OUTCOMES OF THE FOURTEENTH SESSION OF THE SCIENTIFIC COMMITTEE

PREPARED BY: IOTC SECRETARIAT, 14 AUGUST, 2012

PURPOSE

To inform the Working Party on Billfish (WPB) of the recommendations arising from the Fourteenth Session of the Scientific Committee, held from 12–17 December 2011, specifically relating to the work of the WPB.

BACKGROUND

At the Fourteenth Session of the Scientific Committee (SC), the recommendations relevant to the work of the WPB contained in Appendix A were adopted by the SC and provided to the Commission for its consideration.

In addition, the SC noted and endorsed the recommendations made by the WPB in 2011, which included requests to address the deficiencies in data collection, monitoring and reporting by CPCs. The SC requested that the IOTC Secretariat communicate these recommendations to relevant parties so that they may address these matters in 2012 and provide progress updates to the WPB at its next meeting.

The recommendations on the deficiencies in data collection, monitoring and reporting by CPCs in relation to billfish will be discussed under agenda item 5 and in paper IOTC–2012–WPB10–06 and are therefore not presented in this paper.

DISCUSSION

In addition to the recommendations outlined in Appendix A, the SC made several other comments and recommendations relevant to the WPB, which participants are asked to consider:

Implementation of the regional observer scheme

- The SC **NOTED** the update on the implementation of the Regional Observer Scheme set out in Resolution 11/06 *on a Regional Observer Scheme* and **EXPRESSED** its concerns regarding the low level of implementation and reporting to the IOTC Secretariat of both the observer trip reports and the list of accredited observers since the start of the ROS in July 2010 (8 CPCs provided a list of accredited observers and 11 reports were submitted from 4 CPCs). (para. 138 of the SC14 report)
- The SC **RECOMMENDED** that all IOTC CPCs urgently implement the requirements of Resolution 11/04 on a Regional Observer Scheme, which states that: The observer shall, within 30 days of completion of each trip, provide a report to the CPCs of the vessel. The CPCs shall send within 150 days at the latest each report, as far as continuous flow of report from observer placed on the longline fleet is ensured, which is recommended to be provided with 1°x1° format to the Executive Secretary, who shall make the report available to the Scientific Committee upon request. In a case where the vessel is fishing in the EEZ of a coastal state, the report shall equally be submitted to that Coastal State. (para. 11), **NOTING** that the timely submission of observer trip reports to the Secretariat is necessary to ensure that the Scientific Committee is able to carry out the tasks assigned to it by the Commission, including the analysis of accurate and high resolution data, in particular for bycatch, which would allow the scientists to better assess the impacts of fisheries for tuna and tuna-like species on bycatch species. (para. 139 of the SC14 report)

Management strategy evaluation

- The SC **ENDORSED** the roadmap presented for the implementation of MSE in the Indian Ocean in IOTC–2011–SC14–36 and **RECOMMENDED** the Commission agree to initiate a consultative process among managers, stakeholders and scientists to begin discussions about the implementation of MSE in IOTC. (para. 157 of the SC14 report)

RECOMMENDATION

That the WPB **NOTE** the recommendations of the Fourteenth Session of the Scientific Committee and consider how to progress these issues at the present meeting.

APPENDICES

Appendix A: Consolidated set of recommendations of the Fourteenth Session of the Scientific Committee (12–17 December, 2011) to the Commission, relevant to the Working Party on Billfish.

Appendix B: Status of the Indian Ocean billfish resources.

APPENDIX A

CONSOLIDATED SET OF RECOMMENDATIONS OF THE FOURTEENTH SESSION OF THE SCIENTIFIC COMMITTEE (12–17 DECEMBER, 2011) TO THE COMMISSION RELEVANT TO THE WORKING PARTY ON BILLFISH

Extract of the Report of the Fourteenth Session of the Scientific Committee

(IOTC–2011–SC14–R; Appendix XXXVIII, PAGES 248–259)

STATUS OF TUNA AND TUNA-LIKE RESOURCES IN THE INDIAN OCEAN

Billfish

SC14.03 (para. 133) The SC **RECOMMENDED** that the Commission note the management advice developed for each billfish species as provided in the Executive Summary for each species:
- Swordfish (*Xiphias gladius*) – Appendix XX
- Black marlin (*Makaira indica*) – Appendix XXI
- Indo-Pacific blue marlin (*Makaira mazara*) – Appendix XXII
- Striped marlin (*Tetrapturus audax*) – Appendix XXIII
- Indo-Pacific sailfish (*Istiophorus platypterus*) – Appendix XXIV

GENERAL RECOMMENDATIONS TO THE COMMISSION

Examination of the Effect of Piracy on Fleet Operations and Subsequent Catch and Effort Trends

SC14.46 (para. 127) In response to the request of the Commission (para. 40 of the S15 report), the SC **RECOMMENDED** that given the lack of quantitative analysis of the effects of piracy on fleet operations and subsequent catch and effort trends, and the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should be carried out and presented at the next WPTT meeting by the CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China.

Implementation of the Precautionary approach and Management strategy Evaluation

SC14.49 (para. 146) Noting that the development of an MSE process will require management objectives to be specified, the SC **RECOMMENDED** that the Commission provide clear guidance in this regard, noting that the adoption of the Precautionary Approach, as defined in the Fish Stocks Agreement, may be the first step.

SC14.50 (para. 149) The SC **RECOMMENDED** that interim target and limit reference points be adopted and a list of possible provisional values for the major species is listed in Table 5. These values should be replaced as soon as the MSE process is completed. Provisional target reference points would be based on the MSY level of the indicators, and on different multipliers for the limit reference points.

Table 5. Interim target and limit reference points.

Stock	Target Reference Point	Limit Reference Point
Albacore	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.4*F_{MSY}$
Bigeye tuna	B_{MSY}; F_{MSY}	$0.5*B_{MSY}$; $1.3*F_{MSY}$
Skipjack tuna	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.5*F_{MSY}$
Yellowfin tuna	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.4*F_{MSY}$
Swordfish	B_{MSY}; F_{MSY}	$0.4*B_{MSY}$; $1.4*F_{MSY}$

Alternative Management Measures; Impacts of the Purse-Seine Fishery; Juvenile Tuna Catches

SC14.59 (para. 186) The SC **RECOMMENDED** that the Commission note that:
- most of the evidence provided to date has indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}), however recent declines in catch and effort have brought

fishing mortality rates to levels below F_{MSY}. There is a risk of reversing the rebuilding trend if there is any increase in catch in this region. Thus, catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,600 t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.

- the southwest region should continue to be analysed as a special resource, as it appears to be highly depleted compared to the Indian Ocean as a whole. However the difference in depletion does not appear to be as extreme as analyses in previous years have suggested. A review of the spatial assumptions should be conducted following the final results of the Indian Ocean Swordfish Stock Structure (IOSSS) project and the analysis of tagging experiments undertaken by SWIOFP.
- that there is no current need to apply additional management measures to the southwest Indian Ocean, although the resource in the area should be carefully monitored.
- that the Working Party on Methods will be progressing Management Strategy Evaluation over the coming year that will aid in addressing the Commission's request, which was considered as the appropriate mechanism for this work.

RESEARCH RECOMMENDATIONS AND PRIORITIES

Working Party on Billfish (WPB) – Research Recommendations and Priorities

SC14.67 (para. 201) The SC **RECOMMENDED** that marlins and sailfish undergo CPUE analysis in 2012, with striped marlin taking priority over other species.

SC14.68 (para. 202) The SC **RECOMMENDED** that as a matter of priority, striped marlin be the subject of CPUE analysis in 2011, and that CPUE series be compared among fleets where possible.

SC14.69 (para. 203) The SC **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2012, and **RECOMMENDED** that efforts over the coming year be focused on the other billfish species, in particular on striped marlin.

SC14.70 (para. 204) The SC **RECOMMENDED** the following core areas as priorities for research over the coming year;

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

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

Status of the Indian Ocean Swordfish Resource (*Xiphias gladius*)

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

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2009**[2]
Indian Ocean	Catch 2010:	18,956 t	
	Average catch 2006-2010:	23,799 t	
	MSY (4 models):	29,900 t–34,200 t	
	F_{2009}/F_{MSY} (4 models):	0.50–0.63	
	SB_{2009}/SB_{MSY} (4 models):	1.07–1.59	
	SB_{2009}/SB_0 (4 models):	0.30–0.53	

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

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. All models suggest that the stock is above, but close to a biomass level that would produce MSY and current catches are below the MSY level. MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2009}/F_{MSY} < 1$; $SB_{2009}/SB_{MSY} > 1$). Spawning stock biomass in 2009 was estimated to be 30–53% (from Table 1; Fig. 1) of the unfished levels.

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

The SC **RECOMMENDED** that:

1) The Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 2) and annual catches of swordfish should not exceed this estimate.
2) if the recent declines in effort continue, and catch remains substantially below the estimated MSY of 30,000–34,000 t, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
3) The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
4) Advice specific to the southwest region is provided below, as requested by the Commission.

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

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

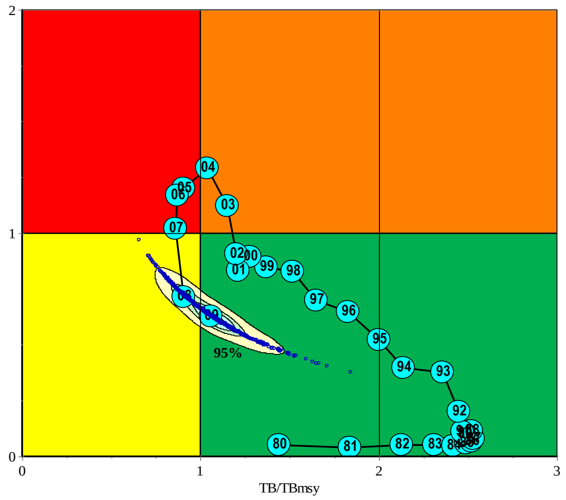


Fig. 1. ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the historical trajectory.

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

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2009**[2]
Southwest Indian Ocean	Catch 2010:	6,513 t	
	Average catch 2006-2010:	7,112 t	
	MSY (3 models):	7,100 t–9,400 t	
	F_{2009}/F_{MSY} (3 models):	0.64–1.19	
	SB_{2009}/SB_{MSY} (3 models):	0.73–1.44	
	SB_{2009}/SB_0 (3 models):	0.16–0.58	

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

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

Southwest Indian Ocean – Management Advice

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY} (Table 3).

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that F2019 > F_{MSY}). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 4).

The SC **RECOMMENDED** that:

1) The Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table 3).
2) Catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
3) The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.

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

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

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Swordfish in the Indian Ocean are currently subject to a single conservation and management measure adopted by the Commission: Resolution 09-02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*. This resolution applies a freezing of fishing capacity for fleets targeting swordfish in the Indian Ocean to levels applied in 2007. The resolution limits vessels access to those that were active (*effective presence*) or under construction during 2007, and were over 24 metres overall length, or under 24 meters if they fished outside the EEZs. At the same time the measure permits CPCs to vary the number of vessels targeting swordfish, as long as any variation is consistent with the national fleet development plan submitted to the IOTC, and does not increase effective fishing effort. This resolution is effective for 2010 and 2011.

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/07 *concerning a record of licensed foreign vessels fishing for tunas and swordfish in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 10/13 *On the implementation of a ban on discards of skipjack tuna, yellowfin tuna, bigeye tuna, and non targeted species caught by purse seiners*.
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Swordfish (*Xiphias gladius*) is a large oceanic apex predator that inhabits all the world's oceans. Throughout the Indian Ocean, swordfish are primarily taken by longline fisheries, and commercial harvest was first recorded by the Japanese in the early 1950's as a bycatch/byproduct of their tuna longline fisheries. Swordfish life history characteristics, including a relatively late maturity, long life and sexual dimorphism, make the species vulnerable to over exploitation. Table 5 outlines some of the key life history traits of swordfish specific to the Indian Ocean.

TABLE 5. Biology of Indian Ocean swordfish (*Xiphias gladius*).

Parameter	Description
Range and stock structure	Northern coastal state waters to 50˚S. Juvenile swordfish are commonly found in tropical and subtropical waters and migrate to higher latitudes as they mature. Large, solitary adult swordfish are most abundant at 15–35˚S. Males are more common in tropical and subtropical waters. By contrast with tunas, swordfish is not a gregarious species, although densities increase in areas of oceanic fronts and seamounts. Extensive diel vertical migrations, from surface waters during the night to depths of 1000 m during the day, in association with movements of the deep scattering layer and cephalopods, their preferred prey. For the purposes of stock assessments, one pan-ocean stock has been assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) indicates the potential for localised depletion of swordfish in the Indian Ocean.
Longevity	30+ years
Maturity (50%)	**Age**: females 6–7 years; males 1–3 years **Size**: females ~170 cm lower-jaw FL; males ~120 cm lower-jaw FL
Spawning season	Highly fecund batch spawner. May spawn as frequently as once every three days over a period of several months in spring. Spawning occurs from October to April in the vicinity of Reunion Island.
Size (length and weight)	Maximum: 455 cm lower-jaw FL; 550+ kg total weight in the Indian Ocean. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males. Most swordfish larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~60 cm lower-jaw FL for artisanal fleets and methods. By one year of age, a swordfish may reach 90 cm lower-jaw FL (~15 kg). The average size of swordfish taken in Indian Ocean longline fisheries is between 40 kg and 80 kg (depending on latitude).

SOURCES: Froese & Pauly (2009); Poisson & Fauvel (2009)

Catch trends

Swordfish are caught mainly using drifting longlines (95%) and gillnets (5%) (Fig. 2). Between 1950 and 1980, catches of swordfish in the Indian Ocean slowly increased in tandem with the level of coastal state and distant water fishing nation longline effort targeting tunas (Figs. 2 and 3). Swordfish were mainly a bycatch of industrial longline fisheries before the early 1990’s with catches slightly increasing from 1950 to 1990 proportionally to the increase in the catches of target species (tropical and temperate tunas).

Since 2004, annual catches have declined steadily (Fig. 2), largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean. Annual catches since 2004 have been dominated by the Taiwan,China and EU fleets (Spain, UK, France and Portugal), with the fishery extending eastward due to the effects of piracy actions (Fig. 4).

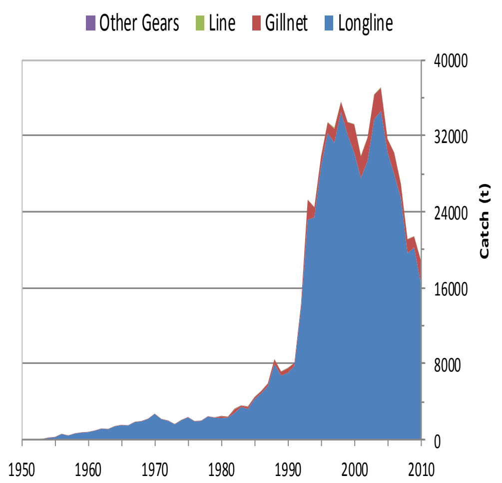


Fig. 2 Catches of swordfish per gear and year recorded in the IOTC Database (1960–2010).

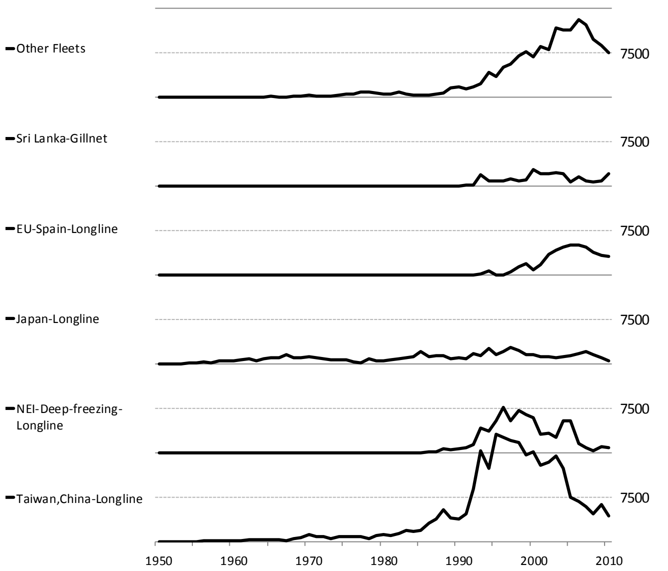


Fig. 3. Catches of swordfish by fleet recorded in the IOTC Database (1960–2010).

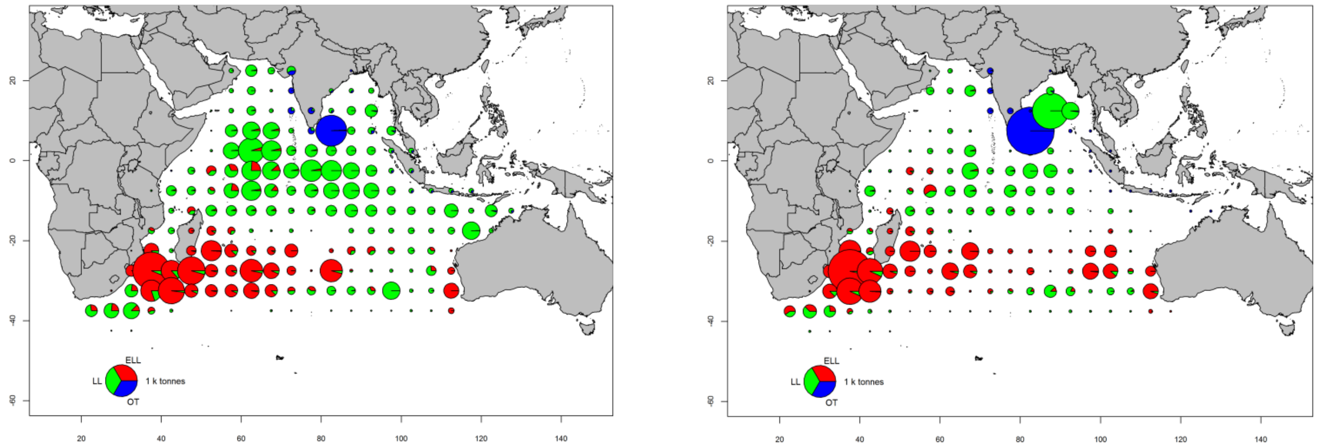


Fig. 4a–b. Time-area catches (total combined in tonnes) of swordfish estimated for 2009 and 2010, by year and type of gear. Swordfish longliners (**ELL**), Other longliners (**LL**), Other fleets (**OT**). Time-area catches are not available for non-longline fleets (OT, blue); catches for those were fully assigned to the one or more 5x5 squares lying within the EEZs of the countries concerned.

TABLE 6. Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2009 (in metric tons). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
ELL				9	1,842	10,439	7,970	8,927	10,727	13,414	15,645	13,629	12,008	8,579	8,423	8,113
LL	282	1,426	2,135	4,337	21,580	17,475	19,600	20,453	23,032	21,206	14,630	14,350	13,443	11,064	11,825	8,373
OT	40	41	53	317	1,094	2,121	2,381	2,514	2,646	2,531	1,461	2,305	1,600	1,515	1,200	2,470
Total	**322**	**1,467**	**2,188**	**4,664**	**24,516**	**30,035**	**29,950**	**31,893**	**36,405**	**37,152**	**31,735**	**30,285**	**27,051**	**21,157**	**21,448**	**18,956**

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

TABLE 7. Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2009 (in metric tons). Data as of October 2011.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
NW	117	551	650	1,469	7,245	9,820	7,969	12,281	15,108	12,276	10,865	10,355	8,719	6,625	4,998	2,204
SW	14	256	405	620	8,599	7,591	8,887	7,359	3,969	6,293	9,680	8,833	7,349	6,188	6,678	6,513
NE	122	405	725	2,017	5,787	6,352	6,379	5,783	8,166	7,775	4,680	6,138	4,973	4,753	6,661	7,393
SE	27	167	271	342	2,518	5,644	6,051	5,737	8,297	9,729	5,753	4,337	5,258	3,507	3,014	2,788
OT	41	88	137	215	368	628	664	734	864	1,079	757	621	752	84	97	58
Total	**322**	**1,467**	**2,188**	**4,664**	**24,516**	**30,035**	**29,950**	**31,893**	**36,405**	**37,152**	**31,735**	**30,285**	**27,051**	**21,157**	**21,448**	**18,956**

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

Uncertainty of time–area catches

Retained catches are fairly well known (Fig. 5); however catches are uncertain for:

- Drifting gillnet fisheries of Iran and Pakistan: To date, Iran has not reported catches of swordfish for its gillnet fishery. Although Pakistan has reported catches of swordfish they are considered to be too low for a driftnet fishery.
- Longline fishery of Indonesia: The catches of swordfish for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years due to insufficient sampling coverage. Although the new catches estimated by the Secretariat are thought to be more accurate, swordfish catches remain uncertain, especially in recent years.
- Longline fishery of India: India has reported very incomplete catches and catch-and-effort data for its longline fishery. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of swordfish remain uncertain.
- Longline fleets from non-reporting countries (NEI): The IOTC Secretariat had to estimate catches of swordfish for a fleet of longliners targeting tunas or swordfish and operating under flags of various non-reporting countries. The catches estimated since 2006 are, however, low.
- Changes to the catch series: There have not been significant changes to the catch series of swordfish since the WPB in 2010. Changes since the last WPB refer to revisions of historic data series for the artisanal

fisheries of Indonesia and India. These changes, however, did not lead to significant changes in the total catch estimates.

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

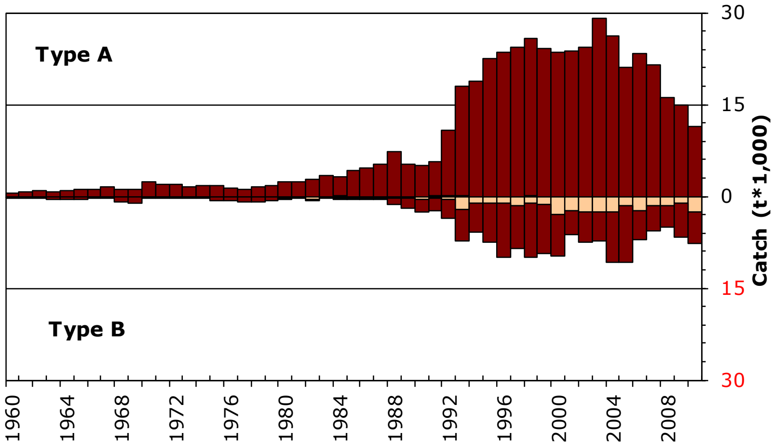


Fig. 5. Uncertainty of time-area catches for swordfish (Data as of October 2011).

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

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 6, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 7.

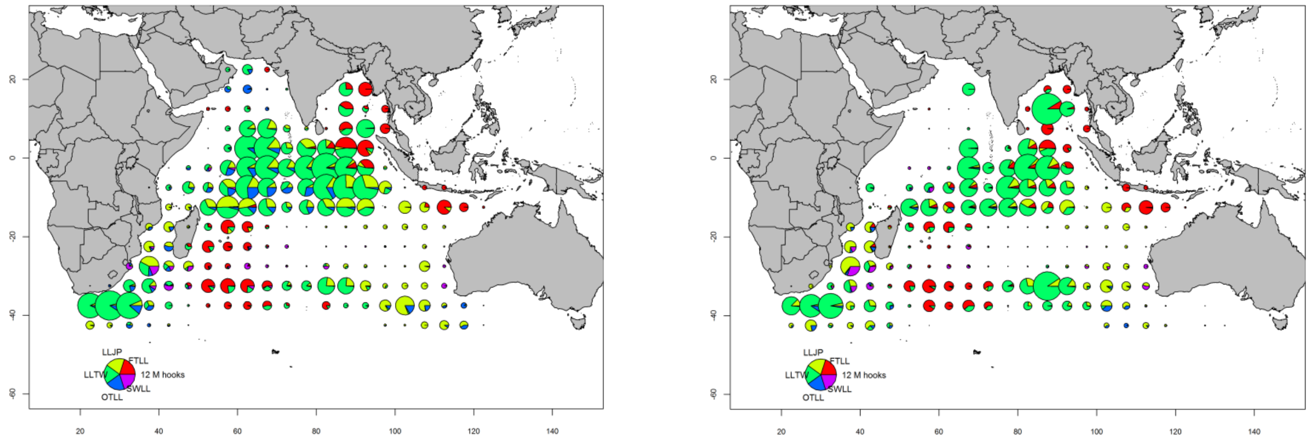


Fig. 6. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

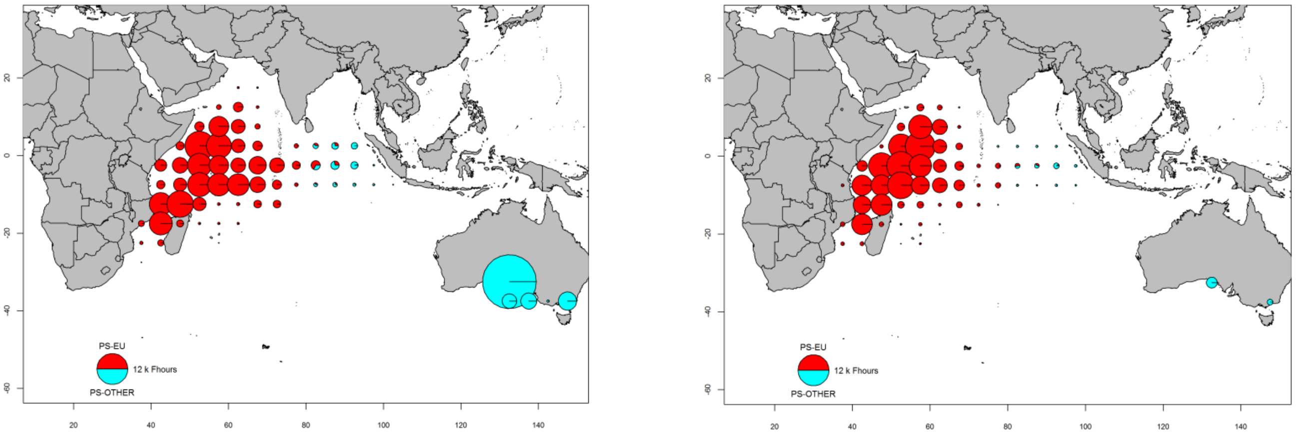


Fig. 7. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

The following CPUE series were used in the stock assessment models for 2011 (Figs. 8 and 9), while the relative weighting of the different CPUE series would be left to the individual analyst to determine and justify to participants:

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

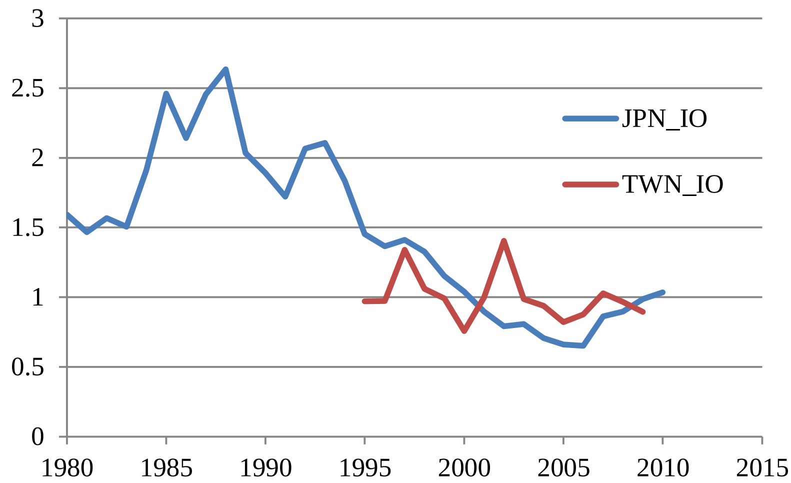


Fig. 8. Aggregate Indian Ocean CPUE series for swordfish. Series have been rescaled relative to their respective means from 1995–2009.

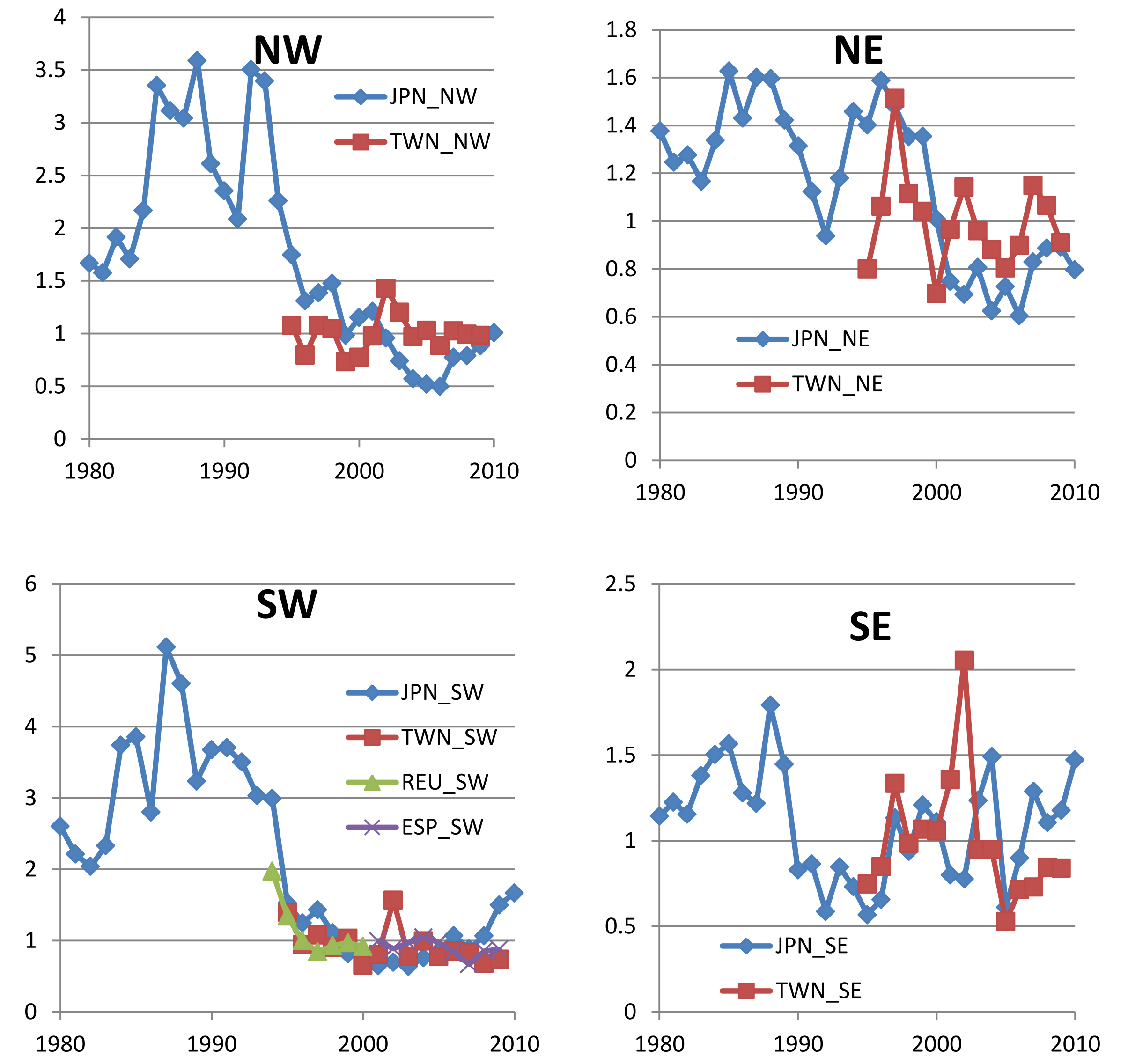


Fig. 9. CPUE series for Indian Ocean swordfish assessments by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods).

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

In general, the amount of catch for which size data for the species are available before 2005 is still very low and the number of specimens measured per stratum has been decreasing in recent years.

- Average fish weight can be assessed for several industrial fisheries although they are incomplete or poor quality for most fisheries before the early-80s and in recent years (low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend (Fig. 10). It is considered encouraging that there are no clear signals of declines in the size-based indices, but these indices should be carefully monitored, as females mature at a relatively large size, therefore, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.
- Catch-at-Size(Age) data are available but the estimates are thought to have been compromised for some years and fisheries due to:
    - the uncertainty in the catches of swordfish for the drifting gillnet fisheries of Iran and the fresh-tuna longline fishery of Indonesia.
    - the total lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (Pakistan, India, Indonesia).
    - the paucity of size data available from industrial longliners since the early-1990s (Japan, Philippines, India and China).
    - the lack of time-area catches for some industrial fleets (Indonesia, India, NEI).
    - the paucity of biological data available, notably sex-ratio and sex-length-age keys.

Fig. 10. Swordfish average weight (1970–2010) derived from catches-at-size estimated from the available length frequency samples of swordfish (average weights are shown only for years in which samples of swordfish are available).

STOCK ASSESSMENT

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

A range of quantitative modelling methods were applied to the swordfish assessment in 2011, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. The different assessments were presented to the WPB in documents IOTC–2011–WPB09–17, 18, 19 and 20.

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

The swordfish stock status was determined by qualitatively integrating the results of the various stock assessments undertaken in 2011 (Tables 1 and 8).
The following should be noted with respect to the various modelling approaches:

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

(e.g. the generation time of swordfish is such that a relatively long time series is required to make inferences about productivity).

TABLE 8. Key management quantities from the Stock Synthesis 3 assessments, for the aggregate and southwest Indian Ocean. Values represent the 50th (5th–95th) percentiles of the (plausibility-weighted) distribution of maximum posterior density estimates from the full range of the models examined.

Management Quantity	Aggregate Indian Ocean	Southwest Indian Ocean
2009 catch estimate	21,500 t	6,700 t
Mean catch from 2005–2009	26,300 t	77,700 t
MSY	31,000 t (20,000– 55,000)	9,400 t (6,500–13,500)
Data period used in assessment	1951–2009	1951–2009
F_{2009}/F_{MSY}	0.50 (0.23–1.08)	0.64 (0.27–1.27)
B_{2009}/B_{MSY}	–	–
SB_{2009}/SB_{MSY}	1.59 (0.94–3.77)	1.44 (0.61–3.71)
B_{2009}/B_0	–	–
SB_{2009}/SB_0	0.35 (0.22–0.42)	0.29 (0.15–0.43)
$B_{2009}/B_{0,\ F=0}$	–	–
$SB_{2009}/SB_{0,\ F=0}$	–	–

LITERATURE CITED

Froese R and Pauly DE, 2009. *FishBase,* version 02/2009, FishBase Consortium, <www.fishbase.org>.

Kolody D, 2009.*An exploratory 'stock synthesis' assessment of the Indian Ocean swordfish fishery 1950–2007*, Seychelles, 6–10 July 2009, IOTC-2009-WPB-10.

Poisson F and Fauvel C, 2009.'Reproductive dynamics of swordfish (*Xiphias gladius*) in the southwestern Indian Ocean (Reunion Island), part 1, Oocyte development, sexual maturity and spawning', *Aquatic Living Resources,* vol. 22, pp. 45–58.

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

Status of the Indian Ocean Black Marlin Resource (*Makaira indica*)

TABLE 1. Status of the Indian Ocean Black Marlin (*Makaira indica*).

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch 2010:	5,018 t	Uncertain
	Average catch 2006–2010:	4,689 t	
	MSY (range):	unknown	
	F_{2009}/F_{MSY} (range):	unknown	
	SB_{2009}/SB_{MSY} (range):	unknown	
	SB_{2009}/SB_0 (range):	unknown	

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

Indian Ocean stock – Management Advice

Stock status. No quantitative stock assessment is currently available for black marlin 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* (Table 1). However, aspects of the biology, productivity and fisheries for this 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.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.
The Scientific Committee considers the following:

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

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

Conservation and Management Measures

Black marlin (*Makaira indica*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

Fisheries Indicators

General

Black marlin (*Makaira indica*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of black marlin and no information on the stock structure or growth and mortality in the Indian Ocean.

TABLE 2. Biology of Indian Ocean black marlin (*Makaira Indica*).

Parameter	**Description**
Range and stock structure	Little is known on the biology of the black marlin in the Indian Ocean. Thus, the information detailed here pertains to information from other oceans, primarily the Pacific. Black marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Individuals have been reported in the Atlantic Ocean but there is no information to indicate the presence of a breeding stock in this area. Black marlin is mainly found in oceanic surface waters above the thermocline and typically near land masses, islands and coral reefs; however, they may range to depths of 1000 m. Thought to associate with schools of small tuna, which is one of its primary food sources (also reported to feed on other fishes, squids, cuttlefishes, octopods, and large decapod crustaceans). No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	Females: 11–12 years; Males: 5–6 years
Maturity (50%)	**Age**: unknown **Size**: females around 100 kg; males 50 to 80 kg total weight
Spawning season	No spawning grounds have been identified in the Indian or Pacific oceans, but in Australia spawning individuals apparently prefer water temperatures around 27-28°C. Highly fecund batch spawner. Females may produce up to 40 million eggs.
Size (length and weight)	Maximum: In other oceans can grow to more than 4.6 m FL and weigh 800 kg total weight. Young fish grow very quickly in length then put on weight later in life. In eastern Australian waters black marlin grows from 13 mm long at 13 days old to 180 cm and around 30 kg after 13 months. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males. Females: 326 cm lower-jaw FL, 800 kg total weight; Males: 255 cm lower-jaw FL, 300 kg total weight. Most black marlin larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~60 cm lower-jaw FL for artisanal fleets and methods. The average size of black marlin taken in Indian Ocean longline fisheries is not available.

SOURCES: Cry et al. (1990); Froese & Pauly (2009); Nakamura (1985); Speare (2003); Sun et al. (2007)

Catch trends

Black marlin are caught mainly under drifting longlines (44%) and gillnets (49%) with remaining catches recorded under troll and hand lines (Fig. 1). Black marlin are the bycatch of industrial and artisanal fisheries. In recent years, the fleets of Taiwan,China (longline), Sri Lanka (gillnet), Indonesia (gillnets) and India (gillnets) are attributed with the highest catches of black marlin (Fig. 2). The minimum average annual catch estimated for the period 2006 to 2010 is around 4,689 t.

Between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches of black marlin in that area, in particular in waters off northwest Australia. In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of black marlin, mostly in waters off the western coast of India and, to a lesser extent, the Mozambique Channel (Fig. 3).

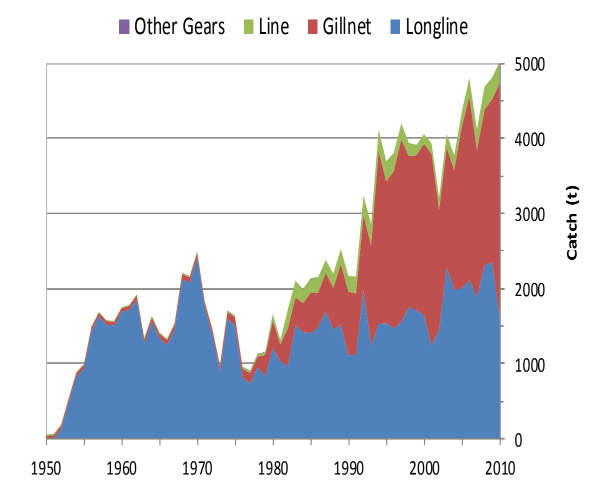


Fig. 1. Catches of black marlin per gear and year recorded in the IOTC Database (1960–2010).

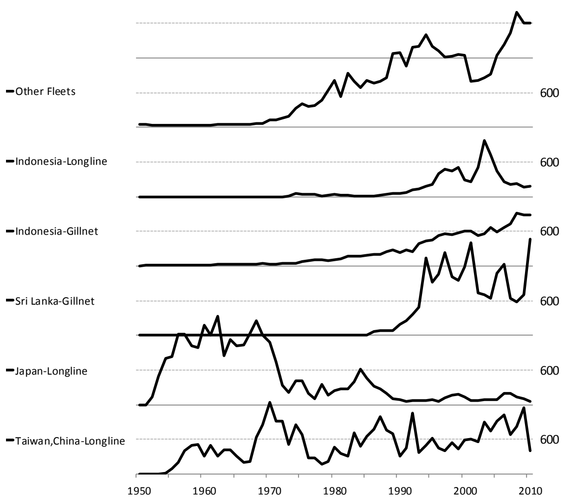


Fig. 2. Catches of black marlin by fleet recorded in the IOTC Database (1960–2010).

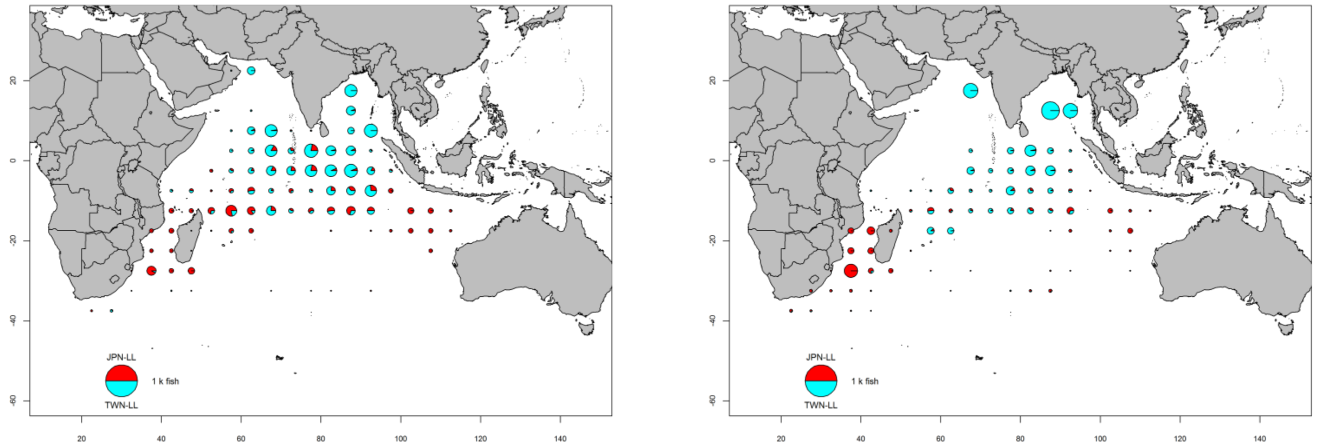


Fig. 3a–b. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2009 (in metric tonnes). Data as of May 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	846	1,633	1,288	1,370	1,501	1,646	1,243	1,454	2,291	1,985	2,002	2,110	1,894	2,302	2,359	1,612
Gillnet	47	60	115	473	1,680	2,287	2,549	1,600	1,589	1,596	2,157	2,446	1,955	2,080	2,165	3,121
Line	15	19	25	177	231	127	146	162	183	195	201	250	273	310	285	286
Other	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	**908**	**1,713**	**1,431**	**2,021**	**3,412**	**4,060**	**3,938**	**3,217**	**4,064**	**3,776**	**4,360**	**4,806**	**4,121**	**4,693**	**4,809**	**5,018**

Uncertainty of time–area catches

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

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

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information
- catches are likely to be incomplete for industrial fisheries for which the black marlin is not a target species
- conflicting catch reports: Longline catches from the Republic of Korea are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- discards are unknown for most industrial fisheries, mainly longliners. Discards of black marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

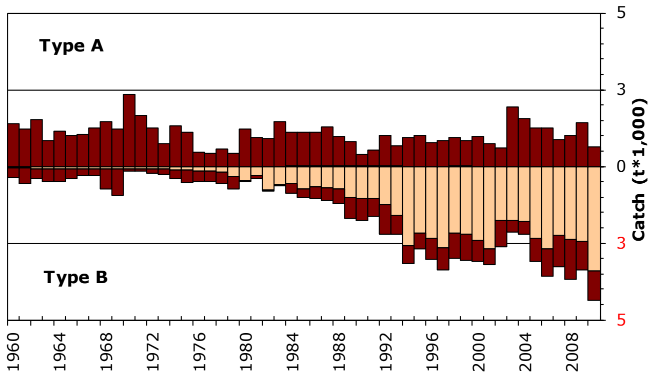


Fig. 4. Uncertainty of time-area catches for black marlin (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

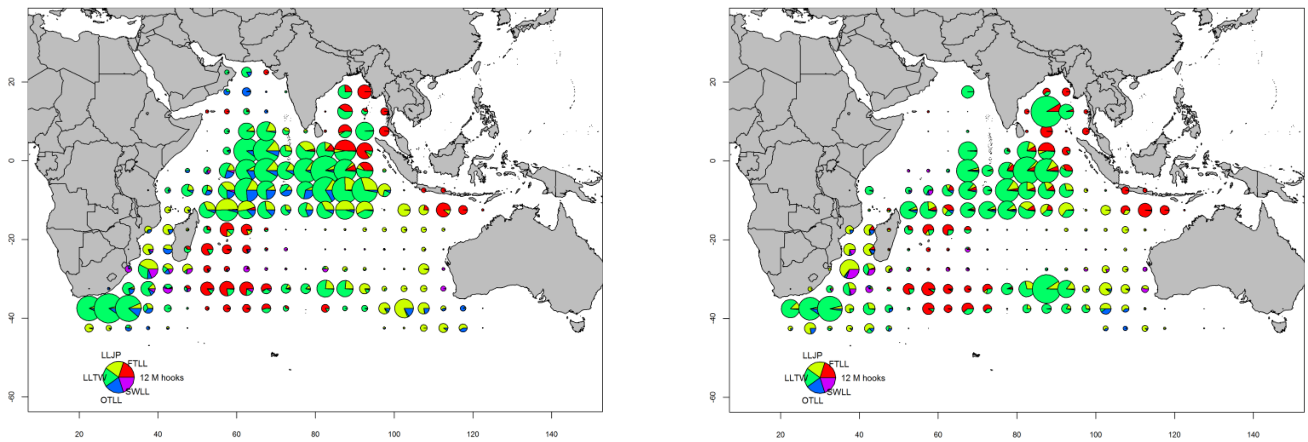


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

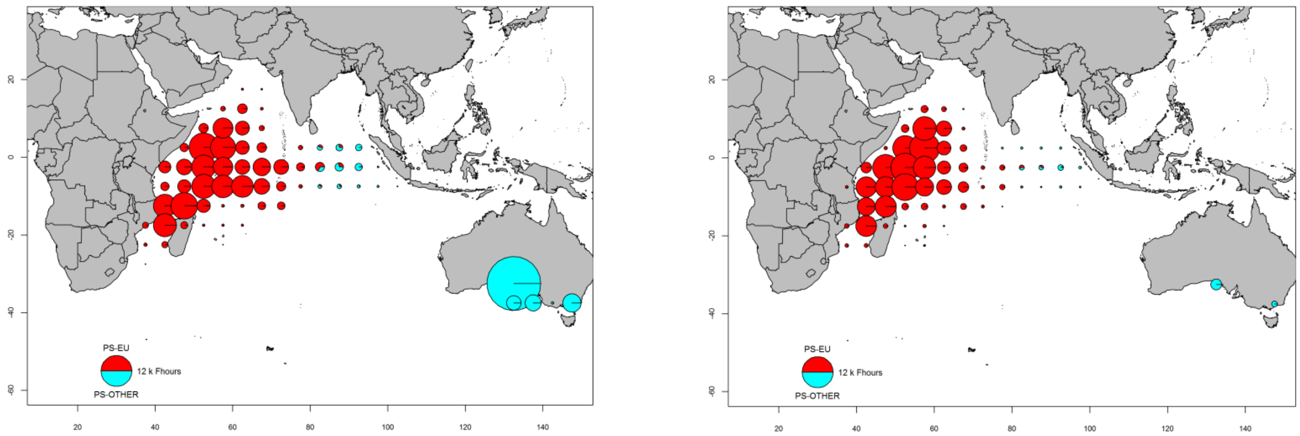


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet; Figs. 7, 8) although catches are thought to be incomplete (catches of non-target species are not always recorded in logbooks). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

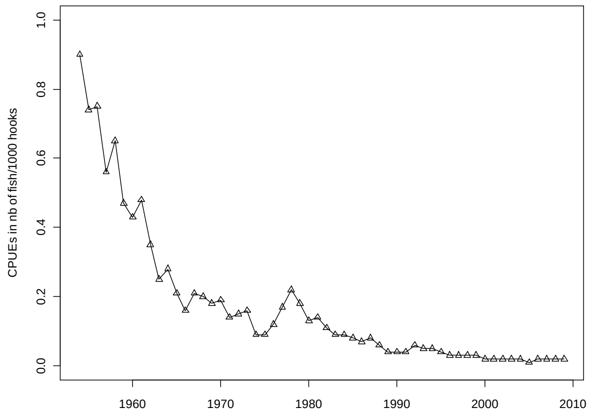


Fig. 7. Nominal CPUE (number of fish by 1,000 hooks) of black marlin caught by Japanese longliners off-Somalia.

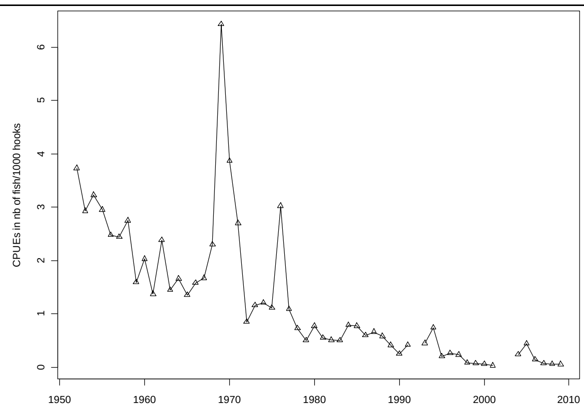


Fig. 8. Nominal CPUE (number of fish by 1,000 hooks) of black marlin caught by Japanese longliners northwest Australia.

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

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

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

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

STOCK ASSESSMENT

No quantitative stock assessment for black marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan, China that represent the best available information. Nominal CPUE exhibited dramatic declines since the beginning of the fishery in two major fishing grounds (West Equatorial and north-west Australia) (Figs. 8 and 9) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Black marlin (*Makaira indica*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	5,000 t
Mean catch from 2006–2010	4,700 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980,\ F=0}$	–
$SB_{2010}/SB_{1980,\ F=0}$	–

LITERATURE CITED

Cyr EC, Dean JM, Jehangeer I & Nallee M, 1990. Age, growth, and reproduction of blue marlin and black marlin from the Indian Ocean. In: Stroud RH (ed) Planning the future of billfishes. Research and management in the 90s and beyond. National Coalition for Marine Conservation, Savannah, GA, pp 309–316.

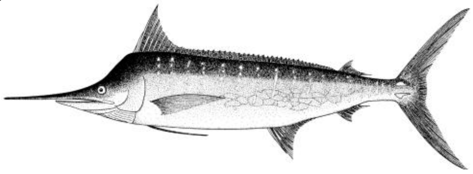
Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

Nakamura I, 1985. FAO species catalogue. Billfish of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes, and swordfishes known to date. FAO Fish. Synop. 125(5), 65 p.

Speare P, 2003. Age and growth of black marlin, *Makaira indica*, in east coast Australian waters. Mar. Freshw. Res., 54(4): 307-314.

Sun C, Liu C & Yeh S, 2007. Age and growth of black marlin (*Makaira indica*) in the waters off eastern Taiwan. Paper presented to the WCPFC Scientific Committee, WCPFC-SC3-BI SWG/WP-2.

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



Status of the Indian Ocean Indo-Pacific Blue Marlin Resource (*Makaira mazara*)

TABLE 1. Status of Indo-Pacific blue marlin (*Makaira mazara*) in the Indian Ocean.

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch 2010:	11,261 t	Uncertain
	Average catch 2006–2010:	9,508 t	
	MSY (range):	unknown	
	F_{2009}/F_{MSY} (range):	unknown	
	SB_{2009}/SB_{MSY} (range):	unknown	
	SB_{2009}/SB_0 (range):	unknown	

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for Indo-Pacific blue marlin in the Indian Ocean, and due to a lack of reliable fishery data for several gears, only very preliminary stock indicators can be used. The standardised CPUE suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being *uncertain* (Table 1). However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base a quantitative assessment is a cause for concern.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The SC **RECOMMENDED** the following:

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

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Indo-Pacific blue marlin (*Makaira mazara*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Indo-Pacific blue marlin (*Makaira mazara*) is a large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Table 2 outlines some key life history parameters relevant for management.

TABLE 2. Biology of Indian Ocean Indo-Pacific blue marlin (*Makaira mazara*).

Parameter	Description
Range and stock structure	Little is known on the biology of the Indo-Pacific blue marlin in the Indian Ocean and the istinction between the blue marlin (*Makaira nigricans*) and Indo-Pacific blue marlin (*Makaira indica*) is not clear. Thus, the information detailed here pertains to information from other oceans, primarily the Pacific and Atlantic oceans. Indo-Pacific Blue marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. In the Pacific Ocean one tagged Indo-Pacific blue marlin is reported to have travelled 3000nm in 90 days. Indo-Pacific Blue marlin is a solitary species and prefers the warm offshore surface waters (>24°C); it is scarce in waters less than 100m in depth or close to land.The Indo-Pacific blue marlin's prey includes octopuses, squid and pelagic fishes such as blackfin tuna and frigate mackerel. Feeding takes place during the daytime, and the fish rarely gather in schools, preferring to hunt alone. No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	~28 years; Females n.a; Males n.a.
Maturity (50%)	**Age**: 2–4 years; females n.a. males n.a. **Size:** females ~50 cm lower-jaw FL (55 kgs whole weight); males ~80 cm lower-jaw FL (40 kgs total weight).
Spawning season	No spawning grounds have been identified in the Indian ocean. Females may produce up to 10 million eggs. In the Pacific ocean, Indo-Pacific blue marlin are thought to spawn between May and September off the coast of Japan.
Size (length and weight)	Maximum: Females 430 cm FL; 910 kgs whole weight; males 300 cm FL; 200 kgs whole weight. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males.

n.a. = not available. SOURCES: Nakamura (1985); Cry et al. (1990); Shimose et al. (2008); Froese & Pauly (2009)

Catch trends

Indo-Pacific blue marlin are caught mainly under drifting longlines (60%) and gillnets (30%) with remaining catches recorded under troll and hand lines (Fig. 1). Indo-Pacific blue marlins are considered to be a bycatch of industrial and artisanal fisheries. The catches of Indo-Pacific blue marlin are typically higher than those of black marlin and striped marlin combined. In recent years, the fleets of Taiwan,China (longline), Indonesia (longline), Sri Lanka (gillnet) and India (gillnet) are attributed with the highest catches of Indo-Pacific blue marlin (Fig. 2). The distribution of Indo-Pacific blue marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean.

Catch trends for Indo-Pacific blue marlin are variable; however, this may reflect the level of reporting. The catches of Indo-Pacific blue marlin under drifting longlines were more or less stable until the mid-80's, at around 3,000 t, steadily increasing since then. The largest catches were recorded in 1997 (~14,000 t). Catches under drifting longlines have been recorded under Taiwan,China and Japan fleets and, recently, Indonesia and several NEI fleets (Fig. 2). In recent years, deep-freezing longliners from Japan and Taiwan,China have reported most of the catches of Indo-Pacific blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel and the Arabian Sea (Fig. 3).

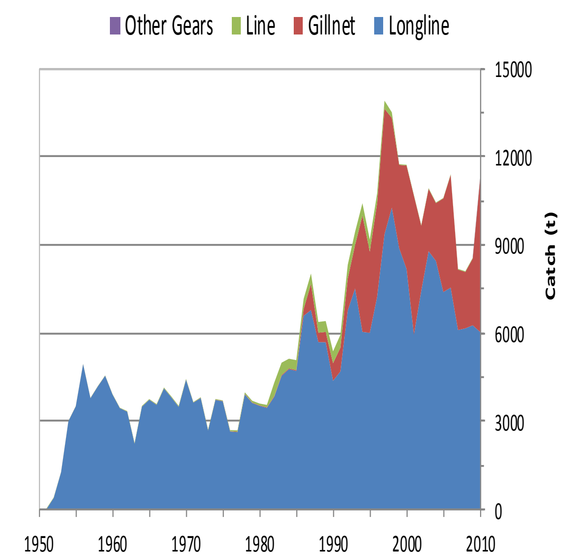


Fig. 1. Catches of Indo-Pacific blue marlin per gear and year recorded in the IOTC Database (1960–2010).

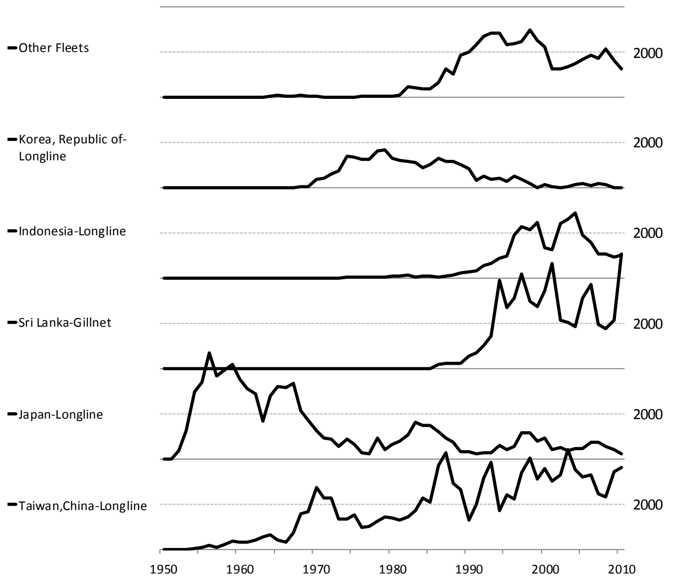


Fig. 2. Catches of Indo-Pacific blue marlin by fleet recorded in the IOTC Database (1960–2010).

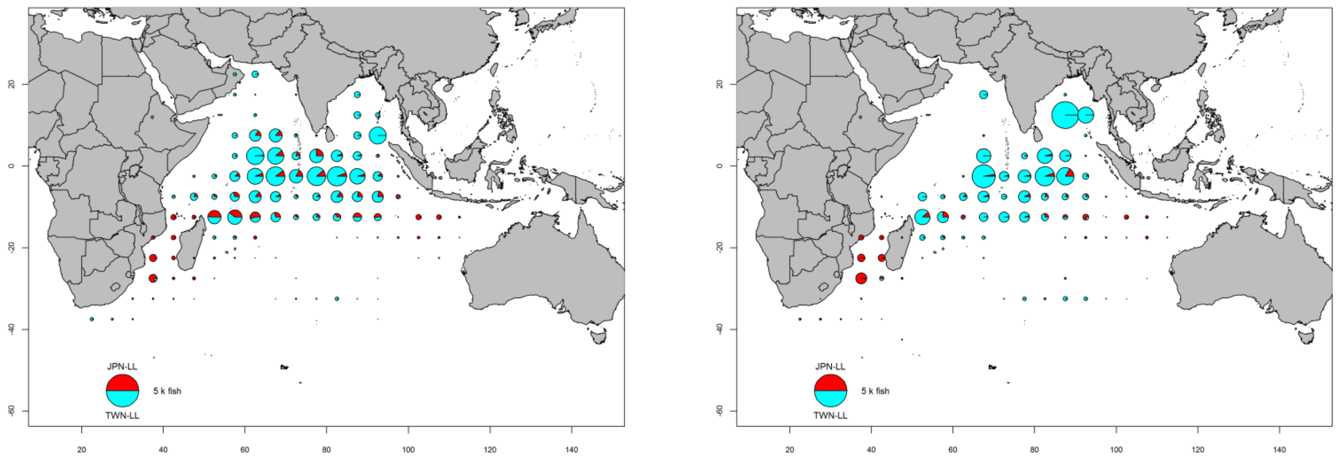


Fig. 3a–b. Time-area catches (in number of fish) of Indo-Pacific blue marlin as reported for the longline (LL) fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of Indo-Pacific blue marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	2,563	3,512	3,474	4,961	7,119	8,184	5,949	7,441	8,791	8,457	7,400	7,550	6,106	6,163	6,267	6,043
Gillnet	3	4	10	194	2,407	3,524	4,732	2,219	2,124	1,972	3,188	3,842	2,059	1,921	2,276	5,193
Line	11	23	34	313	341	27	27	26	25	24	17	21	25	26	23	25
Other	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**2,576**	**3,539**	**3,518**	**5,467**	**9,868**	**11,735**	**10,709**	**9,686**	**10,940**	**10,452**	**10,605**	**11,413**	**8,189**	**8,110**	**8,566**	**11,261**

Uncertainty of time–area catches

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

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

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information
- catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific blue marlin is not a target species
- conflicting catch reports: Longline catches from the Republic of Korea are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of Indo-Pacific blue marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- discards are unknown for most industrial fisheries, mainly longliners. Discards of Indo-Pacific blue marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

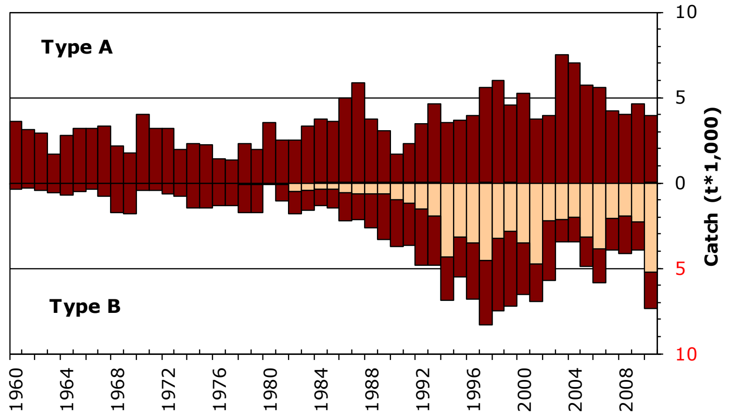


Fig. 4. Uncertainty of time-area catches for Indo-Pacific blue marlin (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

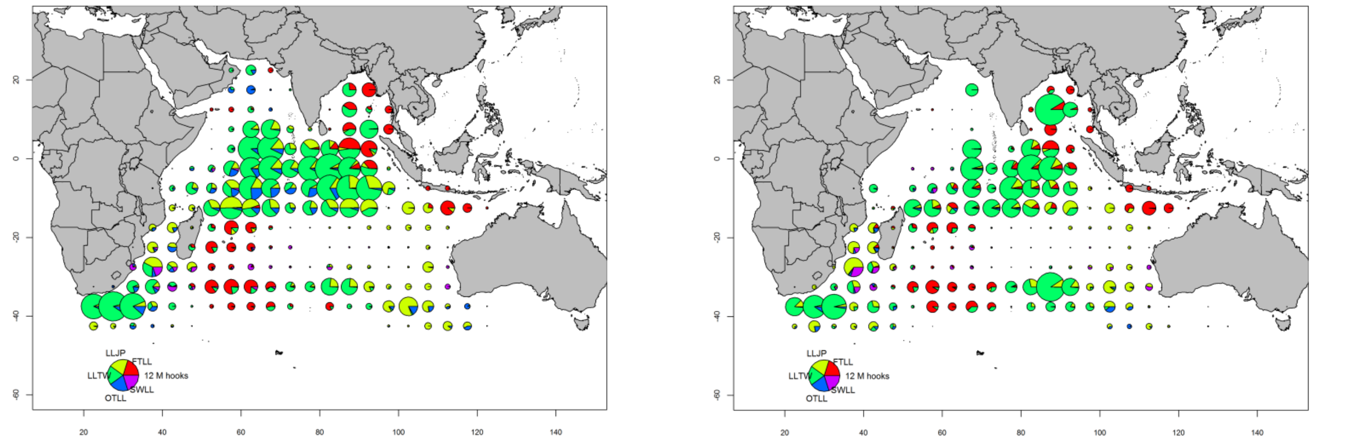
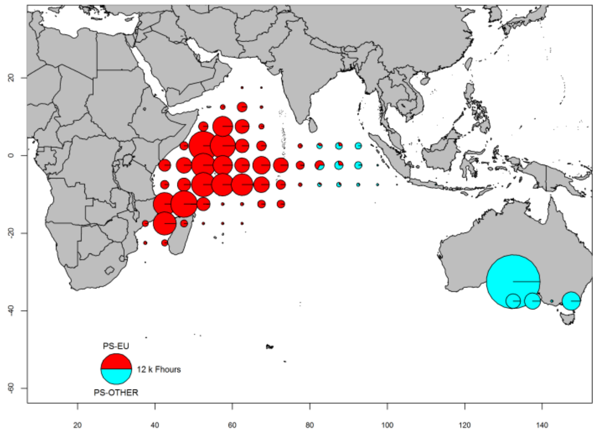


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)



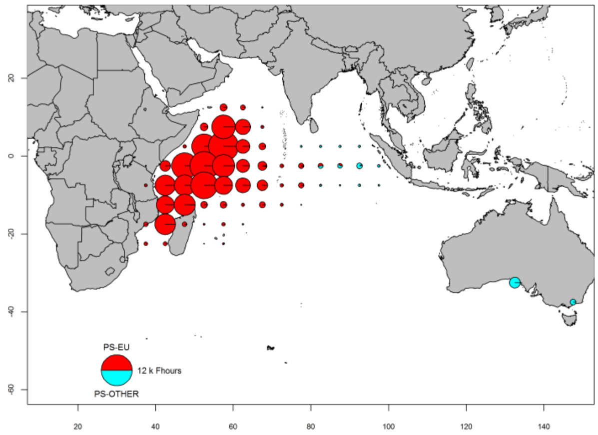


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).

PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)

PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

A CPUE standardisation of Indo-Pacific blue marlin (*Makaira mazara*) caught by the Taiwan,China longline fishery in the Indian Ocean was considered in 2011. The results reveal similar trends of CPUE standardized based on three combinations of fishing areas definitions and data period.

The standardised CPUE for the whole Indian Ocean suggest that there was a decline in the early 1980s, followed by an increase in abundance over the last 20 years (Fig. 7). However, it was also noted that this contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s (Figs. 8 and 9).

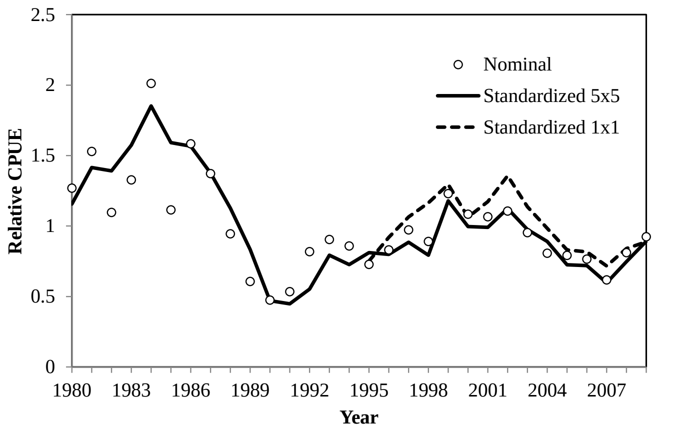


Fig. 7. Area-aggregated nominal and Standardised CPUE of Indo-Pacific blue marlin caught by Taiwan,China longline fleet based on four fishing areas.

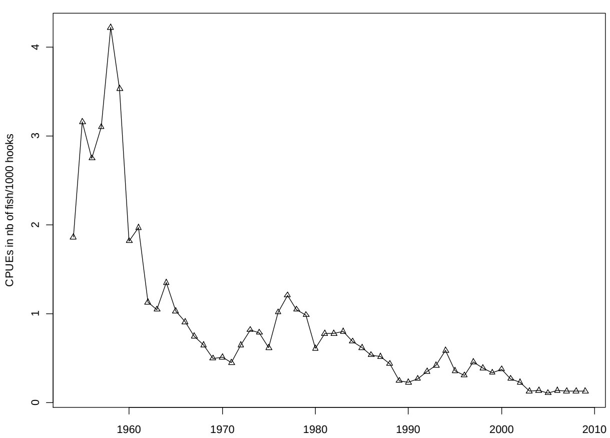


Fig. 8. Nominal CPUE (number of fish by 1,000 hooks) of Indo-Pacific blue marlin caught by Japanese longliners off-Somalia.

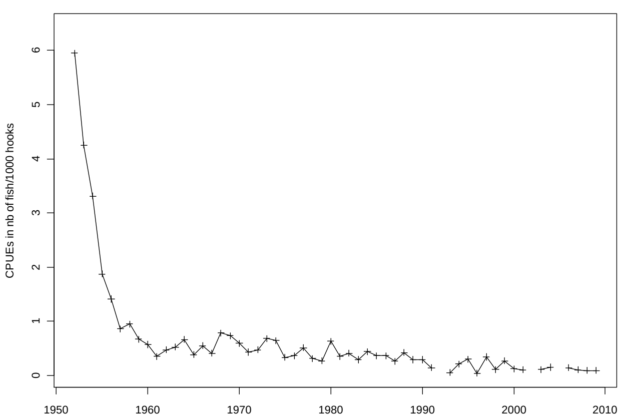


Fig. 9. Nominal CPUE (number of fish by 1,000 hooks) of Indo-Pacific blue marlin caught by Japanese longliners northwest Australia.

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

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

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

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

STOCK ASSESSMENT

No quantitative stock assessment for Indo-Pacific blue marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information (described above). However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Blue marlin (*Makaira mazara*) stock status summary.

Management Quantity	Aggregate Indian Ocean
2010 catch estimate	11,300 t
Mean catch from 2006–2010	9,500 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980,\ F=0}$	–
$SB_{2010}/SB_{1980,\ F=0}$	–

LITERATURE CITED

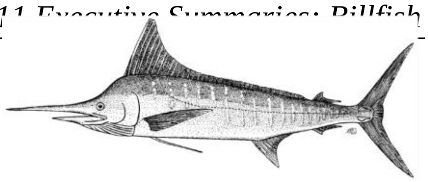
Cyr EC, Dean JM, Jehangeer I & Nallee M, 1990.Age, growth, and reproduction of blue marlin and black marlin from the Indian Ocean. In: Stroud RH (ed) Planning the future of billfishes. Research and management in the 90s and beyond. National Coalition for Marine Conservation, Savannah, GA, pp 309–316.

Froese R & Pauly DE, 2009.FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

Kleiber P, Hinton MG & Uozumi Y, 2003. Stock assessment of blue marlin (*Makaira nigricans*) in the Pacific using MULTIFAN-CL. Mar Freshw Res 54:349–360.

Nakamura I, 1985.FAO species catalogue. Billfish of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes, and swordfishes known to date. FAO Fish.Synop.125(5), 65 p.

Shimose T, Fujita M, Yokawa K, Saito H and Tachihara K, 2008.Reproductive biology of blue marlin *Makaira nigricans* around Yonaguni Island, southwestern Japan. Fish Sci. 75: 109-119.



Status of the Indian Ocean Striped Marlin Resource (*Tetrapturus audax*)

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

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch 2010:	1,921 t	Uncertain
	Average catch 2006–2010:	2,542 t	
	MSY (range):	unknown	
	F_{2010}/F_{MSY} (range):	unknown	
	SB_{2010}/SB_{MSY} (range):	unknown	
	SB_{2010}/SB_0 (range):	unknown	

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for striped marlin 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* (Table 1). However, aspects of the biology, productivity and fisheries for this 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.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The Scientific Committee considers the following:

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

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

CONSERVATION AND MANAGEMENT MEASURES

Striped marlin (*Tetrapturus audax*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

FISHERIES INDICATORS

General

Striped marlin (*Tetrapturus audax*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of this species and no information on the stock structure or growth and mortality in the Indian Ocean.

TABLE 2. Biology of Indian Ocean striped marlin (*Tetrapturus audax*).

Parameter	Description
Range and stock structure	A large oceanic apex predator that inhabits sub-tropical waters of the Indian and Pacific oceans, and is rarely found in the Atlantic Ocean. Its distribution is different from other marlins in that it prefers more temperate or cooler waters and tends to be less migratory. In the Indian Ocean seasonal concentrations of striped marlin occur in four main regions: off the east African coast (0º-10ºS), the south and western Arabian Sea, the Bay of Bengal, and north-western Australian waters. The stock structure of striped marlin in the Indian Oceans is uncertain.
Longevity	~10 years. Females and males n.a.
Maturity (50%)	**Age**: 2–3 years. Females and males n.a.
Spawning season	Highly fecund batch spawner. Females may produce up to 20 million eggs. Unlike the other marlins which are serial spawners, striped marlin appear to spawn once per season.
Size (length and weight)	Maximum: 300+ cm FL; 240 kg total weight. Young fish grow very quickly in length then put on weight later in life. Striped marlin is the smallest of the marlin species; but unlike the other marlin species, striped marlin males and females grow to a similar size.

n.a. = not available. SOURCES: Nakamura (1985); Froese & Pauly (2009).

Catch trends

Striped marlin are caught almost exclusively under drifting longlines (98%) with remaining catches recorded under gillnets and troll lines (Fig. 1). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable; however, this may reflect the level of reporting. The catches of striped marlin under drifting longlines have been changing over time, between 2,000 t and 8,000 t (Fig. 1).

Catches under drifting longlines have been recorded under Taiwan,China, Japan, Republic of Korea fleets and, recently, Indonesia and several NEI fleets (Fig. 2). Taiwan,China and Japan have reported large drops in the catches of striped marlin for its longline fleets in recent years. The reason for such decreases in catches is not fully understood. Between the early-50s and the late-80s part of the Japanese fleet was licensed to operate within the EEZ of Australia, reporting relatively high catches of striped marlin in the area, in particular in waters off northwest Australia. High catches of the species were also reported in the Bay of Bengal during this period, by both Taiwan,China and Japanese longliners. The distribution of striped marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean. In recent years, the fleets of Taiwan,China (longline) and to a lesser extent Indonesia (longline) are attributed with the highest catches of striped marlin.

In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of striped marlin, mostly in the northwest Indian Ocean (Fig. 3). The minimum average annual catch estimated for the period 2006 to 2010 is around 2,542 t. These changes of fishing area and catches over the years are thought to be related to changes in the type of access agreements to EEZs of coastal countries in the Indian Ocean, rather than changes in the distribution of the species over time. Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in the driftnet fishery of the I.R of Iran, as this species has no commercial value in this country.

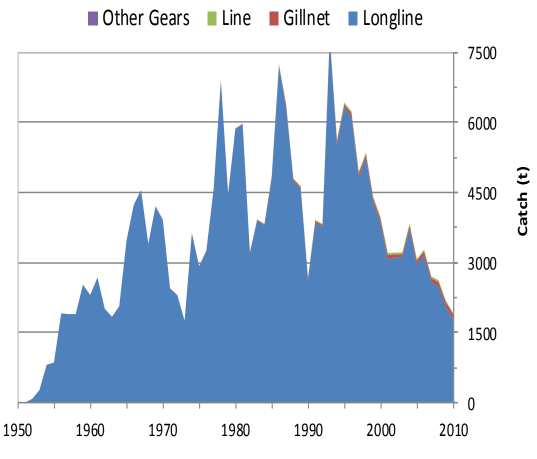


Fig. 1. Catches of striped marlin per gear and year recorded in the IOTC Database (1960–2010).

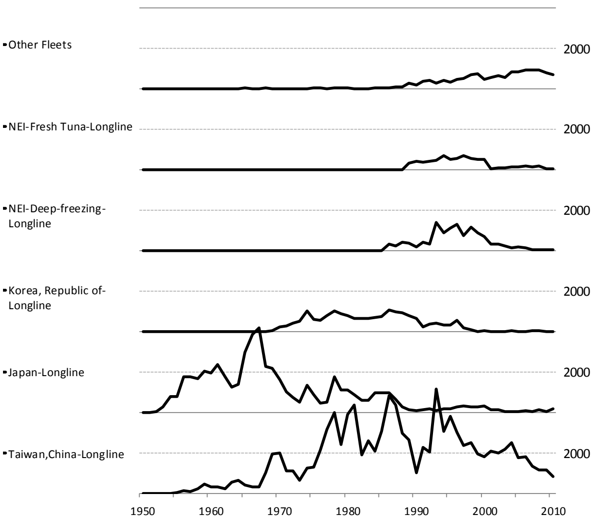


Fig. 2. Catches of striped marlin by fleet recorded in the IOTC Database (1960–2010).

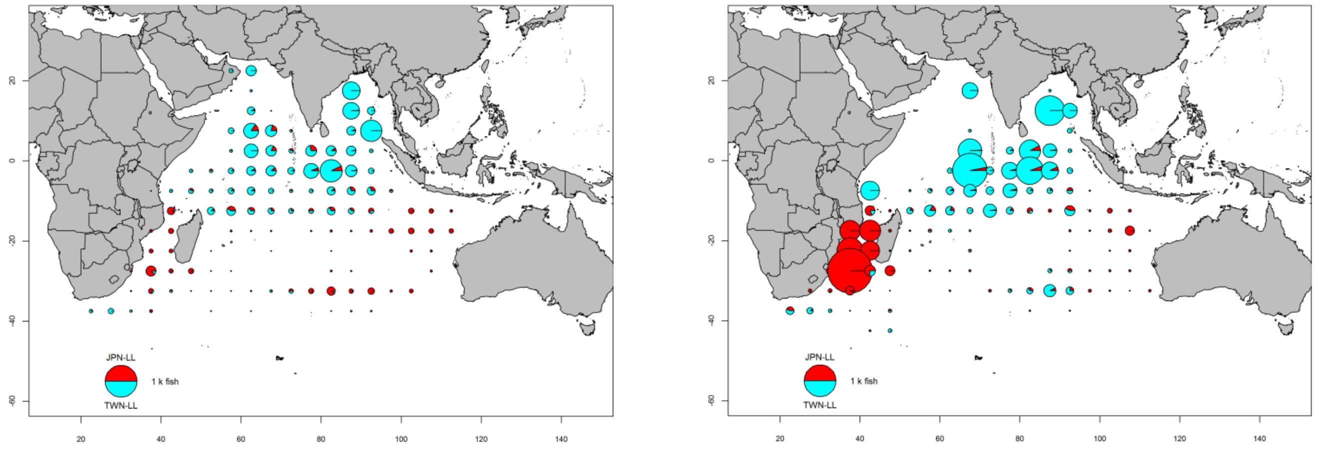


Fig. 3a–b. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	1,024	3,077	3,614	5,042	5,040	3,849	3,069	3,112	3,115	3,730	2,966	3,153	2,582	2,485	2,057	1,773
Gillnet	2	3	6	25	60	83	92	65	66	75	78	89	81	96	96	120
Line	0	0	1	11	35	44	46	38	38	35	36	36	41	41	29	29
Other	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0
Total	**1,026**	**30,80**	**3,625**	**5,079**	**5,135**	**3,975**	**3,207**	**3,216**	**3,219**	**3,839**	**3,079**	**3,279**	**2,705**	**2,622**	**2,182**	**1,921**

Uncertainty of time–area catches

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

- Catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (longliners of Indonesia and Philippines).
- Catches of non-reporting industrial longliners (India, NEI) estimated by the IOTC Secretariat using alternative information. As they are not reported by the countries concerned, catches are likely to be incomplete for some industrial fisheries for which the striped marlin is seldom the target species.
- Conflicting catch reports: The catches for longliners flagged to the Republic of Korea, reported as nominal catches and catches and effort, are conflicting with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of striped marlin over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.

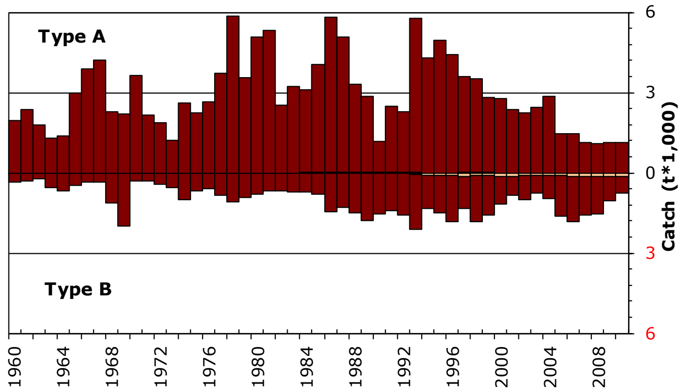


Fig. 4. Uncertainty of time-area catches for striped marlin (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessels flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

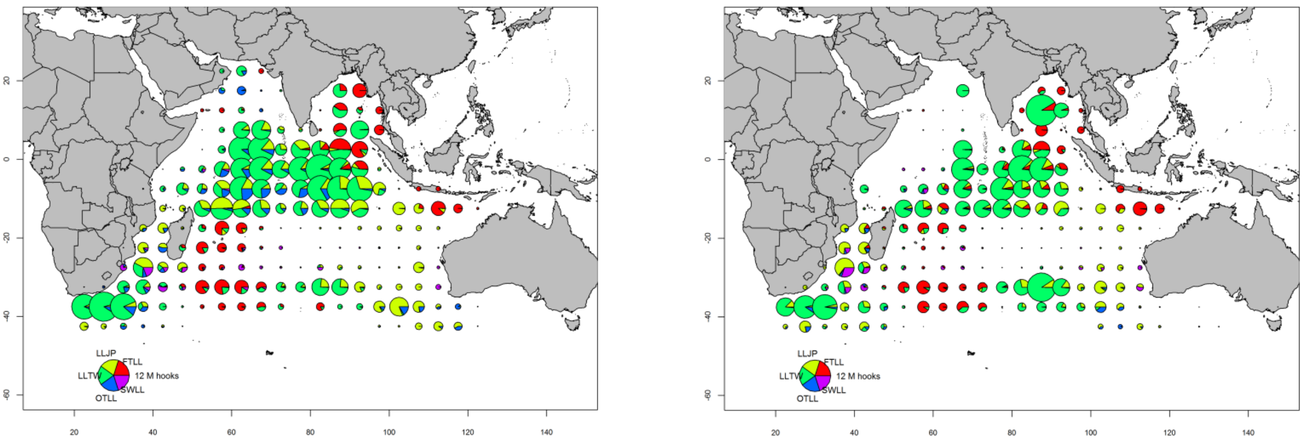


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

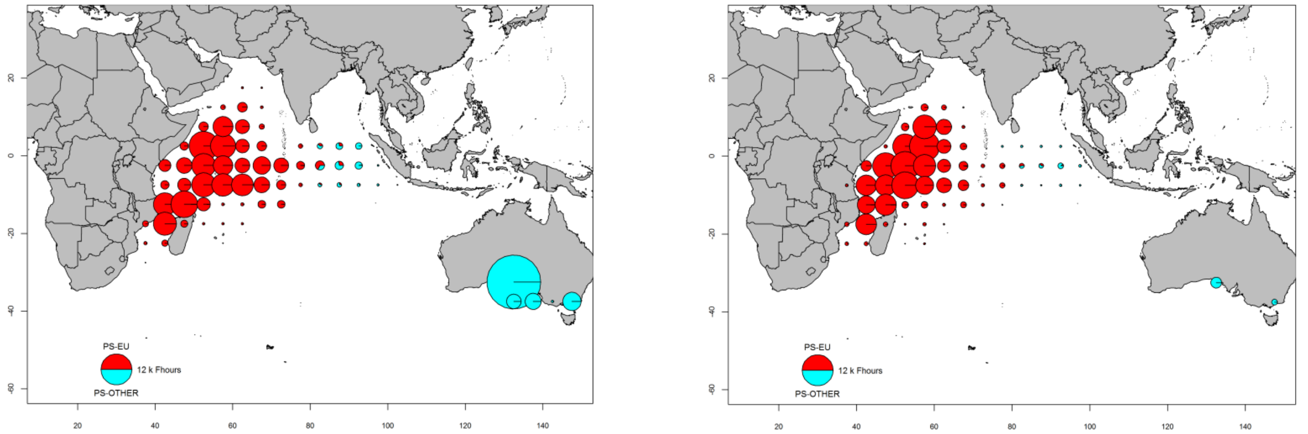


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet; Figs. 7 and 8) although catches are thought to be incomplete (catches of non-target species are not always recorded in logbooks). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

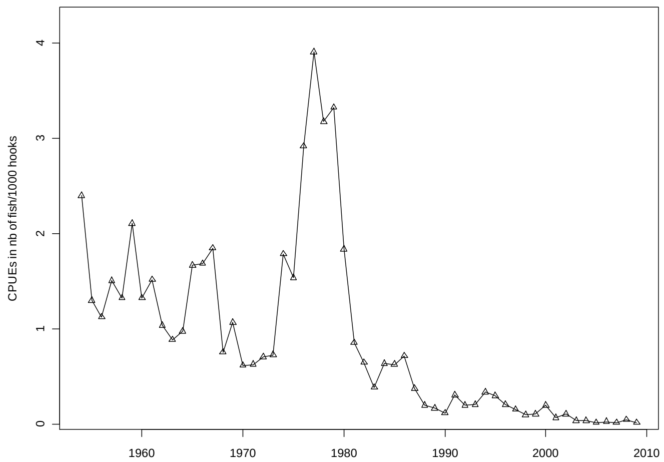


Fig. 7. Nominal CPUE (number of fish by 1,000 hooks) of striped marlin caught by Japanese longliners off-Somalia.

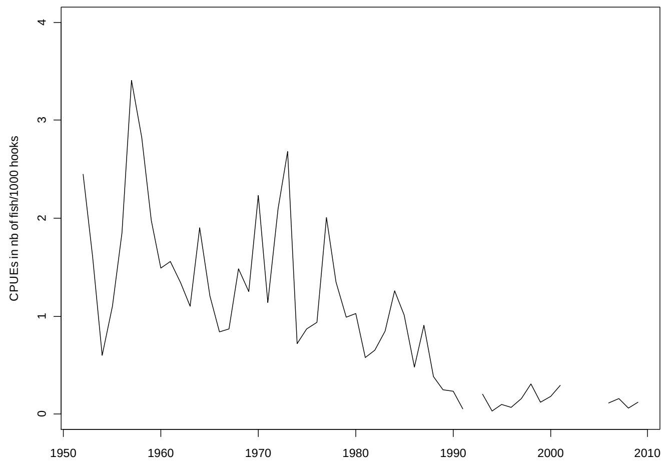


Fig. 8. Nominal CPUE (number of fish by 1,000 hooks) of striped marlin caught by Japanese longliners northwest Australia.

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

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

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

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

STOCK ASSESSMENT

No quantitative stock assessment for striped marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information. Nominal CPUE exhibited declines since the beginning of the fishery in two major fishing grounds (West Equatorial and north-west Australia) (Figs. 7 and 8) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Striped marlin (*Tetrapturus audax*) stock status summary.

Management Quantity	**Aggregate Indian Ocean**
2010 catch estimate	1,900
Mean catch from 2006–2010	2,500
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–
$B_{2010}/B_{1980, F=0}$	–
$SB_{2010}/SB_{1980, F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

Nakamura I, 1985. FAO species catalogue. Billfish of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes, and swordfishes known to date. FAO Fish. Synop. 125(5), 65 p.

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

Status of the Indian Ocean Indo-Pacific Sailfish Resource (*Istiophorus platypterus*)

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

Area[1]	**Indicators – 2011 assessment**		**2011 stock status determination 2010**[2]
Indian Ocean	Catch 2010:	25,498 t	Uncertain
	Average catch 2006–2010:	22,151 t	
	MSY (range):	unknown	
	F_{2010}/F_{MSY} (range):	unknown	
	SB_{2010}/SB_{MSY} (range):	unknown	
	SB_{2010}/SB_0 (range):	unknown	

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

Indian Ocean stock – Management Advice

Stock status. No quantitative stock assessment is currently available for Indo-Pacific 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* (Table 1). However, aspects of the biology, productivity and fisheries for this 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.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource.

The Scientific Committee considers the following:

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

SUPPORTING INFORMATION

(Information collated from reports of the Working Party on Billfish and other sources as cited)

Conservation and Management Measures

Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean is currently subject to a number of conservation and management measures adopted by the Commission, although none are species specific:

- Resolution 08/04 *concerning the recording of catch by longline fishing vessels in the IOTC area*.
- Resolution 09/02 *On the implementation of a limitation of fishing capacity of contracting parties and cooperating non-contracting parties*.
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*.
- Resolution 10/03 *concerning the recording of catch by fishing vessels in the IOTC area*.
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area.*
- Recommendation 11/06 *Concerning the Recording of Catch by Fishing Vessels in the IOTC Area of Competence*.

Fisheries Indicators

General

Indo-Pacific sailfish (*Istiophorus platypterus*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans. Table 2 outlines some key life history parameters relevant for management. There is limited reliable information on the catches of this species and no information on the stock structure or growth and mortality in the Indian Ocean.

TABLE 2. Biology of Indian Ocean Indo-Pacific sailfish (*Istiophorus platypterus*).

Parameter	**Description**
Range and stock structure	Found throughout the tropical and subtropical regions of the Pacific and the Indian Oceans. It is mainly found in surface waters above the thermocline, close to coasts and islands in depths from 0 to 200 m. Indo–Pacific sailfish is a highly migratory species and renowned for its speed and (by recreational fishers) for its jumping behaviour — one individual has been reported swimming at speeds in excess of 110 km/h over short periods. The stock structure of Indo-Pacific sailfish in the Indian Oceans is uncertain. No information on stock structure is currently available in the Indian Ocean; thus for the purposes of assessment, one pan-ocean stock is assumed. However, spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	Females: 11–13 years; Males: 7–8 years
Maturity (50%)	**Age**: females n.a.; males n.a. **Size**: females n.a.; males n.a.
Spawning season	Spawning in Indian waters occurs between December to June with a peak in February and June.
Size (length and weight)	Maximum: 350 cm FL and weight 100 kg total weight. The Indo-Pacific sailfish is one of the smallest-sized billfish species, but is relatively fast growing. Individuals may grow to over 3 m and up to 100kg, and live to around 7 years. Young fish grow very quickly in length then put on weight later in life. Sexual dimorphism in size, growth rates and size and age at maturity—females reach larger sizes, grow faster and mature later than males. Females: 300 cm lower-jaw FL, 50+ kg total weight; Males: 200 cm lower-jaw FL, 40+ kg total weight in the Indian Ocean. Recruitment into the fishery: varies by fishing method. The average weight of fish caught in the Kenyan sports fishery is ~25 kgs whole weight.

n.a. = not available. SOURCES: Nakamura (1985); Speare (2003); Hoolihan (2006); Sun et al. (2007); Froese & Pauly (2009); Ndegwa & Herrera (2011)

Catch trends

Indo-Pacific sailfish is caught mainly under gillnets (78%) with remaining catches recorded under troll and hand lines (15%), longlines (7%) or other gears (Fig. 1). The minimum average annual catch estimated for the period 2006 to 2010 is around 22,151 t. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, Iran, Pakistan and Sri Lanka). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia longliners. This species is also a popular catch for sport fisheries (e.g. Kenya, Mauritius, Seychelles).

Catches of Indo-Pacific sailfish greatly increased since the mid-1980's in response to the development of a gillnet/longline fishery in Sri Lanka (Fig. 2) and, especially, the extension in the area of operation of Iranian gillnet vessels to areas beyond the EEZ of I.R. Iran. The catches of Iranian gillnets (Fig. 2) increased dramatically, more than six-fold, after the late 1990's, from the values averaging 2,000 t in the late 1980's to a maximum of 12,600 t in 2005.

Catches of Indo-Pacific sailfish under drifting longlines and other gears do not show any specific trends in recent years, with total catches amounting to about 5,000 t. However, it is likely that longline fleets under report catches of this species due to its little commercial value. In recent years, deep-freezing longliners from Japan have reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel (Fig. 3).

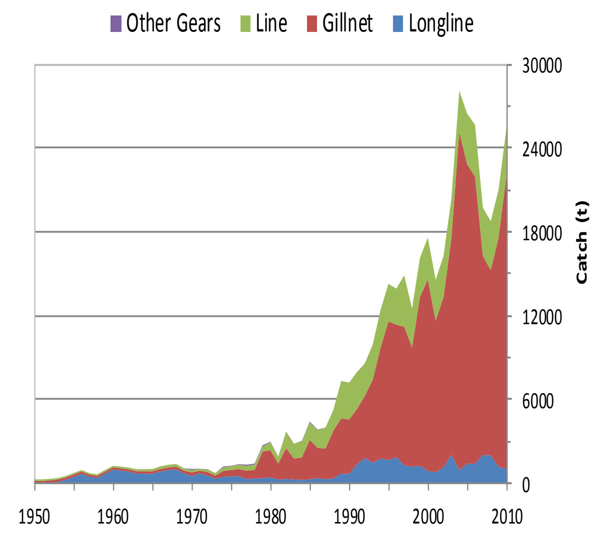


Fig. 1. Catches of Indo-Pacific sailfish per gear and year recorded in the IOTC Database (1960–2010).

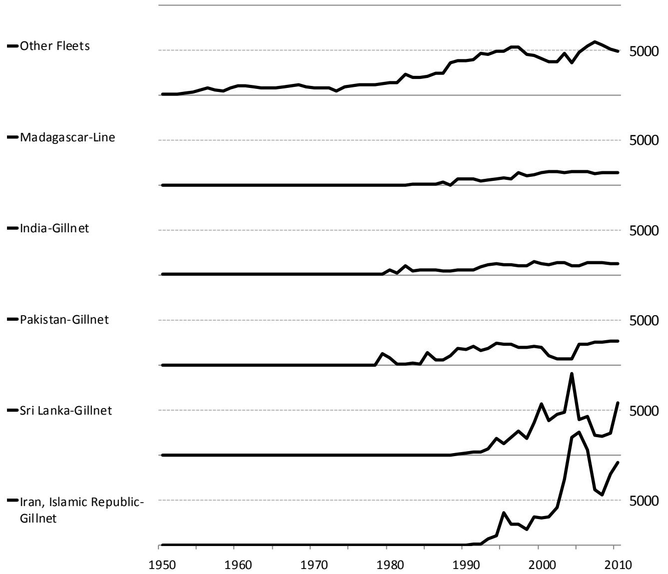


Fig. 2. Catches of Indo-Pacific sailfish by fleet recorded in the IOTC Database (1960–2010).

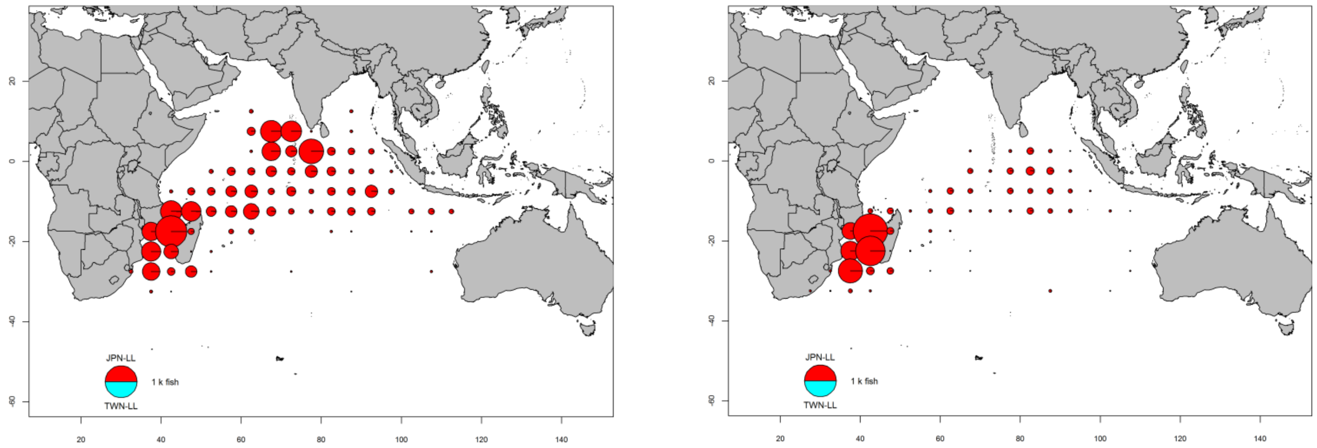


Fig. 3a–b. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 3. Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2009 (in metric tonnes). Data as of October 2011.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Longline	299	819	450	343	1425	876	785	1,135	2,035	926	1,393	1,399	2,021	1,985	1,176	1,032
Gillnet	164	176	544	2,296	7,621	13,708	10,849	12,197	15,525	24,246	21,453	20,572	14,254	13,285	16,441	21,034
Line	106	155	259	1,260	2,739	3,010	2,947	2,954	2,842	2,947	3,635	3,714	3,474	3,500	3,427	3,429
Other	1	1	50	25	3	2	2	2	2	2	2	2	2	2	2	2
Total	**570**	**1,151**	**1,302**	**3,924**	**11,787**	**17,596**	**14,583**	**16,288**	**20,404**	**28,120**	**26,482**	**25,687**	**19,751**	**18,773**	**21,047**	**25,498**

Uncertainty of time–area catches

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

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

- Catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.

- Catches likely to be incomplete for some artisanal fisheries (gillnets of Pakistan, pole and lines of Maldives) due to under-reporting.
- Catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific sailfish is not a target species.
- A lack of catch data for most sport fisheries.
- Changes to the catch series: There have not been significant changes to the catches of Indo-Pacific sailfish since 2010. The changes recorded in recent years originated in a review (by the Secretariat) of the catches reported by Indonesia, resulting in catches slightly lower than those reported by Indonesia.
- Discards are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

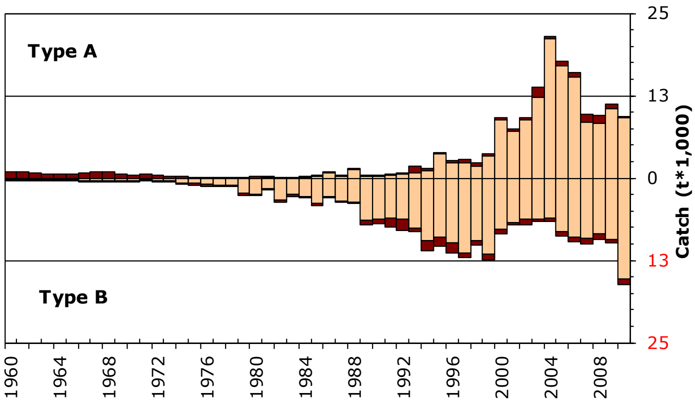


Fig. 4. Uncertainty of time-area catches for Indo-Pacific sailfish (Data as of October 2011).
Catches below the zero-line (Type B) refer to fleets that do not report catch-and-effort data to the IOTC, do not report catch-and-effort data by gear and/or species or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid from 2007 to 2010 are provided in Fig. 5, and total effort from purse seine vessles flagged to the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags), and others, by five degree square grid and main fleets, for the years 2007 to 2010 are provided in Fig. 6.

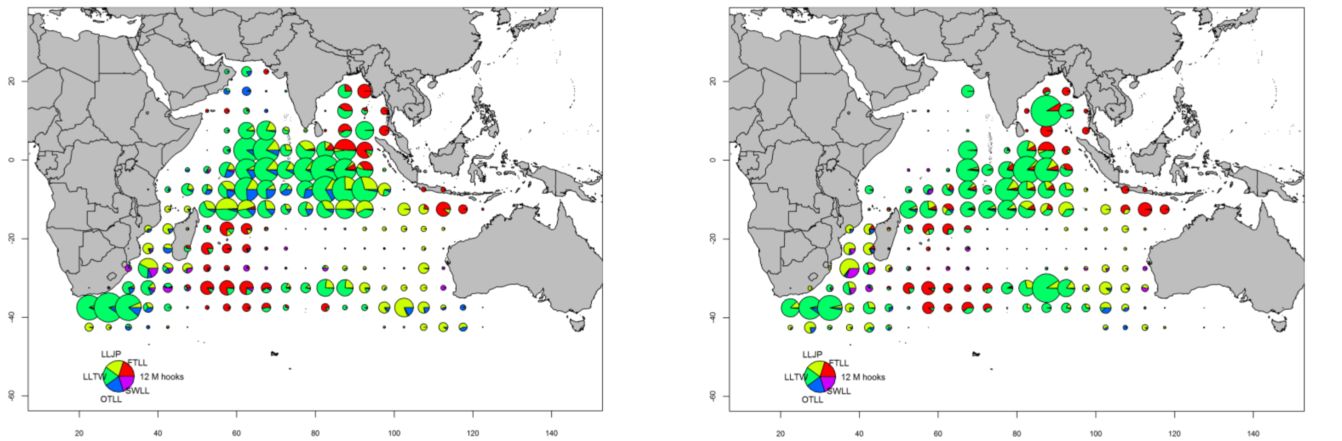


Fig. 5. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, Rep. of Korea and various other fleets)

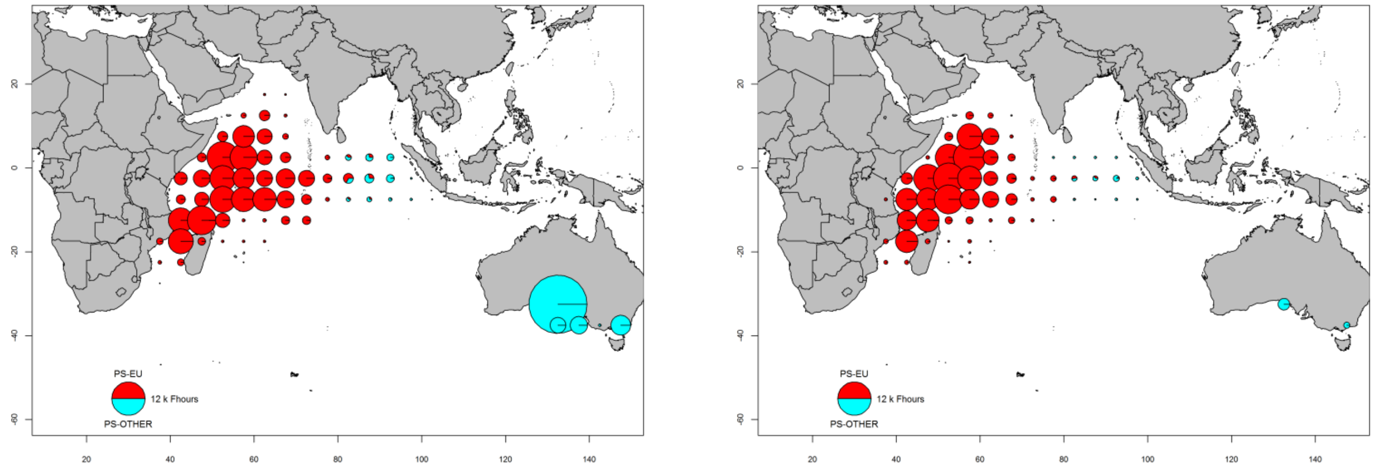


Fig. 6. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2009 (left) and 2010 (right) (Data as of August 2011).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand)

Catch–per–unit–effort (CPUE) trends

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

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

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, the specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (possible bias of existing samples).

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

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

STOCK ASSESSMENT

No quantitative stock assessment for striped marlin in the Indian Ocean is known to exist and no such assessment has been undertaken by the IOTC Working Party on Billfish. However, a preliminary estimation of stock indicators was attempted on the longline catch and effort datasets from Japan and Taiwan,China that represent the best available information. Nominal CPUE exhibited declines since the beginning of the fishery in two major fishing grounds (West Equatorial and north-west Australia) (Figs. 7 and 8) and catches in the initial core areas have also decreased substantially. However, there is considerable uncertainty about the degree to which these indicators represent abundance as factors such as changes in targeting practices, discarding practices, fishing grounds and management practices are likely to interact in the depicted trends. Further work must be undertaken to derive additional stock indicators for this species, because in the absence of a quantitative stock assessment, such indicators represent the only means to monitor the status of the stock and assess the impacts of fishing.

TABLE 4. Indo-Pacific sailfish (*Istiophorus platypterus*) stock status summary.

Management Quantity	**Aggregate Indian Ocean**
2010 catch estimate	25,500 t
Mean catch from 2006–2010	22,200 t
MSY (80% CI)	unknown
Data period used in assessment	–
F_{2010}/F_{MSY} (80% CI)	–
B_{2010}/B_{MSY} (80% CI)	–
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1980} (80% CI)	–
SB_{2010}/SB_{1980}	–

$B_{2010}/B_{1980, F=0}$	–
$SB_{2010}/SB_{1980, F=0}$	–

LITERATURE CITED

Froese R & Pauly DE, 2009. FishBase, version 02/2009, FishBase Consortium, <www.fishbase.org>.

Hoolihan JP, 2006. Age and growth of Indo-Pacific sailfish, *Istiophorus platypterus*, from the Arabian Gulf. Fish Res. 78: 218-226.

Nakamura I, 1985. FAO species catalogue. Billfish of the world. An annotated and illustrated catalogue of marlins, sailfishes, spearfishes, and swordfishes known to date. FAO Fish. Synop. 125(5), 65 p.

Ndegwa S & Herrera M, 2011. Kenyan Sports Fishing Sailfish Catches. Working paper presented to the Ninth Session of the IOTC Working Party on Billfish, IOTC–2011–WPB09–09.