DRAFT: EXECUTIVE SUMMARY: BLACK MARLIN

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

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

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

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013:	14,400 t	*
	Average catch 2009–2013:	11,962 t	
	MSY (1000 t) (80% CI):	10.2 (7.6–13.8)	*
	F_{MSY} (80% CI):	0.25 (0.08–0.45)	
	B_{MSY} (1000 t) (80% CI):	37.8 (14.6–62.3)	
	F_{2013}/F_{MSY} (80% CI):	1.06 (0.39–1.73)	*
	B_{2013}/B_{MSY} (80% CI):	1.13 (0.73–1.53)	
	B_{2013}/B_{1950} (80% CI):	0.57 (0.37–0.76)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; * = **TENTATIVE status:** data poor stock assessment only. Status should be interpreted with caution due to the high levels of uncertainty. Further testing of how sensitive this technique is to model assumptions and available time series of catches, as well as the trialling of an alternative stock assessment approach needs to be undertaken before stock status can be used for management action.

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

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished but and close to or just over the maximum sustainable yield levels (Table 1, Fig. 1). This is the second time that the WPB has applied a SRA technique to black marlin and further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken. However, the WPB considers that the assessment is the best information currently available and as such, should be used to tentatively determine stock status, with the intention that alternative techniques be applied in 2015 to validate the results. Thus, the stock status for black marlin in the Indian Ocean is **TENTATIVELY* not overfished*** but **subject to overfishing***. The stock appears to show an increase in catch rates which is a cause of concern, indicating that fishing mortality levels are likely to have become too high (Fig. 1). Aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a major cause for concern. Research emphasis on developing possible CPUE indicators and further exploration of alternative stock assessment approaches for data poor fisheries are warranted to validate these findings. Given the limited data being reported for coastal gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

Outlook. Total catch for black marlin in recent years has continued to increase to a total of 14,400 t in 2013. There is a moderate to high risk of exceeding MSY-based reference points by 2016 if catches increase further (20% increase) (≈ 44% risk that $B_{2016} < B_{MSY}$, and ≈ 78% risk that $F_{2016} > F_{MSY}$) (Table 2).

The following key points should be noted:

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

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

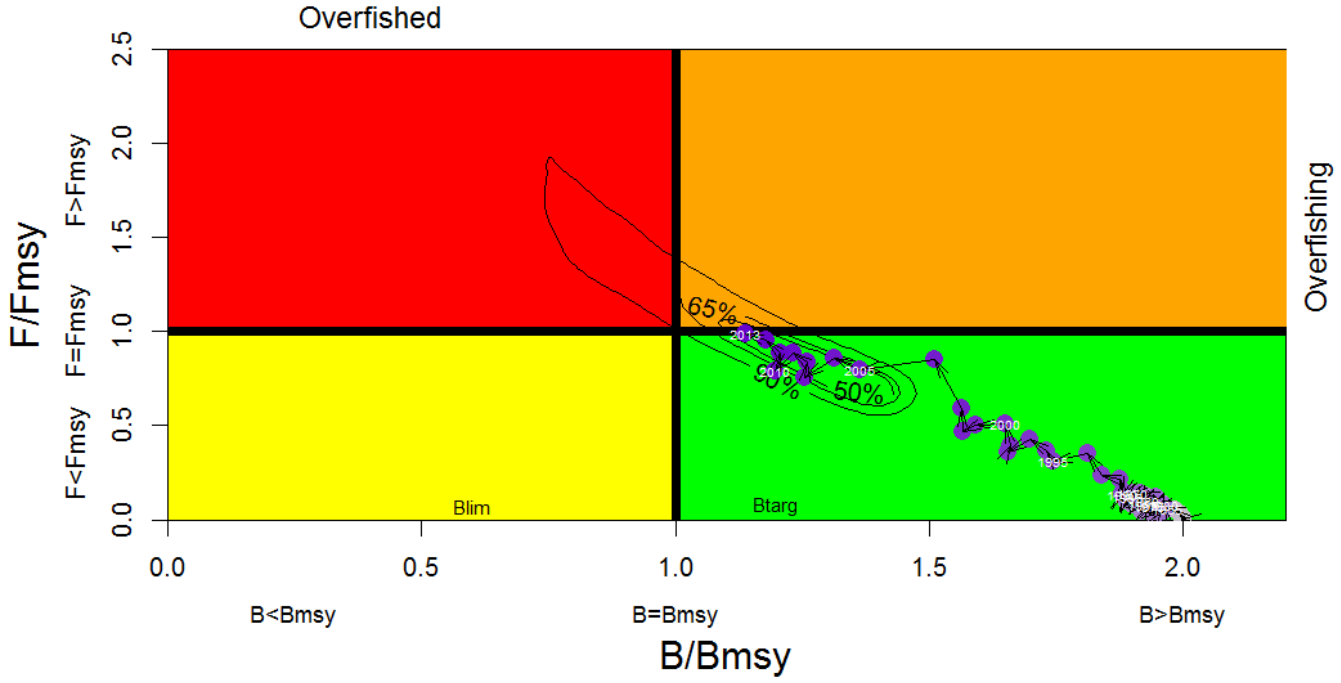


Fig. 1. Black marlin: Stock reduction analysis (Catch MSY Method) aggregated Indian Ocean assessment Kobe plots for black marlin (contours are the 50, 65 and 90 percentiles of the 2013 estimate). Black line indicates the trajectory of the point estimates (blue circles) for the spawning biomass (B) ratio and F ratio for each year 1950–2013.

TABLE 2. Black Marlin: Indian Ocean stock reduction analysis (SRA) Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–13 (12,940 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2011–13) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60%	**70%**	**80%**	**90%**	**100%**	**110%**	**120%**	**130%**	**140%**
$SB_{2016} < SB_{MSY}$	17		24		33		44		56
$F_{2016} > F_{MSY}$	12		30		53		78		99
$SB_{2023} < SB_{MSY}$	10		28		60		95		100
$F_{2023} > F_{MSY}$	7		28		63		100		100

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

APPENDIX I

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 13/03 on the recording of catch and effort by fishing vessels in the IOTC area of competence
- Resolution 13/07 concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information
- Resolution 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 11/04 *on a regional observer scheme*
- Resolution 10/02 *mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*
- Resolution 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Black marlin: General

Black marlin (*Makaira indica*) is a large oceanic apex predator that inhabits tropical and subtropical Indo-Pacific oceans (Fig. 2). Table 3 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.

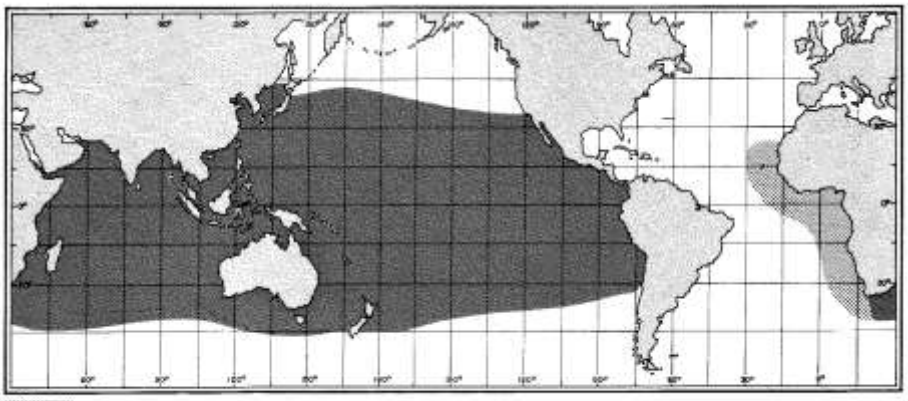


Fig. 2. Black marlin: The worldwide distribution of black marlin (Source: Nakamura 1984)

TABLE 3. Black marlin: 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. Black marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. Some rare 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 inhabits oceanic surface waters above the thermocline and typically near land masses, islands and coral reefs; however rare excursions to mesopelagic waters down to depths of 800 m are known. Thought to associate with schools of small tuna, which is one of its primary food sources (also reported to feed on other fishes, squids and other cephalopods, 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. Long distance migrations at least in the eastern Indian Ocean (two black marlins tagged in Australia were caugh off east Indian coast and Sri Lanka) support a single stock hypothesis. It is known that black marlin forms dense nearshore spawning aggregations, making this species vulnerable to exploitation even by small-scale fisheries. Spatial heterogeneity in stock indicators (catch–per–unit–effort trends) for other billfish species indicates that there is potential for localised depletion.
Longevity	No data available for the Indian Ocean. In the Pacific (Australia) 11–12 years.
Maturity (50%)	**Age**: unknown **Size**: females around 100 kg; males 50 to 80 kg total weight
Spawning	No spawning grounds have been identified in the Indian ocean. Spawning hotspot off eastern Australia apparently

season	has no links with Indian Ocean stock. Spawning individuals apparently prefer water temperatures above 26–27°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 460 cm FL and weigh 800 kg total weight. In the Indian Ocean it reach at least 360 cm LJFL. 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. In the Indian Ocean documented maximum size for females: 306 cm LJFL, 307 kg total weight; males: 280 cm LJFL, 147 kg total weight. Most black marlin larger than 200 kg are female. Recruitment into the fishery: varies by fishing method; ~60 cm LJFL for artisanal fleets and methods. The average size of black marlin taken in Indian Ocean longline fisheries is not available. L-W relationships for the Indian Ocean are: females TW=0.00000010*LJFL**3.7578, males TW=0.00002661*LJFL**3.7578, both sexes mixed TW=0.00000096*LJFL**3.35727, TW in kg, LJFL in cm. However these relationships were obtained from small sample sizes (n=75), therefore it should be treated with caution.

Sources: Nakamura 1985, Cyr et al. 1990, Gunn et al. 2003, Speare 2003; Sun et al. 2007, Froese & Pauly 2009, Romanov & Romanova 2012, Domeier & Speare 2012

Black marlin: Catch trends

Black marlin are caught mainly using drifting longlines (30%) and gillnets (50%) with remaining catches recorded using troll and hand lines (Table 4, Fig. 3). Black marlin are the bycatch of industrial and artisanal fisheries. In recent years, the fleets of Sri Lanka (longline and gillnet), I.R. Iran (gillnet), India (gillnet and troll), Indonesia (troll and hand lines) and Pakistan (gillnet) account for around 90% of the catch of black marlin (Fig. 4). Catches of black marlin have increased steadily since the 1990s, from 2,700 t in 1991 to over 10,000 t in 2011. The highest catches over the time series of black marlin were recorded in 2013, at over 14,000 t (Table 4).

Between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches of black marlin in that area, in particular in waters off northwest Australia (Fig. 5). 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. 5).

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

The catches of black marlin in Sri Lanka have risen steadily since the mid-1990's as a result of the development of the fishery using a combination of drifting gillnets and longlines, from around 1,000 t in the early 1990s to over 4,500 t in 2011. In 2012 and 2013 catches dropped to 3,000 and 2,500 t, respectively. In recent years (2011–13) India has reported higher catches of black marlin for its fisheries, amounting to around 1,500 t to 3,500 t, largely from increases in catches from gillnet and trolling).

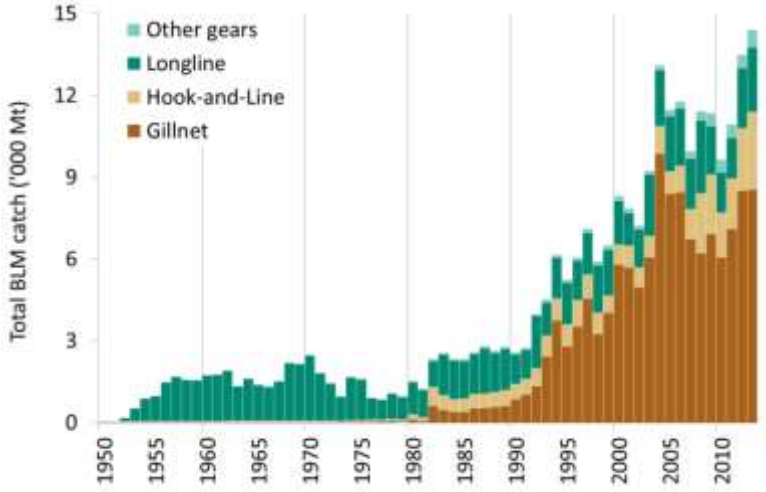


Fig. 3. Black marlin: Catches of black marlin by gear and year recorded in the IOTC Database (1950–2013).

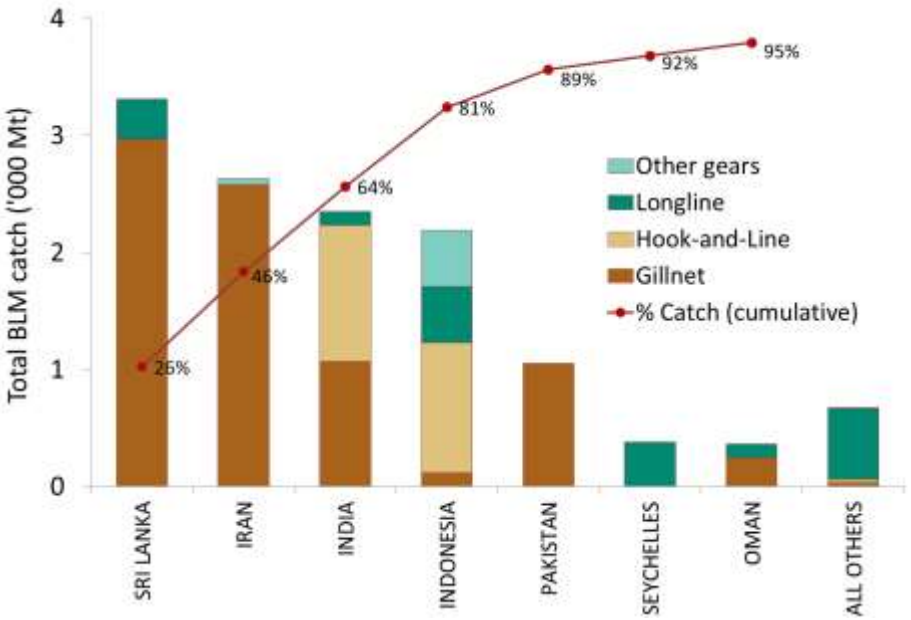


Fig. 4. Black marlin: Average catches in the Indian Ocean over the period 2010–13, by country. Countries are ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of black marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

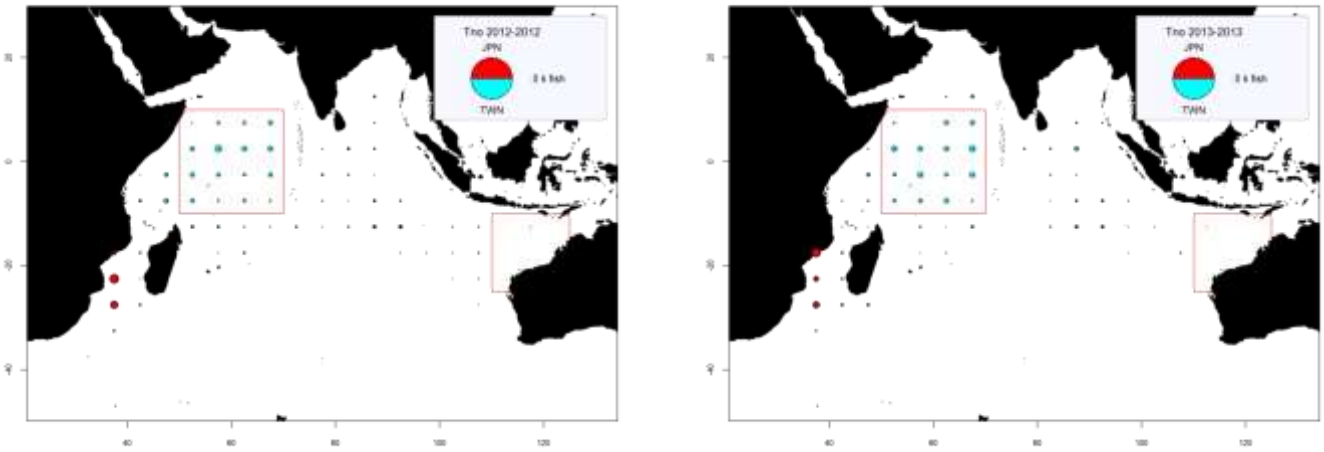


Fig. 5a–b. Black marlin: Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 4. Black marlin: Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2013 (in metric tons). Data as of September 2014.

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

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

Uncertainty of time–area catches

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

Retained catches: uncertain for some fisheries (Fig. 6a), due to the fact that:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the IOTC Secretariat for some years and artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, I.R. Iran and Pakistan) and industrial (longliners of Indonesia and the Philippines) fisheries.
- catches of non-reporting industrial longliners (India and Not Elsewhere Included (NEI)) and the gillnet fishery of Indonesia are estimated by the IOTC Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries as the black marlin is not a target species.
- conflicting catch reports have been received for longline catches from the Rep. of Korea, which are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of black marlin for the Rep. of Korea over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.

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

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

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

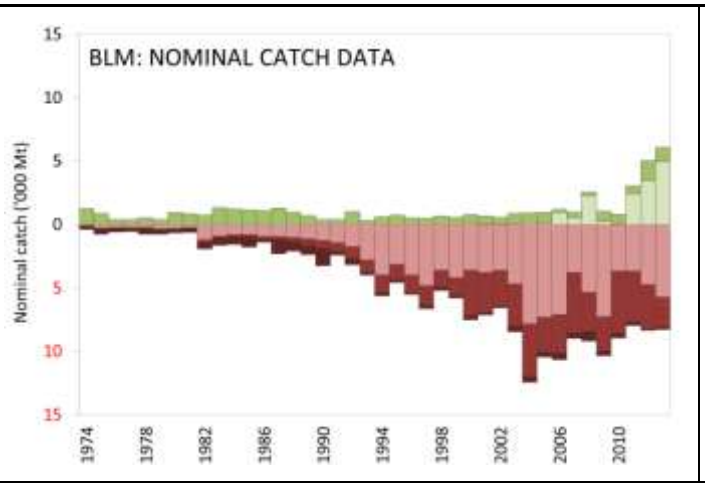
As a result of changes in the catch series for I.R. Iran in 2012 and 2013 – and revision of the catch-by-species for the offshore fishery for earlier years – total catches of black marlin have been revised upwards by as much as 30% to 50% for a number of years around the mid-2000's (e.g. in 2005 total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

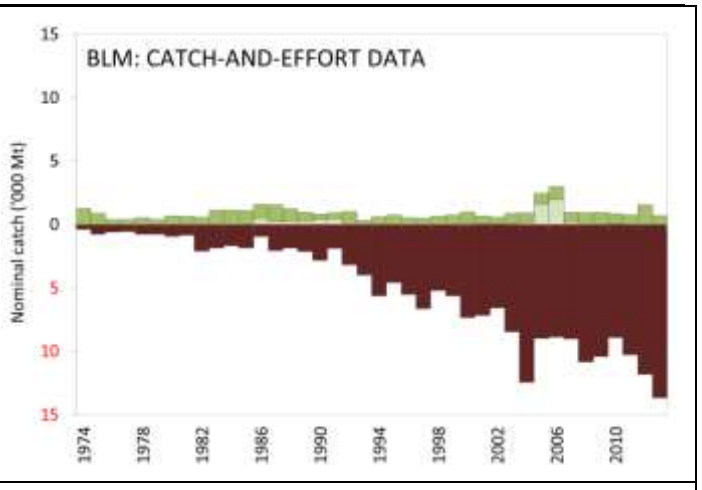
Catch–per–unit–effort (CPUE) Series (Fig. 6b): Standardised CPUE series have not yet been developed. Nominal CPUE series are however available from some industrial longline fisheries (primarily the Japanese longline fleet); although catches are thought to be incomplete (catches of non-target species are not always recorded in logbooks). No catch and effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; or other artisanal (gillnet fisheries of I.R. Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Fish size or age trends (e.g. by length, weight, sex and/or maturity) (Fig. 6c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low. The length frequency distributions derived from samples collected by fishermen on Taiwanese longliners are likely to be biased.

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

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





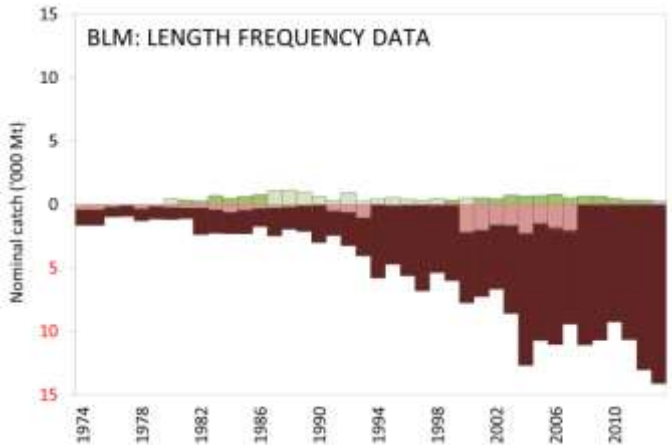


Fig. 6a–c. Black marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards; a score of between 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document; a score of 8 refers to the amount of nominal catch associated with catch-and-effort data that is not available. (Data as of September 2014)*

Key to IOTC Scoring system

Nominal Catch	By species	By gear
Fully available	0	0
Partially available (part of the catch not reported by species/gear)*	2	2
Fully estimated (by the IOTC Secretariat)	4	4

*Catch assigned by species/gear by the IOTC Secretariat; or 15% or more of the catches remain under aggregates of species

Catch-and-Effort	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

Size frequency data	Time-period	Area
Available according to standards	0	0
Not available according to standards	2	2
Low coverage (less than 1 fish measured by metric ton of catch)	2	
Not available at all	8	

Key to colour coding

Total score is 0 (or average score is 0-1)
Total score is 2 (or average score is 1-3)
Total score is 4 (or average score is 3-5)
Total score is 6 (or average score is 5-7)
Total score is 8 (or average score is 7-8)

Black marlin: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2012 and 2013 are provided in Fig. 8, 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 2012 and 2013 are provided in Fig. 9.

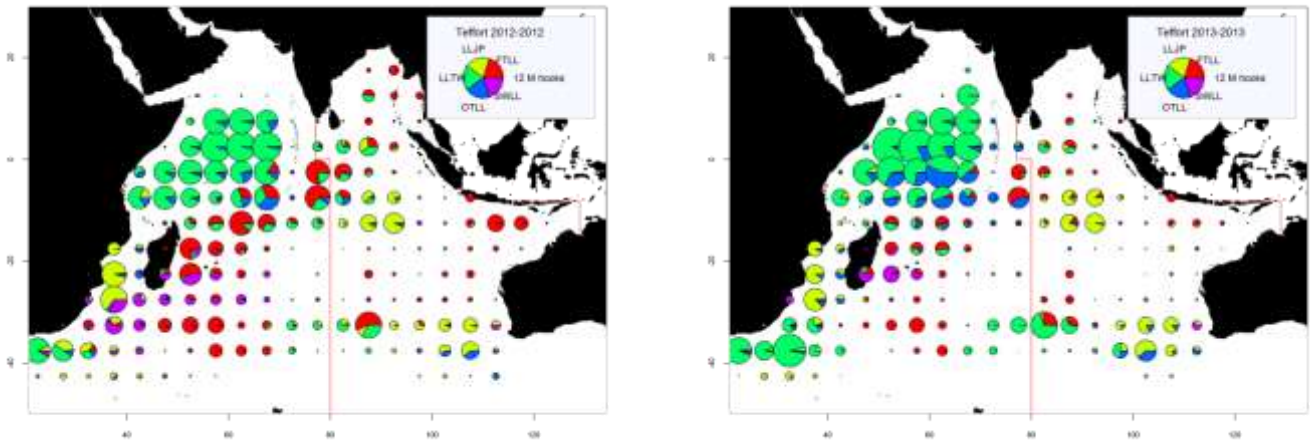


Fig. 8. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): 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)

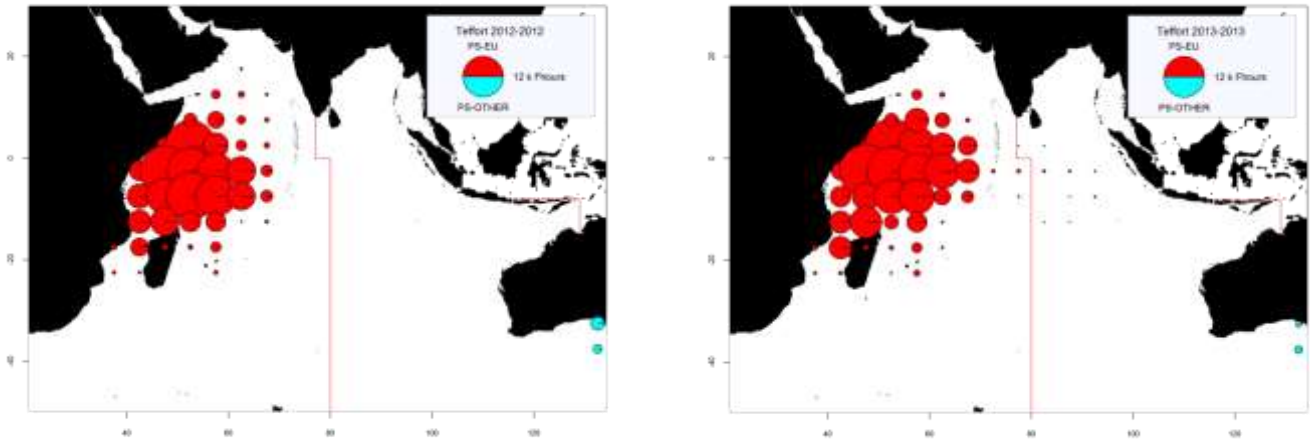


Fig. 9. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

Black marlin: Catch–per–unit–effort (CPUE) trends

Catch rate time series for the longline fleets of Japan and Taiwan,China (Fig. 10) show a similar decreasing trend from 1960's until the end of 2000's. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the early 1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight the doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries. The sharp decline between 1952 and 1958 in the Japanese black marlin CPUE series does not reflect the trend in abundance.

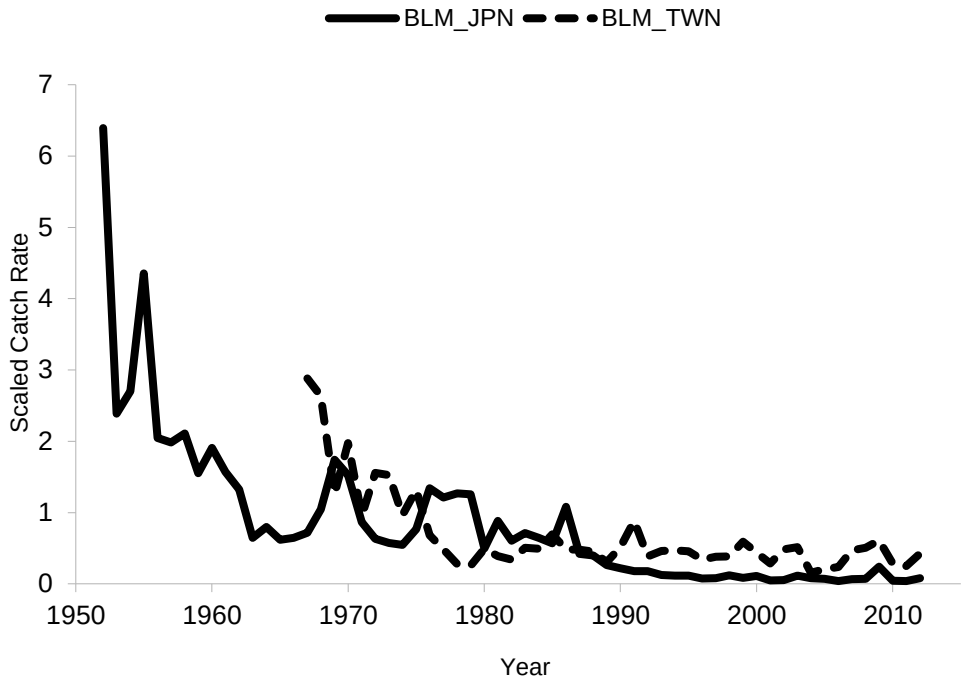


Fig. 10. Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

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).

STOCK ASSESSMENT

Alternative approaches should continue to be explored using the following:

- More effort should be made in examining the standardised CPUE data for use in the assessments as these are the basis for assessments without any age/length data available.
- More attention should be paid to the amount of effective hooks at the depth where the marlins are abundant.
- Age/Length data over time should be collected so that alternative approaches could be examined.
- Further examination of the data poor approaches along with a further developed Bayesian SP Model should be focussed on in 2015 when marlin are next assessed. Since the State-Space model developed is still in beta mode, further work needs to be done on this before endorsing the method.

A sensitivity analysis should be performed using Stock Reduction Analysis methodology, using different series of catch data to assess how robust the estimation of reference points for management are, and how the stock status determination performs.

The results of the stock assessment of black marlin (Table 5) are based on very limited information and in particular are compromised by the uncertainty in the estimates of catches for this species, over the time series. For this reason, the status of the stock is considered to have a high degree of uncertainty. The precautionary approach calls for a more conservative approach for data poor stocks. Thus, the stock status summary for black marlin reflects the results of the assessment but at the same time incorporates information about the approach used.

TABLE 5. Black marlin (*Makaira indica*): Key management quantities from the Stock reduction analysis Model, for the Indian Ocean Black marlin.

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

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