Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
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IOTC–2013–WPB11–R[E]

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

La Réunion, France, 18–22 September 2013

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BIBLIOGRAPHIC ENTRY

IOTC–WPB11 2013. Report of the Eleventh Session of the IOTC Working Party on Billfish. La Réunion, France, 18–22 September 2013. *IOTC–2013–WPB11–R[E]: 85 pp.*

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Indian Ocean Tuna Commission
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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 organization
PS	Purse-seine
q	Catchability
ROS	Regional Observer Scheme
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SFA	Indo-Pacific sailfish (FAO code)
SS3	Stock Synthesis III
STM	Striped marlin (FAO code)
SWO	Swordfish
Taiwan,China	Taiwan, Province of China
WPB	Working Party on Billfish of the IOTC
WPTT	Working Party on Tropical Tunas of the IOTC

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

Level 1: **RECOMMENDED, RECOMMENDATION**: Any conclusion from a subsidiary body of the Commission 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). The intention is that the higher body will consider the recommended action for endorsement.

Level 2: **REQUESTED**: A request from an IOTC body to a particular CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task. Ideally this should be highly specific and contain a timeframe for the completion of the task.

Level 3: **AGREED**: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action for the IOTC body, or a general point of agreement among participants of the meeting.

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 perpetuity.

Any other term: Any other term may be used in addition to the above key terms to highlight to the reader the importance of the relevant paragraph in a report. However, other terms used are considered for explanatory/informational purposes only and have no rating within the reporting terminology hierarchy described above (e.g. Considered; Urged; Acknowledged).

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EXECUTIVE SUMMARY

The Eleventh Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in La Réunion, France, from 18 to 22 September 2013. A total of 24 (23 in 2012) participants attended the Session, including one invited expert, Dr. Humber Andrade, from the Universidade Federal Rural de Pernambuco, Brazil.

The meeting was opened on 18 September, 2013 by the Chair, Dr Jérôme Bourjea (La Réunion, France), who welcomed participants to La Réunion, France.

Catch, Catch-and-effort, Size data

The WPB **RECOMMENDED** that all CPCs assess and improve the status of catch-and-effort data for marlins (by species) and sailfish, noting that improvements to the data for the EU fleets and its provision to the IOTC Secretariat, would be most beneficial to the work of the WPB. (para. 25)

Effect of piracy on billfish fisheries

The WPB **NOTED** that, although no specific analysis of the impacts of piracy on fisheries in the Indian Ocean were presented at this meeting, paper IOTC–2013–WPB11–07 Rev_1 indicated that there has been a substantial displacement of catch (Fig. 1) and effort eastward (Fig. 2). 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 (Fig. 3). In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia. (para. 40)

The WPB **NOTED** that the relative number of active longline vessels in the IOTC area of competence have declined substantially since 2008 (Fig. 3), and **AGREED** that this was likely due to the impact of piracy activities in the western Indian Ocean. Since 2011, there has been an increase in the relative number of active longline vessels in the Indian Ocean for Japan (68 in 2011 to 98 in 2012), China (10 in 2011 to 32 in 2012) and the Philippines (2 in 2011 to 14 in 2012) (Fig. 3). (Para. 41)

Pakistan gillnet fishery

RECALLING IOTC Resolution 12/12 *to prohibit the use of large-scale driftnets on the high seas in the IOTC area*, paragraph 1, which states:

> *"1. The use of large-scale driftnets on the high seas within the IOTC area of competence shall be prohibited." "Large-scale driftnets" are defined as gillnets or other nets or a combination of nets that are more than 2.5 kilometers in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column."*,

the WPB **RECOMMENDED** that the SC note the findings of the study that gillnets in excess of the 2.5 km limit are being used by the gillnet fleets of Pakistan on the high seas, in contravention of Resolution 12/12. (para. 44)

Revision of the WPB workplan

The WPB **RECOMMENDED** that the SC consider and endorse the workplan and assessment schedule for the WPB for 2014, and tentatively for future years, as provided at Appendix XII and Appendix XIII, respectively. (para 192)

Consolidated recommendations of the Eleventh Session of the Working Party on Billfish

The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB11, provided at Appendix XIV, as well as the management advice provided in the draft resource stock status summary for each of the billfish species under the IOTC mandate: (para 205)

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

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	Advice to Commission
Swordfish (whole IO) *Xiphias gladius*	Catch 2011: 21,916 t Average catch 2007-2011: 25,461 t MSY (range): 29,900 t–34,200 t F_{2009}/F_{MSY}: 0.50–0.63 SB_{2009}/SB_{MSY}: 1.07–1.59 SB_{2009}/SB_0: 0.30–0.53	2007					At this time, annual catches of swordfish should not exceed 30,000 t. If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments. <click here for full summary>
Swordfish (southwest IO) *Xiphias gladius*	Catch 2011: 7,566 t Average catch 2007-2011: 8,299 t MSY (range): 7,100 t–9,400 t F_{2009}/F_{MSY}: 0.64–1.19 SB_{2009}/SB_{MSY}: 0.73–1.44 SB_{2009}/SB_0: 0.16–0.58						Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean is not a separate genetic stock. However this region has been subject to localised depletion over the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY}. The catches of swordfish in the southwest Indian Ocean increased in 2010 to 8,046 t, which equals 120.5% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011. If catches are maintained at 2010 levels, the probabilities of violating target reference points in 2012 are less than 18% for F_{MSY} and less than 30% for B_{MSY}, which is considered low. Given that the total estimated catch in 2011 was 7,566 t, lower that the 2010 estimate, the resource remains not subject to overfishing but overfished. <click here for full summary>
Black marlin *Makaira indica*	Catch 2011: 10,291 t Average catch 2007–2011: 9,345 t MSY (range): 8,605 (6,278–11,793) F_{2011}/F_{MSY} (range): 1.03 (0.15–2.19) B_{2011}/B_{MSY} (range): 1.17 (0.75–1.55) B_{2011}/B_0 (range): 0.58 (0.38–0.78)						Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished but is subject to overfishing. However, as this is the first time that the WPB used such a method on marlins, 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. <click here for full summary>
Blue marlin *Makaira nigricans*	Catch 2011: 10,340 t Average catch 2007–2011: 10,074 t MSY (range): 11,690 (8,023–12,400) F_{2011}/F_{MSY} (range): 0.85 (0.63–1.45) B_{2011}/B_{MSY} (range): 0.98 (0.57–1.18) B_{2011}/B_0 (range): 0.48 (na)						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 indicates 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. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be not overfished and not subject to overfishing. <click here for full summary>

Stock	Indicators	Prev[1]	2010	2011	2012	2013	Advice to Commission
Striped marlin *Tetrapturus audax*	Catch 2011: 2,470 t Average catch 2007–2011: 2,538 t MSY (range): 4,408 (3,539–4,578) F_{2011}/F_{MSY} (range): 1.28 (0.95–1.92) B_{2011}/B_{MSY} (range): 0.416 (0.2–0.42) B_{2011}/B_0 (range): 0.18 (n.a.)					Red	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 indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. 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 model indicates that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be overfished and subject to overfishing. <click here for full summary>
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2011: 28,821 t Average catch 2007–2011: 24,494 t MSY (range): Unknown						No quantitative stock assessment is currently available for Indo-Pacific sailfish in the Indian Ocean; due to a lack of fishery data and poor quality of available data for several gears, only preliminary stock indicators can be used. A data poor approach was pursued by the WPB in 2013, though results were considered preliminary and require further sensitivity analysis. Therefore stock status remains uncertain. 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. <click here for full summary>

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

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

1. Opening of the Session

1. The Eleventh Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in La Réunion, France, from 18 to 22 September 2013. A total of 24 (23 in 2012) participants attended the Session. The list of participants is provided at Appendix I.

2. The meeting was opened on 18 September, 2013 by the Chair, Dr Jérôme Bourjea (La Réunion, France), who welcomed participants to La Réunion, France.

Meeting participation fund

3. **NOTING** that 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*), was used to fund the participation of 10 national scientists to the WPB11 meeting (5 in 2012), all of which were required to submit and present a working paper at the meeting, the WPB **RECOMMENDED** that this fund be maintained into the future.

4. The WPB **RECALLED** that the MPF 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.

5. **NOTING** that the Commission had directed the Secretariat (via Resolution 10/05) to ensure that 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, the WPB **RECOMMENDED** that the Secretariat strictly adhere to the directives of the Commission contained in Resolution 10/05, including paragraph 8 which states that '*The Fund 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*.' 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.

2. Adoption of the Agenda and Arrangements for the Session

6. The WPB **ADOPTED** the Agenda provided at Appendix II. The documents presented to the WPB11 are listed in Appendix III.

3. Outcomes of the Fifteenth Session of the Scientific Committee

7. The WPB **NOTED** paper IOTC–2013–WPB11–03 which outlined the main outcomes of the Fifteenth Session of the Scientific Committee (SC15), specifically related to the work of the WPB.

8. The WPB **NOTED** the recommendations of the SC15 on data and research, and agreed to consider how best to progress these issues at the present meeting, in particular on the CPUE analysis of marlins and sailfish, with a core focus on striped marlin.

4. Outcomes of Sessions of the Commission

4.1 Outcomes of the Seventeenth Session of the Commission

9. The WPB **NOTED** paper IOTC–2013–WPB11–04 which outlined the main outcomes of the Seventeenth Session of the Commission, specifically related to the work of the WPB, and **AGREED** to consider how best to provide the SC with the information it needs, in order to satisfy the Commission's requests, throughout the course of the meeting.

10. The WPB **NOTED** the 11 Conservation and Management Measures (CMMs) adopted at the Seventeenth Session of the Commission (consisting of 11 Resolutions and 0 Recommendations), and in particular the following Resolutions which have a direct impact on the work of the WPB:
    - Resolution 13/03 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence*

- Resolution 13/08 *Procedures on a fish aggregating devices (FADs) management plan, including more detailed specification of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of non-target species*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*

Alternative management measures for swordfish

11. The WPB **NOTED** 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.

Kobe II Strategy Matrix

12. The WPB **NOTED** the Commission's request that a Kobe II strategy matrix be provided for all stock assessments (including for SWO in the SWIO) by the species Working Parties, and for these to be included in the report of the SC in 2014 and all future reports. The Commission considered the strategy matrix to be a useful and necessary tool for management.

Employment of a Fisheries Officer

13. **NOTING** that the Commission at its 17th Session approved a new Fishery Officer (Science) position at the IOTC Secretariat, the WPB **REQUESTED** that the Secretariat expedite the recruitment process so that the successful candidate can commence work as soon as possible.

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

14. The WPB **NOTED** paper IOTC–2013–WPB11–05 which aimed to encourage the WPB to review the existing Conservation and Management Measures (CMMs) relevant to billfish, and as necessary to 1) provide recommendations to the SC on whether modifications may be required; and 2) recommend whether other CMMs may be required.

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

5. Progress on the Recommendations of WPB10

16. The WPB **NOTED** paper IOTC–2013–WPB11–06 which provided an update on the progress made in implementing the recommendations from the previous WPB, which were endorsed by the SC, and to provide alternative recommendations for those yet to be completed.

17. 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).

18. The WPB **REQUESTED** that the Secretariat continue to annually 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

19. The WPB **NOTED** paper IOTC–2013–WPB11–08 which provided an update on the development and production of identification cards for billfish.

20. The WPB **EXPRESSED** its thanks to the IOTC Secretariat and other experts involved in the development of the identification cards for billfish and **RECOMMENDED** that the cards be translated into the following languages, in priority order: Farsi, Arabic, Indonesian, Swahili, Spanish, Portuguese and Thai, and that the Commission allocate funds for this purpose. The Secretariat should utilise any remaining funds in the IOTC Capacity Building budget line for 2013 to translate the cards.

21. The WPB **RECOMMENDED** that the Commission allocate additional funds in 2014 to further translate and print sets of the billfish identification cards (budget estimate: Table 2).

TABLE 2. Estimated translation, production and printing costs for 1000 sets of identification guides for billfish.

Description	Unit price	Units required	Total
Translation (per language)	$1000	7	7,000
Typesetting	$1000	4	4,000
Billfish ID cards	$6	1000	6,000
Total estimate (US$)			**17,000**

22. The WPB **REQUESTED** that the IOTC Secretariat makes further edits/improvements in the cards for the next 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.

23. The WPB **ENCOURAGED** all CPCs to implement training sessions on billfish identification to improve the quality of data collected in the field for their observers.

Length-age keys

24. The WPB **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Catch, Catch-and-effort, Size data

25. The WPB **RECOMMENDED** that all CPCs assess and improve the status of catch-and-effort data for marlins (by species) and sailfish, noting that improvements to the data for the EU fleets and its provision to the IOTC Secretariat, would be most beneficial to the work of the WPB.

26. The WPB **REQUESTED** that all CPCs provide the IOTC Secretariat with longline catch-and-effort and size data of marlins (by species) and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

27. The WPB **REQUESTED** that Japan resume size sampling on its commercial longline fleet, and that Taiwan,China provide size data for its fresh longline fleet to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

28. The WPB **REQUESTED** that Indonesia and India continue to improve their data collection programs and provide catch-and-effort and size frequency data for their longline fleets, to the IOTC Secretariat.

29. The WPB **REQUESTED** that all CPCs having artisanal and semi-industrial fleets, in particular I.R. Iran, Pakistan and Sri Lanka, continue to improve and provide catch and effort as well as size data as per IOTC requirements for billfish caught by their fleets. Some developing coastal states indicated that they have difficulties meeting these requirements.

30. **NOTING** that not all CPCs are collecting size data using standard measurements, the WPB **AGREED** that only lower-jaw to fork length, eye to fork length or pectoral to second dorsal length should be taken by fishers, samplers and observers for billfish species.

31. The WPB **REQUESTED** that the EU record and report information on catches of billfish, by species, for its purse seine fisheries.

Data inconsistencies

32. 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, Rep. of Korea and EU,Spain and to report final results at the next WPB meeting.

33. The WPB **REQUESTED** from 2011 that as a matter of priority, India, I.R. Iran (provided by I.R. in August 2013) and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, by the reporting deadline of 30th June each year, noting that this is already a mandatory reporting requirement. As part of this process, these CPCs shall use the billfish identification cards to improve the identification of marlin species caught by their fisheries.

6. MARLINS

6.1 Review of data available at the Secretariat for marlins

34. The WPB **NOTED** paper IOTC–2013–WPB11–07 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 1950–2011. Statistics for 2012 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October). 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.

35. 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.

36. 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 **REQUESTED** that CPCs 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.

37. The WPB **ACKNOWLEDGED** the excellent work undertaken by the IOTC Secretariat in updating the statistics paper and associated data files for the use of the WPB participants, although the latest years data (2011) for the marlins (by species) and sailfish was missing and should be included, as is done for swordfish.

38. The WPB **NOTED** that I.R. Iran had reported data for 2012, but that it was too late to be included in this year's report. Other issues on data inconsistencies with Yemen, missing data from sport fishing groups were also **NOTED**.

39. **NOTING** that the work carried out during the meeting requires an IOTC data expert to be in attendance at each meeting to answer the many and varied questions from participants, the WPB strongly **RECOMMENDED** that the Secretariat support team attending the WPB meeting each year, also contain a staff member from the IOTC Data Section, in addition to the Science Manager and Fishery Officer (Stock Assessment), and for the attendance of the third team member to be incorporated into the IOTC budget for 2014 and for all future years.

Effect of piracy on billfish fisheries

40. The WPB **NOTED** that, although no specific analysis of the impacts of piracy on fisheries in the Indian Ocean were presented at this meeting, paper IOTC–2013–WPB11–07 Rev_1 indicated that there has been a substantial displacement of catch (Fig. 1) and effort eastward (Fig. 2). 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 (Fig. 3). In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia.

41. The WPB **NOTED** that the relative number of active longline vessels in the IOTC area of competence has declined substantially since 2008 (Fig. 3), and **AGREED** that this was likely due to the impact of piracy activities in the western Indian Ocean. Since 2011, there has been an increase in the relative number of active longline vessels in the Indian Ocean for Japan (68 in 2011 to 98 in 2012), China (10 in 2011 to 32 in 2012) and the Philippines (2 in 2011 to 14 in 2012) (Fig. 3).

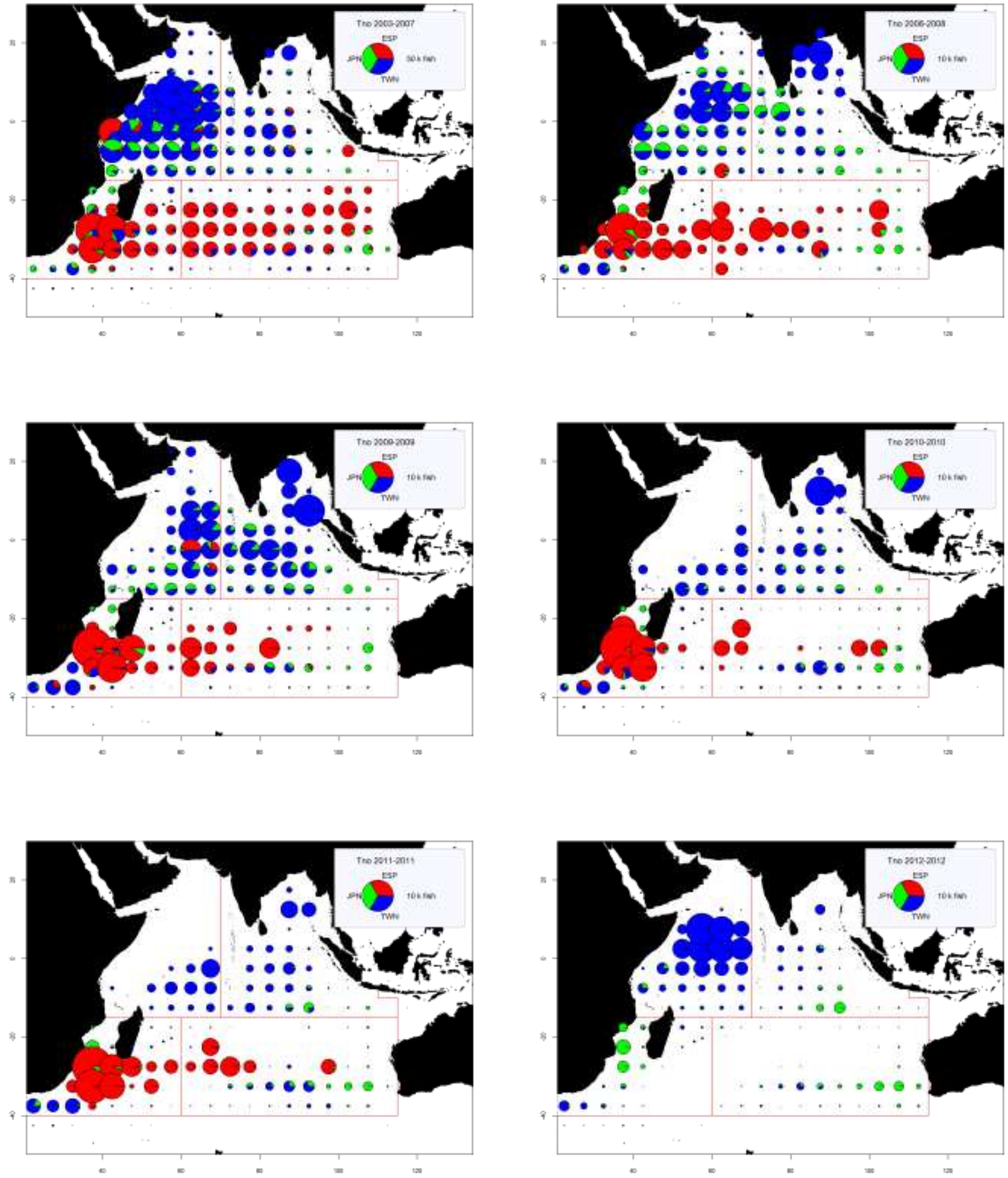

Fig. 1. The geographical distribution of swordfish catches (tonnes) as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU,Spain (ESP), the latter directed at swordfish, for the period 2002–06 and annually from 2007–11. Red lines represent the boundaries of the areas used for the assessments of swordfish. Catch: Japanese longline (green), EU,Spain longline (red), Taiwan,China longline (blue).

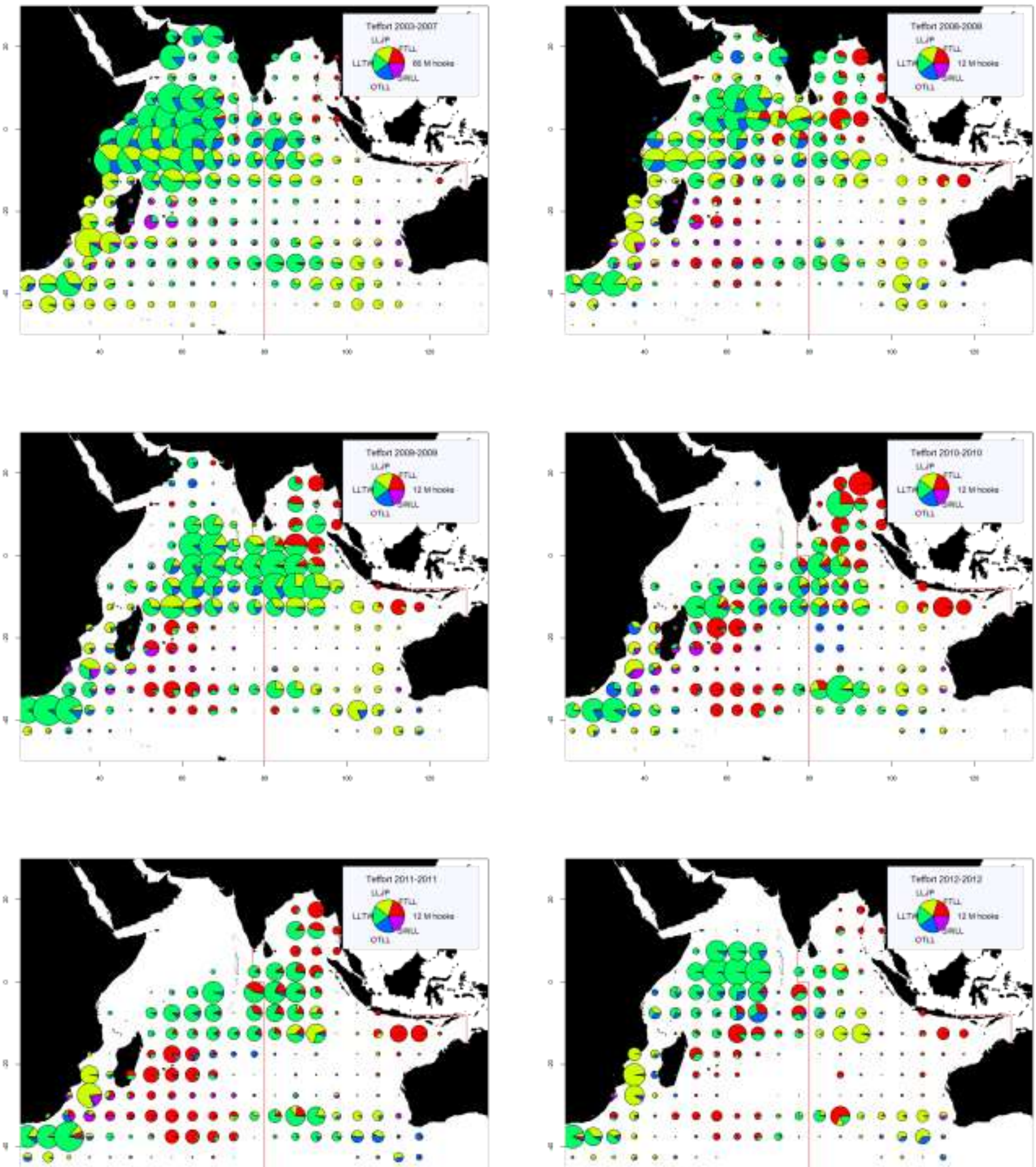

Fig. 2. The geographical distribution of effort by the main longline fleets (millions of hooks) in the IOTC area of competence, for the period 2002–06 and annually from 2007–11 by year, and main fleet. Red lines represent the boundaries of the areas used for the assessments of swordfish. Effort: LLJP (light green): deep-freezing longliners from Japan; LLTW (dark green): deep-freezing longliners from Taiwan,China; SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets); FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets); OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets).

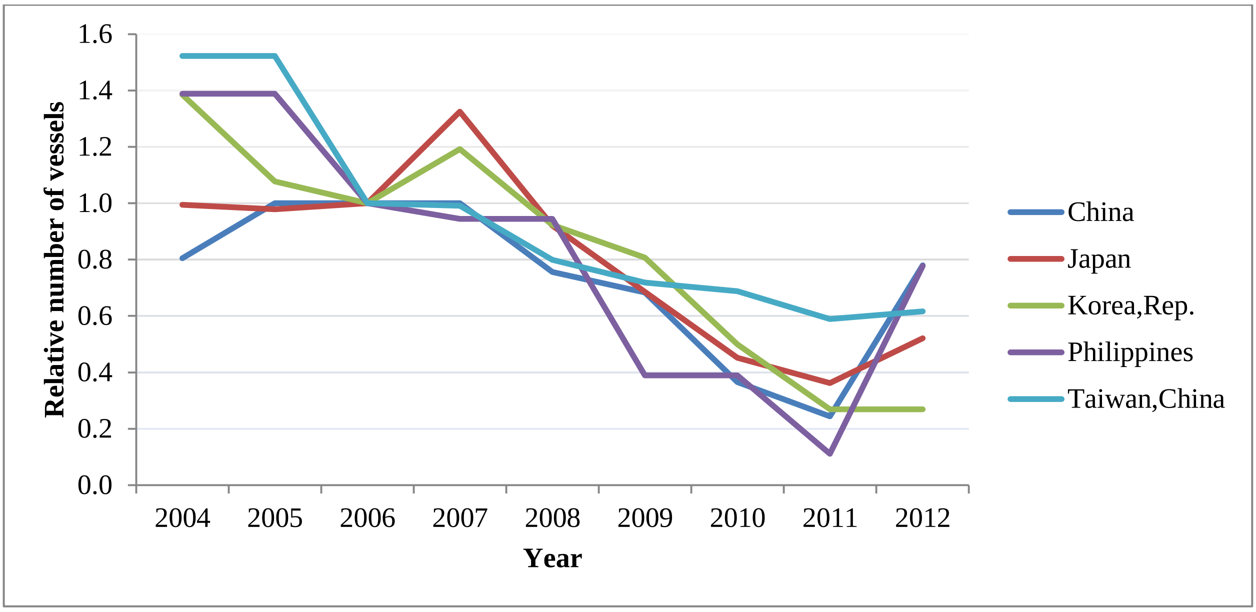

Fig. 3. The change in the relative number of active longline vessels for some fleets in the Indian Ocean since 2004 (Numbers have been scaled to the number of active vessels in 2006).

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

42. The WPB **REQUESTED** that all papers being provided for the consideration of participants clearly present information in support of the analysis undertaken.

Pakistan gillnet fishery

43. The WPB **NOTED** paper IOTC–2013–WPB11–11 which provided an overview of the pelagic gillnet fisheries of Pakistan and their catches of billfish, including the following abstract provided by the authors:

    "*Billfish forms an important part of the bycatch of tuna gillnetting in Pakistan. Represented by six species, annual landing of billfishes is estimated to be about 3,700 m. tons. Although data pertaining to species composition is not recorded but studies initiated by WWF-Pakistan indicate that Indo-Pacific sailfish is the most dominating species of billfish found in Pakistan followed by black marlin and striped marlin. Swordfish is the rarest of all the billfishes which is seldom caught by pelagic gillnetters. Billfishes are not consumed in Pakistan, therefore, major part of the catch is smuggled to Iran whereas small quantities, in salted-dried form, is exported to its traditionally market in Sri Lanka. WWF-Pakistan has recently started data collection regarding fishing ground, species composition, population parameters and other aspects of billfish fishery which revealed that seasonal abundance correlates significantly with the prevailing oceanographic conditions in the northern Arabian Sea. WWF-Pakistan is now endeavouring to establish similar data collection programme in other regional countries of the Northern Arabian Sea so that information about these highly migratory species from the region is available for taking management of the billfish fisheries of the area.*"

44. **RECALLING** IOTC Resolution 12/12 *to prohibit the use of large-scale driftnets on the high seas in the IOTC area*, paragraph 1, which states:

    "1. The use of large-scale driftnets on the high seas within the IOTC area of competence shall be prohibited." "Large-scale driftnets" are defined as gillnets or other nets or a combination of nets that are more than 2.5 kilometers in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column.",

    the WPB **RECOMMENDED** that the SC note the findings of the study that gillnets in excess of the 2.5 km limit are being used by the gillnet fleets of Pakistan on the high seas, in contravention of Resolution 12/12.

45. The WPB **AGREED** that the use of gillnets longer than 2.5 kms within the EEZ of a CPCS, although not prohibited, is not an advisable practice given the likely impacts on coastal ecology, in particular, on marine turtles, marine mammals and other vulnerable bycatch species.

46. The WPB **ENCOURAGED** the authors to continue to gather information on the gillnet fisheries of Pakistan and provide an update at the next WPB meeting.

I.R. Iran billfish fishery

47. The WPB **NOTED** paper IOTC–2013–WPB11–12 which outlined the billfish fishery in the I.R. Iran, including the following abstract provided by the authors:

“*Fishery for tuna and tuna-like species is a major component in large pelagic fisheries in Iran and one of the most important activities in the Persian Gulf and Oman Sea. There are 4 coastal provinces in the areas and about 6,500 out of the 12,000 vessels consist of fishing boats, dhows and vessels which are engaged in tuna and tuna-like species fishing activities in the coastal and offshore waters. Gillnet and purse seine are two main fishing gears for catching large pelagic species in the IOTC area of competence and also some of the small boats use trolling in coastal fisheries. The annual production of large pelagic fishes in Iran was 236,000 t in 2012, of which 208,000 t belongs to tuna and tuna-like fishes in the Indian Ocean areas. Those catches consist of yellowfin tuna 35,110 t, skipjack tuna 27,051 t, bigeye tuna 1,644 t, longtail tuna 76,297 t, kawakawa 26,249 t, frigate tuna 8,219 t, billfish 11,297 t, Indo-Pacific king mackerel 5,537 t and narrow-barred Spanish mackerel 16,510 t.*” – (see paper for full abstract)

48. The WPB **NOTED** the substantial improvement in the data collection programs in I.R. Iran including reporting of species-specific data and **COMMENDED** I.R. Iran for undertaking various actions to implement the recommendations from the previous WPB and SC meetings in 2012.

49. The WPB **NOTED** that I.R. Iran had developed a bycatch committee to deal with all bycatch species matters, although the collection and provision of data for species other than billfish will take more time. Translating the species identification cards into Farsi will assist in this process.

50. The WPB **NOTED** that although billfish are not normally targeted by I.R. Iran vessels, they are a common catch in offshore gillnets.

51. The WPB **NOTED** that the I.R. Iran has developed a pilot logbook project on board its gillnet fleet and is implementing training courses aimed at training fishers on how to collect data and fill out these logbooks, including the identification and reporting of bycatch and discarded species.

52. The WPB **REQUESTED** that I.R. Iran revisit individual logbook archives to try and obtain more details of historical species composition for its industrial fisheries.

Thailand billfish fishery

53. The WPB **NOTED** paper IOTC–2013–WPB11–13 which provided an overview of the billfish fishery of Thailand, including the following abstract provided by the authors:

“*Thai tuna longline consisted of 3 tuna longliners in 2007 and 2 tuna longliners during 2008-12. The main fishing ground was the central and southern part of the Indian Ocean. This report was based on the data extracted from fishing logsheets which were delivered to the Department of Fisheries, Thailand During 2007-12, is summarized and calculated the hook rate in Catch Per Unit Effort (CPUE). The fishing operations recorded 2,276 fishing days. The highest total catch was in 2010 with 607.69 tonnes followed by 2012, 2007, 2011, 2009 and 2008, respectively (494.95, 461.64, 370.39, 295.23 and 265.57 tonnes). The highest CPUE was in 2010 with 13.62 fish/1,000 hooks followed by 2012 and 2007, respectively (10.80 and 10.20 fish/1,000 hooks). The major catch species were bigeye tuna (Thunnus obesus), yellowfin tuna (T. albacares) Albacore tuna (T. alalunga), swordfish and shark. In 2012, the numbers of individual billfish were 736 individual fishes with 25.05 tonnes.*” – (see paper for full abstract)

54. **NOTING** that data from the research vessels of Thailand are not presented by species, the WPB **REQUESTED** that the species level data be presented at the next WPB meeting. The translation of the IOTC species identification guides into Thai would assist in ensuring higher resolution for species identification.

55. The WPB **REQUESTED** the authors undertake a more detailed analysis of trends in billfish landings between the 2008 and 2012, a period identified in the current study of high variability in total landings.

Indonesia billfish fishery

56. The WPB **NOTED** paper IOTC–2013–WPB11–14 Rev_1 which summarised length frequency distributions of billfishes (Xiphiidae and Istiophoridae) from Indonesian tuna longline observer data, including the following abstract provided by the authors:

“*Billfishes are the one of the important byproduct for Indonesian tuna longline fishermen. The objective of this study is to describe length frequency and the distributions of billfishes in Indonesia. Data collections were taken by observer on 83 longline vessels in Benoa Port, Bali, Indonesia from 2005 to 2012. Lower-jaw fork length (LJFL) was used to measure the length of the fish. The results showed that six species of billfishes were caught by longline vessels i.e.: 973 swordfish (X. gladius) range: 50-280 cm; mean±SE: 128±1.48 cm, 94 sailfish (I. platypterus) range: 98-259 cm; mean±SE: 165±3.51 cm, 252 shortbill spearfish*

(T. angustirostris) range: 82-221 cm; mean±SE: 151±1.05 cm, 222 blue marlin (M. mazara) range: 110-298 cm; mean±SE: 192±2.39 cm, 310 black marlin (I. indica) range: 60-307 cm; mean±SE: 184±1.92 cm and 109 striped marlin (K. audax) range: 69-270 cm; mean±SE: 177±3.23 cm. The latitudinal and longitudinal range distributions of six billfishes were range from 0°65' to 33°66' S and from 76°00' to 131°47' E. The majority of billfishes were caught with range from 10°00' to 20°00' S and from 110°00' to 120°00' E. Further study is needed on the biological aspects of billfishes to support their management policy in Indonesia."

57. The WPB **NOTED** that the total reported landings by Indonesia of ~400,000 t of tuna and tuna-like species are highly uncertain and further efforts should be undertaken to refine and verify this value, by species.

58. The WPB **NOTED** that the reasons for the declining trend in recent billfish landings is not clear, although it is a likely function of the changes in fishing areas by the longline fleet, mostly towards the southern Indian Ocean.

59. The WPB **REQUESTED** that Indonesia develop and present a detailed paper on its fleets fishing effort and CPUE, by species, at the next WPB meeting.

60. 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.

61. The WPB **ENCOURAGED** the efforts by Japan to train scientific observers in Indonesia, which should be based on the IOTC Regional Observer Scheme, Observer manual, Observer trip report template and Observer forms, which are available from the IOTC website (http://iotc.org/English/ros.php). The training is currently occurring on both Japanese and Indonesian longliners.

Malaysian billfish fishery

62. The WPB **NOTED** paper IOTC–2013–WPB11–15 which summarised catches of billfish by the Malaysian tuna longliners targeting the tropical and temperate tune in the Indian Ocean, including the following abstract provided by the authors:

    "*A total of 4 Malaysian frozen tuna longliners plus one carrier vessel began to fish for albacore in the vicinity of southern Mauritius since the 3rd quarter of 2011. For this paper, the catch and effort data were analyzed from the record since 2003 to 2010 for tropical tuna and from January 2012 – June 2013 for temperate tuna. Swordfish and marlin contributed 6.85% and 6.34% respectively from the total tuna catch in weight. The highest catch of swordfish and marlin from temperate tuna fishing were recorded in at 7.7 t (July 2012) and 9.7 t (December 2012) respectively. Annually catch ranges for both species vary greatly from 30-217 t for swordfish and 35-225 t for marlin. The average catch rate for swordfish and marlin were 0.36 t/vessel and 0.31 t/vessel respectively and 0.23 t/vessel for sailfish. There were no record of sailfish caught by all the Malaysian tuna longliners and this require further consultation with the vessel operators to identify the problem*."

63. The WPB **NOTED** that overall catch and catch rates presented in the paper were based on an extrapolation of total catch data available from 5 vessels.

64. The WPB **NOTED** that the average number hooks deployed per set by Malaysian longliners is approximately 2,400. The authors should consider providing a revised paper that contains a more precise estimate of CPUE using hook rate metrics, for presentation at the next WPB meeting.

65. **NOTING** that detailed fishing effort data are available since 2012, the WPB **ENCOURAGED** Malaysia to calculate CPUE data for billfishes landed by its fleet, as well as fish weight (size) distributions by species for the consideration of the WPB at its next meeting.

Sri Lanka billfish fishery

66. The WPB **NOTED** paper IOTC–2013–WPB11–16 Rev_1 which provides a review of billfish fishery resources in Sri Lanka, including the following abstract provided by the authors:

    "*This paper reviews the landings of billfish made in large pelagic fisheries during the period 2010-2012. Sri Lanka has a well established offshore fishery targeting for tuna and tuna like species. Apart from tuna, billfish, sharks and seerfish are caught mostly within the EEZ of Sri Lanka as well as in high seas. The annual production of large pelagic fish in Sri Lanka was 135237 t in 2012. Although there is no target fishery for billfish, it makes up to 9% of the total large pelagic landings in Sri Lanka. Majority of the billfish which includes three species of marlins, one species of sailfish and one species of swordfish* *production come from multi-day boats operating offshore fishery. Relatively higher proportion of billfish is being caught using gillnet-longline gear combination. A slight increasing trend in the billfish landings was observed over the period*."

67. The WPB **NOTED** that the decline in the total number of active Sri Lankan vessels in 2011–12 reflects the overall declining trend in commercial fishing activities by Sri Lanka.

68. The WPB **REQUESTED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission (1 fish by metric ton of catch by type of gear and species), including:
    - catches sampled or observed for at least 5% of the vessel activities for coastal fisheries, including collection of catch, effort and size data for IOTC species and main bycatch species;
    - implementation of logbook systems for offshore fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03.

    The information collected through the above activities should allow Sri Lanka to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

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

Mozambique billfish fishery

70. The WPB **NOTED** paper IOTC–2013–WPB11–17 which summarised information on billfish caught in the recreational and sport fishing of south coast of Mozambique: Results of the first census of recreational and sport fishing in 2007 and the sampling program in 2012, including the following abstract provided by the authors:

    "*Despite recreational fishery in Mozambique has been practiced in different modalities, ranging from shore (without boat) to offshore boat based, it was found billfish only in offshore boat based recreational fisheries. These fishes are caught either in recreational fishery for leisure or within the fishery competition (sport fishery). In both modalities (offshore recreational and sport) the gear used to target billfish is hook and line operated with a fishing rod and manual reel. In these fisheries the billfish represent the trophy and the specimens are usually released alive. The results of the first census of recreational fisheries in south cost of Mozambique performed in 2007 revealed that billfish was one of the main target groups in recreational fisheries, together with narrow-barred Spanish mackerel, yellowfin tuna and other tropical tunas. According with the census the main representative billfish species in south coast was the indo-pacific sailfish, but in the subsequent years the monitoring program revealed that black marlin is equally and even more represented in the catches of sport fisheries.*" – (see paper for full abstract)

71. The WPB **ENCOURAGED** Mozambique to continue the excellent work to collected and report on its artisanal, sports and other recreational fisheries catches taken from Mozambique waters at the next WPB meeting.

72. The WPB **NOTED** that in 2012 billfish was estimated to comprise 12% of the total catch in weight of the sport fishery in Mozambique waters, primarily black marlin.

73. **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.

74. 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.

75. **NOTING** that at present no scientific observers are being placed on board foreign flagged vessels licenced to fish in the Mozambique EEZ, the WPB recalled its **RECOMMENDATION** that Mozambique make it a licencing requirement for any foreign vessels fishing in the Mozambique EEZ to take on board scientific observers and to report the data collected as per IOTC requirements. Foreign vessels fishing in the Mozambique EEZ should ensure that scientific observers are brought onboard as per IOTC requirements.

Madagascar billfish fishery

76. The WPB **NOTED** paper IOTC–2013–WPB11–18 which summarised information available for the Malagasy billfish fishery in 2012, including the following abstract provided by the authors:

    "*Madagascar started developing a longline fishery in 2007 by shifting from trawl gear to small longliners. The number of vessel, targeting tuna and tuna like species, has been increasing. In 2012, Madagascar deployed eight fishing vessels less than 24 m off the east coast. Note that some of them are multigear, whereby fishing vessels may target demersal resources and at other times they may target tuna and tuna* *like species. The following results were obtained from the Malagasy observer program database and from pelagic species companies' declarations. With 388 178 hooks, the total catch was 388 tons which are composed of 44.66% tuna, 25.38% billfish, 13.24% shark and 16.72% others species. Billfishes percentage landed comprised mainly of 73.54% swordfish. The contributions of two other species are 19.15% and 7.31% corresponding to striped marlin and other Istiophoridae, respectively. Thus, CPUEs for swordfish and striped marlin were 186.8 Kg/1000 hooks and 48.6 Kg/1000 hooks, respectively. Their length-weight relationships were calculated as Wswordfish= 10-5 LJFL2.9735 and Wstriped marlin=4x10-4 LJFL2.7064*."

77. **NOTING** that the longline fishery in Madagascar is a new and developing fishery, the WPB **REMINDED** Madagascar to ensure that it develops and implements a data collection system, including sampling, logbooks and observers, which would adequately cover the entire fishery.

78. **NOTING** that the scientific observers operating in Madagascar are experiencing difficulty identifying marlins to the species level, the WPB **AGREED** that where observers are not proficient in species level identification, that they should report marlins as a group, and sailfish separately, until such time that they have undergone sufficient training to report at the species level.

79. **NOTING** the apparent confusion in sex determination (i.e. the dominance of males in the data collected by observers), the WPB **ENCOURAGED** scientists from Madagascar to improve species and sex identification at sea and at landing sites by organising dedicated training courses for both scientific observers and fishers.

80. **NOTING** that Madagascar is implementing data collection reports for its pelagic fisheries, the WPB **ENCOURAGED** Madagascar to further develop and expanded the data collection systems for its pelagic longline fisheries in accordance to IOTC requirements.

Recreational and sports fisheries for billfish

81. The WPB **NOTED** paper IOTC–2013–WPB11–19 which summarised developments in the east African billfish conservation and research programme, including the following abstract provided by the authors:

"*The African Billfish Foundation (ABF) have continued to develop the East African Billfish Conservation and Research programme over the past two years taking into account those recommendations emphasised at the Working Party on Billfish 10th Session. A total of 8,369 Billfish have been tagged and released and a further 1,086 released without tags over the past three fishing seasons off the coast of East Africa. The African Billfish Foundation has also received 117 Billfish recapture reports during this time. A recent recapture of a Black Marlin off Mandapam, India expanded the recognised international boundaries of Billfish caught off East Africa, with this being ABF's first billfish recapture off India. In the coming season the ABF, in collaboration with Kenyan sport fishing anglers, hope to compliment the existing data from the conventional tagging programme with the deployment of 5 satellite tags in Marlin. These tags should help yield a greater insight into the movements of Marlin caught in this area.*" – (see paper for full abstract)

82. 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.

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

84. **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 (university or consultant) 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 WPB Chair should 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.

85. 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.

Indian billfish research: Environment influences on abundance

86. The WPB **NOTED** paper IOTC–2013–WPB11–20 which summarised evaluation of the effect of lunar cycle, monsoon and spatial differences on billfishes, including the following abstract provided by the authors:

"*Information on the abundance of resources in time and space is a prerequisite for the success of any fishing operation. Billfishes form a major constituent of Tuna longline fishery around Andaman & Nicobar Islands. The present study is an attempt to evaluate the effect of the lunar cycle and monsoon on the catch rate of billfishes. The study is based on tuna longline survey carried out by M.V. Blue Marlin, survey vessel attached to the Fishery Survey of India, Port Blair around A&N Islands. Catch rates recorded at different latitudes showed that billfishes are more abundant in upper latitude of the region. The results of the present study indicated that there is a significant effect of the lunar cycle on the catch rate of billfishes occurring in the Andaman and Nicobar waters. However, it has been observed that the monsoon effect has no significance on the catch rates. Downward trend of year wise catch rate noticed during the study period warrant strict management measures. The effect of monsoon and the lunar cycle on Billfishes caught by tuna longline and the likely reason for that were elucidated in the text*."

87. **NOTING** that all billfish species were combined for analysis, which may produce a biased result due to differences in species biology, the WPB **REQUESTED** that the authors undertake a similar analysis by species, for the consideration at the next WPB meeting.

88. The WPB **AGREED** that hooking depth should be added as an additional variable in the analysis in subsequent years. Using Temperature-Depth Recorders (TDRs) for longline instrumentation in the future will provide better accuracy in longline fishing depth monitoring.

Guide for dressed billfish

89. The WPB **NOTED** paper IOTC–2013–WPB11–21 which presented preliminary results of the development of identification guide for dressed billfish, including the following abstract provided by the authors:

"*Indian Ocean billfish consist of 5 and 1 species from of Istiophoridae and Xiphiidae families respectively. Their identification was and still is a problematic issue despite progress of IOTC in ID cards development. Many of fisheries landed billfishes dressed but no identification keys exist for dressed billfish. On-going work represents first effort to develop such guide based on morphological approach to avoid expensive and slow genetic identification. Data is collected at landing sites on dressing manner, presence/absence and state of fins, colour of flesh, morphometric measurements, and photograph. A preliminary guide is presented however further sampling and verification of identification tree for striped marlin, Tetrapturus audax is necessary.*"

90. **NOTING** the importance of this study in the context of on-going difficulties for many CPCs to identify marlin species once processed, the WPB **ENCOURAGED** the authors to further develop the identification guide/key for dressed billfish and to present the work at the next WPB meeting, with the intention of adding the guide/key to the IOTC billfish identification guides in the future.

91. The WPB **ENCOURAGED** scientists from all CPCs to collect further data for dressed billfish to improve the quality of the identification of species as well as the length distribution of fish landed.

Maldives billfish landings

92. The WPB **RECALLED** that the level of capture of marlins from the Maldivian artisanal fishery appears to be very high compared to the total catches reported for the Indian Ocean and **REQUESTED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting.

93. The WPB **REQUESTED** that the Maldives implement data collection systems, through logbooks and sampling for its fisheries that incorporate species level information requirements for billfish, as per IOTC standards. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

94. 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 marlins

6.3.1 Nominal and standardised CPUE indices

95. The WPB **NOTED** paper IOTC–2013–WPB11–22 Rev_2 which examined correlations between environmental factors and CPUEs of blue marlin (*Makaira mazara*) and striped marlin (*Kajikia audax*) caught by longline vessels from Taiwan,China in the Indian Ocean, including the following abstract provided by the authors:

"*This study investigated the correlations between environmental factors (Indian Oscillation Index, Dipole Mode Index, Southern Oscillation Index, sheer currents, amplitude of the shear current, thermocline depth, and temperature at depth of 15/55m and temperature gradient at depth of 15/55m) and nominal CPUEs of blue marlin and striped marlin caught by Taiwan,China longline fishery in the Indian Ocean. The results* *clearly showed that there are significant cycle-patterns between CPUEs and most environmental factors. In addition, this study also suggested the environmental factors with the time-lags for CPUE standardization analyses of blue and striped marlins in the Indian Ocean*."

Japanese blue marlin and striped marlin CPUE analysis

96. The WPB **NOTED** paper IOTC–2013–WPB11–23 Rev_1 which presented standardised catch rates for striped marlin (*Tetrapturus audax*) and blue marlin (*Makaira mazara*) in the Indian Ocean using the core fishing area approach with operational catch and effort data of the Japanese tuna longline fisheries, including the following abstract provided by the authors:

    "*We attempted the core fishing area approach and the new area effect concept incorporating environmental data, in order to evaluate standardized catch rates for Striped marlin (Tetrapturus audax) and Blue marlin (Makaira mazara) in the Indian Ocean. We used operational catch and effort data of the Japanese tuna longline fisheries (1971-2012). We discussed pros and cons on the core fishing area approach and the new area effect concept by comparing results from last year.*"

97. The WPB **NOTED** that the analysis was comprehensive by using a core fishing area approach, and detailed area effects in a 1x1 degree grid. The following items were noted for future discussion regarding this standardisation method:
    i) by using a 1x1 grid area the spatial detail of the model is high, but there is a need to estimate many parameters if the area considered is large, which may result in over-parameterised models. It was suggested that a cross-validation process may help diagnose this possible issue.
    ii) for model comparison with differences in the number of estimated parameters it may be better to use an information criteria (e.g. AIC), as R^2 is not penalised by the number of additional parameters added.

98. The WPB **NOTED** that the use of number of hooks between floats (HBF) seems an appropriate approach, but it was also suggested that, if available, the percentage of hooks in the preferred habitat depth of the marlin might provide useful information for the models (habitat based models).

Taiwan,China blue marlin CPUE analysis

99. The WPB NOTED paper IOTC–2013–WPB11–24 Rev_2, which detailed a CPUE standardisation of blue marlin (*Makaira mazara*) caught by Taiwanese longline fishery in the Indian Ocean for 1995 to 2011, including the following abstract provided by the authors:

    "*This study provided a CPUE standardization of blue marlin (Makaira mazara) caught by the Taiwanese longline fishery in the Indian Ocean for time periods of 1980-2011 and 1995-2011. The delta-lognormal GLM model is adopted to perform the CPUE standardization analysis since blue marlin is caught by Taiwanese longline fleet as bycatch species and large amount of zero catches are recorded in the operational data sets. The results indicate that the influence of incorporating environmental effects on CPUE standardization is not significant for blue marlin in the Indian Ocean. The trends of CPUEs in Area 1 (MONS) and Area 3 (Coastal area) revealed substantial decline trends before early 1990s and increased until later 1990s, while the CPUE in Area 2 (ISSG) continuously increased before 1995s. The CPUEs slightly increased before 1998 and 2002 for Area 1 and Area 2 respectively, revealed decreasing patterns until 2008, and they sharply increase in recent years. However, the trend of CPUE in Area 3 obviously increased before 1999 but the continuously decreased thereafter. The area-aggregated CPUE generally reveals a trend for five phases: fluctuated before 1986, sharply decreased during 1986-1990 when the catch began increasing; increased gradually during during1991-1999; decrease gradually during 2000-2007; CPUE obviously increased in recent years*."

Taiwan,China striped marlin CPUE analysis

100. The WPB **NOTED** paper IOTC–2013–WPB11–26 Rev_2 which detailed a CPUE standardisation of striped marlin (*Kajikia audax*) caught by Taiwanese longline fishery in the Indian Ocean for 1995 to 2011, including the following abstract provided by the authors:

    "This study provided a CPUE standardization of striped marlin (Kajikia audax) caught by the Taiwanese longline fishery in the Indian Ocean for time periods of 1980–2011 and 1995–2011. The delta-lognormal GLM model is adopted to perform the CPUE standardization analysis since blue marlin is caught by Taiwanese longline fleet as bycatch species and large amount of zero catches are recorded in the operational data sets. The results indicate that the influence of incorporating environmental effects on CPUE standardization is not significant for striped marlin in the Indian Ocean. The CPUEs in Area MONS and Coastal area revealed similar trends and they substantially decreased since 1980 although the CPUE obviously fluctuated in early years. The CPUE in Area ISSG fluctuated before 1990, substantially increased between 1990 and 1995, and sharply decreased thereafter. In recent years, CPUEs obviously

increased for all three areas. The area-aggregated CPUE obviously fluctuated before 1995 and it revealed obvious and continuous decline trend thereafter, while it slightly increased in recent two years."

101. The WPB **NOTED** that all suggestions from the previous WPB meeting were followed by the authors in the updated series (IOTC–2013–WPB11–24 Rev_2; IOTC–2013–WPB11–26 Rev_2). A number of additional refinements were provided by participants during the Session, which were incorporated into the standardisation for use in stock assessments.

102. The WPB **NOTED** that the use of number of hooks between floats seems an appropriate approach, but it was also suggested that, if available, the percentage of hooks in the habitat depth of the marlin might provide useful information for the models (habitat based models).

Invited Expert review and CPUE analysis for marlins

103. The WPB **NOTED** that the Invited Expert (Dr. Humber Andrade) provided 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.

104. The WPB **AGREED** 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

105. The WPB **NOTED** 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. 4).

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

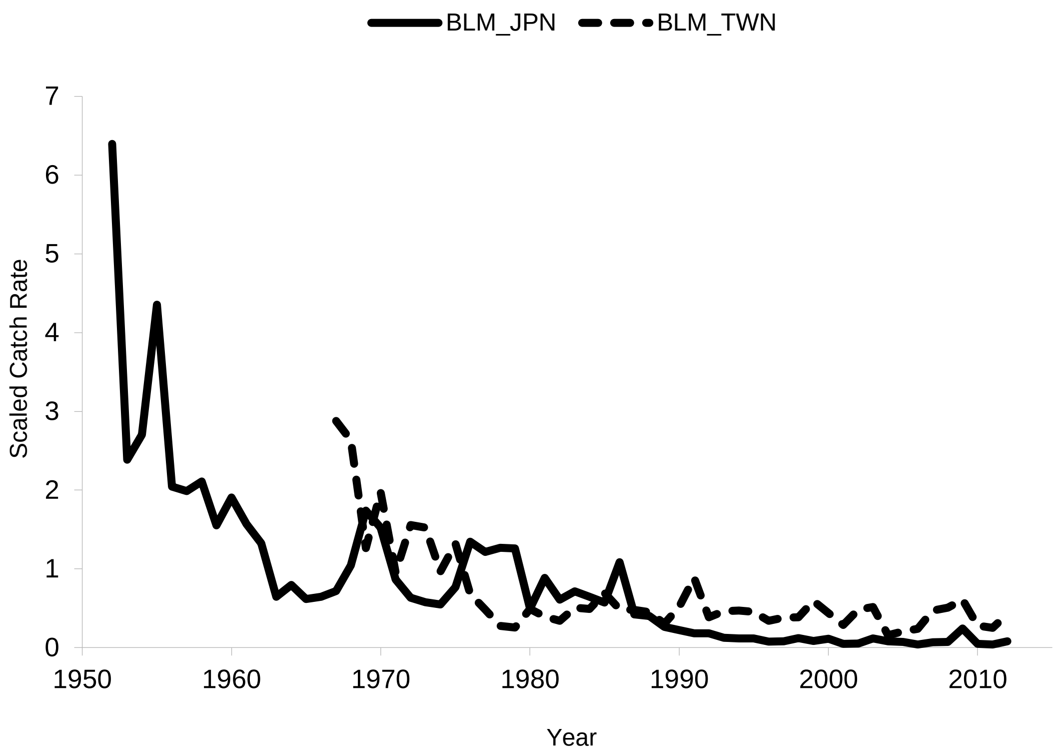

Fig. 4. Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Invited Expert review – Blue marlin

107. The WPB **AGREED** that the sharp decline between 1952 and 1956 in the Japanese blue marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1970 until 2011 is more likely to represent actual declines in stock abundance (Fig. 5).

108. The WPB **NOTED** that the catches and CPUE series estimated for blue marlin were very similar between the longline fleets of Japan and Taiwan,China, although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

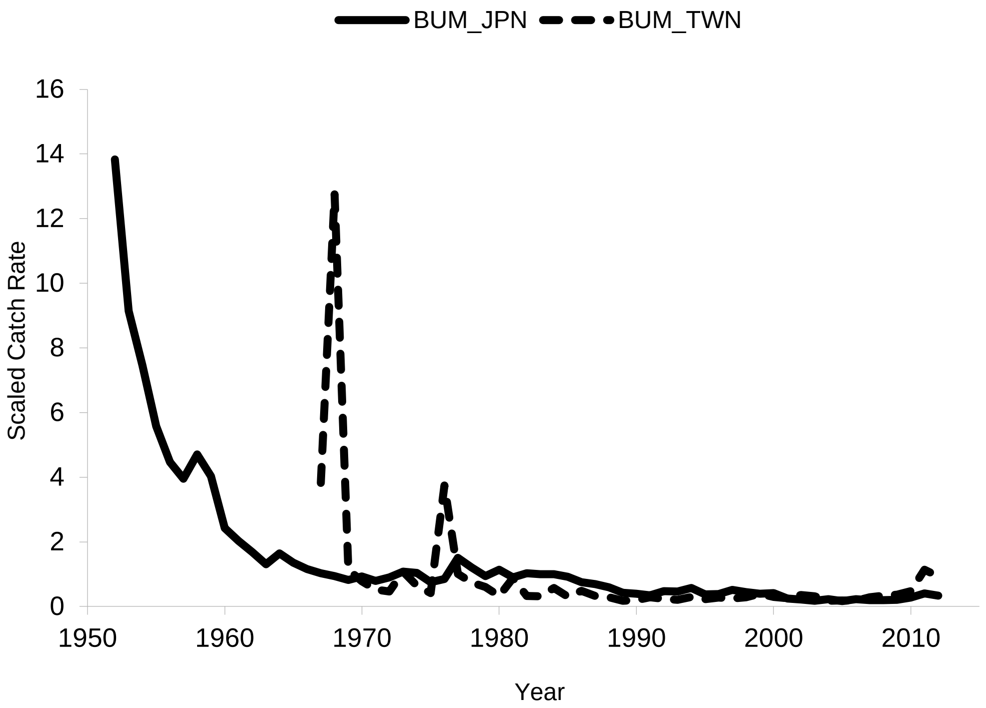

Fig. 5. Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Invited Expert review – Striped marlin

109. The WPB **AGREED** that the sharp decline between 1952 and 1960 in the Japanese striped marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1960 until 2011 is more likely to represent actual declines in stock abundance (Fig. 6).

110. The WPB **NOTED** that the catches and CPUE series estimated for striped marlin were very similar between the longline fleets of Japan and Taiwan,China although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

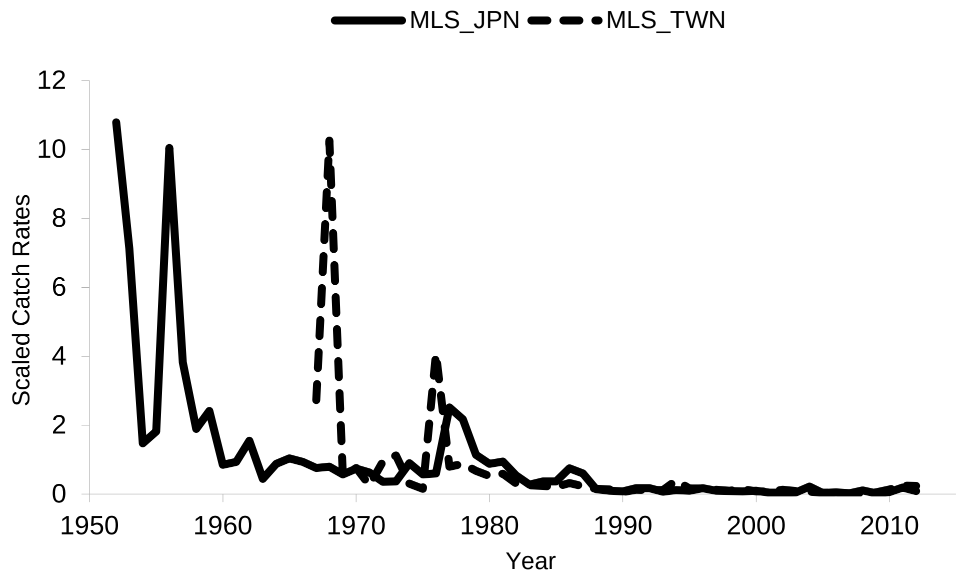

Fig. 6. Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

CPUE discussion summary – Marlins

111. The WPB **REQUESTED** that both Japan and Taiwan,China undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and 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.

Selection of CPUE series for stock assessments

112. The WPB **NOTED** that of the blue marlin CPUE series available for assessment purposes, listed below, the Japan and Taiwan,China CPUE series should be used in the stock assessment model for 2013, for the reasons discussed above (shown in Fig. 7).
   - Japan data (1971–2012): Series from document IOTC–2013–WPB11–23 Rev_1
   - Taiwan,China data (1980–2011): Series from document IOTC–2013–WPB11–24 Rev_2

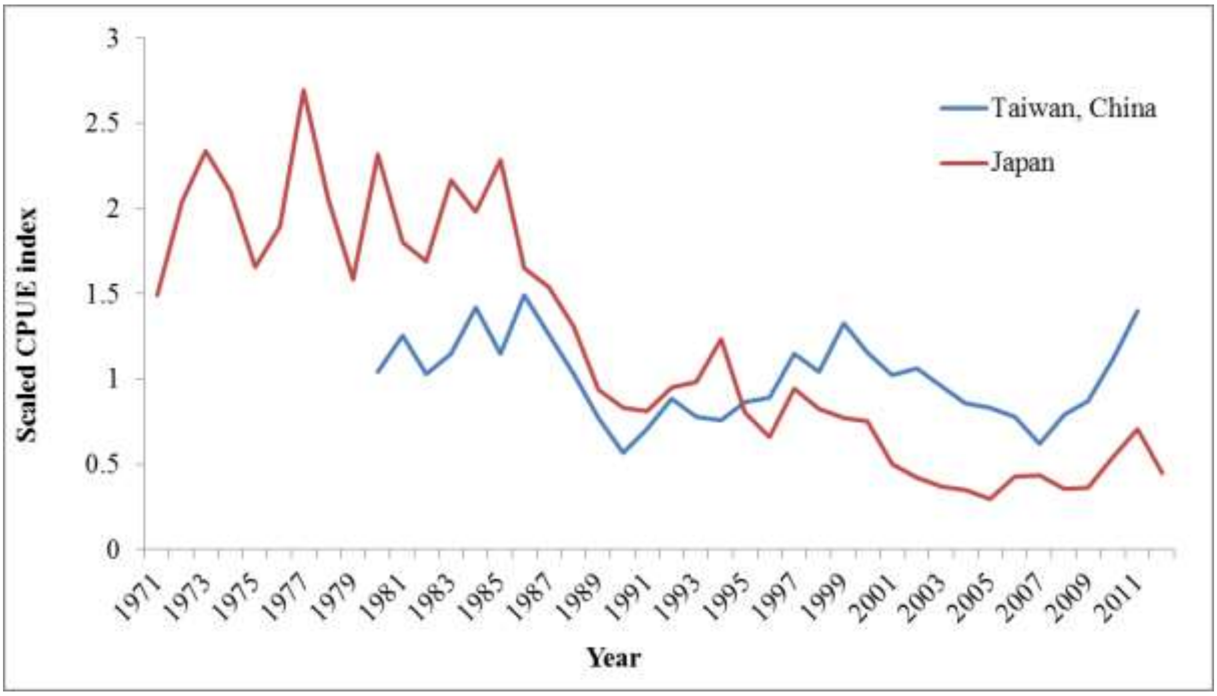

Fig. 7. Blue marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

113. The WPB **NOTED** that of the striped marlin CPUE series available for assessment purposes, listed below, the separate Japan and Taiwan,China series should be used in the stock assessment model for 2013, for the reasons discussed above (shown in Fig. 8).

- Japan data (1971–2012): Series from document IOTC–2013–WPB11–23 Rev_1
- Taiwan,China data (1980–2011): Series from document IOTC–2013–WPB11–26 Rev_2

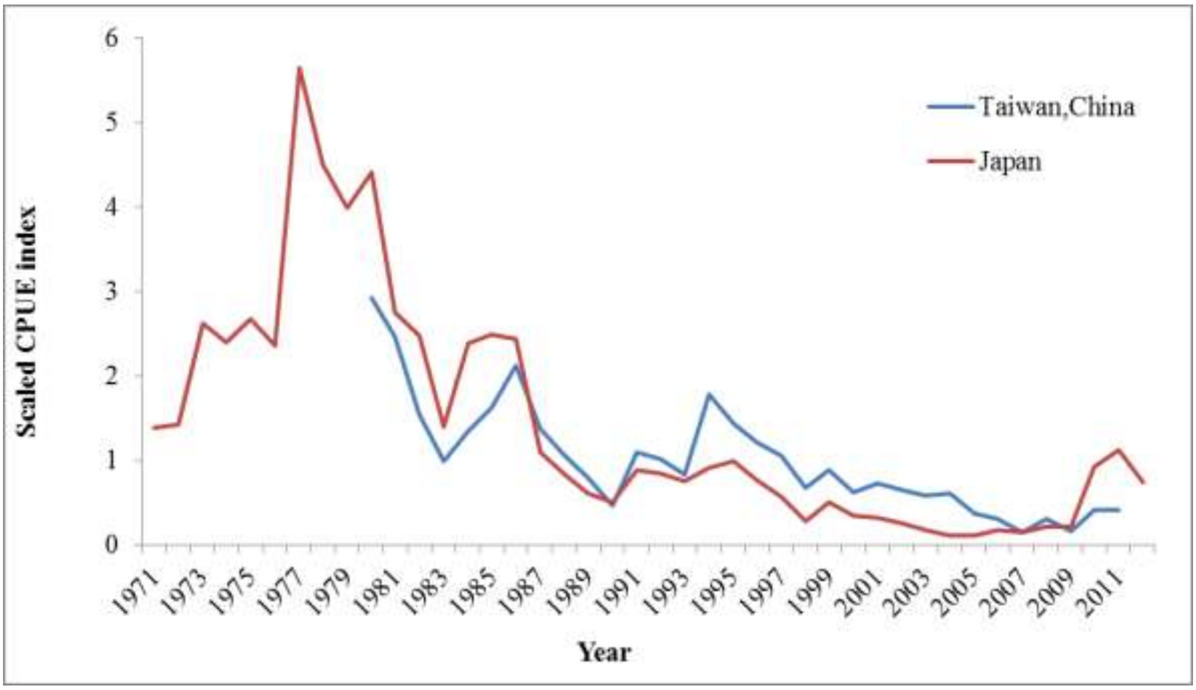

Fig. 8. Striped marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

Parameters for future analyses: CPUE standardisation and stock assessments

114. The WPB **NOTED** that the CPUE standardisation has a low coefficient of determination (r^2), and that these may still be further improved in the future. Possible main effect may be missing from the analysis, and should be further investigated.

115. The WPB **AGREED** that further investigation should be conducted in additional CPUE standardisations. The analyses should be conducted with similar parameters and resolutions in the future. Table 3 provides a possible list of parameters that, if available, can be explored for the standardisation of CPUE as indices of abundance for the stock assessments. A sensitivity analysis to some of these stratifications should be conducted in future CPUE standardisations.

Table 3. A set of parameters for the standardisation of CPUE series in the future for marlin species.

CPUE standardisation parameters	Value for CPUE standardisation
Area	*To be defined (possibly use the North, South and Coastal Areas corresponding to Longhurst Areas for Indian Ocean)* Explore core area(s) with 2*2 and 5*5 cells as an alternative
CE Resolution	Operational data/ Explore habitat based approaches (the effective effort by depth) as an alternative measure
Variables/ Factors	Year, Quarter, Area, HBF, vessel, environmental + interactions
Model	Account for 0's and dispersion in the data

6.3.2 Stock assessments

116. The WPB **NOTED** that a range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the blue marlin and striped marlin in 2013. The models were developed and run during the WPB11 meeting as a result of the increased level of expertise and time resources available during the meeting.

117. The WPB **AGREED** that because the models were developed during the WPB meeting, the '*Guidelines for the presentation of stock assessment models*', as agreed by the SC at its 13th session in 2010 would not necessarily be applied in full. However, the authors of the assessments, shall comply with the guidelines for all future assessments. The various assessments presented to the WPB in 2013 are summarised in the sections below.

118. The WPB **NOTED** that the models explored did not perform well as far as the residual diagnostics, or other were concerned, denoting high uncertainties. However, these models showed similar stock trajectories, and based on the weight-of-evidence approach, the WPB **AGREED** to use the results from the ASPIC model for stock status advice. Further work needs to be conducted in future years to improve these assessments.

119. The WPB **NOTED** that different agencies, and researchers have examined how robust the Stock Reduction Analysis technique is on other stocks and areas, and this is the first time it is being used on marlins in the Indian Ocean. In order to assess the robustness of the Stock Reduction Analysis approach the WPB was referred to the literature sources contained in paper IOTC–2013–WPB11–28 Rev_1.

Blue marlin: Summary of stock assessment models in 2013

120. The WPB **NOTED** Table 4 which provides an overview of the key features of each of the three stock assessments presented in 2013 (3 model types) for blue marlin, while Table 5 provides a summary of the assessment results.

121. The WPB **NOTED** the value of comparing different modelling approaches evaluating alternative hypothesis about the quality of the data used. Evaluating and validating the data is integral in the assessment, as fitting to alternative CPUE indices and assuming different model structures can have a large influence on the assessments.

122. **NOTING** that the assessments carried out in 2013 are further developed than those from 2012, and fit to the best available CPUE and catch data, the WPB **AGREED** that this is the best available data and using all three approaches for concurrence in outcomes was useful. The WPB also **AGREED** to report the ASPIC results for stock status advice.

Table 4. Blue marlin: Summary of final stock assessment model features as applied in 2013.

Model feature	ASPIC	State Space Bayesian production model	Stock Reduction Analysis
Software availability	NMFS toolbox	Coded	Coded
Population spatial structure / areas	1	1	1
Number CPUE Series	2	1	No
Uses Catch-at-length/age	No	No	No
Age-structured	No	No	No
Sex-structured	No	No	No
Number of Fleets	3	1	1
Stochastic Recruitment	No	No	No

Table 5. Blue marlin: Summary of model features for 2013.

Management quantity	ASPIC	State Space Bayesian production model	Stock Reduction Model*
Most recent catch estimate (t) (2011)		10,340	
Mean catch over last 5 years (t) (2007–2011)		10,074	
MSY (80% CI)	11,690 (8,023–12,400)	17,755 (7,854–29,762)	9,524 [6,004–15,105]
Data period (catch)	1950–2011	1950–2011	1950–2011
CPUE series	Japanese + Taiwanese longline	Japanese longline	NA
CPUE period	1971–2011 (Japanese) 1980–2011 (Taiwanese)	1980–2011	NA
$F_{current}/F_{MSY}$ (80% CI)	0.85 (0.63–1.45)	0.748 (0.391–1.788)	1.05 [0.63-1.47]
$B_{current}/B_{MSY}$ (80% CI)	0.98 (0.57–1.18)	0.792 (0.506–1.168)	1.03 [0.03-2.31]
SB_{2011}/SB_{MSY} (80% CI)	n.a.	n.a.	n.a.
SB_{2011}/SB_{MSY} (80% CI)	n.a.	n.a.	n.a.
B_{2011}/B_{1950} (80% CI)	0.775 (n.a.)	0.400 (0.253–0.604)	0.59 [0.02–1.16]
SB_{2011}/SB_{1950} (80% CI)	n.a.	n.a.	n.a
$SB_{2011}/SB_{current,\ F=0}$	n.a.	n.a.	n.a.

*Analytically approximated [95% CI]

Blue marlin: A Stock-Production Model Incorporating Covariates (ASPIC)

123. The WPB **NOTED** paper IOTC–2013–WPB11–32 which provided an evaluation of the uncertainty of catch data and CPUE index on the stock assessment of blue marlin and striped marlin in the Indian Ocean, including the following abstract form the authors:

“*The stock assessment of blue and striped marlin in the Indian Ocean was carried out using ASPIC with a generalized model (Pella-Tomlinson model). Considering the uninformative data series before 1970s, total catch data and standardized CPUE series of Taiwanese and Japanese longline fleets after 1970s were adopted to be fitted to the model. The result indicated that the MSY reference points have been exceed, current (2011) biomass is below the MSY level and current fishing mortality is slightly higher than the MSY level*”

124. The WPB **AGREED** to provide the results of the ASPIC model based on the Japan and Taiwan,China longline data for stock status advice as it is used globally. However, the WPB cautioned readers of this report that the information provided below is only for comparison, is the first time being used for management advice and should be used with caution.

125. The WPB **AGREED** that due to the high uncertainty in the data set and methods used, the point estimates derived from most of the approaches described in Table 5 showed similar dynamics in terms of exploitation rates being higher than in the 1980’s and 1990’s with decreases in rates in recent years.

126. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below for blue marlin (Table 6; Fig. 9).

Table 6. Blue marlin: Key management quantities from the 2013 ASPIC assessment for Indian Ocean blue marlin.

Management Quantity	Indian Ocean
2011 catch estimate	10,340
Mean catch from 2007–2011	10,074
MSY (1000 t) (80% CI)	11,690 (8,023–12,400)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (80% CI)	0.85 (0.63–1.45)
B_{2011}/B_{MSY} (80% CI)	0.98 (0.57–1.18)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (80% CI)	0.48 (n.a.)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950,\ F=0}$	–
$SB_{2011}/SB_{1950,\ F=0}$	–

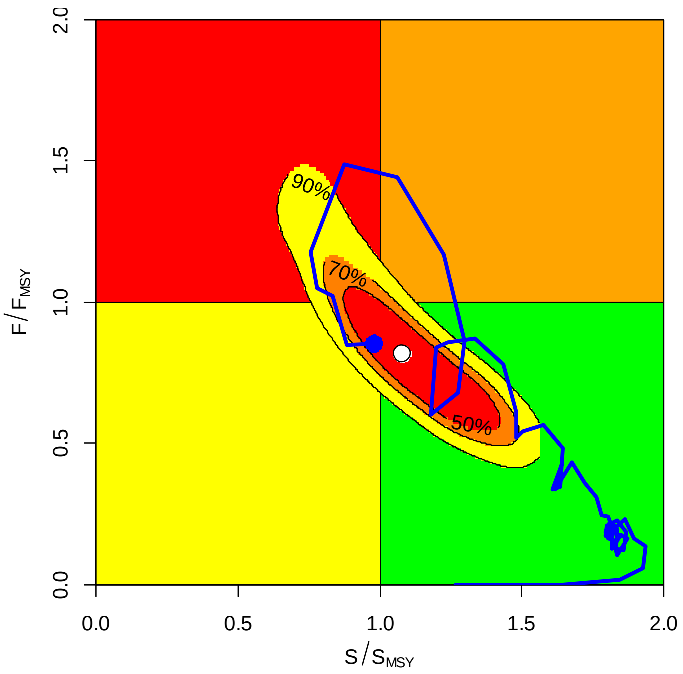

Fig. 9. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimates). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as S) and F ratio for each year 1950–2011. Note the bootstrap mean estimate differs from the median estimates as shown by the point estimate and the profile.

Blue marlin: Bayesian State Space production model

127. The WPB **NOTED** paper IOTC–2013–WPB11–25 which provide a stock assessment of blue marlin (*Makaira mazara*) based on a Bayesian production model, including the following abstract from the authors:

“*Blue marlin is one the bycatch species caught by tuna longline and gillnet fleets in the Indic Ocean. Unique stock in the Indic Ocean is assumed to the most probable hypothesis. The status of the blue marlin stock is unknown and the available data is limited to catch and catch rates. Biomass dynamic models are one of the alternatives to assess the stock status in such poor data scenario. In this paper the blue marlin is assessed by using Bayesian state-space models (Fox and Schaefer types) calculated based on estimated total catches and standardized catch rates of Japan. Informative and non-informative priors were used. Likelihood function was based on log-normal density distributions. Monte Carlo Markov Chains are used to calculate the posterior sample. Three chains starting with different parameters estimations were calculated. The first 30000 samples of each chain were discarded (burnin), and the next 50000 samples were sliced resulting in a final sample with size equal to 1000.* ” – (see paper for full abstract)

128. The WPB **NOTED** the key assessment results for the Bayesian Surplus Production Model as shown below for blue marlin (Table 7).

129. The WPB **NOTED** that this is a new approach being pursued and can be used for comparative purposes with the other assessments undertaken in 2013. However, since it is a work in development, the advice is presented here

for comparative purposes only and no phase plots will be displayed, though overall results are reported (Table 7).

Table 7. Blue marlin: Key management quantities from the 2013 Bayesian State Space production model assessment for Indian Ocean blue marlin.

Management Quantity	**Indian Ocean**
2011 catch estimate	10,340
Mean catch from 2007–2011	10,074
MSY (1000 t) (80% CI)	17,755 (7,854–29,762)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (80% CI)	0.748 (0.391–1.788)
B_{2011}/B_{MSY} (80% CI)	0.792 (0.506–1.168)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (80% CI)	0.400 (0.253–0.604)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950,\ F=0}$	–
$SB_{2011}/SB_{1950,\ F=0}$	–

Blue marlin: Stock reduction analysis

130. The WPB NOTED paper IOTC–2013–WPB11–28 Rev_1 which provide a stock assessment of three billfish species in Indian Ocean, blue marlin, black marlin and striped marlin using stock reduction methods, including the following abstract from the authors:

“*We conduct stock assessments for three Indian Ocean billfish, Blue, Black and Striped 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 all three species in the whole Indian Ocean belong to a single stock and the population size in 1950 is the virgin biomass equal to their carrying capacities. We use recently updated catch data in the analysis. The preliminary results show that for blue marlin the geometric mean virgin biomass is about 86-432 thousand tonnes using the assumption that depletion in 2011 is between 30% and 70%.*” – (see paper for full abstract)

131. The WPB **NOTED** the key assessment results for the Stock Reduction Analysis as shown below for blue marlin (Table 8, Fig. 10).

132. The WPB **NOTED** that the stock trajectory was very similar for ASPIC and SRA, and the overall estimates of optimal yield, optimal fishing mortality and spawning biomass levels were similar across all three models.

133. **NOTING** the similarities in the SRA, ASPIC and Bayesian SP Models, the WPB **AGREED** to present the ASPIC model results for stock status advice.

Table 8. Blue marlin: Key management quantities from the 2013 Stock reduction analysis (SRA) assessment for Indian Ocean blue marlin.

Management Quantity	**Indian Ocean**
2011 catch estimate	10,340
Mean catch from 2007–2011	10,074
MSY (1000 t) (95% CI)	9,524 (6,004–15,105)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (95% CI)	1.05 (0.63–1.47)
B_{2011}/B_{MSY} (95% CI)	1.03 (0.03–2.31)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (95% CI)	0.59 (0.02–1.16)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950,\ F=0}$	–
$SB_{2011}/SB_{1950,\ F=0}$	–

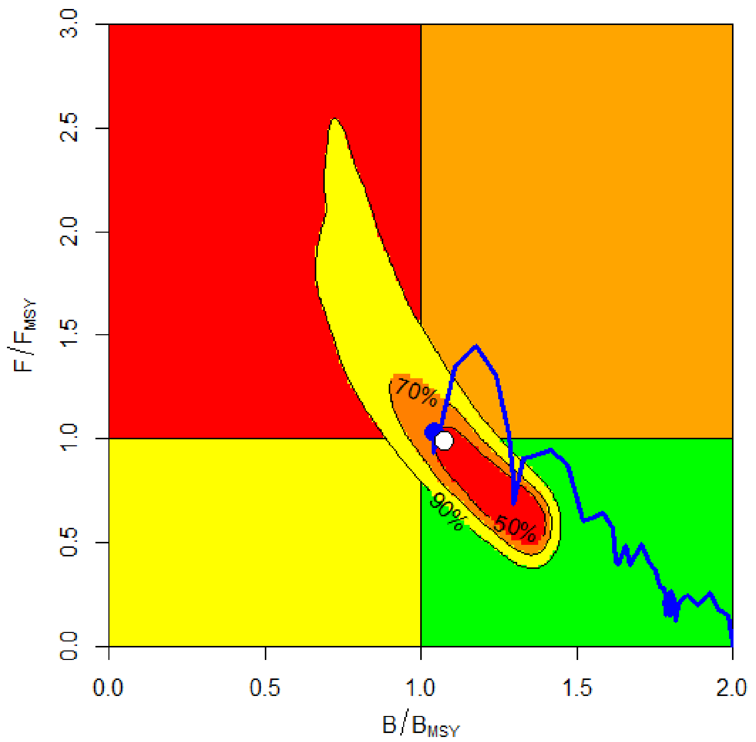

Fig. 10. Blue marlin: Stock reduction analysis aggregated Indian Ocean assessment Kobe plot for blue marlin (95% confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio and F ratio for each year 1950–2011.

Striped marlin: Summary of stock assessment models in 2013

134. The WPB **NOTED** Table 9 which provides an overview of the key features of each of the three stock assessments presented in 2013 (3 model types) for striped marlin, while Table 10 provides a summary of the assessment results.

135. The WPB **NOTED** the value of comparing different modelling approaches evaluating alternative hypothesis about the quality of the data used. Evaluating and validating the data is integral in the assessment, as fitting to alternative CPUE indices and assuming different catchability by period can have a large influence on the assessments.

136. **NOTING** that the assessments carried out in 2013 are further developed than 2012, and fit to the best available CPUE and catch data, the WPB **AGREED** that this is the best available data and using all three approaches for concurrence in outcomes was useful. The WPB also **AGREED** to report the ASPIC results for Stock Status advice.

Table 9. Striped marlin: Summary of final stock assessment model features as applied to striped marlin in 2013.

Model feature	ASPIC	Bayesian State Space production model	Stock Reduction Analysis
Software availability	NMFS toolbox	Coded	Coded
Population spatial structure / areas	1	1	1
Number CPUE Series	2	1	No
Uses Catch-at-length/age	No	No	No
Age-structured	No	No	No
Sex-structured	No	No	No
Number of Fleets	3	1	1
Stochastic Recruitment	No	No	No

Table 10. Striped marlin: Summary of model features for 2013.

Management quantity	ASPIC	State Space Bayesian production model	Stock Reduction Analysis*
Most recent catch estimate (t) (2011)		2,470	
Mean catch over last 5 years (t) (2007–2011)		2,538	
MSY (80% CI)	4,408 (3,539–4,578)	7,455 (2,063–16,837)	4,218 (3,831–4,645)*
Data period (catch)	1950–2011	1950–2011	1950–2011
CPUE series	Japanese + Taiwanese longline	Taiwan,China longline	NA
CPUE period	1971–2011 (Japanese) 1980–2011 (Taiwanese)	1980–2011	NA
$F_{current}/F_{MSY}$ (80% CI) [plausible range of values]	1.28 (0.95–1.92)	1.155 (0.332–5.324)	1.12 [0.74–5.95]
$B_{current}/B_{MSY}$ (80% CI) [plausible range of values]	0.416 (0.20–0.42)	0.324 (0.169–0.602)	0.52 [0.08–0.82]
SB_{2011}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.
SB_{2011}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.
B_{2011}/B_{1950} (80% CI) [plausible range of values]	0.18 (n.a.)	0.166 (0.087–0.309)	0.26 [0.04–0.41]
SB_{2011}/SB_{1950} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.
$SB_{2011}/SB_{current,\ F=0}$	n.a.	n.a.	n.a.

* All SRA Confidence intervals are 95% CI's

A Stock-Production Model Incorporating Covariates (ASPIC) for striped marlin

137. The WPB **NOTED** paper IOTC–2013–WPB11–32 which evaluated the uncertainty of catch data and CPUE index on the stock assessment of blue marlin and striped marlin in the Indian Ocean, including the following abstract from the authors:

“*The stock assessment of blue marlin and striped marlin in the Indian Ocean was carried out using ASPIC with a generalized model (Pella-Tomlinson model). Considering the uninformative data series before 1970s, total catch data and standardized CPUE series of Taiwanese and Japanese longline fleets after 1970s were adopted to be fitted to the model. The result indicated that the MSY reference points have been exceed, current (2011) biomass is below the MSY level and current fishing mortality is slightly higher than the MSY level*.”

138. The WPB **AGREED** to provide the results of the ASPIC model based on the Japan and the Taiwan,China longline data to illustrate the range of uncertainty.

139. The WPB **AGREED** that even though there is high uncertainty in the data set and methods used, the point estimates derived from all approaches described in Table 10 showed similar dynamics in terms of exploitation rates being higher than in the 1980's and 1990's with decreases in rates in recent years.

140. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below for striped marlin (Table 11; Fig. 11).

Table 11. Striped marlin: Key management quantities from ASPIC assessment runs, for the Indian Ocean striped marlin. Runs refer to those shown in Table 10. Note: The MSY is close to the upper limit of the confidence intervals, as the bootstrap mean and ASPIC mean results are slightly different.

Management Quantity	ASPIC
2011 catch estimate	2,470
Mean catch from 2007–2011	2,538
MSY (1000 t) (80% CI)	4,408 (3,539–4,578)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (80% CI)	1.28 (0.95–1.92)
B_{2011}/B_{MSY} (80% CI)	0.416 (0.2–0.42)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (80% CI)	0.18 (n.a.)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950, F=0}$	–
$SB_{2011}/SB_{1950, F=0}$	–

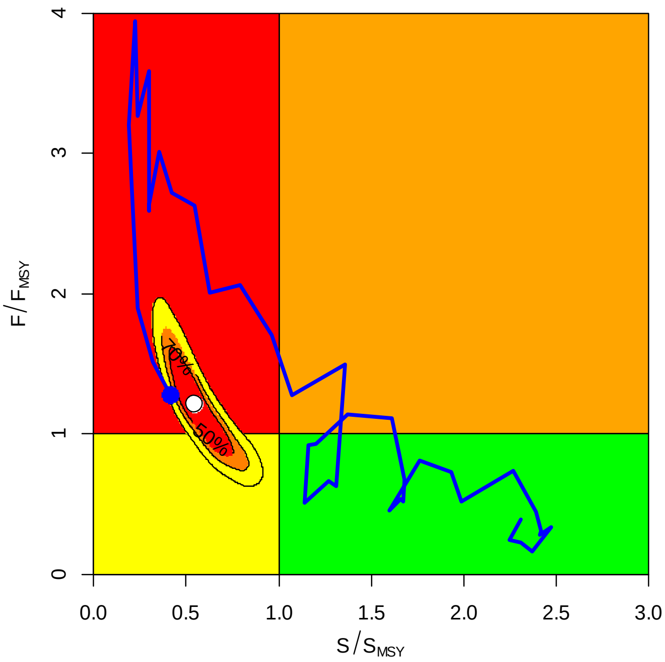

Fig. 11. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (90% bootstrap confidence surfaces shown around 2011 estimate – white dot). Blue line indicates the trajectory of the point estimates for the total biomass (B) (shown as S) ratio and F ratio for each year 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

Striped marlin: Bayesian State Space production model

141. The WPB **NOTED** paper IOTC–2013–WPB11–27 which provided a stock assessment of striped marlin (*Tetrapturus audax*) based on a Bayesian production model, including the following abstract from the authors:

"*Although white marlin is not a target large commercial longline tuna boats, it is often a bycatch. There is little information on stock structure but it is assumed that the one unique stock in the Indic Ocean is the most probable hypothesis. The available data is limited to catch and catch rates. Usually the quality of the data concerning bycatch species is not high, hence it is difficult to achieve success running stock assessment models. In this paper a potentially useful Bayesian version of state-space biomass dynamic models (Fox and Schaefer types) are used in an attempt to assess the status of the white marlin stock of the Indic Ocean. Results are compared to conventional versions in which only the observational error is considered. Calculations were based on estimations of total catch and on standardized catch rates as estimated based on Japan database. In this and in his companion paper (IOTC–2013–WPB11–25) the* *likelihood function was based on log-normal density distributions. Monte Carlo Markov Chains are used to calculate the posterior sample.*" – (see paper for full abstract)

142. The WPB **NOTED** the key assessment results for the Bayesian Surplus Production State Space Model as shown below for striped marlin (Table 12).

143. The WPB **NOTED** that this is a new approach being pursued and can be used for comparative purposes only at this time. No phase plots will be displayed, though overall results are reported (Table 12).

Table 12. Striped marlin: Key management quantities from the 2013 Bayesian State Space production model assessment for Indian Ocean striped marlin.

Management Quantity	Indian Ocean
2011 catch estimate	2,470
Mean catch from 2007–2011	2,538
MSY (1000 t) (80% CI)	7,455 (2,063–16,837)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (80% CI)	1.155 (0.332–5.324)
B_{2011}/B_{MSY} (80% CI)	0.324 (0.169–0.602)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (80% CI)	0.166 (0.087–0.309)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950,\ F=0}$	–
$SB_{2011}/SB_{1950,\ F=0}$	–

Striped marlin: Stock reduction analysis

144. The WPB NOTED paper IOTC–2013–WPB11–28 Rev_1 which provide a stock assessment of three billfish species in Indian Ocean, blue marlin, black marlin and striped marlin using stock reduction methods, including the following abstract from the authors:

"*We conduct stock assessments for three Indian Ocean billfish, Blue, Black and Striped 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 all three species in the whole Indian Ocean belong to a single stock and the population size in 1950 is the virgin biomass equal to their carrying capacities. We use recently updated catch data in the analysis. The preliminary results show that for blue marlin the geometric mean virgin biomass is about 86-432 thousand tonnes using the assumption that depletion in 2011 is between 30% and 70%.*" – (see paper for full abstract)

145. The WPB **NOTED** the key assessment results for the Stock Reduction Analysis as shown below for blue marlin (Table 13, Fig. 12).

146. The WPB **NOTED** that the stock trajectory was very similar for ASPIC and SRA, and the overall estimates of optimal yield, optimal fishing mortality and spawning biomass levels were similar across all three models.

147. **NOTING** the similarities in the SRA, ASPIC and Bayesian SP Models, the WPB **AGREED** to present the ASPIC model results for stock status.

Table 13. Striped marlin: Key management quantities from the 2013 Stock reduction analysis assessment for Indian Ocean blue marlin.

Management Quantity	Indian Ocean
2011 catch estimate	2,470
Mean catch from 2007–2011	2,538
MSY (1000 t) (95% CI)	4,218 (3,831–4,645)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} [plausible range of values]	1.12 [0.74–5.95]
B_{2011}/B_{MSY} [plausible range of values]	0.52 [0.08–0.82]
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} [plausible range of values]	0.26 [0.04–0.41]
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950,\ F=0}$	–
$SB_{2011}/SB_{1950,\ F=0}$	–

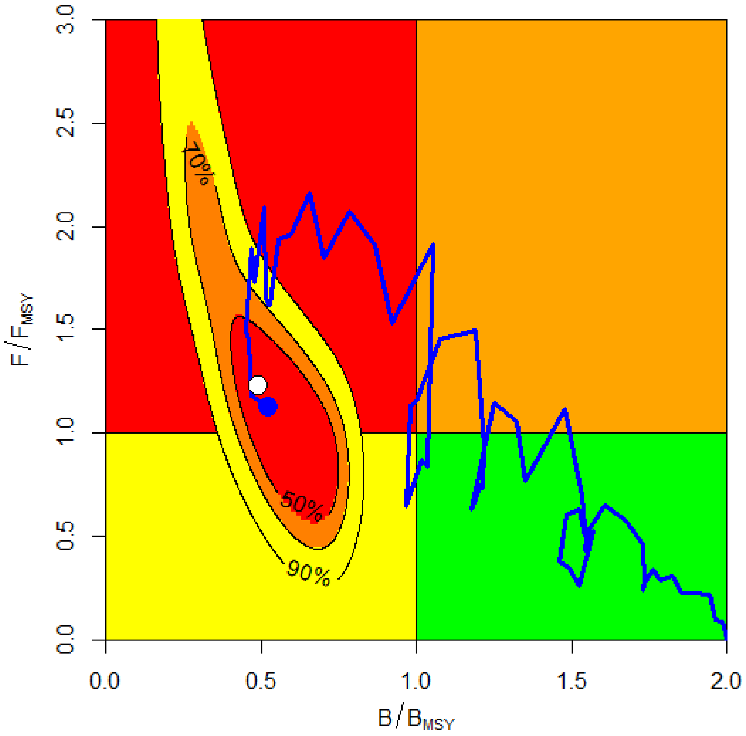

Fig. 12. Striped marlin: Stock reduction analysis aggregated Indian Ocean assessment Kobe plot for Striped marlin (95% confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio and F ratio for each year 1950–2011.

Black marlin: Summary of stock assessment models in 2013

Black marlin: Stock reduction analysis

148. The WPB **NOTED** paper IOTC–2013–WPB11–28 Rev_1 which provided a stock assessment of three billfish species in Indian Ocean, blue marlin, black marlin and striped marlin using stock reduction methods, including the following abstract from the authors:

 "*We conduct stock assessments for three Indian Ocean billfish, Blue, Black and Striped 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 all three species in the whole Indian Ocean belong to a single stock and the population size in 1950 is the virgin biomass equal to their carrying capacities. We use recently updated catch data in the analysis. The preliminary results show that for blue marlin the geometric mean virgin biomass is about 86-432 thousand tonnes using the assumption that depletion in 2011 is between 30% and 70%.*" – (see paper for full abstract)

149. The WPB **NOTED** the key assessment results for the Stock Reduction Analysis as shown below for blue marlin (Table 14, Table 15, Fig. 13).

150. The WPB **AGREED** to provide the results of the Stock reduction analysis Model with uncertainty on black marlin as the trajectories between ASPIC and SRA Model shows similar results and with no CPUE data for black marlin this was the approach to use.

Table 14. Black Marlin: Summary of final stock assessment model (Stock reduction analysis) features as applied to black marlin in 2013.

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 15. Black Marlin: Key management quantities from the Stock reduction analysis Model, for the Indian Ocean Black marlin. Runs refer to those shown in Table 14.

Management Quantity	Stock Reduction Analysis
2011 catch estimate	10,291
Mean catch from 2007–2011	9,345
MSY (1000 t) (95% CI)	8,605 (6,278–11,793)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (95% CI)	1.17 (0.15–2.19)
B_{2011}/B_{MSY} (95% CI)	1.03 (0.75–1.55)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (95% CI)	–
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950, F=0}$	–
$SB_{2011}/SB_{1950, F=0}$	–

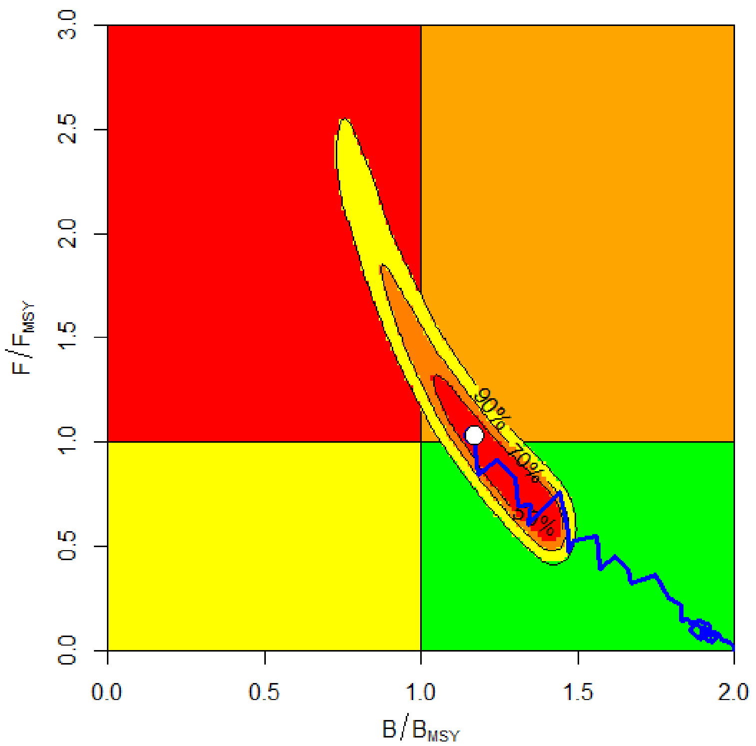

Fig. 13. Black marlin: Stock reduction analysis aggregated Indian Ocean assessment Kobe plots for black marlin (95% confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio and F ratio for each year 1950–2011.

Parameters for future analyses: stock assessments

151. **NOTING** that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses, and this could have a detrimental effect on the quality of advice provided by the WPB, the WPB **RECOMMENDED** that exchanges of data (CPUE indices and coefficient of variation) should be made as early as possible, but no later than 30 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 15 days before a working party meeting, as per the recommendations of the SC, which states: "*The SC also ENCOURAGED data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and RECOMMENDED that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs*." (IOTC–2011–SC14–R; p68)

152. 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.

153. 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.

6.3.3 Selection of Stock Status indicators for marlins

154. The WPB **NOTED** that the assessments carried out in 2013 continued development of approaches pursued in 2012. All three models were essentially giving the same outlook on the stock (and was similar to 2012), and as such the WPB **AGREED** that this year they would use the information for stock status advice.

155. The WPB **AGREED** that stock status should be determined by qualitatively integrating the results of the various stock assessments undertaken in 2013 with other status indicators for each marlin species. The WPB treated all analyses as equally informative, and focussed on the features common to all of the results.

156. In deciding upon the most appropriate way to present the integrated stock assessment results to the SC, the WPB **AGREED** that ASPIC would be used for blue marlin and striped marlin, and the Stock Reduction Analysis model results should be depicted for striped marlin and black marlin, in the species executive summaries.

6.4 Development of management advice for marlins

157. The WPB **ADOPTED** the management advice developed for marlins as provided in the draft resource stock status summaries:
    - Black marlin (*Makaira indica*) – Appendix VII
    - Blue marlin (*Makaira nigricans*) – Appendix VIII
    - Striped marlin (*Tetrapturus audax*) – Appendix IX

6.5 Update of marlin species Executive Summaries for the consideration of the Scientific Committee

158. The WPB **REQUESTED** that the IOTC Secretariat update the draft stock status summaries for the marlin species with the latest 2012 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

7. INDO-PACIFIC SAILFISH

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

159. The WPB **NOTED** paper IOTC–2013–WPB11–07 Rev_2 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for sailfish, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2011. Statistics for 2012 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October). The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching 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.

160. 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.

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

Kenyan sailfish sports fishery

161. The WPB **NOTED** paper IOTC–2013–WPB011–29 which summarised seasonality, morphometrics and feeding behaviour of sailfish (*Istiophorus platypterus*) caught by sports fishers in Kenyan waters, including the following abstract provided by the authors:

    "*Sailfish (Istiophorus platypterus) are among the major target species caught by sports fishers in Kenyan waters. As a conservation measure, sports fishers return the fish to the waters and also tag them in an effort to study them. The retained fish are mainly those injured during the fishing expedition, they are brought on board and these were the ones used for the study which was conducted between November 2012 and January 2013 which is the peak season for sailfishes in the Kenyan waters. For seasonality data, a 19 year daily catch data from 1987 to 2011 was used. The December and January happen to have the peak* *abundance of sailfish in the waters. They average weight of the sailfish was recorded as 28.9 ± 4.4 kg and had an average eye-orbit fork length of 166.5 ±9.5 cm. The major food contents in the fish stomachs were crabs (Charybdis smithii), anchovies Stolephorus commersonii (Lacepède, 1803), and Kawakawa (Euthynnus affinis).*"

162. The WPB **NOTED** the importance of stomach contents analysis for species whose biology is poorly known. Reconstituted weight is also considered to be a better estimate than wet weight.

163. 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.

164. The WPB **ENCOURAGED** the Kenya to expand the study to other billfish species caught by its sports fisheries and for this to be done in collaboration with the African Billfish Foundation.

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

7.3.1 Nominal and standardised CPUE indices

165. 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.

7.3.2 Stock assessments

166. The WPB **AGREED** that although no stock assessment was undertaken for sailfish caught in IOTC fisheries in 2013, further exploratory analysis of the data available should be undertaken in preparation for the next WPB meeting.

7.3.3 Selection of Stock Status indicators for Indo-Pacific sailfish

167. **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.

168. The WPB **REQUESTED** that all CPCs improve data collection and reporting for sailfish given the importance of this species to many sports fisheries operating in the Indian Ocean, in particular for Kenya who indicated that they have a long catch history series available for potential analysis.

169. The WPB **AGREED** that there are limited stock status indicators available for Indo-Pacific sailfish and further work is urgently required in 2014.

7.4 Development of management advice for Indo-Pacific sailfish

170. The WPB **ADOPTED** the management advice developed for Indo-Pacific sailfish (*Istiophorus platypterus*), as provided in the draft resource stock status summary (Appendix X).

7.5 Update of sailfish species Executive Summaries for the consideration of the Scientific Committee

171. The WPB **REQUESTED** that the IOTC Secretariat update the draft stock status summary for sailfish with the latest 2012 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

8. SWORDFISH

8.1 Review of data available at the secretariat for swordfish

172. The WPB **NOTED** paper IOTC–2013–WPB11–07 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 1950–2011. Statistics for 2012 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October). The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching swordfish 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.

173. The WPB **NOTED** the main swordfish 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.

174. **NOTING** the potential underreporting of swordfish catches from Indonesian fresh-tuna longline fisheries and the way in which the IOTC Secretariat had estimated swordfish catches, the WPB **REQUESTED** that catch extrapolation must be undertaken, taking into consideration species-specific targeting (day-deep vs. night-shallow sets) for fleets taking SWO as a bycatch. The WPB was informed that major research and commercial operations targeting tuna in day deep sets produce very low levels of swordfish bycatch even in the areas where swordfish is a dominant species in shallow-night sets.

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

Indian Ocean Swordfish Stock Structure

175. The WPB **NOTED** paper IOTC–2013–WPB11–10 which provided the results of a study using multi-genetic markers and spatio-temporal analysis to determine if there is a single panmictic population of swordfish in the Indian Ocean, including the following abstract provided by the authors:

    "*Genetic population structure of swordfish Xiphias gladius was examined based on 2231 individual samples, collected mainly between 2009 and 2010, among three major sampling areas within the Indian Ocean (IO; twelve distinct sites), Atlantic (two sites) and Pacific (one site) Oceans using analysis of nineteen microsatellite loci (n = 2146) and mitochondrial ND2 sequences (n = 2001) data. Sample collection was stratified in time and space in order to investigate the stability of the genetic structure observed with a special focus on the South West Indian Ocean. Significant AMOVA variance was observed for both markers indicating genetic population subdivision was present between oceans. Overall value of F-statistics for ND2 sequences confirmed that Atlantic and Indian Oceans swordfish represent two distinct genetic stocks. Indo-Pacific differentiation was also significant but lower than that observed between Atlantic and Indian Oceans. However, microsatellite F-statistics failed to reveal structure even at the inter-oceanic scale, indicating that resolving power of our microsatellite loci was insufficient for detecting population subdivision.*" – (see paper for full abstract)

Swordfish catches and environmental features.

176. The WPB NOTED paper IOTC–2013–WPB11–30 Rev_1 which reported on the relationships between swordfish captures and environmental features in the southwest Indian Ocean, including the following abstract provided by the authors:

    "*Oceanic circulation plays a major in the distribution of nutrients and oceanic structures such as fronts and eddies may become hotspots of biological activity through concentration and enrichment processes. Oceanic structures generally attract forage fish and cephalopods and may therefore be targeted by marine top-predators. The link between swordfish (Xiphias gladius) captures and environmental structures is poorly documented in the southwest Indian Ocean despite the growing need of the local fishery from Reunion Island for such information. In this study we used a set of temporal (date, moon phase), geographic (longitude, latitude, distance to coast, bathymetry) and environmental covariates (sea surface temperature, chlorophyll-a concentration, sea level anomalies, index of convergence) to explain variations in swordfish catch per unit of effort (CPUE) throughout 2012. Univariate analyses show strong seasonal and latitudinal patterns in swordfish occurence. We also found that higher swordfish CPUE are associated with shelf-break areas and sea mounts, as well as dynamic environmental structures, even though these relationships explain only a small fraction of swordfish CPUE variations. Chlorophyll-a fronts and dynamic convergent structures as identified by finite-size Lyapunov exponents might attract swordfish.*"

177. The WPB **NOTED** that this work provides important preliminary insights into the variability of swordfish CPUE in relation with environmental variables in the Indian Ocean and urged the authors to provide further updates at the next WPEB meeting.

EU,Portugal swordfish fishery

178. The WPB **NOTED** paper IOTC–2013–WPB11–31 Rev_1 presented an updated overview of the swordfish catches by the Portuguese pelagic longline fishery in the Indian Ocean between 1998–2012: catch, effort, CPUE and catch-at-size, including the following abstract provided by the authors:

    "*The Portuguese longline fishery targeting swordfish in the Indian Ocean started in the late 1990's, targeting mainly swordfish. A recent effort by Portuguese Marine and Atmosphere Institute (IPMA) has been made aiming the collection of historical catch data on this fishery since the late 1990's to the present date. This working document reports an updated overview of the Portuguese swordfish fishery, including analyses on the catches, effort, catch-at-size and CPUE trends for the period 1998-2012. The trends in the swordfish catch-at-size were analyzed annually, and compared between months and regions of operation of the fishery. Nominal annual CPUEs were calculated as kg/1000 hooks, and were standardized with*

Generalized Linear Models (GLMs) using year, quarter, location and swordfish/blue shark ratio as explanatory variables. Three different modeling approaches were used and compared, including tweedie, gamma and lognormal models, and model validation was carried out with a residual analysis. A sensitivity analysis to the influence of the ratio factor in the models was carried out. The results presented in this paper update a previous analysis on the trends of swordfish catches available from the Portuguese longline fishery operating in the Indian Ocean."

179. The WPB **AGREED** that the paper represented an important update of the CPUE and length-distribution analysis related to swordfish stock status in the Southwest Indian Ocean.

180. The WPB **NOTED** that majority of data originated from logbooks and thus, development of CPUE in number rather than in weight may considerably decrease the dataset size.

181. The WPB **NOTED** that ongoing work is focused on disaggregation of data from FAO areas to the exact set position using VMS data.

8.3 Review of new information on the status of swordfish

8.3.1 Nominal and standardised CPUE indices

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

CPUE Summary discussion (from the previous WP meeting – WPB10)

183. 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 (notably southwest region in recent years), 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 number of Hooks Between Floats), 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.
    - Target species are known to have changed substantially for the Japanese and Taiwan,China fleets, and it is unclear if the available data and methods can account for these changes.
    - The effects of some oceanographic variability on the species distribution and catchability are not well understood. Environmental covariates may be confounded with fixed spatial and temporal effects, they could be describing important interannual variability in catchability (which would improve the series), or they could be spuriously correlated with fish abundance (in which case their use could be counter-productive). Until these mechanisms are better understood, it is worth running models with and without environmental covariates.
    - Standard statistical model selection criteria have been shown to prefer over-parameterised models in simulation studies.

184. The WPB **NOTED** the following CPUE series from the 2012 and previous WPB meetings:
    - Japan data (1980–2009): Series 3.2 from document IOTC–2011–WPB09–14, which includes fixed latitude and longitude effects, plus environmental effects.
    - Taiwan,China data (1995–2009): Model 10 from document IOTC–2011–WPB09–23, which includes fixed latitude and longitude effects, plus environmental effects.
    - EU,Portugal data (1999–2011): IOTC–2012–WPB10–11, which includes major areas, seasonal effects and species ratio factors.
    - EU,Spain data (2001–2009): Series 5 from document IOTC–2011–WPB09–23, calculated for the southwest area only (includes sub-region factors and species ratio factors) area and run 1 for the assessment of whole Indian Ocean.
    - EU,La Reunion data (1994–2000): Same series as last year (IOTC–2010–WPB09–03).

185. The WPB **NOTED** the CPUE series used in the stock assessment models for 2011 (shown in Figs. 14 and 15).

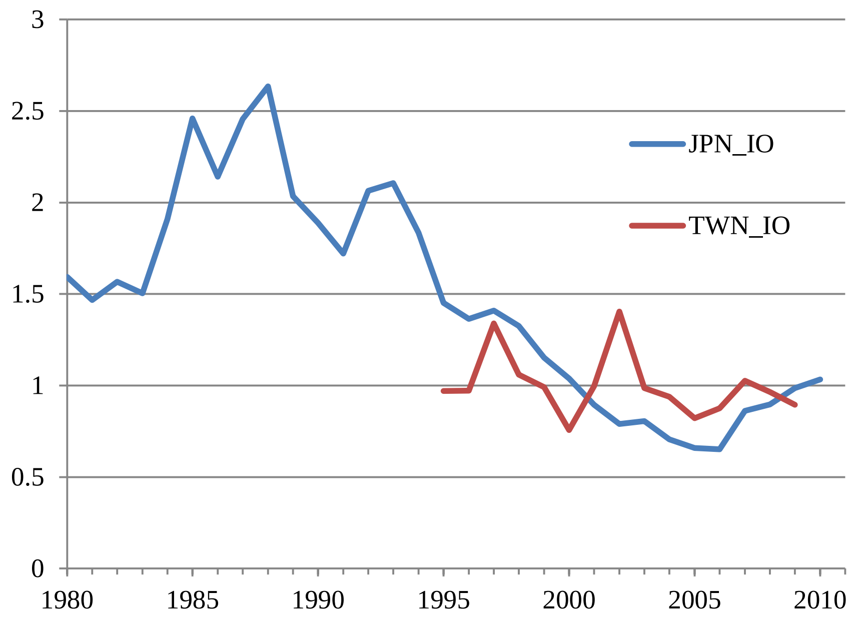

Fig. 14. Swordfish: Recommended CPUE series for Indian Ocean swordfish. Series have been rescaled relative to their respective means from 1980–2010.

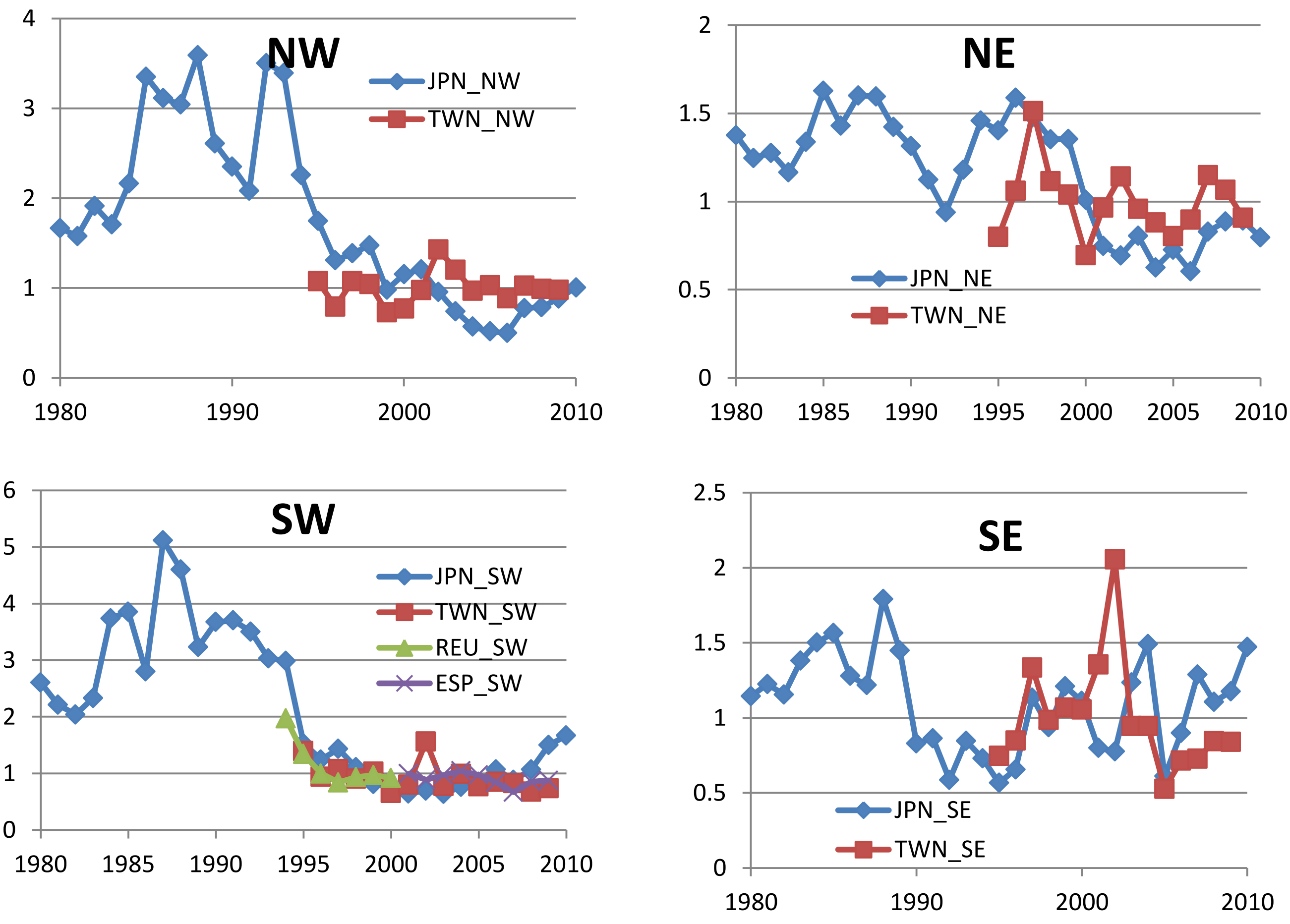

Fig. 15. Swordfish: CPUE series for Indian Ocean swordfish assessments in 2011 by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – south-west; NE – north-east; SE – south-east Indian Ocean.

8.3.2 Stock assessments

186. The WPB **NOTED** that no stock assessment was undertaken for Indian Ocean swordfish in 2013. When considering whether a new stock assessment should be undertaken for the aggregate Indian Ocean and the south-west Indian Ocean in 2014, the WPB **AGREED** new relevant information needed to be presented, in particular a fine scale CPUE analysis for the EU,Spain and EU,France longline fisheries.

187. The WPB **NOTED** that the Stock Reduction Analysis approach should be used for comparative purposes with the others assessments for swordfish in 2014.

8.3.3 Selection of Stock Status indicators for swordfish

188. The WPB **NOTED** the range of quantitative modelling methods that were applied to the swordfish assessment in 2011, 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–2011–WPB09–17, 18, 19 and 20. Each model is summarised in the report of the Ninth Session of the WPB (IOTC–2011–WPB09–R) and are not presented here for brevity.

8.4 Development of management advice for swordfish

189. The WPB **ADOPTED** the management advice developed for swordfish (*Xiphias gladius*), as provided in the draft resource stock status summary (Appendix XI).

8.5 Update of swordfish Executive Summaries for the consideration of the Scientific Committee

190. The WPB **REQUESTED** that the IOTC Secretariat update the draft stock status summary for swordfish with the latest 2012 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

9. Research Recommendations and Priorities

9.1 Revision of the WPB workplan

191. The WPB **NOTED** the range of research projects on billfish, currently underway, or in development within the IOTC area of competence, and reminded participants to ensure that the projects described are included in their National Reports to the SC, which are due on the 17th of November 2013.

192. The WPB **RECOMMENDED** that the SC consider and endorse the workplan and assessment schedule for the WPB for 2014, and tentatively for future years, as provided at Appendix XII and Appendix XIII, respectively.

10. Other Business

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

193. The WPB **NOTED** with thanks, the 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 WPB meeting contributed greatly to the groups understanding of billfish data and assessment methods.

194. 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 2014, by the Invited Experts:
    - **Expertise**: Stock assessment; including from regions other than the Indian Ocean; data poor assessment approaches for marlins (by species).
    - **Priority areas for contribution**: Refining the information base, historical data series and indicators for billfish species for stock assessment purposes (species focus: Swordfish and Indo-Pacific Sailfish).

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

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

10.2 Date and place of the Twelfth Session of the Working Party on Billfish

197. The WPB participants were unanimous in thanking La Reunion, France, for hosting the Eleventh Session of the WPB and commended La Reunion on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

198. 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. In ICCAT for example, wherever a meeting is hosted, many national scientists from that location are able to attend meetings.

199. Following a discussion on who would host the 12th Session of the WPB in 2014, the WPEB **REQUESTED** that the IOTC Secretariat liaise with Kenya to determine if they would be able to host the 12th Session. Three meetings times were proposed: early June, late-July or late-October 2014, and should be held in conjunction with the Working Party on Ecosystems and Bycatch. The meeting location will be communicated by the IOTC Secretariat to the SC for its consideration at its next session to be held in December 2013.

Meeting	2014		2015 (tentative)	
	Date	**Location**	**Date**	**Location**
Working Party on **Billfish**	Options: Early June (5d) 21–25 July (5d) Late-October (5d)	Kenya or Tanzania	Options: Early June (5d) 21–25 July (5d) Late-October (5d)	EU,Portugal or Tanzania
Working Party on **Ecosystems and Bycatch**	After the WPB	Kenya or Tanzania	Prior to the WPB	EU,Portugal or Tanzania

200. Following a discussion on who would host the 13th Session of the WPB in 2015, the WPB **REQUESTED** that the IOTC Secretariat liaise with EU,Portugal to determine if they would be able to host the 13th Session in 2015, in conjunction with the Working Party on Ecosystems and Bycatch. The tentative dates and meeting location will be communicated by the IOTC Secretariat to the SC for its consideration.

201. 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 Election of a Chairperson and a Vice-Chairperson for the next biennium

202. The WPB **NOTED** that both the Chairperson (Dr Jérôme Bourjea, La Réunion, France), and the Vice-Chairperson (Dr. Miguel Neves Santos, EU,Portugal) had completed a first term of two years and thus, the positions were declared open.

203. Noting the rules of procedure of the IOTC: Rule X.6: The Scientific Committee [*and its Working Parties*] shall elect, preferably by consensus, a Chairperson and a Vice-Chairperson from among its members for two years, the WPB **CALLED** for nominations for the newly vacated positions of Chairperson and Vice-Chairperson for the next biennium. Dr Jérôme Bourjea (La Réunion, France) was nominated and re-elected as Chairperson, and the Dr. Miguel Neves Santos (EU,Portugal) was nominated and re-elected as Vice-Chairperson of the WPB for the next biennium.

204. The WPB **RECOMMENDED** that the SC note the re-elected Chairperson, Dr Jérôme Bourjea (La Réunion, France) and re-elected Vice-Chairperson, Dr. Miguel Neves Santos (EU,Portugal), of the WPB for the next biennium.

10.4 Review of the draft, and adoption of the Report of the Eleventh Session of the Working Party on Billfish

205. The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB11, provided at Appendix XIV, as well as the management advice provided in the draft resource stock status summary for each of the billfish species under the IOTC mandate:
    - Black marlin (*Makaira indica*) – Appendix VII
    - Blue marlin (*Makaira nigricans*) – Appendix VIII
    - Striped marlin (*Tetrapturus audax*) – Appendix IX
    - Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix X
    - Swordfish (*Xiphias gladius*) – Appendix XI

206. The report of the Eleventh Session of the Working Party on Billfish (IOTC–2013–WPB11–R) was **ADOPTED** on the 22 September 2013.

APPENDIX I
LIST OF PARTICIPANTS

Chairperson
Mr. Jérôme **Bourjea**
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APPENDIX II
AGENDA FOR THE ELEVENTH WORKING PARTY ON BILLFISH

Date: 18–22 September 2013
Location: Espace TAMARUN
Reunion Island, France
Time: 09:00 – 17:00 daily
Chair: Dr. Jeromé 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 FIFTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (Secretariat)

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

5. PROGRESS ON THE RECOMMENDATIONS OF WPB10 (Chair and Secretariat)

6. MARLINS
- 6.1 Review of data available at the secretariat for marlins (Secretariat)
- 6.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
- 6.3 Review of new information on the status of marlins (all)
    - Nominal and standardised CPUE indices
    - Stock assessments
    - Selection of Stock Status indicators for marlins
- 6.4 Development of management advice for marlins (all)
- 6.5 Update of marlin species Executive Summaries for the consideration of the Scientific Committee (all)

7. SAILFISH
- 7.1 Review of data available at the secretariat for sailfish (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 sailfish (all)
    - Nominal and standardised CPUE indices
    - Stock assessments
    - Selection of Stock Status indicators for sailfish
- 7.4 Development of management advice for sailfish (all)
- 7.5 Update of sailfish species Executive Summaries for the consideration of the Scientific Committee (all)

8. SWORDFISH
- 8.1 Review of data available at the secretariat for swordfish (Secretariat)
- 8.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
    - Southwest Indian Ocean
    - Indian Ocean-wide
- 8.3 Review of new information on the status of swordfish (all)
    - Nominal and standardised CPUE indices
    - Stock assessments
    - Selection of Stock Status indicators for swordfish
- 8.4 Development of management advice for swordfish (all)
- 8.5 Update of swordfish Executive Summaries for the consideration of the Scientific Committee (all)
    - Southwest Indian Ocean
    - Indian Ocean-wide

9. RESEARCH RECOMMENDATIONS AND PRIORITIES
- 9.1 Revision of the WPB work plan (Chair)

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 Twelfth Session of the Working Party on Billfish (Chair and Secretariat)
- 10.3 Election of a Chairperson and a Vice-Chairperson for the next biennium (Secretariat)
- 10.4 Review of the draft, and adoption of the Report of the Eleventh Session of the Working Party on Billfish (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2013–WPB11–01a	Draft: Agenda of the Eleventh Working Party on Billfish	✓(16 June 2013)
IOTC–2013–WPB11–01b	Draft: Annotated agenda of the Eleventh Working Party on Billfish	✓(3 September 2013)
IOTC–2013–WPB11–02	Draft: List of documents of the Eleventh Working Party on Billfish	✓(3 September 2013)
IOTC–2013–WPB11–03	Outcomes of the Fifteenth Session of the Scientific Committee (Secretariat)	✓(28 August 2013)
IOTC–2013–WPB11–04	Outcomes of the Seventeenth Session of the Commission (Secretariat)	✓(28 August 2013)
IOTC–2013–WPB11–05	Review of Conservation and Management Measures relevant to billfish (Secretariat)	✓(29 August 2013)
IOTC–2013–WPB11–06	Progress made on the recommendations of WPB10 (Secretariat)	✓(3 September 2013)
IOTC–2013–WPB11–07 Rev_2	Review of the statistical data and fishery trends for billfish (Secretariat)	✓(3 September 2013) ✓(3 September 2013)
IOTC–2013–WPB11–08	Billfish identification cards (Secretariat)	✓(30 August 2013)
IOTC–2013–WPB11–09	Revision of the WPB work plan (Chair)	✓(28 August 2013)
IOTC–2013–WPB11–10	Multi-genetic marker approach and spatio-temporal analysis suggest there is a single panmictic population of swordfish *Xiphias gladius* in the Indian Ocean (D. Muths, S. Le Couls, H. Evano, P. Grewe & J. Bourjea)	✓(13 August 2013)
IOTC–2013–WPB11–11	Billfish: an important part of the pelagic gillnet fisheries of Pakistan (M. Moazzam)	✓(30 August 2013)
IOTC–2013–WPB11–12	Fishery in Iran with particular reference to billfish (F. Rajaei)	✓(2 September 2013)
IOTC–2013–WPB11–13	Billfish fishery of Thailand (C. Chookong)	✓(2 September 2013)
IOTC–2013–WPB11–14 Rev_1	Length frequency distributions of billfishes (Xiphiidae and Istiophoridae) from Indonesian tuna longline observer data (I. Jatmiko, B. Setyadji & B. Nugraha)	✓(3 September 2013) ✓(30 September 2013)
IOTC–2013–WPB11–15	Catches of billfish by the Malaysian tuna longliners targeting the tropical and temperate tune in the Indian Ocean (S. Basir & N.A. Bakarr)	✓(3 September 2013)
IOTC–2013–WPB11–16 Rev_1	A review on billfish fishery resources in Sri Lanka (H.L.N.S. Herath & R. Maldeniya)	✓(3 September 2013) ✓(16 September 2013)
IOTC–2013–WPB11–17	Billfish caught in the recreational and sport fishing of south coast of Mozambique: Results of the first census of recreational and sport fishing in 2007 and the sampling program in 2012 (R.J. Mutombene)	✓(3 September 2013)
IOTC–2013–WPB11–18	Malagasy Billfish Fishery in 2012 (D.M. Rahombanjanahary)	✓(3 September 2013)
IOTC–2013–WPB11–19	Developments in the east African billfish conservation and research programme (T. Harris, C. Harris & N. Kadagi)	✓(4 September 2013)
IOTC–2013–WPB11–20	Evaluation of the effect of lunar cycle, monsoon and spatial differences on billfishes (M.K. Sajeevan)	✓(5 September 2013)
IOTC–2013–WPB11–21	Preliminary results of the development of identification guide for dressed billfish (E.V. Romanov, L. Le Foulgoc, H. Evano & J. Bourjea)	✓(10 September 2013)
IOTC–2013–WPB11–22 Rev_2	Correlations between environmental factors and CPUEs of blue marlin (*Makaira mazara*) and striped marlin (*Kajikia audax*) caught by Taiwanese longline fishery in the Indian Ocean (S.-P. Wang & T. Nishida)	✓(3 September 2013) ✓(17 September 2013) ✓(23 September 2013)
IOTC–2013–WPB11–23 Rev_1	Standardization of catch rates for Striped marlin (*Tetrapturus audax*) and Blue marlin (*Makaira mazara*) in the Indian Ocean by the core fishing area approach using operational catch and effort data of the Japanese tuna longline fisheries (1971-2012) (T. Nishida & S.P. Wang)	✓(8 September 2013) ✓(20 September 2013)
IOTC–2013–WPB11–24 Rev_2	CPUE standardization of blue marlin (*Makaira mazara*) caught by Taiwanese longline fishery in the Indian Ocean for 1995 to 2011 (S.-P. Wang & T. Nishida)	✓(3 September 2013) ✓(17 September 2013) ✓(23 September 2013)
IOTC–2013–WPB11–25	Stock assessment of blue marlin (*Makaira mazara*) based on a Bayesian production model (H.A. Andrade)	✓(21 September 2013)

Document	Title	Availability
IOTC–2013–WPB11–26 Rev_2	CPUE standardization of striped marlin (*Kajikia audax*) caught by Taiwanese longline fishery in the Indian Ocean for 1995 to 2011 (S.-P. Wang & T. Nishida)	✓(3 September 2013) ✓(17 September 2013) ✓(23 September 2013)
IOTC–2013–WPB11–27	Exploratory stock assessment of the striped marlin (*Tetrapturus audax*) caught in the Indian Ocean as calculated using a state-space biomass dynamic model (H. A. Andrade)	✓(21 September 2013)
IOTC–2013–WPB11–28 Rev_1	Stock assessment of three billfish species in Indian Ocean, blue, black and striped marlin using stock reduction methods (Secretariat)	✓(3 September 2013) ✓(1 October 2013)
IOTC–2013–WPB11–29	Seasonality, morphometrics and feeding behaviour of sailfish (*Istiophorus platypterus*) caught by sports fishers in the Kenyan waters (S. Ndegwa & K.B. Kyalo)	✓(3 September 2013)
IOTC–2013–WPB11–30 Rev_1	Exploratory analysis of the relationship between swordfish capture and environmental features in the southwest Indian Ocean (P. Sabarros, L. Le Foulgoc, E. Romanov, J.F. Ternon & P. Bach)	✓(13 September 2013) ✓(19 September 2013)
IOTC–2013–WPB11–31 Rev_1	An updated overview of the swordfish catches by the Portuguese pelagic longline fishery in the Indian Ocean between 1998–2012: catch, effort, CPUE and catch-at-size (M.N. Santos, R. Coelho & P.G. Lino)	✓(30 August 2013) ✓(22 September 2013)
IOTC–2013–WPB11–32	Evaluating the uncertainty of catch data and CPUE index on the stock assessment of blue marline and striped marlin in the Indian Ocean (S.-P. Wang)	✓(21 September 2013)
Information papers		
IOTC–2012–WPB10–INF01	IOTC SC – Guidelines for the Presentation of Stock Assessment Models	✓(12 June 2012)
IOTC–2012–WPB10–INF02	IOTC CEdata – Exploratory analysis – Longline September 2013 (H.A. Andrade)	✓(21 September 2012)
IOTC–2012–WPB10–INF03	A simple method for estimating MSY from catch and resilience (S. Martell & R. Froese)	✓(3 September 2012)

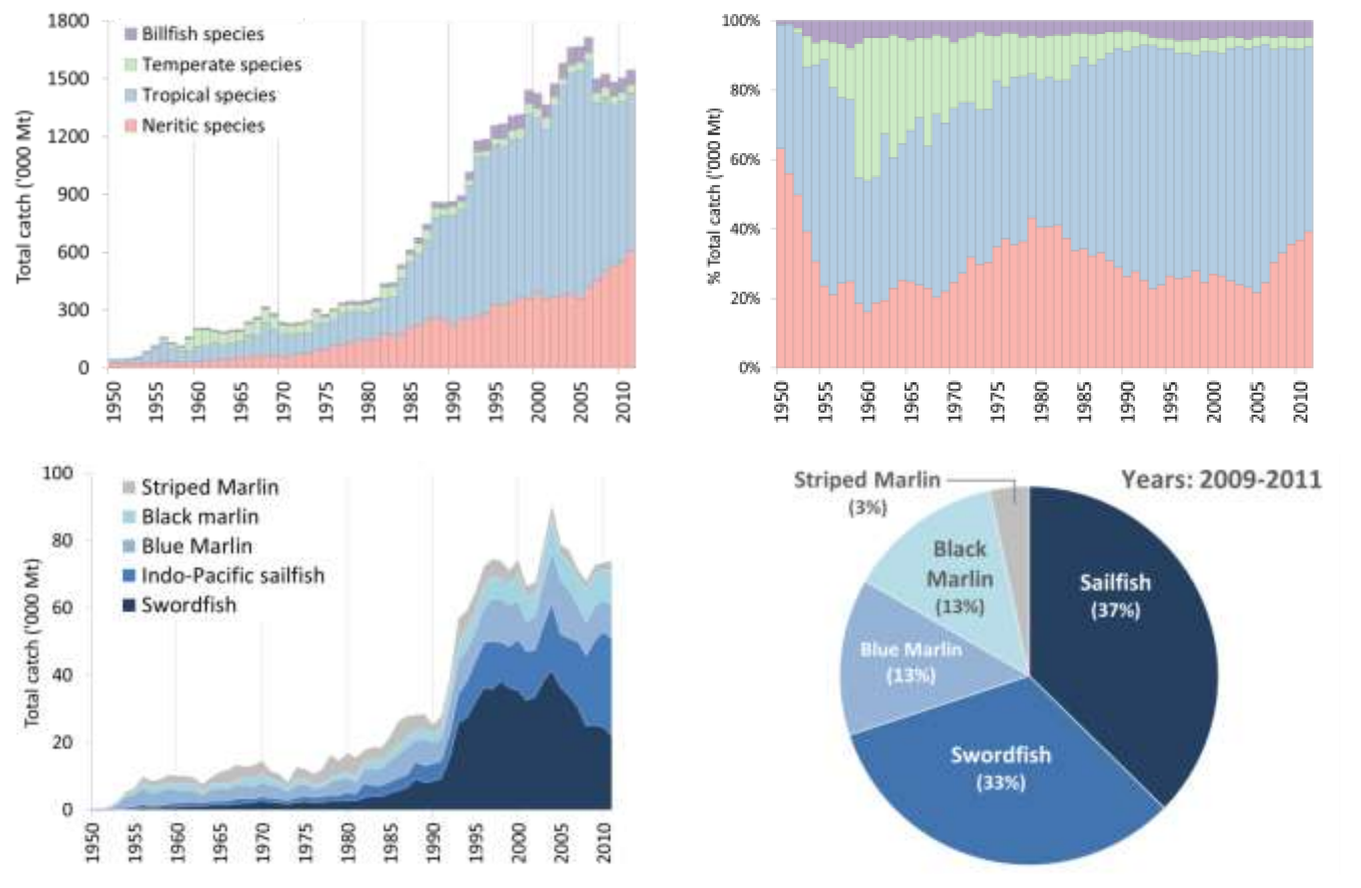
APPENDIX IV
MAIN STATISTICS OF BILLFISH

(*Extract from IOTC–2013–WPB11–07 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 overall catch. 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 2003–06 when catches of 91,000 t were reported (mostly attributed to increases in catches of swordfish, sailfish and blue marlin) (Fig. 1c).

Of the five billfish species, Indo-Pacific sailfish and swordfish account for 70% of the catch in recent years (2009–11; Fig. 1d.), followed by blue marlin and black marlin with 13% of the total catch each. The remaining 3% is striped marlin. The importance of each species, in terms of the 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 operating in the area, 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 declined to around a third of the total billfish catch, largely as a result of declining catches from Taiwan,China.

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% and 70% as catches from gillnet fisheries have become increasingly important for a number of fleets such as I.R. Iran and Sri Lanka. In addition, the number of longline vessels from Taiwan,China 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. While a number of countries in the IOTC region have important fisheries for billfish (Fig. 2), in recent years five countries (Sri Lanka, India, Taiwan,China, I.R. Iran, and Indonesia), have reported as much as two thirds (from 2009–11) of the of the total catches of billfish species from all countries and species combined.



Figs. 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 1950–2011 (a. Top left: total catch; b. Top right percentage, same colour key as Fig. 1a).; **Bottom:** Contribution of each species of billfish to the total combined catches of billfish (c. Bottom left: nominal catch of each species, 1950–2011; d. Bottom right: share of billfish catch by species, 2009–11)

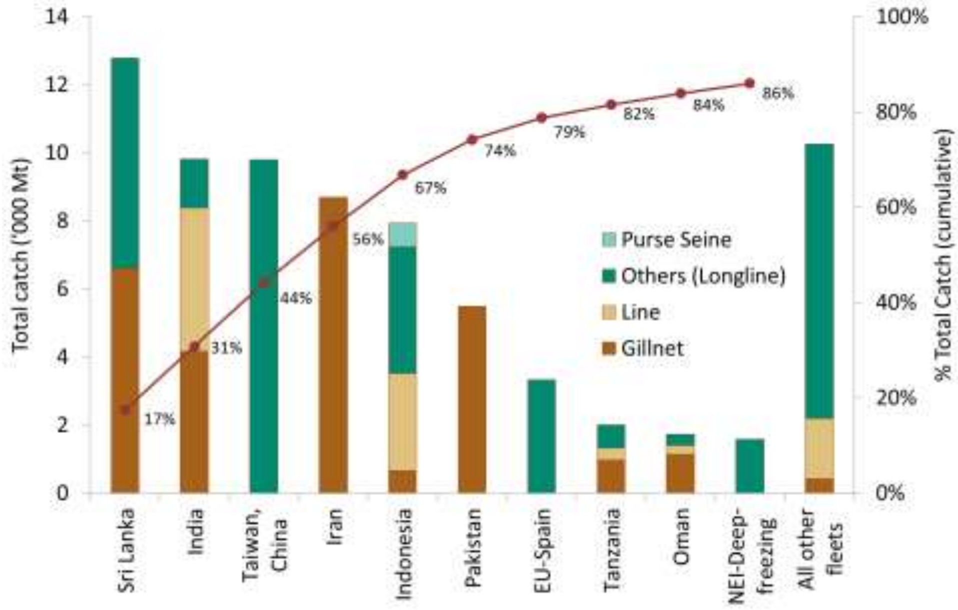


Fig. 2. Swordfish: average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of swordfish reported. The red line indicates the (cumulative) proportion of catches of swordfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

Black marlin (Makaira indica)

Catch trends

Black marlin are caught mainly by drifting longlines (37%) and gillnets (38%) with remaining catches taken by troll and hand lines (**Table 1, Fig. 1**). Black marlin are not targeted by industrial fisheries, but is targeted by some artisanal and sport/recreational fisheries. Black marlin are also known to be taken in purse seine fisheries, but are not currently being reported. In recent years, the fleets of Sri Lanka (longline and gillnet), Indonesia (troll and hand lines) and India (gillnet and troll) account for around 77% 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. Current annual catches are estimated at between 9,000 t to 10,000 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. 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**).

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 recent years (2009–11) India has reported higher catches of black marlin for its fisheries, amounting to around 1,000 t to 2,000 t, largely from increases in catches from gillnet and troll.

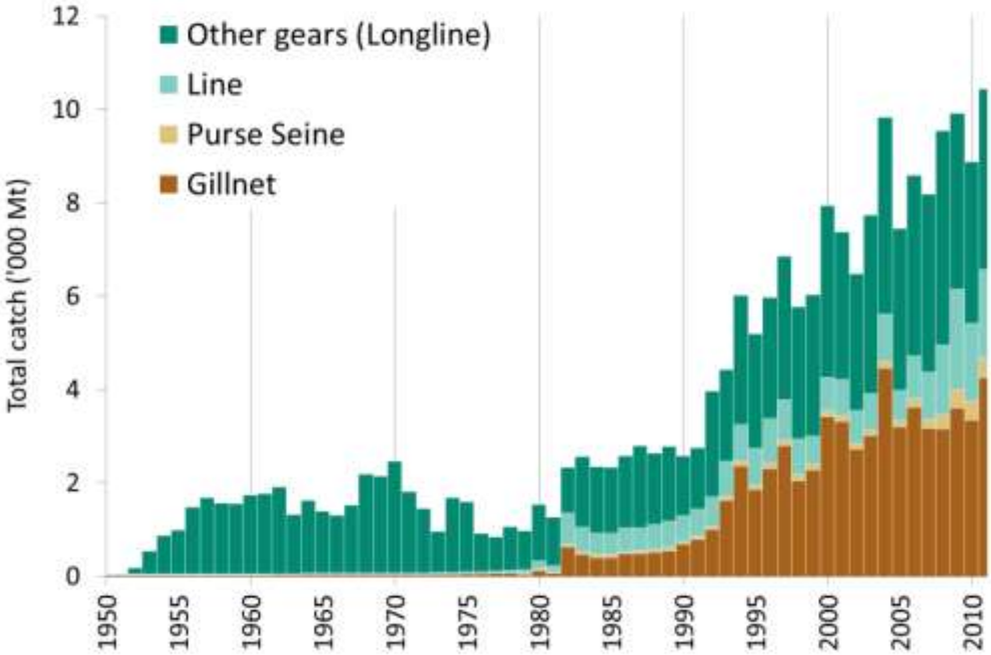


Fig. 1. Black marlin: Catches of black marlin by gear and year recorded in the IOTC Database (1950–2011).

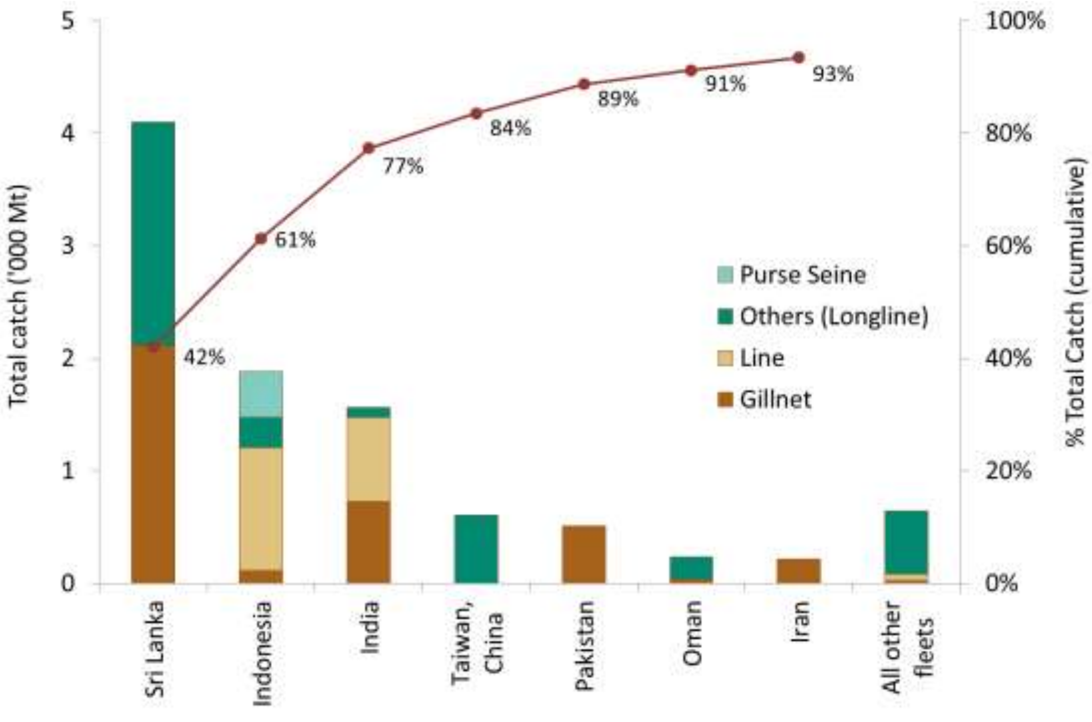


Fig. 2. Black marlin: Average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of black marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

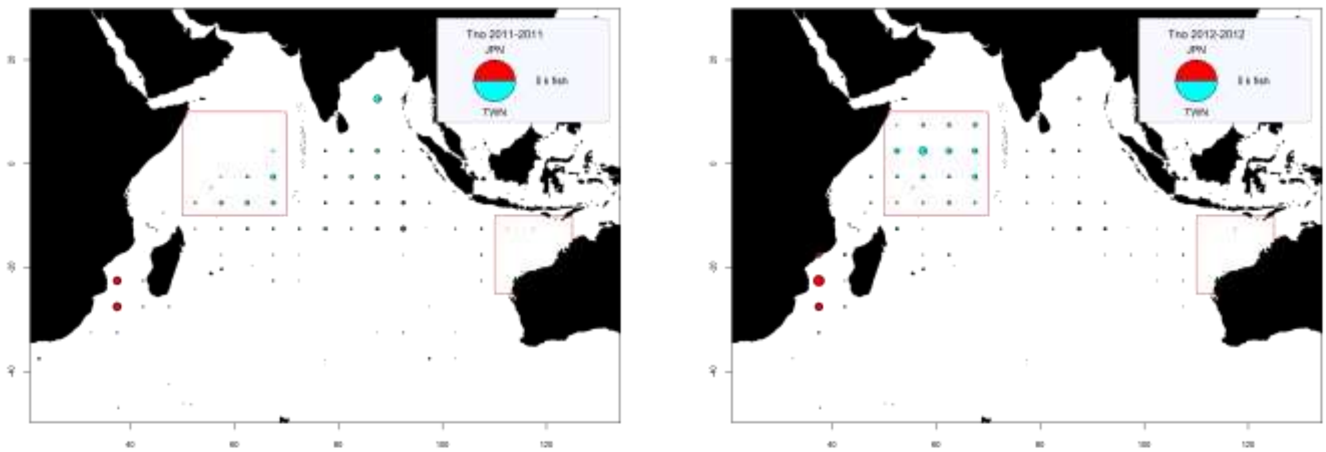


Fig. 3a–b. Black marlin: Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2010 and 2011 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1. Black marlin: Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2011 (in metric tons). Data as of July 2013.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	846	1,633	1,287	1,370	1,487	1,918	1,431	2,285	2,076	2,043	2,136	1,865	2,657	1,824	1,419	1,456
GN	26	31	44	439	2,633	5,153	4,210	4,535	6,582	4,602	5,320	5,082	5,042	5,490	5,218	6,442
HL	24	27	42	446	727	1,020	714	775	1,008	652	913	1,018	1,479	2,159	1,669	1,892
OT	0	0	4	65	112	216	135	142	170	155	216	218	370	452	472	500
Total	896	1,692	1,377	2,320	4,958	8,308	6,490	7,736	9,836	7,451	8,585	8,182	9,548	9,925	8,777	10,291

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 (by species) also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are uncertain for some fisheries (Fig. 4), 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 Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, 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 Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the black marlin is not a target species.
- conflicting catch reports: Longline catches from the Republic of Korea 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 Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- Discards are unknown for most industrial fisheries, mainly longliners. Discards of black marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.
- Changes to the catch series: There have been relatively large changes to catches of black marlin since the WPB meeting in 2012, mostly as a result of revisions to catches estimates for Sri Lanka. Catches of marlins (by species) in Sri Lanka have frequently been misidentified, making catches in previous years highly uncertain and subject to sharp fluctuations between years. Estimates of black marlins have subsequently been revised by IOTC from around 1,000 t to over 4,000 t in the last decade in response to inconsistencies identified in the reported data; with most of the increase the result of reallocation of catch previously reported as blue marlin.

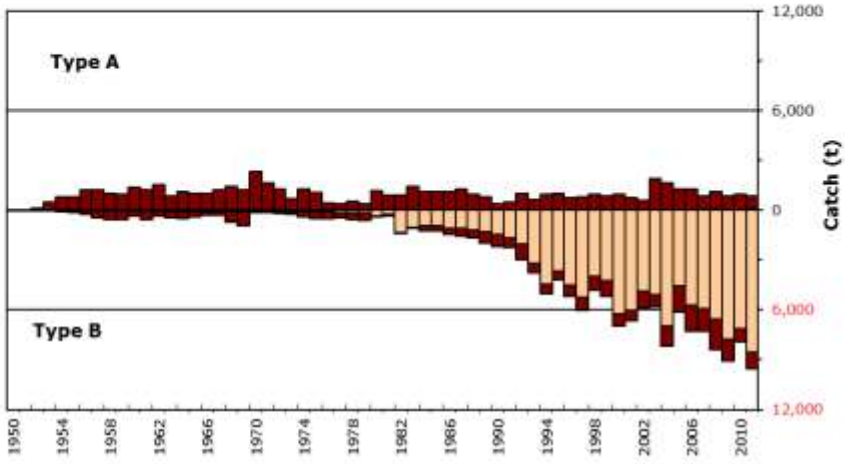


Fig. 4. Black marlin: Uncertainty of annual catch estimates for black marlin (Data as of July 2013).

Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Fish size or age trends (e.g. by length, weight, sex and/or maturity): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low.

Catch-at-Size(Age) tables have not been built for black marlin 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 Secretariat by CPCs.

Blue marlin (Makaira nigricans)

Catch trends

Blue marlin are caught mainly by drifting longlines (65%) and gillnets (30%) with remaining catches recorded taken by troll and hand lines (Table 1, Fig. 1). Blue marlins are considered to be a bycatch of industrial and artisanal fisheries. The 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 (gillnet) Sri Lanka (longline gillnet) account for around 75% 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 recorded taken by drifting longlines were more or less stable until the mid-80’s, at around 3,000–4,000 t, and have steadily increased since then to between 6,000–8,000 t. The largest catches reported by longlines were recorded in 1998 (~11,000 t). Catches taken by drifting longlines have been recorded by Taiwan,China and Japan fleets and, recently, Indonesia, India, Sri Lanka and several NEI fleets (Fig. 2). 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 and the Arabian Sea (Fig. 3).

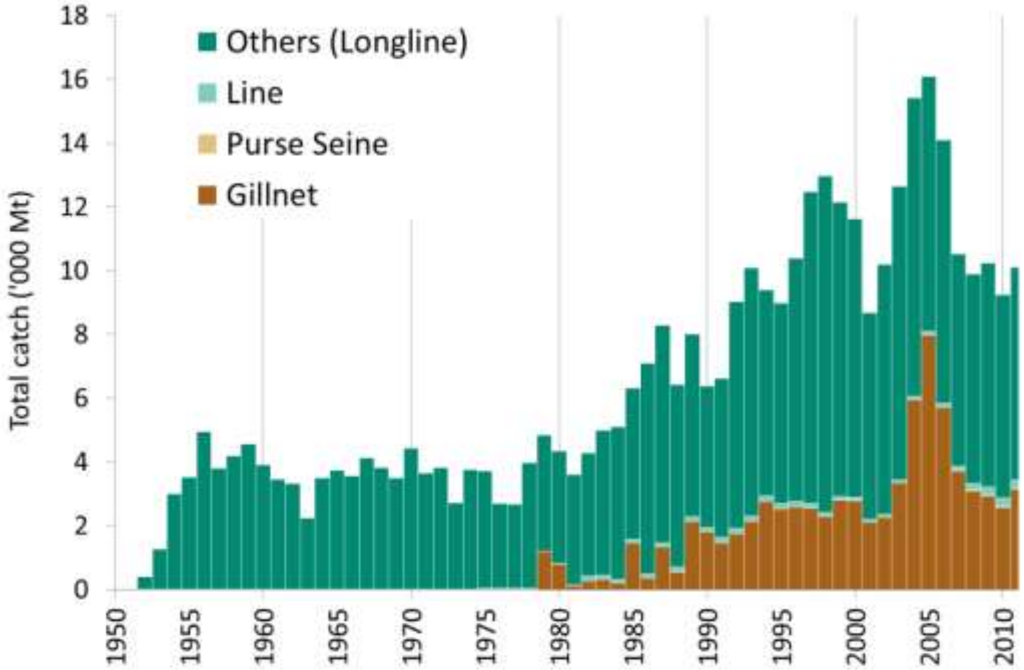


Fig. 1. Blue marlin: Catches of blue marlin by gear and year recorded in the IOTC Database (1950–2011).

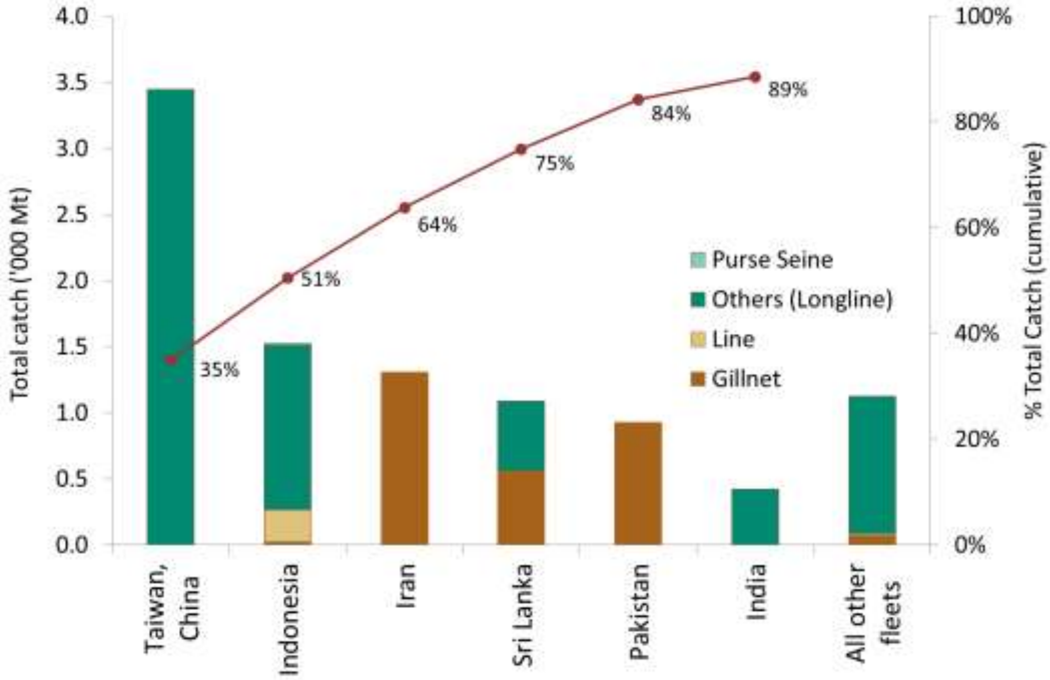


Fig. 2. Blue marlin: average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of blue marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

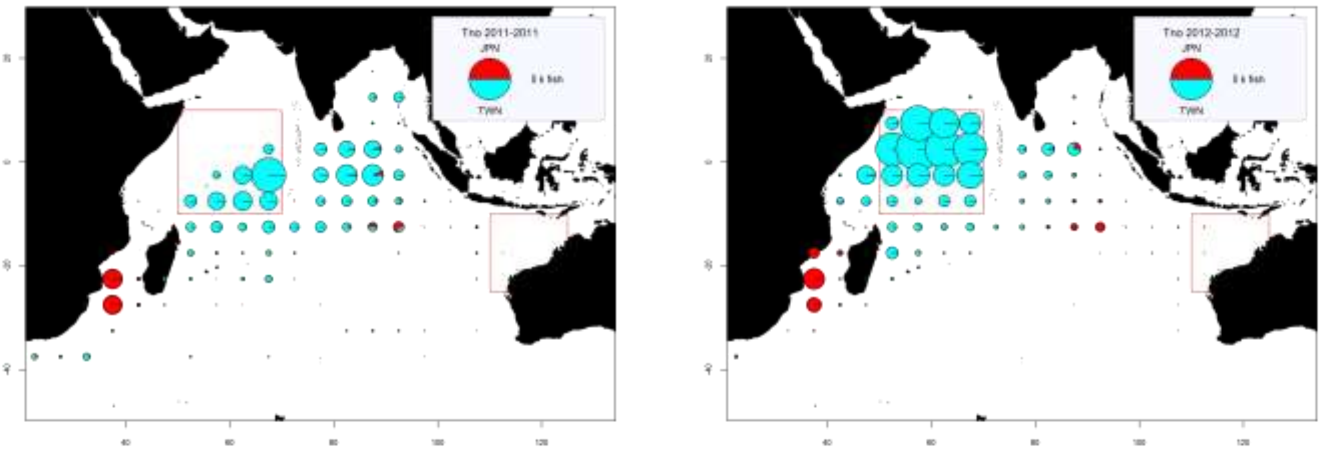


Fig. 3a–b. Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2011 and 2012 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1: Blue marlin: Best scientific estimates of the catches of blue marlin by type of fishery for the period 1950–2011 (in metric tons). Data as of July 2013.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	2,563	3,513	3,482	4,969	7,194	7,338	7,458	8,799	8,806	7,630	7,794	6,153	6,069	6,520	6,039	6,327
GN	1	2	124	764	2,495	4,469	2,654	3,757	6,511	8,370	6,158	4,231	3,603	3,446	3,077	3,730
HL	5	9	18	105	149	120	76	81	95	85	121	122	201	250	271	268
OT	0	0	0	2	4	7	4	5	5	5	7	7	12	15	15	16
Total	2,570	3,525	3,623	5,840	9,842	11,934	10,193	12,642	15,417	16,090	14,080	10,514	9,884	10,230	9,402	10,340

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 (by species) also contribute to the uncertainties of the information available to the IOTC Secretariat.

Retained catches are poorly known for most fisheries (Fig. 4) 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 Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, 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 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**: Longline catches from the Republic of Korea 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 Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- **Discards** are unknown for most industrial fisheries, mainly longliners. Discards of blue marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.
- **Changes to the catch series**: There have been relatively large changes to the catches of blue marlin since the WPB meeting in 2012 mainly for the mid-2000s. Catches for I.R. Iran and Pakistan have been revised upwards following improvements by IOTC in the disaggregation by species of catches reported as (aggregated) billfish catches; some of the catches for Sri Lanka have been reassigned as black marlin in response to large fluctuations in the reported catch estimates due to misidentification of the two species.

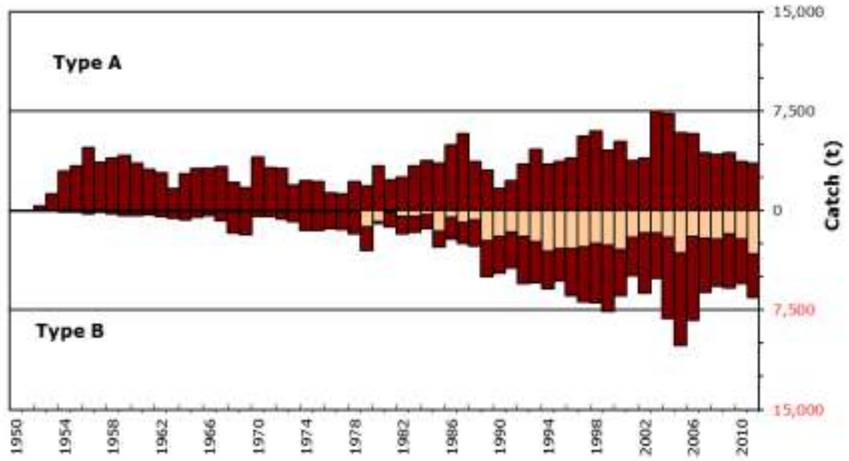


Fig. 4. Blue marlin: Uncertainty of annual catch estimates for blue marlin (data as of July 2013).

Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

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

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan.

Catch-at-Size(Age) tables have not been built for blue marlin 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 Secretariat by CPCs.

Striped marlin (Tetrapturus audax)

Catch trends

Striped marlin are caught almost exclusively by drifting longlines, which in previous years have accounted for as much as 98% of the catch. The remaining catches are recorded by 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 (Fig. 2); however, this may reflect the level of reporting. Similarly, catches reported by drifting longlines are highly variable, with recent falls since 2009 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners.

Catches under drifting longlines have been recorded by Taiwan,China, Japan, Rep. of Korea fleets and, recently, Indonesia and several NEI fleets. Taiwan,China and Japan have reported large drops in the catches of striped marlin for its longline fleets 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 reported 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, since 2007, 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. 4).

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

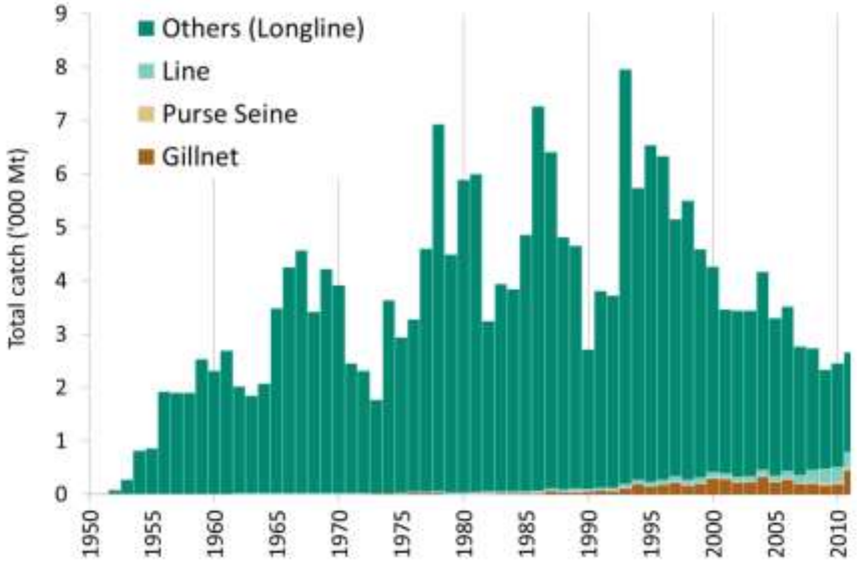


Fig. 1. Striped marlin: Catches of Striped marlin by gear and year recorded in the IOTC Database (1950–2011).

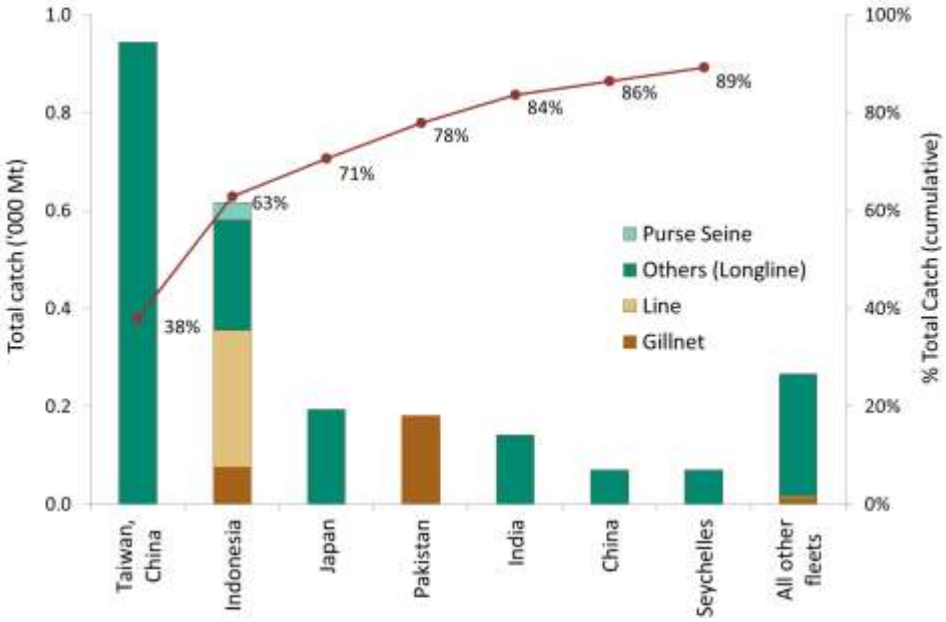


Fig. 2. Striped marlin: Average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of striped marlin reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

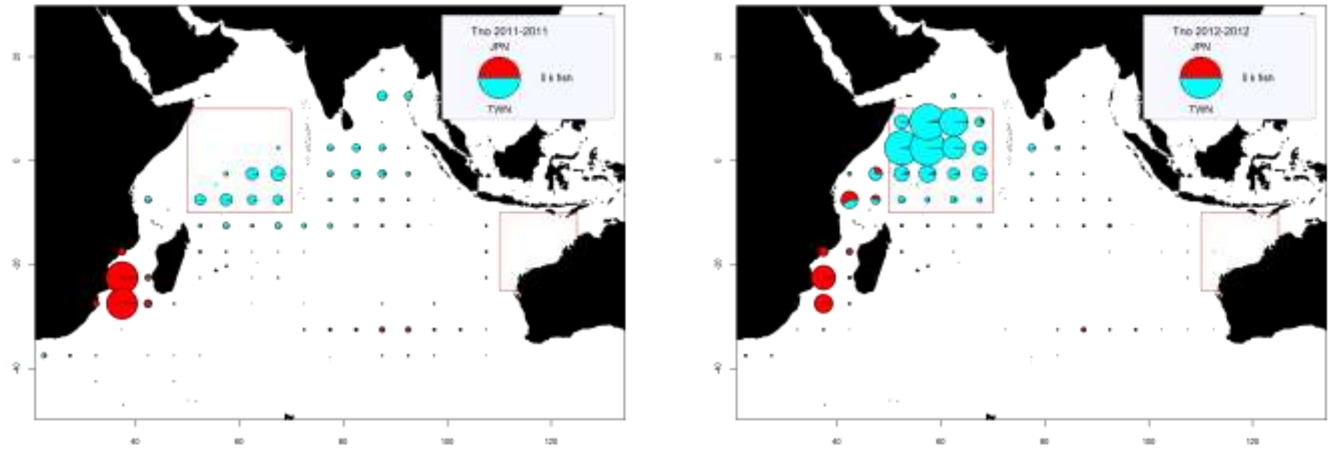


Fig. 3a–b. Striped marlin: Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2011 and 2012 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1. Striped marlin: Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2011 (in metric tons). Data as of July 2013.

Fishery	By decade (average)						By year (last ten years)									
	1950s	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
LL	1,024	3,077	3,609	5,036	4,990	2,946	3,112	3,111	3,722	2,964	3,091	2,415	2,279	1,849	1,882	1,675
GN	5	8	16	22	139	245	226	237	331	235	281	198	196	164	189	452
HL	3	5	11	32	69	130	80	84	102	92	129	134	223	272	284	300
OT	0	0	0	6	10	19	12	13	15	14	19	19	33	40	42	44
Total	1,032	3,089	3,636	5,096	5,208	3,341	3,430	3,445	4,170	3,304	3,520	2,766	2,731	2,324	2,397	2,470

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 are reasonably well known (Fig. 4) 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**: The catches for longliners flagged to the Republic 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 the driftnet fishery of Iran, as this species has no commercial value in this country.
- **Changes to the catch series:** Relatively minor revisions have been made to catches of striped marlin, which have been largely unchanged by reviews of the data series for Iran, Pakistan, Indonesia, Sri Lanka and Indonesia which have been used to adjust the catches of the other billfish species.

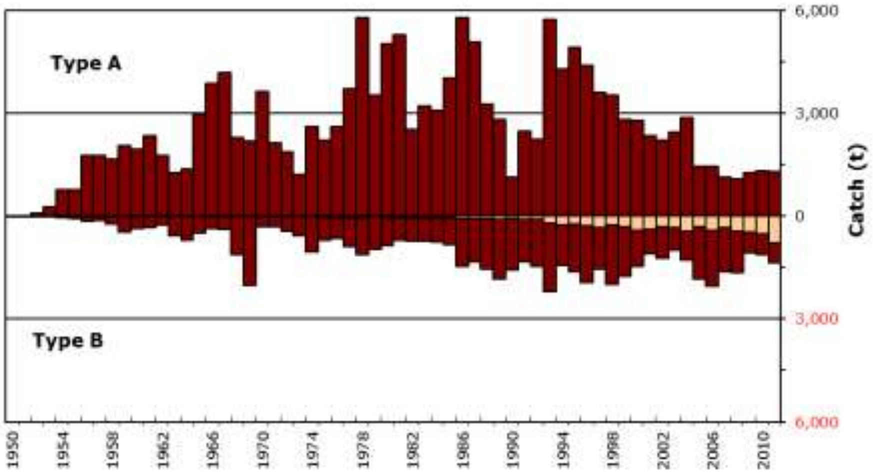


Fig. 4. Striped marlin: Uncertainty of annual catch estimates for striped marlin (Data as of July 2013).

Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

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

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan.

Catch-at-Size(Age) 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 Secretariat by CPCs.

Indo-Pacific sailfish (Istiophorus platypterus)

Catch trends

Indo-Pacific sailfish is caught mainly under gillnets (70%) with remaining catches recorded by troll and hand lines (20%), longlines (8%) or other gears (Table 1, Fig. 1). The average annual catch over recent years is estimated at around 25,000 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, I.R. Iran, Sri Lanka and Pakistan). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia longliners. 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 over 28,000 t in 2011). 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 Iranian gillnet vessels to areas beyond the EEZ of I.R. Iran. In the case of Iranian gillnets (Fig. 3), catches have increased from less than 1,000 t in the early 1990’s to over 7,700 t in 2011.

Catches of Indo-Pacific sailfish under 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 7,000 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).

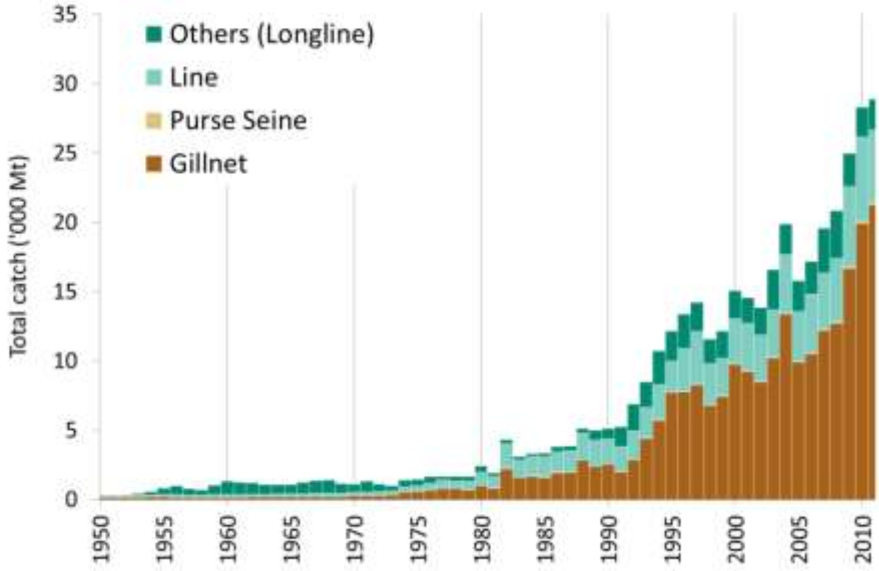


Fig. 1. Indo-Pacific sailfish. Catches of Indo-pacific sailfish by gear and year recorded in the IOTC Database (1950–2011).

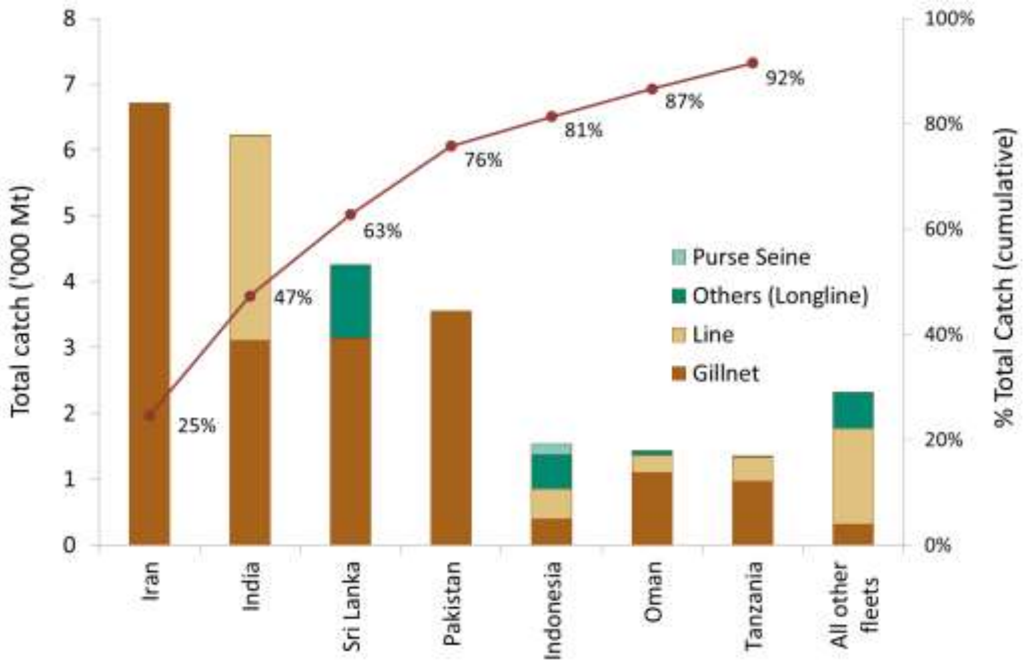


Fig. 30. Indo-Pacific sailfish: Average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of Indo-Pacific sailfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

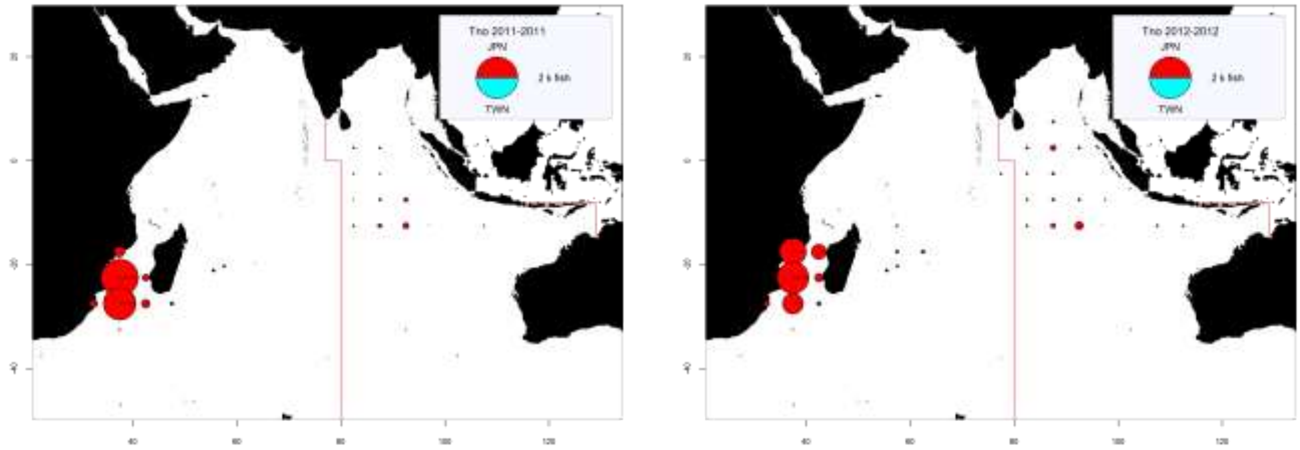


Fig. 3a-f. Indo-Pacific sailfish: Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) for 2011 and 2012 by fleet.

TABLE 1. Indo-Pacific sailfish: Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2011 (in metric tons). Data as of July 2013.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LL	299	819	448	341	1,414	1,453	1,143	2,035	953	1,428	1,418	2,153	2,380	1,356	1,075	942
GN	165	181	493	1,805	5,997	12,282	9,329	12,167	14,559	10,128	11,467	13,261	13,753	17,700	20,955	22,480
HL	171	213	442	1,430	2,540	4,144	3,322	3,686	4,269	4,160	4,220	4,073	4,550	5,749	6,071	5,214
OT	0	0	3	44	42	81	50	52	63	57	80	81	149	168	175	185
Total	634	1,213	1,385	3,619	9,994	17,960	13,845	17,940	19,844	15,772	17,185	19,569	20,831	24,972	28,276	28,821

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. 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 are poorly known for most fisheries (Fig. 3) due to:

- Catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the 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 IP sailfish reported for some fisheries may refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (gillnet fishery of Iran and many coastal fisheries).
- Catches likely to be incomplete for some artisanal fisheries (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** are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

Changes to the catch series: Catches of sailfish since the WPB meeting in 2012 have been revised, in particular around the mid-2000s. The changes mostly affect catch estimates for I.R. Iran, which have been reduced following improvements in the estimation of catch-by-species (specifically, reported catches of sailfish that more likely refer to a combination of billfish species).

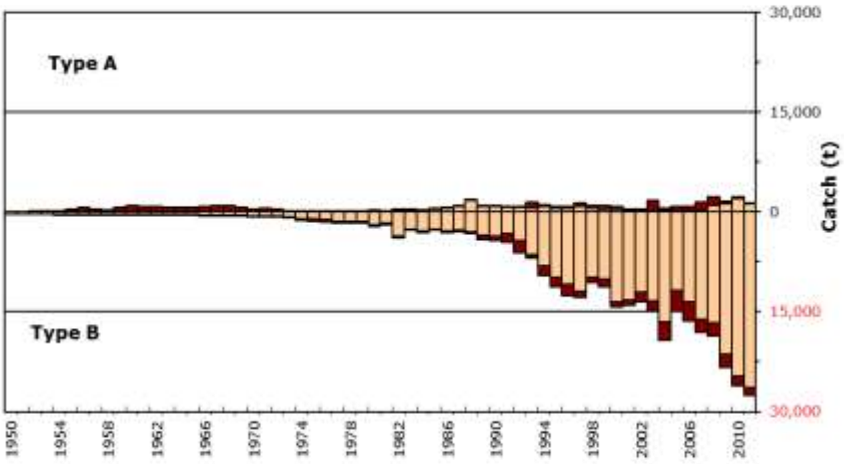


Fig. 4. Indo-Pacific sailfish: Uncertainty of annual catch estimates for Indo-Pacific sailfish. (Data as of July 2013)

Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

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

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s. The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, 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 Secretariat by CPCs.

Swordfish (Xiphias gladius)

Catch trends

Over 90% of swordfish are caught mainly using drifting longlines (>95%), 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 (Fig. 1). 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 9,000 t in 1991 to a peak of 38,000 t in 1998 and 41,000 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 (Portugal, Spain, the UK and other fleets operating under various flags), all targeting swordfish, are the main reasons for this significant increase.

Since 2004, annual catches have declined steadily (Fig. 1), 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 (NEI). The catches have been low since 2006, at just over 1,000 t (Fig. 2).

Swordfish is mostly exploited in the western Indian Ocean (Fig. 3), in waters off Somalia, and in the southwest Indian Ocean. Other important fisheries operate in waters off Sri Lanka, Western Australia and Indonesia. In recent years (Fig. 3) the catches of swordfish in the western tropical Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya and Tanzania, from around 25,000 t in 2005 to 15,000 t in 2008, and in particular 11,000 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.

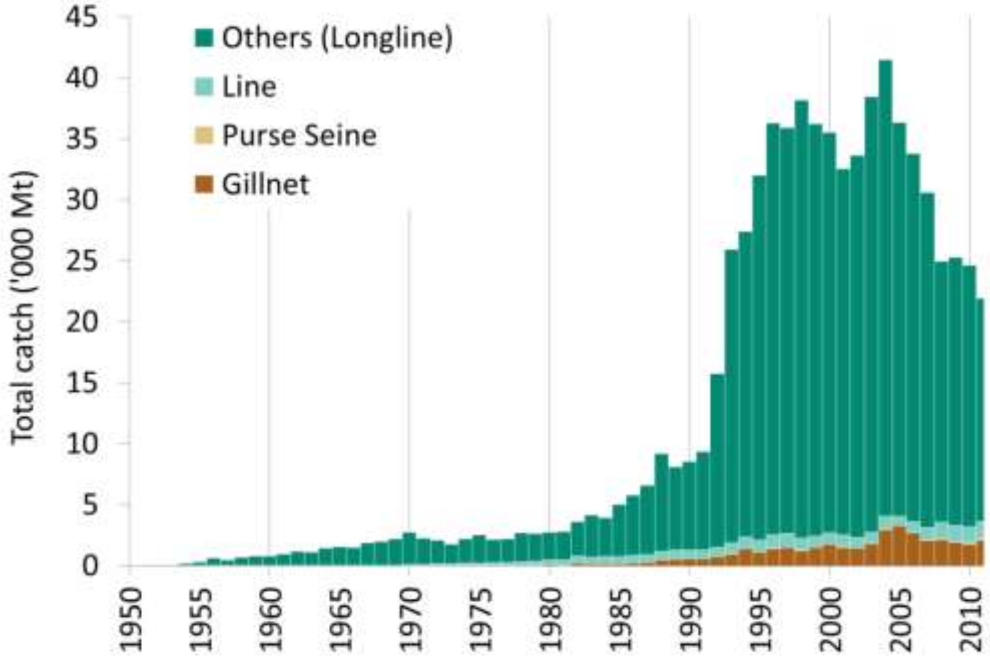


Fig. 1 Swordfish: Catches of swordfish by gear and year recorded in the IOTC Database (1950–2011).

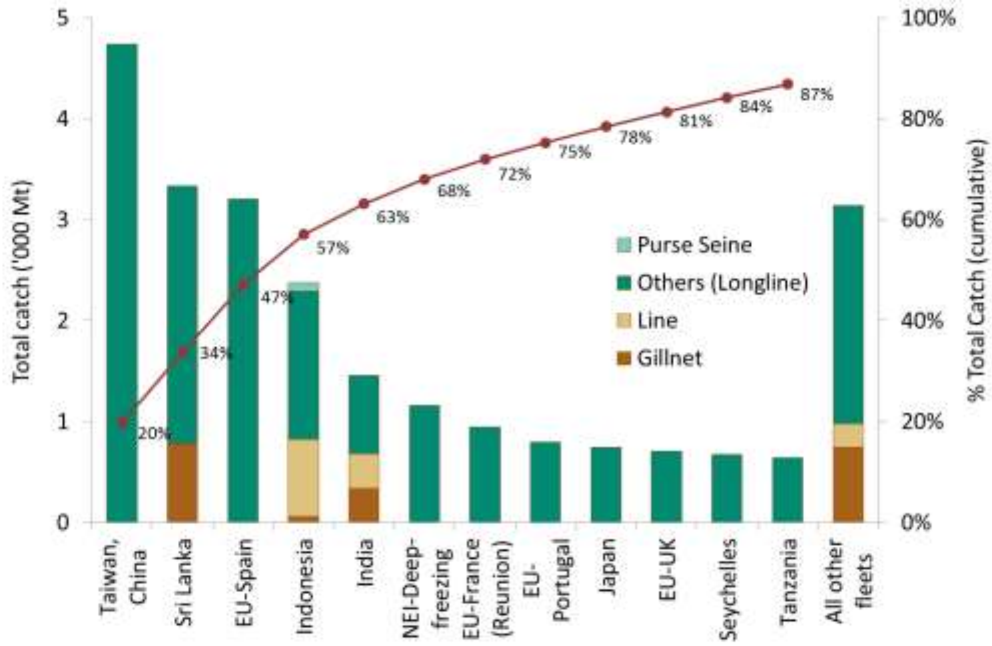


Fig. 2. Swordfish: average catches in the Indian Ocean over the period 2009–11, by country. Countries are ordered from left to right, according to the importance of catches of swordfish reported. The red line indicates the (cumulative) proportion of catches of swordfish for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

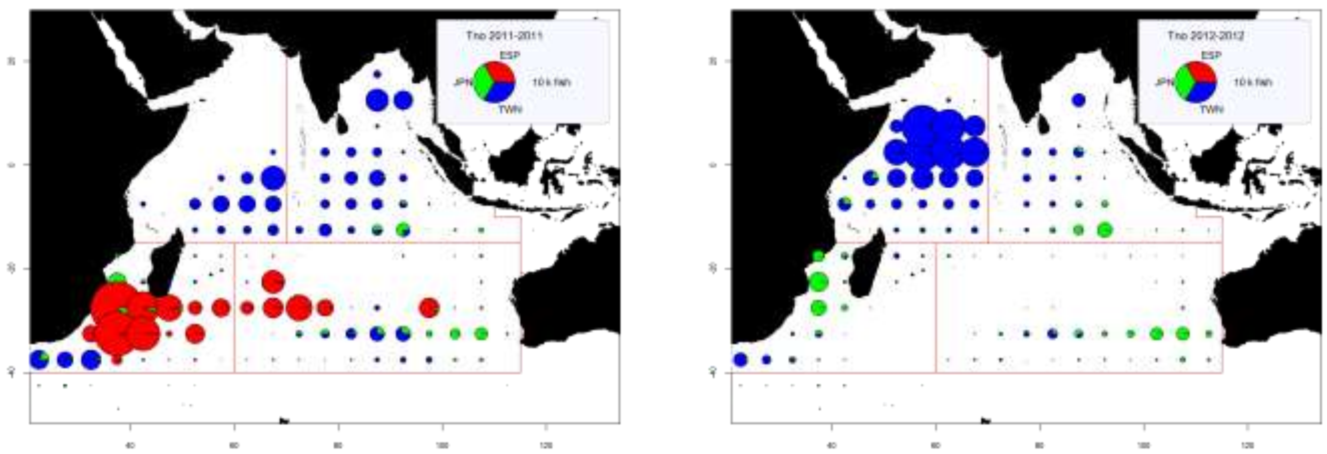


Fig. 3a–b. Swordfish: Time-area catches (total combined in tonnes) of swordfish as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU-Spain (ESP), the latter directed at swordfish, for 2011 and 2012. Red lines represent the boundaries of the areas used for the assessments of swordfish.

TABLE 1. Swordfish: Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2011 (in metric tons). Data as of July 2013.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ELL	0	0	0	9	1841	9998	8903	9470	12740	14965	12999	11535	8197	8155	9516	7790
LL	282	1425	2135	4337	21582	17752	20448	24262	21940	15504	15007	13452	10757	11377	9492	7696
OT	37	39	186	842	3133	5500	4249	4693	6809	5849	5793	5574	6002	5727	5602	6430
Total	**320**	**1,464**	**2,320**	**5,188**	**26,556**	**33,250**	**33,599**	**38,424**	**41,489**	**36,318**	**33,799**	**30,561**	**24,957**	**25,259**	**24,610**	**21,916**

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 1950–2011 (in metric tons). Data as of July 2013

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NW	81	530	776	1,967	9,232	12,694	13,753	16,622	16,413	15,113	13,482	12,029	9,928	8,071	5,308	3,545
SW	18	272	438	673	8,956	9,008	9,034	5,043	8,109	11,645	10,278	9,285	7,402	7,924	9,320	7,566
NE	152	408	729	2,082	5,649	6,725	5,976	8,250	8,367	5,142	6,851	5,864	5,050	7,409	7,317	8,327
SE	23	151	236	280	2,585	4,665	4,643	8,424	8,527	4,368	3,113	3,314	2,353	1,708	2,522	2,322
OT	45	104	141	186	134	158	194	85	73	50	76	68	223	146	143	157
Total	**320**	**1,464**	**2,320**	**5,188**	**26,556**	**33,250**	**33,599**	**38,424**	**41,489**	**36,318**	**33,799**	**30,561**	**24,957**	**25,259**	**24,610**	**21,916**

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. 4); however catches are uncertain for:

- **Drifting gillnet fisheries of Iran and Pakistan**: To date, Iran has not reported catches of swordfish for its gillnet fishery. Although Pakistan has reported catches of swordfish they are considered to be too low for a driftnet fishery (catches of swordfish in recent years represent less than 2% of the total catches of swordfish in the Indian Ocean).
- **Longline fishery of Indonesia**: The catches of swordfish for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years due to insufficient sampling coverage. Although the new catches estimated by the Secretariat are thought to be more accurate, swordfish catches remain uncertain, especially in recent years (where they represent around 6% 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 longline fishery. Although the new catches estimated by the Secretariat are thought to be more accurate,

catches of swordfish remain uncertain (catches of swordfish in recent years represent less than 3% of the total catches of swordfish in the Indian Ocean).

- **Longline fleets from non-reporting countries (NEI)**: The 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 4% of the total catches of swordfish in the Indian Ocean).
- **Discards** are 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 Iran, as this species has no commercial value in this country.
- **Changes to the catch series**: There have been changes to the catches of swordfish since the WPB meeting in 2012. Most changes that have been made to the data series since the last WPB are relatively small increases 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, I.R. Iran, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates.

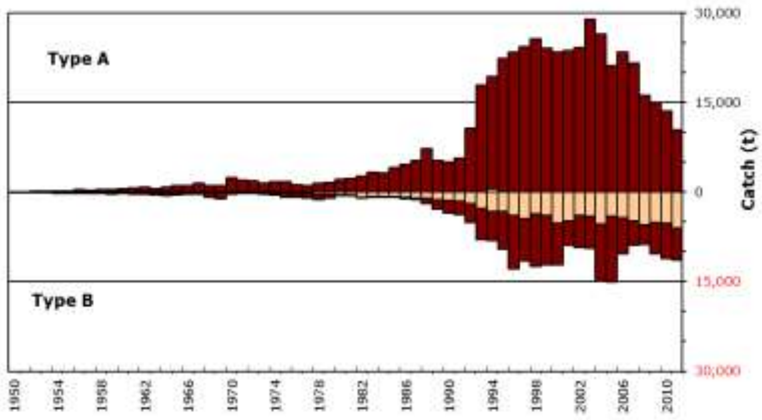


Fig. 4. Swordfish: Uncertainty of annual catch estimates for swordfish (Data as of July 2013).

Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

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.

- **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. It is considered encouraging that there are no clear signals of declines in the size-based indices, but these indices should be carefully monitored, as females mature at a relatively large size, therefore, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.
- **Catch-at-Size(Age)** 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 Iran and the fresh-tuna 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, NEI).
  - the paucity of biological data available, notably sex-ratio and sex-length-age keys.

APPENDIX V
MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF BILLFISH

Extract from IOTC–2013–WPB11–07 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 **Iran** and **Pakistan**: To date, Iran has not reported catches of swordfish and marlins for its gillnet fishery. Although Pakistan has reported catches of swordfish and black marlin, they are considered to be too low for a driftnet fishery and the catches of black marlin are thought to contain other marlins (misidentification); estimates have been partially revised based on information from recent sampling conducted from 2006 onwards. Although very significant catches of marlins are likely to be taken on driftnet fisheries, the paucity of the data available makes it difficult to assess catch levels for driftnet fleets.
- **Gillnet/longline** fishery of **Sri Lanka**: In recent years Sri Lanka has caught over 20% 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 9% 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 Secretariat revised the complete nominal catch dataset for India, using new information available. The catches of billfish estimated in recent years represent around 20% of the total catches in the Indian Ocean, and refer mainly to Indo-Pacific sailfish. 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, 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 estimated for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years 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.
- **Longline** fishery of **India**: In recent years, India has reported very incomplete catches and catch-and-effort data for its commercial longline fishery. The Secretariat has estimated total catches for this period using alternative sources, the final catches estimated considerably higher than those reported (representing 3.5% of the total catches of billfish in recent years).
- **Longline** fishery of the Republic of **Korea**: The nominal catches and catch-and-effort data series for billfish for the longline fishery of Korea are conflicting, with nominal catches of swordfish and marlins lower than the catches reported as catch-and-effort for some years. Although in 2010 the IOTC Secretariat revised the nominal

catch dataset to account for catches reported as catch-and-effort, the quality of the estimates remains unknown. However, the catches of longliners of the Rep. of Korea in recent years are very small.

- **Longline** fishery of **EU-Spain:** To date, the Secretariat has not received catch-and-effort data for marlins and sailfish for the longline fishery of EU-Spain.
- **Purse seine** fisheries of **Seychelles**, **Thailand**, **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 of one fish per tonne of catch recommended by IOTC.
- **Longline** fishery of **Taiwan,China**: Size data have been available for the longline fishery of Taiwan,China since 1980; however, the length frequency distributions of striped marlin and blue marlin differ from those reported by Japan for its longline fishery, with average weights of striped marlin likely to be too large for a longline fishery. Therefore, it is likely that there has been overspread misidentification of striped marlin and blue marlin on board longliners flagged in Taiwan,China.
- **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).
- **Longline** fisheries of **India** and **Oman:** To date, India and Oman have not reported size frequency data for their 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:** 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 **Republic** 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**, **China** and the **Republic** of **Korea**: There has not been regular reporting of length frequency data by sex from any of the referred fisheries.

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:

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 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.
     - 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.

APPENDIX VII
DRAFT RESOURCE STOCK STATUS SUMMARIES – BLACK MARLIN

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

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

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

Area[1]	**Indicators**		**2013 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	10,291 t 9,345 t	**Uncertain**
	MSY (range): F_{2011}/F_{MSY} (range): B_{2011}/B_{MSY} (range): B_{2011}/B_0 (range):	8,605 (6,278–11,793) 1.03 (0.15–2.19) 1.17 (0.75–1.55) 0.58 (0.38–0.78)	

[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)		

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 optimum fishing levels (Table 1). However, as this is the first time that the WPB used such a method on marlin species, 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 an 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.

Outlook. Longline catch and effort for black marlin in recent years has continued to increase to a total of 10,291 t in 2011. The following key points should be noted:

- Maximum Sustainable Yield estimate for the whole Indian Ocean is between 6,278 and 11,793 t.
- improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

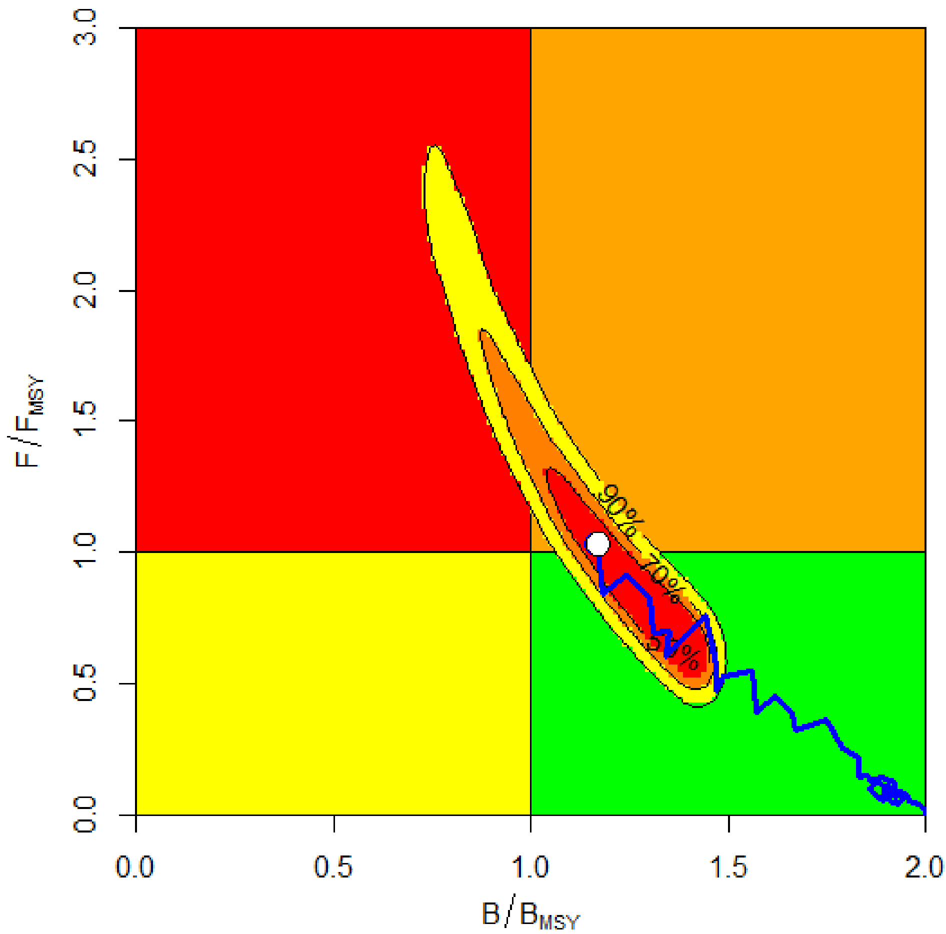


Fig. 1. Black marlin: Stock reduction analysis aggregated Indian Ocean assessment Kobe plots for black marlin (95% confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio and F ratio for each year 1950–2011.

APPENDIX VIII
DRAFT RESOURCE STOCK STATUS SUMMARIES – BLUE MARLIN

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

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

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

Area[1]	Indicators		2013 stock status determination
Indian Ocean	Catch 2011:	10,340 t	(green)
	Average catch 2007–2011:	10,074 t	
	MSY (range):	11,690 (8,023–12,400)	
	F_{2011}/F_{MSY} (range):	0.85 (0.63–1.45)	
	B_{2011}/B_{MSY} (range):	0.98 (0.57–1.18)	
	B_{2011}/B_0 (range):	0.48 (na)	

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

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. 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 indicates 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 indicates that the stock was most likely subject to overfishing in the recent past. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **not overfished** and **not subject to overfishing** (Table 1; Fig. 1). However, 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 still be in an overfished state (biomass less than B_{MSY}) (Table 1; Fig. 1). Given the recent declining effort trend, and a clear rebuilding trajectory (Fig. 1), fishing effort is not considered an immediate concern. Research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are still warranted. Given the limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

Outlook. Longline catch and effort for blue marlin in recent years has continued to increase to a total of 10,340 t in 2011. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is between 8,023–12,400 t.
- improvement in data collection and reporting is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

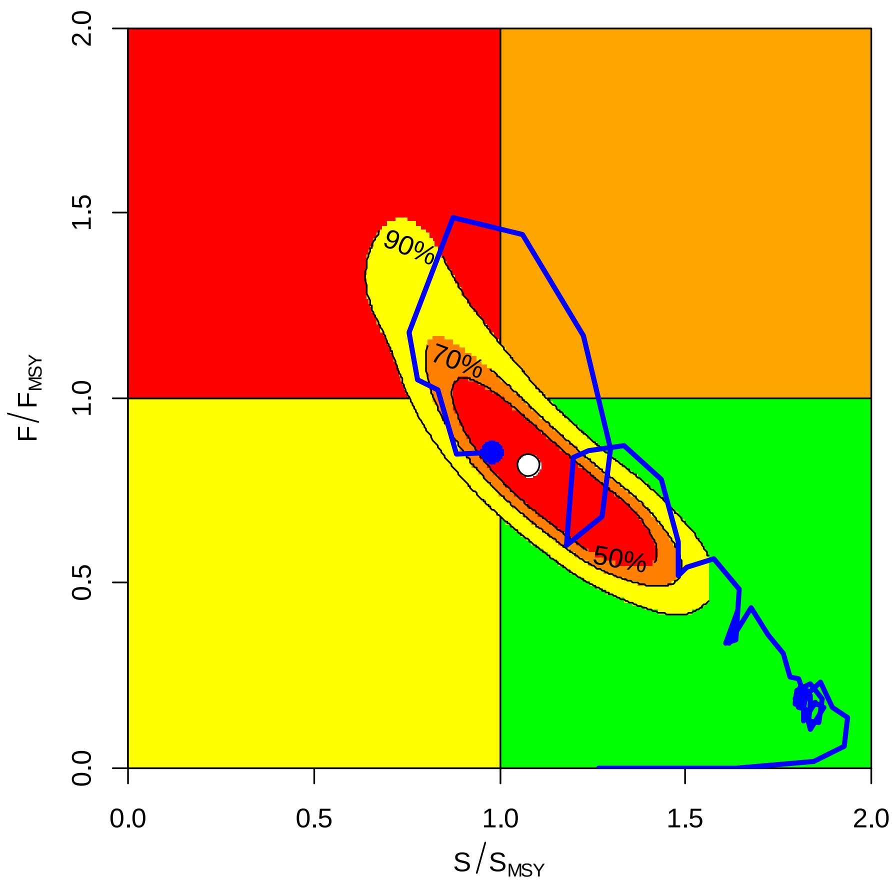


Fig. 1. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as S) and F ratio for each year 1950–2011.

APPENDIX IX
DRAFT RESOURCE STOCK STATUS SUMMARIES – STRIPED MARLIN

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

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

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

Area[1]	**Indicators**		**2013 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	2,470 t 2,538 t	
	MSY (range): F_{2011}/F_{MSY} (range): B_{2011}/B_{MSY} (range): B_{2011}/B_0 (range):	4,408 (3,539–4,578) 1.28 (0.95–1.92) 0.416 (0.2–0.42) 0.18	

[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)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. 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 indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. 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 indicates that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **overfished** and **subject to overfishing** (Table 1; Fig. 1).

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is insufficient information to evaluate the effect this will have on the resource. Given the concerning results obtained from the preliminary stock assessments carried out in 2013 for striped marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 4,408 t (3,539–4,578).
- improvement in data collection and reporting is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

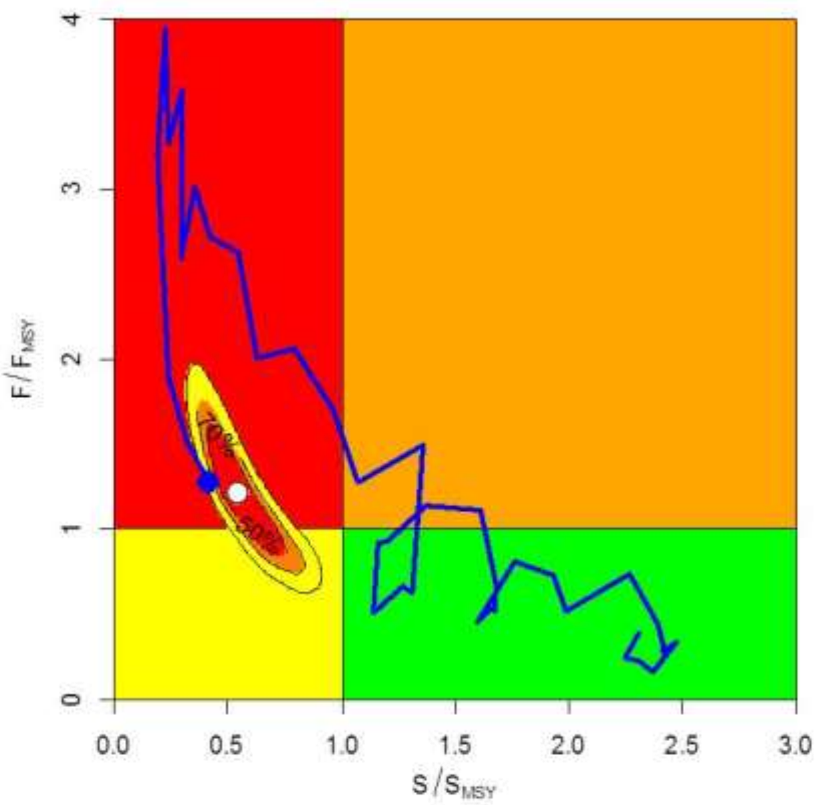
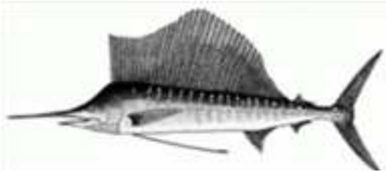


Fig. 1. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (90% bootstrap confidence surfaces shown around 2011 estimate – white dot). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio (shown as S) and F ratio for each year 1950–2011.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

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

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



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

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

Area[1]	**Indicators**		**2013 stock status determination**
Indian Ocean	Catch 2011: Average catch 2007–2011:	28,821 t 24,494 t	**Uncertain**
	MSY (range): F_{2011}/F_{MSY} (range): SB_{2011}/SB_{MSY} (range): SB_{2011}/SB_0 (range):	unknown unknown unknown unknown	

[1]Boundaries for the Indian Ocean = 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($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

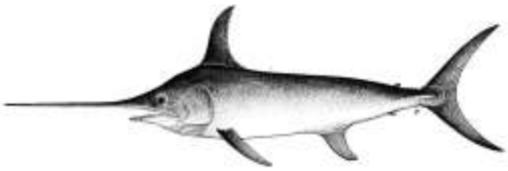
Stock status. No quantitative stock assessment is currently available for Indo-Pacific sailfish in the Indian Ocean; due to a lack of fishery data and poor quality of available data for several gears, only preliminary stock indicators can be used. A data poor approach was pursued by the WPB in 2013, though results were considered preliminary and require further sensitivity analysis. Therefore stock status remains **uncertain** (Table 1). However, 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 considerable concern. Research emphasis on improving indicators and 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:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of Indo-Pacific sailfish are highly uncertain and need to be further reviewed.
- improvement in data collection and reporting, particularly for coastal gillnet and sports fisheries, is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

APPENDIX XI
DRAFT RESOURCE STOCK STATUS SUMMARY – SWORDFISH

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



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

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

Area[1]	Indicators		2013 stock status determination
Indian Ocean	Catch 2011: Average catch 2007–2011:	21,916 t 25,461 t	
	MSY (4 models): F_{2009}/F_{MSY} (4 models): SB_{2009}/SB_{MSY} (4 models): SB_{2009}/SB_0 (4 models):	29,900–34,200 t 0.50–0.63 1.07–1.59 0.30–0.53	

[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($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. All models suggest that the stock is above, but close to a biomass level that would produce MSY and current catches are below the MSY level. MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2009}/F_{MSY} < 1$; $SB_{2009}/SB_{MSY} > 1$). Spawning stock biomass in 2009 was estimated to be 30–53% (from Table 1; Fig. 1) of the unfished levels. The most recent catch estimate of 21,916 t in 2011; indicate that the stock status is unlikely to have changed. Thus, the stock remains not overfished and not subject to overfishing. However, recent revisions to the catch history for swordfish make it timely for a new stock assessment to be undertaken in 2014.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality would not reduce the population to an overfished state. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels until 2019 (<11% risk that $B_{2019} < B_{MSY}$, and <9% risk that $F_{2019} > F_{MSY}$) (Table 2). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 2) and annual catches of swordfish should not exceed this estimate.
- if the recent declines in effort continue, and catch remains substantially below the estimated MSY of 30,000–34,000 t, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- advice specific to the southwest region is provided below, as requested by the Commission.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, but 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).

TABLE 2. Swordfish: Aggregated Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across four assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	60% (12,502 t)	**80%** (16,670 t)	**100%** (20,837 t)	**120%** (25,004 t)	**140%** (29,172 t)
$B_{2012} < B_{MSY}$	0–4	0–8	0–11	2–12	4–16
$F_{2012} > F_{MSY}$	0–1	0–2	0–9	0–16	6–27
$B_{2019} < B_{MSY}$	0–4	0–8	0–11	0–13	6–26
$F_{2019} > F_{MSY}$	0–1	0–2	0–9	0–23	7–31

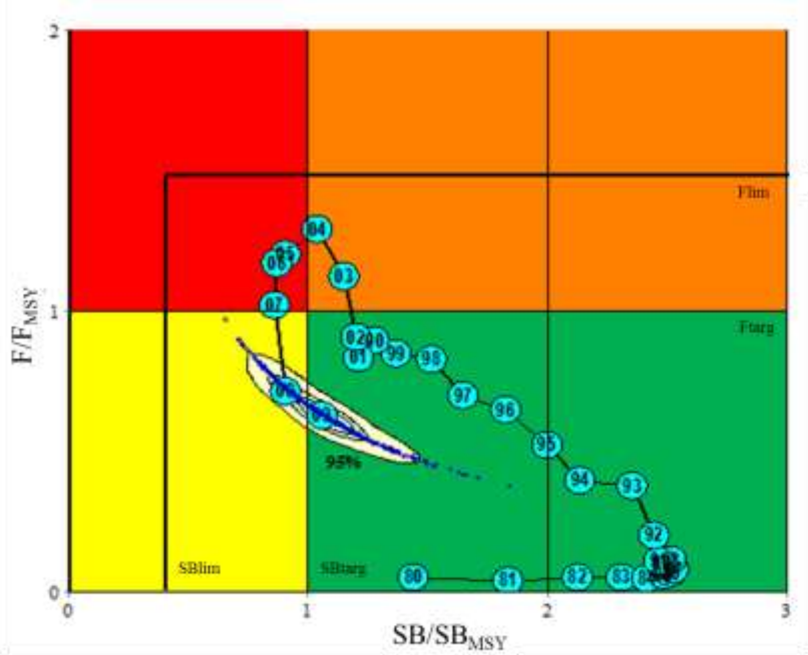


Fig. 1. Swordfish: ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

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

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		2013 stock status determination
Southwest Indian Ocean	Catch 2011: Average catch 2007–2011:	7,566 t 8,299 t	(yellow)
	MSY (3 models): F_{2009}/F_{MSY} (3 models): SB_{2009}/SB_{MSY} (3 models): SB_{2009}/SB_0 (3 models):	7,100 t–9,400 t 0.64–1.19 0.73–1.44 0.16–0.58	

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2011–WPB09–R.

Colour key	Stock overfished (SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing (F_{year}/F_{MSY}> 1)	(red)	(orange)
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)	(yellow)	(green)

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean is not a separate genetic stock. However this region has been subject to localised depletion over the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY} (Table 3). The catches of swordfish in the southwest Indian Ocean increased in 2010 to 8,046 t, which equals 120.5% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011. If catches are maintained at 2010 levels, the probabilities of violating target reference points in 2012 are less than 18% for F_{MSY} and less than 30% for B_{MSY} (Table 4), which is considered low. Given that the total estimated catch in 2011 was 7,566 t, lower that the 2010 estimate, the resource remains not subject to overfishing but overfished, as no further estimate of biomass is available.

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. However, in 2010 and 2011, catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t), with 8,046 t and 7,566 t caught in this region in 2010 and 2011, respectively. The WPB09 estimated that there is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at 2009 levels (<25% risk that B_{2019} < B_{MSY}, and <8% risk that F2019 > F_{MSY}). There is a 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:

- the Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from 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}.
- in 2010 and 2011, catches have exceeded the maximum recommended by the WPB09 and SC14 (6,678 t), with 8,046 t and 7,566 t caught in this region, respectively.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, 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 thus, below the provisional limit reference point of 1.4*F_{MSY}.
    b. **Biomass**: Current spawning biomass is considered to be below the target reference point of SB_{MSY}, and therefore, below the limit reference point of 0.4*SB_{MSY} (Fig. 1).

TABLE 4. Swordfish: Southwest Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across three assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	60% (12,502 t)	**80%** (16,670 t)	**100%** (20,837 t)	**120%** (25,004 t)	**140%** (29,172 t)
$B_{2012} < B_{MSY}$	0–15	0–20	0–25	0–30	12–32
$F_{2012} > F_{MSY}$	0–1	0–5	0–8	0–18	13–34
$B_{2019} < B_{MSY}$	0–15	0–20	0–25	0–32	18–34
$F_{2019} > F_{MSY}$	0–1	0–5	0–8	0–18	19–42

APPENDIX XII
WORK PLAN FOR THE WORKING PARTY ON BILLFISH

Requests from the Commission

At Sessions of the Commission, Conservation and Management Measures adopted contained elements which call on the Scientific Committee, via the WPB, to undertake specific tasks.

(S17 para. 28) The Commission **NOTED** that most of the evidence provided to date has indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and that biomass remains below the level that would produce the maximum sustainable yield (B_{MSY}), however recent declines in catch and effort have brought fishing mortality rates to levels below the level that would produce the maximum sustainable yield (F_{MSY}). A risk of reversing the rebuilding trend remains if there is any increase in catch in this region. Thus, catches of swordfish in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,600 t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.

(S17 para. 29) 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.

Core topics for research agreed at WPB11

The following are the core topic areas considered as priorities for research over the coming years, taking into account data gaps, capacity among CPCs, and areas for implementation (taken from the Report of the 11th Session of the WPB).

Data

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.

Alternative management measures for swordfish

The WPB **NOTED** 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.

Historical data series

The 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.

Length-age keys

The WPB **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Catch, Catch-and-effort, Size data

The WPB **RECOMMENDED** that all CPCs assess and improve the status of catch-and-effort data for marlins and sailfish, noting that improvements to the data for the EU fleets and its provision to the IOTC Secretariat, would be most beneficial to the work of the WPB.

The WPB **REQUESTED** that all CPCs provide the IOTC Secretariat with longline catch-and-effort and size data of marlins and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

The WPB **REQUESTED** that Japan resume size sampling on its commercial longline fleet, and that Taiwan,China provide size data for its fresh longline fleet to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

The WPB **REQUESTED** that Indonesia and India continue to improve their data collection programs and provide catch-and-effort and size frequency data for their longline fleets, to the IOTC Secretariat.

The WPB **REQUESTED** that all CPCs having artisanal and semi-industrial fleets, in particular I.R. Iran, Pakistan and Sri Lanka, provide catch and effort as well as size data as per IOTC requirements for billfish caught by their fleets. Some developing coastal states indicted that they have difficulties meeting these requirements.

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.

The WPB **REQUESTED** from 2011 that as a matter of priority, India, I.R. Iran (provided by I.R. in August 2013) and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, by the reporting deadline of 30th June each year, noting that this is already a mandatory reporting requirement. As part of this process, these CPCs shall use the billfish identification cards to improve the identification of marlin species caught by their fisheries.

Review of data available at the Secretariat for marlins

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 **REQUESTED** that CPCs 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.

I.R. Iran billfish fishery

The WPB **REQUESTED** that I.R. Iran revisit individual logbook archives to try and obtain more details of historical species composition for its industrial fisheries.

Thailand billfish fishery

NOTING that data from the research vessels of Thailand are not presented by species, the WPB **REQUESTED** that the species level data be presented at the next WPB meeting. The translation of the IOTC species identification guides into Thai would assist in ensuring higher resolution for species identification.

The WPB **REQUESTED** the authors undertake a more detailed analysis of trends in billfish landings between the 2008 and 2012, a period identified in the current study of high variability in total landings.

Indonesia billfish fishery

The WPB **REQUESTED** that Indonesia develop and present a detailed paper on its fleets fishing effort and CPUE, by species, at the next WPB meeting.

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.

Sri Lanka billfish fishery

The WPB **REQUESTED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission (1 fish by metric ton of catch by type of gear and species), including:

- catches sampled or observed for at least 5% of the vessel activities for coastal fisheries, including collection of catch, effort and size data for IOTC species and main bycatch species;
- implementation of logbook systems for offshore fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03.

The information collected through the above activities should allow Sri Lanka to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

Recreational and sports fisheries for billfish

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.

Indian billfish research: Environment influences on abundance

NOTING that all billfish species were combined for analysis, which may produce a biased result due to differences in species biology, the WPB **REQUESTED** that the authors undertake a similar analysis by species, for the consideration at the next WPB meeting.

Maldives billfish landings

The WPB **RECALLED** that the level of capture of marlins from the Maldivian artisanal fishery appears to be very high compared to the total catches reported for the Indian Ocean and **REQUESTED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting.

The WPB **REQUESTED** that the Maldives implement data collection systems, through logbooks and sampling for its fisheries that incorporate species level information requirements for billfish, as per IOTC standards. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

CPUE discussion summary – Marlins

The WPB **REQUESTED** that both Japan and Taiwan,China undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and 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.

Parameters for future analyses: stock assessments

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.

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

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.

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.

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.

The WPB **REQUESTED** that all CPCs improve data collection and reporting for sailfish given the importance of this species to many sports fisheries operating in the Indian Ocean. In particular for Kenya who indicated that they have a long catch history series available for potential analysis.

Review of data available at the secretariat for swordfish

NOTING the potential underreporting of swordfish catches from Indonesian fresh-tuna longline fisheries and the way in which the IOTC Secretariat had estimated swordfish catches, the WPB **REQUESTED** that catch extrapolation must be undertaken, taking into consideration species-specific targeting (day-deep vs. night-shallow sets) for fleets taking SWO as a bycatch. The WPB was informed that major research and commercial operations targeting tuna in day deep sets produce very low levels of swordfish bycatch even in the areas where swordfish is a dominant species in shallow-night sets.

Priority species for 2014: *Swordfish and Indo-Pacific sailfish*

High priority projects

- ***Stock status analyses (development of abundance indices)***
    i. Develop/improve accurate standardised CPUE indices for Indo-Pacific sailfish for the Indian Ocean as a whole or by sub-region as appropriate.
    ii. Develop methods to estimate historical catch series by gear.
    iii. Develop life history and biological patterns for the species (namely migration patterns and distribution patterns).
- ***Capacity building***
    i. Scientific assistance to CPCs and specific fleets considered to have the highest risk to billfish species (e.g. gillnet fleets and longline fleets).
- ***Stock assessment***
    i. Swordfish: There is a clear request from the Commission to carry out stock status determinations for swordfish in the southwest Indian Ocean, in addition to the Indian Ocean as a whole.
    ii. Indo-Pacific sailfish: Alternative approaches should be explored as options to determine stock status, by building layers of partial evidence, such as CPUE indices combined with catch data, life-history parameters and yield-per recruit metrics, as well as the use of data poor assessment approaches.

Medium priority project:

- ***Stock structure***
    i. genetic research to determine the connectivity of species throughout their distributions: such studies should be developed at the sub-regional level.
    ii. tagging research to better understand and estimate exploitation rates, the movement dynamics, possible spawning locations, natural mortality, fishing mortality and post-release mortality of stocks from various fisheries in the Indian Ocean.
- ***Biological information***
    i. Quantitative biological studies are necessary throughout the species range to determine key biological parameters including age-at-maturity and fecundity-at-age/length relationships, age-length keys, age and growth, which will be fed into future stock assessments.

APPENDIX XIII
ASSESSMENT SCHEDULE FOR THE WORKING PARTY ON BILLFISH

The IOTC Scientific Committee **RECOMMENDED** that each of its Working Parties undertake stock assessments and development of stock status indicators following the schedule shown in Table 1.

Table 1. Schedule of stock assessments for IOTC species and species of interest in 2014 and tentatively for 2015–2018.

Species	**2014**	**2015**	**2016**	**2017**	**2018**
Working Party on Billfish					
Black marlin	Indicators	**Full assessment**	**Full assessment**	Indicators	**Full assessment**
Blue marlin	Indicators	**Full assessment**	**Full assessment**	Indicators	**Full assessment**
Striped marlin	Indicators	**Full assessment**	**Full assessment**	Indicators	**Full assessment**
Swordfish	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators
Indo-Pacific sailfish	**Full assessment**	Indicators	Indicators	**Full assessment**	Indicators

Note: the assessment schedule may be changed dependant on the annual review of fishery indicators, or SC and Commission requests.

APPENDIX XIV
CONSOLIDATED RECOMMENDATIONS OF THE ELEVENTH SESSION OF THE WORKING PARTY ON BILLFISH

Note: Appendix references refer to the Report of the Eleventh Session of the Working Party on Billfish (IOTC–2013–WPB11–R)

Meeting participation fund

WPB11.01 (para. 3): **NOTING** that 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*), was used to fund the participation of 10 national scientists to the WPB11 meeting (5 in 2012), all of which were required to submit and present a working paper at the meeting, the WPB **RECOMMENDED** that this fund be maintained into the future.

WPB11.02 (para. 5): **NOTING** that the Commission had directed the Secretariat (via Resolution 10/05) to ensure that 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, the WPB **RECOMMENDED** that the Secretariat strictly adhere to the directives of the Commission contained in Resolution 10/05, including paragraph 8 which states that '*The Fund 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*.' 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.

Billfish species identification

WPB11.03 (para. 20): The WPB **EXPRESSED** its thanks to the IOTC Secretariat and other experts involved in the development of the identification cards for billfish and **RECOMMENDED** that the cards be translated into the following languages, in priority order: Farsi, Arabic, Indonesian, Swahili, Spanish, Portuguese and Thai, and that the Commission allocate funds for this purpose. The Secretariat should utilise any remaining funds in the IOTC Capacity Building budget line for 2013 to translate the cards.

WPB11.04 (para. 21): The WPB **RECOMMENDED** that the Commission allocate additional funds in 2014 to further translate and print sets of the billfish identification cards (budget estimate: Table 2).

TABLE 2. Estimated translation, production and printing costs for 1000 sets of identification guides for billfish.

Description	Unit price	Units required	Total
Translation (per language)	$1000	7	7,000
Typesetting	$1000	4	4,000
Billfish ID cards	$6	1000	6,000
Total estimate (US$)			**17,000**

Length-age keys

WPB11.05 (para. 24): The WPB **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Catch, Catch-and-effort, Size data

WPB11.06 (para. 25): The WPB **RECOMMENDED** that all CPCs assess and improve the status of catch-and-effort data for marlins (by species) and sailfish, noting that improvements to the data for the EU fleets and its provision to the IOTC Secretariat, would be most beneficial to the work of the WPB.

Data support

WPB11.07 (para. 39): **NOTING** that the work carried out during the meeting requires an IOTC data expert to be in attendance at each meeting to answer the many and varied questions from participants, the WPB strongly **RECOMMENDED** that the Secretariat support team attending the WPB meeting each year, also contain a staff member from the IOTC Data Section, in addition to the Science Manager and Fishery Officer (Stock Assessment), and for the attendance of the third team member to be incorporated into the IOTC budget for 2014 and for all future years.

Pakistan gillnet fishery

WPB11.08 (para. 44): **RECALLING** IOTC Resolution 12/12 *to prohibit the use of large-scale driftnets on the high seas in the IOTC area*, paragraph 1, which states:

> *"1. The use of large-scale driftnets on the high seas within the IOTC area of competence shall be prohibited." "Large-scale driftnets" are defined as gillnets or other nets or a combination of nets that are more than 2.5 kilometers in length whose purpose is to enmesh, entrap, or entangle fish by drifting on the surface of, or in, the water column."*,

the WPB **RECOMMENDED** that the SC note the findings of the study that gillnets in excess of the 2.5 km limit are being used by the gillnet fleets of Pakistan on the high seas, in contravention of Resolution 12/12.

Mozambique billfish fishery

WPB11.09 (para. 75): **NOTING** that at present no scientific observers are being placed on board foreign flagged vessels licenced to fish in the Mozambique EEZ, the WPB recalled its **RECOMMENDATION** that Mozambique make it a licencing requirement for any foreign vessels fishing in the Mozambique EEZ to take on board scientific observers and to report the data collected as per IOTC requirements. Foreign vessels fishing in the Mozambique EEZ should ensure that scientific observers are brought onboard as per IOTC requirements.

Recreational and sports fisheries for billfish

WPB11.10 (para. 84): **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 (university or consultant) 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 WPB Chair should 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.

Parameters for future analyses: stock assessments

WPB11.11 (para. 151): **NOTING** that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses, and this could have a detrimental effect on the quality of advice provided by the WPB, the WPB **RECOMMENDED** that exchanges of data (CPUE indices and coefficient of variation) should be made as early as possible, but no later than 30 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 15 days before a working party meeting, as per the recommendations of the SC, which states: "*The SC also ENCOURAGED data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and RECOMMENDED that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs*." (IOTC–2011–SC14–R; p68)

Swordfish

Nominal and standardised CPUE indices

WPB11.12 (para. 182): **NOTING** the request from the Commission in 2013 that the southwest region continue to be analysed as a special resource, in addition to the full Indian Ocean assessment, the WPB **RECOMMENDED** that CPCs with longline fleets with important swordfish catches in the southwest Indian Ocean (EU, Taiwan,China and Japan) undertake revised CPUE analysis for their longline fleets in the southwest Indian Ocean, in addition to CPUE analysis for the entire Indian Ocean.

Revision of the WPB workplan

WPB11.13 (para. 192): **192**. The WPB **RECOMMENDED** that the SC consider and endorse the workplan and assessment schedule for the WPB for 2014, and tentatively for future years, as provided at Appendix XII and Appendix XIII, respectively.

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

WPB11.14 (para. 204): The WPB **RECOMMENDED** that the SC note the re-elected Chairperson, Dr Jérôme Bourjea (La Réunion, France) and re-elected Vice-Chairperson, Dr. Miguel Neves Santos (EU,Portugal), of the WPB for the next biennium.

Consolidated recommendations of the Eleventh Session of the Working Party on Billfish

WPB11.15 (para. 205): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB11, provided at Appendix XIV, as well as the management advice provided in the draft resource stock status summary for each of the billfish species under the IOTC mandate:

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