REVIEW OF THE STATISTICAL DATA AVAILABLE FOR INDIAN OCEAN BLUE MARLIN (1950-2020)

Author: IOTC Secretariat

Abstract

The document provides an overview of the consolidated knowledge about fisheries catching blue marlin (*Makaira nigricans*) in the Indian Ocean since the early 1950s based on a range of data sets collected by Contracting Parties and Cooperating Non-Contracting Parties (CPCs) of the IOTC and curated by the IOTC Secretariat. The available fisheries statistics indicate that the catches of blue marlin in industrial longline fisheries have substantially decreased over the last decade when the catches in coastal gillnet and line fisheries have increased, resulting in more than half of the total catch coming form artisanal fisheries in 2020. Information available on discarding practices of blue marlin in industrial fisheries indicates that discard levels are small in longline fisheries while blue marlins are more often discarded in large-scale purse seine fisheries, but in small quantities and with some variability between 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 and shows that the longline fishing grounds for blue marlin are mainly located in the western Indian Ocean when catches from gillnet, ringnet, and line fisheries mostly occur along the coasts of Sri Lanka and India. The reporting of size-frequency data has also improved over the last decade but remains very limited for most coastal fisheries.

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

Introduction

The overarching objective of this paper is to provide participants in the 20th session of the IOTC Working Party on Billfish (WPB20) with a review of the status of the information available on Indian Ocean blue marlin (*Makaira nigricans*) through the analysis of 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 (2022).

Nominal catch

Historical trends (1950-2020)

Nominal catch data available at the IOTC Secretariat indicate that until recently blue marlin was generally caught by industrial fisheries (**Fig. 1a**) with an increasing contribution of catches from artisanal fisheries since the 1980s which grew up representing over 50% of total catches in 2020 (**Fig. 1b**). Overall, total reported catches of blue marlin show an increasing trend until the early 2000s, followed by a generalized decrease over the last two decades, although marked by large variability between years.

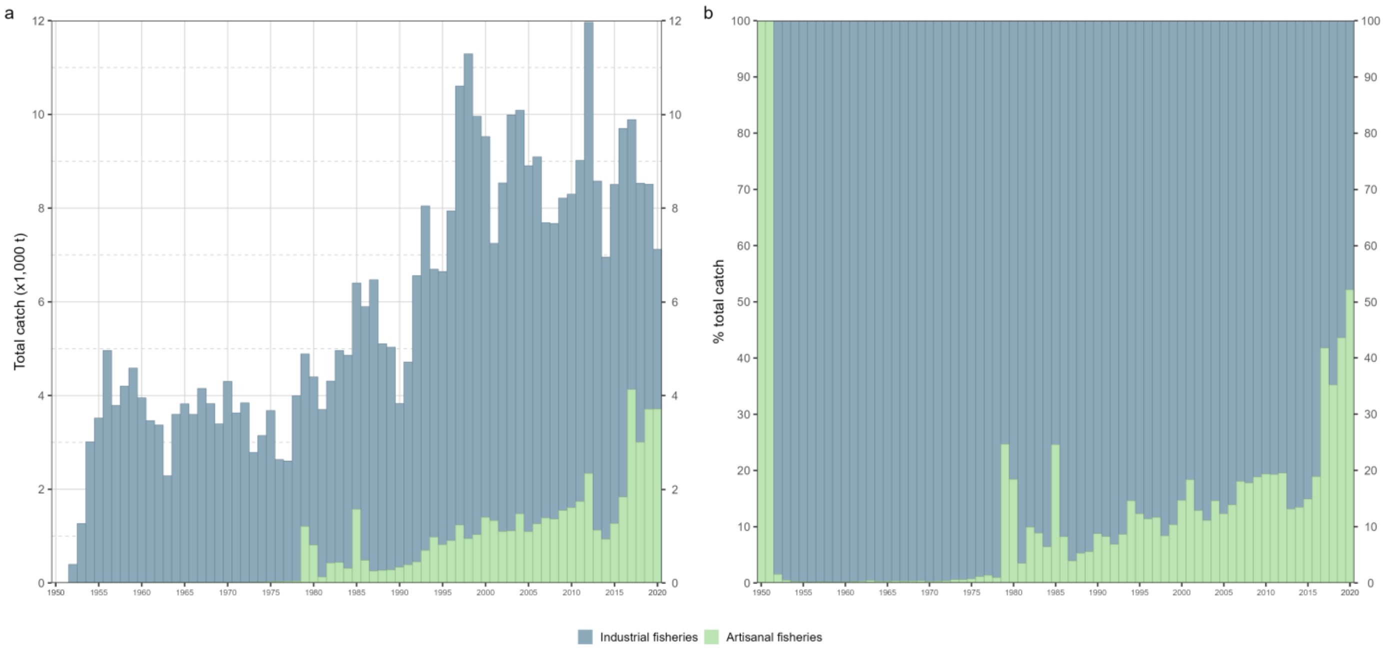

Figure 1: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of blue marlin by type of fishery for the period 1950-2020. Data source: best scientific estimate of nominal catches

Historically, industrial deep-freezing and fresh longline were the main fisheries catching blue marlin in the Indian Ocean (**Table 1a**). The number of longline vessels from Asian fleets (notably Taiwan,China, Korea and Japan as well as Indonesia) increased from the 1960s, which in turn caused an increase in catches of billfish species, including blue marlin. Nonetheless, several longline fleets have gradually reduced, since 2010, the number of vessels operating in the Indian Ocean which resulted in a decreasing catch over the last decade (**Table 1a**). On the contrary, and in the same timeframe, coastal longline fisheries (from India and Sri Lanka, most notably) have been developing further and catches of blue marlin reported to the Secretariat have increased accordingly. Besides, gillnet fisheries have also been increasing their catches of blue marlin over time, and in particular between 2015 and 2019, to the point that now these contribute to about 20% of the total annual catch of the species on average (**Fig. 2b**).

Table 1: Best scientific estimates of average annual nominal catches (metric tons; t) of blue 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 estimate of nominal catches

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Purse seine | Other	0	0	0	2	4	7	107
Longline | Other	0	0	0	10	237	511	341
Longline | Fresh	0	0	38	230	2,293	3,312	2,985
Longline | Deep-freezing	2,567	3,535	3,370	4,312	4,538	4,038	3,652
Line | Coastal longline	0	0	0	10	31	59	568
Line | Trolling	5	9	17	12	32	52	136
Line | Handline	0	0	0	83	105	40	135
Gillnet	1	2	124	454	390	678	1,070
Other	0	0	0	0	0	0	1
Total	2,574	3,546	3,550	5,113	7,629	8,696	8,995

Table 2: Best scientific estimates of annual nominal catches (metric tons; t) of blue marlin by fishery for the period 2011-2020. The background intensity color of each cell is directly proportional to the catch level. Data source: best scientific estimate of nominal catches

Fishery	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Purse seine | Other	16	16	18	16	21	44	780	46	95	65
Longline | Other	703	1,042	443	43	125	156	95	74	86	79
Longline | Fresh	4,262	3,248	3,247	2,624	2,847	2,934	2,409	2,122	2,202	1,502
Longline | Deep-freezing	2,889	6,214	4,054	3,300	4,259	4,744	3,113	3,073	2,288	1,726
Line | Coastal longline	135	141	195	393	505	457	1,505	983	1,233	716
Line | Trolling	88	87	102	106	132	216	214	158	154	232
Line | Handline	45	40	46	23	74	218	257	292	285	1,336
Gillnet	880	1,177	472	449	542	920	1,514	1,781	2,166	1,465
Other	0	0	0	0	0	11	1	1	0	0
Total	9,018	11,965	8,577	6,955	8,506	9,701	9,888	8,531	8,510	7,121

Reported catches of blue marlin were very low in 1950 but sharply increased from 400 t in 1952 to 1,300 t in 1953 (**Fig. 2**). The catches then gradually increased to reach about 11,000 t in 1997, although with some large interannual variability. Between 1960 and 1980 blue marlin was a major billfish species in the Indian Ocean, contributing to a third of all billfish catches. Although the highest catch of blue marlin was recorded in 2012 at about 12,000 t, since then catches have shown a continuous decline over the last decade, reaching 7,100 t in 2020. In recent years, blue marlin only contributed to around 8.5% of the total billfish catches in the Indian Ocean.

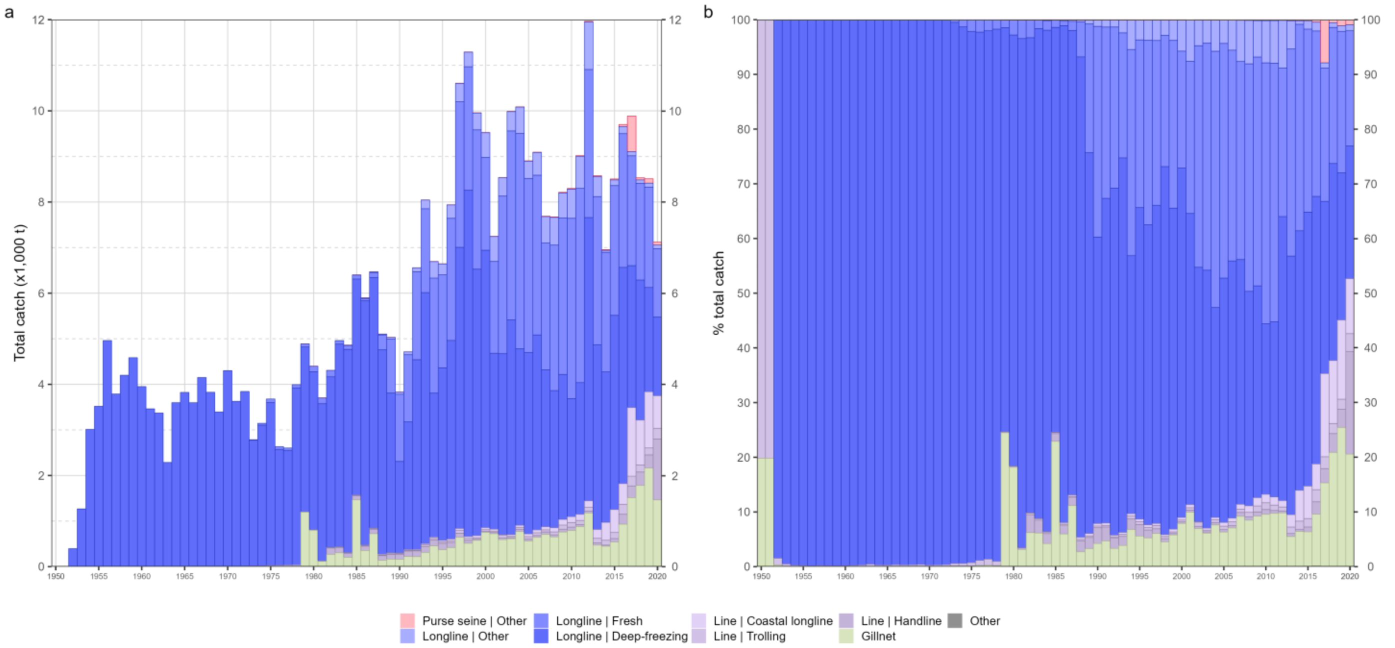

Figure 2: Annual time series of cumulative nominal absolute (a) and relative (b) catches (metric tons; t) of blue marlin by fishery for the period 1950-2020. Data source: best scientific estimate of nominal catches

Very limited catches of blue marlin were reported from coastal fisheries throughout the 1960s and 1970s (**Table 1**). Towards the end of the 1970s, the gillnet fisheries of Pakistan and Sri Lanka, which could operate both in the areas under national jurisdiction and high seas, increased their catches of blue marlin (Herath & Maldeniya 2013, Khan 2017). In 1979, the catches of blue marlin from coastal fisheries were 1,200 t, contributing to about one third of all blue marlin catches in that year.

Catches from coastal fisheries displayed high fluctuations throughout the 1980s, mainly due to the variability in the catch data reported by Pakistan. In fact, Pakistani fisheries developed throughout the 1980s and 1990s, with some shrimp trawlers being converted into pelagic gillnetters (Moazzam 2013) and this resulted in increased catches of both tuna and billfish species. However, no information was available at species level for the catches of billfish at that time and all catches were reported as aggregate species under the species code “BIL” (Moazzam 2013).

In 2017 Pakistan fully revised their time series of gillnet catches for the period 1987-2016 based on information collected through the WWF crew-based data collection programme, although without major improvements on the species composition of billfish catches (IOTC 2019, Moazzam 2019). This required the IOTC Secretariat to post-process all catches of aggregated billfish species from the gillnet fisheries of Pakistan, which in the years between mid-1980s and mid-1990s were in turn all assigned to Indo-Pacific sailfish (*Istiophorus platypterus*) hence explaining the disappearance of blue marlin catches from those reported by the coastal fisheries of Pakistan in the timeframe concerned.

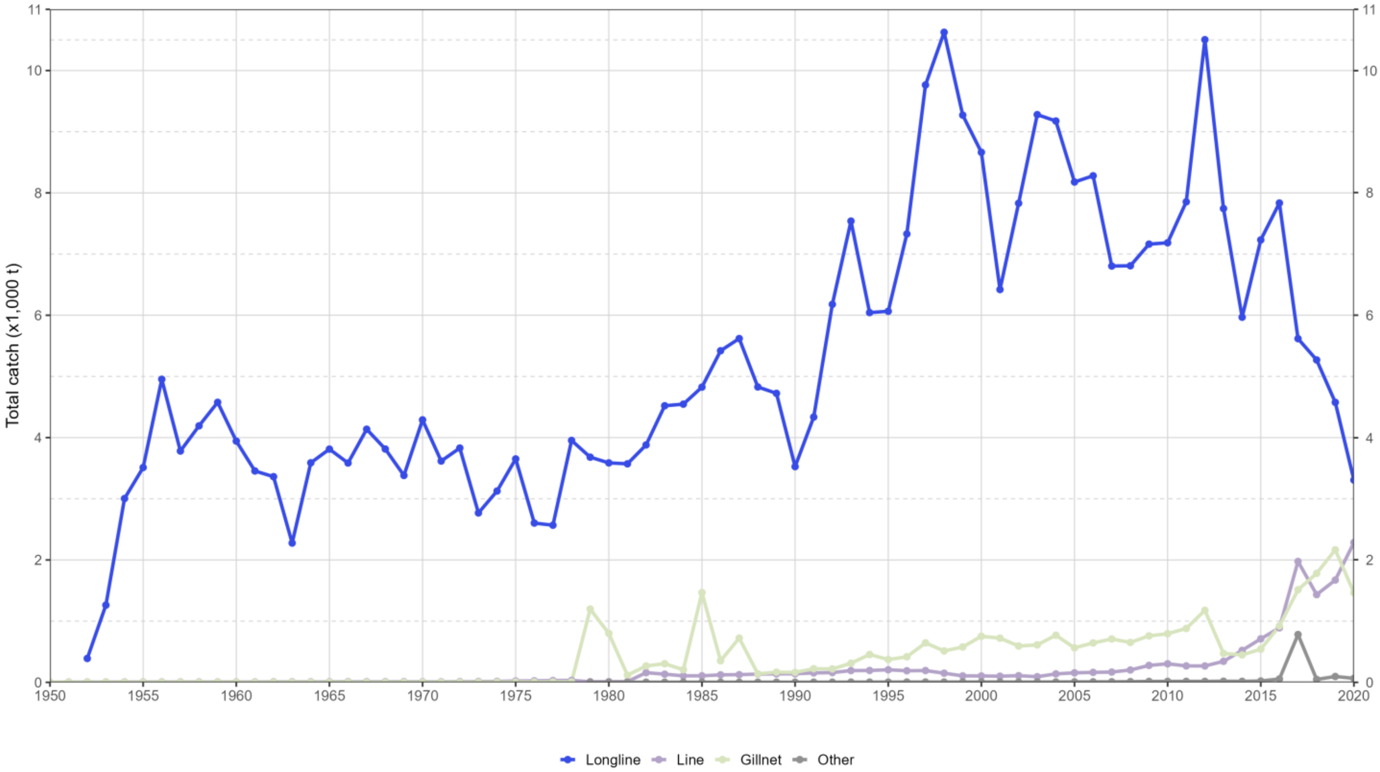

Figure 3: Annual time series of nominal catches (metric tons; t) of blue marlin by fishery group for the period 1950-2020. Data source: best scientific estimate of nominal catches

Blue marlin catches from industrial fisheries have gradually declined in both fresh and deep-freezing longline fisheries during the last decade (**Table 2**). While about 4,300 t of blue marlin were caught by the fresh tuna longline fishery in 2011, the reported catch decreased to about 1,500 t in 2020. The drop in catches could reflect the decline in Indonesian fresh longline vessels as well as some changes in targeted species by the longline vessels from Taiwan,China and China. A similar declining trend in catch was observed for deep-freezing longliners between 2012 and 2020 (**Table 2**).

Main fishery features (2016-2020)

In recent years (2016-2020), deep-freezing longline fisheries contributed to 34.2% of blue marlin catch, followed by fresh longline (25.5%) and gillnet (17.9%) fisheries (**Table 3**). Coastal *line* fisheries (that combine longline, troll line and handline gears) have contributed to about 18.9% of total catches for the species.

Of the 2.4% of catches reported on average by purse seine fisheries (both artisanal and industrial), the majority was recorded by Sri Lankan ringnets in 2017 (around 700 t).

Very limited information on retained catches of blue marlin for industrial purse seine fisheries has been reported to the Secretariat through the nominal catch data form (1-RC) while information from the ROS indicates that some blue marlin may be caught in these fisheries and retained or discarded at sea (see section Discard levels).

Table 3: Mean annual catches (metric tons; t) of blue marlin by fishery between 2016 and 2020. Data source: best scientific estimate of nominal catches

Fishery	Fishery code	Catch	Percentage
Longline | Deep-freezing	LLD	2,989	34.2
Longline | Fresh	LLF	2,234	25.5
Gillnet	GN	1,569	17.9
Line | Coastal longline	LIC	979	11.2
Line | Handline	LIH	478	5.5
Purse seine | Other	PSOT	206	2.4
Line | Trolling	LIT	195	2.2
Longline | Other	LLO	98	1.1
Other	OT	3	0.0

Catches of blue marlin are highly concentrated, as four countries contributed to 75% of total catch levels between 2016 and 2020 (**Fig. 4**). Longline fisheries of Taiwan,China accounted for 36% of the total blue marlin catch, with 17% caught by the deep-freezing longline component. Sri Lankan fisheries also catch substantial amounts of blue marlin with a variety of coastal and offshore fisheries, contributing to 23% of the total catch reported between 2016 and 2020 (**Fig. 4**).

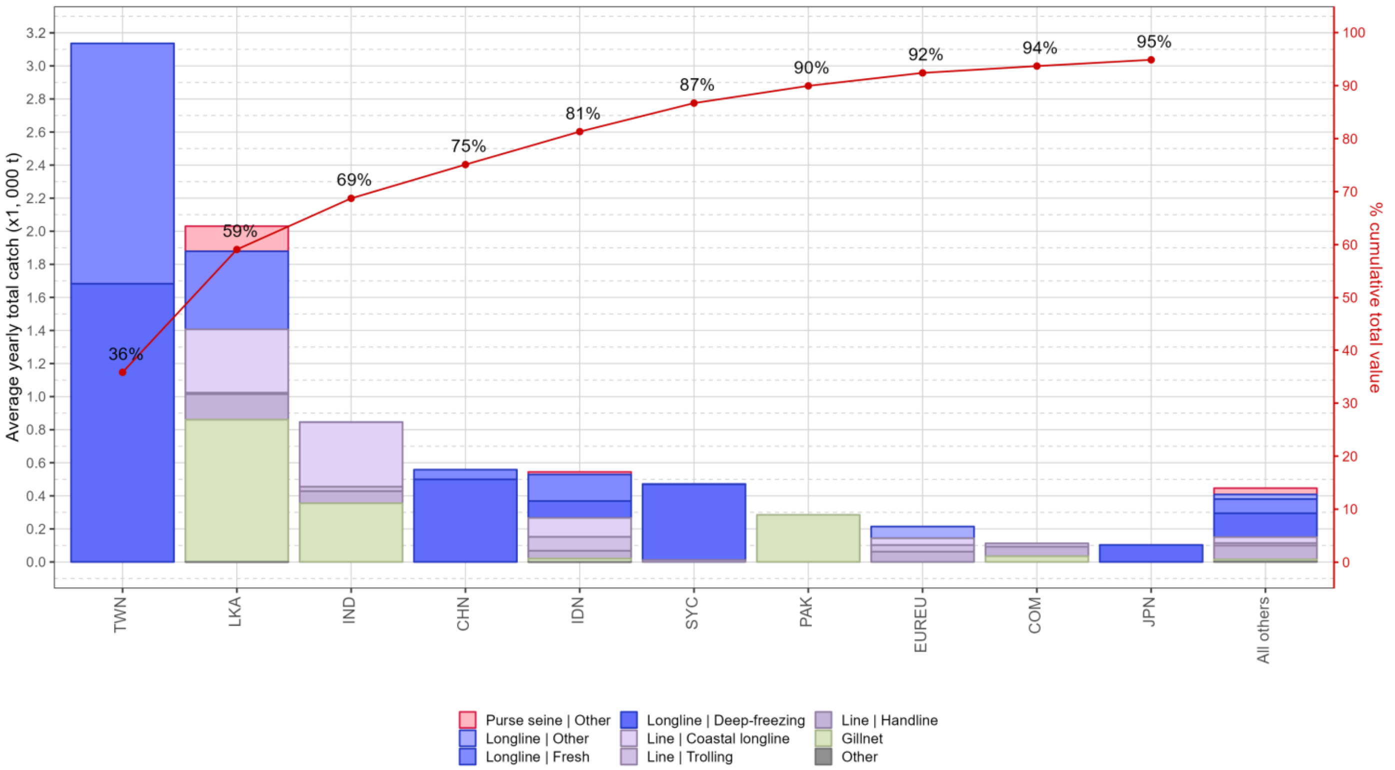

Figure 4: Mean annual catches (metric tons; t) of blue marlin by fleet and fishery between 2016 and 2020, with indication of cumulative catches by fleet. Data source: best scientific estimate of nominal catches

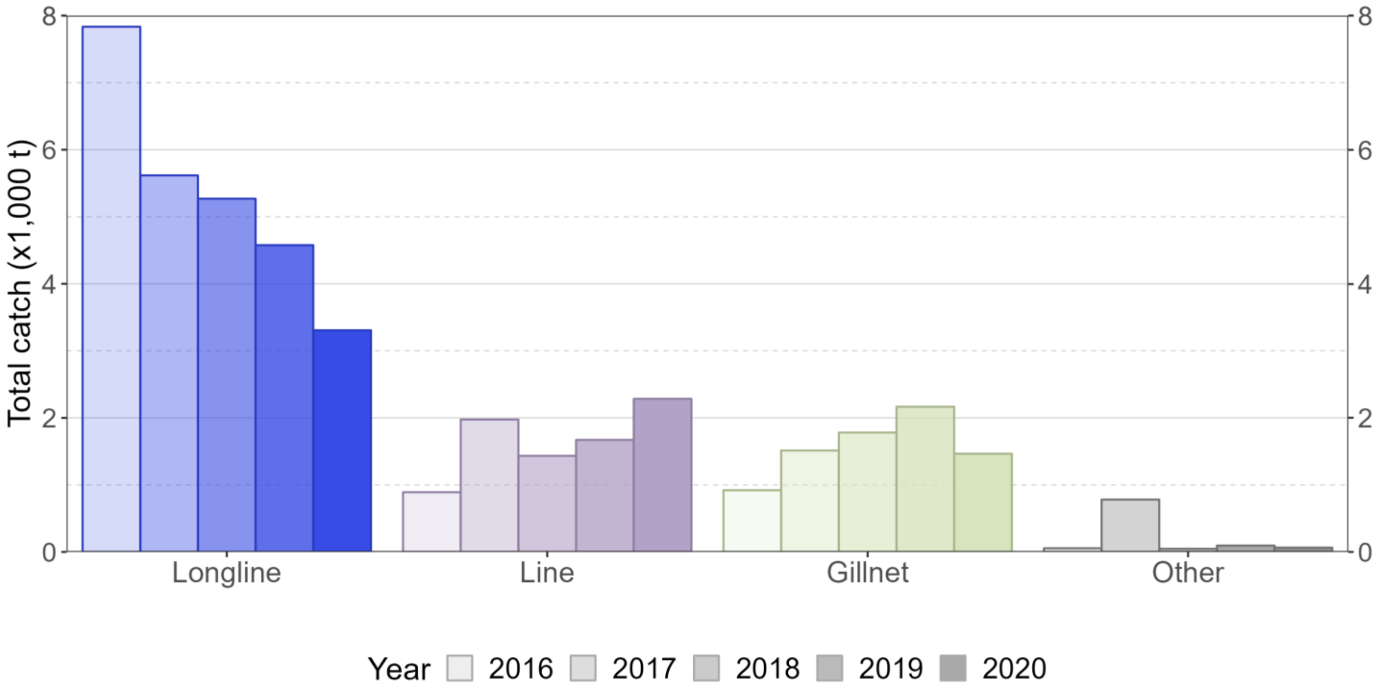

Figure 5: Annual catch (metric tons; t) trends of blue marlin by fishery group between 2016 and 2020. Data source: best scientific estimate of nominal catches

Annual catches of blue marlin by fishery group show that *longline* and *other* fisheries reported declining catches since 2016, as opposed to *line* and *gillnet* fisheries which recorded an overall increase in recent years (**Fig. 5**). Besides the longline fisheries of Sri Lanka and Seychelles, where blue marlin catches increased overall (possibly as a consequence of the increase in number of small longline vessels from both CPCs), blue marlin considerably declined in other longline fisheries. Moreover, the number of Seychelles deep-freezing longline vessels increased from 37 vessels in 2015 to 62 in 2020, resulting in an increase of blue marlin catches for the fleet from 125 t in 2016 to 483 t in 2020.

Catches from gillnet and line fisheries fluctuated for most CPCs in recent years. Catches of line fisheries from Sri Lanka, and particularly those from hand line and coastal longline fisheries, increased in 2017 and again in 2020 following the declines recorded in 2018 and 2019.

Contrary to line fisheries, gillnet catches have continuously declined between 2016 and 2020, which could be due to more coastal longliners and less gillnetters in operation in recent years. Blue marlin catches peaked in 2018 for Sri Lankan gillnet fisheries but declined in subsequent years, while Pakistani gillnets - on the other hand - reported an increase of blue marlin catches from 2019 levels. Furthermore, India did not report catches of billfish broken down by species in recent years but nevertheless recorded an increase in aggregated catches of billfish (**Fig. 6**).

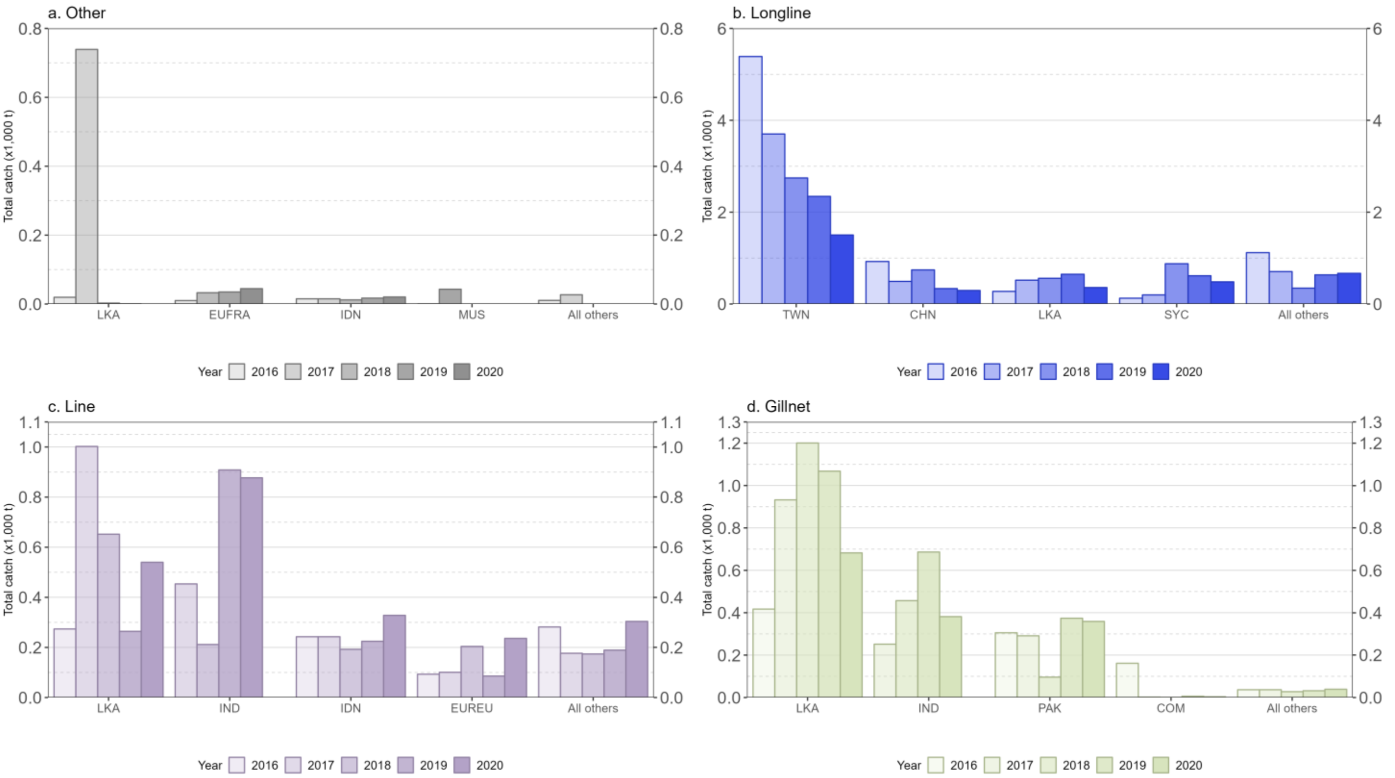

Figure 6: Annual catch (metric tons; t) trends of blue marlin by fishery group and fleet between 2016 and 2020. Data source: [best scientific estimate of nominal catches]

Changes from previous Working Party

There was no significant data revision between the Working Parties on Billfish held in 2021 (WPB19) and 2022 (WPB20) which could impact the historical catch trend of blue marlin. However, the disaggregation of marlin and billfish aggregated catches, which relies on proxy fleets and years, slightly altered the past data estimated for blue marlin (**Fig. 7**). In particular, catches from Pakistan changed to reflect the latest catch breakdown of billfish species reported in recent years (see Appendix I for additional details on the most important changes in nominal catches in recent years).

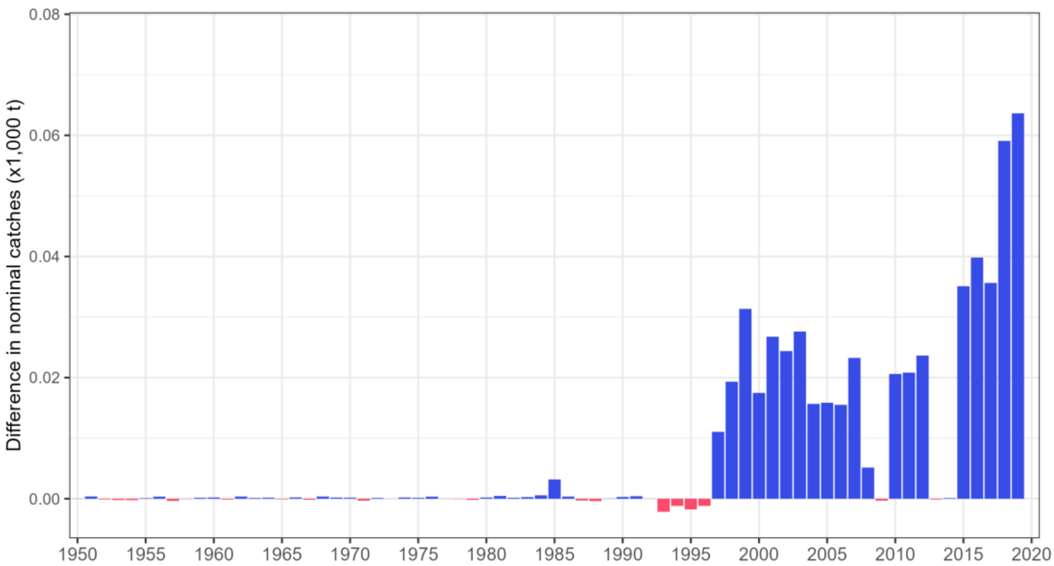

Figure 7: Differences in the available best scientific estimates of nominal catches (metric tons; t) of blue marlin between this WPB and its previous session (WPB19 meeting held in September 2021)

Uncertainties in nominal catch data

It is important to note that the nominal catches of blue marlin are highly uncertain in several fisheries, as the species may have been often under-reported or aggregated with other billfish species. As an example, the Secretariat received historical revisions in the past where catches of blue marlin were either fully removed from the gillnet fisheries of I.R. Iran or considerably reduced for the gillnet fisheries of Pakistan (IOTC 2019).

Although coastal fisheries caught blue marlin in the past, few information was available and the Secretariat estimated the catches for most of the coastal fisheries. The quality of the blue marlin catch data from coastal fisheries improved from the early 2010s, with detailed catches by species provided for Sri Lankan coastal fisheries. Recently, most fisheries reported detailed catches of blue marlin, which resulted in more accurate catch data.

Overall, there are fewer uncertainties in the catch of industrial fisheries. In the 1990s however, several industrial longline fisheries, mostly the fresh tuna longline of several major fleets, were not reporting catch data to the IOTC Secretariat. Hence, most of the catches were estimated using proxy fleets and recorded as *not elsewhere identified* (NEI) (Herrera 2002). Furthermore, the lack of information at species level reduced the accuracy of the data available for blue marlin (**Fig. 8**).

In 2020 less than 10% of blue marlin catch was considered uncertain, and it predominantly included re-estimated catch for coastal fisheries (**Fig. 8**).

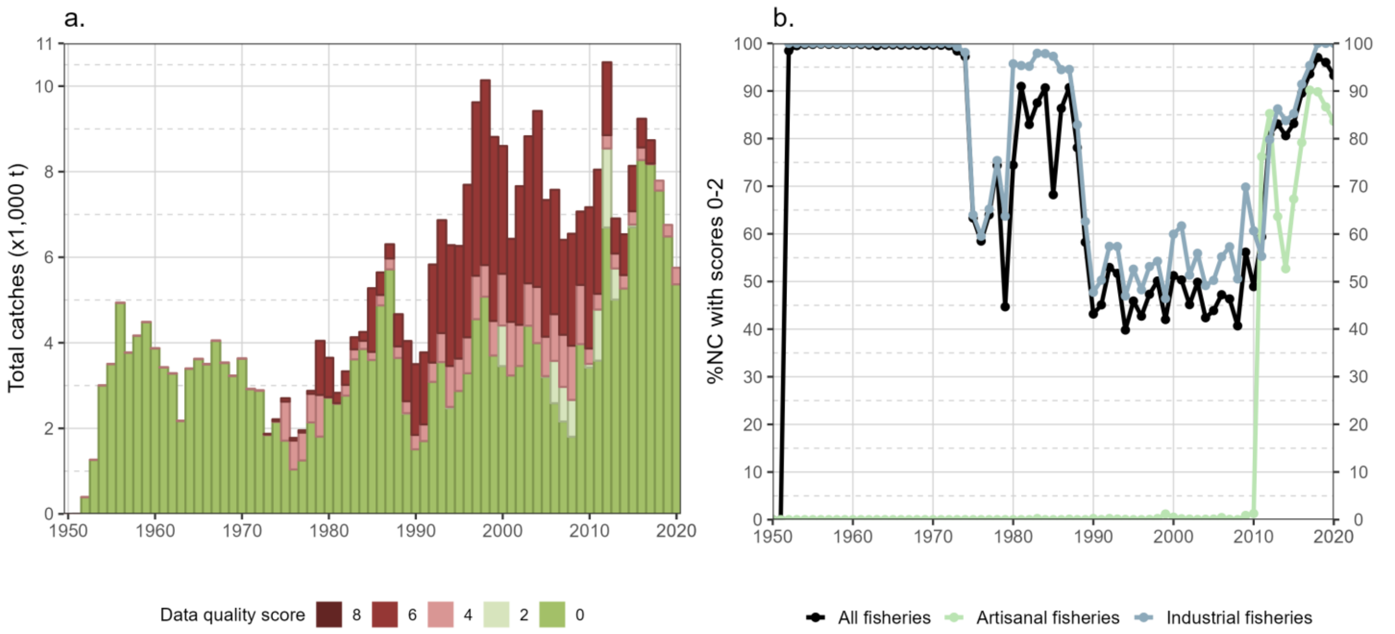

Figure 8: (a) Annual nominal catches (metric tons; t) of blue marlin estimated by quality score and (b) percentage of nominal catches fully or partially reported to the IOTC Secretariat for all fisheries and by type of fishery, in the period 1950-2020

Discard levels

Information collected from scientific observers at sea through the ROS suggests that blue marlin is more often discarded in large-scale purse seine than longline fisheries. Discarding rates vary between fleets, with higher discarding rates in French purse seiners than in Spanish ones. The size composition of the catch shows that blue marlins may be discarded at all sizes in purse seine fisheries, while no size data for discarded blue marlins are available from longline fisheries (**Fig. 9**).

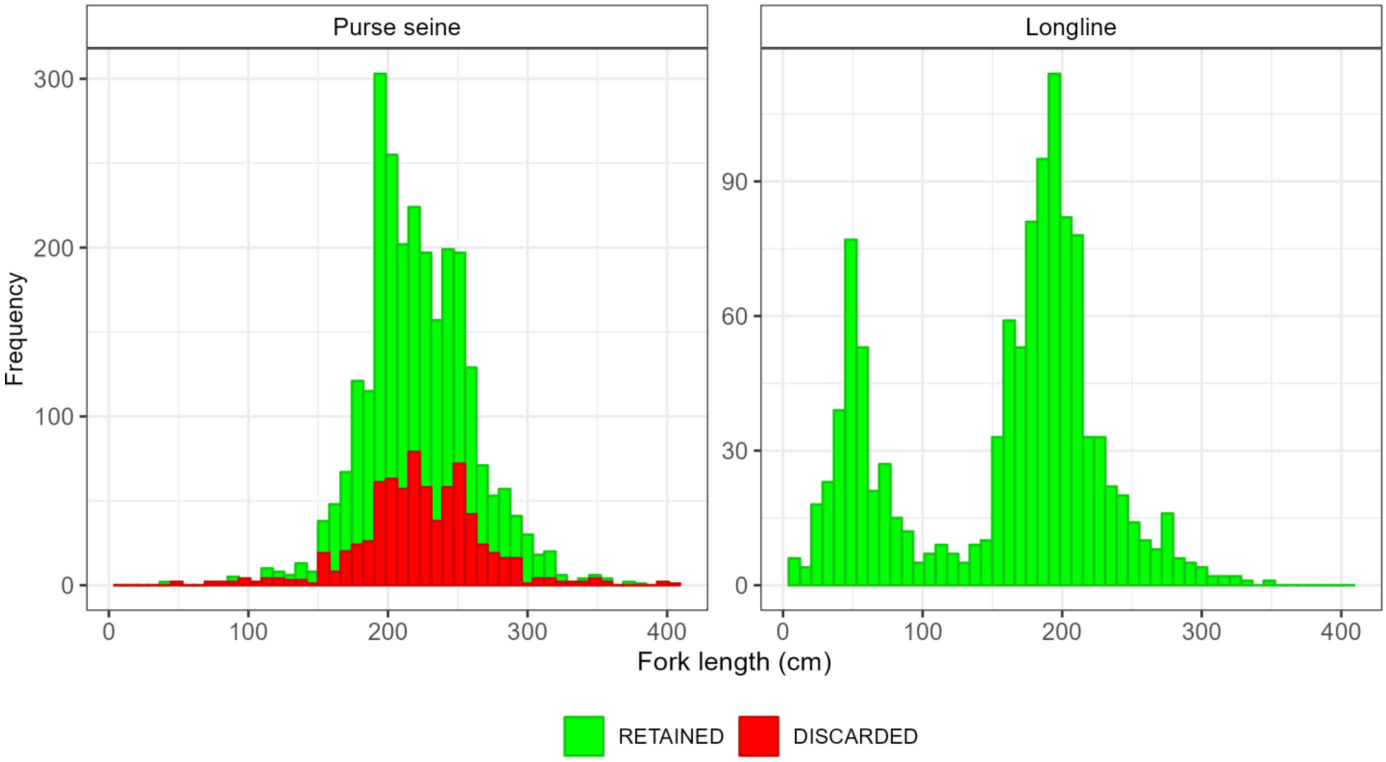

Figure 9: Size (fork length; cm) frequency distribution of blue marlin retained and discarded at sea in purse seine and longline fisheries as available in the ROS regional database

Information collected on the condition (i.e., individual released *dead* or *alive*) suggests that the very large majority of the fish do not survive when discarded at sea, whatever the fishery group or fishing ground (**Figs. 10-11**).

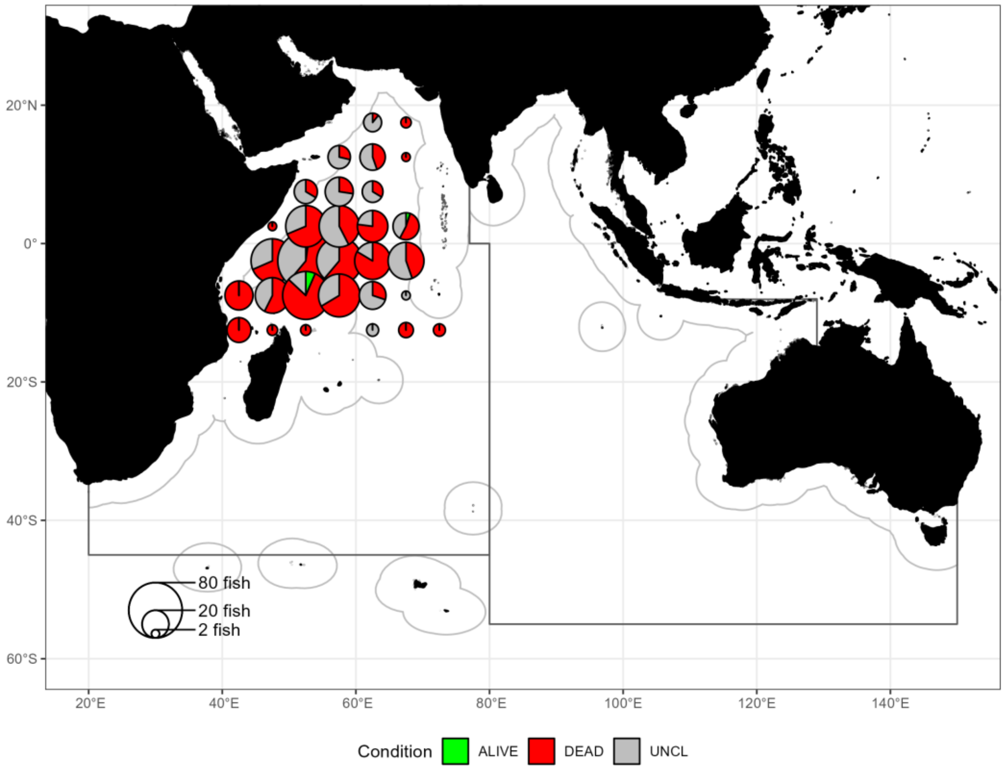

Figure 10: Distribution of blue marlins discarded at sea in the western Indian Ocean purse seine fisheries with information on condition at release as available in the ROS regional database

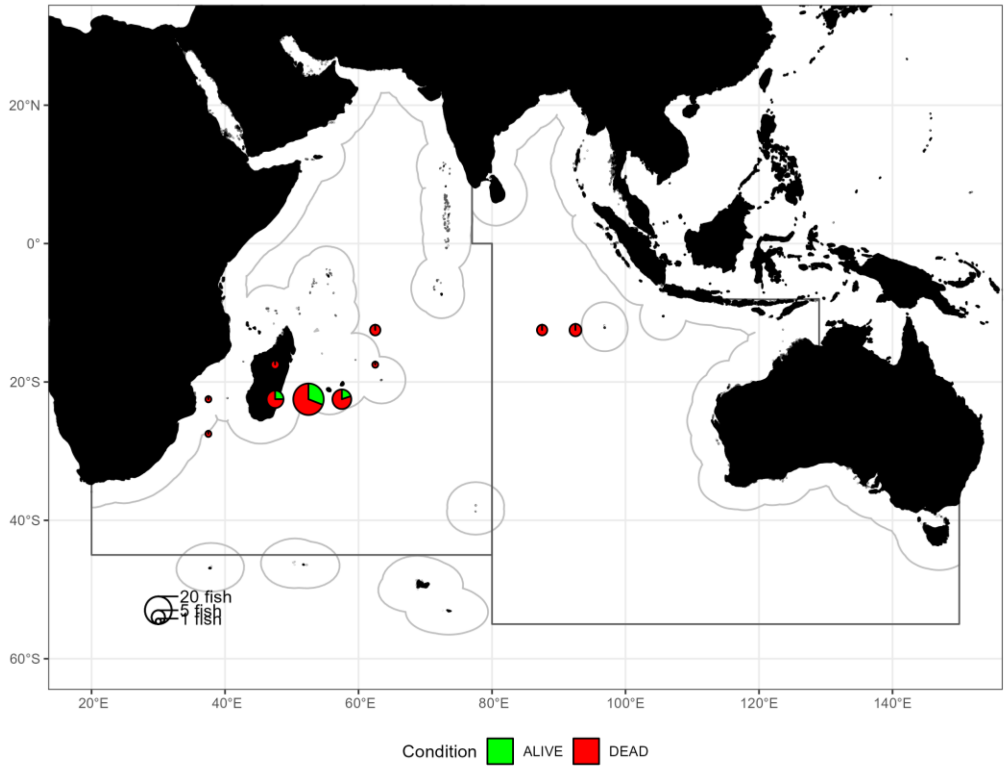

Figure 11: Distribution of blue marlins discarded at sea in the Indian Ocean longline fisheries with information on condition at release as available in the ROS regional database

Geo-referenced catch

Spatial distribution of catches

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

In the past, geo-referenced catches of blue marlin were generally available for the industrial longline fisheries. The distribution of the catch indicates that these were occurring in both the western and eastern Indian Ocean throughout the 1970s and 1980s. In 1990s and 2000s most blue marlin catches were taken by longline vessels from Taiwan,China that operated in the northwestern Indian Ocean (**Figs. 12–13**).

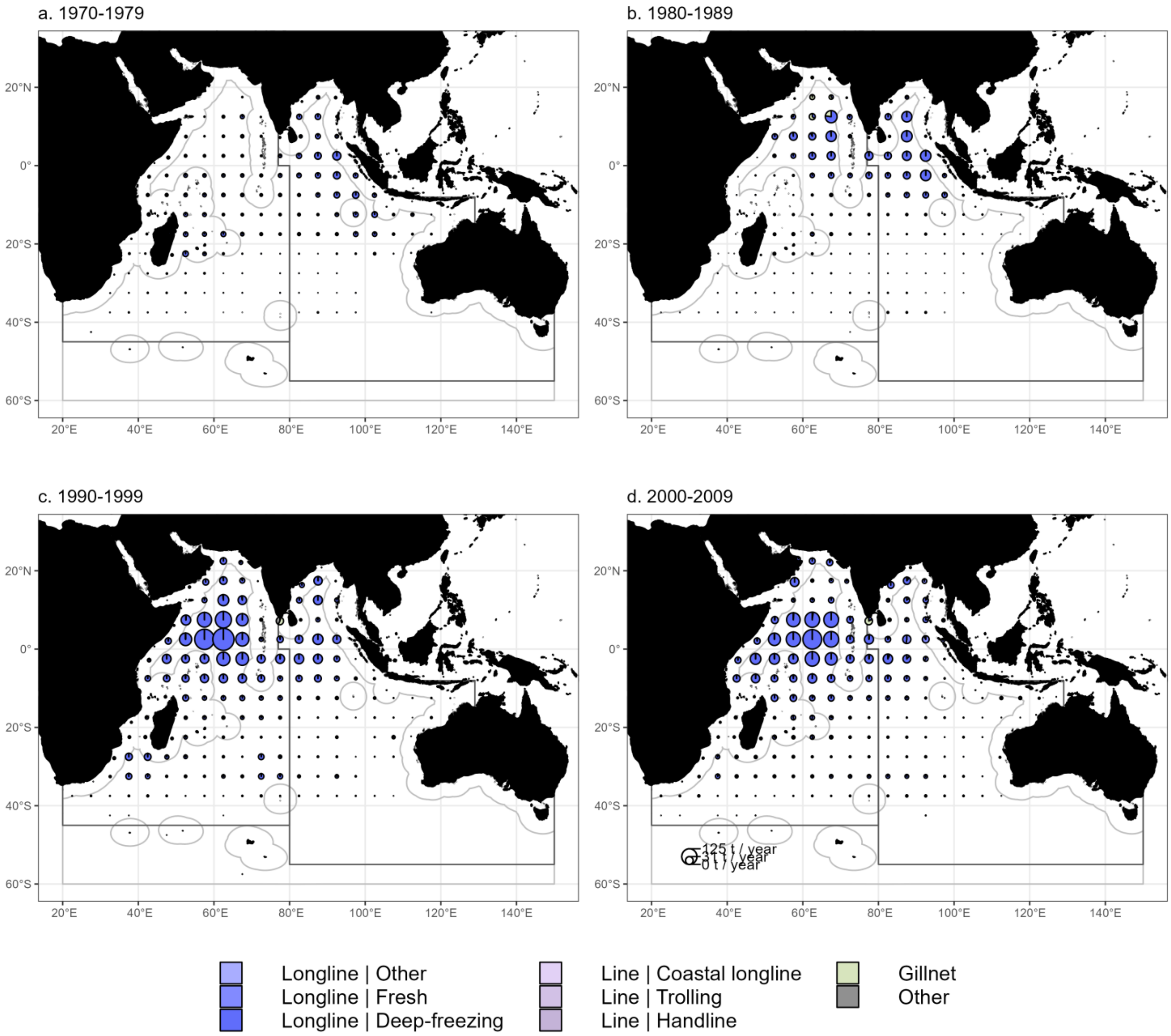

Figure 12: Mean annual time-area catches in weight (metric tons; t) of blue marlin, by decade, 5x5 grid, and fishery. Data source: [time-area catches]

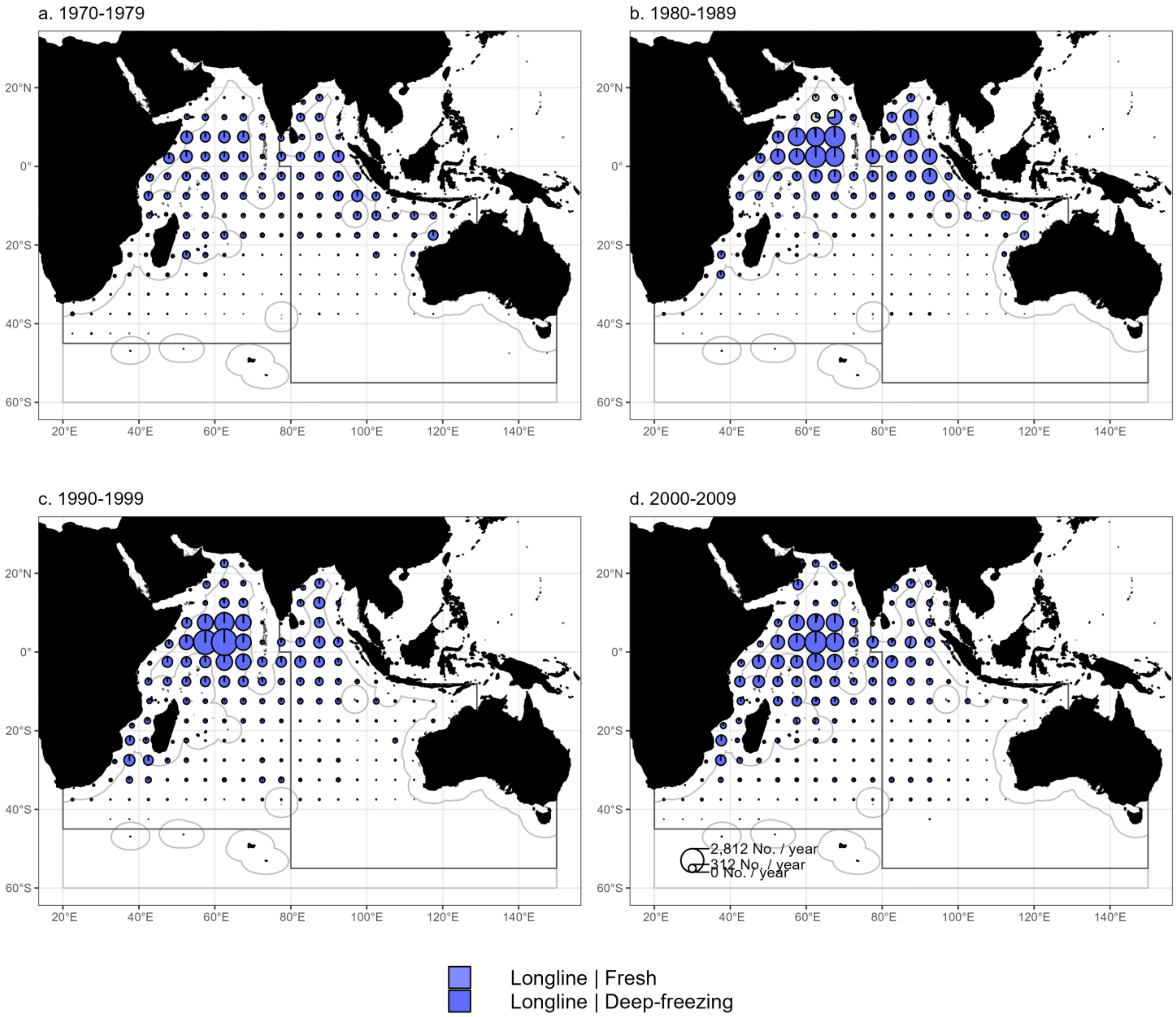

Figure 13: Mean annual time-area catches in numbers of blue marlin, by decade, 5x5 grid, and fishery. Data source: time-area catches

Geo-referenced catches by fishery, last years (2016-2020) and decade (2010-2019)

The quality of the geo-referenced catches reported to the Secretariat has substantially improved in recent years, and spatial information on fishing activities is now available for most industrial and coastal fisheries. In particular, the distributions of catches from Sri Lankan and Indonesian coastal fisheries have become available since 2016 (**Fig 14**). Geo-referenced catches indicate high catch levels in the Bay of Bengal for both line and gillnet fisheries while catches from longline fisheries remained high in the Western Indian Ocean (**Fig 14**).

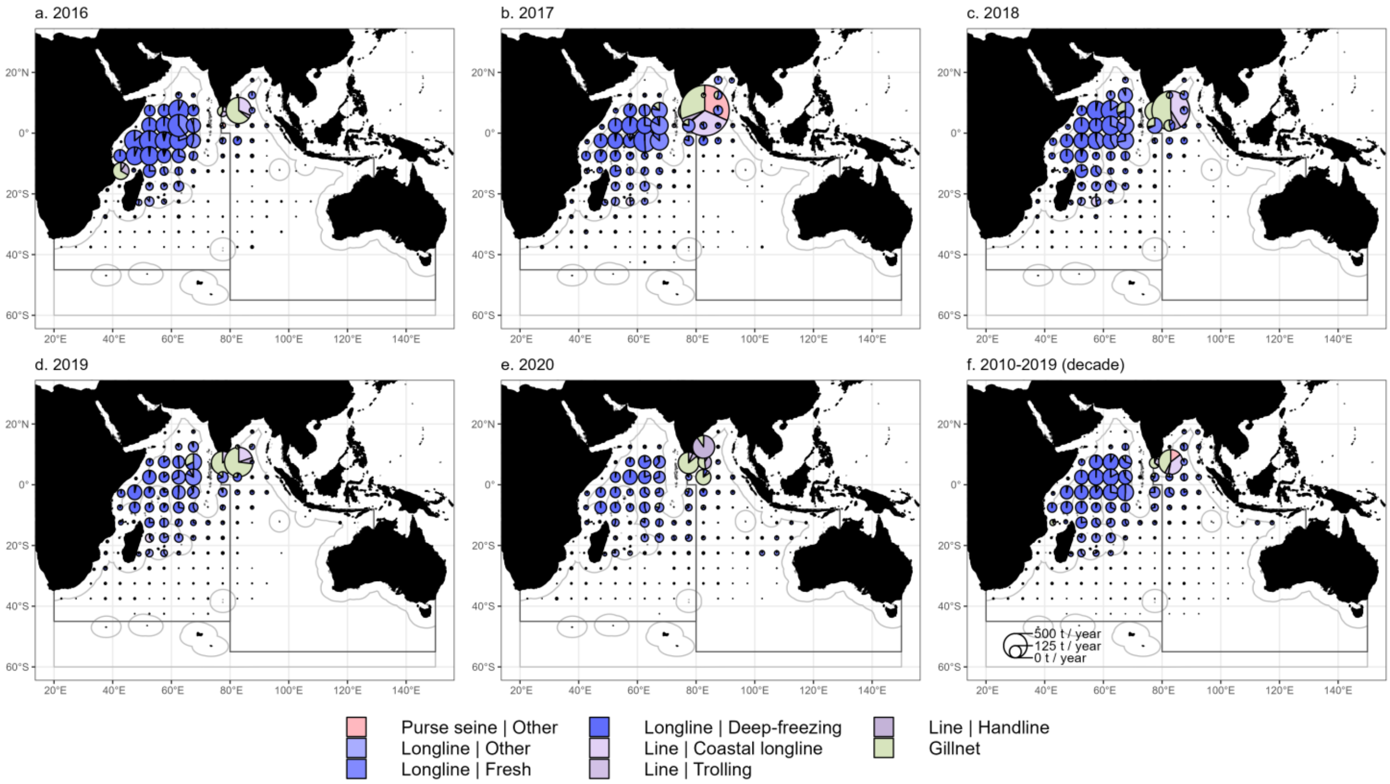

Figure 14: Mean annual time-area catches in weight (metric tons; t) of blue marlin, by year / decade, 5x5 grid, and fishery. Data source: [time-area catches]

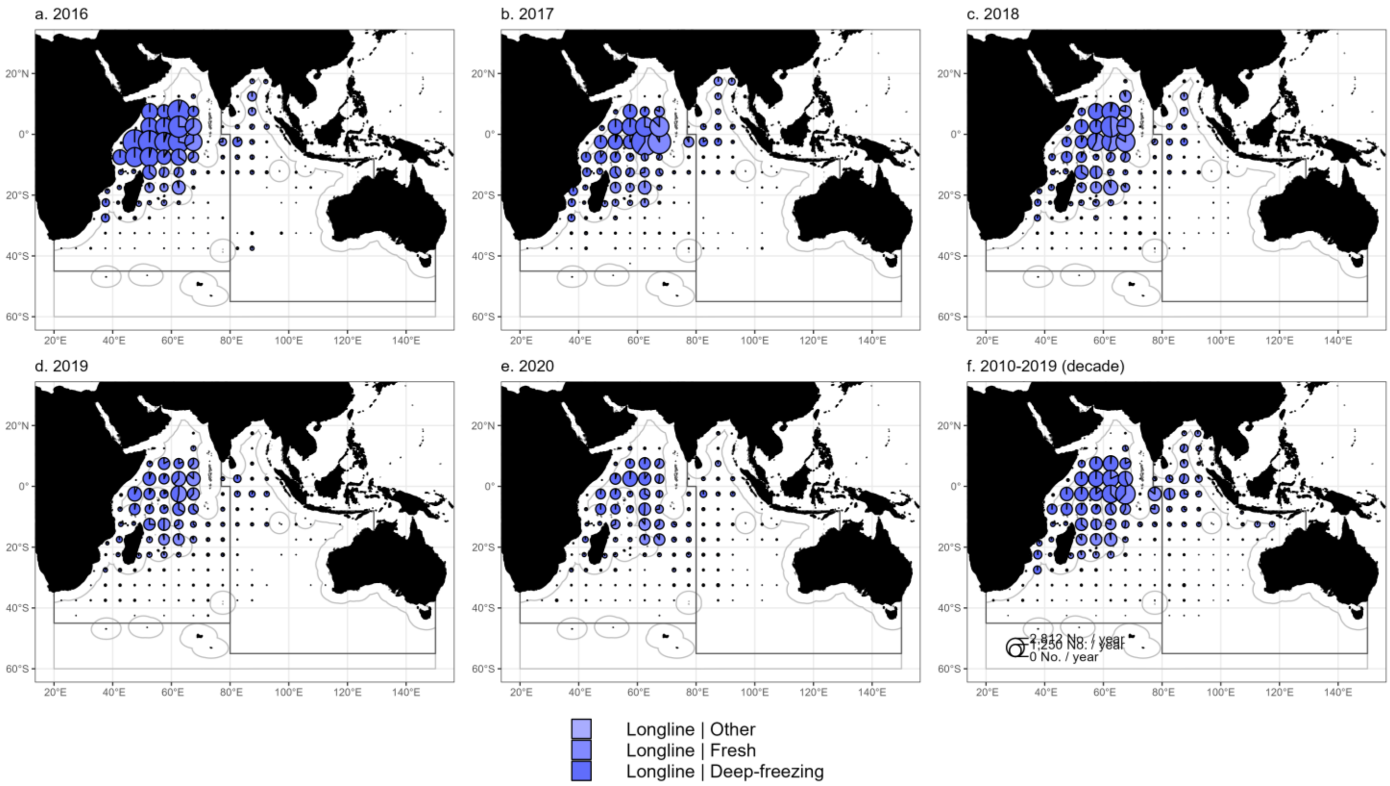

Figure 15: Mean annual time-area catches in numbers of blue marlin, by year / decade, 5x5 grid, and fishery. Data source: [time-area catches]

Uncertainties in catch and effort data

Uncertainties in geo-referenced catch and effort data of blue marlin are higher than those for nominal catch data, as barely any catch and effort data were available for the artisanal fisheries prior to 2014. Besides the limited extent of the data reported to the Secretariat, additional issues have been identified for the catch and effort:

- data from Sri Lankan fisheries have only become available since 2014 (Maldeniya et al. 1995);
- data for the main fisheries of Indonesia have only become available since 2018 and appear characterized by a low coverage for all fisheries;
- data for the fresh tuna longline of China are not available prior to 2009;
- data for the fresh tuna longline of Taiwan,China are not available prior to 2007.

Catch and effort data of good quality (scores 0-2) vary over time (**Fig. 16**) with the increased reports of catch and effort data complemented by an increase in data estimated as being of "*good quality*" from 2010 onwards.

Overall, catch-and-effort data are available for strata covering 80% of the nominal catches reported for 2020, with specific coverage reaching 100% and 50% of the nominal catches reported for the same year by industrial and artisanal fisheries, respectively (**Fig. 16**).

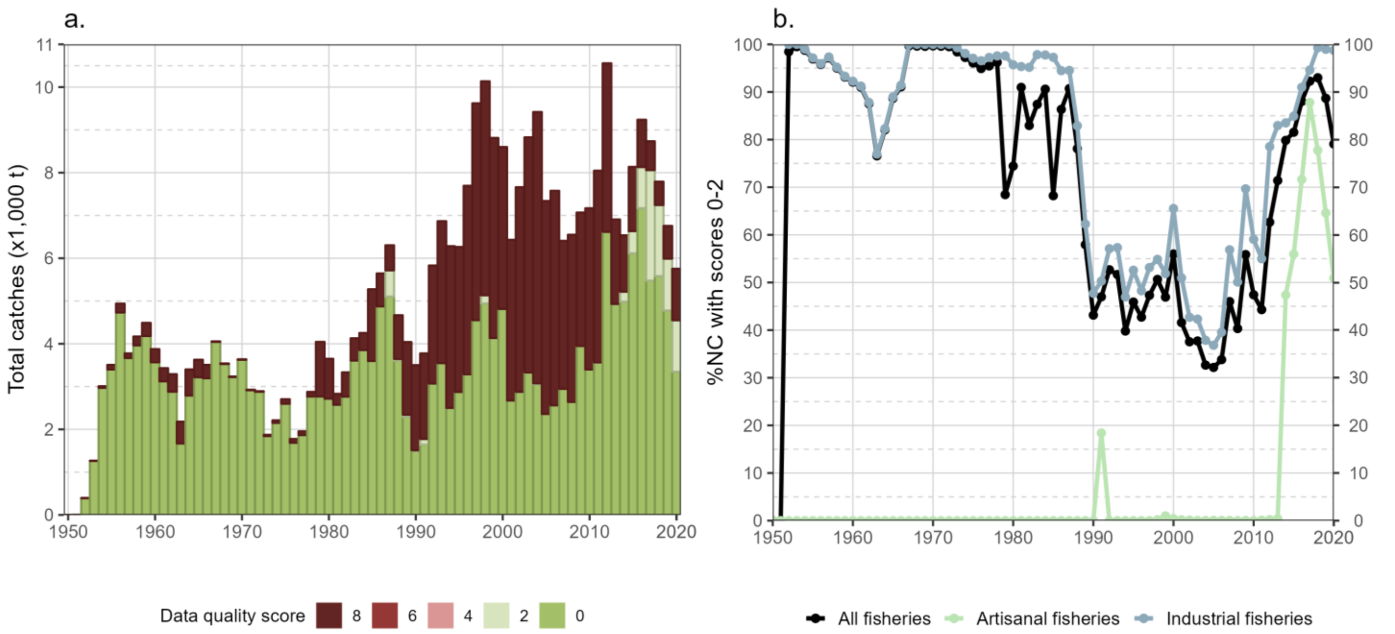

Figure 16: (a) Annual nominal catches (metric tons; t) of blue marlin estimated by quality score and (b) percentage of nominal catches for which geo-referenced catches were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950-2020

Size composition of the catch

Samples availability

By fishery group

The availability of size-frequency samples for blue marlin varies over time and between fishery groups and fleets. Most samples are available for longline fisheries, mainly from Japan since 1970 and from Taiwan,China since 1980 (**Fig. 17**). A significant number of size samples for blue marlin were also collected by the gillnet fishery of Sri Lanka through the IPTP sampling programme conducted between 1988 and 1993.

Aside from the coastal fisheries of Sri Lanka, very few samples are available for other coastal fisheries which all combined contribute to less than 0.3% of all blue marlins samples available in the IOTC database.

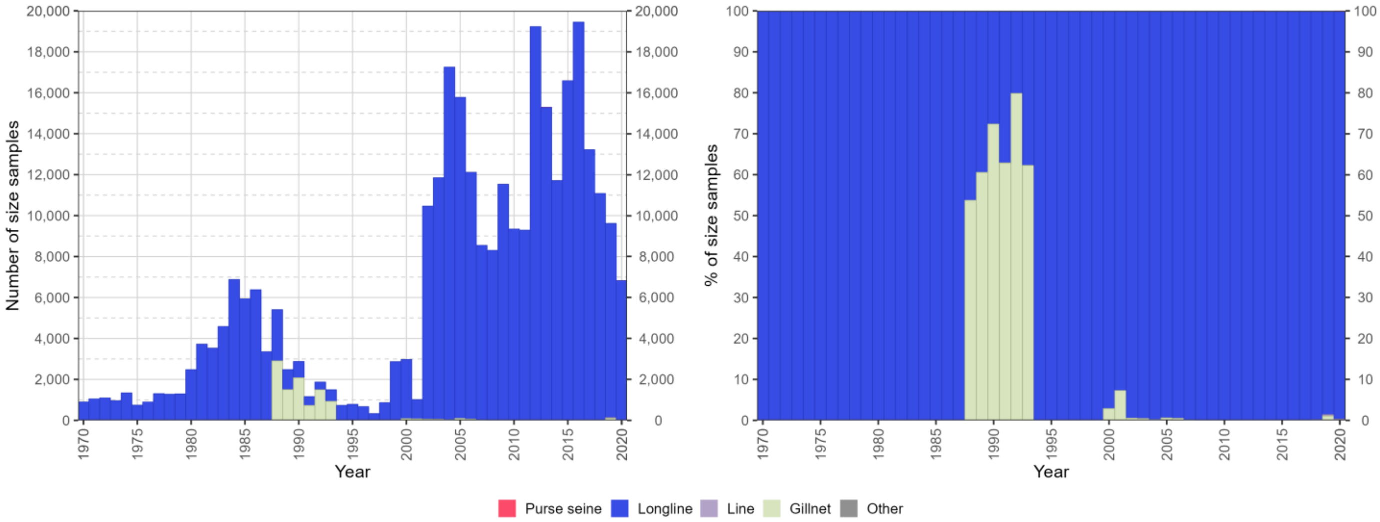

Figure 17: Availability of blue marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and fishery group. Data source: standardized size-frequency dataset

Purse seine fisheries

Overall, only 0.1% of size samples of blue marlins available at the Secretariat have been collected from purse seine fisheries. The spatial extent of the size samples available for these fisheries in recent years is very limited (**Fig. 18**) with some size samples having been collected for both retained and discarded individuals by scientific observers onboard large-scale purse seiners (see section Discards).

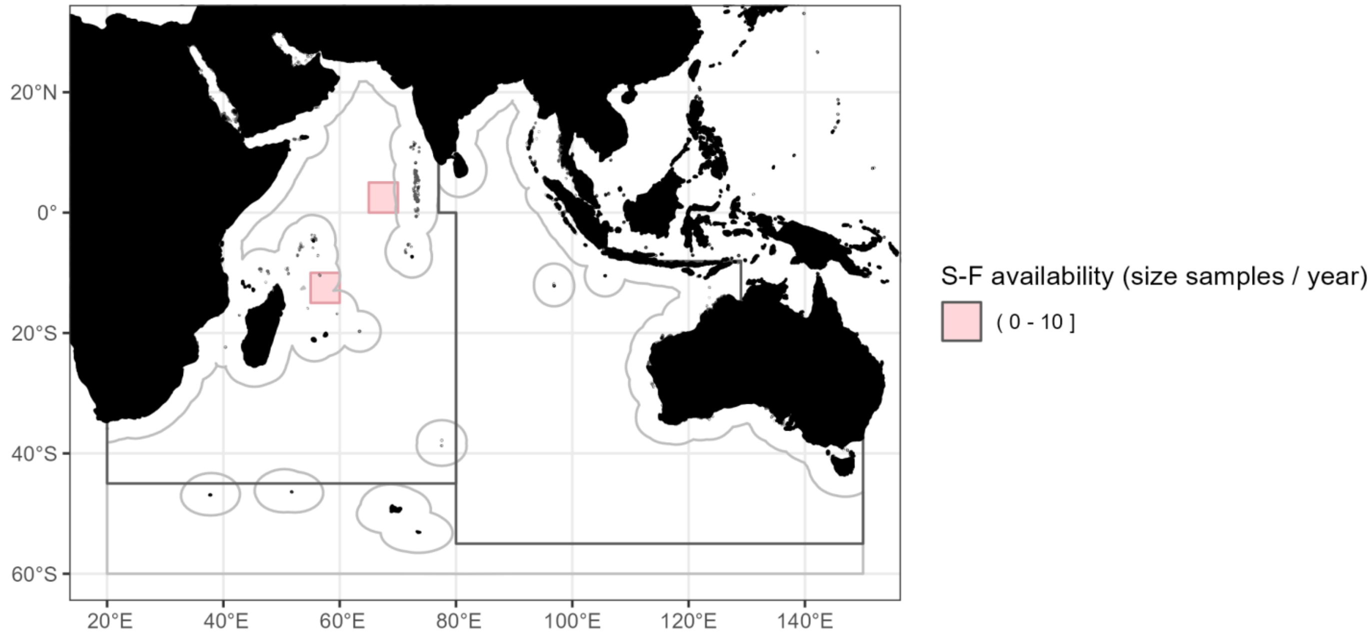

Figure 18: Spatial distribution (average number of samples per grid per year) of available blue marlin size-frequency data for purse seine fisheries in the period 2016-2020. Data source: standardized size-frequency dataset

Gillnet fisheries

Blue marlin samples from gillnet fisheries are available from 1988. As mentioned above, most of the samples were collected through the IPTP sampling programme, with the participation of countries like Sri Lanka, Pakistan, and other coastal countries with intensive sampling programmes implemented by their coastal fisheries at that time. However, only Sri Lanka and Pakistan reported blue marlin samples to the Secretariat.

Furthermore, Sri Lanka had an ongoing sampling programme in 2000 and more recently from 2014, which resulted in an increased quality of the data thanks to the availability of better spatial information (**Fig. 19**).

Overall, the gillnet fisheries contributed about 3% of the total blue marlin samples.

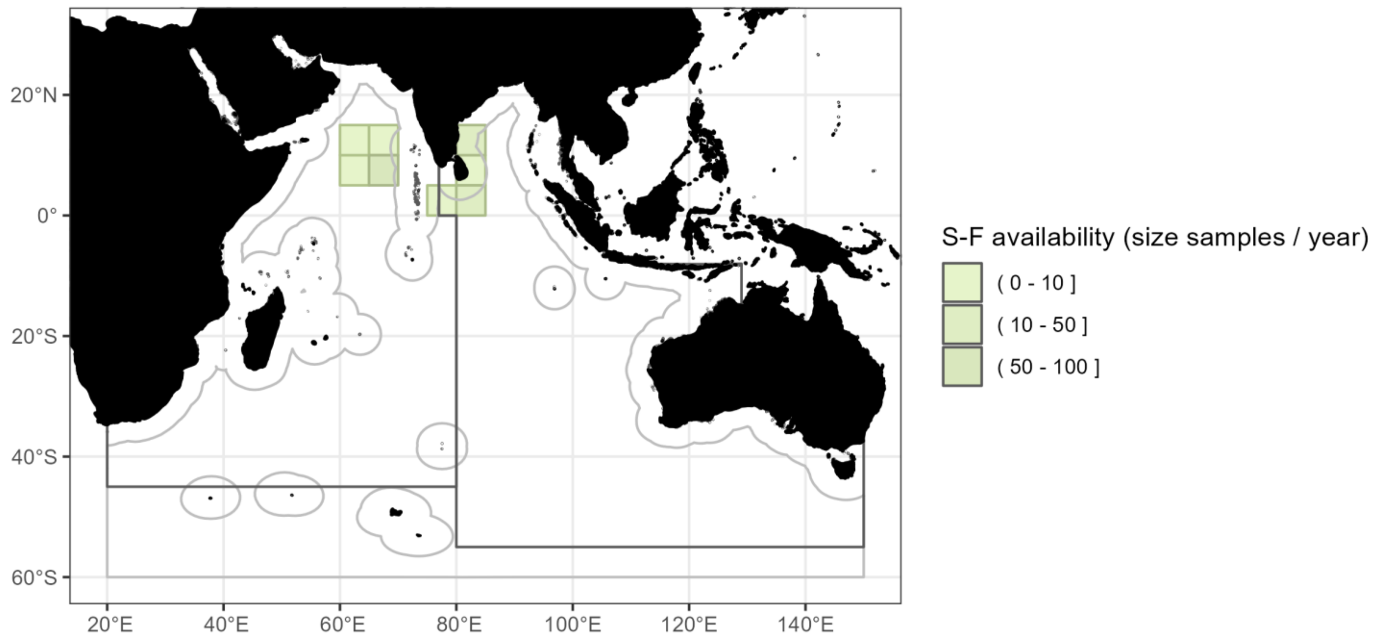

Figure 19: Spatial distribution (average number of samples per grid per year) of available blue marlin size-frequency data for gillnet fisheries in the period 2016-2020. Data source: standardized size-frequency dataset

Line fisheries

Few samples are available from the line fisheries of the coastal States which annually reported only a few hundred tons of catch of blue marlin prior to the 2010s (**Fig. 3**). Despite an increase in the reported catches for coastal longline and handline since then, the levels of sampling have remained very low and samples submitted to the Secretariat were generally not compliant by IOTC standards (e.g., missing information on fishing grounds). Some size samples of blue marlin have been available from the handline and coastal longline fisheries of Reunion Island (EU,France) for the last five years (**Fig. 20**).

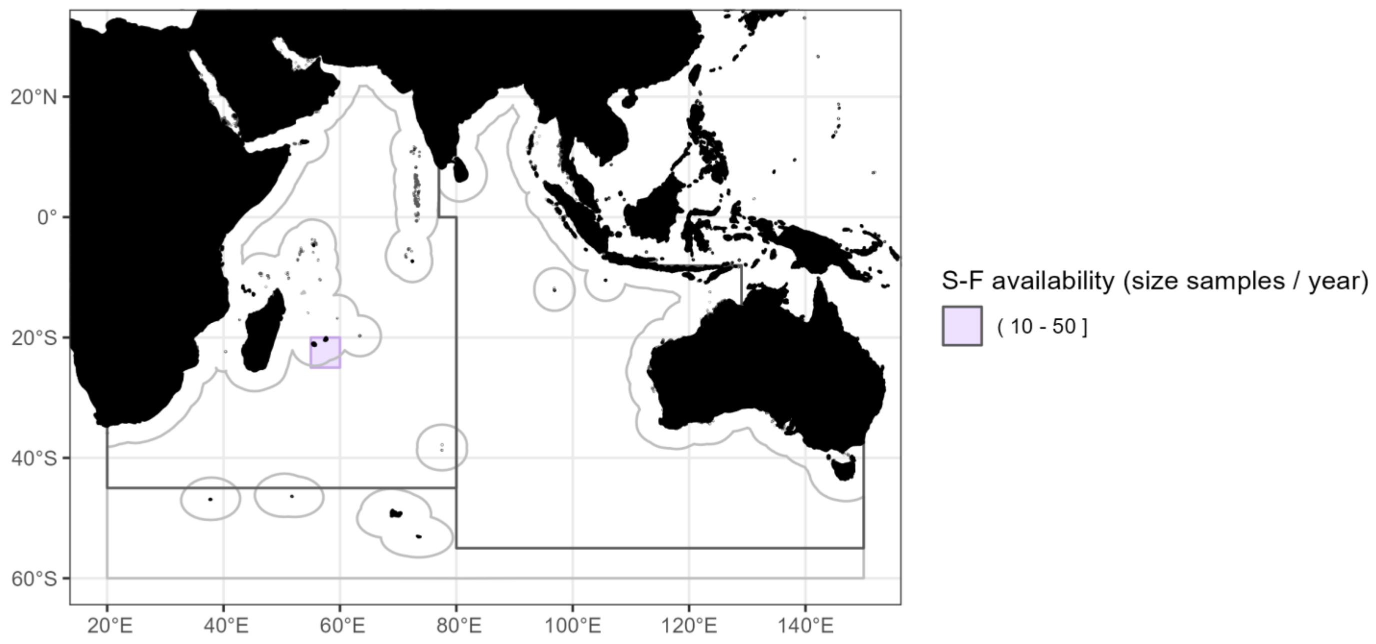

Figure 20: Spatial distribution (average number of samples per grid per year) of available blue marlin size-frequency data for line fisheries in the period 2016-2020. Data source: standardized size-frequency dataset

By fishery

Purse seine fisheries

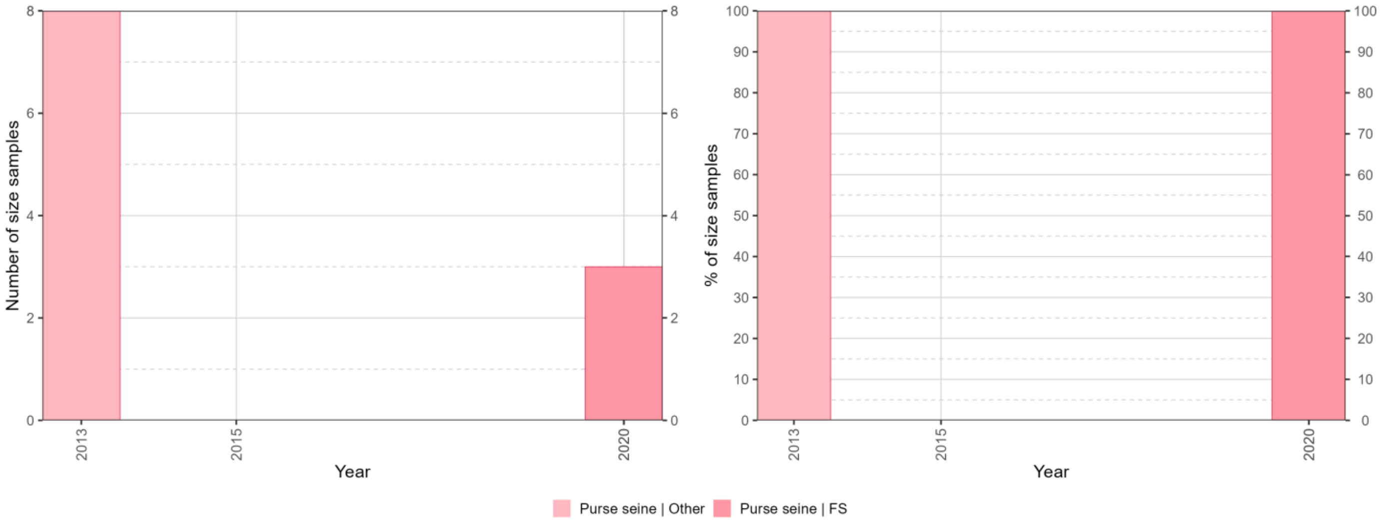

Figure 21: Availability of blue marlin size-frequency data as absolute number of samples per year and purse seine fishery. Data source: standardized size-frequency dataset

Gillnet fisheries

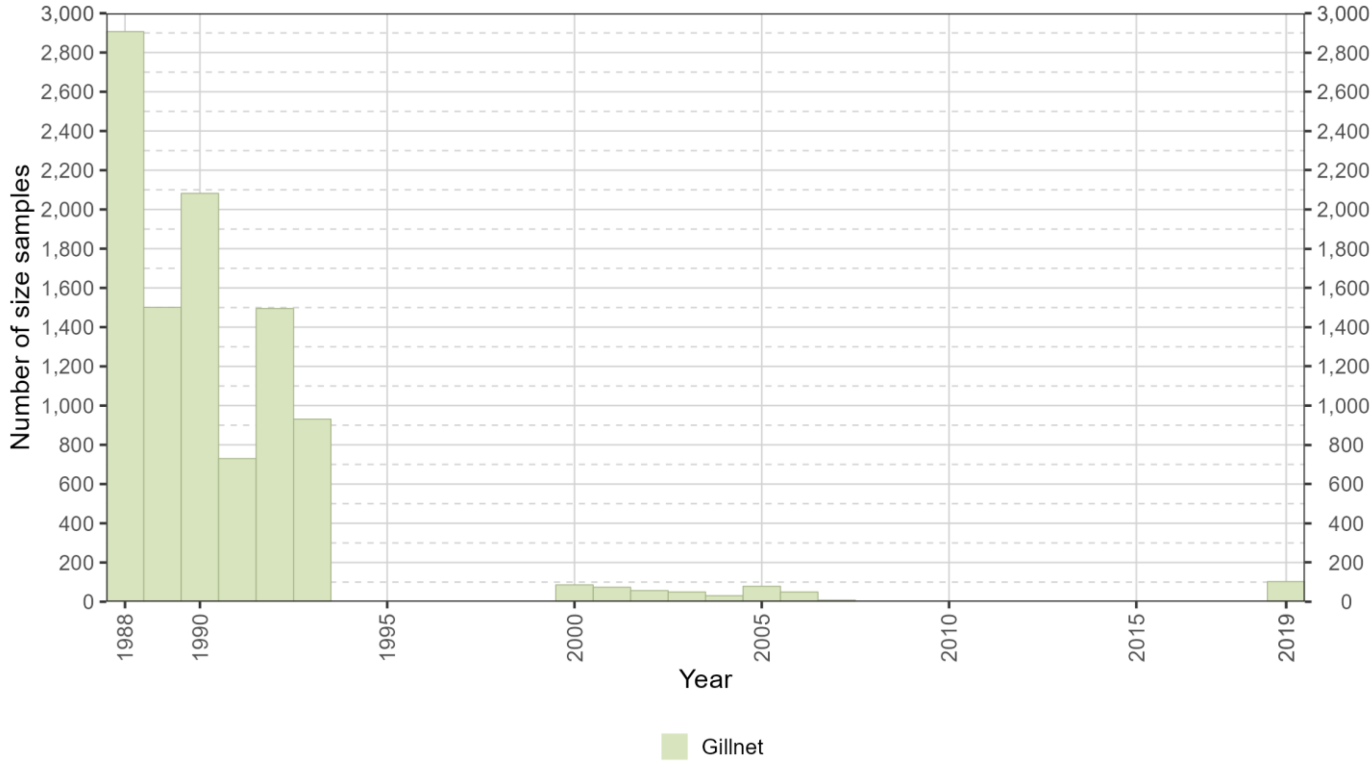

Figure 22: Availability of blue marlin size-frequency data as absolute number of samples per year in gillnet fisheries. Data source: standardized size-frequency dataset

Line fisheries

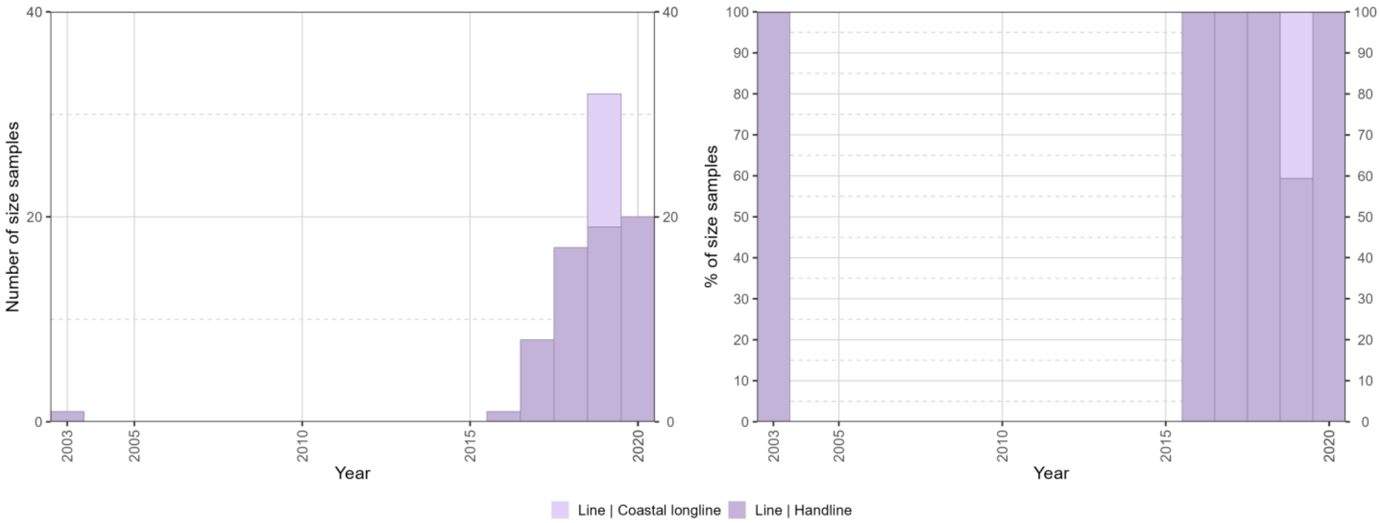

Figure 23: Availability of blue marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and line fishery type. Data source: standardized size-frequency dataset

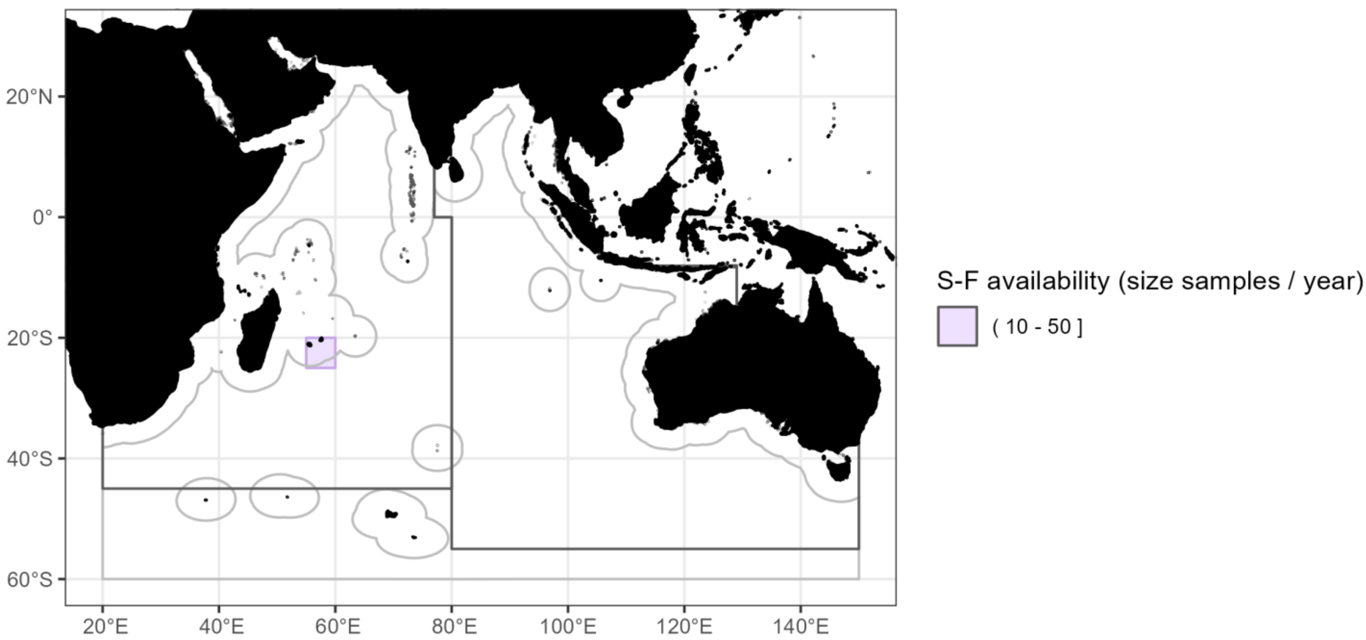

Figure 24: Spatial distribution (average number of samples per grid per year) of available blue marlin size-frequency data by line (coastal longline) fisheries in the period 2016-2020. Data source: standardized size-frequency dataset

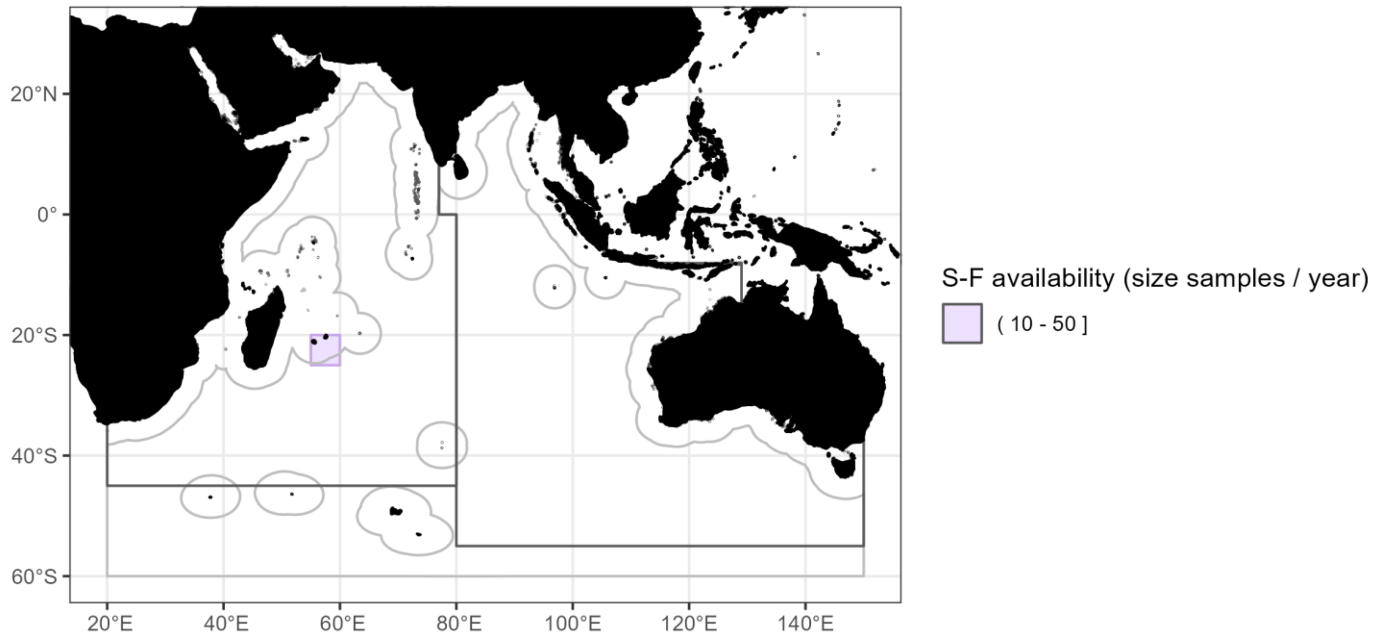

Figure 25: Spatial distribution (average number of samples per grid per year) of available blue marlin size-frequency data by line (handline) fisheries in the period 2016-2020. Data source: [standardized size-frequency dataset]

Other fisheries

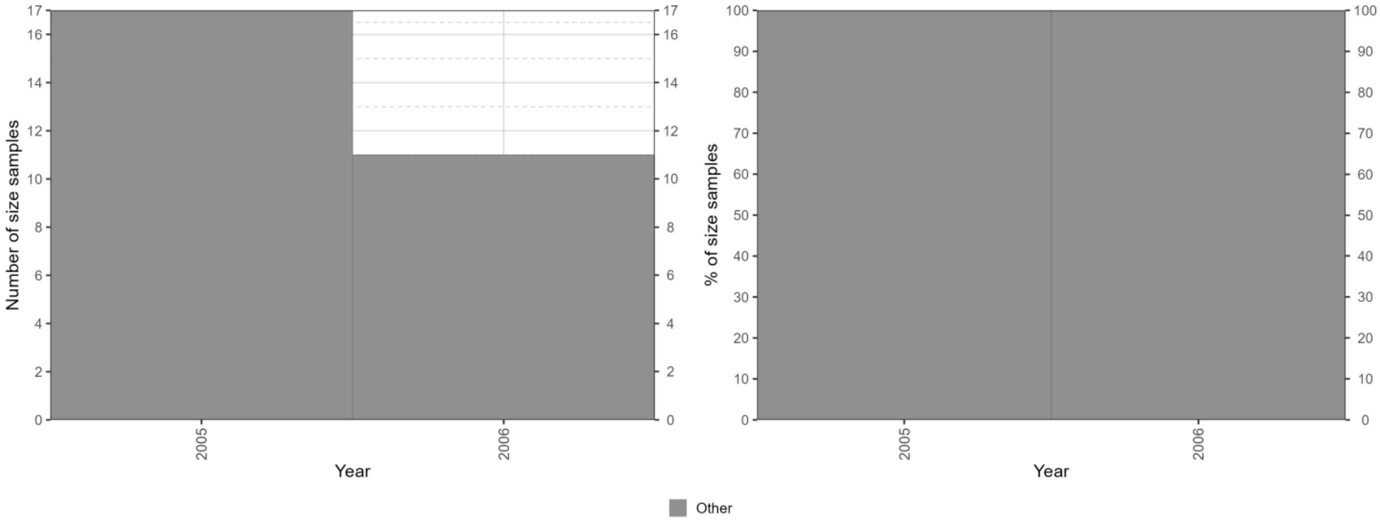

Figure 26: Availability of blue marlin size-frequency data as absolute number of samples (left) and relative number of samples (right) per year and 'other' fishery type. Data source: [standardized size-frequency dataset]

Temporal patterns and trends in size distributions

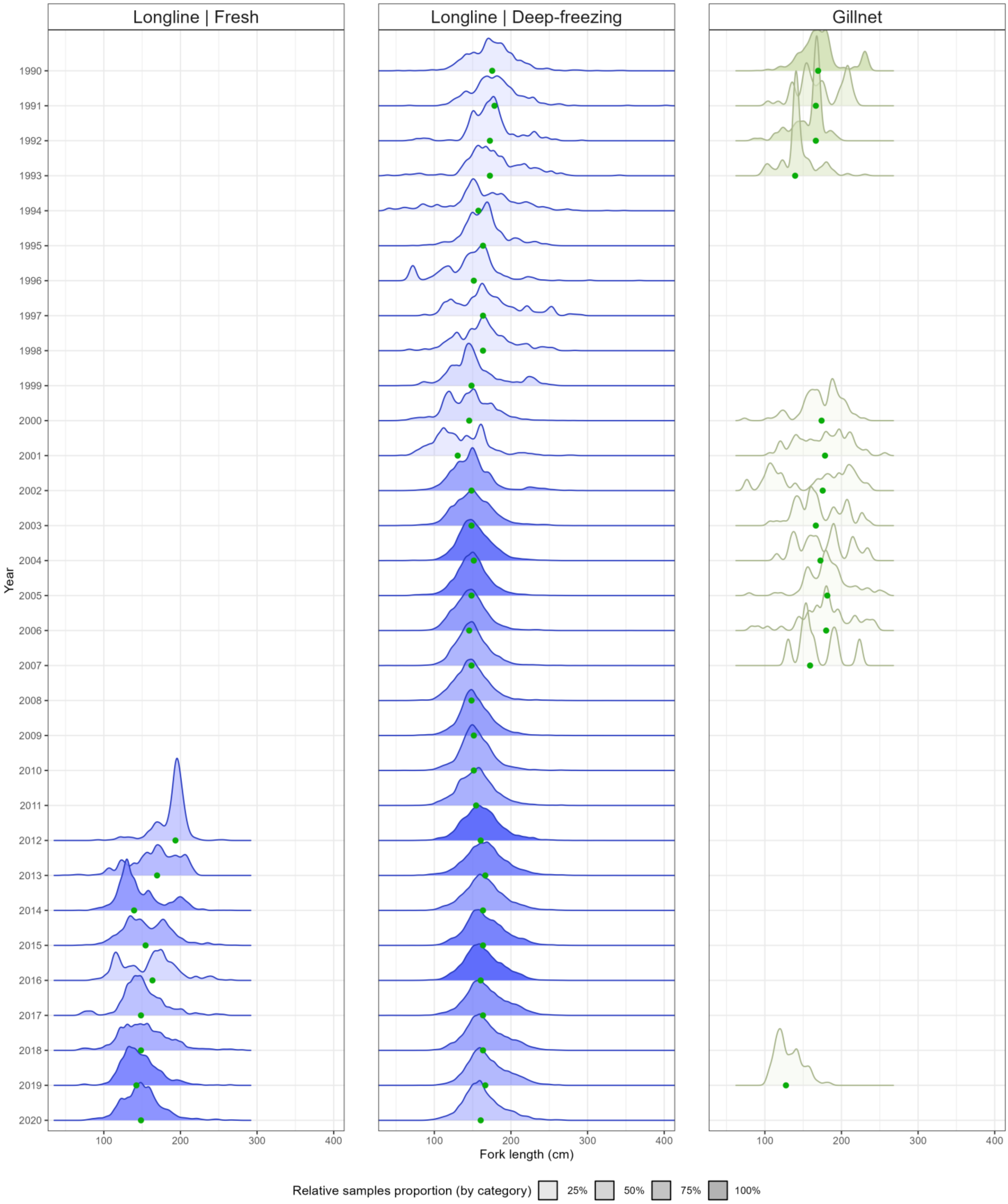

Figure 27: Relative size distribution (fork length; cm) of blue marlin caught by purse seine fishery (Other) and gillnet fishery. Other = no information provided on school association. Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset

Size distribution by fishery and fleet

Longline fisheries

Deep-freezing longline fisheries

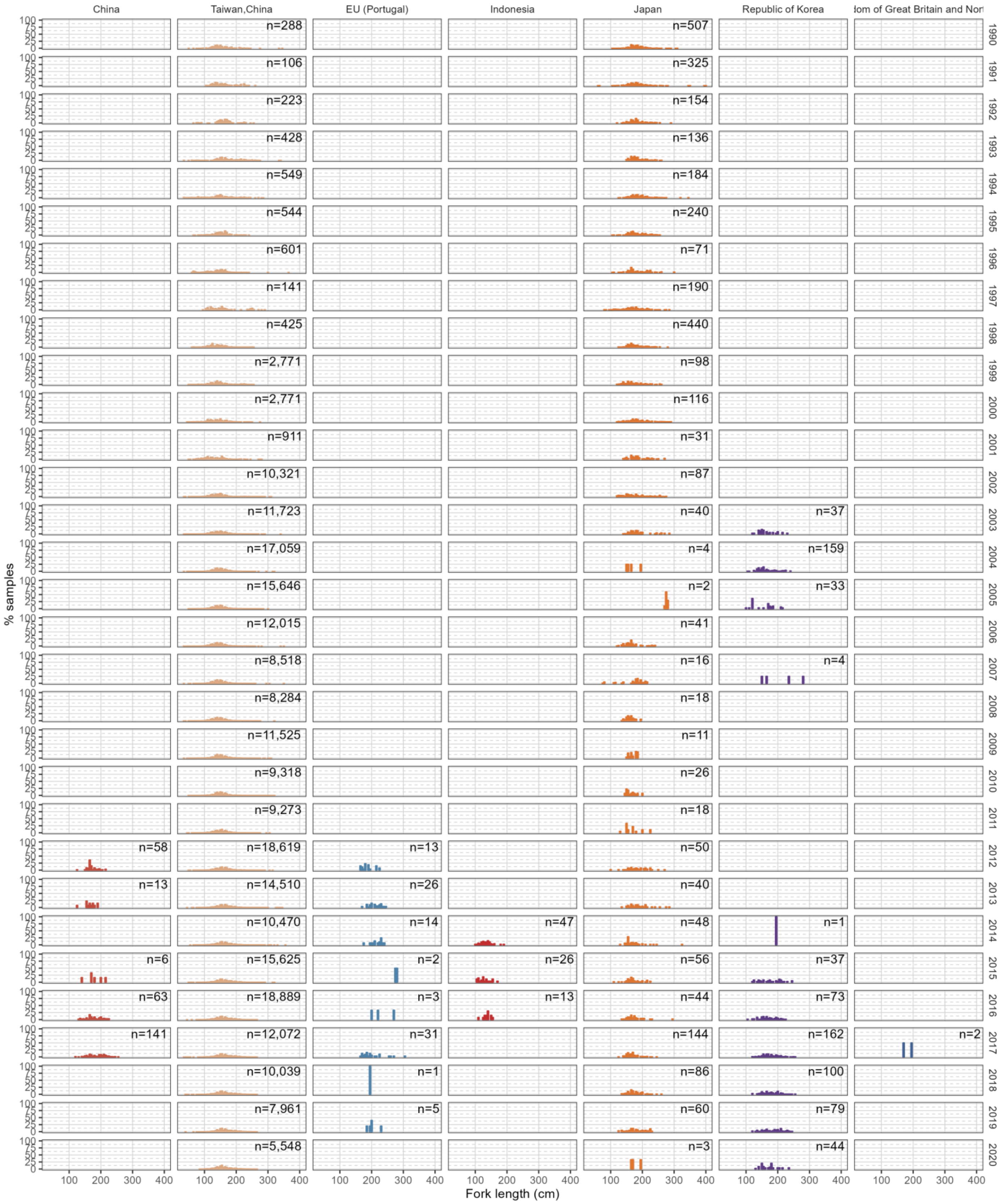

Figure 28: Relative size distribution of blue marlin (fork length; cm) recorded for deep-freezing longline fisheries by year and main fleet. Data source: standardized size-frequency dataset

Fresh tuna longline fisheries

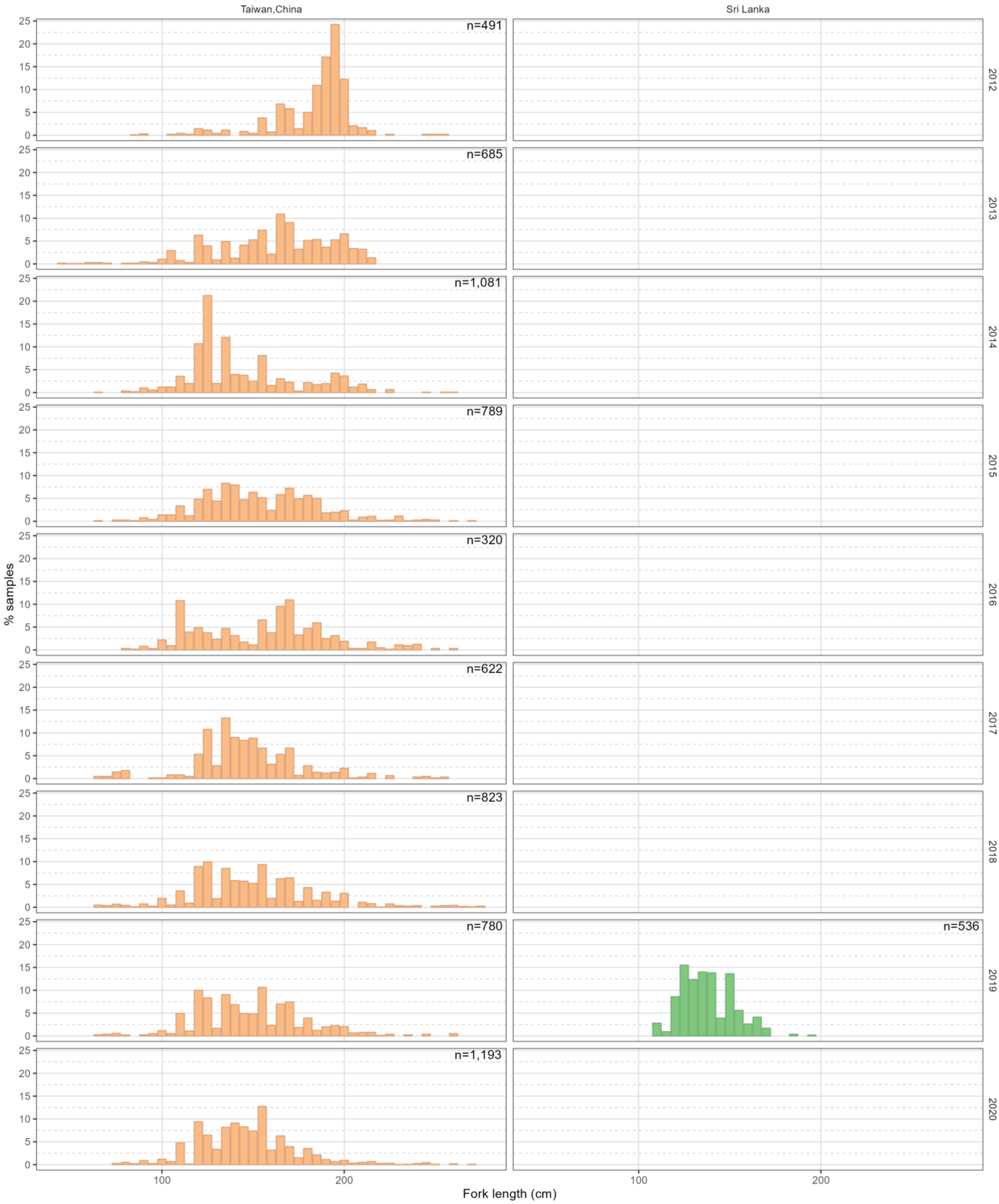

Figure 29: Relative size distribution of blue marlin (fork length; cm) recorded for deep-freezing longline fisheries by year and main fleet. Data source: standardized size-frequency dataset

Gillnet fisheries

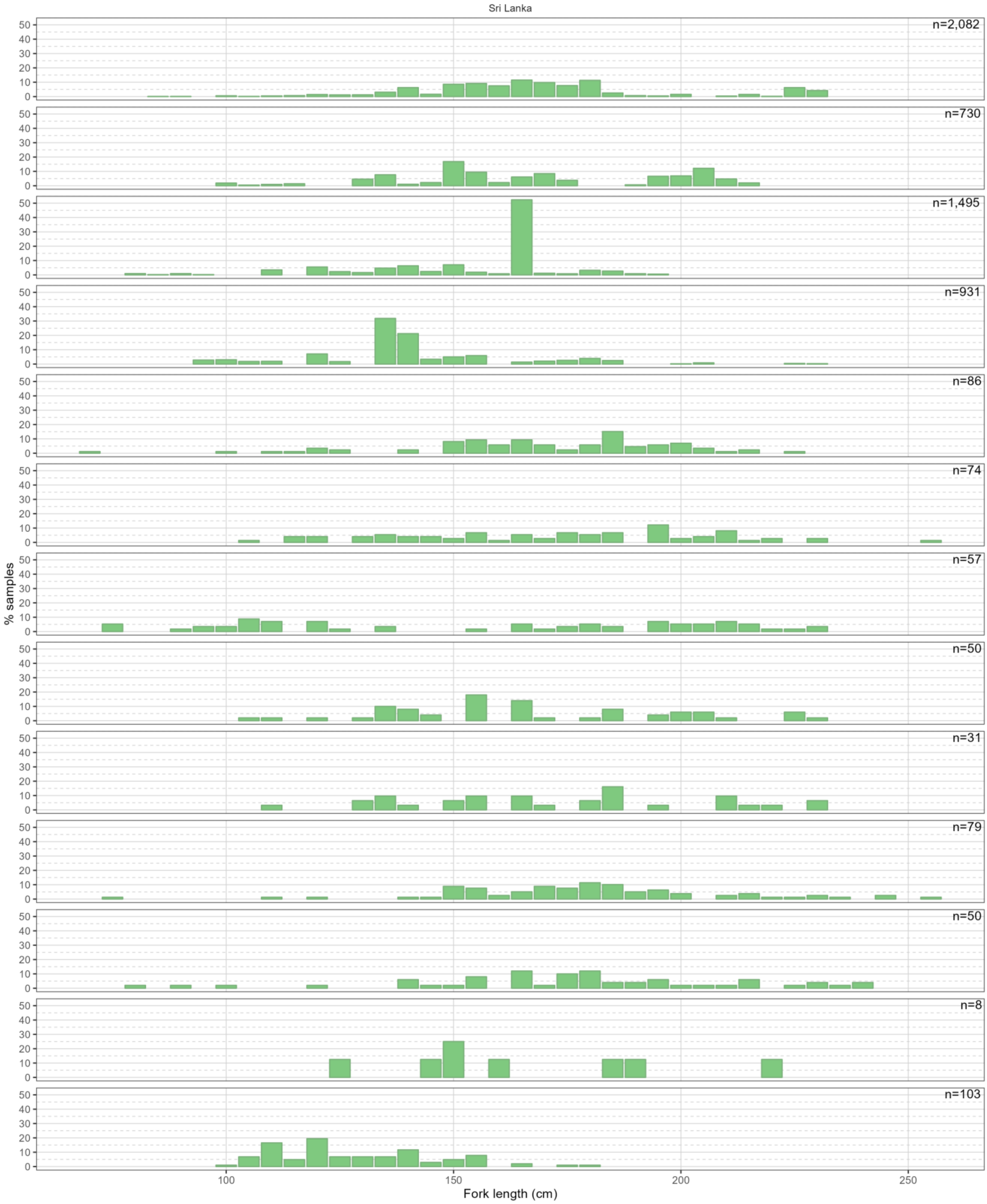

Figure 30: Relative size distribution of blue marlin (fork length; cm) recorded for gillnet fisheries by year and main fleet. Data source: standardized size-frequency dataset

Uncertainties in size-frequency data

Size frequency data are characterized by the lowest quality among the primary data sets that have to be reported to the Secretariat. As previously indicated (see section Size composition of the catch), few size data are available for blue marlin overall and while some nominal catch data are available since the mid-1950s, size-frequency data have only become available from the 1970s for industrial longline fisheries. Furthermore, the quality of the data is generally not by the recommended standards.

The intensification of the longline fishing activities from the 1980s increased the sampling of size data for blue marlin. Hence between 1980 and 1990, the percentage of nominal catch for which size data were available varied between 45% and 70% for all industrial fisheries. The quality of size data from industrial fisheries declined between 1990 and 2007 when some fleets stopped collecting size data, and in particular some non reporting fleets or fleets with both fresh and deep-freezing longline vessels (**Fig. 31**).

On the other hand, size samples collected from coastal fisheries remained generally at low levels, with the exeception of the good sampling coverage achieved during the IPTP sampling programme conducted between 1988 and 1992. Recently, the availability of size samples increased, but the coverage remains limited (**Fig. 31**).

The highest numbers of blue marlin sampled for size were in 2012 and 2015, reaching nearly 20,000 samples in each year. The overall quality of blue marlin size data available, as measured against the percentage of nominal catches, was only 60% in 2020, declining by 10% compared to 2019 (**Fig. 31b**).

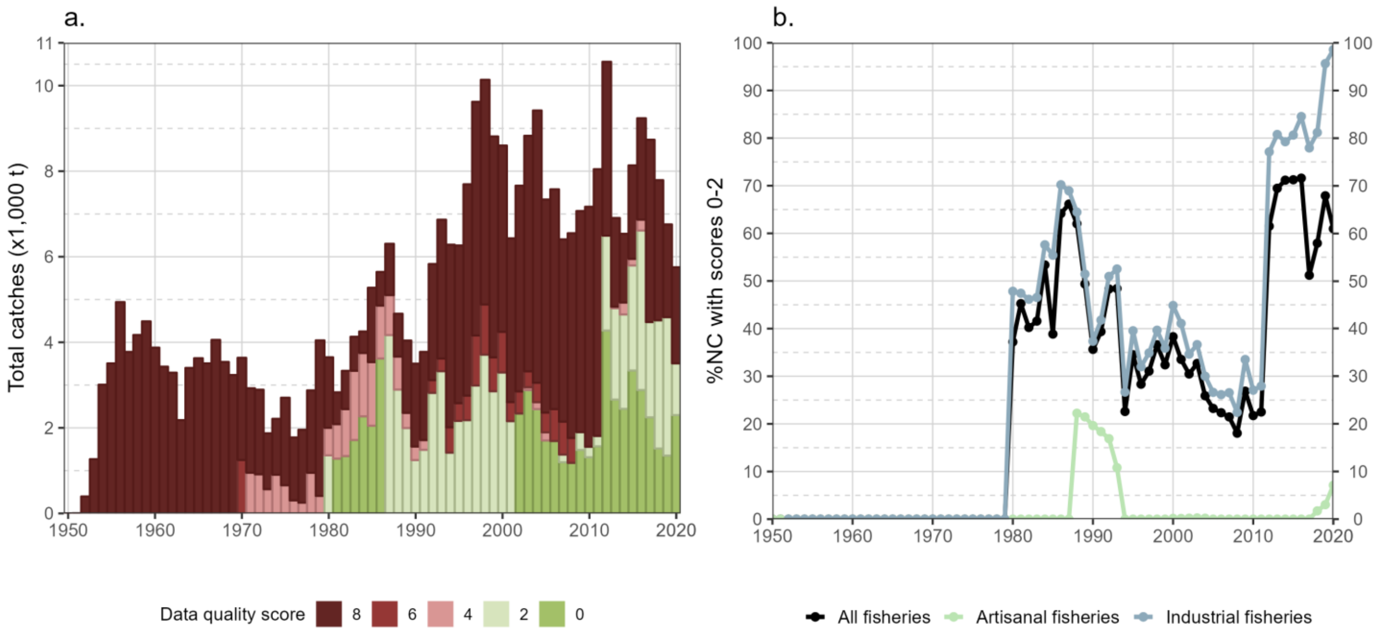

Figure 31: (a) Annual nominal catches (metric tons; t) of blue marlin estimated by quality score and (b) percentage of nominal catches for which geo-referenced size-frequency data were reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950–2020

References

Herath HLNS, Maldeniya R (2013) A review on billfish fishery resources in Sri Lanka IOTC. IOTC, La Réunion, France, 18-22 September 2013, p 10

Herrera M (2002) Catches of industrial fleets operating under flags of non-reporting countries in the IOTC area of competence: An update. In: *IOTC Proceedings*. IOTC, Shanghai, China, 03-11 June 2002, p 125–157

IOTC (2019) Review of Pakistan's reconstructed catch series for tuna and tuna-like species. IOTC, Karachi, Pakistan, 27-30 November 2019, p 17

IOTC (2022) Review of the statistical data available for Indian Ocean billfish. IOTC, Virtual meeting, 12-15 September 2022

Khan W (2017) Fisheries data collection and statistics in Pakistan. IOTC, Victoria, Seychelles, 26-28 November 2017, p 17

Maldeniya R, Dayaratne P, Amarasooriya PDKD (1995) An analysis of billfish landings in the pelagic fisheries in Sri Lanka. p 7

Moazzam M (2013) Billfish: An important part of the pelagic gillnet fisheries of Pakistan. IOTC, La Réunion, France, 18-22 September 2013, p 17

Moazzam M (2019) Crew-based observer program of WWF-Pakistan: A source of data collection on cetacean bycatch. IOTC, La Réunion, France, 03-07 September 2019, p 15

Appendix

Appendix I: Changes in best scientific estimates of nominal catches from previous WPB

Blue marlin catches show limited variation between WPB19 (2021) and WPB20 (2022) as only minimal updates to past data occurred in the meantime. More specifically, Seychelles updated their historical (1998-2019) time series of catches for line and longline fisheries (coastal, deep-freezing, and fresh longliners) due to a gradual switch in target species from swordfish to tunas, with catches from longline targeting swordfish reassigned to coastal longline from 1998 onwards, and the eventual disappearance of swordfish longliners in 2015.

Changes recorded for other fleets reflect the consequence of new data affecting the results of catch disaggregation for IOTC species aggregates (e.g., BILL) regularly performed by the IOTC Secretariat as part of the process producing the IOTC best scientific estimates (**Table 4**).

Zero-sum changes in historical catches for Sri Lankan fisheries reflect recent revisions of the original geo-referenced catch data that are now reported for the correct Indian Ocean area.

Table 4: Changes in best scientific estimates of average annual nominal catches (metric tons; t) of blue marlin by year, fleet, fishery group and main Indian Ocean area between 2016 and 2019, limited to absolute values higher than 10 t

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2019	IND	Gillnet	Eastern Indian Ocean	412	366	46
		Line	Eastern Indian Ocean	833	947	-114
		Line	Western Indian Ocean	75	50	26
	LKA	Gillnet	Eastern Indian Ocean	975	569	406
		Gillnet	Western Indian Ocean	93	499	-406
		Line	Eastern Indian Ocean	264	203	61
		Line	Western Indian Ocean	0	62	-62
		Longline	Eastern Indian Ocean	113	43	70
		Longline	Western Indian Ocean	534	605	-70
		Purse seine	Eastern Indian Ocean	0	24	-24
	MOZ	Line	Western Indian Ocean	86	47	39
	SYC	Longline	Western Indian Ocean	615	520	95
2018	IND	Gillnet	Eastern Indian Ocean	456	395	60
	LKA	Gillnet	Eastern Indian Ocean	1,122	751	371
		Gillnet	Western Indian Ocean	79	449	-371
		Line	Eastern Indian Ocean	652	634	18
		Line	Western Indian Ocean	0	18	-18
		Longline	Eastern Indian Ocean	215	77	138
		Longline	Western Indian Ocean	344	483	-138
	SYC	Longline	Eastern Indian Ocean	0	28	-28
		Longline	Western Indian Ocean	877	858	19
2017	PAK	Gillnet	Western Indian Ocean	291	254	38
	SYC	Line	Western Indian Ocean	16	0	16
		Longline	Western Indian Ocean	198	211	-13
2016	PAK	Gillnet	Western Indian Ocean	305	266	39
	SYC	Line	Western Indian Ocean	24	0	24
		Longline	Western Indian Ocean	126	150	-24