal fisheries (e.g., I.R. Iran and Pakistan (gillnet), Sri Lanka (gillnet-longline),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

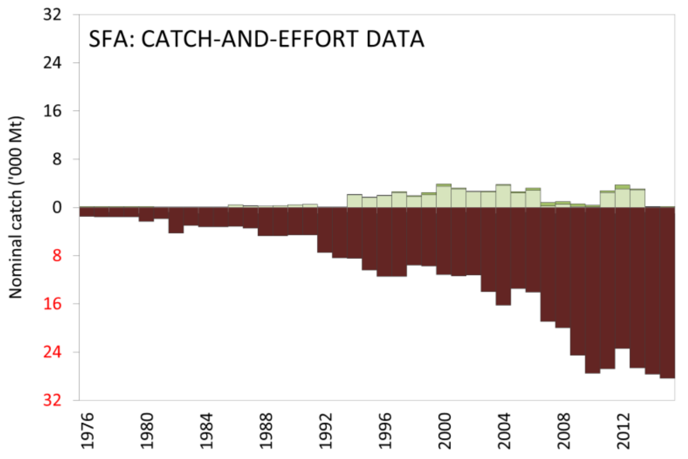
Indo-Pacific sailfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- 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.





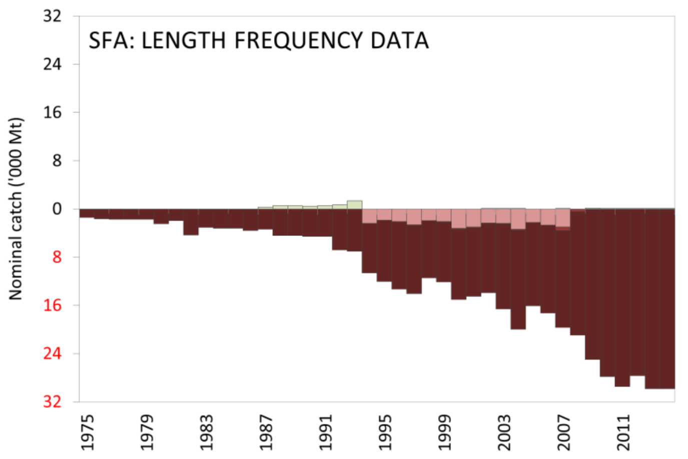


Fig. 4a-c. Indo-Pacific sailfish: data reporting coverage (1976–2015).

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 2016.

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 SWORDFISH

(*Extract from IOTC–2016–WPB14–07 Rev_1*)

Fisheries and main catch trends

- Main fishing gear (2012–15): Longline catches[6] are currently estimated to comprise approximately 85% of total swordfish catches in the Indian Ocean. (**Table 1; Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
Indonesia (fresh longline): 20%;Taiwan,China (longline): 17%; Sri Lanka (longline-gillnet): 12%;; EU,Spain (swordfish targeted longline): 12% (**Fig. 1**).
- Main fishing areas: Primary: Western Indian Ocean, in waters off Somalia, and the southwest Indian Ocean. In recent years (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[7]).

  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. Discards of may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

Changes to the catch series**:** no major changes to the catch series since the WPB meeting in 2015.

TABLE 1. Swordfish: best scientific estimates of catches by type of fishery for the period 1950–2015 (in metric tons). Data as of August 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
ELL	-	-	-	9	1,841	9,785	12,946	10,996	7,655	7,637	9,031	6,835	7,643	7,876	7,419	6,526
LL	260	1,301	1,920	4,313	22,692	20,085	17,227	16,123	13,511	13,810	12,419	10,976	17,466	17,186	24,134	29,789
OT	37	39	186	807	1,989	2,819	2,936	2,809	3,261	3,019	3,033	3,560	4,068	5,286	5,289	5,445
Total	**297**	**1,340**	**2,106**	**5,130**	**26,521**	**32,689**	**33,108**	**29,928**	**24,427**	**24,466**	**24,483**	**21,370**	**29,177**	**30,349**	**36,842**	**41,760**

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**).

[6] Including deep freezing longline (LL), exploratory longline (LLEX), fresh longline (FLL), longlines targeting sharks (SLL), and swordfish targeted longline (ELL).
[7] E.g., Senegal, Guinea, etc.

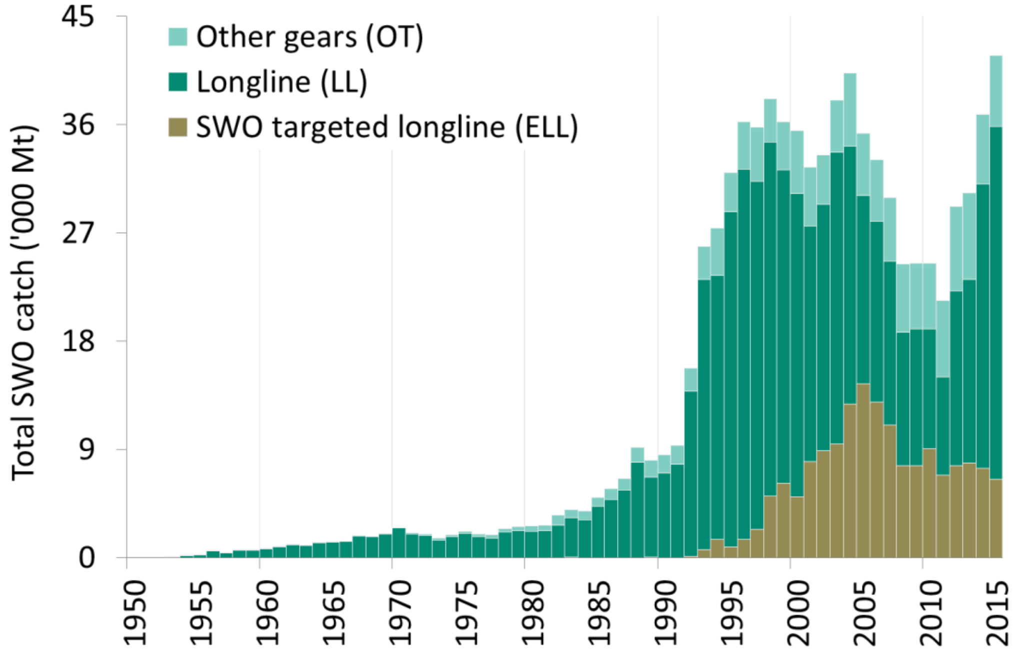


Fig. 1. Swordfish: catches by gear and year recorded in the IOTC Database (1950–2015).
Other gears includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.

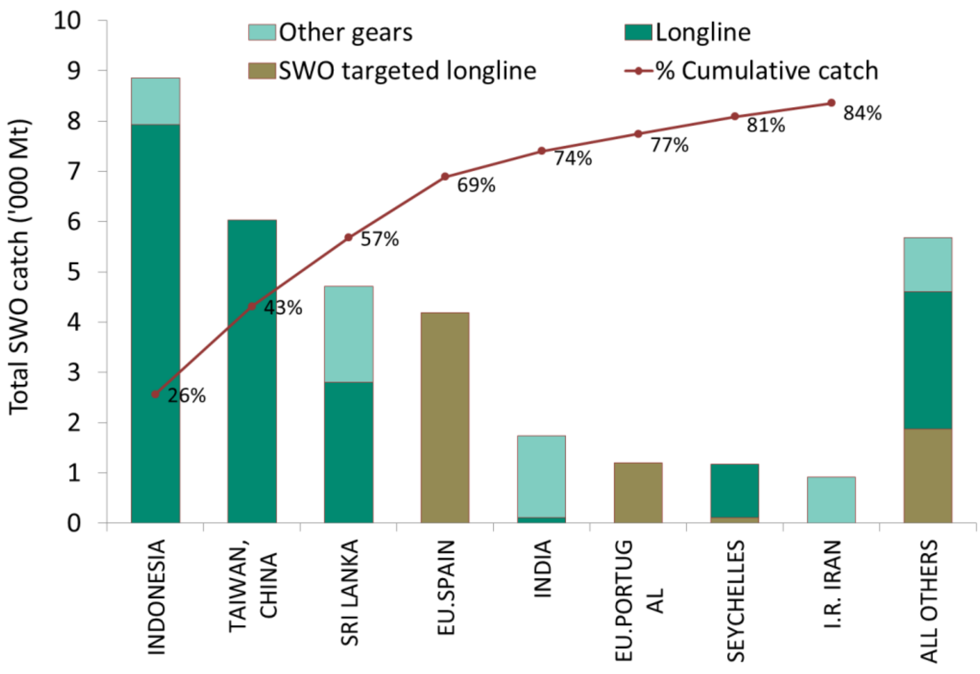


Fig. 2: Swordfish: average catches in the Indian Ocean over the period 2012–15, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of swordfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

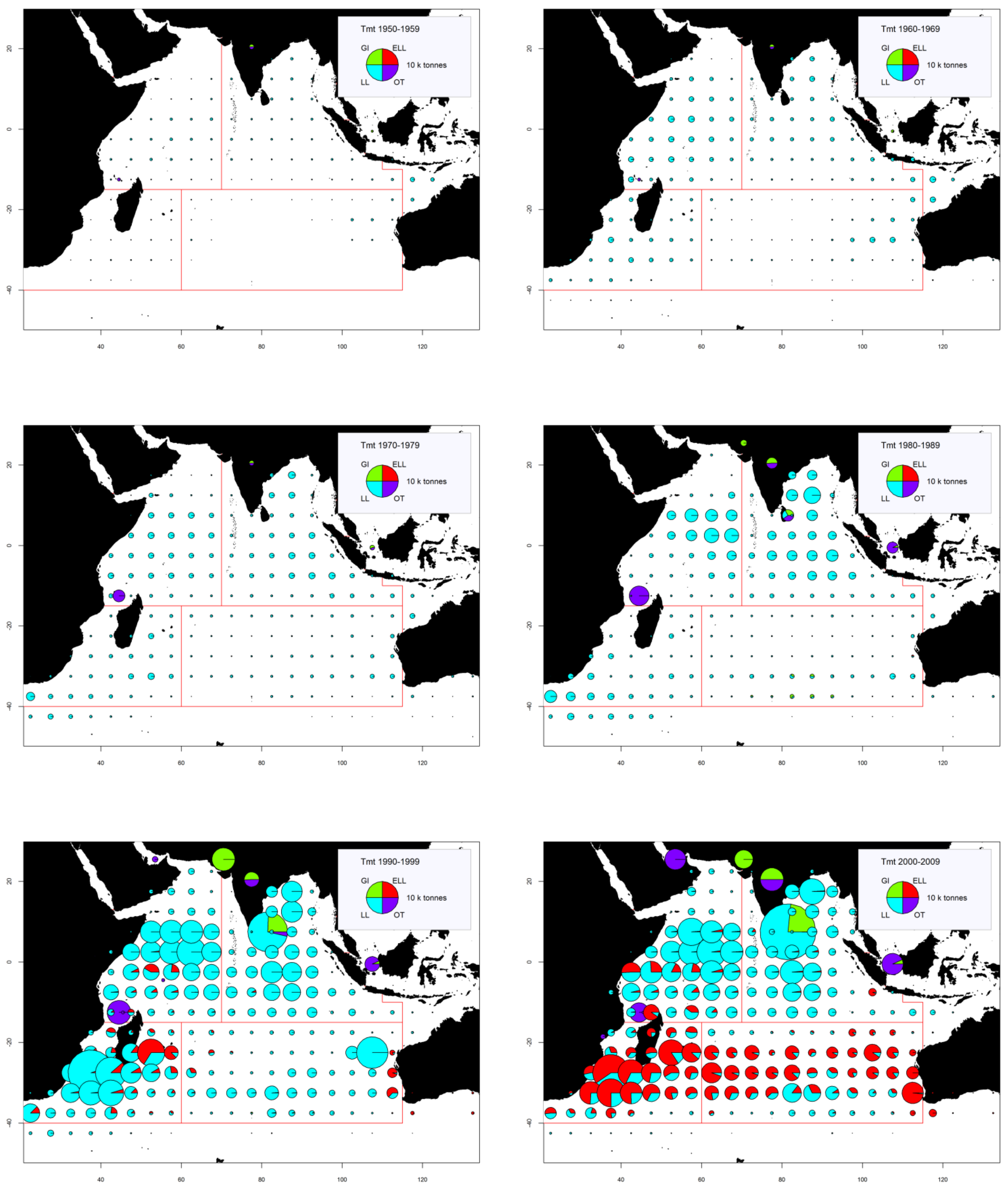


Fig. 3a-f: Swordfish: Time-area catches (total combined in tonnes) as reported for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), gillnet fisheries (**GI**), and for all other fleets combined (**OT**), for the period 1950-2009, by decade and type of gear. Red lines represent the areas used for the assessments of swordfish.

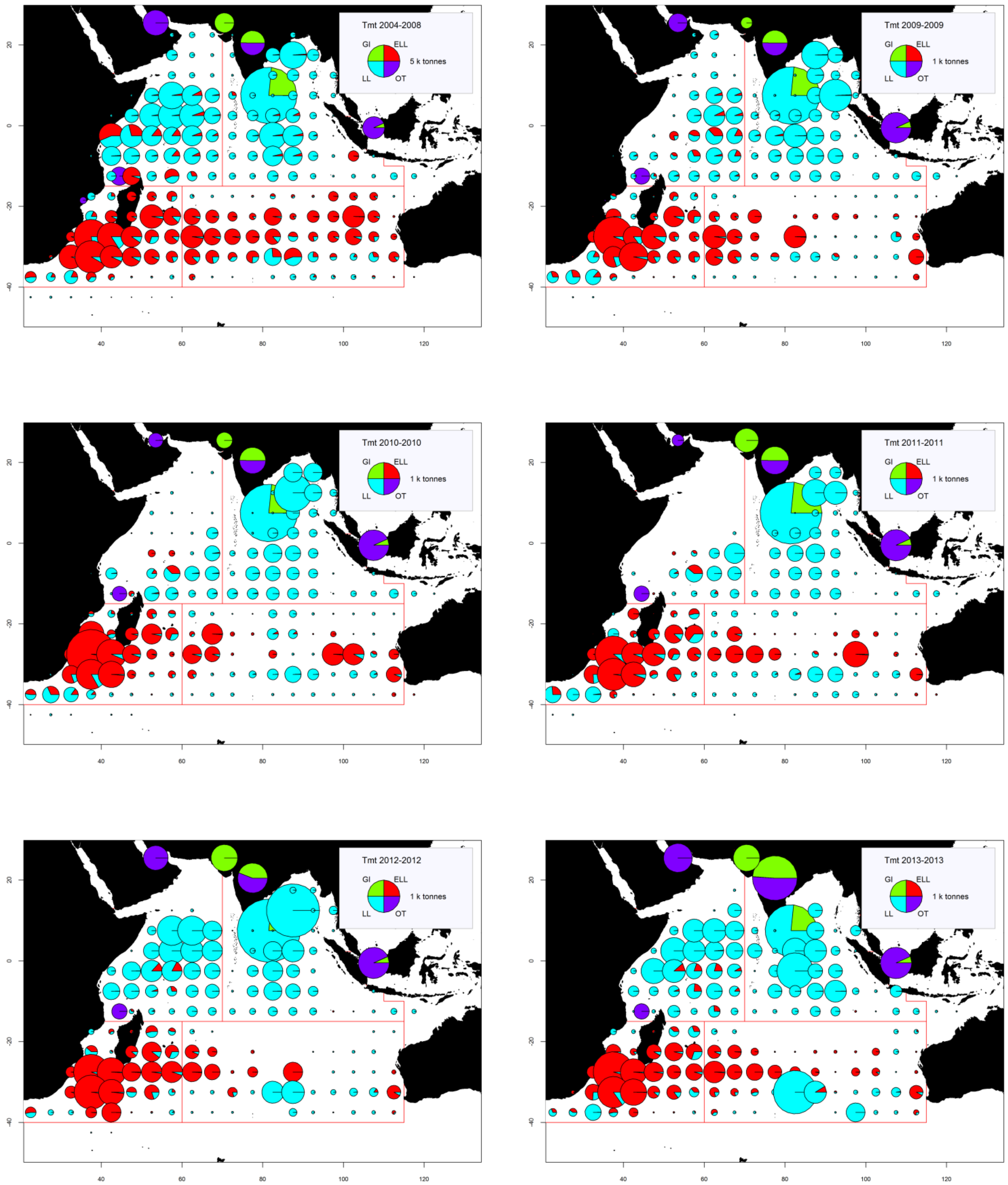


Fig. 4a-f: Swordfish: Time-area catches (total combined in tonnes) for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), gillnet fisheries (**GI**), and for all other fleets combined (**OT**), for the period 2004-2008 by type of gear and for 2009-13, by year and type of gear. Red lines represent the areas used for the assessments of swordfish.

Source: IOTC catch and effort data (raised time area catches).

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.5a**), 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.
- Indonesia (Longline): Catches possibly underestimated due to insufficient sampling coverage – especially in recent years (where they represent around 25% of the total catches).
- 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.

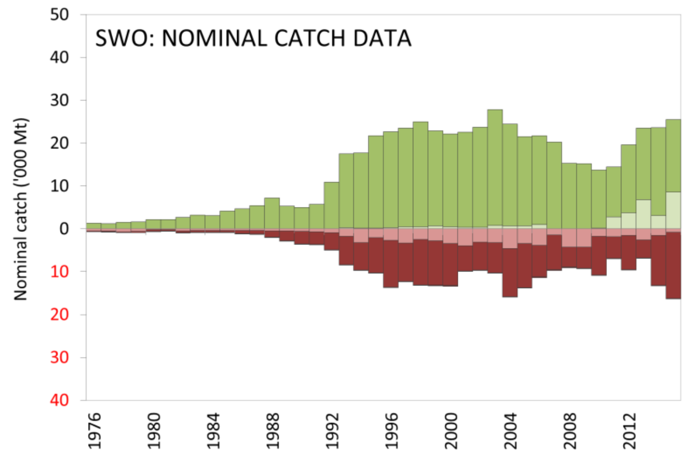
For most other fisheries, catch-and-effort are either not available (e.g., longline fisheries of Indonesia, drifting gillnet fisheries of Iran and Pakistan), or they are considered poor quality – especially since the early-1990s (e.g., gillnet and longline fisheries of Sri Lanka, Taiwan,China fresh-tuna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

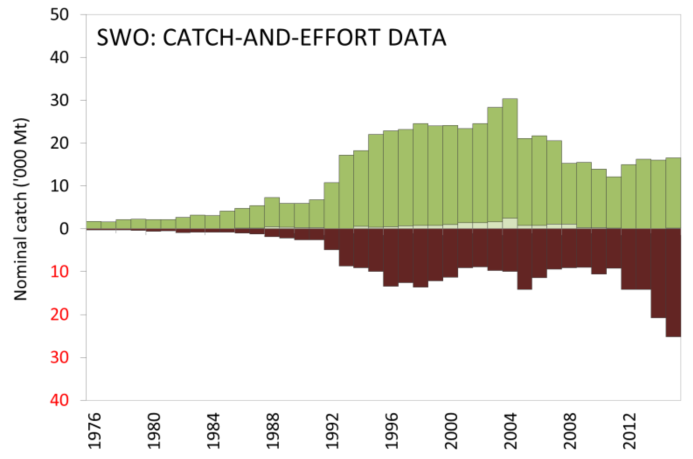
Swordfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)

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. 5c**)

- 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.

- Catch-at-Size (Age) table: data are available but the estimates are thought to have been compromised for some years and fisheries due to:
    1. uncertainty in the length frequency data recorded for longliners of Japan and Taiwan,China: average weights of swordfish derived from length frequency and catch-and-effort data are very different;
    2. uncertainty in the catches of swordfish for the drifting gillnet fisheries of I.R. Iran and the longline fishery of Indonesia;
    3. the total 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);
    4. the paucity of size data available from industrial longliners since the early-1990s (e.g. Japan, Philippines, India and China);
    5. the lack of time-area catches for some industrial fleets (e.g. Indonesia, India, NEI fleets);
    6. 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.





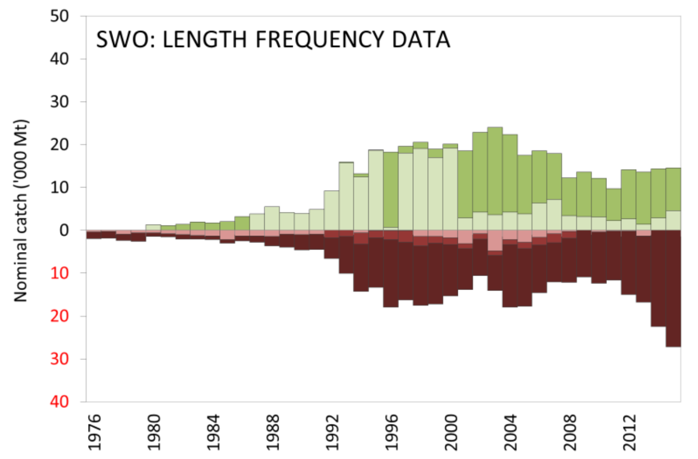


Fig. 5a-c. Swordfish: data reporting coverage (1976–2015).

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 2016.

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–2016–WPB14–07 Rev_1*)

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 its 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 with good monitoring of catches by species, the catches estimated 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. However, the data quality of catches for artisanal fisheries of Indonesia is thought to be poor, with a likely underestimation of catches of billfish in recent years.
- 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. To improve the quality and availability of data for sports fisheries, the IOTC Secretariat has commissioned a pilot Project to improve the collection of catch-and-effort and size frequency from sports fisheries in the Western Indian Ocean. For the initial phase, data collection is focused on sports fisheries in Seychelles, Kenya, Mauritius, and La Reunion. A full update on the Project, including results of the data collection, will be presented to the WPB in 2017.
- Drifting gillnet fisheries of I.R. Iran and Pakistan: In recent years both fisheries have reported catches of billfish at around 20,000 t (25% of the total catches). Catches for this component remain very uncertain:
    - I.R. Iran**:** In recent years I.R. Iran has reported catches of marlins and swordfish for its gillnet fishery, (i.e., catches from 2012 onwards) which significantly revises the catch-by-species previously estimates 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 (coastal/offshore fisheries): In 2016 Pakistan submitted catches for first time in recent years – however the data are significantly different to catches reported by WWF-Pakistan funded sampling in 2012, and also with previous official data reported by Pakistan to the IOTC Secretariat. Data reported by WWF-Pakistan estimates catches from Pakistan account for around 6% of total billfish catches in the Indian Ocean. However, based on the latest data submitted by Pakistan, catches are estimated to be much lower than what has previously been reported by WWF-Pakistan. Verification of the data is currently being undertaken by the IOTC Secretariat to understand the reasons for the differences in reported data for Pakistan before any updates are implemented in the IOTC database.

Catch-and-effort and CPUE series

For a number of fisheries important for billfish catches listed below, catch-and-effort remains either totally 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)**:** To date, the IOTC Secretariat has no complete catch-and-effort data (i.e., data for marlins and sailfish) for the longline fishery of EU,Spain.

- 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 catches estimated are considerably higher than those officially reported to the Secretariat.
- Indonesia (fresh longline): The catches of swordfish and marlins for the fresh tuna longline fishery of Indonesia may have been underestimated in the past due to not being sampled sufficiently in port and also the lack of logbook data from which to derive estimates. The catches of billfish estimated in recent years (all species combined) represent around 10% of the total catches in the Indian Ocean, especially swordfish and blue marlin. Catches for this component are considered to be highly uncertain.
- 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 number of samples for all species are below the minimum sampling coverage of one fish per tonne of catch recommended by IOTC; while 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 size frequency data for billfish for gillnet fisheries.
- 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.
- 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 month and fishing area (i.e., 5 degree square grid) and refer mostly to the component of the catch that is unloaded fresh. For this reason the quality of the samples in the IOTC database are considered unreliable.
- Taiwan,China (fresh-tuna longline)**:** Taiwan,China recently submitted size frequency data for the fresh tuna longline. Data are available for the marlins and swordfish species. However the data are considered uncertain.
- India and Indonesia (artisanal fisheries): To date, India and Indonesia have not reported 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).

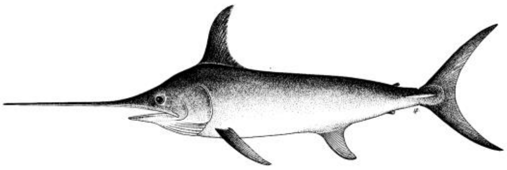
i. Sri Lanka (gillnet and costal fisheries): The IOTC Secretariat to liaise with Sri Lanka (NARA/MFARD) to further improve the estimation of catches of billfish, and revision to the historical time series (e.g., based on the results of 2012 review BOBLME funded sampling of coastal fisheries conducted since 2013).

ii. <u>Indonesia (coastal fisheries):</u> The IOTC Secretariat to continue working with DGCF to improve the quality of data for billfish and other IOTC species for coastal fisheries. A BOBLME/OFCF funded pilot sampling project concludes in October 2015; the results will be used to inform future revisions of catches of IOTC species for Indonesia's coastal fisheries.

iii. <u>I.R. Iran and Pakistan (gillnet fisheries)</u>: The IOTC Secretariat to conduct data support missions with I.R. Iran and Pakistan to undertake an historical data review of billfish catches and resolve current inconsistencies in the catches reported to the IOTC Secretariat.

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		2016 stock status determination
Indian Ocean	Catch 2015: Average catch 2011–2015:	41,760 t 31,900 t	(green)
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_{1950} (80% CI):	39.40 (33.20–45.60) 0.138 (0.137–0.138) 61.4 (51.5–71.4) 0.34 (0.28–0.40) 3.10 (2.44–3.75) 0.74 (0.58–0.89)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)	(yellow)	(green)
Not assessed/Uncertain	(grey)	

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new assessment was undertaken in 2016. Thus, stock status is based on the previous assessment undertaken in 2014, as well as indicators available in 2015. The SS3 model, used for stock status advice, indicated that MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2013}/F_{MSY}< 1$; $SB_{2013}/SB_{MSY}> 1$). All other models applied to swordfish also indicated that the stock is above a biomass level that would produce MSY and current catches were below the MSY level. Spawning stock biomass in 2013 was estimated to be 58–89% of the unfished levels while most recent catches (41,760 t in 2015) are 2,360 t above the MSY level (39,400 t). On the weight-of-evidence available in 2016, catches for 2017 should be kept below MSY and 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 as a whole, and despite the recent increase in total recorded 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 2022 if catches are maintained at current levels (<1% risk that $SB_{2022}< SB_{MSY}$, and <1% risk that $F_{2022}> F_{MSY}$) (Table 2).

Management advice. The most recent catches (41,760 t in 2015) are 2,360 t above the MSY level (39,400 t). Hence catches in 2017 should be reduced to less than MSY (39,400 t). As the updated stock assessment is scheduled in 2017, more concrete advice after 2018 should be developed next year.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 39,400 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. 1).

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. 1).

- **Main fishing gear** (2012–15): Longline catches are currently estimated to comprise approximately 85% of the total estimated swordfish catch in the Indian Ocean (take of the total estimated swordfish catch).
- **Main fleets** (2012–15): Indonesia (fresh longline): 20%; Taiwan,China (longline): 17%; Sri Lanka (longline-gillnet): 12%; EU,Spain (swordfish targeted longline): 12% (take of the total estimated swordfish catch).

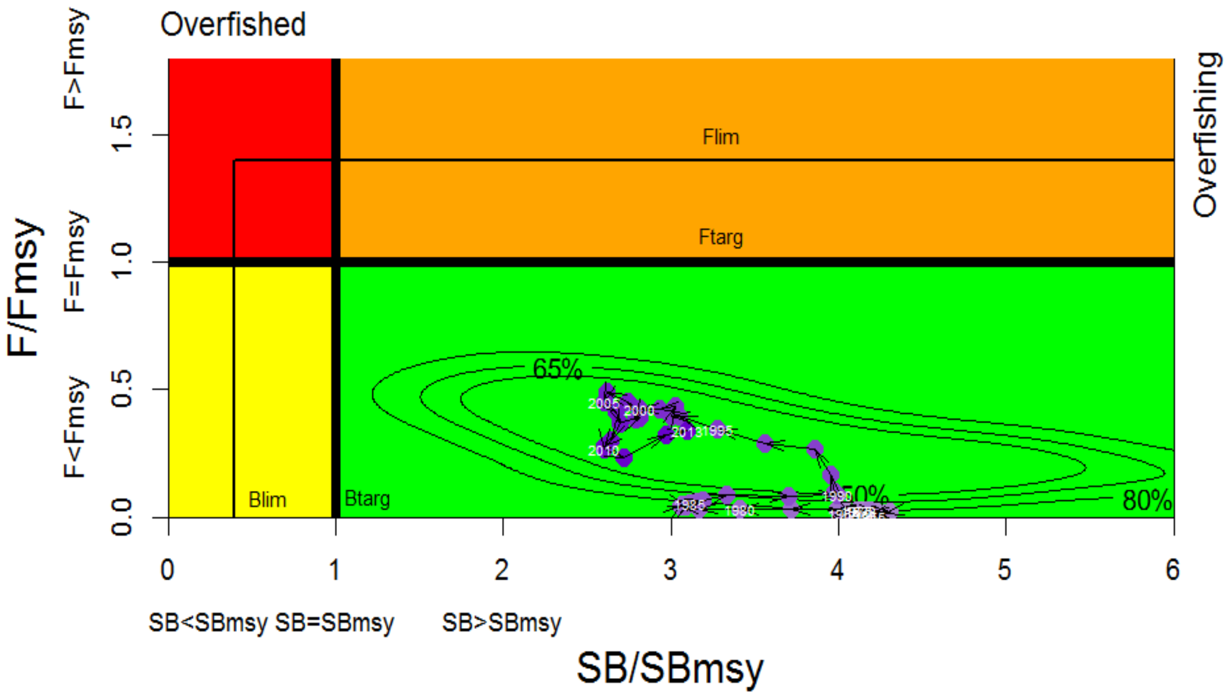


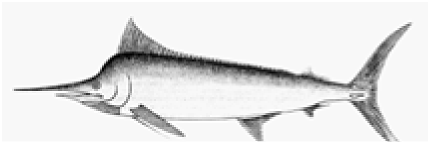
Fig. 1. Swordfish: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2013. Interim target (F_{targ} and SB_{targ}) and limit (F_{lim} 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 (average catch level from 2011–13 (27,809 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 2011–13, 27,809 t) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	16,685 t	19,466 t	22,247 t	25,028 t	27,809 t	30,590 t	33,371 t	36,152 t	38,933 t
$SB_{2016} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{MSY}$	0	0	0	0	0	0	0	0	2
$SB_{2023} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2023} > F_{MSY}$	0	0	0	0	0	0	0	0	4

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		2016 stock status determination
Indian Ocean	Catch 2015:	18,490 t	80%
	Average catch 2011–2015:	15,276 t	
	MSY (1,000 t) (80% CI):	9.932 (6.963-12.153)	
	F_{MSY} (80% CI):	0.211 (0.089-0.430)	
	B_{MSY} (1,000 t) (80% CI):	47.430 (27.435-100.109)	
	F_{2015}/F_{MSY} (80% CI):	2.42 (1.52-4.06)	
	B_{2015}/B_{MSY} (80% CI):	0.81 (0.55-1.10)	
	B_{2015}/B_{1950} (80% CI):	0.30 (0.20-0.41)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

Colour key	Stock overfished($B_{year}/B_{MSY} < 1$)	Stock not overfished ($B_{year}/B_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	80%	19%
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	0%	1%
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Stock status based on BSP-SS stock assessment suggests that the stock in 2015 is in the red zone in the Kobe plot with F/F_{MSY}=2.42 and TB/TB_{MSY}=0.81. Another approach by ASPIC examined in 2016 came to similar conclusions. The Kobe plot (Fig. 1) from the BSP-SS model indicated that the stock has been **subject to overfishing** and **overfished** in recent years (Table 1; Fig. 1).

Outlook. The uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution. The recent sharp increase of catch changed the status of stock to the red zone (Kobe plot). There are almost no chances to keep MSY levels for F and TB in the next 10 years, even if the current catch levels are reduced by 40% (Table 2).

Management advice. The current catches of BLM (average of 17,171 t in the last 3 years, between 2013-2015) are considerably higher than MSY (9,932 t) and the stock is overfished ($B_{curr} < B_{MSY}$) and currently subject to overfishing ($F_{curr} > F_{MSY}$). Even with a 40% reduction in current catches, it is very unlikely (less than 5%) to achieve the Commission objectives of being in the green zone of the Kobe Plot by 2025. Current catch levels are not sustainable and there is a need for urgent actions to decrease this catch levels.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 9,932 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** (2012–15): gillnet: 51%; Longline: 27% (take of the total estimated black marlin catch).
- **Main fleets** (2012–15): I.R. Iran (gillnet): 29%; India (gillnet and troll): 20%, Sri Lanka (gillnet and fresh longline): 19%; Indonesia (fresh longline and hand lines): 15% (take of the total estimated black marlin catch).

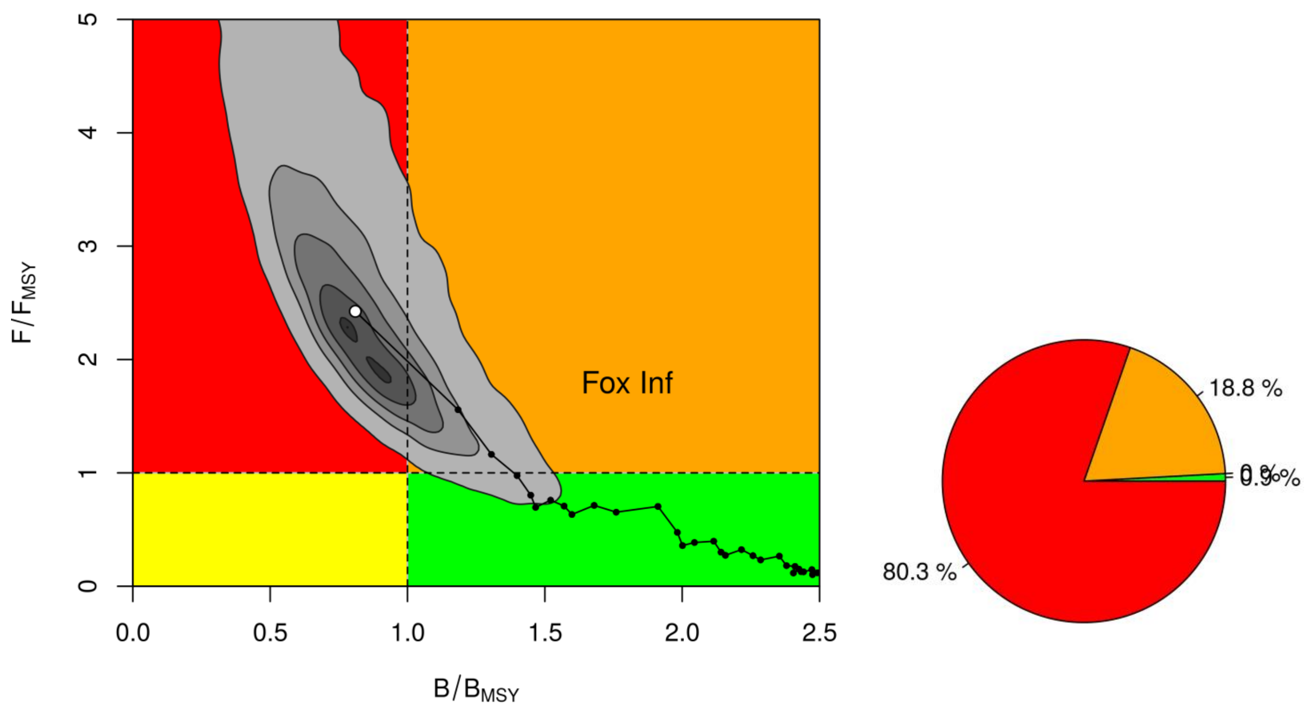


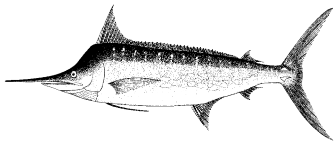
Fig. 1. Black marlin: BSP-SS aggregated Indian Ocean assessment Kobe plots for black marlin (contours are the 25, 50, 75 and 90 percentiles of the 2015 estimate). Black line indicates the trajectory of the point estimates (blue circles) for the spawning biomass (B) ratio and F ratio for each year 1950–2015.

Table 2. Black Marlin: Indian Ocean BSP-SS Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2013–15 (17,171 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 2013–15, 17,171 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	10,303 t	12,020 t	13,737 t	15,454 t	17,171 t	18,888 t	20,605 t	22,322 t	24,039 t
$SB_{2018} < SB_{MSY}$	91	94	96	97	98	98	99	99	99
$F_{2018} > F_{MSY}$	89	96	98	99	100	100	100	100	100
$SB_{2025} < SB_{MSY}$	98	100	100	100	100	100	100	100	100
$F_{2025} > F_{MSY}$	97	99	100	100	100	100	100	100	100

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		2015 stock status determination
Indian Ocean	Catch 2015: Average catch 2011–2015:	15,706 t 14,847 t	47%
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2015}/F_{MSY} (80% CI): B_{2015}/B_{MSY} (80% CI): B_{2015}/B_{1950} (80% CI):	11.926 (9.232–16.149) 0.109 (0.076 –0.160) 113.012 (71.721 – 161.946) 1.18 (0.80–1.71) 1.11 (0.90–1.35) 0.56 (0.44 – 0.71)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

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)	25%	47%
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	1%	28%
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Stock status based on BSP-SS stock assessment suggests that the stock in 2015 is in the orange zone in the Kobe plot and both F and TB are close to their MSYs, i.e., F/F_{MSY}=1.18 and TB/TB_{MSY}=1.11. Two other approaches examined in 2016 came to similar conclusions, namely ASPIC and SS3. The Kobe plot (Fig. 1) from the BSP-SS model indicated that the stock has been **subject to overfishing** but **not overfished** in recent years, while the stock biomass is slightly above the BMSY level (Table 1; Fig. 1).

Outlook. The uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution. The recent rapid increase of catch may bring the status of stock to the red zone (Kobe plot) in the near future if such high levels of catch continues. There is a high risk (50-80%) to exceed MSY-based reference points in next 10 years if the current catch level is continued. But if the catch level is reduced by 20%, then the risk will be reduced to less than 50% (Table 2).

Management advice. The current catches of BUM (average of 15,400 t in the last 3 years, 2013-2015) are higher than MSY (11,926 t) and the stock is currently being overfished ($F_{curr} > F_{MSY}$). In order to achieve the Commission objectives of being in the green zone of the Kobe Plot by 2025 ($F_{2025} < F_{MSY}$ and $B_{2025} > B_{MSY}$) with at least a 50% chance, the catches of blue marlin would have to be reduced by 24% compared to the average of the last 3 years, to a maximum value of 11,704 t.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 11,926 t (estimated range 9,232–16,149 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** (2012–15): Longline: 74%; Gillnet: 23% (of the total estimated blue marlin catch).
- **Main fleets** (2012–15): Taiwan,China (longline): 33%; Indonesia (fresh longline): 31%; Pakistan (gillnet): 12%; I.R. Iran (gillnet): 9%; Sri Lanka: 6% (of the total estimated blue marlin catch).

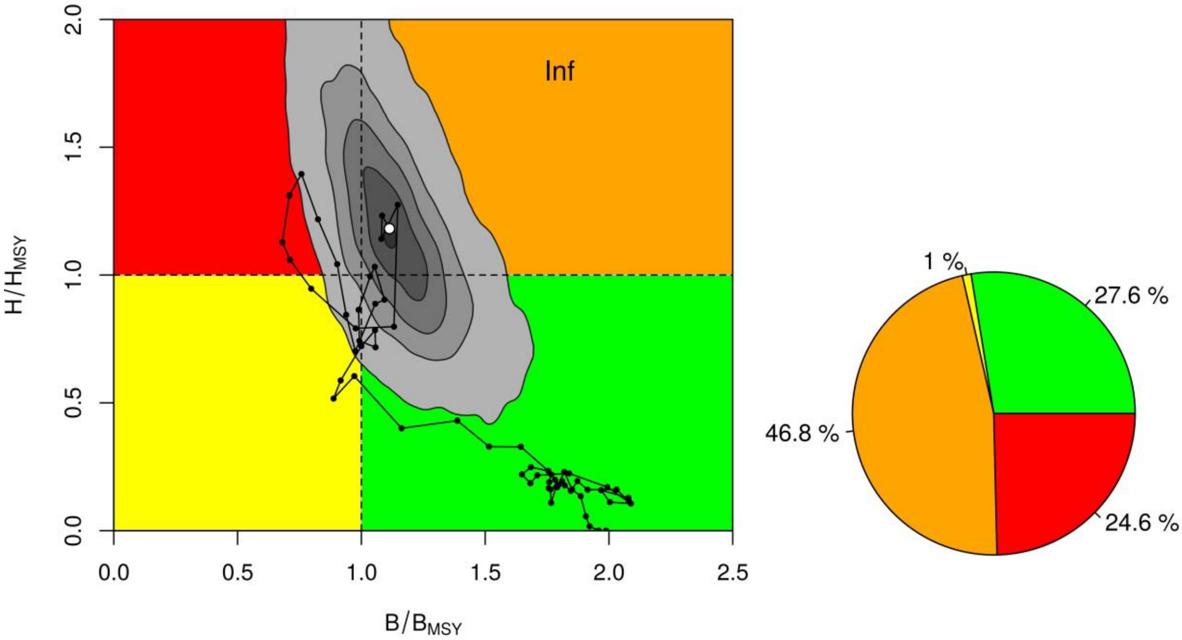


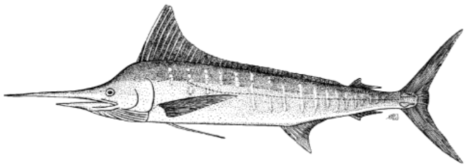
Fig. 1. Blue marlin: BSP-SS Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2015 estimate). Black line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as TB) and F ratio for each year 1950–2015.

Table 2. Blue Marlin: Indian Ocean BSP-SS Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2013–2015 (15,401 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 2013–2015, 15,401 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	9,240 t	10,780 t	12,321 t	13,861 t	15,401 t	16,941 t	18,481 t	20,021 t	21,561 t
$B_{2018}<B_{MSY}$	26	31	37	43	48	54	59	64	69
$F_{2018}>F_{MSY}$	14	30	47	63	75	84	90	94	96
$B_{2025}<B_{MSY}$	16	30	46	60	73	82	88	93	95
$F_{2025}>F_{MSY}$	12	30	51	68	80	89	93	96	98

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**		**2015 stock status determination**
Indian Ocean	Catch 2015: Average catch 2011–2015:	4,410 t 4,481 t	**60%**
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): B_{2014}/B_{MSY} (80% CI): B_{2014}/B_{1950} (80% CI):	5.22 t (5.18–5.59) 0.62 (0.59–1.04) 8.4 t (5.40–8.90) 1.09 (0.62–1.66) 0.65 (0.45–1.17) 0.24 (n.a.–n.a.)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

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)	**60%**	**0%**
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	**36%**	**4%**
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. In 2015 an ASPIC stock assessment confirmed the assessment results from 2012 and 2013 that indicated the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two approaches examined in 2015 came to similar conclusions, namely a Bayesian Surplus Production Model, and a Stock Reduction Analysis using only catch data. The ASPIC model indicated that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. In 2016 reported catches increased to 4,410 t. On the weight-of-evidence available in 2016, the stock is determined to be ***overfished*** and ***subject to overfishing*** (Table 1; Fig. 1).

Outlook. The decrease in longline catch and effort in the years 2009–11 lowered the pressure on the Indian Ocean stock as a whole, however, given the increased catches reported in 2012, 2013 and 2014, combined with the concerning results obtained from the stock assessments carried out in 2012, 2013 and 2015, the outlook is pessimistic for the stock as a whole and a precautionary approach to the management of striped marlin should be considered by the Commission in order to reduce catches well below MSY estimates to enable the stock to rebuild. There is a very high risk of exceeding the biomass MSY-based reference points by 2017 if catches increase further or are maintained at current levels (2014) until 2017 (>75% risk that $B_{2017}< B_{MSY}$, and $F_{2017}> F_{MSY} \approx$ 68%) (Table 2).

Management advice. A precautionary approach to the management of striped marlin should be considered by the Commission to reduce catches below 4,000 t thereby ensuring the stock may rebuild to sustainable levels.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 5,220 t (5,180–5,590). However, the biomass is well below the B_{MSY} reference point and fishing mortality is in excess of F_{MSY} at recent catch levels of around 4,410 t. Catches should be reduced to below 4,000 t following advice from the 18th Session of the Scientific Committee.
- **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 striped marlin.

- **Main fishing gear** (2012–15): Longline: 69%; Gillnet: 24% (of the total estimated striped marlin catch).
- **Main fleets** (2012–15): Indonesia (drifting longline and coastal longline): 36%; Taiwan,China (drifting longline): 23%; I.R. Iran (gillnet): 14%; Pakistan (gillnet): 8% (of the total estimated striped marlin catch).

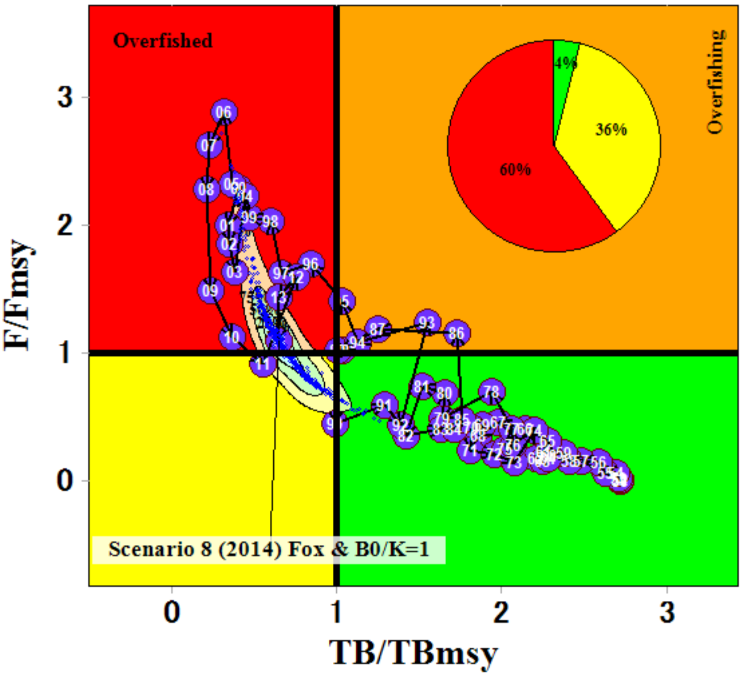


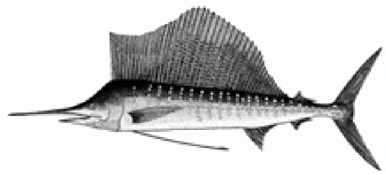
Fig. 1. Striped marlin: ASPIC aggregated Indian Ocean assessment Kobe plot with the confidence surface and compositions of its uncertainties in terms of 4 phases (pie chart).

Table 2. Striped marlin: ASPIC aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from 2012–14 (4,915 t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2012–2014, 4,915 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	2,949 t	3,441 t	3,932 t	4,424 t	4,915 t	5,407 t	5,898 t	6,390 t	6,881 t
$B_{2017} < B_{MSY}$	41	57	59	70	75	82	90	95	97
$F_{2017} > F_{MSY}$	10	19	23	41	68	90	98	100	100
$B_{2024} < B_{MSY}$	7	12	15	29	60	98	100	100	100
$F_{2024} > F_{MSY}$	7	12	14	26	53	99	100	100	100

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**		**2016 stock status determination**
Indian Ocean	Catch 2015: Average catch 2011–2015:	28,455 t 28,543 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2014}/F_{MSY} (80% CI): B_{2014}/B_{MSY} (80% CI): B_{2014}/B_0 (80% CI):	25.00 (17.20–36.30) 0.26 (0.15–0.39) 87.52 (56.30–121.02) 1.05 (0.63–1.63) 1.13 (0.87–1.37) 0.57 (0.44–0.69)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

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. In 2015, data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not yet overfished, but is subject to overfishing (Table 1). In using the SRA method for comparative purposes with other stocks, the use of the target reference points may be possible for the approach. In addition, a Bayesian Surplus Production Model indicated that the stock could be severely overfished so this is a less pessimistic outlook on the stock status. The stock appears to show a continued increase in catch rates which is a cause of concern, indicating that fishing mortality levels may be becoming too high (Fig. 1). 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 a cause for concern. 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. Records of stock extirpation in the Gulf should also be examined to examine the degree of localised depletion in Indian Ocean coastal areas. On the weight-of-evidence available in 2016, the stock is determined to be still **not overfished** but **subject to overfishing**.

Outlook. The estimated increase in coastal gillnet catch and effort in recent years is a substantial cause for concern for the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

Management advice. The same management advice for 2016 (catches below a MSY of 25,000 t) is kept for the next year (2017).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 25,000 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 I.P. sailfish.
- **Main fishing gear** (2012–15): Gillnet: 75%; Troll and handlines: 18% (of the total estimated I.P. sailfish catch).

- **Main fleets** (2012–15): I.R. Iran (gillnet): 31%; Pakistan (gillnet): 18%; India (gillnet and troll): 17%; Sri Lanka (gillnet and fresh longline): 10% (of the total estimated I.P. sailfish catch).

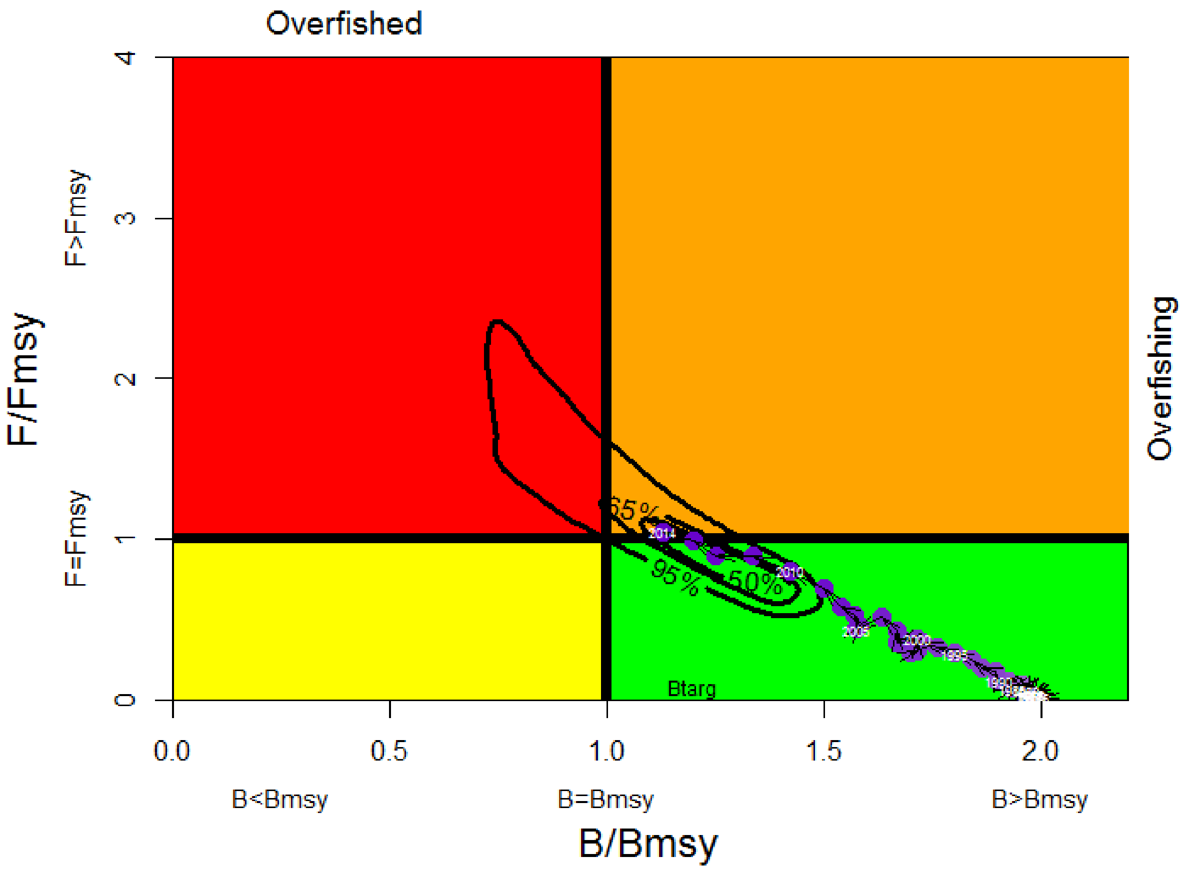


Fig. 1. Indo-Pacific sailfish: Stock reduction analysis (Catch MSY Method) of aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2014 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the B ratio and F ratio for each year 1950–2014.

Table 2. Indo-Pacific sailfish: Indian Ocean stock reduction analysis Kobe II Strategy Matrix.Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2012–2014 (29,164 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 2012–14, 29,164 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
	17,498 t	20,415 t	23,331 t	26,248 t	29,164 t	32,080 t	34,997 t	37,913 t	40,830 t
$B_{2017}<B_{MSY}$	10	15	20	25	30	35	41	47	53
$F_{2017}>F_{MSY}$	16	27	38	49	61	72	83	94	99
$B_{2024}<B_{MSY}$	6	16	28	41	55	68	81	91	97
$F_{2024}>F_{MSY}$	12	23	36	52	68	84	97	100	100

APPENDIX XI
WORKING PARTY ON BILLFISH PROGRAM OF WORK (2017–2021)

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				
				2017	2018	2019	2020	2021
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.	High (1)	1.3 m Euro: (European Union)					
	1.1.1 Next Generation Sequencing (NGS) to determine the degree of shared stocks for billfish in the Indian Ocean 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.	High (1)						
	1.1.2 Nuclear markers (i.e. microsatellite) to determine the degree of shared stocks for billfish (highest priority species: blue, black, striped marlin and sailfish) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate.	High (1)						
	1.1.3 Develop a close-kin mark recapture method (*Bravington et al.* 2016) on marlins to estimates population size and other important demographic parameters. This method includes the sampling of juveniles and adult fish and genetic parenting	High (1)						

	analyses to estimate the population size from mark-recapture models.		
	1.2 Tagging research to determine connectivity, movement rates and mortality estimates of billfish.	High (2)	US$100,000
	1.2.1 Tagging studies (PSAT)		(TBD)
2. Biological and ecological information (incl. parameters for stock assessment)	2.1 Age and growth research	High (7)	
	2.1.1 CPCs to provide further research reports 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 or other research programs.		CPCs directly
	2.2 Age-at-Maturity	High (8)	
	2.2.1 Quantitative biological studies are necessary for billfish throughout its range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.		(CPCs directly)
	2.3 Spawning time and locations	High (9)	
	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.		(CPCs directly)
3. Historical data review	3.1 Changes in fleet dynamics		
	3.1.1 Japan and Taiwan,China to undertake an historical review of their longline fleets and to document the changes in fleet dynamics. 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.	High (6)	(CPCs directly)
	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	High (5)	(CPCs directly)

	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.		
4. Sports/recreational fisheries	4.1 Fishery trends		
	4.1.1 The catch and effort data for sports/recreational fisheries targeting marlins and sailfish in the Indian Ocean should be submitted to the IOTC Secretariat to assist in future assessments for these species. CPCs with active sports/recreational fisheries targeting marlins and sailfish should undertake a comprehensive analysis for provision to the WPB.	High (Ongoing)	Consultant US$54,000
5. CPUE standardization	5.1 Develop and/or revise standardized CPUE series for each billfish species and major fisheries/fleets for the Indian Ocean.		
	5.1.1 Swordfish: Priority LL fleets: Taiwan,China, EU(Spain, Portugal, France), Japan, Indonesia	High (10)	(CPCs directly)
	5.1.2 Striped marlin: Priority fleets: Japan, Taiwan,China	High (11)	(CPCs directly)
	5.1.3 Black marlin: Priority fleets: Longline: Taiwan,China; Gillnet: I.R. Iran, Sri Lanka	High (13)	(CPCs directly)
	5.1.4 Blue marlin: Priority fleets: Japan, Taiwan,China	High (14)	(CPCs directly)
	5.1.5 I.P. Sailfish: Priority fleets: Priority gillnet fleets: I.R. Iran and Sri Lanka; Priority longline fleets: EU(Spain, Portugal, France), Japan, Indonesia;	High (12)	(CPCs directly)
6. Stock assessment / Stock indicators	6.1 Develop and compare multiple assessment approaches to determining stock status for swordfish (SS3, ASPIC, etc.).	High (15)	US$??
	6.2 Stock assessment on billfish species in 2017 and 2018	High (3)	Consultant/ US$16,250
	6.3 Workshops on techniques for assessment including CPUE estimations for billfish species from gillnet fisheries in 2017 and 2018.	High (4)	Consultant US$11,750
7 Target and Limit reference points	7.1 To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High (16)	
	7.1.1 Assessment of the interim reference points as well as alternatives:		WPM

		Used when assessing the Swordfish stock status and when establishing the Kobe plot and Kobe matrices. = Agreed to pass this task temporarily to WPM.								
8	Management measure options	8.1 To advise the Commission, by end of 2016 at the latest, on potential management measures having been examined through the Management Strategy Evaluation (MSE) process.	High (17)							
		8.1.1 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.= Agreed to pass this task temporarily to WPM.		WPM						

Table 2. Five (5) year assessment schedule for the IOTC Working Party on Billfish (WPB)

Species	**2017** **(5 days meeting)**	**2018** **(5 days meeting)**	**2019** **(5 days meeting)**	**2020** **(5 days meeting)**	**2021** **(5 days meeting)**
Black marlin		***Full assessment***		***Full assessment***	
Blue marlin		***Full assessment***		***Full assessment***	
Striped marlin	**Full assessment**		***Full assessment***		***Full assessment***
Swordfish	**Full assessment**				***Full assessment***
Indo-Pacific sailfish			***Full assessment****		

***Including data poor stock assessment methods**

APPENDIX XII
CONSOLIDATED RECOMMENDATIONS OF THE 14TH SESSION OF THE WORKING PARTY ON BILLFISH

Note: Appendix references refer to the Report of the 14th Session of the Working Party on Billfish (IOTC–2016–WPB14–R)

IOTC Resolutions

WPB14.01 (para. 9): **NOTING** the comments by the FAO Legal Counsel at the 20th Session of the IOTC:

> *"First, the Legal Counsel informed the Members that FAO fully acknowledged that the IOTC Agreement, negotiated between 1991 and 1993, and which came into force in 1996, should be modernized, in order to reflect recent developments in the Law of the Sea and modern trends in fisheries management"*. (S20 Para. 94 *To be adopted*)

the WPB **RECOMMENDED** that on the next revision of the IOTC Agreement, short billed spearfish are included as an IOTC species.

Billfish species identification

WPB14.02 (para. 21): The WPB **RECOMMENDED** that funds are allocated for further printing of the species ID guides so that these can be distributed amongst the sports fishing clubs for recreational activities to improve the quality of data reported from these fisheries.

WPB14.03 (para. 24): The WPB **AGREED** on the importance of the hard, waterproof copies of the IOTC species identification guides for observers and port samplers in improving the quality of data collected and **RECOMMENDED** that funds be continued for the translation of these into the priority languages identified by the SC.

Review of the statistical data available for billfish

WPB14.04 (para. 40): The WPB **NOTED** that many CPCs, responsible together for cumulative estimated billfish species catches up to 50% of total catch, do not submit to Secretariat either accurate nominal catch data and/or CPUE series (as per Res. 15/01 and 15/02). Particularly for black marlin (BLM) and Indo-Pacific sailfish (SFA) CPUE-based assessment analysis consider only gear/countries data covering less than 15% of estimated nominal catches. The WPB **NOTED** the Secretariat efforts in conjunction with CPCs (capacity building, observer training) to improve the current situation and **RECOMMENDED** CPCs to fully comply with Resolutions 15/01 and 15/02, providing detailed statistics at the required deadlines.

Stock structure project

WPB14.05 (para. 51): In light of the ongoing delays in the commencement of the EU-funded Indian Ocean stock structure project, the WPB **RECOMMENDED** that the Scientific Committee ensure that a full review is undertaken and that results from this study (and others that have taken place since the project plan was developed) are evaluated and that the work plan of the EU-funded Indian Ocean stock structure project is revised where appropriate. The projects are listed below: (…)

Swordfish habitat and behavior

WPB14.06 (para. 70): Therefore, the WPB **RECOMMENDED** that starting from this WPB14, swordfish is treated as a single stock and separate sections related to swordfish for the southwest Indian Ocean are removed from the executive summary and from the summary of available data for all billfish species.

WPB14.07 (para. 76): At the same time, the WPB **NOTED** that the most recent catches (41,760 t in 2015) were 2,360 t above the MSY level (39,400 t). Hence the WPB **RECOMMENDED** that catches for swordfish in 2017 should be less than MSY and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for swordfish with the latest 2015 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary for its consideration.

Revision of the WPB Program of work (2017–2021)

WPB14.08 (para. 178): The WPB **RECOMMENDED** that more support is provided for the implementation of the ROS for fleets catching the majority of the billfish species (i.e. the gillnet fleets).

WPB14.09 (para. 180): The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2017–2021), as provided at Appendix XI.

Review of the draft, and adoption of the Report of the 14th Session of the Working Party on Billfish

WPB14.10 (para. 188): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB14, 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 2016 (Fig. 8):

- 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

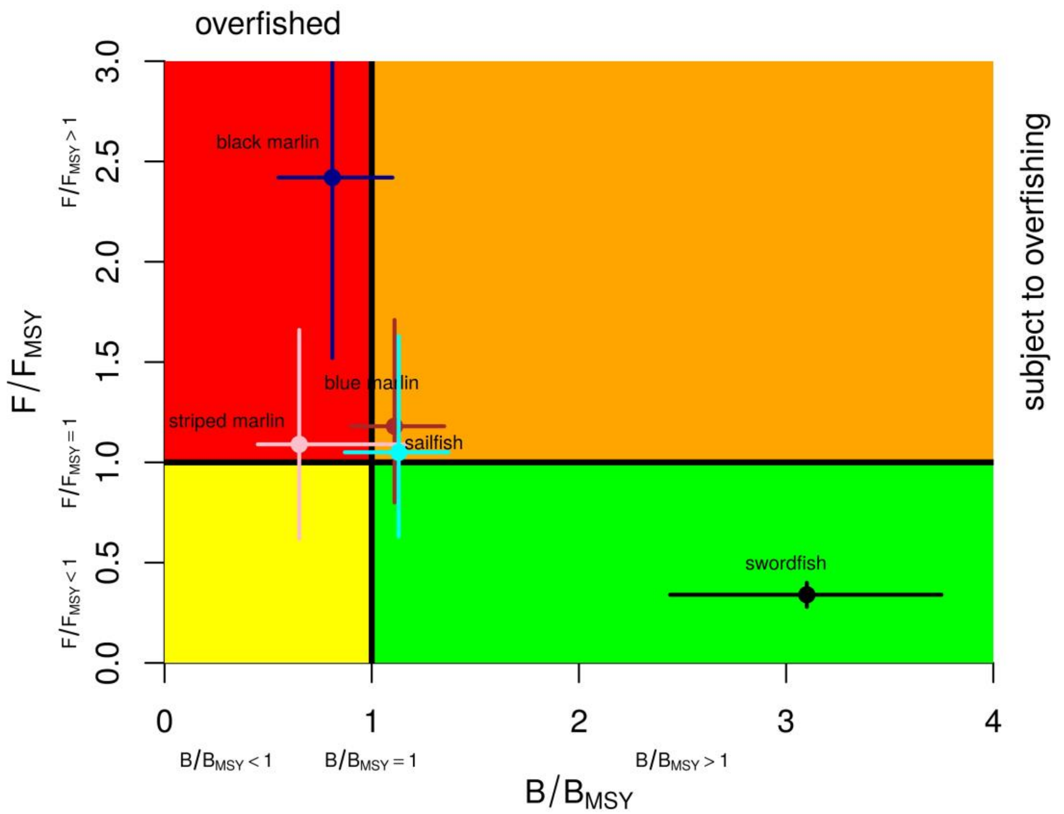


Fig. 8. Combined Kobe plot for swordfish (black), indo-pacific sailfish (cyan), black marlin (light blue), blue marlin (brown) and striped marlin (pink) showing the 2015 and 2016 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.