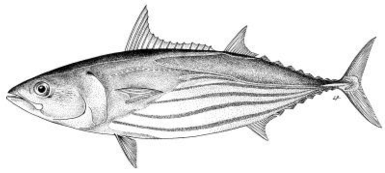
DRAFT EXECUTIVE SUMMARY: SKIPJACK TUNA

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



Status of the Indian Ocean skipjack tuna (SKJ: *Katsuwonus pelamis*) resource

TABLE 1. Skipjack tuna: Status of skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean.

Area[1]	Indicators		2015 stock status determination
Indian Ocean	Catch 2014: Average catch 2010–2014:	432,467 t 402,229 t	
	MSY (1,000 t) (80% CI): F_{MSY} (80% CI): SB_{MSY} (1,000 t) (80% CI): C_{2013}/C_{MSY} (80% CI): SB_{2013}/SB_{MSY} (80% CI): SB_{2013}/SB_0 (80% CI):	684 (550–849) 0.65 (0.51–0.79) 875 (708–1,075) 0.62 (0.49–0.75) 1.59 (1.13–2.14) 0.58 (0.53–0.62)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

Colour key	Stock overfished ($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
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 stock assessment was carried out for skipjack tuna in 2015, thus, stock status is determined on the basis of the 2014 assessment and other indicators presented in 2015. The 2014 stock assessment model results did not differ substantively from the previous (2012 and 2011) assessments; however, the final overall estimates of stock status differ somewhat due to the revision of the input parameters and updated standardised CPUE indices. All the runs carried out in 2014 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. $SB_{2013}/SB_{MSY} > 1$) and in all runs that the current proxy for fishing mortality is below the MSY-based reference level (i.e. $C_{current}/C_{MSY} < 1$) (Table 1 and Fig. 1). The median value of MSY from the model runs investigated was 684,000 t with a range between 550,000 and 849,000 t. Current spawning stock biomass was estimated to be 57% (Table 1) of the unfished levels. Catches in 2014 (≈432,500 t) remain lower than the estimated MSY values from the 2014 stock assessments (Table 1). The average catch over the previous five years (2010–14; ≈402,000 t) also remains below the estimated MSY. Thus, on the weight-of-evidence available in 2014, the skipjack tuna stock is determined to be **not overfished** and is **not subject to overfishing** (Table 1).

Outlook. The recent declines in catch/sets on FADs (in parallel to the increased number of FADs deployed by the purse seine fleet) as well as the large decrease on free school skipjack tuna are thought to be of some concern as the WPTT does not fully understand the cause of those declines. There remains considerable uncertainty in the assessment, and the range of runs analysed illustrate a range of stock status to be between 0.73–4.31 of SB_{2013}/SB_{MSY} based on all runs examined. The Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions. Based on the SS3 assessment conducted in 2013, there is a low risk of exceeding MSY-based reference points by 2016 and 2023 if catches are maintained at the current levels of ≈425,000 t (< 1 % risk that $B_{2016} < B_{MSY}$ and 1 % risk that C_{2023}>MSY as proxy of $F > F_{MSY}$).

Management advice. If catch remains below the estimated MSY levels, then immediate management measures are not required. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.

The following key points should also be noted:

- Maximum Sustainable Yield (MSY): The median MSY value from the model runs investigated was 684,000 t with a range between ≈550,000 and ≈849,000 t (Table 1); However, MSY reference levels from these models were not well determined. Historically, catches in excess of 600,000 t were estimated to coincide with the time that the stock fell below 40% of the unfished level, which maybe a more robust proxy for MSY in this case. Considering the average catch level from 2010–2014 was ≈402,000 t, the stock appears to be in no immediate threat of breaching target and limit reference points. Current stock size is above $SB_{40\%}$ and predicted to increase on the short term. Catches at the level of ≈432,500 t have a low probability of reducing the stock below $SB_{40\%}$ in the short term (3–5 years) and medium term (10 years). However, taking into account the uncertainty related to current skipjack assessment as well as other indicators such the low catch rates of FADs and increased effort, it is recommended that annual catches of skipjack tuna should not exceed the lower value of MSY of the range (≈550,000 t) in order to ensure that stock biomass levels could sustain catches at the MSY level in the long term.

- The Kobe strategy matrix (Table 2) illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- **Interim reference points:** Noting that the Commission in 2015 agreed to Resolution 15/10 *on target and limit reference points and a decision framework*, the following should be noted:
    - **Fishing mortality**: Current fishing mortality is considered to be below the interim target reference point of F_{MSY}, and therefore below the interim limit reference point of $1.5*F_{MSY}$ (Fig. 1). Based on the current assessment there is a very low probability that the interim limit reference points of $1.5*F_{MSY}$ at the current catch levels will be exceeded in 3 or 10 years.
    - **Biomass**: Current spawning biomass is considered to be above the interim target reference point of SB_{MSY}, and therefore above the interim limit reference point of $0.4*SB_{MSY}$ (Fig. 1). Based on the current assessment, there is a low probability that the spawning stock biomass, at the current catch levels, will be below the interim limit reference point of $0.4*SB_{MSY}$ in 3 or 10 years.
- **Main fishing gear** (Average catch 2011–14): Purse seine ≈30.2% (FAD associated school ≈28.7% and free swimming school ≈1.5%); Gillnet ≈26.1%; Pole-and-line ≈20.1%; Other ≈23.6%.
- **Main fleets** (Average catch 2011–14): Indonesia ≈22%; European Union ≈21% (EU,Spain: ≈15%; EU,France: ≈6%); Sri Lanka ≈16%; ≈Maldives 16%; ≈I.R. Iran 7%; Seychelles ≈7%; India ≈7%.

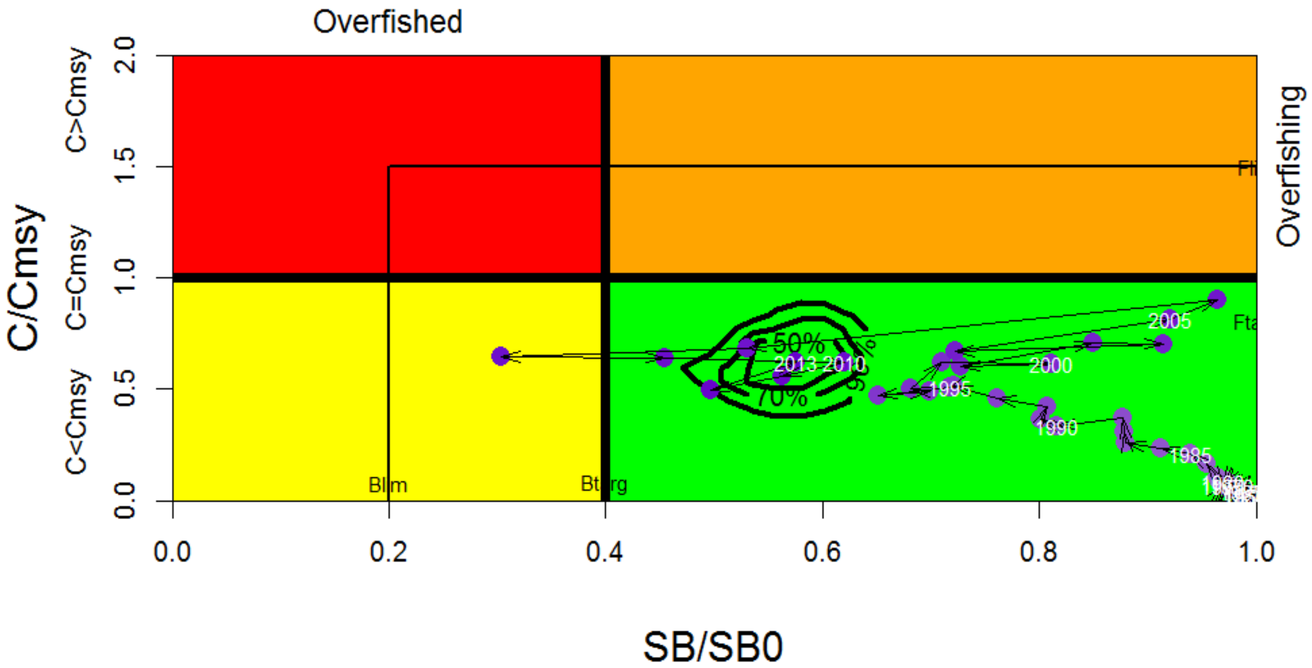


Fig. 1. Skipjack tuna: SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 70 and 90 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB/SB0 ratio and F proxy ratio for each year 1950–2013 estimated as C/C_{MSY}. Interim target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points, are based on 0.4 (0.2) B_0 and $C//C_{MSY}$=1 (1.5) as suggested by WPTT.

TABLE 2. Skipjack tuna: SS3 aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based target (top) and limit (bottom) reference points for nine constant catch projections (average catch level from 2013 (424,580 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 2013) and probability (%) of violating MSY-based target reference points ($SB_{targ} = SB_{MSY}$; $F_{targ} = F_{MSY}$)**								
	60% (254,748 t)	**70%** (297,206 t)	**80%** (339,664 t)	**90%** (382,122 t)	**100%** (424,580 t)	**110%** (467,038 t)	**120%** (509,496 t)	**130%** (551,954 t)	**140%** (594,412 t)
$SB_{2016} < SB_{MSY}$	0	n.a.	1	n.a.	1	n.a.	1	n.a.	9
$F_{2016} > F_{MSY}$	0	n.a.	1	n.a.	1	n.a.	5	n.a.	12
$SB_{2023} < SB_{MSY}$	0	n.a.	1	n.a.	1	n.a.	6	n.a.	25
$F_{2023} > F_{MSY}$	0	n.a.	1	n.a.	1	n.a.	5	n.a.	20

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from 2013) and probability (%) of violating MSY-based limit reference points ($SB_{lim} = 0.4\ SB_{MSY}$; $F_{Lim} = 1.4\ F_{MSY}$)**								
	60% (254,748 t)	**70%** (297,206 t)	**80%** (339,664 t)	**90%** (382,122 t)	**100%** (424,580 t)	**110%** (467,038 t)	**120%** (509,496 t)	**130%** (551,954 t)	**140%** (594,412 t)
$SB_{2016} < SB_{Lim}$	0	n.a.	0	n.a.	0	n.a.	0	n.a.	0
$F_{2016} > F_{Lim}$	1	n.a.	1	n.a.	1	n.a.	1	n.a.	1
$SB_{2023} < SB_{Lim}$	0	n.a.	0	n.a.	0	n.a.	0	n.a.	0
$F_{2023} > F_{Lim}$	0	n.a.	1	n.a.	1	n.a.	1	n.a.	6

APPENDIX I

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- 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 15/06 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna and a recommendation for non-targeted species caught by purse seine vessels in the IOTC area of competence*
- Resolution 15/10 *On target and limit reference points and a decision framework*
- Resolution 15/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- Resolution 14/02 *for the conservation and management of tropical tunas stocks in the IOTC area of competence*
- 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 10/08 *concerning a record of active vessels fishing for tunas and swordfish in the IOTC area*

FISHERIES INDICATORS

Skipjack tuna – General

Skipjack tuna (*Katsuwonus pelamis*) life history characteristics, including a low size and age at maturity, short life and high productivity/fecundity, make it resilient and not easily prone to overfishing. **Table 3** outlines some of the key life history traits of skipjack tuna.

TABLE 3. Skipjack tuna: Biology of Indian Ocean skipjack tuna (*Katsuwonus pelamis*).

Parameter	Description
Range and stock structure	Cosmopolitan species found in the tropical and subtropical waters of the Indian, Pacific and Atlantic Oceans. It generally forms large schools, often in association with other tunas of similar size such as juveniles of yellowfin tuna and bigeye tuna. The tag recoveries from the RTTP-IO provide evidence of rapid, large scale movements of skipjack tuna in the Indian Ocean, thus supporting the current assumption of a single stock for the Indian Ocean. Skipjack recoveries indicate that the species is highly mobile, and covers large distances. The average distance between skipjack tagging and recovery positions is estimated at 640 nautical miles. Skipjack tuna in the Indian Ocean are considered a single stock for assessment purposes.
Longevity	7 years
Maturity (50%)	Age: females and males <2 years. Size: females and males 41–43 cm. Unlike in *Thunnus* species, sex ratio does not appear to vary with size. Most of skipjack tuna taken by fisheries in the Indian Ocean have already reproduced.
Spawning season	High fecundity. Spawns opportunistically throughout the year in the whole inter-equatorial Indian Ocean (north of 20°S, with surface temperature greater than 24°C) when conditions are favourable.
Size (length and weight)	Maximum length: 110 cm FL; Maximum weight: 35.5 kg. The average weight of skipjack tuna caught in the Indian Ocean is around 3.0 kg for purse seine, 2.8 kg for the Maldivian baitboats and 4–5 kg for the gillnet. For all fisheries combined, it fluctuates between 3.0–3.5 kg; this is larger than in the Atlantic, but smaller than in the Pacific. It was noted that the mean weight for purse seine catch exhibited a strong decrease since 2006 (3.1 kg) until 2009 (2.4 kg), for both free (3.8 kg to 2.4 kg) and log schools (3.0 kg to 2.4 kg).

Sources: Collette & Nauen 1983, Froese & Pauly 2009, Grande et al. 2010, Dortel et al. 2012, Eveson et al. 2012
NOAA http://www.nmfs.noaa.gov/fishwatch/species/atl_skipjack.htm 14/12/2011

Skipjack tuna: Fisheries and main catch trends

- Main fishing gear (2011–14): skipjack tuna are mostly caught by industrial purse seiners (≈30%), gillnet (≈25%) and pole-and-line (≈20%) (**Table 4; Fig. 2**).
- Main fleets (and primary gear associated with catches): percentage of total catches (2011–14):

  Almost 70% of catches are accounted for by four fleets (**Fig. 4**):

- Indonesia (coastal purse seine, troll line, gillnet): 22%; Sri Lanka (gillnet-longline): 16%; Maldives (pole-and-line): 16%; EU-Spain (purse seine): 15%.

- Main fishing areas:

  Primary: Western Indian Ocean (West R2), in waters off Somalia (**Table 5; Fig. 3**)

  - In recent years catches of skipjack in this area have dropped considerably as fishing effort has been displaced or reduced due to piracy – particularly catches from industrial purse seiners and fleets using driftnets flagged under I.R. Iran and Pakistan.

  Secondary: Maldives (Area R2b)

- Since the mid-2000s decreases in skipjack catches have also been reported by the Maldivian pole-and-line fishery – although the reasons remain unclear.

- Retained catch trends:

  Purse seine fisheries:

  The increase in catches of skipjack tuna in the last 30 years have largely been driven by the arrival of purse seiners in the early 1980s, and the development of the fishery in association with Fish Aggregating Devices (FADs) since the 1980s. In recent years, well over 90% of the skipjack tuna caught by purse seine vessels are taken from around FADs.

  Annual catches peaked at over 600,000 t in 2006. The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and also increases in the number of FADs (and technology associated with them) used in the fishery.

  Since 2006 catches have declined to around 340,000 t in 2012 – the lowest catches recorded since 1998 – although in 2013 and 2014 catches increased to over 420,000 t.

  Pole-and-line fisheries:

  The Maldivian pole-and-line fishery effectively increased its fishing effort with the mechanisation of its fleet since 1974, including an increase in boat size and power, as well as the use of anchored FADs since 1981. Skipjack tuna represents around 80% of the total catch of Maldives, where catches of skipjack tuna increased regularly between 1980 and 2006 – from around 20,000 t to over 130,000 t.

  Catches of skipjack tuna reported by Maldives pole-and-line have since declined in recent years to as low as 55,000t - less than half the catches taken in 2006 - although the reasons for the decline remain unclear. One explanation may be improvements in the data collection with the introduction of logbooks and more accurate, albeit lower, estimates of skipjack landed; while the introduction of handlines and a shift in targeting from skipjack tuna to yellowfin tuna may also be a contributing factor.

  Gillnet fisheries:

  Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean, including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of I.R. Iran and Pakistan, and gillnet fisheries of Indonesia. In recent years gillnet catches have represented as much as 20% to 30% of the total catches of skipjack tuna in the Indian Ocean. Although it is known that vessels from I.R. Iran and Sri Lanka have been using gillnets on the high seas in recent years, reaching as far as the Mozambique Channel, the activities of these fleets are poorly understood, as no time-area catch-and-effort series have been made available for those fleets to date.

- Discard levels: Low, although estimates of discards are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU countries for the period 2003–07.

***Changes to the catch series*:** no major changes to the catch series since the WPTT meeting in 2014.

Table 4. Skipjack tuna: Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2005–2014), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery. Data as of November 2015.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
BB	10,007	15,148	24,684	41,705	76,903	109,571	139,627	147,902	107,383	99,104	75,761	83,506	69,404	68,817	92,949	87,323
FS	0	0	32	15,232	29,372	25,898	45,110	36,083	25,950	16,211	10,366	8,965	9,138	3,034	5,760	6,317
LS	0	0	134	34,476	125,447	163,576	166,074	210,369	119,199	128,519	148,202	143,905	122,918	80,939	119,854	131,439
OT	5,008	11,719	22,022	38,374	87,948	177,207	204,866	221,806	213,089	194,591	203,470	187,616	181,744	185,922	214,208	207,388
Total	**15,015**	**26,867**	**46,872**	**129,788**	**319,670**	**476,251**	**555,678**	**616,160**	**465,621**	**438,424**	**437,800**	**423,993**	**383,204**	**338,713**	**432,770**	**432,467**

Gears: Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (**OT**) (e.g., troll line, handline, beach seine, Danish seine, liftnet).

Table 5. Skipjack tuna: Best scientific estimates of the catches of skipjack tuna (*Katsuwonus pelamis*) by area [as used for the assessment] by decade (1950–2009) and year (2005–2014), in tonnes. Catches by decade represent the average annual catch. Data as of November 2015.

	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
R1	4,524	9,951	19,284	34,584	80,744	118,318	114,265	109,014	137,692	139,937	151,486	154,434	153,882	149,769	167,635	149,019
R2	1,492	4,117	7,914	59,420	170,502	255,757	309,352	368,688	231,068	211,415	220,124	195,837	171,650	135,552	190,713	214,950
R2b	9,000	12,800	19,674	35,784	68,424	102,176	132,060	138,458	96,861	87,072	66,189	73,721	57,672	53,392	74,422	68,498
Total	**15,015**	**26,867**	**46,872**	**129,788**	**319,670**	**476,251**	**555,678**	**616,160**	**465,621**	**438,424**	**437,800**	**423,993**	**383,204**	**338,713**	**432,770**	**432,467**

Areas: East Indian Ocean (**R1**); West Indian Ocean, (**R2**); Maldives baitboat (R2b).

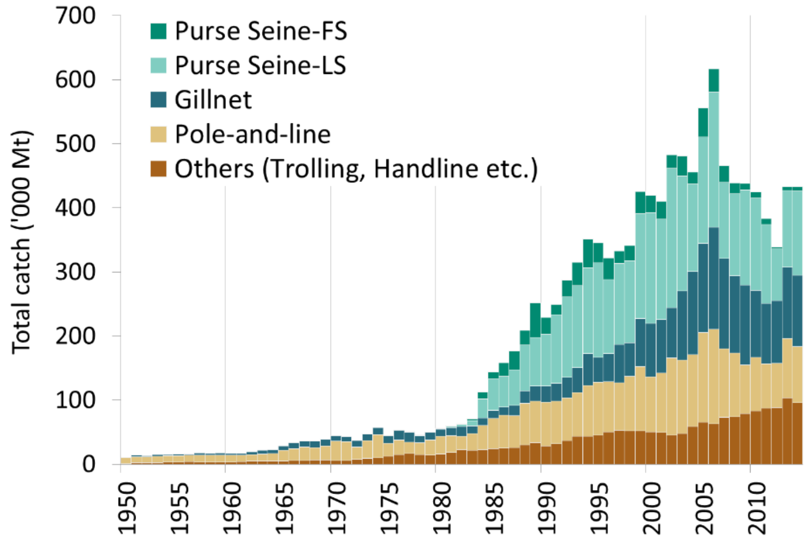


Fig. 2. Annual catches of skipjack tuna by gear (1950–2014). Data as of November 2015.

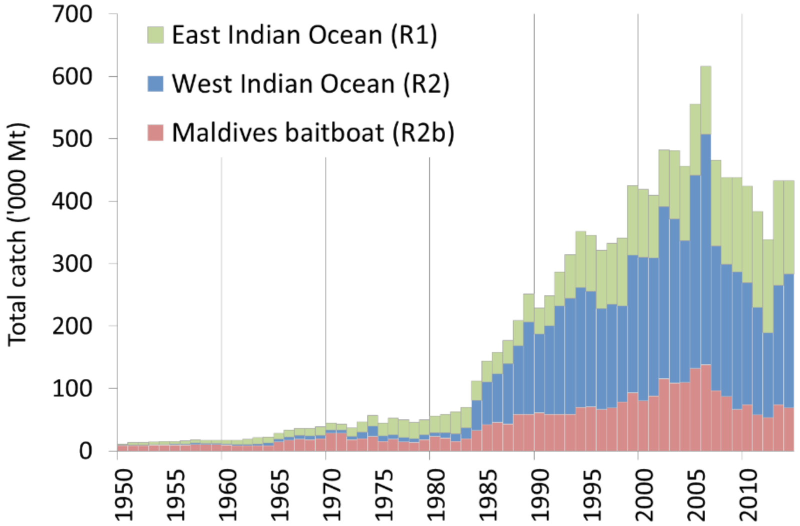


Fig. 3. Skipjack tuna: Catches of skipjack tuna by area by year estimated for the WPTT (1950–2014). **Areas**: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**). Data as of November 2015.

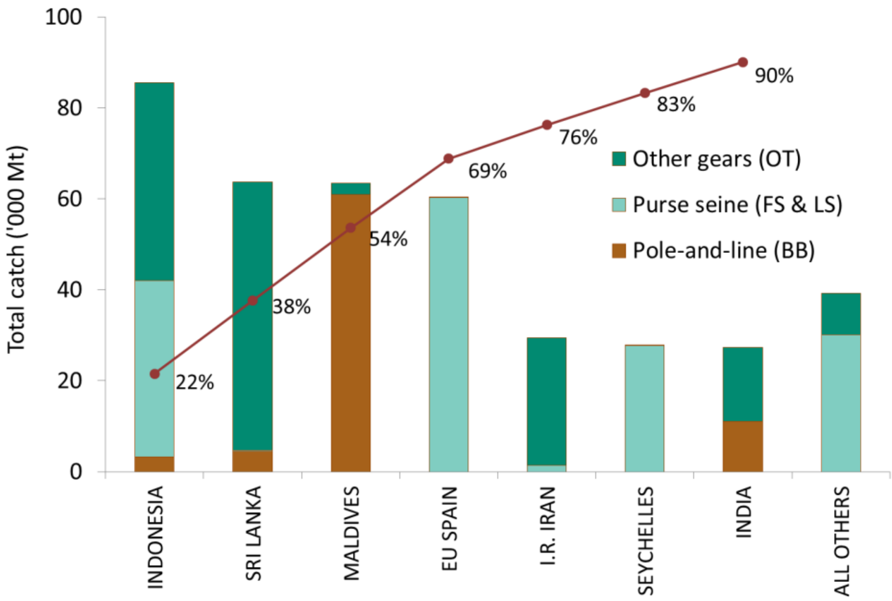


Fig. 4. Skipjack tuna: average catches in the Indian Ocean over the period 2011–14, by country. Countries are ordered from left to right, according to the importance of catches of skipjack reported. The red line indicates the (cumulative) proportion of catches of skipjack for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of November 2015.

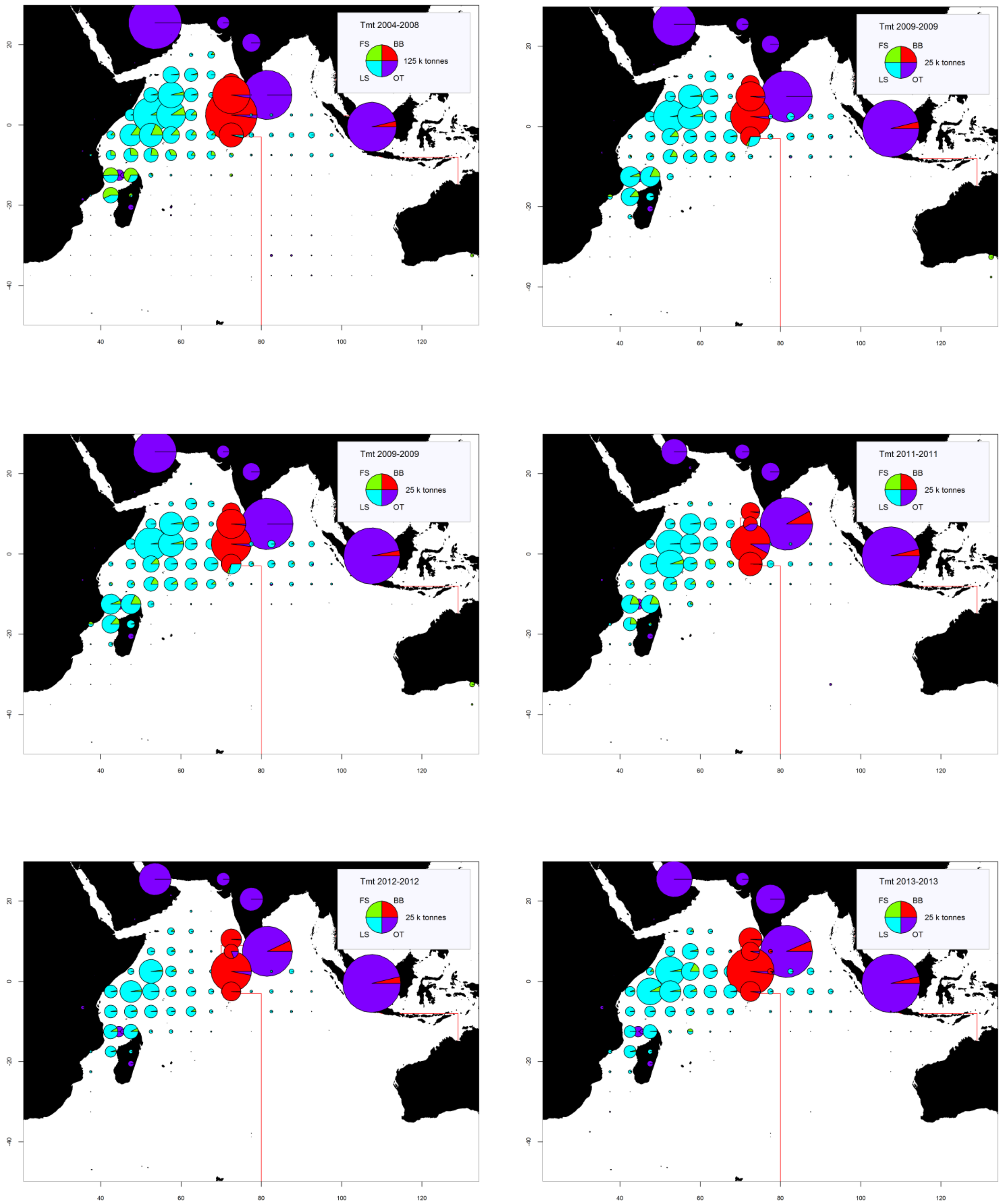


Fig. 5(a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries. Catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded within the area of the countries concerned, in particular driftnets from I.R. Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

Skipjack tuna: data availability and related data quality issues

Retained catches

- Retained catches are considered to be generally well known for the major industrial fleets, with the proportion of catches estimated, or adjusted, by the IOTC Secretariat relatively low (**Fig. 6a**). Catches are less certain for many artisanal fisheries for a number of reasons, including:
    - catches not fully reported by species;
    - uncertainty in the catches from some significant fleets including the Sri Lankan coastal fisheries, and coastal fisheries of Comoros and Madagascar.

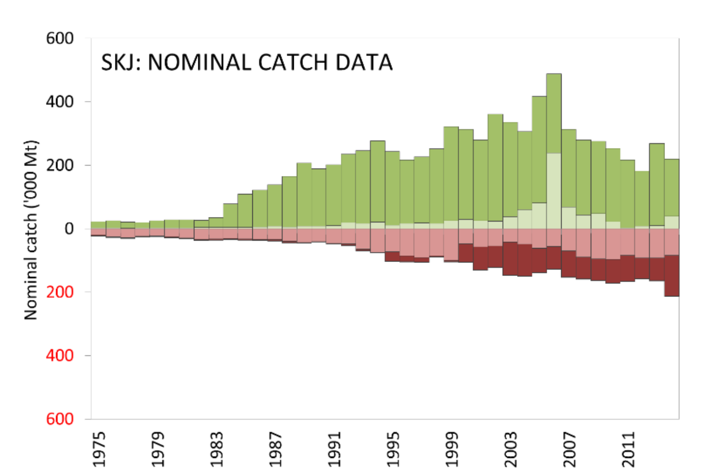
Catch-per-unit-effort (CPUE) trends

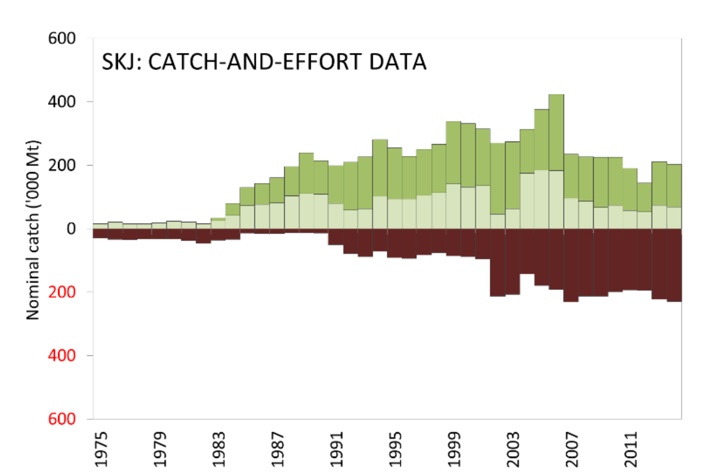
- Catch-and-effort series are available for the various industrial and artisanal fisheries (e.g., Maldives pole-and-line fishery, EU-France purse seine).

  However for a number of other important fisheries catch-and-effort are either not available (**Fig. 6b**), or are considered to be of poor quality, notably:
    - ➢ insufficient data available for the gillnet fisheries of I.R. Iran and Pakistan;
    - ➢ poor quality effort data for the gillnet-longline fishery of Sri Lanka. In previous years catch-and-effort has not been reported fully by area, or disaggregated by gear (i.e., gillnet-longline) according to the IOTC reporting standards – however in 2014 detailed information by EEZ area (for coastal fisheries) and grid area (for offshore fisheries) and gear was submitted to the IOTC Secretariat for the first time;
    - ➢ no catch-and-effort data are available for important coastal fisheries using hand and/or troll lines, in particular Indonesia, India and Madagascar.

Fish size or age trends (e.g., by length, weight, sex and/or maturity)

- Average fish weight: trends in average weights cannot be assessed before the mid-1980s and are also incomplete for most artisanal fisheries, namely hand lines, troll lines and many gillnet fisheries (e.g., Indonesia) (**Fig. 6c, Fig. 7**).
- Catch-at-Size (Age) table: are available but the estimates are uncertain for some years and fisheries due to:
    - ➢ a general lack of size data before the mid-1980s, for all fleets/fisheries;
    - ➢ lack of size data available for some artisanal fisheries, notably most hand lines and troll line fisheries (e.g., Madagascar, Comoros) and many gillnet fisheries (e.g., Indonesia, Sri Lanka) – although in 2014 Sri Lanka reported size information for gillnets for the first time since the early-1990s.
- Catch at length trends: Purse seine free swimming school (**Fig 8a**) and purse seine FAD associated school (**Fig 8b**) length frequency distributions and total number of specimens sampled for lengths (raised to total catch).





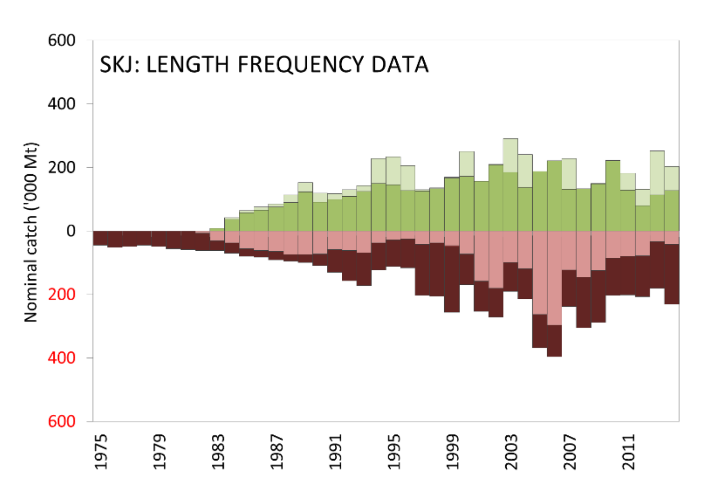


Fig. 6a-c. Skipjack tuna: data reporting coverage (1975–2014).

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 November 2015.

IOTC Data reporting score:

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

*E.g., 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
Fully available according to the minimum reporting standards	0	0
Partially available according to the minimum reporting standards*	2	2
Low coverage (less than 30% of total catch covered through logbooks)	2	
Not available at all	8	

* E.g., Catch-and-effort not fully disaggreaged by species, gear, area, or month.

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

* E.g., Size data not fully available by species, gear, gear, month, or recommended size interval.

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)

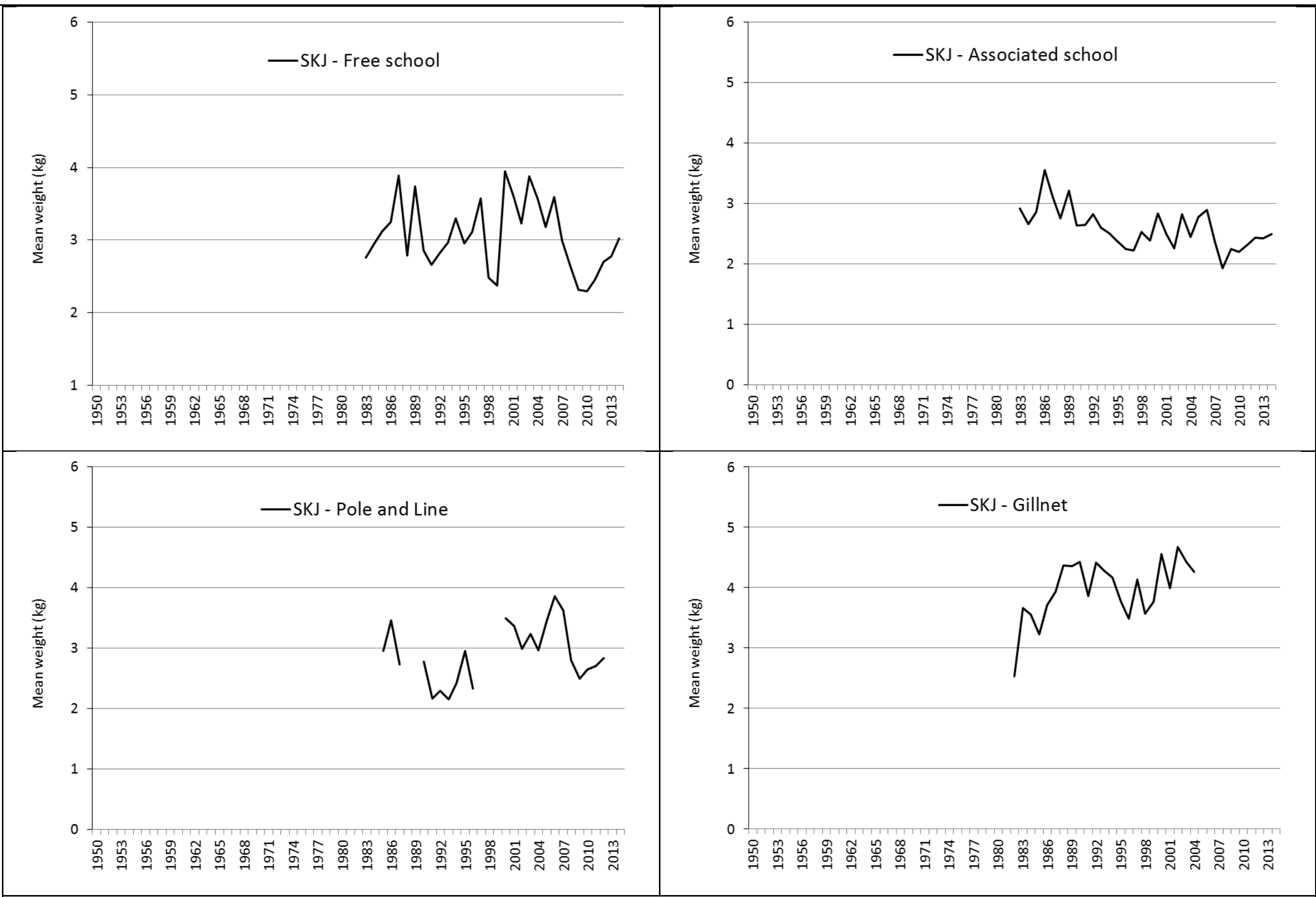


Fig. 7 Average weight of skipjack tuna (SKJ) taken by purse seine on free (top left) and associated (top right) schools, and pole-and-line from Maldives and India (bottom left), gillnets from Sri Lanka, I.R. Iran, and other countries (bottom right)

Fig. 8a Skipjack tuna (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch), by fleet (PS Associated school only).

Fig. 8b Skipjack tuna (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free school only).

Skipjack tuna: Tagging data

- A total of 101,212 skipjack (representing 50.2% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them, 77.4%, were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel and off the coast of Tanzania, between May 2005 and September 2007 (**Fig. 9**). The remaining were tagged during small-scale tagging projects, and by other institutions with the support of IOTC, around the Maldives, India, and in the south west and the eastern Indian Ocean.

- To date, 17,667 specimens (17.5% of releases for this species), have been recovered and reported to the IOTC Secretariat. Around 69.6% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 28.8% by the pole-and-line vessels mainly operating from the Maldives. The addition of the data from the past projects in the Maldives (in 1990s) added 14,506 tagged skipjack tuna to the databases, or which 1,960 were recovered mainly in the Maldives.

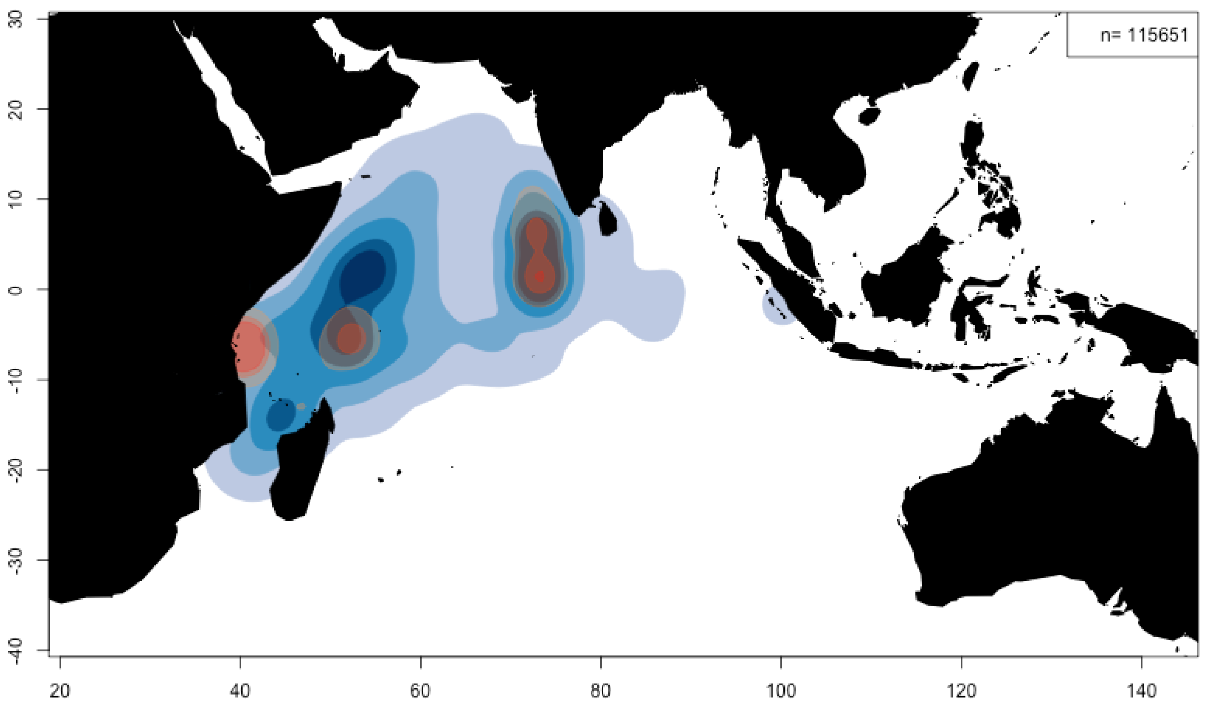


Fig. 9. Skipjack tuna: Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldives) tagging programmes during the 1990s. Data as of September 2012.

Skipjack tuna – Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2013 and 2014 are provided in **Fig. 10**, 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 2013 and 2014 are provided in **Fig. 11**. Total effort exerted by pole-and-line fleets in the Indian Ocean for the years 2013 and 2014 are provided in **Fig. 12**.

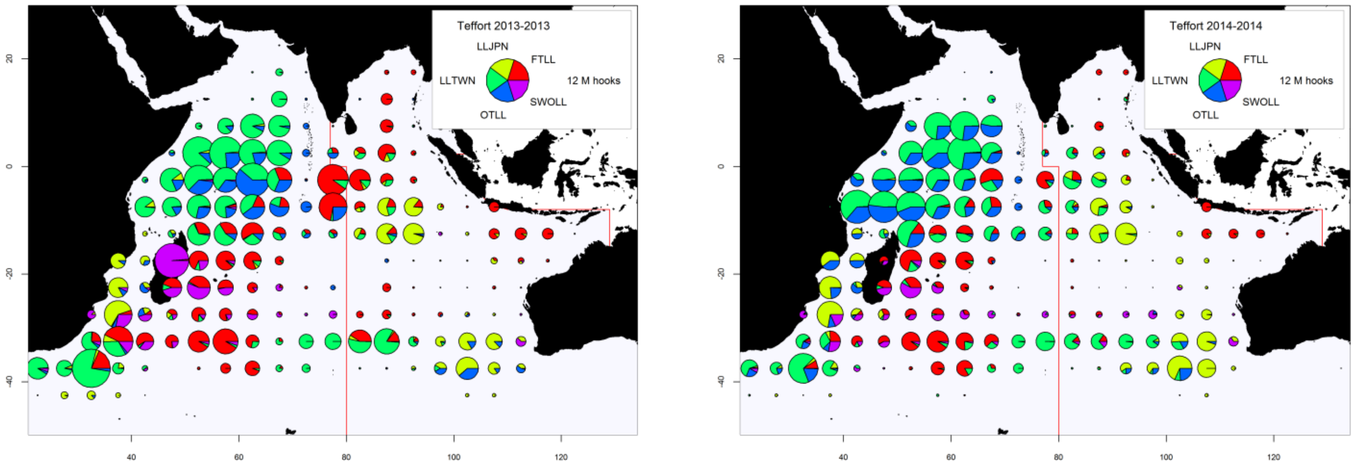


Fig. 10. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2013 (left) and 2014 (right) (Data as of October 2015). **LLJP** (light green): deep-freezing longliners from Japan LLTW (dark green): deep-freezing longliners from Taiwan,China; **SWLL** (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).

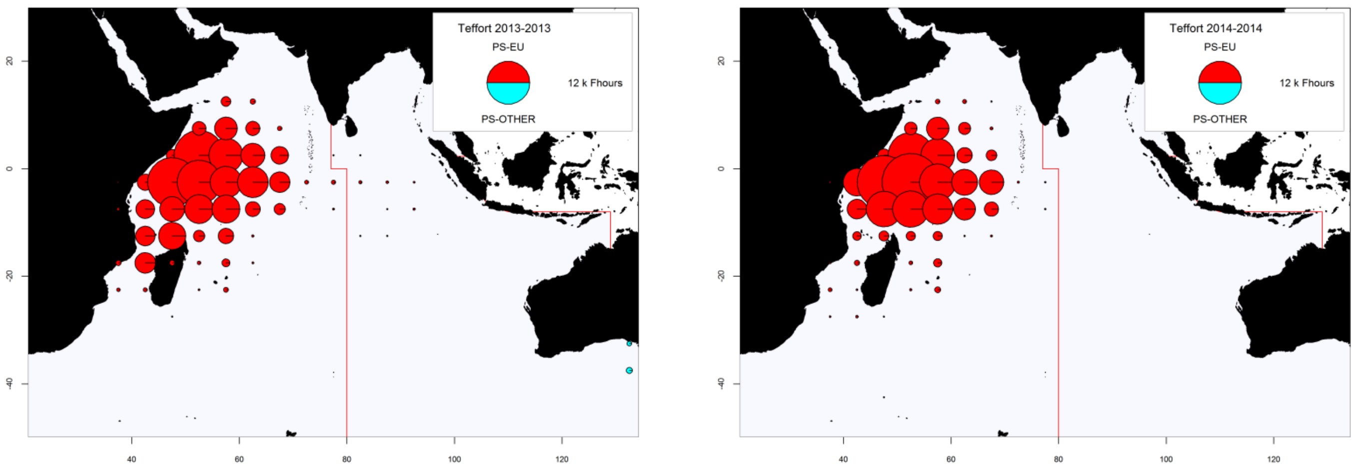


Fig. 11. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2013 (left) and 2014 (right) (Data as of October 2015). **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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).

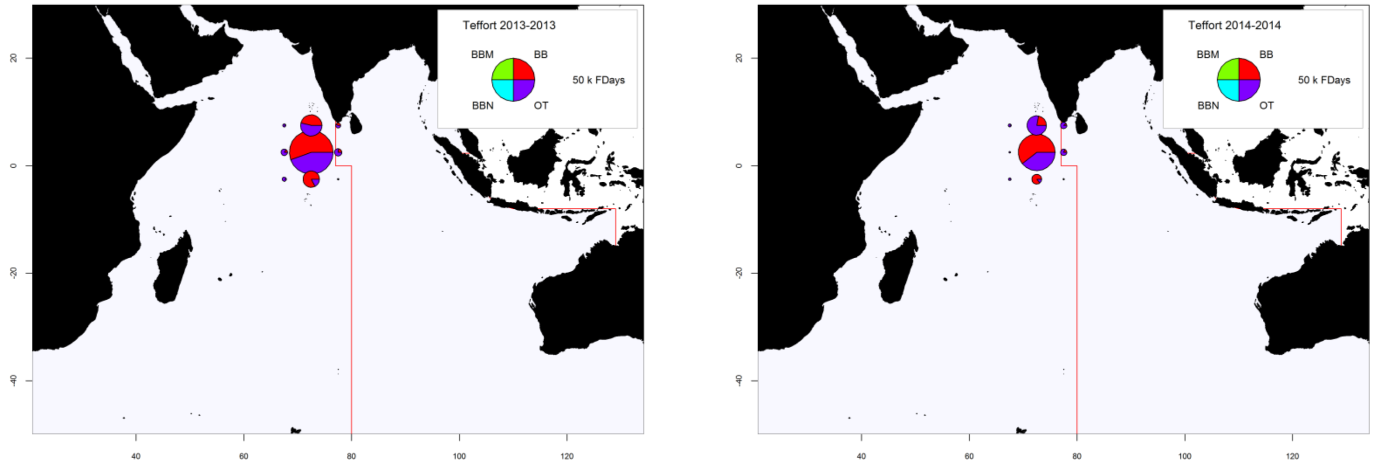


Fig. 12. Effort exerted by pole-and-line fleets in the Indian Ocean, in thousands (k) of trips (equivalent to fishing days), for the years 2013 (left) and 2014 (right) (data as of November 2015). **BBM** (green): Pole-and-line (mechanized baitboats); **BBN** (blue): Pole-and-line (non-mechanized baitboats); **BB** (red): Pole-and-line (all types of baitboat, especially mechanized); **OT** (purple): Pole-and-line and other gears unidentified (effort not available by gear).

Note that the above maps were derived using the available catch-and-effort data in the IOTC database, which is limited to the number of baitboat calls (trips) by atoll by month for Maldivian baitboats for the period concerned. Note that some trips may be fully devoted to handlining, trolling, or other activities (data by gear type are not available since 2002). No data are available for the pole-and-line fisheries of India (Lakshadweep) and Indonesia.

Skipjack tuna: Standardised catch–per–unit–effort (CPUE) trends

The CPUE series presented at the WPTT16 meeting in 2014 are detailed below:

EU,France purse seine CPUE from paper IOTC–2014–WPTT16–41 (**Fig. 13**) which examined skipjack tuna CPUE trends using alternative indices from the EU,France purse seine logbooks.

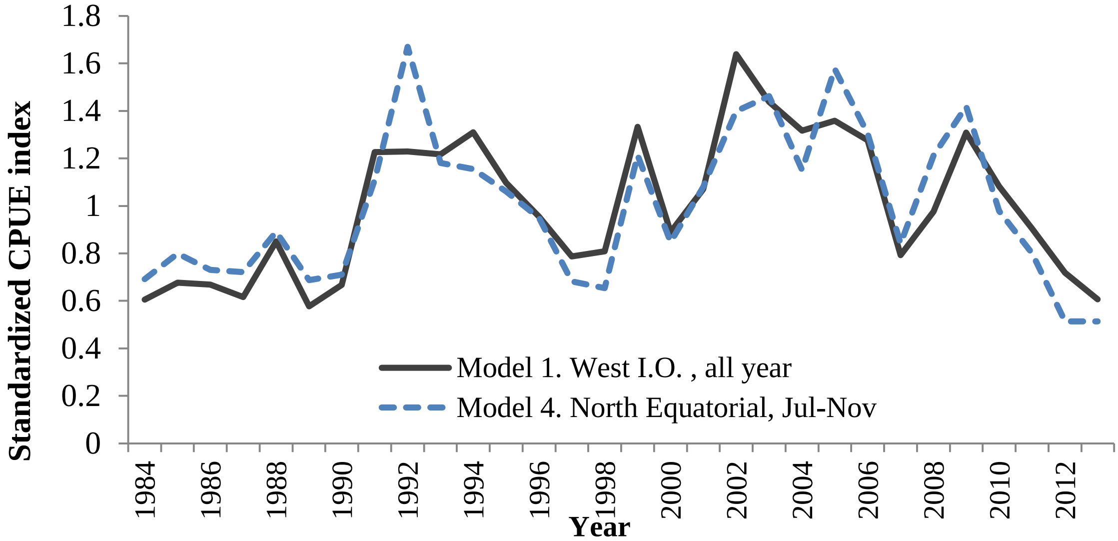


Fig. 13. Skipjack tuna: EU,France purse seine standardised CPUE series for skipjack tuna from 1984–13.

Maldives pole and line CPUE standardisation from paper IOTC–2014–WPTT16–42 (**Fig. 14**) which provided a standardised CPUE series for the Maldives skipjack pole and line fishery from 2004 to 2012, including the reconstruction of historic CPUE until 1985. The CPUE indices for the Maldives are likely to provide a representative index of abundance only for the Maldives area.

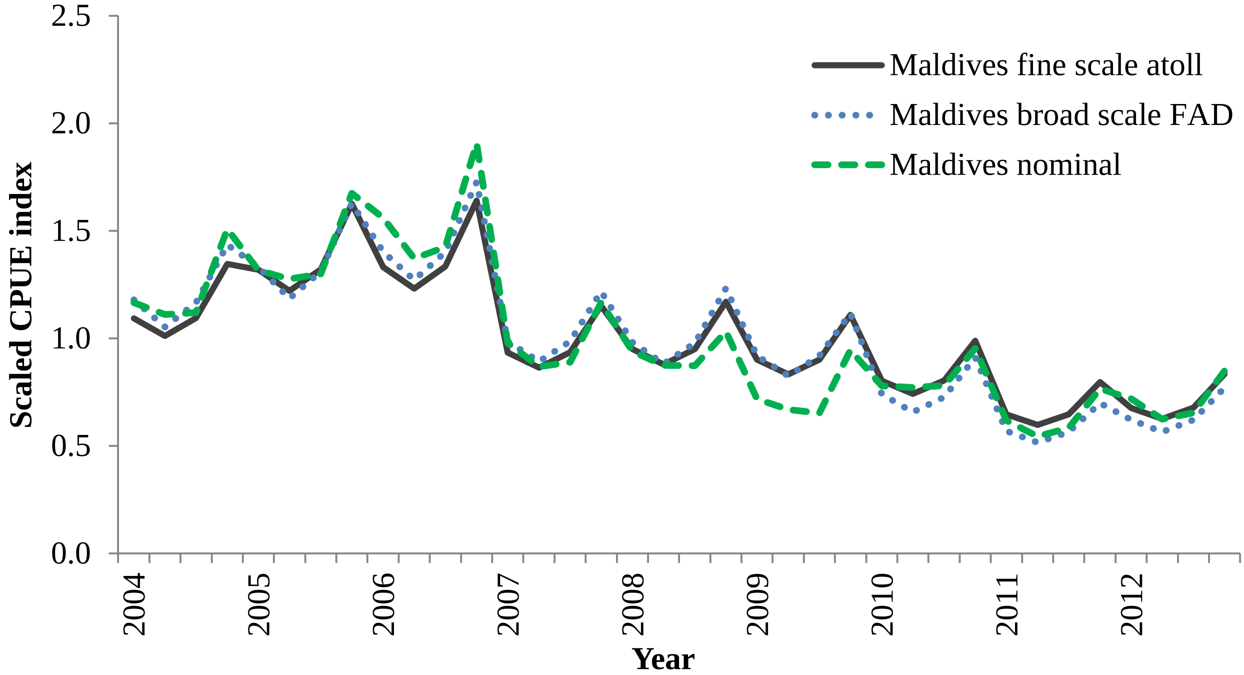


Fig. 14. Skipjack tuna: Maldives pole-and-line nominal and standardised CPUE series for skipjack tuna from 2004–13.

European Union and Associated purse seine CPUE from paper IOTC–2014–WPTT16–INF05 (**Fig. 15**) which examined skipjack tuna CPUE trends using alternative indices from the European Union and Associated purse seine logbooks.

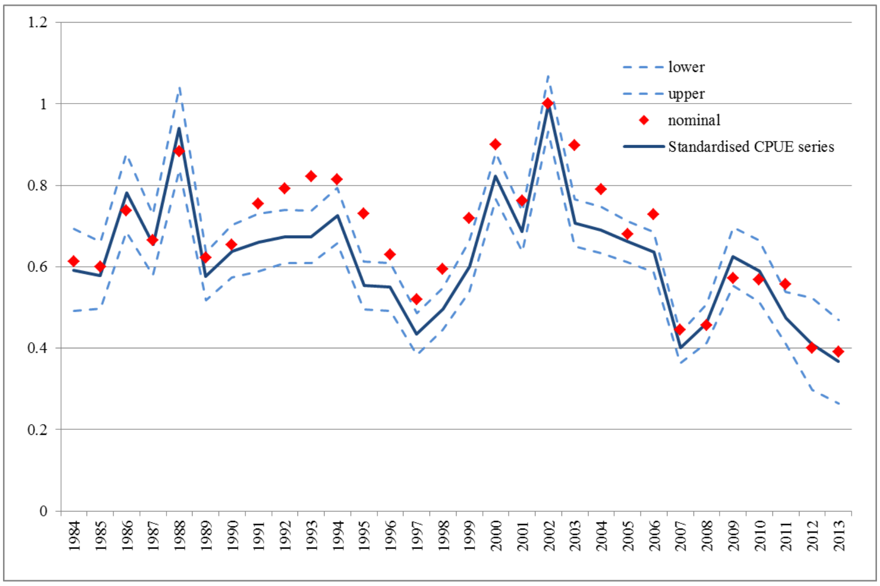


Fig. 15. Skipjack tuna: European Union and Associated purse seine nominal and standardised CPUE series for skipjack tuna from 1984–13.

Stock Assessment

A new stock assessment was carried out in 2014. The following was noted with respect to the SS3 modelling approach presented at the WPTT16 meeting:

- The runs with a high weighting of the tags showed bad fit to tagging data resulting in too many pessimistic results. Thus, an alternative grid that used the M (0.7, 0.8 and 0.9), and h(0.7,0.8 and 0.9), lower weighting of tags along with length composition and CPUE series was proposed and presented.
- The model had issues with estimating MSY related to reference points. C/C_{MSY} was used as in previous assessments (although it should be noted there are concerns with the estimation of this value as well), for the Kobe trajectories.

Some fishery indicators may indicate a lower MSY reference points than SS3, as follows:

- A decline of catches of large skipjack tuna in the last 10 years resulting in a decline of average weight observed for pole-and-line and purse seine fisheries;
- A decline of FAD catch per set by purse seine, during a period of major increase in FAD seeding;
- A decline in the purse seine CPUE of free swimming schools skipjack tuna in most areas;
- A lesser proportion of skipjack tuna relative to other species in the FAD sets;
- There were still issues on the spatial complexity and the use of tags that needed to be further understood. The present model based on a single area does not take into account the complex movement patterns that have been observed from the tagged skipjack tuna recoveries. A new model structure based on MFCL/SS3 could be investigated in future years;
- Mixing rates need to be evaluated under a new model structure with more areas to avoid discounting the first three quarters, as this leads to eliminating more than 70% of the recoveries;
- There were concrens raised about the pole-and-line and purse seine indices of abundance used in the assessment;
- Thus, a stock trajectory based on B_t/B_0 (with a reference at 40% as a proxy MSY as is used for other fisheries) along with a plot of the increasing fishing mortality, F as shown in **Fig. 16**, was agreed to be used.

Further analysis should be conducted or better indices of abundance should be developed.

- The grid based approach accounted for uncertainty in natural mortality, h, CPUE and growth, but for the future assessments models that estimate M within the model structure, and uses a wider range of precision in the variability of growth than the current estimate does (CV=0.2).

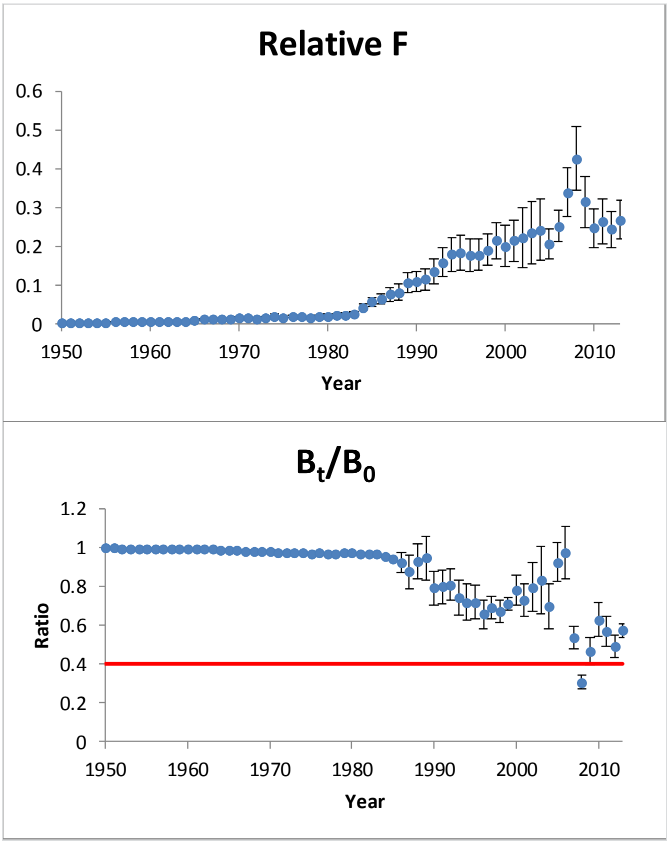


Fig. 16. Skipjack tuna: Top: relative fishing mortality over time. Bottom: B_{MSY}/B_0. Note, these figures were suggested as alternative figures for evaluation as F_{MSY} is not estimated well, reference point $0.4B_0$ was suggested as a target and $0.2B_0$ as a limit for skipjack tuna by the WPTT.

The advice on the status of skipjack tuna in 2014 (**Table 6**) is be derived from the grid agreed using an integrated statistical assessment method. 81 model formulations were investigated to ensure that various plausible sources of uncertainty were incorporated and represented in the final result. In general, the data did not seem to be sufficiently informative to justify the selection of any individual model, and the results are shown as a grid and the median value of the grid. The grid based approach covered the uncertainty in the assessment which is large.

Table 6. Skipjack tuna: Key management quantities from the SS3 assessment, for the Indian Ocean.

Management Quantity	**Indian Ocean**
2013 catch estimate	424,580
Mean catch from 2009–2013	401,100
MSY (1,000 t) (80% CI)	684 (550–849)
Data period used in assessment	1950–2013
F_{MSY} (80% CI)*	0.65 (0.51–0.79)
SB_{MSY} (1,000 t) (80% CI)	875 (708.5–1,075)
F_{2013}/F_{MSY} (80% CI)*	0.42 (0.25–0.62)
C_{2013}/C_{MSY} (80% CI)*	0.62 (0.49–0.75)
B_{2013}/B_{MSY} (80% CI)	n.a.
SB_{2013}/SB_{MSY} (80% CI)	1.59 (1.13–2.14)
B_{2013}/B_{1950} (80% CI)	n.a.
SB_{2013}/SB_{1950} (80% CI)	0.58 (0.53–0.62)
$B_{2013}/B_{1950,\ F=0}$ (80% CI)	n.a.
$SB_{2013}/SB_{1950,\ F=0}$ (80% CI)	n.a.

* Not estimable accurately in SS-III as ascending limb missing from equilibrium yield curve. Instead the target proxy would be C_{2013}/C_{MSY} (80% CI) is 0.62 (0.49-0.75)

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