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

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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 1,900 t annually and contribute around 52% of the total catches of striped marlin in 2023. 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 26,000 t in some years, the combined catch reported for 2023 was 10,400 t. Catch reports of striped marlin mostly came from the Pacific Ocean with 4,000 t in Eastern Pacific and 4,000 t Western and Central Pacific in 2023. Whereas the Indian Ocean only contributed 0.3419956% globally in 2023 (**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.

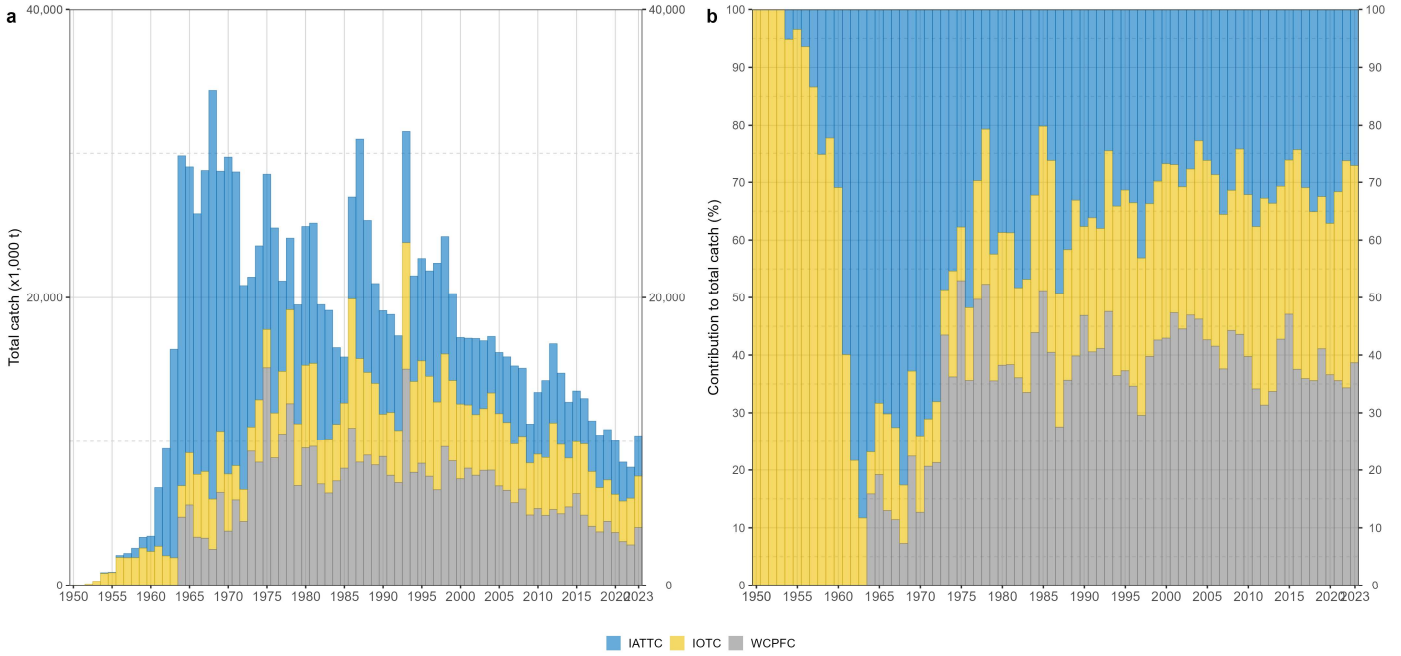

Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of striped marlin by region1950-2023. Source: (https://www.fao.org/fishery/statistics-query/en/capture/capture_quantity))

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 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 (**IOTC2025?**).

Total retained (nominal) catch

Historical trends (1950-2023)

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 9,000 t and fluctuated throughout the period, reaching the minimum catch at 2,600 t in 2020, and slightly increase in 2023 to around 4,000.

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).

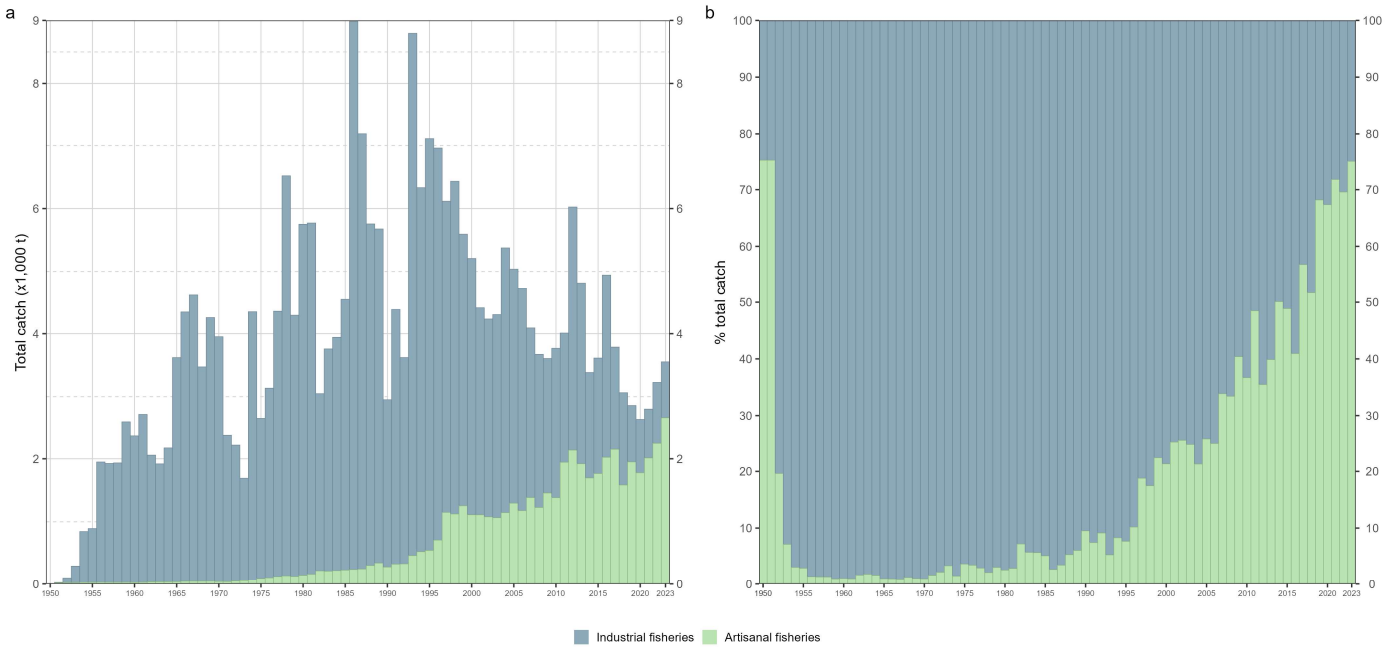

Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of striped marlin by type of fishery for the period 1950-2023. Data source: best scientific estimates of retained catches

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/23/Data/03-NC)

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Purse seine | Other	0	1	1	4	8	13	14
Longline | Other	0	0	0	12	51	89	79
Longline | Fresh	6	10	22	106	815	803	487
Longline | Deep-freezing	1,030	3,107	3,447	5,085	4,266	2,042	1,234
Line | Coastal longline	10	17	38	102	241	376	293
Line | Trolling	5	8	18	48	116	177	207
Line | Handline	1	2	4	10	23	35	56
Gillnet	6	11	24	75	307	926	1,645
Other	0	0	1	2	4	6	12
Total	1,058	3,154	3,554	5,443	5,831	4,466	4,027

Table 2: Annual retained catches (metric tonnes; t) of striped marlin 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	5	4	5	49	7	6	7	5	8	639
Longline | Other	56	82	103	88	53	54	36	27	22	26
Longline | Fresh	426	359	382	272	211	162	128	96	54	139
Longline | Deep-freezing	656	908	2,089	853	734	328	337	250	173	330
Line | Coastal longline	155	95	87	212	117	49	50	57	47	309
Line | Trolling	204	202	206	190	198	61	10	78	15	49
Line | Handline	96	27	54	53	27	42	95	102	50	0
Gillnet	1,778	1,924	2,006	2,049	1,700	2,143	1,958	2,177	2,851	2,053
Other	8	13	12	20	18	15	18	11	7	8
Total	3,384	3,613	4,944	3,787	3,063	2,860	2,639	2,803	3,227	3,553

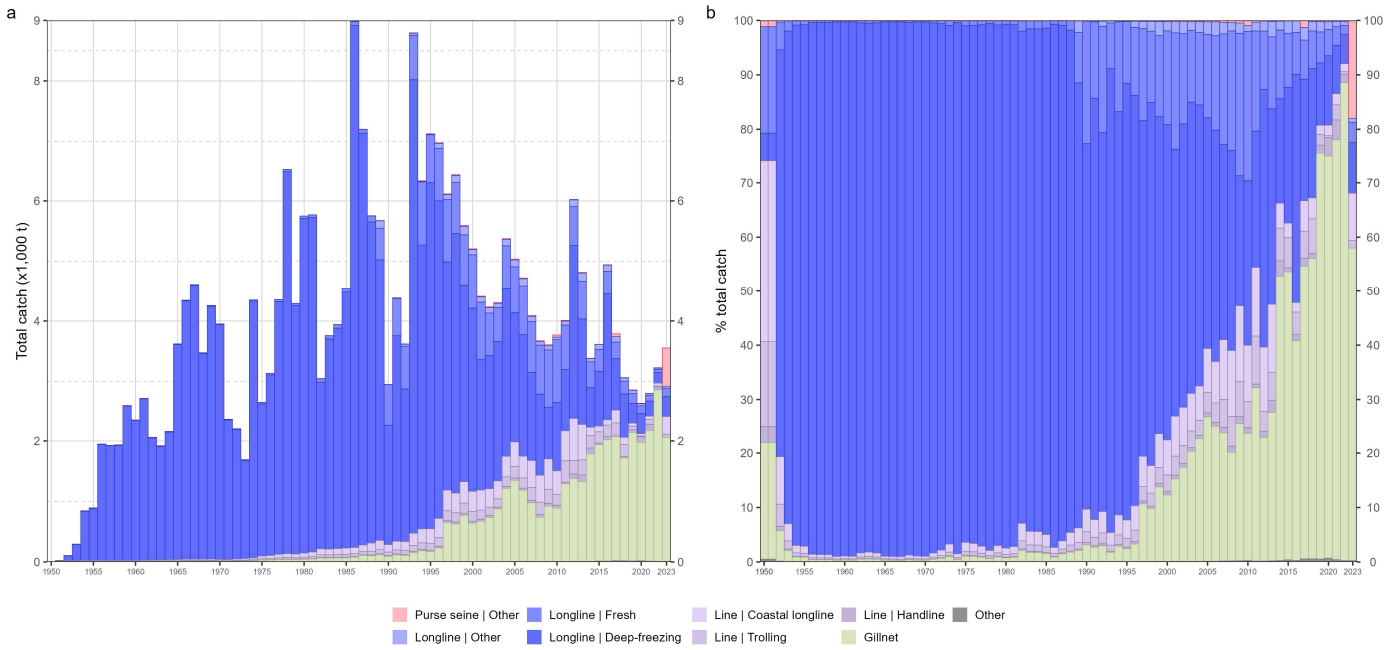

Figure 3: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of striped marlin by fishery for the period 1950-2023. Data source: [best scientific estimates of retained catches]

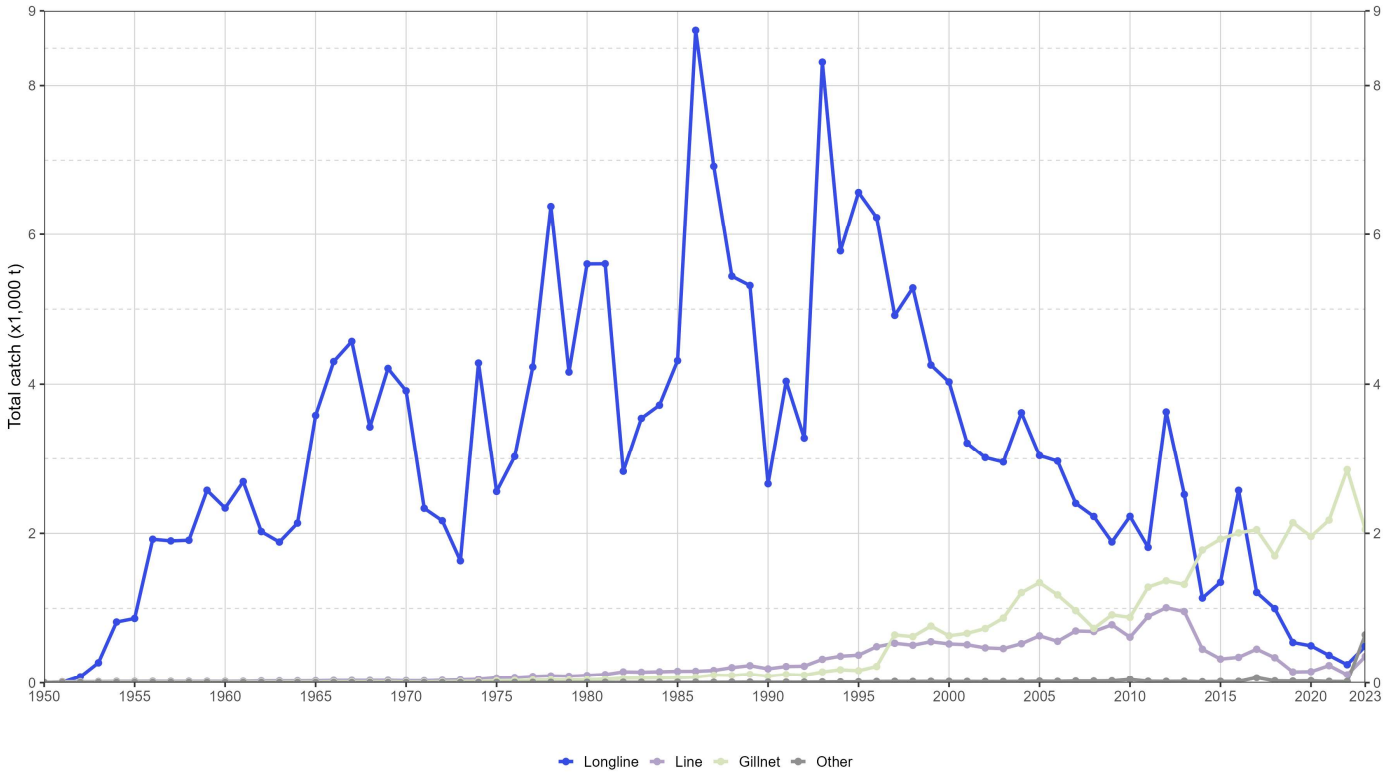

Figure 4: Annual time series of retained catches (metric tonnes; t) of striped marlin by fishery group for the period 1950-2023. Data source: [best scientific estimates of retained catches]

Main fishery features (2019-2023)

In recent years striped marlin have been principally caught by gillnet fisheries, contributing 74.1 showing increasing trends from 2013 (**Table 3**). Fleet-wise, I.R. Iran accounted for over 35% of striped marlin, solely caught from gillnet fisheries, followed by Pakistan and Indonesia with 27% and 16%, 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, is very high for Indonesia in 2023 and longline fisheries,is increasing for most major fleets in 2023 (**Figs. 6-7**).

Table 3: Mean annual catches (metric tonnes; t) of striped marlin 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
Gillnet	GN	2,236	74.1
Longline | Deep-freezing	LLD	284	9.4
Purse seine | Other	PSOT	133	4.4
Longline | Fresh	LLF	116	3.8
Line | Coastal longline	LIC	102	3.4
Line | Handline	LIH	58	1.9
Line | Trolling	LIT	43	1.4
Longline | Other	LLO	33	1.1
Other	OT	12	0.4

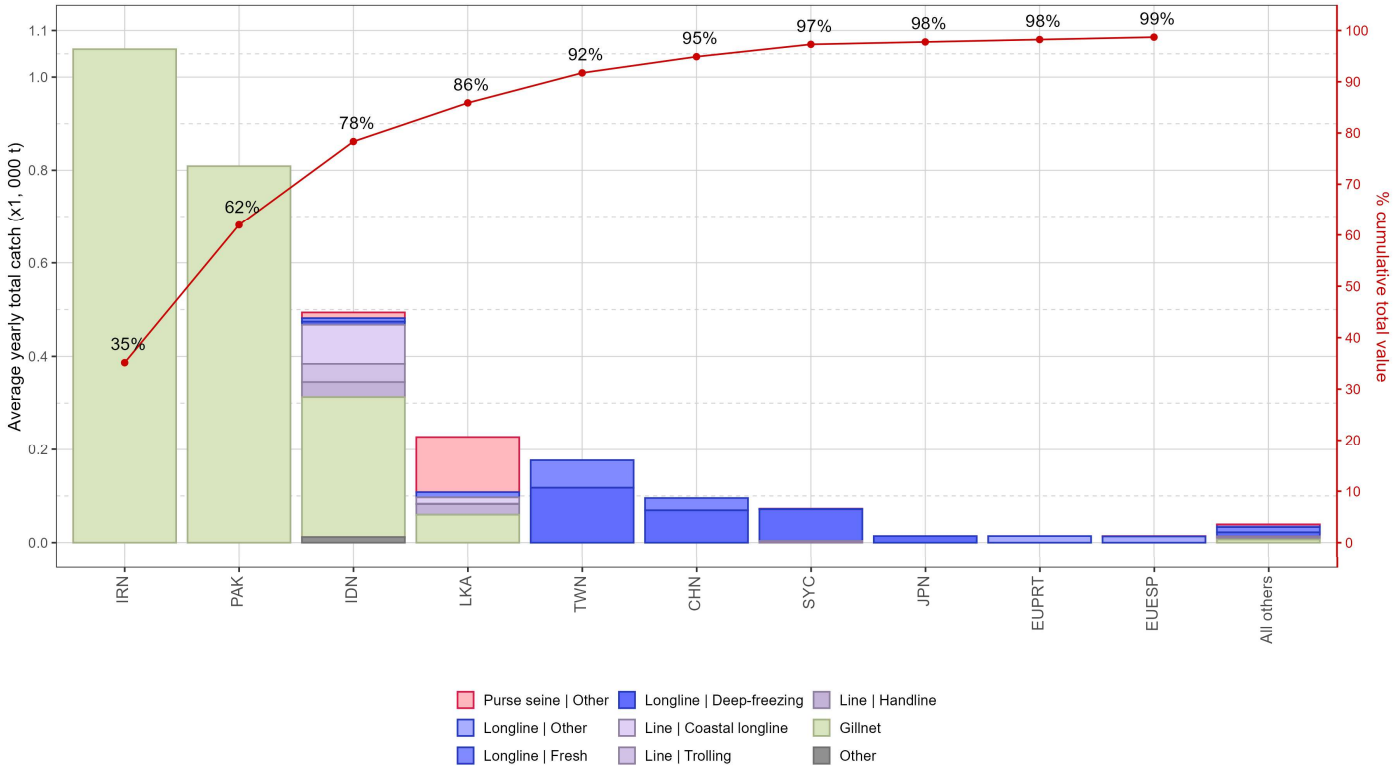

Figure 5: Mean annual catches (metric tonnes; t) of striped marlin by fleet and fishery between 2019 and 2023, with indication of cumulative catches by fleet. Data source: [best scientific estimates of retained catches]

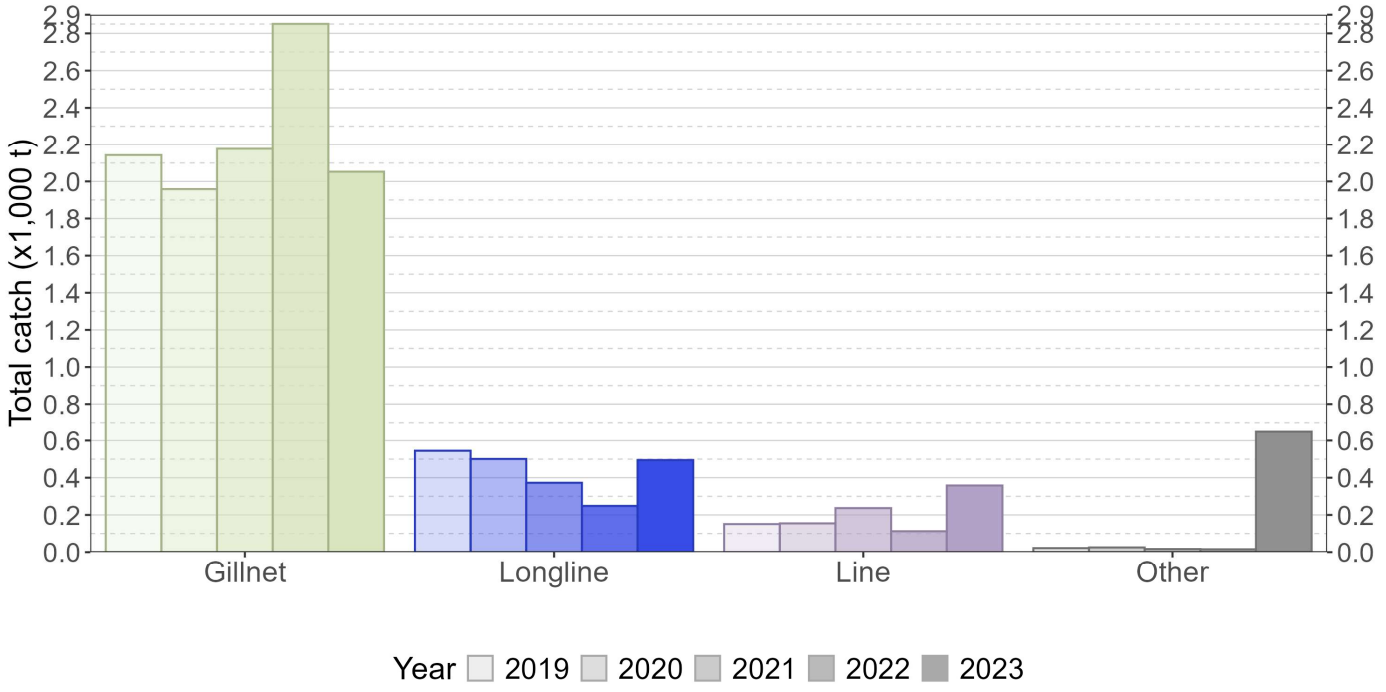

Figure 6: Annual catch (metric tonnes; t) trends of striped marlin by fishery group between 2019 and 2023. Data source: [best scientific estimates of retained catches]

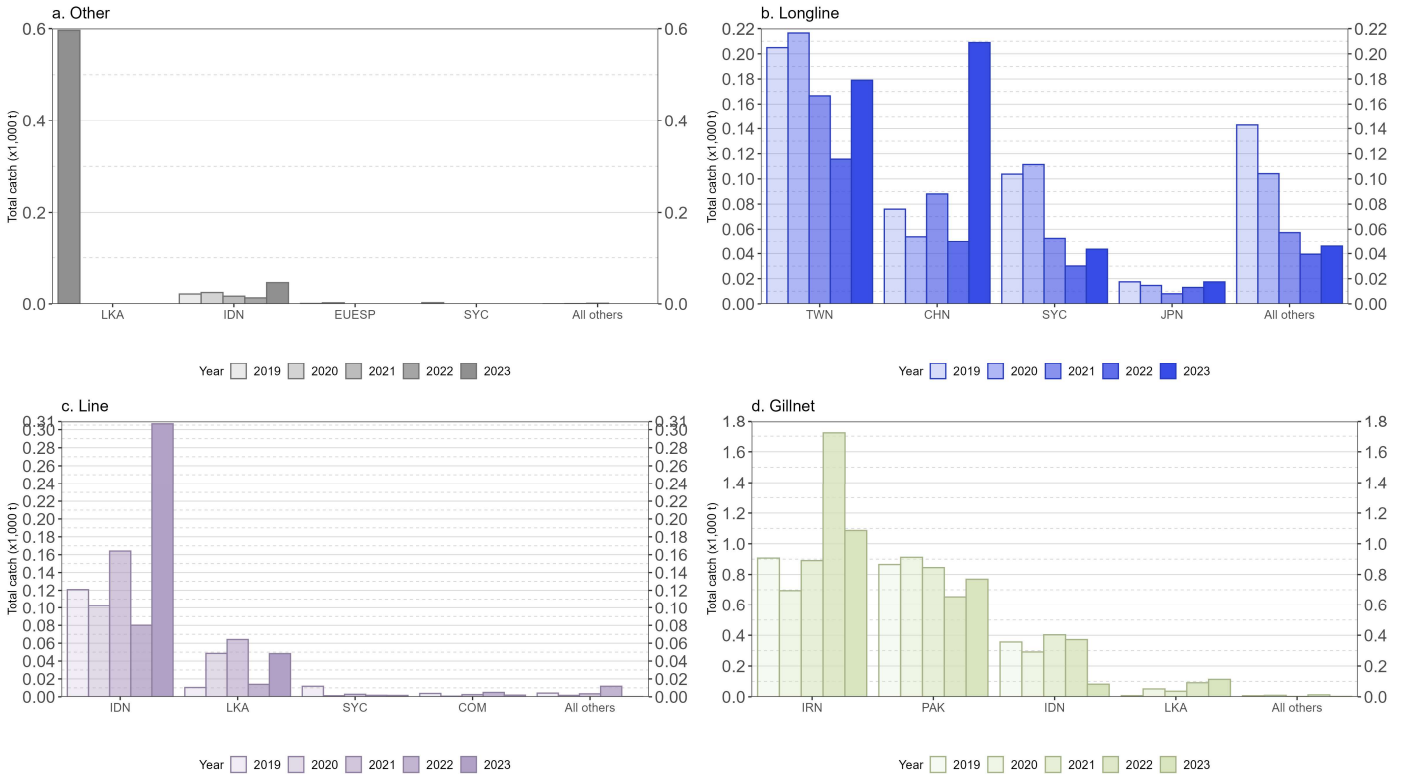

Figure 7: Annual catch (metric tonnes; t) trends of striped marlin by fishery group and fleet between 2019 and 2023. Data source: [best scientific estimates of retained catches]

Changes from previous Working Party

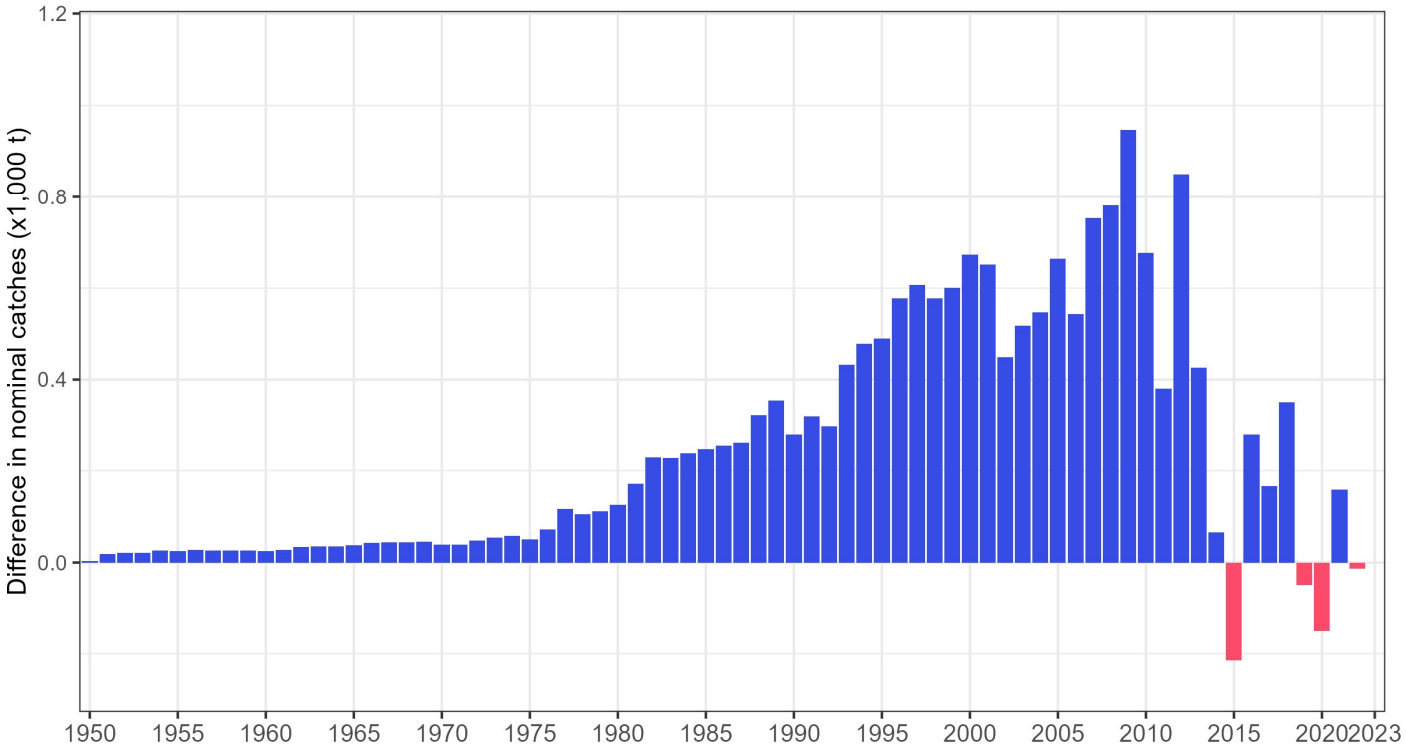

Figure 8: Differences in the available best scientific estimates of retained catches (metric tonnes; t) of striped marlin between this WPB and its previous session (WPB22 meeting held in September 2024)

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, about3% are estimated , with 7.5% in 2023 overall (**Fig. 9**). The partial availability of retained catches of striped marlin is mainly from coastal fisheries of India, 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.

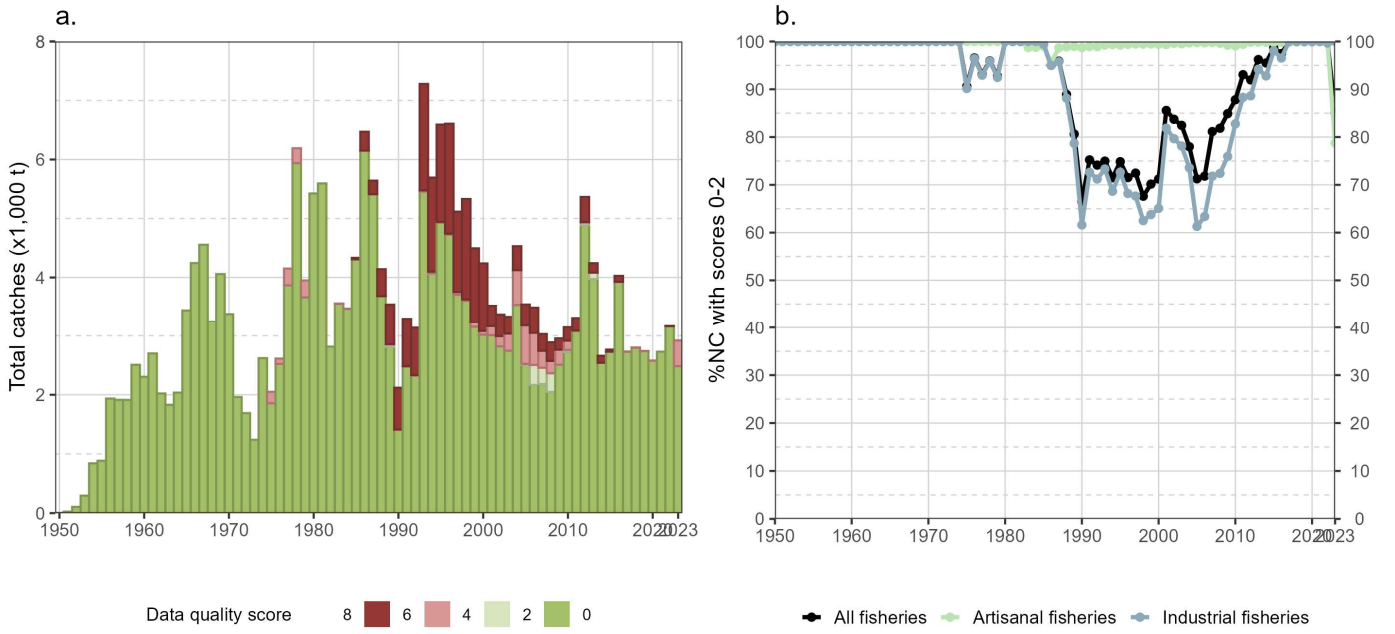

Figure 9: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches fully/partially reported to the IOTC Secretariat for all fisheries and by type of fishery, in the period 1950-2023

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**).

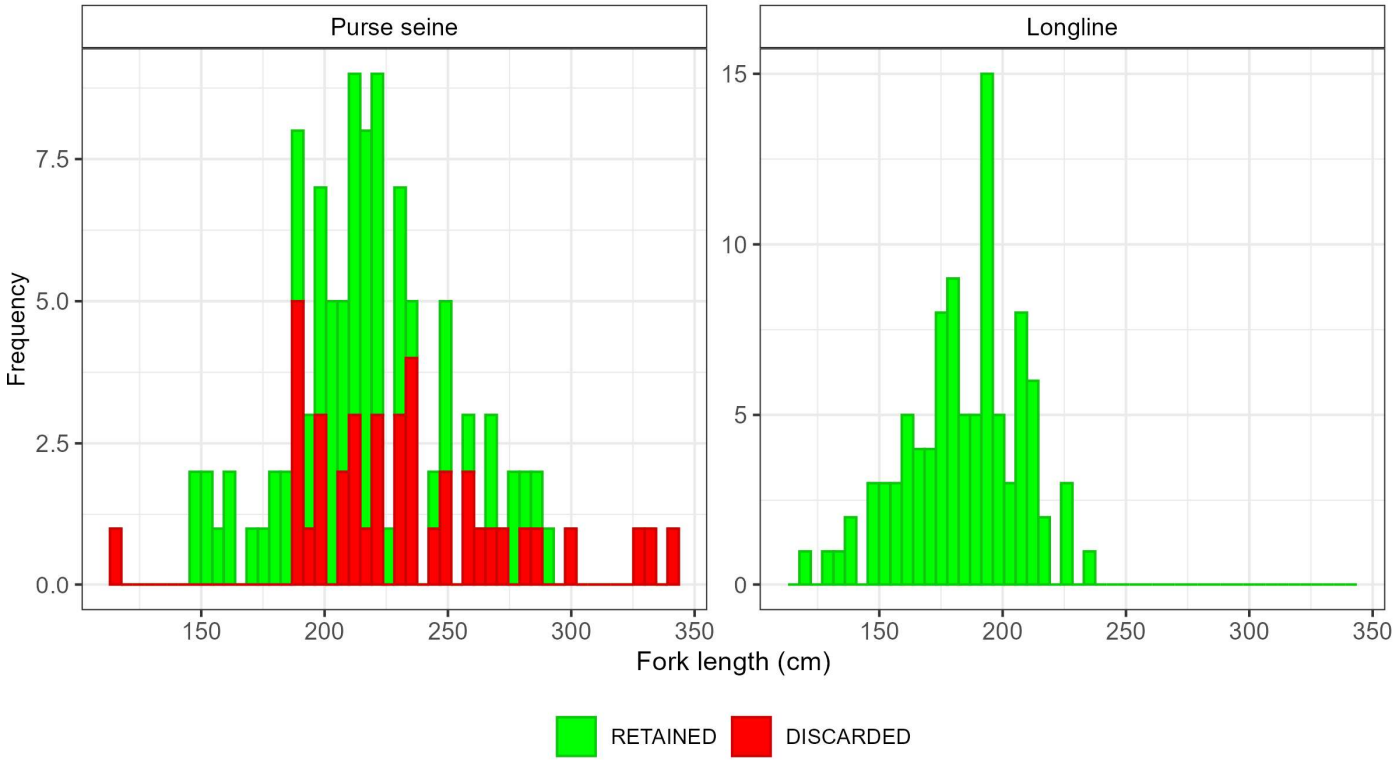

Figure 10: Size (fork length; cm) frequency distribution of striped marlin retained and discarded at sea in purse seine and longline fisheries as available in the ROS regional database

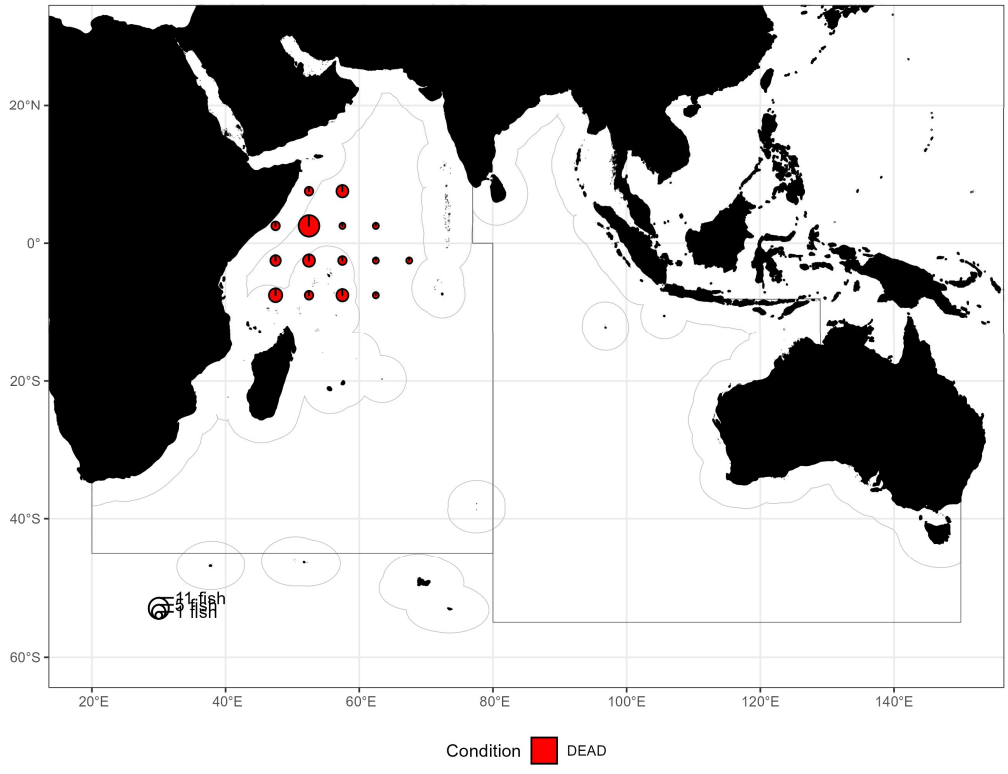

Figure 11: Distribution of striped marlins discarded at sea in the western Indian Ocean purse seine fisheries with information on condition at release as available in the ROS regional database

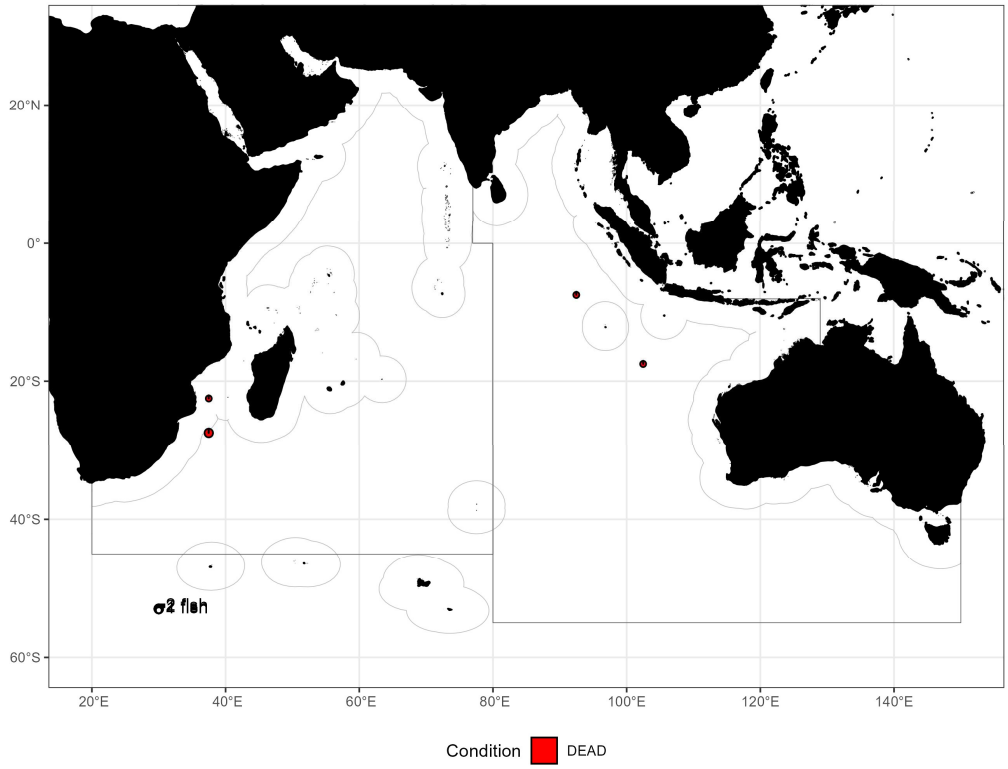

Figure 12: Distribution of striped marlins discarded at sea in the Indian Ocean longline fisheries with information on condition at release as available in the ROS regional database

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, besides in 2023, where some geo-referenced catches are available from Iranian gillnet fisheries.

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

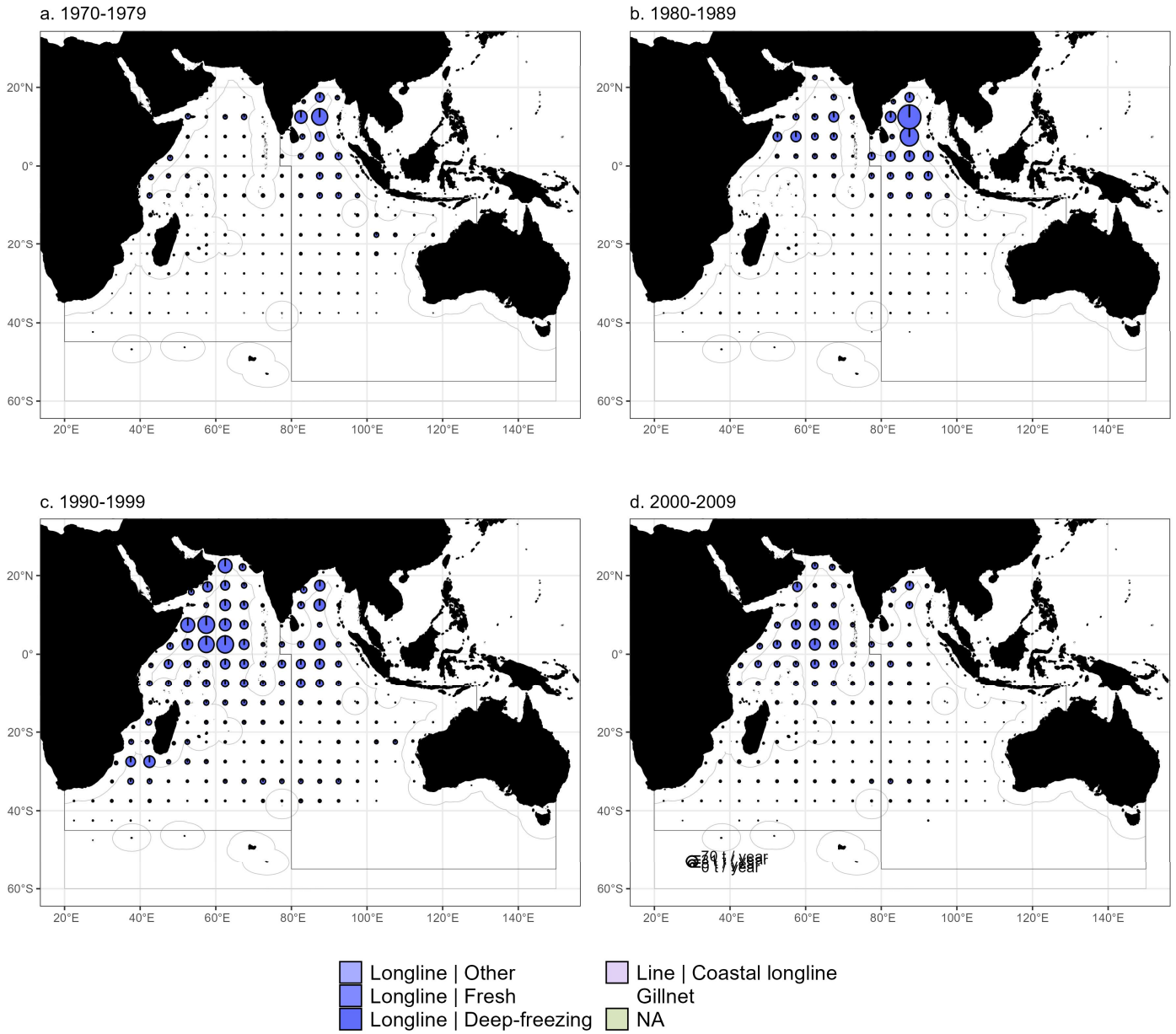

Figure 13: Mean annual time-area catches in weight (metric tonnes; t) of striped marlin, by decade, 5x5 grid, and fishery. Data source: time-area catches

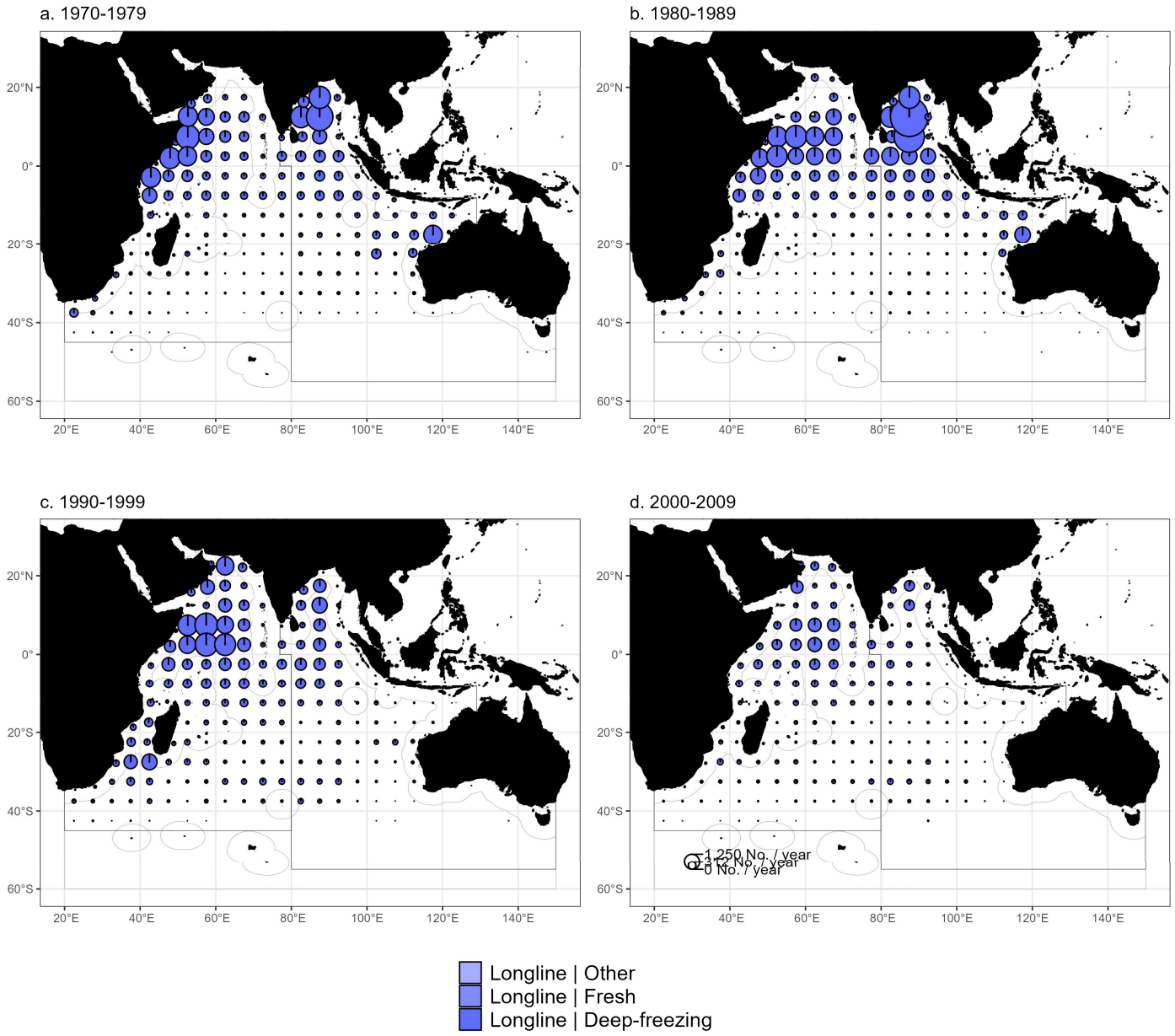

Figure 14: Mean annual time-area catches in numbers of striped marlin, by decade, 5x5 grid, and fishery. Data source: time-area catches

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

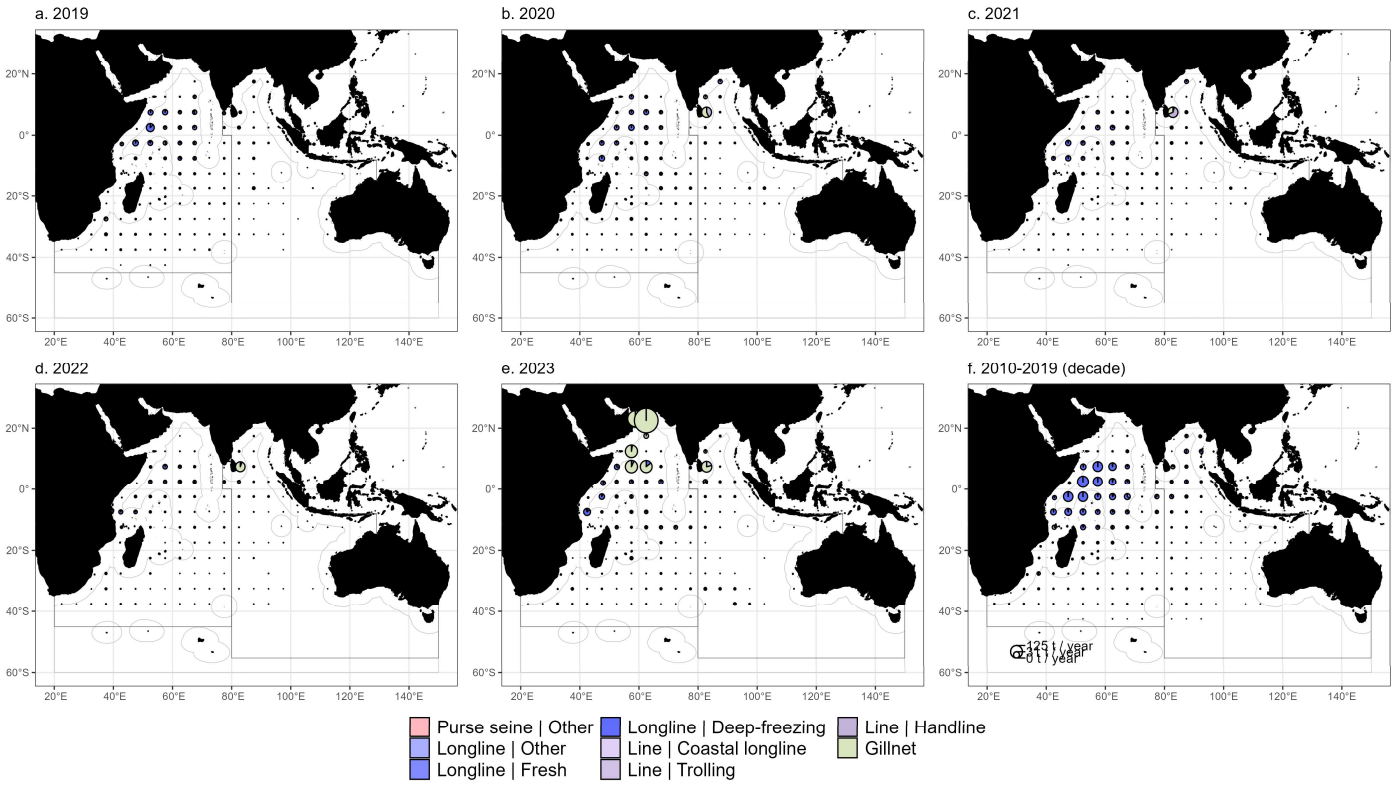

Figure 15: Mean annual time-area catches in weight (metric tonnes; t) of striped marlin, by year / decade, 5x5 grid, and fishery. Data source: time-area catches

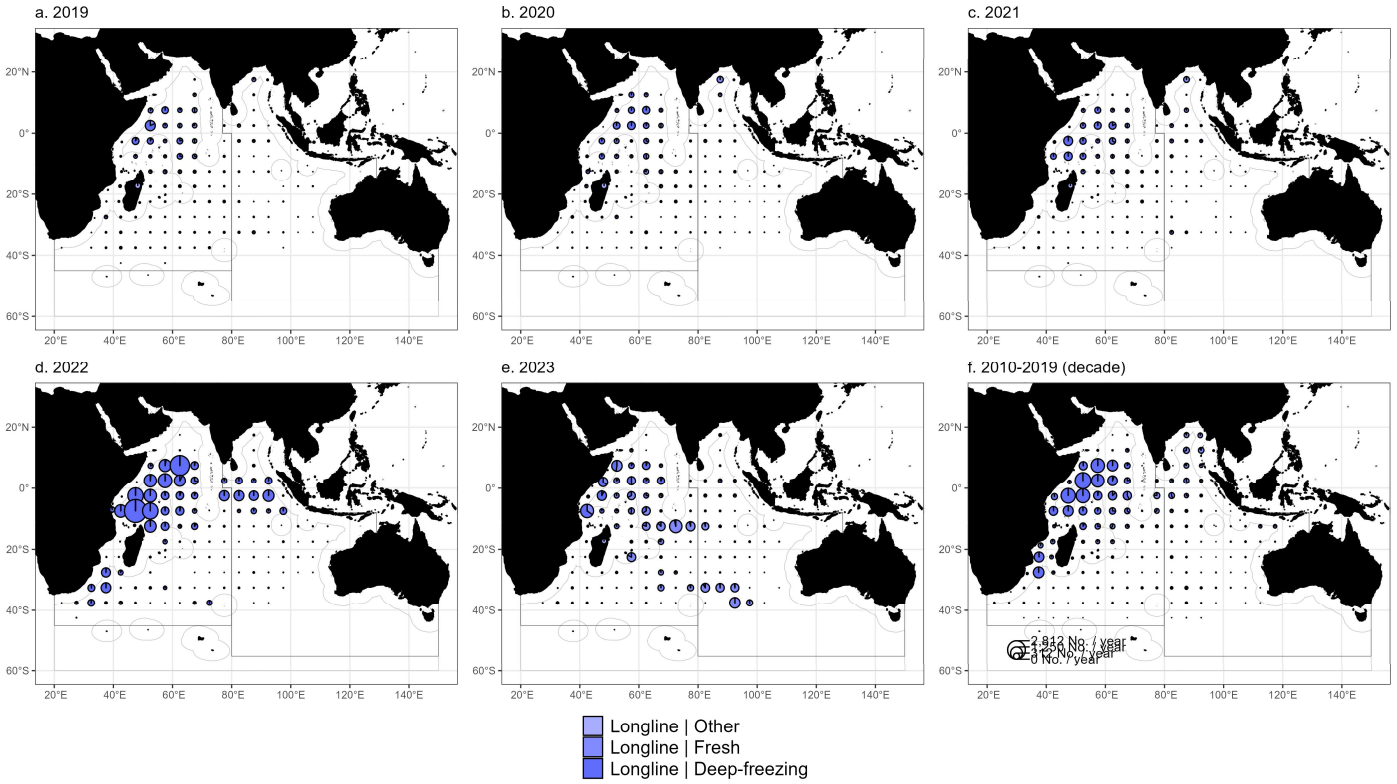

Figure 16: Mean annual time-area catches in numbers of striped marlin, by year / decade, 5x5 grid, and fishery. Data source: time-area catches

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 2019 and 2023, 26% of the geo-referenced catch data for striped marlin has been reported as compared to total retained catches. There are remarkable availability of geo-referenced catch in 2023, attributed to improvement in the reporting by Islamic Republic of Iran, at 58% (**Fig. 17**).

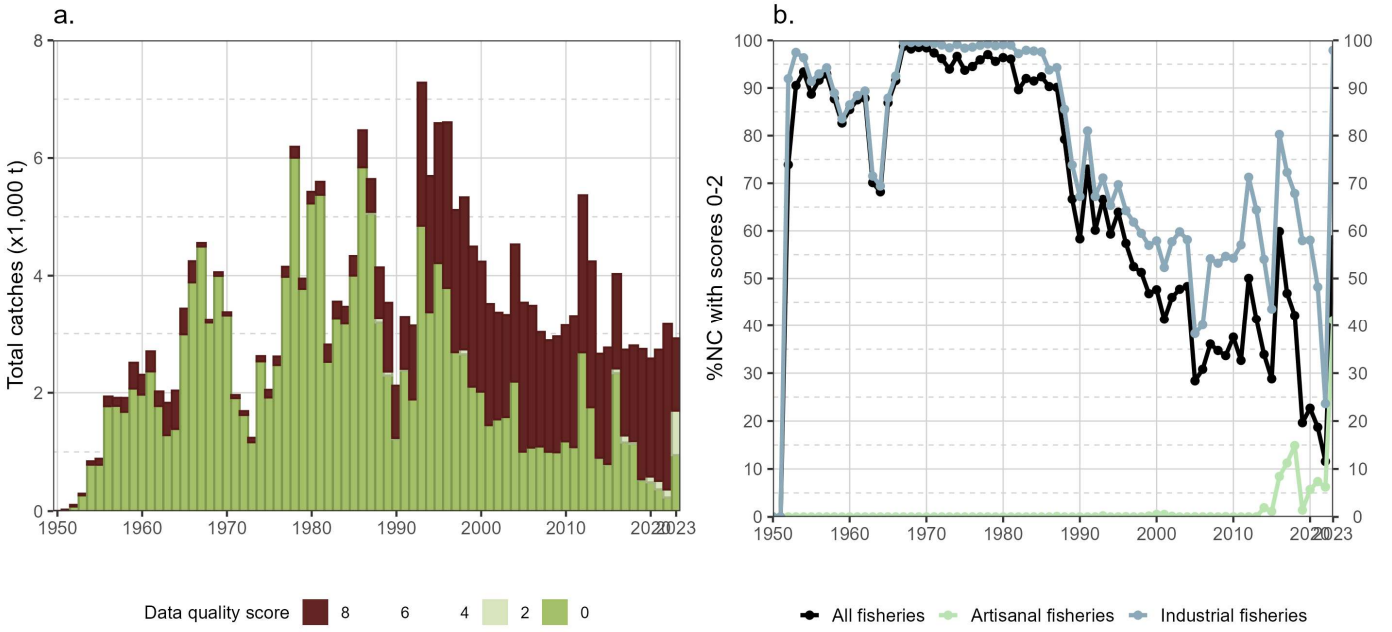

Figure 17: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches for which geo-referenced catches were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of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

Size composition of the catch

Samples availability

Size frequency data for striped marlin are notably scarce compared to other billfish species, representing only 6.8% of the total size samples available for all billfish species. In recent years, coastal fisheries have increasingly dominated marlin catches, although there are no sample recorded from these fisheries. 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

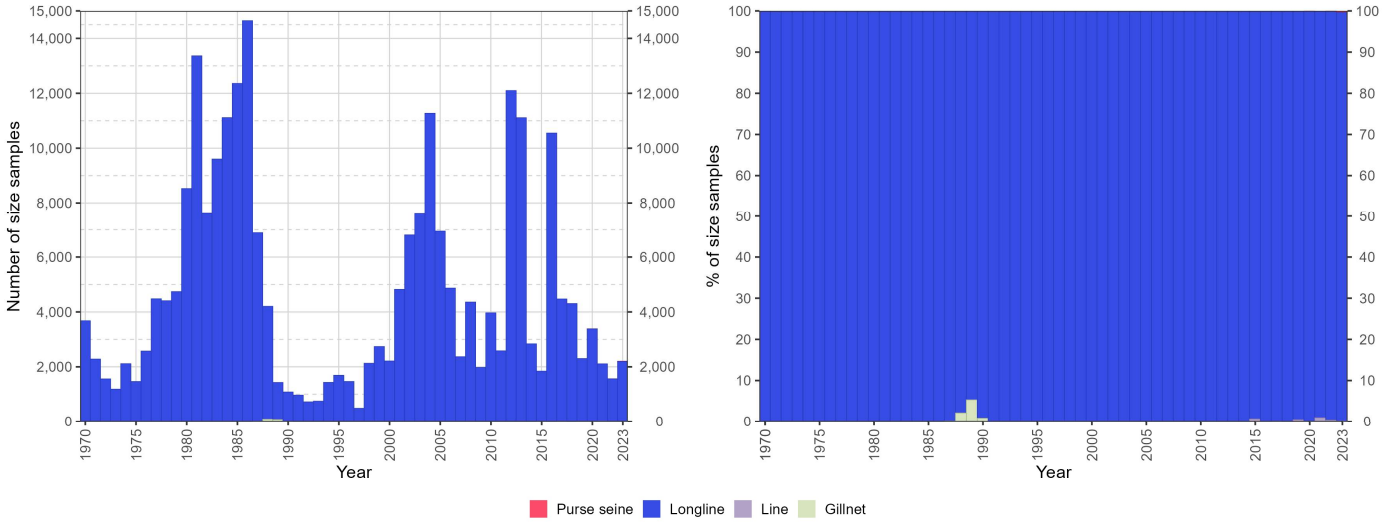

Figure 18: Availability of striped marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset

Longline fisheries

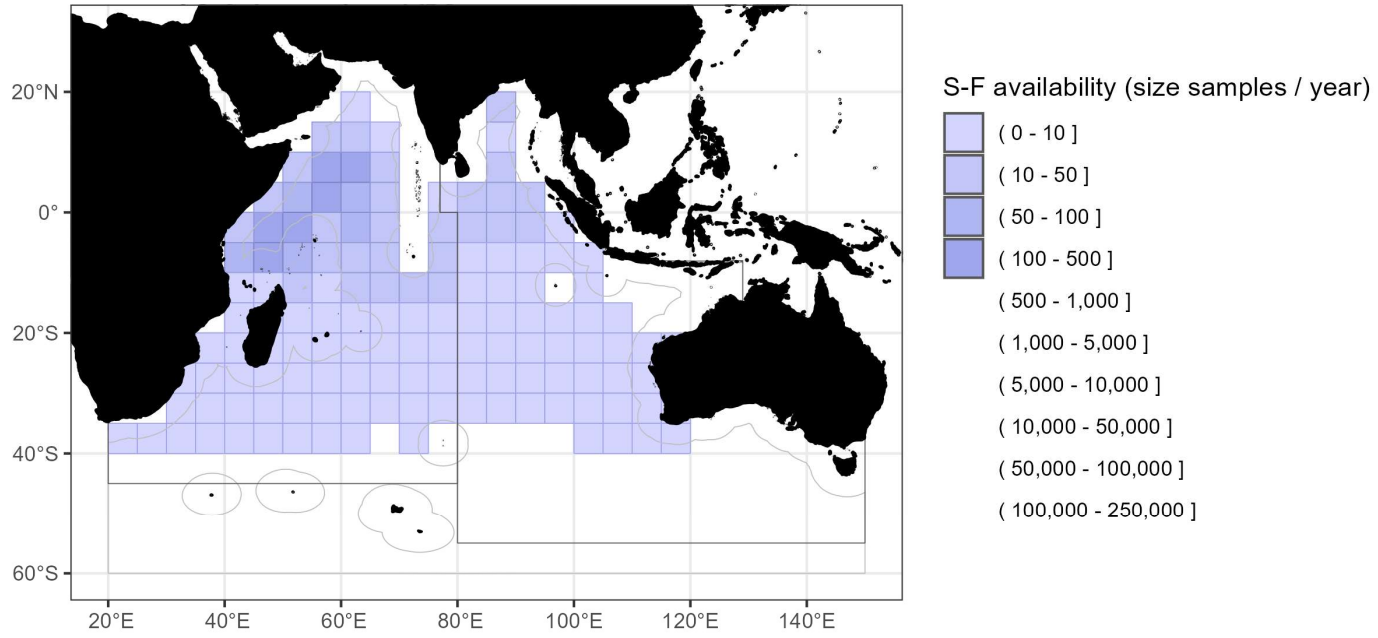

Figure 19: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data for longline fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Line fisheries

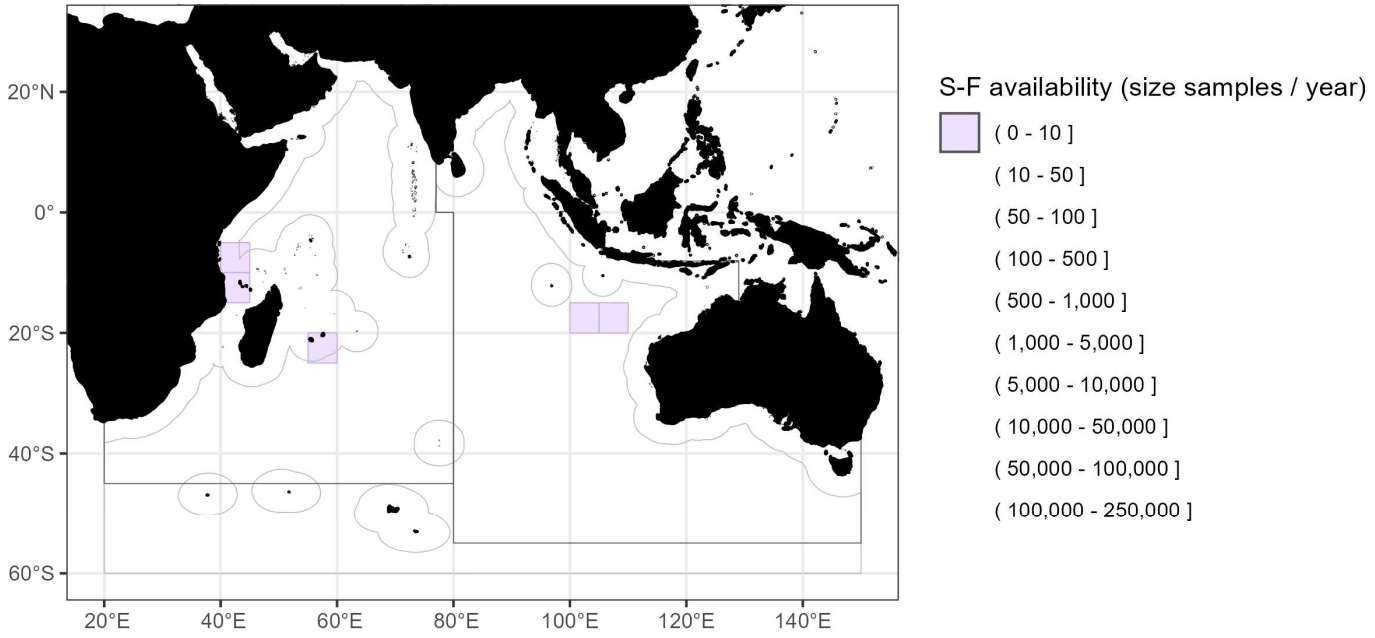

Figure 20: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data for line fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

By fishery

Deep-freezing longline fisheries

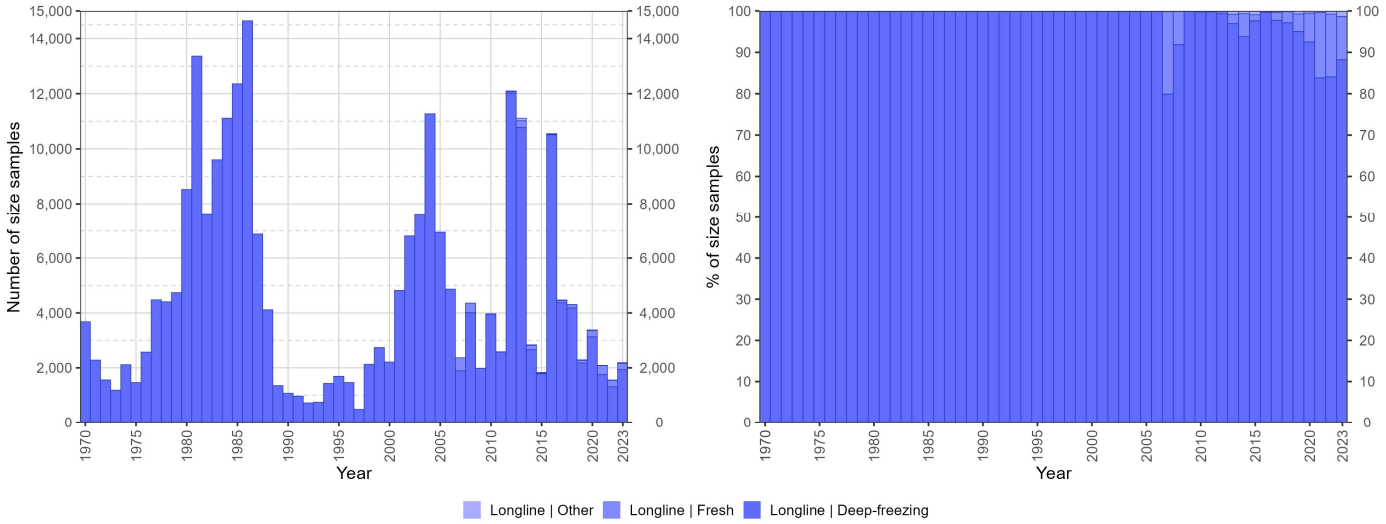

Figure 21: Availability of striped marlin size-frequency data as absolute number of samples per year and longline fishery. Data source: standardized size-frequency dataset

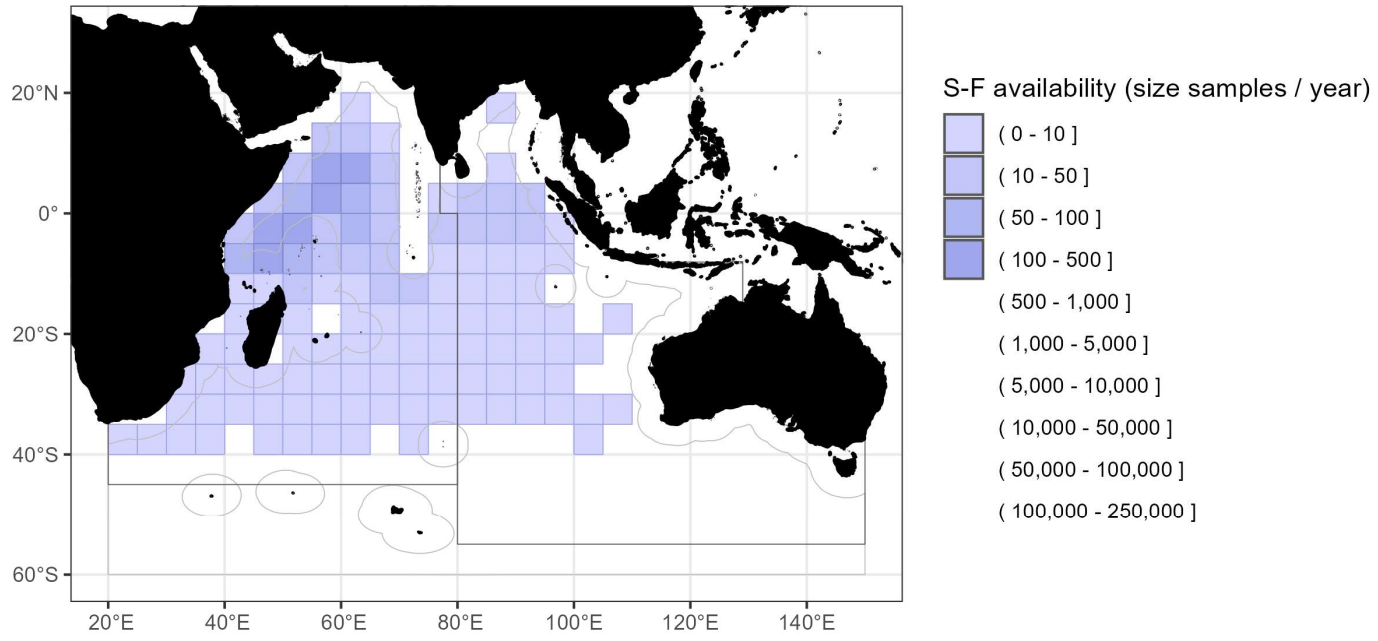

Figure 22: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by deep-freezing longline fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

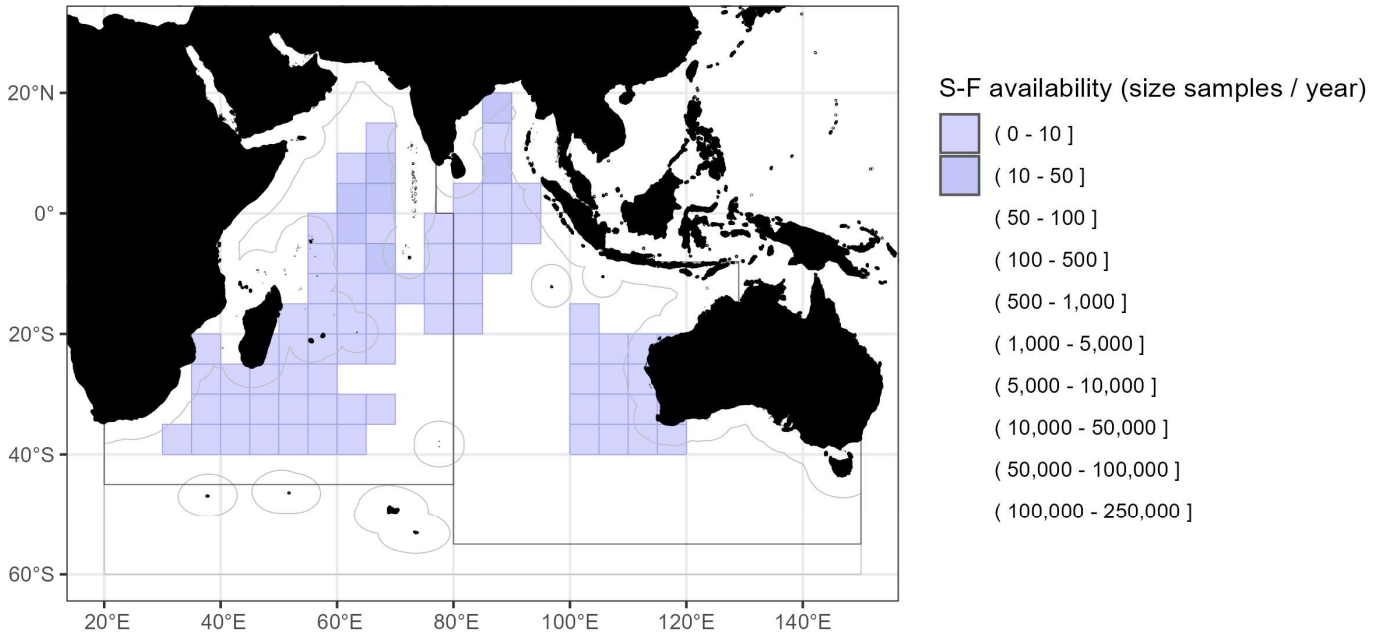

Figure 23: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by fresh longline fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Gillnet fisheries

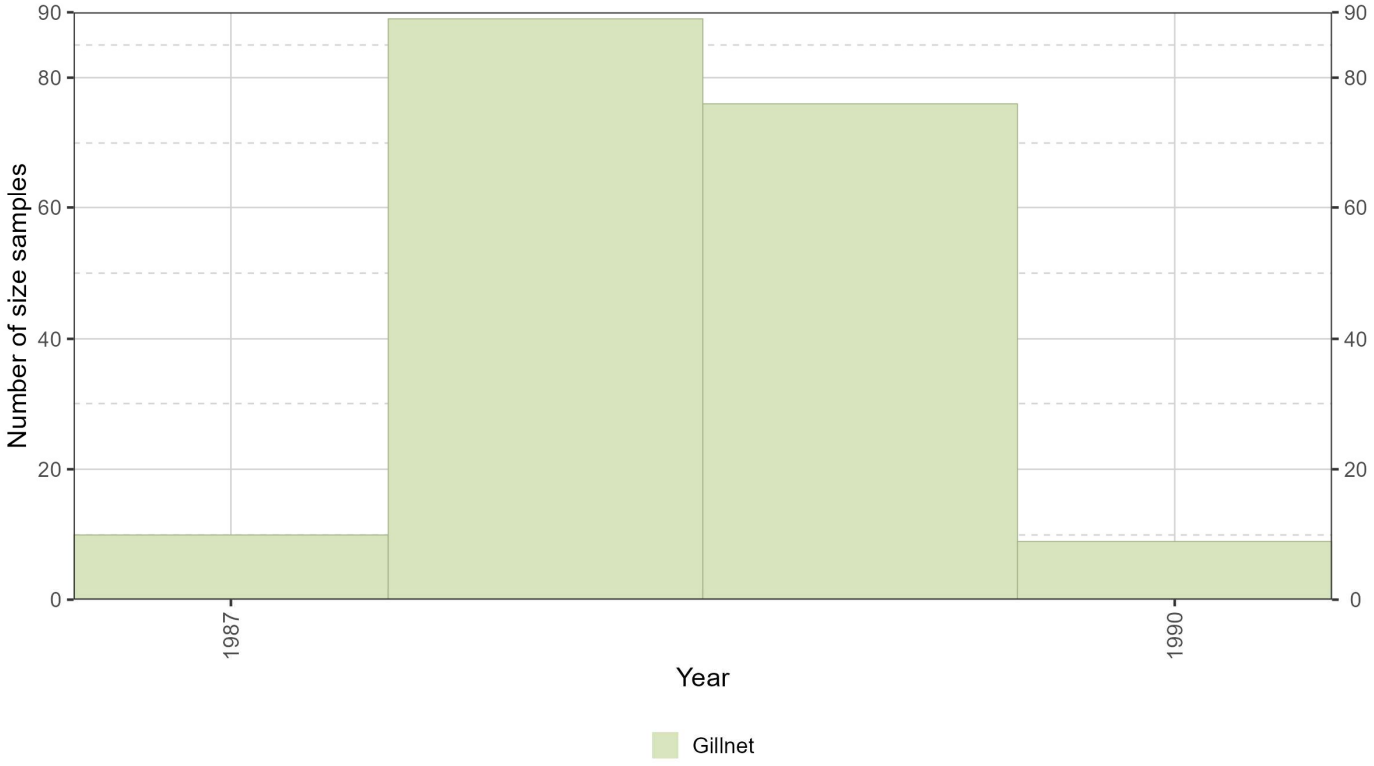

Figure 24: Availability of striped marlin size-frequency data as absolute number of samples per year in gillnet fisheries. Data source: standardized size-frequency dataset

Line fisheries

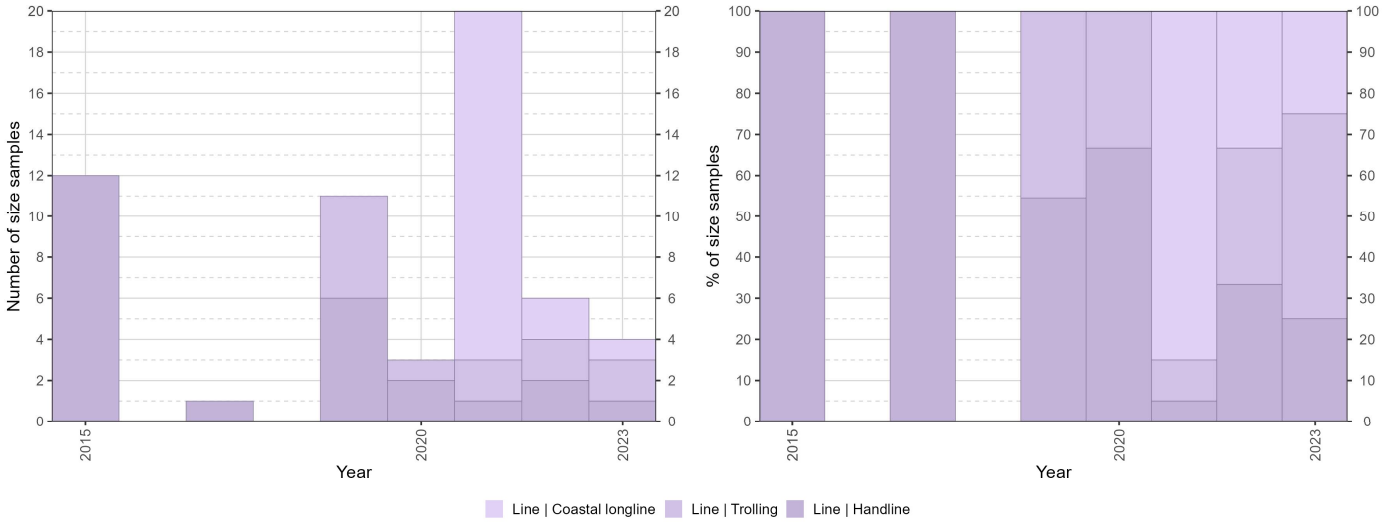

Figure 25: Availability of striped marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: standardized size-frequency dataset

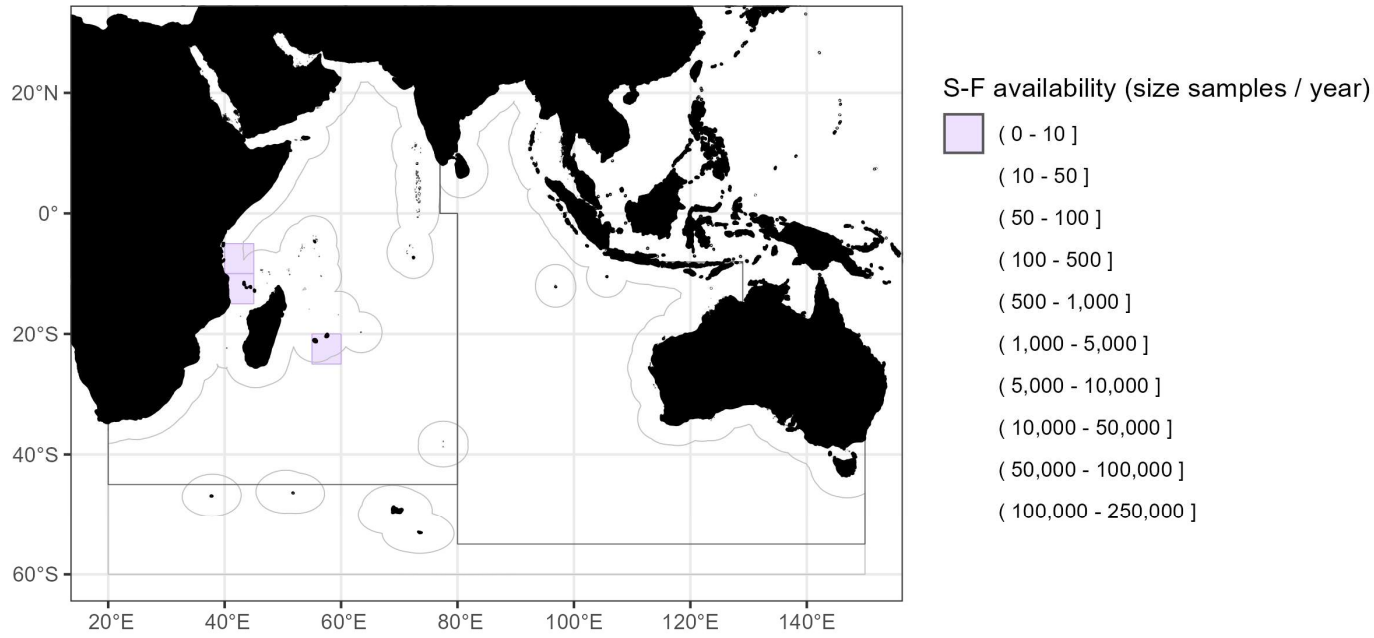

Figure 26: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by line (handline) fisheries in the period 2019-2023. Data source: standardized size-frequency dataset

Temporal patterns and trends in size distributions

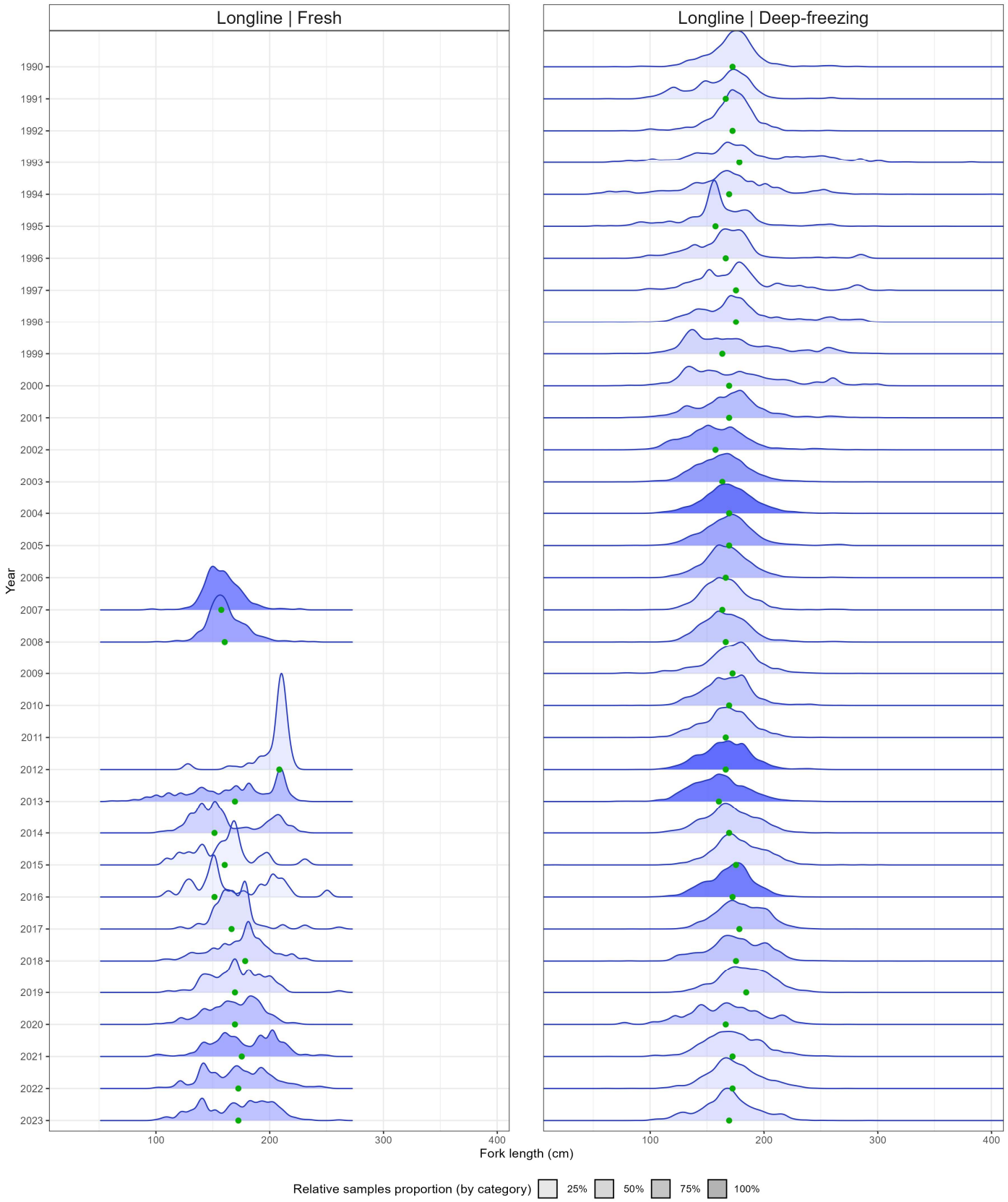

Figure 27: Relative size distribution (fork length; cm) of striped marlin caught by (left panel) fresh longline fisheries and (right panel) deep-freezing longline fisheries. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value.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

Size distribution by fishery and fleet

Deep-freezing longline fisheries

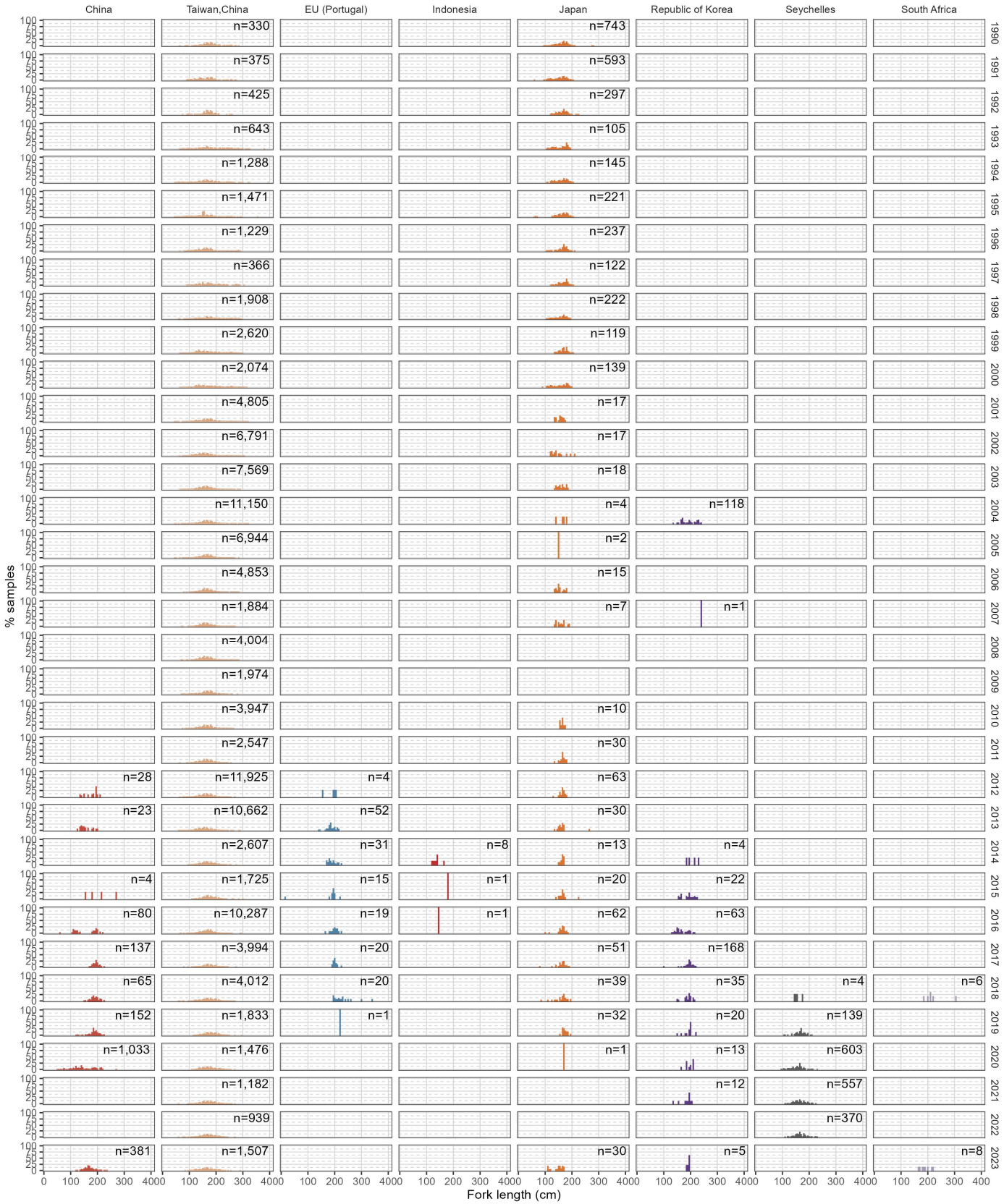

Figure 28: Relative size distribution of striped marlin (fork length; cm) recorded for deep-freezing longline fisheries by year and main fleet. Data source: standardized size-frequency dataset

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 12% of the size sampling relative to the total striped marlin catch reported between 2019 and 2023, with some increase in 2023 from industrial fisheries (**Fig. 30**).

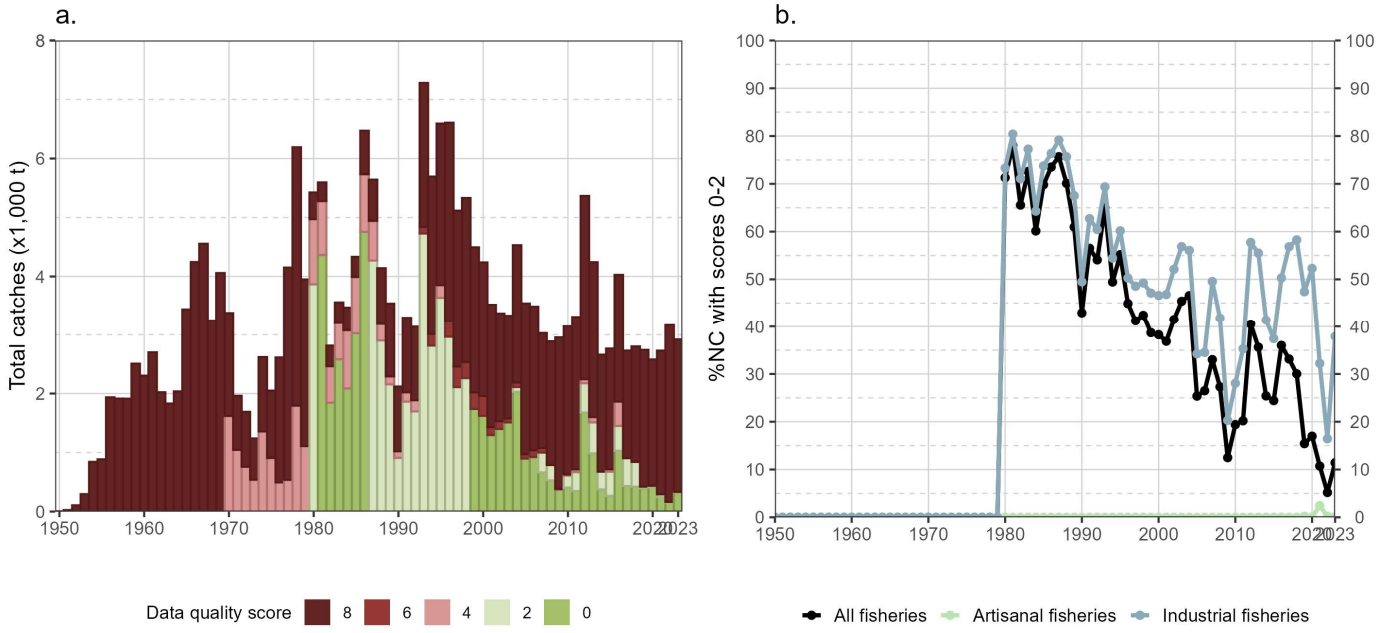

Figure 30: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches for which geo-referenced size-frequency data were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950–2023

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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 major changes were made to the best scientific estimates of retained catches of striped marlin since the 22nd session of the IOTC Working Party on Billfish (WPB22), with overall small modifications in the time series of annual catches (**Fig. 8**). The changes covering the period 1950-2022 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 historical catches by species and fisheries between 1950 and 2022 (**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)
2022	BGD	Gillnet	Eastern Indian Ocean	0	18	-18
	IDN	Gillnet	Eastern Indian Ocean	372	85	286
		Line	Eastern Indian Ocean	80	314	-234
		Longline	Eastern Indian Ocean	8	25	-17
		Purse seine	Eastern Indian Ocean	6	38	-33
2021		Gillnet	Eastern Indian Ocean	403	80	323
		Line	Eastern Indian Ocean	164	299	-135
		Purse seine	Eastern Indian Ocean	5	37	-32
2020		Gillnet	Eastern Indian Ocean	291	100	191
		Line	Eastern Indian Ocean	103	375	-272
		Longline	Eastern Indian Ocean	26	72	-46
		Purse seine	Eastern Indian Ocean	6	47	-40
2019		Gillnet	Eastern Indian Ocean	356	68	288
		Line	Eastern Indian Ocean	121	256	-136
		Longline	Eastern Indian Ocean	25	214	-188
		Purse seine	Eastern Indian Ocean	6	32	-26