REVIEW OF THE STATISTICAL DATA AND FISHERY TRENDS FOR TROPICAL TUNAS

Prepared by: IOTC Secretariat[1], 3 June 2020

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 **May 2020**, 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 (CPCs)*[2], for the period 1950–2018.

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 tuna species, 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, average weights by species
- **Appendix III**: Review of effort trends by type of fisheries

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

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[2] This Resolution superseded IOTC Resolutions 10/02, 98/01, 05/01 and 08/01.

(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].

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°x5° 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 May 2020 this database contains 219,121 releases and 34,352 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*

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

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

Fisheries and catch trends for tropical tuna species

Main species

Skipjack tuna accounts for 48.5% of total catches of tropical tunas, followed closely by yellowfin tuna (42.2%), while catches of bigeye tuna account for the remaining 9.3% of catches (**Fig. 1d**).

Main fishing gears (2014-2018)

Purse seiners account for 42.6% of total catches of tropical tunas, with important catches also reported by handlines and trolling (18.2%), gillnets (18.9%), pole-and-line (11.3%), and longliners (7.7%), with catches occurring 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 (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 51% 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 33% of total catches of these species.

Retained catch trends

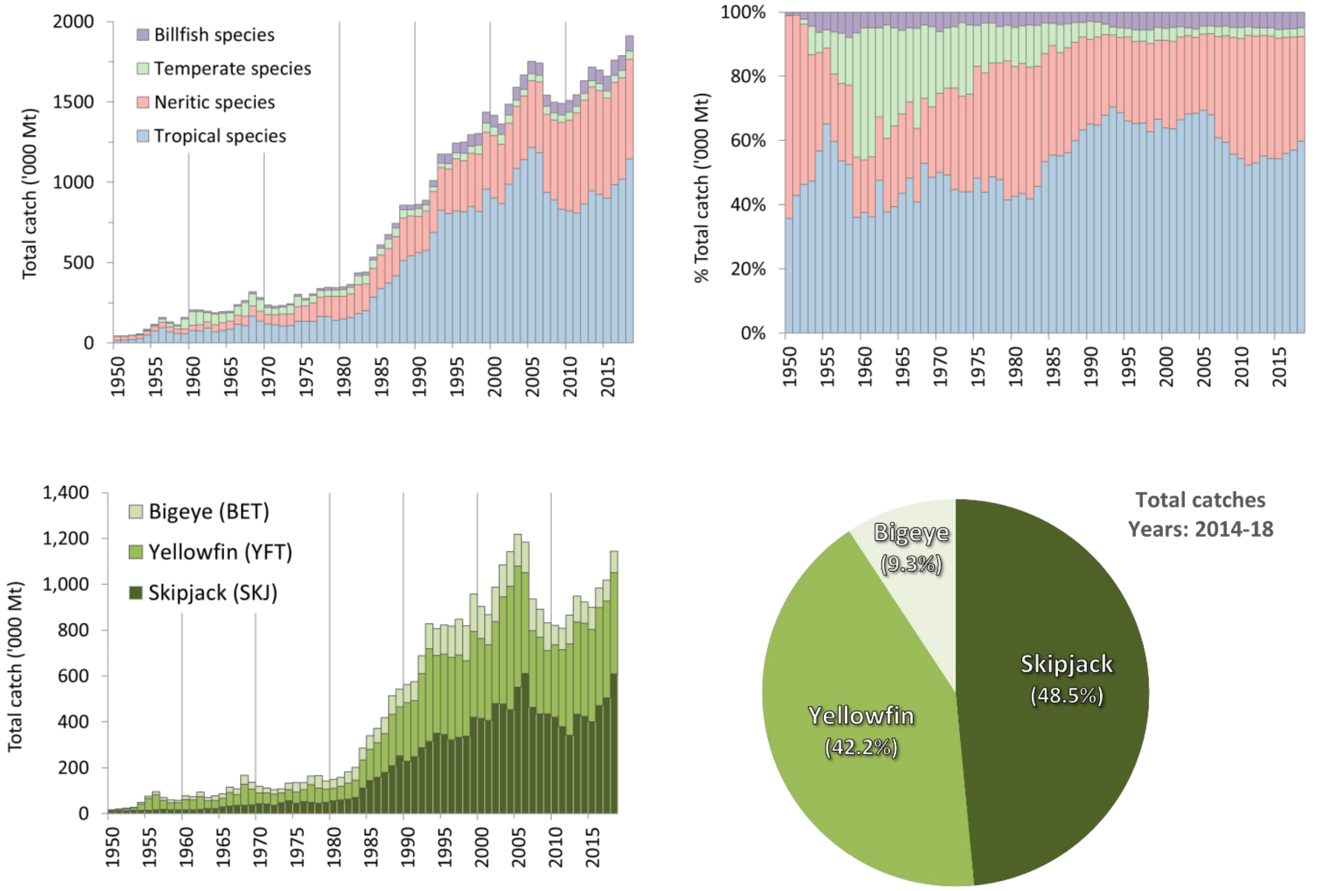
The importance of tropical tunas to the total catches of IOTC species in the Indian Ocean has changed over the years (**Figs. 1a-b.**), in particular following the arrival of industrial purse seine fleets to the Indian Ocean in the early-1980s targeting tropical tunas. With the onset of piracy in the 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 59% of total catches of all IOTC species, compared to ≈68% 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 ≈820,000t during the years of piracy in the late 2000s, to ≈940,000t in 2013 and ≈1,000,000t and over in 2017 and 2018.

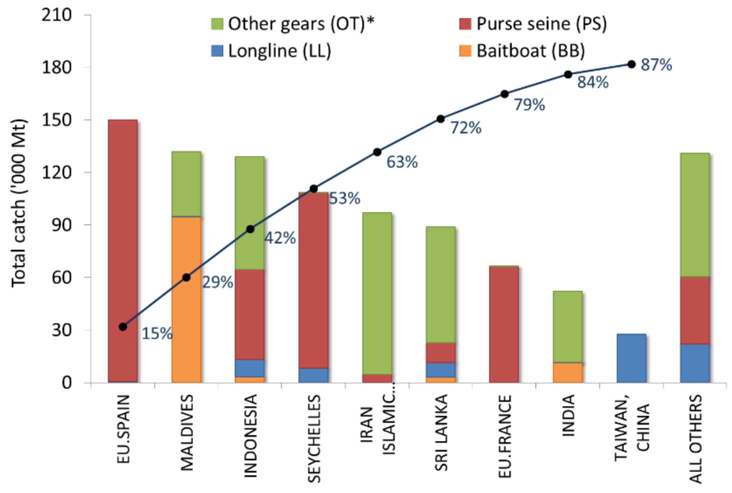
Economic markets

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 1950-2018 (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, 1950-2018; d. Bottom right: share of tropical tuna catch by species, 2014 – 18)



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

Fig. 2. All tropical tunas: average catches in the Indian Ocean over the period 2014 – 18, by country. Countries are ordered from left to right, according to the importance of catches of tropical tunas reported. The dark 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.

Nominal (retained) catches

- **EU (purse seiners)**: changes introduced in the statistical methodologies used by one component of the EU purse-seine fleet to estimate species composition for 2018, resulted in figures largely contrasting with other segments of the same fleet: this specific issue was discussed during the 21st Session of the WPTT and – while no revision to the catch figures was officially introduced – the WPTT agreed on using revised catch levels for stock assessment and management purposes. To date, no official revision for the species composition of catches reported by the EU purse-seine fishery in 2018 was received by the IOTC Secretariat.
- **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 revised upwards by around 3,000t – 6,000t 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.
- **Sri Lanka (gillnet-longline)**: Although Sri Lanka has reported catches of bigeye tuna for its 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 I.R. Iran for years prior to 2012 by 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 700t per year), however these estimates remain uncertain.
- **Pakistan (drifting gillnet)**: Up to 2019, 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.

  Revised catch series for the gillnet fishery of Pakistan (from 1987 to 2018) have been officially endorsed in December 2019 following the WPDCS15 and eventually the 22nd session of the Scientific Committee, and are now included in the IOTC database. These revised catch series introduce sensible changes to the total yearly captures of both Skipjack tuna and Yellowfin tuna: catch volumes of the former are now around 2,165 MT less (on a yearly average), while for the latter an average yearly increase of 6,224 MT is recorded. Still, the revised catch series continue reporting zero catches of Bigeye tuna, which is partially contrasting with information from comparable gillnet fisheries operating in similar areas: for this reason, the IOTC Secretariat is still liaising with the Ministry of Fisheries and WWF Pakistan to understand, and resolve, this potential inconsistency.
- **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 (for Sri Lanka, until 2014) – 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. Currently IOTC estimates are based on FAO data, however the quality of catches remains highly uncertain and 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.

[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 lead to improvements in the estimate of catch for the coastal fisheries of Sri Lanka for 2012 and subsequent years.

- **Comoros (coastal fisheries)**: In 2011 and 12 the IOTC Secretariat and 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 5,000t per year instead of 9,000t). The IOTC Secretariat revised estimates of catch for the period 1995 – 2010 using the new estimates.

Discards – all fisheries

The total amount of tropical tunas discarded at sea remains unknown for most fisheries and time periods prior to 2013 (i.e., prior to the introduction of Resolution 13/11, superseded by Resolutions 15/06 and 17/04[5]). Discards of tropical tunas are thought to be significant during some earlier 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.

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 *IOTC Mandatory statistical requirements* and of limited value in deriving indices of abundance:

- **EU (purse seiners)**: as already discussed for the nominal catches, the changes in statistical methodologies used to estimate species composition from one component of the EU purse seine fleet introduced a range of statistical artifacts in the catch-and-effort data submitted for 2018. A proposal for re-estimating the species composition of time-area catches for the fleet using proxy data (from the same and comparable fleets) was discussed at the WPDCS15 in 2019, although no official revision was received or produced by the IOTC Secretariat to date.
- **I.R. Iran (coastal and offshore fisheries)**: I.R. Iran ranks among the first ten countries with the larger total catches of tropical tunas in 2018 (accounted for mostly by drifting gillnets), however until recently, catch-and-effort have not been reported according to IOTC standards, in particular for vessels operating in offshore waters. Following an IOTC Data Compliance mission in November 2017, I.R. Iran has now begun to submit catch-and-effort data in accordance with the reporting requirements of Resolution 15/02, and this lead to measurable improvements to the data available for the Iranian fisheries in the IOTC database for 2007 and following years.
- **Sri Lanka (gillnet-longline)**: Until 2014 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. For this reason, time-area catches prior to 2014 are considered to be uncertain.
- **Indonesia (longline)**: Several IOTC-OFCF missions were conducted from November 2015 onwards to assist Indonesia with reporting of catch-and-effort, size frequency data and Regional Observer data collected on-board longline vessels. In 2019 (i.e. data for 2018) catch-and-effort data from logbooks covering around 5% of fishing operations for the longline and coastal purse-seine fleet of Indonesia (as well as for some other coastal fisheries) were received by the IOTC Secretariat for the first time as a consequence of the successful implementation of the *One Data* initiative that aims at strengthening data collection processes and coordination at regional and national level.
- **Pakistan (drifting gillnet)**: no catch-and-effort reported for the gillnet fishery, in particular for vessels that operate outside the EEZ of Pakistan. WWF-Pakistan has been a implementing a crew-based data collection programme for over four years, which includes information on total enumeration of catches and fishing location (for sampled vessels), and could be used to estimate catch-and-effort for Pakistan gillnet vessels in the absence of a national logbook program. The IOTC Secretariat is currently liaising with WWF-Pakistan to evaluate the quality of the data collected and see whether these could be used for other purposes beside cross-verifying the revised catch series provided in recent years.

[5] Resolution 17/03 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna, and non-targeted species caught by purse seine vessels in the IOTC area of competence.*

- **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.

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.

  Furthermore, the number of specimens sampled for length on-board longliners flagged in Japan in recent years remains below the minimum of one-fish-per-metric-ton of catch recommended by the IOTC – although size data is now being reported as part of Japan's Regional Observer Scheme data submissions.

  For several years the IOTC Scientific Committee has expressed concern about the poor coverage of length frequency samples for a number of major longline fleets, such as those from Japan, Indonesia, and India, and the potential negative impact this could have on stock assessments.

  In addition, inconsistencies have been noted between the average weights of tropical tunas derived from catch-and-effort and size frequency datasets, particularly for the Taiwanese longline fleet, when comparing data for the same area and time-period.

  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[6].

  In early 2019 an IOTC consultant was hired to review IOTC's longline size frequency data which, among other tasks, included visits to the national fisheries institutions of the key fleets collecting longline size data. The work is has been now finalized and its final report will be presented at the IOTC Working Party on Tropical Tuna as well as at the Scientific Committee in 2020.

- **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[7].

- **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°x5° grid) and they refer exclusively to longliners based in ports in those countries. In 2019 (i.e. data for 2018) size-frequency data in agreement with the requirements of Resolution 15/02 were received by the IOTC Secretariat for the first time for both the coastal and fresh-tuna longline fleet of Indonesia.

- To date, these countries have not reported size frequency data for their fisheries[8]:
  - Longline: India, Oman and the Philippines (longline);
  - Coastal fisheries: India and Yemen (Indonesia has recently reported data for some of their coastal fisheries in 2018)

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.

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

[7] 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 their fisheries.

[8] For the years during which these fisheries were known to operate

An alternative source of such biological information is the Regional Observer Scheme database, that collates data – including size and weight measurement – recorded by scientific observers and reported to the IOTC Secretariat (in detailed form) as part of the ROS data exchange workflow.

A first attempt at using ROS data to estimate length-weight relationships for Albacore tuna was made during the WPTmT 2019: a similar approach could be considered for tropical tuna species in the next future, once the extent of the information within the ROS database is deemed adequate enough for the purpose.

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.

SECTION 3: STATUS OF FISHERIES STATISTICS FOR TROPICAL TUNAS

BET - Bigeye tuna

Fisheries and main catch trends

Main fishing gear (2014–18)

industrial fisheries account for the majority of catches of bigeye tuna, i.e., deep-freezing and fresh longline (≈42%) and purse seine (≈37%) (**Table 2; Fig. 3**).

In recent years catches by gillnet fisheries have also been increasing, due to major changes for some fleets (e.g., Sri Lanka and I.R. Iran); notably increases in boat size, developments in 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 (2014–18): the four main fleets catching bigeye tuna are Indonesia (fresh / coastal longline, coastal purse seine): 25%; Taiwan,China (longline): 16%; EU-Spain (purse seine): 15%; Seychelles (longline and purse seine): 13% (**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 (2011 and following) catches of bigeye tuna in the eastern Indian Ocean have shown a decreasing trend, as some vessels have moved South to target albacore.

Retained catch trends

Total catches of bigeye tuna in the Indian Ocean increased steadily from the 1970's, from around 20,000t in the 1970s, to over 150,000t 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 (totalling at around 90,000t) still remain far below the 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. Development of a proper industrial purse seine fleet for Indonesia in 2018 resulted in significant catches of bigeye tuna being reported for the first time (around 5,000t).

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**).

As for other tropical tuna species (yellowfin tuna in particular), industrial purse seine catches of bigeye tuna on free-school have shown a steady decline in recent years. Total catches of Bigeye tuna for the purse seine fishery were relatively stable at around 20,000 – 30,000t for all fleets until 2017: catches reported in 2018 show an increase of around 50% compared to previous year (45,000t in total) with over 66% of purse seine catches now being reported by EU,Spain and Seychelles (log school, 53% and 13% of total catches in 2018 vs. 27% and 23% in 2017 respectively). This increase can partially be explained with the revisions introduced in the species composition estimation by one component of the EU purse seine fleet, and is still subject to further discussion and analysis.

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.

Catch series

No major changes to the catch series since the WPTT meeting in 2019. Official revisions to Pakistan gillnet catches from 1987 onwards are not affecting the species at all.

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 (2009–2018), 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 May 2020.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BB	21	50	266	1,536	2,968	5,069	6,874	6,789	6,880	6,885	7,386	6,773	6,517	6,864	6,961	5,295
FS	0	0	0	2,340	4,824	6,196	5,301	3,792	6,222	7,180	4,659	5,000	9,633	2,489	10,242	3,634
LS	0	0	0	4,852	18,315	20,273	24,708	18,486	16,386	10,434	22,809	14,868	15,547	19,330	19,456	42,961
LL	6,488	21,861	30,413	43,079	61,962	71,458	52,077	32,420	36,158	67,451	45,646	35,220	33,712	30,841	26,299	19,469
FL	0	0	218	3,066	26,282	23,490	15,810	9,782	12,031	16,816	16,725	13,650	12,401	7,658	8,892	7,147
LI	43	295	658	2,385	4,273	6,042	8,472	8,769	9,336	9,393	9,086	10,407	11,516	10,655	10,121	7,156
OT	38	64	164	859	1,407	3,658	5,558	5,331	7,361	6,600	6,882	7,126	7,070	9,013	8,892	8,576
Total	**6,589**	**22,269**	**31,720**	**58,118**	**120,030**	**136,186**	**118,801**	**85,368**	**94,374**	**124,760**	**113,193**	**93,045**	**96,396**	**86,850**	**90,863**	**94,236**

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**). Background colour intensity is proportional to the catches by fishery and category (i.e. decade, year)

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 (2009–2018), in tonnes. Catches by decade represent the average annual catch. Data as of May 2020.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
A1	2,478	11,959	17,644	35,963	60,572	80,741	63,443	44,786	47,363	78,674	68,393	52,396	57,173	53,891	58,032	64,706
A2	3,911	7,293	10,274	18,022	45,973	45,395	51,921	36,409	42,916	41,646	40,104	36,550	34,400	29,406	28,505	26,207
A3	201	3,017	3,802	4,132	13,486	10,050	3,437	4,174	4,094	4,440	4,695	4,099	4,823	3,552	4,325	3,323
Total	**6,589**	**22,269**	**31,720**	**58,118**	**120,030**	**136,186**	**118,801**	**85,368**	**94,374**	**124,760**	**113,193**	**93,045**	**96,396**	**86,850**	**90,863**	**94,236**

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. Background colour intensity is proportional to the catches by area and category (i.e. decade, year)

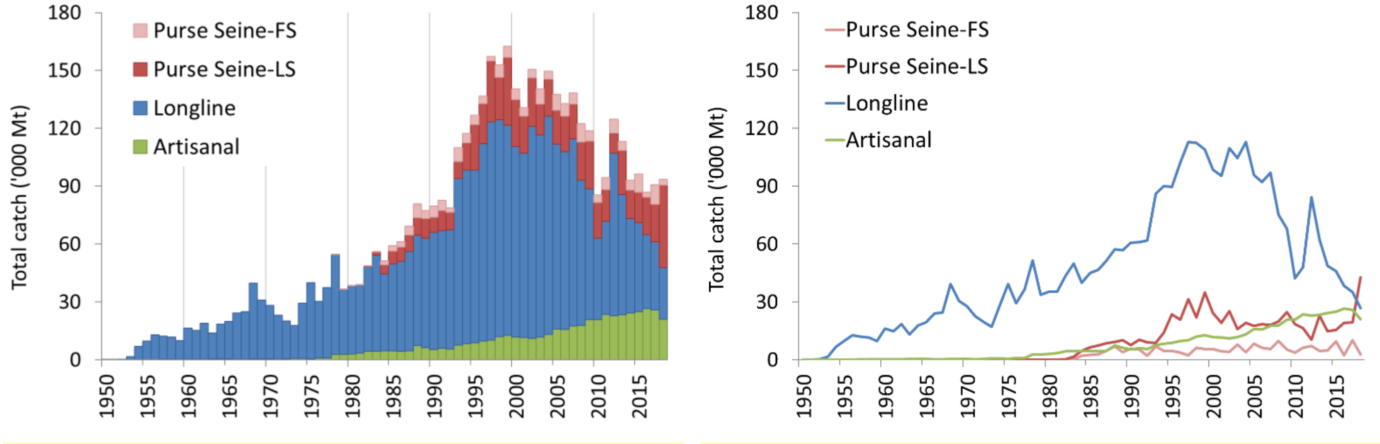


Fig. 3a & b. Annual catches of bigeye tuna by gear (1950–2018). Data as of May 2020

Gear definitions: Longline (fresh and deep-freezing); Purse seine free-school (FS); Purse seine associated school (LS); Artisanal (pole-and-Line, handline, small longlines, gillnet, trolling & other minor artisanal gears).

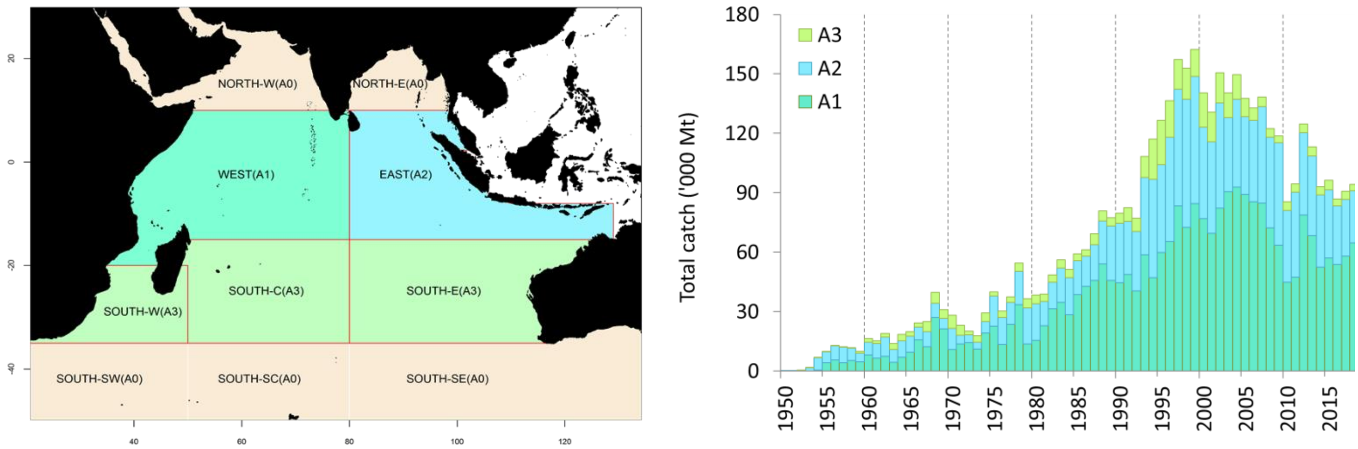


Fig. 4(a-b). Bigeye tuna: Catches of bigeye tuna by (SS3) stock assessment area by year (1950–2018). Catches outside the areas presented in the map were assigned to the closest neighbouring area for the assessment. Data as of May 2020.

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

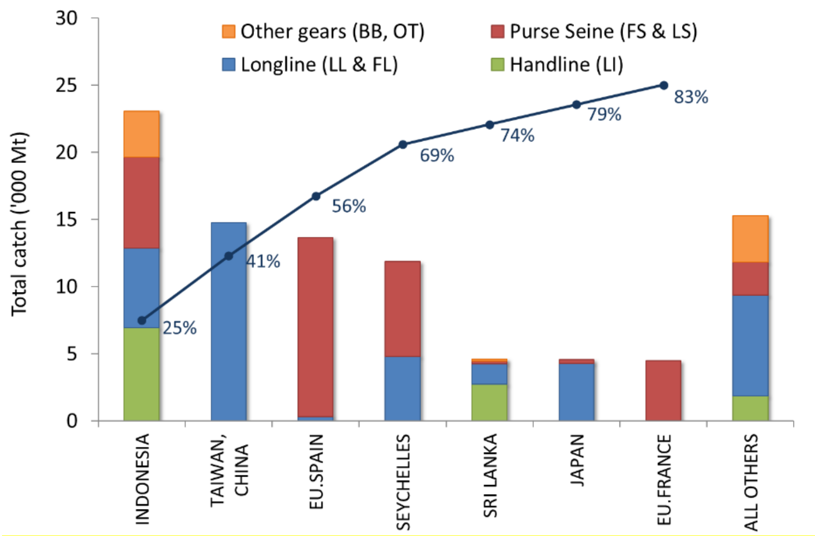


Fig. 5. Bigeye tuna: average catches by country in the Indian Ocean over the period 2014 – 18. Countries are ordered from left to right, according to the importance of catches of bigeye reported. The dark line indicates the (cumulative) proportion of catches of bigeye for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of May 2020.

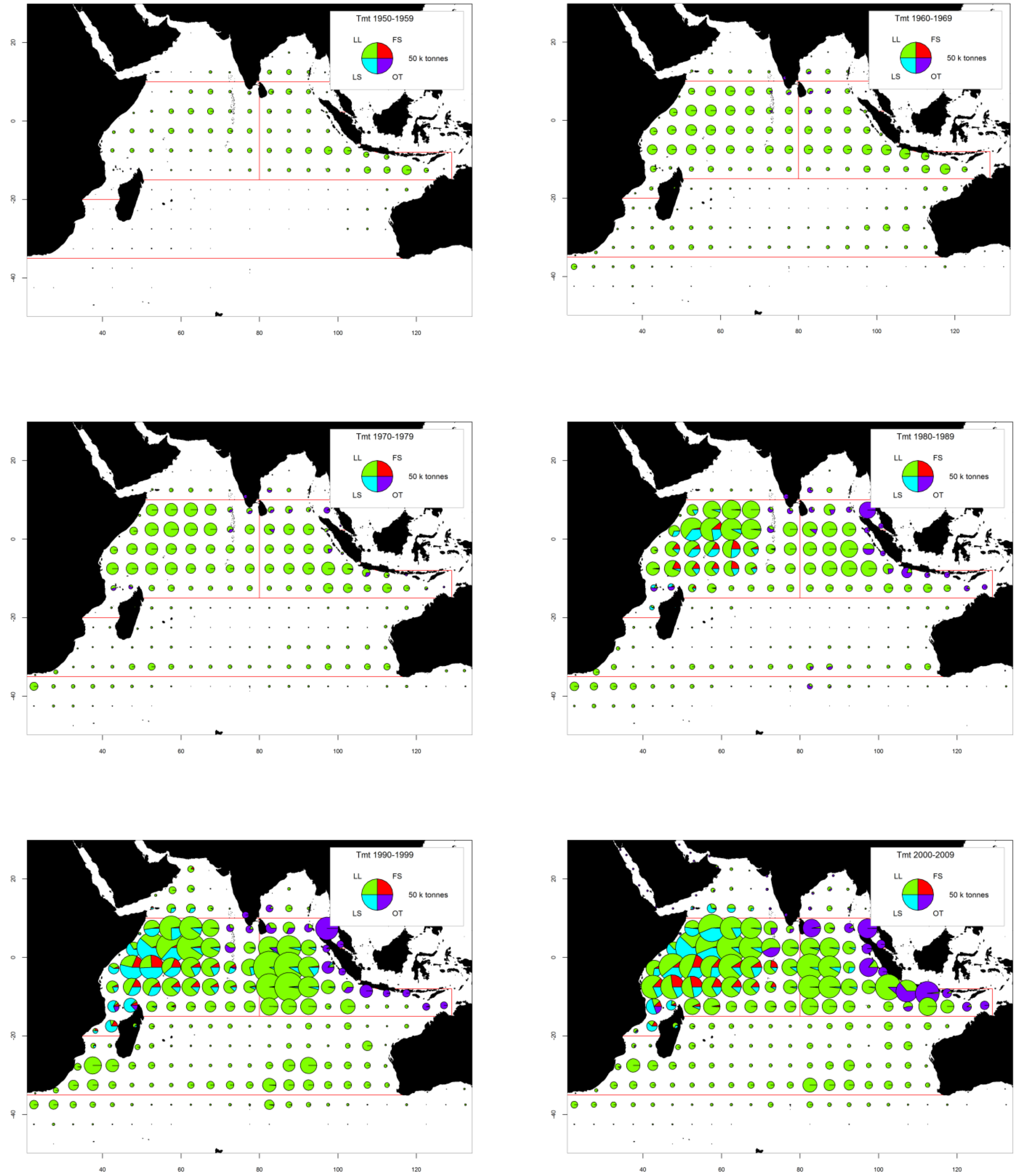


Fig. 6(a-f). Time-area catches (total combined in tonnes) of bigeye tuna estimated for the period 2007–2011 by type of gear and for 2012–16, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries.

Note that the catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded using the estimated areas from the CAS data set. This is particularly true for the driftnets of I.R. Iran, gillnet and longline fishery of Sri Lanka, and longline and coastal fisheries of Indonesia (OT).

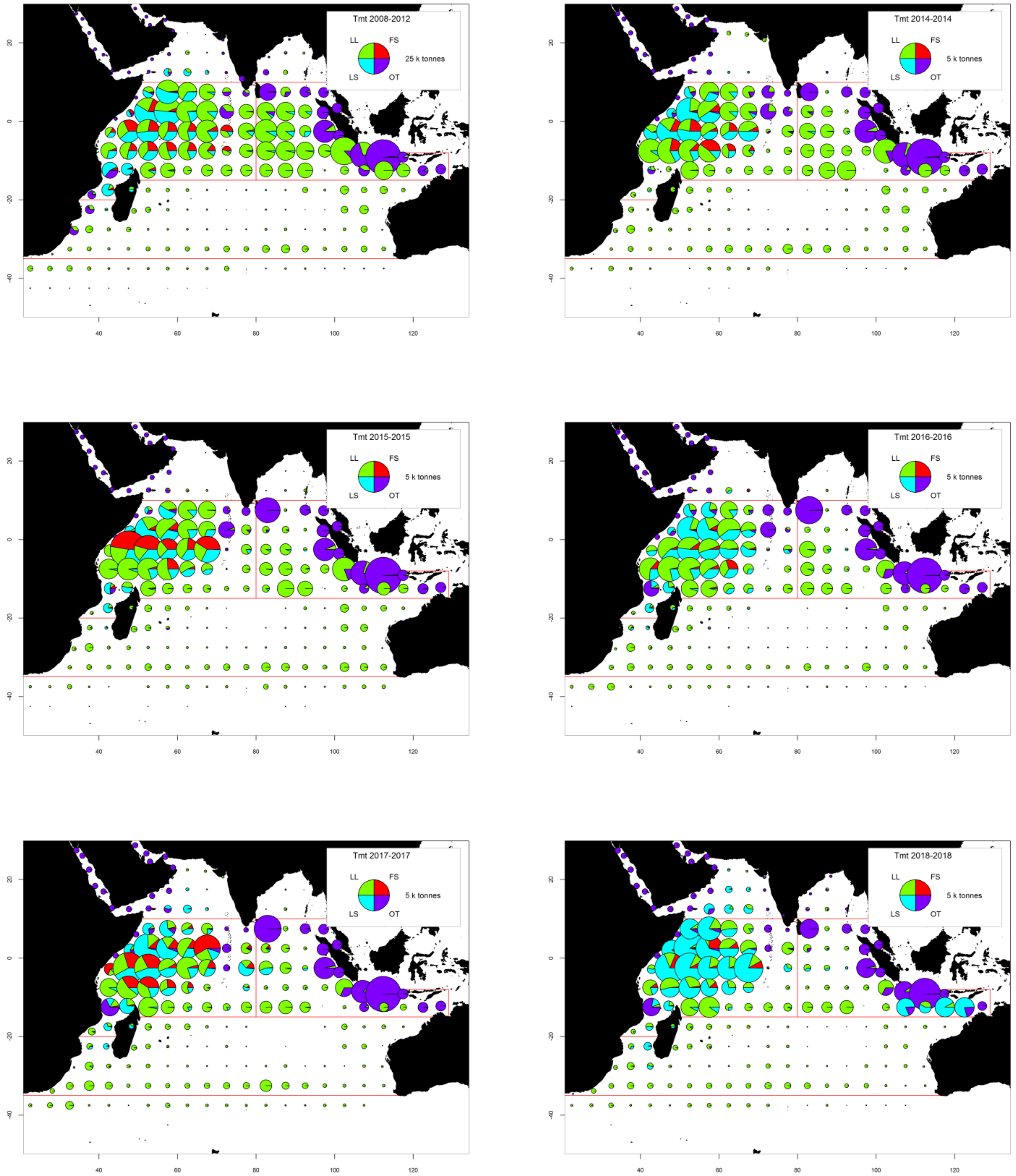


Fig. 7(a-f). Time-area catches (total combined in tonnes) of bigeye tuna estimated for the period 2008–2012 by type of gear and for 2013–17, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), and other fleets (**OT**), including pole-and-line, drifting gillnets, and various coastal fisheries.

Note that the catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded using the estimated areas from the CAS data set. This is particularly true for the driftnets of I.R. Iran (years before 2007), gillnet and longline fishery of Sri Lanka, and longline and coastal fisheries of Indonesia (OT).

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 and Pakistan (before 2012), Sri Lanka (gillnet-longline fishery, before 2014), 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, Malaysia, Oman, and Philippines; improvements in reporting of time-area catches for Indonesian purse seiners were noted in 2018;
  - ➢ Artisanal/coastal fisheries: incomplete or missing data for the driftnet fisheries of I.R. Iran (before 2007) 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). Data for 2018, as a consequence of a decrease in catches from longline fleets and a corresponding relevant increase in catches from industrial purse seine fleets (fishing on log-school), show a decrease in the estimated average weight of caught individuals down to an all-time low of around 6 Kg / fish (Indian Ocean wide, all gears) as opposed to over 10 Kg / fish estimated for the previous year.
- Catch-at-Size (Age) table: data are available, but the estimates are more uncertain for some years and some fisheries due to:
  - 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).
  - lack of size data available for some industrial fleets (NEI, India, Indonesia, I.R. Iran, Sri Lanka).

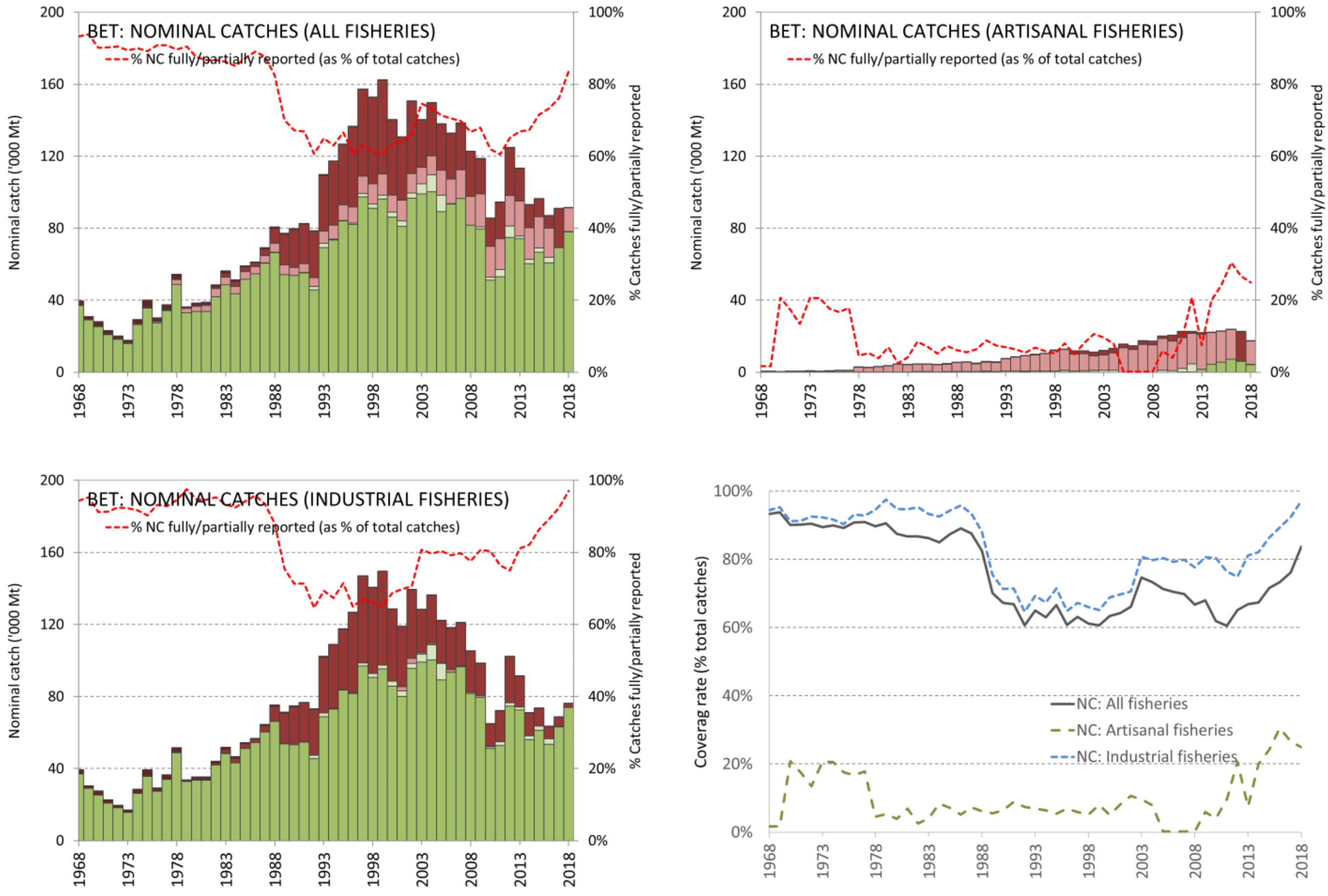


Fig. 8a-c. Bigeye tuna: nominal catches data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

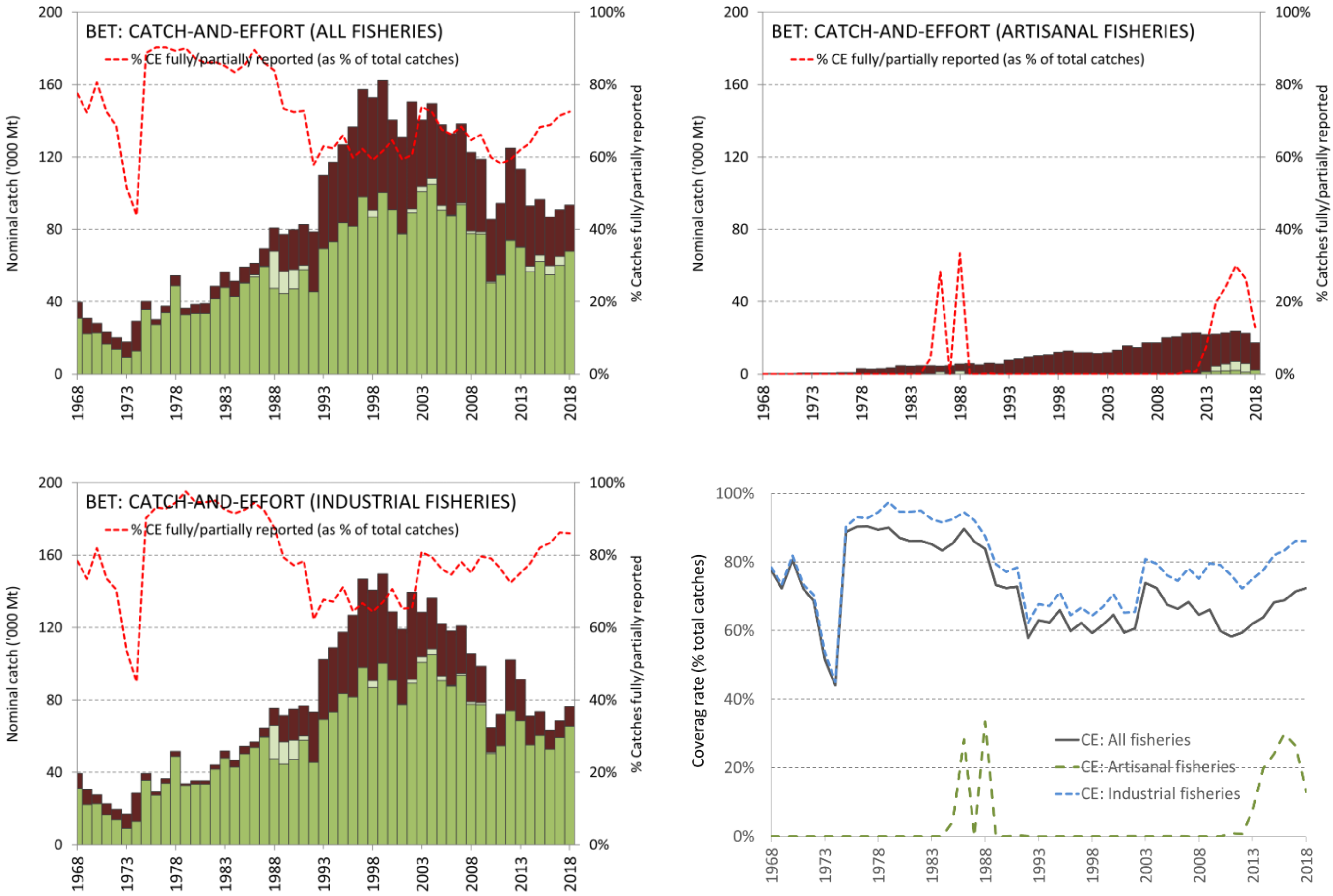


Fig. 8d-f. Bigeye tuna: catch-and-effort data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

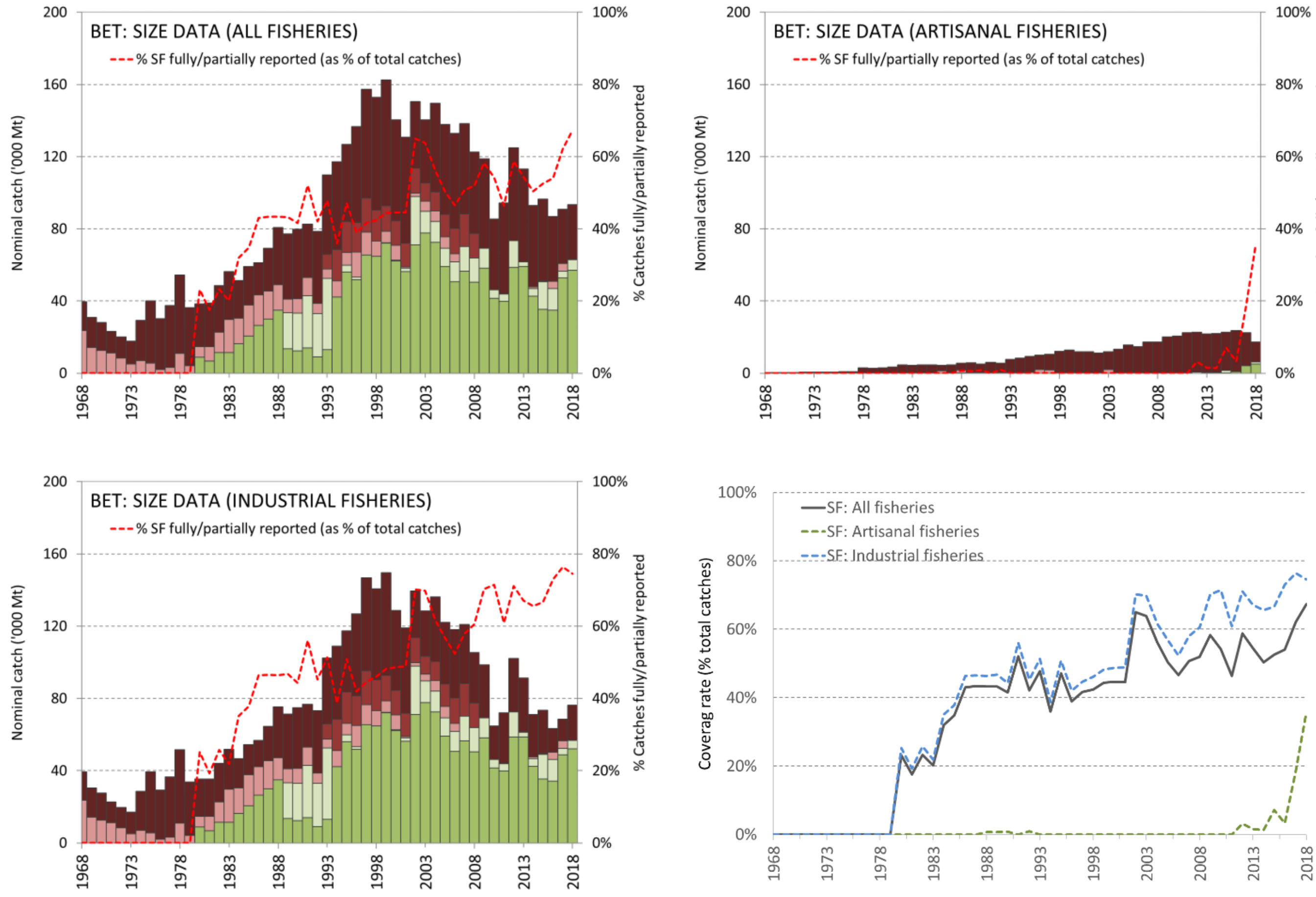


Fig. 8g-i. Bigeye tuna: size frequency data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

Tagging data

- A total of 36,001 bigeye tuna (representing 16% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP), of which ≈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, 5,833 specimens (16% of releases for this species) have been recovered and reported to the IOTC Secretariat[9]. These tags were mainly reported from the purse seine fleets operating in the Indian Ocean (91%), while 5% were recovered from longline vessels.

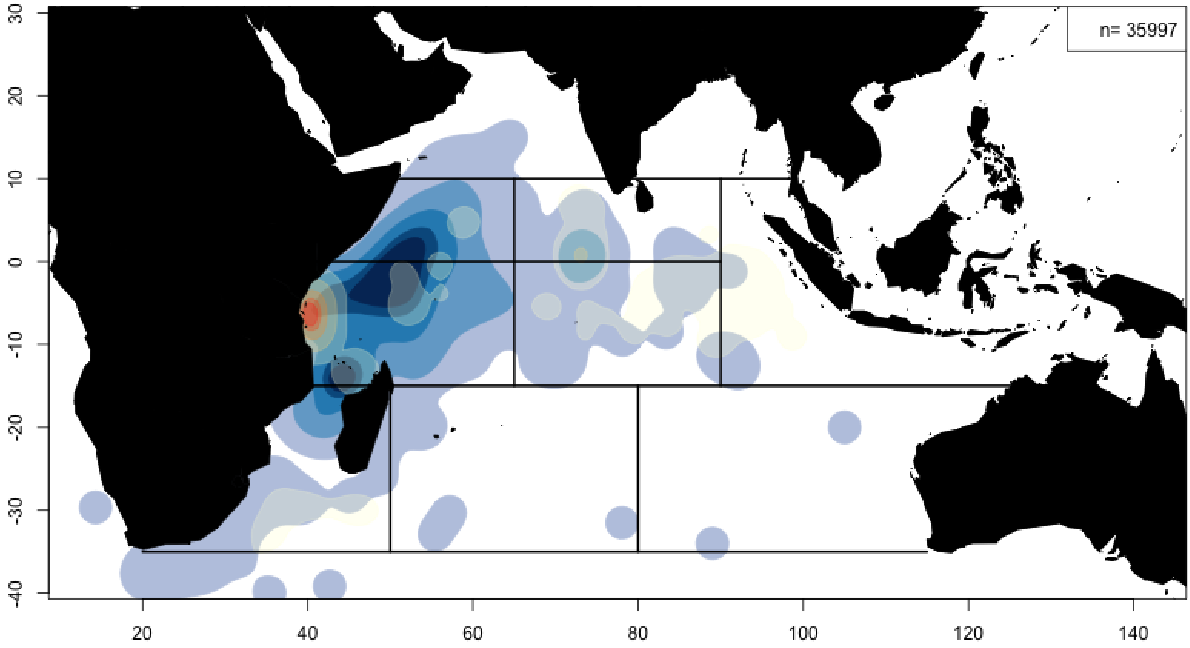


Fig. 9. Bigeye tuna: densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s.

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

SKJ - Skipjack tuna

Fisheries and main catch trends

Main fishing gear (2014–18)

Skipjack tuna are mostly caught by industrial purse seiners (≈49%), gillnet (≈18%) and pole-and-line (≈16%) (**Table 4; Fig. 10**).

Main fleets (and primary gear associated with catches)

Percentage of total catches (2014–18): the five main fleets catching skipjack tuna are EU-Spain (purse seine): 17%; Indonesia (coastal purse seine, troll line, gillnet): 17%; Maldives (pole-and-line): 17%; Seychelles (purse seine): 11% and Sri Lanka (gillnet-longline): 10%; (**Fig. 12**).

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 600,000t in 2006 with the constant increase in catches and catch rates of purse seiners until that year 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 total catches (across all fisheries) have declined to around 340,000t in 2012 – the lowest catches recorded since 1998 – although since 2013 catches have increased sharply and in 2018 reached again a level of 600,000t (around 100,000t more than in 2017) mostly driven by the purse seine (log-school) fisheries.

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 20,000t 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. In 2018 catches from this fishery reached again 100,000t, with the majority of these catches (over 80%) being caught in offshore waters.

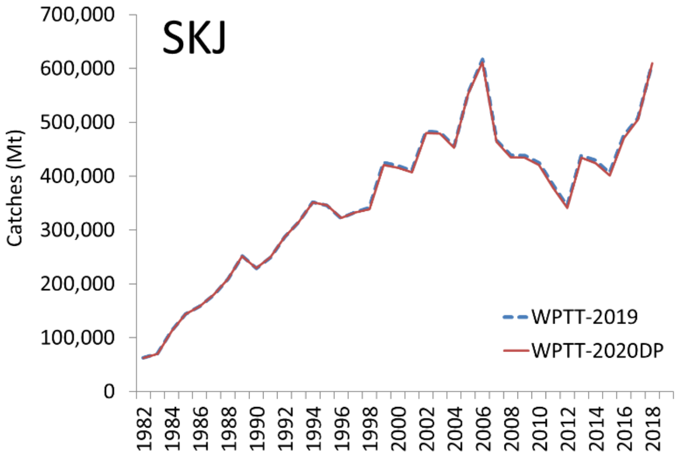
Gillnet fisheries:

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 not fully understood, as time-area catch-and-effort series have been made available for those fleets only in recent years.

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.

Catch series



Total Skipjack catches in the years 1987-2018 have been relatively impacted by the revisions introduced to the official catch series submitted in late 2019 by Pakistan for its gillnet fisheries, with revised catches being now 69,244 MT lower (in total) during considered years.

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 (2009–20118), 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 May 2020.

Fishery	By decade (average)						By year (last ten year)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BB	9,000	12,800	19,275	35,459	67,760	100,496	65,018	71,585	52,489	51,134	72,583	67,301	68,965	68,712	88,617	99,886
FS	0	0	0	13,658	25,197	24,342	9,498	8,708	8,930	2,924	5,625	6,467	7,535	6,560	5,735	5,763
LS	0	0	0	30,673	107,845	153,298	135,797	139,770	120,115	77,992	117,046	118,856	118,785	175,716	195,201	276,124
OT	6,014	14,066	27,642	50,330	118,328	194,845	224,122	200,632	196,916	208,880	238,582	231,435	205,388	219,199	215,933	227,383
Totals	**15,014**	**26,866**	**46,918**	**130,121**	**319,130**	**472,982**	**434,436**	**420,695**	**378,450**	**340,930**	**433,836**	**424,059**	**400,673**	**470,187**	**505,486**	**609,156**

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). Background colour intensity is proportional to the catches by fishery and category (i.e. decade, year)

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 (2009–2018), in tonnes. Catches by decade represent the average annual catch. Data as of May 2020.

Area	By decade (average)						By year (last ten year)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
R1	4,524	9,951	19,330	34,877	80,744	118,318	151,486	154,434	153,882	155,406	171,217	149,052	131,236	116,968	114,413	123,041
R2	1,491	4,116	8,313	59,784	170,626	254,168	217,931	194,676	172,079	134,391	190,036	207,705	200,476	284,507	302,456	386,229
R2b	9,000	12,800	19,275	35,459	67,760	100,496	65,018	71,585	52,489	51,134	72,583	67,301	68,965	68,712	88,617	99,886
Totals	**15,014**	**26,866**	**46,918**	**130,121**	**319,130**	**472,982**	**434,436**	**420,695**	**378,450**	**340,930**	**433,836**	**424,059**	**400,676**	**470,187**	**505,486**	**609,156**

Areas: East Indian Ocean (**R1**); West Indian Ocean, (**R2**); Maldives baitboat (**R2b**). Background colour intensity is proportional to the catches by area and category (i.e. decade, year)

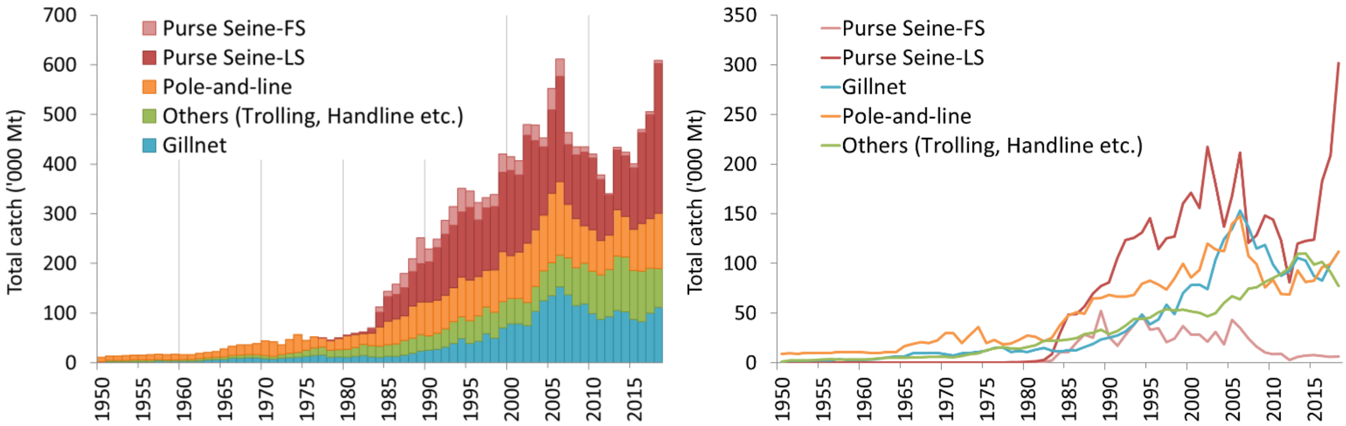


Fig. 10. Annual catches of skipjack tuna by gear (1950–2018). Data as of May 2020.

Gear definitions: 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).

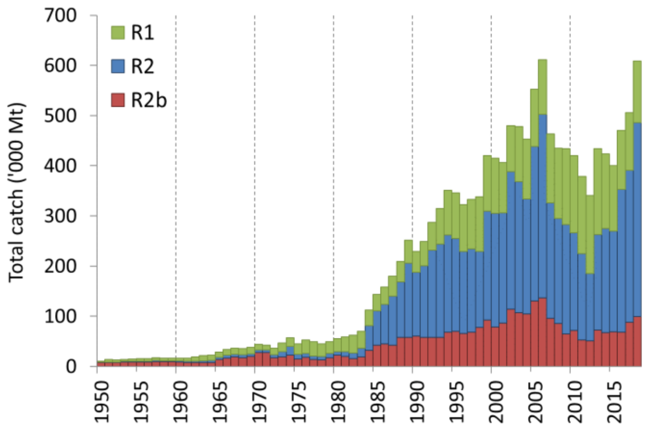


Fig. 11. Skipjack tuna: Catches of skipjack tuna by area by year estimated for the WPTT (1950–2018).
Areas: East Indian Ocean (**R1**); West Indian Ocean (**R2**); Maldives baitboat (**R2b**). Data as of May 2020.

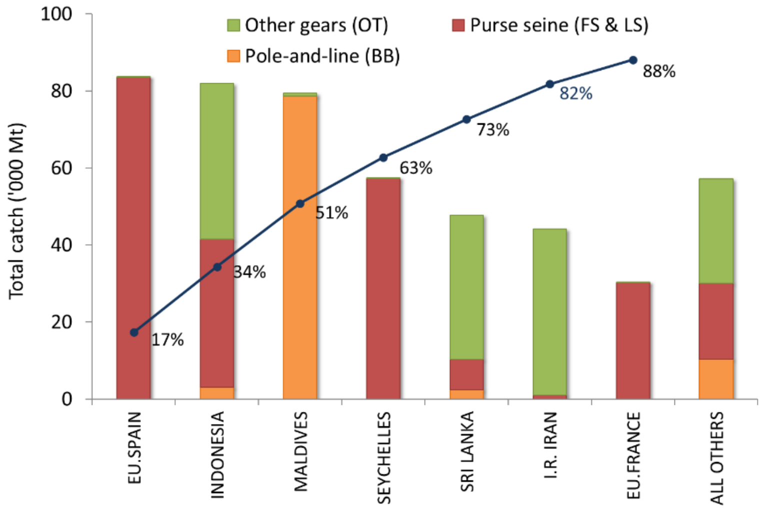


Fig. 12. Skipjack tuna: average catches in the Indian Ocean over the period 2014 – 18, by country. Countries are ordered from left to right, according to the importance of catches of skipjack reported. The dark line indicates the (cumulative) proportion of catches of skipjack for the countries concerned, over the total combined catches of this species reported from all countries and fisheries. Data as of May 2020.

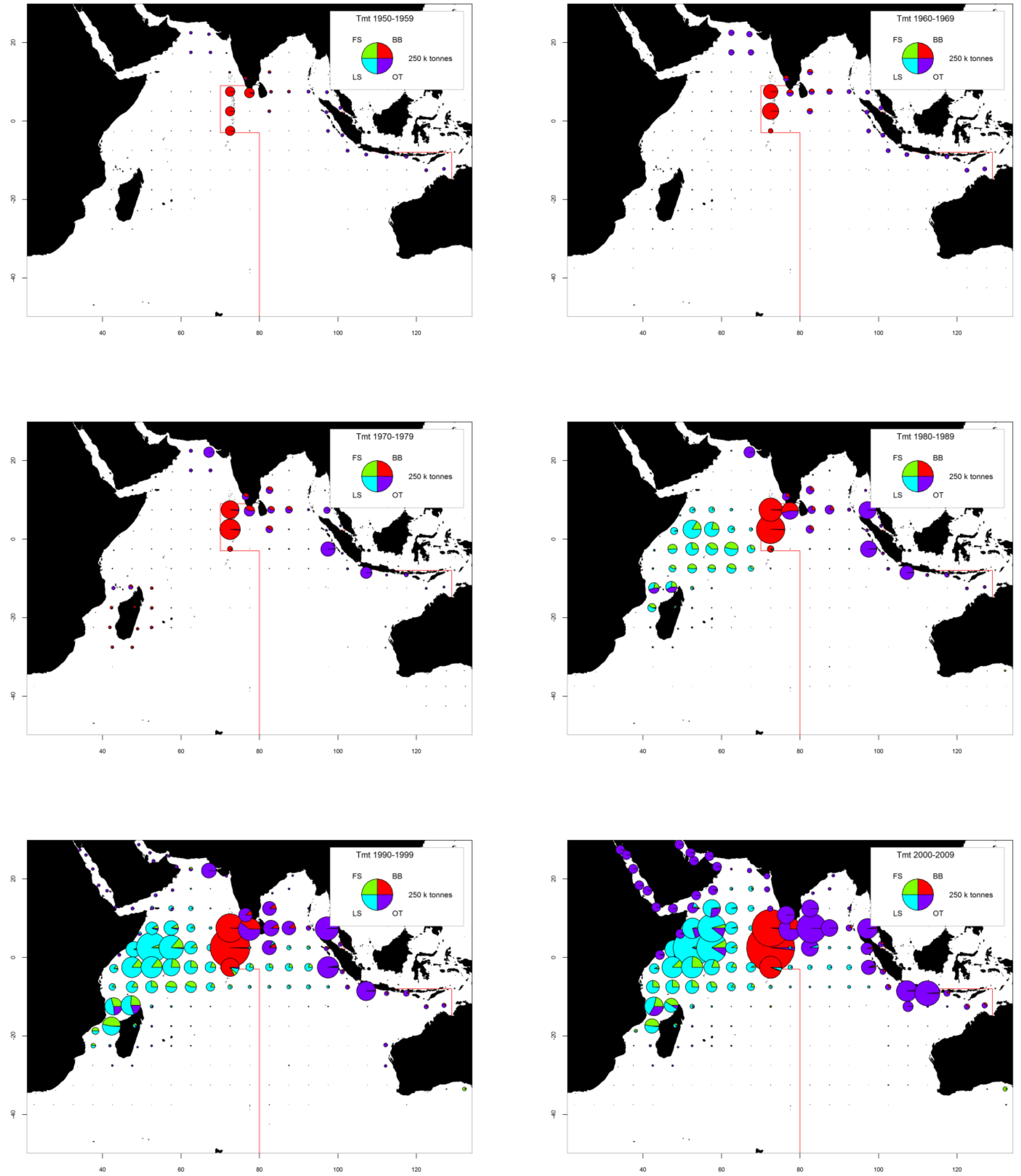


Fig. 13(a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 1950–2009, by decade and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including longline,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

Note that the catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded using the estimated areas from the CAS data set. This is particularly true for the driftnets of I.R. Iran, gillnet and longline fishery of Sri Lanka, and longline and coastal fisheries of Indonesia (OT).

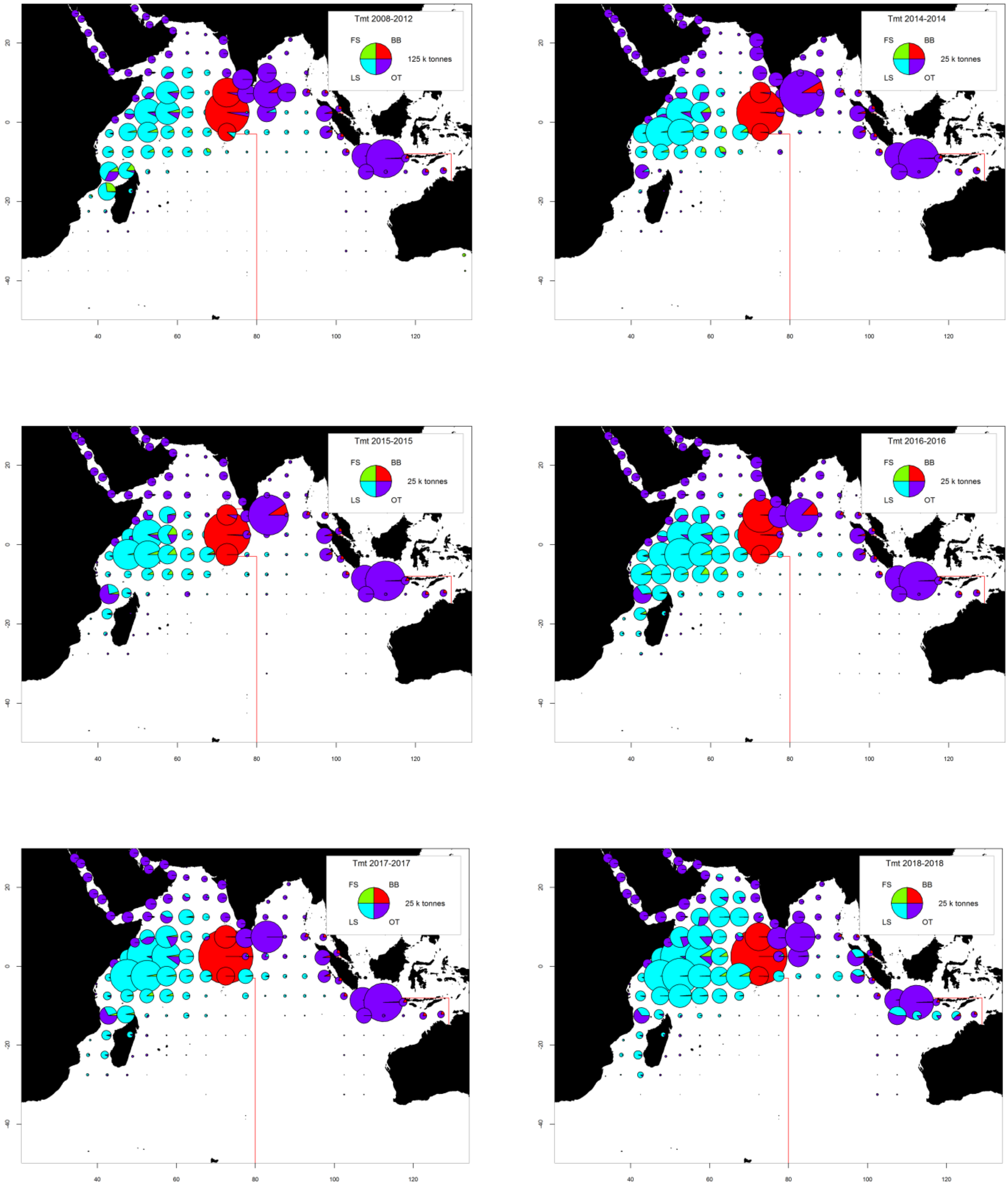


Fig. 14(a-f). Skipjack tuna: Time-area catches (total combined in tonnes) of skipjack tuna estimated for the period 2008–12 by type of gear and for 2013–17, by year and type of gear. Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including longline, drifting gillnets, and various coastal fisheries.

Note that the catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded using the estimated areas from the CAS data set. This is particularly true for the driftnets of I.R. Iran (years before 2007), gillnet and longline fishery of Sri Lanka, and longline and coastal fisheries of Indonesia (OT).

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 (before 2007) 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, since 2014 detailed information by EEZ area (for coastal fisheries) and grid area (for offshore fisheries) and gear started being submitted to the IOTC Secretariat;
    - no catch-and-effort data are available for important coastal fisheries using hand and/or troll lines, in particular Indonesia, India and Madagascar. Time-area catches for handline and troll line fisheries of Indonesia were received in 2018 for the first time.

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) and many gillnet fisheries (e.g., Indonesia, Sri Lanka) – although from 2014 Sri Lanka reported size information for its offshore fisheries.

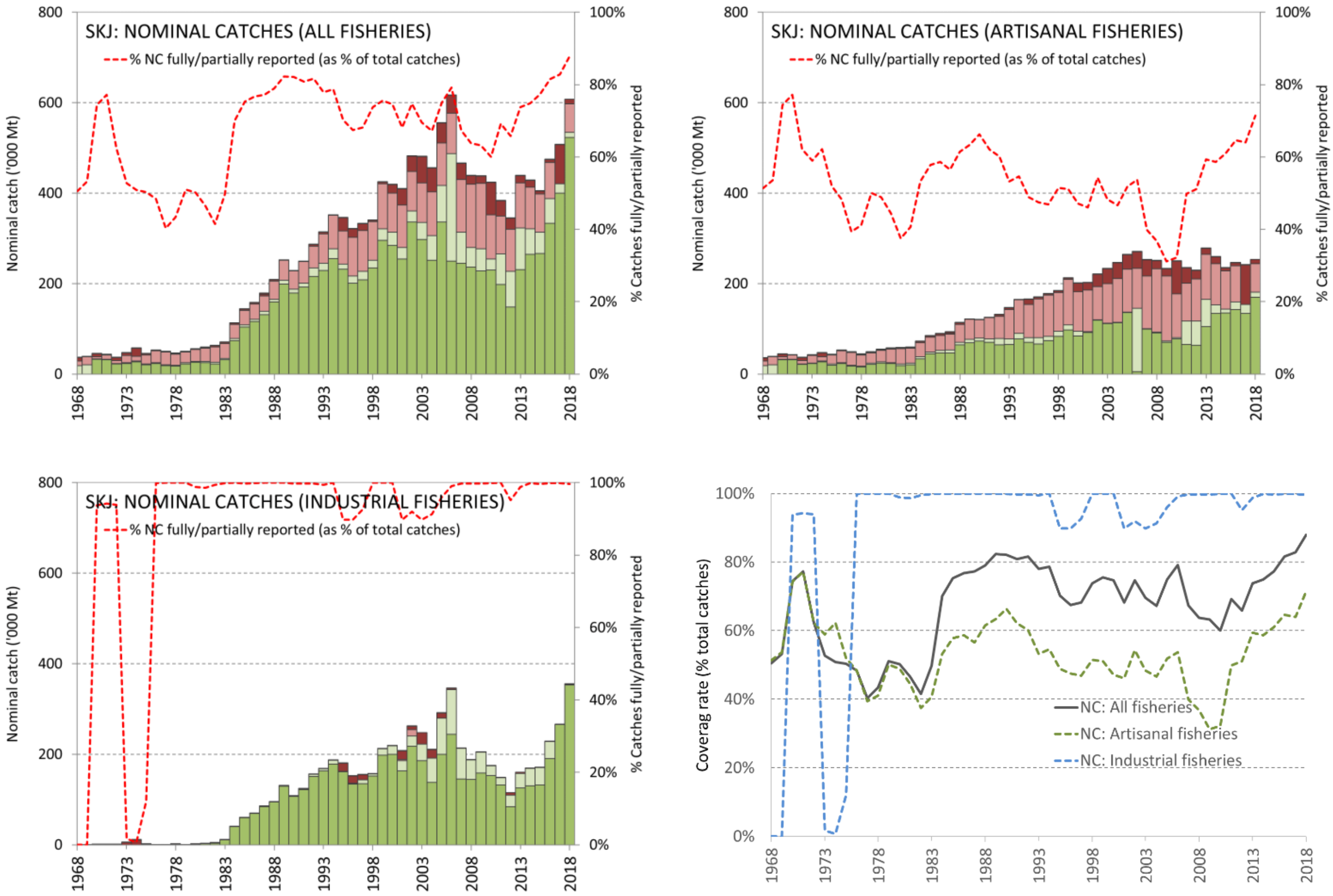


Fig. 15a-c. Skipjack tuna: nominal catches data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

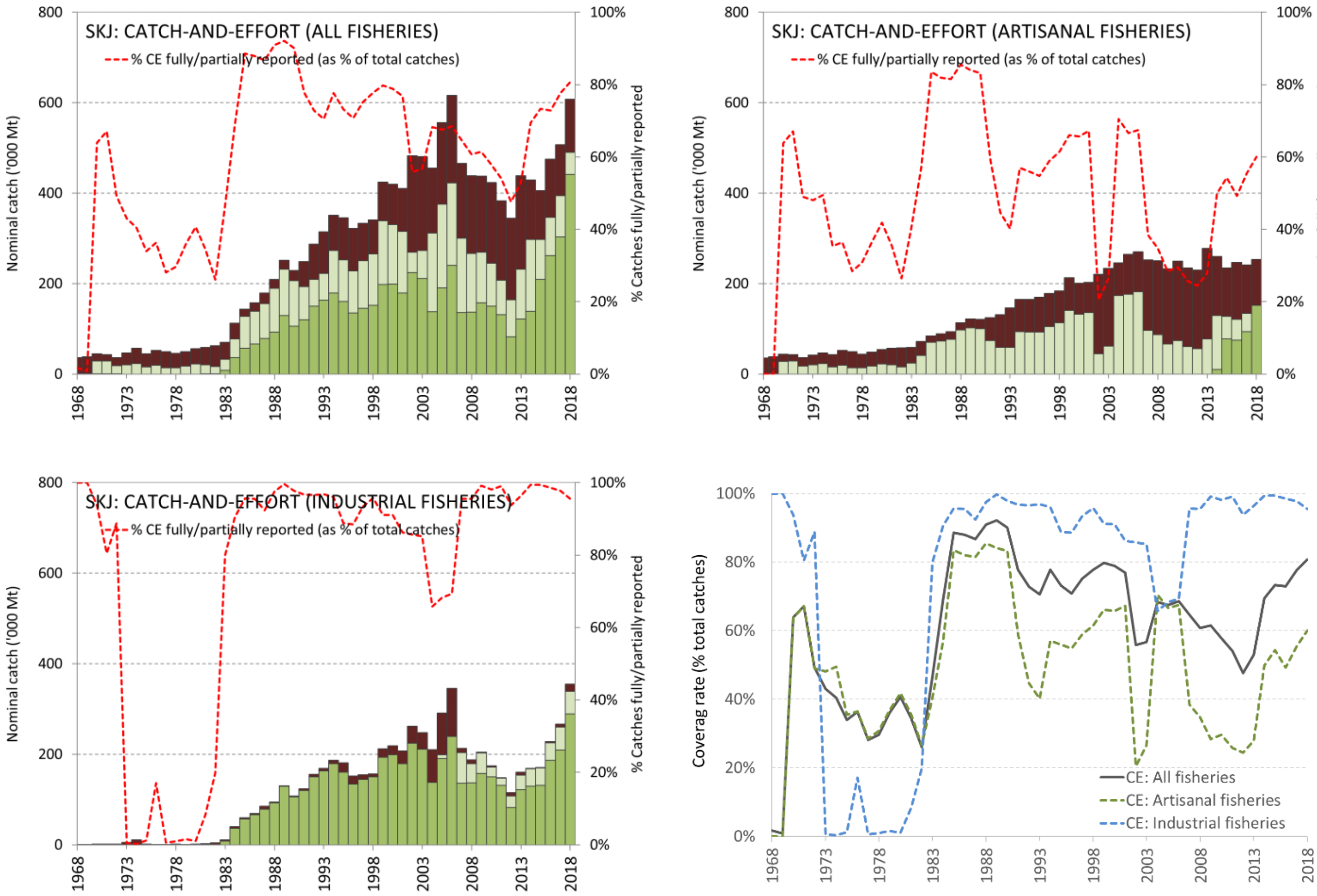


Fig. 15d-f. Skipjack tuna: catch-and-effort data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

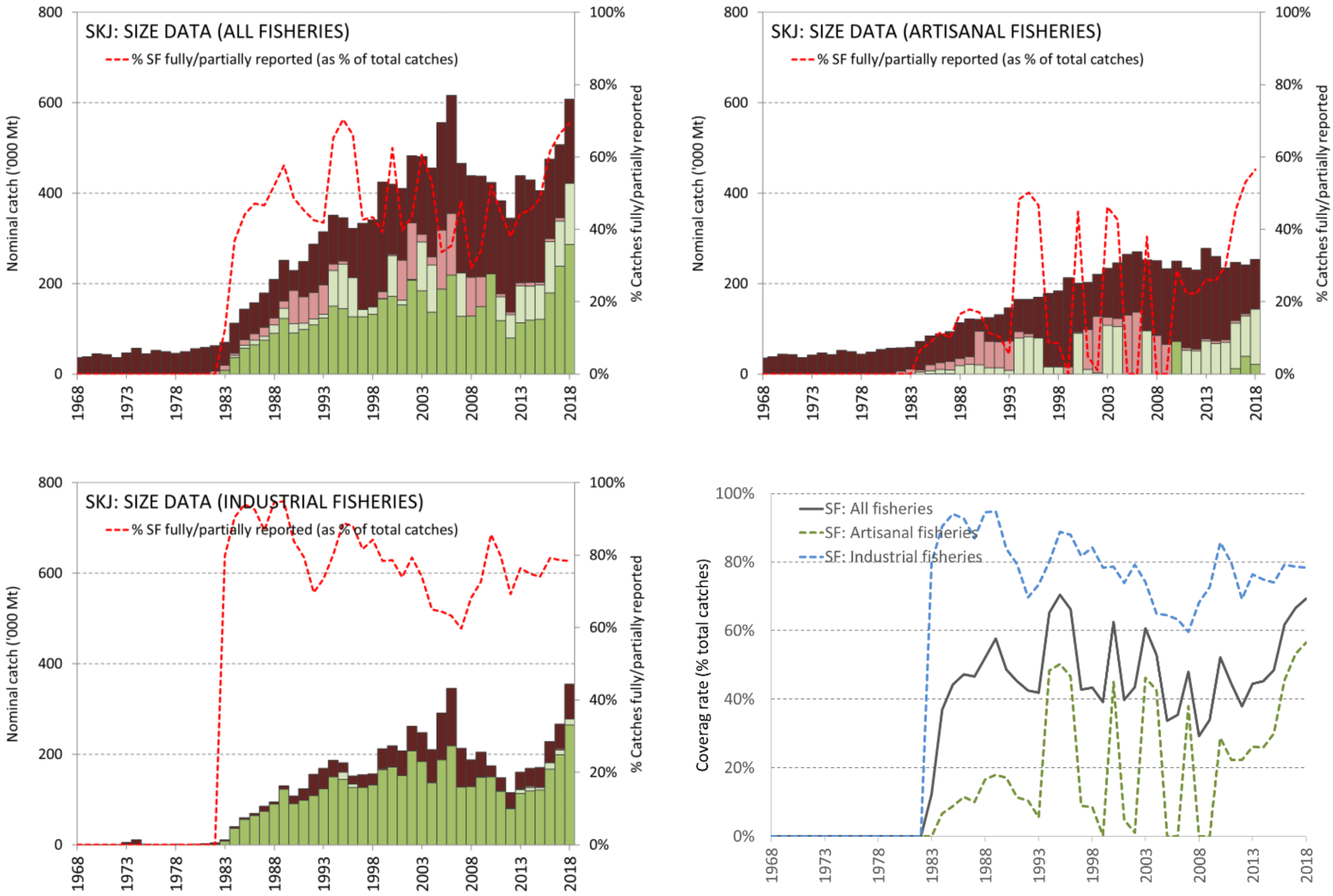


Fig. 15g-i. Skipjack tuna: size frequency data reporting coverage (1968–2017). Data as of September 2018.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

Tagging data

- A total of 115,693 skipjack (representing 53% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP), of which ≈68% were released during the main Regional Tuna Tagging Project-Indian Ocean (RTTP-IO) 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, 17,669 specimens (15% of releases for this species), have been recovered and reported to the IOTC Secretariat. Around 70% of the recoveries were from the purse seine fleets operating from the Seychelles, and around 29% 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.

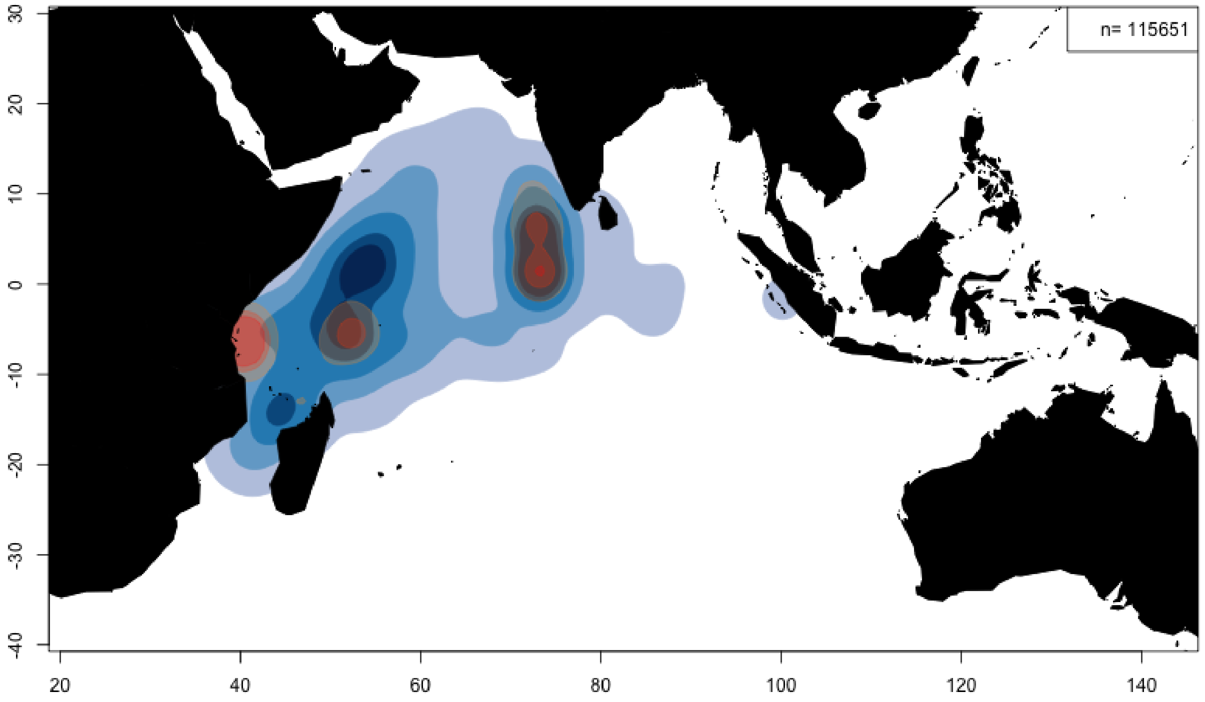


Fig. 16. Skipjack tuna: Densities of releases (in red) and recoveries (in blue). Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s.

YFT - Yellowfin tuna

Fisheries and main catch trends

Main fishing gear (2014-18)

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 40% 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 around 200,000t per annum since 2012. Moreover, the proportion of yellowfin catches from artisanal fisheries has increased from around 30% in 2000 to nearly 50% in recent years.

Main fleets (and primary gear associated with catches)

<u>Percentage of total catches (2014–18):</u> the five main fleets catching yellowfin tuna are EU-Spain (purse seine): 13%; Maldives (handline, pole-and-line): 12%; I.R. Iran (gillnet): 11%; Seychelles (purse seine): 10%; Sri Lanka (gillnet, coastal longliners): 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 30,000t and 70,000t, 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 400,000t by 1993.

Exceptionally high catches were recorded between 2003 and 2006 – with the highest catches ever recorded in 2004 at over 525,000t – 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 current catches over 400,000t recorded.

***<u>Purse seine fishery</u>*:**

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.

As for other tropical tuna species (bigeye in particular), industrial purse seine catches of yellowfin tuna on free-school have shown a steady decline in recent years, reaching an all-time low of around 15,000t in 2018 as opposed to an average of 45,000t recorded for the previous ten years.

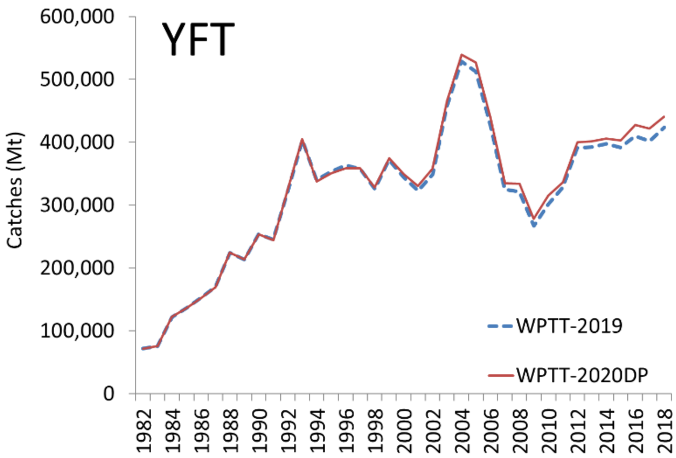
***<u>Longline fishery</u>*:**

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.

Catch series



Total Yellowfin catches in the years 1987-2018 have been impacted by the revisions introduced to the official catch series as submitted in late 2019 by Pakistan for its gillnet fisheries, with revised catches being now 217,449 MT higher (in total) during considered years.

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 (2009–2018), 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 May 2020.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
FS	0	0	18	31,552	64,938	89,204	36,048	32,136	36,453	64,594	34,459	47,427	63,962	49,460	50,700	17,944
LS	0	0	17	17,597	56,278	61,890	51,352	73,382	76,658	66,165	101,900	86,418	78,394	99,267	94,477	116,266
LL	21,990	41,352	29,590	33,968	66,523	57,700	20,080	18,743	20,666	19,669	16,011	15,608	17,851	19,354	18,153	21,167
LF	166	1,258	2,376	7,964	58,997	55,609	49,883	50,485	43,455	44,695	47,270	50,593	40,488	45,095	52,548	68,643
BB	2,111	2,318	5,810	8,295	12,803	16,072	16,826	14,106	14,010	15,512	24,055	20,541	17,642	12,392	18,371	20,029
GI	1,577	4,120	7,928	12,032	39,199	58,819	52,671	64,529	58,073	72,912	65,326	80,484	82,650	82,967	94,515	92,439
HD	616	635	2,920	7,501	19,201	34,464	28,369	34,083	59,401	79,512	70,570	71,576	73,852	85,997	65,514	73,113
TR	1,010	1,829	4,233	7,205	12,061	16,378	15,182	19,980	19,566	28,531	32,448	22,252	16,569	23,298	14,697	16,028
OT	80	193	454	1,871	3,379	5,402	7,358	7,704	7,870	8,222	8,984	11,161	11,497	9,877	12,849	15,202
Total	27,550	51,704	53,345	127,985	333,377	395,537	277,769	315,148	336,152	399,812	401,023	406,060	402,905	427,707	421,824	440,831

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**). Background colour intensity is proportional to the catches by fishery and category (i.e. decade, year)

Table 7. Yellowfin tuna: Best scientific estimates of the catches of yellowfin tuna (*Thunnus albacares*) by area by decade (1950–2009) and year (2009–2018), in tonnes. Catches by decade represent the average annual catch. The areas are presented in Fig. 18(a). Data as of May 2020.

Area	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
R1	2,002	4,487	8,634	19,947	74,576	94,864	70,289	84,309	109,563	141,223	128,427	139,250	146,660	162,343	155,933	160,082
R2	12,259	24,044	22,131	73,395	142,357	181,294	99,927	115,232	121,200	145,309	155,440	162,345	164,882	167,351	162,874	161,779
R3	658	7,337	4,279	7,357	21,774	23,499	18,588	18,236	18,959	17,091	20,722	8,770	14,186	18,604	19,753	14,821
R4	914	1,793	1,358	1,084	3,417	2,390	784	1,206	514	503	676	469	987	486	327	1,082
R5	11,718	14,044	16,944	26,202	91,253	93,489	88,181	96,165	85,916	95,686	95,758	95,226	76,190	78,923	82,937	103,067
Total	27,550	51,704	53,345	127,985	333,377	395,537	277,769	315,148	336,152	399,812	401,023	406,060	402,905	427,707	421,824	440,831

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**). Background colour intensity is proportional to the catches by area and category (i.e. decade, year)

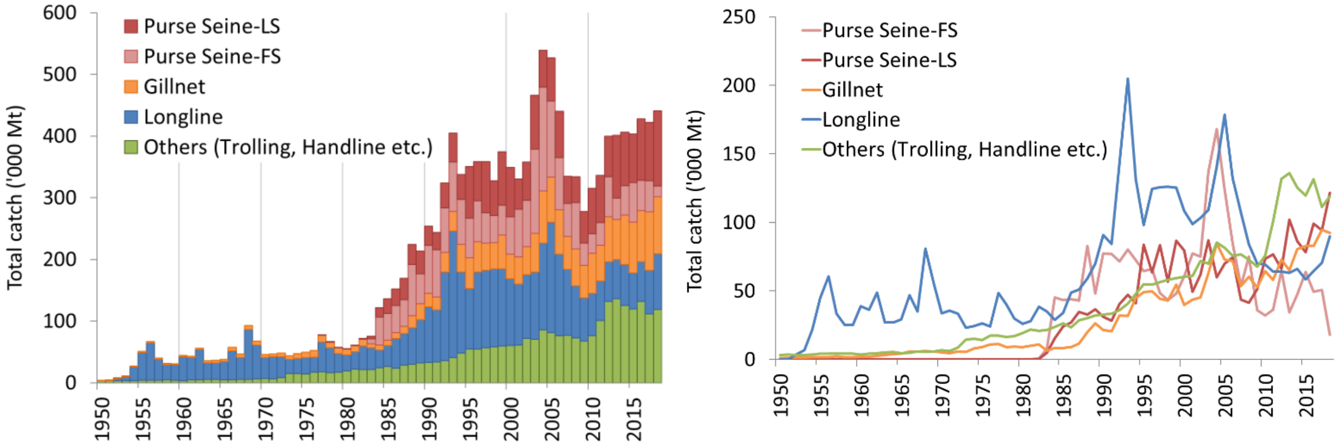


Fig. 17. Annual catches of yellowfin tuna by gear (1950–2018). Data as of May 2020.

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**).

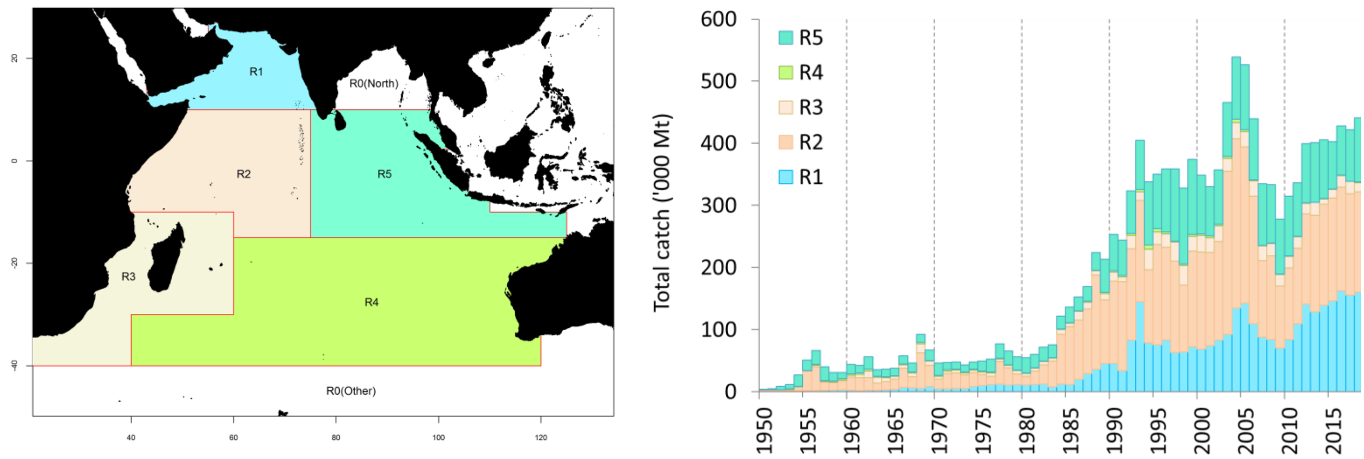
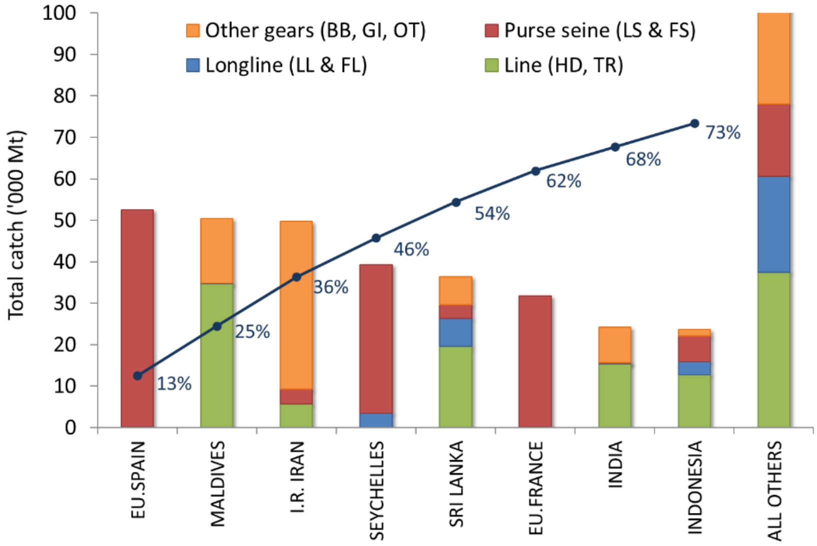


Fig. 18(a-b). Yellowfin tuna: Catches of yellowfin tuna by area by year estimated for the WPTT (1950–2018). Catches in areas R0 were assigned to the closest neighbouring area for the assessment. Data as of May 2020.

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 2014 – 18, by country. Countries are ordered from left to right, according to the importance of catches of yellowfin reported. The dark 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 May 202



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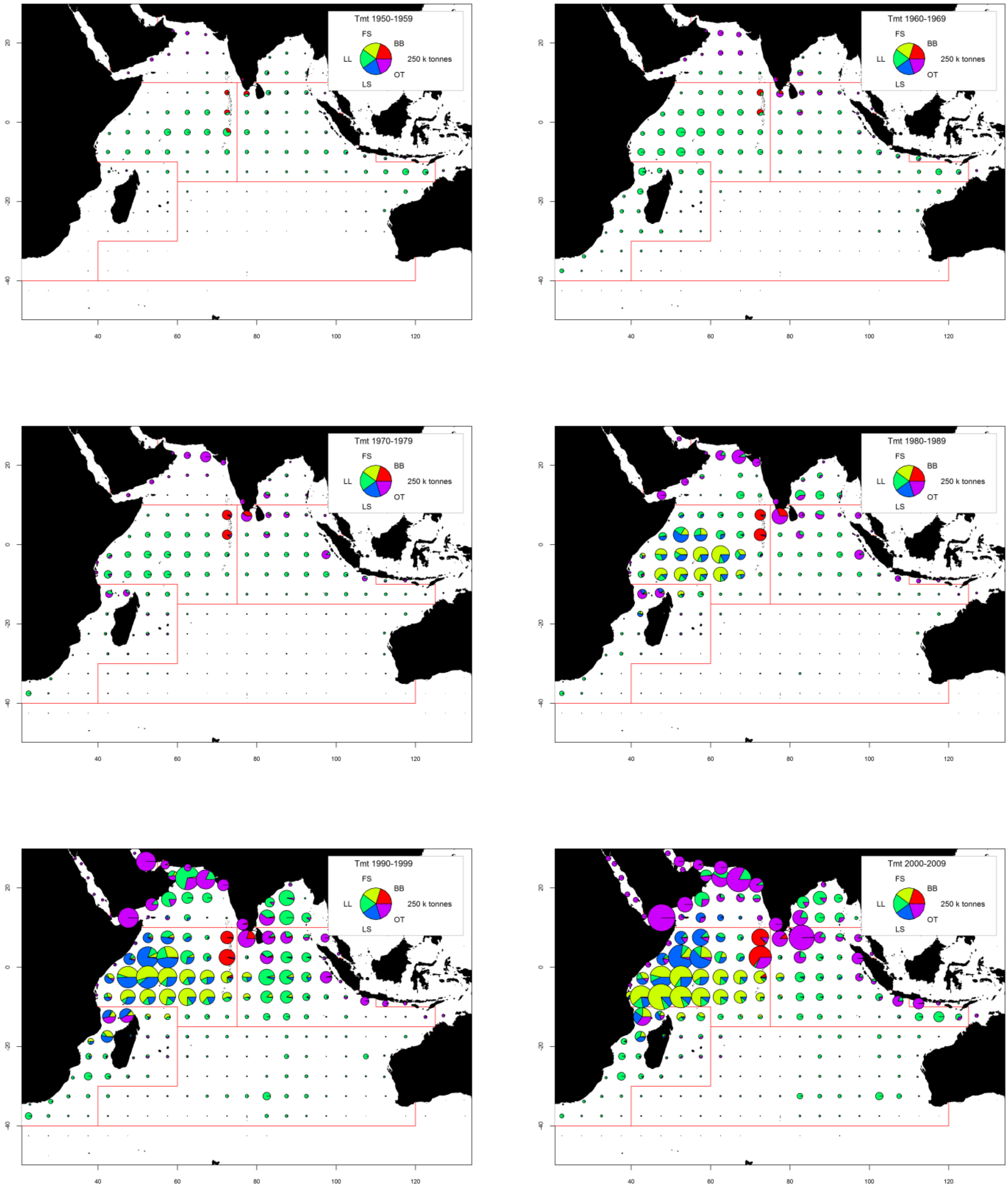


Fig. 20(a-f). Yellowfin tuna: Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 1950–2009, by decade and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**),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

Note that the catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded using the estimated areas from the CAS data set. This is particularly true for the driftnets of I.R. Iran, gillnet and longline fishery of Sri Lanka, and longline and coastal fisheries of Indonesia (OT).

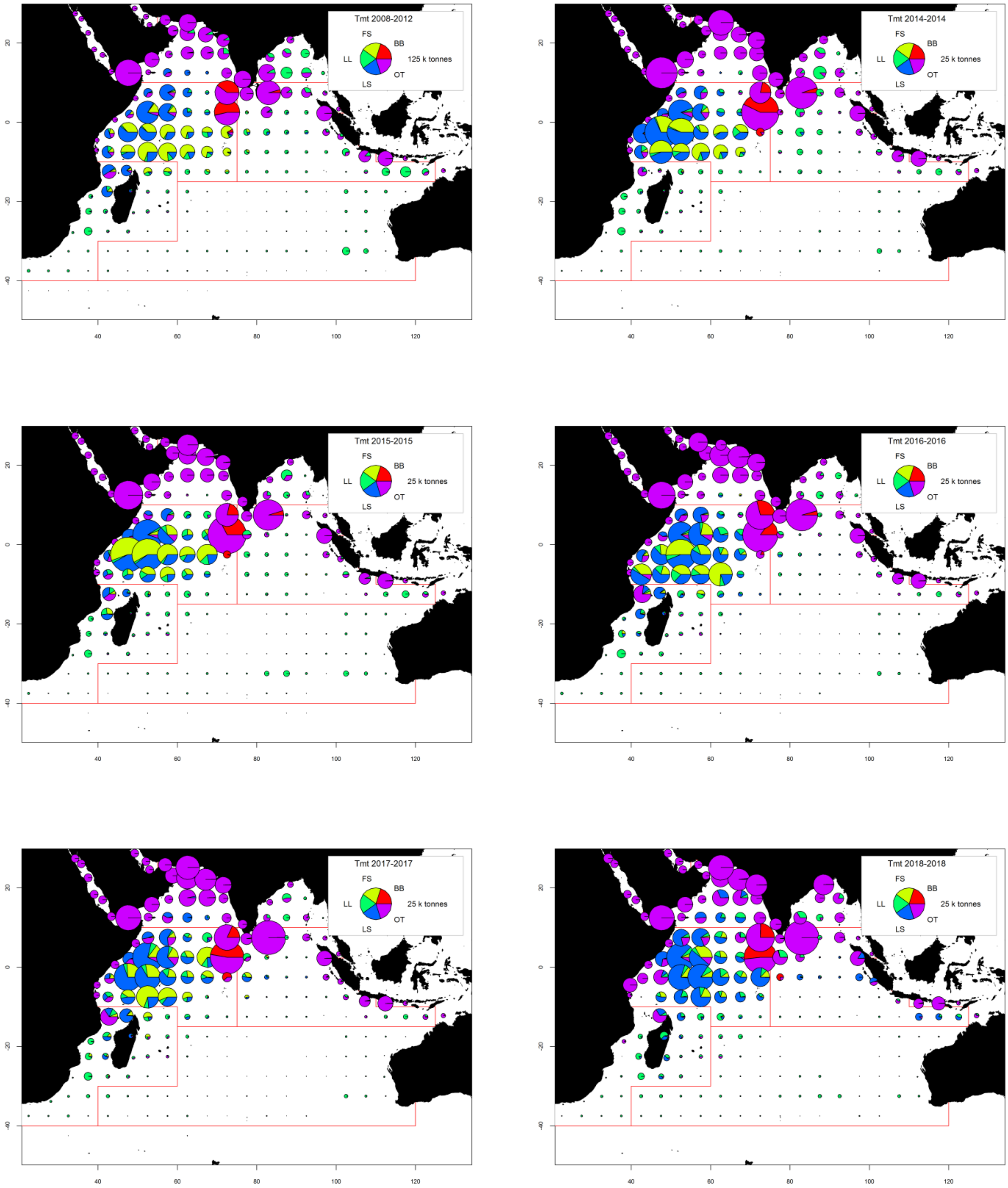


Fig. 21(a-f). Time-area catches (total combined in tonnes) of yellowfin tuna estimated for the period 2008–2012 by type of gear and for 2013–2017, by year and type of gear. Longline (**LL**), Purse seine free-schools (**FS**), Purse seine associated-schools (**LS**), pole-and-line (**BB**), and other fleets (**OT**), including drifting gillnets, and various coastal fisheries.

Note that the catches of fleets for which the flag countries do not report detailed time and area data to the IOTC are recorded using the estimated areas from the CAS data set. This is particularly true for the driftnets of I.R. Iran, gillnet and longline fishery of Sri Lanka, and longline and coastal fisheries of Indonesia (OT).

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;
  - the 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:
  - data for the fresh-tuna longline fishery of Taiwan,China are only available since 2006 and partial data for the fresh-tuna longline fishery of Indonesia is available only for 2018;
  - insufficient data for the gillnet fisheries of I.R., Iran (before 2007) and Pakistan;
  - poor quality effort data for the significant gillnet-longline fishery of Sri Lanka (until 2014);
  - no data are available from important coastal fisheries using hand and/or troll lines, in particular Oman, Yemen, Madagascar and Indonesia (until 2018).

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). Data from the artisanal fisheries of Oman (mainly handlines) is known to be available for some years (until 2016) but has not been officially submitted to the IOTC Secretariat.
  - 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).

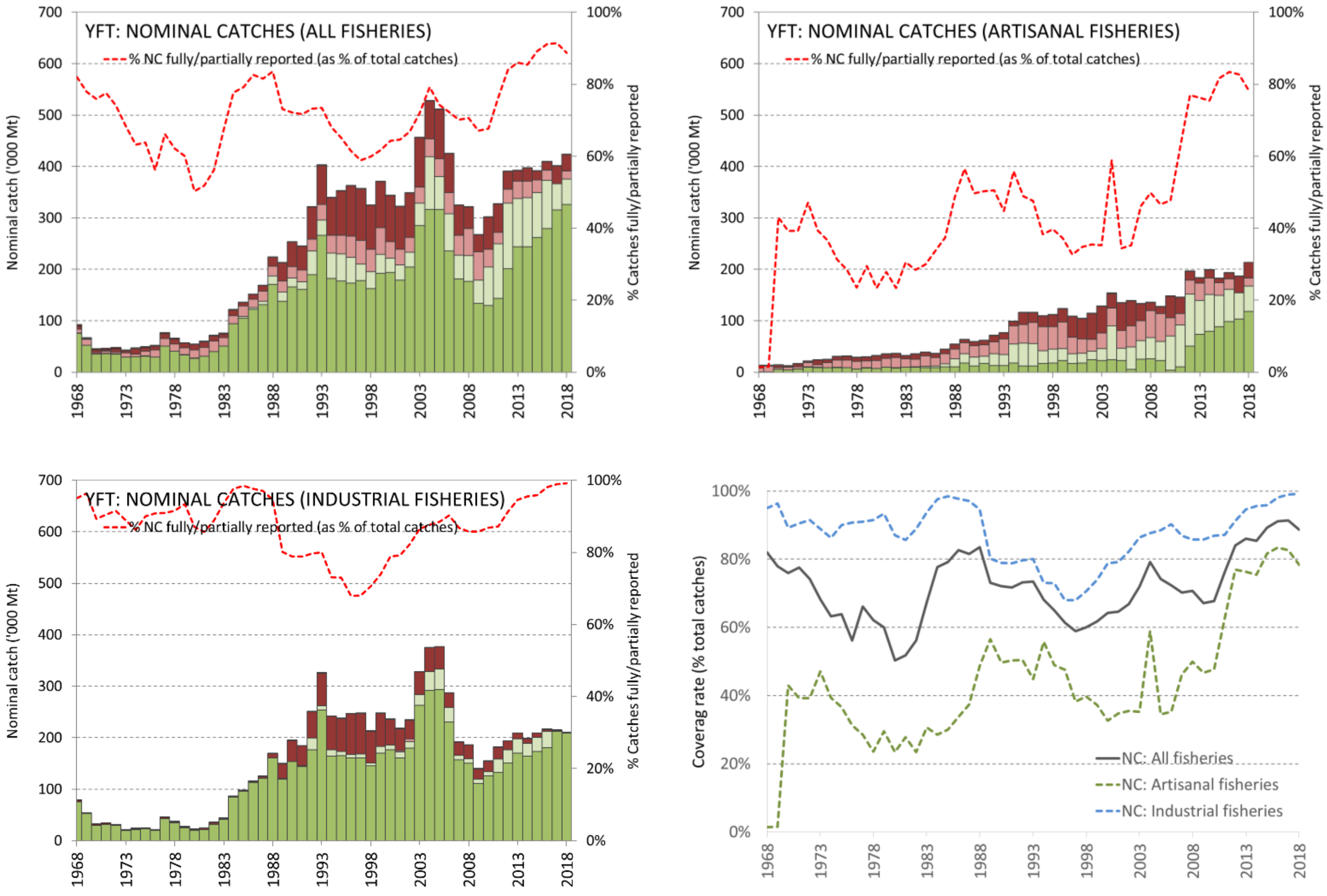


Fig. 22a-c. Yellowfin tuna: nominal catches data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

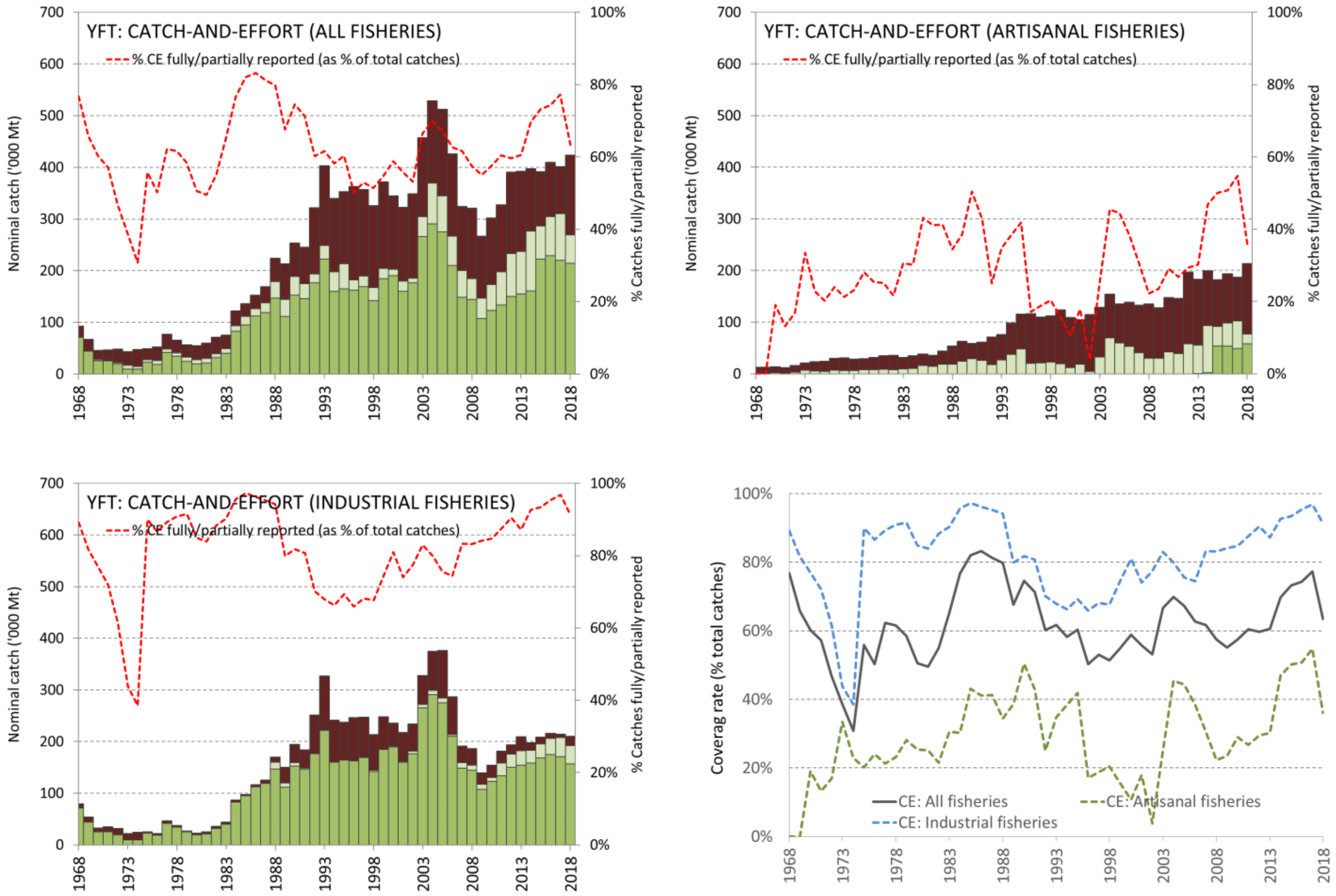


Fig. 22d-f. Yellowfin tuna: catch-and-effort data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

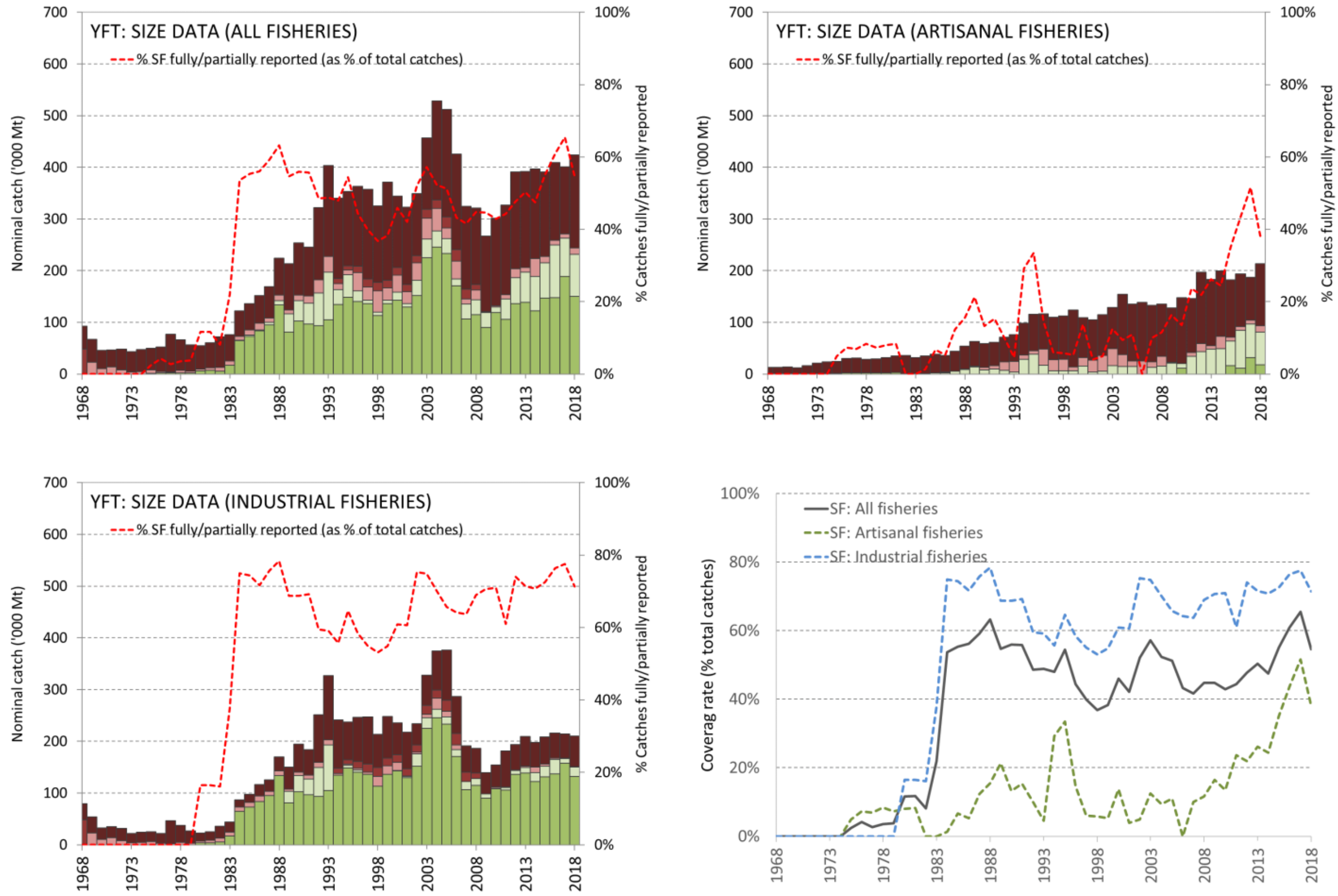


Fig. 22g-i. Yellowfin tuna: size frequency data reporting coverage (1968–2018). Data as of May 2020.

Data reporting scores:

	0
	2
	4
	6
	8

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

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

Tagging data

- A total of 66,543 yellowfin tuna (representing 30% of the total number of fish tagged) were tagged during the Indian Ocean Tuna Tagging Programme (IOTTP). Most of the tagged specimens (82%) 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 10,842 specimens (16% of releases for this species), have been recovered and reported to the IOTC Secretariat. More than 86% of these recoveries we made by the purse seine fleets operating in the Indian Ocean, while around 9% 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.

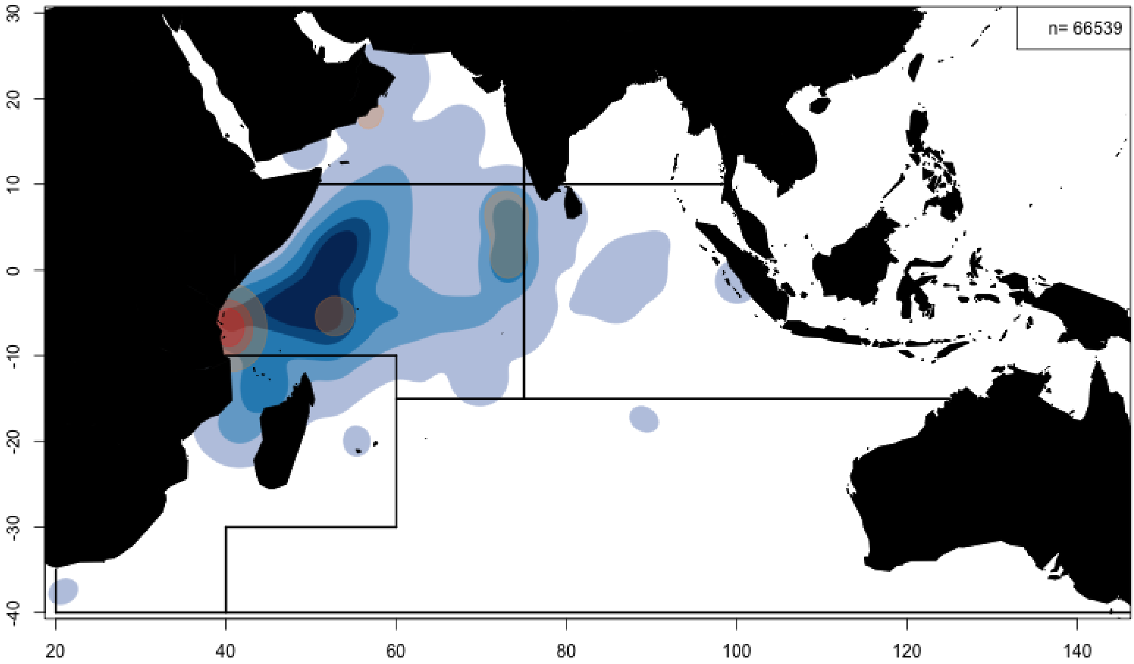


Fig. 23. Yellowfin tuna: Densities of releases (in red) and recoveries (in blue). The black line represents the stock assessment areas. Includes specimens tagged during the IOTTP and also Indian Ocean (Maldivian) tagging programmes during the 1990s.

APPENDIX I - ESTIMATION OF CATCHES OF NON-REPORTING FLEETS

IOTC estimates of catches of non-reporting fleets were updated in 2018:

The high number of non-reporting fleets (i.e., vessels belonging to both IOTC CPCs and non-IOTC parties) operating in the Indian Ocean between the mid-1980's to late-1990's led to large increases in the amount of catches that required to be estimated for that period. This in turn raises questions over the reliability of catches estimated for yellowfin tuna and bigeye tuna, and to a lesser extent, skipjack tuna during those years.

While the number of fleets from non-IOTC parties operating in the Indian Ocean has decreased significantly in recent years, this has been offset by an increase in the number of vessels fishing under flags of some IOTC CPCs, including coastal countries in the IOTC region (e.g., India, Indonesia, I.R. Iran, Kenya, Malaysia, Oman, Seychelles, Tanzania and Thailand) and deep-water fishing nations (e.g., Belize, Guinea and Senegal) – many of which have varying levels of quality of statistics collected for their fisheries.

Purse seine

(**Fig. 24**) Catches for the six former Soviet Union purse seiners, registered under the Thailand flag, were estimated for January-August 2005, and also for one remaining purse seiner (Equatorial Guinea) for 2005–2006. Total catches were estimated using the number of vessels available and the average catches of former Soviet Union purse seiners in previous years. Comparisons were also made to the average catches for other purse seine fleets (for 2005–2006) for purposes of validation of IOTC's estimates. Total catches were then assigned by species and type of school fished according to data available for Thailand purse seiners during the same period.

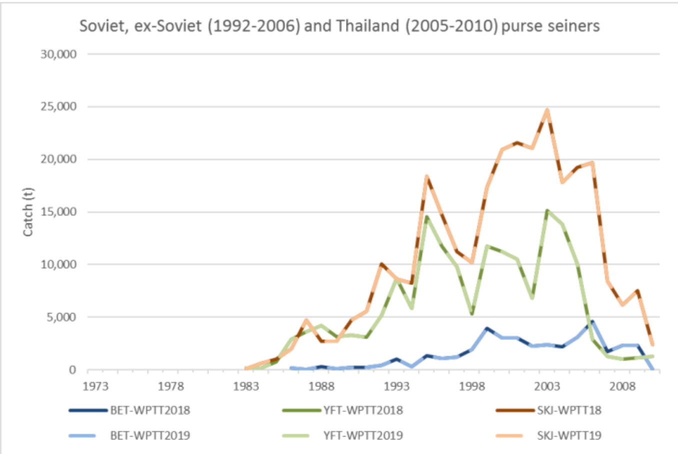


Fig. 24. Catches of Soviet, ex-Soviet and Thai purse seiners estimated in 2019 versus previous catches estimated in 2018 (1983–2010).

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 similar fishing patterns to the longliners from Taiwan,China, Japan, or EU-Spain. The collection of new information on the activities of non-reporting fleets, in particular the numbers and characteristics of non-reporting longliners, has led to improvements in the 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 however – as noted above – such decreases have coincided with an increase in the numbers of vessels operated by some IOTC CPC's. Although these countries usually report catches to the IOTC Secretariat, the data reported are, in some cases, considered incomplete.

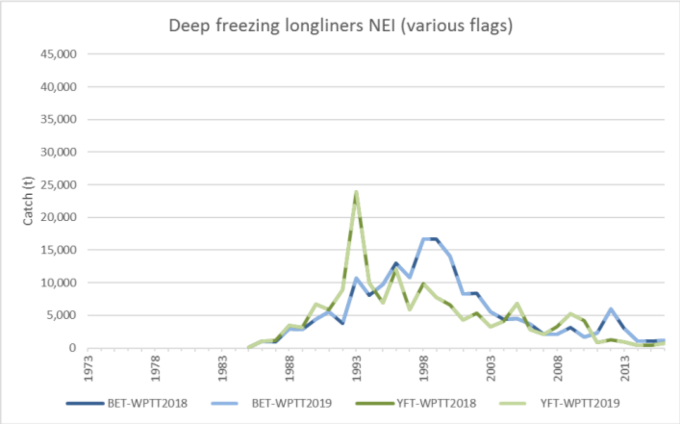


Fig. 25. Catches of deep-freezing longline vessels in the Indian Ocean estimated in 2019 versus catches estimated in 2018 (for the period 1985–2016).

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[10] 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, also for the countries indicated in the next paragraph 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 (2005-16), Indonesia (1973–2001), Thailand (1994–2013), Sri Lanka (1990–2001; 2004–15), Malaysia (1989–2016), 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 2007-16. 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, and that their catches had not been accounted for in previous estimates made by the IOTC Secretariat. Since 2006, the Secretariat has been using the catches published by Taiwan,China.

The catches for fleets other than Taiwan,China for 1973–2016 and for Taiwan,China in years prior to 2001 were estimated according to estimation methodologies detailed in the three bullet points above.

[10] Overseas Fishery Cooperation Foundation of Japan.

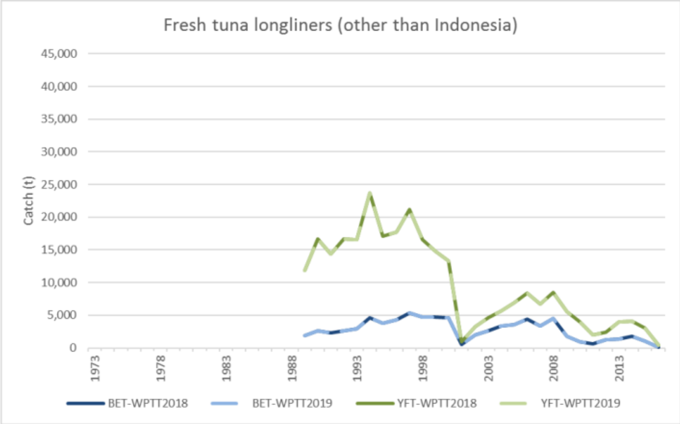


Fig. 26. Catches of fresh-tuna longline vessels based in India, Malaysia, Maldives, Mauritius, Oman, Seychelles, Singapore, Sri Lanka, Thailand and Yemen (mainly registered in China, Taiwan,China and Indonesia) estimated in 2019 versus catches estimated in 2018 (1989–2017).

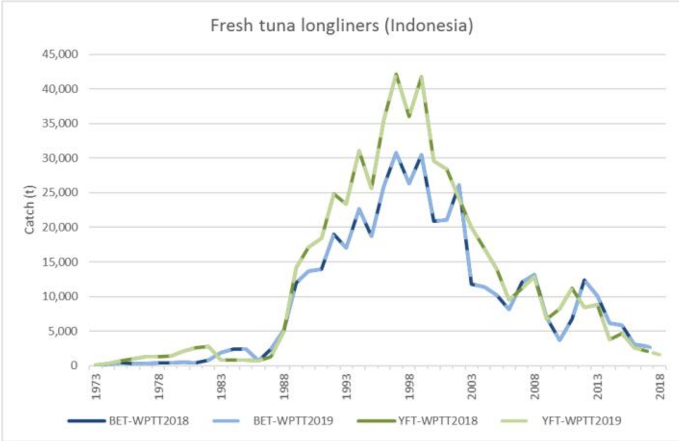


Fig. 27. Catches of fresh-tuna longline vessels based in Indonesia (domestic and foreign) estimated in 2019 versus catches estimated in 2018 (1973–2018).

APPENDIX II - ESTIMATION OF CATCHES-AT-SIZE FOR IOTC TROPICAL TUNA SPECIES

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)[A]	RND=a*L^b	a=0.00002459 b= 2.96670	25,386	n/a
	Longline Line Other Gears	Fork length(cm) – Gilled and gutted weight(kg)[B] Gilled and gutted weight(kg) - Round Weight(kg)[C]	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)[A]	RND=a*L^b	a=0.00002217 b= 3.01211	2,156	n/a
	Longline Line Other Gears	Fork length(cm) – Gilled and gutted weight(kg)[B] Gilled and gutted weight(kg) - Round Weight(kg)[C]	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)[A]	RND=a*L^b	a=0.00000497 b= 3.39292	1,762	n/a

Sources:

A: Length-weight relationships for tropical tunas caught with purse seine in the Indian Ocean: Update and lessons learned (Chassot, E. et al in IOTC-2016-WPDSC12-INF05)

B: Multilateral catch monitoring Benoa (2002-04)

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

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

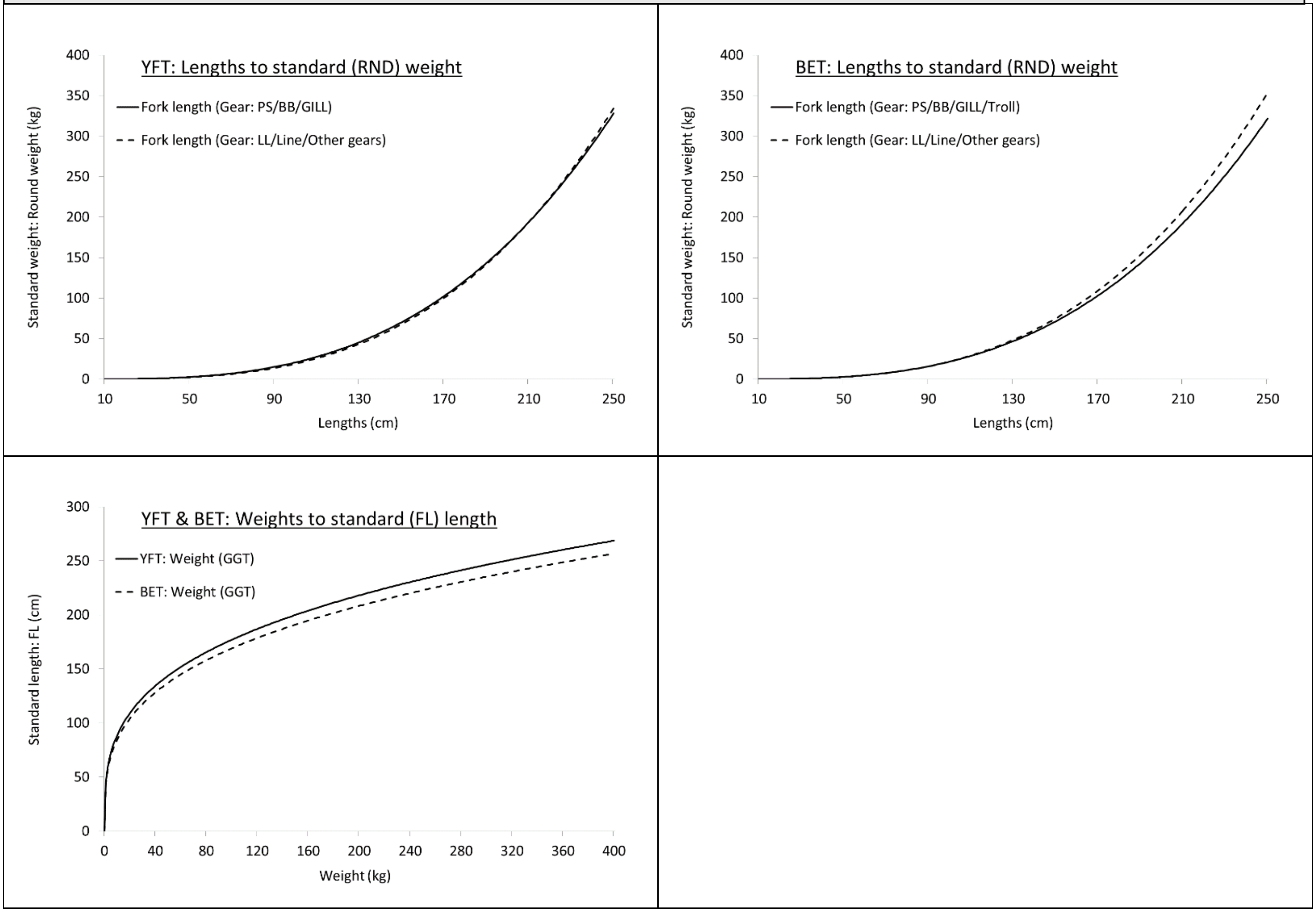
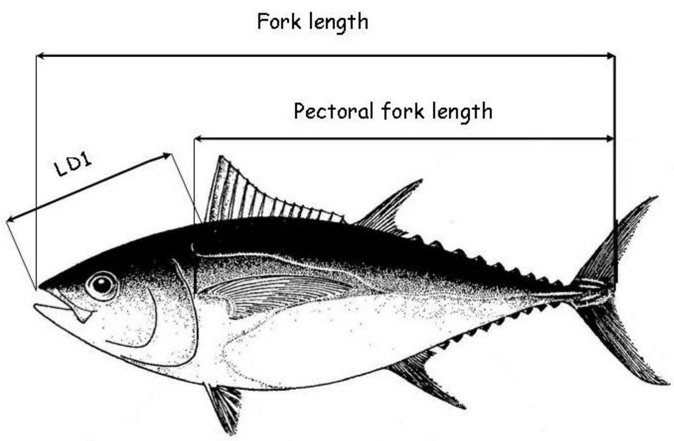


Fig ii. Types of measurements used for tuna

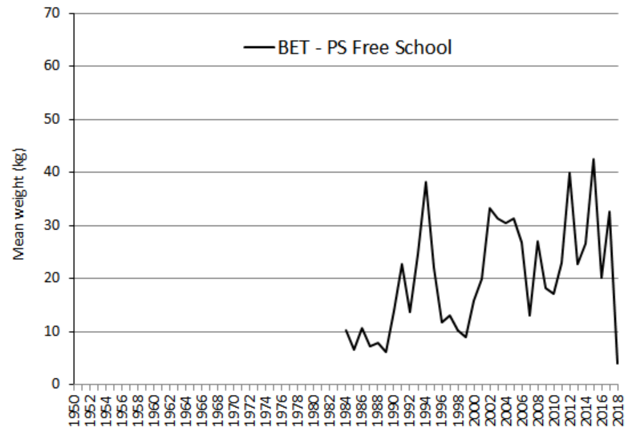


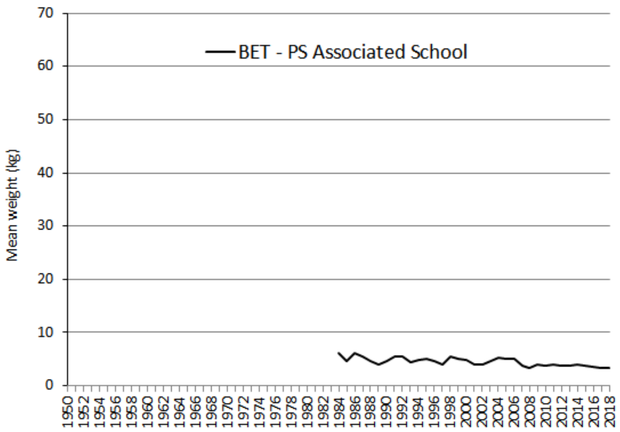
Average weights

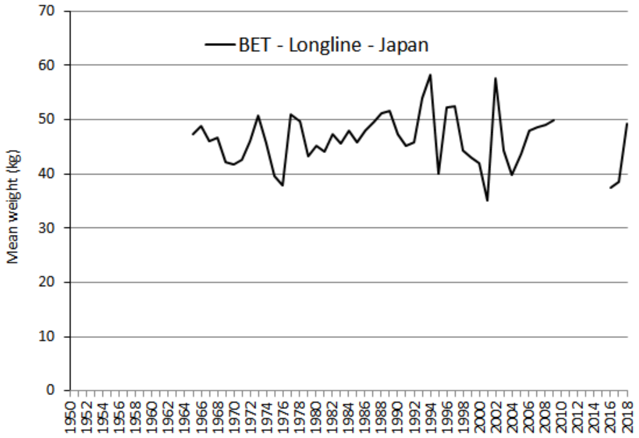
BET - Bigeye tuna

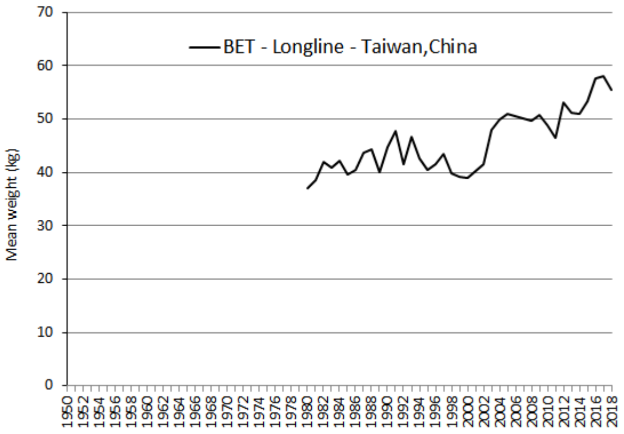
Average weight of bigeye tuna (BET) taken by:

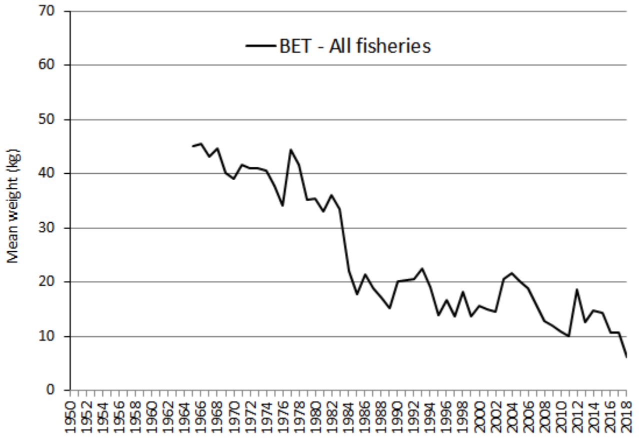
- Purse seine on free (top left) and associated (top right) schools,
- Longlines from Japan (second row left) and Taiwan,China (second row right)
- All fisheries (bottom row left), and all fisheries and main gears (bottom row left)

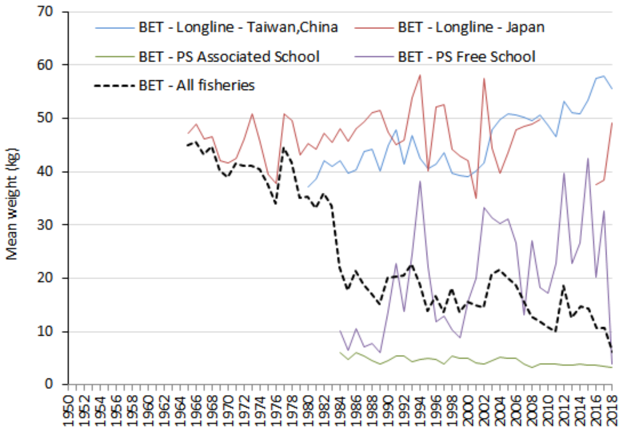


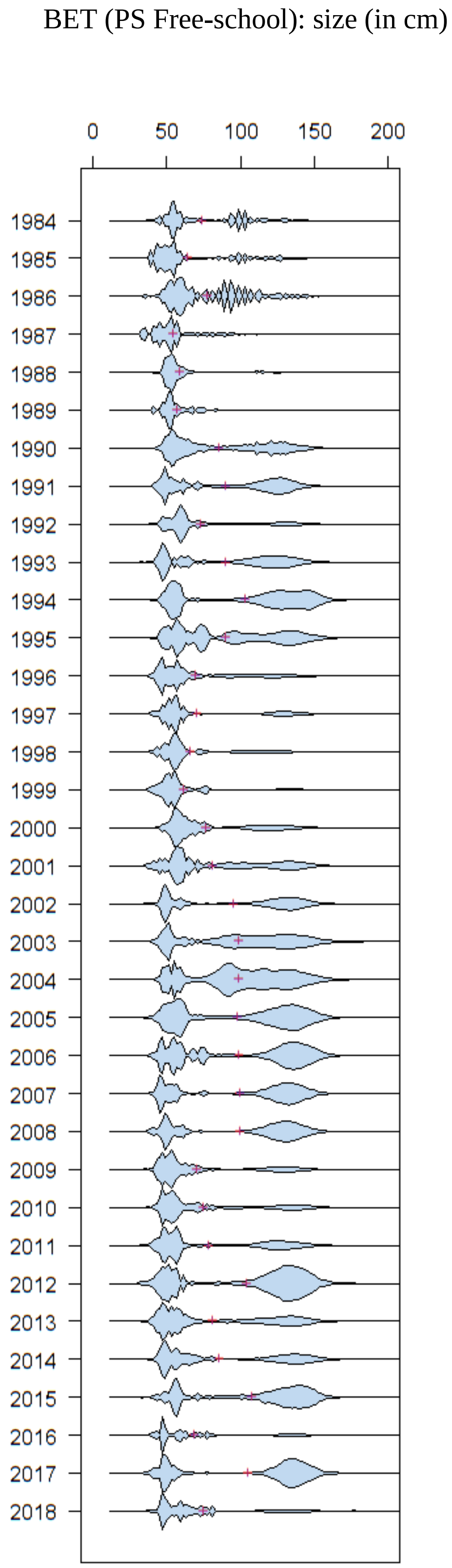


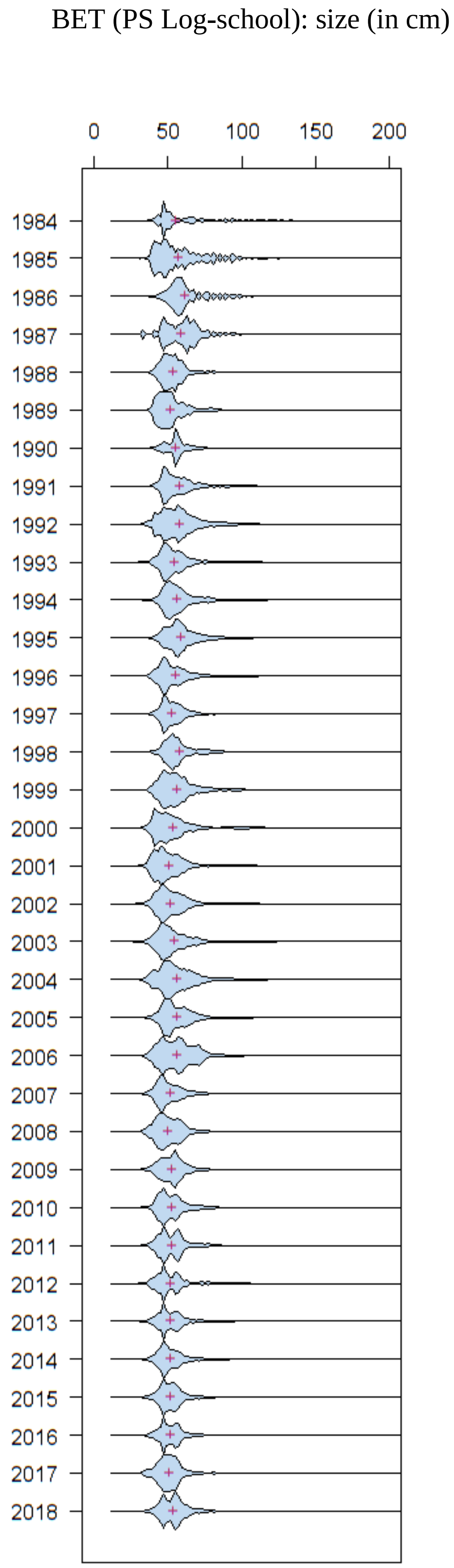






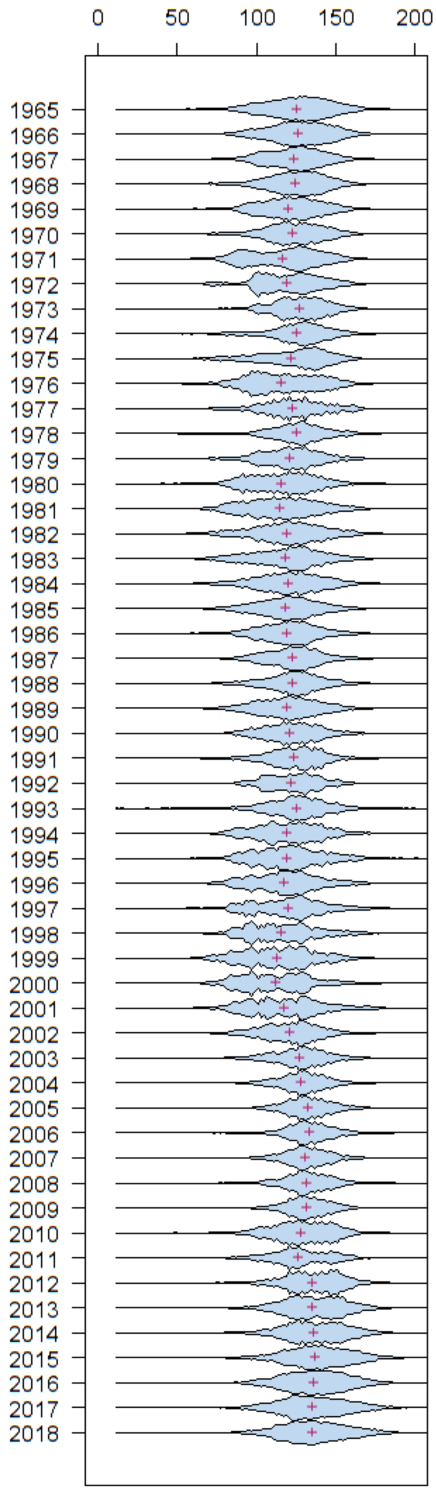






Bigeye tuna (purse seine): **Left**: length frequency distributions for BET PS Free school fisheries (by 2 cm length class). **Right**: Length frequency distributions for BET PS Associated (log) school fisheries (by 2 cm length class). **Source**: IOTC database, May 2020.

BET (LL samples): size (in cm)



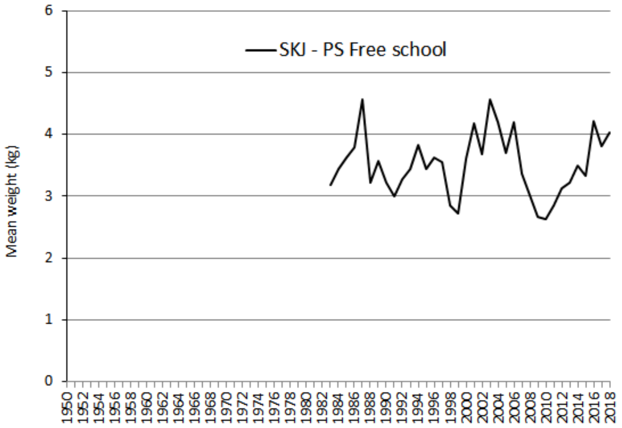
Bigeye tuna (longline): Length frequency distributions for longline fisheries (by 2 cm length class) derived from data available at the IOTC Secretariat.

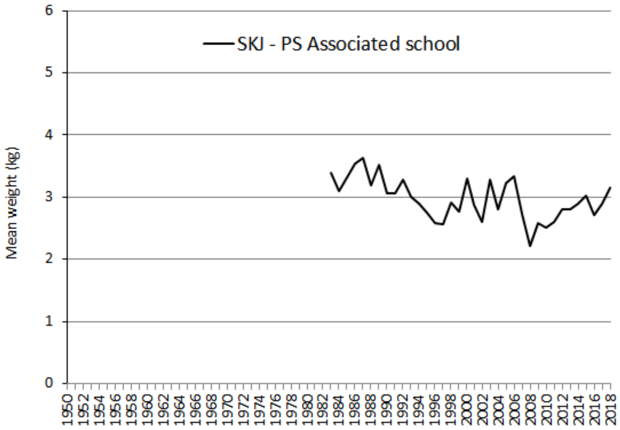
Source: IOTC database.

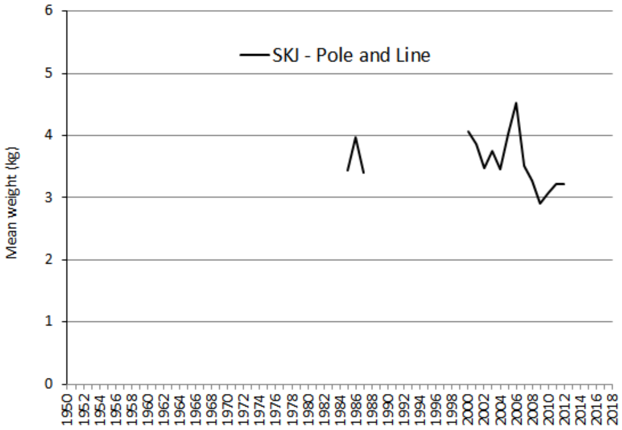
SKJ - Skipjack tuna

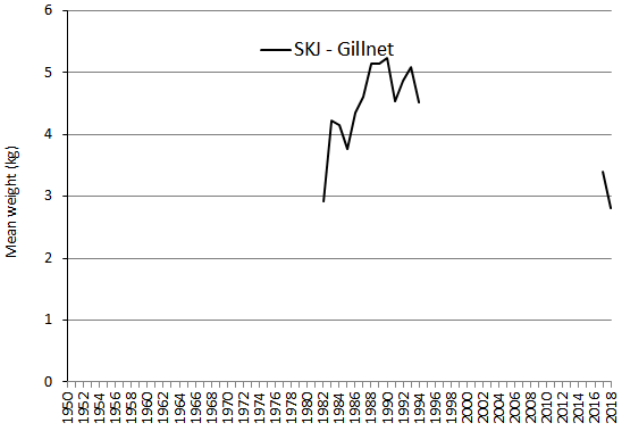
Average weight of skipjack tuna (SKJ) taken by:

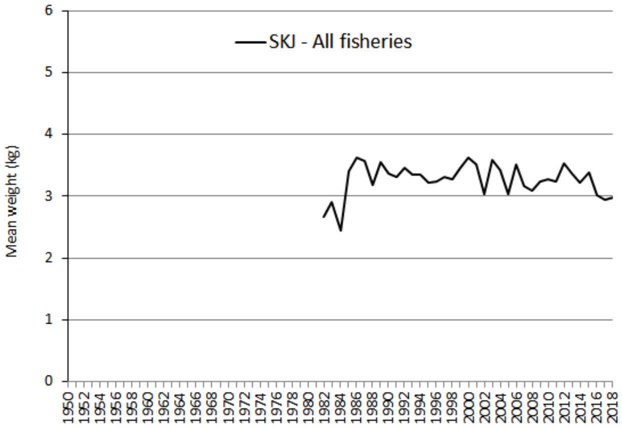
- Purse seine on free (top left) and associated (top right) schools,
- Pole-and-line from Maldives and India (second row left), and gillnets from Sri Lanka, Iran, and other countries (second row right)
- All fisheries (bottom row left), and all fisheries and main gears (bottom row left)

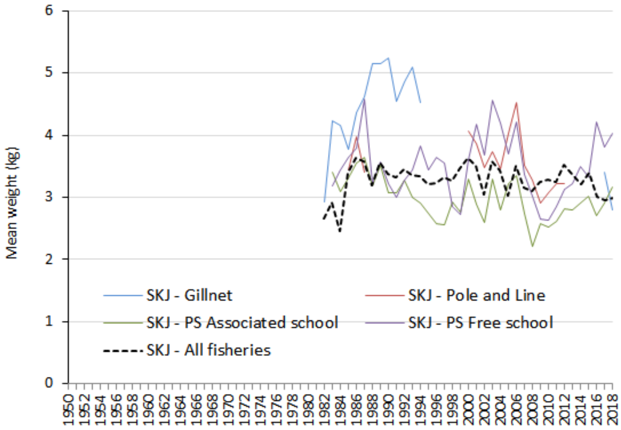


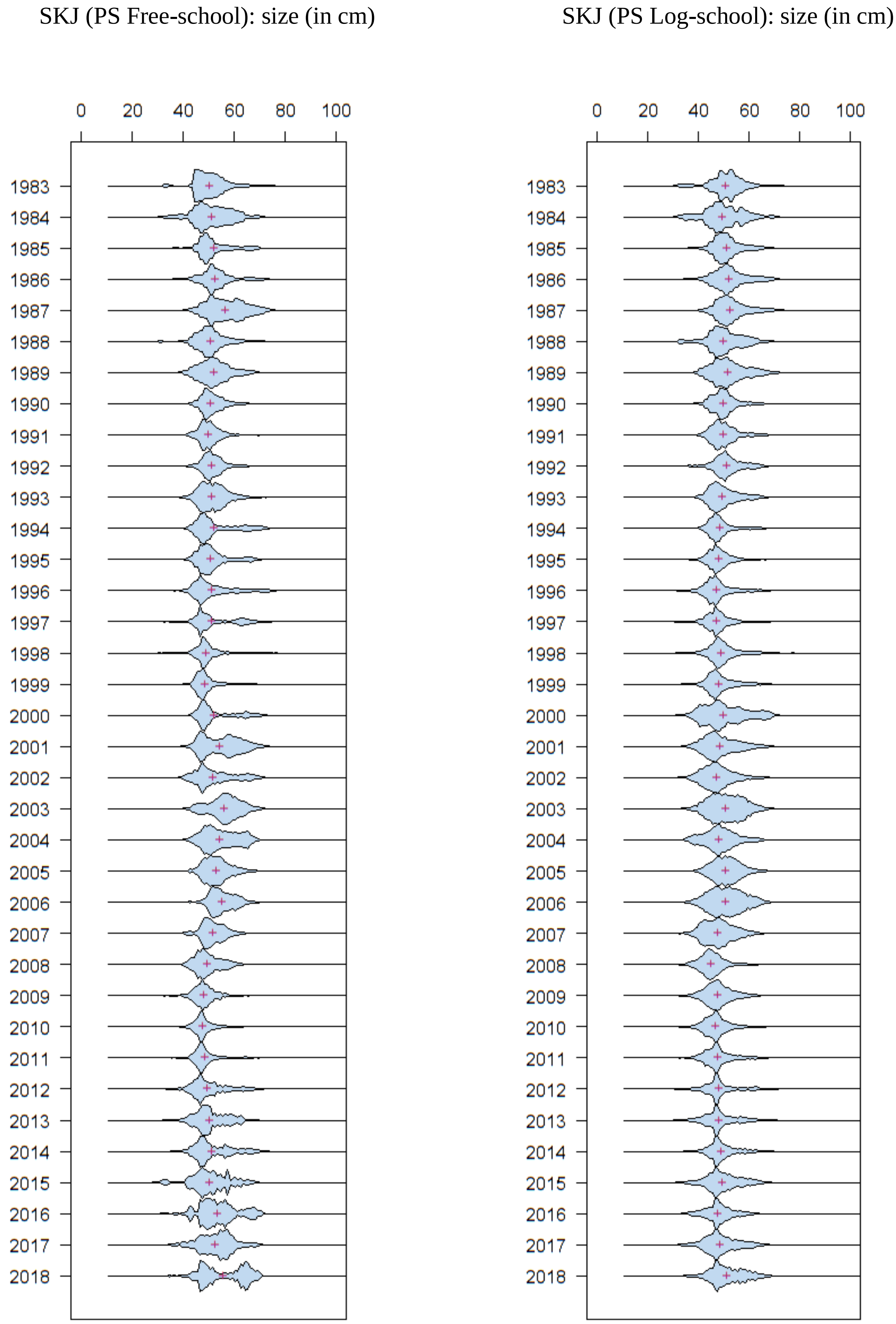












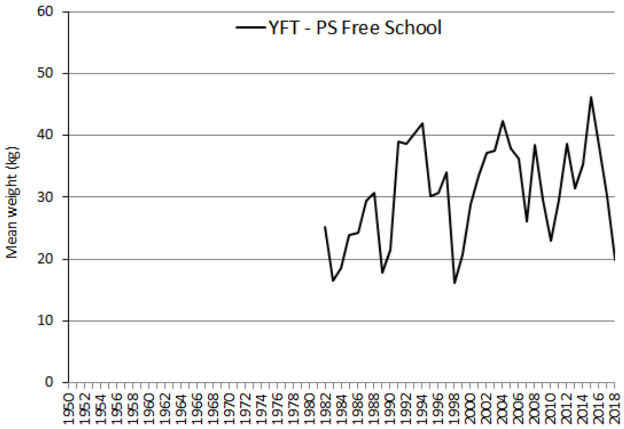
Skipjack tuna (purse seine): **Left**: length frequency distributions for SKJ PS Free school fisheries (by 2 cm length class). **Right**: Length frequency distributions for SKJ PS Associated (log) school fisheries (by 2 cm length class).

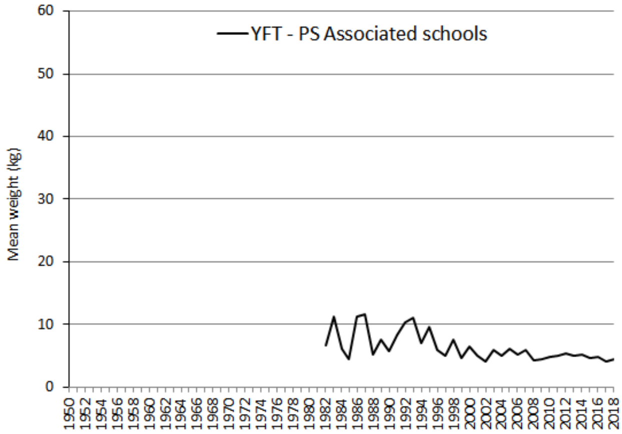
Source: IOTC database, May 2020.

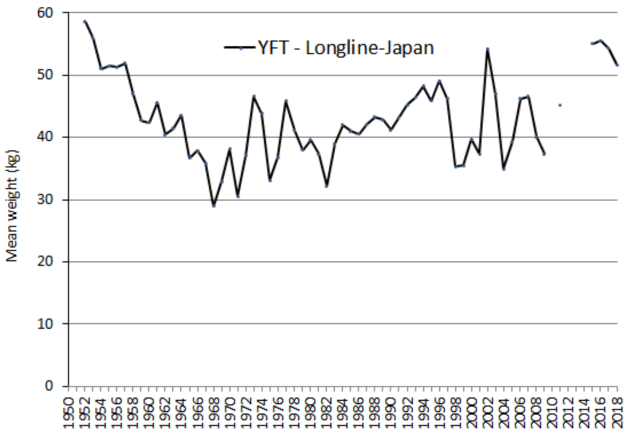
YFT - Yellowfin tuna

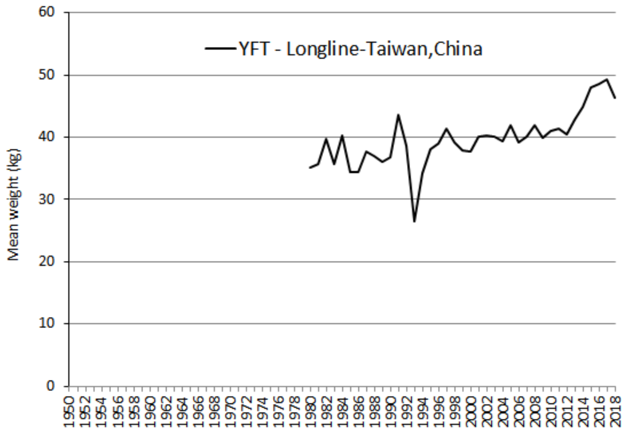
Average weight of yellowfin tuna (YFT) taken by:

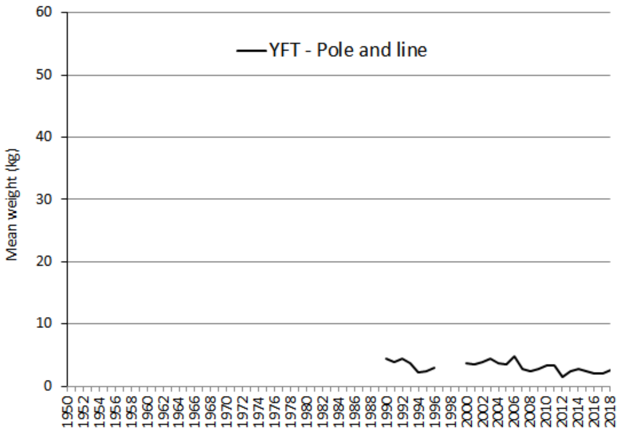
- Purse seine on free (top left) and associated (top right) schools,
- Longlines from Japan (second row left) and Taiwan,China (second row right)
- Pole-and-line from Maldives and India (third row left), and gillnets from Sri Lanka, Iran, and other countries (third row right)
- All fisheries (bottom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

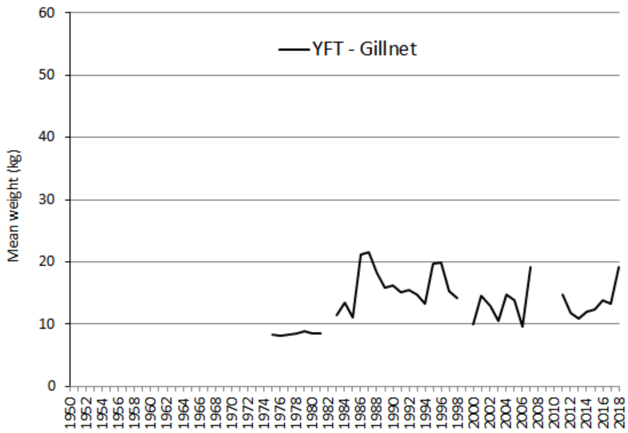


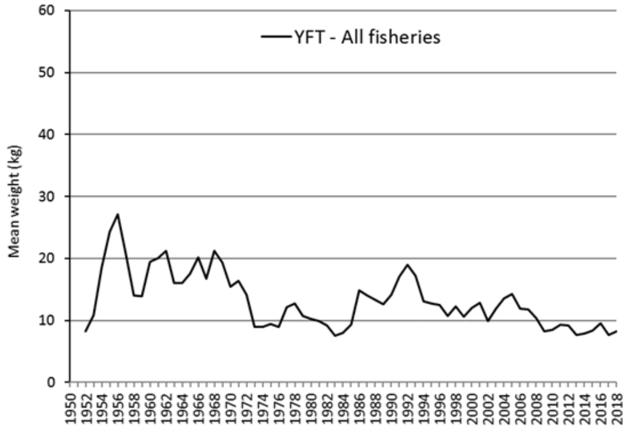


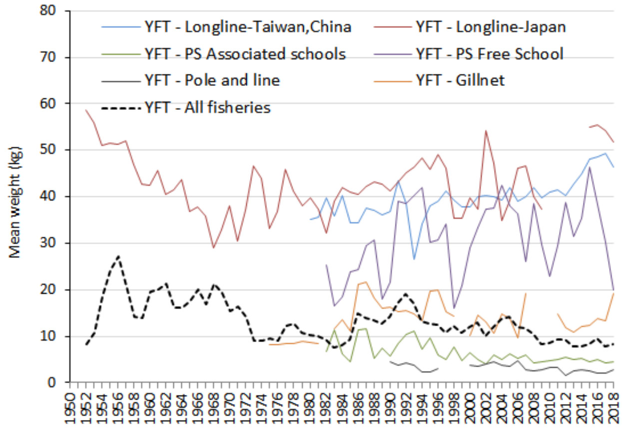


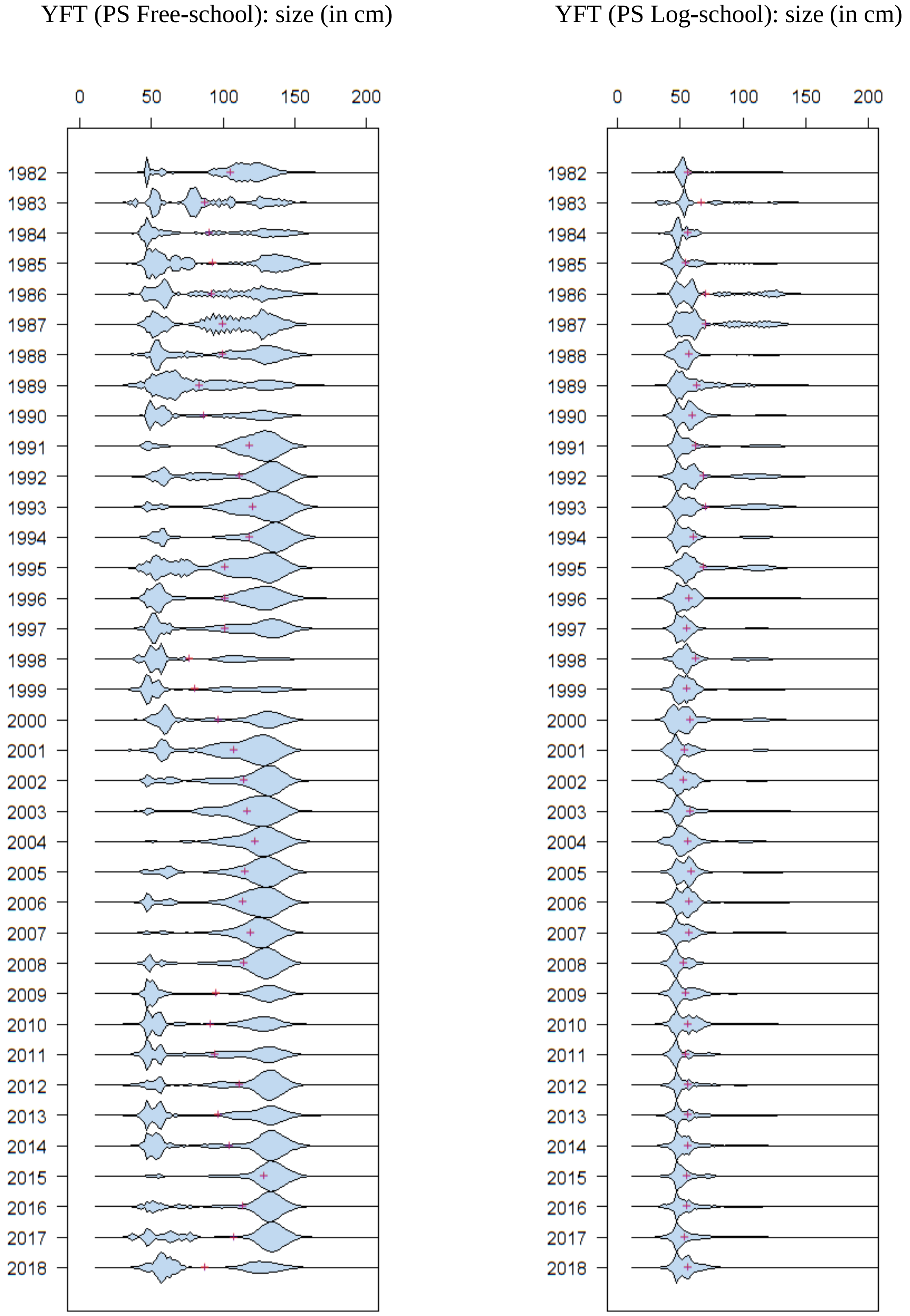







YFT - All fisheries
Mean weight (kg)

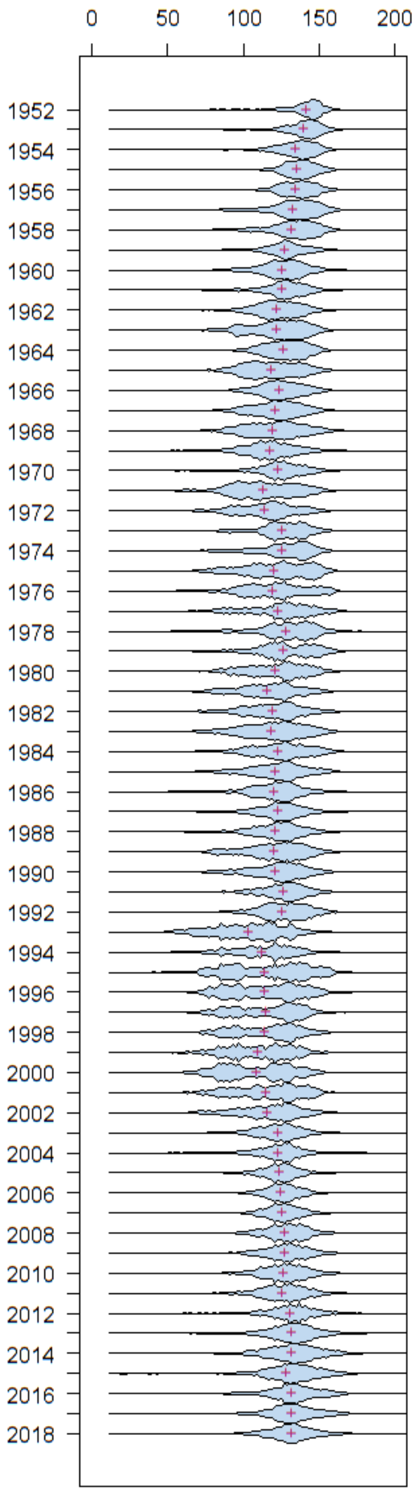

YFT - Longline-Taiwan,China
YFT - Longline-Japan
YFT - PS Associated schools
YFT - PS Free School
YFT - Pole and line
YFT - Gillnet
YFT - All fisheries
Mean weight (kg)



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, May 2020.

YFT (LL samples): size (in cm)



Yellowfin tuna (longline): Length frequency distributions for longline fisheries (total amount of fish measured by 2 cm length class) derived from data available at the IOTC Secretariat.

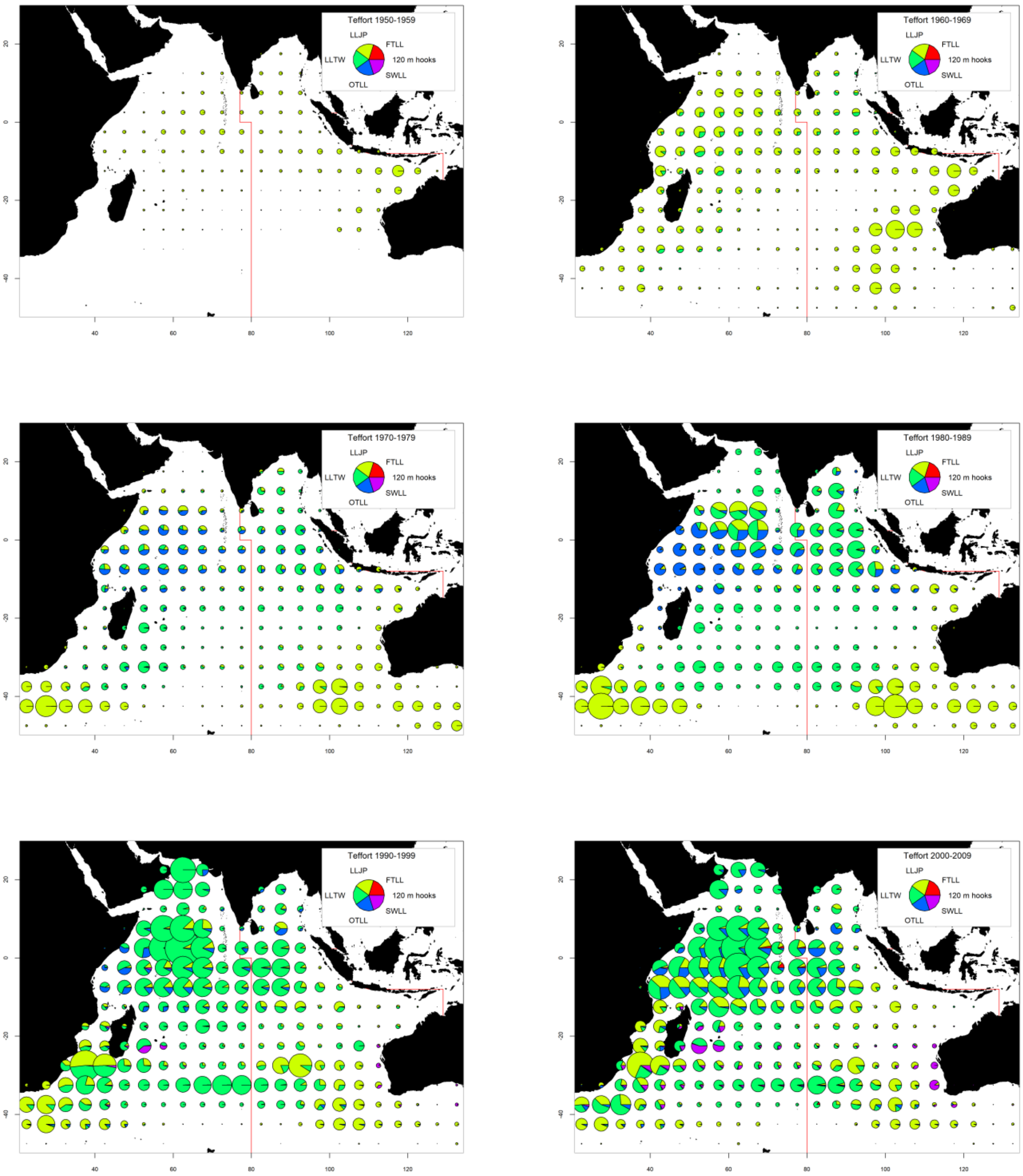
Source: IOTC database.

APPENDIX III - EFFORT TRENDS FOR TROPICAL TUNA FISHERIES

Longline fisheries

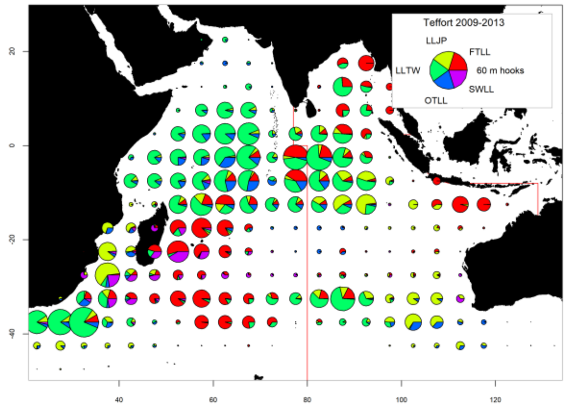
Effort exerted by LONGLINE fleets in the Indian Ocean, in millions (M) of hooks set, by decade (1950-2009) and main fleet:

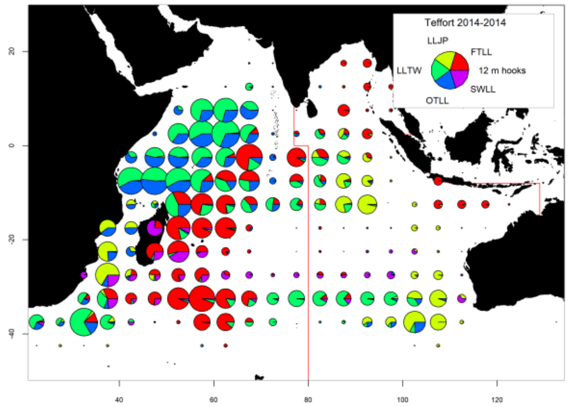
LLJP (light green): deep-freezing longliners from Japan
LLTW (green): deep-freezing longliners from Taiwan,China
SWLL (purple): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red): fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners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

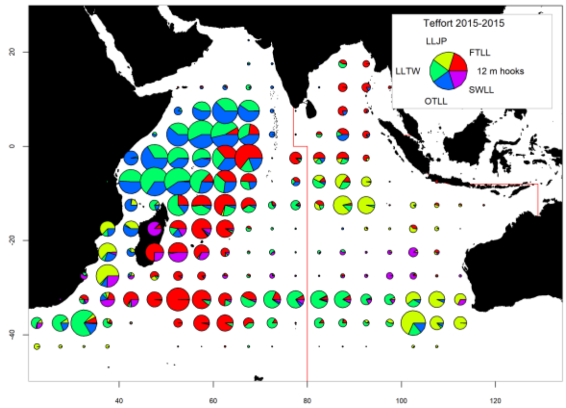


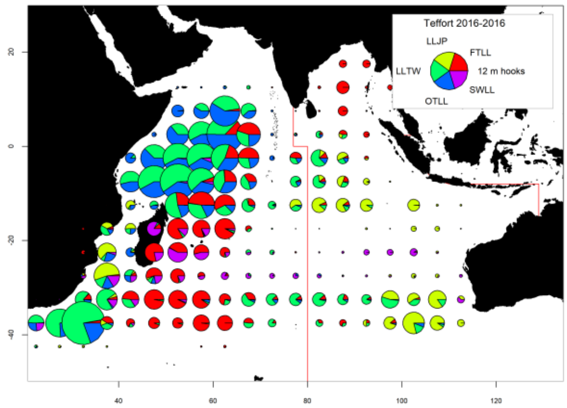
Effort exerted by LONGLINE fleets in the Indian Ocean, in millions (M) of hooks set and main fleet for 2009-2013, and 2014 to 2018:

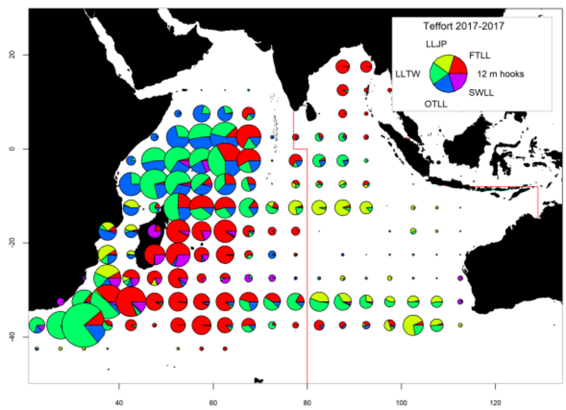
LLJP (light green): deep-freezing longliners from Japan
LLTW (green): deep-freezing longliners from Taiwan,China
SWLL (purple): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets)
FTLL (red): fresh-tuna longliners (China, Taiwan,China and other fleets)
OTLL (blue): Longliners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

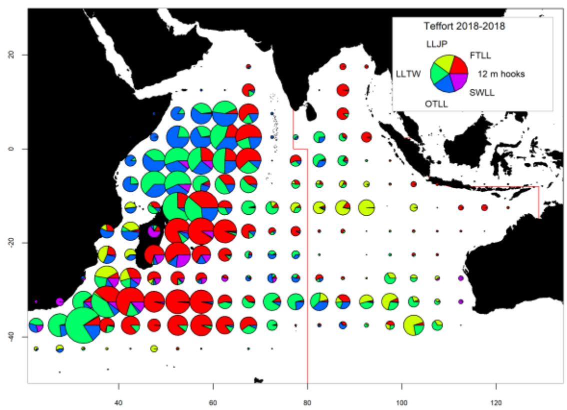










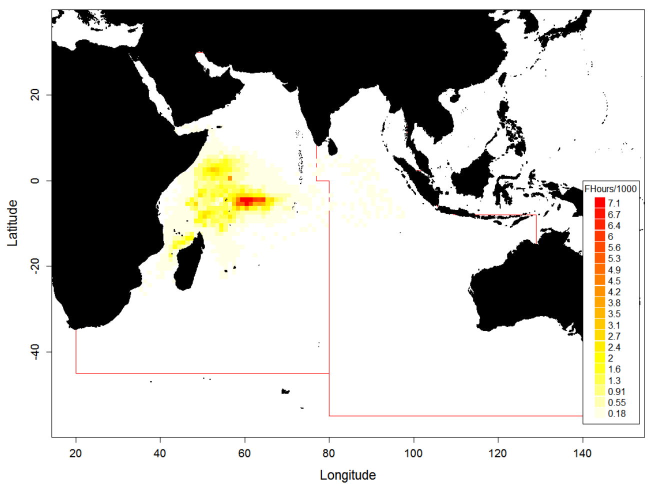


Purse seine fisheries

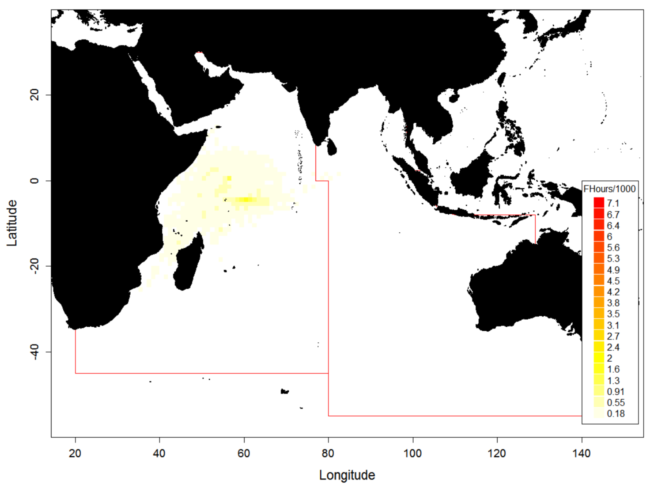
Effort exerted by industrial PURSE SEINE fleets in the Indian Ocean, in thousands (k) of fishing hours (Fhours), by decade (1980-2009) and main fleet:

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

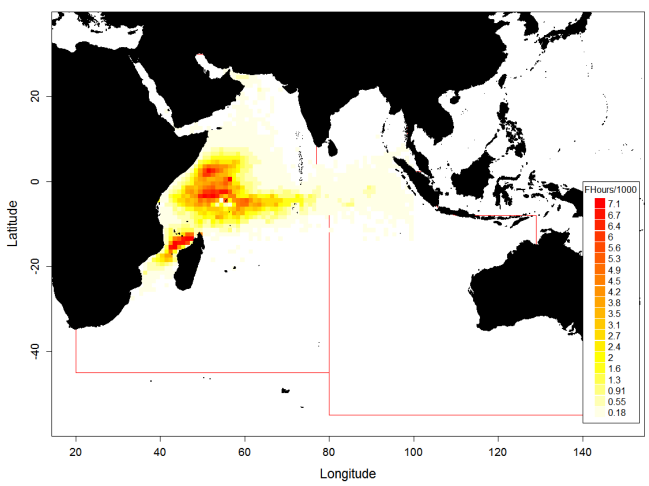
EU PS fishing effort distribution (1980-1989), fishing hours, 1x1 grids)



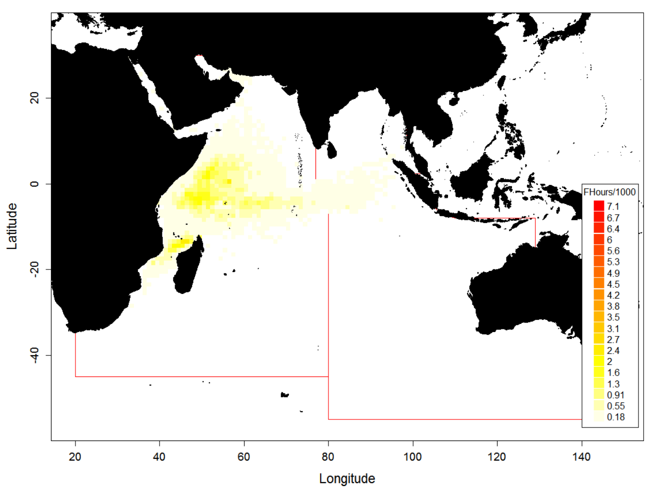
Other PS fleets fishing effort distribution (1980-1989), fishing hours, 1x1 grids)



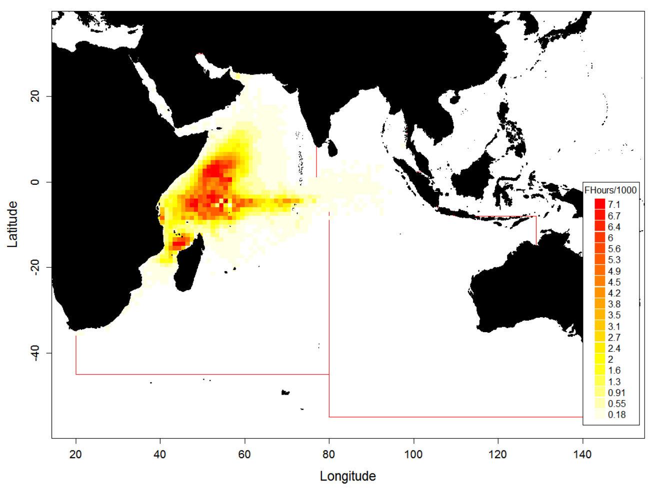
EU PS fishing effort distribution (1990-1999), fishing hours, 1x1 grids)



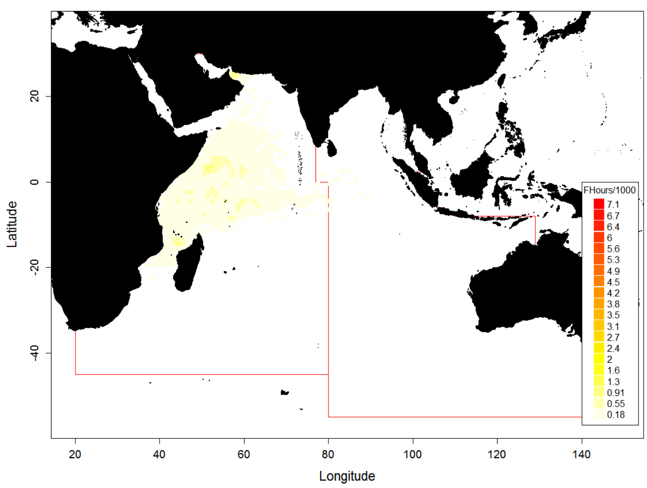
Other PS fleets fishing effort distribution (1990-1999), fishing hours, 1x1 grids)



EU PS fishing effort distribution (2000-2009), fishing hours, 1x1 grids)



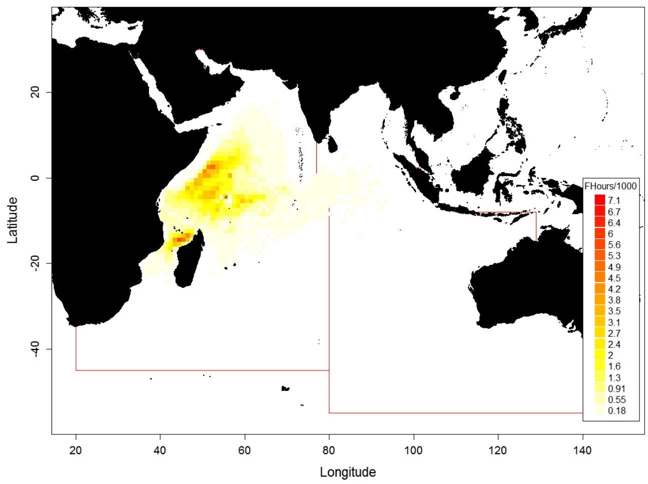
Other PS fleets fishing effort distribution (2000-2009), fishing hours, 1x1 grids)



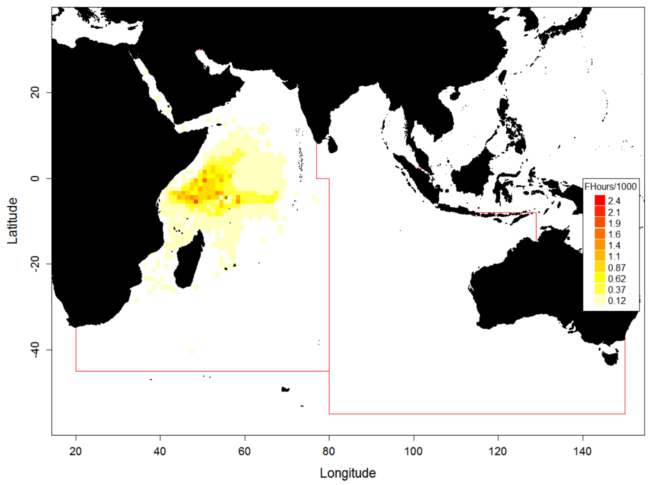
Effort exerted by industrial PURSE SEINE fleets in the Indian Ocean, in thousands (k) of fishing hours (Fhours), for 2009-13 and 2014-18, by year and main fleet:

EU PS: Industrial purse seiners monitored by the EU and Seychelles (operating under flags of EU countries, Seychelles and other flags)
Other PS: 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 as fishing hours for these fleets is **not** available in referenced years.

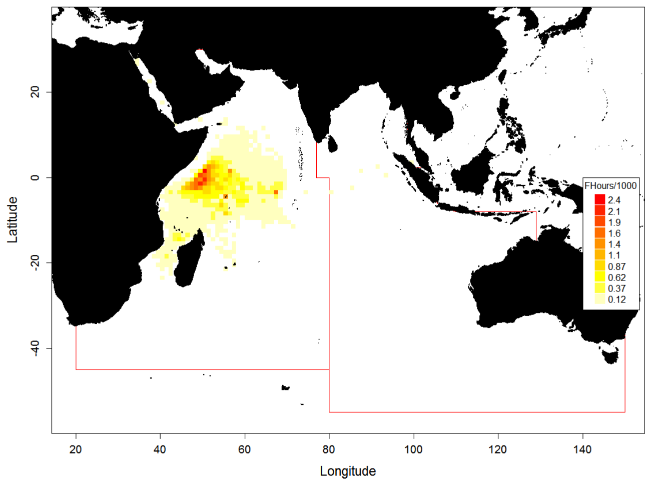
EU PS fishing effort distribution (2009-2013), fishing hours, 1x1 grids)



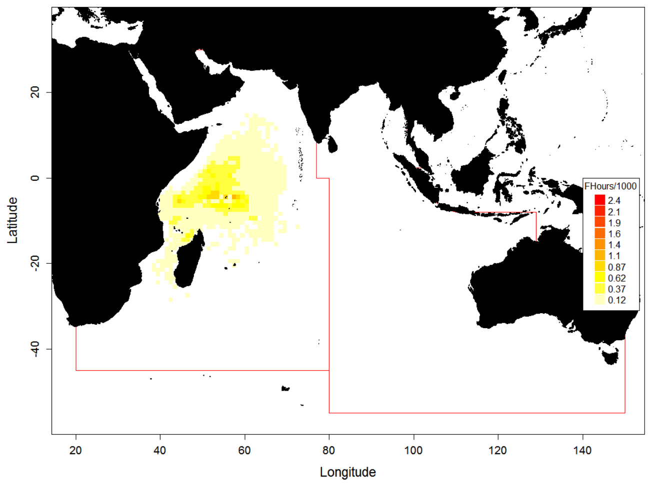
EU PS fishing effort distribution (2014), fishing hours, 1x1 grids)



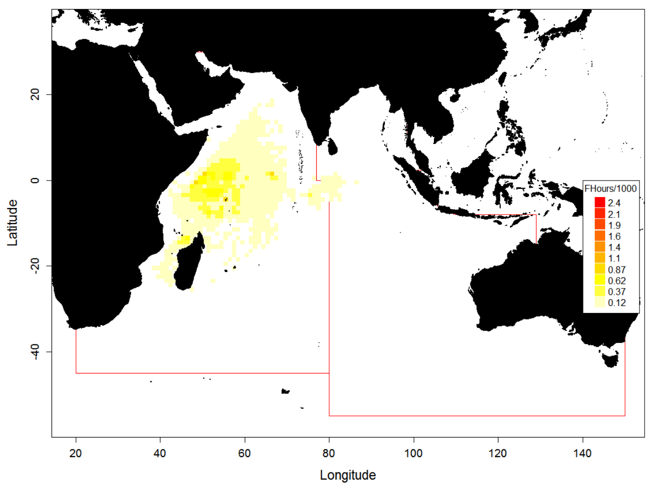
EU PS fishing effort distribution (2015), fishing hours, 1x1 grids)



EU PS fishing effort distribution (2016), fishing hours, 1x1 grids)



EU PS fishing effort distribution (2017), fishing hours, 1x1 grids)



EU PS fishing effort distribution (2018), fishing hours, 1x1 grids)