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

Victoria, Mahé, Seychelles, 4–8 July 2011

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

Contact details:

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

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EXECUTIVE SUMMARY

The Ninth Session of the IOTC Working Party on Billfish (WPB) was held in Victoria, Mahé, Seychelles, from 4 to 8 July 2011. The meeting was attended by 27 individuals, including one invited expert, Dr. Toshihide Kitakado, from the Department of Marine Biosciences of the Tokyo University of Marine Science and Technology in Japan.

The following are a subset of the complete recommendations from the WPB09 to the Scientific Committee, which are provided at Appendix IV.

The WPB noted that the stock structure of the Indian Ocean swordfish resource is under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions. (para. 121)

***Swordfish:* INDIAN OCEAN STOCK – MANAGEMENT ADVICE**

The WPB agreed to the following management advice for swordfish in the Indian Ocean, for the consideration of the Scientific Committee; (para. 135)

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% of the unfished levels.

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 $F_{2019} > F_{MSY}$).

***Swordfish:* SOUTHWEST INDIAN OCEAN RESOURCE – MANAGEMENT ADVICE**

The WPB agreed to the following management advice for the swordfish resource in the southwest Indian Ocean, for the consideration of the Scientific Committee; (para. 137)

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in 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}.

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that $F_{2019} > F_{MSY}$). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region.

***Blue marlin*: INDIAN OCEAN STOCK – MANAGEMENT ADVICE**

The WPB agreed to the following management advice for the blue marlin resource in the Indian Ocean, for the consideration of the Scientific Committee; (para. 139)

Stock status. No quantitative stock assessment is currently available for blue marlin in the Indian Ocean, and due to a lack of reliable fishery data for several gears, only very preliminary stock indicators can be used. The standardised CPUE suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being *uncertain*. However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base a quantitative assessment is a cause for concern.

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 not sufficient information to evaluate the effect this will have on the resource.

***Other marlins and sailfish*: INDIAN OCEAN STOCK – MANAGEMENT ADVICE**

The WPB noted that no quantitative stock assessment is currently available for marlins and sailfish in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain*. However, aspects of the biology, productivity and fisheries for these species combined with the lack of data 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. (para. 141).

The WPB recommended that marlins and sailfish undergo CPUE analysis in 2012, with striped marlin taking priority over other species. (para. 108)

The WPB recommended that as a matter of priority, striped marlin be the subject of CPUE analysis in 2011, and that CPUE series be compared among fleets where possible. (para. 109)

The WPB recommended that a dedicated workshop on CPUE standardization, including issues of interest for other IOTC species should be carried out before the next round of stock assessments in 2012, and that where possible it should include a range of invited experts. (para. 118)

The WPB recommended that the Scientific Committee: (para. 147)

- note the draft resource stock status summaries for:
    i. Swordfish (*Xiphias gladius*) – Appendix VI
    ii. Blue marlin (*Makaira nigricans*) – Appendix VII

1. Opening of the Session

1. The Ninth Session of the IOTC Working Party on Billfish (WPB) was held in Victoria, Mahé, Seychelles, from 4 to 8 July 2011, Chaired by Mr Jan Robinson. A total of 27 participants attended the Session. The list of participants is provided at Appendix I.

2. The meeting was opened on 4 July, 2011 by the Chair, who subsequently welcomed participants to the Seychelles. The Chair informed participants that his second term as Chair of the WPB was due to end at the completion of the current session and that a new Chair and Vice-Chair would need to be elected prior to the close of the meeting.

2. Adoption of the Agenda and arrangements for the session

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

3. Outcomes of the Thirteenth Session of the Scientific Committee

4. The WPB **NOTED** paper IOTC–2011–WPB09–03 which outlined the main outcomes of the Thirteenth Session of the Scientific Committee, specifically related to the work of the WPB.

5. The WPB **NOTED** that the Scientific Committee recommended in 2010, that the Commission consider appropriate Conservation and Management Measures to control and/or reduce effort on the swordfish stock in the southwest Indian Ocean. In making this recommendation to the Commission, the Scientific Committee did not outline key elements required by the Commission to make an informed management decision, specifically related to the area of the southwest Indian Ocean, an indication of the current and historical catch and effort from the area, and the amount of catch or effort that would need to be removed from the area to ensure swordfish in the southwest Indian Ocean would recover to sustainable levels.

6. The WPB **NOTED** the recommendations of the Thirteenth Session of the Scientific Committee on data and research, and agreed to consider how best to progress these issues at the present meeting.

4. Outcomes of the Fifteenth Session of the Commission

7. The WPB **NOTED** paper IOTC–2011–WPB09–04 which outlined the main outcomes of the Fifteenth Session of the Commission, specifically related to the work of the WPB.

8. The WPB **NOTED** that at the Fifteenth Session of the Commission, a proposal for a new measure for the conservation and management of swordfish in the IOTC area of competence was proposed by the European Union. The proposal aimed to establish for all vessels over 24 meters length, and under 24 meters if they fish outside their EEZ, either a closure of a defined area, from 1st August to 1st September, or a reduction in fishing effort by 30% in relation to active capacity expressed in vessels numbers deployed in 2009 from 1st July to 30 September each year in the whole of the IOTC area of competence. The proposed closure area was defined by the coordinates: 25°–35° South and 30°–55° East. Although the Members of the Commission could not reach consensus to adopt the proposal, the Commission made two requests to CPCs:
   - CPCs **agreed** that greater representation at the Working Party on Billfish, especially by the main fleets targeting swordfish such as the Spanish longline fleet, should attend the next meeting to ensure the most complete data sets are available for analysis (IOTC–2011–S15–R, para. 120).
   - The Commission **requests** that the Scientific Committee provide clear advice outlining alternative management approaches which would provide effective protection of a possible southwest Indian Ocean swordfish stock (IOTC–2011–S15–R, para. 46).

9. The WPB **NOTED** with thanks, the improved attendance and participation by national scientists working on billfish fisheries, particularly from the main fleets targeting swordfish (EU,Spain, EU,Portugal and Indonesia).

10. The WPB **NOTED** that the increased attendance by scientists from developing CPCs was partly due to the IOTC Meeting Participation Fund, adopted by the Commission in 2010 (Resolution 10/05 *on the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and **RECOMMENDED** that this fund be maintained.

11. The WPB **NOTED** the Commission's request that a Kobe II strategy matrix be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the Scientific Committee in 2011 and all future reports.

12. The WPB **NOTED** the outcomes of the Fifteenth Session of the Commission, and agreed to consider how best to provide the Scientific Committee with the information it needs, in order to satisfy the Commission's requests, throughout the course of the meeting.

13. The WPB **RECOMMENDED** that the Scientific Committee consider the advice of the WPB on the southwest swordfish resource and to respond to the Commission's request during its 2011 meeting, noting that the Working Party on Methods will be progressing Management Strategy Evaluation over the coming year that will aid in addressing this request, which was considered by participants as the appropriate mechanism for this work.

5. PROGRESS ON THE RECOMMENDATIONS OF WPB08

14. The WPB **NOTED** paper IOTC–2011–WPB09–05 which provided an update on the progress made in implementing the recommendations from previous WPB meetings, and also provided alternative recommendations for the consideration and potential endorsement by participants.

15. The WPB **AGREED** to a set of revised recommendations, that are provided throughout this report and in the consolidated list of recommendations (Appendix IV), for the consideration of the Scientific Committee.

6. REVIEW OF THE DATA AVAILABLE ON BILLFISH

16. The WPB **NOTED** paper IOTC–2011–WPB09–06 which summarised the standing of a range of information received by the secretariat for billfish species, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2009. Statistics for 2010 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October).

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

Swordfish – catch trends

18. The WPB **NOTED** that swordfish are caught mainly using drifting longlines (95%) and gillnets (5%) (Fig. 1). 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 (Figs. 1, 2). 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).

19. The WPB **NOTED** that 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. 3).

Swordfish – uncertainty of time–area catches

20. The WPB **NOTED** that 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.
- 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.
- 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 IOTC Secretariat are thought to be more accurate, catches of swordfish remain uncertain.
- Longline fleets from non-reporting countries (NEI): The IOTC Secretariat had to estimate catches of swordfish for a fleet of longliners targeting tunas or swordfish and operating under flags of various non-reporting countries. The catches estimated since 2006 are, however, low.
- Changes to the catch series: There have not been significant changes to the catch series of swordfish since the WPB in 2010. Changes since the last WPB refer to revisions of historic data series for the artisanal fisheries of Indonesia and India. These changes, however, did not lead to significant changes in the total catch estimates.
- 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.

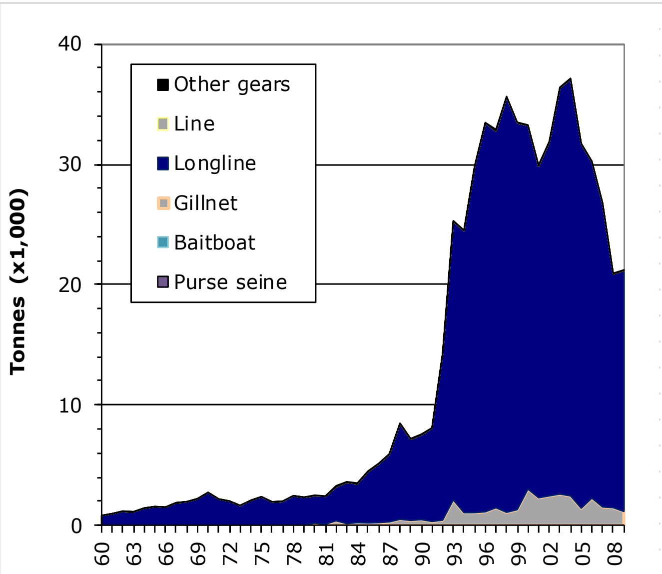


Fig. 1. Catches of swordfish by gear and year recorded in the IOTC Database (1960-2009) (Data as of May 2011).

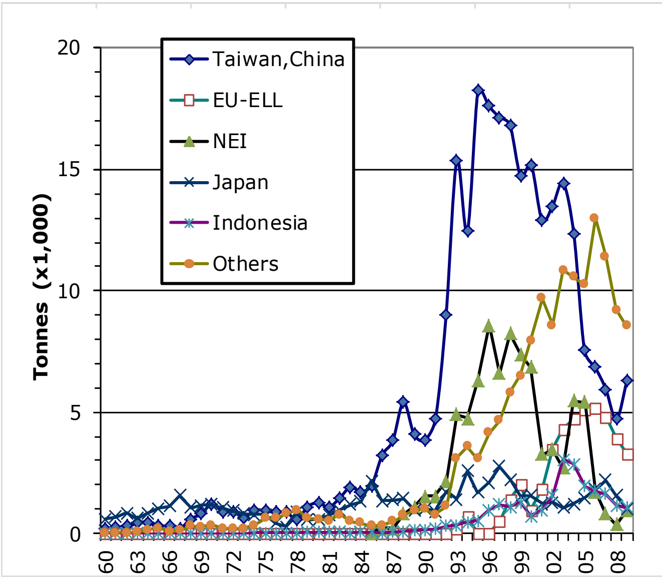


Fig. 2. Catches of swordfish by fleet recorded in the IOTC Database (1960-2009) (Data as of May 2011).

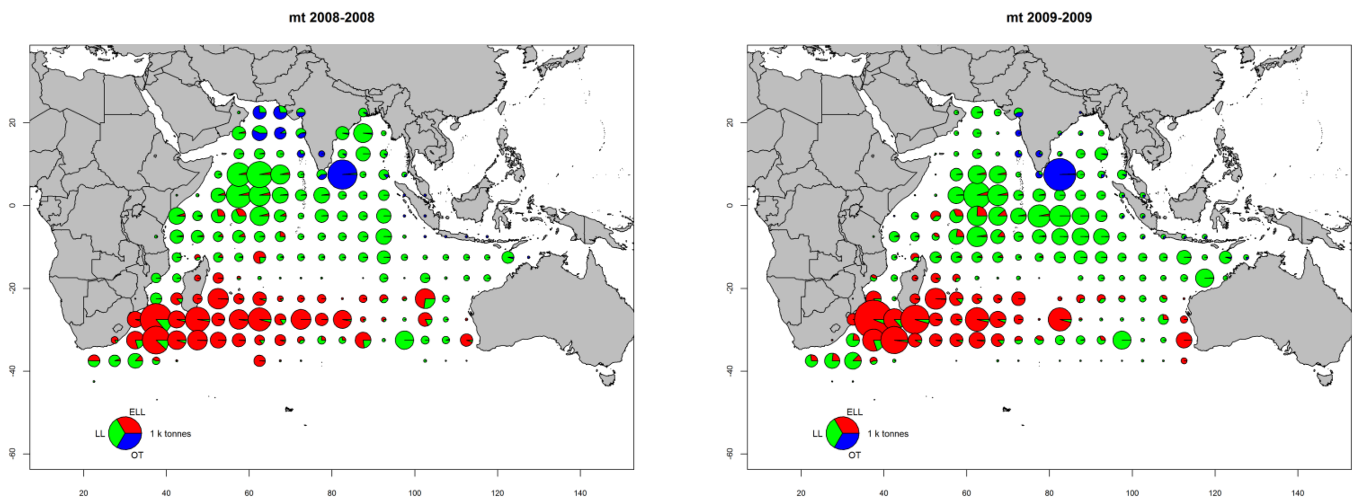


Fig. 3a–b. Time-area catches (total combined in tonnes) of swordfish estimated for 2008 and 2009 by type of gear: Swordfish longliners (ELL), Other longliners (LL), Other fleets (OT). Time-area catches are not available for non-longline fleets (OT, blue); catches for those were fully assigned to the one or more 5x5 squares lying within the EEZs of the countries concerned (Data as of May 2011).

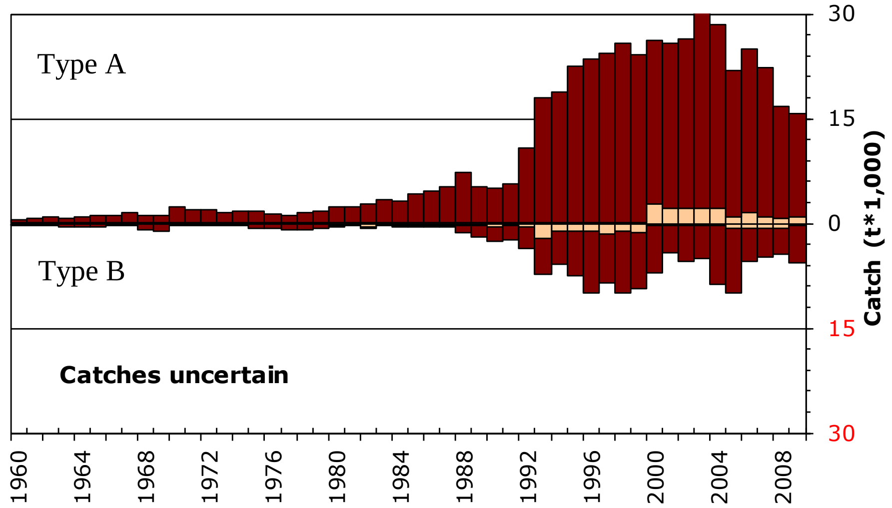


Fig. 4. Uncertainty of time-area catches for swordfish (Data as of May 2011).

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species 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.*

Black marlin – catch trends

21. The WPB **NOTED** that black marlin are caught mainly under drifting longlines (44%) and gillnets (49%) with remaining catches recorded under troll and hand lines (Fig. 5). Black marlin are the bycatch of industrial and artisanal fisheries. In recent years, the fleets of Taiwan,China (longline), Sri Lanka (gillnet), Indonesia (gillnets) and India (gillnets) are attributed with the highest catches of black marlin (Fig. 6). The minimum average annual catch estimated for the period 2005 to 2009 is around 4,569 t.

22. The WPB **NOTED** that 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 (Figs. 7).

Black marlin – uncertainty of time–area catches

23. The WPB **NOTED** that minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

24. The WPB **NOTED** that retained catches are uncertain for some fisheries (Fig. 8), due to the fact that:
    - Catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the IOTC Secretariat for some 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 IOTC 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 IOTC Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
    - A lack of catch data for most sport fisheries.

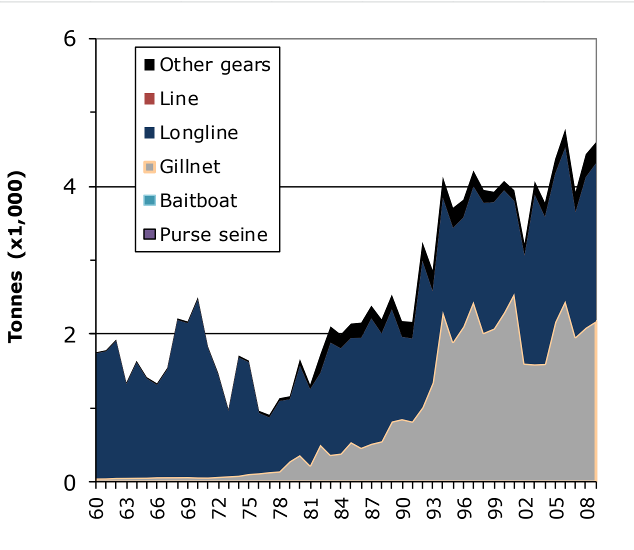


Fig. 5. Catches of black marlin by gear and year recorded in the IOTC Database (1960–2009) (Data as of May 2011).

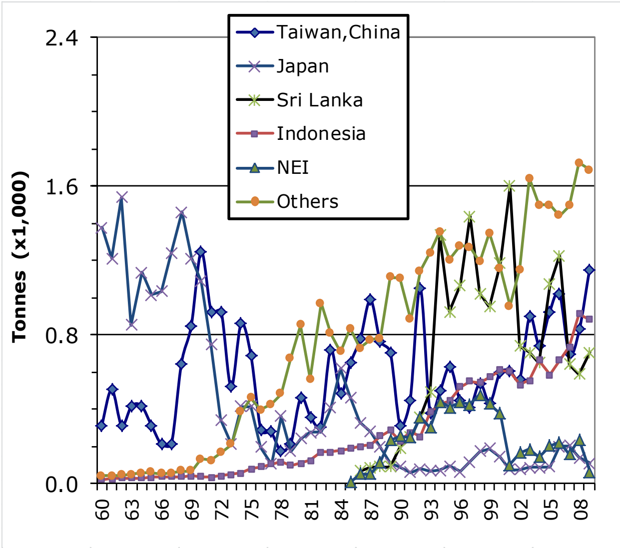


Fig. 6. Catches of black marlin by fleet recorded in the IOTC Database (1960–2009) (Data as of May 2011).

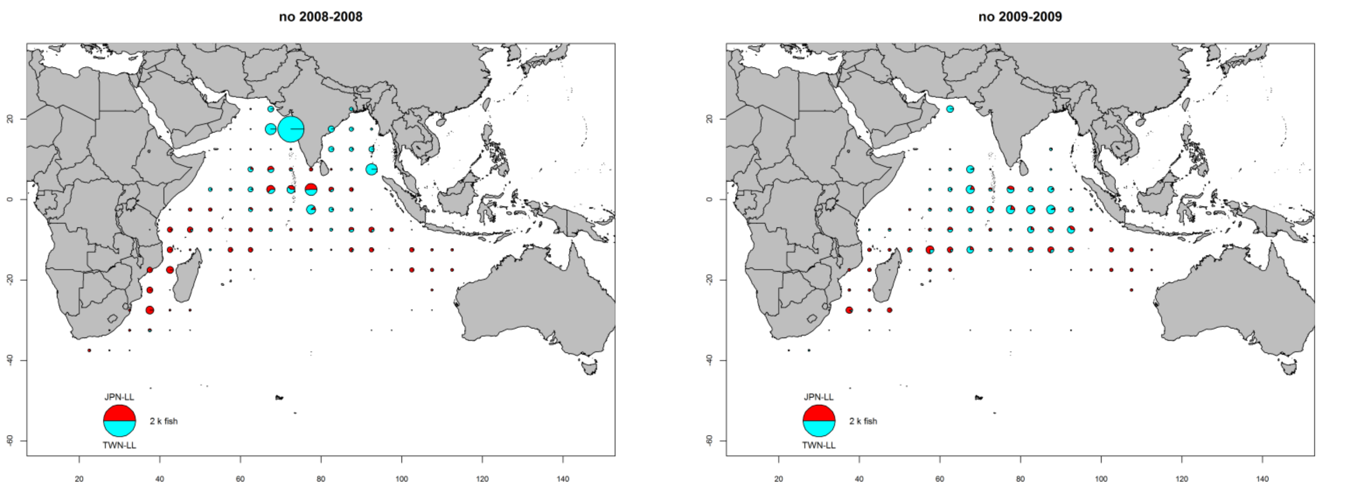


Fig. 7a–b. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2008 and 2009 by fleet (Data as of May 2011).

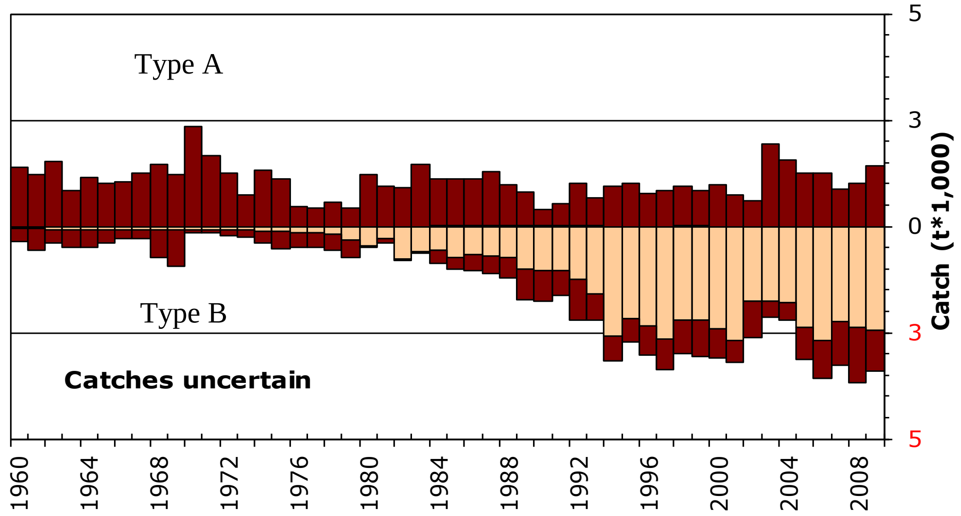


Fig. 8. Uncertainty of time-area catches for black marlin (Data as of May 2011).

Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species 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.

Blue marlin – catch trends

25. The WPB **NOTED** that blue marlins are caught mainly under drifting longlines (60%) and gillnets (30%) with remaining catches recorded under troll and hand lines (Fig. 9). 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), Sri Lanka (gillnet) and India (gillnet) are attributed with the highest catches of blue marlin (Fig. 10). 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.

26. The WPB **NOTED** that catch trends for blue marlin are variable; however, this may reflect the level of reporting. The catches of blue marlin under drifting longlines were more or less stable until the mid-80's, at around 3,000 t, steadily increasing since then. The largest catches were recorded in 1997 (14,000 t). Catches under drifting longlines have been recorded under Taiwan,China and Japan fleets and, recently, Indonesia and several NEI fleets (Fig. 10). In recent years, deep-freezing longliners from Japan and Taiwan,China 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. 11).

Blue marlin – uncertainty of time–area catches

27. The WPB **NOTED** that minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the IOTC Secretariat.

28. The WPB **NOTED** that retained catches are poorly known for most fisheries (Fig. 12) due to:
   - Catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the IOTC Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
   - Catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the IOTC Secretariat using alternative information.
   - Catches are likely to be incomplete for industrial fisheries for which the blue marlin is not a target species.
   - Conflicting catch reports: 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 IOTC 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 IOTC Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
   - A lack of catch data for most sport fisheries.

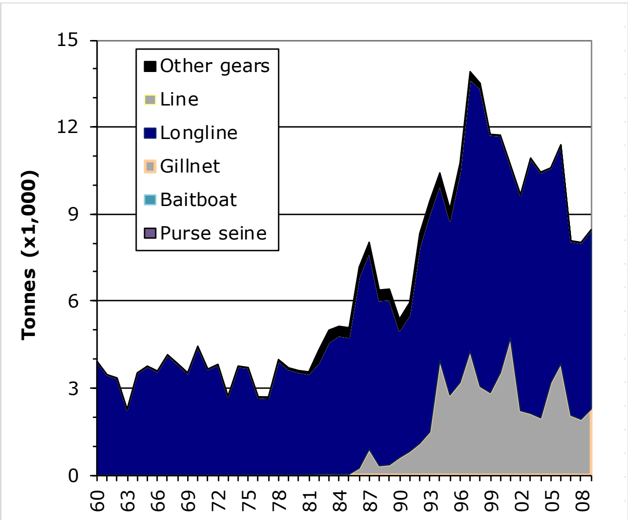


Fig. 9. Catches of blue marlin by gear and year recorded in the IOTC Database (1960–2009) (Data as of May 2011).

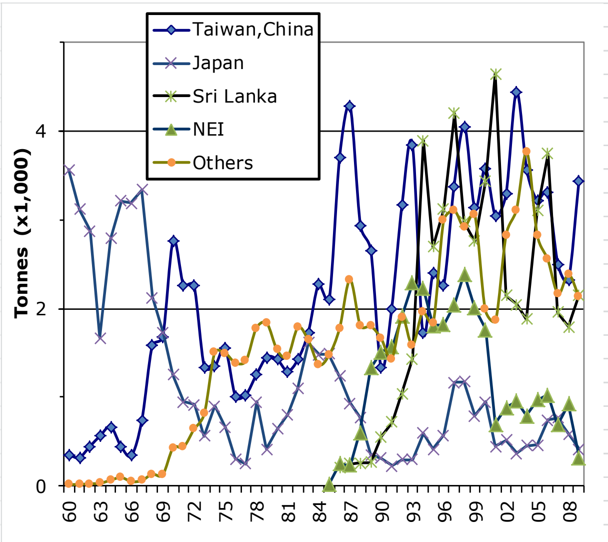


Fig. 10. Catches of blue marlin by fleet recorded in the IOTC Database (1960–2009) (Data as of May 2011).

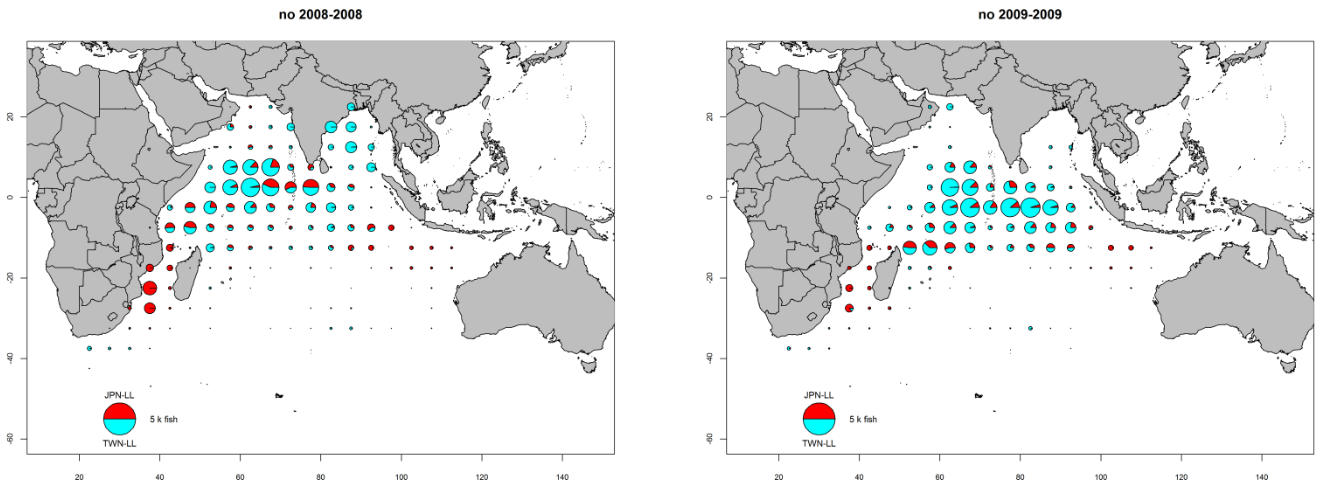


Fig. 11a–b. Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2008 and 2009 by fleet (Data as of May 2011).

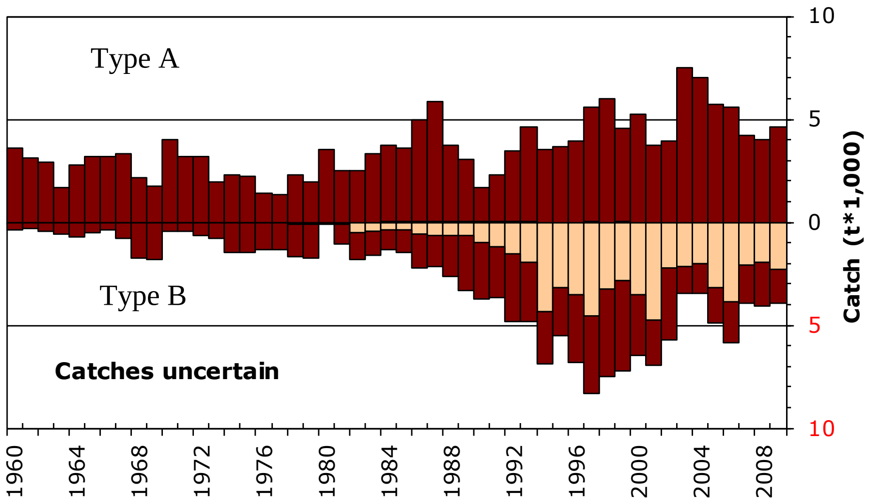


Fig. 12. Uncertainty of time-area catches for blue marlin (Data as of May 2011).

Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species 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.

Striped marlin – catch trends

29. The WPB **NOTED** that striped marlin are caught almost exclusively under drifting longlines (98%) with remaining catches recorded under gillnets and troll lines (Fig. 13). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable; however, this may reflect the level of reporting. The catches of striped marlin under drifting longlines have been changing over time, between 2,000 t and 8,000 t (Fig. 13).

30. The WPB **NOTED** that catches under drifting longlines have been recorded under Taiwan,China, Japan, Republic of Korea fleets and, recently, Indonesia and several NEI fleets (Fig. 14). Taiwan,China and Japan have reported large drops in the catches of striped marlin for its longline fleets in recent years. 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. In recent years, the fleets of Taiwan,China (longline) and to a lesser extent Indonesia (longline) are attributed with the highest catches of striped marlin.

31. The WPB **NOTED** that in recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of striped marlin, mostly in the northwest Indian Ocean (Fig. 15). The minimum average annual catch estimated for the period 2005 to 2009 is around 2,779 t. 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. 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 Iran, as this species has no commercial value in this country.

Striped marlin – uncertainty of time–area catches

32. The WPB **NOTED** that retained catches are reasonably well known (Fig. 16) 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.

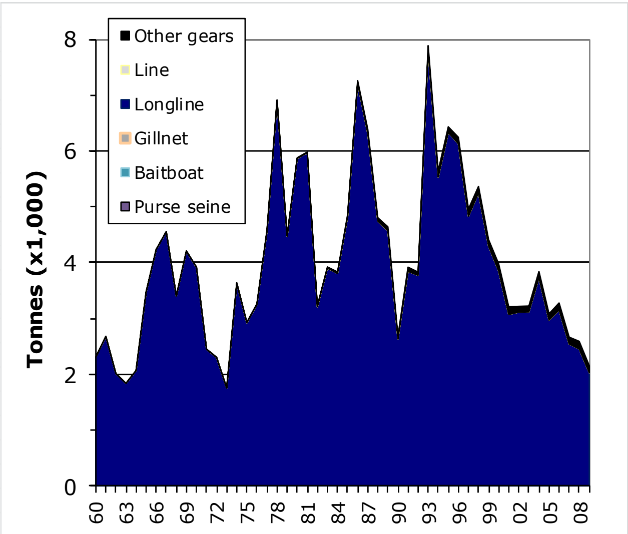


Fig. 13. Catches of striped marlin by gear and year recorded in the IOTC Database (1960–2009) (Data as of May 2011).

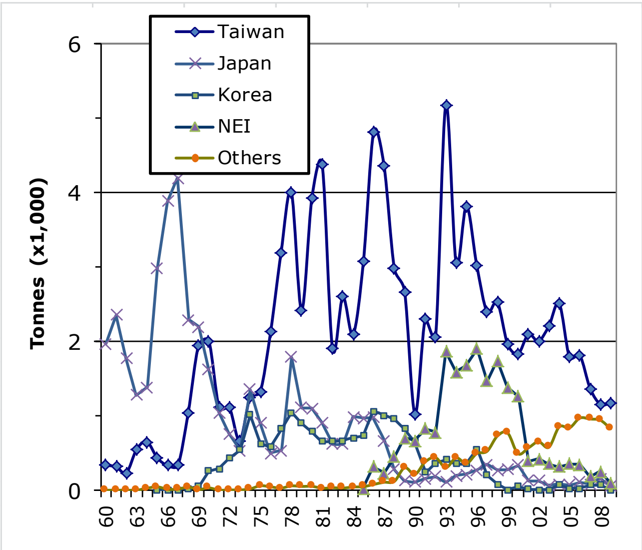


Fig. 14. Catches of striped marlin by fleet recorded in the IOTC Database (1960–2009) (Data as of May 2011).

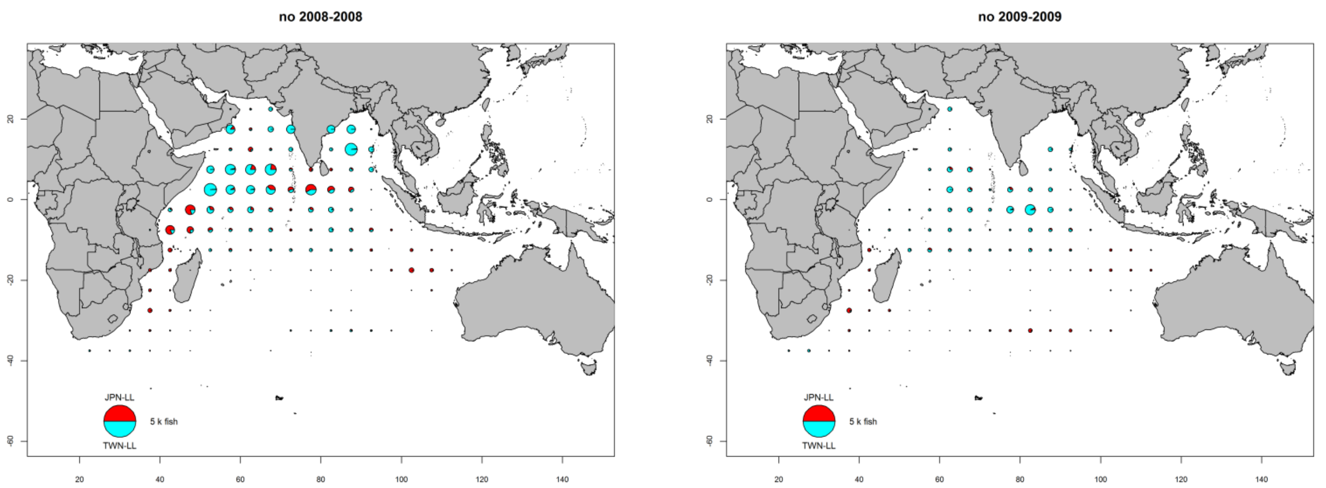


Fig. 15a–b. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2008 and 2009 by fleet (Data as of May 2011).

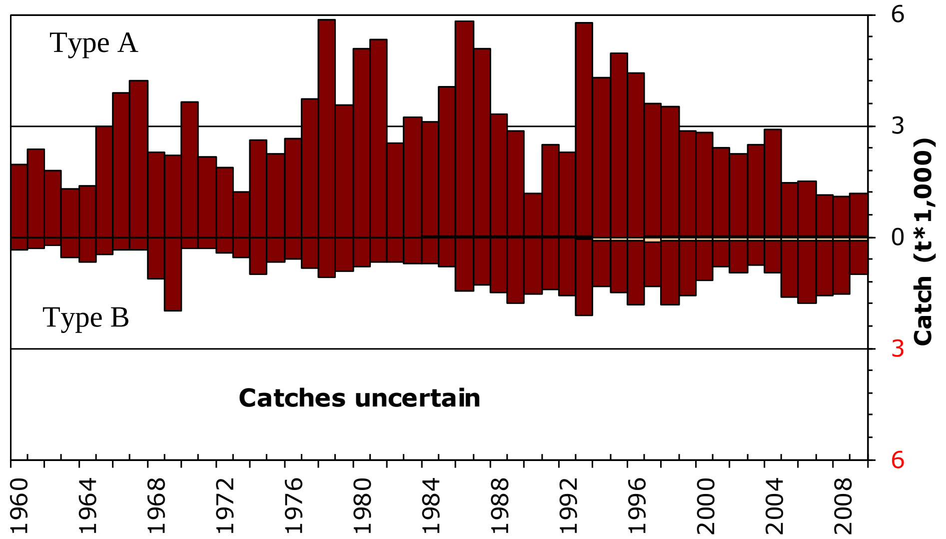


Fig. 16. Uncertainty of time-area catches for striped marlin (Data as of May 2011).

Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species 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

Indo-Pacific sailfish – catch trends

33. The WPB **NOTED** that Indo-Pacific sailfish is caught mainly under gillnets (78%) with remaining catches recorded under troll and hand lines (15%), longlines (7%) or other gears (Fig. 17). The minimum average annual catch estimated for the period 2005 to 2009 is around 22,339 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, Iran, Pakistan and Sri Lanka). 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).

34. The WPB **NOTED** that catches of Indo-Pacific sailfish greatly increased since the mid-1980's in response to the development of a gillnet/longline fishery in Sri Lanka (Fig. 18) and, especially, the extension in the area of operation of Iranian gillnet vessels to areas beyond the

EEZ of Iran. The catches of Iranian gillnets (Fig. 18) increased dramatically, more than six-fold, after the late 1990's, from values averaging the 2,000 t in the late 1980's to a maximum of 12,600 t in 2005.

35. The WPB **NOTED** that catches of Indo-Pacific sailfish under drifting longlines and other gears do not show any specific trends in recent years, with total catches amounting to about 5,000 t. 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. 19).

Indo-Pacific sailfish – uncertainty of time–area catches

36. The WPB **NOTED** that 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.

37. The WPB **NOTED** that retained catches are poorly known for most fisheries (Fig. 20) due to:
    - 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 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.

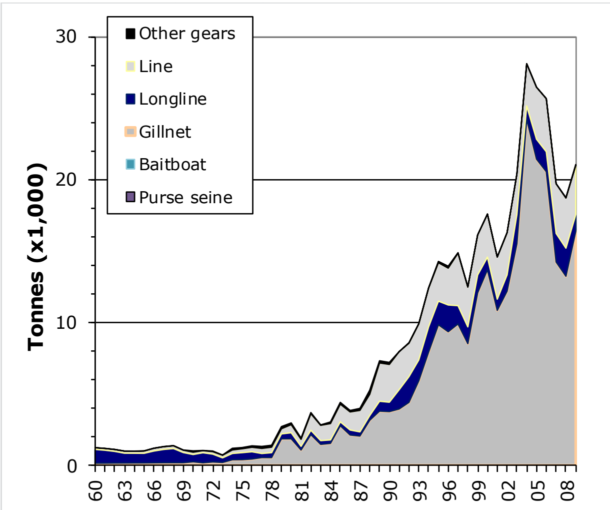


Fig. 17. Catches of Indo-Pacific sailfish per gear and year recorded in the IOTC Database (1960–2009) (Data as of May 2011).

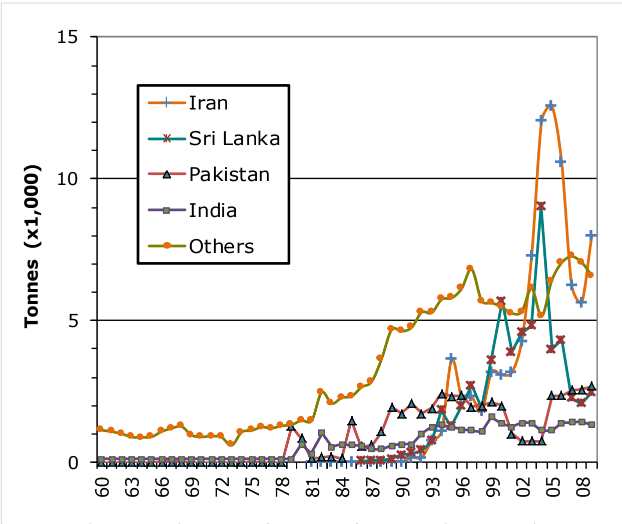


Fig. 18. Catches of Indo-Pacific sailfish by fleet recorded in the IOTC Database (1960–2009) (Data as of May 2011).

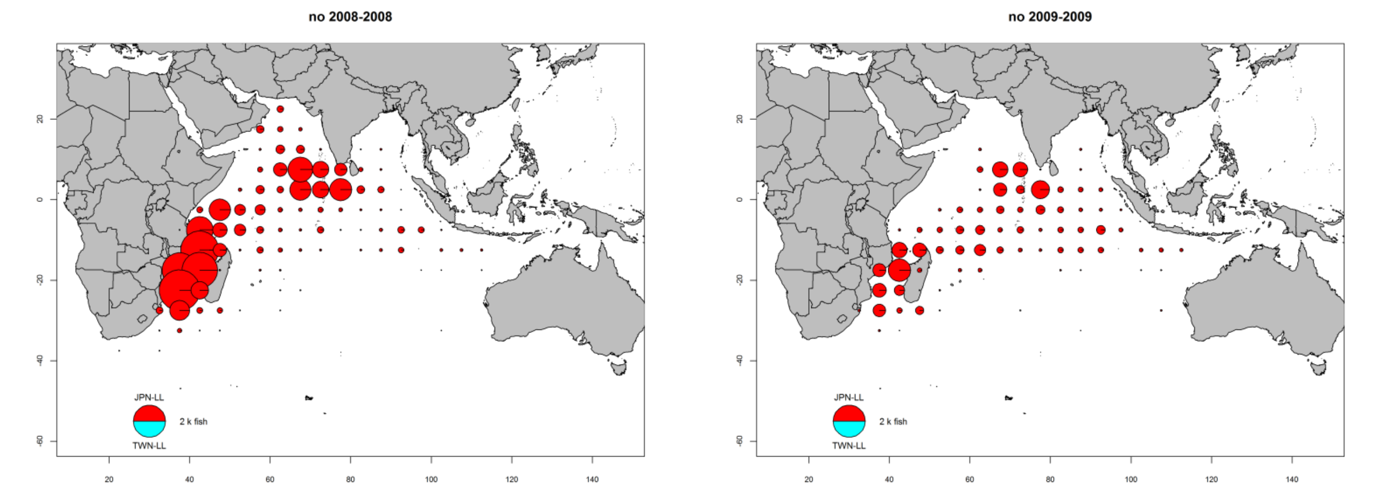


Fig. 19a–b. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 12,008 and 2009 by fleet (Data as of May 2011).

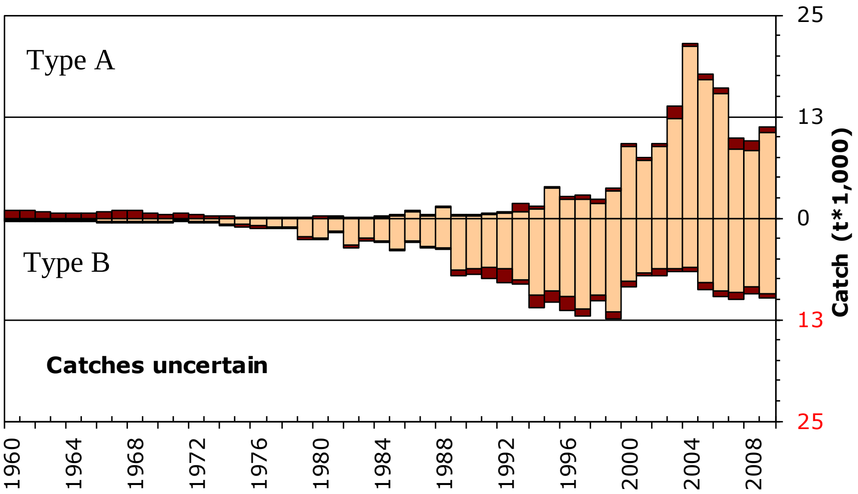


Fig. 20. Uncertainty of time-area catches for Indo-Pacific sailfish (Data as of May 2011).

Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species 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.

Data inconsistencies for the Japanese and Taiwan,China swordfish catches

38. The WPB **NOTED** the preliminary results of a study being carried out by the IOTC Secretariat using data from the IOTC databases for the main longline fisheries. The main objective of the study is to assess 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. Average weights derived from these data sources, by species and year, are not expected to differ significantly if logbook and size data are representative of the fisheries concerned.

39. The WPB **NOTED** that Figure 21 shows the ratio between average weights estimated using logbook and size data for the longline fisheries of Japan, Taiwan,China, Seychelles and EU,Spain. Initially, values close to one indicate that there is consistency in the average weights

estimated and therefore there is no grounds to believe that logbook or size data are not representative of the fishery concerned.

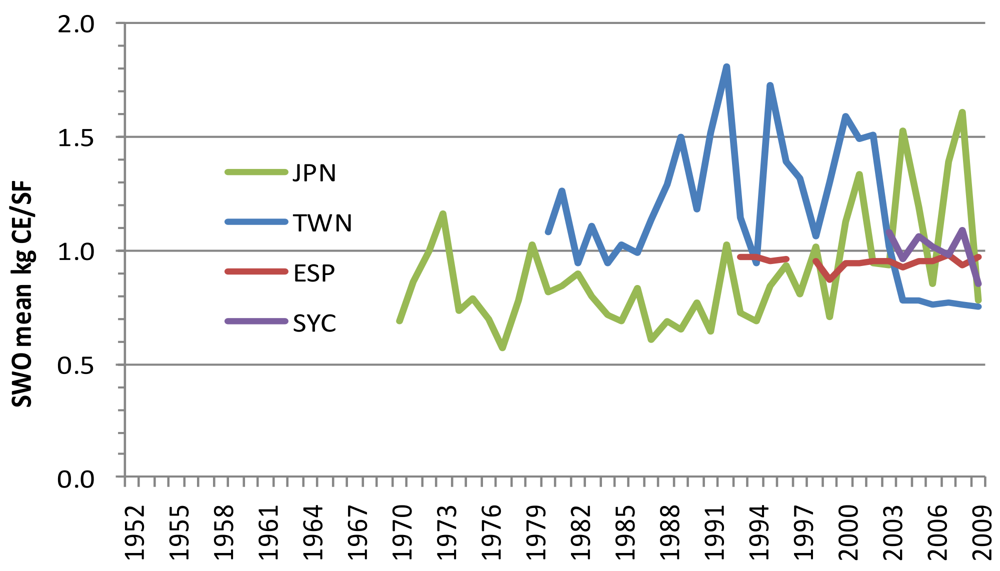


Fig. 21. Index of mean weights estimated by dividing average weights derived from logbook data by those derived by using size frequency data for the longline fisheries of Japan (JPN), Taiwan,China (TWN), EU,Spain (ESP) and Seychelles (SYC). Average weights derived from logbooks (CEno) higher(>1.0)/lower(<1.0) than those estimated from size data (SFno).

40. The WPB **NOTED** that while the ratio values estimated for the fisheries of EU,Spain and Seychelles are close to one, over the entire catch series, this is not the case for Japan and Taiwan,China, for which the values differ considerably (over 80% in some years). In the case of Japan the average weights of swordfish derived from the available size frequency data are markedly higher than those derived using logbook data, for most of the time series. The opposite occurs in the case of Taiwan,China with average weights derived from logbook data markedly higher than those derived from the available size frequency data. The IOTC Secretariat indicated that the discrepancies shown in the average weights may arise from logbooks, size or both datasets not being representative of the fisheries concerned.

41. The WPB **NOTED** and expressed concern that the discrepancies identified may have substantial impacts on stock assessments for swordfish, as assessments use datasets derived from both logbook and size frequency data, including indices of abundance derived from logbook data.

42. The WPB **RECOMMENDED** that the IOTC Secretariat finalize 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.

Data collection and reporting systems

43. The WPB **NOTED** the IOTC Secretariat's recent activities in Iran, which aimed to finalize agreement for the implementation of systems to strengthen data management and to implement pilot sampling activities to assess the quality of the statistics being collected from gillnet fisheries.

44. The WPB **RECOMMENDED** that the IOTC Secretariat travel to India and Pakistan in order to assess the status of data collection and reporting systems in those countries, and to report back to the WPB at its 2012 session.

45. The WPB **RECOMMENDED** that the IOTC Secretariat further assist India and Pakistan in the strengthening of data collection and reporting systems, where required, so as to facilitate reporting of statistics for billfish species as per IOTC standards.

46. The WPB **RECOMMENDED** that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement.

Billfish species identification

47. The WPB **RECOMMENDED** that the IOTC Secretariat, in collaboration with relevant experts, develop species identification cards for marlins and sailfish by the next meeting of the WPB.

48. The WPB **RECOMMENDED** that marlin and sailfish identification material, currently being used by the La Réunion fleets, be provided to the IOTC Secretariat in the coming months to aid in the development of the identification cards.

Length-age keys and other information

49. The WPB **RECOMMENDED** that as a matter of priority, the IOTC Secretariat formally request, and provide assistance where necessary, CPCs that have important fisheries for billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide the basic data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, and sex ratio data, by sex and area.

50. The WPB **RECOMMENDED** that the IOTC Secretariat develop a priority list of measurements to be collected for the purposes of developing length-age keys and other measurement keys, and to communicate this to CPCs before the end of the year.

Sampling coverage

51. The WPB **RECOMMENDED** that the IOTC Secretariat assess levels of reporting for Japan upon receiving size data for 2010 and report back to the next meeting of the WPB.

52. The WPB **RECOMMENDED** that Japan increase sampling coverage to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

53. The WPB **RECOMMENDED** that the WPDCS urges Members with observer programmes to analyse the data collected to estimate discards of billfish species and the precision of these estimates.

Logbook coverage

54. The WPB **RECOMMENDED** that the WPDCS monitor that Members are ensuring that logbook coverage is appropriate to produce acceptable levels of precision (Coefficient of Variation to be initially set at less than 20%) in their catch and effort statistics for billfish species.

55. The WPB **RECOMMENDED** that the IOTC Secretariat request countries include levels of precision in their reports of catch-and-effort for billfish species.

Size data

56. The WPB **RECOGNISED** that some mandatory data collection and reporting requirements, are not feasible due to the lack of taxonomic species identification tools, capacity building and the low prevalence of these species in total catches.

57. **NOTING** that the EU,Portugal had recently reported size data for swordfish from its longline fleets; The WPB **RECOMMENDED** that the EU,Portugal report size data for marlin and sailfish species for its longline fleets, noting that this is already a mandatory reporting requirement.

58. **NOTING** that eleven longliners from the EU,United Kingdom, Kenya, Guinea, and Tanzania have operated in the Indian Ocean in recent years; The WPB **RECOMMENDED** that the

EU,United Kingdom, Kenya, Guinea, and Tanzania make every possible effort to collect and report size data for billfish species for their longline fleets, noting that this is already a mandatory reporting requirement.

59. The WPB **RECOMMENDED** that Japan and Taiwan,China analyse the size samples collected from their longline fisheries for swordfish and marlins in order to verify if the length frequencies derived from such samples are representative of their fisheries. In particular Japan to compare length frequency distributions derived from samples collected:
    - by fishermen on commercial vessels
    - by observers on commercial vessels
    - by scientists on research and training vessels.

60. The WPB **RECOMMENDED** that the IOTC Secretariat follow-up on the results of the study with Japan and Taiwan,China and to report to the next WPB meeting.

61. The WPB **RECOMMENDED** that Taiwan,China collect and provide the IOTC Secretariat with size data for billfish caught by its fresh tuna longliners, noting that this is already a mandatory requirement.

62. The WPB **RECOMMENDED** that the IOTC Secretariat liaise with the EU,Spain in order to assess the status of catch-and-effort data for marlins and sailfish.

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

Other data matters

64. The WPB **RECOMMENDED** that the IOTC Secretariat liaise with the Republic of Korea to inform them about the new nominal catches estimated for its longline fishery.

65. **NOTING** that Japanese scientists are assisting the Republic of Korea in the review of catch-and-effort data series for longline vessels under the flag of Korea; The WPB **RECOMMENDED** that the IOTC Secretariat follow-up with Japan and the Republic of Korea in order to obtain a new catch-and-effort data series from the Republic of Korea as soon as possible.

Preparation of data input files for stock assessment purposes

66. The WPB **NOTED** paper IOTC–2011–WPB09–07 which described the methods used by the IOTC Secretariat to prepare catch tables, length-frequency samples and catch-at-size and catch-at-age tables for swordfish, for the period 1950–2009, using estimates of total catch and the available catch-and effort, size frequency data and other biological data in the IOTC database.

67. The WPB **NOTED** that the IOTC Secretariat estimated total catches of swordfish, in number and weight, per year, quarter, and assessment area and fishery, for the period 1950–2009, using information from the IOTC database, in particular estimates of total catches by fishery and year, and catch-and-effort and size frequency data by time-area strata. In addition, the IOTC Secretariat prepared length-frequency samples from the size frequency data available in the IOTC databases. These datasets were prepared to be used in assessments using estimates of total catches by fishery, area, year and quarter and the samples existing for those strata or estimates of catch-at-size or catch-at-age derived from the referred samples. The results are affected by the lack of information for some fleets, periods and years, and, in particular, by the lack of catch and size data from most artisanal fleets and some industrial fleets.

Fishery trends for billfish

68. The WPB **NOTED** paper IOTC–2011–WPB09–08 which provided a range of fishery indicators to aid the WPB in developing its advice to the Scientific Committee, including total effort from longline vessels flagged in Japan, Taiwan,China and EU,Spain and 5 degree square grid, by year from 2006 to 2009 (Fig. 22).

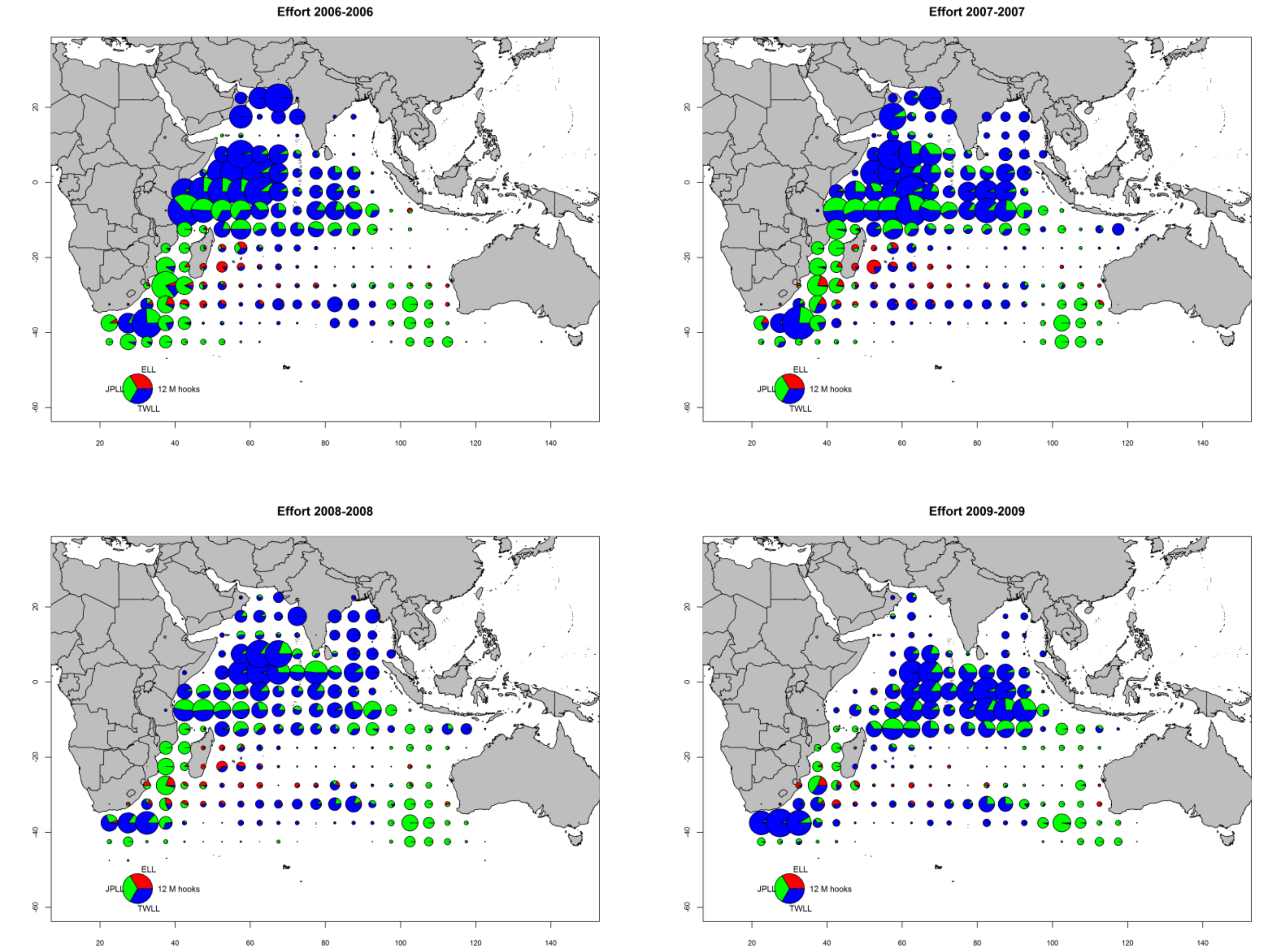


Fig. 22. Number of hooks set (millions) from longline vessels flagged in Japan, Taiwan,China and EU,Spain, by year, and 5 degree square grid, for the years 2006–2009 (Data as of May 2011).

7. New Information on Biology, Ecology, Fisheries and Environmental Data Relating to Billfish

7.1 Review new information on the biology, stock structure, their fisheries and associated environmental data: Marlins, sailfish, swordfish

Sports fisheries

69. The WPB **NOTED** paper IOTC–2011–WPB09–09 which provided an overview of the Kenyan sports fishery for Indo-Pacific sailfish, including the following abstract provided by the authors:

“*This report presents the catches of the Indo-Pacific Sailfish (Istiophorus platypterus) caught by the sports fishers at Malindi sport fishing club. The daily catch data per boat used here is for eighteen years from 1987 to 2006 whereby over 22,000 trips were recorded. The years 1988 and 1999 are not included as the data was missing. Sailfish is usually the main target of the sports fishers and tagging conducted by the African Billfish Foundation (ABF) has mainly concentrated on this species. Initially, most of the sailfish caught were retained but after the sports fishers realized the need to conserve the species, there has been an increased release back to the waters and the ratio of retained catches has been on the decline with only a third of the catch being retained while the* *rest are tagged and released. The season for the Sailfish is between the months of September and February with December being the peak month. Over the 18 years, the average weight of individual fish caught has remained around 25 Kgs. The CPUE for sailfish has steadily declined with occasional rise and fall. The results show that sport fishing data can be used to indicate the abundance of the stock and countries should be encouraged to collect and report the sport fishing data.*"

70. The WPB **RECOMMENDED** that the IOTC Secretariat develop a project aimed at enhancing data recovery from sports and other recreational fisheries in the region, in collaboration with Kenya and other interested parties, and to report progress at the next WPB meeting.

71. The WPB **NOTED** paper IOTC–2011–WPB09–10 which provided an overview of the activities of the African Billfish Foundation (ABF) tagging program, including the following abstract provided by the authors:

"*Over the last fifteen years, the African Billfish Foundation in collaboration with the sport fishing fraternity has run a billfish tagging and recoveries programme in the East African waters. To date, over 45,000 fish have been tagged and up to 1,700 tags have been recovered. This paper explores the trends and changes in the number of different billfish species tagged over the years and the number of billfish recaptured, together with the overall recapture rates for each species. The trends over years show that the sailfish have been tagged in the largest numbers whilst the swordfish are the least of all the species tagged. In regards to the recaptured billfish, the patterns depicted by tagged billfish that have been caught as far as the Arabian Gulf, the West Coast of Australia, South Africa, Reunion, Chagos and many more are also included. This paper also gives an overview of the factors determining the percentage of recapture rates and the tagging efforts. Highlights to the challenges faced in the conservation and management of billfish species in the East African waters have also been discussed in-depth. As a conclusion, the paper also presents the different ways to address the threats facing the billfish species in the Indian Ocean.*"

72. The WPB **RECOMMENDED** 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.

73. The WPB **RECOMMENDED** that as a matter of priority, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, 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 and to report back to the WPB at its meeting in 2012.

74. The WPB **RECOMMENDED** that the IOTC Secretariat provide contact details for purse seine and longline fleets obtained during the Regional Tuna Tagging Project-Indian Ocean (RTTP-IO), to participating billfish foundations so that they may improve their own outreach and awareness campaigns.

75. The WPB **RECOMMENDED** that the African Billfish Foundation (ABF) work with the IOTC Secretariat to facilitate engagement between the ABF and IOTC scientists on issues from data analysis to the collection and dissemination of biological information on billfish species.

Environmental data

76. The WPB **NOTED** paper IOTC–2011–WPB09–11 which provided an overview of environmental data available for assessment purposes, including the following abstract provided by the authors:

"*The Global Ocean Data Assimilation System (GODAS) data published by the NOAA's National Centre for Environmental System (NCEP), have been applied in various areas in oceanography and fisheries worldwide. In the IOTC, they have been applied for CPUE standardization (STD CPUE) works for swordfish, yellowfin tuna and bigeye tuna. As* *there are no synthetic validation studies on the GODAS data, we attempted to do such validations by theory, case studies, application and sea truth. As a conclusion we suggest that GODAS data except salinity data in the NOAA-NCEP can be used for various studies such as fisheries oceanography and CPUE standardization in our case with caution as there are some degrees of errors by year, season and depth in the estimated data. Thus we suggesting use the GODAS data through sea truth (validation). As for the salinity data we need to wait to use until the new assimilated data available by the next generation (better) model because the current salinity data have uncertainty in accuracy due to deficits in the present model for salinity.*"

77. The WPB **AGREED** that the use of environmental data in the catch rate analyses may be useful and that such data should be validated where possible to improve its utility.

Seychelles longline fisheries

78. The WPB **NOTED** paper IOTC–2011–WPB09–24 which provided an up-date on the Seychelles semi-industrial and industrial longline fisheries, focusing on billfishes, including the following abstract provided by the authors:

"*The local pelagic long line fishery targeting swordfish started in the Seychelles in 1995 and expanded rapidly until 2001, and thereafter experiencing declines in 2002, 2003 and 2004. Over the past 6 years an increase in activity was recorded in this fishery. From only 4 vessels active in 2004, there were 9 active vessels in both 2009 and 2010. Fishing effort also increase significantly, reaching similar level (over 500,000 hooks deployed) recorded in the late 1990's. A total of 506,334 hooks were deployed in 2010 for a total catch of 295 tonnes. This represents a decline of 10% in total catch even though there was an increase of 5% in fishing effort compared to the previous year. Swordfish (Xiphias gladius) catches in weight represents 52% of the catch with other billfishes marlin and sailfish making up 2% each. The overall CPUE recorded for this fishery has been on a downward trend over the past 3 years, from 1.29Mt/1000 Hks in 2007 to 0.58 Mt/1000Hks in 2010. The annual swordfish CPUE also shows a decreasing trend from 0.58 Mt/1000hooks in 2005 to 0.37 Mt/1000hooks in 2010. For the Seychelles industrial longline fishery, the fishing effort in terms of hooks deployed and number of fishing days has remained more or less stable for the past 4 years at around 20 million hooks deployed per year and 6000 fishing days, except for a slight drop in 2008. The total catch reported by this fleet in 2009 is estimated at 7,930 Mt obtained from a fishing effort of about 18 million hooks. Following a peak of 0.69 Mt/1000 hooks in 2005, the CPUE of the Seychelles' industrial longline fleet dropped to 0.47Mt/1000 and remained more or less constant at that level between 2006 and 2008. In 2009, the CPUE decrease slightly to 0.41Mt/1000 hooks. The CPUE for billfishes (swordfish, marlin and sailfish has remained more or less stable for the past 4 years.*"

79. The WPB **NOTED** that depredation was considered to be around 19% of the fish caught (all species; 17.5% for swordfish) in the Seychelles longline fishery, which is much higher than in other regions of the Indian Ocean and would lead to bias in the CPUE series.

Mozambique billfish landings

80. The WPB **NOTED** paper IOTC–2011–WPB09–25 which provided an overview of the activities of fleets landing billfish in Mozambique waters, including the following abstract provided by the authors:

"*Mozambique has no national fleet for tuna and tuna like species so swordfish (Xiphias gladius) and marlin (Istiophoridae) are caught by foreign fleet. Landings are undertaken outside the country so it is difficult to sample on landings or to have an observer program. Swordfish and marlin are caught in small quantities by recreational and sport fishing. It is planned in SWIOFP project component 4 (pelagics) to start an observer program to get information on species composition and biological characteristics of the main tuna species.*"

81. The WPB **RECOMMENDED** that sports fishery and other recreational fishery catches taken from Mozambique waters should be reported to the WPB in 2012.

India longline fishery: Indo-Pacific sailfish

82. The WPB **NOTED** paper IOTC–2011–WPB09–26 which provided an overview of the distribution, abundance and biology of Indo-Pacific sailfish in the EEZ of Indian EEZ, including the following abstract provided by the authors:

    "*The tuna long line survey results in the Indian EEZ around Andaman and Nicobar waters shows that tunas, billfishes and sharks are the three major groups of fishes caught in the longline gears. Among them the average annual landings of bill fish is 232 tonnes. Among the bill fishes the Indo pacific sail fish, Istiophorus platypterus has appreciable importance in Andaman waters. The sailfishes are exclusively the by-catches of tuna fishery as there is no aimed commercial fishery exists for the species in the Island groups. Although a by catch sailfishes are of considerable economic value. Very limited work has been done on the distribution and biological aspects of the species. Hence an attempt has been made in the present paper to study the distribution pattern, abundance and some biological aspects such as lengthy frequency, length weight, sex ratio, maturity and spawning and food and feeding habits of the species by analyzing the longline data collected onboard MFV Blue Marlin during the period 2000-2010. The study indicates that the dominant length group for male and female were 161-180cm and 181-200 cm(fork length) respectively. The male to female sex ratio was 1:0.89. The length weight relationship computed for males was* $W = 0.00008\ L^{2.40}$*, r = 0.96 and for females,* $W = 0.0002\ L^{2.23}$*, r= 0.97. The pooled data shows the relationship as* $W = 0.00011\ L^{2.34}$ *, r= 0.96 . Four stages of maturity were recorded for the species viz. immature, maturing, mature and spent. The spawning occurs between December to June with a peak in February and June. The food and feeding study indicated the dominance of two major groups, i.e. cephalopods and teleost fishes in the gut. For male the cephalopods constituted 49% followed by teleost fishes 43% whereas for female the teleost fishes constituted 44% followed by cephalopods(39%).*"

83. The WPB **AGREED** that the biological information collected for Indo-Pacific sailfish and presented to participants was some of the first for this species in the Indian Ocean and where appropriate, should be incorporated into the resource Executive Summary, and published in a peer reviewed journal for wider dissemination.

84. The WPB **RECOMMENDED** that Indian scientists continue to carry out new and innovative research on billfish species, and to report findings to each WPB meeting.

85. The WPB **RECOMMENDED** that as a matter of priority, the IOTC Secretariat liaise with India, Oman, Indonesia, Philippines and Malaysia in order to improve the quality of the data reported from their longline fleets, by species, and to report back to the WPB at its next meeting.

Indonesian longline fishery

86. The WPB **NOTED** paper IOTC–2011–WPB09–27 which provided an overview of the species composition and size distribution of billfish caught by Indonesian tuna longline vessels operating in the Indian Ocean, including the following abstract provided by the authors:

    "*Billfish is generally considered as by-product in tuna long line fleets. About 871 Indonesian tuna long line vessels are fishing in the Indian Ocean. The fishing base of those fleets located in Bungus (West Sumatera), Muara Baru (Jakarta), Palabuhanratu (West Java), Cilacap (Central Java), Muara Baru (Jakarta), and Benoa (Bali). Base on the data of port sampling by enumerator and onboard observation by observer in the year of 2010 in Benoa, catch composition of billfish caught by tuna long line fleets were swordfish 54.89%, blue marlin 17.76% and black marlin 12.97% respectively, followed by small amount of striped marlin, sailfish, and shortbill spearfish. The length size distribution of swordfish 68–197 cm, black marlin and blue marlin 108–206 cm, striped marlin 95 – 158 cm, sailfish 114–175 cm and shortbill spearfish 124–127cm.*"

87. The WPB **NOTED** the difficulties faced by Indonesian scientists and managers in terms of commercial catches being transhipped at sea and highlighted the need for logbooks to be utilised on all commercial fishing vessels, noting that this is already a mandatory requirement.

88. The WPB **NOTED** that the IOTC Secretariat had undertaken a review of historical Indonesian nominal catch series data that resulted in substantial revisions to the series.

89. The WPB **RECOMMENDED** that the IOTC Secretariat send a mission to Indonesia to assist in the reporting of catch-and-effort data and to report progress to the WPB at its next meeting.

Sri Lankan billfish fisheries

90. The WPB **NOTED** paper IOTC–2011–WPB09–28 which provided an overview of the activities of the Sri Lankan fisheries targeting billfish, including the following abstract provided by the authors:

> "*Sri Lanka is one of the oldest and most important large pelagic fish producing, mostly tuna producing island nations in the Indian Ocean. Apart from tuna, billfish, sharks and seer fish are caught mostly within the EEZ of Sri Lanka as well as in high seas. The third largest group of fish reported in the large pelagic fish production in Sri Lanka is the billfish which include three species of marlins, one species of sailfish and one species of sword fish. The three species of Marlins dominates the billfish catch, followed by sailfish. Although billfish are not normally targeted species, they are very common in offshore gillnet and longline catches and are considered as by-catch species. Total billfish production in Sri Lanka in 2010 was 12440 Mt and this is around 10% of the total tuna and tuna like fish production. Relatively higher proportion of billfish is being caught using gillnet-longline gear combination. With the development of the offshore fishery, the contribution of billfish to the marine fishery became significant, and the catch has increased over the years highlighting their importance especially in the large pelagic/offshore fishery in Sri Lanka. Over the last five years, around 65% of the total catch has come from the offshore fishing vessels.*"

91. **NOTING** that to date, Sri Lanka has been unable to provide accurate statistics for billfish species to the IOTC, due to poor species identification and low levels of sampling coverage for its coastal and offshore fisheries;

92. The WPB **RECOMMENDED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission, including:
    - catches sampled 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.

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

93. The WPB **RECOMMENDED** that the IOTC-OFCF Project assist Sri Lanka to strengthen sampling efforts on its coastal and off-shore fisheries in late 2011, where required.

94. The WPB **RECOMMENDED** that billfish catches by Sri Lankan vessels, by gear and location, as per IOTC requirements, be presented at the next WPB meeting.

Indian Ocean Swordfish Stock Structure project (IOSSS)

95. The WPB **NOTED** paper IOTC–2011–WPB09–Inf05 which provided an overview of the Indian Ocean swordfish stock structure (IOSSS) project, including the following abstract provided by the authors:

> "*From 2009 to 2010, dedicated scientific at sea campaigns and national observers programs allowed measuring 5520 swordfishes caught by pelagic long liners (1645 in 2008, 2026 in 2009 and 1840 in 2010), collecting 2535 genetics samples (1263 in 2009 and 1272 in 2010), 1682 gonads, 515 isotopes samples, 305 stomach contents and 665 otoliths from 12 large areas in the IO and bordering Oceans. Samples collection and genetic laboratory procedures were done under a Quality Process in order improve data*

quality and reliability. Based on Bradman et al (2011) paper that showed differences between Seychelles and Timor and Coral Sea (Pacific Ocean) using ND2 mtDNA marker, we used ND2 (N=1544) along with 19 microsatellites loci (N=1690) to analyze the first set of IOSSS genetic sample from 11 separated areas in the IO and West Pacific. First results indicate a high genetic variability for all markers within all sites sampled which was expected for such a large and migratory pelagic fishes and we have not uncovered strong evidences of population differentiation based on the markers we have used. However, some structure does appear in the edge of IOTC competence area, in the SW of the SWIO (influence of Atlantic stock?) and in the NE of the IO. Further investigation using the all set of samples collected (N=2535) will be done in 2011. The most interesting results are to come now under IOSSS project as a stronger structure could be hidden by a sex and seasonal effect within the IO. Based on our strong spatio-temporal sampling stratification, we plan now to investigate if some differences according to sex and sampling season (during and out of the spawning season) do exist in the IO."

96. The WPB **NOTED** that the results of the IOSSS project are preliminary and possibly suggest some structure does appear in the edge of IOTC area of competence.

97. The WPB **NOTED** that project scientists intended on finalising project results by the end of 2011, and requested that the final report be provided to the IOTC Scientific Committee for its consideration.

98. The WPB **NOTED** that there is a gap in sampling coverage of the IOSSS project, for the northwest area of the Indian Ocean, and that obtaining samples from this area remains a high priority.

Portuguese longline fishery

99. The WPB **NOTED** paper IOTC–2011–WPB09–Inf06 which described the historical activities of the Portuguese longline fishery operating in the Indian Ocean since the early 1990's, including the following abstract provided by the authors:

"*The Portuguese longline fishery has operated in the Indian Ocean since the early 1990's. This paper included a summary of gear configuration aspects and shifts, the evolution of the active fleet and annual reported catches for swordfish and the remaining billfishes. An explanation was made on the current revision of historical data about this fishery, which involves revisiting the official logbooks, the collection of VMS data and the access to skippers' personal logbooks (provided on a voluntary basis). This collection of new and old data, will allow a revision of historical catches, and accomplish data reporting to IOTC, namely in terms of catch and effort distribution overtime and size data for a number of species (namely swordfish). Finally, it was presented the data collection of current fishing activities, which involves onboard observers and the implementation of a self-sampling system based on a specially prepared logbook.*"

100. The WPB **NOTED** that in mid-2005 there was a switch in targeting by Portuguese longline vessels from swordfish to sharks, and that the use of wire trace was a clear indication of targeted shark fishing activity.

101. The WPB **NOTED** that billfish catches reported to the IOTC Secretariat by EU,Portugal have previously shown high levels of variability (ratio SWO:BIL), and that validation procedures were in place to improve accuracy.

102. The WPB **RECOMMENDED** that EU,Portuguese scientists undertake a CPUE analysis for the EU,Portuguese longline fleet, and to consider combining the analysis with catch-and-effort data from the EU,Spanish longline fleet for the next WPB meeting.

La Réunion longline fishery

103. The WPB **NOTED** paper IOTC–2011–WPB09–INF11 which described swordfish catches collected during commercial operations and research cruises onboard pelagic longliners of the La Reunion fleet from 2006 to 2010, including the following abstract provided by the authors:

"*Fisheries data used to analyse status of an exploited marine resources are considered as "visible face" of catch, which is manifesting through landings (commercial catches). However an "invisible face" of catch such as non-commercial retained catch and discards might significantly affect stock assessments. For the pelagic longline fishery based at Reunion Island certain number of swordfish individuals are often non-commercialized (undersized individuals retained for self-consumption) or discarded due to small size, damage by toothed whales and sharks (depredation). We analyse an impact of the "invisible face" of swordfish catch on both commercial CPUE values and the size frequency distribution of retained catch. We analyse catch data collected onboard by scientific observers in the frame of the data collection framework (DCF) program (SEALOR program, Bach et al., 2008) from October 2006 to September 2010. Fishing sets are distributed in the South West Indian Ocean (SWOI) and mostly located around Reunion Island, the east coast of Madagascar and off the southern tip of Madagascar, reflecting geographic distribution of the Reunion-based longline fleet. Global data analysis shows that nominal CPUE is about 30% higher than commercial CPUE: 10 ind./1000 hooks and 6.9 ind./1000 hooks respectively. Therefore at a global scale non-commercialised catch and discards (mostly associated with depredation) would lead to an underestimate of nominal swordfish CPUE at about 3 ind./1000 hooks. However this value varies in relation with spatial and temporal distribution of the fishery. Therefore further in depth analysis are necessary to improve the accuracy estimates of the impact of cryptic mortality on actual and commercial nominal and standardized CPUE values. Swordfish individuals less than 100 cm LJFL (lower jaw – fork length) are usually not landed (retained for self-consumption or discarded dead or alive). This has as consequence a left-truncated length frequency distribution (LFD), which might introduce a visible bias on selectivity curves. This part of "undersized" individuals is highest during the first semester of the year (~30%) decreasing to ~5% during the second part. In addition depredation is a common cause of right-truncated LFD in certain periods. Again further in depth analysis must be implemented to quantify accurately the deformation of LFD obtained from landings sampling. Observations onboard fishing vessels are one of the best ways to assess the impact of the "invisible face" of catches on stock status. We believe that CPC's countries must be encouraged and supported to implement their national observer program (NOP).*"

Other new information

104. The WPB **NOTED** the other information papers provided to the meeting, as detailed in IOTC–2011–WPB09–02.

8. REVIEW OF NEW INFORMATION ON THE STATUS OF BILLFISH

8.1 Stock status indicators for marlins and sailfish – Istiophorids:

105. The WPB **NOTED** paper IOTC–2011–WPB09–12 which provided a CPUE standardization of blue marlin (*Makaira mazara*) caught by the Taiwan,China longline fishery in the Indian Ocean, including the following abstract provided by the authors:

"*This study attempts to the standardize CPUE of blue marlin caught by Taiwanese longline fleet in the Indian Ocean using generalized linear model (GLM). Based on the distributions of catch made by Japanese and Taiwanese longline fleets, CPUE of Taiwanese fleet and number of years of catching blue marlin by Taiwanese fleet, six fishing areas are defined for blue marlin in the Indian Ocean. However, there are large amount missing data occur in the northern Indian Ocean before early 1990s and thus four aggregated fishing areas also used to exam the influence of fishing area definition on CPUE standardization. The results reveal similar trends of CPUE standardized based on three combinations of fishing areas definitions and data period. There are no obvious trends for CPUEs in the northwestern and southeastern Indian Ocean, while standardized CPUEs reveal decreasing patterns for other areas. The area-aggregated standardized CPUE reveals three phases: sharply decreased during 1984-1990;*

increased gradually during during1991-2002; decrease gradually during 2002-2007. In recent two years, CPUEs obviously increased in most areas."

106. The WPB **AGREED** that there are no obvious trends for standardised CPUE series in the northwestern and southeastern Indian Ocean, while decreasing trends were apparent in other areas of the Indian Ocean.

107. The WPB **AGREED** that the standardised CPUE for the whole Indian Ocean suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years. However, it was also noted that this contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s.

108. The WPB **RECOMMENDED** that marlins and sailfish undergo CPUE analysis in 2012, with striped marlin taking priority over other species.

109. The WPB **RECOMMENDED** that as a matter of priority, striped marlin be the subject of CPUE analysis in 2011, and that CPUE series be compared among fleets where possible.

8.2 Stock status indicators and stock assessments for swordfish – Xiphias gladius:

Catch-per-unit-effort

110. The WPB **NOTED** papers IOTC–2011–WPB09–13 and IOTC–2011–WPB09–INF04 which provided a review of CPUE issues for the 2011 Indian Ocean swordfish stock assessment, including the following summary provided by the authors:

"*This discussion paper for the informal CPUE workshop immediately prior to the WPB described a number of inter-related issues:*

- *There remains uncertainty about the appropriate spatial units for the CPUE standardization. These issues should be reconsidered at a future date (after the IOSSS results are available).*
- *Trends in standardized 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 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 standardization 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 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-parameterized models in simulation studies.*"

111. The WPB **NOTED** that many of the issues identified in paper IOTC–2011–WPB09–13 were progressed intersessionally and in the informal CPUE workshop held immediately prior to the WPB meeting.

112. The WPB **AGREED** that further progress might be made in a dedicated CPUE workshop, possibly coordinated under the IOTC Methods Working Group, as the same issues are relevant for most of the main species.

Japanese longline CPUE

113. The WPB **NOTED** paper IOTC–2011–WPB09–14 which provided an estimation of the Abundance Index of swordfish in the Indian Ocean based on the fine scale catch and effort data of the Japanese tuna longline fisheries (1980–2010), including the following abstract provided by the authors:

“*We attempted to standardize Japanese longline swordfish nominal CPUE based on the fine scale catch and effort data (set by set). Results suggested that the abundance index (AI) were high level in 1980 to 1997 and decreased rapidly to 2005 then increased sharply to 2010 and recovered to the lower range of the previous high level (1980-1997). At the initial analyses we used anomalies of ENV data as suggested by Kolody (2010) and Nishida (2010). However all ENV data are not sensitive at all (non significant) in the GLM analyses. Thus we re-used the original ENV data as in the past then we found that the a few ENV (moon phase, thermocline depth and temperature gradient at 45m depth) suggested significant effects. This demonstrates effectiveness and importance of some environmental data in the GLM. In addition it was also resulted that V (vessel) affected nominal CPUE which implied that there were different levels of catchability among vessels due to the skipper's skills. From STD CPUE by region we observed good recovery trends in recent years in the southern IO (SW and SE regions), while the steady trends in Northern IO (NE and NW). These recoveries are probably due to much less fishing pressure in recent 3-4 years than before because of the pirate problems in the large part of the western Indian Ocean.*”

114. The WPB **NOTED** paper IOTC–2011–WPB09–15 which provided an investigation of the sharp drop of swordfish CPUE of Japanese tuna longline fisheries in 1990's in the southwest Indian Ocean, including the following abstract provided by the authors:

“*To elucidate the causes of the sharp drop of Japan LL CPUE in the SW IO area, we investigated following 6 points, i.e., (1) to see if the decreases are different between CPUE in no. vs. weight, (2) to see if the sharp decrease patterns in SW are observed in other regions, (3) to see if the decrease in SW are different in 2 types of resolution of CPUE between 1x1 (fine scale) and 5x5 (coarse), (4) to see if CPUE are robust during the sharp drop period in the SW IO, (5) to see if CPUE in other countries show the sharp decrease in the SW and (6) to see other factors (ENV, targeting q and others) affect the decrease. Results of all investigation showed the consistent decrease of JPN CPUE in 1990's in the SW IO including other CPUE in Spain, Taiwan and La Reunion. Furthermore Japan had large catch and effort in the same period when there was a big CPUE drops in 1990's, which implies that CPUE in that period is robust thus realistic. As a conclusion, the sharp drop is considered to be realistic but we don't know which steepness among different degrees of decrease (drop) is the real one.*”

Taiwan,China CPUE

115. The WPB **NOTED** paper IOTC–2011–WPB09–16 which provided a CPUE standardisation of swordfish caught by Taiwan,China longline fishery in the Indian Ocean, including the following abstract provided by the authors:

“*This study carried out the CPUE standardization of swordfish caught by Taiwanese longline fishery in the Indian Ocean for 1995-2009 using generalized linear model (GLM) and generalized additive model (GAM). Including the effect of vessel and the effect of NHBF treated as categorical variable obviously improved the values of R^2, AIC and BIC. Although there were obvious peaks in 2002, the area-specified and area-aggregated standardized CPUEs all reveal gradually decreasing patterns since 1995. The trends of CPUEs standardized by GAM are similar to those standardized by GLM but reveal much smoother patterns. This study also performed GLM by incorporating the* *effects of longitude and latitude and the standardized CPUE trends are similar to other cases. As the suggestion of the working party, the results of GLM with the effect of longitude and latitude are selected as the CPUE series for stock assessment analysis.*"

Spanish longline CPUE

116. The WPB **NOTED** paper IOTC–2011–WPB09–23 which provided standardised catch rates for swordfish caught by the EU,Spain longline fleet in the Indian Ocean during the period 2001–2010, including the following abstract provided by the authors:

"*Standardized catch rates in weight were updated using General Linear Modelling (GLM) procedures from scientific records of the Spanish surface longline targeting swordfish in the Indian Ocean over the period 2001-2010. Twelve runs were tested using different models and area-time definitions. The main factors used for modelling were year, area, time, gear style and ratio, among other options tested (blue shark catch). The models explained up to 53% of the CPUE variability and the trends over time of the standardized catch rates obtained for the different models and area-time definitions are very consistent among them. The highest CPUE values was predicted in all Indian Ocean runs for the year 2003. A decline was predicted until 2007, followed by an increase until 2010, with values which almost reached the highest level predicted for 2003. The analyses restricted to the SW regions, including some runs for a possible area closure, are also consistent among them, suggesting a slighter decrease during the first period and a important increase during the second period.*"

CPUE Summary discussion

117. The WPB **NOTED** that progress had been made on the following issues related to CPUE standardisation prior to the WPB09:
    - Fixed spatial effects by latitude and longitude were added to Japan and Taiwan,China analyses. These were found to be powerful explanatory variables that account for some of the problems associated with shifting effort distributions within the large heterogeneous regions in the analysis.
    - Hooks Between Floats was changed from a continuous to a categorical variable for the Taiwan,China fleet.
    - The steep Japan CPUE decline in the southwest in the 1990s was examined. The decline was confirmed among the three Longhurst (biogeographic province) sub-regions within the southwest. Splitting the analysis into two time periods, (1980–1996 and 1993–2010) suggested that confounding with the change in mainline was not important. The declining trend did not appear to be associated with the environmental covariates. The rapid decrease appears to be a robust signal.
    - The conflicting recent (5 year) trend in the southwest CPUE was examined. The steep CPUE decline for the Taiwan,China CPUE (estimated in 2010) was recognized as an artifact of little effort in the core area analysis. The very steep increase observed in Japan CPUE had no obvious explanation, and conflicts with the trend observed in the EU,Spain and Taiwan,China series.
    - Additional work exploring the environmental effects on catch rates was pursued. An investigation into the reliability of the oceanographic data series was undertaken and as a result temperature and current are considered to be reliable, but salinity data should not be used until better estimates are available from the data assimilation models. Preliminary work using General Additive Models was explored for the Taiwan,China series, and it is recognized that this is useful for examining mechanisms and non-linear responses.

118. The WPB **RECOMMENDED** that a dedicated workshop on CPUE standardization, including issues of interest for other IOTC species should be carried out before the next round of stock

assessments in 2012, and that where possible it should include a range of invited experts (as agreed in para. 112).

119. The WPB **NOTED** that CPUE standardisation and stock assessments should be carried out well in advance of working party meetings in future years (see para. 153).

120. The WPB **AGREED** that the following CPUE series would be used in the stock assessment models for 2011 (shown in Figs. 23 and 24), while the relative weighting of the different CPUE series would be left to the individual analyst to determine and justify to participants:

- 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,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–WPB–03).

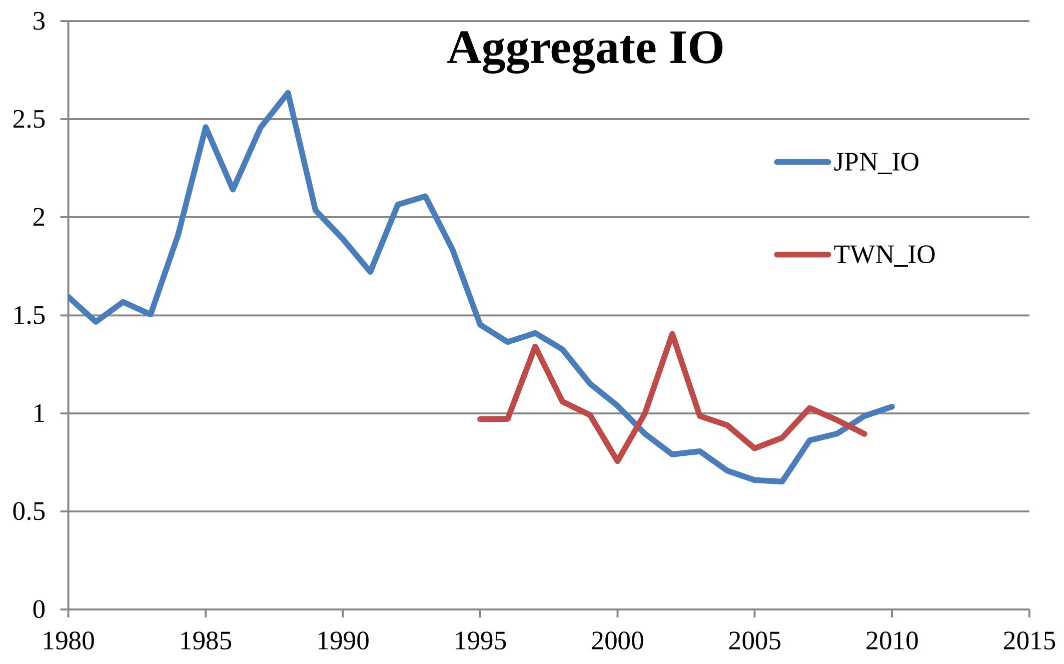


Fig. 23. Recommended CPUE series for Indian Ocean swordfish. Series have been rescaled relative to their respective means from 1995–2009.

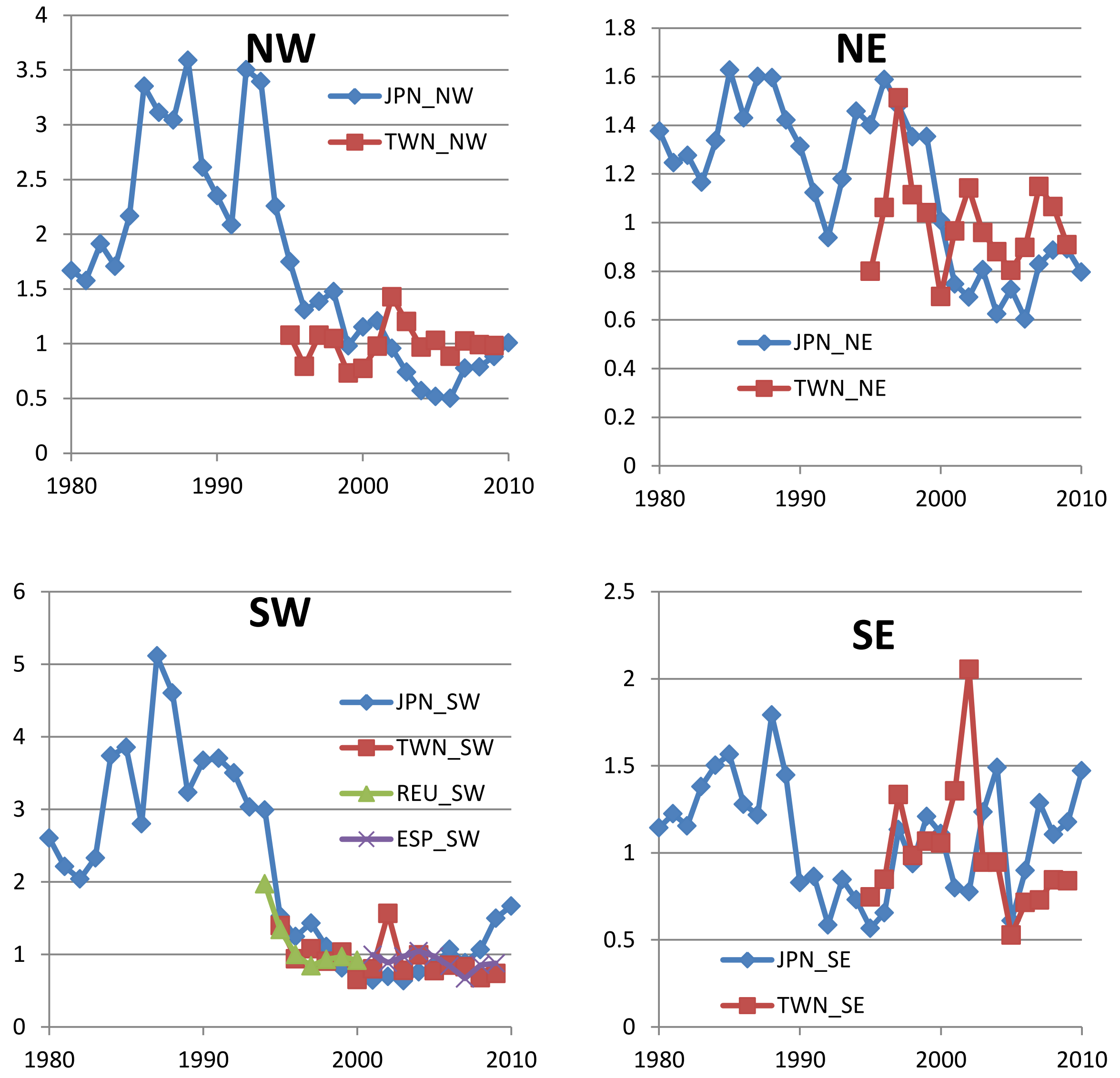


Fig. 24. CPUE series for Indian Ocean swordfish assessments by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods).

Stock assessment

121. The WPB **NOTED** that the stock structure of the Indian Ocean swordfish resource is under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions.

122. The WPB **NOTED** that a range of quantitative modelling methods 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 summarized in the sections below.

123. The WPB **NOTED** the value of comparing different modelling approaches. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a lot of uncertainties in basic swordfish biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to

represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, sometimes the ASPIC model can have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

124. The WPB **AGREED** that swordfish stock status should be determined by qualitatively integrating the results of the various stock assessments undertaken in 2011. The WPB treated all analyses as equally informative, and focussed on the features common to all of the results.

Summary of stock assessment models: swordfish

125. The WPB **NOTED** Tables 1 and 2 which provides an overview of the key features of each of the four stock assessment models used in 2011.

Table 1. Summary of final model features as applied to the Indian Ocean swordfish resource in 2011.

Model feature	SS3	ASPIC	BMAP	ASIA
Software availability	NMFS toolbox	NMFS toolbox	Private	Private
Population spatial structure / areas	4	1	1	1
Number CPUE Series	10	1	4	10
Uses Catch-at-length	Yes	No	No	Yes
Age-structured	Yes	No	No	Yes
Sex-structured	12	1	1	no
Number of Fleets	12 (effectively 8)	1	1	18
Stochastic Recruitment	Yes	No	No	Yes

Table 2. Summary of final model features as applied to the southwest Indian Ocean swordfish resource in 2011.

Model feature	SS3	ASPIC	BMAP	ASIA
Software availability	NMFS toolbox	NMFS toolbox	Private	Private
Population spatial structure / areas	4	1	1	1
Number CPUE Series	10	1	3	10
Uses Catch-at-length	Yes	No	No	Yes
Age-structured	Yes	No	No	Yes
Sex-structured	Yes	No	No	No
Number of Fleets	6 (effectively 2)	1	1	4
Stochastic Recruitment	Yes	No	No	Yes

Stock Synthesis (SS3)

126. The WPB **NOTED** paper IOTC–2011–WPB09–17 which describes an assessment of the aggregate Indian Ocean and southwest swordfish (*Xiphias gladius*) fishery using *Stock Synthesis 3* (SS3) software, including the following summary provided by the authors:

"*The approach uses a highly disaggregated model to integrate several sources of fisheries data and biological research into a unified framework. Core assumptions in the Indian Ocean analysis included:*

- *The population is age- and sex-structured (dimorphic growth), iterated on an annual time-step from 1952-2009 (with constant catch projections to 2019) and spatially disaggregated into 4 areas.*
- *There are 12 fisheries, each assigned to a single area and one of two (pseudo-) length-based selectivity functions: i) longline and ii) gillnet/other. The 'double normal' selectivity function was assumed for both, with flexibility to estimate a dome or logistic shape.*

- *Total recruitment follows a Beverton-Holt relationship, with annual log-normal deviates (in most models) and temporal variability in the proportional distribution of recruits among regions.*
- *Japanese LL CPUE catchability was shared among areas.*
- *The model was fit to 10 CPUE-based relative abundance indices (4 Japanese by area, 4 Taiwanese by area, Reunion and Spain in the SW region) and catch-at-length data from 8 fleets.*
- *Estimated parameters included virgin recruitment, selectivity functions, recruitment deviations, catchability coefficients, and the spatial pattern of recruitment.*
- *Fixed parameters included: stock recruit steepness, variances on recruitment and CPUE errors, life history parameters describing growth, M, maturity schedule. While these values were fixed for any specific model fitting, alternative combinations of fixed parameters were used as described below.*

The SS3 southwest assessment was similar to the Indian Ocean assessment, but with the following main differences: no spatial structure; 6 fisheries; fixed selectivity for the gillnet fleet; 4 CPUE series and 4 catch-at-length series.

The assessments attempted to describe the sensitivity, interactions and uncertainty associated with: i) a number of somewhat arbitrary model assumptions, and ii) key parameters that are known to be difficult to estimate reliably (e.g. steepness). The models with stochastic recruitment tended to fit all of the CPUE series reasonably well, except for TWN in the NW. The size composition data from the EU and semi-industrial fleets in the SW fit very well, while the TWN and JPN fits were somewhat biased in all regions. Estimated biomass differs substantially by region over time, and this is strongly influenced by recruitment variability (in addition to fishery depletion). In total, 243 models were fit for the Indian Ocean, and 324 for the southwest. Stock status estimates were derived from a synthesis of results. Weighting of models was based on qualitative inferences from i) general life history theory, ii) observations from similar populations, and iii) evaluation of the impact of each data source in the model, given the quality and expected information content of the data. Stock status in both cases is clearly sensitive to steepness, and growth/mortality assumptions. In both cases, there was a high probability that $SSB_{2009}>SSB_{MSY}$ and $F_{2009}<F_{MSY}$. However, there was some probability that these reference points were exceeded, and the SW was estimated to be more depleted than the aggregate IO."

127. The WPB **NOTED** the key Stock Synthesis 3 (SS3) assessment results as shown below (Tables 3, 4 and 5; Figs. 25 and 26).

Table 3. Key management quantities from the Stock Synthesis 3 assessments, for the aggregate and southwest Indian Ocean. Values represent the 50th (5th–95th) percentiles of the (plausibility-weighted) distribution of maximum posterior density estimates from the full range of the models examined.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2009 catch estimate (1000 t)	21.5	6.6
Mean catch from 2005–2009 (1000 t)	26.4	7.8
MSY (1000 t)	31 (20– 55)	9.4 (6.5–13.5)
Data period used in assessment	1951–2009	1951–2009
F_{2009}/F_{MSY}	0.50 (0.23–1.08)	0.64 (0.27–1.27)
B_{2009}/B_{MSY}	–	–
SB_{2009}/SB_{MSY}	1.59 (0.94–3.77)	1.44 (0.61–3.71)
B_{2009}/B_0	–	–
SB_{2009}/SB_0	0.35 (0.22–0.42)	0.29 (0.15–0.43)
$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

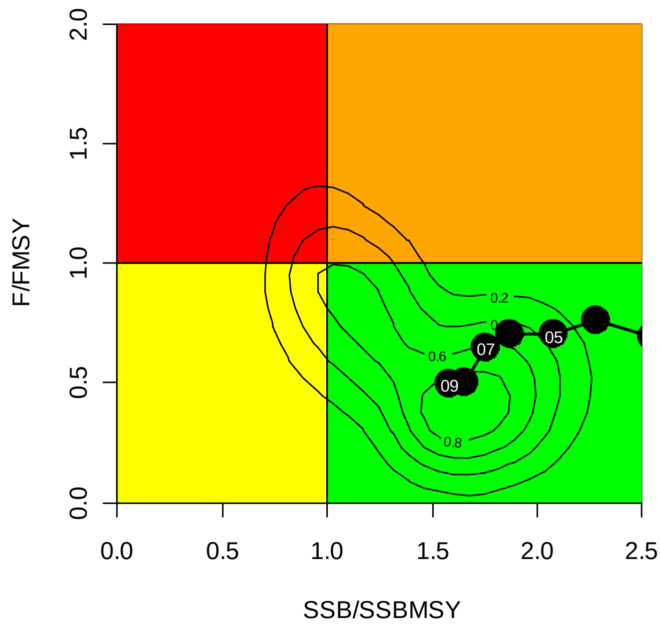


Fig. 25. SS3 Aggregated Indian Ocean assessment Kobe plot. Black circles indicate the trajectory of the median of the weighted combination of models. Contours represent the smoothed probability distribution for 2009 (isopleth units are probability relative to the maximum).

Table 4. SS3 Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage of weighted model maximum posterior densities) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) summarised for 3 and 10 years into the future.

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and probability (%) of violating reference point				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	4	8	11	12	15
$F_{2012} > F_{MSY}$	<1	2	9	16	27
$B_{2019} < B_{MSY}$	4	8	11	13	21
$F_{2019} > F_{MSY}$	<1	2	9	23	31

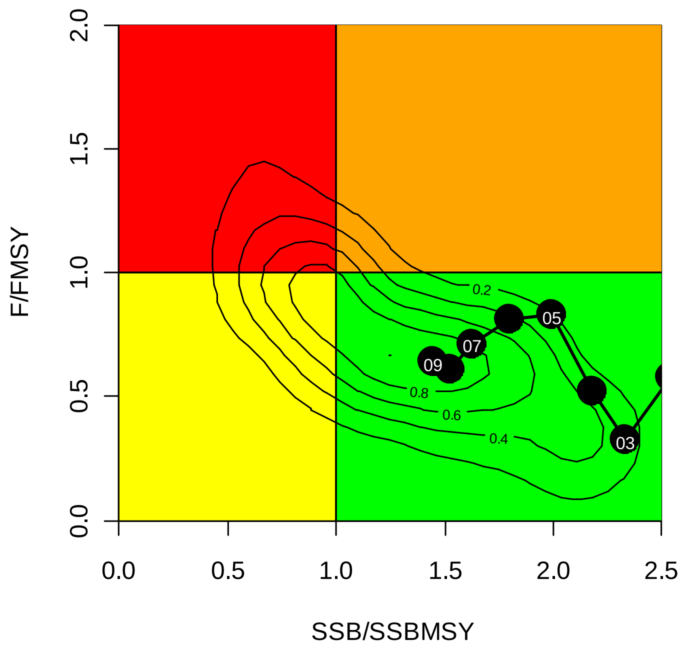


Fig. 26. SS3 Southwest Indian Ocean assessment Kobe plot. Black circles indicate the trajectory of the median of the weighted combination of models. Contours represent the smoothed probability distribution for 2009 (isopleth units are probability relative to the maximum).

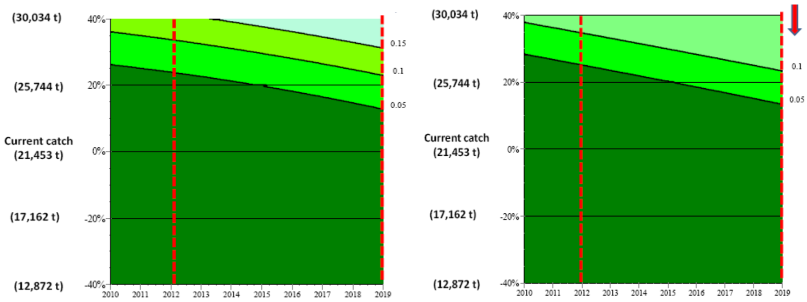
Table 5. SS3 Southwest Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage of weighted model maximum posterior densities) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years into the future.

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and probability (%) of violating reference point				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	15	20	25	30	32
$F_{2012} > F_{MSY}$	<1	5	8	18	34
$B_{2019} < B_{MSY}$	15	20	25	32	34
$F_{2019} > F_{MSY}$	<1	5	8	18	42

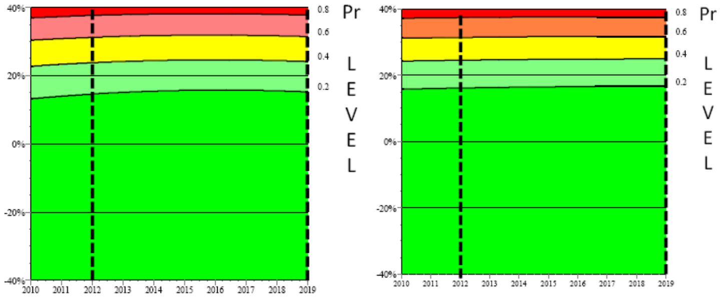
Age-aggregated production model (ASPIC)

128. The WPB **NOTED** paper IOTC–2011–WPB09–18, and IOTC–2011–WPB09–18_rev1 which provided a stock assessments and MSE risk analyses (Kobe II) of swordfish in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC), including the following abstract provided by the authors:

“*We conducted the stock assessment of swordfish (Xiphias gladius) in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC) for 30 years (1980-2009). The ASPIC analyses suggest that the current status of IO SW and the whole Indian Ocean are in the yellow zone in the Kobe plot (but close to borders of both Fmsy and TBmsy) and the green zone (but close to TBmsy) respectively. Recent low catch and fishing efforts of tuna (SWO) longliners due to the pirate problems in the western Indian Ocean probably provide positive effect to recover the IO SWO stocks*.



Graphic representations of the Kobe II strategy matrices (left: total biomass and right: F). The Y-axis represents the level of catch, 0% being the current situation (2009). Color represents probabilities of the risks expecting to be more than MSY levels.



Graphic representations of the Kobe II strategy matrices (left: total biomass and right: F). The Y-axis represents the level of catch, 0% being the current situation (2009). Color represents probabilities of the risks expecting to be more than MSY levels."

129. The WPB **NOTED** the key assessment results for the Age-aggregated production model (ASPIC) as shown below (Tables 6, 7 and 8; Figs. 27 and 28).

Table 6. Key management quantities from the ASPIC assessment, for the aggregate and southwest Indian Ocean.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2009 catch estimate (1000 t)	21.5	6.6
Mean catch from 2005–2009 (1000 t)	26.4	7.8
MSY (1000 t) (80% CI)	29.9 (28.7–30.9)	8.6 (8.2–8.9)
Data period used in assessment	1980–2009	1980–2009
F_{2009}/F_{MSY} (80% CI)	0.63 (0.54–0.74)	0.85 (0.73–1.05)
B_{2009}/B_{MSY} (80% CI)	1.21 (1.06–1.36)	0.97 (0.79–1.12)
SB_{2009}/SB_{MSY}	–	–
B_{2009}/B_0 (80% CI)	0.53 (0.41–0.67)	0.58 (0.40–0.77)
SB_{2009}/SB_0	–	–
$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

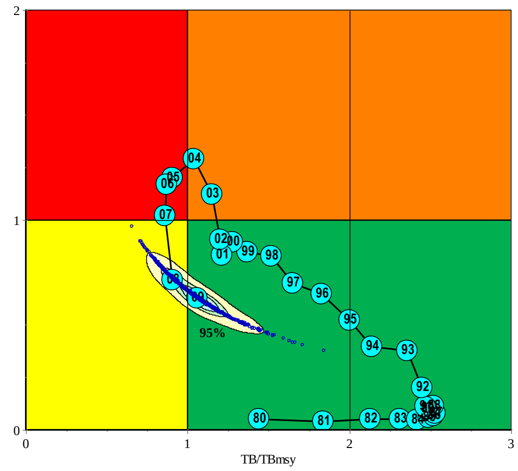


Fig. 27. ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the historical trajectory.

Table 7. ASPIC Aggregated Indian Ocean assessment Kobe II Strategy Matrix. 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%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0	0	0	12	12
$F_{2012} > F_{MSY}$	0	0	0	0	13
$B_{2019} < B_{MSY}$	0	0	0	0	26
$F_{2019} > F_{MSY}$	0	0	0	0	28

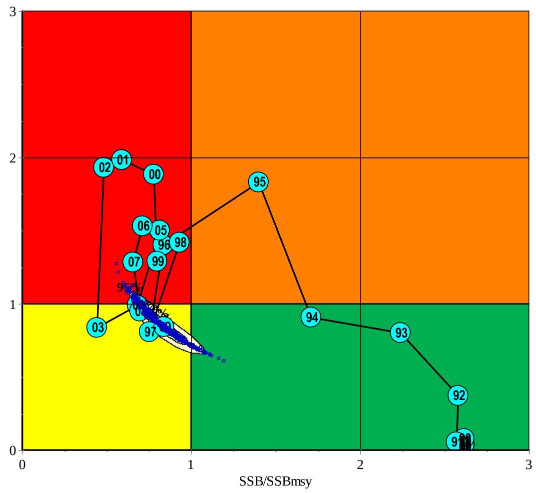


Fig. 28. ASPIC Southwest Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate historical the trajectory.

Table 8. ASPIC Southwest Indian Ocean assessment Kobe II Strategy Matrix. 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%	80%	100%	120%	140%
$B_{2012} < B_{MSY}$	0	0	0	0	12
$F_{2012} > F_{MSY}$	0	0	0	0	13
$B_{2019} < B_{MSY}$	0	0	0	0	27
$F_{2019} > F_{MSY}$	0	0	0	0	28

Production models based on the Bayesian averaging method (BMAP)

130. The WPB **NOTED** paper IOTC–2011–WPB09–19 which provided a stock assessment of the Indian Ocean swordfish by production models based on the Bayesian averaging method BMAP, including the following abstract provided by the authors:

“*Advanced age-structured models and synthesis analyses are getting common in the fishery stock assessment, but these are sometimes sensitive to assumptions made. Meanwhile, simple and traditional production models such as Schaefer and Fox models require a few assumptions and therefore they inherently tend to be robust. This is an important feature when not so much information/data are available for a target stock, in which cases even selection of a better production model has uncertainty to some extent. The paper WPB09-19 attempted model averaging to address the model uncertainty. Among possible procedures of such an attempt, Bayesian model averaging is employed. The posterior probabilities of models, which are used as weights to respective models, are derived through an Importance Sampling (IS) method while the parameter estimates are derived via a Sampling and Importance Resampling (SIR). The results for the whole Indian Ocean showed that the stock is in a state of healthy. The estimated MSY was 30.77 (SE=0.880), which is greater than those in recent a couple of years. However, the results in the putative stock in the SW region suggested that the point estimate of the Bratio in 2009 against Bmsy is less than 1 and the current depletion level is less than 40%. Given this situation, the catch level should not be increased in sense of avoid any risks. The authors noted the method can be extended to catch-at-age or length-at-age analyses and continue their efforts to develop them.*”

131. The WPB **NOTED** the assessment results for the production models based on the Bayesian averaging method BMAP as shown below (Tables 9, 10 and 11; Figs. 29 and 30).

Table 9. Key management quantities from the production models based on the Bayesian averaging method (BMAP), for the aggregate and southwest Indian Ocean.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2009 catch estimate (1000 t)	21.5	6.6
Mean catch from 2005–2009 (1000 t)	26.4	7.8
MSY (1000 t)	31 (SE=0.88)	7.9 (SE=0.20)
Data period used in assessment	Catch:1950–2009 CPUE:1980–2009	Catch:1954–2009 CPUE:1980–2009
F_{2009}/F_{MSY}	0.615 (SE=0.053)	0.884 (SE=0.071)
B_{2009}/B_{MSY}	1.073 (SE=0.090)	0.942 (SE=0.071)
SB_{2009}/SB_{MSY}	–	–
B_{2009}/B_0	0.481 (SE=0.043)	0.375 (SE=0.028)
SB_{2009}/SB_0	–	–
$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

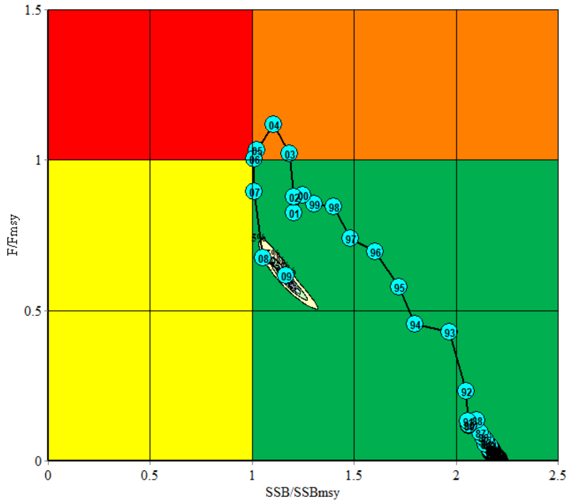


Fig. 29. BMAP Aggregated Indian Ocean assessment Kobe plot (95% Confidence intervals shown around 2009 estimate). Blue circles indicate historical trajectory.

Table 10. BMAP Aggregated Indian Ocean assessment Kobe II Strategy Matrix. 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%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0	0	<1	2	16
$F_{2012} > F_{MSY}$	0	0	0	<1	17
$B_{2019} < B_{MSY}$	0	0	0	<1	18
$F_{2019} > F_{MSY}$	0	0	0	<1	19

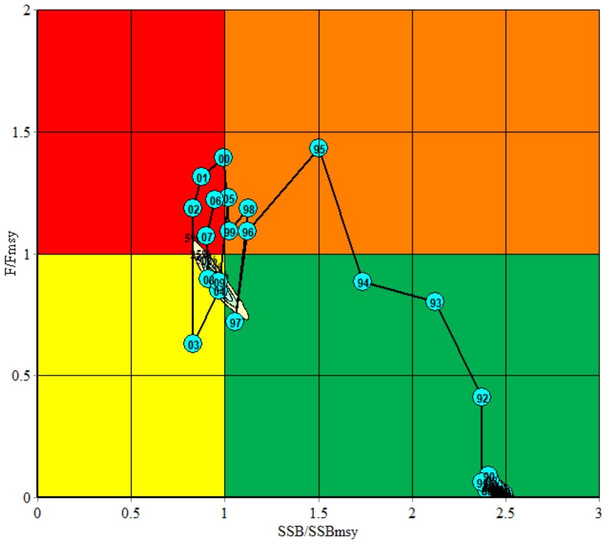


Fig. 30. BMAP Southwest Indian Ocean assessment Kobe plot (95% Confidence intervals shown around 2009 estimate). Blue circles indicate historical trajectory.

Table 11. BMAP Southwest Indian Ocean assessment Kobe II Strategy Matrix. 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%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	<1	8	26	57	92
$F_{2012} > F_{MSY}$	0	0	6	60	99
$B_{2019} < B_{MSY}$	0	0	3	61	100
$F_{2019} > F_{MSY}$	0	0	<1	61	100

Age-structured integrated analysis (ASIA)

132. The WPB **NOTED** paper IOTC–2011–WPB09–20 which provided an age–structured assessment model to swordfish in the Indian Ocean, including the following abstract provided by the authors:

"*This study evaluated the stock status of swordfish in the Indian Ocean based on the age-structured integrated approach (ASIA). Since local depletion occurred for swordfish in the southwestern Indian Ocean in recent years, this study also attempted to evaluate the status for the stock only in the southwestern Indian Ocean. Based on the results of this study, the current stock status for the entire Indian Ocean might not be overfishing or overfished though various results can be obtained from different assumptions of pre-specified biological parameters. However, most results indicated that the status of the stock in the southwestern region is probably not in a health condition but the assessment results are very sensitive to the assumption of the steepness of the stock-recruitment relationship. The stock status could shift from optimistic condition with a high reproductivity assumption to pessimistic condition with a low reproductivity assumption. Even with a 40% increase in catch, the results of projection analysis indicated that there is a very low probability of the spawning biomass dropping below* S_{MSY} *and the probability of the fishing intensity exceeding above* F_{MSY}*.*"

133. The WPB **NOTED** the assessment results for the Age-structured integrated analysis (ASIA) as shown below (Tables 12 and 13; Figs. 31 and 32).

Table 12. Key management quantities from the ASIA assessment, for the aggregate and southwest Indian Ocean.

Management Quantity	**Aggregate Indian Ocean**	**Southwest Indian Ocean**
2009 catch estimate (1000 t)	21.5	6.6
Mean catch from 2005–2009 (1000 t)	26.4	7.8
MSY (1000 t)	31 (SE=0.88)	7.9 (SE=0.20)
Data period used in assessment	1950–2009	1954–2009
F_{2009}/F_{MSY}	0.595	1.187
B_{2009}/B_{MSY}	1.177	0.823
SB_{2009}/SB_{MSY}	1.376	0.727
B_{2009}/B_0	0.420	0.299
SB_{2009}/SB_0	0.301	0.159
$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

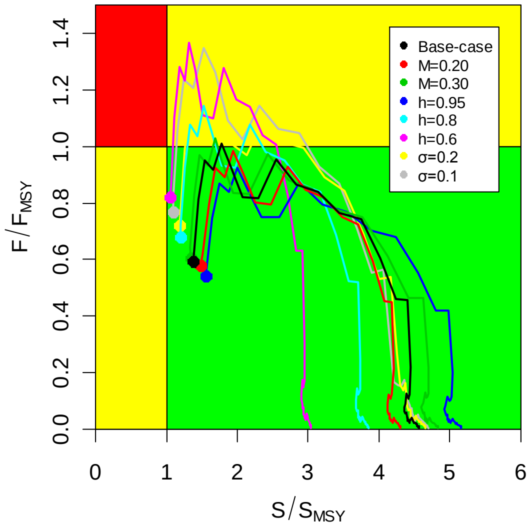


Fig. 31. ASIA Aggregate Indian Ocean assessment Kobe plot. Coloured lines indicate historical trajectory.

Table 13. ASIA Aggregated Indian Ocean assessment Kobe II Strategy Matrix. 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%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	<1	1	2	3	4
$F_{2012} > F_{MSY}$	0	0	<1	2	6
$B_{2019} < B_{MSY}$	0	0	<1	2	6
$F_{2019} > F_{MSY}$	0	0	<1	3	7

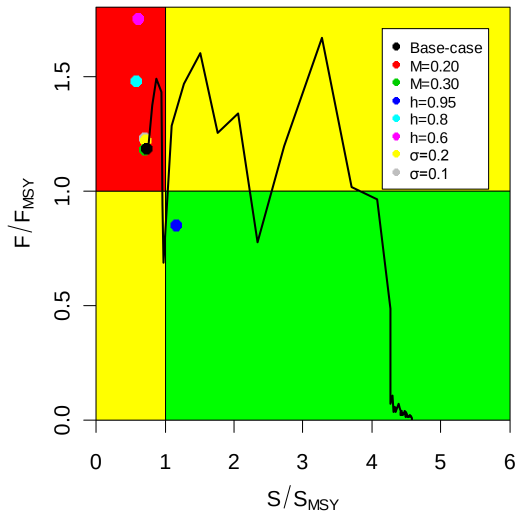


Fig. 32. ASIA Southwest Indian Ocean assessment Kobe plot. Black line indicates historical trajectory.

134. The WPB **NOTED** the following with respect to the various modelling approaches:

- There was more confidence in the abundance indices this year due to the additional CPUE analyses from Japan and Taiwan,China, and the addition of the EU,Spain series. This has led to improved confidence in the overall assessments and the southwest in particular.
- The southwest region should continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole. However the difference in depletion does not appear to be as extreme as analyses in previous years have suggested. A review of the spatial assumptions should be conducted following the final results of the IOSSS project.
- Further analysis is required on the appropriate way to use the size composition data in the integrated models. In particular, consideration of the large discrepancies between size composition data and mean weight data for Japanese and Taiwan,China fleets is needed.
- There is large uncertainty in swordfish growth rate estimates, and this has important implications for the integrated assessments. Most of these differences seem to be attributable to the interpretation of fin spine annulus counts, which have not been directly validated. Further information might be sought from growth increment data from the Atlantic tagging programs.
- It was recognised that the effects of depredation (at least from the southwest), and discarding should be examined in future analyses.
- It was recognised that the deterministic production models were only able to explore a limited number of modelling options. The structural rigidity of these simple models causes numerical problems when fit to long time series for some cases. It was suggested that truncating the catch and CPUE time series would allow more options to be explored. However, some participants of the WPB suggested that it would be more appropriate to consider the model rather than discarding potentially informative data (e.g. the generation time of swordfish is such that a relatively long time series is required to make inferences about productivity).
- It was noted that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses properly, and this could have a detrimental effect on the quality of advice provided by the WPB.

9. Develop Technical Advice on the Status of the Stocks

Swordfish

Indian Ocean stock – Management Advice

135. The WPB **AGREED** to the following management advice for swordfish in the Indian Ocean, for the consideration of the Scientific Committee;

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 14) of the unfished levels.

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 15).

136. The WPB **RECOMMENDED** that the Scientific Committee consider the following;

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 14) 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.

Table 14. Summary of (best point estimate) Aggregate Indian Ocean stock status reference points from the different modeling approaches. Catch estimate for 2009 and mean catch from 2005–2009 also provided (data as of May 2011).

Management quantity	SS3*	ASPIC*	BMAP*	ASIA
2009 catch estimate (1000 t)		21.5		
Mean catch from 2005–2009 (1000 t)		26.4		
MSY (1000 t)	31	29.9	30.8	34.2
F_{2009}/F_{MSY}	0.50	0.63	0.62	0.59
B_{2009}/B_{MSY}	–	1.21	1.07	1.18
SB_{2009}/SB_{MSY}	1.59	–	–	1.38
B_{2009}/B_0	–	0.53	0.48	0.42
SB_{2009}/SB_0	0.35	–	–	0.30
$B_{2009}/B_{0,\ F=0}$	–	–	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–	–	–

*Note that the production models do not distinguish between spawning and total biomass. The two values are used interchangeably here and in the technical advice.

Table 15. Aggregated Indian Ocean assessment Kobe II 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%	80%	100%	120%	140%
$B_{2012} < B_{MSY}$	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

SOUTHWEST INDIAN OCEAN RESOURCE – MANAGEMENT ADVICE

137. The WPB **AGREED** to the following management advice for the swordfish resource in the southwest Indian Ocean, for the consideration of the Scientific Committee;

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in 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} (Table16).

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that $F_{2019} > F_{MSY}$). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 17).

138. The WPB **RECOMMENDED** that the Scientific Committee consider the following;

- the Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table16).
- catches 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}.
- The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

Table 16. Summary of (best point estimate) southwest Indian Ocean stock status reference points from the different modeling approaches. Catch estimate for 2009 and mean catch from 2005–2009 also provided (data as of May 2011).

Management quantity	SS3*	ASPIC*	BMAP*	ASIA
2009 catch estimate (1000 t)	6.6			
Mean catch from 2005–2009 (1000 t)	7.8			
MSY (1000 t)	9.4	8.6	7.9	7.1
F_{2009}/F_{MSY}	0.64	0.85	0.88	1.19
B_{2009}/B_{MSY}	–	0.97	0.94	0.82
SB_{2009}/SB_{MSY}	1.44	–	–	0.73
B_{2009}/B_0	–	0.58	0.38	0.30
SB_{2009}/SB_0	0.29	–	–	0.16
$B_{2009}/B_{0,\ F=0}$	–	–	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–	–	–

*Note that the production models do not distinguish between spawning and total biomass. The two values are used interchangeably here and in the technical advice.

Table 17. Southwest Indian Ocean assessment Kobe II 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%	80%	100%	120%	140%
$B_{2012} < B_{MSY}$	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

Blue marlin

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

139. The WPB **AGREED** to the following management advice for the blue marlin resource in the Indian Ocean, for the consideration of the Scientific Committee;

Stock status. No quantitative stock assessment is currently available for blue marlin in the Indian Ocean, and due to a lack of reliable fishery data for several gears, only very preliminary stock indicators can be used. The standardised CPUE suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being *uncertain*. However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base a quantitative assessment is a cause for concern.

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 not sufficient information to evaluate the effect this will have on the resource.

140. The WPB **RECOMMENDED** that the Scientific Committee consider the following;
    - the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
    - annual catches of blue marlin urgently need to be reviewed.
    - improvement in data collection and reporting is required to assess the stock.

Other marlins and sailfish

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

141. The WPB **NOTED** that no quantitative stock assessment is currently available for marlins and sailfish in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain*. However, aspects of the biology, productivity and fisheries for these species combined with the lack of data 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.

9.1 Update of species Executive Summaries

142. The WPB **NOTED** paper IOTC–2011–WPB09–21 which aimed to encourage the WPB to develop clear and concise draft Executive Summaries for each billfish species for the consideration of the Scientific Committee.

143. The WPB **NOTED** that Recommendation 30 from the IOTC performance review panel states: “New guidelines for the presentation of more user friendly scientific reports in terms of stock assessments should be developed. …”.).

144. The WPB **NOTED** that the IOTC currently uses the reference points of SB_{MSY} (or B_{MSY}) and F_{MSY} in providing its advice on stock status to the Commission and typically represents the advice as a ratio of current spawning biomass (SB_{curr}), total biomass (B_{curr}) or fishing rates/mortality to SB_{MSY}, B_{MSY} and F_{MSY} respectively; species with current spawning biomass estimates $<SB_{MSY}$ or $<B_{MSY}$ are considered overfished, and fishing mortality $>F_{MSY}$ is considered overfishing. There are currently no agreed harvest strategies, explicit target of limit reference points or decision rules that are followed when reference points are being approached or have been reached. Stocks of tuna and tuna-like species under the IOTC mandate are currently classified independently in each of the two categories described above (overfished and overfishing). Within these two categories there is a positive and a negative, as well as an uncertain status.

145. The WPB **NOTED** that, at the Fifteenth Session of the Indian Ocean Tuna Commission, the Commission made the following request of the Scientific Committee, and by default, the Working Parties:

> "*The Commission noted the provision by the Scientific Committee of the Kobe II matrix for bigeye tuna and swordfish, and recognized that it is a useful and necessary tool for management. The Commission requests that such matrices be provided for all stock assessments by the species Working Parties, in particular for yellowfin tuna, and for these to be included in the report of the Scientific Committee in 2011 and all future reports*." (IOTC–2011–S15–R, para. 37).

146. The WPB **ENDORSED** the new Executive Summary format to be used in developing the draft resource Executive Summaries for the Scientific Committee's consideration.

147. The WPB **RECOMMENDED** that the Scientific Committee:

- **NOTE** the current definition of overfishing used by the IOTC, where fishing mortality is in excess of F_{MSY} ($F_{curr}/F_{MSY} > 1$) is considered overfishing;
- **NOTE** that fishing mortality in excess of F_{MSY} is not always defined as overfishing (within tRFMOs) if the stock is well above the B_{MSY} level, although no specific threshold has been defined;
- **CONSIDER** the current definition of overfishing ($F_{curr}/F_{MSY} > 1$), and determine that if in situations where the biomass of a given stock is well above B_{MSY}, but $F_{curr}/F_{MSY} > 1$, under what circumstances should a stock be classified as subject to overfishing.
- **NOTE** the draft resource stock status summaries for:
    - i. Swordfish (*Xiphias gladius*) – Appendix VI
    - ii. Blue marlin (*Makaira nigricans*) – Appendix VII

148. The WPB **RECOMMENDED** that the IOTC Secretariat update the draft stock status summaries with 2010 catch data once obtained, and for these to be provided to the Scientific Committee as part of the Draft Executive Summaries, for its consideration.

9.2 Review of current Conservation and Management Measures for billfish species

149. The WPB **NOTED** paper IOTC–2011–WPB09–22 which aimed to encourage the WPB to review the existing Conservation and Management Measures (CMM) relating to billfish (Resolutions 08/04, 09/02, 10/02, 10/03, 10/07, 10/08 and Recommendation 10/13); and as necessary to 1) provide recommendations to the Scientific Committee on whether modifications may be required; and 2) recommend whether other CMMs may be required.

150. The WPB **AGREED** that it did not have the resources at the current meeting to address this issue, however, it was agreed to revisit it at the next meeting of the WPB.

10. RESEARCH RECOMMENDATIONS AND PRIORITIES

10.1 Development a draft work plan for the WPB

151. The WPB **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2012, and **RECOMMENDED** that efforts over the coming year be focused on the other billfish species, in particular on striped marlin.

152. The WPB **RECOMMENDED** the following core areas as priorities for research over the coming year;

- Swordfish stock structure and migratory range – using genetics
- Swordfish stock structure and movement rates – using tagging techniques
- Billfish species growth rates
- Size data analyses

- Stock status indicators – exploration of indicators from available data
- CPUE standardization – swordfish, marlins and sailfish
- Stock assessment – Istiophorids
- Depredation – focus on the southwest

11. OTHER BUSINESS

11.1 Deadlines for data submission relating to Billfish

153. The WPB **ENCOURAGED** data to be used in billfish stock assessments, including standardised CPUE, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than one month prior to each meeting, from the IOTC Secretariat.

11.2 Date and place of the Tenth Session of the Working Party on Billfish

154. The WPB participants were unanimous in thanking the Seychelles Fishing Authority for hosting the Ninth Session of the WPB and commended the Seychelles on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

155. Following a discussion on who would host the Tenth Session of the WPB, the WPB **RECOMMENDED** that the IOTC Secretariat liaise with Indonesia to determine if it would be feasible to hold the next meeting of the WPB in September or October 2012, in conjunction with another IOTC working party, in Indonesia. La Réunion was identified as an alternate meeting location. The exact dates and meeting location will be confirmed and communicated by the IOTC Secretariat to the Scientific Committee for its consideration.

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

156. The WPB **NOTED** with thanks, the contributions of the invited expert for the meeting, Dr. Toshihide Kitakado, from the Department of Marine Biosciences of the Tokyo University of Marine Science and Technology in Japan.

157. 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 2012:
    - Expertise: experience with CPUE analysis for marlins and/or sailfish.
    - Priority areas for contribution: Striped marlin CPUE analysis.

11.4 Election of the Chairperson and Vice-Chairperson of the Working Party on Billfish for the Next Biennium

158. The WPB **NOTED** with thanks, the outstanding contributions of the Chair, Mr Jan Robinson, over the two past *biennia*.

159. The WPB **CONSIDERED** candidates for the positions of Chair and Vice-Chair of the WPB. Mr Jerome Bourjea was nominated as Chair, and Mr Miguel Santos was nominated as Vice-Chair of the WPB for the next *biennium*, pending final approval by their home institutions.

160. The WPB **RECOMMENDED** that once finalised, the IOTC Secretariat forward the names of the elected individuals for the next *biennium*, to the Scientific Committee for **noting**.

11.5 Review of the draft, and adoption of the Report of the Ninth Session of the Working Party on Billfish

161. The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB09, provided at Appendix IV.

162. The report of the Ninth Session of the Working Party on Billfish (IOTC–2011–WPB09–R) was **ADOPTED** on the 8 July 2011.

APPENDIX I
LIST OF PARTICIPANTS

Agustinus Anung Widodo
Research Center for Fisheries Management & Conservation (RCFMC); Ministry of Marine Affairs & Fisheries-Indonesia (MMAF) – Indonesia
anungwd@yahoo.co.id

Cindy Assan
Seychelles Fishing Authority – Seychelles
cassan@sfa.sc

Pascal Bach
Institut de recherche pour le développement (IRD) – EU,France
pascal.bach@ird.fr

Jerome Bourjea
Institut Français De Recherche Pour L'Exploitation De La Mer (Ifremer) – EU,La Réunion
Jerome.bourjea@ifremer.fr

Sarah Le Couls
Institut Français De Recherche Pour L'Exploitation De La Mer (Ifremer) – EU,La Réunion
Sarah.le.couls@ifremer.fr

Shunji Fujiwara
IOTC-OFCF Project
Shunji.fujiwara@iotc.org

Vincent Lucas
Seychelles Fishing Authority – Seychelles
vlucas@sfa.sc

Miguel Herrera
Indian Ocean Tuna Commission – Secretariat
miguel.herrera@iotc.org

Michael Hinton
Inter-American Tropical Tuna Commission – IATTC
mhinton@iattc.org

Nelly Kadagi
African Billfish Foundation
nelly@africanbillfish.org

Toshihide Kitakado
Department of Marine Bioscience, Tokyo University of Marine Science and Technology – Invited Expert – Japan
kitakado@kaiyodai.ac.jp

Dale Kolody
Indian Ocean Tuna Commission – Secretariat
dale.kolody@iotc.org

Sabrena Lawrence
Seychelles Fishing Authority – Seychelles
slawrence@sfa.sc

Julien Million
Indian Ocean Tuna Commission – Secretariat
julien.million@iotc.org

Tom Nishida
National Research Institute of Far Seas Fisheries (NRIFSF), Fisheries Research Agency – Japan
tnishida@affrc.go.jp

Budi Nugraha
Research Institute For Tuna Fisheries
Ministry of Marine Affairs And Fisheries – Indonesia
budinug03@yahoo.com

Barbara Palha De Sousa
Instituto Nacional De Investigacao Pesqueira – Mozambique
bsousa2@gmail.com

Lakshmana Perumal Ramalingam
Fishery Survey of India, Government of India, Ministry of Agriculture – India
ramalingam.1961@yahoo.com

Lucia Pierre
Indian Ocean Tuna Commission – Secretariat
lucia.pierra@iotc.org

Fariborz Rajaei
Iran Fisheries Organization – Iran
rajaeif@gmail.com

Jose Ramón Fernandez Costa
Spanish Institute of Oceanography – EU,Spain
jose.costa@co.ieo.es

Henry Riggs-Miller
The Billfish Foundation
henry@fins.sc

Jan Robinson
Seychelles Fishing Authority – Chair – Seychelles
jrobinson@sfa.sc

Miguel Neves Santos
Portuguese Fisheries Research Institute – EU,Portugal
mnsantos@ipimar.pt

Sujeewa Sisira Kumara Haputhantri
National Aquatic Resources Research and Development Agency (NARA) – Sri Lanka
sisirahaputhantri@yahoo.com

Stephen Waithaka Ndegwa
Ministry of Fisheries Development of Kenya – Kenya
ndegwafish@yahoo.com

Sheng-Ping Wang
National Taiwan Ocean University, Department of Environmental Biology and Fisheries Science – Taiwan,China
wsp@mail.ntou.edu.tw

David Wilson
Indian Ocean Tuna Commission – Secretariat
david.wilson@iotc.org

APPENDIX II
AGENDA FOR THE NINTH WORKING PARTY ON BILLFISH

Date: 4 – 8 July 2011
Location: Seychelles Fishing Authority Conference Room, Victoria, Mahé, Seychelles
Time: 09:00 – 17:00 daily

1. OPENING OF THE MEETING

2. ADOPTION OF THE AGENDA

3. OUTCOMES OF THE THIRTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

4. OUTCOMES OF THE FIFTEENTH SESSION OF THE COMMISSION

5. PROGRESS MADE ON THE RECOMMENDATIONS OF WPB08

6. REVIEW OF DATA AVAILABLE ON BILLFISH

7. NEW INFORMATION ON BIOLOGY, ECOLOGY, FISHERIES AND ENVIRONMENTAL DATA RELATING TO BILLFISH

7.1 Review new information on the biology, stock structure, their fisheries and associated environmental data:

- *Marlins*
- *Sailfish*
- *Swordfish*
  - *Southwest Indian Ocean*
  - *Indian Ocean-wide.*

8. REVIEW OF NEW INFORMATION ON THE STATUS OF BILLFISH

8.1 Stock status indicators for marlins and sailfish - Istiophorids:

- *Marlins*
- *Sailfish*.

8.2 Stock status indicators and stock assessments for swordfish – *Xiphias gladius*:

- *Southwest Indian Ocean*
  - *Indicators*
  - *Assessments*
  - *Review and presentation of projection results, including Kobe 2 Strategy Matrix.*
- *Indian Ocean-wide*
  - *Indicators*
  - *Assessments*
  - *Review and presentation of projection results, including Kobe 2 Strategy Matrix.*

9. DEVELOP TECHNICAL ADVICE ON THE STATUS OF THE STOCKS

9.1 Update of species Executive Summaries:

- *Marlins*
- *Sailfish*
- *Swordfish*
  - *Southwest Indian Ocean*
  - *Indian Ocean-wide.*

10. RESEARCH RECOMMENDATIONS AND PRIORITIES

10.1 Development a draft work plan for the WPB.

11. OTHER BUSINESS

11.1 Deadlines for data submission relating to Billfish
11.2 Date and place of the Tenth Session of the Working Party on Billfish
11.3 Development of priorities for an Invited Expert at the next WPB meeting
11.4 Election of a new Chairperson and Vice-Chairperson for the next biennium
11.5 Review of the draft, and adoption of the Report of the Ninth Session of the Working Party on Billfish.

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2011–WPB09–01a	Draft agenda of the Ninth Working Party on Billfish	✓(6 April)
IOTC–2011–WPB09–01b	Draft annotated agenda of the Ninth Working Party on Billfish	✓(13 June)
IOTC–2011–WPB09–02	List of documents	✓(13 June)
IOTC–2011–WPB09–03	Outcomes of the Thirteenth Session of the Scientific Committee (Secretariat)	✓ (6 April)
IOTC–2011–WPB09–04	Outcomes of the Fifteenth Session of the Commission (Secretariat)	✓ (6 April)
IOTC–2011–WPB09–05	Progress made on the recommendations of WPB08 (Secretariat and Chair)	✓ (17 April)
IOTC–2011–WPB09–06	Review of the statistical data available for the billfish species (M. Herrera and L. Pierre — Secretariat)	✓ (6 April)
IOTC–2011–WPB09–07	Preparation of data input files for the stock assessments of Indian Ocean Swordfish (M. Herrera and L. Pierre — Secretariat)	✓ (6 April)
IOTC–2011–WPB09–08	Review of fishery trends for billfish species (M. Herrera and J. Million — Secretariat)	✓ (13 June)
IOTC–2011–WPB09–09_rev1	Kenyan Sports Fishing Sailfish Catches (S. Ndegwa and M. Herrera)	✓ (28 June)
IOTC–2011–WPB09–10	East Africa billfish conservation and research: marlin, sailfish and swordfish mark-recapture field studies (N. I. Kadagi, T. Harris and N. Conway)	✓ (13 June)
IOTC–2011–WPB09–11	Validation of the Global Ocean Data Assimilation System (GODAS) data in the NOAA National Center for Environmental System (NCEP) by theory, comparative studies, applications and sea truth (T. Nishida, T. Kitakado, H. Matsuura and S. P. Wang)	✓ (4 July)
IOTC–2011–WPB09–12_rev2	CPUE standardization of blue marlin (*Makaira mazara*) caught by Taiwanese longline fishery in the Indian Ocean (S. P. Wang, S. H. Lin and T. Nishida)	✓ (2 July)
IOTC–2011–WPB09–13	Review of CPUE issues for the 2011 Indian Ocean swordfish stock assessment (D. Kolody)	✓ (7 June)
IOTC–2011–WPB09–14	Estimation of the Abundance Index (AI) of swordfish (*Xiphias gladius*) in the Indian Ocean (IO) based on the fine scale catch and effort data of the Japanese tuna longline fisheries (1980–2010) (T. Nishida, T. Kitakado and S. P. Wang)	✓ (30 June)
IOTC–2011–WPB09–15	Investigation of the sharp drop of swordfish CPUE of Japanese tuna longline fisheries in 1990's in the SW Indian Ocean (T. Nishida and T. Kitakado)	✓ (30 June)
IOTC–2011–WPB09–16_rev1	CPUE standardization of swordfish (*Xiphias gladius*) caught by Taiwanese longline fishery in the Indian Ocean (S. P. Wang and T. Nishida)	✓ (1 July) ✓ (12 July) –rev1
IOTC–2011–WPB09–17	An age-, sex- and spatially-structured stock assessment of the Indian Ocean swordfish fishery 1950-2009, including special emphasis on the south-west region (D. Kolody)	✓ (30 June)
IOTC–2011–WPB09–18_rev1	Preliminary stock assessments and MSE risk analyses (Kobe II) of swordfish (*Xiphias gladius*) in the Indian Ocean by A Stock-Production Model Incorporating Covariates (ASPIC) (T. Nishida, T. Kitakado and S. P. Wang)	✓ (30 June)
IOTC–2011–WPB09–19_rev1	Attempt of stock assessment of the Indian Ocean swordfish resources by production model based on the Bayesian averaging method (T. Kitakado and T. Nishida)	✓ (3 July)
IOTC–2011–WPB09–20_rev1	The application of an age-structured assessment model to swordfish (*Xiphias gladius*) in the Indian Ocean (S. P. Wang and T. Nishida)	✓ (15 July)

Document	Title	Availability
IOTC–2011–WPB09–21	Template for the 'Executive Summary' for billfish species (Secretariat and Chair)	✓ (13 June)
IOTC–2011–WPB09–22	Review of current Conservation and Management Measures for billfish species (Secretariat and Chair)	✓ (13 June)
IOTC–2011–WPB09–23_rev1	Standardized catch rates for the swordfish (*Xiphias gladius*) caught by the Spanish longline in the Indian Ocean during the period 2001–2010 (A. Ramos-Cartelle, B. García-Cortés, J. Fernández-Costa and J. Mejuto)	✓ (13 June)
IOTC–2011–WPB09–24	Up-date on the Seychelles semi-industrial and industrial longline fisheries, focusing on billfishes (C. Assan, S. Lawrence and V. Lucas)	✓ (1 July)
IOTC–2011–WPB09–25	Mozambique: Country report prepared for the Indian Ocean Tuna Commission (B. Palha de Sousa)	✓ (30 May)
IOTC–2011–WPB09–26	Distribution, abundance and biology of Indo-Pacific sailfish, *Istiophorus platypterus* (Shaw and Nodder, 1792) in the Indian EEZ around Andaman and Nicobar (L. Ramalingam and A. B. Kar)	✓ (30 June)
IOTC–2011–WPB09–27_rev1	Species composition and size distribution of billfish caught by Indonesian tuna long-line vessels operating in the Indian Ocean (A. A. Widodo, B. Nugraha, F. Satria and A. Barata)	✓ (29 June)
IOTC–2011–WPB09–28	A review on billfish fishery resources in Sri Lanka (S.S.K. Haputhantri and R. Maldeniya)	✓ (27 June)
IOTC–2011–WPB09–INF01	IATTC: Status of swordfish in the eastern Pacific Ocean in 2010 and outlook for the future (M. Hinton and M. Maunder)	✓ (3 June)
IOTC–2011–WPB09–INF02	Direct comparison of mitochondrial markers for the analysis of swordfish population structure (H. Bradmana, P. Greweb and B. Appleton)	✓ (3 June)
IOTC–2011–WPB09–INF03	Using adaptive area stratification to standardize catch rates with application to North Pacific swordfish (*Xiphias gladius*) (M. Ichinokawaa and J. Brodziak)	✓ (3 June)
IOTC–2011–WPB09–INF04	Note for discussion on the Indian Ocean (IO) swordfish (SWO) CPUE (T. Nishida and T. Kitakado)	✓ (6 June)
IOTC–2011–WPB09–INF05	Preliminary results of the Indian Ocean swordfish stock structure project – IOSSS – focus on the population genetic approach (J. Bourjea, S. Le Couls, P. Grewe, H. Evano and D. Muths)	✓ (6 June) +PPT presentation at meeting
IOTC–2011–WPB09–INF06	The Portuguese longline fishing activities in the Indian Ocean: ongoing activities aiming the collection of historical data (M. N. Santos)	PPT presentation at meeting
IOTC–2011–WPB09–INF07	Ocean scale hypoxia-based habitat compression of Atlantic istiophorid billfishes (E. D. Prince, J. Luo, C. P. Goodyear, J. P. Hoolihan, D. Snodgrass, E. S. Orbesen, J. E. Serafy, M. Ortiz and M. J. Schirripa)	✓ (14 June)
IOTC–2011–WPB09–INF08	Evaluating post-release behaviour modification in large pelagic fish deployed with pop-up satellite archival tags (J. P. Hoolihan, J. Luo, F. J. Abascal, S. E. Campana, G. De Metrio, H. Dewar, M. L. Domeier, L. A. Howey, M. E. Lutcavage , M. K. Musyl, J. D. Neilson, E. S. Orbesen, E. D. Prince, and J. R. Rooker)	✓ (14 June)
IOTC–2011–WPB09–INF09	Vertical habitat use of sailfish (*Istiophorus platypterus*) in the Atlantic and eastern Pacific, derived from pop-up satellite archival tag data (J. P. Hoolihan, J. G Luo, C. P. Goodyear, E. S. Orbesen and E. D. Prince)	✓ (14 June)
IOTC–2011–WPB09–INF10	Guidelines for the presentation of stock assessment models (IOTC Scientific Committee)	✓ (6 June)
IOTC–2011–WPB09–INF11	Note on swordfish catches collected during commercial operations and research cruises onboard pelagic longliners of the La Reunion fleet from 2006 to 2010 (P. Bach, E. Romanov, N. Rabearisoa and A. Sharp)	✓ (4 July) PPT presentation at meeting

APPENDIX IV
CONSOLIDATED RECOMMENDATIONS OF THE NINTH SESSION OF THE WORKING PARTY ON BILLFISH

Note: Appendix references refer to the Report of the Ninth Session of the Working Party on Billfish (IOTC–2011–WPB09–R)

Outcomes of the Fifteenth session of the Commission

WPB09.01 (para. 10): The WPB **NOTED** that the increased attendance by scientists from developing CPCs was partly due to the IOTC Meeting Participation Fund, adopted by the Commission in 2010 (Resolution 10/05 *on the establishment of a Meeting Participation Fund for developing IOTC Members and non-Contracting Cooperating Parties*), and **RECOMMENDED** that this fund be maintained.

WPB09.02 (para. 13): The WPB **RECOMMENDED** that the Scientific Committee consider the advice of the WPB on the southwest swordfish resource and to respond to the Commission's request during its 2011 meeting, noting that the Working Party on Methods will be progressing Management Strategy Evaluation over the coming year that will aid in addressing this request, which was considered by participants as the appropriate mechanism for this work.

Data inconsistencies for the Japanese and Taiwan,China swordfish catches

WPB09.03 (para. 43): The WPB **RECOMMENDED** that the IOTC Secretariat finalize 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.

Data collection and reporting systems

WPB09.04 (para. 44): The WPB **RECOMMENDED** that the IOTC Secretariat travel to India and Pakistan in order to assess the status of data collection and reporting systems in those countries, and to report back to the WPB at its 2012 session.

WPB09.05 (para. 45): The WPB **RECOMMENDED** that the IOTC Secretariat further assist India and Pakistan in the strengthening of data collection and reporting systems, where required, so as to facilitate reporting of statistics for billfish species as per IOTC standards.

WPB09.06 (para. 46): The WPB **RECOMMENDED** that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement.

Billfish species identification

WPB09.07 (para. 47): The WPB **RECOMMENDED** that the IOTC Secretariat, in collaboration with relevant experts, develop species identification cards for marlins and sailfish by the next meeting of the WPB.

WPB09.08 (para. 48): The WPB **RECOMMENDED** that marlin and sailfish identification material, currently being used by the La Réunion fleets, be provided to the IOTC Secretariat in the coming months to aid in the development of the identification cards.

Length-age keys and other information

WPB09.09 (para. 49): The WPB **RECOMMENDED** that as a matter of priority, the IOTC Secretariat formally request, and provide assistance where necessary, CPCs that have important fisheries for billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide the basic data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, and sex ratio data, by sex and area.

WPB09.10 (para. 50): The WPB **RECOMMENDED** that the IOTC Secretariat develop a priority list of measurements to be collected for the purposes of developing length-age keys and other measurement keys, and to communicate this to CPCs before the end of the year.

Sampling coverage

WPB09.11 (para. 51): The WPB **RECOMMENDED** that the IOTC Secretariat assess levels of reporting for Japan upon receiving size data for 2010 and report back to the next meeting of the WPB.

WPB09.12 (para. 52): The WPB **RECOMMENDED** that Japan increase sampling coverage to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

WPB09.13 (para. 53): The WPB **RECOMMENDED** that the WPDCS urges Members with observer programmes to analyse the data collected to estimate discards of billfish species and the precision of these estimates.

Logbook coverage

WPB09.14 (para. 54): The WPB **RECOMMENDED** that the WPDCS monitor that Members are ensuring that logbook coverage is appropriate to produce acceptable levels of precision (Coefficient of Variation to be initially set at less than 20%) in their catch and effort statistics for billfish species.

WPB09.15 (para. 55): The WPB **RECOMMENDED** that the IOTC Secretariat request countries include levels of precision in their reports of catch-and-effort for billfish species.

Size data

WPB09.16 (para. 57): **NOTING** that the EU,Portugal had recently reported size data for swordfish from its longline fleets; The WPB **RECOMMENDED** that the EU,Portugal report size data for marlin and sailfish species for its longline fleets, noting that this is already a mandatory reporting requirement.

WPB09.17 (para. 58): **NOTING** that eleven longliners from the EU,United Kingdom, Kenya, Guinea, and Tanzania have operated in the Indian Ocean in recent years; The WPB **RECOMMENDED** that the EU,United Kingdom, Kenya, Guinea, and Tanzania make every possible effort to collect and report size data for billfish species for their longline fleets, noting that this is already a mandatory reporting requirement.

WPB09.18 (para. 59): The WPB **RECOMMENDED** that Japan and Taiwan,China analyse the size samples collected from their longline fisheries for swordfish and marlins in order to verify if the length frequencies derived from such samples are representative of their fisheries. In particular Japan to compare length frequency distributions derived from samples collected:

- by fishermen on commercial vessels
- by observers on commercial vessels
- by scientists on research and training vessels.

WPB09.19 (para. 60): The WPB **RECOMMENDED** that the IOTC Secretariat follow-up on the results of the study with Japan and Taiwan,China and to report to the next WPB meeting.

WPB09.20 (para. 61): The WPB **RECOMMENDED** that Taiwan,China collect and provide the IOTC Secretariat with size data for billfish caught by its fresh tuna longliners, noting that this is already a mandatory requirement.

WPB09.21 (para. 62): The WPB **RECOMMENDED** that the IOTC Secretariat liaise with the EU,Spain in order to assess the status of catch-and-effort data for marlins and sailfish.

WPB09.22 (para. 63): The WPB **RECOMMENDED** that the EU,Spain longline fleet provide the IOTC Secretariat with catch-and-effort and size data of marlins and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

Other data matters

WPB09.23 (para. 64): The WPB **RECOMMENDED** that the IOTC Secretariat liaise with the Republic of Korea to inform them about the new nominal catches estimated for its longline fishery.

WPB09.24 (para. 65): **NOTING** that Japanese scientists are assisting the Republic of Korea in the review of catch-and-effort data series for longline vessels under the flag of Korea; The WPB **RECOMMENDED** that the IOTC Secretariat follow-up with Japan and the Republic of Korea in order to obtain a new catch-and-effort data series from the Republic of Korea as soon as possible.

Sports fisheries

WPB09.25 (para. 70): The WPB **RECOMMENDED** that the IOTC Secretariat develop a project aimed at enhancing data recovery from sports and other recreational fisheries in the region, in collaboration with Kenya and other interested parties, and to report progress at the next WPB meeting.

WPB09.26 (para. 72): The WPB **RECOMMENDED** 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.

WPB09.27 (para. 73): The WPB **RECOMMENDED** that as a matter of priority, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, 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 and to report back to the WPB at its meeting in 2012.

WPB09.28 (para. 74): The WPB **RECOMMENDED** that the IOTC Secretariat provide contact details for purse seine and longline fleets obtained during the Regional Tuna Tagging Project-Indian Ocean (RTTP-IO), to participating billfish foundations so that they may improve their own outreach and awareness campaigns.

WPB09.29 (para. 75): The WPB **RECOMMENDED** that the African Billfish Foundation (ABF) work with the IOTC Secretariat to facilitate engagement between the ABF and IOTC scientists on issues from data analysis to the collection and dissemination of biological information on billfish species.

Mozambique billfish landings

WPB09.30 (para. 81): The WPB **RECOMMENDED** that sports fishery and other recreational fishery catches taken from Mozambique waters should be reported to the WPB in 2012.

India longline fishery: Indo-Pacific sailfish

WPB09.31 (para. 84): The WPB **RECOMMENDED** that Indian scientists continue to carry out new and innovative research on billfish species, and to report findings to each WPB meeting.

WPB09.32 (para. 85): The WPB **RECOMMENDED** that as a matter of priority, the IOTC Secretariat liaise with India, Oman, Indonesia, Philippines and Malaysia in order to improve the quality of the data reported from their longline fleets, by species, and to report back to the WPB at its next meeting.

Indonesian longline fishery

WPB09.33 (para. 89): The WPB **RECOMMENDED** that the IOTC Secretariat send a mission to Indonesia to assist in the reporting of catch-and-effort data and to report progress to the WPB at its next meeting.

Sri Lankan billfish fisheries

WPB09.34 (para. 92): The WPB **RECOMMENDED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission, including:

- catches sampled 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.

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

WPB09.35 (para. 93): The WPB **RECOMMENDED** that the IOTC-OFCF Project assist Sri Lanka to strengthen sampling efforts on its coastal and off-shore fisheries in late 2011, where required.

WPB09.36 (para. 94): The WPB **RECOMMENDED** that billfish catches by Sri Lankan vessels, by gear and location, as per IOTC requirements, be presented at the next WPB meeting.

Portuguese longline fishery

WPB09.37 (para. 102): The WPB **RECOMMENDED** that EU,Portuguese scientists undertake a CPUE analysis for the EU,Portuguese longline fleet, and to consider combining the analysis with catch-and-effort data from the EU,Spanish longline fleet for the next WPB meeting.

Stock status indicators for marlins and sailfish – Istiophorids:

WPB09.38 (para. 108): The WPB **RECOMMENDED** that marlins and sailfish undergo CPUE analysis in 2012, with striped marlin taking priority over other species.

WPB09.39 (para. 109): The WPB **RECOMMENDED** that as a matter of priority, striped marlin be the subject of CPUE analysis in 2011, and that CPUE series be compared among fleets where possible.

Stock status indicators and stock assessments for swordfish – *Xiphias gladius*:

Catch-per-unit-effort

WPB09.40 (para. 118): The WPB **RECOMMENDED** that a dedicated workshop on CPUE standardization, including issues of interest for other IOTC species should be carried out before the next round of stock assessments in 2012, and that where possible it should include a range of invited experts (as agreed in para. 112).

Swordfish – Indian Ocean Stock

WPB09.41 (para. 136): The WPB **RECOMMENDED** that the Scientific Committee consider the following;

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 14) 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.

Swordfish – Southwest Indian Ocean resource

WPB09.42 (para. 138): The WPB **RECOMMENDED** that the Scientific Committee consider the following;

- the Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table16).

- catches 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}.
- The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

Blue marlin

WPB09.43 (para. 140): The WPB **RECOMMENDED** that the Scientific Committee consider the following;

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of blue marlin urgently need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.

Update of species Executive Summaries

WPB09.44 (para. 147): The WPB **RECOMMENDED** that the Scientific Committee:

- **NOTE** the current definition of overfishing used by the IOTC, where fishing mortality is in excess of F_{MSY} ($F_{curr}/F_{MSY} > 1$) is considered overfishing;
- **NOTE** that fishing mortality in excess of F_{MSY} is not always defined as overfishing (within tRFMOs) if the stock is well above the B_{MSY} level, although no specific threshold has been defined;
- **CONSIDER** the current definition of overfishing ($F_{curr}/F_{MSY} >1$), and determine that if in situations where the biomass of a given stock is well above B_{MSY}, but $F_{curr}/F_{MSY} >1$, under what circumstances should a stock be classified as subject to overfishing.
- **NOTE** the draft resource stock status summaries for:
  i. Swordfish (*Xiphias gladius*) – Appendix VI
  ii. Blue marlin (*Makaira nigricans*) – Appendix VII

WPB09.45 (para. 148): The WPB **RECOMMENDED** that the IOTC Secretariat update the draft stock status summaries with 2010 catch data once obtained, and for these to be provided to the Scientific Committee as part of the Draft Executive Summaries, for its consideration.

Development a draft work plan for the WPB

WPB09.46 (para. 151): The WPB **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2012, and **RECOMMENDED** that efforts over the coming year be focused on the other billfish species, in particular on striped marlin.

WPB09.47 (para. 152): The WPB **RECOMMENDED** the following core areas as priorities for research over the coming year;

- Swordfish stock structure and migratory range – using genetics
- Swordfish stock structure and movement rates – using tagging techniques
- Billfish species growth rates
- Size data analyses
- Stock status indicators – exploration of indicators from available data
- CPUE standardization – swordfish, marlins and sailfish
- Stock assessment – Istiophorids
- Depredation – focus on the southwest

Date and place of the Tenth Session of the Working Party on Billfish

WPB09.48 (para. 155): Following a discussion on who would host the Tenth Session of the WPB, the WPB **RECOMMENDED** that the IOTC Secretariat liaise with Indonesia to determine if it would be feasible to hold the next meeting of the WPB in September or October 2012, in conjunction with another IOTC working party, in Indonesia. La Réunion was identified as an alternate meeting location. The exact dates and meeting location will be confirmed and communicated by the IOTC Secretariat to the Scientific Committee for its consideration.

Election of the Chairperson and Vice-Chairperson of the Working Party on Billfish for the Next Biennium

WPB09.49 (para. 160): The WPB **RECOMMENDED** that once finalised, the IOTC Secretariat forward the names of the elected individuals for the next *biennium*, to the Scientific Committee for **noting**.

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

WPB09.50 (para. 161): The WPB **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPB09, provided at Appendix IV.

APPENDIX V
MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF BILLFISH

Extract from IOTC–2011–WPB09–06

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).
- **Gillnet/longline** fishery of **Sri Lanka**: 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.
- **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. 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 2011 the Secretariat revised the complete nominal catch dataset for India, using new information available. To date, India has not reported catch-and-effort data for its artisanal fisheries.

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

- **Sport** fisheries of **Australia, EU,France(La Réunion)**, **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.

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 in port.
- **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.
- **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 is unknown.
- **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.

4. Size data from All Fisheries:

- **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).
- **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[1]:** To date, Taiwan,China has not provided size frequency data for its fresh-tuna longline fishery.
- **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.

[1] Refers to Taiwan Province of China

APPENDIX VI
DRAFT RESOURCE STOCK STATUS SUMMARIES – SWORDFISH

DRAFT: STATUS OF THE INDIAN OCEAN SWORDFISH (*XIPHIAS GLADIUS*) RESOURCE

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

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2009[2]
Indian Ocean	Catch 2009:	21,500 t	(green)
	Average catch 2006-2009:	26,400 t	
	MSY (4 models):	29,900 t–34,200 t	
	F_{2009}/F_{MSY} (4 models):	0.50–0.63	
	SB_{2009}/SB_{MSY} (4 models):	1.07–1.59	
	SB_{2009}/SB_0 (4 models):	0.30–0.53	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.

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

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) of the unfished levels.

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).

Recommendations to the Scientific Committee

The WPB **agreed** that:

1) 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.
2) 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.
3) The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
4) Advice specific to the southwest region is provided below, as requested by the Commission.

TABLE 2. 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%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	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

DRAFT: STATUS OF THE SOUTHWEST INDIAN OCEAN SWORDFISH (*XIPHIAS GLADIUS*) RESOURCE

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

Area[1]	Indicators – 2011 assessment		2011 stock status determination 2009[2]
Southwest Indian Ocean	Catch 2009:	6,600 t	(yellow)
	Average catch 2006-2009:	7,800 t	
	MSY (3 models):	7,100 t–9,400 t	
	F_{2009}/F_{MSY} (3 models):	0.64–1.19	
	SB_{2009}/SB_{MSY} (3 models):	0.73–1.44	
	SB_{2009}/SB_0 (3 models):	0.16–0.58	

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2011–WPB09–R.
[2]The stock status refers to the most recent years' data used for the assessment.

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

SOUTHWEST INDIAN OCEAN – MANAGEMENT ADVICE

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in 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).

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current 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).

Recommendations to the Scientific Committee

The WPB **agreed** that:

1) The Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table 3).
2) Catches 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}.
3) The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

TABLE 4. 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%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	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 VII
DRAFT RESOURCE STOCK STATUS SUMMARIES – BLUE MARLIN

DRAFT: STATUS OF THE INDIAN OCEAN BLUE MARLIN (*MAKAIRA NIGRICANS*) RESOURCE

TABLE 1. Status of blue marlin (*Makairanigricans*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination**
			2009[2]
Indian Ocean	Average catch 2006–2009:	9,400 t	Uncertain
	Catch 2009:	8,600 t	
	MSY (range):	no stock assessment	
	F_{2009}/F_{MSY} (range):	no stock assessment	
	SB_{2009}/SB_{MSY} (range):	no stock assessment	
	SB_{2009}/SB_0 (range):	no stock assessment	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for blue marlin in the Indian Ocean, and due to a lack of reliable fishery data for several gears, only very preliminary stock indicators can be used. The standardised CPUE suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being *uncertain*. However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base a quantitative assessment is a cause for concern.

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 not sufficient information to evaluate the effect this will have on the resource.

Recommendations to the Scientific Committee

The WPB **agreed** that:

1) the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown
2) annual catches of blue marlin urgently need to be reviewed.
3) improvement in data collection and reporting is required to assess the stock.