



## REVIEW OF THE STATISTICAL DATA AVAILABLE FOR INDIAN OCEAN STRIPED MARLIN (1950-2021)

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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 1,600 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 to the tRFMOs for 2021 was 6,400 t. Catch reports of striped marlin mostly came from the Eastern Pacific Ocean during the 1960s after when they started to show a decreasing trend to reach a minimum of 1349 t in 2021. Since the mid-1970s, the Western-Central Pacific and Indian Oceans have equally contributed on average to about 37% of the total catch of striped marlin (**Fig. 1b**).

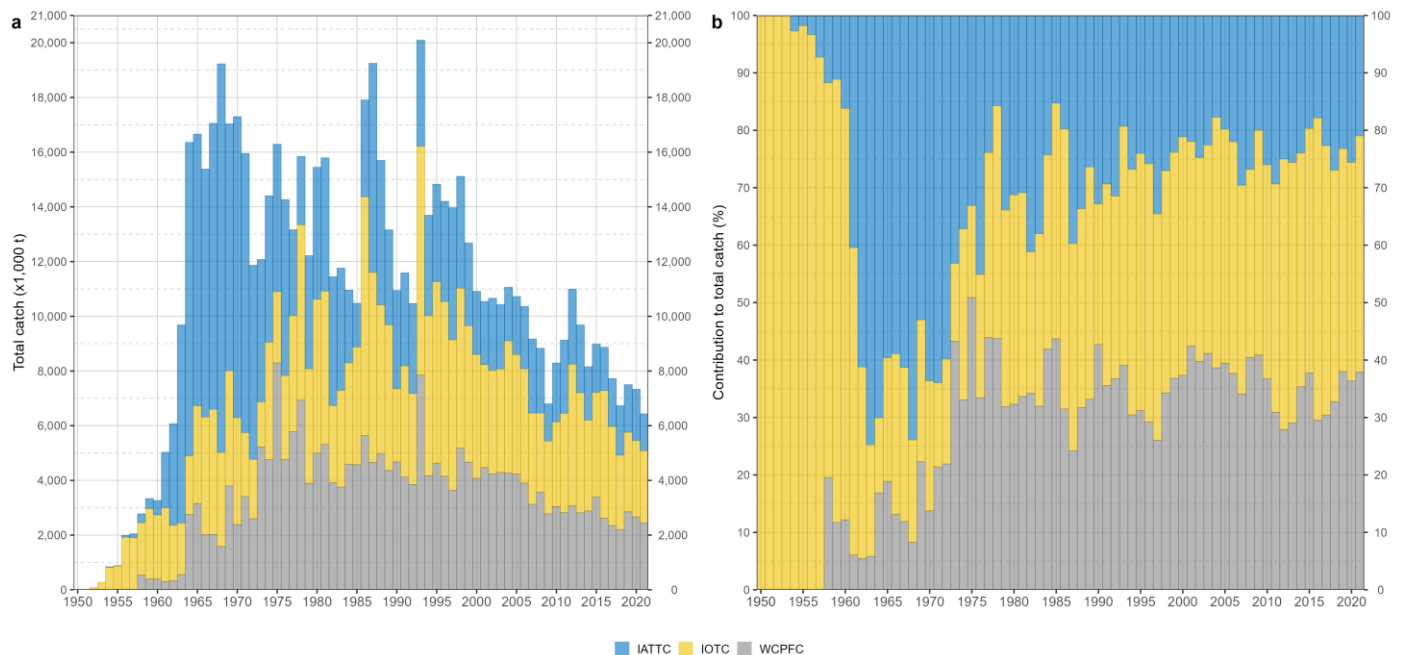


Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of striped marlin by tuna Regional Fisheries Management Organisation for the period 1950-2021. IATTC = [Inter-American Tropical Tuna Commission](#); IOTC = [Indian Ocean Tuna Commission](#); WCPFC = [Western & Central Pacific Fisheries Commission](#). Source: [Global Tuna Atlas](#)

The overarching objective of this paper is to provide participants in the data preparatory meeting of the 21<sup>st</sup> Session of the IOTC Working Party on Billfish ([WPB21](#)) 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 IOTC ([2023](#)).

## Total retained (nominal) catch

### Historical trends (1950-2021)

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.

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](#)).

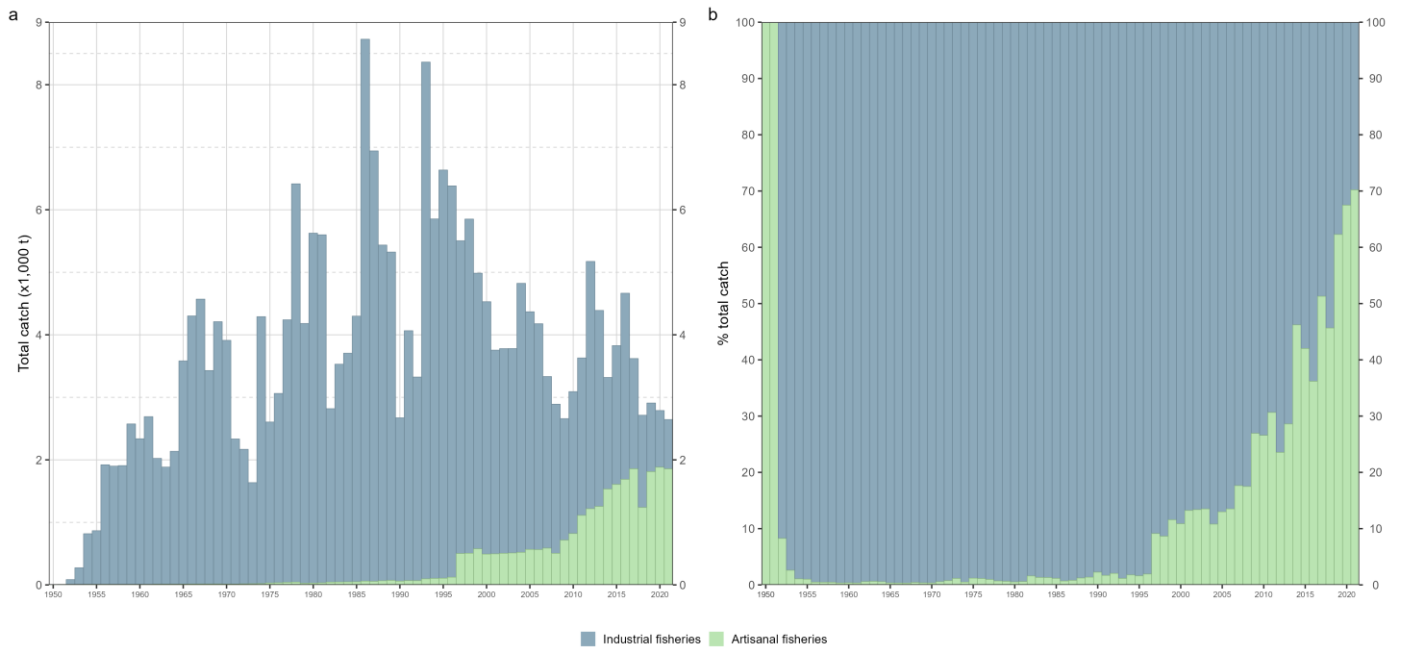


Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of striped marlin by type of fishery for the period 1950-2021. Data source: [best scientific estimates of retained catches](#)

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](#)

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	744	635
Longline   Deep-freezing	1,028	3,104	3,441	5,068	4,231	2,103	1,272
Line   Coastal longline	0	0	1	23	45	91	233
Line   Trolling	3	5	9	6	14	23	49
Line   Handline	0	0	0	3	12	23	34
Gillnet	5	8	16	20	169	717	1,384
Other	0	0	0	1	2	3	7
<b>Total</b>	<b>1,036</b>	<b>3,117</b>	<b>3,485</b>	<b>5,201</b>	<b>5,364</b>	<b>3,810</b>	<b>3,734</b>

Table 2: Annual retained catches (metric tonnes; t) of striped marlin by fishery for the period 2012-2021. The background intensity color of each cell is directly proportional to the catch level. Data source: [best scientific estimates of retained catches](#)

Fishery	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Purse seine   Other	36	42	37	36	37	87	30	32	47	37
Longline   Other	111	137	56	82	103	88	53	54	36	27
Longline   Fresh	767	935	577	672	366	326	206	360	190	95
Longline   Deep-freezing	2,893	1,817	729	967	2,161	926	733	318	320	248
Line   Coastal longline	194	231	246	255	254	333	247	183	204	181
Line   Trolling	48	55	47	46	49	62	37	48	60	49
Line   Handline	49	57	25	0	29	26	6	55	163	142
Gillnet	1,069	1,107	1,594	1,761	1,659	1,764	1,396	1,852	1,760	1,858
Other	7	9	8	8	7	9	6	7	10	8
<b>Total</b>	<b>5,174</b>	<b>4,390</b>	<b>3,318</b>	<b>3,827</b>	<b>4,665</b>	<b>3,621</b>	<b>2,714</b>	<b>2,909</b>	<b>2,789</b>	<b>2,645</b>

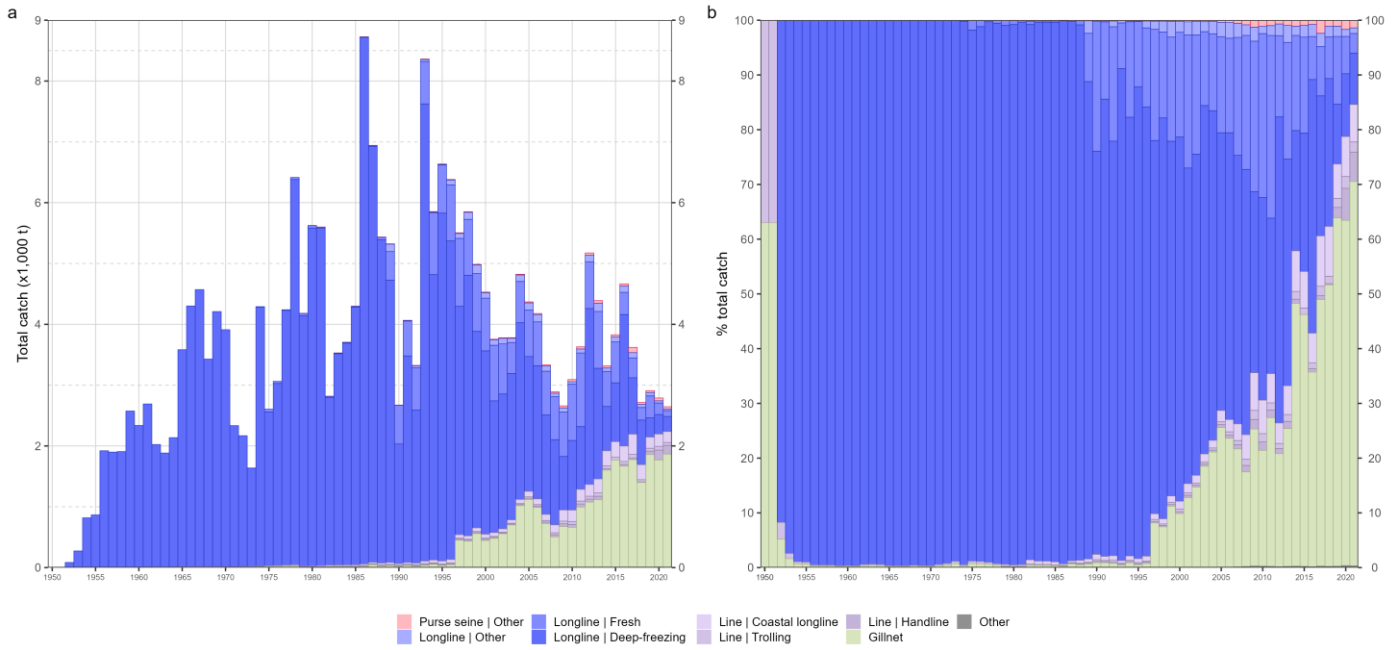


Figure 3: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of striped marlin by fishery for the period 1950-2021. Data source: [best scientific estimates of retained catches](#)

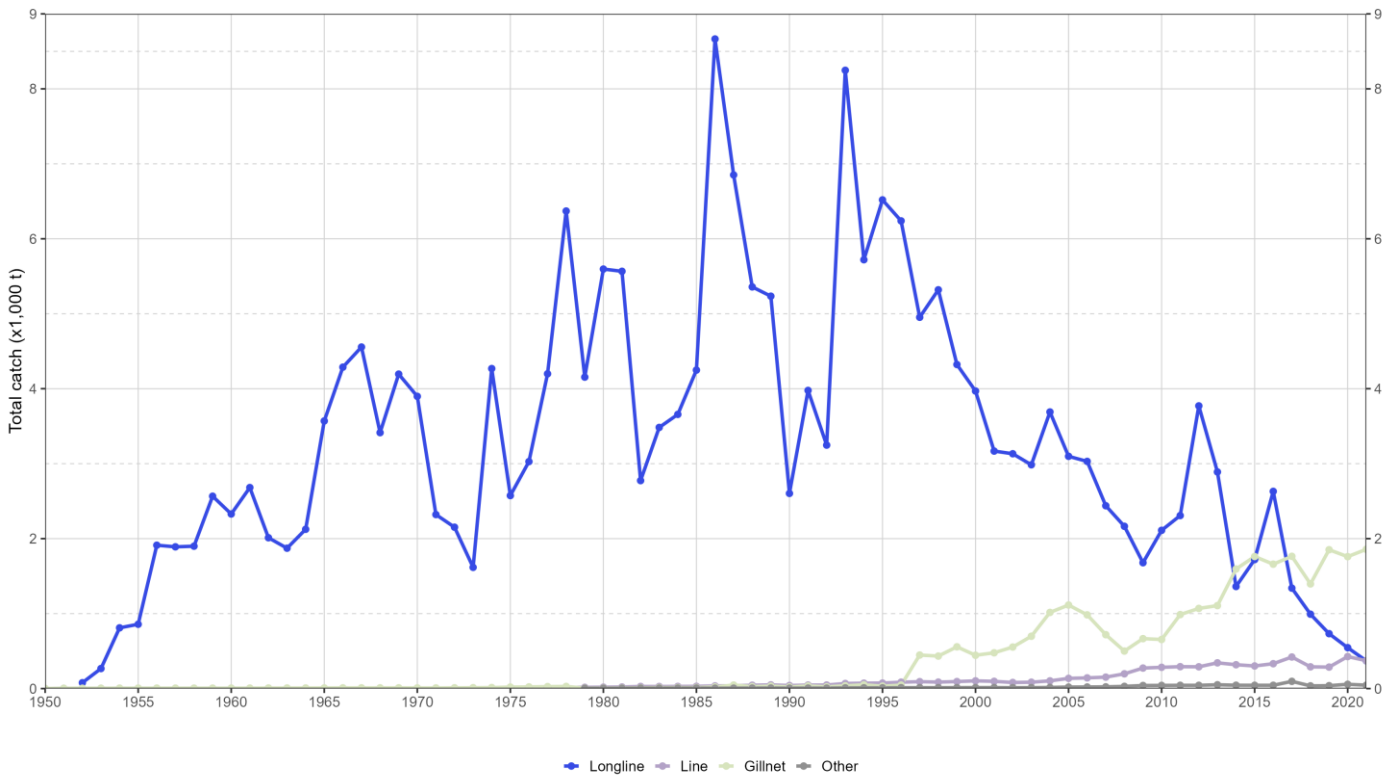


Figure 4: Annual time series of retained catches (metric tonnes; t) of striped marlin by fishery group for the period 1950-2021. Data source: [best scientific estimates of retained catches](#)

### Main fishery features (2017-2021)

Table 3: Mean annual catches (metric tonnes; t) of striped marlin by fishery between 2017 and 2021. Data source: [best scientific estimates of retained catches](#)

Fishery	Fishery code	Catch	Percentage
Gillnet	GN	1,726	58.8
Longline   Deep-freezing	LLD	509	17.3
Longline   Fresh	LLF	235	8.0
Line   Coastal longline	LIC	229	7.8
Line   Handline	LIH	79	2.7
Longline   Other	LLO	51	1.7
Line   Trolling	LIT	51	1.7
Purse seine   Other	PSOT	47	1.6
Other	OT	8	0.3

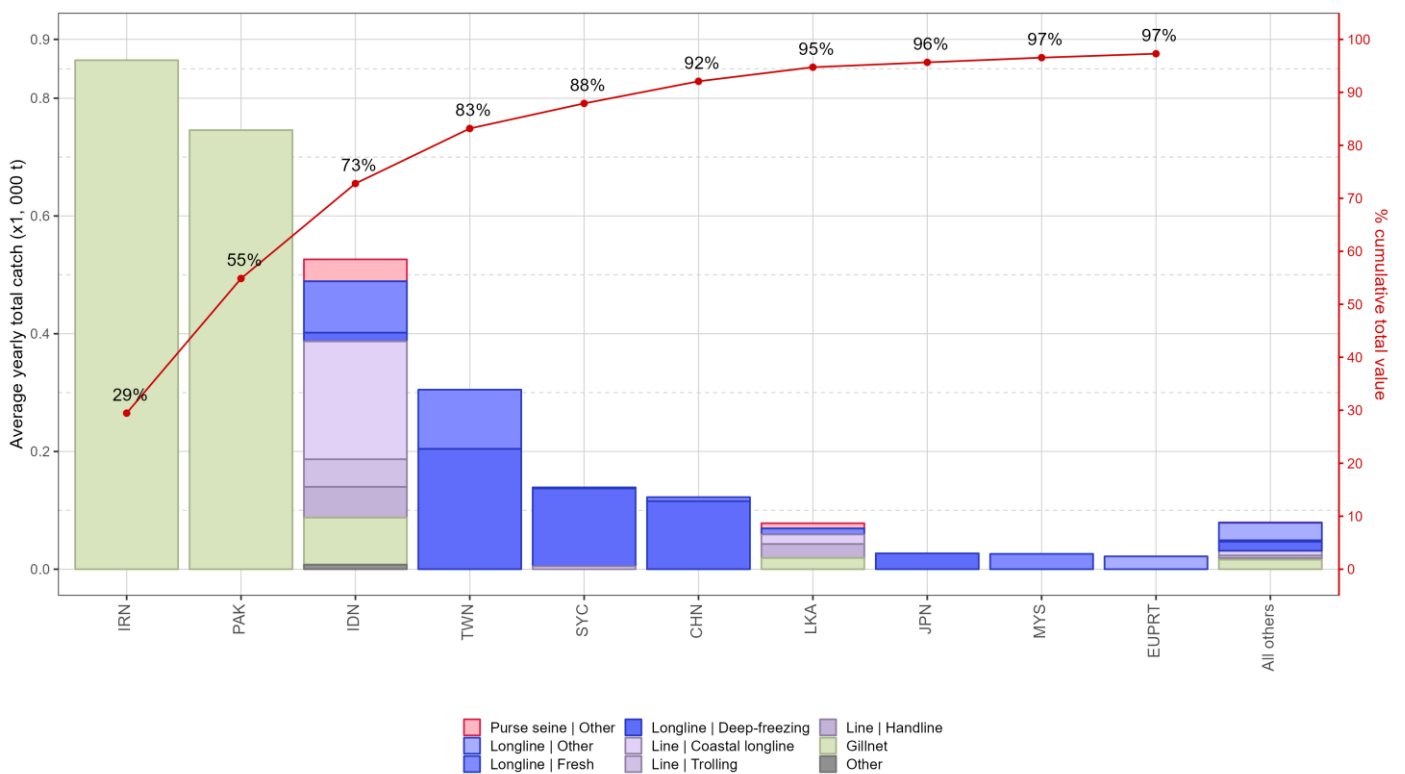


Figure 5: Mean annual catches (metric tonnes; t) of striped marlin by fleet and fishery between 2017 and 2021, with indication of cumulative catches by fleet. Data source: [best scientific estimates of retained catches](#)

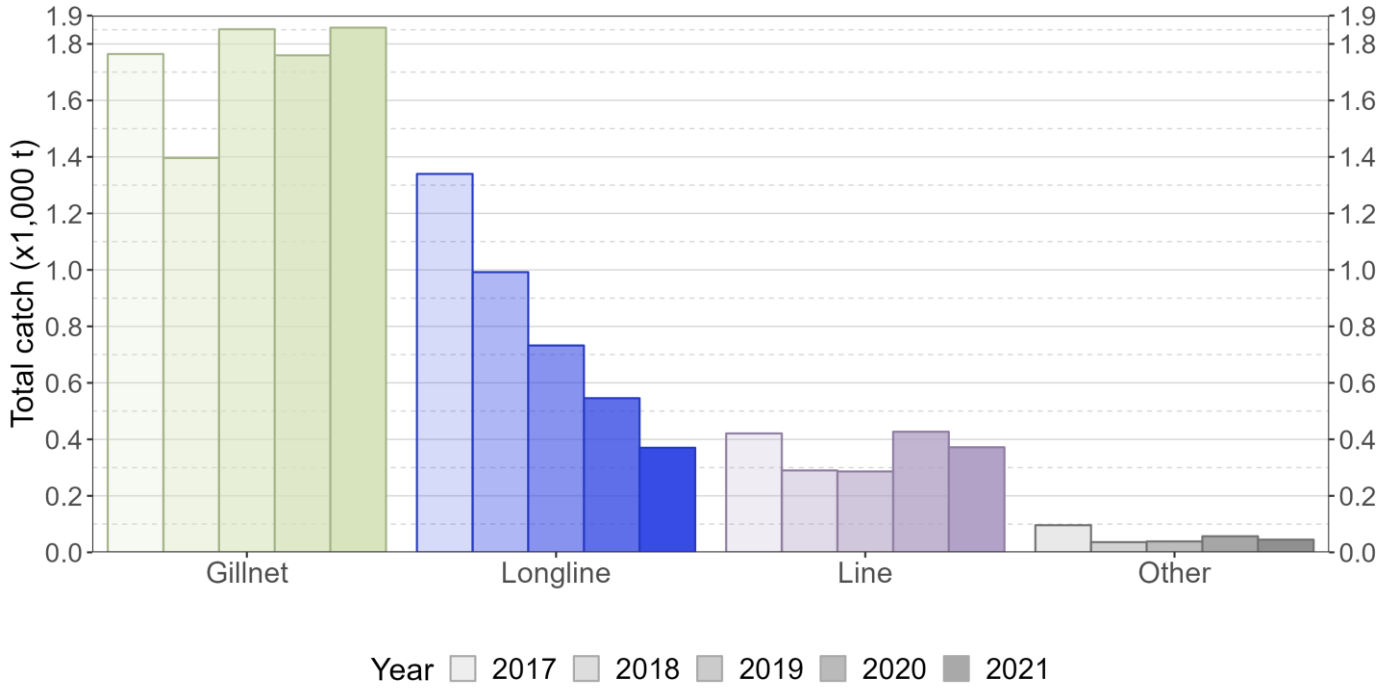


Figure 6: Annual catch (metric tonnes; t) trends of striped marlin by fishery group between 2017 and 2021. Data source: [best scientific estimates of retained catches](#)

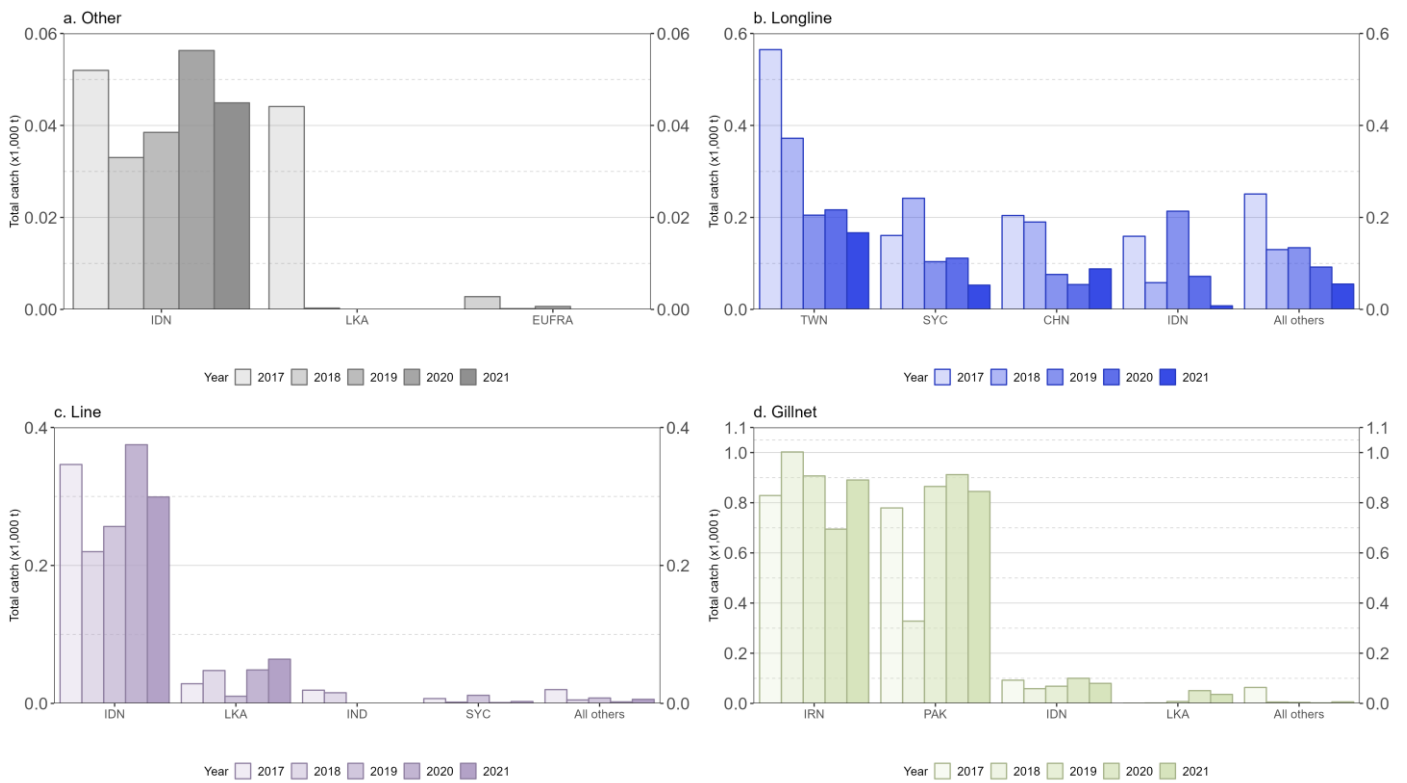


Figure 7: Annual catch (metric tonnes; t) trends of striped marlin by fishery group and fleet between 2017 and 2021. Data source: [best scientific estimates of retained catches](#)

Changes from previous Working Party

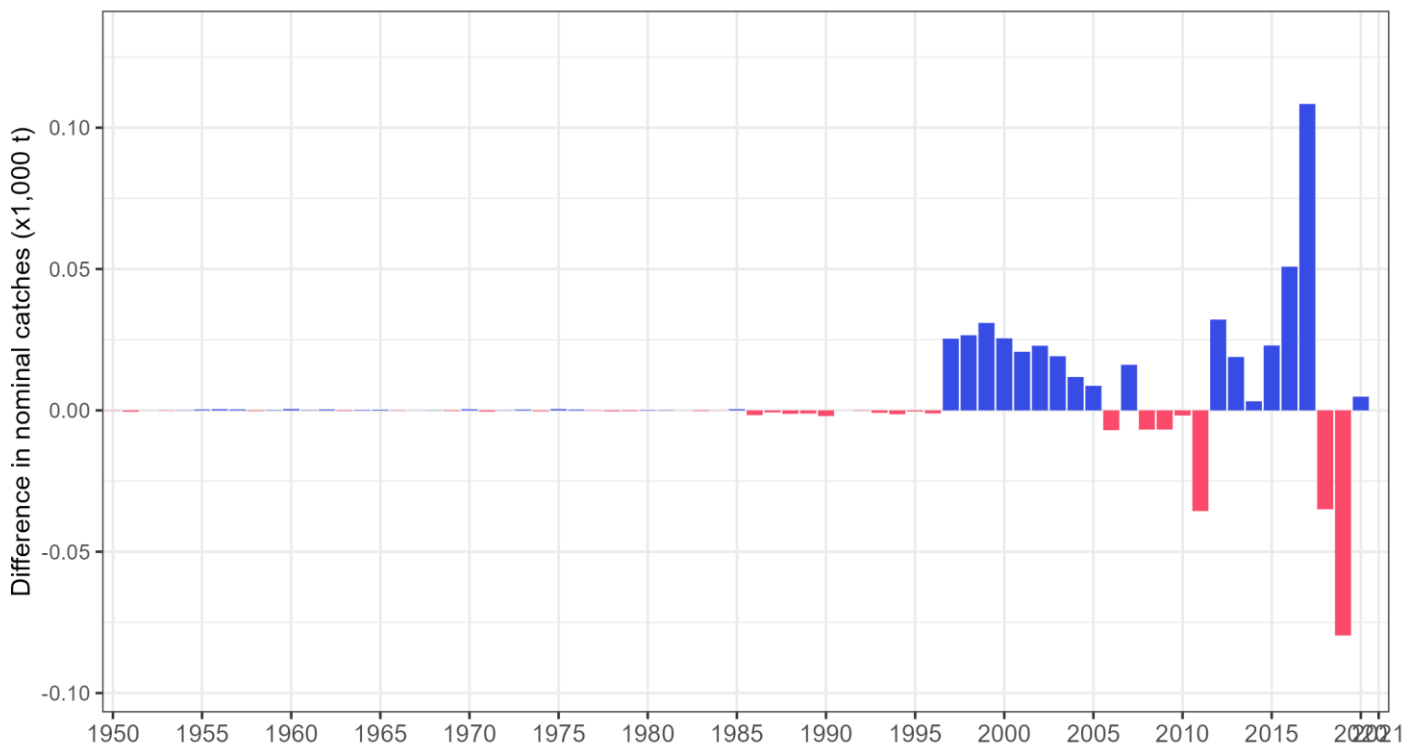


Figure 8: Differences in the available best scientific estimates of retained catches (metric tonnes; t) of striped marlin between this WPB and its previous session ([WPB20](#) meeting held in September 2022)



### Uncertainties in retained catch data

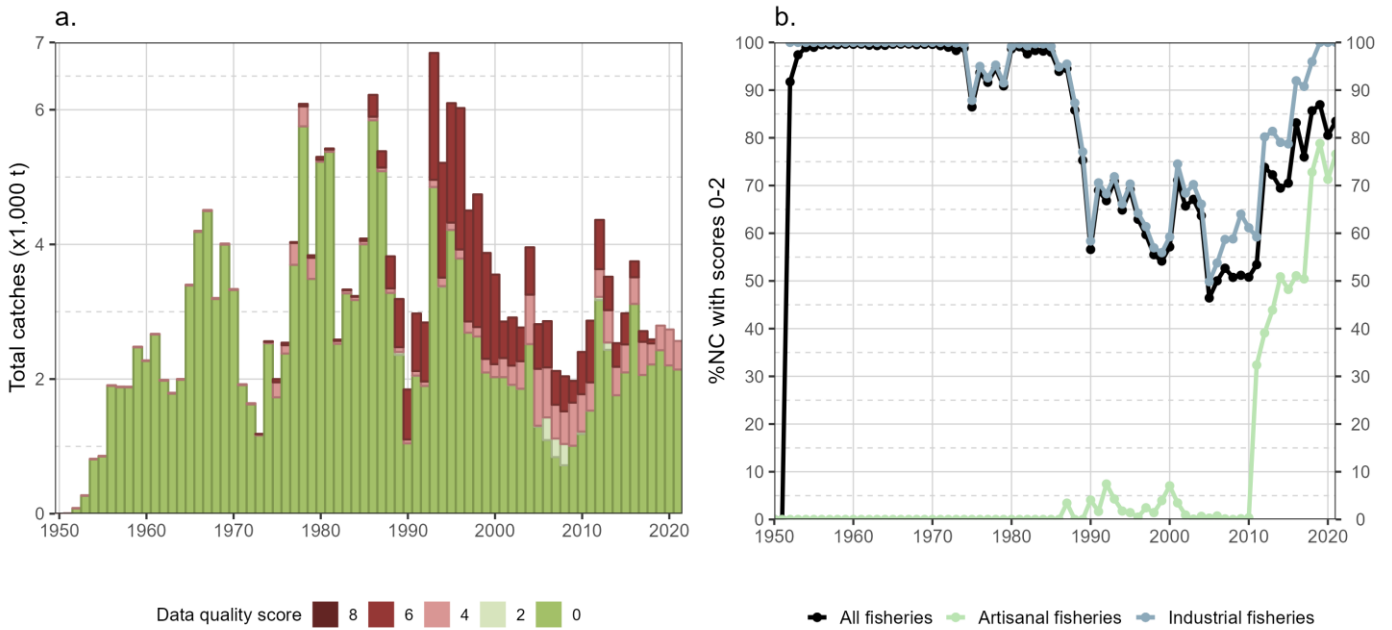


Figure 9: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches fully/partially reported to the IOTC Secretariat for all fisheries and by type of fishery, in the period 1950-2021

### Discard levels

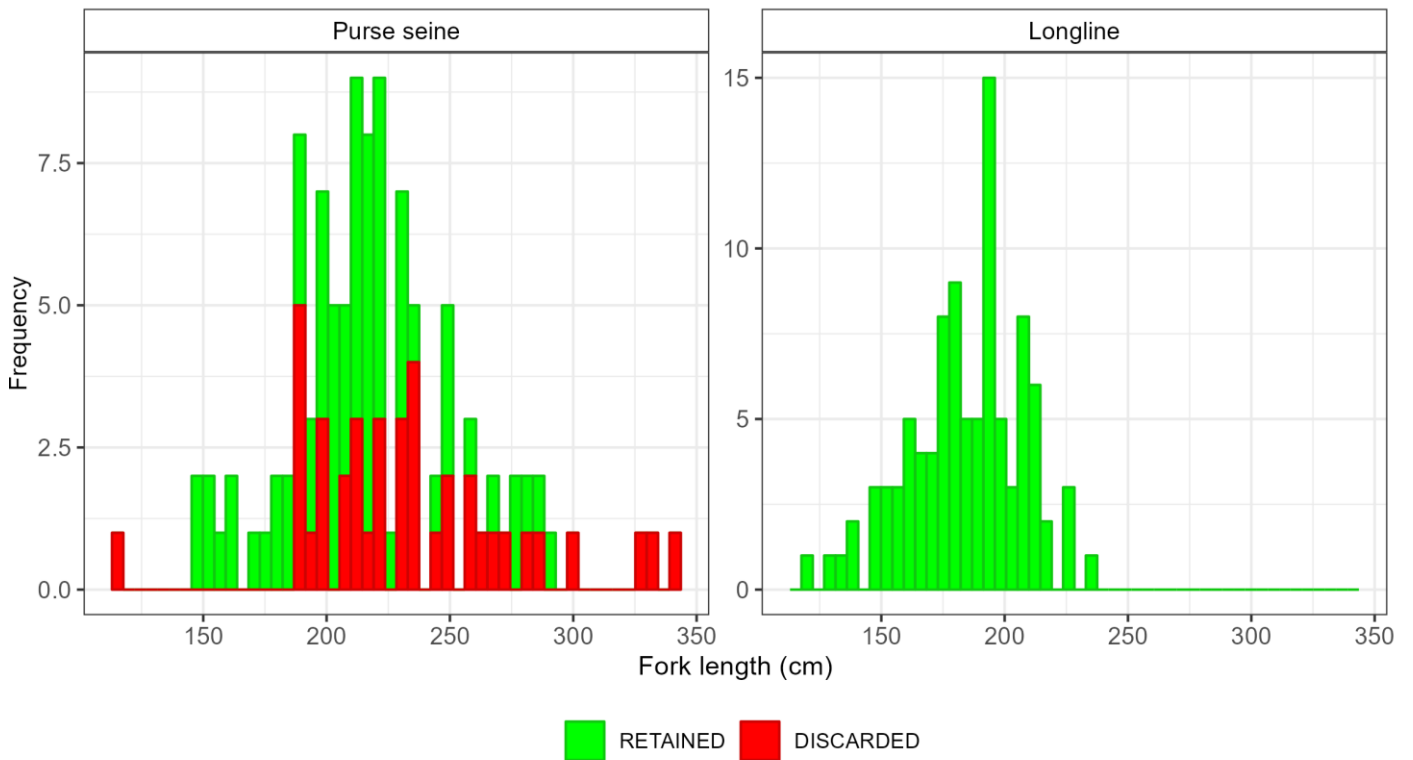


Figure 10: Size (fork length; cm) frequency distribution of striped marlin retained and discarded at sea in purse seine and longline fisheries as available in the ROS regional database

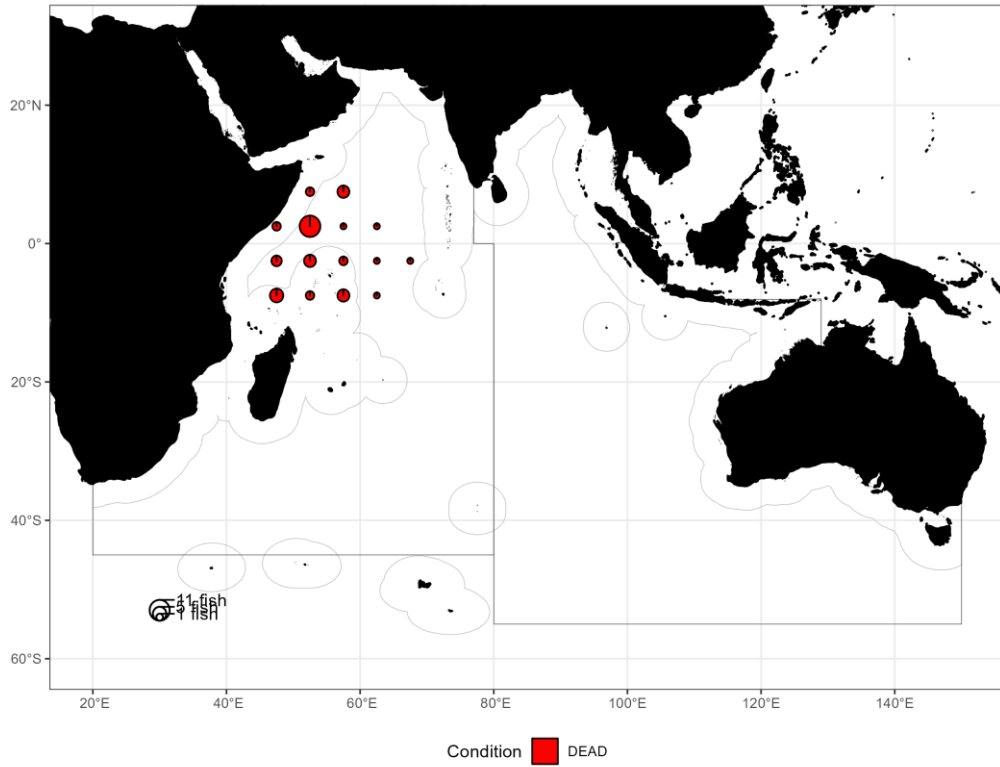


Figure 11: Distribution of striped marlins discarded at sea in the western Indian Ocean purse seine fisheries with information on condition at release as available in the ROS regional database

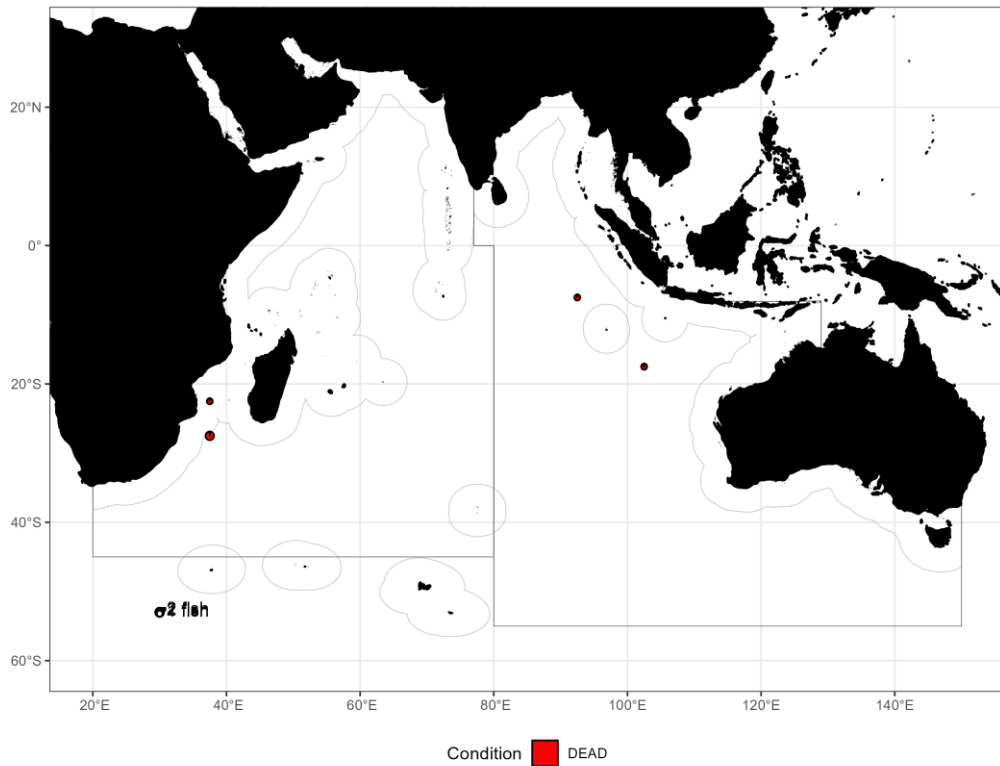


Figure 12: Distribution of striped marlins discarded at sea in the Indian Ocean longline fisheries with information on condition at release as available in the ROS regional database

# Geo-referenced catch

## Spatial distribution of catches

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

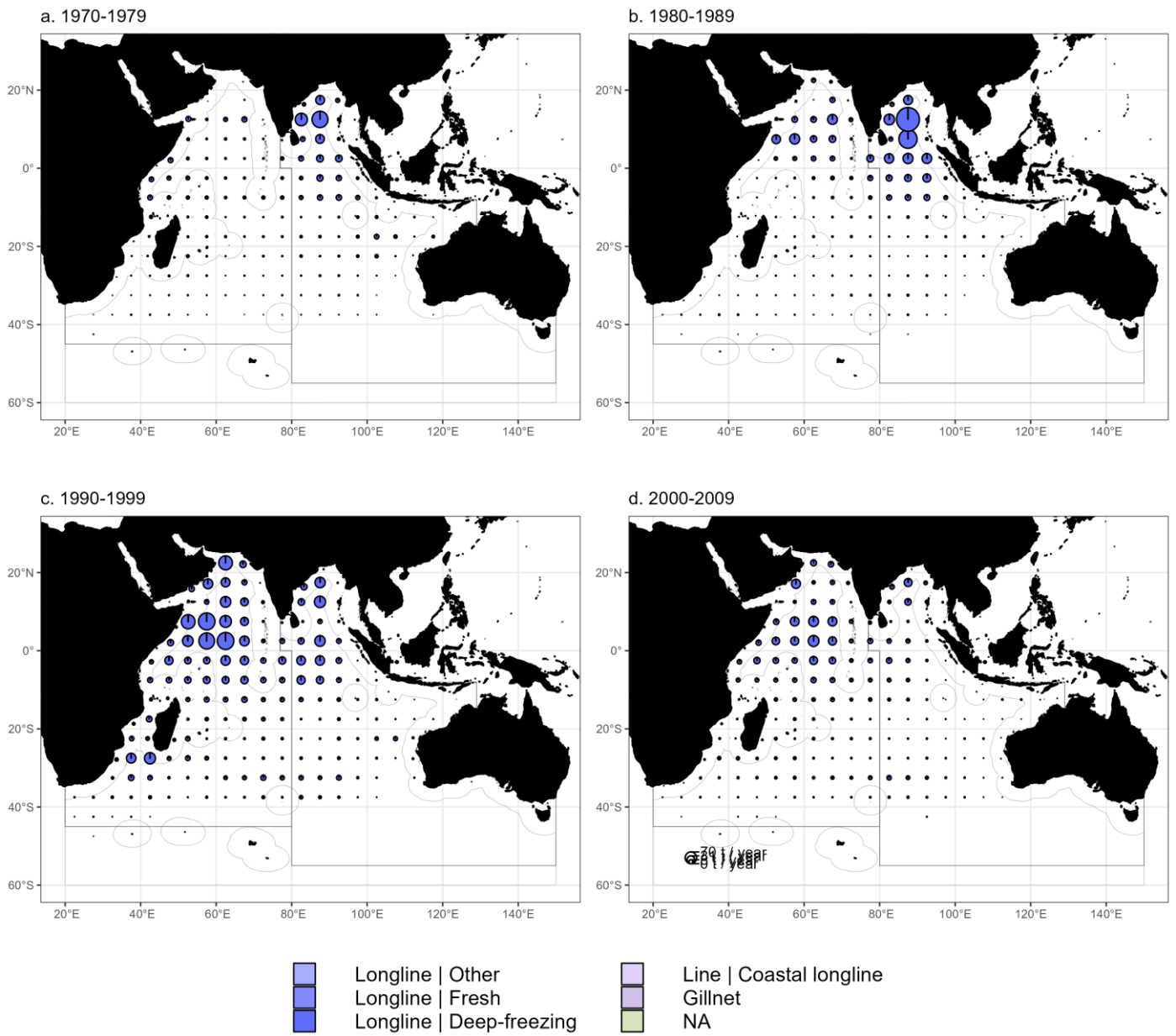


Figure 13: Mean annual time-area catches in weight (metric tonnes; t) of striped marlin, by decade, 5x5 grid, and fishery. Data source: [time-area catches](#)

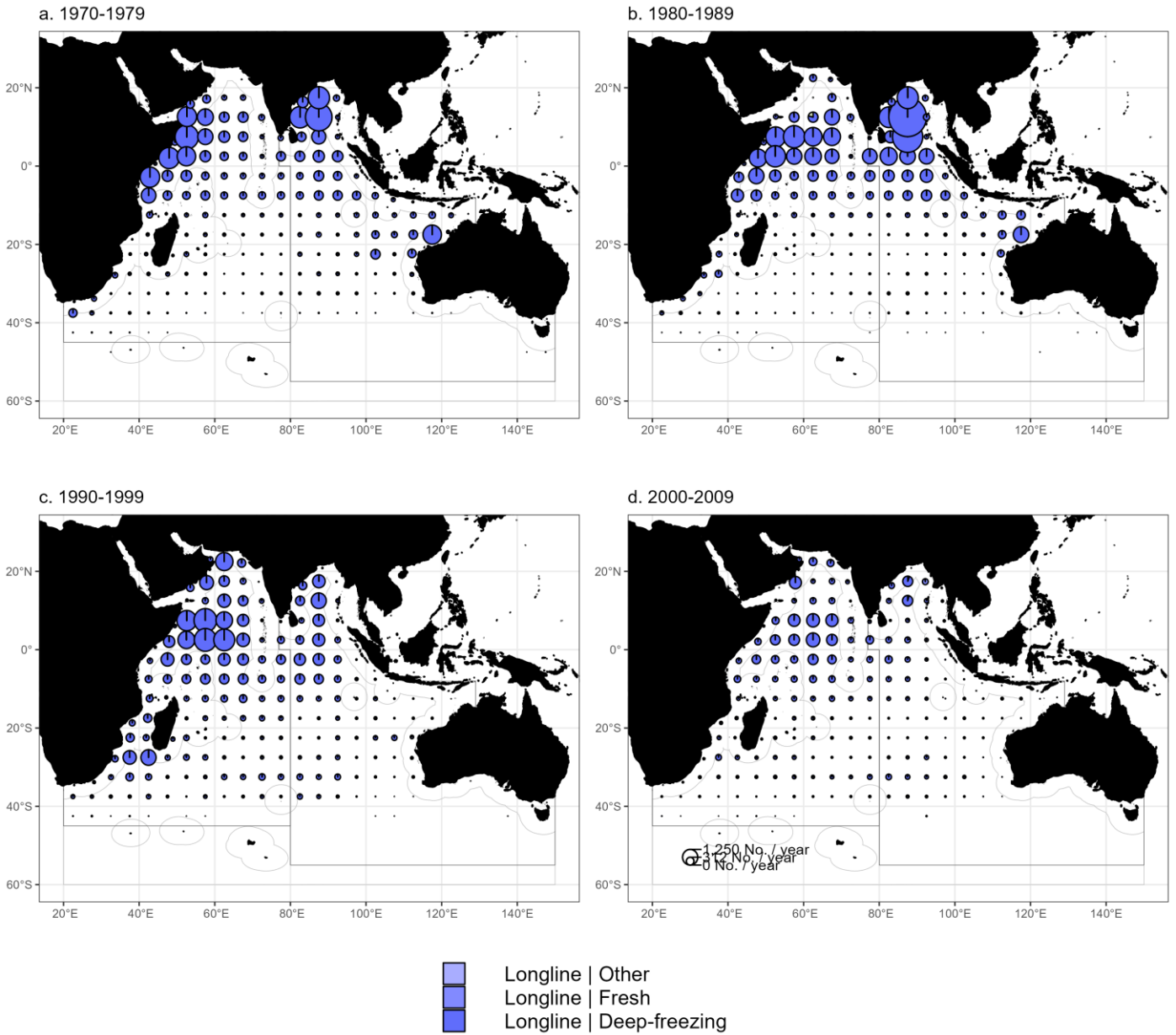


Figure 14: Mean annual time-area catches in numbers of striped marlin, by decade, 5x5 grid, and fishery. Data source: [time-area catches](#)

Geo-referenced catches by fishery, last years (2017-2021) and decade (2010-2019)

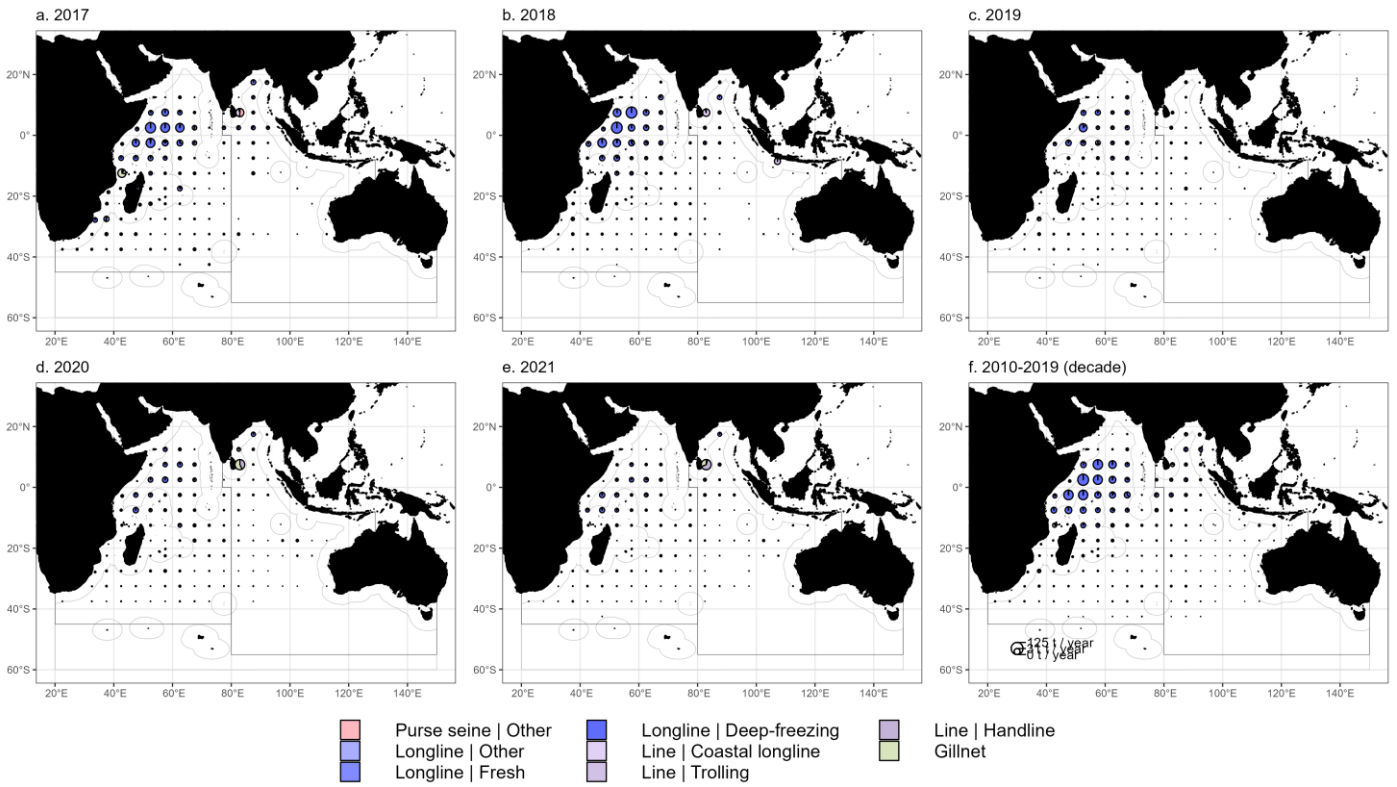


Figure 15: Mean annual time-area catches in weight (metric tonnes; t) of striped marlin, by year / decade, 5x5 grid, and fishery. Data source: [time-area catches](#)

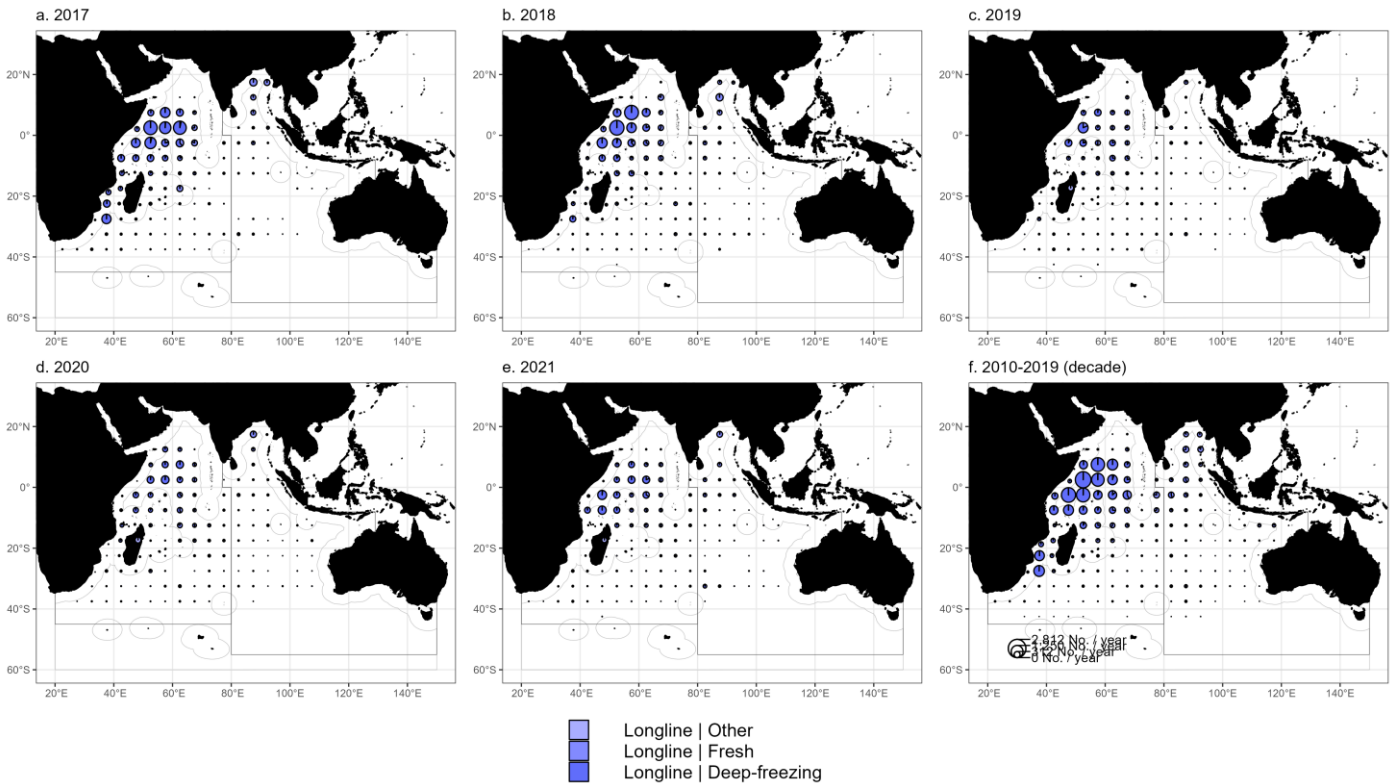


Figure 16: Mean annual time-area catches in numbers of striped marlin, by year / decade, 5x5 grid, and fishery. Data source: [time-area catches](#)

## Uncertainties in catch and effort data

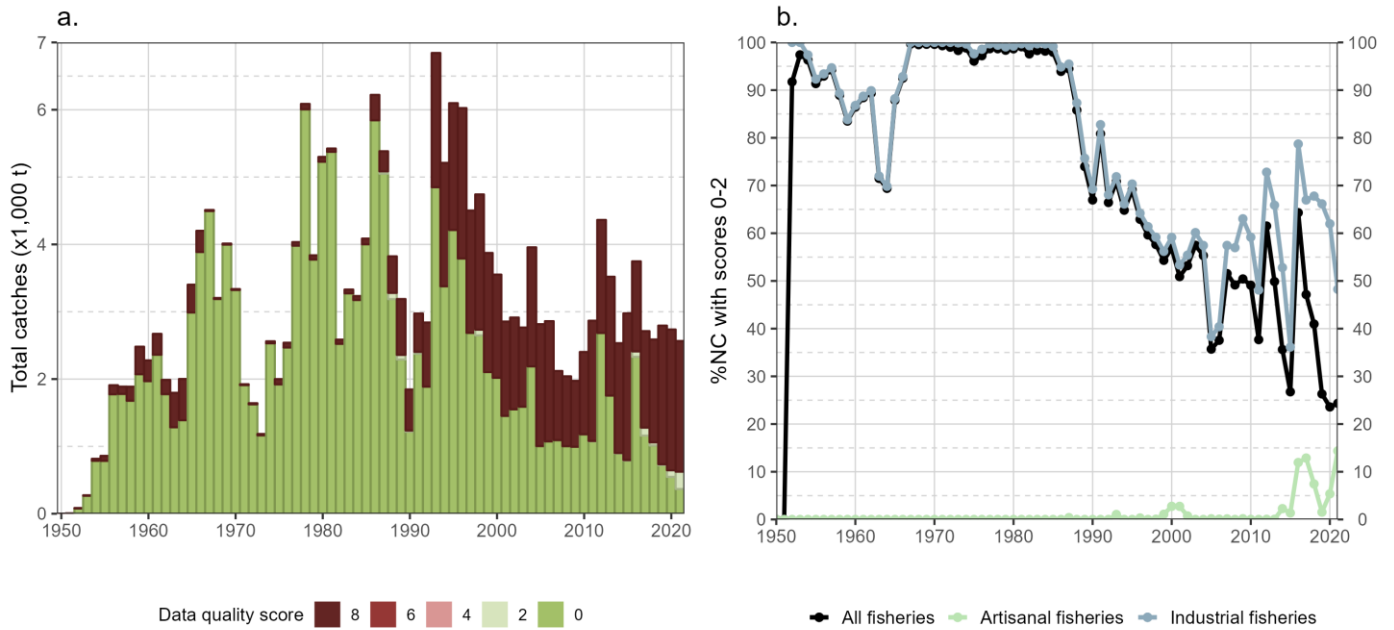


Figure 17: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches for which geo-referenced catches were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950-2021

## Size composition of the catch

### Samples availability

#### By fishery group

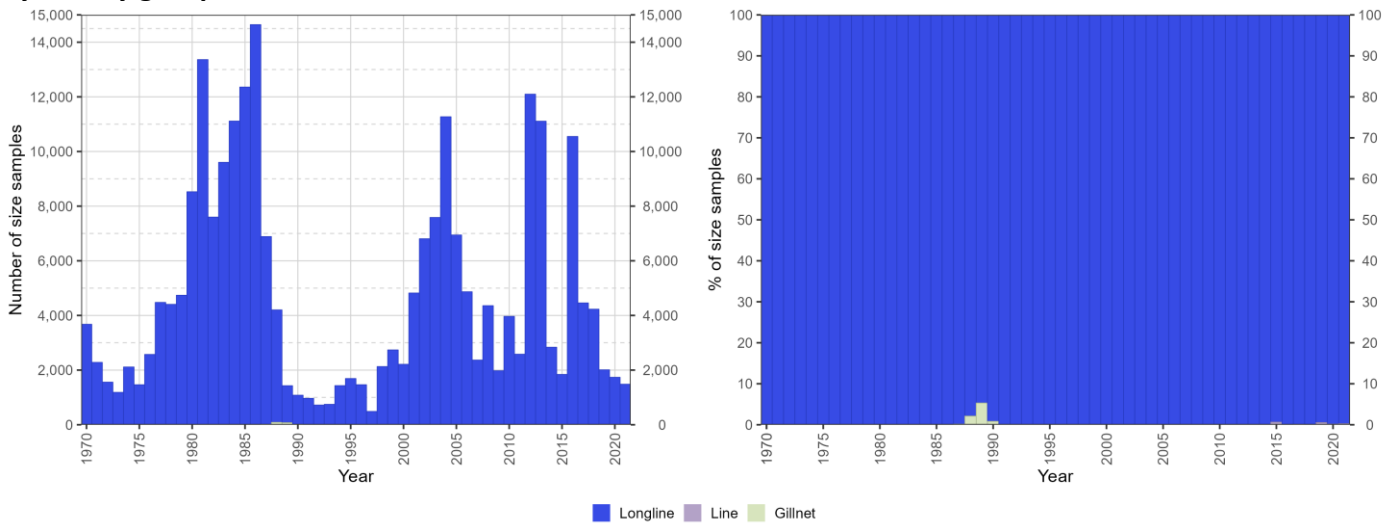


Figure 18: Availability of striped marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: [standardized size-frequency dataset](#)

Longline fisheries

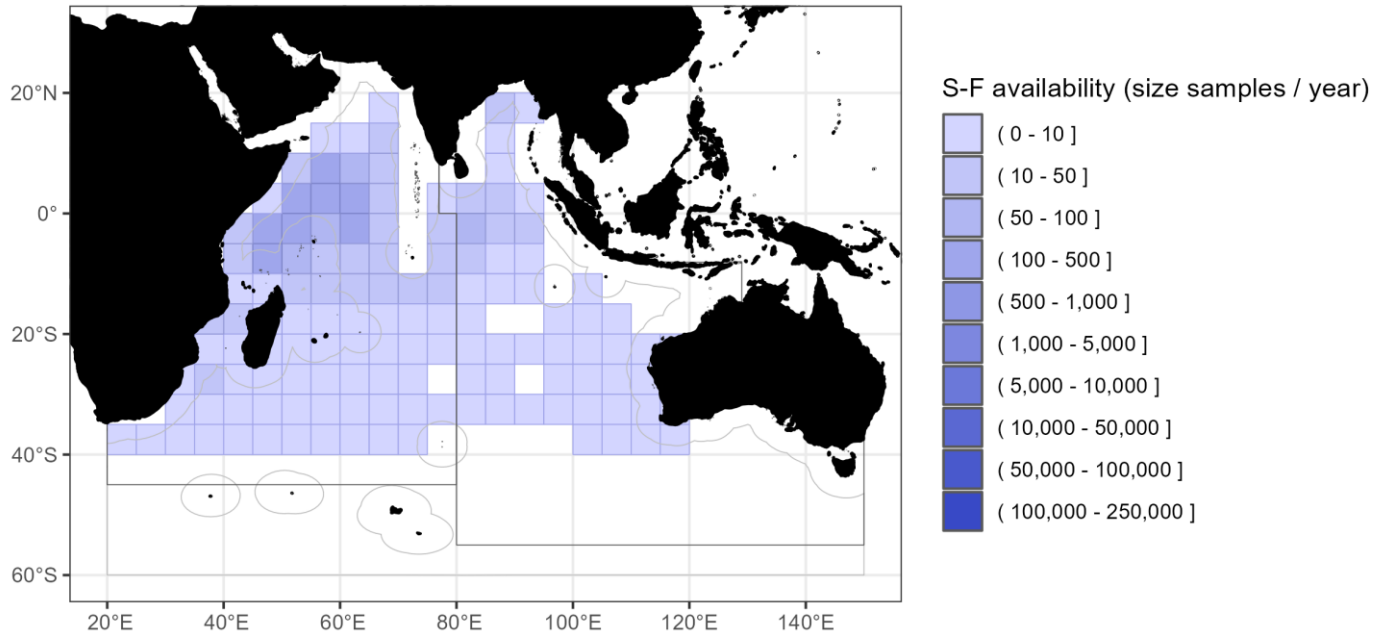


Figure 19: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data for longline fisheries in the period 2017-2021. Data source: [standardized size-frequency dataset](#)

Line fisheries

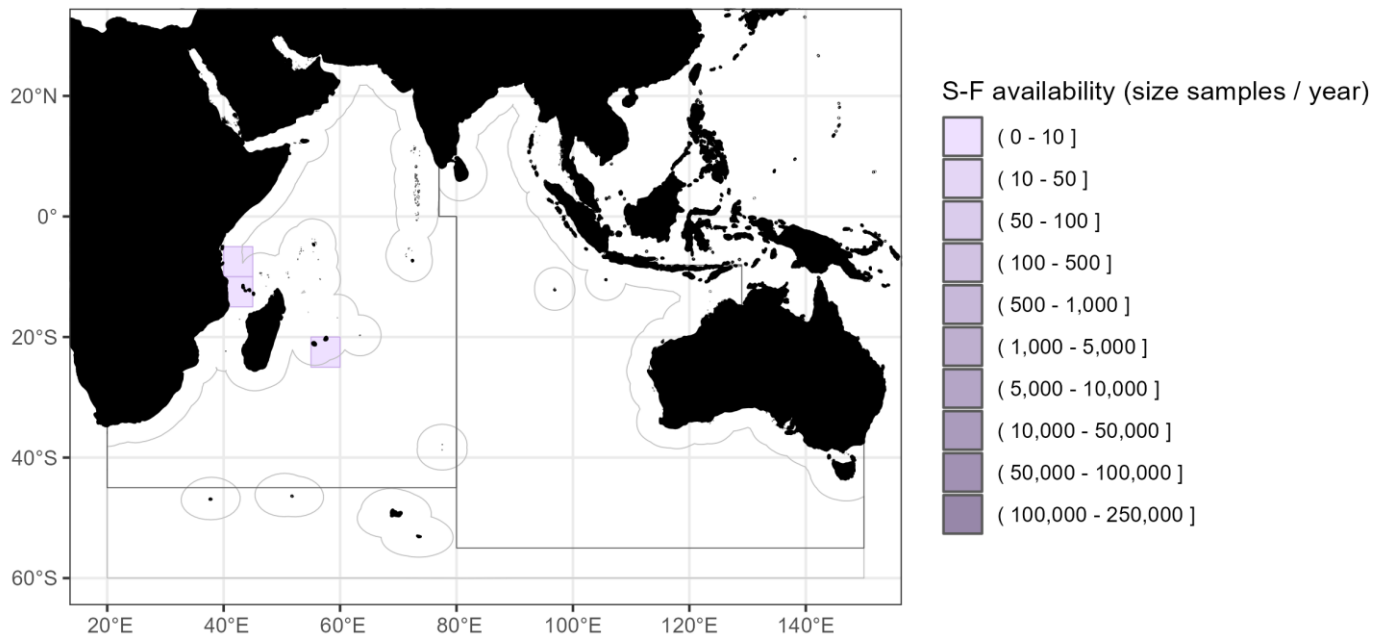


Figure 20: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data for line fisheries in the period 2017-2021. Data source: [standardized size-frequency dataset](#)

By fishery

Deep-freezing longline fisheries

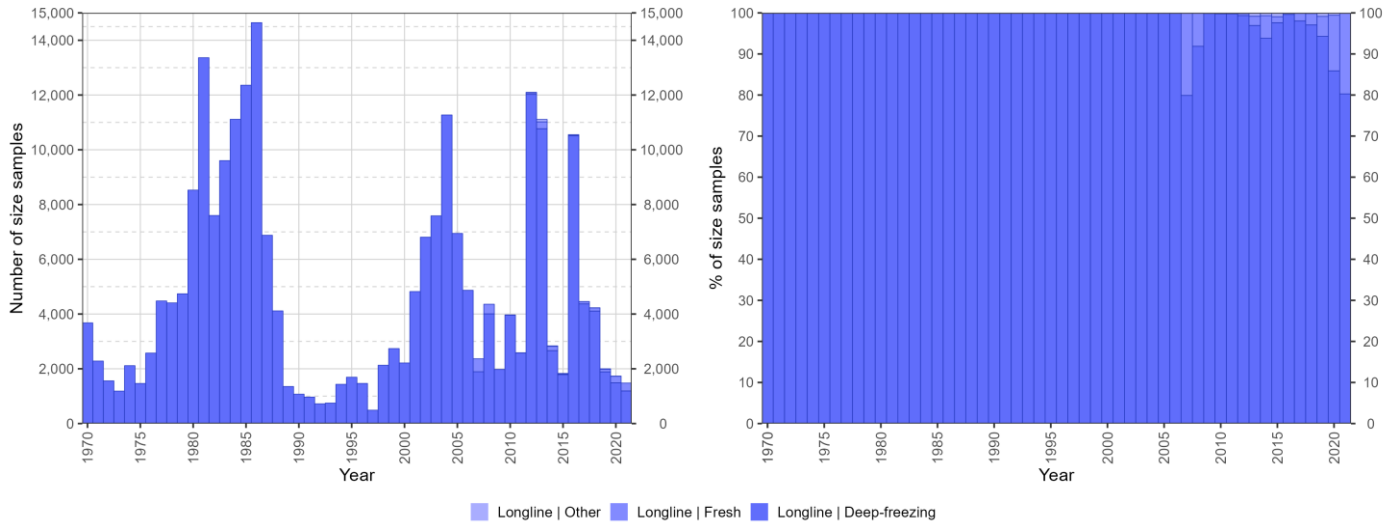


Figure 21: Availability of striped marlin size-frequency data as absolute number of samples per year and longline fishery. Data source: [standardized size-frequency dataset](#)

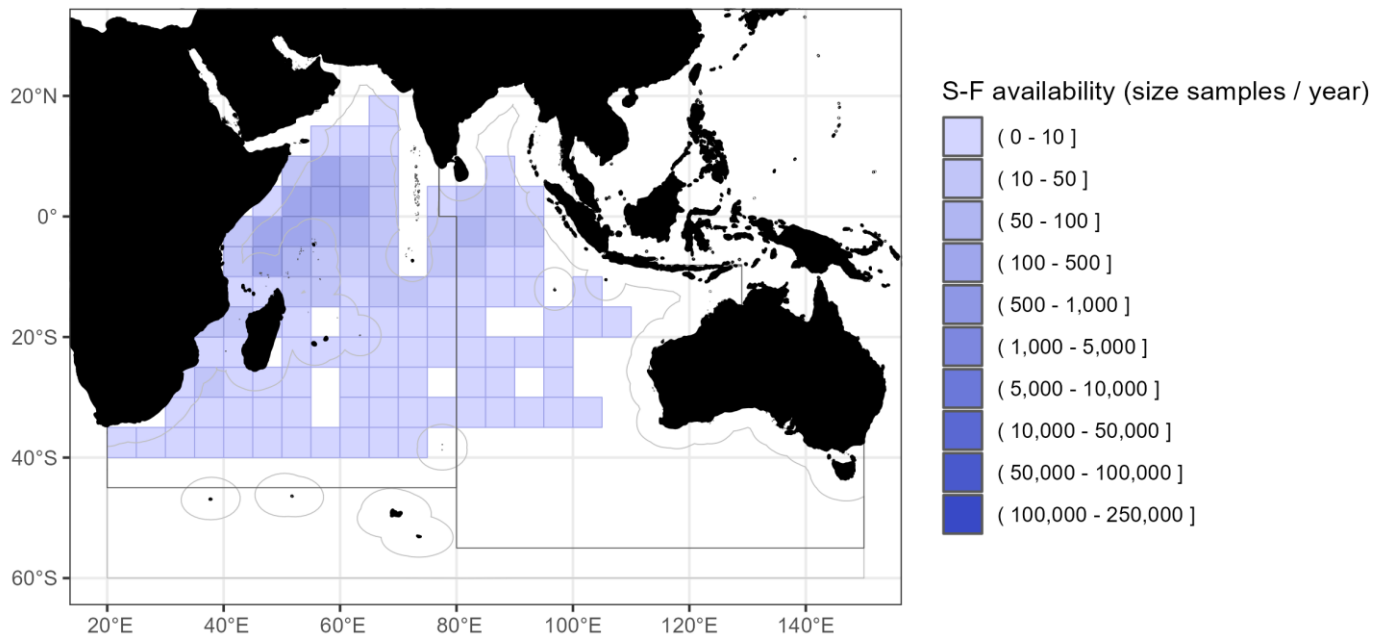


Figure 22: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by deep-freezing longline fisheries in the period 2017-2021. Data source: [standardized size-frequency dataset](#)



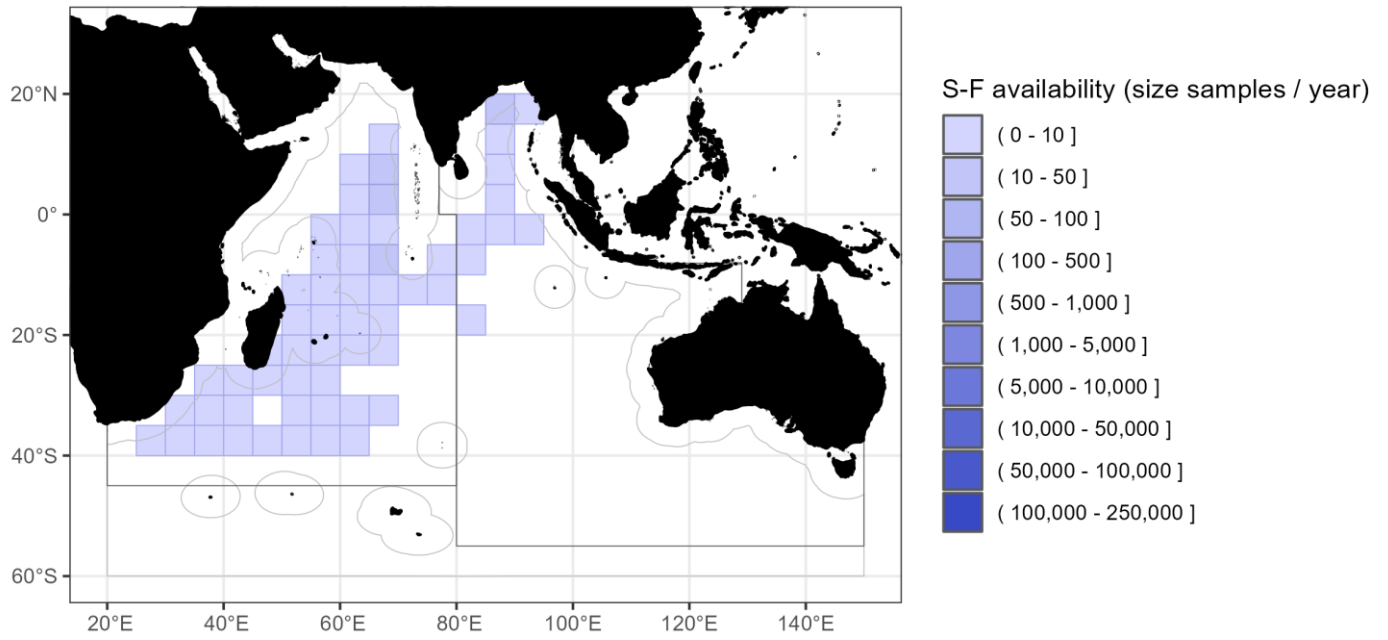


Figure 23: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by fresh longline fisheries in the period 2017-2021. Data source: [standardized size-frequency dataset](#)

Gillnet fisheries

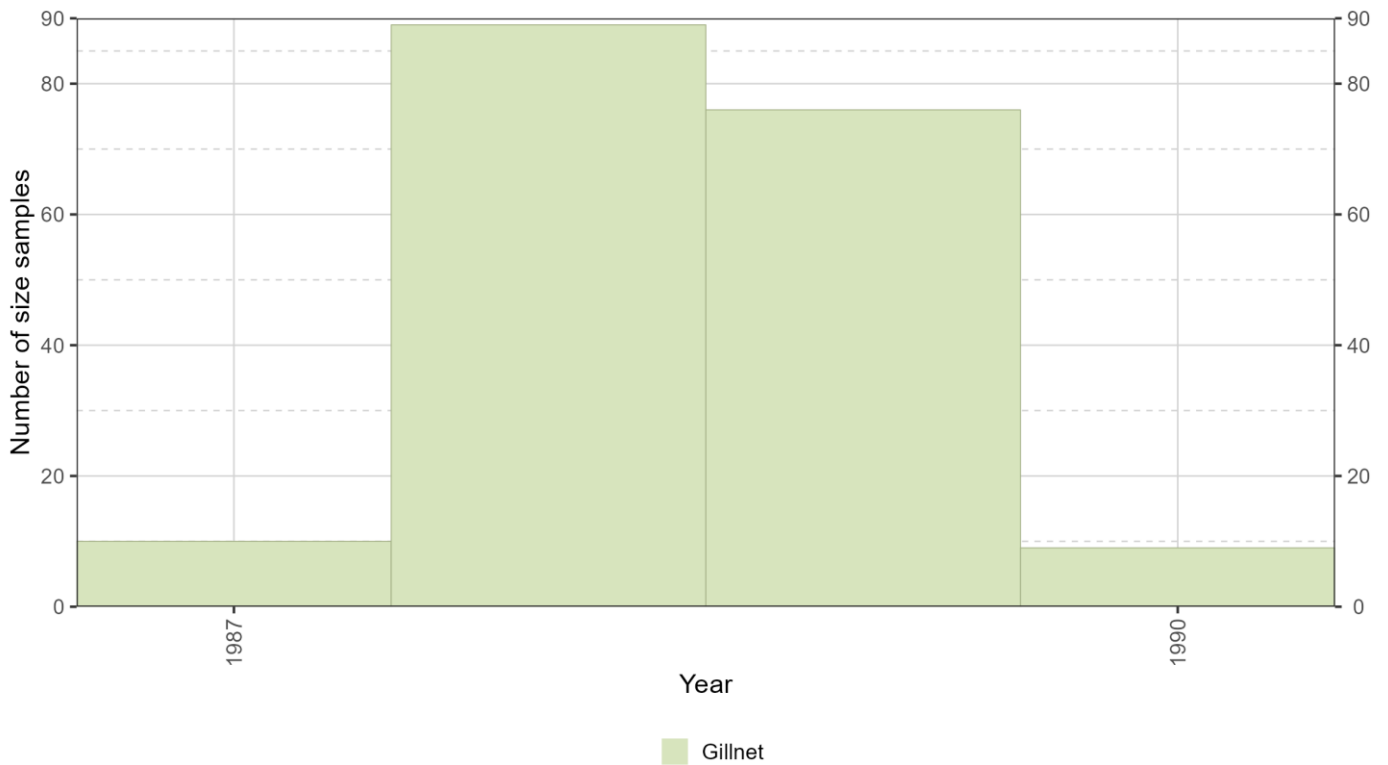


Figure 24: Availability of striped marlin size-frequency data as absolute number of samples per year in gillnet fisheries. Data source: [standardized size-frequency dataset](#)

Line fisheries

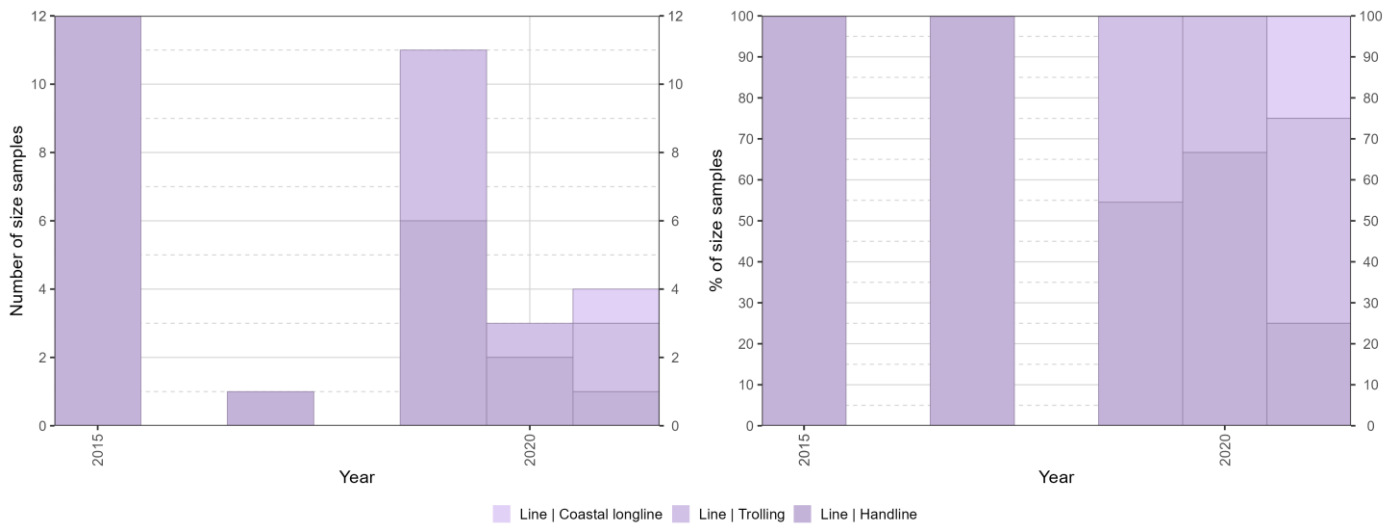


Figure 25: Availability of striped marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: [standardized size-frequency dataset](#)

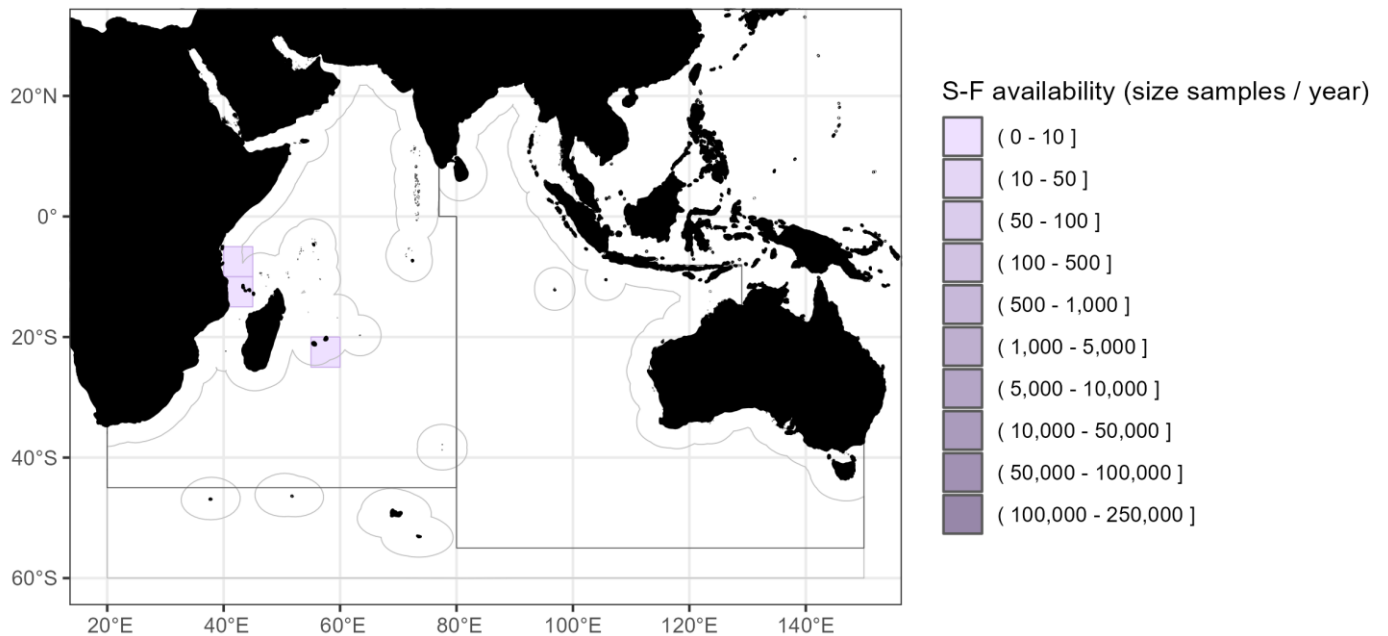


Figure 26: Spatial distribution (average number of samples per grid per year) of available striped marlin size-frequency data by line (handline) fisheries in the period 2017-2021. Data source: [standardized size-frequency dataset](#)

### Temporal patterns and trends in size distributions

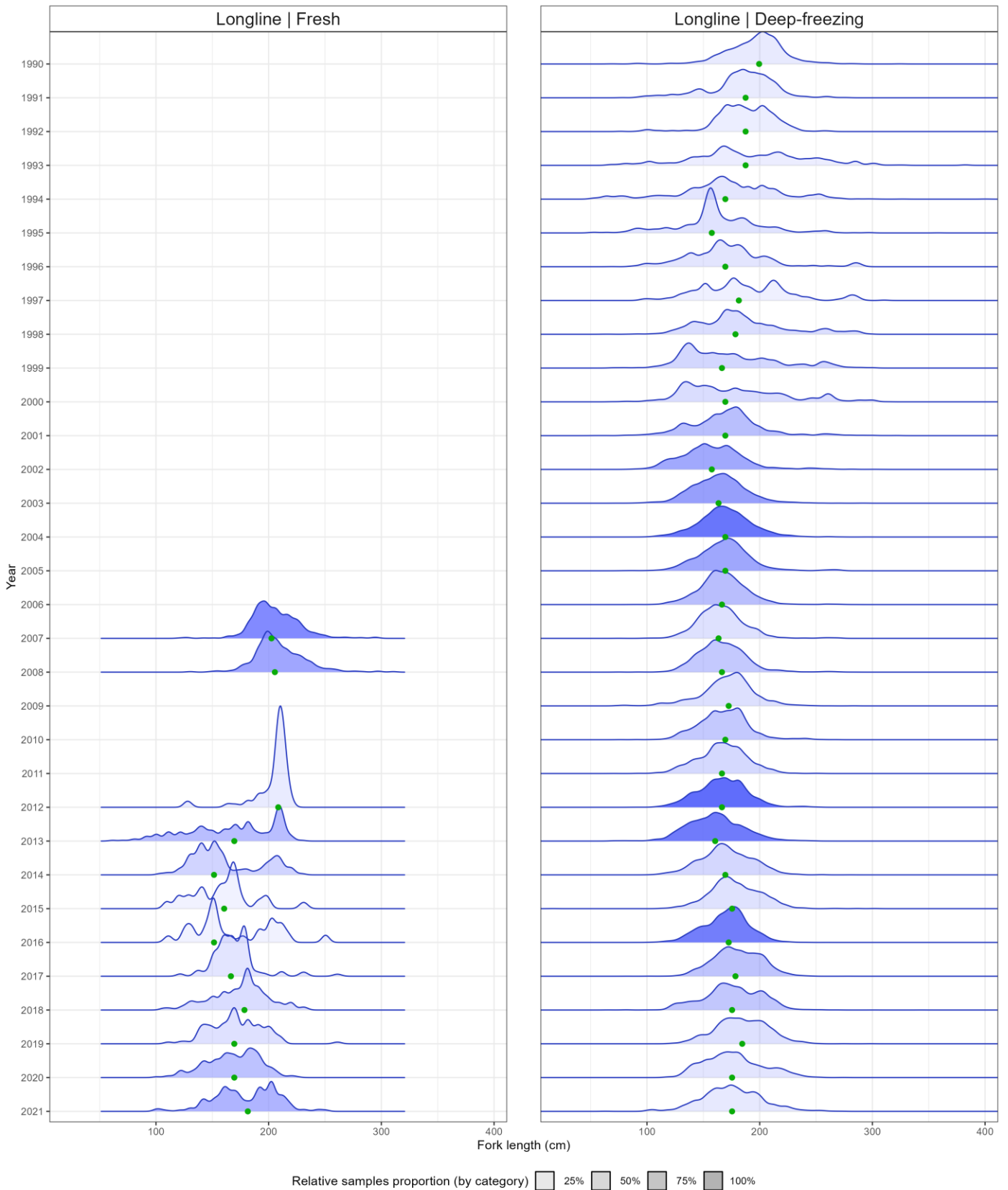


Figure 27: Relative size distribution (fork length; cm) of striped marlin caught by (left panel) fresh longline fisheries and (right panel) deep-freezing longline fisheries. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value.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

Size distribution by fishery and fleet

Deep-freezing longline fisheries

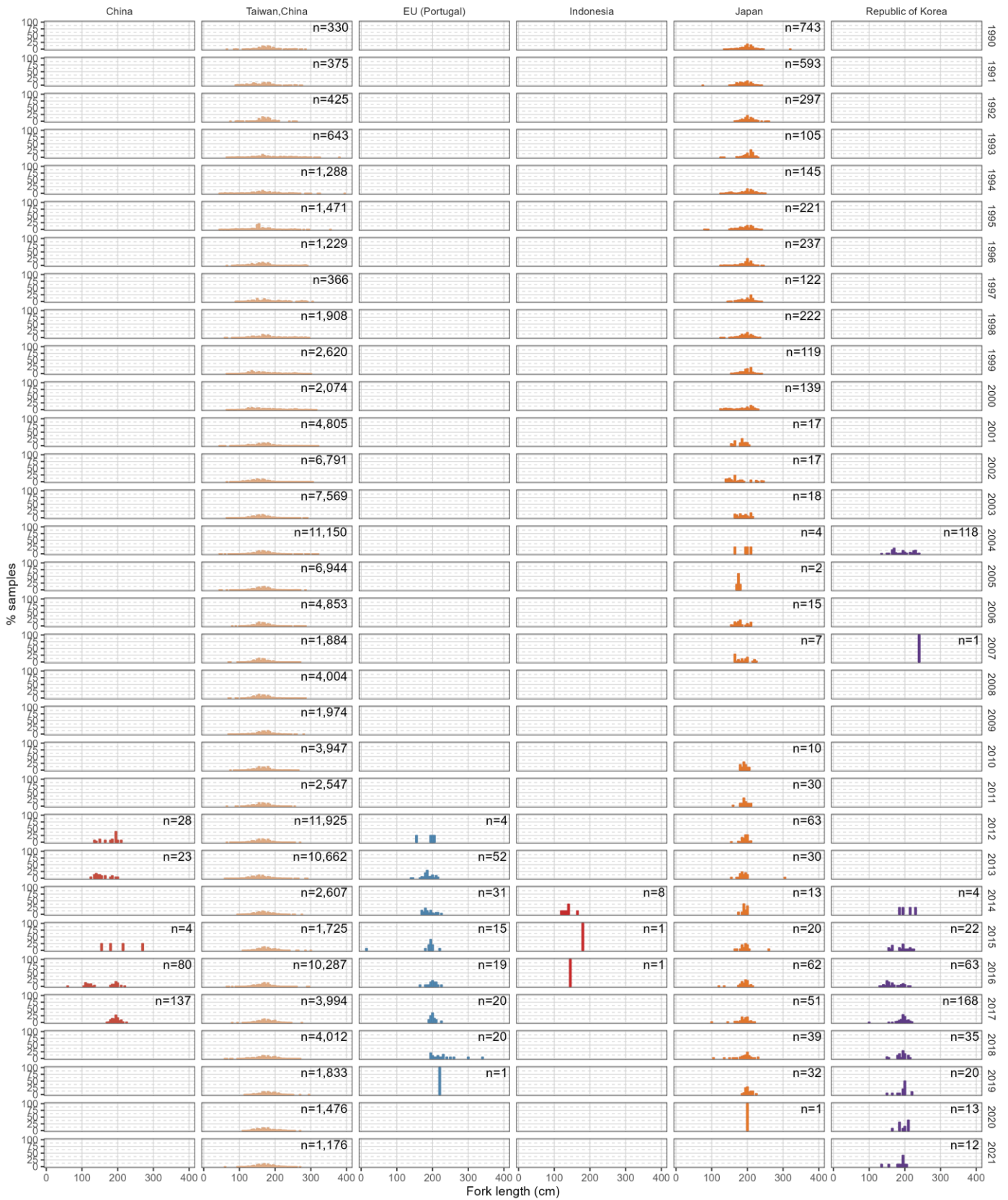


Figure 28: Relative size distribution of striped marlin (fork length; cm) recorded for deep-freezing longline fisheries by year and main fleet. Data source: [standardized size-frequency dataset](#)

Fresh longline fisheries

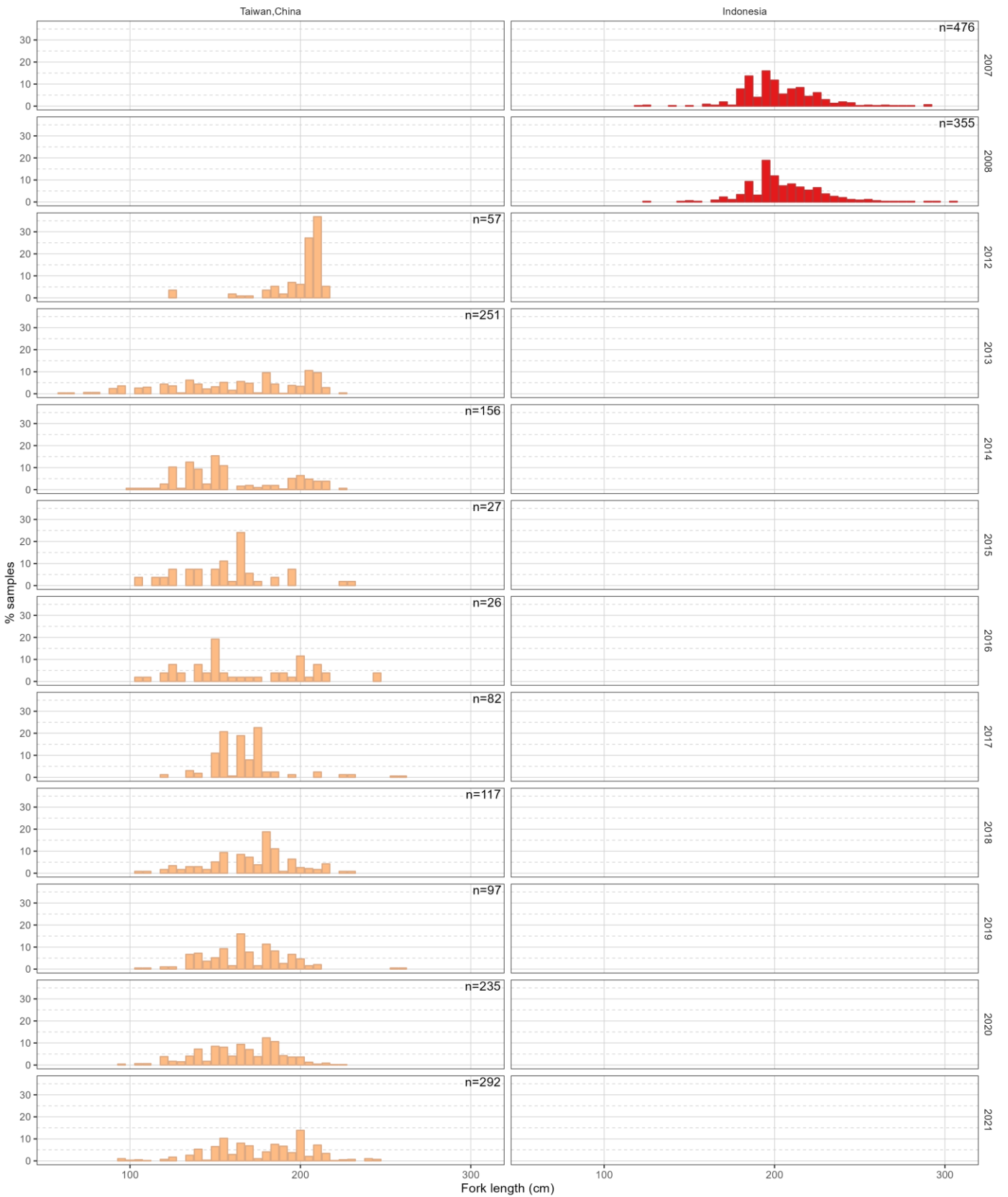


Figure 29: Relative size distribution of striped marlin (fork length; cm) recorded for fresh longline fisheries by year and main fleet. Data source: [standardized size-frequency dataset](#)

## Uncertainties in size-frequency data

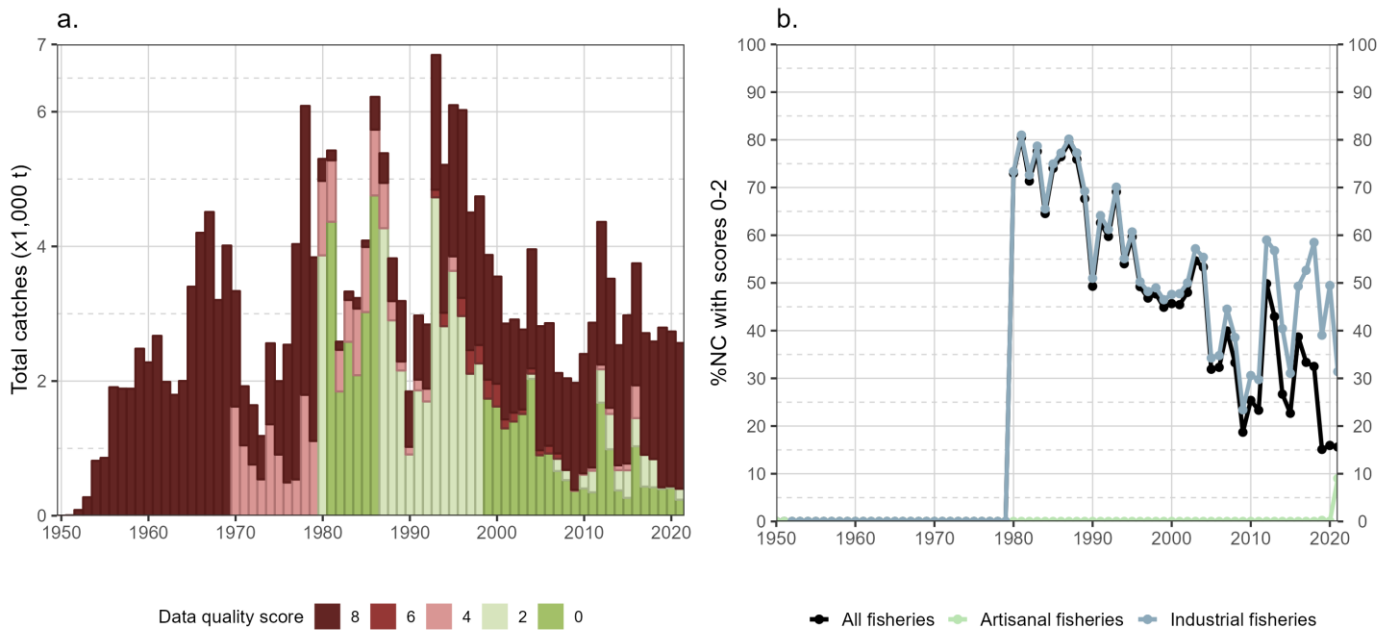


Figure 30: (a) Annual retained catches (metric tonnes; t) of striped marlin estimated by quality score and (b) percentage of total retained catches for which geo-referenced size-frequency data were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950–2021

## References

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## Appendices

### Appendix I: Taxonomy

Rank	Taxon
Kingdom	<i>Animalia</i>
Subkingdom	<i>Bilateria</i>
Infrakingdom	<i>Deuterostomia</i>
Phylum	<i>Chordata</i>
Subphylum	<i>Vertebrata</i>
Infraphylum	<i>Gnathostomata</i>
Superclass	<i>Actinopterygii</i>
Class	<i>Teleostei</i>
Superorder	<i>Acanthopterygii</i>
Order	<i>Perciformes</i>
Suborder	<i>Xiphoidei</i>
Family	<i>Istiophoridae</i>
Genus	<i>Kajikia</i>
Species	<i>Kajikia audax</i>

## 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 20<sup>th</sup> session of the IOTC Working Party on Billfish ([WPB20](#)), with overall small modifications in the time series of annual catches (**Fig. 8**). The changes covering the period 2017-2019 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)
2019	IRN	Gillnet	Western Indian Ocean	907	985	-78
2018		Gillnet	Western Indian Ocean	1,002	1,037	-34
2017	IDN	Gillnet	Eastern Indian Ocean	92	74	18
		Line	Eastern Indian Ocean	346	277	69
	IND	Gillnet	Western Indian Ocean	17	38	-21
	PAK	Gillnet	Western Indian Ocean	779	739	40