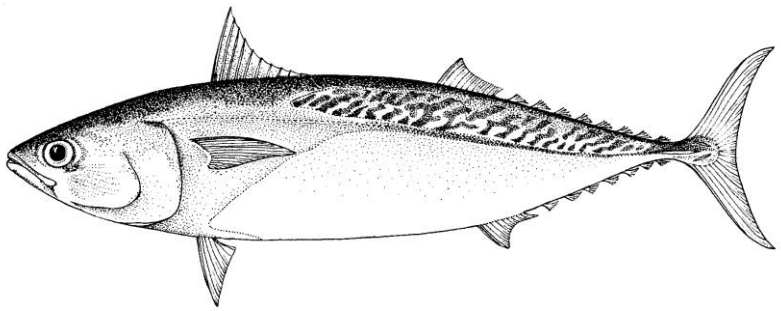
REVIEW OF FISHERIES STATISTICAL DATA AVAILABLE FOR INDIAN OCEAN FRIGATE TUNA

Author: IOTC Secretariat



Introduction

The overarching objective of the paper is to provide participants at the 14th Session of the IOTC Working Party on Neritic Tunas (WPNT14) with a review of the status of fisheries information available on frigate tuna (*Auxis thazard*) (Cantor 1849) occurring in the Indian Ocean. The document describes the temporal and spatial trends in retained catches at global and ocean-basin scale and the main characteristics of the fisheries catching frigate tuna in the Indian Ocean, as well as providing an assessment of the reporting quality of the data sets available at the IOTC Secretariat. A full description of the data sources, processing steps to generate the data sets, and key for reporting quality scores is available in IOTC Secretariat (2023).

Global catches

Total frigate tuna catches increased significantly from late 2000s, with catches from Western Pacific Ocean peaked 159,000t in 2014. In recent years, catches in Indian Ocean remain on average 107,000t, between 2018 and 2022 (**Fig. 1**).

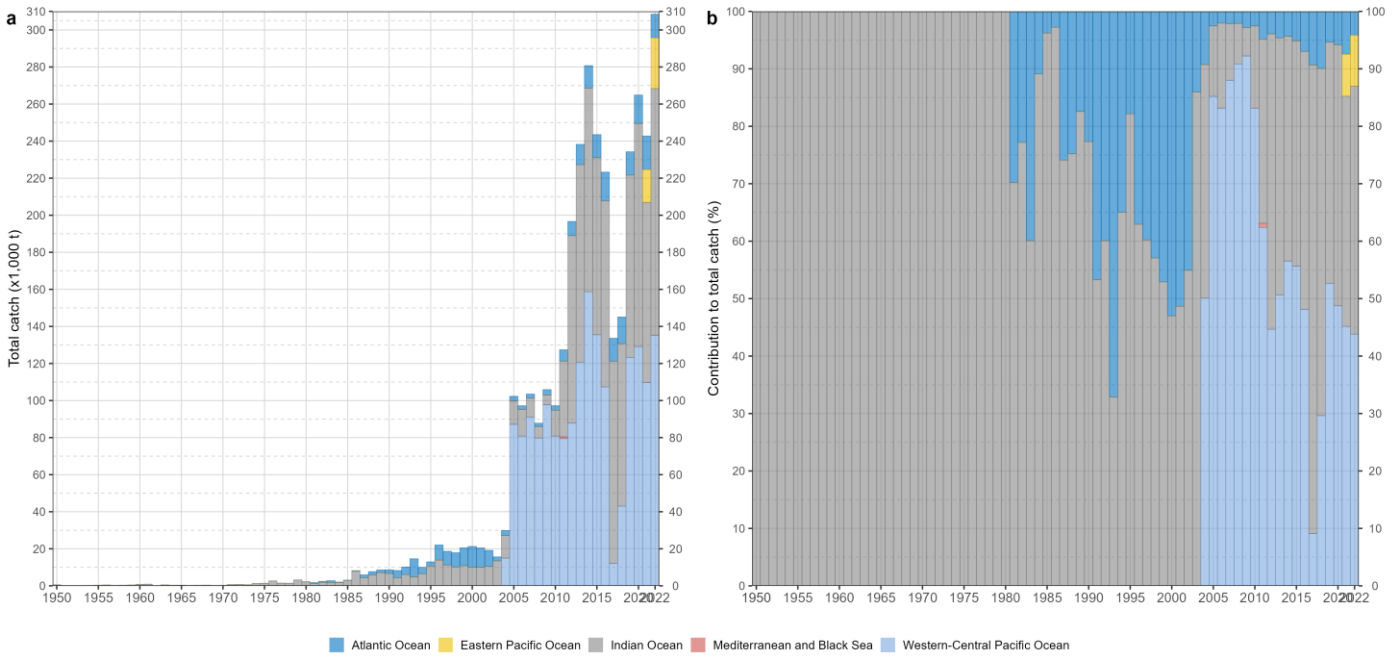


Figure 1: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of frigate tuna by ocean basin for the period 1950-2021. Source: FAO global capture production database

Similar to bullet tuna, Indonesia catches more frigate tuna than any other countries, not only in Indian Ocean, also in the Pacific Ocean (**Fig. 2**).

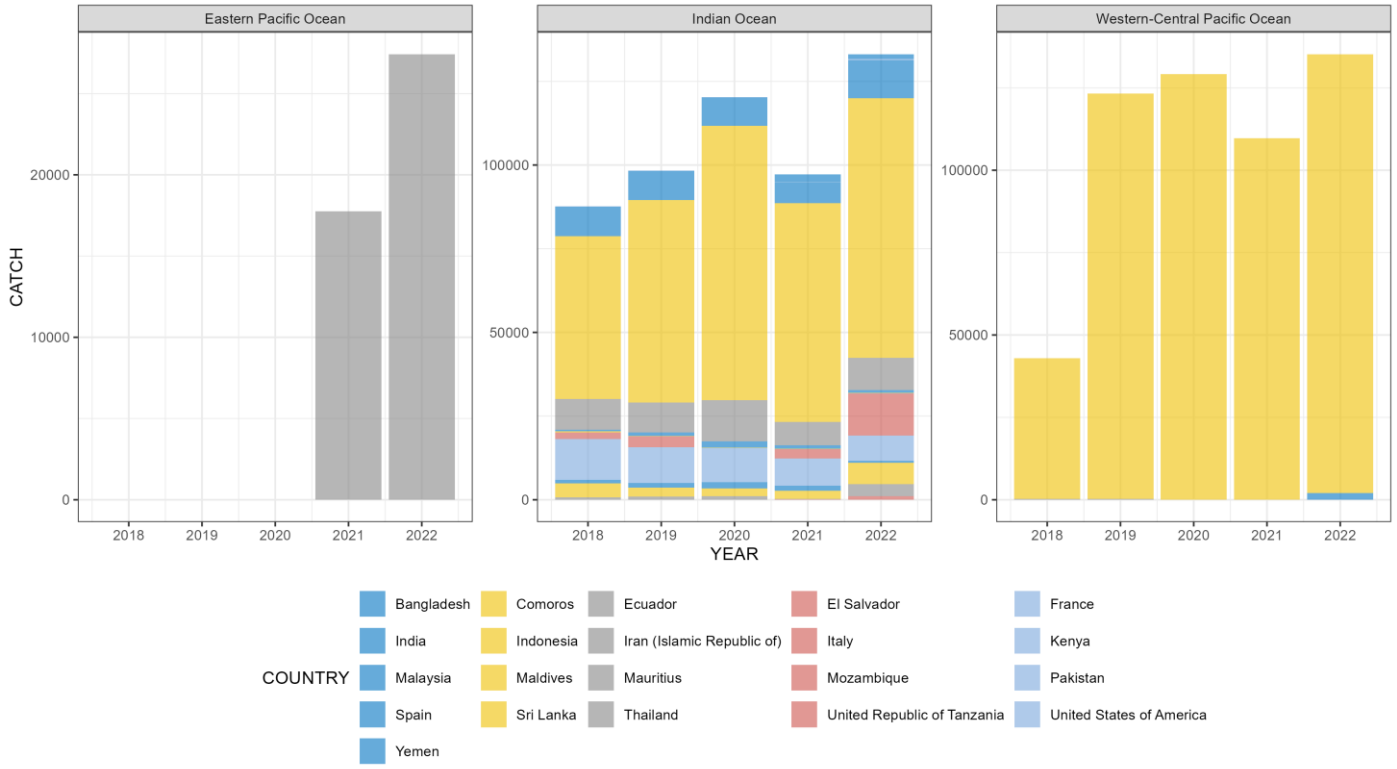


Figure 2: Annual time series of cumulative retained catches (metric tonnes; t) of frigate tuna by country from different Ocean the period 2018-2022. Source: FAO global capture production database

Indian Ocean catches & discards

Historical trends (1950-2022)

Catches historically, fluctuated, as the fisheries catching frigate tuna faced similar setback as bullet tuna catches. Increased in catches from purse seine, gillnet and line fisheries from the 2000s (**Tab. @tab(tab:NCByDecadeAndFisheryTable)**). Significant catches from pole and line fisheries of Maldives in early decades, but reduced considerably in recent years (**Fig. 3**).

Table 1: Mean annual retained catches (metric tonnes; t) of frigate tuna by decade and fishery for the period 1950-2019. The background intensity colour of each cell is directly proportional to the catch level. Data source: [best scientific estimates of retained catches](https://www.iotc.org/meetings/14th-working-party-neritic-tunas-wpnt14-meetingData/03-NC)

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Purse seine | Other	0	15	825	4,667	7,555	10,021	12,429
Longline | Other	0	0	0	26	1,228	858	1,307
Longline | Fresh	0	0	0	0	0	0	19
Longline | Deep-freezing	0	0	0	0	0	0	3
Line | Coastal longline	10	248	959	2,586	5,274	18,071	24,887
Line | Trolling	1,209	2,098	3,264	4,641	7,999	8,282	9,593
Line | Handline	44	60	196	203	457	710	1,454

Fishery	1950s	1960s	1970s	1980s	1990s	2000s	2010s
Baitboat	1,429	1,989	2,018	1,333	3,662	3,897	939
Gillnet	493	1,247	2,836	6,631	14,145	25,688	39,523
Other	13	19	330	2,323	4,390	8,929	13,681
Total	3,196	5,676	10,428	22,411	44,709	76,455	103,835

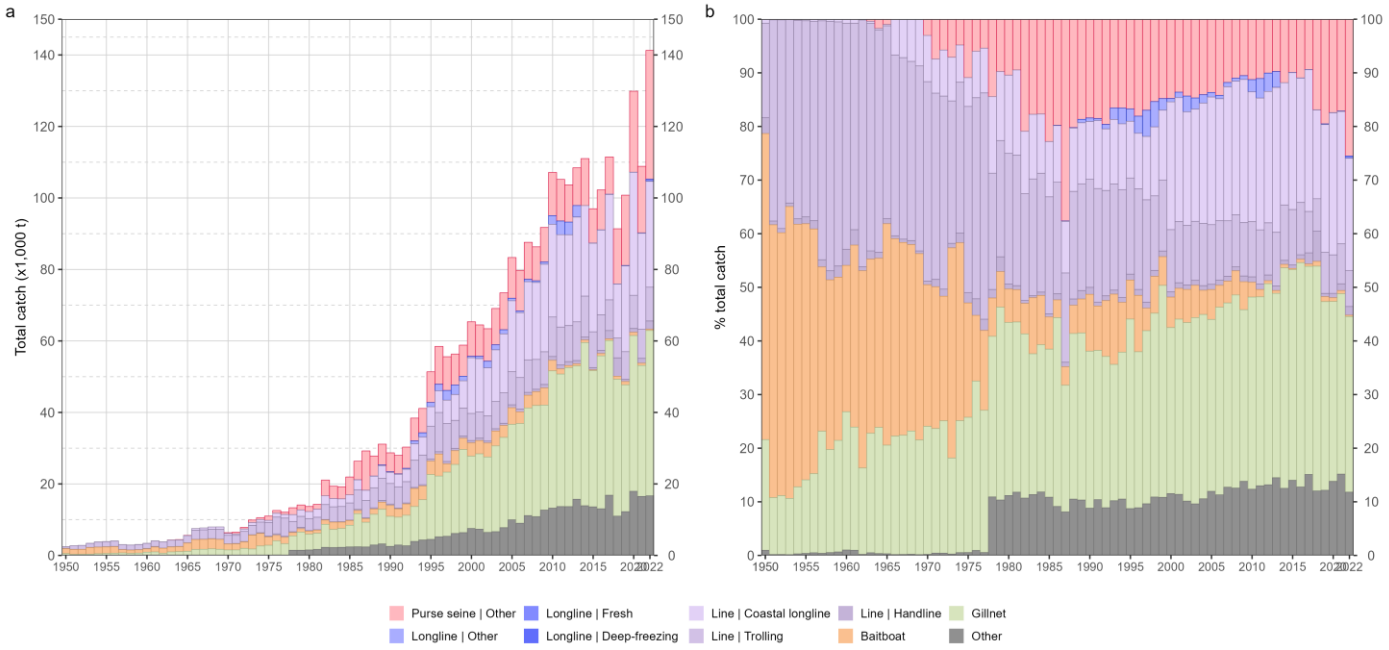


Figure 3: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) cumulative contribution to the total retained catches (percentage; %) of frigate tuna by fishery for the period 1950-2022. Data source: best scientific estimates of retained catches

Table 2: Annual retained catches (metric tonnes; t) of frigate tuna by fishery for the period 2013-2022. The background intensity colour of each cell is directly proportional to the catch level. Data source: [best scientific estimates of retained catches](https://www.iotc.org/meetings/14th-working-party-neritic-tunas-wpnt14-meetingData/03-NC)

Fishery	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Purse seine | Other	10,572	13,143	9,638	11,199	10,478	15,459	19,671	22,661	18,640	36,036
Longline | Other	3,233	0	0	0	0	0	0	0	0	0
Longline | Fresh	0	0	27	21	20	17	107	13	91	588
Longline | Deep-freezing	0	0	2	9	1	4	14	2	2	23
Line | Coastal longline	29,291	25,341	24,765	23,716	29,478	15,114	23,997	34,407	26,874	29,588
Line | Trolling	10,856	11,453	10,024	9,976	8,593	5,526	7,754	9,302	8,119	9,469
Line | Handline	918	825	615	855	2,313	5,148	605	1,065	1,354	2,278
Baitboat	572	717	228	653	493	823	931	911	649	376
Gillnet	37,301	45,647	38,107	42,779	43,268	38,305	35,465	43,563	36,616	46,255
Other	15,707	13,890	13,579	13,048	16,829	10,985	12,243	17,934	16,507	16,666
Total	108,450	111,016	96,983	102,258	111,474	91,380	100,786	129,858	108,852	141,279

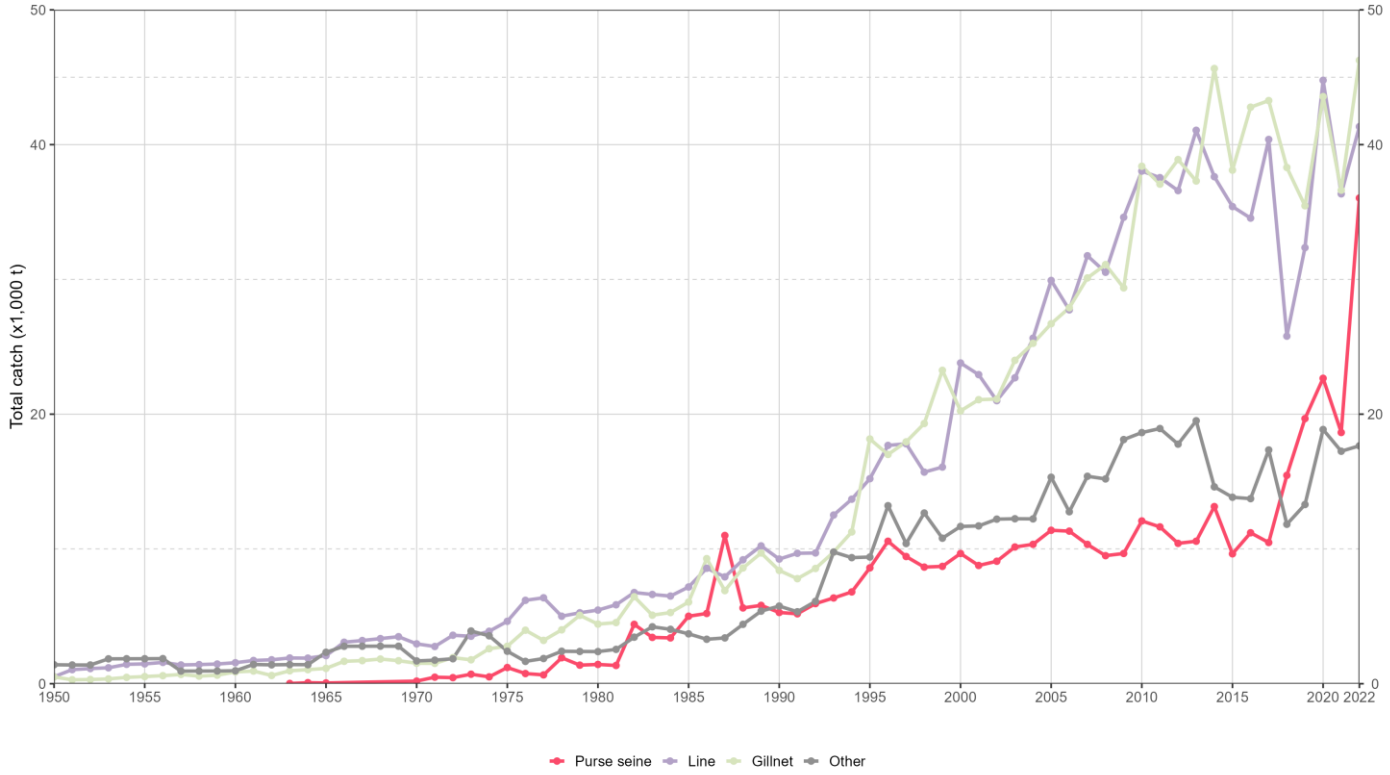


Figure 4: Annual time series of retained catches (metric tonnes; t) of frigate tuna by fishery group for the period 1950-2022. Data source: [best scientific estimates of retained catches]

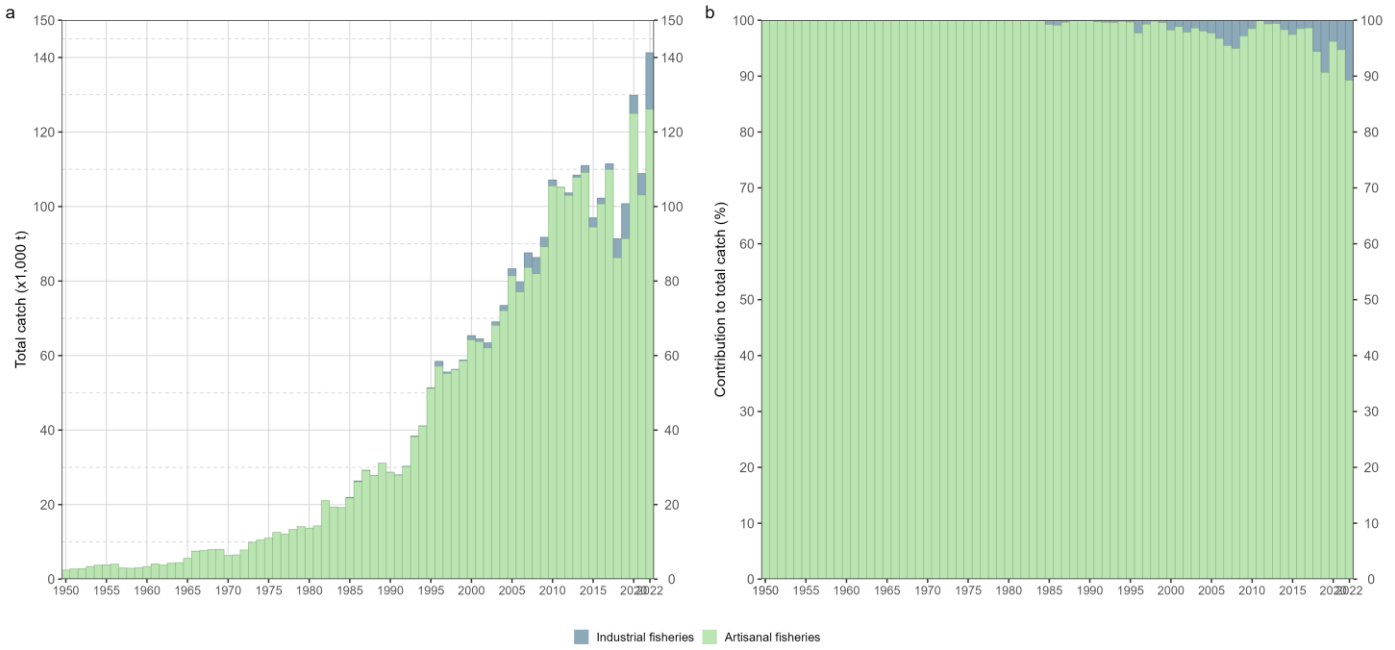


Figure 5: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) cumulative contribution to the total retained catches (percentage; %) of frigate tuna by type of fishery for the period 1950-2022. Data source: best scientific estimates of retained catches

Recent fishery features (2018-2022)

Recent years, catches of frigate tuna increased considerably from purse seine, gillnet, and line fisheries, attributed to increased in catch data of Indonesia and Thailand (**Tab. @tab(tab:NCByYearAndFisheryTableRP)**)

Table 3: Mean annual retained catches (metric tonnes; t) of frigate tuna by fishery between 2018 and 2022. Data source: [best scientific estimates of retained catches](https://www.iotc.org/meetings/14th-working-party-neritic-tunas-wpnt14-meetingData/03-NC)

Fishery	Fishery code	Catch	Percentage
Gillnet	GN	40,041	35.0
Line | Coastal longline	LIC	25,996	22.7
Purse seine | Other	PSOT	22,493	19.7
Other	OT	14,867	13.0
Line | Trolling	LIT	8,034	7.0
Line | Handline	LIH	2,090	1.8
Baitboat	BB	738	0.6
Longline | Fresh	LLF	163	0.1
Longline | Deep-freezing	LLD	9	0.0

Indonesia, India and Thailand accounted for the majority catches in recent years, with diverse fisheries catching frigate tuna from Indonesia and India, whereas Thailand catches are excluvely from purse seine fisheries (**Fig. @fig(fig:NCByFleetAndFisheryParetoRP)**).

Although an overall increasing trend, catches fluctuated from gillnet and line fisheries in recent years (**Fig. @fig(fig:NCTrendsByFisheryGroupAllRP)**), owing to inconsistenct catches from Indonesia, major line, purse seiene, and gillnet (**Fig. @fig(fig:NCTrendsByFisheryGroupRP)**)

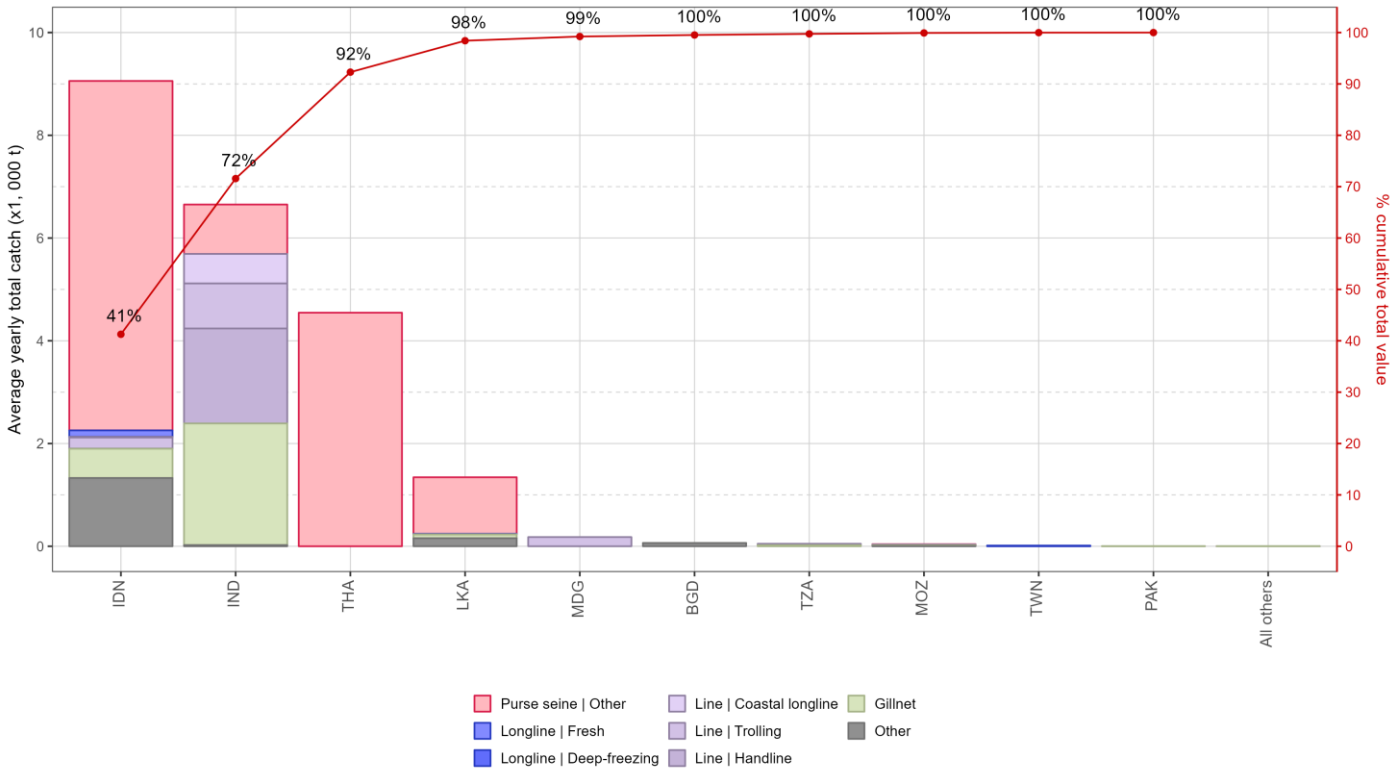


Figure 6: Mean annual retained catches (metric tonnes; t) of frigate tuna by fleet and fishery between 2018 and 2022, with indication of cumulative contribution (percentage; %) of catches by fleet. Data source: best scientific estimates of retained catches

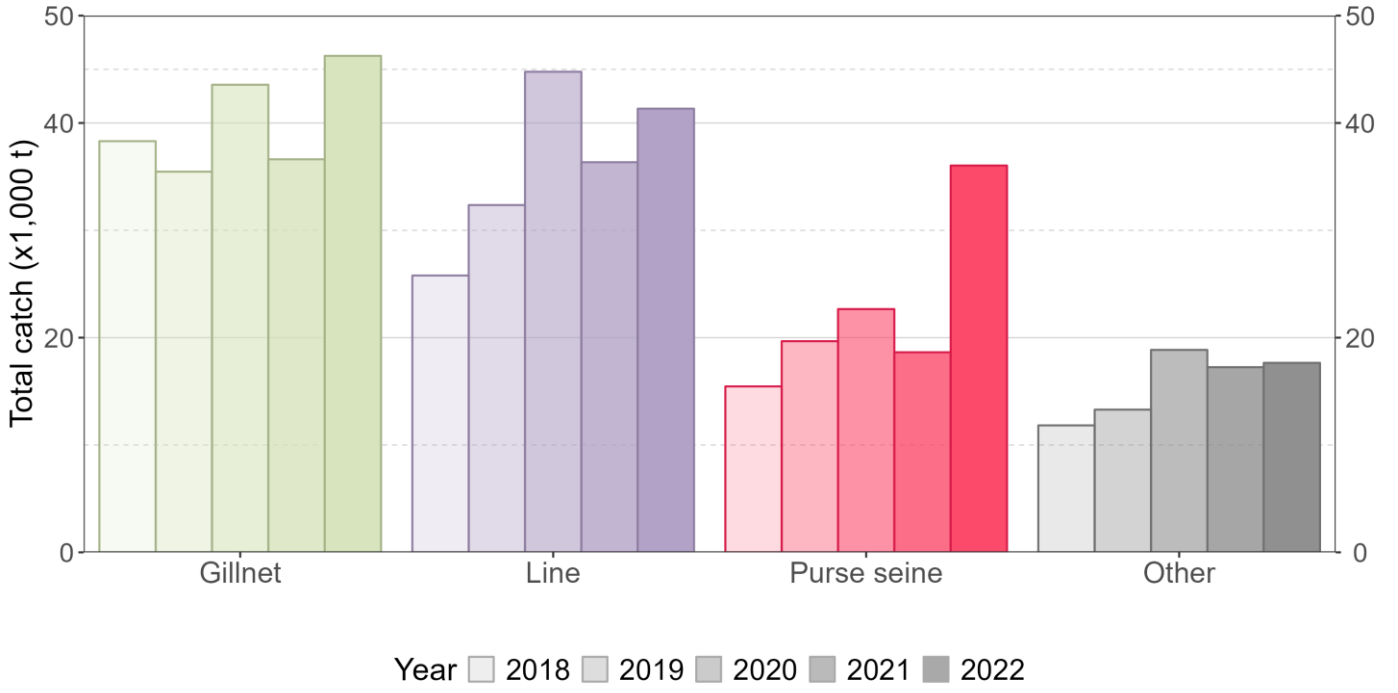


Figure 7: Annual trends in retained catch (metric tonnes; t) of frigate tuna by fishery group between 2018 and 2022. Data source: best scientific estimates of retained catches

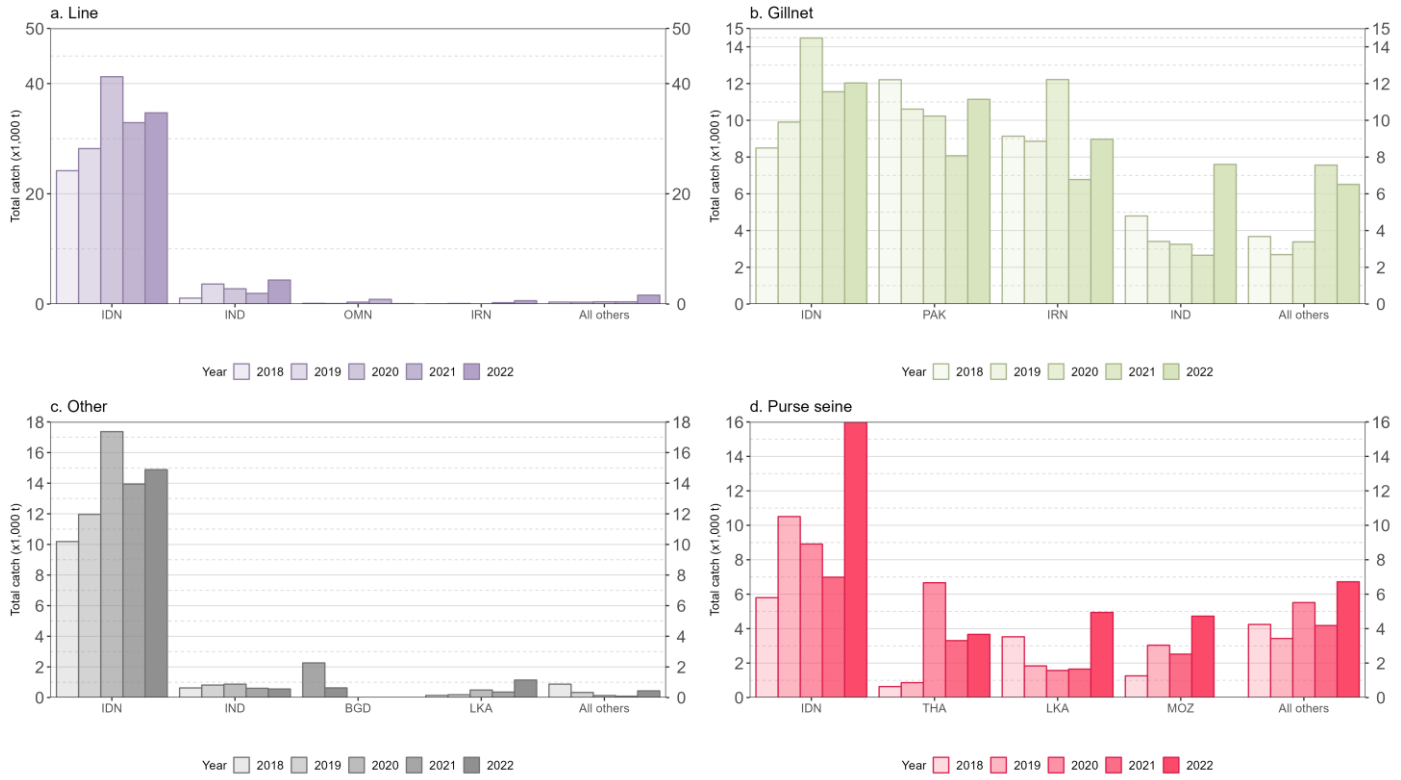


Figure 8: Annual trends in retained catch (metric tonnes; t) of frigate tuna by fishery group and fleet between 2018 and 2022. Data source: best scientific estimates of retained catches

Changes from previous Working Party

Thailand revision of catches from 2006 to recent years, affected the historical catches of frigate tuna, whereby catches increased by around, and review by EU-Italy with inclusion of neritic tuna species from the retained catches (**Fig. 9**).

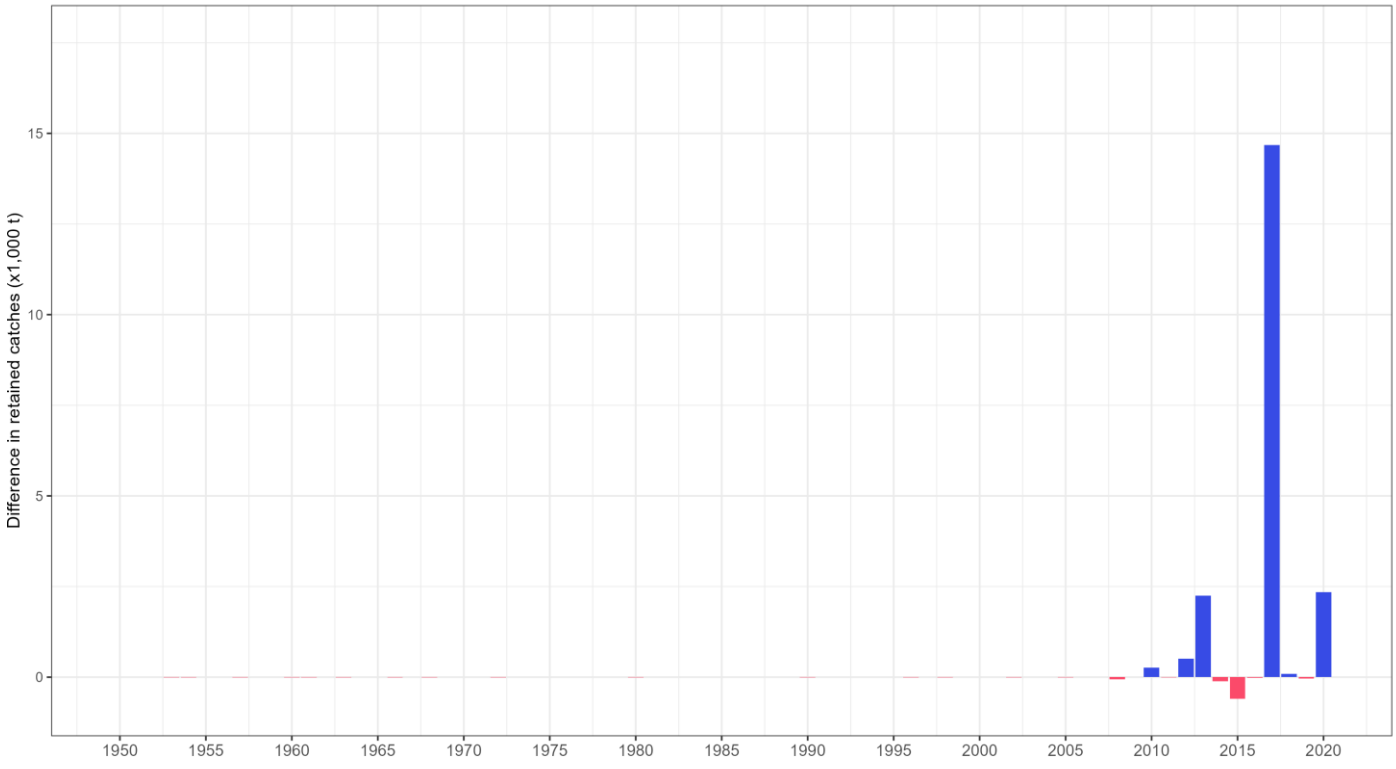


Figure 9: Differences in the annual retained catches (metric tonnes; t) of frigate tuna available at this WPNT and its previous session (WPNT12 meeting held in July 2022). Details by year, fleet, fishery group, and Indian Ocean major area given in Appendix II

Uncertainties in retained catch data

the quality of catch available for frigate tuna shows increasing improvement, with good quality catches (non-estimated), at about ~ 50% in 2022 (**Fig. @ref(fig:NCQualityCombined)**).

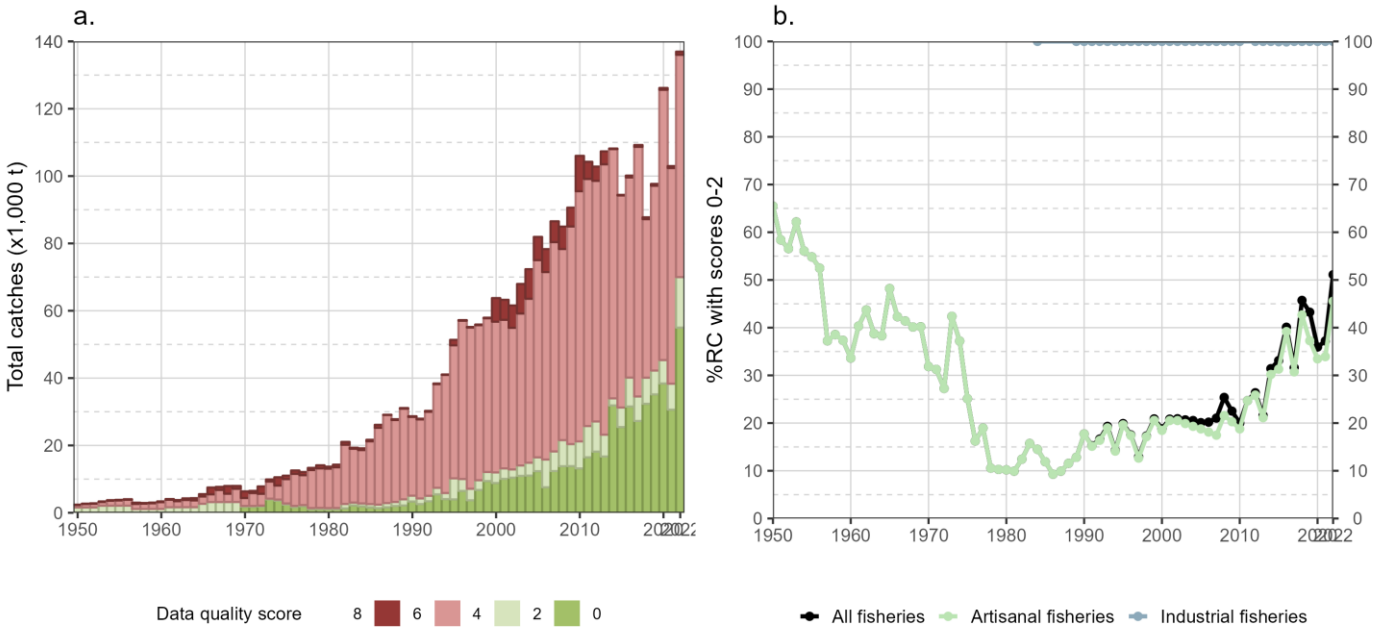


Figure 10: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches fully or partially reported to the IOTC Secretariat to all retained catches (percentage; %) of frigate tuna for all fisheries and by type of fishery, for the period 1950-2022

Discards

Very little information is available on discards of neritic tunas in coastal and semi-industrial fisheries of the Indian Ocean. Discarding of neritic tunas has been shown to occur in large-scale longline and purse seine fisheries that target tropical tunas and billfish but the quantities are considered to be small (Huang & Liu 2010, Ruiz et al. 2018). The implementation of IOTC Res. 19/05 on the retention of bycatch onboard purse seiners since late 2019 is assumed to have resulted in a reduction of the discards of frigate tuna in this fishery.

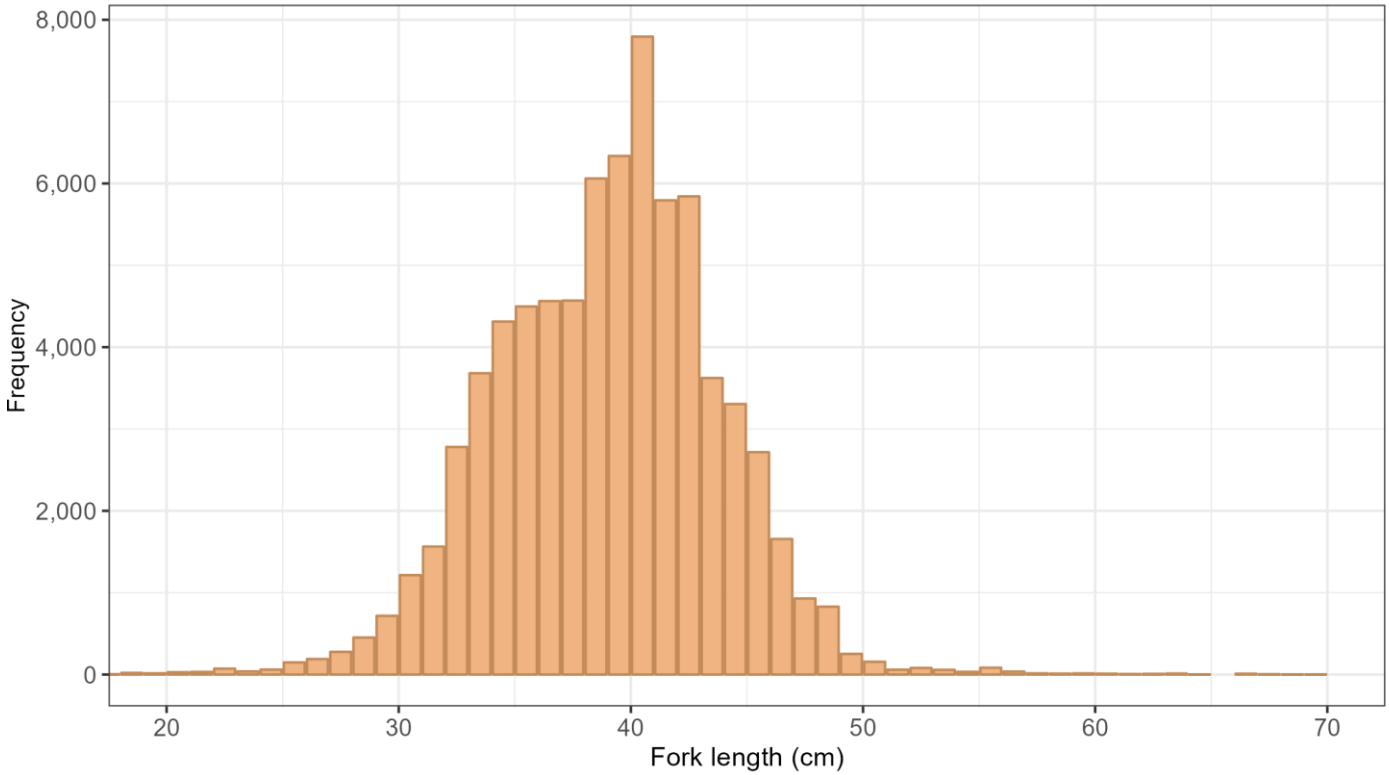


Figure 11: Size-frequency distribution of frigate tuna discarded at sea in purse seine fisheries as available in the ROS regional database

Spatial distribution of catch

Geo-references catches

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

Availability of geo-referenced catch and effort data for frigate was very low in the early decades, where distribution indicated mainly data from Sri Lanka (**Fig. @ref(fig:CARawByFisheryAndDecades**), and recent years, increased in the level of reporting, where distribution indicated catches around I. R Iran, Sri Lanka, and Indonesia (**Fig. @ref(fig:CARawByFisheryAndYears**).

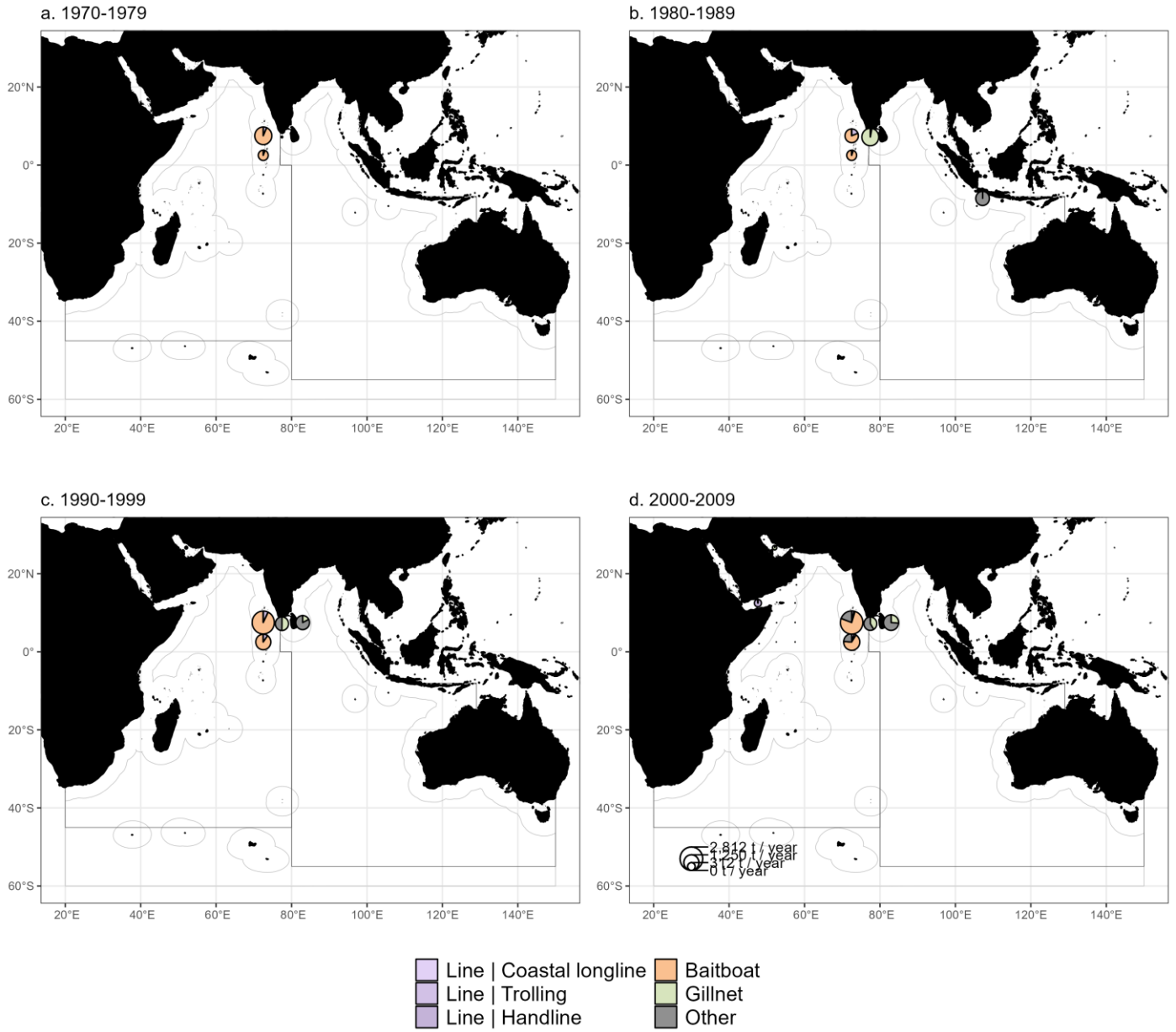


Figure 12: Mean annual time-area catches (metic tonnes; t) of frigate tuna, by decade, 5-degree grid area, and fishery. Light grey solid lines delineate areas beyond national jurisdiction. Data source: time-area catches

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

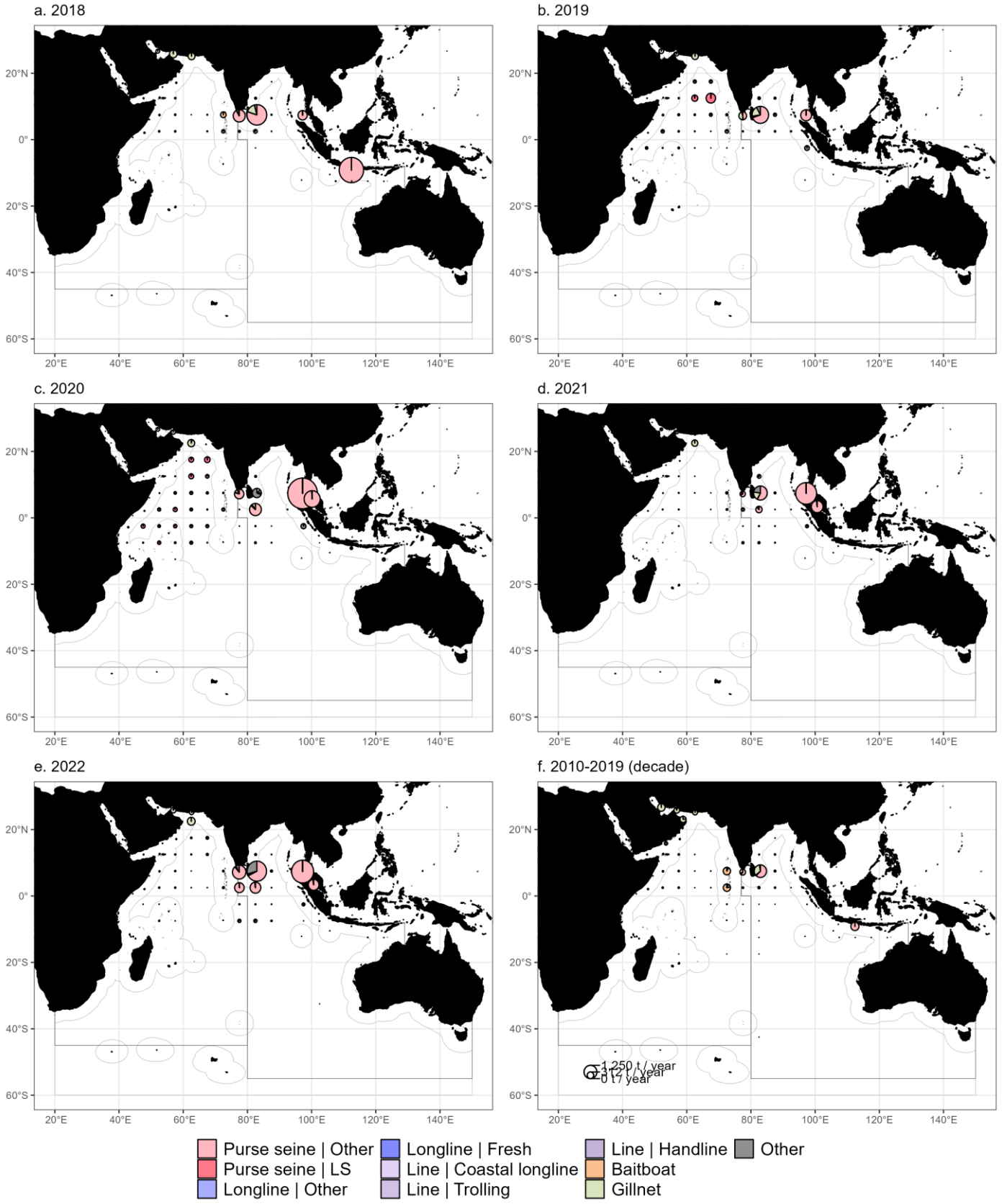


Figure 13: Mean annual time-area catches (metric tonnes; t) of frigate tuna, by year and decade, 5-degree grid area, and fishery. Light grey solid lines delineate areas beyond national jurisdiction. Data source: time-area catches

Domestic catches within areas under national jurisdiction (2018-2022)

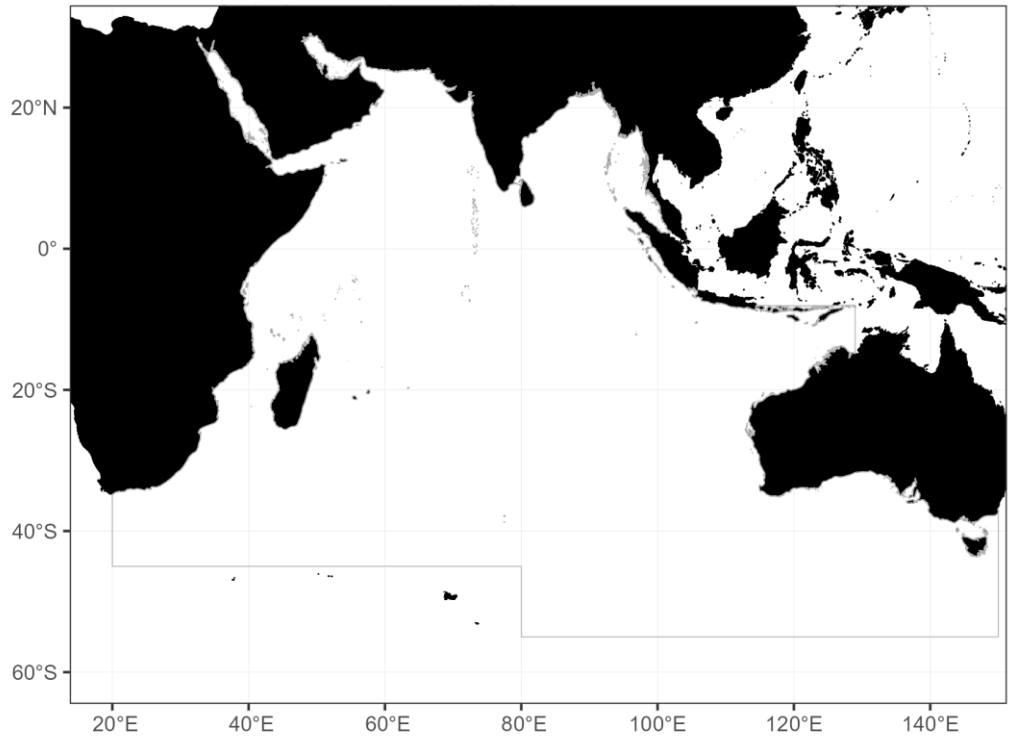


Figure 14: Mean annual density of catch (t km^{-2}) of frigate tuna reported for domestic fisheries operating in areas under national jurisdiction of IOTC coastal states between 2018 and 2022. Data source: best scientific estimates of retained catches

Uncertainties in geo-referenced catch and effort data

The quality of catch and effort catches available improved in recent years, although not a retained catch level, hence less than 40% of available catch and effort are considered as good data (**Fig. 15**).

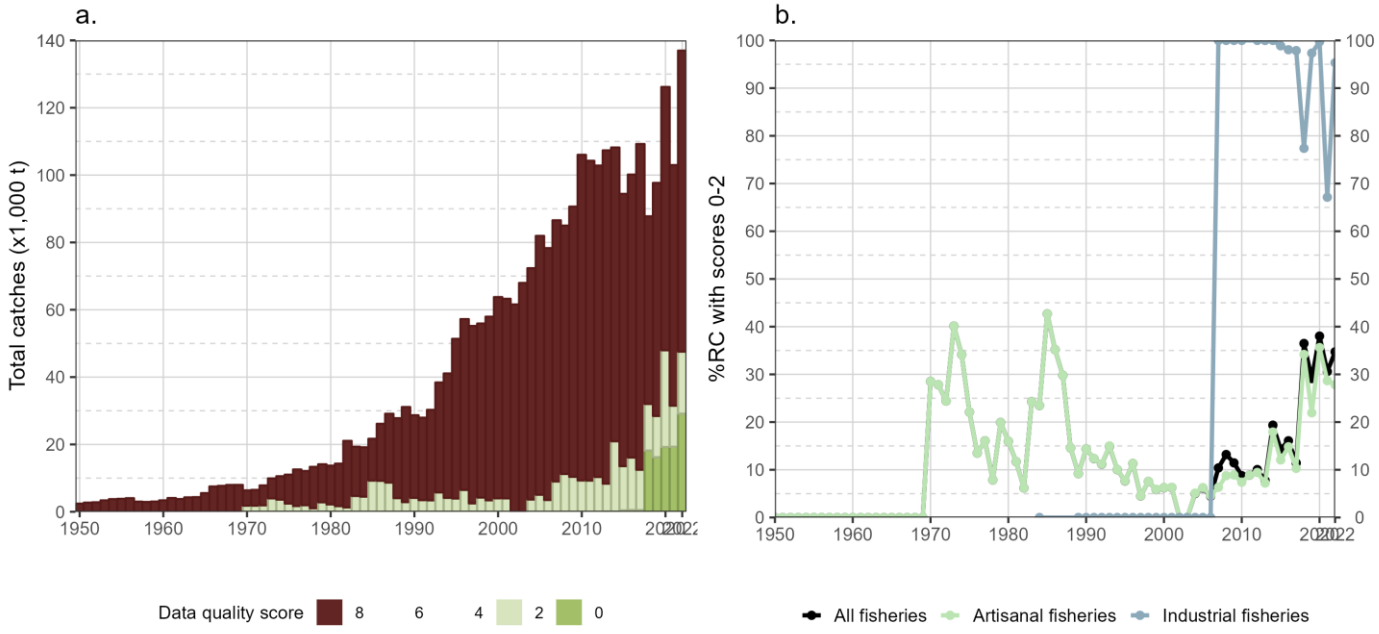


Figure 15: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches (percentage; %) with corresponding geo-referenced catch and effort data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02) to all retained catches of frigate tuna for all fisheries and by type of fishery, for the period 1950-2022

Size composition of the catch

Samples availability

By fishery group

Historically, most sample were collected from gillnet fisheries, attributed to sample programme under IPTP from major gillnet fisheries, such as Sri Lanka and I. R Iran. In recent years, frigate tuna are sampled mainly purse seine fisheries, with over 90% (**Fig. 16**).

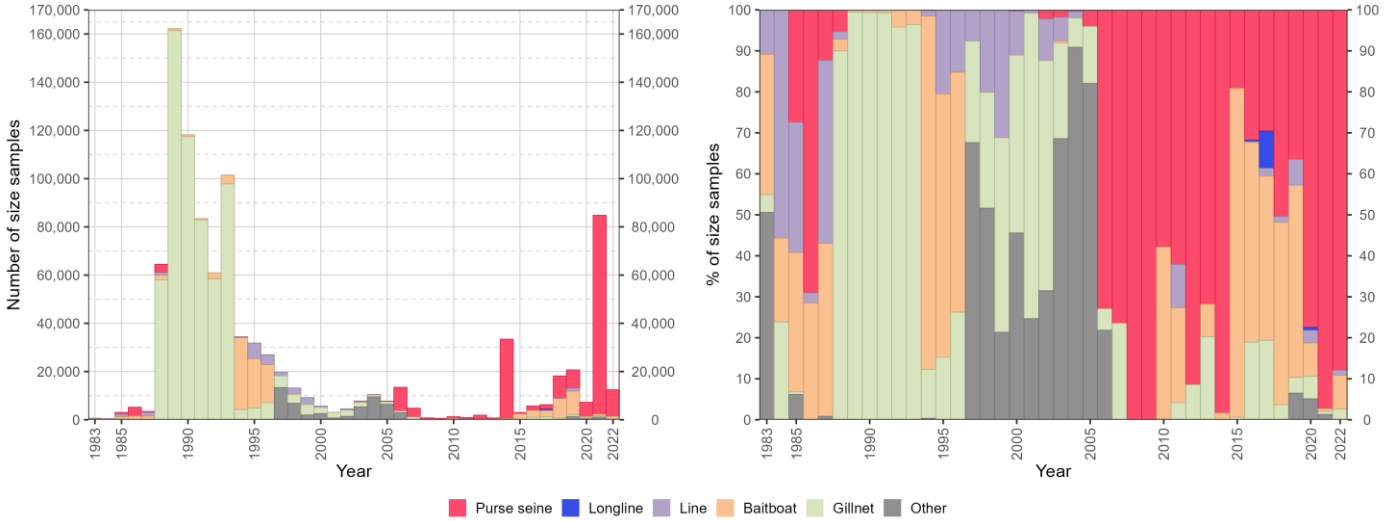


Figure 16: Availability of size-frequency data for frigate tuna as (left) absolute and (right) relative number of samples per year and fishery group. Data source: standardized size-frequency dataset

Purse seine fisheries

Distribution of sample data indicate significant sample from Western Ocean, atrributed to sample and observers collecting sampled of all frigate tuna, and increased sample from Thailand and Indonesia (**Fig. @ref(fig:SFHeatmapFGPS**).

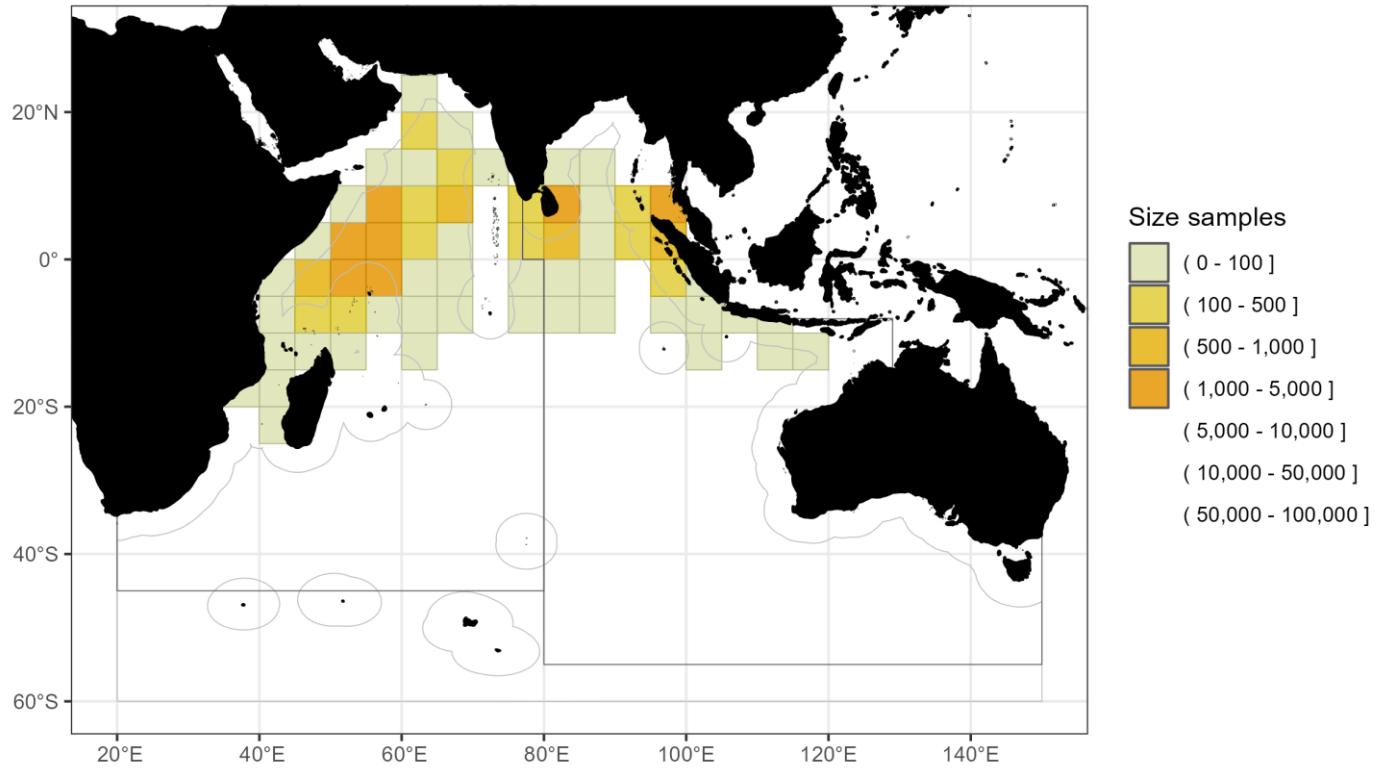


Figure 17: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in purse seine fisheries during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

Gillnet fisheries

Sri Lankan gillnet sample significant number of frigate tuna, and also Indonesia, reported sample (**Fig. @ref(fig:SFHeatmapFGPS**)

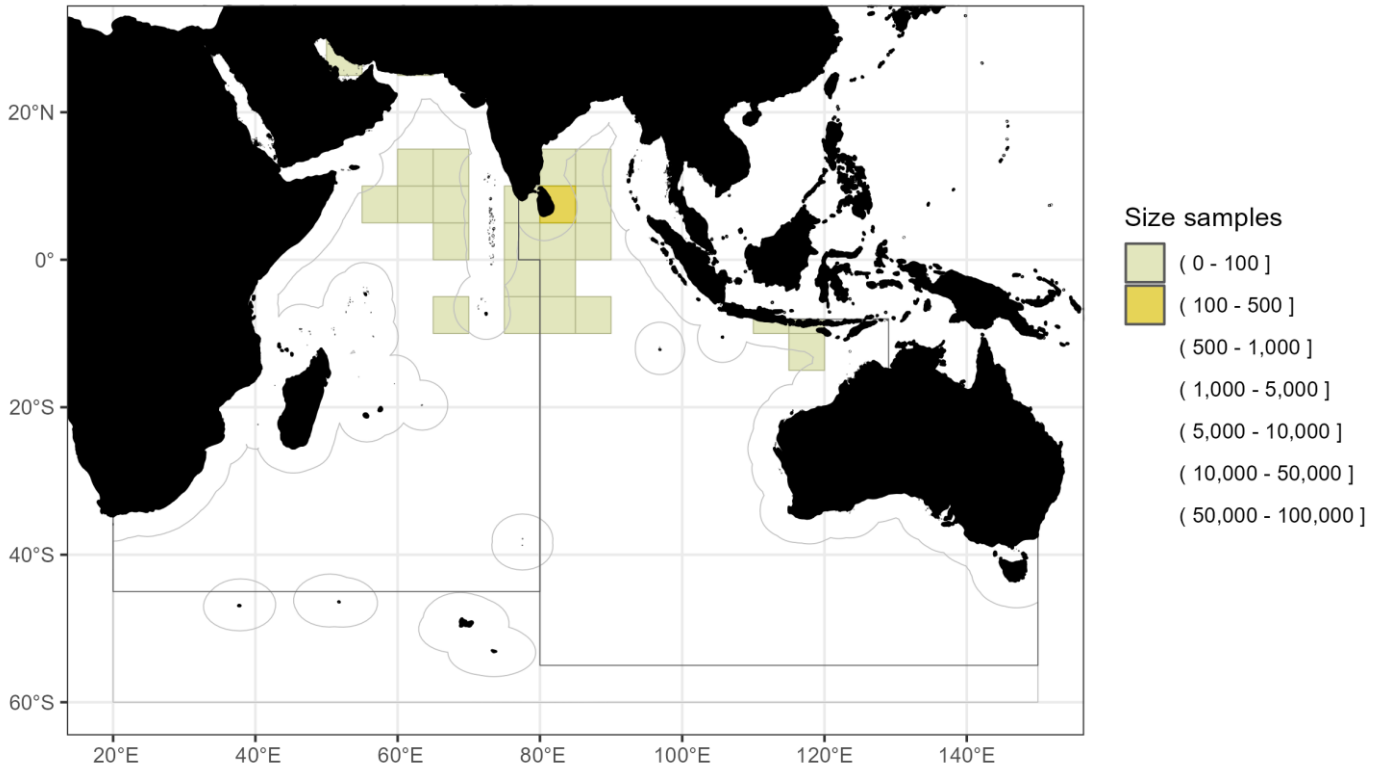


Figure 18: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in gillnet fisheries during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

Line fisheries

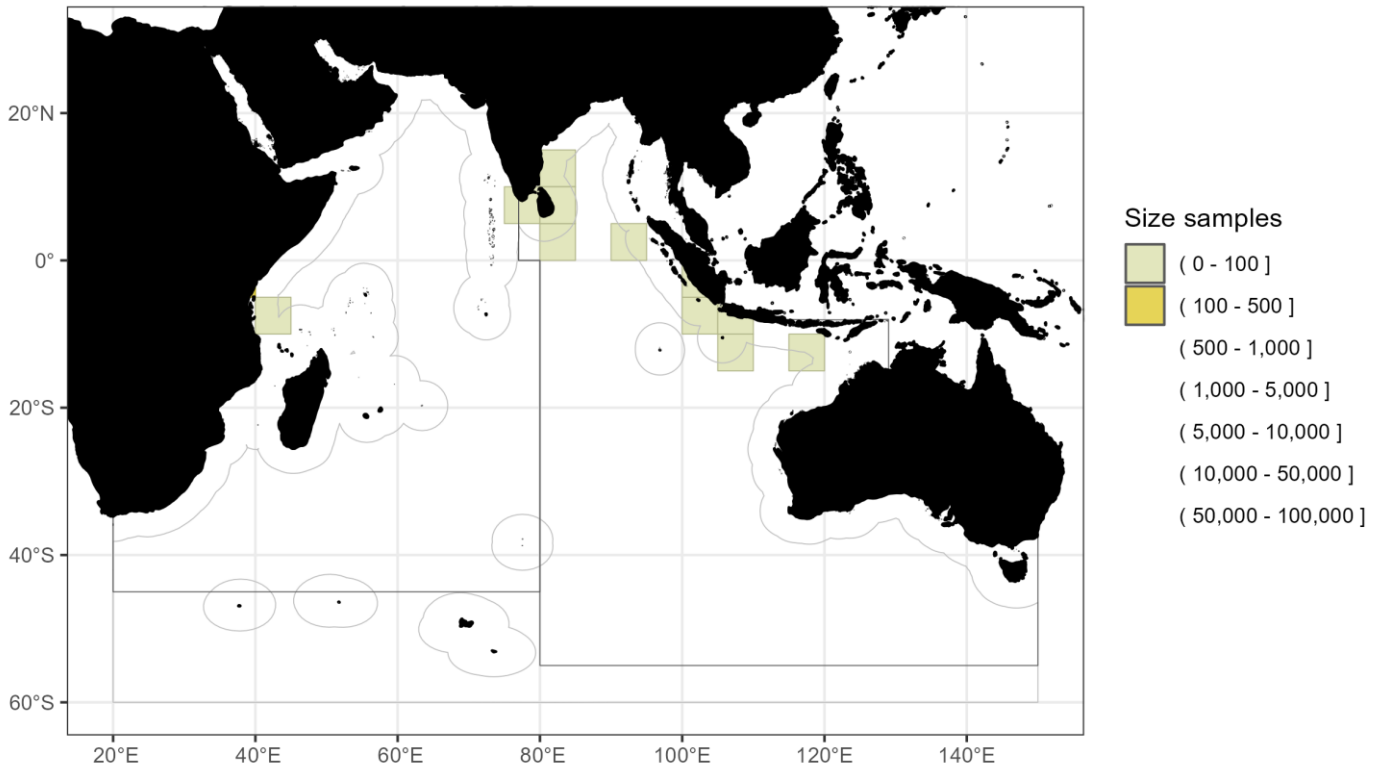


Figure 19: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in line fisheries during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

Other fisheries

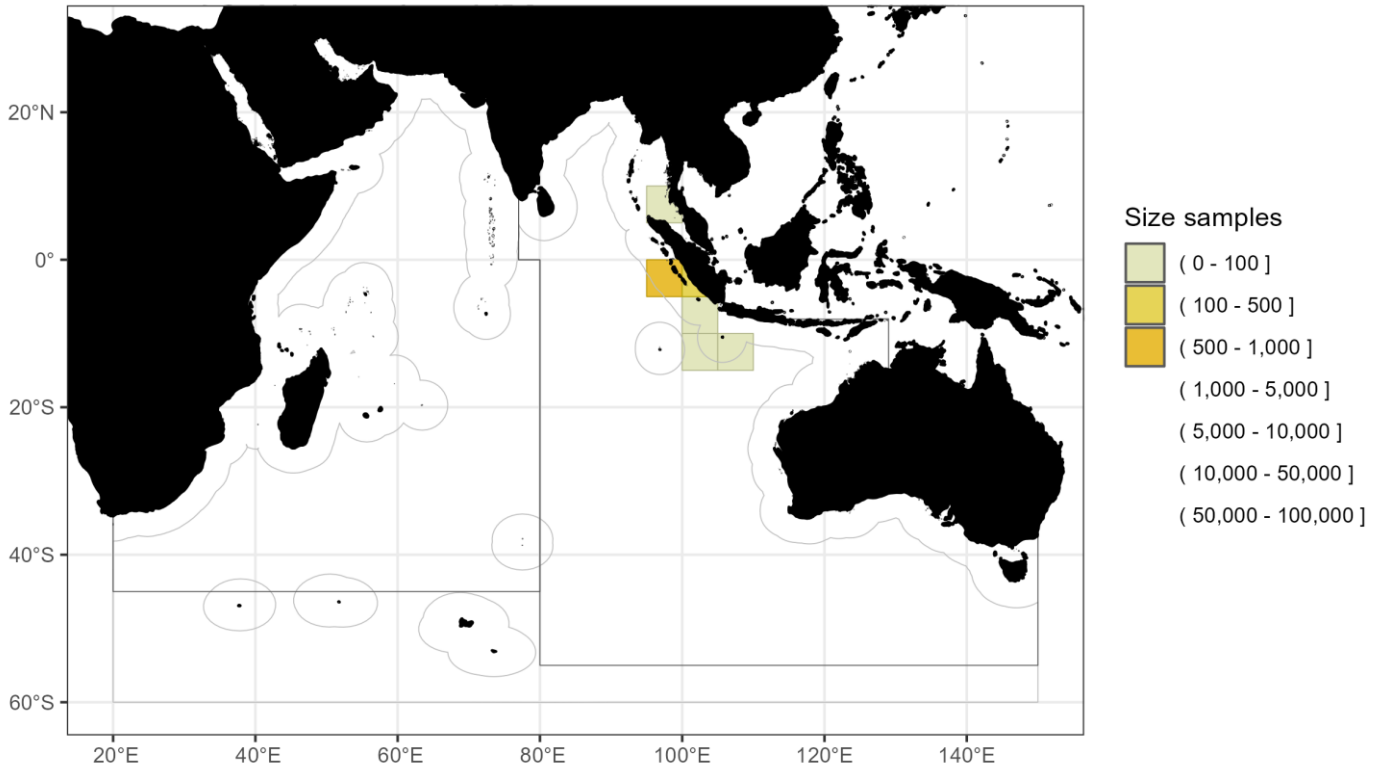


Figure 20: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in other fisheries (beach seine, harpoon, liftnet, unclassified) during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

By fishery

Purse seine fisheries

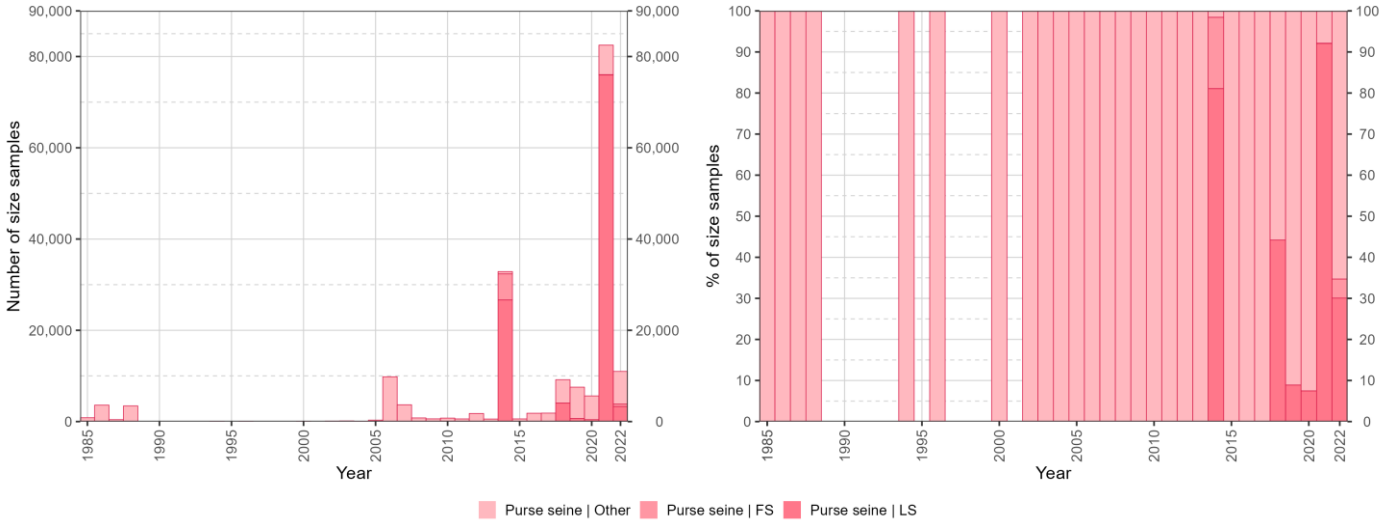


Figure 21: Availability of size-frequency data for frigate tuna as (left) absolute and (b) relative number of samples per year and type of purse seine fishery. Data source: standardized size-frequency dataset

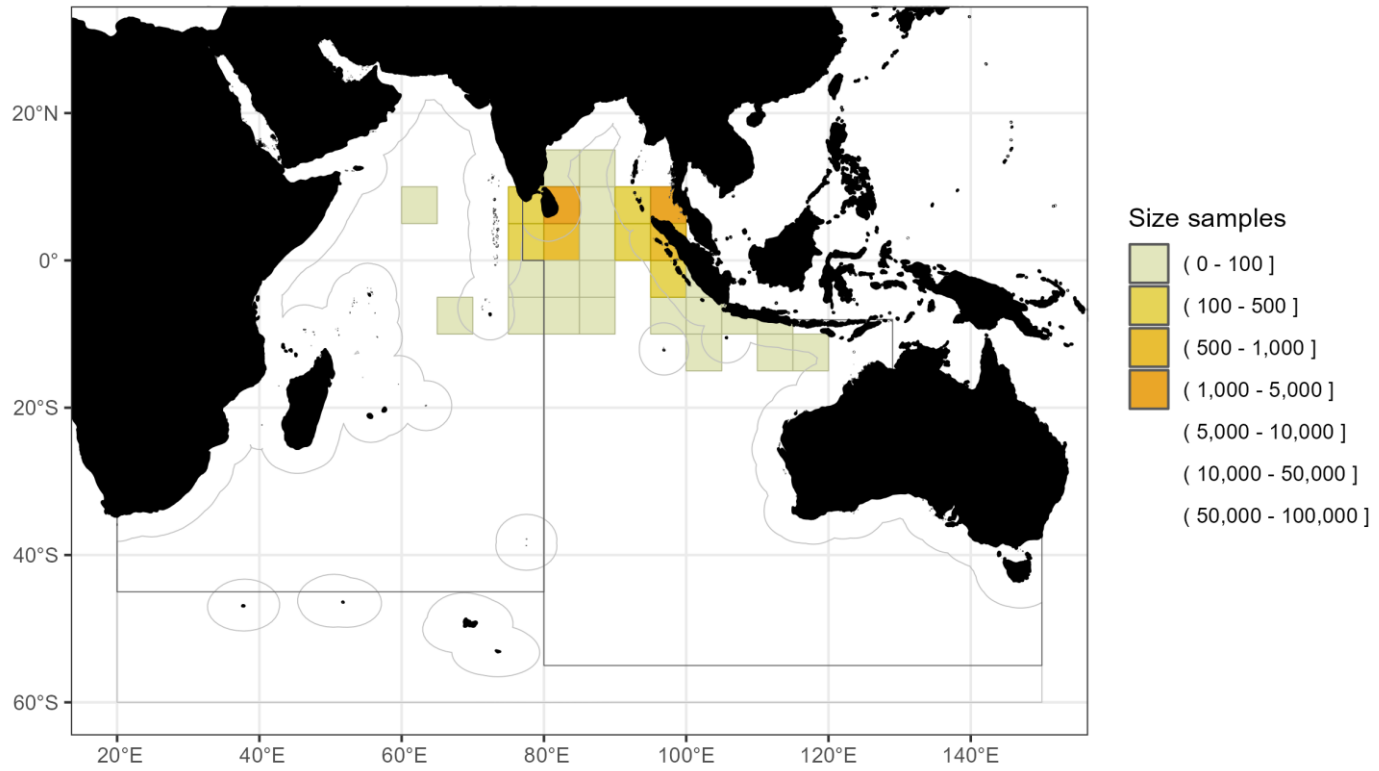


Figure 22: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in coastal and ringnet purse seine fisheries (Purse seine|Other) during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

Gillnet fisheries

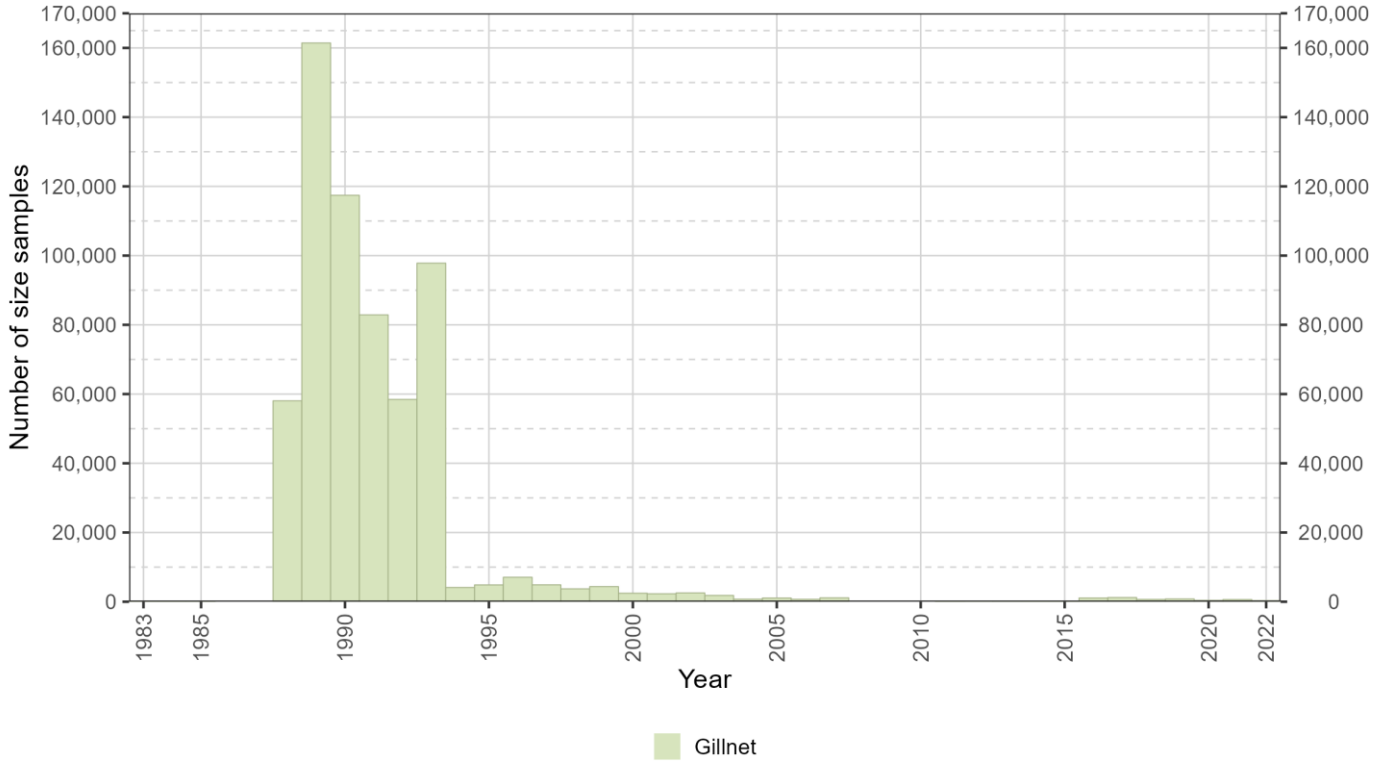


Figure 23: Availability of size-frequency data for frigate tuna as absolute number of samples per year in gillnet fisheries. Data source: standardized size-frequency dataset

Line fisheries

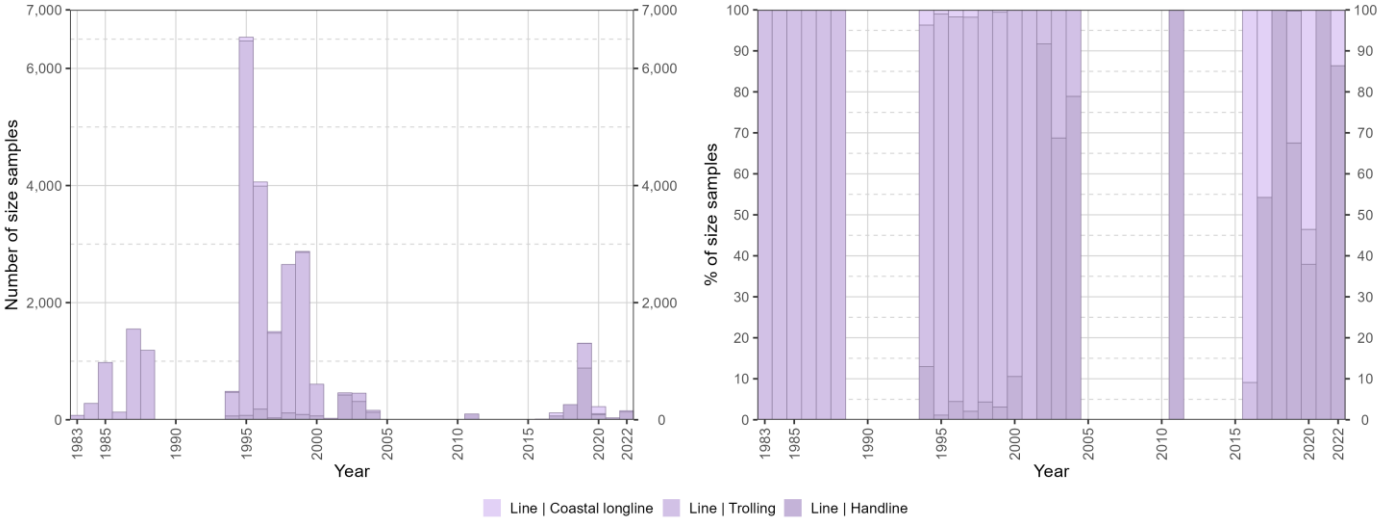


Figure 24: Availability of size-frequency data for frigate tuna as (left) absolute and (right) relative number of samples per year and line fishery type. Data source: standardized size-frequency dataset

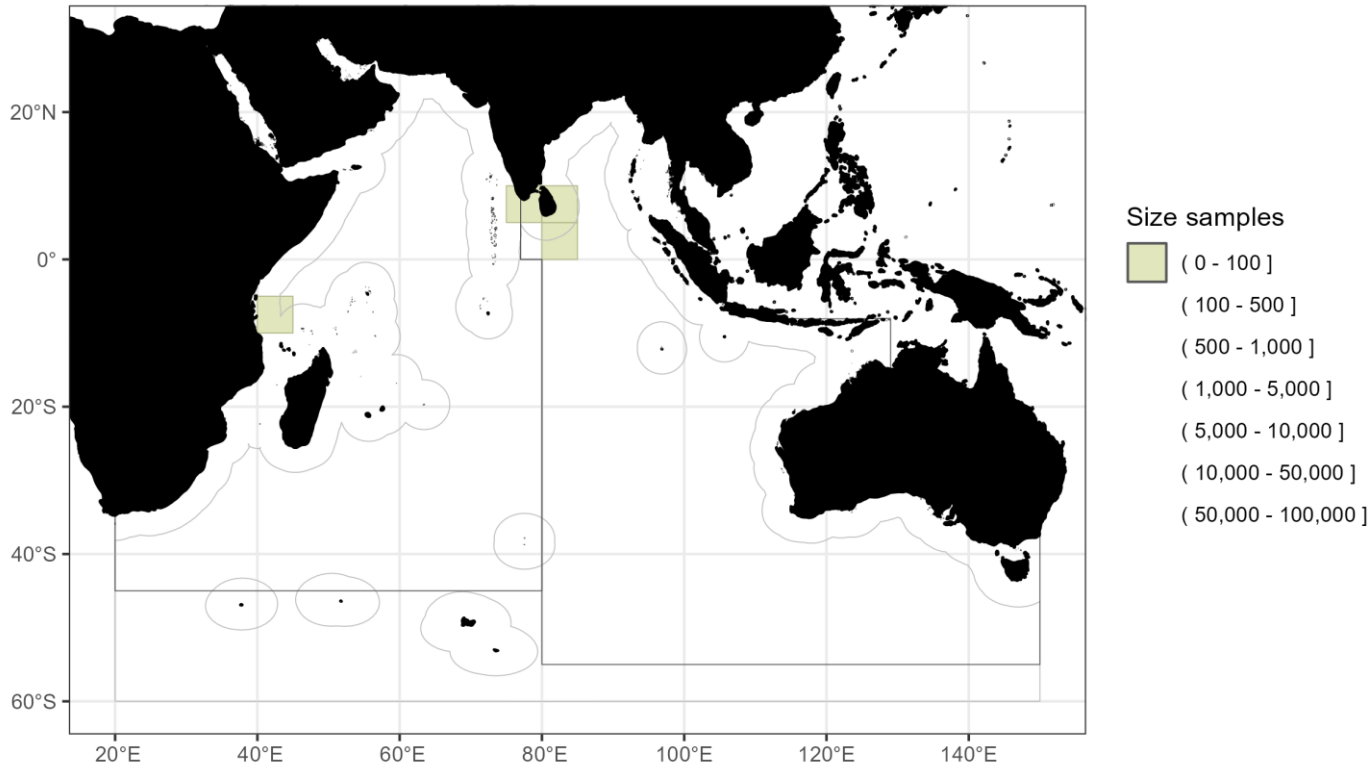


Figure 25: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in coastal longline fisheries during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

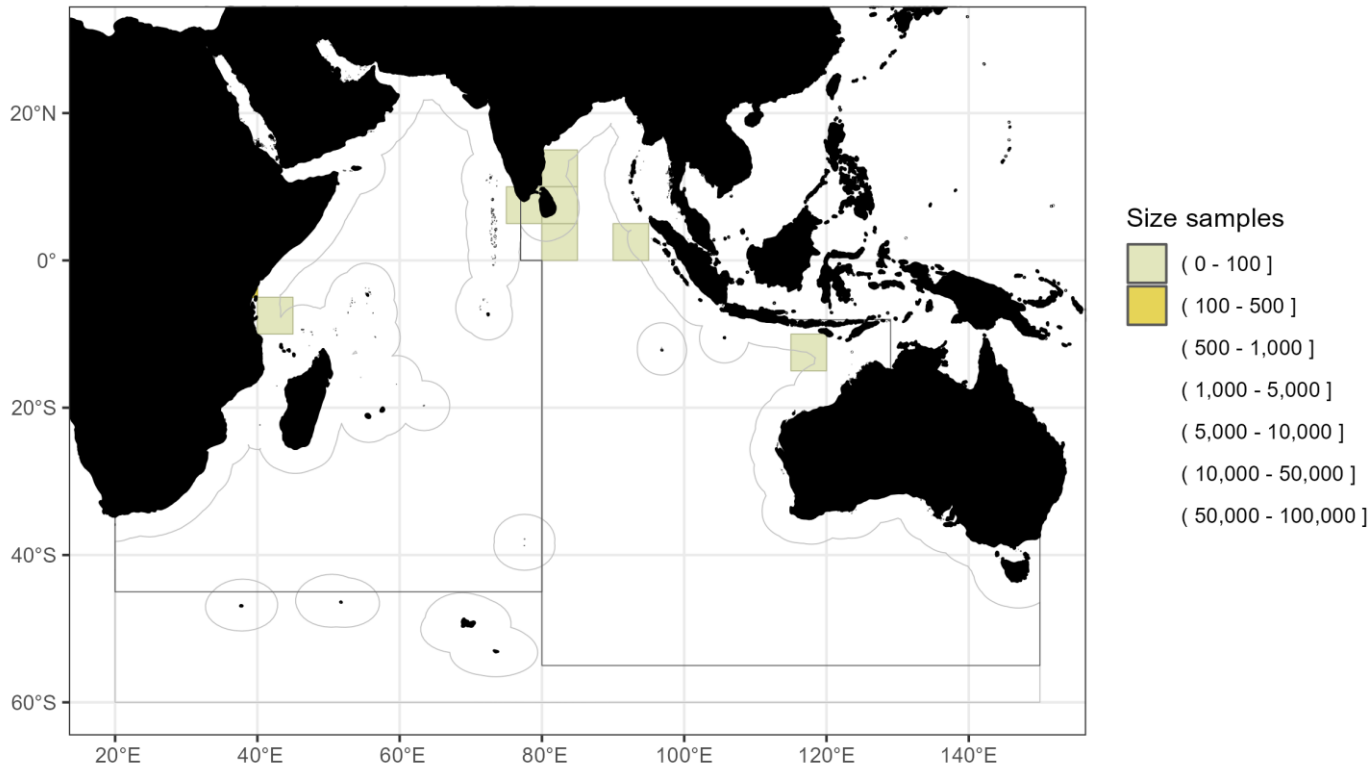


Figure 26: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in handline fisheries during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

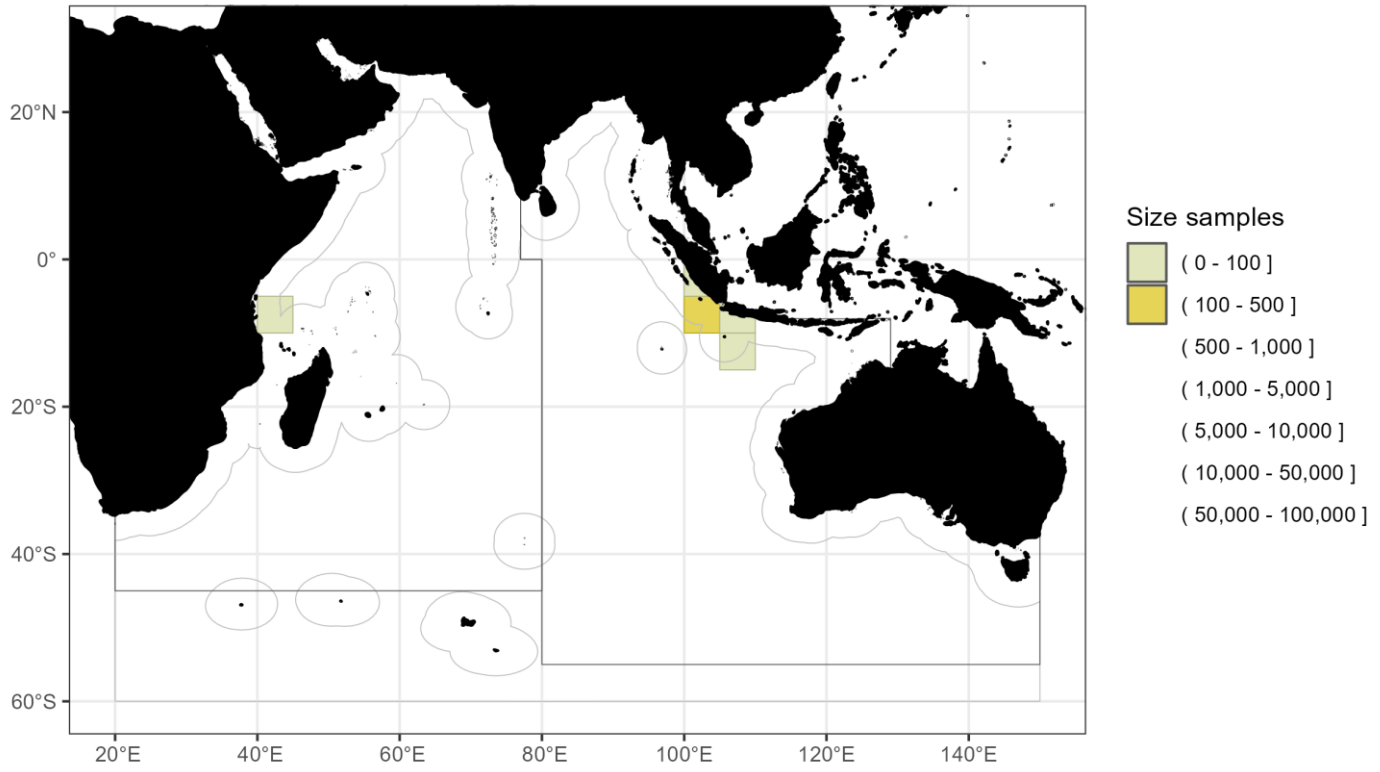


Figure 27: Spatial distribution (mean annual number of samples per 5-degree grid area) of available size-frequency data for frigate tuna caught in trolling fisheries during 2018-2022. Light grey solid lines delineate areas beyond national jurisdiction. Data source: standardized size-frequency dataset

Other fisheries

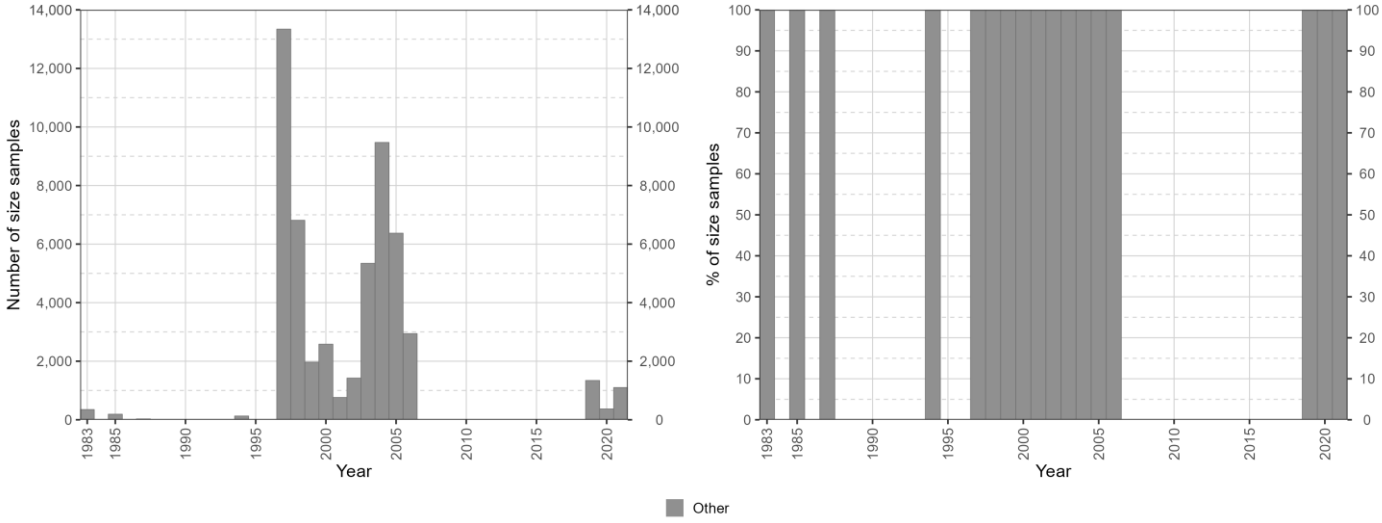


Figure 28: Availability of size-frequency data for frigate tuna as (left) absolute and (right) relative number of samples per year for 'other' fishery types (beach seine, harpoon, liftnet, unclassified). Data source: standardized size-frequency dataset

Temporal patterns and trends in size distributions

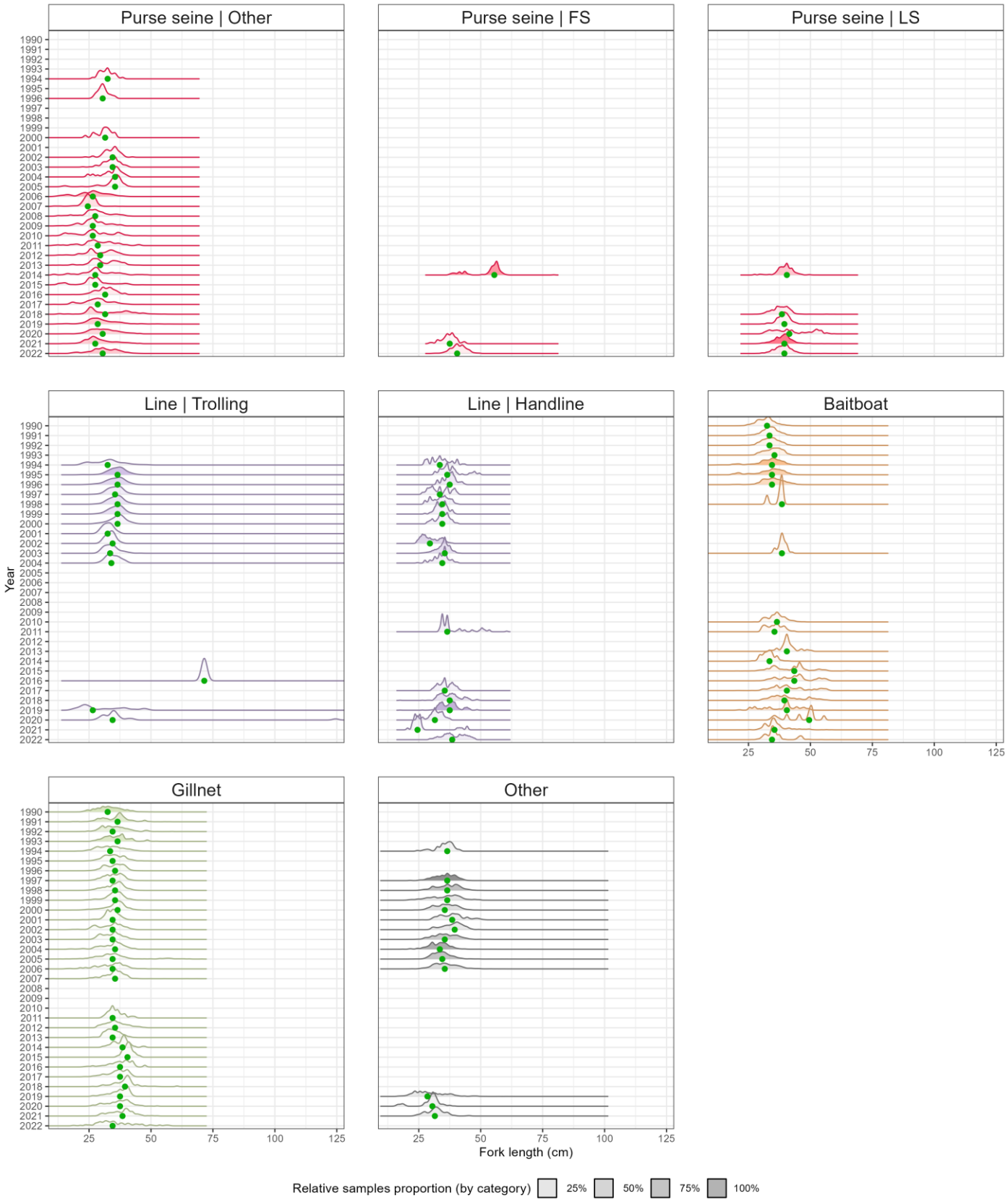


Figure 29: Relative size distribution (fork length; cm) of frigate tuna caught in coastal and ringnet purse seine fisheries (Purse seine|Other), gillnet fisheries, and other fisheries (beach seine, harpoon, liftnet, unclassified). Fill intensity is proportional to the number of samples recorded for the year, while the green dot corresponds to the median value. Data source: standardized size-frequency dataset

Size distribution by fishery and fleet

Purse seine fisheries (other)

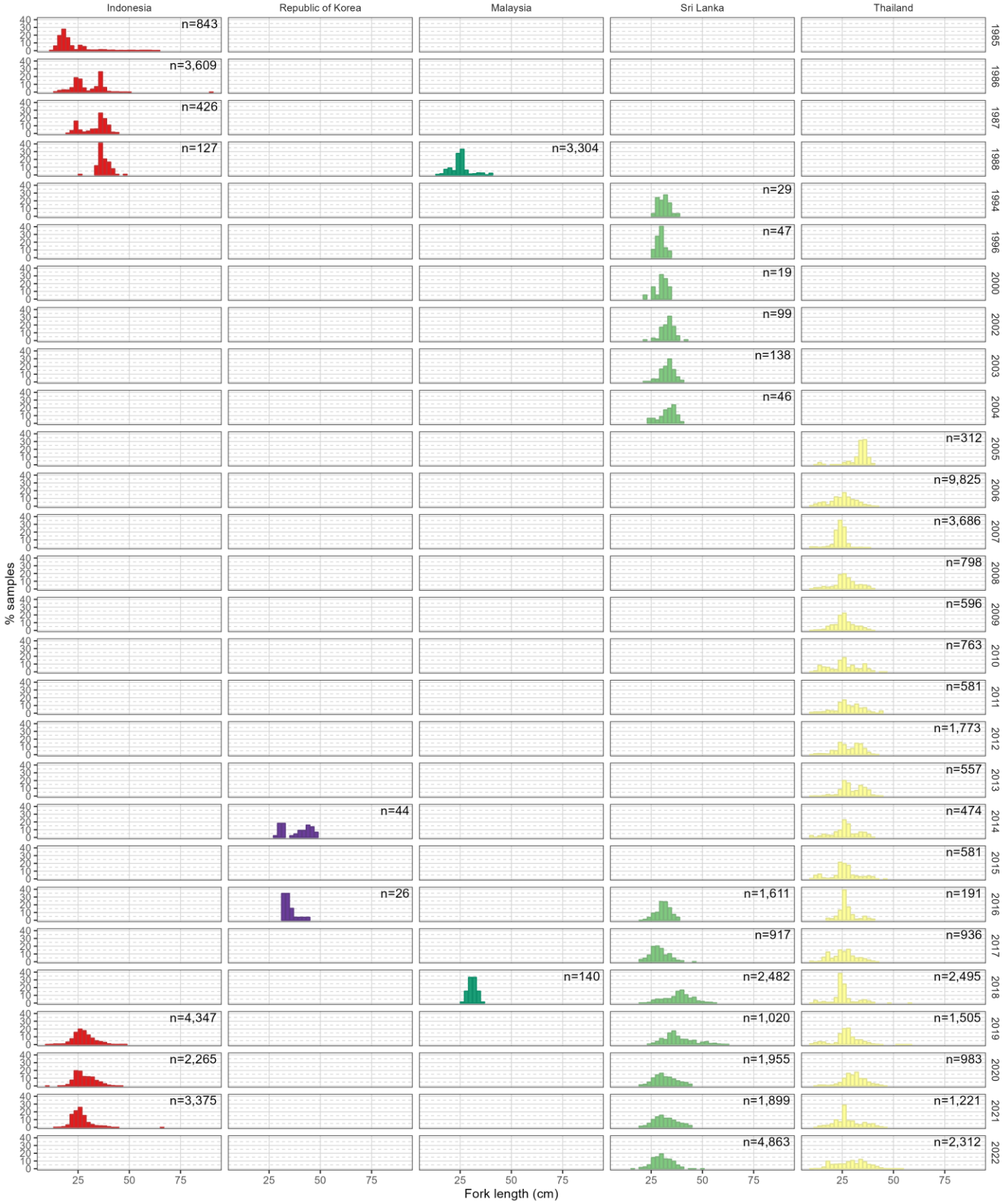


Figure 30: Relative size distribution of frigate tuna (fork length; cm) caught in coastal purse seine and ringnet fisheries (Purse seine|Other) by year and main fleet. Data source: [standardized size-frequency dataset]

Gillnet fisheries

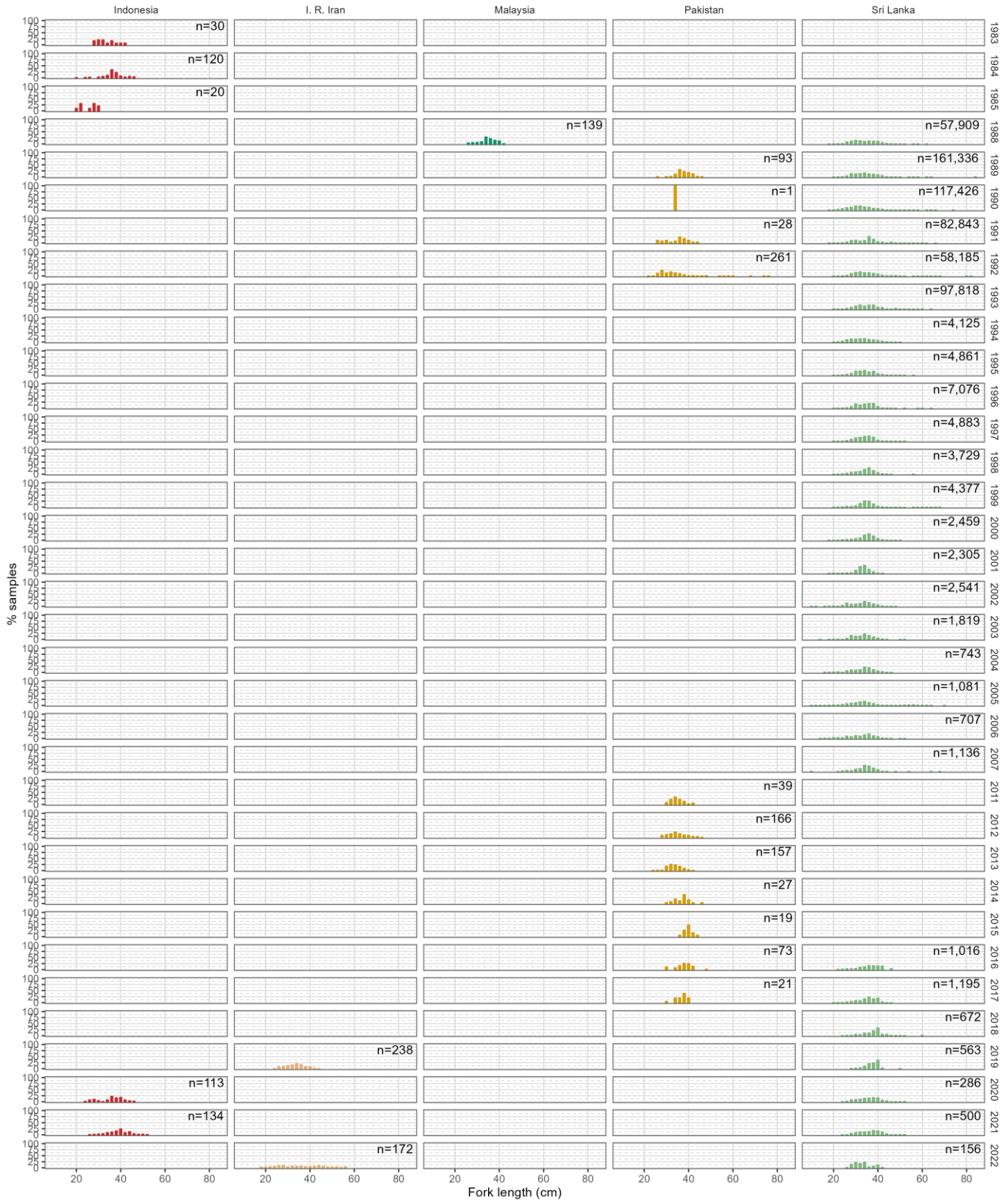


Figure 31: Relative size distribution of frigate tuna (fork length; cm) caught in gillnet fisheries by year and main fleet. Data source: standardized size-frequency dataset

Uncertainties in geo-referenced size-frequency data

As a neritic species, size frequency remains very uncertain. Compared to the available retained catches, only around 3% are available (**Fig. 32**).

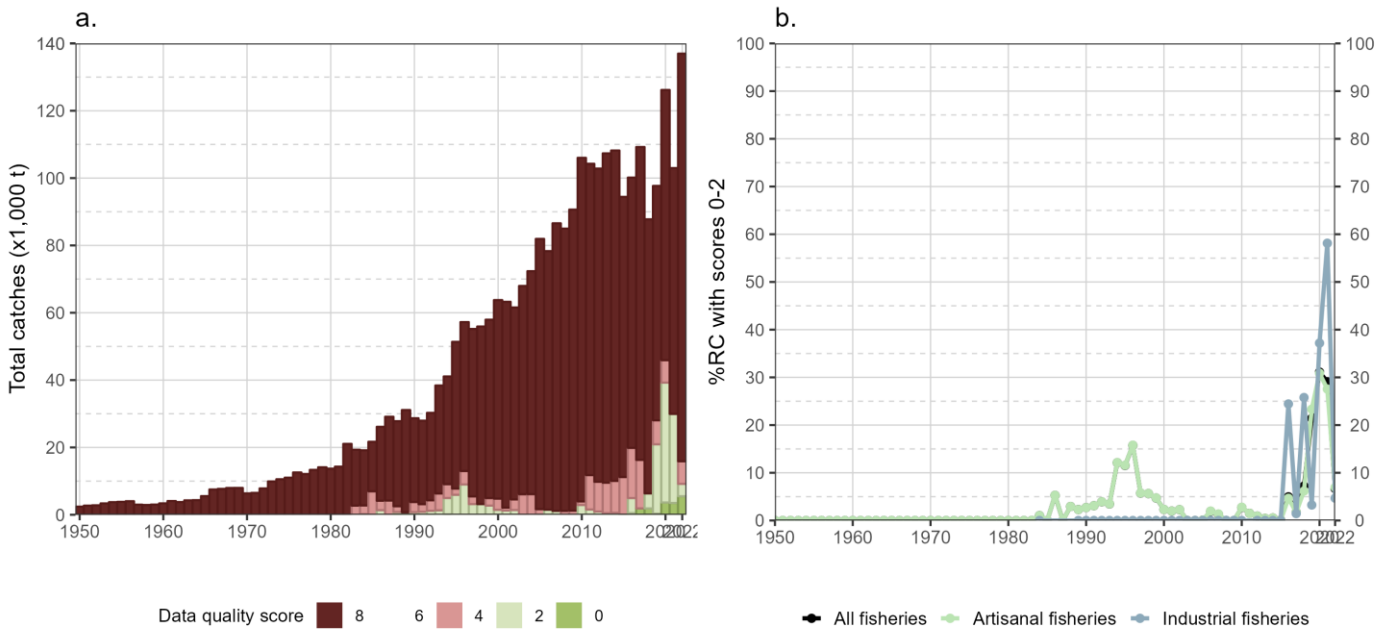


Figure 32: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches with corresponding geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 to all retained caches (percentage; %) of frigate tuna for all fisheries and by type of fishery, for the period 1950-2022

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

Table 4: Changes in best scientific estimates of annual retained catches (metric tonnes; t) of frigate tuna by 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)
2021	ARE	Gillnet	Western Indian Ocean	626	0	626
		Line	Western Indian Ocean	99	0	99
	BGD	Gillnet	Eastern Indian Ocean	75	0	75
		Other	Eastern Indian Ocean	2,262	0	2,262
	EUESP	Purse seine	Western Indian Ocean	1,597	0	1,597
	EUFRA	Purse seine	Western Indian Ocean	84	0	84
	IDN	Baitboat	Eastern Indian Ocean	59	0	59
		Gillnet	Eastern Indian Ocean	11,554	0	11,554
		Line	Eastern Indian Ocean	32,910	0	32,910
		Longline	Eastern Indian Ocean	82	0	82
		Other	Eastern Indian Ocean	13,799	0	13,799
		Purse seine	Eastern Indian Ocean	6,986	0	6,986
	IND	Baitboat	Western Indian Ocean	532	0	532
		Gillnet	Eastern Indian Ocean	1,359	0	1,359
		Gillnet	Western Indian Ocean	1,297	0	1,297
		Line	Eastern Indian Ocean	1,605	0	1,605
		Line	Western Indian Ocean	329	0	329
		Other	Western Indian Ocean	72	0	72
		Purse seine	Eastern Indian Ocean	19	0	19
		Purse seine	Western Indian Ocean	933	0	933
	IRN	Gillnet	Western Indian Ocean	6,777	0	6,777
		Line	Western Indian Ocean	250	0	250
	LKA	Gillnet	Eastern Indian Ocean	391	0	391
		Gillnet	Western Indian Ocean	12	0	12
		Line	Eastern Indian Ocean	11	0	11
		Other	Eastern Indian Ocean	357	0	357
		Purse seine	Eastern Indian Ocean	1,624	0	1,624
		Purse seine	Western Indian Ocean	28	0	28

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
	MDG	Line	Western Indian Ocean	180	0	180
	MDV	Baitboat	Western Indian Ocean	58	0	58
	MOZ	Gillnet	Western Indian Ocean	145	0	145
		Line	Western Indian Ocean	104	0	104
		Purse seine	Western Indian Ocean	2,519	0	2,519
	MYS	Other	Eastern Indian Ocean	15	0	15
		Purse seine	Eastern Indian Ocean	1,019	0	1,019
	NEIPS	Purse seine	Western Indian Ocean	11	0	11
	OMN	Gillnet	Western Indian Ocean	5,897	0	5,897
		Line	Western Indian Ocean	851	0	851
	PAK	Gillnet	Western Indian Ocean	8,070	0	8,070
	SYC	Purse seine	Western Indian Ocean	507	0	507
	THA	Purse seine	Eastern Indian Ocean	3,304	0	3,304
	TZA	Gillnet	Western Indian Ocean	371	0	371
	YEM	Gillnet	Western Indian Ocean	38	0	38
2020	ARE	Gillnet	Western Indian Ocean	641	669	-28
	THA	Purse seine	Eastern Indian Ocean	6,664	977	5,687
2019	IDN	Line	Eastern Indian Ocean	28,202	28,222	-21
	IRN	Gillnet	Western Indian Ocean	8,860	8,938	-78
		Line	Western Indian Ocean	98	20	78
2018	MOZ	Gillnet	Western Indian Ocean	108	125	-17
		Line	Western Indian Ocean	73	93	-20
	NEIPS	Purse seine	Western Indian Ocean	138	0	138
2017	IDN	Baitboat	Eastern Indian Ocean	68	55	14
		Gillnet	Eastern Indian Ocean	13,372	10,712	2,660
		Line	Eastern Indian Ocean	38,090	30,513	7,577
		Other	Eastern Indian Ocean	15,971	12,794	3,177
		Purse seine	Eastern Indian Ocean	6,636	5,316	1,320
	MOZ	Gillnet	Western Indian Ocean	158	184	-26
		Line	Western Indian Ocean	101	128	-28

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
		Other	Western Indian Ocean	626	638	-11
2016	IDN	Line	Eastern Indian Ocean	30,541	30,513	28
		Other	Eastern Indian Ocean	12,806	12,794	12
2015	MOZ	Gillnet	Western Indian Ocean	1,086	1,565	-479
		Line	Western Indian Ocean	233	335	-103
2014	IDN	Gillnet	Eastern Indian Ocean	11,480	11,500	-20
		Line	Eastern Indian Ocean	32,701	32,757	-56
		Other	Eastern Indian Ocean	13,711	13,735	-24
2013		Gillnet	Eastern Indian Ocean	13,033	12,627	406
		Line	Eastern Indian Ocean	37,123	35,966	1,157
		Other	Eastern Indian Ocean	15,566	15,081	485
		Purse seine	Eastern Indian Ocean	6,467	6,266	202
2012		Gillnet	Eastern Indian Ocean	11,156	11,063	93
		Line	Eastern Indian Ocean	31,776	31,512	264
		Other	Eastern Indian Ocean	13,324	13,213	111
		Purse seine	Eastern Indian Ocean	5,536	5,490	46
2010		Gillnet	Eastern Indian Ocean	10,867	10,799	68
		Line	Eastern Indian Ocean	30,953	30,759	194
		Other	Eastern Indian Ocean	12,979	12,897	81
		Purse seine	Eastern Indian Ocean	5,392	5,358	34
	MOZ	Gillnet	Western Indian Ocean	211	304	-93
		Line	Western Indian Ocean	45	65	-20
2008		Gillnet	Western Indian Ocean	188	273	-85
		Line	Western Indian Ocean	89	59	30