# BLACK MARLIN

## 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, of which only one (15/05) is species specific:

- Resolution 15/01: *On the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 15/02: *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPC's)*
- Resolution 15/05: *On conservation measures for Striped marlin, Black marlin and Blue marlin*
- Resolution 15/11: *On the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 14/05: *Concerning a record of licensed foreign vessels fishing for IOTC species in the IOTC area of competence and access agreement information*
- Resolution 11/04: *On a regional observer scheme*
- Resolution 10/08: C*oncerning 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. 1**). **Table 1** 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.

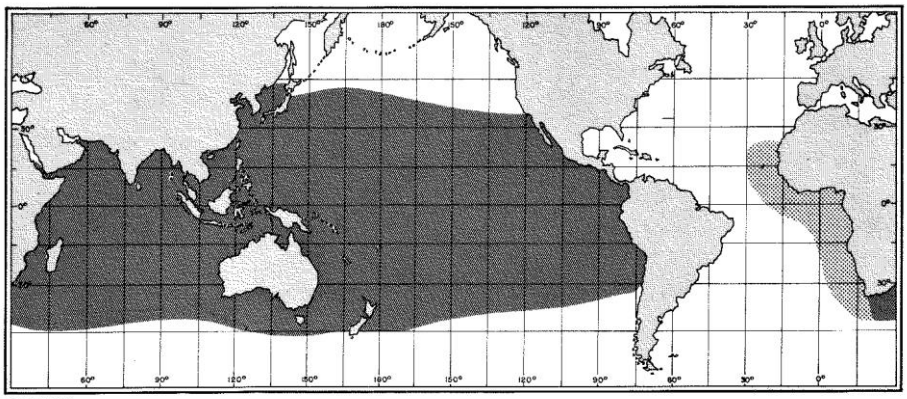


**Fig. 1.** Black marlin: The worldwide distribution of black marlin (Source: Nakamura 1984).

**TABLE 1.** 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 caught 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 | **Age**: unknown; |

| | |
|---|---|
| (50%) | **Size**: females around 100 kg; males 50 to 80 kg total weight. |
| Spawning season | No spawning grounds have been identified in the Indian ocean. Spawning hotspot off eastern Australia apparently 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.<br>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.<br>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.<br>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.<br>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

**Fisheries and main catch trends**

- Main fishing gear (2012–16): black marlin are largely considered to be a non-target species of industrial and artisanal fisheries. Gillnets account for around 53% of total catches in the Indian Ocean, followed by longlines (17%), with remaining catches recorded under troll and handlines. (**Fig. 2**)
- Main fleets (and primary gear associated with catches): percentage of total catches (2012–16):
  Iran (gillnet): 28%; India (gillnet and troll): 21%; Sri Lanka (gillnet and fresh longline): 19%; Indonesia (fresh longline and hand lines): 15% (**Fig. 3**).
- Main fishing areas: Primary: 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 in that area, in particular in waters off northwest Australia. Secondary: in recent years, deep-freezing longliners from Japan and Taiwan,China have reported catches of black marlin off the western coast of India and the Mozambique Channel.
- Retained catch trends:
  Catches have increased steadily since the 1990s, from 2,800 t in 1991 to over 10,000 t since 2004. The highest catches were recorded in 2015, at over 18,000 t (**Table 2**) – largely due to increases reported by the offshore gillnet fisheries of I.R. Iran.

  Catches in Sri Lanka have also 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 3,000 t in recent years.
- Discard levels**:** Low, although estimates of discards are unknown for most industrial fisheries, mainly longliners. Discards may also occur in some gillnet fisheries.

***Changes to the catch series*****:** no major changes to the catch series since the WPB meeting in 2014, when catches were revised substantially following new reports of catches-by-species for drifting gillnet fleets by Iran[1].

Any differences in the data series since the last WPB are changes to the nominal catch as a result of reallocation of catches reported as other billfish species or as aggregated billfish species groups reported by, e.g., Sri Lanka, and Pakistan to a lesser extent. These changes, however, did not lead to very significant changes in the total catch estimates for black marlin.

[1] Prior to 2013 I.R. Iran reported aggregated catches for all billfish species, which were estimated by species and gear by the IOTC Secretariat. Iran has provided catches by billfish species for the first time, from 2012 onwards, which significantly revised the catch-by-species previously estimated by the Secretariat: the main change being the higher proportions of black marlin, rather than blue marlin reported by I.R. Iran, assigned to the offshore gillnet fishery. As a result of changes in the catch series total catches of black marlin for I.R. Iran were revised upwards by as much as 30% to 50% for a number of years around the mid-2000's.

**TABLE 2.** Black marlin: best scientific estimates of catches by type of fishery for the period 1950–2016 (in metric tons).

| Fishery | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| LL | 862 | 1661 | 1391 | 1728 | 1571 | 1985 | 1921 | 3033 | 1839 | 1868 | 1974 | 2176 | 2640 | 3491 | 2937 | 3005 |
| GN | 26 | 31 | 45 | 454 | 2762 | 6917 | 6738 | 6227 | 6936 | 6071 | 8957 | 8495 | 8567 | 9690 | 8894 | 8185 |
| HL | 24 | 27 | 42 | 451 | 736 | 1028 | 1060 | 1349 | 2146 | 1630 | 1864 | 2260 | 3061 | 4535 | 6523 | 6183 |
| OT | 0 | 0 | 4 | 65 | 112 | 226 | 257 | 329 | 460 | 472 | 490 | 483 | 693 | 461 | 454 | 456 |
| **Total** | **912** | **1,719** | **1,482** | **2,698** | **5,181** | **10,156** | **9,976** | **10,937** | **11,380** | **10,040** | **13,285** | **13,414** | **14,961** | **18,177** | **18,808** | **17,829** |

**Fisheries:** Longline (**LL**); Gillnet (**GN**); Hook-and-Line (includes handline, trolling, baitboat, and sport fisheries) (**HL**); Other gears (includes coastal purse seine, Danish purse seine, beach seine, and purse seine) (**OT**).

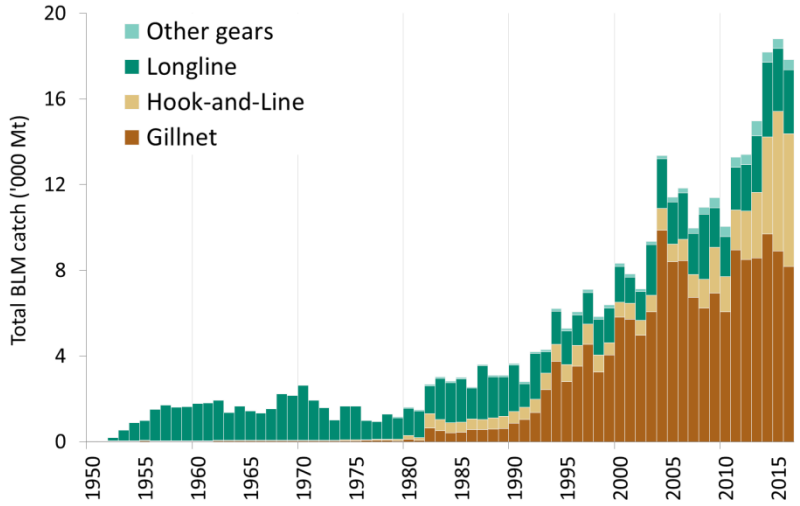



**Fig. 2.** Black marlin: catches by gear and year recorded in the IOTC Database (1950–2016). *Note: Other gears includes: coastal purse seine, Danish purse seine, beach seine and purse seine.*

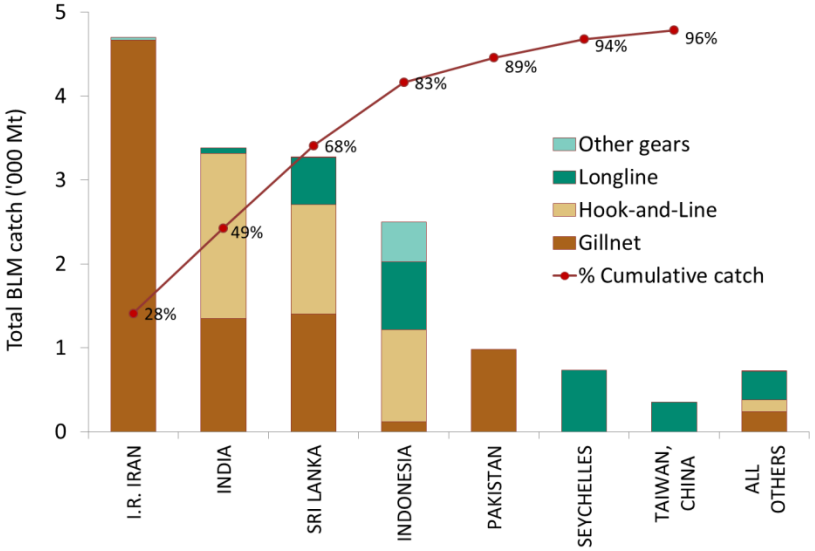



**Fig. 3.** Black marlin: average catches in the Indian Ocean over the period 2012–16, by fleet and gear. Fleets are ordered from left to right, according to the volume of catches reported. The red line indicates the (cumulative) proportion of catches of black marlin for the fleets concerned, over the total combined catches reported from all fleets and gears.

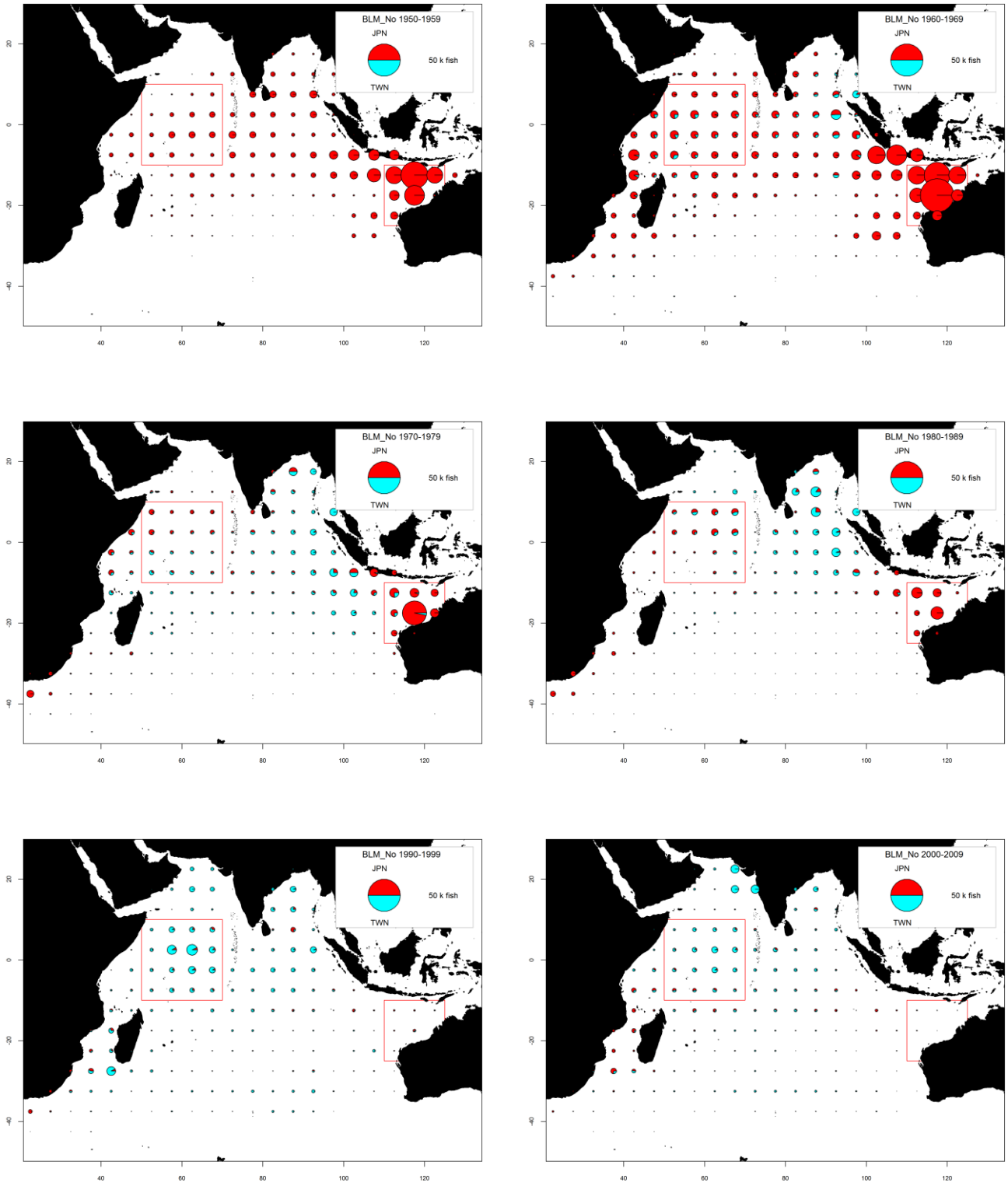



**Fig. 4a-f.** Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 1950–2009, by decade and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB. Source: IOTC catch and effort data.

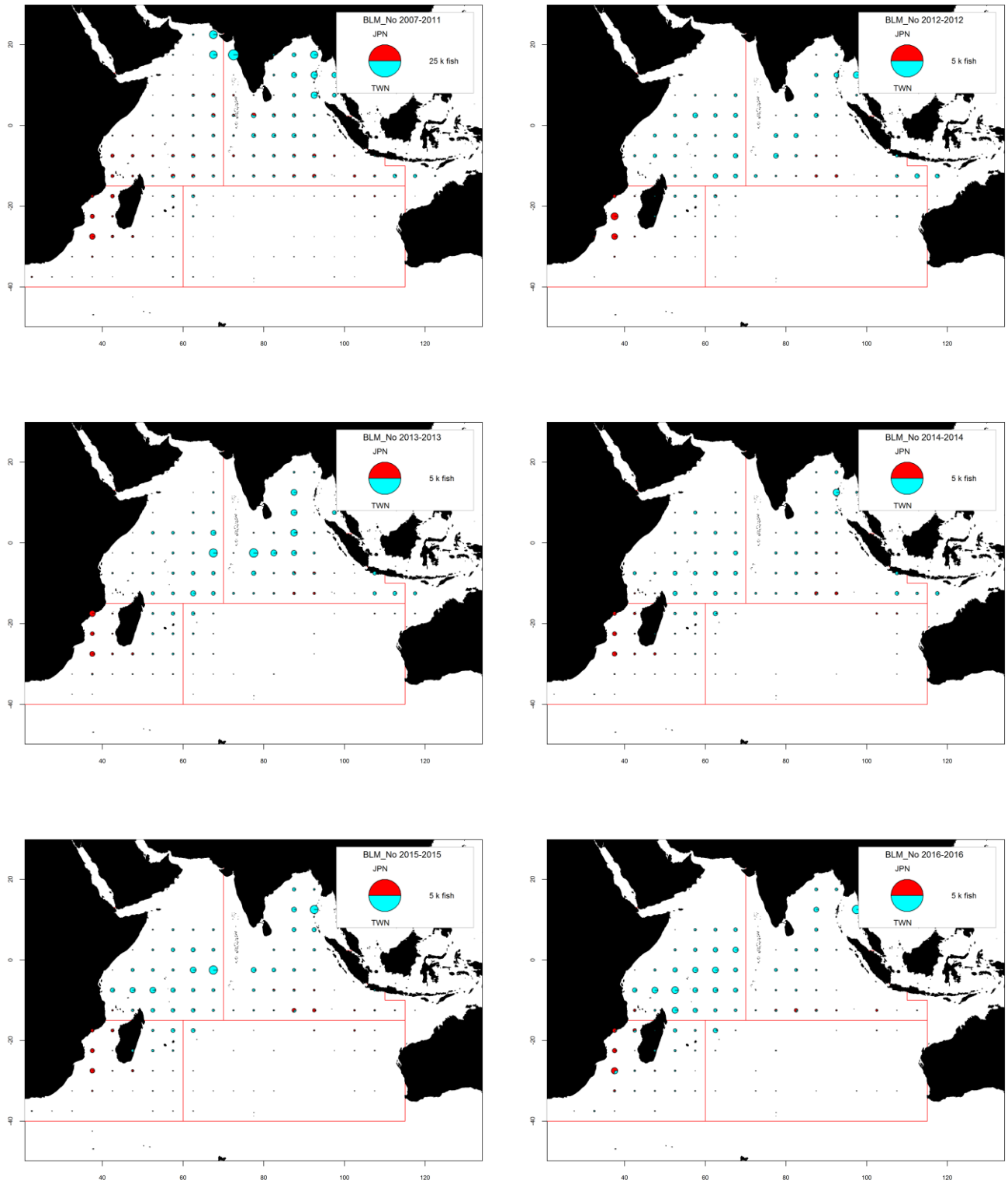



**Fig. 5a-f.** Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for the period 2007–11 by fleet and for 2012–16, by year and fleet. Red lines represent the marlin hotspots identified by the IOTC WPB. Source: IOTC catch and effort data.

***Black marlin: estimation of catches – data related issues***

**Retained catches –** a very high proportion of the catches of black marlin are estimated, or adjusted, by the IOTC Secretariat are (**Fig. 6a**), due to a number of uncertainties in the catches:

- Species aggregates: 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 years and artisanal fisheries (e.g., gillnet/longline fishery of Sri Lanka and artisanal fisheries of India, Iran and Pakistan) and industrial fisheries (e.g., longliners of Indonesia and Philippines).
- Non-reporting fleets: catches of non-reporting industrial longliners (e.g., India, NEI) and the gillnet fishery of Indonesia are estimated by the Secretariat using alternative information.
- Non-target species: catches are likely to be incomplete for industrial fisheries for which black marlin are not a target species.
- Conflicting catch reports: longline catches from the Republic of Korea 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 blue marlin remain uncertain for this fleet.
- Lack of catch data for most sport fisheries.
- Species misidentification: difficulties in the identification of marlins also contribute to uncertainties in the catch estimates of black marlin available to the Secretariat.

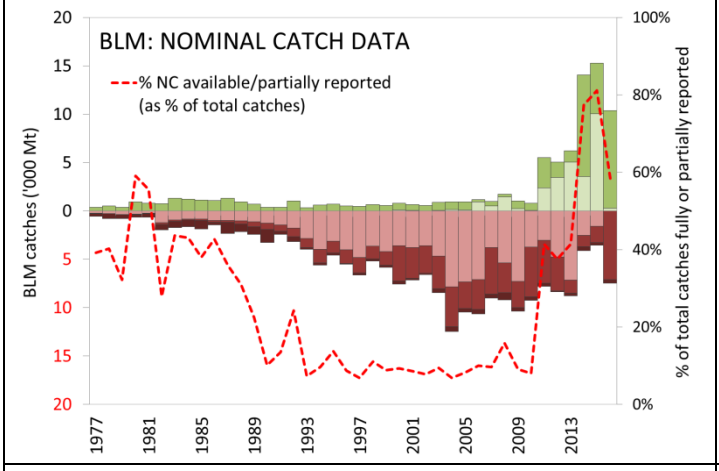
***Black marlin –catch-per-unit-effort (CPUE) trends***

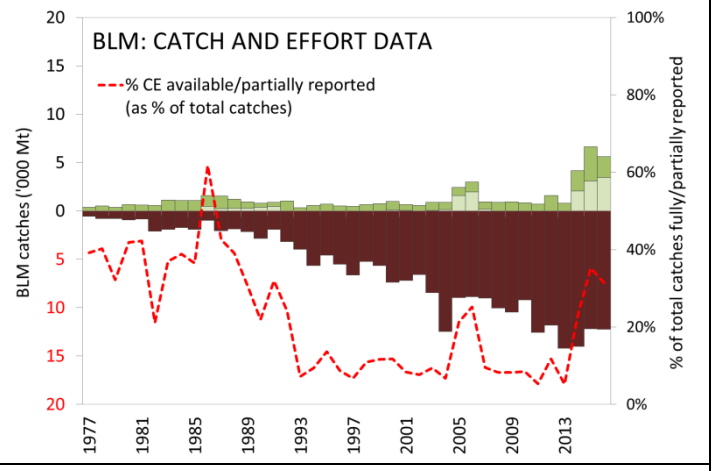
- Availability: Nominal CPUE series are available for some industrial longline fisheries, although catches are likely to be incomplete (as catches of non-target species are not always recorded in logbooks).

  No catch-and-effort data are available from sports fisheries, other than for partial data from the sports fisheries of Kenya; likewise no data are available for other artisanal fisheries (gillnet fisheries of Iran, Indonesia and Pakistan). Unreliable data from gillnet/longlines of Sri Lanka) or other industrial fisheries (NEI longliners and all purse seiners).
- Main CPUE series available: Japan, Taiwan,China and Indonesia longline fleets.

***Black 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. However, the number of specimens measured on Japanese longliners in recent years is very low. Also the length frequency distributions derived from samples collected by fishermen on Taiwanese longliners are likely to be biased.
- Catch-at-Size (Age) table: not available, due to lack of size samples and uncertainty over the reliability of retained catch estimates, or conflicting catch-and-effort data. 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 Secretariat by CPCs.



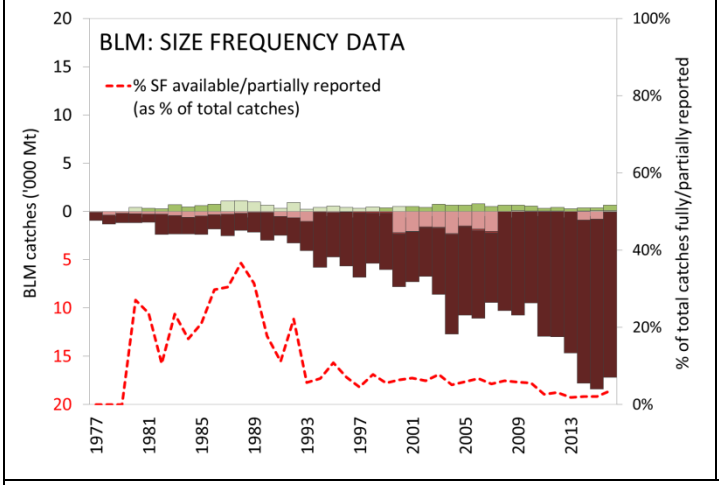




**Fig. 6a-c.** Black marlin: data reporting coverage (1977–2016).

*Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where:*

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 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;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

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)

### *Fishing effort trends*

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2015 and 2016 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 in 2015 and 2016 are provided in **Fig. 8**.

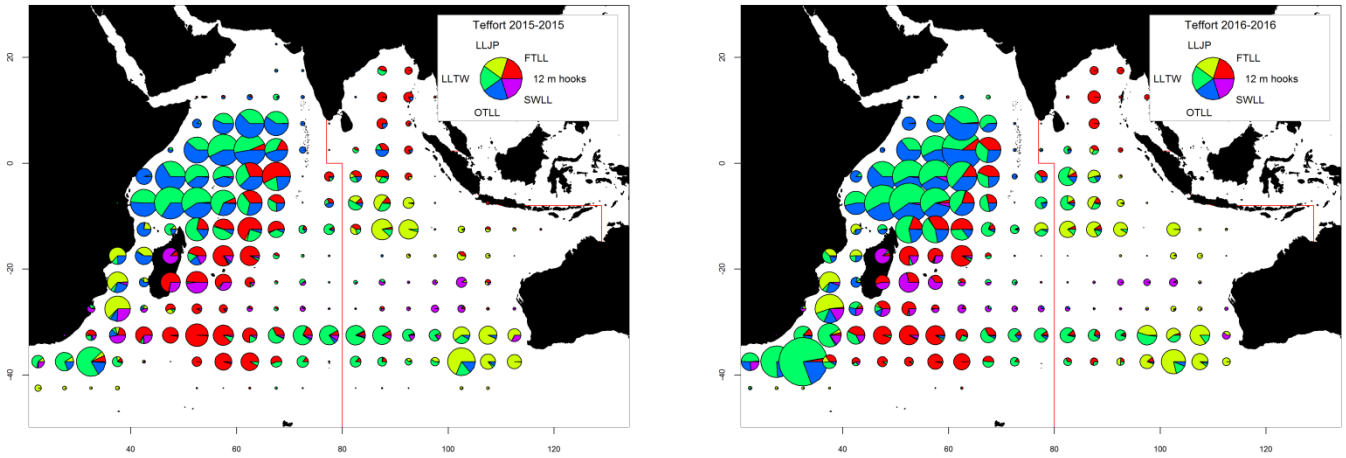



**Fig. 7.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2015 (left) and 2016 (right). **LLJP** (light green): deep-freezing longliners from Japan; **LLTW** (dark green): deep-freezing longliners from Taiwan,China; **SWLL** (turquoise): 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).

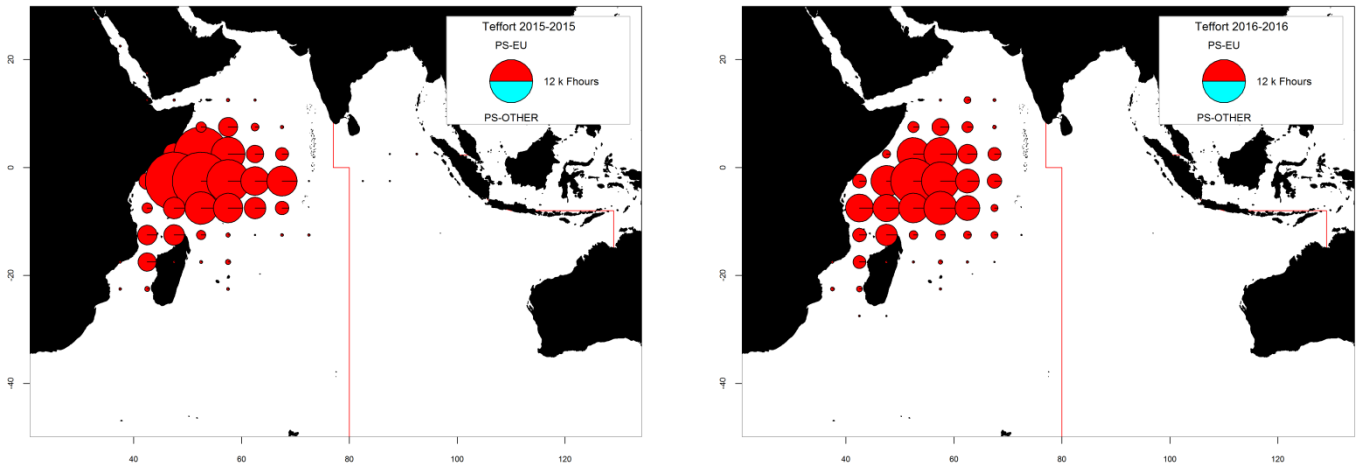



**Fig. 8.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2015 (left) and 2016 (right). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags); **PS-OTHER** (light blue): 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: Standardised catch–per–unit–effort (CPUE) trends*

In 2016, four standardized CPUE series were made available for the assessment of black marlin: Japan (split into earlier and later time periods), Taiwan,China and Indonesia The combined plot of these series is shown in Figure 9.

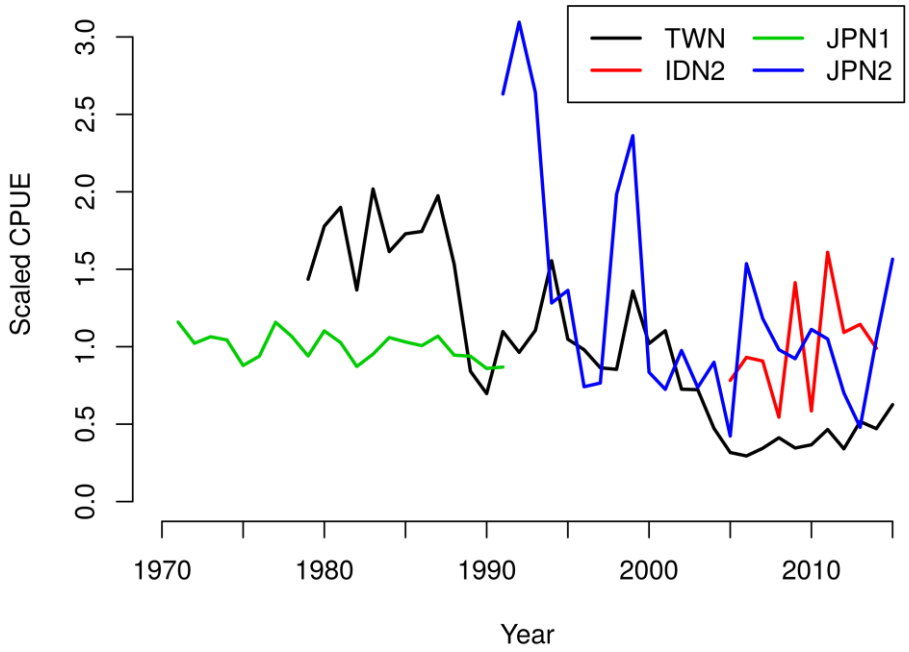



**Fig. 9.** Black marlin: Standardised CPUE series for Japan (JPN1, JPN2), Taiwan,China (TWN) and Indonesia (IDN2) as provided by national scientists for stock assessment purposes.

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**

Two models (ASPIC and Bayesian state space Surplus Production Model) were applied to the Black marlin in 2016. Both models indicated that the stock is overfished and subject to overfishing. The WPB agreed to use the results from the Bayesian state space Surplus Production Model for stock status advice.

The results of the stock assessment of black marlin (**Table 3**) 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.

Alternative approaches should continue to be explored considering that:

- 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.

**TABLE 3.** Black marlin (*Makaira indica*): Key management quantities from the BSP-SS assessment, for the Indian Ocean.

| Management Quantity | Indian Ocean |
|---|---|
| 2015 catch estimate | 18,490 |
| Mean catch from 2011–2015 | 15,276 |
| MSY (1000 t) (80% CI) | 9.932 (6.963 – 12.153) |
| Data period used in assessment | 1950 – 2015 |
| $F_{MSY}$ (80% CI) | 0.211 (0.089 – 0.430) |
| $B_{MSY}$ (1000 t) (80% CI) | 47.430 (27.435 – 100.109) |
| $F_{2015}/F_{MSY}$ (80% CI) | 2.42 (1.52 – 4.06) |
| $B_{2015}/B_{MSY}$ (80% CI) | 0.81 (0.55 – 1.10) |
| $SB_{2015}/SB_{MSY}$ | n.a. |
| $B_{2015}/B_{1950}$ (80% CI) | 0.30 (0.20 – 0.41) |
| $SB_{2015}/SB_{1950}$ | n.a. |
| $B_{2015}/B_{1950, F=0}$ | n.a. |
| $SB_{2015}/SB_{1950, F=0}$ | n.a. |

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