DRAFT: EXECUTIVE SUMMARY: BLUE MARLIN

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

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

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

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	13,834 t 11,531 t	
	MSY (1000 t) (80% CI): F_{MSY} (80% CI): B_{MSY} (1,000 t) (80% CI): F_{2011}/F_{MSY} (80% CI): B_{2011}/B_{MSY} (80% CI): B_{2011}/B_{1950} (80% CI):	11.70 (8.02–12.40) 0.49 (n.a.) 23.70 t (n.a.) 0.85 (0.63–1.45) 0.98 (0.57–1.18) 0.48 (n.a.)	

[1]Boundaries for the Indian Ocean = IOTC area of competence; n.a. = not available

Colour key	Stock overfished(B_{year}/B_{MSY}< 1)	Stock not overfished (B_{year}/B_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		
Not assessed/Uncertain		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No new assessment was undertaken for blue marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014.The standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently being exploited at sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method: Stock Reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicated that the stock was subject to overfishing in the past which reduced the stock biomass to below the B_{MSY} level. In the recent past, the stock experienced reduced fishing pressure and as a result, the stock biomass recovered to the B_{MSY} level (Fig. 1). Total reported landings increased substantially in 2012 to 17,252 t, well above the MSY estimate of 11,690 t. In 2013 reported catches declined slightly to 13,843 t, still above the MSY level. Given the sharp increase in reported catches over the last two years, that are well above the MSY level, the stock is likely to have moved to a state of being subject to overfishing. However, the impact that these increased catches is likely to have on biomass is uncertain. Thus, on the weight-of-evidence available to the WPB, the stock status is determined to remain as **not overfished** and **not subject to overfishing** (Table 1; Fig. 1).

Outlook. The uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution as the stock may be in an overfished state (biomass less than B_{MSY}) and given that reported catches over the last two years have been well in excess of the MSY levels recommended, fishing effort is likely to be a serious concern, suggesting the stock may have moved back to a subject to overfishing status. The limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, require efforts to be made to rectify these information gaps urgently. It is likely that there is a low risk of exceeding MSY-based reference points by 2015 if catches are maintained at 2011 levels, although projections are not provided as per Table 2. These will be calculated during the next assessment of blue marlin.

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is between 8,023–12,400 t, and catches should not exceed the upper estimate.

- **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 blue marlin.
- **Main fishing gear** (2010–13): Longline and gillnet catches are currently estimated to comprise approximately 69% and 29% of the total estimated blue marlin catch in the Indian Ocean, respectively.
- **Main fleets** (2010–13): Taiwan,China: 35%; Indonesia: 24%; Pakistan: 15%.
- **Improvements required**: improvement in data collection and reporting is required to further assess the stock.

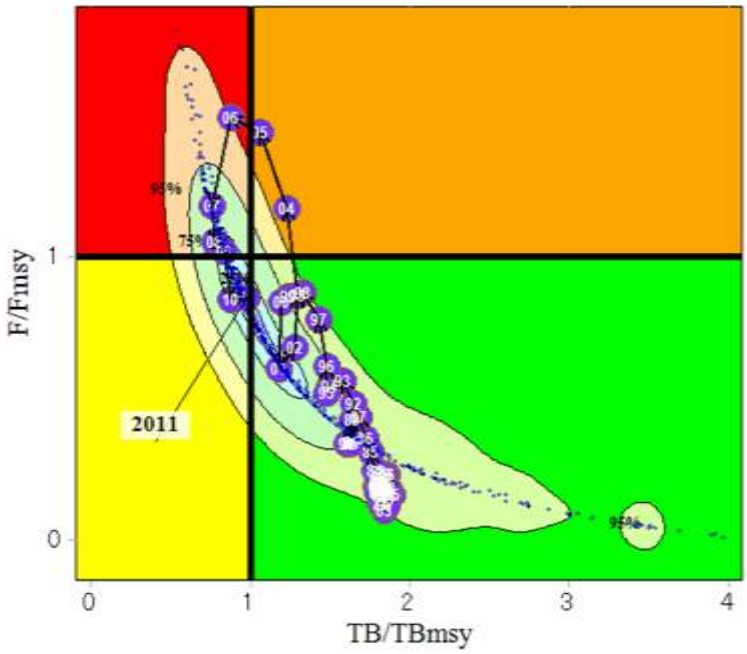

Fig. 1. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011.

TABLE 2. Blue Marlin: Indian Ocean ASPIC Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target reference points for nine constant catch projections (average catch level from 2011–2013 (13,539 t), ± 10%, ± 20%, ± 30% ± 40%) projected for 3 and 10 years. These will be calculated during the next assessment of blue marlin.

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2009–2011) 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%**
$B_{2015} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2015} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$B_{2022} < B_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
$F_{2022} > F_{MSY}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

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 blue marlin) reference points set by the Commission. n.a.: not available.

APPENDIX I

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Blue marlin (*Makaira nigricans*) 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

Blue marlin: General

Blue marlin (*Makaira nigricans*) is a large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans (Fig. 2). Table 3 outlines some key life history parameters relevant for management.

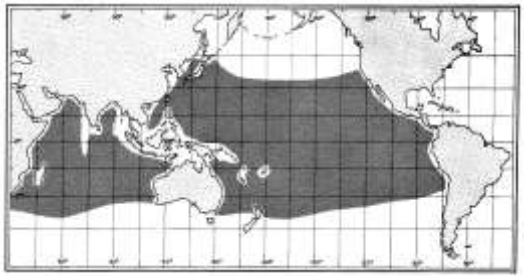

Fig. 2. Blue marlin: The worldwide distribution of blue marlin (Source: Nakamura 1984).

TABLE 3. Blue marlin: Biology of Indian Ocean blue marlin (*Makaira nigricans*).

Parameter	Description
Range and stock structure	Little is known on the biology of the blue marlin in the Indian Ocean. Blue marlin is a highly migratory, large oceanic apex predator that inhabits tropical and subtropical waters of the Indian and Pacific oceans. It is capable for long-distance migrations: in the Pacific Ocean a tagged blue marlin is reported to have travelled 3000 nm in 90 days. In the Indian Ocean a blue marlin tagged in South Africa was recaptured after 90 days at liberty off the southern tip of Madagascar crossing Mozambique Channel and travelling 1398 km with average speed 15.5 km/day. Other tagging off western Australia revealed potential intermixing of Indian Ocean and Pacific stocks: one individual was caught in the Pacific Indonesian waters. Blue marlin is a solitary species and prefers the warm offshore surface waters (>24°C); it is scarce in waters less than 100 m in depth or close to land. The blue marlin's prey includes octopuses, squid and pelagic fishes such as 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 LJFL (55 kgs whole weight); males ~80 cm LJFL (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, 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. L-W relationships for the Indian Ocean are: females TW=0.00000026*LJFL^3.59846 males TW=0.00001303*LJFL^2.89258, both sexes mixed TW=0.00000084*LJFL^3.39404. TW in kg, LJFL in cm

n.a. = not available. Sources: Nakamura 1985, Cry et al. 1990, Shimose et al. 2008, Froese & Pauly 2009, Romanov & Romanova 2012

Blue marlin: Catch trends

The catch series for the blue marlin was substantially revised in 2014, following new reports of catch for drifting gillnet fleets. Blue marlin are caught mainly using drifting longlines (70%) and gillnets (25%) with remaining catches recorded by troll and hand lines (Table 4, Fig. 2). Blue marlins are considered to be a bycatch of industrial and artisanal fisheries. Longline catches of blue marlin are typically higher than those of black marlin and striped marlin combined. In recent years, the fleets of Taiwan,China (longline), Indonesia (longline and handline), I.R. Iran and Pakistan (gillnet), and Sri Lanka (longline gillnet) account for around 90% of the total catch of blue marlin (Fig. 3). The distribution of blue marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean (Fig. 4).

Catch trends for blue marlin are variable; however, this may reflect the level of reporting. The catches of blue marlin by drifting longlines were more or less stable until the late-70's, at around 3,000 t to 4,000 t, and have steadily increased since then to reach values between 8,000 t and 13,000 t since the early 1990's. The largest catches reported by longlines were recorded in 2012 (~12,000 t) and 1998 (~11,000 t). The high catches in 2012 are likely to be the consequence of higher catch rates by some longline fleets, which resumed operation in the Western Tropical Indian Ocean. Catches by drifting longlines have been recorded under Taiwan,China and Japan fleets and, recently, Indonesia, India, Sri Lanka and several Not Elsewhere Included (NEI) fleets (Fig. 4). In recent years, the deep-freezing longliners from Taiwan,China and Japan have reported most of the catches of blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel (Fig. 4).

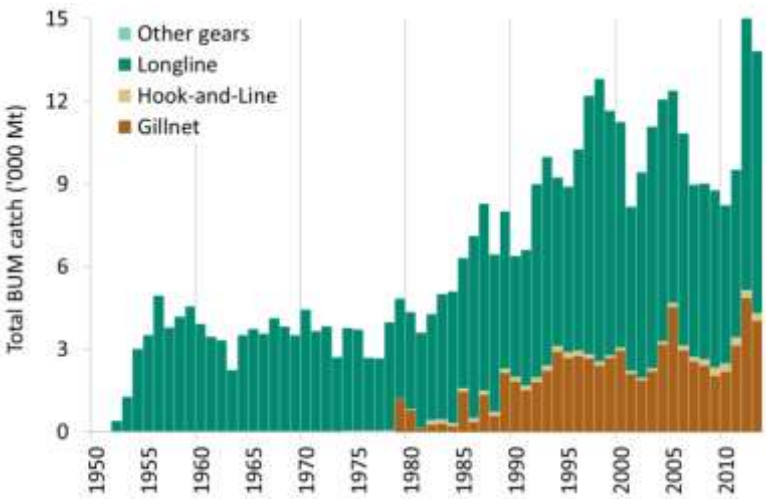

Fig. 2. Blue marlin: Catches of blue marlin by gear and year recorded in the IOTC Database (1950–2013).

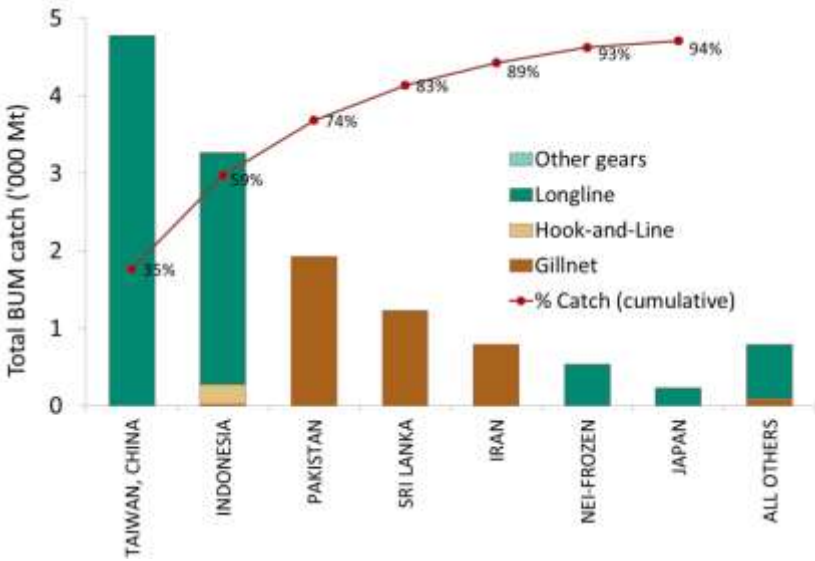

Fig. 3. Blue marlin: Average catches in the Indian Ocean over the period 2010–13, by fleet/countries, ordered from left to right, according to the importance of catches of blue marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the fleet/countries concerned, over the total combined catches of this species reported from all fleets/countries and fisheries.

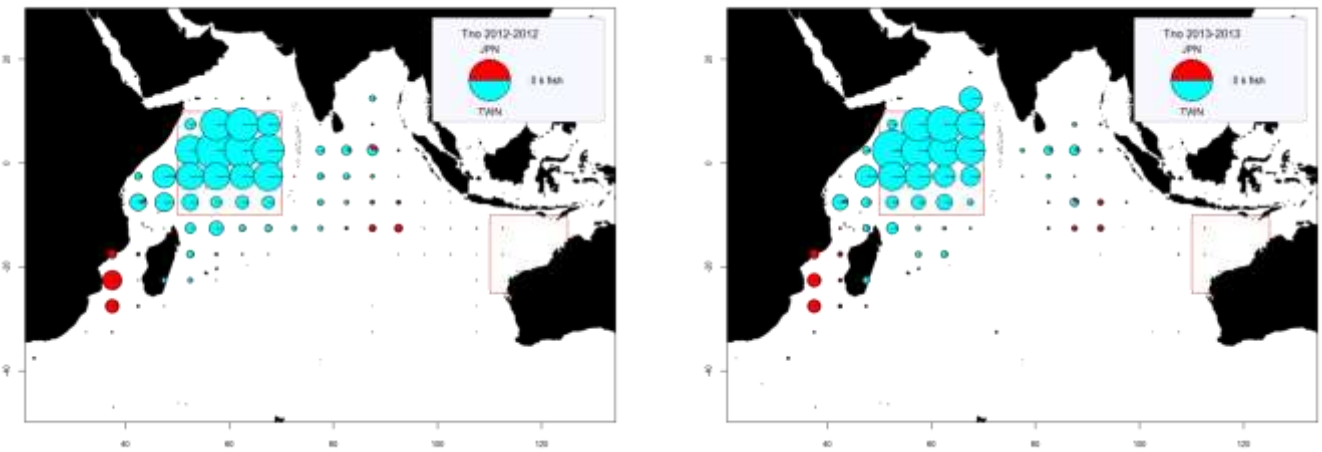

Fig. 4a–b. Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013, by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 4: Blue marlin: Best scientific estimates of the catches of blue 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	2,563	3,515	3,493	4,982	7,200	7,384	8,800	7,721	7,734	6,276	6,397	6,463	5,751	6,093	12,101	9,514
GN	1	2	124	761	2,357	2,687	3,172	4,545	2,977	2,559	2,410	2,049	2,198	3,148	4,879	4,032
HL	5	9	17	105	149	133	107	130	139	151	202	265	282	276	257	273
OT	0	0	0	2	4	7	5	7	8	8	11	15	15	16	15	16
Total	**2,570**	**3,527**	**3,634**	**5,850**	**9,711**	**10,211**	**12,085**	**12,404**	**10,857**	**8,994**	**9,019**	**8,791**	**8,246**	**9,532**	**17,252**	**13,834**

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: poorly known for most fisheries (Fig. 5a) due to:

- catch reports often refer to total catches of all three marlin species combined or as an aggregate of all billfish species; catches by species are estimated by the 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 Philippines) fisheries.
- catches of non-reporting industrial longliners (India, NEI) and the gillnet fishery of Indonesia are estimated by the IOTC Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the blue marlin is not a target species.
- conflicting catch reports 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 blue 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 blue 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 blue marlin may also occur in some gillnet fisheries.

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

In previous years IR Iran has reported aggregated catches for all billfish species, which were then estimated by species and gear by the IOTC Secretariat. In 2014 IR Iran provided catches by billfish species, for 2012 and 2013, which substantially revises the catch-by-species previously estimated by the IOTC Secretariat.

The main change is the substantially higher proportions of black marlin in the new catches reported by IR Iran rather than blue marlin, assigned to the offshore gillnet fishery As a result of changes in the catch series for IR Iran – and revision of the catch-by-species for the offshore fishery for earlier years based on the 2012 and 2013 data – total catches of blue marlin have been revised down by as much as 20% for a number of years around the mid-2000's.

Catch–per–unit–effort (CPUE) Series (Fig. 5b): Nominal CPUE series are available from some industrial longline fisheries (primarily the Japanese longline fleet) although catches are likely 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 IR 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. 5c): Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped marlin and blue marlin may occur in some longline fisheries; the length frequency distributions derived from samples collected by fishermen on Taiwan,China longliners are likely to be biased.

Catch-at-Size(Age) (Fig. 6): Fish size is derived from various length and weight information, however the reliability of the size data is reduced for some fleets and when relatively few fish out of the total catch are measured.

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

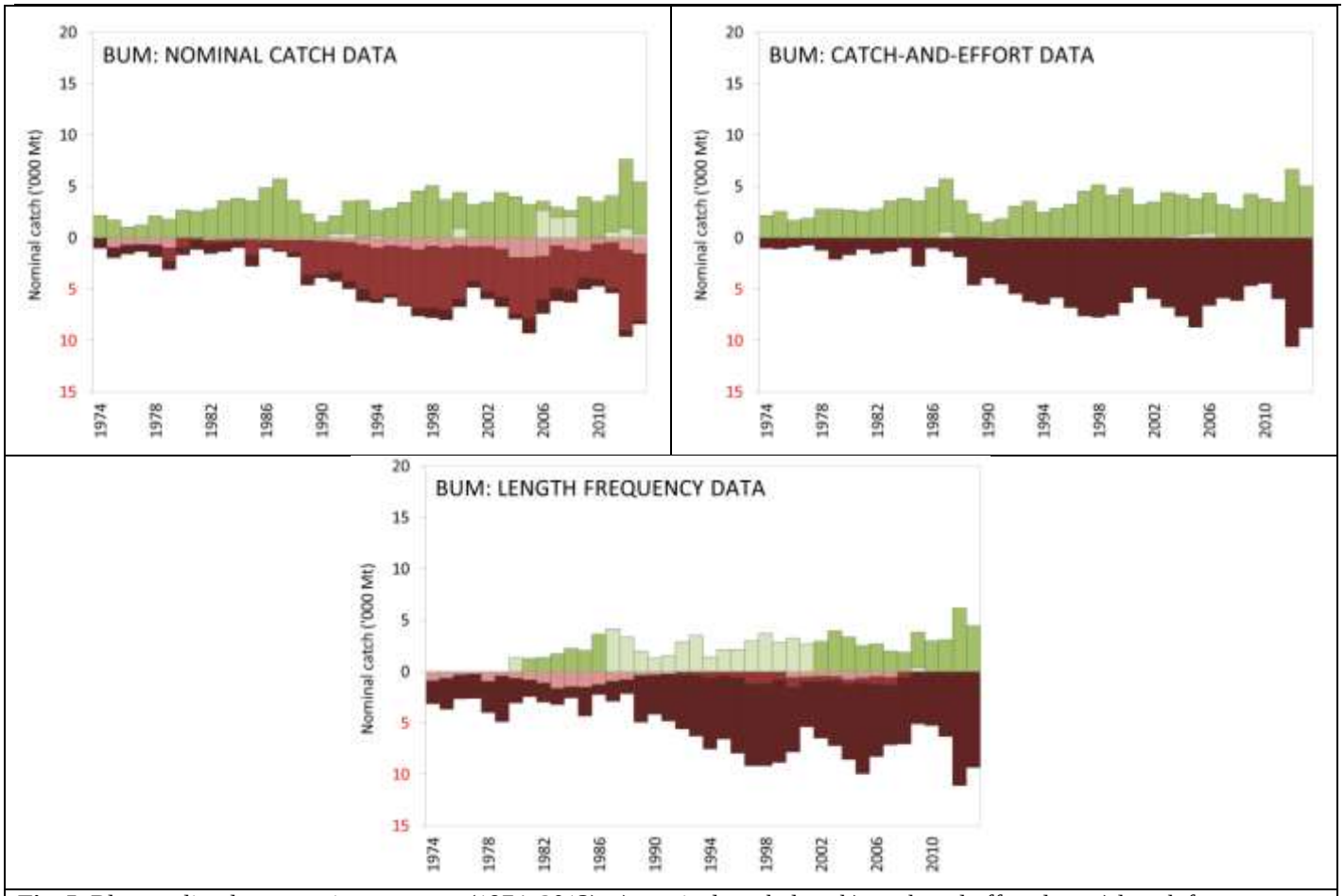

Fig. 5. Blue marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal 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)

Fig. 6. Blue marlin: Longline catch-at-size length distributions (Data as of September 2014)

Blue 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. 7, 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. 8.

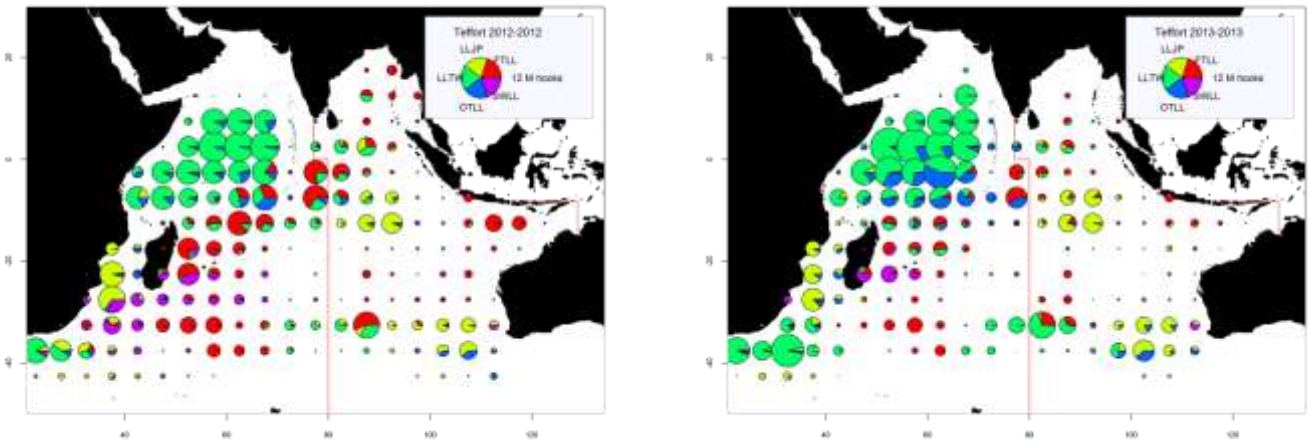

Fig. 7. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): 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)

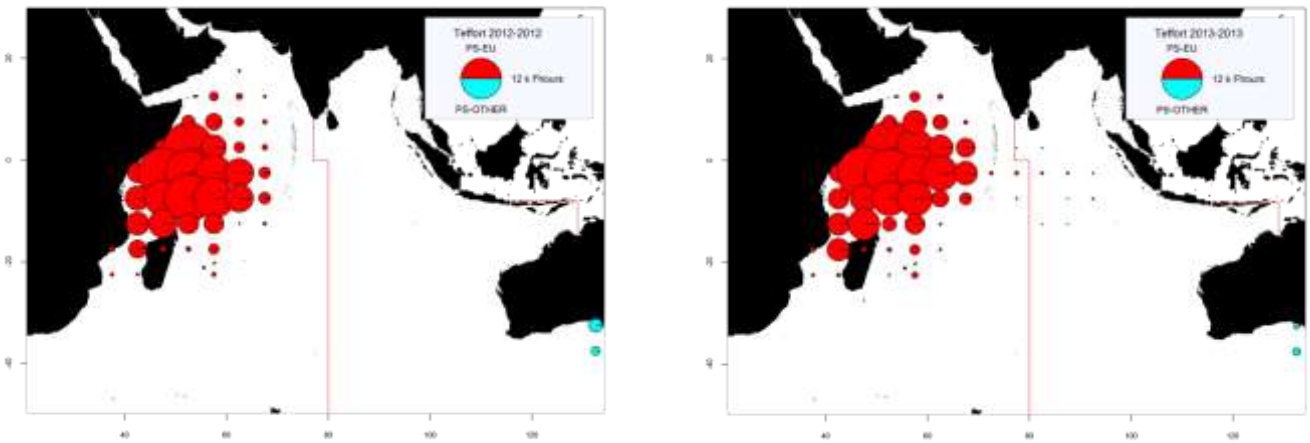

Fig. 8. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

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

The sharp decline between 1952 and 1956 in the Japanese blue marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1970 until 2011 is more likely to represent actual declines in stock abundance (Fig. 9). The catches and CPUE series estimated for blue marlin were very similar between the longline fleets of Japan and Taiwan,China, although there were two peaks in the Taiwan,China data series. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

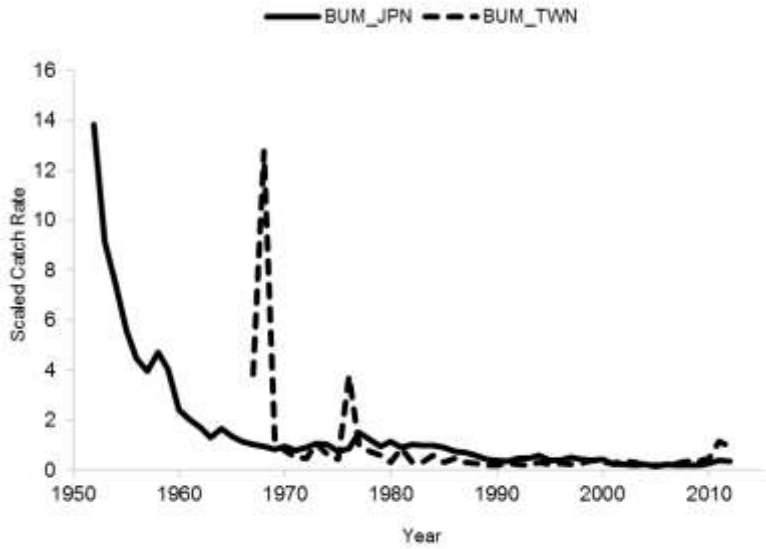

Fig. 9. Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Of the blue marlin CPUE series available for assessment purposes, the Japan and Taiwan,China CPUE series (Fig. 10) were used in the stock assessment model for 2013.

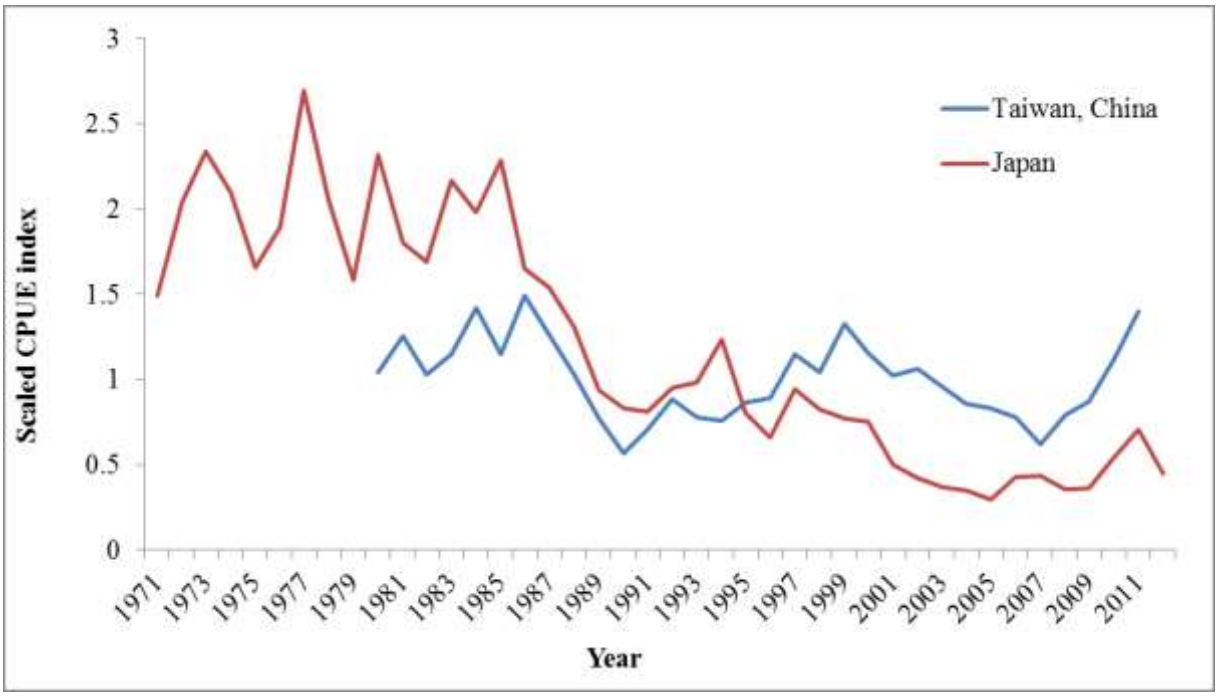

Fig. 10. Blue marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

Both Japan and Taiwan,China should undertake a historical review of their longline data and to document the changes in fleet dynamics for presentation and the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the blue marlin in 2013. The models explored did not perform well as far as the residual diagnostics, or other were concerned, denoting high uncertainties. However, these models showed similar stock trajectories, and based on the weight-of-evidence approach, the WPB agreed to use the results from the ASPIC model for stock status advice. Further work needs to be conducted in future years to improve these assessments.

The standardised longline CPUE series indicate a decline in abundance in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently being exploited at sustainable levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method, Stock reduction Analysis using only catch data. The Kobe plot (Fig. 1) from the ASPIC model indicates that the stock was most likely subject to overfishing in the recent past. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **not overfished** and **not subject to overfishing** (Tables 1, 5; Fig. 1). However, the uncertainty in the data available for assessment purposes and the CPUE series suggests that the advice should be interpreted with caution as the stock may still be in an overfished state (biomass less than B_{MSY}) (Table 1; Fig. 1). Given the recent declining effort trend, and a clear rebuilding trajectory (Fig. 1), fishing effort is not considered an immediate concern. Research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are still warranted. Given the limited data being reported for gillnet fisheries, and the importance of sports fisheries for this species, efforts must be made to rectify these information gaps.

TABLE 5. Blue marlin: Blue marlin (*Makaira nigricans*) stock status summary

Management Quantity	Aggregate Indian Ocean
2012 catch estimate	13,885 t
Mean catch from 2008–2012	10,640 t
MSY (80% CI)	9,524 (6,004–15,105)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (80% CI)	1.05 (0.63–1.47)
B_{2011}/B_{MSY} (80% CI)	1.03 (0.03–2.31)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (80% CI)	0.59 (0.02–1.16)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950, F=0}$	–
$SB_{2011}/SB_{1950, F=0}$	–

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