REVIEW OF INDIAN OCEAN YELLOWFIN TUNA STATISTICAL DATA

Author: IOTC Secretariat

Introduction

Yellowfin tuna is caught in all oceans, and more abundantly in the Western-Central Pacific Ocean, which accounted for about 53% of the total catches of the species in recent years (**Fig. 1**). Historical catches show an increasing trend from the 1950s to the early 2000s, followed by a decline by about 19% in the mid-2000s. During this period, a substantial decline in yellowfin catch was reported in both the Eastern Pacific Ocean and Indian Ocean, while the catch trend remained positive in the Western-Central Pacific Ocean. In recent years catches of yellowfin tuna from all regions increased drastically, reaching around 1.6 million t in 2021.

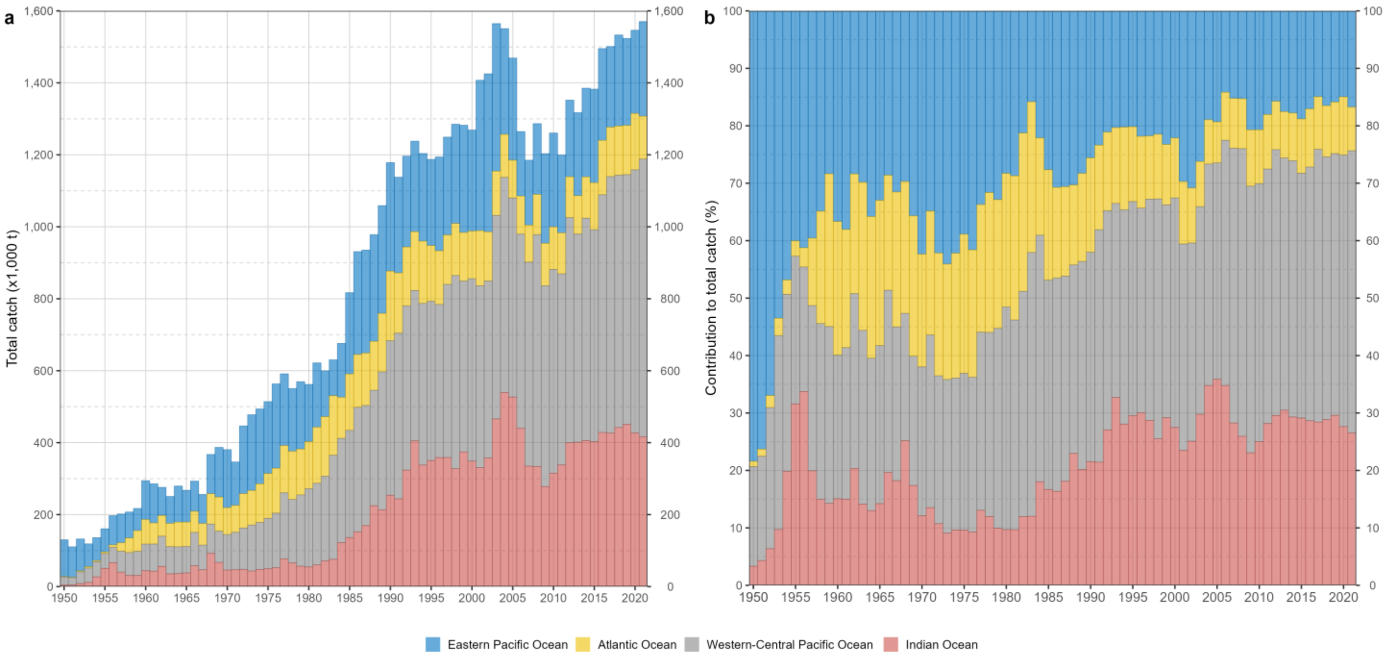

Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of yellowfin tuna by ocean basin for the period 1950-2021. Source: Global Tuna Atlas

The overarching objective of the paper is to provide participants to the 25th Session of the IOTC Working Party on Tropical Tunas (WPTT25) with a review of the status of the information on yellowfin tuna (*Thunnus albacares*; YFT) available to the IOTC Secretariat as of October 2023. The document provides an overview of the fisheries catching yellowfin 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. A full description of the data collated and curated by the Secretariat is available in paper IOTC-2023-WPTT25-03.1 (IOTC 2023).

Retained catches

Historical trends (1950-2022)

Indian Ocean fisheries

Retained catches of yellowfin tuna show a generally increasing trend over the last seven decades, with some variability between years. The total catches increase slowly between the mid-1950s and mid-1980s, averaging between 18,000 t and 87,000 t, with longliners and gillnetters as the main fisheries (**Table 1** & **Figs. 2-3**).

Table 1: Best scientific estimates of average annual retained catches (metric tonnes; t) of yellowfin tuna by decade and fishery for the period 1950-2022. The background intensity color of each cell is directly proportional to the catch level. Data source: yellowfin tuna raised time-area catches

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Purse seine | Other		13	205	1,170	2,185	3,590	7,393	6,819
Purse seine | FS			60	31,552	64,938	89,204	43,725	36,929
Purse seine | LS			58	17,648	56,279	61,890	90,223	89,860
Longline | Other				354	5,677	14,454	7,164	582
Longline | Fresh			879	4,286	47,612	34,150	20,588	18,813
Longline | Deep-freezing	27,487	41,352	29,589	33,824	66,077	56,671	17,918	15,639
Line | Coastal longline	168	1,262	1,824	3,488	6,185	11,146	28,307	41,301
Line | Trolling	1,003	1,820	4,187	6,608	11,058	13,219	18,256	18,258
Line | Handline	627	647	2,902	8,117	20,232	34,574	70,481	112,718
Baitboat	2,111	2,318	5,810	8,295	12,805	16,077	17,542	13,140
Gillnet	1,571	4,114	7,928	12,020	39,199	58,818	76,932	62,418
Other	80	189	310	674	1,133	1,746	2,592	2,673
Total	33,047	51,714	53,751	128,036	333,380	395,538	401,119	419,150

Catches increase more rapidly in the early 1980s with the arrival of the purse seiners and increased activity of longliners and other fleets, reaching around 400,000 t by 1993 (**Figs. 2-3**). Exceptionally high catches were recorded between 2003 and 2006 – with the highest catches ever recorded in 2004 at over 540,000 t – while catches of bigeye tuna, which are generally associated with the same fishing grounds as yellowfin tuna, remained at average levels.

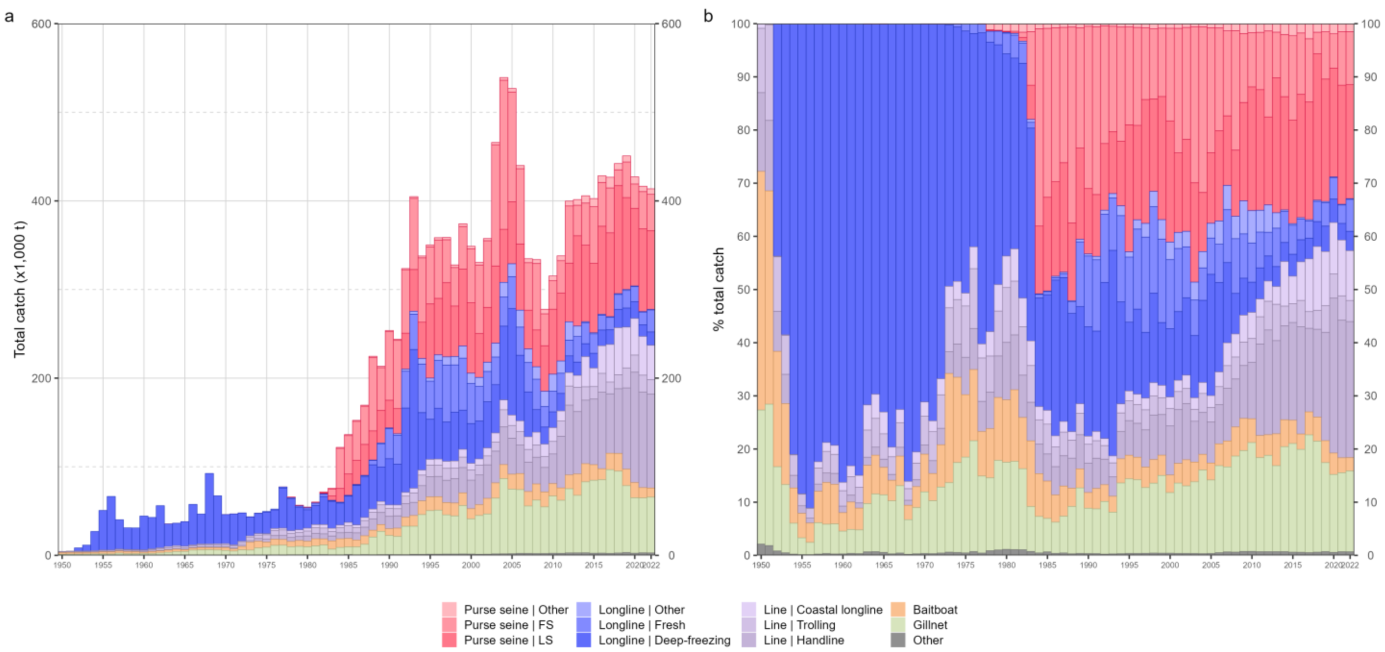

Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of yellowfin tuna by fishery for the period 1950-2022. LS = schools associated with floating objects; FS = free-swimming schools. Data source: yellowfin tuna raised time-area catches

Between 2007 and 2009 catches dropped considerably (to around 52% of 2004 levels) as longline fishing effort in the western Indian Ocean was displaced eastwards or reduced due to the threat of piracy in areas close to the areas of national jurisdiction of Somalia. 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 European Union (EU) and Seychelles, which has enabled fishing operations to continue. Since 2013, catches have steadily increased from 404,000 t to an average of around 430,000 t between 2018 and 2022, and a maximum close to 450,000 t in 2019 (**Table 2**).

Table 2: Best scientific estimates of annual retained catches (metric tonnes; t) of yellowfin tuna by fishery for the period 2013-2022. The background intensity color of each cell is directly proportional to the catch level. Data source: yellowfin tuna raised time-area catches

Fishery	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Purse seine | Other	6,433	8,313	9,101	7,525	12,150	7,145	6,872	8,097	6,140	6,222
Purse seine | FS	34,459	47,426	63,963	49,460	50,700	17,909	40,147	27,557	42,059	41,170
Purse seine | LS	101,898	86,417	78,395	99,268	94,479	121,790	103,774	87,479	93,321	88,779
Longline | Other	11,667	1,077	1,189	1,036	923	954	1,111	643	561	542
Longline | Fresh	28,981	23,763	21,987	16,817	13,959	16,827	19,787	17,137	14,431	24,870
Longline | Deep-freezing	15,028	14,523	16,608	17,740	16,519	20,697	21,541	18,843	13,017	15,057
Line | Coastal longline	13,447	34,073	20,922	31,134	42,415	53,067	45,948	41,402	43,777	38,726
Line | Trolling	27,417	15,091	14,136	21,168	13,356	15,767	22,595	19,343	19,010	16,421
Line | Handline	70,388	71,649	74,021	86,444	67,071	73,050	91,757	124,489	107,812	105,854
Baitboat	24,072	20,541	17,642	12,392	18,482	20,030	18,625	17,228	11,797	10,395
Gillnet	64,948	80,105	82,299	82,883	94,487	92,344	75,471	62,519	61,848	62,887
Other	2,780	2,837	2,397	2,485	2,208	2,626	3,160	2,420	2,841	2,758
Total	401,517	405,816	402,660	428,352	426,750	442,205	450,788	427,156	416,614	413,679

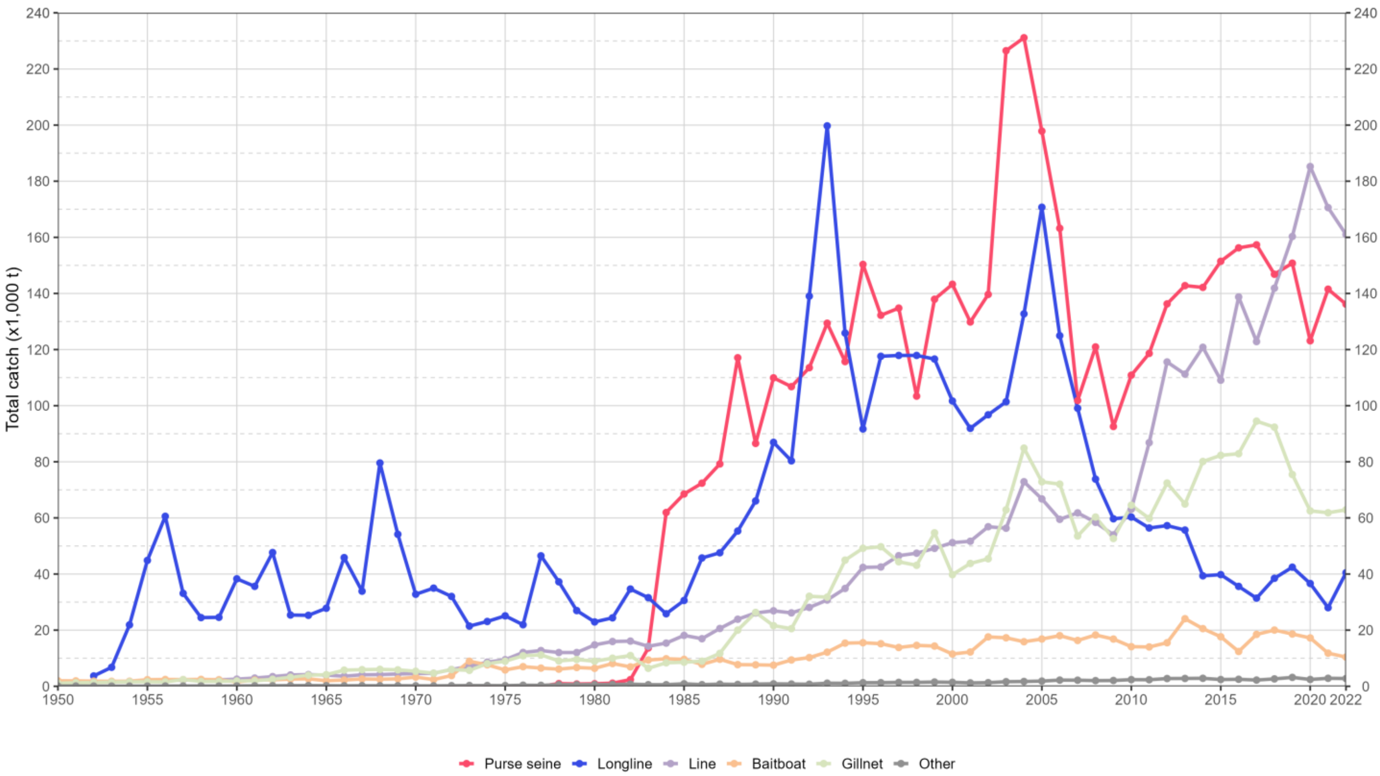

Figure 3: Annual time series of retained catches (metric tonnes; t) of yellowfin tuna by fishery group for the period 1950-2022. Data source: best scientific estimate of retained catches

Contrary to other oceans, the artisanal fishery component of yellowfin catches in the Indian Ocean has always been substantial, accounting annually for more than 40% of the total catches from the mid-1970s to the early 1980s and since 2007. Between 2018 and 2022, the mean annual catches of artisanal fisheries were close to 220,000 t (50% of total catches), while industrial fisheries caught on average 210,000 t every year (**Fig. 4**).

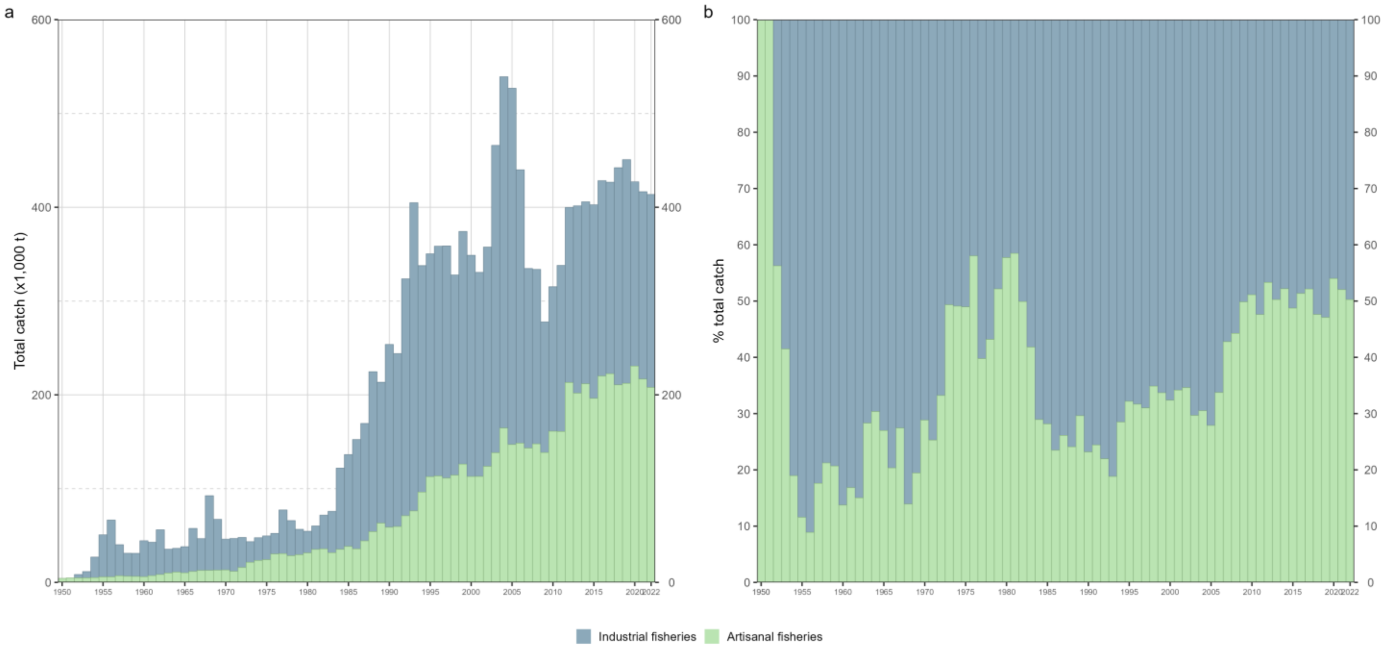

Figure 4: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of yellowfin tuna by type of fishery for the period 1950-2022. Data source: best scientific estimate of retained catches

Regarding purse seine fisheries, historical captures of yellowfin tuna by fishing mode show a generally increasing trend in percentages of catches from FOB-associated schools from 2004 onward, accompanied by yearly fluctuations of the contribution of each fishing mode which can vary up to 20% between two consecutive years. EU,France appears to have generally relied less on catches from FOB-associated schools, to the point that the percentage over total yellowfin tuna catches for the flag exceeded 60% only in 2011 and from 2017 onward.

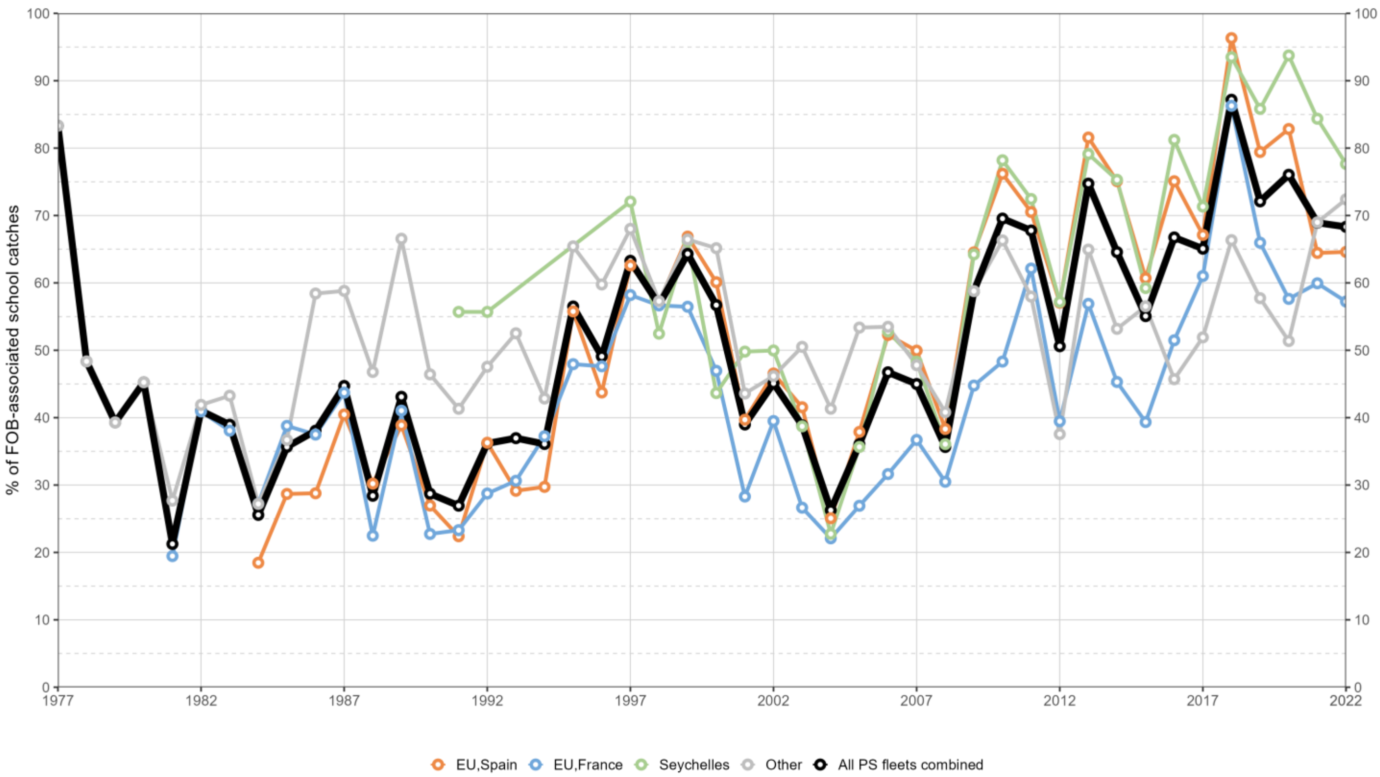

Figure 5: Annual percentages of purse seine FOB-associated catches of yellowfin tuna by fleet for the period 1977-2022. *Other* includes purse seine fleets such as ex-Soviet Union, I.R. Iran, France (Mayotte), Mauritius, Japan, Korea, Indonesia, Thailand, EU,Italy, Belize and others. Data source: time-area catch dataset for purse seine fisheries (Res. 15/02)

On the contrary, since 2009 EU,Spain and Seychelles regularly reported 60% or more of their yellowfin tuna catches from FOB-associated schools. Between 2013 and 2022, catches from all purse seine fleets combined showed a fluctuation between 55% and 87% in the fraction of catches from FOB-associated schools, with a maximum of 87% in 2018, and around 68% in 2022 (**Fig. 5**).

The detected decreases in relative catches from FOB-associated schools since 2018 might be a consequence of changes in fishing practices for all concerned fleets after the entry in force of the various IOTC resolutions on an interim plan for rebuilding the Indian Ocean yellowfin tuna stock.

Recent fishery features (2018-2022)

Yellowfin tuna is caught by a large diversity of fisheries from many fleets operating all over the Indian Ocean. Between 2018 and 2022, purse seine fisheries (all fishing modes combined, and including catches from small purse seiners and ringnetters) reported an average annual catch of around 140,000 t of yellowfin tuna, contributing to around 32% of the total retained catches (**Table 3**). During the same period, line fisheries in coastal areas represented the other major contributor of yellowfin tuna catches, with an average annual catch of around 164,000 t of which 101,000 t caught with handlines, 45,000 t with coastal longlines, and 19,000 t with trolling lines.

Between 2018 and 2022, gillnet fisheries represented 17% of the recent catches with more than 70,000 t caught annually. Industrial longline and baitboat fisheries represented around 9% and 4% of the yellowfin tuna catches, respectively (**Table 3 & Fig. 3**).

Table 3: Mean annual catches (metric tonnes; t) of yellowfin tuna by fishery between 2018 and 2022. LS = schools associated with floating objects; FS = free-swimming schools. Data source: yellowfin tuna raised time-area catches

Fishery	Fishery code	Catch	Percentage
Line | Handline	LIH	100,592	23.4
Purse seine | LS	PSLS	99,029	23.0
Gillnet	GN	71,014	16.5
Line | Coastal longline	LIC	44,584	10.4
Purse seine | FS	PSFS	33,768	7.9
Line | Trolling	LIT	18,627	4.3
Longline | Fresh	LLF	18,610	4.3
Longline | Deep-freezing	LLD	17,831	4.1
Baitboat	BB	15,615	3.6
Purse seine | Other	PSOT	6,895	1.6
Other	OT	2,761	0.6
Longline | Other	LLO	762	0.2

In recent years (2018-2022), average annual catches of yellowfin tuna have been shared between several CPCs, to the point that around 80% of all annual catches is accounted for by nine distinct fleets, with Oman, I.R. Iran, EU,Spain, Seychelles, and Maldives reaching (or getting close to) about 10% of average total annual catches each (**Fig. 6**).

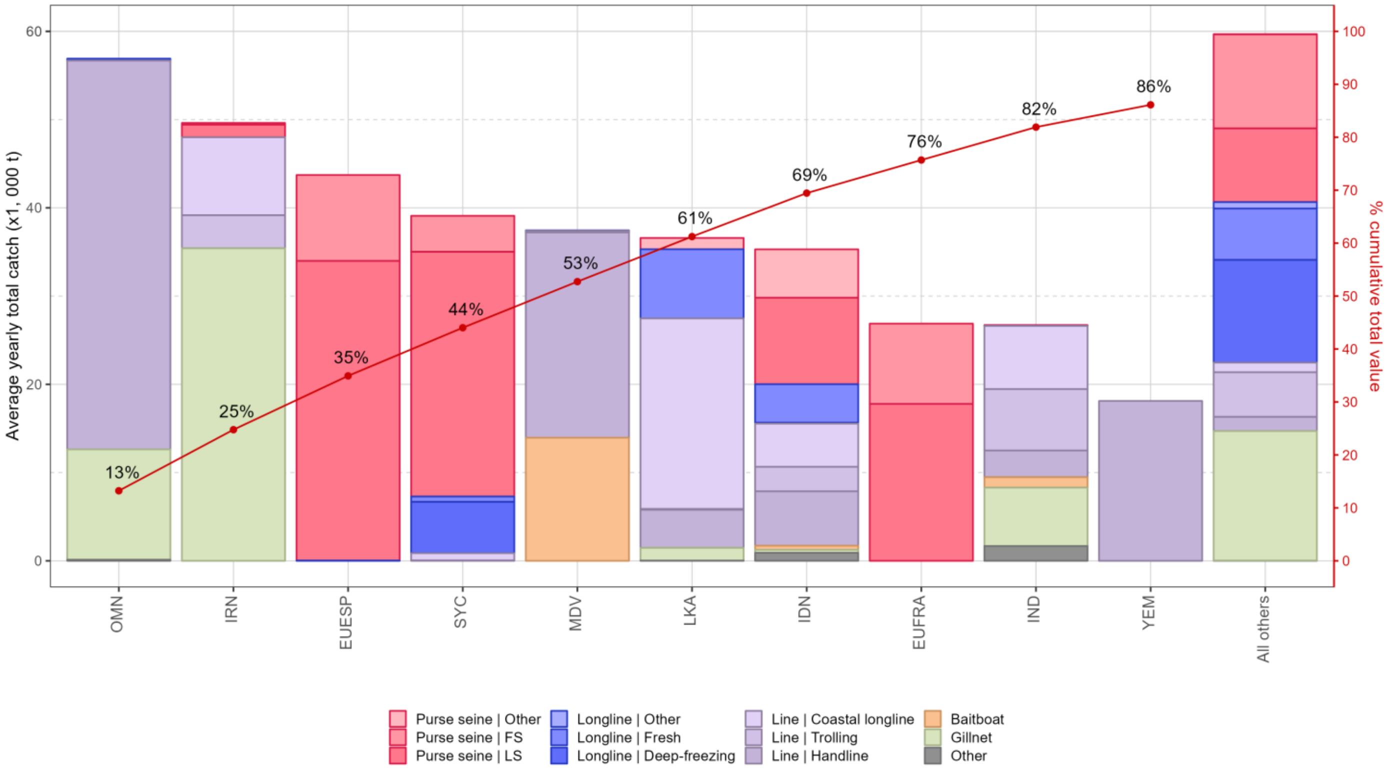

Figure 6: Mean annual catches (metric tonnes; t) of yellowfin tuna by fleet and fishery between 2018 and 2022, with indication of cumulative catches by fleet. FS = free-swimming schools; LS = schools associated with floating objects. Data source: yellowfin tuna raised time-area catches

Catch trends by fishery group in the same period (2018-2022) showed a marked increasing trend in catches reported for line fisheries from about 123,000 t in 2017 to 185,000 t in 2020. In 2022, line fisheries dominated all fishery groups with a total catch of 161,000 t of yellowfin tuna (**Fig. 7**). Catches from purse seiners have substantially decreased from 157,000 t in 2018 to 123,000 t in 2020, before re-increasing to 136,000 t in 2022. Similarly, gillnet fisheries showed a decrease in catch levels of yellowfin tuna between 2017 and 2020 before stabilizing at around 63,000 t in 2022. Catches of yellowfin also decreased in longline and baitboat fisheries in recent years, amounting in 2021 to 40,000 t and 10,000 t, respectively.

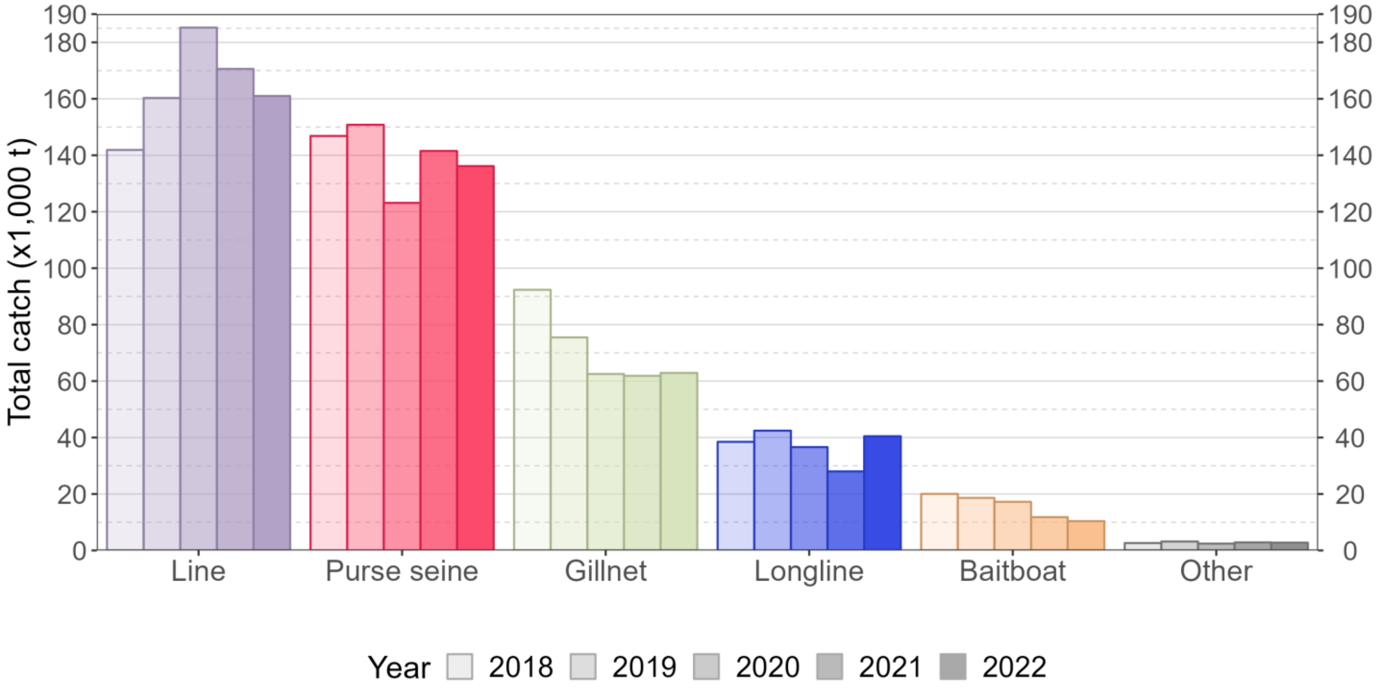

Figure 7: Annual catch (metric tonnes; t) trends of yellowfin tuna by fishery group between 2018 and 2022. Data source: best scientific estimate of retained catches

Regarding industrial purse seine fisheries, recent catch trends show that all the major fleets (EU,Spain, Seychelles, and EU,France) have reduced their catch levels since 2018, with the only notable exception being Indonesia (which ranks fourth in terms of catches of yellowfin tuna for the period and fishery considered) and whose catches increased sensibly compared to 2018 levels (**Fig. 9a**). Mauritius (aggregated under *all others*) ranks fifth in this category, with an increasing trend in purse seine yellowfin catches detected from 2016 to 2019, followed by a sharp decrease in 2020-2021 associated to a comparable decrease in efforts. Overall, the decrease in catches strongly varied with the type of school association. Catches on free-swimming schools showed a sharp increase between 2018 and 2019 for the fleets of EU, Mauritius, and Seychelles (**Fig. 8a**). Meanwhile, catches on FOB-associated schools showed a generalized decreasing trend between 2018 and 2022 for all fleets except Indonesia, with 2018 being the peak year with a maximum total catch of more than 120,000 t caught on FOB-associated schools (**Fig. 8b**).

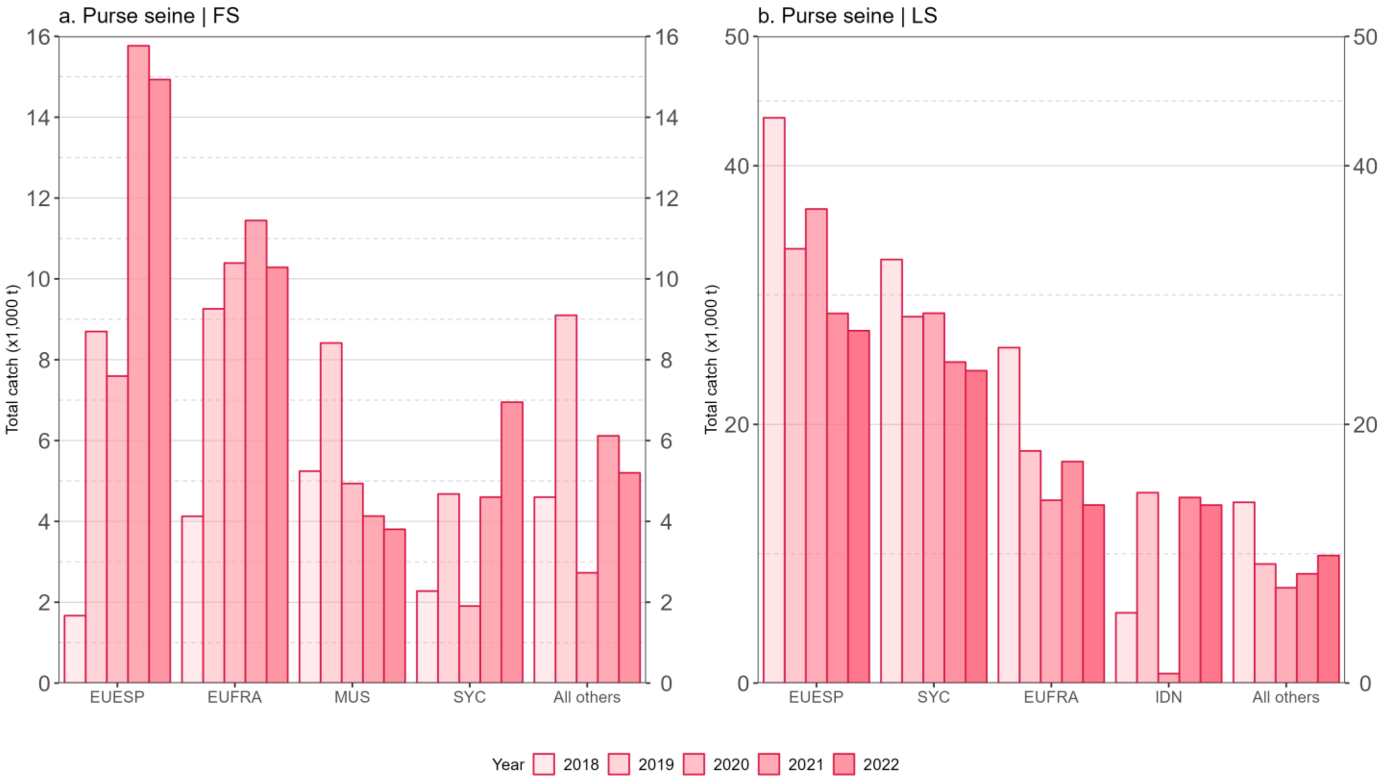

Figure 8: Annual purse seine catch (metric tonnes; t) trends of yellowfin tuna by fishing mode and fleet between 2018 and 2022. FS = free-swimming schools; LS = schools associated with floating objects. Data source: yellowfin tuna raised time-area catches

Recent longline catch trends show a mixed situation when focusing on the key fleets: while longliners from Taiwan,China, China, and Japan (with the latter now aggregated under *all others*) have maintained or decreased their yellowfin tuna catch levels since 2018, catches reported by Sri Lanka and Seychelles have increased to peak levels in 2019 before declining again until 2021. All other longline fleets have reported relatively stable catch levels in the period concerned, except Indonesia for which peak catches of over 11,000 t are reported for 2022 (**Fig. 9b**).

Fleets using line or assimilated gears (handline, troll-line, coastal longline) show generally stable trends in catch levels since 2018, with the only notable exception of handlines from Maldives, which appear to be facing a contraction phase compared to the peak year (2018), and Oman, which has instead registered marked increases from 2019 onwards compared to previous years. However, catches from the handline fisheries of Yemen are estimated to be at constant levels due to the lack of information from the source (**Fig. 9c**) and the contribution to increased catch levels for all fleets aggregated under *all others* is mostly due to catches reported by coastal longliners of I.R. Iran, which has been supporting the development of this fishery in recent years (Hosseini et al. 2018).

The baitboat fishery of the Maldives has experienced a major decline in the catches of yellowfin tuna in recent years, with the total catches reaching 9,100 t in 2022, notwithstanding the fact that the effort exerted in that year was quite comparable to 2020 (**Fig. 9d**). It is interesting to note that such a sharp decline in the yellowfin tuna catches was also observed in the baitboat fishery in the past, in the year 2016 for instance.

Trends in gillnet catches of yellowfin tuna strongly vary with the fleet. Catches from I.R. Iran have decreased from an average of about 42,700 t between 2017 and 2019 to about 34,000 t in 2020-2021 and then to around 26,500 in 2022 (**Fig. 9d**). Catches from Pakistani gillnetters reported a marked decrease in catches since 2017 due to an extended period of fishing closure, high volatility in tuna market price, and poor environmental conditions in 2019 which also affected the Pakistani catches of neritic tunas (Moazzam 2021). By contrast, catches by Omani gilnetters have remained stable to around 10,000 t between 2018 and 2021, to then increase sharply to 20,000 t in 2022.

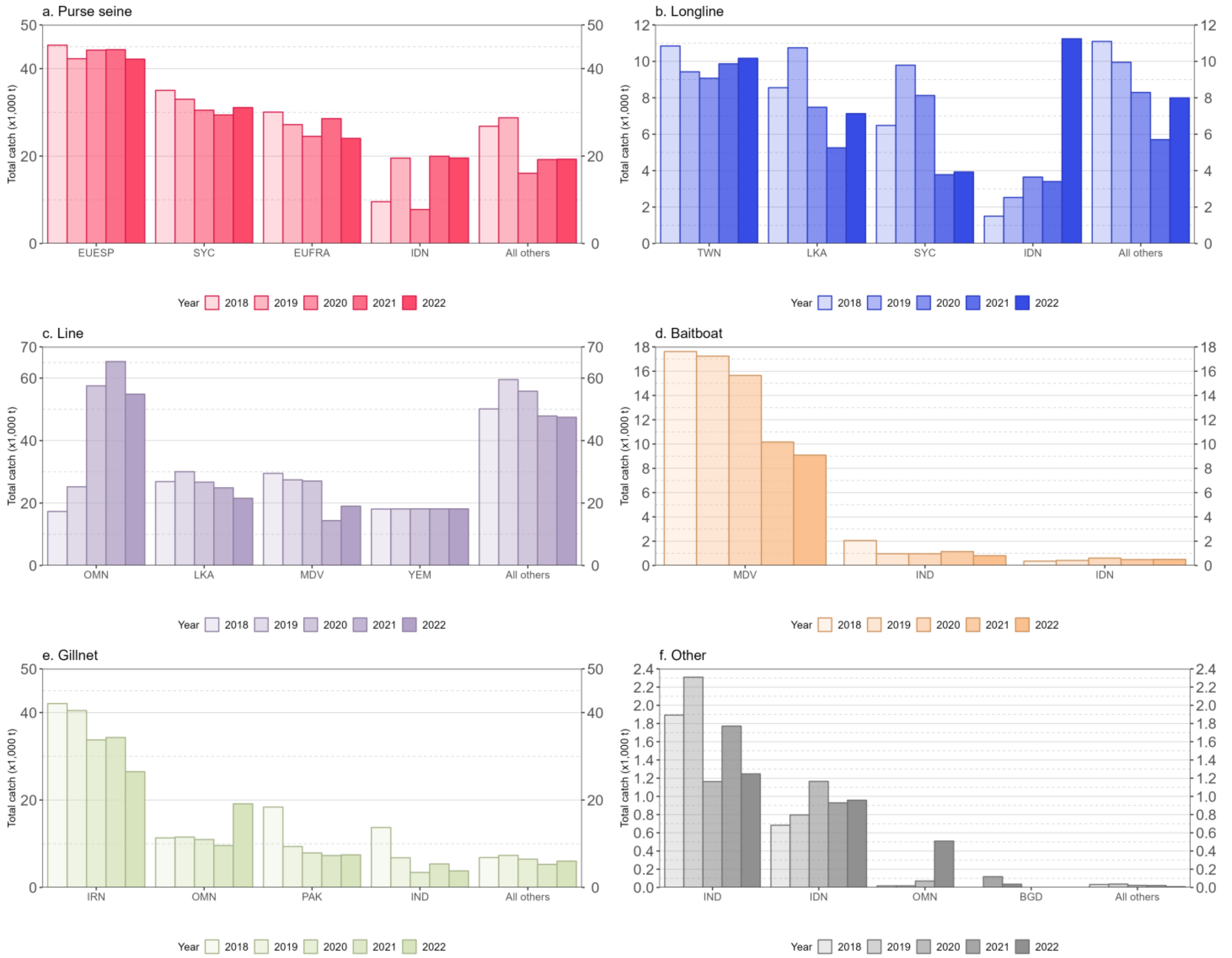

Figure 9: Annual catch (metric tonnes; t) trends of yellowfin tuna by fishery group and fleet between 2018 and 2022. Data source: best scientific estimate of retained catches

Changes from previous WPTT

Very limited changes were detected in the latest time series of best scientific estimates of yellowfin tuna catches compared to those available for the data preparatory meeting of the Working Party on Tropical Tunas in May 2023, and are mainly due to slight updates in the disaggregation of historical catches (**Fig. 10** and **Table 4**).

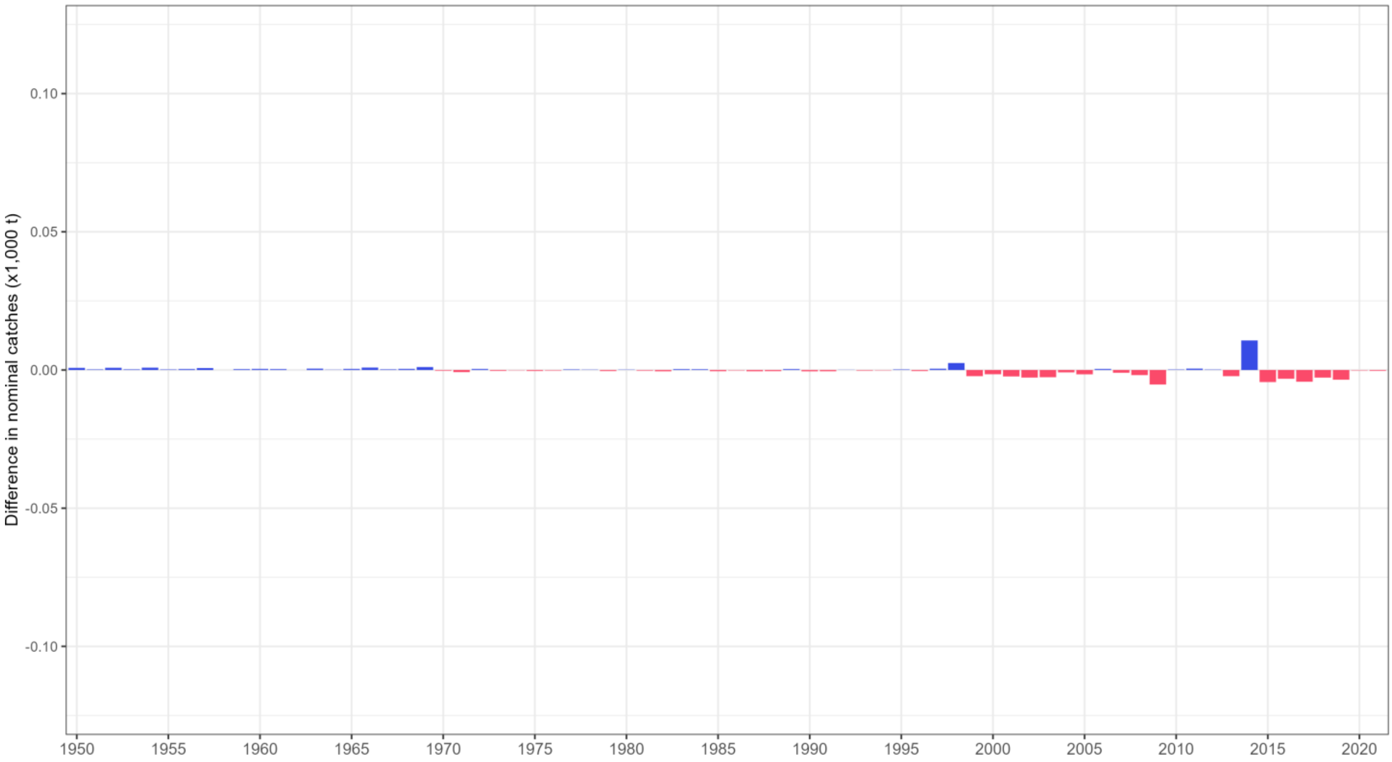

Figure 10: Differences in the available best scientific estimates of retained catches (metric tonnes; t) of yellowfin tuna between this WPTT and its previous session (data preparatory meeting held in May 2023)

Table 4: Changes in best scientific estimates of average annual retained catches (metric tonnes; t) of yellowfin 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 2021 and 2022

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2021	MYS	Longline	Eastern Indian Ocean	86	109	-23
		Longline	Western Indian Ocean	305	281	23

Uncertainties in retained catches data

Reporting quality

The overall quality of the retained catches of yellowfin tuna shows some large variability between 1950 and 2022 (**Fig. 11**). In some years, a large portion of the retained catches of yellowfin tuna had to be estimated through the breakdown of catches reported using species or gear aggregates. The data quality was particularly poor between 1994 and 2002 when less than 70% of the retained catches were fully or partially reported, with most reporting issues coming from coastal fisheries.

The quality has steadily improved over the last decade, to the point that around 83% of the catches was fully available straight from the original CPC submissions in 2022. Nevertheless, more than 29,000 t of retained catches of yellowfin tuna (7% of the total catches) were scored between 6 and 8 and required to be mostly estimated by the Secretariat. In particular, the handline catches of Yemen were repeated from previous years at levels of about 18,000 t and based on information retrieved from the FAO global capture production database. Furthermore, catches from all fisheries of Tanzania and Kenya had to be estimated in absence of data submitted to the Secretariat for the statistical year 2022.

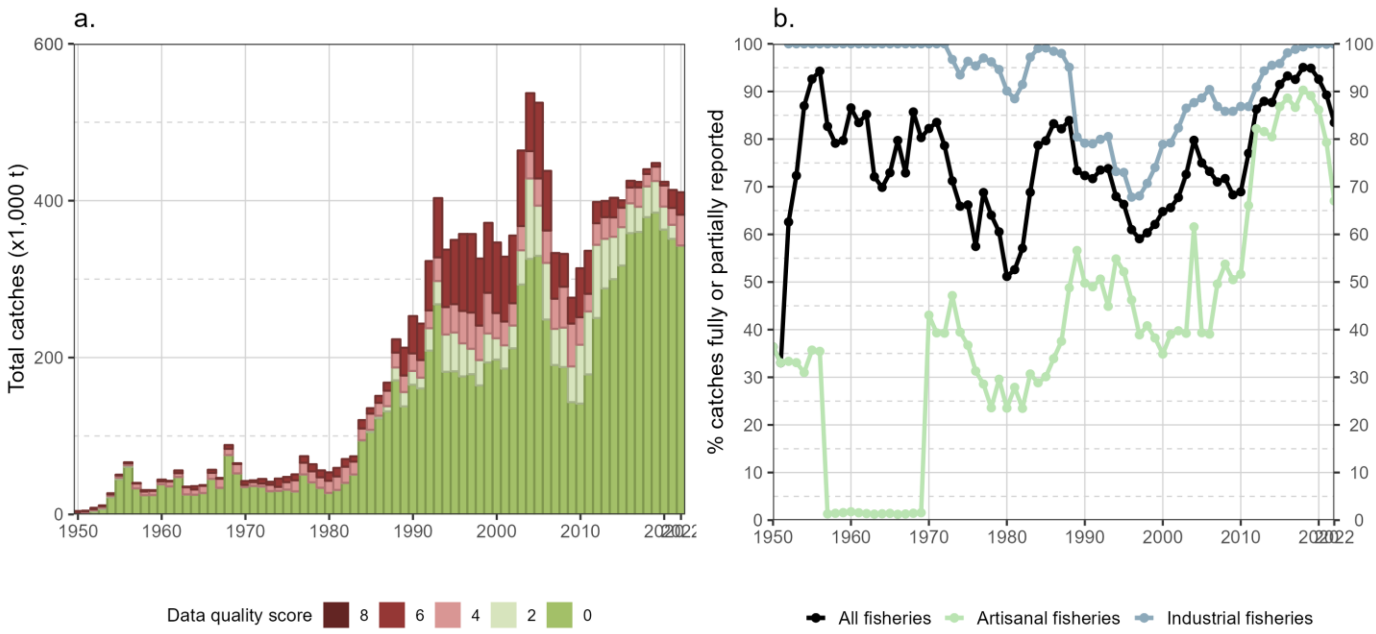

Figure 11: (a) Annual retained catches (metric tonnes; t) of yellowfin tuna estimated by quality score and (b) percentage of retained catches fully or partially reported to the IOTC Secretariat for all fisheries and by type of fishery in the period 1950-2022

Some important issues have been identified in the past to affect the time series of retained catches of yellowfin tuna:

- Coastal fisheries of Indonesia, Madagascar, Yemen, and Sri Lanka (other than gillnet/longline): the retained catches of yellowfin tuna for these fisheries have been estimated by the IOTC Secretariat in recent years (until 2014 for Sri Lanka). The quality of the estimates is thought to be very poor due to the lack of information available about the artisanal fisheries operating in these countries.
- From 2021 until today, the Secretariat has been working closely with Indonesia to review the methodology used by the IOTC for estimating the species composition of the catch of Indonesian artisanal fisheries (MMAF 2021). The Second Draft Report on the review of the re-estimation methodology was presented at the 18th Working Party on Data Collection and Statistics;
- Drifting gillnet fishery of Pakistan: revised catch series spanning the period 1987-2018 have been officially endorsed by the 22nd session of the Scientific Committee, and are now included in the IOTC database. These revised catch series resulted in increased catches of yellowfin tuna by more than 6,200 t each year between 1987 and 2018. There are large uncertainties around the estimates (IOTC 2019c);
- Gillnet fishery of Tanzania: catches have been repeated since 2014 in absence of information;

- Purse seine fishery of EU,Spain: changes introduced in the methodology used to estimate the species composition of the catch for 2018 resulted in figures largely contrasting with other segments of the same fleet (IOTC 2019b). Following the and Data Preparatory meeting of the WPTT24 (IOTC 2022a) and based on the methodology presented in IOTC (2019a), the species composition of the catch has been estimated by the Secretariat for that year (IOTC 2022b) but have now been reverted to officially reported information received by the Secretariat in July 2023;

- Longline fishery of Indonesia: no report of historical catches for national longliners that are not based in Indonesia (e.g., Port Louis, Mauritius).

Discard levels

The total amount of yellowfin 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 2013 (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 yellowfin tuna are mainly composed of fish smaller than 50 cm (~0.94 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 amounted to a few hundred tonnes annually in that period (Ruiz et al. 2018).

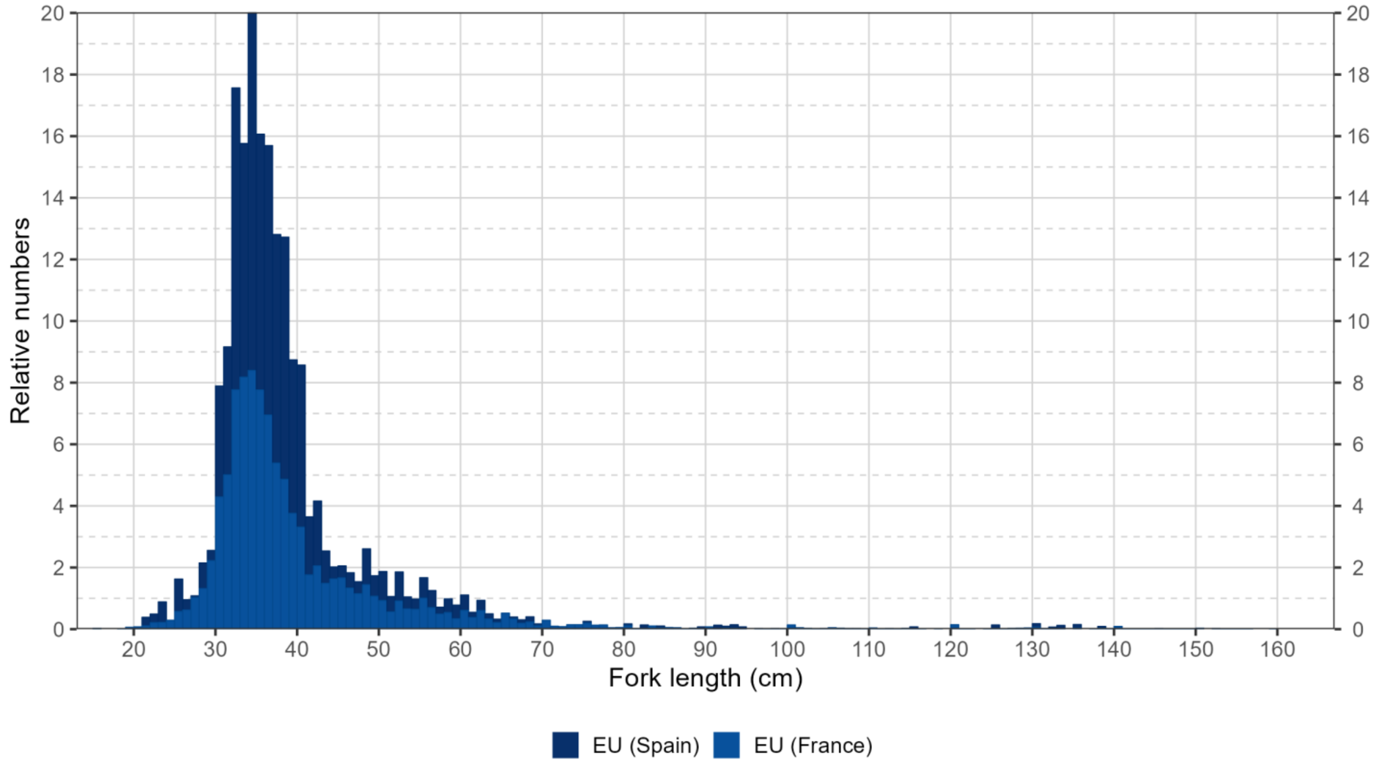

Figure 12: Fork length (cm) distribution of yellowfin tuna discarded at sea in purse seine fisheries during the period 2016-2020 (n = 129,520). Data source: IOTC ROS database

Discarding may also occur in tropical longline fisheries, mainly due to depredation by sharks and cetaceans (Rabearisoa et al. 2018). In the Taiwanese longline fishery operating in the Indian Ocean for instance, the discarding rate of yellowfin tuna has been estimated at 0.42% in the fleet targeting yellowfin tuna and 3.43% 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 2009-2018. The data show no clear pattern in the size of the yellowfin tunas discarded at sea (since the depredation process might not be size-selective) although the discards in the Reunion-based fresh longline fishery are smaller than in the Japanese deep-freezing longline fishery, i.e., a median of 63.5 cm vs. 94.5 cm (**Fig. 13**). Recently, the practice of high grading in longline fisheries has been suggested to occur in some pelagic longline fisheries operating in the South of the Indian Ocean. Preliminary analysis conducted on size data of retained yellowfin tuna caught in Indian Ocean longline fisheries does not seem to support the hypothesis of major changes in discarding practice, e.g., linked to high grading in relation with the implementation of Res. 17/01 (Medley et al. 2021).

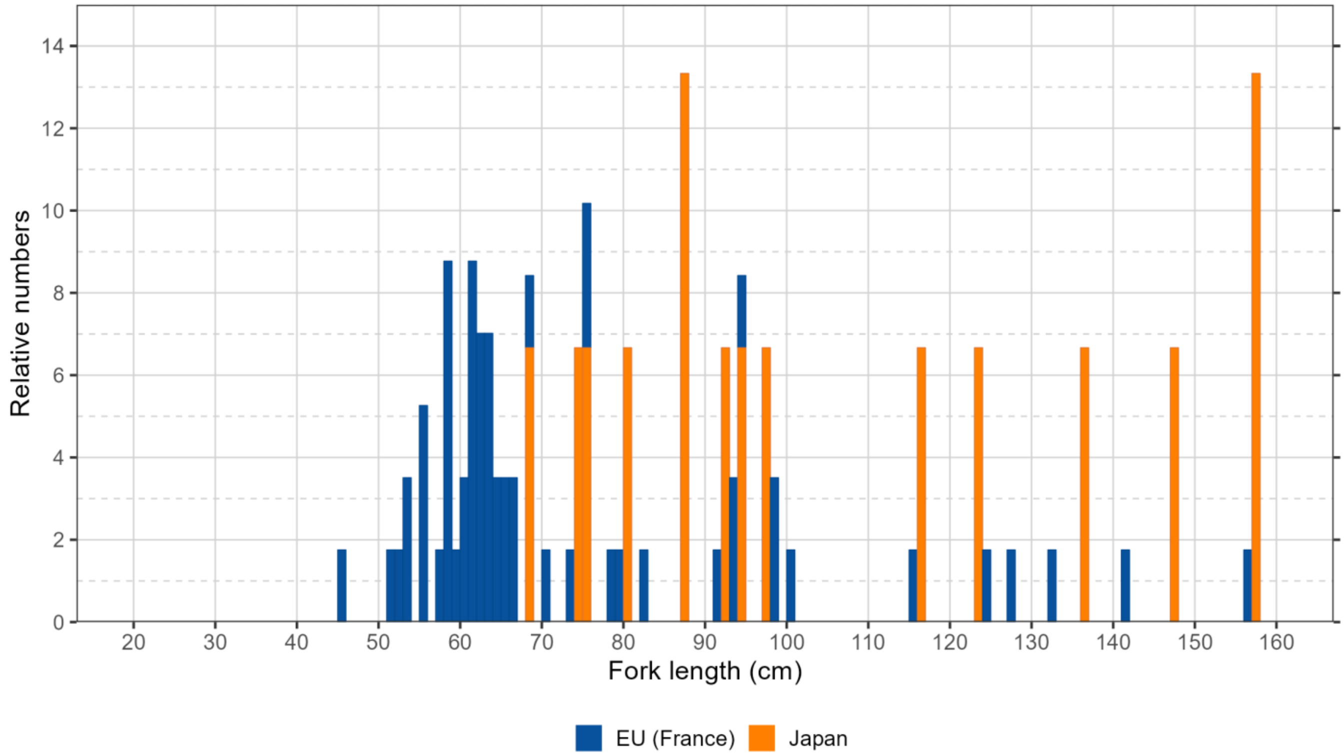

Figure 13: Fork length (cm) distribution of yellowfin tuna discarded at sea in longline fisheries during the period 2009-2020 (n = 516). Data source: IOTC ROS database

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 yellowfin tuna over the last decades (**Fig. 14**). As early as the 1950s, yellowfin tuna was caught by large-scale longline fisheries across most of the Indian Ocean while coastal gillnet and line fisheries were active in the Arabian Sea and baitboats in the Maldives and off the south-western coast of India.

Throughout the 1960s and 1970s, the longline fisheries expanded in the south-western part of the Indian Ocean, including in the Mozambique Channel (**Fig. 14.b-c**). From the 1980s, the purse seine fishery developed in the western Indian Ocean, with most of the yellowfin tuna caught in free-swimming schools (**Fig. 14.d**).

During the 1990s and 2000s the industrial purse seine fisheries increased their catches and expanded their fishing grounds in the western Indian Ocean, while the coastal fisheries of the northern countries of the Indian Ocean grew substantially in importance and a large fresh longline fishery developed in the north-eastern Indian Ocean (**Fig. 14.e-f**).

The overall annual distribution of yellowfin tuna catches by fishery has changed little over the period 2018-2022 (**Fig. 15**). Most yellowfin tuna catches are located in the central and western Indian Ocean, with important catches also reported around Sri Lanka and along the coasts of Indonesia. Purse seine fisheries largely dominate in the western Indian Ocean around the Seychelles archipelago (between 20°S and 10°N), and showed an expansion towards the north between 2018 and 2022, possibly because of the ad-interim plan for rebuilding the yellowfin tuna stock (IOTC resolutions 16/01 and superseding) which triggered changes in fishing practices.

Georeferenced catches by fishery and decade (1950-2009)

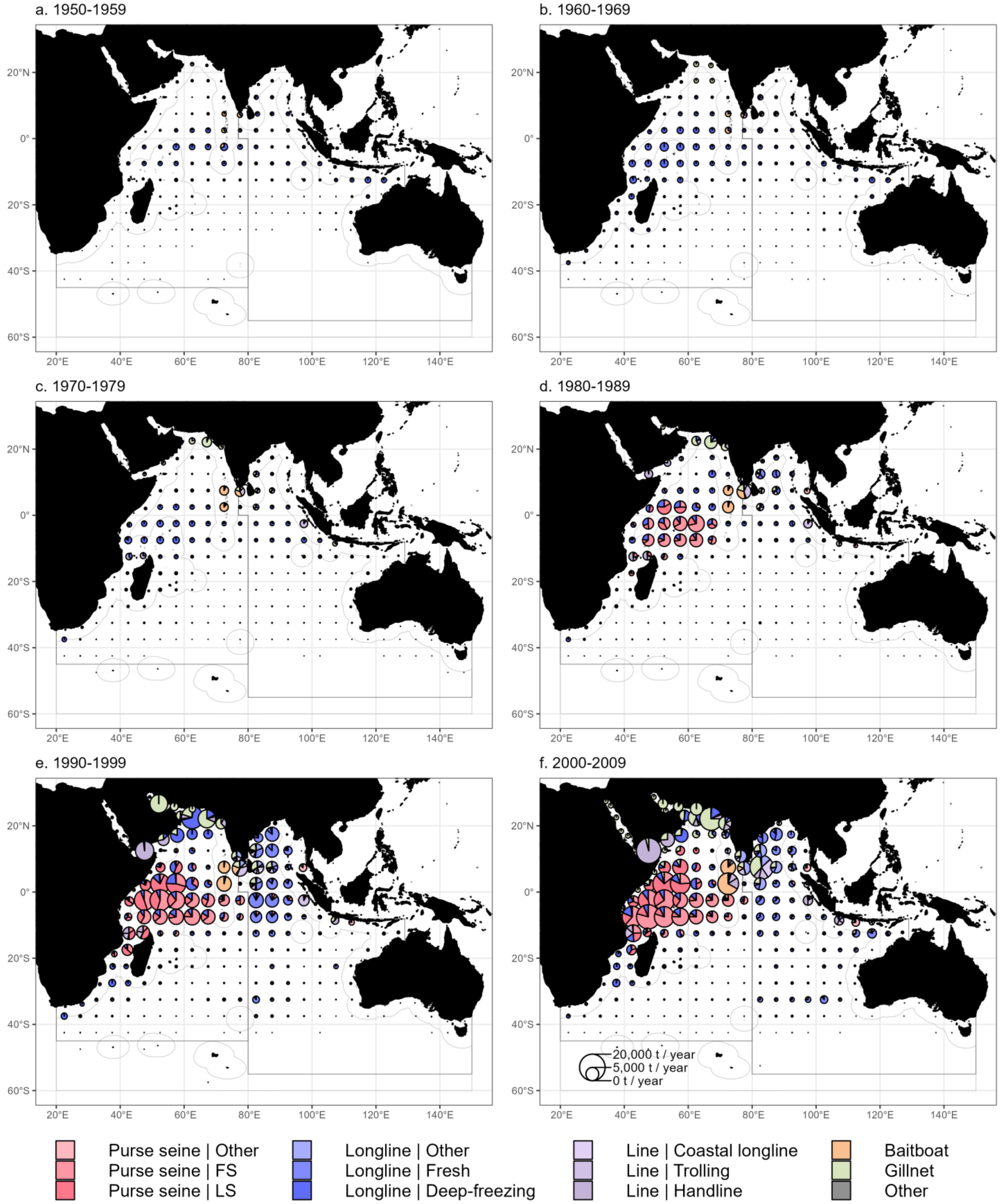

Figure 14: Estimated mean annual time-area catches (metric tonnes; t) of yellowfin tuna by decade, 5x5 grid, and fishery. Data source: yellowfin tuna raised time-area catches

Georeferenced catches by fishery, last years (2018-2022) and decade (2010-2019)

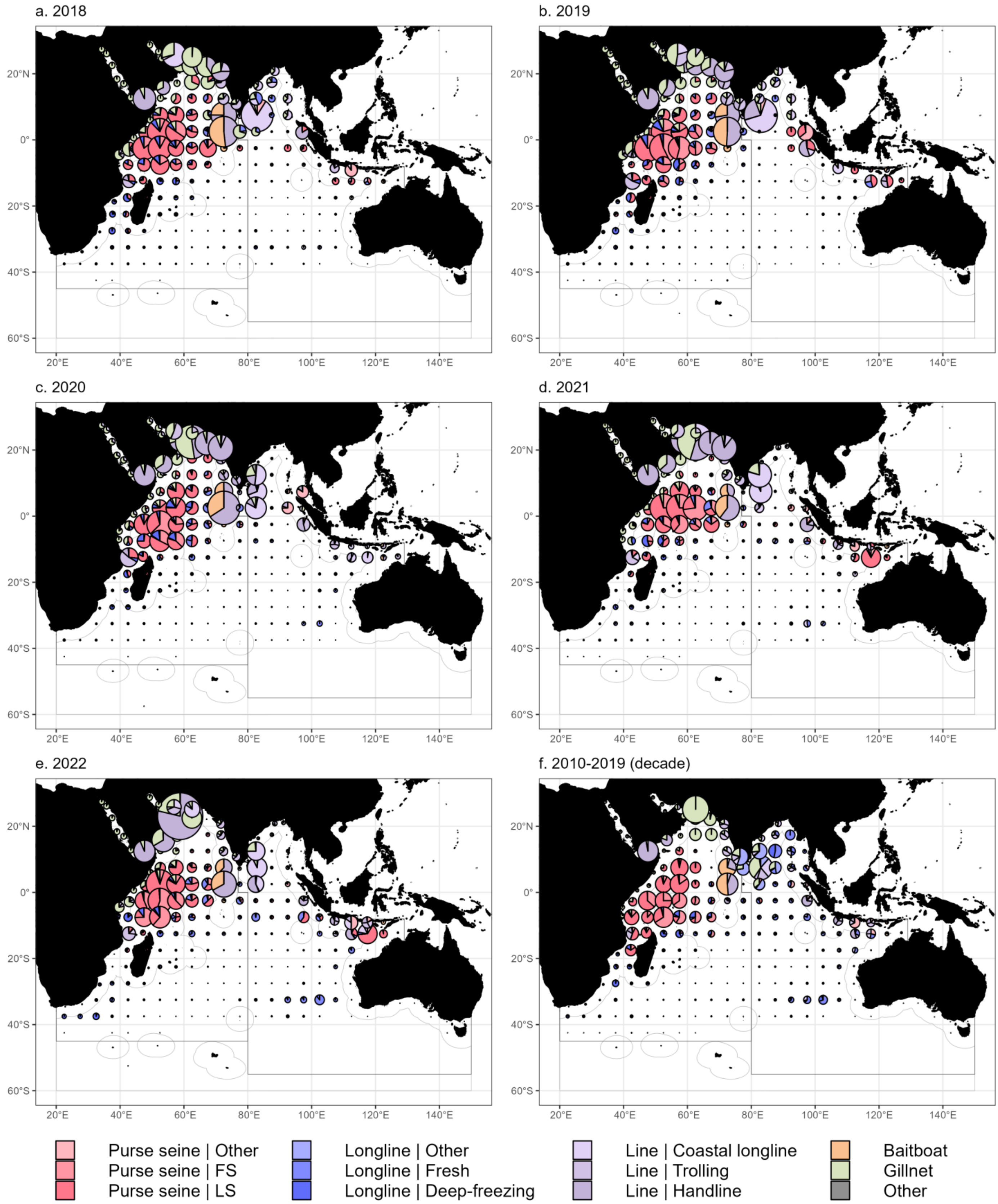

Figure 15: Estimated mean annual time-area catches (metric tonnes; t) of yellowfin tuna by year / decade, 5x5 grid, and fishery. Data source: yellowfin tuna raised time-area catches

Indonesia appears to have developed an industrial purse seine fishery since 2018 (**Fig. 15d-e**), which mainly operates in coastal areas of the eastern Indian Ocean with vessels of length overall between 30 and 40 m. Baitboat fishing is essentially concentrated in the Maldives archipelago while gillnet and line fisheries (handline, trolling, and coastal longline) are widely used along the coasts of Oman, Pakistan, India, Sri Lanka, Indonesia, and Yemen, with very little information available for this latter country.

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 are considered to be of poor quality. Consequently, the trend in quality of the catch-effort data is driven to some extent by the relative contribution of artisanal fisheries to the total catches of yellowfin tuna (**Fig. 16.b**).

The main issues identified in the past concern:

- the fresh-tuna longline fishery of Taiwan,China, for which data have only been available since 2006, and the fresh-tuna longline fishery of Indonesia, with data only available from 2018 onward (although logbook coverage is thought to be low);
- the gillnet fisheries of I.R. Iran (before 2007) and Pakistan, for which data are either incomplete or lacking;
- the gillnet-longline fishery of Sri Lanka (until 2014), described by poor quality effort data;
- important coastal fisheries using hand and/or troll lines, and in particular those from Oman, Yemen, Madagascar, India, and Indonesia (until 2018), for which no data (or incomplete data) have been reported to the Secretariat.

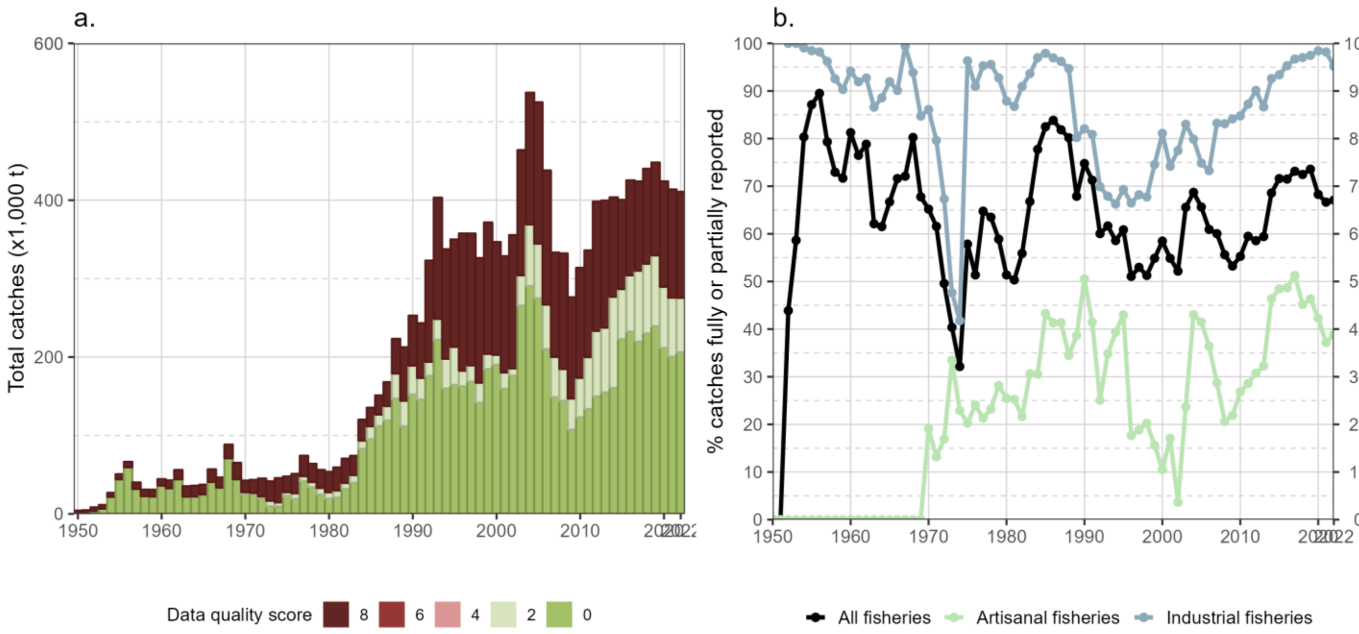

Figure 16: Annual retained catches (metric tonnes; t) of yellowfin tuna estimated by quality score (barplot) and percentage of geo-referenced catches reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950-2022

The percentage of data considered of good quality (scores of 0-2) varied between 51% and 75% during the 1990s and 2000s and has stabilized over the last decade showing an increasing trend in quality overall from 59% in 2013 to 74% in 2013, with 67% of good quality data available in 2022 (**Fig. 16.a-b**). Catch and effort data became progressively available for some important fisheries such as coastal longline, fresh longline, and hand line from Sri Lanka since 2014, coastal longline from I.R. Iran since 2016, small-scale purse seine and fresh longline from Indonesia since 2018, and some smaller fisheries such as trolling from Indonesia and hand line from Kenya since 2018.

Nevertheless, geo-referenced catch-effort data are not available for about 33% (i.e., around 140,000 t) of the total nominal catches of yellowfin tuna in 2022.

No information was available for several coastal fisheries, including:

- the handline fisheries of Oman (~55,000 t), Yemen (~18,000 t), and India (~1,000 t);
- the gillnet fisheries of Oman (~19,000 t), Pakistan (~6,000 t), Tanzania (~4,000t), and India (~4,000 t);
- the coastal longline and trolling fisheries of India (~5,000 t), Comoros (~ t), and I.R. Iran (~3,000 t).

In addition, no spatial information has been provided by a few industrial purse seine fisheries such as EU,Italy (since 2016) and I.R. Iran (since the beginning of the time series), with the two fleets accounting in 2022 for relatively low total catch levels of yellowfin tuna of ~2,400 t and ~ t, respectively.

Size composition of the catch

Samples availability

By fishery group

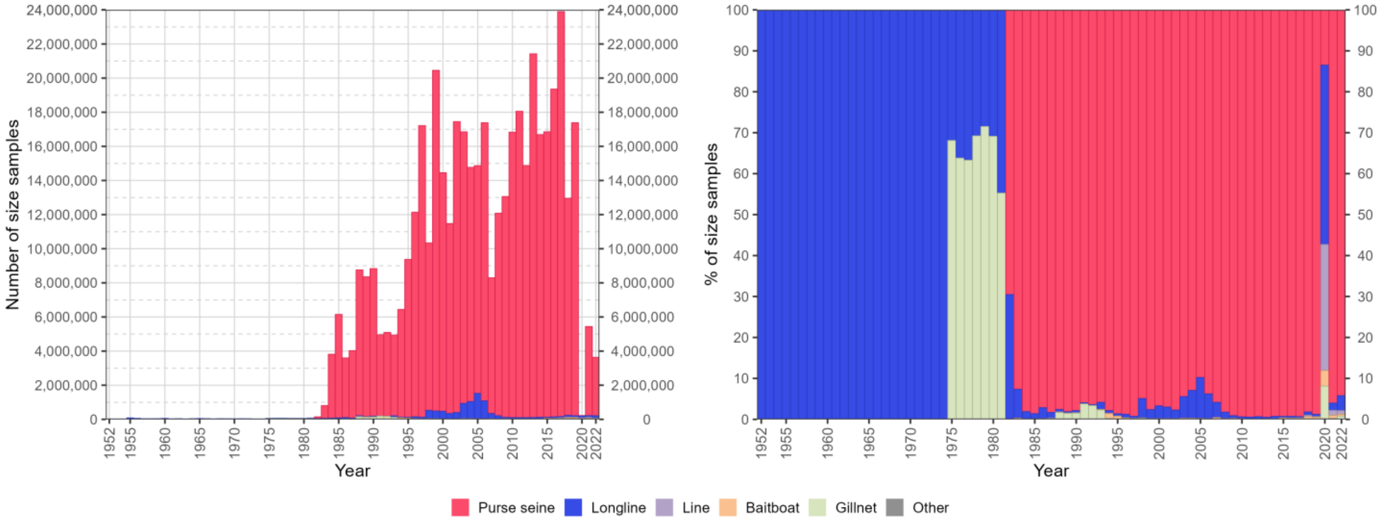

Figure 17: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset (Res. 15/02)

Comprehensive size-frequency data for yewllofin 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 20 million individual lengths reported for a single year (**Fig. 17**).

The contribution of longline fisheries to the total available samples for the species became more evident during the 2000s, and reflects the actual level of catches from these fisheries (**Fig. 22**). In general, samples from all other fisheries (using baitboats, gillnets and miscellaneous gears mostly of artisanal nature) are limited and highly dependent on the fleet (**Fig. 32**).

Due to the CoViD-19 pandemic, size-frequency data of yellowfin 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 is generally representative of the fishing grounds where the fisheries operate, and proportional to the level of recorded captures (**Fig. 18**).

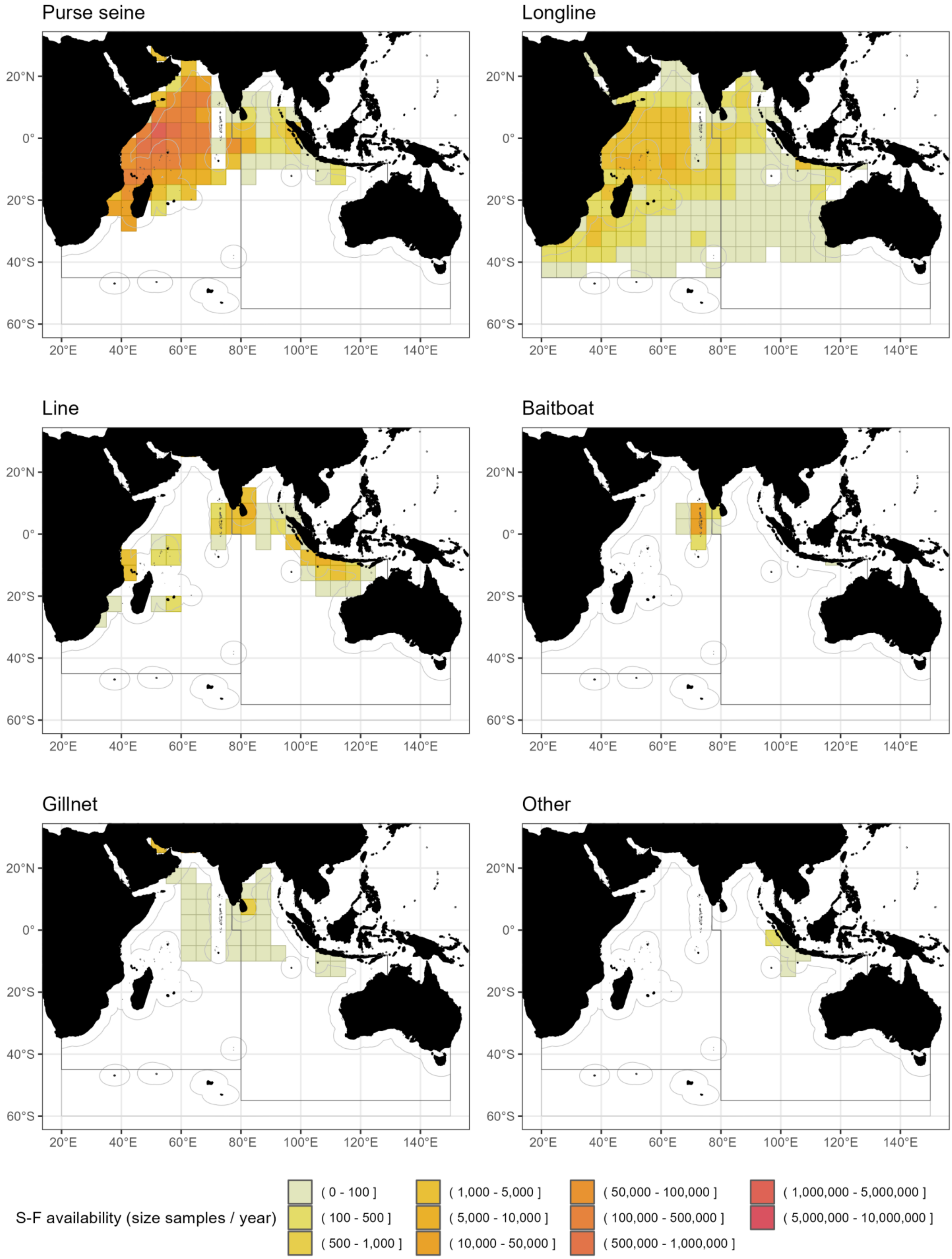

Figure 18: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data for each fishery group in the period 2018-2022. Data source: standardized size-frequency dataset (Res. 15/02)

By fishery

Purse seine fisheries

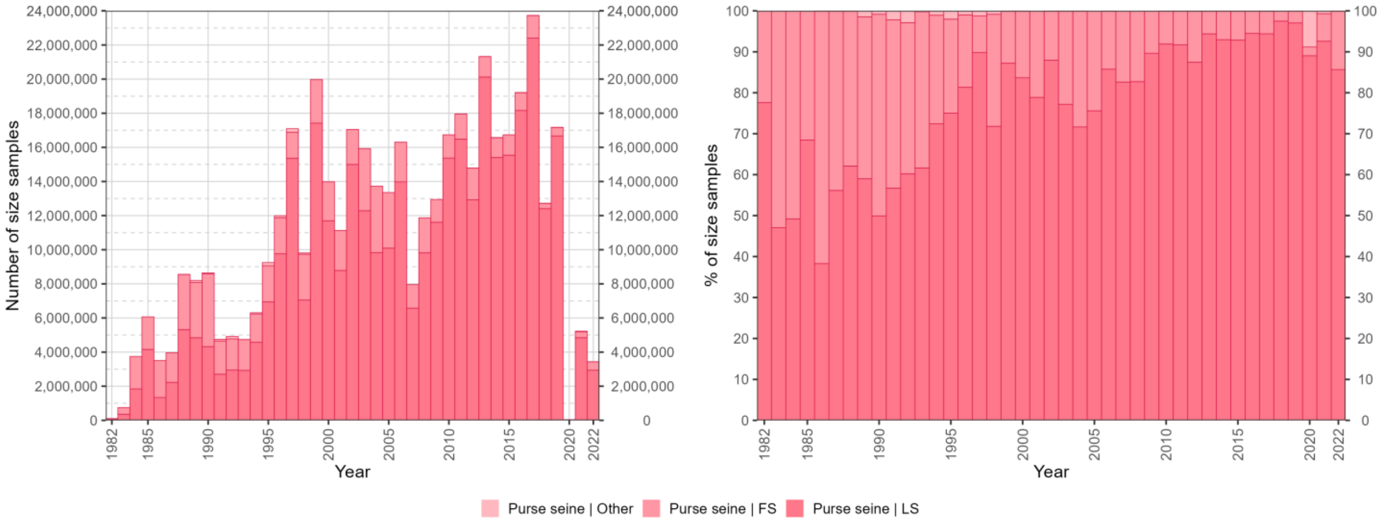

Figure 19: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and purse seine fishery type. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

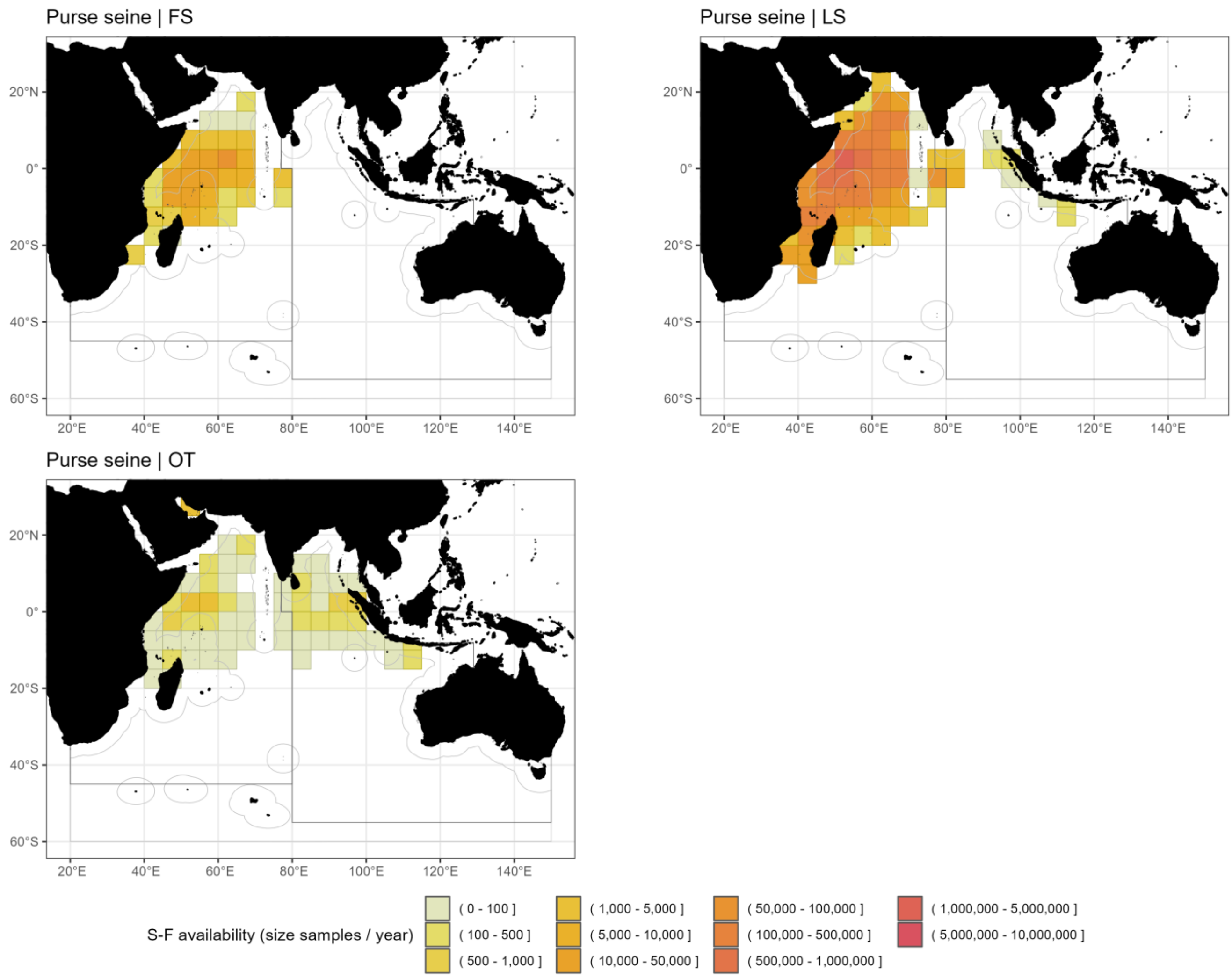

Figure 20: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by purse seine fishery types in the period 2018-2022. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

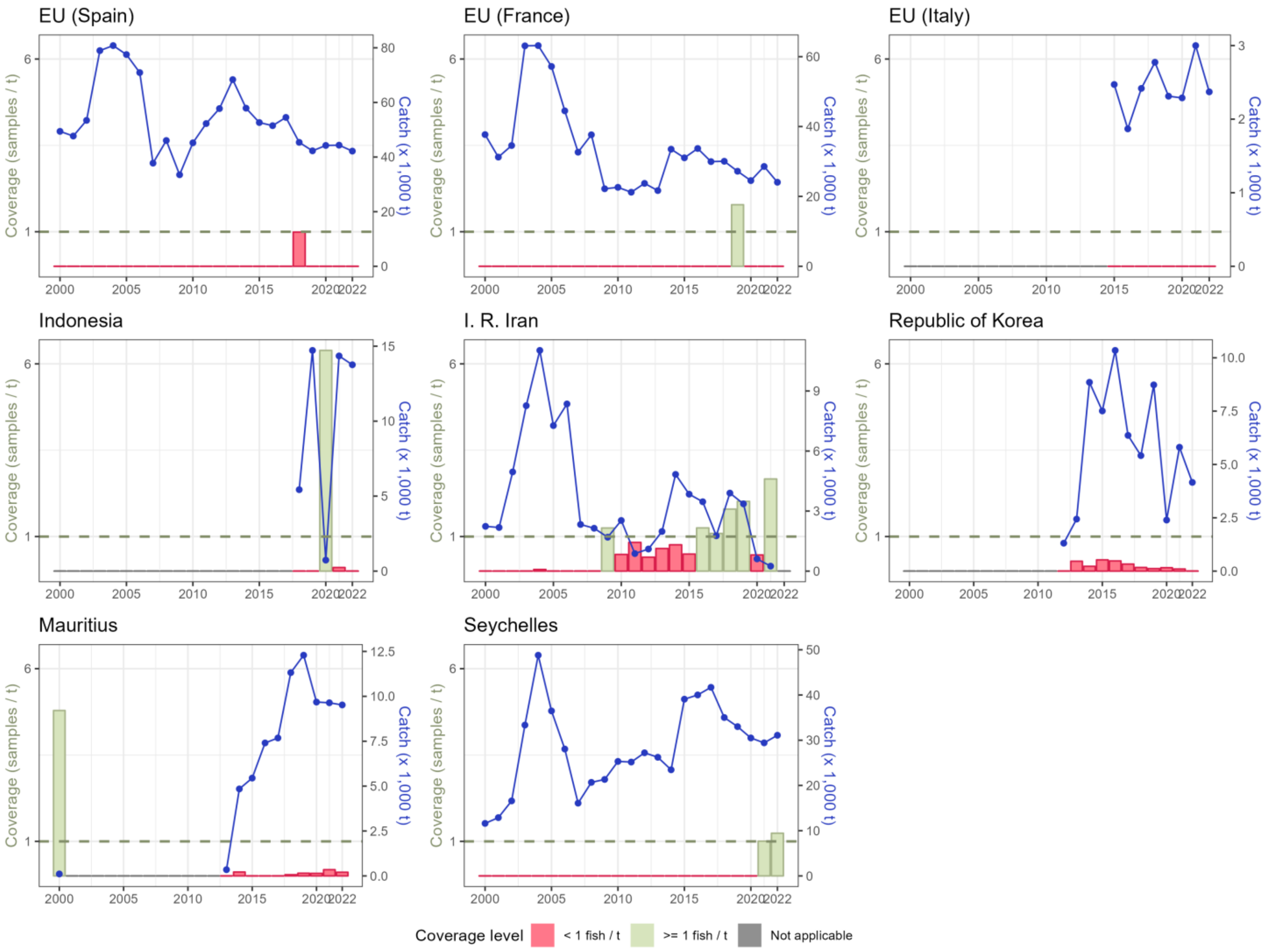

Figure 21: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major purse seine fleets, by fleet and year (2000-2022). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Longline fisheries

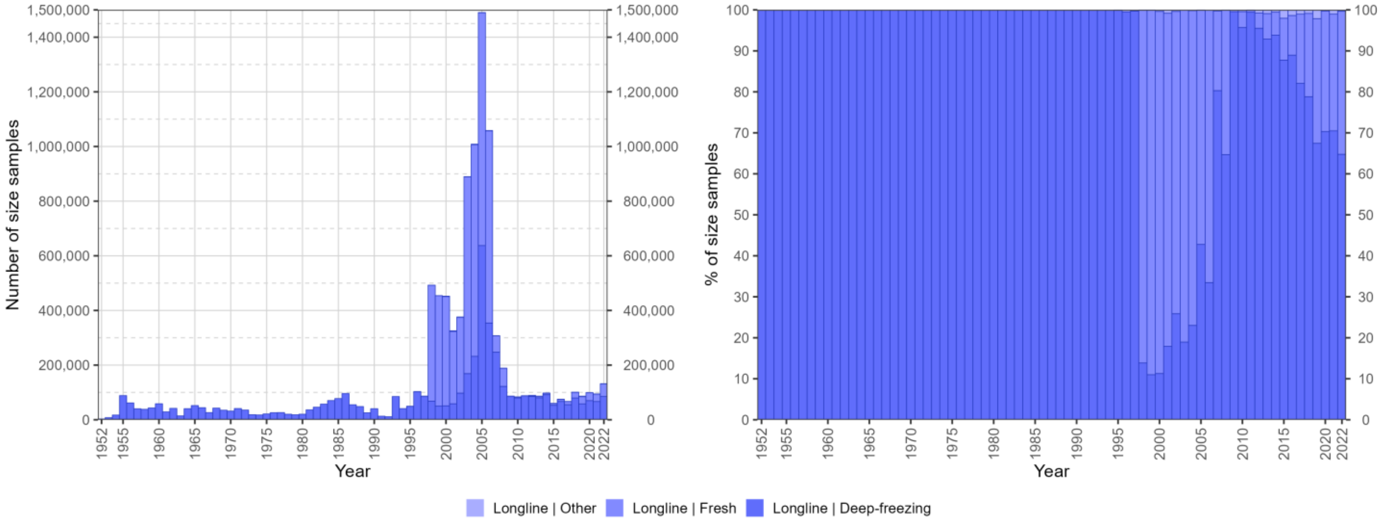

Figure 22: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and longline fishery type. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

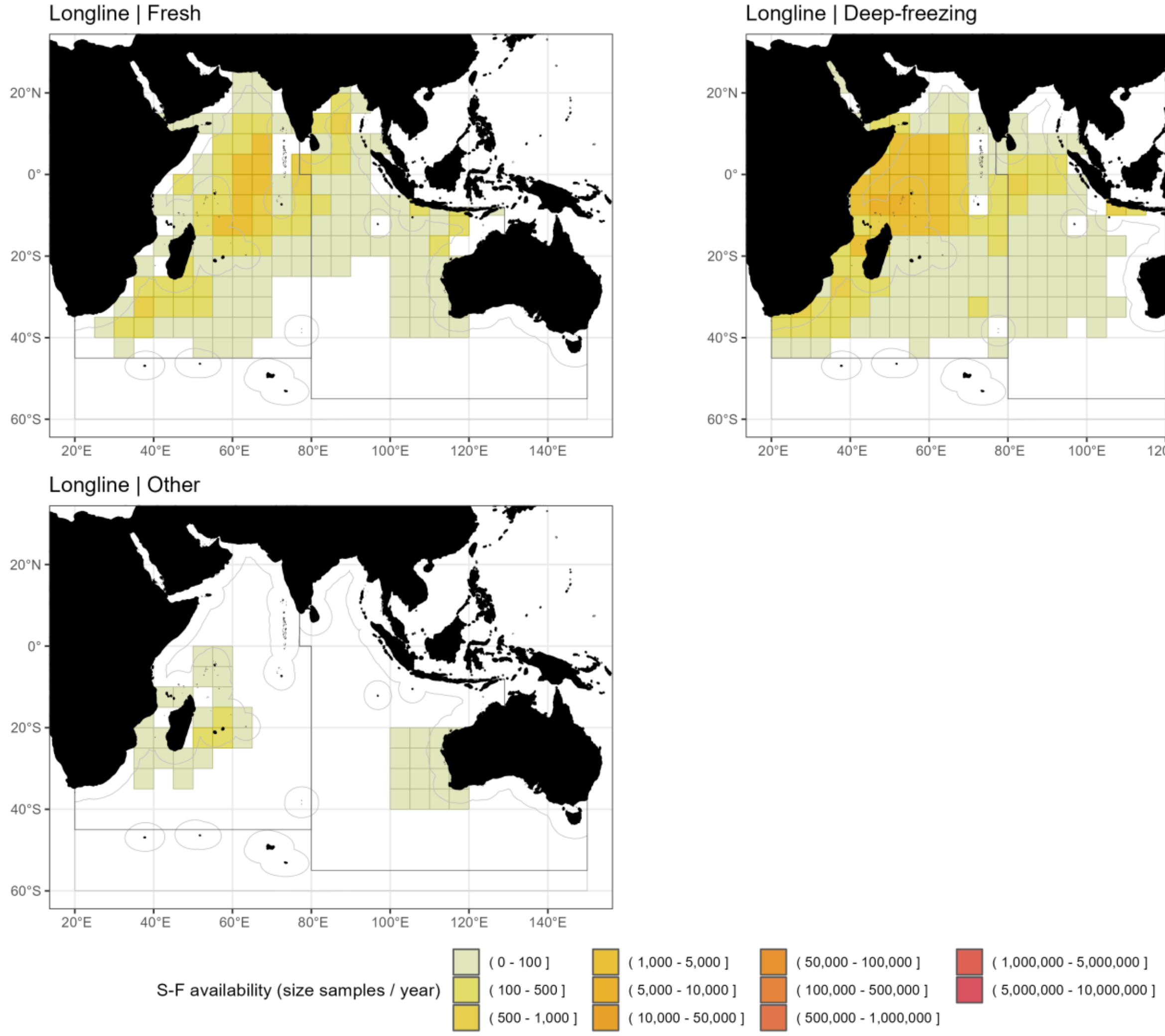

Figure 23: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by longline fishery types in the period 2018-2022. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Coverage levels of yellowfin tuna samples over the period considered indicate that longliners from Taiwan,China were regularly exceeding the minimum threshold of 1 measured fish per metric tonne of retained catches. Japanese longliners, instead, reached or surpassed that level only between 2017 and 2019, which is an indication that the representativeness of yellowfin tuna samples from the Japanese deep-freezing longliners in previous years might not be optimal (**Fig. 24**). Same considerations can be made for size-frequency data from the other longline fleets with the possible exception of those from Seychelles which were relatively well sampled prior to 2015 (**Fig. 24**). Information provided by the Seychelles Fishing Authority indicates that complementary size-frequency data collected throughout the period 2015-2021 should be submitted to the Secretariat in 2023. However, it is important to note how the analysis of longline size-frequency data available at the IOTC Secretariat shows strong variability in the quality and reliability of the data available from Taiwan,China and Seychelles over time and space, leading to the recommendation of omitting these data from stock assessments until the issues have been addressed (Hoyle et al. 2021) (see also details in section Uncertainties in size-frequency data).

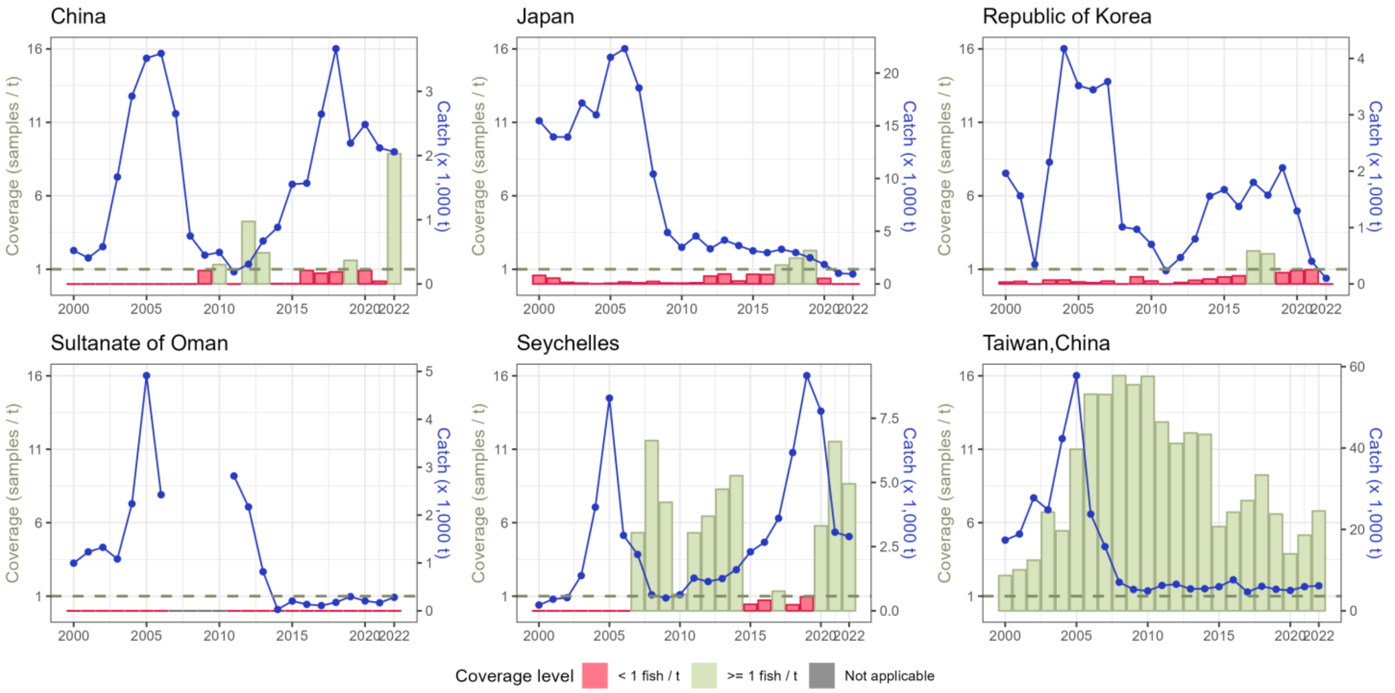

Figure 24: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major deep-freezing longline fleets, by fleet and year (2000-2022). Data source: standardized size-frequency dataset (Res. 15/02)

In the case of fresh-tuna longliners, the level of coverage (and more in general the availability of samples) varies greatly with the fleet and years considered. In recent years, only Sri Lanka, Taiwan,China, and Malaysia (to a lesser extent) managed to reach the minimum level of coverage, while the other fleets did not reach the sampling target of 1 fish per metric tonne in most years (**Fig. 25**).

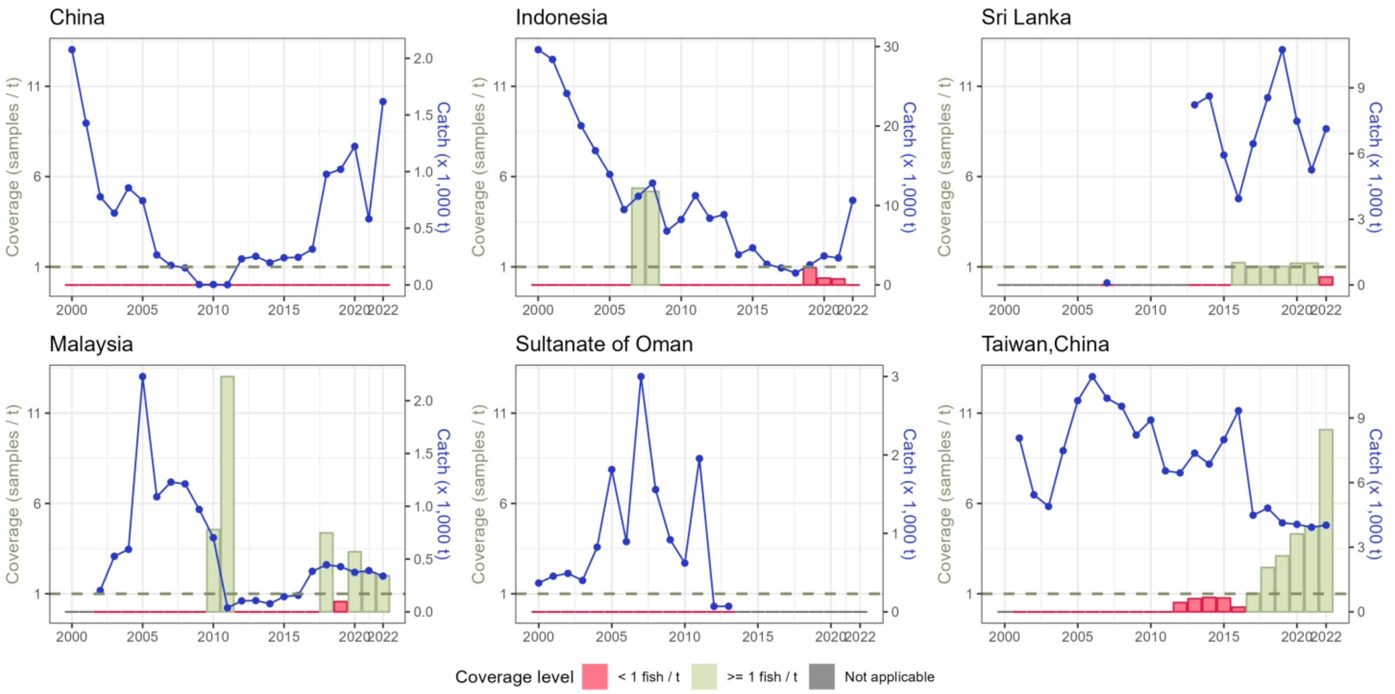

Figure 25: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major fresh-tuna longline fleets, by fleet and year (2000-2022). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Longliners targeting swordfish are also known to interact frequently with the species. Among the major fleets involved in this fishery, Australia is the one that has been generally sampling the species at very good levels, i.e., well above the minimum threshold required by IOTC. Madagascar, which was able to provide size frequency data in recent years thanks to a project funded by the World Bank, has failed to provided size data in 2021 upon termination of the project. All other fleets tend to alternate years of sufficient sampling with years in which no information is collected or reported to the Secretariat. The swordfish longline fishery of EU,Spain ranks worst in terms of coverage level, with the minimum coverage only reached in 2021 in the considered timeframe (**Fig. 25**).

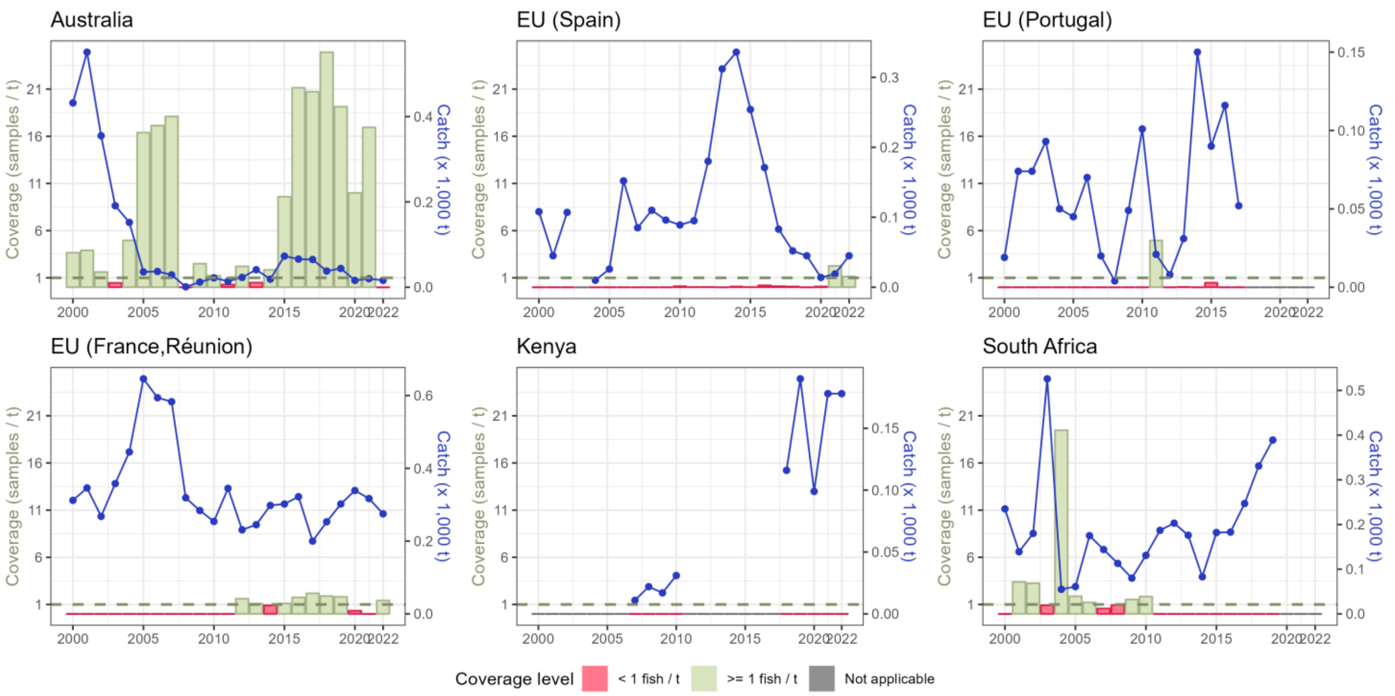

Figure 26: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major swordfish targeting longline fleets, by fleet and year (2000-2022). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Line fisheries

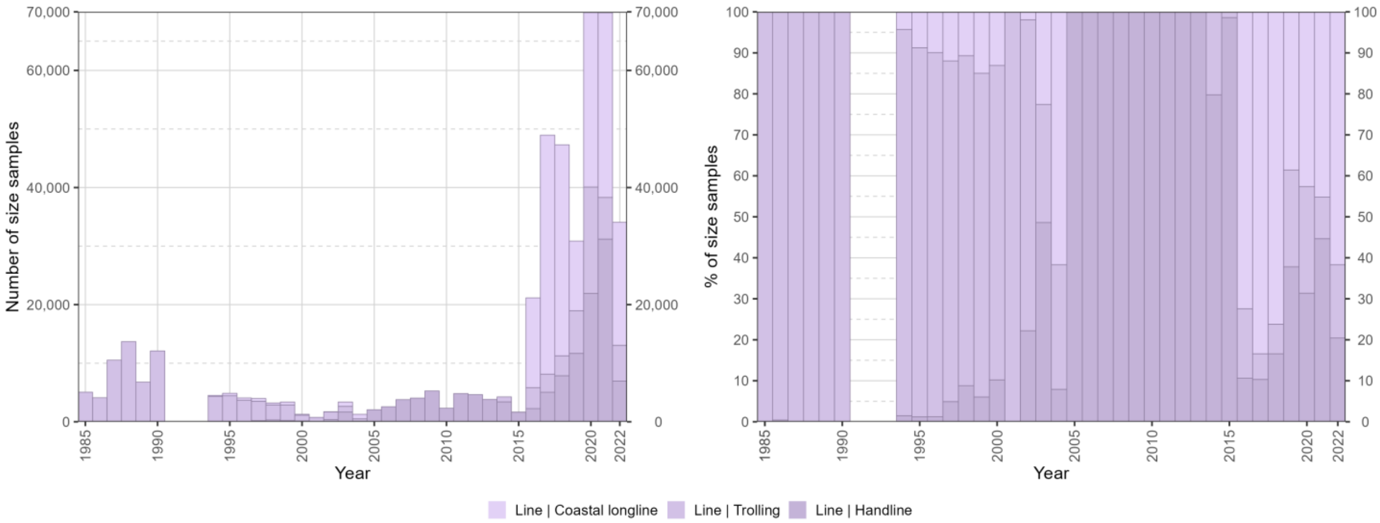

Figure 27: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

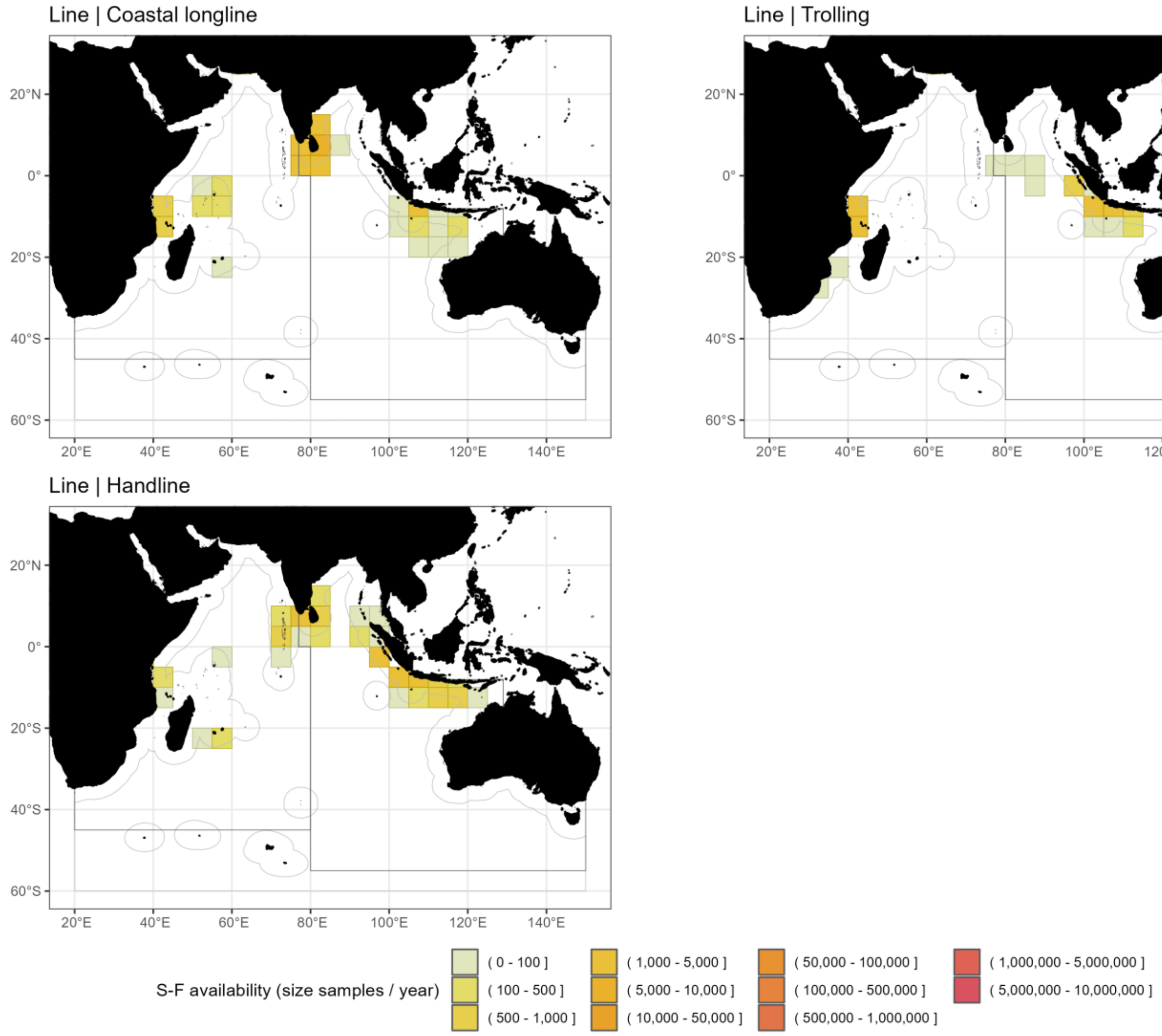

Figure 28: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by line fishery types in the period 2018-2022. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

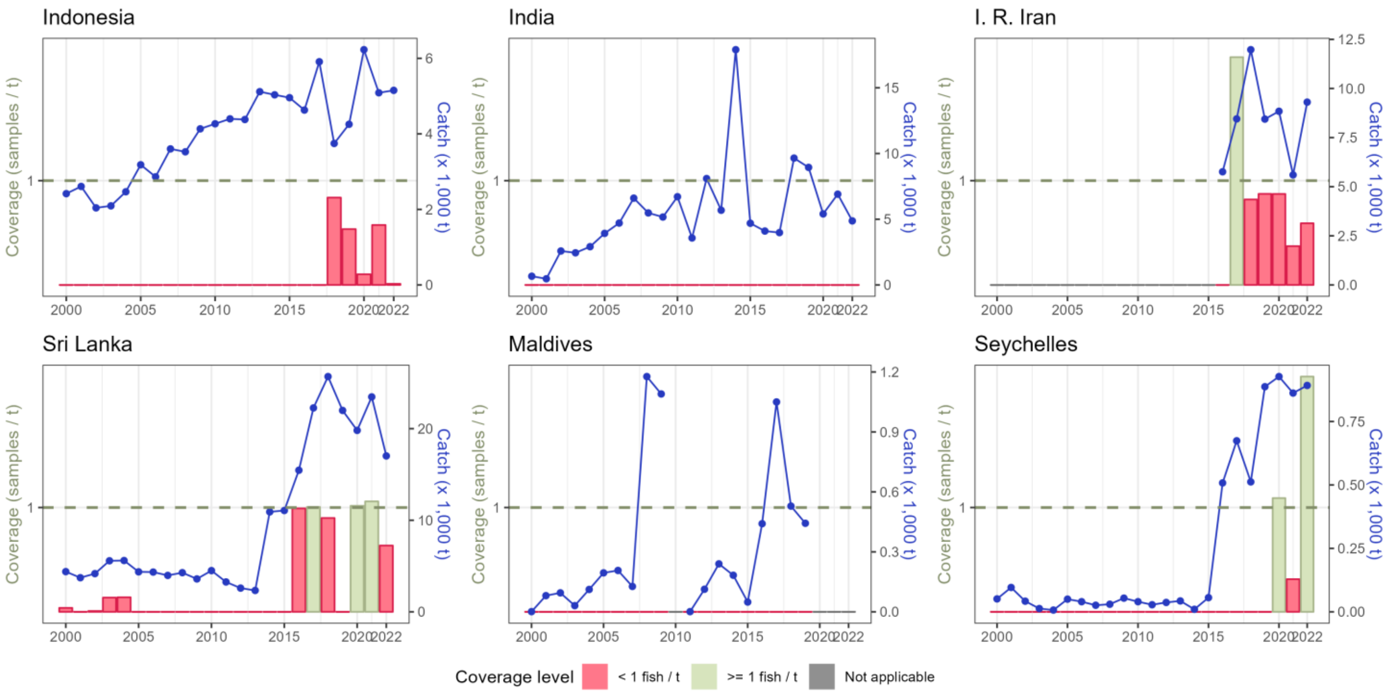

Figure 29: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major coastal longline fleets, by fleet and year (2000-2022). Data source: standardized size-frequency dataset (Res. 15/02)

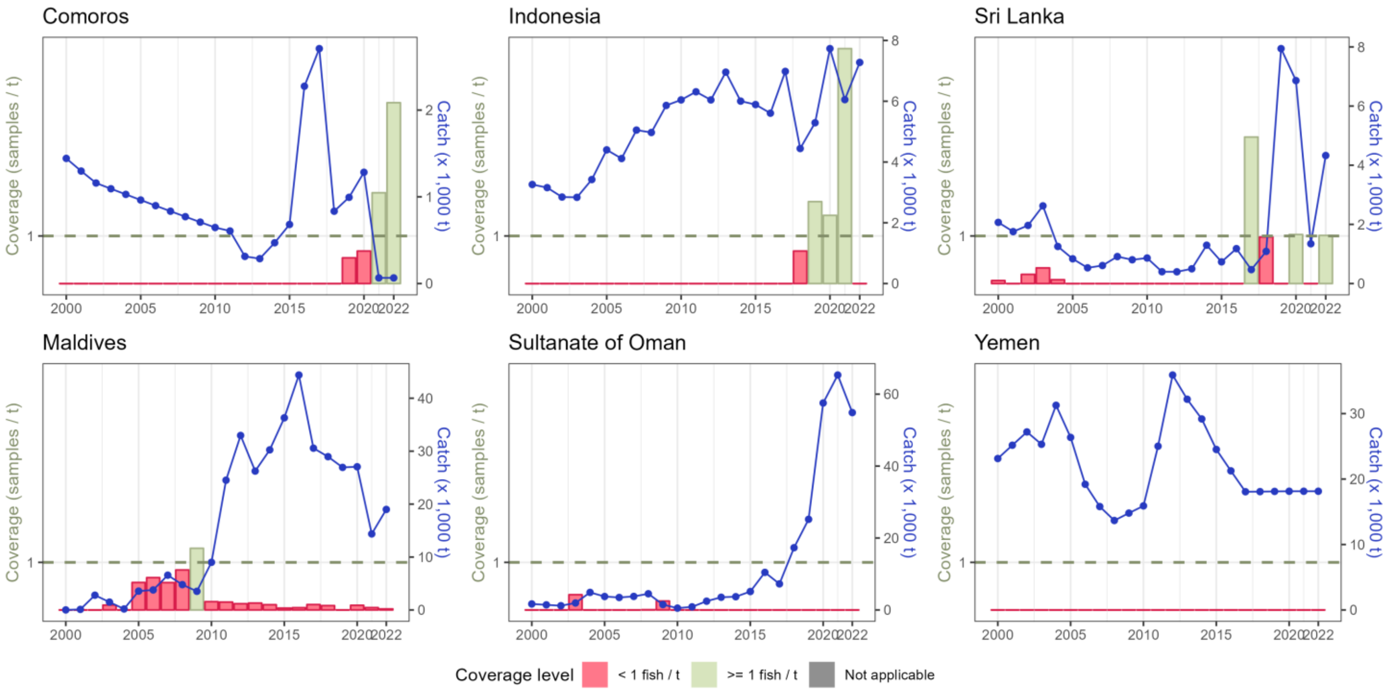

Figure 30: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major handline fleets, by fleet and year (2000-2022). Data source: standardized size-frequency dataset (Res. 15/02)

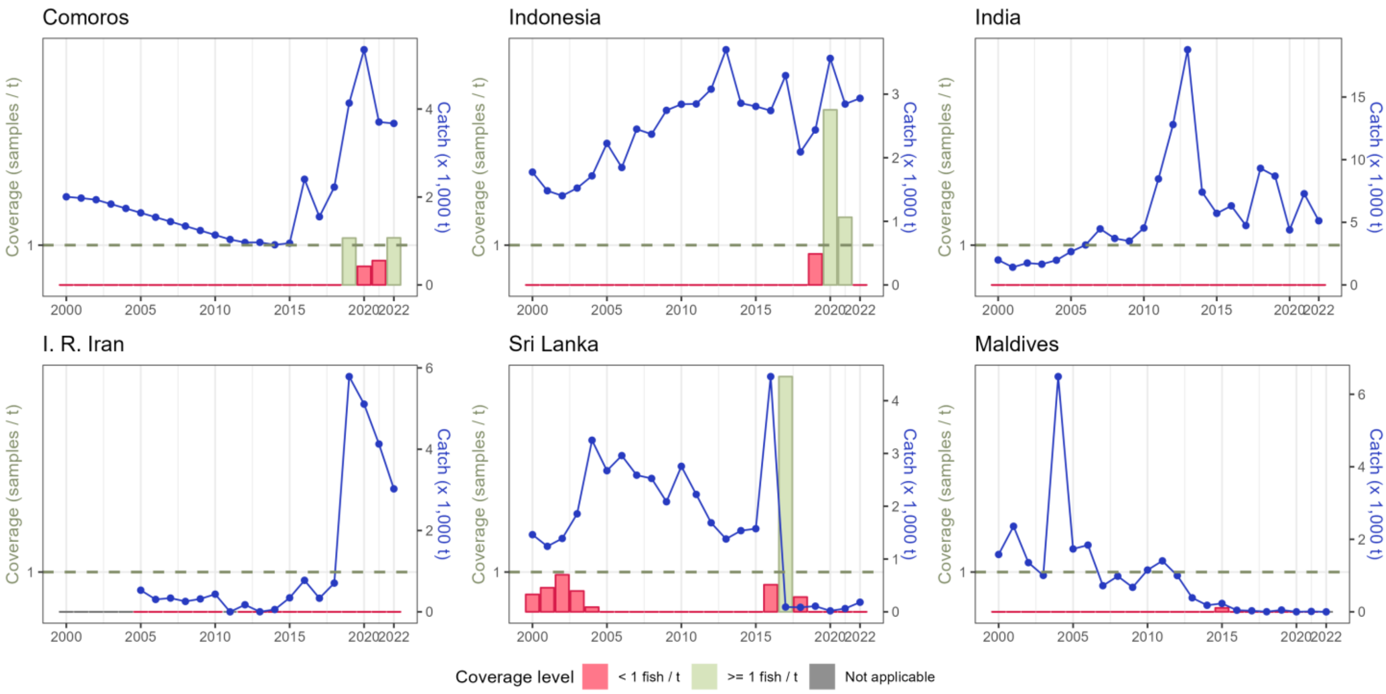

Figure 31: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major troll line fleets, by fleet and year (2000-2022). Data source: standardized size-frequency dataset (Res. 15/02)

Other fisheries

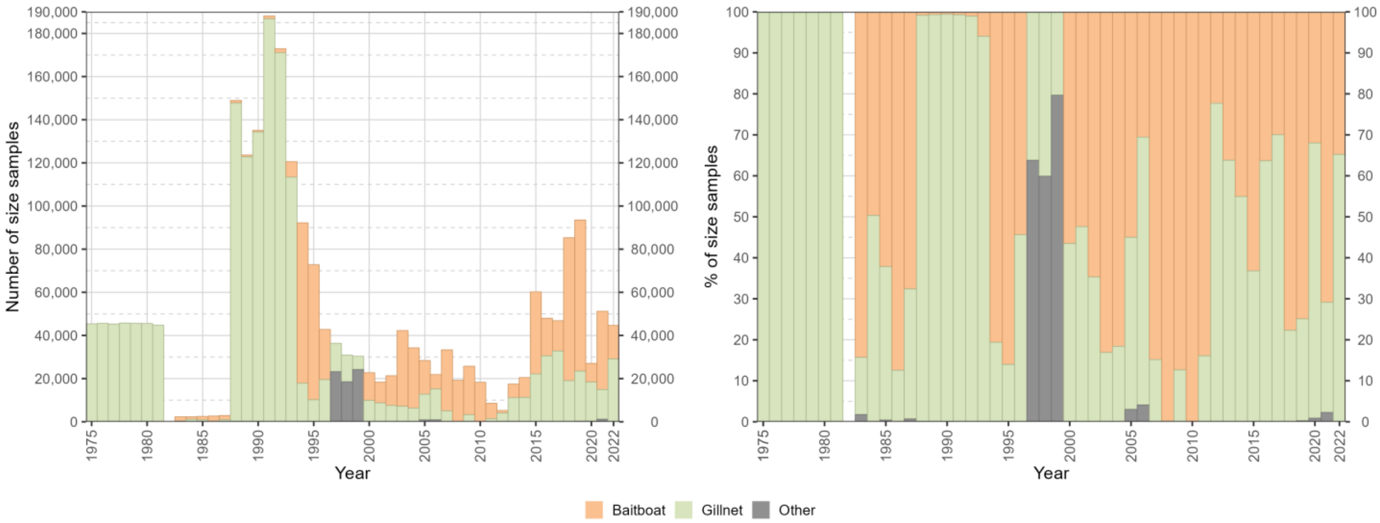

Figure 32: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and all other fishery types. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

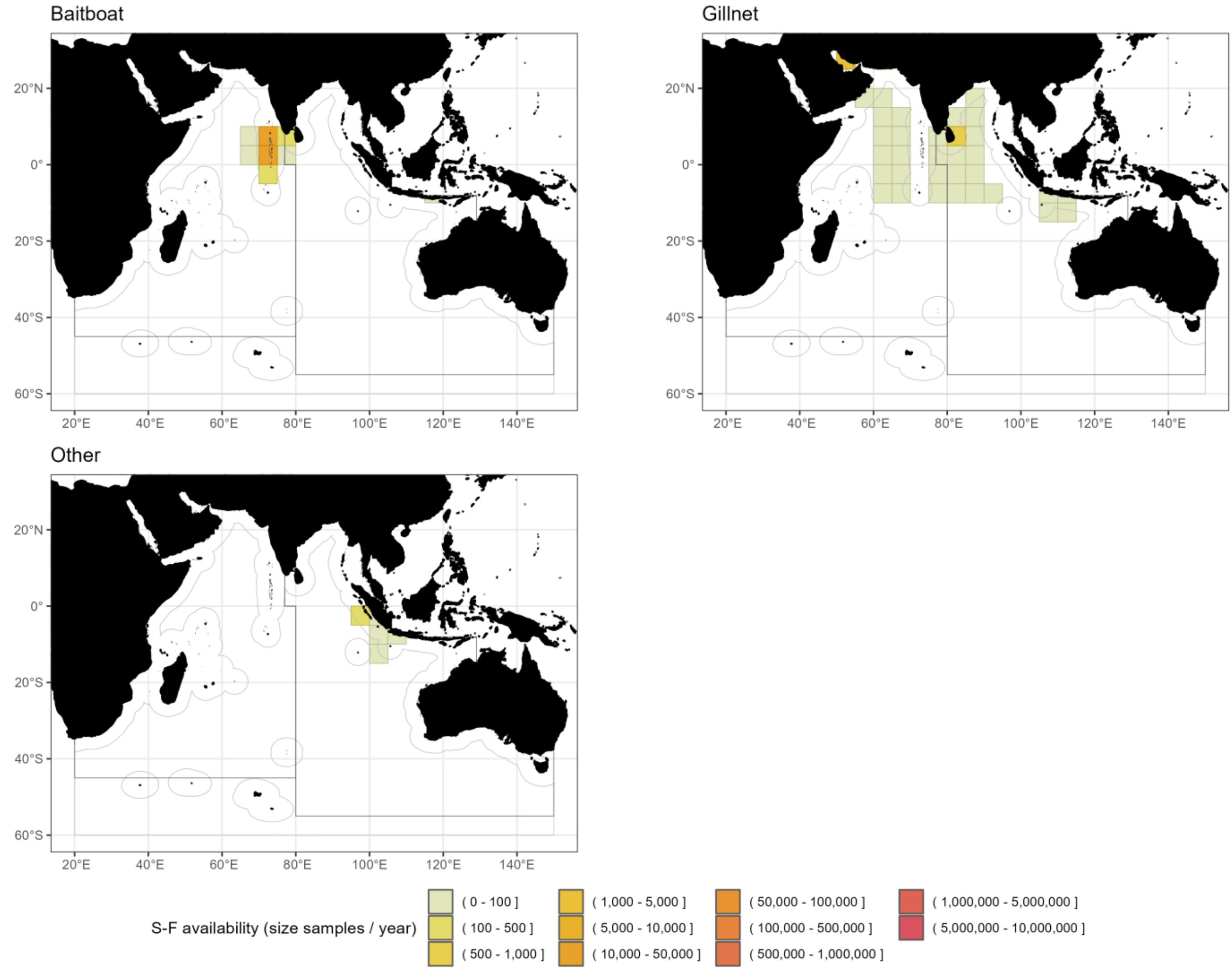

Figure 33: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by all other fishery types in the period 2018-2022. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

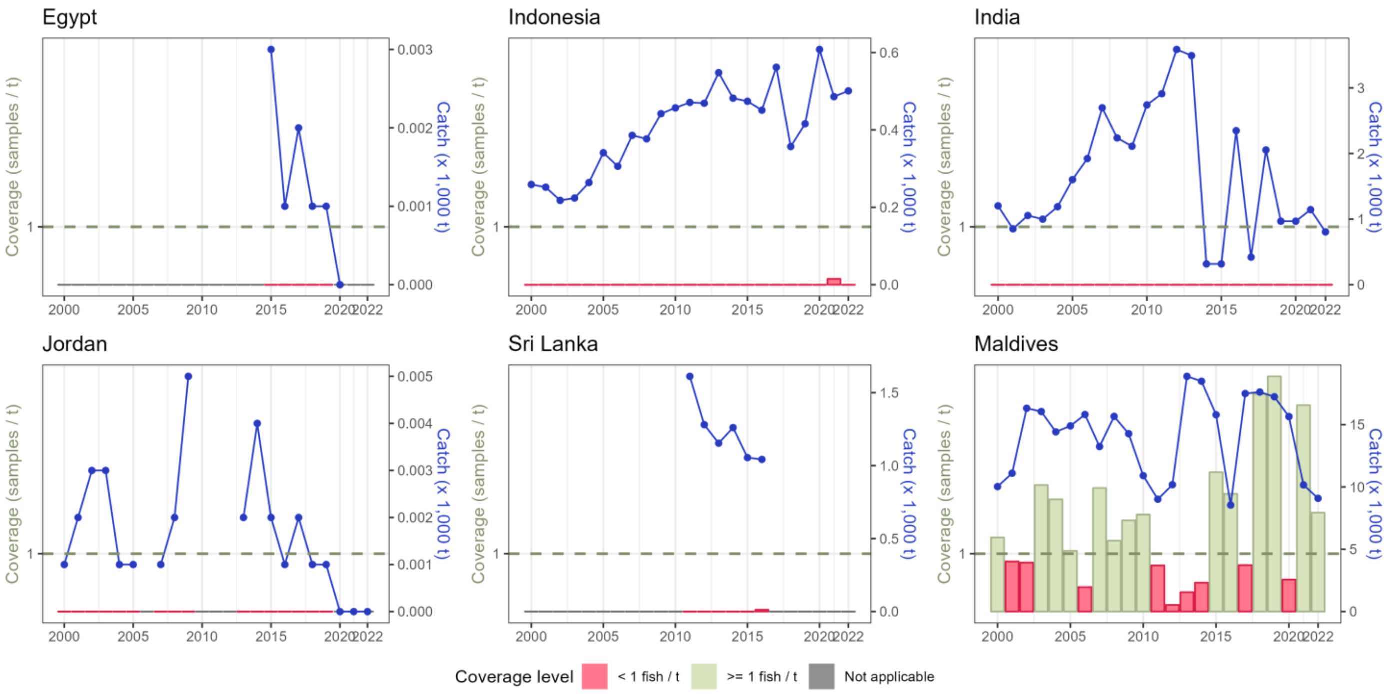

Figure 34: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major baitboat fleets, by fleet and year (2000-2022). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

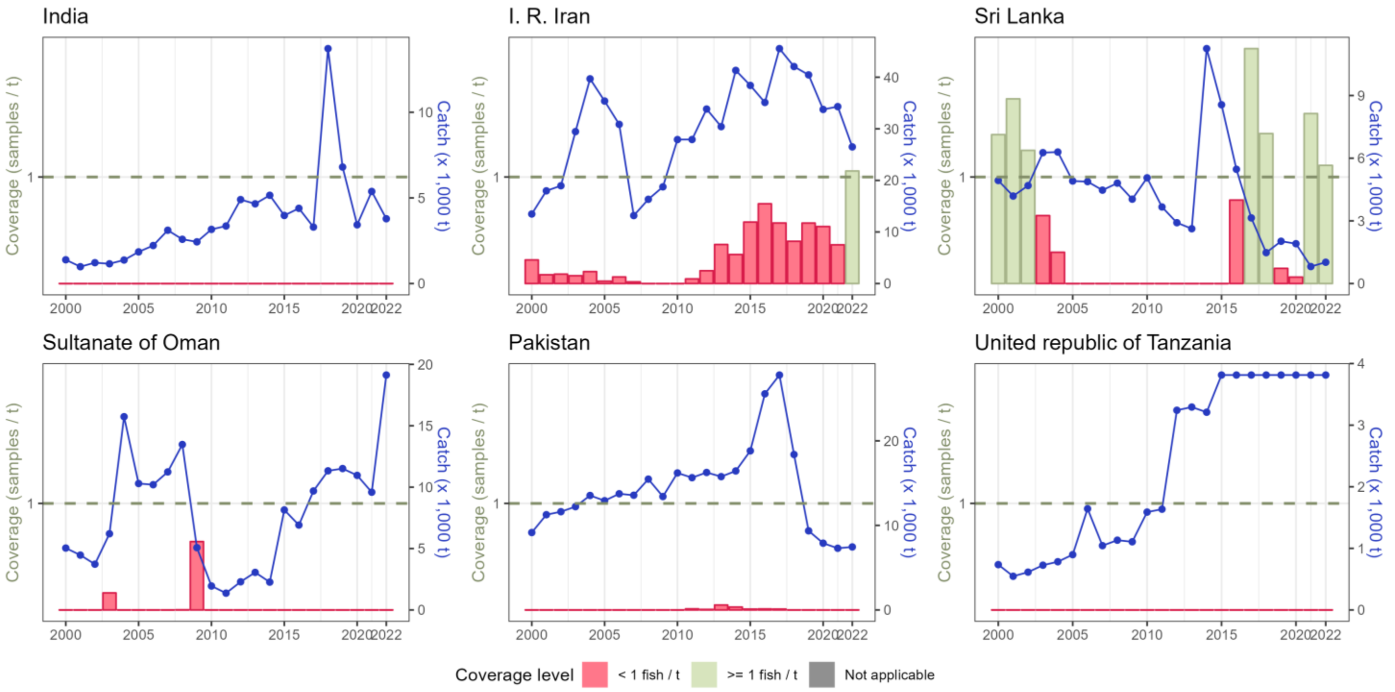

Figure 35: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major gillnet fleets, by fleet and year (2000-2022). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

The sampling levels reached by coastal fisheries are generally low, and in some cases (e.g., handline and baitboat fisheries) this might reflect the limited level of interactions with the species. Among all fisheries and fleet concerned, only Indonesian handlines appear to be well sampled in recent years. Coastal longline fisheries, which are considered as the most relevant among all artisanal fisheries catching yellowfin 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 species of tuna instead.

Temporal patterns and trends in size distributions

Industrial purse seine fisheries

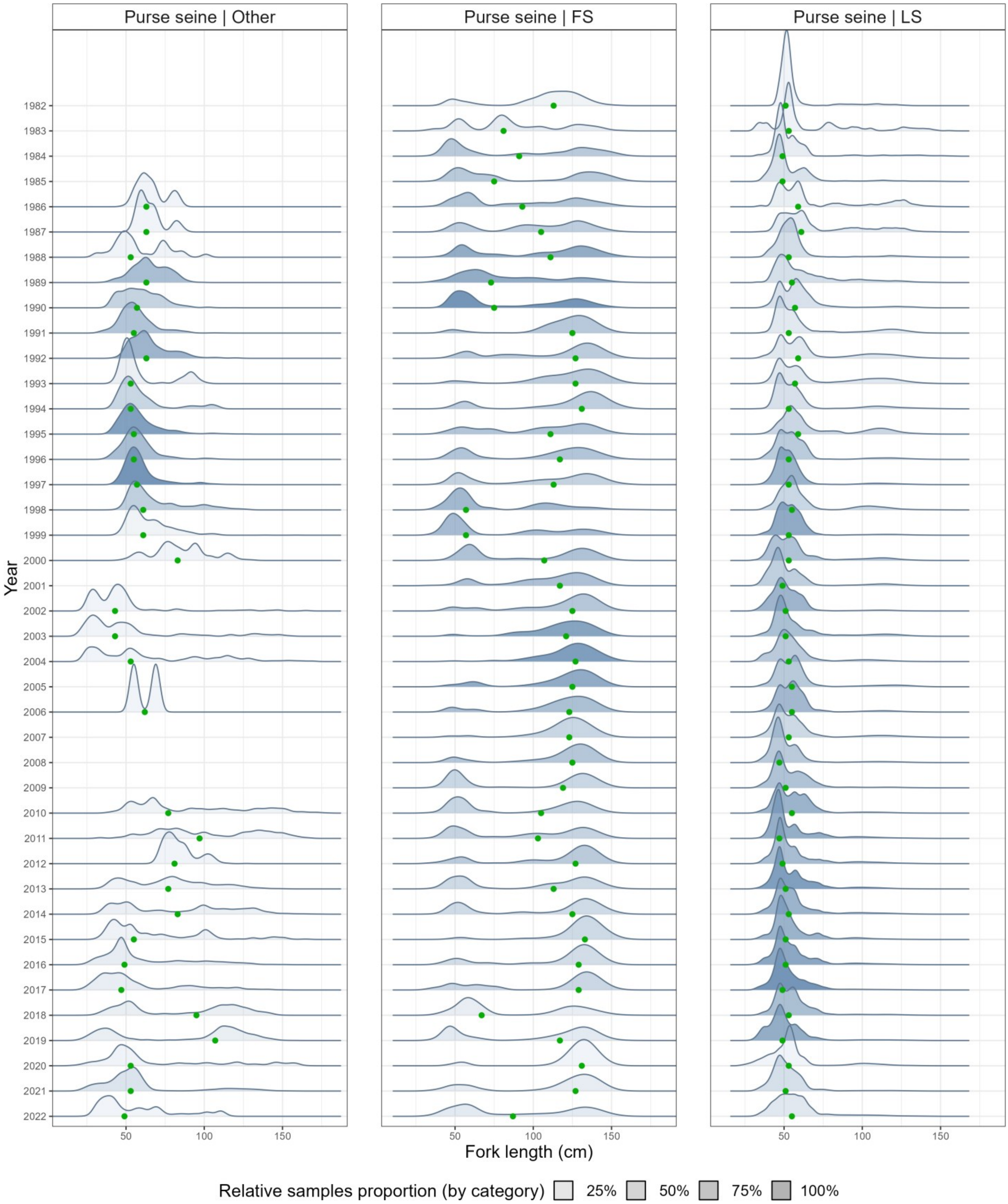

Figure 36: Relative size distribution (fork length in 2 cm size bins) of yellowfin tuna caught by all purse seine fleets for the period 1982-2022. Other = no information provided on the school association; FS = free-swimming schools; LS = schools associated with floating objects. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: yellowfin tuna standardized size-frequency dataset (Res. 15/02)

Industrial longline fisheries

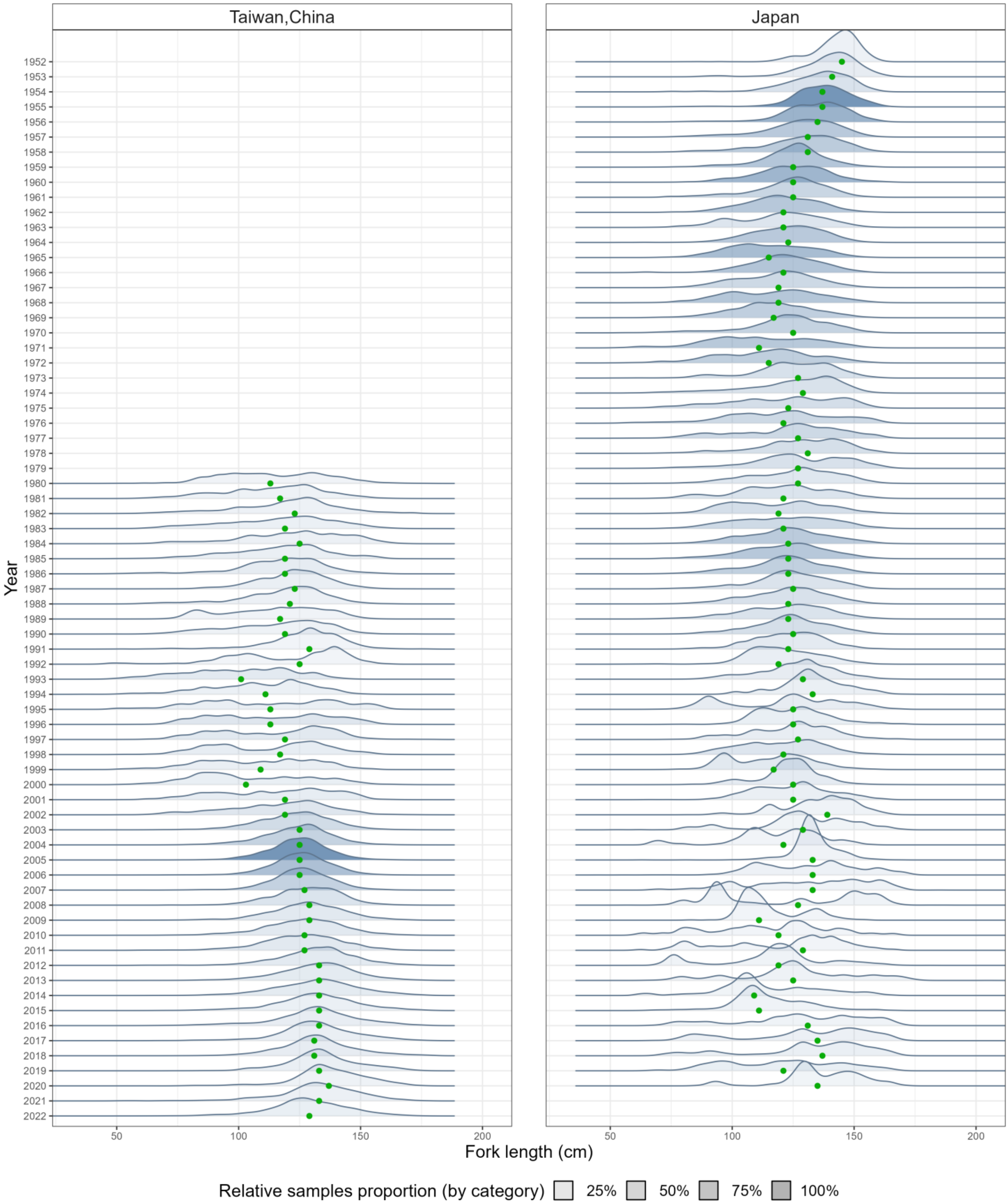

Figure 37: Relative size distribution (fork length in 2 cm size bins) of yellowfin tuna caught by the main deep-freezing longline fleets for the period 1952-2022. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: [yellowfin tuna standardized size-frequency dataset](#) (Res. 15/02)

Figure 38: Relative size distribution (fork length in 2 cm size bins) of yellowfin tuna caught by all other longline fleets (excluding Japan and Taiwan,China), by fleet for the period 1991-2022. Data source: [yellowfin tuna standardized size-frequency dataset](#) (Res. 15/02)

Temporal trends in estimated average weights

Trends in average weights of yellowfin 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 estimated for the longline fisheries of Japan and Taiwan,China are stable at around 40-50 kg / fish (**Fig. 40**). On the contrary, average weights estimated for the log-associated school component of the purse seine fisheries show a declining trend from the mid-1990s onward, and the resulting estimated average weight of yellowfin tuna caught by this fishery is now as low as 8.7 kg / fish.

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

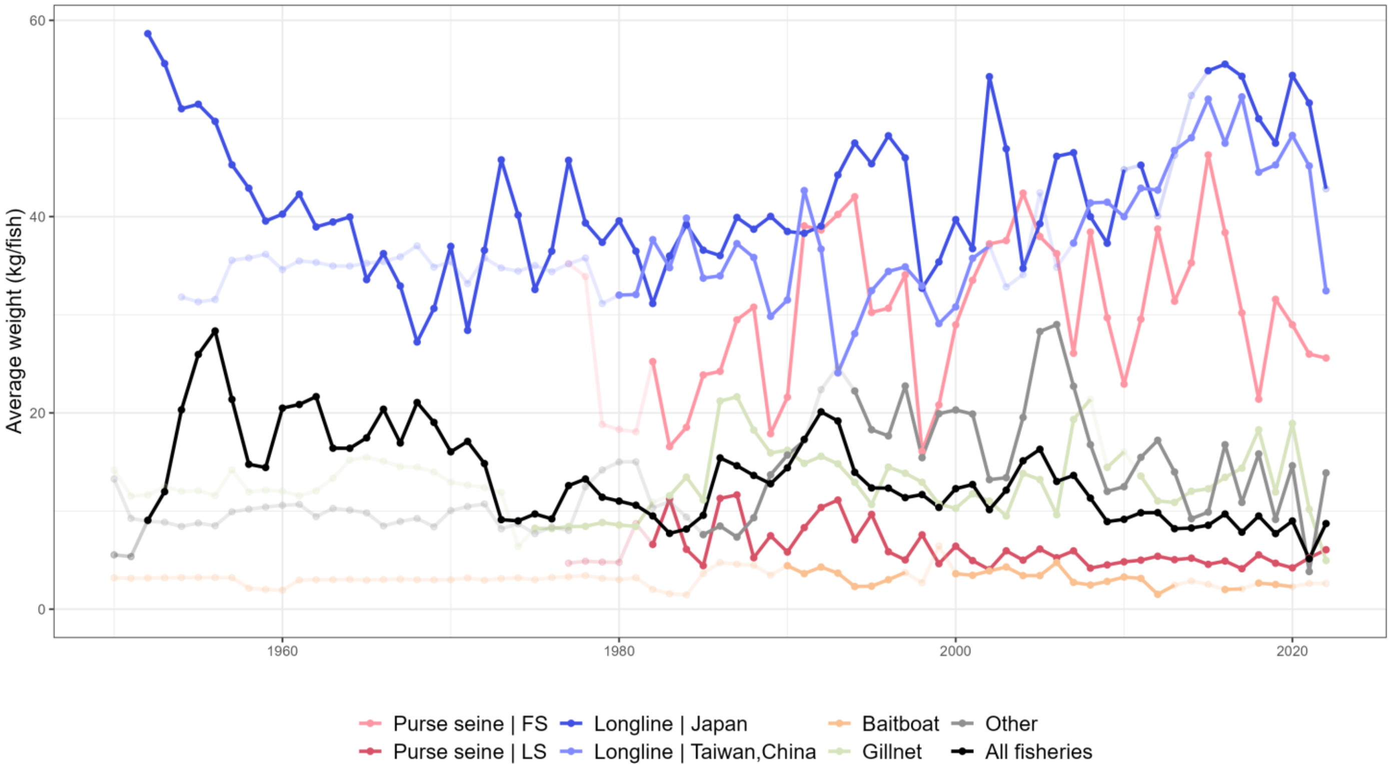

Figure 39: Combined estimated yellowfin tuna average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. LS = schools associated with floating objects; 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

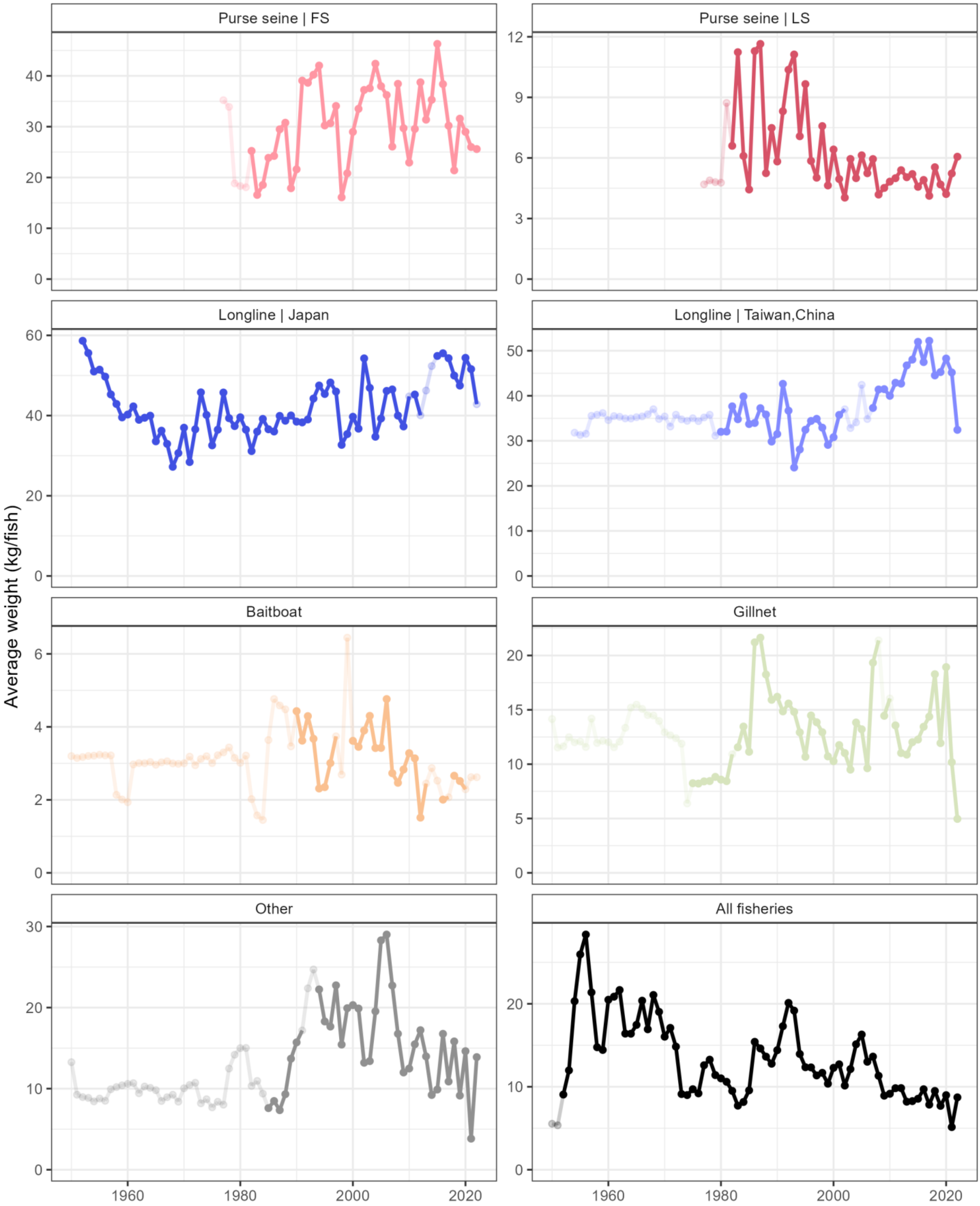

Figure 40: Estimated yellowfin tuna average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. LS = schools associated with floating objects; FS = 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 data for all fisheries together 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 decline in deployed efforts by several industrial longline fleets combined with the rapid increase in catches from schools associated to floating objects in the purse seine fishery (**Fig. 39**).

Spatial distribution of average weights

Estimated average weights by decade (1950-2019)

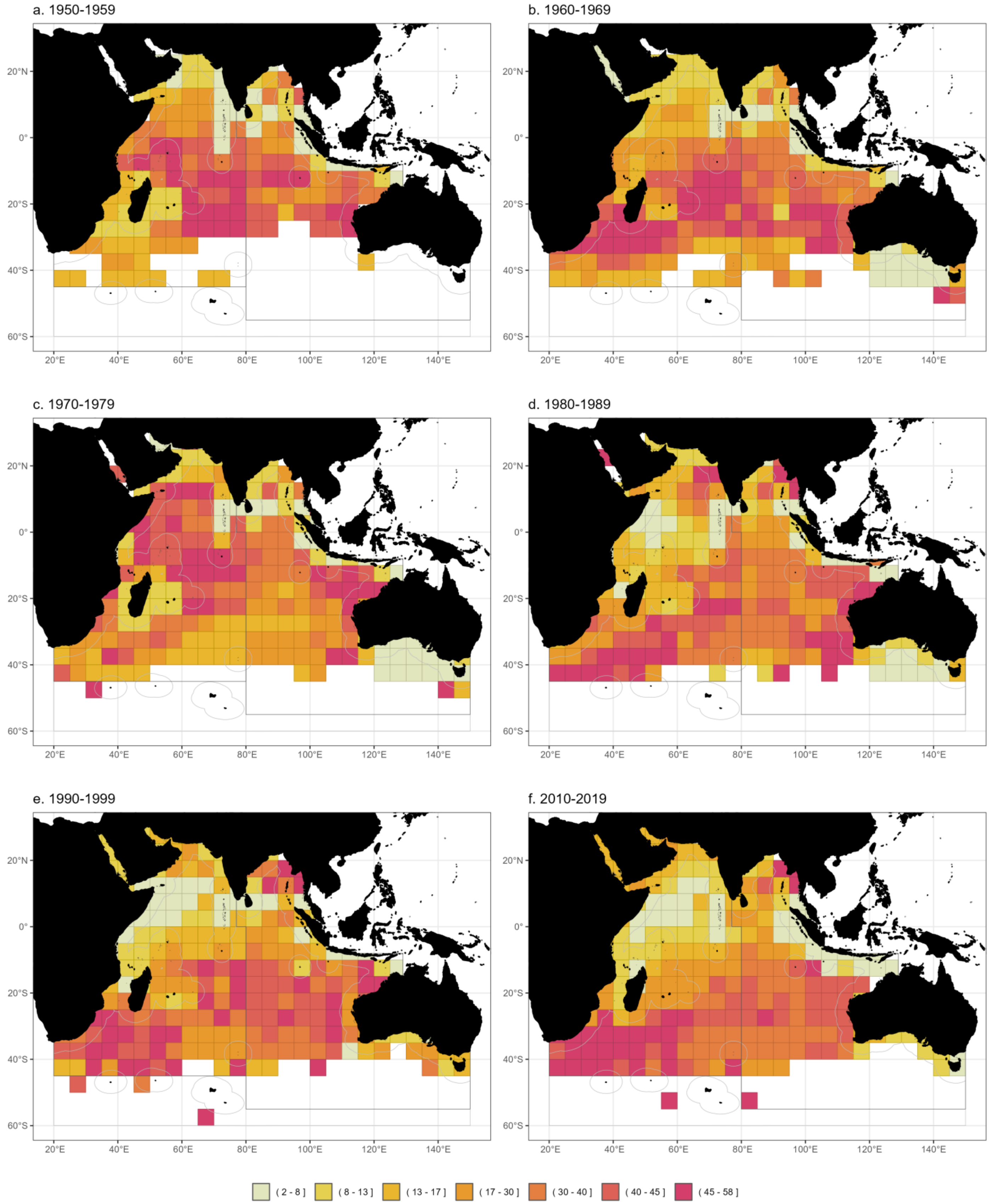

Figure 41: Estimated yellowfin tuna average weight (kg/fish) in the catch by decade and 5x5 grid, for all fisheries combined for the period 1950-2019. Data source: raised time-area catches

Estimated average weights by year (2018-2022) and last decade (2010-2019)

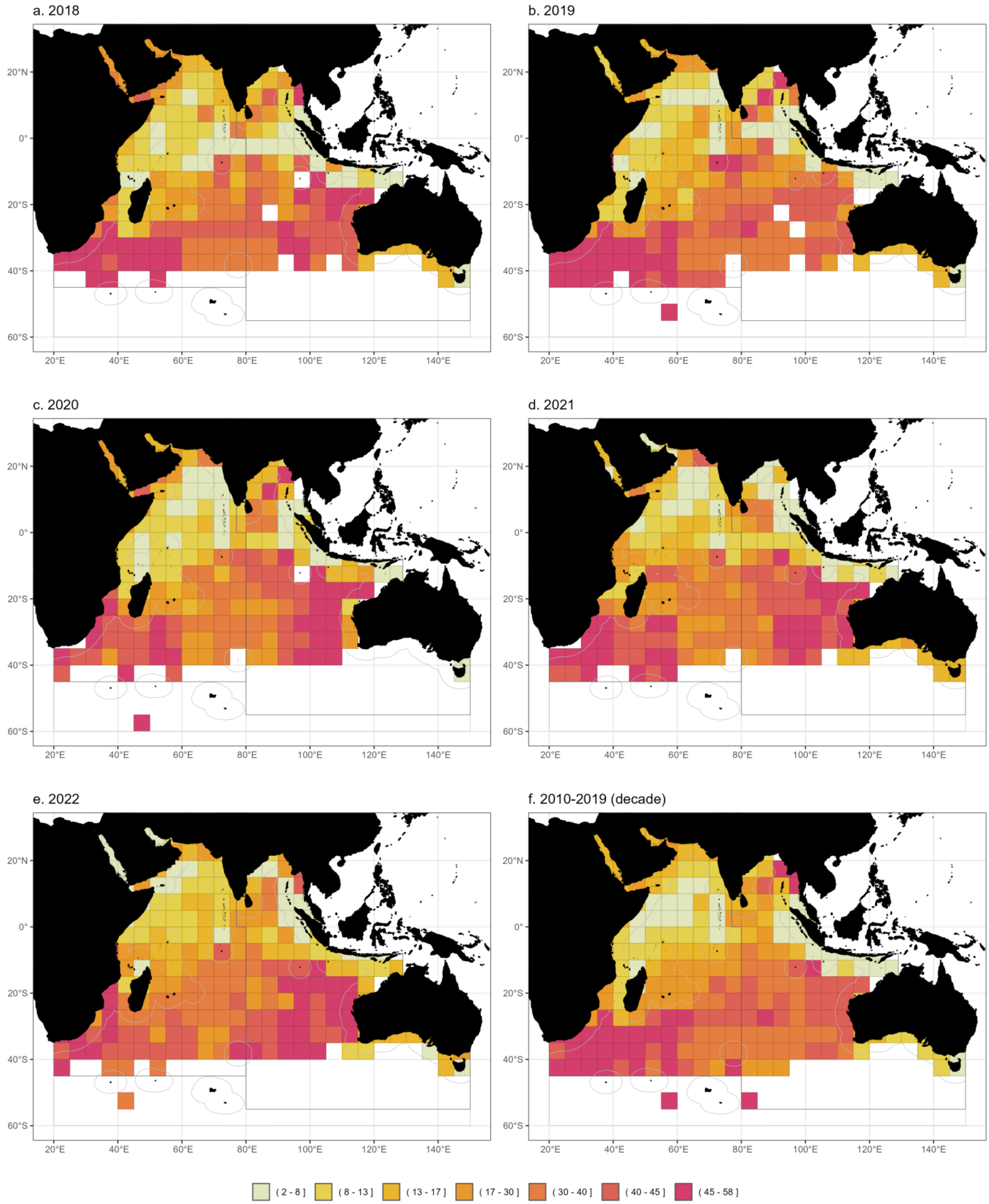

Figure 42: Estimated yellowfin tuna average weight (kg/fish) in the catch by year and 5x5 grid, for all fisheries combined for the period 2018-2022 and for the decade 2010-2019. Data source: raised time-area catches

Estimated average weights by fishery group in recent years (2018-2022)

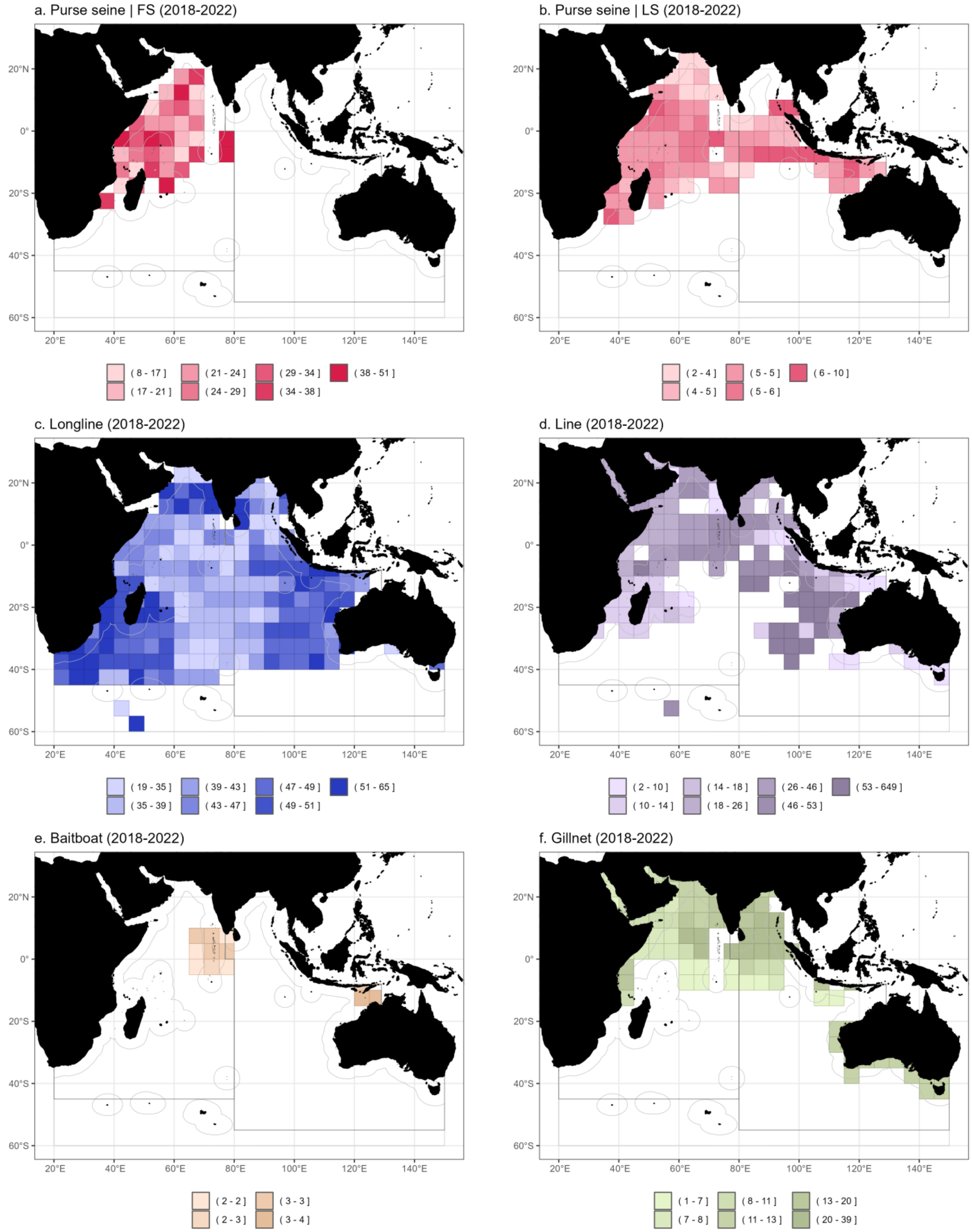

Figure 43: Estimated yellowfin tuna average weight (kg/fish) in the catch by 5x5 grid and fishery group for the period 2018-2022. LS = schools associated with floating objects; FS = free-swimming schools. Data source: raised time-area catches

Uncertainties in size-frequency data

The overall quality – as measured by the percentage of retained catches with size data of quality scores between 0-2 – of size data available for yellowfin tuna in IOTC databases is poor, particularly for artisanal fisheries. Almost no size data are available prior to the 1980s and the fraction of data of acceptable quality remained at around 50% since 1984 (ranging between 37% and 66%) (**Fig. 44**). Following an increase in quality from about 46% in 2020 to around 66% in 2017, the quality substantially decreased to 47% in 2022.

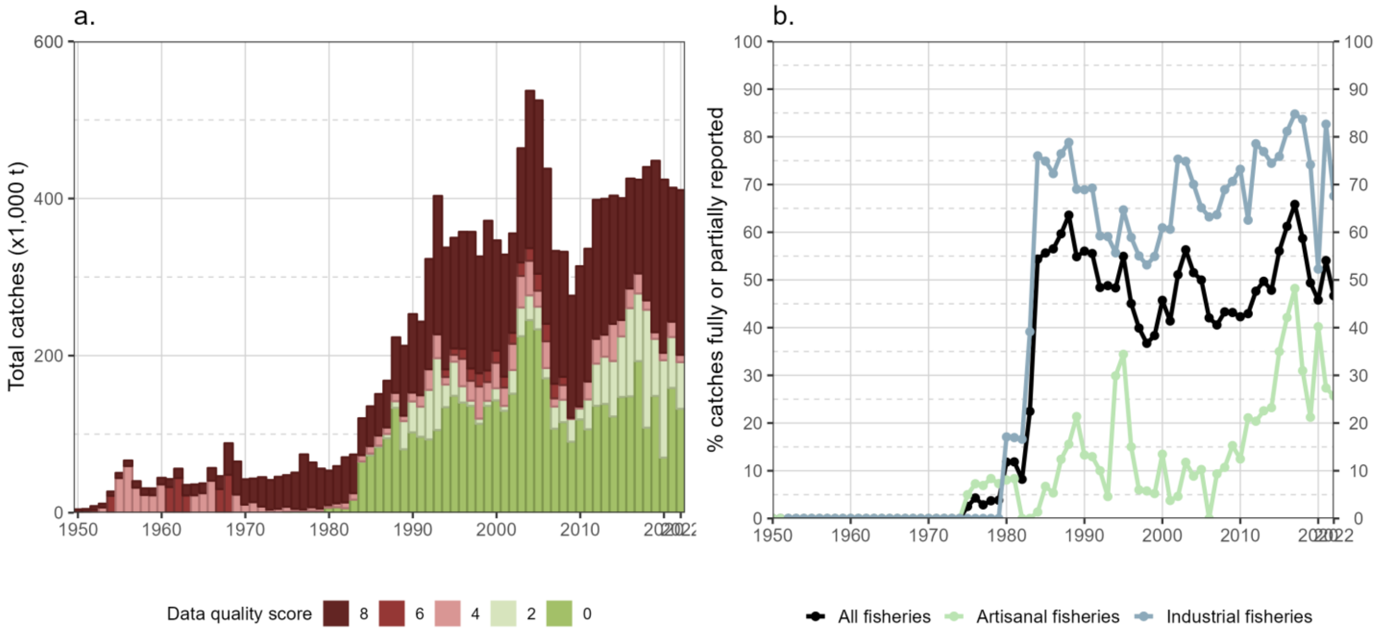

Figure 44: Annual retained catches (metric tonnes; t) of yellowfin tuna estimated by quality score (barplot) and percentage of geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2022

Industrial purse seine fisheries

Size-frequency data for yellowfin 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* (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 fleet (and assimilated flags, 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. 45**) and FOB-associated schools (**Fig. 47**) 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 is located at around 140 cm FL, while fish measured from FOB-associated schools tends to have one single mode at around 50 cm FL.

For free-swimming schools, though, data show some notable exceptions to this trend, specifically for EU,France (2018), EU,Spain (2019), Mauritius (2017), and Seychelles (2017, 2018 and 2019) (**Table 5**), which all show a much higher first mode in the lower part of the size distribution (at around 60 cm FL) (**Fig. 45**).

Similar discrepancies can also be found in the case of size-frequencies from FOB-associated schools, with data showing sub-modes at around 100 and 130 cm FL for EU,Spain (2018) and EU,France (2019, 2020) (**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. 47**).

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 the years 2015 and 2017. Also, data from Mauritian purse seiners with correct attribution of the fishing mode are only available for the year 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 fraction of what usually provided in the past (**Fig. 45**).

Size-frequency data for 2020 is completely absent for EU,Spain and only available in limited numbers for EU,France, Mauritius, and Seychelles (**Fig. 47**), with EU,Spain confirming their ongoing effort to recover the missing size data and share it as soon as possible (IOTC, pers. comm.).

Size-frequency data for all other industrial purse seine fleets include information from Indonesia, I.R. Iran, Japan, and Republic of Korea (**Fig. 49**). 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 (**Fig. 49**).

The size-distribution of Indonesian samples is quite peculiar and indicates that the fishery is catching smaller than average individuals as the very strong mode at around 30 cm FL seems to suggest. Considering that the data are originally reported as sourced from the *small purse seine* component of the Indonesian fleet (IOTC gear code *PSS*, that includes vessels with a LOA well above 24 m, that appear to operate in coastal waters on the basis of the geo-referenced catches available to the IOTC Secretariat from 2018 onward) further clarification might be required to estimate the accuracy and representativeness of these samples and whether or not they could be properly used for scientific purposes.

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 (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 lower numbers for Indonesia and I.R. Iran).

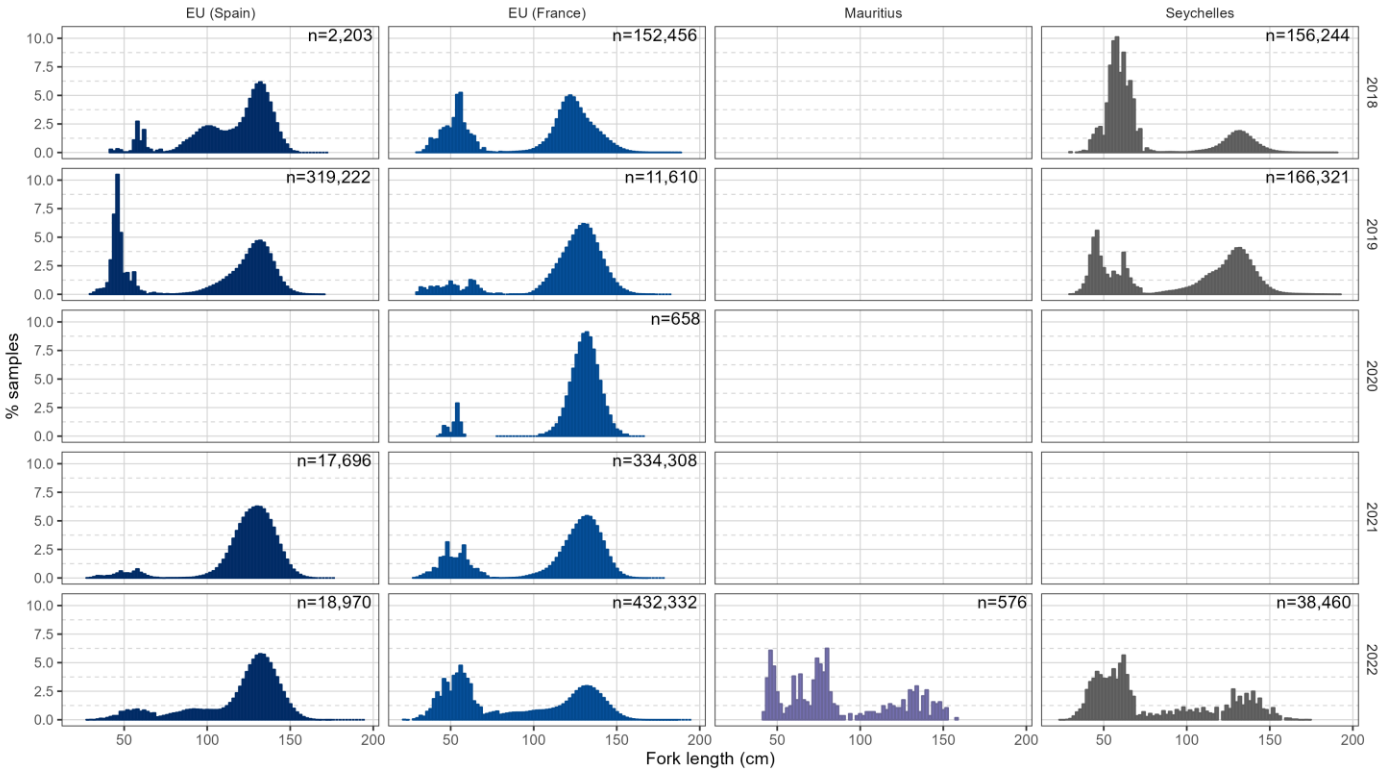

Figure 45: Relative size distribution of yellowfin tuna (fork length; cm) recorded for free-swimming schools, by year (2018–2022) and main purse seine fleet. Data source: standardized size-frequency dataset (Res. 15/02)

Table 5: Percentage of sampled yellowfin tuna with fork length below 75 cm recorded by the major purse seine fleets fishing on free-swimming schools, as reported for the period 2018-2022. Data source: standardized size-frequency dataset (Res. 15/02)

Fleet	2018	2019	2020	2021	2022
EU (Spain)	9	37		6	11
EU (France)	36	14	8	26	47
Mauritius					45
Seychelles	77	41			61

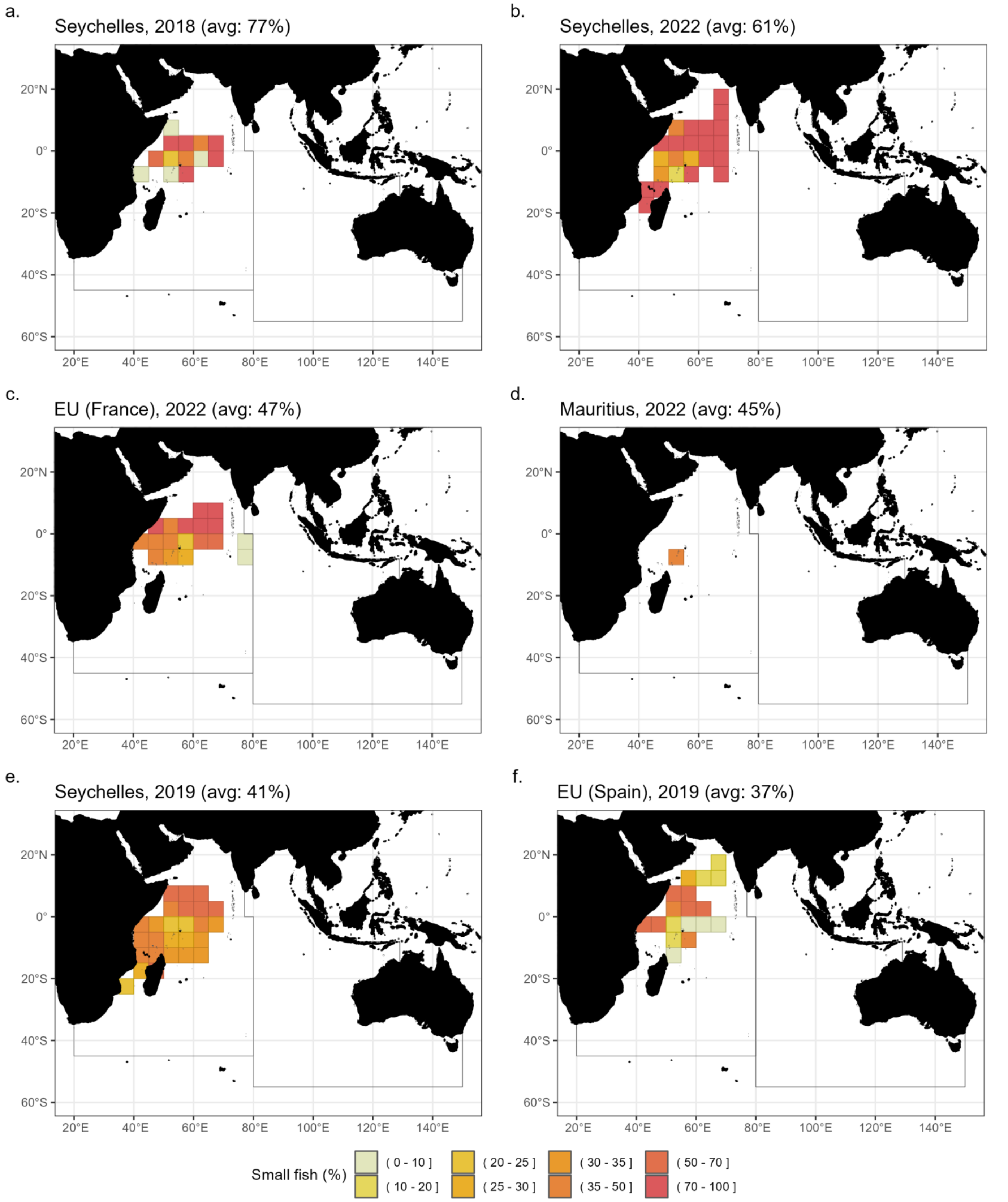

Figure 46: Spatial distribution of sampled yellowfin tuna with fork length below 75 cm recorded by the major purse seine fleets fishing on free-swimming schools, as reported for the period 2018-2022. Data source: standardized size-frequency dataset (Res. 15/02)

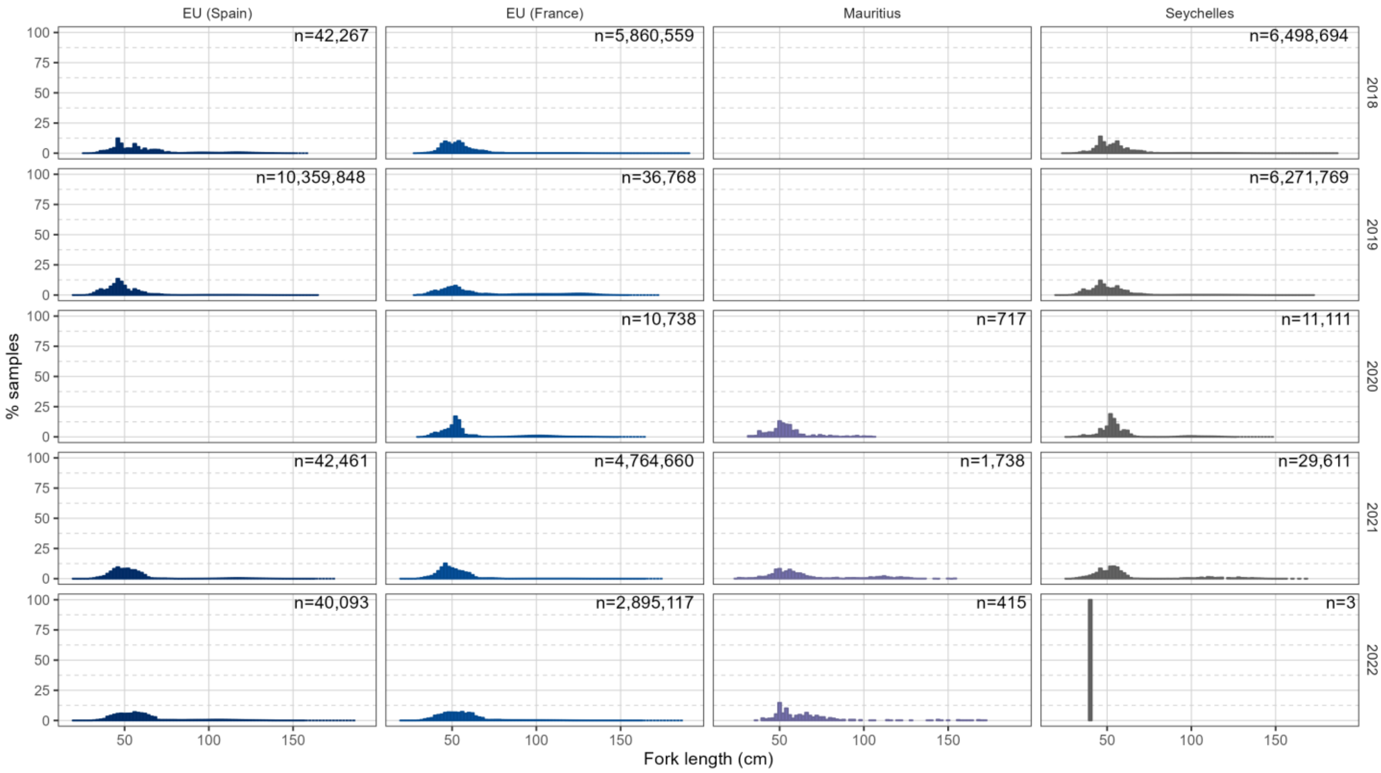

Figure 47: Relative size distribution of yellowfin tuna (fork length; cm) recorded for FOB-associated schools, by year (2018–2022) and major purse seine fleet. Data source: standardized size-frequency dataset (Res. 15/02)

Table 6: Percentage of sampled yellowfin tuna with fork length above 75 cm recorded by the major purse seine fleets fishing on FOB-associated schools, as reported for the period 2018-2022. Data source: standardized size-frequency dataset (Res. 15/02)

Fleet	2018	2019	2020	2021	2022
EU (Spain)	18	4		9	17
EU (France)	7	29	17	4	10
Mauritius			8	24	18
Seychelles	7	6	8	17	0

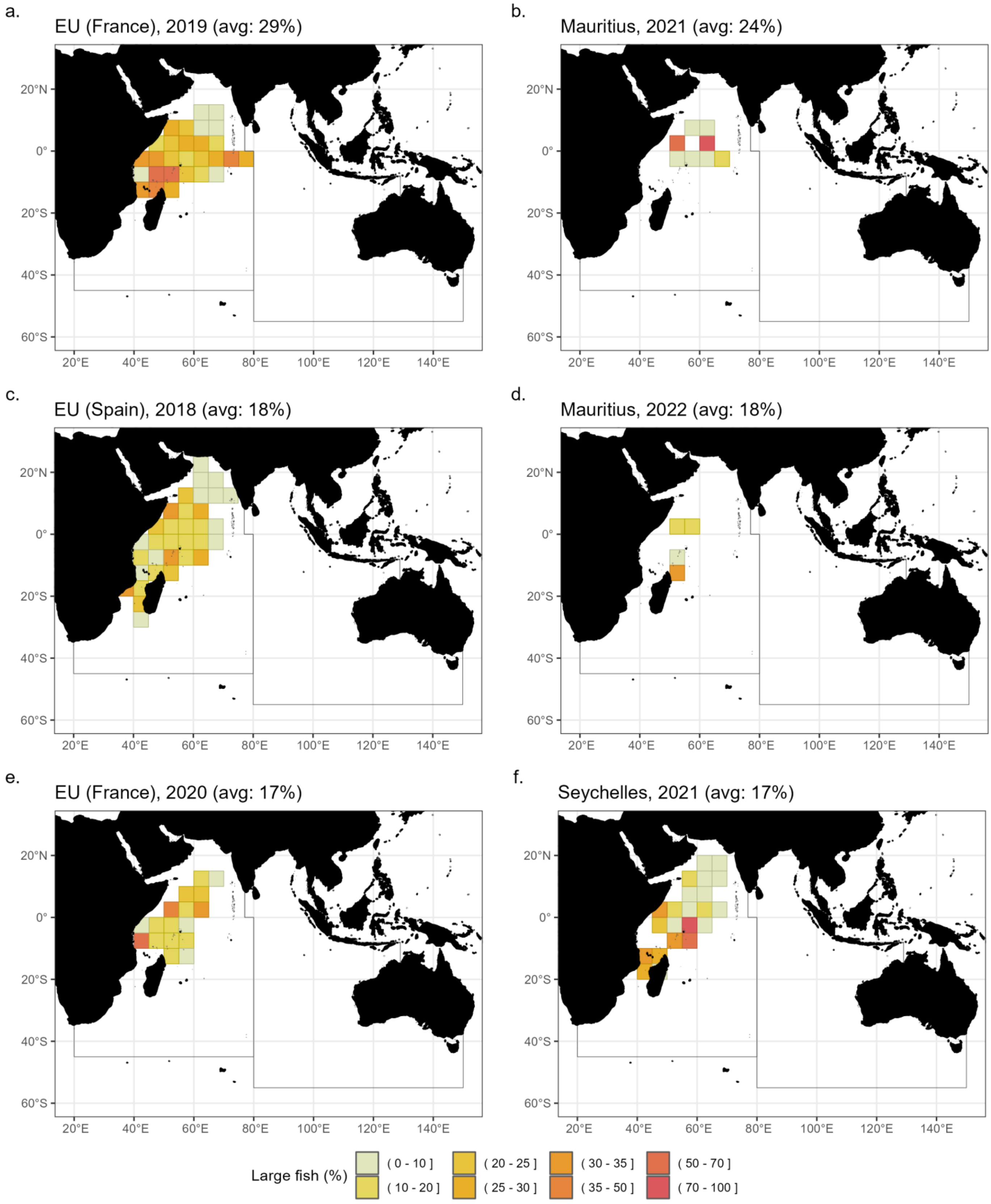

Figure 48: Spatial distribution of sampled yellowfin tuna with fork length above 75 cm recorded by the major purse seine fleets fishing on FOB-associated schools, as reported for the period 2018-2022. Data source: standardized size-frequency dataset (Res. 15/02)

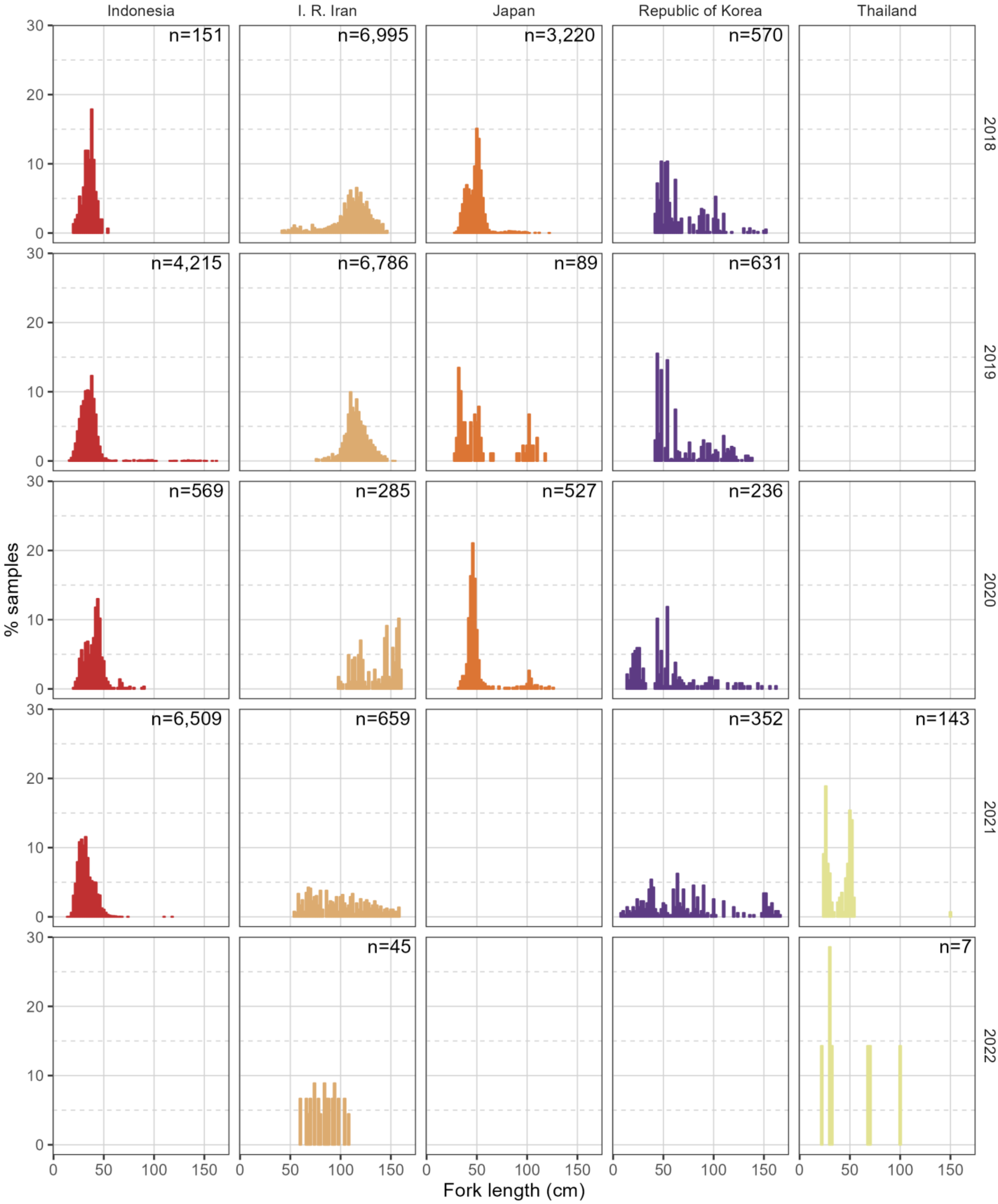

Figure 49: Relative size distribution of yellowfin tuna (fork length in cm) recorded for unclassified schools, by year (2018–2022) and other purse seine fleet. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Industrial longline fisheries

The major industrial longline fisheries appear to be well-sampled for several years and fleets, with some of them (Japan, Rep. of Korea, China, Taiwan,China and EU,Portugal) having consistently reported data from observers at sea in recent periods. Nevertheless, ongoing discussions on potential bias in sampling involving the longline fleets of Japan and Taiwan,China (mostly) have not yet been resolved (Geehan & Hoyle 2013, Hoyle et al. 2021).

In the case of the deep-freezing longline fleet from Taiwan,China, the availability of well-sampled size-frequency data and of geo-referenced catches both in numbers and weights allows performing a comparison between the average weights calculated from the two data sets. Average weights from the size-frequency data set are calculated by applying the length-weight conversion equation to the number of samples reported for each size bin (IOTC-WPTT 2022). Average weights from the catch and effort data set are calculated by dividing the catch in weight by the catch in numbers available for the same strata.

The available size-frequency data for the fishery from Taiwan,China are sampled well-above the minimum level of 1 fish per tonne of retained catches (as required by Res. 15/02), if not for the years between 1989 and 1993 (**Fig. 50**). The average weights calculated from the two data sets are in (variable) agreement only until 2002: from this point in time onward, the average weight calculated from the size-frequency data set is consistently higher than the average weight calculated from the catch and effort data set up to a maximum difference of around 15 kg / fish in favour of the former, as detected in 2022 (when the coverage level of the size-frequency data was of around 6.8 samples per metric ton) (**Fig. 50**).

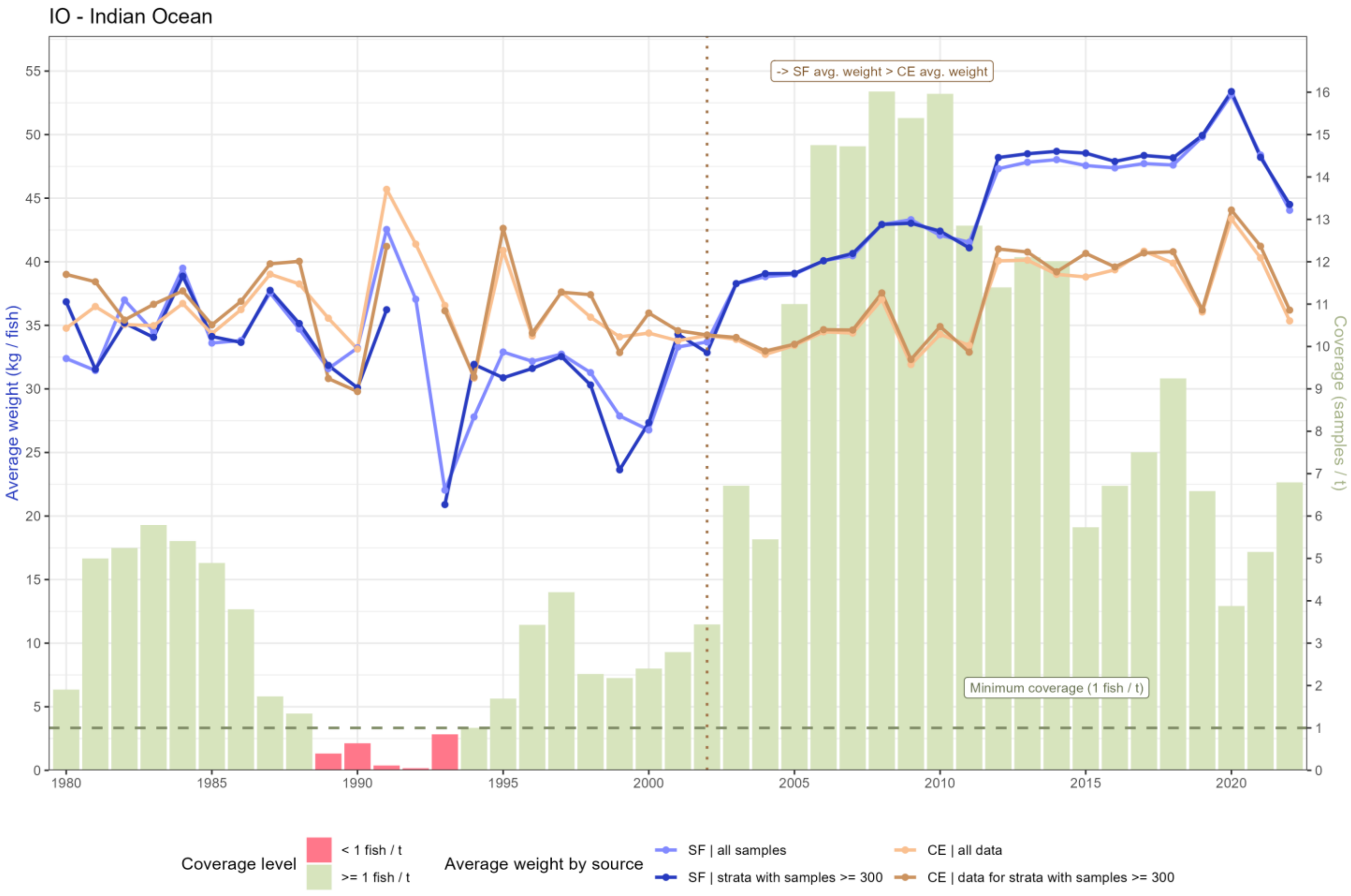

Figure 50: Difference in average weights (all Indian Ocean areas) of yellowfin tuna caught by the deep-freezing fleet of Taiwan,China as calculated from the available size-frequency and catch and effort data (1980-2022). Data source: standardized size-frequency dataset and time-area catch dataset for longline fisheries (Res. 15/02)

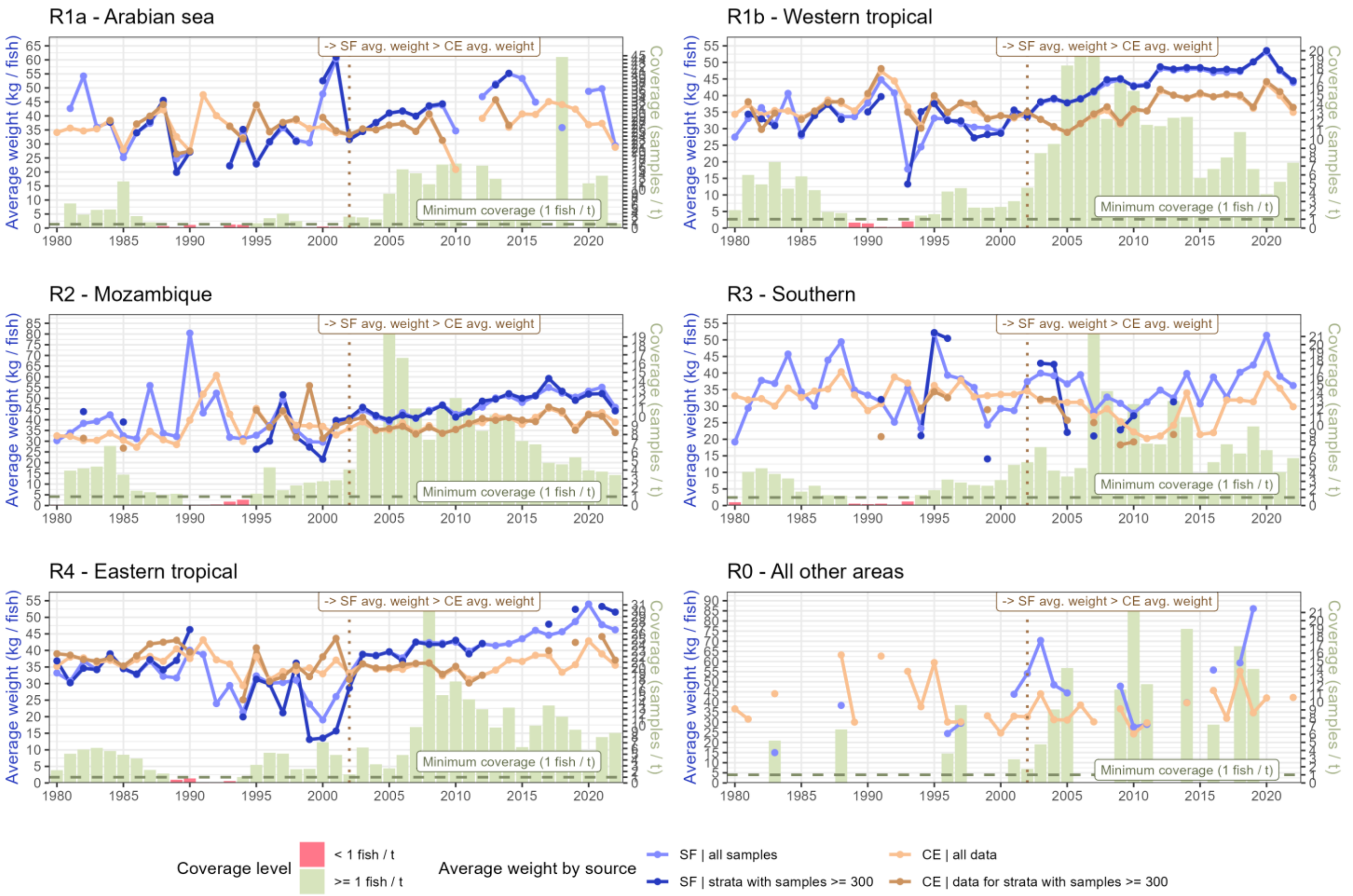

Figure 51: Difference in average weights by stock-assessment areas of yellowfin tuna caught by the deep-freezing fleet of Taiwan,China as calculated from the available size-frequency and catch and effort data (1980-2022). Data source: standardized size-frequency dataset and time-area catch dataset for longline fisheries (Res. 15/02)

These results suggest that, from 2002 onward, either the size sampling was biased towards larger fish (blue lines), or that the logbook data used to produce the catch-and-effort records submitted to the IOTC Secretariat are inaccurate (orange lines). This, notwithstanding the fact that length measurements for the Taiwan,China longline fleet include samples taken by scientific observers at sea (generally less than 5-10% of total annual samples since 2002).

In the period considered (2000-2022), yellowfin tuna size-frequency records submitted for the longline fleet of Japan were comprised of 24,653 individuals recorded in logbooks and 25,592 individuals measured by onboard observers. In this case, the number of individuals measured by observers amounted to ~100% of those recorded in logbooks, also because starting from 2012 Japan has been providing - in agreement with the requirements of Res. 15/02 - size-frequency data exclusively sourced through their national observer programme. - Very few samples have been recorded by Japanese deep-freezing longliners in the last two years (2020-2021) and these originate exclusively from the Mozambique Channel (R2) (**Fig. 55**)

On the contrary, and in the same period considered, yellowfin tuna size-frequency records submitted for the longline fleet of Taiwan,China were comprised of 2,622,879 individuals recorded in logbooks, and 42,162 individuals measured by onboard observers. In this case, the magnitude of the size data collected by observers corresponds to ~1.6% of that reported in logbooks, even though Taiwan,China has been consistently providing both sources of information since 2002 (**Fig. 54**).

Further analysis based on the comparison of size-frequency distributions of yellowfin tuna caught by longliners from Japan and Taiwan,China during 2000-2022 in common strata (defined as the combination of assessment areas and 5-year intervals) shows that:

- logbook size data for Japan and Taiwan,China can only be compared during the 2000s, as the former were completely replaced by scientific observer data from 2010 onwards. Nevertheless, when data are available for both fleets, these appear to be in relatively good agreement only in the Mozambique Channel (R2) in the early 2000s (**Fig. 52**). However, the differences should be further investigated through the use of statistical models as they could stem from seasonal or spatial effects as well as other factors (Hoyle et al. 2021);

- size data from scientific observers are available from both fleets for a longer period of time (from 2010 onwards) and only in good agreement in the southern Indian Ocean (R3) in the late 2010s, while the comparison of the distributions in common strata (i.e., assessment areas and 5-year blocks) shows that small yellowfin tunas observed in the Japanese fishery are generally absent from the samples available for the longline fishery of Taiwan,China (**Fig. 53**);

- when size data for deep-freezing longliners from Taiwan,China are available in good numbers through both scientific observers and logbook data, the two sources are generally in agreement, particularly from 2010 onwards (**Fig. 54**). For previous years, data from logbooks seems to be biased towards larger fish in the Arabian Sea (R1a) and Mozambique Channel (R2) (**Fig. 54**);

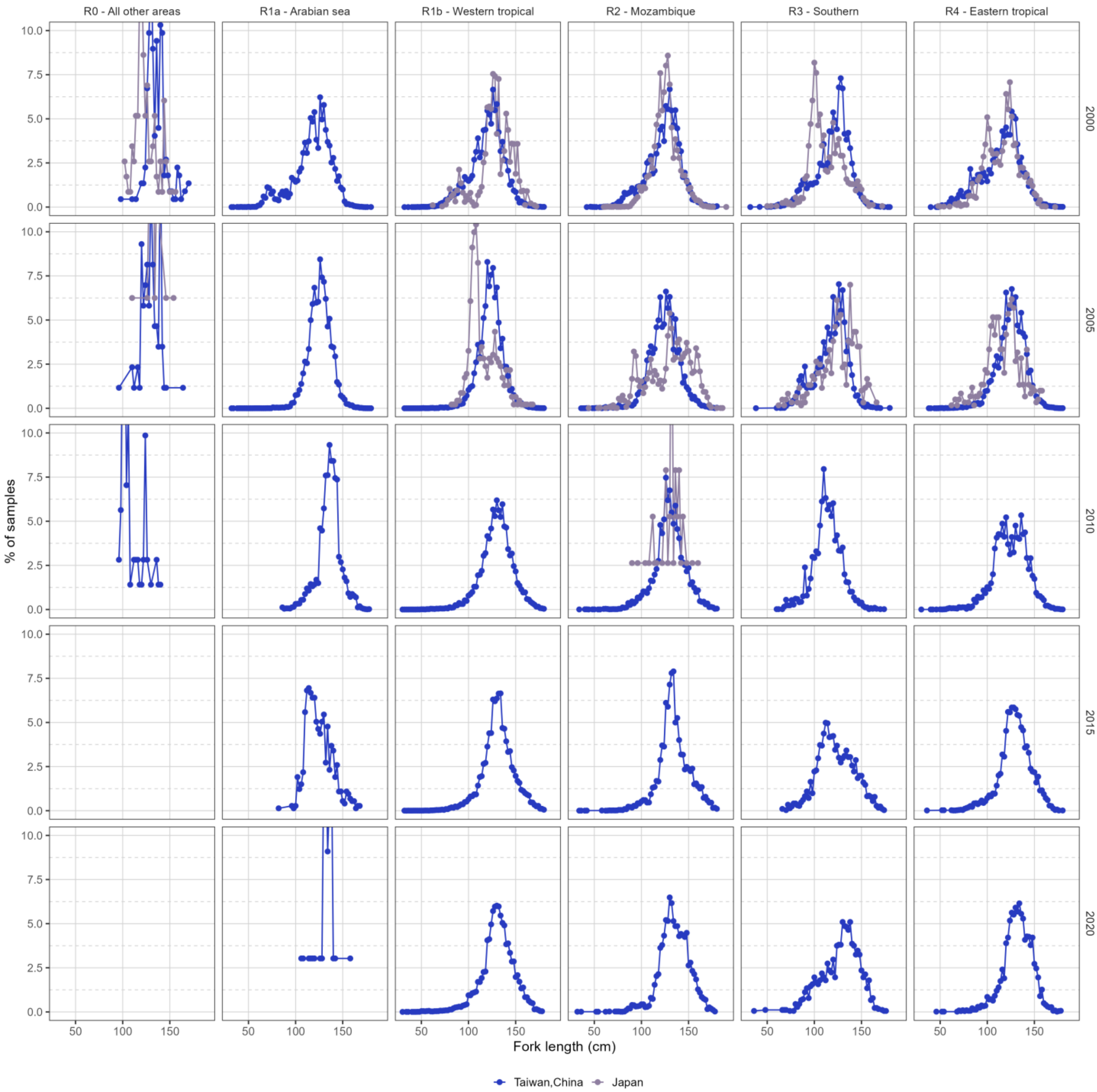

Figure 52: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported through logbooks by the deep-freezing longline fleets of Japan and Taiwan,China, by stock assessment area and five-year periods. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

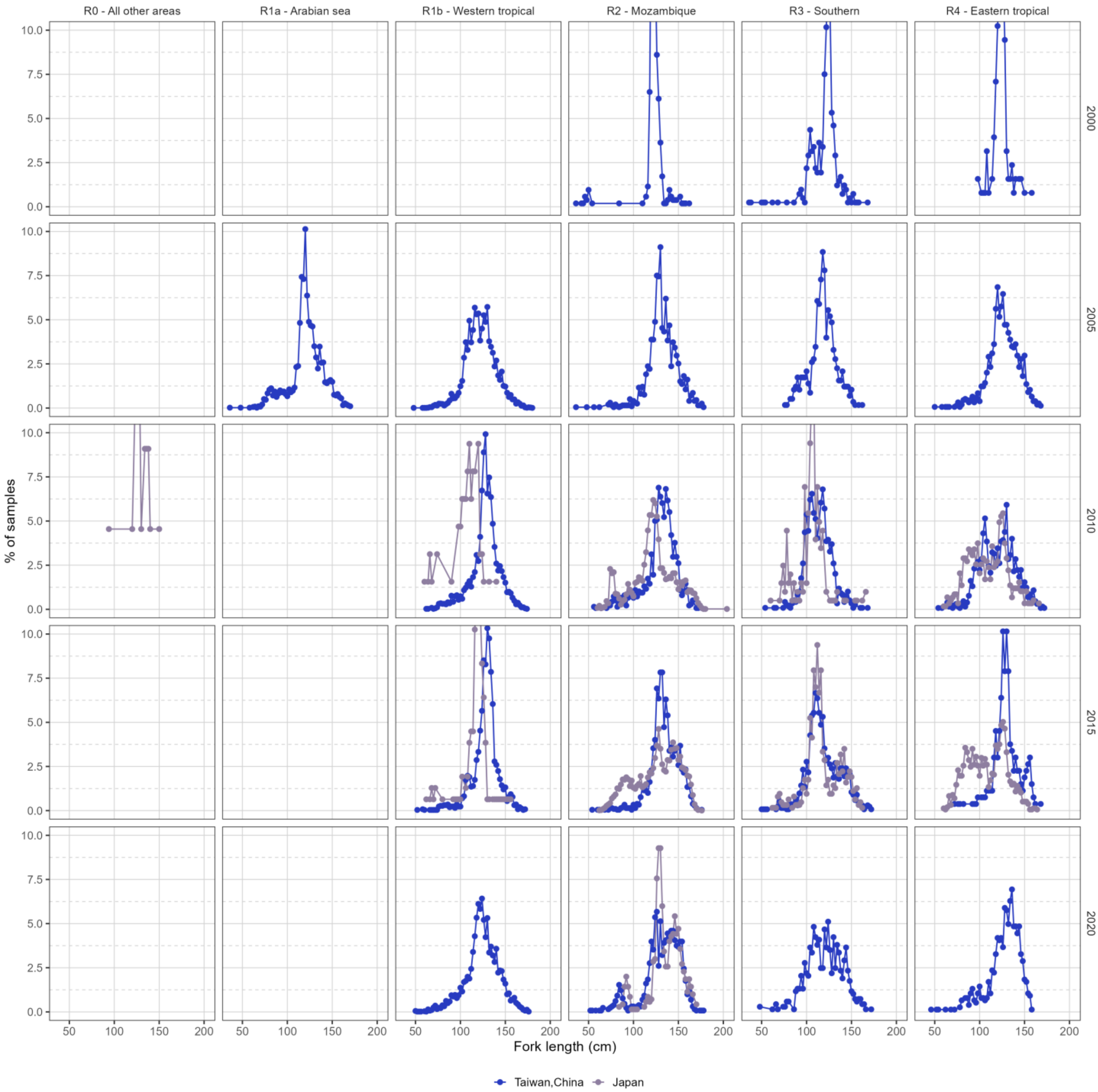

Figure 53: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported through scientific observers by the deep-freezing longline fleets of Japan and Taiwan,China, by stock assessment area and five-year periods. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

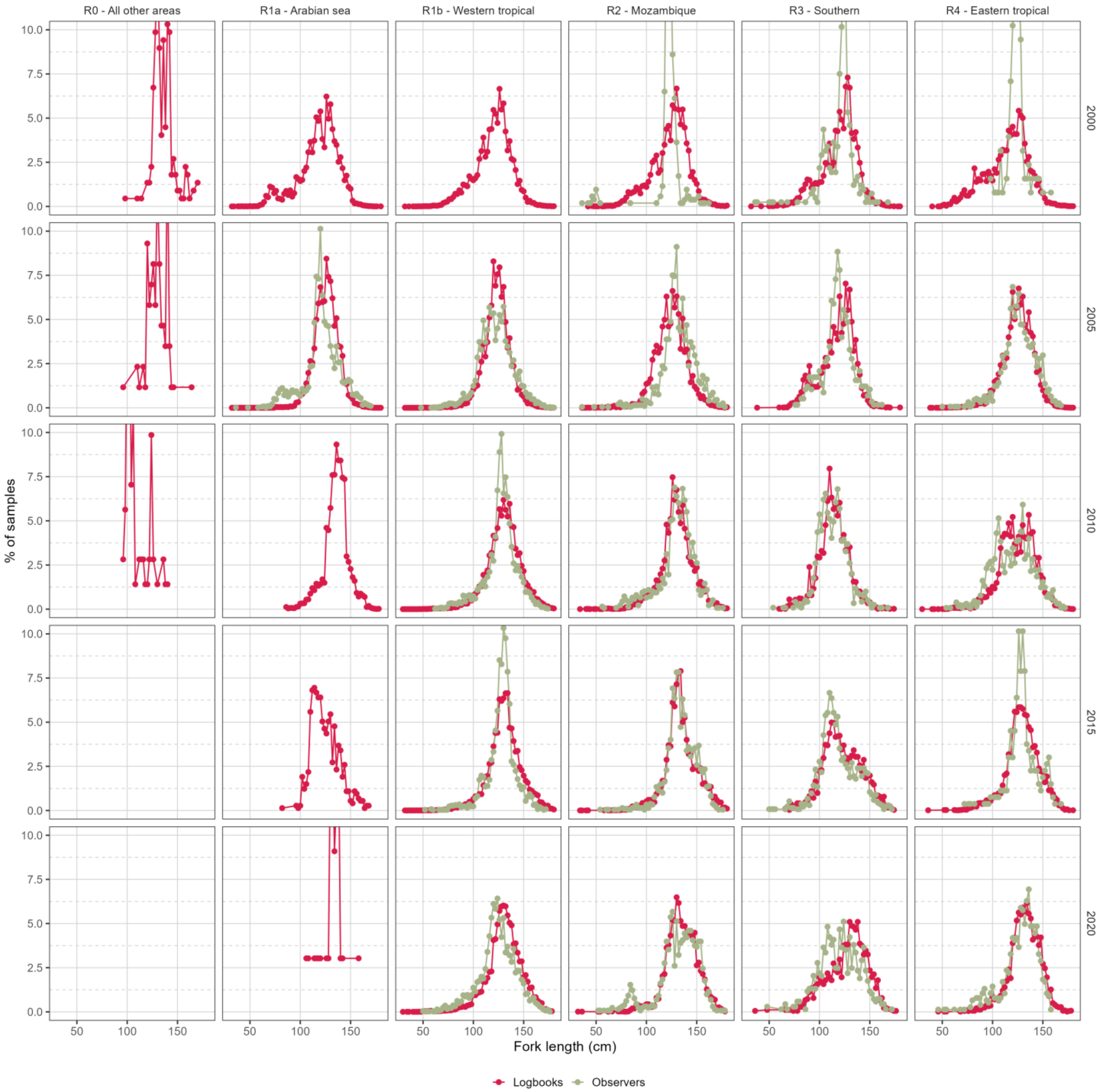

Figure 54: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported by the deep-freezing longline fleets of Taiwan,China, by source (scientific observers vs. logbooks), stock assessment area and five-year periods. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

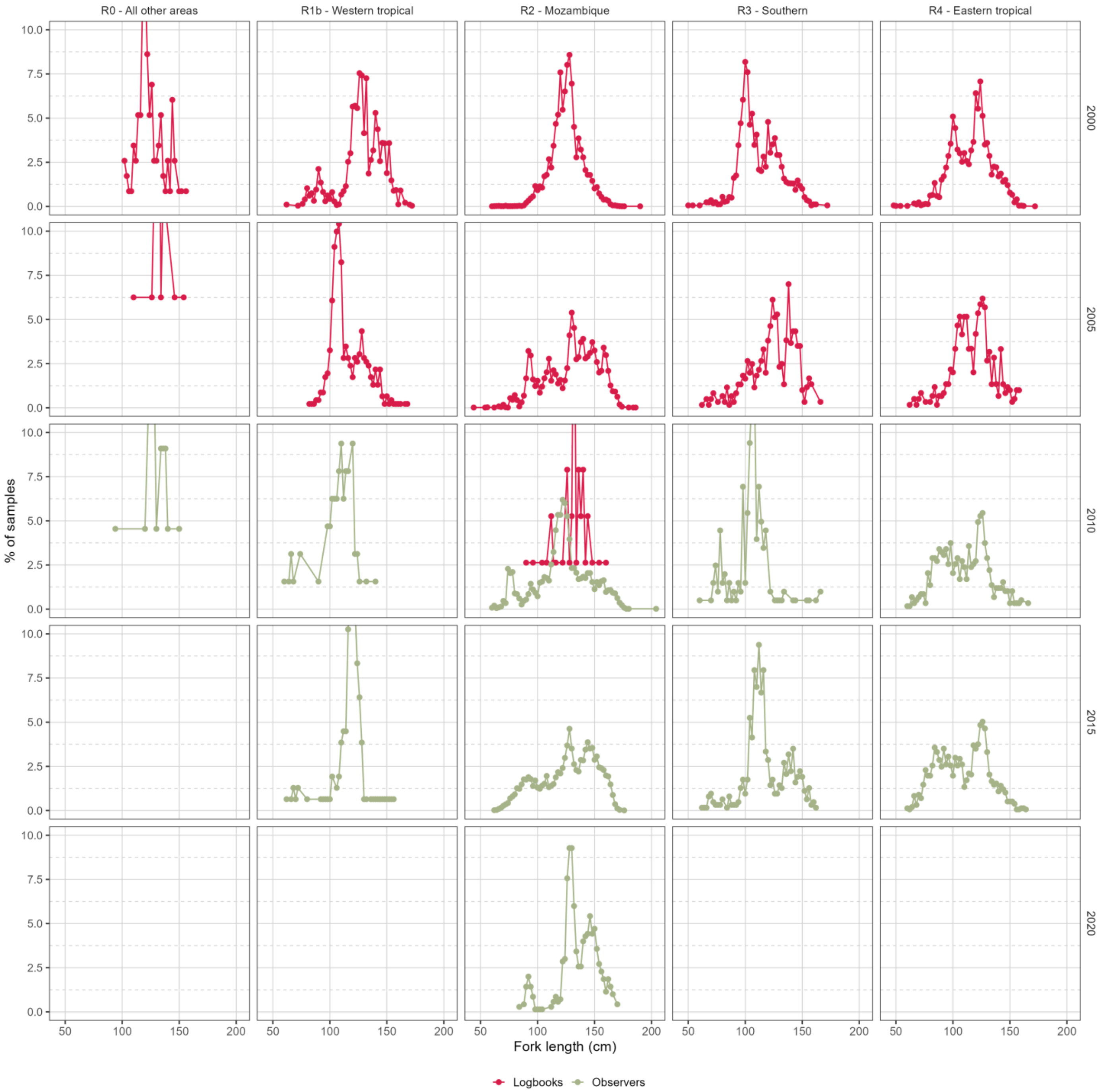

Figure 55: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported by the deep-freezing longline fleets of Japan, by source (scientific observers vs. logbooks), stock assessment area and five-year periods. Data source: standardized size-frequency dataset (Res. 15/02)

References

Amandè MJ, Chassot E, Chavance P, Murua H, Molina AD de, Bez N (2012) Precision in Bycatch Estimates: The Case of Tuna Purse-Seine Fisheries in the Indian Ocean. ICES Journal of Marine Science 69:1501–1510.

Geehan J, Hoyle S (2013) Review of length frequency data of the Taiwanese distant water longline fleet. IOTC, San Sebastian, Spain, 23-28 October 2013, p 30

Hosseini SA, Mirzaei M, Azhang B, Daryanabard R (2018) Iran small-scale tuna longline fishery targeting yellowfin tuna (*Thunnus albacares*) in Oman Sea: A preliminary study. IOTC, p 12

Hoyle S, Chang S-T, Fu D, Itoh T, Lee S-I, Lucas J, Matsumoto T, Yeh Y-M, Wu R-F, Lee MK (2021) Review of size data from Indian Ocean longline fleets, and its utility for stock assessment. IOTC, Virtual meeting, 25-30 October 2021, p 95

Huang H-W, Liu K-M (2010) Bycatch and Discards by Taiwanese Large-Scale Tuna Longline Fleets in the Indian Ocean. Fisheries Research 106:261–270.

IOTC (2019a) Alternative approaches to the revision of official species composition for the Spanish log-associated catch-and-effort data for tropical tuna species in 2018. IOTC, Karachi, Pakistan, 27-30 November 2019, p 27

IOTC (2023) Overview of Indian Ocean tropical tuna fisheries. IOTC, San Sebastian, Spain, 30 October - 04 November 2023, p 26

IOTC (2019b) Report of the 21st Session of the IOTC Working Party on Tropical Tunas. IOTC, Donostia-San Sebastian, Spain, 21-26 October 2019.

IOTC (2022a) Report of the 24th Session of the IOTC Working Party on Tropical Tunas, Data Preparatory Meeting. IOTC, Virtual meeting, 30 May-3 June 2022.

IOTC (2022b) Review of Indian Ocean bigeye tuna statistical data. IOTC, Virtual meeting, 24-29 October 2022, p 50

IOTC (2019c) Review of Pakistan’s reconstructed catch series for tuna and tuna-like species. IOTC, Karachi, Pakistan, 27-30 November 2019, p 17

IOTC-WPTT (2022) Equations used to convert from fork length to round weight for tropical tunas species IOTC.

Medley P, Defaux V, Huntington T (2021) Exploratory analysis of tropical tuna longline selectivity and its implications for stock assessment. IOTC, Virtual meeting, 10-14 May 2021, p 13

Miller KI, Nadheeh I, Jauharee AR, Anderson RC, Adam MS (2017) Bycatch in the Maldivian Pole-and-Line Tuna Fishery. PLOS ONE 12:e0177391.

MMAF (2021) Draft report on the review of re-estimation methodology of Indonesia’s annual tuna catch data in IOTC for 2017-2019. IOTC, Virtual meeting, 29 November - 3 December 2021, p 37

Moazzam M (2021) Declining neritic tuna landings in Pakistan: Causes and impact on fishing effort and marketing. IOTC, Virtual meeting, 05-09 July 2021, p 9

Rabearisoa N, Sabarros PS, Romanov EV, Lucas V, Bach P (2018) Toothed Whale and Shark Depredation Indicators: A Case Study from the Reunion Island and Seychelles Pelagic Longline Fisheries. PLOS ONE 13:e0202037.

Ruiz J, Abascal F, Bach P, Baez J-C, Cauquil P, Grande M, Krug I, Lucas J, Murua H, Lourdes Alonso ML, Sabarros PS (2018) Bycatch of the European, and associated flag, purse seine tuna fishery in the Indian Ocean for the period 2008-2017. IOTC, Cape Town, South Africa, 10-17 September 2018, p 15