REVIEW OF THE STATISTICAL DATA AVAILABLE FOR INDIAN OCEAN STRIPED MARLIN (1950-2022)

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Abstract

The document provides an overview of the consolidated knowledge about fisheries catching striped marlin (*Kajikia audax*) 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 available fisheries statistics indicate that striped marlins have been essentially caught in industrial deep-freezing longline fisheries until the 2000s, with some large interannual variability in the catches reported to the Secretariat. While longline catches of striped marlin have shown a major decline since the mid-1990s, becoming very small (~300 t) in recent years, catches of striped marlin from the coastal gillnet fisheries of I.R. Iran and Pakistan have steadily increased to average 1,800 t annually and contribute around 66% of the total catches of striped marlin in 2021. Information available on discarding practices of striped marlin in industrial fisheries indicates that discard levels are small in both longline and purse seine fisheries, and all individuals discarded at sea were assessed to be dead. Discarding in coastal fisheries interacting with the species is poorly known but considered to be negligible. Most information available on the spatial distribution of catch and effort comes from large-scale longline fisheries while almost no information is available on the fishing grounds of the coastal gillnet and longline fisheries catching striped marlin. Consequently, the quality of the geo-referenced catch data reported to the Secretariat has substantially decreased over the last three decades. Very little information is available on the size composition of the catch of striped marlin in the Indian Ocean, except for large-scale longline fisheries.

Keywords: billfish | striped marlin | Indian Ocean | tuna fisheries

Introduction

Striped marlin (*Kajikia audax*) is a species of marlin that occurs in tropical and subtropical waters throughout the Pacific and Indian Oceans. Information available from the tuna Regional Fisheries Management Organisations (tRFMOs) shows a general decreasing trend in the global catch of striped marlin since the 1970s, although with some large interannual variability (**Fig. 1a**). While global catch levels exceeded 18,000 t in some years, the combined catch reported for 2022 was 9,100 t. Catch reports of striped marlin mostly came from the Pacific Ocean with 3,000 t in Eastern Pacific and 2,000 t Western and Central Pacific in 2022. Whereas the Indian Ocean only contributed 0.3737304% globally in 2022 (**Fig. 1b**).

Stock status of the striped marlin in the Indian Ocean is assessed as subject to overfishing in 2021, and the IUCN classified the striped marlin as least concern globally, attributed to around 14% decline in catch worldwide.

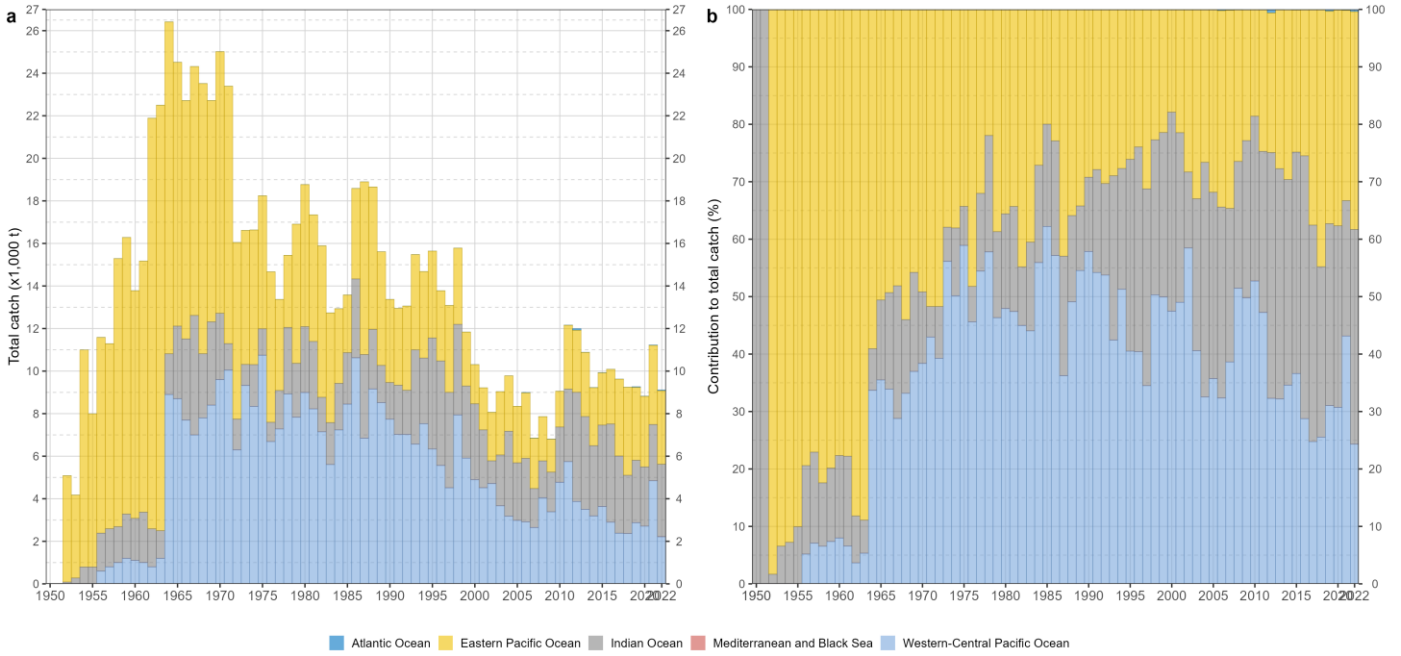

Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of black marlin by region1950-2022. Source: (https://www.fao.org/fishery/statistics-query/en/capture/capture_quantity))

The overarching objective of this paper is to provide participants in the data preparatory meeting of the 22nd Session of the IOTC Working Party on Billfish (WPB22) with a review of the status of the information available on striped marlin, 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 (**IOTC2024?**).

Total retained (nominal) catch

Historical trends (1950-2022)

Overall, total reported catches of striped marlin show a marked decrease from the early 2000s until today (**Fig. 2a**), with a peak in annual catches recorded in 1986 at around 8,700 t and fluctuated throughout the period, reaching the minimum catch at 2,600 t in 2021, and slightly increase in 2022 to around 3,000.

Historical trends of striped marlin catches indicate the species is the least abundant billfish caught, with a contribution to around 9% of total billfish catches in the Indian Ocean. Furthermore, due to striped marlin found abundantly in the Arabian sea (Nakamura 1985), and increasing report by fisheries in Northwest Indian Ocean in recent years, the fraction of catches reported by artisanal fisheries is increasing (**Fig. 2b**). Nevertheless, the development of longline fisheries in the mid-1950s increased catches of billfish species in general, including striped marlin, as did the drastic development of gillnet fisheries from the 1980s onward (**Table 1**) in several coastal countries (Maldeniya et al. 1995, Hornby et al. 2014).

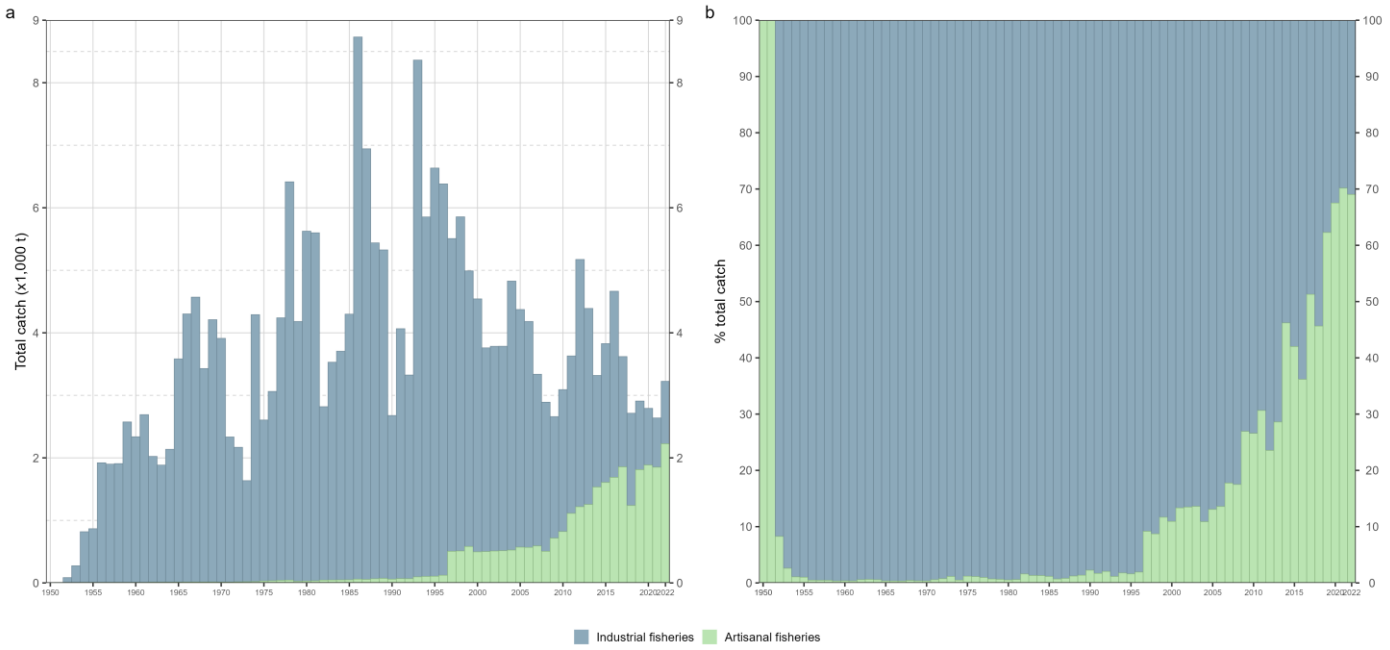

Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of striped marlin by type of fishery for the period 1950-2022. Data source: best scientific estimates of retained catches

Table 1: Mean annual retained catches (metric tonnes; t) of striped marlin 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/21/Data/03-NC)

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Purse seine | Other	0	0	0	5	8	17	41
Longline | Other	0	0	0	12	51	89	79
Longline | Fresh	0	0	18	63	832	745	635
Longline | Deep-freezing	1,028	3,104	3,441	5,069	4,232	2,103	1,272
Line | Coastal longline	0	0	1	23	46	94	236
Line | Trolling	3	5	9	6	14	23	48
Line | Handline	0	0	0	2	10	20	31
Gillnet	5	8	16	20	170	721	1,384
Other	0	0	0	1	2	3	7
Total	1,036	3,117	3,485	5,202	5,365	3,814	3,734

Table 2: Annual retained catches (metric tonnes; t) of striped marlin by fishery for the period 2013-2022. 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/21/Data/03-NC)

Fishery	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Purse seine | Other	42	37	36	37	87	30	32	47	37	41
Longline | Other	137	56	82	103	88	53	54	36	27	22
Longline | Fresh	935	577	672	366	326	206	360	190	95	61
Longline | Deep-freezing	1,817	729	967	2,161	926	733	318	320	247	183
Line | Coastal longline	240	246	255	254	333	247	183	204	181	237
Line | Trolling	55	47	46	49	62	37	48	60	49	91
Line | Handline	48	25	0	29	26	6	55	163	142	19
Gillnet	1,107	1,594	1,761	1,659	1,764	1,396	1,852	1,763	1,852	2,564
Other	9	8	8	7	9	6	7	10	8	8
Total	4,390	3,318	3,827	4,665	3,620	2,714	2,909	2,792	2,638	3,225

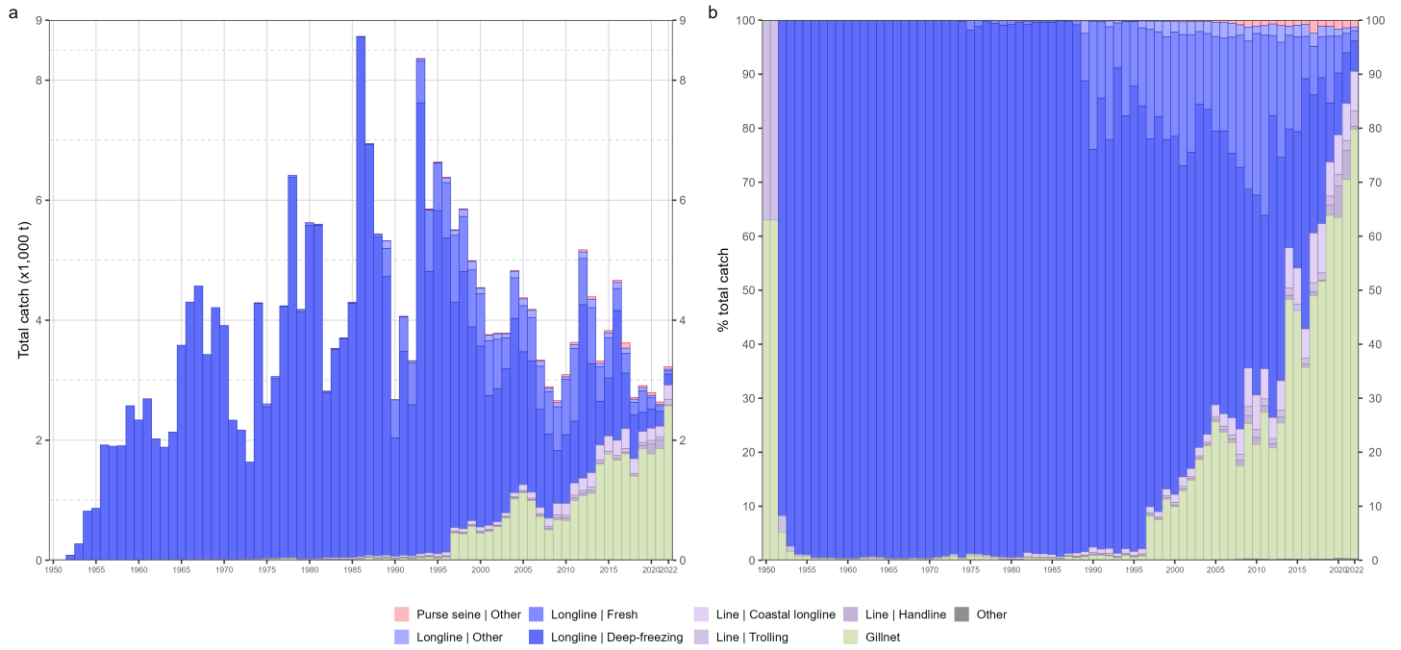

Figure 3: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of striped marlin by fishery for the period 1950-2022. Data source: [best scientific estimates of retained catches]

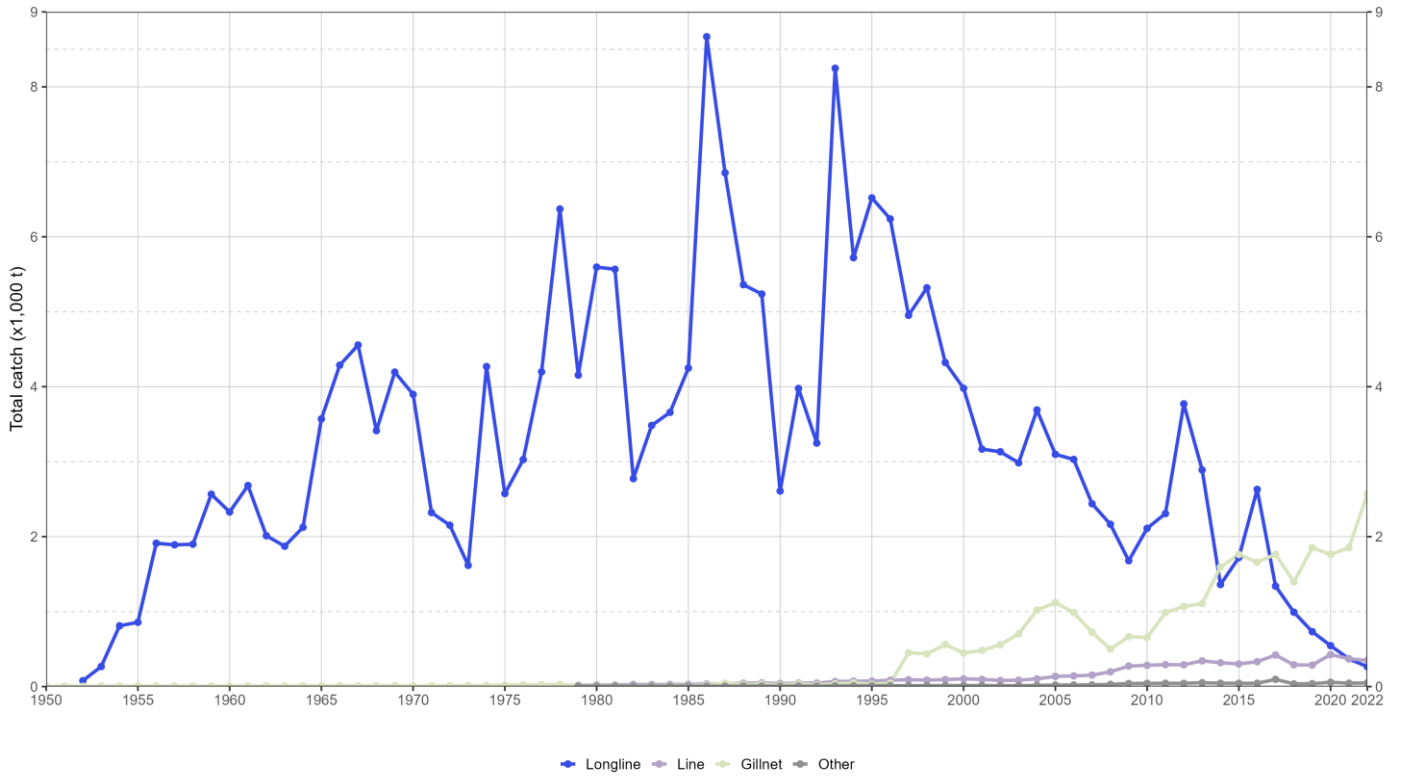

Figure 4: Annual time series of retained catches (metric tonnes; t) of striped marlin by fishery group for the period 1950-2022. Data source: [best scientific estimates of retained catches]

Main fishery features (2018-2022)

In recent years striped marlin have been principally caught by gillnet fisheries, contributing 66 showing increasing trends from 2013 (**Table 3**). Fleet-wise, I.R. Iran accounted for over 37% of striped marlin, solely caught from gillnet fisheries, followed by Pakistan and Indonesia with 25% and 17%, respectively, from diverse fisheries (**Fig. 5**).

The data shows notable trends by fishery group for individual fleets. In particular, the gillnet fisheries of the Islamic Republic of Iran experienced a peak in 2022, similar to black marlin trend, with more than two-fold increased compared to catches in 2021. Catches from line fisheries, although increased slightly, remained below the peak in 2019 Longline fisheries, other the hand continue to decline, largely attributed to the shift in target species of Taiwan,China and other industrial longline (**Figs. 6-7**).

Table 3: Mean annual catches (metric tonnes; t) of striped marlin by fishery between 2018 and 2022. Data source: [best scientific estimates of retained catches](https://www.iotc.org/WPB/21/Data/03-NC)

Fishery	Fishery code	Catch	Percentage
Gillnet	GN	1,885	66.0
Longline | Deep-freezing	LLD	360	12.6
Line | Coastal longline	LIC	210	7.4
Longline | Fresh	LLF	182	6.4
Line | Handline	LIH	77	2.7
Line | Trolling	LIT	57	2.0
Purse seine | Other	PSOT	38	1.3
Longline | Other	LLO	38	1.3
Other	OT	8	0.3

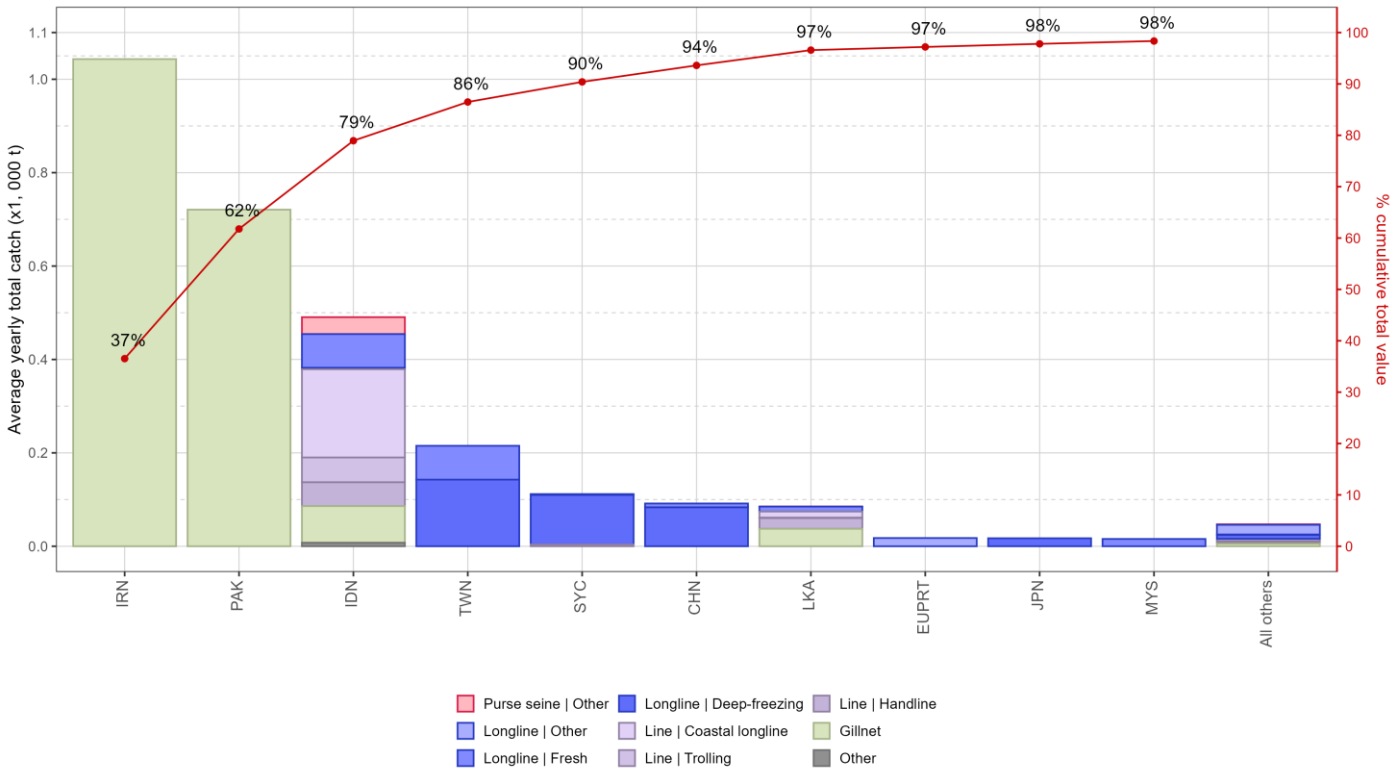

Figure 5: Mean annual catches (metric tonnes; t) of striped marlin by fleet and fishery between 2018 and 2022, with indication of cumulative catches by fleet. Data source: best scientific estimates of retained catches

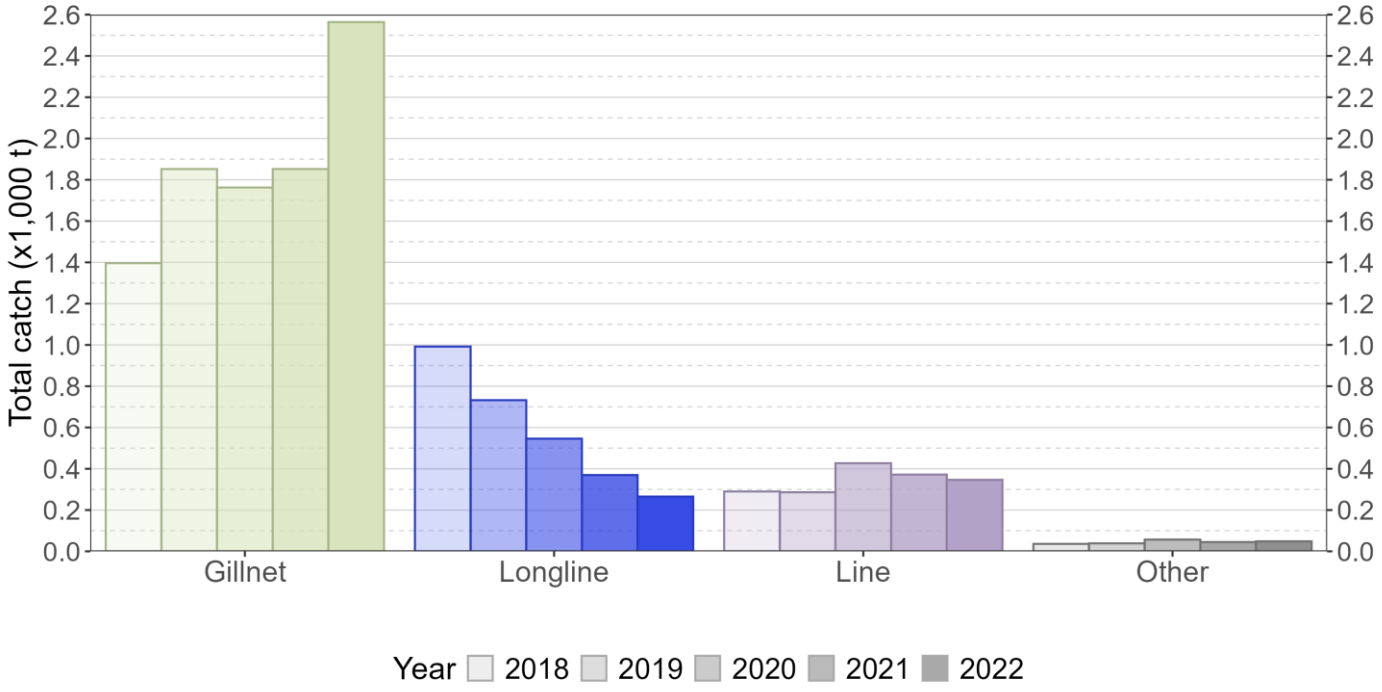

Figure 6: Annual catch (metric tonnes; t) trends of striped marlin by fishery group between 2018 and 2022. Data source: best scientific estimates of retained catches

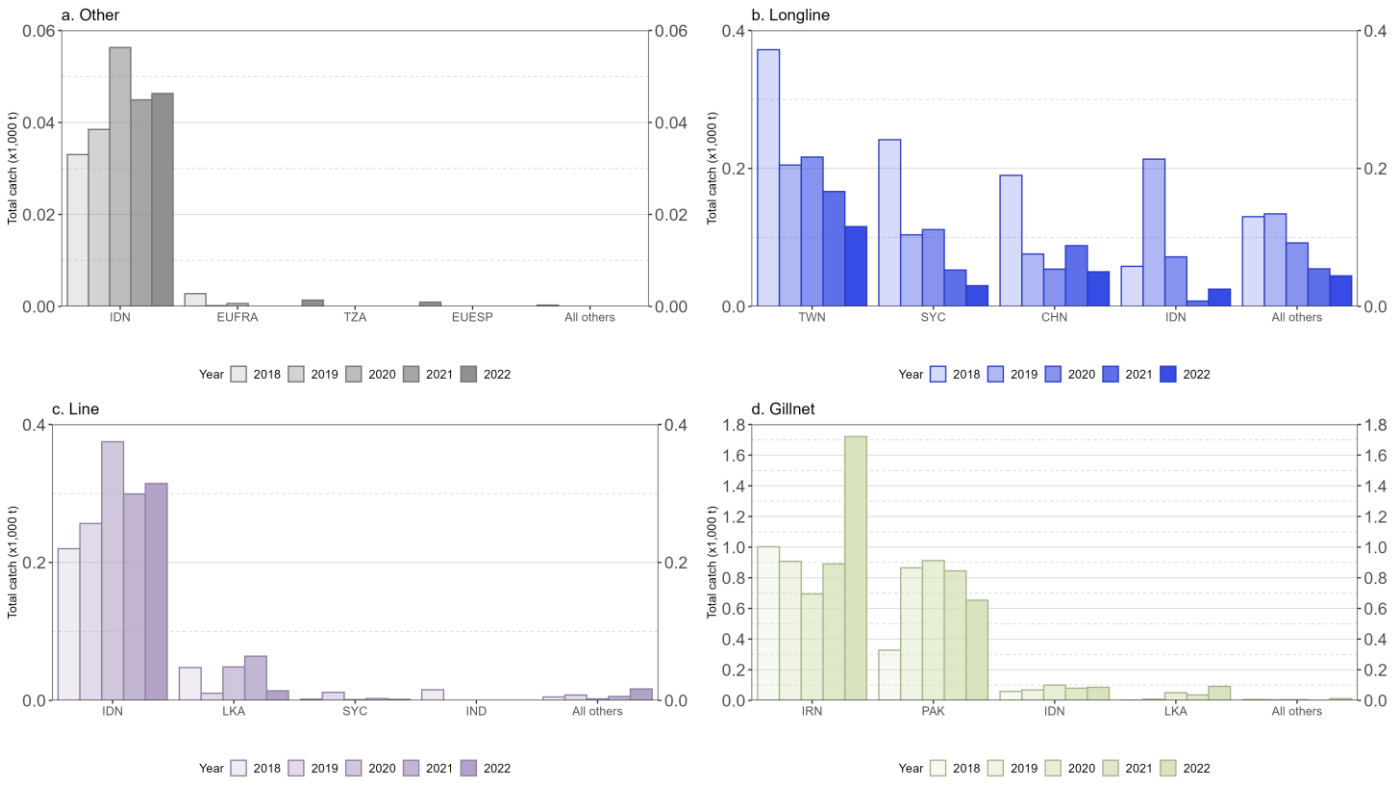

Figure 7: Annual catch (metric tonnes; t) trends of striped marlin by fishery group and fleet between 2018 and 2022. Data source: best scientific estimates of retained catches

Changes from previous Working Party

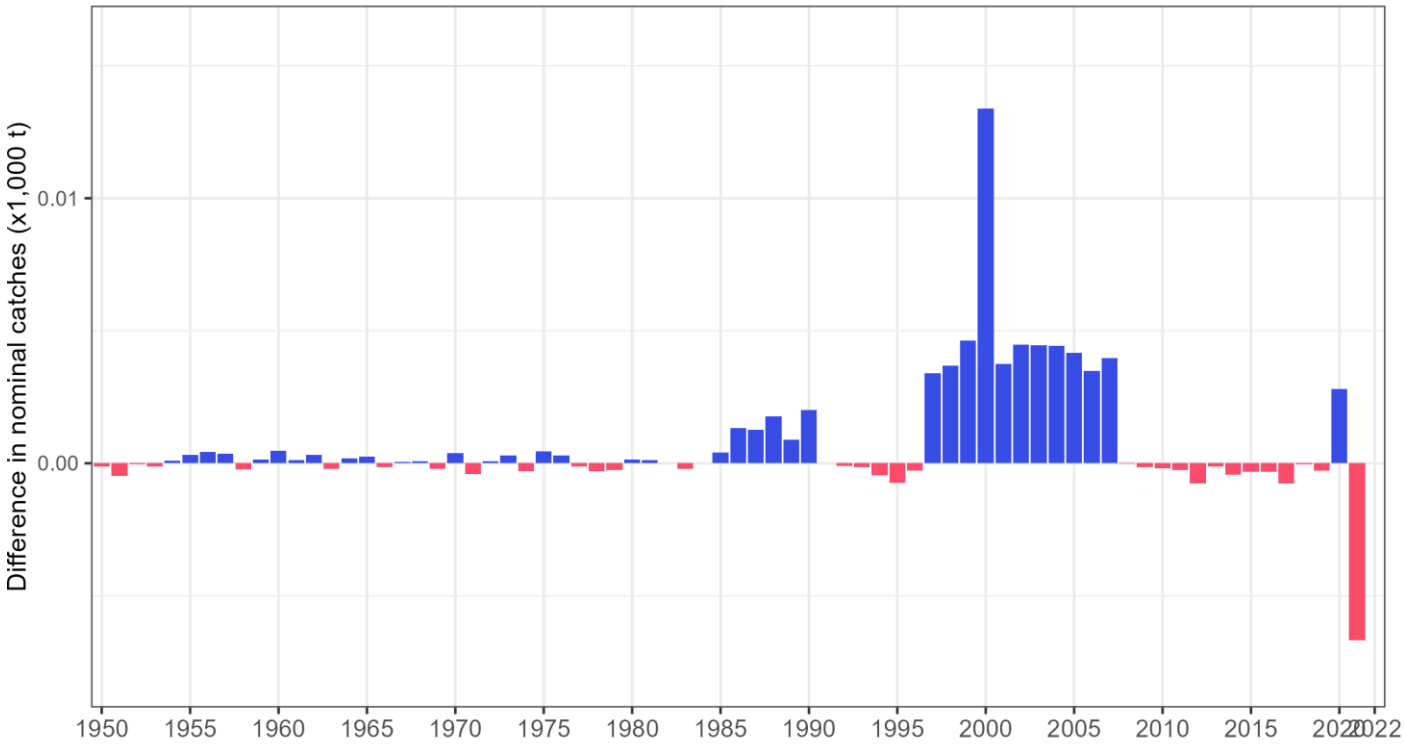

Figure 8: Differences in the available best scientific estimates of retained catches (metric tonnes; t) of striped marlin between this WPB and its previous session (WPB21 meeting held in September 2023)

Uncertainties in retained catch data

Recent analysis of the data reported to the Secretariat for striped marlin reveals that the primary fleets involved in striped marlin fishing are generally compliant with reporting requirements of retained catches by species and fisheries. However, about15.4% are estimated , with 7% in 2022 overall (**Fig. 9**). The partial availability of retained catches of striped marlin is mainly from coastal fisheries of India and Indonesia, which although reported catches, the Secretariat has to further re-estimate, as the reported data are uncertain, with continuous high fluctuation in the data by species and gear, which could be attributed to inadequate monitoring of the extensive and diverse fisheries in these countries.

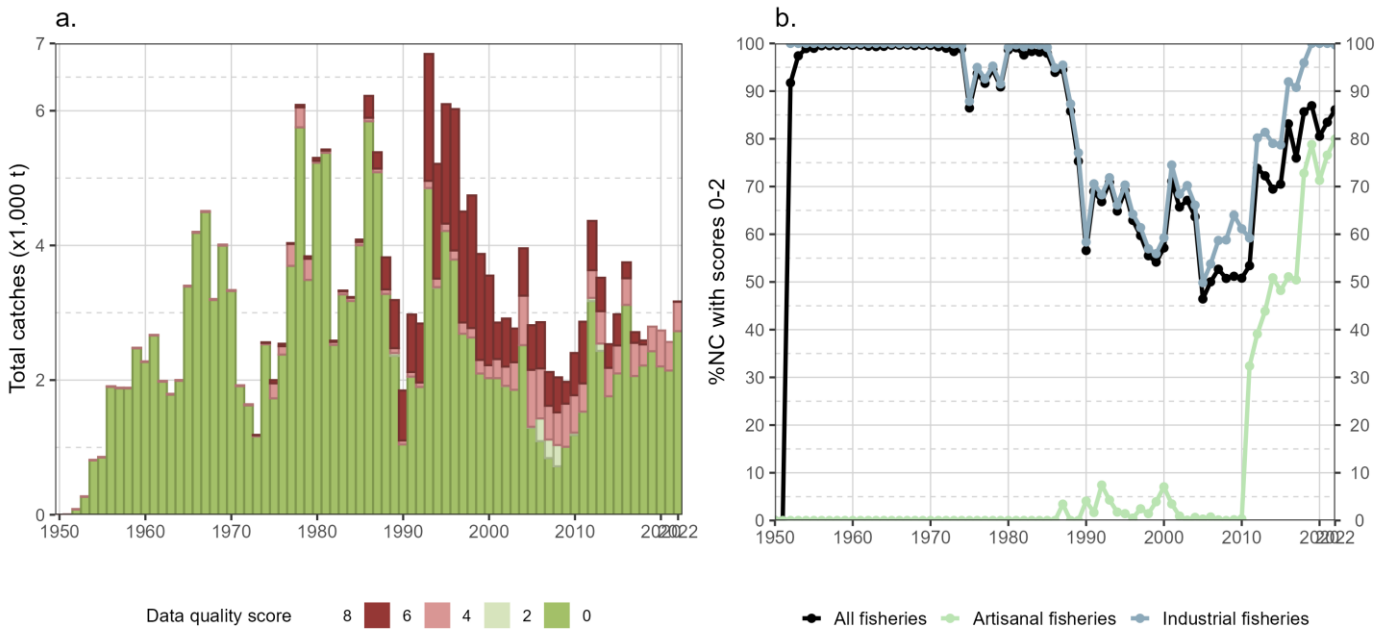

Figure 9: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches fully/partially reported to the IOTC Secretariat for all fisheries and by type of fishery, in the period 1950-2022

Discard levels

The majority of striped marlin caught are retained, as shown in **Fig. ??** of the ROS data report. However, purse seine fisheries discard some striped marlin for reasons such as lack of commercial value or poor condition of the fish. The map in **Fig. ??** illustrates that most of the discarded striped marlin from purse seine fisheries are discarded dead. Although discard rates for striped marlin from longline fisheries are lower, the majority of discarded fish are also discarded dead (**Fig. 12**).

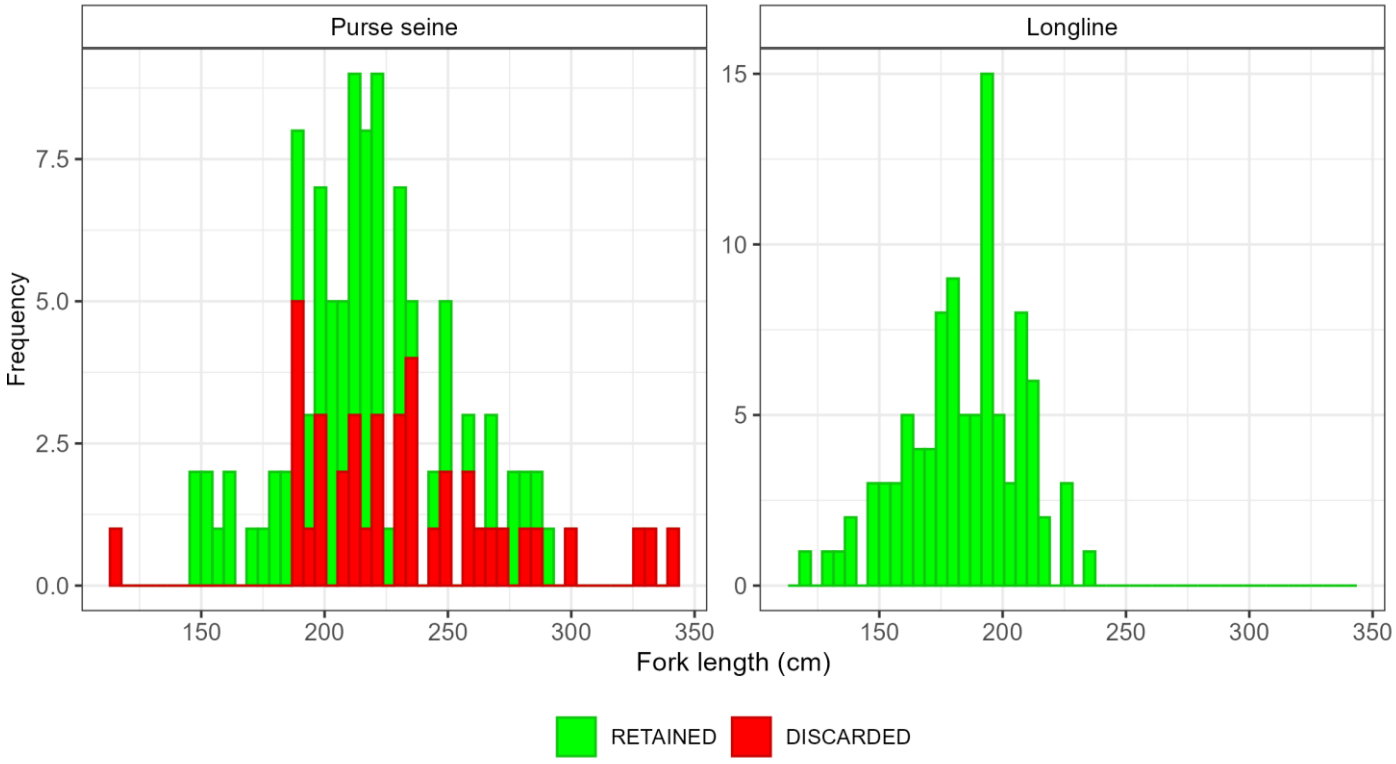

Figure 10: Size (fork length; cm) frequency distribution of striped marlin retained and discarded at sea in purse seine and longline fisheries as available in the ROS regional database

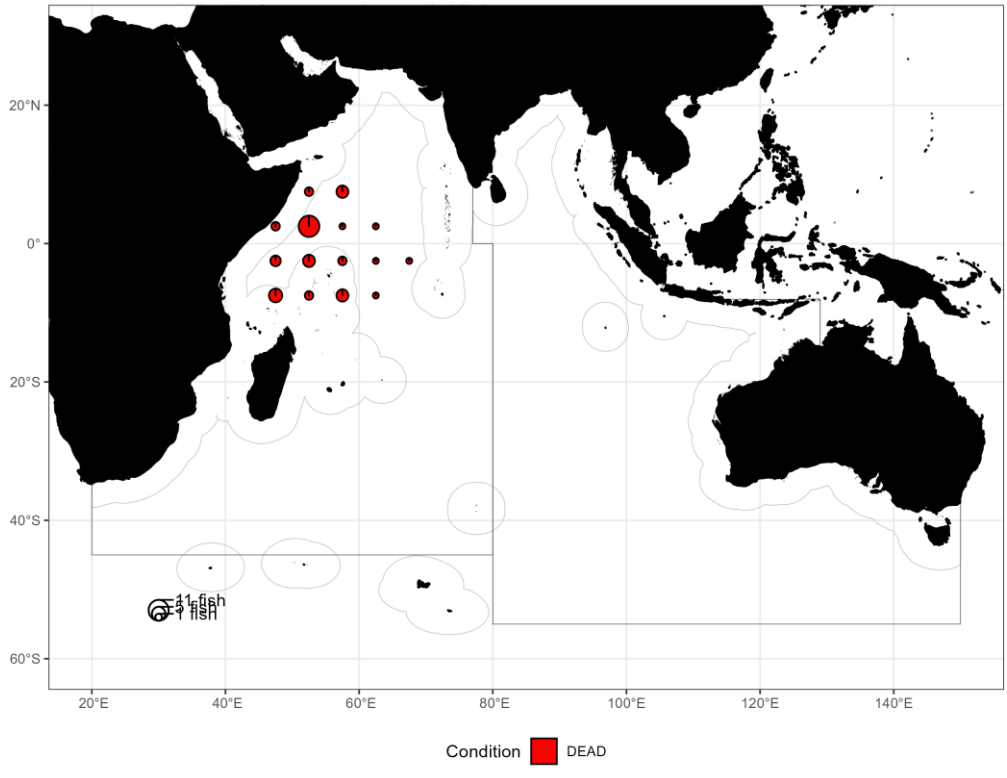

Figure 11: Distribution of striped marlins discarded at sea in the western Indian Ocean purse seine fisheries with information on condition at release as available in the ROS regional database

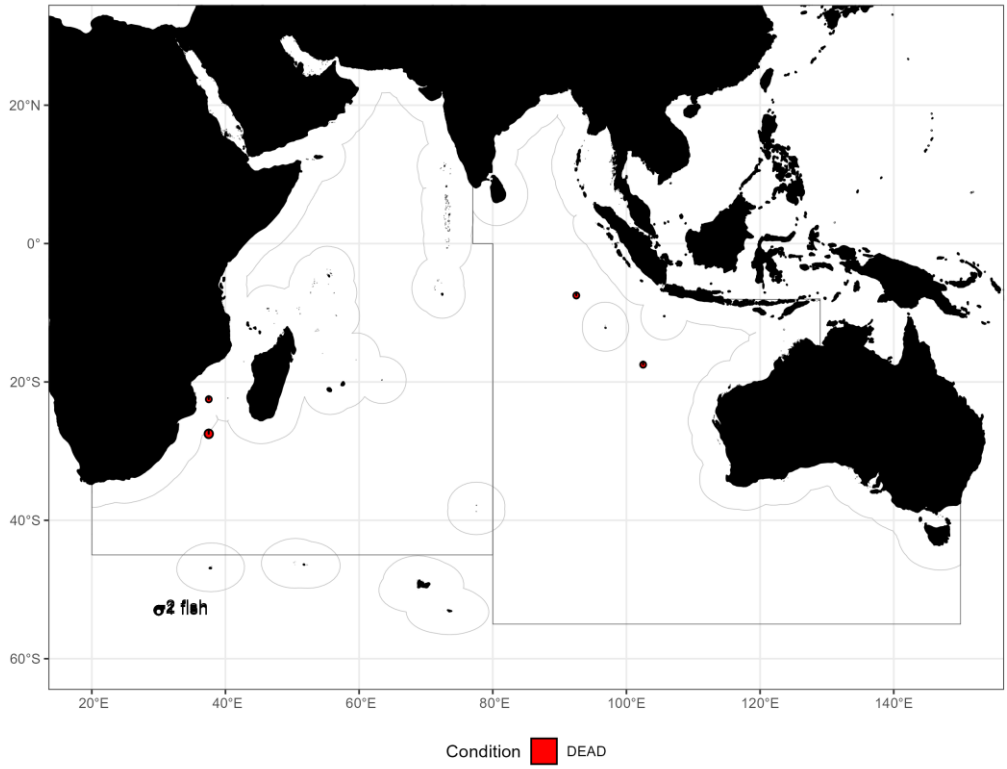

Figure 12: Distribution of striped marlins discarded at sea in the Indian Ocean longline fisheries with information on condition at release as available in the ROS regional database

Geo-referenced catch

Spatial distribution of catches

Geo-referenced catch data for striped marlin have been available since the early decades, primarily from longline fisheries operating close to Sri Lanka EEZ, which have historically been the main source of striped marlin catches. In recent years, geo-referenced data from artisanal fisheries have also become available, though these are not fully raised and some CPCs have incomplete reports. **Figs. 13-14-15** illustrate catch distribution across different fisheries over various periods, highlighting regional trends and changes in distribution by fishery type. compared to other billfish, less geo-referenced catch data are available from coastal fisheries.

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

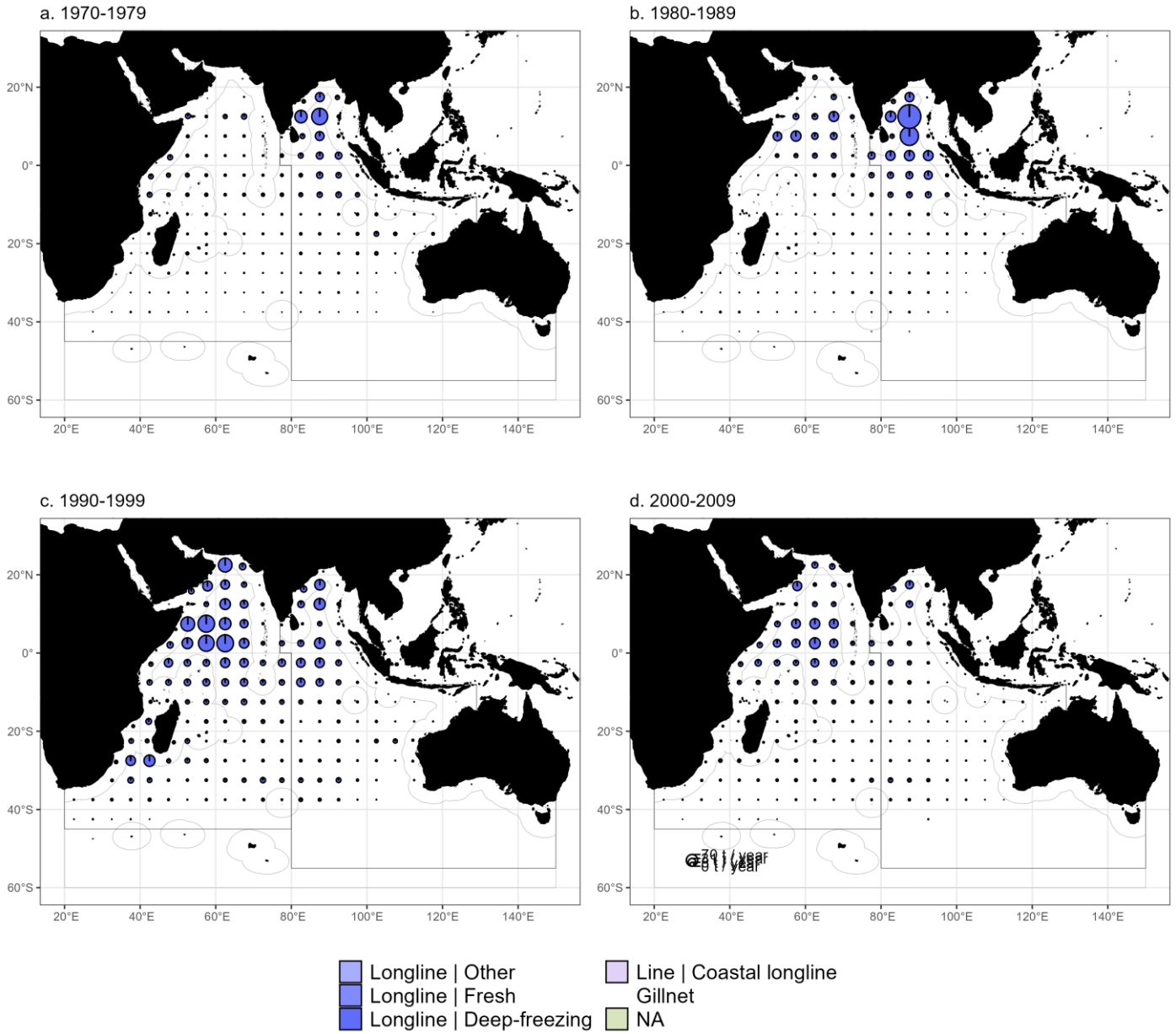

Figure 13: Mean annual time-area catches in weight (metric tonnes; t) of striped marlin, by decade, 5x5 grid, and fishery. Data source: time-area catches

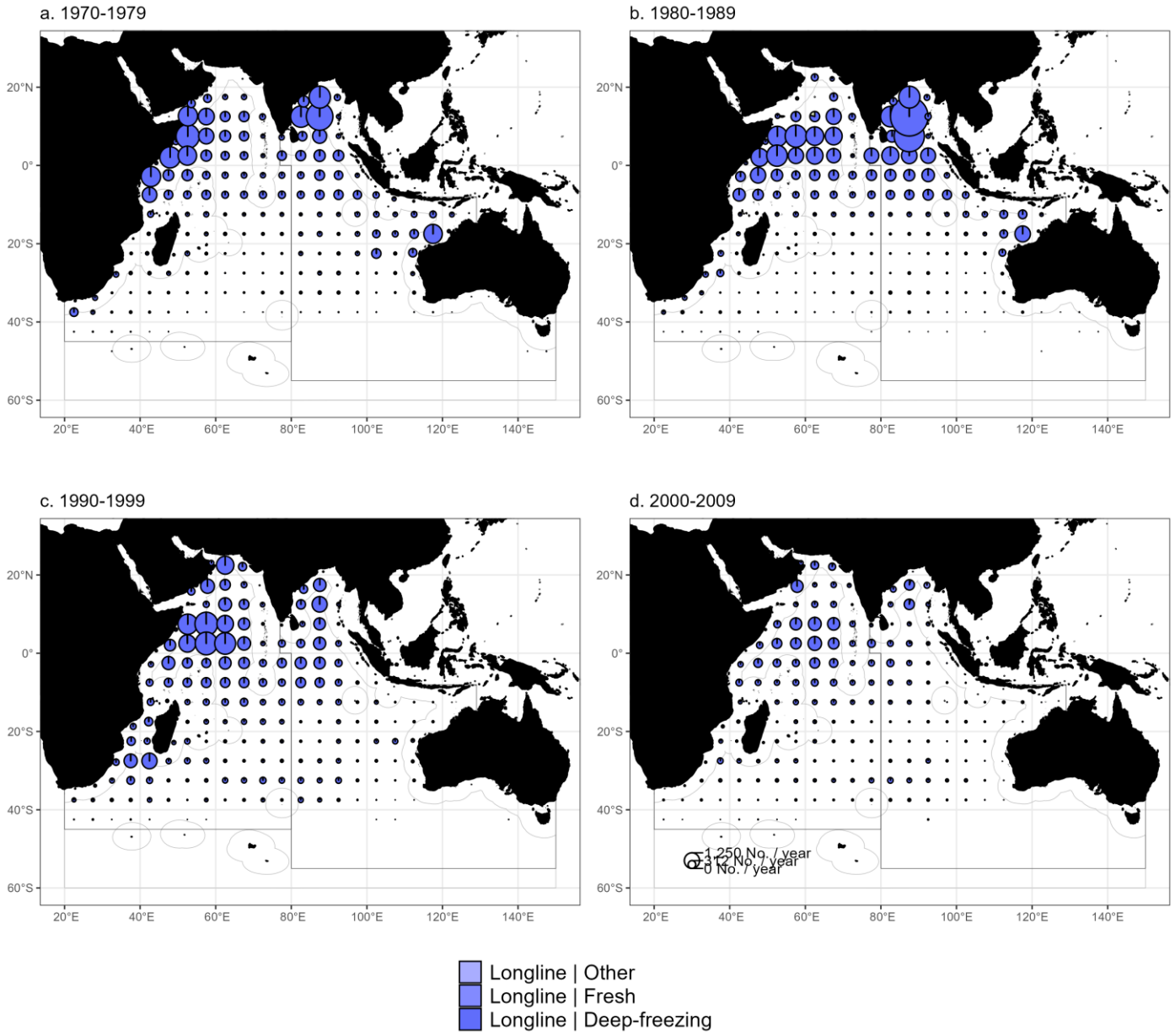

Figure 14: Mean annual time-area catches in numbers of striped marlin, by decade, 5x5 grid, and fishery. Data source: time-area catches

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

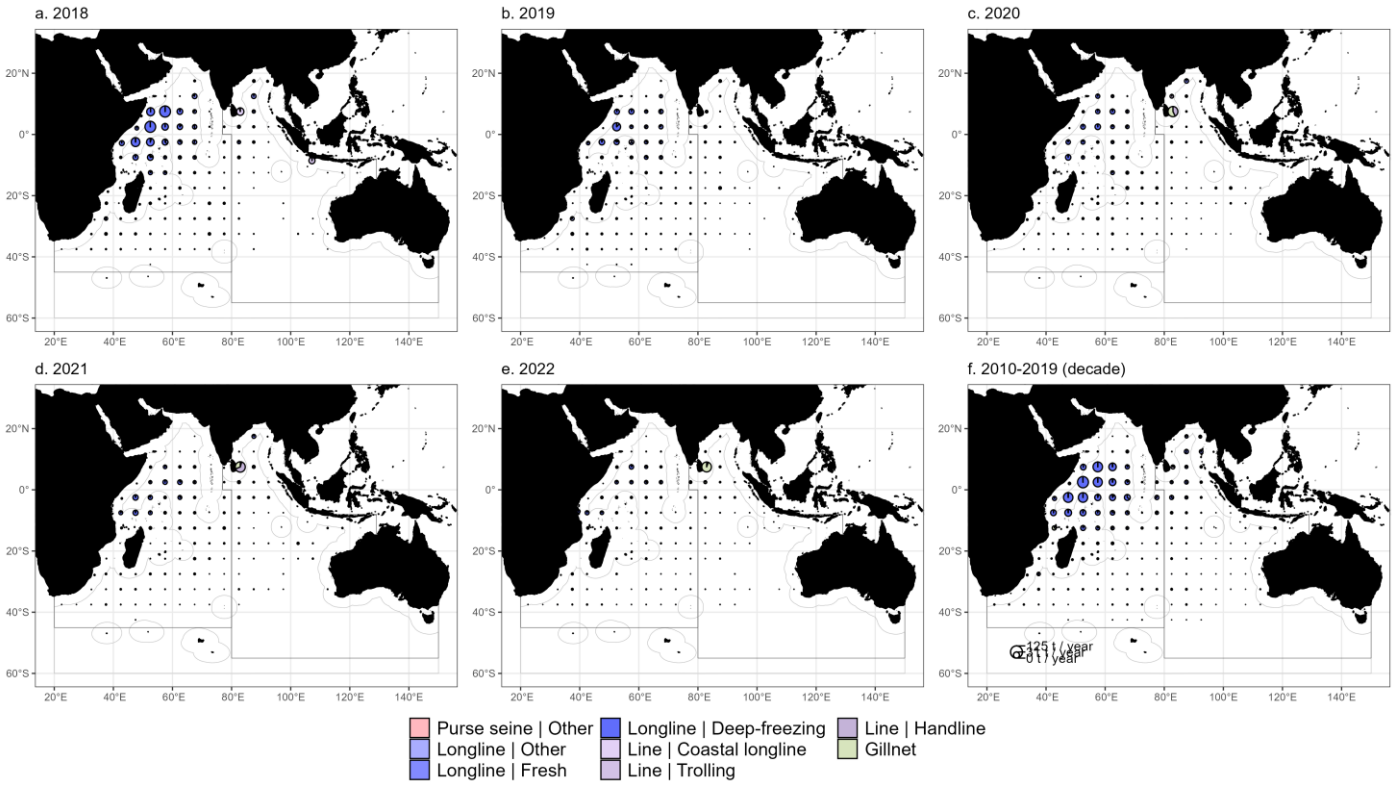

Figure 15: Mean annual time-area catches in weight (metric tonnes; t) of striped marlin, by year / decade, 5x5 grid, and fishery. Data source: time-area catches

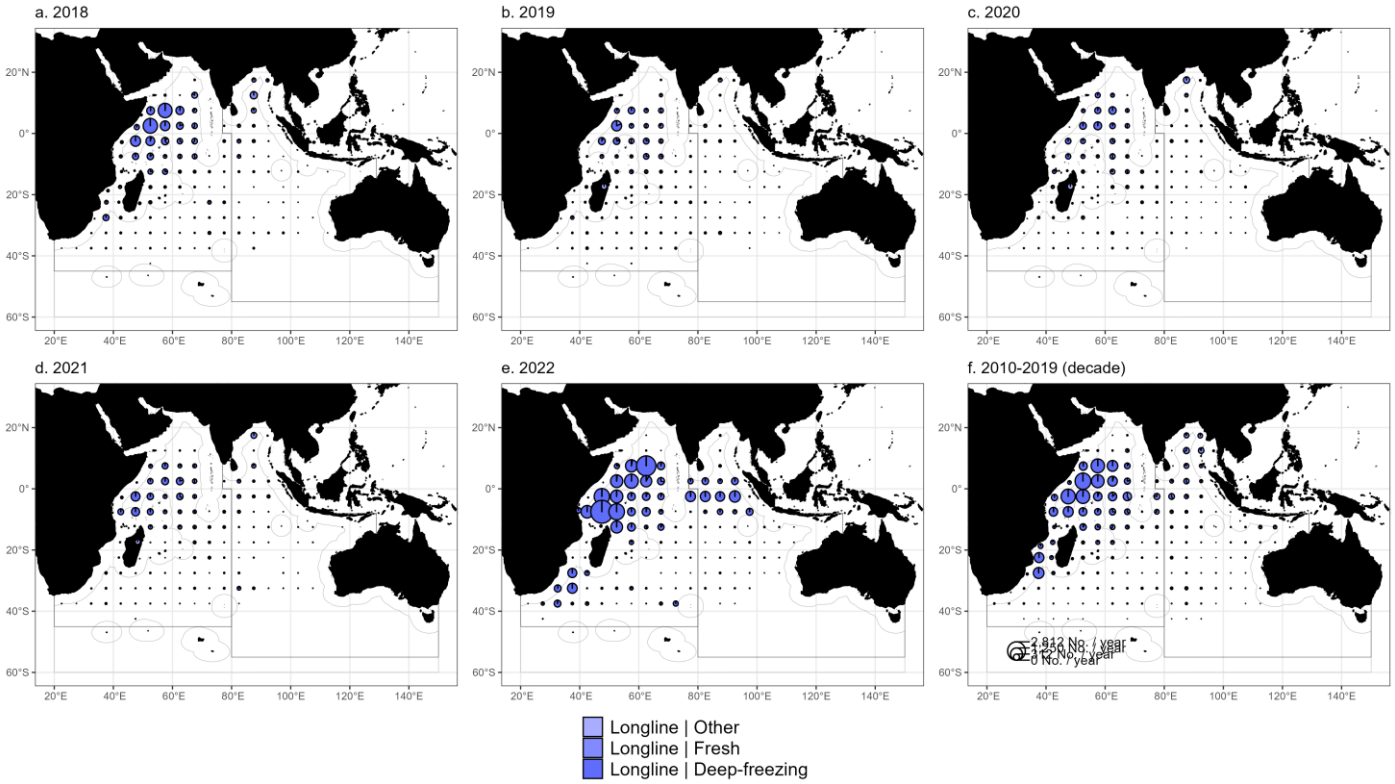

Figure 16: Mean annual time-area catches in numbers of striped marlin, by year / decade, 5x5 grid, and fishery. Data source: time-area catches

Uncertainties in catch and effort data

Geo-referenced catch data for striped marlin, similar to other marlin are rarely available due to the nature of dominant fleets. This discrepancy is due to the fact that not all CPCs with significant striped marlin catches have robust data collection systems to record geo-referenced information. In recent years, the Islamic Republic of Iran (post-2010) has

reported catch and effort data, although this data is not fully raised and lacks complete spatial information. Indonesia (post-2017) has provided data with limited coverage, and Sri Lanka (post-2014), but coverage relative to striped marlin retained catches show decreasing trend. Overall, between 2018 and 2022, 26% of the geo-referenced catch data for striped marlin has been reported as compared to total retained catches (**Fig. 17**).

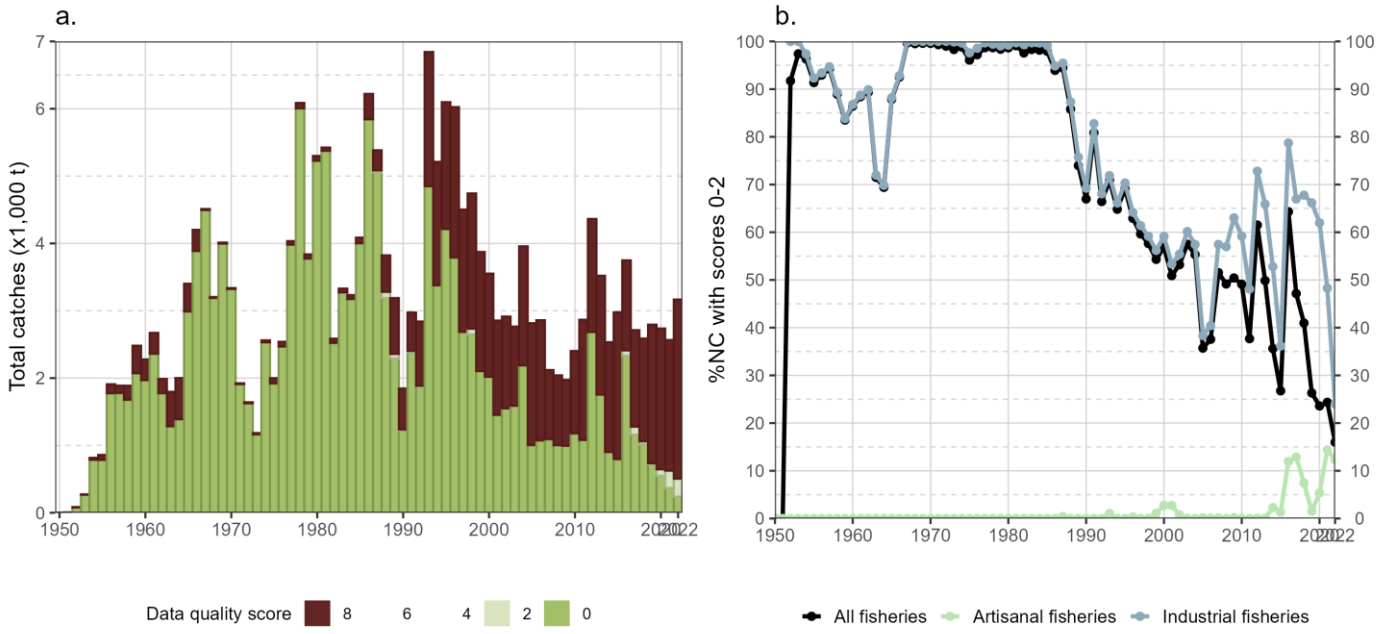

Figure 17: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches for which geo-referenced catches were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950-2022

Size composition of the catch

Samples availability

Size frequency data for striped marlin are notably scarce compared to other billfish species, representing only 6.9% of the total size samples available for all billfish species. In recent years, coastal fisheries have increasingly dominated marlin catches. However, sampling from these fisheries faces several challenges:

(i) Port Sampling Limitations: Sampling is primarily conducted at landing sites, which may not fully capture the complete range of catches.

(ii) Processing Issues: A significant portion of landed marlins are processed (e.g., headed), which complicates species identification and makes size sampling more difficult.

Geo-referenced size sampling for striped marlin is extensively available from longline fisheries, with limited samples from gillnet and line fisheries in the 1980s (**Fig. 18**). The distribution of size samples available by fishery groups is as follows:

- Longline Fisheries: Sampling is conducted throughout the Indian Ocean, with a notable concentration of samples collected around the Somalia area (**Fig. 19**).
- Line Fisheries: Size samples are collected around the East coast of Africa (**Fig. 20**).

By fishery group

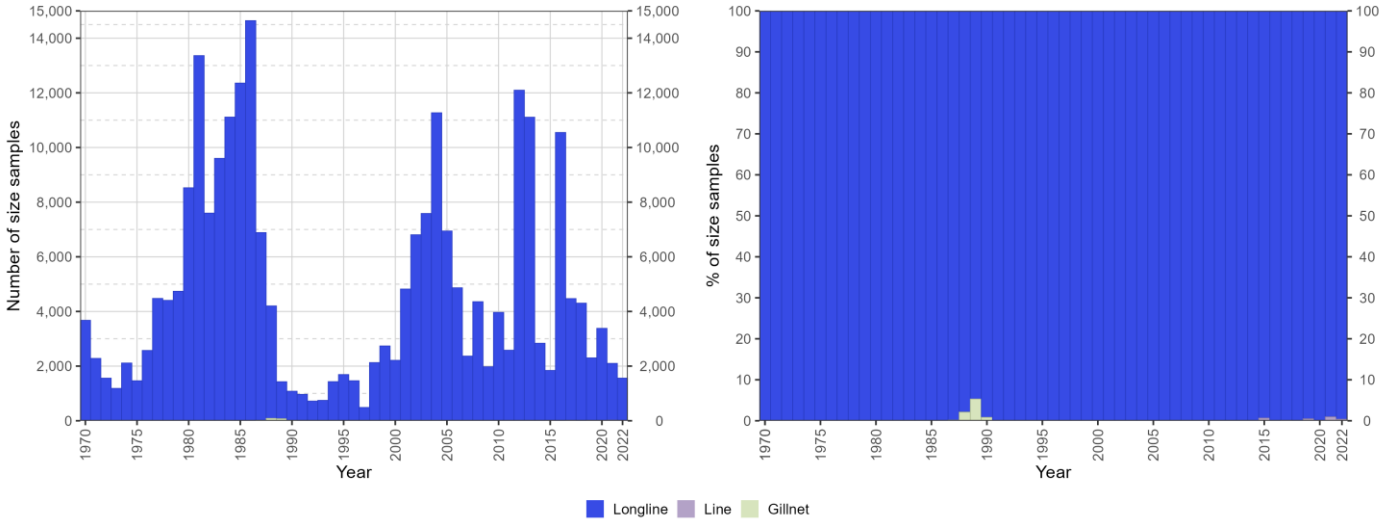

Figure 18: Availability of striped marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset

Longline fisheries

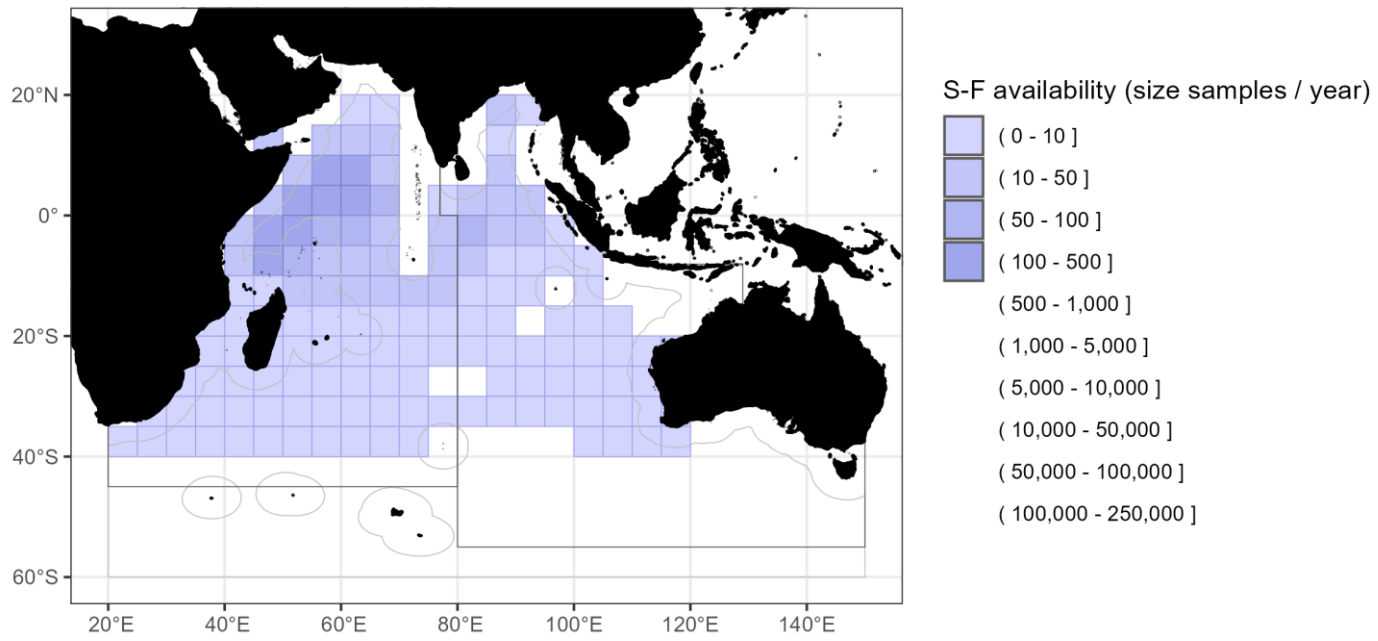

Figure 19: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data for longline fisheries in the period 2018-2022. Data source: standardized size-frequency dataset

Line fisheries

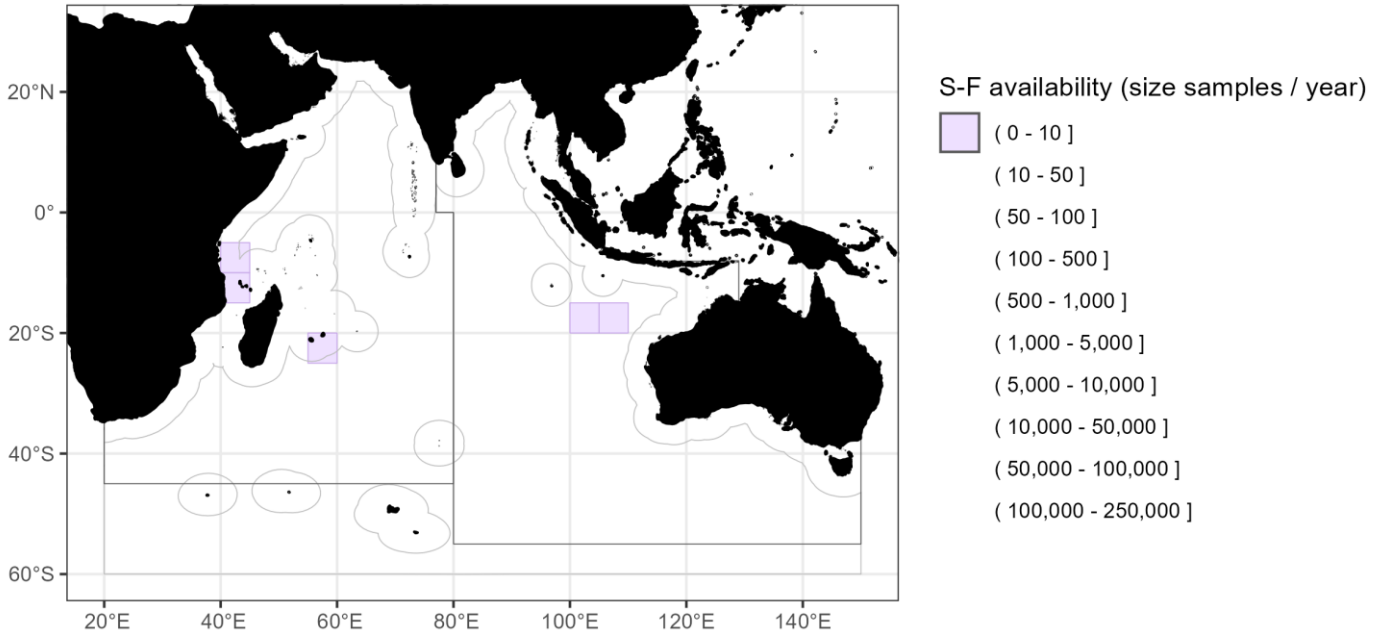

Figure 20: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data for line fisheries in the period 2018-2022. Data source: standardized size-frequency dataset

By fishery

Deep-freezing longline fisheries

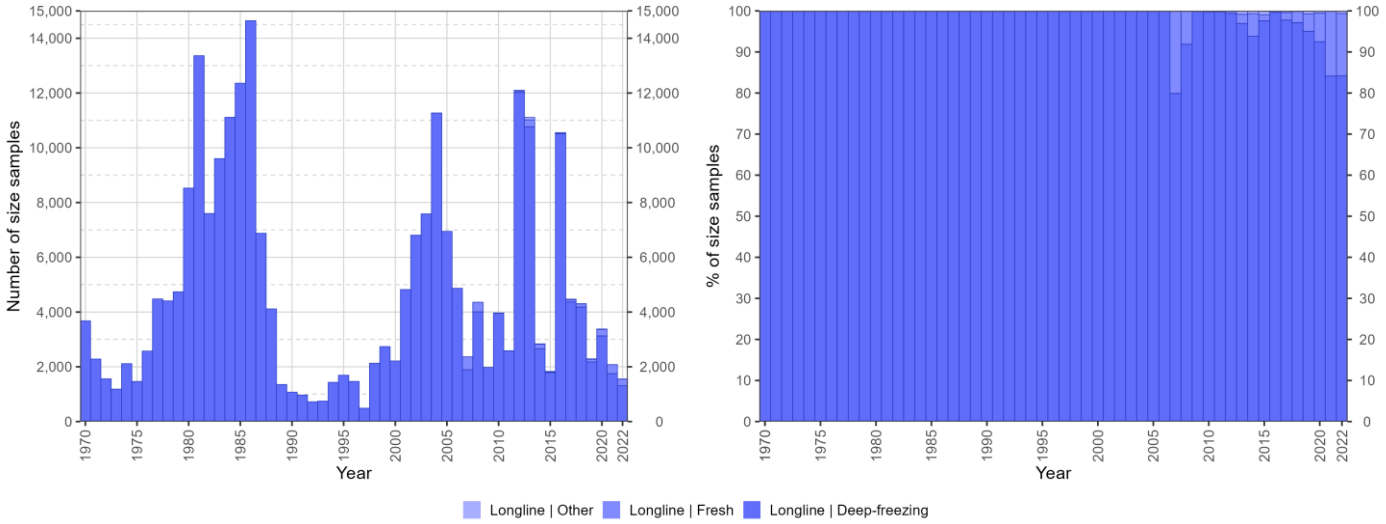

Figure 21: Availability of striped marlin size-frequency data as absolute number of samples per year and longline fishery. Data source: standardized size-frequency dataset

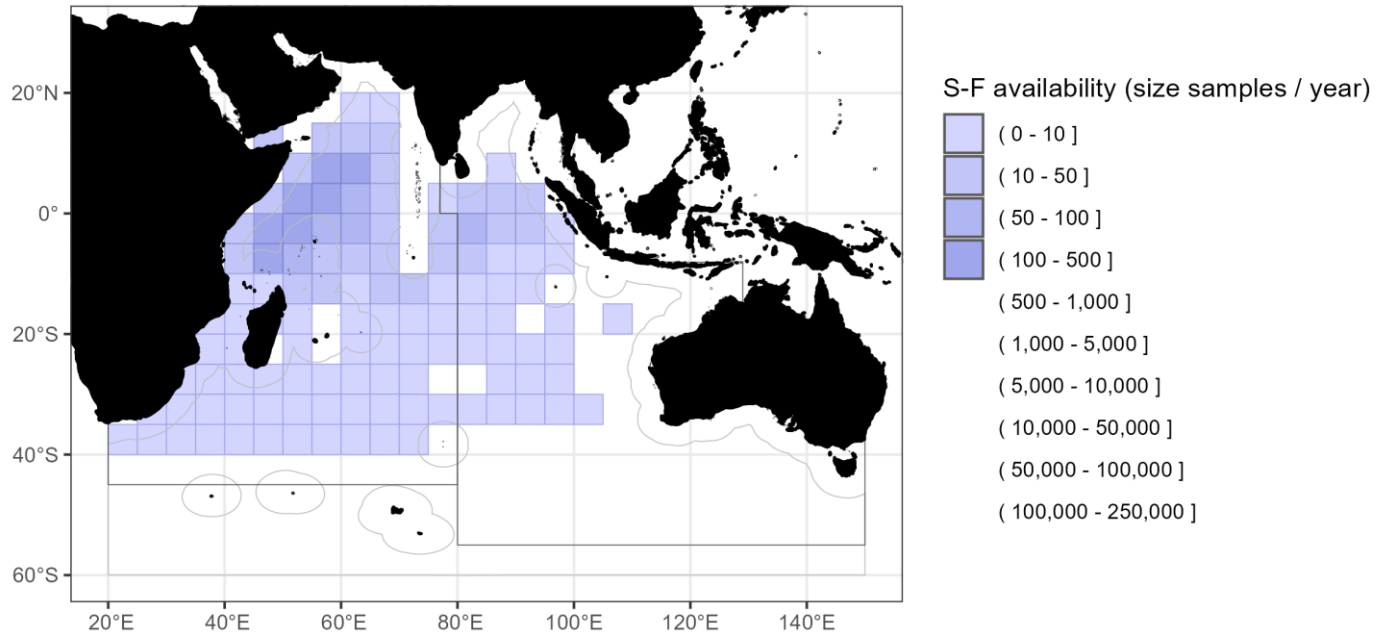

Figure 22: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by deep-freezing longline fisheries in the period 2018-2022. Data source: standardized size-frequency dataset

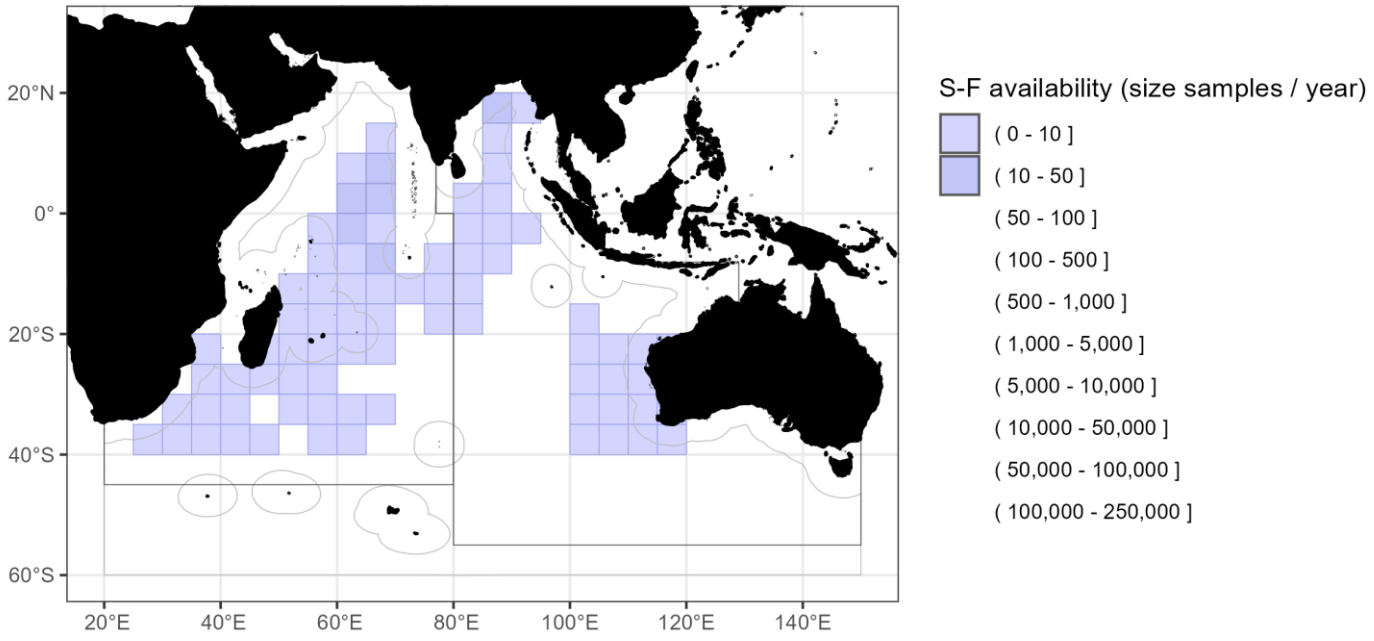

Figure 23: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by fresh longline fisheries in the period 2018-2022. Data source: standardized size-frequency dataset

Gillnet fisheries

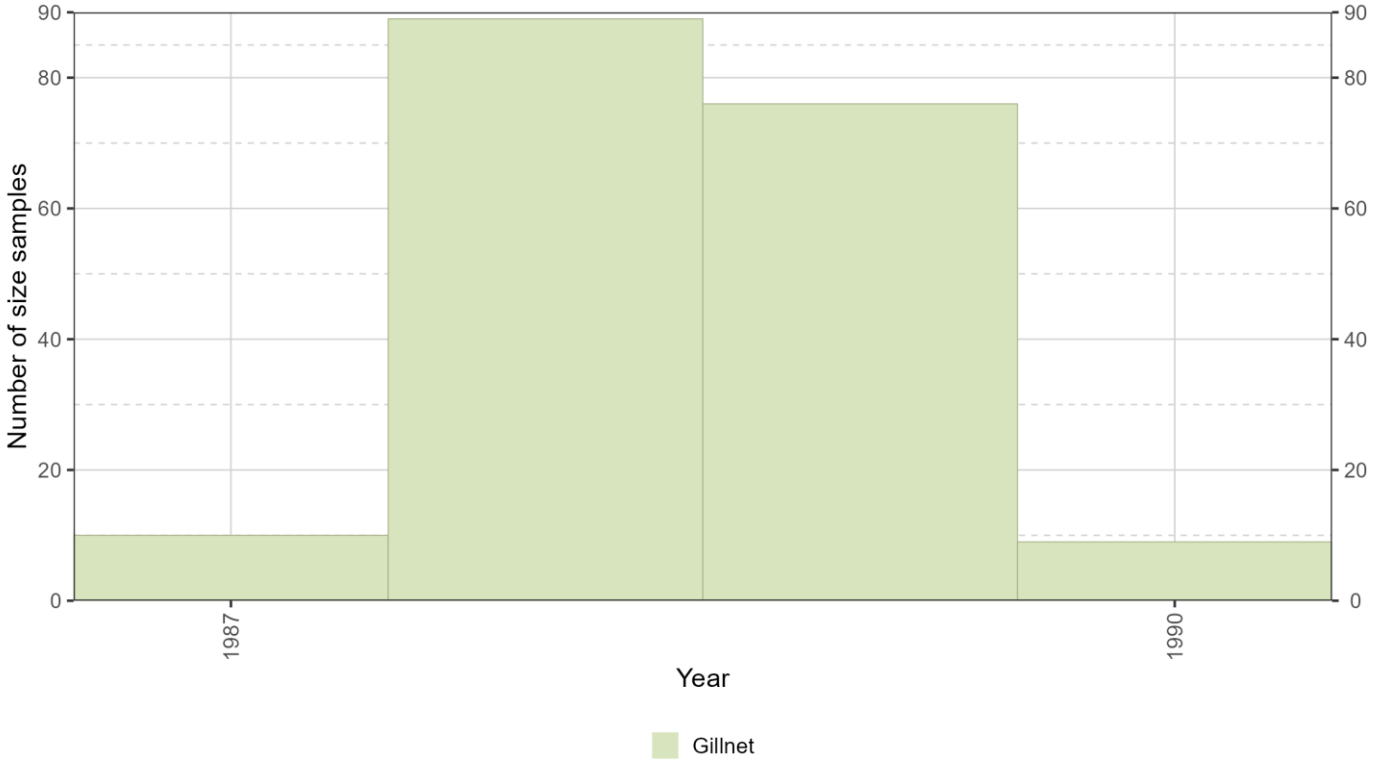

Figure 24: Availability of striped marlin size-frequency data as absolute number of samples per year in gillnet fisheries. Data source: standardized size-frequency dataset

Line fisheries

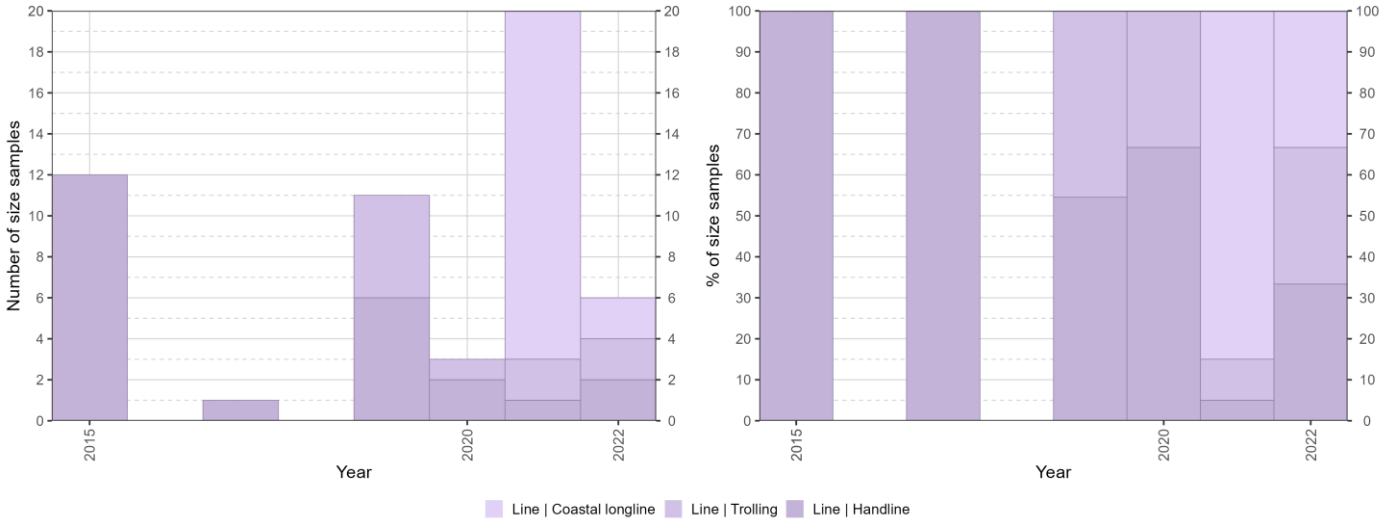

Figure 25: Availability of striped marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: standardized size-frequency dataset

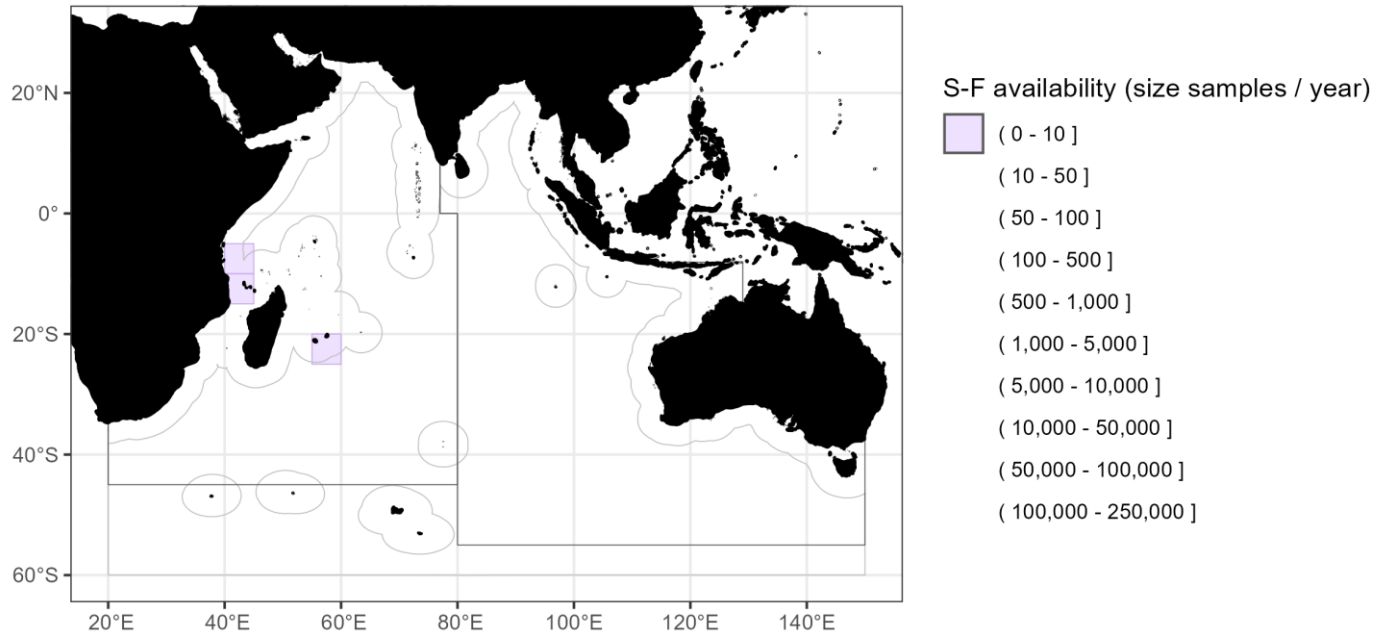

Figure 26: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by line (handline) fisheries in the period 2018-2022. Data source: standardized size-frequency dataset

Temporal patterns and trends in size distributions

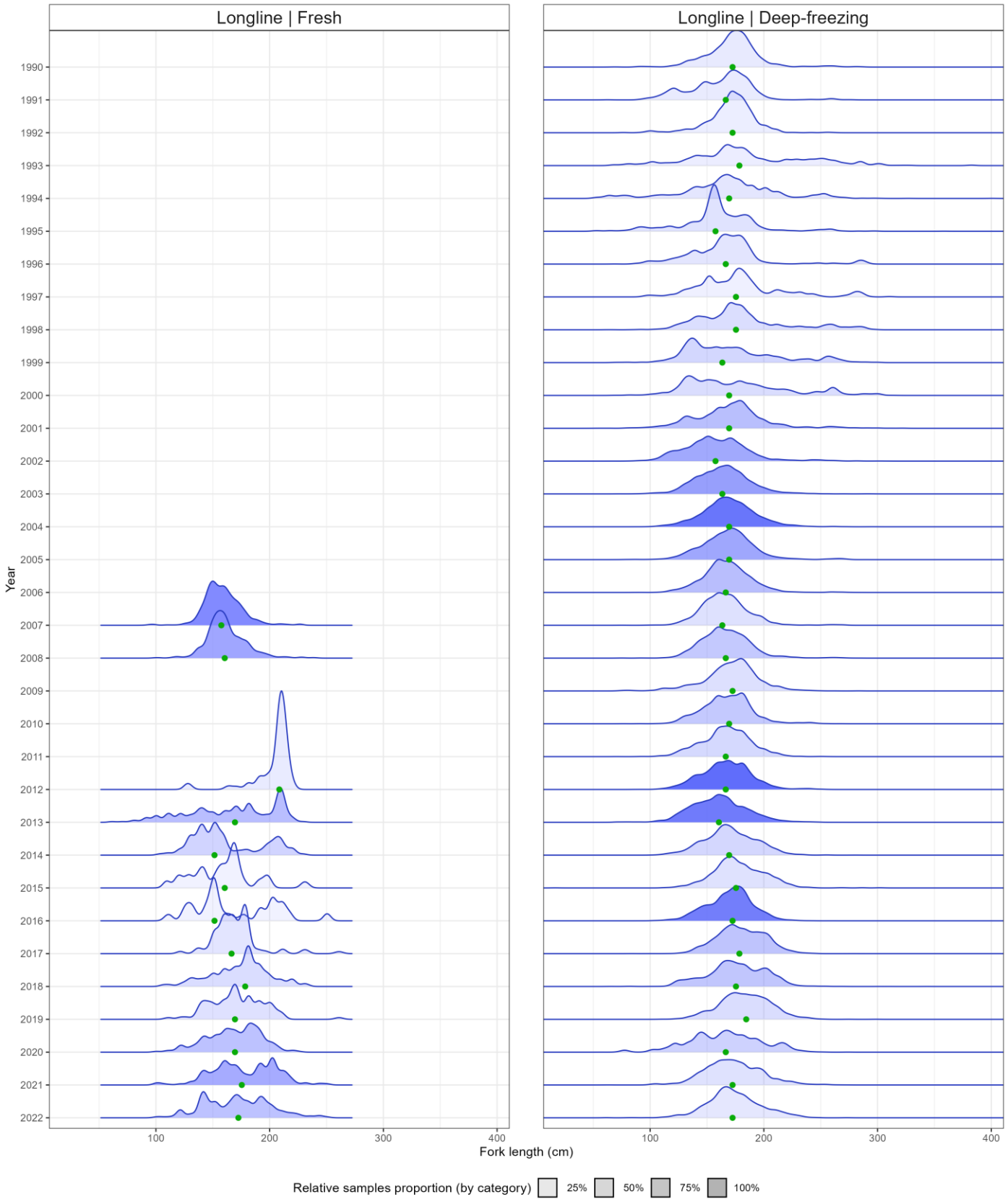

Figure 27: Relative size distribution (fork length; cm) of striped marlin caught by (left panel) fresh longline fisheries and (right panel) deep-freezing longline fisheries. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset

Size distribution by fishery and fleet

Deep-freezing longline fisheries

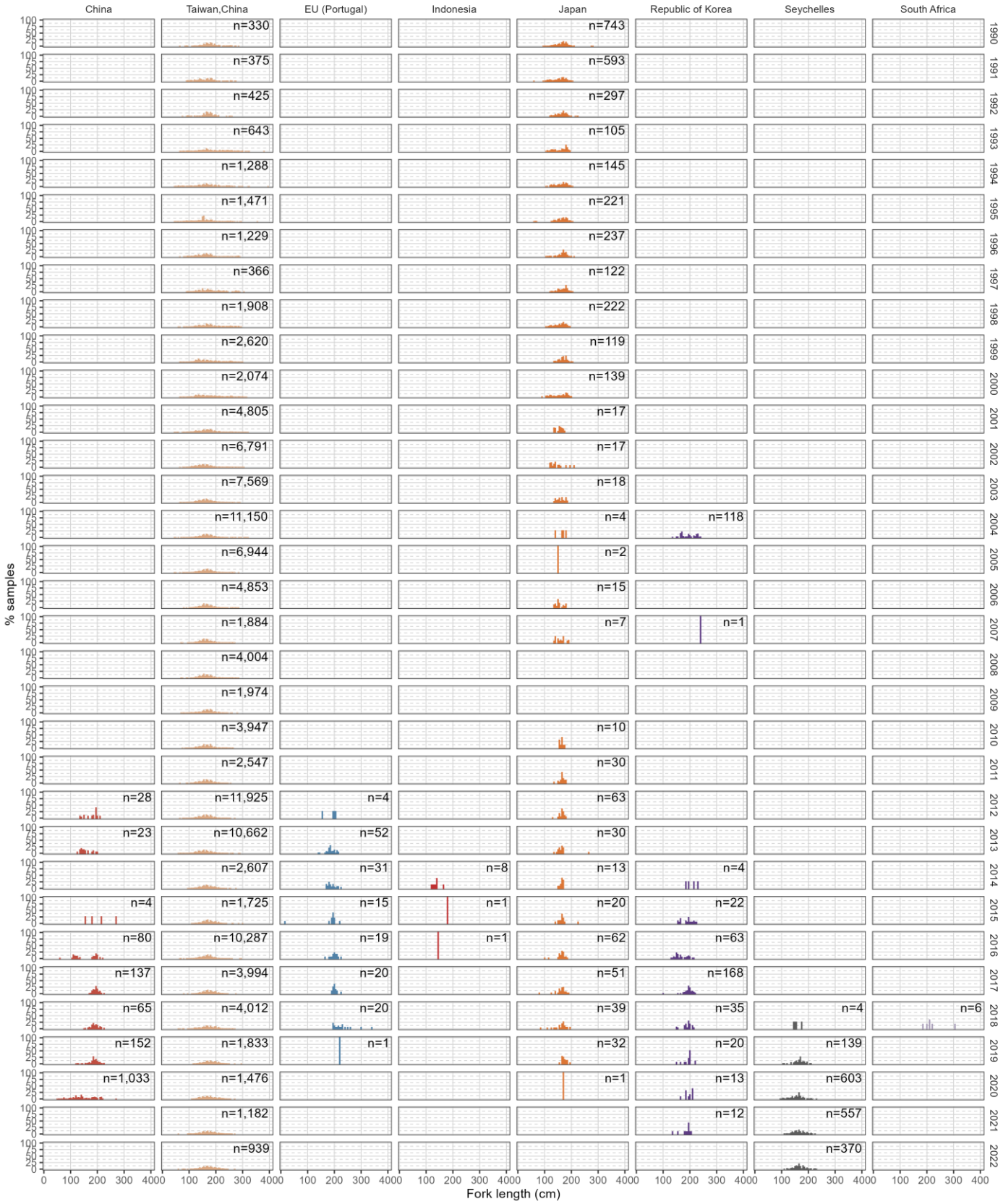

Figure 28: Relative size distribution of striped marlin (fork length; cm) recorded for deep-freezing longline fisheries by year and main fleet. Data source: standardized size-frequency dataset

Fresh longline fisheries

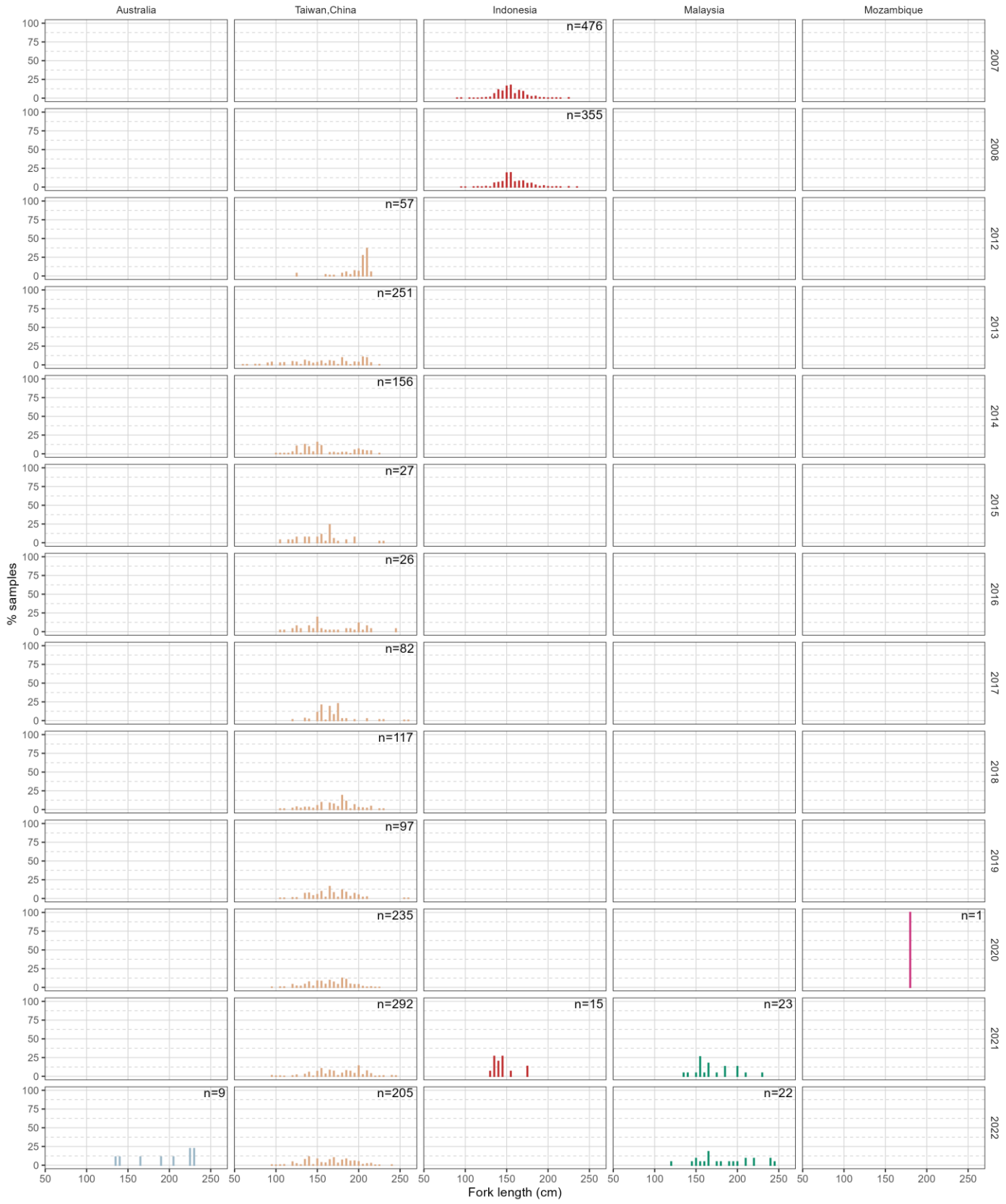

Figure 29: Relative size distribution of striped marlin (fork length; cm) recorded for fresh longline fisheries by year and main fleet. Data source: standardized size-frequency dataset

Uncertainties in size-frequency data

The availability of size frequency data for striped marlin is notably limited compared to the reported retained catches of the species. Major fleets that report striped marlin catches frequently do not collect size samples, and only fleets

with well-established data collection systems provide size samples for most species. As a result, the quality of the data is considered poor, with only 16% of the size sampling relative to the total striped marlin catch reported between 2018 and 2022 (**Fig. 30**).

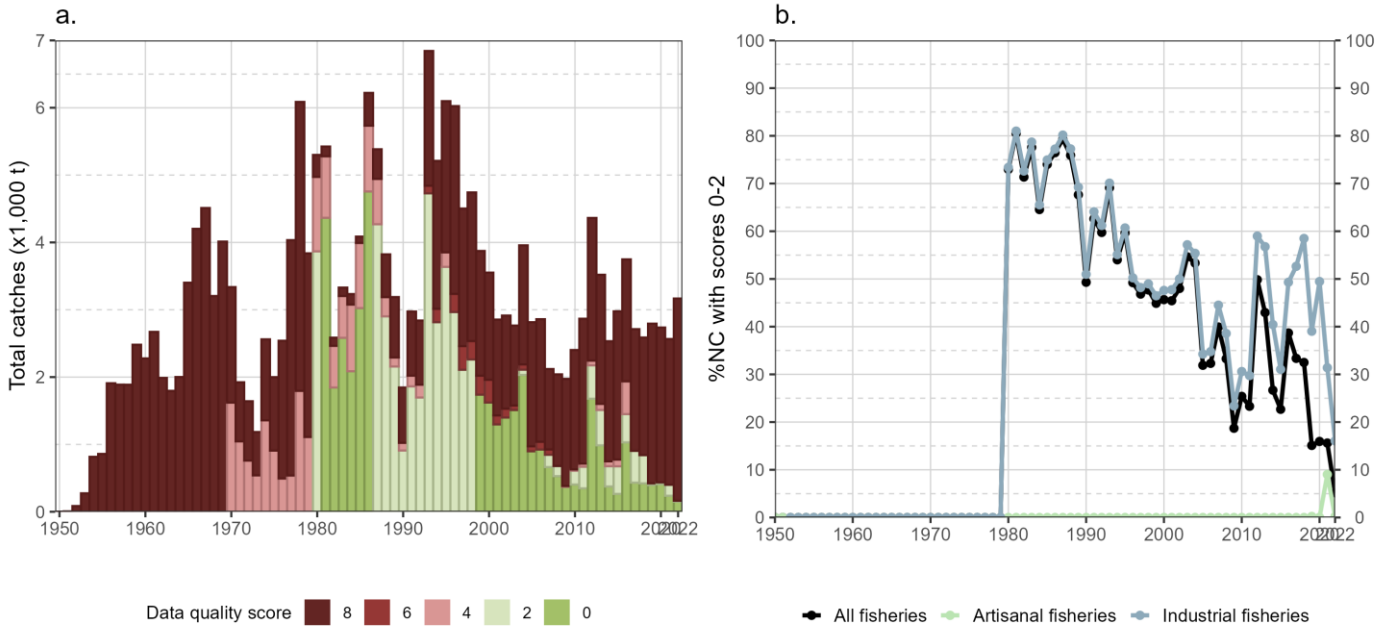

Figure 30: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches for which geo-referenced size-frequency data were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950–2022

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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	*Istiophoridae*
Genus	*Kajikia*
Species	*Kajikia audax*

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

Some minor improvements were made to the best scientific estimates of retained catches of striped marlin since the 21st session of the IOTC Working Party on Billfish (WPB10), with overall small modifications in the time series of annual catches (**Fig. 8**). The changes covering the period 2017-2021 were due to: (i) billfish aggregated catch affected by changed to in the latest catch breakdown of billfish species reported in recent years (Pakistan and India), and (ii) re-estimation of Indonesian 2017 catches by species to reflect the total catch (**Table 4**).

Table 4: Changes in best scientific estimates of annual retained catches (metric tonnes; t) of striped marlin 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)