DRAFT: EXECUTIVE SUMMARY: STRIPED MARLIN

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

Status of the Indian Ocean striped marlin (MLS: *Tetrapturus audax*) resource

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

Area[1]	Indicators		2014 stock status determination
Indian Ocean	Catch 2013: Average catch 2009–2013:	4,429 t 3,667 t	
	MSY (1,000 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_0 (80% CI):	4.41 t (3.54–4.58) 0.36 (n.a.) 12.43 t (n.a.) 1.28 (0.95–1.92) 0.416 (0.2–0.42) 0.18 (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 ($B_{year}/B_{MSY} \geq 1$)
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. No new assessment was undertaken for striped marlin in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013 an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently subject to overfishing and that biomass is below the level which would produce MSY, using catch data up until 2011. 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 has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. Total reported landings increased in 2012 to 6,088 t, well above the MSY estimate of 4,408 t. In 2013 reported catches declined to 4,429 t, still above the MSY level. Thus, on the weight-of-evidence available to the WPB in 2014, the stock is determined to be **overfished** and **subject to overfishing** (Table 1; Fig. 1).

Outlook. The decrease in longline catch and effort in the years 2009–11 lowered the pressure on the Indian Ocean stock as a whole, however, the increased catches reported in 2012 and 2013, combined with the concerning results obtained from the preliminary stock assessment carried out in 2012 and the follow-up assessment in 2013 for striped marlin, the outlook is pessimistic for the stock as a whole and a precautionary approach to the management of striped marlin should be considered by the Commission. There is a very high risk of exceeding the biomass MSY-based reference points by 2015 if catches increase further or are maintained at current levels (2011) until 2015 (>93% risk that $B_{2015} < B_{MSY}$), but a low risk that $F_{2019} > F_{MSY}$ (≈ 7% if maintained, ≈ 30% if increased by 10%) (Table 2).

The following key points should be noted:

- **Maximum Sustainable Yield (MSY)**: estimate for the whole Indian Ocean is 4,408 t (3,539–4,578). However, the biomass is well below the B_{MSY} reference point and fishing mortality is in excess of F_{MSY} at recent catch levels, of around 2,500 t. Catches should be reduced to below 2,500 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 striped marlin.
- **Main fishing gear** (2013): Longline and gillnet catches are currently estimated to comprise approximately 73% and 19% of the total estimated striped marlin catch in the Indian Ocean, respectively.

- **Main fleets**: Taiwan,China: 32%; Indonesia: 26%; Pakistan: 9%; I.R. Iran: 8%.
- **Improvements required**: improvement in data collection and reporting is required to further assess the stock.

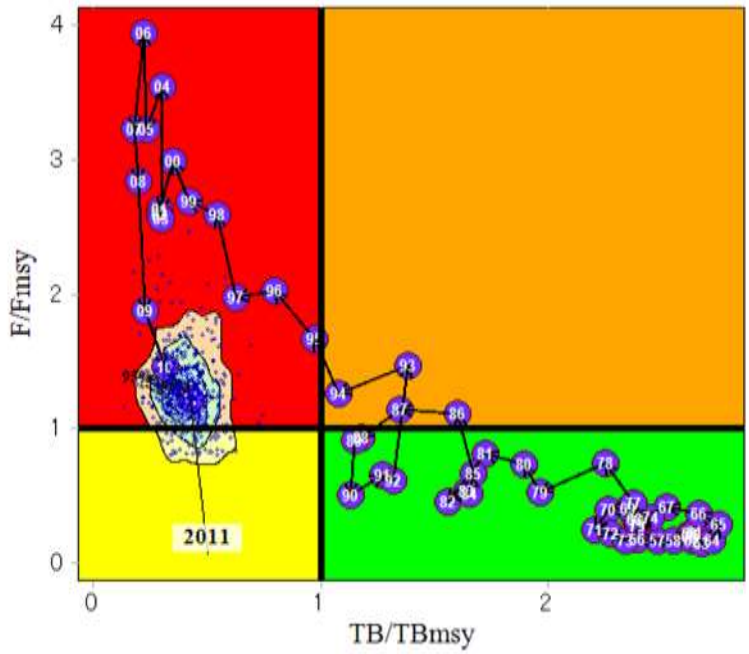

Fig. 1. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (90% bootstrap confidence surfaces shown around 2011 estimate – white dot). Blue line indicates the trajectory of the point estimates for the total biomass (B) ratio (shown as TB) and F ratio for each year 1950–2011. Note: The MSY is close to the upper limit of the confidence intervals, as the bootstrap mean and ASPIC mean results are slightly different.

TABLE 2. Striped 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 2009–2011 (2,607 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 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%**
$B_{2015} < B_{MSY}$	41	59	77	85	93	96	99	99	100
$F_{2015} > F_{MSY}$	0	0	0	4	7	30	54	77	100
$B_{2022} < B_{MSY}$	0	0	0	0	0	2	4	52	100
$F_{2022} > F_{MSY}$	0	0	0	0	0	0	0	51	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 striped 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

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

- Resolution 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

Striped marlin: General

Striped marlin (*Tetrapturus audax*) 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 this species and no information on the stock structure or growth and mortality in the Indian Ocean.

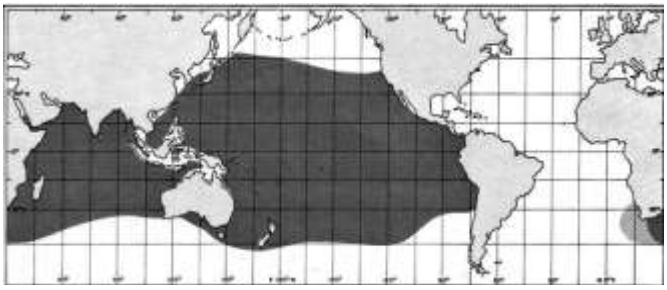

Fig. 2. Striped marlin: The worldwide distribution of striped marlin (Source: Nakamura, 1984)

TABLE 3. Striped marlin: Biology of Indian Ocean striped marlin (*Tetrapturus audax*)

Parameter	Description
Range and stock structure	A large oceanic apex predator that inhabits tropical and sub-tropical 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. Its distribution is different from other marlins in that it prefers more temperate or cooler waters however in the Indian Ocean it is common in tropical zone: off the east African coast (0-10ºS), the south and western Arabian Sea, the Bay of Bengal, and north-western Australian waters. Several transoceanic migrations were reported in the Indian Ocean (the longest is from Kenya to Australia). Therefore a single stock hypothesis apparently is most appropriate for stock assessement and management.
Longevity	~10 years. Females and males n.a.
Maturity (50%)	Age: 2–3 years. Females and males n.a.
Spawning season	Highly fecund batch spawner. Females may produce up to 20 million eggs. Usually spawn in the vicinity of oceanic islands, seamounts or coastal areas, associated with local increases in primary productivity. In the Indian Ocean larvae of this species was recorded off the Somalian coast, around Reunion and Mauritius and off north-western Australia.
Size (length and weight)	In the Indian Ocean documented maximum size for females 314 cm LJFL and 330 kg TW, for males 292 cm LJFL, 185 kg TW. However males longer than 260 cm LJFL are rare. Young fish grow very quickly in length then put on weight later in life. Striped marlin is the smallest of the marlin species; but unlike the other marlin species, striped marlin males and females grow to a similar size. L-W relationships for the Indian Ocean are: females TW=0.00000009*LJFL**3.76598 males TW=0.00005174*LJFL**2.59633, both sexes mixed TW=0.00000039*LJFL**3.50024, TW in kg, LJFL in cm.

n.a. = not available. Sources: Nakamura 1985, Gonzalez-Armas et al. 1999, Hyde et al. 2006, Froese & Pauly 2009, Kadagi et al. 2011, Romanov & Romanova 2012

Striped marlin: Catch trends

The catch series for the striped marlin was revised in 2014, following new reports of catch for drifting gillnets and the fisheries of Indonesia. Striped marlin are caught mainly using drifting longlines (72% of the total catch). The remaining catches are recorded under gillnets and troll lines (Table 4, Fig. 3). Striped marlin are generally considered to be a bycatch of industrial fisheries. Catch trends for striped marlin are variable, ranging from 2000 t to 8000 t per year; however, this may reflect the level of reporting. Similarly, catches reported using drifting longlines are highly variable, with lower catch levels between 2009 and 2011 largely due to declining catches reported by Taiwan,China, deep-freezing and fresh-tuna longliners. The catches of striped marlin increased in 2012 and 2013, as longline vessels resumed their activities in the Western tropical Indian Ocean.

Catches using drifting longlines have been recorded under Taiwan,China, Japan, Rep. of Korea fleets and, recently, Seychelles, Indonesia and several Not Elsewhere Included (NEI) fleets (Fig. 4). Large drops in the catches of striped marlin have been recorded for the longline fleets of Japan and Taiwan,China since the mid-1980's and mid-1990's, respectively. The reason for such decreases in catches is not fully understood. Between the early-50s and the late-80s part of the Japanese fleet was licensed to operate within the EEZ of Australia, reporting relatively high catches of striped marlin in the area, in particular in waters off northwest Australia. High catches of the species were also recorded in the Bay of Bengal during this period, by both Taiwan,China and Japanese longliners. The distribution of striped marlin catches has changed since the 1980's with most of the catch now taken in the western areas of the Indian Ocean (Fig. 5). These changes of fishing area and catches over the years are thought to be related to changes in the type of access agreements to EEZs of coastal countries in the Indian Ocean, rather than changes in the distribution of the species over time. However, between 2007 and 2011, catches in the northwest Indian Ocean have dropped markedly, in tandem with a reduction of longline effort in the area as a consequence of maritime piracy off Somalia (Fig. 5). Catch levels increased substantially in 2012 and, to a lesser extent in 2013.

The catches of striped marlin reported by fleets using gillnets have been low over the entire time-series, amounting to between 500 t and 1,000 t in recent years. However, recent information received by the IOTC Secretariat tends to indicate that the catches of striped marlin by the gillnet fishery of Pakistan may be much higher than those officially reported, and a thorough review of the catch series may be required in the future for this species. Discards are believed to be low although they are unknown for most industrial fisheries, mainly longliners.

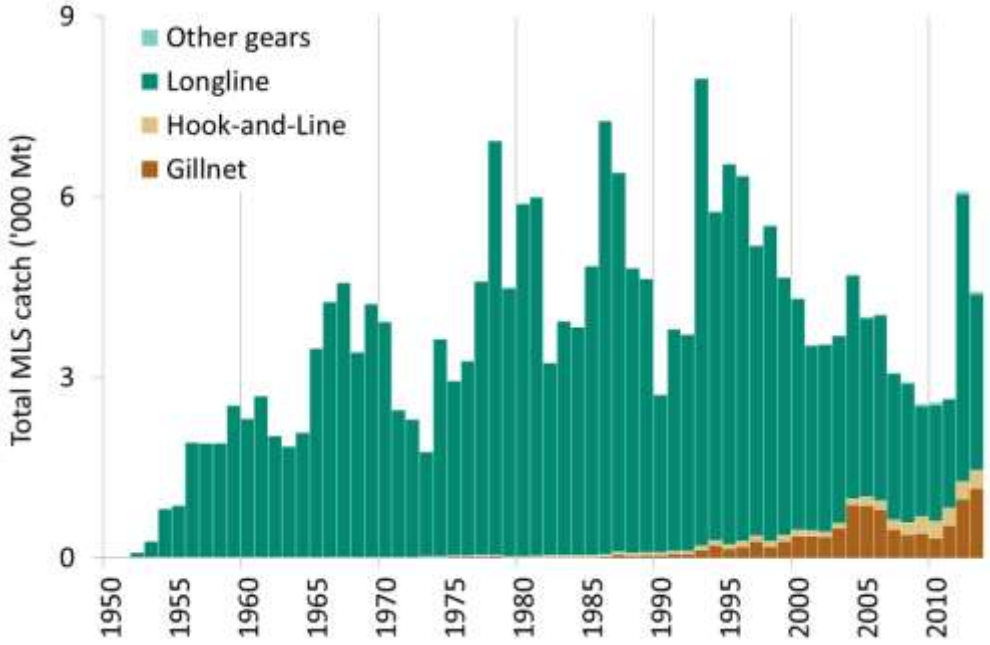

Fig. 3. Striped marlin: Catches of Striped marlin by gear and year recorded in the IOTC Database (1950–2013).

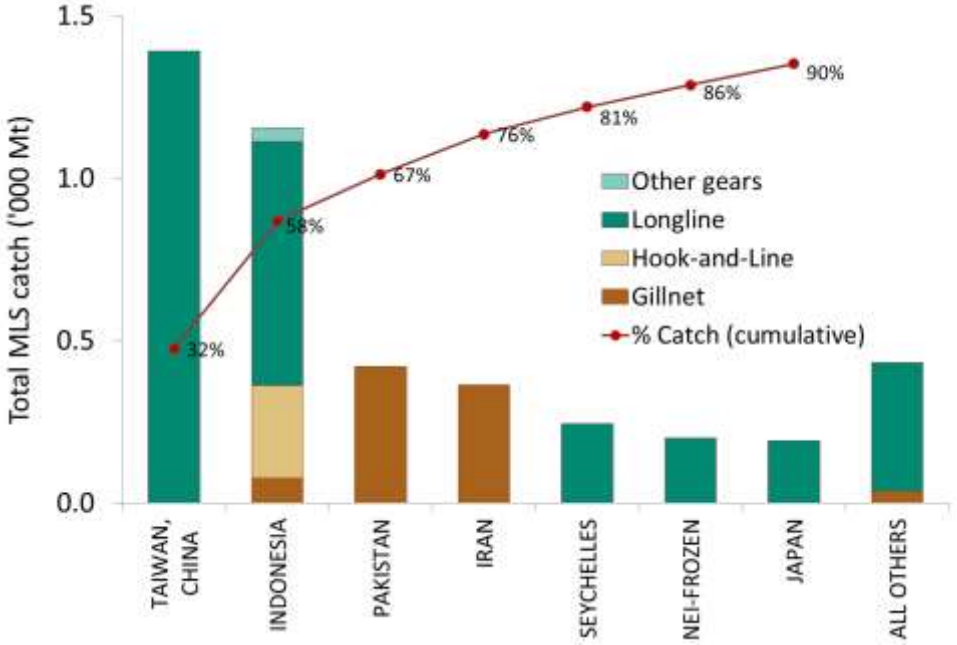

Fig. 4. Striped marlin: Average catches in the Indian Ocean over the period 2010–13, by fleet or country, ordered from left to right, according to the importance of catches of black marlin reported. The red line indicates the (cumulative) proportion of catches of striped marlin for the fleets or countries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

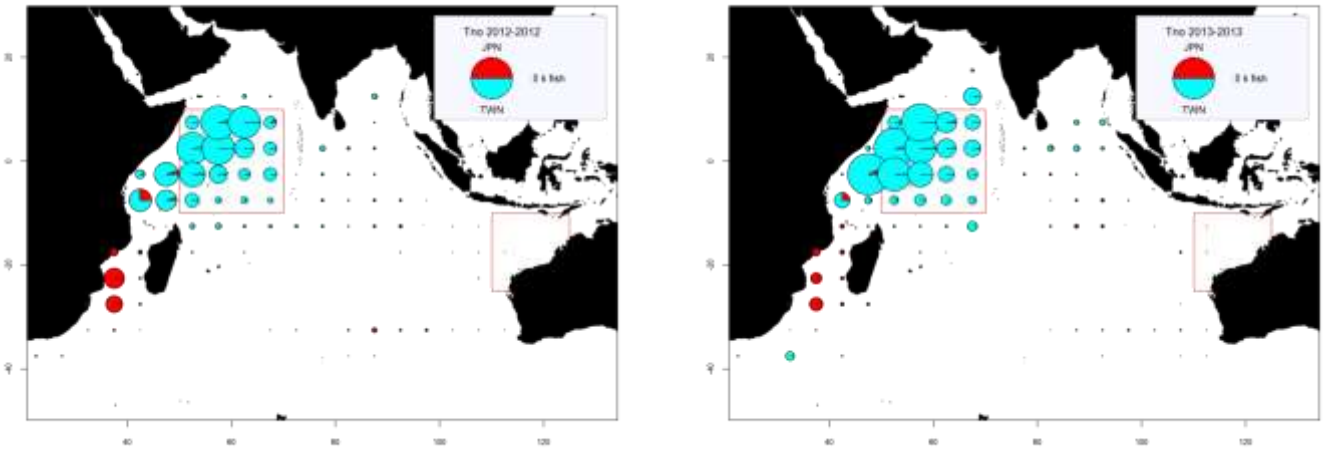

Fig. 5a–b. Striped marlin: Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for a) 2012 and b) 2013 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 4. Striped marlin: Best scientific estimates of the catches of striped 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	1,024	3,076	3,605	5,029	4,990	2,951	3,713	2,974	3,086	2,433	2,313	1,846	1,935	1,801	4,778	2,937
GN	5	8	16	22	161	541	880	876	807	479	389	407	330	540	983	1,160
HL	3	5	10	32	69	135	102	135	142	153	195	273	277	286	284	289
OT	0	0	0	6	10	20	15	20	21	23	29	41	41	43	43	43
Total	**1,031**	**3,089**	**3,631**	**5,089**	**5,229**	**3,647**	**4,710**	**4,005**	**4,055**	**3,087**	**2,927**	**2,567**	**2,583**	**2,670**	**6,088**	**4,429**

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

Uncertainty of time–area catches

Retained catches: reasonably well known (Fig. 6a) although they remain uncertain for some fleets:

- Catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (longliners of Indonesia and Philippines).

- Catches of non-reporting industrial longliners (India, NEI) estimated by the IOTC Secretariat using alternative information. As they are not reported by the countries concerned, catches are likely to be incomplete for some industrial fisheries for which the striped marlin is seldom the target species.
- Conflicting catch reports for the drifting gillnet fishery of Pakistan, with very high catches of striped marlins reported by alternative sources, as derived from sampling in different locations in Pakistan.
- Conflicting catch reports for longliners flagged to the Rep. of Korea, reported as nominal catches and catches and effort, are conflicting with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of striped marlin over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.

Discards: Thought to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in some driftnet fisheries.

Changes to the catch series: There have been minor changes to the catches of striped marlins since the WPB meeting in 2013. The main revisions occur around the mid-2000s as a result of improvements to the estimate of total catch and catch-by-species for IR Iran and Indonesia. These changes, however, did not lead to substantial changes in the catch estimates for striped marlins.

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. 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 be occurring in the Taiwan,China longline fishery; the length frequency distributions derived from samples collected on Taiwan,China longliners differ greatly from those collected on longliners flagged in Japan.

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 IR Iran and Pakistan, gillnet/longlines of Sri Lanka, gillnets of Indonesia) or industrial fisheries (NEI longliners and all purse seiners).

Catch-at-Size(Age) (Fig. 7): 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 or the samples collected are unreliable.

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

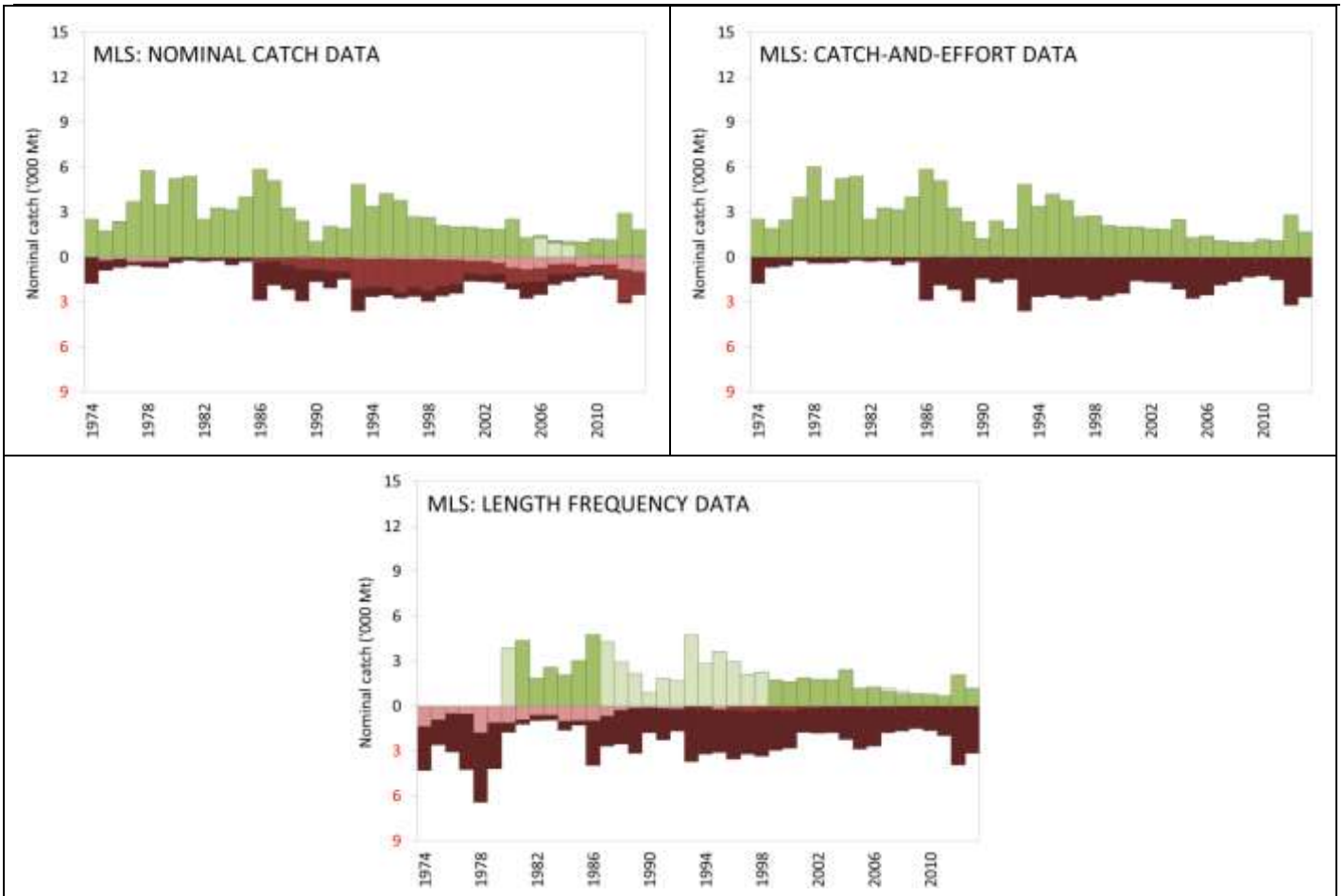

Fig. 6. Striped marlin: data reporting coverage (1974–2013). a) nominal catch data; b) catch-and-effort data; c) length frequency data. *Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of 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)

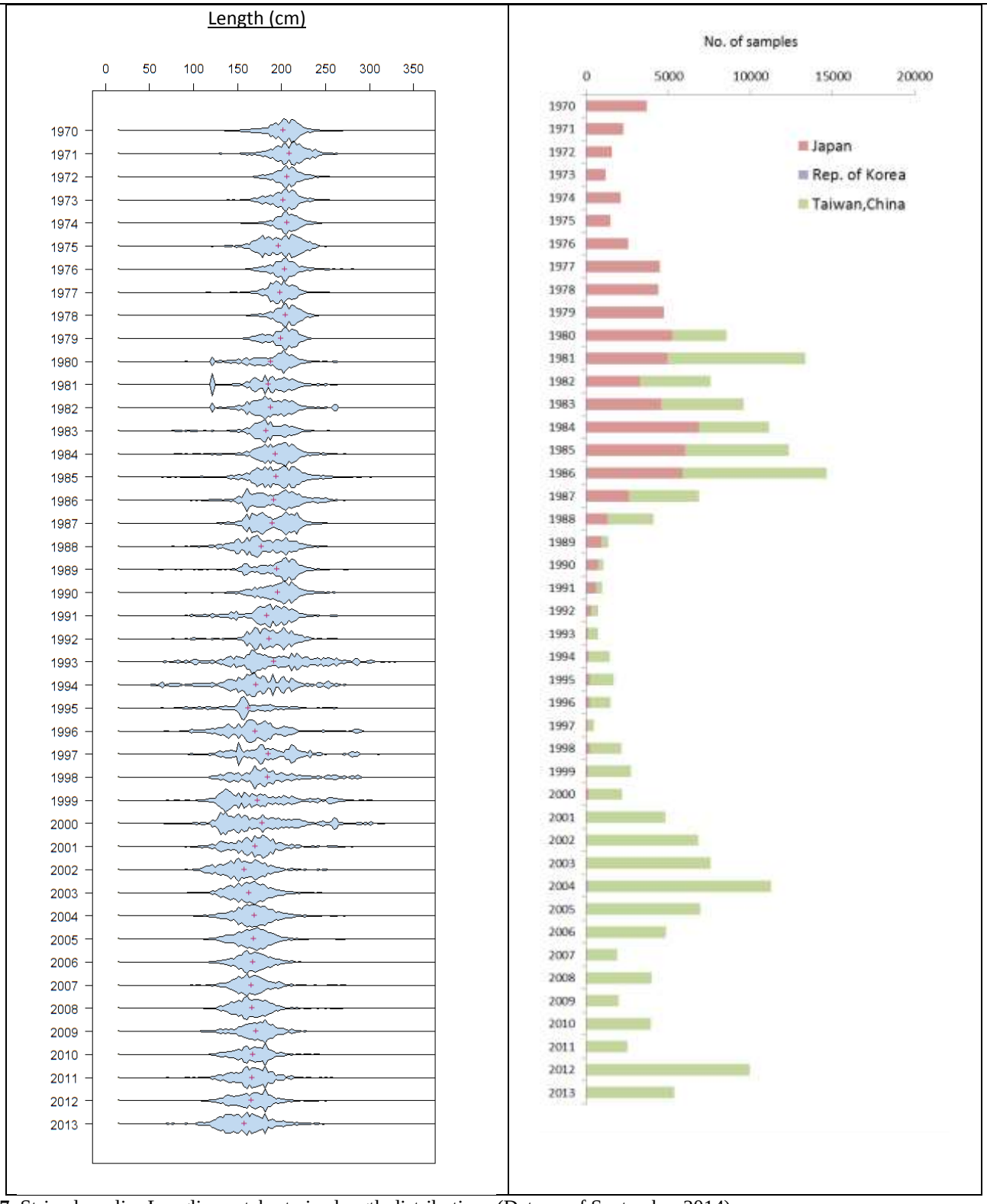

Fig. 7. Striped marlin: Longline catch-at-size length distributions (Data as of September 2014)

***Striped 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.

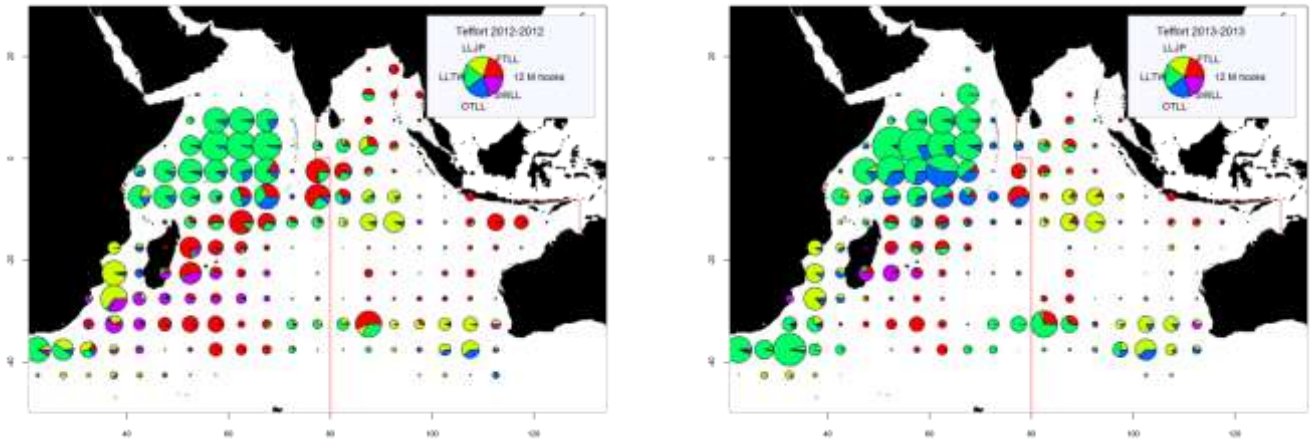

Fig. 8. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise):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

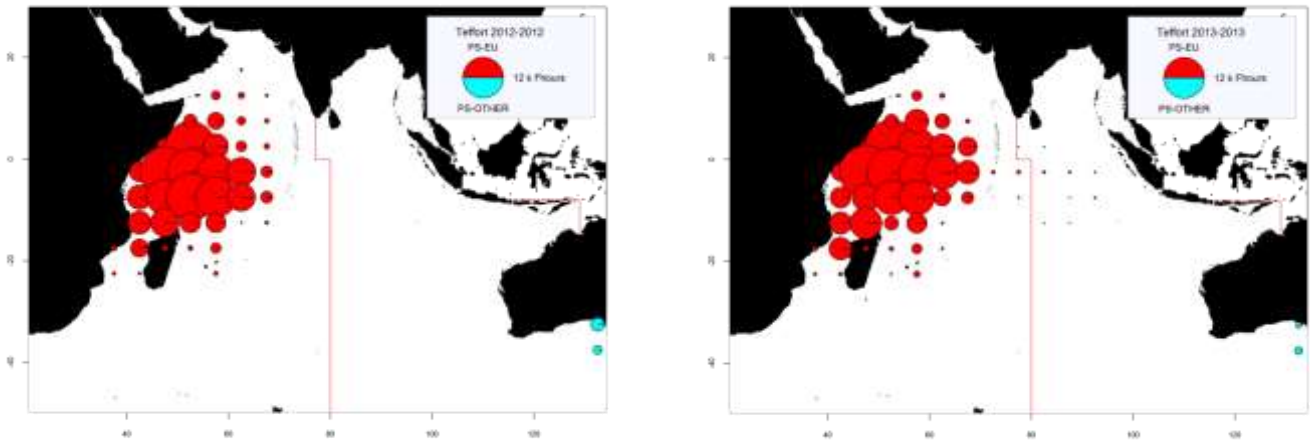

Fig. 9. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles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

***Striped marlin:** Catch–per–unit–effort (CPUE) trends*

The sharp decline between 1952 and 1960 in the Japanese striped marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1960 until 2011 is more likely to represent actual declines in stock abundance (Fig. 10).

The catches and CPUE series estimated for striped 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.

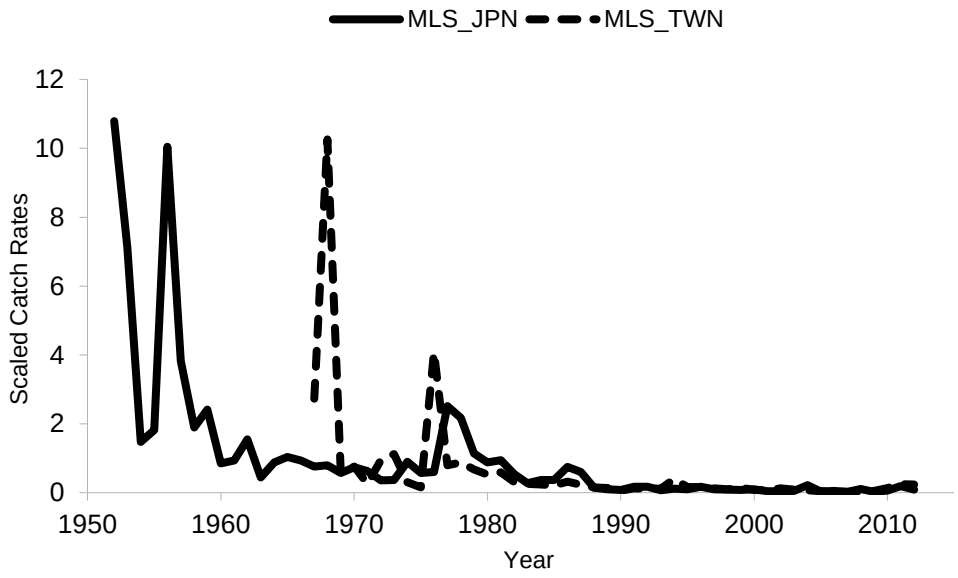

Fig. 10. Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

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.

Of the striped marlin CPUE series available for assessment purposes, the separate Japan and Taiwan,China series were used in the stock assessment model for 2013 (Fig. 11).

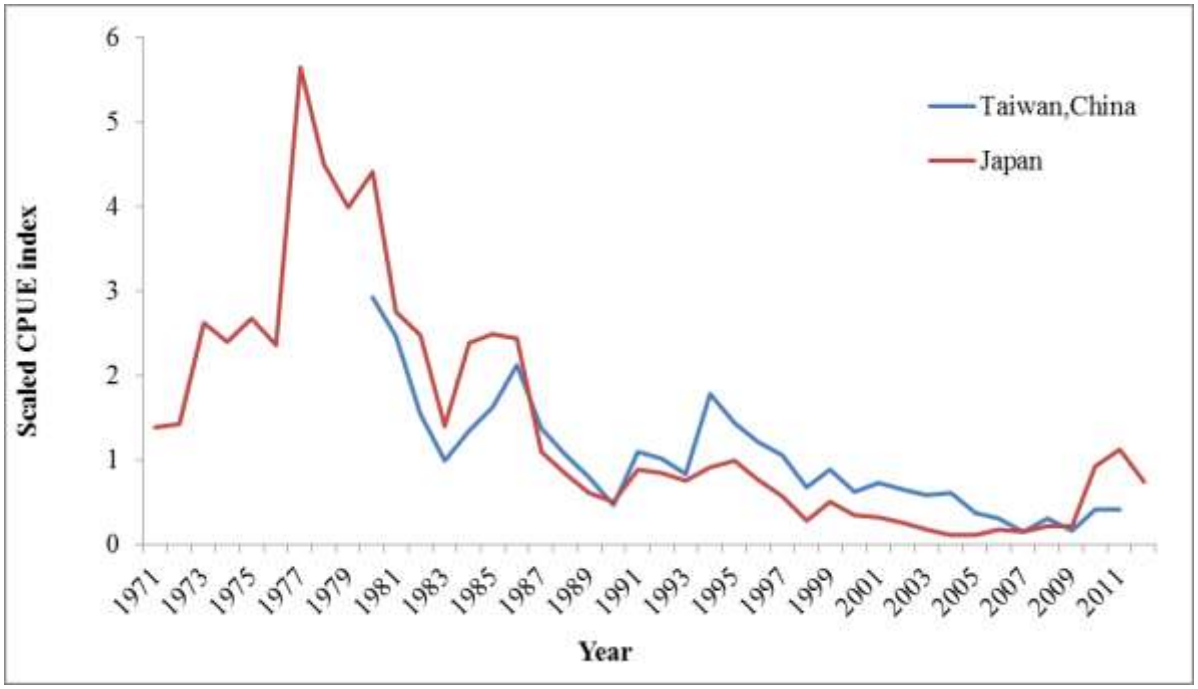

Fig. 11. Striped marlin: Comparison of the CPUE series for the longline fleets of Japan and Taiwan,China. Scaling was carried out using the average of the overlapped years.

STOCK ASSESSMENT

A range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Stock Reduction Analysis) were applied to the striped 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 CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicates the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. 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 has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B_{MSY} level and shows little signs of rebuilding despite the declining effort trend. Thus, on the weight-of-evidence available to the WPB, the stock is determined to be **overfished** and **subject to overfishing** (Table 1, 5; Fig. 1).

TABLE 5. Striped marlin (*Tetrapturus audax*) stock status summary

Management Quantity	Aggregate Indian Ocean
2013 catch estimate	4,429 t
Mean catch from 2009–2013	3,667 t
MSY (80% CI)	4,408 (3,539–4,578)
Data period used in assessment	1950–2011
F_{2011}/F_{MSY} (80% CI)	1.28 (0.95–1.92)
B_{2011}/B_{MSY} (80% CI)	0.416 (0.2–0.42)
SB_{2011}/SB_{MSY}	–
B_{2011}/B_{1950} (80% CI)	0.18 (n.a.)
SB_{2011}/SB_{1950}	–
$B_{2011}/B_{1950, F=0}$	–
$SB_{2011}/SB_{1950, F=0}$	–

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