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		2013 stock status determination
Indian Ocean	Catch 2012: Average catch 2008–2012:	13,885 t 10,640 t	
	MSY (range): F_{2011}/F_{MSY} (range): B_{2011}/B_{MSY} (range): B_{2011}/B_{1950} (range):	11,690 (8,023–12,400) 0.85 (0.63–1.45) 0.98 (0.57–1.18) 0.48 (na)	

[1]Boundaries for the Indian Ocean = IOTC area of competence

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 ($F_{year}/F_{MSY}\leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. 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** (Table 1; 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.

Outlook. Total catch and effort for blue marlin in recent years has continued to increase to a total of 13,885 t in 2012 (9,919 in 2011). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is between 8,023–12,400 t.
- improvement in data collection and reporting is required to further assess the stock.
- research emphasis on improving indicators and further exploration of stock assessment approaches for data poor fisheries are warranted.

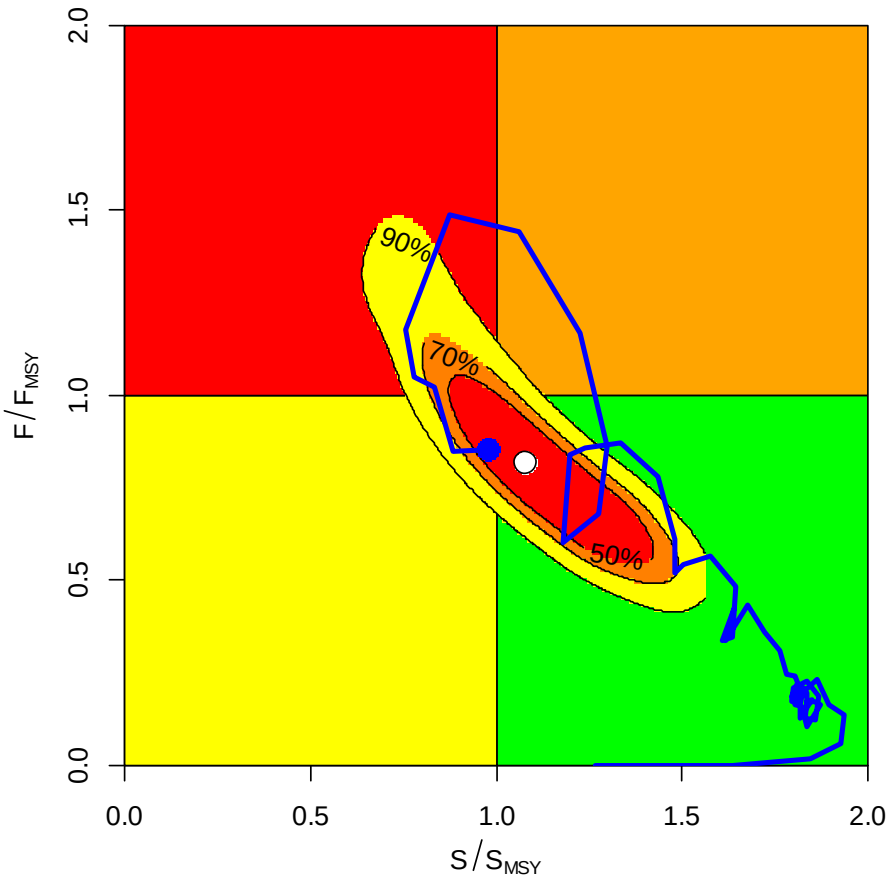

Fig. 1. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (90% bootstrap confidence surfaces shown around 2011 estimate). Blue line indicates the trajectory of the point estimates for the biomass (B) ratio (shown as S) and F ratio for each year 1950–2011.

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 2 outlines some key life history parameters relevant for management.

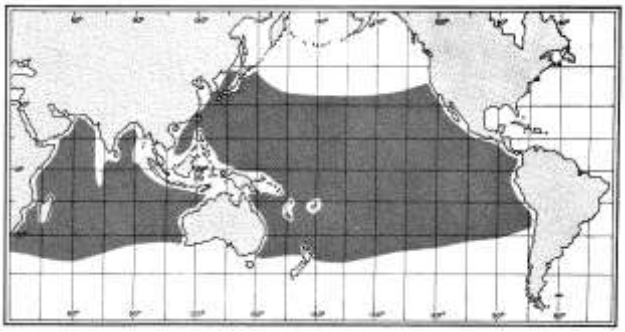

Fig. 2. Blue marlin: The worldwide distribution of blue marlin (Source: Nakamura 1984).

TABLE 2. 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

Blue marlin are caught mainly by drifting longlines (66%) and gillnets (33%) with remaining catches recorded taken by troll and hand lines (Table 3, Fig. 3). Blue marlins are considered to be a bycatch of industrial and artisanal fisheries. The catches of blue marlin are typically higher than those of black marlin and striped marlin combined.

In recent years (2010–12), the fleets of Taiwan,China (longline), Indonesia (longline and handline), I.R. Iran (gillnet) Sri Lanka (longline gillnet) accounted for around 75% of the total catch of blue marlin (Fig. 4). 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. 5).

Catch trends for blue marlin are variable; however, this may reflect the level of reporting. The catches of blue marlin recorded taken by drifting longlines were more or less stable until the mid-80's, at around 3,000–4,000 t, and have steadily increased since then to between 6,000–8,000 t. The largest catches reported by longlines were recorded in 1998 (~13,000 t). Catches taken by drifting longlines have been recorded by Taiwan,China and Japan fleets and, recently, Indonesia, India, Sri Lanka and several 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 and the Arabian Sea (Fig. 5).

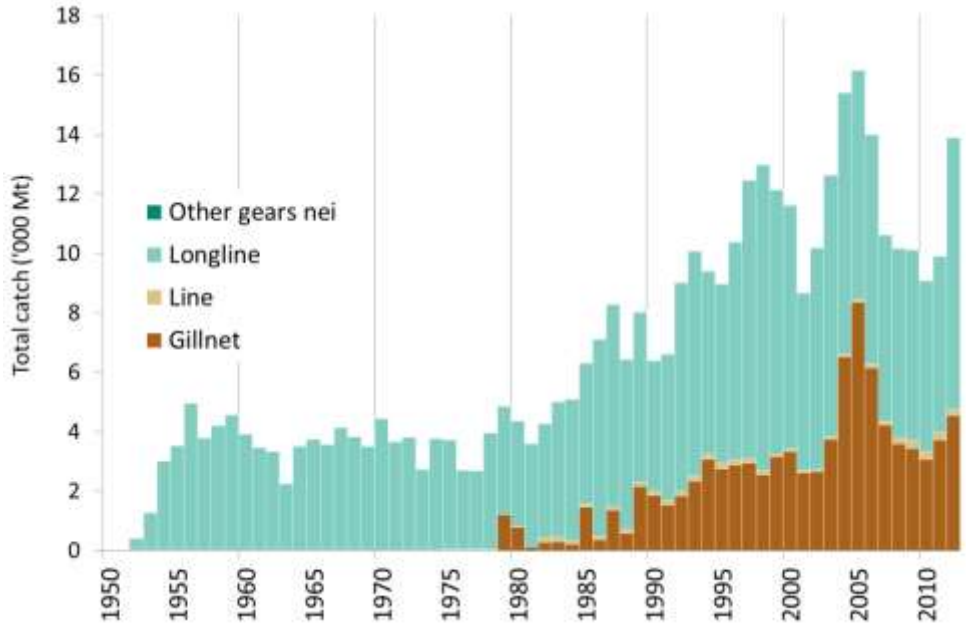

Fig. 3. Blue marlin: Catches of blue marlin by gear and year recorded in the IOTC Database (1950–2012) (Data as of October 2013).

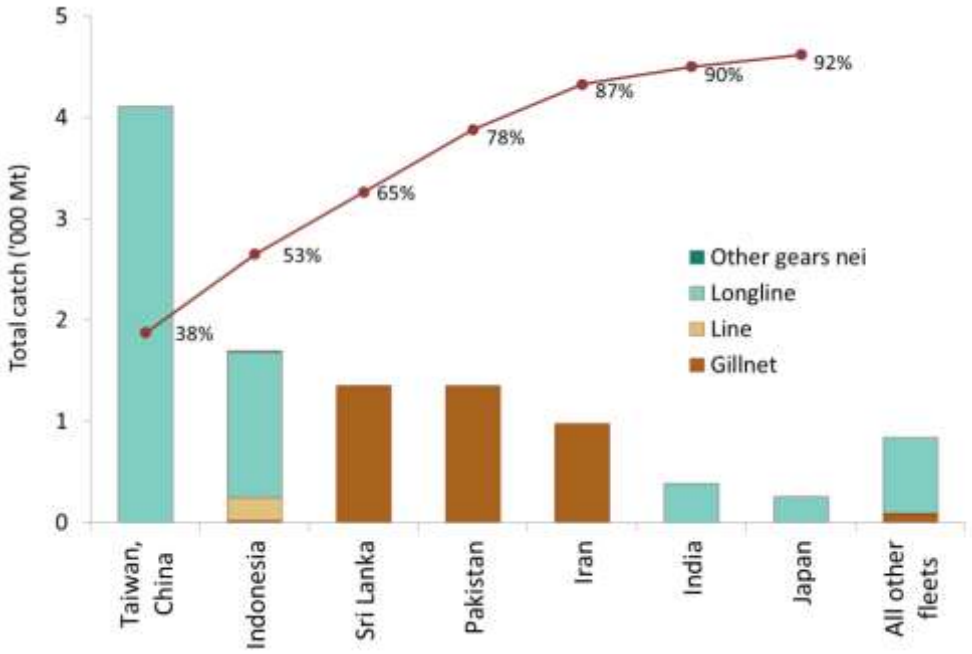

Fig. 4. Blue marlin: average catches in the Indian Ocean over the period 2009–12, by country. Countries are ordered from left to right, according to the importance of catches of blue marlin reported. The red line indicates the (cumulative) proportion of catches of blue marlin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries (Data as of October 2013).

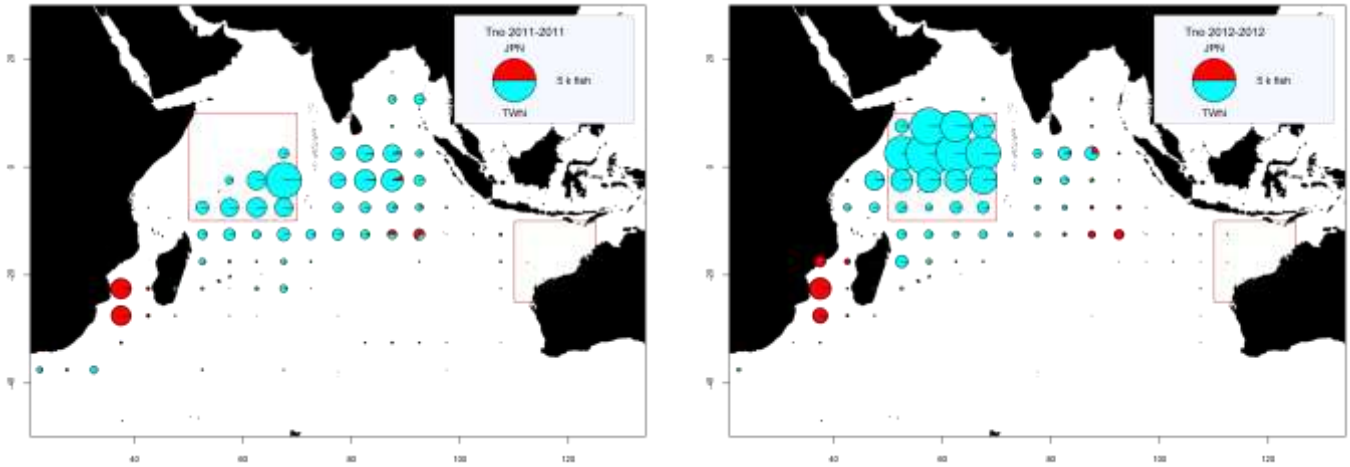

Fig. 5a–b. Blue marlin: Time-area catches (in number of fish) of blue marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2011 and 2012 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 3: Blue marlin: Best scientific estimates of the catches of blue marlin by type of fishery for the period 1950–2012 (in metric tons) (Data as of October 2013).

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
LL	2,563	3,515	3,489	4,977	7,197	7,368	8,786	8,794	7,714	7,727	6,264	6,367	6,433	5,730	5,921	9,141
GN	1	2	124	761	2,489	4,464	3,752	6,508	8,367	6,155	4,228	3,599	3,440	3,063	3,716	4,546
HL	5	9	17	105	149	120	81	95	85	121	122	201	250	271	265	187
OT	0	0	0	2	4	7	5	5	5	7	7	12	15	15	16	11
Total	**2,570**	**3,526**	**3,630**	**5,844**	**9,840**	**11,960**	**12,624**	**15,401**	**16,171**	**14,009**	**10,621**	**10,179**	**10,138**	**9,080**	**9,919**	**13,885**

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 (by species) also contribute to the uncertainties of the information available to the IOTC Secretariat.

Retained catches are poorly known for most fisheries (Fig. 6) 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 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 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 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 blue marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.
- **Changes to the catch series**: There have been relatively large changes to the catches of blue marlin since the WPB meeting in 2012 mainly for the mid-2000s. Catches for I.R. Iran and Pakistan have been revised upwards following improvements by IOTC in the disaggregation by species of catches reported as (aggregated) billfish catches; some of the catches for Sri Lanka have been reassigned as black marlin in response to large fluctuations in the reported catch estimates due to misidentification of the two species.

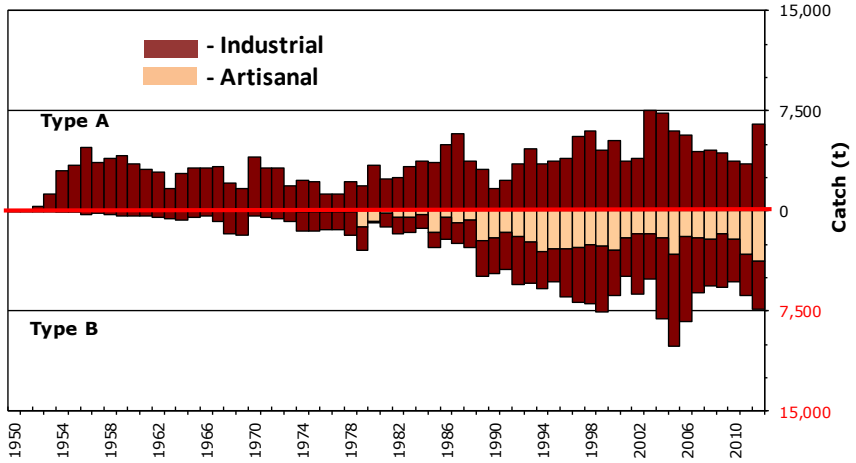

Fig. 6. Blue marlin: Uncertainty of annual catch estimates for blue marlin (Data as of October 2013). Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Blue marlin: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2011 and 2012 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 2011 and 2012 are provided in Fig. 8.

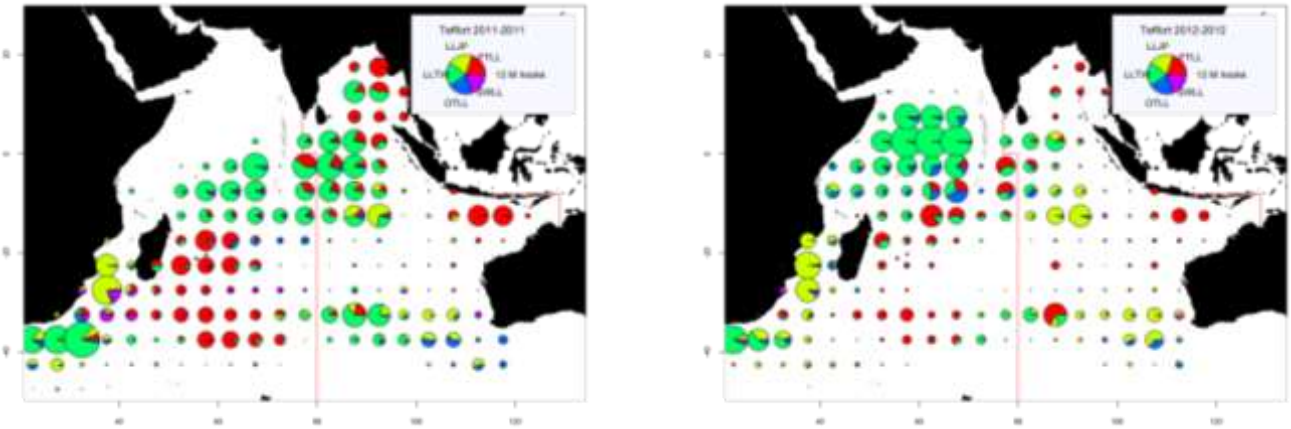

Fig. 7. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): 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)

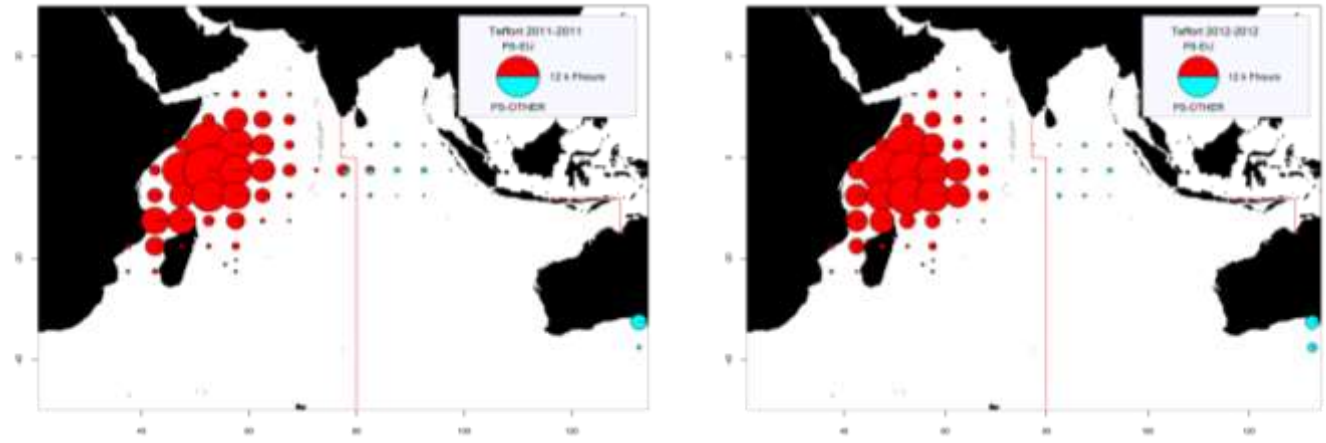

Fig. 8. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2011 (left) and 2012 (right) (Data as of October 2013).
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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.

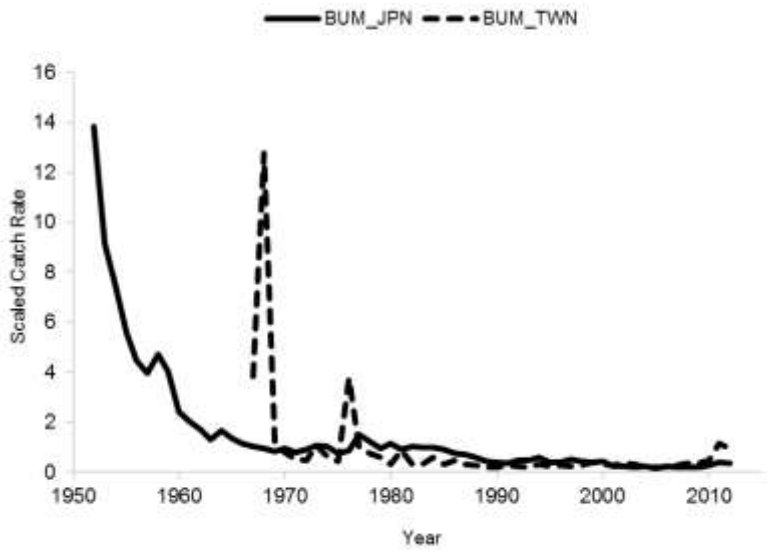

Fig. 9. Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

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.

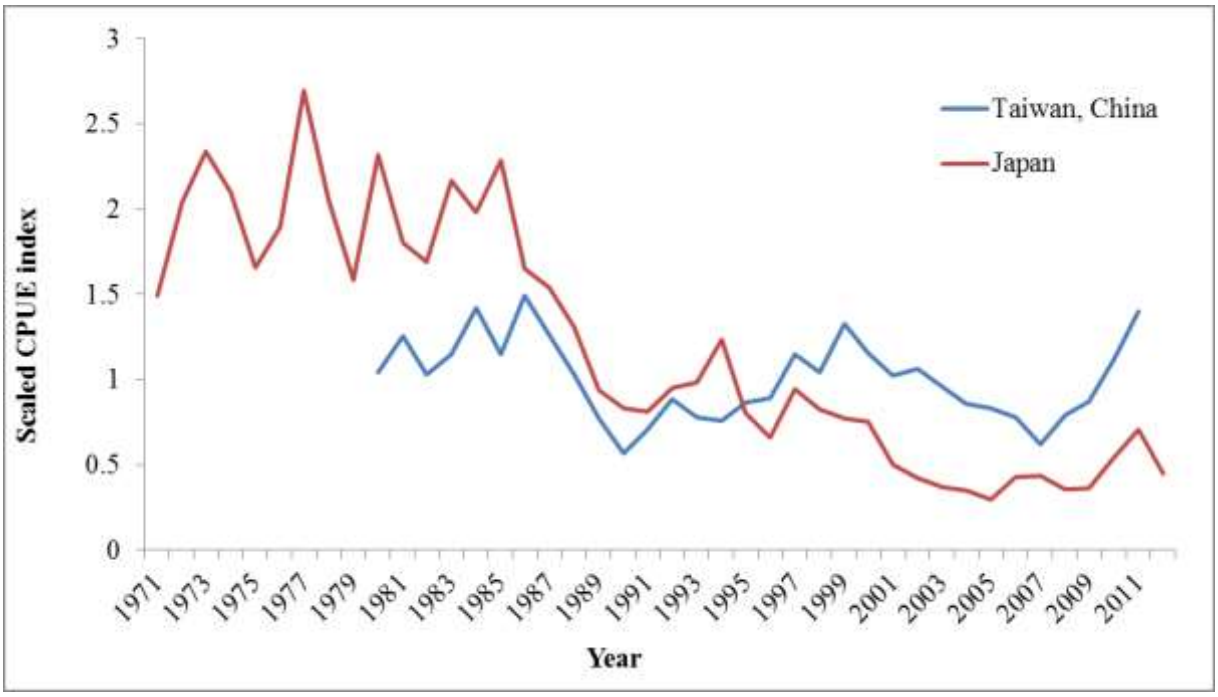

Fig. 10. Blue marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

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.

Blue marlin: 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 (Fig. 11). However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan.

Catch-at-Size(Age) tables have not been built for 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.

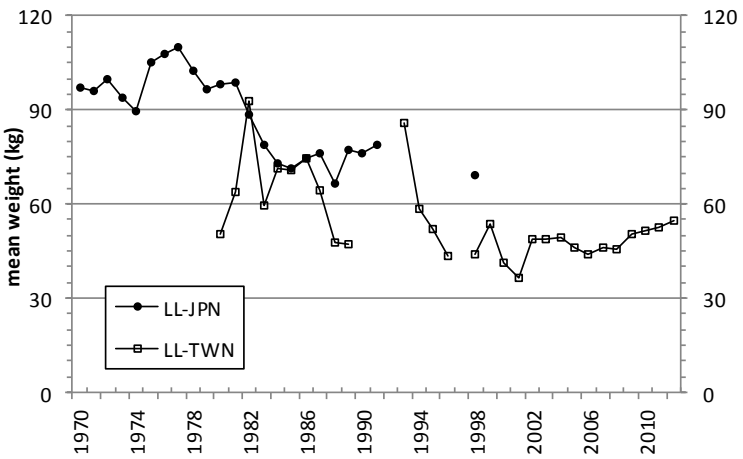

Fig. 11. Blue marlin: Average weight of blue marlin (kg) estimated from the size samples available for longliners of Japan (1970–2012) and Taiwan,China (1980–2012). Note: Average weights are shown only for years in which 300 or more specimens were sampled for length.

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** (Table 1; 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 4. 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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