# Report of the 13th Session of the IOTC Working Party on Billfish

Olhão, Portugal, 1–5 September 2015

**DISTRIBUTION:**

Participants in the Session
Members of the Commission
Other interested Nations and International Organizations
FAO Fisheries Department
FAO Regional Fishery Officers

**BIBLIOGRAPHIC ENTRY**

IOTC–WPB13 2015. Report of the 13th Session of the IOTC Working Party on Billfish. Olhão, Portugal, 2015. *IOTC–2015–WPB13–R[E]: 98 pp.*

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



Contact details:

Indian Ocean Tuna Commission
Le Chantier Mall
PO Box 1011
Victoria, Mahé, Seychelles
Ph: +248 4225 494
Fax: +248 4224 364
Email: secretariat@iotc.org
Website: http://www.iotc.org

**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) |
| 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 | Generalised linear model |
| HBF | Hooks between floats |
| IO | Indian Ocean |
| IOTC | Indian Ocean Tuna Commission |
| LL | Longline |
| M | Natural Mortality |
| MLE | Maximum Likelihood Estimation |
| MSY | Maximum sustainable yield |
| n.a. | Not applicable |
| NGO | Non-governmental organisation |
| 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 formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

***Level 3: General terms to be used for consistency:***
**AGREED**: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.
**NOTED/NOTING**: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

***Any other term:*** Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

# TABLE OF CONTENTS

## EXECUTIVE SUMMARY

The 13th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Olhão, Portugal, from 1 to 5 September 2015. A total of 23 participants (21 in 2014, 24 in 2013) attended the Session. The meeting was opened on 1 September 2015 by the Chairperson, Dr Jérôme Bourjea (EU,France), who welcomed participants to Portugal.

The following are a subset of the complete recommendations from the WPB13 to the Scientific Committee, which are provided at Appendix XIII.

***Sports fishery data collection***

WPB13.04 (para. 21): The WPB **RECOMMENDED** that the Chairperson and Vice-Chairperson continue to work in collaboration with the IOTC Secretariat and the African Billfish Foundation to find a suitable funding source and lead investigator to undertake the project outlined in Appendix VI. The aim of the project is to enhance data recovery from sports and other recreational fisheries in the western Indian Ocean region. The Chairperson shall circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence at a later date.

***WPB Program of work***

WPB13.06 (para. 148): The WPB **RECOMMENDED** that the reporting deadline for stock assessment inputs (index of abundance, catch reconstructions, size data, etc.) be moved from 30 days to 60 days prior to the meeting in which the species is to be assessed.

WPB13.07 (para. 149): The WPB **RECOMMENDED** that the Scientific Committee consider and endorse the WPB Program of Work (2016–2020), as provided at Appendix XII.

***Hiring of a consultant to assist the WPB with data poor stock assessment approaches***

WPB13.08 (para. 154): The WPB **RECOMMENDED** that a consultant be hired to develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline. This activity should be a high priority within the Scientific Committee's Program of Work. Terms of Reference will be provided to the SC's consideration in 2015. An indicative budget is provided at Table 18.

WPB13.09 (para. 155): The WPB **RECOMMENDED** that a consultant be hired to carry out workshops on data poor techniques for assessment including CPUE estimations for billfish species. This activity should be a high priority within the Scientific Committee's Program of Work. Terms of Reference will be provided to the SC's consideration in 2015. An indicative budget is provided at Table 19.

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

WPB13.10 (para. 162): The WPB **RECOMMENDED** that the SC note that Dr Tom Nishida (Japan) and Dr Evgeny Romanov (La Reunion, France) were elected as Chairperson and Vice-Chairperson of the WPB for the next biennium.

***Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Billfish***

WPB13.11 (para. 166): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB13, provided at Appendix XIII, 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 2015 (Fig. 10):

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

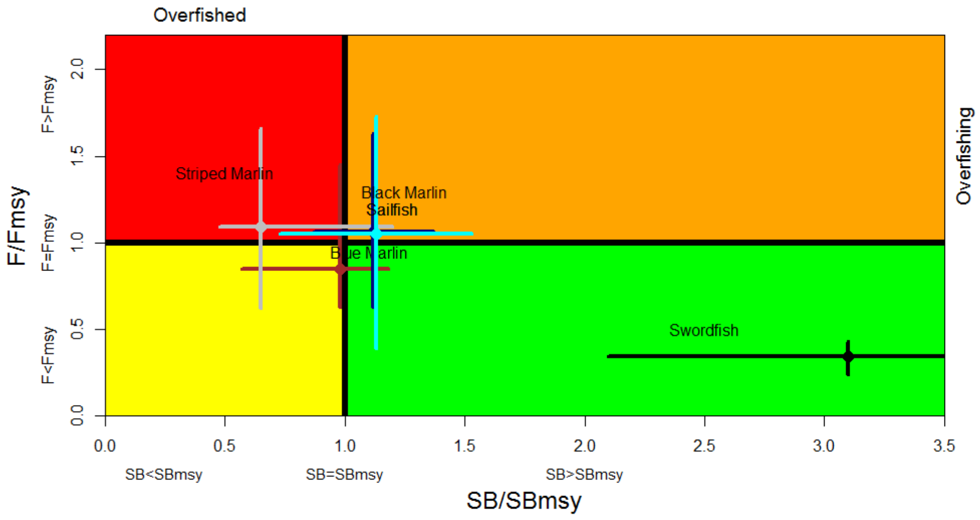



**Fig. 10.** Combined Kobe plot for swordfish (black), black marlin (light blue), blue marlin (brown), striped marlin (grey) and I.P. sailfish (navy blue) showing the 2013, 2014 and 2015 (most recent stock assessments) estimates of current stock size (SB or B, species assessment dependent) and current 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] | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Advice to the Scientific Committee |
|---|---|---|---|---|---|---|---|---|---|
| Swordfish (whole IO) *Xiphias gladius* | Catch 2014: 29,902 t<br>Average catch 2010–2014: 27,510 t<br>MSY (1,000 t) (80% CI): 39.40 (33.20–45.60)<br>$F_{MSY}$ (1,000 t) (80% CI): 0.138 (0.137–0.138)<br>$SB_{MSY}$ (80% CI): 61.4 (51.5–71.4)<br>$F_{2013}/F_{MSY}$ (80% CI): 0.34 (0.28–0.40)<br>$SB_{2013}/SB_{MSY}$ (80% CI): 3.10 (2.44–3.75)<br>$SB_{2013}/SB_{1950}$ (80% CI): 0.74 (0.58–0.89) | 2007 | | | | | | | No new assessment was undertaken in 2015. 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 are below the MSY level. Spawning stock biomass in 2013 was estimated to be 58–89% of the unfished levels. On the weight-of-evidence available in 2015, the stock is determined to be ***not overfished*** and ***not subject to overfishing***. Click here for full stock status summary: Appendix VII |
| Black marlin *Makaira indica* | Catch 2014: 17,948 t<br>Average catch 2010–2014: 13,534 t<br>MSY (1000 t) (95% CI): 10.2 (7.6–13.8)<br>$F_{MSY}$ (95% CI): 0.25 (0.08–0.45)<br>$B_{MSY}$ (1000 t) (95% CI): 37.8 (14.6–62.3)<br>$F_{2013}/F_{MSY}$ (95% CI): 1.06 (0.39–1.73)<br>$B_{2013}/B_{MSY}$ (95% CI): 1.13 (0.73–1.53)<br>$B_{2013}/B_{1950}$ (95% CI): 0.57 (0.37–0.76) | | | | | | | | No new assessment was undertaken in 2015. Thus, stock status is based on the previous assessment undertaken in 2014, as well as indicators available in 2015. The 2014 assessment was the second time that the WPB has applied a Stock Reduction Analysis technique to black marlin. Catches in 2014 have increase substantially from those estimated in 2013, with 17,948 t landed (up from 14,776 t). The continued large increases in catches is a substantial cause for concern. On the weight-of-evidence available in 2015, the stock is determined to be ***not overfished*** but ***subject to overfishing***. Click here for full stock status summary: Appendix VIII |
| Blue marlin *Makaira nigricans* | Catch 2014: 14,495 t<br>Average catch 20109–2014: 13,152 t<br>MSY (1000 t) (80% CI): 11.70 (8.02–12.40)<br>$F_{MSY}$ (80% CI): 0.49 (n.a.)<br>$B_{MSY}$ (1,000 t) (80% CI): 23.70 t (n.a.)<br>$F_{2011}/F_{MSY}$ (80% CI): 0.85 (0.63–1.45)<br>$B_{2011}/B_{MSY}$ (80% CI): 0.98 (0.57–1.18)<br>$B_{2011}/B_{1950}$ (80% CI): 0.48 (n.a.) | | | | | | | | No new assessment was undertaken in 2015. Thus, stock status is based on the previous assessment undertaken in 2014, as well as indicators available in 2015. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently being exploited near maximum levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method: Stock Reduction Analysis using only catch data. Total reported landings increased substantially in 2012 to 17,252 t, well above the MSY estimate of 11,690 t. In 2013 reported catches declined slightly to 13,843 t, still above the MSY level. Given the sharp increase in reported catches over the last two years, that are well above the MSY |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | level, the stock is may have moved to a state of being subject to overfishing. On the weight-of-evidence available in 2015, the stock is determined to be ***overfished*** but ***not subject to overfishing***. Click here for full stock status summary: Appendix IX |
| Striped marlin<br>*Tetrapturus audax* | Catch 2014: 4,049 t<br>Average catch 2010–2014: 4,122 t<br>MSY (1,000 t) (80% CI): 5.22 t (5.18–5.59)<br>$F_{MSY}$ (80% CI): 0.62 (0.59–1.04)<br>$B_{MSY}$ (1,000 t) (80% CI): 8.4 t (5.40–8.90)<br>$F_{2014}/F_{MSY}$ (80% CI): 1.09 (0.62–1.66)<br>$B_{2014}/B_{MSY}$ (80% CI): 0.65 (0.45–1.17)<br>$B_{2014}/B_{1950}$ (80% CI): 0.24 (n.a.–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 2015 reported catches declined to 4,049 t. On the weight-of-evidence available in 2015, the stock is determined to be ***overfished*** and ***subject to overfishing***. Click here for full stock status summary: Appendix X |
| Indo-Pacific Sailfish<br>*Istiophorus platypterus* | Catch 2014: 29,860 t<br>Average catch 2010–2014: 28,980 t<br>MSY (1,000 t) (80% CI): 25.00 (17.20–36.30)<br>$F_{MSY}$ (80% CI): 0.26 (0.15–0.39)<br>$B_{MSY}$ (1,000 t) (80% CI): 87.52 (56.30–121.02)<br>$F_{2014}/F_{MSY}$ (80% CI): 1.05 (0.63–1.63)<br>$B_{2014}/B_{MSY}$ (80% CI): 1.13 (0.87–1.37)<br>$B_{2014}/B_{1950}$ (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 examine the degree of localised depletion in Indian Ocean coastal areas. On the weight-of-evidence available in 2015, the stock is determined to be ***not overfished*** but ***subject to overfishing***. Click here for full stock status summary: Appendix XI |

This indicates the last year taken into account for assessments carried out before 2010

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

# 1. OPENING OF THE SESSION

1. The 13th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Olhão, Portugal, from 1 to 5 September 2015. A total of 23 participants (21 in 2014, 24 in 2013) attended the Session. The list of participants is provided at Appendix I. The meeting was opened on 1 September 2015 by the Chairperson, Dr Jérôme Bourjea (EU,France), who welcomed participants to Portugal.

# 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 WPB13 are listed in Appendix III.

# 3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

## *3.1 Outcomes of the 17th Session of the Scientific Committee*

3. The WPB **NOTED** paper IOTC–2015–WPB13–03 which outlined the main outcomes of the 17th Session of the Scientific Committee (SC17), specifically related to the work of the WPB.

4. **NOTING** paper IOTC–2015–WPB13–INF01 which detailed the new '*Guidelines for the presentation of CPUE standardisations and stock assessment models'* which were updated and adopted by the Scientific Committee at its meeting in December 2014, the WPB **REMINDED** all those delivering CPUE and Stock Assessment papers to adhere to the guidelines.

5. The WPB **NOTED** that in 2014, the SC made a number of requests in relation to the WPB12 report (noting that updates on Recommendations of the SC17 are dealt with under Agenda item 3.4). Those requests and the associated responses from the WPB13 are provided below for reference.

- ***Recreational and sports fisheries for marlins and IP sailfish in the Indian Ocean***
  - ***NOTING** that in 2011, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, commenced a process to facilitate the acquisition of catch-and-effort and size data from sport fisheries, by developing and disseminating reporting forms to Sport Fishing Centres in the region, the SC **REQUESTED** that the Chair and Vice-Chair of the WPB, work in collaboration with the IOTC Secretariat and the African Billfish Foundation to find a suitable funding source and lead investigator to undertake the project outlined in Appendix VI of the WPB12 Report. The aim of the project is to enhance data recovery from sports and other recreational fisheries in the western Indian Ocean region. The IOTC Secretariat shall circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence at a later date.* (SC17. Para. 35)
  - **Response:** Substantial effort was directed to finding suitable funding sources for this important work in 2014/15, however to date, all organisations approached have declined the request.
- ***Tier approach for providing stock status advice***
  - The SC **CONSIDERED** the proposal from the WPB to adopt a process to determine if a 'Tier' approach to ***providing*** stock status advice will likely enable the IOTC working parties to better communicate the levels of uncertainty present in the indicators used for monitoring the condition/status of IOTC stocks by categorising the types of assessments conducted, for the development of management advice/actions. Initial details of how a 'Tier' approach may be constructed are provided in Appendix XII of the WPB12 Report. The SC **REQUESTED** that the Chair of the WPM shall liaise with interested scientists to develop a revised proposal that includes the experience of other bodies, such as ICES, for consideration at the next SC meeting. (SC17. Para. 128)
  - **Response**: The IOTC Working Party on Methods will discuss this at its 6th Session to be held in October 2015.

## *3.2 Outcomes of the 19th Session of the Commission*

6. The WPB **NOTED** paper IOTC–2015–WPB13–04 Rev_1 which outlined the main outcomes of the 19th 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.

7. The WPB **NOTED** the 11 Conservation and Management Measures (CMMs) adopted at the 19th Session of the Commission (consisting of 11 Resolutions and 0 Recommendations) as listed below:

***IOTC Resolutions***

- Resolution 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence*
- Resolution 15/02 *On mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)*
- Resolution 15/03 *On the vessel monitoring system (VMS) programme*
- Resolution 15/04 *Concerning the IOTC record of vessels authorised to operate in the IOTC area of competence*
- Resolution 15/05 *On conservation measures for striped marlin, black marlin and blue marlin*
- Resolution 15/06 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna, and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 15/07 *On the use of artificial lights to attract fish to drifting fish aggregating devices*
- Resolution 15/08 *Procedures on a fish aggregating devices (FADs) management plan, including a limitation on the number of FADs, more detailed specifications of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species*
- Resolution 15/09 *On a fish aggregating devices (FADs) working group*
- Resolution 15/10 *On target and limit reference points and a decision framework*
- Resolution 15/11 *On the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*

8. The WPB **NOTED** that pursuant to Article IX.4 of the IOTC Agreement, the above mentioned Conservation and Management Measures shall become binding on Members, 120 days from the date of the notification communicated by the IOTC Secretariat in IOTC Circular 2015–049 (i.e. 10 September 2015).

9. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2014, which have relevance for the WPB (details as follows: paragraph numbers refer to the report of the Commission (IOTC–2015–S19–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. 10. *The Commission **CONSIDERED** the list of recommendations made by the SC17 (Appendix VI) from its 2014 report (IOTC–2014–SC17–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 (S19) and incorporated within 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. 10 of the S19 report)*

***Shortbill spearfish***

*The Commission **NOTED** the Scientific Committee recommendation SC17.09, which indicated that shortbill spearfish (Tetrapturus angustirostris) should be included in the list of species to be managed by the IOTC considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries. However, adding a new species to the official list of those to be covered by the IOTC mandate would require a modification of the IOTC Agreement. Such an inclusion would be considered at that time. (para. 11 of the S19 report)*

***Black marlin and blue marlin***

*The Commission **NOTED** the advice from the Scientific Committee that indicates that black marlin is currently subject to overfishing, and that blue marlin is currently overfished. (para. 16 of the S19 report)*

*The Commission **NOTED** that CMM proposal IOTC–2015–S19–PropE will provide a discussion point for these species, to address the concerns raised by the Scientific Committee. (para. 17 of the S19 report)*

***Striped marlin***

*The Commission **NOTED** the advice from the Scientific Committee that indicates the striped marlin stock is currently subject to overfishing and that biomass is below the level which would produce MSY. 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 recent declining effort trend. (para. 21 of the S19 report)*

*The Commission **RECALLED** that at its last Session, it agreed that it should take a precautionary approach to the management of striped marlin and consider, at its 19$^{th}$ Session, proposals for Conservation and Management Measures to reduce fishing pressure for striped marlin. (para. 22 of the S19 report)*

*The Commission **NOTED** that CMM proposal IOTC–2015–S19–PropE will provide a discussion point for this species, to address the concerns raised by the Scientific Committee. (para. 23 of the S19 report)*

***Swordfish***

*The Commission **NOTED** that the Scientific Committee had agreed with the advice from the Working Party on Billfish that there is no evidence of a separate genetic stock of swordfish in the southwest Indian Ocean, although this region has been subject to localised depletion over the past decade, or longer. Accordingly, until new evidence becomes available there is no need to conduct a separate stock assessment for this area. (para. 26 of the S19 report)*

***NOTING** the advice from the Scientific Committee on swordfish stock structure, and that the original concern expressed by the Commission was not about there being a separate stock, but rather, about the documented localised depletion in the southwest Indian Ocean, the Commission **AGREED** that a separate stock assessment is not necessary. (para. 27 of the S19 report)*

***Meeting Participation Fund***

*The Commission **NOTED** that the MPF was used to fund the participation of a reduced number of national scientists to the Working Parties in 2014 (49 in 2014; 58 in 2013; 42 in 2012), all of which were required to submit and present a working paper at the meeting. (para. 37 of the S19 report)*

*The Commission **NOTED** that at its 2014 meeting, the Scientific Committee had recommended that the Meeting Participation fund be maintained into the future and increased back to its original allocation of $200,000 per year (see recommendations SC17.34, para. 119). As per the IOTC Rules of Procedure (2014), the SC had reminded the IOTC Secretariat that the MPF budget should be spent at the ratio of 75:25 (science : non-science meetings) which would equate to US$150,000 science : US$50,000 non-science meeting. (para. 38 of the S19 report)*

*The Commission **AGREED** that the MPF budget remains important and therefore provisions according to the estimated needs will be integrated into the budget. (para. 39 of the S19 report)*

***Consultants***

***NOTING** the Scientific Committee's attempts to prioritise the various projects and consultancies which it had requested funding for in 2016, in particular, that the High priority projects were those which it felt must be undertaken in 2016, the Commission **REQUESTED** that only those High priority projects listed in the Scientific Committee budget be funded by the Commission's regular budget, with exceptions detailed in other areas of the S19 report. (para. 40 of the S19 report)*

10. **NOTING** the Commission's response to the recommendation by the WPB and SC in 2014 to add the shortbill spearfish (*Tetrapturus angustirostris*) to the list of species to be managed by the IOTC, the WPB **ACKNOWLEDGED** that this would be considered at the next revision of the IOTC Agreement, as the shortbill spearfish is a member of family Istiophoridae with ocean-wide distribution is highly-migratory and is commonly caught by IOTC fisheries.

***Meeting Participation Fund (MPF)***

11. The WPB **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 (current deadline is 45 days), and that the full Draft paper be submitted no later than 45 days (current deadline is 15 days) before the start of the relevant meeting, so that the Selection Panel may 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.

### *3.3 Review of Conservation and Management Measures relevant to billfish*

12. The WPB **NOTED** paper IOTC–2015–WPB13–05 which aimed to encourage participants at the WPB13 to review some of the existing Conservation and Management Measures (CMM) relevant to billfish, noting the CMMs referred to in document IOTC–2015–WPB13–04, and provided as Information Papers (IOTC–2015–WPB13–INF02 to INF05); 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.

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

### *3.4 Progress on the recommendations of WPB12*

14. The WPB **NOTED** paper IOTC–2015–WPB13–06 Rev_1 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.

15. 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.

***Billfish species identification***

16. **NOTING** that the Commission has approved US$30,000 for the printing of the species identification cards in 2016, as confirmed by the IOTC Secretariat at the 19th Session of the Commission, the WPB **RECOMMENDED** that the billfish species identification cards already translated into languages other than English and French, be printed in the first quarter of 2016 for dissemination.

17. The WPB **RECALLED** that electronic versions of the currently translated species identification cards are available at the following web link for download: http://iotc.org/science/species-identification-cards

18. The WPB **REQUESTED** the IOTC Secretariat to assist in translation of Billfish ID card into Malay-Bahasa, Sinhalese and Portuguese languages as a priority, **NOTING** with thanks, the offer from WWF Mozambique and IPMA (Portugal) to help in translating the cards into Portuguese.

19. The WPB **REQUESTED** CPCs provide feedback on the usefulness of the printed card in improving species identification for all billfish catches in reported statistics, at each WPB meeting.

20. The WPB reiterated the **RECOMMENDATION** that the IOTC Secretariat ensure that hard copies of the identification cards continue to be printed as many CPCs scientific observers, both on board and port, still do not have smart phone technology/hardware access and need to have hard copies. At this point in time, electronic formats, including 'applications or apps' are only suitable for larger scale vessels, and even in the case of EU purse seine vessels, the use of hard copies is relied upon due to on board fish processing and handling conditions, as well as weather conditions. Electronic versions may be developed as a complementary tools.

***Sports fishery data collection***

21. The WPB **RECOMMENDED** that the Chairperson and Vice-Chairperson continue to work in collaboration with the IOTC Secretariat and the African Billfish Foundation to find a suitable funding source and lead investigator to undertake the project outlined in Appendix VI. The aim of the project is to enhance data recovery from sports and other recreational fisheries in the western Indian Ocean region. The Chairperson shall circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence at a later date.

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

### *4.1 Review of the statistical data available for billfish*

22. The WPB **NOTED** paper IOTC–2015–WPB13–07 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 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2014. 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 the standard measurement used for each species. A summary of the supporting information for the WPB is provided in Appendix IV.

23. The WPB **NOTED** the main billfish data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix V, and

**REQUESTED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

24. **NOTING** that the IOTC Secretariat estimates total catches using alternative sources to obtain the best possible information to use in scientific advice, and that this approach has been endorsed by the SC, the WPB **AGREED** that this approach should continue.

25. The WPB **NOTED** that the recent increase of billfish catches in the north-west Indian Ocean was probably associated with decreased piracy activities and the return of many fleets such as longline and gillnet into this area (i.e. Japan (longline), TaiwanChina (longline) and I.R. Iran (gillnet)).

26. **NOTING** that the high variability of striped marlin reported catches (in particular periods with extremely high catches followed by low catches) remained unexplained, the WPB **REQUESTED** that the main fleets reporting catches of striped marlin (Japan, Taiwan,China and Rep. of Korea) investigate the variability observed and report findings to the next WPB meeting focusing on striped marlin.

27. The WPB **REQUESTED** the IOTC Secretariat to provide total catches for each billfish species by area (NE, NW, SE, SW, OT) as this information should be available every year, not only assessment years.

### *4.2 Review of new information on fisheries and associated environmental data*

***Malaysian billfish fishery***

28. The WPB **NOTED** paper IOTC–2015–WPB13–10 which outlined the billfish fishery by Malaysian flagged tuna longline vessels operating in the southwest Indian Ocean, including the following abstract provided by the authors:
“*A total of 5 Malaysian tuna longliners began to fish for albacore in the vicinity of southern Madagascar since the 3rd quarter of 2011. Total catch of billfishes (which comprised of marlin and swordfish) in 2014 showed a significance increase to 118.56 tons from only 53.78 tons in 2013. The sudden increased was recorded for swordfish from only 22.4 tons in 2013 to 93.14 tons in 2014, an increased of over 300%. The catches of marlin showed a decreased by 19.28% in 2014 compared to 2013. Peak landing periods can be observed for both species which does not coincide with peak fishing periods.*”

29. The WPB **AGREED** that single marlin species reported in the fishing logbooks as black marlin most probably is a mixture of several species: black marlin, blue marlin and striped marlin.

30. **NOTING** the absence of observers onboard fishing vessels, which leads to misidentification of marlins to the species level in this study, the WPB **REQUESTED** Malaysia to engage with the IOTC Regional Observer Scheme (ROS) training workshops. The IOTC ROS workshop series will commence in Oman this October with additional workshops planned in 2016 for the eastern Indian Ocean CPCs.

31. The WPB **REMINDED** Malaysia of the requirement contained in Resolution 11/04 that all observer reports must be submitted to the IOTC Secretariat within 150 days of the end of the observer trip.

***Maldives billfish fishery***

32. The WPB **NOTED** paper IOTC–2015–WPB13–11 which provided an update on the Maldives billfish fishery, including the following abstract provided by the authors:
*“Fishers have been targeting billfish in the Maldives for a long time but the billfish fishery in the Maldives did not expand until recently. The complete ban of shark fishing across the Maldives in 2010 appeared to have compelled those engaged in the shark fishery to target billfishes. In addition, billfishes are a popular fish consumed by tourists visiting the Maldives. The expansion of the tourism industry had opened new opportunities for billfish fishers and has also initiated big game fishing targeting billfish and other large fish. In the targeted billfish fishery, fishers from several communities across the country, catch billfish using troll lines and drop lines along the outer edge of the atolls. Billfish are also taken as bycatch in the longline fishery and also occasionally in the large yellowfin handline fishery and the troll fishery targeting kawakawa and frigate tuna. Foreign longline vessels were allowed to fish in the Maldives EEZ from mid 1980s till 2010.*” – (see paper for full abstract)

33. The WPB **NOTED** that the Maldives fisheries are dominated by artisanal vessels using a large variety of gears to catch billfish and that about 80% of Maldivian catch are represented by Indo-Pacific sailfish.

34. The WPB **AGREED** that the actual level of billfish landings are highly uncertain, due to widely dispersed landing sites and that the vessels targeting billfish are not currently covered by an on-board observer program.

35. **NOTING** the pending implementation of logbooks for reef fish fisheries, expected in early 2016 the WPB **REQUESTED** that the Maldives provide an update on its implementation at the next WPB meeting.

36. The WPB **AGREED** that market landing data should be combined with logbook data and reported to the IOTC Secretariat, so that a complete idea of landings is available on billfish species.

***I.R. Iran billfish fishery***

37. The WPB **NOTED** paper IOTC–2015–WPB13–12 which outlined the billfish gillnet fishery in the I.R. Iran, including the following abstract provided by the authors:

"*Iran (Islamic Republic of) fishing grounds in Northern and southern waters of the country are located in the Caspian Sea and Persian Gulf and Oman Sea. 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. The long Iranian coastline about 193 port and landing places and about 143 thousand fishermen individuals which are directly engaged in fishing activities and Around 12 thousand fishing crafts consist of fishing boats, Dhows and vessels using different fisheries including: Gillnet, Purse seine Trolling, Trawl and Wire-trap which are engaged in fishing operation according to a time schedule during different fishing seasons in the coastal and offshore waters. Gillnet and purse seine are two main fishing methods used by Iranian vessels to target large pelagic species (especially tuna and tuna-like) in the IOTC area competency and also some of small boats used trolling in coastal fisheries. Gillnet is the dominant gear in all areas. Majority of the production come from the Gillnet coastal and offshore waters. More Billfish's are caught as incidental catch in offshore waters targeting other species. In terms of area, more Billfishes are caught in northwestern areas.*" – (see paper for full abstract)

38. The WPB **NOTED** that the new data reported by I.R. Iran highlighted the importance of those 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 compromise 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 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.

39. The WPB **REQUESTED** that the IOTC Secretariat assist I.R. Iran to assess if separate reporting on I.P. sailfish in the Persian Gulf and Oman Sea is possible, and I.R. Iran report at the next WPB.

***Seychelles billfish fishery***

40. The WPB **NOTED** paper IOTC–2015–WPB13–13 which outlined the billfish bycatch by the Seychelles industrial longline fishery, including the following abstract provided by the authors:

"*Billfishes are incidental catches of Seychelles industrial longline fishery primarily targeting bigeye tuna. On average billfishes comprising of swordfish, marlins and sailfish accounted for 14% of the total catch of that fishery per year, over the last 11 years. The Seychelles industrial longline fleet started operating in the Indian Ocean in 1999 and in 2014, the fleet comprised of 36 vessels with an average of 542.3 GT. The total billfish catches exhibited same trend in catches as bigeye tuna with a progressive drop in the total billfish catches (swordfish, marlins and sailfish) from 2004 to 2011 followed by a sharp increased in catches in 2012 where catches of both swordfish and marlins increased from less than 400 Mt to around a 1000 Mt amounting to a record catch of 2,144 Mt of billfishes since the beginning of the fishery. Similarly, the catch rate for billfish followed a decreasing trend from 2004 to 2011 and increased sharply in 2012 to 0.11 Mt/1000 hooks and has stabilized to around 0.07 Mt/1000 hooks over the last two years.*" – (see paper for full abstract)

41. The WPB **NOTED** that catches presented in the paper are those for Seychelles-flagged vessels (i.e. vessels registered in Seychelles), and that catches presented correspond to those reported to fisheries authorities and have not been raised to take into consideration total fishing effort.

42. The WPB **NOTED** that catches of billfish by the Seychelles flagged fleet increased substantially in 2012, associated with bigeye tuna catches and a decrease in albacore catches. Such changes in catchability may indicate associated changes in fishing strategy (i.e. a return to waters outside the Somalian EEZ) or environmental anomaly.

***Thailand billfish fishery***

43. The WPB **NOTED** paper IOTC–2015–WPB13–14 which outlined the billfish catch by the Thailand longline fishery from 2010 to 2014, including the following abstract provided by the authors:

"*Thai tuna longliners have operated in the Indian Ocean since 2007. This report was based on the data extracted from fishing logsheets by three Thai tuna longliners namely, "Mook Andaman 018" "Mook Andaman 028" and "Ceribu", which declared to Department of Fisheries, Thailand. Data from their logsheets displayed important information of their fishing operation and effort. During the years 2010-2014, fishing grounds were mainly in the Western of Indian Ocean with 1,980 fishing day. The total catch by numbers was 61,179 fishes with 2,331.19 tons. The average catch rate (CPUE) of total catch were 11.62 fish/1,000 hooks and 442.71 kg/1,000 hooks. The major species caught were bigeye tuna (Thunnus obesus), yellowfin tuna (T. albacares), albacore tuna (T. alalunga), billfish, sharks and other species constituting 44.40, 20.59, 20.76, 9.82, 3.45 and 0.95% of the total catch, respectively. During the years 2010-2014,* *billfish were caught 6,009 fishes with 281.27 tons. The average catch rate of billfish was 1.14 fish/1,000 hooks and 53.42 kg/1,000 hooks.*" – (see paper for full abstract)

44. The WPB **NOTED** that Thailand has deployed large longliners in the Indian Ocean since 2007 and was reminded that 2007-12 data were presented to the WPB in 2013. However, when presenting fishery data of this nature, Thailand was reminded that it should be presented for the entire history of the fishery, in this case from 2007-2014.

45. The WPB **ENCOURAGED** fishery authorities from Thailand to deploy observers onboard large longliners and to send observer reports in accordance with IOTC Resolution 11/04 *on a regional observer scheme*.

***ObServe: Database and operational software***

46. The WPB **NOTED** paper IOTC–2015–WPB13–29 which provided an overview of 'ObServe', a database and operational software for longline and purse seine fishery data, including the following abstract provided by the authors:
"*Observation data collected aboard fishing vessels are essential to describe the impact of fisheries on fish community. The Institut de Recherche pour le Développement (IRD, France) has been sending observers aboard tropical purse-seiners since 1995 in the Atlantic and Indian Oceans, and longliners since 2007 in the Indian Ocean. Since 2005, IRD is appointed by the European Union (EU) and the French Direction des Pêches Maritimes et de l'Aquaculture (DPMA, French government) to conduct scientific observations aboard French vessels to monitor tropical fisheries in the framework of EU Data Collection Framework (DCF). To monitor this program, the Observatoire Thonier (OT) from IRD has been developing since 2010 an information system named ObServe that is intended to manage data collected in the framework of DCF. ObServe consists of (i) a central database based on PostgreSQL, (ii) a Java-based software used for data acquisition and management, and (iii) data synchronization features between these two modules.*" – (see paper for full abstract)

47. The WPB **AGREED** that ObServe is useful tool to store and manage tuna fisheries data collected by observers on board both purse seine and longline vessels and **REQUESTED** that IRD presents this tool to the IOTC Secretariat.

48. The WPB **ENCOURAGED** IRD to develop training modules on ObServe utilisation, for potential incorporation within the broader IOTC Regional Observer Scheme training program.

### 4.3 New information on sport fisheries

***Kenyan sports fishery***

49. The WPB **NOTED** paper IOTC–2015–WPB13–15 which provided an overview of historical catch of marlins caught by sports fishers in Kenyan waters, including the following abstract provided by the authors:
"*Black marlin (Makaira indica), Blue marlin (Makaira nigricans) and Striped marlins (Tetrapturus audax) are among the billfishes caught by sports fishers in Kenyan waters. Recreational fishery data consisting of retained, tag and release data of marlins obtained from sports fishers' clubs between 1987 and 2012 were used to investigate historical trend of three species of marlins through time. A total of 2,926 fish were caught. Black marlins were the majority with 1,221 recorded closely followed by Striped marlins at 1,132 while only 209 blue marlins were reported. Temporal distribution of the Striped marlins and Blue marlin show a peak in January with most of the catches appearing between December and March. Black marlins have two main seasons with the first occurring between January and March with a peak in February while the second season occurs between July and September with the peak in September. Although the annual catches of Striped marlin and Black marlins are usually below 50, between 2009 and 2010, the catches of striped marlins were 113 and 233 respectively while the peak catches of Black marlin were experienced between 2006 and 2010 ranging between 63 and 148.*" – (see paper for full abstract)

50. The WPB **AGREED** that sport fisheries CPUE would be important sources of information on billfish abundance, and potentially in future stock assessments.

51. The WPB **ACKNOWLEDGED** the analysis on the Kenya long-term sport fisheries dataset and **REQUESTED** that Kenya continues investigating this dataset for consideration at the next WPB meeting.

52. 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 fish species.

***African Billfish Foundation***

53. **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.

54. The WPB **NOTED** the absence of ABF representatives at the WPB13 meeting and **ENCOURAGED** both the ABF and IOTC to find solutions to ensure the presence of the ABF in future meetings of WPB, particularly given the importance and relevance of their activities in relation to the WPB Program of Work.

***Istiophorid billfish taxonomy***

55. The WPB **NOTED** an ad-hoc presentation on the '*Taxonomy of istiophorid billfish*' which outlined current status of billfish taxonomy in the World Oceans, including the following abstract provided by the authors:

"*Taxonomy and systematics of billfish underwent considerable changes in recent 40 years. There are several approaches that still considered as valid in scientific community. Classic morphological approach of Nakamura (1983 recognised 2 billfish families (Xiphiidae and Istiophoridae). The former consist monospecific genus represented by single species Xiphias gladius. The latter consists of three genera (Istiophorus, Makaira and Tetrapturus) represented by 13 species. Some species from the group were not recognized at certain level, in particular by FAO recognising Indo-Pacific blue marlin and Atlantic blue marlin were as single species: Makaira nigricans. Recent billfish taxonomy developed using genetic markers (Collette et al., 2006, Hanner et al., 2011) proposed five genera (Istiophorus, Istiompax, Kajikia, Makaira, and Tetrapturus) represented by 9 species. Nomenclature of billfish based on genetic approach is not widely recognized yet but often used in scientific work in parallel with morphology-based nomenclature. Adoption of new nomenclature implies changes in IOTC data collection forms, manuals and databases.*"

56. The WPB **AGREED** that the IOTC, an FAO regional body, should continue to follow FAO accepted nomenclature, until such time as FAO modified them.

57. The WPB **AGREED** that information to be presented at IOTC working parties and other meetings should be in compliance with FAO-accepted nomenclature. This was of particular concern at the WPB13, as there were several papers on striped marlin were presented with alternative specie names. This would be of even more concern if data is being submitted to the IOTC Secretariat with different species names.

# 5. SWORDFISH

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

***Mozambique swordfish longline fishery***

58. The WPB **NOTED** paper IOTC–2015–WPB13–16 which provided an overview of swordfish catches from the Mozambique longline fleet, as determined by on-board observers, including the following abstract provided by the authors:

"*Preliminary results of the implementation of on-board observer sampling program on Mozambique longline fleet indicated swordfish as one of the most common target species in southern Mozambique, besides of bigeye and yellowfin tuna. Together these three species represented 70% of the fish caught in numbers and approximately 85% of the total retained catch in weight. Particularly swordfish represented 29% of the catch in numbers and approximately 25% of the total retained catch in weight. From the total number of swordfish specimens sampled to assess their biological attributes during April to June (n=126), 82% were female and the remaining 18% were male fish (ratioM:F=1:4). The majority were fish with active gonads (stage II), 56% of female fish and 95% of males. Ripe females were also significant in the catches, 36% of total female swordfish sampled. The average fork length (±SD) for swordfish was 118 cm (±40), with an average size for males of 125 cm (±24) and 117 cm (±42) for females.*" – (see paper for full abstract)

59. The WPB **NOTED** the importance for Mozambique to continue and increase the fishery observer program as this is a new fleet to the fishery that is currently increasing. The fleet size is expected to increase by up to 11 longline vessels by the end of 2015. The authors explained that the fishery started in December 2014. In 2015 the observer coverage is expected to be between 5-10% of fishing effort.

60. The WPB **NOTED** the very low percentage of blue shark in the reported catch, which is unusual given that the main target species is swordfish. There is also considerable catch of tropical tunas, which is also not very usual in longline fisheries targeting mainly swordfish. In terms of marlins, only black marlin was recorded, which again was considered unusual. This could be happening due to the depth of the hooks being set deeper than usual longline vessels targeting swordfish targeting, or because of seasonal aspects, as the current data analysed to this stage is only based on very few trips and in limited seasons.

61. The WPB **NOTED** that the fishery observers used in the program are trained by the Mozambique National Fisheries Institute and listed at the IOTC fishery observers database. Observers are employed by the Mozambique Government as fisheries officers.

62. The WPB **NOTED** that logbooks are also being used by the new longline vessels entering the fishery, with almost 100% usage, and all vessels have VMS.

### *5.2 Review of new information on the status of swordfish*

#### *5.2.1 Nominal and standardised CPUE indices*

63. **NOTING** that swordfish was not a priority species in 2015 (it will be assessed in 2017 as per the Program of Work (see Appendix XII), no updated CPUE indices were submitted for consideration by the WPB in 2015. However, the WPB **REQUESTED** that key CPCs (Taiwan,China, Sri Lanka, Indonesia, Japan and EU,Portugal, EU,Spain) provide updated CPUE indices annually as indicators of stock status between stock assessment years.

64. The WPB **AGREED** that during the meeting prior the next swordfish stock assessment (scheduled in 2017), time should be dedicated to prepare clear guidelines to the work to be done on standardisation of CPUE as well as stock assessment in order to improve the selection of stock status indicators. Time should also be devoted to the examination of biological parameters, and catch at size (length-composition) data used in assessments.

#### *5.2.2 Selection of Stock Status indicators for swordfish*

65. The WPB **AGREED** that swordfish stock status should be determined from the SS3 stock assessment undertaken in 2014 as it was considered most likely to numerically and graphically represent the current status of swordfish in the Indian Ocean. The WPB other analysis were treated as being informative of the results.

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

66. The WPB **ADOPTED** the management advice developed for swordfish (*Xiphias gladius*), as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for swordfish with the latest 2014 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 VII

## 6. MARLINS

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

***Striped marlin genetic population structure***

67. The WPB **NOTED** paper IOTC–2015–WPB13–30 which provided an overview of the development of a novel high-throughput assay to evaluate genetic population structure in striped marlin, including the following abstract provided by the authors:

    "*To date, population genetic studies of highly migratory marine fishes have generally been characterized by a small number of molecular markers that represent a limited portion of the genome, and opportunistic sampling designs that include a small number of individuals per putative population. These characteristics compromise the statistical power necessary to detect the low levels of genetic differentiation typically associated with populations of marine fishes. Additionally, unintentional sampling of mixed-population assemblages results in a noisy genetic signal that may obscure population-specific information. Although previous evaluations of genetic population structure in Pacific striped marlin have identified multiple populations, genetic differentiation has been low and likely compromised by small numbers of molecular markers and samples per population, and sampling of mixed-population assemblages. In the current study, next-generation sequencing-based methodology will be used to identify large numbers of molecular markers in samples collected using a biologically-informed sampling design to target individual populations.*" – (see paper for full abstract)

68. The WPB **AGREED** that this study may provide important information on genetic structure of striped marlin stocks and that there are plans to investigate the stock structure of marlins and Indo-Pacific sailfish.

69. The WPB **ENCOURAGED** all CPCs to collaborate with the authors in the collection of genetic material for further study.

70. The WPB **REQUESTED** the IOTC Secretariat to seek additional information on the project and to compare it with the current IOTC Stock Structure Project, so that the two projects may complement each other.

*La Reunion observer data*

71. The WPB **NOTED** paper IOTC–2015–WPB13–20 which detailed spatio-temporal and length distributions of istiophorids in the southwest Indian Ocean inferred from scientific, observer and self-reporting data of the Reunion Island based pelagic longline fishery, including the following abstract provided by the authors:

"*The Reunion Island longline fishery primarily targets swordfish at night but also catches tuna and istriophorids (black marlin Makaira indica, blue marlin Makaira mazara, striped marlin Tetrapturus audax, Indo-Pacific sailfish Istiophorus platypterus, and shortbill spearfish Tetrapturus angustirostris) often in the daytime. Using data collected by professional observers and fishermen in the framework of EU Data Collection Program between 2007 and 2014, and data collected at the occasion of scientific cruises, we intend in this paper to (i) assess the quality of billfish identification, (ii) provide spatio-temporal distributions of billfish catch per unit of effort, and (iii) length distribution for these 5 species. We found a relatively high proportion of unidentified billfish highlighting poor species recognition by some observers and fishermen in years prior to 2013. Our results demonstrate some deviation between scientist/observer data and self-reported data by fishermen for blue and striped marlins. Concerning spatio-temporal patterns of billfish catch per unit of effort, we found that higher catch per unit effort of blue and black marlin were recorded during the first and fourth quarters of the year while Indo-Pacific sailfish abundance was higher during the fourth quarter only*." – (see paper for full abstract)

72. The WPB **AGREED** that the IOTC species identification cards have been and will continue to be an essential tool in the improvement of marlin species identification by fishing crew and observers.

73. **NOTING** the commitments and effort made by CAP-RUN in training and identification card implementation/use, the WPB **ENCOURAGED** CAP-RUN to continue this extremely important activity.

74. **NOTING** that training of observers and crew is long-term and necessarily meticulous work that should be done on a recurrent way in order to optimise the efficiency of observers, the WPB **RECOMMENDED** that the IOTC Secretariat increases its effort in training observers, including species identification.

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

### 6.2.1 Nominal and standardised CPUE indices

*Japan longline CPUE*

75. The WPB **NOTED** paper IOTC–2015–WPB13–17 Rev_1 which provided a CPUE standardisation for striped marlin caught by the Japanese longline fishery (Figs. 1, 2) in IOTC area of competence, including the following abstract provided by the authors:

"*In order to address stock assessment for striped marlin (Tetrapturus audax) in the Indian Ocean, we calculated standardized catch per unit effort (CPUE) of Japanese longline fishery. We supposed four area definitions (North East, North West, South East and South West). We used operational catch and effort data compiled by National Research Institute of Far Seas Fisheries, Japan. To reduce zero-catch ratio, we addressed three approaches 1) data screening with simple log-normal model, 2) core area with lon-normal model 3) separated time series with log-normal model (1976-1989, 1990-2013). We calculated combine standardized CPUE that was area weighted under 1) and 3) approach. In addition, we discussed difficulties to treat zero-catch data for a future work*."

76. The WPB **NOTED** that the time series show a peak and a large drop from the early to the later years. This is considered to be a function of a change in catchability prior to and after 1990. The series was subsequently split at 1990 for separate the standardisations. The CPUE in the period prior to 1990 may be an overestimation of the relative abundance. In addition, there were a large number of zero records, and since the Zero Inflated Model did not converge. Hence, the log-Normal model was used, with added mean 10% value of the overall nominal CPUE constant (though probably not the most appropriate).

77. The WPB **NOTED** that the 2011 point should not be used, as effort (number of sets) substantially declined in the year.

78. The WPB **NOTED** that interactions were not used in the model due to convergence issues, though it would help smoothen some of the large variances. Other techniques such as a polynomial term in the Hooks Between Floats (HBF), or using GAMS (cubic splines) were alternatives to the proxies of targets.

79. The WPB **NOTED** that using vessel effects or trip effect (possibly as random effects) may also help, as well as using a Delta Log Normal Model to deal with zero's in the dataset.

80. The WPB **NOTED** that similar to 2013, the core area approach should be examined and that the series should be split so that catchability changes before and after 1990 could be examined. Using the proportion of catches of main target species such as bigeye tuna and yellowfin tuna of total catch would also be a useful to analyse in subsequent years (however this index includes a biomass trajectory effect, thus it needs careful treatment).

81. **NOTING** the new series presented by the authors during the meeting, with the series split discussed above (1990) (Fig. 1), the WPB **AGREED** to exclude the estimated 2011 standardised point for stock assessment purposes due to low coverage in that year. The peak in the very beginning of the series was also discussed, but retained for assessment purposes. Discarding the series prior to 1980 is an option to be considered for the next stock assessment, but was finally used in the assessment.

82. The WPB **NOTED** that using cluster analysis may be a solution for catchability issues discussed during the meeting. HBF is thought to be an information factor of catchability because Japan longline vessels changed from shallow sets to deep sets.

***Taiwan,China longline CPUE***

83. The WPB **NOTED** paper IOTC–2015–WPB13–31 Rev_1 which provided a CPUE standardisation for striped marlin caught by the Taiwan,China longline fishery (Figs. 1, 2) in IOTC area of competence, including the following abstract provided by the authors:

"*In this study, cluster analysis and principle component analysis were conducted based on catch composition of Taiwanese longline fishery in the Indian Ocean. Both of clusters and principle component scores can represent the historical fishing pattern related to characteristics of targeting species. Also, there were appropriate relationships between numbers of hooks between float and clusters of catch composition and principle component scores. Therefore, clusters of catch composition and principle component scores can be used as substitute factors related to characteristics of fishing operations when information of number of hooks between float is not available. In addition, the CPUE standardization of striped marlin (Kajikia [Tetrapturus] audax) caught by the Taiwanese longline fishery in the Indian Ocean was conducted for time periods of 1980-2013. Since striped marlin is caught by Taiwanese longline fleet as bycatch species and large amounts of zero catches was recorded in the operational data, CPUE standardization was conducted using the delta-lognormal GLM*." – (see paper for full abstract)

84. The WPB **NOTED** the improvement in the approach presented and thanked the author for submitting the series despite not being able to attend the meeting in person. Some improvements such as presenting which interaction terms were used in the final model should be made in future years. Also diagnostic analysis of residuals, and exploratory analysis of the effect of the variables would be useful.

85. The WPB **AGREED** that the Principle Component Analysis (PCA) approach should be used instead of the Clustering approach as this gave better results on AIC and BIC values, when modelling the positive sets. However, the use of Component 3 of the PCA may not be appropriate

86. The WPB **NOTED** that the use of clustering and PCA was a useful approach in dealing with the absence of HBF prior to 1995, and such techniques help examine sets that are used for targeting certain species groups and use all the data in the Taiwan,China database.

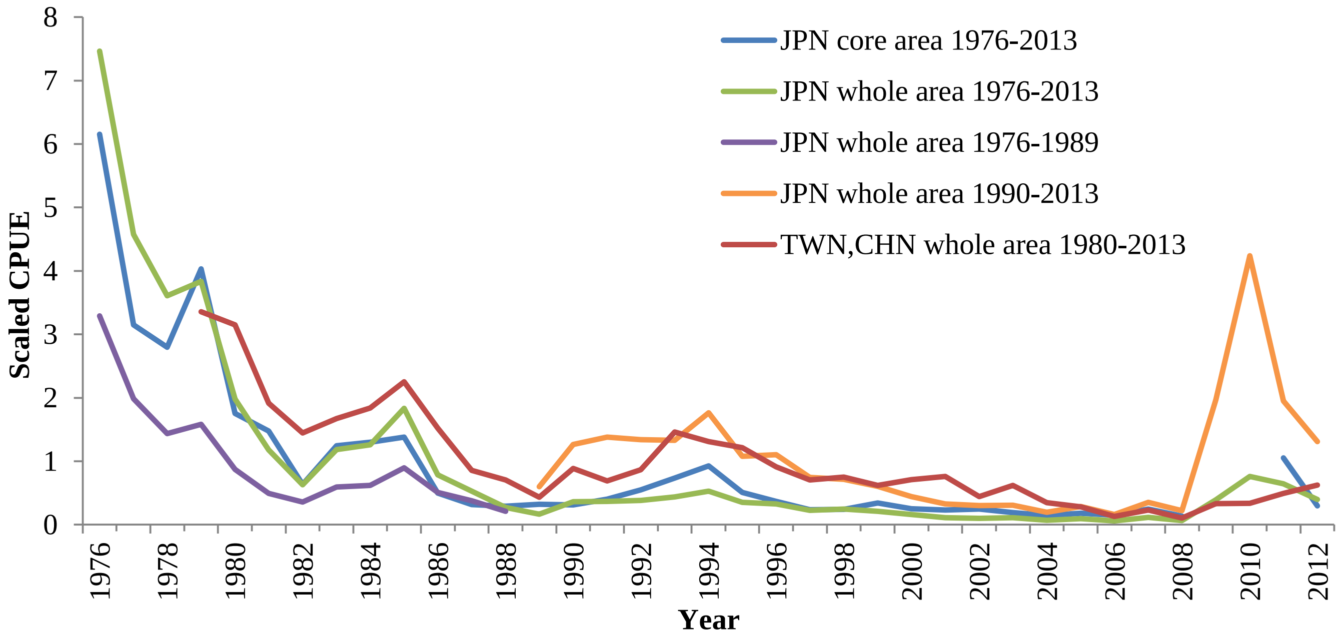



**Fig. 1.** Striped marlin. Japan and Taiwan,China longline standardised CPUE series. CPUEs were scaled with respect to the mean of the each standardised period, for Japan longline core area (JPN core area 1976-2013), Taiwan,China longline (TWN,CHN whole area 1980-2013), Japan longline all areas (JPN whole area 1976-2013), Japan longline all

areas from 1976 to 1989 (JPN whole area 1976-1989), and Japan longline all areas from 1990 to 2013 (JPN whole area 1990-2013).

***CPUE Summary discussion***

87. The WPB **AGREED** that there was merit in exploring the option of pooling the data across fleets (Japan and Taiwan,China). This was examined in the CPUE workshop (CPUEWS) on longline fisheries for tropical tunas and was a recommendation made by the CPUEWS. In addition using cluster analysis and fleet effects may improve and determine targeting effects over time, and help obtain a more representative index accounting for changes in catchability.

88. The WPB **ENCOURAGED** further analysis on standardisation to deal with these effects in future years, and work collaboratively with Taiwan,China to address these issues.

89. The WPB **NOTED** the following regarding the state of CPUE analysis for fleets with important catches of striped marlin in the IOTC area of competence:
   - Uncertainty remains on the appropriate spatial units for the CPUE standardisation.
   - Trends in standardised CPUE differ among fleets that operate in the same area, and efforts should be made to understand why there are these differences for the main longline fleets operating in similar areas.
   - Fleet effects should be examined in subsequent years, and appropriate methods of dealing with zero catches using alternative methods, like the hurdle models (e.g. Delta approach), and zero inflated models should be used.
   - In general the methods to deal with bycatch species in longline fisheries have improved substantially.

90. The WPB **AGREED** that study of environmental data (e.g. climate index and/or factors affecting catchability) in relation with CPUE changes should be encouraged as an important tool in understanding short-term CPUE spikes.

91. The WPB **NOTED** that of the striped marlin CPUE series available for assessment purposes, the Japan and Taiwan,China series were used in the final stock assessment models investigated in 2015, for the reasons discussed above (Fig. 2).
   - Japan data (1976–2013) with a split at 1990 due to changes in catchability, and the 2011 standardised point removed, from document IOTC–2015–WPB13–17 Rev_1.
   - Taiwan,China data (1980–2014) from document IOTC–2015–WPB13–31 Rev_1, with preliminary data for 2014 added in Fig. 2.

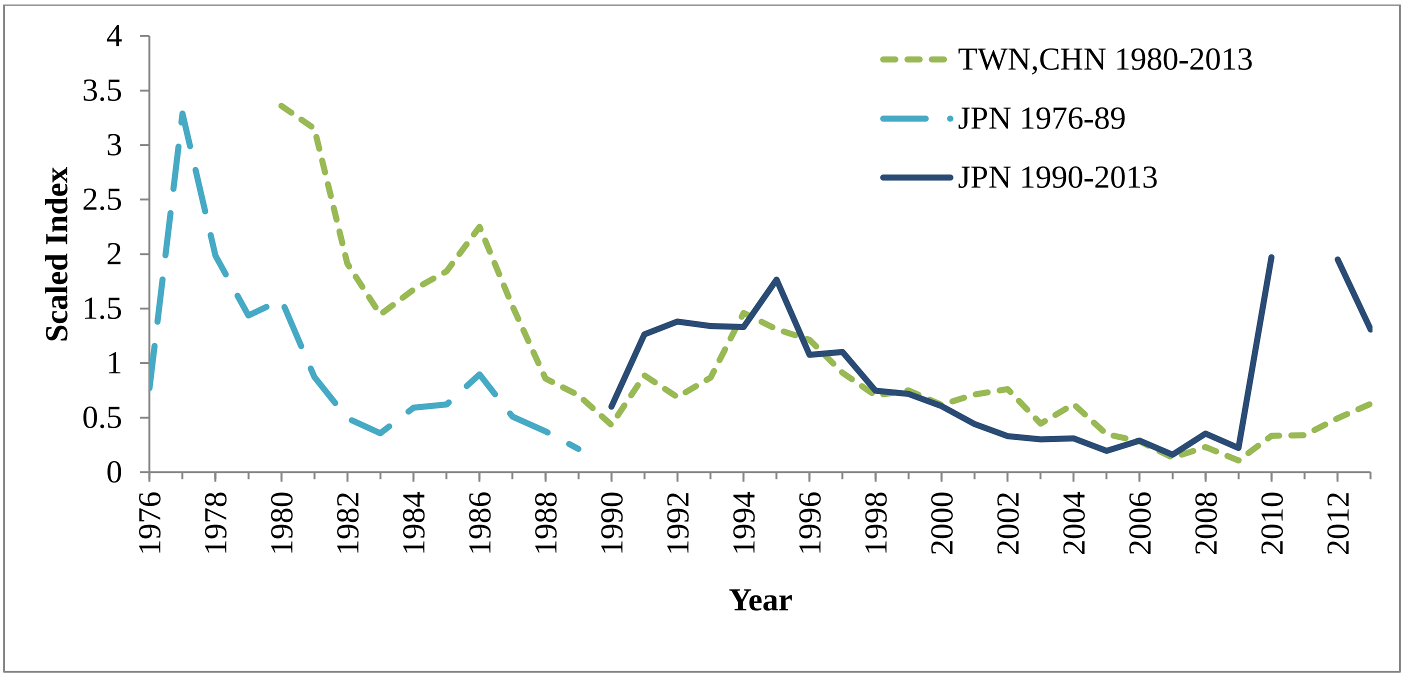



**Fig. 2.** Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) and Taiwan,China (TWN,CHN) as calculated based on the IOTC catch and effort aggregated dataset (whole Indian Ocean). Values were scaled with respect to the mean of the period used for each series. Japan index was split due to different catchability before and after 1990, and the 2011 standardised point removed.

#### *6.2.2 Stock assessments*

***Striped marlin: Summary of stock assessment models in 2015***

92. The WPB **NOTED** Table 2 which provide an overview of the key features of each of the stock assessments presented in 2015 for the Indian Ocean-wide assessments (4 model types). Similarly, Table 3 provides a summary of the assessment results.

**Table 2.** Striped marlin: **Indian Ocean-wide** assessments. Summary of final stock assessment model features as applied to the Indian Ocean striped marlin resource in 2015.

| **Model feature** | **BSPM (Doc# 18)** | **ASPIC (Doc #19 Rev_2)** | **ASIA (Doc# 32 Rev_1)** | **SRA (Doc# 33)** |
|---|---|---|---|---|
| Software availability | Private | NMFS toolbox | Private | Martell and Froese 2012 |
| Population spatial structure / areas | 1 | 1 | 1 | 1 |
| Number CPUE Series | 2 | 2 | 2 | No |
| Uses Catch-at-length/age | No | No | Yes | No |
| Age-structured | No | No | Yes | No |
| Sex-structured | No | No | Yes | No |
| Number of Fleets | 1 | 3 | 3 | 1 |
| Stochastic Recruitment | No | No | Yes | No |

**Table 3.** Striped marlin: **Indian Ocean-wide** summary of key management quantities from the assessments undertaken in 2015.

| Management quantity | **BSPM** (Doc# 18)** | **ASPIC (Doc #19 Rev_2)** | **ASIA (Doc# 32 Rev_1)** | **SRA (Doc# 33)** |
|---|---|---|---|---|
| 2014 catch estimate (t) | 4,049 | | | |
| Mean catch from 2010–2014 (t) | 4,122 | | | |
| *h* (steepness) (base case) | n.a. | n.a. | 0.86 | n.a. |
| MSY (1,000 t) (80% CI) | 5.14 (4.50–9.71) | 5.22 (5.18–5.59) | 6.40 (5.25–7.85) | 4.31 (4.11–4.61) |
| Data period (catch) | 1950–2013 | 1950–2014 | 1950–2014 | 1950–2014 |
| CPUE series | LL: Japan & Taiwan,China | LL: Japan & Taiwan,China | LL: Japan & Taiwan,China | n.a. |
| CPUE period | Japan: 1971–2012 Taiwan,China: 1980–2011 | Japan: 1976–1989 Japan: 1990–2013 Taiwan,China: 1980–2013 | Japan: 1976–2013 Taiwan,China: 1980–2013 | n.a. |
| $F_{MSY}$ (80% CI) | 0.33 (0.26-0.36) | 0.62 (0.59–1.04) | 0.73 (0.71–0.75) | 0.14 (0.09–0.18) |
| $SB_{MSY}$ or $*B_{MSY}$ (1,000 t) (80% CI) | 13.10 (*12.75*–24.61) | 8.4 (5.4–8.9) | 6.95 (5.73–8.50) | 32.07 (24.00–37.09) |
| $F_{2014}/F_{MSY}$ (80% CI) | 1.38 (0.00–4.30) | 1.09 (0.62–1.66) | 0.55 (0.33–0.91) | 1.58 (0.70–3.11) |
| $B_{2014}/B_{MSY}$ (80% CI) | 0.64 (*0.34*–2.10) | 0.65 (0.45–1.17) | n.a. | 0.57 (0.30–0.79 |
| $SB_{2014}/SB_{MSY}$ (80% CI) | n.a. | n.a. | 0.85 (0.53–1.29) | n.a. |
| $B_{2014}/B_{1950}$ (80% CI) | 0.32 (*0.17*–1.00) | 0.24 (n.a.–n.a.) | n.a. | 0.29 (0.15–0.40) |
| $SB_{2014}/SB_{1950}$ | n.a. | n.a. | 0.24 (0.15–0.37) | n.a. |

| | | | | |
|---|---|---|---|---|
| (80% CI) | | | | |
| $B_{2014}/B_{1950, F=0}$ (80% CI) | n.a. | n.a. | n.a. | n.a. |
| $SB_{2014}/SB_{current, F=0}$ (80% CI) | n.a. | n.a. | n.a. | n.a. |

LL = longline; n.a. = not available; ** 95% CI; Numbers in *italics* are 95% levels as Maximum Likelihood Estimate (MLE) from a skewed distribution.

**Bayesian Surplus Production Model (BSPM)**

93. The WPB **NOTED** paper IOTC–2015–WPB13–18 which provided a stock assessment for striped marlin in the Indian Ocean using a Bayesian Surplus Production Model (BSPM), including the following abstract provided by the authors:

"*CPUE data derived from the Japanese LL fleet catching Striped marlin is used in a Bayesian Surplus production model with non-informative 'priors' and informative priors. Non-informative 'priors' were used on r, and K, assuming the population was at K when the catch time-series begins in 1950. Catch data was used from 1950 and key reference points, namely $S_{MSY}$ and MSY were estimated using the Markov Chain Monte Carlo MCMC or Sample Importance Resample (SIR) algorithm. Results indicate the stock is overfished and at very low abundance levels relative to historic abundance (4% of virgin biomass ($0.04B_0$)). Fishing mortality rates are also excessively high (>1.5 $F_{MSY}$ levels) and unless a substantial reduction in catch levels occur in the near future, the stock is unlikely to recover to MSY levels. The results are consistent when examining sensitivities to 'prior' choice. Additional runs using the Japanese LL CPUE indicated the stock is still overfished where stock size is $0.6B_{MSY}$ and experiencing fishing mortality levels that are >1.5 $F_{MSY}$ levels. Based on the bi-modal distributions of the chain, the models appear to have poor convergence and should not be used to examine stock status till convergence is achieved.*"

94. The WPB **NOTED** the key assessment results for the BSPM as shown below (Tables 4 and 5; Fig. 3).

**Table 4.** Striped marlin: Key management quantities from the BSPM assessment, for the Indian Ocean. **Note**: 95 % confidence intervals and data up until 2013 only are presented below, as this model was abandoned during the meeting due to a lack of convergence.

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2014 catch estimate (t) | 4,049 |
| Mean catch from 2010–2014 (t) | 4,122 |
| MSY (1000 t) (95% CI) | 5.14<br>(3.10–11.17) |
| Data period (catch) | 1950–2013 |
| $F_{MSY}$ (95% CI) | 0.33<br>(0.24–0.36) |
| $SB_{MSY}$ or $*B_{MSY}$ (1,000 t) (95% CI) | 13.1<br>(*12.75*–24.61) |
| $F_{2014}/F_{MSY}$ (95% CI) | 1.38<br>(0.00–5.85) |
| $B_{2014}/B_{MSY}$ (95% CI) | 0.64<br>(*0.34*–2.47) |
| $SB_{2014}/SB_{MSY}$ (95% CI) | n.a. |
| $B_{2014}/B_{1950}$ (95% CI) | 0.32<br>(*0.17*–1.00) |
| $SB_{2014}/SB_{1950}$ (95% CI) | n.a. |
| $B_{2014}/B_{1950, F=0}$ (95% CI) | n.a. |
| $SB_{2014}/SB_{1950, F=0}$ (95% CI) | n.a. |

n.a.: not available; Numbers in *italics* are 95% levels as MLE from a skewed distribution.

**Aggregate Indian Ocean**

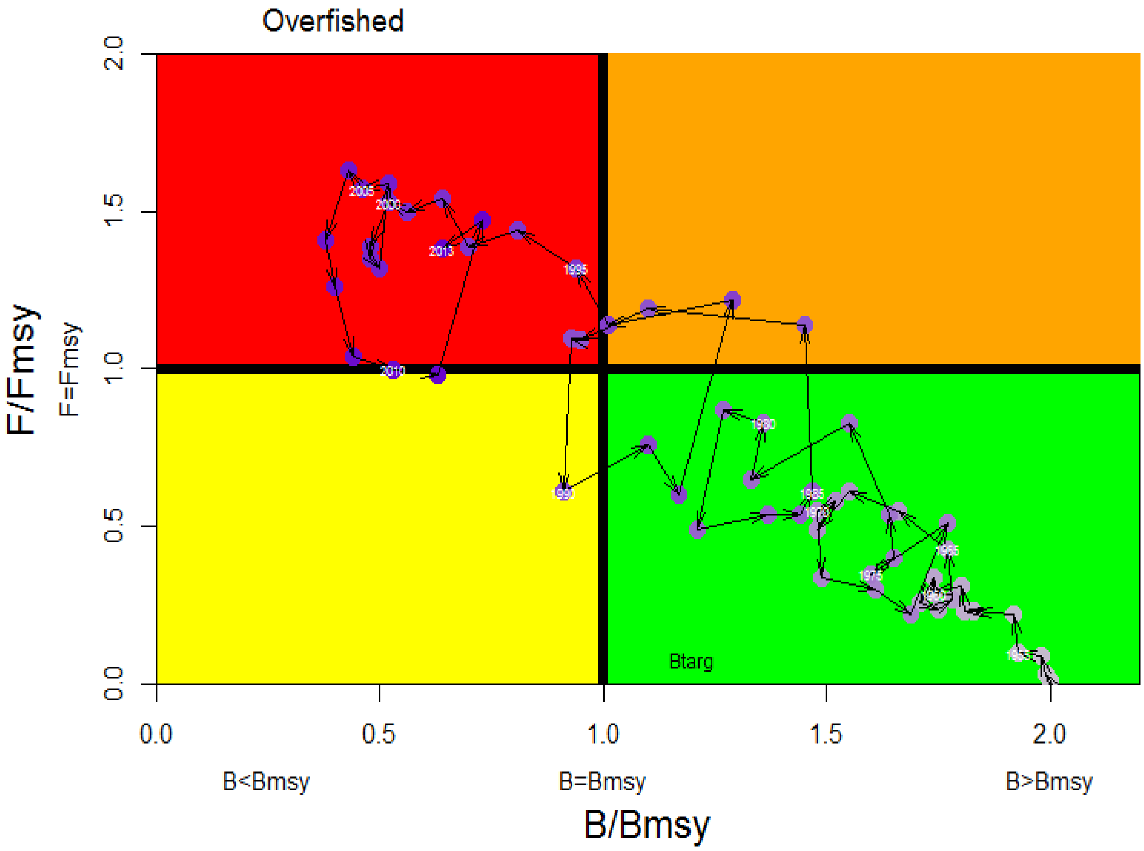



**Fig. 3.** Striped marlin: BSPM aggregated Indian Ocean assessment Kobe plot using the Japanese CPUE data. The confidence intervals are not shown as there are problems with model convergence. This is the model trajectory of the MLE solution. The final data point is 2013, as the assessment was not updated to include 2014 data due to convergence issues.

**Table 5.** Striped marlin: BSPM 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. Note: the model has two modes and the distribution is centred in the positive space (although the MLE indicated the stock is overfished), hence the low probabilities of exceeding targets. In addition the model was run with 2013 as the last data point, and projections were made for 2016 and 2023.

| **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%** (2,949 t) | **70%** (3,441 t) | **80%** (3,932 t) | **90%** (4,424 t) | **100%** (4,915 t) | **110%** (5,407 t) | **120%** (5,898 t) | **130%** (6,390 t) | **140%** (6,881 t) |
| $B_{2016} < B_{MSY}$ | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| $F_{2016} > F_{MSY}$ | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 16 | 24 |
| | | | | | | | | | |
| $B_{2023} < B_{MSY}$ | 14 | 14 | 14 | 14 | 14 | 14 | 17 | 26 | 33 |
| $F_{2023} > F_{MSY}$ | 14 | 14 | 14 | 14 | 14 | 14 | 20 | 29 | 37 |

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

- The model convergence is problematic, as there are issues with the plots on r and K.
- The fact that we have 2 peaks in the distribution is problematic in the way the posterior samples were used in estimating the uncertainty.
- Although the approach has some potential and is in agreement with other approaches, using an aggregated fishery is problematic, and the fact that we use only Japan longline CPUE rather than both Taiwan,China and Japan is problematic.
- Further development of this approach is required to obtain model convergence.

**A Stock-Production Model Incorporating Covariates (ASPIC)**

96. The WPB **NOTED** paper IOTC–2015–WPB13–19 Rev_2 which provided a stock assessment for striped 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 perform the stock assessment of striped marlins in the Indian Ocean based on total catch data and standardized CPUE series of Taiwanese and Japanese longline fleets. In the ASPIC assessments, we use three fleets' models (Japan LL_1:1950-89, Japan LL_2:1990-2014 and Taiwan,China LL type including other fleets). Japan LL is divided by 2 periods because there are large gap in q before and after 1990. Then we set up 8 scenarios, i.e., two production models by Schaefer and Fox with two options of B0/K (estimated and fixed=1) and two options of starting years (1976 and 1977) to see if very low STD_CPUE value in 1976 is valid. Among 8 scenarios, scenario 6 (Fox model with B0/K=1 and with 1976) produced the best goodness of fitness in terms of RMSE (Root Mean Square Error) and R2 (STD_CPUE). According to the results of scenario 6, F2014/Fmsy=1.09 and TB2014/TBmsy=0.65.*" – (see paper for full abstract)

97. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below (Tables 6 and 7; Fig. 4).

**Table 6.** Striped marlin: Key management quantities from the ASPIC assessment, for the Indian Ocean.

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2014 catch estimate (t) | 4,049 |
| Mean catch from 2010–2014 (t) | 4,122 |
| MSY (1000 t) (80% CI) | 5.22<br>(5.18–5.59) |
| Data period (catch) | 1950–2014 |
| $F_{MSY}$ (80% CI) | 0.62<br>(0.59–1.04) |
| $SB_{MSY}$ or $*B_{MSY}$ (1,000 t) (80% CI) | 8.4*<br>(5.4–8.9) |
| $F_{2014}/F_{MSY}$ (80% CI) | 1.09<br>(0.62–1.66) |
| $B_{2014}/B_{MSY}$ (80% CI) | 0.65<br>(0.45–1.17) |
| $SB_{2014}/SB_{MSY}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950}$ (80% CI) | 0.24<br>(n.a.–n.a.) |
| $SB_{2014}/SB_{1950}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950, F=0}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{1950, F=0}$ (80% CI) | n.a. |

n.a. = not available

**Aggregate Indian Ocean**

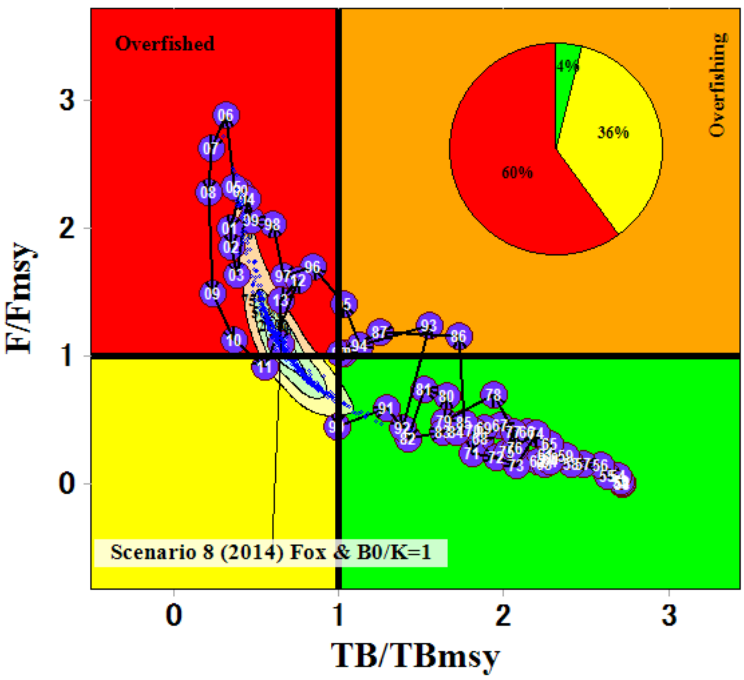



**Fig. 4.** Striped marlin: ASPIC aggregated Indian Ocean assessment Kobe plot with the confidence surface and compositions of its uncertainties in terms of 4 phases (pie chart).

**Table 7.** 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%** (2,949 t) | **70%** (3,441 t) | **80%** (3,932 t) | **90%** (4,424 t) | **100%** (4,915 t) | **110%** (5,407 t) | **120%** (5,898 t) | **130%** (6,390 t) | **140%** (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 |

98. The WPB **NOTED** the following with respect to the ASPIC modelling approach presented at the meeting:
    - 3 fleet model (Japan LL 1950-89, Japan LL 1990-2014 and Taiwan,China LL) was used to represent all fisheries (other fleets were aggregated in Taiwan,China LL) .
    - Fox model fits better that the Schaeffer model.
    - B0/K could not be estimated. Thus B0/K=1 was assumed which produced the final results.
    - Taiwan,China standardized CPUE fits best ($r^2$=0.53), Japan LL (1990-2014, $r^2$=0.31) and Japan LL (1950-1989, $r^2$=0.1). The last fleet fit was poor.
    - Model runs with and without the early 1976-1980 data (Japan) were examined. Further work on CPUE standardization needs to be done to understand these spikes from 1976-1977. The model results are not very sensitive to whether these points were included or not, and for final results all data from the new CPUE series of Japan were recommended to be used. These are final results presented.

**Age-structured integrated analysis (ASIA)**

99. The WPB **NOTED** paper IOTC–2015–WPB13–32 Rev_1 which provided a stock assessment of striped marlin in the Indian Ocean using an age-structured integrated analysis, including the following abstract provided by the authors:

    "*This study evaluated the stock status of striped marlin in the Indian Ocean using a sex-specific and age-structured integrated approach (ASIA). Generally, the model appropriately fits to the observed length-frequency data, except for non- longline fisheries. The model can fit to the Taiwanese CPUE data well, but model fits of Japanese CPUE data was inappropriate for early years since Japanese CPUE sharply decreased in early years but an assumption of constant catchability was used in the model. Based on the* *model estimates, both of current fishing intensity and spawning biomass were lower than MSY level. Therefore, the results of this study indicated that the stock status of striped marlin in the Indian Ocean might be overfished but not be overfishing. However, the assessment results of this study might be highly uncertain because of absence of life history parameters and insufficient length-frequency data for striped marlin in the Indian Ocean*."

100. The WPB **NOTED** the key assessment results for the age-structured integrated analysis (ASIA) as shown in Tables 8 and 9 and in Fig. 5.

**Table 8.** Striped marlin: Key management quantities from the ASIA assessment, for the Indian Ocean.

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2014 catch estimate (t) | 4,049 |
| Mean catch from 2010–2014 (t) | 4,122 |
| MSY (1000 t) (80% CI) | 6.40 (5.25–7.85) |
| Data period (catch) | 1950–2014 |
| $F_{MSY}$ (80% CI) | 0.73 (0.71–0.75) |
| $SB_{MSY}$ or $*B_{MSY}$ (1,000 t) (80% CI) | 6.95 (5.73–8.50) |
| $F_{2014}/F_{MSY}$ (80% CI) | 0.55 (0.33–0.91) |
| $B_{2014}/B_{MSY}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{MSY}$ (80% CI) | 0.85 (0.53–1.29) |
| $B_{2014}/B_{1950}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{1950}$ (80% CI) | 0.24 (0.15–0.37) |
| $B_{2014}/B_{1950,\ F=0}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{1950,\ F=0}$ (80% CI) | n.a. |

n.a. = not available

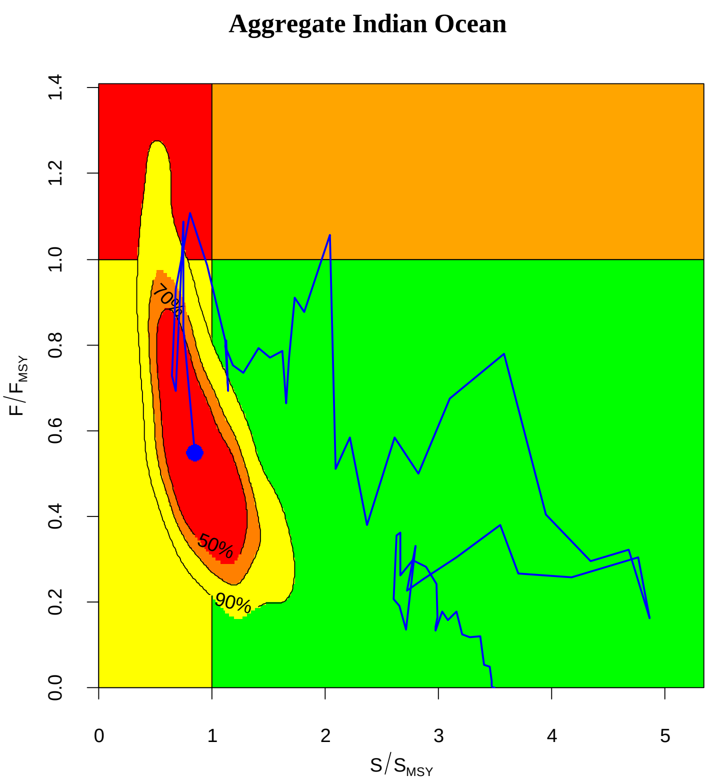



**Fig. 5.** Striped marlin: ASIA aggregated Indian Ocean assessment Kobe plot (Spawning biomass SB shown as S). The trajectory (blue line) was calculated based on the median of 1000 re-samplings of Bayesian posterior distribution. Blue circle indicate the estimate for 2014. Concentric ellipses represent 50%, 70% and 90% confidence surface of the estimate for 2014.

**Table 9.** Striped marlin: ASIA 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 ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (2,949 t) | **70%** (3,441 t) | **80%** (3,932 t) | **90%** (4,424 t) | **100%** (4,915 t) | **110%** (5,407 t) | **120%** (5,898 t) | **130%** (6,390 t) | **140%** (6,881 t) |
| $SB_{2017} < SB_{MSY}$ | 6.6 | 7.2 | 10.3 | 14.5 | 18 | 21.8 | 24.7 | 27.9 | 32.2 |
| $F_{2017} > F_{MSY}$ | 0 | 0 | 0.1 | 0.8 | 6.6 | 15.3 | 35.4 | 56 | 75.7 |
| | | | | | | | | | |
| $SB_{2024} < SB_{MSY}$ | 2.4 | 3.3 | 5.1 | 10.6 | 26 | 46.5 | 77.1 | 90.6 | 96.2 |
| $F_{2024} > F_{MSY}$ | 0 | 0 | 0 | 0 | 5.6 | 69.3 | 99.1 | 100 | 100 |

101. The WPB **NOTED** the following with respect to the ASIA modelling approach presented at the meeting:
   - The model fits to Japan longline CPUE in earlier years was problematic, but captures the overall trend fairly well.
   - These are dependent on the quality of length frequency data, and the CPUE data. Different weighting approaches for the likelihood are therefore required.
   - The model used most biological parameters from the Pacific Ocean and as such there is a high degree of uncertainty in the life history dynamics that may affect the assessment.

**Stock Reduction Analysis (SRA) for Striped Marlin**

102. The WPB **NOTED** paper IOTC–2015–WPB13–33 which provided a stock assessment for striped marlin in the Indian Ocean by A Stock Reduction Analysis (SRA), including the following abstract provided by the authors:

   "*We conduct stock assessments for Indian Ocean sailfish using data poor approaches. We used a catch-based stock reduction analysis method. The method is based on a classical biomass dynamics model, requires only catch history but not fishing effort or CPUE. Known population growth rate will improve the assessment result. In this paper, we assume that the two species analysed, in the whole Indian Ocean belong to a single stock and the population size in 1950 is the virgin biomass, and is also equal to their carrying capacities. We use recently updated catch data in the analysis till 2014. For striped marlin the geometric mean virgin biomass was about 48 to 74.2 thousand tonnes, and the intrinsic population growth rate is about 0.20(0.19-0.4 95% CI). The entire stock can support a MSY of nearly 4.31 thousand tonnes. Catch levels in recent year may have been too high, and likely overfishing is occurring on the stock.*"

103. The WPB **NOTED** the key assessment results for Stock Reduction Analysis (SRA) as shown below (Tables 10 and 11; Fig. 6).

**Table 10.** Striped marlin: Key management quantities from the SRA assessment, for the Indian Ocean.

| Management Quantity | Aggregate Indian Ocean |
|---|---|
| 2014 catch estimate (t) | 4,049 |
| Mean catch from 2010–2014 (t) | 4,122 |
| MSY (1000 t) (80% CI) | 4.31 (4.11–4.61) |
| Data period (catch) | 1950–2014 |
| $F_{MSY}$ (80% CI) | 0.14 (0.09–0.18) |
| $SB_{MSY}$ or $*B_{MSY}$ (1,000 t) (80% CI) | 32.07* (24.00–37.09) |
| $F_{2014}/F_{MSY}$ (80% CI) | 1.58 (0.70–3.11) |
| $B_{2014}/B_{MSY}$ (80% CI) | 0.57 (0.30–0.79) |
| $SB_{2014}/SB_{MSY}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950}$ (80% CI) | 0.29 (0.15–0.4) |
| $SB_{2014}/SB_{1950}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950,\ F=0}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{1950,\ F=0}$ (80% CI) | n.a. |

n.a. = not applicable

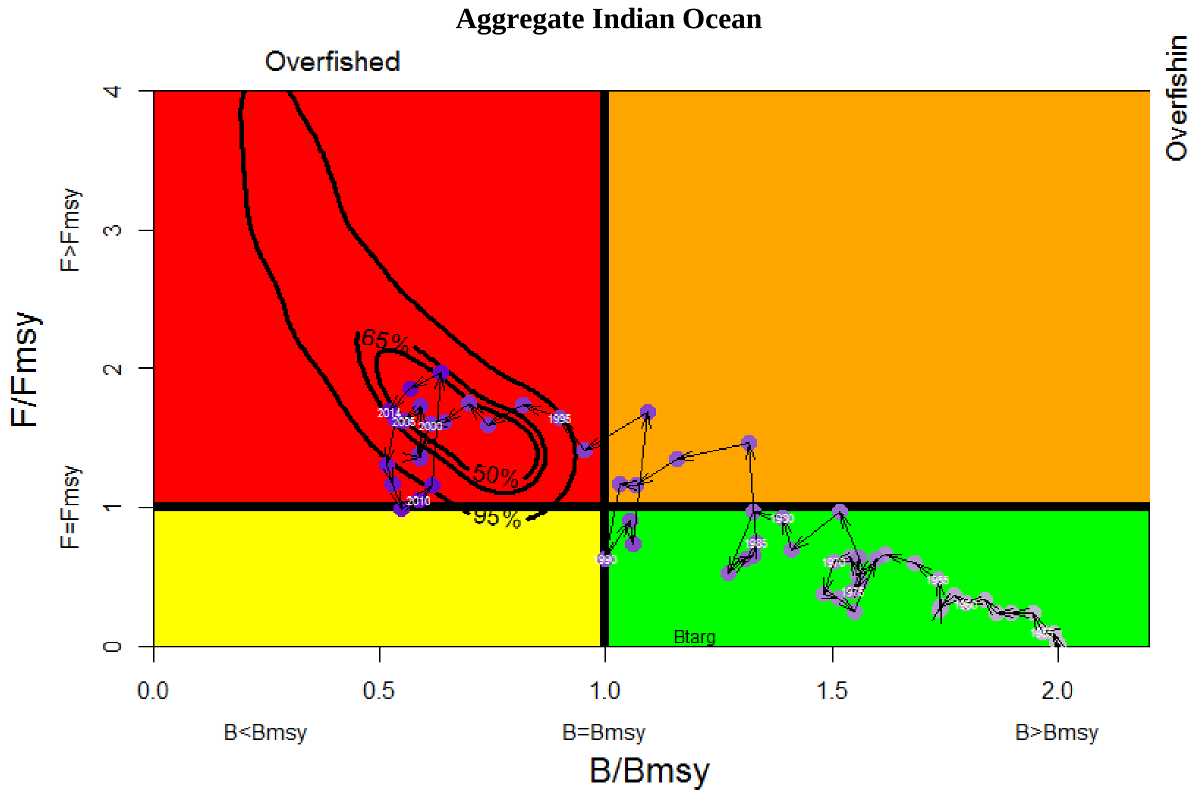



**Fig. 6.** Striped marlin: SRA aggregated Indian Ocean Kobe plot. The trajectory (black line) was calculated based on the median of all possible runs meeting the SRA depletion criteria at the beginning and end of the series. Blue circles indicate the point estimate for each year. Concentric ellipses represent 50%, 65% and 95% confidence surface of the estimate for 2014.

**Table 11.** Striped marlin: 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 (4,915 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years. These will be calculated during the next assessment of Indo-Pacific sailfish.

| 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%** (2,949 t) | **70%** (3,441 t) | **80%** (3,932 t) | **90%** (4,424 t) | **100%** (4,915 t) | **110%** (5,407 t) | **120%** (5,898 t) | **130%** (6,390 t) | **140%** (6,881 t) |
| $B_{2017} < B_{MSY}$ | 98 | 99 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| $F_{2017} > F_{MSY}$ | 62 | 81 | 99 | 100 | 100 | 100 | 100 | 100 | 100 |
| | | | | | | | | | |
| $B_{2024} < B_{MSY}$ | 69 | 83 | 99 | 100 | 100 | 100 | 100 | 100 | 100 |
| $F_{2024} > F_{MSY}$ | 41 | 62 | 92 | 99 | 100 | 100 | 100 | 100 | 100 |

104. The WPB **NOTED** the following with respect to the SRA modelling approach presented at the meeting:
- Model runs indicated that the stock was experiencing overfishing and is overfished.
- The runs appeared to converge and gave more consistent results for the assessment, i.e. similar to BSPM and the ASPIC.

***Parameters for future analyses: stock assessments***

105. The WPB **AGREED** that alternative approaches should be explored using the following:
- Examination of the standardised CPUE data for use in the assessments as these are the basis for assessments without any age/length data available.
- More attention should be paid to the amount of effective hooks at the depth where marlins are abundant.
- Age/Length data over time should be collected so that alternative approaches could be examined These data are quite sparse for marlins and there is a need to improve the coverage of this over time.

- Further examination of the data poor approaches on gillnet fisheries, along with a further developed Integrated Models should be a focus during the next assessment year for striped marlin.
- Improved life history parameters for the stock assessment should be collected for the Indian Ocean (growth curve, natural mortality, etc.).

#### *6.2.3 Selection of Stock Status indicators for marlins*

106. The WPB **NOTED** that the assessments carried out in 2015 continued development of approaches pursued in previous years for striped marlin. All models, except the ASIA model, were essentially giving the same outlook on the stock (and was similar to 2013 when striped marlin was last assessed (using data up until 2012)), and as such the WPB **AGREED** that this year they would use the ensemble of information from the assessment for developing stock status advice.

107. The WPB **AGREED** that stock status should be determined by qualitatively integrating the results of the various stock assessments undertaken in 2015. The ASPIC model would be used for the status summary in the species executive summary.

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

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

109. 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 2014 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 VIII
    - Blue marlin (*Makaira nigricans*) – Appendix IX
    - Striped marlin (*Tetrapturus audax*) – Appendix X

## 7. INDO-PACIFIC SAILFISH

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

***I.P. sailfish biology: Indonesia longline***

110. The WPB **NOTED** paper IOTC–2015–WPB13–21 which detailed some biological parameters of Indo-Pacific sailfish caught by Indonesian longliners in eastern Indian Ocean, including the following abstract provided by the authors:

    "*This paper present some biological parameters of Indo-Pacific sailfish (Istiophorus platypterus) caught by Indonesia longliners in eastern Indian Ocean. The parameters cover size distribution, length to length relationship, length to weight relationship, and sex ratio. Data used for analysis comprised of daily monitoring data tuna and tuna-like species from 2002-2014 and scientific observer data from 2006-2014, courtesy of Research Institute for Tuna Fisheries (RITF). The result showed that most (73.63%) of the sailfish caught were distributed at size range from 155-210 cmLJFL. Due to insufficient data on sex, the length-to-length relationship was calculated using pooled sex. The linear regression equation models were LJFL=1.1456PFL+21.089; LJFL=1.04EFL+13.772; and EFL=1.099PFL+7.3534. The non-linear regression analysis (power function) was also executed to study the length-weight relationship; the 'r' value was found to be 0.80013 and the regression equation* $W_{GGT} = 0.0009PFL^{2.048}$. *The sex ratio (proportion of female to total of male and female) was 0.63 (equal with 1:1,* $X^2=3.31<X^2_{(0.05)}=3.84$*).*"

111. The WPB **NOTED** that CPUE time series from the Indonesian longline fleet might produce an important contribution to the stock assessment of I.P. sailfish and **REQUESTED** Indonesian scientists to bring standardised CPUE data for the next WPB meeting. If assistance is required, then a formal request to the IOTC Secretariat should be made.

112. **NOTING** that data on length and weight could be collected during landing for pooled samples but fish are grouped by homogenous size batches during unloading, the WBP **AGREED** that Indonesia should try using average weight of fish, as a fishery indicator for the stock.

***I.P. sailfish morphometric relationships: Sri Lanka fisheries***

113. The WPB **NOTED** paper IOTC–2015–WPB13–22 which provided a length-weight relationship and some morphometric relationships of Indo-Pacific sailfish using biological data of gillnet fishery and longline fishery in Sri Lanka, including the following abstract provided by the authors:
"*Indo – Pacific Sailfish (Istiophorus platypterus) is one of the important billfish species found in the large pelagic fishery in Sri Lanka. Though tuna is the key target group in the gillnet fishery and longline fishery in Sri Lanka, billfish including sailfish is also frequently caught as a non-target species. In many cases, the whole billfish is not landed by the vessels. The billfish caught at sea is cut into two or three pieces and brought onboard to the fishing port. Therefore, it is not possible to obtain accurate length and weight measurements during the port sampling. In addition, since there is no proper onboard observer programme existing for Sri Lankan fishing vessels, collecting biological data for billfish is a challenging task. In order to minimize this issue, an initial attempt was made to obtain some morphometric relationships for sailfish. For this purpose, morphometric measurements of occasionally landed whole sailfish in the gillnet fishery and longline fishery were obtained at the fishing ports in the west coast of Sri Lanka in 2014.*" – (see paper for full abstract)

114. The WPB **AGREED** that this study presents important information on conversion factors for I.P. sailfish and that Sri Lanka should continue its work on morphometric sampling of I.P. sailfish in order to increase sample size and improve the quality of the data.

***I.P. sailfish observations: EU,Portugal longline fleet***

115. The WPB **NOTED** paper IOTC–2015–WPB13–23 which provided observations on the Indo-Pacific sailfish, from the EU,Portugal pelagic longline fleet in the Indian Ocean, including the following abstract provided by the authors:
"*The Portuguese pelagic longline fishery in the Indian Ocean started in the late 1990's, targeting mainly swordfish in the southwest region. This working document analyses, for the first time, the catch, nominal CPUE trends, size distribution, sex-ratios and at-haulback mortality for the Indo-Pacific sailfish (Istiophorus platypterus) occasionally captured as bycatch in this fishery. The data was recorded by fishery observers and skippers logbooks, and was analysed between 2011 and 2014. The nominal CPUEs were calculated in n/1000 hooks and were analysed both spatially and in a yearly time series, showing an increase in 2012 and a decrease for the more recent years. The spatial size distribution of the catches seems to indicate that smaller individuals occur mostly in more coastal waters while the larger specimens prefer offshore waters. Overall, there were more females than males in the catch, with a trend of increasing female proportions with increasing specimen sizes. The overall at-haulback mortality of this species is high, with 69.6% of the specimens recorded dead at haulback.*" – (see paper for full abstract)

116. **NOTING** the small sampling size reported in the study, due to the fact that I.P. sailfish is a non-target species in Portuguese longline fisheries, the WPB **AGREED** that Portugal should continue sampling efforts to collect data on both I.P sailfish and marlins.

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

### *7.2.1 Nominal and standardised CPUE indices*

***I.P. sailfish longline standardised CPUE***

117. The WPB **NOTED** paper IOTC–2015–WPB13–24 which detailed catch rates of Indo-Pacific sailfish as calculated based on IOTC longline dataset, including the following abstract provided by the authors:
"*Estimations of relative abundance indices are cornerstones in most of the fisheries stock assessments. In tuna fisheries relative abundance indices are often calculated by standardizing the commercial catch-per-unit-effort (CPUE). Whenever the species of interest is bycatch the task may become difficult because the datasets are limited, incomplete or biased (e.g. underreports). However, in some cases like the Indo Pacific sailfish (Istiophorus platypterus) to look at those limited databases may be the alternative. In this paper a simple model was used to standardize the CPUE of sailfish based on a limited database, which does not include fishing operational information (e.g. number of hooks between floats). In addition the data are aggregated by month and by square (5º latitude x 5º longitude). Time series of standardized CPUE based on the aggregated database were calculated for Korea and for Japan. Estimations for Korea in 1975-1987 timespan are probably useful for stock assessment. In that timespan the target species of Korean longline fishermen did not change much as indicated by the proportions of the tuna species in the catches.*" – (see paper for full abstract)

118. The WPB **NOTED** that such exercises are important to compare the aggregated datasets with fine scale data that are analysed by the CPC's. Based on these datasets, there is more data available from some fleets like the Rep. of Korea that could be used in an assessment.

119. The WPB **AGREED** that it would be possible to use Rep. of Korea and Japan longline data weighted by area.

120. The WPB **NOTED** that time trends of the standardised CPUE calculated based on detailed data set and on aggregated data set were very similar, specially before 2007. However, important differences showed up in the end of the time series.

121. The WPB **NOTED** that time trends of nominal CPUE were similar to those of the standardised CPUE across the years. The use of the nominal CPUE in stock assessments of some of the billfish species may be an alternative when there are no data to calculate standardised CPUE. However, some sensitivity analysis are encouraged to assess the differences of stocks assessment as calculated using standardised CPUE time series, or nominal CPUE data.

***I.P. sailfish gillnet CPUE***

122. The WPB **NOTED** paper IOTC–2015–WPB13–25 which provided an estimation of catch-per-unit-effort of Indo-Pacific sailfish caught with gillnet in the north of Indian Ocean, including the following abstract provided by the authors:

“*Data concerning catches of Indo Pacific sailfish (Istiophorus platypterus) is limited. Only approximate estimations are available in the Indian Ocean Tuna Commission (IOTC). In addition there are not catch-effort data of handline and gillnet boats, which have caught most of the unloaded sailfish. Estimations of catch-per-unit-effort (CPUE) in a conventional way are not feasible. However, the number of gillnet boats have been reported to IOTC by Iran, Oman, Sri Lanka and Pakistan. Those four countries rank among the top five higher sailfish catches. In this paper the number of boats is tentatively used as a proxy of the carrying capacity and of the effort. In order to calculate CPUE assumptions concerning relative efficiencies of boats of Iran and Oman of different sizes were also necessary. Estimations of CPUE calculated here indicate that: a) Catches were probably underestimated in the beginning of the Iran, Sri Lanka and maybe Oman time series; and b) Estimations of catch of Oman and Pakistan of the end of time series were remarkably high if compared to the number of boats reported.*” – (see paper for full abstract)

123. The WPB **NOTED** that the study presented was an important piece of work required as to assess the effects of the gillnet fleets on billfish in the Indian Ocean.

124. The WPB **NOTED** the following:
- While the number of vessels may be appropriate to use, the use of vessels with multi-gear (e.g. Sri Lanka), needs to be accounted for as this may indicate differential efficiency by gear across the year.
- Population structure issues are important as catches and CPUE maybe estimated on different populations in different areas, and not representative of the entire Indian Ocean.
- The data prior to 1995 may not be accurate nor the fact that the number of vessels fluctuating from year to year. As such, results of this work should be interpreted with caution. Data after 1995 may be more appropriate to use as IOTC had developed programs of work to estimate catches and effort in multiple countries (e.g. I.R. Iran after 1995).
- Even though the data is from nominal CPUE, it may still be useful for assessments as signals from other CPUE standardisations were very similar to the nominal CPUE.

***I.P. sailfish Japan longline standardized CPUE***

125. The WPB **NOTED** paper IOTC–2015–WPB13–26 which provided a CPUE standardisation of sailfish caught by the Japan longline fishery in the Indian Ocean from 1994 to 2014, including the following abstract provided by the authors:

“*CPUE of sailfish (Istiophorus platypterus) caught by Japanese longline vessels in the Indian Ocean from 1994 to 2014 was standardized by GLM applying Log-normal error structured model and Negative binomial error structured model. For analysis, considering historical distribution of effort and CPUE, three core sub-areas, Area1: western tropical Indian Ocean, Area2: eastern tropical Indian Ocean, and Area3: West off Madagascar were prepared. The standardized CPUEs derived from both models showed similar trends in all areas. In all areas, CPUEs have been fluctuate around average level and did now show increasing or decreasing trend through the period analyzed. In recent five years, CPUE in Area2 has been lower than average while that in Area3 has been average level. Since that in Area1 has been quite low level, in recent three years in special, this trend is not reliable because of its shortage of data.”*

126. The WPB **NOTED** that a composite index across the Indian Ocean should be computed weighted by Area.

127. The WPB **NOTED** the following issues with the standardisation that should be addressed in subsequent years:
- 5*5 Area effects are more appropriate than environmental effects, as environmental effects could be confounded with abundance rather than catchability.

- It appeared that the environmental data worked in Area 3 but not in one and two. Probable reasons for this were that the majority of the catch data was in Area 3 for the longline fleet.

***CPUE Summary discussion***

128. The WPB **AGREED** that approaches examined on gillnet catchability and CPUE are important, and even if not accurate at this time, due to reported fishery effort, it gives us a good idea of what may be happening within the fishery.

129. The WPB **ENCOURAGED** further analysis on the gillnet component of the I.P. sailfish fishery and to further develop such indices across all marlins in the Indian Ocean. While the longline fishery is useful for examining CPUE given the distribution of I.P. sailfish, it may not be the best index to use as an index of abundance to use in an assessment.

130. The WPB **NOTED** the following regarding the state of CPUE analysis for fleets with important catches of I.P. sailfish in the IOTC area of competence:
    - Data used in CPUE calculations for artisanal fleets needs to improve so we have an index from a largest component of the catch for I.P. sailfish.
    - In addition nominal CPUE from the gillnet component of the fleet should be standardised (e.g. using vessel days, or size of vessels operating, etc.).
    - Trends in nominal CPUE differ considerably among fleets that operate in the same area, and efforts should be made to understand this difference.
    - Alternative models to assess zeros should be used in the standardisation process for longline fleets, as well as possibly using area effects rather than environmental effects.

131. The WPB **NOTED** that of the I.P. sailfish CPUE series available for assessment purposes, separate index from the gillnet fleets, and Japan and Rep. of Korean longline series were used in the final stock assessment models investigated in 2015, for the reasons discussed above (Fig. 7).
    - IOTC Rep. of Korea longline data (1974–1987) from document IOTC–2015–WPB13–24.
    - IOTC gillnet data (1983–2013) from document IOTC–2015–WPB13–25.
    - Japan longline data (1994–2014) from document IOTC–2015–WPB13–26.

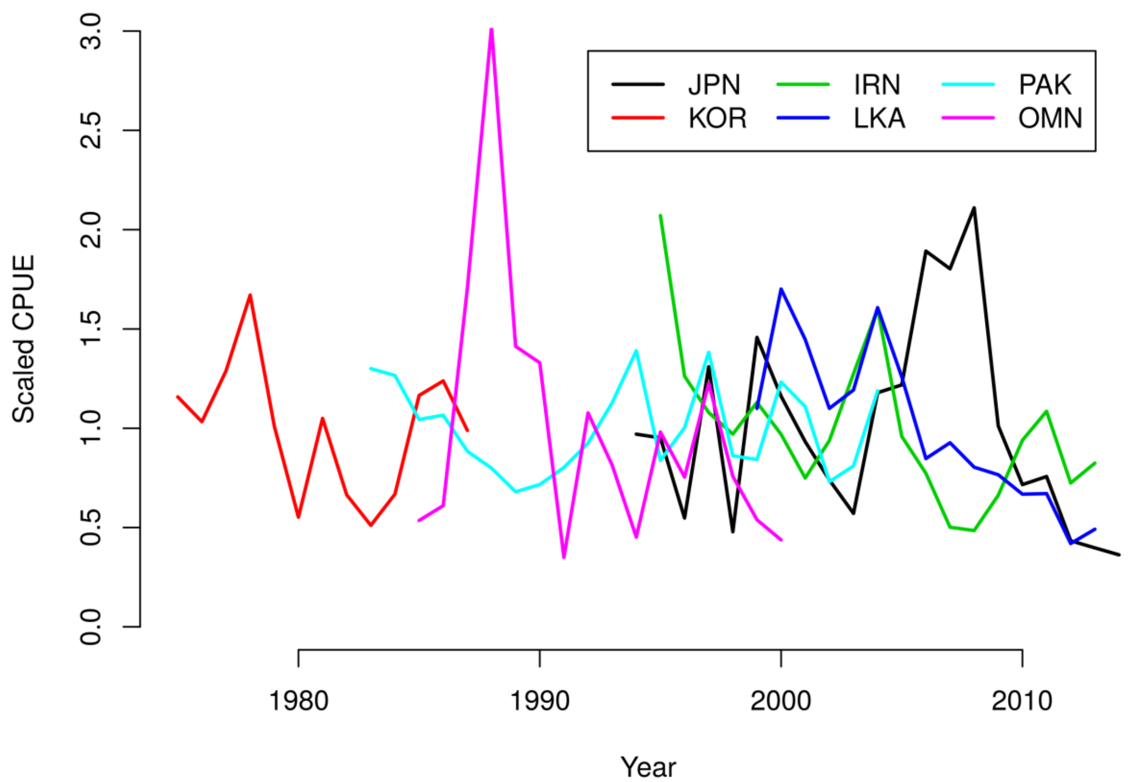



**Fig. 7.** I.P. sailfish: Catch rates of I.P. sailfish for Rep. of Korea (standardised KOR), I.R. Iran (IRN), Sri Lanka (LKA), Oman (OMN) and Pakistan (PAK) as calculated based on the IOTC catch and effort aggregated dataset (whole Indian Ocean), and for Japan (standardised JPN) as calculated using detailed dataset. Values were scaled with respect to their overall means.

#### *7.2.2 Stock assessments*

### *I.P. Sailfish: Summary of stock assessment models in 2015*

132. The WPB **NOTED** Table 12 which provide an overview of the key features of each of the stock assessments presented in 2015 for the Indian Ocean-wide assessments (2 model types). Similarly, Table 13 provides a summary of the assessment results.

**Table 12.** I.P. sailfish: **Indian Ocean-wide** assessments. Summary of final stock assessment model features as applied to the Indian Ocean I.P. sailfish resource in 2015.

| **Model feature** | **BPM (Doc# 27)** | **SRA (Doc# 28 Rev_1)** |
|---|---|---|
| Software availability | Coded | Coded |
| Population spatial structure / areas | 1 | 1 |
| Number CPUE Series | 1 to 6 | No |
| Uses Catch-at-length/age | No | No |
| Age-structured | No | No |
| Sex-structured | No | No |
| Number of Fleets | 1 to 6 | 1 |
| Stochastic Recruitment | No | No |

**Table 13.** I.P. sailfish: **Indian Ocean-wide** summary of key management quantities from the assessments undertaken in 2015.

| Management quantity | **BPM (Doc# 27)** | **SRA (Doc# 28 Rev_1)** |
|---|---|---|
| 2014 catch estimate (t) | 29,860 | |
| Mean catch from 2010–2014 (t) | 28,980 | |
| *h* (steepness) (base case) | n.a. | n.a. |
| MSY (1,000 t) (80% CI) | 33.215 (15.78–87.40) | 25 (19.50–35.40) |
| Data period (catch) | 1950–2014 | 1950–2014 |
| CPUE series | Japan (LL) | n.a. |
| CPUE period | 1976–2013 | n.a. |
| $F_{MSY}$ (80% CI) | 0.27 (0.09–0.65) | 0.26 (0.15–0.39) |
| $SB_{MSY}$ or $^*B_{MSY}$ (1,000 t) (80% CI) | 155.70* (61.20–267.50) | n.a. |
| $F_{2014}/F_{MSY}$ (80% CI) | 1.69 (0.48–4.79) | 1.05 (0.63–1.63) |
| $B_{2014}/B_{MSY}$ (80% CI) | 0.53 (0.32–0.91) | 1.13 (0.87–1.37) |
| $SB_{2014}/SB_{MSY}$ (80% CI) | n.a | n.a. |
| $B_{2014}/B_{1950}$ (80% CI) | 0.27 (0.16–0.48) | 0.56 (0.44–0.67) |
| $SB_{2014}/SB_{1950}$ (80% CI) | n.a. | n.a. |
| $B_{2014}/B_{1950, F=0}$ (80% CI) | n.a. | n.a. |
| $SB_{2014}/SB_{current, F=0}$ (80% CI) | n.a. | n.a. |

LL = longline; n.a. = not available

**Bayesian Production Model (BPM)**

133. The WPB **NOTED** paper IOTC–2015–WPB13–27 which provided a stock assessment of Indo Pacific sailfish using separated and composite estimations of relative abundance indices, using a Bayesian Production Model (BPM), including the following abstract provided by the authors:

"*In this paper a state-space Bayesian production model was fitted to longline and gillnet catch rate of the Indo Pacific sailfish (SFA) caught in the Indian Ocean. Most of the time series proved to be not informative about the parameters of the production models. However Sri Lanka and Iran gillnet datasets, and Japan longline dataset convey some information. Results are conflictive as estimations base on Sri Lanka database indicates the stock has been overfished, while the calculations based on the other databases indicate the stock has been fished in a moderate pace. Those results might be considered a starting point for crucial discussions about SFA, as far as the calculations were underpinned by critical assumptions concerning the reliability of the catch, and on the usefulness of the catch rate estimations as good relative abundance indices.*"

134. The WPB **NOTED** the key assessment results for the BPM as shown below (Tables 14 and 15; Fig. 8).

**Table 14.** I.P. sailfish: Key management quantities from the BPM assessment, for the Indian Ocean.

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2014 catch estimate (t) | 29,860 |
| Mean catch from 2010–2014 (t) | 28,980 |
| MSY (1000 t) (80% CI) | 33.22 (15.78–87.40) |
| Data period (catch) | 1950–2014 |
| $F_{MSY}$ (80% CI) | 0.27 (0.09-0.65) |
| $SB_{MSY}$ or $^*B_{MSY}$ (1,000 t) (80% CI) | 155.73* (61.24–267.48) |
| $F_{2014}/F_{MSY}$ (80% CI) | 1.69 (0.48–4.79) |
| $B_{2014}/B_{MSY}$ (80% CI) | 0.53 (0.32–0.91) |
| $SB_{2014}/SB_{MSY}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950}$ (80% CI) | 0.27 (0.16–0.48) |
| $SB_{2014}/SB_{1950}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950,\ F=0}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{1950,\ F=0}$ (80% CI) | n.a. |

n.a. = not available

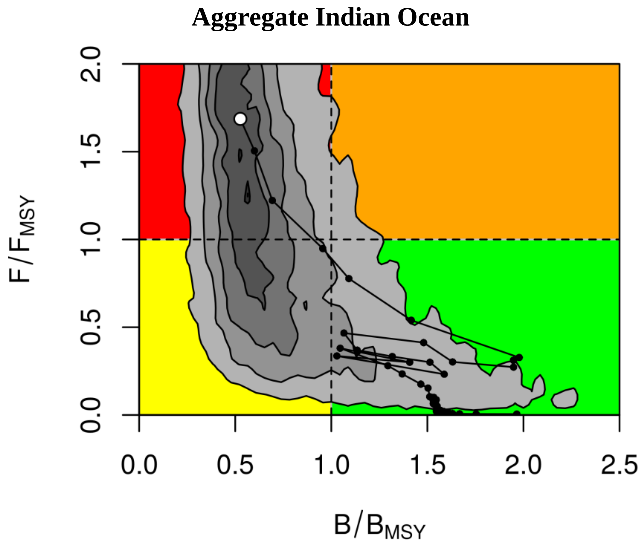



**Fig. 8.** I.P sailfish: BPM aggregated Indian Ocean assessment Kobe plot. Contour lines are at 0.025, 0.25, 0.50, 0.75 and 0.975 of the largest density. Dots and solid lines stand for the trajectory of marginal medians of ratios $F/F_{MSY}$ and $B/B_{MSY}$.

**Table 15.** I.P. sailfish: BPM 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 (29,164 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 2012–14, 29,164 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (17,498 t) | **70%** (20,415 t) | **80%** (23,331 t) | **90%** (26,248 t) | **100%** (29,164 t) | **110%** (32,080 t) | **120%** (34,997 t) | **130%** (37,913 t) | **140%** (40,830 t) |
| $B_{2017} < B_{MSY}$ | 68 | 70 | 71 | 73 | 75 | 76 | 78 | 79 | 80 |
| $F_{2017} > F_{MSY}$ | 46 | 52 | 56 | 60 | 64 | 67 | 70 | 73 | 75 |
| $B_{2024} < B_{MSY}$ | 45 | 50 | 54 | 58 | 62 | 65 | 68 | 71 | 73 |
| $F_{2024} > F_{MSY}$ | 40 | 46 | 51 | 55 | 60 | 63 | 67 | 70 | 72 |

135. The WPB **NOTED** the following with respect to the BPM modelling approach presented at the meeting:
    - All the models converged.
    - Most of the time series do not convey much information about model's parameters.
    - Estimations based on the datasets which convey information indicate that stock is currently overfished in the sense $F/F_{MSY}$ ratio is likely higher than 1, and $B/B_{MSY}$ is probably below 1. However, uncertainty is high as indicated by the wide contour plots in Kobe plot.
    - The use of composite indices and of individual CPUEs calculated for gillnets are encouraged in the future. However, only the Japan standardised catches rates should be considered, because it is the only time series calculated using standard approaches which are known to render potentially useful relative abundance indices.
    - All the projections using the estimations for Japan dataset assuming TACs ranging from 0.6× average catch (2012–14) to 1.4× average catch (2012–14) indicate the probabilities that the stock will still overfished in the next years were relatively high (> 0.6).

**Stock Reduction Analysis (SRA)**

136. The WPB **NOTED** paper IOTC–2015–WPB13–28 Rev_1 which provided a stock assessment of Indo Pacific sailfish in the Indian Ocean using a catch-based stock reduction analysis (SRA) method, including the following abstract provided by the authors:

    "*We conduct stock assessments for Indian Ocean sailfish using data poor approaches. We used a catch-based stock reduction analysis method. The method is based on a classical biomass dynamics model, requires only catch history but not fishing effort or CPUE. Known population growth rate will improve the assessment result. In this paper, we assume that the two species analysed, in the whole Indian Ocean belong to a single stock and the population size in 1950 is the virgin biomass, and is also equal to their carrying capacities. We use recently updated catch data in the analysis to 2014. For sailfish the geometric mean virgin biomass was about 93.2to 308.2 thousand tonnes, and the intrinsic population growth rate is about 0.59 (0.26-1.32 95% CI). The entire stock can support a MSY of nearly 25 thousand tonnes. Catch levels in recent year may have been too high, and likely overfishing is occurring on the stock*."

137. The WPB **NOTED** the key assessment results for the SRA as shown below (Tables 16 and 17; Fig. 9).

**Table 16.** I.P. sailfish: Key management quantities from the SRA assessment, for the Indian Ocean.

| **Management Quantity** | **Aggregate Indian Ocean** |
|---|---|
| 2014 catch estimate (t) | 29,860 |
| Mean catch from 2010–2014 (t) | 28,980 |
| MSY (1000 t) (80% CI) | 25.00 (16.18–35.17) |
| Data period (catch) | 1950–2014 |
| $F_{MSY}$ (80% CI) | 0.26 (0.15–0.39) |
| $SB_{MSY}$ or $*B_{MSY}$ (1,000 t) (80% CI) | 87.52 (56.3–121.02) |

| | |
|---|---|
| $F_{2014}/F_{MSY}$ (80% CI) | 1.05 (0.63–1.63) |
| $B_{2014}/B_{MSY}$ (80% CI) | 1.13 (0.87–1.37) |
| $SB_{2014}/SB_{MSY}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950}$ (80% CI) | 0.56 (0.44–0.67) |
| $SB_{2014}/SB_{1950}$ (80% CI) | n.a. |
| $B_{2014}/B_{1950,\ F=0}$ (80% CI) | n.a. |
| $SB_{2014}/SB_{1950,\ F=0}$ (80% CI) | n.a. |

n.a. = not available

**Aggregate Indian Ocean**

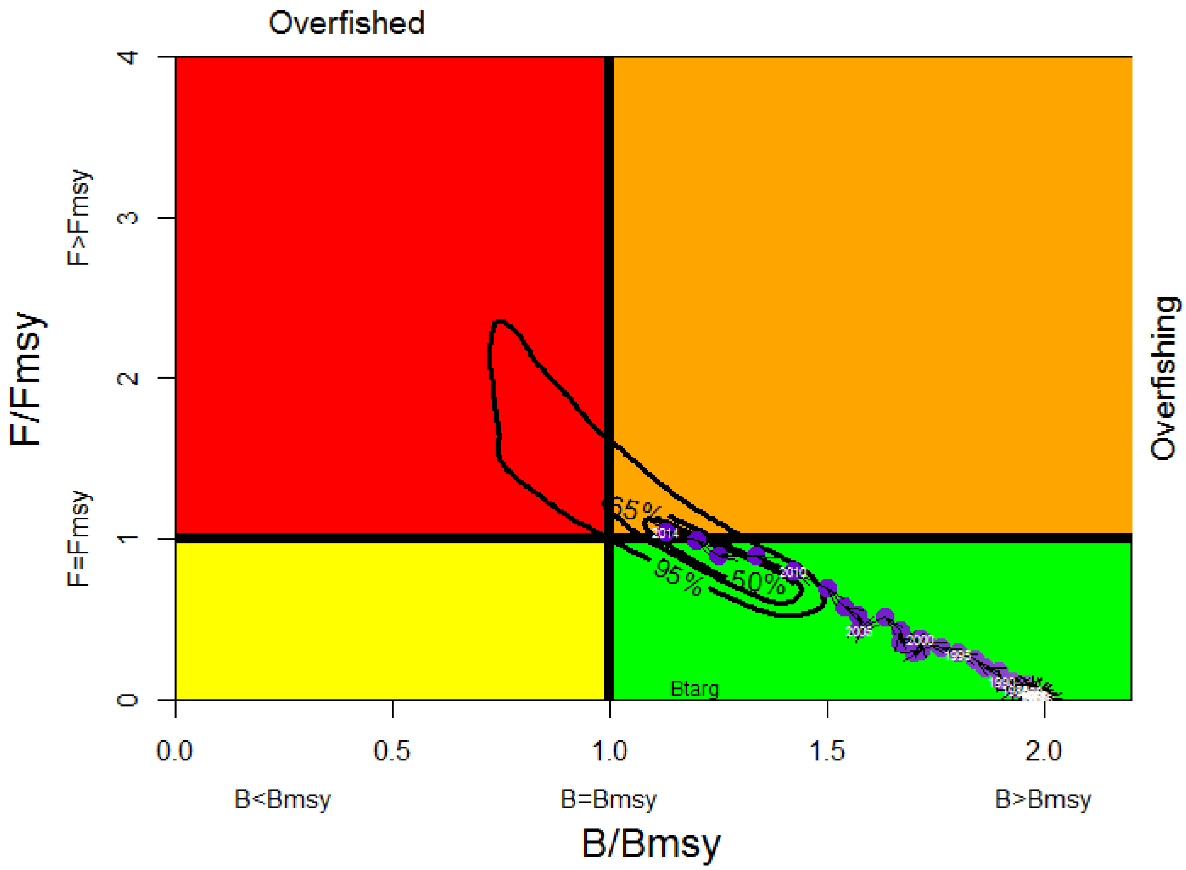



**Fig. 9.** I.P. sailfish: Stock reduction analysis (SRA) (Catch MSY Method) for the aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2014 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the B ratio and F ratio for each year 1950–2014.

**Table 17.** I.P. sailfish: SRA 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 (29,164 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 2012–14; 29,164 t) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (17,498 t) | **70%** (20,415 t) | **80%** (23,331 t) | **90%** (26,248 t) | **100%** (29,164 t) | **110%** (32,080 t) | **120%** (34,997 t) | **130%** (37,913 t) | **140%** (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 |

138. The WPB **NOTED** the following with respect to the SRA modelling approach presented at the meeting:
    - The method being assumption based would create difference if the assumptions changed.
    - The results were consistent with the assessment done in 2014, though they give a different picture than what the longlines CPUE series indicates.
    - The use of this method is useful to estimate target yield but may not be a good indicator of current biomass level.

#### *7.2.3 Selection of Stock Status indicators for I.P sailfish*

139. The WPB **AGREED** that since this was the first year of using the BSPM that the Stock Reduction Analysis (SRA) should form the basis for stock status advice. This was primarily due to the following reasons:
    - the data was highly uncertain on both the catch and effort series for the gillnet fleet, and
    - the Japan longline CPUE was from a fleet that catches a small portion of I.P. sailfish.

140. The WPB **REQUESTED** that the Chairperson contact scientists from the U.A.E. to obtain the latest information from the I.P. sailfish fishery in the Gulf, as the most recent information submitted to the WPB some time ago suggested that the fishery may be collapsing or have collapsed. Any new information received should be submitted to the next WPB meeting as part of a general review of I.P. sailfish fisheries in the Indian Ocean.

### *7.3 Development of management advice for I.P. sailfish and update of I.P. sailfish species Executive Summary for the consideration of the Scientific Committee*

141. 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 2014 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:
    - o Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XI

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

142. The WPB **NOTED** paper IOTC–2015–WPB13–09 which provided an initial introduction to the types of Conservation and Management Measures (other than quota allocation) currently in use by other RFMOs and discussed the pros and cons of each type of management approach. In addition, it discusses the particular characteristics of fisheries under the IOTC mandate which may influence the relevance and appropriateness of interim alternative management options for adoption by the Commission. Secondly, it seeks comment on this paper so that it may be further refined for consideration by other IOTC bodies.

143. **NOTING** that the Commission has requested the Scientific Committee and its subsidiary bodies to propose alternative management measures for billfish species, the WPB **REQUESTED** that the Chairperson and Vice-Chairperson, in consultation with the IOTC Secretariat and others, discuss and present alternative management measures at the next WPB for those species that are overfished and/or subject to overfishing.

## 9. WPB PROGRAM OF WORK

### *9.1 Revision of the WPB Program of work (2016–2020)*

144. The WPB **NOTED** paper IOTC–2015–WPB13–08 Rev_1 which provided an opportunity to consider and revise the WPB Program of Work (2016–2020), by taking into account the specific requests of the Commission, Scientific Committee, and the resources available to the IOTC Secretariat and CPCs.

145. The WPB **RECALLED** that the SC, at its 17th Session, made the following request to its working parties:

> "*The SC **REQUESTED** that during the 2015 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*." (SC17. Para 178)

146. The WPB **NOTED** the range of research projects on billfish, currently underway, or in development within the IOTC area of competence, and reminded participants to ensure that the projects described are included in their National Reports to the SC, which are due on 9 November 2015.

147. The WPB **REQUESTED** that the Chairperson and Vice-Chairperson of the WPB, in consultation with the IOTC Secretariat, develop Terms of Reference (TOR) to determine connectivity, movement rates and mortality for billfish stocks in the Indian Ocean using satellite tagging. As this is already a priority area of work, determined by the Scientific Committee and endorsed by the Commission, the TORs should then be circulated to potential funding sources.

148. The WPB **RECOMMENDED** that the reporting deadline for stock assessment inputs (index of abundance, catch reconstructions, size data, etc.) be moved from 30 days to 60 days prior to the meeting in which the species is to be assessed.

149. The WPB **RECOMMENDED** that the Scientific Committee consider and endorse the WPB Program of Work (2016–2020), as provided at Appendix XII.

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

150. The WPB **NOTED** with thanks, the continued 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, WPB12 and WPB13 meetings have contributed greatly to the groups understanding of billfish data and assessment methods. Dr. Andrade contributed to the WPB on a voluntary basis for the past two years as the Invited Expert and his expertise has been greatly appreciated and contributed substantially the stock status determination of billfish under the IOTC mandate.

151. 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 2016, by an Invited Expert:
    - **Expertise**: Stock assessment; including from regions other than the Indian Ocean; data poor assessment approaches for marlins (black marlin and blue marlin are scheduled for assessment in 2016).
    - **Priority areas for contribution**: Refining the information base, historical data series and indicators for billfish species for stock assessment purposes (species focus: black marlin and blue marlin).

152. The WPB **AGREED** that due to the outstanding contributions of Dr Humber Andrade to the WPB over the past four years, it would be highly beneficial to facilitate his participation at the next WPB meeting.

153. The WPB **NOMINATED** and **ENDORSED** Dr Humber Andrade as the Invited Expert to attend the next WPB meeting, pending Scientific Committee approval.

### *9.3 Hiring of a consultant to assist the WPB with data poor stock assessment approaches*

154. The WPB **RECOMMENDED** that a consultant be hired to develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline. This activity should be a high priority within the Scientific Committee's Program of Work. Terms of Reference will be provided to the SC's consideration in 2015. An indicative budget is provided at Table 18.

**Table 18.** Estimated budget required to hire a consultant to carry out data poor stock assessment on billfish species in 2016 and 2017.

| **Description** | **Unit price** | **Units required** | **2016 Total (US$)** | **2017 Total (US$)** |
|---|---|---|---|---|
| Develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline, and data poor assessments (fees) | 450 | 25 | 11,250 | 11,250 |
| Develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline (travel) | 5,000 | 1 | 5,000 | 5,000 |
| | | Total estimate | **16,250** | **16,250** |

155. The WPB **RECOMMENDED** that a consultant be hired to carry out workshops on data poor techniques for assessment including CPUE estimations for billfish species. This activity should be a high priority within the Scientific Committee's Program of Work. Terms of Reference will be provided to the SC's consideration in 2015. An indicative budget is provided at Table 19.

**Table 19.** Estimated budget required to hire a consultant to carry out workshops on data poor techniques for assessment including CPUE estimations for billfish species in 2016 and 2017.

| Description | Unit price | Units required | 2016 Total (US$) | 2017 Total (US$) |
|---|---|---|---|---|
| Develop material for training workshop and delivery of a workshop (fees) | 450 | 15 | 6,750 | 6,750 |
| Develop material for training workshop and delivery of a workshop (travel) | 5,000 | 1 | 5,000 | 5,000 |
| | | Total estimate | **11,750** | **11,750** |

# 10. Other Business

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

***Chairperson***

156. The WPB **NOTED** that the second term of the current Chairperson, Dr Jérôme Bourjea (EU,France) is due to expire at the closing of the current WPB meeting and as per the IOTC Rules of Procedure (2014), participants are required to elected a new Chairperson for the next biennium.

157. The WPB **THANKED** Dr Jérôme Bourjea (EU,France) for his Chairmanship over the past four years and looked forward to his continued engagement in the activities of the WPB in the future.

158. **NOTING** the Rules of Procedure (2014), the WPB **CALLED** for nominations for the newly vacated position of Chairperson of the IOTC WPB for the next biennium. Dr Tom Nishida (Japan) was nominated, seconded and elected as Chairperson of the WPB for the next biennium.

***Vice-Chairperson***

159. The WPB **NOTED** that during the inter-sessional period, Dr Miguel Neves Santos (EU,Portugal) vacated the position as Vice-Chairperson due to other commitments. As per the IOTC Rules of Procedure (2014), participants are required to elected a new Vice-Chairperson for the next biennium.

160. The WPB **THANKED** Dr Santos for his role in supporting the Chairperson and the WPB, over the past four years and looked forward to his continued engagement in the activities of the WPB in the future.

161. **NOTING** the Rules of Procedure (2014), the WPB **CALLED** for nominations for the newly vacated position of Vice-Chairperson of the IOTC WPB for the next biennium. Dr Evgeny Romanov (La Reunion, France) was nominated, seconded and elected as Vice-Chairperson of the WPB for the next biennium.

162. The WPB **RECOMMENDED** that the SC note that Dr Tom Nishida (Japan) and Dr Evgeny Romanov (La Reunion, France) were elected as Chairperson and Vice-Chairperson of the WPB for the next biennium.

### 10.2 Date and place of the 14th and 15th Sessions of the Working Party on Billfish

163. The WPB **THANKED** Portugal for hosting the 13th Session of the WPB and commended IPMA, Portugal on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

164. 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 14th and 15th Sessions of the WPB in 2016 and 2017 respectively, the WPB **REQUESTED** that the IOTC Secretariat liaise with Sri Lanka to determine if they would be able to host the 14th Session, and Kenya and Indonesia if they would host the 15th Session. 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 November 2015 (Table 20).

**Table 20.** Draft meeting schedule for the WPB (2016 and 2017)

| | 2016 | | | 2017 | | |
|---|---|---|---|---|---|---|
| **Meeting** | **No.** | **Date** | **Location** | **No.** | **Date** | **Location** |
| Working Party on **Billfish** (WPB) | 14th | 1–5 September (5d)/ or late October | Sri Lanka | 15th | 1–5 September (5d) or late October | Kenya or Indonesia |
| Working Party on **Ecosystems and Bycatch** (WPEB) | 12th | 7–11 September (5d) or Late October | Sri Lanka | 13th | 7–11 September (5d) or late October | Kenya or Indonesia |

165. 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.

### *10.4 Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Billfish*

166. The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB13, provided at Appendix XIII, 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 2015 (Fig. 10):
   - Swordfish (*Xiphias gladius*) – Appendix VII
   - Black marlin (*Makaira indica*) – Appendix VIII
   - Blue marlin (*Makaira nigricans*) – Appendix IX
   - Striped marlin (*Tetrapturus audax*) – Appendix X
   - Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XI

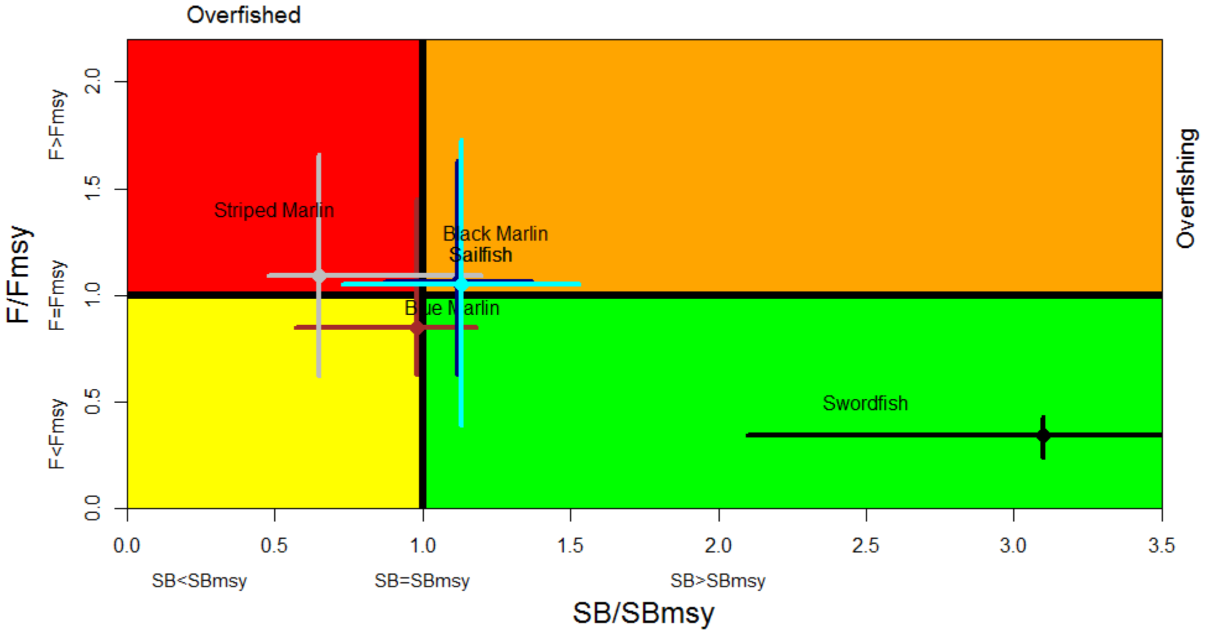



**Fig. 10.** Combined Kobe plot for swordfish (black), black marlin (light blue), blue marlin (brown), striped marlin (grey) and I.P. sailfish (navy blue) showing the 2013, 2014 and 2015 (most recent stock assessments) estimates of current stock size (SB or B, species assessment dependent) and current 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.

**167.** The report of the 13th Session of the Working Party on Billfish (IOTC–2015–WPB13–R) was **ADOPTED** on the 5 September 2015.

# APPENDIX I
# LIST OF PARTICIPANTS


**Chairperson**
Dr Jérôme **Bourjea**
IFREMER
Sète, France
Email: Jerome.Bourjea@ifremer.fr

**Vice-Chairperson**
Vacant

**Invited Expert**
Dr Humber Agrelli **Andrade**
Universidade Federal Rural de Pernambuco – UFRPE
Brazil
Email: humber.andrade@gmail.com

**Other Participants**:
Mrs Cindy **Assan**
Seychelles Fishing Authority, Seychelles
Email: cassan@sfa.sc

Mr Pascal **Bach**
IRD,
Sète, France
Email: pascal.bach@ird.fr

Mr Rui **Coelho**
IPMA, Portuguese Institute for the Ocean and Atmosphere, Olhao
EU,Portugal
Email: rpcoelho@ipma.pt

Mr Jose Ramon Fernandez **Costa**
IEO-Spanish Institute of Oceanography, Spain
Email: jose.costa@co.ieo.es

Dr Wetjens **Dimmlich**
World Wide Fund for Nature, Seychelles
Email: wdimmlich@wwf.panda.org

Dr S S K **Haputhantri**
National Aquatic Resources Research and Development Agency, Sri Lanka
Email: sisirahaputhantri@yahoo.com

Dr Hirotaka **Ijima**
National Research Institute of Far Seas Fisheries, Japan
Email: ijima@affrc.go.jp

Mr Ahmed Riyaz **Jauharee**
Marine Research Centre, Ministry of Fisheries and Agriculture, Maldives
Email: arjauhary@yahoo.com

Mrs Juliette **Lucas**
Seychelles Fishing Authority, Seychelles
Email: jlucas@sfa.sc

Mr Benson **Macharia Kirathe**
State Department of Fisheries, Kenya
Email: benson.macharia@yahoo.com

Mr Rui Jorge **Mutombene**
National Fisheries Research Institute, Mozambique
Email: ruimutombene@gmail.com

Dr Tom **Nishida**
National Research Institute of Far Sea Fisheries, (NRIFSF), National Research and Development Agency, Japan
Email: aco20320@par.odn.ne.jp

Mr Ahmad Adnan **Nuruddin**
SEAFDEC/MFRDMD, Department of Fisheries, Malaysia
Email: adnan@seafdec.org.my

Dr Evgeny **Romanov**
CAP RUN – HYDRO REUNION
Le Port, Reunion Island, France
Email: evgeny.romanov@ird.fr

Ms Daniela **Rosa**
Portuguese Institute for the Ocean and Atmosphere (IPMA),
EU,Portugal
Email: Daniela.rosa@ipma.pt

Dr Philippe S **Sabarros**
IRD, Reunion Island, France
Email: philippe.sabarros@ird.fr

Mr Bram **Setyadji**
Research Institute for Tuna Fisheries
Bali, Indonesia
Email: bram.setyadji@gmail.com

Dr Rishi **Sharma**
Indian Ocean Tuna Commission, Seychelles
Email: rishi.sharma@iotc.org

Dr David **Wilson**
Indian Ocean Tuna Commission, Seychelles
Email: david.wilson@iotc.org

Mr Aekharat **Wongkeaw**
Department of Fisheries, Thailand
Email: aekfish@hotmail.com

D.S. **Nandasena**
Department of Fisheries and Aquatic Resources
Sri Lanka
Email: nandasenads@gmail.com

# APPENDIX II
# AGENDA FOR THE 13TH WORKING PARTY ON BILLFISH

**Date:** 1–5 September 2015
**Location:** Olhão, Portugal
**Venue:** Real Marina Hotel and Spa
**Time:** 09:00 – 17:00 daily
**Chair**: Dr Jerôme Bourjea; **Vice-Chair**: Vacant

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 17th Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 19th 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 WPB12 (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 2015: Striped 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 (Priority species for 2015: I.P. 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 sailfish (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for sailfish
   - 7.3 Development of management advice for sailfish and update of 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 (2016–2020) (Chairperson and IOTC Secretariat)

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

**10. OTHER BUSINESS**

10.1 Election of a Chairperson and Vice-Chairperson for the WPB for the next biennium (IOTC Secretariat)

10.2 Date and place of the 14th and 15th Sessions of the Working Party on Billfish (Chairperson and IOTC Secretariat)

10.3 Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Billfish (Chairperson)

# APPENDIX III
# LIST OF DOCUMENTS

| Document | Title | Availability |
|---|---|---|
| IOTC–2015–WPB13–01a | Agenda of the 13th Working Party on Billfish | ✓(23 December 2014)<br>✓(27 August 2015)<br>✓(1 September 2015) |
| IOTC–2015–WPB13–01b | Annotated agenda of the 13th Working Party on Billfish | ✓(17 August 2015)<br>✓(29 August 2015)<br>✓(4 September 2015) |
| IOTC–2015–WPB13–02 | List of documents of the 13th Working Party on Billfish | ✓(4 August 2015)<br>✓(29 August 2015)<br>✓(5 September 2015) |
| IOTC–2015–WPB13–03 | Outcomes of the 17th Session of the Scientific Committee (IOTC Secretariat) | ✓(7 April 2015) |
| IOTC–2015–WPB13–04 Rev_1 | Outcomes of the 19th Session of the Commission (IOTC Secretariat) | ✓(1 July 2015)<br>✓(17 August 2015) |
| IOTC–2015–WPB13–05 | Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat) | ✓(8 April 2015) |
| IOTC–2015–WPB13–06 Rev_1 | Progress made on the recommendations and requests of WPB12 and SC17 (IOTC Secretariat) | ✓(28 January 2015)<br>✓(17 August 2015) |
| IOTC–2015–WPB13–07 | Review of the statistical data and fishery trends for billfish (IOTC Secretariat) | ✓(17 August 2015) |
| IOTC–2015–WPB13–08 Rev_1 | Revision of the WPB Program of Work (2016–2020) (Chair & IOTC Secretariat) | ✓(15 April 2015)<br>✓(23 July 2015) |
| IOTC–2015–WPB13–09 | DRAFT: Development of options for alternative management measures (including closures) for billfish in the IOTC area of competence (IOTC Secretariat) | ✓(17 August 2015) |
| IOTC–2015–WPB13–10 Rev_1 | Catch of billfishes by Malaysian tuna longliners in the southwestern Indian Ocean (Nuruddin, AA, Basir S, Jamon S and Saleh MFM) | ✓(17 August 2015)<br>✓(2 September 2015) |
| IOTC–2015–WPB13–11 | The Maldives billfish fishery – an update (Jauharee AR) | ✓(17 August 2015) |
| IOTC–2015–WPB13–12 Rev_1 | A review on tuna and tuna-like species in Iran and present status of gillnet billfish fishery (Rajaei F) | ✓(16 August 2015)<br>✓(23 August 2015) |
| IOTC–2015–WPB13–13 Rev_2 | Billfish by-catches of the Seychelles industrial longline fishery (Assan C) | ✓(17 August 2015)<br>✓(28 August 2015)<br>✓(2 September 2015) |
| IOTC–2015–WPB13–14 | Catch of billfish by Thai tuna longliners during 2010-2014 (Wongkeaw A, Lirdwitayaprasit P & Luesrithawornsin P) | ✓(17 August 2015) |
| IOTC–2015–WPB13–15 | Historical catches of marlins caught by sports fishers in the Kenyan waters (Ndegwa S & Benson MK) | ✓(17 August 2015) |
| IOTC–2015–WPB13–16 Rev_1 | Swordfish caught in longline fishery of southern Mozambique. Preliminary information based on observer onboard sampling (Mutombene RJ) | ✓(17 August 2015)<br>✓(5 September 2015) |
| IOTC–2015–WPB13–17 | Standardization of CPUE for striped marlin (*Tetrapturus audax*) of Japanese longline fishery in Indian Ocean (Ijima H, Ochi D, Nishida T & Okamoto H) | ✓(17 August 2015) |
| IOTC–2015–WPB13–18 | Indian Ocean striped marlin assessment based on the CPUE indices derived from the Japanese and Taiwanese longline fleets (IOTC Secretariat) | ✓(4 August 2015) |
| IOTC–2015–WPB13–19 Rev_1 | Stock assessments for striped marlin (*Tetrapturus audax*) in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC) (Nishida T) | ✓(17 August 2015)<br>✓(6 September 2015) |
| IOTC–2015–WPB13–20 Rev_1 | Spatio-temporal and length distributions of istiophorids in the southwest Indian Ocean inferred from scientific, observer and self-reporting data of the Reunion Island based pelagic longline fishery (Chevallier A, Sabarros PS, Rabearisoa N, Romanov E & Bach P) | ✓(17 August 2015)<br>✓(3 September 2015) |
| IOTC–2015–WPB13–21 | Some biological parameters of Indo-Pacific sailfish (*Istiophorus platypterus* Shaw, 1792) caught by Indonesian longliners in eastern Indian Ocean (Setyadji B, Nugraha B & Novianto D) | ✓(7 August 2015) |

| Document | Title | Availability |
|---|---|---|
| IOTC–2015–WPB13–22 Rev_1 | Estimate length-weight relationship and some morphometric relationships of Indo-Pacific sailfish (*Istiophorus platypterus*) using biological data of gillnet fishery and longline fishery in Sri Lanka (Haputhantri SSK & Perera HACC) | ✓(14 August 2015)<br>✓(2 September 2015) |
| IOTC–2015–WPB13–23 Rev_1 | Observations on the Indo-Pacific sailfish, *Istiophorus platypterus*, from the Portuguese pelagic longline fleet in the Indian Ocean (Coelho C, Rosa D, Lino P & Santos MN) | ✓(16 August 2015)<br>✓(3 September 2015) |
| IOTC–2015–WPB13–24 | Catch rates of Indo-Pacific sailfish (*Istiophorus platypterus*) as calculated based on IOTC longline dataset (Andrade HA) | ✓(16 August 2015) |
| IOTC–2015–WPB13–25 | Estimation of catch-per-unit-effort of Indo Pacific sailfish (*Istiophorus platypterus*) caught with gillnet in the north of Indian Ocean (Andrade HA) | ✓(14 August 2015) |
| IOTC–2015–WPB13–26 | CPUE standardization of sailfish (*Istiophorus platypterus*) caught by Japanese longline fishery in the Indian Ocean from 1994 to 2014 (Okamoto H & Ijima H) | ✓(13 August 2015) |
| IOTC–2015–WPB13–27 | Preliminary stock assessment of Indo Pacific sailfish (*Istiophorus platypterus*) using separated and composite estimations of relative abundance indices (Andrade HA) | ✓(17 August 2015) |
| IOTC–2015–WPB13–28 | Stock assessment of Indo-Pacific sailfish in the Indian Ocean (IOTC Secretariat) | ✓(4 August 2015) |
| IOTC–2015–WPB13–29 | ObServe: Database and operational software for longline and purse seine fishery data (Cauquil P, Rabearisoa N, Sabarros PS, Chavance P & Bach P) | ✓(17 August 2015) |
| IOTC–2015–WPB13–30 | Development of a novel high-throughput assay to evaluate genetic population structure in striped marlin (*Kajikia audax*) (Mamoozadeh N, McDowell J & Graves J) | ✓(14 August 2015) |
| IOTC–2015–WPB13–31 Rev_1 | CPUE standardization of striped marlin (*Kajikia audax*) caught by Taiwanese longline fishery in the Indian Ocean using targeting effect derived from cluster and principle component analyses (Wang S-P) | ✓(26 August 2015)<br>✓(2 September 2015) |
| IOTC–2015–WPB13–32 Rev_1 | Stock assessment of striped marlin (*Kajikia audax*) in the Indian Ocean using an age-structured integrated approach (Wang S-P) | ✓(26 August 2015)<br>✓(28 August 2015) |
| **Information papers** | | |
| IOTC–2015–WPB13–INF01 | IOTC SC – Guidelines for the Presentation of Stock Assessment Models | ✓(29 January 2015) |
| IOTC–2015–WPB13–INF02 | Resolution 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence* | ✓(17 August 2015) |
| IOTC–2015–WPB13–INF03 | Resolution 15/02 *On mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)* | ✓(17 August 2015) |
| IOTC–2015–WPB13–INF04 | Resolution 15/05 *On conservation measures for striped marlin, black marlin and blue marlin* | ✓(17 August 2015) |
| IOTC–2015–WPB13–INF05 | Resolution 15/10 *On target and limit reference points and a decision framework* | ✓(17 August 2015) |
| IOTC–2015–WPB13–INF06 | Systematics of the billfishes (Xiphiidae and Istiophoridae) (Nakamura I) | ✓(27 August 2015) |
| IOTC–2015–WPB13–INF07 | Phylogeny of recent billfishes (Xiphioidei) (Collette BB, McDowell JR & Graves JE) | ✓(27 August 2015) |
| IOTC–2015–WPB13–INF08 | DNA barcoding of billfishes (Hanner R, Floyd R, Bernard A, Collette BB & Shivji M) | ✓(27 August 2015) |
| **Data sets** | | |
| IOTC–2015–WPB13–DATA01 Rev_1 | Billfish datasets available (30 July 2015) | ✓(7 July 2015)<br>✓(30 July 2015) |
| IOTC–2015–WPB13–DATA03 Rev_2 | Data for the assessment of Indian Ocean Striped Marlin and Sailfish stock | ✓(7 July 2015)<br>✓(30 July 2015)<br>✓(23 August 2015) |
| IOTC–2015–WPB13–DATA04 Rev_1 | Japan standardised longline CPUE series 1971–2013 | ✓(20 July 2015)<br>✓(17 August 2015) |
| IOTC–2015–WPB13–DATA05 | Taiwan,China standardised longline CPUE series 1980–2013 | ✓(20 July 2015) |
| IOTC–2015–WPB13–DATA06 | Nominal catches per Fleet, Year, Gear, IOTC Area and species | ✓(29 July 2015) |

| **Document** | **Title** | **Availability** |
|---|---|---|
| IOTC–2015–WPB13–DATA07 | Catch and Effort - longline | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA08 | Catch and Effort - vessels using pole and lines or purse seines | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA09 | Catch and Effort - coastal | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA10 | Catch and Effort - all vessels | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA11 | Catch and Effort - reference | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA12 | Size Frequency - All billfish species | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA13 | DATA - Billfish equations | ✓(30 July 2015) |
| IOTC–2015–WPB13–DATA14 | Size frequency - reference | ✓(30 July 2015) |

# APPENDIX IVA
# MAIN STATISTICS OF BILLFISH
(*Extract from IOTC–2015–WPB13–07*)

**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 10 years 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.

  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):

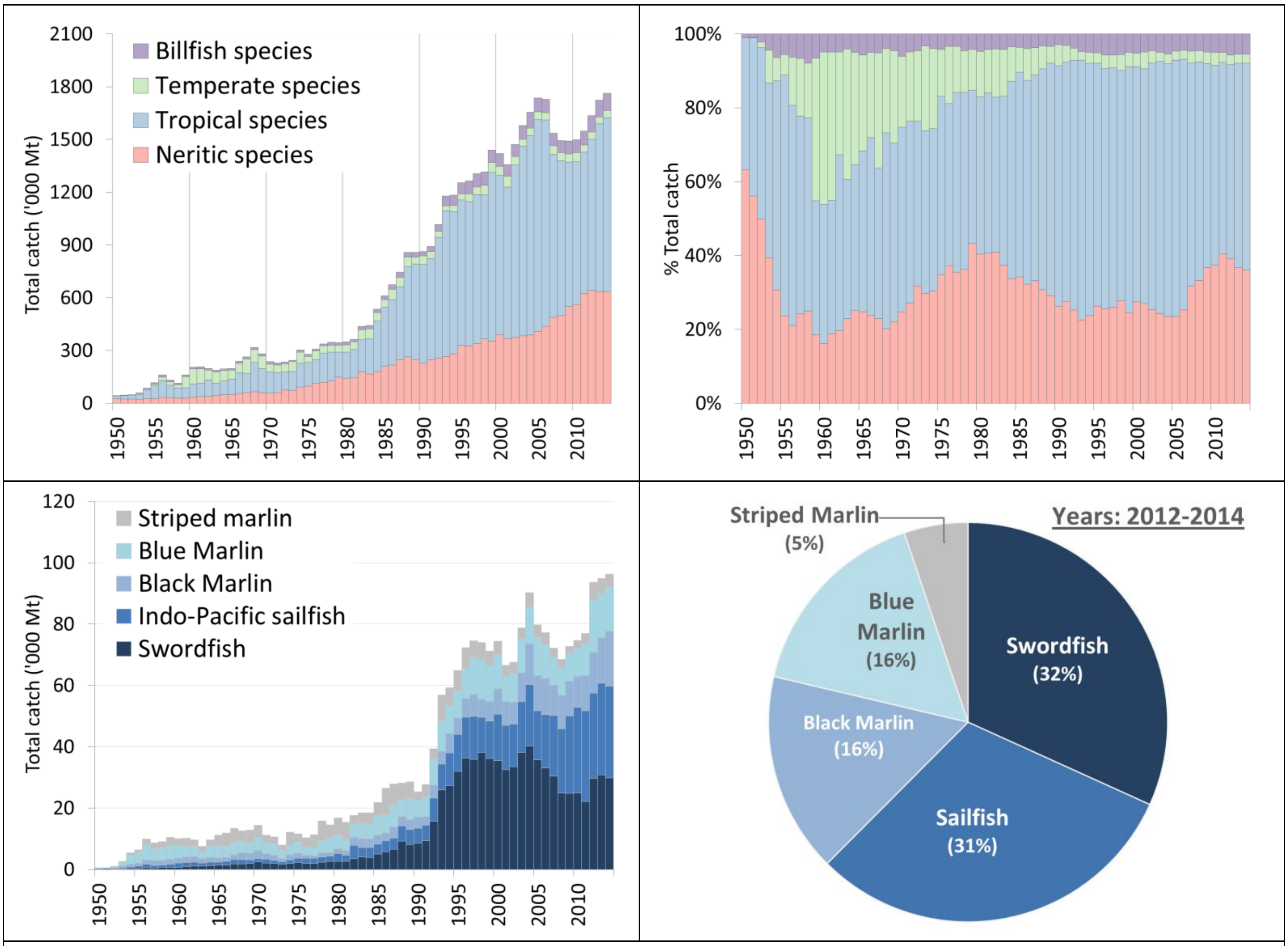
  In recent years six fleets (I.R. Iran, Indonesia, Taiwan,China, Sri Lanka, India and Pakistan) have reported over 75% of the total catches of billfish species from all IOTC fleets combined (**Fig. 2a**).

- 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 largest increases reported by I.R. Iran, Pakistan, and Taiwan,China) (**Fig. 1c**).

[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 1950–2014 (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, 1950–2014; d. Bottom right: share of billfish catch by species, 2012–14 average catch**).**

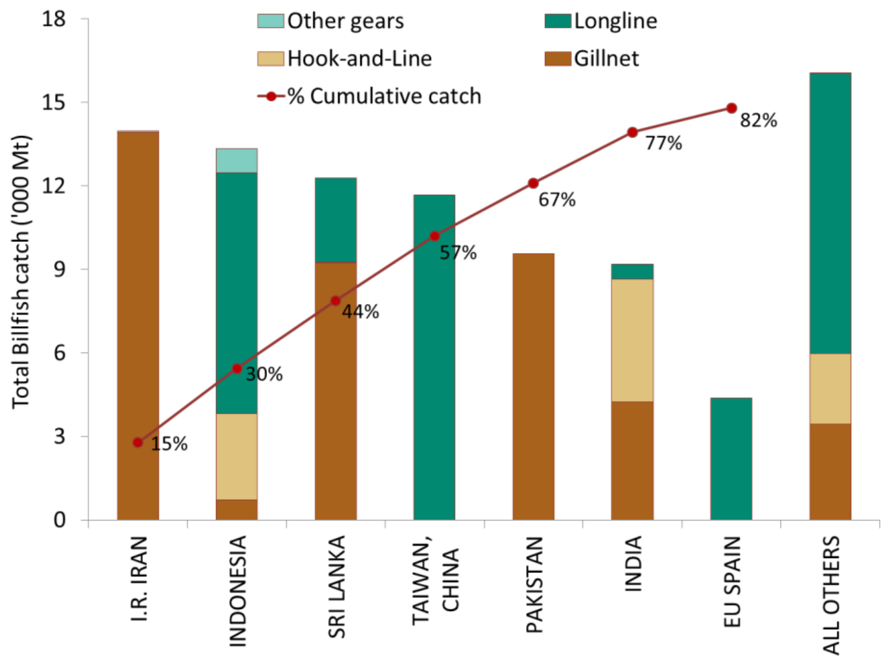
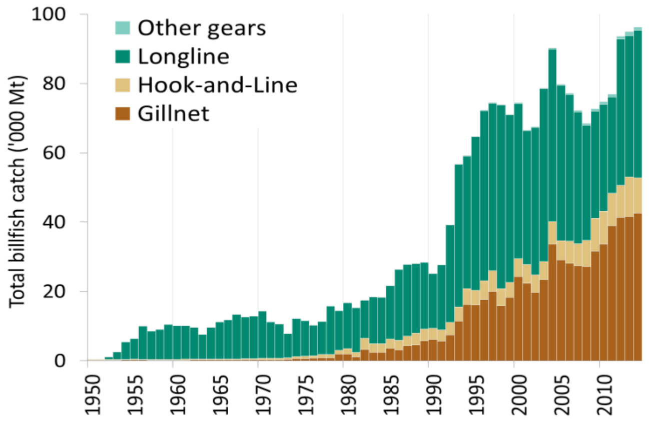



**Fig. 2a:** Billfish (all species): average catches in the Indian Ocean over the period 2011–14, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of all billfish species for the fleets concerned, over the total combined catches reported from all fleets and gears.



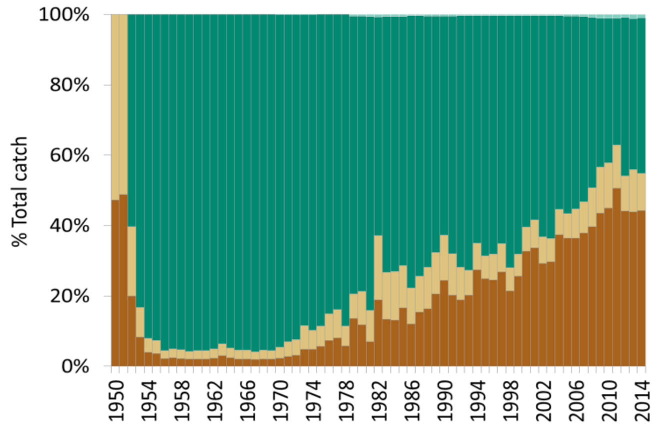




**Fig. 2b-c:** Billfish (all species): catches in the Indian Ocean over the period 1950–2014, by gear. Fig 2b. Left: nominal catch of all billfish species, by gear; Fig. 2c. Right: percentage share of all billfish species catches, by gear.

# APPENDIX IVB
# MAIN STATISTICS OF BLACK MARLIN

(*Extracts from IOTC–2015–WPB13–07*)

**Black marlin (*Makaira indica*)**

***Fisheries and main catch trends***

- Main fishing gear (2011–14): black marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for around 59% of total catches in the Indian Ocean, followed by longlines (19%), with remaining catches recorded under troll and handlines. (**Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):
Iran (gillnet): 24%; Sri Lanka (gillnet and fresh longline): 23%; India (gillnet and troll): 23%; Indonesia (fresh longline and hand lines): 18% (**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 (**Figs. 3, 4**)
- Retained catch trends:
Catches have increased steadily since the 1990s, from 2,800 t in 1991 to over 10,000 t since 2008. The highest catches were recorded in 2014, at nearly 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 1950–2014 (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** |
| LL | 862 | 1661 | 1391 | 1727 | 1571 | 1979 | 1953 | 2169 | 1920 | 3025 | 1834 | 1929 | 1989 | 2134 | 2554 | 4470 |
| GN | 26 | 31 | 44 | 439 | 2761 | 6917 | 8390 | 8458 | 6738 | 6227 | 6936 | 6071 | 7115 | 8517 | 8530 | 9949 |
| HL | 24 | 27 | 42 | 447 | 742 | 1032 | 840 | 983 | 1060 | 1357 | 2146 | 1629 | 1865 | 2261 | 3000 | 2987 |
| OT | 0 | 0 | 4 | 65 | 112 | 226 | 227 | 237 | 257 | 329 | 460 | 472 | 490 | 483 | 693 | 543 |
| **Total** | **912** | **1,719** | **1,480** | **2,679** | **5,186** | **10,154** | **11,411** | **11,847** | **9,975** | **10,938** | **11,376** | **10,101** | **11,459** | **13,395** | **14,776** | **17,948** |

**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.

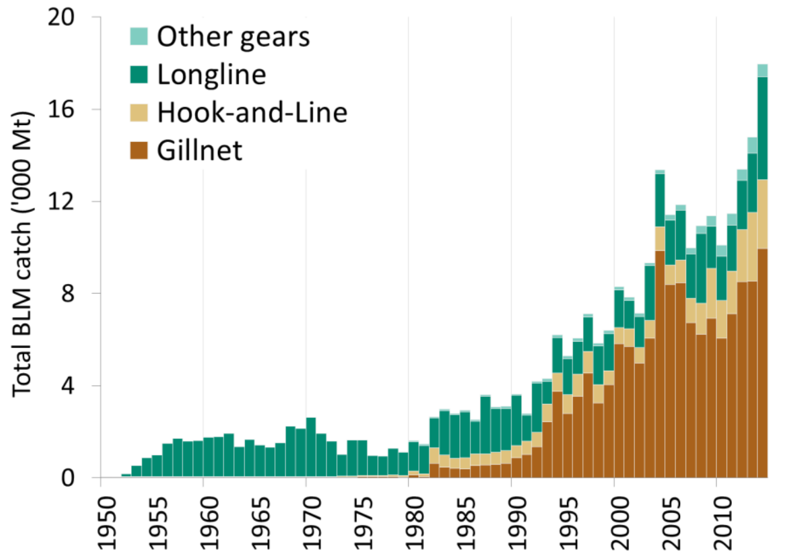



**Fig. 1.** Black marlin: catches by gear and year recorded in the IOTC Database (1950–2014). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

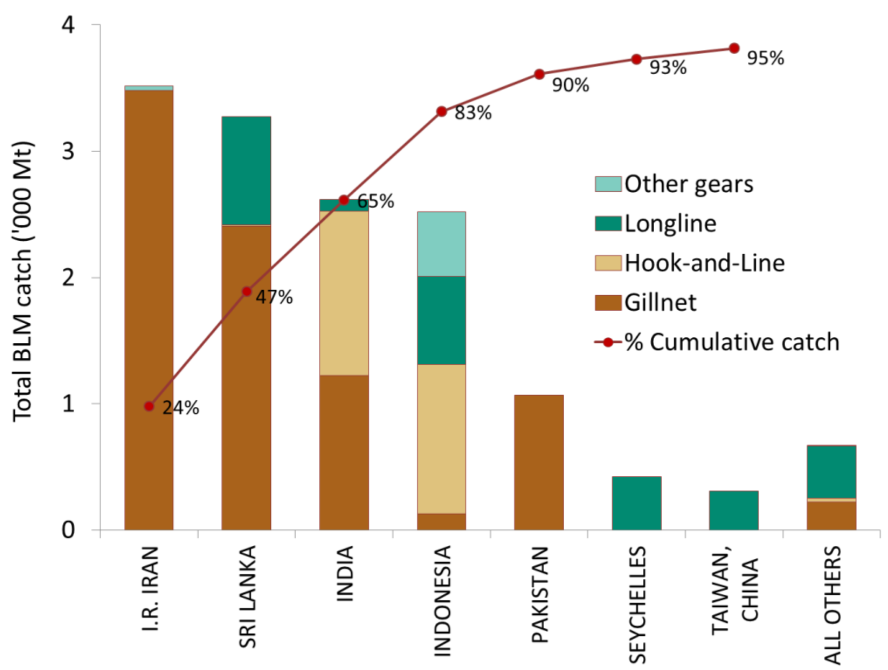



**Fig. 2.** Black marlin: average catches in the Indian Ocean over the period 2011–14, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of black marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

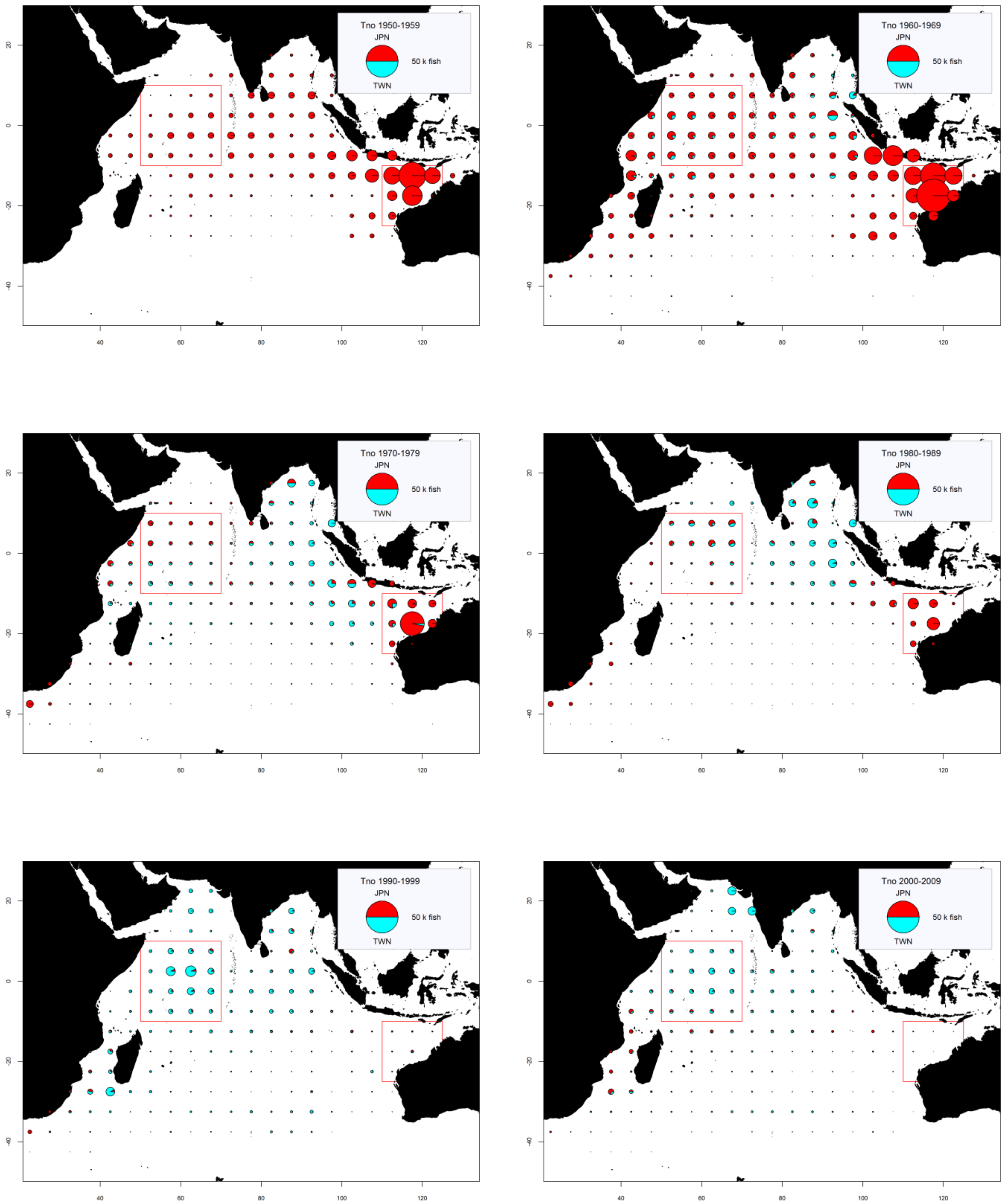



**Fig. 3a-f.** Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

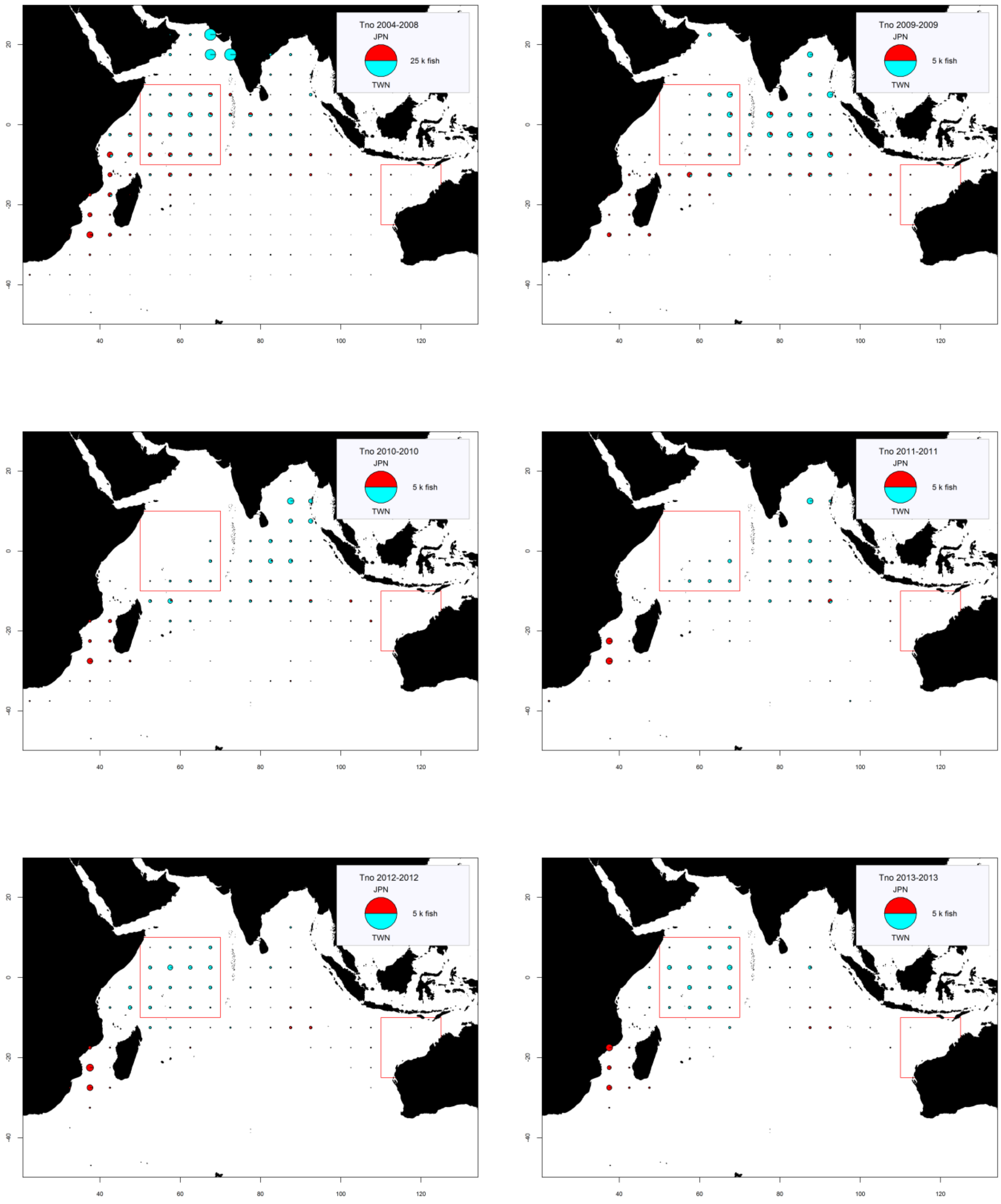



**Fig. 4a-f.** Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2004–08 by fleet and for 2009–13, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

***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 IOTC 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 IOTC 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 IOTC 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 IOTC 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 IOTC Secretariat.

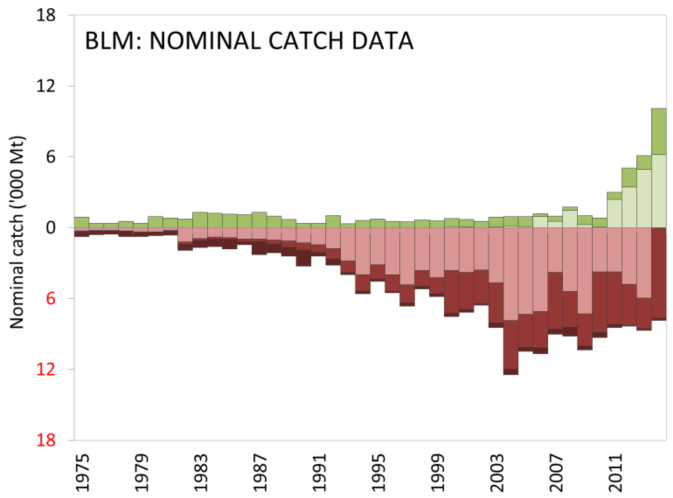
***Black marlin – Nominal catch-per-unit-effort (CPUE) trends***

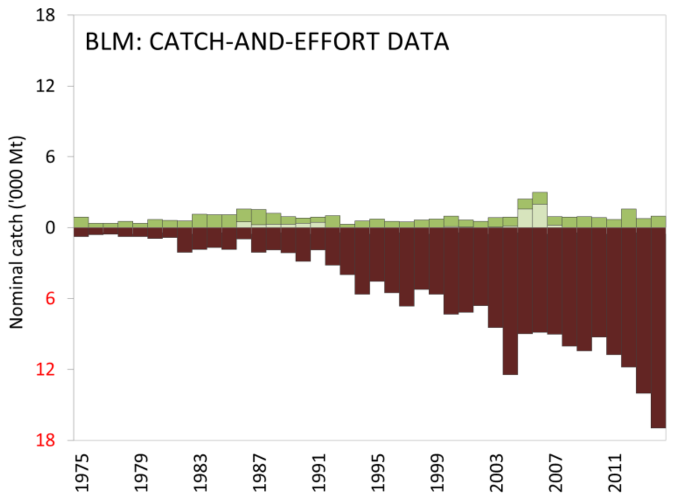
- Availability: Standardized CPUE series have not yet been developed for black marlin. Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  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 I.R. 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.

***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 IOTC Secretariat by CPCs.



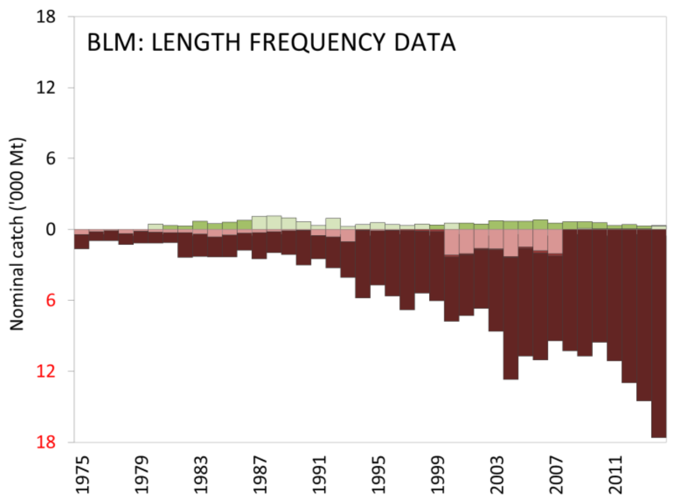




**Fig. 5a-c.** Black marlin: data reporting coverage (1975–2014).

*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 2015.*

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
(*Extracts from IOTC–2015–WPB13–07*)

**Blue marlin (*Makaira nigricans*)**

***Fisheries and main catch trends***

- Main fishing gear (2011–14): Blue marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Longline catches[3] account for around 69% of total catches in the Indian Ocean, followed by gillnets (28%), with remaining catches recorded under troll and handlines. (**Table 1; Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):

  Taiwan,China (longline): 33%; Indonesia (fresh longline): 28%; Pakistan (gillnet): 14%; I.R. Iran (gillnet): 7%, and Sri Lanka (7%) (**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 (**Figs. 3, 4**).
- 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 1950–2014 (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 |
| LL | 2,567 | 3,535 | 3,409 | 4,545 | 6,982 | 7,399 | 7,813 | 7,826 | 6,384 | 6,355 | 6,639 | 6,616 | 7,210 | 11,810 | 10,113 | 10,041 |
| GN | 1 | 2 | 124 | 760 | 2,357 | 2,687 | 4,545 | 2,977 | 2,559 | 2,410 | 2,049 | 2,198 | 3,148 | 4,879 | 4,024 | 4,052 |
| HL | 5 | 9 | 17 | 105 | 159 | 145 | 145 | 152 | 167 | 197 | 276 | 303 | 268 | 264 | 366 | 384 |
| OT | 0 | 0 | 0 | 2 | 4 | 7 | 7 | 8 | 8 | 11 | 15 | 15 | 16 | 16 | 17 | 17 |
| **Total** | **2,574** | **3,546** | **3,550** | **5,412** | **9,501** | **10,238** | **12,510** | **10,963** | **9,119** | **8,972** | **8,979** | **9,132** | **10,642** | **16,969** | **14,521** | **14,495** |

**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.

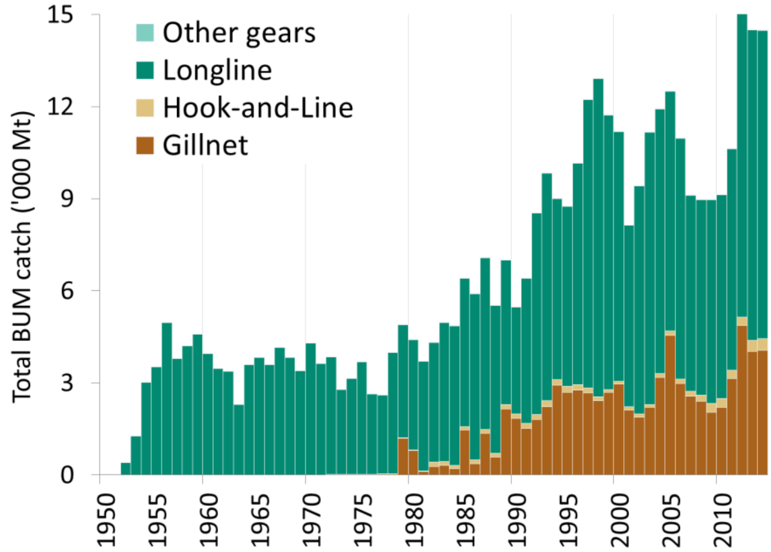



**Fig. 1.** Blue marlin: catches by gear and year recorded in the IOTC Database (1950–2014). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

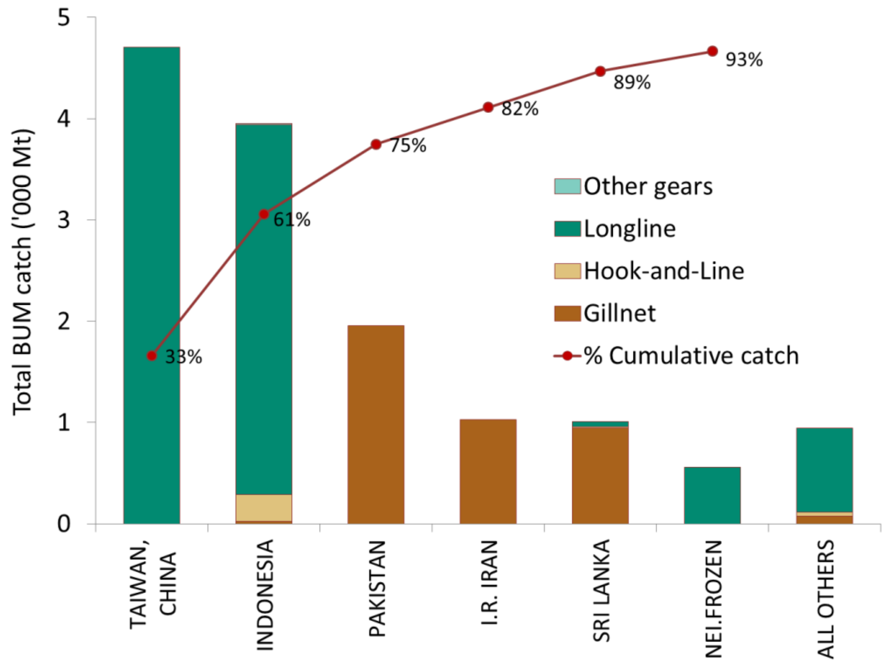



**Fig. 2.** Blue marlin: average catches in the Indian Ocean over the period 2011–14, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

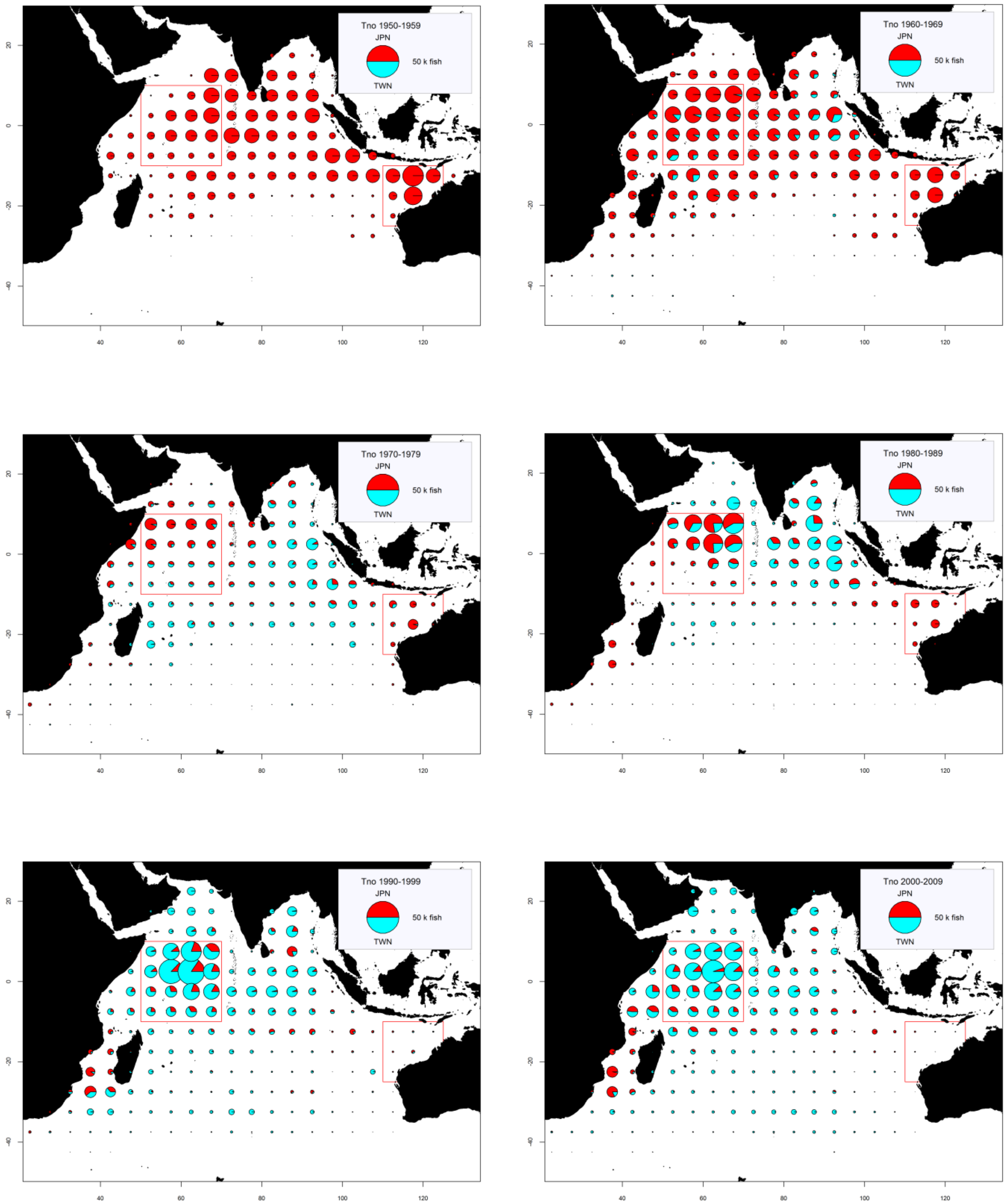



**Fig. 3a-f.** Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950-2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

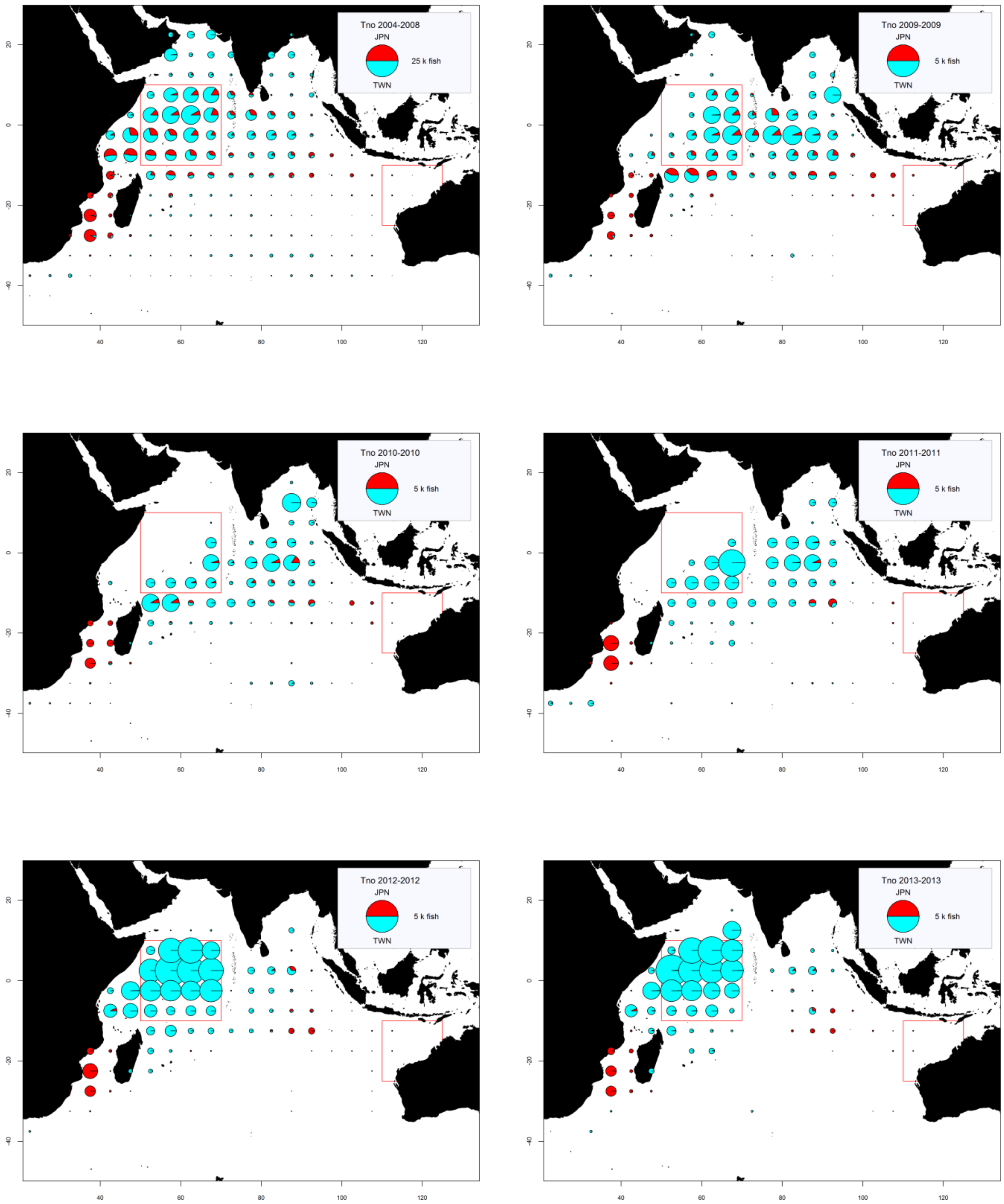



**Fig. 4a-f.** Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2004–08 by fleet and for 2009–13, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

# APPENDIX IVD
# MAIN STATISTICS OF STRIPED MARLIN
(*Extracts from IOTC–2015–WPB13–07*)

***Striped marlin (Tetrapturus audax)***

## *Fisheries and main catch trends*

- Main fishing gear (2011–14): 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 (28%), with remaining catches recorded under troll and handlines. (**Table 1, Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):

  Indonesia (drifting longline and coastal longline): 32%; Taiwan,China (drifting longline): 26%; I.R. Iran (gillnet): 11%; and Sri Lanka (gillnet): 10% (**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 (**Figs. 3, 4**) 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 2014[5].

**TABLE 1.** Striped marlin: best scientific estimates of catches by type of fishery 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 |
| LL | 1,028 | 3,104 | 3,458 | 5,144 | 5,120 | 2,915 | 3,080 | 3,020 | 2,345 | 2,098 | 1,668 | 2,053 | 2,277 | 4,500 | 3,330 | 2,303 |
| GN | 5 | 8 | 16 | 22 | 161 | 541 | 876 | 807 | 479 | 389 | 407 | 331 | 542 | 984 | 1,169 | 1,359 |
| HL | 3 | 5 | 10 | 32 | 70 | 136 | 136 | 143 | 152 | 198 | 273 | 282 | 293 | 288 | 335 | 339 |
| OT | 0 | 0 | 0 | 6 | 10 | 20 | 20 | 21 | 23 | 29 | 41 | 42 | 44 | 43 | 48 | 48 |
| **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** |

**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 striped marlin.

**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**).

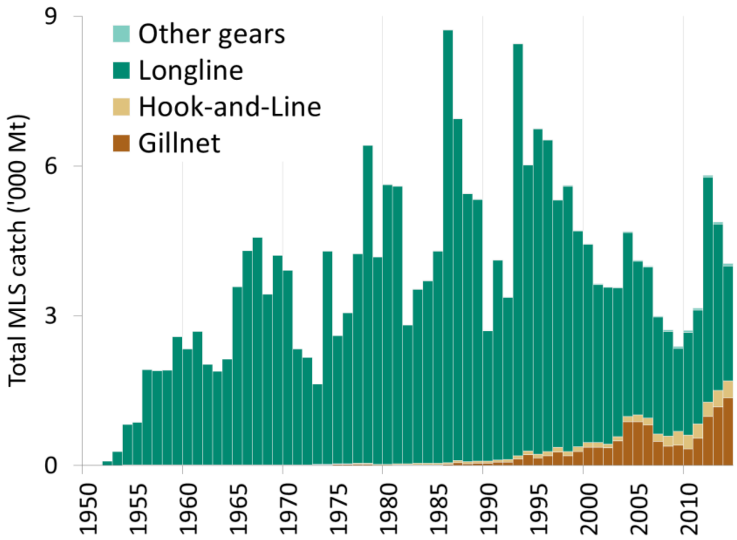



**Fig. 1.** Striped marlin: catches by gear and year recorded in the IOTC Database (1950–2014). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

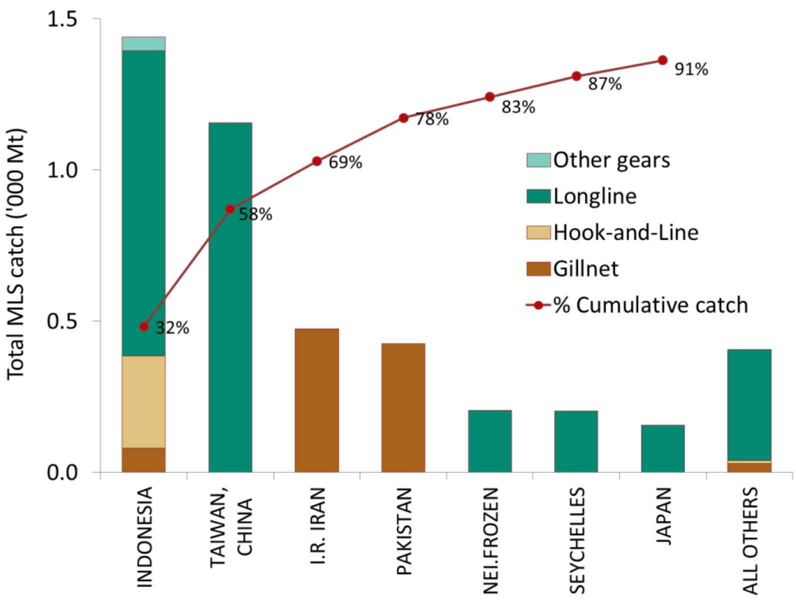



**Fig. 2.** Striped marlin: average catches in the Indian Ocean over the period 2011–14, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

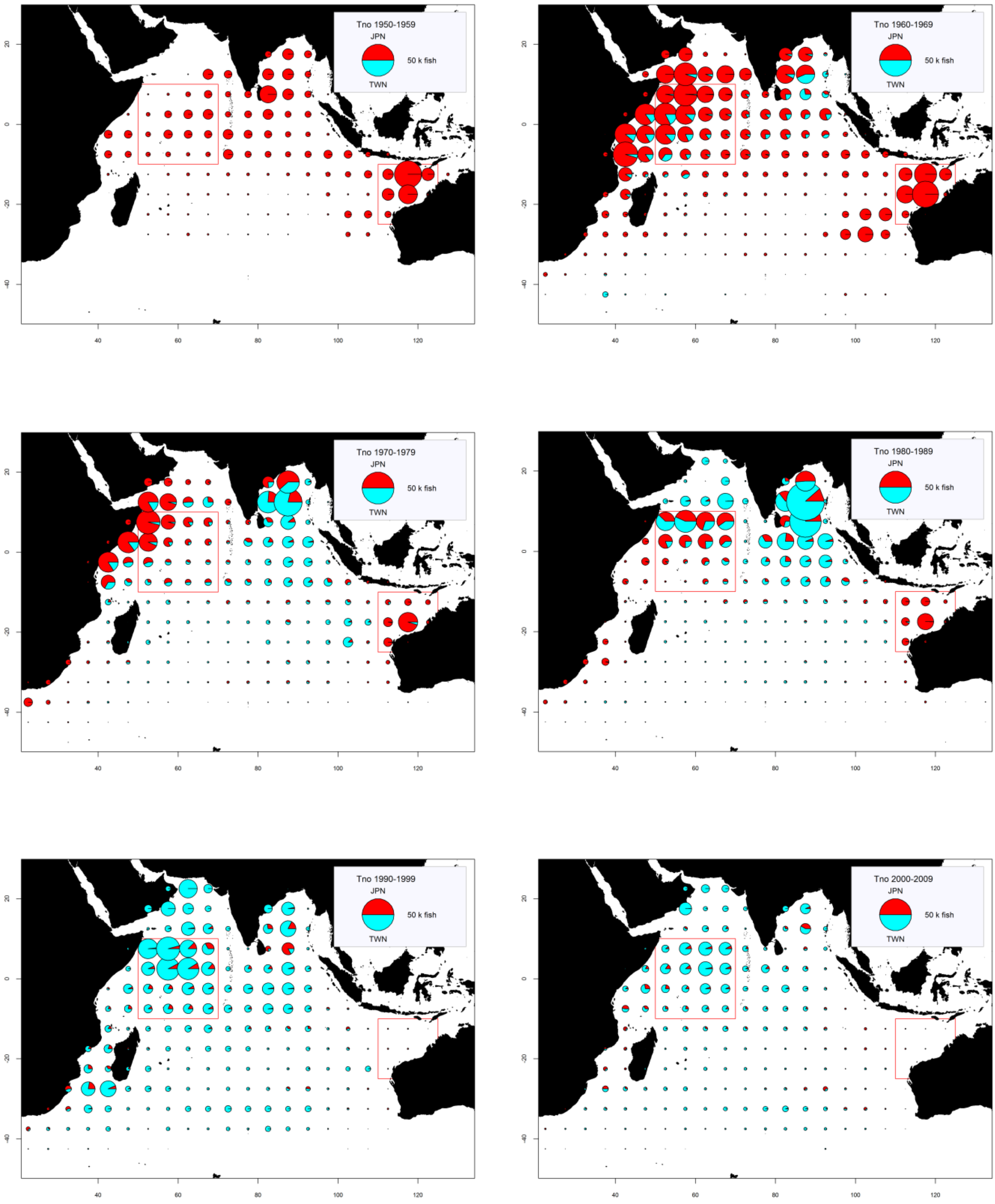



**Fig. 3a-f.** Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

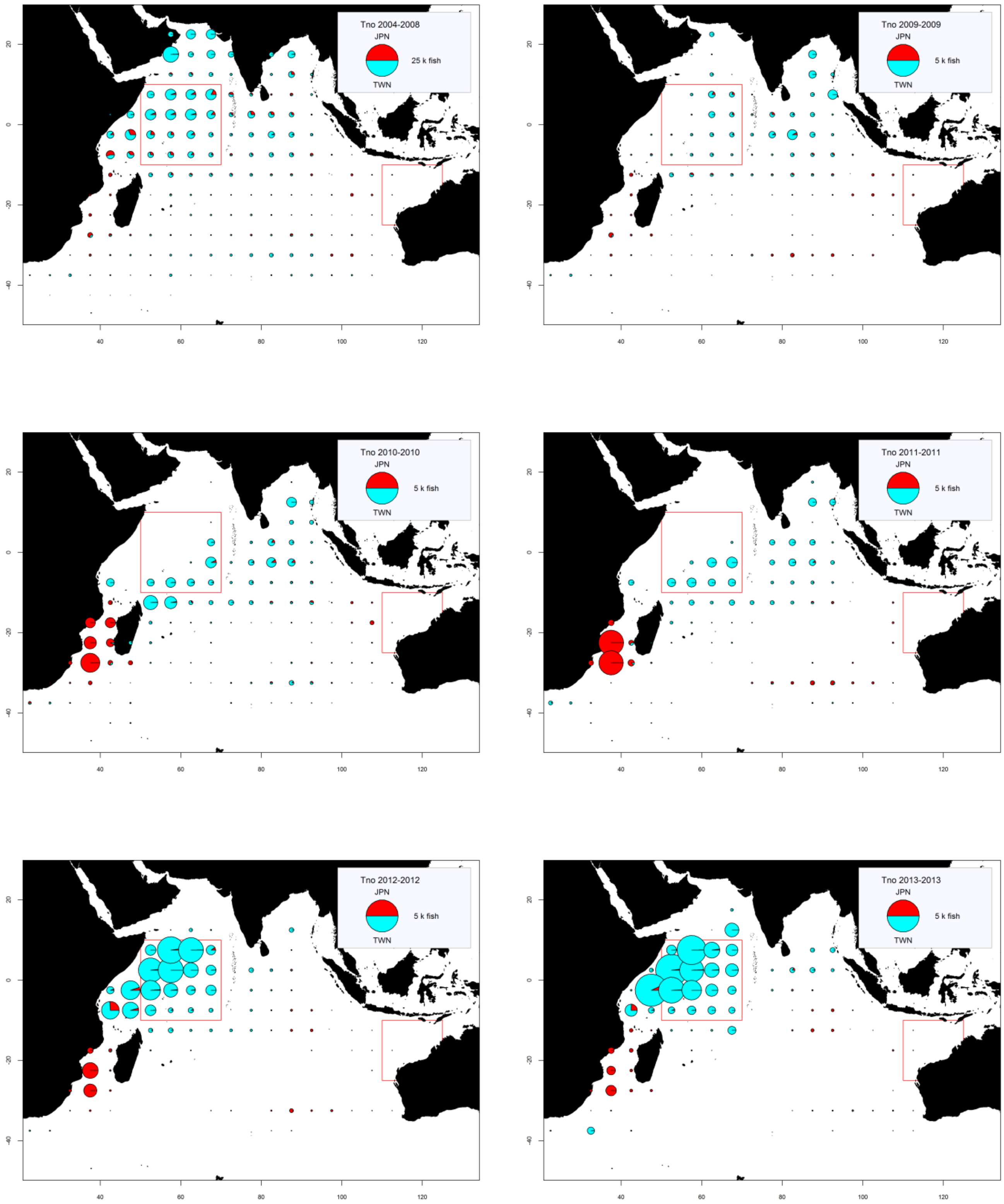



**Fig. 4a-f.** Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2004–08 by fleet and for 2009–13, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB.

***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:

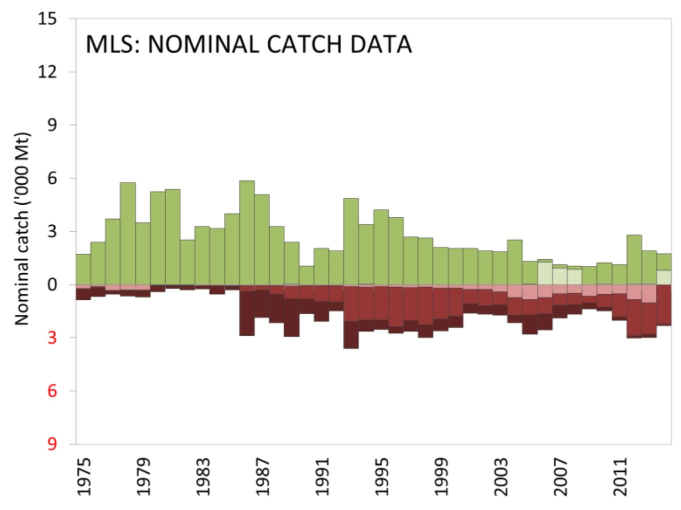
- Species aggregates: catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., 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 IOTC 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.

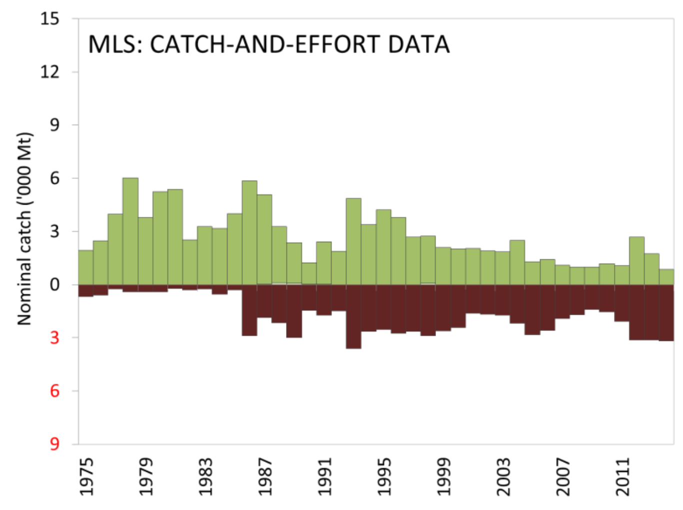
***Striped marlin – Nominal catch-per-unit-effort (CPUE) trends***

- 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, 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.

***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.



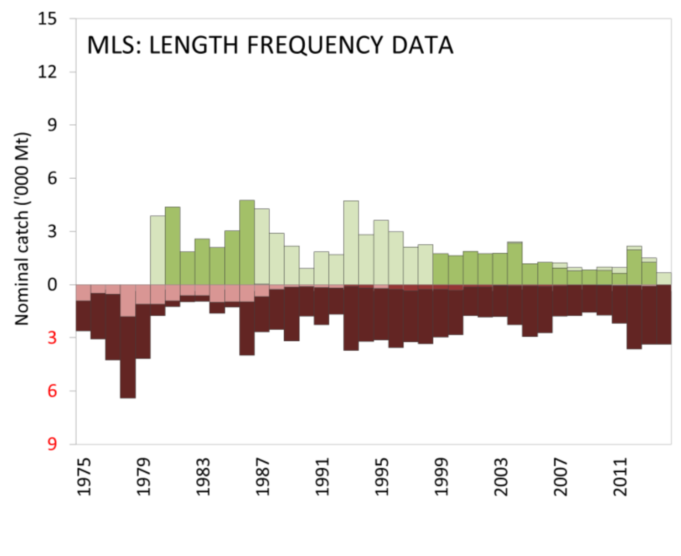




**Fig. 5a-c.** Striped marlin: data reporting coverage (1975–2014).

*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 2015.*

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) |
| (light red) | 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

(*Extracts from IOTC–2015–WPB13–07*)

***Indo-Pacific sailfish (Istiophorus platypterus)***

***Fisheries and main catch trends***

- Main fishing gear (2011–2014): gillnets account for around 78% of total catches in the Indian Ocean, followed by troll and hand lines (17%), with remaining catches recorded under longlines and other gears (**Table 1**, **Fig. 1**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):

  Three quarters of the total catches of Indo-Pacific sailfish are accounted for by four countries situated in the Arabian Sea: Iran (gillnet): 28%; Pakistan (gillnet): 19%; India (gillnet and troll): 17%; and Sri Lanka (gillnet and fresh longline) (**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 2010.

  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 (**Figs. 3, 4**).
- 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 2014[6].

**TABLE 1.** Indo-Pacific sailfish: best scientific estimates of catches by type of fishery 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 |
| LL | 297 | 804 | 385 | 257 | 1,400 | 1,422 | 1,340 | 1,309 | 2,179 | 2,548 | 1,269 | 676 | 469 | 1,039 | 1,200 | 1,892 |
| GN | 165 | 181 | 508 | 1,827 | 6,056 | 12,501 | 11,048 | 11,712 | 13,417 | 13,863 | 18,285 | 21,037 | 23,393 | 21,417 | 22,844 | 23,531 |
| HL | 171 | 213 | 456 | 1,427 | 2,477 | 3,932 | 3,602 | 4,197 | 4,024 | 4,445 | 5,430 | 5,999 | 5,477 | 5,090 | 5,587 | 4,235 |
| OT | - | - | 2 | 26 | 41 | 85 | 84 | 88 | 95 | 134 | 171 | 175 | 184 | 180 | 275 | 201 |
| **Total** | **633** | **1,197** | **1,351** | **3,537** | **9,974** | **17,941** | **16,074** | **17,306** | **19,715** | **20,990** | **25,155** | **27,887** | **29,522** | **27,727** | **29,906** | **29,860** |

**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**).

[6] 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.

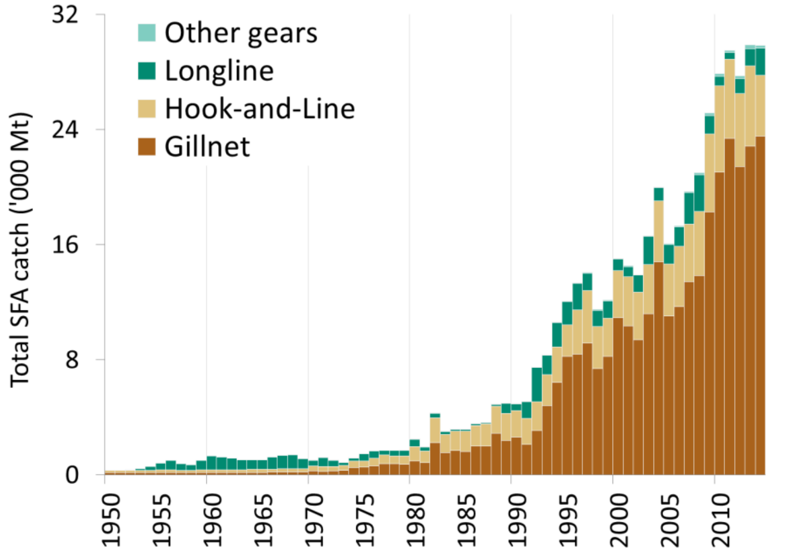



**Fig. 1.** Indo-Pacific sailfish: catches by gear and year recorded in the IOTC Database (1950–2014). Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.

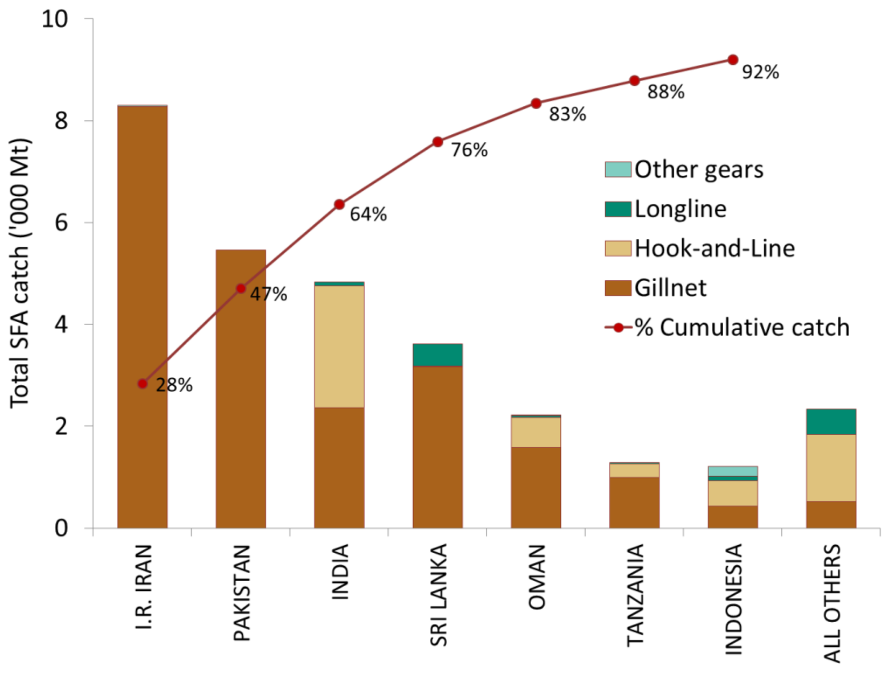



**Fig. 2.** Indo-Pacific sailfish: average catches in the Indian Ocean over the period 2011–14, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

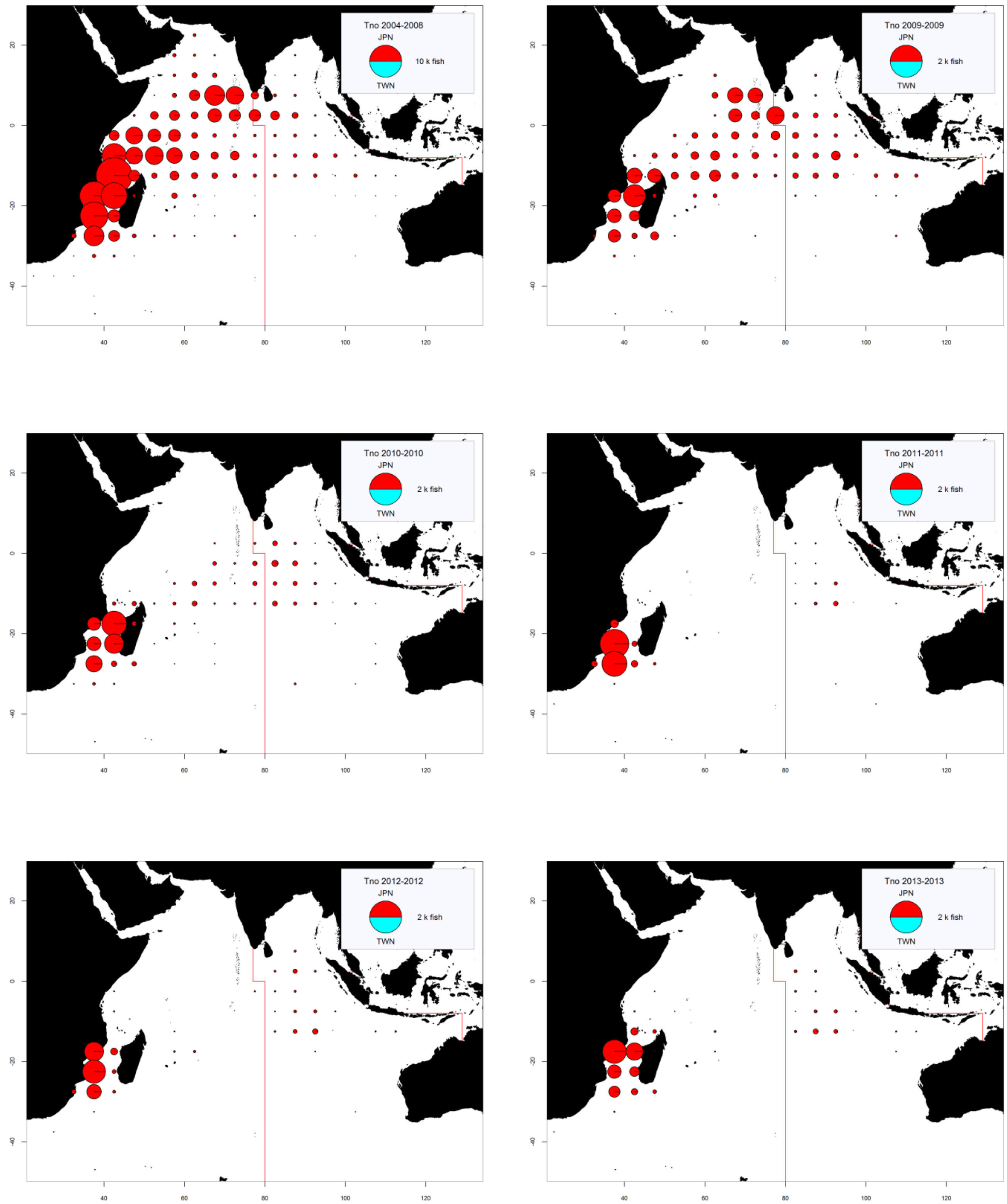



**Fig. 3a-f.** Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) for the period 2004–08, by fleet and for 2009–13, by year and fleet. Red lines represent the IOTC Areas.

***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.

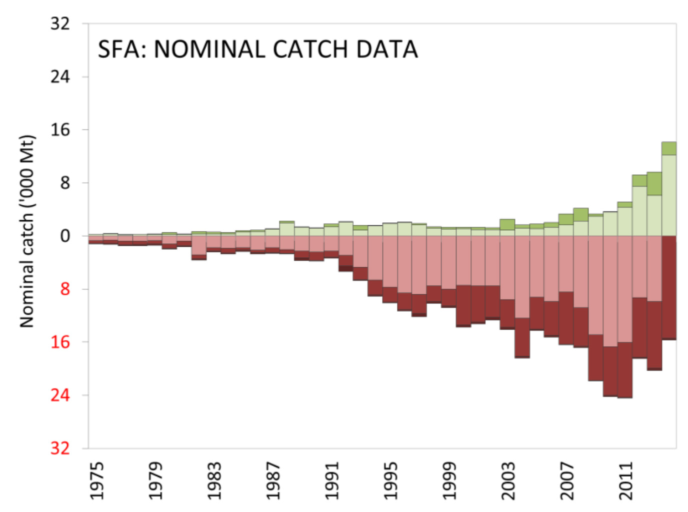
  There is also a lack of catch data for most sport fisheries.

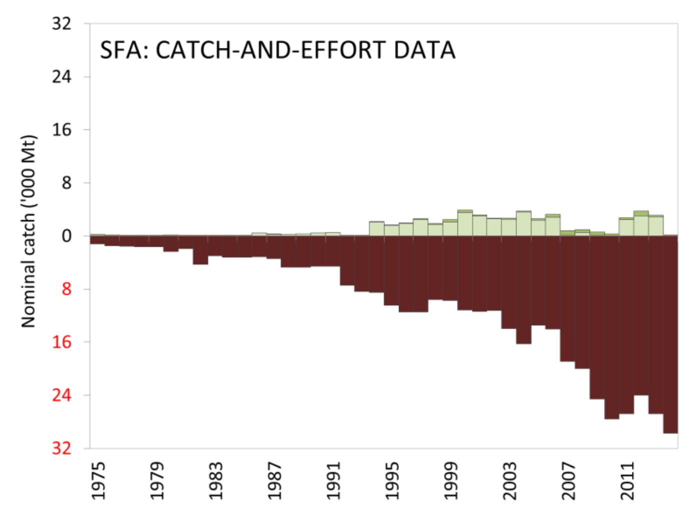
***Indo-Pacific sailfish – Nominal catch-per-unit-effort (CPUE) trends***

- 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.



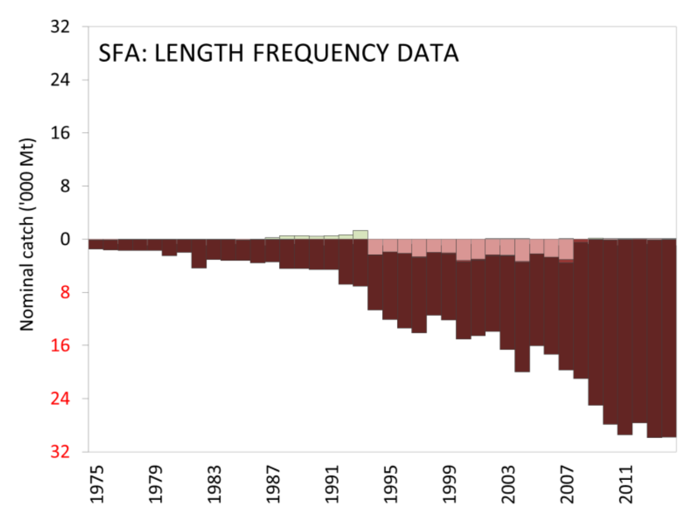




**Fig. 4a-c.** Indo-Pacific sailfish: data reporting coverage (1975–2014).

*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 2015.*

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
(*Extracts from IOTC–2015–WPB13–07*)

***Swordfish* (*Xiphias gladius*)**

### *Fisheries and main catch trends*

- Main fishing gear (2011–14): Longline catches[7] are currently estimated to comprise approximately 76% of total swordfish catches in the Indian Ocean. (**Table 1, 2; Fig. 1**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):

  Taiwan,China (longline): 19%; Sri Lanka (longline-gillnet): 15%; Indonesia (fresh longline): 15%; EU,Spain (swordfish targeted longline): 15% (**Fig. 2**).
- 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[8]).

  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 (**Figs. 3, 4**).
- 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 2014.

**TABLE 1.** Swordfish: best scientific estimates of catches by type of fishery 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 |
| ELL | - | - | - | 9 | 1,841 | 10,000 | 14,965 | 13,021 | 11,571 | 8,190 | 8,106 | 9,510 | 7,686 | 8,337 | 8,526 | 7,750 |
| LL | 260 | 1,301 | 1,920 | 4,313 | 22,692 | 20,049 | 17,390 | 17,145 | 16,053 | 13,443 | 13,725 | 12,364 | 10,929 | 17,318 | 17,000 | 16,601 |
| OT | 37 | 39 | 186 | 807 | 1,989 | 2,819 | 3,337 | 2,936 | 2,809 | 3,261 | 3,019 | 3,033 | 3,560 | 4,068 | 5,318 | 5,551 |
| **Total** | **297** | **1,340** | **2,106** | **5,130** | **26,521** | **32,868** | **35,693** | **33,102** | **30,434** | **24,895** | **24,850** | **24,908** | **22,174** | **29,723** | **30,844** | **29,902** |

**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**).

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

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

**TABLE 2.** Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2014 (in metric tons). Data as of August 2015.

| Area | 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 | 93 | 501 | 704 | 1,867 | 8,276 | 10,174 | 12,254 | 10,794 | 8,430 | 6,256 | 4,506 | 2,739 | 2,553 | 8,593 | 8,421 | 8,397 |
| SW | 13 | 232 | 368 | 600 | 8,622 | 7,678 | 9,791 | 9,002 | 7,423 | 6,370 | 6,381 | 8,427 | 7,204 | 7,272 | 7,127 | 7,107 |
| NE | 156 | 414 | 686 | 2,143 | 6,502 | 9,291 | 7,976 | 9,282 | 9,359 | 8,798 | 10,862 | 10,157 | 9,406 | 11,665 | 12,112 | 11,739 |
| SE | 35 | 186 | 278 | 382 | 3,033 | 5,706 | 5,656 | 4,017 | 5,207 | 3,466 | 3,097 | 3,574 | 3,005 | 2,190 | 3,184 | 2,658 |
| OT | 0 | 7 | 69 | 138 | 88 | 20 | 16 | 6 | 15 | 5 | 5 | 12 | 7 | 3 | 1 | 2 |
| **Total** | **297** | **1,340** | **2,106** | **5,130** | **26,521** | **32,868** | **35,693** | **33,102** | **30,434** | **24,895** | **24,850** | **24,908** | **22,174** | **29,723** | **30,844** | **29,902** |

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

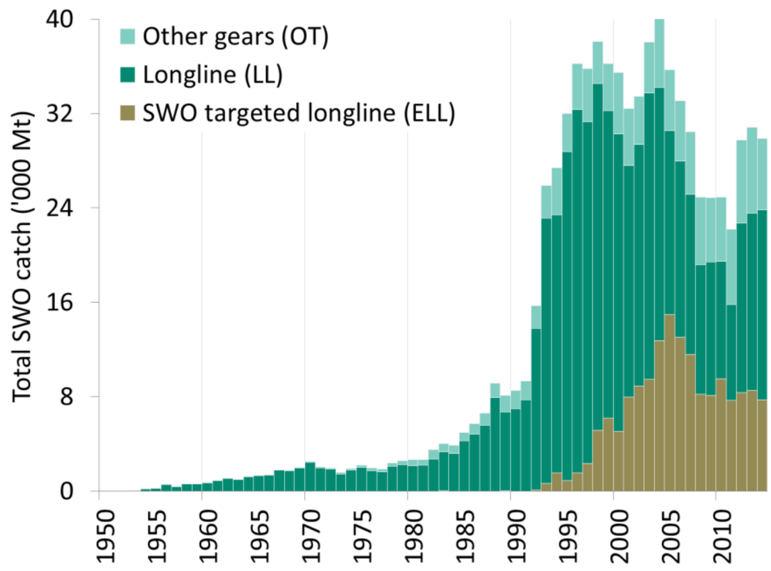



**Fig. 1.** Swordfish: catches by gear and year recorded in the IOTC Database (1950–2014). Other gears includes: longline-gillnet, handline, gillnet, coastal longline, troll line, sport fishing, and all other gears.

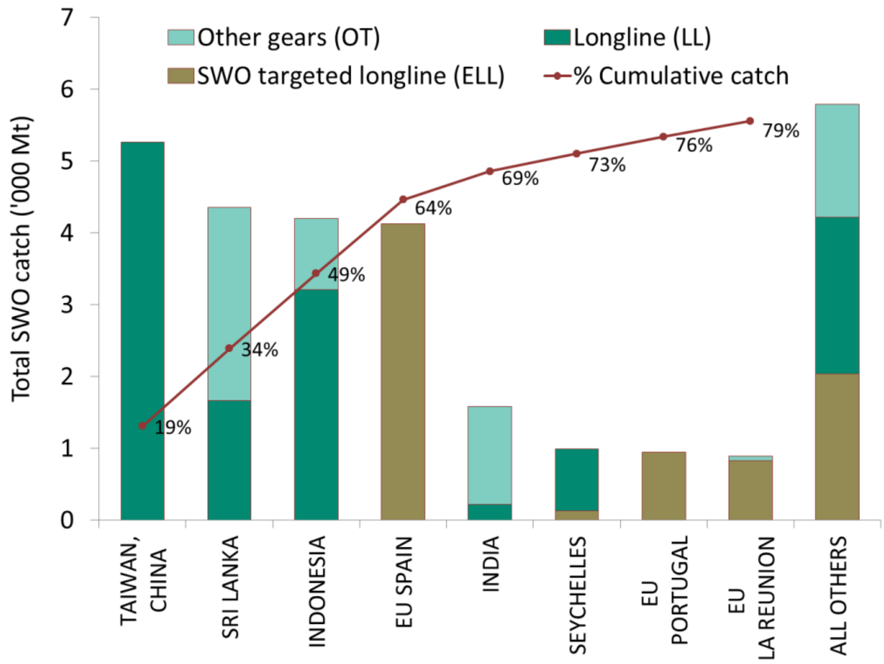



**Fig. 2.** Swordfish: average catches in the Indian Ocean over the period 2011–14, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of swordfish for the fleets concerned, over the total combined catches reported from all fleets and gears.

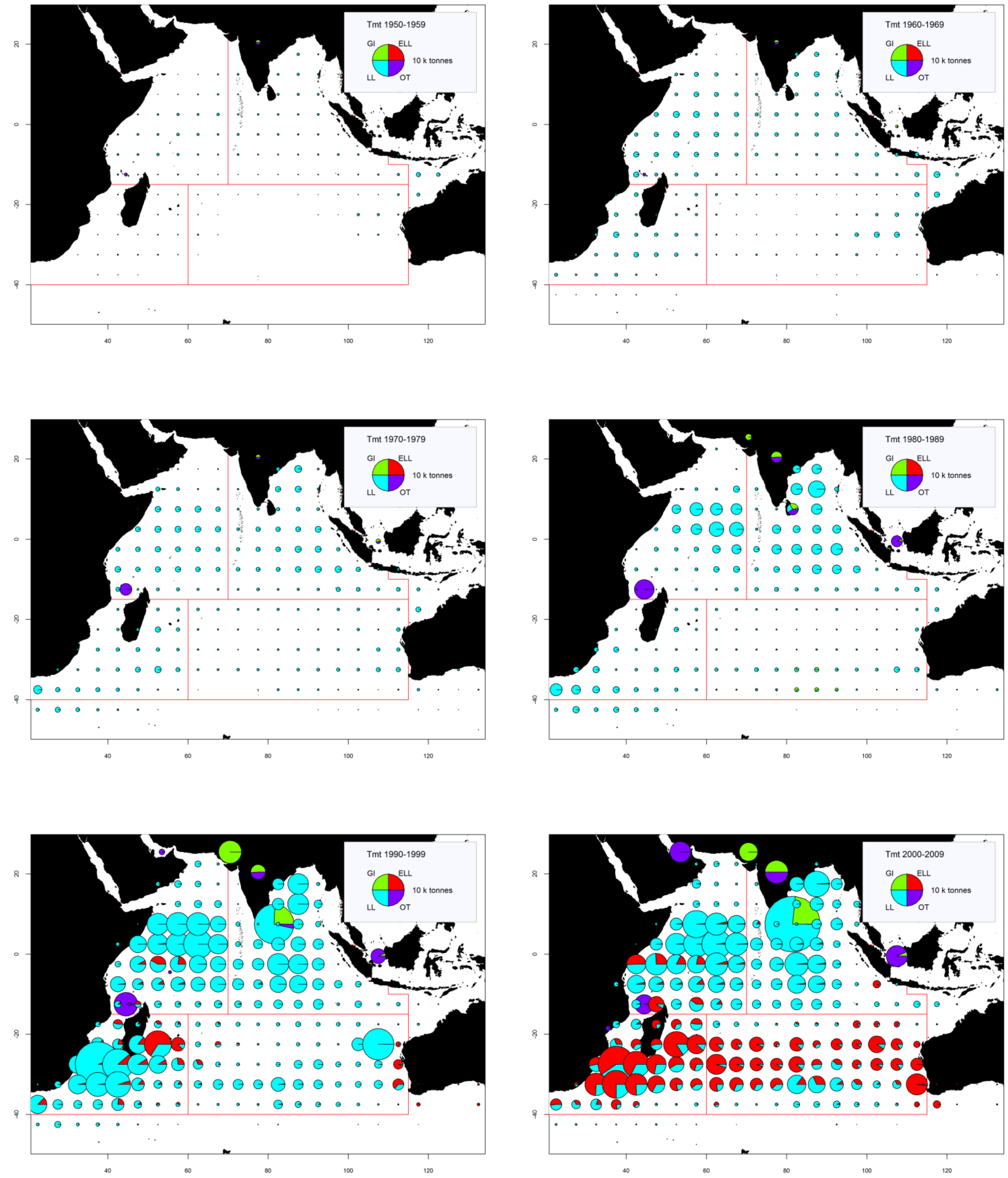



**Fig. 3a-f:** Swordfish: Time-area catches (total combined in tonnes) as reported for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), gillnet fisheries (**GI**), and for all other fleets combined (**OT**), for the period 1950-2009, by decade and type of gear. Red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

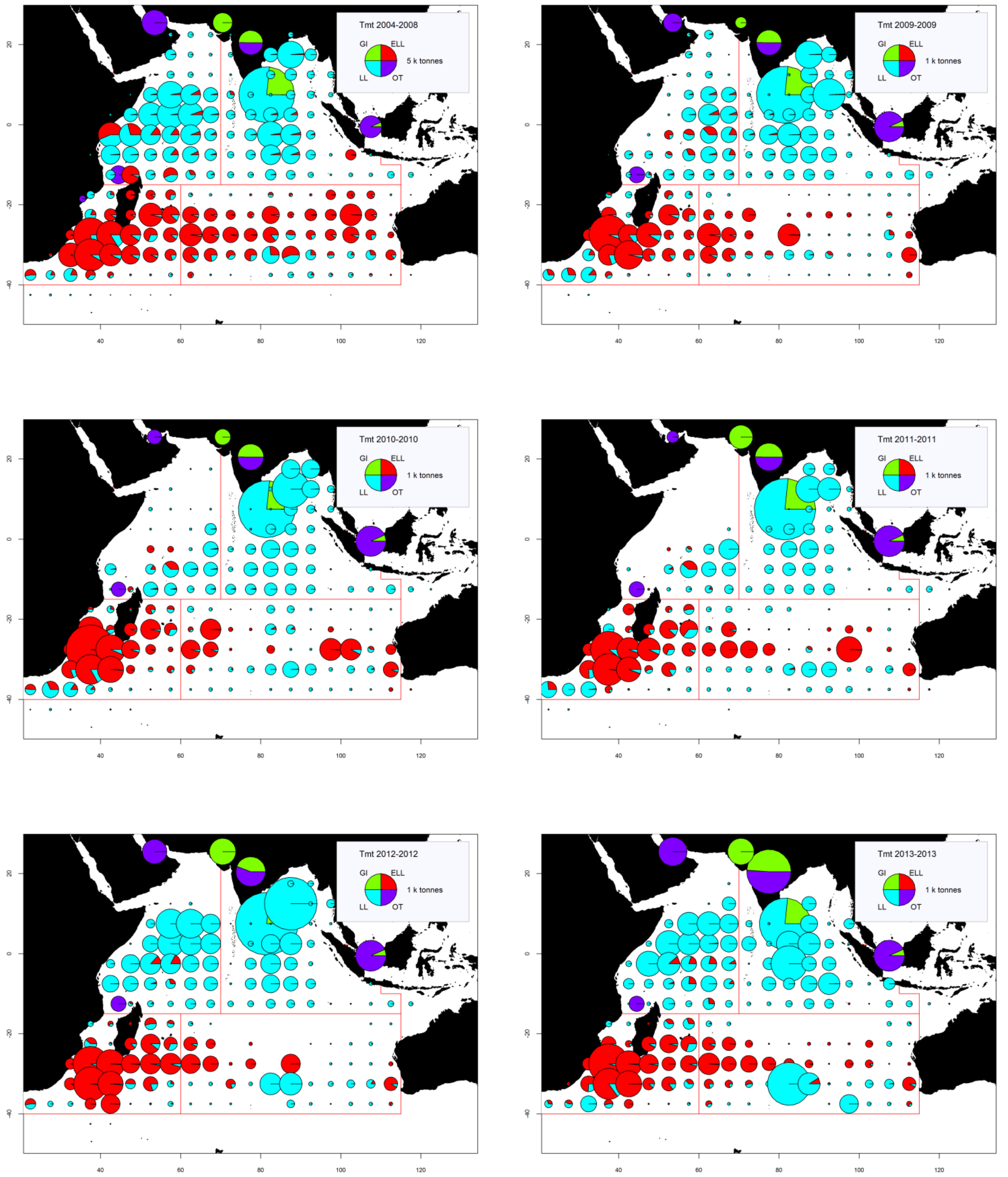



**Fig. 4a-f:** Swordfish: Time-area catches (total combined in tonnes) for longline fisheries targeting swordfish (**ELL**), other longline fisheries (**LL**), gillnet fisheries (**GI**), and for all other fleets combined (**OT**), for the period 2004-2008 by type of gear and for 2009-13, by year and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

***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 12% 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 is thought to be low and does 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.

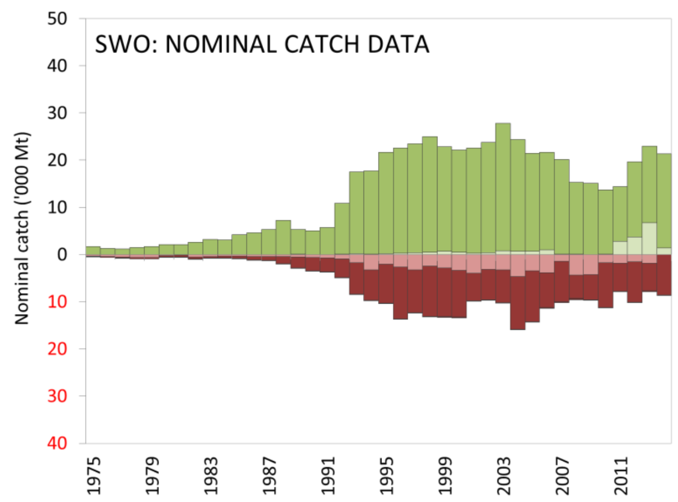
For most other fisheries, catch-and-effort are either not available (e.g., gillnet and longline fishery of Sri Lanka and drifting gillnet fisheries of I.R. Iran and Pakistan), or they are considered poor quality – especially since the early-1990s (e.g., Indonesia, Taiwan,China fresh-tuna longliners,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

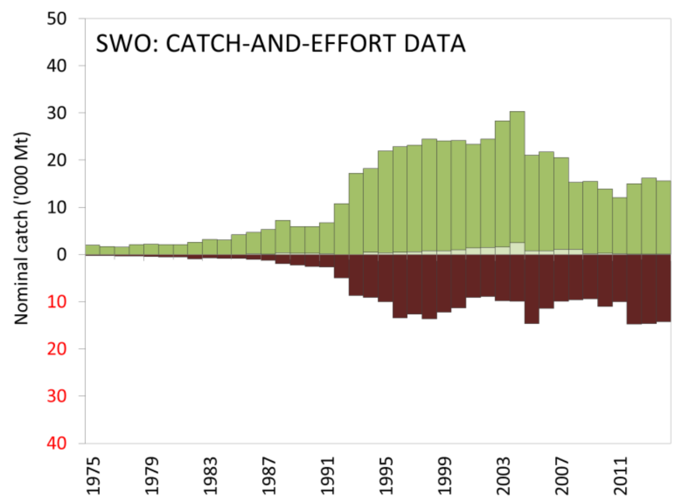
***Swordfish – Fish size or age trends (e.g., by length, weight, sex and/or maturity)***

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 to a 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:
    - i. 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;
    - ii. uncertainty in the catches of swordfish for the drifting gillnet fisheries of I.R. Iran and the longline fishery of Indonesia;
    - iii. 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);
    - iv. the paucity of size data available from industrial longliners since the early-1990s (e.g. Japan, Philippines, India and China);
    - v. the lack of time-area catches for some industrial fleets (e.g. Indonesia, India, NEI fleets);
    - vi. the paucity of biological data available, notably sex-ratio and sex-length-age keys.
- Sex ratio data: have not been provided to the Secretariat by CPCs.



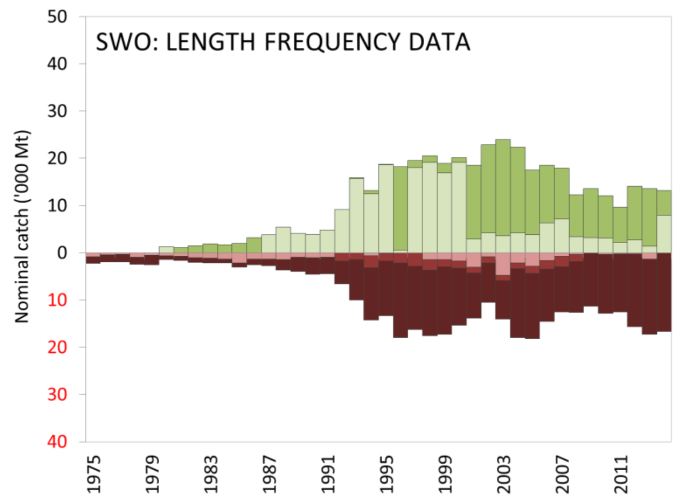




**Fig. 5a-c.** Swordfish: data reporting coverage (1975–2014).

*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 2015.*

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–2015–WPB13–07*

The following list 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.

***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: To date, no data have been received from any of the referred sport fisheries. Sport fisheries are known to catch billfish species, and are particularly important for catches of blue marlin, black marlin and Indo-Pacific sailfish. Although data are available from other 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.
- Drifting gillnet fisheries of I.R. Iran and Pakistan:

  a) In recent years both fisheries have reported catches of billfish at around 20,000 t (20% 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 estimated by the IOTC Secretariat. While the IOTC Secretariat has used the new catch reports to re-build the historical series (pre-2012) for its offshore gillnet fishery, estimates for the historical series remain highly uncertain.
  - Pakistan: The catches reported by Pakistan for recent years, including swordfish and black marlin, differ markedly from the alternative estimates received by the IOTC Secretariat (based on WWF funded sampling).

***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 10/02, and therefore of limited value in deriving indices of abundance:

- EU,Spain (longline)**:** To date, the IOTC Secretariat has not 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 IOTC 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)**:** Data are only available for striped marlin and swordfish for the year 2010, with no size data available for other species or years.
- 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. Indonesia (coastal fisheries): 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. I.R. Iran and Pakistan (gillnet fisheries): 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
# TERMS OF REFERENCE: FACILITATING THE ACQUISITION OF CATCH-AND-EFFORT AND SIZE DATA FROM SPORT FISHERIES OPERATING IN THE WESTERN INDIAN OCEAN

**Scientific Services to be provided:**

Following the requests of the IOTC Working Party on Billfish and the Scientific Committee to commence a process to facilitate the acquisition of catch-and-effort and size data from sport fisheries, by developing and disseminating reporting forms to Sport Fishing Centres in the region, the IOTC requires a short term consultancy for the following activities with the budget provided at Table 1:

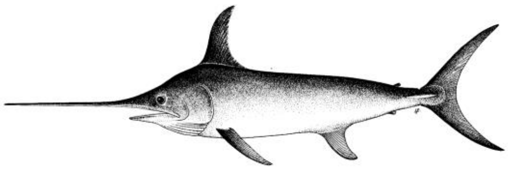
1. Complete a directory of sport fishing centres in the western Indian Ocean region (developing CPCs west of India: east Africa, Middle-East), including contact persons, emails and telephone numbers.
2. Develop and disseminate a database, using access or any other user-friendly software, and standardised recording and reporting forms adapted to Sport Fishing Centres in the western Indian Ocean region (developing CPCs west of India: east Africa, Middle-East):
   - Under the supervision of the IOTC Secretariat, the consultant would develop a database and standardised data collection/reporting forms based on the information necessary to carry out future analysis by IOTC scientists, of indices of abundance, trends in size as well as the collection of biological material.
   - Develop a comprehensive training package on data collection and management. The package would include:
     - the development of a manual "Sports fishery data collection, management and reporting in the western Indian Ocean region" to be used by Sports Fishing Centres, national fisheries agencies of IOTC CPCs, or any other relevant organisations.
     - data sheets, data input and reporting procedures, and the development of communication/awareness materials. The training shall focus on the understanding of the data needs, how to accurately collect the necessary information to complete the data forms and input data in the database, and the procedures to report to the IOTC Secretariat.
   - Implement and deliver the training materials to Sports Fishing Centers, national fisheries agencies, and any other relevant organisations. It is envisaged that to effectively deliver the training to the above, the Consultant would need to:
     - travel to each IOTC CPC in the region where sports fishing catches are considered to be an important contribution to overall catches from sport fishing and/or total catches from all fishing methods (sports, industrial etc.).
     - travel with at least one relevant officer of the national fisheries agency, which would be organised through the IOTC Secretariat. Specific countries to be visited would be determined in conjunction with the IOTC Secretariat and grouped where possible to minimise travel costs. The IOTC Secretariat would travel with the consultant for the first group of countries to be visited to assist the consultant in the delivery of training material, and to deliver the IOTC context component, for the Consultant to replicate during other country visits.
3. Create a network of Sport Fishing Centres, national fisheries agencies, IOTC scientists, and any other relevant organisations, so that they may improve their own outreach and awareness campaigns, in addition to data collection, management, exchange and analysis.
4. To document the work undertaken and to provide a draft report to the IOTC Secretariat no later than 6 months after the commencement of the project.
5. To develop a presentation of the results for a third party to describe the work undertaken and the results to the next IOTC Working Party on Billfish.

**Table 1.** Estimated budget required to hire a consultant to facilitate the acquisition of catch-and-effort and size data from sport fisheries operating in the western Indian Ocean.

| Description | Unit price (US$) | Units required | Total (US$) |
|---|---|---|---|
| Consultant | 400 | 100 days | 40,000 |
| Travel (2 trips) | 7,000 | 2 | 14,000 |
| | | Total estimate | **54,000** |

# APPENDIX VII
# 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 | | 2015 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2014:<br>Average catch 2010–2014: | 29,902 t<br>27,510 t | (green) |
| | MSY (1,000 t) (80% CI):<br>$F_{MSY}$ (80% CI):<br>$SB_{MSY}$ (1,000 t) (80% CI):<br>$F_{2013}/F_{MSY}$ (80% CI):<br>$SB_{2013}/SB_{MSY}$ (80% CI):<br>$SB_{2013}/SB_{1950}$ (80% CI): | 39.40 (33.20–45.60)<br>0.138 (0.137–0.138)<br>61.4 (51.5–71.4)<br>0.34 (0.28–0.40)<br>3.10 (2.44–3.75)<br>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 ($SB_{year}/SB_{MSY}$≥ 1) |
|---|---|---|
| Stock subject to overfishing($F_{year}/F_{MSY}$> 1) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | (yellow) | (green) |
| Not assessed/Uncertain | (grey) | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** No stock assessment undertaken in 2015. Thus, the SS3 model used in 2014 (using data up until the end of 2013) is used for stock status advice, as well as indicators available in 2015. The SS3 model 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 are below the MSY level. Spawning stock biomass in 2013 was estimated to be 58–89% (from Table 1; Fig. 1) of the unfished levels. The most recent catch estimate of 29,902 t for 2014 (a decrease from 2013 catches of 30,844 t) suggests that the stock status is unlikely to have changed. Thus, the stock remains **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.*** Management measures are not required which would pre-empt current Resolutions and planned management strategy evaluation for swordfish.

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** (2011–14): Longline catches are currently estimated to comprise approximately 76% of the total estimated swordfish catch in the Indian Ocean (take of the total estimated swordfish catch).

- **Main fleets** (2011–14): Taiwan,China (longline): 19%; Sri Lanka (longline/gillnet): 15%; Indonesia (longline): 15%; EU,Spain (longline): 15% (take of the total estimated swordfish catch).

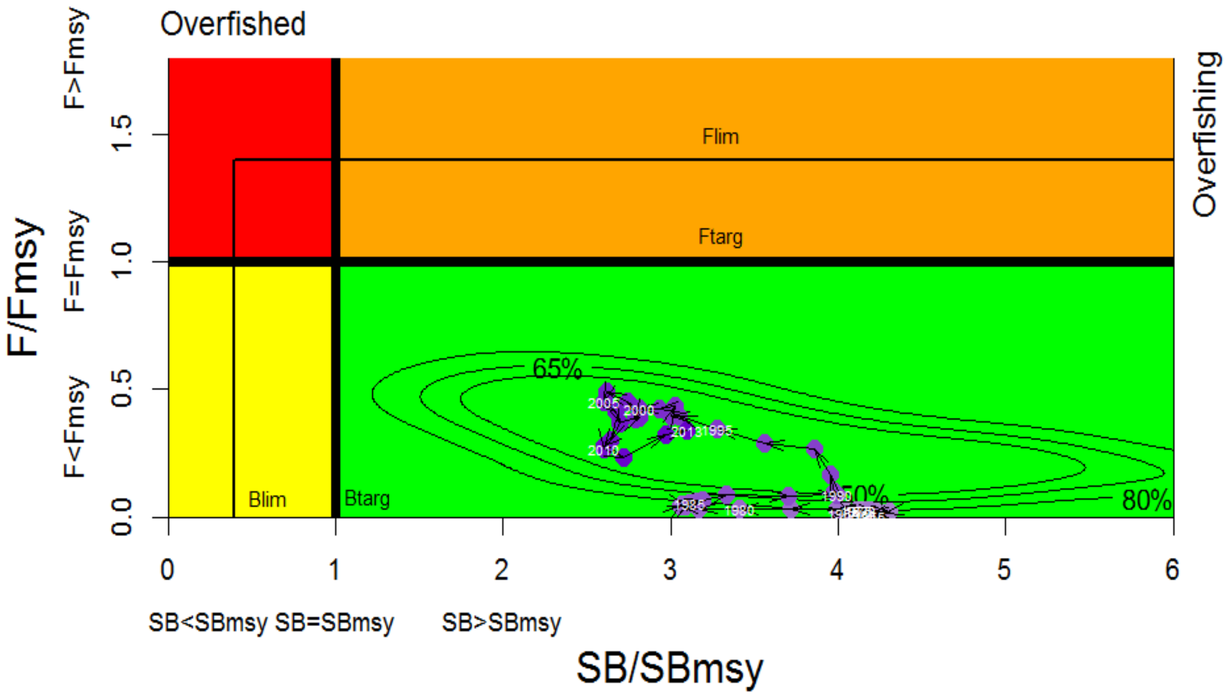



**Fig. 1.** Swordfish: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2013. Interim target ($F_{targ}$ and $SB_{targ}$) and 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) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (16,685 t) | **70%** (19,466 t) | **80%** (22,247 t) | **90%** (25,028 t) | **100%** (27,809 t) | **110%** (30,590 t) | **120%** (33,371 t) | **130%** (36,152 t) | **140%** (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 |
| **Reference point and projection timeframe** | **Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)** | | | | | | | | |
| | **60%** (16,685 t) | **70%** (19,466 t) | **80%** (22,247 t) | **90%** (25,028 t) | **100%** (27,809 t) | **110%** (30,590 t) | **120%** (33,371 t) | **130%** (36,152 t) | **140%** (38,933 t) |
| $SB_{2016} < SB_{Lim}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $F_{2016} > F_{Lim}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| $SB_{2023} < SB_{Lim}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $F_{2023} > F_{Lim}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |

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

**TABLE 3.** Swordfish: Status of swordfish (*Xiphias gladius*) in the southwest Indian Ocean.

| **Area**[1] | **Indicators** | | **2015 sub-regional status determination** |
|---|---|---|---|
| Southwest Indian Ocean | Catch 2014:<br>Average catch 2010–2014: | 7,107 t<br>7,427 t | (yellow) |
| | MSY (1,000 t) (80% CI):<br>$F_{MSY}$ (80% CI):<br>$B_{MSY}$ (1,000 t) (80% CI):<br>$F_{2013}/F_{MSY}$ (80% CI):<br>$B_{2013}/B_{MSY}$ (80% CI):<br>$B_{2013}/B_{1950}$ (80% CI): | 9.86 (9.11–10.57)<br>0.63 (0.59–0.70)<br>12.68 (12.52–12.78)<br>0.89 (0.61–1.14)<br>0.94 (0.68–1.23)<br>0.16 (n.a.) | |

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2014–WPB12–07 Rev_2.

| **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) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | (yellow) | (green) |
| Not assessed/Uncertain | (grey) | |

### SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

***Sub-regional status.*** No assessment undertaken in 2015 as the Commission has agreed that no further stock assessment needs to be undertaken until the completion of the IOTC stock structure project. Thus, the models used in 2014 (using data up until the end of 2013) are used for sub-regional status advice, as well as indicators available in 2015. The assessments carried out in 2014 produced conflicting results (ASIA, BBDM and ASPIC). ASPIC is presented here for consistency with the previous advice. The southwest Indian Ocean region has been subject to localised depletion over the past decade and biomass remains below the level that would produce MSY ($B_{MSY}$). Declines in catch and effort brought fishing mortality rates to levels below $F_{MSY}$. In 2014, 7,107 t of swordfish were recorded caught from this region, which equals 106% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011 (Table 3). Thus, the resource remains **not subject to overfishing** but **overfished**.

***Outlook.*** The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. However, from 2010 to 2014 catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t). If catches are maintained at 2011–13 levels, the probabilities of violating target reference points in 2016 are ≈ 81% for $F_{MSY}$ and ≈ 40% for $B_{MSY}$ (Table 4). There is however a high risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 4).

***Management advice***. A precautionary approach to the management of swordfish in the southwest Indian Ocean should be considered by the Commission, to reduce catches below 6,000 t to ensure the population in this area may rebuild.

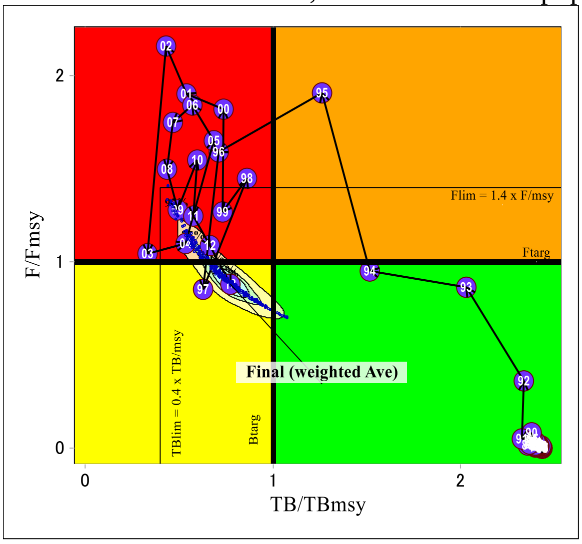


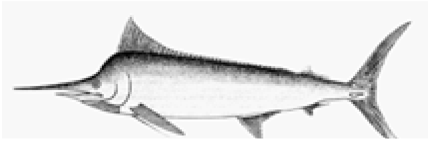

**Fig. 2.** Swordfish: ASPIC southwest Indian Ocean assessment Kobe plot (The horizontal blue line represents $F_{LIM}$ and the vertical blue line represents $B_{LIM}$). The results are from a preferred model option: Model weighted average using the inverse of the Root Mean Square errors across models (scenario) 2 and 4 (IOTC–2014–WPB12–24 Rev_2).

**TABLE 4.** Swordfish: ASPIC **southwest** 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 2011–13 (7,236 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 2011–13) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (4,342 t) | **70%** (5,065 t) | **80%** (5,789 t) | **90%** (6,512 t) | **100%** (7,236 t) | **110%** (7,960 t) | **120%** (8,683 t) | **130%** (9,407 t) | **140%** (10,130 t) |
| $B_{2016} < B_{MSY}$ | 9 | 13 | 19 | 28 | 40 | 53 | 65 | 82 | 86 |
| $F_{2016} > F_{MSY}$ | 3 | 6 | 30 | 56 | 81 | 91 | 98 | 99 | 100 |
| $B_{2023} < B_{MSY}$ | 0 | 0 | 1 | 3 | 14 | 41 | 87 | 100 | 100 |
| $F_{2023} > F_{MSY}$ | 0 | 0 | 5 | 67 | 92 | 98 | 99 | 100 | 100 |
| **Reference point and projection timeframe** | **Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based limit reference points ($B_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)** | | | | | | | | |
| | **60%** (4,342 t) | **70%** (5,065 t) | **80%** (5,789 t) | **90%** (6,512 t) | **100%** (7,236 t) | **110%** (7,960 t) | **120%** (8,683 t) | **130%** (9,407 t) | **140%** (10,130 t) |
| $B_{2016} < B_{Lim}$ | 4 | 6 | 8 | 14 | 20 | 23 | 40 | 45 | 65 |
| $F_{2016} > F_{Lim}$ | 3 | 6 | 15 | 15 | 20 | 33 | 45 | 67 | 100 |
| $B_{2023} < B_{Lim}$ | 0 | 0 | 0 | 6 | 24 | 26 | 49 | 74 | 100 |
| $F_{2023} > F_{Lim}$ | 0 | 0 | 0 | 10 | 22 | 45 | 67 | 96 | 100 |

# APPENDIX VIII
## 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** | | **2015 stock status determination** |
|---|---|---|---|
| Indian Ocean | Catch 2014: | 17,948 t | (orange) |
| | Average catch 2010–2014: | 13,536 t | |
| | MSY (1,000 t) (80% CI): | 10.2 (7.6–13.8) | |
| | $F_{MSY}$ (80% CI): | 0.25 (0.08–0.45) | |
| | $B_{MSY}$ (1,000 t) (80% CI): | 37.8 (14.6–62.3) | |
| | $F_{2013}/F_{MSY}$ (80% CI): | 1.06 (0.39–1.73) | |
| | $B_{2013}/B_{MSY}$ (80% CI): | 1.13 (0.73–1.53) | |
| | $B_{2013}/B_{1950}$ (80% CI): | 0.57 (0.37–0.76) | |

[1]Boundaries for the Indian Ocean = IOTC area of competence;

| **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) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | (yellow) | (green) |
| Not assessed/Uncertain | (grey) | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** No stock assessment undertaken in 2015. Thus, the models used in 2014 (using data up until the end of 2013) is used for stock status advice, as well as indicators available in 2015. A Stock reduction analysis (SRA) technique (data poor method) was used for the second time in 2014 on black marlin. The assessment is the best information currently available and as such, is used to determine stock status, with the intention that alternative techniques be applied to further validate the results in 2016. Total catches have continued to increase, with 17,948 t landed in 2014, up by almost 22% from 2013 levels (14,776 t). Thus, the stock status for black marlin in the Indian Ocean is **not overfished** but **subject to overfishing** (Table 1, Fig. 1). The fishery appears to show an increase in catch rates which is a substantial cause of concern, indicating that fishing mortality levels are unsustainable (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 major cause for concern. Research emphasis on developing possible CPUE indicators and further exploration of alternative stock assessment approaches for data poor fisheries are warranted to validate these findings. 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.

***Outlook.*** Total catch for black marlin in recent years has continued to increase substantially to a total of 17,948 t in 2014 (Note: MSY estimate ~10,000 t). There is a high to very high risk of exceeding MSY-based reference points by 2016 if catches remain at 2014 levels (≈ 56% risk that $B_{2016} < B_{MSY}$, and ≈ 99% risk that $F_{2016} > F_{MSY}$) (Table 2).

***Management advice.*** A precautionary approach to the management of black marlin should be considered by the Commission, to reduce catches below MSY estimates (~10,000 t), thereby ensuring the stock does not fall below $B_{MSY}$, and become overfished.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is between 10,200 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** (2011–14): gillnet: ~59%; Longline: ~19% (take of the total estimated black marlin catch).

- **Main fleets** (2011–14): I.R. Iran: 24%; Sri Lanka: 23%; India: 23%; Indonesia: 18% (take of the total estimated black marlin catch).

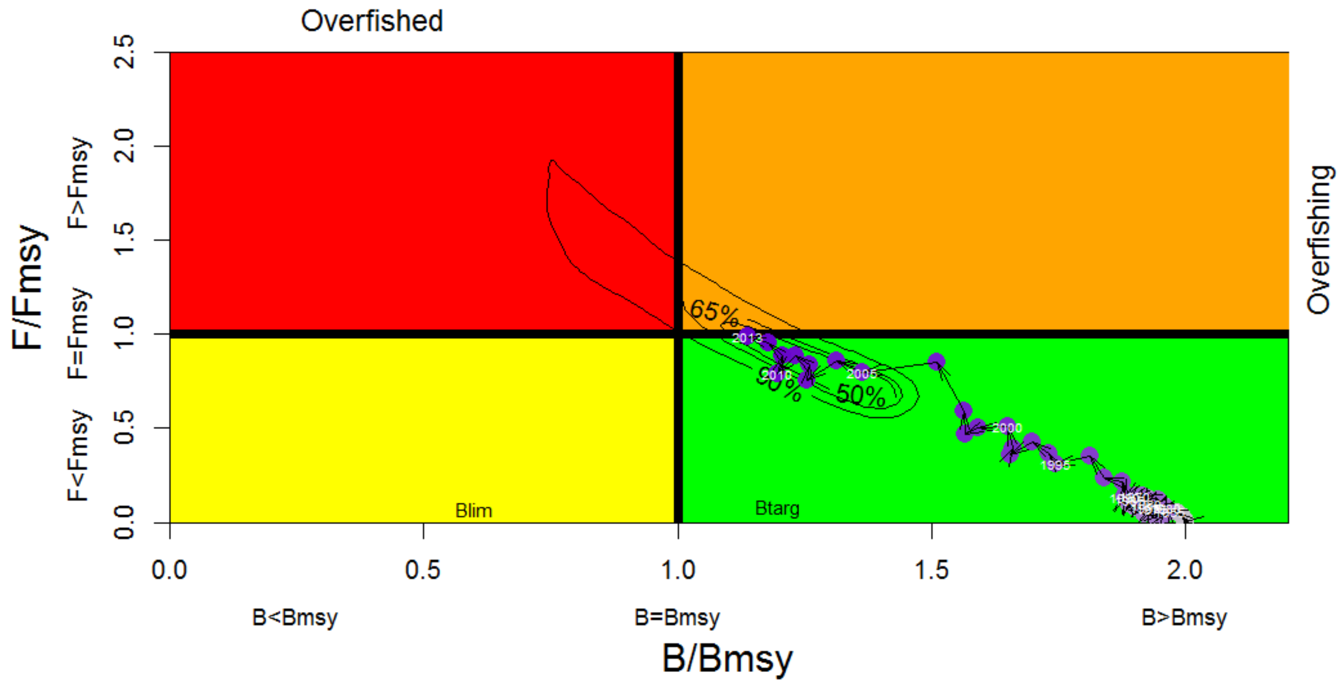


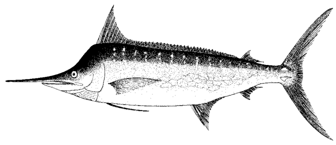

**Fig. 1**. Black marlin: Stock reduction analysis (Catch MSY Method) aggregated Indian Ocean assessment Kobe plots for black marlin (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black line indicates the trajectory of the point estimates (blue circles) for the spawning biomass (B) ratio and F ratio for each year 1950–2013.

**TABLE 2.** Black Marlin: Indian Ocean stock reduction analysis (SRA) Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–13 (12,940 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) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (7,764 t) | **70%** (9,058 t) | **80%** (10,352 t) | **90%** (11,646 t) | **100%** (12,940 t) | **110%** (14,234 t) | **120%** (15,528 t) | **130%** (16,822 t) | **140%** (18,116 t) |
| $SB_{2016} < SB_{MSY}$ | 17 | n.a. | 24 | n.a. | 33 | n.a. | 44 | n.a. | 56 |
| $F_{2016} > F_{MSY}$ | 12 | n.a. | 30 | n.a. | 53 | n.a. | 78 | n.a. | 99 |
| $SB_{2023} < SB_{MSY}$ | 10 | n.a. | 28 | n.a. | 60 | n.a. | 95 | n.a. | 100 |
| $F_{2023} > F_{MSY}$ | 7 | n.a. | 28 | n.a. | 63 | n.a. | 100 | n.a. | 100 |

# APPENDIX IX
# 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 2014:<br>Average catch 2010–2014: | 14,495 t<br>13,152 t | (yellow) |
| | MSY (1,000 t) (80% CI):<br>$F_{MSY}$ (80% CI):<br>$B_{MSY}$ (1,000 t) (80% CI):<br>$F_{2011}/F_{MSY}$ (80% CI):<br>$B_{2011}/B_{MSY}$ (80% CI):<br>$B_{2011}/B_{1950}$ (80% CI): | 11.70 (8.02–12.40)<br>0.49 (n.a.)<br>23.70 (n.a.)<br>0.85 (0.63–1.45)<br>0.98 (0.57–1.18)<br>0.48 (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) | (red) | (orange) |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | (yellow) | (green) |
| Not assessed/Uncertain | (grey) | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** No stock assessment undertaken in 2015. Thus, the models used in 2013 (using data up until the end of 2011) is used for stock status advice, as well as indicators available in 2015. The standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated that the stock was subject to overfishing in the past which reduced the stock biomass to below the $B_{MSY}$ level (Fig. 1). Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method: Stock Reduction Analysis using only catch data. In the recent past, the stock experienced reduced fishing pressure and as a result, the stock biomass recovered to the $B_{MSY}$ level (Fig. 1). Total reported landings increased substantially in 2012 to 16,969 t, well above the MSY estimate of 11,690 t. In 2013 and 2014 reported catches declined slightly to 14,521 t and 14,495 t respectively, still above the MSY level. Given the high catches over the last three years, that are well above the MSY level, the stock is likely to have moved to a state of being subject to overfishing. However, the impact that these increased catches is likely to have on biomass is uncertain. Thus, on the weight-of-evidence available, the stock status remains **overfished** but **not subject to overfishing** (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 as the stock may be in an overfished state (biomass less than $B_{MSY}$) and given that reported catches over the last two years have been well in excess of the MSY levels recommended, fishing effort is likely to be a serious concern, suggesting the stock may have moved back to a subject to overfishing status. The limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, require efforts to be made to rectify these information gaps urgently. It is likely that there is a low risk of exceeding MSY-based reference points by 2015 if catches are maintained at 2011 levels, although projections are not provided as per Table 2. These will be calculated during the next assessment of blue marlin.

***Management advice.*** A precautionary approach to the management of blue marlin should be considered by the Commission, to reduce catches below MSY estimates (~11,000 t), thereby ensuring the stock does not remain below $B_{MSY}$ (overfished).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 11,700 t (estimated range 8,023–12,400 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** (2011–14): Longline: 69%; Gillnet: 28% (of the total estimated blue marlin catch).
- **Main fleets** (2011–14): Taiwan,China: 33%; Indonesia: 28%; Pakistan: 14%; I.R. Iran 7%; Sri Lanka: 7% (of the total estimated blue marlin catch).

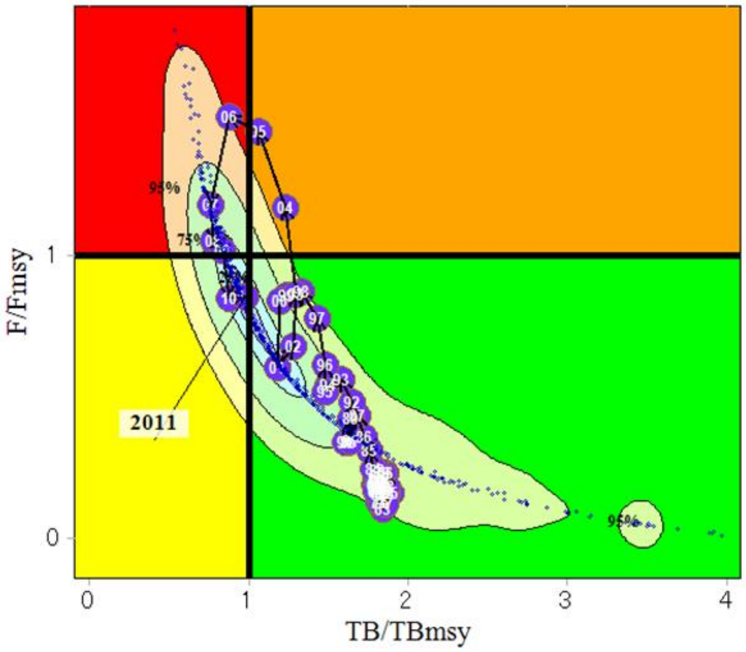


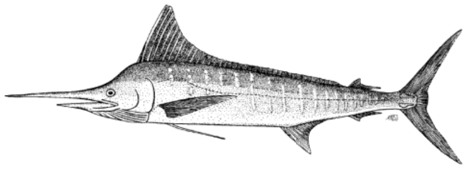

**Fig. 1.** Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011.

**TABLE 2.** Blue Marlin: Indian Ocean ASPIC Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–2013 (13,539 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years. These will be calculated during the next assessment of blue marlin.

| Reference point and projection timeframe | Alternative catch projections (relative to the average catch level from 2009–2011) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (8,123 t) | **70%** (9,477 t) | **80%** (10,831 t) | **90%** (12,185 t) | **100%** (13,539 t) | **110%** (14,892 t) | **120%** (16,247 t) | **130%** (17,601 t) | **140%** (18,955 t) |
| $B_{2015} < B_{MSY}$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| $F_{2015} > F_{MSY}$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| $B_{2022} < B_{MSY}$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| $F_{2022} > F_{MSY}$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

## APPENDIX X
## 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 2014: | 4,049 t | |
| | Average catch 2010–2014: | 4,122 t | |
| | MSY (1,000 t) (80% CI): | 5.22 t (5.18–5.59) | |
| | $F_{MSY}$ (80% CI): | 0.62 (0.59–1.04) | |
| | $B_{MSY}$ (1,000 t) (80% CI): | 8.4 t (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.–n.a.) | |

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available. Percentage of times the stock status from plausible model runs is in each respective quadrant of the Kobe plot shown below.

| 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***. Stock status is based on the new assessments undertaken in 2015. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. 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, using catch data up until 2014. Two other approaches examined in 2015 came to similar conclusions, namely a Bayesian Surplus Production Model, and a data poor stock assessment method, Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from 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. Thus, on the weight-of-evidence available the stock is determined to remain as **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, 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, 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 MSY estimates (~5,220 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 4,429 t. Catches should be reduced to below 2,500 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 striped marlin.
- **Main fishing gear** (2011–14): Longline: 69%; Gillnet: 28% (of the total estimated striped marlin catch).
- **Main fleets** (2011–14): Indonesia: 32%; Taiwan,China: 26%; I.R. Iran 11%; Pakistan: 9% (of the total estimated striped marlin catch).

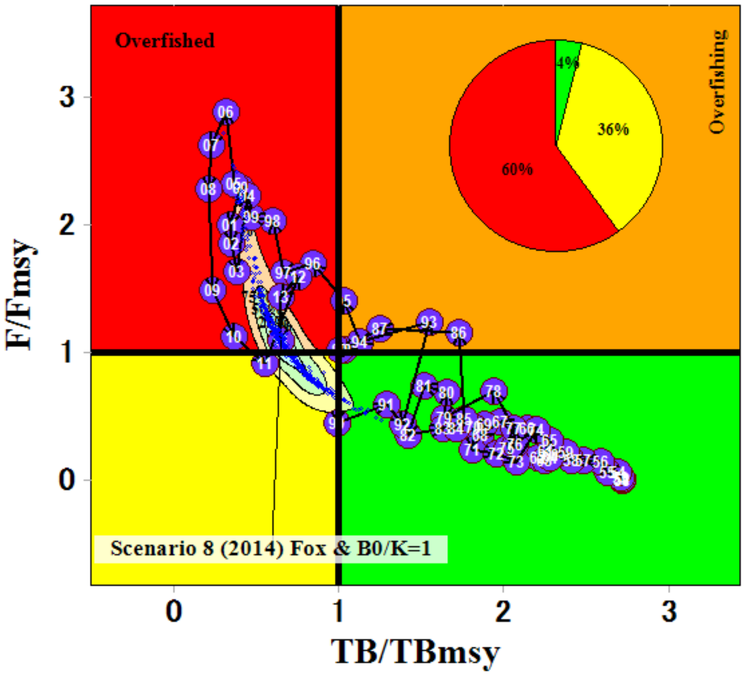


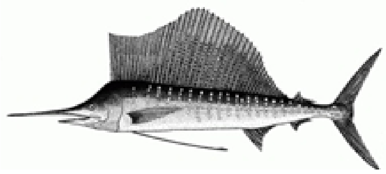

**Fig. 1.** Striped marlin: ASPIC aggregated Indian Ocean assessment Kobe plot with the confidence surface and compositions of its uncertainties in terms of 4 phases (pie chart).

**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%** (2,949 t) | **70%** (3,441 t) | **80%** (3,932 t) | **90%** (4,424 t) | **100%** (4,915 t) | **110%** (5,407 t) | **120%** (5,898 t) | **130%** (6,390 t) | **140%** (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 XI
## 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 | | 2015 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2014:<br>Average catch 2010–2014: | 29,860 t<br>28,980 t | |
| | MSY (1,000 t) (80% CI):<br>$F_{MSY}$ (80% CI):<br>$B_{MSY}$ (1,000 t) (80% CI):<br>$F_{2014}/F_{MSY}$ (80% CI):<br>$B_{2014}/B_{MSY}$ (80% CI):<br>$B_{2014}/B_0$ (80% CI): | 25.00 (17.20–36.30)<br>0.26 (0.15–0.39)<br>87.52 (56.30–121.02)<br>1.05 (0.63–1.63)<br>1.13 (0.87–1.37)<br>0.57 (0.44–0.69) | |

[1]Boundaries for the Indian Ocean = IOTC area of competence

| 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) | | |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | | |
| Not assessed/Uncertain | | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** 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 2015, the stock is determined to be **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.*** A precautionary approach to the management of I.P sailfish should be considered by the Commission, to reduce catches below MSY estimates (~25,000 t), thereby ensuring the stock does not fall below $B_{MSY}$, and become overfished.

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** (2011–14): Gillnet: 78%; Troll and handlines: 17% (of the total estimated I.P. sailfish catch).

- **Main fleets** (2011–14): I.R. Iran: 28%; Pakistan: 19%; India: 17%; Sri Lanka: 12% (of the total estimated I.P. sailfish catch).

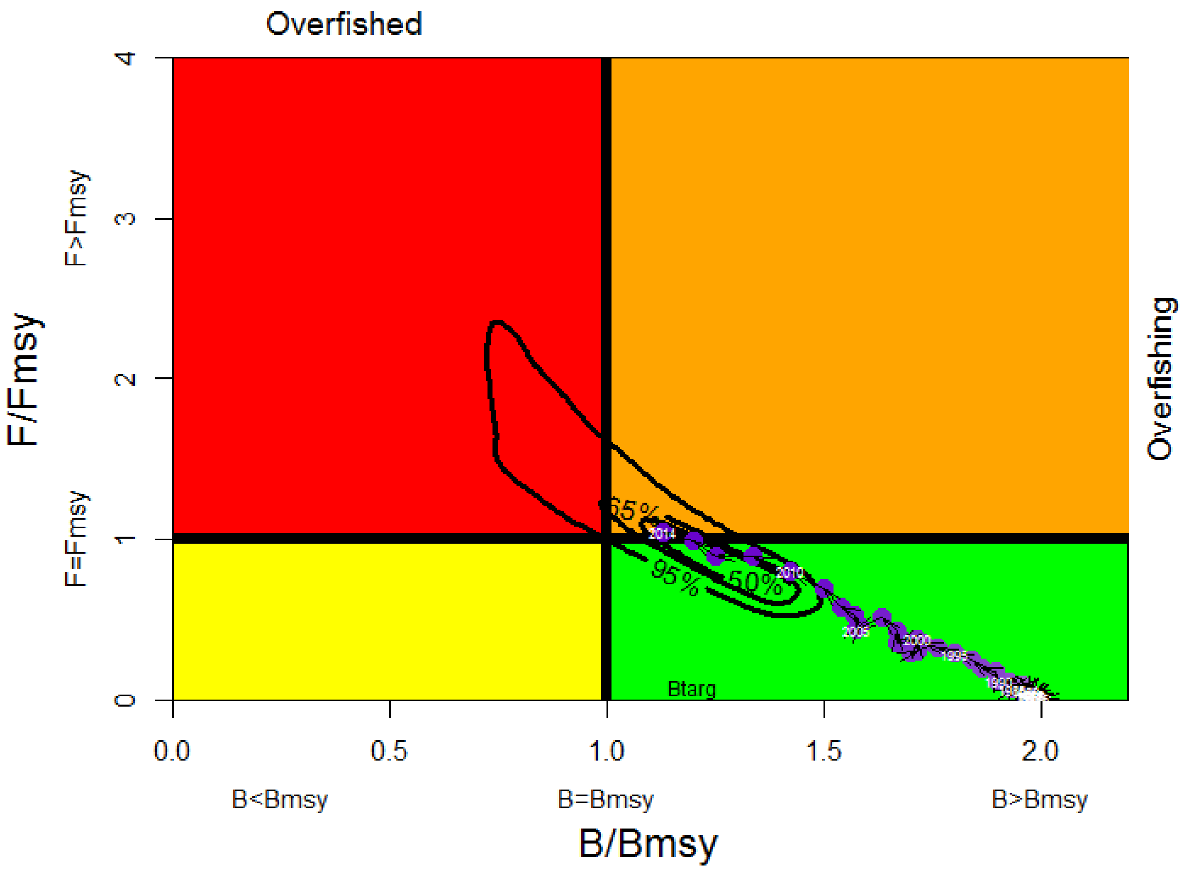



**Fig. 1.** Indo-Pacific sailfish: Stock reduction analysis (Catch MSY Method) of aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2014 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the B ratio and F ratio for each 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%** (17,498 t) | **70%** (20,415 t) | **80%** (23,331 t) | **90%** (26,248 t) | **100%** (29,164 t) | **110%** (32,080 t) | **120%** (34,997 t) | **130%** (37,913 t) | **140%** (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 XII
# WORKING PARTY ON BILLFISH PROGRAM OF WORK (2016–2020)

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 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2016 | 2017 | 2018 | 2019 | 2020 |
| 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 | 1.3 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 | | | | | | |
| | 1.1.2 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 | | | | | | |
| | 1.2 Tagging research to determine connectivity, movement rates and mortality estimates. | High | US$?? by Chair WPB | | | | | |
| | 1.2.1 Tagging studies (P-SAT) | | (TBD) | | | | | |
| 2. Biological and ecological information | 2.1 Age and growth research | High | | | | | | |
| | 2.1.1 CPCs to provide further research reports on billfish biology, namely age and growth studies including through the use of fish | | CPCs directly | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (incl. parameters for stock assessment) | otolith or other hard parts, either from data collected through observer programs or other research programs. | | | | | | |
| | | 2.2 Age-at-Maturity | High | | | | | |
| | | 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. | | US$?? (CPCs directly) | | | | |
| | | 2.3 Spawning time and locations | High | US$?? | | | | |
| | | 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 | Medium | US$?? | | | | |
| | | 3.1.1 Japan and Taiwan,China to undertake an historical review of their longline fleets and to document the changes in fleet dynamics. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data. | Medium | US$?? (CPCs directly) | | | | |
| | | 3.2 Species identification | | US$?? | | | | |
| | | 3.2.1 The quality of the data available at the IOTC Secretariat on marlins (by species) is likely to be compromised by species miss-identification. Thus, CPCs should review their historical data in order to identify, report and correct (if possible) potential identification problems that are detrimental to any analysis of the status of the stocks. | Medium | (CPCs directly) | | | | |
| 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 | High | Consultant US$54,000 | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | targeting marlins and sailfish should undertake a comprehensive analysis for provision to the WPB. | | | | | | | |
| 5. | CPUE standardisation | 5.1 Develop and/or revise standardised 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 | (CPCs directly) | | | | | |
| | | 5.1.2 Striped marlin: Priority fleets: Japan, Taiwan,China | High | (CPCs directly) | | | | | |
| | | 5.1.3 Black marlin: Priority fleets: Longline: Taiwan,China; Gillnet: I.R. Iran, Sri Lanka) | High | (CPCs directly) | | | | | |
| | | 5.1.4 Blue marlin: Priority fleets: Taiwan,China | High | (CPCs directly) | | | | | |
| | | 5.1.5 I.P. Sailfish: Priority fleets: Priority longline fleets: EU(Spain, Portugal, France), Japan, Indonesia; Priority gillnet fleets: I.R. Iran and Sri Lanka | High | (CPCs directly) | | | | | |
| | | 5.1.6 Develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline, and data poor stock assessments | High | See 6.2 below | | | | | |
| 6. | Stock assessment / Stock indicators | 6.1 Develop and compare multiple assessment approaches to determining stock status for swordfish (SS3, ASPIC, etc.). | High | US$?? | | | | | |
| | | 6.2 Data poor stock assessment on billfish species in 2016 and 2017 | High | Consultant / US$16,250 | | | | | |
| | | 6.3 Workshops on data poor techniques for assessment including CPUE estimations for billfish species in 2016 and 2017. | High | 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 | | | | | | |
| | | 7.1.1 Assessment of the interim reference points as well as alternatives: Used when assessing the Swordfish stock status and when establishing the Kobe plot and Kobe matrices.<br>= Agreed to pass this task temporarily to WPM. | | 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 | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 8.1.1 These management measures will therefore have to ensure the achievement of the conservation and optimal utilisation 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** | **2016 (5 day meeting)** | **2017 (5 day meeting)** | **2018 (5 day meeting)** | **2019 (5 day meeting)** | **2020 (5 day meeting)** |
|---|---|---|---|---|---|
| Black marlin | **Full assessment*** | | | **Full assessment*** | |
| Blue marlin | **Full assessment*** | | | **Full assessment*** | |
| Striped marlin | | Indicators | **Full assessment*** | | |
| Swordfish (IO, SWIO) | Indicators | **Full assessment** | | | **Full assessment** |
| Indo-Pacific sailfish | | Indicators | **Full assessment*** | | |

*Including data poor stock assessment methods

# APPENDIX XIII
# CONSOLIDATED RECOMMENDATIONS OF THE 13TH SESSION OF THE WORKING PARTY ON BILLFISH

***Note: Appendix references refer to the Report of the 13th Session of the Working Party on Billfish (IOTC–2015–WPB13–R)***

***Meeting Participation Fund (MPF)***

WPB13.01 (para. 11): The WPB **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 (current deadline is 45 days), and that the full Draft paper be submitted no later than 45 days (current deadline is 15 days) before the start of the relevant meeting, so that the Selection Panel may 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.

***Billfish species identification***

WPB13.02 (para. 16): **NOTING** that the Commission has approved US$30,000 for the printing of the species identification cards in 2016, as confirmed by the IOTC Secretariat at the 19th Session of the Commission, the WPB **RECOMMENDED** that the billfish species identification cards already translated into languages other than English and French, be printed in the first quarter of 2016 for dissemination.

WPB13.03 (para. 20): The WPB reiterated the **RECOMMENDATION** that the IOTC Secretariat ensure that hard copies of the identification cards continue to be printed as many CPCs scientific observers, both on board and port, still do not have smart phone technology/hardware access and need to have hard copies. At this point in time, electronic formats, including 'applications or apps' are only suitable for larger scale vessels, and even in the case of EU purse seine vessels, the use of hard copies is relied upon due to on board fish processing and handling conditions, as well as weather conditions. Electronic versions may be developed as a complementary tools.

***Sports fishery data collection***

WPB13.04 (para. 21): The WPB **RECOMMENDED** that the Chairperson and Vice-Chairperson continue to work in collaboration with the IOTC Secretariat and the African Billfish Foundation to find a suitable funding source and lead investigator to undertake the project outlined in Appendix VI. The aim of the project is to enhance data recovery from sports and other recreational fisheries in the western Indian Ocean region. The Chairperson shall circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence at a later date.

***Observer data***

WPB13.05 (para. 74): **NOTING** that training of observers and crew is long-term and necessarily meticulous work that should be done on a recurrent way in order to optimise the efficiency of observers, the WPB **RECOMMENDED** that the IOTC Secretariat increases its effort in training observers, including species identification.

***WPB Program of work***

WPB13.06 (para. 148): The WPB **RECOMMENDED** that the reporting deadline for stock assessment inputs (index of abundance, catch reconstructions, size data, etc.) be moved from 30 days to 60 days prior to the meeting in which the species is to be assessed.

WPB13.07 (para. 149): The WPB **RECOMMENDED** that the Scientific Committee consider and endorse the WPB Program of Work (2016–2020), as provided at Appendix XII.

***Hiring of a consultant to assist the WPB with data poor stock assessment approaches***

WPB13.08 (para. 154): The WPB **RECOMMENDED** that a consultant be hired to develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline. This activity should be a high priority within the Scientific Committee's Program of Work. Terms of Reference will be provided to the SC's consideration in 2015. An indicative budget is provided at Table 18.

**Table 18.** Estimated budget required to hire a consultant to carry out data poor stock assessment on billfish species in 2016 and 2017.

| Description | Unit price | Units required | 2016 Total (US$) | 2017 Total (US$) |
|---|---|---|---|---|
| Develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline, and data poor assessments (fees) | 450 | 25 | 11,250 | 11,250 |
| Develop CPUE series for billfish species in coastal gillnet and fisheries other than industrial longline (travel) | 5,000 | 1 | 5,000 | 5,000 |
| | | Total estimate | **16,250** | **16,250** |

WPB13.09 (para. 155): The WPB **RECOMMENDED** that a consultant be hired to carry out workshops on data poor techniques for assessment including CPUE estimations for billfish species. This activity should be a high priority within the Scientific Committee's Program of Work. Terms of Reference will be provided to the SC's consideration in 2015. An indicative budget is provided at Table 19.

**Table 19.** Estimated budget required to hire a consultant to carry out workshops on data poor techniques for assessment including CPUE estimations for billfish species in 2016 and 2017.

| Description | Unit price | Units required | 2016 Total (US$) | 2017 Total (US$) |
|---|---|---|---|---|
| Develop material for training workshop and delivery of a workshop (fees) | 450 | 15 | 6,750 | 6,750 |
| Develop material for training workshop and delivery of a workshop (travel) | 5,000 | 1 | 5,000 | 5,000 |
| | | Total estimate | **11,750** | **11,750** |

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

WPB13.10 (para. 162): The WPB **RECOMMENDED** that the SC note that Dr Tom Nishida (Japan) and Dr Evgeny Romanov (La Reunion, France) were elected as Chairperson and Vice-Chairperson of the WPB for the next biennium.

***Review of the draft, and adoption of the Report of the 13th Session of the Working Party on Billfish***

WPB13.11 (para. 166): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB13, provided at Appendix XIII, 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 2015 (Fig. 10):

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

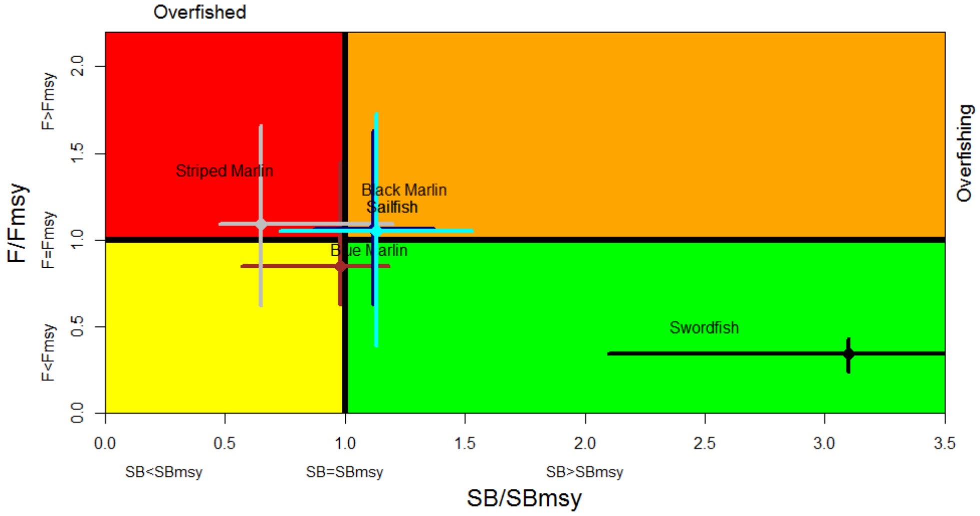



**Fig. 10.** Combined Kobe plot for swordfish (black), black marlin (light blue), blue marlin (brown), striped marlin (grey) and I.P. sailfish (navy blue) showing the 2013, 2014 and 2015 (most recent stock assessments) estimates of current stock size (SB or B, species assessment dependent) and current 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.