Report of the Twelfth Session of the IOTC Working Party on Billfish

Yokohama, Japan, 21–25 October 2014

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Acronyms

ABF	African Billfish Foundation
ASPIC	A Stock-Production Model Incorporating Covariates
B	Biomass (total)
B_{MSY}	Biomass which produces MSY
BLM	Black marlin (FAO code)
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
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**).

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EXECUTIVE SUMMARY

The 12th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Yokohama, Japan, from 21 to 25 October 2014. A total of 21 participants (24 in 2013) attended the Session.

The following are a subset of the complete recommendations from the WPB12 to the Scientific Committee, which are provided at Appendix XIV.

Recreational and sports fisheries for marlins and IP sailfish in the Indian Ocean

(para. 63): **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 WPB **RECOMMENDED** that the Chair and Vice-Chair 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 will be 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.

Revision of the WPB Program of work (2015–2019)

(para. 154): **NOTING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the WPB **RECOMMENDED** that the SC consider requesting the Commission to include it in the list of species to be managed by the IOTC.

(para. 159): The WPB **RECOMMENDED** that the Scientific Committee consider adopting 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.

(para. 160): The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2015–2019), as provided at Appendix XIII.

Consolidated list of recommendations of the 12th Session of the Working Party on Billfish

(para. 169): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB12, provided at Appendix XIV, 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 2014 (Fig. 11):

- 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

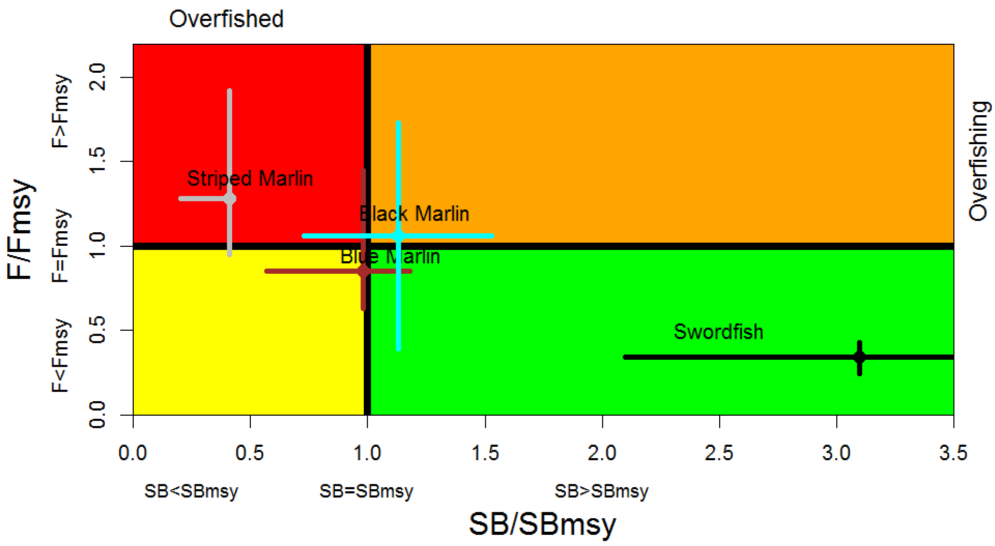

Fig. 11. Combined Kobe plot for swordfish (black), black marlin (light blue), blue marlin (brown) and striped marlin (grey) showing the 2013 and 2014 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and 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	Advice to Commission
Swordfish (whole IO) *Xiphias gladius*	Catch 2013: 31,804 t Average catch 2009–2013: 26,510 t MSY (1,000 t) (80% CI): 39.40 (33.20–45.60) F_{MSY} (1,000 t) (80% CI): 0.138 (0.137–0.138) SB_{MSY} (80% CI): 61.4 (51.5–71.4) F_{2013}/F_{MSY} (80% CI): 0.34 (0.28–0.40) SB_{2013}/SB_{MSY} (80% CI): 3.10 (2.44–3.75) SB_{2013}/SB_{1950} (80% CI): 0.74 (0.58–0.89)	2007						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. The most recent catch estimate of 31,804 t in 2013 indicate that the stock status is unlikely to have changed. Click here for full stock status summary: Appendix VII
Swordfish (southwest IO) *Xiphias gladius*	Catch 2013: 7,349 t Average catch 2009–2013: 7,265 t MSY (1000 t) (80% CI): 9.86 (9.11–10.57) F_{MSY} (80% CI): 0.63 (0.59–0.70) B_{MSY} (1000 t) (80% CI): 12.68 (12.52–12.78) F_{2013}/F_{MSY} (80% CI): 0.89 (0.61–1.14) B_{2013}/B_{MSY} (80% CI): 0.94 (0.68–1.23) B_{2013}/B_{1950} (80% CI): 0.16 (n.a.)							The assessments carried out in 2014 produced substantially conflicting results (ASIA, BBDM and ASPIC). However, the ASPIC model runs are presented here just 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 2013, 7,349 t of swordfish catches were recorded from this region, which equals 110% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011. If catches are maintained at 2013 levels, the probabilities of violating target reference points in 2016 are ≈ 81% for F_{MSY} and ≈ 40% for B_{MSY}. Click here for full stock status summary: Appendix VII
Black marlin *Makaira indica*	Catch 2013: 14,400 t Average catch 2009–2013: 11,962 t MSY (1000 t) (95% CI): 10.2 (7.6–13.8) F_{MSY} (95% CI): 0.25 (0.08–0.45) B_{MSY} (1000 t) (95% CI): 37.8 (14.6–62.3) F_{2013}/F_{MSY} (95% CI): 1.06 (0.39–1.73) B_{2013}/B_{MSY} (95% CI): 1.13 (0.73–1.53) B_{2013}/B_{1950} (95% CI): 0.57 (0.37–0.76)						* * *	This is the second time that the WPB has applied a Stock reduction analysis (SRA) technique to black marlin and further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken. However, the WPB considers that the assessment is the best information currently available and as such, should be used to tentatively determine stock status, with the intention that alternative techniques be applied in 2015 to validate the results. Thus, the stock status for black marlin in the Indian Ocean is **TENTATIVELY* not overfished*** but **subject to overfishing***. The stock appears to show an increase in catch rates which is a cause of concern, indicating that fishing mortality levels are likely to have become too high. Click here for full stock status summary: Appendix VIII
Blue marlin *Makaira nigricans*	Catch 2013: 13,834 t Average catch 2009–2013: 11,531 t MSY (1000 t) (80% CI): 11.70 (8.02–12.40) F_{MSY} (80% CI): 0.49 (n.a.) B_{MSY} (1,000 t) (80% CI): 23.70 t (n.a.) F_{2011}/F_{MSY} (80% CI): 0.85 (0.63–1.45) B_{2011}/B_{MSY} (80% CI): 0.98 (0.57–1.18) B_{2011}/B_{1950} (80% CI): 0.48 (n.a.)							No new assessment was undertaken for blue marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. 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 the stock is currently being exploited at sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in

Stock	Indicators	Prev[1]	2010	2011	2012	2013	2014	Advice to Commission
								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. 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 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. Click here for full stock status summary: Appendix IX
Striped marlin *Tetrapturus audax*	Catch 2013: 4,429 t Average catch 2009–2013: 3,667 t MSY (1,000 t) (80% CI): 4.41 t (3.54–4.58) F_{MSY} (80% CI): 0.36 (n.a.) B_{MSY} (1,000 t) (80% CI): 12.43 t (n.a.) F_{2011}/F_{MSY} (80% CI): 1.28 (0.95–1.92) B_{2011}/B_{MSY} (80% CI): 0.416 (0.2–0.42) B_{2011}/B_0 (80% CI): 0.18 (n.a.)							No new assessment was undertaken for striped marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013 an ASPIC stock assessment confirmed the preliminary assessment results from 2012 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 2011. 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. The Kobe plot 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. Total reported landings increased in 2012 to 6,088 t, well above the MSY estimate of 4,408 t. In 2013 reported catches declined to 4,429 t, still above the MSY level. Click here for full stock status summary: Appendix X
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2013: 29,750 t Average catch 2009–2013: 28,087 t MSY (1,000 t) (80% CI): 27.84 (24.70–35.00) F_{MSY} (80% CI): 0.27 (0.16–0.39) B_{MSY} (1,000 t) (80% CI): 95.2 (62.89–127.73) F_{2013}/F_{MSY} (80% CI): 1.19 (0.66–1.72) B_{2013}/B_{MSY} (80% CI): 1.12 (0.88–1.37) B_{2013}/B_0 (80% CI): 0.56 (0.44–0.69)							Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished and close to or exceeding maximum sustainable yield levels. However, as this is the first time that the WPB used such a method on Indo-Pacific sailfish, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status. Thus, the stock status remains **uncertain**. Nonetheless in using the SRA method for comparative purposes with other stocks, the WPB considers that the use of the target reference points may be possible for the approach. 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. Records of stock extirpation in the Gulf should also be examined to examine the degree of localised depletion in Indian Ocean coastal areas. Click here for full stock status summary: Appendix XI

[1]This indicates the last year taken into account for assessments carried out before 2010; ***** = **TENTATIVE status:** Data poor stock assessment only. Status should be interpreted with caution due to the high levels of uncertainty. Further testing of how sensitive this technique is to model assumptions and available time series of catches, as well as the trialling of an alternative stock assessment approach

needs to be undertaken before stock status can be used for management action; n.a. = not available

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 12th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Yokohama, Japan, from 21 to 25 October 2014. A total of 21 participants (24 in 2013) attended the Session. The list of participants is provided at Appendix I. The meeting was opened on 21 September 2014 by the Chair, Dr Jérôme Bourjea (La Réunion, France), who welcomed participants to Yokohama, Japan.

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 WPB12 are listed in Appendix III.

3. Outcomes of the 16th Session of the Scientific Committee

3. The WPB **NOTED** paper IOTC–2014–WPB12–03 which outlined the main outcomes of the 16th Session of the Scientific Committee (SC16), specifically related to the work of the WPB.

4. **NOTING** that the SC adopted a set of standardised IOTC Working Party and Scientific Committee reporting terminology, contained in Appendix IV of the SC16 Report (para. 23 of the SC16 Report), the WPB **AGREED** that the terminology (which is provided in the opening pages of this WPB12 Report) will provide greater clarity and remove some of the ambiguity in the way advice is provided to the next level in the Commission's structure.

5. The WPB **RECALLED** that the SC adopted revised '*Guidelines for the presentation of stock assessment models'* in 2012, which include the minimum requirements for presenting CPUE standardisations. All participants who undertake CPUE standardisations and/or stock assessments should familiarise themselves with these guidelines (provided in paper IOTC–2014–WPB12–INF01).

6. The WPB **NOTED** that in 2013, the SC made a number of requests in relation to the WPB11 report (noting that updates on Recommendations of the SC16 are dealt with under Agenda item 5. Those requests and the associated responses from the WPB12 are provided below for reference.

7. The WPB **NOTED** that in 2013, the SC endorsed a range of research requests by the WPB11. A subset of those requests and the associated responses from the WPB12 are provided below for reference:

- ***Historical data series***
  - *The SC[WPB]* ***REQUESTED*** *that both Japan and Taiwan,China undertake an historical review of their longline fleets and to document the changes in fleet dynamics for presentation at the next WPB meeting. 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.*
  - **Response:** Both Japan and Taiwan,China have committed to provide updates at the next WPB meeting in 2015. Taiwan,China indicated that it had already commenced work in this regard.
- ***Data inconsistencies***
  - *Noting the progress made to date, the WPB* ***REQUESTED*** *that the IOTC Secretariat finalise the study aimed at assessing the consistency of average weights derived from the available catch and effort data, as derived from logbooks, and size data provided by Japan, Taiwan,China, Seychelles and EU,Spain and to report final results at the next WPB meeting.*
  - **Response:** Although attempts have been made to complete this task, high levels of uncertainty in the data currently held at the IOTC Secretariat have prevented a meaningful conclusion. Further efforts will be made in 2014/15.
- **Indo-Pacific sailfish - other**
  - ***NOTING*** *that limited new information on I.P. sailfish were presented at the WPB11, the WPB* ***REQUESTED*** *that the IOTC Secretariat contact scientists from the U.A.E. to obtain the latest information from the sailfish fishery in the Gulf, as the most recent information submitted to the WPB some time ago suggested that the fishery may be collapsing. Any new information received should be submitted to the next WPB meeting as part of a general review of sailfish fisheries in the Indian Ocean.*
  - **Response:** Although attempts have been made to obtain the data requested, at this point these have been unsuccessful. Further attempts will be made in 2014/15.

4. Outcomes of Sessions of the Commission

4.1 Outcomes of the 18th Session of the Commission

8. The WPB **NOTED** paper IOTC–2014–WPB12–04 which outlined the main outcomes of the 18th 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.

9. The WPB **NOTED** the 7 Conservation and Management Measures (CMMs) adopted at the 18th Session of the Commission (consisting of 6 Resolutions and 1 Recommendation):

IOTC Resolutions

- Resolution 14/01 *On the removal of obsolete Conservation and Management Measures*
- Resolution 14/02 *For the conservation and management of tropical tunas stocks in the IOTC area of competence*
- Resolution 14/03 *On enhancing the dialogue between fisheries scientists and managers*
- Resolution 14/04 *Concerning the IOTC record of vessels authorised to operate in the IOTC area of competence*
- Resolution 14/05 *Concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 14/06 *On establishing a programme for transhipment by large-scale fishing vessels*

IOTC Recommendations

- Recommendation 14/07 *To standardise the presentation of scientific information in the annual Scientific Committee report and in Working Party reports*

10. The WPB **ACKNOWLEDGED** the importance of standardising the way in which the subsidiary bodies of the Commission provide advice. Recommendation 14/07, newly adopted at the 18th Session of the Commission, details a range of options for further standardising the way in which advice may be presented in the IOTC Executive Summaries. While the current species Executive Summaries already comply with most of the suggestions contained in Recommendation 14/07, there is always room for improvement. However, the SC's '*Guidelines for the presentation of stock assessment models'* adopted in 2012 (provided in paper IOTC–2014–WPB12–INF01), will now need to be updated to include the new elements from Recommendation 14/07.

11. **RECALLING** the outcomes of the informal workshop on CPUE standardisation, which include the following request of the SC:

> *The SC EXPRESSED concern that the majority of the important recommendations issued by the SC to the various working parties in previous years in regards to CPUE standardisation have often not been addressed, and that there was no major progress on these issues during the past two years. Therefore, the SC REQUESTED that the scientists in charge of this work make every possible effort to consider those guidelines in future CPUE standardisation work in order to improve the quality of CPUE series which are essential to stock assessments*.

and **NOTING** IOTC Recommendation 14/07 discussed in para. 10 above, the WPB **REQUESTED** that the IOTC Secretariat facilitate the updating of the '*Guidelines for the presentation of stock assessment models*' (provided in paper IOTC–2014–WPB12–INF01), with the new elements from Recommendation 14/07 and the new CPUE standardisation guidelines. A draft update shall be submitted to the Scientific Committee for its consideration in December 2014, and presented by the SC Chair.

12. **NOTING** that the Commission also made a number of general comments and requests on the recommendations made by the Scientific Committee in 2013, which have relevance for the WPB (details as follows: paragraph numbers refer to the report of the Commission (IOTC–2014–S18–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.

> *The Commission addressed the list of recommendations made by the SC16 (Appendix V) from its 2013 report (IOTC–2013–SC16–R) that related specifically to the Commission. The Commission **ENDORSED** the list of recommendations, taking into account the range of issues outlined in this Report (S18) and incorporated within adopted Conservation and Management Measures. (para. 10 of the S18 report)*
>
> ***Striped marlin***
>
> *The Commission **NOTED** the advice from the SC 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. 15 of the S18 report)

*The Commission **AGREED** that it should take a precautionary approach to the management of striped marlin and consider, at its 19th Session, proposals for Conservation and Management Measures to reduce fishing pressure for striped marlin; including the consideration of zone-based management of fishing effort. (para. 16 of the S18 report)*

*The Commission **AGREED** that all CPCs should take a precautionary approach and immediately reduce their impact on striped marlin in the IOTC area of competence. (para. 17 of the S18 report)*

Meeting participation fund

13. **NOTING** that the MPF was used to fund the participation of only 4 national scientists to the WPB12 meeting in 2014 (from 8 applications) compared to 10 recipients in 2013 (from 10 applications), all of which were required to submit and present a working paper at the WPB meeting, the WPB **RECOMMENDED** that the Scientific Committee consider the following:

- The IOTC Meeting Participation Fund (MPF), adopted by the Commission in 2010 (Resolution 10/05 *On the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and now incorporated into the IOTC Rules of Procedure (2014), was established for the purposes of supporting scientists and representatives from IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs) who are developing States to attend and contribute to the work of the Commission, the Scientific Committee and its Working Parties.
- The Commission has made the following directives to the IOTC Secretariat:
  - a) The Commission had directed the IOTC Secretariat (via Resolution 10/05 and now via the IOTC Rules of Procedure (2014)) to ensure that: (para. 88 of the S18 Report)
    - i. the MPF be utilised, as a first priority, to support the participation of scientists from developing CPCs in scientific meetings of the IOTC, including Working Parties, rather than non-science meetings.
    - ii. the MPF will be allocated in such a way that no more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings.
    - iii. thus, 75% of the annual MPF shall be allocated to facilitating the attendance of developing CPC scientists to the Scientific Committee and its Working Parties.
  - b) The Commission had directed the IOTC Secretariat that any cost savings made on the annual IOTC budget, shall also be used to further supplement the $60,000 currently budgeted for the MPF.
- In accordance with para. 89 of the S18 Report, the IOTC Secretariat is actively seeking extra budgetary funding sources to supplement the MPF budget from individual Contracting Parties as well as other interested groups. However, the WPB was informed by the IOTC Secretariat that other sources should actively be sought by interested candidates, including the UNFSA meeting fund, as well as through their own domestic budgetary processes.
- The detailed explanation of the MPF usage and expenditure in 2014, as described in para. 14 below.

14. The WPB **REQUESTED** that as 4 of the 8 applications approved for funding by the WPB MPF selection panel were rejected by the IOTC Secretariat due to insufficient funds (Madagascar, Malaysia, Mozambique and Thailand), a detailed explanation (including a budget breakdown recipient by recipient) of how the entire MPF available for 2014 (from the IOTC Regular budget (US$60,000) and via budget savings (e.g. ICRU, or other sources)), be provided to the SC for its consideration at its 17th Session to be held in December 2014. For transparency purposes, the explanation shall also include a detailed list of those candidates who's funding request was rejected.

15. The WPB **RECOMMENDED** that the Scientific Committee consider revising the MPF rules of procedure, so that a Draft paper be submitted to the relevant Working Party MPF Selection Panel earlier than the current 15 days before the meeting, so that the Panel may review the full paper rather than just the abstract, and provide guidance on areas for improvement and the suitability of the application to receive funding using the MPF. The justification of this request is based upon the reduced funds available and the need to maximise benefits. However, some participants did not want the deadline to be brought earlier than the current 15 day deadline.

Alternative management measures for swordfish

16. The WPB **RECALLED** that at its 17th Session, the Commission **REQUESTED** that the southwest region continue to be analysed as a special resource [*for swordfish*], as it appears to be highly depleted compared to the Indian Ocean as a whole.

4.2 Review of Conservation and Management Measures (CMMs) relevant to billfish

17. The WPB **NOTED** paper IOTC–2014–WPB12–05 which aimed to encourage participants at the WPB12 to review some of the existing Conservation and Management Measures (CMM) relevant to billfish, noting the CMMs contained in document IOTC–2014–WPB12–04; and as necessary to 1) provide recommendations to the Scientific Committee on whether modifications may be required; and 2) recommend whether other CMMs may be required.

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

Resolution 11/04 *on a Regional Observer Scheme*

19. The WPB **NOTED** that the level of implementation of the requirements contained in IOTC Resolution 11/04 remains very poor, with low levels of reporting to the IOTC Secretariat of both the observer reporting templates and the list of registered observers since the start of the ROS in July 2010.

20. **NOTING** that electronic monitoring (video) has now been trialled and successfully implemented in many fisheries worldwide (e.g. Australia, European Union, USA, New Zealand), with the aim of supplementing scientific observers on board vessels; and given the current difficulties cited as reasons for not deploying scientific observers under the IOTC Regional Observer Scheme (ROS) on board large-scale gillnet vessels operating in the Indian Ocean; the WPB **RECOMMENDED** that the IOTC Secretariat, facilitate the development of a project concept note/proposal to trial video monitoring to evaluate the efficacy of video cameras in the collection of information on catch, discards and fishing effort as a means to supplement scientific observer coverage for large-scale gillnet vessels. The trial will include an evaluation of the main challenges of using video data such as the accurate identification of IOTC and bycatch species, weight and size of catches and the time taken to process the footage and extract the required data. The concept note/proposal shall also include a clear indication that the IOTC data confidentiality policy (Resolution 12/02) will need to be modified to ensure any data/information collected is for the sole purpose of scientific analysis and not for compliance purposes. The concept note should include a detailed budget and be communicated to a range of potential funding organisations.

5. PROGRESS ON THE RECOMMENDATIONS OF WPB11

21. The WPB **NOTED** paper IOTC–2014–WPB12–06 which provided an update on the progress made in implementing the recommendations from the previous WPB meeting which were endorsed by the Scientific Committee, and **AGREED** to provide alternative recommendations for the consideration and potential endorsement by participants as appropriate given any progress.

22. The WPB **NOTED** 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 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).

23. The WPB **REQUESTED** that the IOTC Secretariat continue to prepare a paper on the progress of the recommendations arising from the previous WPB, incorporating the final recommendations adopted by the Scientific Committee and endorsed by the Commission.

Billfish species identification

24. The WPB **RECALLED** its recommendation from 2013, that the billfish species identification cards be translated into a range of priority languages, and that the Commission allocate funds for this purpose. It was also recommended that the Secretariat utilise any remaining funds in the IOTC Capacity Building budget line for 2013 to translate the cards. (WPB Recommendation WPB11.03; para. 20 of the WPB11 Report). This recommendation was subsequently endorsed by the Scientific Committee via SC Recommendation SC16.57 (para. 141 of the SC16 Report).

25. The WPB **RECALLED** its recommendation from 2013, that the Commission allocate additional funds in 2014 to further translate and print sets of the billfish identification cards, with a budget estimate of US$17,000

(WPB11 Recommendation WPB11.04; para. 21 of the WPB11 Report). This was subsequently endorsed by the SC, with the requested budget to be spread over 2014 and 2015.

26. The WPB **NOTED** that the Commission at its 18th Session approved the translation and printing recommendations of the SC, with US$12,000 allocated for this purpose. The WPB was informed by the IOTC Secretariat that the translation process had commenced with a consultant hired to prepare the text contained in all of the identification cards into a format that will be used for translation in early 2015. The intention is to seek 'voluntary' translators for as many of the priority languages as possible, and to hire the services for the remaining languages as necessary.

27. The WPB **RECALLED** is request from the WPB11, that the IOTC Secretariat makes further edits/improvements to the cards for the next English and French printing, as necessary, and also to examine the feasibility of producing the cards in electronic (e-book) format for future use using smart media/hardware.

28. **NOTING** the recent online survey distributed by the IOTC Secretariat, the WPB strongly **RECOMMENDED** that the IOTC Secretariat ensure that hard copies of the identification cards continue to be printed in hard copy form 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 on board. 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.

6. SWORDFISH

6.1 Review of data available at the secretariat for swordfish

29. The WPB **NOTED** paper IOTC–2014–WPB12–07 Rev_2 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for swordfish, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2013. 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.

30. 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.

31. **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 majority of the WPB **AGREED** that this approach should continue. However, some participants objected to this, suggesting that the WPB only use national/country reports from the officially nominated government source.

Glossary of terms

32. The WPB **NOTED** that following recommendations from both the Scientific Committee and the Compliance Committee to the Commission, to clarify a range of terms used in IOTC Conservation and Management Measures, including definitions for type of fisheries, area and species covered by Resolution 10/02, the IOTC Secretariat is in the process of finalising a Terms of Reference for a consultant to undertake the following project: *Development of harmonised terms and definitions for the IOTC Conservation and Management Measures (CMMs)*. The overarching aim of the work will be to enhance the understanding and facilitate the effective implementation of the IOTC Conservation and Management Measures (CMMs), by providing clear definitions for the terms frequently used.

33. The WPB **REQUESTED** that the IOTC Secretariat ensure that the following terms are provided to the Consultant hired to undertake the work detailed in para 32: Industrial fisheries: longline fisheries, surface fisheries; and coastal/artisanal fisheries, with the intention that the consultant will provide detailed definitions for each, separately or in combination as appropriate.

6.2 Review of new information on the biology, stock structure, fisheries and associated environmental data

I.R. Iran billfish fishery

34. The WPB **NOTED** paper IOTC–2014–WPB12–09 which outlined the billfish fishery in the I.R. Iran, including the following abstract provided by the authors:

"*Iran fishing grounds in southern waters of country are of the oldest and most important resources of large pelagic species. There are 4 coastal provinces in those areas and about 11 thousands vessels consist of fishing boat, dhows and vessels which are engaged in fishing in the coastal and offshore waters. There are three fishing methods targeting tuna and tuna-like species in the IOTC area which include gillnet and purse seine and also some of small boats use trolling in coastal fisheries. Billfish production in Iran is at increasing trend during a period of 5 years i.e. from 2009 to 2013 shows a sustainable increase. Gillnet is the dominant fishing gear in the IOTC area competency, Majority of the production comes from the Gillnet vessels operating within EEZ as well as offshore fishery.*" – (see paper for full abstract)

35. **NOTING** the continued substantial improvement in the data collection programs in I.R. Iran including reporting of species-specific data and the various actions being undertaken to implement the requests and recommendations from the previous WPB and SC meetings, the WPB **CONGRATULATED** I.R. Iran for extending its port sampling scheme to cover all species of billfish, and reporting estimates of catch for the year 2012 and 2013.

36. The WPB **NOTED** that the new data reported by I.R. Iran had been used to revise the historical catch series. 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 I.R. Iran makes every possible effort to assess the areas and times fished by its fishery and report this information to the next meeting of the WPB.

37. The WPB **REQUESTED** that the IOTC Secretariat assist I.R. Iran to assess if separate reporting on Indo-Pacific Sailfish in the Indian Ocean and Gulf is possible.

Sri Lanka billfish fishery

38. The WPB **NOTED** paper IOTC–2014–WPB12–10 Rev_1 which provides a review of billfish fishery resources in Sri Lanka, including the following abstract provided by the authors:

"*Sri Lanka has a well-established fishery for large pelagic fishery resources targeting tuna. The annual production of large pelagics was 123,872 mt in 2013 and of which tuna represented 74% of the total. Although there is no target fishery for billfish, Sri Lanka makes considerable contribution to the billfish production in the Indian Ocean. Noticeable increase in billfish catches have been reported in 2010, the Government development initiative may influence fishermen in northern and eastern provinces to explore more offshore fishing grounds may influence increased of billfish catches and thereafter billfish catch has been in more or less stabilized level, make up to 10% 0f the total large pelagic landings over the past three years. Five species of billfishes have been identified in local commercial landings. This includes 3 species of marlins; black marlin (Makaira indica), blue marlin (Makaira nigricans), striped marlin (Tetrapturus audax), two non-marlin species; the sailfish (Istiophorus platypterus) and the swordfish (Xiphias gladius). In catch composition, Marlin dominated the catch followed by swordfish however, in 2013 catch of swordfish increased, making up to 44% while least represented by marlin, only 23%. Relative increase of fishing effort of longline may influence the higher catch of swordfish in 2013.*" – (see paper for full abstract)

39. **NOTING** the changes in the species composition of billfish landed by Sri Lankan vessels, and the large increase in the catches of billfish recorded between the years 2009 and 2010, the WPB **REQUESTED** that Sri Lanka explores further the reasons driving those changes and presents this to the next meeting of the WPB.

Indian billfish fishery

40. The WPB **NOTED** paper IOTC–2014–WPB12–11 Rev_2 which provided an overview of the Indian billfish fishery, including the following abstract provided by the authors:

"*In India, billfish fishery is contributed by Indo-pacific sailfish, blue marlin, black marlin, striped marlin and swordfish. The landings of the billfishes along the Indian coast are showing an increasing trend since the 1990s and the estimated landing during 2012 was 11613 t. Drift gillnets-cum-longline, handlines and longlines operated from mechanized and motorized craft contributed maximum to the catches. Along the east coast, peak catches occur during July-September and along the west coast during October-March. Length-weight structure and biology of the dominant species are presented and discussed.*"

41. The WPB **REQUESTED** that India continue to improve its data collection programs and provide catch-and-effort and size frequency data for their longline fleets, to the IOTC Secretariat, as per IOTC data reporting requirements for its longline, surface and coastal/artisanal fisheries.

Otolith shape and swordfish stock structure

42. The WPB **NOTED** paper IOTC–2014–WPB12–12 which tested otolith shape as a tool to evaluate the stock structure of swordfish in the Indian Ocean, including the following abstract provided by the authors:

"*Swordfish (Xiphias gladius) is an oceanic-pelagic species currently fully exploited by several fisheries in the Indian Ocean, with suspicion of overexploitation in the southwest, but without a clear understanding of the real stock structure within this Ocean. Population structure of the Indian stock was studied in the western Indian Ocean using 395 individual samples collected from 2009 to 2014. Sagittal otoliths of the fish have been removed and shape analysis performed on these calcified pieces. Otolith morphometrics data and normalized Elliptical Fourier Descriptors (EFDs) were then extracted automatically by the dedicated image-analysis system TNPC. Preliminary, side effect was tested by Redundancy analysis (RDA) combined to permutation tests on 91 individual samples and showed no significant differences in the outline shape between the right and left otoliths. Consequently, 395 sagittal otoliths were used to identify stocks among several geographical areas (La Reunion, Mozambique channel, Rodrigues, South Africa, South Malagasy, Sri Lanka and Thailand) within the Indian Ocean.*" – (see paper for full abstract)

43. The WPB **NOTED** the work done to investigate another approach to confirm the hypotheses of a unique stock of swordfish in the Indian Ocean found using population genetics. No structure was found between the samples collected in several sites in the western and northern Indian Ocean

44. The WPB **NOTED** that although this method has been used for fish species in coastal or habitats with high complexity (reef or estuarine), it was an unproven method for pelagic species where the environmental influences on otolith growth are known to be minimal. Further work would be required on species with known spatial population structure before it could be considered a useful technique for billfish or other pelagic species.

Indonesia billfish fishery and length-weight relationships

45. The WPB **NOTED** paper IOTC–2014–WPB12–13 which the results of a preliminary analysis of the length – weight relationship of swordfish, black marlin and blue marlin caught by Indonesian longliners in the Indian Ocean, including the following abstract provided by the authors:

"*This paper presents several equations for converting among measures of size (length and weight) for swordfish (Xiphias gladius), black marlin (Makaira indica), and blue marlin (Makaira nigricans) caught by Indonesian longliners in the Indian Ocean. The equations use for transforming eye fork length and pectoral fork length to lower jaw fork length, and pectoral fork length to lower jaw fork length. The result showed that there were no significant differences existed between females and males among length measures for swordfish, blue marlin, and black marlin (ANCOVA, P> 0.05). The sex ratio (proportion of female to total of male and female) for swordfish and black marlin was 0.51 and 0.55 respectively (equal with 1:1) while for blue marlin was 0.62 where proportion of female was higher than male*."

46. **NOTING** that conversion factors to estimate round weight of billfish landed by Indonesian vessels are difficult to derive from data collected in port, as the majority of billfish species are processed at-sea and are not unloaded as live weight, the WPB **AGREED** on the need to identify fisheries having observer programmes in place to collect this information, including processed weight to live weight raising factors; and length to live weight equations.

47. **NOTING** that in recent years Indonesia has reported incomplete length frequency data for its longline fishery, from port sampling, and that the data collected through the various observer schemes in Indonesia may be useful to add to the IOTC database, the WPB **REQUESTED** that Indonesia reports this information prior to the 18th Session of the Scientific Committee to the IOTC Secretariat.

48. **RECALLING** the following request made to Indonesia in 2013, the WPB also **NOTED** the response provided during the WPB12:

- *The WPB **NOTED** that the current observer coverage for the Indonesian longline fleet is approximately 2% of total fishing effort. In 2013 Indonesia plans to deploy additional scientific observers on its longline, purse seine and gillnet vessels in order to reach the minimum required coverage level of 5%, as specified in Resolution 11/04 on a regional observer scheme. At present observers are only being deployed on its longline fleet. The WPB **REQUESTED** that the result of these additional scientific observer deployments be reported at the next WPB meeting.* (WPB11 Report, para. 60)
- **Response**: The newly collected scientific observer data is currently being processed and will be submitted to the IOTC Secretariat prior to the SC18 for its consideration.

Patterns of swordfish capture in relation to fishing time moon illumination and fishing depth

49. The WPB **NOTED** paper IOTC–2014–WPB12–14 Rev_1 which details patterns of swordfish capture in relation to fishing time moon illumination and fishing depth, including the following abstract provided by the authors:

"*Pelagic longline is a fishing gear used worldwide to target large pelagic fish. The longline corresponds to a mainline with hundreds to thousands branchlines equipped with baited hooks. As capture success depends on attraction of fish towards the hooks, a higher catch rate generally corresponds to the deployment of the gear at the right time and depth. Timing and hook depth distribution influence both the catch of target species and bycatch. In this study we analyzed the patterns of swordfish capture in relation with two major factors of the longline fishing strategy: fishing depth and fishing time. First, we used data collected from a self-reporting project to investigate the relation between catch and maximum fishing depth recorded by temperature depth recorders. Second, we analyzed capture time data obtained from research fishing surveys carried out with a longline equipped with time depth recorders and hook timers."* – (see paper for full abstract)

50. The WPB **NOTED** that fishing time may be an appropriate mitigation measure for bycatch in pelagic longline vessels targeting swordfish in the southwest Indian Ocean, principally for fisheries setting 500 to 1000 hooks per fishing operation.

51. The WPB **AGREED** that limiting the fishing period between dusk (beginning of the setting) and 5 am would reduce bycatch substantially, in particular for sharks, without negatively impacting swordfish catch.

52. The WPB **NOTED** that monitoring fishing operations (maximum fishing depth of the gear) is a relevant way to collect additional data of a variable contributing to variations in CPUE.

Environmental drivers of swordfish local abundance in the south-west Indian Ocean

53. The WPB **NOTED** paper IOTC–2014–WPB12–15 Rev_1 which describes environmental drivers of swordfish local abundance in the south-west Indian Ocean, including the following abstract provided by the authors:

"*Oceanic environmental conditions drive the abundance and distribution of marine organisms. Hydrodynamic structures such as fronts and eddies may become hotspots of biological activity through local concentration of nutrients. As oceanic structures generally attract forage fish and cephalopods, they often are foraging grounds for top-predators. The link between swordfish (<u>Xiphias gladius</u>) catch and environmental features in the south-west Indian Ocean is poorly documented despite Reunion Island local fishery's growing need for such information. In this study, we used a set of operational and environmental covariates to explain variations in swordfish nominal catch per unit of effort (nCPUE) throughout 2011-2013. We proceeded in two steps: (i) the nominal CPUE (nCPUE) was standardised according to operational aspects of fishing operations, and (ii) the residual CPUE (rCPUE) from the standardisation model was used to test the effects of various environmental descriptors on swordfish abundance.*" – (see paper for full abstract)

54. The WPB **NOTED** that higher swordfish abundance can be found in association with hydrodynamic features such as sheering fronts between eddies in oligotrophic waters of the southwest Indian Ocean.

55. **NOTING** that this work provides important insights into the variability of swordfish CPUE in relation to environmental variables in the Indian Ocean and builds upon the preliminary work presented at the previous WPB meeting in 2013, the WPB **ENCOURAGED** the authors to provide further updates at the next WPB meeting and to engage in preparatory discussions with the various authors of the CPUE standardisation papers in 2015.

Information Papers and other matters

Madagascar billfish fishery

56. The WPB **NOTED** information paper IOTC–2014–WPB12–INF02 which provided an overview of billfish catches in the Malagasy EEZ from 2011 to 2013 by foreign flagged longliners. Unfortunately, the application by the author was rejected by the IOTC Secretariat on budget grounds, as it was indicated that there were insufficient funds in the MPF.

57. The WPB **NOTED** that Madagascar is implementing data collection reports for its pelagic fisheries, and **ENCOURAGED** Madagascar to further develop and expanded the data collection systems for its pelagic longline fisheries in accordance to IOTC requirements, and report progress at the next WPB meeting.

Swordfish tagging programs

58. The WPB **NOTED** an ad hoc presentation entitled: *What we knew about SWO migrations in the Indian Ocean?' summarized current knowledge on horizontal movements of swordfish in the Indian Ocean*", including the following abstract provided by the presenter:

"It was shown that three past and ongoing tagging programs is known for the area: African Bill Foundation (ABF) Kenya, CSIRO (Australia) and SWIOFP (IRD, UCT, DAFF), Reunion Island, South Africa. ABF is ongoing program while CSIRO and SWIOFP are past projects. ABF and CSIRO using

conventional tagging while SWIOFP project used PSATs. ABF tagged 1058 swordfish between 1992 and 2014 and CSIRO tagged 422 individuals in 2000-2005. A total of 13 tag recoveries were reported for conventional tagging (8 for ABF and 5 for CSIRO). Maximum period at liberty was 1008 days (travelling distance 1425 miles) reported in CSIRO study while longest movement was recorded for ABF tagged fish 2400 miles for a 373 days) and 3600 miles for an unknown period. The latter fish crossed Indian Ocean from Kenya to Mid-Indian Ridge. During SWIOFP project a total of 14 swordfish were tagged with PSAT. All of tags were detached prematurely from the fish and only 5 tags produced exploitable data. Longest PSAT tracking period was 91 days. PSAT tagged fish demonstrated limited range movements off South Africa, within Mozambique Basin, Mozambique Channel and off Southern tip of Madagascar."

59. The WPB **AGREED** that such limited data is insufficient to understand migration in stock intermixing pattern in the Indian Ocean.

60. The WPB **AGREED** that further tagging efforts are necessary and should be considered as a priority in the WPB Program of Work. It was proposed to develop a dedicated IOTC swordfish tagging program using both PSAT and opportunistic conventional tagging as important components of such a program.

Recreational and sports fisheries for marlins and IP sailfish in the Indian Ocean

61. The WPB **NOTED** the challenges faced in the conservation and management of the billfish species in East African waters, particularly for the artisanal gillnet fishery.

62. The WPB **RECALLED** the excellent efforts being undertaken by the African Billfish Foundation to develop a tag and recapture database in Kenya and Tanzania.

63. **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 WPB **RECOMMENDED** that the Chair and Vice-Chair 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 will be 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.

64. 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.

65. The WPB **RECALLED** the following paragraphs from the previous WPB meeting (WPB11) targeted at specific CPCs with active recreational and sports fisheries for billfish in the Indian Ocean, that are likely to contribute substantially to the total marlin and IP sailfish catches, and **REQUESTED** updates to be provided before the next WPB meeting in 2015:

- ***Kenyan sailfish sports fishery:***
    - ➢ *The WPB **NOTED** that catch and effort data for the sports fishery in Kenya from 1987–2010 should be submitted to the IOTC Secretariat to assist in future assessments for these species.*
    - ➢ *The WPB **REQUESTED** that Kenya undertake a comprehensive analysis based on their long-term sport fisheries for consideration at the next WPB meeting.*
- ***Mozambique sports fishery***
    - ➢ *The WPB **ENCOURAGED** Mozambique to develop a monitoring program of catches and releases of billfish by its sports fishers, and collaborate with the African Billfish Foundation to expand their tagging efforts to Mozambique.*
    - ➢ ***NOTING** that Mozambique possess a database of sport fishing clubs in the southern part of the country, the WPB **ENCOURAGED** the further development the database for northern coastal areas and to share this information with the African Billfish Foundation and the IOTC Secretariat.*

- ***Maldives sports fishery***
  - *The WPB* ***AGREED*** *that although there are currently no sports fishery data collection programs in the Maldives, such programs would be highly beneficial given the rapidly expanding sports fishing industry operating in Maldivian waters.*

6.3 Review of new information on the status of swordfish

6.3.1 New information for future analysis

SEAPODYM

66. The WPB **NOTED** paper IOTC–2014–WPB12–16 Rev_1 which describes the application of the SEAPODYM model to swordfish in the Pacific and Indian Ocean including the following abstract provided by the authors:
"*In 2011, a first Spatial Ecosystem And Population Dynamic Model (SEAPODYM) application to Pacific swordfish (Xiphias gladius) was developed in collaboration with the Secretariat of the Pacific Community (SPC) and the PIFSC/NOAA (Hawaii, USA). The objective was to investigate the impacts of both fishing and climate variability on this species. The oceanic environment used to force SEAPODYM was predicted from a coupled physical-biogeochemical ocean model (NEMO-PISCES) driven by an atmospheric reanalysis (NCEP) on a 2° x month resolution (ORCA2 grid) over the historical fishing period (1948-2003). Available spatially-disaggregated catch per unit of effort (CPUE) and length-frequency data from the fisheries operating in the Pacific Ocean were assimilated into the model to achieve parameter optimization with a Maximum Likelihood Estimation (MLE) approach. The preliminary results suggested the existence of 3 overlapping adult core habitats, in good agreement with previous hypotheses of 3 sub-stocks mentioned in the literature (Kolody et al. 2009; Hinton & Maunder 2011; Courtney and Piner 2009), but nevertheless linked by their common tropical spawning grounds.*" – (see paper for full abstract)

67. The WPB **NOTED** that the first attempt of SEAPODYM (Spatial Ecosystem And Population Dynamic Model) on swordfish in the Indian Ocean proposes hypothesis on a range of spatio-temporal distributions of this swordfish life history stages (juveniles, sub-adults and mature adults).

68. The WPB **NOTED** that it is the first time that estimations of stock size and dynamics are obtained from an integrative model based on environmental and prey fields. The estimation of MSY from SEAPODYM environment-driven methodology will be a useful comparison with conventional stock assessment models.

69. The WPB **NOTED** that SEAPODYM parameterisation is data-reliant. It used available catch and effort spatial data and would benefit from additional length-frequency data to improve the selectivity estimation of fisheries.

70. The WPB **NOTED** that immediate perspectives of this work are to use higher spatial resolution (1° grid), available conventional tagging data and to open the eastern boundary of the Indian Ocean spatial domain. These will allow the improvement of SEAPODYM outputs in terms of stock assessment, MSY estimates, movement patterns and connectivity with Pacific populations.

71. The WPB strongly **ENCOURAGED** the authors to continue this important and highly useful work for billfish species in the Indian Ocean. Annual updates on the work should be presented at WPB meetings for comparison with stock assessments each year.

Model structure

72. The WPB **NOTED** paper IOTC–2014–WPB12–17 which provided an evaluation of data and model structure uncertainty for the stock assessment of swordfish in the Indian Ocean, including the following abstract provided by the authors:
"*Swordfish in the Indian Ocean (Xiphias gladius) have historically been exploited by Japan and Taiwan. Since the early 1990s, the catch of swordfish in the Indian Ocean increased substantially owing to the seasonal targeting of the Taiwanese fishery, the targeting of EU longline fisheries, and exploitation of semi-industrial longline and artisanal fisheries. Although the recent stock assessments suggested that the MSY-based reference points were not exceeded for the Indian Ocean population, these assessment results may be misleading because they lacked the consideration of uncertainty about changes in fishing operations and model structure assumptions. In this study, we conducted a stock assessment using an integrated age-structured model and evaluated estimates of management quantities under alternative assumptions for changes in catchability for CPUE-based indices of abundance and for gear selectivity. The results of this study indicated that assuming time-blocks for catchabilities may be appropriate to reflect the changes in fishing operations of Japanese and Taiwanese longline fleets.*" – (see paper for full abstract)

73. The WPB **NOTED** that the stock status could be derived from the assessment model when time-varied catchability or selectivity was adopted. However, more information related to change in fishing behaviour is necessary to support these assumptions.

74. The WPB **NOTED** that linear decrease/increase in catchability could be taken into account when developing the relationship between CPUE and abundance.

75. The WPB **NOTED** that change in catchability might lead to substantial decrease in CPUE, but other factors, such as change in biological process, might be more influential on abundance.

76. The WPB **ENCOURAGED** the authors to continue investigation of the impact of uncertainty of billfishes CPUE data in model structure.

6.3.2 Nominal and standardised CPUE indices

77. **RECALLING** the request from the Commission in 2013 that the southwest region continue to be analysed as a special resource until further notice, in addition to the full Indian Ocean assessment, the WPB **REQUESTED** that CPCs with longline fleets with important swordfish catches in the southwest Indian Ocean (EU, Taiwan,China and Japan) continue to undertake revised CPUE analysis for their longline fleets in the southwest Indian Ocean, in addition to CPUE analysis for the entire Indian Ocean.

EU,Portugal: Indian Ocean swordfish longline CPUE 1998–2013

78. The WPB **NOTED** papers IOTC–2014–WPB12–18 and IOTC–2014–WPB12–19 which details swordfish catches by the EU,Portugal pelagic longline fleet between 1998–2013 in the Indian Ocean and Southwest Indian Ocean, as well as effort, standardised CPUE and catch-at-size, including the following abstracts 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. A recent effort by the Portuguese Institute for the Ocean and Atmosphere (IPMA) was made to collect of historical catch and effort data on this fishery since the late 1990's to the present date, as well as vessel monitoring system (VMS) data. This working document analyses the catch and effort, catch-at-size, and standardized CPUE trends for that period. The trends in the swordfish catch-at-size were analyzed annually and compared between seasons, revealing a decrease in the sizes in the first period of the time series (up to 2009) followed by an increase in the median sizes in the more recent years. Nominal annual CPUEs were calculated as kg/1000 hooks, and were standardized with Generalized Linear Models (GLM) using year, quarter, area, gear type, vessel, swordfish/blue shark ratio and regional:seasonal interactions." – (see papers for full abstract)

79. The WPB **NOTED** that the ratio maybe problematic, as well as the cluster analysis to deal with targeting effect, as both use catch information in both sides of the equation. Percentile of CPUE ranking could be used as an approach to test whether the standardisation can be improved.

80. **NOTING** that the two first years in the time series (1998 and 1999) were exploratory for this fishery (i.e. limited number of vessels, effort and fished area), the WPB **AGREED** not to include these on the standardised time series for stock assessment purposes.

81. The WPB **NOTED** that the data is mostly derived from logbooks of a fishery that has swordfish as the target species, thus developing standardised CPUE in number rather than in weight would considerably decrease the dataset size and consequently spatial-temporal representativeness.

82. The WPB **NOTED** that the same issues as identified in the Indian Ocean apply to the southwest Indian Ocean (see paper IOTC–2014–WPB12–19 above).

EU,Spain: Indian Ocean swordfish longline CPUE 2001–2012

83. The WPB **NOTED** paper IOTC–2014–WPB12–20 Rev_1 which provides a standardised catch rates for swordfish caught by the EU,Spain longline fleet operating in the Indian Ocean during 2001–2012, including the following abstract provided by the authors:

    "Standardized catch rates in weight were updated using General Linear Modeling from scientific records of the Spanish surface longline targeting swordfish in the Indian Ocean over the period 2001-2012. The base case run and several sensitivity runs were conducted for comparison with previous analyses. The main factors used for modeling were year, area, time, gear style and ratio. Different area stratifications, time criteria and other factors were considered in 6 tested runs. The models explained up to 53% of the CPUE variability. Base case and sensitivity trials for the whole Indian Ocean have shown similar CPUE trends over time. A first period from 2001 to 2007 with an overall decreasing trend in the standardized CPUE indices was predicted by all models followed by a second recovery period from 2007 to 2010 and a third period exhibiting a stable trend from 2010 to 2012. The analyses restricted to

the SW regions are also consistent with each another, suggesting a decrease during the first period, an important increase during the second period and stabilization during the third period, with the most recent year reaching levels similar to those predicted for the initial period of the time series"

Japan: Indian Ocean swordfish longline CPUE 1971–2013

84. The WPB **NOTED** paper IOTC–2014–WPB12–21 Rev_1 which provides a CPUE standardization of swordfish exploited by Japanese tuna longline fisheries in the Indian Ocean, including the following abstract provided by the authors:

"*We conducted to standardize CPUE (STD_CPUE) of swordfish exploited by Japanese tuna longline fishery in the Indian Ocean using 43 years of the set by set catch and effort data (1971-2013). For this time we attempted to use SWO cluster derived from the cluster analyses as targeting correction factor and compared with the traditional one (number of hooks between floats) (NHBF). We also compared STD_CPUE with and without SWO cluster data. As a result, it was suggested that STD_CPUE with SWO cluster data and with SWO clusters produced the best performance. This best STD_CPUE further suggested that STD_CPUE (SWO abundance) continuously decreased from 1971 to 2005 and then increased to 2013, consequently the higher level have been kept in recent 8 years (2006-2013), while there are a lot of noises (ups and downs) throughout the whole period (1971-2013).*"

85. The WPB **NOTED** that:
    - the effect of clusters produces similar trends to NHBF (traditional approach) but provide smoother trend. The GLM fits slightly better to the data when using clusters rather than NHBF.
    - the series used has large implications on the assessment. As the trend of decline with the SWO cluster is not as steep as using NHBF, then its overall results will be more optimistic on the assessment
    - case 5 (SWO cluster) is probably better than 6 (NHBF) in general. Targeting effects by NHBF are better used with a direct variable, but clustering approaches maybe more appropriate when there are no NHBF information and when the fishery is multi-metier in nature.
    - NHBF by Taiwan,China is not showing a very good correlation as in the SWO cluster results, so using the SWO cluster instead of NHBF seems to be better in the GLM models.
    - the NHBF is similar for targeting across different species targeting effects, and therefore can be a misleading indicator.

86. The WPB **AGREED:**
    - to use case 5 (swordfish cluster in swordfish target data) and 3 (NHBF in all data) in assessments, with NHBF being the traditional run and the SWO cluster a new approach using cluster as a proxy for target effects.
    - that simulation approaches should be used to test whether NHBF or cluster is the most suitable approach. As the Japanese fleet is not targeting swordfish, clusters may not be applicable in this analysis.
    - that both series could be used in the analysis in 2014.

87. The WPB **REQUESTED** that some further investigations be conducted in subsequent years.

Taiwan,China: Indian Ocean swordfish longline CPUE 1980–2012

88. The WPB **NOTED** paper IOTC–2014–WPB12–22 which provides a CPUE standardisation of swordfish exploited by Taiwan,China tuna longline fisheries in the Indian Ocean, including the following abstract provided by the authors:

"In this study, cluster analysis was used to classify the data sets in relation to the species composition of catches. Based on the results of cluster analysis, data sets were grouped into nine clusters and assigned to specific fishing types. The CPUE standardization of swordfish of Taiwanese longline fishery in the Indian Ocean for 1980-2012 using generalized linear model (GLM). Including the effect of cluster related to fishing types substantially improved the performance of GLM. The effect of cluster was the most effective variable for explaining the variance of nominal CPUE. Generally, the trends of standardized CPUE obtained from GLMs with cluster effect were relatively smoother than those obtained from GLMs without cluster effect. In addition, the trends of standardized CPUE were somewhat different when using all data sets or data sets extracted from cluster with higher catch proportions of swordfish, especially for areas SW and SE. Because few data sets were available from swordfish clusters for area SW and SE in early and recent years, the estimates may be highly uncertain. Therefore, we would suggest that the standardized CPUE series obtained from GLM with cluster effect based on all data sets might be more appropriate to be applied to stock assessment as relative abundance indices."

89. The WPB **NOTED** that:
    - the approach was an improvement over what was done in 2011.

- Modelling vessels as random effects rather than a fixed effect maybe more appropriate. The appropriate technique could use longitudinal (i.e. cross-sectional data) data analysis.
- clusters maybe misappropriating sets when targeting was not being used in the early 1980's. This is clearly indicated in TWN data in SWIO, as there is more variation using clustering approach *versus* traditional approach (NHBF).

CPUE Summary discussion

90. The WPB **AGREED** that there was merit in exploring the option of using all data from the four available CPUE data sets (Japan, Taiwan,China, EU,Spain and EU,Portugal) together in a combined CPUE analysis with a common area definition, to avoid missing combinations (area/quarter/other factors), by incorporating a "fleet effect". This may lead to a single standardised CPUE series which would avoid the need for CPUE series weighting and allowing better area coverage.

91. The WPB **ENCOURAGED** further analysis on such approach, namely in terms of the size distribution of the catches from the different fleets. Using vessels effect is important in the CPUE standardization process. However, vessel effects may be captured incorrectly, as catch is highly dependent on skippers efficiency. If finer scale data (time of set) is available, it should be used in subsequent years to account for targeting effects.

92. **NOTING** that while using production models for stock assessment, standardised CPUE in weight may be more appropriate than by number. In cases where swordfish is not actively targeted, it would be acceptable to develop standardised CPUE in number rather than in weight, the WPB **REQUESTED** the Scientific Committee consider requesting the WPM to investigate this matter.

93. The WPB **NOTED** the following regarding the state of CPUE analysis for fleets with important catches of swordfish in the IOTC area of competence:
    - Uncertainty remains about the appropriate spatial units for the CPUE standardisation. These issues should be reconsidered prior to the next stock assessment for swordfish is undertaken.
    - Trends in standardised CPUE differ considerably among fleets that operate in the same area, and efforts should be made to understand why.
    - The steep decline in Japanese CPUE in the southwest region in the early 1990s may exaggerate the perception of population decline because it occurs during a period of rapidly changing main line material (and the NHBF), and the timing of the decline is sensitive to spatial assumptions.
    - The spatial distribution of effort has changed substantially for all of the main longline fleets, and the analysis needs to account for spatial heterogeneity within the large standardisation regions.
    - Principle Components Analysis of individual multi-metier fleets may produce a more representative CPUE and trends.
    - The approaches pursued above could be applied to a core-area.

Aggregate Indian Ocean CPUE summary

94. The WPB **NOTED** that of the CPUE series available for assessment purposes, the Japan, Taiwan,China, EU,Portugal and EU,Spain series were used in the final stock assessment models investigated in 2014, for the reasons discussed above (Figs. 1, 2).
    - EU,Portugal data (2000–2013): Model 2 from IOTC–2014–WPB12–19
    - EU,Spain data (2001–2012): Run 4 from document IOTC–2014–WPB12–20 Rev_1 and Run 2 for the assessment of whole Indian Ocean.
    - Japan data (1971–2013): Case 5 (SWO cluster, SWO data) and case 3 (NHBF, all data) from document IOTC–2014–WPB12–21 Rev_1.
    - Taiwan,China data (1980–2012): Series 2 from document IOTC–2014–WPB12–22.

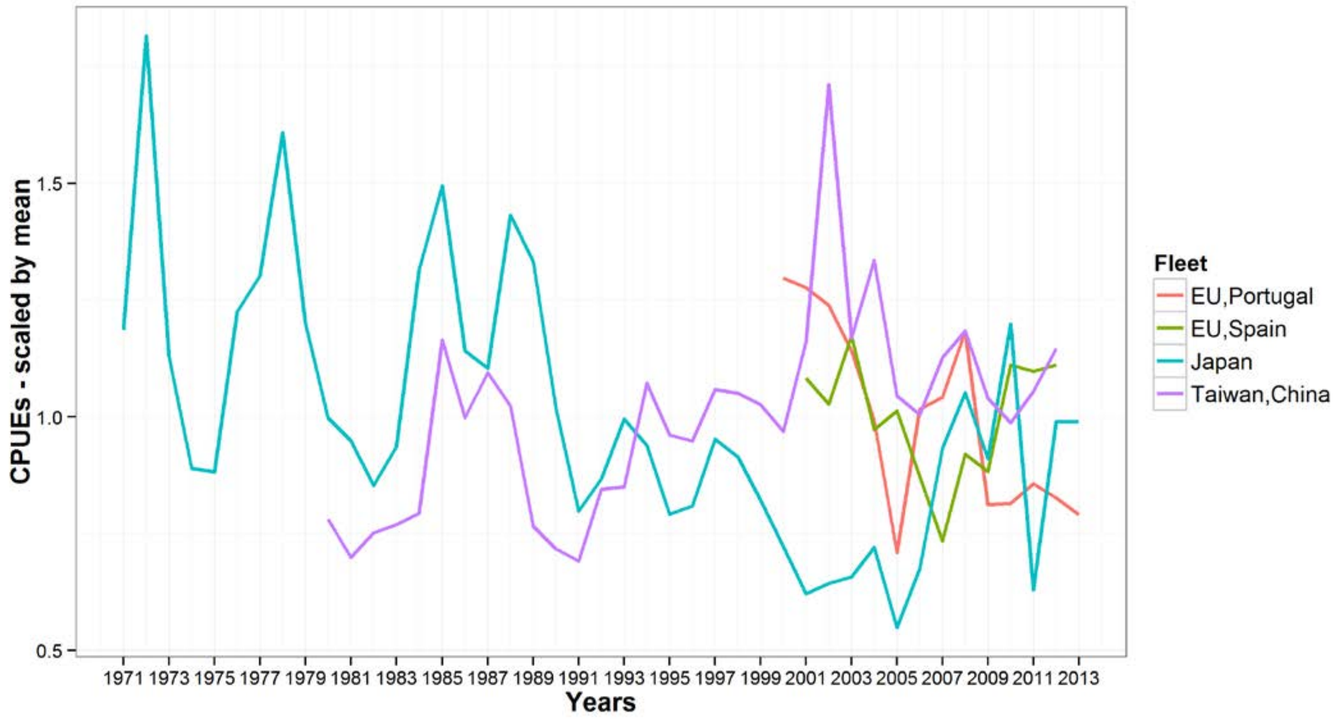

Fig. 1. Aggregate whole Indian Ocean Swordfish: CPUE series for the Indian Ocean swordfish assessments (ASIA, ASPIC and BBDM) in 2014. Series have been rescaled relative to their respective means (for different overlapping time periods).

95. The WPB **NOTED** that of the CPUE series available for assessment purposes (Fig. 1) the Japan, Taiwan,China, EU,Portugal and EU,Spain series, by area, were used in the final SS3 stock assessment model to develop management advice (Fig. 2).

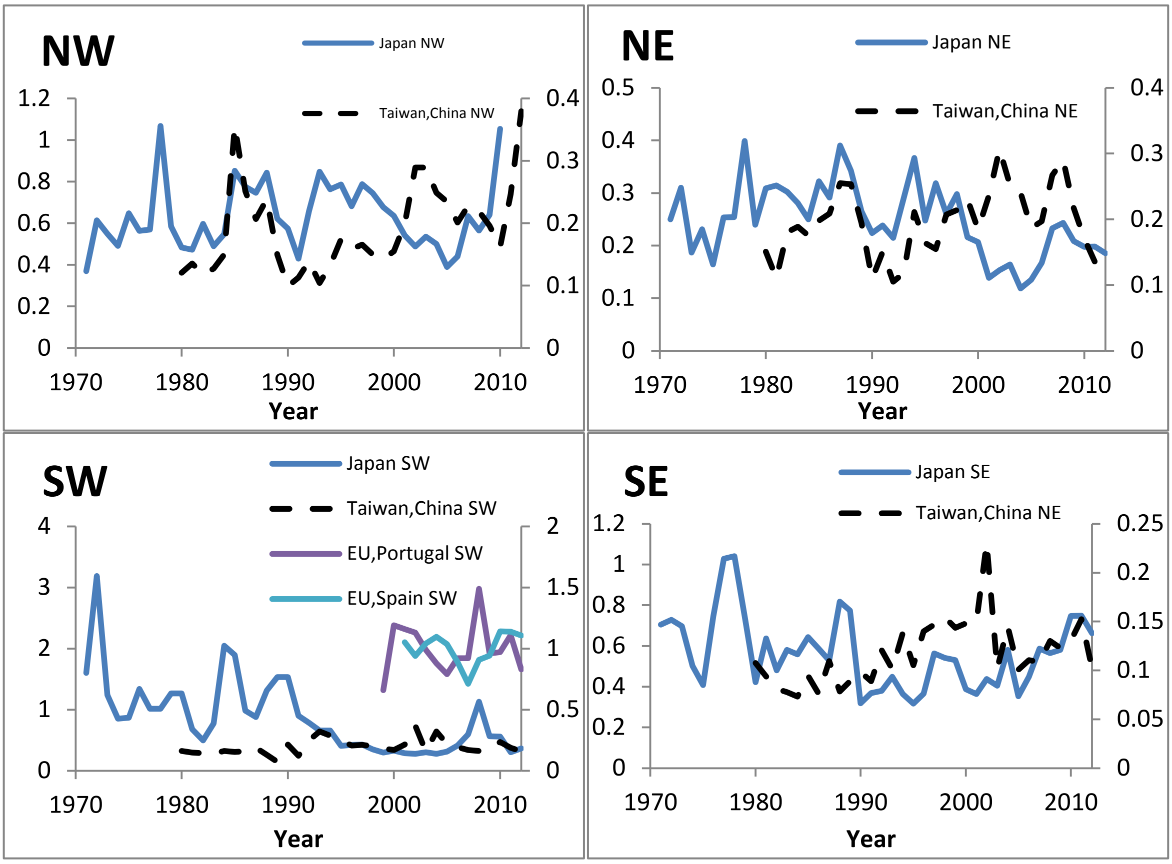

Fig. 2. Swordfish: CPUE series used in the final SS3 stock assessment model in 2014 by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – southwest; NE – northeast; SE – southeast Indian Ocean.

Southwest Indian Ocean CPUE summary

96. The WPB **NOTED** the CPUE series used in the southwest Indian Ocean stock assessment models for 2014 (shown in Fig. 3). The final assessment . In the case of the SWIO, we used the Japanese series only.

97. The WPB **NOTED** that of the CPUE series available for the southwest Indian Ocean for assessment purposes, listed below, the Japanese case (scenario) 3 in paper IOTC–2014–WPB12–21 Rev_1 (Fig. 3) was used in the final stock assessment model for management advice.

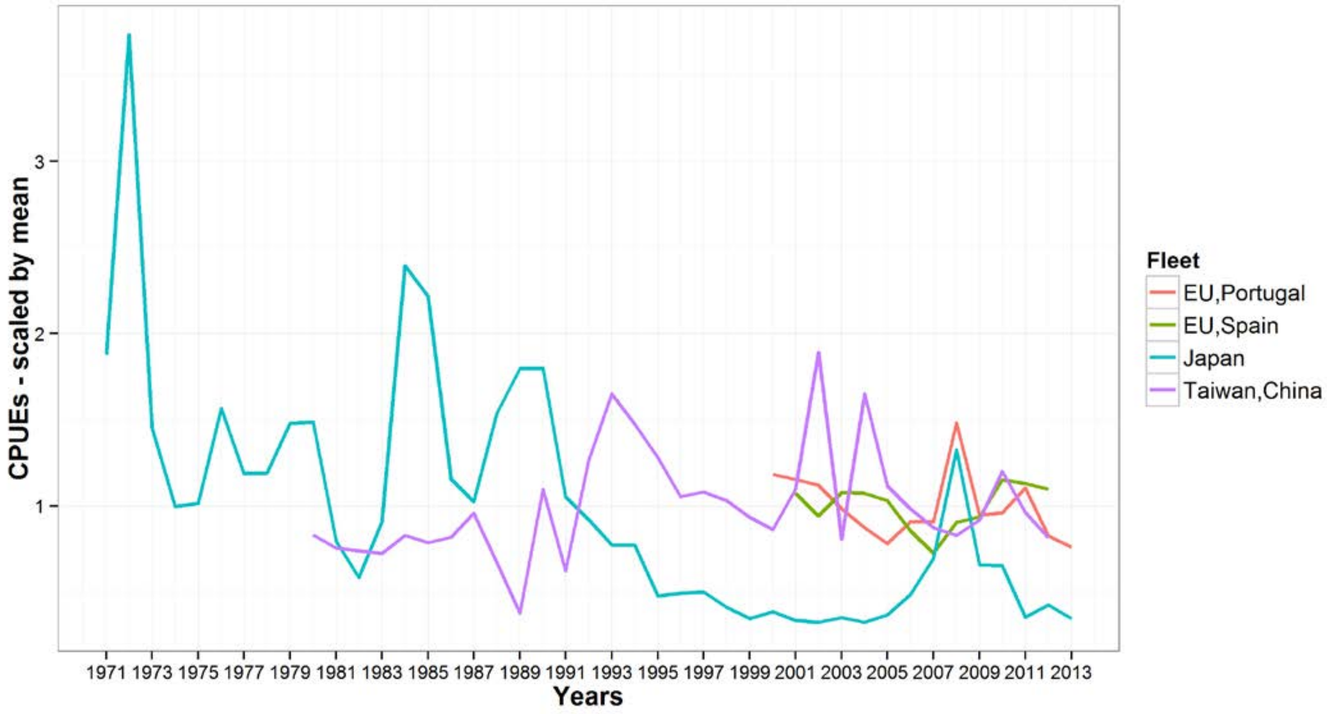

Fig. 3. Swordfish: CPUE series for the **southwest** Indian Ocean swordfish assessments in 2014. Series have been rescaled relative to their respective means (for different overlapping time periods).

6.3.3 Stock assessments

98. The WPB **NOTED** that a range of quantitative modelling methods (ASIA, ASPIC, BBDM and SS3) as detailed below were applied to the assessment of swordfish in 2014, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. The different assessments were presented to the WPB in documents IOTC–2014–WPB12–23, 24 Rev_2, 25 and 26 Rev_3. Each model is summarised in the sections below.

Swordfish: Summary of stock assessment models in 2014

99. The WPB **NOTED** Tables 2 and 3, which provide an overview of the key features of each of the stock assessments presented in 2014 for the Indian Ocean-wide assessments (4 model types) and the southwest Indian Ocean assessments (3 model types) respectively. Similarly, Tables 4 and 5 provide a summary of the assessment results.

Table 2. Swordfish: **Indian Ocean-wide** assessments. Summary of final stock assessment model features as applied to the Indian Ocean swordfish resource in 2014.

Model feature	ASIA (Doc# 23)	ASPIC (Doc #24 Rev_2)	BBDM (Doc# 25)	SS3 (Doc# 26 Rev_3)
Software availability	Private	NMFS toolbox	H. A. Andrade	NMFS toolbox
Population spatial structure / areas	1	1	1	4
Number CPUE Series	10	1	1	10
Uses Catch-at-length/age	Yes	No	No	Yes
Age-structured	Yes	No	No	Yes
Sex-structured	Yes	No	No	Yes
Number of Fleets	13	1	1	12
Stochastic Recruitment	Yes	No	No	Yes

Table 3. Swordfish: **Southwest Indian Ocean** assessments. Summary of final model features as applied to the southwest Indian Ocean swordfish resource in 2014.

Model feature	**ASIA (Doc# 23)**	**ASPIC (Doc #24 Rev_2)**	**BBDM (Doc# 25)**
Software availability	Private	NMFS toolbox	H. A. Andrade
Population spatial structure / areas	1	1	1
Number CPUE Series	4	1	1
Uses Catch-at-length	Yes	No	No
Age-structured	Yes	No	No
Sex-structured	Yes	No	No
Number of Fleets	4	1	1
Stochastic Recruitment	Yes	No	No

Table 4. Swordfish: **Indian Ocean-wide** summary of key management quantities from the assessments undertaken in 2014.

Management quantity	**ASIA (Doc# 23)**	**ASPIC (Doc #24 Rev_2)**	**BBDM (Doc# 25)**	**SS3 (Doc# 26 Rev_3)**
Most recent catch estimate (t) (2013)	31,804			
Mean catch over last 5 years (t) (2009–2013)	26,510			
h (steepness) (base case)	0.75	n.a.	n.a.	0.75
MSY (1,000 t) (80% CI)	23.40 (20.0–26.8)	36.80 (24.6–56.3)	41.13 (32.76–53.83)	39.40 [25.0–92.4]
Data period (catch)	1950–2013	1950–2013	1950–2013	1950–2013
CPUE series	LL: Japan, Taiwan, Spain Portugal	LL Japan	LL: Japan	LL: TWN,CHN, Japan and EU by area
CPUE period	1971–2013, 1980–2012, 2001–2012, 2000–2013	1971–2013	1971–2013	1981–2013
F_{MSY} (80% CI)	0.23 (0.19–0.26)	0.39 (0.27–0.61)	0.30 (0.18–0.53)	0.14 [0.09–0.28]
SB_{MSY} or *B_{MSY} (1,000 t) (80% CI)	54.69 (46.59–62.80)	89.24* (58.74–124.50)	144.2* (76.04–226.37)	61.4 [9.8–81.2]
$F_{current}/F_{MSY}$ (80% CI)	0.83 (0.68–1.00)	0.56 (0.52–0.59)	0.49 (0.35 – 0.66)	0.34 [0.08–0.70]
B_{2013}/B_{MSY} (80% CI)	n.a.	1.61 (1.58–1.68)	1.57 (1.36–1.82)	n.a.
SB_{2013}/SB_{MSY} (80% CI)	2.30 (2.04–2.56)	n.a.	n.a.	3.10 [1.92–6.35]
B_{2013}/B_{1950} (80% CI)	n.a.	0.76 (n.a.)	0.79 (0.65–0.96)	n.a.
SB_{2013}/SB_{1950} (80% CI)	0.66 (0.58–0.73)	n.a.	n.a.	0.74 [0.57–0.84]
$SB_{2013}/SB_{current, F=0}$ (80% CI)	n.a.	n.a.	n.a.	n.a.

LL = longline; n.a. = not available

Table 5. Swordfish: Southwest Indian Ocean summary of key management quantities from the assessments undertaken in 2014.

Management quantity	**ASIA (Doc# 23)**	**ASPIC (Doc #24 Rev_2)**	**BBDM (Doc# 25)**
Most recent catch estimate (t) (2013)	7,349		
Mean catch over last 5 years (t) (2009–2013)	7,265		
h (steepness)	0.75	n.a.	n.a.
MSY (1,000 t) (80% CI)	8.86 (7.27–10.44)	9.86 (9.11–10.57)	13.78 (6.37–24.40)
Data period (catch)	1950–2013	1950–2013	1950–2013
CPUE series	LL: Japan, Taiwan, Spain Portugal	LL: Japan	LL: Japan
CPUE period	1971–2013, 1980–2012, 2001–2012, 2000–2013	1971–2013	1971–2013
F_{MSY} (80% CI)	0.20 (0.19–0.21)	0.63 (0.59–0.70)	0.09 (0.04–0.18)
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI)	20.87 (17.09–24.65)	12.68* (12.52–12.78)	168.70* (84.93–233.80)
$F_{current}/F_{MSY}$ (80% CI)	0.51 (0.38–0.65)	0.89 (0.61–1.14)	1.66 (0.84–4.00)
B_{2013}/B_{MSY} (80% CI)	n.a.	0.94 (0.68–1.23)	0.32 (0.21–0.51)
SB_{2013}/SB_{MSY} (80% CI)	2.06 (1.71–2.41)	n.a.	n.a.
B_{2013}/B_{1950} (80% CI)	n.a.	0.16 (n.a.)	0.16 (0.11–0.27)
SB_{2013}/SB_{1950} (80% CI)	0.59 (0.49–0.70)	n.a.	n.a.
$SB_{2013}/SB_{current,\ F=0}$ (80% CI)	n.a.	n.a.	n.a.

LL = longline; n.a. = not available

Age-structured integrated analysis (ASIA)

100. The WPB **NOTED** paper IOTC–2014–WPB12–23 which provided a stock assessment of swordfish 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 swordfish in the Indian Ocean based on the sex-specific age-structured integrated approach (ASIA). Nine scenarios were conducted based on the different assumptions related to incorporation of CPUE data and pre-specific biological parameters. For all scenarios, the model generally fits to the observed length frequency data well for all fleets, while the model cannot fit to CPUEs very well for some of fleets in years before early-1990s, especially for JPLL-SW and TWLL-SW because these CPUEs changed sharply since the mid of 1990s but catchabilities were assumed to be constant over time for each fleet. For whole Indian Ocean, the results of most scenarios indicated that the current fishing intensity was lower than MSY level and the current spawning biomass was higher than MSY level, while the current fishing intensity may slightly higher than MSY level when lower reproductivity was assumed for swordfish. For southwest Indian Ocean, the results of all scenarios indicated that the current fishing intensity was lower than MSY level and the current spawning biomass was higher than MSY level. Base on the results of this study, the status of swordfish in the Indian Ocean and in the southwestern Indian Ocean might not be overfishing or overfished."*

101. The WPB **NOTED** the key assessment results for the age-structured integrated analysis (ASIA) as shown in Tables 6, 7, 8 and in Fig. 4.

Table 6. Swordfish: Key management quantities from the ASIA assessment, for the Indian Ocean.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2013 catch estimate	31,804	7,349
Mean catch from 2009–2013	26,510	7,265
MSY (1000 t) (80% CI)	23.40 (20.0–26.80)	8.86 (7.27–10.44)
Data period used in assessment	1950–2013	1950–2013
F_{MSY} (80% CI)	0.23 (0.19–0.26)	0.20 (0.19–0.21)
SB_{MSY} (1000 t) (80% CI)	54.69 (46.59–62.80)	20.87 (17.09–24.65)
F_{2013}/F_{MSY} (80% CI)	0.83 (0.68–1.00)	0.51 (0.38–0.65)
B_{2013}/B_{MSY} (80% CI)	n.a.	n.a.
SB_{2013}/SB_{MSY} (80% CI)	2.30 (2.04–2.56)	2.06 (1.71–2.41)
B_{2013}/B_{1950} (80% CI)	n.a.	n.a.
SB_{2013}/SB_{1950} (80% CI)	0.66 (0.58–0.73)	0.59 (0.49–0.70)
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.	n.a.
$SB_{2013}/SB_{1950,\ F=0}$ (80% CI)	n.a.	n.a.

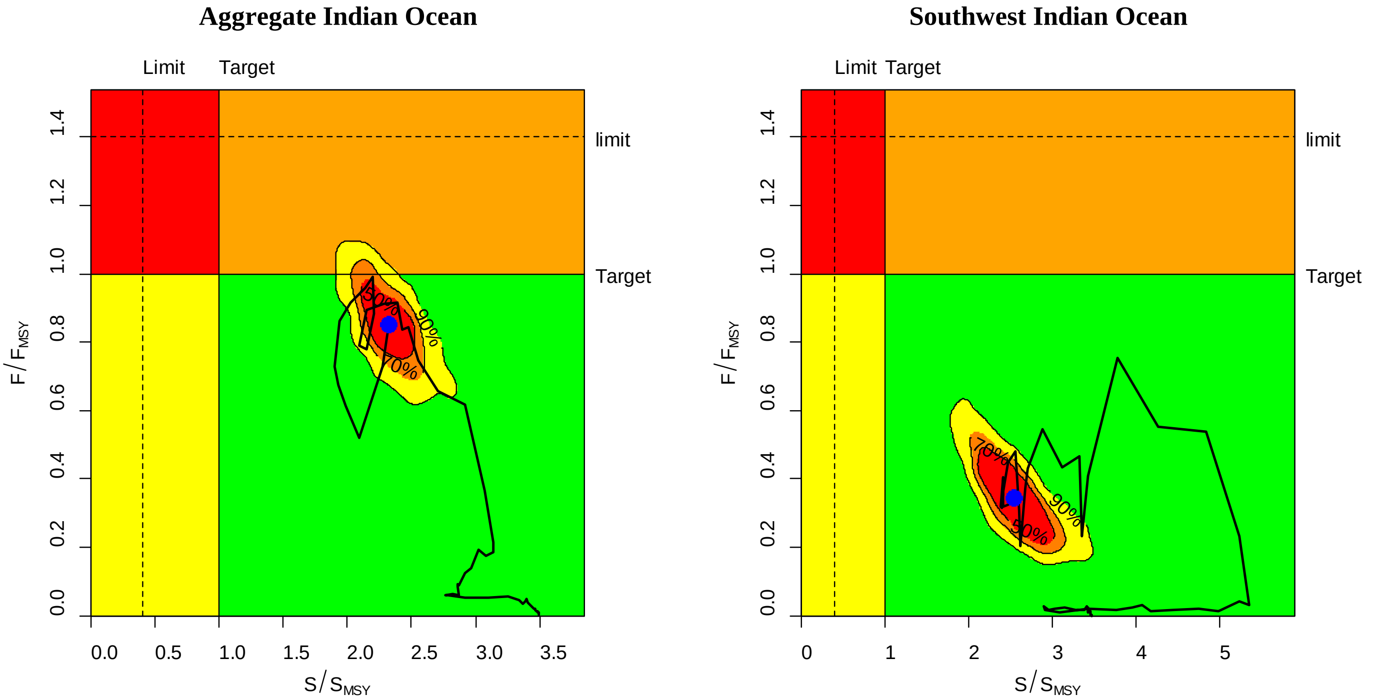

Fig. 4. Swordfish: ASIA a) aggregated and b) southwest Indian Ocean assessments Kobe plots (The horizontal blue line represents F_{LIM} and the vertical blue line represents B_{LIM}) (Total biomass B shown as S) The results are from a preferred model option: Base case in paper IOTC–2014–WPB12–23 Rev_1. * The trajectories were calculated based on the median of 1000 re-samplings of Bayesian posterior distribution. Blue circles indicate the estimates in 2013.

Table 7. Swordfish: 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 2011–13 (27,809 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 ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{MSY}$	0	0	0	0	6	58	99	100	100
$SB_{2023} < SB_{MSY}$	0	0	0	0	14	73	95	100	100
$F_{2023} > F_{MSY}$	0	0	0	0	30	100	100	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 ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{Lim}$	0	0	0	0	1	2	50	93	97
$SB_{2023} < SB_{Lim}$	0	0	0	0	0	32	89	99	100
$F_{2023} > F_{Lim}$	0	0	0	0	7	99	100	100	100

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

Table 8. Swordfish: ASIA **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 (7,239 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 ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{MSY}$	0	0	0	0	0	0	8	31	51
$SB_{2023} < SB_{MSY}$	0	0	0	0	0	18	56	94	97
$F_{2023} > F_{MSY}$	0	0	0	0	0	45	100	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 ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{Lim}$	0	0	0	0	0	0	0	5	13
$SB_{2023} < SB_{Lim}$	0	0	0	0	0	1	20	82	96
$F_{2023} > F_{Lim}$	0	0	0	0	0	24	97	100	100

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

102. The WPB **NOTED** the following with respect to the ASIA modelling approach presented at the meeting:
- The model fits to Japanese and Taiwanese CPUE data were still problematic since the CPUE data revealed conflictive trends as shown in previous analyses, especially for southwest Indian Ocean.
- The results from the base case are presented in the report.

A Stock-Production Model Incorporating Covariates (ASPIC)

103. The WPB **NOTED** paper IOTC–2014–WPB12–24 Rev_2 which provided a stock assessment for swordfish in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC) which incorporates some of the improvements agreed at the previous WPB meeting, including the following abstract provided by the authors:

“*Stock and risk assessments were conducted by ASPIC software using 64 years data (1950-2013) for swordfish in the whole and the SW Indian Ocean. In the stock assessments, uncertainties between production models (Schaefer vs. Fox) and targeting effect (SWO cluster vs. NHBF) were taken into account. As for the Whole Indian Ocean, the stock is now at the well safe zone (green zone in the Kobe plot), i.e., Total biomass (TB) ratio=1.61 and F ratio=0.56. Risk assessments suggests no risks violating MSY levels at all if the current 3 years average catch (2011-2013) (28,000 tons) or even 120% level (33,000 tons) continues next 10 years. As for the SW Indian Ocean, the stock is now at the recovering stage (yellow zone close to both MSY levels of TB and F in the Kobe plot), i.e., Total biomass (TB) ratio=0.94 and F ratio=0.89. Risk assessment suggests that there are medium risks violating MSY levels of TB ratio levels next 10 years if the current 3 years average catch (2011- 2013) (7,300 tons) continues. As for F ratio, if the current 3 years average catch level (7,300 tons) continues, there are high risks violating MSY levels*.”

104. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below (Tables 9, 10, 11; Fig. 5).

Table 9. Swordfish: Key management quantities from the ASPIC assessment, for the Indian Ocean.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2013 catch estimate	31,804	7,349
Mean catch from 2009–2013	26,510	7,265
MSY (1000 t) (80% CI)	36.8 (24.6–56.3)	9.86 (9.11–10.57)
Data period used in assessment	1950–2013	1950–2013
F_{MSY} (80% CI)	0.39 (0.27–0.61)	0.63 (0.59–0.70)
B_{MSY} (1000 t) (80% CI)	89.24 (58.74–124.50)	12.68 (12.52–12.78)
F_{2013}/F_{MSY} (80% CI)	0.56 (0.52–0.59)	0.89 (0.61–1.14)
B_{2013}/B_{MSY} (80% CI)	1.61 (1.58–1.68)	0.94 (0.68–1.23)
SB_{2013}/SB_{MSY} (80% CI)	n.a.	n.a.
B_{2013}/B_{1950} (80% CI)	0.76 (n.a.)	0.16 (n.a.)
SB_{2013}/SB_{1950} (80% CI)	n.a.	n.a.
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.	n.a.
$SB_{2013}/SB_{1950,\ F=0}$ (80% CI)	n.a.	n.a.

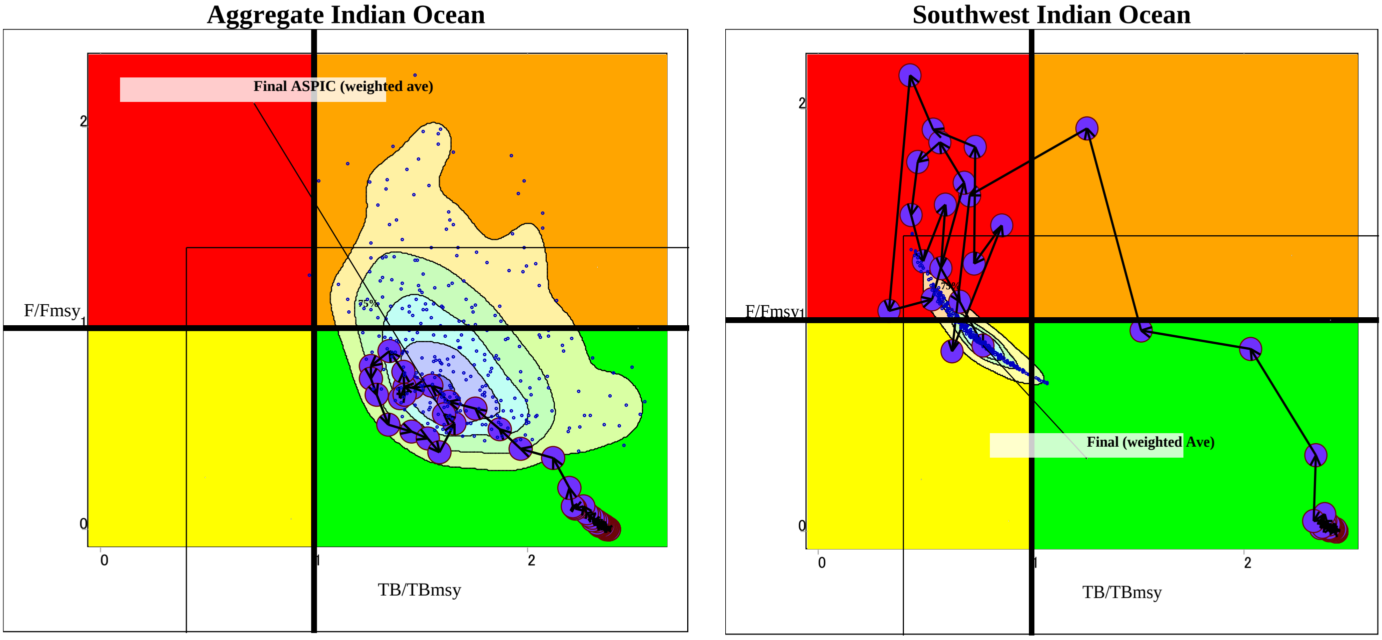

Fig. 5. Swordfish: ASPIC a) aggregated and b) southwest Indian Ocean assessments Kobe plots (The horizontal blue line represents F_{LIM} and the vertical blue line represents B_{LIM}). The results are from a preferred model option: Model weighted average using the inverse of the Root Mean Square errors across all models used (IOTC–2014–WPB12–24 Rev_2).

Table 10. Swordfish: 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 2011–13 (27,809 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{MSY}$	0	1	1	2	3	4	6	8	11
$F_{2016} > F_{MSY}$	0	0	0	0	0	2	3	10	17
$B_{2023} < B_{MSY}$	0	0	0	1	3	7	11	29	47
$F_{2023} > F_{MSY}$	0	0	0	0	0	4	9	33	56
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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2016} > F_{Lim}$	0	0	0	0	0	0	0	1	1
$B_{2023} < B_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2023} > F_{Lim}$	0	0	0	0	0	0	0	12	24

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

Table 11. 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 (7,239 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{MSY}$	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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{Lim}$	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

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

105. The WPB **NOTED** the following with respect to the ASPIC modelling approach presented at the meeting:
   - Japanese standardised CPUE with traditional targeting effect (NHBF) fits better to ASPIC than by swordfish cluster.
   - ASPIC results by Schaefer are more conservative than by FOX.
   - Schaefer fits better to CPUE series, but Fox fits better to the catch and the overall fit in the model.
   - The Japanese standardised CPUE fits well to global catch trends (increased catch implies a lower CPUE).
   - ASPIC runs suggests the Japanese standardised CPUE for the southwest Indian Ocean is less reliable than in the whole Indian Ocean as 2 scenarios did not converge.

Bayesian Biomass Dynamics Model (BBDM)

106. The WPB **NOTED** paper IOTC–2014–WPB12–25 which provided a stock assessment of swordfish in the Indian Ocean using an BBDM analysis, including the following abstract provided by the authors:

> *"Swordfish is often caught as by catch of fleets targeting tunas, but the species is the target of some fleets. Unique stock in the Indian Ocean is assumed to the most probable hypothesis, though there is some concern about a possible local depletion in the southwest area. In this work Bayesian production models (Schaefer and Fox types) were used in the stock assessment of swordfish caught in the entire Indian Ocean, and in the southwest part of the Indian Ocean. Models were fitted to total catch and to standardized catch per unit effort (CPUE) time series calculated based on Japan, Taiwan,China separated datasets, but also on a composite indices calculated based on Japan and Taiwan,China plus EU,Portugal and EU,Spain fleets. Informative and non-informative priors were used. Likelihood function was based on log-normal density distributions. Monte Carlo Markov Chains algorithm was used to calculate the posterior samples. Most of the models have converged. Standardized CPUE time series of Japan are informative about the parameters of the production models for the whole Indian Ocean. Estimations indicate the stock is not overexploited if we rely on Ymsy, Fmsy and Bmsy benchmarks. Calculations based only on southwest database did not result in meaningful estimations."*

107. The WPB **NOTED** the key assessment results for the aggregate and southwest Indian Ocean analyses as shown in Tables 12, 13, 14 and in Fig. 6.

Table 12. Swordfish: Key management quantities from the BBDM assessment, for the Indian Ocean.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2013 catch estimate	31,804	7,349
Mean catch from 2009–2013	26,510	7,265
MSY (1000 t) (80% CI)	41.13 (32.76 – 53.83)	13.78 (6.37–24.40)
Data period used in assessment	1950–2013	1950–2013
F_{MSY} (80% CI)	0.30 (0.18–0.53)	0.09 (0.04–0.18)
B_{MSY} (1000 t) (80% CI)	144.20 (76.04–226.37)	168.70 (84.93–233.80)
F_{2013}/F_{MSY} (80% CI)	0.49 (0.35–0.66)	1.66 (0.84–4.00)
B_{2013}/B_{MSY} (80% CI)	1.57 (1.36–1.82)	0.32 (0.21–0.51)
SB_{2013}/SB_{MSY} (80% CI)	n.a.	n.a.
B_{2013}/B_{1950}(80% CI)	0.79 (0.65–0.96)	0.16 (0.11–0.27)
SB_{2013}/SB_{1950} (80% CI)	n.a.	n.a.
$B_{2013}/B_{1950, F=0}$ (80% CI)	n.a.	n.a.
$SB_{2013}/SB_{1950, F=0}$ (80% CI)	n.a.	n.a.

Aggregate Indian Ocean **Southwest Indian Ocean**

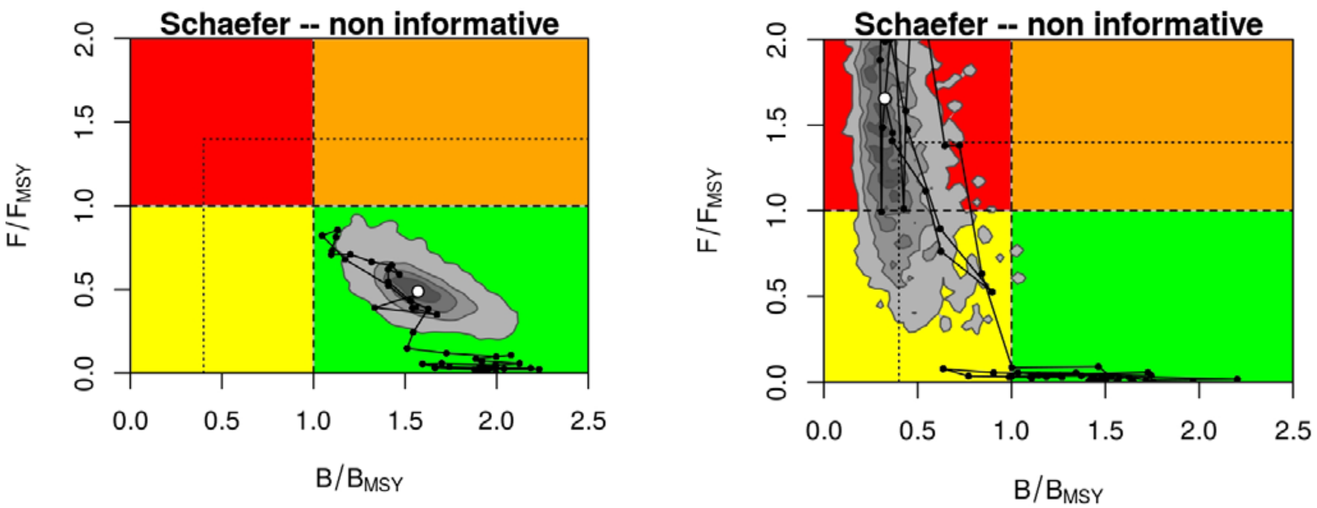

Fig. 6. Swordfish: BBDM a) aggregated and b) southwest Indian Ocean assessment Kobe plot (The horizontal blue line represents F_{LIM} and the vertical blue line represents B_{LIM}). The results are from a preferred model option: Schaefer Type model with non informative prior (IOTC–2014–WPB12–25).

Table 13. Swordfish: BBDM 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 2011–13 (27,809 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{MSY}$	0	0	0	0	0	<1	<1	<1	<1
$F_{2016} > F_{MSY}$	0	<1	<1	<1	<1	1	2	4	8
$B_{2023} < B_{MSY}$	0	0	0	<1	<1	1	3	8	16
$F_{2023} > F_{MSY}$	<1	<1	<1	<1	1	3	6	11	22
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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**

$B_{2016}< B_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2016}> F_{Lim}$	0	0	0	<1	<1	<1	<1	<1	1
$B_{2023}< B_{Lim}$	0	0	0	0	0	<1	<1	<1	2
$F_{2023}> F_{Lim}$	0	0	<1	<1	<1	<1	2	4	10

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

Table 14. Swordfish: BBDM **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 (7,239 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016}< B_{MSY}$	99	99	99	99	99	99	99	99	99
$F_{2016}> F_{MSY}$	41	51	59	66	72	77	82	85	89
$B_{2023}< B_{MSY}$	72	75	78	81	84	86	88	90	91
$F_{2023}> F_{MSY}$	30	38	46	53	59	65	70	75	80
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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016}< B_{Lim}$	55	57	59	61	63	65	68	70	71
$F_{2016}> F_{Lim}$	27	35	42	50	56	63	68	72	76
$B_{2023}< B_{Lim}$	31	36	42	48	53	58	64	68	72
$F_{2023}> F_{Lim}$	2	31	37	45	52	58	64	69	73

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

108. The WPB **NOTED** the following with respect to the BBDM modelling approach presented at the meeting:
- State-space biomass dynamics models (observational plus process error) fits are not biased.
- Schaefer model outperformed Fox model in most of the calculations.
- Results gathered with Schaefer model are more conservative.
- The Japan dataset are informative on the parameters of the production model for the aggregated Indian Ocean.
- Estimations of parameters calculated for the southwest part of the Indian Ocean are not meaningful.
- Calculations for the aggregated Indian Ocean indicate the stock is not overfished.

Stock Synthesis III (SS3)

109. The WPB **NOTED** paper IOTC–2014–WPB12–26 Rev_3 which provided a stock assessment for swordfish in the Indian Ocean by Stock Synthesis III (SS3) model, including the following abstract provided by the authors:

> "*An Indian Ocean swordfish (Xiphias gladius) stock assessment using Stock Synthesis 3 (SS3) software is described. The approach uses a highly disaggregated model to integrate several sources of fisheries data and biological research into a unified framework. The model used is updated from the analysis conducted in 2011. Rather than use a fairly complex grid as used in 2011, the model examined this year key uncertainties, namely growth, natural mortality, steepness and weighting of the length composition data as opposed to the CPUE survey data (2 growth curves with 2 natural mortality vectors that correspond to the growth curves from a biological basis (total of 2 choices), 3 steepness values, and two weighting alternatives of data, and examining once CPUE series scenario that is equally weighted across all series, and one that only examines the Japanese CPUE series, with the EU fleets representing the SW Region). The implications of 10 years of projections over a ranged of constant catch levels (60, 80, 100, 120, 140% of current) are summarized in a management decision table (Kobe 2 Strategy Matrix), based on a weighted average of the model results. The analysis is conducted for the Indian Ocean stock as a*

*whole. Results indicate that the stock is **not overfished**, and **not subject to overfishing**. Key indicators on the Indian Ocean Swordfish stock using a set of model evaluated across two growth curves and a range of Maturations, M's and effective sample sizes are shown below (ranges are plausible ranges across all models examined in Tables 7 and 8, and points are medians across all runs examined).*"

110. The WPB **NOTED** the key assessment results for the Stock Synthesis III model (SS3) as shown below (Tables 15, 16; Fig. 7).

Table 15. Swordfish: Key management quantities from the SS3 assessment, for the Indian Ocean, using a base case with the growth curve from paper IOTC–2010–WPB08–08 Rev_1, M=0.25, and steepness=0.75, ESS=200, and all CPUE data used for point estimates). CI values are 80% from the base case run.

Management Quantity	Indian Ocean
2013 catch estimate	31,804 t
Mean catch from 2009–2013	26,510 t
MSY (1000 t) (80% CI)	39.40 (33.20–45.60)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)	0.138 (0.137–0.138)
SB_{MSY} (1000 t) (80% CI)	61.4 (51.5–71.40)
F_{2013}/F_{MSY} (80% CI)	0.34 (0.28–0.40)
B_{2013}/B_{MSY} (80% CI)	n.a.
SB_{2013}/SB_{MSY} (80% CI)	3.10 (2.44–3.75)
B_{2013}/B_{1950} (80% CI)	n.a.
SB_{2013}/SB_{1950} (80% CI)	0.74 (0.58–0.89)
$B_{2013}/B_{1950, F=0}$ (80% CI)	n.a.
$SB_{2013}/SB_{1950, F=0}$ (80% CI)	n.a.

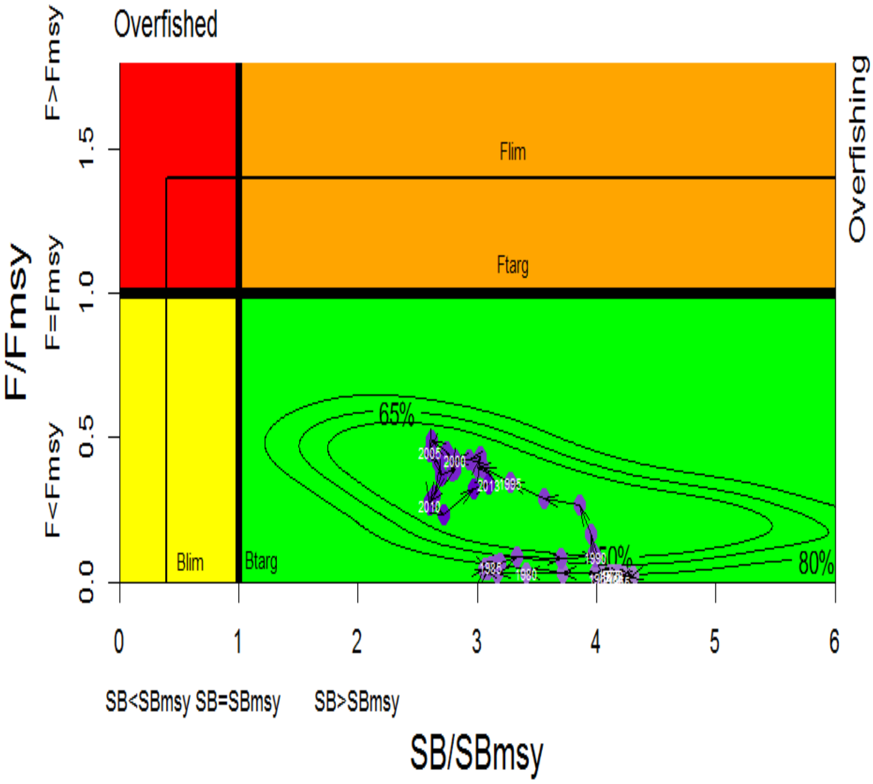

Fig. 7. Swordfish: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2013. Interim target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points, as set by the Commission, are shown.

Table 16. 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2015} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2015} > F_{MSY}$	0	0	0	0	0	0	0	0	2
$SB_{2022} < SB_{MSY}$	0	0	0	0	0	0	0	0	0
$F_{2022} > F_{MSY}$	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 ($SB_{lim} = 0.4\ B_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2015} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2015} > F_{Lim}$	0	0	0	0	0	0	0	0	4
$SB_{2022} < SB_{Lim}$	0	0	0	0	0	0	0	0	0
$F_{2022} > F_{Lim}$	0	0	0	0	0	0	0	0	4

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

111. The WPB **NOTED** the following with respect to the SS3 modelling approach presented at the meeting:
    - The results were consistent with the other approaches, and had better fits for the Japanese only CPUE series versus all CPUE series.
    - Fits to the early 70's were poor and the model had problems fitting to the earlier period, and the method proposed to start the CPUE series from 1980 was plausible, as the other results seemed unrealistic.
    - Fits to only the Japanese CPUE tended to give more pessimistic results.
    - The following parameters for the assessments, namely using the growth curve from paper IOTC–2010–WPB08–08 Rev_1, with early maturation (50% by age 5), as well as a steepness of 0.75 (intermediate between a low and high values of 0.6 and 0.9) with an M=0.25, and a higher ESS (200) was valid and useful to compare with ASIA.
    - For accounting for structural uncertainty the proposed grid used in IOTC–2014–WPB12–26 Rev_3 was appropriate. As noted by in paper IOTC–2014–WPB12–17, the approach followed here seemed to make sense and would be used for stock status advice for the complete Indian Ocean.

6.3.4 Selection of Stock Status indicators for swordfish

112. The WPB **NOTED** the following with respect to the various modelling approaches used in 2014:
    - There was more confidence in the abundance indices this year due to the additional exploratory CPUE analyses from Japan and Taiwan,China. This has led to improved confidence in the overall assessments.
    - The Japan longline CPUE series is more likely to closely represent swordfish abundance at this time, because a substantial part of the Japan longline fleet has a long term series of swordfish bycatch even though it has never targeted swordfish. In addition, it is the only CPUE series that decreases as catch increases.
    - Conversely, the Taiwan,China CPUE seems to demonstrate very strong targeting shifts away from swordfish in the core area and back towards swordfish in recent years.
    - CPUE series should not be averaged across series with different trends as this is likely to result in spurious trends. Thus, only series which are considered to be most representative of abundance, in this case the Japan longline series, should be the primary CPUE series used in stock assessments while further work is carried out on the other series (Taiwan,China, EU,Spain and EU,Portugal).
    - It was recognised that the deterministic production models were only able to explore a limited number of modelling options. The structural rigidity of these simple models causes numerical problems when fit to long time series for some cases.

113. 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.

114. The WPB **AGREED** that there is value in undertaking a number of different modelling approaches to facilitate comparison. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a lot of uncertainties in basic swordfish biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, sometimes the ASPIC model can have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

115. The WPB **NOTED** that the southwest Indian Ocean assessments had substantial conflicting results based on the different model runs (ASIA, BBDM and ASPIC).

Parameters for future analyses: CPUE standardization and stock assessments

116. The WPB **AGREED** that in order to obtain comparable CPUE standardisations, the analyses shall be conducted with similar approaches (note that fleets that have additional or different data, this should not be an issue). Differences in CPUE signals from different CPC's should be investigated further in subsequent years. Table 17 provide a possible set of parameters, discussed during the WPB12, that shall give guidelines (and should not be an exclusive to this list), if available, for the standardisation of CPUE in preparation for the next WPB meeting to be used as indices of abundance for the stock assessments.

117. The WPB **AGREED** that a fine scale (operational data) CPUE analysis for the EU,France longline fishery is needed for the next swordfish stock assessment and should be incorporated in the WPB Program of Work.

118. The WPB **NOTED** that the Stock Reduction Analysis approach was also run for comparative purposes with the others assessments for swordfish (see paper IOTC–2014–WPB12–27).

Table 17. Swordfish: A set of parameters for the standardisation of CPUE series in preparation for the next WPB meeting.

CPUE standardisation parameters	Value for next CPUE standardisation
Area	*To be defined.* Explore core area(s)
CE Resolution	Operational data
GLM Factors	Year, Quarter, Area (e.g. 5*5 area effect), HBF (or targeting cluster), vessel + interactions
All fleet	*Combine data for all fleets with the above effects + fleet*

119. The WPB **AGREED** that CPUE standardisation should account for targeting effects as it is one of the main reasons for differential nominal CPUE trends.

120. The WPB **AGREED** that a global CPUE standardisation could be undertaken by pooling all the data available for the main longline fleets in one analyses and weighting the series.

121. The WPB **NOTED** the information presented and **REQUESTED** that in the future presentation of the equations used to convert from non-standard to standard measurements be based upon a standard agreed to by the WPB. In this way, inter sessional work will be led by the WPB Chair in order to review available equation from peer reviewed and grey literature, check for complementary non-published datasets available upon CPC and propose a set of standard equation at the next WPB for Indian Ocean billfishes.

122. The WPB **AGREED** that the model parameters contained in Table 18 should be used for swordfish stock assessments for the next applicable WPB meeting, with appropriate sensitivity runs, unless modifications to the parameters are agreed to by the WPB participants following inter-sessional work to be undertaken under the guidance of the Chair and Vice-Chair.

Table 18. Swordfish: Model parameters agreed to by the WPB for use in base case stock assessment runs for the next applicable WPB meeting.

Biological parameters	**Value for assessments**
Stock structure	Males and Females (IO, SWIO)
Sex ratio	Initially 1:1
Age (longevity)	30+
Natural mortality	M=0.25 (alternatively M=0.4)
Growth formula	L=Linf(1-exp(-k(t-tzero)) Linf= 274.86 (f), 234 (m), k =0.1377 (f), 0.1690 (m), t0=2 (f), 2.18 (m)
Weight-length allometry	a = 9.133x10^{-6} b=3.012
Maturity	Maturity slope, 0.0953, length at 50% maturation=170.4 (f)
Fecundity	Proportional to Biomass
Stock-recruitment	Beverton-Holt (h=0.75), σ_r=0.4
Other parameters	
Fisheries	13 (ASIA), 12 (SS-3),
Abundance indices	Japan (4/1 area), Taiwan,China (4/1 area), EU,Spain (1 area, SW), EU,Portugal (1 area-SW)
Selectivity	Dome shaped Double Normal or Logistic

6.4 Development of management advice for swordfish

123. 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 2013 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

7. MARLINS

7.1 Review of data available at the IOTC Secretariat for marlins

124. The WPB **NOTED** paper IOTC–2014–WPB12–07 Rev_2 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for marlins (by species), in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2013. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching marlins (by species) in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, and size-frequency. A summary of the supporting information for the WPB is provided in Appendix IV.

125. The WPB **NOTED** the main marlin 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.

126. The WPB **NOTED** that the quality of the data available at the IOTC Secretariat on marlins (by species) is likely to be compromised by species miss-identification and reminded CPCs to review their historical data in order to identify and correct potential identification problems that are detrimental to any analysis of the status of the stocks, and to report any changes to the IOTC Secretariat as soon as possible.

7.2 Review of new information on the biology, stock structure, fisheries and associated environmental data

No new information presented to the WPB12.

7.3 Review of new information on the status of marlins

Nominal and standardised CPUE indices

Invited Expert review and CPUE analysis for marlins

127. The WPB **RECALLED** paper IOTC–2013–WPB11–INF02, which was an update to papers IOTC–2012–WPB10–INF11 and INF12 presented at the WPB10 meeting in 2012, on the exploratory analysis of the longline fisheries and the CPUE analysis for black marlin, blue marlin and striped marlin.

128. The WPB **RECALLED** that the information paper was informative and that such documents/reviews are useful to the work of the WPB. Such explanatory analysis is needed to better identify and understand different patterns contained in the data that would help in the standardisation process.

Invited Expert review – Black marlin

129. The WPB **RECALLED** that the catch rate estimates are still highly variable over time for both longline fleets from Japan and Taiwan,China and the similarity between both the longline datasets from Japan and Taiwan,China (Fig. 8).

130. The WPB **RECALLED** that both catch rate time series (Japan and Taiwan,China) show a similar decreasing trend from 1960's until the end of 2000's. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the early 1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight that the WPB have doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries.

131. The WPB **RECALLED** that the sharp decline between 1952 and 1958 in the Japanese black marlin CPUE series does not reflect the trend in abundance.

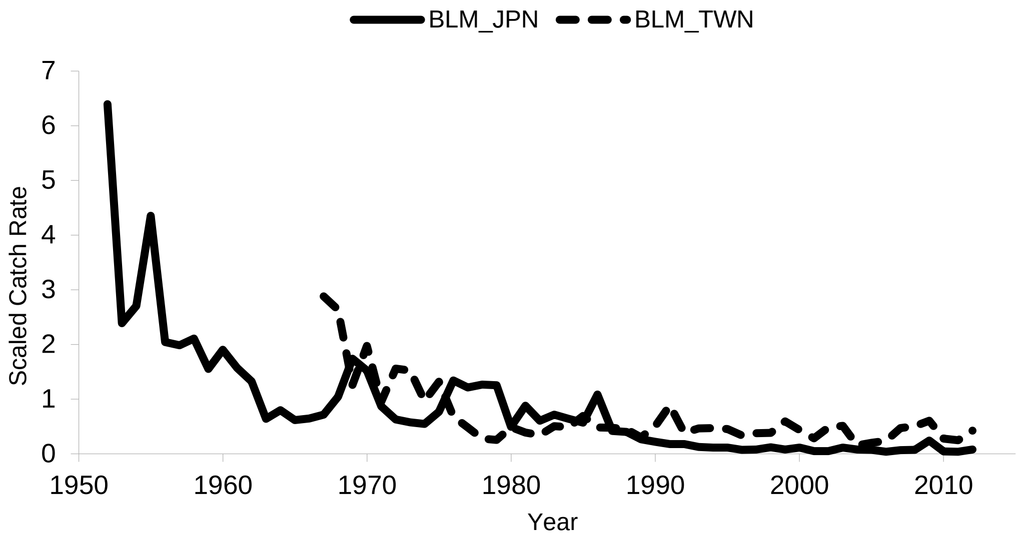

Fig. 8. Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Black marlin: Summary of stock assessment models in 2014

Black marlin: Stock reduction analysis

132. The WPB **NOTED** paper IOTC–2014–WPB12–27 which provided a stock assessment for sailfish and black marlin using stock reduction approaches, including the following abstract provided by the authors:

> "*We conducted stock assessments for Indian Ocean sailfish and Black marlin. 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 represents the virgin biomass, and is also equal to their carrying capacities. We use recently updated catch data in the analysis. For Black marlin, the geometric mean virgin biomass was about 37.4 to 142 thousand tonnes, and the intrinsic population growth rate is about 0.56 (0.25-1.3 95% CI). The entire stock can support a MSY of nearly 10.2 thousand tonnes. Catch levels in recent year may have been too high, and likely overfishing is occurring on the stock.*"

133. The WPB **NOTED** the key assessment results for the Stock Reduction Analysis (SRA) as shown below for black marlin (Tables 19, 20, 21; Fig. 9).

Table 19. Black Marlin: Summary of final stock assessment model (Stock reduction analysis) features as applied to black marlin in 2014.

Model feature	Stock Reduction Analysis
Software availability	Coded
Population spatial structure / areas	1
Number CPUE Series	No
Uses Catch-at-length/age	No
Age-structured	No
Sex-structured	No
Number of Fleets	1
Stochastic Recruitment	No

Table 20. Black Marlin: Key management quantities from the Stock reduction analysis Model, for the Indian Ocean Black marlin.

Management Quantity	Indian Ocean
2013 catch estimate	11,443 t
Mean catch from 2009–2013	10,803 t
MSY (1000 t) (80% CI)	10.20 (8.40–12.30)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)	0.25 (0.14–0.38)
B_{MSY} (1000 t) (80% CI)	37.80 (22.90–52.04)
F_{2013}/F_{MSY} (80% CI)	1.06 (0.62–1.50)
B_{2013}/B_{MSY} (80% CI)	1.13 (0.87–1.39)
SB_{2013}/SB_{MSY} (80% CI)	n.a.
B_{2013}/B_{1950} (80% CI)	0.57 (0.44–0.70)
SB_{2013}/SB_{1950} (80% CI)	n.a.
$B_{2013}/B_{1950, F=0}$ (80% CI)	n.a.
$SB_{2013}/SB_{1950, F=0}$ (80% CI)	n.a.

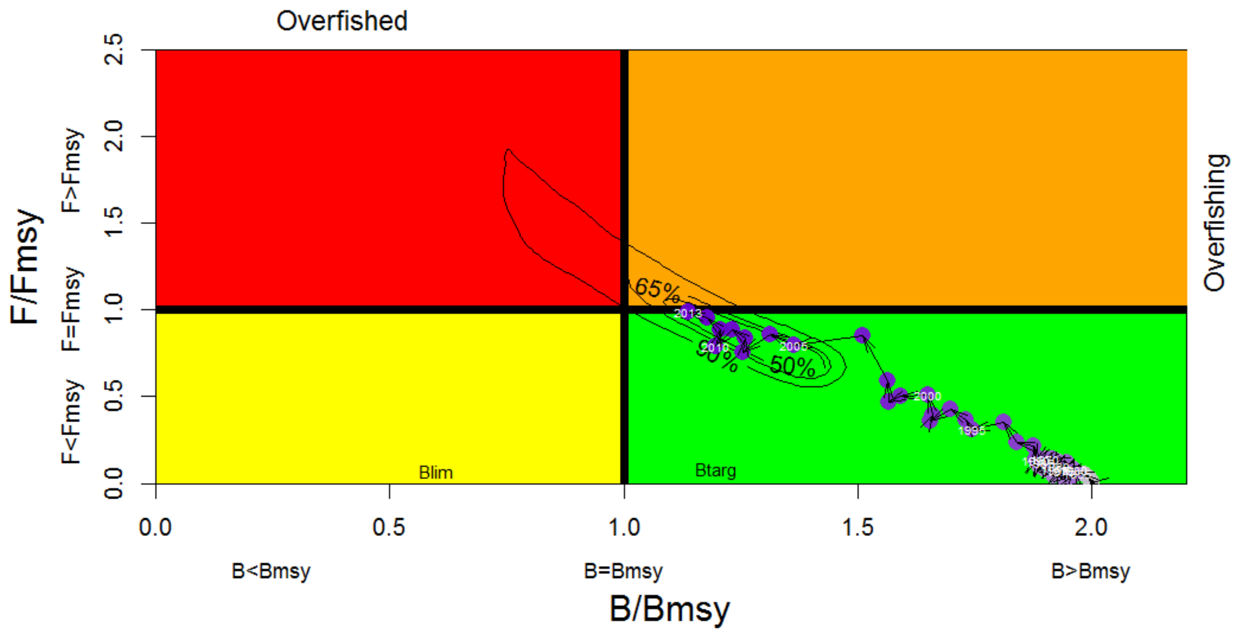

Fig. 9. Black marlin: Stock reduction analysis (Catch MSY Method) aggregated Indian Ocean assessment Kobe plots for black marlin (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black line indicates the trajectory of the point estimates (blue circles) for the spawning biomass (SB) ratio and F ratio for each year 1950–2013.

Table 21. Black Marlin: Indian Ocean stock reduction analysis (SRA) 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 (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 ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)								
	60%	70%	80%	90%	100%	110%	120%	130%	140%
$SB_{2016} < SB_{MSY}$	17	-	24	-	33	-	44	-	56
$F_{2016} > F_{MSY}$	12	-	30	-	53	-	78	-	99
$SB_{2023} < SB_{MSY}$	10	-	28	-	60	-	95	-	100
$F_{2023} > F_{MSY}$	7	-	28	-	63	-	100	-	100

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

134. The WPB **NOTED** the following with respect to the SRA modelling approach presented at the meeting:
    - The data quality was poor and hence the advice on yield was not good. However, given its probably a low estimate, one can ascertain that the model predicts the lower estimate of MSY.

Parameters for future analyses: stock assessments

135. The WPB **AGREED** that alternative approaches should be explored using the following:
    - More effort should be made in examining 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 the marlins are abundant.
    - Age/Length data over time should be collected so that alternative approaches could be examined.
    - Further examination of the data poor approaches along with a further developed Bayesian SP Model should be focussed on in 2015 when marlin are next assessed. Since the State-Space model developed is still in beta mode, further work needs to be done on this before endorsing the method.

136. The WPB **REQUESTED** that a sensitivity analysis be performed using Stock Reduction Analysis methodology, using different series of catch data to assess how robust the estimation of reference points for management are, and how the stock status determination performs.

7.3.3 Selection of Stock Status indicators for marlins

Black marlin

137. The WPB **NOTED** that the results of the stock assessment of black marlin are based on very limited information and in particular are compromised by the uncertainty in the estimates of catches for this species, over the time series. For this reason, the status of the stock is considered to have a high degree of uncertainty.

138. The WPB **AGREED** on the need to provide advice for this species and that the precautionary approach calls for a more conservative approach for data poor stocks. Thus, the stock status summary for black marlin reflects the results of the assessment but at the same time incorporates information about the approach used.

139. The WPB **AGREED** on the need to explore the use of a 'tier' approach (see Section 9.1: 'Tier' approach to stock status advice) to present stock status advice.

Blue marlin and Striped marlin

140. The WPB **NOTED** that as no new assessments were carried out for blue marlin and striped marlin in 2014, the assessments carried out in 2013, in combination with other indicators such as recent catch trends should be used to develop updated management advice.

7.4 Development of management advice for marlins

141. The WPB **ADOPTED** the management advice developed for marlins as provided in the draft resource stock status summary and **REQUESTED** that the IOTC Secretariat update the draft stock status summary for marlins with the latest 2013 catch data, and for the summary to be provided to the SC 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

8. INDO-PACIFIC SAILFISH

8.1 Review of data available at the secretariat for Indo-Pacific sailfish

142. The WPB **NOTED** paper IOTC–2014–WPB12–07 Rev_1 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for IP sailfish, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2013. The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching IP sailfish in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, and size-frequency. A summary of the supporting information for the WPB is provided in Appendix IV.

143. The WPB **NOTED** the main sailfish 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.

8.2 Review of new information on the biology, stock structure, fisheries and associated environmental data

No new information presented.

8.3 Review of new information on the status of Indo-Pacific sailfish

8.3.1 Nominal and standardised CPUE indices

144. The WPB **NOTED** that currently there is insufficient data to develop a CPUE series for Indo-Pacific sailfish caught in the IOTC area of competence.

8.3.2 Stock assessments

145. The WPB **NOTED** paper IOTC–2014–WPB12–27 which provided a stock assessment for Indo-Pacific sailfish and black marlin using stock reduction approaches, including the following abstract provided by the authors:

> "*We conducted stock assessments for Indian Ocean sailfish and Black marlin. 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. For sailfish the geometric mean virgin biomass was about 104 to 320 thousand tonnes, and the intrinsic population growth rate is about 0.595 (0.26-1.33 95% CI). The entire stock can support a MSY of nearly 27.2 thousand tonnes. Catch levels in recent year may have been too high, and likely overfishing is occurring on the stock.*"

146. The WPB **NOTED** the key assessment results for the Stock Reduction Analysis (SRA) as shown below for Indo-Pacific sailfish (Tables 22, 23; Fig. 10).

Table 22 Indo-Pacific sailfish: Summary of final stock assessment model (Stock reduction analysis) features as applied to I.P. sailfish in 2014.

Model feature	Stock Reduction Analysis
Software availability	Coded
Population spatial structure / areas	1
Number CPUE Series	No
Uses Catch-at-length/age	No
Age-structured	No
Sex-structured	No
Number of Fleets	1
Stochastic Recruitment	No

Table 23. Indo-Pacific sailfish: Key management quantities from the SRA approach used.

Management Quantity	Indian Ocean
2013 catch estimate	34,481 t
Mean catch from 2009–2013	32,414 t
MSY (1000 t) (80% CI)	27.84 (24.70–35.00)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)	0.27 (0.16–0.39)
B_{MSY} (1000 t) (80% CI)	95.2 (62.89–127.73)
F_{2013}/F_{MSY} (80% CI)	1.19 (0.66–1.72)
B_{2013}/B_{MSY} (80% CI)	1.12 (0.88–1.37)
SB_{2013}/SB_{MSY} (80% CI)	n.a.
B_{2013}/B_{1950} (80% CI)	0.56 (0.44–0.69)
SB_{2013}/SB_{1950} (80% CI)	n.a.
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.
$SB_{2012}/SB_{1950,\ F=0}$ (80% CI)	n.a.

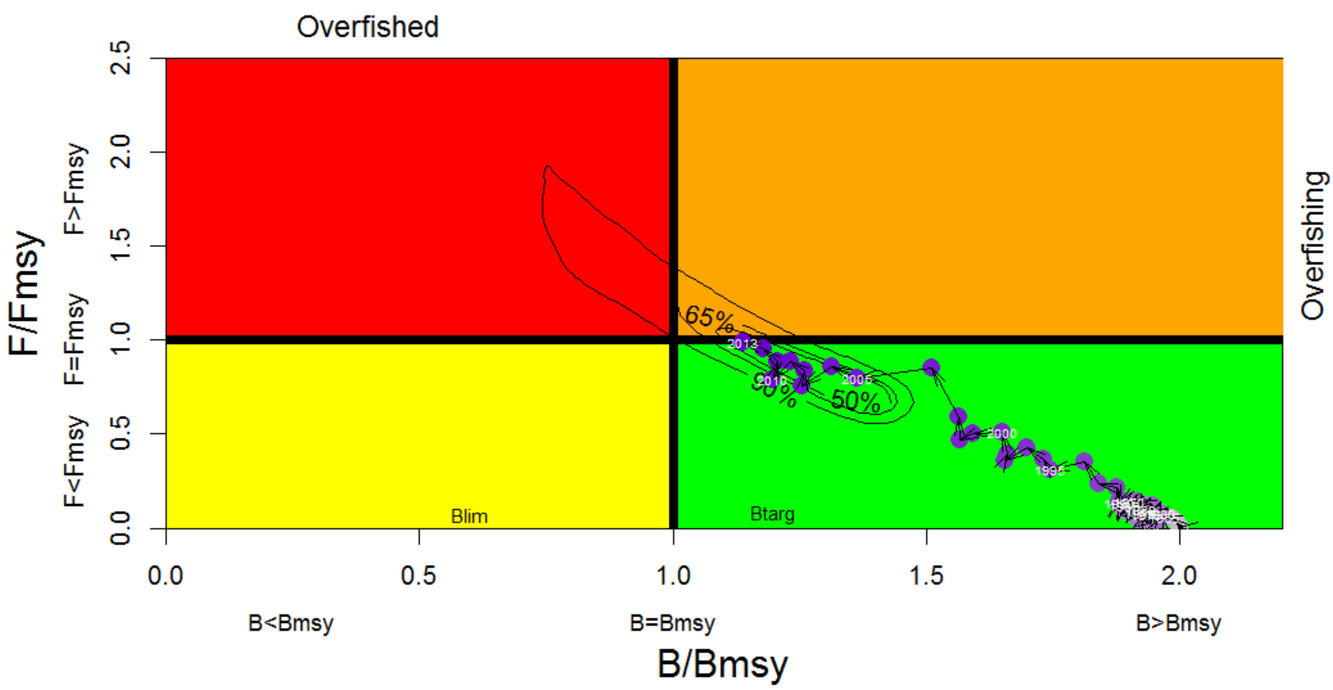

Fig. 10. Indo-Pacific sailfish: Stock reduction analysis (Catch MSY Method) for the aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the SB ratio and F ratio for each year 1950–2013.

147. The WPB **NOTED** the following with respect to the SRA modelling approach presented at the meeting:
   - The data quality was poor and hence the advice on yield was not good. Given this was the first year that such an analysis was presented to WPB, further analysis and verification of the trends identified needs to be carried out in 2015.

8.3.3 Selection of Stock Status indicators for Indo-Pacific sailfish

148. The WPB **NOTED** that the results of the stock assessment of Indo-Pacific sailfish are based on very limited information and in particular are compromised by the uncertainty in the estimates of catches for this species, over the time series. As this was the first time that IP sailfish was the subject of an assessment, stock status should remain as ‘uncertain’ until further work is carried out by the WPB in 2015.

149. The WPB **REQUESTED** that the IOTC Secretariat 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.

8.4 Development of management advice for Indo-Pacific sailfish

150. 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 2013 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration:
    - Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XI

9. WPB PROGRAM OF WORK

9.1 Revision of the WPB Program of work (2015–2019)

151. The WPB **NOTED** paper IOTC–2014–WPB12–08 Rev_1 which provided the WPB12 with an opportunity to consider and revise the WPB Program of Work (2015–2019), by taking into account the specific requests of the Commission, Scientific Committee, and the resources available to the IOTC Secretariat and CPCs.

152. The WPB **RECALLED** that the SC, at its 16th Session, requested that all Working Parties provide their work plans with items prioritised based on the requests of the Commission or the SC. (SC16. para. 194). Similarly, at the 18th Session of the Commission, the Scientific Committee was requested to provide its Program of Work on a multi-year basis, with project priorities clearly identified. In doing so, the SC should consider the immediate and longer term needs of the Commission.

153. 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 in early November, 2014.

154. **NOTING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the WPB **RECOMMENDED** that the SC consider requesting the Commission to include it in the list of species to be managed by the IOTC.

Stock structure research

155. The WPB **NOTED** that in 2013, the SC made an additional recommendation on stock structure research, targeted primarily at neritic tunas under the IOTC mandate. Subsequently, at the request of the EU, a concept note was developed to examine if there is population structure of neritic tunas throughout the Indian Ocean. The IOTC Secretariat proposed that the list of species be expanded from only neritic tunas, to other IOTC species, including billfish, tropical and temperate tunas. The concept note has since been approved by the EU who will contribute €1.3 million and require an additional 20% co-contribution (€260,000) from either the IOTC regular budget or in combination with collaborating Institutions. The project will encourage a collaborative approach to the extent feasible to meet the needs of the Commission. The need to work collaboratively with scientists in other oceans to assess stock structure as well as with scientists within the Indian Ocean region was highlighted. A detailed project proposal, calling for expressions of interest from potential collaborators will be made publically available in the near future.

'Tier' approach to stock status advice

156. The WPB **CONSIDERED** a 'Tier' approach to providing stock status advice to the Scientific Committee 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.

157. The WPB **AGREED** that a four 'Tier' approach could be designed to apply different types of assessments and cater for different amounts of data available for IOTC stocks. The approach could include increased levels of precaution that correspond to increasing levels of uncertainty about stock status, in order to reduce the level of risk associated with increased uncertainty. In this approach, each stock is assigned to one of four tier levels depending on the amount and type of information available to assess stock status, where Tier 1 represents the highest quality of information available (i.e. a robust quantitative stock assessment) and Tier 4 the lowest.

158. The WPB **NOTED** that the four Tier rules are designed to apply to three types of assessments. Tiers 1 and 2 are used for stocks for which there is a quantitative stock assessment that provides estimates of current absolute and relative biomass (Tier 1 if the assessment is regarded as "robust", Tier 2 for a less certain or preliminary assessment).Tier 3 is based on estimates of current fishing mortality derived from catch curves (requiring age and/or length frequency data, but not catch rates or abundance estimates). Tier 4 is based on recent trends in catch rates. An example of a 4 Tier system:

Tier 1: robust quantitative assessment
Tier 2: preliminary quantitative assessment
Tier 3: estimates of F from catch curves (age/length data)
Tier 4: trends in standardised CPUE

159. The WPB **RECOMMENDED** that the Scientific Committee consider adopting 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.

Summary

160. The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2015–2019), as provided at Appendix XIII.

10. Other Business

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

161. 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 and WPB12 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.

162. 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 2015, by an Invited Expert:
    - **Expertise**: Stock assessment; including from regions other than the Indian Ocean; data poor assessment approaches for marlins and Indo-Pacific sailfish (by species).
    - **Priority areas for contribution**: Refining the information base, historical data series and indicators for billfish species for stock assessment purposes (species focus: striped marlin and Indo-Pacific Sailfish).

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

164. The WPB **NOMINATED** and **ENDORSED** Dr. Humber Andrade as the Invited Expert to attend the next WPB meeting.

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

165. The WPB **RECOMMENDED** that a consultant be hired to assist in building capacity among the WPB participants by supplementing the skill set available within IOTC CPCs to develop data poor stock assessment approaches for billfish stocks. An indicative budget is provided at Table 24.

Table 24. Estimated budget required to hire a consultant to carry out data poor stock assessment on billfish species in 2015 and 2016.

Description	**Unit price**	**Units required**	**2015 Total (US$)**	**2016 Total (US$)**
Billfish tuna stock assessments using data poor approaches and/or indicator development (fees)	450	25	11,250	11,250
Billfish tuna stock assessment and/or indicator development (travel)	5,000	1	5,000	5,000
		Total estimate	**16,250**	**16,250**

10.2 Date and place of the 13th Session of the Working Party on Billfish

166. The WPB **THANKED** Japan for hosting the 12th Session of the WPB and commended Japan on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

167. 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 13th and 14th Sessions of the WPB in 2015 and 2016 respectively, the WPB **REQUESTED** that the IOTC Secretariat liaise with EU,Portugal to determine if they would be able to host the 13th 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 December 2014. As swordfish was would not be a priority for stock assessment in these two years, the meeting should be held early in the year as detailed in Table 25.

Table 25. Draft meeting schedule for the WPB (2015 and 2016)

Meeting	**2015**		**2016**	
	Date	**Location**	**Date**	**Location**
Working Party on **Ecosystems and Bycatch**	Options: (5d) 27–31 May 14–18 Oct.	EU,Portugal	Options: (5d) Late May Mid Oct.	TBD
Working Party on **Billfish**	After the WPEB (5d)	EU,Portugal	Prior to the WPEB (4d)	TBD

168. 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.

10.3 Review of the draft, and adoption of the Report of the 12th Session of the Working Party on Billfish

169. The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB12, provided at Appendix XIV, 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 2014 (Fig. 11):
    - 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

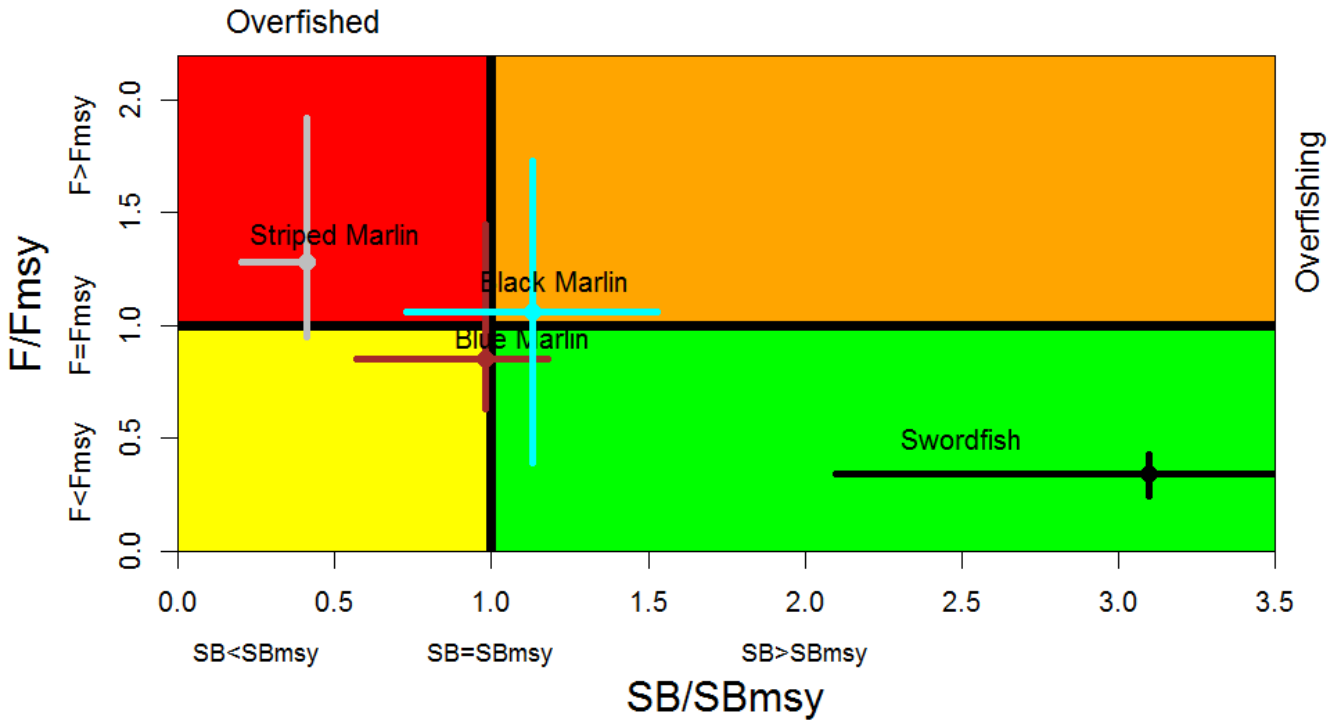

Fig. 11. Combined Kobe plot for swordfish (black), black marlin (light blue), blue marlin (brown) and striped marlin (grey) showing the 2013 and 2014 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.

170. The report of the 12th Session of the Working Party on Billfish (IOTC–2014–WPB12–R) was **ADOPTED** on the 25 October 2014.

APPENDIX I
LIST OF PARTICIPANTS

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Dr Jérôme **Bourjea**
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APPENDIX II
AGENDA FOR THE 12TH WORKING PARTY ON BILLFISH

Date: 21–25 October 2014
Location: Queen's forum, Queen's Tower B 7th floor
Yokohama, Kanagawa, Japan
Time: 09:00 – 17:00 daily
Chair: Dr. Jerome Bourjea; **Vice-Chair**: Dr. Miguel Neves dos Santos

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

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

3. **OUTCOMES OF THE 16th SESSION OF THE SCIENTIFIC COMMITTEE** (IOTC Secretariat)

4. **OUTCOMES OF SESSIONS OF THE COMMISSION**
   - 4.1 Outcomes of the 18th Session of the Commission (IOTC Secretariat)
   - 4.2 Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat)

5. **PROGRESS ON THE RECOMMENDATIONS OF WPB11** (Chair and IOTC Secretariat)

6. **SWORDFISH (Priority species for 2014)**
   - 6.1 Review of data available at the secretariat for swordfish (IOTC Secretariat)
   - 6.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
     - Southwest Indian Ocean
     - Indian Ocean-wide
   - 6.3 Review of new information on the status of swordfish (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for swordfish
   - 6.4 Development of management advice for swordfish (all)
   - 6.5 Update of swordfish Executive Summaries for the consideration of the Scientific Committee (all)
     - Southwest Indian Ocean
     - Indian Ocean-wide

7. **MARLINS**
   - 7.1 Review of data available at the secretariat for marlins (IOTC Secretariat)
   - 7.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
   - 7.3 Review of new information on the status of marlins (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for marlins
   - 7.4 Development of management advice for marlins (all)
   - 7.5 Update of marlin species Executive Summaries for the consideration of the Scientific Committee (all)

8. **INDO-PACIFIC SAILFISH**
   - 8.1 Review of data available at the secretariat for sailfish (IOTC Secretariat)
   - 8.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
   - 8.3 Review of new information on the status of sailfish (all)
     - Nominal and standardised CPUE indices
     - Stock assessments
     - Selection of Stock Status indicators for sailfish
   - 8.4 Development of management advice for sailfish (all)
   - 8.5 Update of sailfish species Executive Summaries for the consideration of the Scientific Committee (all)

9. **WPB PROGRAM OF WORK**
   - 9.1 Revision of the WPB Program of Work (2015–2019) (Chair and IOTC Secretariat);

10. **OTHER BUSINESS**
    - 10.1 Development of priorities for an Invited Expert at the next WPB meeting (Chair)
    - 10.2 Date and place of the 13th Session of the Working Party on Billfish (Chair and IOTC Secretariat)
    - 10.3 Review of the draft, and adoption of the Report of the 12th Session of the Working Party on Billfish (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2014–WPB12–01a	Draft: Agenda of the 12th Working Party on Billfish	✓(23 July 2014) ✓(20 October 2014)
IOTC–2014–WPB12–01b	Draft: Annotated agenda of the 12th Working Party on Billfish	✓(6 October 2014) ✓(23 October 2014)
IOTC–2014–WPB12–02	Draft: List of documents of the 12th Working Party on Billfish	✓(29 September 2014) ✓(23 October 2014)
IOTC–2014–WPB12–03	6 Outcomes of the 16th Session of the Scientific Committee (IOTC Secretariat)	✓(10 September 2014)
IOTC–2014–WPB12–04	Outcomes of the 18th Session of the Commission (IOTC Secretariat)	✓(10 September 2014)
IOTC–2014–WPB12–05	Review of Conservation and Management Measures relevant to billfish (IOTC Secretariat)	✓(10 September 2014)
IOTC–2014–WPB12–06	Progress made on the recommendations of WPB11 (IOTC Secretariat)	✓(10 September 2014)
IOTC–2014–WPB12–07 Rev_2	Review of the statistical data and fishery trends for billfish (IOTC Secretariat)	✓(6 October 2014) ✓(15 October 2014) ✓(21 October 2014)
IOTC–2014–WPB12–08 Rev_1	Revision of the WPB Program of Work (2015–2019) (Chair & IOTC Secretariat)	✓(29 September 2014) ✓(23 October 2014)
General fishery updates		
IOTC–2014–WPB12–09	An overview on large pelagic species in Iran & billfish fishery status (Rajaei F)	✓(6 October 2014)
IOTC–2014–WPB12–10 Rev_1	Status of billfish in large pelagic fisheries in Sri Lanka (Maldeniya R)	✓(6 October 2014) ✓(24 October 2014)
IOTC–2014–WPB12–11 Rev_2	Billfish fishery of the Indian seas – an update (Sethi B & Mathew A)	✓(6 October 2014) ✓(11 October 2014) ✓(24 October 2014)
Swordfish (SWO)		
IOTC–2014–WPB12–12	Otolith shape as a valuable tool to evaluate the stock structure of swordfish (*Xiphias gladius*) in the Indian Ocean (Mahe K, Evano H, Mille T & Bourjea J)	✓(29 September 2014)
IOTC–2014–WPB12–13	Preliminary analysis of length – weight relationship of swordfish (*Xiphias gladius*), black marlin (*Makaira indica*), and blue marlin (*Makaira nigricans*) caught by Indonesian longliners in the Indian Ocean (Setyadji B, Jatmiko I, Wujdi A & Nugraha B)	✓(6 October 2014)
IOTC–2014–WPB12–14 Rev_1	Patterns of swordfish capture in relation to fishing time, moon illumination and fishing depth (Bach P, Sabarros PS, Romanov EV, Puech A, Capello M & Lucas V)	✓(10 October 2014) ✓(24 October 2014)
IOTC–2014–WPB12–15 Rev_1	Environmental drivers of swordfish local abundance in the south-west Indian Ocean (Sabarros PS, Romanov E, Dagorne D, Le Foulgoc L, Ternon J-F & Bach P)	✓(9 October 2014) ✓(21 October 2014)
IOTC–2014–WPB12–16 Rev_1	Applications of the SEAPODYM model to swordfish in the Pacific and Indian Ocean (Dragon AC, Lehodey P & Senina I)	✓(6 October 2014) ✓(10 October 2014)
IOTC–2014–WPB12–17	Evaluating data and model structure uncertainty for the stock assessment of swordfish (*Xiphias gladius*) in the Indian Ocean (Wang S-P, Maunder M, Nishida T & Chen Y-R)	✓(6 October 2014)
SWO CPUE papers		
IOTC–2014–WPB12–18	Swordfish catches by the Portuguese pelagic longline fleet between 1998–2013 in the Indian Ocean: effort, standardized CPUE and catch-at-size (Santos MN, Coelho R & Lino PG)	✓(19 September 2014)
IOTC–2014–WPB12–19	Swordfish catches by the Portuguese pelagic longline fleet between 1998–2013 in the southwest Indian Ocean: effort, standardized CPUE and catch-at-size (Santos MN, Coelho R & Lino PG)	✓(29 September 2014)
IOTC–2014–WPB12–20 Rev_1	Standardized catch rates for the Swordfish (*Xiphias gladius*) caught by the Spanish longline in the Indian Ocean during the 2001-2012 period (Fernández-Costa J, Ramos-Cartelle A, García-Cortés B & Mejuto J)	✓(1 October 2014) ✓(7 October 2014)

Document	Title	Availability
IOTC–2014–WPB12–21 Rev_1	CPUE standardization of swordfish (*Xiphias gladius*) exploited by Japanese tuna longline fisheries in the Indian Ocean using cluster analysis for targeting effect (Nishida T & Wang S-P)	✓(6 October 2014) ✓(18 October 2014)
IOTC–2014–WPB12–22	CPUE standardization with targeting analysis for swordfish (*Xiphias gladius*) caught by Taiwanese longline fishery in the Indian Ocean (Wang S-P & Nishida T)	✓(6 October 2014)
SWO Stock assessment papers		
IOTC–2014–WPB12–23	Stock assessment of swordfish (*Xiphias gladius*) in the Indian Ocean using age-structured integrated analysis (Wang S-P & Nishida T)	✓(7 October 2014)
IOTC–2014–WPB12–24 Rev_2	Stock and risk assessments of swordfish (*Xiphias gladius*) in the Indian Ocean by ASPIC incorporating uncertainties (Nishida T & Wang S-P)	✓(8 October 2014) ✓(20 October 2014) ✓(24 October 2014)
IOTC–2014–WPB12–25	Stock assessment of Indian Ocean swordfish using a Bayesian production model with process and observational errors (Humber A)	✓(22 October 2014)
IOTC–2014–WPB12–26 Rev_3	An Age-, Sex- and Spatially-Structured Stock Assessment of the Indian Ocean Swordfish Fishery 1950–2012, using Stock Synthesis (Sharma R & Herrera M)	✓(6 October 2014) ✓(18 October 2014) ✓(21 October 2014)
Other billfish		
IOTC–2014–WPB12–27	Stock assessment billfish species in the Indian Ocean: Black Marlin and Sailfish (Sharma R)	✓(7 October 2014)
Information papers		
IOTC–2014–WPB12–INF01	IOTC SC – Guidelines for the Presentation of Stock Assessment Models	✓(10 September 2014)
IOTC–2014–WPB12–INF02	Billfishes caught in the Malagasy EEZ from 2011 to 2013 by the foreign longliners (Fanazava R)	✓(9 October 2014)
Data sets		
IOTC–2014–WPB12–DATA01	Billfish datasets available (IOTC Secretariat)	✓(9 September 2014)
IOTC–2014–WPB12–DATA02	Taiwan-China standardised longline CPUE series 1980–2012	✓(28 September 2014)
IOTC–2014–WPB12–DATA03	Japan standardised longline CPUE series 1971–2013	✓(1 October 2014)
IOTC–2014–WPB12–DATA04	EU-Spain standardised longline CPUE series 2001–2012	✓(1 October 2014)
IOTC–2014–WPB12–DATA05	EU-Portugal standardised longline CPUE series 1998–2013	✓(28 September 2014)
IOTC–2014–WPB12–DATA06	Nominal Catches per Fleet, Year, Gear, IOTC Area and species	✓(28 September 2014)
IOTC–2014–WPB12–DATA07	Catch and Effort - Longline	✓(28 September 2014)
IOTC–2014–WPB12–DATA08	Catch and Effort - vessels using pole and lines or purse seines	✓(28 September 2014)
IOTC–2014–WPB12–DATA09	Catch and Effort - Coastal	✓(28 September 2014)
IOTC–2014–WPB12–DATA10	Catch and Effort - all vessels	✓(28 September 2014)
IOTC–2014–WPB12–DATA11	Catch and Effort - reference	✓(28 September 2014)
IOTC–2014–WPB12–DATA12 Rev_1	Data for the assessment of Indian Ocean swordfish stock	✓(28 September 2014)
IOTC–2014–WPB12–DATA13 Rev_1	Size Frequency – All billfish species	✓(28 September 2014) ✓(16 October 2014)
IOTC–2014–WPB12–DATA14 Rev_1	Data – Billfish equations	✓(28 September 2014) ✓(16 October 2014)
IOTC–2014–WPB12–DATA15	Size Frequency - reference	✓(29 September 2014)

APPENDIX IVA
MAIN STATISTICS OF BILLFISH

(*Extract from IOTC–2014–WPB12–07 Rev_2*)

The contribution of billfish to the total catches of IOTC species in the Indian Ocean has remained relatively constant over the years (Fig. 1a, b), accounting for 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, with the exception of 2004 and 2012–13 when catches over 90,000 t were reported (mostly attributed to increases in catches of blue marlin, and striped marlin) (Fig. 1c).

Of the five billfish species under the IOTC mandate, sailfish and swordfish account for 65% of the catch in recent years (2011–13; Fig. 1d), followed by blue marlin and black marlin with 15% of the total catch each, and the remaining 5% accounted for by striped marlin. The importance of each species, in terms of share of total catch of billfish, has changed over time – mostly as a result of changes to the number of longline vessels. 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 from the Atlantic Ocean, increasing the share of total billfish catch from 20–30% in the early 1990s to as much as 50% by 2002. Catches of swordfish over the last 10 years have since declined back to around a third of the total billfish catch, largely as a result of declining catches from Taiwan,China. Very large catches of marlins were also recorded in 2012 and, to a lesser extent, 2013. This increase in the catches is likely to come from increased activities by longliners in waters of the western central and northwest Indian Ocean. The return of the fleet to this area, previously affected by piracy, is the consequence of increased security in the area off Somalia.

The majority of catches of billfish are caught by longline vessels. Up to the early 1980s longline vessels accounted for over 90% of the total billfish (largely as bycatch); in the last 20 years the proportion has fallen to between 50% to 70% as catches from gillnet fisheries have become increasingly important for a number of fleets such as Iran and Sri Lanka. 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, catches are still dominated by a number of longline fleets – namely Taiwan,China and European fleets, fleets that seem to be resuming fishing activities in their main fishing grounds. While a number countries in the IOTC region have important fisheries for billfish (Fig. 2), in recent years six fleets (Sri Lanka, Indonesia, Taiwan,China, I.R. Iran, Pakistan and India), have reported as much as 75% (from 2011–13) of the of the total catches of billfish species from all fleets and species combined.

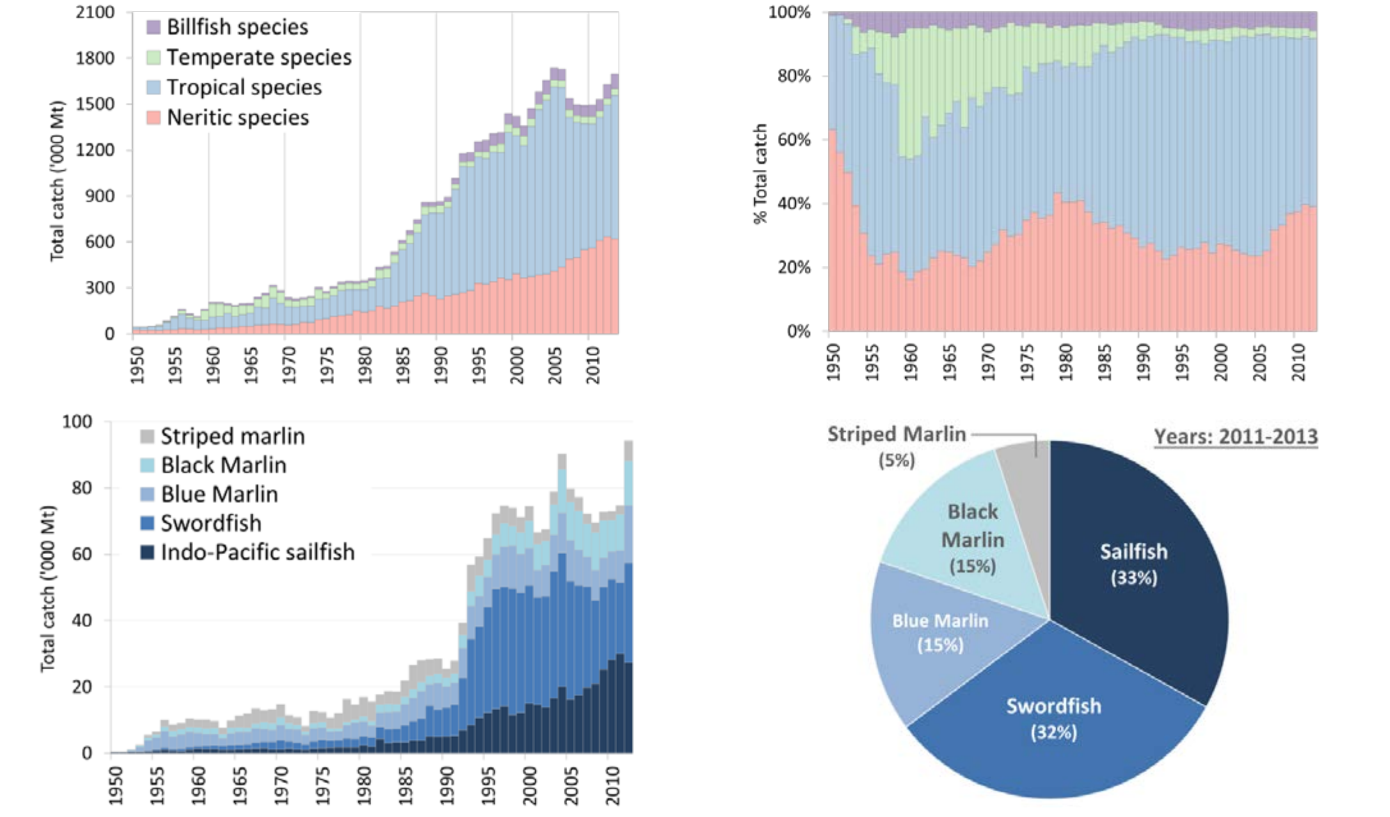

Fig. 1a-d. Billfish: **Top:** Contribution of the five billfish species under the IOTC mandate to the total catches of IOTC species in the Indian Ocean, over the period 1950–2013. a) total catch; b) percentage (same colour key as Fig. 1a); **Bottom**: Contribution of each species of billfish to the total combined catches of billfish. c) nominal catch of each species, 1950–2013; b) share of billfish catch by species, 2011–13.

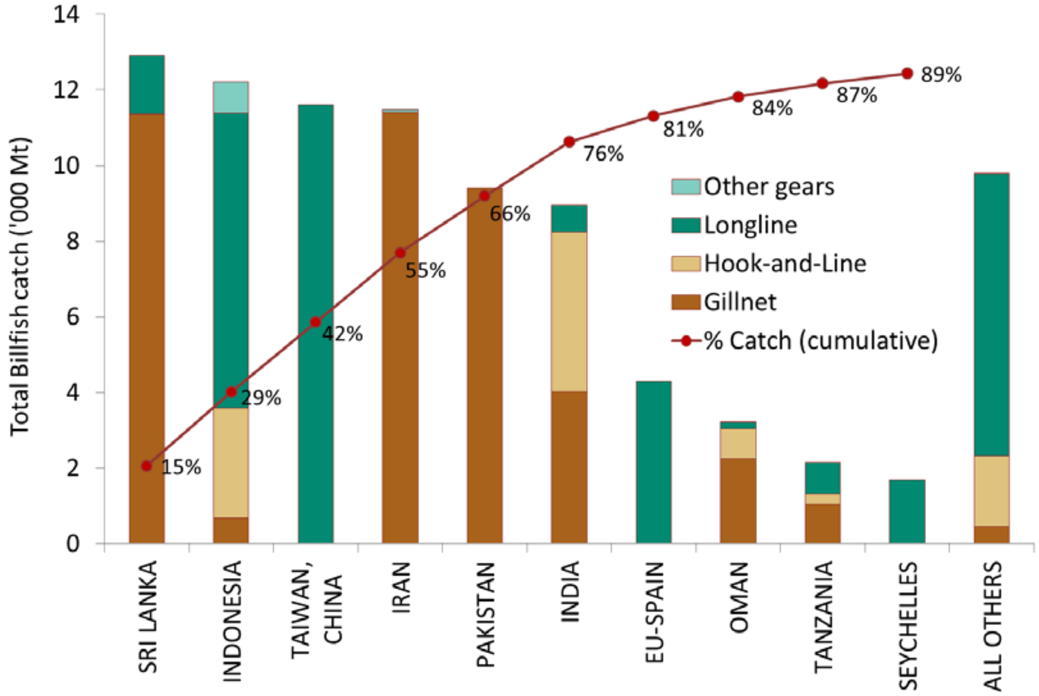

Fig. 2. Billfish (all species): average catches in the Indian Ocean over the period 2010–13, by country or fleet. Countries or fleets are ordered from left to right, according to the importance of catches reported. The red line indicates the (cumulative) proportion of catches of all billfish species for the countries concerned, over the total combined catches reported from all countries and fisheries.

APPENDIX IVB
MAIN STATISTICS OF BLACK MARLIN

(*Extracts from IOTC–2014–WPB12–07 Rev_2*)

Black marlin (Makaira indica)

Catch trends

Black marlin are caught mainly using drifting longlines (30%) and gillnets (50%) with remaining catches recorded using troll and hand lines (Table 1, Fig. 1). Black marlin are the bycatch of industrial and artisanal fisheries. In recent years, the fleets of Sri Lanka (longline and gillnet), I.R. Iran (gillnet), India (gillnet and troll), Indonesia (troll and hand lines) and Pakistan (gillnet) account for around 90% of the catch of black marlin (Fig. 2). Catches of black marlin have increased steadily since the 1990s, from 2,700 t in 1991 to over 10,000 t in 2011. The highest catches over the time series of black marlin were recorded in 2013, at over 14,000 t (Table 1).

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 of black marlin in that area, in particular in waters off northwest Australia (Fig. 3). In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of black marlin, mostly in waters off the western coast of India and, to a lesser extent, the Mozambique Channel (Fig. 3).

In 2013 and 2014 I.R. Iran reported catches of swordfish and marlins for its drifting gillnet fisheries for the first time. The catches of black marlin reported, 3,000 t in 2012 and 4,000 t in 2013, were used to re-build historical catches for I.R. Iran. Pakistan has also reported catches of marlins for its fishery in recent years, with catches of black marlin at around 1,000 t in 2012–13. The new catches estimated for drifting gillnet fisheries represent over 30% of the total catches of black marlin in the Indian Ocean.

The catches of black marlin in Sri Lanka have 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 4,500 t in 2011. In 2012 and 2013 catches dropped to 3,000 and 2,500 t, respectively. In recent years (2011–13) India has reported higher catches of black marlin for its fisheries, amounting to around 1,500 t to 3,500 t, largely from increases in catches from gillnet and trolling).

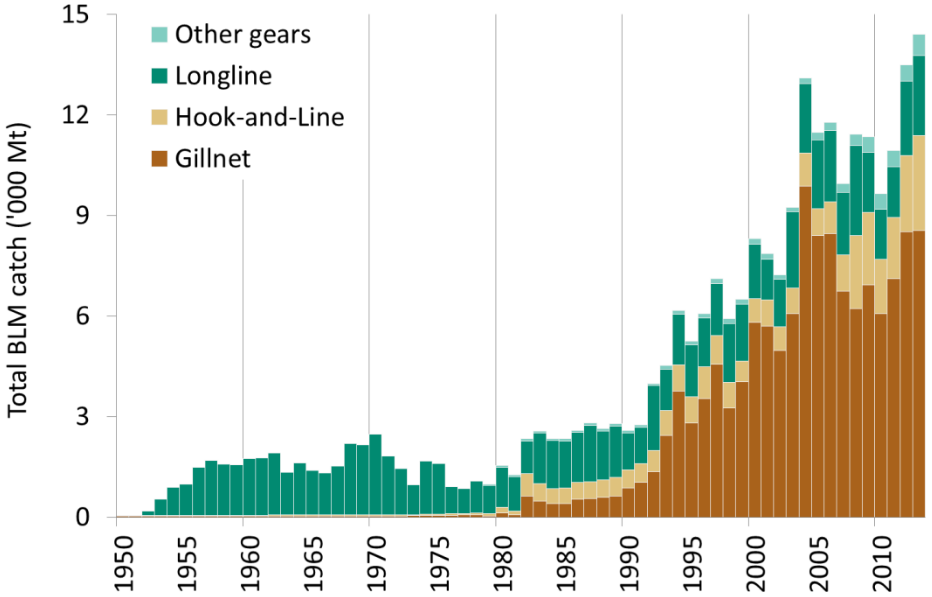

Fig. 1. Black marlin: Catches of black marlin by gear and year recorded in the IOTC Database (1950–2013).

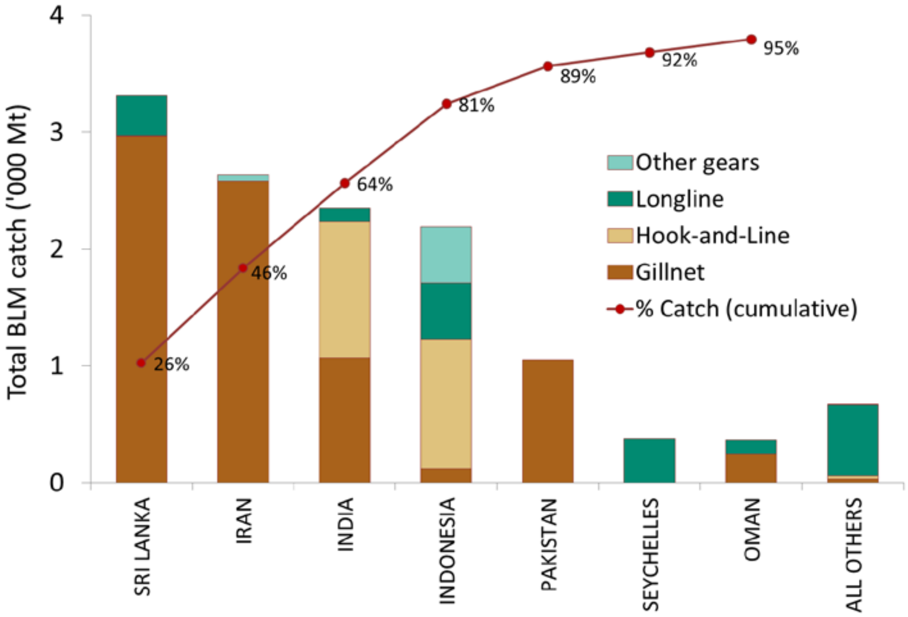

Fig. 2. Black marlin: Average catches in the Indian Ocean over the period 2010–13, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

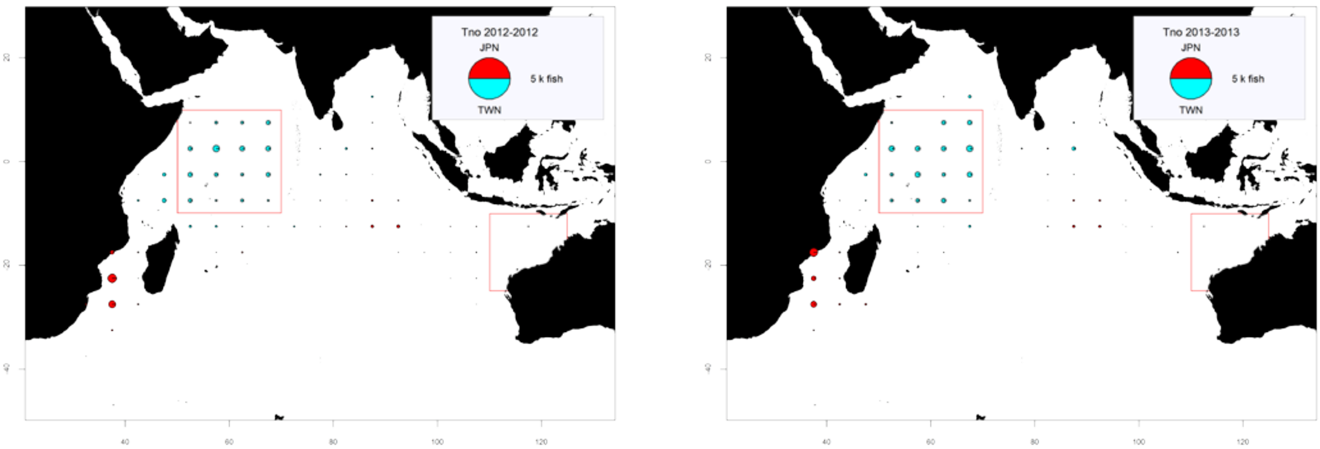

Fig. 3a–b. Black marlin: Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1. Black marlin: Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2013 (in metric tons). Data as of September 2014.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	846	1,633	1,288	1,370	1,485	1,911	2,071	2,053	2,120	1,872	2,684	1,788	1,484	1,501	2,226	2,374
GN	26	31	44	439	2761	6,916	9,870	8,390	8,458	6,738	6,222	6,931	6,065	7,113	8,516	8,551
HL	24	27	42	446	727	1,032	996	812	954	1,078	1,351	2,164	1,634	1,836	2,267	2,837
OT	0	0	4	65	112	226	170	227	237	257	329	460	465	482	479	637
Total	**896**	**1,692**	**1,377**	**2,320**	**5,085**	**10,085**	**13,107**	**11,483**	**11,769**	**9,944**	**10,585**	**11,343**	**9,649**	**10,932**	**13,487**	**14,400**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the IOTC Secretariat.

Retained catches: uncertain for some fisheries (Fig. 4a), due to the fact that:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the IOTC Secretariat for some years and artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. Iran and Pakistan) and industrial (longliners of Indonesia and the Philippines) fisheries.
- catches of non-reporting industrial longliners (India and Not Elsewhere Indicated (NEI)) and the gillnet fishery of Indonesia are estimated by the IOTC Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries as the black marlin is not a target species.
- conflicting catch reports have been received for longline catches from the Rep. of Korea, which are 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 Rep. 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 black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.

Discards: unknown for most industrial fisheries, mainly longliners. Discards of black marlin may also occur in some driftnet fisheries.

Changes to the catch series: There have been relatively large revisions to catches of black marlin since the WPB meeting in 2013, mostly the result of changes to catch-by-species for I.R. Iran, and to a lesser extent Indonesia.

As previously noted, in 2014 I.R. Iran provided detailed catches for billfish species that substantially revised the catch-by-species previously estimated by the IOTC Secretariat; the main change being the proportion of catches assigned as black marlin rather than blue marlin for I.R. Iran's offshore gillnet fishery.

As a result of changes in the catch series for I.R. Iran in 2012 and 2013 – and revision of the catch-by-species for the offshore fishery for earlier years – total catches of black marlin have been revised upwards by as much as 30% to 50% for a number of years around the mid-2000's (e.g. in 2005 total catches of black marlin in the Indian Ocean have been revised from around 7,400 t to nearly 11,500 t).

Catch–per–unit–effort (CPUE) Series (Fig. 4b): Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet); although catches are thought to be incomplete (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; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Fig. 4c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low. The length frequency distributions derived from samples collected by fishermen on Taiwanese longliners are likely to be biased.

Catch-at-Size(Age): tables have not been built for black marlin due to a lack of information reported by CPCs and the issues identified with some datasets. Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets or when relatively few fish out of the total catch are measured.

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

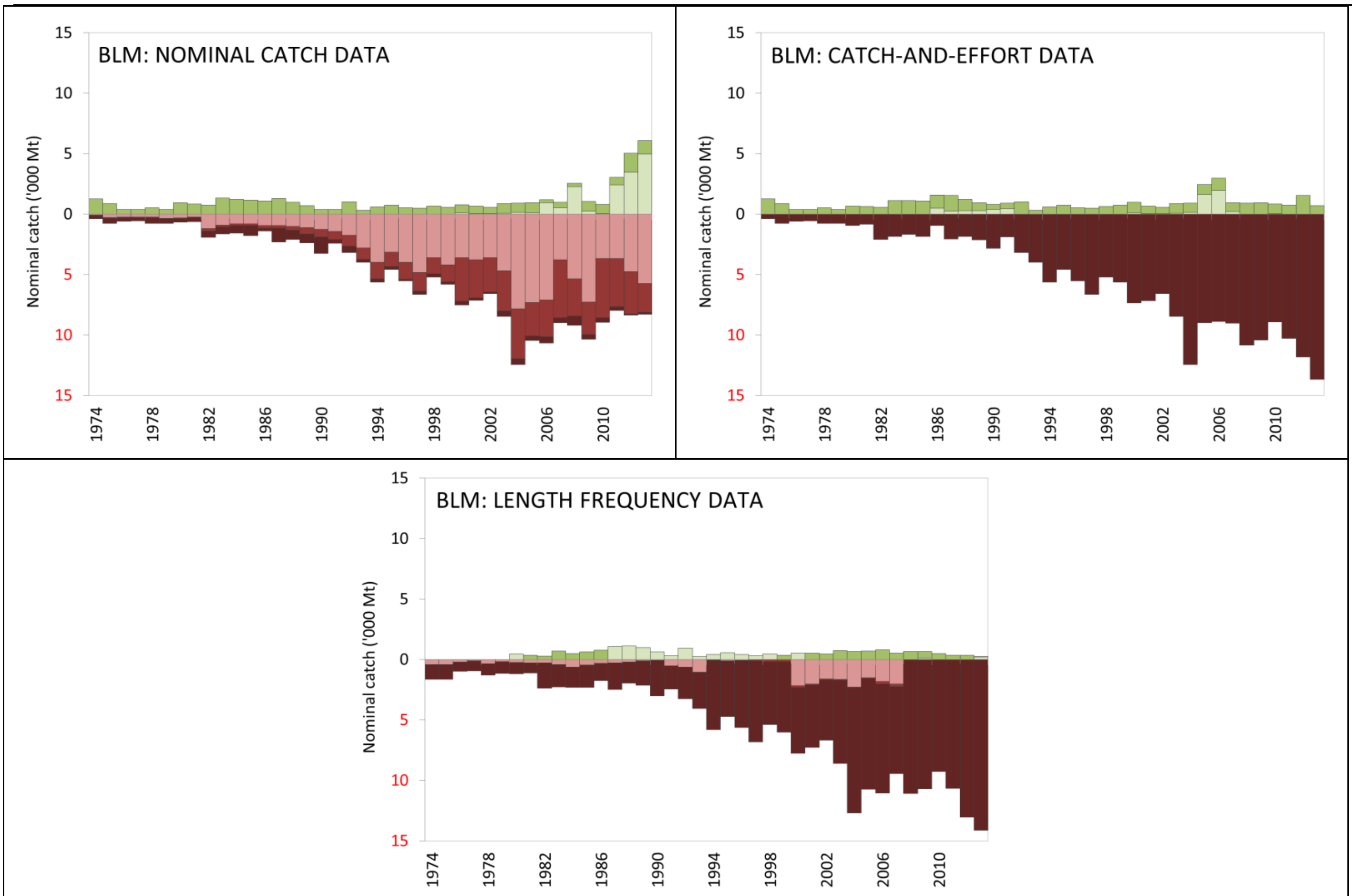

Fig. 4a–c. Black marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 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; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. (Data as of September 2014)*

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–2014–WPB12–07 Rev_2*)

Blue marlin (Makaira nigricans)

Catch trends

The catch series for the blue marlin was substantially revised in 2014, following new reports of catch for drifting gillnet fleets. Blue marlin are caught mainly using drifting longlines (70%) and gillnets (25%) with remaining catches recorded by troll and hand lines (Table 1, Fig. 1). Blue marlins are considered to be a bycatch of industrial and artisanal fisheries. Longline catches of blue marlin are typically higher than those of black marlin and striped marlin combined. In recent years, the fleets of Taiwan,China (longline), Indonesia (longline and handline), I.R. Iran and Pakistan (gillnet), and Sri Lanka (longline gillnet) account for around 90% of the total catch of blue marlin (Fig. 2). The distribution of blue marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean (Fig. 3).

Catch trends for blue marlin are variable; however, this may reflect the level of reporting. The catches of blue marlin by drifting longlines 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 13,000 t since the early 1990's. The largest catches reported by longlines were recorded in 2012 (~12,000 t) and 1998 (~11,000 t). The high catches in 2012 are likely to be the consequence of higher catch rates by some longine fleets, which resumed operation in the Western Tropical Indian Ocean. Catches by drifting longlines have been recorded under Taiwan,China and Japan fleets and, recently, Indonesia, India, Sri Lanka and several Not Elsewhere Indicated (NEI) fleets (Fig. 10). In recent years, the deep-freezing longliners from Taiwan,China and Japan have reported most of the catches of blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel (Fig. 3).

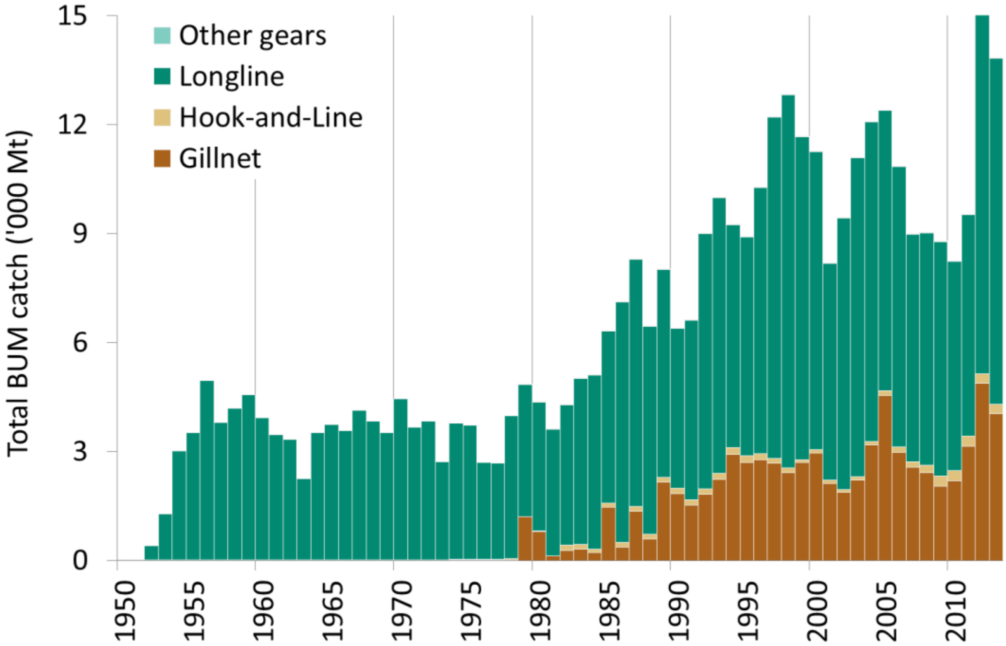

Fig. 1. Blue marlin: Catches of blue marlin by gear and year recorded in the IOTC Database (1950–2013).

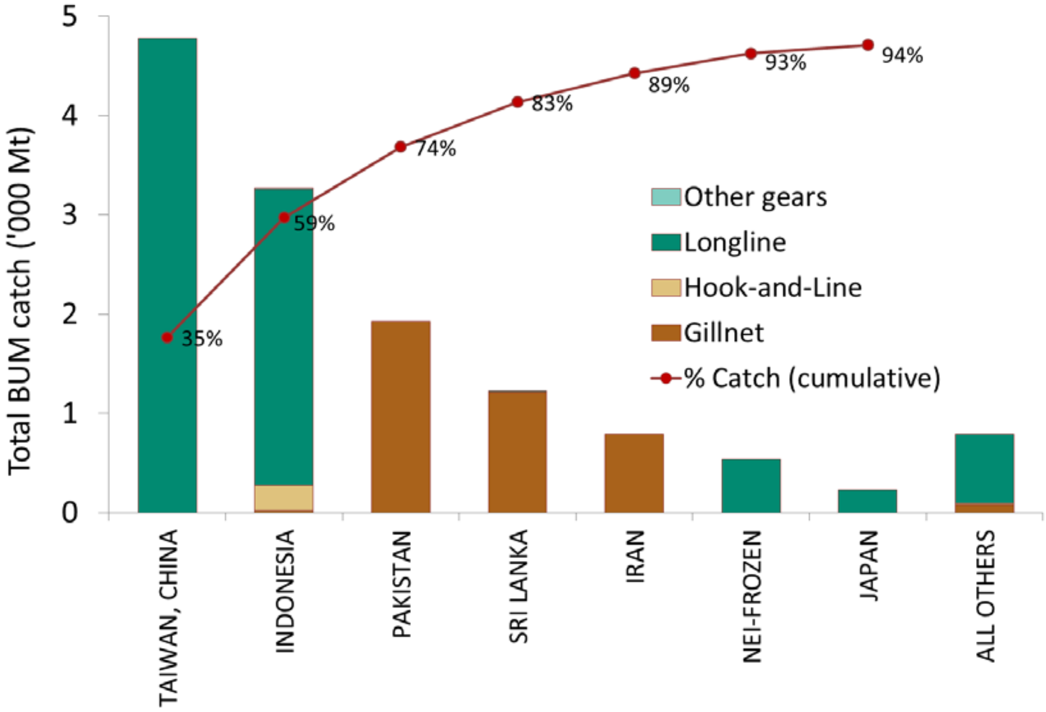

Fig. 2. Blue marlin: Average catches in the Indian Ocean over the period 2010–13, by fleet/countries, ordered from left to right, according to the importance of catches of blue marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the fleet/countries concerned, over the total combined catches of this species reported from all fleets/countries and fisheries.

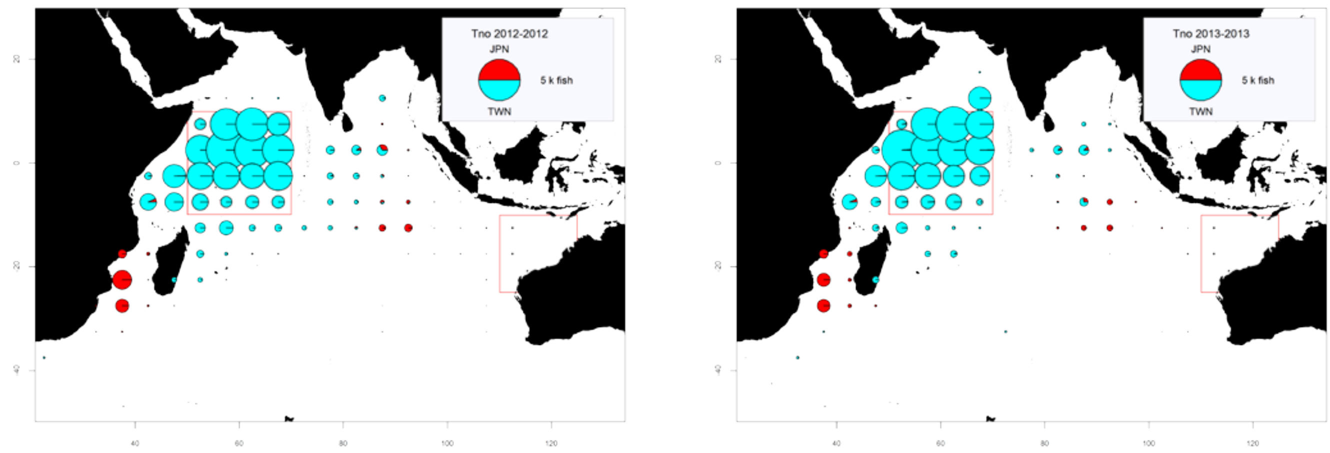

Fig. 3a–b. Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2011 and b) 2012, by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1: Blue marlin: Best scientific estimates of the catches of blue marlin by type of fishery for the period 1950–2013 (in metric tons). Data as of September 2014.

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
LL	2,563	3,515	3,493	4,982	7,200	7,384	8,800	7,721	7,734	6,276	6,397	6,463	5,751	6,093	12,101	9,514
GN	1	2	124	761	2,357	2,687	3,172	4,545	2,977	2,559	2,410	2,049	2,198	3,148	4,879	4,032
HL	5	9	17	105	149	133	107	130	139	151	202	265	282	276	257	273
OT	0	0	0	2	4	7	5	7	8	8	11	15	15	16	15	16
Total	**2,570**	**3,527**	**3,634**	**5,850**	**9,711**	**10,211**	**12,085**	**12,404**	**10,857**	**8,994**	**9,019**	**8,791**	**8,246**	**9,532**	**17,252**	**13,834**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches: poorly known for most fisheries (**Fig. 4a**) due to:

- 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 (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the IOTC Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the blue marlin is not a target species.
- conflicting catch reports for longline catches from the Rep. of Korea, which are 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 blue marlin for the Rep. 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.
- a lack of catch data for most sport fisheries.

Discards: unknown for most industrial fisheries, mainly longliners. Discards of blue marlin may also occur in some gillnet fisheries.

Changes to the catch series: There have been relatively large revisions to the catch estimates of blue marlin since the WPB meeting in 2013, mostly the result of changes to catch-by-species for Iran, and to a lesser extent Indonesia.

In previous years Iran has reported aggregated catches for all billfish species, which were then estimated by species and gear by the IOTC Secretariat. In 2014 IR Iran provided catches by billfish species, for 2012 and 2013, which substantially revises the catch-by-species previously estimated by the IOTC Secretariat.

The main change is the substantially higher proportions of black marlin in the new catches reported by IR Iran rather than blue marlin, assigned to the offshore gillnet fishery As a result of changes in the catch series for IR Iran – and revision of the catch-by-species for the offshore fishery for earlier years based on the 2012 and 2013 data – total catches of blue marlin have been revised down by as much as 20% for a number of years around the mid-2000's.

Catch–per–unit–effort (CPUE) Series (Fig. 4b): Nominal CPUE series are available from some industrial longline fisheries (primarily the Japanese longline fleet) although catches are likely to be incomplete (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; or other artisanal (gillnet fisheries of IR Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Fig. 4c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped marlin and blue marlin may occur in some longline fisheries; the length frequency distributions derived from samples collected by fishermen on Taiwan,China longliners are likely to be biased.

Catch-at-Size(Age) (Fig. 5): 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.

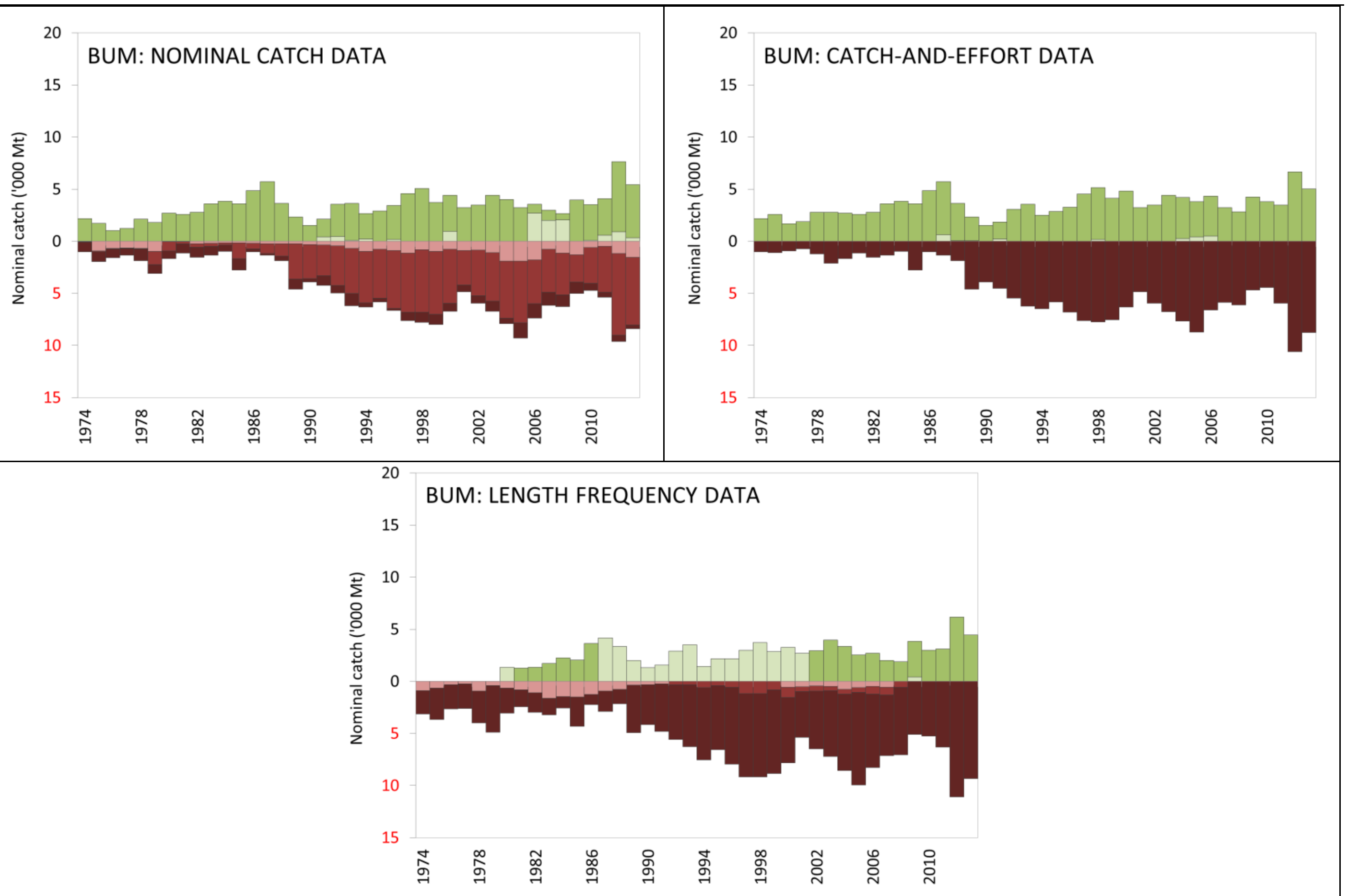

Fig. 4. Blue marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 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; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. (Data as of September 2014)*

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)

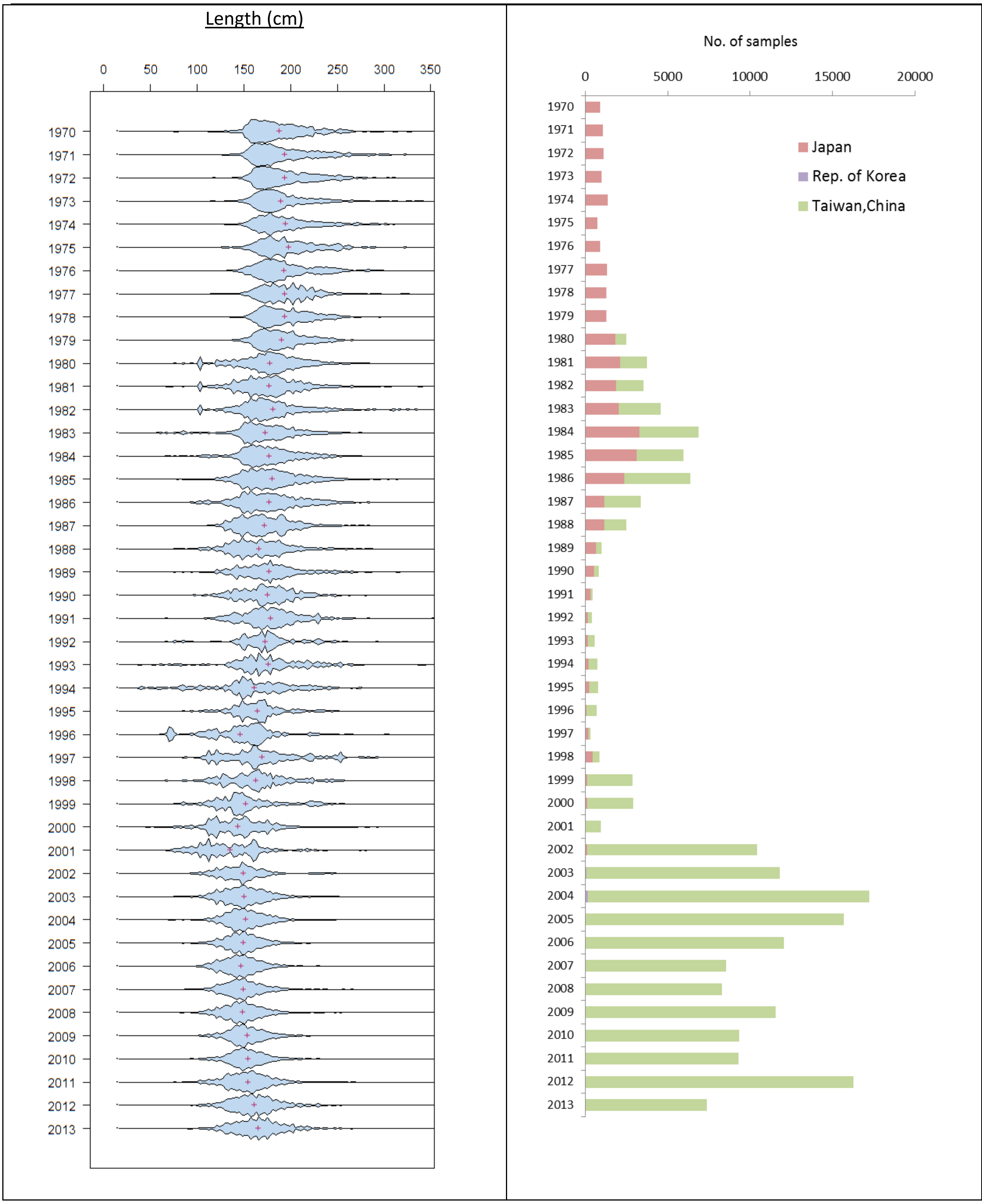

Fig. 5. Blue marlin: Longline catch-at-size length distributions (Data as of September 2014)

APPENDIX IVD
MAIN STATISTICS OF STRIPED MARLIN

(*Extracts from IOTC–2014–WPB12–07 Rev_2*)

Striped marlin (Tetrapturus audax)

Catch trends

The catch series for the blue marlin was revised in 2014, following new reports of catch for drifting gillnets and the fisheries of Indonesia. Striped marlin are caught mainly using drifting longlines (72% of the total catch). The remaining catches are recorded under gillnets and troll lines (Table 1, Fig. 1). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable, ranging from 2000 t to 8000 t per year; however, this may reflect the level of reporting. Similarly, catches reported using 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. The catches of striped marlin increased in 2012 and 2013, as longline vessels resumed their activities in the Western tropical Indian Ocean.

Catches using drifting longlines have been recorded under Taiwan,China, Japan, Rep. of Korea fleets and, recently, Seychelles, Indonesia and several Not Elsewhere Indicated (NEI) fleets (Fig. 2). Large drops in the catches of striped marlin have been recorded for the longline fleets of Japan and Taiwan,China since the mid-1980’s and mid-1990’s, respectively. The reason for such decreases in catches is not fully understood. Between the early-50s and the late-80s part of the Japanese fleet was licensed to operate within the EEZ of Australia, reporting relatively high catches of striped marlin in the area, in particular in waters off northwest Australia. High catches of the species were also recorded in the Bay of Bengal during this period, by both Taiwan,China and Japanese longliners. The distribution of striped marlin catches has changed since the 1980‘s with most of the catch now taken in the western areas of the Indian Ocean (Fig. 3). These changes of fishing area and catches over the years are thought to be related to changes in the type of access agreements to EEZs of coastal countries in the Indian Ocean, rather than changes in the distribution of the species over time. However, between 2007 and 2011, catches in the northwest Indian Ocean have dropped markedly, in tandem with a reduction of longline effort in the area as a consequence of maritime piracy off Somalia (Fig. 3). Catch levels increased substantially in 2012 and, to a lesser extent in 2013.

The catches of striped marlin reported by fleets using gillnets have been low over the entire time-series, amounting to between 500 t and 1,000 t in recent years. However, recent information received by the IOTC Secretariat tends to indicate that the catches of striped marlin by the gillnet fishery of Pakistan may be much higher than those officially reported, and a thorough review of the catch series may be required in the future for this species. Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners.

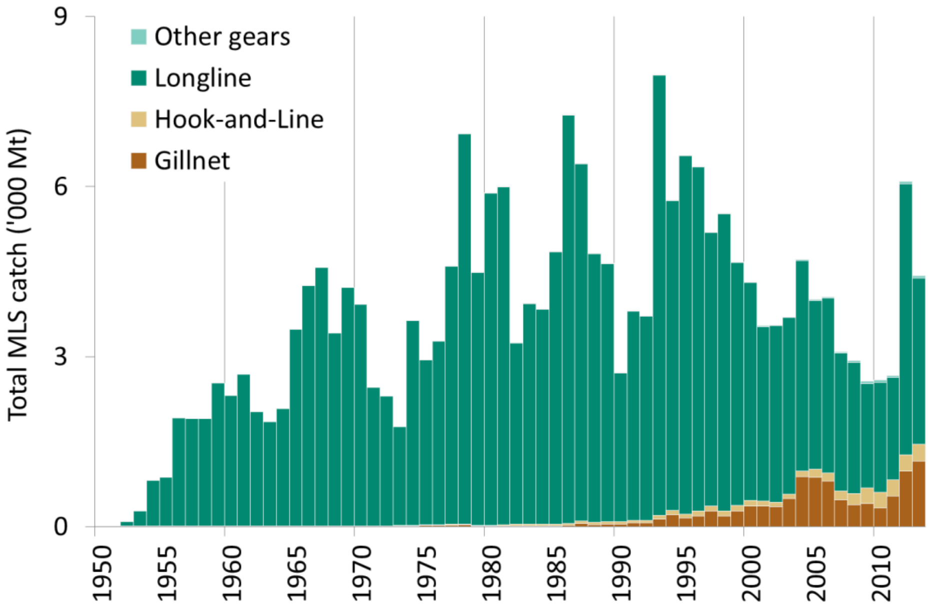

Fig. 1. Striped marlin: Catches of Striped marlin by gear and year recorded in the IOTC Database (1950–2013).

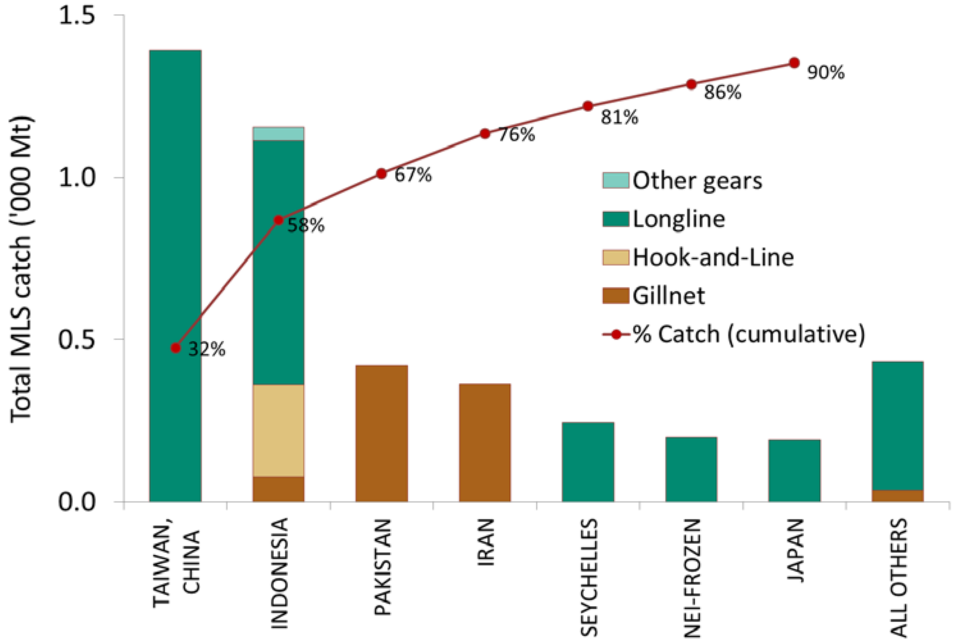

Fig. 2. Striped marlin: Average catches in the Indian Ocean over the period 2010–13, by fleet or country, ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets or countries concerned, over the total combined catches of this species reported from all fleets or countries and fisheries.

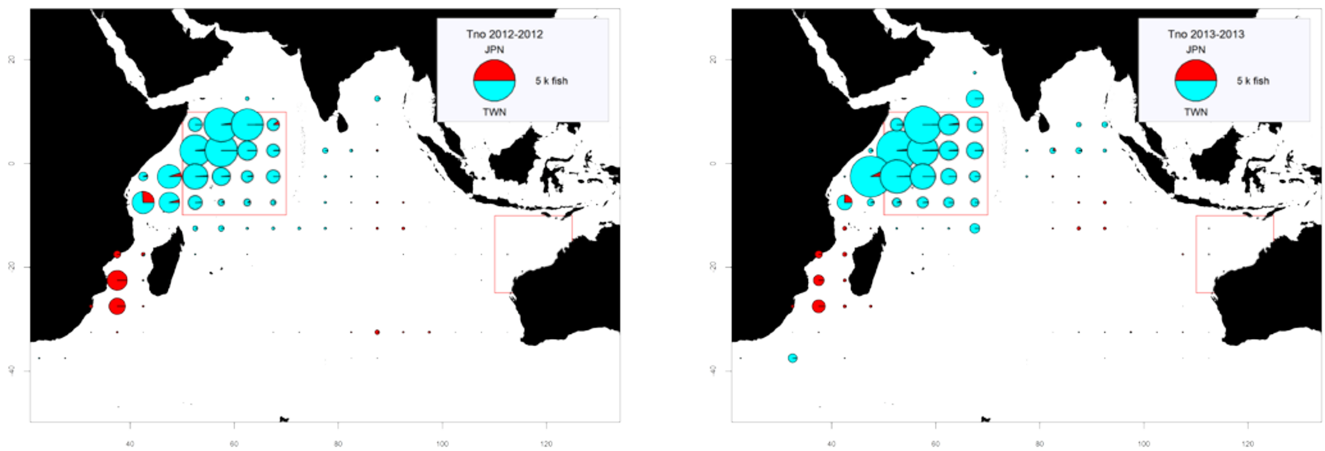

Fig. 3a–b. Striped marlin: Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1. Striped marlin: Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2013 (in metric tons). Data as of September 2014

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	1,024	3,076	3,605	5,029	4,990	2,951	3,713	2,974	3,086	2,433	2,313	1,846	1,935	1,801	4,778	2,937
GN	5	8	16	22	161	541	880	876	807	479	389	407	330	540	983	1,160
HL	3	5	10	32	69	135	102	135	142	153	195	273	277	286	284	289
OT	0	0	0	6	10	20	15	20	21	23	29	41	41	43	43	43
Total	**1,031**	**3,089**	**3,631**	**5,089**	**5,229**	**3,647**	**4,710**	**4,005**	**4,055**	**3,087**	**2,927**	**2,567**	**2,583**	**2,670**	**6,088**	**4,429**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Retained catches: reasonably well known (Fig. 4a) although they remain uncertain for some fleets:

- 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).

- Catches of non-reporting industrial longliners (India, NEI) estimated by the IOTC Secretariat using alternative information. As they are not reported by the countries concerned, catches are likely to be incomplete for some industrial fisheries for which the striped marlin is seldom the target species.
- Conflicting catch reports for the drifting gillnet fishery of Pakistan, with very high catches of striped marlins reported by alternative sources, as derived from sampling in different locations in Pakistan.
- Conflicting catch reports for longliners flagged to the Rep. of Korea, reported as nominal catches and catches and effort, are conflicting with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of striped marlin over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.

Discards: Thought to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in some driftnet fisheries.

Changes to the catch series: There have been minor changes to the catches of striped marlins since the WPB meeting in 2013. The main revisions occur around the mid-2000s as a result of improvements to the estimate of total catch and catch-by-species for IR Iran and Indonesia. These changes, however, did not lead to substantial changes in the catch estimates for striped marlins.

Fish size or age trends (e.g. by length, weight, sex and/or maturity (Fig. 4c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped marlin and blue marlin may be occurring in the Taiwan,China longline fishery; the length frequency distributions derived from samples collected on Taiwan,China longliners differ greatly from those collected on longliners flagged in Japan.

Catch–per–unit–effort (CPUE) series (Fig. 4b): Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet) although catches are thought to be incomplete (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; or other artisanal (gillnet fisheries of IR Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Catch-at-Size(Age) (Fig. 5): Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured or the samples collected are unreliable.

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

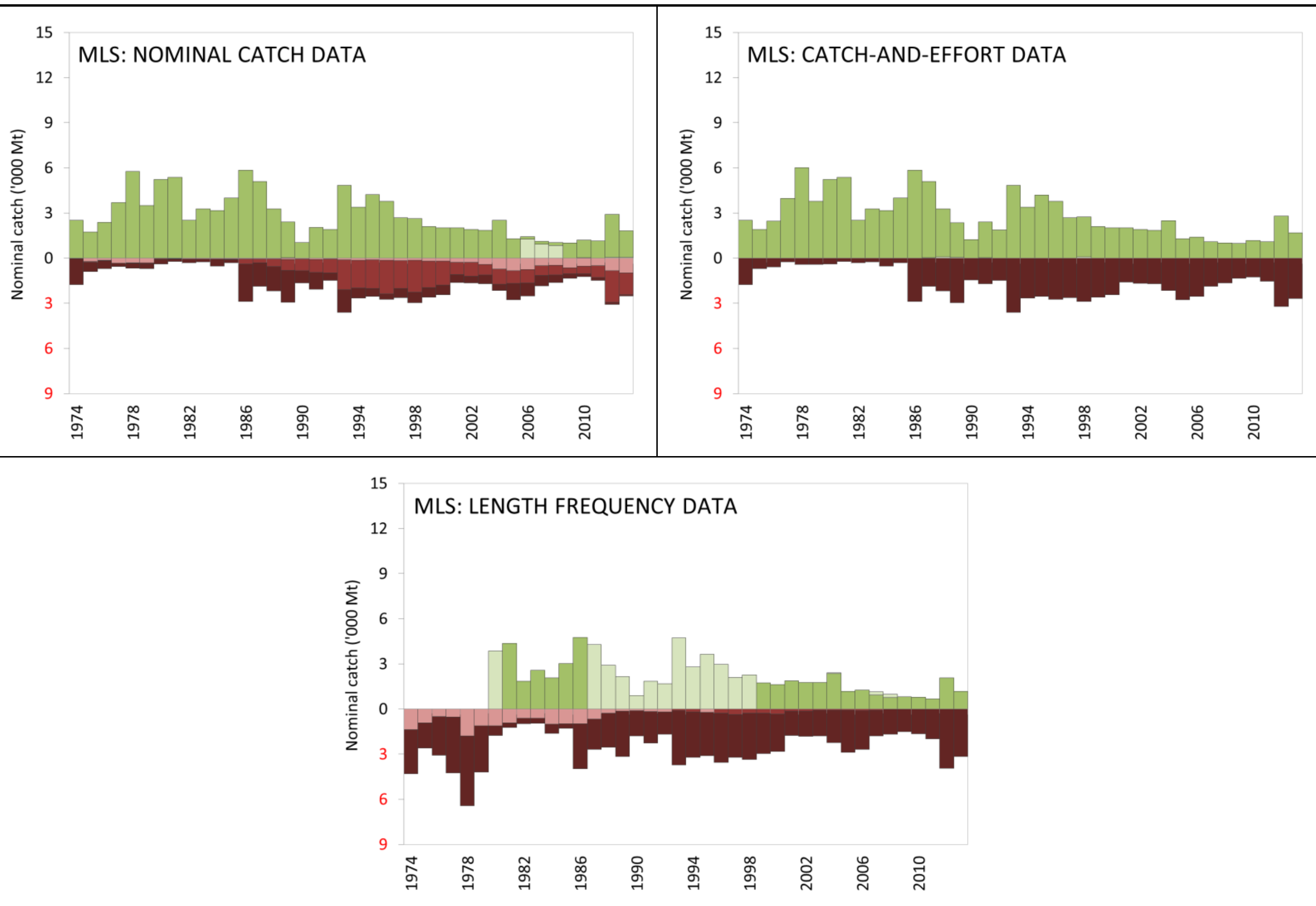

Fig. 4. Striped marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 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; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. (Data as of September 2014)*

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)

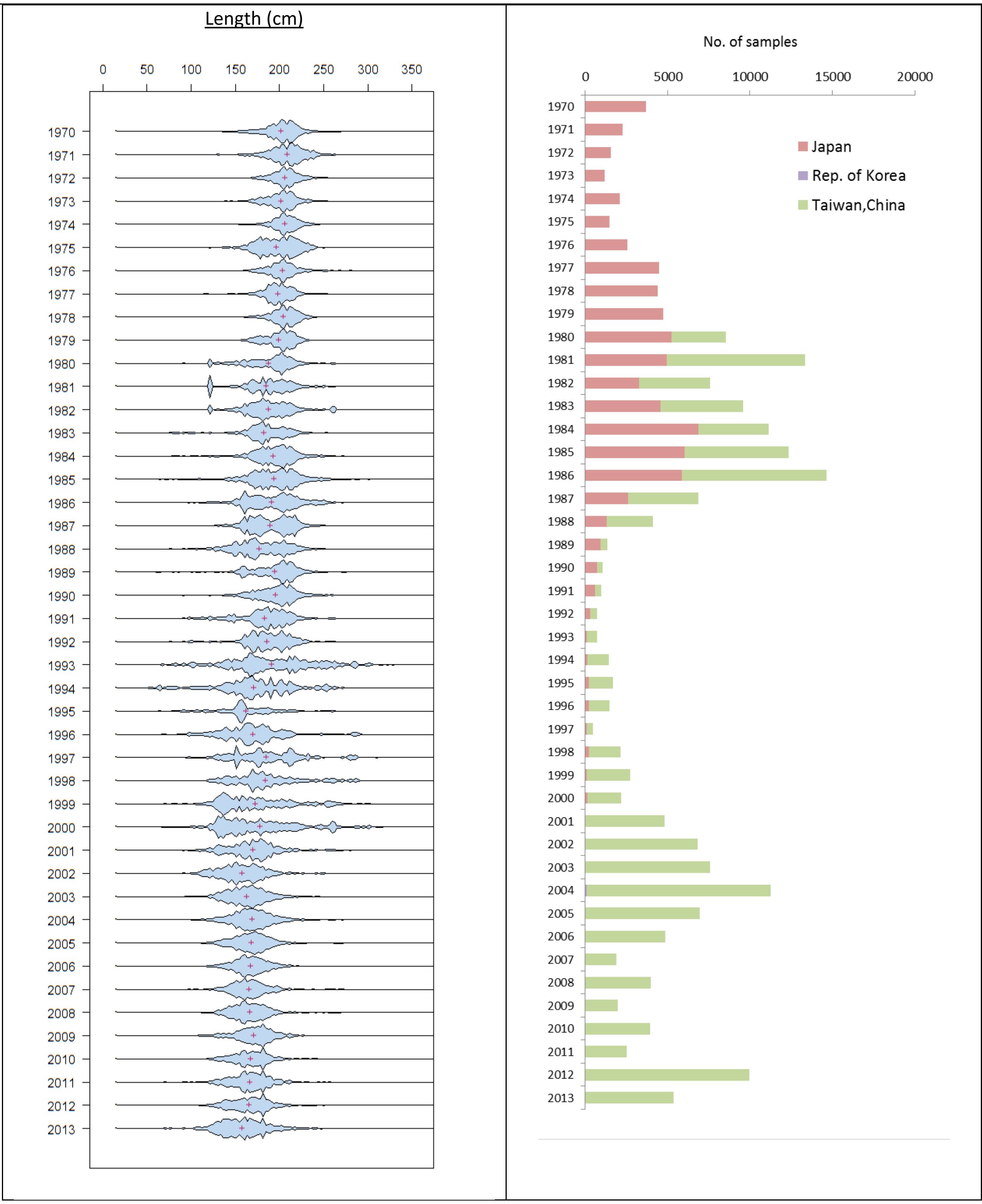

Fig. 5. Striped marlin: Longline catch-at-size length distributions (Data as of September 2014)

APPENDIX IVE
MAIN STATISTICS OF INDO-PACIFIC SAILFISH

(*Extracts from IOTC–2014–WPB12–07 Rev_2*)

Indo-Pacific sailfish (Istiophorus platypterus)

Catch trends

Indo-Pacific sailfish is caught mainly using gillnets (75%) with remaining catches recorded using troll and hand lines (20%), longlines (5%) or other gears (Table 1, Fig. 1). The average annual catch over recent years is estimated at around 29,000 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, IR Iran, Sri Lanka and Pakistan). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia and other longline fleets. This species is also a popular catch for sport fisheries (e.g. Kenya, Mauritius, Seychelles).

Catches of Indo-Pacific sailfish greatly increased since the mid-1990's (from around 5,000 t in the early 1990s to almost 30,000 t in 2011 and similar catch levels in the following years. The increases are largely due to the development of a gillnet/longline fishery in Sri Lanka (Fig. 2) and especially, the extension in the area of operation of IR Iran gillnet vessels to areas beyond the EEZ of IR Iran. In the case of IR Iran gillnets (Fig. 2), catches have increased from less than 1,000 t in the early 1990's to over 7,700 t in 2011 and similar values in subsequent years.

Catches of Indo-Pacific sailfish using drifting longlines (Table 1) and other gears have also increased – to a lesser extent than catches from gillnet – from around 2,500 t to over 8,000 t in recent years. However, it is likely that longline fleets under report catches of this species due to its 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 (Fig. 3).

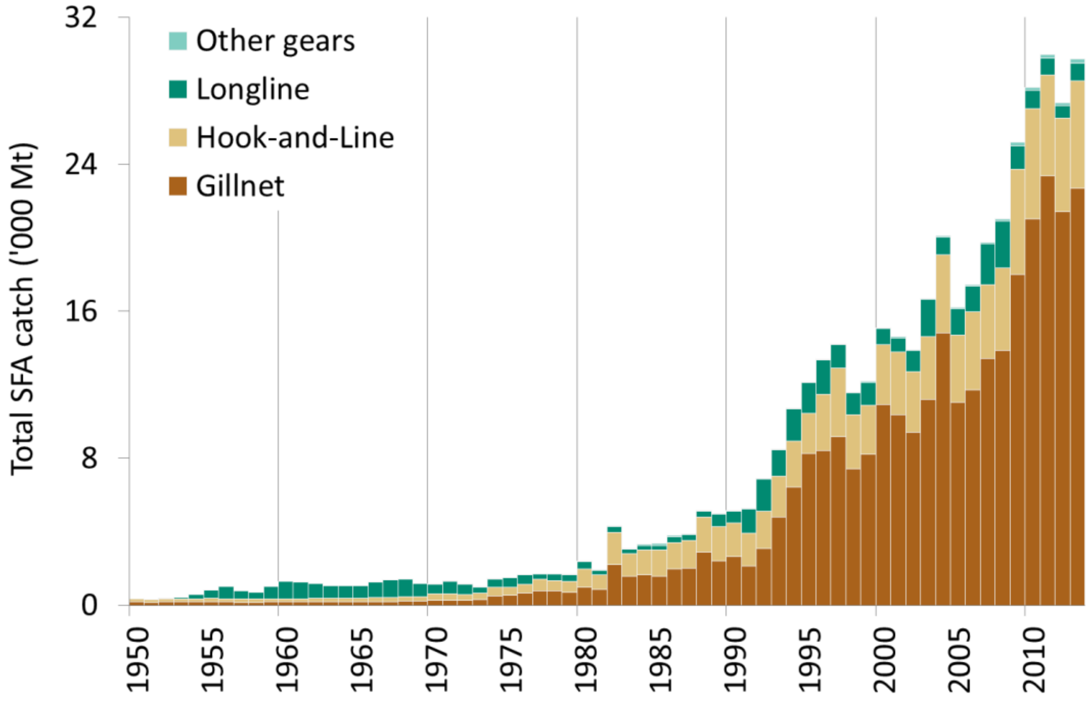

Fig. 1. Indo-Pacific sailfish. Catches of Indo-pacific sailfish by gear and year recorded in the IOTC Database (1950–2013).

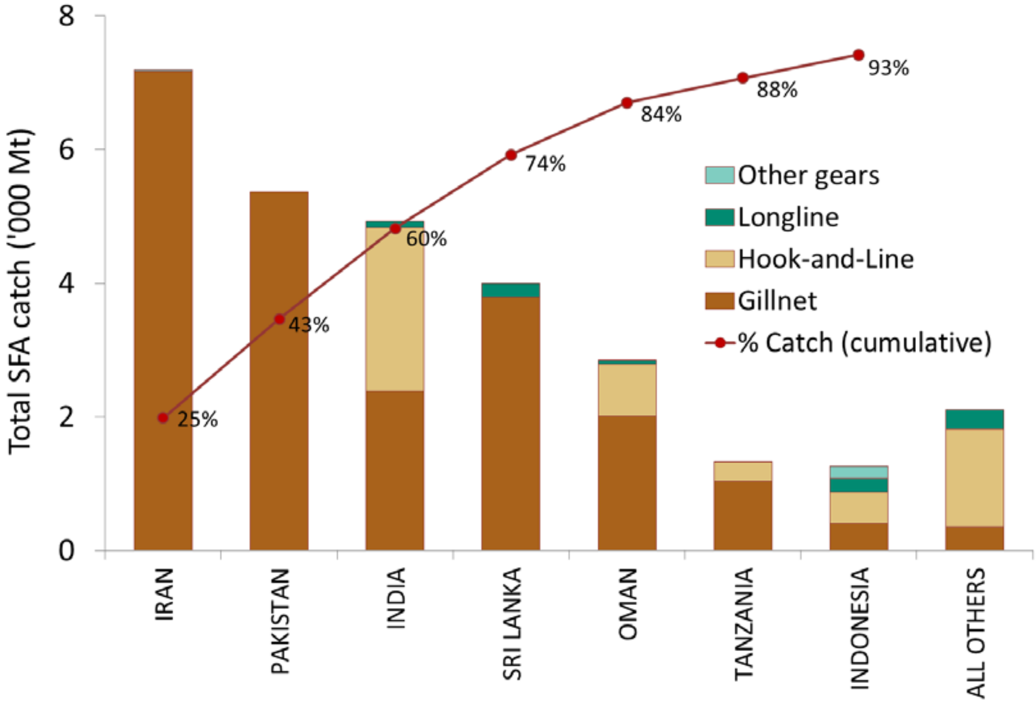

Fig. 2. Indo-Pacific sailfish: Average catches in the Indian Ocean over the period 2010–13, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

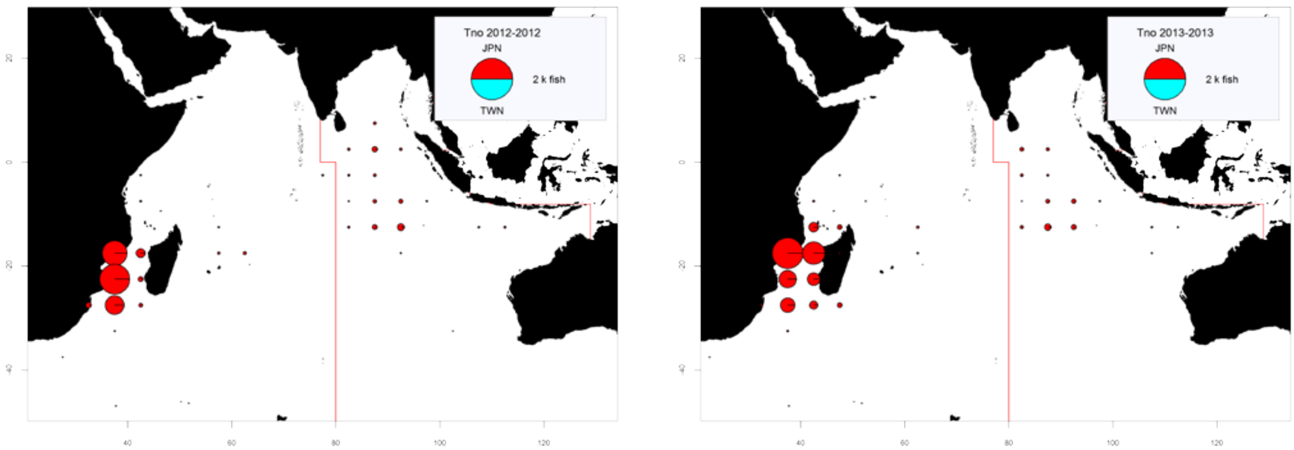

Fig. 3a-f. Indo-Pacific sailfish: Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) for a) 2012 and b) 2013 by fleet.

TABLE 1. Indo-Pacific sailfish: Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2013 (in metric tons). Data as of September 2014.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
LL	299	818	444	335	1,411	1,466	958	1,438	1,403	2,223	2,526	1,299	991	928	664	975
GN	165	181	507	1,809	6,056	12,470	14,798	11,047	11,712	13,415	13,862	17,994	21,028	23,385	21,413	22,699
HL	171	213	456	1,430	2,498	3,980	4,269	3,645	4,240	4,024	4,513	5,720	5,992	5,472	5,096	5,821
OT	-	-	3	44	42	85	63	84	88	95	134	171	172	181	178	255
Total	**634**	**1,212**	**1,410**	**3,618**	**10,007**	**18,000**	**20,088**	**16,215**	**17,443**	**19,758**	**21,034**	**25,183**	**28,184**	**29,965**	**27,351**	**29,750**

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Unlike the other billfish, Indo-Pacific sailfish are probably more reliably identified because of the large and distinctive first dorsal fin that runs most of the length of the body.

Retained catches: poorly known for most fisheries (Fig. 4a) due to:

- Catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the IOTC Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- Catches of Indo-Pacific sailfish reported for some fisheries may refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (many coastal fisheries).
- Catches likely to be incomplete for some artisanal fisheries (e.g. gillnets of Pakistan, pole and lines of Maldives) due to under-reporting.
- Catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific sailfish is not a target species.
- A lack of catch data for most sport fisheries.

Discards: unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

Changes to the catch series: Catches of Indo-Pacific sailfish remain largely unchanged since the WPB meeting in 2013, and have been unaffected by revisions to the catch-by-species for IR Iran gillnet offshore fisheries, and also the revisions to the catch series in Indonesia.

Catch–per–unit–effort (CPUE) series (Fig. 4b): Standardised and nominal CPUE series have not yet been developed. No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of IR Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Fig. 4c): 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, the specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (possible bias of existing samples).

Catch-at-Size(Age): tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

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

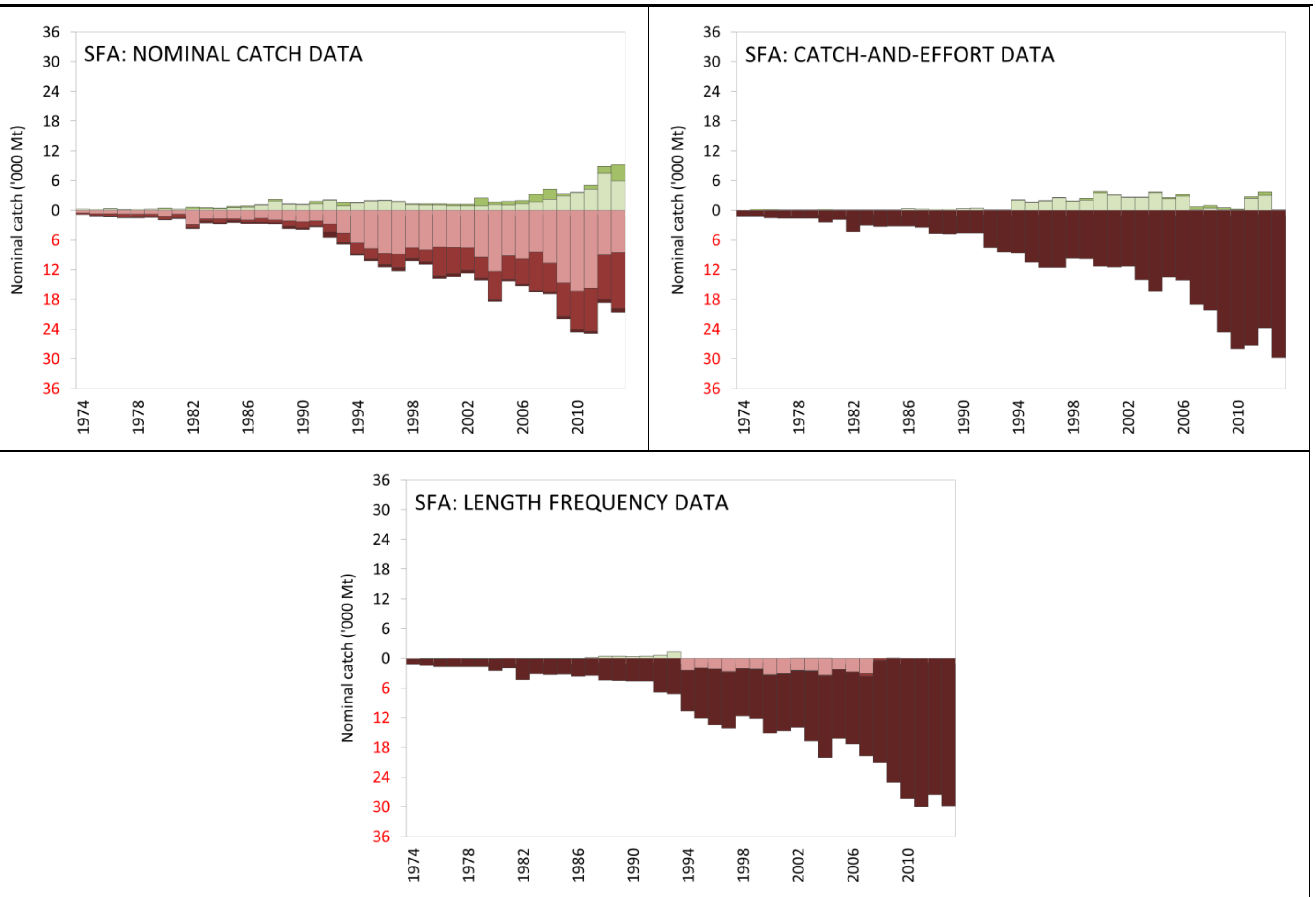

Fig. 4a–c. Indo-Pacific sailfish: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 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; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. (Data as of September 2014)*

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–2014–WPB12–07 Rev_2*)

Swordfish (*Xiphias gladius*)

Catch trends

Over 90% of Swordfish are caught mainly using drifting longlines (>85%) (Fig. 1), on longline fisheries directed to tunas (Table 1, LL) or swordfish (Table 1, ELL), while the remaining the catches are taken by other fisheries, in particular drifting gillnets. Between 1950 and 1980, catches of swordfish in the Indian Ocean slowly increased in tandem with the level of coastal state and distant water fishing nation longline effort targeting tunas. Swordfish were mainly a bycatch of industrial longline fisheries before the early 1990's with catches slightly increasing from 1950 to 1990 proportionally to the increase in the catches of target species (tropical and temperate tunas).

The catches of swordfish markedly increased after 1990, from around 8,000 t in 1991 to a peak of 36,000 t in 1998 and 37,000 t in 2004. The change in target species from tunas to swordfish by part of the fleet of Taiwan,China along with the development of longline fisheries in Australia, Reunion island, Seychelles and Mauritius and the arrival of longline fleets from the Atlantic Ocean (EU,Portugal, EU,Spain the EU,UK and other fleets operating under various flags[1]), all targeting swordfish, are the main reasons for this significant increase.

Since 2004, annual catches have declined steadily, largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean. Annual catches since 2004 have been dominated by the Taiwan,China and EU fleets (Spain, UK, France and Portugal), with the fishery extending eastward due to the effects of piracy actions (Fig. 2).

Catches of swordfish of up to 6,000 t have been recorded in recent years for a fleet of deep-freezing and fresh tuna longliners operating under flags of non-reporting countries (Not Elsewhere Indicated (NEI)). The catches have been low since 2007, at around 1,000 t.

The catches of Swordfish of industrial longliners from Japan have increased proportionally to those of yellowfin tuna, the target species of this fleet during the first years of the fishery, and have remained stable until the early 1990's. The average annual catches over the last two decades have amounted to around 1,600 t, rising to over 2,500 t in 1994 and 1997, although most recently in 2012 and 2013 catches of between 600 t to 700 t have been reported.

Sri Lanka swordfish catches have ranged between 2,400 and 5,500 t over the last decade, with the highest catches recorded in 2013. These are taken mostly by vessels that use a combination of drifting gillnets and longlines. Results from the sampling conducted by NARA[2] during 2005 and 2006 with the support of the IOTC-OFCF[3] Project in different locations in Sri Lanka led to a re-estimation of the historical catch series in 2012[4].

The catches of Indonesian fresh-tuna longliners operating in Indian Ocean waters increased steadily until 2003 (3,400 t), and have decreased since then. It is, however, likely that the catches recorded for the swordfish are incomplete, as the statistics for years before 2003 are thought to be more uncertain (as port sampling was only initiated in 2003), and coverage of the frozen component of catches from port sampling, which is likely to contain substantial amounts of swordfish, was not sufficient. Catch estimates for 2012 and 2013 are three-fold those in 2011 and remain uncertain.

During the last two decades, several domestic longline fisheries targeting swordfish started to operate in Reunion (EU-France), Australia, Seychelles, South Africa and, more recently, Mauritius, with total accumulated catches estimated to be between 2,000 t and 3,000 t in recent years (see 'All other fleets, Fig. 2).

EU longliners flagged to Spain, Portugal and the UK coming from the Atlantic Ocean have been operating in the Indian Ocean since the early 90s with current accumulated catches around 5,000 t. Around 25% of the catches of swordfish in the Indian Ocean have been taken by vessels operating under EU flags in recent years.

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[1] Senegal, Guinea, etc.

[2] National Aquatic Resources and Development Agency of Sri Lanka

[3] Overseas Fisheries Cooperation Foundation of Japan

[4] Moreno et al. (2012). Pilot project to improve data collection for tuna, sharks and billfish from artisanal fisheries in the Indian Ocean. Part II: Revision of catch statistics for India, Indonesia and Sri Lanka (1950-2011). Assignment of species and gears to the total catch and issues on data quality. Document presented at the 15th Session of the IOTC Scientific Committee, Seychelles, 10-15 December 2012. IOTC–2012–SC15–38

The annual catches of swordfish by longliners from the Rep. of Korea, recorded since 1965, have rarely exceeded 1,000 t. The highest catch, 1,100 t, was recorded in 1994. In 2010 the IOTC Secretariat revised the catches of swordfish for Rep. of Korea over the time-series using catches reported as nominal catches and catch-and-effort.

Swordfish is mostly exploited in the western Indian Ocean (Fig. 4), in waters off Somalia, and in the southwest Indian Ocean. Other important fisheries operate in waters off Sri Lanka, Western Australia and Indonesia. In 2009–11 the catches of swordfish in the western tropical Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania, from around 13,000 t in 2005 to 6,500 t in 2008, and in particular 2,500 t in 2011. The drop in catches is the consequence of a drop in fishing effort in the area by longline fisheries, due to either piracy or decreased fish abundance, or a combination of both. Catches in 2012 in this area were three-fold those in 2011.

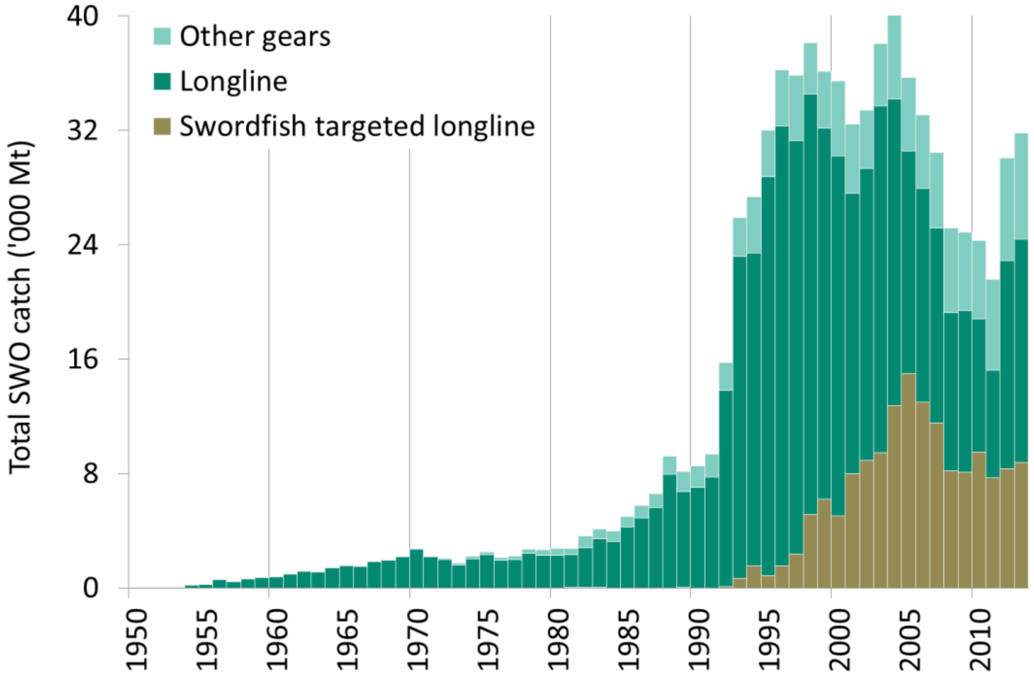

Fig. 1 Swordfish: Catches of swordfish by gear and year recorded in the IOTC Database (1950–2013).

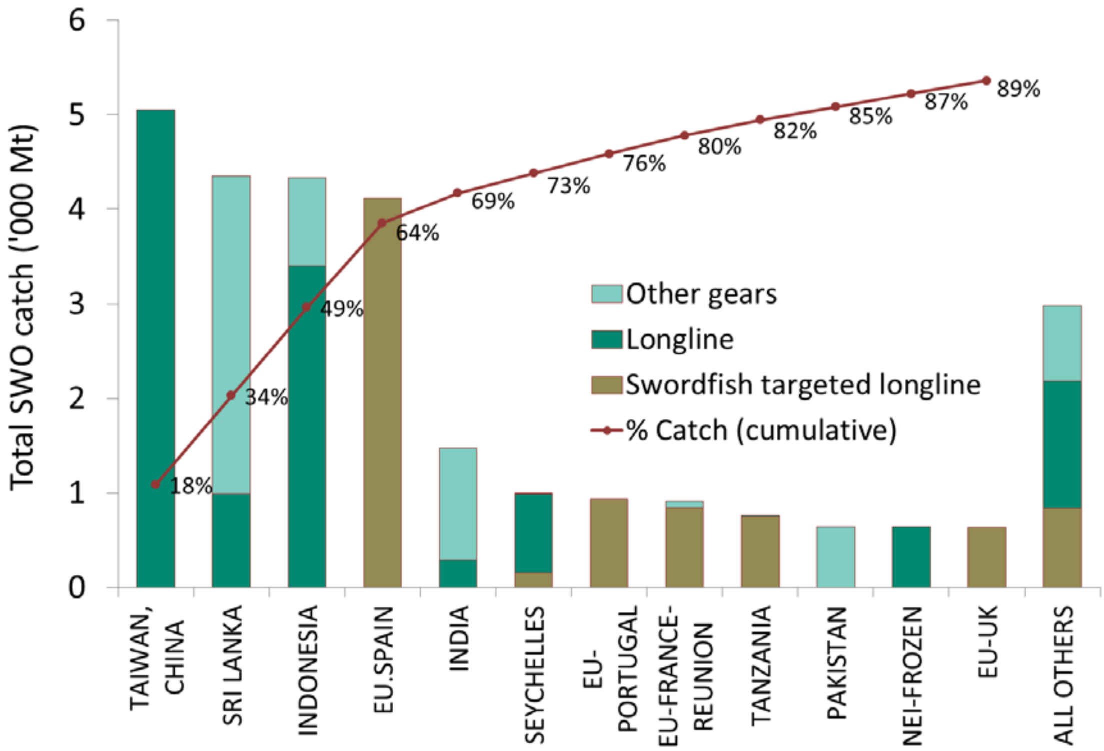

Fig. 2. Swordfish: average catches in the Indian Ocean over the period 2010–13, by fleet or country, ordered from left to right, according to the importance of catches of swordfish reported. The red line indicates the (cumulative) proportion of catches of swordfish for the fleets or countries concerned, over the total combined catches of this species reported from all fleets or countries and fisheries.

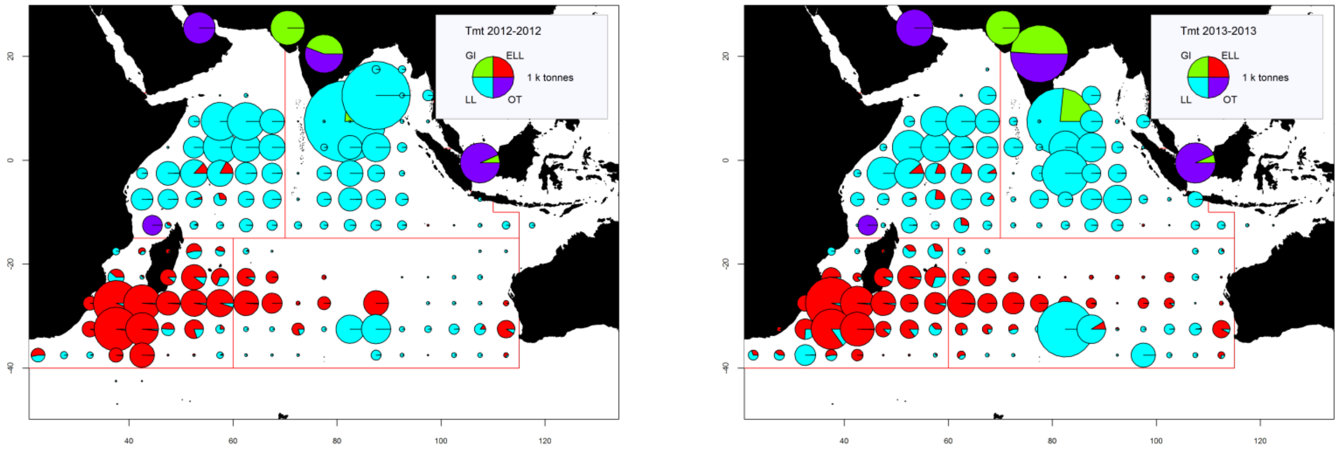

Fig. 3a–b. Swordfish: Time-area catches (total combined in tonnes) of swordfish for longline fisheries targeting swordfish (ELL), other longline fisheries (LL), gillnet fisheries (GI), and for all other fleets combined (OT), for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Red lines represent the areas used for the assessments of swordfish.

TABLE 1. Swordfish: Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2013 (in metric tons). Data as of September 2014.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
ELL	-	-	-	9	1,841	9,993	12,740	14,965	13,009	11,543	8,173	8,106	9,510	7,686	8,337	8,785
LL	282	1,425	2,136	4,372	22,689	20,048	24,204	17,390	17,129	16,080	13,497	13,726	11,740	10,332	17,484	17,575
OT	37	39	186	807	1,998	2,846	3,324	3,337	2,936	2,810	3,482	3,019	3,020	3,545	4,237	5,445
Total	**320**	**1,465**	**2,322**	**5,189**	**26,527**	**32,886**	**40,267**	**35,693**	**33,074**	**30,433**	**25,153**	**24,852**	**24,270**	**21,564**	**30,058**	**31,804**

Fisheries: Swordfish longline (**ELL**); Longline (**LL**); Other gears (**OT**)

TABLE 2. Swordfish: Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2013 (in metric tons). Data as of September 2014

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
NW	100	547	776	1,888	8,278	10,180	12,868	12,254	10,785	8,430	6,321	4,506	2,668	2,483	8,690	8,683
SW	14	254	406	606	8,624	7,682	6,325	9,791	8,995	7,423	6,437	6,381	8,211	7,005	7,354	7,349
NE	168	453	756	2,168	6,504	9,296	11,400	7,975	9,275	9,359	8,889	10,862	9,896	9,147	11,796	12,489
SE	37	203	307	387	3,034	5,709	9,641	5,656	4,014	5,207	3,502	3,097	3,483	2,923	2,215	3,283
OT	0	8	76	140	88	20	33	16	6	15	5	5	11	6	4	1
Total	**320**	**1,465**	**2,322**	**5,189**	**26,527**	**32,886**	**40,267**	**35,693**	**33,074**	**30,433**	**25,153**	**24,852**	**24,270**	**21,564**	**30,058**	**31,804**

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

Uncertainty of time–area catches

Retained catches: are fairly well known (Fig. 4a); however catches are uncertain for:

- **Drifting gillnet** fisheries of IR Iran and Pakistan: The IOTC Secretariat used the catches of swordfish and marlins reported by IR Iran for the years 2012 and 2013 to rebuild historical catches of billfish for this fishery. However, catch rates and species composition for the Iranian and Pakistani gillnet fisheries differ and they are also in contradiction with other estimates, derived from sampling in Pakistan. Estimates of catches of swordfish by drifting gillnet in Pakistan and IR Iran have represented over 4% of the total combined catches of swordfish reported, from all fisheries.
- **Longline** fishery of Indonesia: The catches of swordfish for the longline fishery of Indonesia may have been underestimated over the time series due to insufficient sampling coverage. Although the new catches estimated by the IOTC Secretariat for the period 2003–09 are thought to be more accurate, swordfish catches remain uncertain, especially in recent years (where they represent around 12% of the total catches of swordfish in the Indian Ocean).
- **Longline fishery of India:** India has reported very incomplete catches and catch-and-effort data for its commercial longline fishery. Although the new catches estimated by the IOTC Secretariat are thought to be

more accurate, catches of swordfish remain uncertain (catches of swordfish in recent years represent less than 4% of the total catches of swordfish in the Indian Ocean).

- **Longline** fleets from non-reporting countries (NEI): The IOTC Secretariat had to estimate catches of swordfish for a fleet of longliners targeting tunas or swordfish and operating under flags of various non-reporting countries. The catches estimated since 2006 are, however, low (they represent around 3% of the total catches of swordfish in the Indian Ocean).

Discards: believed to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of swordfish may also occur in the driftnet fishery of IR Iran, as this species has no commercial value in this country.

Changes to the catch series: There have been relatively minor revisions to the catches of swordfish since the WPB meeting in 2013. Any differences in the data series since the last WPB are relatively small changes to the nominal catch as a result of reallocation of catch reported as other billfish species or as aggregated species groups reported by Sri Lanka, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates for swordfish.

Catch–per–unit–effort (CPUE) Series (Fig. 4b): Catch and effort series are available from some industrial longline fisheries. Nevertheless, catch and effort are not available from some fisheries or they are considered poor quality, especially since the early 90s (Indonesia, fresh-tuna longliners from Taiwan,China[5], Non-reporting longliners (NEI)). In addition, catch-and-effort data are not available for the gillnet and longline fishery of Sri Lanka and the drifting gillnet fisheries of IR Iran and Pakistan.

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. 4c).

- **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 in recent years (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) (Figs. 5, 6): data are available but the estimates are thought to have been compromised for some years and fisheries due to:

- the uncertainty in the length frequency data recorded for longliners of Japan and Taiwan,China, for which average weights of swordfish derived from length frequency data and catch-and-effort data are very different.
- the uncertainty in the catches of swordfish for the drifting gillnet fisheries of IR Iran and the longline fishery of Indonesia.
- the total lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (Pakistan, India, Indonesia).
- the paucity of size data available from industrial longliners since the early-1990s (Japan, Philippines, India and China).
- the lack of time-area catches for some industrial fleets (Indonesia, India, IR Iran, Pakistan, NEI).
- the paucity of biological data available, notably sex-ratio and sex-length-age keys.

[5] Catch-and-effort statistics for the fresh-tuna longline fishery of Taiwan,China are available since 2007, although logbook coverage levels are still low.

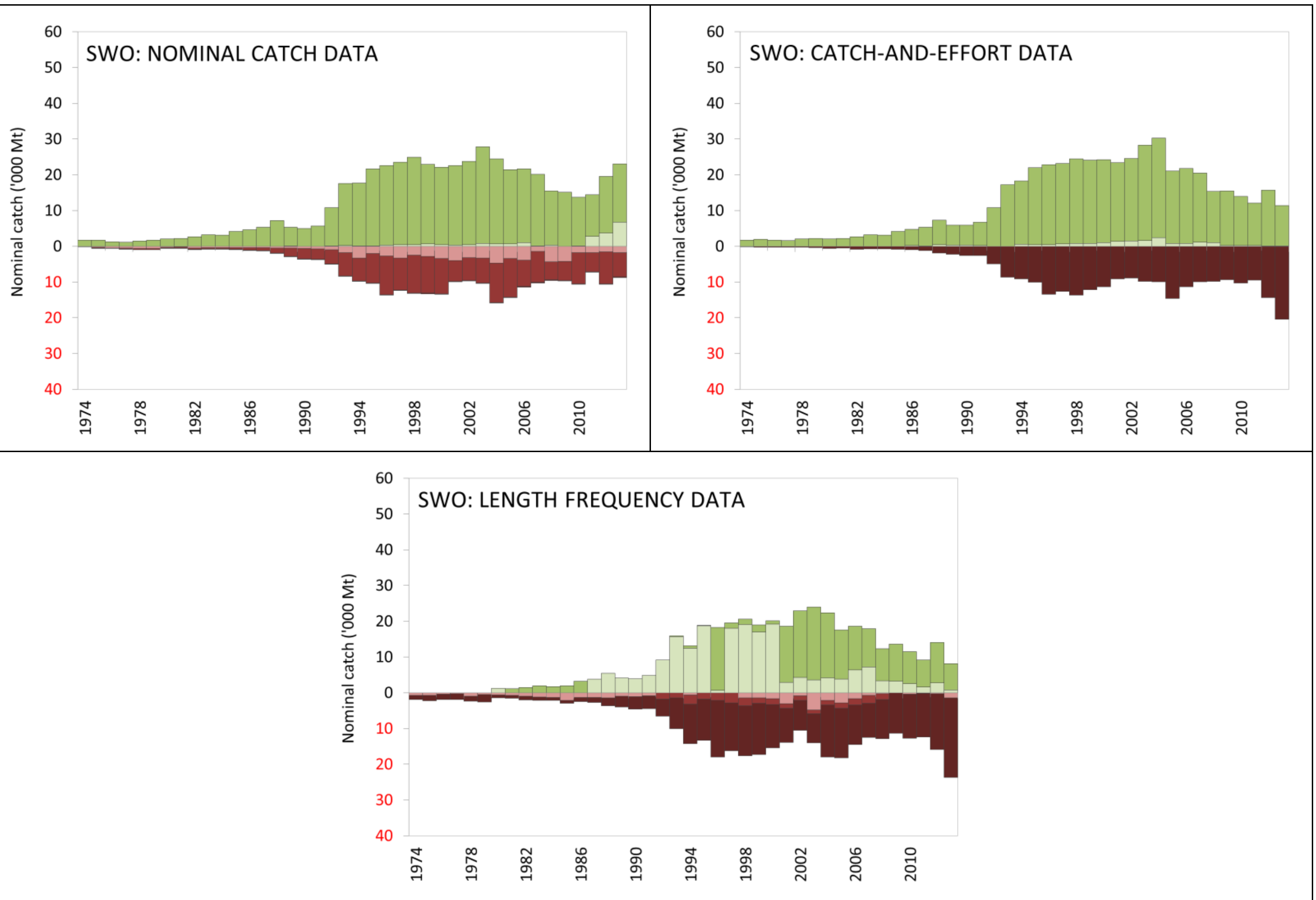

Fig. 4a-c. Swordfish: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 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; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. (Data as of September 2014)*

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)

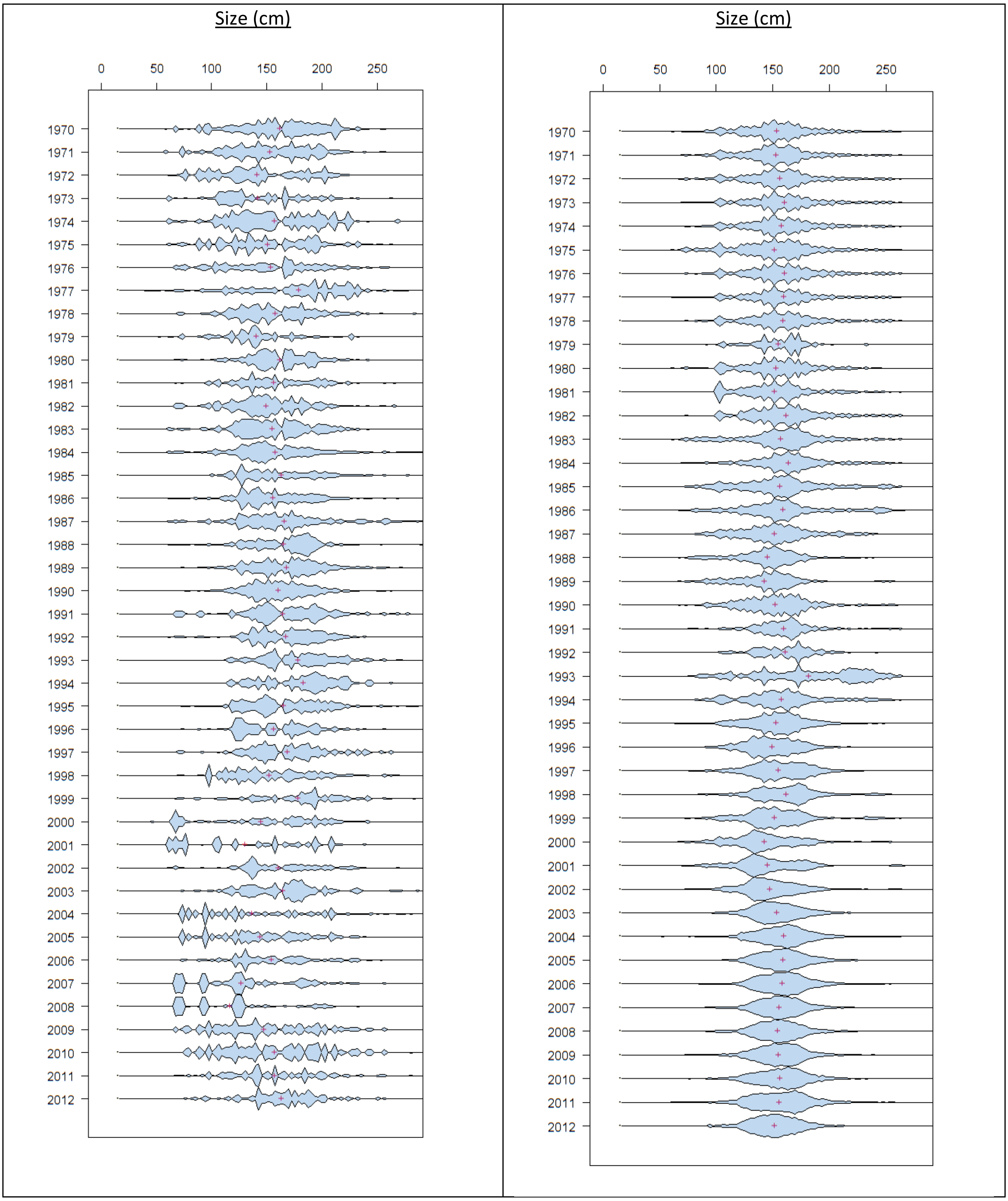

Fig. 5. Swordfish: Longline catch-at-size length distributions for Japan (left) and Taiwan,China (right) (Data as of September 2014)

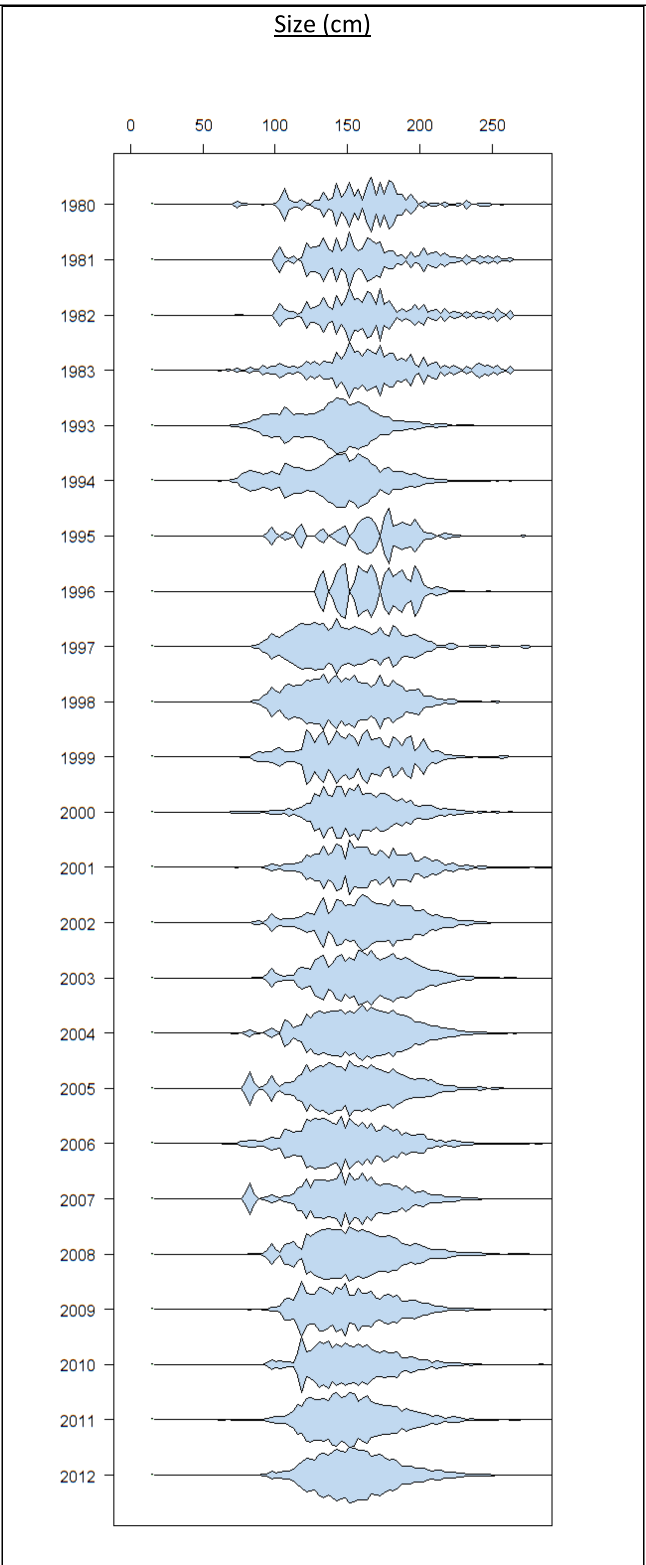

Fig. 6. Swordfish: Longline catch-at-size length distributions for combined EU,Spain, EU,Portugal and EU,UK vessels (Data as of September 2014) Contains data for EU longliners (from EU.Spain, EU.Portugal and the EU,UK)

APPENDIX V
MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF BILLFISH

Extract from IOTC–2014–WPB12–07 Rev_2

The following list is provided by the Secretariat for the consideration of the WPB. The list covers the main issues which the Secretariat considers to negatively affect the quality of the statistics available at the IOTC, by type of dataset and fishery.

1. Catch-and-Effort data from Artisanal Fisheries:

- **Drifting gillnet** fisheries of **I.R. Iran** and **Pakistan**: In recent years I.R. Iran has reported catches of marlins and swordfish for its gillnet fishery, including catches for the years 2012 and 2013. The IOTC Secretariat used the new catches reported by I.R. Iran to re-build the historical series of catches of billfish for its offshore gillnet fishery. In addition, the catches reported by Pakistan for recent years, including swordfish and black marlin, differ markedly from alternative estimates received by the IOTC Secretariat. 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.
- **Gillnet/longline** fishery of **Sri Lanka**: In recent years Sri Lanka has caught over 10% of the catches of marlins in the Indian Ocean. Although Sri Lanka has reported catches of marlins by species for its gillnet/longline fishery, the catch ratio of blue marlin to black marlin has changed dramatically over time. This is thought to be a sign of frequent misidentification rather than the effect of changes in catch rates for this fishery. Although the IOTC Secretariat adjusted the catches of marlins using proportions derived from years with good monitoring of catches by species, the catches estimated remain uncertain.
- **Artisanal** fisheries of **Indonesia**: The catches of billfish reported by Indonesia for its artisanal fisheries in recent years are considerably higher than those reported in the past, and represent around 5% of the total catches of billfish in the Indian Ocean. In 2011 the Secretariat revised the complete nominal catch dataset for Indonesia, using information from various sources, including official reports. However, the quality of the dataset for the artisanal fisheries of Indonesia is thought to be poor, with a likely underestimation of catches of billfish in recent years.
- **Artisanal** fisheries of **India**: In early 2012 the IOTC Secretariat revised the complete nominal catch dataset for India, using new information available. The catches of billfish estimated in recent years represent around 8% of the total catches in the Indian Ocean, and refer mainly to Indo-Pacific sailfish and black marlin. To date, India has not reported catch-and-effort data for its artisanal fisheries.

2. Catch-and-Effort data from Sport Fisheries:

- **Sport** fisheries of **Australia, EU,France(Reunion)**, **India**, **Indonesia**, **Madagascar**, **Mauritius**, **Oman, Seychelles**, **Sri Lanka**, **Tanzania**, **Thailand** and **UAE**: To date, no data have been received from any of the referred sport fisheries. Sport fisheries are known to catch billfish species, in particular blue marlin, black marlin and Indo-Pacific sailfish. Although data are available from other sport fisheries in the region (Kenya, Mauritius, Mozambique, South Africa), this information cannot be used to estimate levels of catch for other fisheries.

3. Catch-and-Effort data from Industrial Fisheries:

- **Longline** fishery of **Indonesia**: The catches of swordfish and marlins for the fresh tuna longline fishery of Indonesia may have been underestimated in the past due to them not being sampled sufficiently in port and to 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 highly uncertain.
- **Longline** fishery of **India**: 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, the final catches estimated considerably higher than those reported (representing 2% of the total catches of billfish in recent years).
- **Longline** fishery of the **Rep. of Korea**: The nominal catches and catch-and-effort data series for billfish for the longline fishery of Rep. 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 Rep. of Korea in recent years are very small.

- **Longline** fishery of **EU,Spain:** To date, the IOTC Secretariat has not received catch-and-effort data in the format required for time/area for billfish for the longline fishery of EU,Spain.
- **Purse seine** fisheries of **Seychelles**, **Thailand**, **I.R. Iran** and **Japan**: To date, the referred countries have not reported catches of billfish from purse seiners, although they are thought to be very low.

4. Size data from All Fisheries:

- Size data for all billfish species is generally considered unreliable and insufficient to be of use for stock assessment purpose, as sampling numbers for all species are below the minimum sampling coverage one fish per tonne of catch recommended by IOTC; and the quality of the samples collected by fishermen on commercial boats cannot be verified.
- **Longline** fishery of **Taiwan,China**: Size data have been available for the longline fishery of Taiwan,China since 1980; however, the IOTC Secretariat has identified some issues in the length frequency distributions, in particular fish recorded under various types of size class bins (e.g. 1cm, 2cm, 10cm, etc.) all reported under a unique class bin (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.
- **Gillnet** fisheries of **Iran** and **Pakistan:** To date, Iran and Pakistan have not reported size frequency data for their gillnet fisheries.
- **Gillnet/longline** fishery of **Sri Lanka:** Although Sri Lanka has reported length frequency data for swordfish and marlins in recent years, the lengths reported are considered highly uncertain, due to misidentification of marlins and likely sampling bias (large specimens of swordfish and marlins are highly processed and not sampled for length, while small specimens are sampled).
- **Longline** fisheries of **India** and **Oman:** To date, India and Oman have not reported size frequency data for their commercial longline fisheries.
- **Longline** fishery of **Indonesia**: Indonesia has reported size frequency data for its fresh-tuna longline fishery in recent years. However, the samples cannot be fully disaggregated by month and fishing area (5x5 grid) and refer mostly to the component of the catch that is unloaded fresh. The quality of the samples in the IOTC database is for this reason uncertain.
- **Fresh-tuna longline** fishery of **Taiwan,China**[6]**:** Data are only available for striped marlin and swordfish for the year 2010, with no size data available for other species or years.
- **Longline** fishery of **Japan:** The number of samples reported and total number of fish sampled for the longline fishery of Japan since 2000 has been very low.
- **Artisanal** fisheries of **India** and **Indonesia**: To date, India and Indonesia have not reported size frequency data for their artisanal fisheries.

5. Biological data for all billfish species:

- Industrial **longline** fisheries, in particular **Taiwan,China**, **Indonesia**, **EU**, **China** and the **Rep. of Korea**: The Secretariat had to use length-age keys, length-weight keys, and processed weight-live weight keys for billfish species from other oceans due to the general paucity of biological data available from the fisheries indicated.
- Industrial **longline** fisheries, in particular **Taiwan,China**, **Indonesia**, **EU**, and **China**: There has not been regular reporting of length frequency data by sex from any of the referred fisheries.

[6] Refers to Taiwan Province of China.

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$)	Units required	2015 Total (US$)
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
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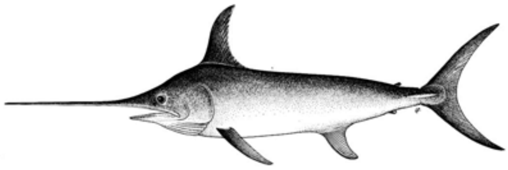

Status of the Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

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

Area[1]	**Indicators**		**2014 stock status determination**
Indian Ocean	Catch 2013: Average catch 2009–2013:	31,804 t 26,510 t	(green)
	MSY (1,000 t) (80% CI): F_{MSY} (1,000 t) (80% CI): SB_{MSY} (80% CI): F_{2013}/F_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_{1950} (80% CI):	39.40 (33.20–45.60) 0.138 (0.137–0.138) 61.4 (51.5–71.4) 0.34 (0.28–0.40) 3.10 (2.44–3.75) 0.74 (0.58–0.89)	

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

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. 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 ($F_{2012}/F_{MSY} < 1$; $SB_{2012}/SB_{MSY} > 1$). 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 31,804 t in 2013 indicate 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. Management measures are not required which would pre-empt current Resolutions and planned management strategy evaluation for swordfish. 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). **NOTE:** Advice specific to the southwest region is provided below, as requested by the Commission.

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 2013 agreed to Resolution 13/10 *on interim 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** (2010–13): Longline catches are currently estimated to comprise approximately 85% of the total estimated swordfish catch in the Indian Ocean.
- **Main fleets** (2010–13): Taiwan,China: 18%; Sri Lanka: 16%; Indonesia: 15%; EU,Spain: 14%.

- **Improvements required**: Continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in the assessments.

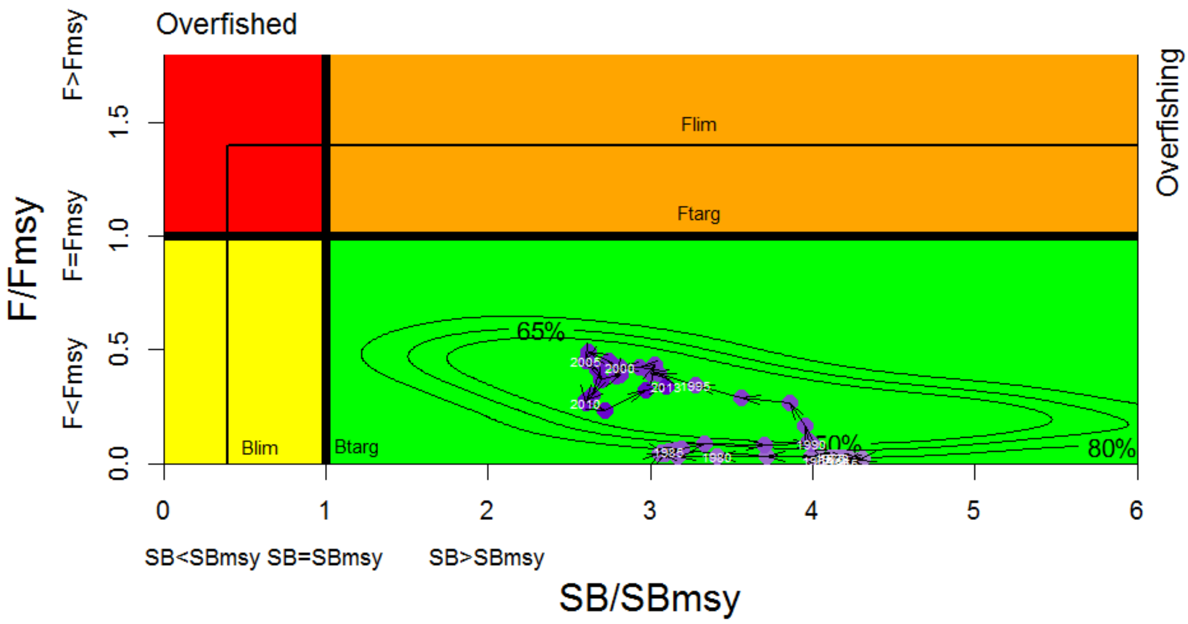

Fig. 1. Swordfish: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 80 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2013. Interim target (F_{targ} and SB_{targ}) and limit (F_{lim} 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{MSY}$	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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{Lim}$	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

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

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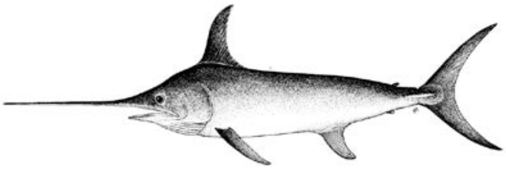


Status of the southwest Indian Ocean swordfish (SWO: *Xiphias gladius*) resource

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

Area[1]	**Indicators**		**2014 stock status determination**
Southwest Indian Ocean	Catch 2013: Average catch 2009–2013:	7,349 t 7,265 t	(yellow)
	MSY (1000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): B_{2013}/B_{MSY} (80% CI): B_{2013}/B_{1950} (80% CI):	9.86 (9.11–10.57) 0.63 (0.59–0.70) 12.68 (12.52–12.78) 0.89 (0.61–1.14) 0.94 (0.68–1.23) 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 ($B_{year}/B_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	(yellow)	(green)
Not assessed/Uncertain	(grey)	

NOTE: The following advice is provided on the basis of the following:

Commission request: *The Commission* ***REQUESTED*** *that the southwest region continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole.*

Scientific Committee: *The SC* ***NOTED*** *that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches.*

NOTE: Comment from the 12th Working Party on Billfish:

The WPB ***NOTED*** *that information received after the last stock assessment carried out in 2011, indicated that there is no evidence for a separate stock in the southwest Indian Ocean (Paper IOTC–2012–WPB10–15 and published as Muths et. al 2013 (see IOTC–2013–WPB11–10). Hence, from a biological point of view, it does not make sense to conduct a separate assessment for this region.*

Working Party on Billfish: Paragraph from the WPB10 Report on the two papers cited above*: The WPB* ***RECOMMENDED*** *that the SC note that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision.* (para. 127 of the WPB10 Report).

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

Stock status. The assessments carried out in 2014 produced substantially conflicting results (ASIA, BBDM and ASPIC). However, the ASPIC model runs are presented here just 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 2013, 7,349 t of swordfish catches were recorded from this region, which equals 110% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011(Table 3). If catches are maintained at 2013 levels, the probabilities of violating target reference points in 2016 are ≈ 81% for F_{MSY} and ≈ 40% for B_{MSY} (Table 4). 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 2013 catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t). The WPB10 estimated that there is a low to moderate risk of exceeding MSY-based reference points by 2023 if catches are reduced by 20% from 2013 levels (≈ 1% risk that $B_{2023} < B_{MSY}$, and ≈ 5% risk that $F_{2023} > F_{MSY}$) (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).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the southwest Indian Ocean is 9,100–10,400 t (Table 3). Catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
- **Provisional reference points**: Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim 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 hence, below the provisional limit reference point of 1.4*F_{MSY} (Fig. 1).
    b. **Biomass**: Current spawning biomass is considered to be below the target reference point of SB_{MSY}, but above the limit reference point of 0.4*SB_{MSY} (Fig. 1).
- **Main fishing gear** (2010–13): Longline catches are currently estimated to comprise approximately 85% of the total estimated swordfish catch in the Indian Ocean.
- **Main fleets** (2010–13): Taiwan,China: 18%; Sri Lanka: 16%; Indonesia: 15%; EU,Spain: 14%.
- **Improvements required**: Continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in the assessments.

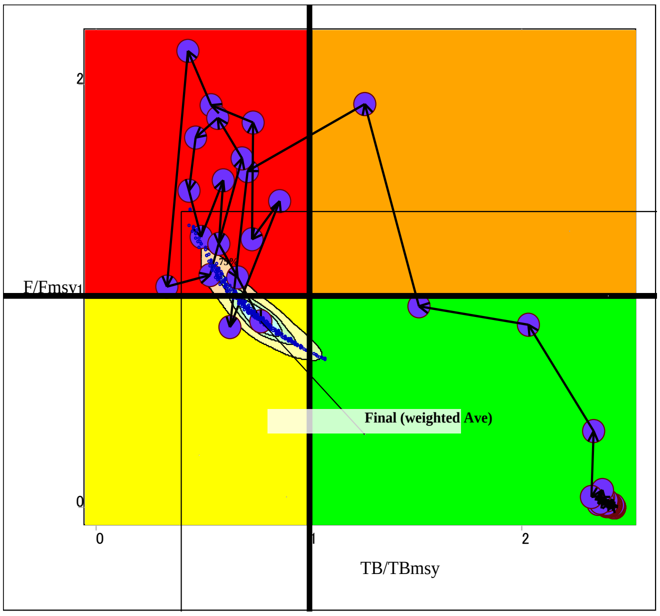


Fig. 2. Swordfish: ASPIC southwest Indian Ocean assessment Kobe plot (The horizontal blue line represents F_{LIM} and the vertical blue line represents B_{LIM}). The results are from a preferred model option: Model weighted average using the inverse of the Root Mean Square errors across models (scenario) 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{MSY}$	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

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})								
$F_{2023} > F_{MSY}$	0	0	5	67	92	98	99	100	100
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{Lim}$									
$F_{2016} > F_{Lim}$									
$B_{2023} < B_{Lim}$									
$F_{2023} > F_{Lim}$									

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit reference points set by the Commission.

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		2014 stock status determination
Indian Ocean	Catch 2013:	14,400 t	*
	Average catch 2009–2013:	11,962 t	
	MSY (1000 t) (80% CI):	10.2 (7.6–13.8)	*
	F_{MSY} (80% CI):	0.25 (0.08–0.45)	
	B_{MSY} (1000 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; * = **TENTATIVE status:** data poor stock assessment only. Status should be interpreted with caution due to the high levels of uncertainty. Further testing of how sensitive this technique is to model assumptions and available time series of catches, as well as the trialling of an alternative stock assessment approach needs to be undertaken before stock status can be used for management action; n.a. = not available

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished but and close to or just over the maximum sustainable yield levels (Table 1, Fig. 1). This is the second time that the WPB has applied a SRA technique to black marlin and further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken. However, the WPB considers that the assessment is the best information currently available and as such, should be used to tentatively determine stock status, with the intention that alternative techniques be applied in 2015 to validate the results. Thus, the stock status for black marlin in the Indian Ocean is **TENTATIVELY* not overfished*** but **subject to overfishing***. The stock appears to show an increase in catch rates which is a cause of concern, indicating that fishing mortality levels are likely to have become 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 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 to a total of 14,400 t in 2013. There is a moderate to high risk of exceeding MSY-based reference points by 2016 if catches increase further (20% increase) (≈ 44% risk that $B_{2016} < B_{MSY}$, and ≈ 78% risk that $F_{2016} > F_{MSY}$) (Table 2).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is between 7,600 and 13,800 t.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework*, no such interim points have been established for black marlin.
- **Main fishing gear** (2010–13): gillnet catches are currently estimated to comprise approximately 62% of the total estimated black marlin catch in the Indian Ocean.

- **Main fleets** (2010–13): Sri Lanka: 26 %; I.R. Iran: 20%; India: 18%.
- **Improvements required**: improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock.

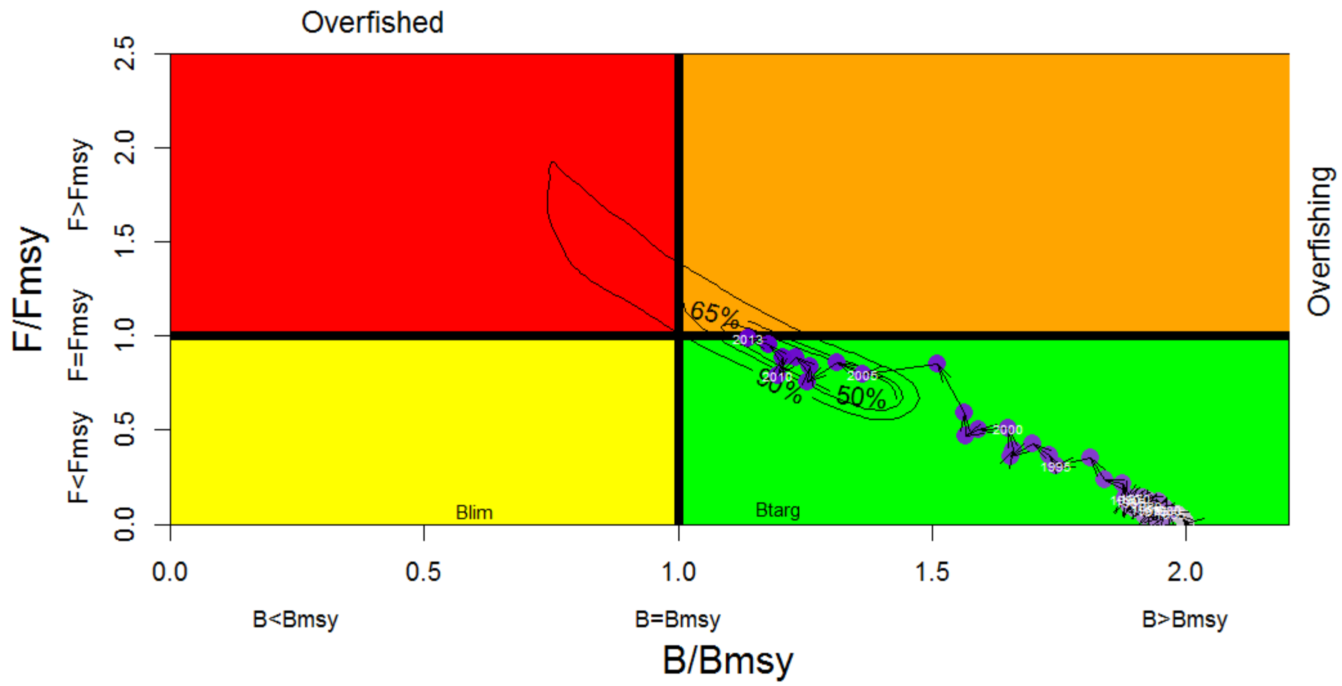


Fig. 1. Black marlin: Stock reduction analysis (Catch MSY Method) aggregated Indian Ocean assessment Kobe plots for black marlin (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black line indicates the trajectory of the point estimates (blue circles) for the spawning biomass (B) ratio 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{MSY}$	17		24		33		44		56
$F_{2016} > F_{MSY}$	12		30		53		78		99
$SB_{2023} < SB_{MSY}$	10		28		60		95		100
$F_{2023} > F_{MSY}$	7		28		63		100		100

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit (none for black marlin) reference points set by the Commission.

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		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	13,834 t 11,531 t	
	MSY (1000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2011}/F_{MSY} (80% CI): B_{2011}/B_{MSY} (80% CI): B_{2011}/B_{1950} (80% CI):	11.70 (8.02–12.40) 0.49 (n.a.) 23.70 t (n.a.) 0.85 (0.63–1.45) 0.98 (0.57–1.18) 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 ($B_{year}/B_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new assessment was undertaken for blue marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014.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 the stock is currently being exploited at sustainable 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. The Kobe plot (Fig. 1) from the ASPIC model indicated that the stock was subject to overfishing in the past which reduced the stock biomass to below the B_{MSY} level. 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 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 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 to the WPB, the stock status is determined to remain as **not overfished** and **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.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is between 8,023–12,400 t, and catches should not exceed the upper estimate.

- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework*, no such interim points have been established for blue marlin.
- **Main fishing gear** (2010–13): Longline and gillnet catches are currently estimated to comprise approximately 69% and 29% of the total estimated blue marlin catch in the Indian Ocean, respectively.
- **Main fleets** (2010–13): Taiwan,China: 35%; Indonesia: 24%; Pakistan: 15%.
- **Improvements required**: improvement in data collection and reporting is required to further assess the stock.

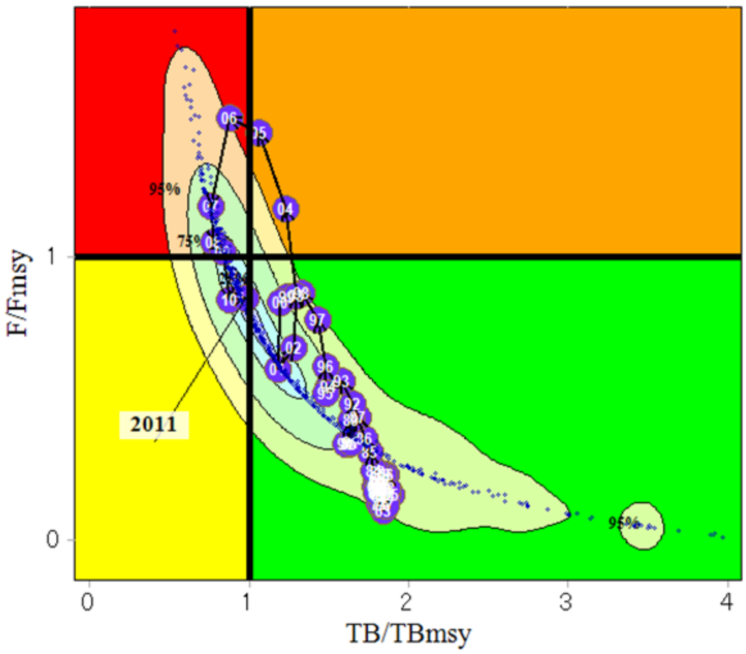


Fig. 1. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011.

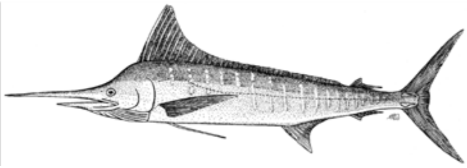
TABLE 2. Blue Marlin: Indian Ocean ASPIC Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–2013 (13,539 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years. These will be calculated 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%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2015} < B_{MSY}$	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.

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit (none for blue marlin) reference points set by the Commission.

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		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	4,429 t 3,667 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2011}/F_{MSY} (80% CI): B_{2011}/B_{MSY} (80% CI): B_{2011}/B_0 (80% CI):	4.41 t (3.54–4.58) 0.36 (n.a.) 12.43 t (n.a.) 1.28 (0.95–1.92) 0.416 (0.2–0.42) 0.18 (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 ($B_{year}/B_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new assessment was undertaken for striped marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013 an ASPIC stock assessment confirmed the preliminary assessment results from 2012 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 2011. 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. 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. Total reported landings increased in 2012 to 6,088 t, well above the MSY estimate of 4,408 t. In 2013 reported catches declined to 4,429 t, still above the MSY level. Thus, on the weight-of-evidence available to the WPB in 2014, the stock is determined to be **overfished** and **subject to overfishing** (Table 1; Fig. 1).

Outlook. The decrease in longline catch and effort in the years 2009–11 lowered the pressure on the Indian Ocean stock as a whole, however, the increased catches reported in 2012 and 2013, combined with the concerning results obtained from the preliminary stock assessment carried out in 2012 and the follow-up assessment in 2013 for striped marlin, the outlook is pessimistic for the stock as a whole and a precautionary approach to the management of striped marlin and should be considered by the Commission. There is a very high risk of exceeding the biomass MSY-based reference point by 2015 if catches increase further or are maintained at current levels (2011) until 2015 (>93% risk that $B_{2015} < B_{MSY}$), but a low risk that $F_{2019} > F_{MSY}$ (≈ 7% if maintained, ≈ 30% if increased by 10%) (Table 2).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 4,408 t (3,539–4,578). 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 2,500 t. Catches should be reduced to below 2,500 t.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework,* no such interim points have been established for striped marlin.

- **Main fishing gear** (2013): Longline and gillnet catches are currently estimated to comprise approximately 73% and 19% of the total estimated striped marlin catch in the Indian Ocean, respectively.
- **Main fleets**: Taiwan,China: 32%; Indonesia: 26%; Pakistan: 9%; I.R. Iran: 8%.
- **Improvements required**: improvement in data collection and reporting is required to further assess the stock.

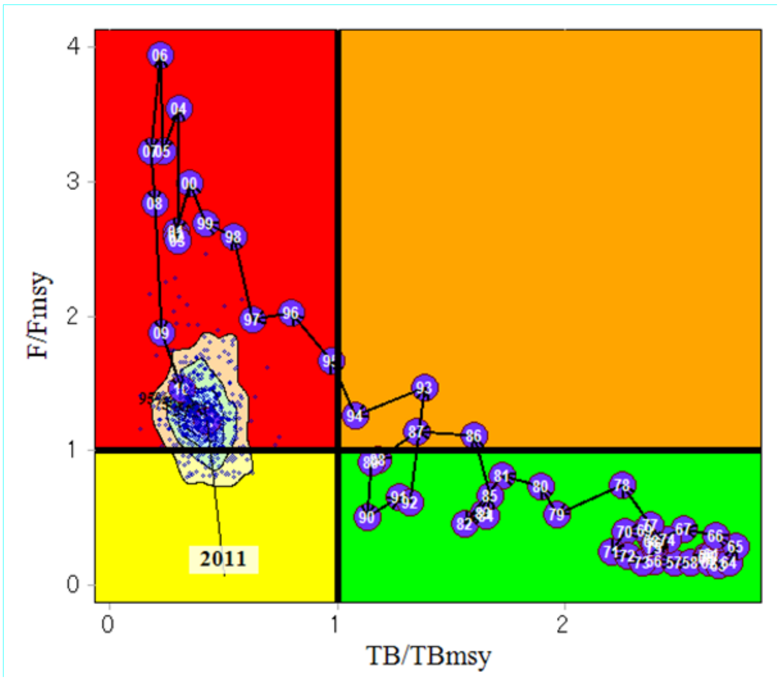


Fig. 1. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (90% bootstrap confidence surfaces shown around 2011 estimate – white dot). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011. Note: The MSY is close to the upper limit of the confidence intervals, as the bootstrap mean and ASPIC mean results are slightly different.

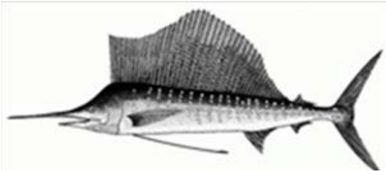
TABLE 2. Striped Marlin: Indian Ocean ASPIC Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2009–2011 (2,607 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2009–2011) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2015} < B_{MSY}$	41	59	77	85	93	96	99	99	100
$F_{2015} > F_{MSY}$	0	0	0	4	7	30	54	77	100
$B_{2022} < B_{MSY}$	0	0	0	0	0	2	4	52	100
$F_{2022} > F_{MSY}$	0	0	0	0	0	0	0	51	100

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit (none for striped marlin) reference points set by the Commission.

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		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	29,750 t 28,087 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2013}/F_{MSY} (80% CI): B_{2013}/B_{MSY} (80% CI): B_{2013}/B_0 (80% CI):	27.84 (24.70–35.00) 0.27 (0.16–0.39) 95.2 (62.89–127.73) 1.19 (0.66–1.72) 1.12 (0.88–1.37) 0.56 (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 overfished and close to or exceeding maximum sustainable yield levels (Table 1). However, as this is the first time that the WPB used such a method on Indo-Pacific sailfish, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status. Thus, the stock status remains **uncertain**. Nonetheless in using the SRA method for comparative purposes with other stocks, the WPB considers that the use of the target reference points may be possible for the approach. 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 developing possible CPUE indicators 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.

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.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is unknown.
- **Provisional reference points**: Although the Commission adopted interim reference points for swordfish in Resolution 13/10 *on interim target and limit reference points and a decision framework,* no such interim points have been established for I.P. sailfish.
- **Main fishing gear** (2010–13): Gillnet catches are currently estimated to comprise approximately 77% of the total estimated I.P. sailfish catch in the Indian Ocean.
- **Main fleets** (2010–13): I.R. Iran: 25%; Pakistan: 18%; India: 17%; Sri Lanka: 14%.

- **Improvements required**: Improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock with a greater degree of certainty.

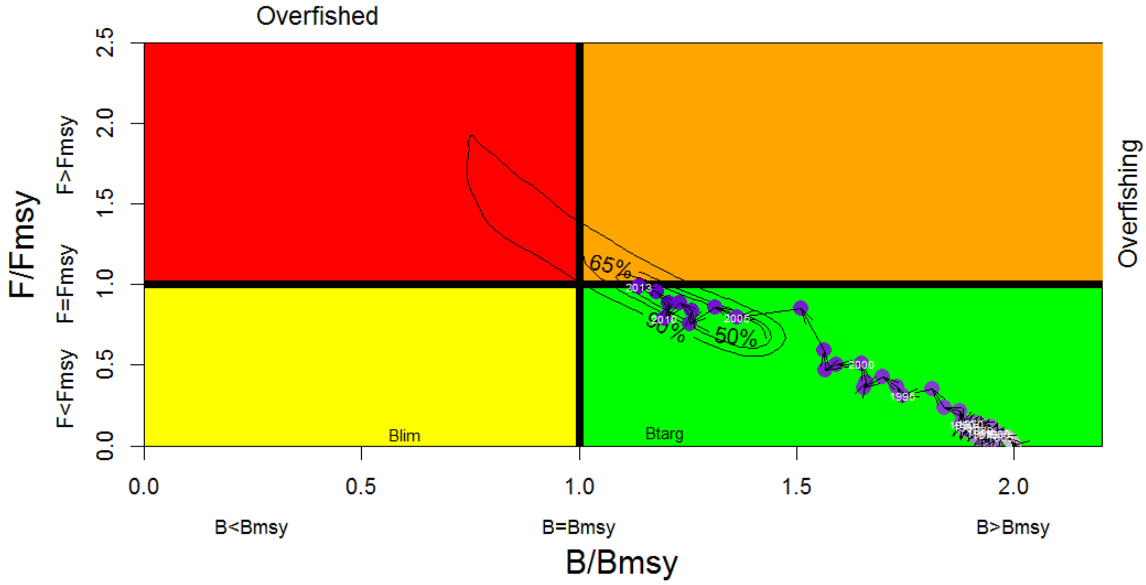


Fig. 1. Indo-Pacific sailfish: Stock reduction analysis (Catch MSY Method) of aggregated Indian Ocean assessment Kobe plot (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black lines indicate the trajectory of the point estimates (blue circles) for the B ratio and F ratio for each year 1950–2013.

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 2011–2013 (13,539 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 2011–2013) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$B_{2016} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2016} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$B_{2023} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2023} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: As detailed in Recommendation 14/07, the colour coding used above, and refers to 25% probability levels (Green = 0–25; Yellow = >25–50; Orange = >50–75; Red = >75–100) associated with the interim target and limit (none for IP sailfish) reference points set by the Commission.

APPENDIX XII
OPTIONS FOR A 'TIER' APPROACH TO PROVIDING STOCK STATUS ADVICE

A Tiered approach to providing stock status advice will enable the IOTC working parties and Scientific Committee 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.

A four tier approach may be designed to apply different types of assessments and cater for different amounts of data available for IOTC stocks. The approach could include increased levels of precaution that correspond to increasing levels of uncertainty about stock status, in order to reduce the level of risk associated with increased uncertainty. In this approach, each stock is assigned to one of four tier levels depending on the amount and type of information available to assess stock status, where Tier 1 represents the highest quality of information available (i.e. a robust quantitative stock assessment) and Tier 4 the lowest.

The four Tier rules are designed to apply to three types of assessments. Tiers 1 and 2 are used for stocks for which there is a quantitative stock assessment that provides estimates of current absolute and relative biomass (Tier 1 if the assessment is regarded as "robust", Tier 2 for a less certain or preliminary assessment).Tier 3 is based on estimates of current fishing mortality derived from catch curves (requiring age and/or length frequency data, but not catch rates or abundance estimates). Tier 4 is based on recent trends in catch rates.

Example of a 4 Tier system:
- Tier 1: robust quantitative assessment
- Tier 2: preliminary quantitative assessment
- Tier 3: estimates of F from catch curves (age/length data)
- Tier 4: trends in standardised CPUE

Tier 1

Tier 1 analysis would have a well established and agreed quantitative stock assessment. A robust quantitative assessment that provides estimates of current biomass levels, and estimates of, or appropriate proxies for B_{LIM}, B_{TARG} and F_{TARG}. The interim target and limit reference points are those set by the Commission.

Tier 2

Tier 2 analysis would apply to species and/or stocks which have a less robust quantitative assessment, or a preliminary quantitative assessment. A less robust quantitative assessment should still provide estimates of current biomass levels, and estimates of, or appropriate proxies for B_{LIM}, B_{TARG} and F_{TARG}. The interim target and limit reference points are those set by the Commission.

Tier 3

Tier 3 analysis is not a robust quantitative stock assessment, but is used where information is available on the age structure of annual catches and annual total catch weight, as well as knowledge of basic biological parameters, e.g. natural mortality, age-length relationships, length/weight relationships, stock recruitment relationship steepness, age at maturity and age at recruitment to the fishery. The estimation of fishing mortality is made using all this information. The time period used to estimate fishing mortality is the same as that used to estimate current catch.

Tier 4

Tier 4 analysis would apply to species with the least amount of information about current stock status, i.e. there is no reliable information available on either current biomass or current exploitation rate. It is assumed that there is information available on current catch levels and trends in catch rates. The Tier 4 analysis involves the selection CPUE reference points that are taken as proxies for the estimated B_{LIM} and B_{TARG}.

This is done by assuming that the CPUE is proportional to stock abundance, an assumption that is made in most assessments. If the stock was at unexploited equilibrium at the start of fishing, then the initial CPUE level at the start of the time series would correspond to the unexploited biomass or B_0, and the other reference points are the appropriate fractions of this (e.g. 20% for B_{20}). For most IOTC stocks there is not a full CPUE time series back to the start of fishing, so it is necessary to choose a reference period from the data series that we do have where we think we can make a reasonable estimate of the level of depletion of the stock. Most IOTC species are considered to be fully exploited by a particular year, so a reference period against which current rates are compared is chosen around this time when CPUE levels and catches were relatively stable. A default period may be chosen, but other periods could be used for some species and fisheries which were not fully developed by the default.

It would then be assumed that during the reference period the stock was at the level that would provide maximum sustainable yield, i.e. the CPUE corresponds to B_{MSY}. This is why, for these stocks, the Tier 4 rule would use the average CPUE in the reference period as a CPUE target, and the average catch in that period as a catch target.

APPENDIX XIII
WORKING PARTY ON BILLFISH PROGRAM OF WORK (2015–2019)

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**: Priority topics for obtaining the information necessary to develop stock status indicators for billfish in the Indian Ocean;
- **Table 2**: High priority topics, by project for billfish in the Indian Ocean; and
- **Table 3**: 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	Priority
Stock structure (connectivity)	Research to describe the population structure and connectivity of billfish within the Indian Ocean (and adjacent Pacific and Atlantic waters as appropriate) (Priority species: High = swordfish, striped marlin; Medium = Indo-Pacific sailfish)	High
	▪ Genetics	High
	▪ Otolith microchemistry/isotope research	Med
	▪ Otolith shape	Med
	▪ Tagging studies (P-SAT)	High
	▪ Tagging studies (opportunistic conventional tagging)	Med
Biological and ecological information (parameters for stock assessment)	Age and growth research	High
	Age-at-Maturity	High
	Fecundity-at-age/length relationships	Medium
	Spawning time and locations	High
Historical data review	Changes in fleet dynamics	High
	Species identification	High
Sports/recreational fisheries	Fishery trends	High
CPUE standardisation	Develop and/or revise standardised CPUE series for each billfish species and major fisheries/fleets for the Indian Ocean Swordfish: Priority LL fleets: Taiwan,China, EU(Spain, Portugal, France), Japan, Indonesia Striped marlin: Priority fleets: Japan, Taiwan,China Black marlin: Priority fleets: Taiwan,China Blue marlin: Priority fleets: Taiwan,China Sailfish: Priority fleets: Priority LL fleets: EU(Spain, Portugal, France), Japan, Indonesia; Priority GN fleets: I.R. Iran and Sir Lanka	High
Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for all billfish	High
	Develop and investigate new methods for data poor stocks (marlins and IP sailfish)	High
Target and Limit reference points	To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs).	High
Management measure options	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

Table 2. High priority topics, by project for billfish in the Indian Ocean.

Topic	Sub-topic and project	Priority
Stock structure (connectivity)	Research to describe the population structure and connectivity of billfish (swordfish and striped marlin) within the Indian Ocean (and adjacent Pacific and Atlantic waters as appropriate) ▪ Next Generation Sequencing (NGS) to determine the degree of shared stocks for billfish (highest priority species: swordfish and striped marlin) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate. ▪ Nuclear markers (i.e. microsatellite) to determine the degree of shared stocks for billfish (highest priority species: striped marlin) in the Indian Ocean with the southern Atlantic Ocean and Pacific Ocean, as appropriate. ▪ Tagging studies (P-SAT)	High
Biological and ecological information (parameters for stock assessment)	Age and growth research ▪ CPCs to provide further research reports on billfish biology, namely age and growth studies including using through the use of fish otolith or other hard parts, either from data collected through observer programs or other research programs.	High
	Age-at-Maturity ▪ Quantitative biological studies are necessary for billfish throughout their range to determine key biological parameters including age/size-at-maturity and fecundity-at-age/length relationships, which will be fed into future stock assessments.	High
	Spawning time and locations ▪ Collect gonad samples from billfish to confirm the spawning time and location of the spawning area that are presently hypothesized for each billfish species	High
Historical data review	Changes in fleet dynamics ▪ Japan and Taiwan,China to undertake an historical review of their longline fleets and to document the changes in fleet dynamics. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.	High
	Species identification ▪ 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.	High
Sports/recreational fisheries	Fishery trends ▪ The catch and effort data for sports/recreational fisheries targeting marlins and sailfish in the Indian Ocean should be submitted to the IOTC Secretariat to assist in future assessments for these species. CPCs with active sports/recreational fisheries targeting marlins and sailfish should undertake a comprehensive analysis for provision to the WPB.	High
CPUE standardisation	Develop and/or revise standardised CPUE series for each billfish species and major fisheries/fleets for the Indian Ocean ▪ Swordfish: Priority LL fleets: Taiwan,China, EU(Spain, Portugal, France), Japan, Indonesia ▪ Striped marlin: Priority fleets: Japan, Taiwan,China ▪ Black marlin: Priority fleets: Taiwan,China ▪ Blue marlin: Priority fleets: Taiwan,China ▪ IP Sailfish: Priority fleets: Priority LL fleets: EU(Spain, Portugal, France), Japan, Indonesia; Priority GN fleets: I.R. Iran and Sir Lanka	High

Stock assessment / Stock indicators	Develop and compare multiple assessment approaches to determining stock status for billfish	High
Target and Limit reference points	To advise the Commission, by end of 2016 at the latest on Target Reference Points (TRPs) and Limit Reference Points (LRPs). ▪ Used when assessing billfish stock status and when establishing the Kobe plot and Kobe matrices	High
Management measure options	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. ▪ 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.	High

Table 3. Assessment schedule for the IOTC Working Party on Billfish (WPB)

Species	**2015 (5 day meeting)**	**2016 (5 day meeting)**	**2017 (5 day meeting)**	**2018 (4 day meeting)**	**2019 (4 day meeting)**
Working Party on Billfish					
Black marlin		**Full assessment***		**Full assessment***	
Blue marlin		**Full assessment***			**Full assessment***
Striped marlin	**Full assessment***		**Full assessment***		**Full assessment***
Swordfish (IO, SWIO)	Indicators	Indicators	**Full assessment**		
Indo-Pacific sailfish	**Full assessment***			**Full assessment***	

***Including data poor stock assessment methods**

APPENDIX XIV
CONSOLIDATED RECOMMENDATIONS OF THE 12TH SESSION OF THE WORKING PARTY ON BILLFISH

Note: Appendix references refer to the Report of the 12th Session of the Working Party on Billfish (IOTC–2014–WPB12–R)

Meeting participation fund

WPB12.01 (para. 13): **NOTING** that the MPF was used to fund the participation of only 4 national scientists to the WPB12 meeting in 2014 (from 8 applications) compared to 10 recipients in 2013 (from 10 applications), all of which were required to submit and present a working paper at the WPB meeting, the WPB **RECOMMENDED** that the Scientific Committee consider the following:

- The IOTC Meeting Participation Fund (MPF), adopted by the Commission in 2010 (Resolution 10/05 *On the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and now incorporated into the IOTC Rules of Procedure (2014), was established for the purposes of supporting scientists and representatives from IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs) who are developing States to attend and contribute to the work of the Commission, the Scientific Committee and its Working Parties.
- The Commission has made the following directives to the IOTC Secretariat:
  - a) The Commission had directed the IOTC Secretariat (via Resolution 10/05 and now via the IOTC Rules of Procedure (2014)) to ensure that: (para. 88 of the S18 Report)
    - iv. the MPF be utilised, as a first priority, to support the participation of scientists from developing CPCs in scientific meetings of the IOTC, including Working Parties, rather than non-science meetings.
    - v. the MPF will be allocated in such a way that no more than 25% of the expenditures of the Fund in one year is used to fund attendance to non-scientific meetings.
    - vi. thus, 75% of the annual MPF shall be allocated to facilitating the attendance of developing CPC scientists to the Scientific Committee and its Working Parties.
  - b) The Commission had directed the IOTC Secretariat that any cost savings made on the annual IOTC budget, shall also be used to further supplement the $60,000 currently budgeted for the MPF.
- In accordance with para. 89 of the S18 Report, the IOTC Secretariat is actively seeking extra budgetary funding sources to supplement the MPF budget from individual Contracting Parties as well as other interested groups. However, the WPB was informed by the IOTC Secretariat that other sources should actively be sought by interested candidates, including the UNFSA meeting fund, as well as through their own domestic budgetary processes.
- The detailed explanation of the MPF usage and expenditure in 2014, as described in para. 14 below.

WPB12.02 (para. 15): The WPB **RECOMMENDED** that the Scientific Committee consider revising the MPF rules of procedure, so that a Draft paper be submitted to the relevant Working Party MPF Selection Panel earlier than the current 15 days before the meeting, so that the Panel may review the full paper rather than just the abstract, and provide guidance on areas for improvement and the suitability of the application to receive funding using the MPF. The justification of this request is based upon the reduced funds available and the need to maximise benefits. However, some participants did not want the deadline to be brought earlier than the current 15 day deadline.

Resolution 11/04 *on a Regional Observer Scheme*

WPB12.03 (para. 20): **NOTING** that electronic monitoring (video) has now been trialled and successfully implemented in many fisheries worldwide (e.g. Australia, European Union, USA, New Zealand), with the aim of supplementing scientific observers on board vessels; and given the current difficulties cited as reasons for not deploying scientific observers under the IOTC Regional Observer Scheme (ROS) on board large-scale gillnet vessels operating in the Indian Ocean; the WPB **RECOMMENDED** that the IOTC Secretariat, facilitate the development of a project concept note/proposal to trial video monitoring to evaluate the efficacy of video cameras in the collection of information on catch, discards and fishing effort as a means to supplement scientific observer coverage for large-scale gillnet vessels. The trial will include an evaluation of the main challenges of using video data such as the accurate identification of IOTC and bycatch species, weight and size of catches and the time taken to process the footage and extract the required data. The concept note/proposal shall also include a clear indication that the IOTC data confidentiality policy (Resolution 12/02) will need to be modified to ensure any data/information collected is for the sole purpose of scientific analysis and not for compliance purposes. The concept note should include a detailed budget and be communicated to a range of potential funding organisations.

Billfish species identification

WPB12.04 (para. 28): **NOTING** the recent online survey distributed by the IOTC Secretariat, the WPB strongly **RECOMMENDED** that the IOTC Secretariat ensure that hard copies of the identification cards continue to be printed in hard copy form 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 on board. 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.

Recreational and sports fisheries for marlins and IP sailfish in the Indian Ocean

WPB12.05 (para. 63): **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 WPB **RECOMMENDED** that the Chair and Vice-Chair 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 will be 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.

Revision of the WPB Program of work (2015–2019)

WPB12.06 (para. 154): **NOTING** that one of the Indian Ocean billfish species (shortbill spearfish, *Tetrapturus angustirostris*) is currently not listed among the species managed by IOTC, and considering the ocean-wide distribution of this species, its highly-migratory nature, and that it is a common bycatch in IOTC managed fisheries, the WPB **RECOMMENDED** that the SC consider requesting the Commission to include it in the list of species to be managed by the IOTC.

WPB12.07 (para. 159): The WPB **RECOMMENDED** that the Scientific Committee consider adopting 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.

WPB12.08 (para. 160): The WPB **RECOMMENDED** that the SC consider and endorse the WPB Program of Work (2015–2019), as provided at Appendix XIII.

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

WPB12.09 (para. 165): The WPB **RECOMMENDED** that a consultant be hired to assist in building capacity among the WPB participants by supplementing the skill set available within IOTC CPCs to develop data poor stock assessment approaches for billfish stocks. An indicative budget is provided at Table 24.

Table 24. Estimated budget required to hire a consultant to carry out data poor stock assessment on billfish species in 2015 and 2016.

Description	Unit price	Units required	2015 Total (US$)	2016 Total (US$)
Billfish tuna stock assessments using data poor approaches and/or indicator development (fees)	450	25	11,250	11,250
Billfish tuna stock assessment and/or indicator development (travel)	5,000	1	5,000	5,000
		Total estimate	**16,250**	**16,250**

Consolidated recommendations of the 12th Session of the Working Party on Billfish

WPB12.10 (para. 169): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB12, provided at Appendix XIV, 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 2014 (Fig. 11):

- 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

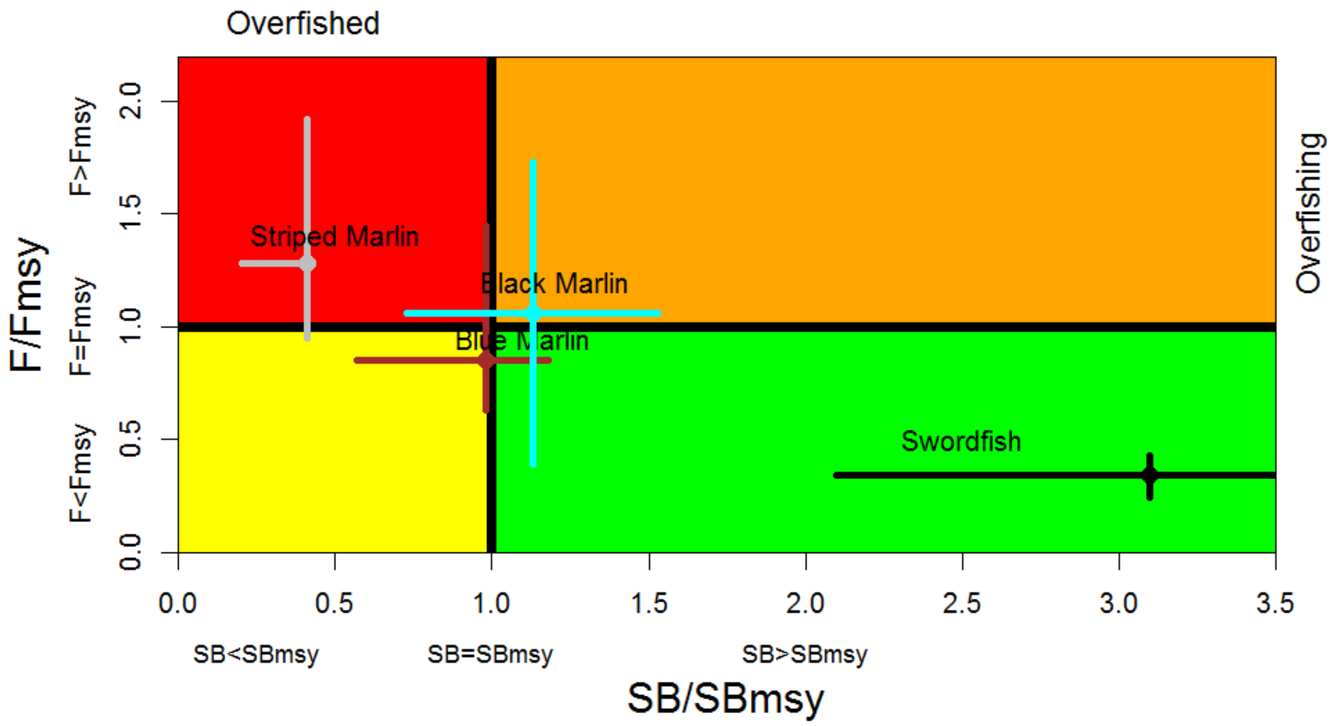


Fig. 11. Combined Kobe plot for swordfish (black), black marlin (light blue), blue marlin (brown) and striped marlin (grey) showing the 2013 and 2014 estimates of current stock size (SB or B, species assessment dependent) and current fishing mortality (F) in relation to optimal spawning stock size and optimal fishing mortality. Cross bars illustrate the range of uncertainty from the model runs.