REVIEW OF INDIAN OCEAN SKIPJACK TUNA STATISTICAL DATA

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Introduction

The overarching objective of the paper is to provide participants at the preparatory meeting of the 25th Session of the IOTC Working Party on Tropical Tunas (WPTT25(DP)) with a review of the status of the information on skipjack tuna (*Katsuwonus pelamis*; SKJ) available at the IOTC Secretariat as of May 2023. The document provides an overview of the fisheries catching skipjack tuna in the Indian Ocean through temporal and spatial trends in catches and their main recent features, as well as an assessment of the reporting quality of the data sets.

Skipjack tuna is caught in all the oceans, with the majority of catches reported by the WCPFC (Western & Central Pacific Fisheries Commission). From the 1950s to the present, global historical catches show a constantly increasing trend, with catches reaching a maximum of 3,260,000 t in 2019 (**Fig. 1**). IOTC contribution represents around 20% of the total catches in recent years.

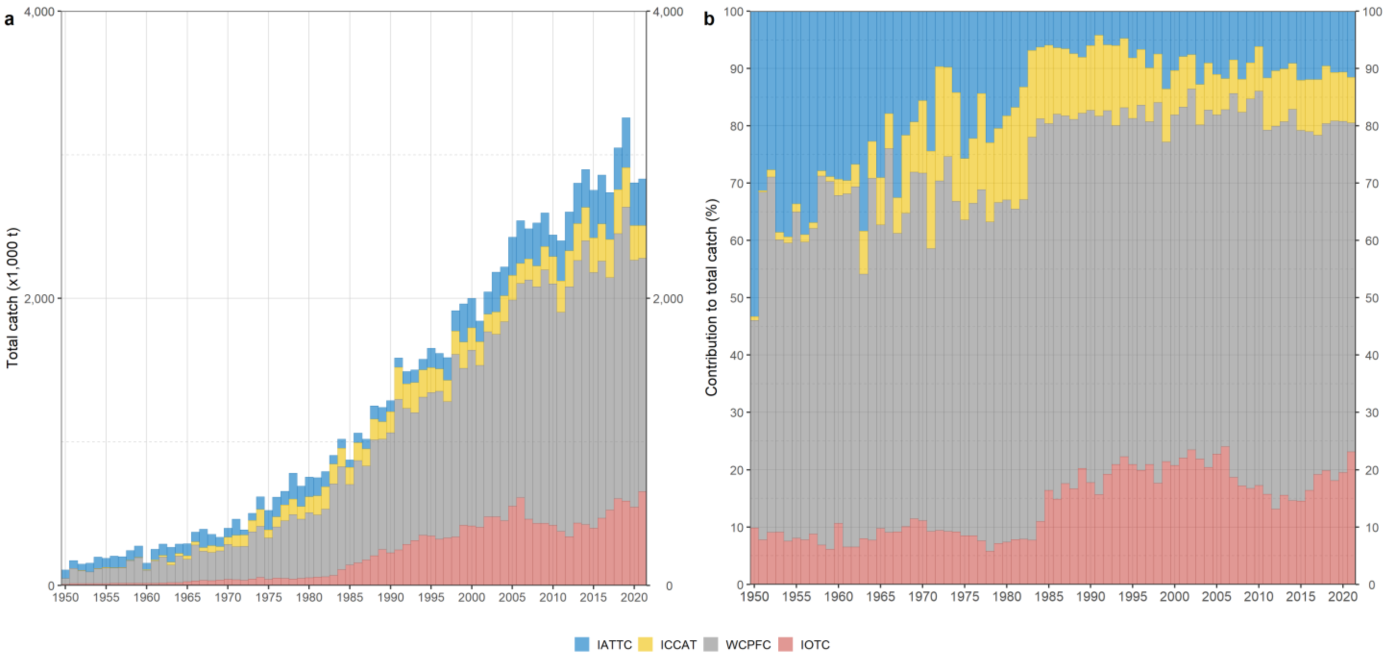

Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of skipjack tuna by tuna Regional Fisheries Management Organisation for the period 1950-2021. IATTC = Inter-American Tropical Tuna Commission; ICCAT = International Commission for the conservation of Atlantic Tunas; IOTC = Indian Ocean Tuna Commission; WCPFC = Western & Central Pacific Fisheries Commission. Source: Global Tuna Atlas

Retained catches

Historical trends (1950-2021)

Retained catches of skipjack tuna show an increasing trend over the last seven decades, with annual levels ranging between 15,000 and 473,000 t (from the mid-1950s to the mid-2000s) and with some variability across years. Catches dropped considerably from the late-2000s, reaching an annual average of 459,000 t during the 2010s, i.e., around 5% less than what caught on average during the previous decade. Purse seiners, baitboat and gillnetters are the main fisheries for the species, and together comprise over 90% of the catches between the 1950s and 2000s, and over 90% in the last full decade (**Table 1** & **Figs. 2-3**).

Table 1: Best scientific estimates of average annual retained catches (t) of skipjack tuna by decade and fishery for the period 1950-2019. The background intensity color of each cell is directly proportional to the catch level. Data source: raised time-area catches

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Purse seine | Other		93	4,527	7,435	13,563	24,710	42,643	53,802
Purse seine | FS			137	15,252	30,776	25,672	9,515	9,646
Purse seine | LS			415	34,496	124,044	163,801	168,087	249,953
Longline | Other				45	625	1,812	859	1
Longline | Fresh					4	347	1,351	1,579
Longline | Deep-freezing	244	382	65	38	96	55	71	56
Line | Coastal longline	6	29	186	1,210	2,516	5,064	12,358	12,016
Line | Trolling	2,370	4,190	8,649	12,277	21,128	20,505	25,789	25,738
Line | Handline	22	37	556	1,364	2,825	4,013	6,059	8,635
Baitboat	10,007	15,148	24,688	41,705	76,933	109,622	88,578	121,328
Gillnet	2,310	6,776	11,187	14,521	43,154	111,688	96,387	108,439
Other	104	277	515	1,829	3,468	5,728	7,743	9,994
Total	15,063	26,931	50,926	130,172	319,132	473,017	459,440	601,187

Catches of skipjack tuna were dominated by Baitboat fisheries until the mid-1980s, when increased rapidly with the development of the industrial purse seine fishery.(**Fig. 2**). Exceptionally high catch levels were recorded from the early 2000s, with the highest catches ever recorded in 2021 at over 660,000 t.(**Fig. 3**)

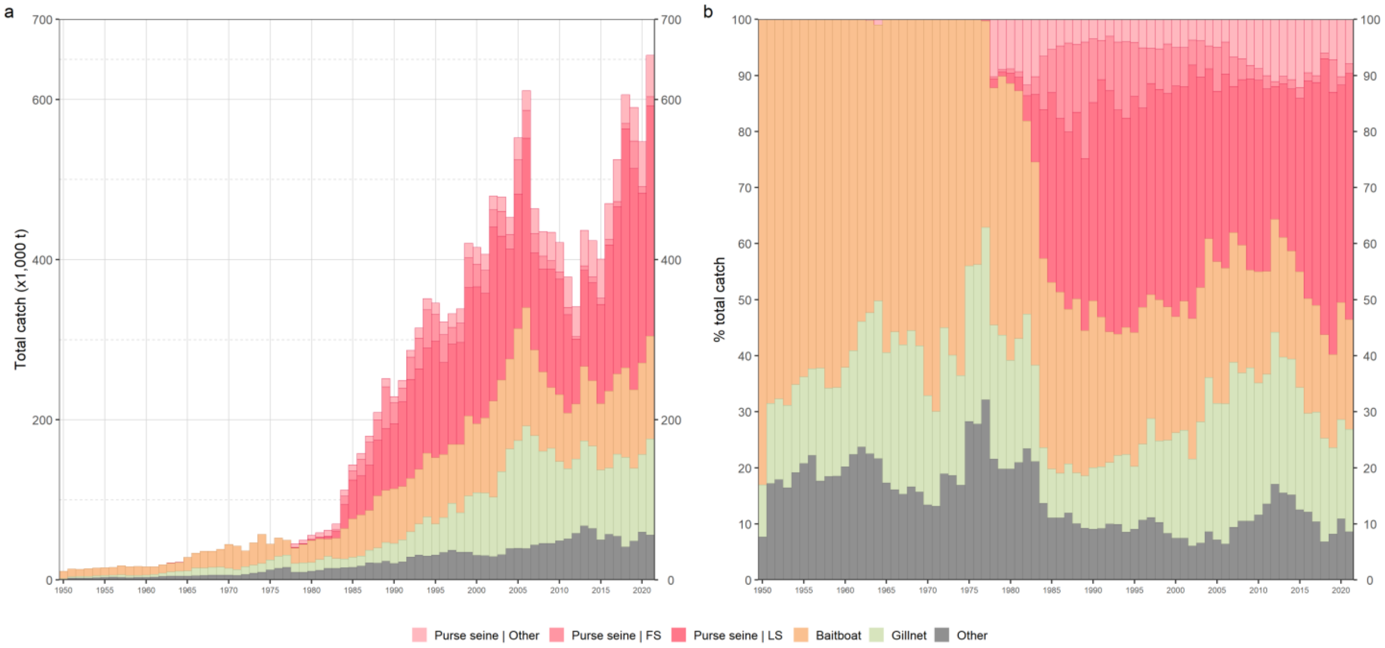

Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (t) of skipjack tuna by fishery for the period 1950-2021. LS = schools associated with floating objects; FS = free-swimming schools. Data source: raised time-area catches

Catches of tropical tuna overall declined in 2011 and 2012 as a consequence of the piracy threats in the western Indian Ocean from 2009. Catches of skipjack tuna, however, were least affected among all tropical tunas, as coastal fisheries used to contribute significantly to skipjack tuna catches and were less affected by the piracy compared to large industrial fisheries, and in particular those operating in waters close to the EEZ of Somalia.

Catches of all purse seine fisheries combined show an increasing trend from 2013, after a slight decrease in 2012, with unusually high catches reported during 2019 (353,000 t). Potential biases caused by changes in data processing methodologies introduced by some of the major fleets could have affected the catch rate in 2018. More specifically, a change in the methodology used to estimate species composition by EU,Spain introduced unusually high catch figures for skipjack in the years concerned, but these have been temporarily re-estimated by the IOTC Secretariat under advice from the IOTC Working Party on Tropical Tunas (IOTC 2022) and in agreement with IOTC (2019a). As of 2023, though, all data has been reverted back to what originally reported by EU,Spain for 2018.

Offshore and coastal fisheries like gillnet and baitboat, and more recently line fisheries, show an increasing trend in the skipjack catches, with gillnet reaching a peak of 120,000 t in 2021, and baitboat peaked at 128,000 t in 2021.

Table 2: Best scientific estimates of annual retained catches (t) of skipjack tuna by fishery for the period 2012-2021. The background intensity color of each cell is directly proportional to the catch level. Data source: raised time-area catches

Fishery	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Purse seine | Other	37,745	44,233	45,345	48,506	44,567	52,818	36,182	42,288	55,941	51,663
Purse seine | FS	2,984	5,742	7,230	7,800	6,888	6,170	6,225	34,335	7,980	11,311
Purse seine | LS	80,989	119,864	122,518	123,994	182,735	208,876	298,526	276,212	212,329	287,577
Longline | Other	1,991	2,224	1	0	6	1	0	1	1	1
Longline | Fresh	5,536	2,303	476	767	537	678	1,546	1,663	1,995	1,163
Longline | Deep-freezing	72	88	65	58	138	67	59	59	64	48
Line | Coastal longline	13,285	20,575	21,520	8,925	10,791	12,432	9,127	11,491	12,793	11,238
Line | Trolling	22,179	27,585	29,163	27,684	32,200	27,532	21,102	21,401	25,228	26,248
Line | Handline	7,681	6,201	5,209	5,122	5,792	5,189	3,718	6,033	9,437	7,833
Baitboat	68,870	93,138	81,598	82,771	96,299	100,207	111,887	98,030	114,345	128,310
Gillnet	92,668	105,877	102,854	87,362	82,681	102,760	111,971	90,981	96,950	119,928
Other	7,608	8,753	7,955	7,616	7,504	8,619	5,790	7,895	10,195	9,794
Total	341,609	436,582	423,932	400,605	470,139	525,348	606,133	590,390	547,258	655,115

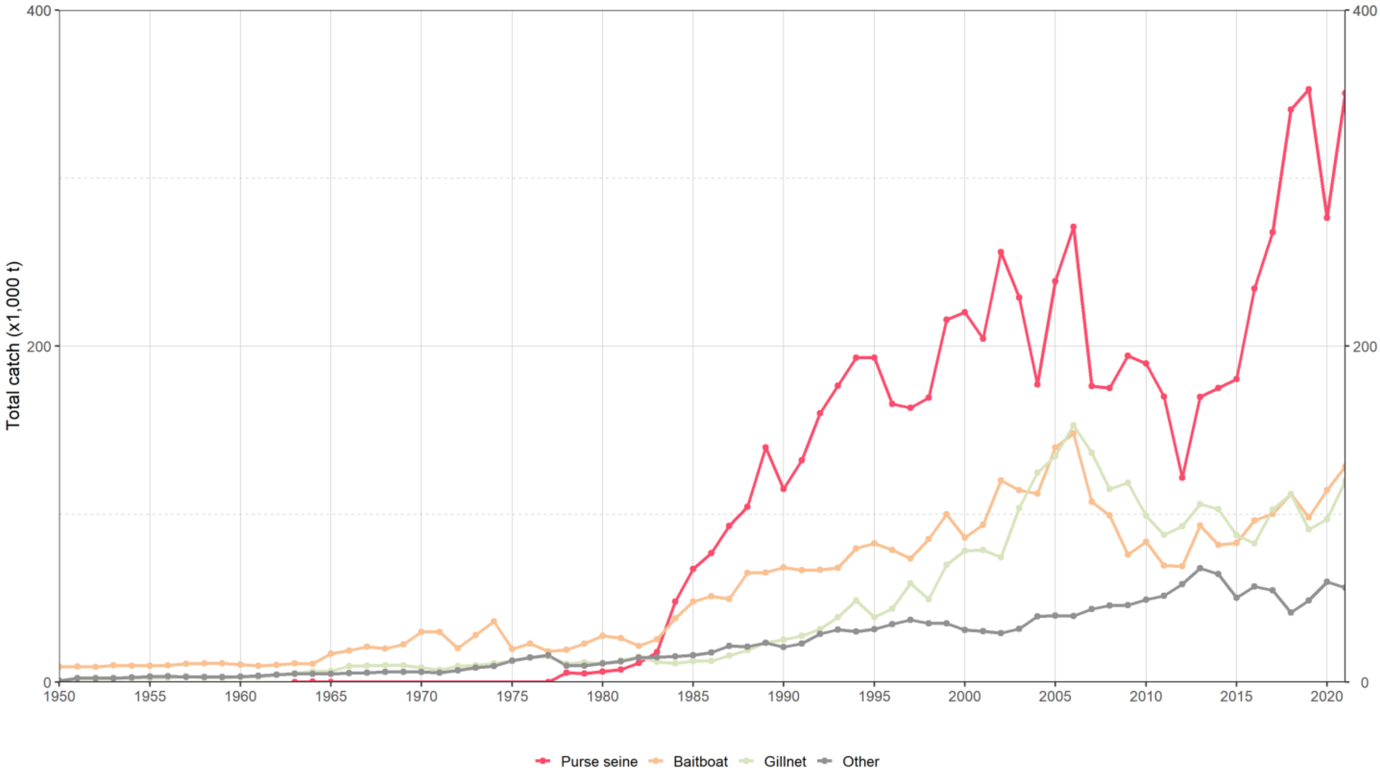

Figure 3: Annual time series of retained catches (t) of skipjack tuna by fishery group for the period 1950-2021. Data source: best scientific estimate of retained catches

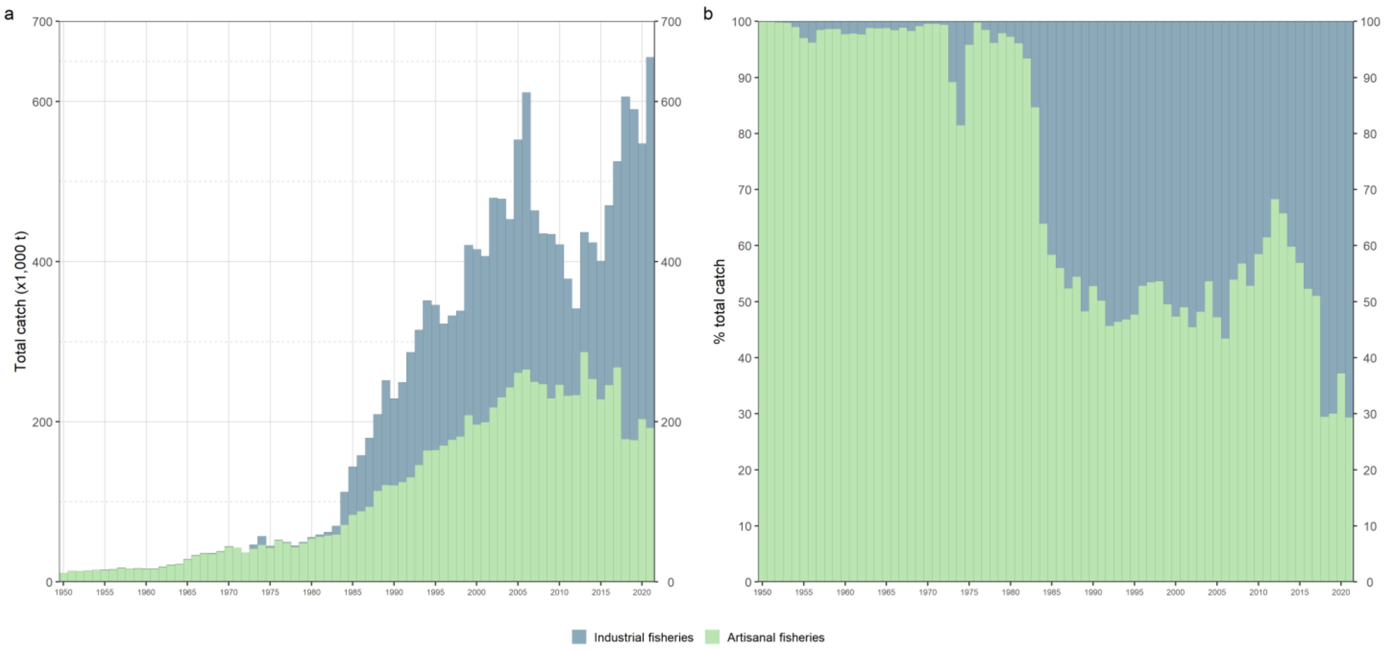

Figure 4: Annual time series of cumulative retained absolute (a) and relative (b) catches (t) of skipjack tuna by type of fishery for the period 1950-2021. Data source: best scientific estimate of retained catches

Trends in the artisanal fishery component of skipjack tuna catches in the Indian Ocean are characterized by a stable increase from the early 1980s, followed by marked fluctuations in the mid-2010s. A substantial decrease in the contribution of artisanal catches to total catches was detected in 2021, when artisanal fisheries accounted for only 29% of total catches for the species. This decline is a result of the reclassification of catches from Maldivian fisheries from 2018 onwards, and more specifically those from baitboat and handline fisheries which have now been apportioned between the *offshore* (industrial) and *coastal* (artisanal) components, resulting in skipjack tuna been mainly caught by the former. Nevertheless, some artisanal fisheries such as those from Bangladesh and Yemen reported an increase of skipjack tuna catches in recent years. Between 2017 and 2021, mean annual catches from artisanal fisheries were close to 200,000 t (35% of total catches), with industrial fisheries catching on average 380,000 t per year (**Fig. 4**).

Purse seine catch trends by fishing mode

Purse seine fisheries continue to catch large quantities of skipjack tuna from schools associated with drifting floating objects (FOBs), even though sporadic fluctuations in the relative percentages of the two fishing modes (i.e., free vs. associated schools) can be detected in some years (e.g., 2019). The EU (EU,Spain and EU,France, as little to no data is available in recent years for vessels flagged by EU,Italy) and Seychelles fleets combined reported over 80% of their skipjack tuna catches as originating from FOB-associated schools since the early-2000s.

Between 2012 and 2021, the fraction of catches from FOB-associated schools reported by all purse seine fleets combined, fluctuated between 89% and 98% , with around 98% of skipjack tuna catches reported in 2018 and around 96% in 2021 (**Fig. 5**).

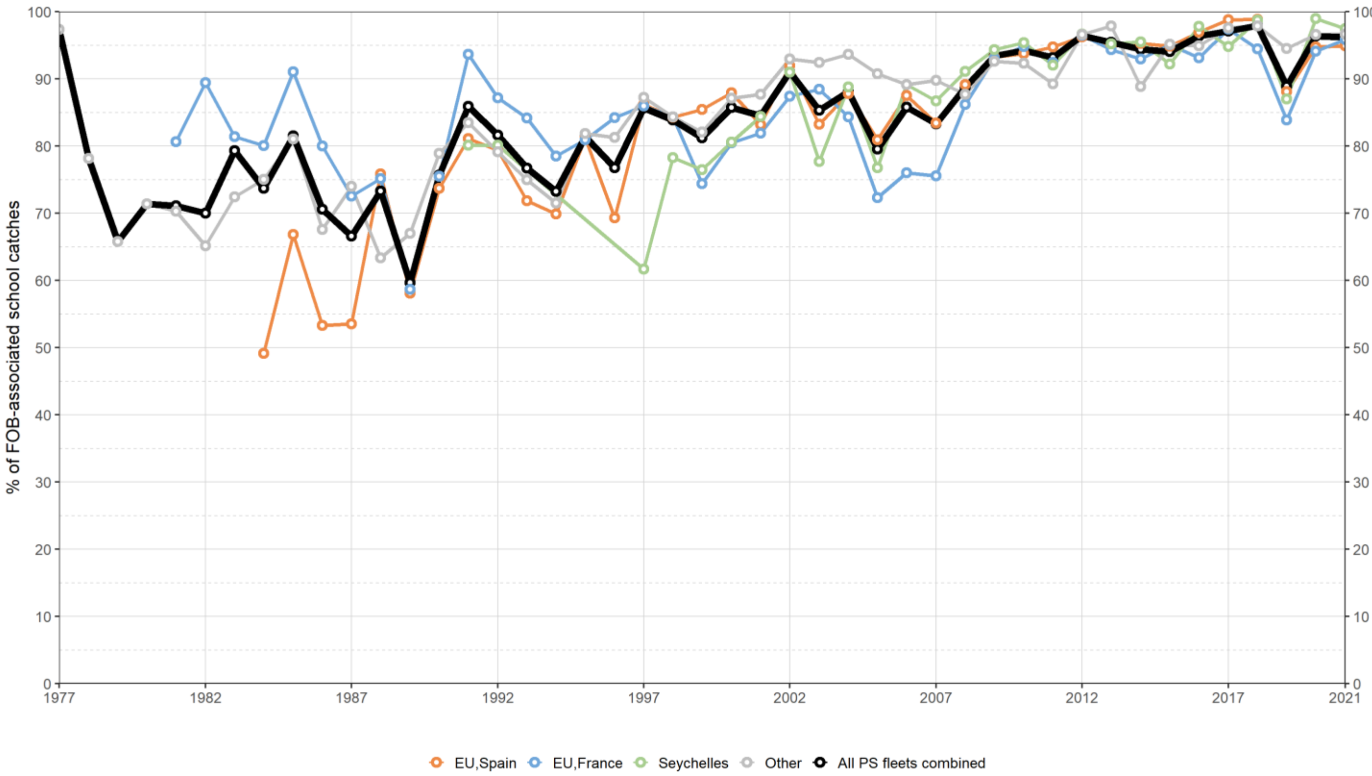

Figure 5: Annual percentages of purse seine FOB-associated catches of skipjack tuna by fleet for the period 1977-2021. *Other* includes purse seine fleets such as ex-Soviet Union, I.R. Iran, France (Mayotte), Mauritius, Japan, Korea, Indonesia, Thailand, EU,Italy, Belize, and others. Data source: time-area catch dataset for purse seine fisheries (Res. 15/02)

Main fishery features (2017-2021)

Skipjack tuna is caught mainly by purse seiner, baitboat and gillnet fisheries from different fleets operating all over the Indian Ocean. Between 2017 and 2021, purse seine fisheries (all fishing modes combined) caught on average more than 318,000 t of skipjack tuna per year, contributing to around 54% of total retained catches for the species (**Table 3**). During the same period, baitboat and gillnet fisheries represented the second main contributor of skipjack tuna catches, with about 111,000 t and 105,000 t (around 19% and 18% of the total) caught every year, respectively (**Table 3 & Fig. 3**).

Table 3: Mean annual catches of skipjack tuna (t) by fishery between 2017 and 2021. LS = schools associated with floating objects; FS = free-swimming schools. Data source: raised time-area catches

Fishery	Fishery code	Catch	Percentage
Purse seine | LS	PSLS	256,704	43.9
Baitboat	BB	110,556	18.9
Gillnet	GN	104,518	17.9
Other	OT	52,089	8.9
Purse seine | Other	PSOT	47,778	8.2
Purse seine | FS	PSFS	13,204	2.3

Average annual catches of skipjack tuna between 2017 and 2021 have been shared between several CPCs, with around 70% of all annual catches accounted by Indonesia, Eu,Spain, Maldives, and Seychelles (**Fig. 6**).

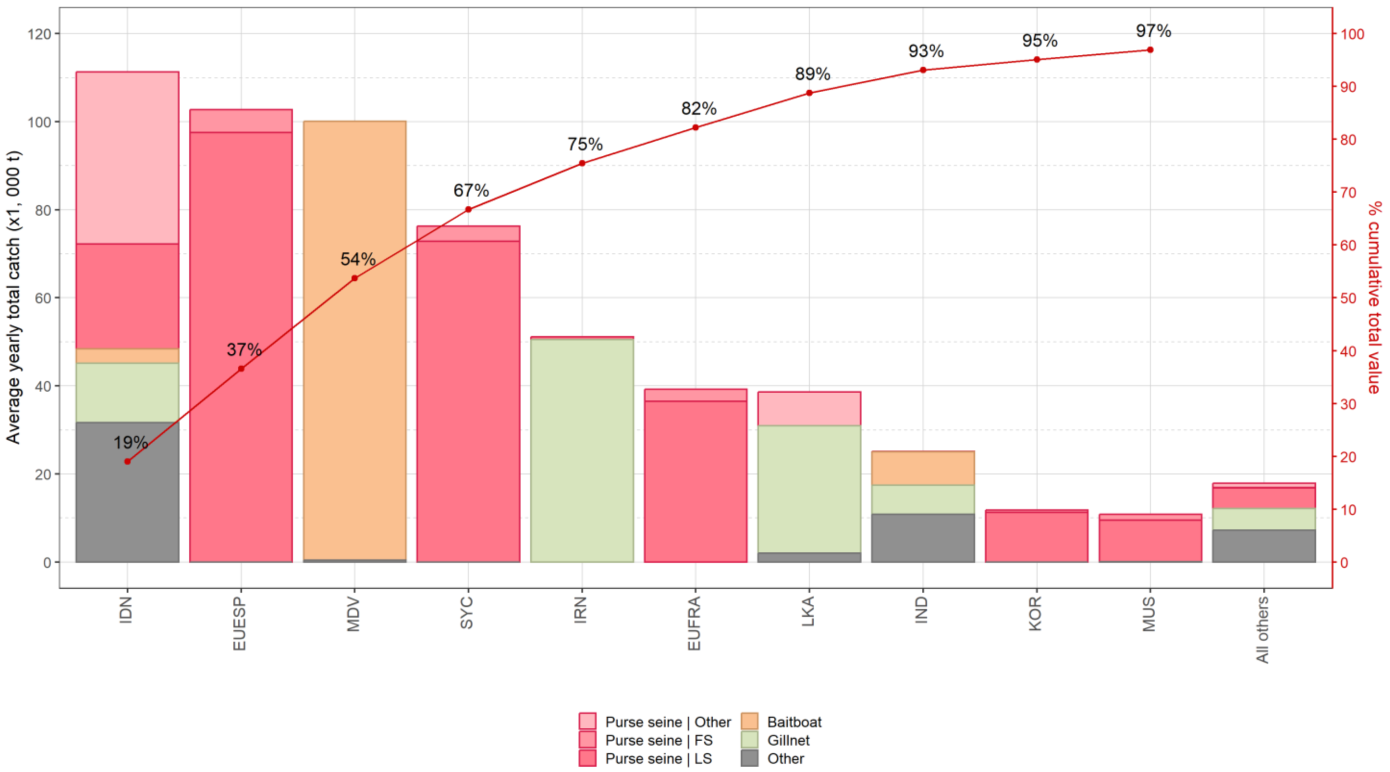

Figure 6: Mean annual catches of skipjack (t) tuna by fleet and fishery between 2017 and 2021, with indication of cumulative catches by fleet. FS = free-swimming schools; LS = schools associated with floating objects. Data source: raised time-area catches

Catch trends by fishery group in the same period (2017-2021) show different behaviors when comparing industrial purse seiner fisheries with other fishery groups, with fluctuating trends in purse seine catches from 2019 to 2021 and recent increases detected in other fishery groups (**Fig. 7**).

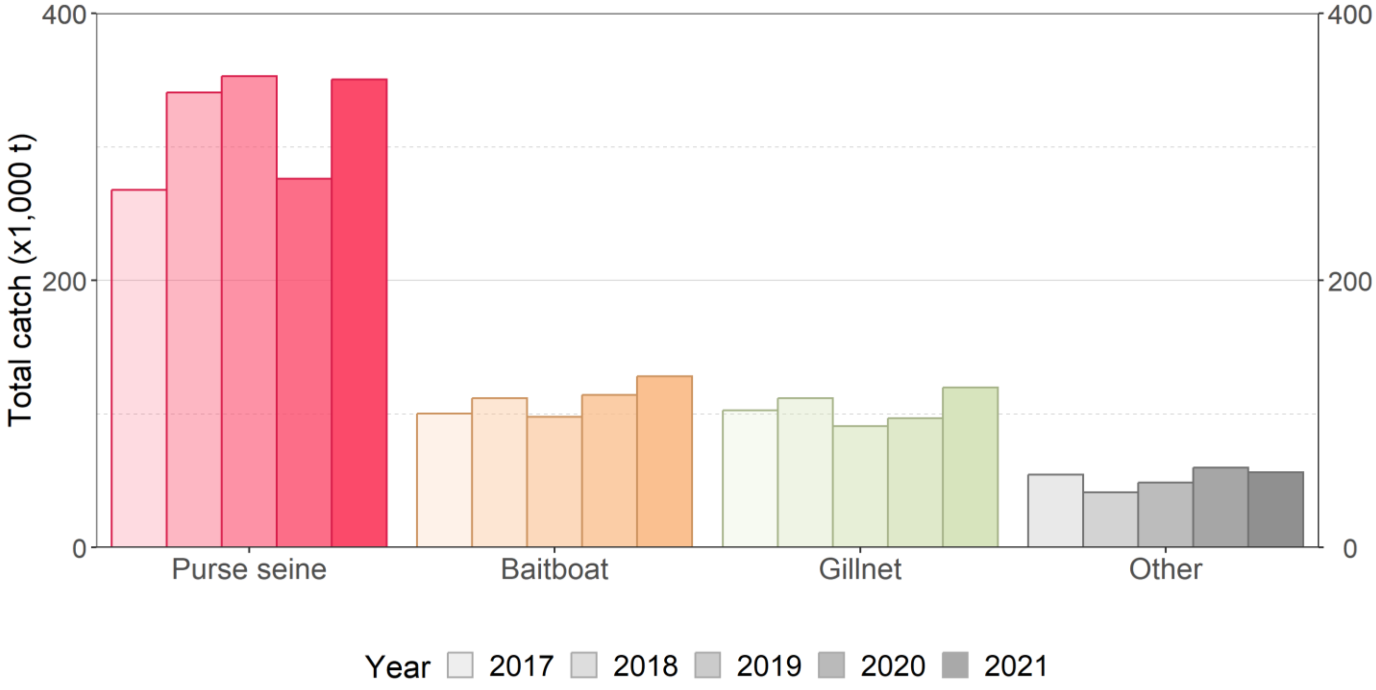

Figure 7: Annual catch (t) trends of skipjack tuna by fishery group between 2017 and 2021. Data source: best scientific estimate of retained catches

Regarding industrial purse seine fisheries, catches from all fleets combined remain generally stable in the last five years, with recent peaks in catches identified in 2019 and 2021 (**Fig. 7**). Recent catch trends by purse seine fleet (all fishing modes combined) show similar patterns in the contribution from all major fleets, with generalized decreases reported in 2020 and a recovery in 2021, potentially due to the onset of the CoViD-19 pandemic (**Fig. 9a**).

Overall, changes in catches from purse seine fleets strongly vary with the type of school association. Catches on free-swimming schools (which are generally lower in magnitude) show a mixed situation with high variability across years for all fleets involved (**Fig. 8a**), while catches on FOB-associated schools have generally stable recent trends, except for 2021 when unusually high catches were reported by Indonesia, EU,Spain, and EU,France on FOB-associated schools (**Fig. 8b**).

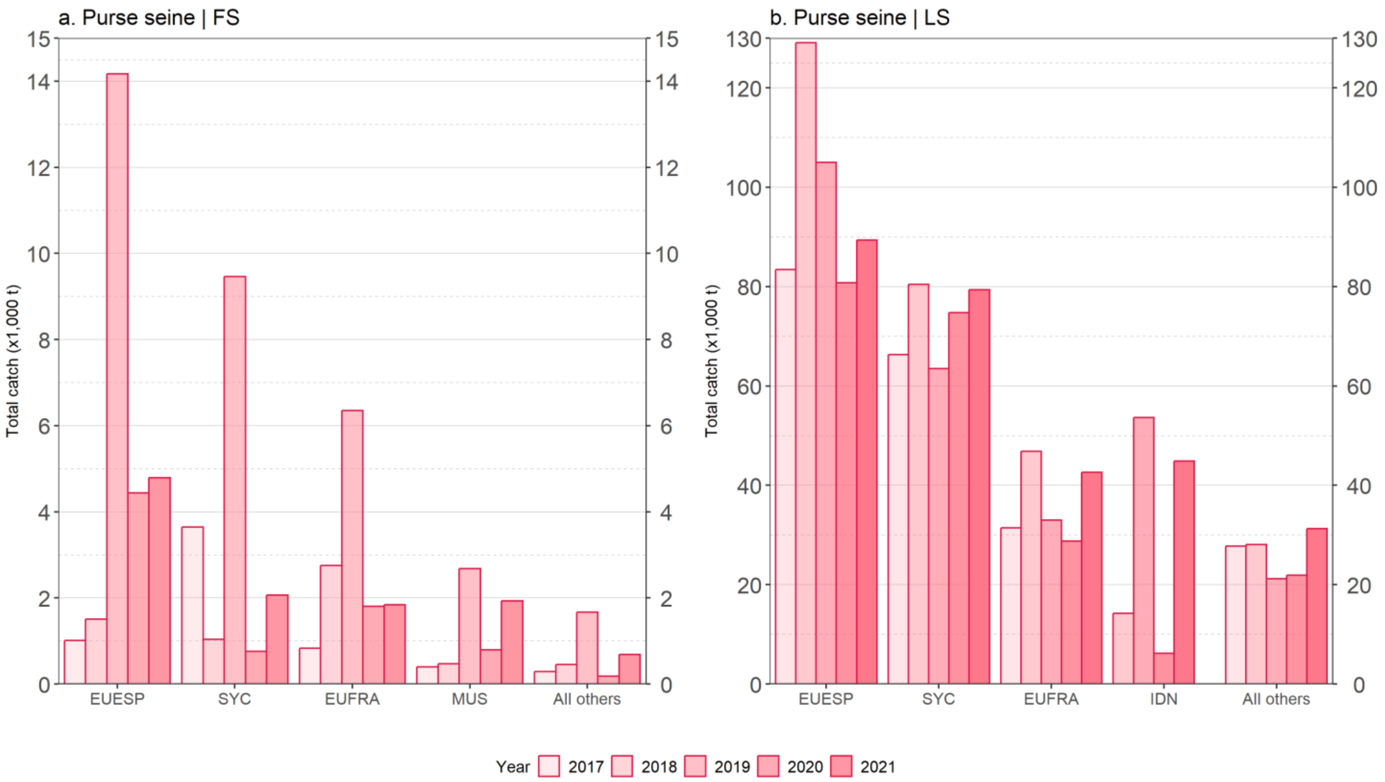

Figure 8: Annual purse seine catch (t) trends of skipjack tuna by fishing mode and fleet between 2017 and 2021. FS = free-swimming schools; LS = schools associated with floating objects. Data source: raised time-area catches

Recent data from baitboat fisheries, whith the majority of reported by Maldives, show an increasing trend in catch levels from 2018, with a slight drop in 2019 followed by a new increase in catches that brought the totals back to 2018 levels and above (**Fig. 9c**). Among the gillnet fisheries operating in the Indian Ocean, those from I.R. Iran represent the largest contributors in recent years, with catches reaching over 50% of total gillnet catches in 2021 (**Fig. 9d**).

Fleets using line or assimilated gears (handline, troll-line, coastal longline) show an overall decline in catch since 2017. At fleet level, Indonesia, which is a major contributor appear to be in a phase of slight contractions compared to previous years, with catches in 2021 reported at significantly lower levels than 2020 (**Fig. 9d**).

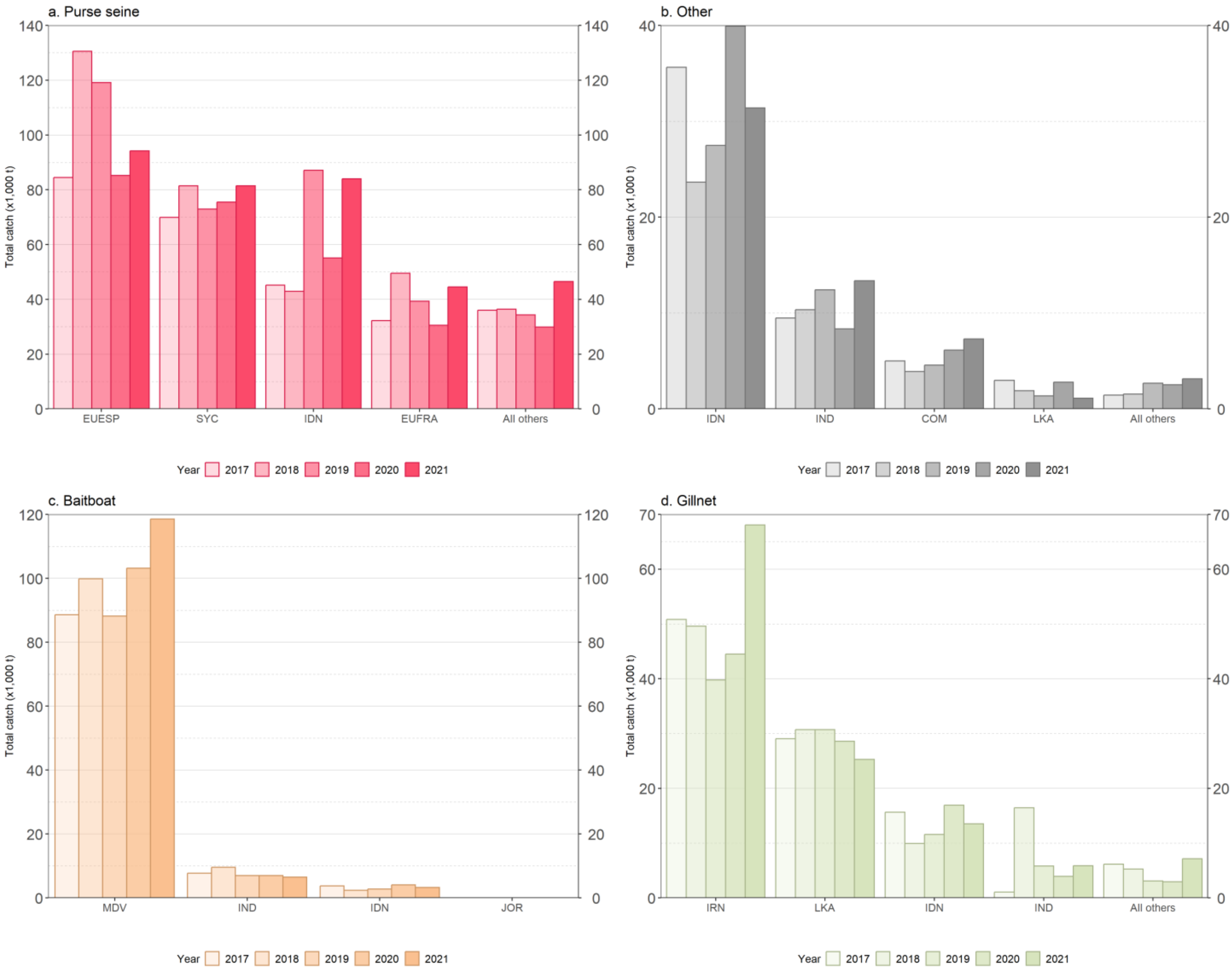

Figure 9: Annual catch (t) trends of skipjack tuna by fishery group and fleet between 2017 and 2021. Data source: best scientific estimate of nominal catches

Changes from previous WPTT

Limited but significant changes were detected in the latest time series of catches of skipjack tuna compared to the best scientific estimates of retained catches available to the last meeting of the Working Party on Tropical Tunas in October 2022, summing up to an overall annual change of -2,353 t for 2018 (**Fig. 10**).

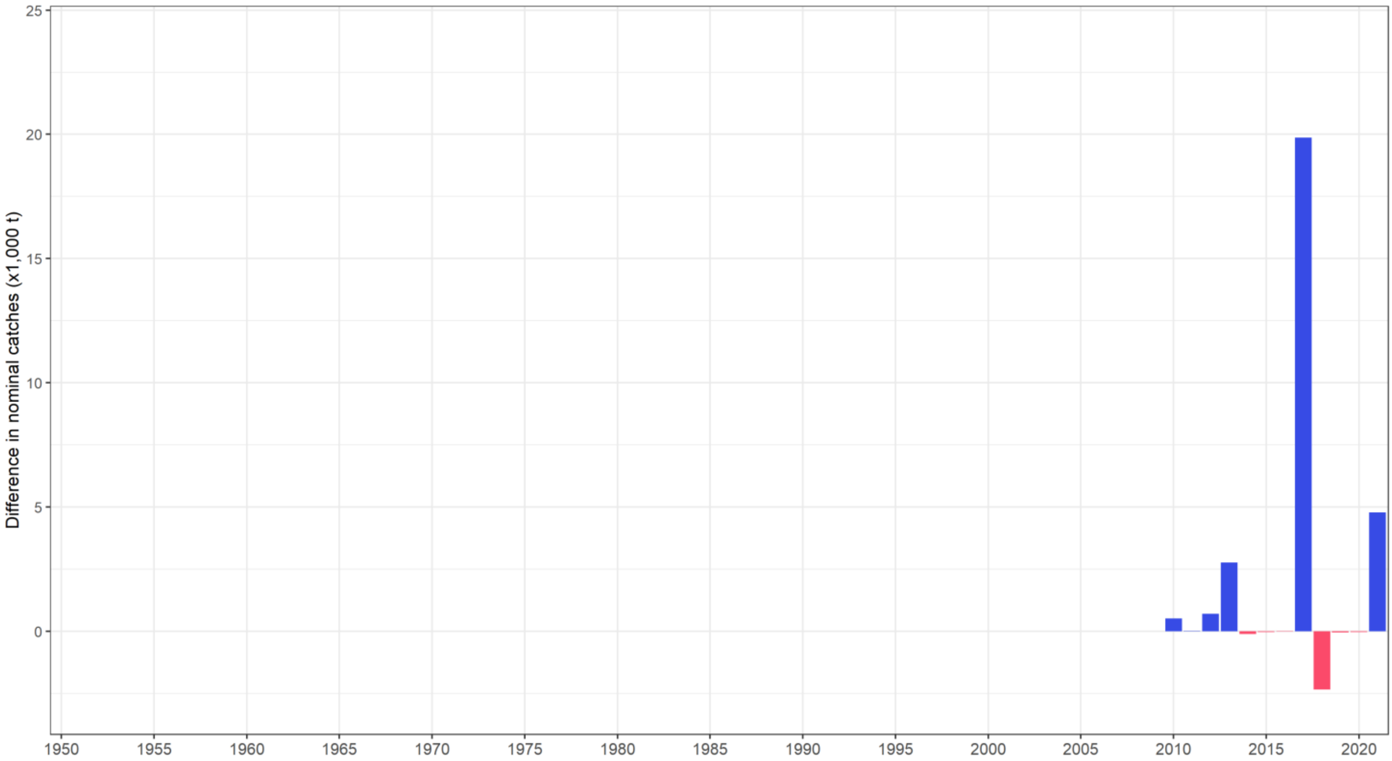

Figure 10: Differences in the available best scientific estimates of retained catches (t) of skipjack tuna between this WPTT and its previous session (24th WPTT, meeting held in October 2022)

These changes are a consequence of the request made by the WPTT24(DP) to re-estimate the species composition of the Spanish component of the European Union purse-seine fleet for 2018 (IOTC 2022) due to the differences introduced in the original estimates by a revision in the statistical procedures used by EU,Spain. The issue was first identified during the 21st session of the Working Party on Tropical Tunas held in 2019 (IOTC 2019c), and the approach for the current re-estimation was presented during the Working Party on Data Collection and Statistics in the same year (IOTC 2019b).

The re-estimation applied by the IOTC Secretariat resulted in a decrease of almost 2,400 t in catches of skipjack tuna recorded for 2018 (**Table 4**) while increasing by the same amount of EU,Spain overall catches of yellowfin tuna for the year concerned.

Besides the changes in catches from the Spanish component of the European Union purse-seine fleet, other relevant changes were introduced in the revised catches of Indonesian artisanal fisheries for 2017, resulting from the disaggregation process of aggregated catch in the database.

Table 4: Changes in best scientific estimates of average annual retained catches of skipjack tuna by year, fleet, fishery group and main Indian Ocean area, limited to absolute values higher than 10 t. Data source: best scientific estimate of retained catches 2020 and 2021

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2021	EUITA	Purse seine	Western Indian Ocean	5,416	2,433	2,984
	IDN	Baitboat	Eastern Indian Ocean	3,283	3,217	66
		Gillnet	Eastern Indian Ocean	13,516	13,244	273
		Line	Eastern Indian Ocean	23,245	22,777	469
		Other	Eastern Indian Ocean	7,136	6,992	144
		Purse seine	Eastern Indian Ocean	83,966	83,178	788
	MOZ	Line	Western Indian Ocean	99	46	53
	YEM	Gillnet	Western Indian Ocean	1,352	338	1,014
		Line	Western Indian Ocean	675	1,688	-1,014
2020	MOZ	Line	Western Indian Ocean	9	46	-37
2019	IDN	Line	Eastern Indian Ocean	19,920	19,935	-15
		Purse seine	Eastern Indian Ocean	87,099	87,124	-25
2018	EUESP	Purse seine	Western Indian Ocean	130,572	132,933	-2,361
2017	IDN	Baitboat	Eastern Indian Ocean	3,800	3,044	756
		Gillnet	Eastern Indian Ocean	15,644	12,532	3,112
		Line	Eastern Indian Ocean	26,904	21,553	5,352
		Other	Eastern Indian Ocean	8,259	6,616	1,643
		Purse seine	Eastern Indian Ocean	45,229	36,232	8,997
2016	DJI	Gillnet	Western Indian Ocean	29	18	11
	IDN	Gillnet	Eastern Indian Ocean	12,543	12,532	11
		Line	Eastern Indian Ocean	21,572	21,553	20
		Purse seine	Eastern Indian Ocean	36,265	36,232	33

Uncertainties in retained catch data

Reporting quality

The quality of the retained catches of skipjack tuna reported to the IOTC Secretariat varies over the years (**Fig. 11**), and is mostly driven by the contribution of coastal fisheries to total catches. The quality of retained catch data from coastal fisheries shows a declining trend from the 1990s to the 2010s. The situation improved from the mid-2010s, mostly thanks to the implementation of new data collections systems in Sri Lanka and I.R.Iran. On the contrary, the quality of data reported by the coastal fisheries of Indonesia and India, which are also key contributors, remains low due known issues affecting their national data collection systems. Furthermore, estimates of catches from industrial fisheries *not elsewhere identified* (NEI) were drastically reduced through improved reporting and the effective implementation of Port State Measures, and more specifically port inspections schemes.

Although the main coastal fisheries are progressing with improvements in their data collection systems, reporting of fisheries data by some of them remains an issue. These include troll lines from Madagascar, small-scale purse seine and handline fisheries from Mozambique, as well as most of the coastal fisheries of Tanzania. Furthermore, catches of Indonesian artisanal fisheries have been annually re-estimated since the early 2010s based on fixed species compositions depending on each fishing gear and derived from samples primarily collected in the 2000s (Moreno et al. 2012). In 2021, the percentage of skipjack tuna catch fully or partially reported to the Secretariat was 86%.

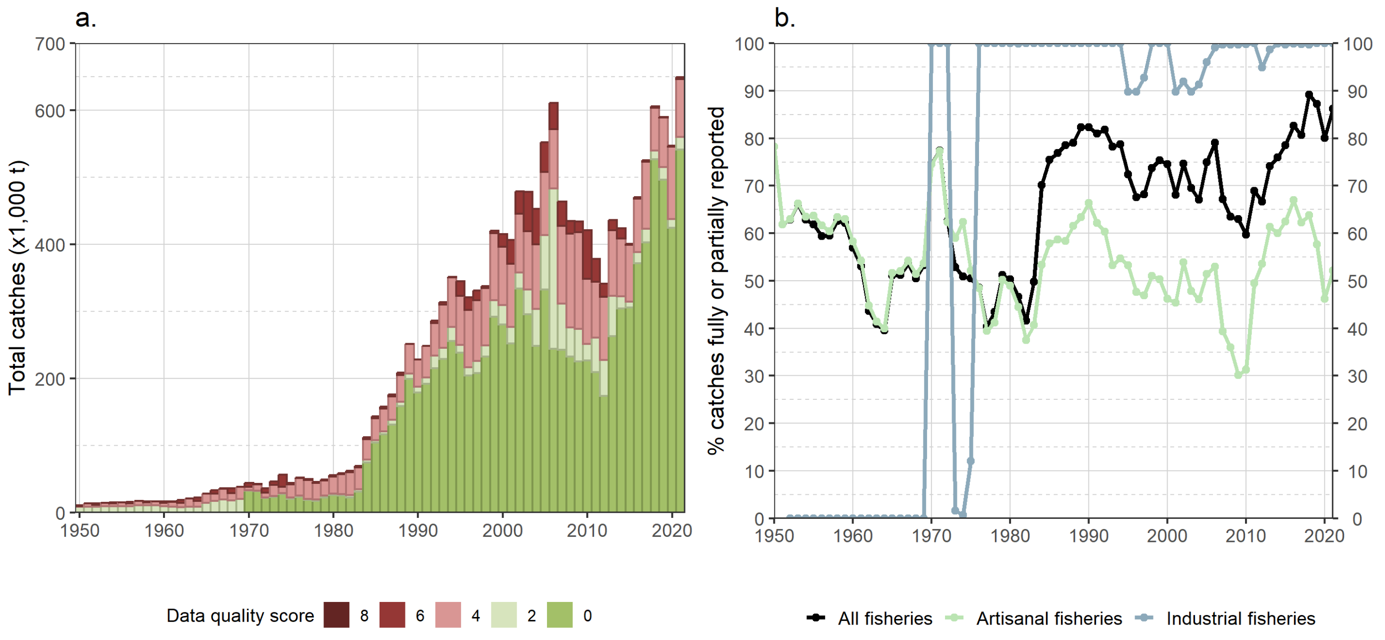

Figure 11: Annual retained catches (t) of skipjack tuna estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950-2021

Discard levels

The total amount of skipjack tuna discarded at sea remains unknown for most fisheries and time periods despite the obligation to report these data as per IOTC Res. 15/02. Furthermore, and except for very specific situations (i.e., the fish caught is considered unfit for human consumption or there is insufficient storage capacity following the final set of a trip), all tropical tunas caught with purse seine have to be retained onboard since 2018 (IOTC Res. 19/05).

Discarding of tropical tunas is thought to be small in coastal fisheries and negligible in baitboat fisheries (Miller et al. 2017). Besides, data collected by observers at sea have shown that the level of discarding of tropical tunas is low in the Indian Ocean purse seine fishery and discarding mostly occurs in schools associated with floating objects (Amandè et al. 2012). Purse seine discards of skipjack tuna are mainly composed of fish smaller than 50 cm (~5.7 kg), although a few larger fish may be discarded when damaged (**Fig. 12**). Estimates for the main component of the Indian Ocean purse seine fleet showed they amount to a few hundred tons annually (Ruiz et al. 2018).

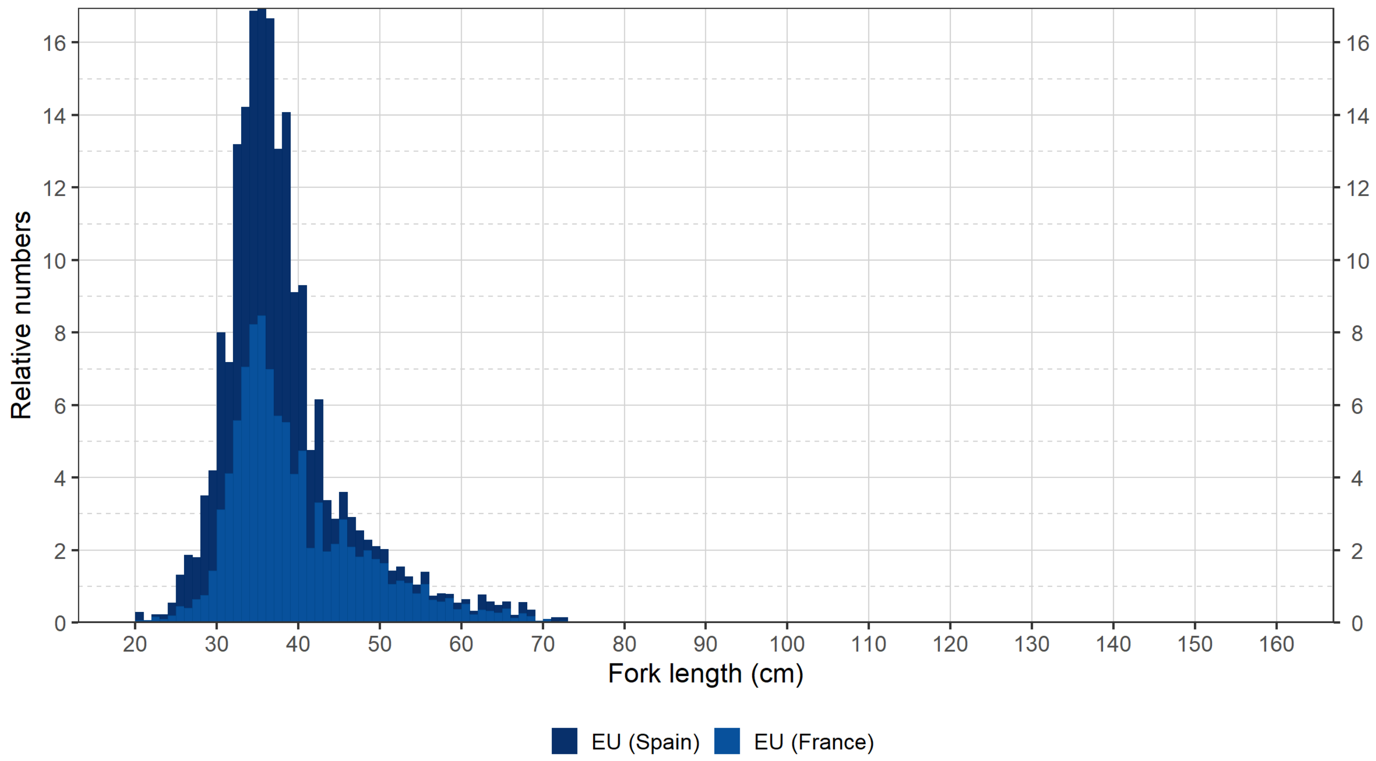

Figure 12: Fork length distribution of skipjack tuna discarded at sea in purse seine fisheries during the period 2016-2020 (n = 214,824). Data source: IOTC ROS database

Discarding may also occur in tropical longline fisheries, mainly due to depredation by sharks and cetaceans (Rabearisoa et al. 2018). In the Taiwan,China longline fishery, for instance, the discarding rate of skipjack tuna (which is a non-targeted species) has been estimated at 38.05% in the fleet targeting bigeye tuna during 2004-2008 (Huang & Liu 2010).

There is currently little information in the ROS database on discarding practices in longline fisheries except for a small sample of fish observed in French and Japanese longliners during 2014-2020. almost no discard of skipjack tuna from the Japanese longline, whereas the size of the skipjack tunas discarded at sea by the Reunion-based fresh longline fisheries are small (**Fig. 13**).

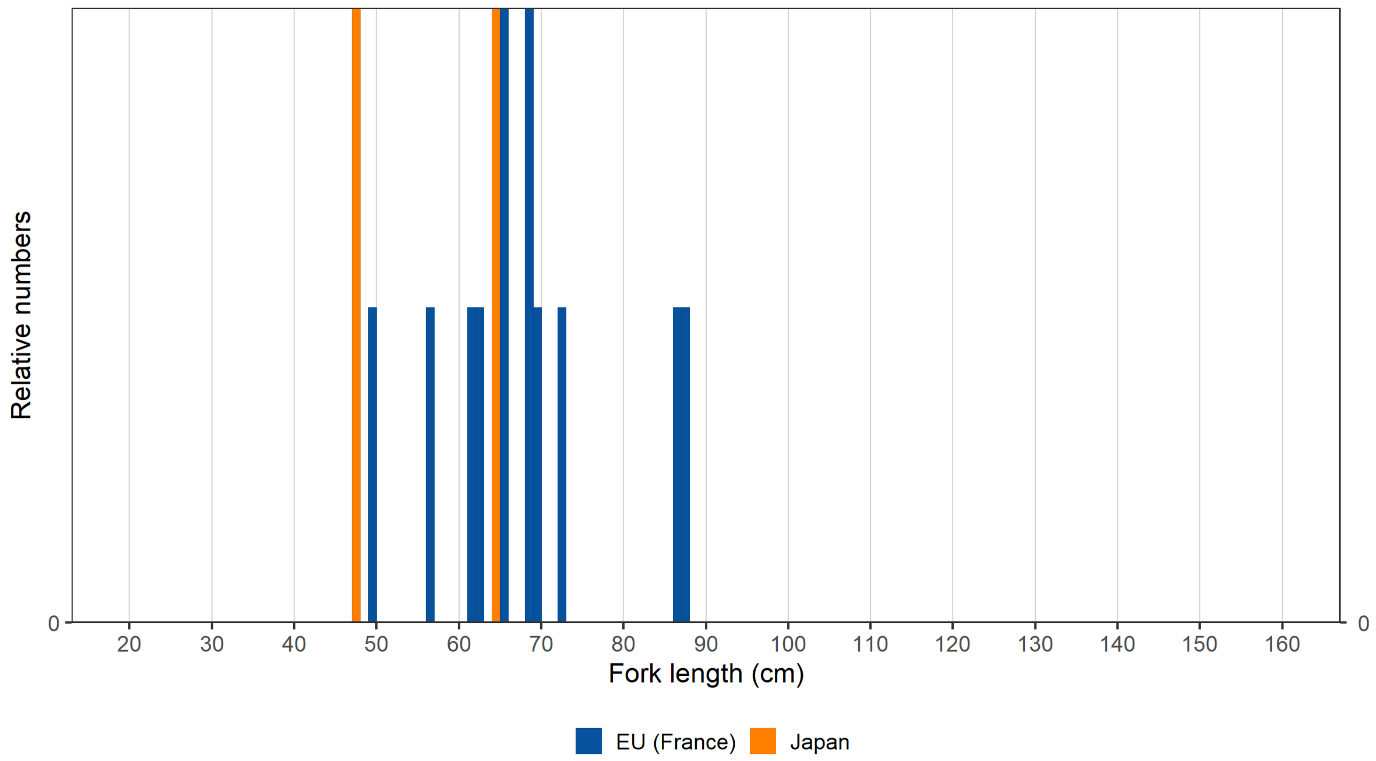

Figure 13: Fork length distribution of skipjack tuna discarded at sea in longline fisheries during the period 2014-2020 (n = 112). Data source: IOTC ROS database

Overall, more data on discards collected from observers at sea are required to better assess the extent and variability of discarding practices in Indian Ocean longline fisheries. The IOTC Secretariat acknowledges that several of the CPCs currently submitting ROS trip reports have all the information and the technical knowledge to provide the original scientific data in a format more suitable for incorporation in the ROS database, and therefore the Secretariat is seeking active collaboration from all concerned CPCs to ensure that new and historical ROS data could be properly submitted and used for further analysis.

Geo-referenced catch

Spatial distribution of catches

Estimated geo-referenced catches show the spatial expansion and major changes that took place in the fisheries targeting skipjack tuna over the last decades (**Fig. 14**). As early as the 1950s, skipjack tuna was caught by baitboat fisheries in Maldivian, Indian, and Sri Lankan waters, while coastal gillnet and line fisheries were active in the Northwest Indian Ocean, including the Arabian sea.

From the 1980s, with the development of the purse seine fishery in the western Indian Ocean, most of the skipjack tuna started to be caught on schools associated to floating objects. The available data also shows the development of gillnet and line fisheries in the Eastern Indian Ocean (**Fig. 14d**). During the 1990s and 2000s, the purse seine and baitboat fisheries increased catches and expanded their fishing grounds in the western Indian Ocean, while gillnet and line fishery developed further in the north-eastern Indian Ocean (**Fig. 14e-f**). The overall annual distribution of skipjack tuna catches by fishery has changed little over the period 2017-2021 (**Fig. 15**) with the only notable exception of industrial purse seine fisheries that expanded their fishing grounds toward the Arabian sea more consistently, possibly because of changes in fishing practices introduced by the Yellowfin tuna rebuilding plan (IOTC Res. 21/01).

Georeferenced catches by fishery and decade (1950-2009)

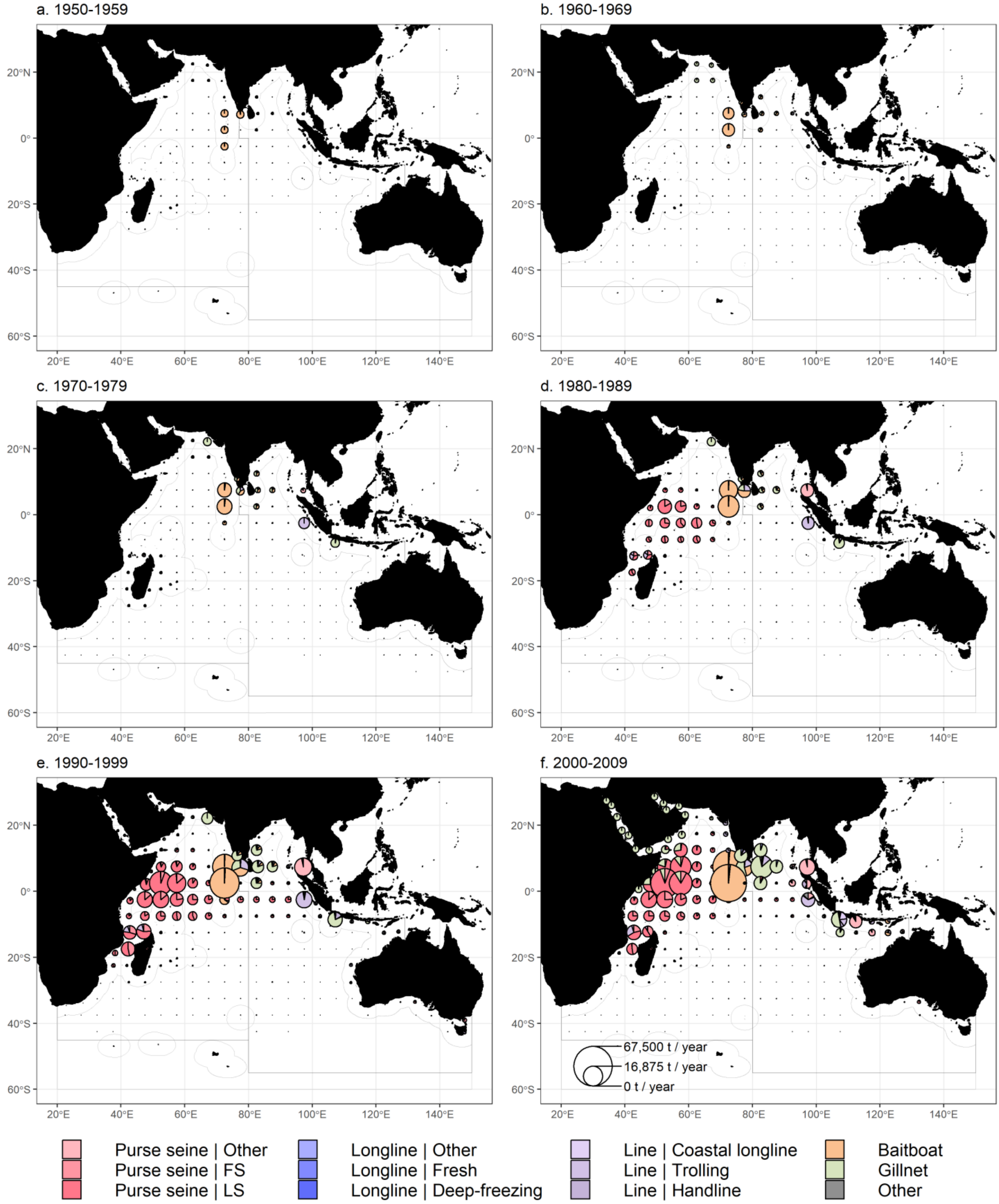

Figure 14: Estimated mean annual time-area catches (t) of skipjack tuna, by decade, 5x5 grid, and fishery. Data source: raised time-area catches

Georeferenced catches by fishery, last years (2017-2021) and decade (2010-2019)

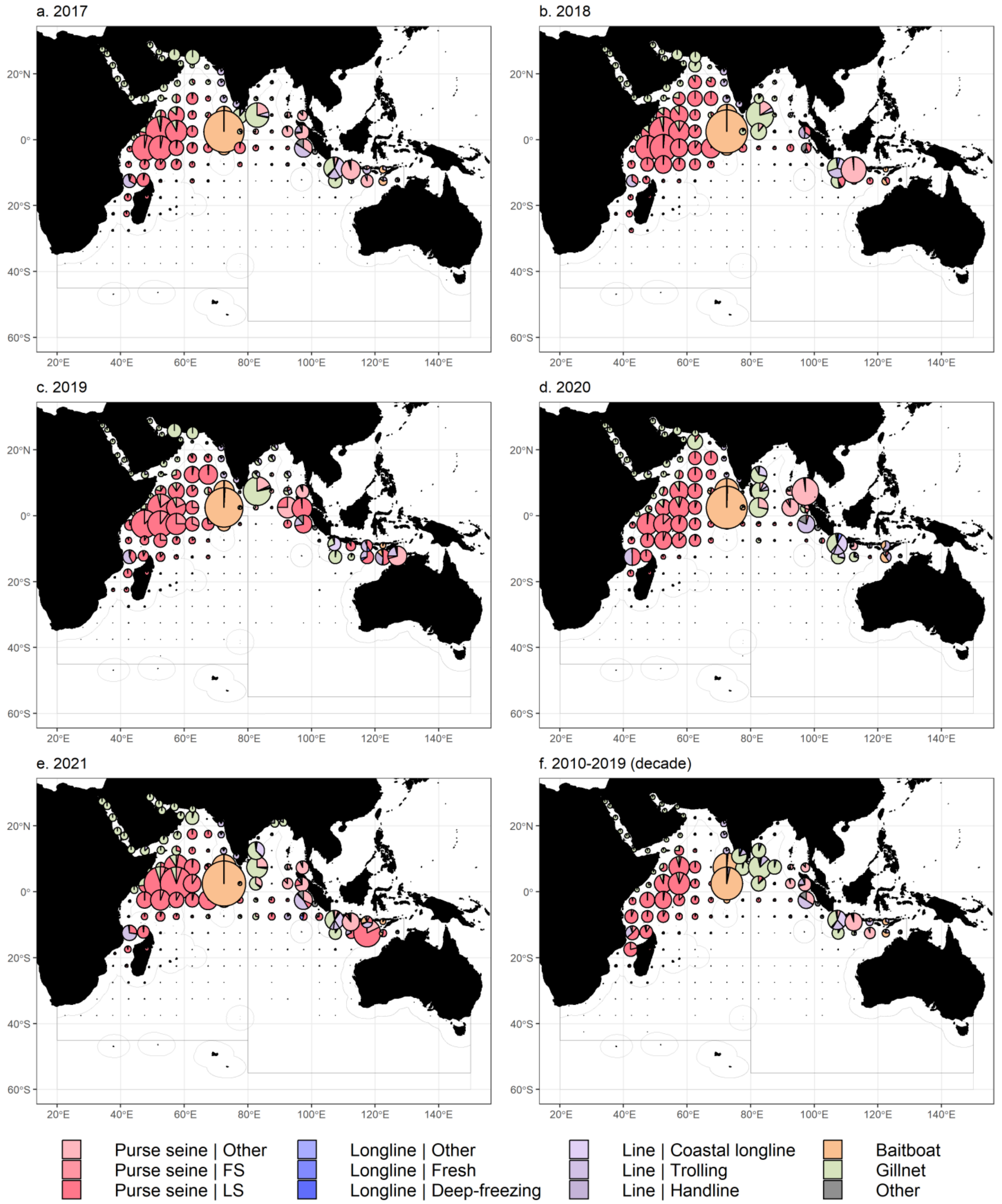

Figure 15: Estimated average annual time-area catches (t) of skipjack tuna, by year / decade, 5x5 grid, and fishery. Data source: raised time-area catches

Recent data from Indonesia (2018 and following years) suggest the development of an industrial purse seine fishery (**Fig. 15d-e**) which mainly operates in coastal areas of the eastern Indian Ocean with vessels of length overall (LOA) between 30 and 40 m. Indonesia confirmed that such industrial purse seine fishery was indeed operating prior to 2018, and that the lack of information in that timeframe is to be attributed to long standing issues with the categorization of the fleet with respect to the IOTC criteria, which are in the process of being resolved. Baitboat fishing is essentially concentrated in the Maldives archipelago, while gillnet fisheries are widely used along the coasts of India, Sri Lanka, Indonesia, and in the Arabian sea. Line fisheries, on the other hand, are catching skipjack tuna mainly in the Sumatra area.

Uncertainties in catch and effort data

Catch and effort series are available for most industrial fisheries and some important artisanal fisheries. However, for many artisanal fisheries these data are either not available or considered to be of poor quality. Consequently, the trend in the quality of the catch and effort data is driven to some extent by the relative contribution of artisanal fisheries to the total catches of skipjack tuna (**Fig. 16b**).

The main issues identified in the past concern:

- purse seine and other fisheries of Indonesia, with data only available from 2018 onward (although logbook coverage is thought to be low);
- the purse seine fisheries of I.R. Iran (until 2004) for which data are either incomplete or lacking;
- the fisheries of Sri Lanka (since 2014), described by poor quality effort data;
- some coastal fisheries for which no data (or incomplete data) have been reported to the Secretariat, in particular: Comoros (until 2018), Indonesia (2018 and 2020), India, Tanzania, and Pakistan (no catch).

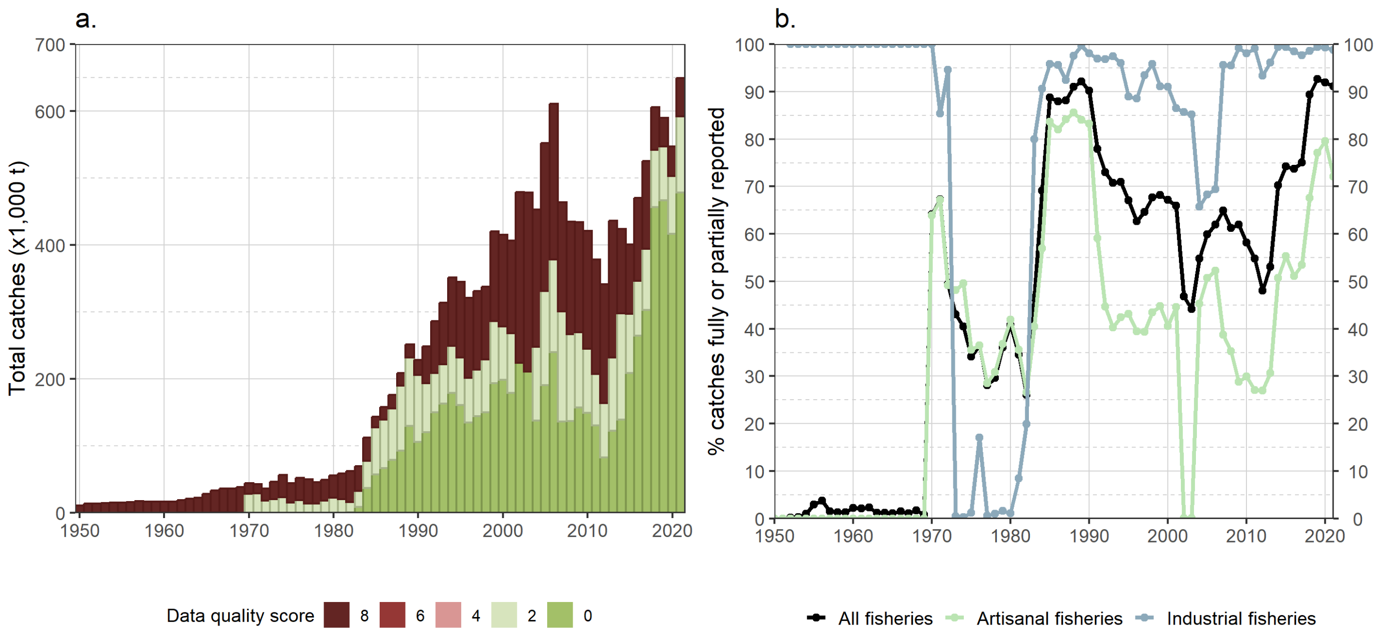

Figure 16: Annual retained catches (t) of skipjack tuna estimated by quality score (barplot) and percentage of geo-referenced catches reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950-2021

The percentage of data considered of good quality (scores of 0-2) varied between 44%-90% during the 1990s and 2000s, and improved over the last decade showing an overall increasing trend from 48% in 2012 to 93% in 2019, with a slight decline to 91% in 2021 (**Fig. 16a-b**). Catch and effort data have progressively become available for some important coastal fisheries, such as those from Sri Lanka since 2014, I.R. Iran since 2007, and Indonesia since 2018.

Nevertheless, geo-referenced catch and effort data were unavailable for about 9% (i.e., around 60,000 t) of the total nominal catches of skipjack tuna in 2021. In addition, no spatial information has been provided by the industrial purse seine fishery of EU,Italy (since 2016), which in 2021 accounts for relatively low total catch levels of skipjack tuna of ~5,400 t.

Size composition of the catch

Samples availability

By fishery group

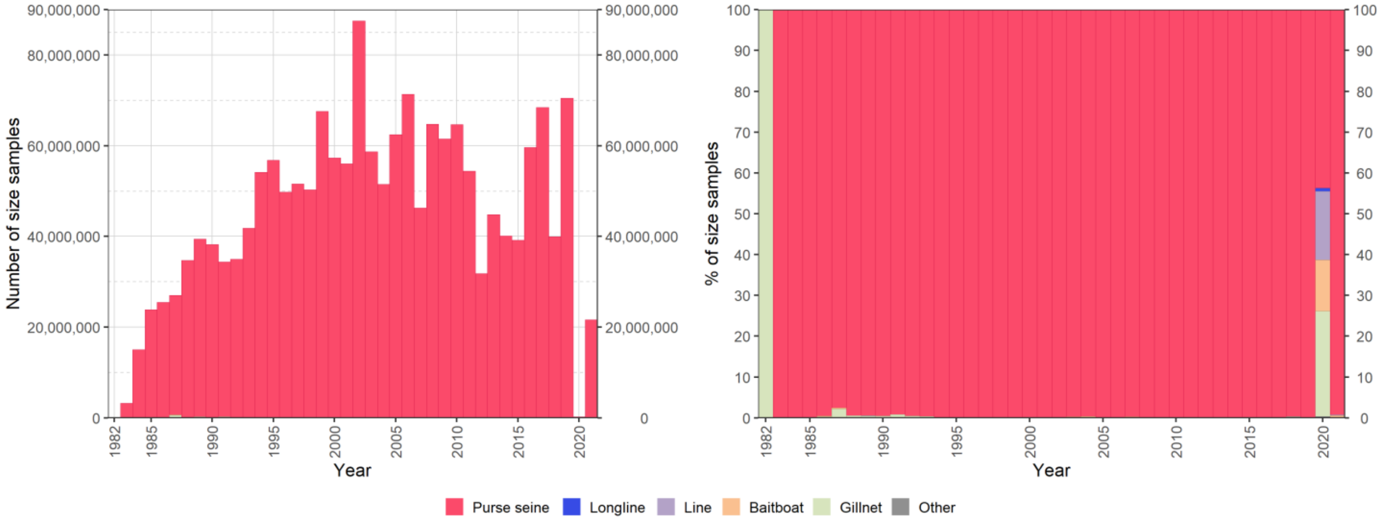

Figure 17: Availability of skipjack tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset (Res. 15/02)

Comprehensive size-frequency data for skipjack tuna are only available from the beginning of the 1980s (see also Uncertainties in size-frequency data).

Most of the samples available to the IOTC Secretariat have been collected since the development of the purse seine fishery in the Indian Ocean and reported as *raised* samples (i.e., processed at the source to represent *catch-at-size* for the fleets and years concerned). This explains the magnitude of the samples available from these fisheries, which at its peak reached over 30 million individual lengths reported for a single year (**Fig. 17**).

The contribution of other fisheries to the total available samples for the species is insignificant, and does not reflect the actual level of catches from these fisheries. (**Fig. 28**).

Due to the CoViD-19 pandemic, size-frequency data of skipjack tuna collected by purse seine fisheries are basically unavailable for 2020, if not for a very limited number of individuals sampled by EU,France, Mauritius, and Seychelles.

The spatial distribution of the available samples by fishery type in the last five years (**Fig. 18**) is generally representative of the fishing grounds where the fisheries operate and proportional to the level of recorded captures.

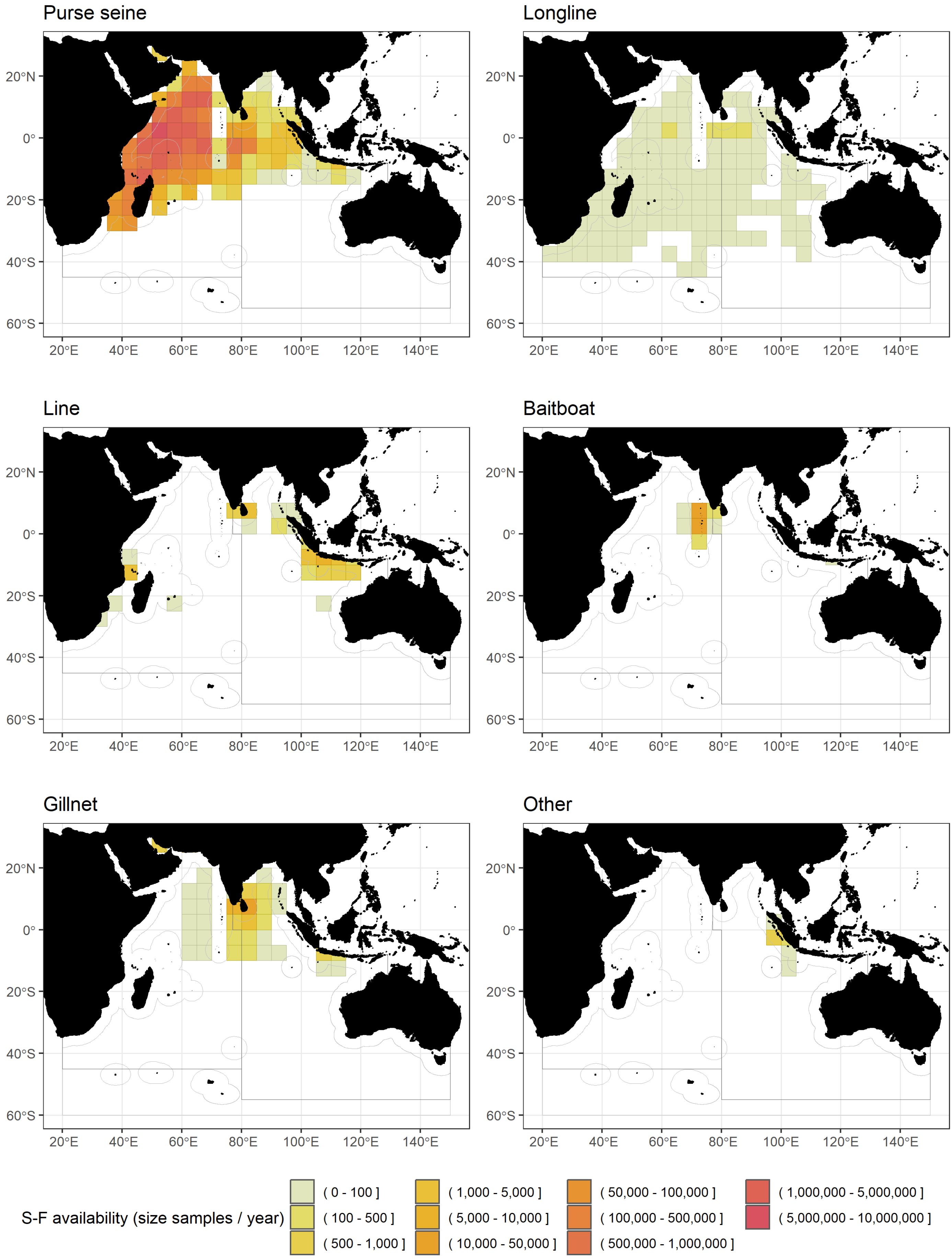

Figure 18: Spatial distribution (average number of samples per grid per year) of available skipjack tuna size-frequency data for each fishery group in the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

By fishery

Purse seine fisheries

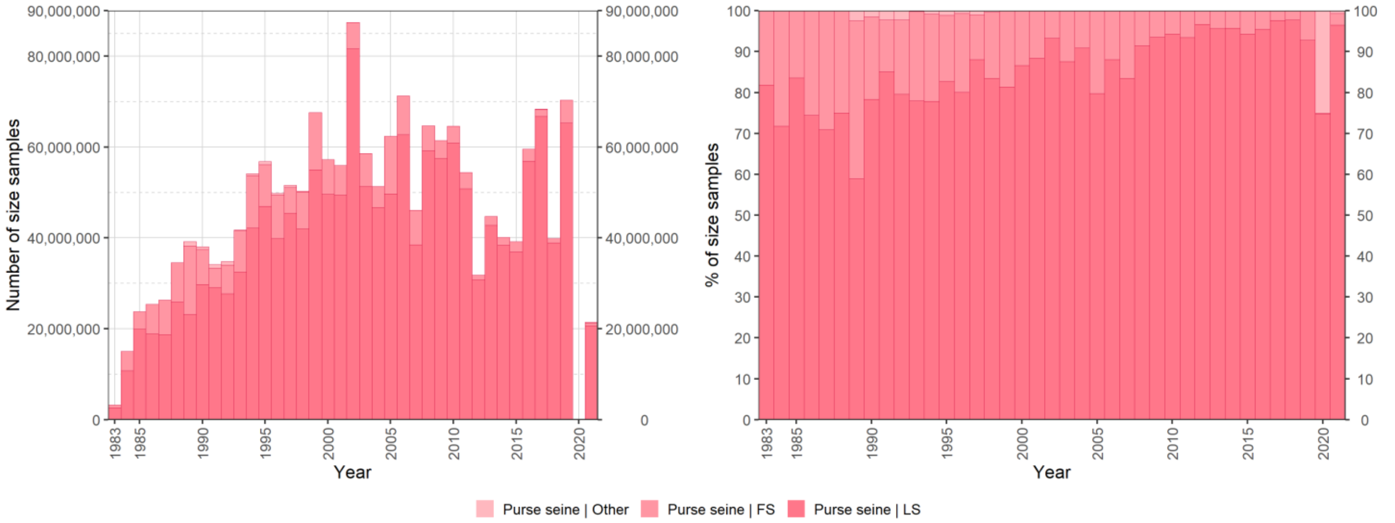

Figure 19: Availability of skipjack tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and purse seine fishery type. Data source: standardized size-frequency dataset (Res. 15/02)

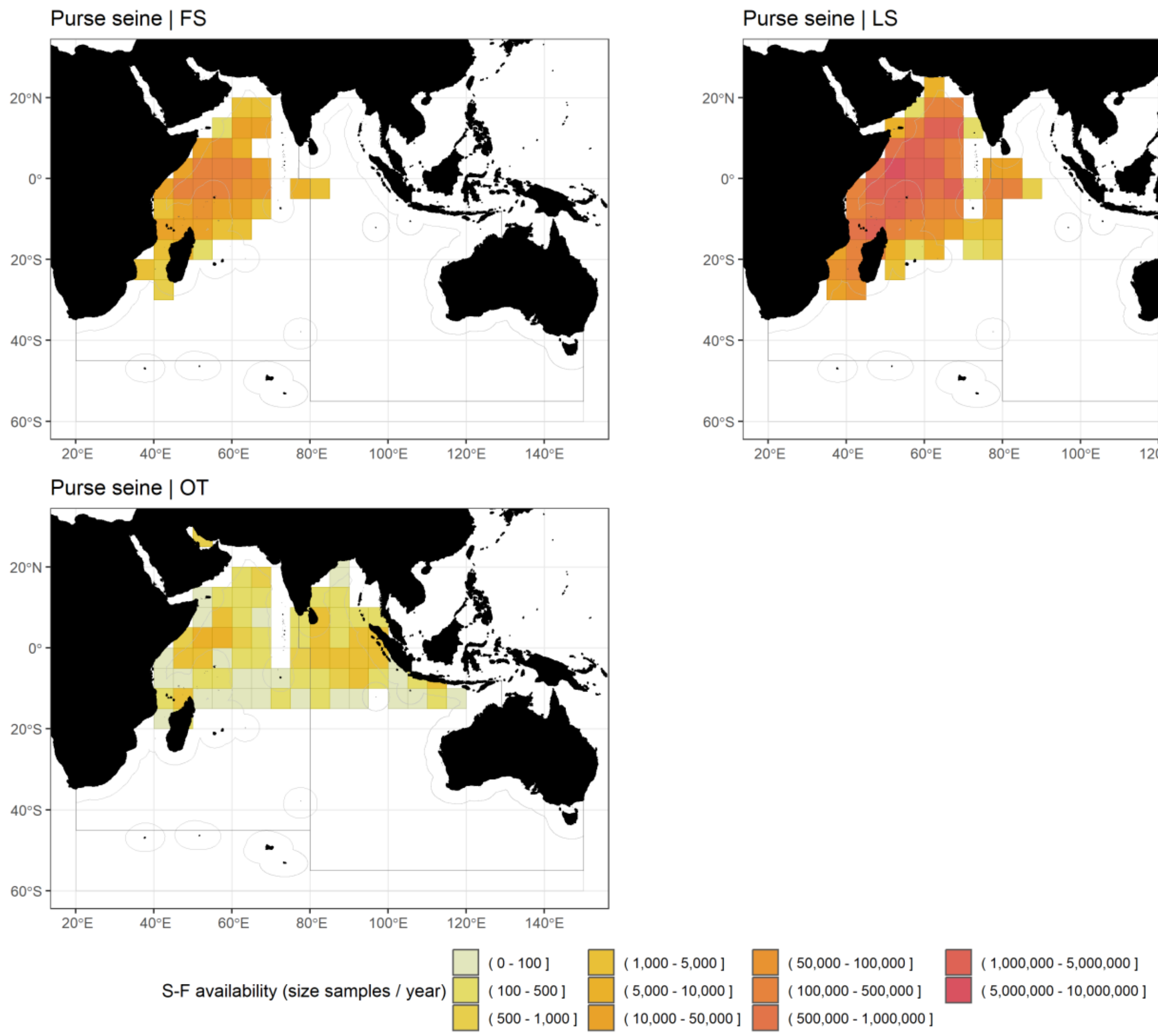

Figure 20: Spatial distribution (average number of samples per grid per year) of available skipjack tuna size-frequency data by purse seine fishery types in the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

Longline fisheries

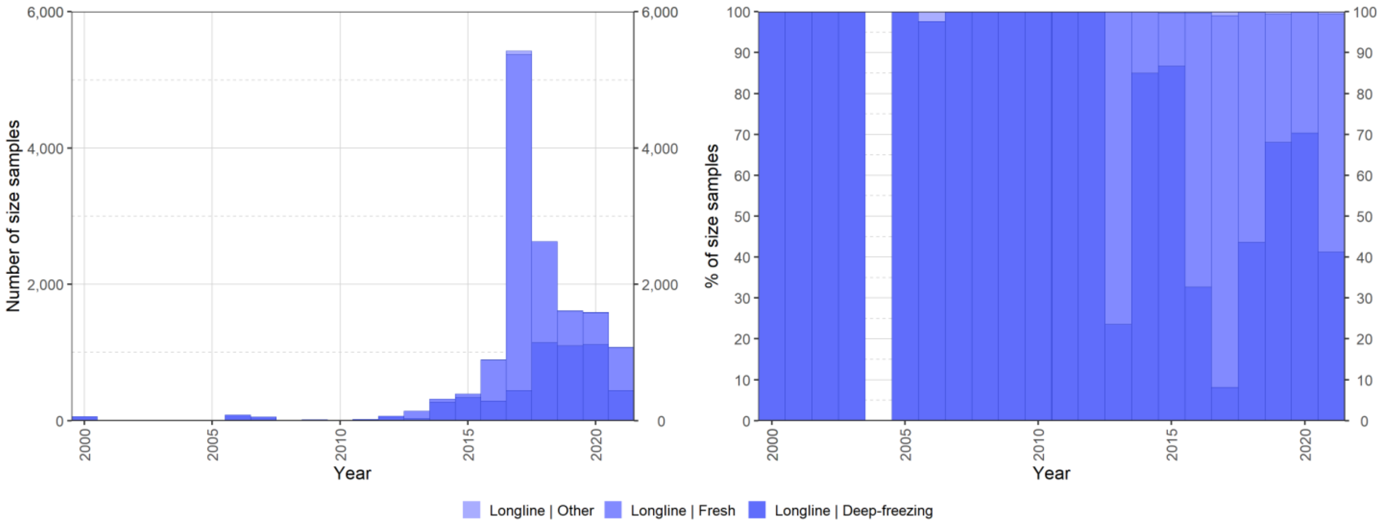

Figure 21: Availability of skipjack tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and longline fishery type. Data source: [standardized size-frequency dataset] (Res. 15/02)

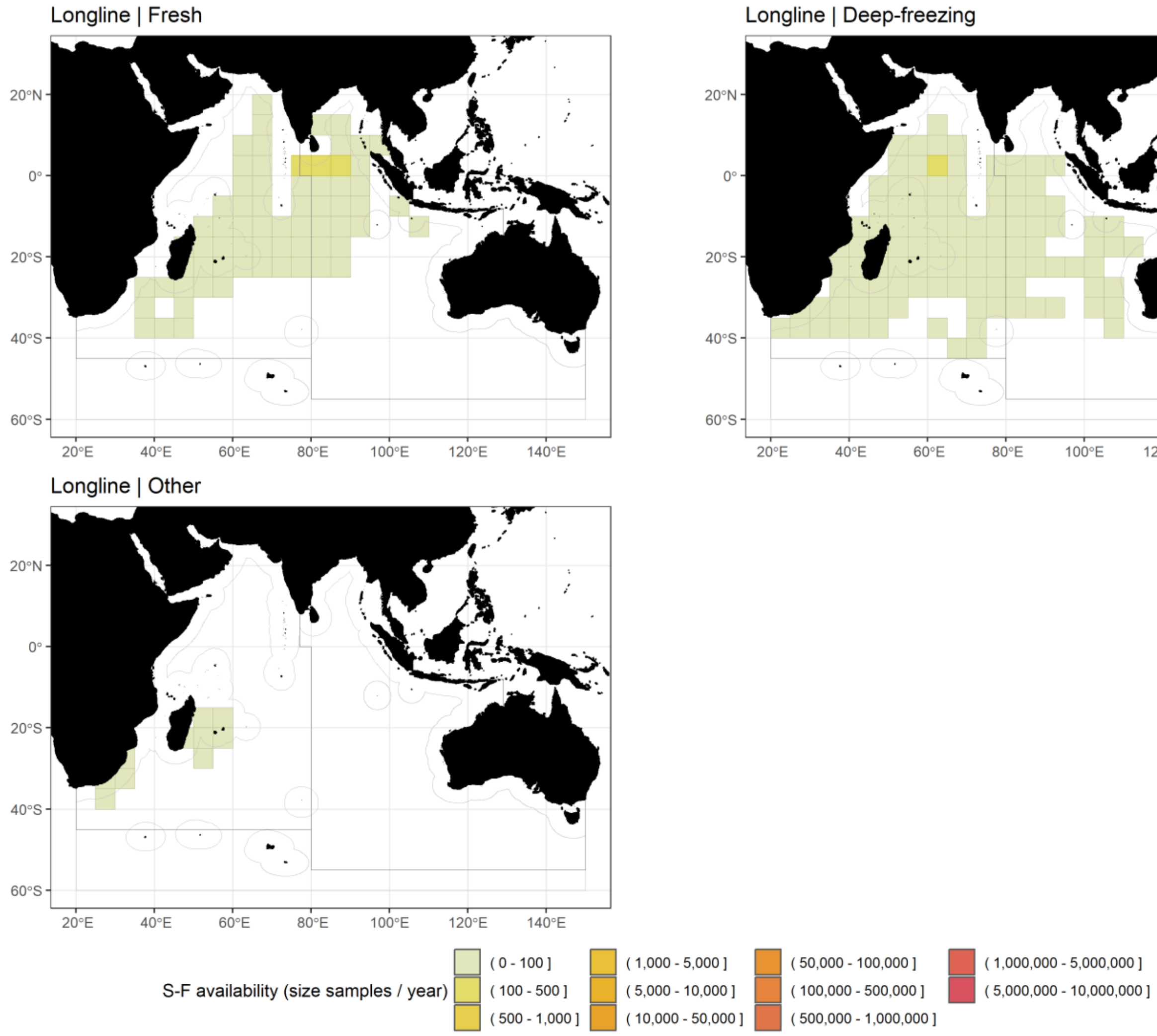

Figure 22: Spatial distribution (average number of samples per grid per year) of available skipjack tuna size-frequency data by longline fishery types in the period 2017-2021. Data source: [standardized size-frequency dataset] (Res. 15/02)

Line fisheries

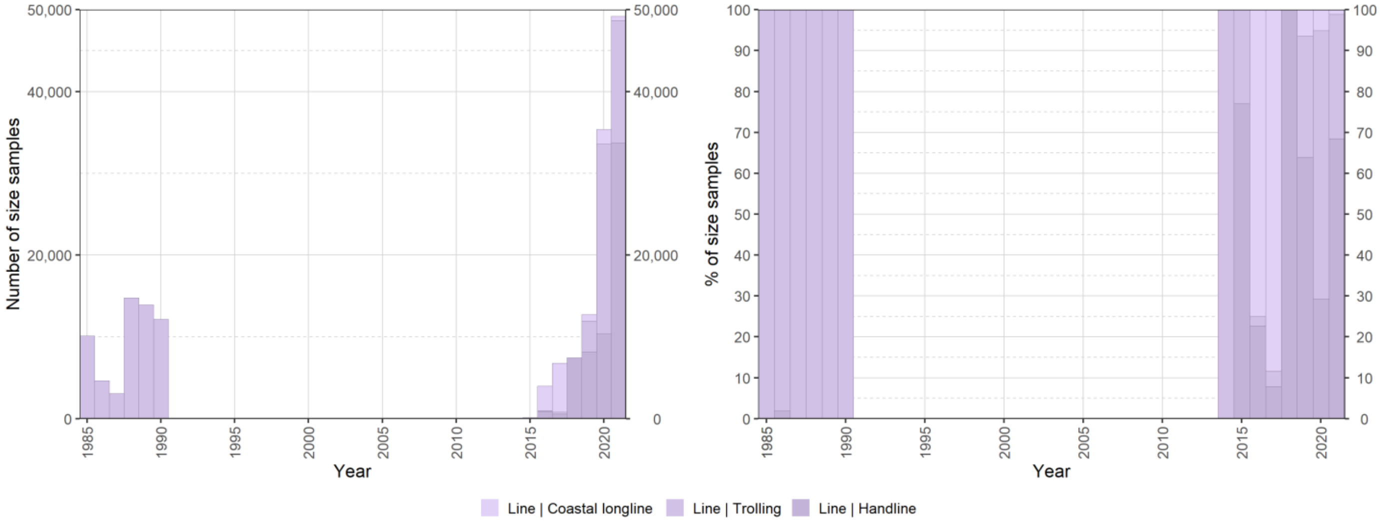

Figure 23: Availability of skipjack tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: standardized size-frequency dataset (Res. 15/02)

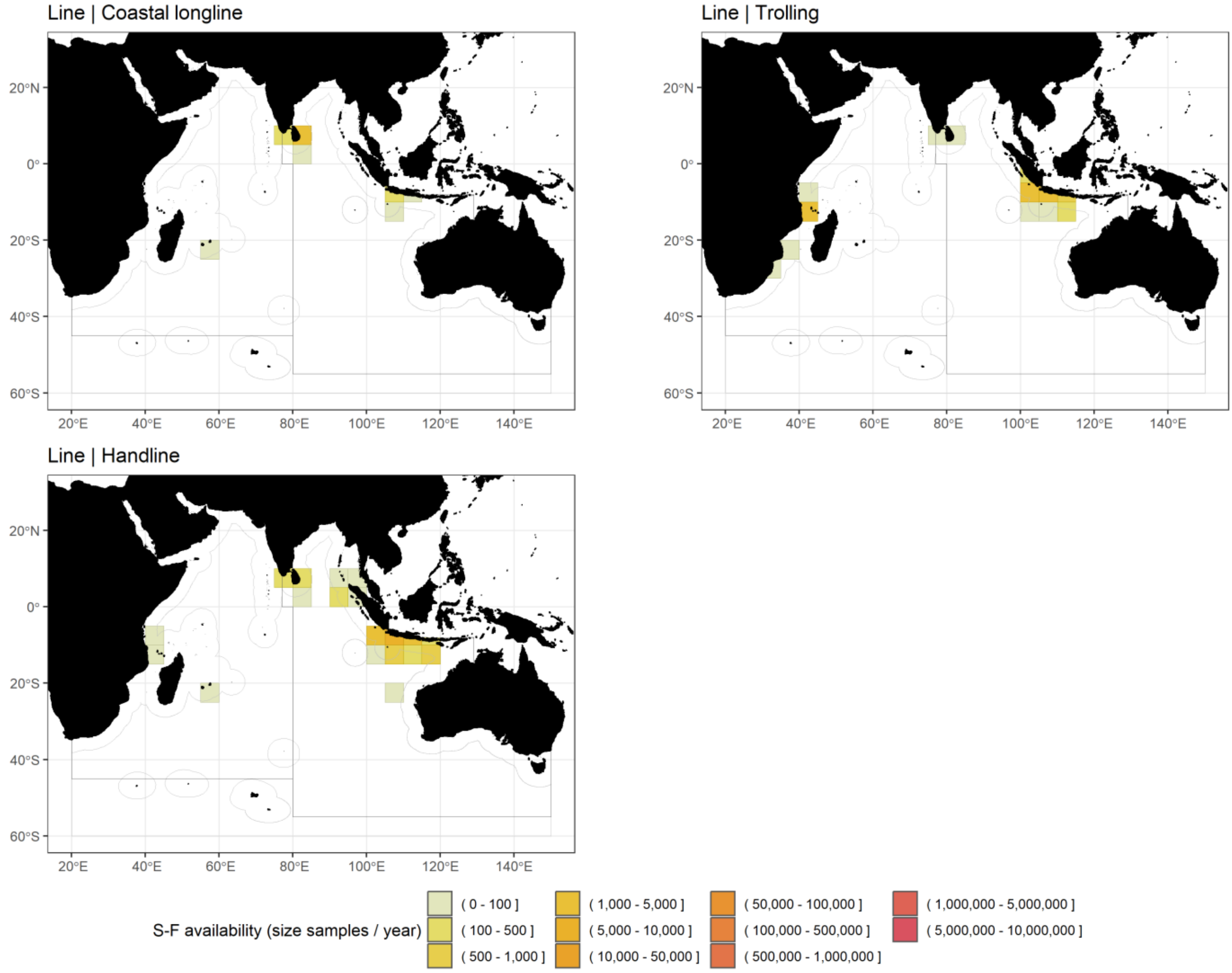

Figure 24: Spatial distribution (average number of samples per grid per year) of available skipjack tuna size-frequency data by line fishery types in the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

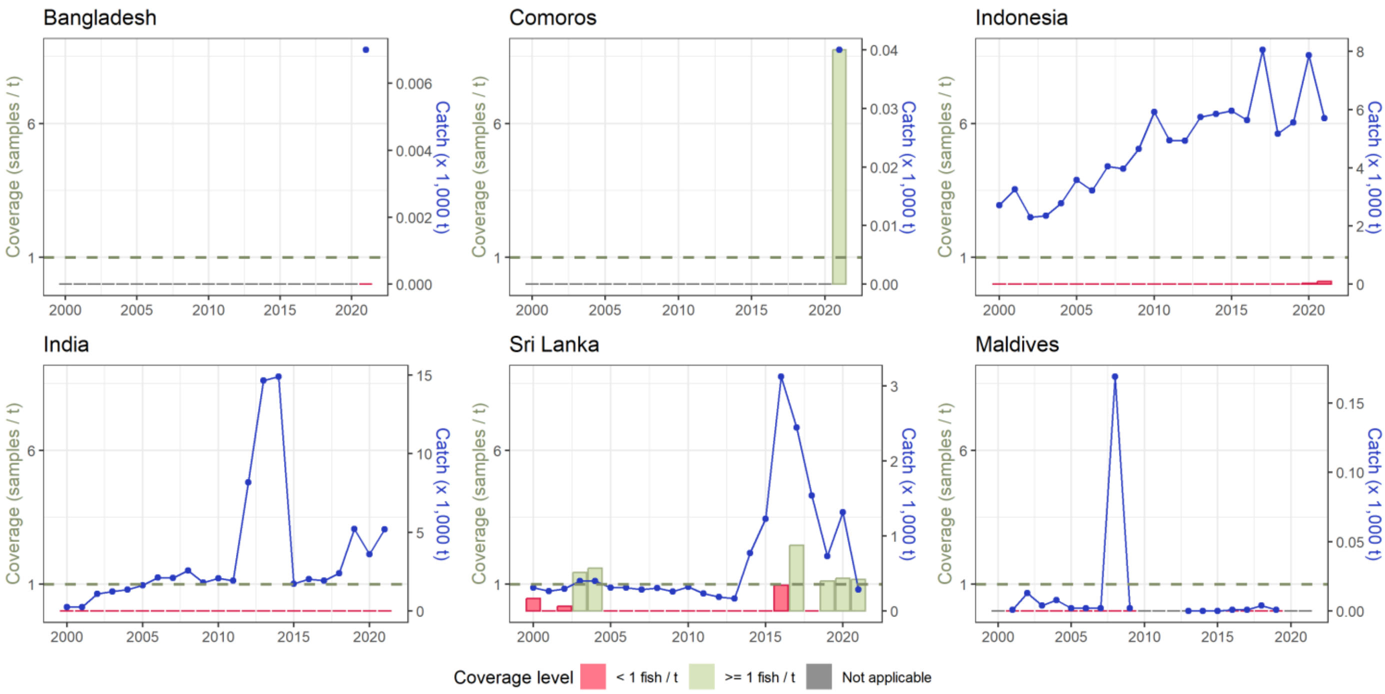

Figure 25: Size-frequency samples coverage (number of fish measured by t of retained catches) of skipjack tuna caught by the major coastal longline fleets, by fleet and year (2000-2021). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

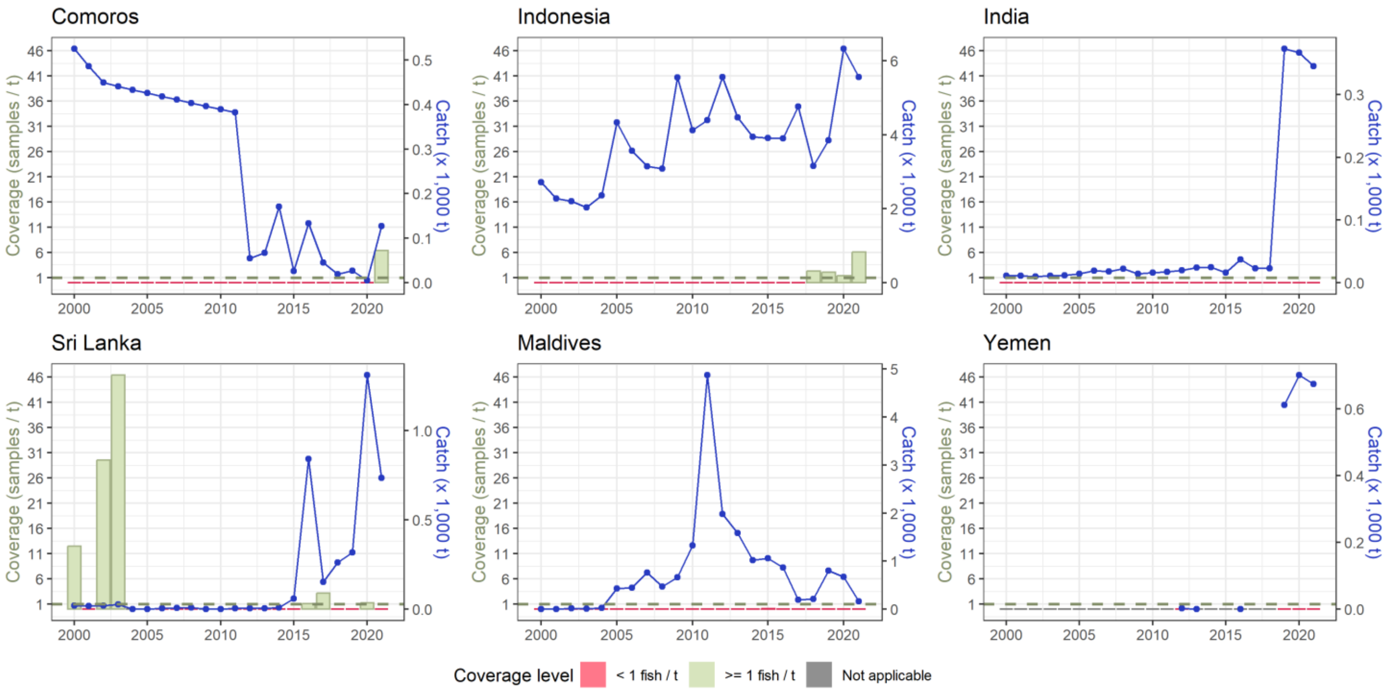

Figure 26: Size-frequency samples coverage (number of fish measured by t of retained catches) of skipjack tuna caught by the major handline fleets, by fleet and year (2000-2021). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

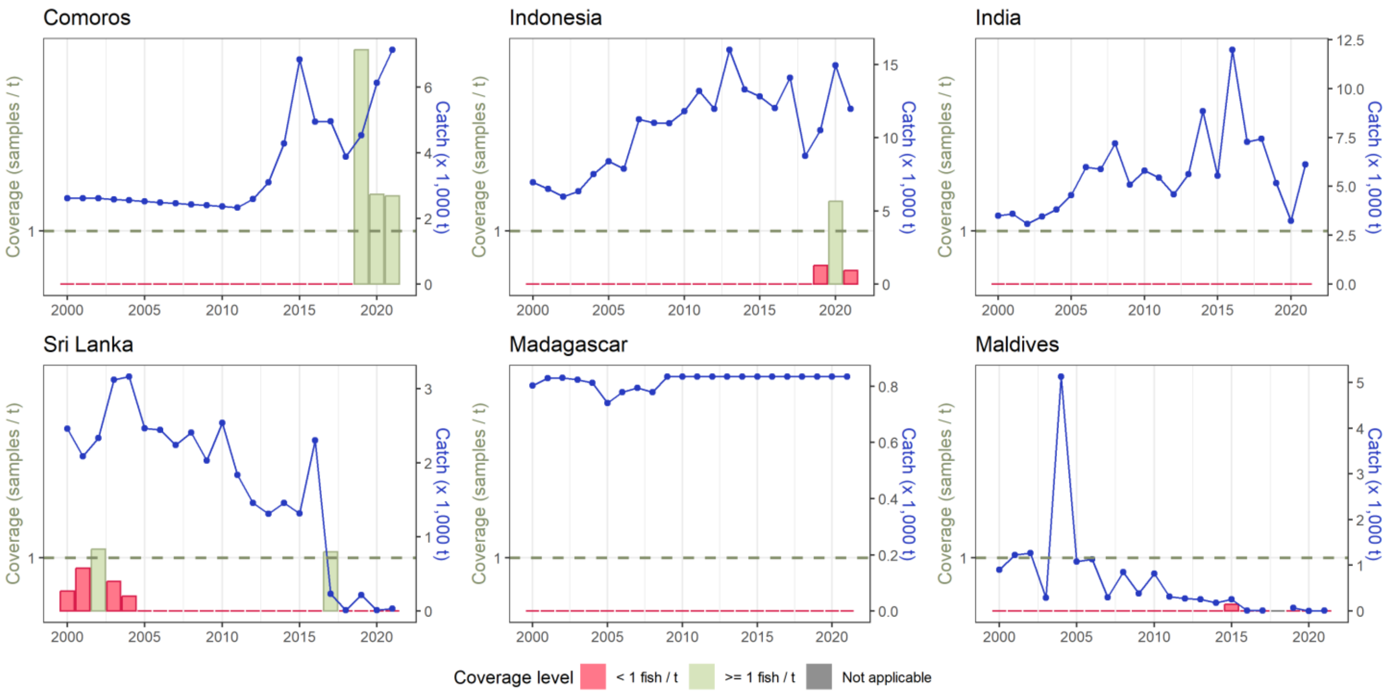

Figure 27: Size-frequency samples coverage (number of fish measured by t of retained catches) of skipjack tuna caught by the major trolling fleets, by fleet and year (2000-2021). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Other fisheries

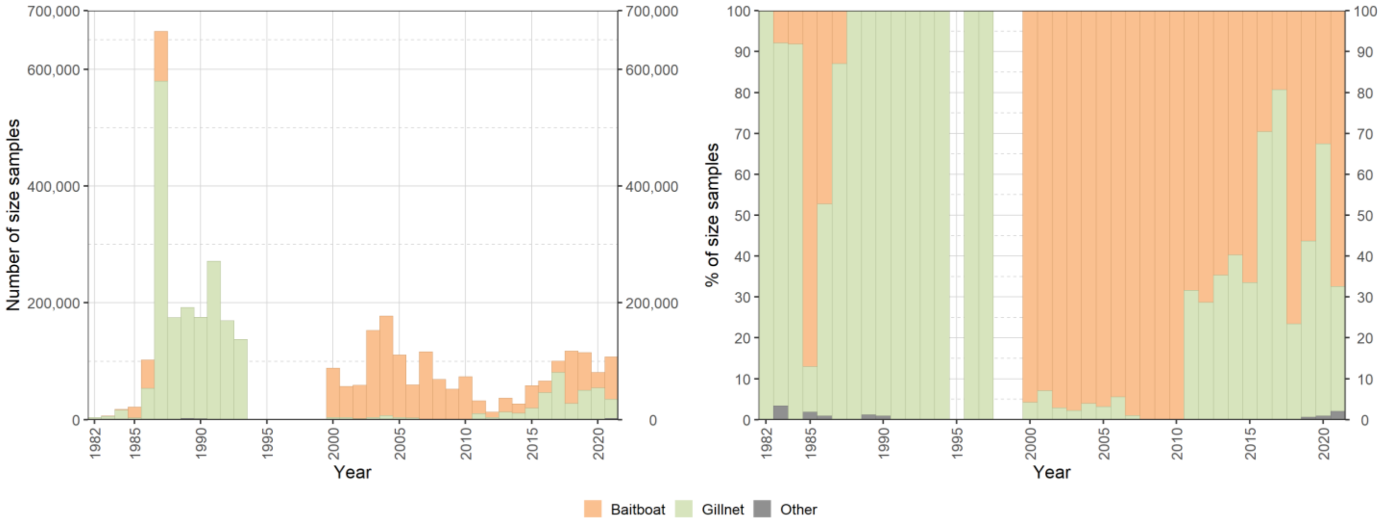

Figure 28: Availability of skipjack tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and all other fishery types. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

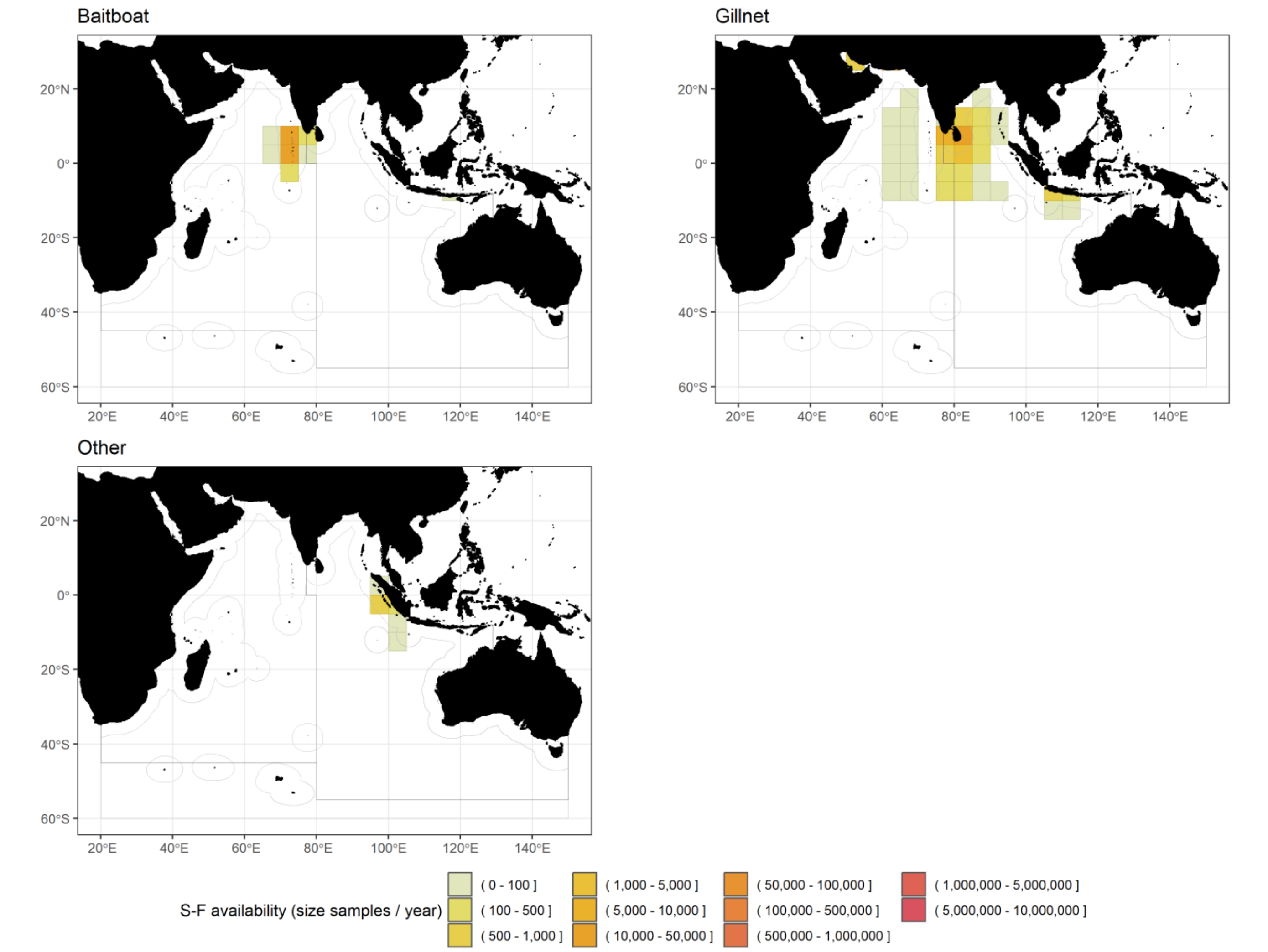

Figure 29: Spatial distribution (average number of samples per grid per year) of available skipjack tuna size-frequency data by all other fishery types in the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

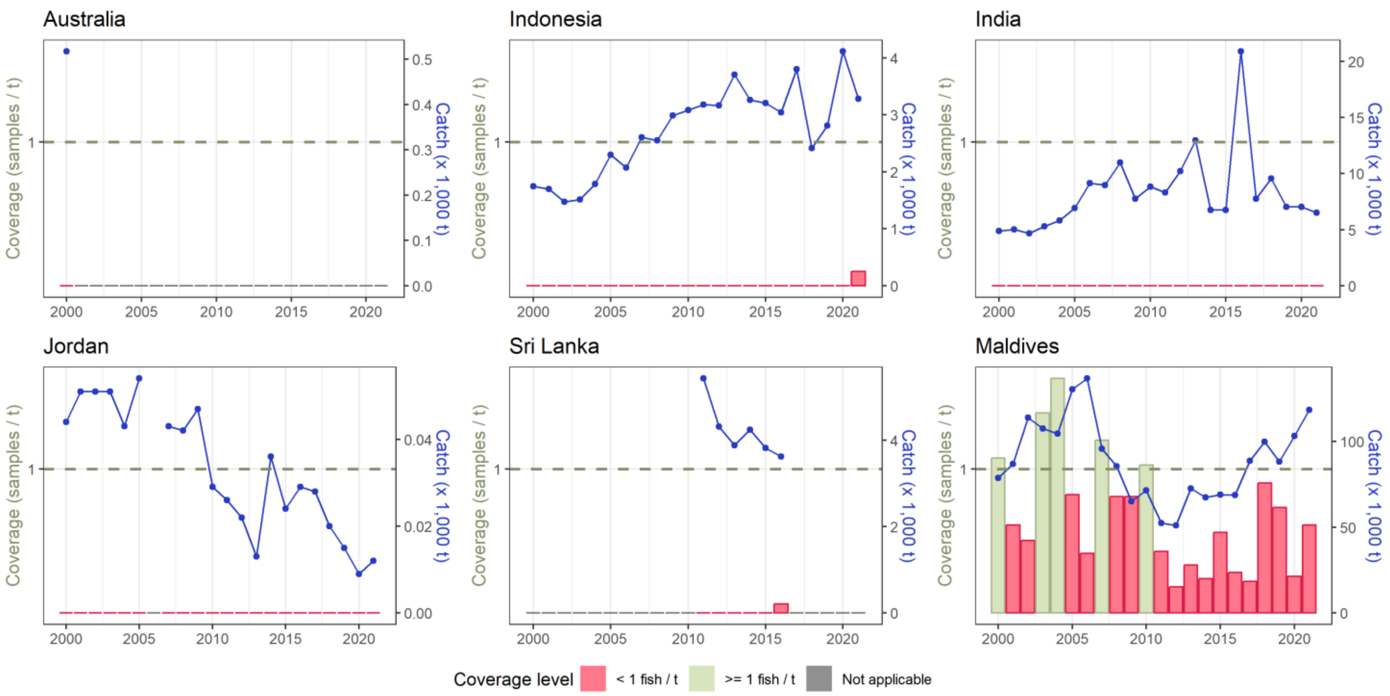

Figure 30: Size-frequency samples coverage (number of fish measured by t of retained catches) of skipjack tuna caught by the major baitboat fleets, by fleet and year (2000-2021). Data source: standardized size-frequency dataset (Res. 15/02)

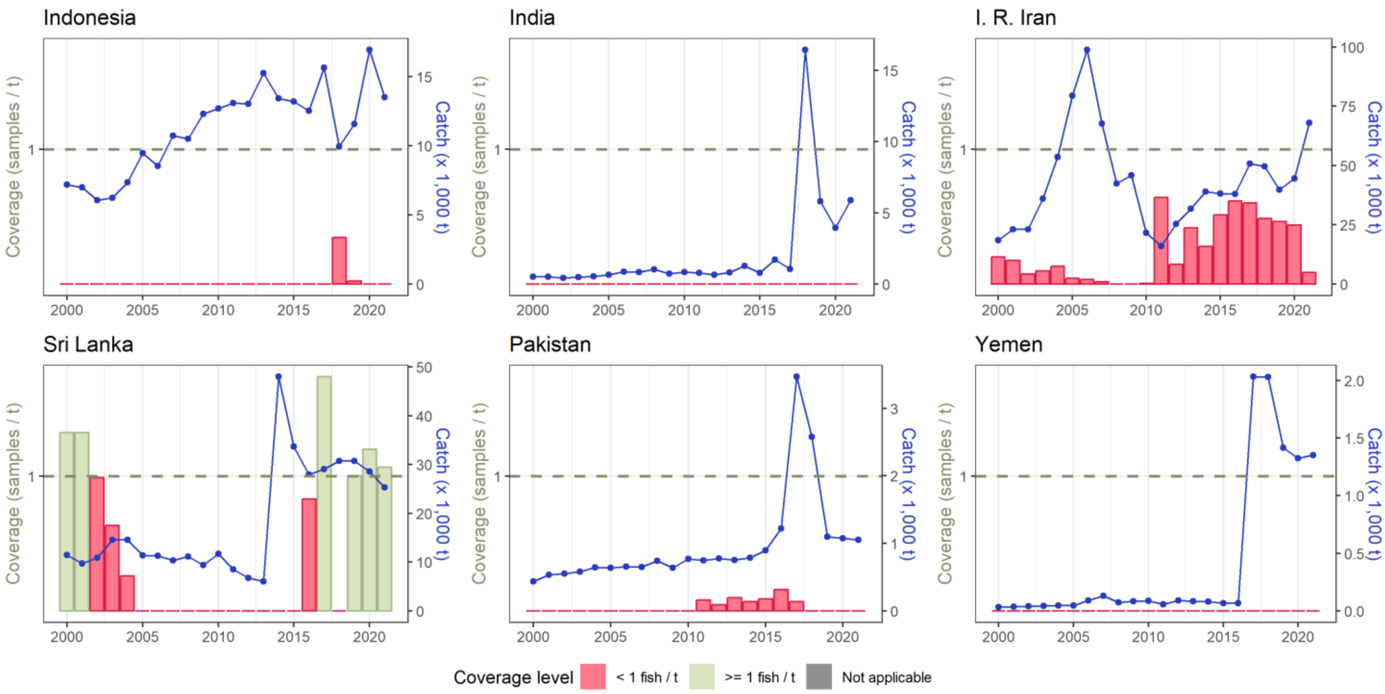

Figure 31: Size-frequency samples coverage (number of fish measured by t of retained catches) of skipjack tuna caught by the major gillnet fleets, by fleet and year (2000-2021). Data source: standardized size-frequency dataset (Res. 15/02)

Sampling levels reached by all other Indian Ocean fisheries are generally low, and in some cases (e.g., gillnet, handline, and baitboat fisheries) they might reflect the limited level of interactions with the species. Among all fisheries and fleets concerned, only Sri Lankan, Maldivian, Iranian, and Indonesian fisheries appear to be reasonably sampled in recent years. Baitboat and gillnet fisheries, which are considered as the most relevant among all artisanal fisheries catching skipjack tuna, are instead very limited in terms of coverage levels and sample availability. It could also be possible that the limited availability of samples (which in the case of small-scale fisheries are to be recorded at the landing sites) reflects well known issues in the ability of identifying the species, with smaller individuals that might have been reported as other smaller tuna species instead.

Temporal patterns and trends in size distributions

Industrial purse seine fisheries

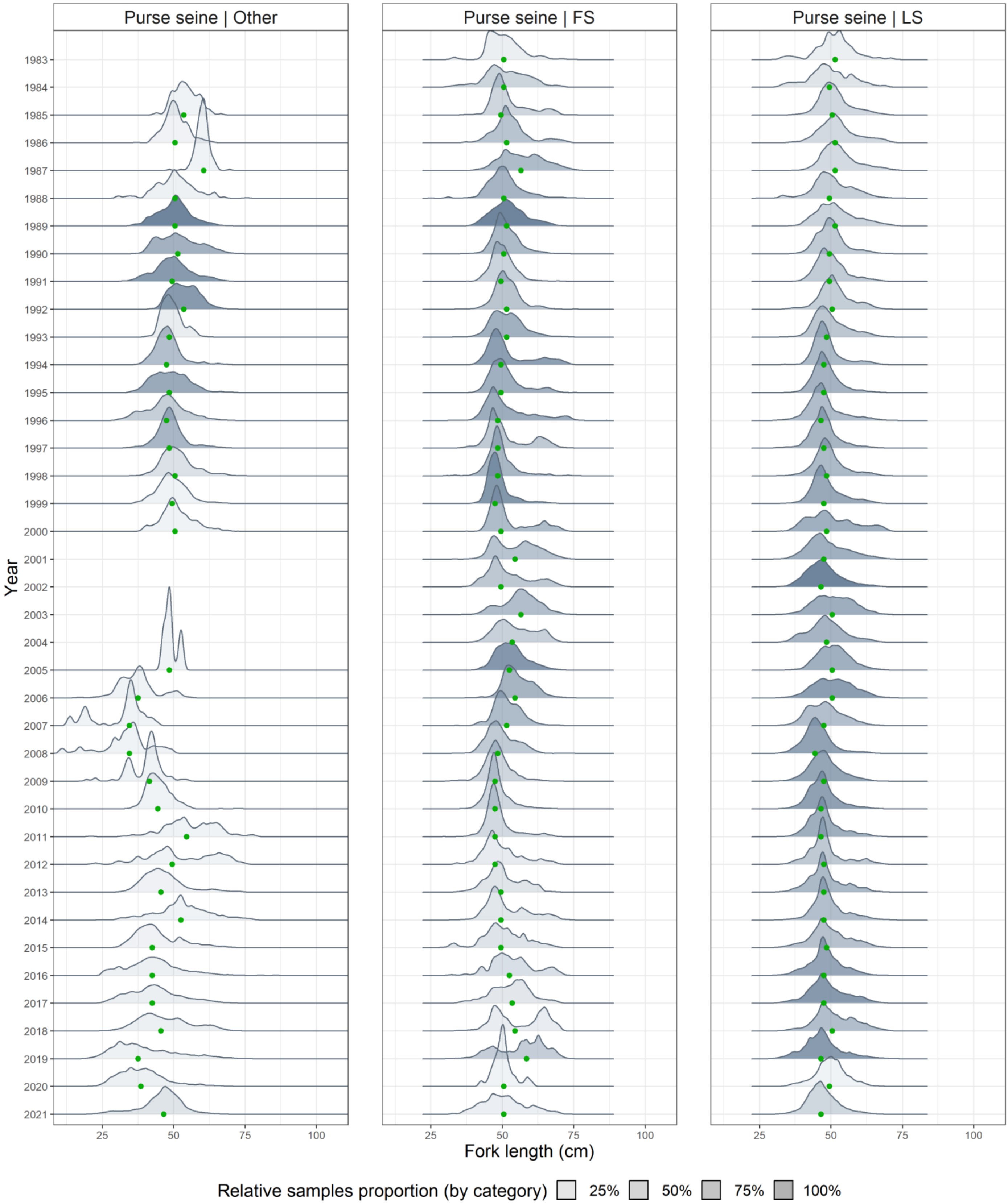

Figure 32: Relative size distribution (fork length in 2 cm size bins) of skipjack tuna caught by all purse seine fleets for the period 1983-2021. Other = no information provided on the school association; FS = free-swimming schools; LS = schools associated with floating objects. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset (Res. 15/02)

Coastal fisheries

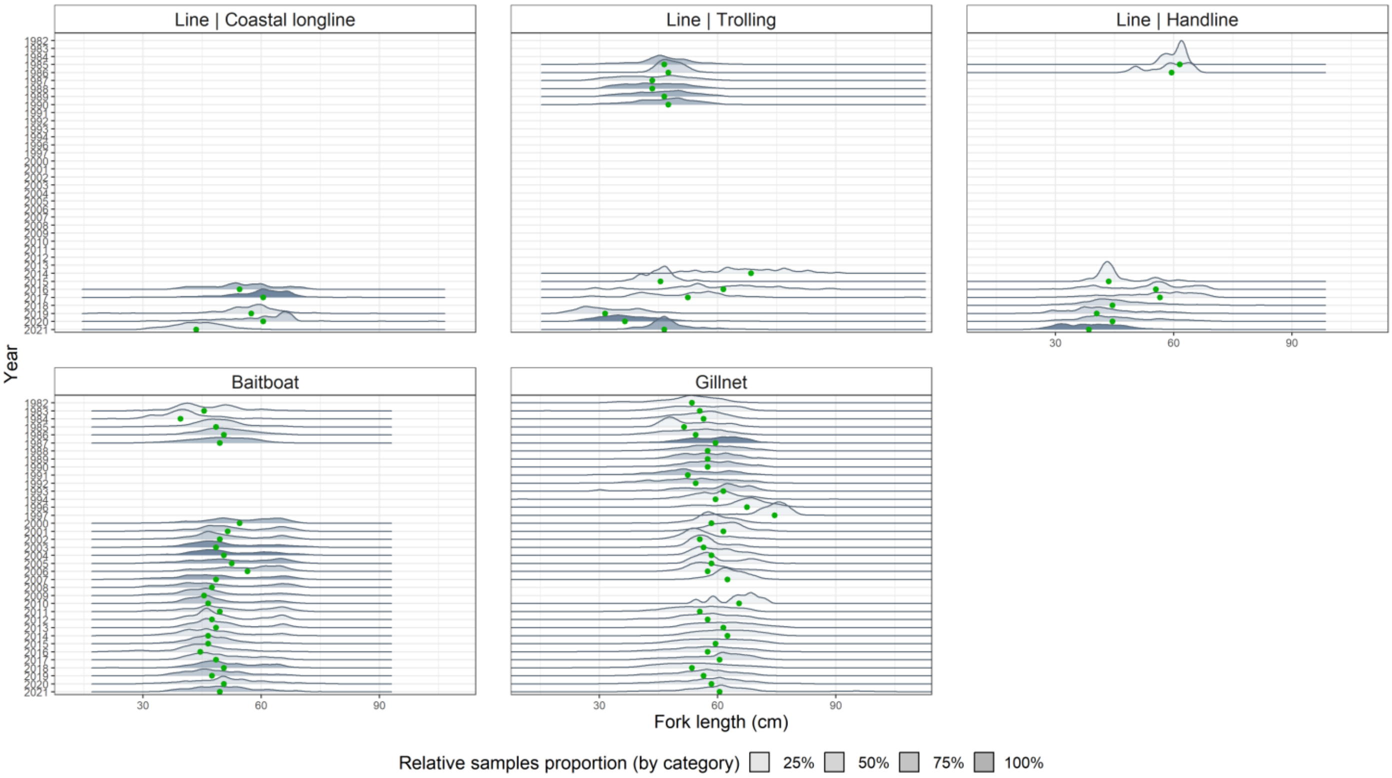

Figure 33: Relative size distribution (fork length in 2 cm size bins) of skipjack tuna caught by all coastal fisheries for the period 1983-2021. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset (Res. 15/02)

Baitboat fisheries

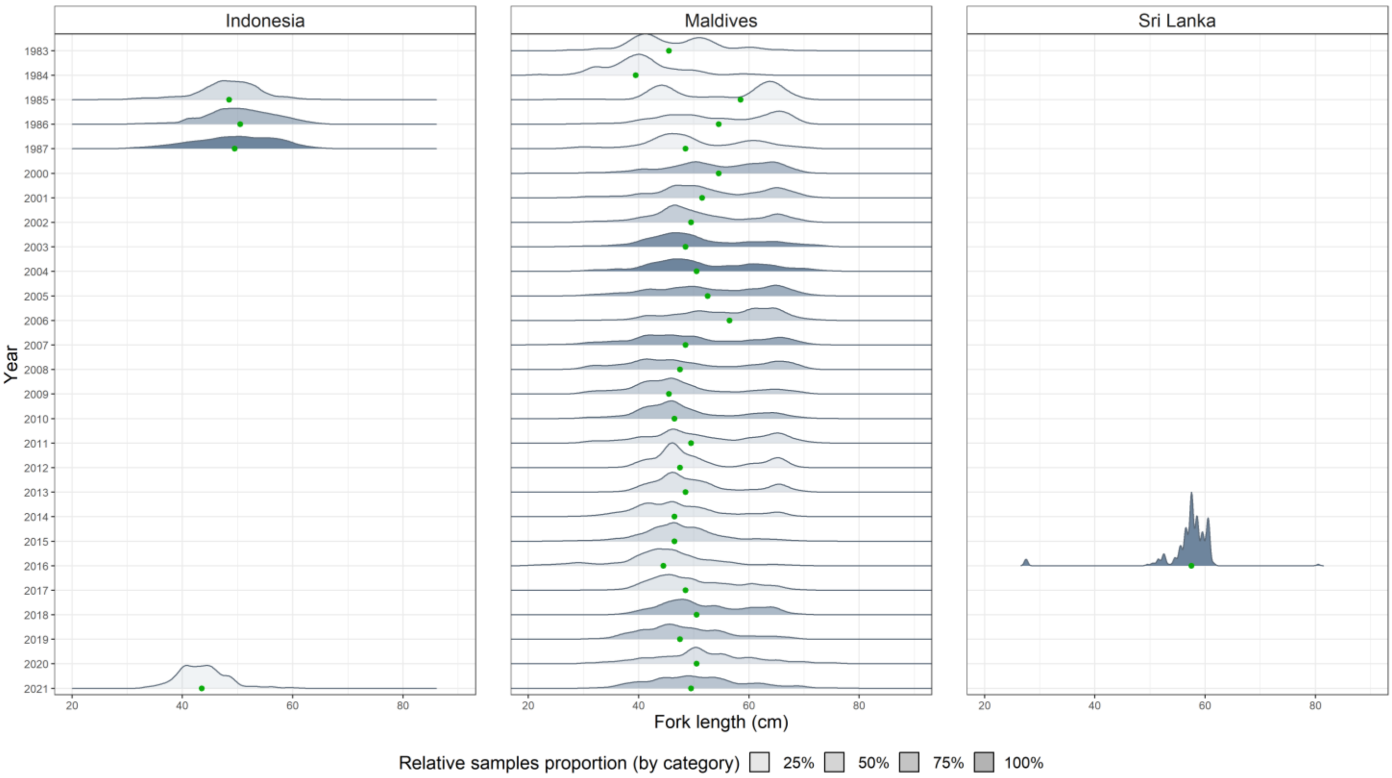

Figure 34: Relative size distribution (fork length in 2 cm size bins) of skipjack tuna caught by baitboat fleets for the period 1983-2021. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset (Res. 15/02)

Gillnet fisheries

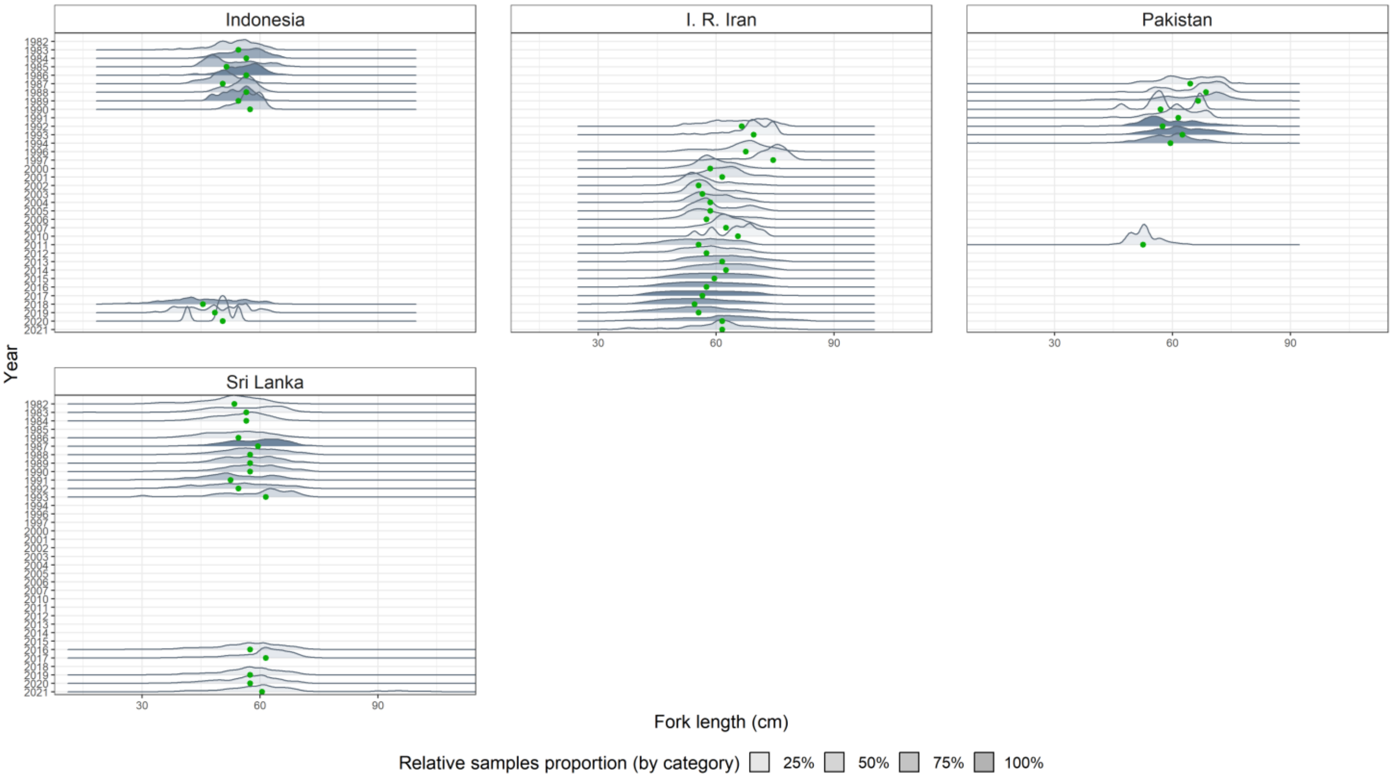

Figure 35: Relative size distribution (fork length in 2 cm size bins) of skipjack tuna caught by gillnet fleets for the period 1983-2021. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset (Res. 15/02)

Temporal trends in estimated average weights

Trends in average weights of skipjack tuna can be derived from the raised time-area catches in weight and numbers. While they can be estimated for the entire time series and for each fishery, due to the lack of original samples for several strata (especially in the early periods of the fisheries) they are considered accurate only for those periods for which actual samples are available and cover strata that correspond to at least 50 t of retained catches per year.

Considering the limitations in the original data and in the process that produces this estimation, it shall be noted that the average weights calculated for the log associated and free school component of the purse seine fisheries are relatively stable and fluctuate at around 2-4kg and 3-5 kg respectively (**Fig. 37**). Other purse seine fisheries operating in the Indian Ocean, on the contrary, shows marked fluctuations with a higher estimated average weight of 4.5 kg in the 1980s, which declined to 0.8 kg in 2021 (lower than the estimated average for all fisheries combined, which in 2021 was estimated at 2.1 kg).

In fact, the overall estimated trend in average weights for all fisheries (**Fig. 37 - 'All fisheries'**) decreases as average weights are stable for most fisheries, if not for the drastic decline from purse seine other than the industrial ones (**Fig. 37 - 'Purse seine | OT'**).

Trends in average weight for all other fisheries (baitboat, gillnet and all other gears) are more challenging to assess due to their inherently artisanal nature, which in turn implies a lower number of available samples and with a lower quality compared to those provided by the industrial fleets (which are recorded through logbooks or collected by scientific observers, in several cases).

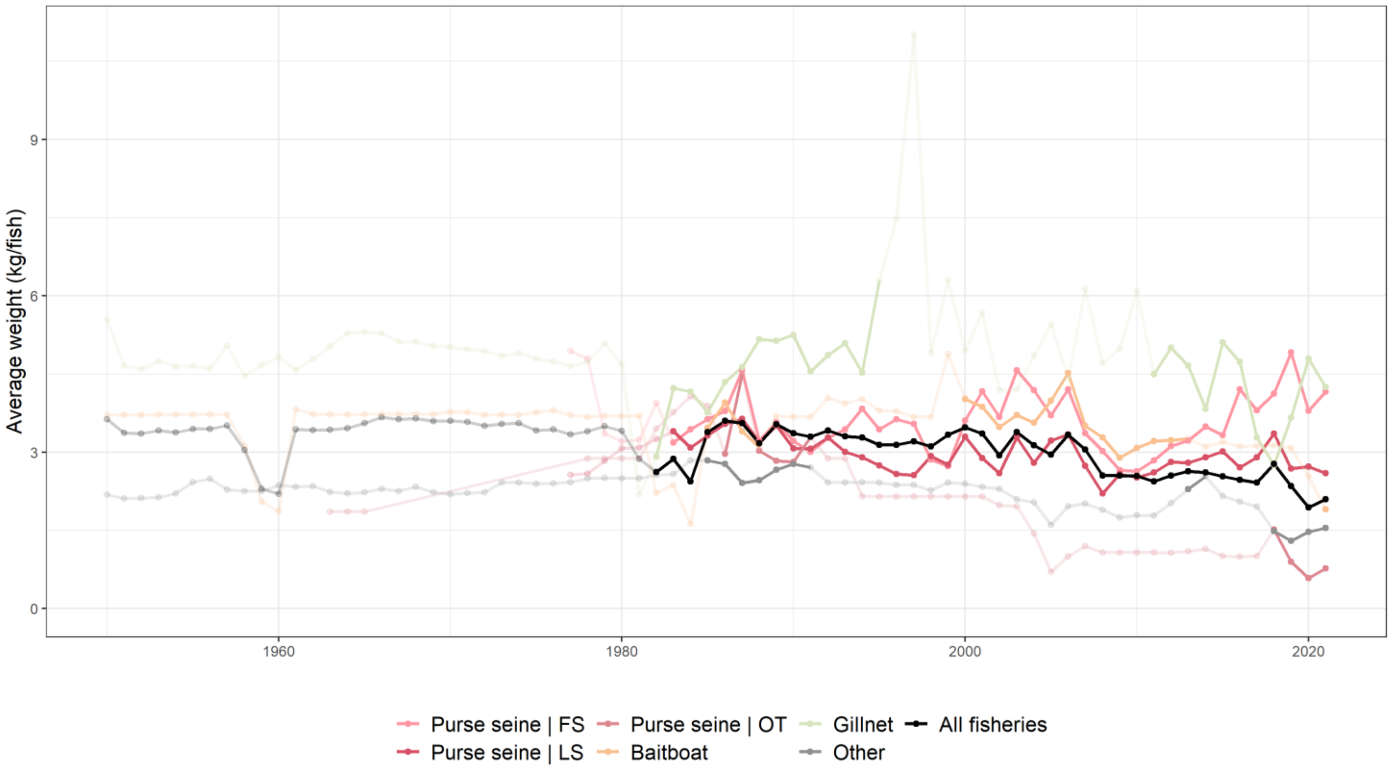

Figure 36: Combined estimated skipjack tuna average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. LS = schools associated with floating objects; FS = free-swimming schools. Longline | Japan = includes data from longliners flagged by Japan, Rep. of Korea and Thailand; Longline | Taiwan = includes data from longliners flagged by Taiwan,China and all other flags not otherwise mentioned. Data source: raised time-area catches

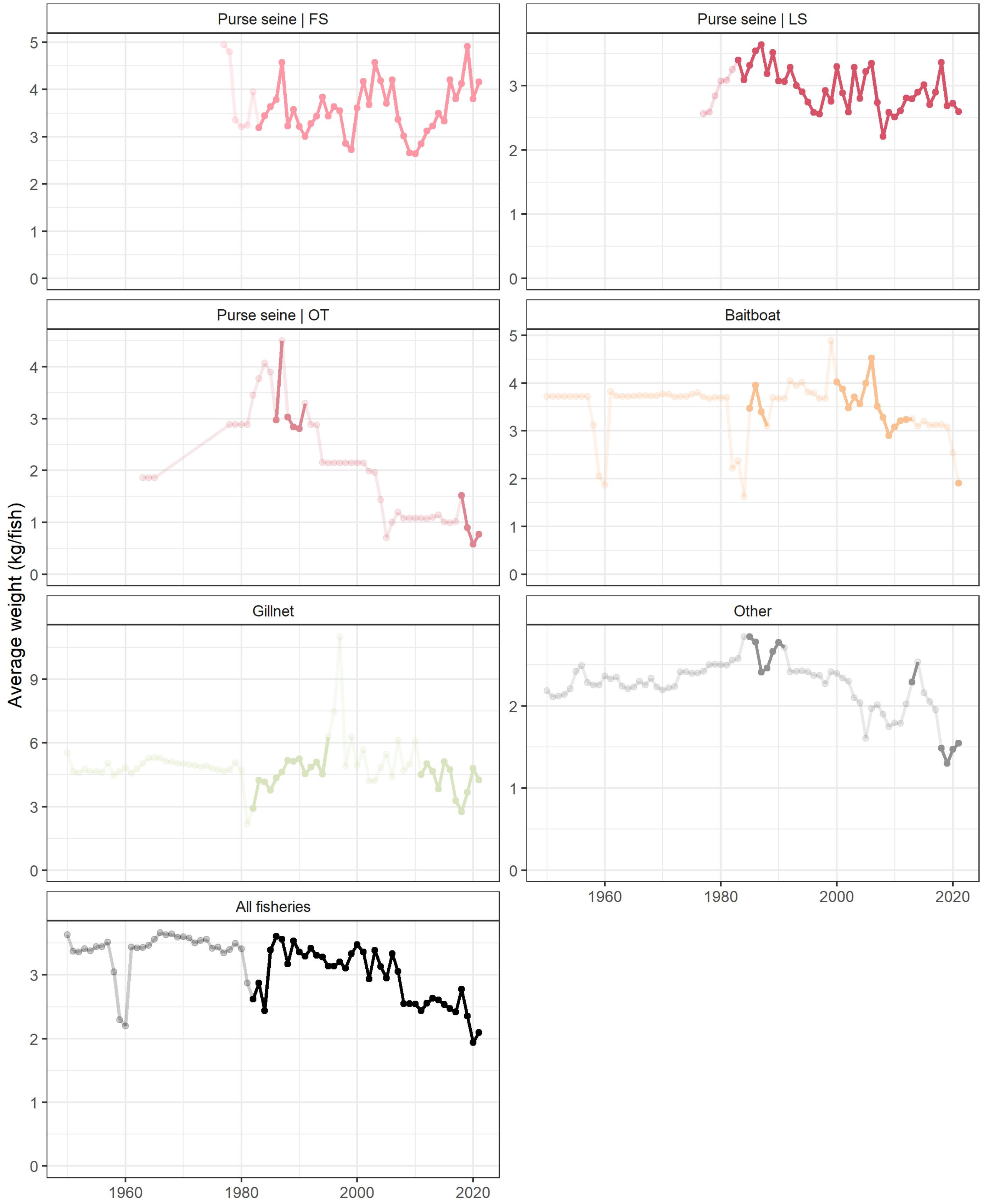

Figure 37: Estimated skipjack tuna average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. LS = schools associated with floating objects; FS = free-swimming schools. Longline | Japan = includes data from longliners flagged by Japan, Rep. of Korea and Thailand; Longline | Taiwan = includes data from longliners flagged by Taiwan,China and all other flags not otherwise mentioned. Data source: raised time-area catches

Overall, the trend in average weights that results from combining together data for all fisheries shows a clear and steady decrease in the size of fish caught since the beginning of the 1990s, which can be explained by the generalized increased efforts exerted by several coastal fleets combined with the rapid increase in catches from schools associated to floating objects in the purse seine fishery (**Fig. 36**).

Spatial distribution of average weights

Estimated average weights by decade (1950-2019)

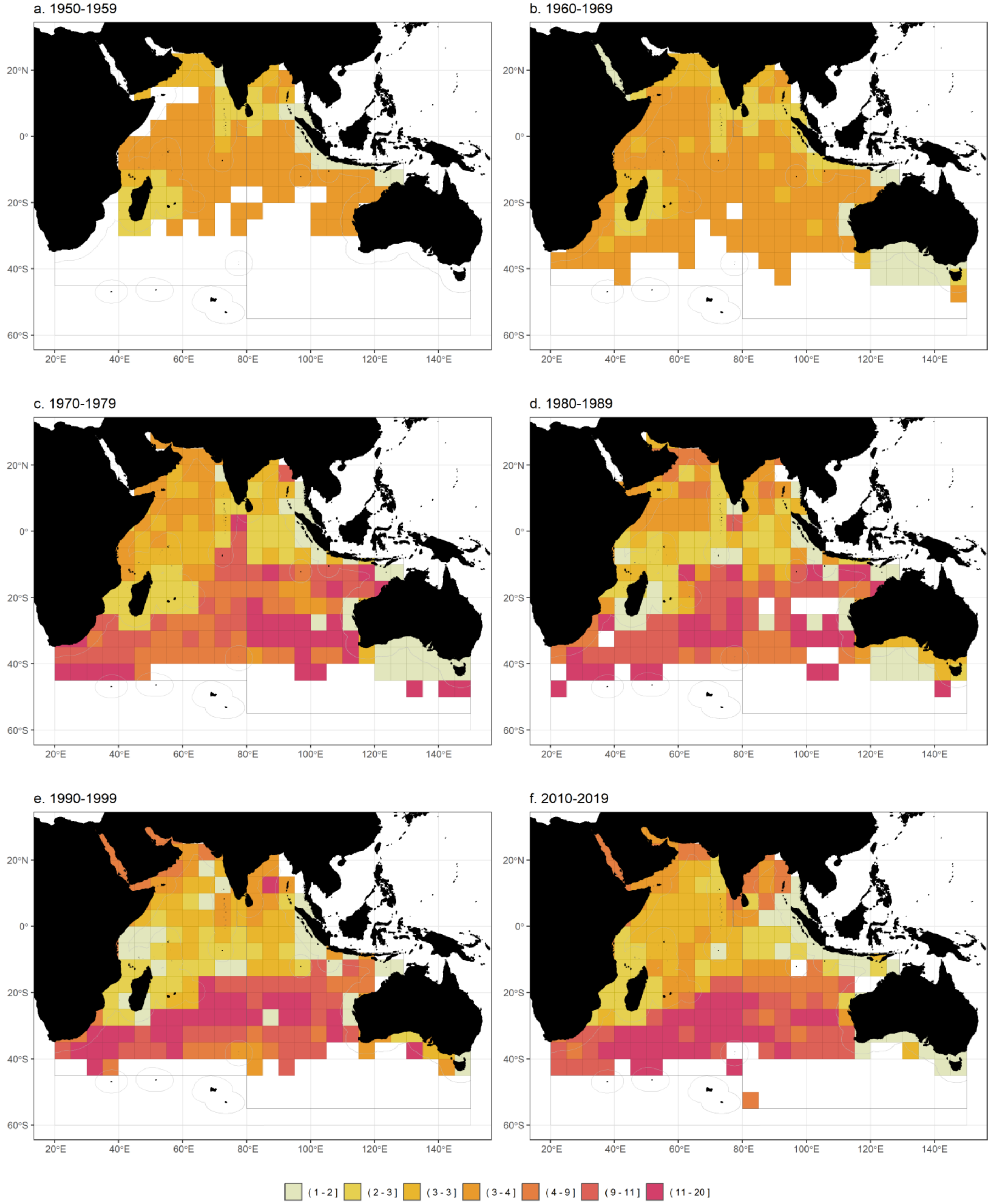

Figure 38: Estimated skipjack tuna average weight (kg/fish) in the catch by decade and 5x5 grid, for all fisheries combined for the period 1950-2019. Data source: raised time-area catches

Estimated average weights by year (2017-2021) and last decade (2010-2019)

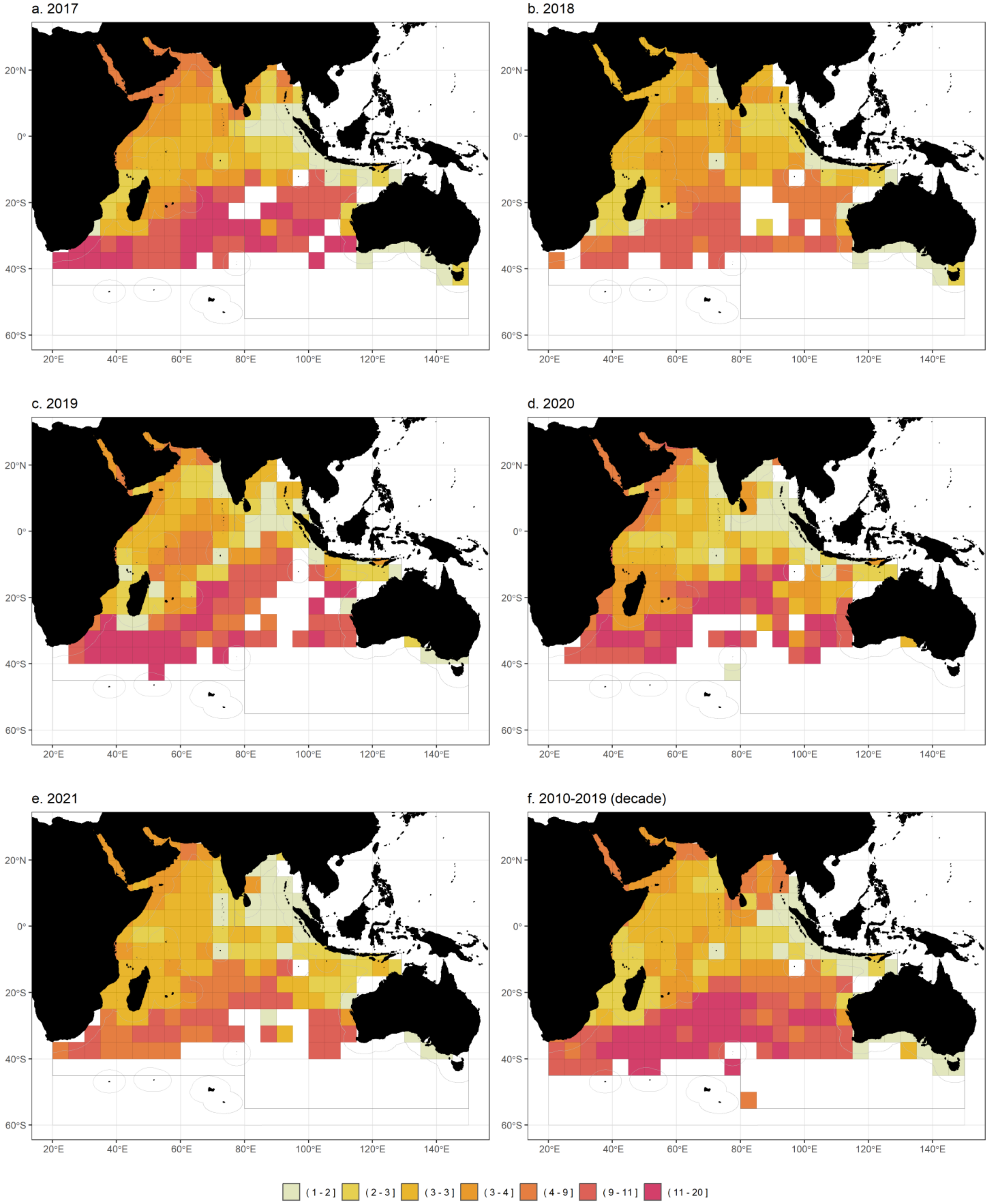

Figure 39: Estimated skipjack tuna average weight (kg/fish) in the catch by year and 5x5 grid, for all fisheries combined for the period 2017-2021 and for the decade 2010-2019. Data source: raised time-area catches

Estimated average weights by fishery group in recent years (2017-2021)

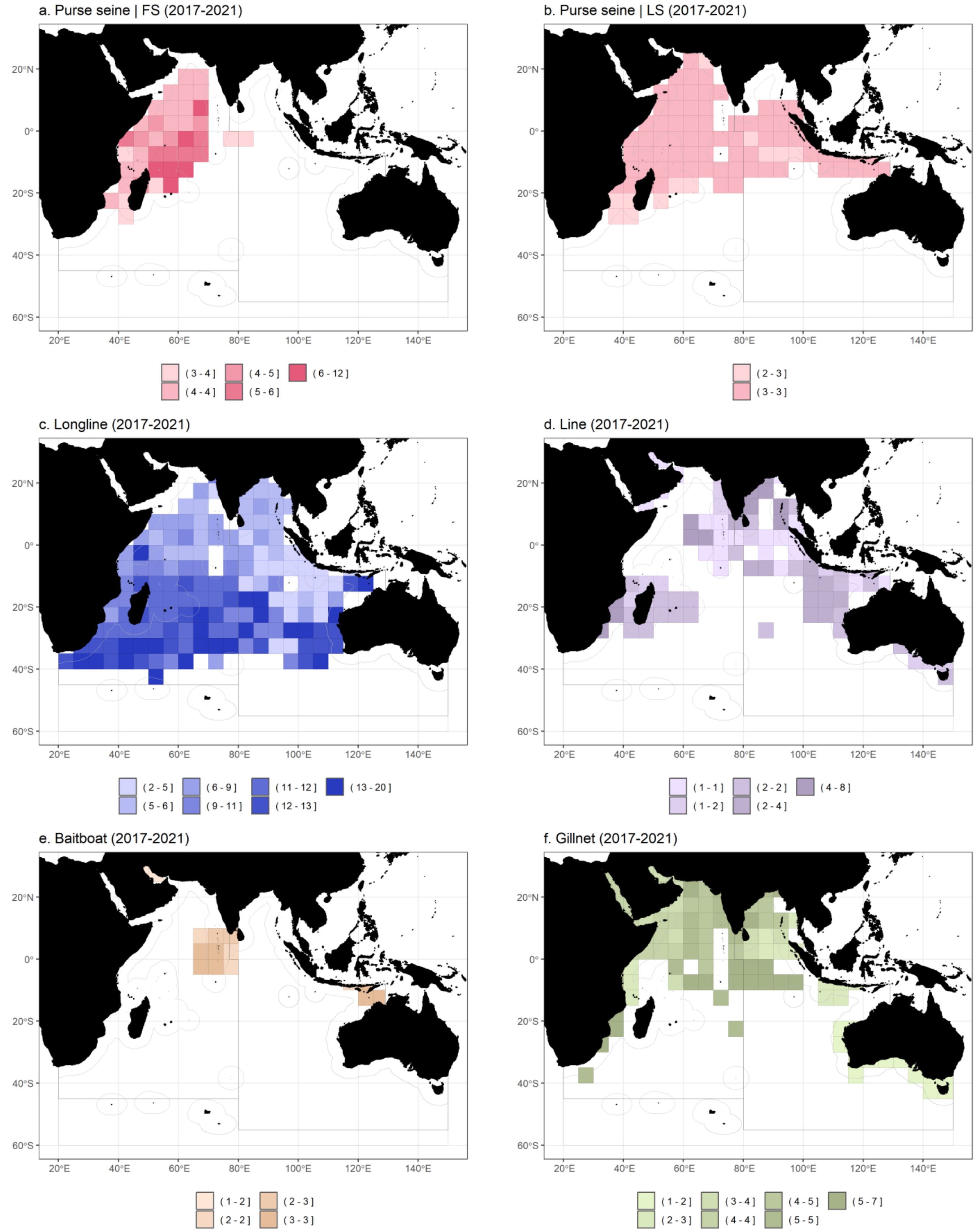

Figure 40: Estimated skipjack tuna average weight (kg/fish) in the catch by 5x5 grid and fishery group for the period 2017-2021. LS = schools associated with floating objects; FS = free-swimming schools. Data source: raised time-area catches

Uncertainties in size-frequency data

The overall quality of size data available in the IOTC databases for skipjack tuna, as measured by the percentage of retained catches with size data of quality scores between 0-2, is particularly poor for artisanal fisheries. Almost no size data are available prior to the 1980s, and the fraction of data of acceptable quality averages around 52% since 1984 (ranging between 29% and 79%) with a marked increase in quality from about 38% in 2012 to around 79% in 2021 (**Fig. 41a**).

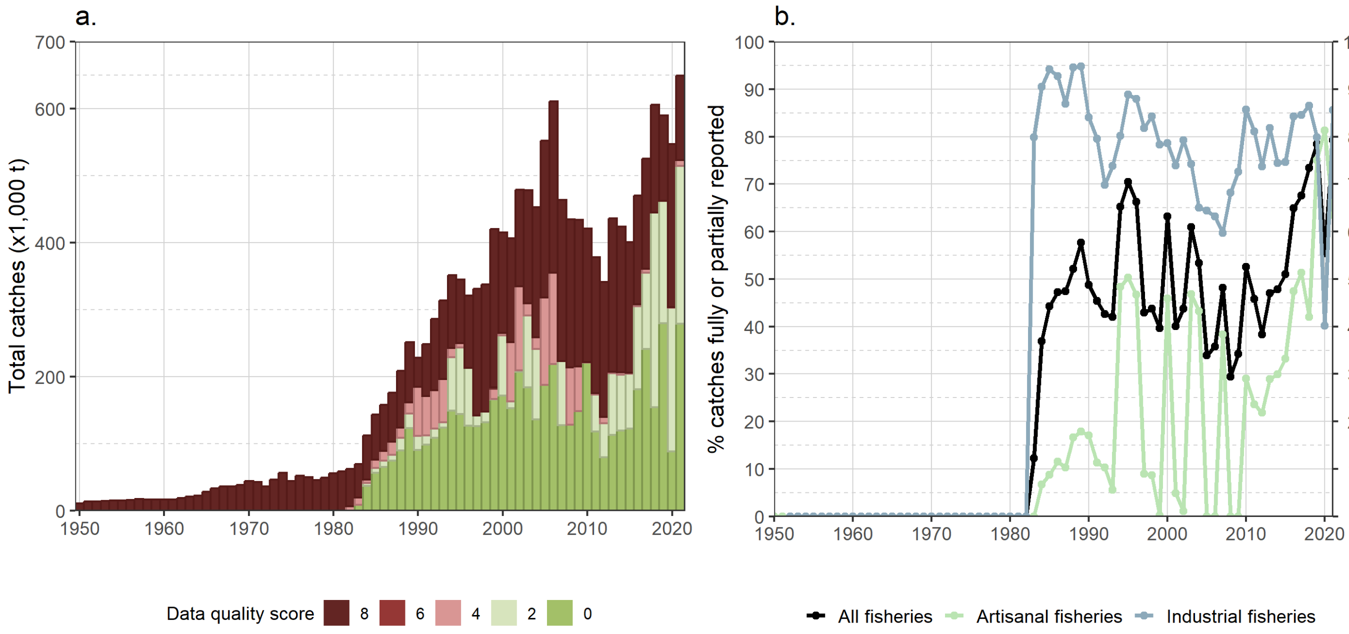

Figure 41: Annual retained catches (t) of skipjack tuna estimated by quality score (barplot) and percentage of geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2021

Industrial purse seine fisheries

Size-frequency data for skipjack tuna are available for several years for the major industrial purse seine fleets. Depending on the fleet and year, though, the data can comprise a mix of *raw* (i.e., as recorded) and *raised* (to total catches) measurements, which in turn yield sensible differences in the magnitude of the fish sampled across fleets and years. Regarding the EU and comparable fleets (i.e., Seychelles and Mauritius in the last decade) it has been suggested by national scientists that raw and raised samples differ only in total numbers of fish measured, and that actual differences in the resulting size distribution between the two types of records can be treated as negligible.

Considering the main purse seine fleets, the difference in number of fish sampled between free-swimming schools (**Fig. 42**) and FOB-associated schools (**Fig. 43**) reflects the different percentages of sets taken on the two different fishing modes, with free-school sets being generally lower in numbers than FOB-associated ones.

Also, the length distributions for the two fishing modes tend to have very distinct characteristics, with fish measured from free-swimming schools showing two modes, of which the most marked located at around 50 cm FL, while fish measured from FOB-associated schools tends to have one single mode at around 40 cm FL.

For free-swimming schools, in some instances, some fleets shows size distribution of above the threshold (**Table 5**), which all show a much higher first mode in the lower part of the size distribution (at above 50 cm FL) (**Fig. 42**).

In the case of size-frequencies from FOB-associated schools, the main mode is defined around 40 cm FL. Although some data showing values at around 60 cm FL for EU,Spain (2018), and Seychelles (2018) (**Table 6**). Data for these strata have been provided as raw measurements, while all others are reported as raised to total catches, i.e., they can be considered to represent catch-at-size (**Fig. 43**).

Considering the impracticalities of managing a mix of raw and raised size data, as it is currently the case, the IOTC Secretariat is liaising with concerned CPCs to ensure that either both data sets are provided at the same time, or preference is given to raw measurements for both historical and new data submissions.

It is also worth noting that data for the Italian-flagged component of the EU purse seine fleet are only available for 2015 and 2017. Also, data from Mauritian purse seiners with correct attribution of the fishing mode are only available for 2017, as data for 2018 and 2019 - collected by observers at sea - have been reported to the IOTC Secretariat without explicit information on the school type.

It has been challenging for several fleets to implement regular sampling programmes in 2020 due to the insurgence of the CoViD-19 pandemic, and therefore size data for 2020 is very limited in numbers, particularly when considering fish caught on free-swimming schools for which data is only available from EU,France albeit to levels corresponding to a negligible fraction of what usually provided in the past (**Fig. 42**).

Size-frequency data for 2020 is entirely absent for EU,Spain and only available in limited numbers for EU,France, Mauritius, and Seychelles (**Fig. 43**), with EU,Spain confirming their ongoing effort to recover size data from the original providers and share it as soon as possible (IOTC, pers. comm.).

Size-frequency data are available in recent years for other industrial purse seine fleets, and include information from Indonesia, I.R. Iran, Japan, and the Republic of Korea (**Fig. 45**). Unfortunately, except for I.R. Iran in 2015, the size data submitted to the IOTC Secretariat by these fleets are not categorized by fishing mode, and therefore cannot be directly compared with the corresponding information from all other fleets. At the same time, the characteristics of the size distributions available for each of these fleets are such to suggest that Indonesian purse seiners, as well as Japanese and Korean ones (to a lesser extent), are mostly fishing on FOB-associated schools, whereas Iranian purse seiners appear to have been fishing predominantly on free-swimming schools in recent years. furthermore, samples of skipjack tuna from Thailand are exclusively reported by coastal purse seine fisheries (**Fig. 45**).

Size data reported by non-EU fleets do not always comply with the requirement of sampling at least one fish per metric ton of retained catches by species. In particular, data from Indonesia and the Republic of Korea (even though the latter are collected by observers at sea) are consistently below the threshold set by Res. 15/02 for all years concerned, and this further questions the representativeness of the length samples reported by the two fleets.

Finally, these fleets seem to have been less affected by the CoViD-19 pandemic, as data were regularly provided by all of them (albeit in numbers lower than usual in the case of Indonesia and I.R. Iran) (**Fig. 45**).

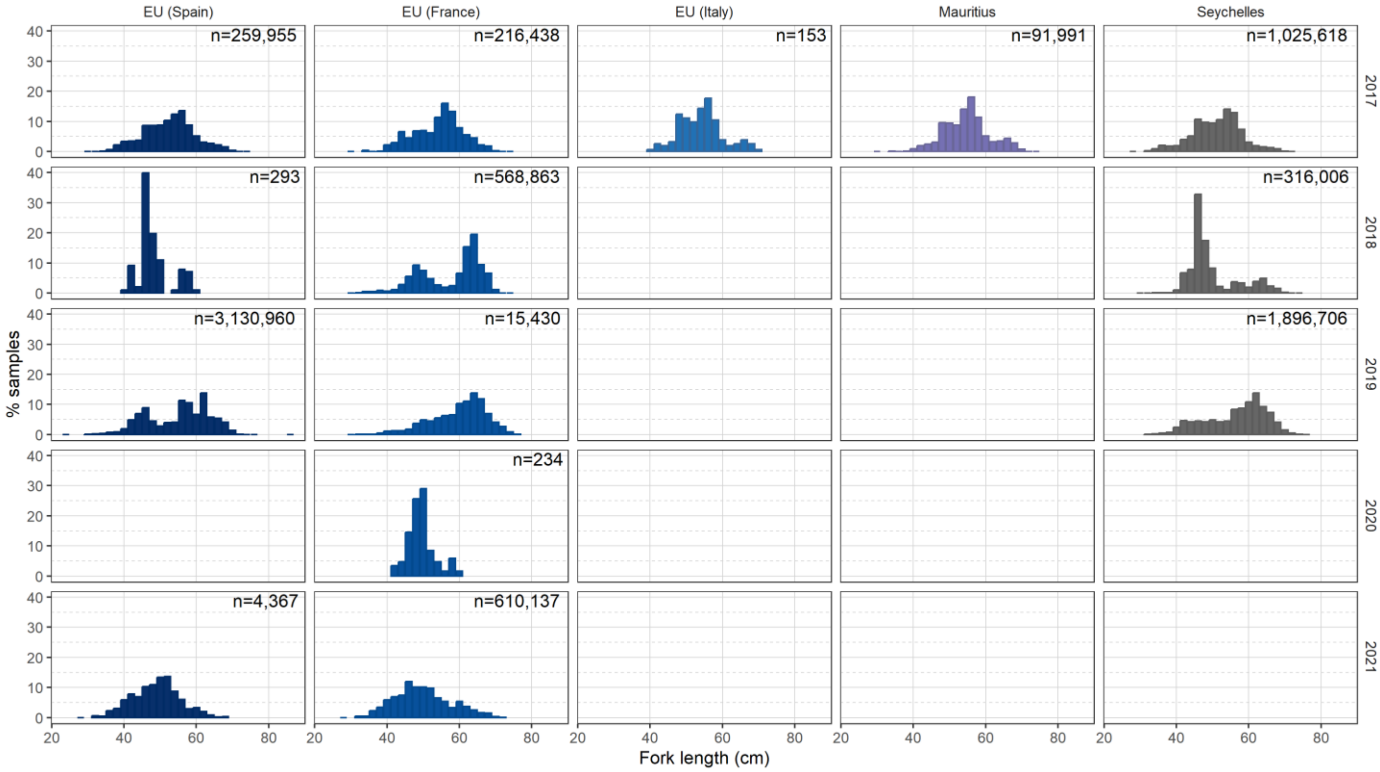

Figure 42: Relative size distribution of skipjack tuna (fork length in cm) recorded for free-swimming schools, by year (2017–2021) and main purse seine fleet. Data source: standardized size-frequency dataset (Res. 15/02)

Table 5: Percentage of sampled skipjack tuna with fork length below 40 cm recorded by the major purse seine fleets fishing on free-swimming schools, as reported for the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

Fleet	2017	2018	2019	2020	2021
EU (Spain)	3	0	2		6
EU (France)	0	2	1	0	7
Mauritius	0				
Seychelles	5	0	2		

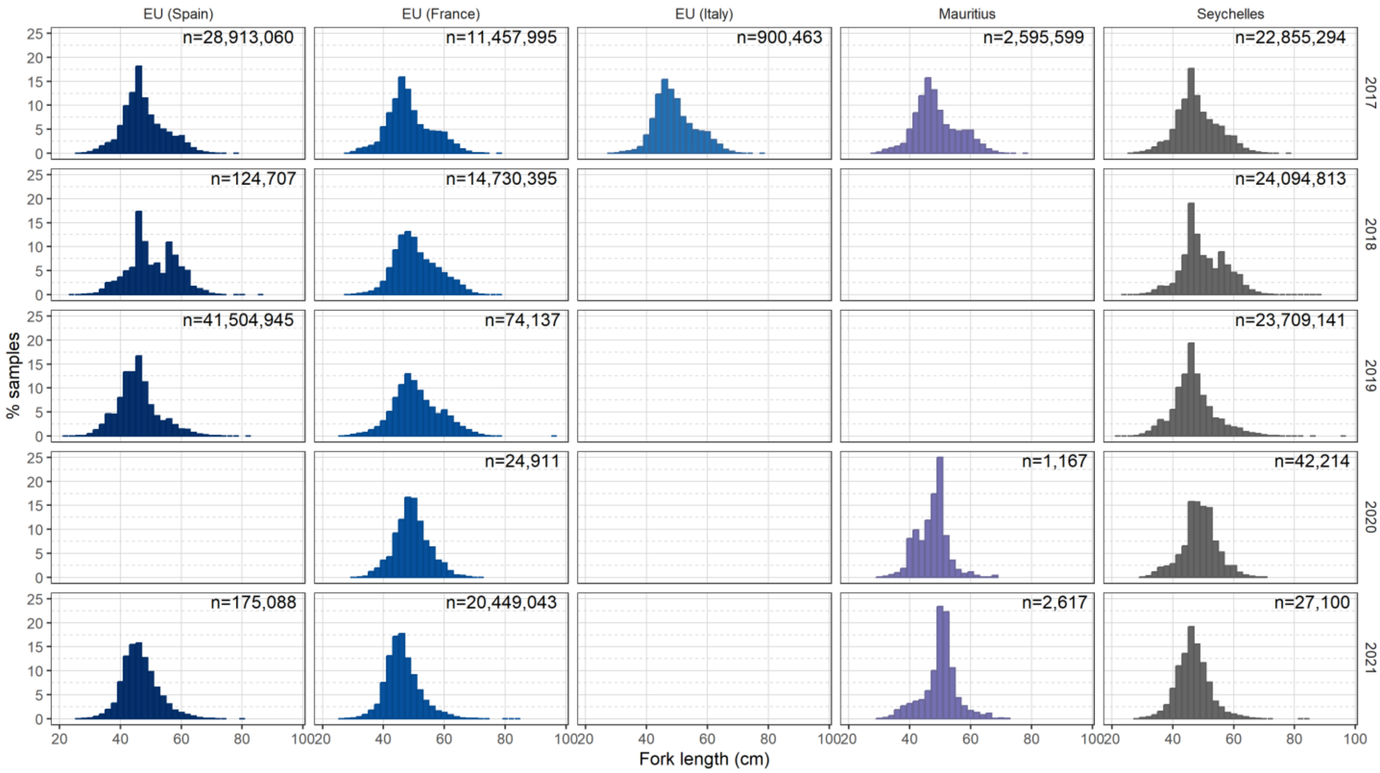

Figure 43: Relative size distribution of skipjack tuna (fork length in cm) recorded for FOB-associated schools, by year (2017–2021) and major purse seine fleet. Data source: standardized size-frequency dataset (Res. 15/02)

Table 6: Percentage of sampled skipjack tuna with fork length above 40 cm recorded by the major purse seine fleets fishing on FOB-associated schools, as reported for the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

Fleet	2017	2018	2019	2020	2021
EU (Spain)	92	93	87		93
EU (France)	94	97	95	97	94
Mauritius	94			96	
Seychelles	93	95	90	94	94

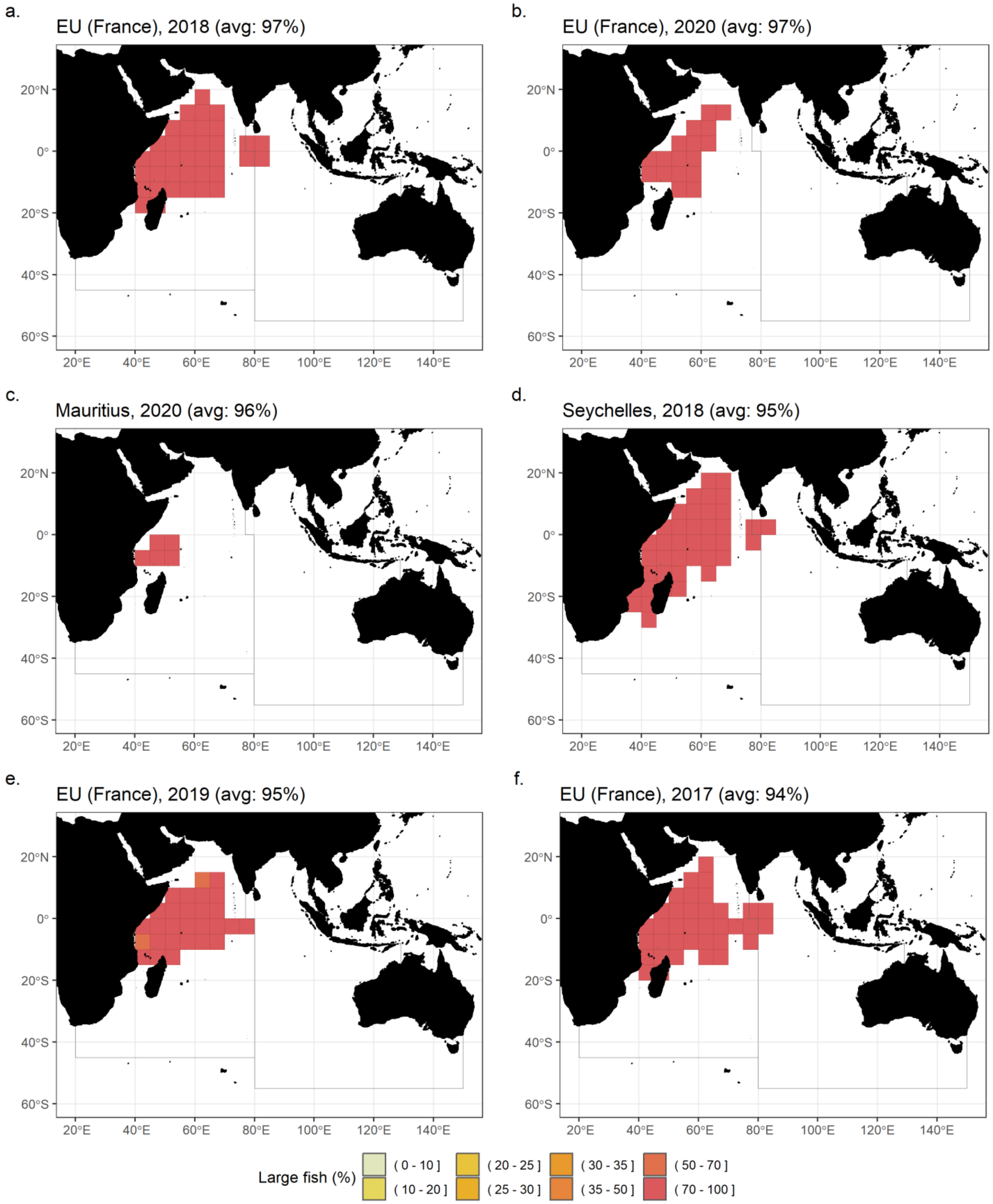

Figure 44: Spatial distribution of sampled skipjack tuna with fork length above 40 cm recorded by the major purse seine fleets fishing on FOB-associated schools, as reported for the period 2017-2021. Data source: standardized size-frequency dataset (Res. 15/02)

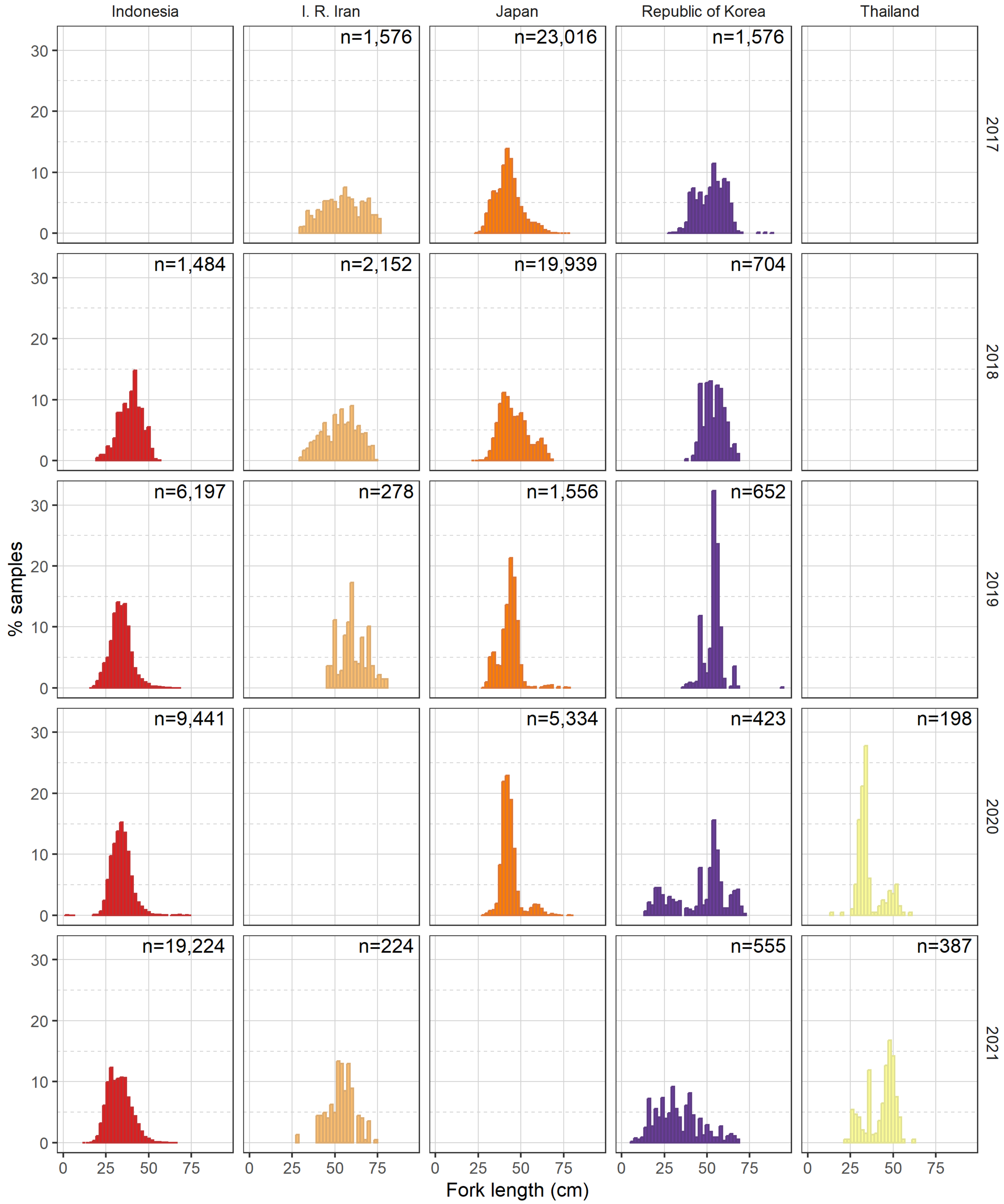

Figure 45: Relative size distribution of skipjack tuna (fork length in cm) recorded for unclassified schools, by year (2017–2021) and other purse seine fleet. Data source: standardized size-frequency dataset (Res. 15/02)

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