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

Report of the Seventh Session of the IOTC

Working Party on Billfish

Seychelles 6 – 10 July 2009

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1. OPENING OF THE MEETING AND ADOPTION OF THE AGENDA

1. The Seventh Meeting of the Working Party on Billfish (WPB) was opened on 6 July 2009 in Victoria, Seychelles. The chair, Mr. Jan Robinson, subsequently welcomed the participants (Appendix I) and the Agenda for the meeting was adopted as presented in Appendix II.

2. The list of documents presented to the meeting is given in Appendix III.

1. REVIEW OF STATISTICAL DATA FOR BILLFISH

3. The Secretariat presented the data available for billfish in the document IOTC-2009-WPB-09-05

1.1. Catch trends - nominal catch (NC) data

Swordfish

4. Swordfish is caught mainly using drifting longlines (95%) and gillnets (5%) (Figure 1). Swordfish was mainly a bycatch of industrial longline fisheries before the early 1990's. Catches increased gradually from 1950 to 1990 as the catches of targeted species (such as tropical and temperate tunas) increased. Catches increased markedly after 1990 to peaks of around 35,000 tonnes in 1998 and 36,000 tonnes in 2003 and 2004. The current catch of swordfish is around 30,000 tonnes. The increase in catch is attributed to a change in target species from tunas to swordfish by part of the Taiwanese fleet, the development of longline fisheries in Australia, La Reunion, Seychelles and Mauritius targeting swordfish, and the arrival of longline fleets from the Atlantic Ocean (Portugal, Spain and other fleets operating under various flags) also targeting swordfish (Figure 2).

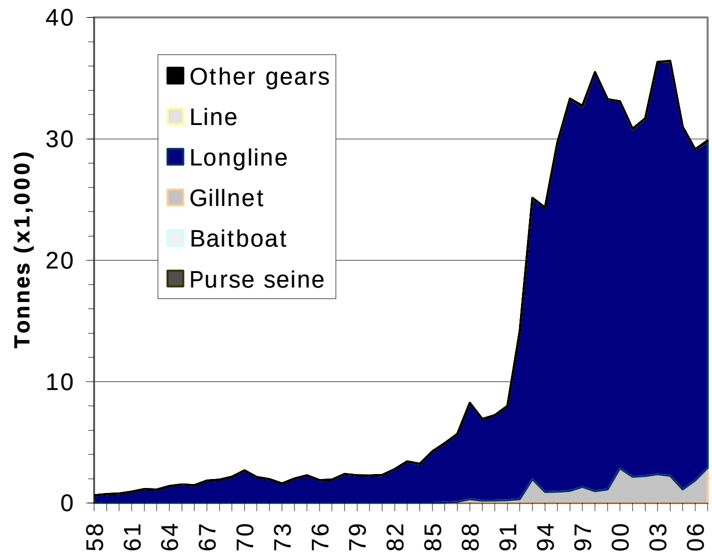


Figure 1. *Catches of swordfish in the Indian Ocean by gear type (1958-2007). From document IOTC-2009-WPB-05*

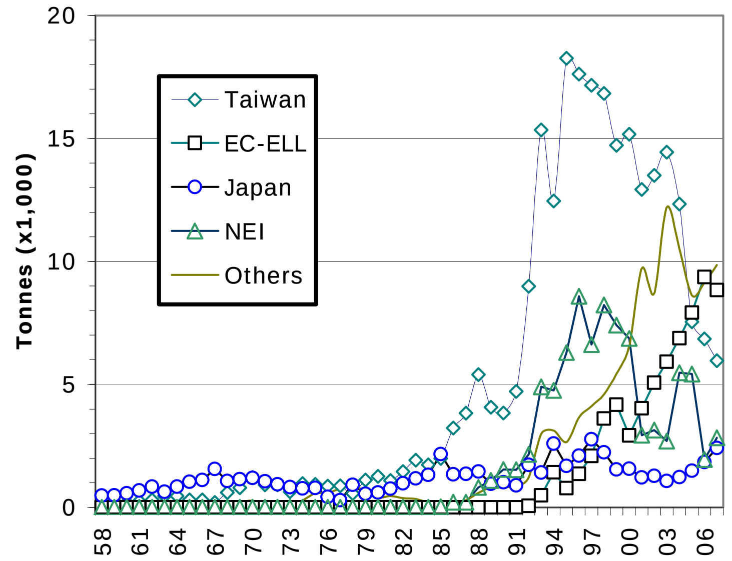


Figure 2. *Catches of Swordfish by fleet recorded in the IOTC Database (1958-2007). From document IOTC-2009-WPB-05*

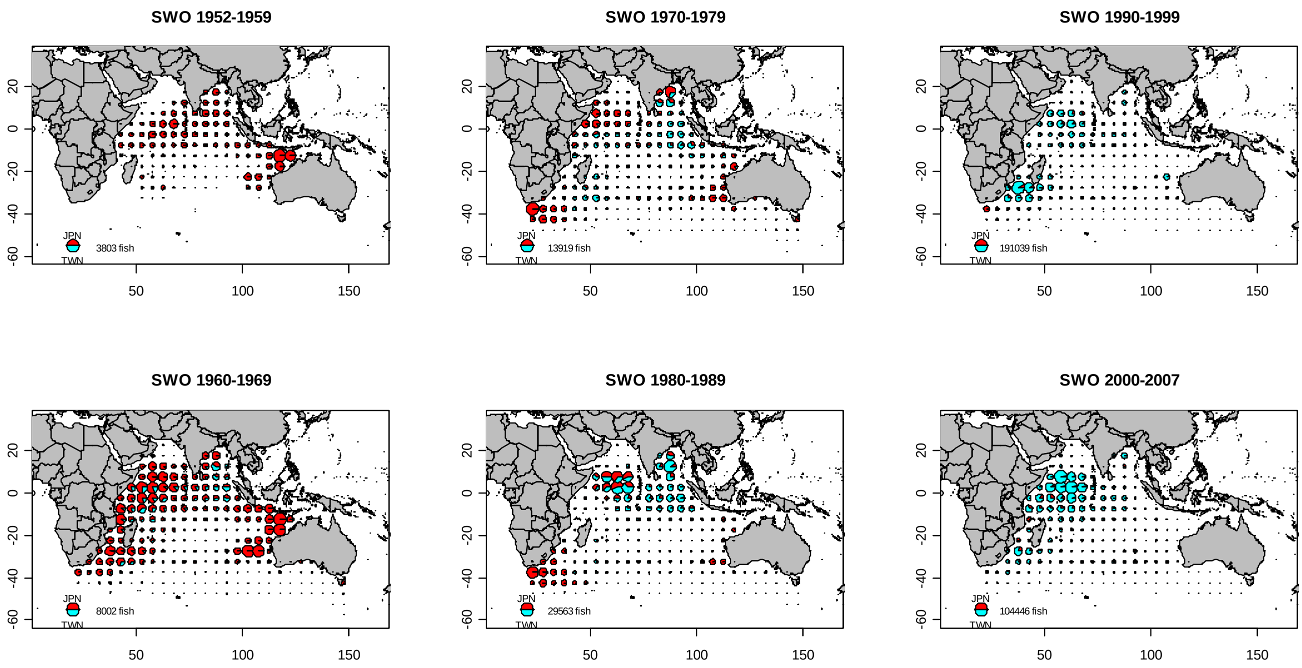


Figure 3. *Total annual catches of swordfish (number) by Taiwanese and Japanese longline vessels operating in the Indian Ocean for the last 6 decades. From document IOTC-2009-WPB-15*

Marlins

5. Blue, black and striped marlins are caught mainly using drifting longlines (70%) and gillnets (20%) and some troll and hand lines. These species are considered as bycatch for industrial and artisanal fisheries, but they are targeted by sport fisheries. Minimum catch estimates for the three marlin species have been derived from very small amounts of information and are therefore highly uncertain. The total catch of all marlin species varies from year to year. It reached a maximum of around 24,000 tonnes in 1997 while current catches are around 18,000 tonnes to 21,000 tonnes.

6. Catches of blue marlin are usually greater than those of black and striped marlin combined. The minimum average annual catch estimated for blue marlin for the period 2003 to 2007 is around 11,500 tones (Figure 4). In recent years, the fleets of Taiwan,China (longline), Japan, several NEI fleets (longline) and Sri Lanka (gillnet) are attributed with the highest catches of this species. The distribution of blue marlin catches has changed since the

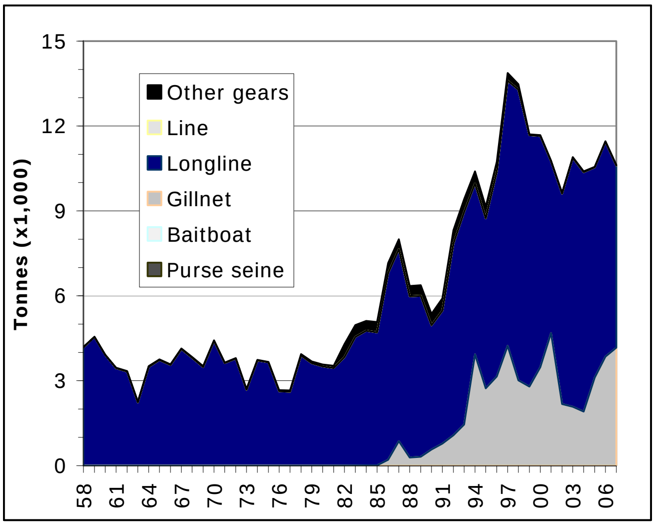
1980's, with catches in the western Indian Ocean increasing and an increase in the catch by the Taiwanese fleets (Figure 5).

7. The minimum average annual catch of black marlin estimated for the period 2003 to 2007 is around 3,300 tonnes (Figure 4), with the fleets of Taiwan,China,

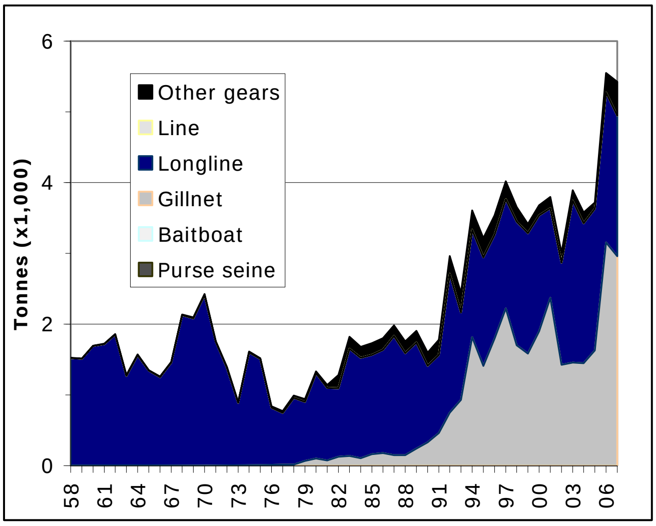
8. China (longline), Japan, (longline), Sri Lanka (gillnet) and Indonesia (longline and gillnet) are attributed with the highest catches of black marlin. The distribution of black marlin catches has changed since the 1980s with most of the catch now taken in the western areas of the Indian Ocean. Since the 1990s most of the longline catch has been taken by the Taiwanese fleets (Figure 6).

9. The minimum average annual catch estimated for striped marlin for the period 2003 to 2007 is around 3,000 tonnes (Figure 4). In recent years, the fleets of Taiwan,China (longline) and to a lesser extent several NEI fleets (longline) are attributed with the highest catches of this species. The distribution of striped marlin catches has changed since the 1980's with most of the longline catch now taken in the western areas of the Indian Ocean. As with the other marlin species, since the 1990's most of the longline catch has been taken by the Taiwanese fleets (Figure 7).

a. Blue Marlin



b. Black Marlin



c. Striped Marlin

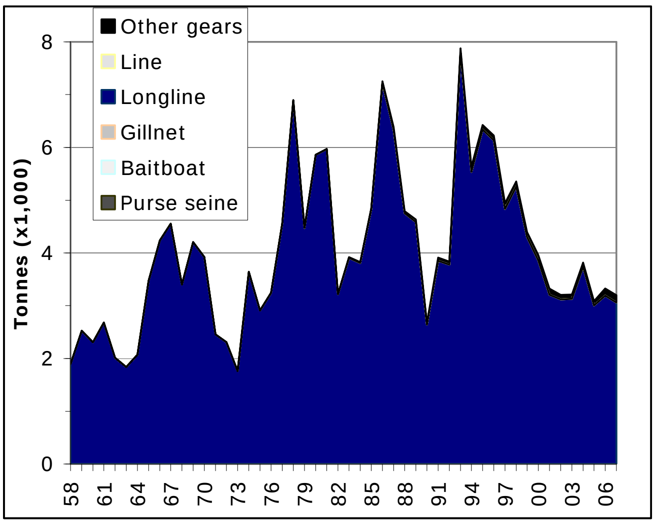


Figure 4*. Estimated catches of marlins(a. blue marlin, b. black marlin, c. striped marlin) by gear recorded in the IOTC Database (1958-2007). From document IOTC-2009-WPB-05.*

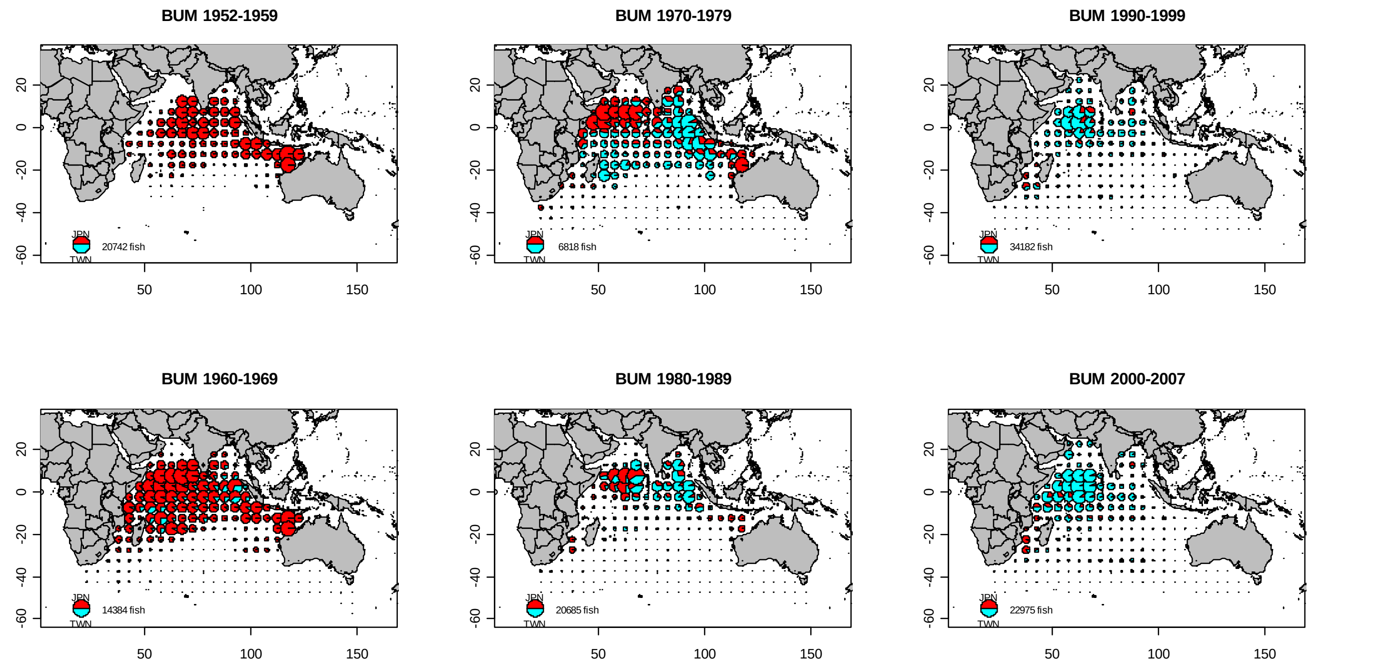


Figure 5*. Total total catches of blue marlin (number) by longline vessels operating in the Indian Ocean per decade over the period 1952 to 2007. From document IOTC-2009-WPB-15*

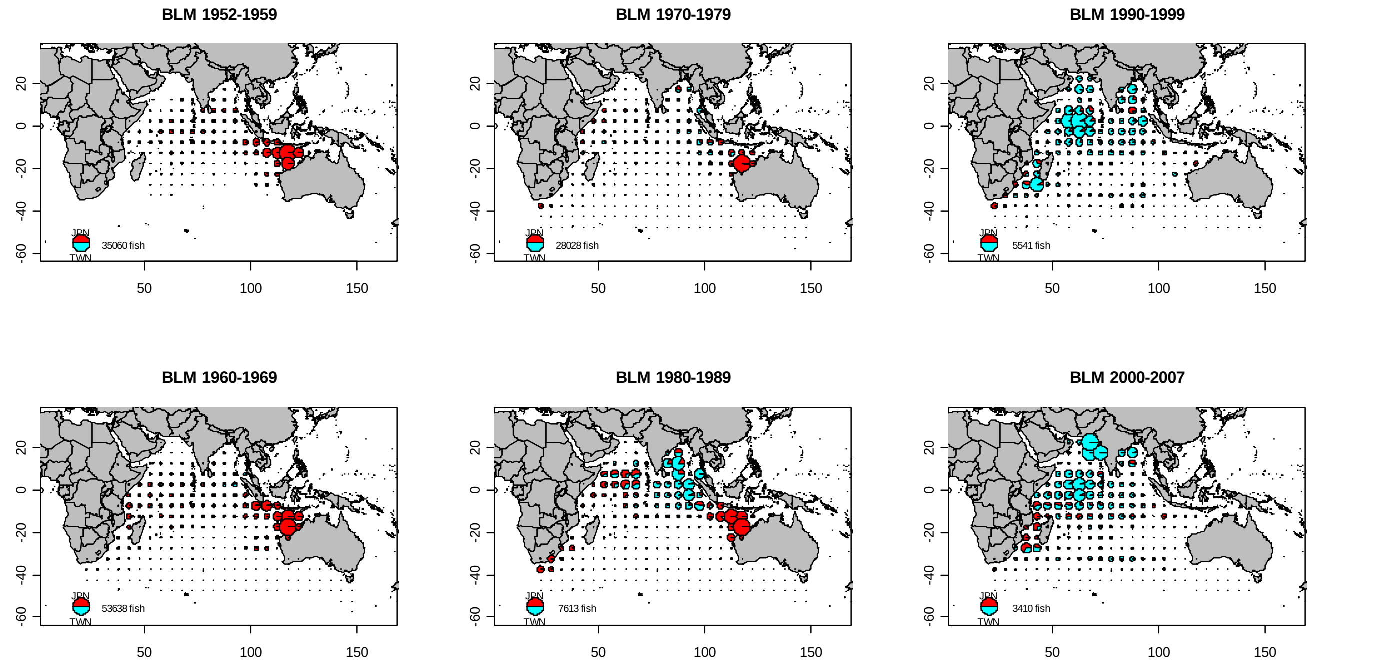


Figure 6*. Total catches of black marlin (number) by longline vessels operating in the Indian Ocean per decade over the period 1952 to 2007. From document IOTC-2009-WPB-15.*

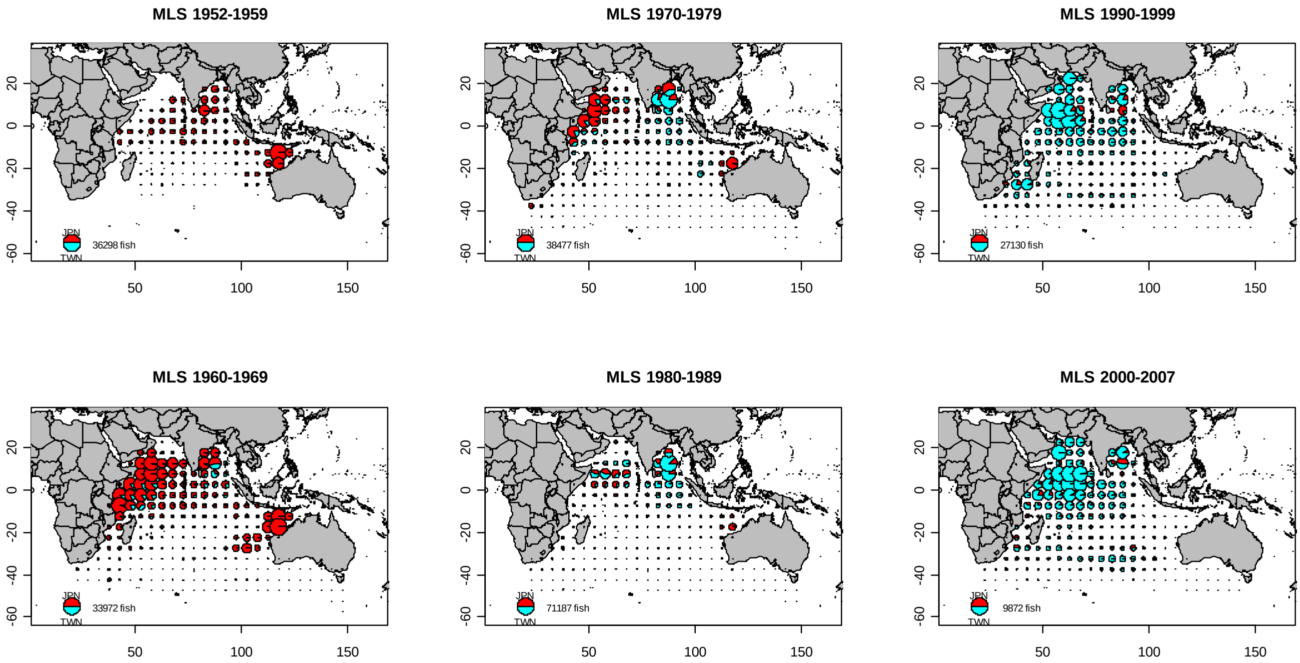


Figure 7*. Total catches of striped marlin (number) by longline vessels operating in the Indian Ocean per decade over the period 1952 to 2007. From document IOTC-2009-WPB-15.*

Indo-Pacific Sailfish

10. Sailfish is caught mainly by gillnets (89%) and to a lesser extent troll and hand lines (5%), longlines (5%) and other gears (Figure 8). The catches of sailfish have greatly increased since the mid-1980s in response to the development of the gillnet / longline fishery in Sri Lanka. Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. The minimum average annual catch estimated for the period 2003 to 2007 is around 23,000 tonnes. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea and are Iran, Sri Lanka, India and Pakistan. Smaller catches are reported for line fishers in Comores and Mauritius and by Indonesia longliners (Figure 8). Reports of sailfish catches from the longline fleet are recent and occur only for the Japanese fleet.

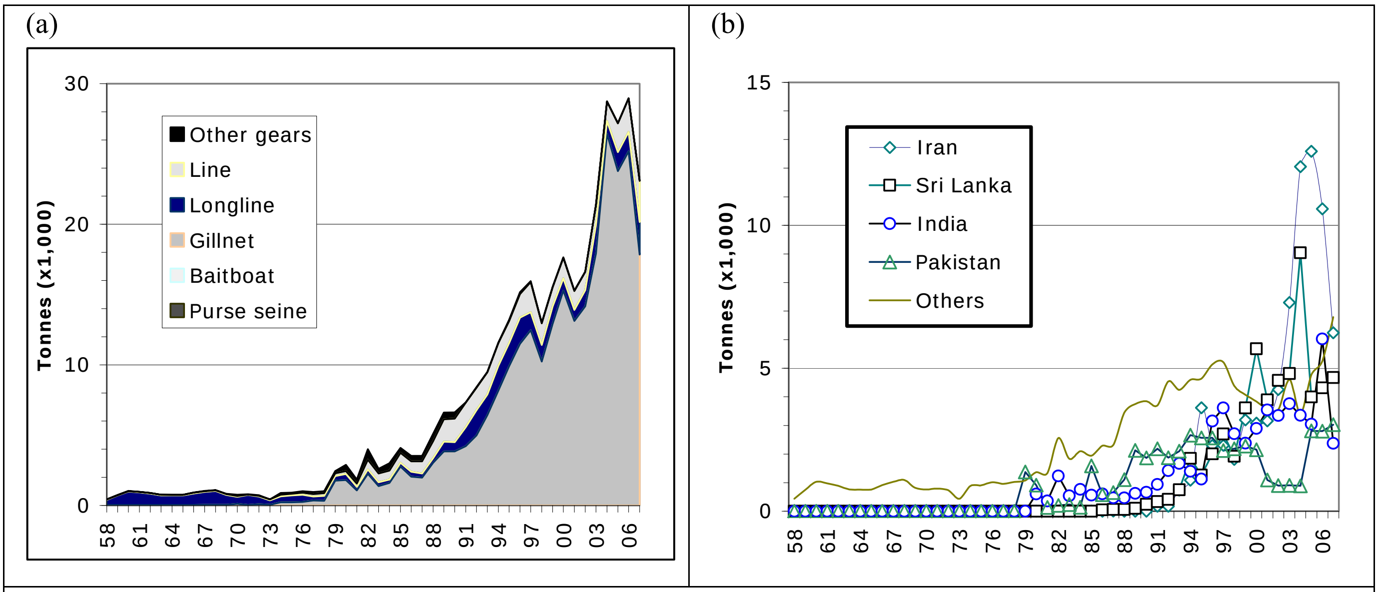


Figure 8*. Estimated catches of sailfish by (a) gear and (b) fleet recorded in the IOTC Database (1958-2007). From document IOTC-2009-WPB-05.*

1.2. The current status of data for billfish

Swordfish

Retained catches of the major fleets are considered to be accurate; however, uncertainties in the overall catch arise (Figure 9) due to:

- non-reporting industrial longliners (NEI): The numbers of non-reporting longliners targeting swordfish appear to have increased in recent years as there has been an increase in reports of foreign vessels operating in the Indian Ocean from third parties.
- poor reports from IOTC CPC's: The catches of swordfish recorded for the longline fleet of India were estimated by the IOTC Secretariat since India has never reported catches for its commercial longline fleet (around 70 vessels operating since 2004). Malaysia and Indonesia do not report catches for those longliners operating under their flags which do not unload in their countries. The catches for this component were estimated by the IOTC Secretariat.
- conflicting catch reports: The catches for South Korean longliners reported as nominal catches and catches and effort are conflicting, with higher catches recorded in the CE table.

Discard levels are believed to be low although they are unknown for most industrial fisheries.

CPUE Series: Catch and effort data are available from the major industrial longline fleets. Nevertheless, catch and effort data are not available from some fisheries or they are considered of poor quality, especially throughout the 1990s (*eg.* Indonesia, fresh-tuna longliners from Taiwan,China, and non-reporting longliners (NEI)). The catch and effort that are available from artisanal fisheries are believed to be inaccurate (poor quality effort data for the gillnet/longline fishery of Sri Lanka).

Trends in average weight can be assessed for several industrial fisheries although they are incomplete or poor quality for most fisheries before the early-1980s and in recent years (due to low sample size and time-area coverage for longliners from Japan).

Catch-at-Size(Age) table: CAS are available but the estimates less certain (Figure 9) for some years and fisheries due to:

- a lack of size data before the early-1980s and from artisanal fisheries (Sri Lanka)
- a paucity of size data available from industrial longliners since the early-1990s (Japan, Seychelles, Philippines, India, China)
- a paucity of catches per area available for some industrial fleets (NEI)
- a paucity of the biological data available, notably sex-ratio at size and sex-length-age keys

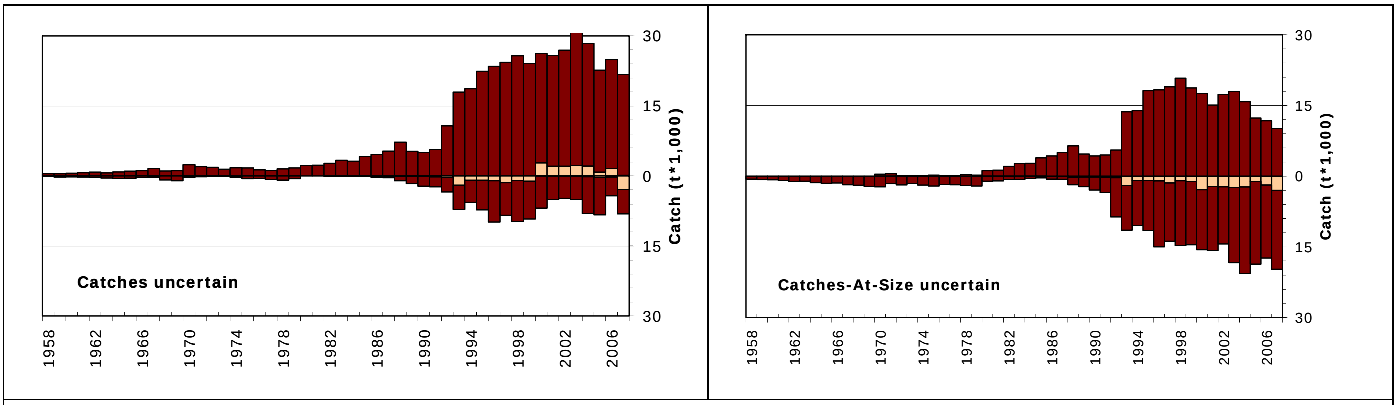


Figure 9*. Uncertainty of annual catch estimates (left) and catch at size data (right) for swordfish. The amount of the catch below the zero-line has been categorised as uncertain according to the criteria given in document IOTC-2009-WPB-05. Data as of June 2009 Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets. From document IOTC-2009-WPB-05.*

Blue marlin

Retained catches are poorly known for many fisheries (Figure 10) due to:

- catches per species not being available for many artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and some industrial (longliners of Indonesia and Philippines) fisheries

- uncertain catches for non-reporting industrial longliners (India, NEI)
- catches being incomplete for many industrial fisheries for which the blue marlin is seldom the target species. No catches are available for industrial purse seiners although they are known to occur
- conflicting catch reports: The catches for South Korean longliners reported as nominal catches and catches and effort are conflicting, with higher catches recorded in the CE table
- a lack of catch data for major sport fisheries (*eg.* Mauritius, Madagascar, Reunion, Seychelles).

Discard levels are unknown for most industrial fisheries, mainly longliners.

CPUE Series: Catch and effort data are available from some industrial longline fisheries although the catch data are possibly incomplete (the catches of species other than the target are not always recorded in the logbooks). Catch and effort are unavailable for sport fisheries, besides the sport fisheries of Kenya and South Africa, or are unavailable for other artisanal (gillnet/longlines of Sri Lanka) or industrial fisheries (NEI longliners and all purse seiners).

Trends in average weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured in recent years is, however, very low.

Catch-at-Size(Age) table: The Secretariat has not built CAS or CAA tables for blue marlin. The paucity of size data available for this species make it difficult to estimate CAS.

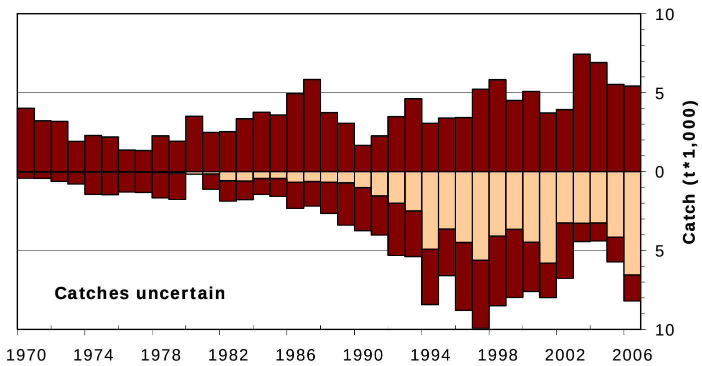


Figure 10. *Uncertainty of annual catch estimates for blue marlin. The amount of the catch below the zero-line has been categorised as uncertain according to the criteria given in the text in IOTC-2008-WPB-08. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets. Data as of June 2009. From document IOTC-2008-WPB-08.*

Black marlin

Retained catches are poorly known for many fisheries (Figure 11) due to:

- catches per species not being available for many artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and some industrial (longliners of Indonesia and Philippines) fisheries
- uncertain catches for non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia
- catches being incomplete for most industrial fisheries for which the black marlin is seldom the target species.
- conflicting catch reports: The catches for South Korean longliners reported as nominal catches and catches and effort are conflicting, with higher catches recorded in the CE table
- a lack of catch data for major sport fisheries (*eg.* Mauritius, Madagascar, Reunion, Seychelles).

Discard levels are unknown for most industrial fisheries, mainly longliners.

CPUE Series: Catch and effort data are available for some industrial longline fisheries although the catch data may be incomplete (the catches of species other than the target are not always recorded in the logbooks). Catch and effort are unavailable from sport fisheries, besides the sport fisheries of Kenya and South Africa, or are unavailable for other artisanal (gillnet/longlines of Sri Lanka) or industrial fisheries (NEI longliners and all purse seiners).

Trends in average weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The amount of specimens measured in recent years is, however, very low.

Catch-at-Size (Age) table: The Secretariat has not built CAS or CAA tables for black marlin. The paucity of size data available for this species make it difficult to estimate CAS.

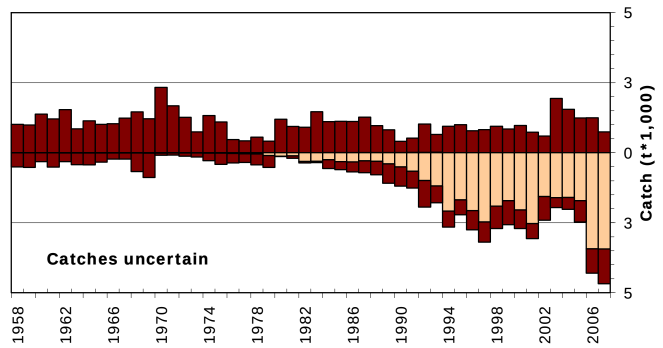


Figure 11. *Uncertainty of annual catch estimates for black marlin. The amount of the catch below the zero-line has been categorised as uncertain according to the criteria given in the text in document IOTC-2009-WPB-05. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets. Data as of June 2009. From document IOTC-2009-WPB-05*

Striped marlin

Retained catches are reasonably well known; however, overall catches are uncertain (Figure 12) due to:

- catches per species are not available for some industrial fisheries (longliners of Indonesia and Philippines).
- uncertain catches for non-reporting industrial longliners (India, NEI)
- catches are believed to be incomplete for many industrial fisheries as striped marlin is seldom a target species.
- conflicting catch reports: The catches for South Korean longliners reported as nominal catches and catches and effort are conflicting, with higher catches recorded in the CE table
- a lack of catch data from major sport fisheries (*eg*. Mauritius, Madagascar, Reunion, Seychelles).

Discard levels are believed to be low although they are unknown for most industrial fisheries, mainly longliners.

CPUE Series: Catch and effort data are available for some industrial longline fisheries although the catch data may be incomplete (the catches of species other than the target are not always recorded in the logbooks). Catch and effort are unavailable for industrial fisheries (NEI longliners).

Trends in average weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The amount of specimens measured in recent years is, however, very low.

Catch-at-Size (Age) table: The Secretariat has not built CAS or CAA tables for striped marlin. The paucity of size data available for this species make it difficult to estimate CAS.

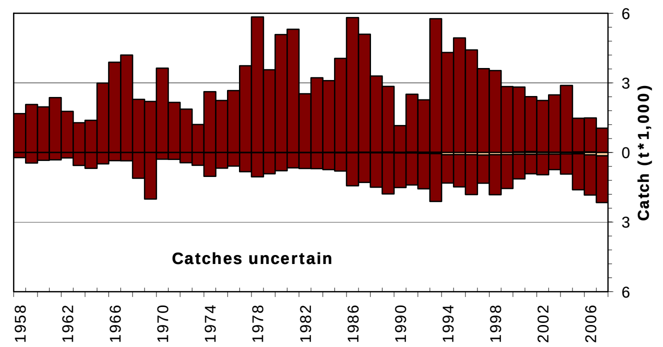


Figure 12. *Uncertainty of annual catch estimates for striped marlin. The amount of the catch below the zero-line has been categorised as uncertain according to the criteria given in the text of document IOTC-2009-WPB-05. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets. Data as of June 2009. From document IOTC-2009-WPB-05*

Indo-Pacific Sailfish

Retained catches are poorly known for most fisheries (Figure 13) due to:

- catches per species not being available for many artisanal fisheries (mainly India and Indonesia)
- catches being very incomplete for most industrial fisheries for which this species is a by-catch and catches being incomplete for many artisanal fisheries (gillnets of Pakistan, pole and lines of Maldives) due to under-reporting.
- a lack of catch data for sport fisheries (*eg.* Mauritius, Madagascar, Reunion, Seychelles).

Discard levels are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate to high).

CPUE Series: Catch and effort data are available for some industrial longline fisheries but they are believed to be of poor quality (catches of sailfish are incomplete). Catch and effort are unavailable for sport fisheries besides the sport fisheries of Kenya and South Africa. The catch and effort that are available from artisanal fisheries are believed inaccurate (no data from Iran and Pakistan and poor quality effort data for the gillnet/longline fishery of Sri Lanka).

Trends in average weight can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s. The amount of specimens measured is, however, very low. Furthermore, the specimens discarded might not be accounted for by industrial fisheries, where they are presumed to be of lower size (possible bias of existing samples).

Catch-at-Size(Age) table: The Secretariat has not built CAS or CAA tables for IP sailfish. The paucity of size data available for this species make it difficult to estimate CAS.

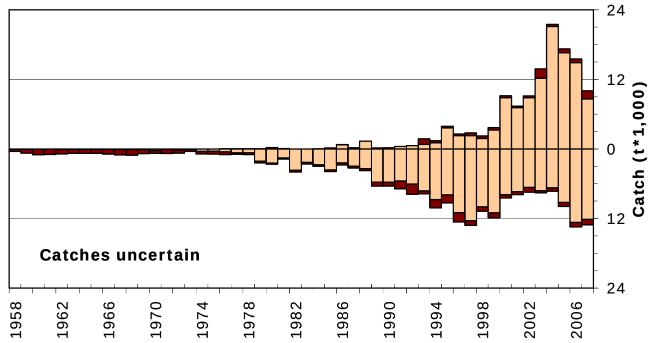


Figure 13. *Uncertainty of annual catch estimates for Indo-Pacific sailfish. The amount of the catch below the zero-line has been categorised as uncertain according to the criteria given in the text in document IOTC-2009-WPB-05. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets. Data as of June 2009. From document IOTC-2009-WPB-05*

WPB discussion on data issues

11. The WPB noted the paucity of information from sport fisheries in the Indian Ocean, noting that data are only held by the Secretariat for the sport fisheries of Kenya and South Africa. The WPB stressed the need for other countries having sport fisheries to collect and report this information to the Secretariat, in particular Australia, Madagascar, Maldives, Mauritius, Oman, Reunion, Seychelles, Tanzania, Thailand and UAE. The WPB agreed that standardised CPUE's derived from data collected for sport fisheries may significantly improve the assessments of marlins and, especially, Indo-Pacific sailfish.

12. The WPB reiterated its request for countries having important fisheries for billfish to improve data collection and reporting in the following areas:

    - Species breakdown: the WPB noted that the identification of marlins and sailfish, remains an issue, urging countries to take the necessary measures to ensure that billfish catches are reported by species.
    - Bycatch and discards: The WPB noted that levels of reporting for bycatch and discards remain low, urging countries to incorporate estimates of bycatches and discards of billfish in their routine data reports, preferably derived from observer data.

- Length frequency data by sex: The WPB noted that the amount of length frequency data available for billfish species remains low, in spite of the recommendations in place. The WPB stressed the need for countries having important catches of billfish to collect and report length frequency data, by species by sex, as soon as possible.
- Biological parameters: The WPB noted the paucity of length-weight and other conversion factors for billfish species, in particular for marlin species, stressing the need for more information to be collected on these species.

1.3. Preparation of the data for the stock assessments of swordfish: mains issues

13. The Secretariat presented document IOTC-2009-WPB-06, which describes 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 stock assessments. For this data preparation, estimates of total catch and the available catch-and-effort, size frequency data and other biological data were extracted from the IOTC database, covering the period 1950-2007.

14. Using information from the IOTC database, the IOTC Secretariat estimated total catches of swordfish, for the period 1950-2007, in number and weight and by year, quarter, and assessment area and fishery. Catch-and-effort and size frequency data by time-area strata were also estimated (figure 14). In addition, the Secretariat prepared length-frequency samples from the size frequency data available in the IOTC databases. The sampling unit is the proportion of space-time strata per units of 10° of latitude and 20° of longitude, quarterly time units by fleet. These datasets were prepared to be used in assessments using Stock-Synthesis-III. The Secretariat also estimated Catch-at-Size (figure 15) and Catch-at-Age tables for swordfish, again by using information available in the IOTC databases, to be used for an Age-Structured Production Model assessment. Data preparation was affected by the lack of information for some fleets, periods and years, and, in particular, by the lack of catch and size data for most artisanal fleets and some industrial fleets.

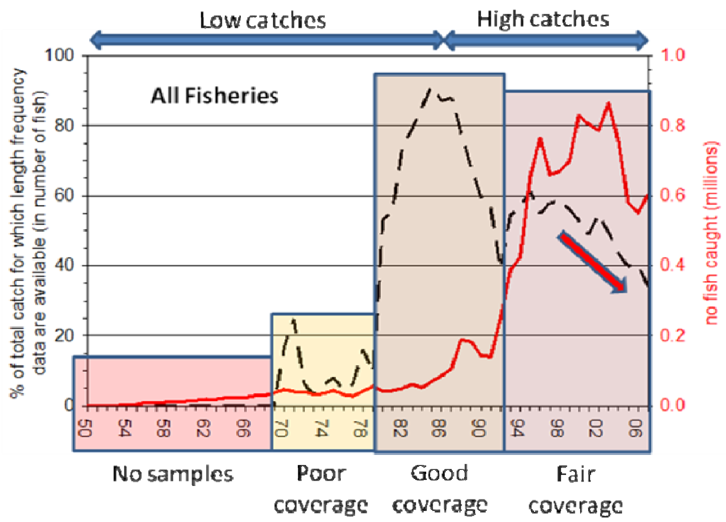


Figure 14. *Total numbers of swordfish (SWO) estimated (continuous line) and proportion (in number of fish) estimated (broken line) for strata having length frequency data (all gears combined), by year (1950-2007).*

- The amount of catches for which length frequency samples are available has changed over time, a pattern which is detailed below in terms of different periods:
- 1950-1969: The total catches of swordfish estimated for this period are low (below 1,500t in most years). No size frequency data are available for this period. The majority of the catches of swordfish for the period come from the Japanese and Taiwanese longine fleets.
- 1970-1979: The total catches of swordfish estimated for this period range between 2,000t and 3,000t. Size frequency data are only available for the longline fishery of Japan. Between 3-16% of the total catches estimated (in number) are covered by size frequency sampling. Samples are not available for the longline fishery of Taiwan,China during this period.

- 1980-1991: The total catches of swordfish estimated for this period range from 2,000t to 8,000t. Samples are available for the majority of the strata having catches of swordfish, representing 55-91% of the estimated total catches of swordfish (in number), depending on the year.
- 1992-2007: The total catches of swordfish estimated for this period range between 14,000t and 35,000t. Between 40-60% of the total catches estimated (in number) come from fisheries for which samples are available. The major constraints in this period are:
  - poor sample sizes and time-are coverage for the longline fishery of Japan
  - lack of length frequency samples for the longline fisheries of Seychelles, India, Oman and various other flags (NEI), and
  - lack of samples or poor quality samples from gillnet and other artisanal fisheries.

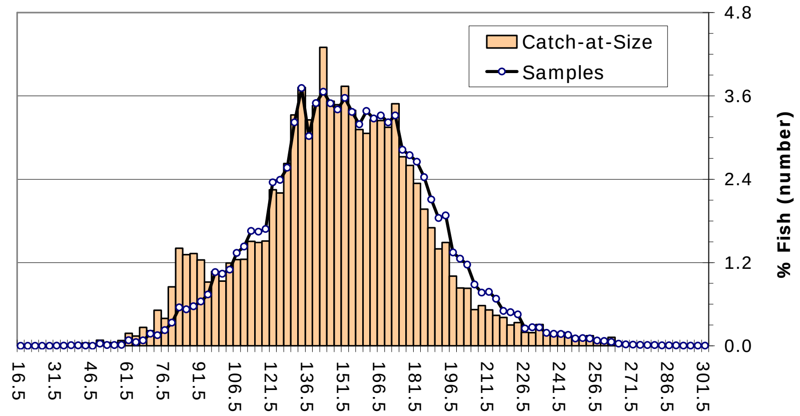


Figure 15. *Proportion that the numbers of swordfish sampled (blue line)/estimated (CAS; orange bars) under each 3cm length class (in number) make out of the total numbers of swordfish sampled/ estimated over the entire time-area series (1950-2007), all fisheries combined.*

15. The estimated length frequency distributions (catch-at-size) for some fisheries and periods differ significantly from the length frequency samples in the case of:

- the longline fishery of Japan and other assimilated fleets for the period 2000-07.
- artisanal fisheries over the entire period

16. The following factors may explain these discrepancies:

- <u>No weighting applied in the aggregation of samples under the strata selected for the assessment:</u> No weighting procedure is used in the allocation of the individual samples available to the fishery, area and period concerned. The samples available for each assessment area, fishery, year and quarter are aggregated by summing up all the specimens sampled by length class from all the fleets and gears concerned and over the entire area and period. However, the sample weights derived from the samples may represent various levels of coverage, depending on the strata involved.
- <u>Catches at size derived from samples containing a low number of specimens:</u> The shape of some CAS distributions tends to suggest that the number of specimens from which the catches at size were derived is too low. The minimum number of specimens needed for a sample to be raised to total catches, 30 specimens, is the same for all species. This number may be insufficient for species having a wide length frequency distribution, as it is the case with the swordfish.

17. In addition, certain length classes (80-83cm, 164-167cm, 249-252cm) are poorly represented in the length frequency distributions derived from both the samples and the CAS for Japan over the entire time series. These gaps originate in the conversion (deterministic) of swordfish lengths from measurements of eye-fork length to lower-jaw fork length, as the measurements reported by Japan refer mostly to eye-fork length measurements aggregated into 5cm length classes.

18. The WPB noted the issues identified above and stressed the need for countries having fisheries catching significant amounts of swordfish to revise their sampling schemes to incorporate the collection of length frequency data by sex. The WPB further noted that the decrease in sample size in recent years is a concern and urged countries, in particular Japan, Seychelles (longline) and Taiwan,China (fresh-tuna longline), to increase sampling coverage to ensure that the size data collected are representative of the fishery concerned.

19. The WPB expressed concerns about the effects that the above issues may have on the assessments of swordfish.

20. The WPB acknowledged the work undertaken by the Secretariat in the preparation of data

2. INFORMATION ON BIOLOGY, ECOLOGY, OCEANOGRAPHY AND FISHERIES RELATING TO BILLFISH

Reproductive biology of swordfish

21. Document IOTC-2009-WPB-03 and 04 described new information on the reproductive biology of swordfish in the Indian Ocean. The reproductive dynamics of swordfish (*Xiphias gladius*) was investigated from catches of the Reunion Island-based longline swordfish fishery between 19–25 ◦S and 48–54 ◦E. Thus, 1727 swordfish (size range 75–289 cm, lower jaw-to-fork length, LJFL) were sampled on board commercial fishing vessels during the period of May 1998 to January 2001. Reproductive activity was assessed using macroscopic gonad characteristics, trends of gonadal indexes for both sexes, oocyte size-frequency distributions and microscopic investigation of oocyte development stages. Size at first maturity (L50) for female and male swordfish was estimated in Indian Ocean for the first time. L50 was estimated at 170 cm and 120 cm (LJFL) for females and males, respectively. Spawning occurred from October to April (figure 16) in the vicinity of Reunion Island where sex ratio of caught populations fluctuated seasonally. The seasonal changes in sex ratio and the incidence of larger individuals at the beginning of the spawning season provide some preliminary indications of synchronized movements of swordfish between spawning grounds and neighbouring regions. An overview of the available information on reproductive biology and dynamics of swordfish in Indian Ocean and eastern Pacific indicated that spawning activity is localized in discrete areas (figure 17), and showed that there is incomplete information on spawning grounds in this extended area.

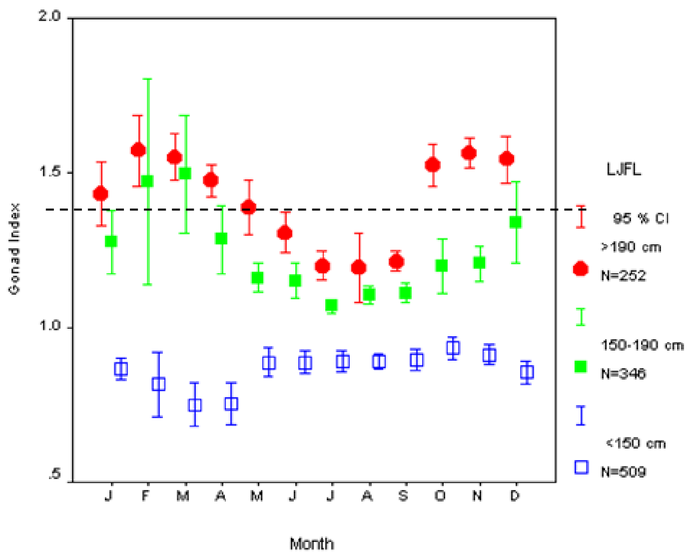


Figure 16. *Monthly variation in mean Gonad index (IGH) of females in the vicinity of Reunion Island. Error bars are 95% confidence intervals. Threshold value (1.375) of the Gonad index defined by Hinton et al (1997) above which females should spawn shortly. From document 2009- IOTC-2009-WPB-04.*

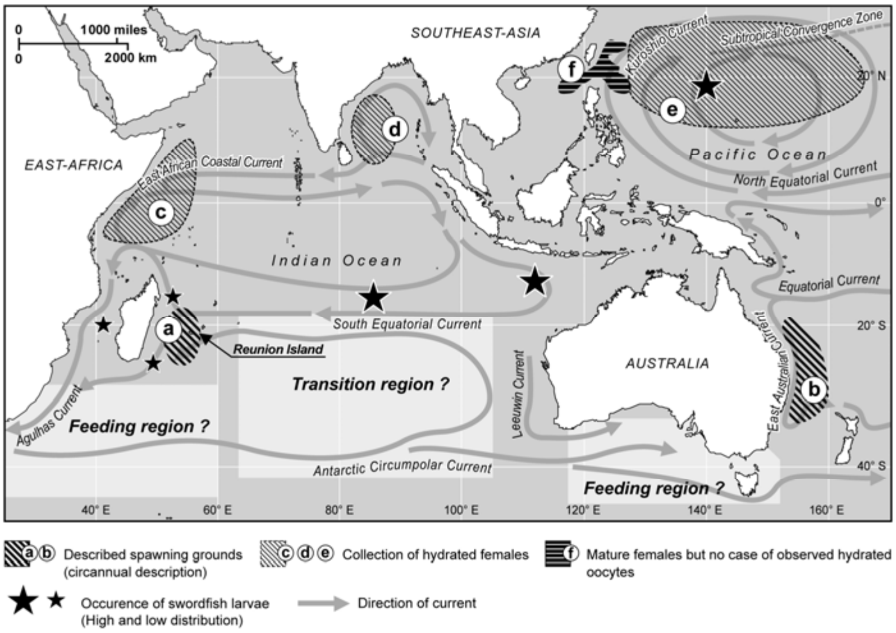


Figure 17. *Map showing all available information on the reproductive biology of swordfish in Indian Ocean and in the western Pacific Ocean. From document 2009- IOTC-2009-WPB-03.*

22. Batch fecundity and relative fecundity of swordfish (*Xiphias gladius*) in the southwestern Indian Ocean were estimated from seven gravid swordfish females (size range 127–225 cm lower jaw-to-fork length, LJFL) with unovulated, hydrated oocytes collected onboard Reunion-based (France) longline swordfish fishing vessels between December 1999 to January 2001. To investigate the spawning pattern of swordfish, data were collected through a combination of two at sea sampling regimes. A total of 17 007 geo-located size data of swordfish were recorded during 8 years (1993-2001) and a total of 1727 (size range 75–289 cm, LJFL) swordfish gonads (1107 females and 620 males) were sampled from May 1998 to January 2001. The estimated batch fecundity ranged from 995 000 hydrated oocytes for the smallest ripe female to 4.3 millions for the largest female sampled measuring respectively 127 to 225 cm in curved length (LJFL). The relative fecundity ranged from 25 to 72 hydrated oocytes per gram of body weight. It was found that batch fecundity was positively correlated with fish length and that the older/larger females have earlier and longer spawning seasons than younger/ smaller females. These findings suggested that older/larger females which are seasonally migrating in this spawning ground seem to play a major role in reproductive success of the species in producing significantly more offspring than younger females during an extended spawning season. Examination of the length-frequency date from the fishery indicated that the young fish are resident around Reunion and around the seamounts off Reunion Island.

23. Older/bigger females which are seasonally migrating seem to play a major role in reproductive success of the species by producing significantly more offspring than younger females during an extended spawning season. Swordfish stocks have been under a high fishing pressure for decades in this part of the world and may be affected by the phenomenon called "size and age structure truncation" which could induce decline in age and length at maturity and finally lower population productivity Conover and Munch 2002). Moreover, Berkeley *et al*. (2004), Longhurst (2002) proposed the Big Old Fat Fecund Female Fish (BOFFFF) hypothesis suggesting that these individuals are more biologically valuable due to their age and reproductive abilities. If this hypothesis is confirmed for swordfish, the removal of the larger, older individuals could be detrimental for this stock and the current results should be used to support new policies to preserve population age structure and to allow escapement of unwanted sized fish.

The French longline fishery

24. Document IOTC-2009-WPB-07 described the current status of the French longline fishery focusing on the La Reunion swordfish fishery. The first longliner started in 1991 and currently there are 46 vessels averaging just under 15 metres in length, operating in the fishery (figure 18) and fishing in the South West Indian Ocean (between 10°S,45°E and 30°S,60°E).

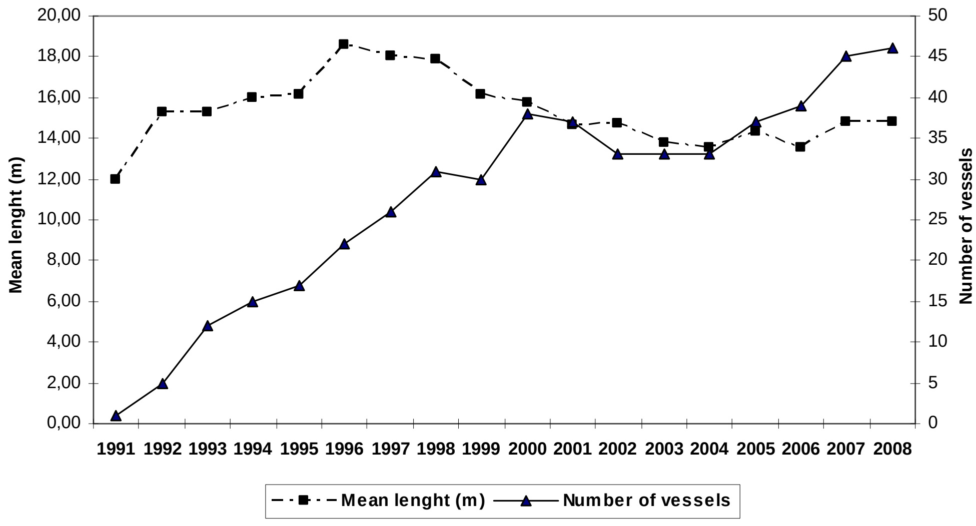
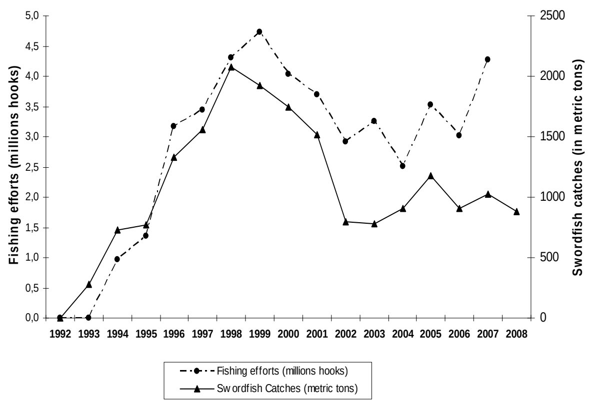


Figure 18. *Number of French longliners and their mean size over the period 1991 to 2008. From document IOTC-2009-WPB-07.*

25. The fleet mainly targets swordfish but also retains other species like tuna, dolphin fish, other billfishes, sharks and wahoos. In 2000, the catch comprised around 50% swordfish while in recent years this has dropped, to around 35% in 2008. According to fishermen, the La Réunion longline fleet is still targeting swordfish, but their strategy is also dependant on tunas, with fishing grounds east of Madagascar (targeted for bigeye tuna) during the winter time and those around La Réunion targeted for albacore during the summer time.

26. Effort steadily increased from 1994 to 1998 (reaching more than 4 million hooks) and then decreased to 3 million hooks in 2006 (figure 19a). After a peak of catches in 1998 (2,000 tonnes), annual swordfish catches have recently stabilized at around 1,000 tonnes (Figure 19a). However, the CPUE for this species has been declining since 1994 (Figure 19b).



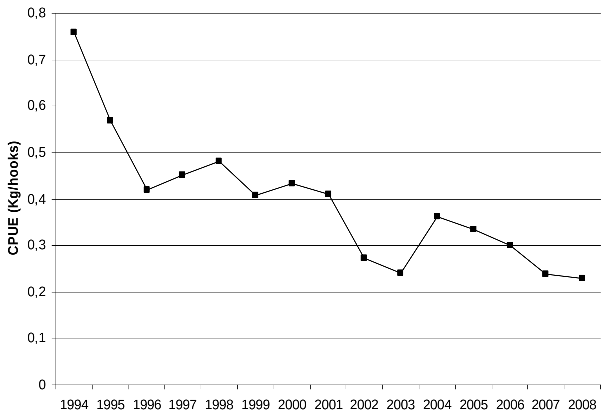


Figure 19. *Catch and effort (a) and CPUE (b) of swordfish caught by La Réunion longline fishery from 1994 to 2008. From document IOTC-2009-WPB-07.*

27. Since 1994, IFREMER has sampled the size of swordfish caught by the French longliners fleet operating in the Indian Ocean. In 2008, 1654 swordfishes were measured (Lower Jaw Fork length – LJFL) and the average LJFL of swordfish was 161.6 cm (Figure 20).

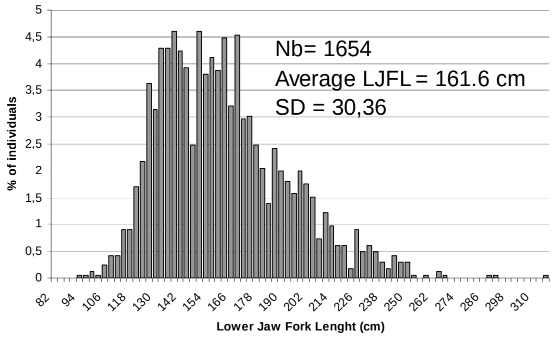


Figure 20. *Distribution of size (LJF length) of swordfish caught by La Reunion's longliners in 2008. From document IOTC-2009-WPB-07.*

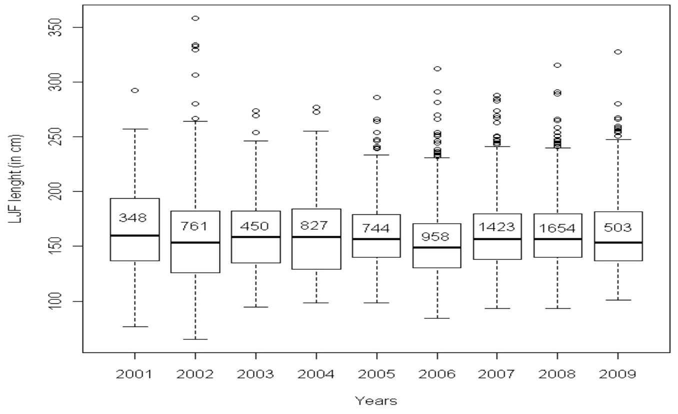


Figure 21. *Evolution of the distribution of the mean size of swordfish (Boxplot) caught by La Reunion's longliners from 2001 to 2008. From document IOTC-2009-WPB-07.*

28. Based on size data collected since 1994, there has been no significant change in the average size (LJFL) of swordfish caught by the French longliners operating in the South West Indian Ocean (Figure 21).

29. The other billfish species caught by the French longline fishery are sailfish (*Istiophorus platypterus)*, shortbill spearfish (*Tetrapturus angustirostris)*, blue marlin (*Makaira mazara)*, black marlin (*M. Indica)* and striped marlin – (*T. Audax)*. In 2008, this fleet caught 100 tons (4.2% of total catches) of other billfishes (2.7%, 1.0 and 0.5 of marlins, sailfishes and spearfishes, respectively) (Figure 22).

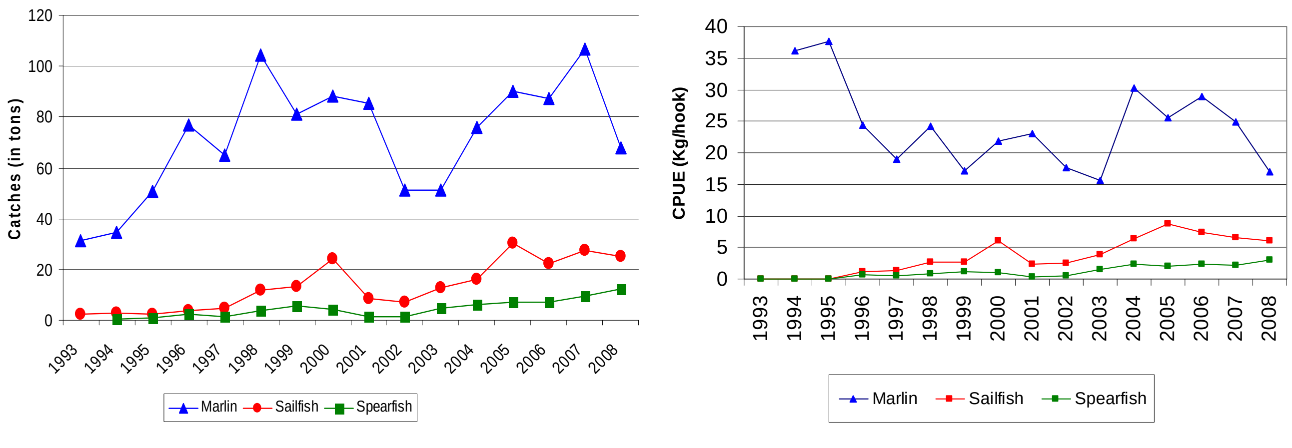


Figure 22. *Evolution of the catches (left) and CPUE (right) for other billfishes (marlins, sailfishes and shortbill spearfishes) caught by La Reunion's longliners from 1993 to 2008. From document IOTC-2009-WPB-07.*

The La Reunion coastal fishery

30. The Reunion coastal fleet comprised 210 active boats in 2008 (203 in 2007) which use hand-line and troll-line gears. Two coastal fleets fish for large pelagic fishes: one targeting only large pelagic fishes (30 boats in 2007) and another targeting both benthic fishes and large pelagic fishes (170 boats in 2007). Estimates of effort for the large pelagic fishes, are difficult to obtain because, despite data reporting being obligatory since 2006, the levels of reporting have been variable and landings are uncertain. Work is being undertaken to improve this situation with interview sampling being conducted at the different harbours of the island.

Advice from the WPB for future work

31. The WPB noted that analyses of CPUE should take account of the component of the fleet that switches targeting between swordfish and tunas. Standardization of the Reunion CPUE series would take into account targeting factors and the WPB recommends that a standardized series should be presented to the next Session.

32. The WPB noted that while the Spanish and Portuguese fleets are operating in the same areas as the La Reunion fleet and also targeting swordfish, the species composition was very different, with larger proportion of swordfish in catches made by the other European fleets. This is possibly due to different targeting depths and should be investigated.

Seychelles semi-industrial longline fishery

33. Document IOTC-2009-WPB-13 described the evolution of the Seychelles semi-industrial longline fishery, a monofilament longline fishery targeting mainly swordfish and tuna and operated solely by Seychellois fishers. The local pelagic longline fishery targeting swordfish started in Seychelles in 1995. In 2008, a total of 72 longline fishing trips were conducted by 7 semi-industrial long fishing vessel targeting swordfish and tuna compared to 40 trips conducted by 4 vessels during the previous year (figure 23).

34. The total landed catch for 2008 was estimated at 233 tonnes compared to 248 tonnes reported in 2007, this represents a decrease of 6% (figure 24). The CPUE for swordfish has decreased from 0.86 tonnes/1000 hooks in 2005 to 0.28 tonnes/1000 hooks in 2008 (figure 25). The average species composition over the last 5 years was dominated by swordfish making up 52% of the total catch, and followed by bigeye (21%) and yellowfin tuna (20%) (figure 26). Since 2005, however, the proportion of tuna caught by the semi industrial fishery has increased and in 2007, for the first time since the beginning of the fishery, tuna (125 Mt) dominate the catch accounting for 51% of the total catch. In 2008 tuna still dominated the catch, with 103 tonnes caught compared to 98 tonnes for swordfish.

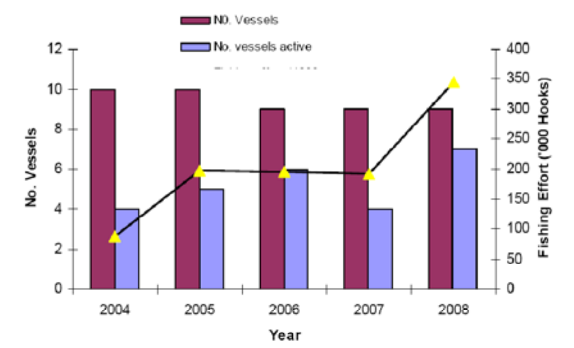


Figure 23. *Number of vessels active and fishing effort of semi Industrial fishery, 2004- 2008. From document IOTC-2008-WPB-13*

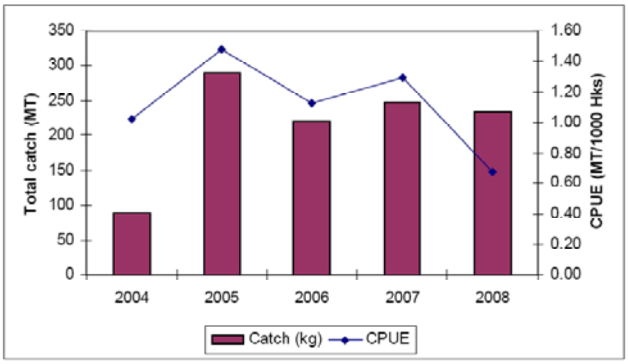


Figure 24. *Catch and catch rate of semi Industrial fishery targeting swordfish or tuna, 2004- 2008. From document IOTC-2009-WPB-16*

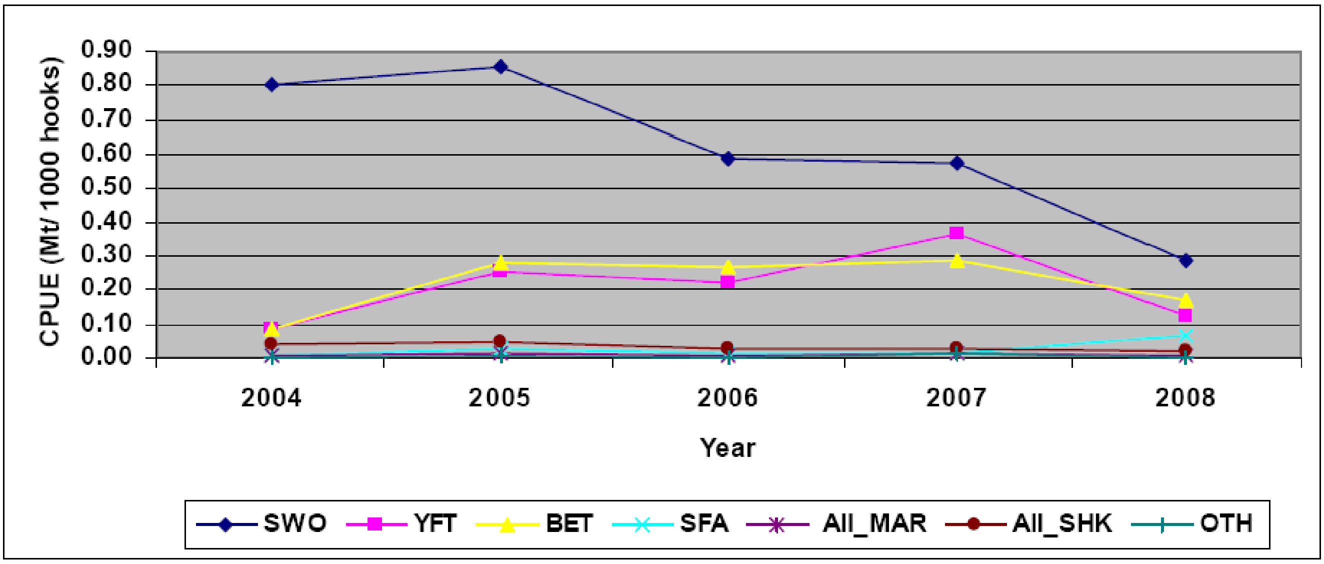


Figure 25. *Catch rate (t/1000 hooks) by species of semi Industrial fishery, 2004- 2008. From document IOTC-2009-WPB-13*

35. Over the past 5 years, a total of 1221 swordfish were sampled for size frequency data, representing 13% of the total swordfish catches. The mean PAL (pectoral to anal length) of swordfish over the past 5 years was 54.1 cm (figure 27).

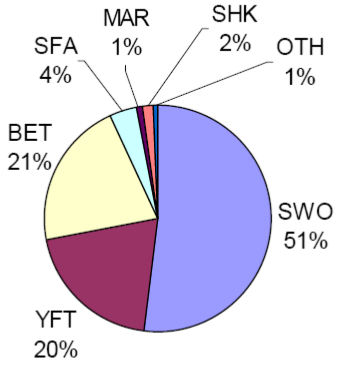


Figure 26. *Average Species composition of semi Industrial fishery for the 2004- 2009 period. From document IOTC-2009-WPB-13*

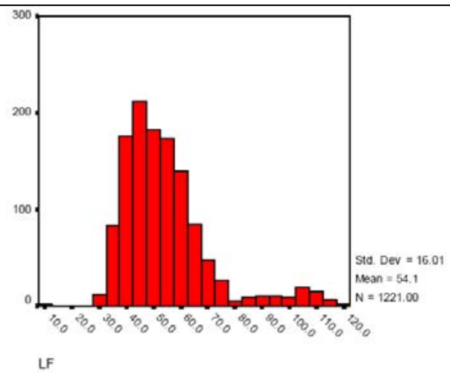


Figure 27. *Swordfish size frequency distributions (PAL in cm) from fish landed by Seychelles' longliners in Victoria for the period 2004 - 2008 (n=1221). From document IOTC-2009-WPB-13*

36. During 2008 a total of 4 vessels, in the semi-industrial longline fleet have continued to target sharks. Only a small proportion of shark carcasses are landed, with most shark finned and the meat discarded at sea. A total of 33 fishing trips targeting sharks were conducted in 2008 compared to 60 trips in 2007. The total quantities of shark meat and fins landed were 21.02 and 8.88 tonnes, respectively. Compared to 2007, this represents an increase of 3% in shark meat landed and a decrease of 52% in fins landed.

Advice from the WPB for future work

37. The WPB thanked Seychelles for the information provided noting that, while the report contained information for the semi-industrial longline fishery, it did not cover the activities of the large-scale longline fleet that operates under Seychelles flag. The WPB requested that Seychelles considers presenting billfish data collected for both longline fleets at future meetings.

38. Following a question from the WPB, Seychelles confirmed that they are still plans to standardize the CPUE series, with assistance from the Secretariat, and will present these results at the next Session.

Billfish in Indonesia fresh tuna longline fishery

39. Indonesia has a well-established offshore fishery targeting tuna. Although there is no target fishery for billfish, catches of these species by Indonesia contribute significantly to billfish production in the Indian Ocean. Billfish production in Indonesia has shown an increasing trend since the early 1990's, matching increases in tuna production and reaching around 5,000 tonnes in 2007 (figure 28). In terms of species composition, swordfish dominates and contributes around 40% of billfish catchin 2007. Longlines are the dominant fishing gear in all areas, while troll lines and hand lines operate as a combination of gears. Sailfish is caught as incidental catch in coastal, small-scale fisheries targeting surface tuna species. Training of port sampling teams in data recording protocols is needed to improve estimation of billfish catches.

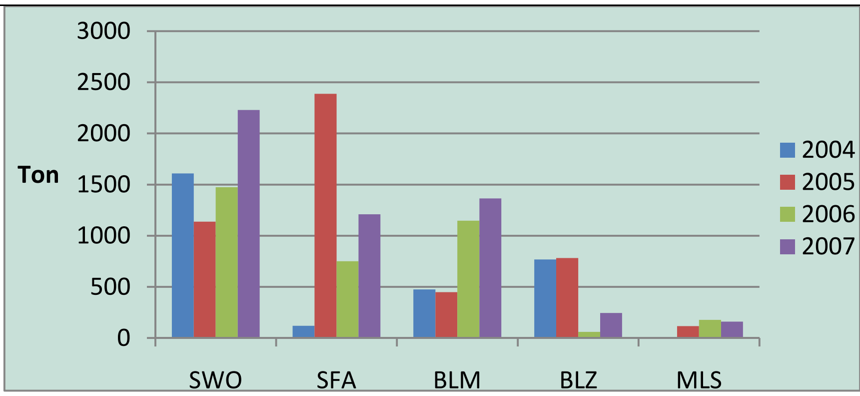


Figure 28. *Billfish production from Indian Ocean Waters of Indonesia 2004-2007*

Advice from the WPB for future work

40. The WPB welcomed Indonesia's participation to the meeting and the information provided, noting that Indonesia is an important fishing nations for billfish species. The WPB encouraged continued participation by Indonesia.

41. The WPB noted that the catch estimates presented by Indonesia have been derived from reports by the fishing sector, and recommended that Indonesia make an effort to reconcile these estimates with those obtained from port sampling, considering also the activities of Indonesian vessels that are not based in Indonesian ports.

Billfish as bycatch of the Purse-Seine fishery

42. The main results of the by-catch estimation and characteristics for the European purse seine tuna fishery and associated flags for the 2003-2007 period (cf. IOTC–2008–WPEB–12) were presented, as well as preliminary estimates of billfish discards for this fishery. Data are based on the French and Spanish observer programmes representing a total of 1958 observed sets (4% of the total number of sets in this period). Estimation used a raising factor based on tuna production (tonnes by 1,000 tonnes of tuna landed) by the fleets. The total by-catch was estimated at 10,487 tonnes, corresponding to 35.7 tonnes per 1,000 tonnes of tuna landed. Tuna discards represented 72.4% of the total bycatch, followed by fish (19.5%), sharks (6%, 2.2t/1,000t), billfishes (1.5%, 0.5t/1,000t) and rays (0.6%, 0.2t/1,000t).

43. The total billfish observed constituted 407 individuals (98 on FADs and 307 on FSC) with a total weight of 41 tonnes (FADs 9 and FSC 32 tonnes), and representing 1.5% of the total discards (2% on FADs and 1% on FSC) and 0.5 tonnes per 1,000 tonnes of tuna landed (0.6 tonnes on FADs and 0.4 tonnes on FSC). From 2003 to 2007, the total discard of billfish fluctuated around 170 tonness a year (125-200 tonnes). Figures raised to the total purse seine fleet (51 boats, see IOTC-2008-WPTT-05 for more details) and disaggregated by species are reported in table 1.

Table 1. *Bycatch of billfish in the purse-seine fishery raised to the total fleet.*

	2003	2004	2005	2006	2007	2003-2007
Total PS commercial catch (1000t)	289.4	265.8	289.0	310.5	196.5	270.2
Total Billfish discards	193.2	180.7	184.1	179.4	115.5	170.6
BLM / M. Indica	57.4	53.0	54.5	54.2	34.7	50.8
BUM / M. mazzara	24.7	23.7	23.7	22.2	14.4	21.8
MLS / T. audax	50.2	48.1	48.2	45.2	29.4	44.2
FIS / Istiophoridae	27.7	28.8	27.3	22.2	14.9	24.2
SSP / T. angustirostris	3.2	2.9	3.0	3.2	2.0	2.9
SFA / I. albicans	26.4	20.8	24.0	29.3	18.0	23.7
SWO / X. gladius	3.5	3.4	3.3	3.1	2.0	3.1

Advice from the WPB for future work

44. The WPB recommended that information on billfish bycatch from the current observer programmes should be compared to historical data from previous observer programmes and be presented at the next meetings.

3. UPDATE OF STOCK INDICATORS

3.1. *Swordfish*

Catch Trends

45. After the beginning of the Japanese longline fishery in the Indian Ocean in 1952, catches of swordfish increased slowly reaching around 4,000 tonnes in 1985. Due to large increase in effort and changes in targeting practices catches significantly increased from the mid-1980s until the mid-1990s, after which time they stabilized at between 30,000 and 33,000 tonnes per year, with a reported catch of 29,892tonnes in 2007 (figure 1).

CPUE Indices

The Japanese longline fishery

46. Document IOTC-2009-WPB-08 described the standardisation of swordfish CPUE for the Japanese tuna longline fisheries in the Indian Ocean over the period 1980-2007, using Generalized liner models (GLM). As in the last Sessions, the 9 sub-areas used in earlier assessments were condensed into 4 areas (Figure 29a) in order to reduce non convergence problems in the GLM analyses caused by missing values. Prior to last year 5x5 degree based catch and effort data had been used. However, it was recognized that such low resolution is not sensitive to fine-scale environmental data such as sea temperature, salinity, shear currents and ocean fronts. In addition, it was recommended during the WPB in 2008 that daily moon phase data be used. Therefore, to match environmental data, daily and fine-scale catch and effort data were used for the current assessment.

47. GLM results suggested that the abundance index (AI) rapidly increased from 1980 to 1988, then decreased gradually until 2006, followed by a sharp increase in 2007. Using daily fine scale CPUE (set by set) data it was found that nominal CPUE are significantly affected by environmental factors such as ocean fronts, shear currents, moon phase and temperature and salinity at the depth at which swordfish is caught (45m) (figure 29b). These findings were not obtained when coarse-scale (5x5) nominal CPUE data were used in the past and demonstrate the effectiveness of using fine-scale CPUE data. AI in the NW showed a gradual decreasing trend, while AI in the SW showed a sharp decreasing trend. By contrast, AI in the East (NE and SE) showed a relatively constant trend (figure 30). Based on the patterns of monsoon-driven ocean currents and consideration of 2 spawning areas (around La Reunion and off south Java Island, Indonesia), it was hypothesized that there may be three stocks in the Indian Ocean (SW, NW and E stocks) which intermingled at the borders.

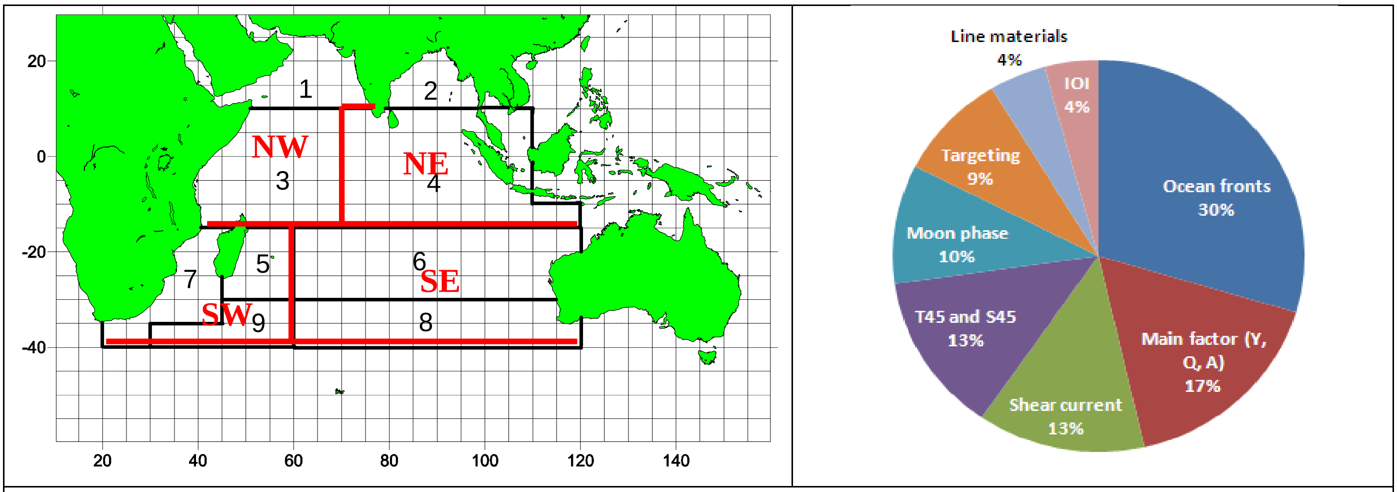


Figure 29a. *Areas used in the standardisation of swordfish CPUE from the Japanese and Taiwanese tuna longline fisheries in the Indian Ocean. From document IOTC-2008-WPB-03 ;**b.** Factors affecting the nominal CPUE based on the GLM analyses for the Japanese set by set catch and effort data.*

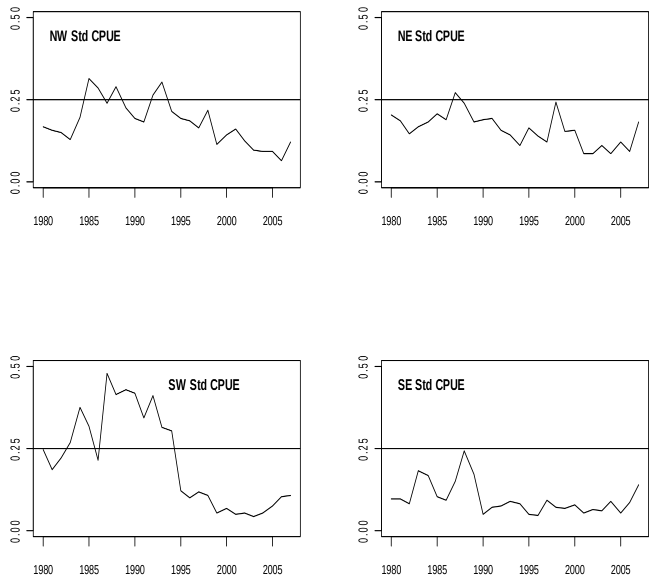


Figure 30. *Standardised CPUE index for the Japanese longline fleet 1980 to 2007 in four areas of the Indian Ocean in nb of fish/1000h. IOTC-2009-WPB-08.*

48. The WPB noted the uptake by Japan of the recommendation, made at the previous Sessions, that set by set data be used for the CPUE standardization and discussed the improvements that use of detailed data has provided for the integration of environmental data in the model. It was recommended that Japan continue to use this approach in the future.

49. The WPB noted the significant decline in AI for the SW area and identified that this could be a consequence of various factors including the environmental heterogeneity of the area, targeting issues and specification of the model (*eg*. interactions between environmental factors and spatial patterns in the fishery). Technological changes leading to an increase in tuna catch rates (*eg*. changes in longline fishing depth, number of hooks between floats) might have had a potential negative impact on swordfish catchability and CPUE. Figure 31 shows the distribution in effort before and after 1995 for the Japanese and Taiwanese longline fleet, clearly indicating the move of the Japanese fleet from the southern bluefin tuna fishing grounds to northern fishing areas.

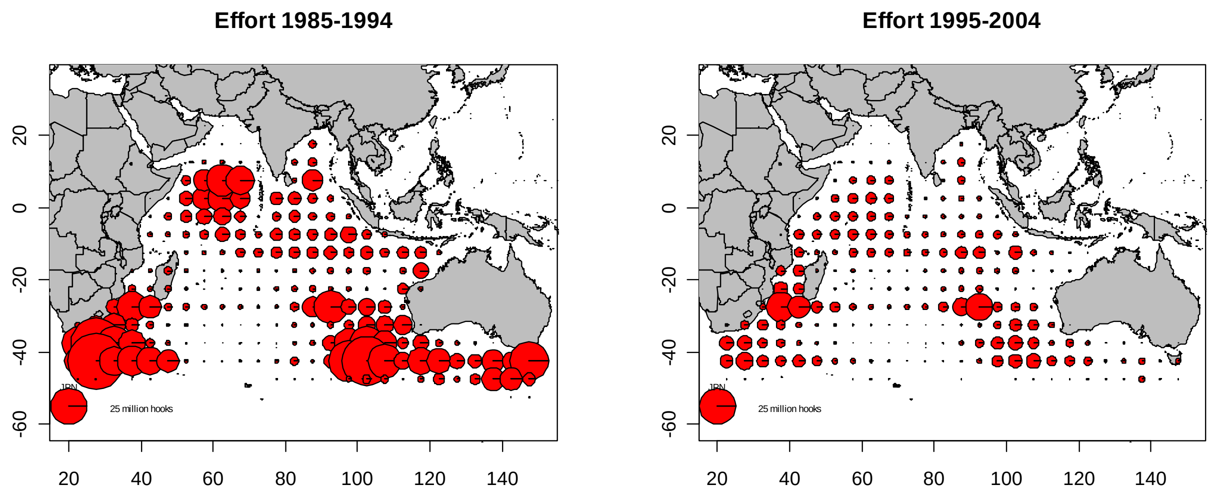


Figure 31. *Effort of the Japanese longline fleet before and after 1995.*

50. Figure 32 demonstrates that the SW area used for the assessment is very heterogeneous grouping three different ecosystemic area as described by Longhurst, the Indian South Subtropical Gyre (ISSG), the Southern Subtropical Convergence (SSTC) and the Eastern Africa Coastal (EAFR). Also the distribution of swordfish catches since the beginning of the fishery (between 1952 and 2007) show heterogeneous patterns in the SW area with the largest catches occurring in the EAFR.

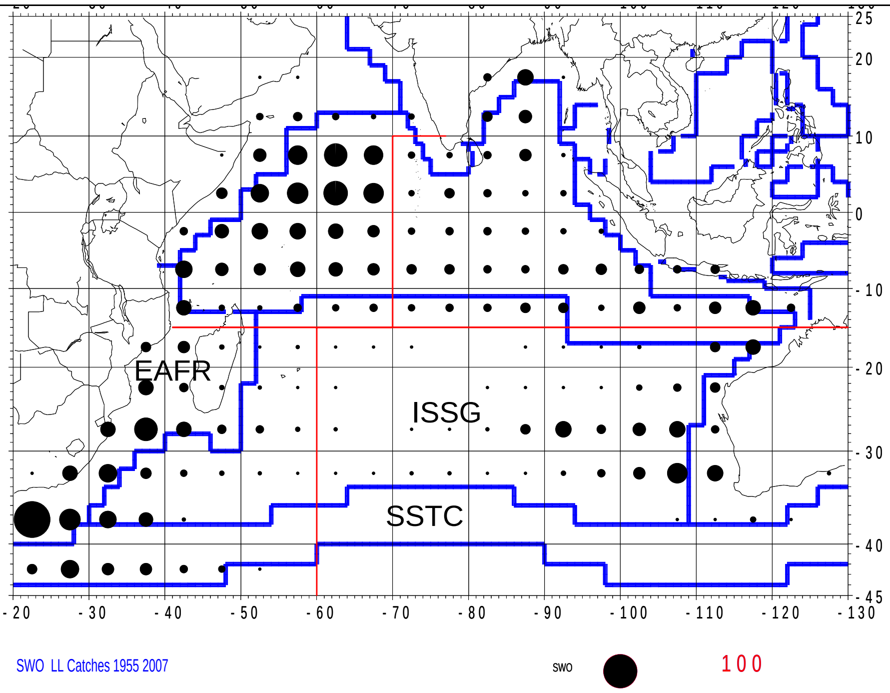


Figure 32. *Catches of swordfish between 1955-2007 in the Longhurst areas (in blue) and in the areas used for the stock assessment (in red).*

51. Consequently, the WPB recommended that the SW area be further investigated using alternative time/area strata and additional standardized CPUE series (*eg.* La Réunion, Spain and South Africa).

The Taiwanese longline fishery

52. Document IOTC-WPB-2009-12 described the swordfish CPUE standardization for the Taiwanese longline fishery in the Indian Ocean for the period 1980-2007 using a GLM. Before 1994, only 5x5 data were available. Thereafter, 1x1 data have been recorded for most data sets. In addition, information on the number of hooks between float (NHBF) is only available since 1995. According to the availability of the data, four cases were examined based on daily set-by-set catch and effort data and environment information (Table 2).

Table 2. *Cases used in the standardisation of swordfish CPUE from the Taiwanese longline fisheries in the Indian Ocean.*

Case 1	Data with 5x5-degree information for 1980-2007 are used to standardize CPUE and swordfish catch composition is used as target effect.
Case 2	Data with 5x5-degree information for 1995-2007 are used to standardize CPUE and NHBF is used as target effect.
Case 3	Data with 1x1-degree information for 1994-2007 are used to standardize CPUE and swordfish catch composition is used as target effect.
Case 4	Data with 1x1-degree information for 1995-2007 are used to standardize CPUE and NHBF is used as target effect.

53. The standardized CPUEs in northern areas (NE and NW) fluctuated without obvious patterns. However, the standardized CPUE in the SW area gradually decreased since the early 1990s, and recent CPUE has decreased below the level of the 1980s. The standardized CPUE in SE area also reveals a decreasing pattern after 2002 (figure 33). The area-aggregated standardized CPUE was very stable before the early 2000s, but since then the CPUE has decreased gradually (figure 34).

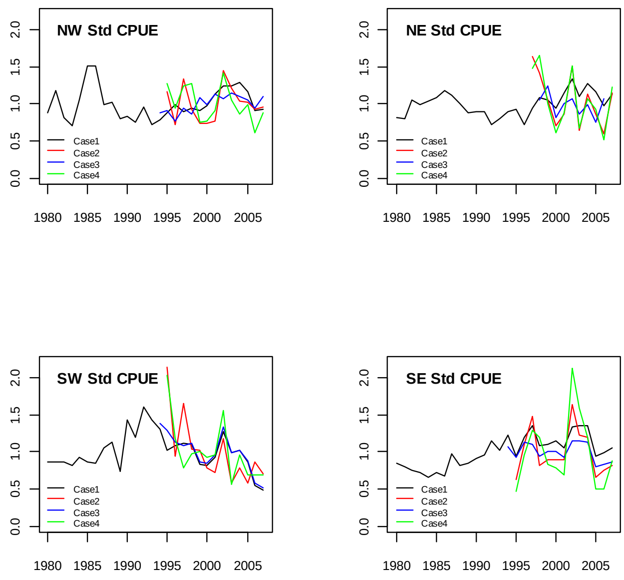


Figure 33. *Standardised CPUE trends for swordfish by the Taiwanese longline fishery in four areas of the Indian Ocean derived using four model cases in nb of fish/1000h. From document IOTC-2009-WPB-12.*

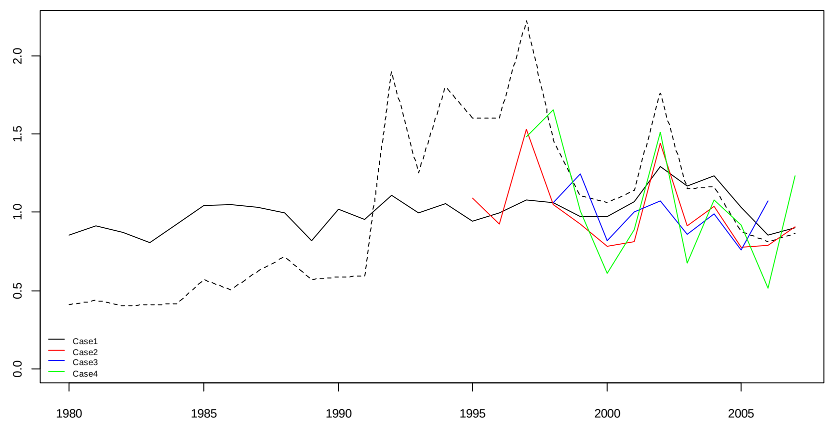


Figure 34. *Standardised CPUE trends for swordfish by the Taiwanese longline fishery in the entire Indian Ocean derived using four model cases. Nominal CPUE is also shown. From document IOTC-2009-WPB-12.*

Average weight trends

54. The annual average weights of swordfish have been variable and without trend over time (Figure 35a). The annual average weight for swordfish reported by longline fleets has been higher (around 50kg) than that reported for other gears (around 20kg). The WPB noted the numbers of swordfish being measured by the major fleets catching this species (Figure 35b) and reiterated its concern about the lack of size data being reported (as shown in Figure 9) recognising that detecting any trend in average size is likely to be influenced by low sample sizes, discard practices and area fished.

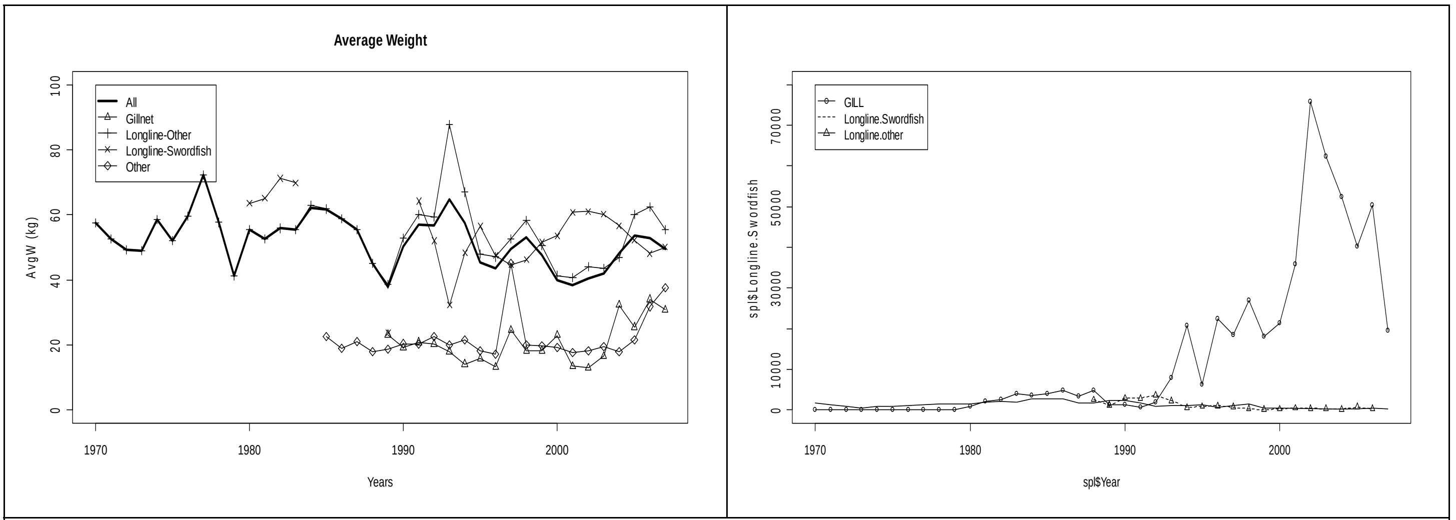


Figure 35. *(a) mean weights of swordfish estimated from longline samples reported by Japanese and Taiwanese fleets (b) numbers of fish measured. Data as of July 2009.From document IOTC-2009-WPB-15.*

Length frequency distributions from catch samples

55. There have been no major trends in the length composition of swordfish catches over time (figure 36); in particular, reductions in the numbers of large swordfish are not apparent. Most fish measured are between 135-195 cm long. Similarly, there were no major changes in the age composition of the catch of swordfish since 1960 (figute 37). Catch-at-Age were estimated using a VB model and swordfish data from the Australian waters in the Indian Ocean (Young, J., and A. Drake, 2004)[1].

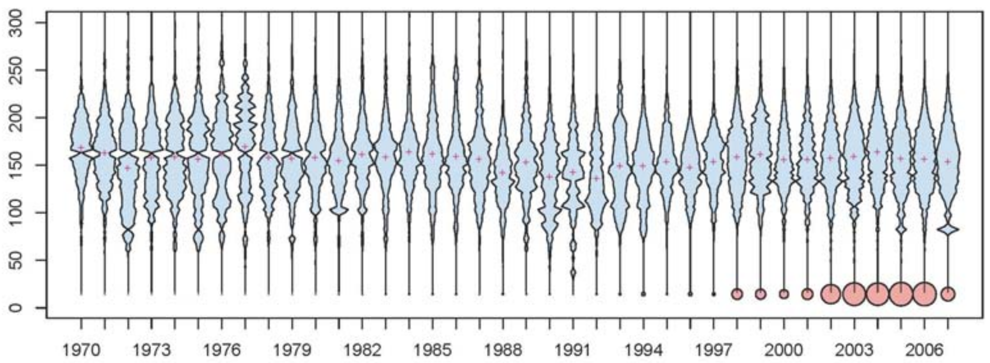


Figure 36. *Length composition of swordfish measured from catches over time (violins) and sample size (red circles). From document IOTC-2009-WPB-15*

[1] Young, J., and A. Drake. 2004. Age and growth of broadbill swordfish (Xiphias gladius) from Australian waters. Final report for project 2001/014, Fisheries Research Development Corporation, Canberra, Australia. 121 pp.

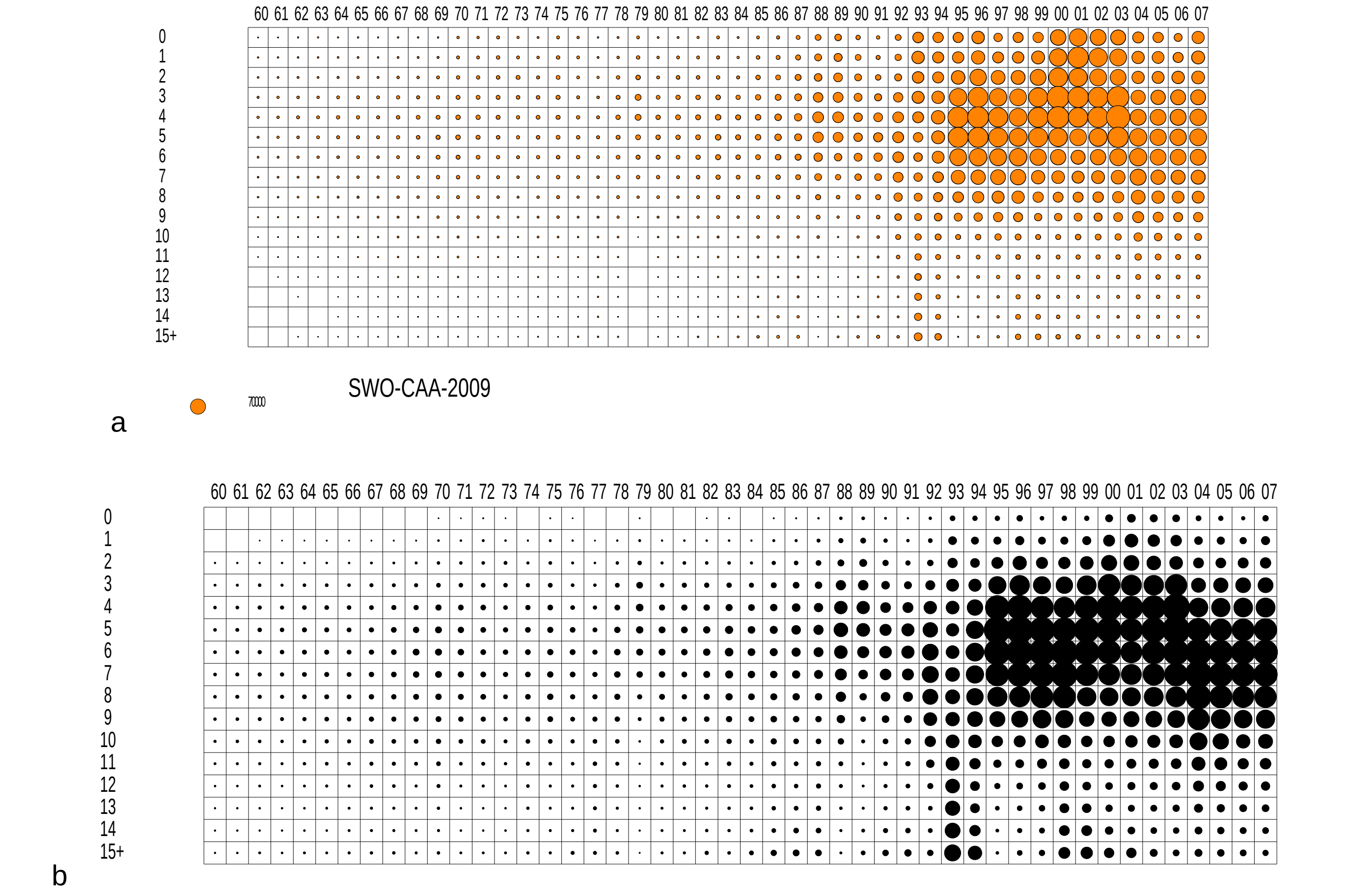
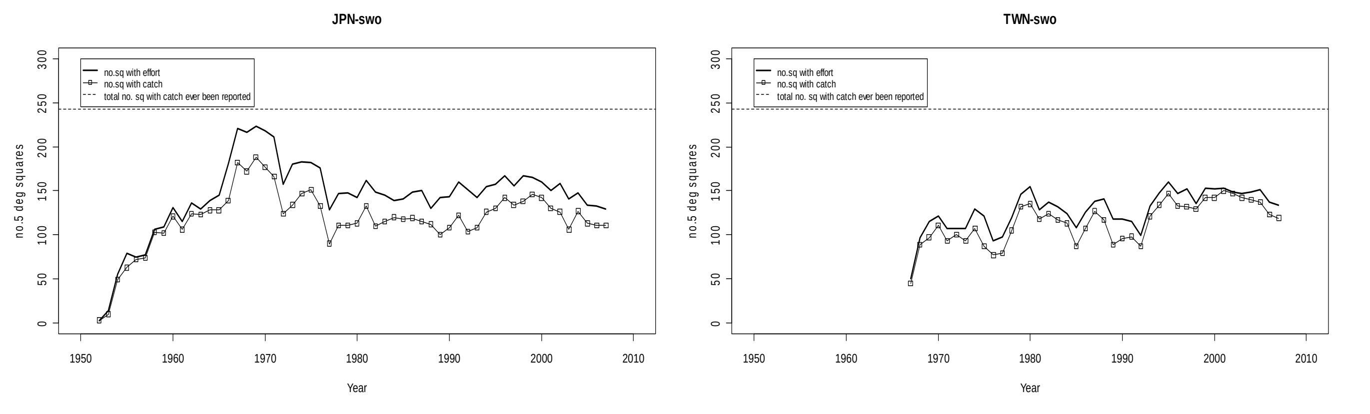


Figure 37. *Distribution of the CAA in a)number and b) weight of fish from 1960 to 2007.*

Areas fished

56. The WPB noted that the expanding and contracting nature of the swordfish fishery over time might have important implications for the interpretation of CPUE as an index of relative abundance. Examination of the numbers of 5degree squares fished with swordfish catches compared to the total number of 5 degree squares fished (Figure 38) shows that the Japanese and Taiwanese fishing grounds are of a similar size. In the case of Japan the change in area fished over time arise from an initial exploratory period and changing numbers of vessels. In the case of Taiwan,China, changes in the area fished may be influenced by the levels of logbook coverage over time. The gap between the two lines may reflect targeting practices. When the lines are close, this may indicate that swordfish is the target species. This is apparent for the Spanish fleet where the number of areas fished and number of areas having catches of swordfish are identical because swordfish is the target of this fleet.



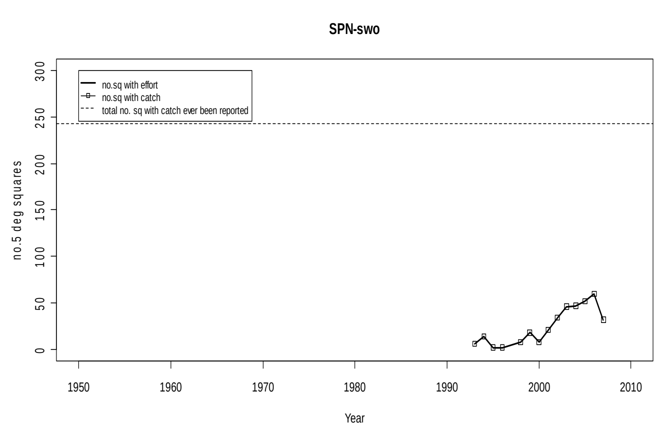


Figure 38. The numbers of 5deg squares fished by the major longline fleets catching swordfish in the Indian Ocean.

3.2. Marlins and Sailfish

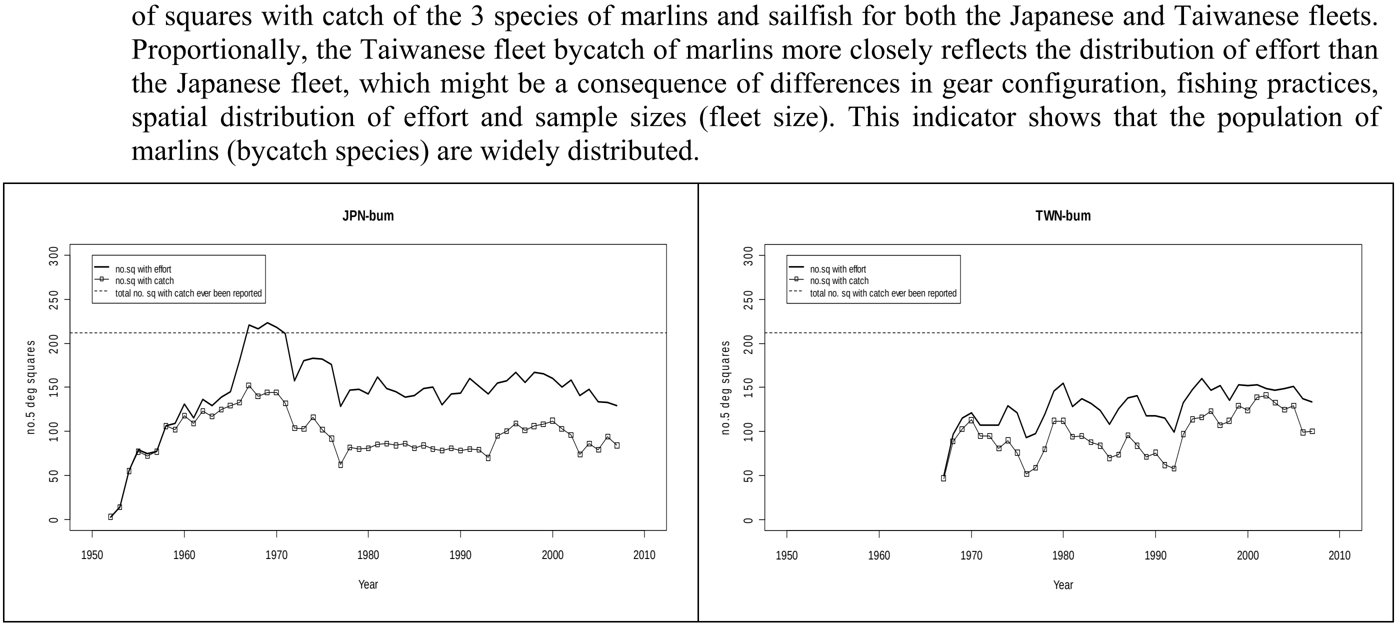
57. Marlins and sailfishes are highly migratory species taken in relatively minor quantities in the Indian Ocean compared to tunas and swordfish. They are not typically targeted by commercial fisheries, but they are targeted by many sports fisheries. Marlins and sailfish are large predators that play an important role in pelagic ecosystems as they may influence the abundance, distribution and behaviour of a wide range of pelagic species.

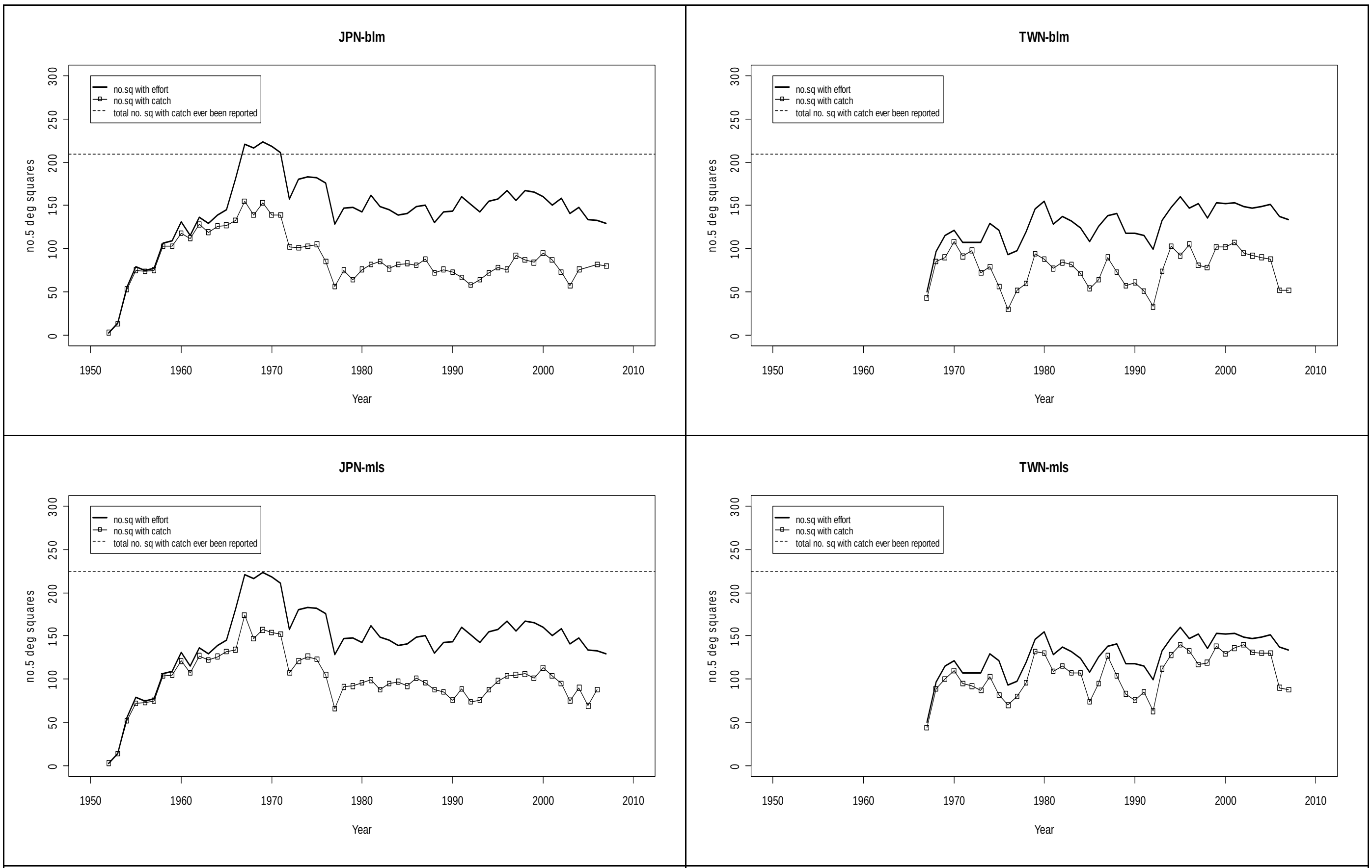
58. Given the paucity of data and the intermittent nature of the fisheries exploiting marlins and sailfish, many of the quantitative stock assessment approaches used by scientists for tunas and swordfish cannot be used on these species and a range of more qualitative stock status indicators invariably become the only available means to follow the status of these populations.

59. Following a request from the WPB in 2008, stocks status indicators have been developed for marlins and sailfish.

i. Blue and black marlin are mainly caught by longlines and gillnets. Their catches, stable from the beginning of the longline fishery until the mid 1980s, increased dramatically during the early 1990s (figure 4a and 4b). Record catches of blue marlin where observed in 1997, while 2006 and 2007 saw an increase of 1,000 tonnes in the catch of black marlin compared to 2005 with catches peaking at around 5,500 tonnes during the last two years. For striped marlin, mainly caught by the longline fleets, the level of catches has been higly variable since 1958, but showing a slight increasing trend (figure 4c). Catches reached around 3,300 tonnes for the last two years.

ii. Annual percentage of fishing effort by area: figure 39 describes the number of squares fished and number of squares with catch of the 3 species of marlins and sailfish for both the Japanese and Taiwanese fleets. Proportionally, the Taiwanese fleet bycatch of marlins more closely reflects the distribution of effort than the Japanese fleet, which might be a consequence of differences in gear configuration, fishing practices, spatial distribution of effort and sample sizes (fleet size). This indicator shows that the population of marlins (bycatch species) are widely distributed.





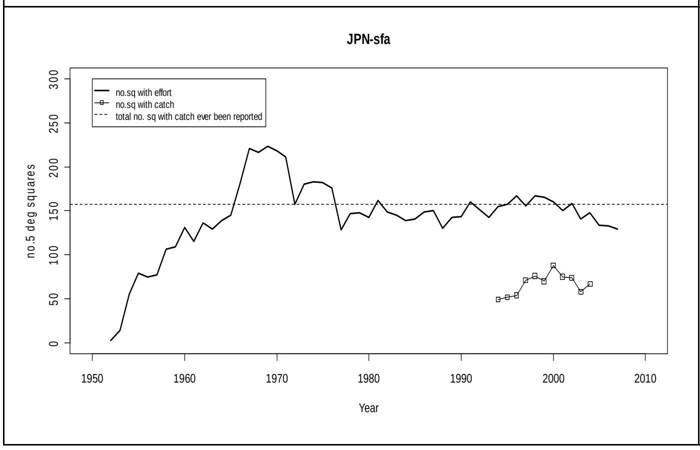


Figure 39. *The numbers of 5deg squares fished by the major longline fleets catching blue marlin (BUM), black marlin (BLM), striped marlin (MLS) and sailfish (SFA) in the Indian Ocean.*

60. Figure 40 shows the trends of nominal CPUE for marlins in two of the major historical fishing zones of the Indian Ocean. A continual decline in this indicator over time may signal that the stock is being depleted. Around the Seychelles, CPUE's show a variable but decreasing trend for each species since the start of industrial fisheries in 1952. A similar trend is exhibited for marlins in north-west Australia (another of the major historical fishing zones).

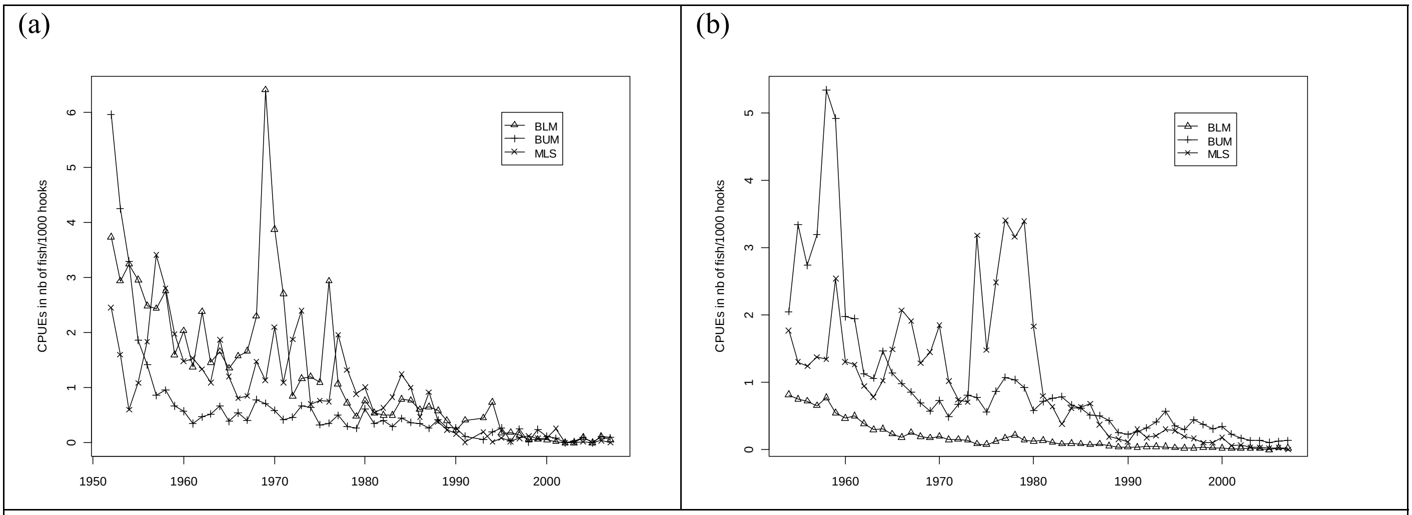


Figure 40. *(a) nominal yearly CPUE (in numbers of fishes / 1000 hooks) of Japanese longliners in the North West Australia area (10-20°S,110-120°E) for blue marlin (BUM), striped marlin (MLS) and black marlin (BLM) (b) nominal yearly CPUE (in numbers of fishes / 1000 hooks) of Japanese longliners in the area around Seychelles Islands (10°N-10°S,50-70°E).*

61. Analyses of catch and SST temperature data by area (figure 41) indicate that Istiophorids are mainly fished by longliners in warm waters at SST over 25°C (93.5 % of their total catches for the period 1952-2007), in equatorial areas of the Indian Ocean and along the East African coast between Madagascar and South Africa (figure 42). Annual nominal CPUEs were calculated for the Japan longline fleet fishing in SST over 25°C (based on the average environmental data, at a 5° quarter level) and show major declines for the 3 species (figure 43), falling to 2%, 6% and 6% of their initial levels (black, blue and striped marlins, respectively).

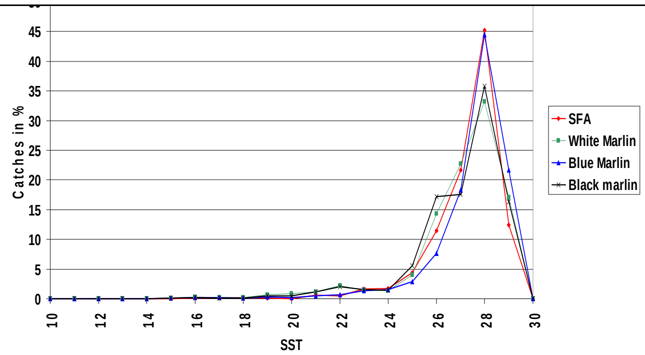


Figure 41. *Catches of all LL fleets as a function of SST (by 5° and quarter) during the 1953-2007 period*

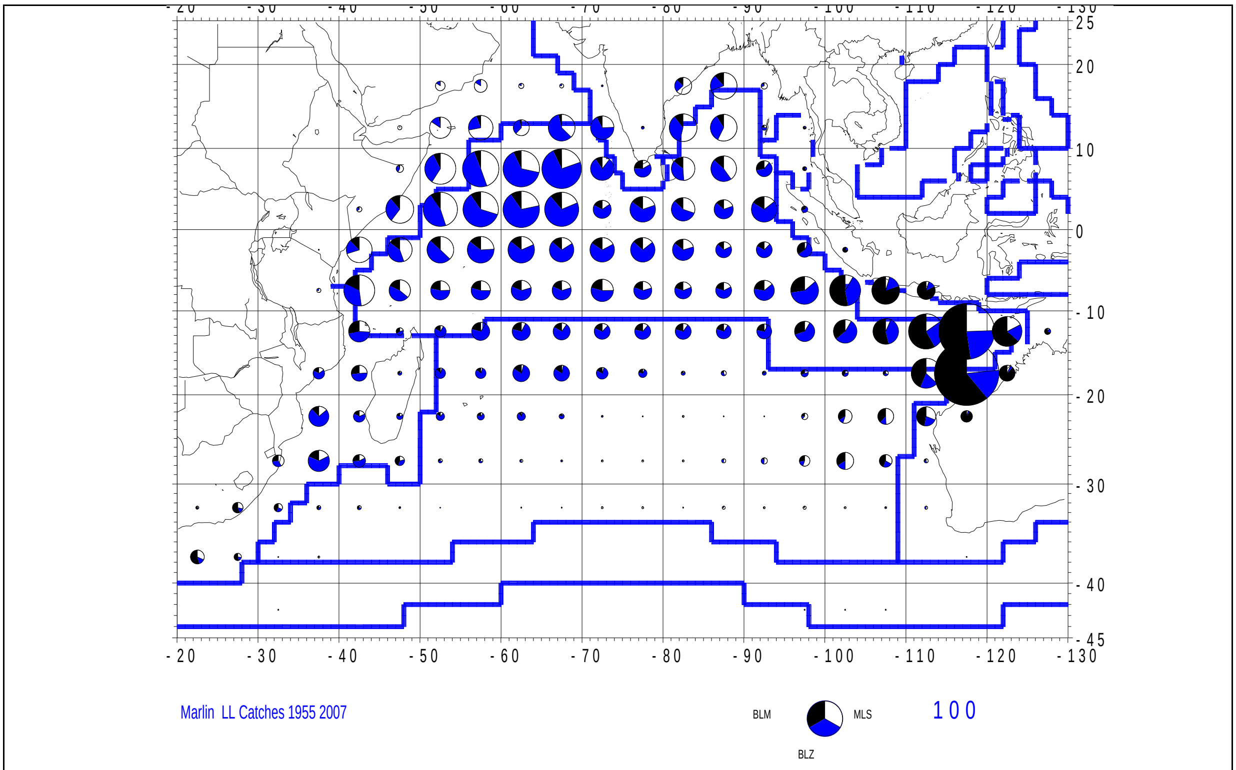


Figure 42. *Average yearly catches of marlins in the IO reported by longline fleets during the 1955-2007 period*

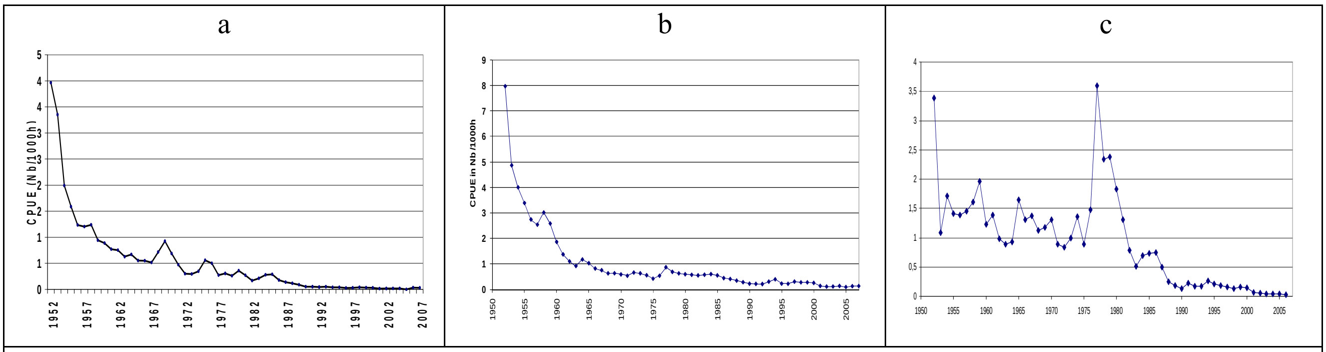


Figure 43. *Longliner Japanese CPUE series in warm waters (SST>25°C) for a. Black marlin,b) blue marlin and c) striped marlin*

62. Figure 44 illustrates an indicator for each marlin species based on the annual total of 5 degree squares in which at least 10 fish were caught. For all species, the index increased from 1952 to 1967, then declined until 1976-77. Since the late 1970s, the index has been variable and without clear trends. The black marlin index is typically lower than those of the other marlins, while the trends of blue marlin and striped marlin indices are similar. A continual decline in this indicator over time may signal that the stock is being depleted.

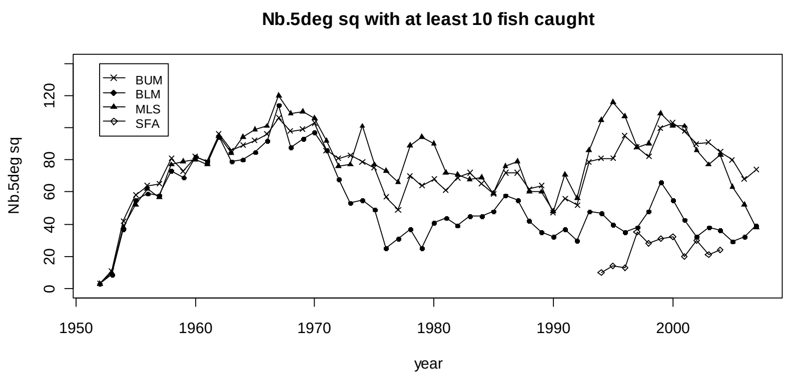
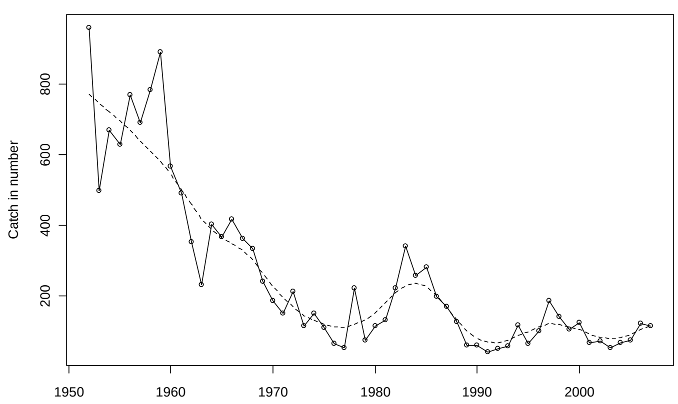


Figure 44. *Number of 5° squares with a minimal catch of at least 10fish of black (BLM) , blue (BUM) and striped marlin (MLS) in the Indian Ocean. From document IOTC-2009-WPB-15*

63. Figure 45 illustrates trends in the annual mean of the three highest monthly catches of each marlin species by Japanese longliners taken by 5 degree squares by month across the entire Indian Ocean. A continual decline in this indicator over time may signal that the stock is being depleted. Each marlin species is showing a variable but declining trend in this indicator since the start of the industrial fishery.



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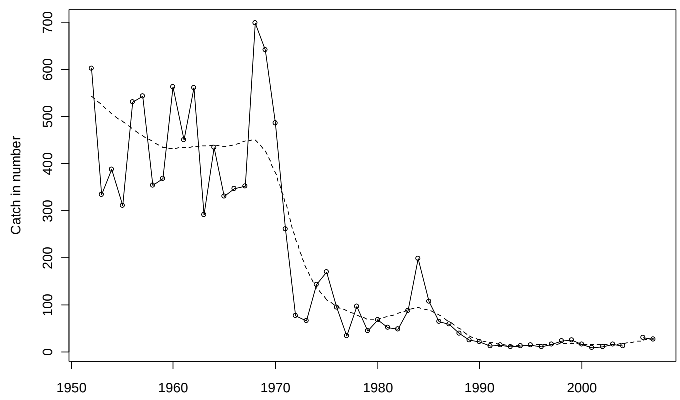

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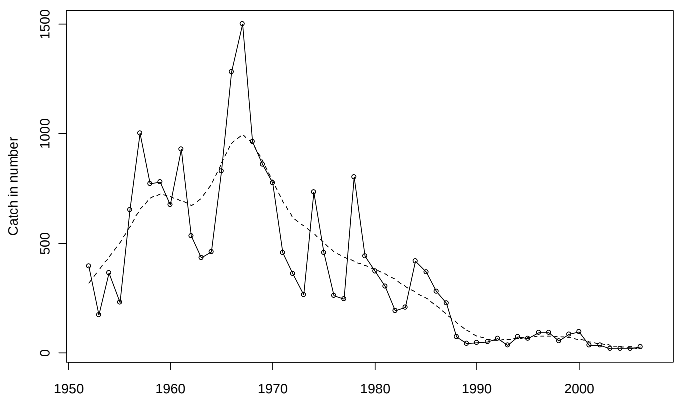


b

Figure 45. *Annual mean of the 3 highest monthly catches of blue marlin (a) black marlin (b) and striped marlin (c)by Japanese longliners taken by 5° squares (in numbers of fishes) for the period 1952-2007, with the general trend showed by a Friedman super-smoother.*

64. The status of all marlin stocks remains uncertain. While these species are not important for their market value, they are of great interest for scientists, due to their potential role in pelagic ecosystems (as billfishes are

probably playing a keystone role in some areas), and also for sport fisheries which often provide a major input to the local economy.

65. The WPB noted that the new indicators presented this year for the marlins are still very preliminary and their interpretation should proceed with caution. There was considerable uncertainty about the degree to which the derived indicators represent abundance.

66. Bearing in mind the uncertainties in catch data, the trend of total yearly catches does not show significant declines for the blue and black marlins in recent years in spite of increasing trends in fishing effort exerted by the combined artisanal and industrial fisheries. However, striped marlin catches have been declining since the early 1990s, possibly indicating overfishing.

67. Conflicting trends between marlin catches and CPUEs may be explained by several factors, in particular:

- poor data quality: under reporting and miss-identification of marlins are currently overarching concern.
- changes in fishing areas: movement of some effort towards areas with lower concentration of marlins.
- gear configuration and targeting practices: technological changes targeting an increase of tuna catch rates (*eg.* changes in longline fishing depth, number of hooks between floats) may have had a potentially negative impact on billfish catchability and CPUEs.
- changes in billfish behaviour

68. Current catch of sailfish in the Indian Ocean are at a similar level to those for swordfish, around 30,000 tonnes. However, this species seems to be widely under reported by both industrial and artisanal fleets. In addition to the general lack of catch and effort data, the historical catch and effort data of the Japanese longline fleet include a mixture of Indo-Pacific sailfish (*Istiophorus platypterus*) and short spearfish (*Tetrapurus angustirostris)*

69. The WPB identified that these trends are similar to the major declines observed early in the development of the Indian Ocean longline fisheries, for which the underlying causes remain uncertain, a situation which also applies in the analysis of the WPB. 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, is a cause for considerable concern. The WPB recommended that a major research project on billfish be develop for the Indian Ocean as soon as possible, which should include improved statistical data collection for industrial and artisanal fisheries, collection of data for the sport fisheries, biological research (ie. growth, reproduction and studies of stock structure using tagging techniques among others), and development of stock assessment techniques dedicated to these species (Appendix IV)

4. STOCK ASSESSMENTS OF BILLFISH

4.1. 2009 stock assessment for Swordfish

70. A range of quantitative modelling methods were applied to the swordfish assessment in 2009, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. Table 5 provides an overview of key features of the different models, Table 6 summarizes key concerns about the use of each model and Table 7 summarizes key reference points. The different assessments were presented to the WPB in documents IOTC-2009-WPB-09, 10 and 11. Each model is summarized in the sections below.

AGE-AGGREGATED PRODUCTION MODEL (ASPIC)

71. During the WPB, an Age-Structured Production Model Including Covariates (ASPIC ver. 5.05) was applied to a stock assessment of swordfish in the Indian Ocean (1952-2007). The main two types of input information are:

- (a) catch by 4 types of gears by year, *ie.* longline (Japan) by catching swordfish, longline (Taiwan,China) targeting swordfish seasonally, (Target) targeting swordfish using the shallow longline settings and gillnet (gillnet & other gears).
- (b) Abundance indices of Japan (1980-2007) and Taiwan,China (case 4) (1995-2007 without the 2002 data, based on the set by set daily data with the targeting correction factor, NHBF: number of hooks between floats).

72. Three scenarii were set up using different abundance indices (AI) (Japan, Taiwan,China and Japan & Taiwan,China combined). Scenario 3 was judged to be the most plausible (AI of Japan & Taiwan,China combined) and gave a MSY of 33,200 tonnes (80% CI: 32,200-34,100 tonnes), F (2007)/F (msy) =0.70 (0.58-0.84), TB (Total biomass) (2007)/TB (MSY) =1.29 (1.14-1.56), K (carrying capacity) =120,000 tonnes and Depletion = TB (2007)/K =0.56. Considering the recent catch level (about 30,000 tonnes), the model suggested that swordfish in the Indian Ocean has been harvested around MSY levels (figure 46).

73. Kobe plots illustrated the ASPIC results are shown in figure 46.

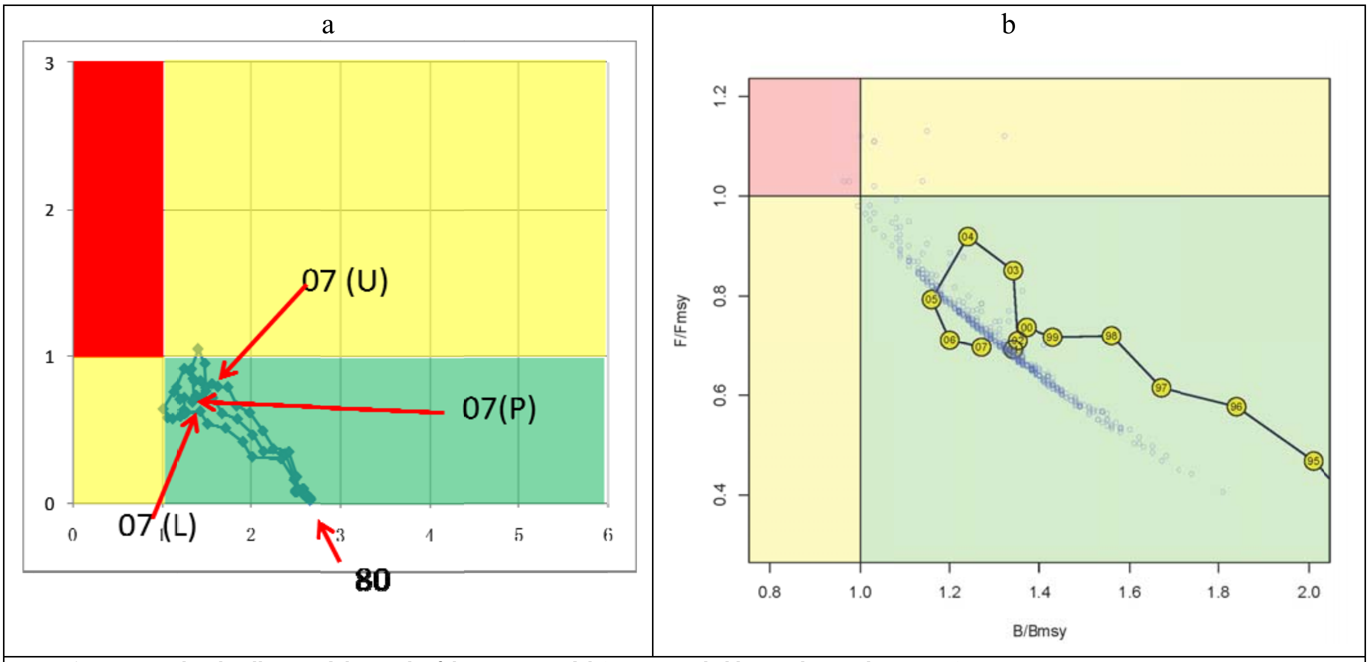


Figure 46. *Kobe plot illustrated the result of the ASPIC model (a. 80% CI, b. blue circles 500 bootstraps)*

74. The WPB recognized that the Indian Ocean swordfish population seems to be reasonably compatible with the assumptions of a deterministic production model at this time and noted that this approach has provided a successful basis for advice and successful management of North Atlantic swordfish in ICCAT for many years. There is little evidence for high recruitment variability, and the smooth "one way trip" character of the fishery is such that transient lags in the population due to complicated age structure do not seem to be causing minimization problems. Furthermore, it was recognized that the production model is likely to be reasonably robust to several problems that potentially affect the more complicated models, *eg*. uncertainty in basic biological characteristics (growth rates, M), limited size data, and high probability of shifting selectivity associated with targeting shifts. The WPB was encouraged to see consistency in the model estimates resulting from use of combined Taiwan,China and Japan CPUEs.

AGE-STRUCTURED PRODUCTION MODEL (ASPM)

75. Working paper IOTC-2009-WPB-09 was presented, describing the application of an Age-Structured Production Model (ASPM) to a stock assessment of swordfish in the Indian Ocean. The two main inputs in this model are the CPUEs series (figure 38) and the CAA (figures 36).

76. Scenarios using the AI of TWN (1995-2007 without 2002, using the set by set data with the correction factor of targeting, NHBF) produced similar and plausible ASPM results to those of Japan but with less fitness (R2=60% for Japan and 35% for Taiwan,China). ASPM could not achieve convergence combining AI of Japan and TWN together. The authors concluded that based on the most plausible scenario using only Japan's AI, F is 30% above MSY while SSB is just above the MSY level (figure 47), which suggests that we should not increase the current F. Three types of CPUE trends (Japan, Taiwan,China and La Reunion) in the SW IO (Indian Ocean) consistently show rapid declining trends. Thus the authors concluded that F should be decreased, especially in SW IO.

77. The WPB noted a number of concerns about age-structured production models in general. In the specific case of the Indian Ocean swordfish population, there are a number of problems with the catch-at-age matrix

including uncertainty with the length-age conversions and non-representative sampling. There is a further problem associated with the estimation of selectivity functions outside of the model. In this application, the assumed selectivities did not seem to be compatible with known observations of large/old fish in the catch distribution. Attempts to try alternative selectivity resulted in numerical convergence problems. Due to these problems, the WPB considered the results of this model to be less reliable than the other models.

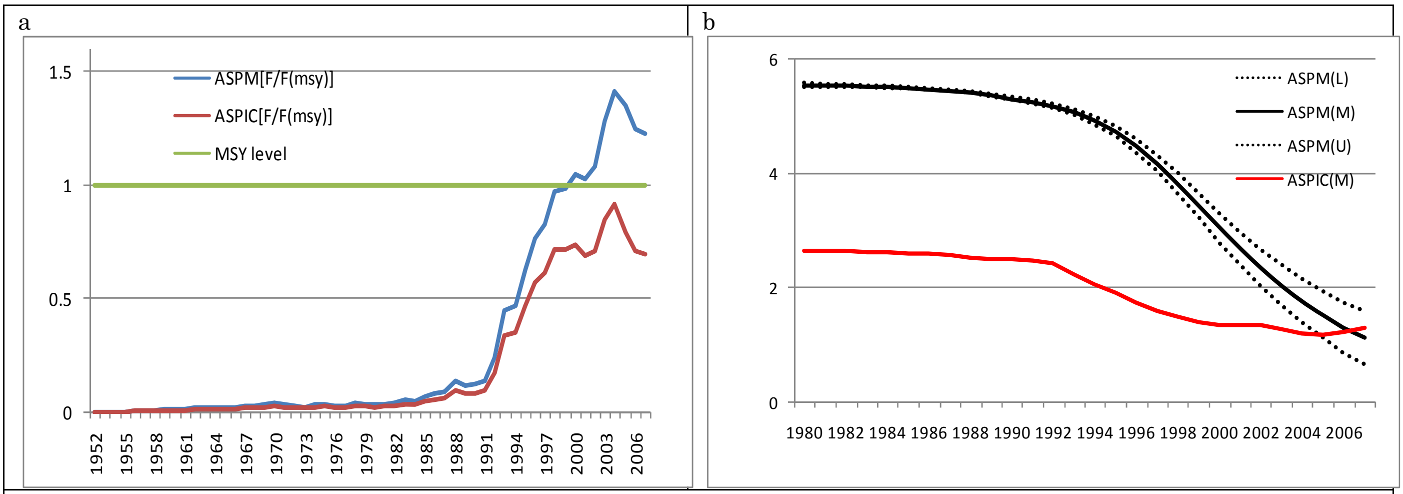


Figure 47. a)*Times series of F/F$_{msy}$ for ASPIC and ASPM, b)SSB/SSB$_{msy}$ for ASPM (in black) and TB/TB$_{msy}$for ASPIC*

78. Kobe plots illustrated the ASPM results are show in figure 48 and compared with the ASPIC results.

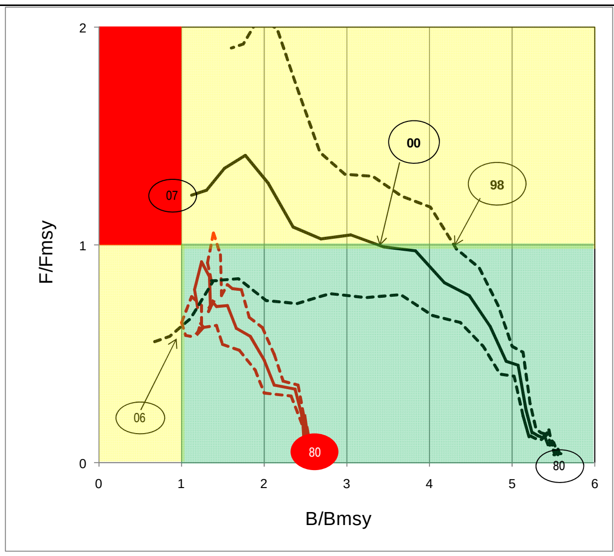


Figure 48. *Results of ASPIC (red) and ASPM (black) with the 80% CI (1980-2007).*

AGE-STRUCTURED INTEGRATED ANALYSIS (ASIA)

79. Document IOTC-WPB-2009-11 was presented describing the preliminary application of an age-structured assessment model to swordfish in the Indian Ocean (Wang, 2007)2. This study explored estimation of the exploitation rates and the spawning biomass by fitting the age-structured assessment model to all catch and size, Japanese and Taiwanese CPUE data, and biological parameters (growth sex ratio and maturity). The CPUE series of Japanese and Taiwanese longline fleets were not consistent. Separating the CPUEs of Japanese longline fleets into two time periods substantially improves the model fits to the CPUEs of Japanese longline fleets. The results indicated that current fishing intensity was about 30-50% of FMSY and the spawning biomass maintained at about 67-87% of S0 and more than triple of SMSY. However, more pessimistic stock status estimates resulted from the assumption that selectivities of all longline fleets are assumed to be logistic curves.

[2] Wang, S. P., C. L. Sun, A. E. Punt, and S. Z. Yeh, 2007. Application of the sex-specific age-structured assessment method for swordfish, *Xiphias gladius*,in the North Pacific Ocean. Fish. Res., 84: 282-300.

80. Biomass and fishing intensity time series trajectories from 5 model specifications from Table 3 are shown in figure 49.

Table 3. *Scenarii used for the age-structures integrated analysis*

Scenario	Description
Sce1	Two time periods for CPUEs of JPLL
Sce2	Two time periods for CPUEs of TWLL-SW and TWLL-SE
Sce3	Two time periods for CPUEs of JPLL, TWLL-SW and TWLL-SE
Sce4	Dome-shaped selectivities for all fleets
Sce5	CPUEs of TWLL from Case4

81. The WPB noted that splitting the Japanese CPUE time series into two time periods was essentially the same as down-weighting this series relative to the Taiwanese CPUE series. The Japanese series declines dramatically, while the Taiwanese series (case 1, 1980-2007) is relatively stable or increasing prior to 2000. The standardization must not be working correctly for at least one fleet. The Japanese fleet is a bycatch fishery with known targeting shifts that likely affect catchability. In the SW region, there was a dramatic drop in Japanese CPUE ~1995 which was not observed in the La Reunion fleet, and appears to be consistent with a fine-scale shift in effort into the Mozambique Channel. In contrast, the Taiwanese fleet is the largest swordfish targeting fleet in the Indian Ocean, and would be expected to increase targeting efficiency over time. The standardized CPUE series from La Reunion and Spain both suggest moderate declines in abundance prior to 2000, but these series are short (and fragmented in the case of Spain). These findings illustrate the fundamental conflict between the two CPUE series prior to ~2000.

82. When the Japanese CPUE was weighted heavily relative to the Taiwanese, the fit to the size composition data was degraded. However, given the uncertainty in assumed growth and mortality rates, and possible selectivity changes over time, it is not clear whether the effect on the size composition fit was critical. The WPB questioned the assumption of logistic selectivity, noting that swordfish have size- and sex-specific distributions, with very large individuals often located in areas where they are not targeted (*eg*. in the SBT fishery). This suggests that a dome-shaped selectivity is reasonable for most fleets. It is important that the sensitivity of the model to selectivity assumptions is recognized.

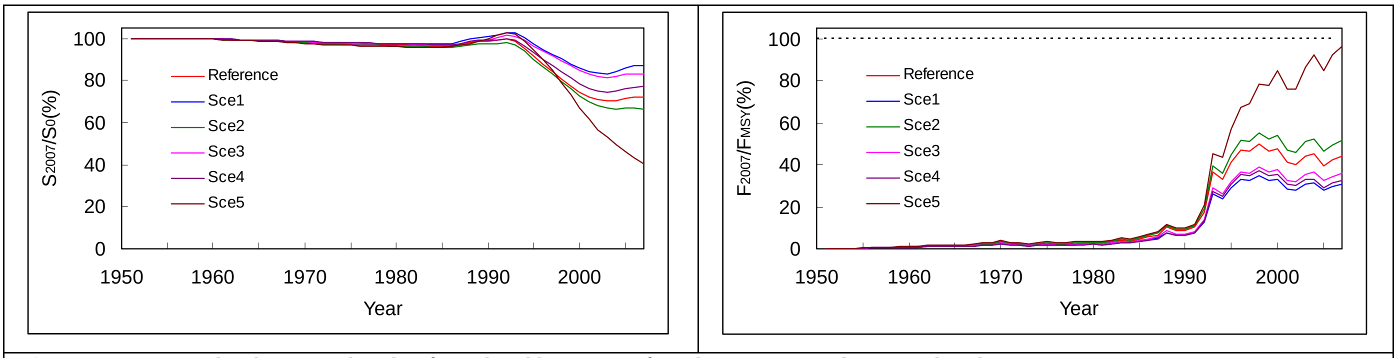


Figure 49 *Biomass and Fishing mortality plots for 5 plausible scenarios from the age-structured integrated analysis*

83. Kobe plots illustrated the ASIA results are show in figure 50.

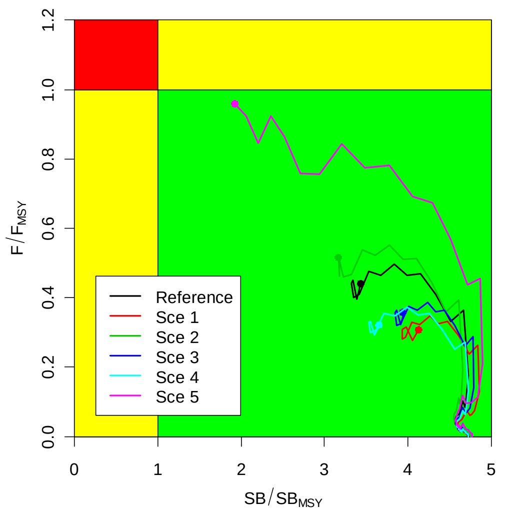


Figure 50. *Kobe plot for results of ASIA based on various scenarios (1951-2007). Circles are estimates for 2007.*

SS3 – SPATIALLY DISAGGREGATED INTEGRATED ANALYSIS

84. Working paper IOTC-2009-WPB-10 was presented, describing a preliminary Indian Ocean swordfish stock assessment using Stock Synthesis 3 (SS3) software. The model population was disaggregated by age, sex, and area (4 regions corresponding to the spatial units used in the Japanese and Taiwanese longline catch rate standardization). The model represented a form of site fidelity in which there is a single spawning stock and permanent residence in the areas of recruitments (<1% chance per year of migrating to an adjacent region). The assessment attempted to integrate the available fisheries data (catch in mass from 24 fleets, standardized CPUE from 3 fleets (Japan, Taiwan,China and La Reunion, disaggregated into 9 longline fleets), catch length composition data from 18 fleets) and biological data (on growth rates, maturity, and stock structure).

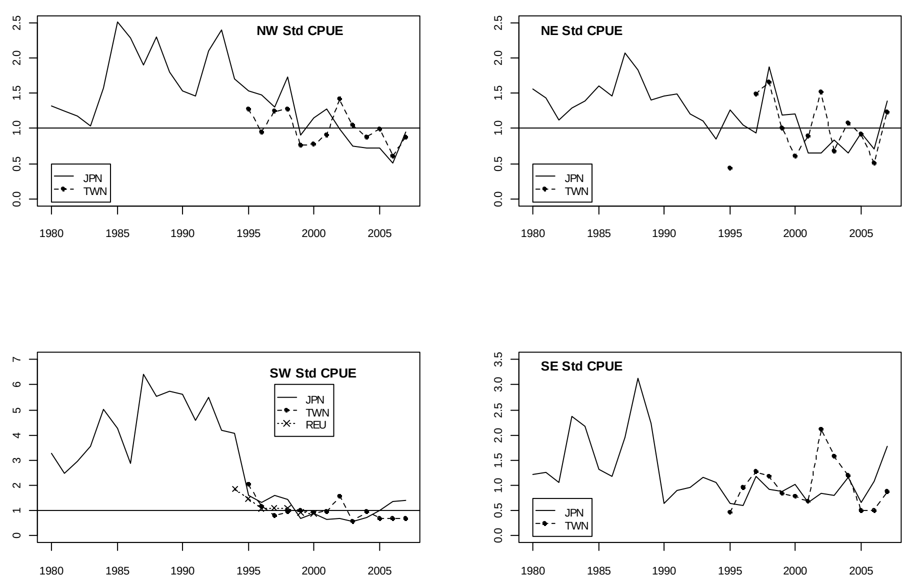


Figure 51 *Standardized CPUE by area for Japanese and Tawainese (Case4) longline fleets, and nomical CPUE for La Reunion longline fleet in the South-West area (all series have been rescaled to have a mean of 1 over the interval 1997-2007 and 1997-2000 for La Réunion).*

85. Numerical problems were observed in many model specifications, though results were reasonably stable and plausible when i) the SW Japanese CPUE series was truncated to the interval 1996-2007 (to avoid a steep CPUE decline that appears to be an artefact of spatial shifts in effort in the 1990s), ii) the Taiwanese CPUE series was restricted to case 4 (1995-2007), and iii) deterministic recruitment was used. In these cases, the model provided a reasonable fit for all of the CPUE series, and most of the length frequency data (NE gillnet series was the major exception). The alternative model assumptions did have substantive implications for the MPD estimates of stock

status. Given the large number of uncertainties and inconsistencies identified through the process, the results are considered primarily in the context of an exercise in prioritization for future assessments and supporting analyses. In particular the area-specific population estimates are questionable, but the aggregate biomass estimates are probably comparable to those from the other models.

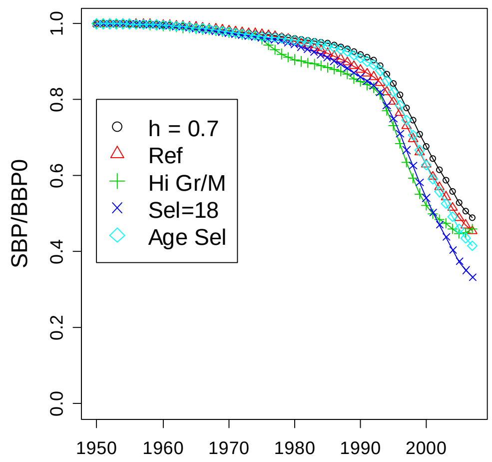
86. Five scenarios are included in the stock status summary (Table 4)

Table 4. *Description of the 5 scenarii used with SS3*

SS3 model	Distinguishing features
Ref	Stock-Recruit steepness=0.9 Growth rate slow (Young and Drake, 2004)[1] M=0.2 2 length-based "double-normal" selectivity functions
h=0.7	As Ref except: steepness=0.7
Hi Gr/M	As Ref except: Growth Rate fast (DeMartini *et al.*, 2007)[3]; M=0.4
Sel=18	As Ref except: 18 length-based "double-normal" selectivity functions
Age Sel	As Ref except: 2 age-based "double-normal" selectivity functions

87. The WPB noted that the biomass estimates for the NE region seem high relative to the western regions, which historically sustained much higher catches (figure 52c). This was recognized as a reason for exploring the validity of the current geographical area-weighting scheme used to create the area-specific series (and the aggregate CPUE used in the other models). If the fisheries do not operate in the whole geographical region, these weightings might not be appropriate.

[3] DeMartini E.E., Uchiyama J.H., Humphreys R.L. Jr., Sampaga J.D., Williams H.A., 2007, Age and growth of swordfish (*Xiphias gladius*) caught by the Hawaii-based pelagic longline fishery. Fish. Bull. 105, 356–367.



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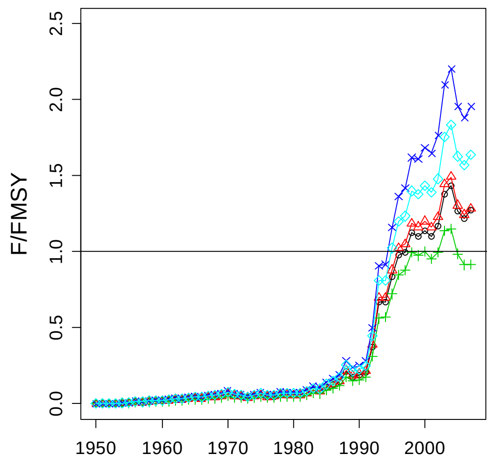

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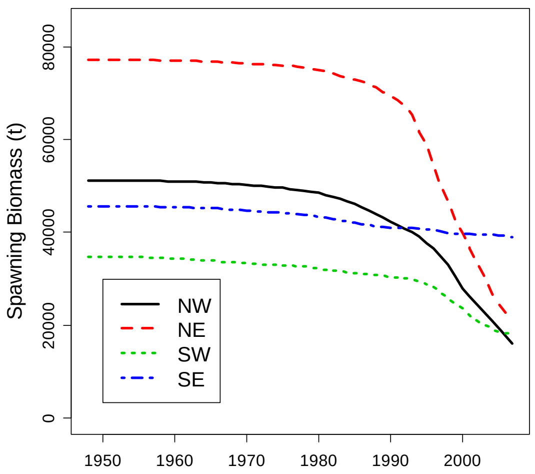

c

Figure 52. a,b and c) *Aggregate results across the 4 areas of biomass and fishing mortality estimates from five versions of the spatially-disaggregated SS3 model.*

88. Kobe plots illustrating the SS3 results are shown in figure 53

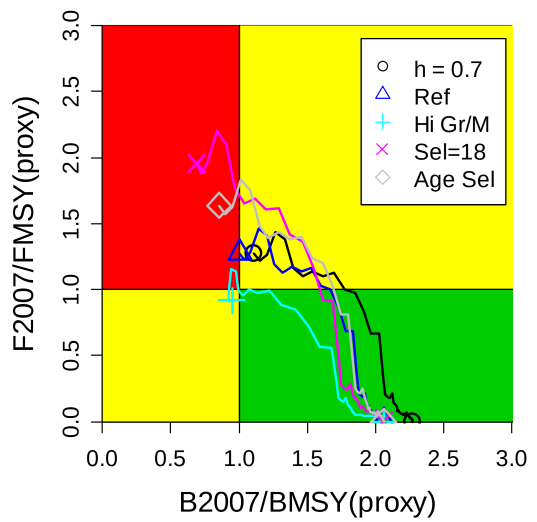

Figure 53. *Kobe plot for the SS3 models (defined in Table 4). Note that MSY, BMSY and FMSY were defined in relation to an MSY proxy (SPR 50%), which is more pessimistic than the true MSY*

Table 5. *Summary of model features as applied to Indian Ocean swordfish in 2009.*

	ASPIC	ASPM	Integrated Analysis	SS3
Uses CPUE	Yes (2 series)	Yes (1 series)	Yes (8 series)	Yes (9 series)
Uses Catch-at-age		Yes (approximated with age-length key)		
Uses Catch-at-length			Yes	Yes
Age-structured		Yes	Yes	Yes
Sex-structured				Yes
Number of Fleets	4 (effectively 1)	4	18	24 (effectively 18)
Population spatial structure Areas	1	1	1	4
Stochastic Recruitment			Yes	Yes, but unstable in many cases

Table 6. *List of known problems associated with different models applied to the Indian Ocean swordfish assessment in 2009.*

<table>
<tr><th></th><th>ASPIC</th><th>ASPM</th><th>Age-structured Integrated Analysis</th><th>SS3</th></tr>
<tr><td>CPUE Series</td><td colspan="4">• conflicting series indicate that catchability is not constant for at least one of the fleets (despite standardization)
• appropriate weighting factors among areas is uncertain (and resulting scaled CPUE series from Japan and Taiwan,China are not consistent across areas)</td></tr>
<tr><td>size composition data</td><td></td><td colspan="3">• Sampling poor in some fleets
• Trends are not consistent between fleets which suggests non-random sampling or changing selectivity for at least some fleets</td></tr>
<tr><td>age composition data</td><td></td><td>age-structure approximation from poor length frequency sampling</td><td></td><td></td></tr>
<tr><td rowspan="2">Selectivity assumptions</td><td rowspan="2"></td><td>selectivity estimated externally from model</td><td></td><td></td></tr>
<tr><td colspan="3">selectivity assumed constant over time despite apparent targeting shifts</td></tr>
<tr><td rowspan="2">Model Complexity Issues</td><td>cannot represent time lags, high recruitment variability or effects of variable selectivity among fleets</td><td colspan="3">• depend on uncertain biological assumptions (M, growth rates)</td></tr>
<tr><td colspan="3">assumes single homogenous population and cannot quantify localized abundance changes</td><td>Can represent depletion by sub-region, but spawning and movement assumptions
Are poorly quantified</td></tr>
</table>

Table 7. *Summary of key stock status reference points from the different models that the Working Party considered plausible. MPD = Maximum Posterior Density (or equivalent best point estimate).*

	ASPIC	ASPM	Integrated Analysis	SS3
Uncertainty	MPD 80% bootstrap	MPD 80% bootstrap	MPD range	MPD range
B2007 (1000 t)	57 (NA)	61 (NA)	167-581	55-101
B0 (1000 t)	120 (64-213)	316 (NA)	711-417	137-206
BMSY (1000 t)	44 (23-78)	54 (NA)	87-150	67-101
B2007/B0	0.48 (NA)	0.19 (NA)	0.40-0.87	0.33-0.49
B2007/BMSY	1.31 (1.13-1.46)	1.13 (0.65-1.60)	1.92-4.13	0.69-1.11
F2007/FMSY	0.79 (0.58-0.84)	1.23 (0.55-1.90)	0.31-0.96	0.92-1.96
MSY (1000 t)	33 (32-34)	27 (25-30)	28-46	21-33

Summary of the assessment results

89. The WPB agreed on the following:

- The long Japanese and Taiwanese CPUE series have conflicting trends, with the Japanese (by-catch) fleet suggesting substantial decline in abundance prior to ~2000, and the Taiwanese (targeted) fleet suggesting stable abundance over this period.
  - There is evidence for targeting shifts within the Japanese fleet that may be exaggerating the rate of estimated swordfish decline (particularly in the SW region).
  - The targeting data available for the Taiwanese fleet is limited, and there are reasons to think that efficiency would be increasing in this fleet, thus underestimating the biomass decline.
  - The standardized series from Japan, Taiwan,China (using the HBF data available since 1995), La Reunion and the Spanish fleet are all trending generally downward since the 1990s.
- The size composition data was not considered to be very informative from the swordfish fleets because conflicting trends suggest that either selectivity has been changing or the sampling is biased for at least some of the fleets. Variation in catch size composition within strata may depend on fine-scale targeting and is common to swordfish fisheries (*eg.* Atlantic fishery).
- The models which rely primarily on the Japanese CPUE are more pessimistic than those which rely primarily on the Taiwanese CPUE.
- The spatial depletion estimates from SS3 seemed plausible in general, but there were several concerns about the approach (and localized CPUE series), and the WPB did not feel comfortable providing area-specific advice at this time on the basis of this model.
- The ASPM results were considered to be the least reliable because of known problems associated with this type of application (*ie*. CAA estimated with difficulties, the need for externally estimated selectivity curves). It was also observed that the ASPM depletion estimate (B2007/B0) was not consistent with the range of results from the other models (Table 6).
- Among the other age-structured approaches, the ASIA was considerably more optimistic than the spatially disaggregated (SS3) models, in terms of both current fishing mortality and biomass. These differences are probably less a result of the spatial structure than other assumptions. In particular, the ASIA tended to give higher weighting to the optimistic Taiwanese CPUE than the pessimistic Japanese CPUE (in most cases the age of maturity was assumed to be younger as well).
- The ASPIC results are intermediate between these latter two approaches.

5. TECHNICAL ADVICE ON BILLFISH

Swordfish

90. The WPB generally considered it useful to have had several different assessment approaches tabled at the meeting. The stock status reference points from the range of models varies considerably, but a number of general consistencies were evident. Given the limitations identified for each model, and the uncertainties associated with the data inputs, the WPB felt that restricting the management advice to a single model would lead to an understatement of the uncertainty. This summary attempts a qualitative summary across models and data-based indicators.

91. When the current stock status estimates are compared among models, it is evident that there is a large degree of uncertainty (figure 54a). The MSY related ratio reference points were reasonably consistent among three of the model approaches while the ASIA model was a very optimistic outlier. However, in recognition of the fact that MSY-related reference points are often difficult to quantify reliably, a number of management agencies prefer to use depletion-based biomass stock status indicators. Figure 54b illustrates that there is less uncertainty associated with the depletion and MSY estimates. Most approaches suggest that MSY could reasonably be in the range of ~28-34,000 tonnes, though this is the lower end of the range for some models and the upper end of the range for others. Similarly, all approaches (except ASPM) suggest that depletion could be in the range of B2007/B0 = 0.4 – 0.5, though again this may be an upper or lower end of the plausible range depending on the model. Comparison across models suggest that current catches are probably near MSY (and F is probably near FMSY), but could be somewhat above or below (figure 55).

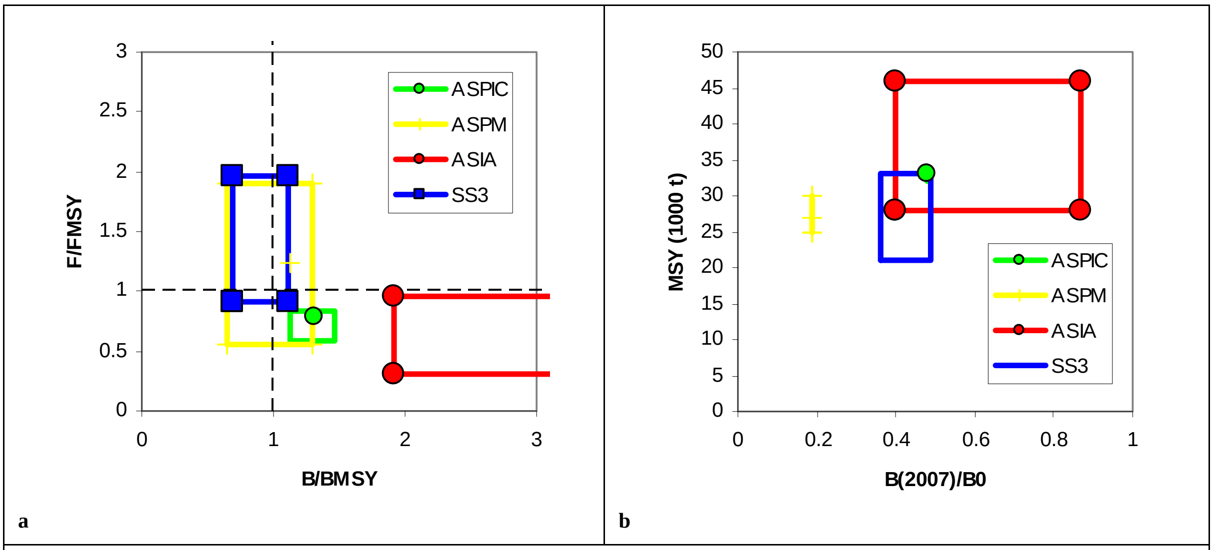

Figure 54. *Comparison of reference points across the range of models defined in Table 5 (it is noted that models are not capturing interactions but only bounds)*

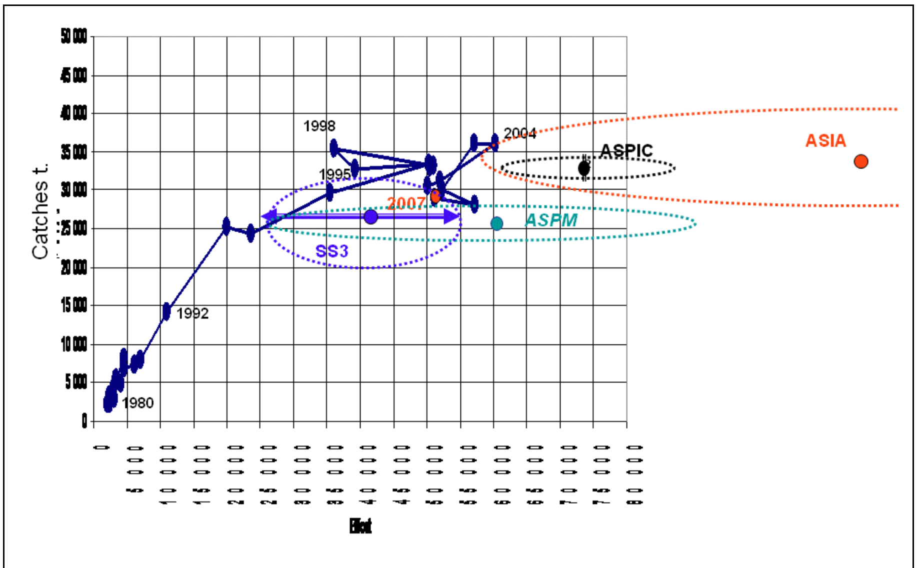

Figure 55.*Position and uncertainty of the MSY for the 4 models used for the swordfish assessment in 2009.*

92. The WPB considered the ASPIC Kobe plot provided a reasonably representative graphical summary of the stock status history, although this plot does not describe the full uncertainty represented by the full set of models (figure 48).

93. Given the general recent declining trend in all the CPUE series, and the fully exploited status of the stock, the WPB expects that abundance will likely decline further at current effort levels, especially considering that the issue of increases in efficiency has not been fully addressed in the current standardization. When combined with the uncertainty in the assessment, the WPB considers that there is a reasonably high probability that common target and limit reference points (*eg*. BMSY, 0.4B0) may be marginally exceeded, and this probability will increase over time if effort remains at current levels or increases further. There does not seem to be a strong conservation-based justification for highly disruptive management action at this time, but precautionary measures such as capacity control or catch limits will reduce the risk of creating an overcapacity problem or increasing the risk of exceeding common biomass limit reference points.

94. The apparent fidelity of swordfish to particular areas is a matter for concern as this can lead to localised depletion. The CPUE of the Japanese fleet in the south west IO has the strongest decline of the four areas examined in 2009; furthermore, the La Reunion CPUE series shows a declining trend in this area over the last 10 years. In previous years, localised depletion was inferred on the basis of decreasing CPUEs following fine-scale analyses of the catch and effort data. Therefore the WPB cannot discount the possibility that localised depletion is

still occurring in some areas. Localised depletion has occurred in other parts of the world where swordfish have been heavily targeted

5.1. Marlins and sailfish

95. 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.

96. The WPB recommended that the development of a dedicated project on billfish should be considered as a priority (Appendix IV). Such a project should also concentrate on improving the data on billfish reported to the Secretariat for industrial, artisanal and sport fisheries

6. STATUS OF IMPLEMENTATION OF RECOMMENDATIONS ISSUING FROM PREVIOUS MEETINGS OF THE WPB

97. The WPB revised the status of implementation of recommendations arising from previous meetings of the WPB. The status is revised on Table 8 below.

Table 8. *Status of implementations of recommendations from previous meetings of the WPB*

A. Data and statistics			
Recommendation	Addressed To	Year Issued	Implemented
Members having artisanal fisheries for swordfish and marlins to improving their collection and reporting of species and gear information *Remarks: Sri Lanka to increase sampling coverage to 2005-06 levels, including identification and reporting of marlins by species* *Follow-up: The IOTC Secretariat will contact Sri Lanka* *Deadline: Next WPB Meeting*	Sri Lanka	2001	No
Members having artisanal fisheries for sailfish to providing catch and effort data for those fisheries *Remarks: Iran, India and Pakistan to provide catch-and-effort data and size data for billfish, including gillnet fisheries* *Follow-up: The IOTC Secretariat to contact the IOTC Liaison Officers in Iran, India and Pakistan* *Deadline: Next WPB Meeting*	Iran Oman India Pakistan	2008 2008 2008 2008	No Fully No No
Members increasing sampling coverage to obtain acceptable levels of precision in their catch and effort statistics *Remarks: This recommendation is too vague; the WPB agreed on the need to set-up minimum levels of precision for the catches of billfish species, including for fisheries for which these species are a by-catch. The WPB agreed that, initially, the CV should be less than 20% for all billfish species and fisheries.* *Follow-up: The WPB to address this issue to the next session of the WPDCS as it may have implications for target species* *Deadline: Next WPB Meeting*	All CPC's	2008	Partially
The Secretariat to identify the major sports fishing bodies in the Indian Ocean and approach them regarding access to any available data sets, including size data *Remarks: Need to continue work* *Follow-up: The Secretariat* *Deadline: Next WPB Meeting*	Secretariat	2001	Ongoing
The Secretariat to make a special request to members in this year's SC meeting	Secretariat	2008	Fully

reminder to integrate analyses of sport fisheries data in their National Reports *Remarks: Need for this information to be reported on a routine basis* *Follow-up: The Secretariat* *Deadline: Next WPB Meeting*			
Members having industrial fisheries for swordfish, marlins and sailfish to improving their collection and reporting of species information. This should include tools to assist fishers and data collectors to correctly identify billfish species *Remarks: Need for countries to implement the standard IOTC longline logbooks* *Follow-up: The Secretariat to remind countries that do not report billfish catch by species (eg. Philippines, etc.)* *Deadline: Next WPB Meeting*	All CPC's	2001	Partially
The Republic of Korea improving the consistency of its catch and effort statistics *Remarks: Need to address this issue to the SC* *Follow-up: WPB to address to the SC* *Deadline: Next WPB Meeting*	Korea, Rep.	2003	No
Indonesia and Taiwan,China collecting and reporting catch and effort data for their fresh tuna longliner fleets *Remarks: Taiwan,China and Indonesia are implementing logbook systems* *Follow-up: IOTC Secretariat* *Deadline: Next WPB Meeting*	Indonesia Taiwan,China	2003 2003	Ongoing Ongoing
The EC-Spain LL to provide catch-and-effort data of marlins and sailfish by time and area strata *Remarks: Need to address this issue to the SC* *Follow-up: WPB to address to the SC* *Deadline: Next WPB Meeting*	EC-Spain	2003	No
The EC-UK long line fleet to provide catch and effort for all species	EC-UK	2008	Fully
Members reporting on IOTC species taken as bycatch *Remarks: The needs have been addressed by other recommendations.*	All CPC's	2000	Partially
Members with observer programmes to analyse the data collected to estimate retained catches and discards and the precision of these estimates *Remarks: Need to reformulate this to make the reporting specific for billfish species* *Follow-up: IOTC Secretariat* *Deadline: Next WPB Meeting*	All CPC's	2003	Partially
The EC and India collecting and reporting size data for their longline fleets, notably for marlins and sailfish *Remarks: Need to address this issue to the SC; need to address a special request to Portugal, including conflicting CE data* *Follow-up: WPB to address to the SC* *Deadline: Next WPB Meeting*	India EC	2003 2003	No No
Taiwan,China collecting and providing size data from their fresh tuna longliners *Remarks: Need for Taiwan,China to implement data collection and report size data to the IOTC as soon as possible* *Follow-up: IOTC Secretariat* *Deadline: Next WPB Meeting*	Taiwan,China	2003	No
Japan increasing size sampling coverage from its longline fleet *Remarks: Japan to implement observer programmes on its commercial fishery from July 2010; size data will be collected through observers* *Follow-up: IOTC Secretariat*	Japan	2003	No

Deadline: 2011			
Members having sport fisheries collecting and reporting size data to the Secretariat *Remarks: Combined with a previous recommendation.*	All CPC's	2003	No
Members collecting and reporting size data for artisanal fisheries for billfish, in particular gillnet fisheries of Iran, India and Pakistan *Remarks: Moved and combined with a previous recommendation.*	Iran India Pakistan	2003	No No No
Members reviewing their existing sampling schemes to ascertain that the data collected are representative of their fisheries and provide the results to the Secretariat *Remarks: This recommendation is too vague; the WPB agreed on the need to set-up minimum levels of precision for the size composition of the catch of billfish species, including for fisheries for which these species are a by-catch.* *Follow-up: The WPB to address this issue to the next session of the WPDCS as it may have implications for other target species* *Deadline: Next WPB Meeting*	All CPC's	2008	No
Conversion relationships: Members submitting to the Secretariat the basic data that would be used to establish length-age keys, length-weight keys, processed weight-live weight keys, non-standard to standard measurements for billfish species *Remarks: The Secretariat to request this information to countries having important fisheries for billfish, including the raw data* *Follow-up: The IOTC Secretariat* *Deadline: Next WPB meeting*	All CPC's	2001	Partially
Obtaining sex ratio information by size and area *Remarks: The Secretariat to request this information to countries having important fisheries for billfish, including the raw data* *Follow-up: The IOTC Secretariat* *Deadline: Next WPB meeting*	All CPC's	2001	Partially
Analysis of the apparent stability in the catch size data and whether the existing data are representative of the fishery *Remarks: main fishing fleets (Japan and Taiwan,China) to analyze the size samples collected from their fisheries in order to verify if the length frequency data derived from the samples available are representative of the fishery.* *Follow-up: the IOTC Secretariat* *Deadline: Next WPB meeting*	WPB	2008	No

B. Research			
Recommendation	Addressed To	Year Issued	Implemented
Swordfish stock structure and migratory range — using genetics techniques IOTC CPC's to participate or contribute to the planned IOSSS project *Remarks: No results expected until mid-2010 and the final project will be concluded by October 2011. New partnerships have been formed and are needed to obtain samples from northern Indian Ocean.*	All CPC's	2000	Ongoing
Swordfish stock structure and movement rates — using tagging techniques • Scientific tagging, primarily with electronic tags • Encouraging longline fishermen and observers to tag small swordfish and where possible mark fish with OTC. • Use the existing momentum for tag recovery process under the RTTP-IO	All CPC's	 2000 2001 2008	 No No No

• Collaborate with the (pop up) tagging initiatives of SWIOFP and MADE *Remarks: Secretariat to encourage voluntary conventional tagging by fleets through EU and other CPCs, including small swordfish tagging and OTC marking for growth studies and validation. Use of existing RTTP-IO network for tag recovery would facilitate conventional tagging programme. PAT tags for swordfish planned under SWIOFP in 2009/2010.*		2008	Ongoing
Swordfish growth: CPC's to undertake growth studies and report on these regularly to the WPB. This should include opportunistic tagging and OTC work. *Remarks: There are plans to analyze the Reunion swordfish growth data. Swordfish growth studies are being conducted in Taiwan,China based on samples from Taiwanese observer programme and results are expected in a few years. No known studies on sailfish or marlins.*	All CPC's	2001	Partially
Size data analyses: Conversion of lengths to ages using different assumptions on sex ratios at size/age for the Taiwanese, Japan and EC fleets size data *Remarks: Secretariat will coordinate this work*	WPB	2008	No
Stock status indicators: The WPB requested the Secretariat to coordinate the exploration of indicators from available data and report these to the next meeting of the WPB *Remarks: work to be continued*	Secretariat	2008	Ongoing
CPUE Standardization: • Examine the relationship between the number of hooks per basket and hook depth *Remarks: China and Taiwan,China conducting current TDR studies and data will be reported at future meetings. Australian TDR study results to be sourced by Secretariat.* • Improving the definition of variables that could be used as a proxy for targeting. *Remarks: Consistencies between Japan and Taiwan,China improving due to the increasing time-series of Taiwanese data on NHBF.* *Secretariat to review standard logbook requirements to include relevant variables* • Examine methods to better account for the influence of zero catches in CPUE analyses *Remarks: Sensitivity analyses using delta log-normal models to be attempted by Japan and Taiwan,China for next session.* • Consideration of alternative ways of combining area-specific indices into a global index using different weighting schemes. Consider alternative methods of estimating fish densities in areas across the species range that have not been fished consistently over time. *Remarks: Spatial model indicating that this requires further investigation. Inconsistencies in CPUE within regions (eg. SW Indian Ocean) selected for spatial models in 2009 require further analyses to understand influence of environmental heterogeneity at sub-regional scales.* • Continue the work on integration of environmental factors – validation for factors such as sheer currents. *Remarks: Progress made in 2009 with integration of environmental variables in*	WPB	2001	Ongoing

CPUE standardization due to use of set by set data. • Use of same space and time scales *Remarks: Done* Efforts should be made to provide additional standardized CPUE series from other fisheries (*eg.* La Réunion, Seychelles and South Africa) for the next WPB *Remarks: Will be presented at next session. Secretariat to assist Seychelles. Spain scientists to be encouraged to participate and at least provide updated CPUE standardized series for next session.*			
Stock assessment: Further development of stock assessment models for swordfish including models that examine localised depletion, age structured models and habitat-based models *Remarks: Ongoing with progress made in 2008 and 2009*	WPB	2003	Ongoing
Research on Istiophorids: The WPB recommended that the following research on istiophorids be undertaken. • In collaboration with sports fishing bodies, the collection of biometric and morphometric data. • Increased tagging of billfish in the Indian Ocean should be encouraged on an opportunistic basis. • Popup satellite tagging experiments should be conducted on an opportunistic basis on blue, black and striped marlins. Collaboration with relevant SWIOFP initiatives should be explored *Remarks: Due to a lack of progress with Istiophorids in terms of biological studies and assessment, the WPB has recommended the development of a programmatic approach with defined actions and activities (see appendix IV for TOR of a proposed outline for an Istiophorid research project in the Indian Ocean).*	All CPC's	2001	No

7. RESEARCH PRIORITIES

Response to the request from the Commission in relation to apparent localised Swordfish depletions

98. The WPB still considered determination of stock structure as a research priority as the information available tends to indicate localized depletion in certain areas. Ongoing initiatives, such as IOSSS and SWIOFP, should provide better information on the stock structure. The WPB encourages the countries in the region to cooperate with those initiatives. These programs should also be complemented by support to tagging programmes in both longline and sport fisheries.

99. To better understand the situation in the SW IO, the WPB recommended that a range of possible CPUE series and other indicators in the region be standardized and assessed in order to better explore the fine-scale patterns. The WPB recommended that the on going spatially disaggregated approach is continued for the future assessments.

7.1. Recommendations to improve the data available to IOTC

100. Improve the catch and effort data for artisanal fisheries, by:

- Sri Lanka to increase sampling coverage to 2005-06 levels in order to improve its collection and reporting of species and gear information.

- Iran, India and Pakistan to provide catch and effort and size data for their artisanal fisheries, notably gillnet and hand line, including catches of billfish disaggregated by species.
- Members to increase sampling coverage to obtain acceptable levels of precision (CV to be initially set at less than 20%) in their catch and effort statistics. The Secretariat to request countries to include levels of precision in their reports of catches and effort for billfish species.
- The WPB to address a request to the next meeting of the WPDCS to establish the levels of precision that are adequate for catch and size data for billfish species caught by artisanal fisheries.

101. Improve the recovery of existing catch and effort data from sport fisheries, by:

- The Secretariat to coordinate catch-and-effort and size data collection from major sports fishing bodies in the Indian Ocean and analysis of the information retrieved (CPUE and size data).

102. Improve the catch and effort and size data from industrial fisheries by:

- Members having industrial fisheries for swordfish, marlins and sailfish to use the standard IOTC logbooks to collect catch-and-effort data by species. This should include tools to assist fishers and data collectors to correctly identify billfish species. The Secretariat to urge countries that do not collect logbook data as per the IOTC standards to implement the IOTC standard logbooks as soon as possible.
- India to report catch-and-effort and size data for billfish species for its commercial longline fishery. The WPB to address this issue to the IOTC SC.
- The Republic of Korea to revise its catch-and-effort data series as soon as possible; the WPB to address this issue to the IOTC SC.
- The IOTC Secretariat to follow-up on the logbook programmes initiated by Indonesia and Taiwan,China for the collection of catch-and-effort data from their fresh tuna longliner fleets.
- Taiwan,China to collect and provide size data from its fresh tuna longliners.
- The EC-Spain longline to provide catches and size data of marlins and sailfish by time and area strata. The WPB to address this issue to the IOTC SC.
- The EC-Portugal, EC-UK, Kenya, Guinea, Senegal and Tanzania to collect and report size data for billfish species for its longline fleets.
- The Secretariat to request EC-Portugal to provide more information on the activities of longliners under its flag, especially concerning the limited fishing area covered by year.
- Japan to increase size sampling coverage (to cover a minimum of 10% of the catch (in number) by quarter by 10° latitude - 20° longitude area) from its longline fleet. The WPB to address this issue to the IOTC SC.
- Members ensuring that logbook coverage is appropriate to produce acceptable levels of precision (CV to be initially set at less than 20%) in their catch and effort statistics for billfish species. The Secretariat to request countries to include levels of precision in their reports of catches and effort for billfish species.
- Members with observer programmes to analyse the data collected to estimate discards of billfish species and the precision of these estimates. The Secretariat to request countries to provide estimates of discard levels of billfish species, including levels of precision for these estimates.
- The WPB to address a request to the next meeting of the WPDCS to establish the levels of precision that are adequate for
    - Catches of billfish, by species, fishery and time-area strata.
    - Size data of billfish, by species, fishery and time-area strata.

103. Reduce uncertainty in the following biological parameters important for the assessment of stock status of IOTC species by:

- Conversion relationships: The Secretariat to request CPC's having important fisheries for billfish to collect and provide the basic data that would be used to establish length-age keys and non-standard measurements to standard measurements keys (*eg.* length-weight keys, processed weight-live weight keys, non-standard length measurements-fork length measurements) for billfish species, by sex and area.

- The Secretariat to request CPC's having important fisheries for billfish to collect and provide sex ratio information by size and area.
- Japan and Taiwan,China to analyze 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.

7.2. Research recommendations

104. Swordfish stock structure and migratory range — using genetics techniques: The WPB encourages IOTC members to participate or contribute to the planned IOSSS project as much as possible, in particular in the collection of samples for analysis by the project. Samples from northern areas of the Indian Ocean are of particular importance.

105. Swordfish stock structure and movement rates — using tagging techniques: Including:

- The EC, Taiwan,China, Japan, Seychelles, Indonesia and the EC to initiate conventional tagging of swordfish specimens by longline fishermen and observers, in particular tagging of small swordfish specimens, and where possible inject fish with OTC.
- Use of the RTTP-IO tag recovery scheme to collect swordfish tags.
- Collaborate with SWIOFP in the implementation of its 2009/2010 programme to tag swordfish using PAT tags, in particular tag recovery and analysis of the results.

106. Swordfish growth: The IOTC Secretariat to promote the growth studies undertaken by Reunion (EC-France) and Taiwan,China scientists and comparison of the results obtained through those and other projects.

107. Size data analyses: The IOTC Secretariat to coordinate studies on the conversion of swordfish lengths into ages by using different assumptions on sex ratios at size/age for the Taiwan,China, Japan and EC fleets size data.

108. Stock status indicators: The IOTC Secretariat to further coordinate the exploration of indicators from available data and report these to next meetings of the WPB.

109. CPUE Standardization:

- China and Taiwan,China to report the results of their ongoing TDR studies (relationship between the number of hooks per basket and hook depth) to the next meeting of the WPB. The IOTC Secretariat to provide the results of a TDR study conducted by Australia at the next meeting of the WPB.
- Japan, Taiwan,China, EC, Seychelles and Indonesia to conduct research studies intended to improve the definition of variables that could be used as a proxy for targeting of swordfish, in particular changes in the number of hooks per basket set-times, area fished, moon-phase, use of light-sticks, bait-types and species composition. The WPB to review the results of these studies at its 2012 meeting. The WPB to review the standard IOTC requirements for logbook data on the basis of the results of these studies.
- Japan and Taiwan,China to examine the influence of zero catches in CPUE analyses through sensitivity analysis using delta log-normal models and report the results of these analysis to the next meeting of the WPB.
- Japan, Taiwan,China and the EC to conduct studies to ascertain that the areas used for the assessment are appropriate, in particular analysis of the influence of environmental heterogeneity at sub-regional scales and the combination of area-specific indices into a global index using different weighting schemes
- The EC and Seychelles to use set by set data in the standardization of the CPUEs for its longline fisheries and to report the results to the next meeting of the WPB. The IOTC Secretariat to assist Seychelles with this study, where required.

Given the importance of these recommended actions to the swordfish assessment, the WPB encourages that a collaborative approach to the work be taken.

110. Stock assessment: The IOTC Secretariat to promote further development of stock assessment models for swordfish, in particular development of the models used by the WPB in 2008 and 2009.

111. Research on Istiophorids: The WPB showed concern about the paucity of the biological data available for marlins and Indo-Pacific sailfish noting the consequences that this is having on the assessments of the species. In order to overcome these problems the WPB recommended the implementation of a Large Scale Research Programme to collect the information required for these species, in particular biometric and morphometric data, marlins and sailfish movements, growth, and other information required for stock assessment (Appendix IV). The WPB agreed to address this request to the IOTC SC

8. OTHER BUSINESS

112. None.

9. ADOPTION OF THE REPORT

113. The Report was adopted in the main on Friday 10 July 2009 and finalised by correspondence on 01 October 2009.Thanks were conveyed to Seychelles Fishing Authority for the use of the SFA Training Room.

APPENDIX I
List of Participants

Ms. Cindy Assan
Fisheries Scientist
Research and Development
Seychelles Fishing Authority
P.O. Box 449, Victoria
SEYCHELLES
Tel: 248 670300
Fax: +248 224805
Email: cassan@sfa.sc

M. Jérome Bourjea
Researcher
IFREMER
BP 60
rue Jean Bertho
Le Port 97822 CEDEX
LA REUNION
Tel:+262 262 420340
Fax:+262 262 433684
Email: jérome.bourjea@ifremer.fr

Ms. Nanet Bristol
Fisheries Scientist
Researc and Development Section
Seychelles Fishing Authority
P.O. Box 449
Victoria
Mahé
SEYCHELLES
Tel: 248 670376
Fax: +248 224805
Email: nbristol@sfa.sc

M. Hugues Evano
Technician
Fisheries Dpt.
IFREMER
P.O.60
Rue Jean Bertho
Le Port 97822
France/REUNION
Tel: +02 62 420340
Email: Hugues.Evano@ifremer.fr

Dr. Alain Fonteneau
Fisheries Biologist
IRD - Centre de Recherche Halieutique Méditerrannéenne et Tropicale
UR 109 THETIS
B.P. 171
Av. Jean Monnet 34203 Sète Cedex
FRANCE
Tel: +33 4 99 57 3255
Fax: +33 4 99 57 3295
Email:alain.fonteneau@ird.fr

Dr. Dale Kolody
Fisheries Scientist
CSIRO Marine and Atmospheric Research
P.O.Box 1538, Hobart, Tasmania, 7001
AUSTRALIA
Tel: + 61 (0) 3 6232 5121
Email: dale.kolody@csiro.au

M. Mahiswara
Fisheries Scientist
Marine Affairs and Fisheries
Research Institute For Marine Fisheries
Jl Muara Baru Ujung
Jakarta 14440
INDONESIA
Tel: +62 21 6602044
Fax: +62 21 6605912
Email: mahiswr@yahoo.com

Dr. Tsutomu (Tom) Nishida
Scientist
National Research Institute of Far Seas Fisheries
Fisheries Research Agency of Japan
5-7-1, Orido, Shimizu
Shizuoka 424-8633
JAPAN
Tel: +054 336 6052
Fax: +054 336 6052
Email: tnishida@affrc.go.jp

M. Renaud Pianet
Scientist
IRD
B.P. 570
Victoria
SEYCHELLES
Tel: +248 224742
Fax: +248 224742
Email:renaud.pianet@ird.fr

Dr. Ramalingam
Senior Fisheries Scientist
Department of Animal Husbandry, Dairying and Fisheries
Fishery Survey of India, Govt of India
Ministry of Agriculture
Goa 403803
Tel:+ 0832 2520428
Tel:+ 0832 2520957
Email: ramalingam.1961@yahoo.com

Dr Sheng-Ping Wang
National Taiwan Ocean university
Department of Environmental Biology and Fisheries Science
2 Beining Rd
Keelung
TAIWAN
Tel:+ 886 2 2462 5208
Fax: 886 2 2463 6834
Email: wsp@mail.ntou.edu.tw

CHAIRPERSON

Mr. Jan Robinson
Manager, Fisheries Research
Seychelles Fishing Authority
P.O. Box 449
Victoria
Mahé
SEYCHELLES
Tel: 248 670338
Fax: 284 224508
Email: jrobinson@sfa.sc

IOTC SECRETARIAT

Indian Ocean Tuna Commission
P.O.Box 1011 Fishing Port
Victoria
SEYCHELLES
Tel: (+248) 225494
Fax: (+248) 224364

M. Alejandro Anganuzzi
Executive Secretary
Email: aa@iotc.org

M. Miguel Herrera
Data Coordinator
Email: mh@iotc.org

M. Julien Million
Tagging Officer
Email: jm@iotc.org

Ms. Lucia Pierre
Data Assistant
Email: lp@iotc.org

IOTC-OFCF PROJECT / PROJET OFCF-CTOI

M. Shunji Fujiwara
IOTC-OFCF Fishery Expert
Email: sf@iotc.org

APPENDIX II
AGENDA FOR THE WORKING PARTY ON BILLFISH

1. OPENING OF THE MEETING

2. ADOPTION OF THE AGENDA

3. REVIEW OF THE DATA

- Review of the statistical data available for the billfish species (Secretariat)

4. NEW INFORMATION ON BIOLOGY, ECOLOGY AND FISHERIES OCEANOGRAPHY RELATING TO BILLFISH

- Review new information on the biology, stock structure of billfish, their fisheries and associated environmental data

  Papers as provided by Members

5. REVIEW OF NEW INFORMATION ON THE STATUS OF BILLFISH

- Stock status indicators for marlins, sailfish and swordfish.
  - *Catch and effort*
  - *CPUE*
  - *Changes in fishing area*
  - *Trends in size distributions of the catch*
  - *Other billfish stock indicators*
- Stock assessments
  - Assessment methods
  - Spatially disaggregated assessment methods
- Selection of Stock Status indicators and Likely future trends under alternative exploitation scenarios

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6. DEVELOP TECHNICAL ADVICE ON THE STATUS OF THE STOCKS

- Marlins – new Executive Summary
- Sailfish – new Executive Summary
- Swordfish – update the Executive Summary

7. RESEARCH RECOMMENDATIONS AND PRIORITIES

8. OTHER BUSINESS

APPENDIX III
List of documents

Document	Title	Availability
IOTC-2009-WPB-01	Agenda of the Working Party on Billfish	✓
IOTC-2009-WPB-02	WPB List of documents	✓
IOTC-2009-WPB-03	Reproductive dynamics of swordfish (*Xiphias gladius*) in the southwestern Indian Ocean (Reunion Island). Part 1: oocyte development, sexual maturity and spawning.	✓
IOTC-2009-WPB-04	Reproductive dynamics of swordfish (*Xiphias gladius*) in the southwestern Indian Ocean (Reunion Island). Part 2: fecundity and spawning pattern	✓
IOTC-2009-WPB-05	Status of IOTC Databases for billfish species	✓
IOTC-2009-WPB-06	Preparation of data input files for the stock assessments of Indian Ocean Swordfish	✓
IOTC-2009-WPB-07	Up-date of the La Réunion longline and coastal fisheries data with special focus on billfishes	✓
IOTC-2009-WPB-08	Estimation of the abundance index of swordfish (*X. gladius*) in the Indian Ocean based on the fine scale catch and effort data in the Japanese tuna longline fisheries (1980-2007)	✓
IOTC-2009-WPB-09	Preliminary stock assessment of swordfish (*X. gladius*) in the Indian Ocean by the Age Structure Production Model (ASPM) (1952-2007)	✓
IOTC-2009-WPB-10	An Exploratory "Stock Synthesis" Assessment of the Indian Ocean Swordfish Fishery 1950-2007	✓
IOTC-2009-WPB-11	Preliminary application of an age-structured assessment model to swordfish (*Xiphias gladius*) in the Indian Ocean	✓
IOTC-2009-WPB-12	CPUE standardization of swordfish (*Xiphias gladius*) caught by Taiwanese longline fishery in the Indian Ocean for 1980-2007	✓
IOTC-2009-WPB-13	Status Of Seychelles Semi Industrial Longline Fishery	✓
IOTC-2009-WPB-14	Billfish fisheries in Indonesia	✓
IOTC-2009-WPB-15	Other Billfish Stock Status Indicators	✓
IOTC-2009-WPB-PRES1	New insights on Reproductive strategy of swordfish (*Xiphias gladius*) in the Southwestern Indian Ocean	✓
IOTC-2009-WPB-PRES2	Billifish Fishery in Indonesia	✓
IOTC-2009-WPB-PRES3	Biological parameter for SA (Taiwan,China)	✓
IOTC-2009-WPB-PRES4	STD JPN CPUE - Estimation of Abundance Index (1980-2007)	✓
IOTC-2009-WPB-PRES5	Preliminary stock assessment of swordfish in the Indian Ocean by ASPM (1952-2007)	✓
IOTC-2009-WPB-PRES5b	Results of ASPIC and revised ASPM	✓
IOTC-2009-WPB-PRES5c	Addendum	✓
IOTC-2009-WPB-PRES7	Status of IOTC databases for Billfish species	✓
IOTC-2009-WPB-PRES8	Preliminary application of an age-structured assessment model to swordfish (*Xiphias gladius*) in the Indian Ocean	✓
IOTC-2009-WPB-PRES8b	Addendum	✓
IOTC-2009-WPB-PRES9	CPUE standardization of swordfish (*Xiphias gladius*) caught by Taiwanese longline fishery in the Indian Ocean for 1980-2007	✓
IOTC-2009-WPB-PRES10	Bycatch and discards of the European Purse-seine tuna fishery in the Indian Ocean	✓

Document	Title	Availability
IOTC-2009-WPB-INF01	Age and growth of Indo-Pacific sailfish, *Istiophorus platypterus*, from the Arabian Gulf	✓
IOTC-2009-WPB-INF02	Genetic population structure of the Swordfish (*Xiphias gladius*) in the southwest Indian Ocean: Sex-biased differentiation, congruency between markers and its incidence in a way of stock assessment	✓
IOTC-2009-WPB-INF03	Exploratory Modelling of the Indian Ocean Swordfish Fishery, using an age-structured, sex-structured and spatially-disaggregated implementation of Stock Synthesis software	✓

APPENDIX IV
GUIDELINES FOR A RESEARCH PROJECT ON BILLFISH

The WPB express its concern upon the global lack of investigation targeting the conservation of billfish in the Indian Ocean, when the major declines in the CPUEs of the species should be a source of worry for scientists, managers, sport fishermen and environmental NGOs. This problem is due to the fact that these species are very seldom targeted by fisheries, but most often taken as by catches of various tuna fisheries.

The WPB concluded that the best and only way to solve this problem faced by the IOTC would be to launch an ad hoc research "Billfish Programme". This programme should have its own budget, potentially funded by external donors (as the ICCAT Billfish programme created in 1986), and also a scientific coordinator.

The detailed goals, priorities and budget of this programme should be:

- Promote the improvement of billfish **statistics** on selected industrial and artisanal fisheries, targeting in priority fisheries and countries that are known for their large catches of billfishes (such as Iran, Sri Lanka, Indonesia, India, Pakistan, etc)
- Promote an active **data mining** targeting the identification and recovery of data from billfish sport fisheries in the IO (CPUEs and sizes).
- Target an active analysis of existing historical catch and effort data on billfish, including those from sport fisheries and from observers.
- Promote **biological investigations** on billfish: their growth, movements and stock structure, feeding, spawning, their behaviour, etc
- Promote tentative stock assessment of billfish stocks, using new methods that could use in order to obtain a realistic assessment of these stocks, taking into account the limited amount of data available on these species, and making a full use of the various fishery indicators that can be calculated for these stocks.