REVIEW OF THE STATISTICAL DATA AVAILABLE FOR INDIAN OCEAN SWORDFISH (1950-2023)

Author: IOTC Secretariat

Abstract

The document provides an overview of the consolidated knowledge about fisheries catching swordfish (*Xiphias gladius*) in the Indian Ocean since the early 1950s based on a range of data sets collected by the Contracting Parties and Cooperating Non-Contracting Parties (CPCs) of the IOTC and curated by the IOTC Secretariat. The quality of the total retained catches of swordfish is considered to be good and overall the best among the five billfish species under IOTC mandate. The available fisheries statistics show that swordfish are mostly caught in both large-scale and coastal longline fisheries although gillnet fisheries have increased their catches over the last decade. Catches of large-scale longline fisheries have shown a steady decrease since 2004 while longline catches from the areas of national jurisdiction of Sri Lanka and India to a lesser extent have sharply increased since 2010. Information available on discarding practices collected through the IOTC Regional Observer Program shows that discarding in longline fisheries is mostly driven by size in some fleets. Discarding in coastal fisheries interacting with the species is poorly known but considered to be negligible. Information available on the spatial distribution of catch and effort has substantially improved over the last decade, particularly for coastal fisheries. Consolidated data show that swordfish are caught across all the Indian Ocean although the main fishing grounds appear to be located in the western Indian Ocean and around the coasts of Sri Lanka and India. Recent fisheries statistics, indicated catches of swordfish in the Aden Gulf. The reporting of size-frequency data has improved in recent years, particularly thanks to the data reported for the longline fisheries of Sri Lanka and Seychelles.

Keywords: billfish | swordfish | Indian Ocean | tuna fisheries

Introduction

Swordfish (*Xiphias gladius*) is the most widely distributed species of billfish, occurring in tropical, subtropical, and temperate waters throughout the world oceans. Information available from FAO fisheries statistics shows the major increase in the global catch of swordfish that took place between the 1950s and 2000s when it reached a plateau at around 100,000 t (**Fig. 1a**). After a decline observed during 2008-2011 due to piracy threat in the Indian Ocean, catches of swordfish increased and peaked at about at 153,000 t in 2016, before showing a strong decrease in recent years to reach about 125,000 t in 2023, the decline occurring in all oceans. The Indian Ocean represents a major fishing ground for swordfish and has contributed to about one third of the global swordfish catch during 2017-2023 (**Fig. 1b**).

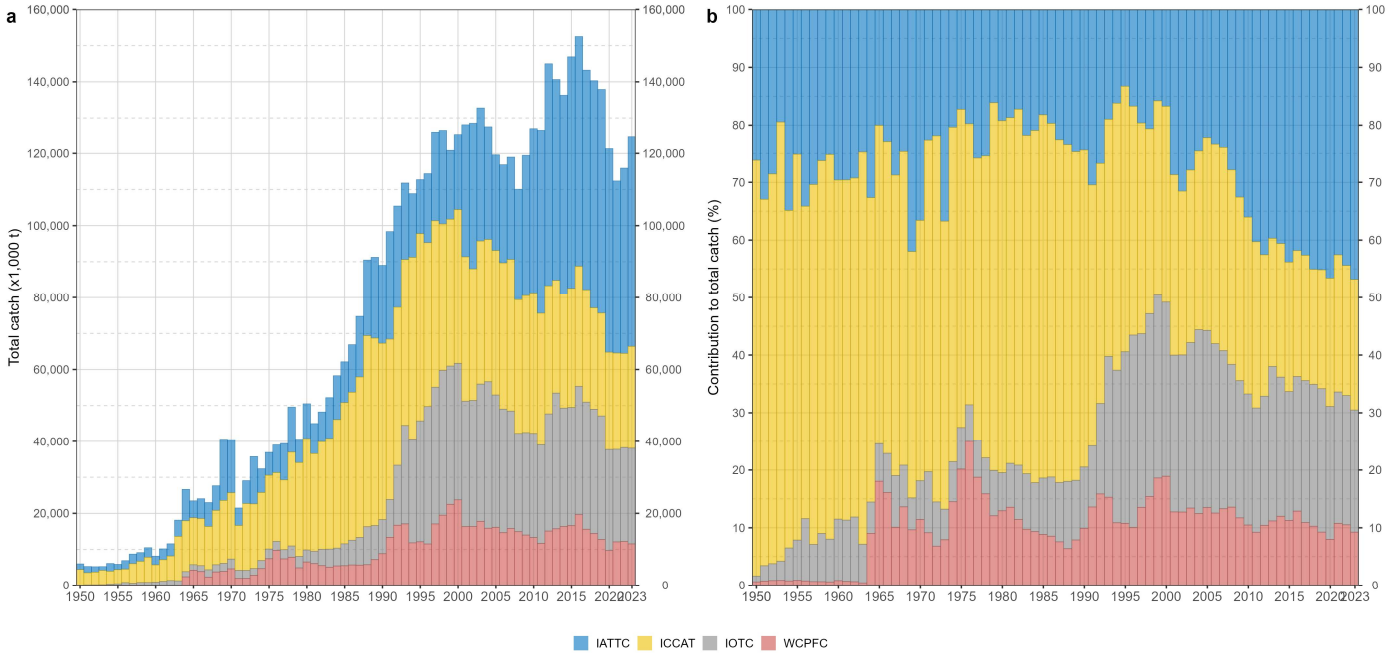

Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of swordfish by region1950-2023. Source: (https://www.fao.org/fishery/statistics-query/en/capture/capture_quantity)

The overarching objective of this paper is to provide participants in the data preparatory meeting of the 23rd Session of the IOTC Working Party on Billfish (WPB23) with a review of the status of the information available on swordfish 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 (**IOTC2025?**).

Total retained (nominal) catch

Historical trends (1950-2023)

Catches reported for Indian Ocean swordfish showed a sharp increase in the 1990s linked to the expansion of the high-seas longline fisheries combined with the development of several smaller-range longline fisheries targeting swordfish for the fresh market (**Figs. 2-4** and **Table 1**). Catch levels were the highest throughout the late 1990s and 2000s at about 37,000 t before they decreased to about 28,000 t between 2008 and 2011 during the period of piracy threat which prevented longliners to operate in the rich fishing grounds of the Somali basin. Catches reached the pre-piracy levels between 2013 and 2019 but showed a sharp decline in 2020-2022 (**Fig. 2a**). While industrial fisheries represented most of the reports of swordfish catch since the mid-1950s, the contribution of coastal fisheries has steadily increased since the mid-2000s (**Fig. 2a**). In 2023, coastal fisheries contributed to 38% of the total catch of retained swordfish reported to the Secretariat.

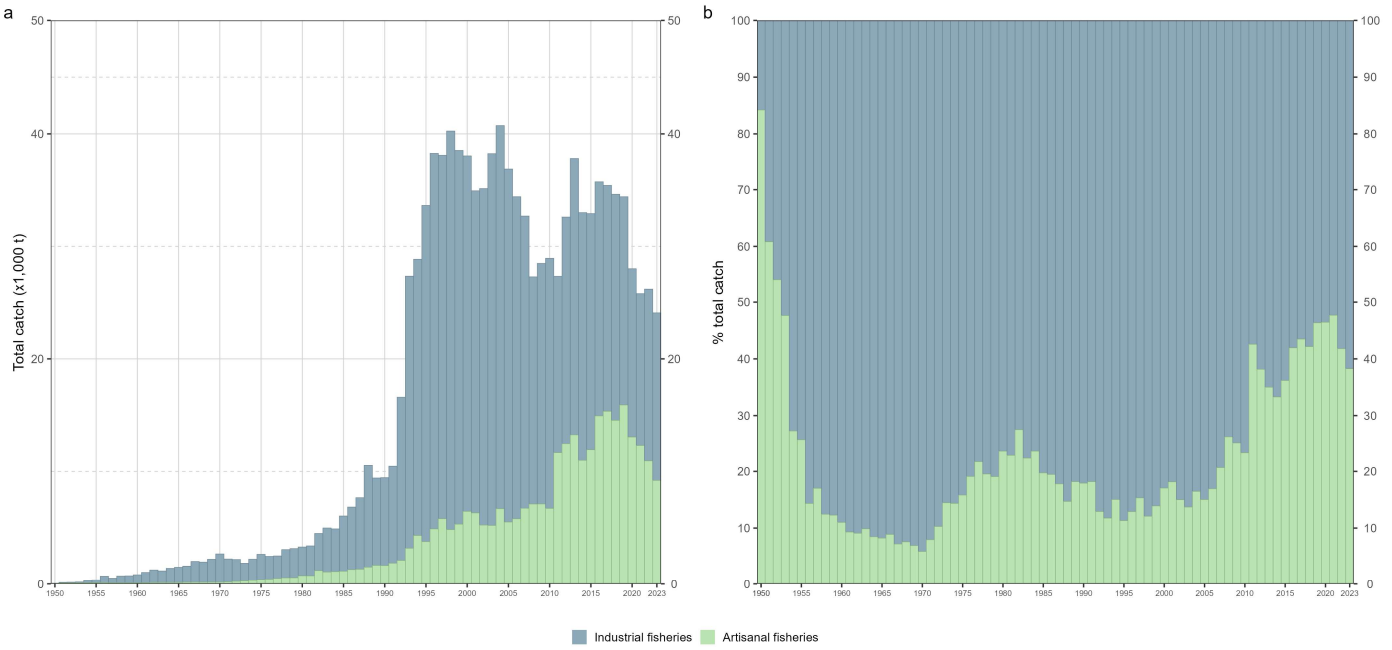

Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of swordfish by type of fishery for the period 1950-2023. Data source: [best scientific estimates of retained catches]

Table 1: Mean annual retained catches (metric tonnes; t) of swordfish by decade and fishery for the period 1950-2019. The background intensity color of each cell is directly proportional to the catch level. Data source: [best scientific estimates of retained catches](https://www.iotc.org/WPB/23/Data/03-NC)

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Purse seine | Other	0	0	0	1	3	4	120
Longline | Other	0	0	0	44	2,861	11,896	7,595
Longline | Fresh	48	80	183	587	2,422	3,069	6,009
Longline | Deep-freezing	277	1,329	1,970	4,304	20,098	15,336	7,334
Line | Coastal longline	62	98	211	594	1,461	2,357	6,080
Line | Trolling	4	6	16	46	91	134	283
Line | Handline	10	9	136	418	606	378	1,137
Baitboat	0	0	0	0	1	1	2
Gillnet	14	15	20	181	582	1,472	4,682
Other	0	0	1	2	4	6	10
Total	415	1,538	2,536	6,176	28,129	34,654	33,252

Longline has been the main fishing gear catching swordfish in the Indian Ocean over the last seven decades. Prior to the 1990s, swordfish was mostly taken in deep-freezing longline fisheries targeting tunas in both temperate and tropical waters. The expansion of the activities of the Asian deep-freezing longline fisheries in the 1990s led to a substantial increase in swordfish catches which were around five times more than during the previous decade (**Table 1**). While the contribution of deep-freezing longline fisheries to swordfish catch started to decrease from the late 1990s, several longline fisheries targeting specifically swordfish developed in both the western (Taiwan,China, EU,France, EU,Spain, EU,Portugal) and eastern (Australia) Indian Ocean. Since the early 2010s, the contribution of coastal longline fisheries (mostly driven by Sri Lanka) and gillnet fisheries (dominated by Yemen in some years) has

progressively increased although there are some large uncertainties associated with the quality of the data for those latter fisheries (see Uncertainties in retained catch data).

Catches from gillnet fisheries show increasing trend from 2010 decade, and continued to increasing, although fluctuated in some years.

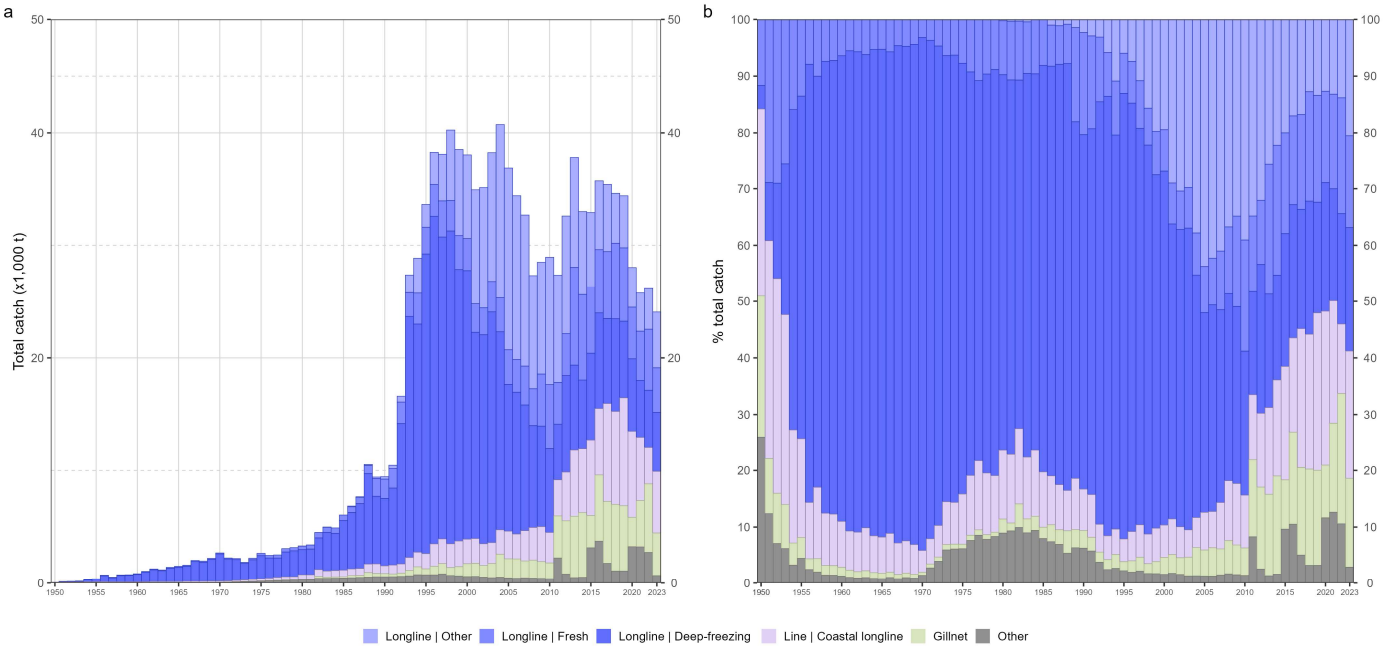

Figure 3: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of swordfish by fishery for the period 1950-2023. Data source: best scientific estimates of retained catches

Table 2: Annual retained catches (metric tonnes; t) of swordfish by fishery for the period 2014-2023. The background intensity color of each cell is directly proportional to the catch level. Data source: [best scientific estimates of retained catches](https://www.iotc.org/WPB/23/Data/03-NC)

Fishery	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Purse seine | Other	30	44	49	742	266	17	8	19	45	138
Longline | Other	7,370	6,579	6,073	5,936	4,412	4,603	3,550	3,393	3,613	4,934
Longline | Fresh	7,559	5,896	5,646	5,965	6,724	6,534	4,560	4,338	5,383	3,935
Longline | Deep-freezing	6,141	7,753	8,440	7,501	8,178	6,762	6,398	5,117	5,131	5,273
Line | Coastal longline	5,636	6,634	5,932	8,716	8,281	9,595	7,656	5,568	3,207	5,438
Line | Trolling	203	147	867	329	183	203	100	150	196	67
Line | Handline	300	2,971	2,831	665	667	891	3,122	3,018	2,438	488
Baitboat	3	7	1	4	0	1	1	1	0	0
Gillnet	5,722	2,857	5,851	5,466	5,879	5,768	2,604	4,081	6,048	3,769
Other	11	0	0	49	1	1	31	62	83	10
Total	32,975	32,888	35,690	35,373	34,590	34,374	28,030	25,747	26,143	24,053

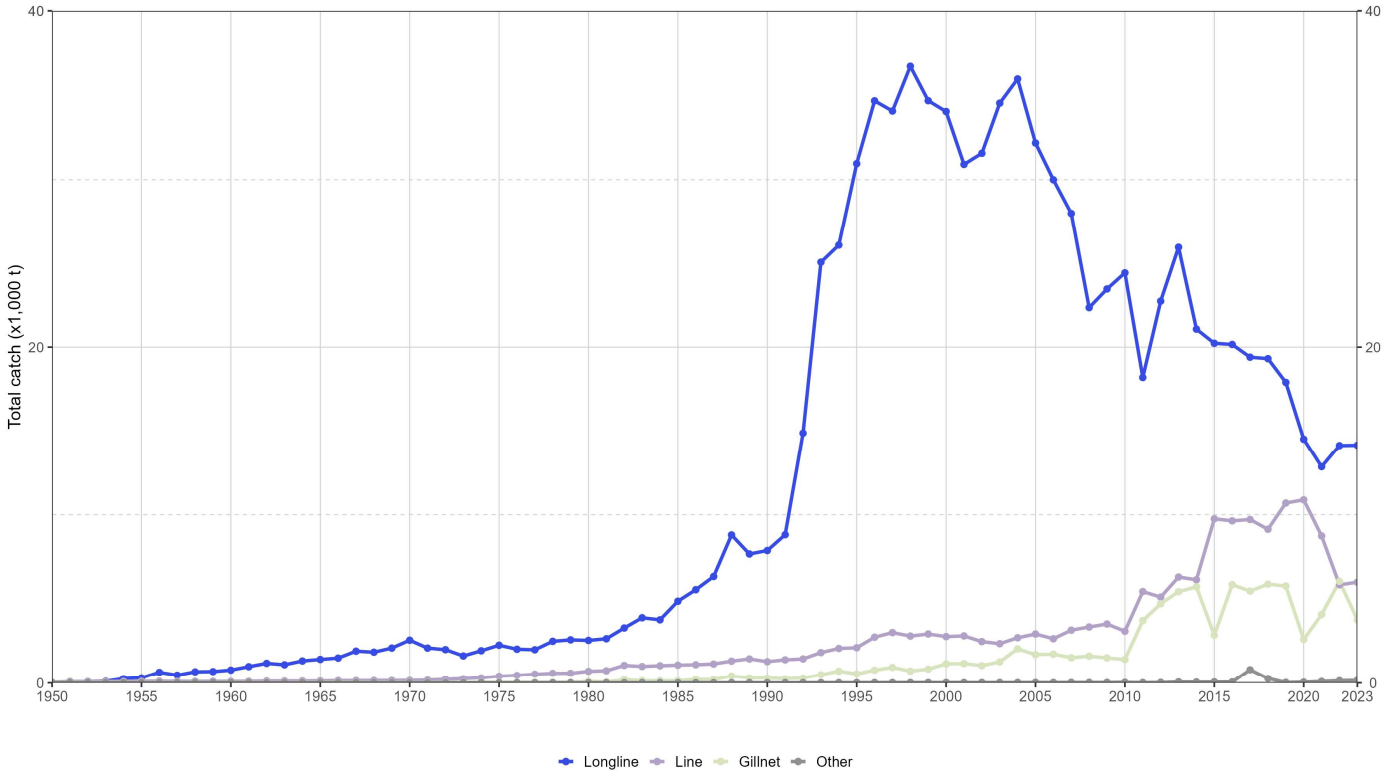

Figure 4: Annual time series of retained catches (metric tonnes; t) of swordfish by fishery group for the period 1950-2023. Data source: best scientific estimates of retained catches

Main fishery features (2019-2023)

Recently, fisheries composed of smaller longliners(LIC) operating both in areas of national jurisdiction (NJA) and medium scale longliners (LLF) the high seas (ABNJ) have been catching as much swordfish as the deep-freezing longline fisheries. Between 2019 and 2023, these two components contributed to 41% of the total swordfish catch reported to the Secretariat (**Table. 3**).

Table 3: Mean annual catches (metric tonnes; t) of swordfish by fishery between 2019 and 2023. Data source: [best scientific estimates of retained catches](https://www.iotc.org/WPB/23/Data/03-NC)

Fishery	Fishery code	Catch	Percentage
Line | Coastal longline	LIC	6,293	22.7
Longline | Deep-freezing	LLD	5,736	20.7
Longline | Fresh	LLF	4,950	17.9
Gillnet	GN	4,454	16.1
Longline | Other	LLO	4,019	14.5
Other	OT	2,218	8.0

Sri Lankan fisheries took the bulk of the catch of Indian Ocean swordfish in recent years, i.e., about 27% of all swordfish catches between 2019 and 2023 (**Fig. 5**). The second most important fleet was Taiwan,China which catch swordfish with a mix of fresh and deep-freezing longliners and contributed to about 18% of all swordfish catch during that period. The other main fleets catching swordfish were EU,Spain, India, Yemen, Indonesia, China, I.R. Iran, and EU,Portugal (**Fig. 5**).

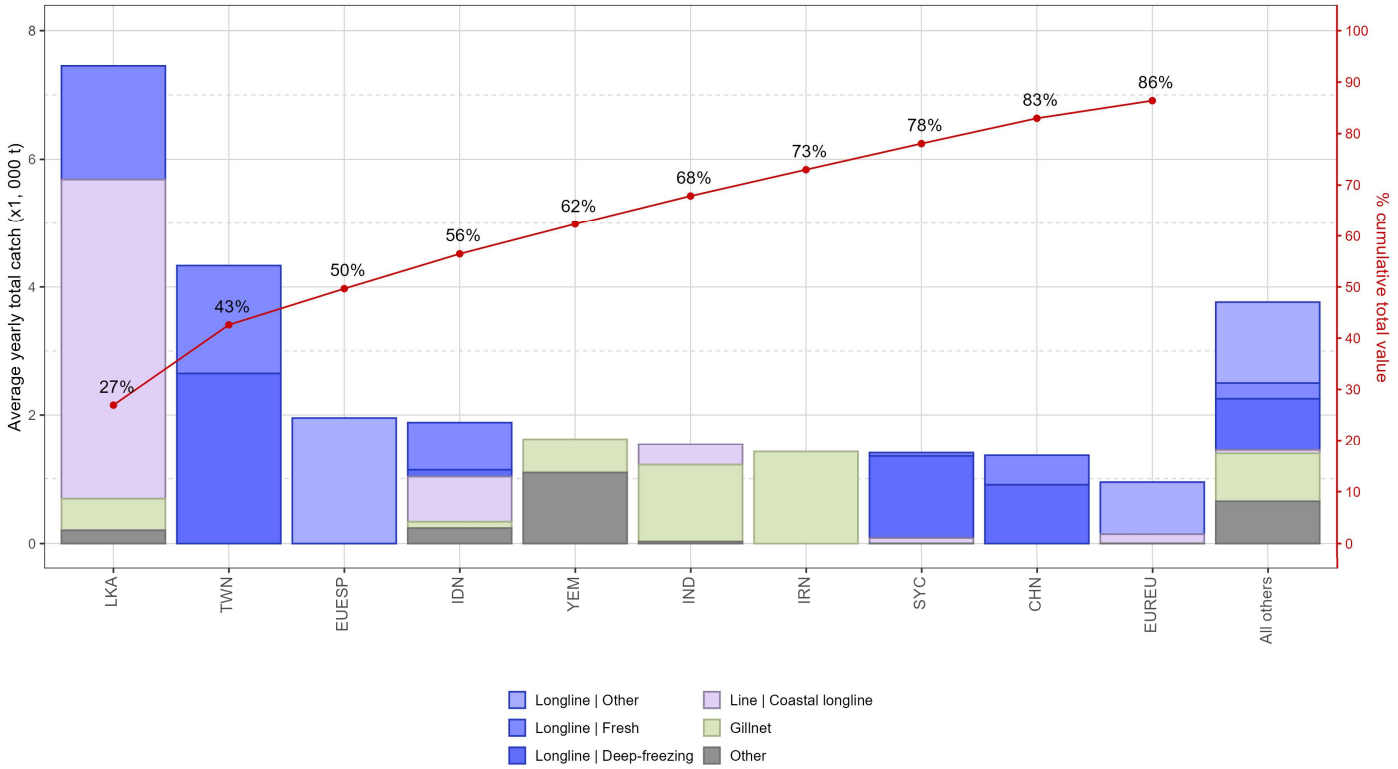

Figure 5: Mean annual catches (metric tonnes; t) of swordfish by fleet and fishery between 2019 and 2023, with indication of cumulative catches by fleet. Data source: best scientific estimates of retained catches

Recent catches of swordfish show different trends between fishery groups. Longline fisheries show an overall declining trend in recent years, from 18,000 t in 2019 to 14,000 t in 2023 (**Fig. 6**). Catches from line fisheries show more variability, following an increased catch reported for 2020 at around 11,000 t, catches declined to around 6,000 t in 2023. The third highest catch is from gillnet fisheries for which catches increased in 2022 by 48% compared to 2021 (**Fig. 6**).

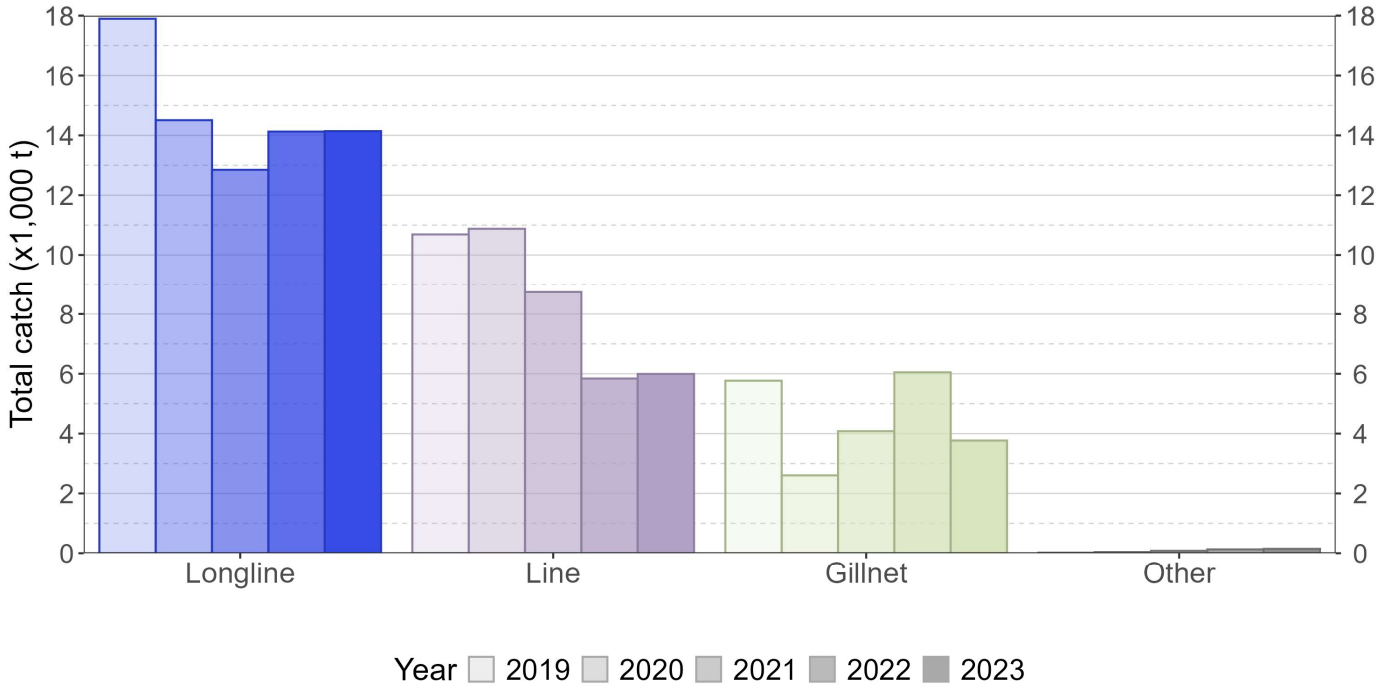

Figure 6: Annual catch (metric tonnes; t) trends of swordfish by fishery group between 2019 and 2023. Data source: best scientific estimates of retained catches

Longline fisheries from Taiwan,China, which reported the highest swordfish catch in 2018 at around 0 t, dropped by -Inf% in 2021, but increased slightly in 2022. Besides Taiwan,China, swordfish catches decreased from all other longline fisheries (**Fig. 7b**).

Overall catches of swordfish from line fisheries indicate a slight increase in recent years. However, Sri Lankan line fisheries, with the highest catch, which caught over 8,000 t in 2019, faced a major decline, with catches reaching as low as 4,000 t in 2021. Recently, following some review by the FAO, significant catches of swordfish were reported from Yemen, averaging at 2,000 t per year (**Fig. 7c**).

Although swordfish catches from gillnet fisheries are not as high as from longline and line fisheries and the recent catch levels fluctuated for some fisheries, gillnet fisheries of India and I.R.Iran reported an increased catch in 2022 (**Fig. 7d**). Indonesia and Sri Lanka have other fisheries with some catches of swordfish in recent years, although the yearly average is as low as around 37 t. Catches from Yemen, increased in 2023 (**Fig. 7a**).

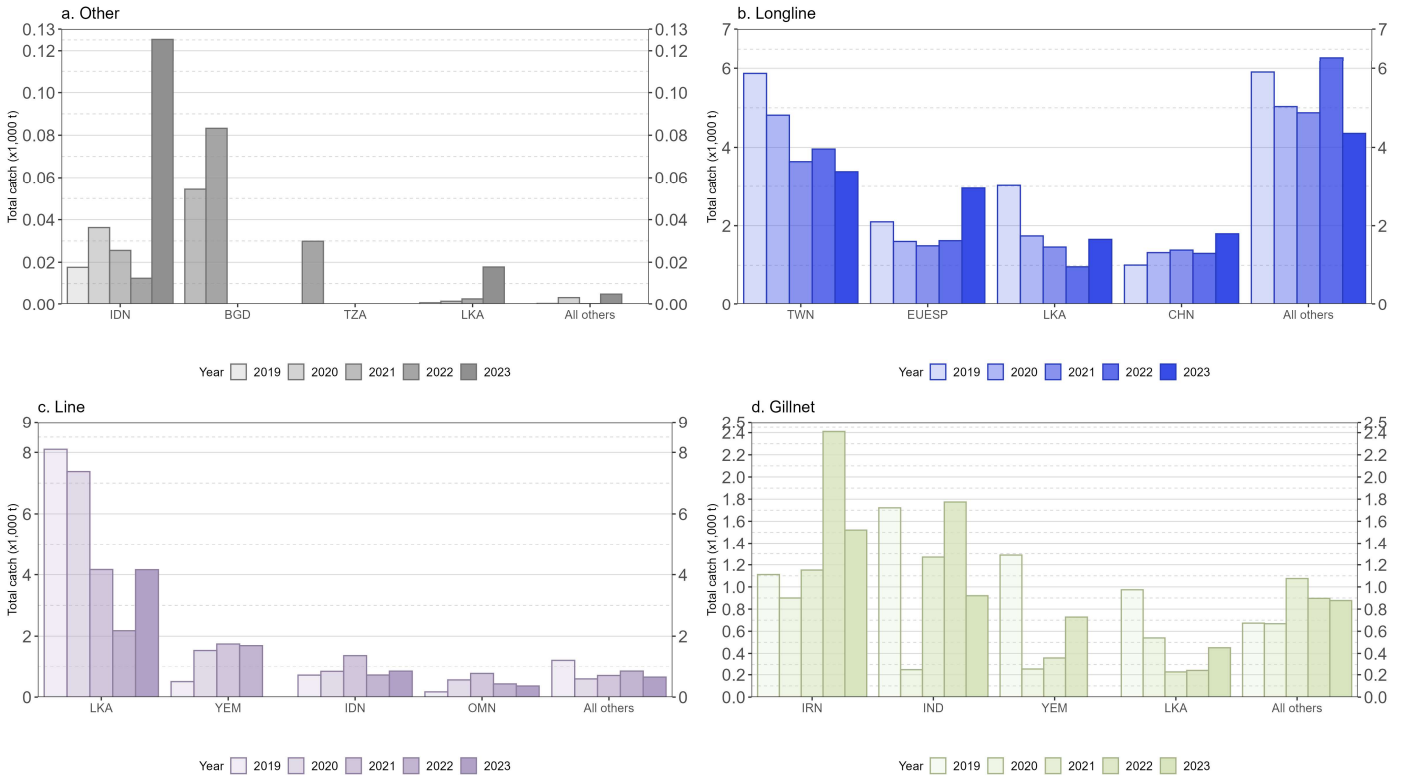

Figure 7: Annual catch (metric tonnes; t) trends of swordfish by fishery group and fleet between 2019 and 2023. Data source: best scientific estimates of retained catches

Changes from previous Working Party

Between the WPB22 and WPB23, there were revisions in the catch series which affected swordfish historical catches (**Fig. 8**). The revisions concerned a few fisheries and were performed for several reasons (see Appendix II). The major changes occurred for the historical swordfish catches reported for Yemen and historical review of Indonesia catches. Previously, the data published through the FAO global capture production database indicated that only Indo-Pacific sailfish was caught as billfish species in Yemeni fisheries. Updates for swordfish catches were reported for several fleets, both industrial and coastal fisheries.

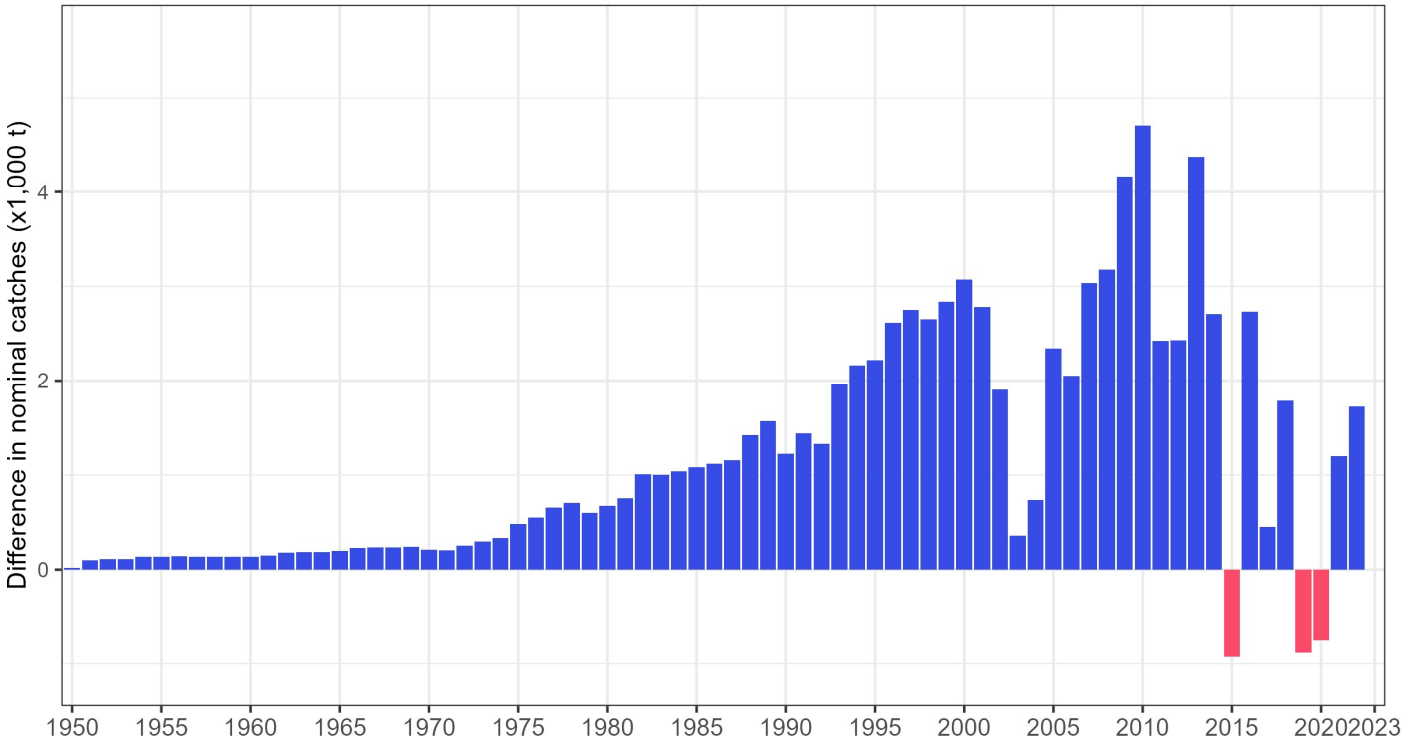

Figure 8: Differences in the available best scientific estimates of retained catches (metric tonnes; t) of swordfish between this WPB and its previous session (WPB22 meeting held in September 2024)

Uncertainties in retained catch data

The overall reporting quality of catches of retained swordfish is considered to be good as most data have been reported for industrial longline fisheries which are generally monitored with good collection and reporting systems (**Fig. 9**). The quality decreased throughout the 1990s and 2000s when some large-scale longline fisheries were found not to directly report catches to the Secretariat (**Herrera2002?**). In parallel, the reporting quality of total retained catches from artisanal fisheries was very low during the 1990s, with only 39.5% of the catch being fully or partially reported (**Fig. 9**). However, the quality substantially improved over the last decade, reaching an average of 100% between 2014 and 2022, mostly reflecting the improvement in reporting for Sri Lankan fisheries.

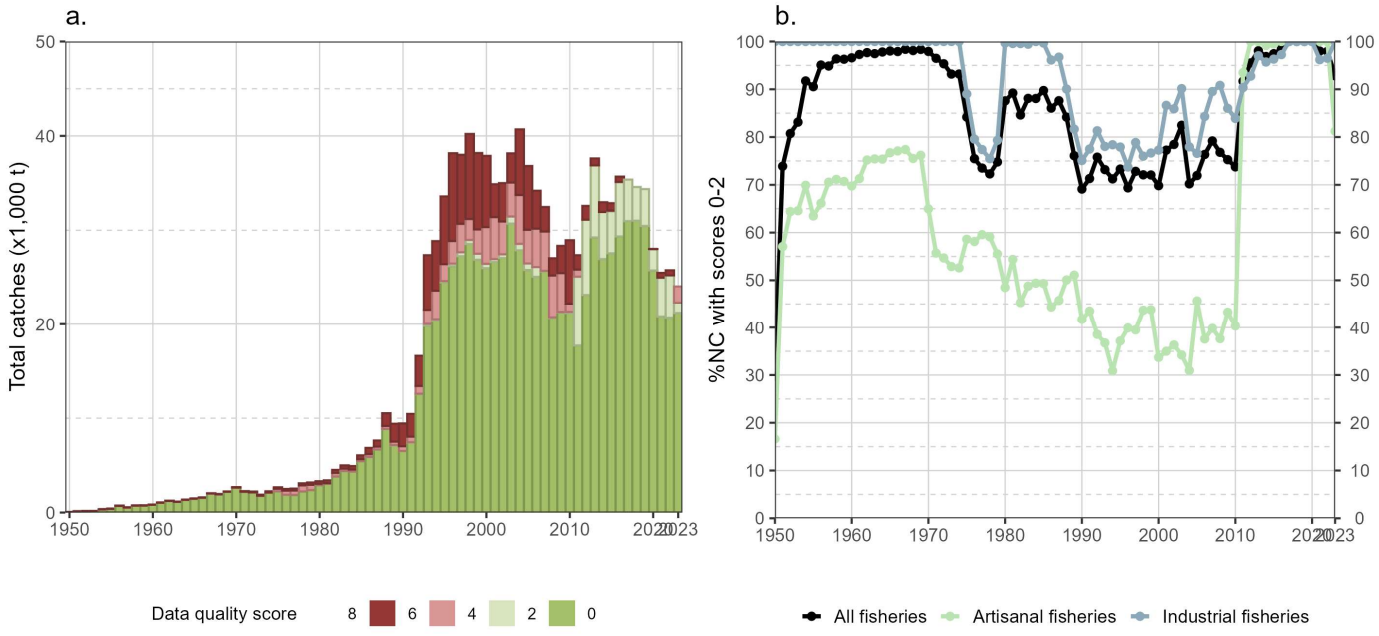

Figure 9: (a) Annual retained catches (metric tonnes; t) of swordfish estimated by quality score and (b) percentage of total retained catches fully or partially reported to the IOTC Secretariat for all fisheries and by type of fishery, in the period 1950-2023

Discard levels

The total discard levels of swordfish caught in the Indian Ocean are poorly known. Information available at the Secretariat includes: (i) discarded catch data from few fisheries through the 1DI form, which are not raised to the total and (ii) observer data collected onboard high-seas fishing vessels that only cover a few fleets (i.e., Japan and EU,France). Data from the ROS database indicate that some discards of swordfish occurred in both longline and purse seine fisheries, at higher rates for the former.

Observer data also show differences in size of discarded and retained swordfish between the two gears, although limited information is available from purse seine fisheries. While swordfish could be discarded at any size in purse seine fisheries, most swordfish discarded in longline fisheries were found to be smaller than 100 cm lower-jaw fork length (**Fig. 10**).

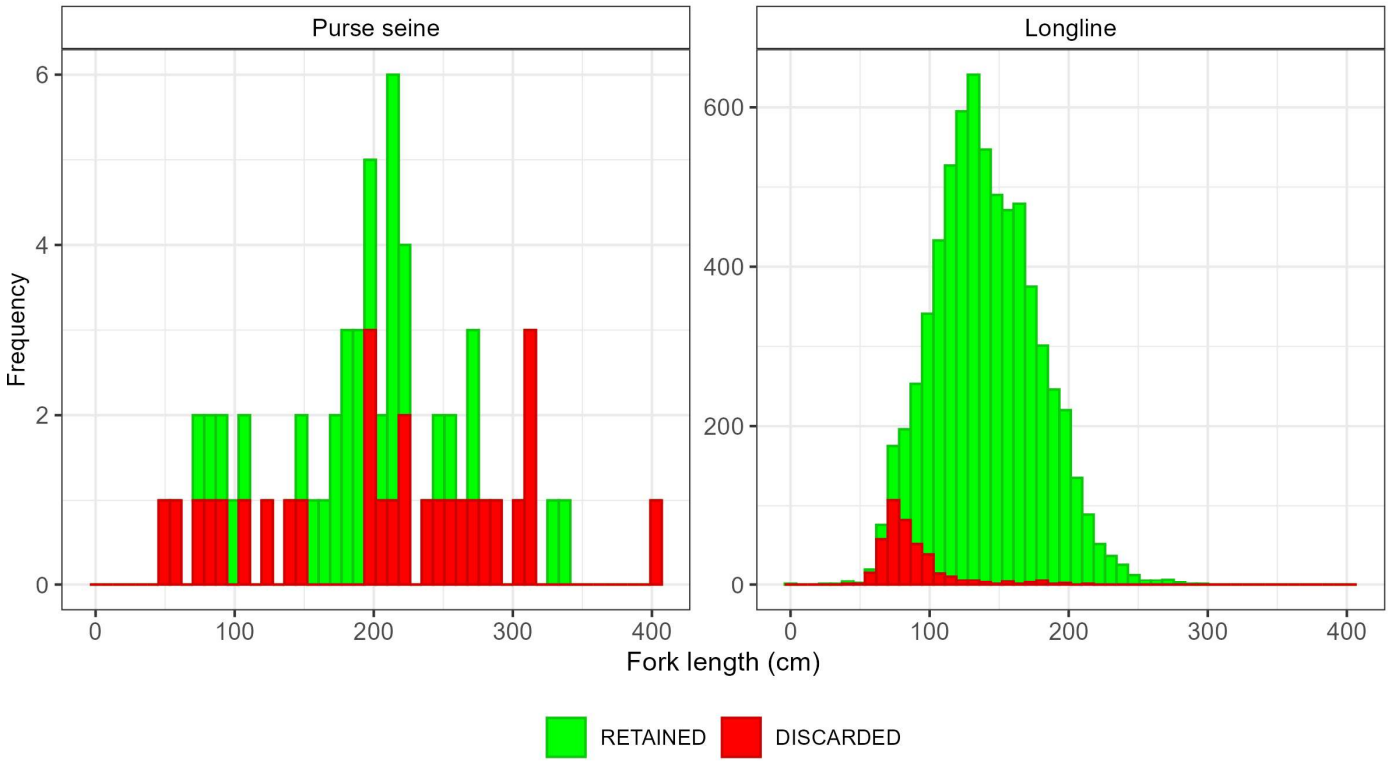

Figure 10: Size (lower-jaw fork length; cm) frequency distribution of swordfish retained and discarded at sea in purse seine and longline fisheries as available in the ROS regional database

Information on swordfish condition at release is only available from longline and purse seine fisheries having operated in the Western Indian Ocean. Although with some variability between fleets, global estimates of condition show that most swordfish were discarded dead in both types of fisheries, i.e., 84% and 95% for purse seine and longline, respectively (**Figs. 11-12**).

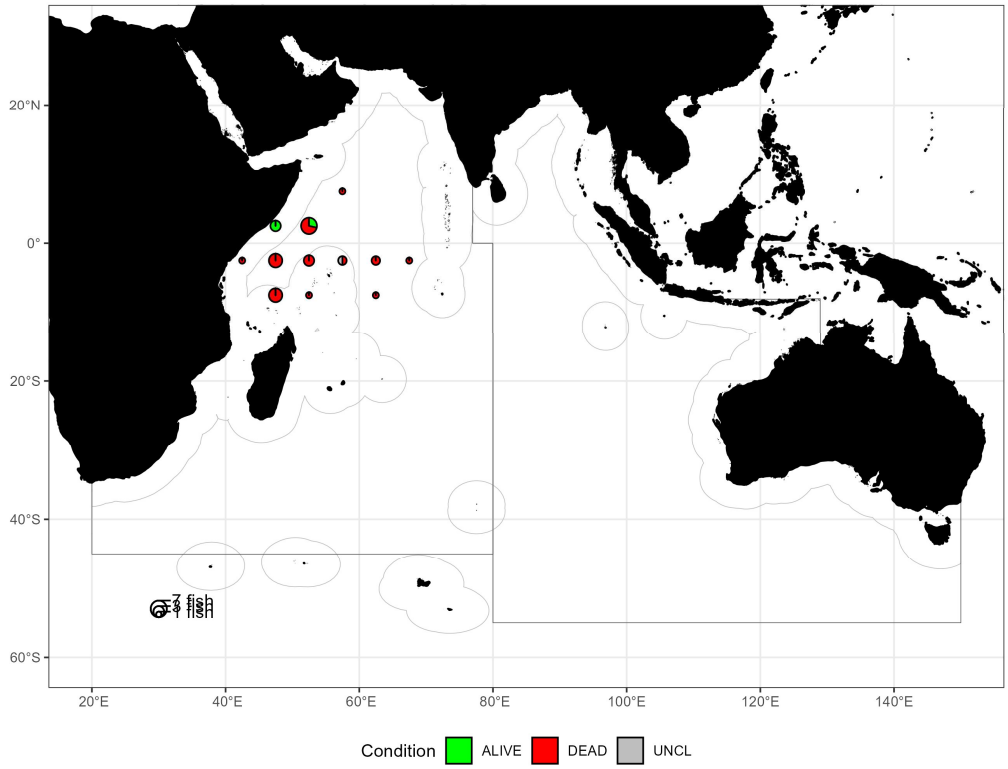

Figure 11: Distribution of swordfish discarded at sea in the western Indian Ocean purse seine fisheries with information on condition at release as available in the ROS regional database

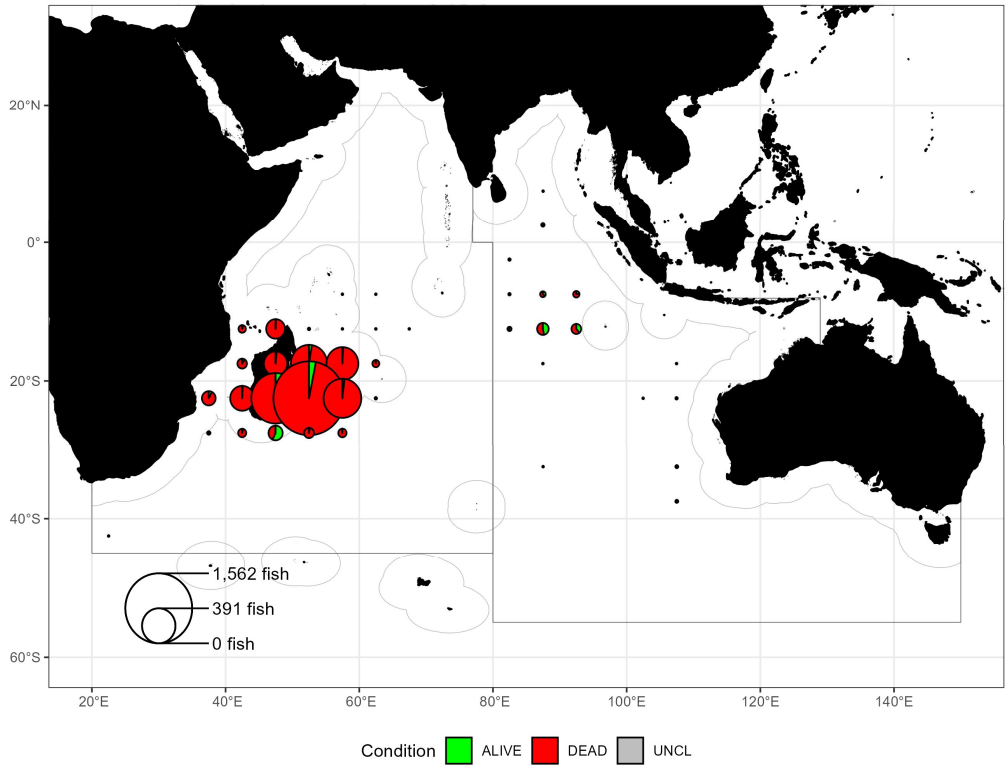

Figure 12: Distribution of swordfish discarded at sea in the Indian Ocean longline fisheries with information on condition at release as available in the ROS regional database

Geo-referenced catch

Spatial distribution of catches

Geo-referenced catches by fishery and decade (1950-2009)

Geo-referenced catches show the spatial expansion and major changes that took place in the fisheries catching swordfish over the past decades (**Fig. 13**). Spatial catch data in weight (t) are available since the 1970s, while only catch in numbers are available at the beginning of the time series. **Fig. 13** shows the expansion of the deep-freezing longline fisheries catching swordfish around South African waters and in the northwestern Indian Ocean from the 1990s. Significant catches were reported from gillnet fisheries in Sri Lankan waters throughout the 1990s and 2000s. Longline fisheries that caught swordfish from the 2000s in the south Indian Ocean changed to other types of longliners, switching their target species and moving operations mainly towards the north Indian Ocean.

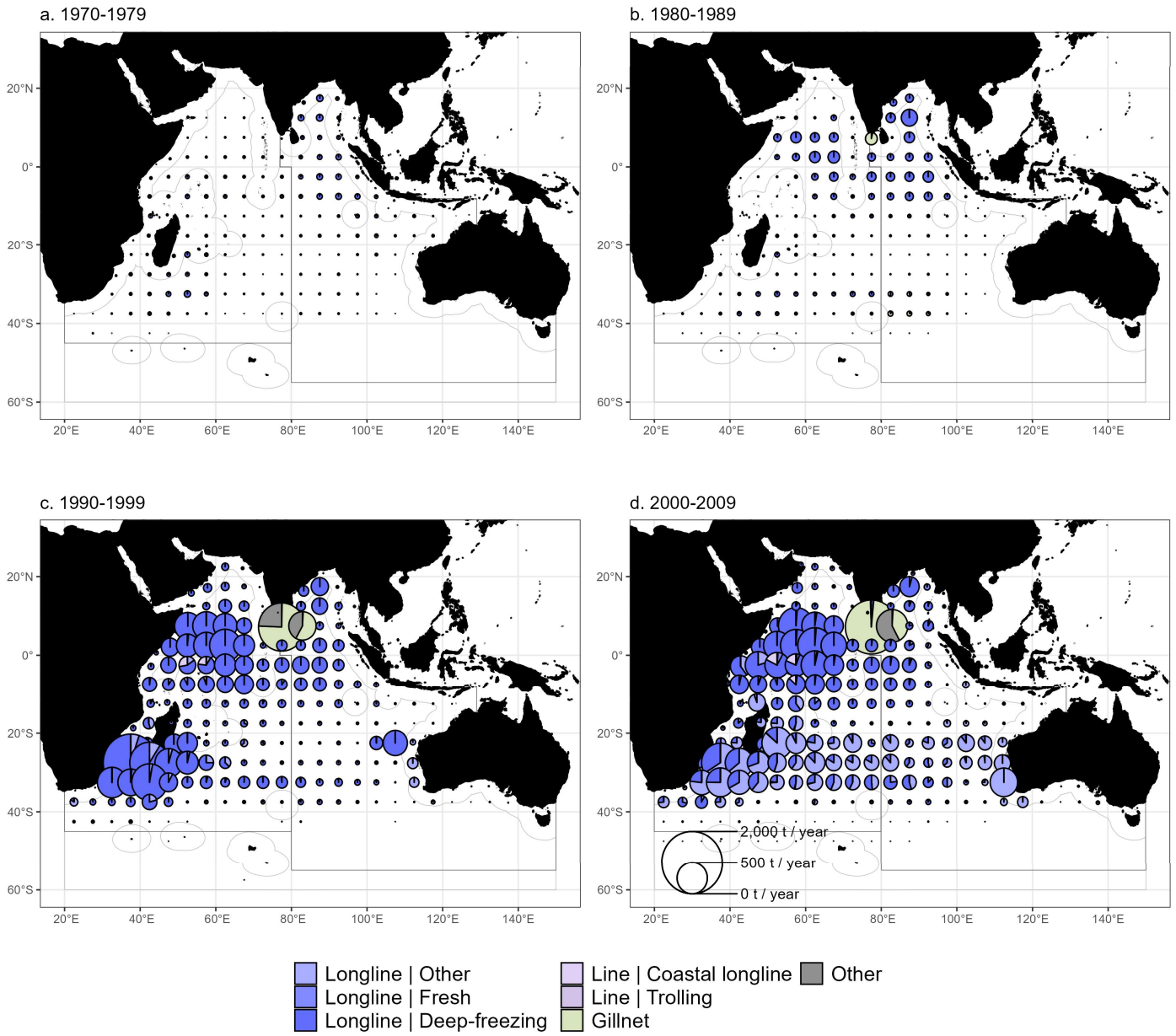

Figure 13: Mean annual time-area catches in weight (metric tonnes; t) of swordfish, by decade, 5x5 grid, and fishery. Data source: time-area catches

Geo-referenced catch data in number show that the distribution of swordfish catches from longline fisheries spans over the whole Indian Ocean since the 1970s (**Fig. 14**). Catches substantially increased from the 1980s with higher levels reported for the north Indian Ocean. The increased number of Taiwanese and Japanese deep-freezing longline vessels operating around South Africa in the 1990s increased the catches of swordfish in the southwestern Indian

Ocean. Throughout the 2000s, a different longline fishing method, specifically targeting swordfish, was found to occur more frequently in the south Indian Ocean.

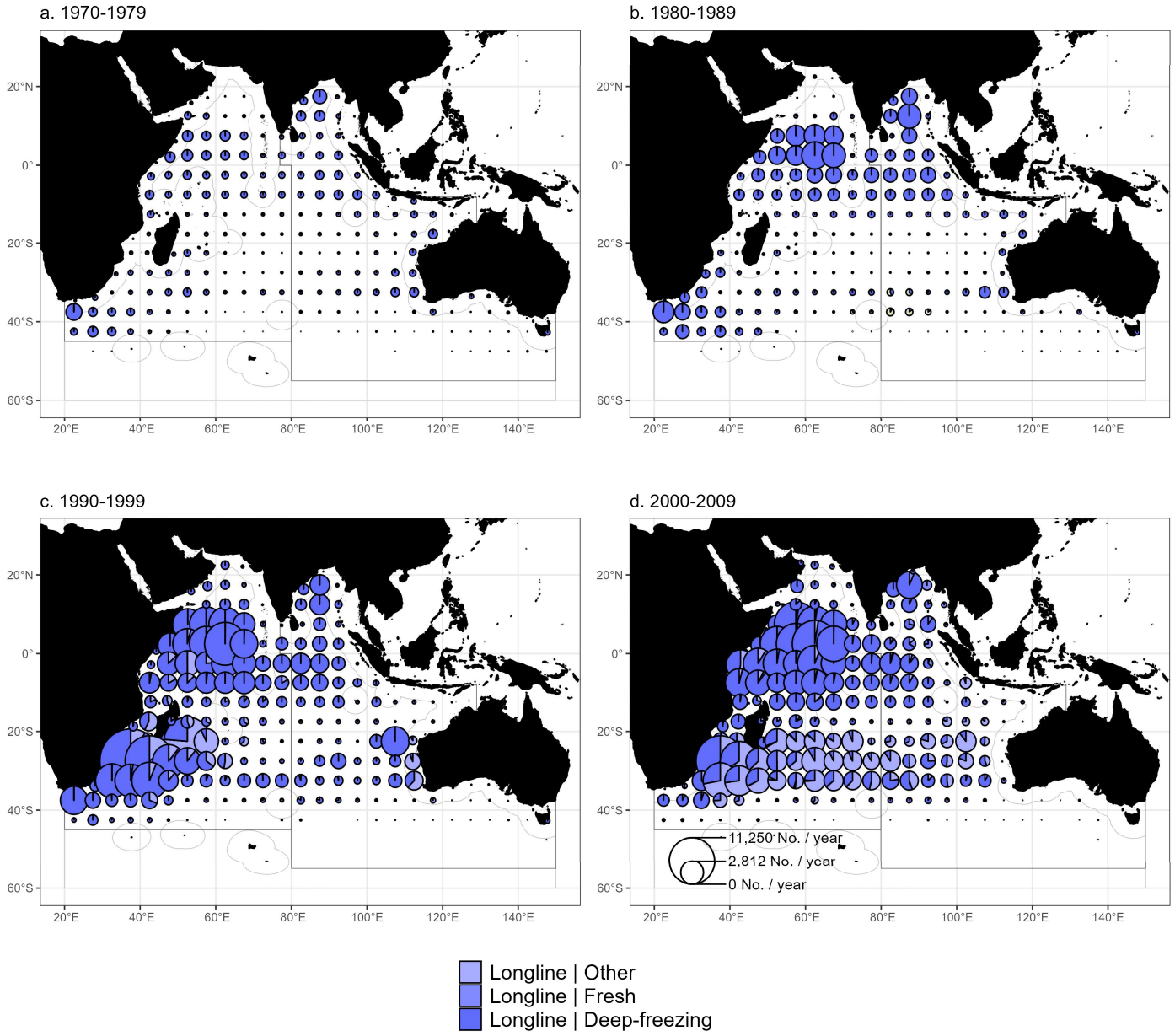

Figure 14: Mean annual time-area catches in numbers of swordfish, by decade, 5x5 grid, and fishery. Data source: time-area catches

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

During the last five years, the annual distribution of swordfish catch in weight showed some variability, with coastal longline catches increasing in the north Indian Ocean, mostly around Sri Lanka. Geo-referenced data also show some important catches from purse seine and gillnet fisheries distributed around the north Indian Ocean in recent years. The distribution patterns between 2019 and 2023 differ from the 2010s, with a continuous distribution in the south of the catches from longline fisheries (**Fig. 15**).

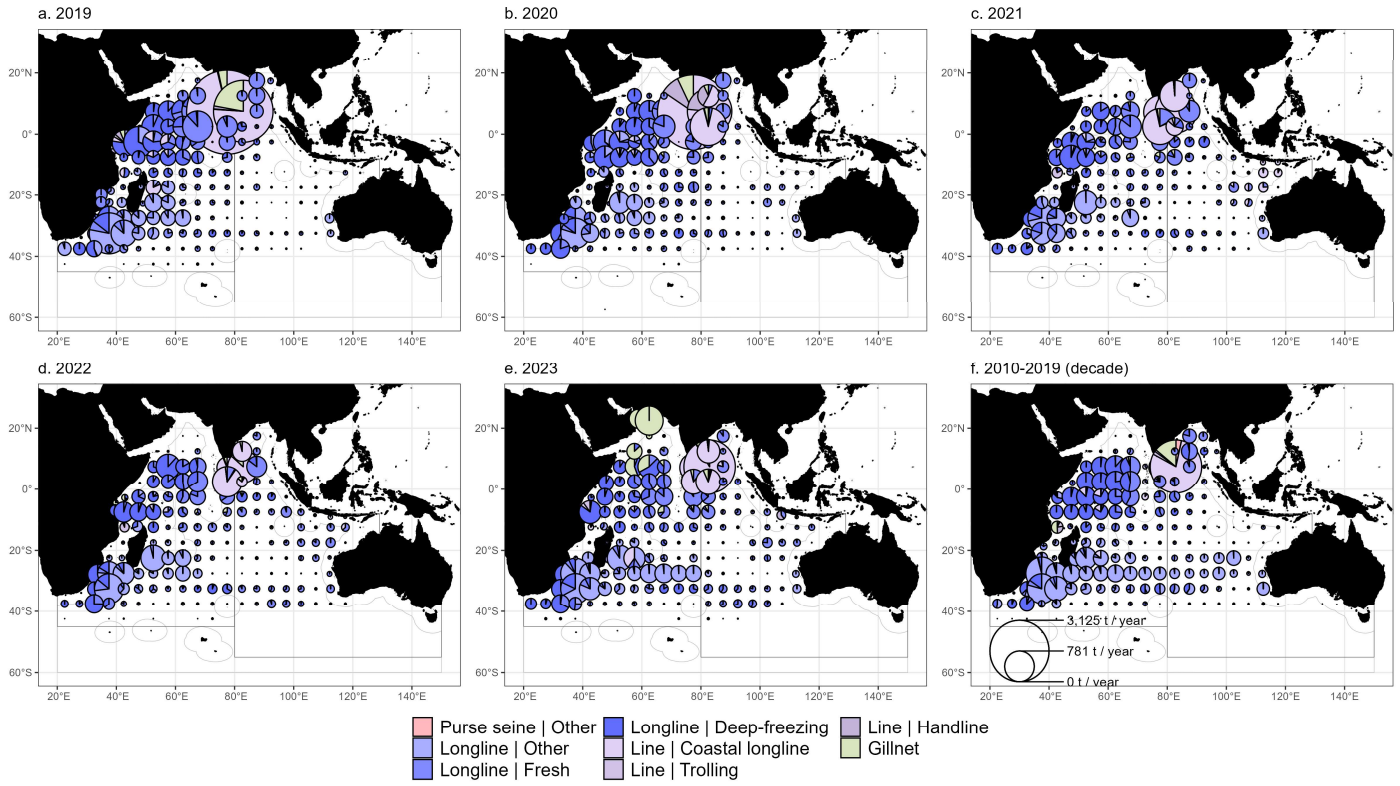

Figure 15: Mean annual time-area catches in weight (metric tonnes; t) of swordfish, by year / decade, 5x5 grid, and fishery. Data source: time-area catches

Contrary to the geo-referenced catch in weight, catches in numbers of fish are only available from longline fisheries in recent years. The distribution pattern indicates an increase in catch from 2017 from the fresh and other longline fisheries in the western Indian Ocean. Similar to the information provided through the catch in weight, less catches were reported from deep-freezing longline fisheries operating in the south, as compared to the distributions observed during previous decades (**Fig. 16**).

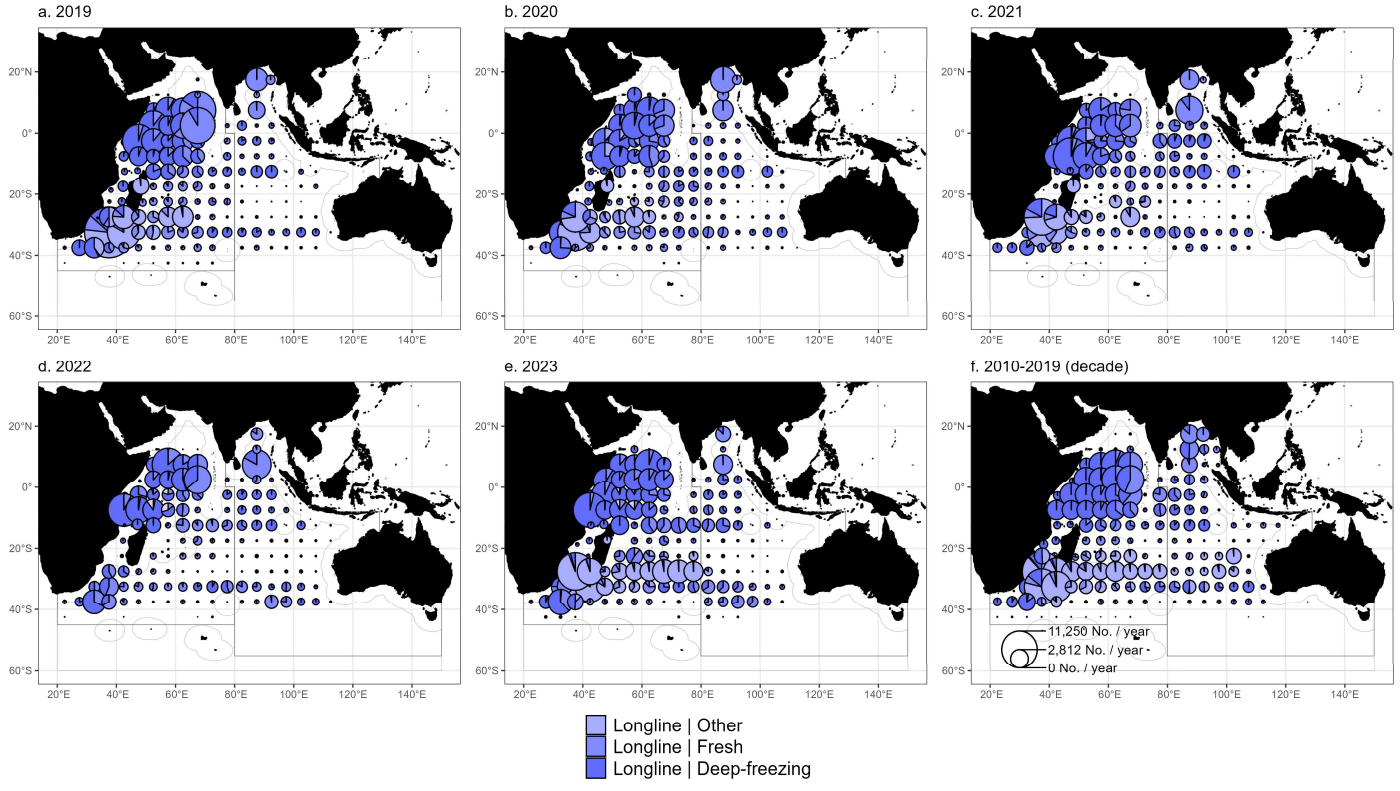

Figure 16: Mean annual time-area catches in numbers of swordfish, by year / decade, 5x5 grid, and fishery. Data source: time-area catches

Uncertainties in catch and effort data

Swordfish catch and effort data are available from the early 1950s and the quality was good as the species were mainly caught by industrial longline fisheries mostly described by good data collection and reporting systems. The overall quality started to deteriorate when other fisheries, particularly when smaller fisheries began targeting swordfish, which had limited capacity to submit catches, especially with spatial information. Hence, although some information on fishing effort became available, the reporting quality was found to be poor. Furthermore, some fisheries that were known to have catches of swordfish did not record geo-referenced catch and effort data.

The quality of geo-referenced catch and effort data improved from 2014, with improvement in the data collected by some coastal fisheries, particularly Sri Lanka, with significant catches of swordfish from coastal fisheries. Besides Sri Lanka, Indonesia submitted geo-referenced catch and effort, although with a low coverage (<30%). In recent years, spatial data with good quality (scoring 0-2) declined to as low as 62% in 2014 overall. Following the worsening in quality of the data received from industrial fisheries which targeted swordfish, between 2010 and 2015 to about 73%, and artisanal remaining low at around 13%. The quality improved to 87% in 2023 due to significant reports of geo-referenced data from coastal fisheries catching swordfish. However, as many fisheries are recovering from the effect of the COVID-19 pandemic, the rate of reporting geo-referenced data declined in 2022 to 65% overall, with the reporting quality of artisanal fisheries reduced to 31% (**Fig. 17**).

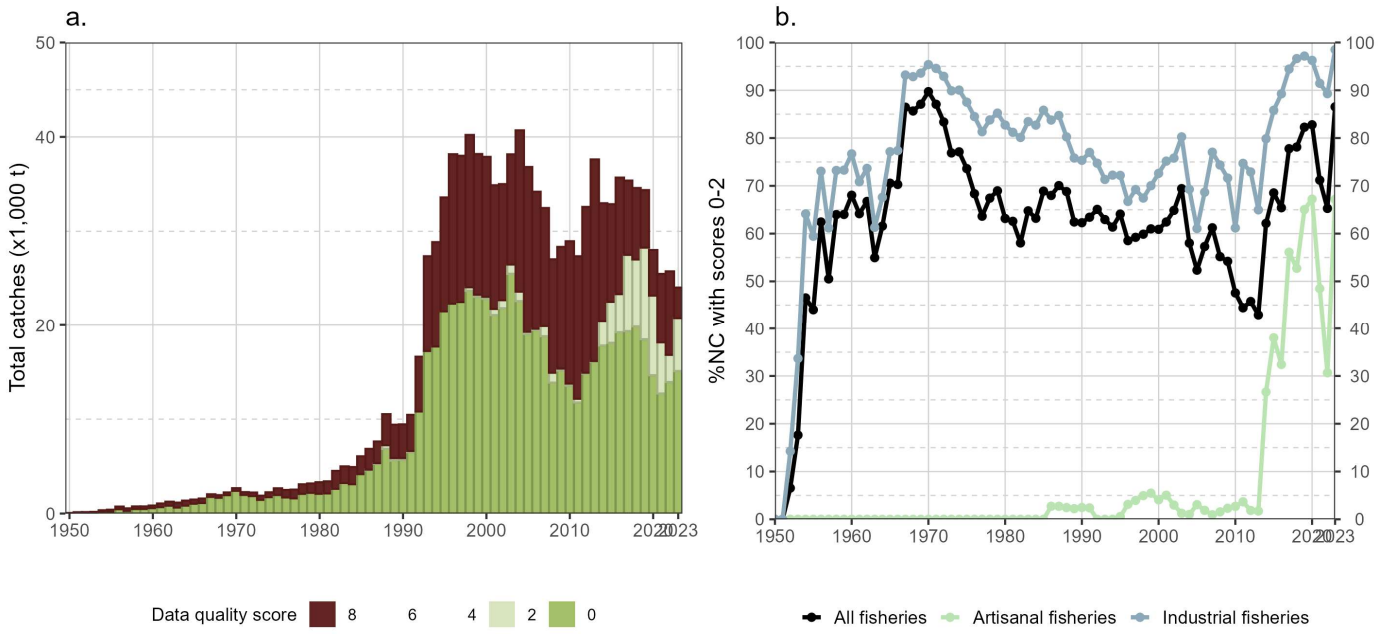

Figure 17: (a) Annual retained catches (metric tonnes; t) of swordfish estimated by quality score and (b) percentage of total retained catches for which geo-referenced catches were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950-2023

Size composition of the catch

Samples availability

The sample trend indicates that most swordfish samples collected are from longline fisheries, representing about 97.2% of all size samples available at the Secretariat, although with some variation in the trend. The peak of swordfish samples collected was in the mid-2000s with a substantial number from longline fisheries of EU-Spain, which target swordfish. However, in recent years, fewer samples of swordfish were reported for several reasons:

(i) less large longline vessels targeting swordfish operated in the Indian Ocean;

(ii) small longline vessels do not sample large quantities of fish;

(iii) inconsistencies in the coverage of small fisheries catching swordfish;

(iv) smaller fishing vessels catching swordfish do not have observers on-board.

The total number of swordfish sampled reached a lower peak in recent years at 27,961 in 2020, reflecting the impact of the CoViD-19 pandemic leading to (i) less data collected, (ii) no observers on board vessels, and (iii) minimum fishing activities. Besides longline fisheries, swordfish samples are also collected from gillnet and line fisheries (**Fig. 18**).

By fishery group

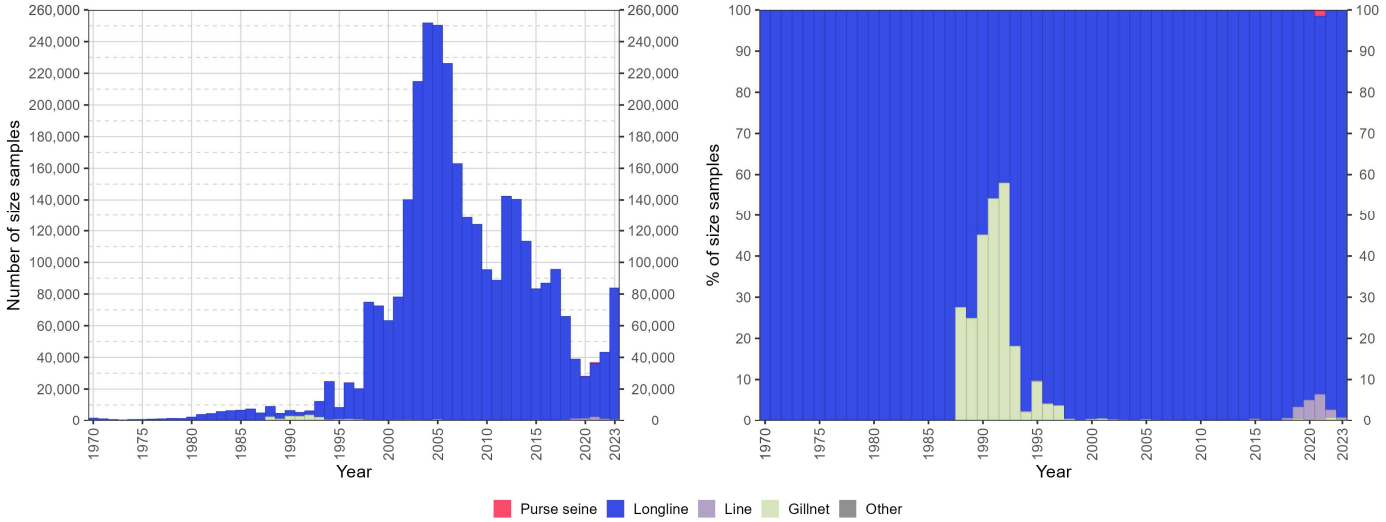

Figure 18: Availability of swordfish size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset

Samples distribution

The distributions of swordfish samples by fisheries indicate that samples from longline fisheries are coming from across all the Indian Ocean, with high concentrations in the southwest Indian Ocean around southern African waters, northern Indian Ocean, Somalian waters, and western Australia (**Fig. 19**).

Limited samples are available from line and gillnet fisheries. Swordfish caught from gillnet fisheries are low compared to longline and line fisheries, which are also reflected in the level of samples collected from gillnet fisheries. Samples from gillnet fisheries are distributed around the northern Indian Ocean, as only Sri Lanka reported size-frequency data of swordfish from gillnet fisheries in recent years (**Fig. 20**). Distributions of swordfish samples collected from line fisheries are high around the coasts of Sri Lanka and Indonesia, and less in Western Indian Ocean (**Fig. 21**). Purse seine fisheries, contrary to other fisheries, are not sampling swordfish, although there are evident from observers' data that swordfish interacted in purse seine fisheries. In 2021, however, Tanzania measured some swordfish from its coastal purse seine fisheries (**Fig. 22**).

Longline fisheries

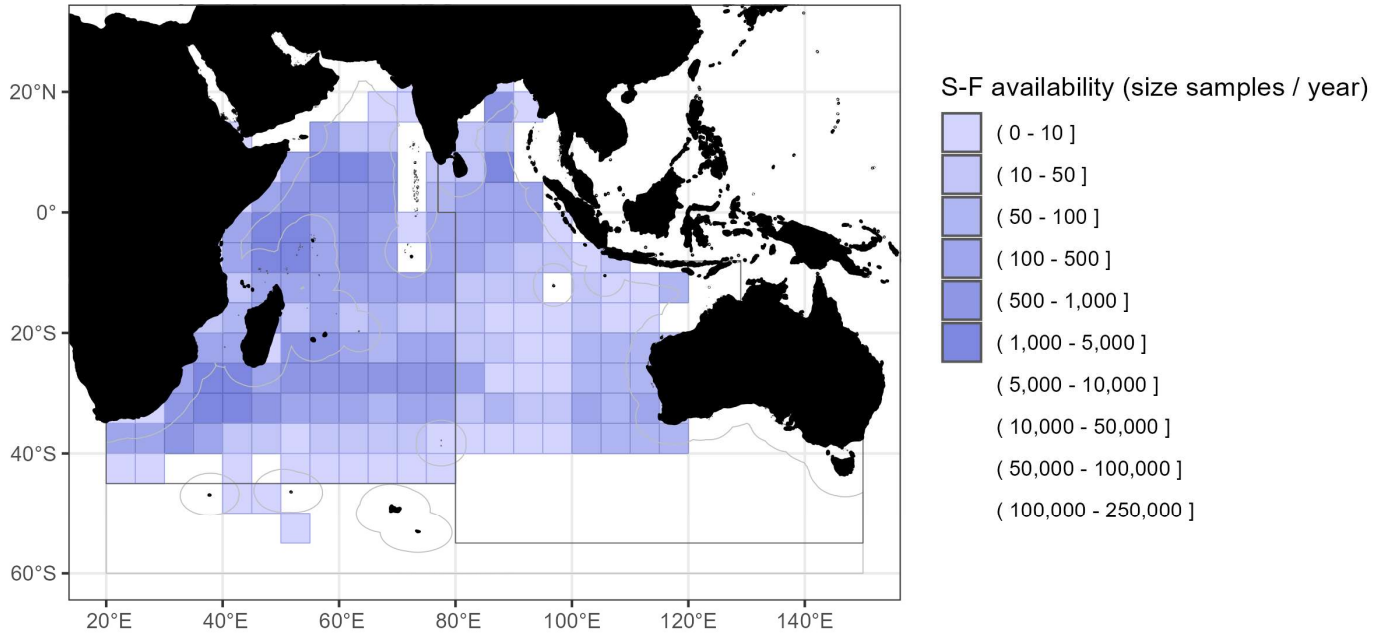

Figure 19: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for longline fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Gillnet fisheries

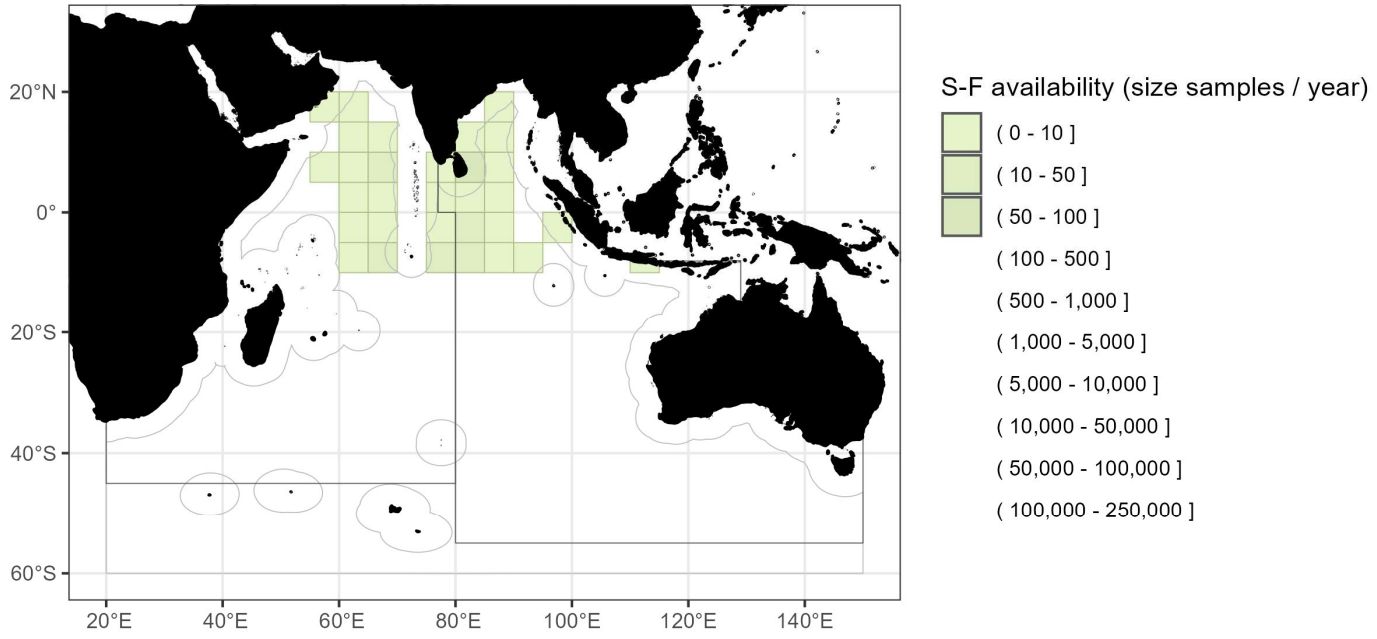

Figure 20: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for gillnet fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Line fisheries

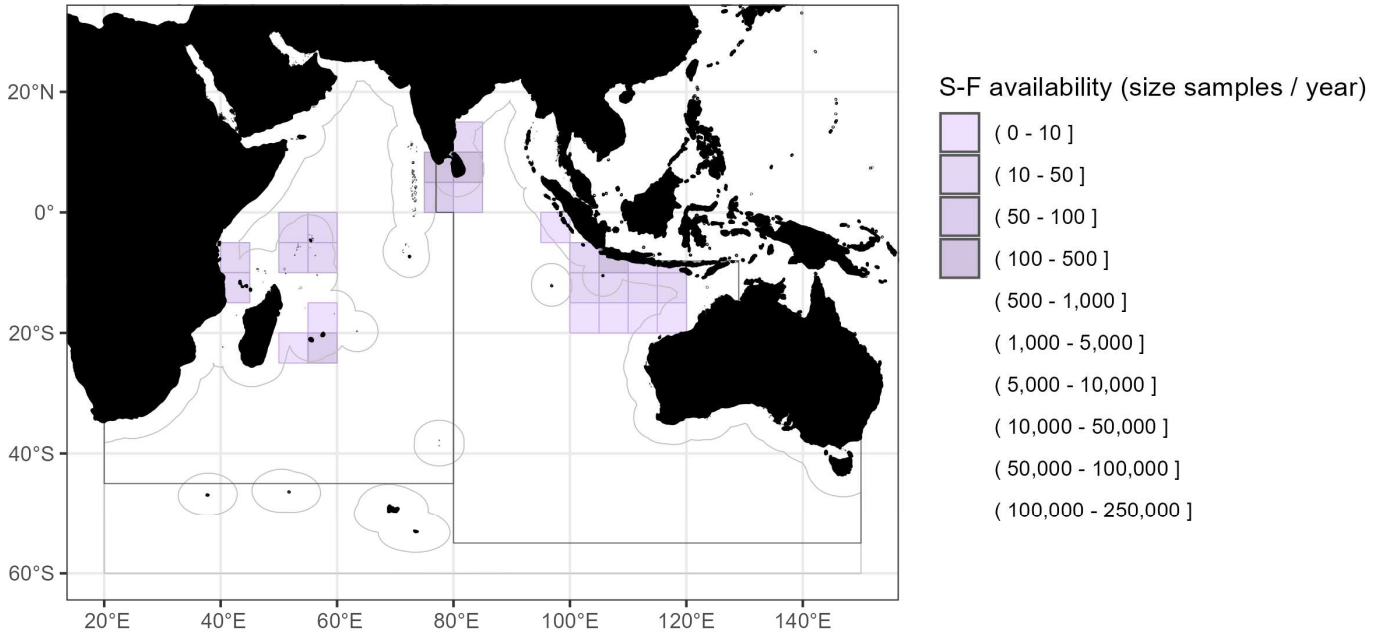

Figure 21: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for line fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Purse seine fisheries

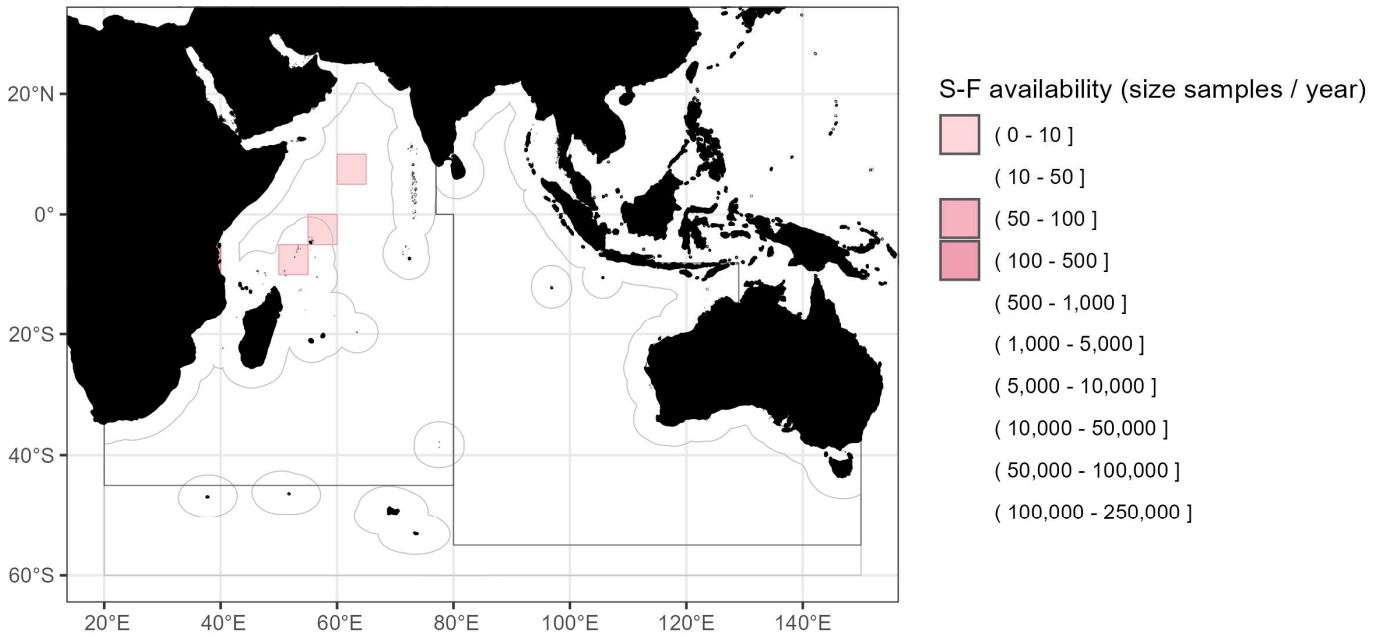

Figure 22: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for purse seine fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

By fishery

Spatial distribution and availability of swordfish samples by fishery types denote the shift of number of samples collected by deep-freezing longliners in the past to more samples from other longline fisheries in recent years (**Fig. 24**). Samples taken by deep-freezing longline vessels are mainly distributed in the western Indian Ocean (**Fig. 25**), and likewise from fresh longine fishery, with further samples collected in eastern Sri Lanka (**Fig. 26**). Purse seine fisheries on free-swimming schools and schools associated with drifting floating objects recorded samples of swordfish in the western Indian Ocean (**Figs. 29- 30**). Line fisheries with increased catch of swordfish in recent years, samples collected by coastal longline fisherise are distributed around Indonesia, Sri Lanaka, and small island fisheries in western Indian, i.e., Mauritius, Seychelles, and Reunion island (**Fig. 32**), around Mozambique, Tanzania and Indonesia by handline fisheries (**Fig. 33**), and collected by trolling fisheries in Comoros (**Fig. 34**).

Gillnet fisheries

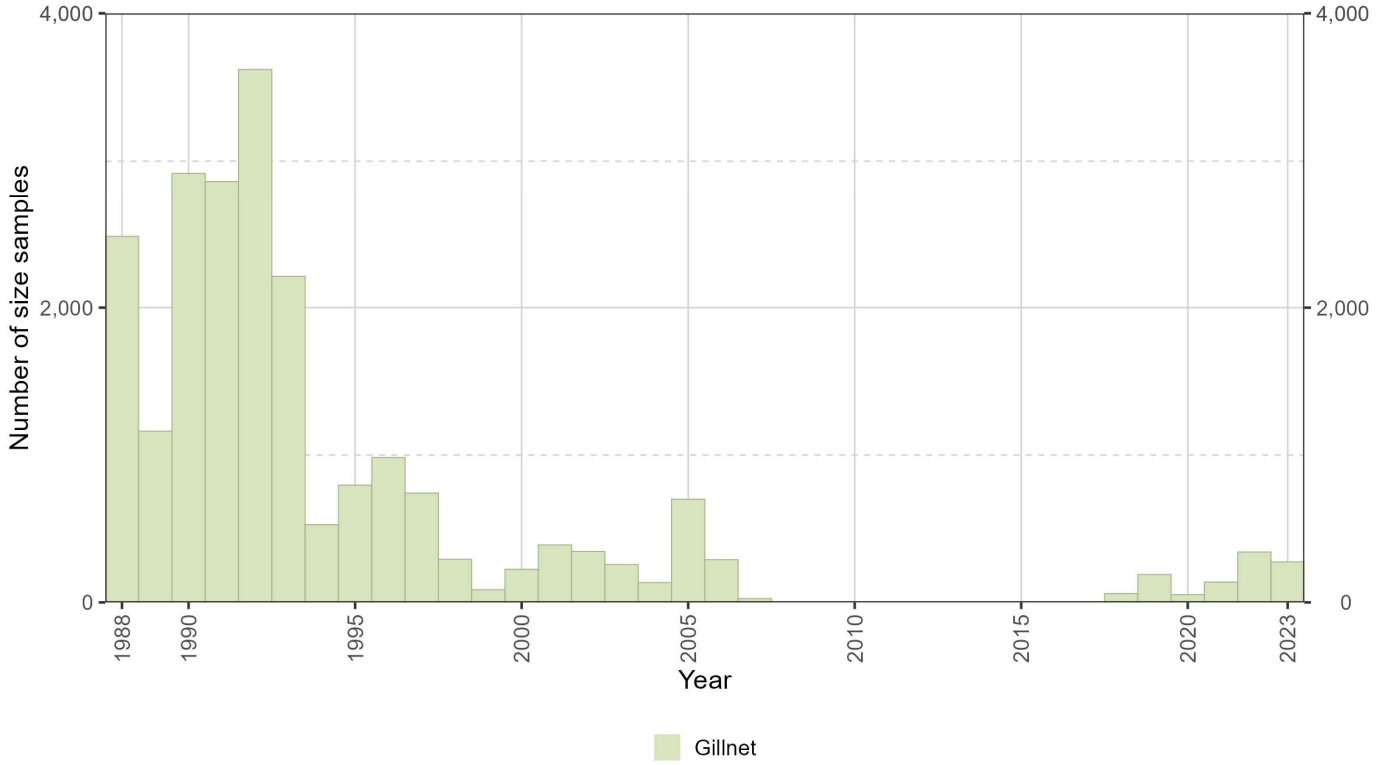

Figure 23: Availability of swordfish size-frequency data as absolute number of samples per year in gillnet fisheries. Data source: standardized size-frequency dataset

Longline fisheries

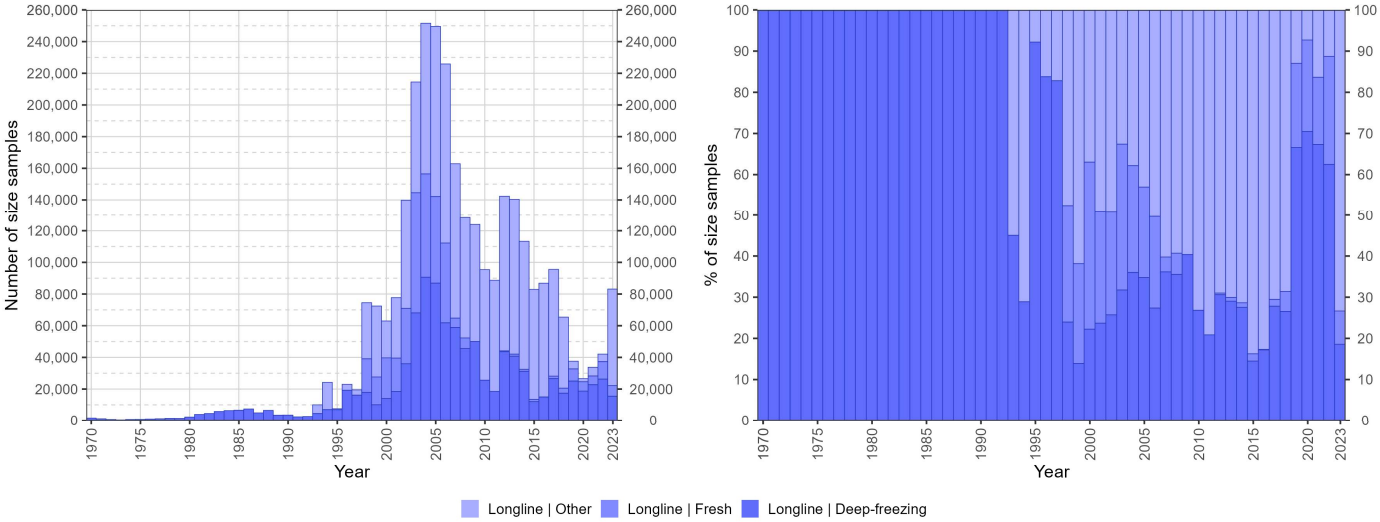

Figure 24: Availability of swordfish size-frequency data as absolute number of samples per year and longline fishery. Data source: standardized size-frequency dataset

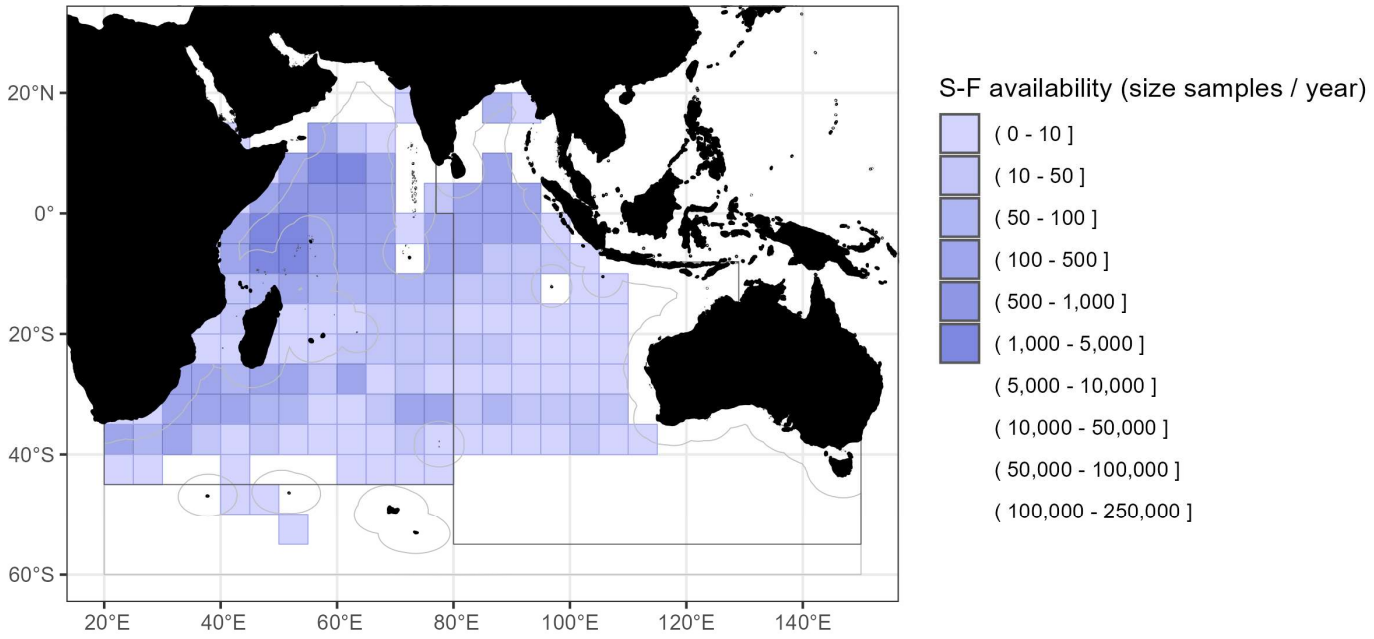

Figure 25: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for deep-freezing longline fisheries (LLD) in the period 2019-2023. Data source: standardized size-frequency dataset

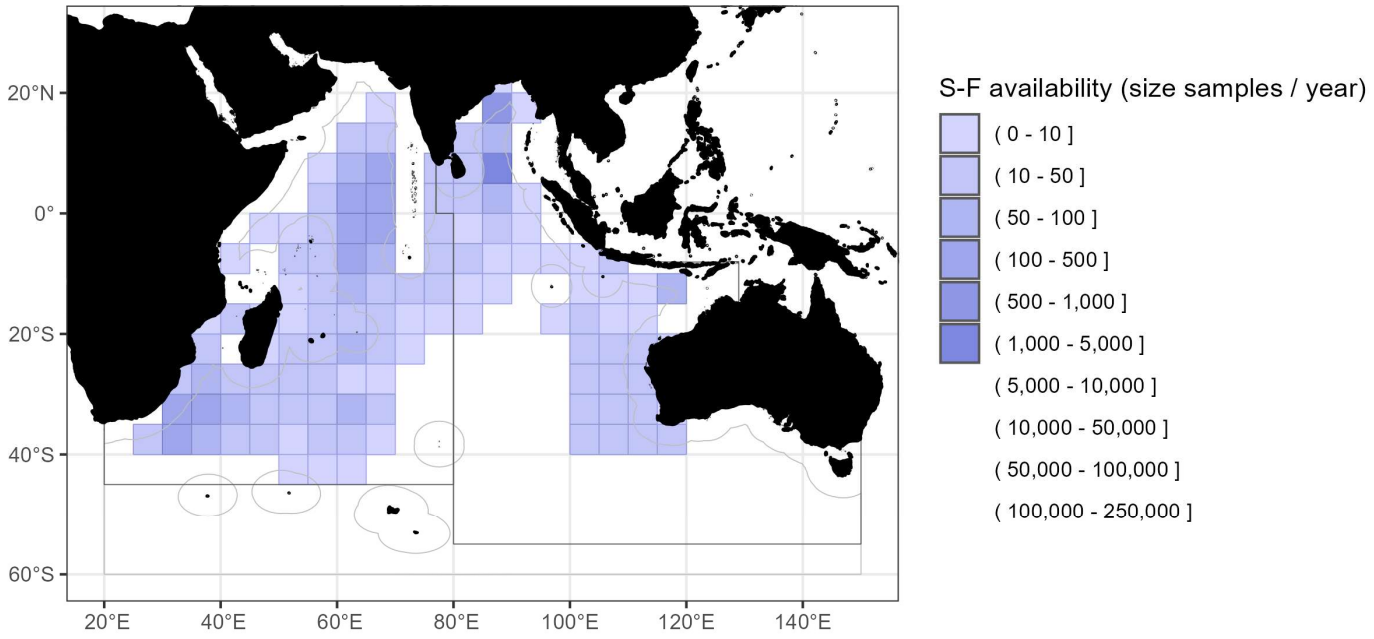

Figure 26: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for fresh longline fisheries (LLF) in the period 2019-2023. Data source: standardized size-frequency dataset

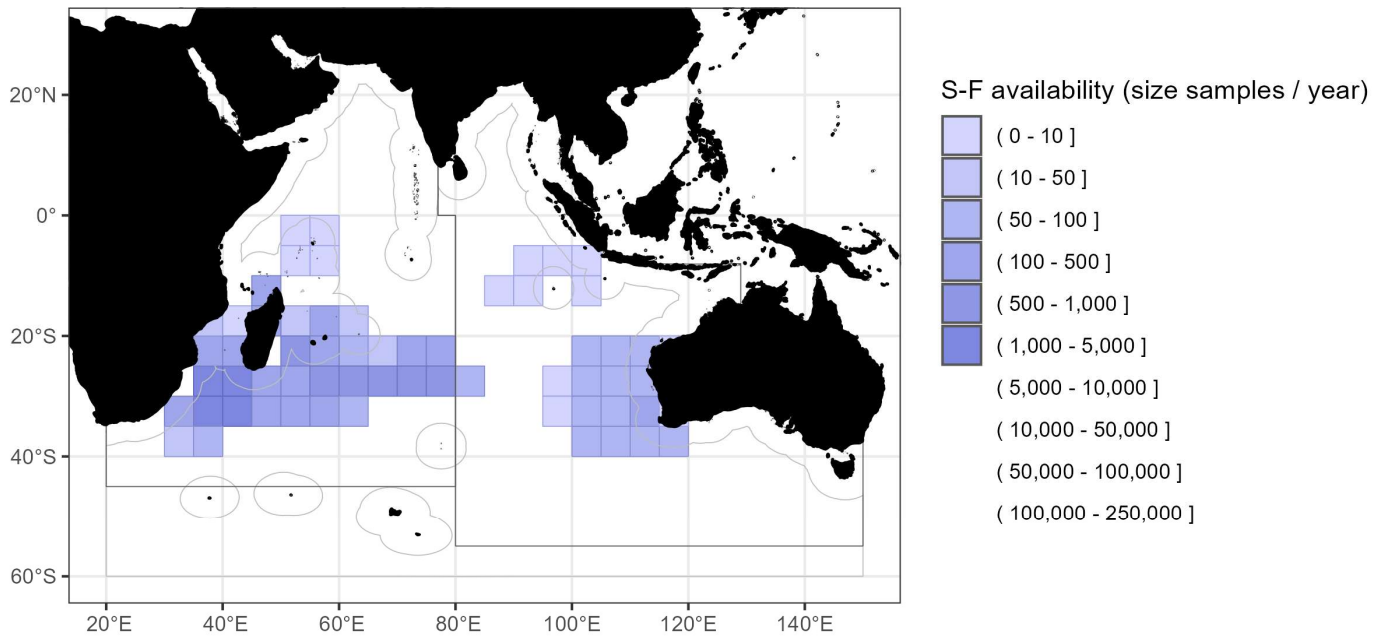

Figure 27: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data for swordfish and shark-targeted longline fisheries (LLO) in the period 2019-2023. Data source: standardized size-frequency dataset

Purse seine fisheries

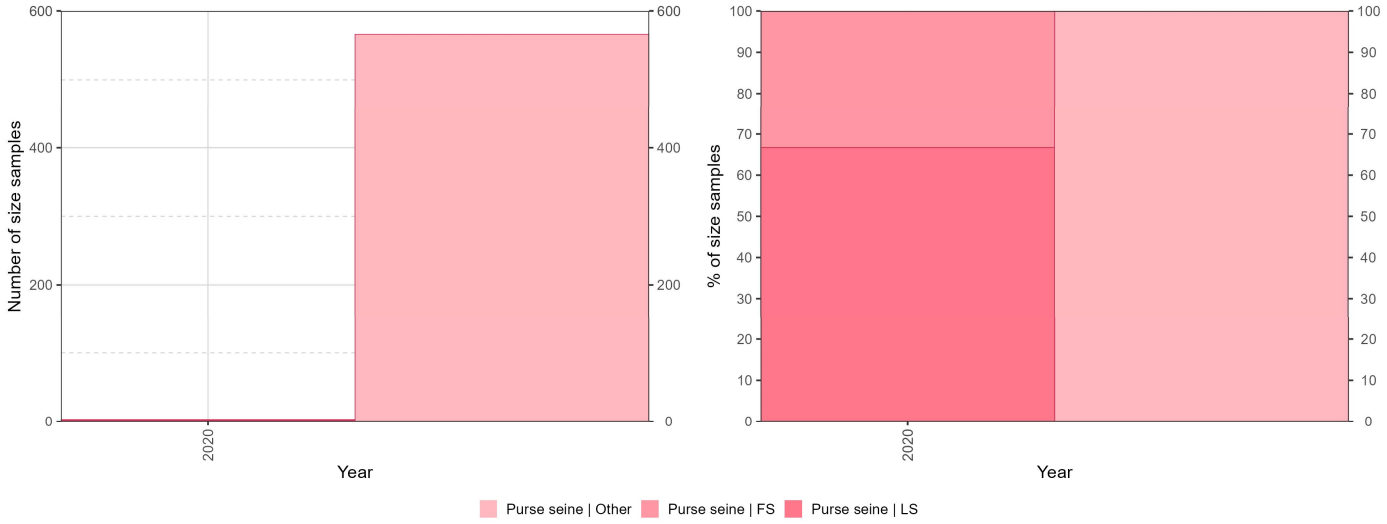

Figure 28: Availability of swordfish size-frequency data as absolute number of samples per year and purse seine fishery. FS = free-school; LS = school associated with drifting floating object. Data source: standardized size-frequency dataset

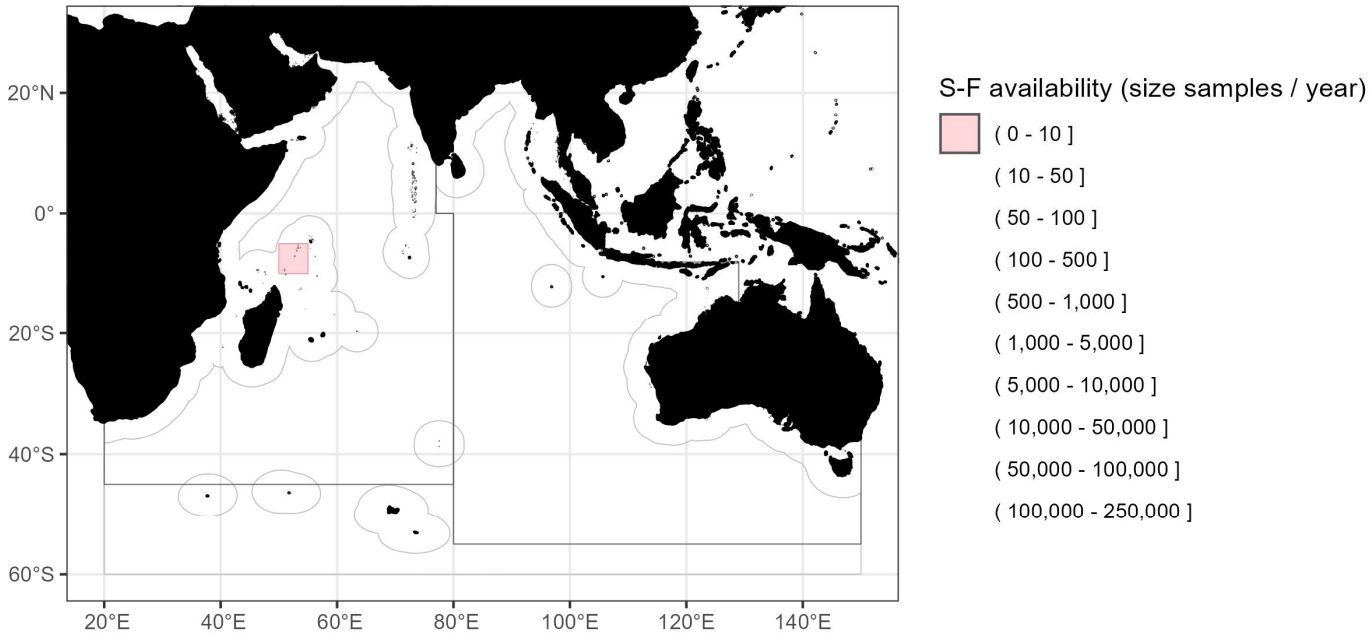

Figure 29: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data by purse seine fisheries on free-swimming schools (PSFS) in the period 2019-2023. Data source: standardized size-frequency dataset

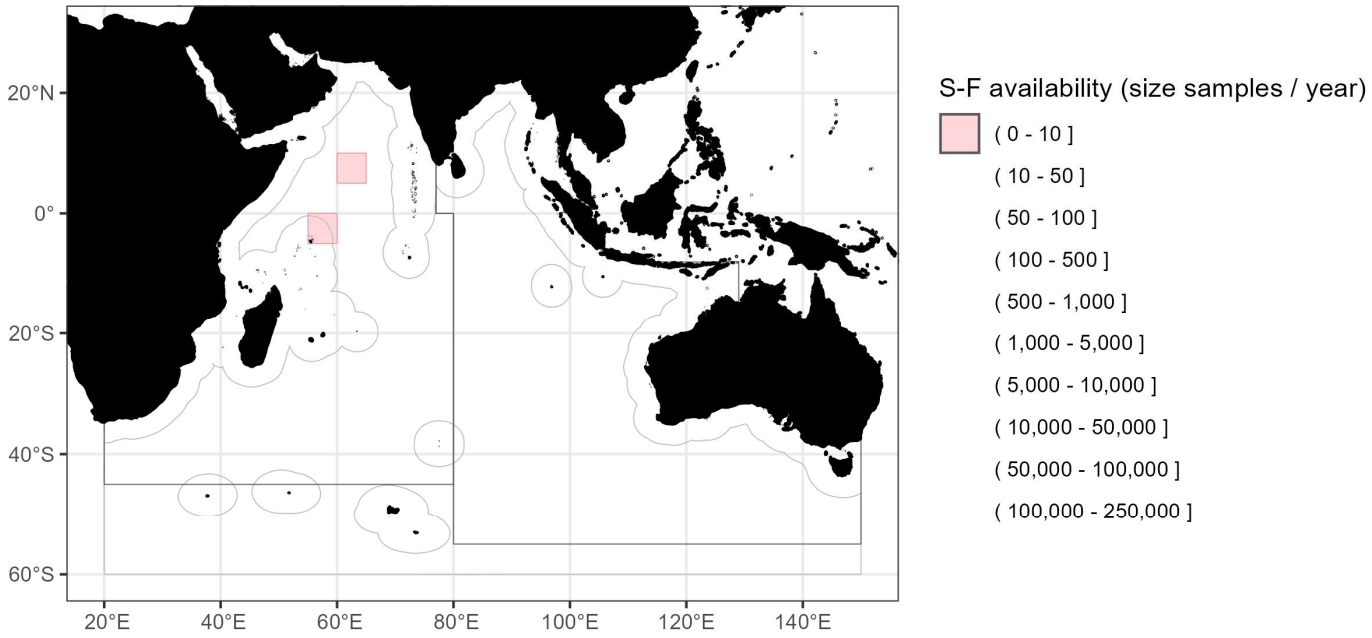

Figure 30: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data by purse seine fisheries on schools associated with drifting floating objects (PSLS) in the period 2019-2023. Data source: standardized size-frequency dataset

Line fisheries

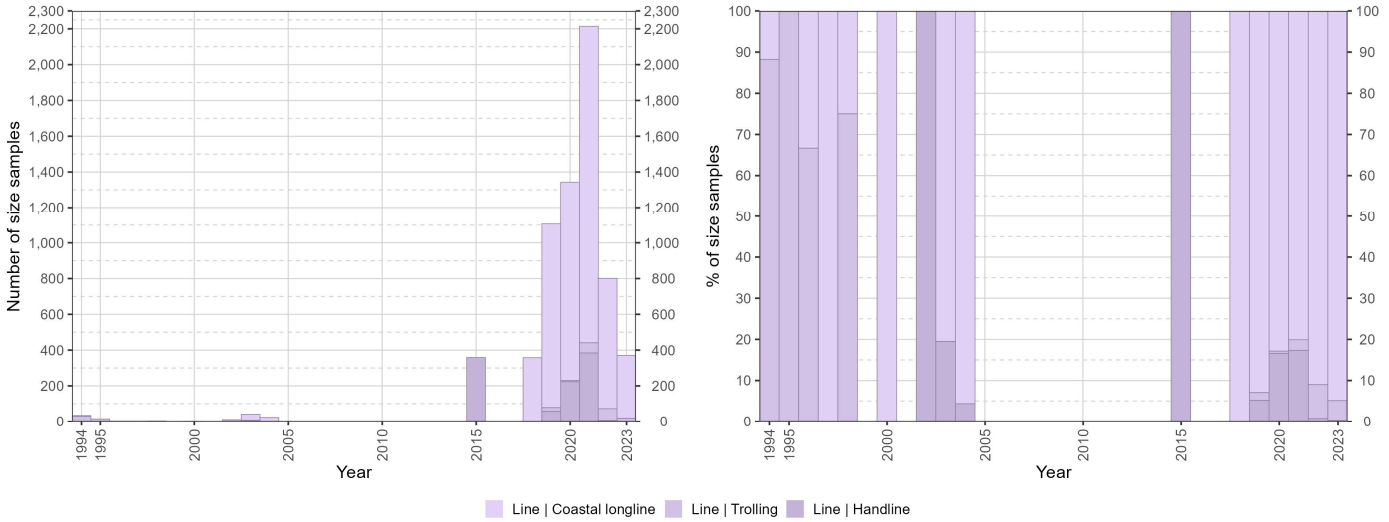

Figure 31: Availability of swordfish size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and type of line fishery. Data source: standardized size-frequency dataset

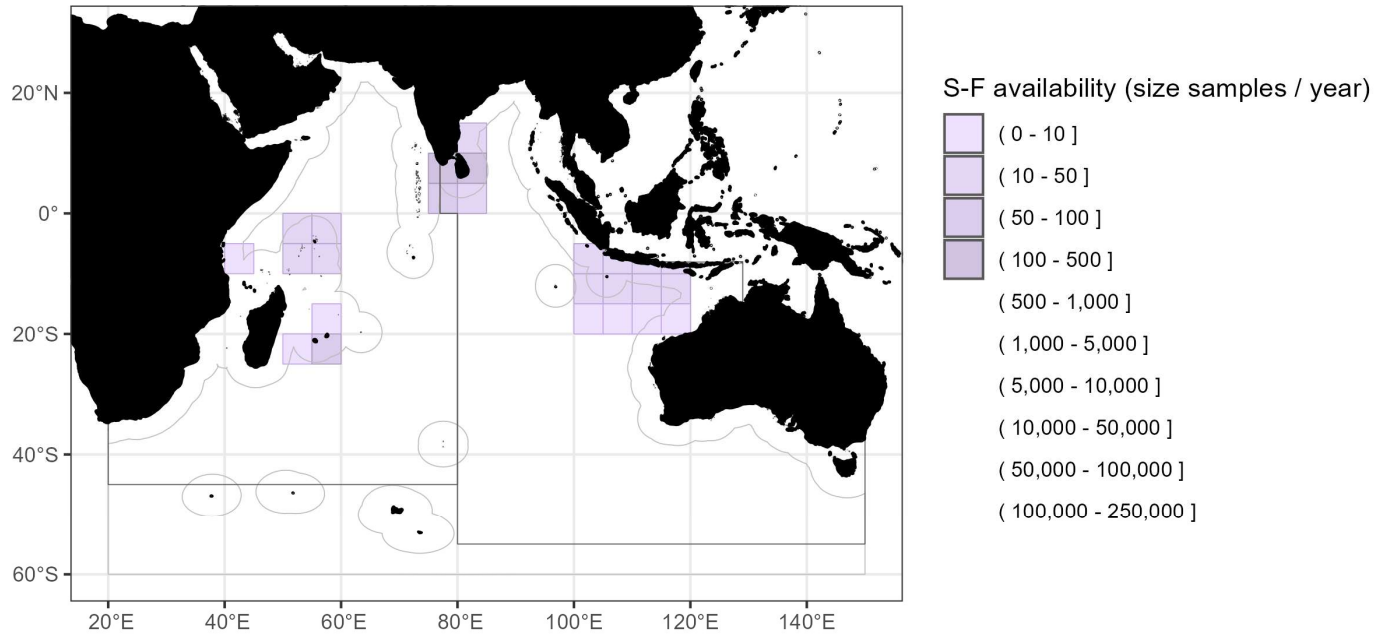

Figure 32: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data by line (coastal longline) fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

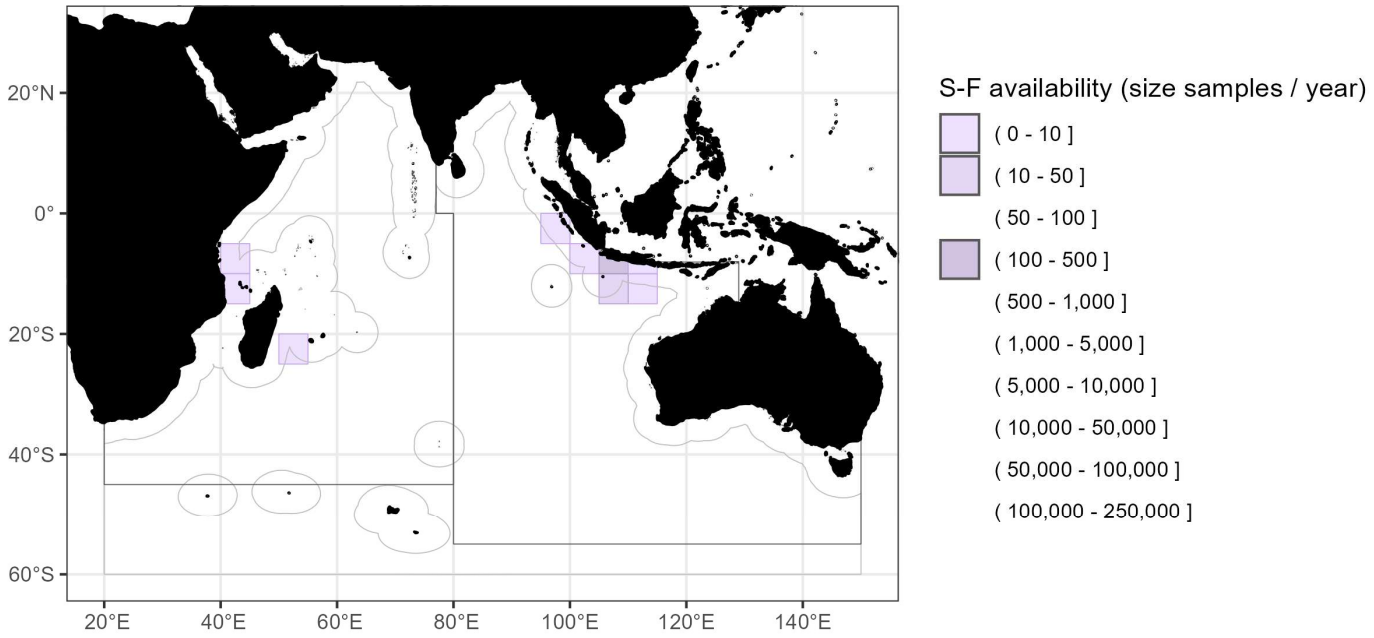

Figure 33: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data by line (handline) fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

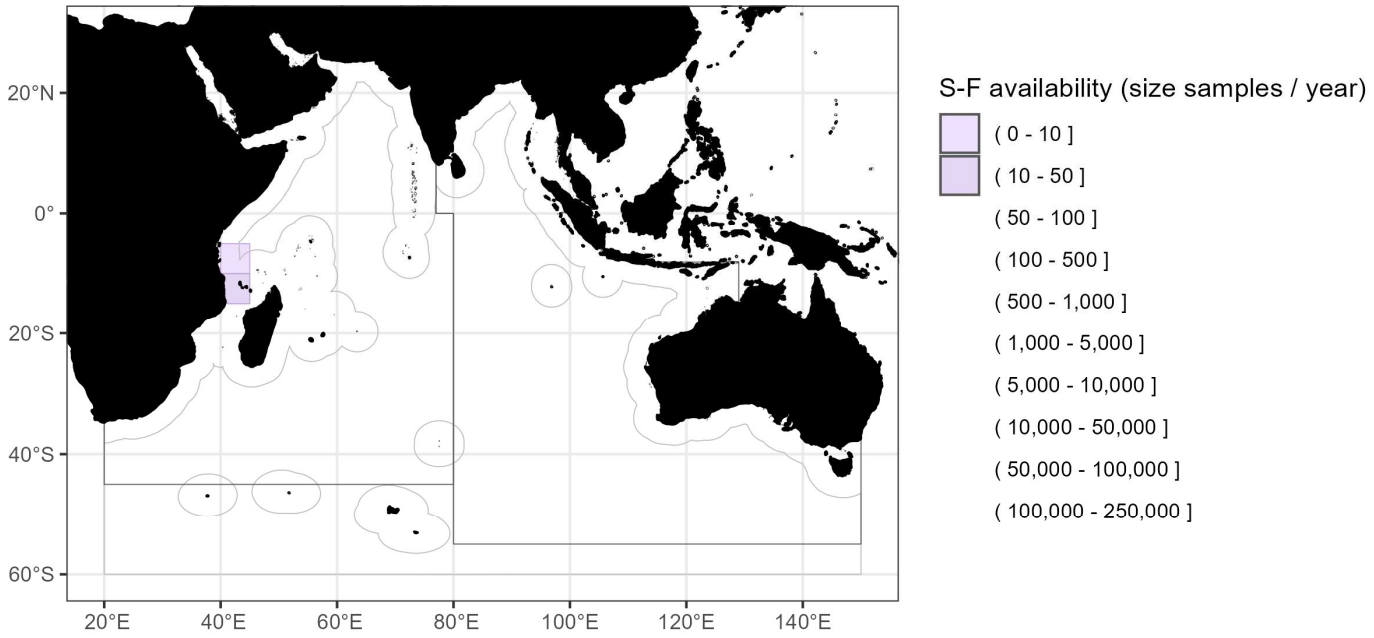

Figure 34: Spatial distribution (average number of samples per grid per year) of available swordfish size-frequency data by line (trolling) fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Other fisheries

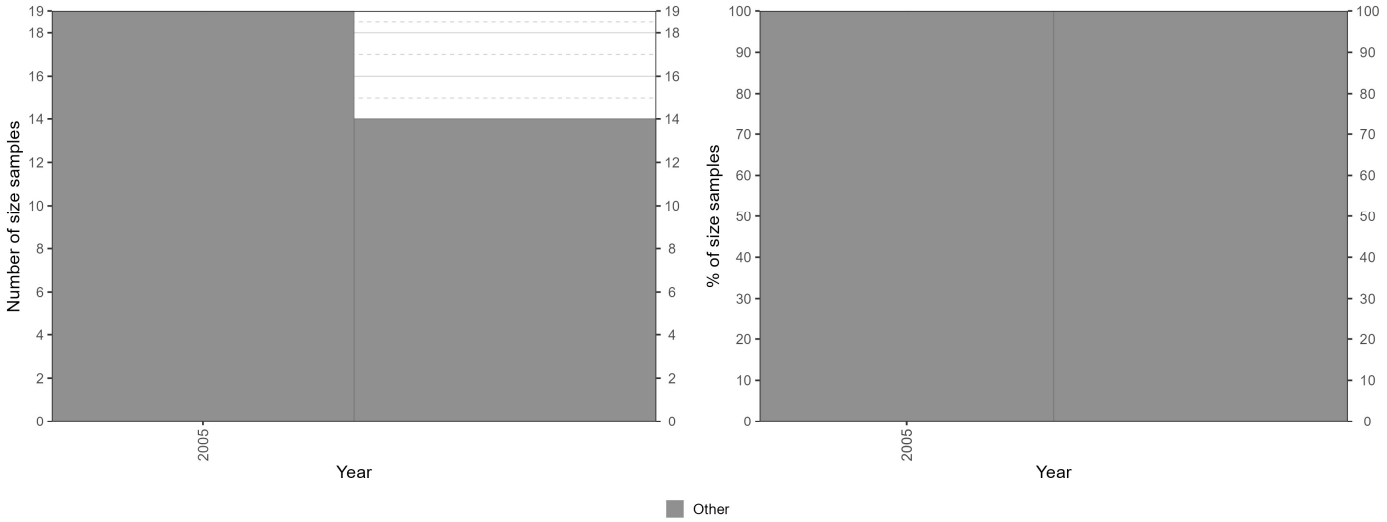

Figure 35: Availability of swordfish size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and 'other' fishery type. Data source: standardized size-frequency dataset

Temporal patterns and trends in size distributions

The samples collected indicate variation in sizes by fisheries and over time. Temporal patterns indicate that samples from longline fisheries are around 100 to 200 cm, with high frequency distribution around of 150 cm for all longline fisheries. The patterns for line and gillnet differ from longline fisheries and do not have a consistent frequency. In the past, samples collected from line had high frequency around 90 and 150 cm, however in recent years, the median values varied between 100 and 200 cm. Like line fisheries, gillnet fisheries size-frequency distributions in recent years differ to the size-frequency distributions available prior to 2008. The median values of gillnet samples in recent years vary between 90 and 160 cm, while in the past they were between 100 and 150 cm (**Fig. 36**).

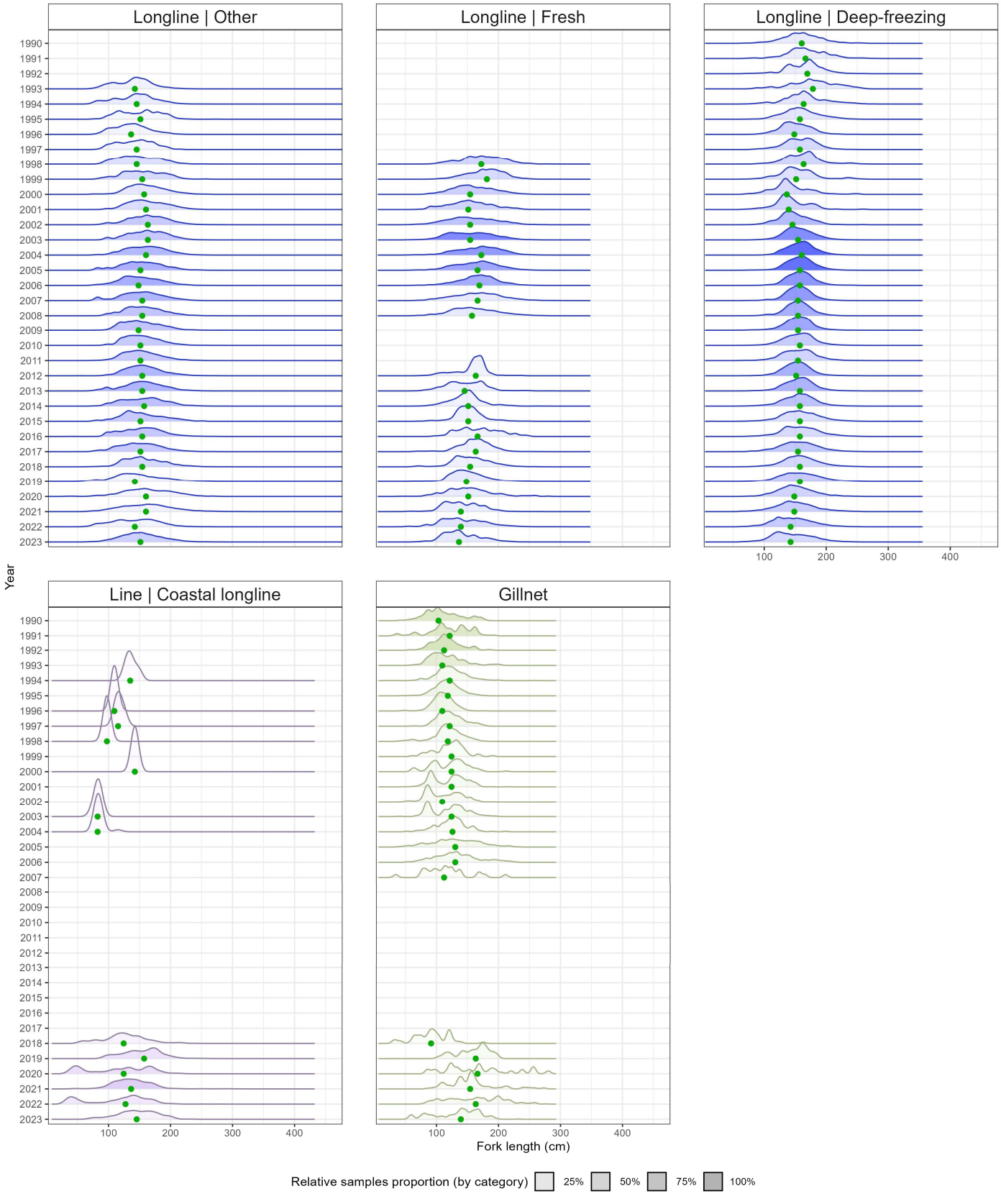

Figure 36: Relative size distribution (fork length; cm) of swordfish caught by longline and gillnet fisheries. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset

Size distribution by fishery and fleet

Fleet-wise, Taiwan,China and Japan deep-freezing longline fleets sampled swordfish since the early 1990s and had the same general distribution patterns. Most of the deep-freezing longline fisheries have size frequency distributions between 100 and 200 cm, besides the Korean deep-freezing longline fleet which measured some larger swordfish in recent years (over 300 cm) (**Fig. 37**).

The samples collected from fresh tuna longline fleets are fewer compared to deep-freezing longliners, and predominantly from Taiwan,China, Indonesia, and other non-identified fresh tuna longline fleets in the past. Recently, various other fresh tuna longline fleets have been sampling swordfish. Despite the differences between fleets, size distributions from fresh tuna longline fisheries remained between 100 and 200 cm. However, smaller swordfish samples were recorded from Seychelles and Malaysia fresh tuna longline fisheries, which measured around 15 cm (**Fig. 38**).

Fisheries that target swordfish and sharks sampled significant number of swordfish prior to 2018, and less in recent years (**Fig. 39**) . There are two types of longline fisheries targeting swordfish and sharks, the larger vessels operating on the high seas and smaller vessels operating in the EEZ. Despite the variation in operation, slight differences in the distribution patterns are observed. EU-Spain, which targeted swordfish using the American-style monofilament longline (García-Cortés & Mejuto 2005) reported raised size frequency of swordfish between the late 1990s and late 2010s, with a distribution pattern between 48 cm and 348 cm. The Spanish Institute of Oceanography (IEO), which conducted at-sea sampling program, suspended the program in 2020 due to COVID-19 pandemic and other administrative issues (Instituto Español de Oceanografía & Pesca 2022). EU-Reunion has stable swordfish fisheries compared to other small island nations with longline targeting swordfish. Hence, the size frequency distribution from EU-Reunion maintained some consistency in the sampling from the late 1990s to recent years, with distribution patterns ranging between 15cm and 345 cm, although some outliers in 2018 (around 400 cm). EU,Portugal on the contrary, collected sampling through observer programme from 2011.

Following some marketing problems for swordfish faced by Seychelles due to too high contents of cadmium and mercury, the semi-industrial longline fishery shifted toward targeting tunas recently. The sampling of swordfish from the Seychelles swordfish-longline fishery varies both in the number of samples collected and size distribution patterns over the years. Similar patterns have been observed from the semi-industrial longline fishery of Mauritius, which has stopped its operations in 2021. In the eastern Indian Ocean, Australia had a longline fishery targeting swordfish from 2000 to 2007. Thereafter, there were some variations in the sampling intensity, reflecting the reduction in swordfish catches from Australia due to a substantial decline in the number of longline vessels from 2005. The number of samples increased from 2015 with an average distribution range comprised between 60 cm and 303 cm in recent years.

Sampling of swordfish from gillnet fisheries are only collected by Sri Lanka (**Fig. 40**). Although the sampling program began in the 1990s, the distribution patterns and number of swordfish measured vary over time, possibly due to a combination of changes in the type of fishing gear and fishing grounds. Sri Lanka gillnet size frequency collected between 2018 and 2021 averaged at 110 fish per year. The size-frequency distribution patterns reported for 2020 and 2021 are between 75 cm and 330 cm, which differ with samples collected between 2018 and 2019 (30 cm and 330 cm). #### Deep-freezing longline fisheries

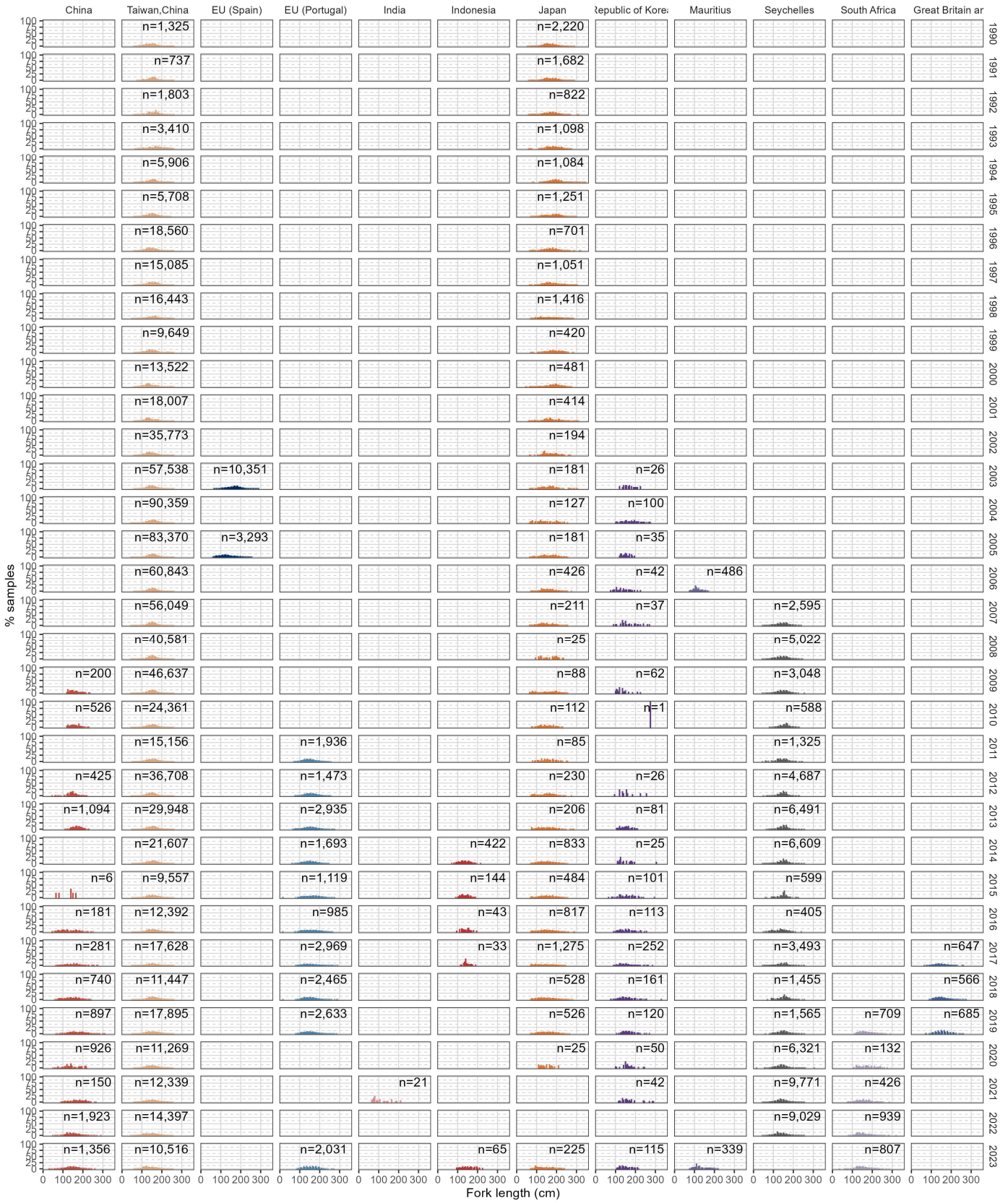

Figure 37: Relative size distribution of swordfish (fork length; cm) recorded for deep-freezing longline fisheries (LLD) by year and main fleet. Data source: [standardized size-frequency dataset]

Fresh longline fisheries

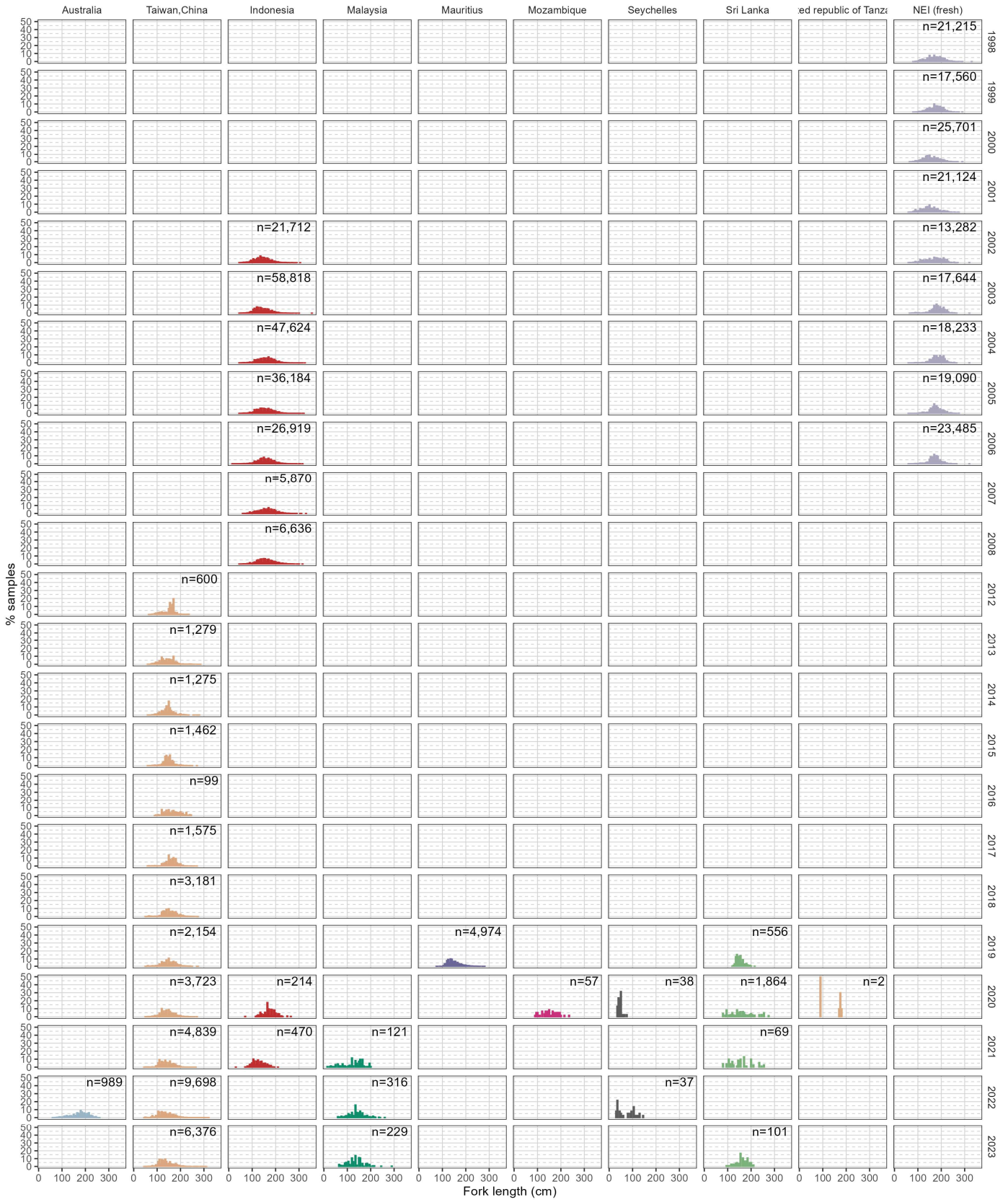

Figure 38: Relative size distribution of swordfish (fork length; cm) recorded for fresh longline fisheries (LLF) by year and main fleet. Data source: standardized size-frequency dataset

Swordfish and sharks-targeted longline fisheries

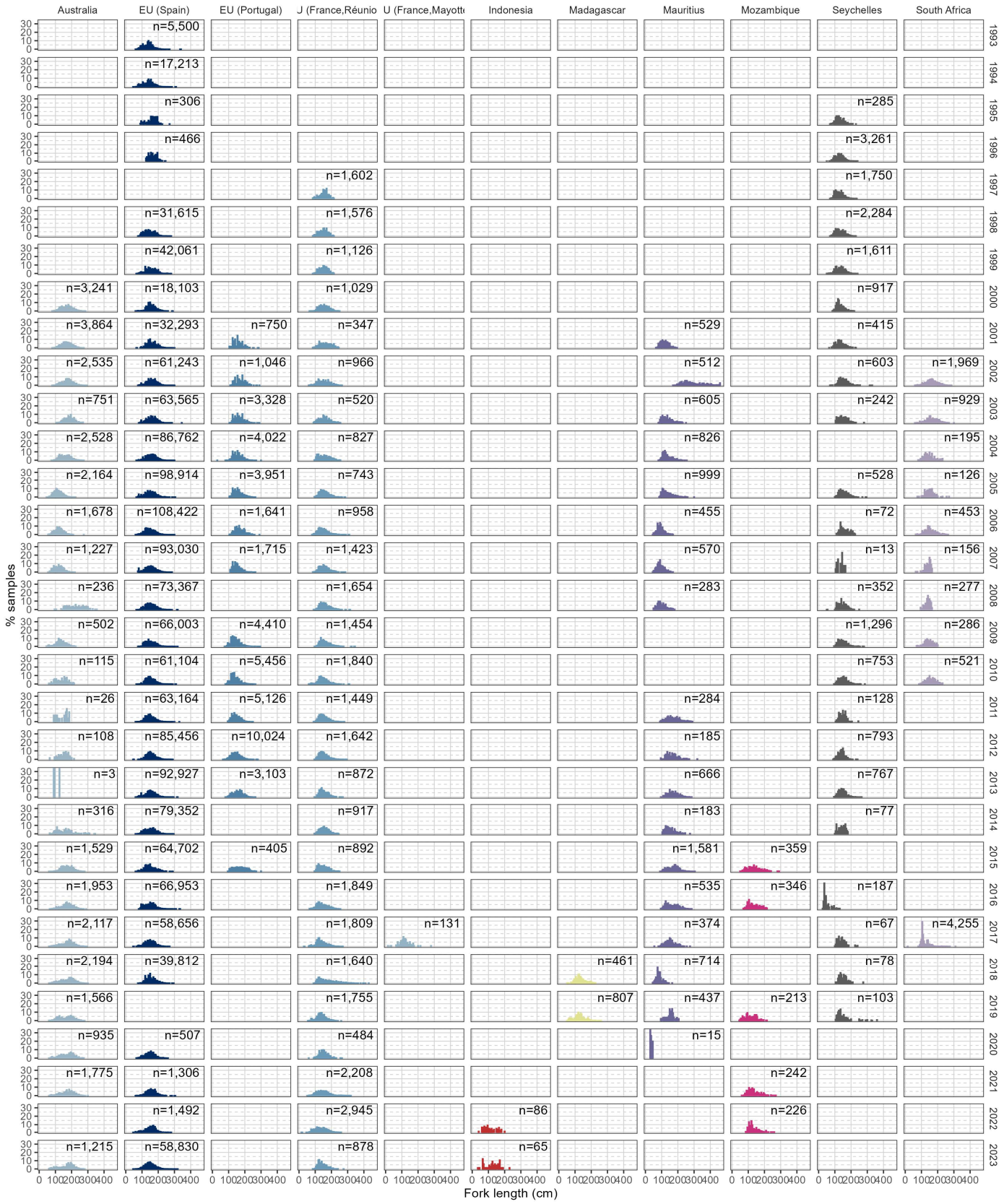

Figure 39: Relative size distribution of swordfish (fork length; cm) recorded for swordfish and shark-targeted longline fisheries (LLO) by year and main fleet. Data source: standardized size-frequency dataset

Gillnet fisheries

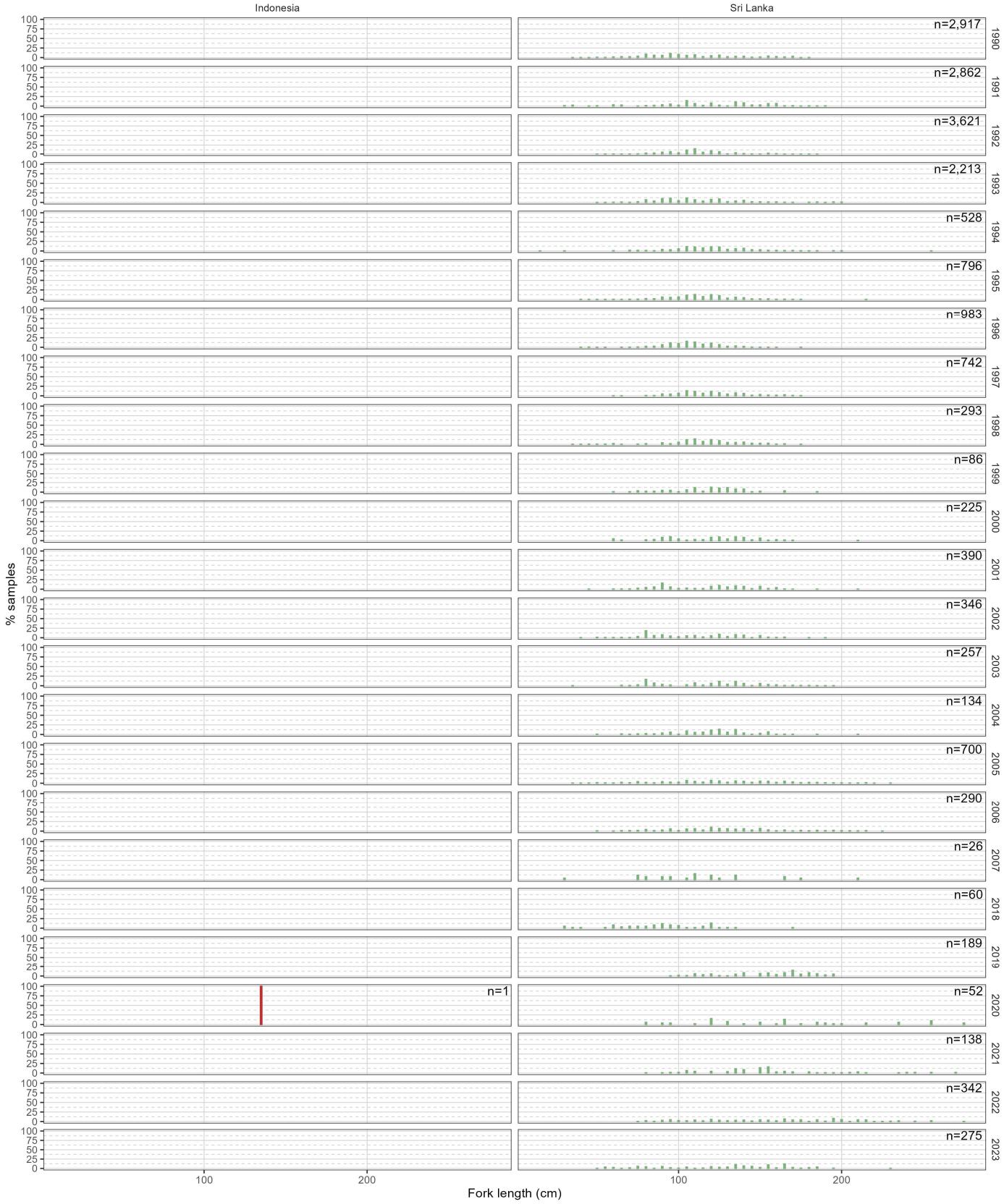

Figure 40: Relative size distribution of swordfish (fork length; cm) recorded for gillnet fisheries by year and main fleet. Data source: standardized size-frequency dataset

Uncertainties in size-frequency data

The quality of geo-referenced size-frequency data of swordfish shows inadequate data are available in relation to the retained catch data of swordfish. Limited swordfish size-frequency data was available before 1980 and with poor

quality. Since the 1980s, the quality of size data began to improve, whereby more fleets started to report data, particularly from industrial fisheries. Good quality size-frequency data (scoring between 0-2), in relation to retained catch data of swordfish was at 38% in 1980 and fluctuated around the same level thereafter. The quality improved in recent years to reach 73% overall, with recent improvement in the quality of size frequency data from coastal fisheries. However, the good quality was 45% in 2022 (**Fig. 41**).

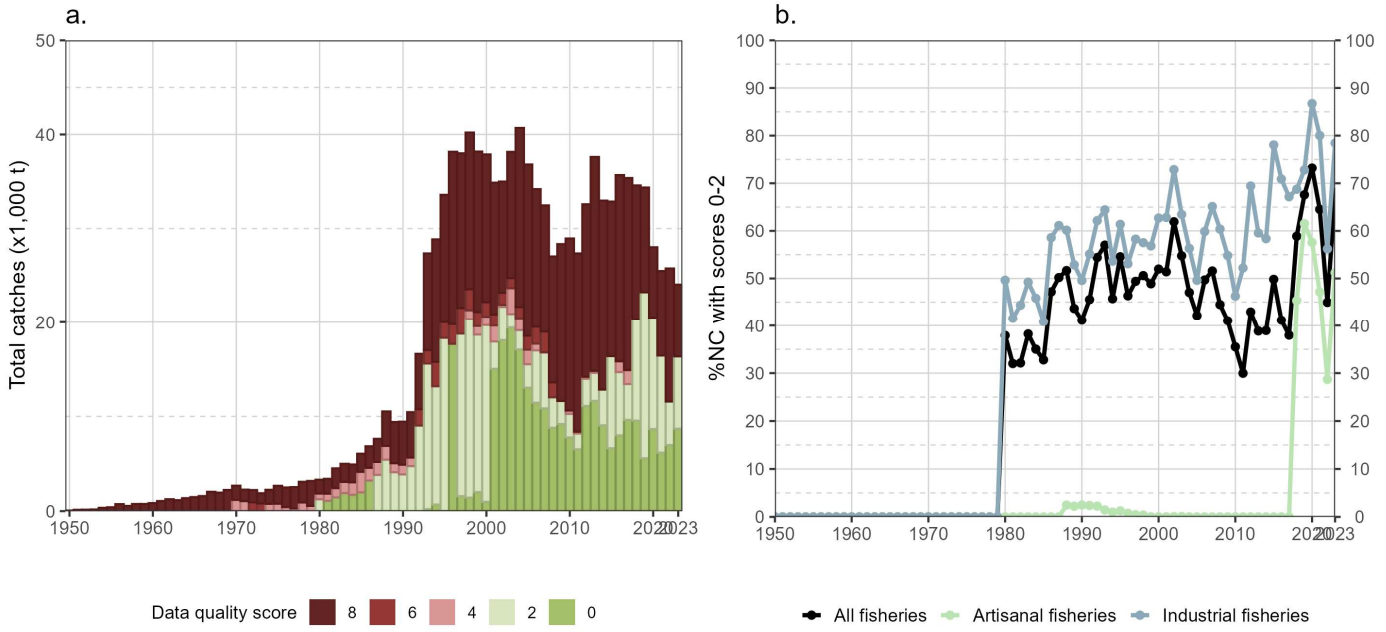

Figure 41: (a) Annual retained catches (metric tonnes; t) of swordfish estimated by quality score and (b) percentage of retained catches for which geo-referenced size-frequency data were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950–2023

Temporal trends in estimated average weights

Trends in the average weights of swordfish 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 should be noted that the average weights calculated for the longline fisheries of Japan and Taiwan,China between 2000 and 2022 fluctuated at around 53 kg and 50 kg respectively (**Fig. 43**). With Japan reaching the minimum average weight 26 kg in 2008, due to significant decrease in catches and sample collected in the Northwest Indian Ocean during piracy time. Taiwn,China however, the average weight peaked at 93 kg in 1990s, when a high number of Taiwanese longliners operated in Western Indian Ocean.

The average weight in the catch of fisheries other than longline fisheries from Japan and Taiwan,China was around 40 kg between 2000 and 2022, when there were more reliable samples. The average weights prior to the mid-1990s (at 40 kg) were estimated as no samples were available during that period (**Fig. 43**).

The trend for all fisheries catching swordfish in the Indian Ocean since 1950s show an average weight of 45 kg between 2000 and 2022. However, in the early 1990s the average weight peaked to 80 kg, reflecting the high average weight from the Taiwanese longline fishery in that period.

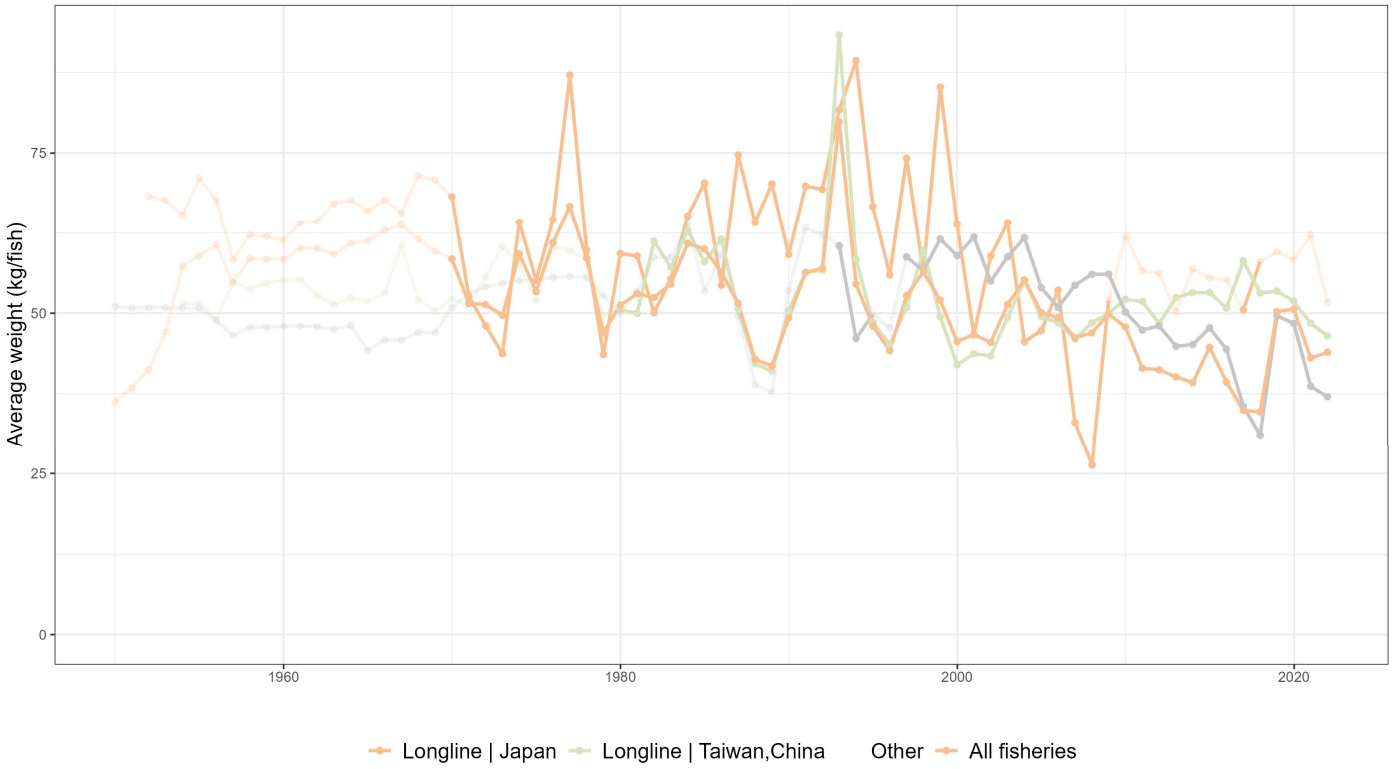

Figure 42: Combined estimated swordfish average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. Longline | Japan = includes data from longliners flagged by Japan, Rep. of Korea, Oman and Thailand; Longline | Taiwan = includes data from longliners flagged by Taiwan,China and other longliners operating similarly or ex-Taiwan,China longliners; and Other fisheries not otherwise mentioned. Data source: raised time-area catches

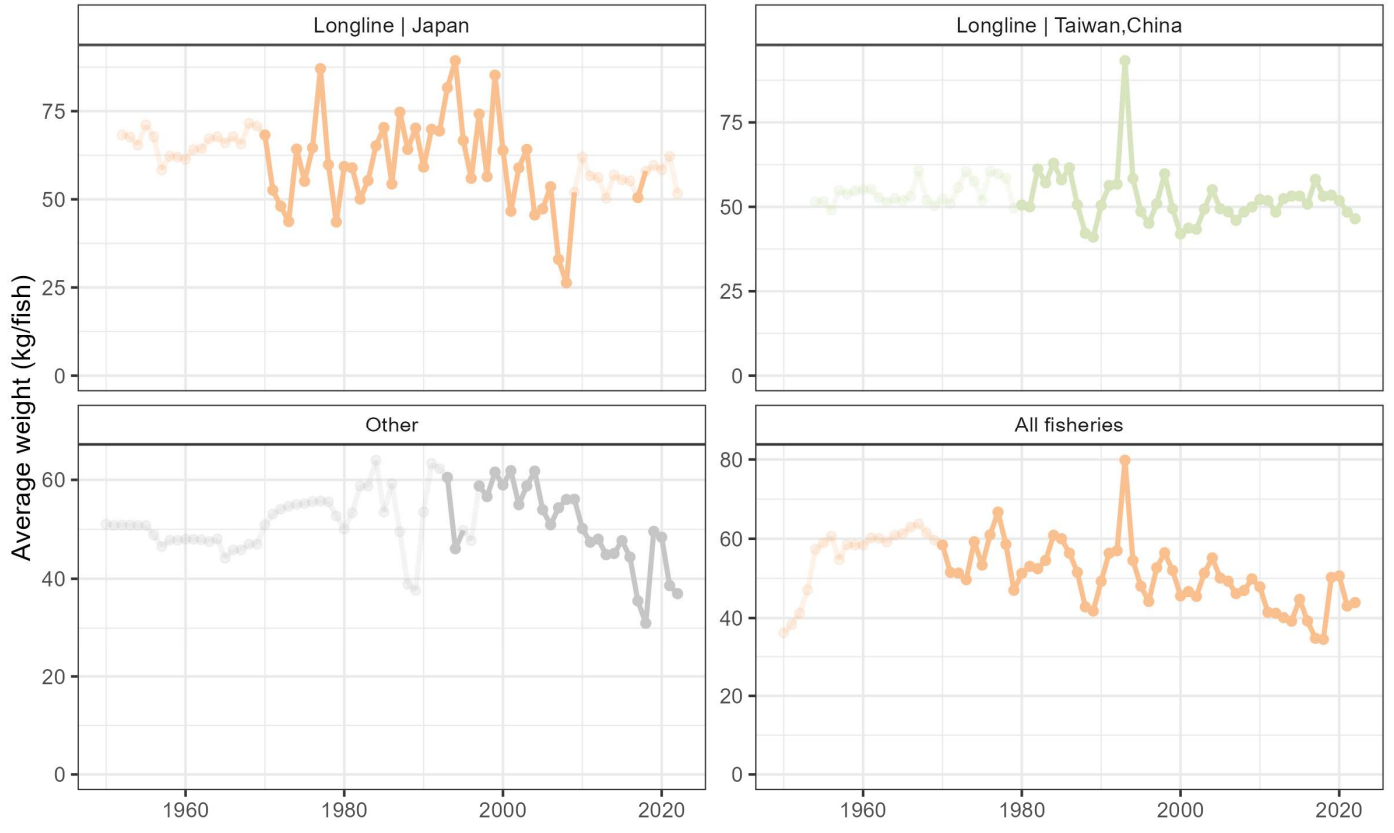

Figure 43: Estimated swordfish average weight (kg/fish) in the catch by fishery and year. Semi-transparent points correspond to years for which the original size samples cover strata with reported catches (by year and fishery) **lower** than 50 t. Longline | Japan = includes data from longliners

flagged by Japan, Rep. of Korea, Oman and Thailand; Longline | Taiwan = includes data from longliners flagged by Taiwan,China and other longliners operating similarly or ex-Taiwan,China longliners; and Other fisheries 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 slow decrease in the size of fish caught since the beginning of the 2000s, which can be explained by the generalized decline from longline fisheries targeting swordfish in recent years (**Fig. 42**).

Spatial distribution of average weights

Estimated average weights by decade (1950-2019)

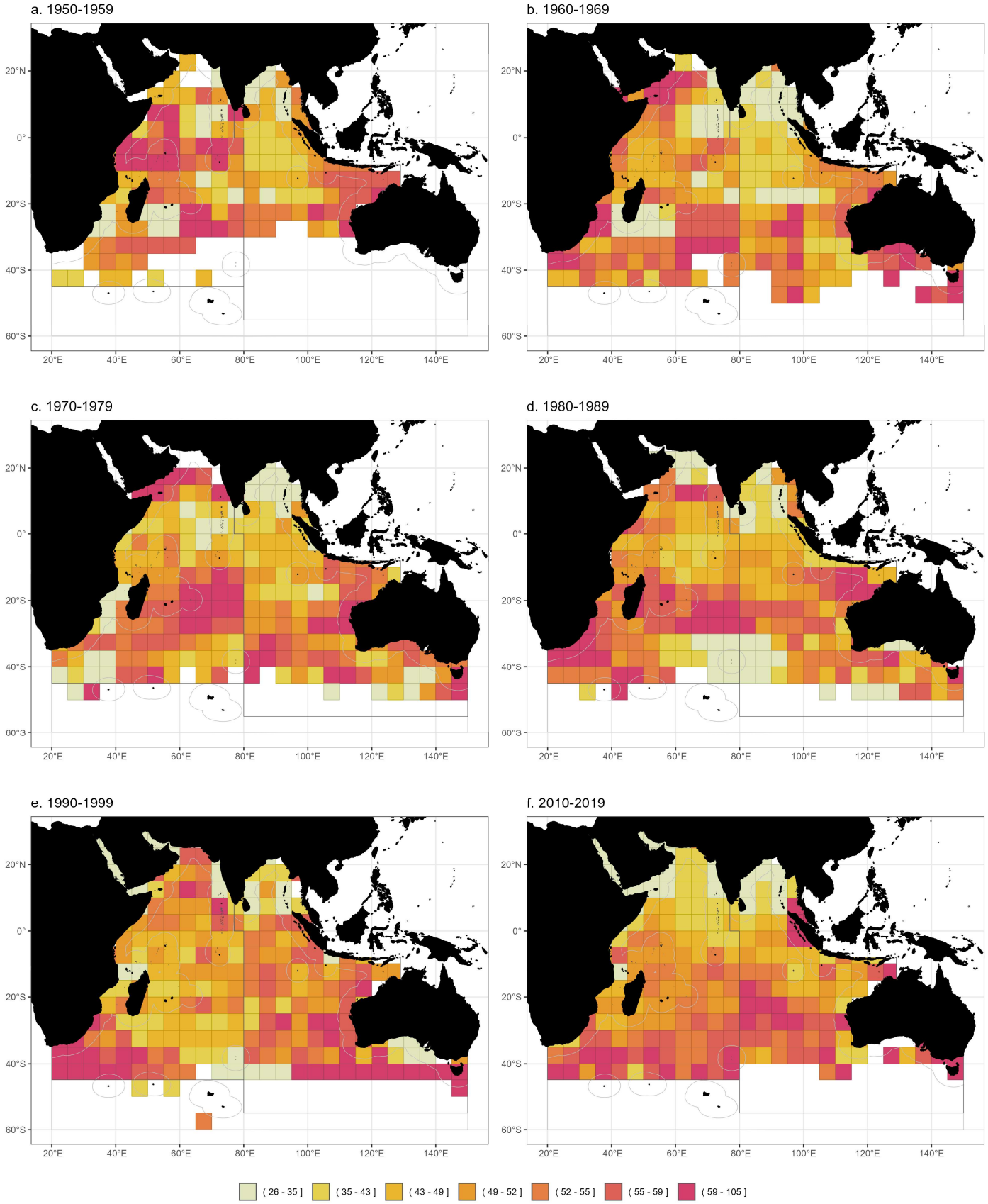

Figure 44: Estimated swordfish average weight (kg/fish) in the catch by decade and 5x5 grid, for all fisheries combined for the period 1950-2019. Data source: raised time-area catches

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

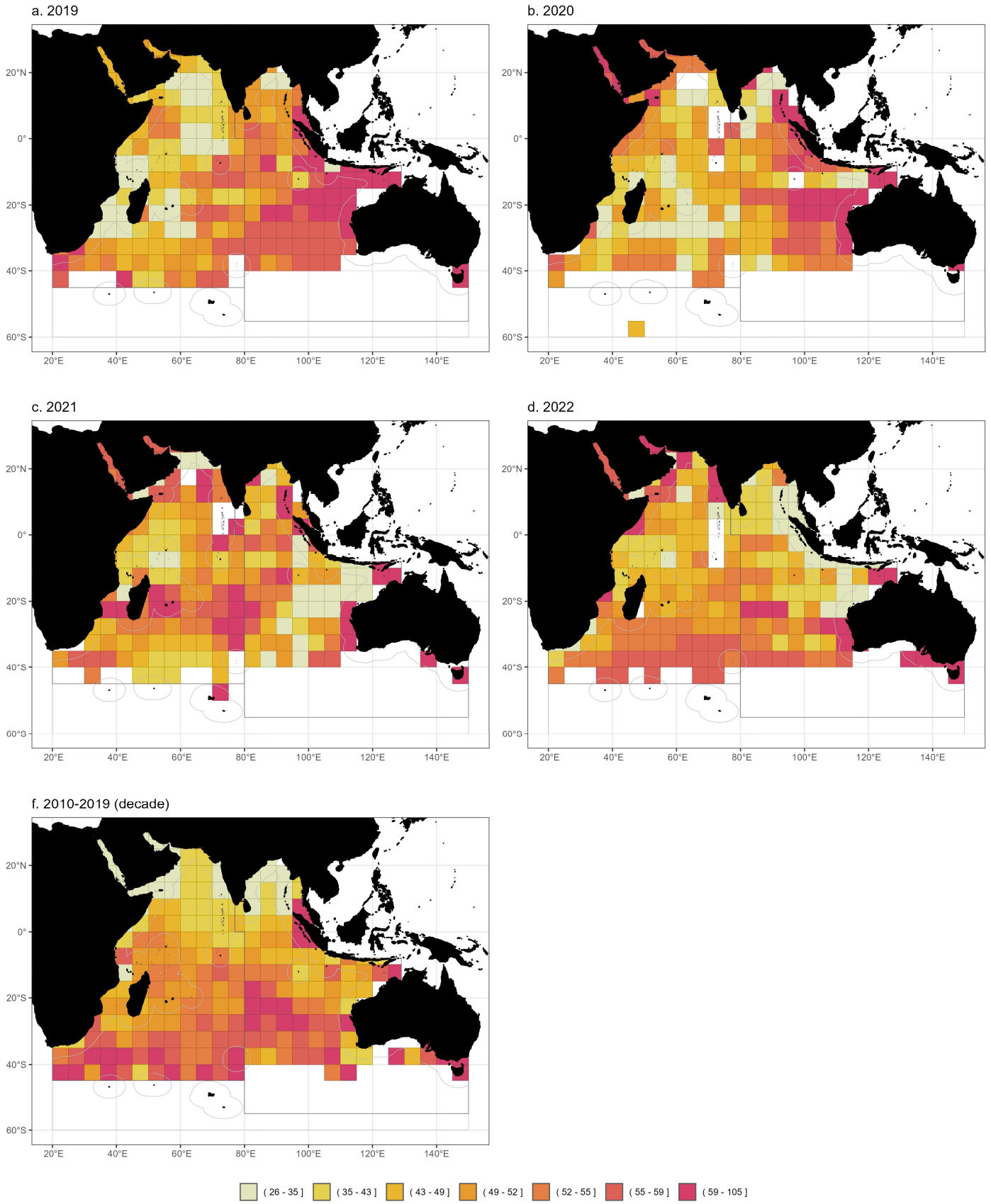

Figure 45: Estimated swordfish average weight (kg/fish) in the catch by year and 5x5 grid, for all fisheries combined for the period 2019-2023 and for the decade 2010-2019. Data source: raised time-area catches

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

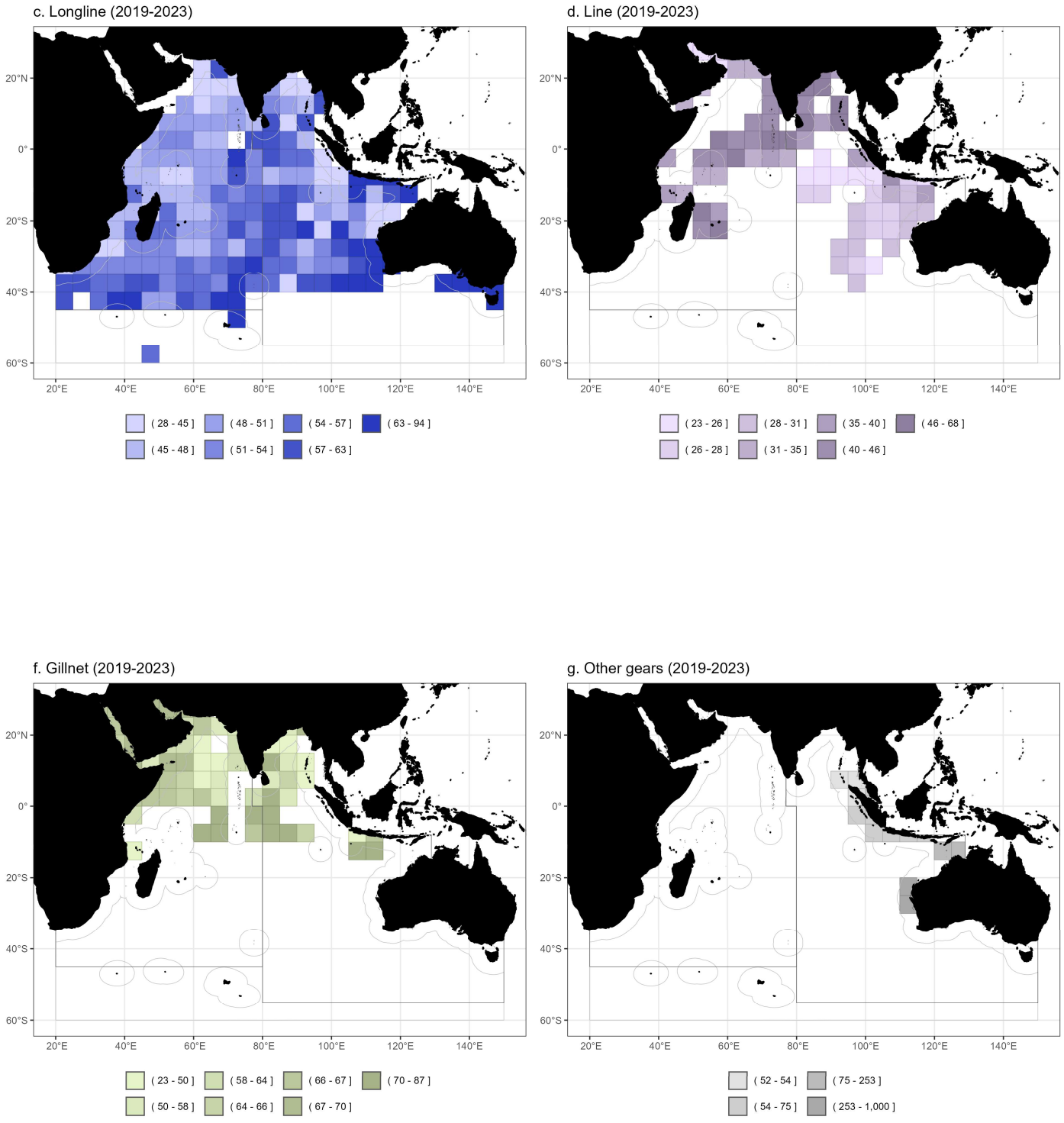

Figure 46: Estimated swordfish average weight (kg/fish) in the catch by 5x5 grid and fishery group for the period 2019-2023. LS = schools associated with floating objects; FS = free-swimming schools. Data source: raised time-area catches

References

García-Cortés B, Mejuto J (2005) Scientific estimations of bycatch landed by the Spanish surface longline fleet targeting swordfish (*Xiphias gladius*) in the Indian Ocean: 2001 – 2003 period. IOTC, Phuket, Thailand, 20 July 2005, p 9

Instituto Español de Oceanografía, Pesca SG de (2022) EU: National Report 2022 to IOTC Scientific Committee: Annex 2: EU Spain. Seychelles

Appendices

Appendix I: Taxonomy

Rank	Taxon
Kingdom	*Animalia*
Subkingdom	*Bilateria*
Infrakingdom	*Deuterostomia*
Phylum	*Chordata*
Subphylum	*Vertebrata*
Infraphylum	*Gnathostomata*
Superclass	*Actinopterygii*
Class	*Teleostei*
Superorder	*Acanthopterygii*
Order	*Perciformes*
Suborder	*Xiphioidei*
Family	*Xiphiidae*
Genus	*Xiphias*
Species	*Xiphias gladius*

Appendix II: Changes in best scientific estimates of retained catches from previous WPB

Some improvements were made to the best scientific estimates of retained catches of swordfish since the 21st session of the IOTC Working Party on Billfish (WPB21), with overall small modifications in the time series of annual catches (**Fig. 8**). The changes covering the period 2017-2021 were due to: (i) updates of billfish catches by Yemen (YEM) as available in the FAO global capture production database and (ii) some minor catch revision for some fisheries of Indonesia, Japan, I.R. Iran, and Kenya (**Table 4**).

Table 4: Changes in best scientific estimates of annual retained catches (metric tonnes; t) of swordfish by year, fleet, fishery group and main Indian Ocean area, limited to absolute values higher than 10 t

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2022	BGD	Gillnet	Eastern Indian Ocean	235	37	198
		Other	Eastern Indian Ocean	83	0	83
	IDN	Gillnet	Eastern Indian Ocean	130	68	62
		Line	Eastern Indian Ocean	710	850	-139
		Longline	Eastern Indian Ocean	2,370	1,301	1,069
		Purse seine	Eastern Indian Ocean	12	132	-120
	JPN	Longline	Eastern Indian Ocean	370	416	-46
		Longline	Western Indian Ocean	43	54	-11
	YEM	Gillnet	Western Indian Ocean	728	537	191
		Line	Western Indian Ocean	1,692	1,249	443
2021	BGD	Gillnet	Eastern Indian Ocean	203	30	174
		Line	Eastern Indian Ocean	0	99	-99
		Other	Eastern Indian Ocean	54	0	54
	IDN	Gillnet	Eastern Indian Ocean	115	66	49
		Line	Eastern Indian Ocean	1,368	815	554
		Longline	Eastern Indian Ocean	694	432	261
		Purse seine	Eastern Indian Ocean	17	88	-71
	JPN	Longline	Eastern Indian Ocean	404	439	-35
	YEM	Gillnet	Western Indian Ocean	359	305	54
		Line	Western Indian Ocean	1,746	1,481	265
2020	IDN	Line	Eastern Indian Ocean	829	1,021	-192
		Longline	Eastern Indian Ocean	449	924	-474
		Other	Eastern Indian Ocean	31	12	18
		Purse seine	Eastern Indian Ocean	4	110	-105
	TMP	Gillnet	Eastern Indian Ocean	13	0	13

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2019	IDN	Gillnet	Eastern Indian Ocean	98	57	41
		Longline	Eastern Indian Ocean	176	1,036	-860
		Purse seine	Eastern Indian Ocean	15	77	-61
	JPN	Longline	Western Indian Ocean	136	147	-11