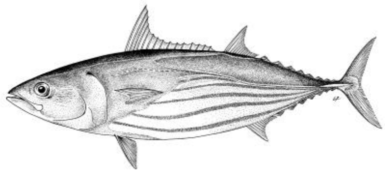
# DRAFT: EXECUTIVE SUMMARY: SKIPJACK TUNA

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 | | 2014 stock status determination |
|---|---|---|---|
| Indian Ocean | Catch 2013:<br>Average catch 2009–2013: | 424,580 t<br>401,132 t | |
| | MSY (1000 t) (80% CI):<br>$C_{MSY}$ (80% CI):<br>$SB_{MSY}$ (1,000 t) (80% CI):<br>$C_{2013}/C_{MSY}$ (80% CI):<br>$SB_{2013}/SB_{MSY}$ (80% CI):<br>$SB_{2013}/SB_0$ (80% CI): | 684 (550–849)<br>0.65 (0.51–0.79)<br>875 (708–1,075)<br>0.62 (0.69–0.75)<br>1.59 (1.13–2.14)<br>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 ($SB_{year}/SB_{MSY}$≥ 1) |
|---|---|---|
| Stock subject to overfishing($F_{year}/F_{MSY}$> 1) | | |
| Stock not subject to overfishing ($F_{year}/F_{MSY}$≤ 1) | | |
| Not assessed/Uncertain | | |

### INDIAN OCEAN STOCK – MANAGEMENT ADVICE

***Stock status.*** 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 current the 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 (≈424,000 t) remain lower than the estimated MSY values from the 2014 stock assessments (Table 1). The average catch over the previous five years (2009–13; ≈401,000 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 around 425,000 t (< 1 % risk that $B_{2016} < B_{MSY}$ and 1 % risk that $C_{2023}$>MSY as proxy of $F > F_{MSY}$).

The following key points should 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 6000,000 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 2009–2013 was 401,000 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 425,000 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. 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 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.
- **Provisional reference points:** Noting that the Commission in 2013 agreed to Resolution 13/10 *on interim 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 provisional target reference point of $F_{MSY}$, and therefore below the provisional limit reference point of $1.5*F_{MSY}$ (Fig. 1). Based on the current assessment there is a very low probability that the 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 target reference point of $SB_{MSY}$, and therefore above the 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 limit reference point of $0.4*SB_{MSY}$ in 3 or 10 years.
- **Main fishing gear** (2009–13): Other (NEI) ≈48%; Purse seine ≈32.6% (log ≈30.7% and free swimming school ≈1.8%); Pole-and-line ≈19.5%.;
- **Main fleets**: European Union ≈23% (EU,Spain: ≈16%; EU,France: ≈7%); Indonesia ≈21%; Sri Lanka ≈18%; ≈Maldives 16%; Seychelles ≈8%.

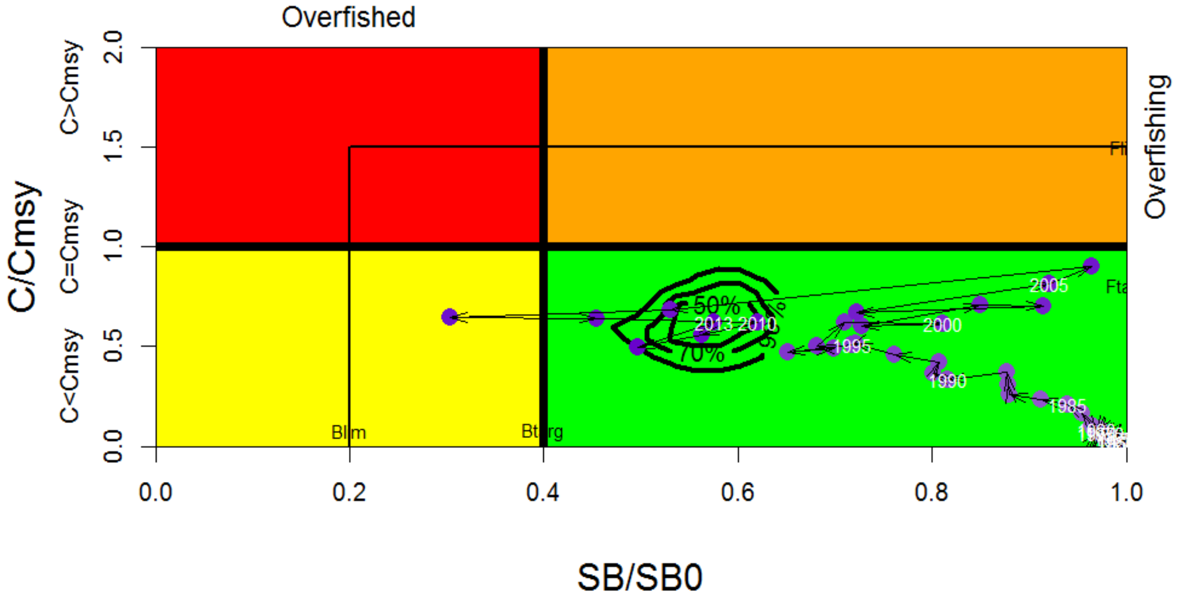



**Fig. 1. Skipjack tuna:** SS3 Aggregated Indian Ocean assessment Kobe plot (contours are the 50, 70 and 90 percentiles of the 2013 estimate). Blue circles indicate the trajectory of the point estimates for the SB/SB0 ratio and F proxy ratio for each year 1950–2013 estimated as $C/C_{MSY}$. Interim target (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% (254,748t) | 70% (297,206t) | 80% (339,664t) | 90% (382,122t) | 100% (424,580t) | 110% (467,038t) | 120% (509,496t) | 130% (551,954t) | 140% (594,412t) |
| $SB_{2016} < SB_{MSY}$ | 0 | | 1 | | 1 | | 1 | | 9 |
| $F_{2016} > F_{MSY}$ | 0 | | 1 | | 1 | | 5 | | 12 |
| $SB_{2023} < SB_{MSY}$ | 0 | | 1 | | 1 | | 6 | | 25 |
| $F_{2023} > F_{MSY}$ | 0 | | 1 | | 1 | | 5 | | 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 $B_{MSY}$; $F_{Lim}$ = 1.4 $F_{MSY}$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **60%** (254,748t) | **70%** (297,206t) | **80%** (339,664t) | **90%** (382,122t) | **100%** (424,580t) | **110%** (467,038t) | **120%** (509,496t) | **130%** (551,954t) | **140%** (594,412t) |
| $SB_{2016} < SB_{Lim}$ | 0 | | 0 | | 0 | | 0 | | 0 |
| $F_{2016} > F_{Lim}$ | 1 | | 1 | | 1 | | 1 | | 1 |
| $SB_{2023} < SB_{Lim}$ | 0 | | 0 | | 0 | | 0 | | 0 |
| $F_{2023} > F_{Lim}$ | 0 | | 1 | | 1 | | 1 | | 6 |

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# 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 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 13/03 *on the recording of catch and effort by fishing vessels in the IOTC area of competence*
- Resolution 13/10 *On interim target and limit reference points and a decision framework*
- Resolution 13/11 *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 12/11 *on the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating Non-Contracting Parties*
- 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

#### *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.<br>Size: females and males 41–43 cm.<br>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.<br>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 catch trends*

Catches of skipjack tuna increased slowly from the 1950s, reaching around 50,000 t during the mid-1970s, mainly due to the activities of fleets using pole-and-lines and gillnets (Table 4; Fig. 2). The catches increased rapidly with the arrival of the purse seiners in the early 1980s, and skipjack became one of the most important commercial tuna species in the Indian Ocean. Annual catches peaked at over 600,000 t in 2006 (Table 4). Since 2006 catches have declined to around 340,000 t in 2012 – the lower catches recorded since 1998 – although preliminary figures for 2013 indicate an increase in catch levels to around 424,000 t.

**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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch, noting that some gears were not used since the beginning of the fishery.

| 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 |
| BB | 10,007 | 15,148 | 24,684 | 41,705 | 77,079 | 109,528 | 112,142 | 139,660 | 147,937 | 107,383 | 99,104 | 75,761 | 83,458 | 69,355 | 68,788 | 93,016 |
| FS | 0 | 0 | 41 | 15,251 | 30,614 | 25,724 | 18,565 | 43,166 | 34,930 | 24,199 | 16,274 | 10,433 | 8,774 | 9,000 | 2,984 | 5,775 |
| LS | 0 | 0 | 125 | 34,474 | 124,015 | 163,799 | 137,232 | 168,018 | 211,509 | 120,951 | 128,448 | 148,135 | 144,097 | 123,056 | 80,989 | 119,839 |
| OT | 4,999 | 11,712 | 21,951 | 38,282 | 87,732 | 177,024 | 187,541 | 204,363 | 221,524 | 213,015 | 195,418 | 203,406 | 186,560 | 180,998 | 185,283 | 205,951 |
| **Total** | **15,006** | **26,860** | **46,801** | **129,713** | **319,440** | **476,075** | **455,481** | **555,208** | **615,900** | **465,547** | **439,243** | **437,736** | **422,889** | **382,409** | **338,045** | **424,580** |

**Gears**: Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (**OT**).

The increase in skipjack tuna catches by **purse seiners** (Fig. 2) is due to the development of a fishery in association with drifting Fish Aggregating Devices (FADs) (Table 4) in the 1980s. In recent years, over 90% of the skipjack tuna caught by purse seine vessels is taken from around FADs. Catches by purse seiners increased steadily since 1984 with the highest catches recorded in 2002 and 2006 (>240,000 t). Catches of skipjack dropped in the years 2003 and 2004, probably as a consequence of high purse seine catch rates on free schools of yellowfin tuna during those years. The constant increase in catches and catch rates of purse seiners until 2006 are believed to be associated with increases in fishing power and in the number of FADs (and the technology associated with them) used in the fishery. In 2007 purse seine catches declined by around 100,000 t (from around 245,000 t in 2005 145,000 t in 2007). The sharp decline in purse seine catches since 2007 coincided with a similar decline in the catches by Maldivian baitboats.

**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 (2004–2013), in tonnes. Data as of September 2014. Catches by decade represent the average annual catch.

| | By decade (average) | | | | | | By year (last ten years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
| R1 | 4,524 | 9,951 | 19,291 | 34,586 | 80,757 | 118,327 | 119,042 | 114,269 | 109,016 | 137,688 | 139,941 | 151,487 | 153,432 | 152,943 | 149,001 | 159,360 |
| R2 | 1,483 | 4,110 | 8,235 | 59,667 | 170,901 | 257,243 | 231,897 | 310,526 | 370,153 | 232,052 | 213,718 | 221,230 | 197,872 | 176,977 | 137,910 | 192,638 |
| R2b | 9,000 | 12,800 | 19,275 | 35,459 | 67,782 | 100,505 | 104,542 | 130,412 | 136,730 | 95,807 | 85,584 | 65,018 | 71,585 | 52,489 | 51,134 | 72,583 |
| **Total** | **15,006** | **26,860** | **46,801** | **129,713** | **319,441** | **476,075** | **455,481** | **555,208** | **615,900** | **465,547** | **439,243** | **437,736** | **422,889** | **382,409** | **338,046** | **424,581** |

**Areas**: East Indian Ocean (**R1**); West Indian Ocean, (**R2**); Maldives pole-and-line (R2b).

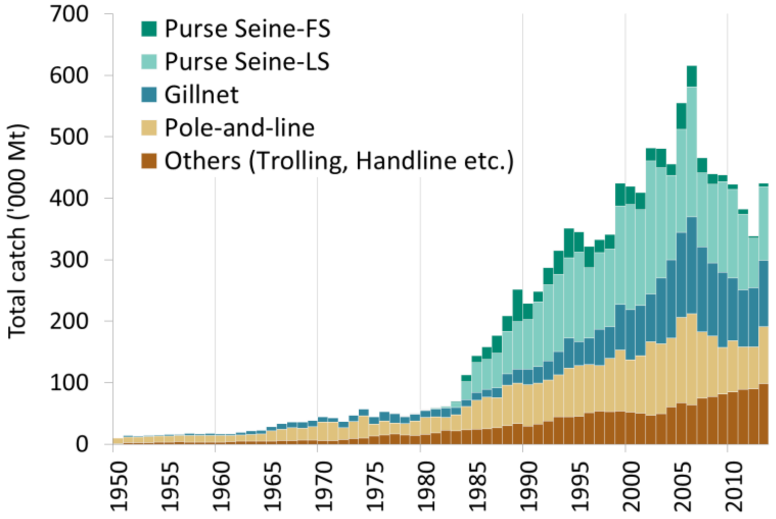



**Fig. 2. Skipjack tuna:** Annual catches of skipjack tuna by gear (1950–2013). Data as of Sept. 2014.

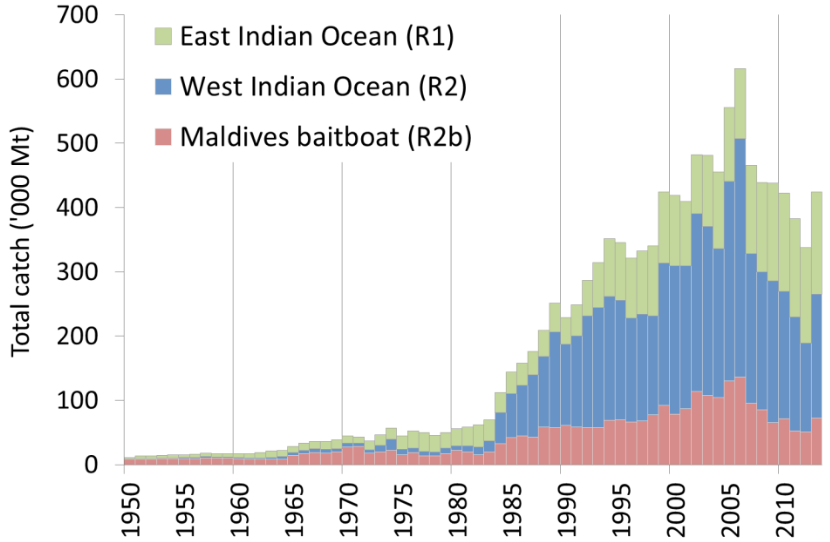



**Fig. 3. Skipjack tuna:** Catches of skipjack tuna by area by year estimated for the WPTT (1950–2013). Data as of September 2014. **Areas**: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**)

The Maldivian fishery (Fig. 2) has effectively increased its fishing effort with the mechanisation of its pole-and-line fleet since 1974, including an increase in boat size and power and the use of anchored FADs since 1981. Skipjack tuna represents around 80% of the total catch of Maldives, where skipjack catch rates regularly increased between 1980 and 2006 – the year in which the highest skipjack catch was recorded for this fishery (≈140,000 t). Catches of skipjack tuna reported by Maldives have since declined in recent years to as low as 55,000 t, representing less than half the catches taken in 2006, although catches of around 75,000 t have been reported in 2013. The recent decline in skipjack catches by Maldives is, in part, related to the introduction of handlines targeting large specimens of yellowfin tuna.

Several fisheries using gillnets have reported large catches of skipjack tuna in the Indian Ocean (Figs. 4, 5), including the gillnet/longline fishery of Sri Lanka, driftnet fisheries of 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 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.

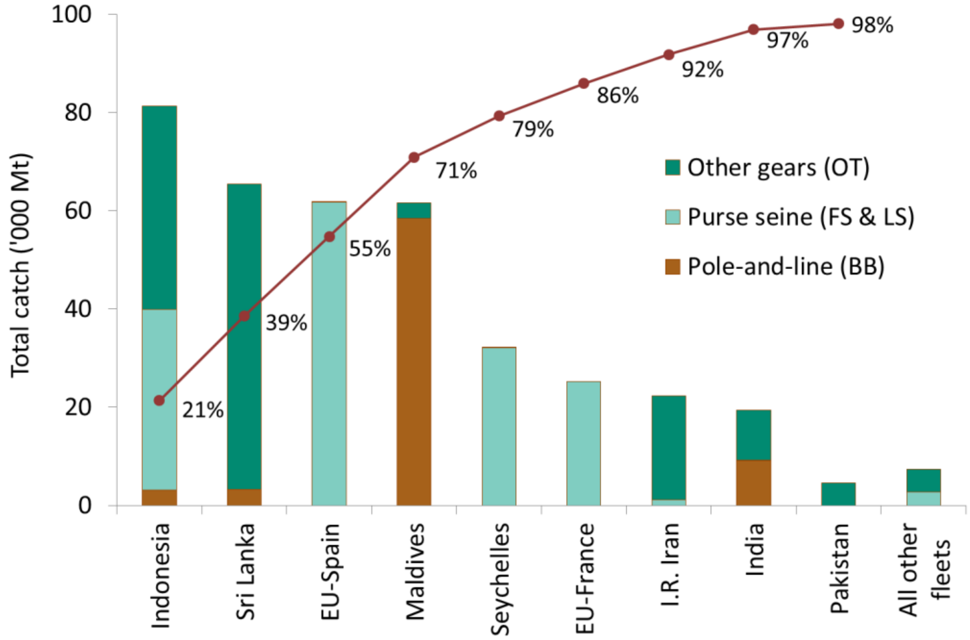



**Fig. 4. Skipjack tuna**: average catches in the Indian Ocean over the period 2010–12, by fleet. Fleets are ordered from left to right, according to the importance of catches of skipjack tuna reported. The red line indicates the (cumulative) proportion of catches of skipjack tuna for the fleets concerned, over the total combined catches of this species reported from all fleets and fisheries. Data as of September 2014.

The majority of the catches of skipjack tuna originate from the western Indian Ocean (Fig. 3). Since 2007 however, catches of skipjack tuna in the western Indian Ocean have dropped considerably, especially in areas off Somalia, Kenya, Tanzania and around the Maldives. The drop in catches are considered by the SC to be partially explained by the reduction in fishing effort by some fisheries due to the effects of piracy in the western Indian Ocean region, including industrial purse seiners and fleets using driftnets from Iran and Pakistan; and, as already noted, a decrease in catches of skipjack tuna by Maldivian baitboats following the introduction of handlines targeting yellowfin tuna.

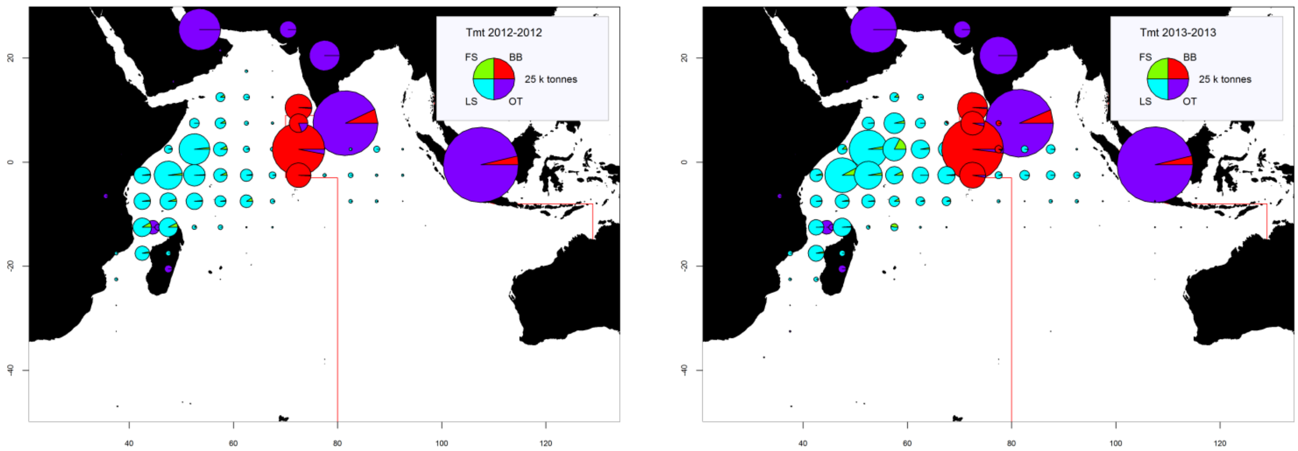



**Fig. 5 (a-f). Skipjack tuna:** Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2004–08 by type of gear and for 2009–13, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries. Data as of September 2014. The 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 Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

## Skipjack tuna: Status of Fisheries Statistics at the IOTC

**Retained catches:** Generally well known for the industrial fisheries but are less certain for many artisanal fisheries (Fig. 6a), notably because:

- catches are not being reported by species
- there is uncertainty about the catches from some significant fleets including the Sri Lankan coastal fisheries, and the coastal fisheries of Madagascar.

**Discards:** Believed to be low although they are unknown for most industrial fisheries, excluding industrial purse seiners flagged in EU fleets for the period 2003–2007.

**Changes to the catch series:** There have been no major changes to the catches of skipjack tuna since the WPTT in 2012.

**Catch–per–unit–effort (CPUE) Series**: Catch and effort data are available from various industrial and artisanal fisheries (Fig. 6b). However, these data are not available from some important fisheries or they are considered to be of poor quality for the following reasons:

- insufficient data available for the gillnet fisheries of Iran and Pakistan
- the poor quality effort data for the gillnet/longline fishery of Sri Lanka

no data are available from 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)** (Figs. 7, 8, 9): Cannot be assessed before the mid-1980s and are incomplete for most artisanal fisheries thereinafter, namely hand lines, troll lines and many gillnet fisheries (Indonesia).

**Catch-at-Size table**: CAS are available but the estimates are uncertain for some years and fisheries due to (Fig. 6c):

- the lack of size data before the mid-1980s
- the paucity of size data available for some artisanal fisheries, notably most hand lines and troll lines (Madagascar, Comoros) and many gillnet fisheries (Indonesia, Sri Lanka).

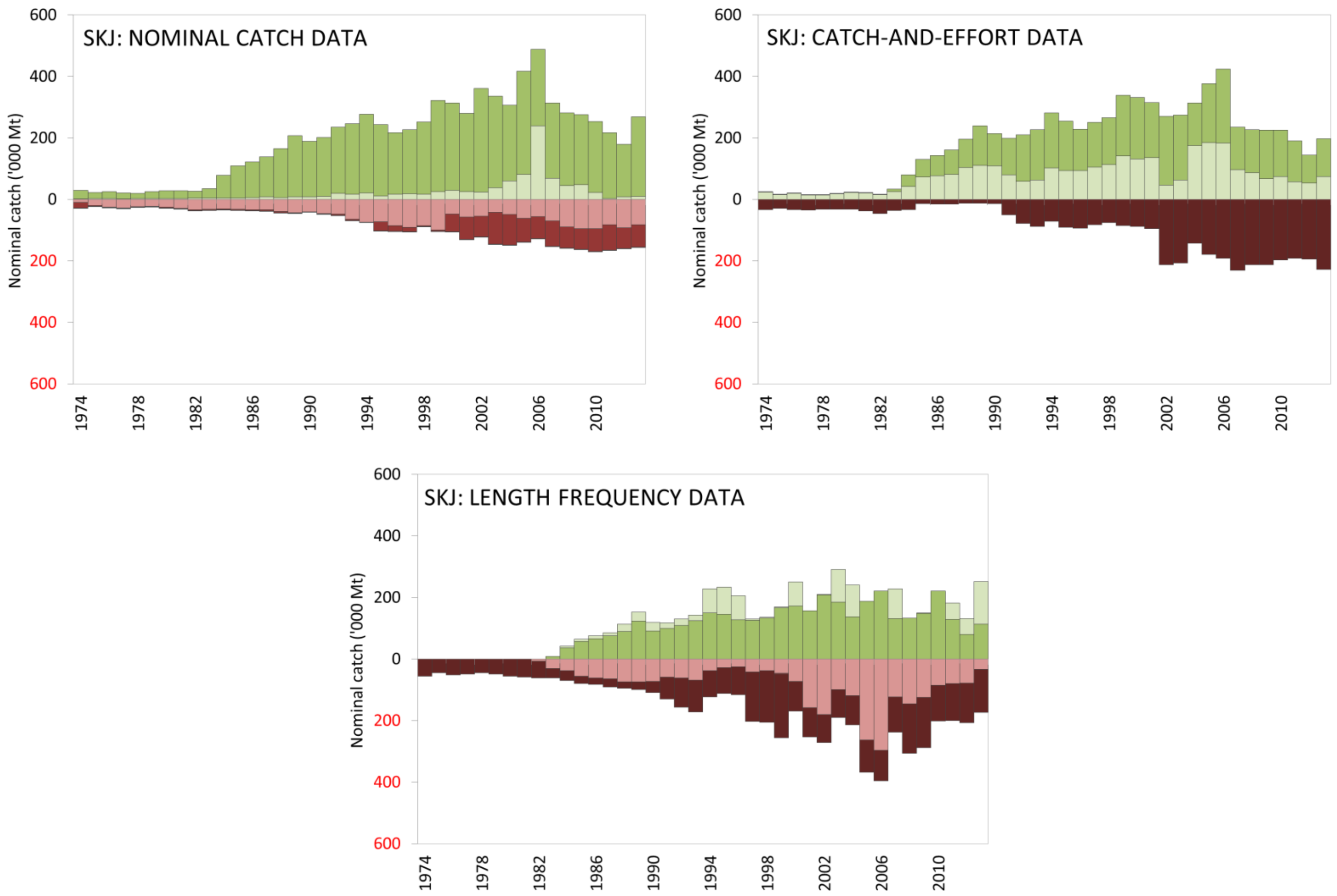



**Fig. 6a-c. Skipjack tuna:** data reporting coverage (1974–2013). Each IOTC dataset (nominal catch, catch-and-effort, and length frequency) are assessed against IOTC reporting standards, where: a score of 0 indicates the amount of nominal catch associated with each dataset that is fully reported according 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)

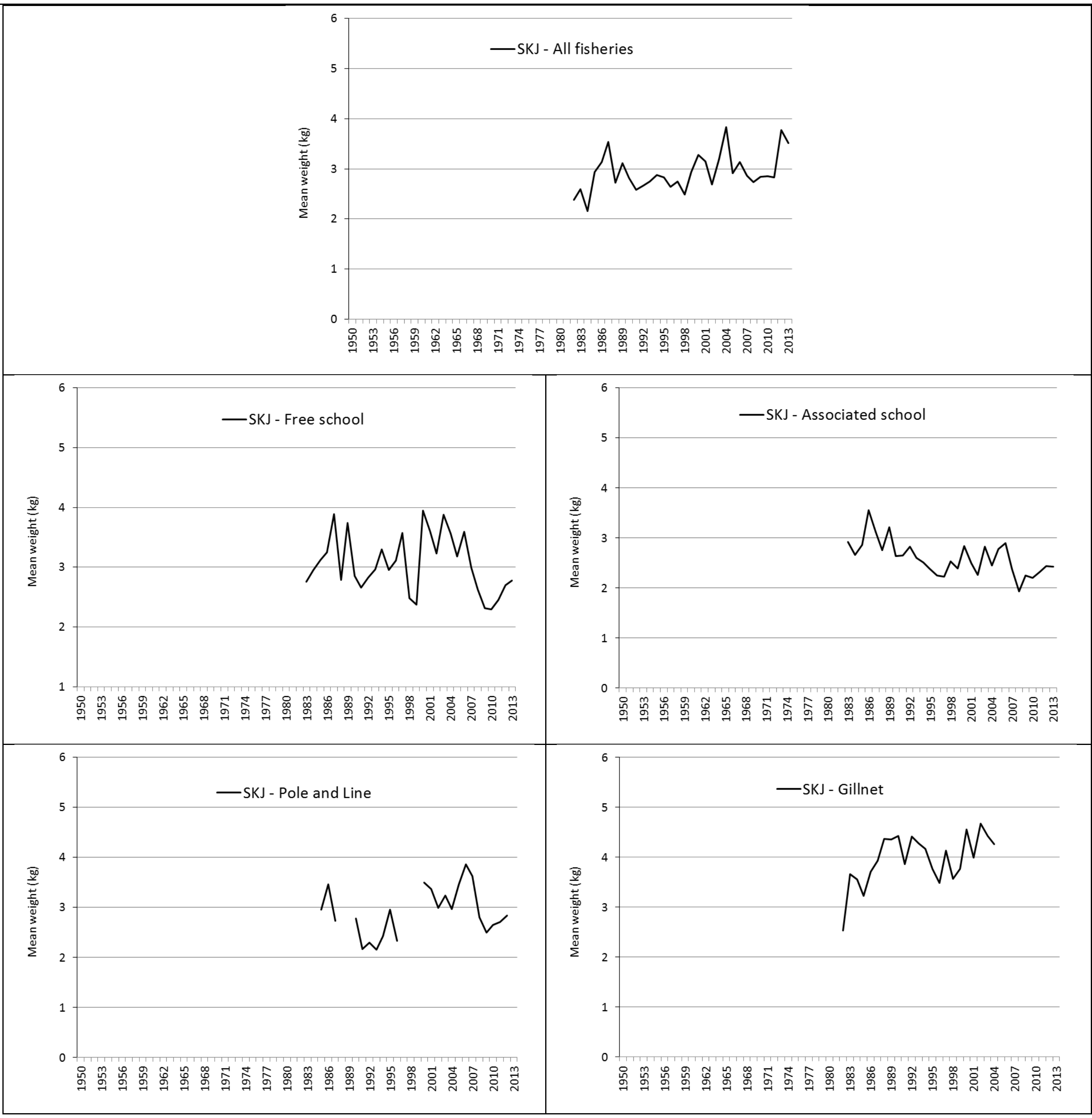
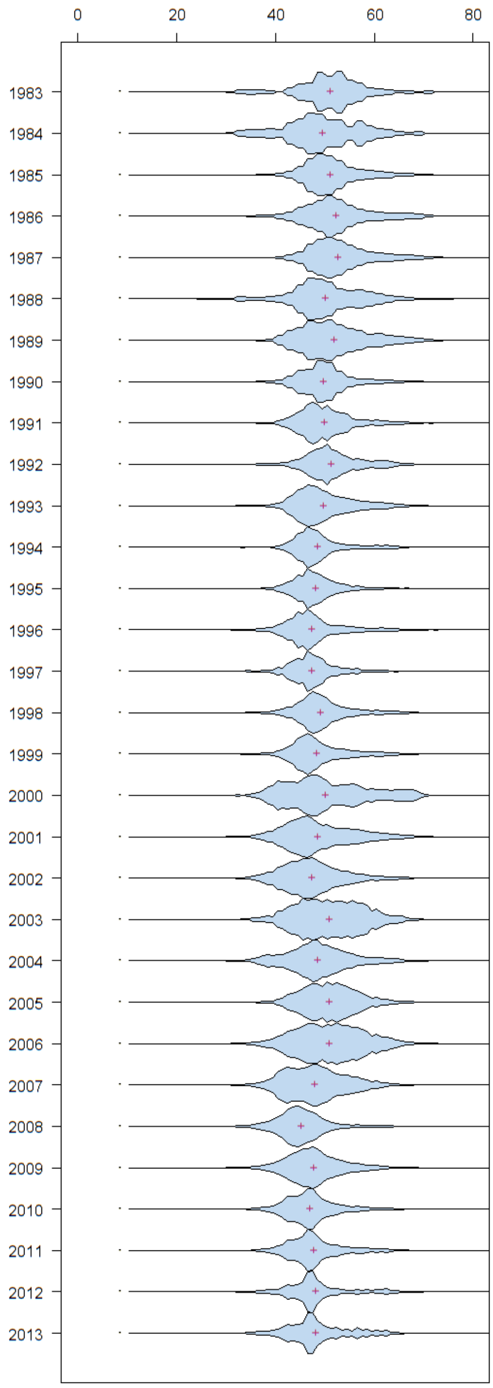



**Fig. 7. Skipjack tuna**: Average weight of skipjack tuna (SKJ) taken by All fleets combined (top), Purse seine on free (top left) and associated (top right) schools, Pole-and-line from Maldives and India (bottom left), Gillnets from Sri Lanka, Iran, and other countries (bottom right).

Skipjack tuna (PS LS): size (in cm)




Skipjack tuna (PS LS): no. of specimens ('000) (raised to total catch)

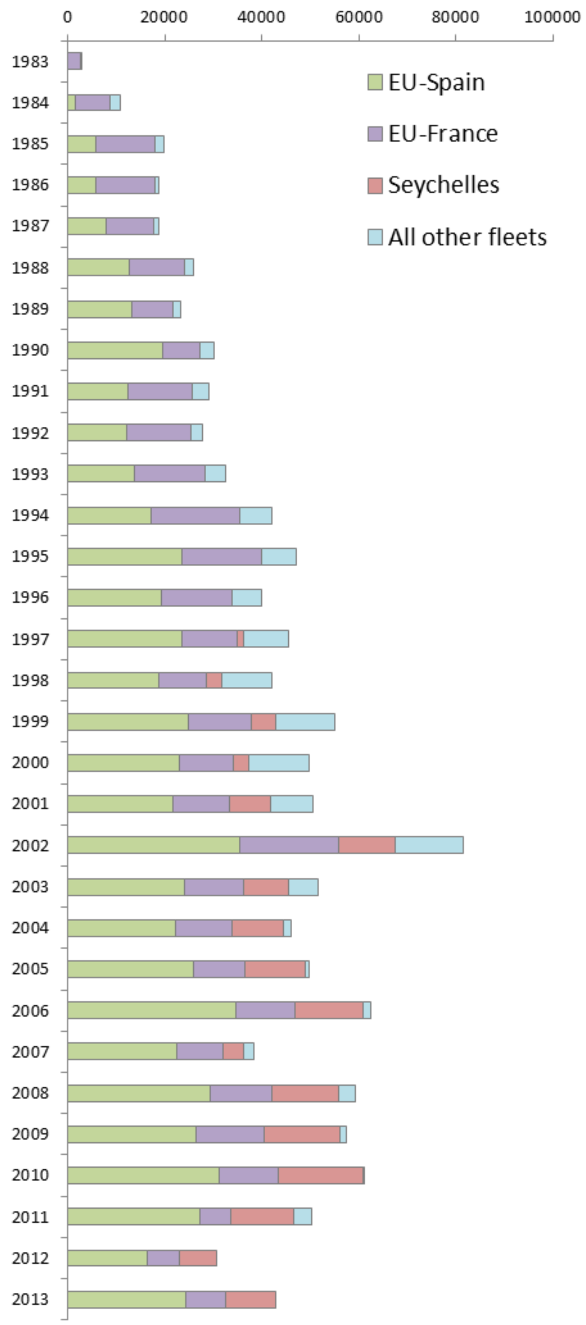



**Fig. 8. Skipjack tuna** (PS Associated school): **Left:** length frequency distributions for PS Associated school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised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

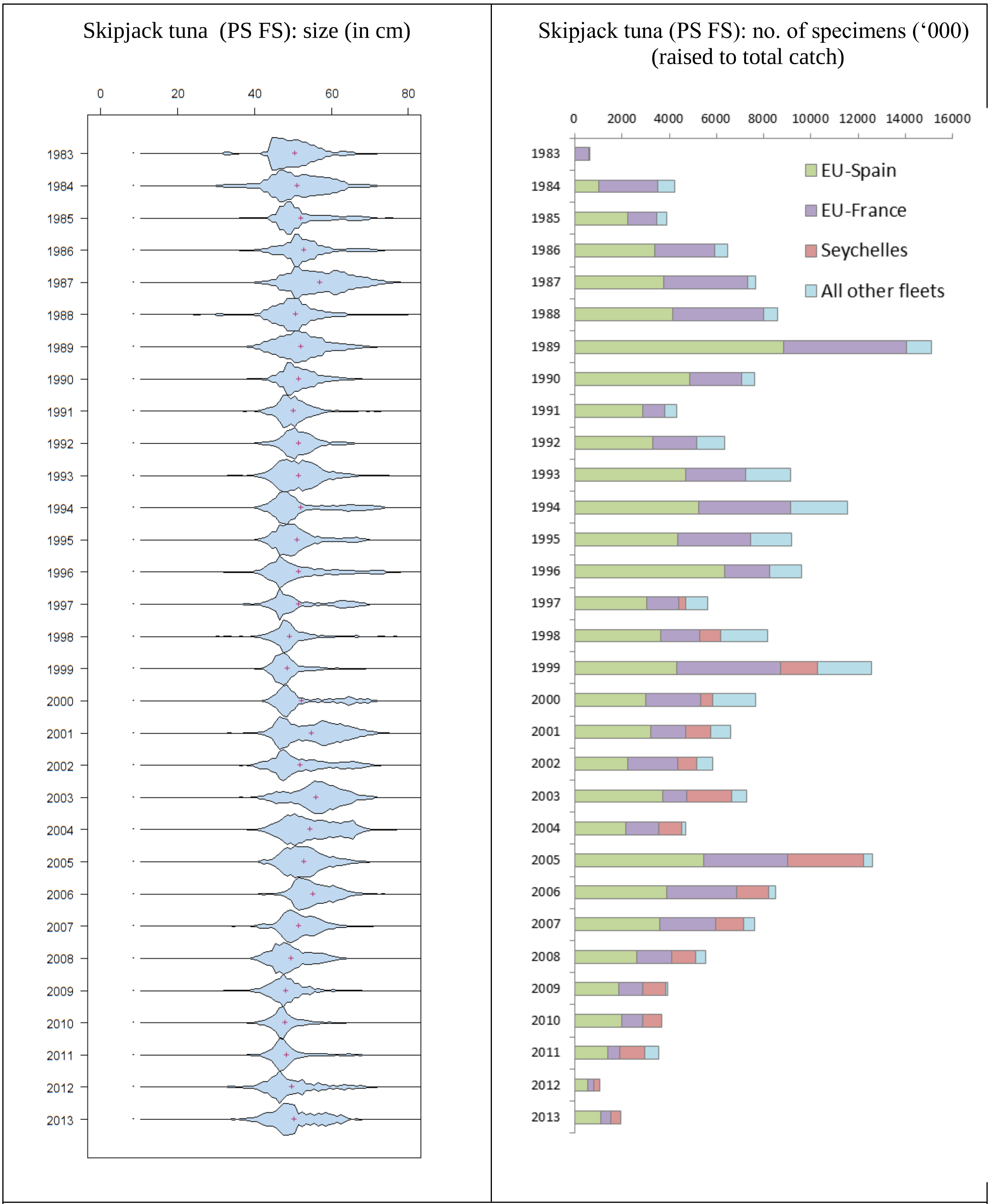



**Fig. 9. Skipjack tuna** (PS Free school): **Left:** length frequency distributions for PS Free school fisheries (total amount of fish measured by 1 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of skipjack tuna specimens sampled for lengths (raised to total catch), by fleet (PS Free school only). FS: Free swimming school.

***Skipjack tuna – 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. 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 2011 and 2012 are providedin Fig 12. Effort data for 2014 has not yet been reported.

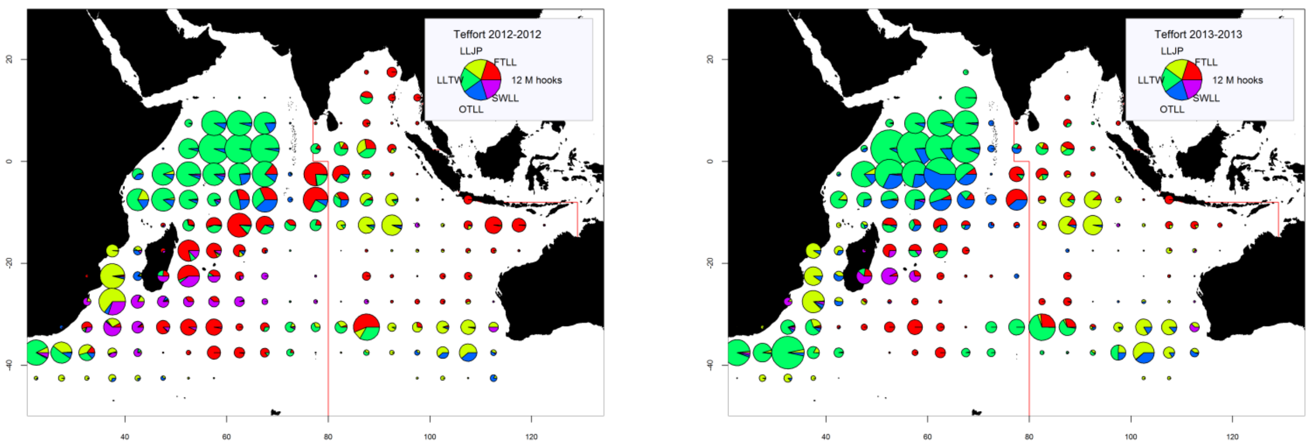



**Fig. 10.** Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014).
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (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)

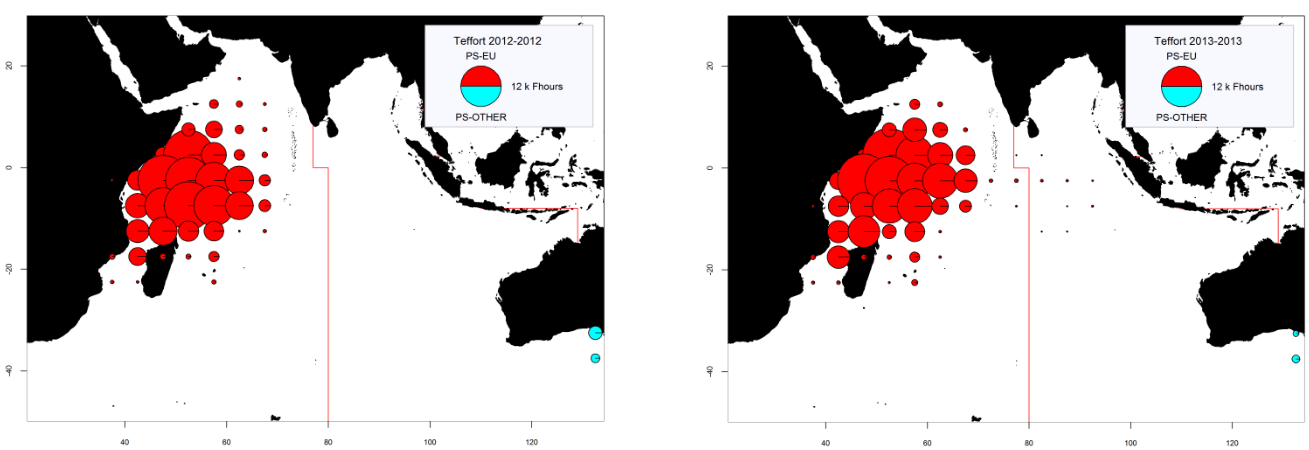



**Fig. 11.** Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2012 (left) and 2013 (right) (Data as of September 2014)
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles 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)

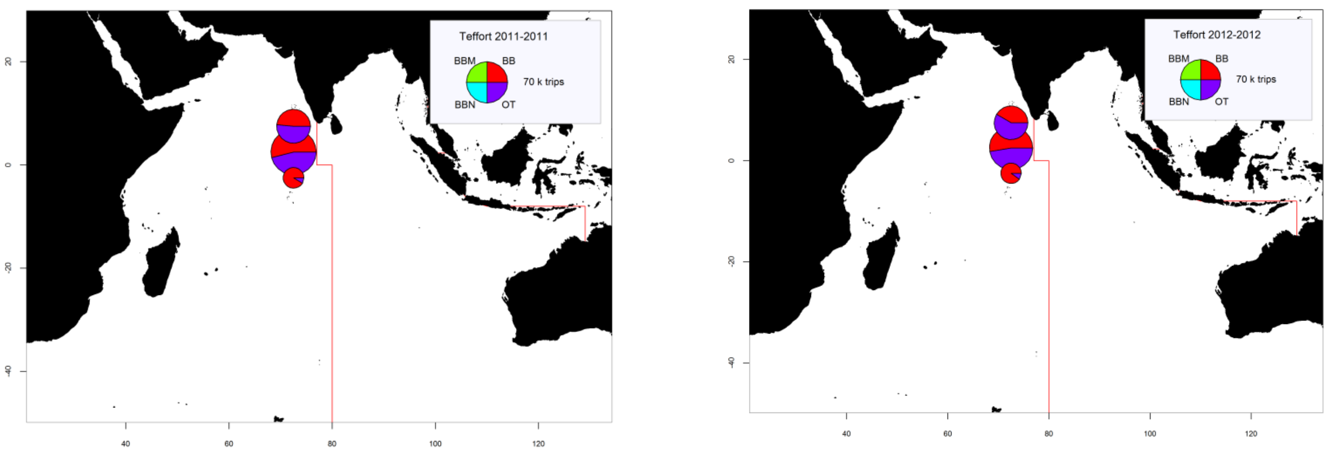



**Fig. 12.** Effort exerted by pole-and-line fleets in the Indian Ocean, in thousands (k) of trips (equivalent to fishing days), for the years 2011 (left) and 2012 (right) (Data as of September 2014). Note: Effort data for 2014 has not yet been reported. BBM (green): Pole-and-line (mechanized baitboats); 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.

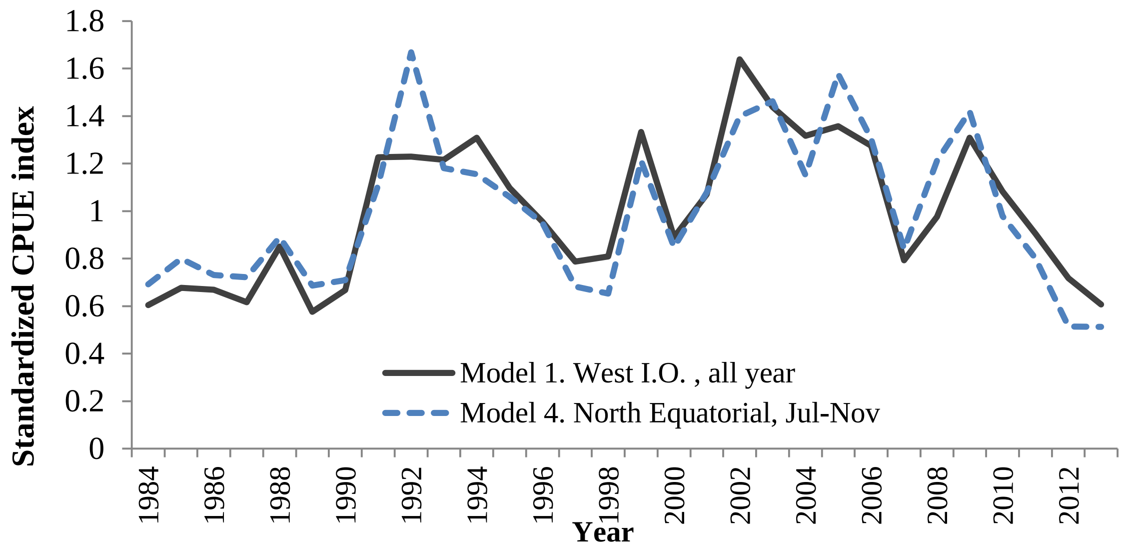



**Fig. 13.** EU,France purse seine standardised CPUE series for skipjack tuna from 1984–13.

***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 the CPUE indices for the Maldives are likely to provide a representative index of abundance only for the Maldives area.

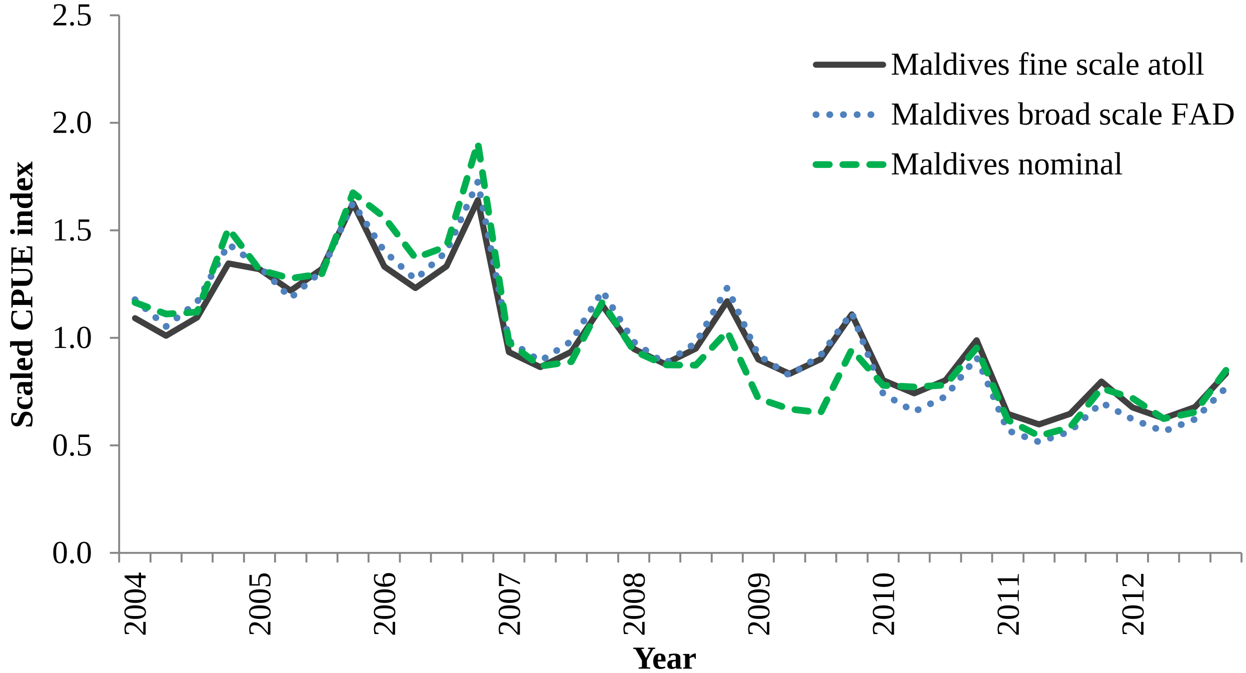



**Fig. 14.** Maldives pole-and-line nominal and standardised CPUE series for skipjack tuna from 2004–13.

***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.

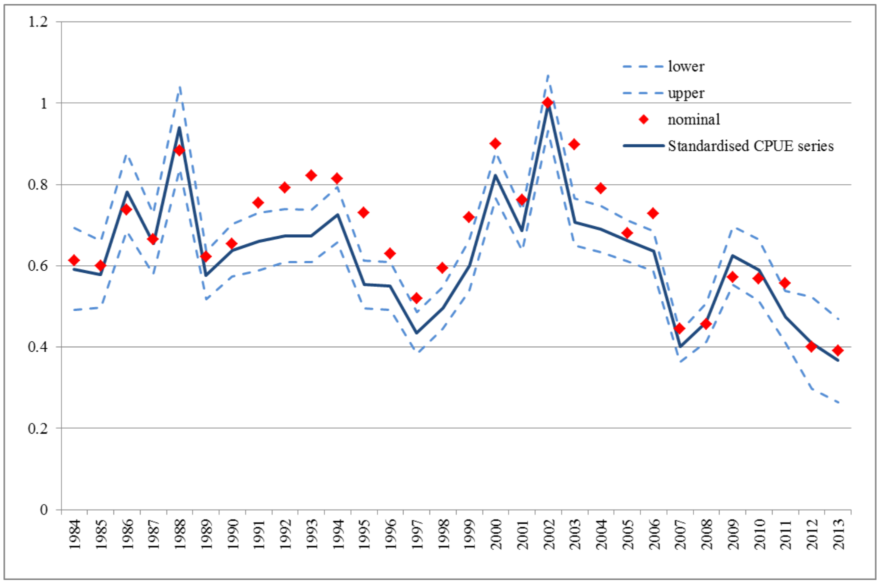



**Fig. 15.** European Union and Associated purse seine nominal and standardised CPUE series for skipjack tuna from 1984–13.

***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. 16). 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, of which 1,960 were recovered mainly in the Maldives.

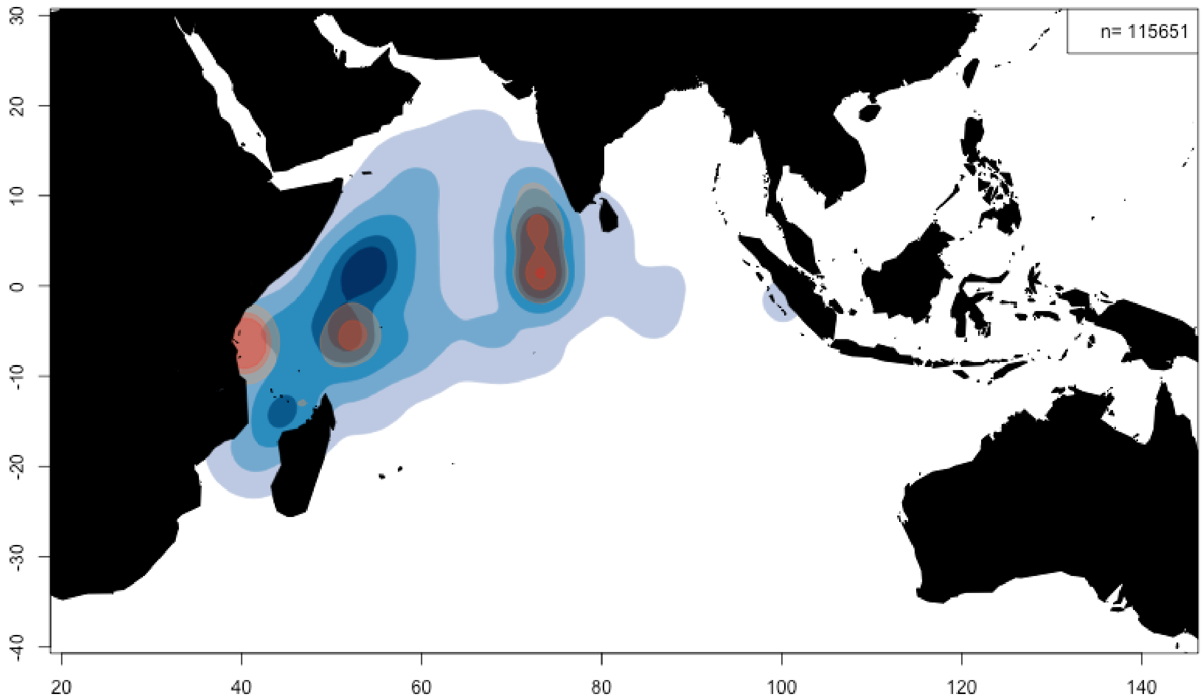



**Fig. 16**. **Skipjack tuna:** Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2012.

**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. 17, 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).

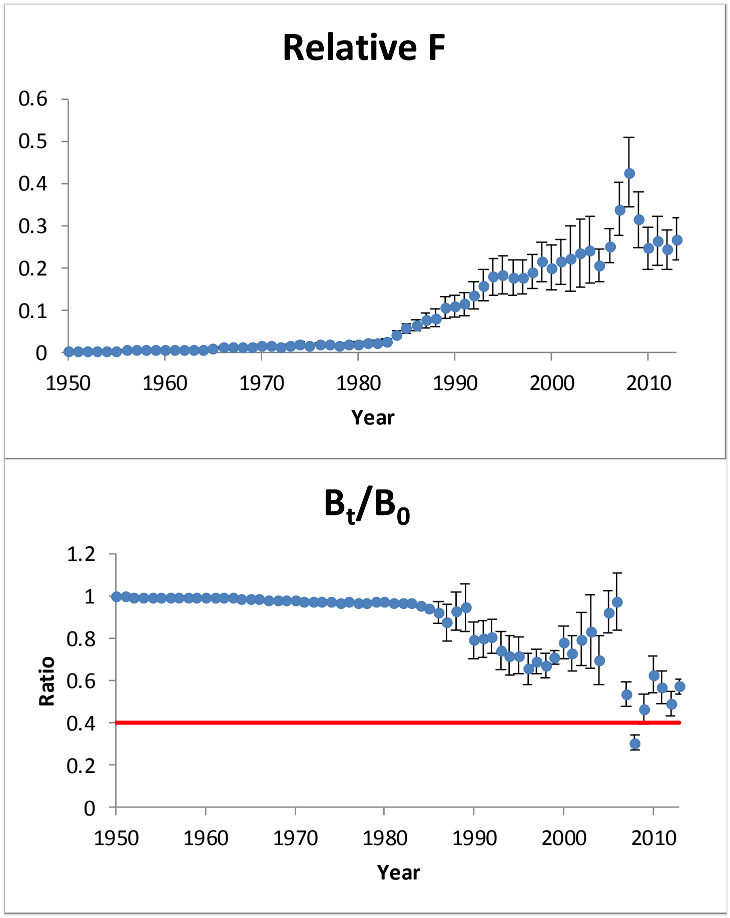



**Fig. 17.** Top: relative fishing mortality over time. Bottom: $B_{MSY}/B_0$. Note, these figures were suggested as alternative figures for evaluation as $F_{MSY}$ is not estimated well, reference point $0.4B_0$ was suggested as a target and $0.2B_0$ as a limit for skipjack tuna by the WPTT.

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 (1000 t) (80% CI) | 684 (550–849) |
| Data period used in assessment | 1950–2013 |
| $F_{MSY}$ (80% CI)* | 0.65<br>(0.51–0.79) |
| $SB_{MSY}$ (1000 t) (80% CI) | 875<br>(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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