YELLOWFIN TUNA

SUPPORTING INFORMATION

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

CONSERVATION AND MANAGEMENT MEASURES

Yellowfin tuna (*Thunnus albacares*) in the Indian Ocean is currently subject to a number of Conservation and Management Measures adopted by the Commission:

- Resolution 16/01 *On an interim plan for rebuilding the Indian Ocean Yellowfin tuna stock in the IOTC Area of Competence*
- 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

Yellowfin tuna: General

Yellowfin tuna *(Thunnus albacares)* is a cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. **Table 1** outlines some of the key life history traits of yellowfin tuna relevant for management.

TABLE 1. Yellowfin tuna: Biology of Indian Ocean yellowfin tuna (*Thunnus albacares*).

Parameter	Description
Range and stock structure	A cosmopolitan species distributed mainly in the tropical and subtropical oceanic waters of the three major oceans, where it forms large schools. Feeding behaviour has been extensively studied and it is largely opportunistic, with a variety of prey species being consumed, including large concentrations of crustaceans that have occurred recently in the tropical areas and small mesopelagic fishes which are abundant in the Arabian Sea. It has also been observed that large individuals can feed on very small prey, thus increasing the availability of food for this species. Archival tagging of yellowfin tuna has shown that this species can dive very deep (over 1000 m) probably to feed on meso-pelagic prey. Longline catch data indicates that yellowfin tuna are distributed throughout the entire tropical Indian Ocean. The tag recoveries of the RTTP-IO provide evidence of large movements of yellowfin tuna, thus supporting the assumption of a single stock for the Indian Ocean. The average distance travelled by yellowfin between being tagging and recovered is 710 nautical miles, and showing increasing distances as a function of time at sea.
Longevity	9 years
Maturity (50%)	Age: females and males 3–5 years. Size: females and males 100 cm.
Spawning season	Spawning occurs mainly from December to March in the equatorial area (0-10°S), with the main spawning grounds west of 75°E. Secondary spawning grounds exist off Sri Lanka and the Mozambique Channel and in the eastern Indian Ocean off Australia.
Size (length and weight)	Maximum length: 240 cm FL; Maximum weight: 200 kg. Newly recruited fish are primarily caught by the purse seine fishery on floating objects. Males are predominant in the catches of larger fish at sizes than 140 cm (this is also the case in other oceans). The sizes exploited in the Indian Ocean range from 30 cm to 180 cm fork length. Smaller fish (juveniles) form mixed schools with skipjack tuna and juvenile bigeye tuna and are mainly limited to surface tropical waters, while larger fish are found in surface and sub-surface waters. Intermediate age yellowfin tuna are seldom taken in the industrial fisheries, but are abundant in some artisanal fisheries, mainly in the Arabian Sea.

Sources: Froese & Pauly 2009

Yellowfin tuna: Fisheries and main catch trends

- Main fishing gear (2012–16): In recent years catches have been evenly split between industrial and artisanal fisheries. Purse seiners (free and associated schools) and longline fisheries still account for around 50% of total catches, while catches from artisanal gears – namely handline, gillnet, and pole-and-line – have steadily increased since the 1980s (**Table 2**; **Fig.1**).

  Contrary to other oceans, the artisanal fishery component of yellowfin catches in the Indian Ocean are substantial, accounting for catches of over 200,000 t per annum since 2012. Moreover, the proportion of yellowfin catches from artisanal fisheries has increased from around 30% in 2000 to nearly 50% in recent years.

- Main fleets (and primary gear associated with catches): percentage of total catches (2012–16):
  European Union ≈21% (EU-Spain ≈15%; EU-France ≈7%) (purse seine); Maldives (handline, pole-and-line): 12%; Indonesia (fresh longline, handline): 10%; I.R. Iran (gillnet): 10% (**Fig.2**).

- Main fishing areas: Primary: Western Indian Ocean, around Seychelles and waters off Somalia (Area R2), and Mozambique Channel (Area R3) (**Table 3**; **Fig.3**).

- Retained catch trends:
  Catches of yellowfin tuna remained stable between the mid-1950s and the early-1980s, ranging between 30,000 t and 70,000 t, with longliners and gillnetters the main fisheries. Catches increased rapidly in the early-1980s with the arrival of the purse seiners and increased activity of longliners and other fleets, reaching over 400,000 t by 1993.

  Exceptionally high catches were recorded between 2003 and 2006 – with the highest catches ever recorded in 2004 at over 525,000 t – while catches of bigeye tuna ,which are generally associated with the same fishing grounds as yellowfin tuna remained at average levels.

  Between 2007 and 2011 catches dropped considerably (around ≈40% compared to 2004) as longline fishing effort in the western Indian Ocean was displaced eastwards or reduced due to the threat of piracy. Catches by purse seiners also declined over the same period – albeit not to the same extent as longliners – due to the presence of security personnel onboard purse seine vessels of the EU and Seychelles which has enabled fishing operations to continue.

  Since 2012 catches have once again been increasing, with catches over 400,000 t recorded.

  Purse seine fishery:

  Although some Japanese purse seiners have fished in the Indian Ocean since 1977, the purse seine fishery developed rapidly with the arrival of European vessels between 1982 and 1984. Since then, there has been an increasing number of yellowfin tuna caught, with a larger proportion of the catches consisting of adult fish, as opposed to catches of bigeye tuna, which are mostly composed of juvenile fish.

  The purse seine fishery is characterized by the use of two different fishing modes. The fishery on floating objects (FADs) catches large numbers of small yellowfin tuna in association with skipjack tuna and juvenile bigeye tuna, compared to the fishery on free swimming schools, which catches larger yellowfin tuna on multi-specific or mono-specific sets.

  Longline fishery:

  The longline fishery started in the early 1950's and expanded rapidly throughout the Indian Ocean. The longline fishery targets several tuna species in different parts of the Indian Ocean, with yellowfin tuna and bigeye tuna being the main target species in tropical waters. The longline fishery can be subdivided into a deep-freezing longline component (i.e., large scale deep-freezing longliners operating on the high seas from Japan, Korea and Taiwan,China) and a fresh-tuna longline component (i.e., small to medium scale fresh tuna longliners from Indonesia and Taiwan,China).

- 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.

Table 2. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2007–2016), in tonnes. 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	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
FS	-	-	18	31,552	64,938	89,204	53,526	74,985	36,049	32,135	36,453	64,593	34,494	47,426	63,944	48,202
LS	-	-	17	17,597	56,278	61,890	43,778	41,540	51,351	73,383	76,659	66,166	101,868	86,370	78,382	98,659
LL	21,990	41,352	29,589	33,968	66,318	56,878	51,426	26,039	20,002	18,744	20,667	19,670	16,010	15,595	17,847	19,530
FL	164	1,255	2,369	7,946	58,965	55,605	55,619	58,102	49,884	50,485	43,455	54,643	60,679	63,004	52,767	61,646
BB	2,111	2,318	5,810	8,295	12,803	16,072	16,326	18,279	16,827	14,105	14,009	15,511	24,046	20,502	17,599	10,342
GI	1,566	4,109	7,928	11,995	39,539	49,392	43,511	47,871	41,907	51,118	49,279	63,459	56,159	71,361	71,117	64,762
HD	552	537	2,916	7,274	18,849	34,169	33,796	30,316	28,296	34,081	59,348	79,408	70,176	71,078	73,207	81,808
TR	1,079	1,934	4,243	7,462	12,456	16,679	19,894	17,568	15,259	19,982	19,618	28,836	32,753	22,105	16,597	18,244
OT	80	193	453	1,870	3,379	5,402	6,704	6,557	7,359	7,704	7,871	8,215	8,861	10,624	10,923	9,486
Total	**27,542**	**51,698**	**53,344**	**127,959**	**333,524**	**385,291**	**324,580**	**321,259**	**266,933**	**301,737**	**327,359**	**400,502**	**405,048**	**408,065**	**402,384**	**412,679**

Gears: Purse seine free-school (**FS**); Purse seine associated school (**LS**); Deep-freezing longline (**LL**); Fresh-tuna longline (**FL**); Pole-and-Line (**BB**); Gillnet (**GI**); Hand line (**HD**); Trolling (**TR**); Other gears nei (**OT**).

Table 3. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2007–2016), in tonnes. Catches by decade represent the total annual catch.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
R1	2,079	4,611	6,685	16,063	61,992	71,877	72,864	63,492	46,088	54,888	73,410	102,775	100,381	92,968	87,062	85,019
R2	11,483	23,134	21,280	71,721	138,292	180,936	127,720	137,696	104,650	124,450	147,025	178,977	180,642	195,177	206,460	209,695
R3	847	7,555	5,889	9,620	24,018	25,203	25,194	21,541	20,061	19,839	21,177	18,375	22,497	10,719	16,910	20,769
R4	918	1,799	1,411	1,284	8,455	6,464	2,026	1,646	1,467	2,480	2,052	2,415	12,023	2,220	11,198	8,786
R5	11,766	13,737	17,523	27,961	87,187	85,506	85,916	83,224	77,957	85,548	75,594	89,848	80,331	87,792	66,900	69,249
OT	448	862	557	1,310	13,581	15,305	10,861	13,660	16,710	14,533	8,101	8,111	9,174	19,190	13,853	19,161
Total	**27,542**	**51,698**	**53,344**	**127,959**	**333,524**	**385,291**	**324,580**	**321,259**	**266,933**	**301,737**	**327,359**	**400,502**	**405,048**	**408,065**	**402,384**	**412,679**

Areas: Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel including southern (**R3**); South Indian Ocean including southern (**R4**); East Indian Ocean including Bay of Bengal(**R5**), Other fishing areas (OT) corresponds to Area (R0 in Fig.18 below).

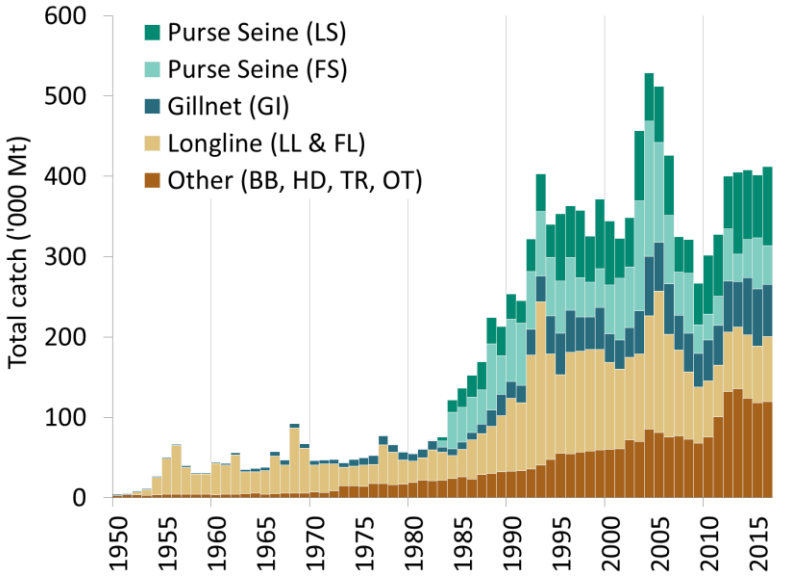


Fig.1. Annual catches of yellowfin tuna by gear (1950–2016).

Notes: Purse seine (LS):

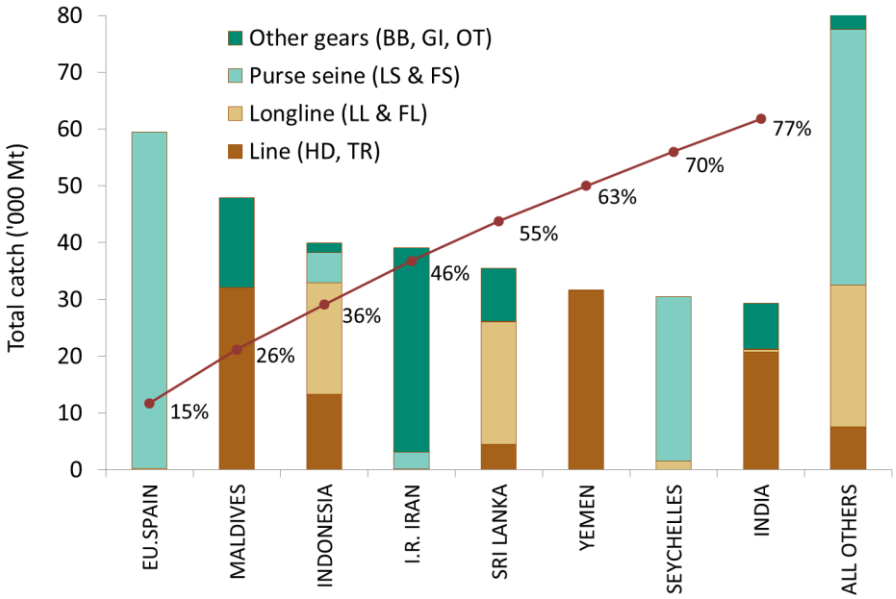


Fig.2. Yellowfin tuna: average catches in the Indian Ocean over the period 2012–16, by country. Countries are ordered from left to right, according to the importance of catches of yellowfin reported. The red line indicates the (cumulative) proportion of catches of yellowfin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries.

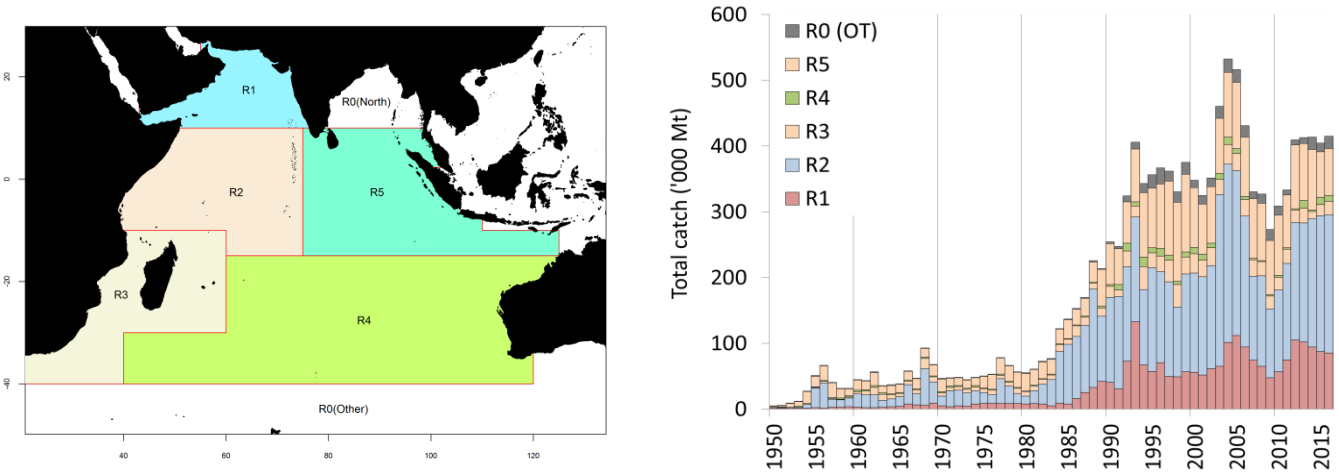


Fig.3(a-b). Yellowfin tuna: Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2016). Catches in areas R0 were assigned to the closest neighbouring area for the assessment. Data as of September 2016.

Areas: Arabian Sea (**R1**); Off Somalia (**R2**); Mozambique Channel, including southern (**R3**); South Indian Ocean including southern (**R4**); East Indian Ocean, including Bay of Bengal(**R5**).

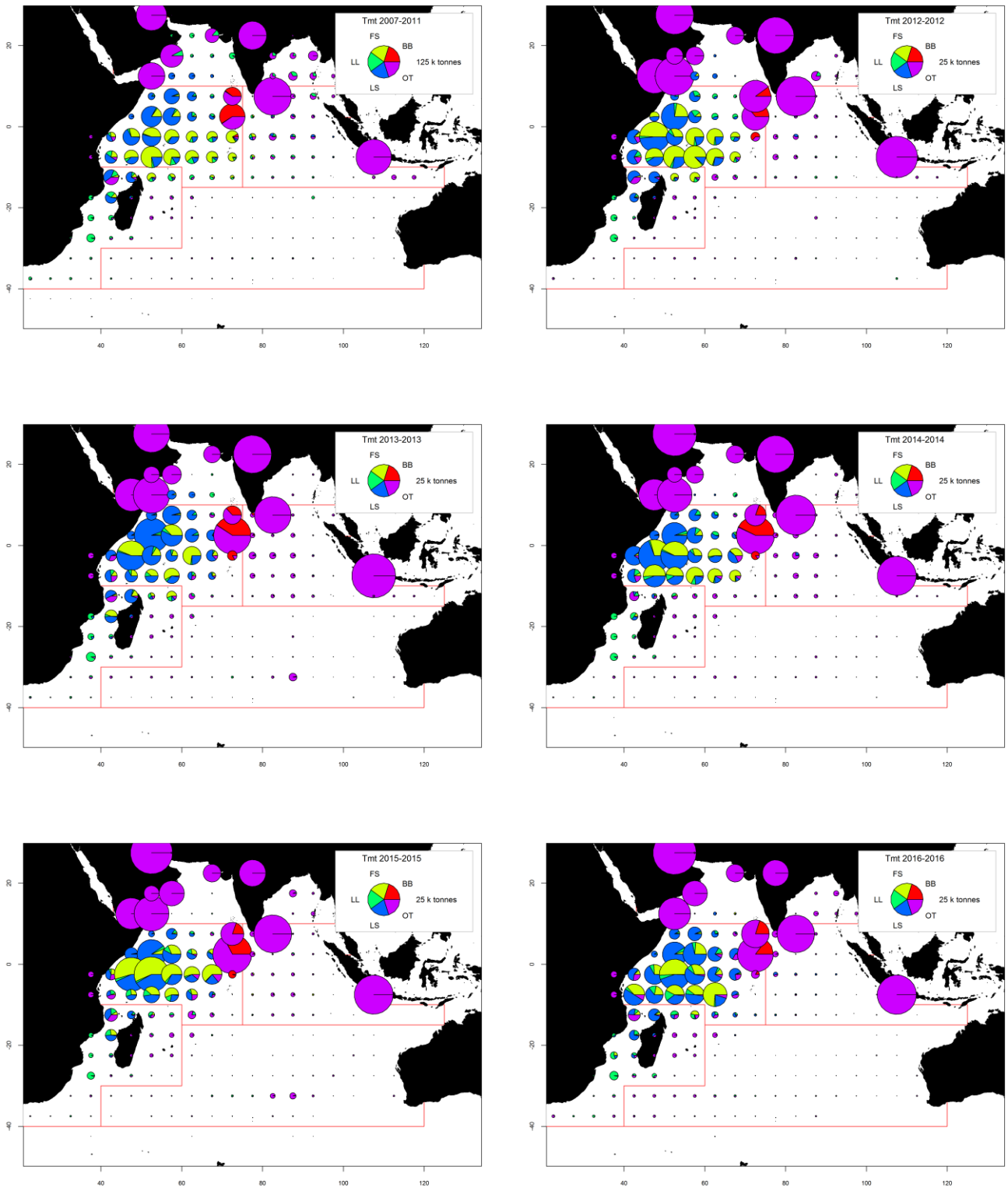


Fig. 4(a-f). Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 2007–2011 by type of gear and for 2012–2016, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including 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 Yemen, Oman, Comoros, Indonesia and India.

Yellowfin tuna: data availability and related data quality issues

Retained catches

- Data are considered to be generally well known for the major industrial fisheries, with the proportion of catches estimated, or adjusted, by the IOTC Secretariat relatively low (**Fig.5a**). Catches are less certain for the following fisheries/fleets:
  - many coastal fisheries, notably those from Indonesia, Sri Lanka, Yemen, and Madagascar;
  - gillnet fishery of Pakistan;
  - Non-reporting industrial purse seiners and longliners (NEI), and longliners of India.

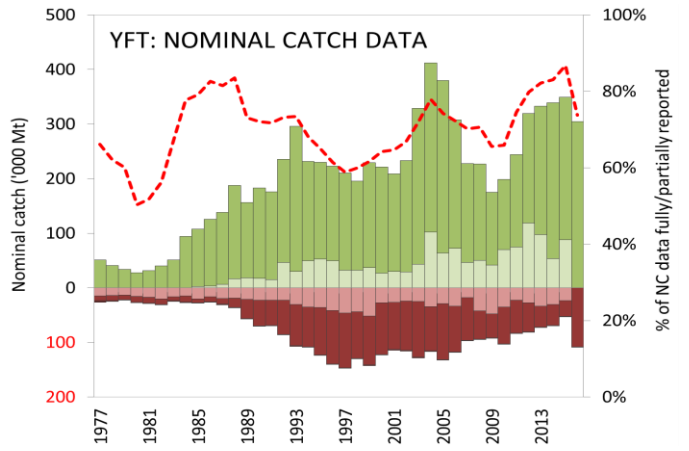
Catch-per-unit-effort (CPUE) trends

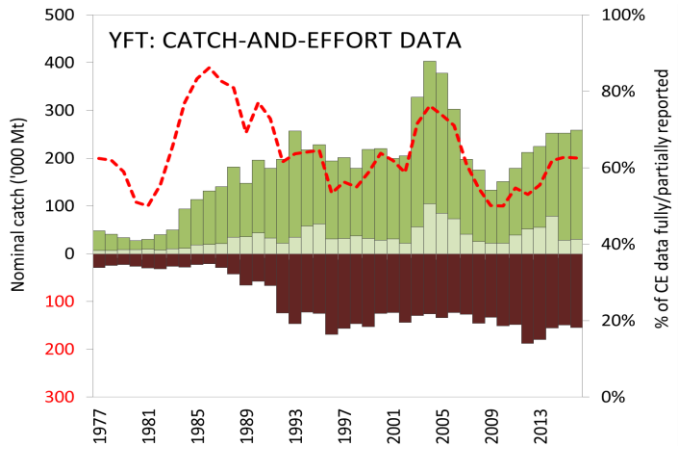
- Availability: Catch-and-effort series are available for the major industrial and artisanal fisheries (e.g., Japan longline, Taiwan,China) (**Fig.5b**).

  However, for other important fisheries catch-and-effort are either not available, or are considered to be of poor quality for the following reasons:
  - no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006;
  - insufficient data for the gillnet fisheries of I.R., Iran and Pakistan;
  - poor quality effort data for the significant gillnet-longline fishery of Sri Lanka;
  - no data are available from important coastal fisheries using hand and/or troll lines, in particular Yemen, Indonesia, and Madagascar.

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

- Average fish weight: trends in average weight can be assessed for several industrial fisheries but they are very incomplete or of poor quality for some fisheries, namely hand lines (Yemen, Comoros, Madagascar), troll lines (Indonesia) and many gillnet fisheries (**Fig.5c**).
  - Purse seine vessels typically take fish ranging from 40 to 140 cm fork length (FL), while smaller fish are more common in catches taken north of the equator.
  - Longline gear mainly catches large fish, from 80 to 160 cm FL, although smaller fish in the size range 60 cm – 100 cm (FL) have been taken by longliners from Taiwan,China since 1989 in the Arabian Sea.
- Catch-at-Size (Age) table: data are available, although the estimates are more uncertain in some years and some fisheries due to:
  - size data not being available from important fisheries, notably Yemen, Pakistan, Sri Lanka and Indonesia (lines and gillnets) and Comoros and Madagascar (lines)
  - the paucity of size data available from industrial longliners from the late-1960s up to the mid-1980s, and in recent years (Japan and Taiwan,China)
  - the paucity of catch by area data available for some industrial fleets (NEI fleets, I.R. Iran, India, Indonesia, Malaysia).





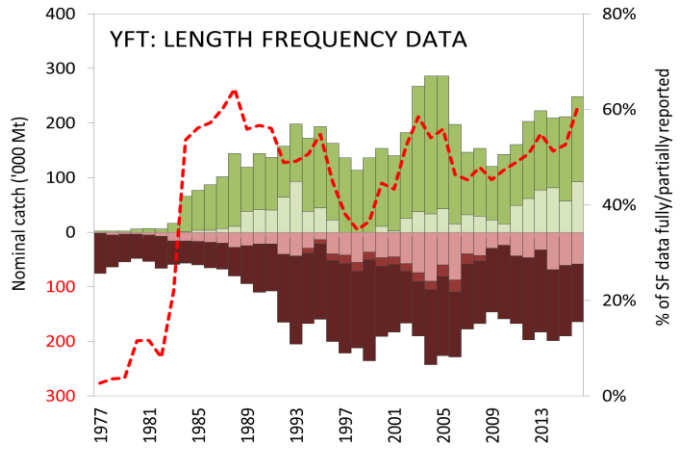


Fig.5a-c. Yellowfin tuna: data reporting coverage (1977–2016).

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

- *Score 0: indicates the amount of nominal catch associated with each dataset that is fully reported according to IOTC standards;*
- *Scores: 2 – 6 refers to the amount of nominal catch associated with each dataset that is partially reported by gear and/or species (i.e., adjusted by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document;*
- *Score: 8 refers to the amount of nominal catch associated with catch-and-effort or size frequency data that is not available.*

The red dotted line indicates the proportion of data (in terms of total catches) fully or partially reported for each dataset.

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	

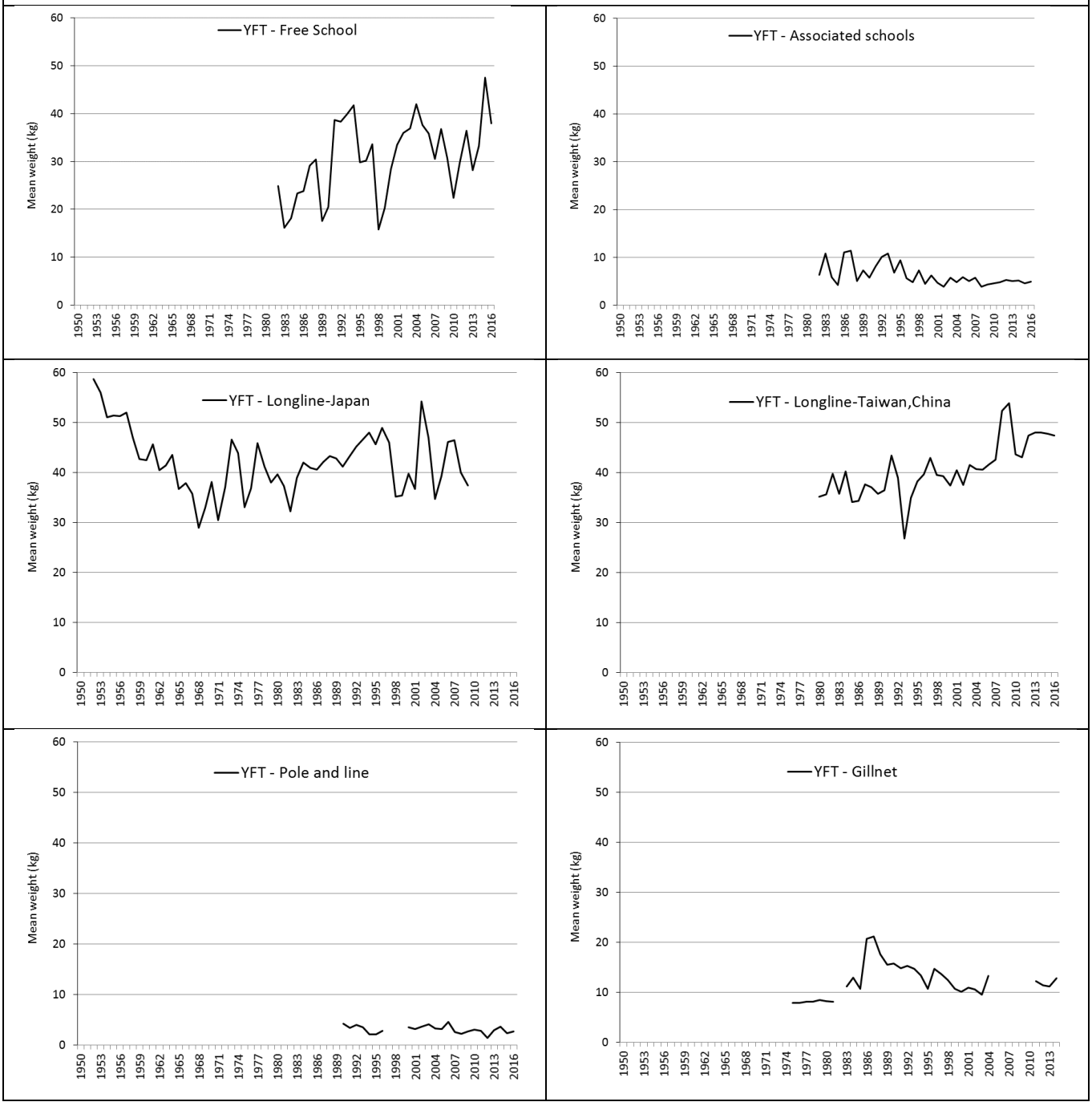
* E.g., Size data not fully available by species, gear, gear, month, or recommended size interval.

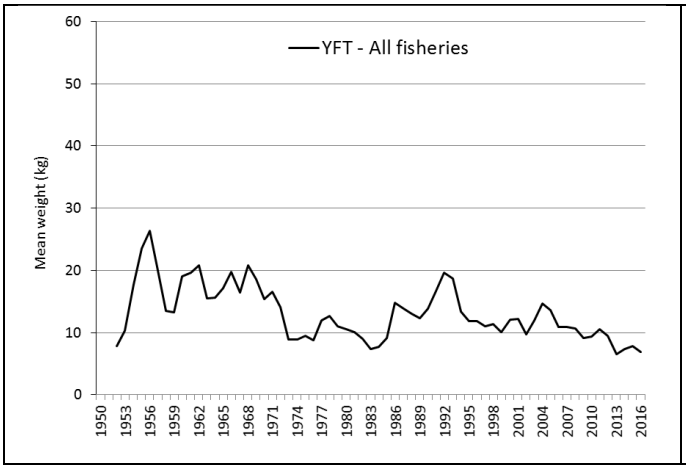
Key to colour coding

- 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. 6 Average weight of yellowfin tuna (YFT) taken by:

- Purse seine on free (top left) and associated (top right) schools,
- Longlines from Japan (second row left) and Taiwan,China (second row right)
- Pole-and-line from Maldives and India (third row left), and gillnets from Sri Lanka, Iran, and other countries (third row right)
- All fisheries (bottom row left), and all fisheries and main gears (bottom row left)




YFT - All fisheries
Mean weight (kg)
0
10
20
30
40
50
60
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
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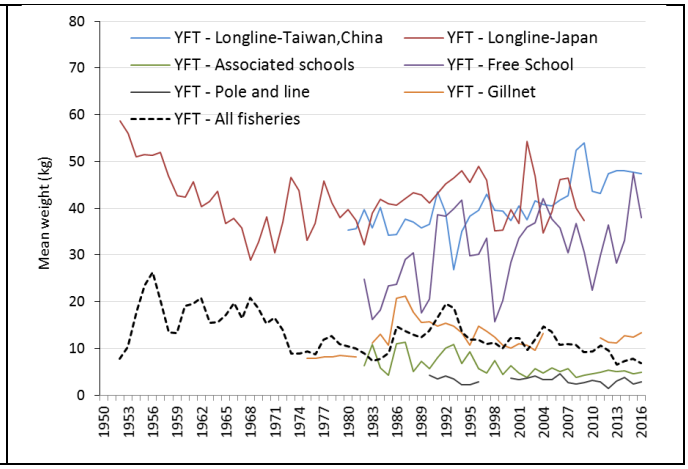
2004
2007
2010
2013
2016


YFT - Longline-Taiwan,China
YFT - Longline-Japan
YFT - Associated schools
YFT - Free School
YFT - Pole and line
YFT - Gillnet
YFT - All fisheries
Mean weight (kg)
0
10
20
30
40
50
60
70
80
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
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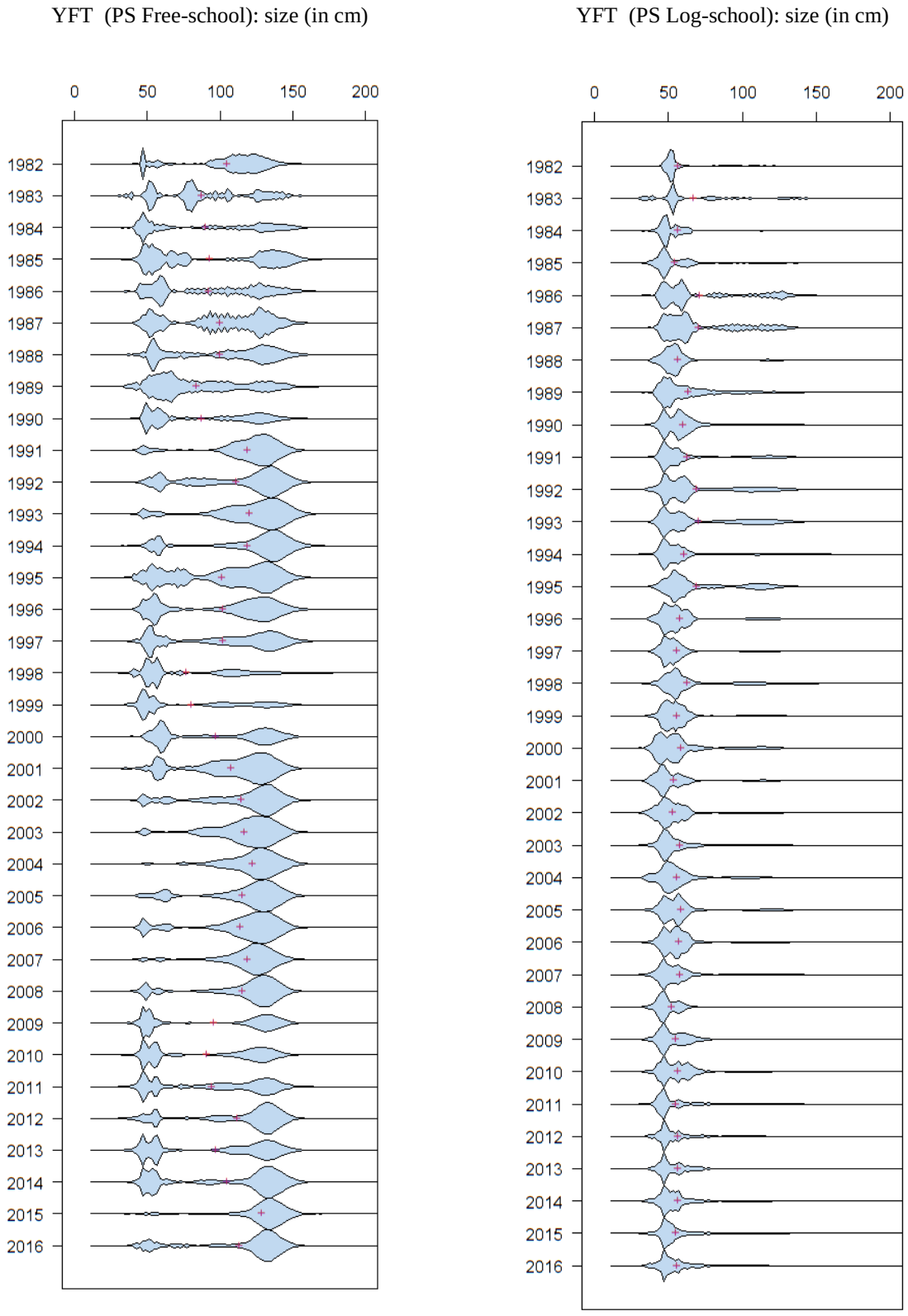


Fig.7 Yellowfin tuna (purse seine): **Left:** length frequency distributions for YFT PS Free school fisheries (by 2 cm length class). **Right**: Length frequency distributions for YFT PS Associated (log) school fisheries (by 2 cm length class). Source: IOTC database.

YFT (LL samples): size (in cm)

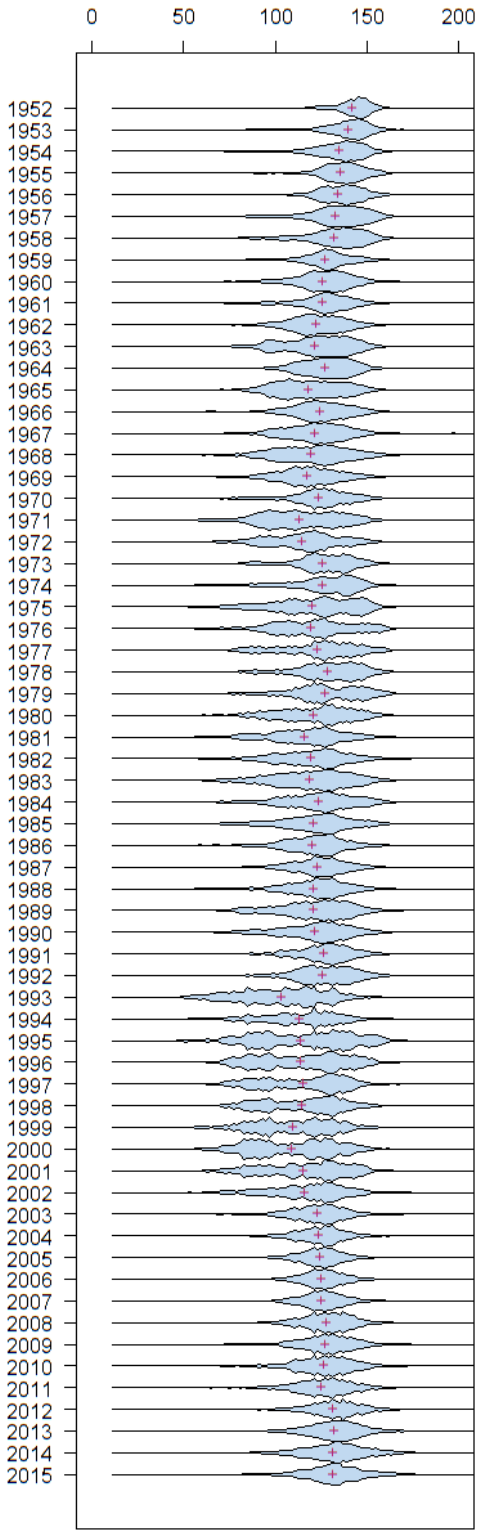


Fig. 8 Yellowfin tuna (longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths, by fleet (longline only).

Yellowfin tuna: tagging data

- A total of 63,328 yellowfin tuna (representing 31.4% of the total number of specimens tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of the tagged specimens (86.4%) were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and were released around Seychelles, in the Mozambique Channel, along the coast of Oman and off the coast of Tanzania, between May 2005 and September 2007 (**Fig.9**). The remaining specimen were tagged during small-scale tagging projects, and by other institutions with the support of IOTC Secretariat, in Maldives, India, and in the south west and the eastern Indian Ocean.
- To date, around 10,840 specimens (17.1%), have been recovered and reported to the IOTC Secretariat. More than 85.9% of these recoveries were made by the purse seine fleets operating in the Indian Ocean, while around 9.1% were made by pole-and-line and less than 1% by longline vessels. The addition of the data from the past projects in the Maldives (in 1990s) added 3,211 tagged yellowfin tuna to the databases, or which 151 were recovered, mainly from the Maldives.

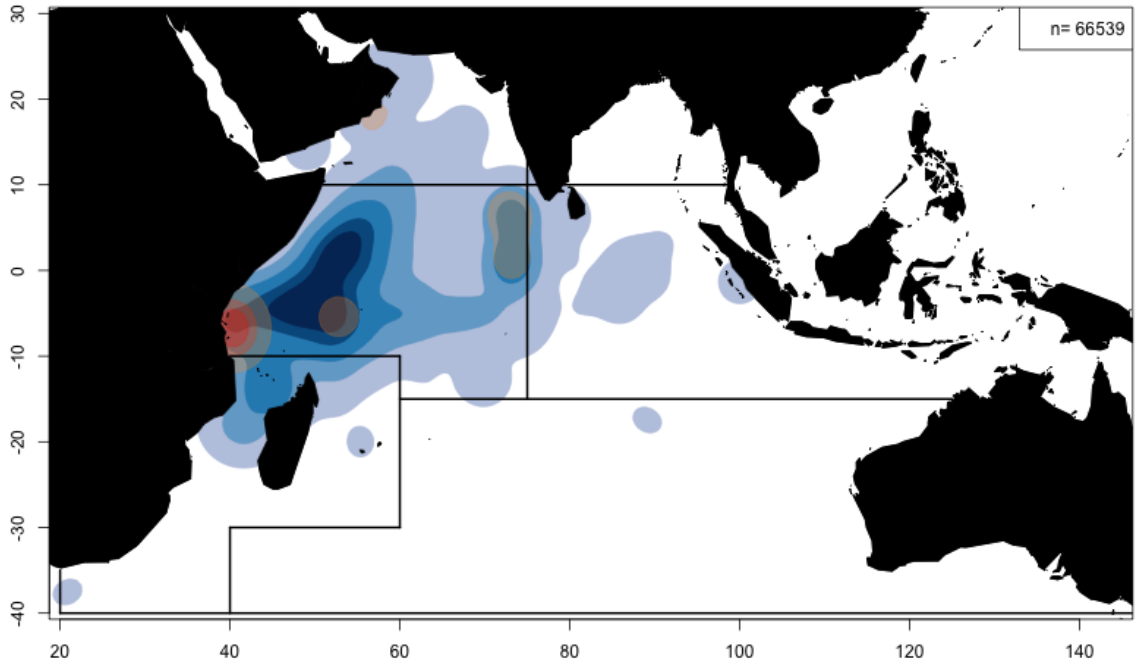


Fig.9. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s.

Yellowfin tuna: Effort trends

Total effort from longline vessels flagged to Japan, Taiwan,China and EU,Spain by five degree square grid in 2015 and 2016 are provided in **Fig.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 in 2015 and 2016 are provided in **Fig.11**.

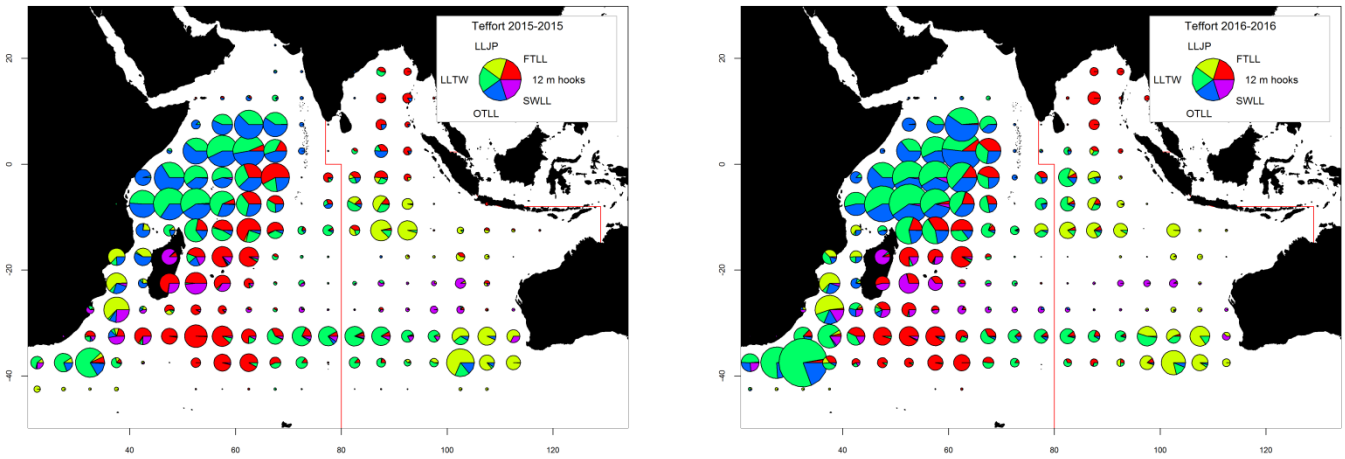


Fig.10. Number of hooks set (millions) from longline vessels by five degree square grid and main fleets, for the years 2014 (left) and 2015 (right). Definition of fisheries:

- **LLJP** (light green): deep-freezing longliners from Japan
- **LLTW** (dark green): deep-freezing longliners from Taiwan,China
- **SWLL** (purple): 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, South Korea and various other fleets)

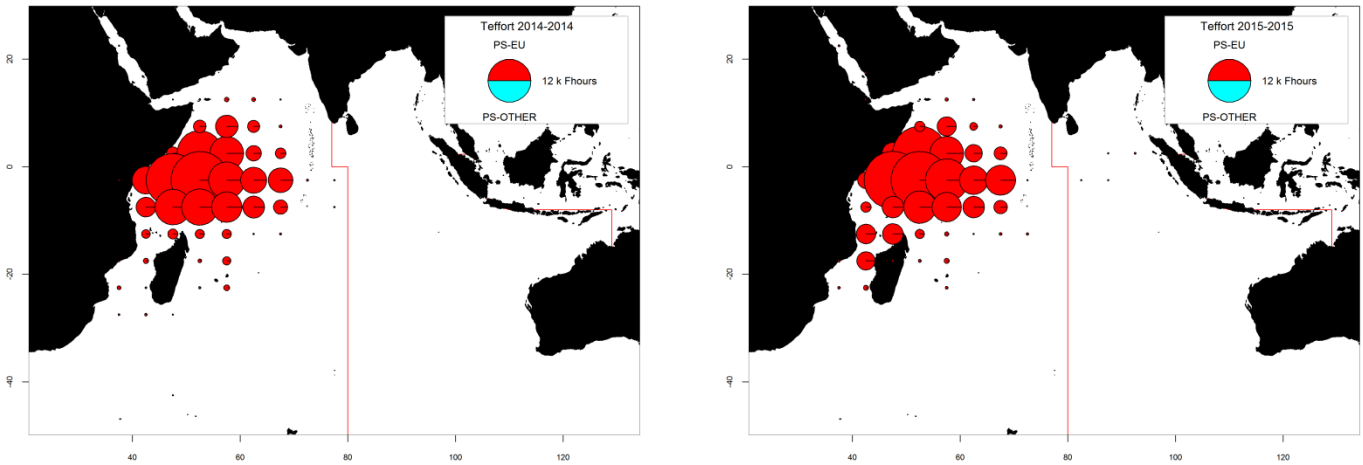


Fig.11. Number of hours of fishing (Fhours) from purse seine vessels by 5 degree square grid and main fleets, for the years 2015 (left) and 2016 (right). Definition of fisheries:

- **PS-EU** (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
- **PS-OTHER** (light blue): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin) (excludes effort data for purse seiners of Iran and Thailand, and days-at-sea recorded for Australia)

Yellowfin tuna – Standardised catch–per–unit–effort (CPUE) trends

The CPUE series presented at the WPTT18 meeting in 2016 are listed below. The joint longline CPUE by region (1979–2015) was utilised for the final stock assessment model runs and in the development of management advice, noting that the Japanese and Taiwanese longline series from the tropical areas and the Indian Ocean as a whole, showed very similar trends (**Figs. 12 & 13**).

- Joint longline CPUE (1979-2015): Series (regions 1 to 4) from document IOTC-2016-WPTT18-14.
- EU (France and Spain) PS CPUE from document IOTC–2016–WPTT18–24.
- Japan data (1960–2015): Series (whole Indian Ocean, tropical area, temperate area) from document IOTC–2016–WPTT18–25.

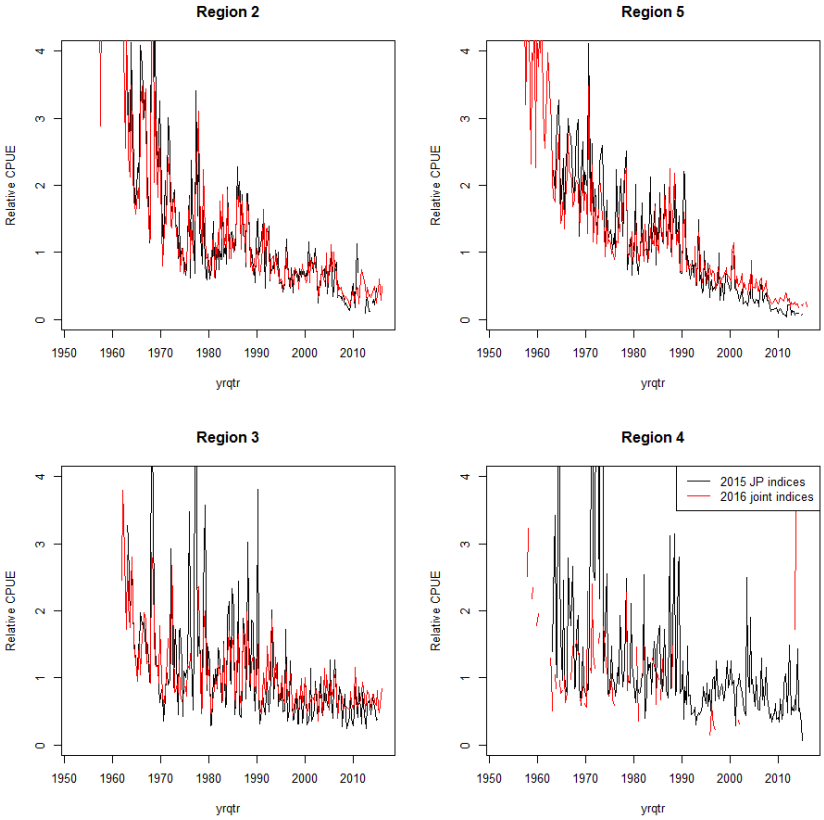
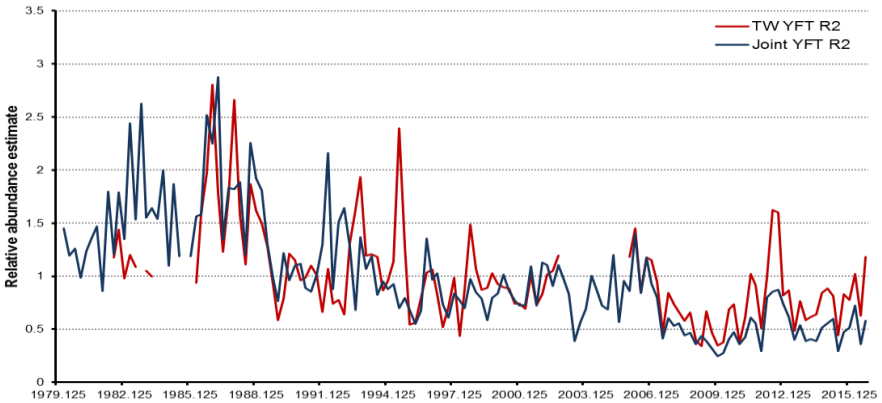


Fig.12: Comparison of the 2016 joint indices described in this paper (red) with the Japanese indices developed in 2015 and used in the 2015 yellowfin stock assessment (black).



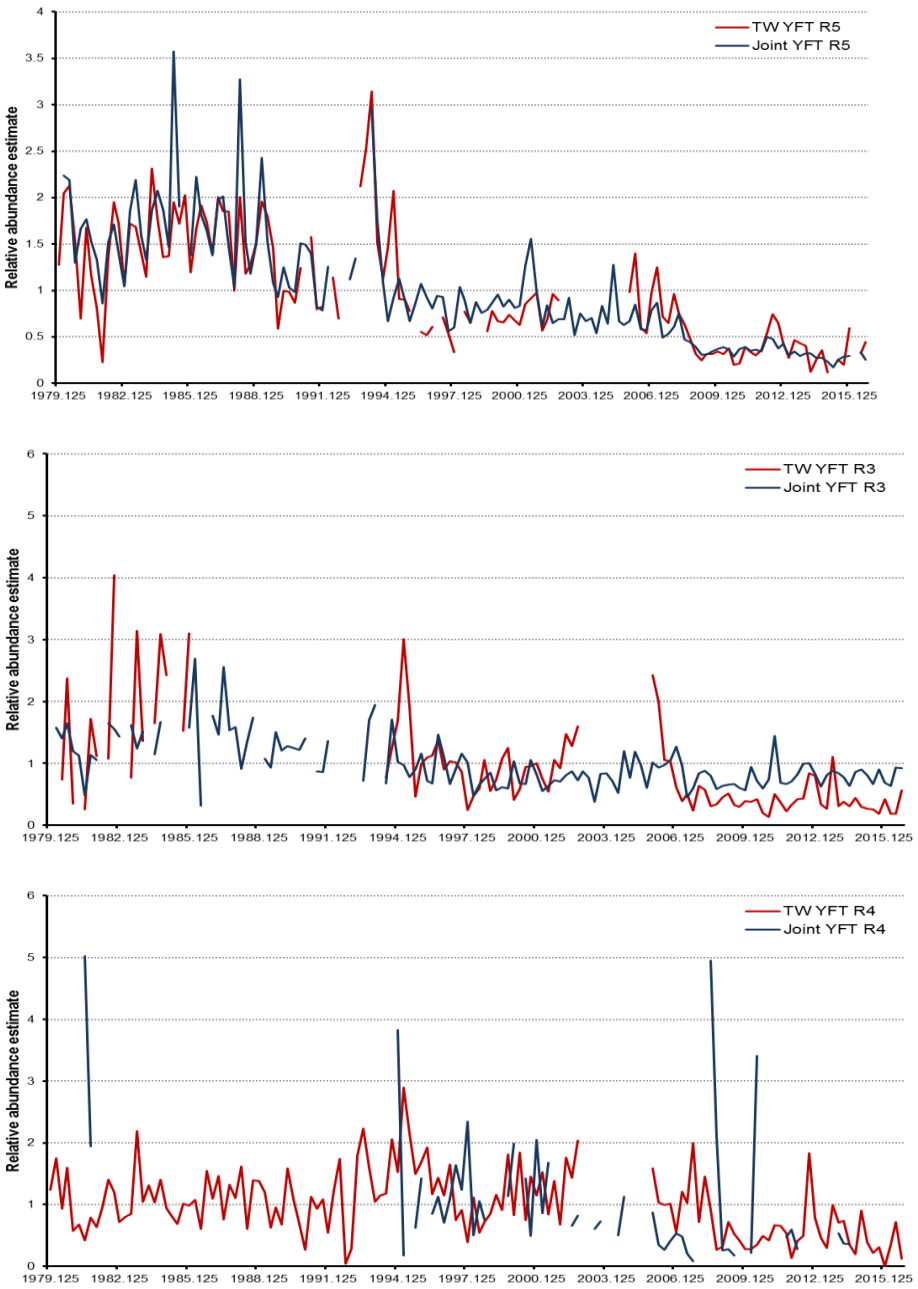


Fig.13. Comparisons of Taiwan,China yellowfin tuna CPUE time series (red) with those estimated during the 2016 collaborative project (blue) by region.

The following points in relation to the longline CPUE discussions in 2016 should be noted:

- The WPTT reiterated that the multi-nation CPUE standardisation collaboration continue their efforts to improve the understanding of commercial CPUE as relative abundance indices, and expand future work to include other fleets.

STOCK ASSESSMENT

The following should be noted with respect to the SS3 modelling approach used for determining stock status (**Table 4**) at the WPTT18 meeting:

- The SS3 modelling approach (updated from 2015 stock assessment specifications) included the following additional data sets:
    i. Fishery catches from 2015.

ii. Revised purse seine catches from 2014.
iii. Composite LL CPUE indices for Regions 1-4[1] (Hoyle, et al 2016).
iv. CPUE indices for free school (1984-2015) and FAD (2004-2014) from Katara et al (2016).

- CPUE indices for the PS fishery were available and were included in a number of model trials. However, the WPTT did not consider these indices to represent stock abundance and consequently did not include these indices in the final model options.
- The impact of each one of the changes made to the 2015 stock assessment model specification was assessed. The most influential factor was the use of the joint LL CPUE indices, which led to a stock status estimation of overexploited and undergoing overexploitation – but at relatively lower levels in *F* than estimated for 2014 (-17%), and with higher biomass levels of +35%.
- A series of sensitivity runs were made to the updated base case:
  i. CPUE indices for free school (1984-2015) and FAD (2004-2014), from Katara et al (2016).
  ii. Down weighting of tagging information.
  iii. Increasing the tagging mixing period to 8 quarters.
- Based on the discussions on the tagging mixing period during previous WPTT meetings, related to the assessment of yellowfin and other tropical tuna stocks, the WPTT recommended that additional work be conducted to elucidate the most appropriate approach to tag modelling in IOTC stock assessments.
- The model scenario with an extended mixing period for the tag recoveries results in a stock at very similar levels relative to B_{MSY} of the base case scenario, but a fishing mortality for 2015 below the estimated F_{MSY}.
- The projections reflect low recruitment estimated for the recent past, which results in a decline in spawning biomass in the short term, regardless of the catch level projected. In the longer term, the assumption of deterministic recruitment results in increased spawning biomass when these cohorts enter the spawning population.

[1] Hoyle, et al (2016), Collaborative study of tropical tuna CPUE from multiple Indian Ocean longline fleets in 2016, IOTC-2016-WPTT18-14, available at: http://www.iotc.org/documents/collaborative-study-tropical-tuna-cpue-multiple-indian-ocean-longline-fleets-2016.

Table 4. Yellowfin tuna: Key management quantities from the SS3 assessment conducted in 2016, for the Indian Ocean*. Values represent the Maximum Posterior Density from the base case and the confidence interval empirically derived from the covariance matrix.

Management Quantity	**Indian Ocean**
Most recent catch estimate (t) (2015)	407,574
Mean catch over last 5 years (t) (2011–2015)	390,188
h (steepness)	0.8
MSY (1,000 t) (80% CI)	422 (406-444)
Data period (catch)	1950–2015
CPUE series/period	1972–2015
F_{MSY} (80% CI)	0.15 (0.15-0.15)
SB_{MSY} or $*B_{MSY}$ (1,000 t) (80% CI)	947 (900-983)
F_{2015}/F_{MSY} (80% CI)	1.11 (0.86-1.36)
B_{2015}/B_{MSY} (80% CI)	n.a.
SB_{2015}/SB_{MSY} (80% CI)	0.89 (0.79-0.99)
B_{2015}/B_{1950} (80% CI)	n.a.
SB_{2015}/SB_{1950} (80% CI)	0.289 (n.a.-n.a.)
$SB_{2015}/SB_{current,\ F=0}$ (80% CI)	n.a.

** The management quantities refer to the data used in the last assessment, conducted in 2016.*

LITERATURE CITED

Froese R, Pauly DE (2009) *FishBase*, version 02/2009, FishBaseConsortium, <www.fishbase.org>