REVIEW OF THE STATISTICAL DATA AND FISHERY TRENDS FOR TROPICAL TUNAS

PREPARED BY: IOTC SECRETARIAT[1], 28 OCTOBER 2016

PURPOSE

To provide the Working Party on Tropical Tunas (WPTT) with a review of the status of the information available on tropical tuna species in the databases at the IOTC Secretariat as of **October 2016**, as well as a range of fishery indicators, including catch and effort trends, for fisheries catching tropical tunas in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, size-frequency and other data, in particular release and recapture (tagging).

BACKGROUND

Prior to each WPTT meeting the Secretariat develops a series of maps, figures and tables that highlight historical and emerging trends in the fisheries data held by the Secretariat. This information is used during each WPTT meeting to inform discussions around stock assessment and in developing advice to the Scientific Committee.

This document summarises the standing of a range of information received for the tropical tuna species, under the IOTC Mandate (**Table 1**), in accordance with IOTC Resolution 15/02 *Mandatory statistical requirements for IOTC Members and Cooperating Non-Contracting Parties (CPC's)*[2], for the period 1950–2015.

The document also provides: summaries of any important reviews to series of historical catches for tropical tuna species; a range of fishery indicators, including catch and effort trends, for fisheries catching tropical tunas in the IOTC area of competence.

The report is split into the following sections:

- **Section 1**: Overview of data for tropical tuna species in the Indian Ocean
- **Section 2**: Data issues related to the statistics reported to the IOTC for tropical tunas
- **Section 3**: Main fisheries and catch data available for each tropical tunas, including:
    - Catch trends
    - Status of fisheries statistics for tropical tunas
    - Status of tagging data
- **Appendix I**: Estimation of catches of non-reporting fleets
- **Appendix II**: IOTC standard length and weight equations for tropical tunas
- **Appendix III**: IOTC standard length and weight equations for tropical tunas

Major data categories covered by the report

Nominal catches: Total annual retained catches (in live weight) and discards (in live weight and number), estimated per fleet, IOTC Area, gear and year for a large area. If these data are not reported the Secretariat estimates a total catch from a range of sources (including: partial catch and effort data; data in the FAO FishStat database; catches estimated by the IOTC from data collected through port sampling; data published through web pages or other means; and data reported by parties on the activity of vessels under their flag (IOTC Resolution 10/08; IOTC Resolution 12/05) or other flags (IOTC Resolution 14/05; IOTC Resolution 05/03); data on imports of bigeye tuna from vessels under the flag concerned (IOTC Resolution 01/06); and data on imports of tropical tunas from canning factories collaborating with the International Seafood Sustainability Foundation[3].

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[2] This Resolution superseded IOTC Resolutions 10/02, 98/01, 05/01 and 08/01.

[3] With catch imports by vessel, trip, species and commercial category forwarded to the IOTC Secretariat on each quarter.

Catch and effort data: Refers to the fine-scale data – usually from logbooks – reported in aggregated format: per fleet, year, gear, type of school, month, grid and species. Information on the use of fish aggregating devices (FADs) and activity of vessels that assist industrial purse seiners to locate tuna schools (supply vessels) is also collected.

Length frequency data: individual body lengths of IOTC species per fleet, year, gear, type of school, month and 5 degrees square areas.

Tagging data: release and recovery data gathered in the framework of the Indian Ocean Tuna Tagging Programme (IOTTP), which encompass data gathered during the Regional Tuna Tagging Project – Indian Ocean (RTTP-IO) and data gathered during a series of Small-scale tuna tagging projects in Maldives, India, Mayotte, Indonesia and by other institutions, e.g. SEAFDEC, NRIFSF, with the support of IOTC. In 2012, the data from past projects implemented in Maldives in the 1990s was added to the tagging database at the Secretariat, and as of September 2015 this database contains 219,121 releases and 34,341 recoveries.

Tropical tuna species and main fisheries in the Indian Ocean

Table 1 below shows the three species of tropical tunas under IOTC management.

Table 1. Tropical tuna species under the IOTC mandate

IOTC code	English name	Scientific name
BET	Bigeye tuna	*Thunnus obesus*
SKJ	Skipjack tuna	*Katsuwonus pelamis*
YFT	Yellowfin tuna	*Thunnus albacares*

SECTION 1: OVERVIEW OF DATA FOR TROPICAL TUNA SPECIES IN THE INDIAN OCEAN

Fisheries and catch trends for tropical tuna species

- Main species: Yellowfin tuna accounts for 45% of total catches of tropical tunas, followed closely by skipjack tuna (≈44%), while catches of bigeye tuna account for the remaining 11% of catches (**Fig. 1d**).

- Main fishing gear (2012-15): purse seiners account for 36% of total catches of tropical tunas, with important catches also reported by gillents (19%), handlines and trolling (18%), longlines (14%), and pole-and-line (11%), in both coastal waters and the high seas.

  Tropical tunas are the target species of many industrial and artisanal fisheries throughout the Indian Ocean, although they are also a bycatch of fisheries targeting other tunas, small pelagic species, or other non-tuna species.

- Main fleets (i.e., highest catches in recent years): Tropical tunas are caught by both coastal countries in the Indian Ocean and distant water fishing nations (**Fig. 2**).

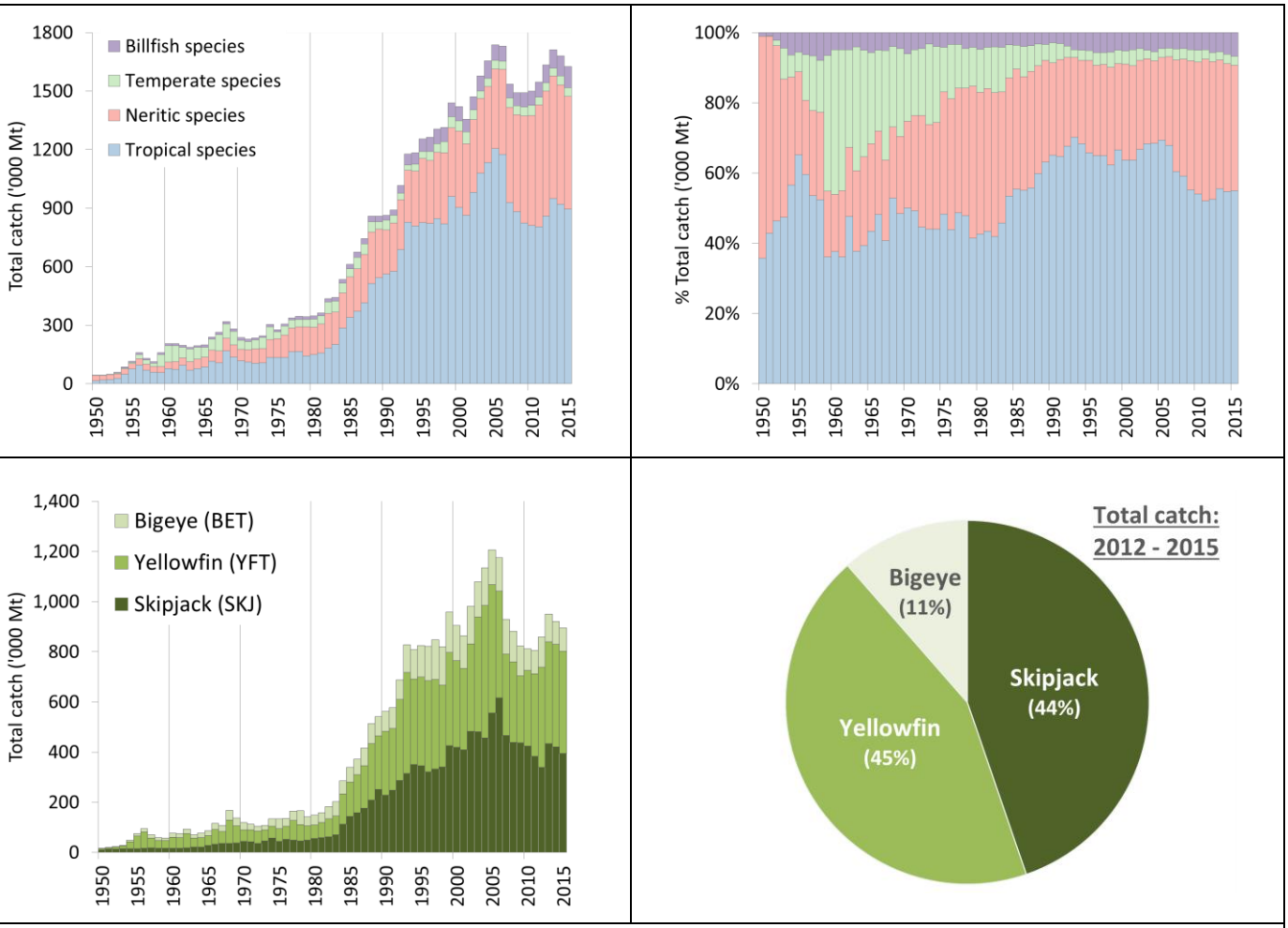
  In recent years the coastal fisheries of five countries (Indonesia, Maldives, Sri Lanka, I.R. Iran, and India) have accounted for ≈55% of the total catches of tropical tuna species in the Indian Ocean, while the industrial purse seiners and longliners flagged as EU-Spain, Seychelles and EU-France reported a further 27% of total catches of these species.

- Retained catch trends: The importance of tropical tunas to the total catches of IOTC species in the Indian Ocean has changed over the years (**Figs. 1a-b.**), in particular following the arrival of industrial purse seine fleets to the Indian Ocean in the early-1980s targeting tropical tunas. With the onset of piracy in the late-2000s, the activities of fleets operating in the north-west Indian Ocean have been displaced or reduced – particularly the Asian distant-water longline fleet – leading to a relative decline in the proportion of catches from tropical tunas (i.e., currently around 55% of total catches of all IOTC species, compared to ≈60% over the (pre-piracy) period 1950-2008).

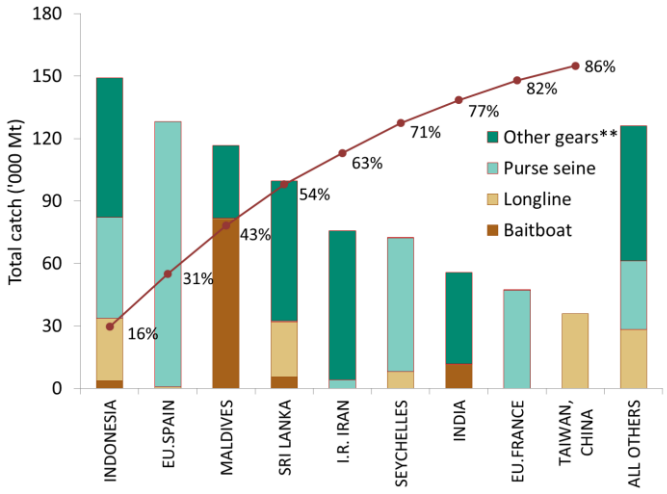
  Since 2012 catches of tropical tunas appear to show signs of recovery – in particular catches from the distant water longline fleets (e.g., Taiwan,China) – as a result of the reduction of the threat of piracy and return of fleets and to the north-west Indian Ocean. Total catches of tropical tunas have increased from < 820,000 t during the years of piracy in the late 2000s, to over 950,000 t in 2013.

- Economic markets: The majority of catches of tropical tuna species are sold to international markets, including the *sashimi* market in Japan (large specimens of yellowfin tuna and bigeye tuna in fresh or deep-frozen condition), and processing plants in the Indian Ocean region or abroad (small specimens of skipjack tuna and, to a lesser

extent, yellowfin tuna and bigeye tuna). A component of the catches of tropical tunas, in particular skipjack tuna caught by some coastal countries in the region, is sold in local markets or retain by the fishermen for direct consumption.



Figs. 1a-d. Top: Contribution of the three tropical tuna species under the IOTC mandate to the total catches of IOTC species in the Indian Ocean, over the period 1950-2015 (a. Top left: total catch; b. Top right percentage, same colour key as Fig. 1a).; **Bottom:** Contribution of each tropical tuna species to the total combined catches of tropical tunas (c. Bottom left: nominal catch of each species, 1950-2015; d. Bottom right: share of tropical tuna catch by species, 2012-15)



*** Other gears includes handline, gillnet, gillnet-longline, trawling.*

Fig. 2. All tropical tunas: average catches in the Indian Ocean over the period 2012–15, by country. Countries are ordered from left to right, according to the importance of catches of tropical tunas reported. The red line indicates the (cumulative) proportion of catches of tropical tunas for the countries concerned, over the total combined catches of species reported from all countries and fisheries.

SECTION 2: SUMMARY OF DATA ISSUES RELATED TO THE STATISTICS OF TROPICAL TUNA SPECIES REPORTED TO THE IOTC

The following section provides a summary of the main issues that the IOTC Secretariat considers to negatively affect the quality of tropical tuna statistics available at the IOTC, by type of dataset and fishery, for the consideration of the WPTT.

1. Nominal (retained) catches

- Taiwan,China (longline): inconsistencies have been noted between catches of bigeye tuna originating from the Indian Ocean by the Taiwanese longline fleet – as reported by the nominal catches compared to the Bigeye Statistical Document – as a result of possible of misreporting of catches between the Atlantic and Indian Oceans. Between 2001-2004 the Bigeye Statistical Document has recorded higher catches of Indian Ocean bigeye tuna compared to nominal catches – even after the official nominal catches were been revised upwards by around 3,000 t – 6,000 t per annum. While current bigeye nominal catches in the IOTC database are closer to those reported to the Bigeye Statistical Document, discrepancies still remain and the issue has still not been fully resolved.
- Maldives (pole-and-line): the pole-and-line fishery is known to catch some juvenile bigeye tuna, however up to 2013 catches of yellowfin tuna and bigeye tuna were aggregated and reported to the IOTC Secretariat as yellowfin tuna only. The IOTC Secretariat has previously used the proportion of bigeye tuna collected in the Maldives in previous sampling programs to disaggregate the catches of yellowfin tuna, per year – with average catches of bigeye tuna estimated at around 850 t per year.

  While Maldives has made some progress in improving the accuracy of catches by species, notably with the introduction of logbooks since 2012, estimates of bigeye tuna still remain uncertain for earlier years and further work is needed to improve the accuracy of catches for the historical series.
- Sri Lanka (gillnet-longline fishery): Although Sri Lanka has reported catches of bigeye tuna for it's gillnet/longline fishery, catches are considered to be too low, possibly due to the mislabelling of catches of bigeye tuna as yellowfin tuna.
- I.R. Iran (drifting gillnet): In 2013 I.R. Iran reported catches of bigeye tuna for its drifting gillnet fishery for the first time, (i.e., data for year 2012). The IOTC Secretariat has estimated caches of bigeye tuna for Iran for years before 2012, assuming various levels of activity of vessels using driftnets on the high seas, depending on the year, and catch ratios between bigeye tuna and yellowfin tuna recorded for industrial purse seiners on free-swimming tuna schools in the northwest Indian Ocean. Catches of bigeye tuna have been estimated for the period 2005–2011 (at around 700 t per year), however estimates remain uncertain.
- Pakistan (drifting gillnet): Up to 2016, Pakistan has not reported catches of bigeye tuna for its gillnet fishery, although a component of the fleet is known to operate on the high seas, where catches of bigeye tuna are reported by other fleets operating the same area.
- Coastal fisheries of Indonesia, Madagascar, Sri Lanka[4] (other than gillnet/longline) and Yemen: The catches of tropical tunas for these fisheries have been estimated by the IOTC Secretariat in recent years – although the quality of the estimates is thought to be very poor due to the lack of information available about the fisheries operating in these countries.
  - *Update*: In 2016, IOTC catch estimates for Yemen were updated – based on FAO data – however the quality of catches remains highly uncertain. A more substantial review of catches is still required.
- Indonesia (longline): has not reported catches for longliners under their flag that are not based in their ports.
- Comoros (coastal fisheries): In 2011-12 the IOTC and the OFCF provided support to the strengthening of data collection for the fisheries of Comoros, including a Census of fishing boats and the implementation of sampling to monitor the catches unloaded by the fisheries in selected locations over the coast. The IOTC Secretariat and the *Centre National de resources Halieutiques* of Comoros derived estimates of catch using the data collected and the new catches estimated are at around half the values reported in the past by Comoros (around 5,000 t per year instead of 9,000 t). The IOTC Secretariat revised estimates of catch for the period 1995-2010 using the new estimates.

[4] In 2012-13 the Ministry of Fisheries and Aquatic Resources Development of Sri Lanka received support from IOTC, the OFCF and BOBLME to strengthen its data collection and processing system, which should lead to improvements in the estimate of catch for the coastal fisheries of Sri Lanka for 2012 and subsequent years.

2. Discards – all fisheries

- The total amount of tropical tunas discarded at sea remains unknown for most fisheries and time periods. Discards of tropical tunas are thought to be significant during some periods of industrial purse seine fisheries using fish aggregating devices (FADs) and may also be high due to depredation of catches of longline fisheries, by sharks or marine mammals, in tropical areas.
  - *Update*: The IOTC Secretariat is actively working with CPCs to develop the Regional Observer Scheme, which will lead to improvements in the estimates of discards of tropical tunas. However, for the moment, estimates of discards remain highly uncertain.

3. Catch-and-effort

For a number of fisheries important for catches of tropical tuna, catch-and-effort remains either unavailable, incomplete (e.g., missing catches by species or gear), or only partially reported according to the standards of IOTC Resolution 15/02 and of limited value in deriving indices of abundance:

- I.R. Iran (coastal and offshore fisheries): I.R. Iran ranks sixth largest in terms of total catches of tropical tunas (accounted for mostly by drifting gillnets), however catch-and-effort have not been reported according to IOTC standards, in particular for vessels operating outside of its EEZ. No information is reported on effort, while catches are provided by province rather than 5° grid area.
- Sri Lanka (gillnet-longline): In previous years Sri Lanka has not reported catch-and-effort data as per the IOTC standards, including separate catch-and-effort data for gillnet-longline and catch-and-effort data for those vessels that operate outside its EEZ.
  - *Update*: In 2014 Sri Lanka provided more detailed catch-and-effort for the first time, which the IOTC Secretariat is currently reviewing.
- Indonesia (longline): To date, Indonesia has not reported catch-and-effort data for its longline fishery.
  - *Update*: An IOTC-OFCF mission was conducted in November 2015 to assist Indonesia with reporting of catch-and-effort, size frequency data and Regional Observer data collected on-board longline vessels. Although no catch-and-effort has still not been reported, Indonesia is planning to begin reporting data in 2017.
- Pakistan (drifting gillnet): no catch-and-effort reported for the gillnet fishery, in particular for vessels that operate outside the EEZ of Pakistan.
- India (longline): catches and catch-and-effort data have been reported for its commercial longline fishery for activities inside of the EEZ of India. However, India has not reported catches of tropical tunas or other species for longline vessels under its flag, operating offshore.

4. Size data (all fisheries)

- Japan and Taiwan,China (longline fisheries): In 2010, the IOTC Scientific Committee identified several issues concerning the size frequency statistics available for Japan and Taiwan,China, which remain unresolved. In 2013 the IOTC Secretariat presented a paper to WPTT-15 documenting the current data quality issues and inconsistences between the length frequency data and catch-and-effort reported in particular by Taiwan,China since the mid-2000s[5].

  The WPTT recommended an inter-sessional meeting attached to the WPDCS and WPM on *data collection and processing systems for size data from the main longline fleets in the Indian Ocean*, be carried out in early 2014. Unfortunately arrangements for the inter-sessional meeting were never taken forward.
  - *Update*: Collaboration between the IOTC Secretariat, Japan, and Taiwan,China is on-going and progress will be reported to the WPDCS, WPTT and SC in due course. Japan is due to present an update at WPDCS in 2016.
- In addition, the number of specimens sampled for length on-board longliners flagged in Japan in recent years remains below the minimum recommended by the IOTC (i.e., 1 fish per metric ton of catch measured for length).

[5] See IOTC Secretariat, IOTC-2013-WPTT15-41 Rev_1, for more details.

- I.R. Iran and Pakistan (gillnet): although both countries have reported size frequency data gillnet fisheries in recent years, data have not been reported by area and the number of samples are below the minimum sample size recommended by the IOTC.
- Sri Lanka (gillnet-longline): Although Sri Lanka has reported length frequency data for tropical tunas in recent years, sampling coverage is below recommended levels and lengths are not available by gear type or fishing area[6].
  - *Update*: In 2014 Sri Lanka provided more detailed catch-and-effort for the first time, which the IOTC Secretariat is currently reviewing.
- Indonesia (longline): size frequency data have been reported for its fresh-tuna longline fishery in previous years (e.g., 2002-2003), however samples cannot be fully broken fishing area (i.e., 5° degree grid) and they refer exclusively to longliners based in ports in those countries.
  - *Update*: An IOTC-OFCF mission was conducted in November 2015 to assist Indonesia with reporting of catch-and-effort, size frequency data and Regional Observer data collected on-board longline vessels. Size data collected by the observers was submitted for the first time in 2016.
- To date, these countries have not reported size frequency data for their fisheries:
  - Longline: India, Oman and the Philippines (longline);
  - Coastal fisheries: India, Indonesia and Yemen (coastal fisheries).

5. Biological data for all tropical tuna species

- Surface and longline fisheries, in particular Taiwan,China, Indonesia, Japan, and China:

  The IOTC database does not contain enough data to allow for the estimation of statistically robust length-weight keys or non-standard size to standard length keys for tropical tuna species, due to the general lack of biological data available from the Indian Ocean.

  A summary of the current biological length-weight equations and availability of alternative sources are documented in Appendix II for the consideration of the WPTT, following the recommendation of the WPDCS.

3. STATUS OF FISHERIES STATISTICS FOR TROPICAL TUNAS

Bigeye tuna (BET)

Fisheries and main catch trends

- Main fishing gear (2012–15): industrial fisheries account for the majority of catches of bigeye tuna, i.e., deep-freezing and fresh longline (≈57%) and purse seine (≈27%) (**Table 2; Fig. 3**).

  In recent years catches by gillnet fisheries have also been increasing, due to major changes some fleets (e.g., Sri Lanka and I.R. Iran); notably changes in boat size, fishing techniques and fishing grounds, with vessels using deeper gillnets on the high seas in areas important for bigeye tuna targeted by other fisheries.

- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  Indonesia (fresh longline, coastal longline, and coastal purse seine): 26%; Taiwan,China (longline): 22%; Seychelles (longline and purse seine): 11%; EU-Spain (purse seine): 10% (**Fig. 5**).

- Main fishing areas: Primary: Western Indian Ocean, in waters off Somalia (West A1), although in recent years fishing effort has moved eastwards due to piracy. Secondary: Eastern Indian Ocean (East A2) (**Table 3; Fig.4**).

  In contrast to yellowfin tuna and skipjack tuna – where the majority catches are taken in the western Indian Ocean – bigeye tuna is also exploited in the eastern Indian Ocean, particularly since the late 1990's due to increased activity of small longliners fishing tuna to be marketed fresh (e.g., Indonesia). However, in recent years catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend, as some vessels have moved south to target albacore.

[6] In 2012-13 the Ministry of Fisheries and Aquatic Resources Development of Sri Lanka received support from IOTC, the OFCF and BOBLME to strengthen its data collection and processing system, including collection of more length frequency data from the fisheries.

- Retained catch trends:

  Total catches of bigeye tuna in the Indian Ocean increased steadily from the 1970's, from around 20,000 t in the 1970s, to over 150,000 t by the late 1990s with the development of the industrial longline fisheries and arrival of European purse seiners during the 1980s. Since 2007 catches of bigeye tuna by longliners have been relatively low - less than half the catch levels recorded - before the onset of piracy in the Indian Ocean (e.g., ≈50,000 t).

  Longline fisheries:

  Bigeye tuna have been caught by industrial longline fleets since the early 1950's, but before 1970 only represented incidental catches. After 1970, the introduction of fishing practices that improved catch rates of bigeye tuna, and emergence of a sashimi market, resulted in bigeye tuna becoming a primary target species for the industrial longline fleets. Large bigeye tuna (averaging just above 40 kg) are primarily caught by longliners, in particular deep-freezing longliners.

  Since the late 1980's Taiwan,China has been the major longline fleet targeting bigeye tuna in the Indian Ocean, accounting for as much as 40-50% of the total longline catch in the Indian Ocean (**Fig. 5**).

  Between 2007 and 2011 catches have fallen sharply, largely due to the decline in the number of Taiwanese longline vessels active in the north-west Indian Ocean in response to the threat of piracy. Since 2012 catches appear to show some signs of recovery as a consequence of improvements in security in the area off Somalia and return of fleets (mostly Taiwan,China longline vessels) resuming activities in their main fishing grounds (West (A1)). However current catches still remain far below levels recorded in 2003 and 2004.

  Purse seine fisheries:

  Since the late 1970's, bigeye tuna has been caught by purse seine vessels fishing on tunas aggregated on floating objects and, to a lesser extent, associated to free swimming schools (**Fig. 3**) of yellowfin tuna or skipjack tuna. Purse seiners under flags of EU countries and Seychelles account for the majority of purse seine catches of bigeye tuna in the Indian Ocean (**Fig. 5**) – mainly small juvenile bigeye (averaging around 5 kg) compared to longliners which catch much larger sized fish. While purse seiners take lower tonnages of bigeye tuna compared to longliners, they take larger numbers of individual fish.

  While the activities of purse seiners have also been affected by piracy in the Indian Ocean, the decline in catches of tropical tunas have not been as marked as for longline fleets. The main reason is the presence of security personnel onboard purse seine vessels of the EU and Seychelles, which has made it possible for vessels under these flags to continue operating in the northwest Indian Ocean (**Fig. 6**).

- 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*:** Minor revisions to 2014 catches of bigeye tuna (around -7%, or 7,500 t), as a result of final data received in December 2014 for longline fleets, plus revisions to catches for several other fleets (e.g., Indonesia, NEI fleet, Madagascar, EU-France). Otherwise no major changes to the catch series since the WPTT meeting in 2015.

Table 2. Bigeye tuna: Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by gear and main fleets [or type of fishery] by decade (1950–2009) and year (2006–2015), in tonnes. Catches by decade represent the average annual catch, noting that some gears were not in operation since the beginning of the fishery. Data as of September 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
BB	21	50	266	1,536	2,968	5,069	5,176	6,047	6,109	6,874	6,789	6,880	6,878	7,266	6,188	5,717
FS	-	-	0	2,340	4,824	6,196	6,407	5,672	9,646	5,301	3,792	6,222	7,180	4,654	4,845	8,966
LS	-	-	0	4,852	18,315	20,273	18,526	18,104	19,874	24,708	18,486	16,386	10,434	22,814	15,032	15,860
LL	6,488	21,861	30,413	43,079	62,350	71,465	73,350	74,531	51,883	52,077	32,420	36,158	67,451	45,646	35,625	31,367
FL	-	-	218	3,066	26,282	23,490	18,788	22,450	23,323	15,810	9,782	12,031	12,495	14,710	13,383	16,153
LI	43	295	658	2,384	4,272	5,935	5,891	6,827	6,939	8,001	8,541	8,046	7,617	8,963	9,001	8,132

OT	38	63	164	860	1,408	3,765	4,673	4,622	4,742	6,029	5,558	6,989	8,363	6,790	6,781	6,542
Total	**6,589**	**22,269**	**31,720**	**58,118**	**120,419**	**136,194**	**132,813**	**138,255**	**122,516**	**118,801**	**85,368**	**92,712**	**120,418**	**110,844**	**90,856**	**92,736**

Gears: Pole-and-Line (**BB**); Purse seine free-school (**FS**); Purse seine associated school (**LS**); Deep-freezing longline (**LL**); Fresh-tuna longline (**FL**); Line (handline, small longlines, gillnet & longline combine) (**LI**); Other gears nei (gillnet, trolling & other minor artisanal gears)(**OT**).

Table 3. Bigeye tuna: Best scientific estimates of the catches of bigeye tuna (*Thunnus obesus*) by area [as used for the assessment] by decade (1950–2009) and year (2006–2015), in tonnes. Catches by decade represent the average annual catch. Data as of September 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A1	2,478	11,965	17,642	35,960	60,915	80,740	85,414	84,927	72,300	63,459	44,882	46,666	80,236	67,856	51,598	54,612
A2	3,909	7,280	10,271	18,018	45,972	45,533	41,069	48,449	45,688	51,843	36,262	41,669	35,268	37,437	34,424	33,238
A3	202	3,024	3,806	4,139	13,531	9,921	6,330	4,879	4,528	3,499	4,224	4,378	4,915	5,550	4,833	4,886
Total	**6,589**	**22,269**	**31,720**	**58,118**	**120,419**	**136,194**	**132,813**	**138,255**	**122,516**	**118,801**	**85,368**	**92,712**	**120,418**	**110,844**	**90,856**	**92,736**

Areas: West Indian Ocean, including Arabian sea (A1); East Indian Ocean, including Bay of Bengal (A2); Southwest and Southeast Indian Ocean, including southern (A3). Catches in Areas (**0**) were assigned to the closest neighbouring area for the assessment.

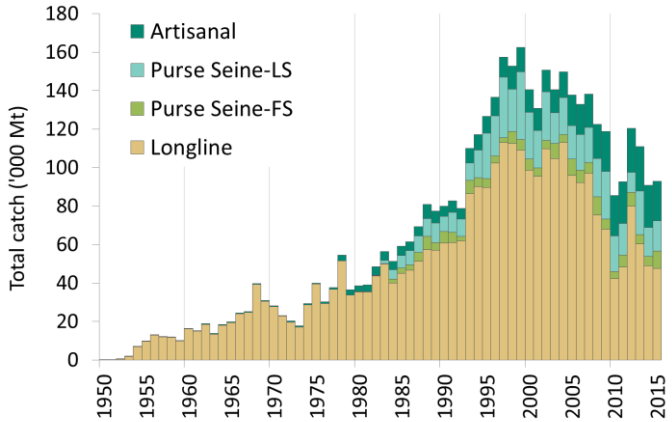
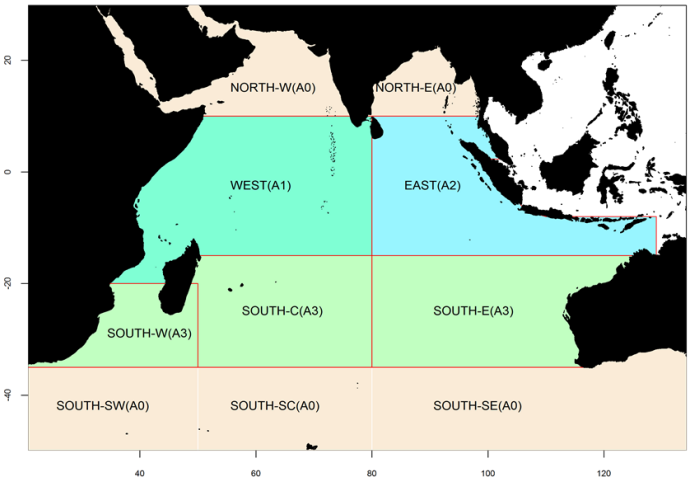


Fig. 3. Annual catches of bigeye tuna by gear (1950–2015). Data as of September 2016.

Gears (as agreed by WPTT): Longline Taiwan,China and associated fleets **(Longline-Taiwan);** Longline Japan and associated fleets **(Longline-Japan)**; Purse seine free-school (**FS**); Purse seine associated school (**LS**); Other gears nei (pole-and-Line, handline, small longlines, gillnet, trolling & other minor artisanal gears) (**Artisanal**).



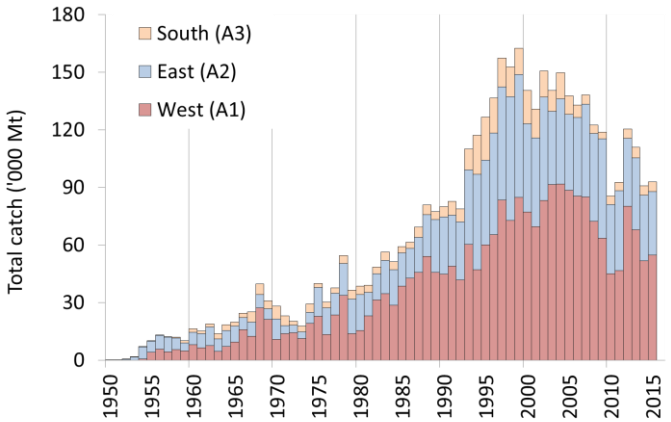


Fig. 4(a-b). Bigeye tuna: Catches of bigeye tuna by (SS3) stock assessment area by year (1950–2015). Catches outside the areas presented in the map were assigned to the closest neighbouring area for the assessment. Data as of September 2016.

Areas: West Indian Ocean (**A1**); East Indian Ocean (**A2**); Southwest and Southeast Indian Ocean (**A3**). Catches in Areas (**0**) were assigned to the closest neighbouring area for the assessment.

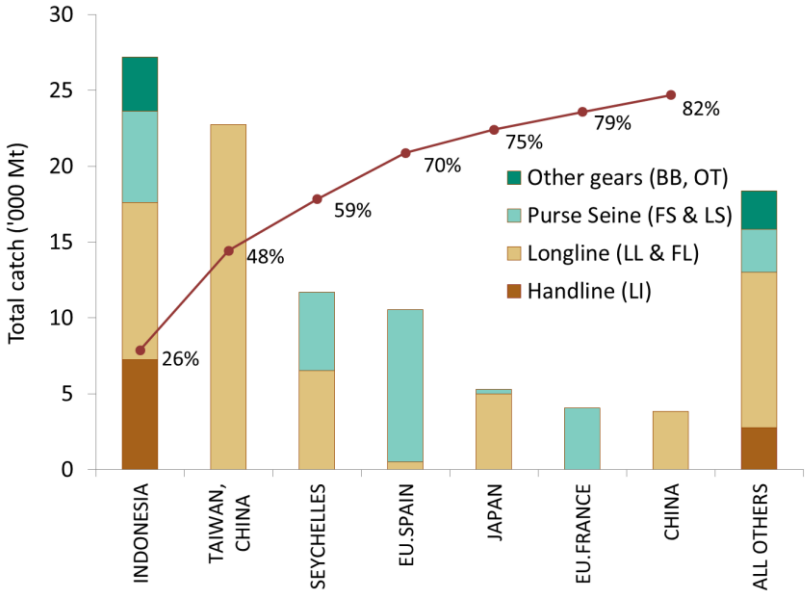


Fig. 5. Bigeye tuna: average catches in the Indian Ocean over the period 2012–15, by country. Countries are ordered from left to right, according to the importance of catches of bigeye reported. The red line indicates the (cumulative) proportion of catches of bigeye for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of September 2016.

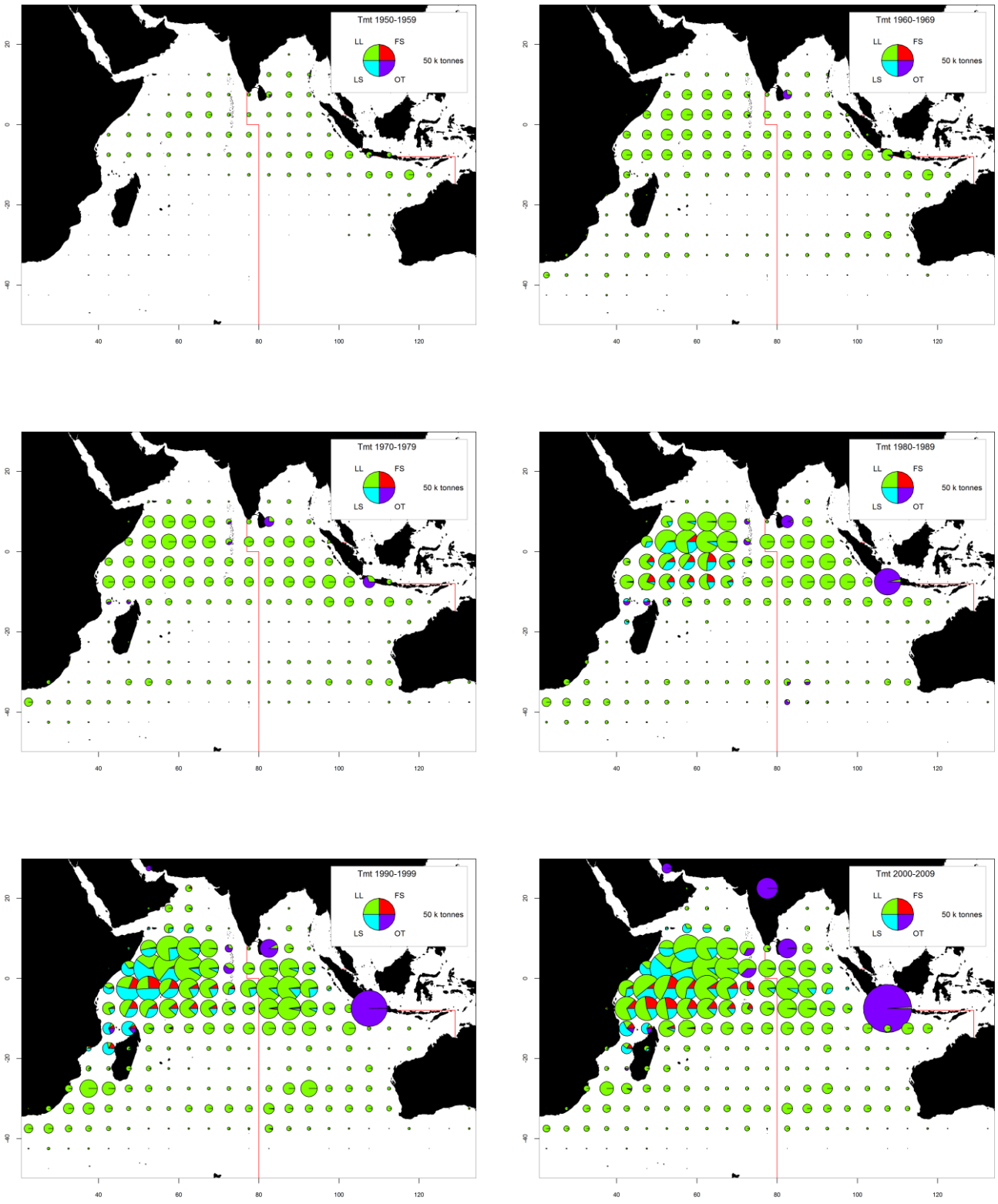


Fig. 6(a-f). Bigeye tuna: Time-area catches (total combined in tonnes) of bigeye tuna estimated for the period 1950–2009, by decade and type of gear.Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries.

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 I.R. Iran, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Indonesia.

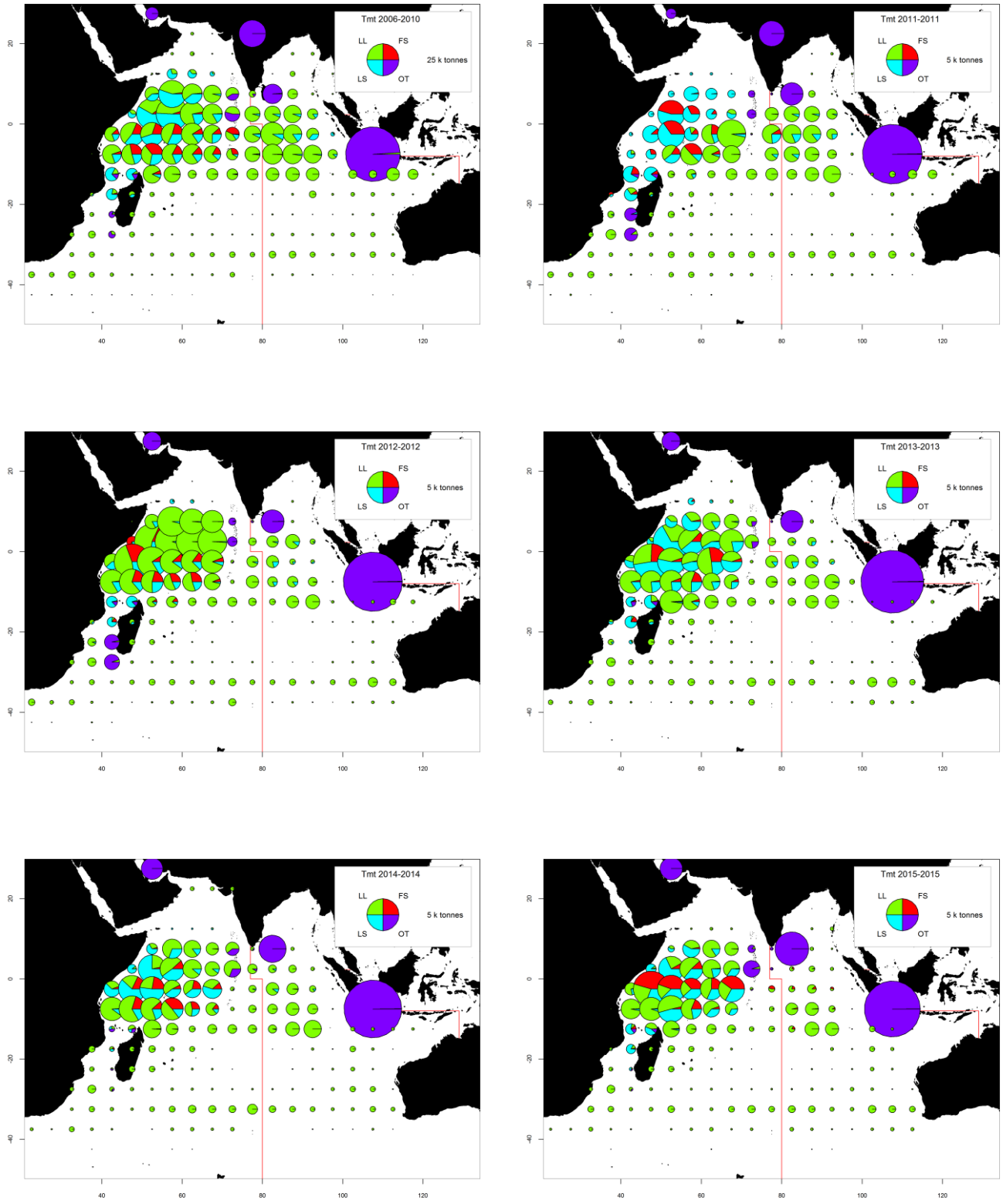


Fig. 7(a-f). Time-area catches (total combined in tonnes) of bigeye tuna estimated for the period 2006–2010 by type of gear and for 2011–15, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries.

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 I.R. Iran, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Indonesia.

Bigeye tuna: data availability and related data quality issues

Retained catches

- Data are considered to be relatively reliable for the main industrial fleets targeting bigeye tuna, with the proportion of catches estimated or adjusted by the IOTC Secretariat relatively low (**Fig. 8a**).
- Catches are less certain for the following fisheries/fleets:
  - Non-reporting industrial purse seiners and longliners (NEI) and other industrial fisheries (e.g. longliners of India).
  - Some artisanal fisheries, including: pole-and-line fishery in Maldives, drifting gillnet fisheries of I.R. Iran (before 2012) and Pakistan, Sri Lanka (gillnet-longline fishery) and the artisanal fisheries in Indonesia, Comoros (before 2011) and Madagascar.

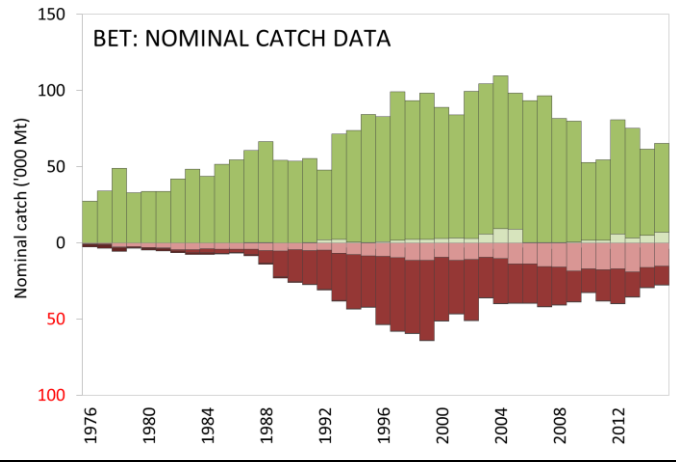
Catch-per-unit-effort (CPUE) trends

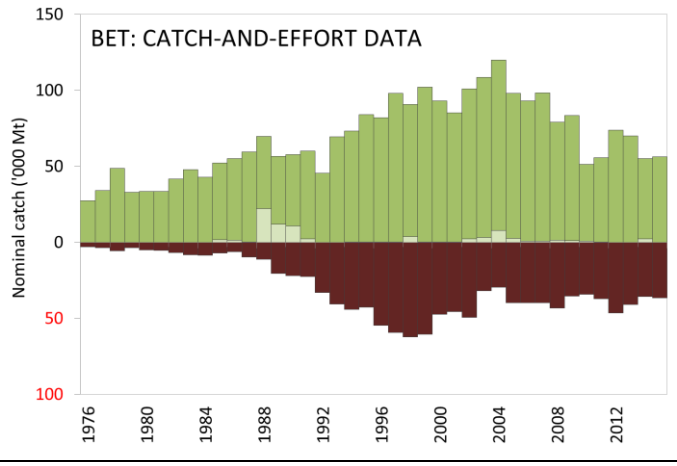
- Availability: Standardized CPUE series are available for the major industrial longline fisheries (i.e., Japan, Rep. of Korea, Taiwan,China).

  For most other fisheries, catch-and-effort are either not available (**Fig. 8b**), or are considered to be of poor quality – especially since the early-1990s and for the following fisheries/fleets:
  - NEI purse seine and longliners: no data available.
  - Fresh-tuna longline fisheries: no data are available for the fresh-tuna longline fishery of Indonesia, while data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006;
  - Other industrial fisheries: uncertain data from significant fleets of industrial purse seiners from I.R. Iran, and longliners from India, Indonesia, Malaysia, Oman, and Philippines;
  - Artisanal/coastal fisheries: incomplete or missing data for the driftnet fisheries of I.R. Iran and Pakistan, and the gillnet-longline fishery of Sri Lanka, especially in recent years.

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

- Average fish weight: can be assessed for several industrial fisheries although they are incomplete (**Fig. 8c**) or of poor quality for most fisheries before the mid-1980s and for some fleets in recent years (e.g. Japan and Taiwan,China longline) .
- Catch-at-Size (Age) table: data are available, but the estimates are more uncertain for some years and some fisheries due to:
  i. lack of size data available from industrial longliners before the mid-60s, from the early-1970s up to the mid-1980s and in recent years (Japan and Taiwan,China).
  ii. lack of size data available for some industrial fleets (NEI, India, Indonesia, I.R. Iran, Sri Lanka).





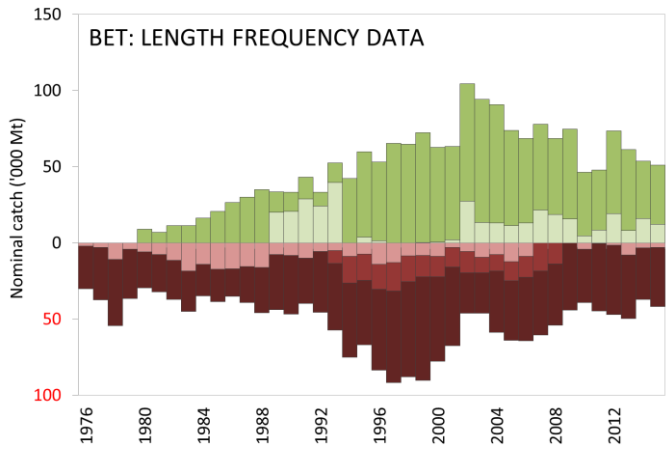


Fig. 8a-c. Bigeye tuna: data reporting coverage (1976–2015).

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 2016.

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)

Bigeye tuna: Tagging data

- A total of 35,997 bigeye tuna (17.9%) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of them (96.0%) were tagged during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) and released off the coast of Tanzania in the western Indian Ocean, between May 2005 and September 2007 (**Fig. 9**). The remaining were tagged during small-scale projects, and by other institutions with the support of the IOTC Secretariat, in the Maldives, Indian, and in the south west and the eastern Indian Ocean.
- To date, 5,824 specimens (16.2% of releases for this species) have been recovered and reported to the IOTC Secretariat[7]. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (90.7%), while 5.4% were recovered from longline vessels.

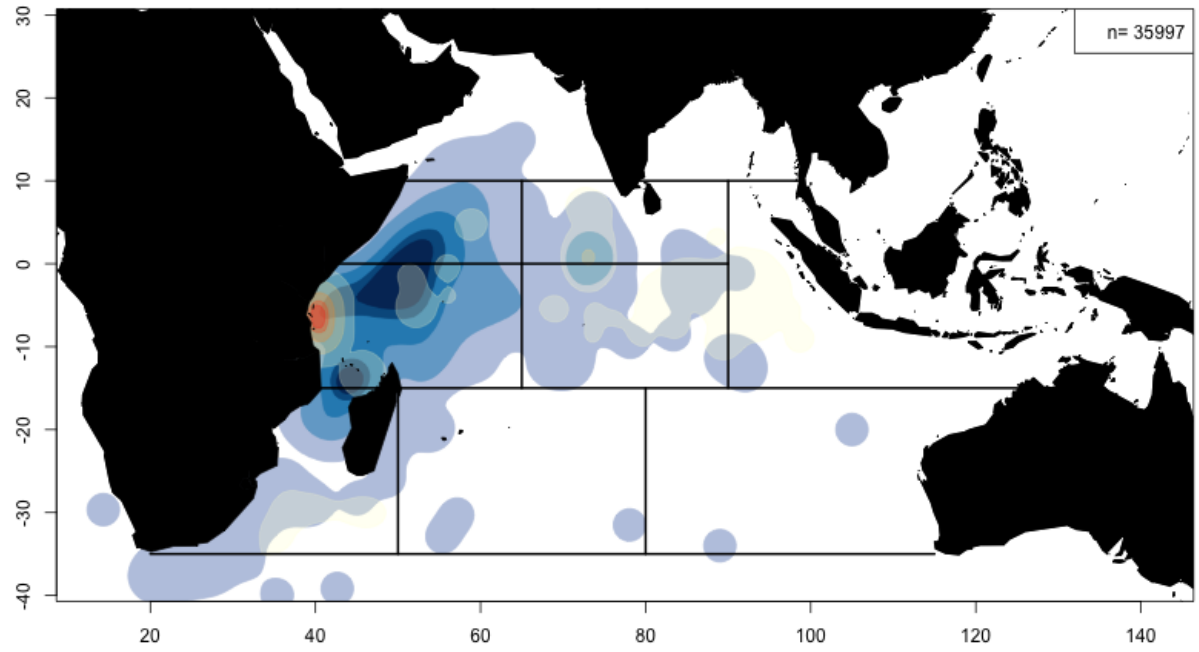


Fig. 9. Bigeye tuna: densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s.

[7] Recoveries by species based on species ID recorded during tagging, prior to release.

Skipjack tuna (SKJ)

Fisheries and main catch trends

- Main fishing gear (2012–15): skipjack tuna are mostly caught by industrial purse seiners (≈39%), gillnet (≈26%) and pole-and-line (≈21%) (**Table 4; Fig. 10**).

- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  Almost 70% of catches are accounted for by four fleets (**Fig. 12**):

  - Indonesia (coastal purse seine, troll line, gillnet): 21%; Maldives (pole-and-line): 17%; Sri Lanka (gillnet-longline): 15%; EU-Spain (purse seine): 15%.

- Main fishing areas:

  Primary: Western Indian Ocean (West R2), in waters off Somalia (**Table 5; Fig.11**)

  - 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, but may possibly be related to a change in targeting to yellowfin tuna.

- 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 an increase 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 catches since 2013 have ranged between 390,000 t to 425,000 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 2015.

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 (2006–2015), 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 September 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
BB	9,000	12,800	19,275	35,459	67,760	100,496	136,695	95,807	85,584	65,018	71,585	52,489	51,134	72,583	67,301	68,965
FS	0	0	0	13,658	25,197	24,342	32,684	23,567	14,863	9,498	8,708	8,930	2,924	5,625	6,467	7,546
LS	0	0	0	30,673	107,845	153,298	190,553	108,252	117,835	135,797	139,770	120,115	77,992	117,046	118,869	118,915
OT	6,015	14,067	27,597	49,997	118,867	198,114	256,228	237,993	220,143	227,486	203,928	201,671	206,667	239,038	228,793	198,529
Total	**15,015**	**26,867**	**46,872**	**129,788**	**319,670**	**476,251**	**616,161**	**465,620**	**438,425**	**437,799**	**423,991**	**383,205**	**338,718**	**434,292**	**421,430**	**393,955**

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 (2006–2015), in tonnes. Catches by decade represent the average annual catch. Data as of September 2016.

	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
R1	4,524	9,951	19,284	34,584	80,744	118,318	109,014	137,692	139,937	151,486	154,434	153,882	149,769	167,639	145,972	130,356
R2	1,492	4,116	8,313	59,744	171,166	257,437	370,451	232,121	212,903	221,295	197,972	176,835	137,814	194,070	208,157	194,633
R2b	9,000	12,800	19,275	35,459	67,760	100,496	136,695	95,807	85,584	65,018	71,585	52,489	51,134	72,583	67,301	68,965
Total	**15,015**	**26,867**	**46,872**	**129,788**	**319,670**	**476,251**	**616,161**	**465,620**	**438,425**	**437,799**	**423,991**	**383,205**	**338,718**	**434,292**	**421,430**	**393,954**

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

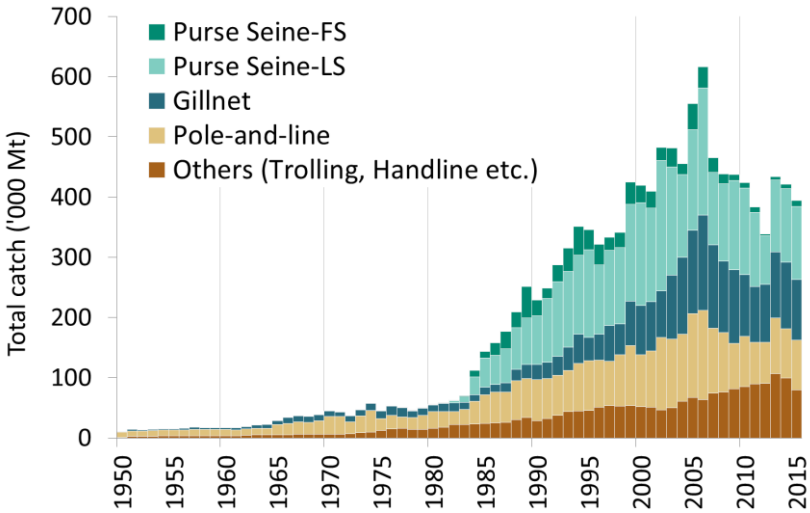


Fig. 10. Annual catches of skipjack tuna by gear (1950–2015). Data as of October 2016.

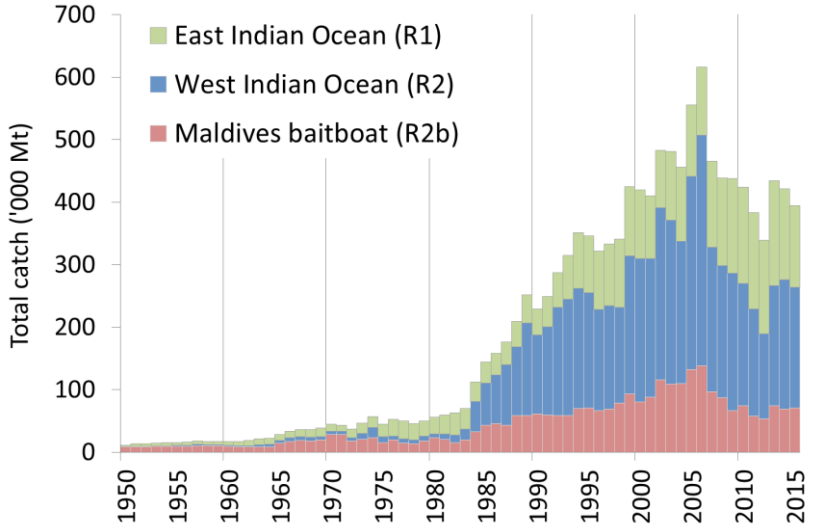


Fig. 11. Skipjack tuna: Catches of skipjack tuna by area by year estimated for the WPTT (1950–2015).

Areas: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**). Data as of September 2016.

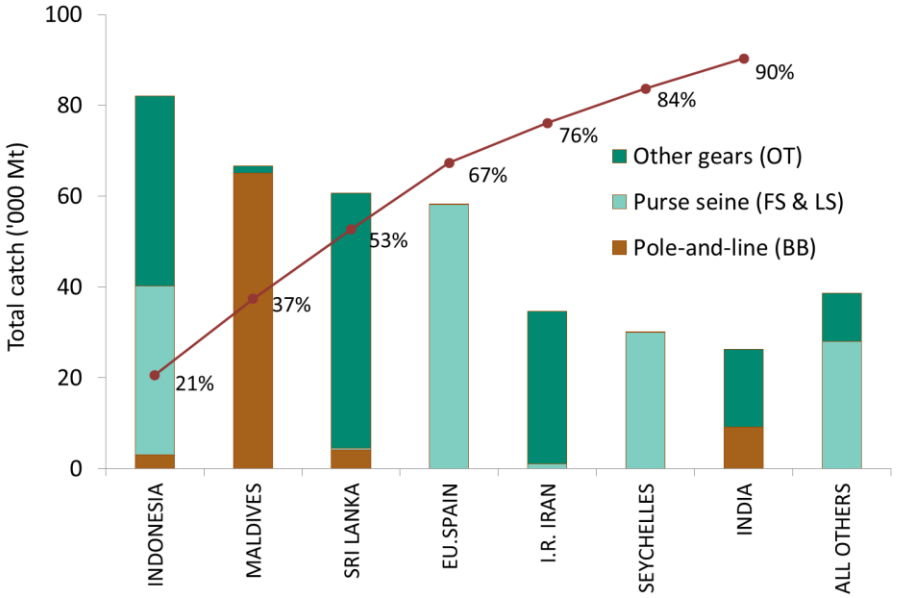


Fig. 12. Skipjack tuna: average catches in the Indian Ocean over the period 2012–15, by country. Countries are ordered from left to right, according to the importance of catches of skipjack reported. The red line indicates the (cumulative) proportion of catches of skipjack for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of October 2016.

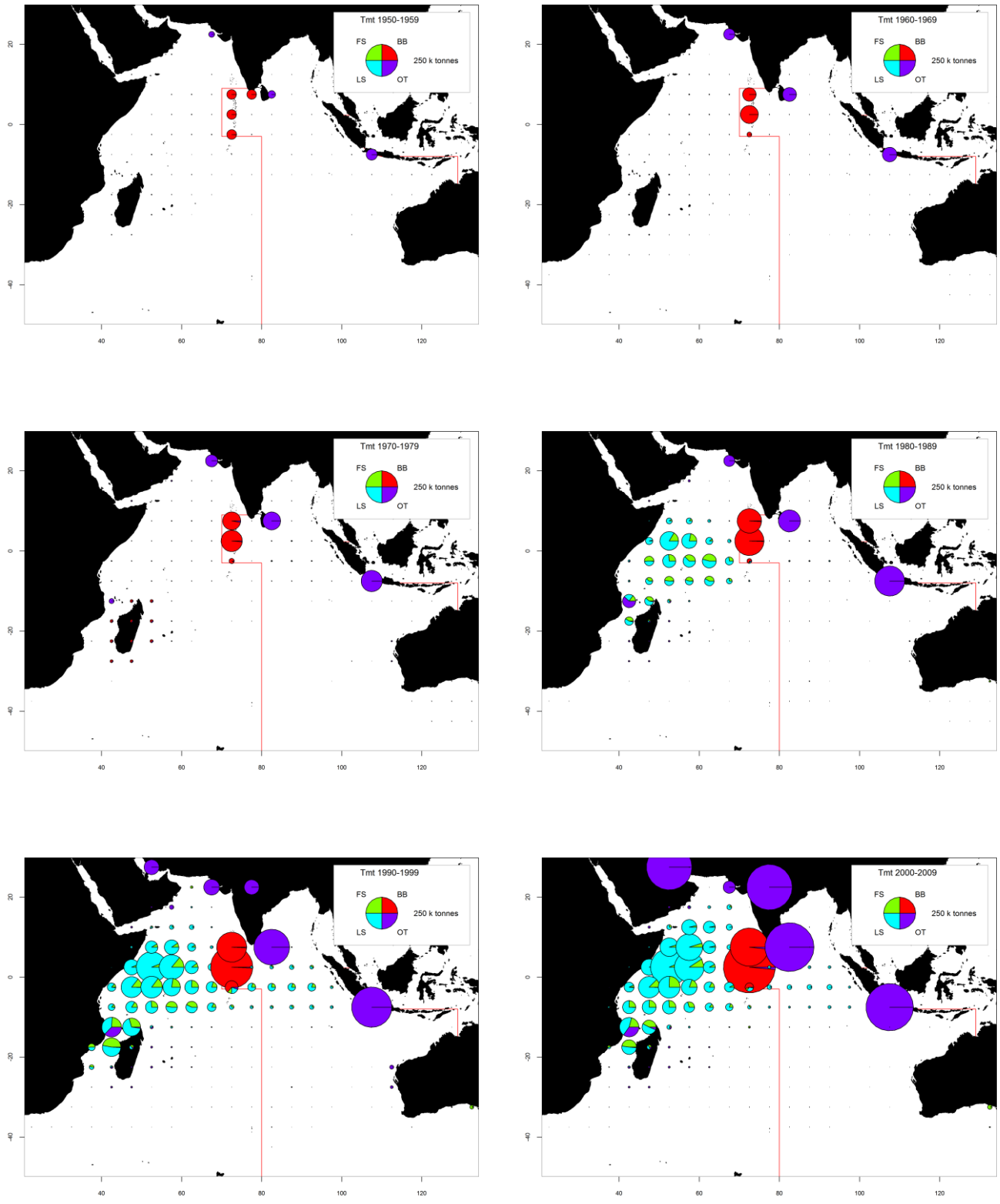


Fig. 13(a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 1950–2009, by decade and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries.

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 I.R. Iran and Pakistan, gillnet and longline fishery of Sri Lanka, and coastal fisheries of Comoros, Indonesia and India.

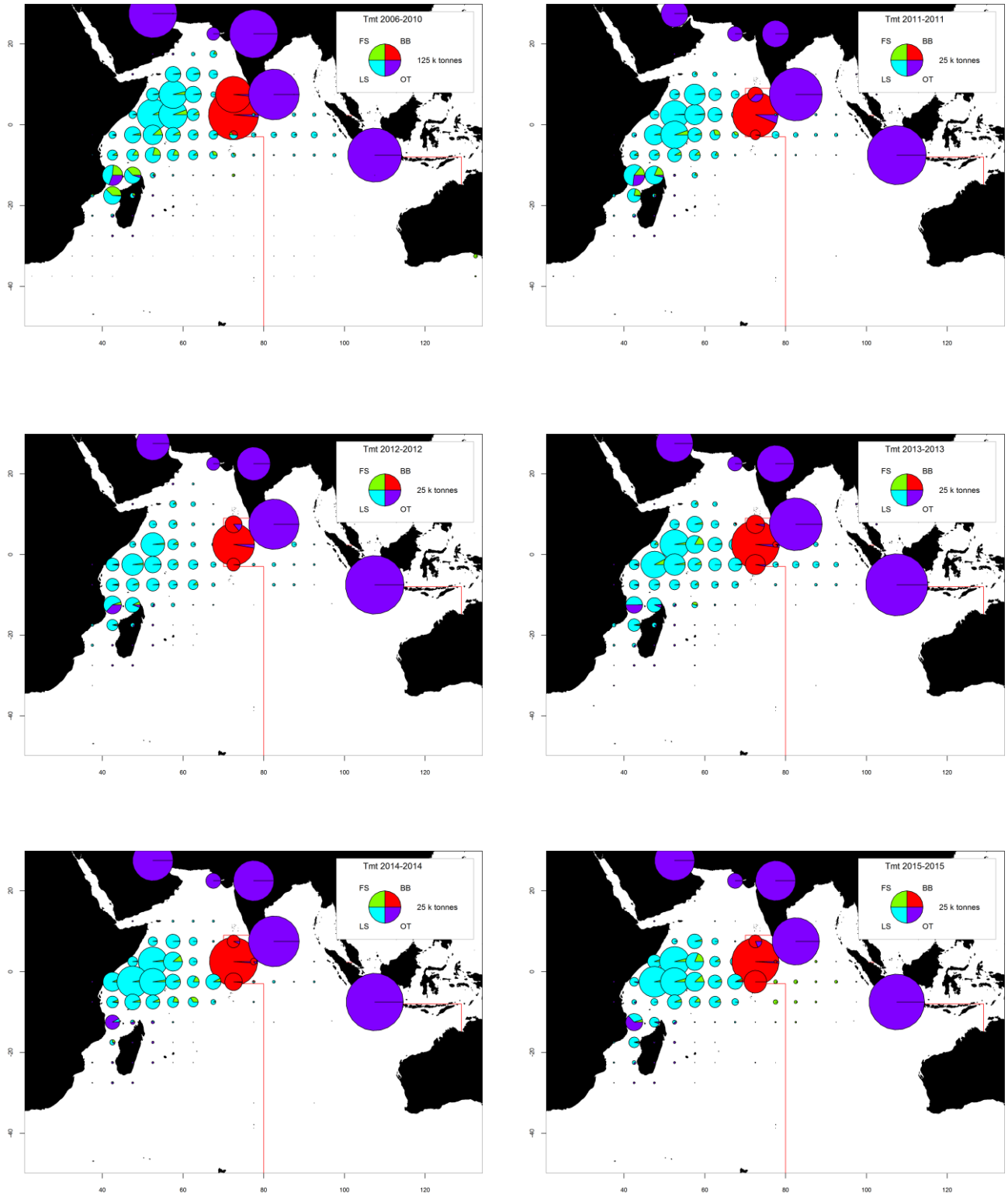


Fig. 14(a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2006–10 by type of gear and for 2011–15, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (BB), and other fleets (**OT**), 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. 15a**). 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.

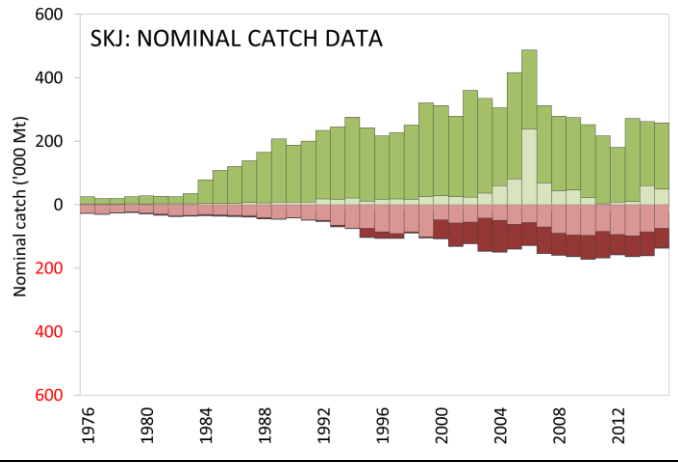
Catch-per-unit-effort (CPUE) trends

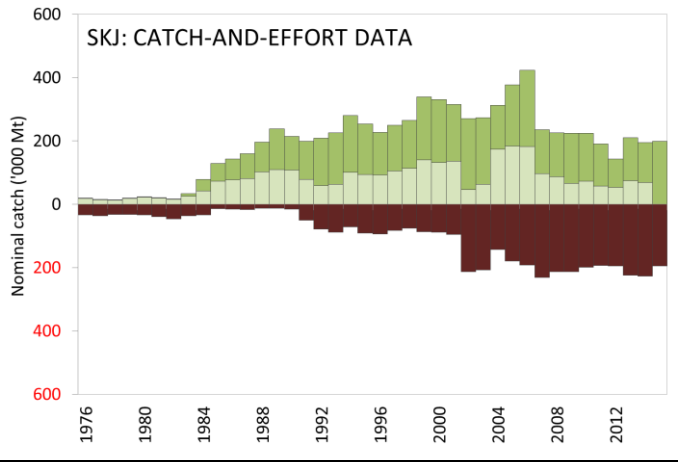
- Catch-and-effort series are available for the various industrial and artisanal fisheries (e.g., Maldives pole-and-line fishery, EU-France purse seine).

  However for a number of other important fisheries catch-and-effort are either not available (**Fig. 15b**), 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. 15c**).
- 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.





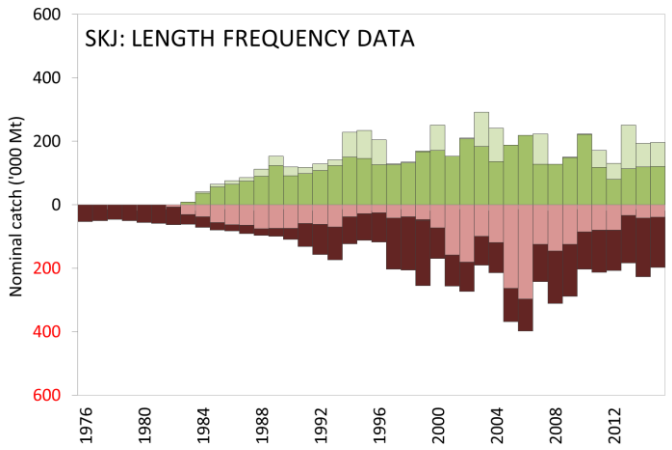


Fig. 15a-c. Skipjack tuna: data reporting coverage (1976–2015).

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 2016.

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)

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, or which 1,960 were recovered mainly in the Maldives.

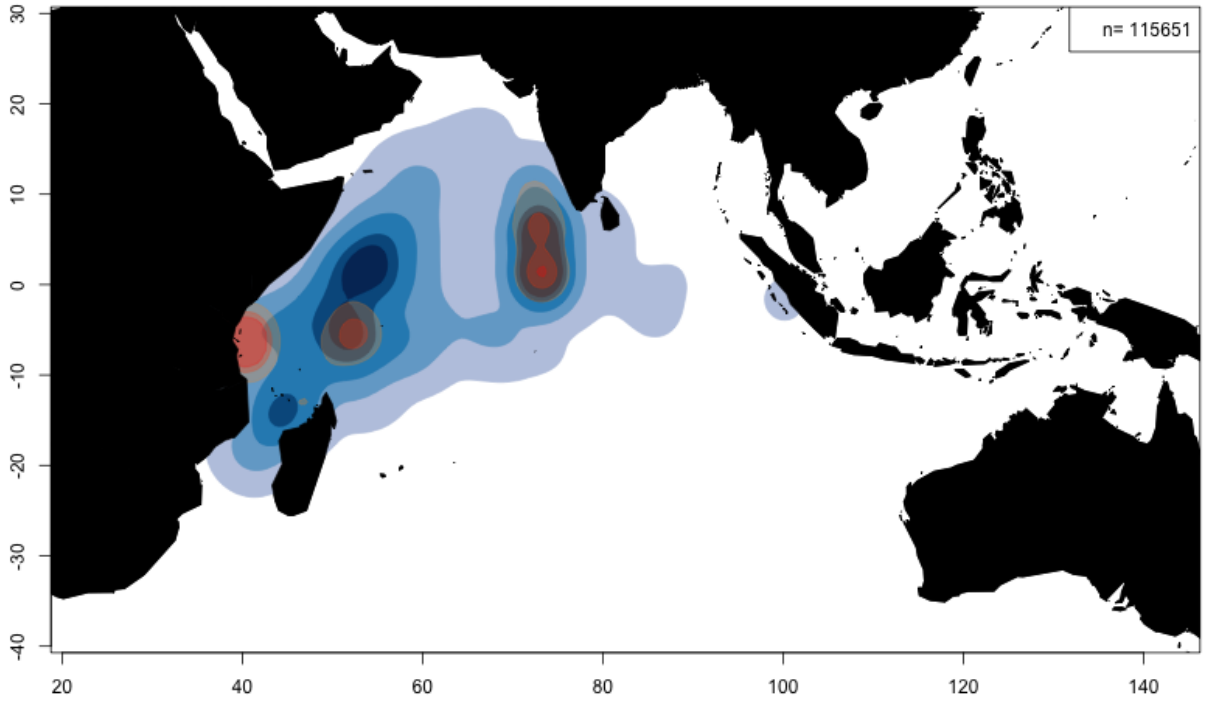


Fig. 16. Skipjack tuna: Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s.

Yellowfin tuna (YFT)

Fisheries and main catch trends

- Main fishing gear (2012–15): 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 6**; **Fig. 17**).

  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 the most recent years.

- Main fleets (and primary gear associated with catches): percentage of total catches (2012–15):
  EU-Spain (purse seine): 15%; Maldives (handline, pole-andline): 12%; Indonesia (fresh longline, handline): 10%; I.R. Iran (gillnet): 9% (**Fig. 19**).

- Main fishing areas: Primary: Western Indian Ocean, around Seychelles and waters off Somalia (Area R2), and Mozambique Channel (Area R3) (**Fig.18**).

- 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 have been 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 over 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.

***Changes to the catch series*:** In 2014 catches of yellowfin tuna were revised downwards by approximately 20,000 t (≈5% of total yellowfin catches) due to misreporting of catches by Mayotte, and also revisions to catches catches for other fleets (e.g., Yemen). Otherwise there were no major changes to the catch series since the WPTT meeting in 2014.

Table 6. 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 (2006–2015), 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 September 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
FS	-	-	18	31,552	64,938	89,204	85,039	53,527	74,986	36,048	32,136	36,453	64,594	34,457	45,799	67,254
LS	-	-	17	17,597	56,279	61,890	74,601	43,777	41,539	51,352	73,382	76,658	66,165	101,906	88,373	75,879
LL	21,990	41,352	29,589	33,968	66,318	56,879	70,714	51,426	26,038	19,999	18,744	20,667	19,671	16,012	15,654	16,598
LF	141	1,214	2,281	7,721	58,526	55,539	57,138	55,620	58,102	49,884	50,484	43,455	54,642	60,679	61,982	58,534
BB	2,111	2,318	5,810	8,295	12,803	16,072	18,022	16,326	18,280	16,828	14,105	14,010	15,511	24,047	20,501	17,790
GI	1,565	4,108	7,928	11,993	39,540	49,393	62,579	43,510	47,872	41,907	51,121	50,967	63,458	56,159	66,539	67,797
HD	561	555	2,956	7,635	19,480	34,769	34,678	34,636	31,371	28,945	35,003	60,492	79,695	70,227	71,033	80,531
TR	1,092	1,958	4,292	7,327	12,264	16,144	17,371	19,052	16,514	14,611	19,058	18,731	28,551	32,702	30,634	15,950
OT	80	193	454	1,871	3,379	5,402	5,800	6,703	6,556	7,361	7,705	7,872	8,214	8,861	7,996	7,240
Total	**27,539**	**51,698**	**53,345**	**127,960**	**333,524**	**385,292**	**425,942**	**324,577**	**321,258**	**266,935**	**301,738**	**329,305**	**400,501**	**405,050**	**408,511**	**407,573**

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 7. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2006–2015), in tonnes. Catches by decade represent the average annual catch. The areas are presented in Fig. 20(a). Data as of September 2016.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
R1	1,933	4,398	8,671	20,043	75,074	85,385	101,268	78,629	72,123	60,238	71,820	103,549	131,953	118,818	129,634	141,075
R2	12,260	24,036	22,128	73,396	142,289	180,712	202,148	123,070	134,824	99,681	115,068	121,507	145,543	155,463	161,886	165,132
R3	724	7,449	4,283	7,400	21,812	23,591	23,683	23,613	19,907	18,536	18,195	18,909	17,064	20,841	9,601	13,733
R4	918	1,799	1,356	1,085	3,411	2,503	1,864	1,031	577	890	1,413	522	593	833	511	1,269
R5	11,705	14,015	16,909	26,037	90,939	93,100	96,979	98,234	93,827	87,590	95,242	84,818	105,348	109,095	106,879	86,364
Total	**27,539**	**51,698**	**53,345**	**127,960**	**333,524**	**385,292**	**425,942**	**324,577**	**321,258**	**266,935**	**301,738**	**329,305**	**400,501**	**405,050**	**408,511**	**407,573**

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**).

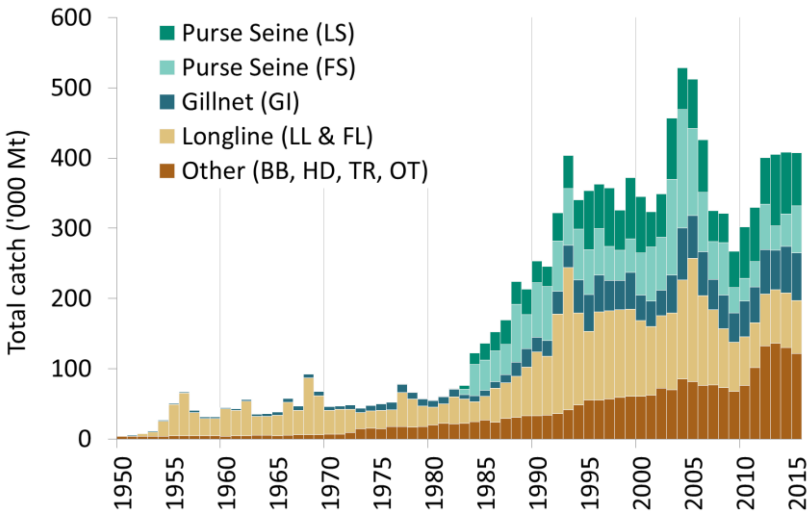
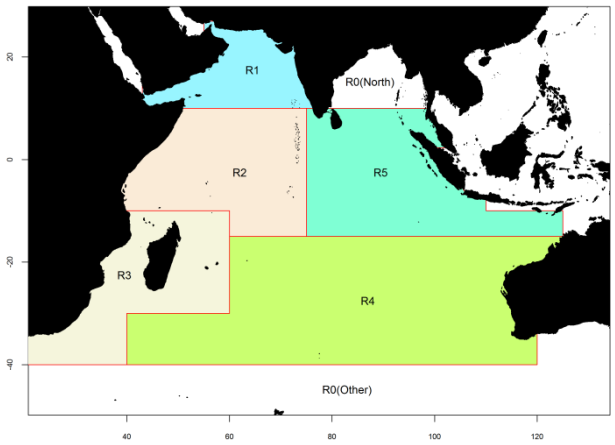


Fig. 17. Annual catches of yellowfin tuna by gear (1950–2015). Data as of September 2016.



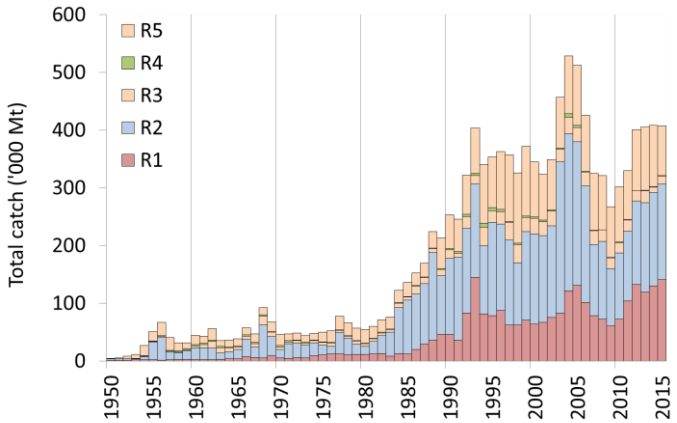


Fig. 18(a-b). Yellowfin tuna: Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2015). Catches in areas R0 were assigned to the closest neighbouring area for the assessment. Data as of September 2016.

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**).

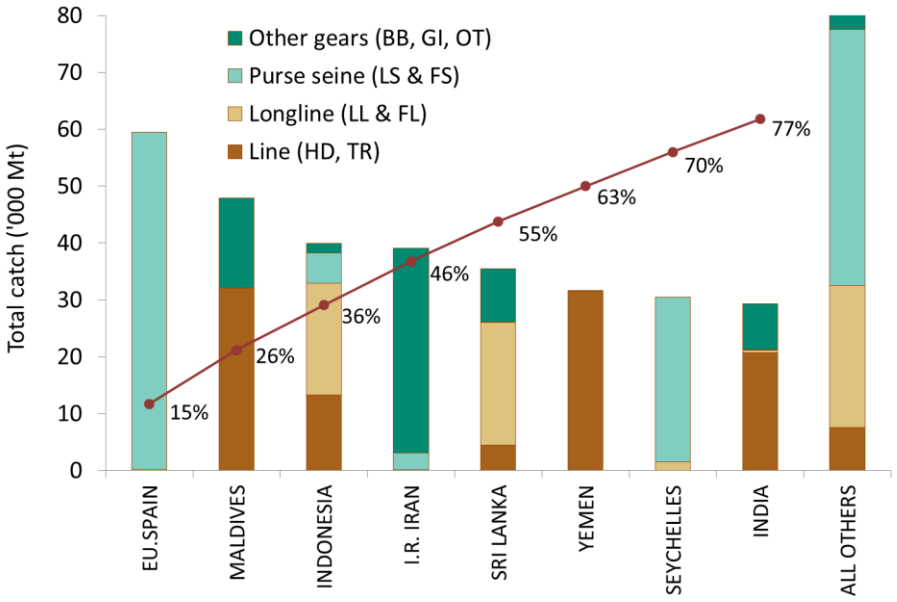


Fig. 19. Yellowfin tuna: average catches in the Indian Ocean over the period 2012–15, by country. Countries are ordered from left to right, according to the importance of catches of yellowfin reported. The red line indicates the (cumulative) proportion of catches of yellowfin for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of September 2016.

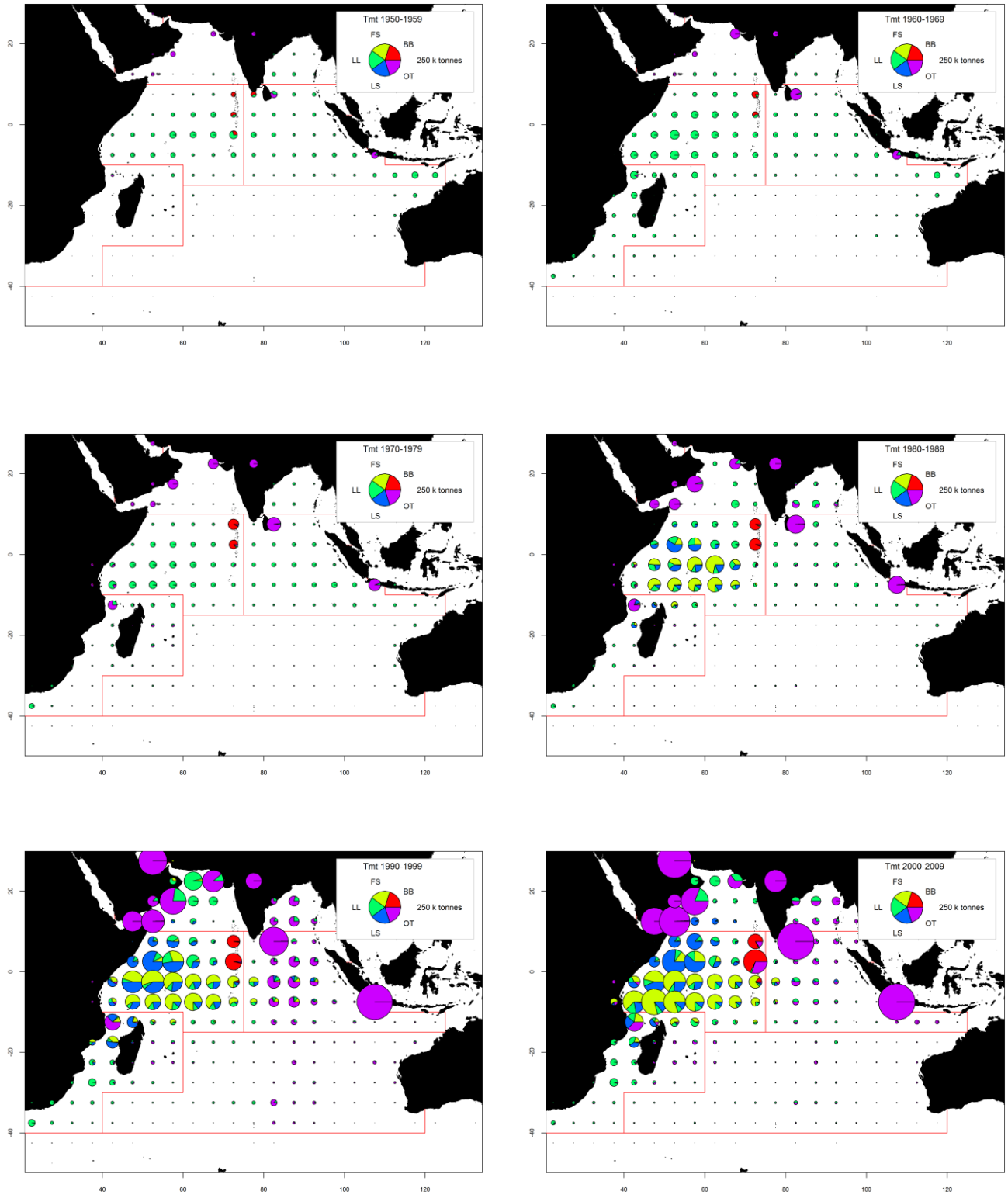


Fig. 20(a-f). Yellowfin tuna: Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 1950–2009, by decade and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), 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.

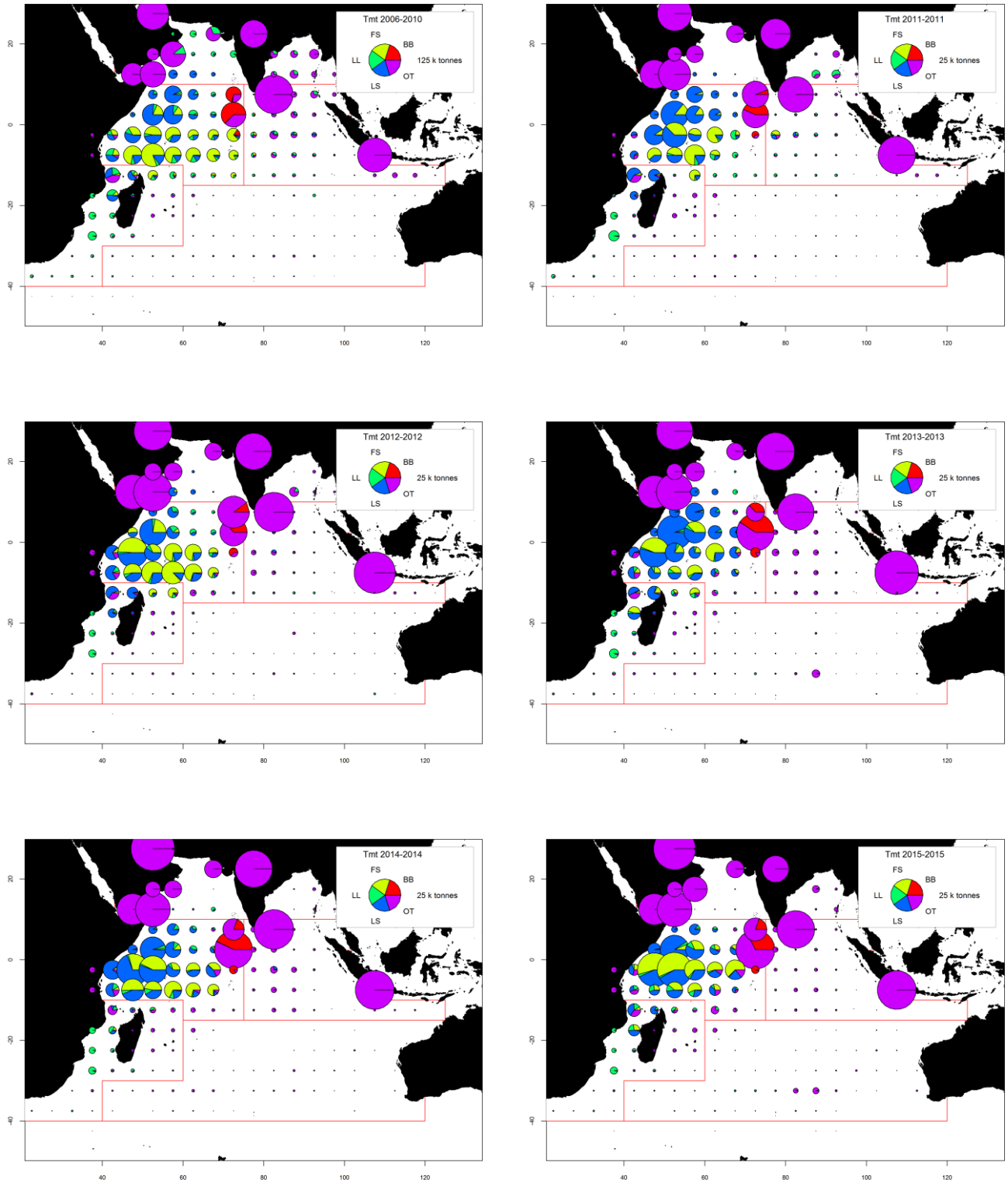


Fig. 21(a-f). Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 2006–2010 by type of gear and for 2011–2015, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other 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. 22a**). 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

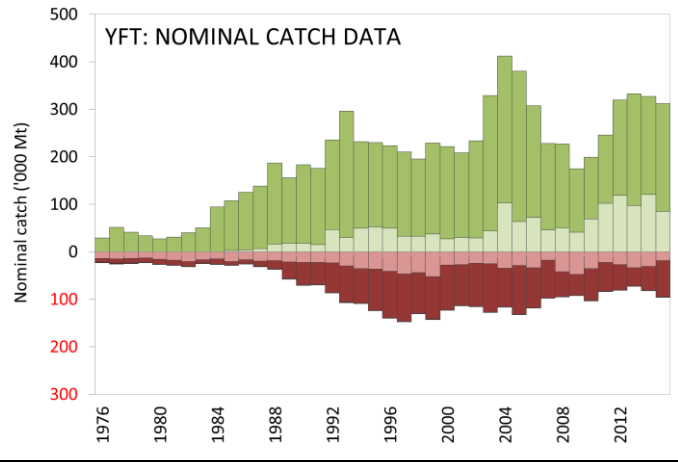
- Availability: Catch-and-effort series are available for the major industrial and artisanal fisheries (e.g., Japan longline, Taiwan,China) (**Fig. 22b**).

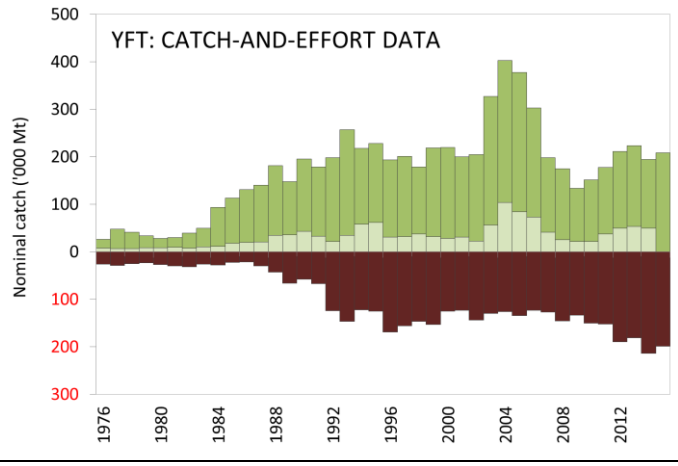
  However, for other important fisheries catch-and-effort are either not available, or are considered to be of poor quality for the following reasons:
  - no data are available for the fresh-tuna longline fishery of Indonesia, over the entire time series, and data for the fresh-tuna longline fishery of 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. 22c**).
  - 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).





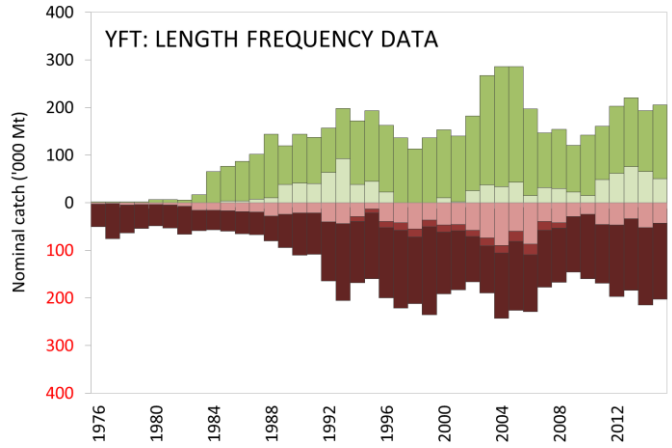


Fig. 22a-c. Yellowfin tuna: data reporting coverage (1976–2015).

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 2016.

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)

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. 23**). 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 we 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.

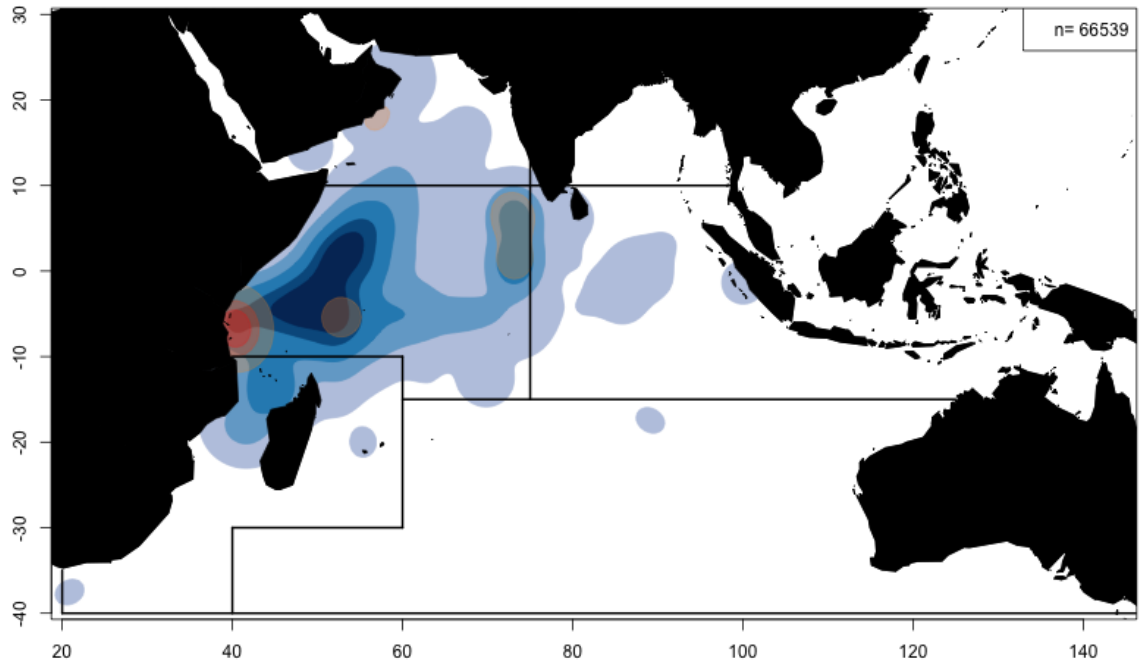


Fig. 23. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s. Data as of September 2016.

APPENDIX I

ESTIMATION OF CATCHES OF NON-REPORTING FLEETS

The estimates of catches of non-reporting fleets were updated in 2016:

The high number of non-reporting fleets operating in the Indian Ocean between the mid-1980's and the late 1990's led to large increases in the amount of catch that required to be estimated for that period. This reduced confidence in the catch estimates for yellowfin tuna and bigeye tuna, and to a lesser extent, skipjack tuna during those years. In recent years the number of fleets from non-IOTC Parties has decreased significantly. However, the decrease in the numbers of industrial vessels fishing in the Indian Ocean from non-IOTC parties has coincided with an increase in the numbers of vessels fishing under flags of some IOTC parties, including coastal countries in the IOTC region (India, Indonesia, I.R. Iran, Kenya, Malaysia, Oman, Seychelles, Tanzania and Thailand) and deep-water fishing nations (Belize, Guinea and Senegal), the quality of the statistics collected by these countries varying depending on the case.

- **Purse seine** (**Fig. 24**): Catches for the six former Soviet Union purse seiners, currently under the Thailand flag, were estimated for January-August 2005 and those for the remaining purse seiner (Equatorial Guinea) for 2005–2006. Total catches were estimated using the number of vessels available, the average catches of the former Soviet Union purse seiners in previous years, and average catches available for other fleets for 2005–2006. Total catches were assigned to species and type of school fished according to data available for Thailand purse seiners during the same period (2005–2006). The amount of catch that the Secretariat has to estimate for this fleet has decreased considerably in recent years. It is thought that there are no longer purse seiners operating under flags of non-reporting countries.

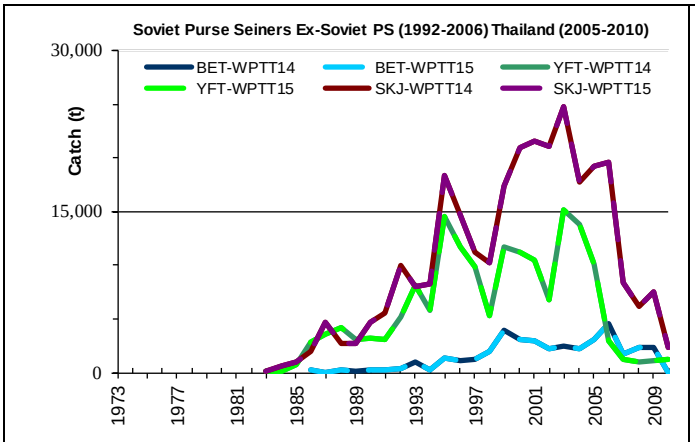


Fig. 24. Catches of Soviet, ex-Soviet and Thai purse seiners estimated in 2012 versus previous catches estimated in 2011 (1983–2010)

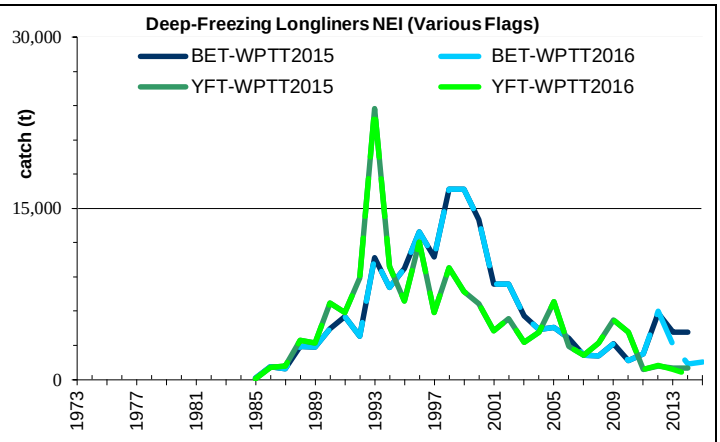


Fig. 25. Catches of deep-freezing longline vessels in the Indian Ocean estimated in 2016 versus catches estimated in 2015 (1985–2014)

- **Deep-freezing longline** (**Fig. 25**): The catches by large longliners from several non-reporting countries were estimated using IOTC vessel records and the catch data from Taiwanese, Japanese or Spanish longliners, based on the assumption that most of the vessels operate in a way similar to the longliners from Taiwan,China, Japan, or EU-Spain. The collection of new information on the activities of non-reporting fleets during the last year, in particular the numbers and characteristics of non-reporting longliners, led to improved estimates of catches. Since 1999 the number of non-reporting longliners in the Indian Ocean has decreased considerably leading to a marked decrease in catch levels. Such decrease has coincided with an increase in the numbers of vessels operated by some IOTC CPC's. Although these countries usually report catches to the Secretariat, the data reported are, in some cases, considered incomplete (as indicated in Section 3)
- **Fresh tuna longline** (**Figs. 26-27**): Fresh tuna longline vessels, mainly from China, Taiwan,China, India, Malaysia, Belize and Indonesia, have been operating in the Indian Ocean since the early 1970's. The catches of these fleets have been estimated by the IOTC Secretariat by using information from the following three sources:
    - Catches reported by the flag countries: Although China reported total catches for its longline fleet they were not reported by type of longline until 2006 (fresh-tuna longline or deep-freezing longline). The Secretariat estimated the catches of fresh-tuna longliners for 1999–2005 by using the total catches

reported, the numbers of fresh-tuna longline vessels provided by China and catch rates for fresh-tuna longliners available from other years.

- Information on catches and vessel activity collected through several catch monitoring schemes implemented in the main ports of landing for these vessels, involving the IOTC-OFCF[8] and/or institutions in the countries where the fleets are based and/or foreign institutions. This applies to Indonesia (2002–2006), Thailand (1998–2006), Sri Lanka (2002–03), Malaysia (2000–2006), Oman (2004–2005) and Seychelles (2000–2002). Since 2007 Indonesia and Malaysia have reported catches for their longline fleets, however in the case of Indonesia the catches reported are thought to be incomplete as they do not monitor the activities of vessels under their flags based in other countries. The Secretariat estimated the catches of this component as for the countries indicated below.
- Information available on the number of fresh-tuna longline vessels operating in other ports or on the activity of those vessels (e.g. the number of vessel unloading or total catches unloaded). This applies to India (2005-15), Indonesia (1973–2001), Thailand (1994–2013), Sri Lanka (1990–2001; 2004–15), Malaysia (1989–2015), Singapore, Mauritius and Maldives (recent years). The catches in these ports and years were estimated from the known/presumed levels of activity of the vessels and the average catches obtained in ports that were covered through sampling.

In 2006 Taiwan,China provided total catches for its longline tuna fleet operating in the Indian Ocean for the period 2000 to 2005. The catches for 2006-12 have also been provided, including time area catches and effort for 2007-15. The catches published by Taiwan,China were slightly higher than those that the IOTC Secretariat had estimated from the data collected through port sampling. The new catches provided for 2001-05 were used to replace those in the IOTC database. This was done on the assumption that vessels from Taiwan,China had operated in ports of non-reporting countries, their catches not accounted for in estimates made by the Secretariat. The Secretariat has been using the catches published by Taiwan,China since 2006.

The catches for fleets other than Taiwan,China for 1973–2015 and for Taiwan,China in years prior to 2001 were estimated as explained in the three bullet points above.

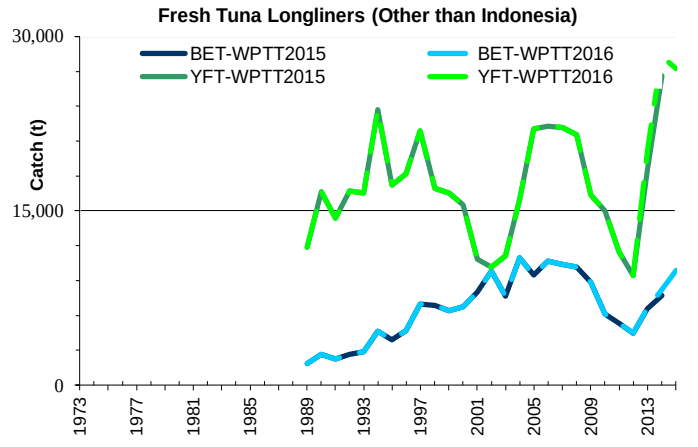


Fig. 26. Catches of fresh-tuna longline vessels based in India, Malaysia, Maldives, Mauritius, Oman, Seychelles, Singapore, Sri Lanka, Thailand and Yemen (mainly registered in China, Taiwan,China and Indonesia) estimated in 2016 versus catches estimated in 2015 (1989–2014)

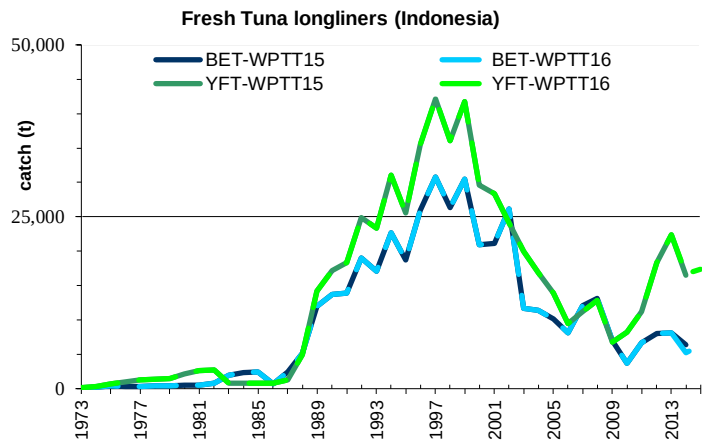


Fig. 27. Catches of fresh-tuna longline vessels based in Indonesia (domestic and foreign) estimated in 2016 versus catches estimated in 2015 (1973–2014)

[8] Overseas Fishery Cooperation Foundation of Japan.

APPENDIX II

ESTIMATION OF CATCHES AT SIZE FOR IOTC TROPICAL TUNA SPCIES

Table 1: Current IOTC equations to convert from non-standard measurements into standard length (fork length), by species

Species: Yellowfin tuna — ***Standard length: Tip of snout to fork of tail***

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight gilled and gutted[A]	a*W^b	a= 44.28699 b= 0.3008591	2,361	Min:14 Max:71	a=0.00752476509 b=2.86244E-07	-4.626246E-05	4.095958	a=3.033852 b=495.6385
Length to the base of the 1st dorsal fin[B]	a*L^b	a=2.0759 b=1.1513	7,036	Min: 29 Max: 164				

Species: Bigeye tuna — ***Standard length: Tip of snout to fork of tail***

Type Measurement	*Equation*	*Parameters*	*Sample size*	*Size*	*Variance*	*Covariance ab*	*Mean Residual*	*Gradient*
Weight gilled and gutted[A]	a*W^b	a= 42.2186 b= 0.3012349	316	Min:12 Max:107	a=0.0321755341 b=1.299934E-06	-0.0002034041	3.98137	a=3.03806 b=473.1455
Length to the base of the 1st dorsal fin[C]	$\frac{(L+a)^2}{(b)^2}$	a=21.45108 b=5.28756	2,858	Min:13 Max:48				

Sources:

A: Data from Penang Sampling Programme (1992-93)

B: Data from the Indian Ocean (Marsac, F. et al in IOTC-2006-WPTT-09)

C: Data from the Atlantic Ocean, Champagnat et Pianet (1974) (ibid. B)

Table 2: Current IOTC equations used to convert from standard length into round weight, per species

Species	*Gear Type/s*	*From type measurement – To type measurement*	*Equation*	*Parameters*	*Sample size*	*Length*
Yellowfin tuna	Purse seine Pole and Line Gillnet	Fork length – Round Weight(kg)[D]	RND=a*L^b	a= 0.00001886 b= 3.0195	6,752	Min: 29 Max: 164
	Longline Line Other Gears	Fork length(cm) – Gilled and gutted weight(kg)[E] Gilled and gutted weight(kg) - Round Weight(kg)[F]	GGT=a*L^b RND=GGT*1.13	a= 0.0000094007 b= 3.126843987	15,133	Min:72 Max:177
Bigeye tuna	Purse seine Pole and Line Gillnet Trolling	Fork length(cm) – Round Weight(kg)[G]	RND=a*L^b	a= 0.000027000 b= 2.95100	n/a	n/a
	Longline Line Other Gears	Fork length(cm) – Gilled and gutted weight(kg)[E] Gilled and gutted weight(kg) - Round Weight(kg)[F]	GGT=a*L^b RND=GGT*1.13	a= 0.0000159207 b= 3.0415414023	12,047	Min:70 Max:187
Skipjack tuna	All gears	Fork length(cm) – Round Weight(kg)[H]	RND=a*L^b	a= 0.0000074800 b= 3.25260	14,140	Min:32 Max:78

Sources:

D: Data from the Indian Ocean (Marsac, F., et al. in IOTC-2006-WPTT-09)

E: Multilateral catch monitoring Benoa (2002-04)

F: ICCAT Field Manual (Appendix 4: Population parameters for key ICCAT species. Product Conversion Factors)

G: Cort (1986)

H: Data from the Atlantic Ocean, Cayré et Laloë (Fonteneau, A. et J. Marcille (eds), 1988: Ressources, pêche et biologie des thonidés tropicaux de l'Atlantique Centre-Est. FAO Doc.Tech.Pêches, (292), page262)

Sources of alternative equations:

Andrade, et al. (2001), Allometry coefficient variations of the length–weight relationship of skipjack tuna (Katsuwonus pelamis) caught in the southwest South Atlantic, Fisheries Research, 55: 307-312.

Batista da Silva, et al. (2011), Weight length relationship and length conversion of yellowfin tuna, from fisheries associated with an offshore buoy in the western equatorial Atlantic, Arquivos de Ciências do Mar, 44 (2): 83 – 88.

Chang, et al. (2008), Preliminary estimation of length-weight relationship of Atlantic bigeye tuna from Taiwanese observer data, ICCAT, 62(2): 480-484.

Kaymaram, et al. (2014), Estimates of Length-Based Population Parameters of Yellowfin Tuna (Thunnus albacares) in the Oman Sea, Turkish Journal of Fisheries and Aquatic Sciences, 14: 101-111.

Mohan, et al. (1985), Length-weight relationship of skipjack and yellowfin tuna from Minicoy waters, CMFRI: Tuna Fisheries of the Exclusive Economic Zone of India: Biology and Stock Assessment.

Oliveira, et al. (2005), Length-weight relationships and length-length conversions of tunas and swordfish in the northeast of Brazil, ICCAT, 58 (5): 1724-1728.

PIFSC Administrative report H-03-01 (2003), Updated Weight-on-Length Relationships for Pelagic Fishes Caught in the Central North Pacific Ocean and Bottom fishes from the Northwestern Hawaiian Islands.

Rohit, et al. (2008), Yellowfin tuna fishery by traditional fishermen at Visakhapatnam, Andhra Pradesh, Journal of the Marine Biological Association of India, 50 (1) : 62 – 68.

Sun, et al. (2006), Reproductive biology of bigeye tuna in the Western and Central Pacific Ocean, WCPFC-SC2-2006/BI WP-1.

Zhu, et al. (2008), Length-frequency composition and weight-length relations for bigeeye tuna, yellowfin tuna, and albacore in the Atlantic, Indian, and Eastern Pacific Oceans, Acta Ichthyological et Piscatoria, 38 (2): 157-161.

Zorica, et al. (2008), Biometry, length-length and length-weight relationships of juveniles and adults of Atlantic bonito, Sarda sarda, in the eastern Middle Adriatic Sea, Acta Adriatica, 49(1): 65-72.

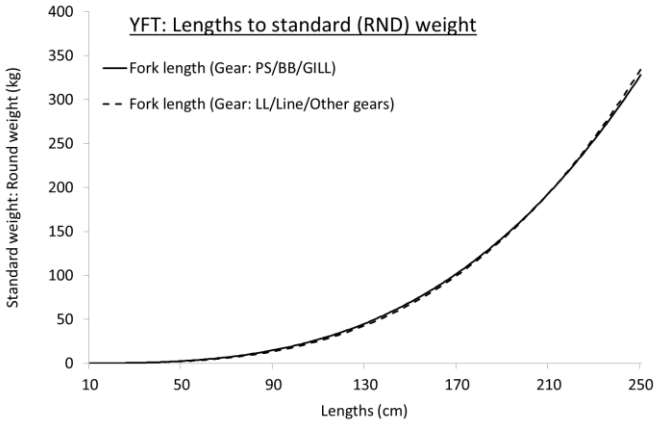
Table 3: Number and proportion of samples reported to the IOTC Secretariat by measurement type and species (data as of Sept. 2014).

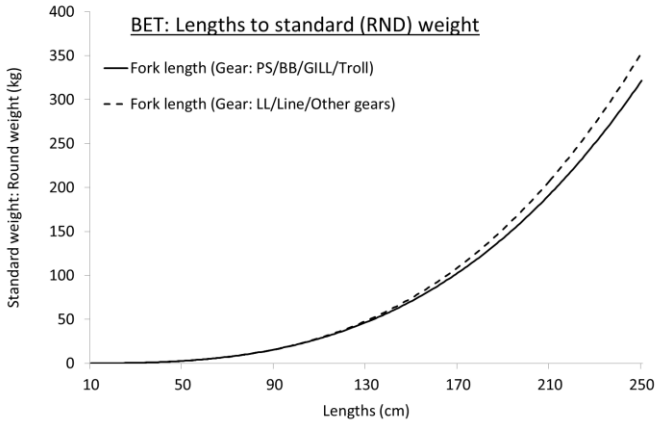
Measurement type	Bigeye tuna	Skipjack tuna	Yellowfin tuna
Fork length	47,102,890	465,344,150	144,053,004
Fork length (by using a Board)		259,093	57,047
Fork length (converted from weight/length)	1,736		1,854
Fork length (converted tape measure lengths)	30	474,431	176,614
Fork length (unconverted tape measure lengths)	2,888	1,143,739	274,656
Gilled and gutted weight	429,804		625,034
First dorsal fin-fork length	582		939
First dorsal fin-fork length (Tape measure length)	18		57
Round Weight	563,071		770,336
Total no. of samples**	48,101,019	467,221,413	145,959,541

Measurement type	Bigeye tuna	Skipjack tuna	Yellowfin tuna
Fork length	97.9%	99.6%	98.7%
Fork length (by using a Board)	0.0%	0.1%	0.0%
Fork length (converted from weight/length)	0.0%	0.0%	0.0%
Fork length (converted tape measure lengths)	0.0%	0.1%	0.1%
Fork length (unconverted tape measure lengths)	0.0%	0.2%	0.2%
Gilled and gutted weight	0.9%	0.0%	0.4%
First dorsal fin-fork length	0.0%	0.0%	0.0%
First dorsal fin-fork length (Tape measure length)	0.0%	0.0%	0.0%
Round Weight	1.2%	0.0%	0.5%
Total no. of samples**	100.0%	100.0%	100.0%

** Includes a mixture of raised (i.e., Purse seine) and unraised (e.g., Longline and Gillnet) specimens sampled for length/weight.

Figure i: Charts showing standard length and weigh conversion equations for tropical tuna species.





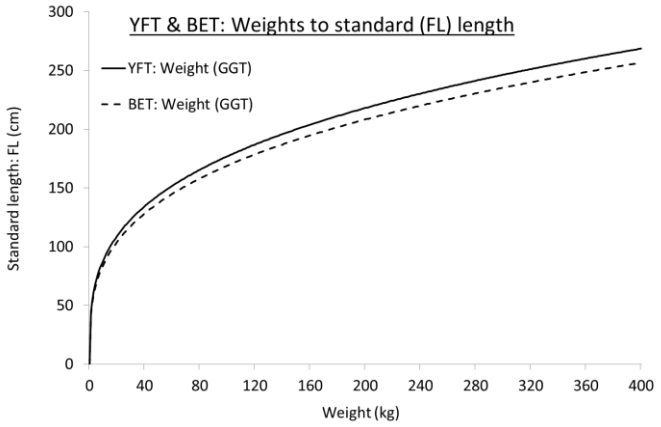
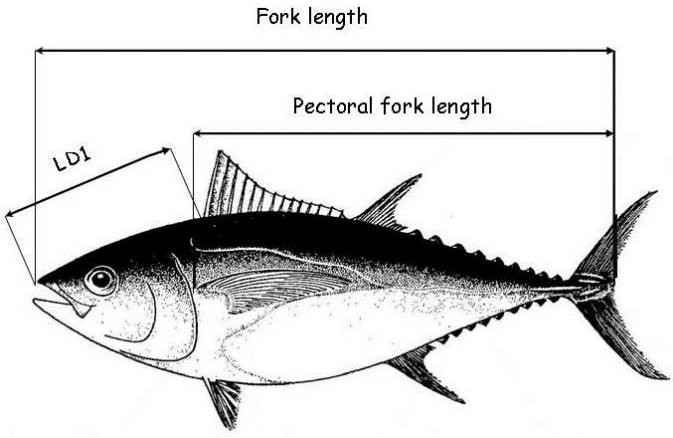


Fig ii. Types of measurements used for tuna



APPENDIX III

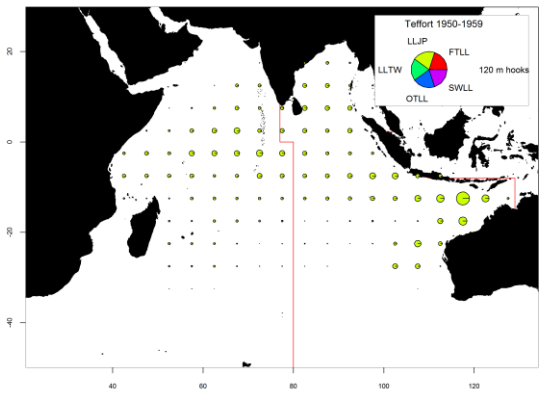
REVIEW OF FISHERIES TRENDS FOR TROPICAL TUNAS

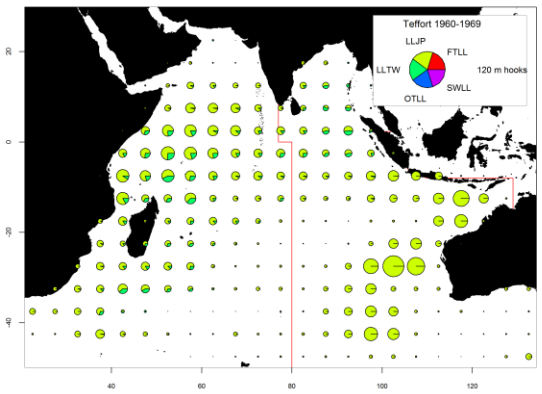
1. EFFORT

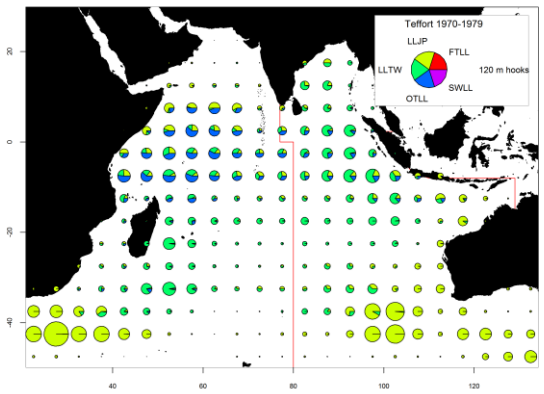
a) Longline

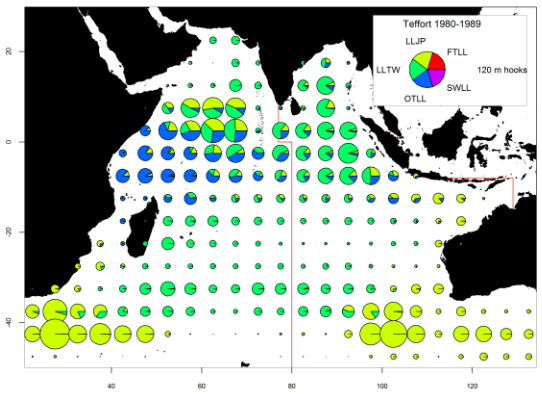
Effort exerted by LONGLINE fleets in the Indian Ocean, in millions (M) of hooks set, by decade (1950-2009) and main fleet:

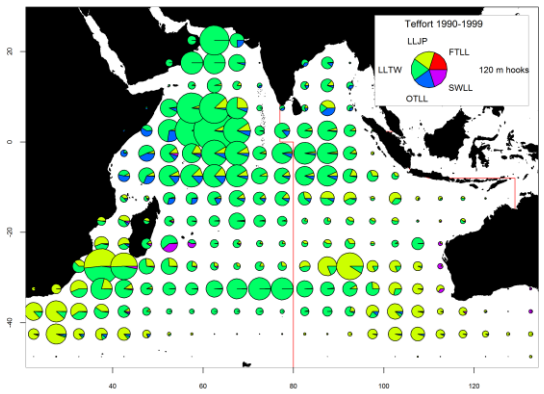
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets)

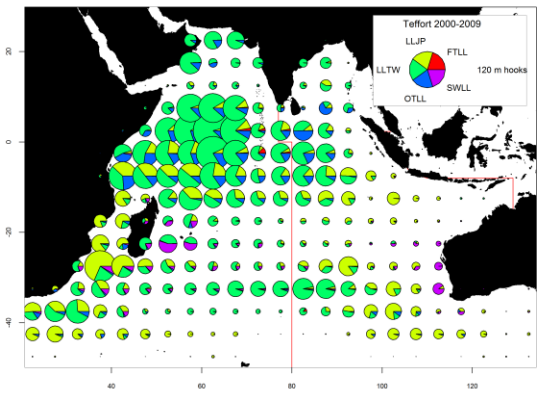






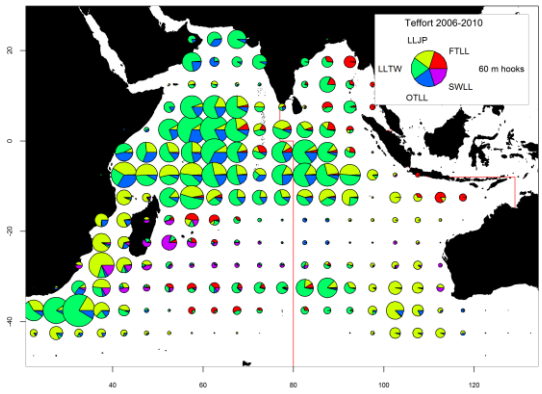


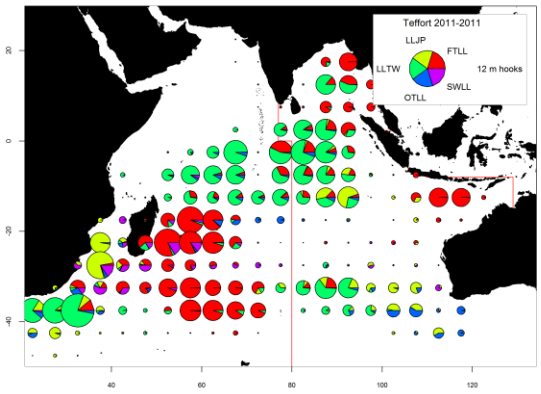


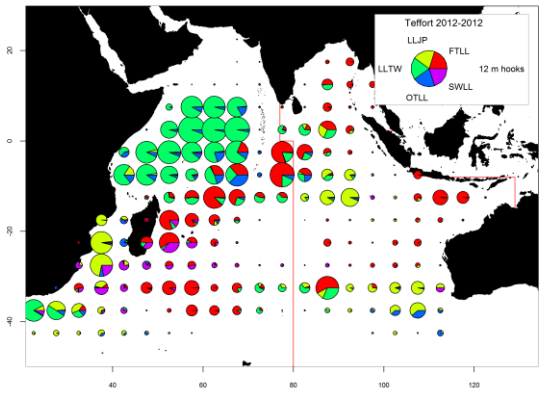


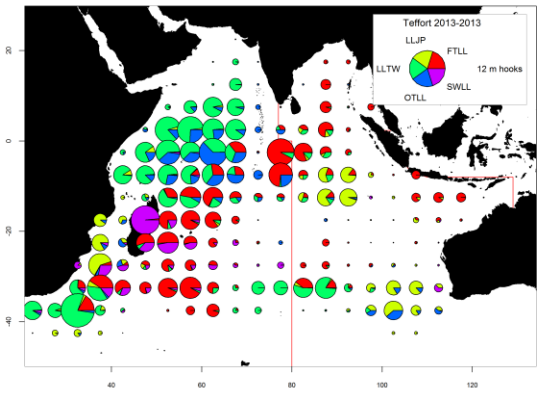
Effort exerted by LONGLINE fleets in the Indian Ocean, in millions (M) of hooks set, and main fleet for 2006-2010, and 2011 to 2015:

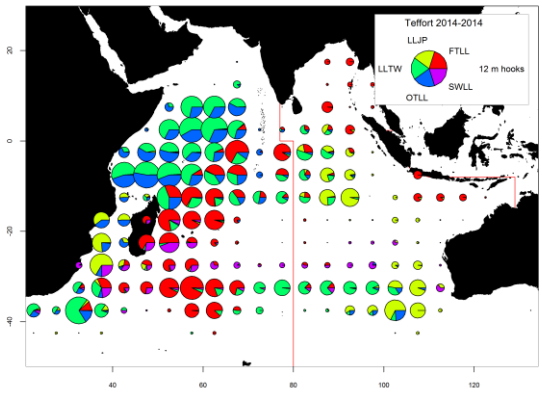
LLJP (light green): deep-freezing longliners from Japan
LLTW (dark green): deep-freezing longliners from Taiwan,China
SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets)

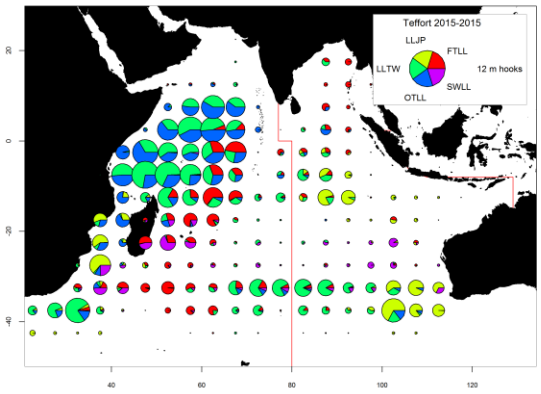












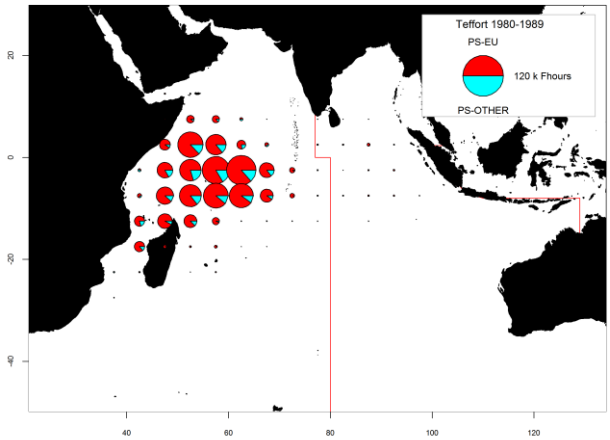
Purse seine

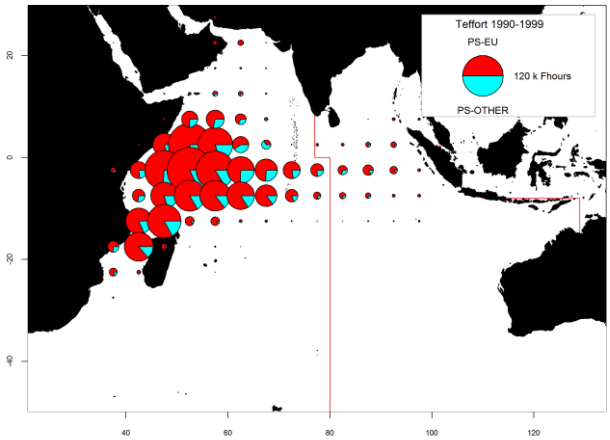
Effort exerted by industrial PURSE SEINE fleets in the Indian Ocean, in thousands (k) of fishing hours (Fhours), by decade (1980-2009) and main fleet:

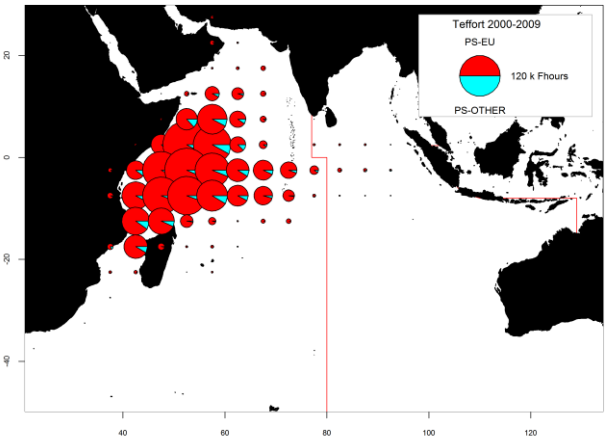
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)

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, and days-at-sea recorded for Australia)





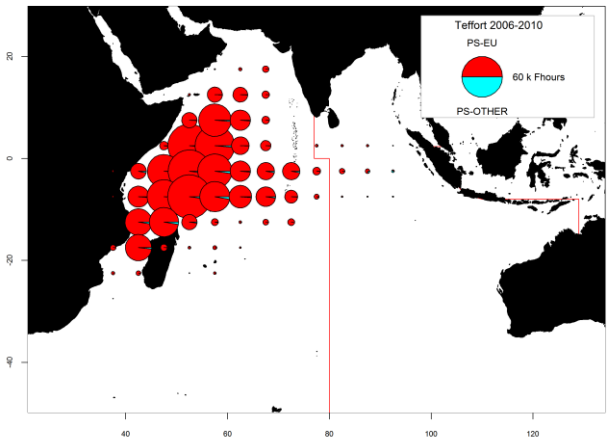


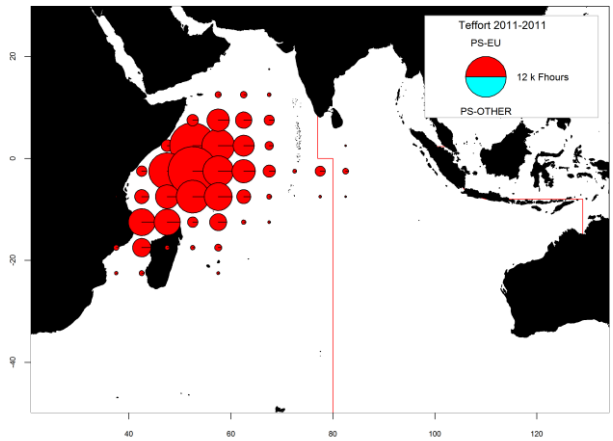
Effort exerted by industrial PURSE SEINE fleets in the Indian Ocean, in thousands (k) of fishing hours (Fhours), for 2006-10 and 2011-15, by year, and main fleet:

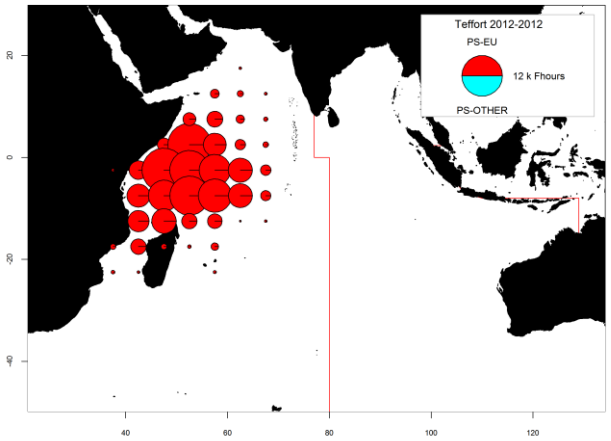
PS-EU (red): Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)

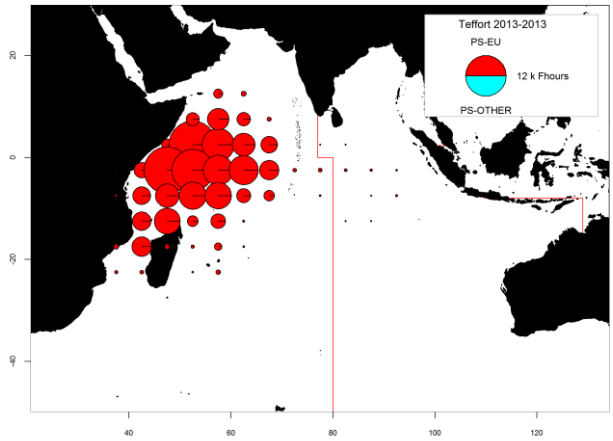
PS-OTHER (green): Industrial purse seiners from other fleets (includes Japan, Mauritius and purse seiners of Soviet origin)

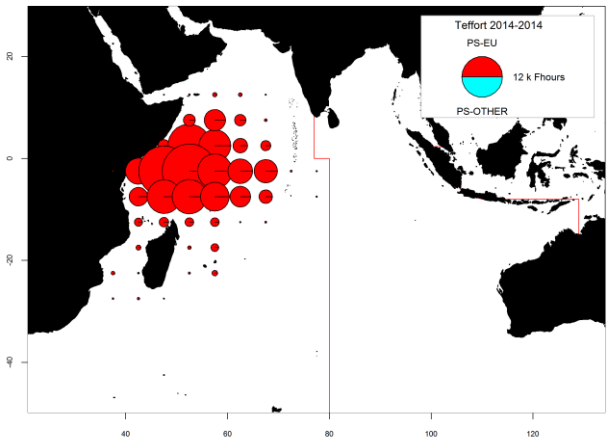
(excludes effort data for purse seiners of Iran and Thailand, and days at sea recorded for Australia)

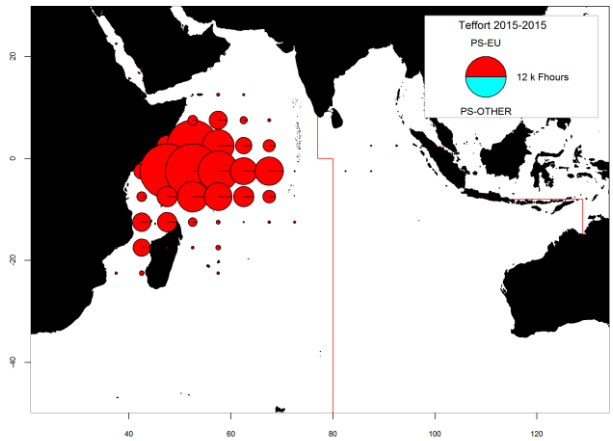










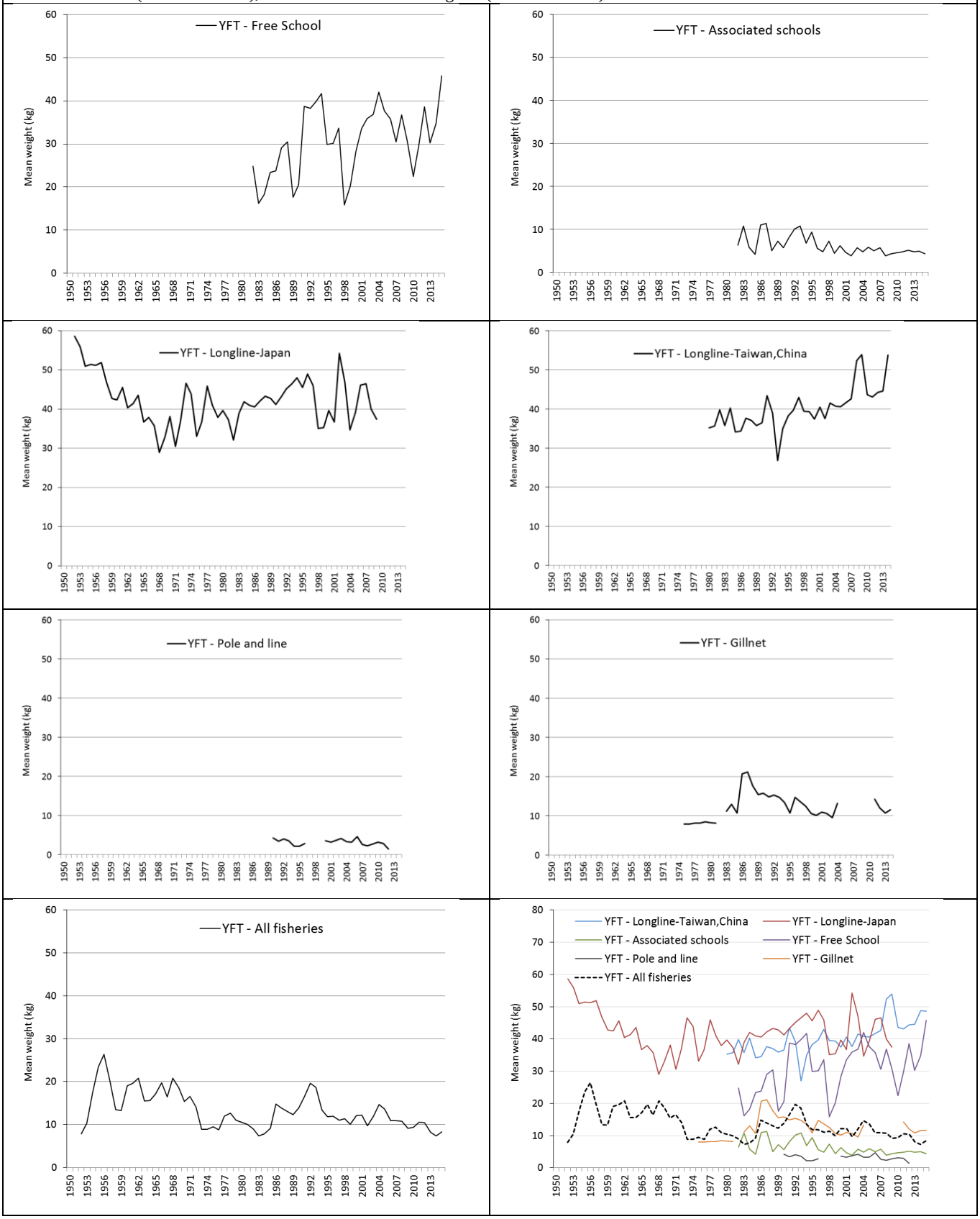


2. AVERAGE WEIGHT

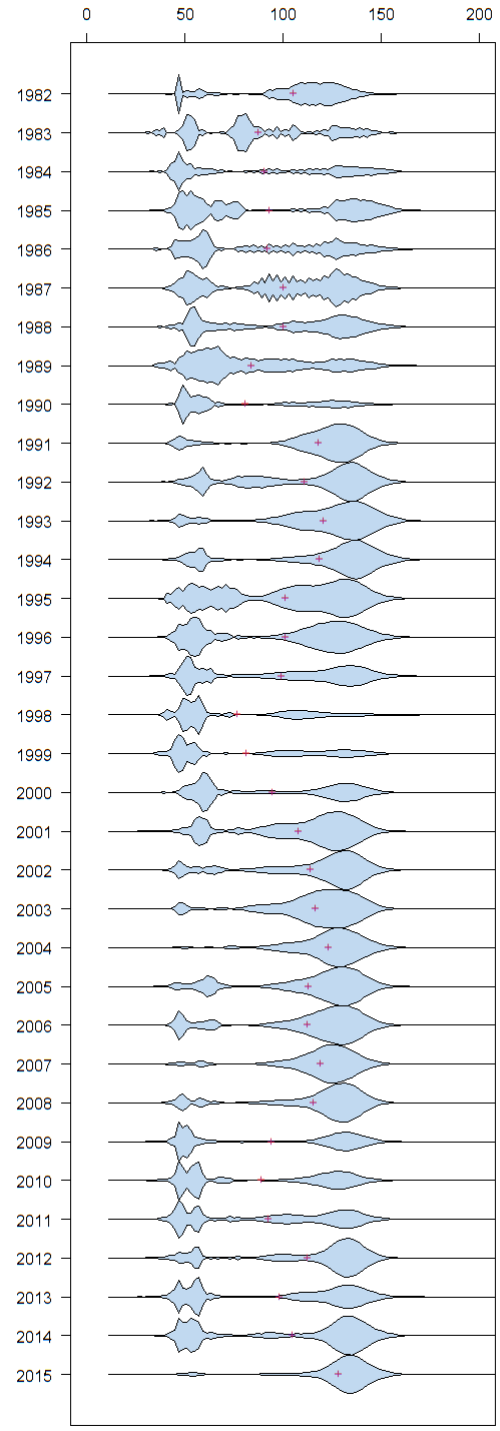
a. Yellowfin tuna (YFT)

Average weight of yellowfin tuna (YFT) taken by:

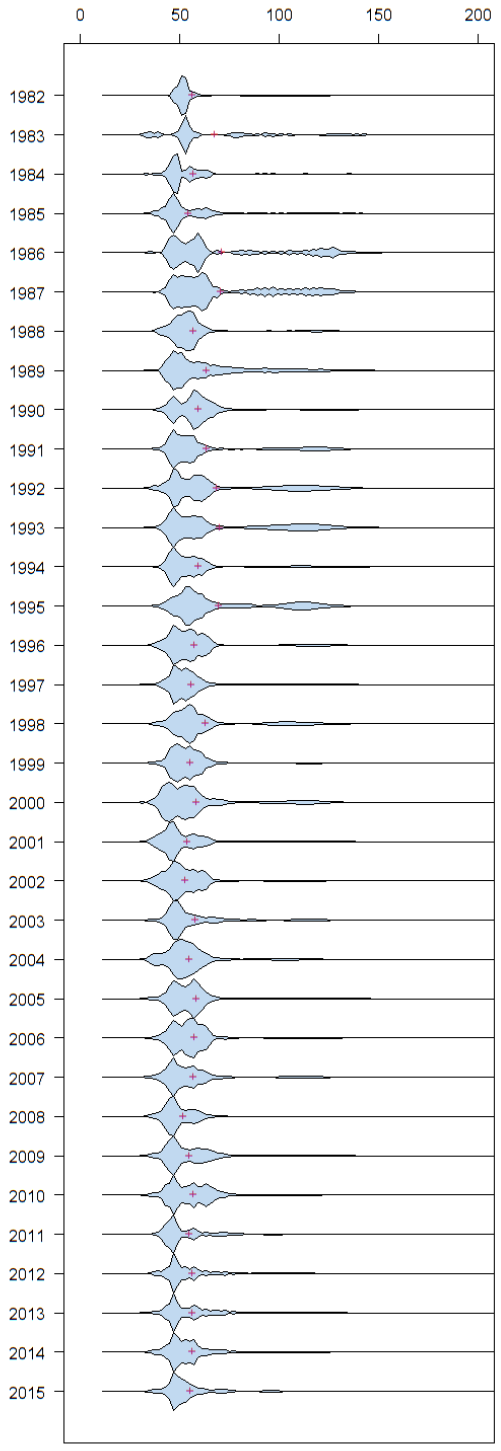
- Purse seine on free (top left) and associated (top right) schools,
- Longlines from Japan (second row left) and Taiwan,China (second row right)
- Pole-and-line from Maldives and India (third row left), and gillnets from Sri Lanka, Iran, and other countries (third row right)
- All fisheries (bottom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



YFT (PS Free-school): size (in cm)

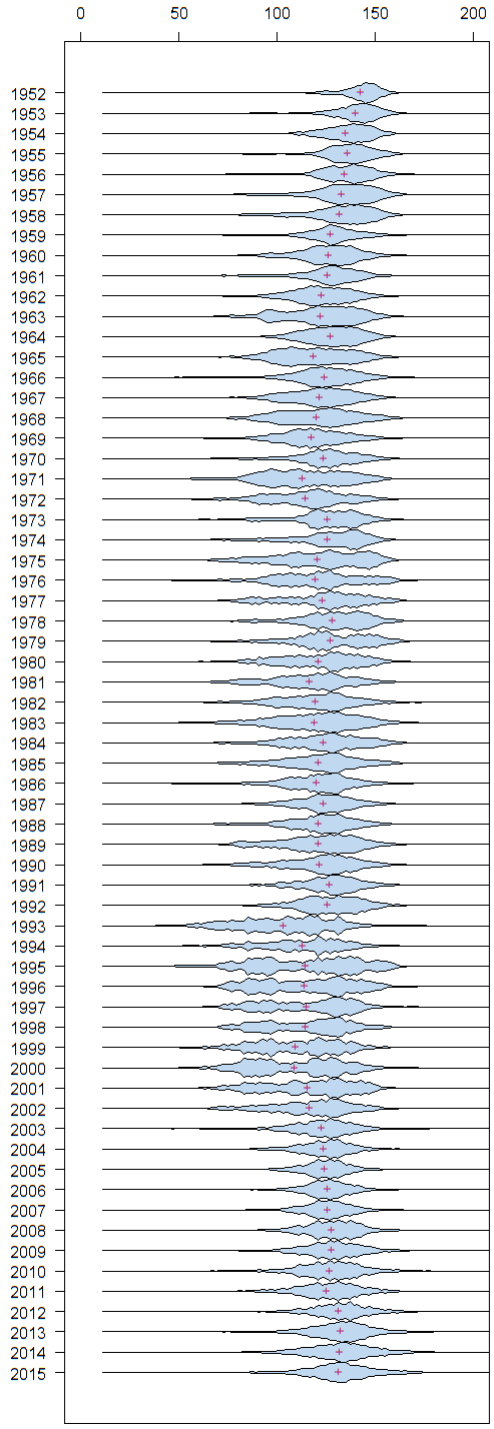


YFT (PS Log-school): size (in cm)

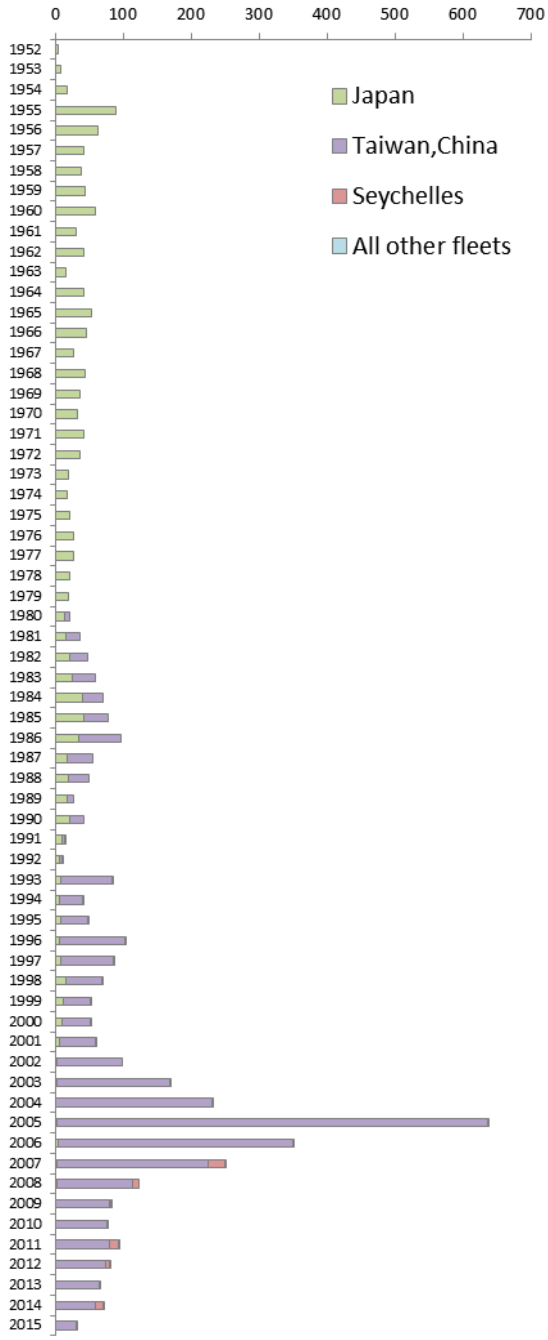


Yellowfin tuna (purse seine): **Left:** length frequency distributions for YFT PS Free school fisheries (by 2 cm length class). **Right**: Length frequency distributions for YFT PS Associated (log) school fisheries (by 2 cm length class). Source: IOTC database.

YFT (LL samples): size (in cm)



YFT (LL): no. of samples (‘000)

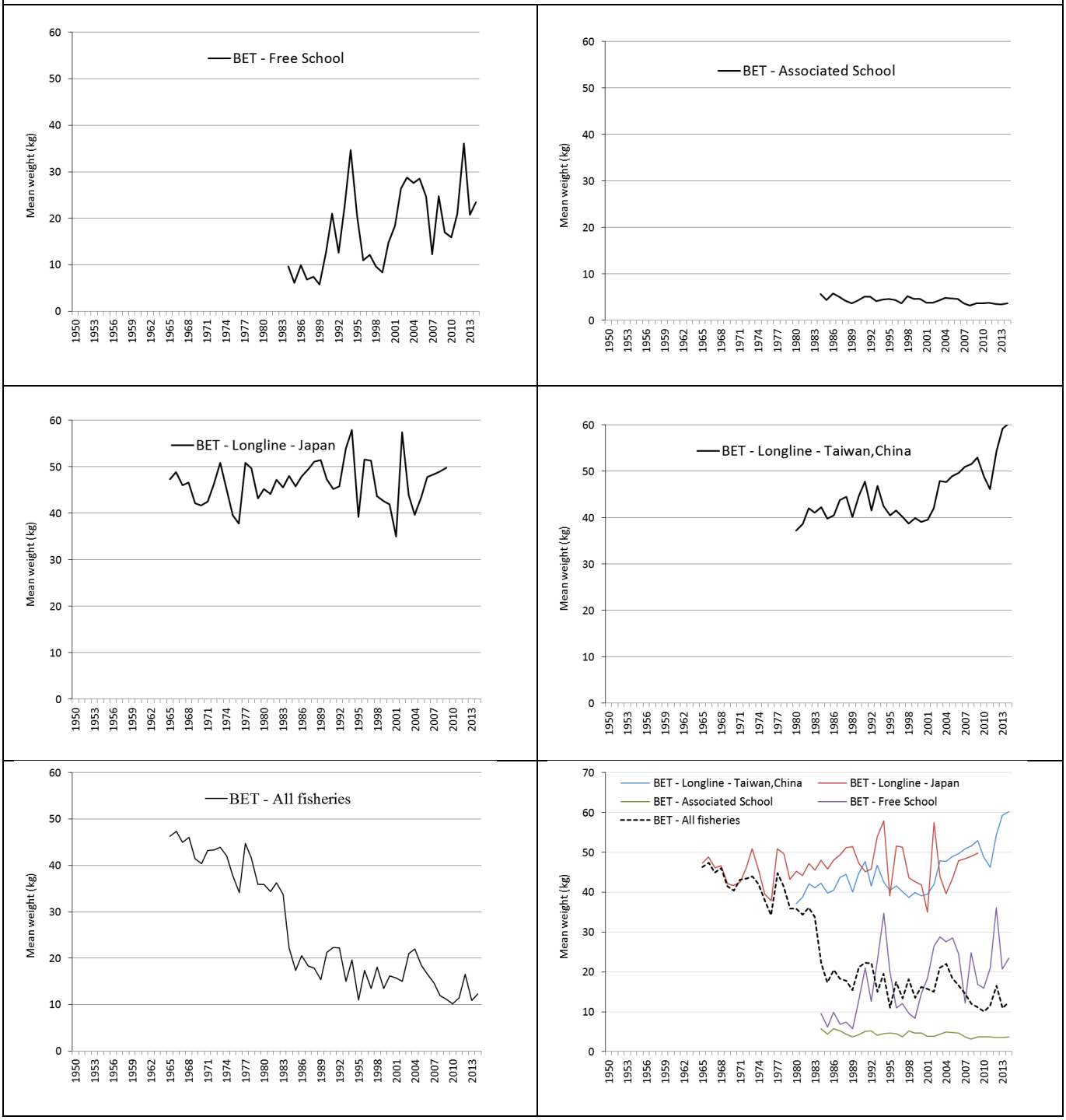


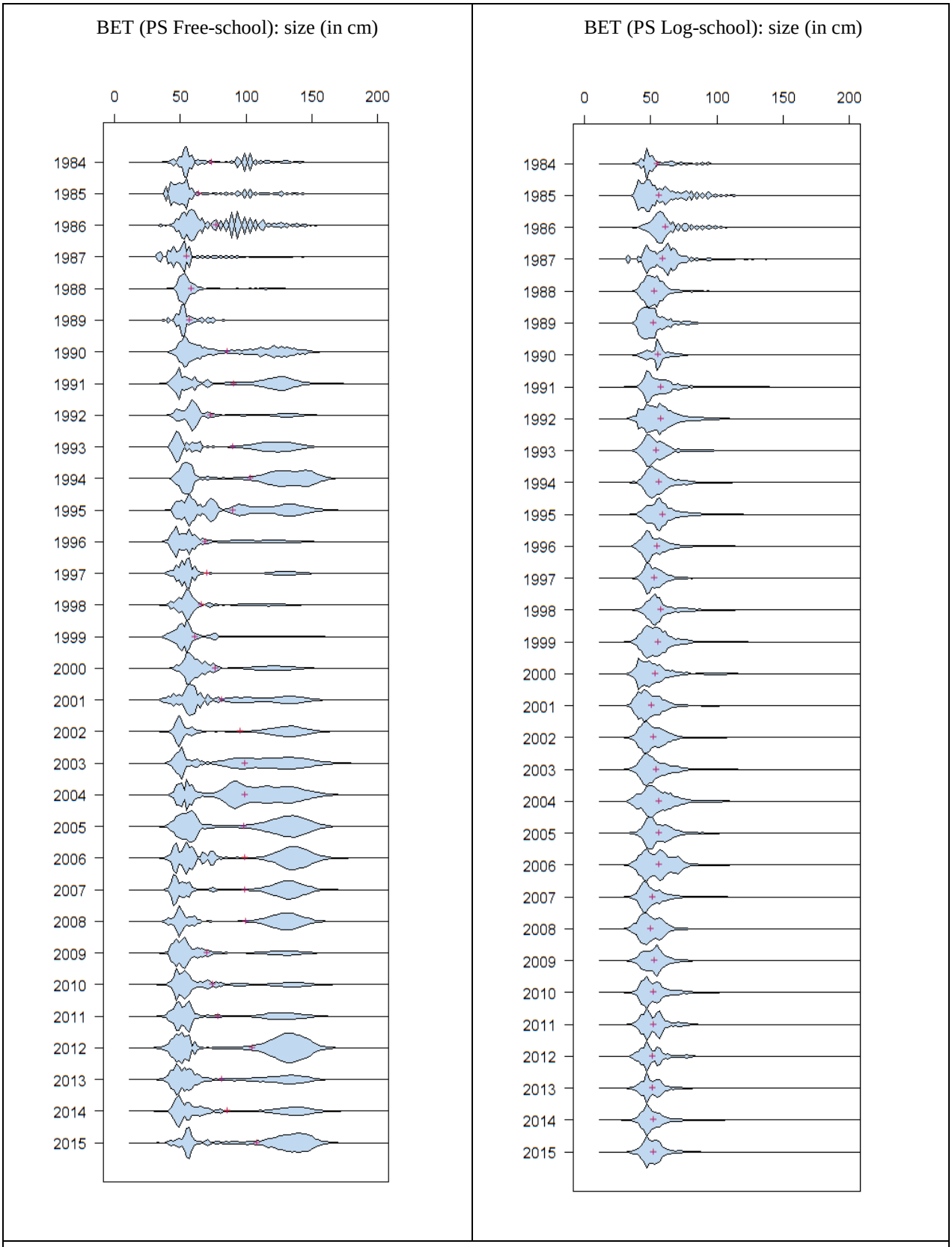
Yellowfin tuna (longline): **Left:** length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of yellowfin tuna specimens sampled for lengths, by fleet (longline only).

b. Bigeye tuna (BET)

Average weight of bigeye tuna (BET) taken by:

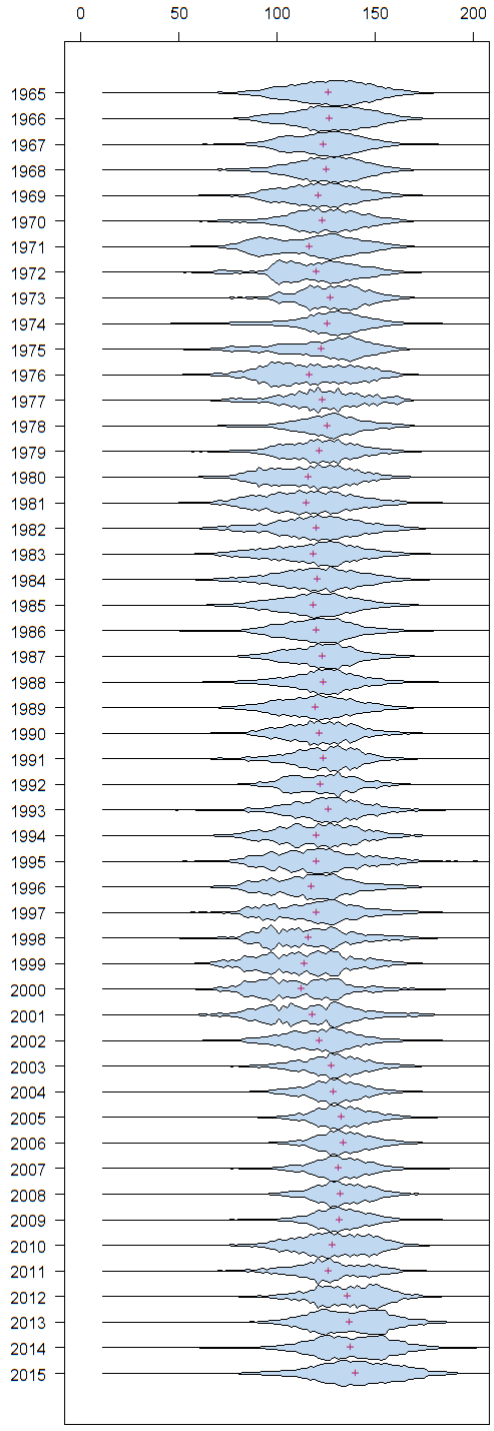
- Purse seine on free (top left) and associated (top right) schools,
- Longlines from Japan (second row left) and Taiwan,China (second row right)
- All fisheries (bottom row left), and all fisheries and main gears (bottom row left)



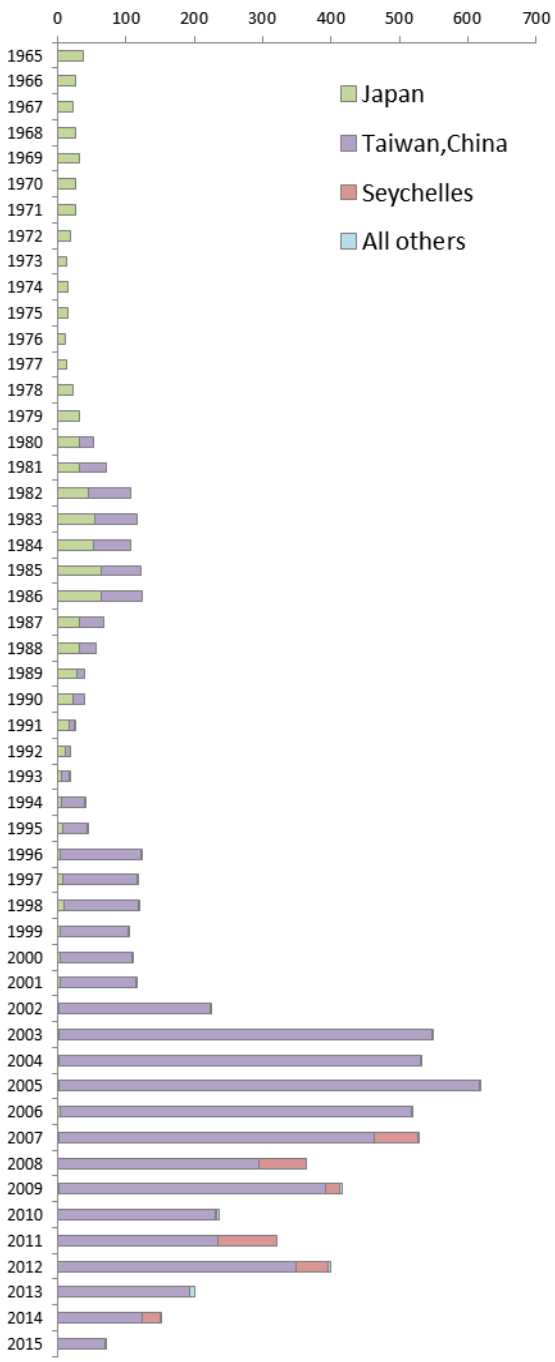


Bigeye tuna (purse seine): **Left:** length frequency distributions for BET PS Free school fisheries (by 2 cm length class). **Right**: Length frequency distributions for BET PS Associated (log) school fisheries (by 2 cm length class). Source: IOTC database.

BET (LL samples): size (in cm)



BET (LL): no. of samples (‘000)

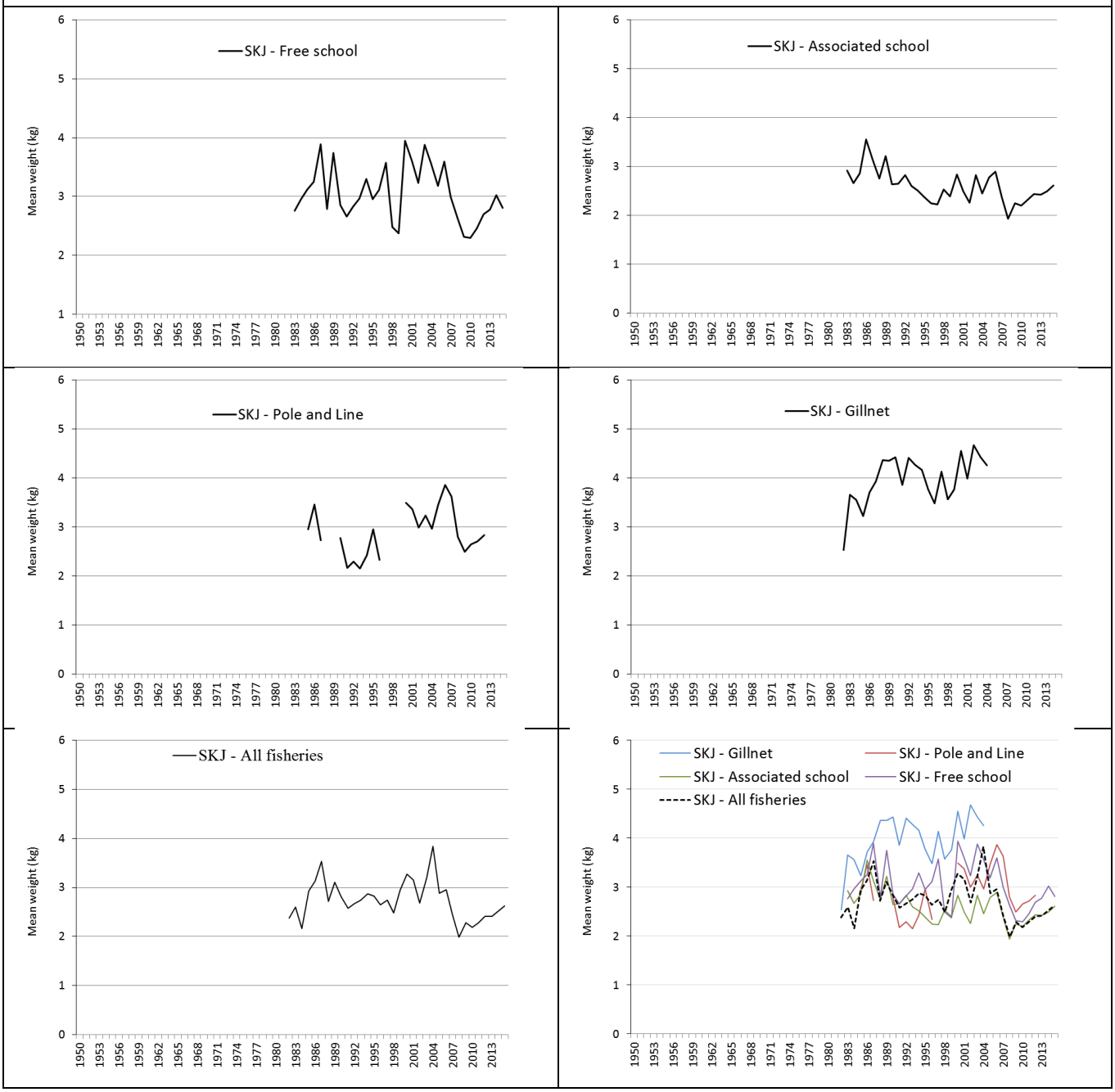


Bigeye tuna (longline): **Left:** length frequency distributions for longline fisheries (by 2 cm length class) derived from data available at the IOTC Secretariat. **Right**: Number of bigeye tuna specimens sampled for lengths, by fleet (longline only).

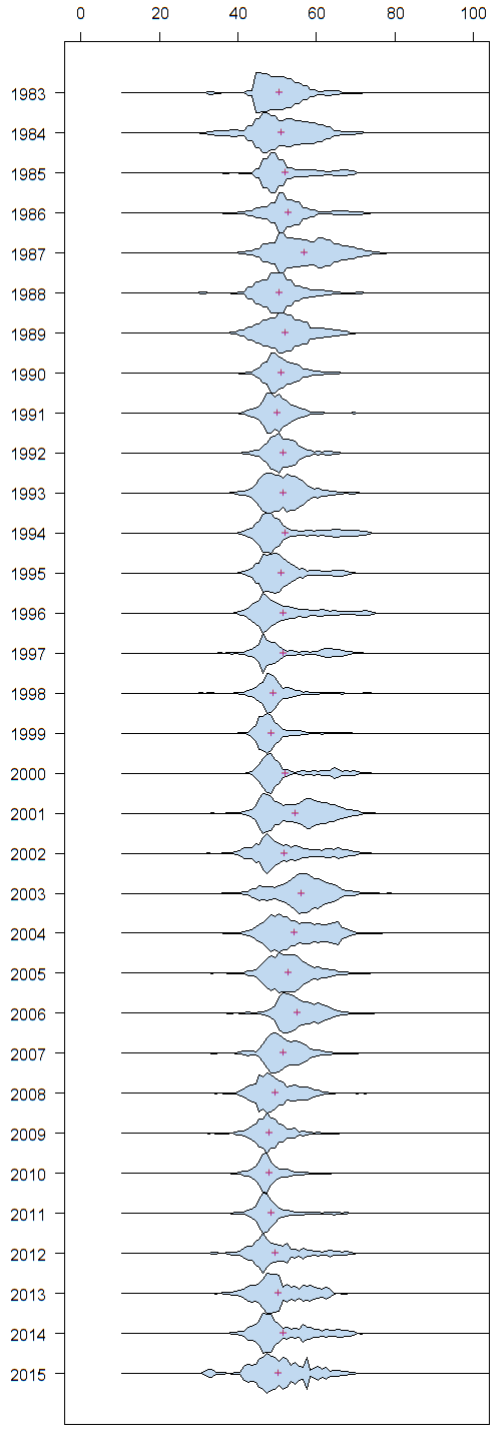
c. Skipjack tuna (SKJ)

Average weight of skipjack tuna (SKJ) taken by:

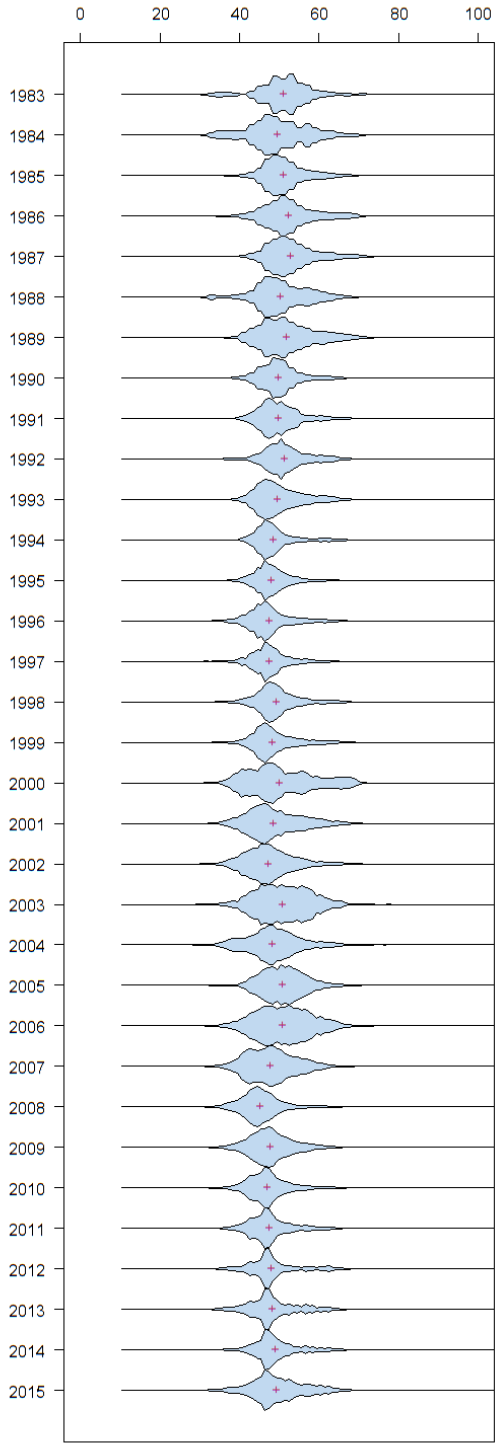
- Purse seine on free (top left) and associated (top right) schools,
- Pole-and-line from Maldives and India (second row left), and gillnets from Sri Lanka, Iran, and other countries (second row right)
- All fisheries (bottom row left), and all fisheries and main gears (bottom row left)



SKJ (PS Free-school): size (in cm)



SKJ (PS Log-school): size (in cm)



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