REVIEW OF INDIAN OCEAN YELLOWFIN TUNA STATISTICAL DATA

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Introduction

The overarching objective of the paper is to provide participants to the 26th Session of the IOTC meeting of the Working Party on Tropical Tunas (WPTT26) with a review of the status of the information on yellowfin tuna (*Thunnus albacares*; YFT) available to the IOTC Secretariat as of June 2024. 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.

Retained catches

Historical trends (1950-2023)

Indian Ocean fisheries

Yellowfin tuna catches gradually increased over the decades, reaching over 300,000 tonnes in the 1990s, largely due to the introduction of new fishing technologies in the Indian Ocean, such as industrial purse seine vessels and advanced longliners. The primary fisheries during the earlier decades included coastal fisheries, distant-water longline fleets, and purse seine operations that emerged in the 1980s (**Table 1** & **Figs. 1-2**). Catches rose from approximately 28,000 tonnes in the 1950s to a peak of 333,000 tonnes in the 1990s. The highest recorded catch occurred in 2004, totaling 540,000 tonnes. This significant increase in catches can be attributed to the rising number of vessels across various fisheries, including deep-freezing longlines, purse seiners, and gillnets.

Table 1: Best scientific estimates of average annual retained catches (metric tonnes; t) of yellowfin tuna by decade and fishery for the period 1950-2023. 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	6,781
Purse seine | FS			60	31,552	64,938	89,204	44,611	31,932
Purse seine | LS			58	17,648	56,278	61,890	89,465	93,552
Longline | Other				354	5,677	14,454	7,164	601
Longline | Fresh			879	4,286	47,612	34,150	20,588	19,615
Longline | Deep-freezing	27,487	41,352	29,589	33,824	66,077	56,671	17,918	16,446
Line | Coastal longline	168	1,262	1,824	3,488	6,185	11,145	28,306	40,862
Line | Trolling	1,003	1,820	4,186	6,655	11,136	13,257	18,256	18,091
Line | Handline	627	646	2,903	8,070	20,154	34,538	70,481	112,519
Baitboat	2,111	2,318	5,810	8,295	12,805	16,077	17,542	13,163
Gillnet	1,571	4,114	7,928	12,020	39,199	58,818	76,938	60,121
Other	80	189	310	674	1,133	1,746	2,592	2,599

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s
Total	33,047	51,714	53,751	128,036	333,379	395,538	401,254	416,281

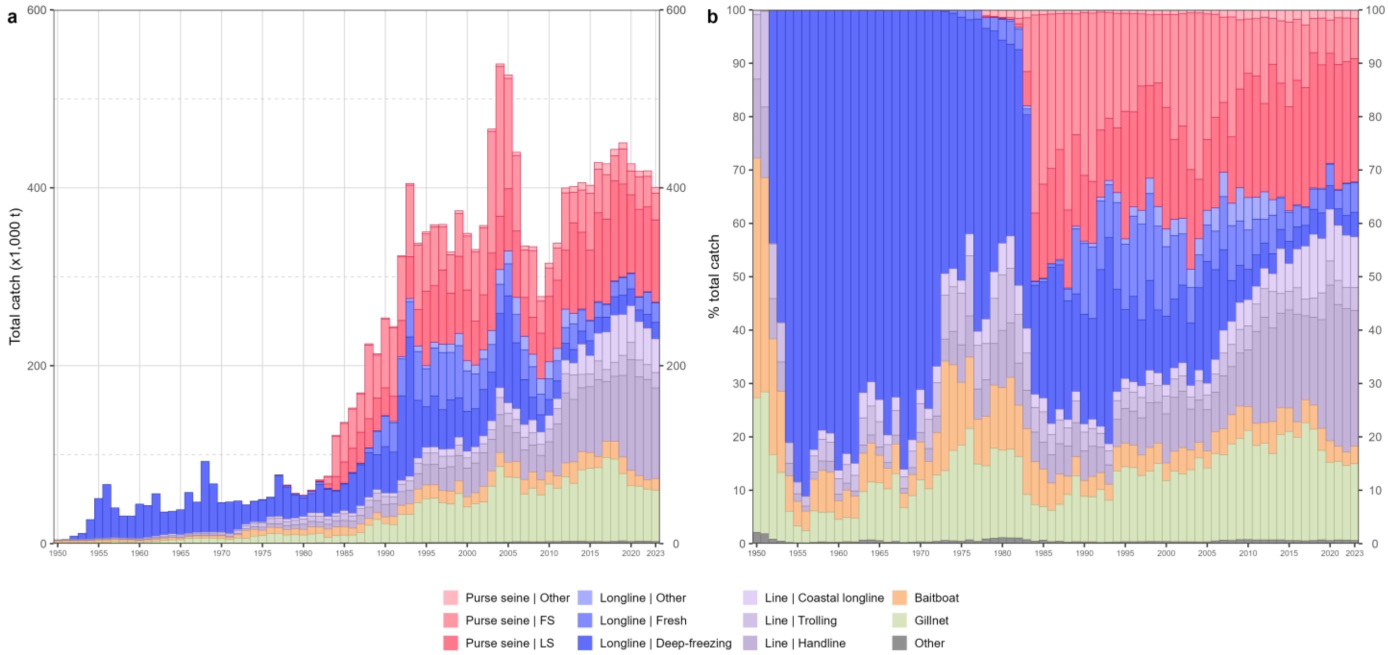

Figure 1: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of yellowfin tuna by fishery for the period 1950-2023. LS = schools associated with floating objects; FS = free-swimming schools. Data source: yellowfin tuna raised time-area catches

Catches began to decline significantly from 2007, falling to a low of 278,000 tonnes in 2009. This decline was primarily due to industrial vessels being forced to leave Somali national waters in response to insurgency and piracy in key fishing grounds, prompting them to fish in the Eastern Indian Ocean and other regions. Subsequently, catches by deep-freezing longline vessels remained low due to a decrease in their activities in the Western Indian Ocean, despite some stabilization in the area. In contrast, industrial purse seine vessels resumed operations in the Western Indian Ocean, bolstered by enhanced security measures onboard. From 2010 onwards, the catch trend showed an upward trajectory, accompanied by a shift in vessel types targeting yellowfin tuna. Consequently, catches from line fisheries increased, peaking at 185,000 tonnes in 2020 (**Table 2**). Overall, catches have steadily risen over the past decade, averaging 422,000 tonnes since 2014, although this remains lower than levels seen in the early 2000s.

Table 2: Best scientific estimates of annual retained catches (metric tonnes; t) of yellowfin tuna by fishery for the period 2014-2023. The background intensity color of each cell is directly proportional to the catch level. Data source: yellowfin tuna raised time-area catches

Fishery	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Purse seine | Other	8,313	9,101	7,525	12,150	7,145	6,872	8,091	6,135	6,337	6,562
Purse seine | FS	47,426	63,968	49,070	50,060	28,416	39,529	26,694	36,656	34,364	30,015
Purse seine | LS	86,402	78,578	99,781	95,331	112,313	104,144	88,056	98,269	95,310	92,572
Longline | Other	1,077	1,189	1,036	923	954	1,111	643	561	542	658
Longline | Fresh	23,763	21,987	16,817	13,959	16,827	19,787	17,137	14,431	24,870	22,021
Longline | Deep-freezing	14,523	16,608	17,740	16,519	20,697	21,541	18,843	12,932	15,529	18,480
Line | Coastal longline	34,073	20,922	31,134	42,414	53,062	45,948	41,397	43,211	40,899	37,941
Line | Trolling	15,091	14,136	21,168	13,356	15,766	22,595	19,341	19,008	16,764	17,250
Line | Handline	71,649	74,021	86,444	67,073	73,052	91,754	124,476	111,036	112,682	101,880
Baitboat	20,541	17,642	12,392	18,482	20,030	18,625	17,228	11,797	10,542	13,086
Gillnet	80,105	82,299	82,883	94,487	92,362	75,517	62,618	61,710	58,512	57,645
Other	2,837	2,397	2,485	2,208	2,626	3,160	2,420	2,841	2,758	2,376
Total	405,801	402,847	428,475	426,961	443,249	450,583	426,943	418,586	419,109	400,487

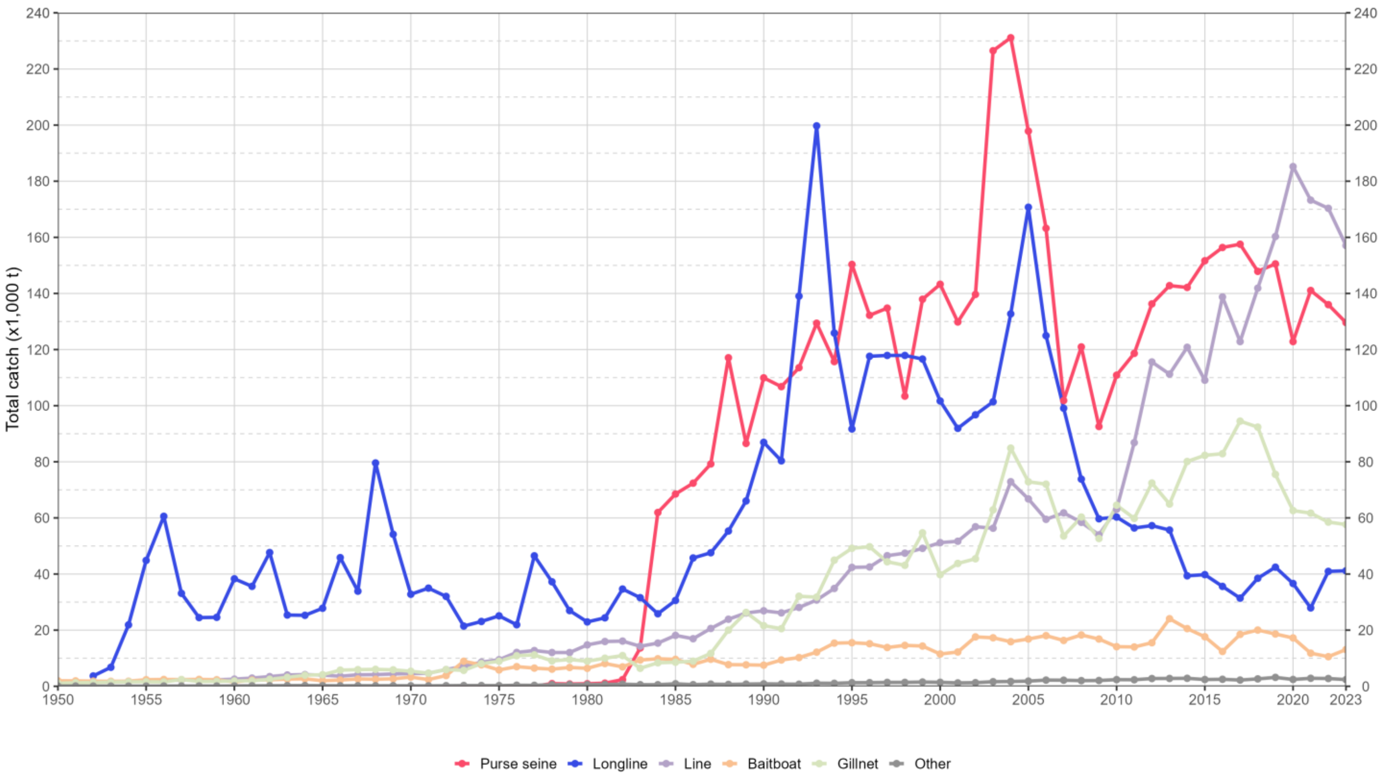

Figure 2: Annual time series of retained catches (metric tonnes; t) of yellowfin tuna by fishery group for the period 1950-2023. Data source: best scientific estimate of retained catches

In contrast to other oceans, the artisanal fishery component of yellowfin tuna catches in the Indian Ocean has consistently been substantial, accounting for over 40% of total catches annually from the mid-1970s to the early 1980s and again since 2007. Between 2019 and 2023, the mean annual catches from artisanal fisheries were approximately

210,000 tonnes, representing 51% of total catches, with significant contribution of 54% in 2020 (**Fig. 3**). However, in recent years, the contribution of yellowfin tuna from coastal fisheries has declined to49% by 2023.

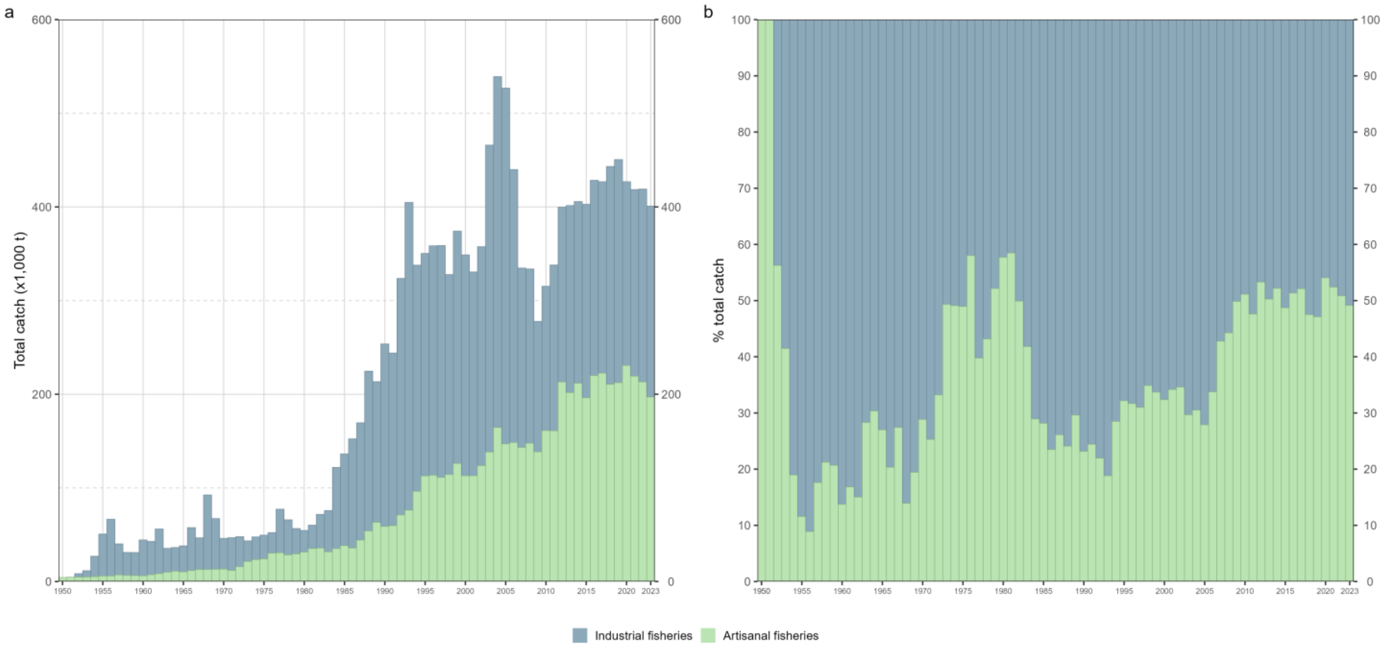

Figure 3: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of yellowfin tuna by type of fishery for the period 1950-2023. Data source: [best scientific estimate of retained catches]

Historical catches of yellowfin tuna by fishing mode reveal a generally increasing trend in the percentage of catches from FOB-associated schools from 2004 onward, accompanied by annual fluctuations in the contributions of each fishing mode, which can vary by up to 20% between consecutive years. The EU, particularly EU-France, has generally relied less on catches from FOB-associated schools, with the percentage of total yellowfin tuna catches exceeding 60% for this flag only in 2011 and from 2017 onward.

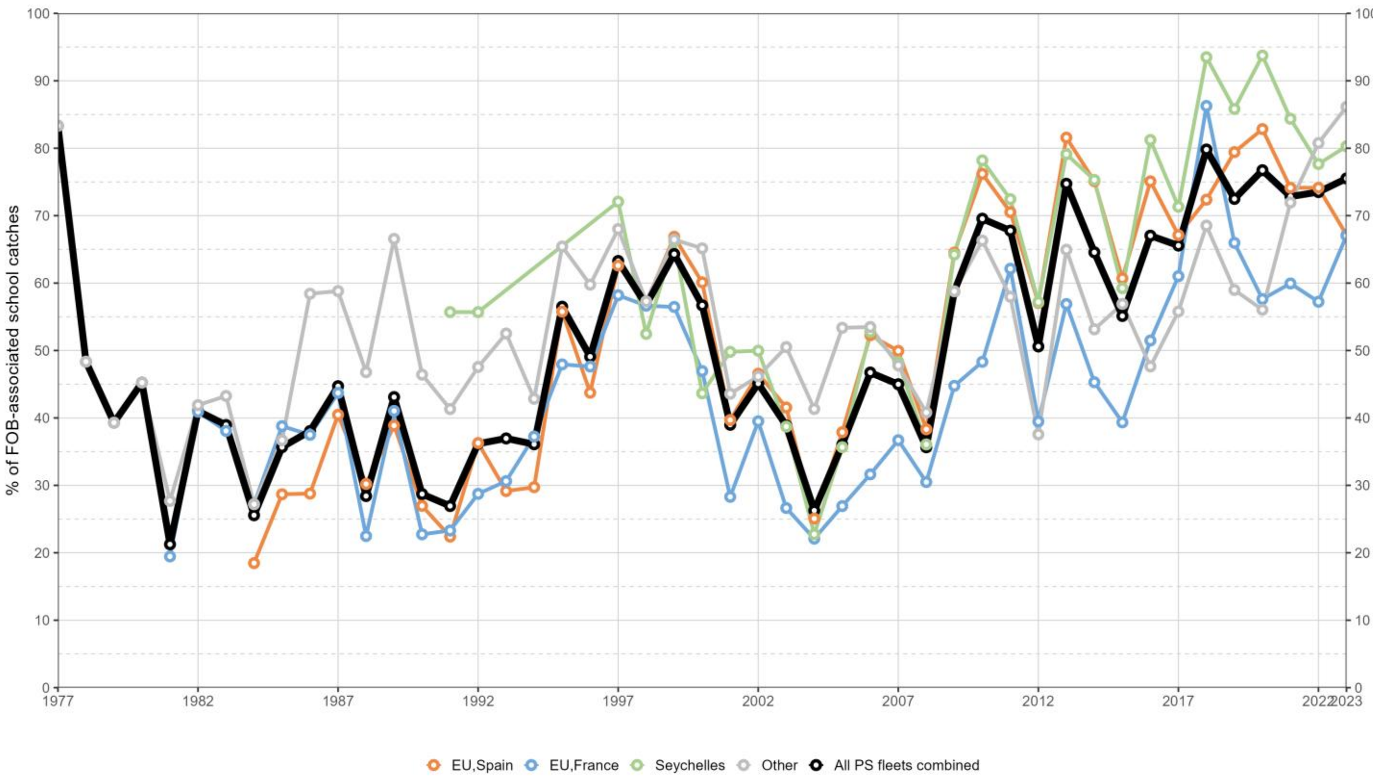

Figure 4: Annual percentages of purse seine FOB-associated catches of yellowfin tuna by fleet for the period 1977-2023. *Other* includes purse seine fleets such as ex-Soviet Union, I.R. Iran, France (Mayotte), Mauritius, Japan, Korea, Indonesia, Thailand, EU,Italy, Belize and others. Data source: [time-area catch dataset for purse seine fisheries] (Res. 15/02)

Catch contributions from FOB-associated schools within purse seine fisheries rose significantly between 2014 and 2023, with combined catches from all fleets fluctuating between 55% and 80%. The maximum percentage of 80% was recorded in 2018 (**Fig. 4**). The decrease in relative catches from FOB-associated schools since 2018 may be attributed to changes in fishing practices across all fleets, following the implementation of various IOTC resolutions aimed at rebuilding the Indian Ocean yellowfin tuna stock. Despite ongoing discussions about reducing dependency on FOBs, the proportion of purse seine catches from FOBs increased across all fleets, with around 76% in 2023.

Recent fishery features (2019-2023)

In recent years, the average catch of yellowfin tuna has shown significant contributions of various fisheries, with coastal fisheries playing a major role.**Table 3** illustrates that line, purse seine, and gillnet fisheries are the three primary contributors to yellowfin tuna catches:

- **Line fisheries**: The contribution of line fisheries increased, averaging 169,000 tonnes, representing 40% of the total catches. This includes 108,000 tonnes caught with handlines, 42,000 tonnes with coastal longlines, and 19,000 tonnes with trolling lines.
- **Purse seine fisheries**: Inclusive all industrial fishing modes, as well as small purse seiners and ringnetters, purse seine fisheries are the second largest fisheries contributors, with around 140,000 tonnes, representing 32.1 % of total catch.
- **Gillnet fisheries**: vessels with gillnet fisheries, operated not only in the coastal areas, but also in areas beyond national jurisdiction (ABNJ). they account for 14.9 % of total catches.
- **Other fisheries**: Industrial longline fisheries have lower catches of yellowfin tuna compared to other industrial fisheries, as they primarily target mainly bigeye and albacore tuna. The total contribution from longline fisheries is only 8.9 %. Additionally, baitboat and other coastal fisheries capture very few yellowfin tuna.

Table 3: Mean annual catches (metric tonnes; t) of yellowfin tuna by fishery between 2019 and 2023. 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	108,366	25.6
Purse seine | LS	PSLS	95,670	22.6
Gillnet	GN	63,200	14.9
Line | Coastal longline	LIC	41,879	9.9
Purse seine | FS	PSFS	33,452	7.9
Longline | Fresh	LLF	19,649	4.6
Line | Trolling	LIT	18,992	4.5
Longline | Deep-freezing	LLD	17,465	4.1
Baitboat	BB	14,255	3.4
Purse seine | Other	PSOT	6,799	1.6
Other	OT	2,711	0.6
Longline | Other	LLO	703	0.2

As noted, significant catches of yellowfin tuna are from line fisheries. Between 2019 and 2023, around 70% of the catch are accounted for by seven fleets, with Omani line fisheries catching over 12%, on average in during this period (**Fig. 5**). Oman and the Islamic Republic of Iran collectively contributed to 26% of total yellowfin tuna catches, mainly operating within the national jurisdictional areas (NJA) and employing small-scale fisheries, predominantly handline and gillnet methods. In contrast, industrial purse seine fleets accounted for 31% of catches in recent years, distributed among 11 different fleets.

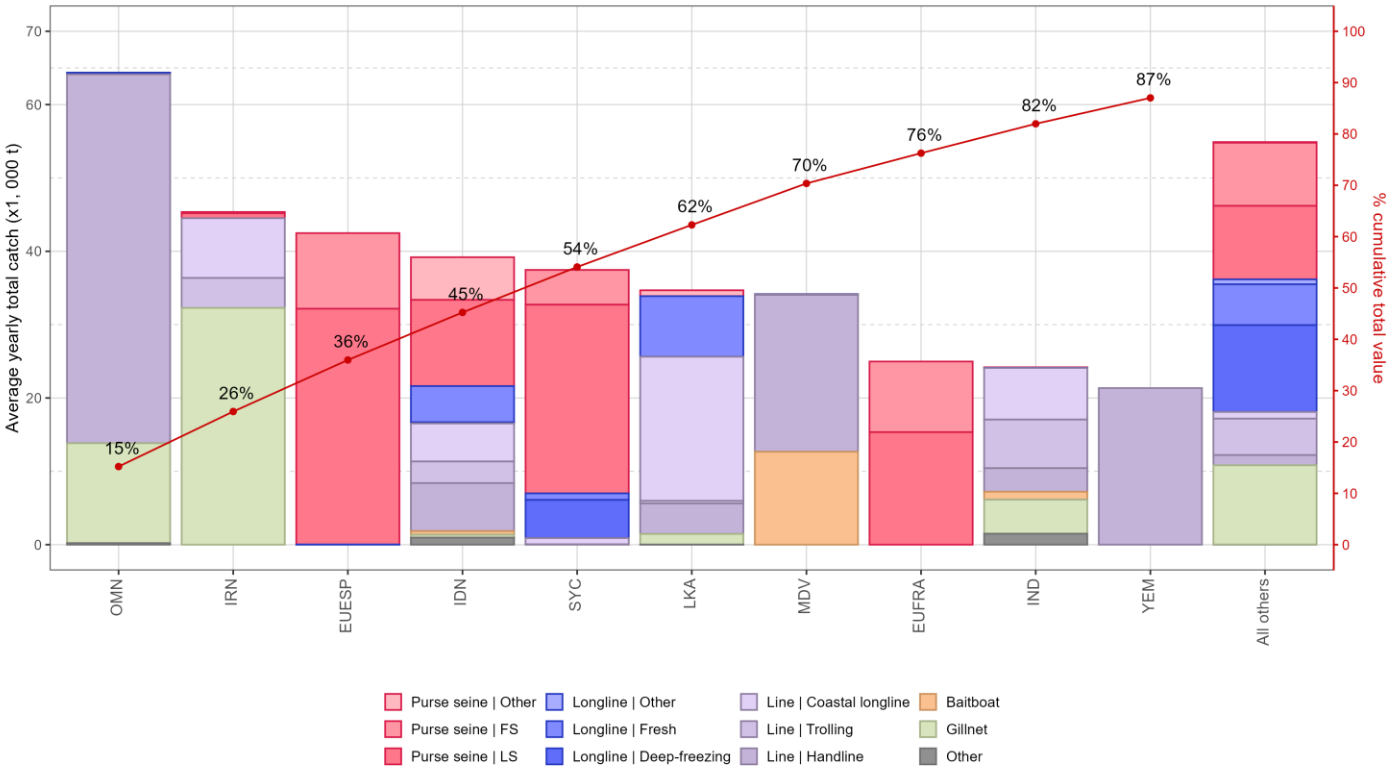

Figure 5: Mean annual catches (metric tonnes; t) of yellowfin tuna by fleet and fishery between 2019 and 2023, with indication of cumulative catches by fleet. FS = free-swimming schools; LS = schools associated with floating objects. Data source: yellowfin tuna raised time-area catches

The overall catch trend by fishery group indicates a decline in recent years (2019-2023) across the main fishery groups. Catches from line fisheries peaked at 185,000tonnes in 2020, but have steadily declined thereafter. In contrast, purse seine fisheries, which recorded their lowest catch in 2020, experience an increase in catches starting in 2021. Gillnet fisheries, however, maintained their catches to a consistent level (**Fig. 6**).

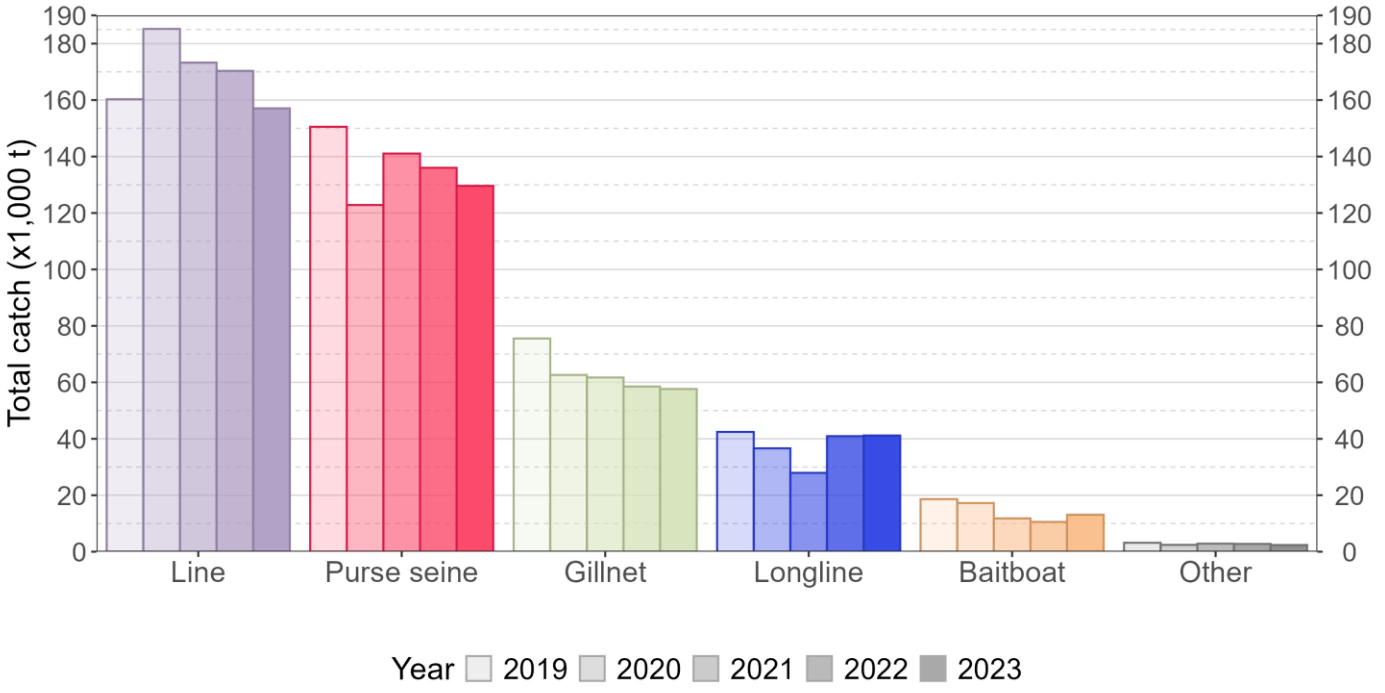

Figure 6: Annual catch (metric tonnes; t) trends of yellowfin tuna by fishery group between 2019 and 2023. Data source: best scientific estimate of retained catches

Industrial purse seine fisheries which contributed 31% and consisted of two fishing modes, catches fluctuated in recent years from all major fleets. Catches from free-swimming schools increased by EU.Spain vessels from 2021, reaching a maximum of 13,000 in 2023. Whereas catches from other fleet fishing on free-schools declined (**Fig. 8a**). EU.Spain and Seychelles, the main fleets fishing on FOBs-associated schools, faced decline in the catches from 2020, which could be attributed to fewer operations from these fleets in the Indian Ocean from 2020 after COVID-19, and the need to reduce catches of yellowfin to maintain catch limits in accordance to resolution 21/01. Catches from EU.Spain and Seychelles FOB-associated schools in 2023 reached lowest point, 37,000 tonnes and 29,000, respectively. In contrast, catches of Indonesia purse seine fisheries, fishing FOB-associated school, increased sharply from 2021 (**Fig. 8b**).

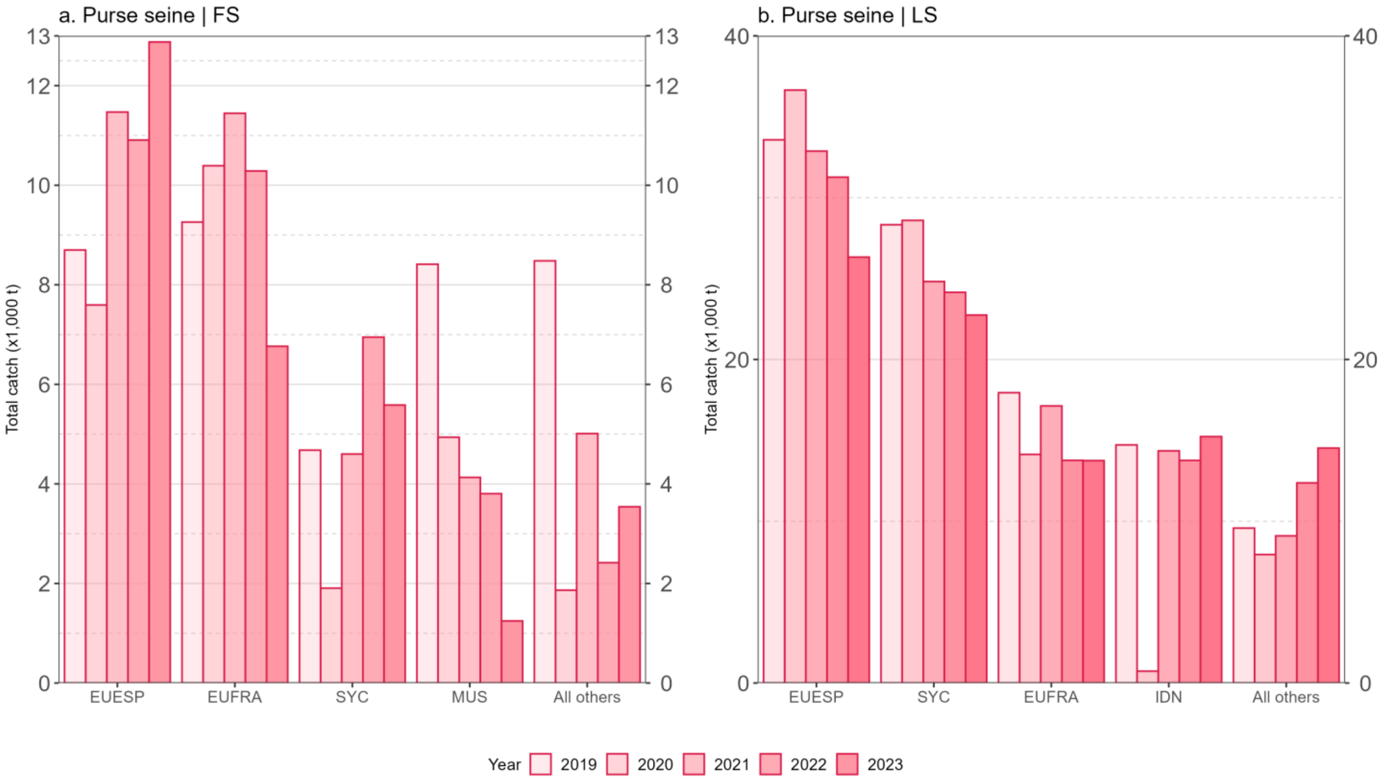

Figure 7: Annual purse seine catch (metric tonnes; t) trends of yellowfin tuna by fishing mode and fleet between 2019 and 2023. FS = free-swimming schools; LS = schools associated with floating objects. Data source: yellowfin tuna raised time-area catches

Although the catches by fishing modes within purse seine fisheries show variations among major fleets, overall purse seine catches have gradually reduced across all fleets in recent years (**Fig. 8a**). Other fisheries exhibit mixed trends. Notably, fleets with significant yellowfin tuna catches from line fisheries have experienced marked declines. Omani handline catches peaked in 2021 at 65,000 tonnes but declined to 49,000 tonnes in 2023. Similarly, Sri Lanka's line fisheries, primarily using coastal longlines, recorded lower catches in 2023 (**Fig. 8c**). The increase in aggregated catches under *all others* is largely attributed to catches reported by coastal longliners from the Islamic Republic of Iran, which has been actively supporting the development of this fishery in recent years (Hosseini et al. 2018).

Longline fisheries, while catching less yellowfin tuna overall, showed variation in catch trends but recorded an increase in 2023. Sri Lanka and other fleets reported higher catches in 2023, in contrast to Indonesia, which saw a sharp decline to 5,000 tonnes, down from 11,000 tonnes in 2022 (**Fig. 8b**).

Few fleets reported yellowfin tuna catches from baitboat fisheries. While the Maldives is the major player in this category, India and Indonesia also participate in baitboat fishing. Although Maldivian baitboat fisheries experienced decreased yellowfin catches in 2021 and 2022, catches rose in 2023, reaching 11,200 tonnes, though still below the 2019 level of (19,000) tonnes (**Fig. 8d**).

In gillnet fisheries, the Islamic Republic of Iran remains the primary contributor, averaging 32,000 tonnes in recent years. The decline in Iranian gillnet catches may be linked to the conversion of some gillnet vessels into seasonal coastal longliners targeting yellowfin tuna. In contrast, catches from Omani and Pakistani gillnet fisheries have shown an increasing trend in recent years. Omani average catches shifted from 11,000 tonnes between 2019 and 2021 to 18,000 tonnes in 2022. Meanwhile, Pakistani average catches have remained stable at 8,000 tonnes (**Fig. 8e**). Catches from other fisheries (**Fig. 8f**) varied, with India reporting between 2,000 tonnes in 2019 and 1,000 tonnes in 2023, while catches from other fleets have been more consistent.

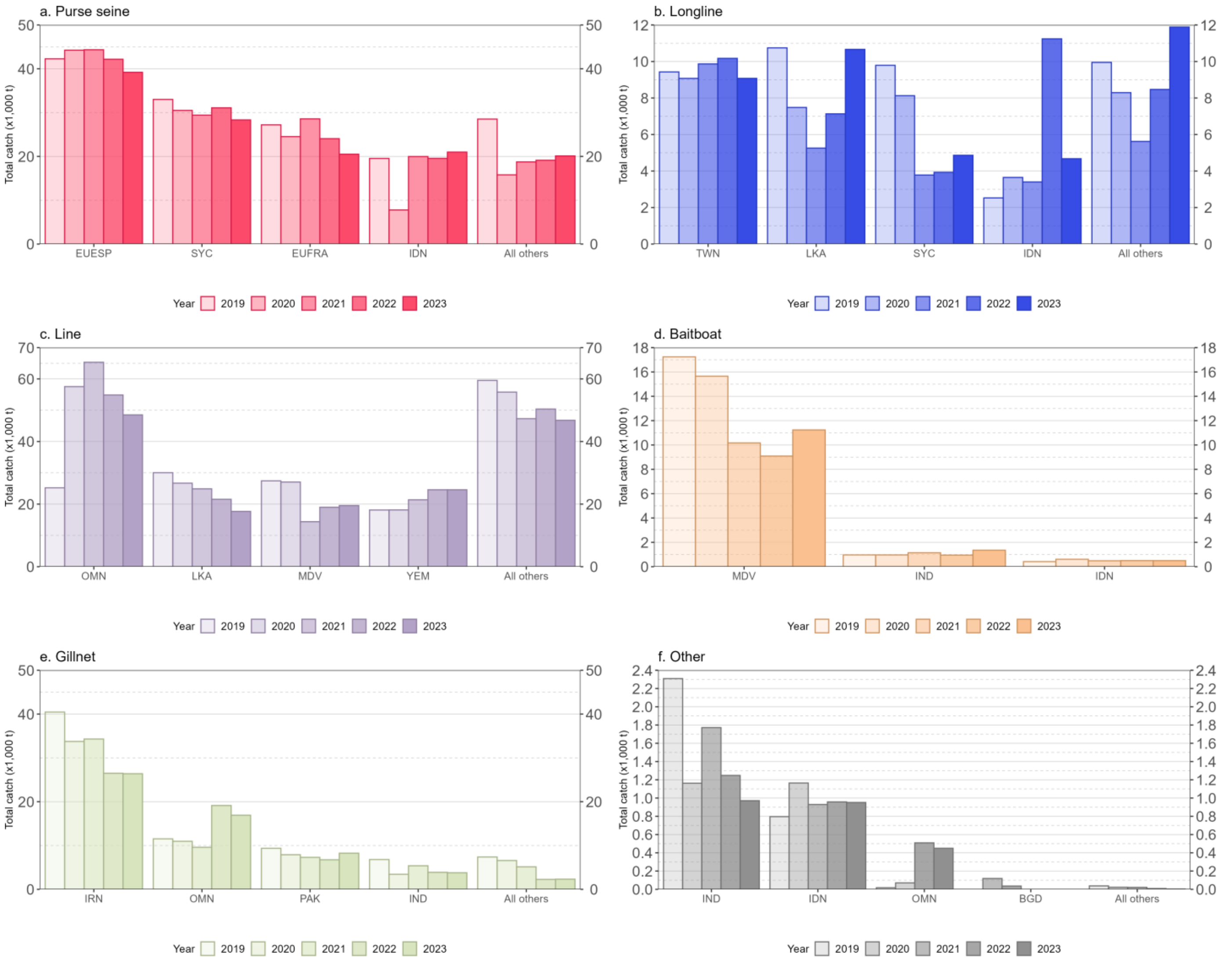

Figure 8: Annual catch (metric tonnes; t) trends of yellowfin tuna by fishery group and fleet between 2019 and 2023. Data source: best scientific estimate of retained catches

Changes from previous WPTT

Changes in catches compared to the data used for the preparatory meeting primarily reflect updated information from certain fleets. The revised catches vary by country, as illustrated in (**Fig. 9** and **Table 4**). These updates are mainly based on revised catch data published by the FAO, which must be incorporated into the catch statistics of countries for which the IOTC relies on FAO data as a source.

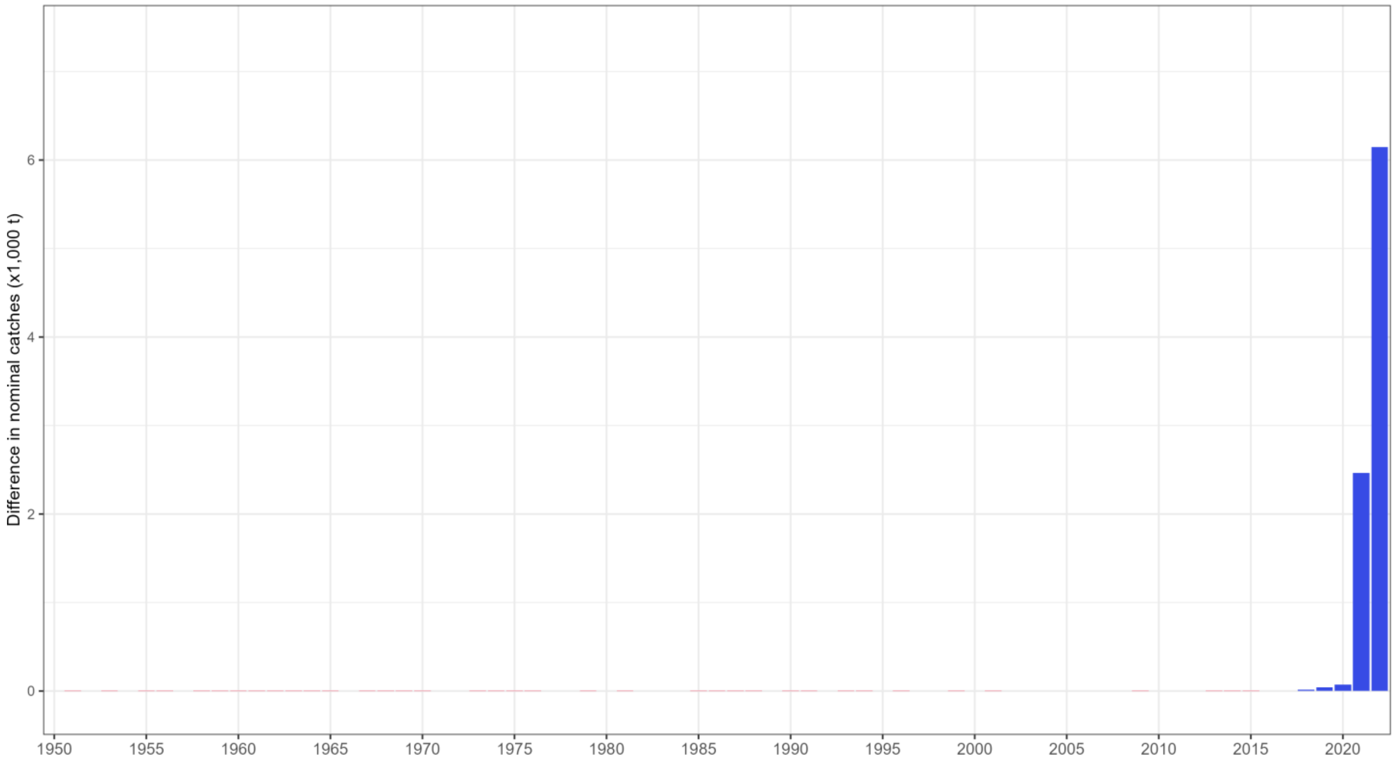

Figure 9: Differences in the available best scientific estimates of retained catches (metric tonnes; t) of yellowfin tuna between this WPTT and its previous session (data preparatory meeting held in May 2024)

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 between this WPTT and its previous session (data preparatory meeting held in May 2024)

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2022	DJI	Gillnet	Western Indian Ocean	38	7	31
	JPN	Longline	Western Indian Ocean	1,173	1,235	-62
	TMP	Gillnet	Eastern Indian Ocean	15	0	15
	YEM	Line	Western Indian Ocean	24,575	18,134	6,441
2021	JPN	Longline	Western Indian Ocean	803	842	-39
	KEN	Line	Western Indian Ocean	226	240	-14
	TMP	Gillnet	Eastern Indian Ocean	13	0	13
	YEM	Line	Western Indian Ocean	21,370	18,134	3,236
2020	KEN	Line	Western Indian Ocean	273	290	-17
	TMP	Gillnet	Eastern Indian Ocean	111	0	111
2019		Gillnet	Eastern Indian Ocean	46	0	46
2018		Gillnet	Eastern Indian Ocean	18	0	18

Uncertainties in retained catches data

Reporting quality

Significant catches of yellowfin tuna are reported as required, allowing the Secretariat to estimate minimum catches, though variations occur over time. In earlier decades, the quality of reported data was poor; not all data were well disaggregated by species or gear, and some fleets did not report their catches. During the 1990s, a substantial proportion of retained catch data was unavailable, with only 66% of total catches being fully or partially accessible (quality score 0-2) (**Fig. 10**).

The quality of retained yellowfin tuna catches varies by fishery type, with significant fluctuations in the availability of catches from both industrial and artisanal fisheries. Despite the high uncertainty in earlier periods, current retained catches are more consistent, with a high proportion available, 100% from industrial fisheries and 86% from artisanal fisheries between 2019 and 2023. The overall availability of retained catches in 2023 was 88%. The reduction in data availability in 2023 compared to 2022 can be attributed to the lack of primary source data from Oman, which is critical given that Oman contributes significantly to yellowfin tuna catches (16%). Catches from some fleets still require estimation by the Secretariat or supplementation from alternative sources, particularly the FAO global capture production database.

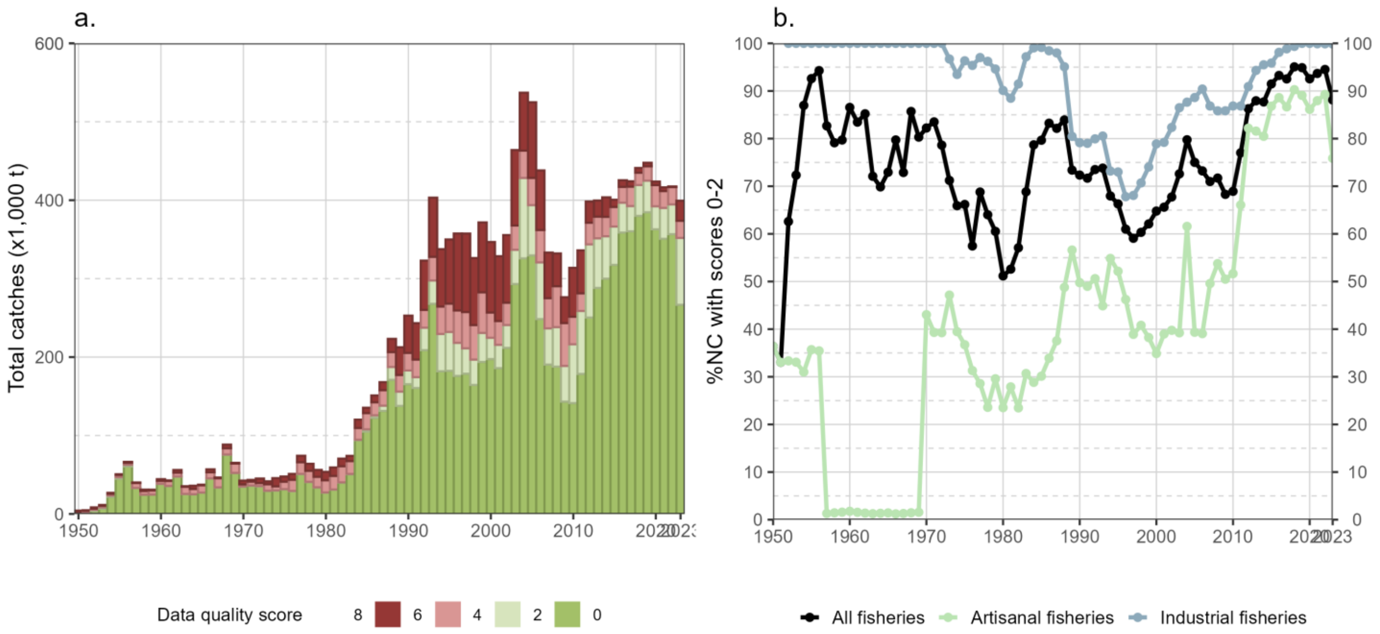

Figure 10: (a) Annual retained catches (metric tonnes; t) of yellowfin tuna estimated by quality score and (b) percentage of retained catches fully or partially reported to the IOTC Secretariat for all fisheries and by type of fishery in the period 1950-2023

Issues regarding historical catches remain unresolved for most Contracting Parties (CPCs), despite several attempts to improve data quality. The main historical challenges identified with retained catches of yellowfin tuna include:

- 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 (Ministry of Marine Affairs and Fisheries of Indonesia 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 Secretariat 2019);

- Gillnet fishery of Tanzania: catches have been repeated since 2014 in absence of information, until 2021;
- 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. 11**). 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).

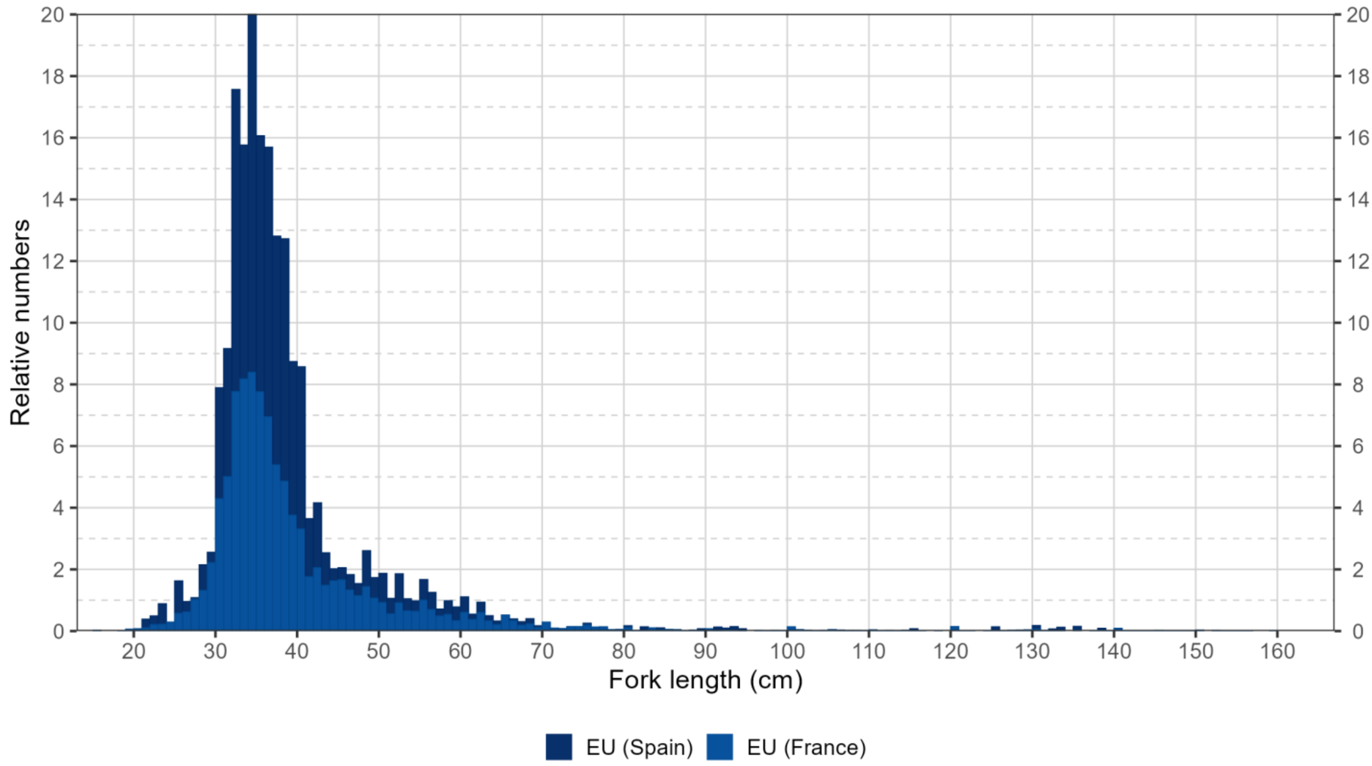

Figure 11: Fork length (cm) distribution of yellowfin tuna discarded at sea in purse seine fisheries during the period 2016-2020 (n = 129,520). Data source: IOTC ROS database

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. 12**). 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).

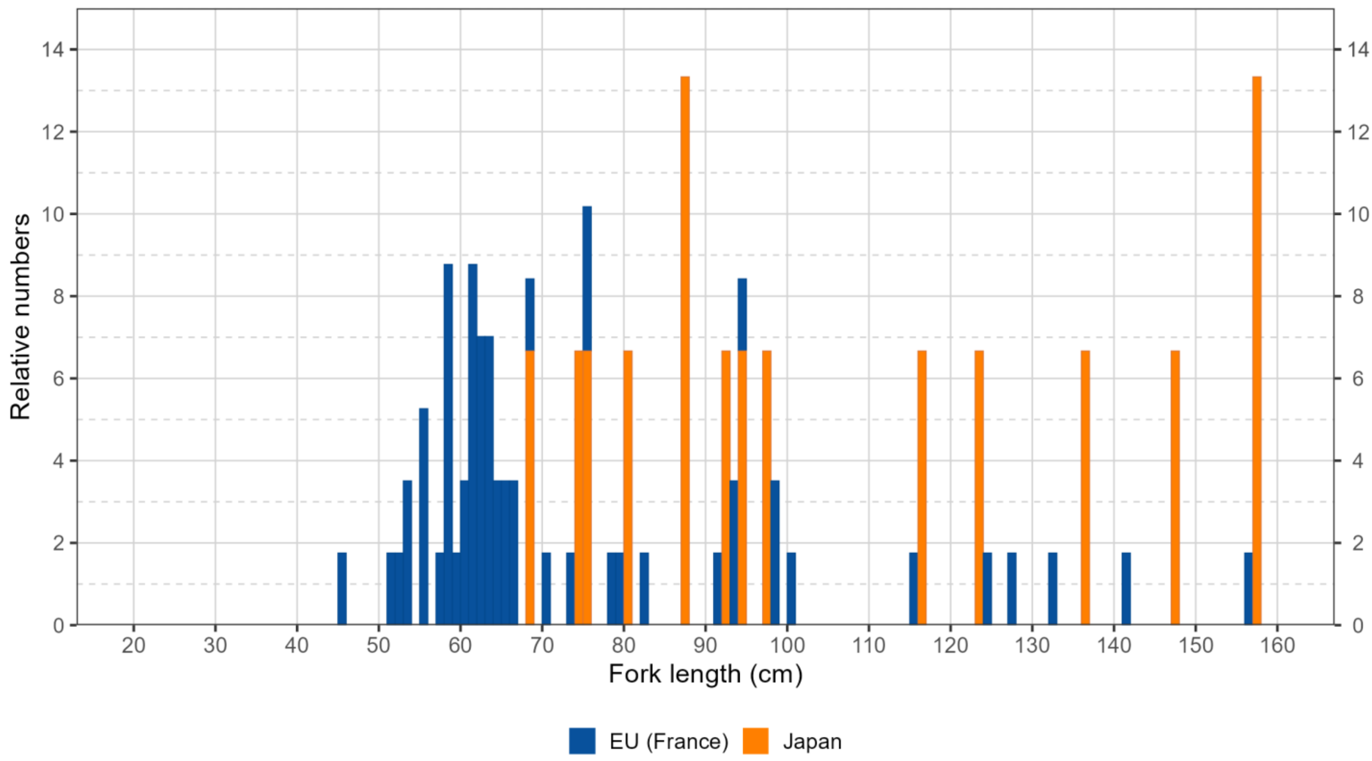

Figure 12: Fork length (cm) distribution of yellowfin tuna discarded at sea in longline fisheries during the period 2009-2020 (n = 516). Data source: IOTC ROS database

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

Catches of yellowfin tuna have been recorded throughout the Indian Ocean since the 1950s. However, spatial-temporal data have been scarce, with most available information focusing on industrial fisheries, particularly longline fleets, which were the predominant industrial fishery. The catch distribution maps illustrate the availability and quantity of yellowfin tuna catches by decade for the main fisheries (**Fig. 13**).

Throughout the 1960s and 1970s, the longline fisheries expanded in the south-western part of the Indian Ocean, including in the Mozambique Channel (**Fig. 13.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. 13.d**). While substantial catches of yellowfin tuna have been reported from coastal fisheries, the spatial distribution of these catches began to be documented in the 1970s, highlighting catches from gillnet and baitboat fisheries in the northern Indian Ocean (**Fig. 13.c**). The data primarily originate from India’s coastal fisheries and Maldives’ baitboat fisheries.

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. 13.e-f**).

The georeferenced catch distribution indicates a shift in fisheries targeting yellowfin tuna, although the main fishing grounds remain in the western Indian Ocean. In addition to this shift, the availability of geo-referenced catch data for yellowfin has improved in recent years (2019-2023). Notably, significant catches are now reported from Sri Lanka and the Arabian Sea, underscoring the importance of line fisheries in this region. This trend also reflects a declining importance of purse seine fisheries, with fewer longline fisheries contributing to the overall catch (**Fig. 14**).

Georeferenced catches by fishery and decade (1950-2009)

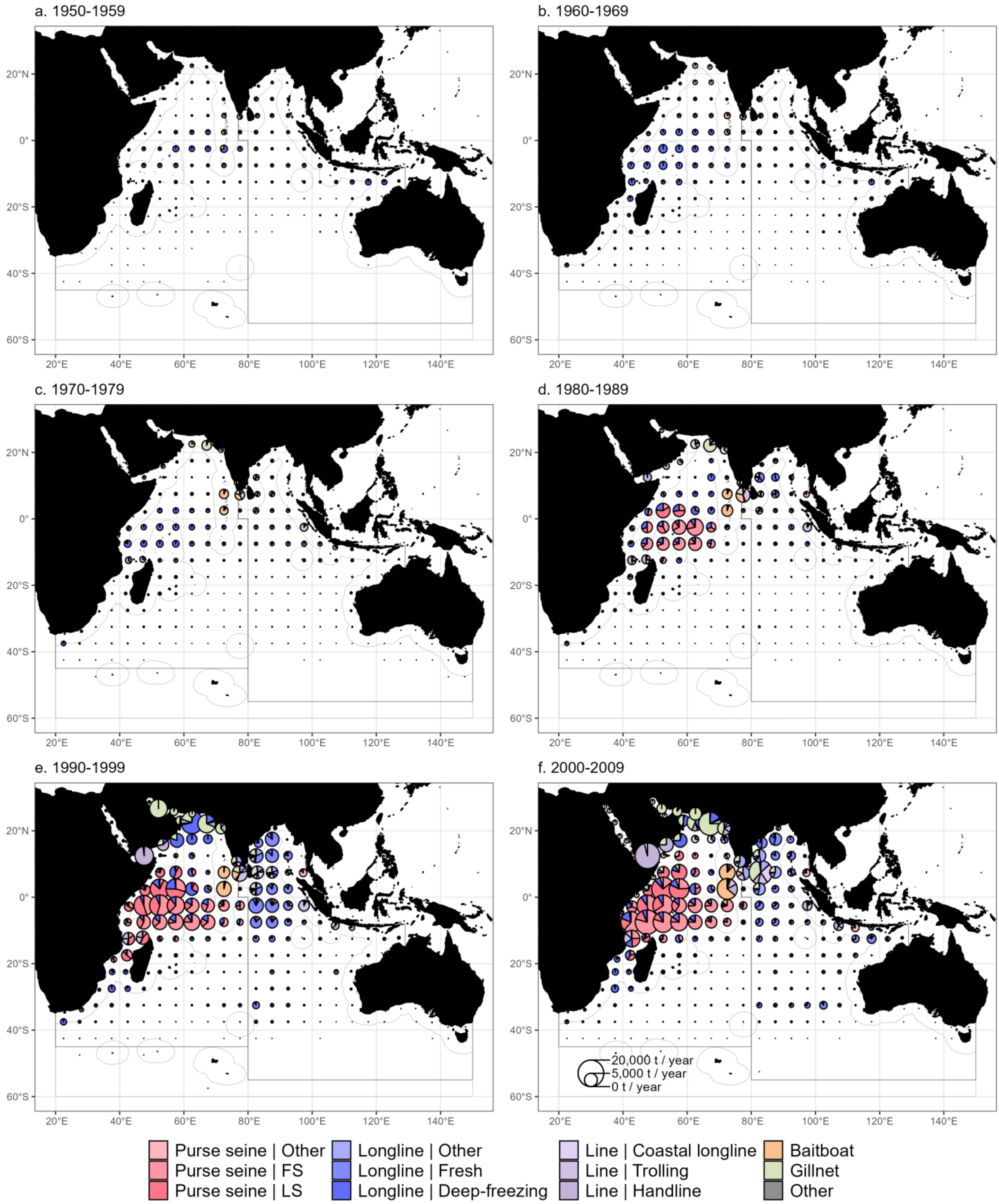

Figure 13: Estimated mean annual time-area catches (metric tonnes; t) of yellowfin tuna by decade, 5x5 grid, and fishery. Data source: yellowfin tuna raised time-area catches

Georeferenced catches by fishery, last years (2019-2023) and decade (2010-2019)

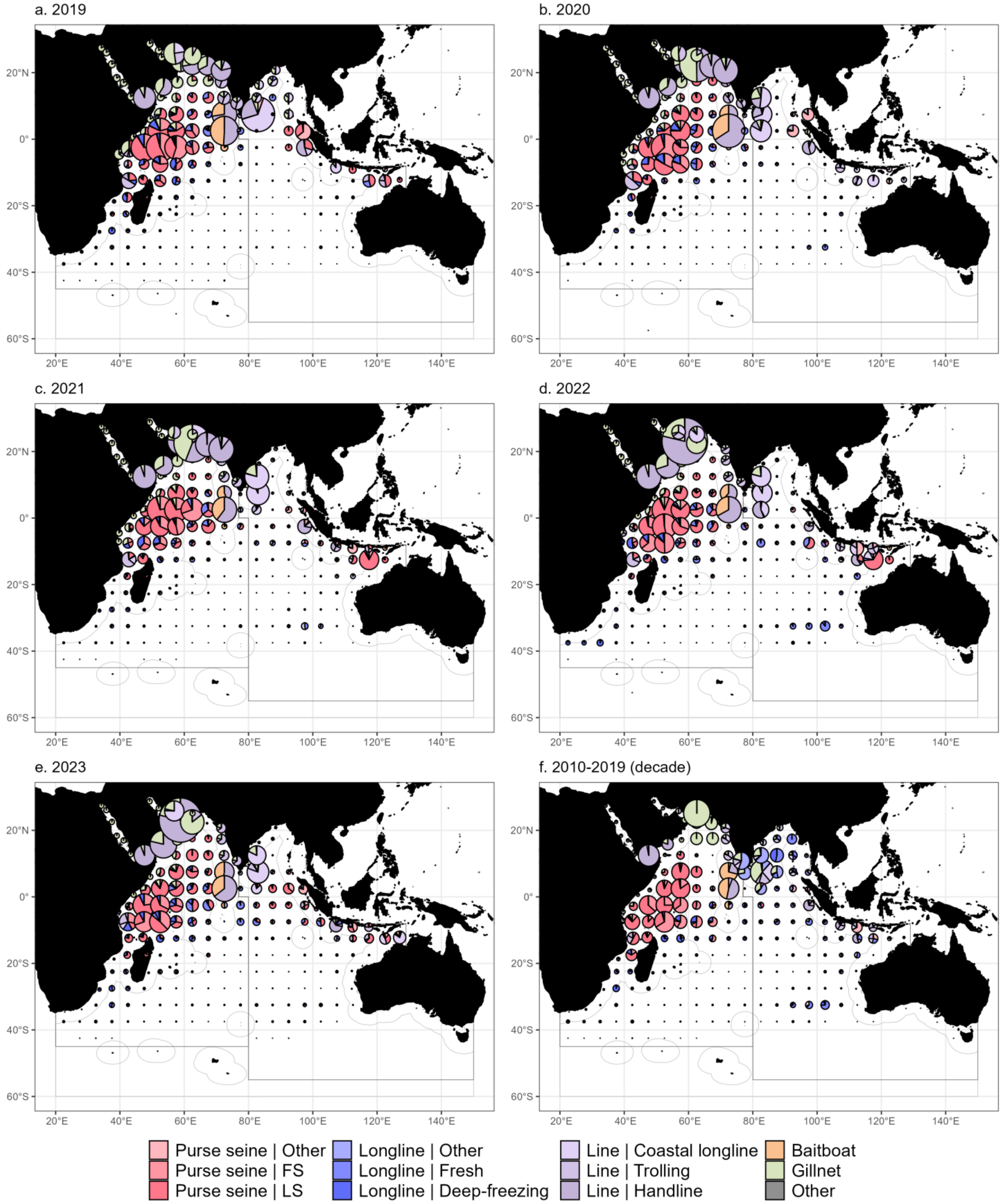

Figure 14: Estimated mean annual time-area catches (metric tonnes; t) of yellowfin tuna by year / decade, 5x5 grid, and fishery. Data source: yellowfin tuna raised time-area catches

Recently, Indonesia has reported retained catches of yellowfin tuna from industrial purse seine fisheries operating within the NJA, specifically from vessels with length overall less than 40 meters. However, the spatial coverage of these reports is low and variable. Catches from this fishery are rising, although this trend is not well represented in all maps (**Fig. 14d-e**). Baitboat fishing is predominantly concentrated in the Maldives archipelago, while gillnet and line fisheries (including handline, trolling, and coastal longline) are widely utilized along the coasts of Oman, Pakistan, India, Sri Lanka, Indonesia, and Yemen, although very little information is available for the latter country.

Uncertainties in catch and effort data

The availability of catch and effort data remains challenging, as not all CPCs with significant yellowfin tuna catches are reporting spatial-temporal data, particularly from coastal fisheries. The data received from these coastal fisheries is often of poor quality, primarily due to the absence of complete information, such as proper spatial grids, and insufficient coverage, which hinders accurate total catch estimates. As a result, the quality of catch-effort data is significantly influenced by the contribution of artisanal fisheries to the overall yellowfin tuna catches (**Fig. 15.b**).

The main issues identified in the past concern:

- Inadequate disaggregated catch and effort data from Taiwan, China’s longline fisheries.
- Low coverage catch and effort data from Indonesia reported from 2018, and lack of catch and effort data prior to 2018, for all fisheries
- 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;
- Significant coastal fisheries using hand and/or troll lines, particularly those in Oman, Yemen, Madagascar, and India, for which no or incomplete data have been reported to the Secretariat.

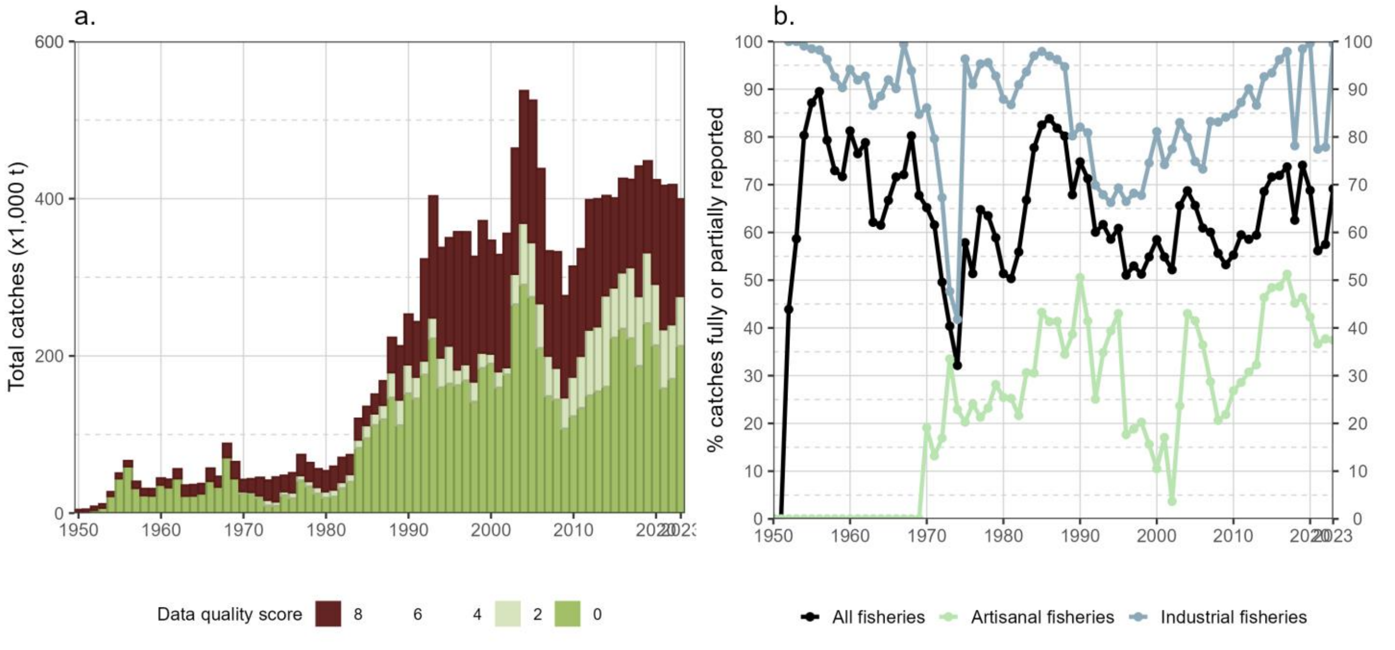

Figure 15: Annual retained catches (metric tonnes; t) of yellowfin tuna estimated by quality score (barplot) and percentage of geo-referenced catches reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950-2023

In recent years, the availability of spatial geo-referenced catch,in relation to total retained catches varied, ranging between 56% in 2021 and 74% in 2017. This decline contrasts with the higher availability seen in the past when industrial fisheries were the predominant contributors to yellowfin tuna catches, achieving geo-referenced data for 82% of total retained catches. Although there has been an overall upward trend in data availability, in 2023 only 69% of good quality data available, with a concering low of just 37% for the artisanal fisheries (**Fig. 15.a-b**).

Nevertheless, geo-referenced catch-effort data are not available for about 31% (i.e., around 120,000 t) of the total nominal catches of yellowfin tuna in 2023.

Fisheries which continuously slacken with geo-referenced catch data, by either not providing or low coverage spatial data, there average retained catch contribution in recent years are:

Fisheries that consistently lag in providing geo-referenced catch data, either by failing to submit data or offering low coverage, their average contributions to retained catches in recent years are important:

- Omani fisheries: 15%, which includes handline, gillnet, and more recently, industrial purse seine fisheries, but lacks geo-referenced data for all fisheries.
- Yemeni fisheries: 5%, with retained catches sourced from the FAO database, primarily from handline fisheries; however, the specific gear used cannot be confirmed.
- Indonesia : 9%, encompassing diverse fisheries but reporting low coverage of catch and effort data since 2018, missing geo-referenced data for previous years.
- I. R Iran: 11%, with yellowfin catches derived from coastal longline and gillnet fisheries; reported catch and effort data lack proper spatial referencing and are not raised to total catch estimates.
- India: 6% from various fisheries, does not report spatial-temporal data.

Size composition of the catch

Samples availability

By fishery group

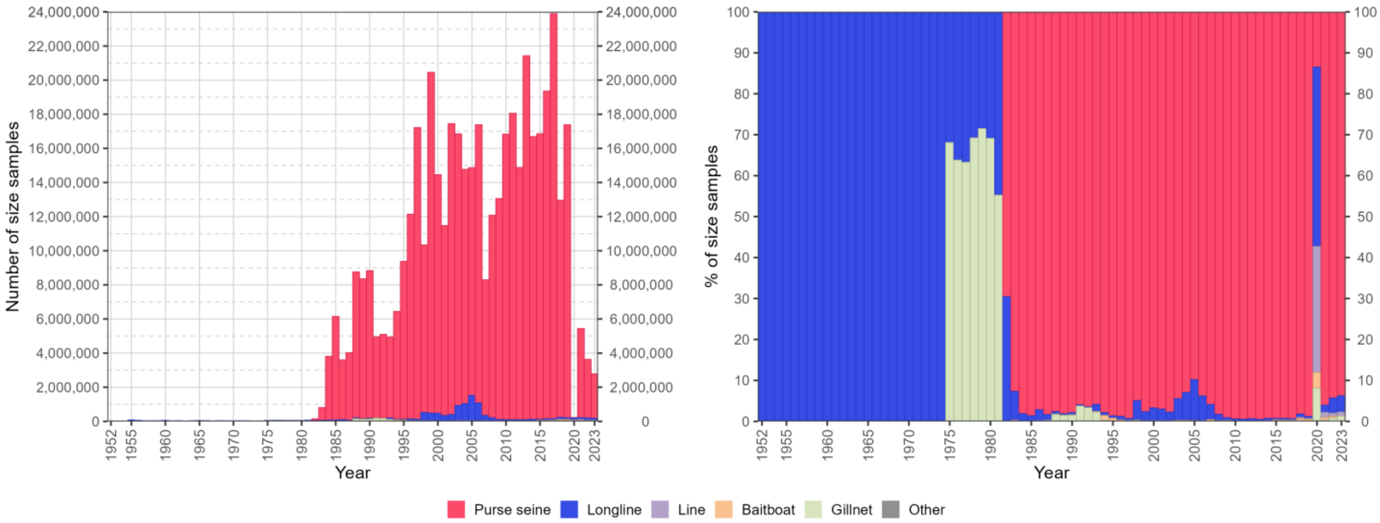

Figure 16: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset (Res. 15/02)

Industrial longline and purse seine fisheries maintain consistent sampling of yellowfin tuna throughout the period, noting that comprehensive size data are available from 1980s, in contrast coastal fisheries (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. . However, in recent years, CPCs with industrial purse seine fisheries have shifted from reporting raising samples to providing raw sample sizes, leading to a significant decline in the availability of size data from purse seine fisheries (**Fig. 16**).

The spatial distribution of available samples by fishery type over the last five years generally reflects the fishing grounds where these fisheries operate and is proportional to the level of recorded captures (**Fig. 17**). As shown in the chart, the majority of size samples are derived from purse seine fisheries, with a high concentration collected in the Western

Indian Ocean. In contrast, longline fisheries have a more widespread distribution across the Indian Ocean, though they also exhibit a higher average of samples collected in the Western Indian Ocean. Meanwhile, the distribution of samples from coastal fisheries, using line, baitboat, and gillnet, is limited to Near-Jurisdictional Areas (NJAs), with some gillnet data obtained from the high seas (**Fig. 17**).

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.

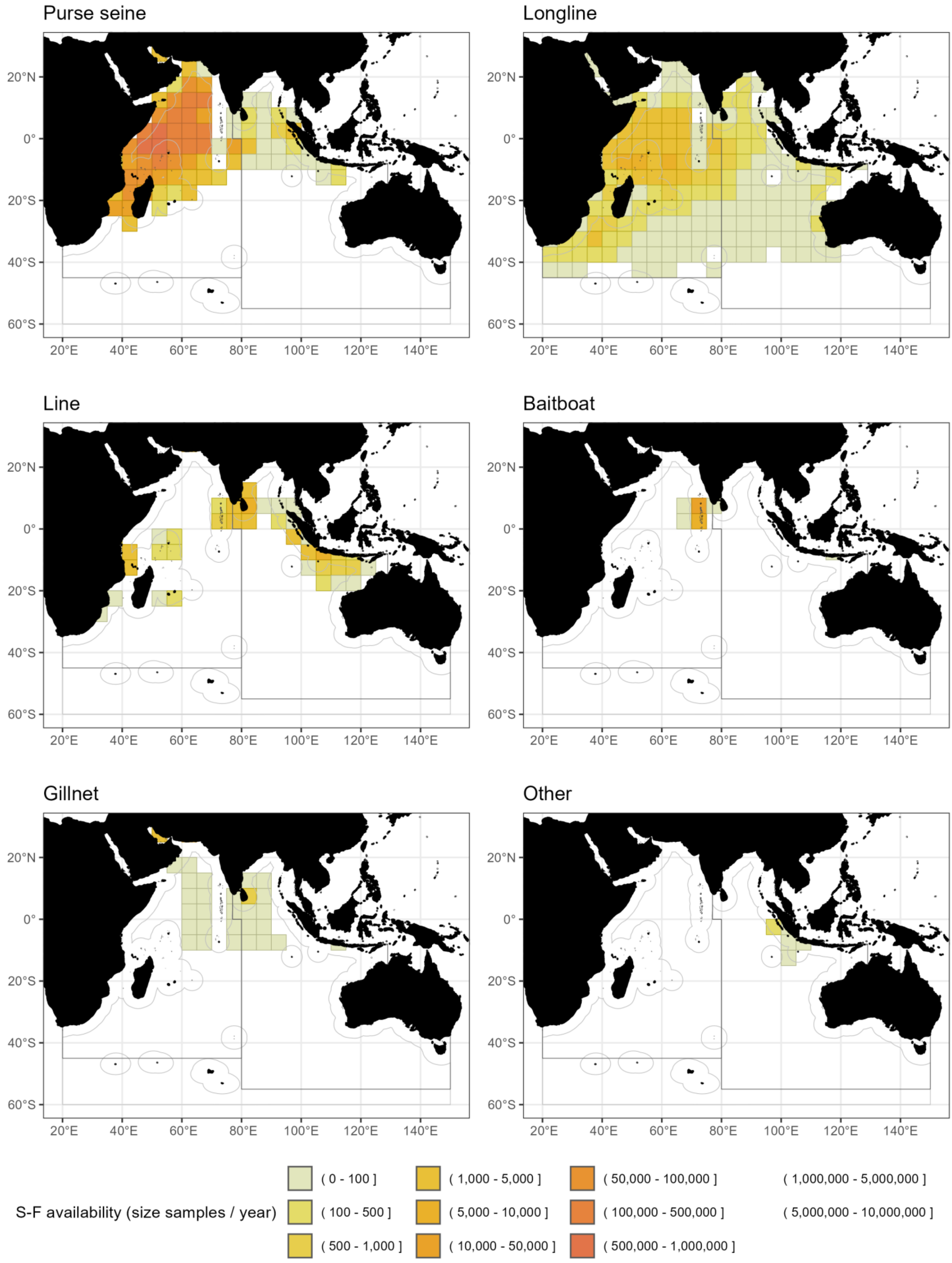

Figure 17: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data for each fishery group in the period 2019-2023. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

By fishery

Purse seine fisheries

Although yellowfin tuna catches come from various types of purse seine fisheries (including FOB-associated schools, free-swimming schools, and other coastal purse seine fisheries), most data collected are from purse seine fishing targeting FOBs, reflecting the high level of catches from these fisheries (**Fig. 18**).

Samples from free-swimming schools and FOB-associated schools are primarily distributed in the high seas of the Western Indian Ocean, with some samples collected around Indonesia. In contrast, samples from other purse seine fisheries are mainly found in Exclusive Economic Zones (EEZs), mainly samples collected from coastal purse seine, along with some samples from industrial fleets that do not specify the fishing mode, across the Indian Ocean (**Fig. 19**).

Coverage from most fleets does not meet the reporting requirement of a minimum threshold of one measured fish per metric tonne of retained catches. Despite some fleets reporting a high sample size, these samples were raised and not based on original data. When considering original data submitted, Japan's purse seine fisheries exceeded the minimum threshold of one measured fish per metric tonne of retained catches. Conversely, the EU and Seychelles primarily reported raised sample sizes, with some original data available, which are close to minimum threshold (**Fig. 20**).

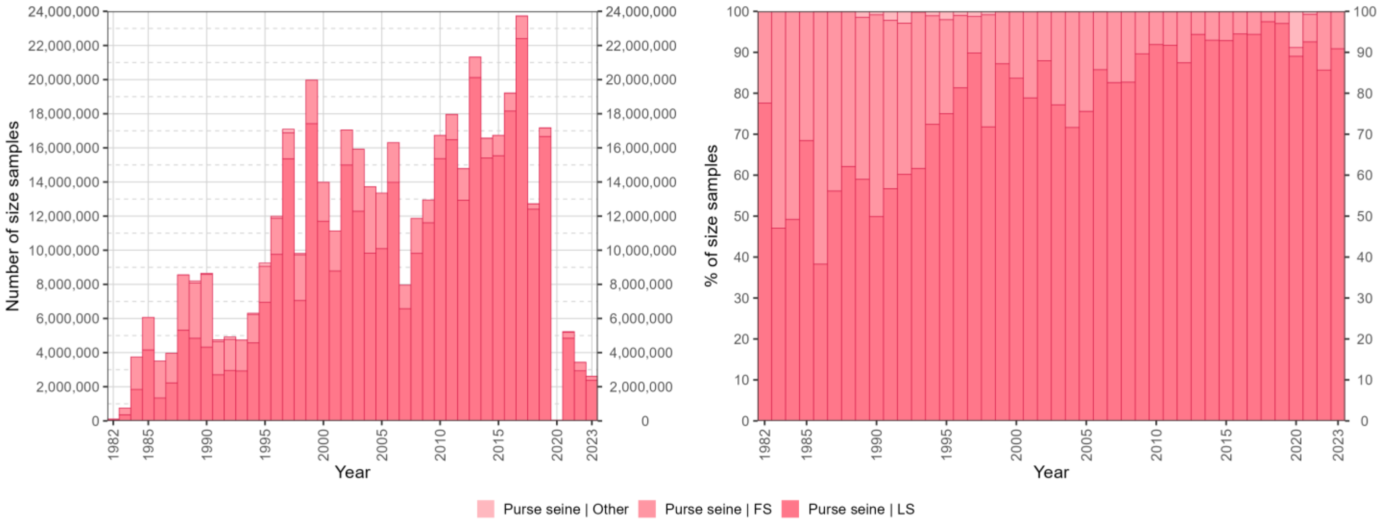

Figure 18: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and purse seine fishery type. Data source: standardized size-frequency dataset (Res. 15/02)

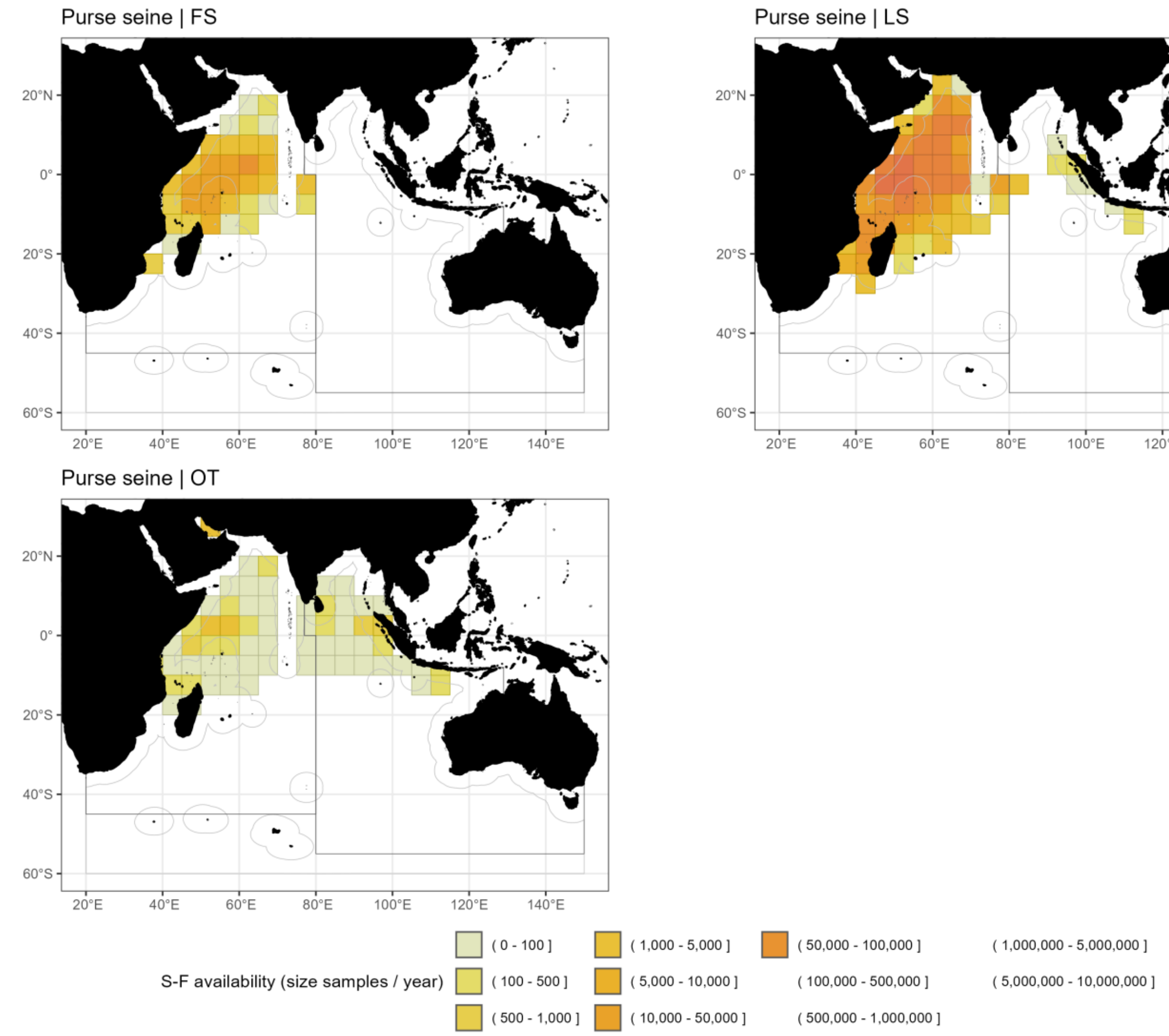

Figure 19: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by purse seine fishery types in the period 2019-2023. Data source: standardized size-frequency dataset (Res. 15/02)

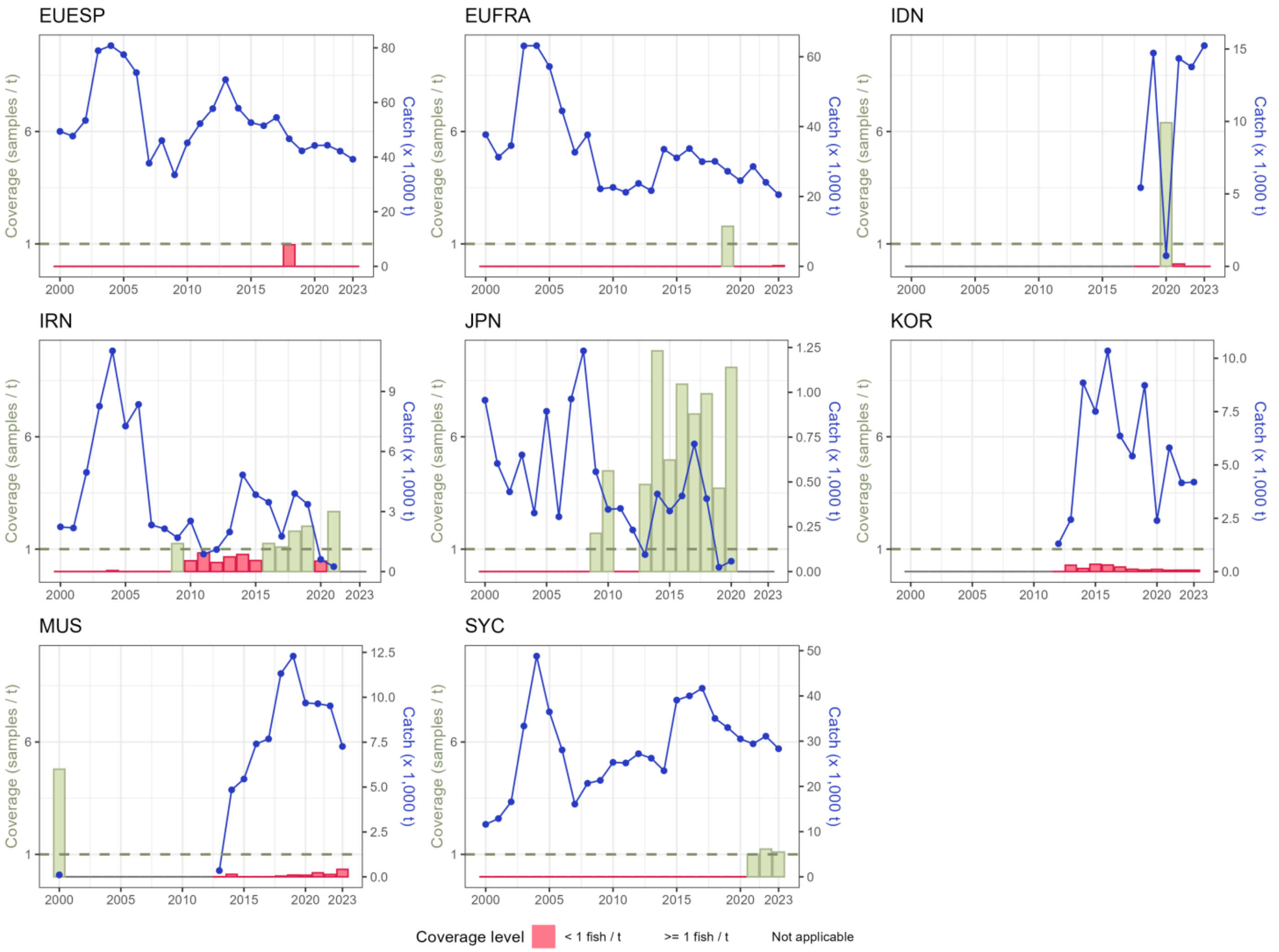

Figure 20: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major purse seine fleets, by fleet and year (2000-2023). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Longline fisheries

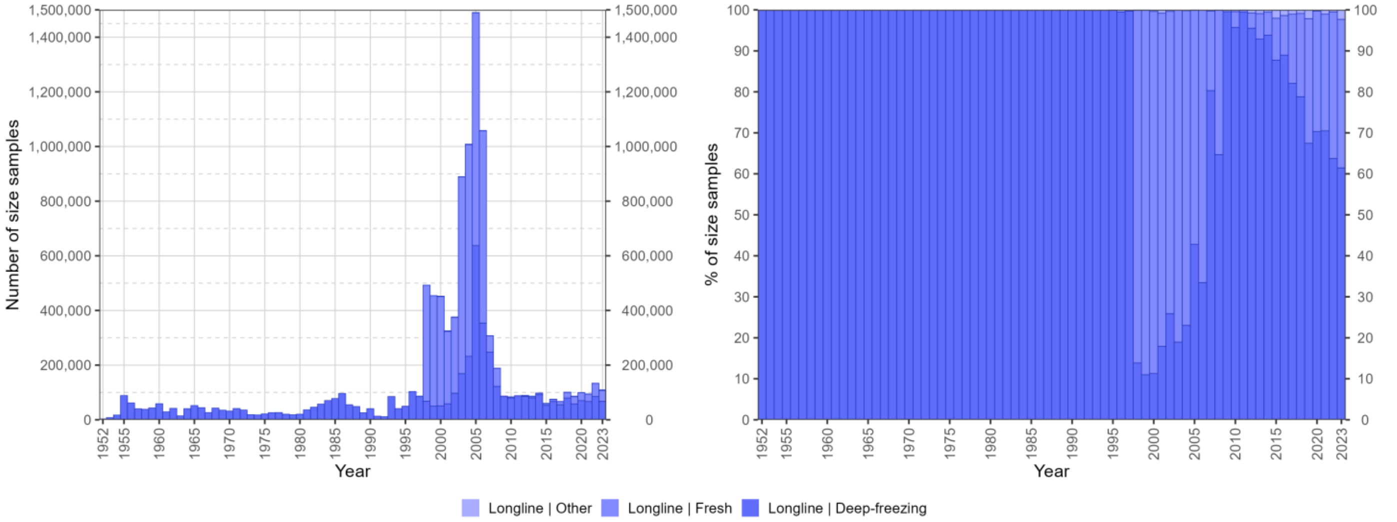

Figure 21: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and longline fishery type. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

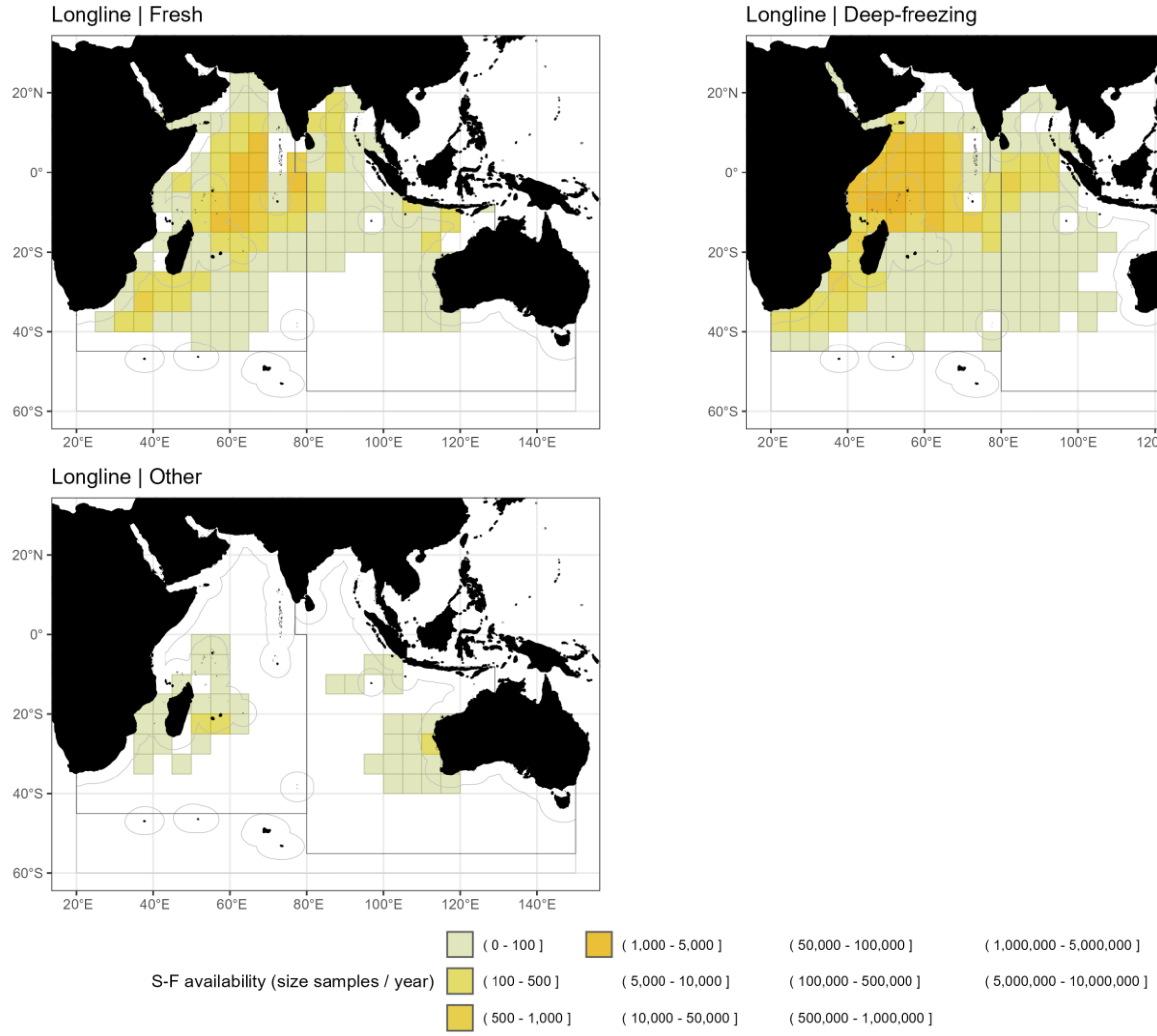

Figure 22: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by longline fishery types in the period 2019-2023. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Coverage levels of yellowfin tuna samples over the assessed period indicate that longliners from Taiwan, China, consistently exceeded the minimum threshold of one measured fish per metric tonne of retained catches. In contrast, Japanese longliners reached or surpassed this level only between 2017 and 2019, suggesting that the representativeness of yellowfin tuna samples from Japanese deep-freezing longliners in earlier years may not have been optimal (**Fig. 23**). Similar considerations apply to size-frequency data from other longline fleets, with the possible exception of those from Seychelles, which were relatively well sampled prior to 2015 (**Fig. 23**).

The Seychelles Fishing Authority has indicated that complementary size-frequency data collected from 2015 to 2021 should be submitted to the Secretariat in 2023. However, it is crucial to note that the analysis of longline size-frequency data available at the IOTC Secretariat reveals significant variability in the quality and reliability of data from Taiwan, China, and Seychelles over time and space. This variability leads to the recommendation to omit 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). Despite fluctuations in sampling coverage, in 2023, China, Korea, Seychelles, and Taiwan, China, exceeded the minimum threshold of one measured fish per metric tonne of retained catches.

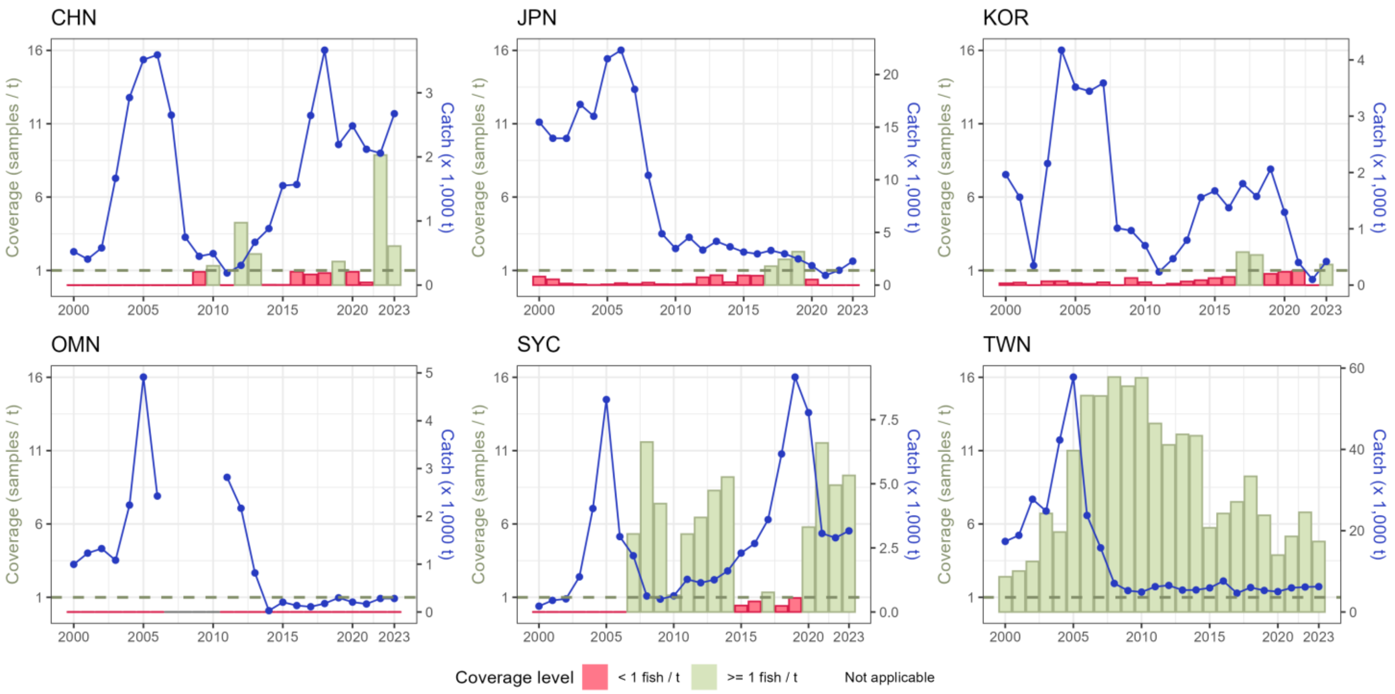

Figure 23: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major deep-freezing longline fleets, by fleet and year (2000-2023). Data source: standardized size-frequency dataset (Res. 15/02)

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. 24**).

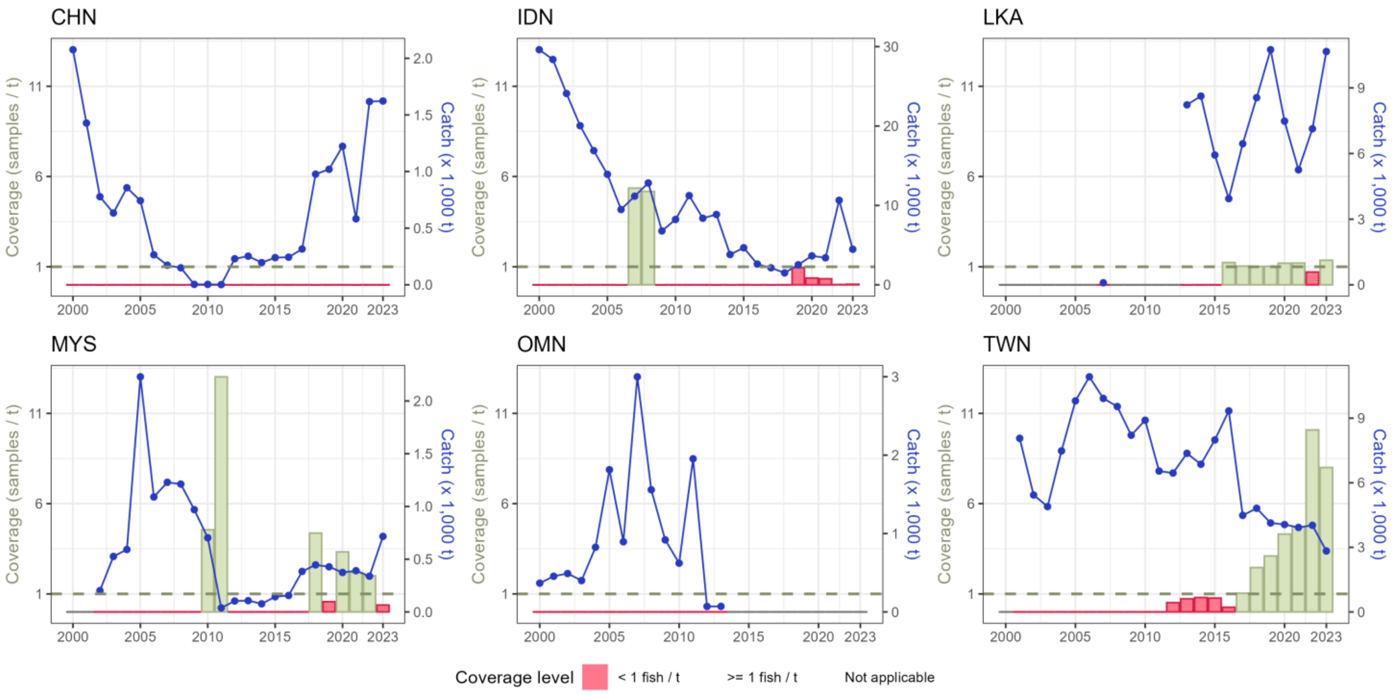

Figure 24: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major fresh-tuna longline fleets, by fleet and year (2000-2023). Data source: standardized size-frequency dataset (Res. 15/02)

Longliners targeting swordfish frequently interact with yellowfin tuna. Among the major fleets involved in this fishery, Australia consistently samples the species at levels well above the minimum threshold required by the IOTC. Madagascar was able to provide size frequency data in recent years, thanks to a project funded by the World Bank, but failed to submit size data in 2021 following the project's termination. Other fleets tend to alternate between years of sufficient sampling and years in which no information is collected or reported to the Secretariat. The swordfish longline fisheries of EU,Spain, and EU,Portugal rank lowest in terms of coverage, achieving the minimum coverage only in 2021 and 2011, respectively for the EU fleets, whereas Kenya during the considered time frame (**Fig. 24**). This low coverage is largely attributed to the limited importance of yellowfin tuna in these fleets.

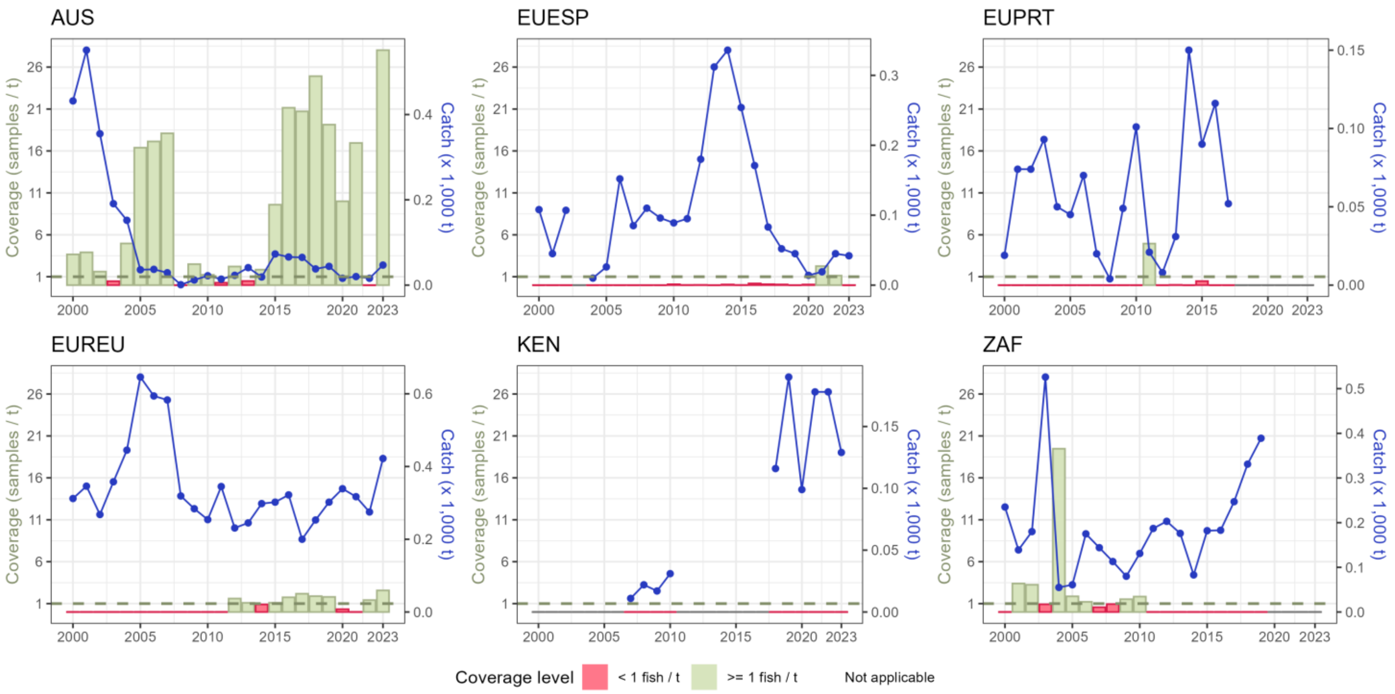

Figure 25: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major swordfish targeting longline fleets, by fleet and year (2000-2023). Data source: standardized size-frequency dataset (Res. 15/02)

Line fisheries

Line fisheries are becoming increasingly important for yellowfin tuna, with catches from handline and coastal longline fisheries rising in recent years. However, many significant line fishery fleets often fail to report size data. Recently, Seychelles and Sri Lanka have made notable progress in this area, both exceeding the minimum threshold of one measured fish per metric tonne of retained catches for coastal longline fisheries (**Fig. 28**). The Maldives has a long history of size data from handline fisheries, although it remains below the minimum threshold, while Oman previously collected size data from its handline fishery. In recent years, both Indonesia and Sri Lanka have improved their data collection for handline fisheries (**Fig. 29**). Nonetheless, sampling from the trolling fishery remains low, despite Indonesia collecting size data since the early 1980s (**Fig. 30**).

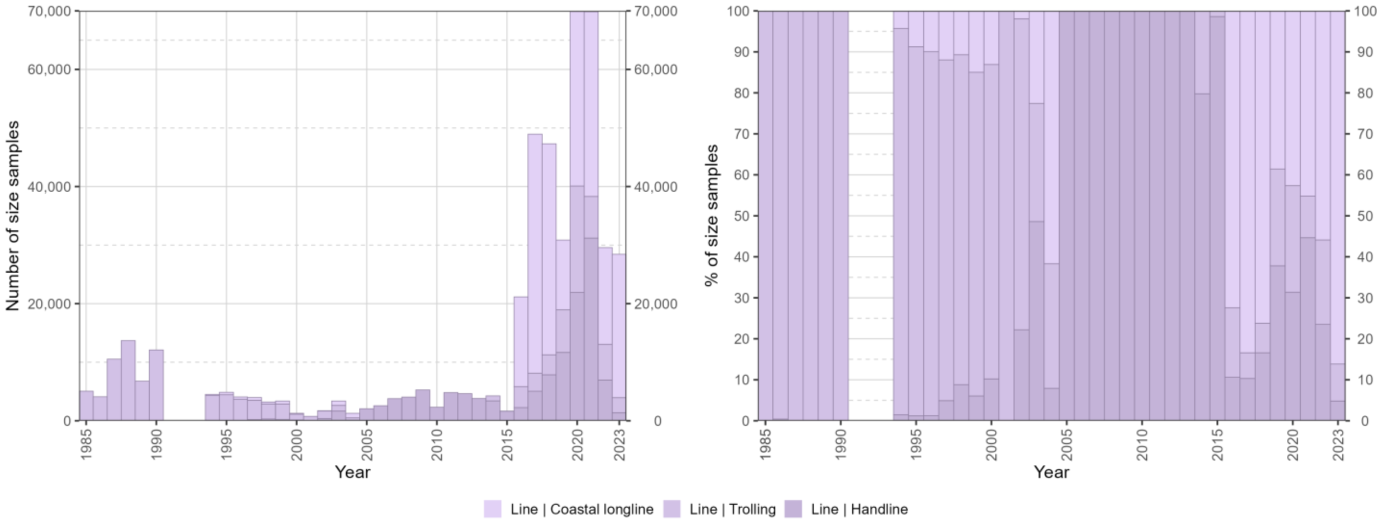

Figure 26: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: standardized size-frequency dataset (Res. 15/02)

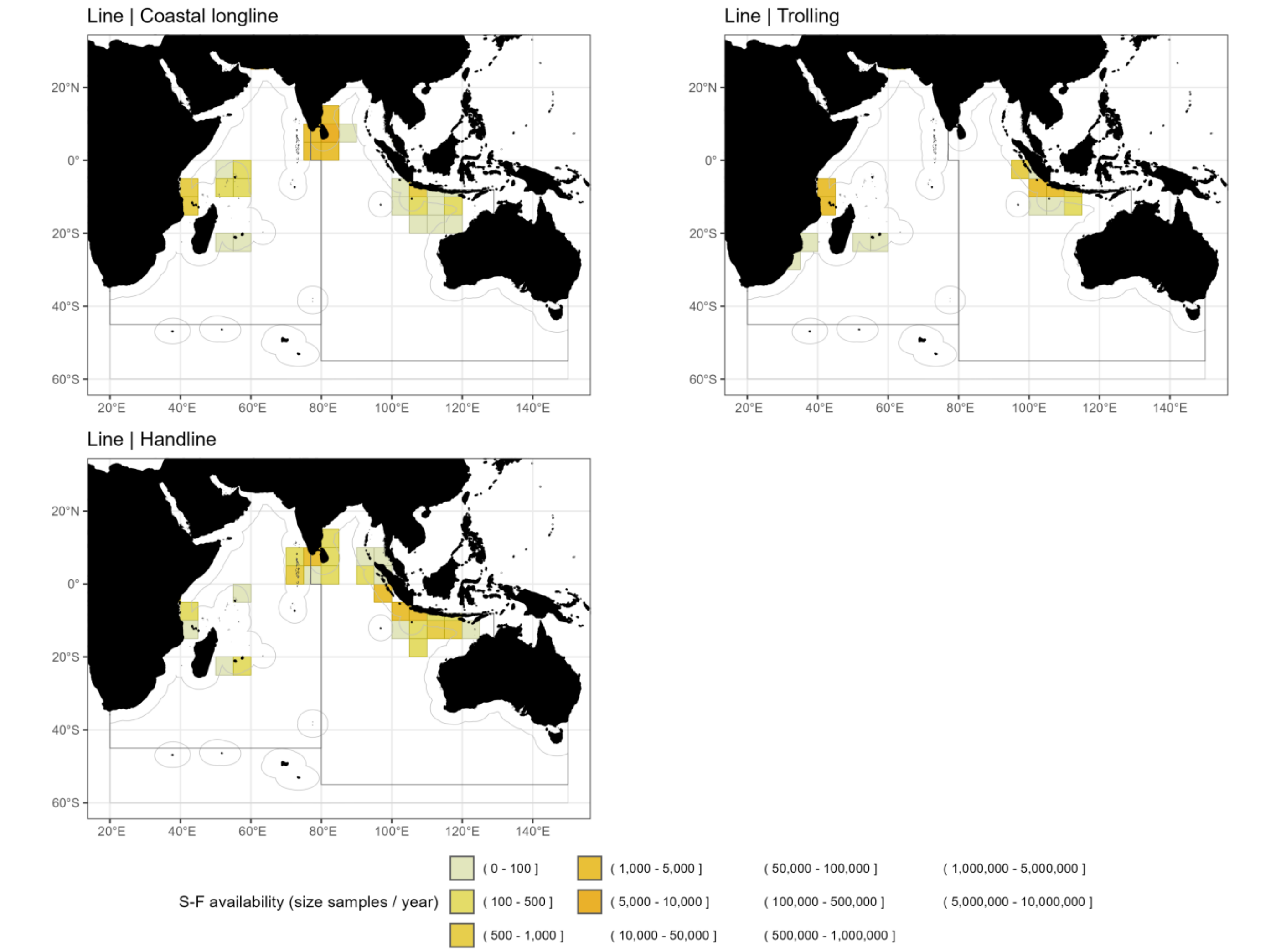

Figure 27: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by line fishery types in the period 2019-2023. Data source: standardized size-frequency dataset (Res. 15/02)

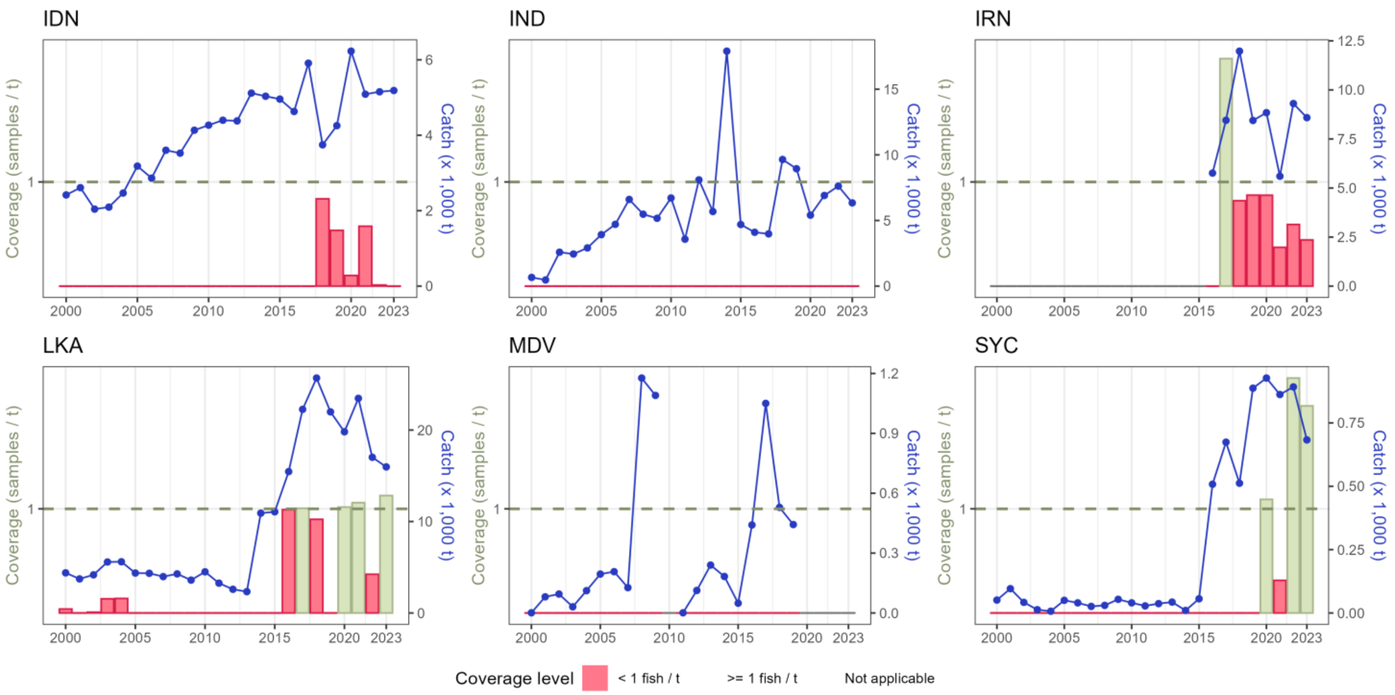

Figure 28: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major coastal longline fleets, by fleet and year (2000-2023). Data source: standardized size-frequency dataset (Res. 15/02)

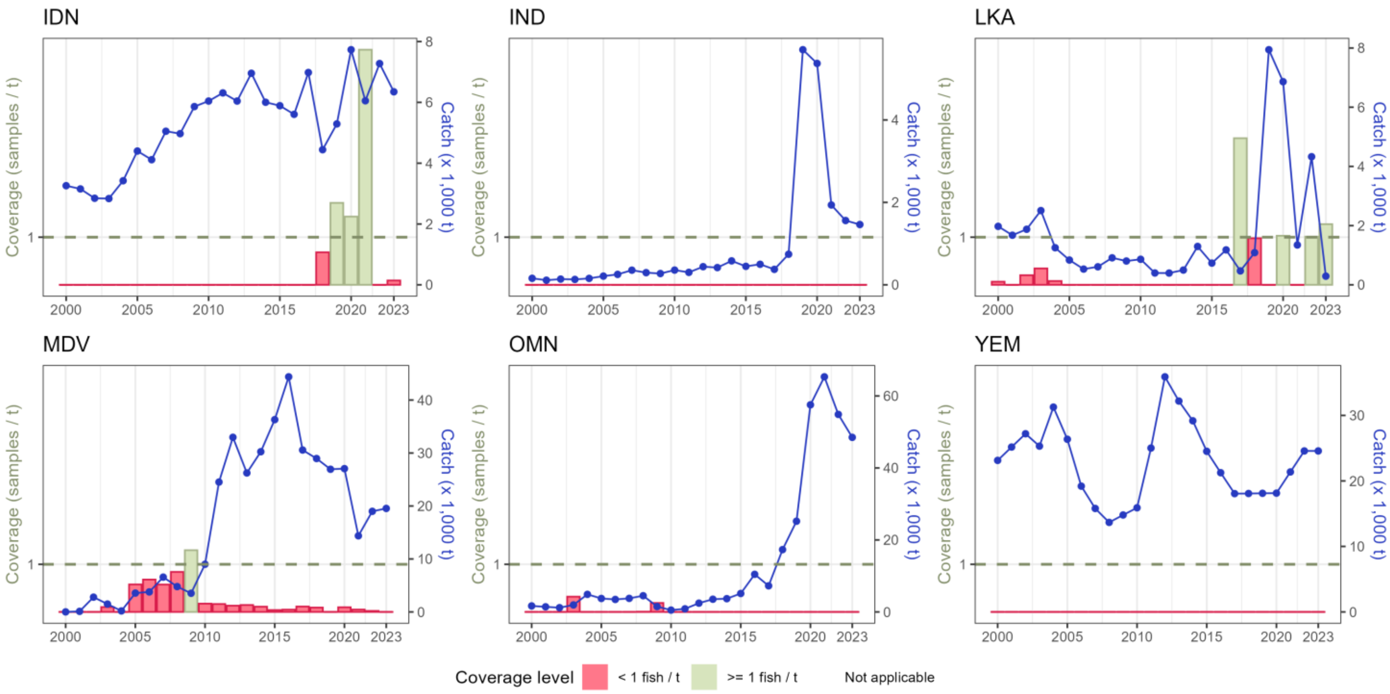

Figure 29: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major handline fleets, by fleet and year (2000-2023). Data source: standardized size-frequency dataset (Res. 15/02)

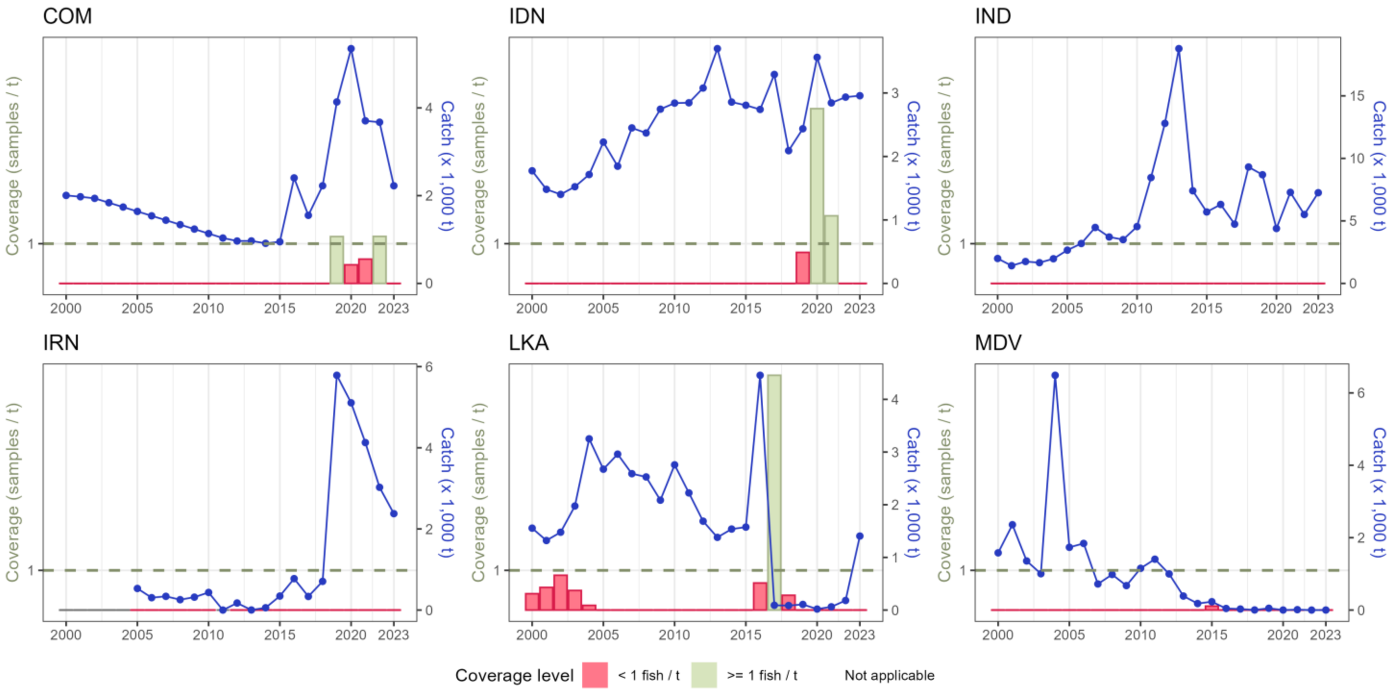

Figure 30: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major troll line fleets, by fleet and year (2000-2023). Data source: standardized size-frequency dataset (Res. 15/02)

Other fisheries

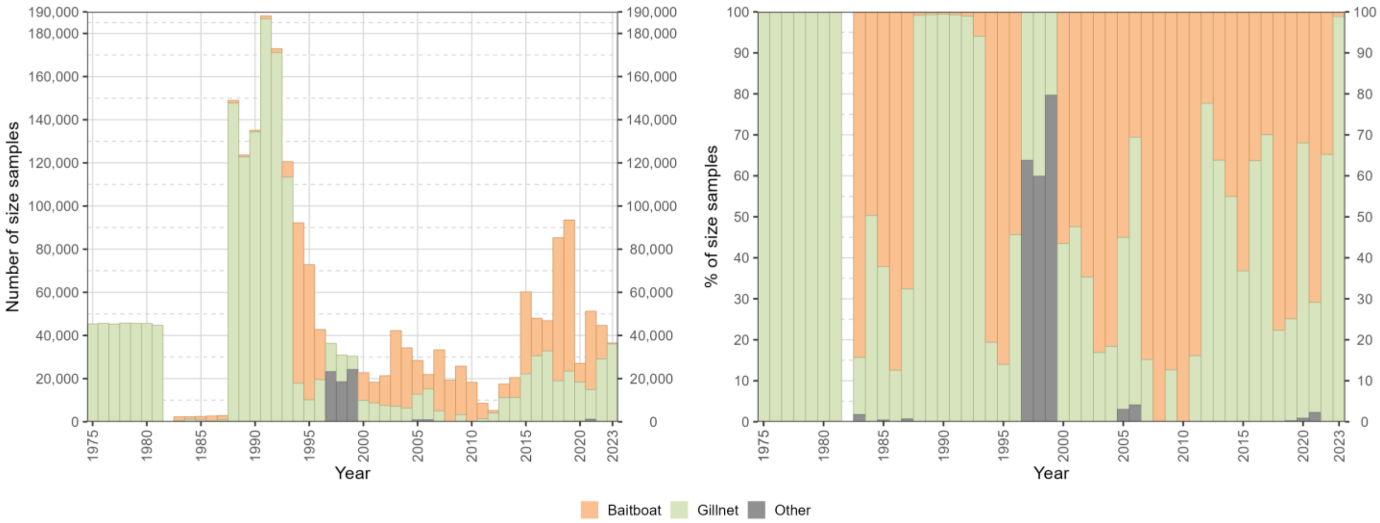

Figure 31: Availability of yellowfin tuna size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and all other fishery types. Data source: standardized size-frequency dataset (Res. 15/02)

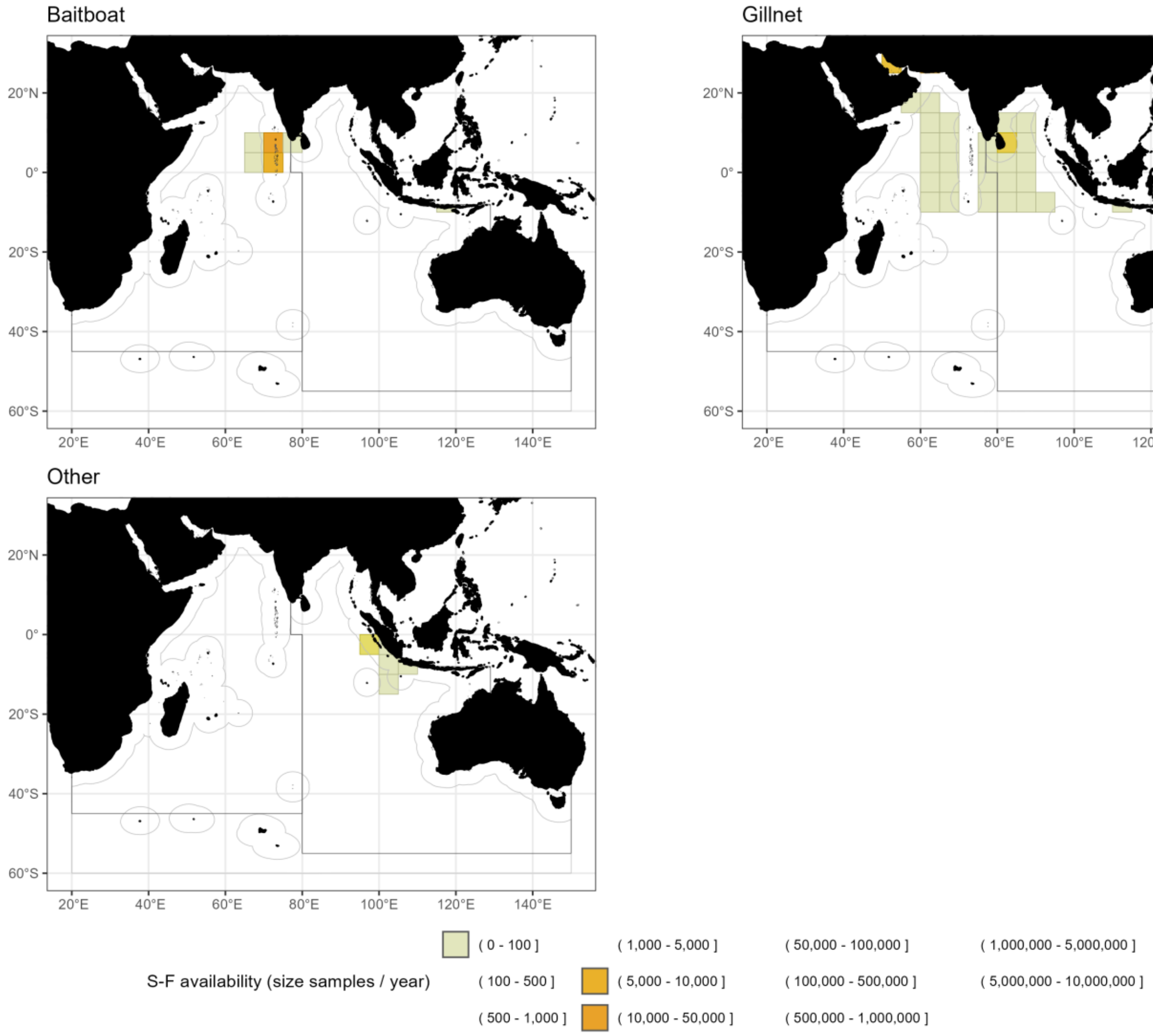

Figure 32: Spatial distribution (average number of samples per grid per year) of available yellowfin tuna size-frequency data by all other fishery types in the period 2019-2023. Data source: standardized size-frequency dataset (Res. 15/02)

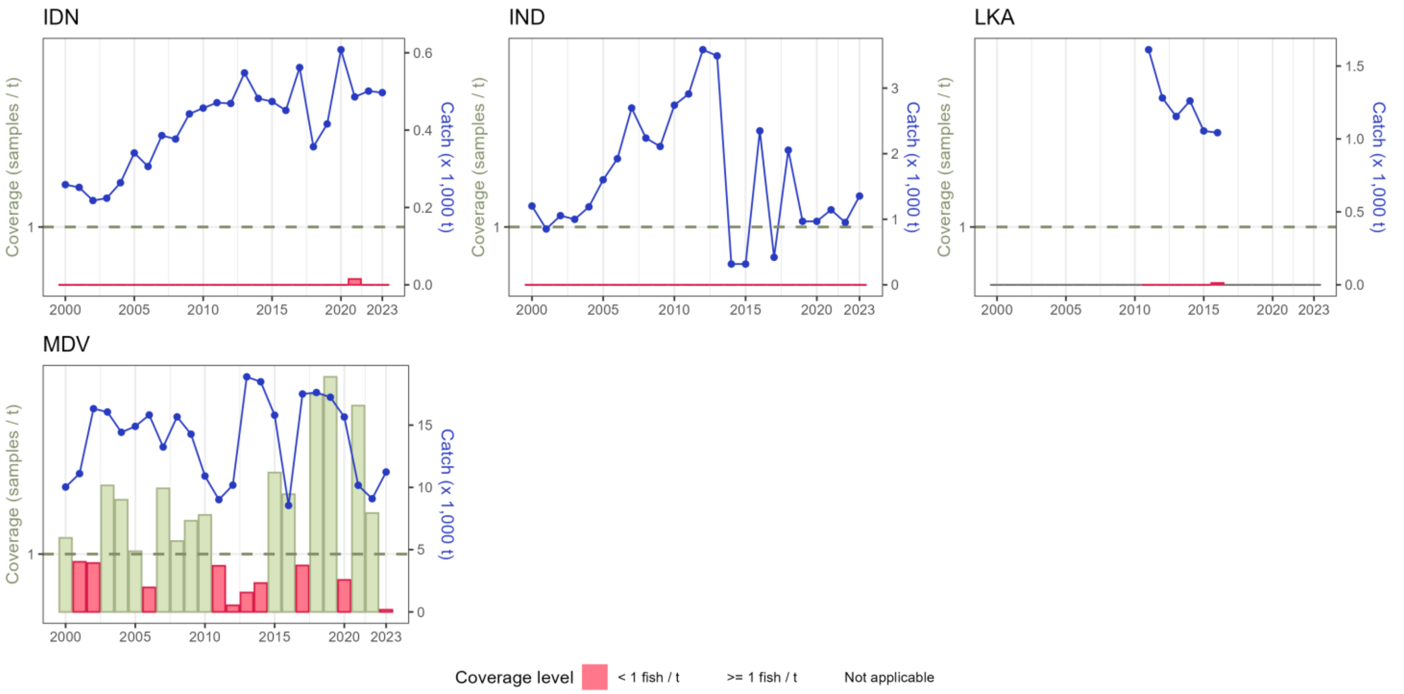

Figure 33: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major baitboat fleets, by fleet and year (2000-2023). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

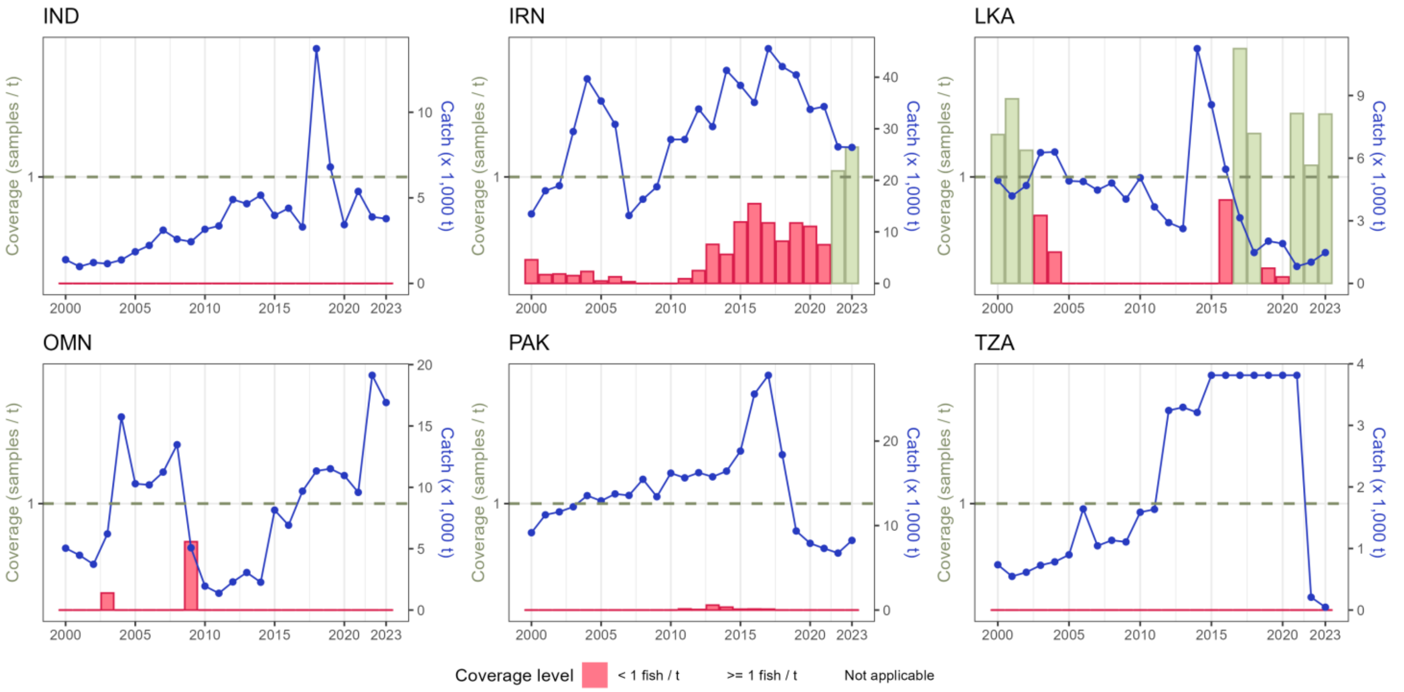

Figure 34: Size-frequency samples coverage (number of fish measured by t of retained catches) of yellowfin tuna caught by the major gillnet fleets, by fleet and year (2000-2023). Data source: [standardized size-frequency dataset](#) (Res. 15/02)

Among all fisheries and fleet concerned, only Indonesian handlines and Sri Lanka appears 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

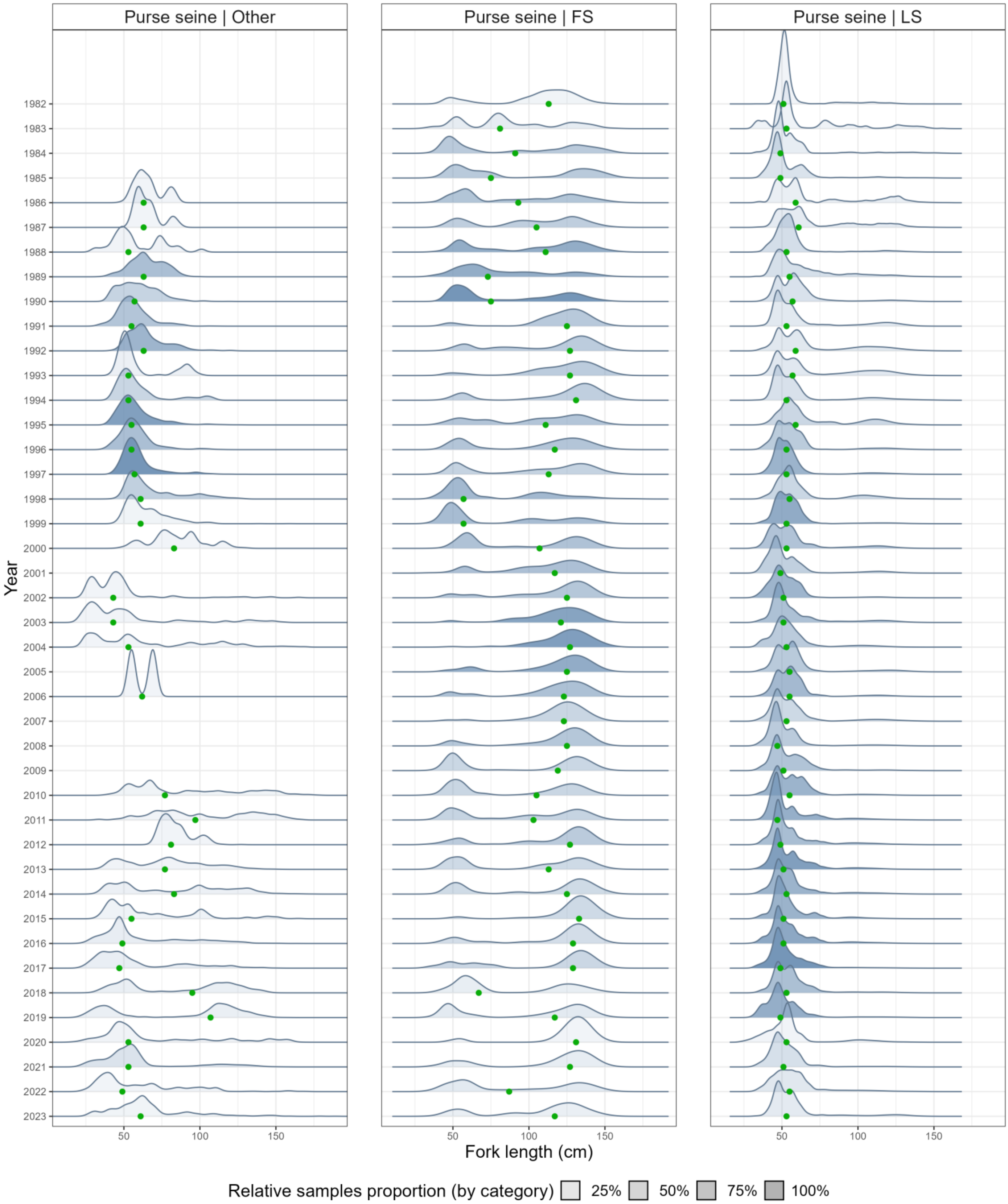

Figure 35: Relative size distribution (fork length in 2 cm size bins) of yellowfin tuna caught by all purse seine fleets for the period 1982-2023. Other = no information provided on the school association; FS = free-swimming schools; LS = schools associated with floating objects. Fill intensity is proportional 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

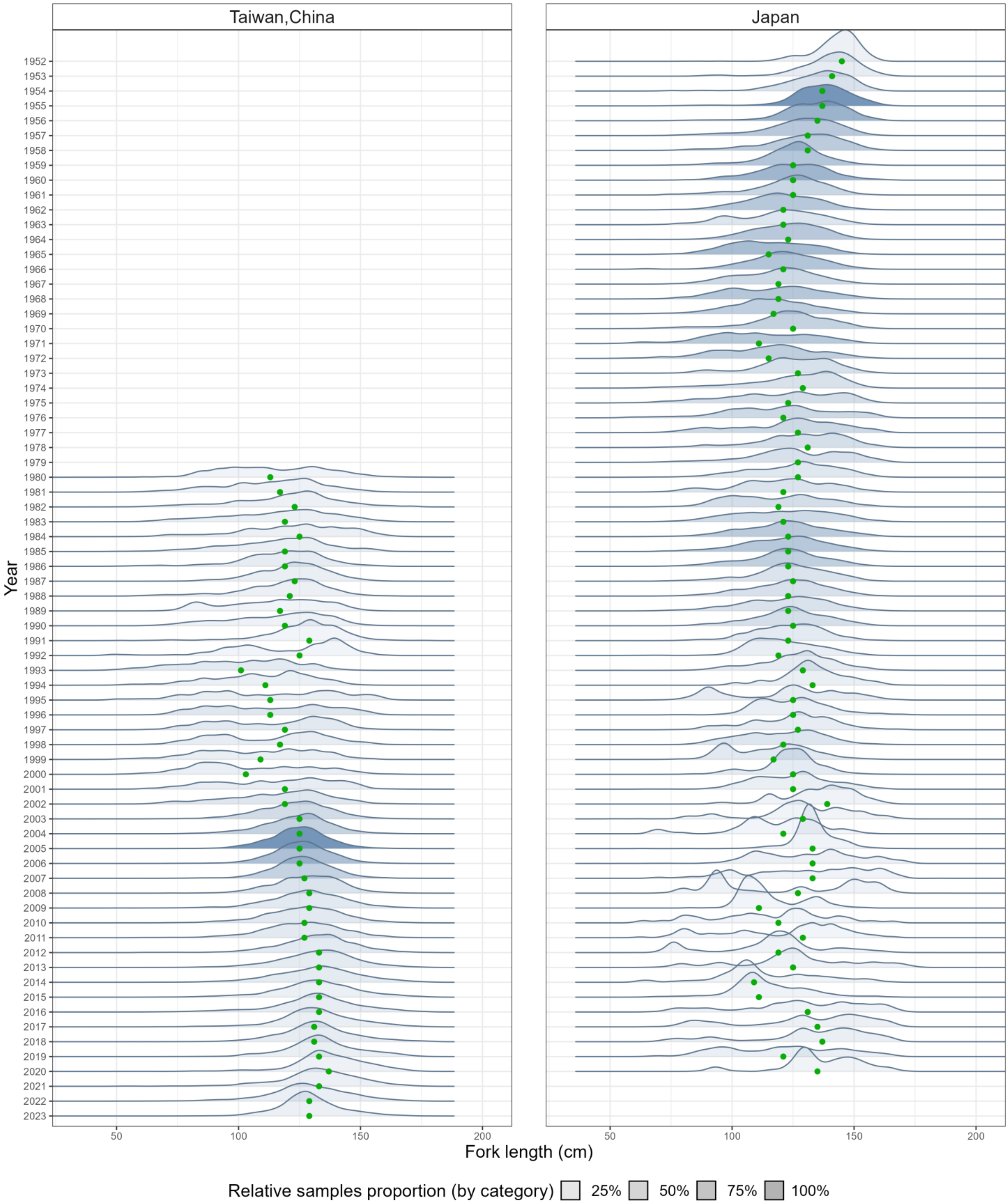

Figure 36: Relative size distribution (fork length in 2 cm size bins) of yellowfin tuna caught by the main deep-freezing longline fleets for the period 1952-2023. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: yellowfin tuna standardized size-frequency dataset (Res. 15/02)

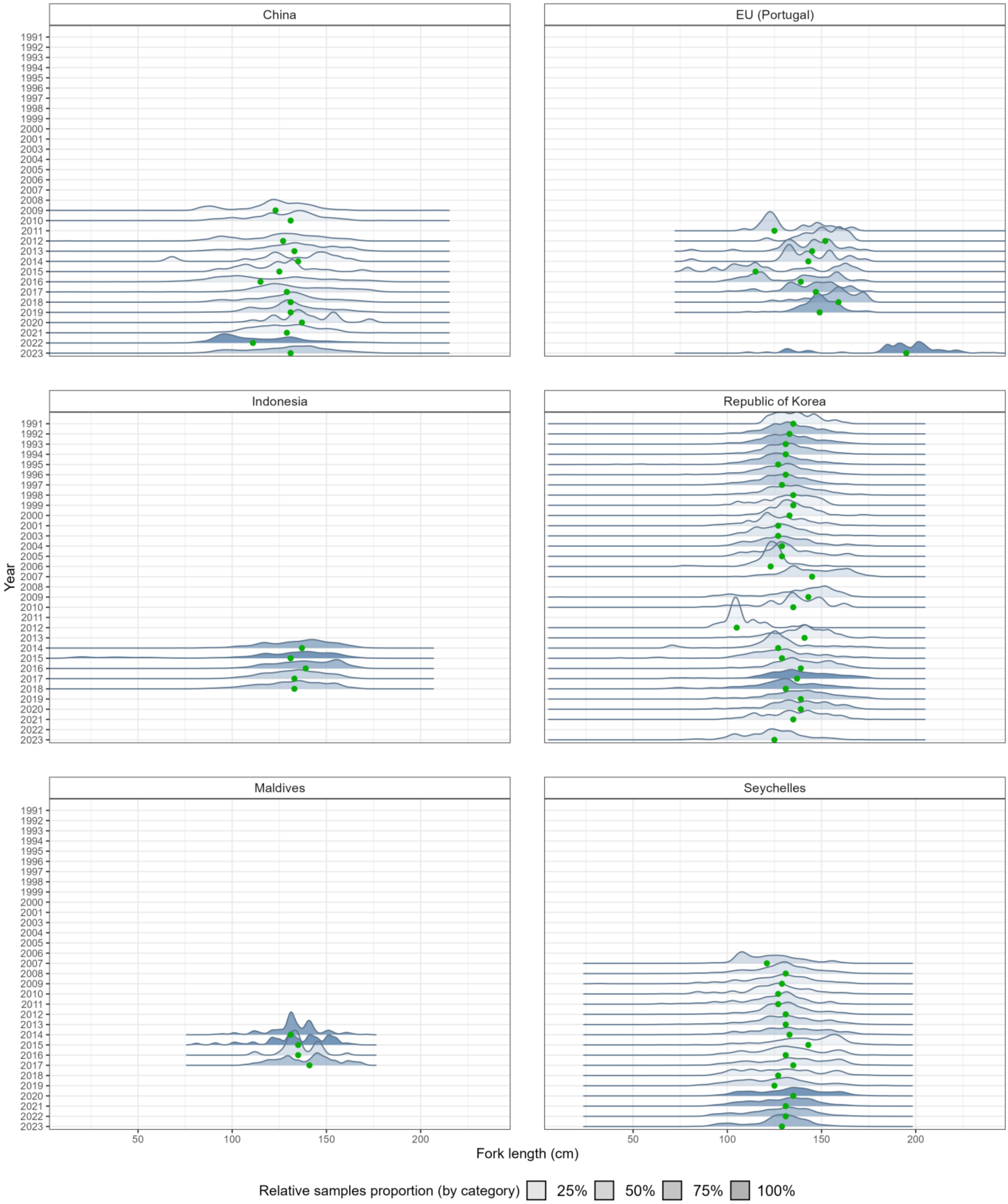

Figure 37: Relative size distribution (fork length in 2 cm size bins) of yellowfin tuna caught by all other longline fleets (excluding Japan and Taiwan,China), by fleet for the period 1991-2023. Data source: [yellowfin tuna standardized size-frequency dataset](#) (Res. 15/02)

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. 39**). 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 6.2 kg / fish. On the contrary, the average weight from purse seine fisheries operating on free swimming schools, increased to 31.3 kg / fish in 2023. In addition, average weight from gillnet fisheries rose to 21.1 kg / fish in 2023, although the overall trend indicates a lower average weight (4.5 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).

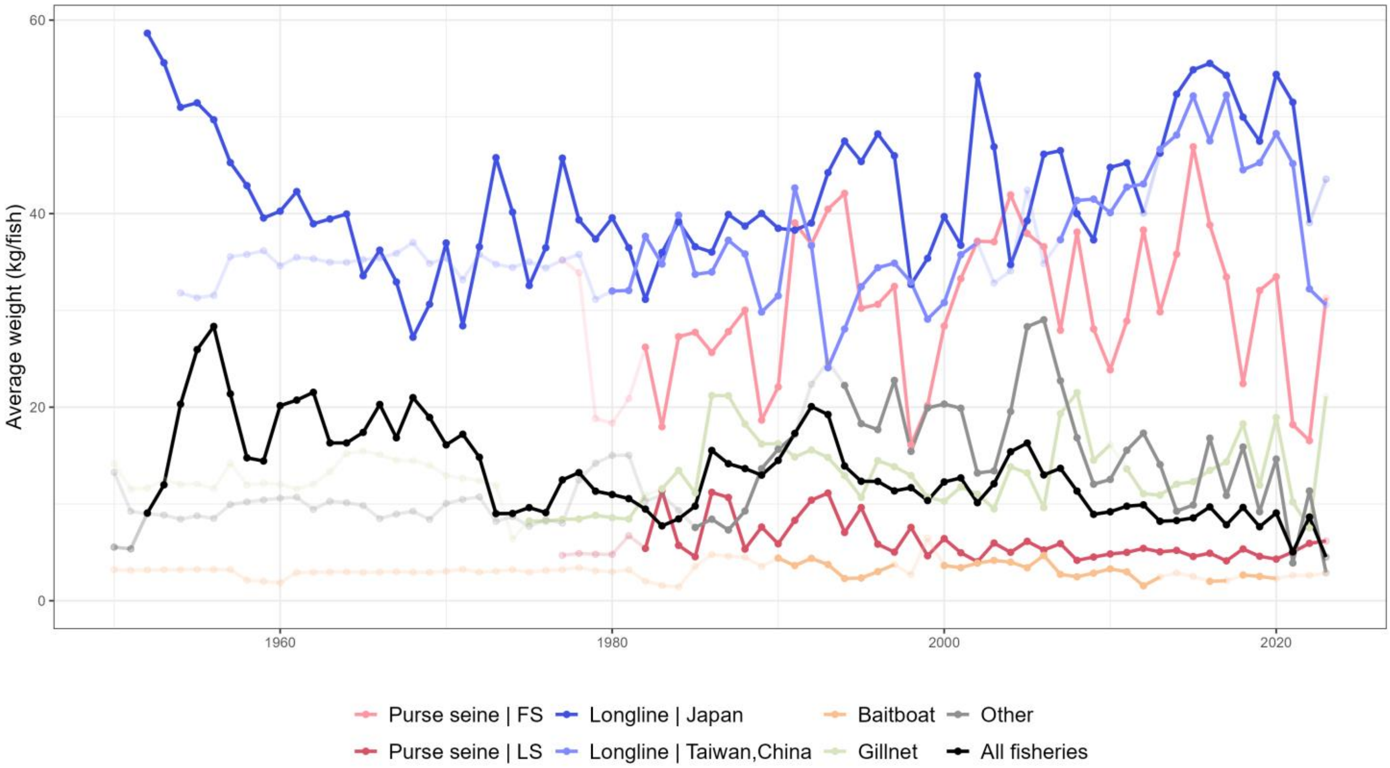

Figure 38: Combined estimated yellowfin tuna average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. LS = schools associated with floating objects; 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

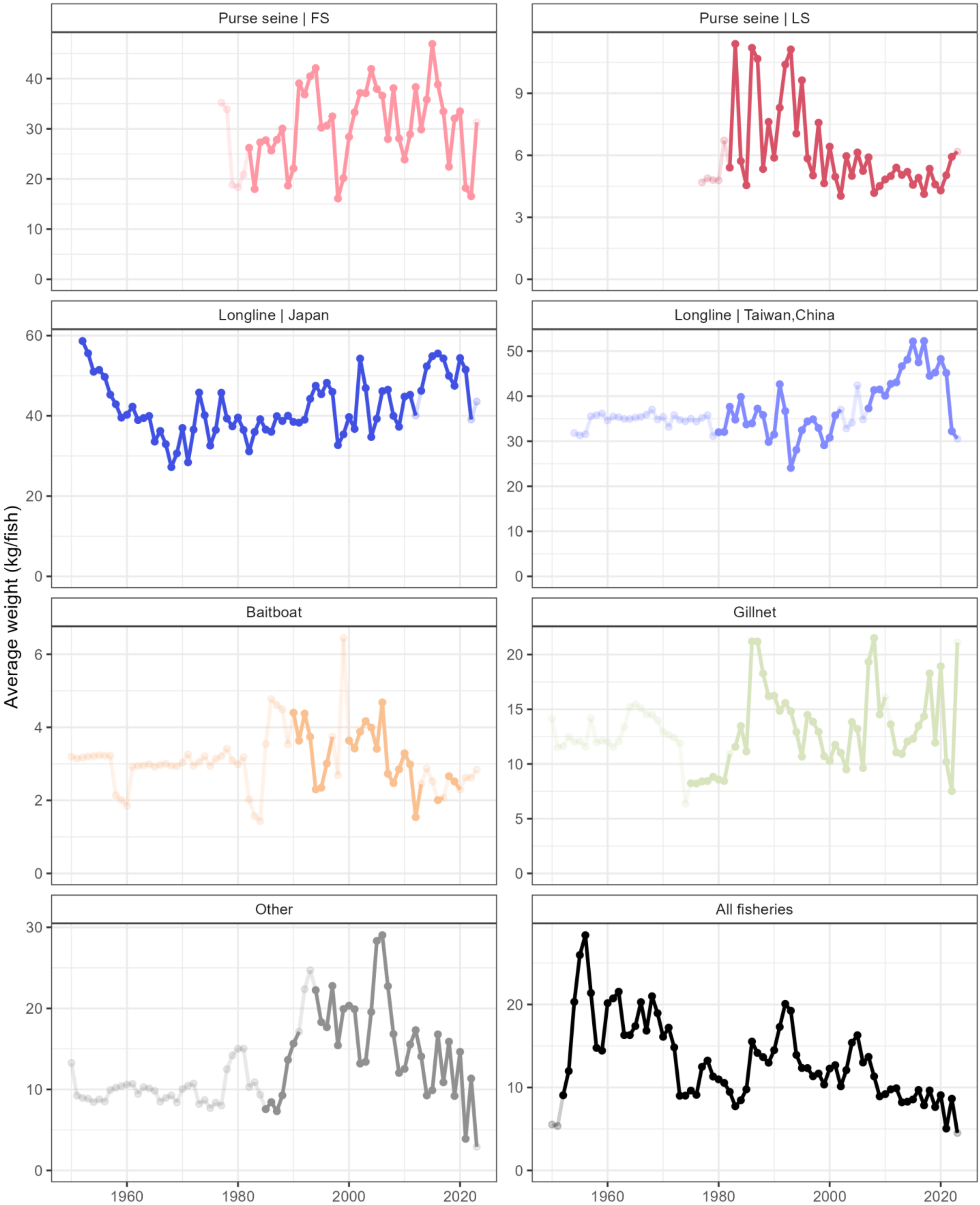

Figure 39: Estimated yellowfin tuna average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. LS = schools associated with floating objects; FS = 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. 38**).

Spatial distribution of average weights

Estimated average weights by decade (1950-2019)

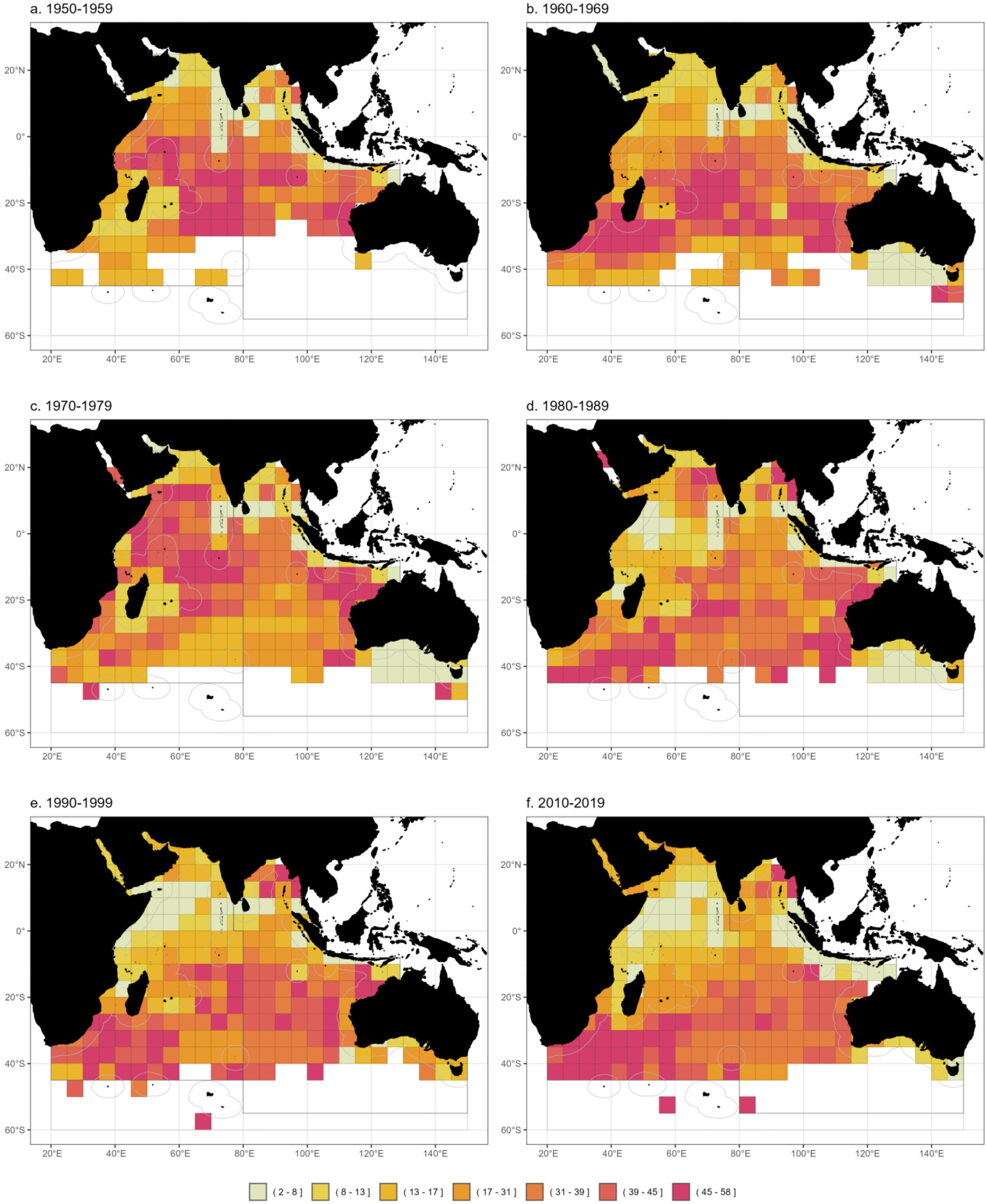

Figure 40: Estimated yellowfin tuna average weight (kg/fish) in the catch by decade and 5x5 grid, for all fisheries combined for the period 1950-2019. Data source: raised time-area catches

Estimated average weights by year (2019-2023) and last decade (2010-2019)

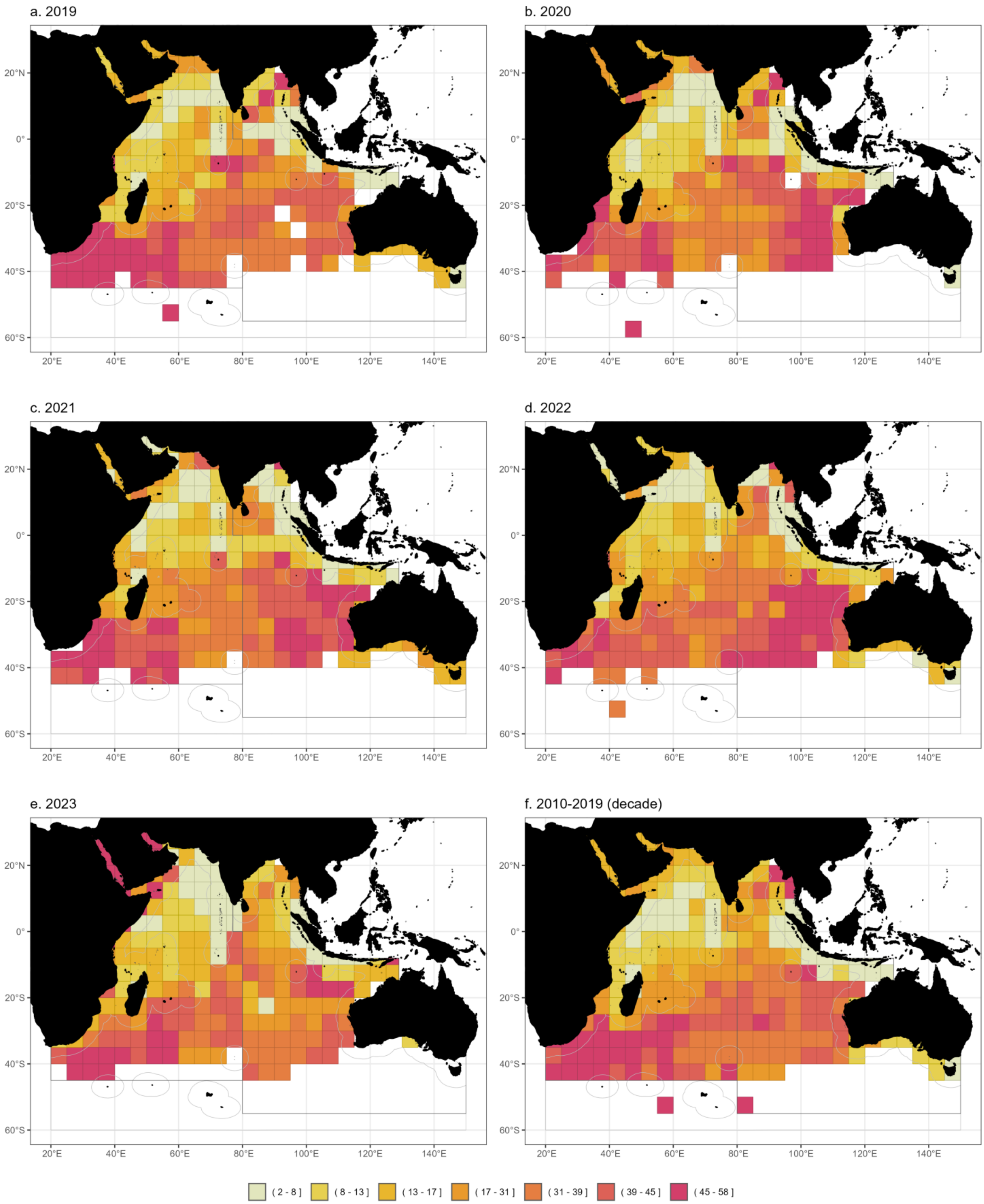

Figure 41: Estimated yellowfin tuna average weight (kg/fish) in the catch by year and 5x5 grid, for all fisheries combined for the period 2019-2023 and for the decade 2010-2019. Data source: raised time-area catches

Estimated average weights by fishery group in recent years (2019-2023)

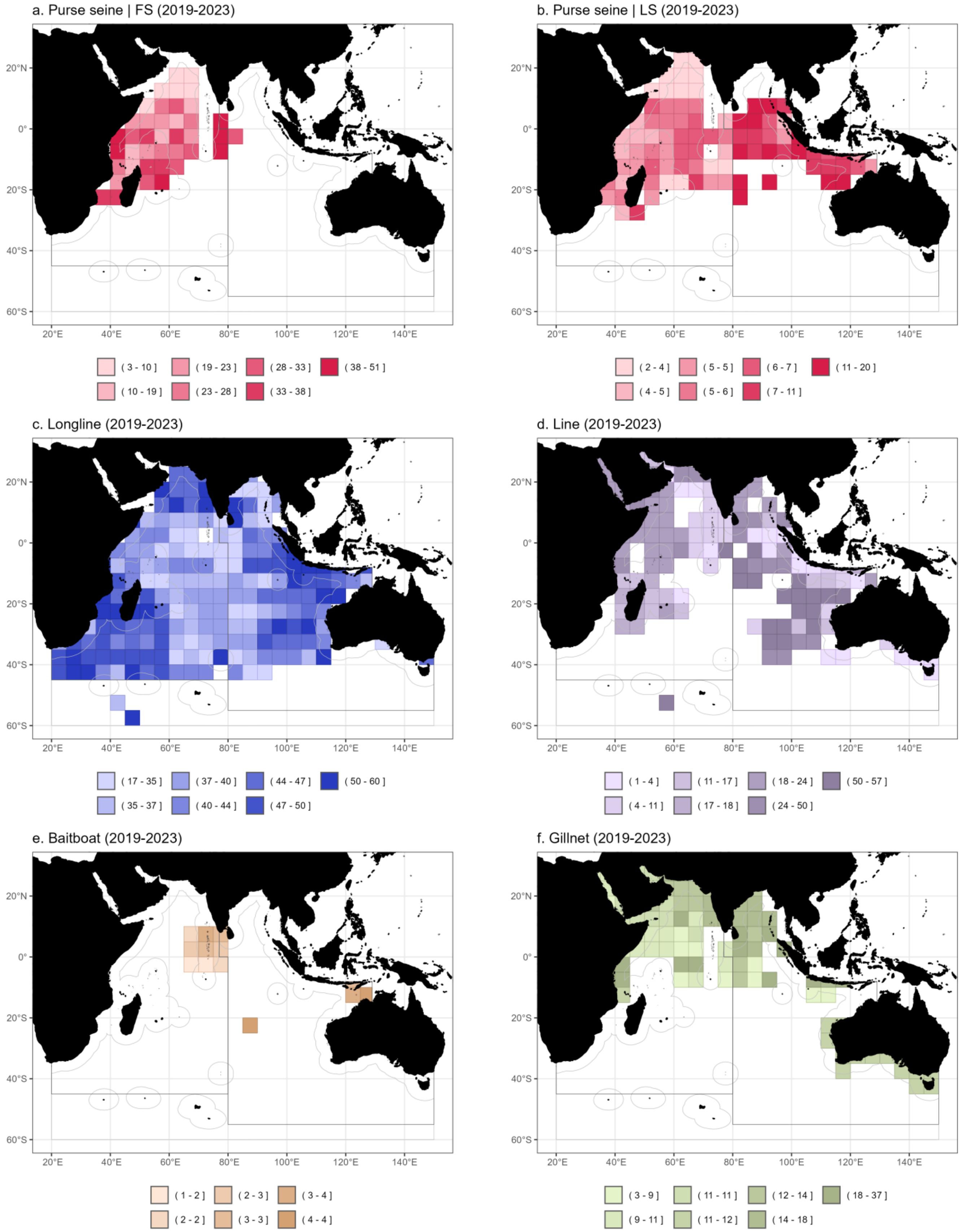

Figure 42: Estimated yellowfin tuna average weight (kg/fish) in the catch by 5x5 grid and fishery group for the period 2019-2023. LS = schools associated with floating objects; FS = free-swimming schools. Data source: raised time-area catches

Uncertainties in size-frequency data

The quality and availability of size frequency data, remain low, comparing to other datasets. The percentage of retained catches with size data of quality scores between 0-2 in the IOTC database is poor for the yellowfin tuna, with further decline in artisanal size data, and the fraction of data of acceptable quality remained at around 49% since 1984. The trend indicates availability of size data from mid 1970s, from which the quality remained below, but improved in the mid 1980s to reach 64% in 1988. The quality of size frequency fluctuated, for both industrial and artisanal fisheries from the 1990, although there was an improvement in availability from artisanal fisheries in mid 1990S, attributed to size data collection from the Indo-Pacific Tuna Development and Management Programme (IPTP) sampling programme in Sri Lanka, I. R. Iran, Oman and Pakistan. Following an increase in quality from about 37% in 1998 to around 65% in 2017, the quality substantially decreased to 44% in 2023 (**Fig. 43**).

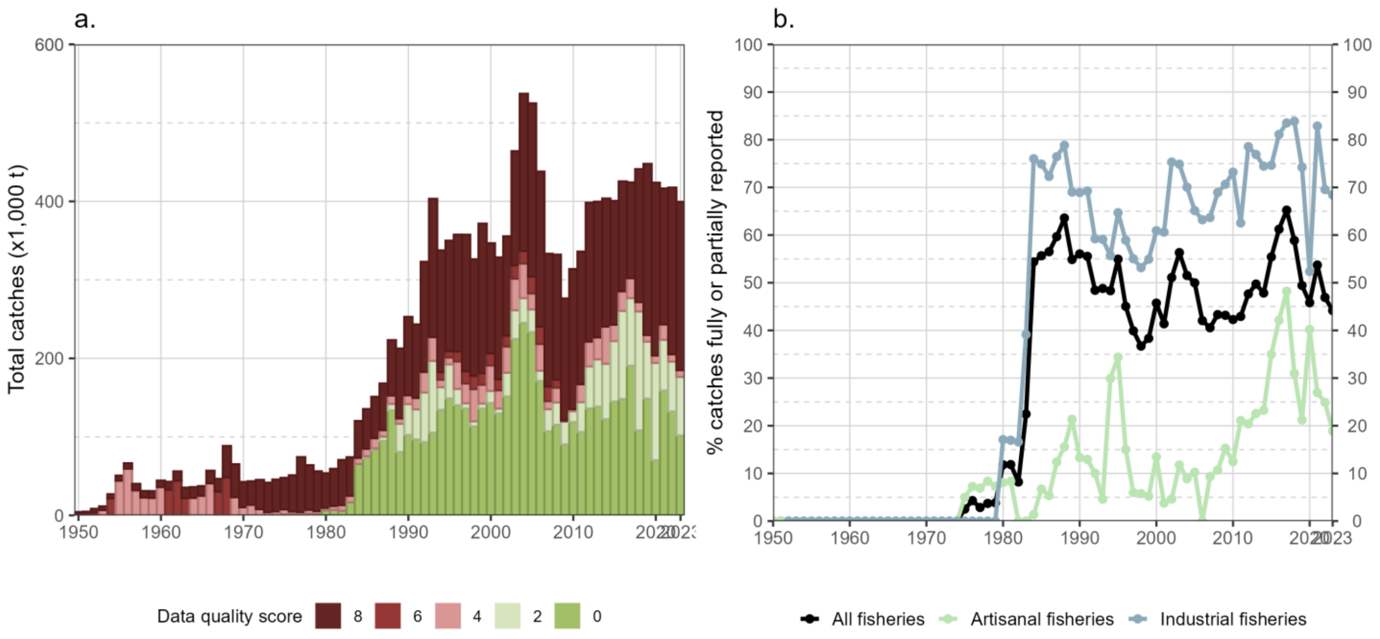

Figure 43: Annual retained catches (metric tonnes; t) of yellowfin tuna estimated by quality score (barplot) and percentage of geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2023

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. 44**) and FOB-associated schools (**Fig. 46**) reflects the different percentages of sets taken on the two different fishing modes.

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 (2022), EU,Spain (2019), Mauritius (2022), and Seychelles (2019 and 2022) (**Table 5**), which all show a much higher first mode in the lower part of the size distribution (at around 60 cm FL) (**Fig. 44**).

Size frequencies from FOB-assocaited schools, with data showing sub-modes at around 100 ans 130 are rarely indicated in recent years, although there were some data in the past (**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. 46**).

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.

Recently EU provided size frequencies of Italian-flagged vessels collected by observers on board vessel from 2015, which are of discarded yellowfin tuna. Worth noting that in the IOTC database 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. 44**).

Size-frequency data for 2020 is completely absent for EU,Spain and only available in limited numbers for EU,France, Mauritius, and Seychelles (**Fig. 46**), 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 are limited (**Fig. 48**). 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. 48**).

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).

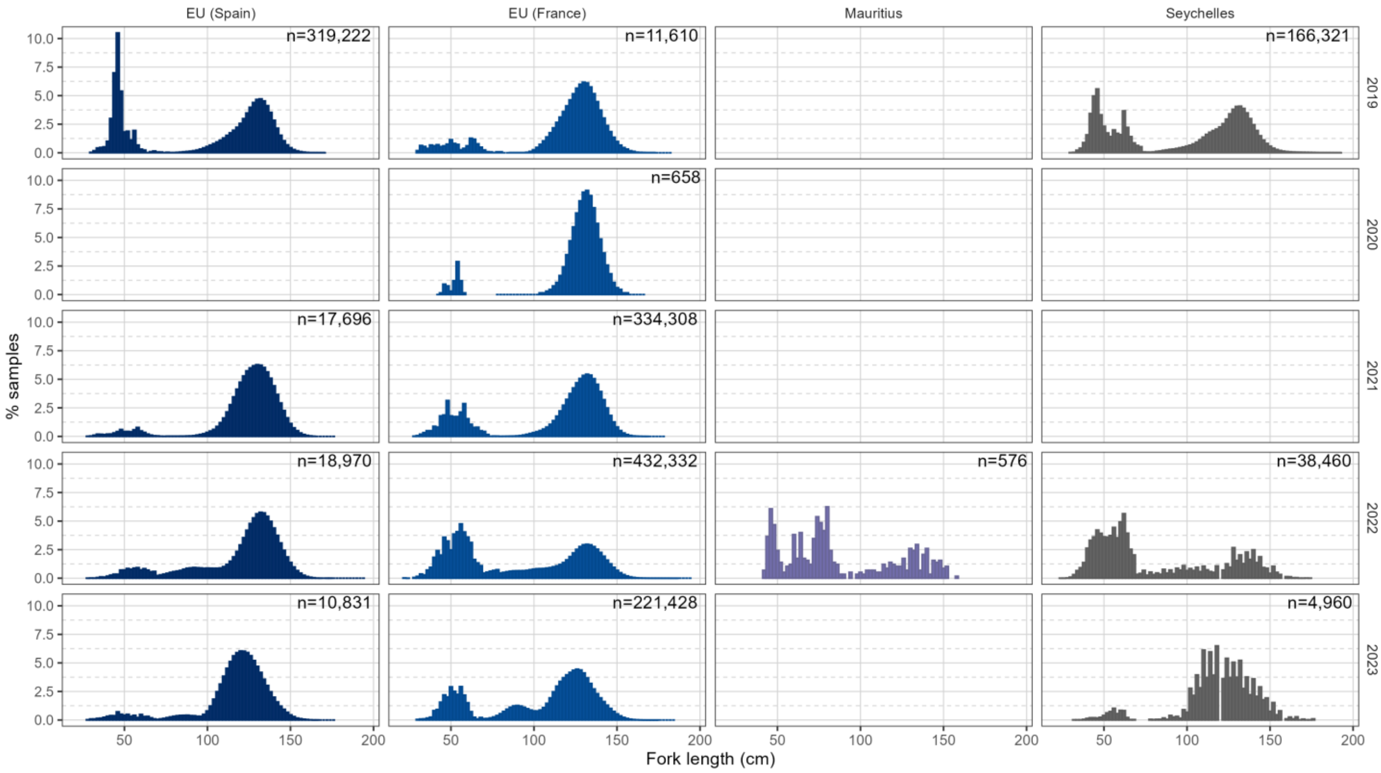

Figure 44: Relative size distribution of yellowfin tuna (fork length; cm) recorded for free-swimming schools, by year (2019–2023) and main purse seine fleet. Data source: [standardized size-frequency dataset](https://www.iotc.org/WPTT/26/data/11-SFYFT) (Res. 15/02)

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 2019-2023. Data source: [standardized size-frequency dataset](https://www.iotc.org/WPTT/26/data/11-SFYFT) (Res. 15/02)

Fleet	2019	2020	2021	2022	2023
EU (Spain)	37		6	11	7
EU (France)	14	8	26	47	24
Mauritius				45	
Seychelles	41			61	6

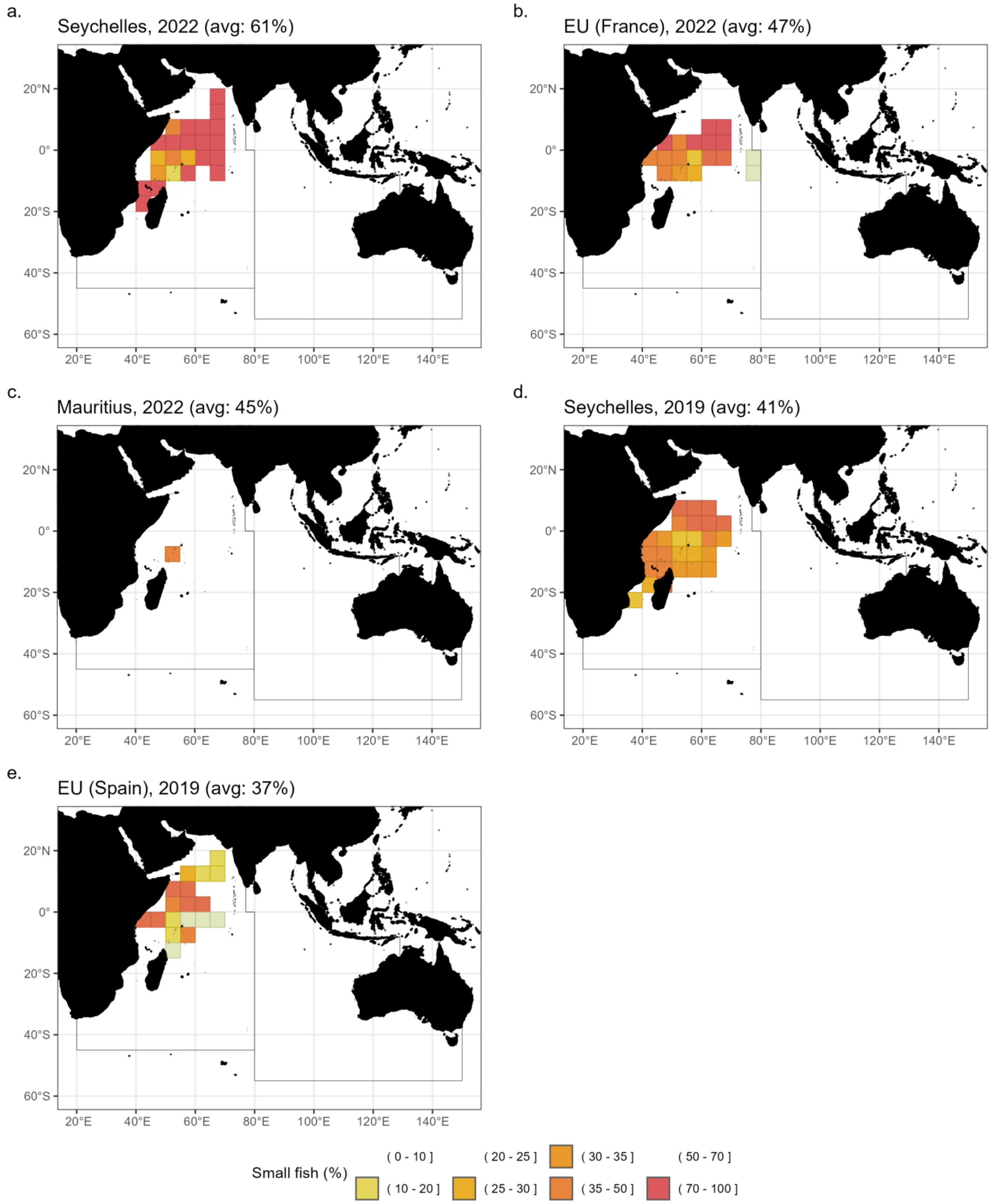

Figure 45: Spatial distribution of sampled yellowfin tuna with fork length below 75 cm recorded by the major purse seine fleets fishing on free-swimming schools, as reported for the period 2019-2023. Data source: standardized size-frequency dataset (Res. 15/02)

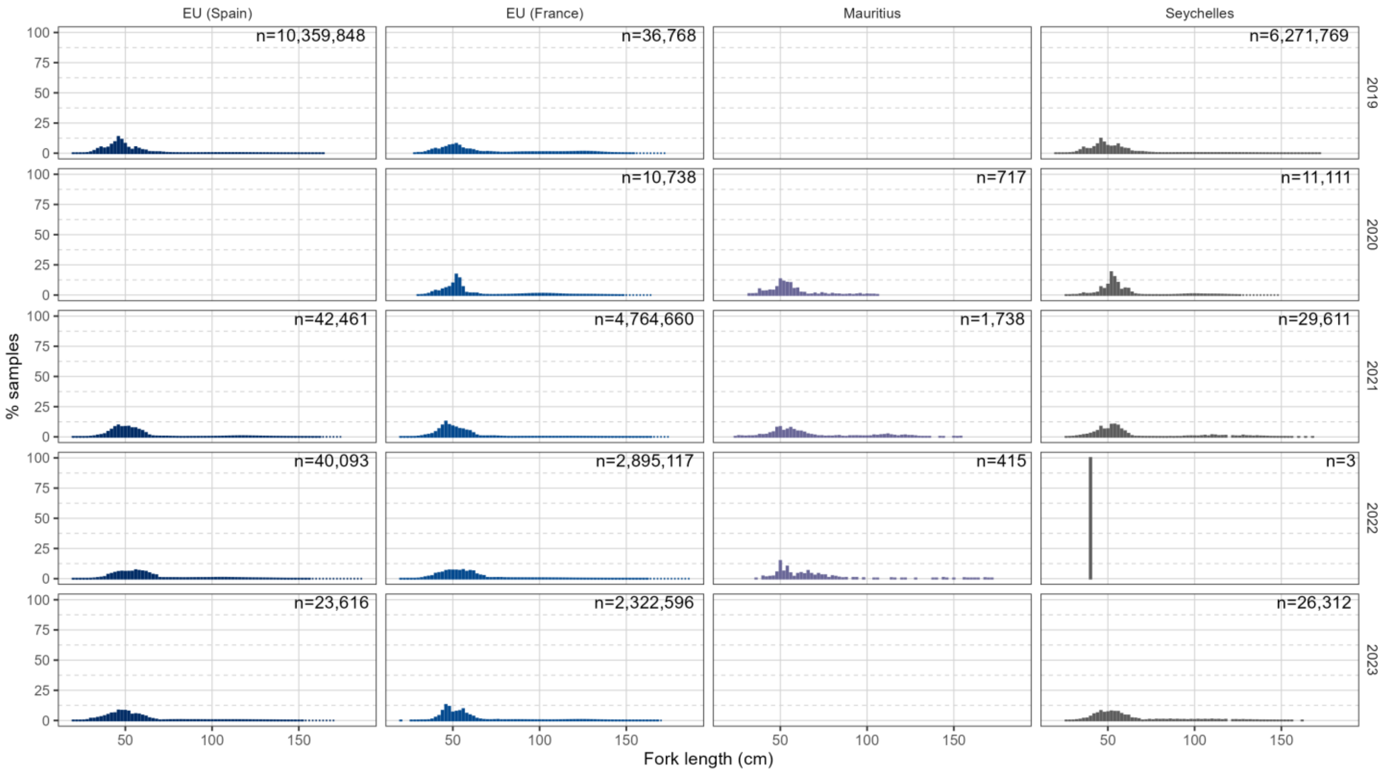

Figure 46: Relative size distribution of yellowfin tuna (fork length; cm) recorded for FOB-associated schools, by year (2019–2023) and major purse seine fleet. Data source: standardized size-frequency dataset (Res. 15/02)

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 2019-2023. Data source: [standardized size-frequency dataset](https://www.iotc.org/WPTT/26/data/11-SFYFT) (Res. 15/02)

Fleet	2019	2020	2021	2022	2023
EU (Spain)	4		9	17	11
EU (France)	29	17	4	10	11
Mauritius		8	24	18	
Seychelles	6	8	17	0	17

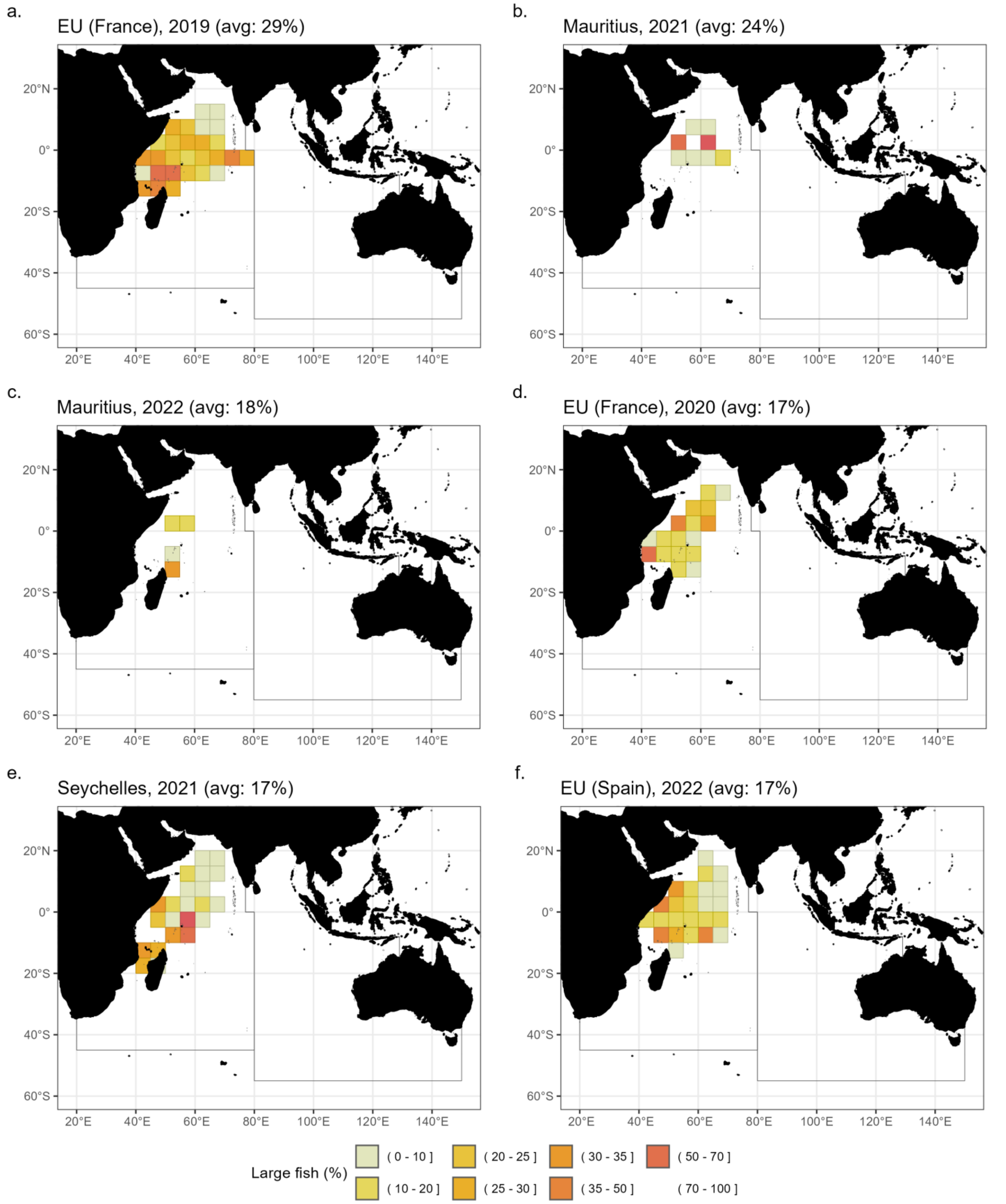

Figure 47: Spatial distribution of sampled yellowfin tuna with fork length above 75 cm recorded by the major purse seine fleets fishing on FOB-associated schools, as reported for the period 2019-2023. Data source: standardized size-frequency dataset (Res. 15/02)

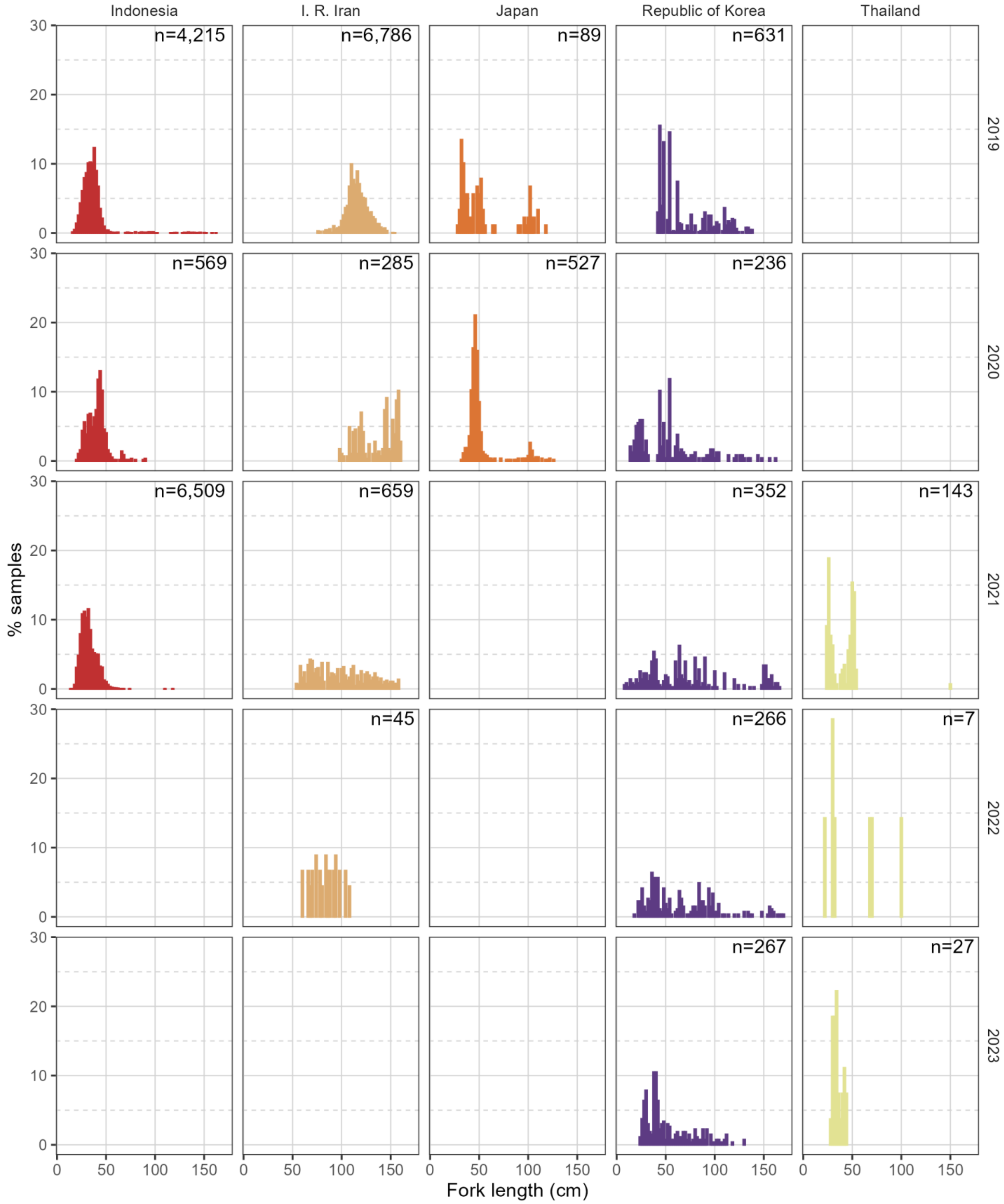

Figure 48: Relative size distribution of yellowfin tuna (fork length in cm) recorded for unclassified schools, by year (2019–2023) and other purse seine fleet. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

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. 49**). 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 2023 (when the coverage level of the size-frequency data was of around 4.8 samples per metric ton) (**Fig. 49**).

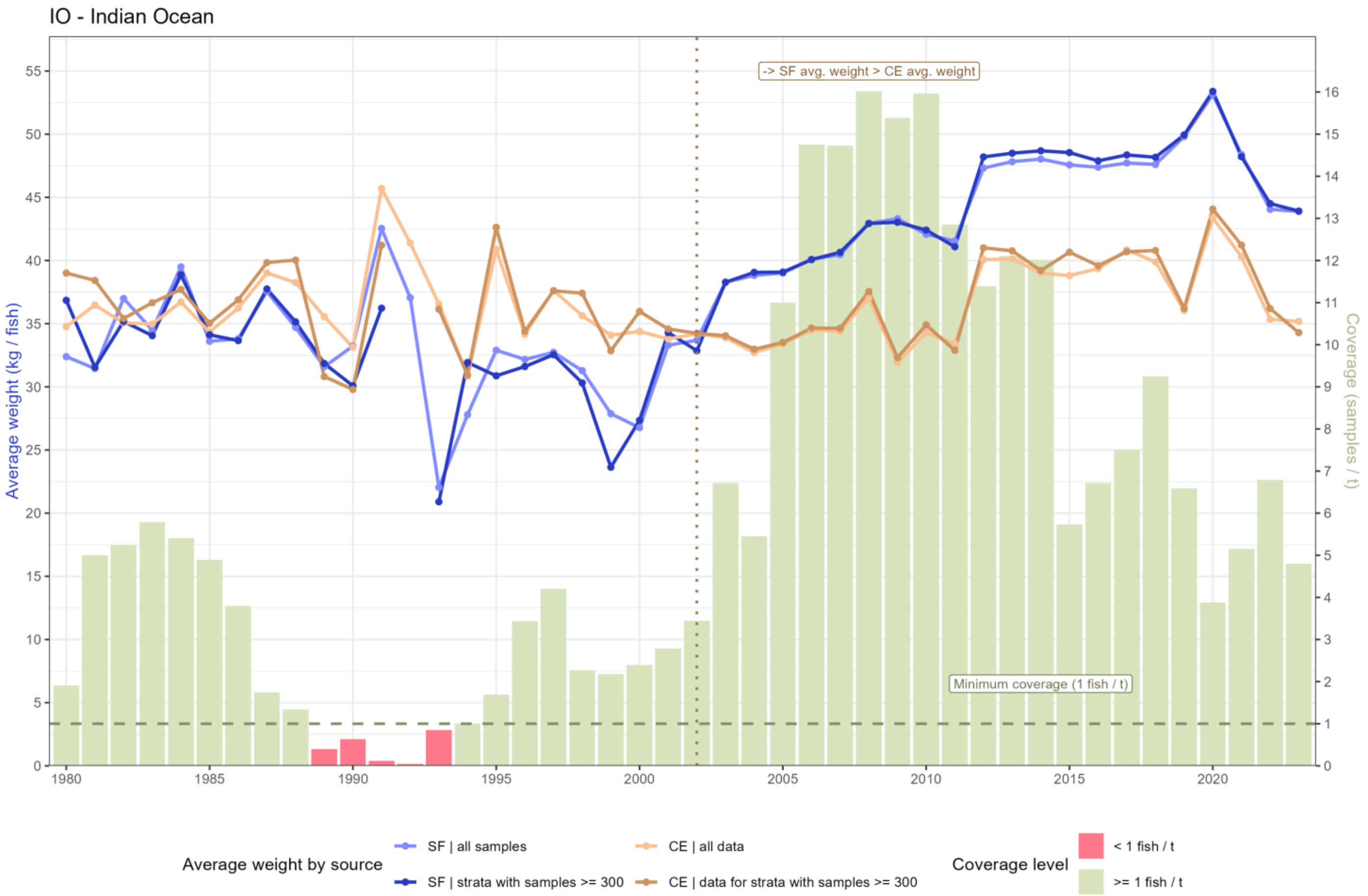

Figure 49: Difference in average weights (all Indian Ocean areas) of yellowfin tuna caught by the deep-freezing fleet of Taiwan,China as calculated from the available size-frequency and catch and effort data (1980-2023). Data source: standardized size-frequency dataset and time-area catch dataset for longline fisheries (Res. 15/02)

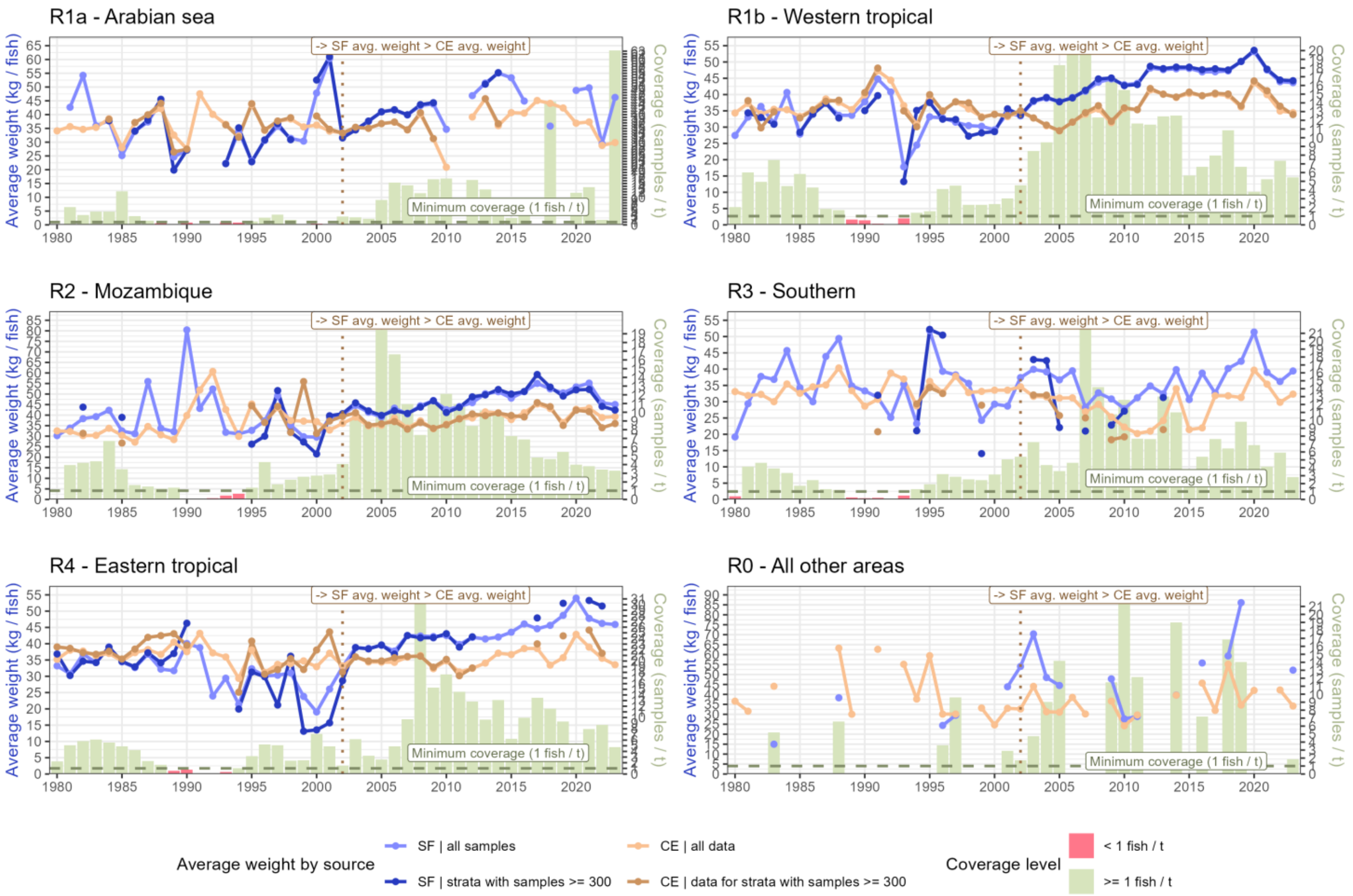

Figure 50: Difference in average weights by stock-assessment areas of yellowfin tuna caught by the deep-freezing fleet of Taiwan,China as calculated from the available size-frequency and catch and effort data (1980-2023). Data source: standardized size-frequency dataset and time-area catch dataset for 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 (2000-2023), 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. 54**)

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 2,652,865 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. 53**).

Further analysis based on the comparison of size-frequency distributions of yellowfin tuna caught by longliners from Japan and Taiwan,China during 2000-2023 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. 51**). 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. 52**);
- 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. 53**). For previous years, data from logbooks seems to be biased towards larger fish in the Arabian Sea (R1a) and Mozambique Channel (R2) (**Fig. 53**);

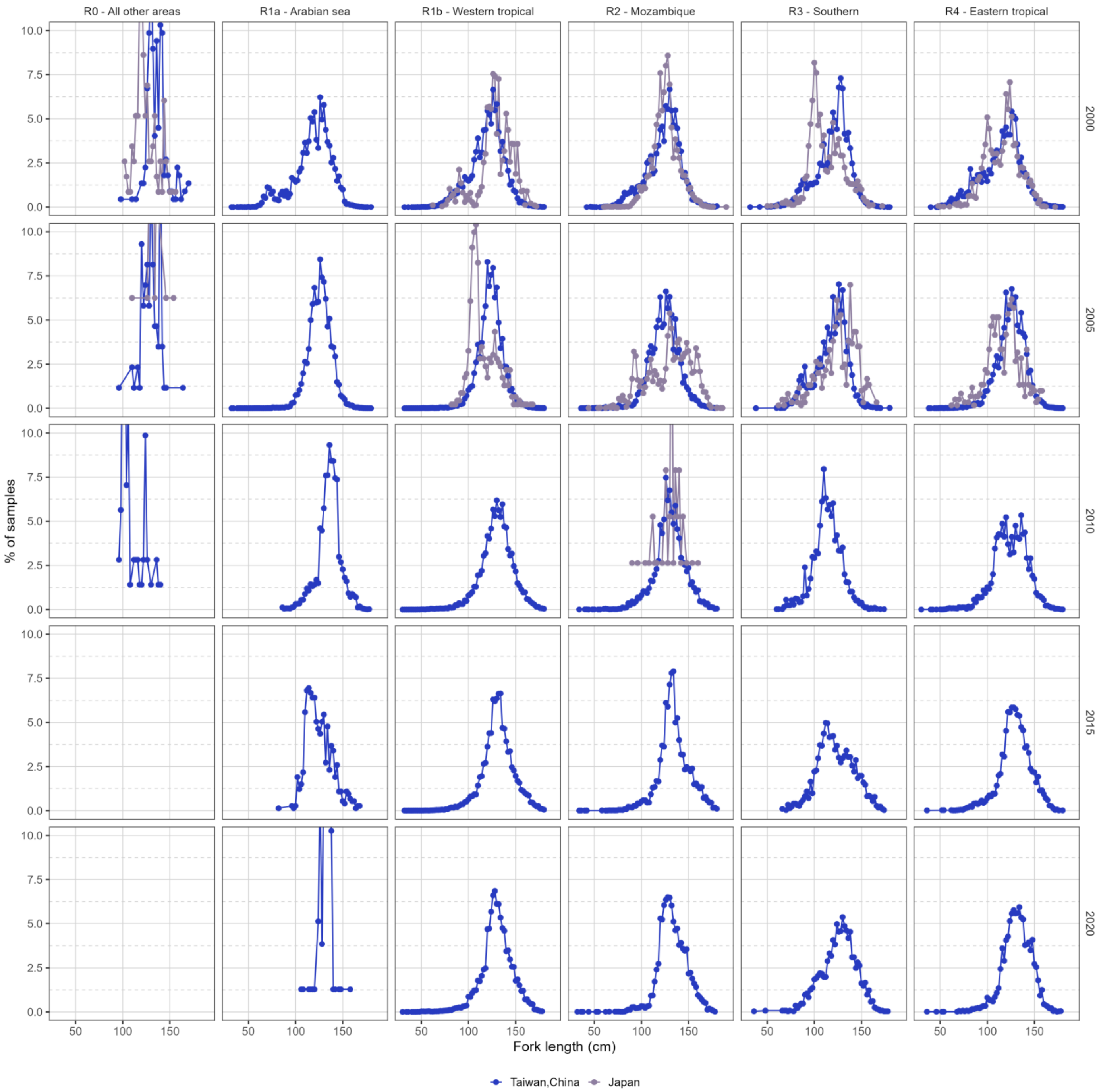

Figure 51: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported through logbooks by the deep-freezing longline fleets of Japan and Taiwan,China, by stock assessment area and five-year periods. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

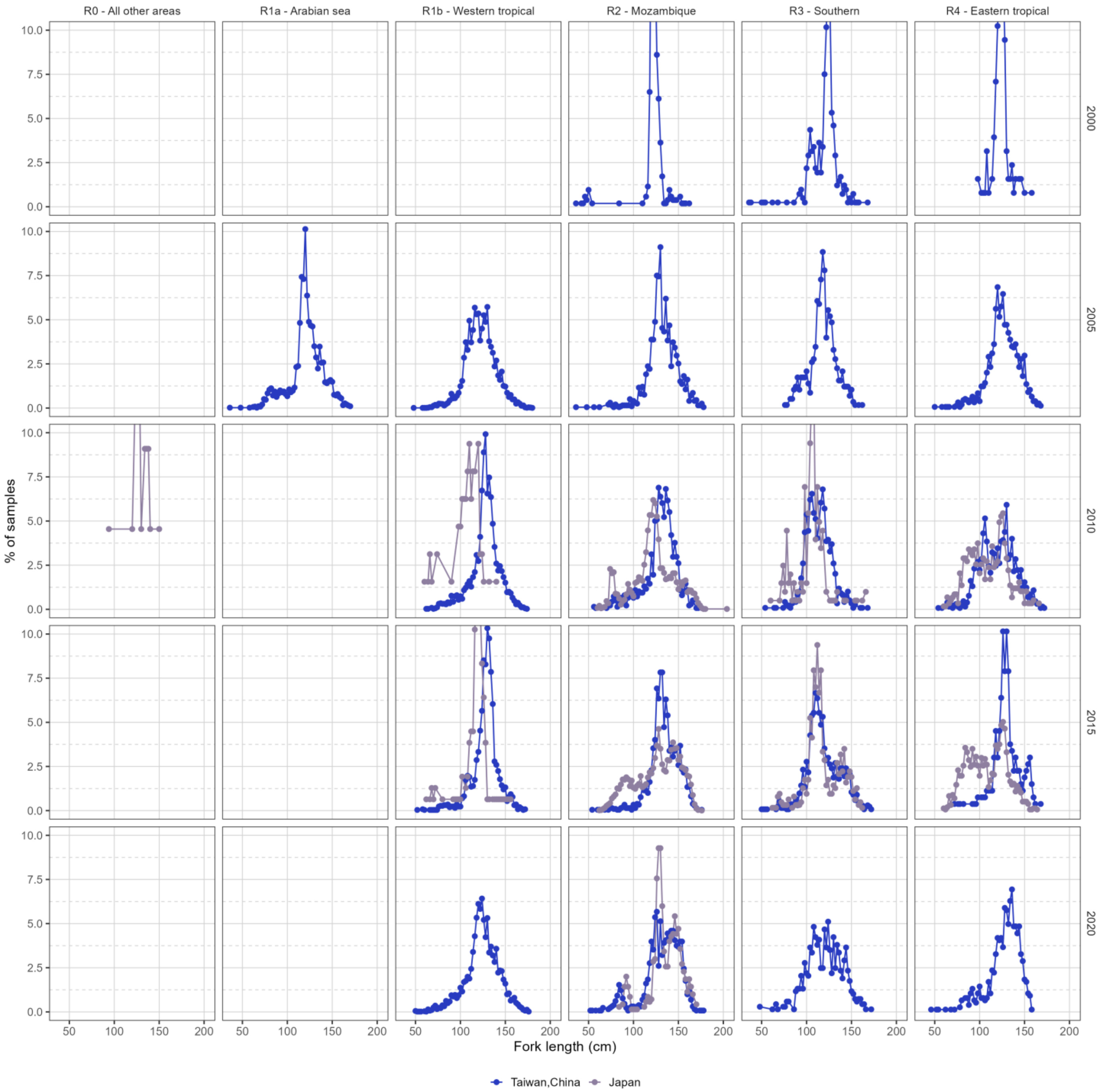

Figure 52: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported through scientific observers by the deep-freezing longline fleets of Japan and Taiwan,China, by stock assessment area and five-year periods. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

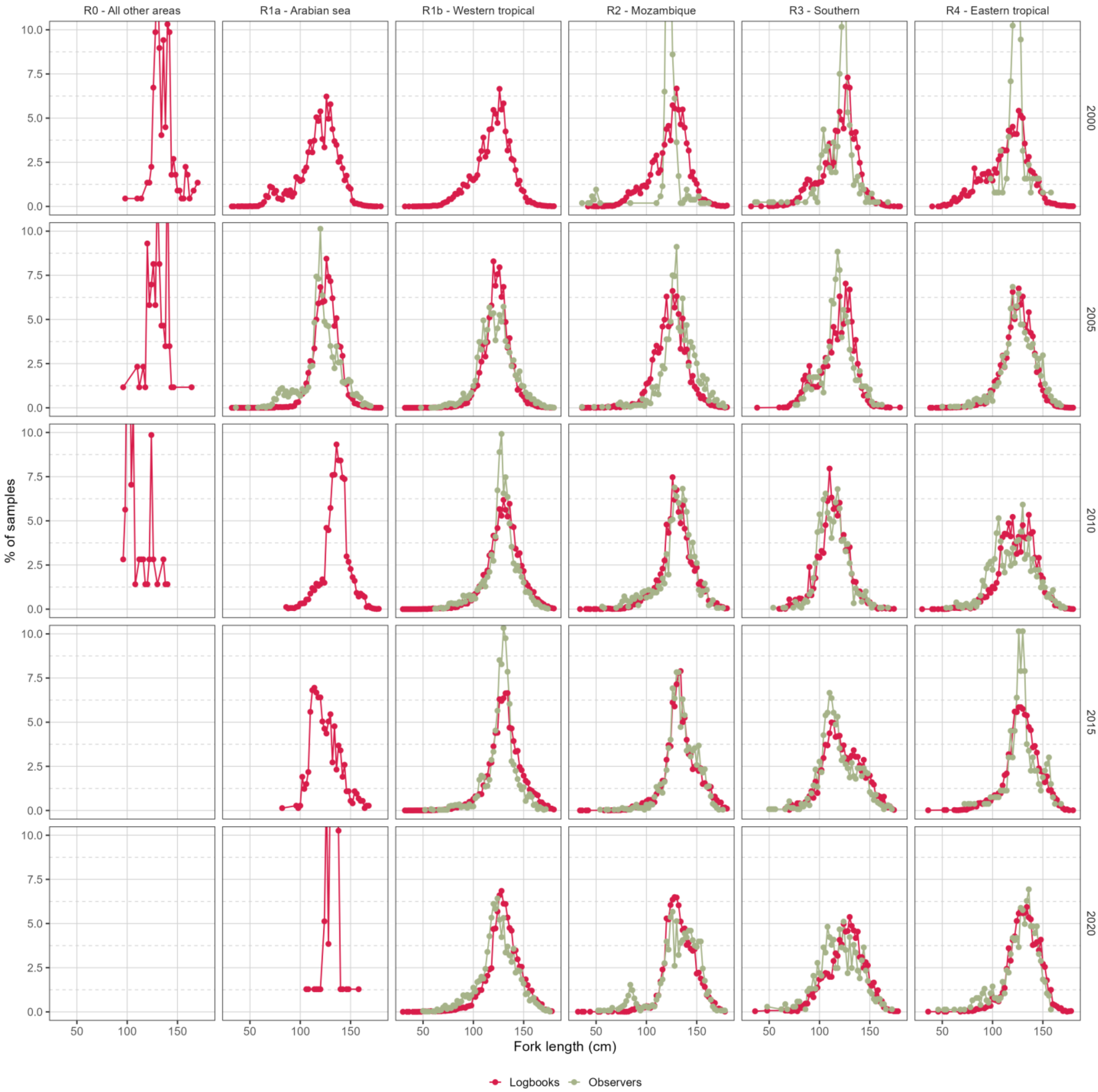

Figure 53: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported by the deep-freezing longline fleets of Taiwan,China, by source (scientific observers vs. logbooks), stock assessment area and five-year periods. Data source: standardized size-frequency dataset (Res. 15/02)

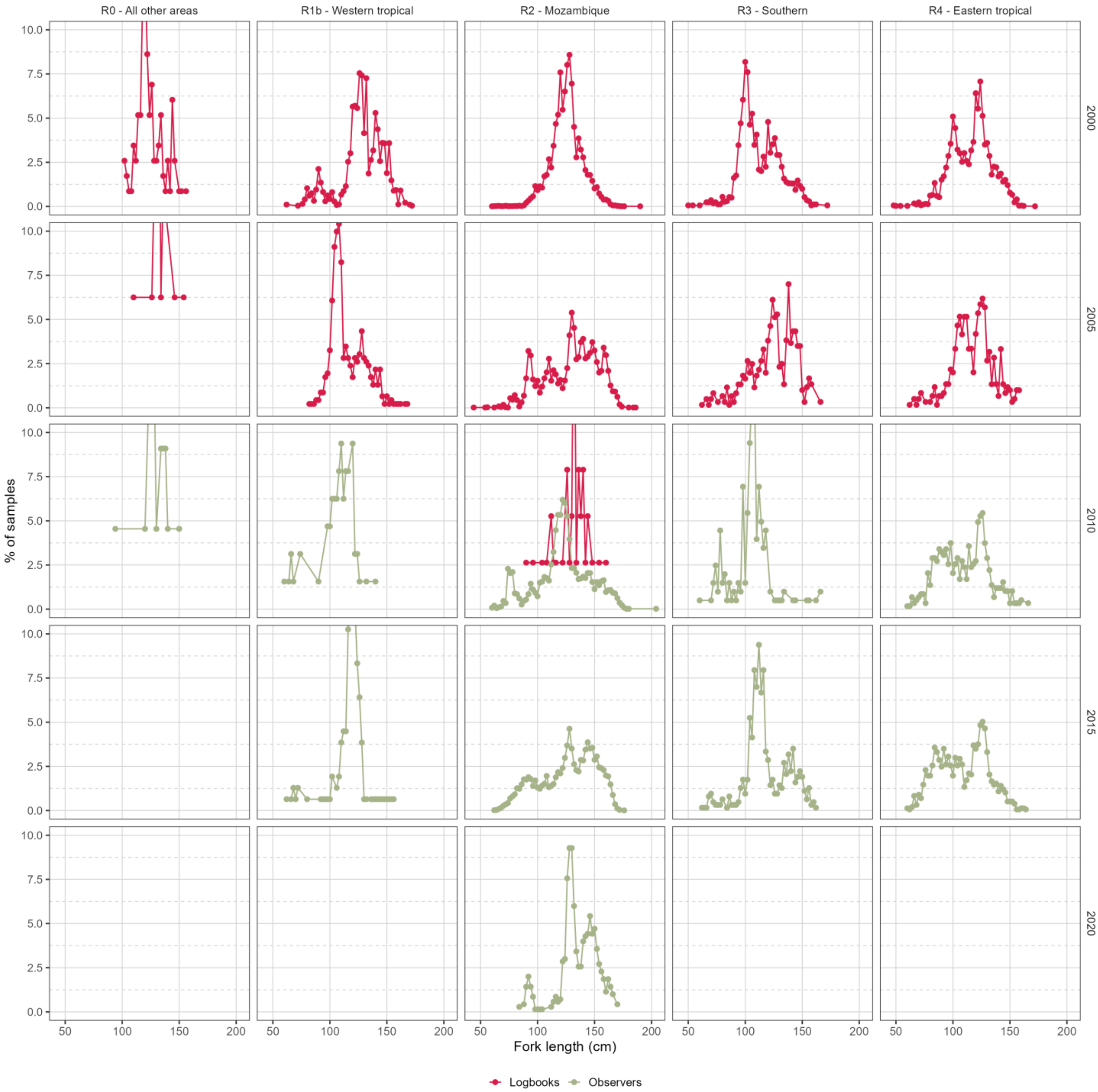

Figure 54: Relative size distribution (fork length; 2-cm size bins) of yellowfin tuna reported by the deep-freezing longline fleets of Japan, by source (scientific observers vs. logbooks), stock assessment area and five-year periods. Data source: [standardized size-frequency dataset](#) (Res. 15/02)

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