OVERVIEW OF INDIAN OCEAN TROPICAL TUNA FISHERIES

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Introduction

Global catches of tropical tunas living in oceanic habitats, i.e., bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonus pelamis*), and yellowfin tuna (*Thunnus albacares*), have steadily increased over the few last decades to exceed 5 million metric tons in 2019 (FAO 2021). The contribution of the Indian Ocean to the global catch of tropical tuna mainly increased from the early 1980s with the development of the large-scale purse seine fishery to reach a maximum of about 28%, while decreasing to about 21% in recent years, down to 1 million metric tons in 2019 (**Fig. 1**).

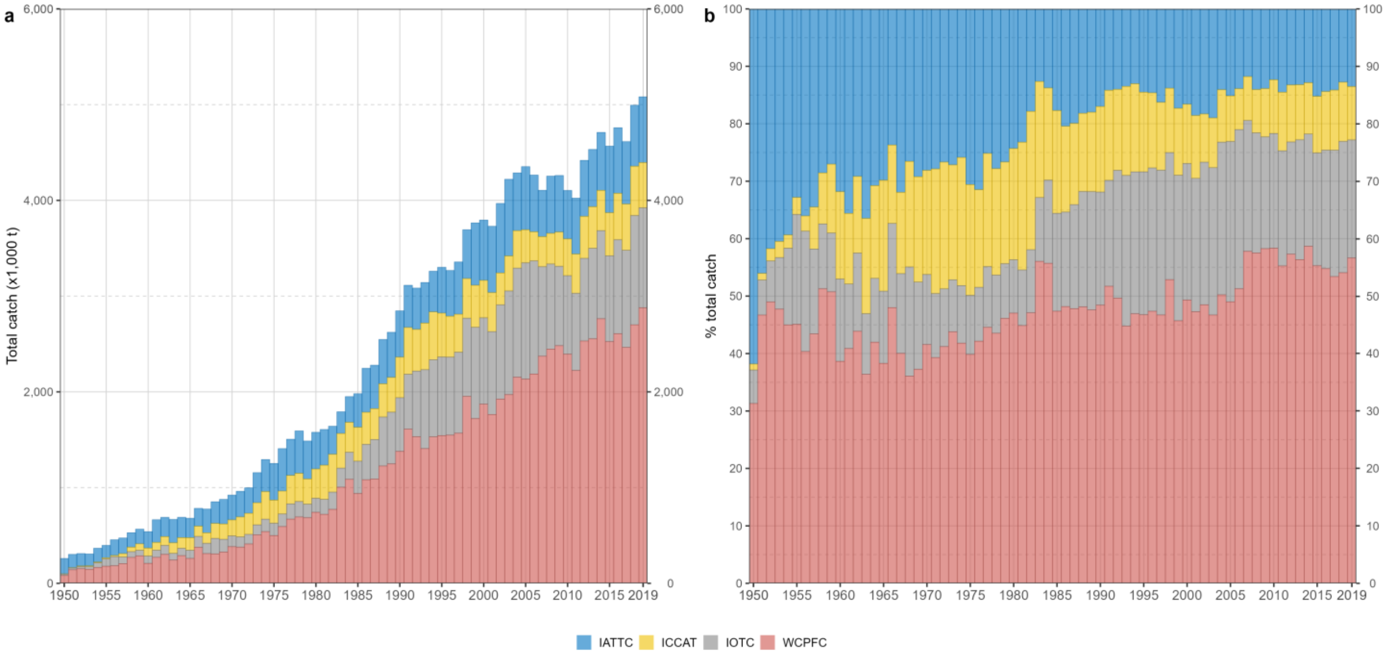

Figure 1: Annual time series of cumulative nominal catches (t) of tropical tunas by tuna Regional Fisheries Management Organisation for the period 1950-2020. IATTC = Inter-American Tropical Tuna Commission; ICCAT = International Commission for the conservation of Atlantic Tunas; IOTC = Indian Ocean Tuna Commission; WCPFC = Western-Central Pacific Ocean Commission. Source: Global Tuna Atlas

The overarching objective of this paper is to provide participants at the data preparatory meeting of the 24th Session of the IOTC Working Party on Tropical Tunas (WPTT24(DP)) with a review of the status of the information available on Indian Ocean tropical tropical tunas. The document provides an overview of the data sets available in the IOTC Secretariat databases as of May 2022, the methods used for processing and assessing the reporting quality of the main data sets, and a description of the main trends and features of Indian Ocean tropical tuna fisheries over the last seven decades.

Materials

Several fisheries data sets shall be reported to the IOTC Secretariat by the Contracting Parties and Cooperating Non-Contracting Parties (CPCs) as per the IOTC Conservation and Management Measures (CMMs) and following the standards and formats defined in the IOTC Reporting guidelines. Although not mandatory, the use of the IOTC forms is recommended to report the data to the Secretariat as they facilitate data curation and management.

Nominal catch data

Nominal catches correspond to the total retained catches (in live weight) per year, Indian Ocean major area, fleet, and fishing gear (IOTC Res. 15/02) and can be reported through IOTC form 1RC. In addition, in order to support the monitoring of the catch limits implemented by some industrial fisheries for the CPCs having objected to IOTC Resolution 21/01 as part of the interim plan for rebuilding the yellowfin tuna stock, IOTC Res. 19/01 requests CPCs to submit their catches of yellowfin tuna from 2019 explicitly disaggregated by vessel length and area of operation (i.e., for vessel of 24 m overall length and over, and for those under 24 m if they fish outside the Exclusive Economic Zone (EEZ) of the flag state) (IOTC Form 1RC-YFT).

Changes in the IOTC consolidated data sets of nominal catches (i.e., raw and best scientific estimates) may be required as a result of:

i. updates received by December 30th each year, of the preliminary data for longline fleets submitted by June 30th of the same year (IOTC Res. 15.02);

ii. revisions of historical data by CPCs following corrections of errors, addition of missing data, changes in data processing, etc.

iii. changes in the estimation process performed by the Secretariat based on evidence of improved methods and/or assumptions (e.g., selection of proxy fleets, updated morphometric relationships) and upon endorsement by the Scientific Committee.

Geo-referenced catch and effort data

Catch and effort data refer to finer-scale data, usually from logbooks, reported in aggregated format and stratified per year, month, grid, fleet, gear, type of school, and species (IOTC Res. 15/02). The IOTC forms designed for reporting geo-referenced catch and effort data vary according to the nature of the fishing gear (e.g., surface, longline, and coastal gears). In addition, information on the use of fish aggregating devices (FADs) and activity of the support vessels that assist industrial purse seiners also has to be collected and reported to the Secretariat through IOTC forms 3FA and 3SU.

Discard data

The IOTC follows the definition of discards adopted by FAO in previous reports (Alverson et al. 1994, Kelleher 2005) which considers all non-retained catch, including individuals released alive or discarded dead. Estimates of total annual discard levels in live weight (or number) by Indian Ocean major area, species and type of fishery shall be reported to the Secretariat as per IOTC Res. 15/02. The IOTC form 1DI has been designed for the reporting of discards and the data contained shall be extrapolated at the source to represent the total level of discards for the year, gear, fleet, Indian Ocean major area, and species concerned, including turtles, cetaceans, and seabirds.

Nevertheless, discard data reported to the Secretariat with IOTC Form 1DI are generally scarce, not raised, and not complying with all IOTC reporting standards. For these reasons, the most accurate information available on discards comes from the IOTC Regional Observer Scheme (IOTC Res. 11/04) that aims to collects detailed information (e.g., exact location in space and time of the sets and interactions, including the fate of observed individuals) on discards of IOTC and bycatch species for industrial fisheries (see below).

Size frequency data

The size composition of catches may be derived from the data set of individual body lengths or weights collected at sea and during the unloading of fishing vessels. The IOTC Form 4SF provides all fields requested for a complete reporting of size frequency data to the stratification by fleet, year, gear, type of school, month, grid and species as required by IOTC Res. 15/02. While the great majority of size data reported through IOTC Form 4SF are for retained catches, CPCs can also use the same form to report size data of discarded individuals. Furthermore, additional size data (including those for individuals discarded at sea) may be collected through onboard observer programs and reported to the Secretariat as part of the ROS (see below).

Socio-economic data

The IOTC Form 7PR has been designed to voluntarily report prices of fish per type of product and market for the target species of Indian Ocean tuna and tuna-like species. To date, very little information is available at the Secretariat on the socio-economics of fisheries for tuna and tuna-like species (e.g., sale price, operating costs, jobs).

The Fisheries Development Division of the Pacific Islands Forum Fisheries Agency (FFA) has been collating monthly time series of tuna price data on key markets to use them as indicators of the trends in the price received by operators (IOTC 2021a). Time series of price cover the period from January 2000 to December 2020 and include (i) import prices in Thailand for canning-grade frozen skipjack and yellowfin tunas (USD/t), (ii) import prices in Japan for sashimi-grade fresh and frozen bigeye and yellowfin tunas caught with longline (YEN/kg) and (iii) import prices in the USA from Oceania for sashimi-grade fresh (chilled) bigeye and yellowfin tunas caught with longline (USD/kg). Fish prices were adjusted for inflation using US Consumer Price Index data to obtain real prices (Ruaia et al. 2020). These time series are considered more representative of trends in tuna price than the prices received by operators (i.e., ex-vessel prices) which may strongly depend on the markets and transport costs (Ruaia et al. 2020).

In addition, the FFA collates information on fuel price which is a major driver of costs in high seas fisheries is considered a good proxy of fishing costs (Sala et al. 2018), with the assumption that real non-fuel fishing costs have remained constant over time (Ruaia et al. 2020). The crude oil spot price, computed as the arithmetic average of the spot price of Brent, Dubai, and West Texas, provides a global index of the value of fuel for fishing vessels as crude oil forms the basis for most fuels used in most fishing vessels (e.g., marine diesel oil). Time series of import price for tropical tunas and fuel price are given in Appendix I.

Regional Observer Scheme

Resolution 11/04 on the ROS makes provision for the development and implementation of national observer schemes among the IOTC CPCs starting from July 2010 with the overarching objective of collecting *"verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence"*. The ROS aims to cover *"at least 5% of the number of operations/sets for each gear type by the fleet of each CPC while fishing in the IOTC Area of competence of 24 meters overall length and over, and under 24 meters if they fish outside their EEZs shall be covered by this observer scheme"*. Observer data collected as part of the ROS include: (i) fishing activities and vessel positions, (ii) catch estimates with a view to identifying catch composition and monitoring discards, bycatch, and size frequency, (iii) gear type, mesh size and attachments employed by the master, and (iv) information to enable the cross-checking of entries made to the logbooks (i.e., species composition and quantities, live and processed weight and location). In addition, the ROS database includes morphometric data (i.e., lengths and weights) collected at sea by fisheries observers which are of particular interest for deriving morphometric relationships. A full description of the ROS data requirements for each fishing gear is provided in IOTC (2021b).

A comprehensive description of the status, coverage, and data collected as part of the ROS is provided in IOTC (2021c). Although incomplete and characterized by a large variability in coverage between fisheries and over space and time, observer data include information on the fate of the catches (i.e., retained or discarded at sea) as well as on the condition of the discards. Observer data are also the main source of spatial information on interactions between IOTC fisheries and seabirds, marine turtles, cetaceans, as well as any other species encountered.

To date, the ROS regional database contains information for a total of 1,492 commercial fishing trips (845 from purse seine vessels and 647 from longline vessels of various types) made during the period 2005-2019 from 7 fleets: Japan, EU,France and Sri Lanka for longline fisheries and EU,Spain, EU,France, Japan, Korea, Mauritius, and Seychelles for purse seine fisheries. In addition, some observer reports have been submitted to the Secretariat by some CPCs (e.g., Taiwan,China) but data sets were not provided in electronic format at the operational level following the ROS standards, *de facto* preventing the entry of these data in the ROS regional database.

Tagging data

Tag release and recovery data gathered in the framework of the Indian Ocean Tuna Tagging Programme (IOTTP), which encompass data gathered during the Regional Tuna Tagging Project – Indian Ocean (RTTP-IO) and data gathered during a series of small-scale tuna tagging projects in Maldives, India, Mayotte, Indonesia and by other institutions, e.g., the Southeast Asian Fisheries Development Center (SEAFDEC) and the National Research Institute of Far Seas Fisheries (NRIFSF), with the support of IOTC. In 2012, the data from past projects implemented in Maldives in the 1990s were added to the tagging database at the Secretariat.

Morphometric data

Different length-length and length-weight relationships have been estimated for Indian Ocean tropical tuna based on morphometric data collected through fisheries monitoring programs and research projects (**Table 1**).

Table 1: Summary of morphometric relationships available for Indian Ocean tropical tunas. FL = fork length (cm); RD = round weight (kg); GG = Gilled-and-gutted weight (kg). N = number of samples; LL = longline; GN = gillnet; PL = pole and line; PS = purse seine; OT = Other gears

Species	Equation	Gears	N	MinFL	MaxFL	a	b	Reference
BET	RD = a*FL^b	GN;PL;PS	2,156	29.5	174	2.2170e-05	3.012110	Chassot et al. 2016
BET	GG = a*FL^b	LL;OT	12,047	70.0	187	1.5921e-05	3.041541	Geehan and Pierre 2013
BET	RD = a*GG+b	LL;OT	12,047	70.0	187	1.1300e+00	0.000000	Geehan and Pierre 2013
SKJ	RD = a*FL^b	ALL	1,762	30.0	73	4.9700e-06	3.392920	Chassot et al. 2016
YFT	RD = a*FL^b	GN;PL;PS	25,386	29.0	166	2.5490e-05	2.966700	Chassot et al. 2016
YFT	GG = a*FL^b	LL;OT	15,133	72.0	177	9.4007e-06	3.126844	Geehan and Pierre 2013
YFT	RD = a*GG+b	LL;OT	15,133	72.0	177	1.1300e+00	0.000000	Geehan and Pierre 2013

Methods

The release of the IOTC curated data sets for tropical tunas is done following some processing data steps which are briefly summarized below.

Data processing

First, standard controls and checks are performed to ensure that the metadata and data submitted to the Secretariat are consistent and include all mandatory fields (e.g., dimensions of the strata, etc.). The controls depend on each type of data set and may require the submission of revised data from CPCs if the original one is found to be incomplete.

Second, a series of processing steps is applied to derive the best scientific estimates of nominal catches for the 16 IOTC species (see **Appendix V** of IOTC (2014)), by implementing the following rules:

a. When nominal catches are not reported by a CPC, catch data from the previous year may be repeated or catches may be derived from a range of sources, e.g., partial catch and effort data, the FAO FishStat database, data on imports of tropical tunas from processing factories collaborating with the International Seafood Sustainability Foundation, etc.;

b. For some specific fisheries characterized by well-known, outstanding issues in terms of data quality, a process of re-estimation of species and/or gear composition may be performed based on data available from other years or areas, or by using proxy fleet (i.e., fleets occurring in the same strata which are assumed to have a very similar catch composition, e.g., Moreno et al. (2012) and IOTC (2018));

c. Finally, a disaggregation process is performed to break down the catches by species (**Table 2**) and gear (**Table 3**) when these are reported as *aggregates*.

Table 2: List of species groups that include one or more tropical tuna species

Species code	Species name	Species scientific name	BET	SKJ	YFT
AG10	Skipjack tuna and kawakawa	*Katsuwonus pelamis; Euthynnus affinis*		✓	
AG35	Yellowfin tuna and skipjack tuna	*Thunnus albacares; Katsuwonus pelamis*		✓	✓
AG45	Albacore, yellowfin tuna and bigeye tuna	*Thunnus alalunga; Thunnus albacares; Thunnus obesus*	✓		✓
TUN	Tunas nei	*Thunnini*	✓	✓	✓
TUS	True tunas nei	*Thunnus spp*	✓	✓	✓
TUX	Tuna-like fishes nei	*Scombroidei*	✓	✓	✓

Table 3: List of gear aggregates with their component gear codes (limited to gear aggregates that have reported catches of tropical tunas)

Aggr. code	Gear aggregate	Category	BB	GILL	HAND	LIFT	LLCO	PS	PSS	RR	TRAW	TROL
BBPS	Baitboat and purse seine	Baitboat	✓					✓				
GIHT	Gillnet and hand line and troll line	Gillnet		✓	✓							✓
HATR	Hand line and Troll line	Trolling			✓							✓
HOOK	Hook and line	Trolling			✓		✓					✓
LLTR	Coastal Longline and Troll line combination	Longline					✓					✓
UNCL	Unclassified	Other	✓	✓	✓	✓	✓		✓	✓	✓	✓

Third, and applying only to the five major IOTC species (albacore, bigeye tuna, skipjack tuna, yellowfin tuna, and swordfish), geo-referenced catches are raised to the best scientific estimates of nominal catches using available information and by either leveraging data from proxy fleets or adopting substitution schemes when the spatio-temporal information is not available for a given stratum. For this reason, the raised data sets represent the best scientific estimates of the geo-referenced catches given the information available to the Secretariat and the issues with data availability and data quality affecting several fisheries. The raised data comprise catches in weight and number and stratified by year, month, fleet, gear, school type (when available) and 5x5 degrees grid, covering the entire time series for which nominal catches are available. The average weight of swordfish in the catch can be computed directly from the raised weights and numbers for each fishery, with the accuracy of the results being directly proportional to the availability and quality of geo-referenced catch and size-frequency data for the stratum.

Fourth, and applying to all 16 IOTC species plus the most common shark species defined in the appendices of IOTC Resolution 15/01, filtering and conversions are applied to the size-frequency data in order to harmonize their format and structure and remove data which are non-compliant with IOTC standards, e.g., when provided with size bins exceeding the maximum width considered meaningful for the species (IOTC 2020b). The standard length measurements considered at IOTC are the eye fork length (EFL; straight distance from the orbit of the eye to the fork of the tail) for black and blue marlins and the fork length (FL; straight distance from the tip of the lower jaw to the fork of the tail) for all other species subject to mandatory size measurements (IOTC 2020b). All size samples collected using other types of measurements are converted into FL and EFL by using the IOTC equations, considering size range and intervals that may vary with species. If no IOTC-endorsed equations exist to convert from a given length measurement for a species to the standard FL and EFL measurements, the original size data are not disseminated but kept within the IOTC databases for future reference.

Last, a specific process is applied to the tagging data collected for the three tropical tuna species, to specifically filter dubious records, correct for potential tag loss, and adjust for under-reporting of recaptures (IOTC 2020a).

Data quality

A scoring system has been implemented to assess the quality of the nominal catch, catch-effort, and size-frequency data available at the Secretariat for all IOTC species. The determination of the score varies according to the type of data set and aims to account for reporting coverage and compliance with IOTC reporting standards (**Table 4**). Overall, the lower the score, the better the quality. It is to note that the quality scoring does not account for sources of uncertainty affecting the nominal catches such as under-reporting and misreporting.

Table 4: Key to IOTC quality scoring system

Data set	Criterion	By species	By gear
Nominal catch	Fully available	0	0
	Partially available	2	2
	Fully estimated	4	4
Catch and effort	Available according to standards	0	0
	Not available according to standards	2	2
	Low coverage (<30% logbooks)	2	
	Not available	8	
Size frequency	Available according to standards	0	0
	Not available according to standards	2	2
	Low coverage (<1 fish per ton caught)	2	
	Not available	8	

Nominal catches

Historical trends (1950-2020)

Total nominal catches reported for the 16 species under the mandate of the Indian Ocean Tuna Commission (IOTC) have steadily increased from the 1950s to reach a maximum of more than 1.91 million t in 2018 and 1.88 million t in 2020. Tropical tuna have always dominated the total IOTC catch between 1950 and 2020, although their contribution to total catches has varied over time in relation to different factors such as the expansion of fisheries targeting other species categories, the development of the purse seine fishery starting from the 1980s, and the threats of piracy in the late 2010s. In 2020, the total catch of tropical tuna in the Indian Ocean has been estimated at 1.07 million t, reaching 56.7% of catches of all IOTC species combined.

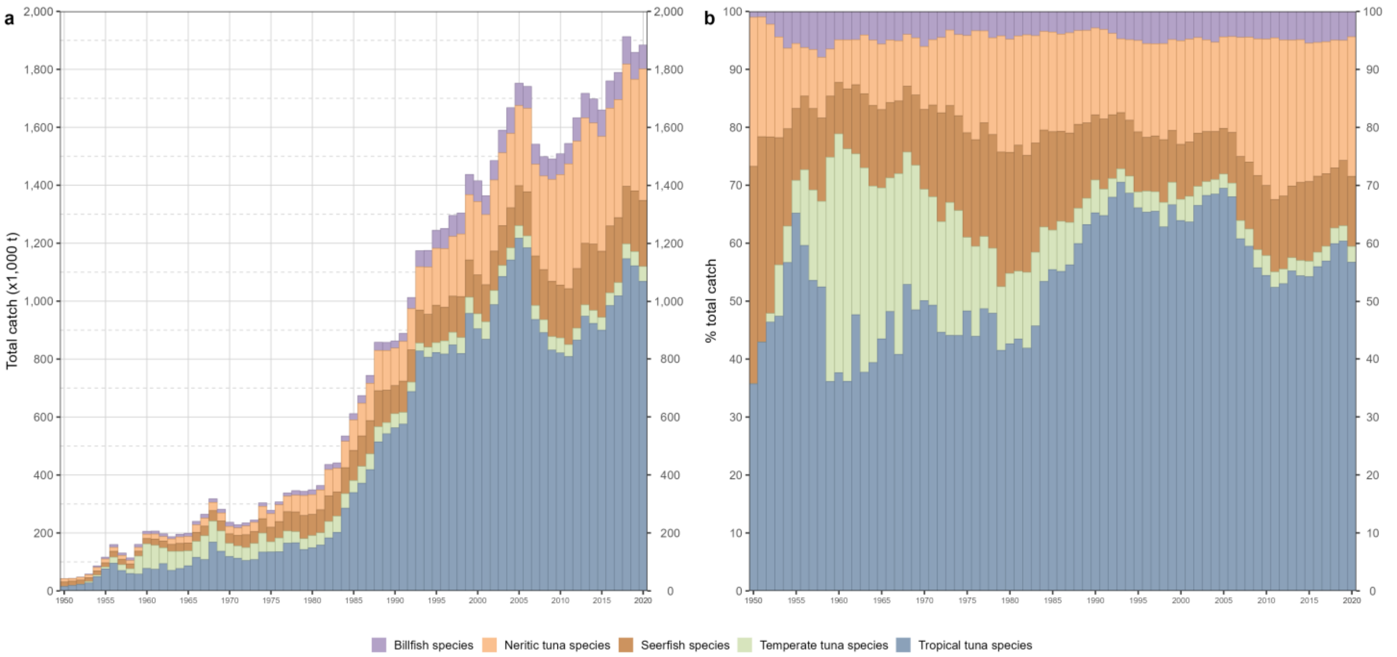

Figure 2: Annual time series of cumulative nominal absolute (a) and relative (b) catches (t) of all IOTC tuna and tuna-like species by species category for the period 1950-2020

Catches of tropical tunas in the Indian Ocean have shown a sharp increase from the early to mid-1980s with the arrival of purse seiners from the Atlantic Ocean and the quick development of the fishery that eventually showed an almost constant increase until the mid-2000s, when total catches reached a maximum of more than 1.22 million t (**Fig. 3**).

While yellowfin tuna dominated the tropical tuna catches prior to the 1970s, their contribution decreased from more than 60% in the mid-1950s to around 40% of the total catch in the early 1980s, a value that has remained fairly stable over the last four decades (**Fig. 3**). The catches of yellowfin tuna increased from around 28,000 t during the 1950s to around 435,000 t in recent years.

The contribution of skipjack tuna to the total tropical tuna catch showed an almost continuous increase over time, from less than 30% in the mid-1950s to more than 50% in recent years (**Fig. 3**). The catches of skipjack tuna increased from around 15,000 t during the 1950s to around 545,000 t in recent years.

Bigeye tuna has mostly always been the species that contributed the least to the tropical tuna catch (**Fig. 3**). Their contribution to the catches showed a steady decline from 30% in the late 1970s to 10% in recent years. The catches of bigeye tuna increased from around 7,000 t in the 1950s to around 89,000 t between 2016 and 2020 (see IOTC-2022-WPTT24(DP)-07 - BET data for additional information).

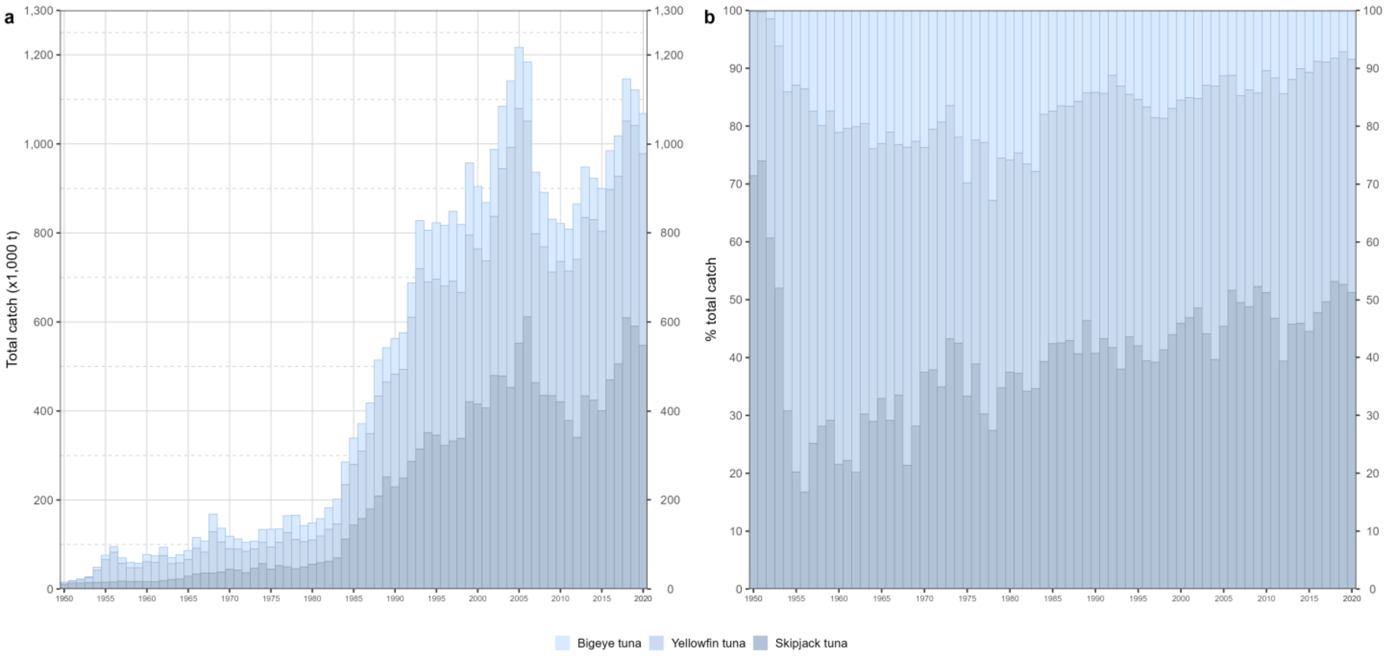

Figure 3: Annual time series of cumulative nominal absolute (a) and relative (b) catches (t) of tropical tuna species by species for the period 1950-2020

The majority of tropical tuna has been caught by industrial fisheries from the mid-1980s and throughout the 1990s and 2000s, i.e., they contributed to about 64% of the total catch over that period (**Fig. 4**). Over the same period, the total catch of tropical tuna taken by Indian Ocean artisanal fisheries steadily increased to reach around 432,000 t in recent years. Following the major decline of the catches by industrial fisheries in the late 2000s, the catch levels of artisanal and industrial fisheries were similar between 2010 and 2015 at about 448,000t, prior to a re-increase of the industrial catch which contributed to about 59% of the tropical tuna catch and amounted to about 636,000 t in recent years (**Fig. 4**).

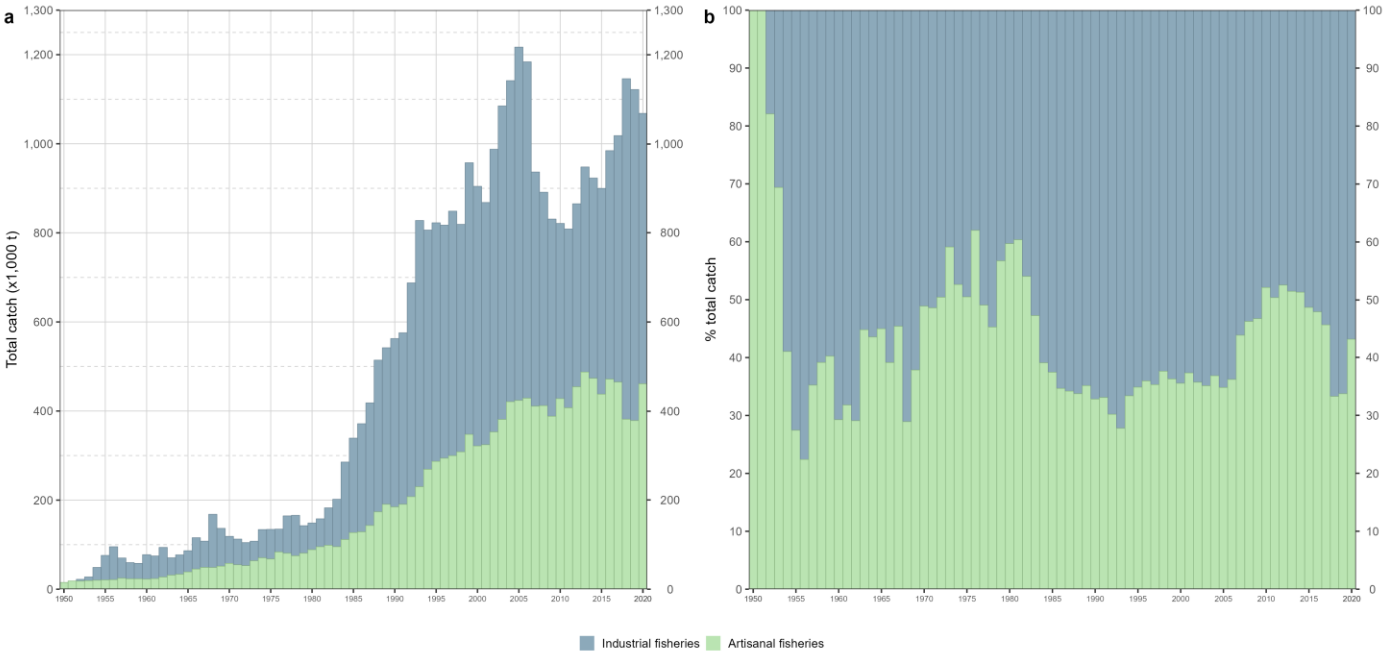

Figure 4: Annual time series of nominal catches (t) of tropical tuna species by fishery type for the period 1950-2020

Tropical tunas are harvested by a large diversity of fisheries and fishing gears. Except for all longline fisheries and purse seine fisheries catching free-swimming schools, all other fisheries have shown an increasing trend in their total catch of tropical tuna over the last decades (**Fig. 5a**). The contribution of the different fisheries to the total tropical tuna catch has showed major changes over time in relation with the development, expansion, or decline of the fisheries between 1950 and 2020 (**Fig. 5b**).

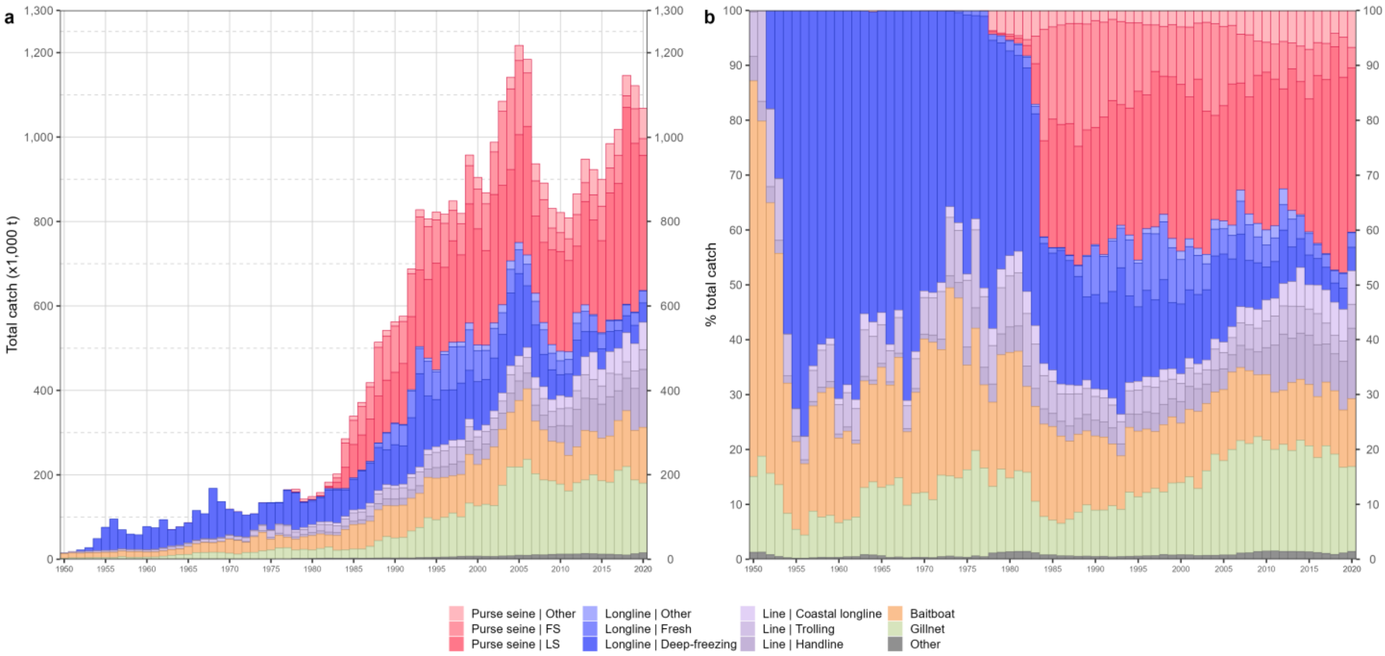

Figure 5: Annual time series of nominal catches (t) of tropical tuna species by fishery for the period 1950-2020

Main fishery features (2016-2020)

Purse seines, gillnets, and pole and lines contribute to the large majority of tropical tuna catch in the Indian Ocean. In recent years, purse seine on tuna schools associated with drifting floating objects has been the dominant fishing gear, representing about one third of the total tropical tuna catch estimated by the IOTC Secretariat for the years between 2016 and 2020 (**Table 5**). Over the same period, gillnets and pole and lines have contributed to 17.2% and 11.4% of the total catch, respectively. Catches from coastal line fisheries are also substantial in the Indian Ocean (18.9% for all combined line fisheries) while longline fisheries now represent a small part of the tropical tuna catch, i.e., 6.8% for all combined longline fisheries.

Table 5: Mean annual catches (t) of Indian Ocean tropical tuna by fishery between 2016 and 2020. LS = schools associated with floating objects; FS = free-swimming schools

Fishery	Fishery code	Catch	Percentage
Purse seine | LS	PSLS	361,989	33.9
Gillnet	GN	183,865	17.2
Baitboat	BB	121,861	11.4
Line | Handline	LIH	95,393	8.9
Line | Coastal longline	LIC	62,474	5.9
Purse seine | Other	PSOT	58,809	5.5
Purse seine | FS	PSFS	55,069	5.2
Line | Trolling	LIT	44,311	4.1
Longline | Deep-freezing	LLD	43,697	4.1
Longline | Fresh	LLF	26,405	2.5
Other	OT	12,275	1.1
Longline | Other	LLO	1,638	0.2

Tropical tunas are currently caught at high levels by several fleets, with EU,Spain ranking first among the IOTC countries during the period 2016-2020 thanks to the high productivity of its large-scale purse seiners (**Fig. 6**). The following major fishing nations are Indonesia, Maldives, and Seychelles, which are described by very different profiles of fishery composition. These four countries together have contributed to 53.7% of the total tropical tuna catch of the Indian Ocean between 2016 and 2020.

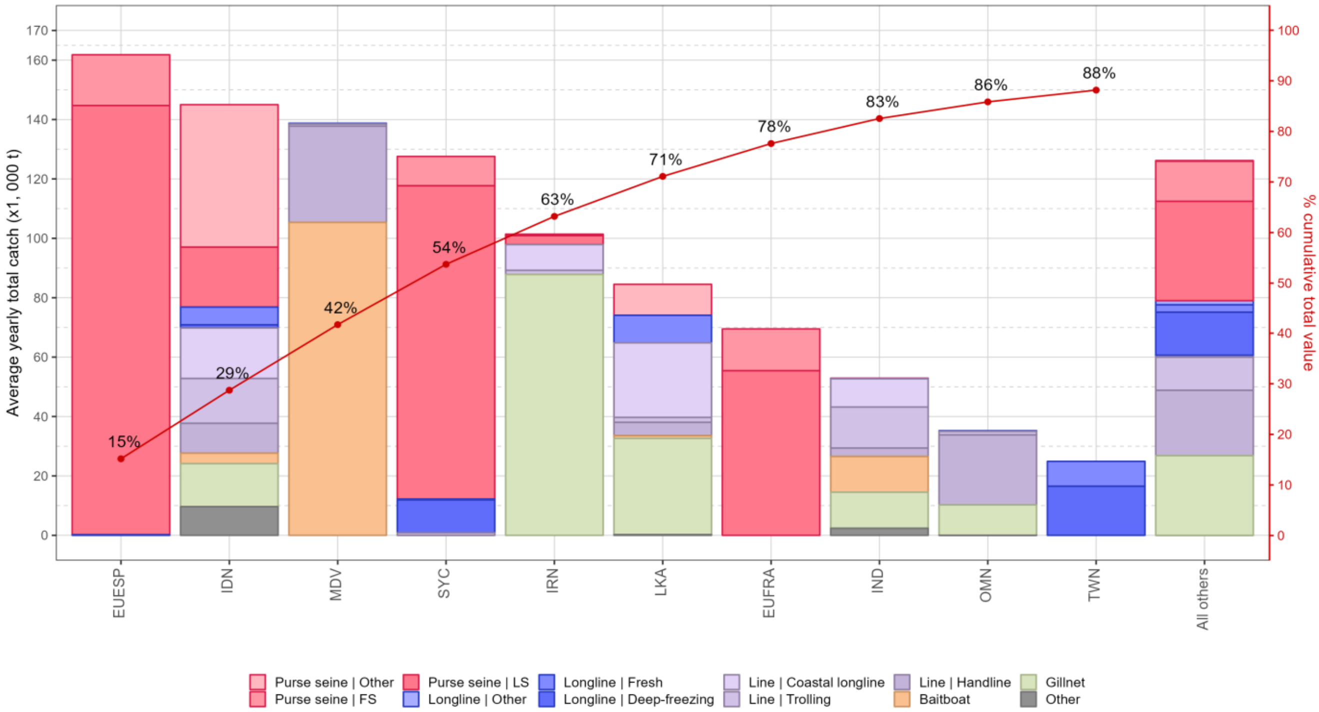

Figure 6: Mean annual catches (t) of Indian Ocean tropical tuna by fleet and fishery between 2016 and 2020, with indication of cumulative catches by fleet. FS = free-swimming schools; LS = schools associated with floating objects

Figures 7 and 8 show the recent temporal trends in nominal catch of tropical tuna by fishery group and fleet between 2016 and 2020. Overall, the catch levels strongly vary across fishery groups while the main fleets display different interannual changes in catch within each fishery group.

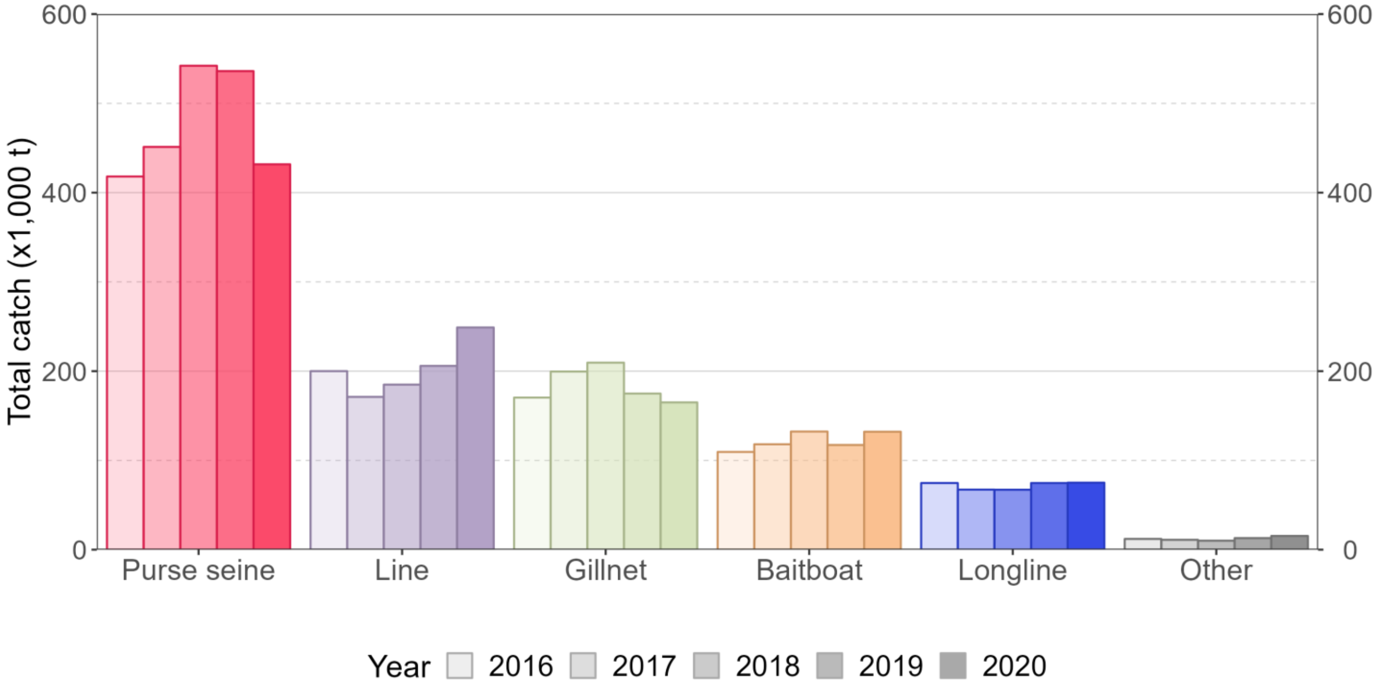

Figure 7: Annual catch (t) trends of Indian Ocean tropical tuna by fishery group between 2016 and 2020

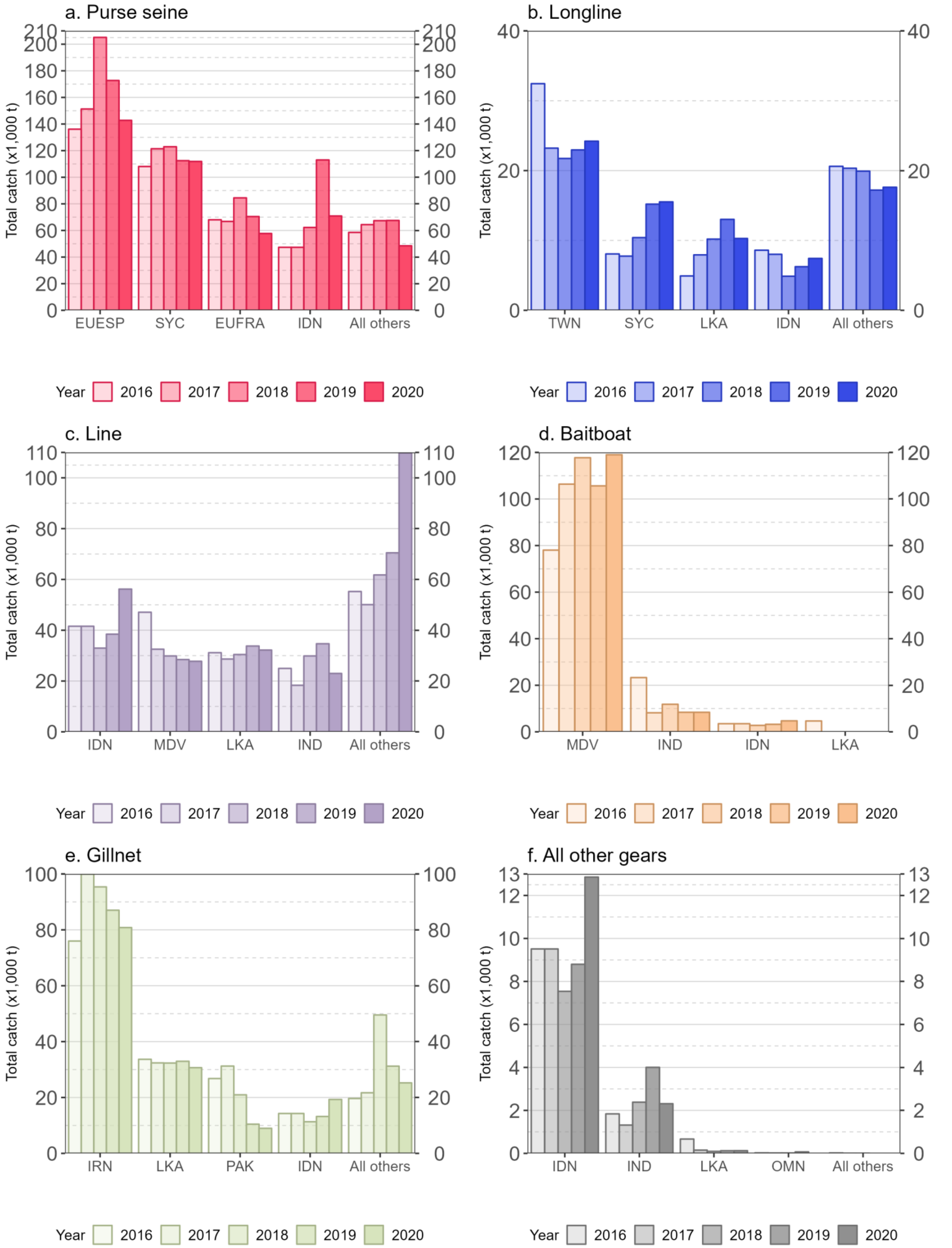

Figure 8: Annual catch (t) trends of Indian Ocean tuna by main fishery group and fleet between 2016 and 2020

Reporting quality of nominal catch data

The quality of the nominal catch data reported for tropical tuna to the IOTC Secretariat shows major variability over the years (**Fig. 9**). As expected, the overall reporting quality for industrial fisheries is better than for artisanal fisheries, mostly because larger vessels are generally monitored with logbooks and landing recording systems. The collection of fisheries data for coastal small-scale and semi-industrial fleets is generally more difficult from a logistical point of view, since it generally requires the implementation of routine stratified catch assessment surveys combined with regular boat frame surveys and data processing systems (Caddy & Bazigos 1985, Stamatopoulos 2002). The reporting quality of the nominal catch data has shown an increasing trend over the last decade although it decreased in 2019-2020, partly due to the COVID-19 pandemic. In 2020, the percentage of tropical tuna catches fully or partially reported to the Secretariat was 81%.

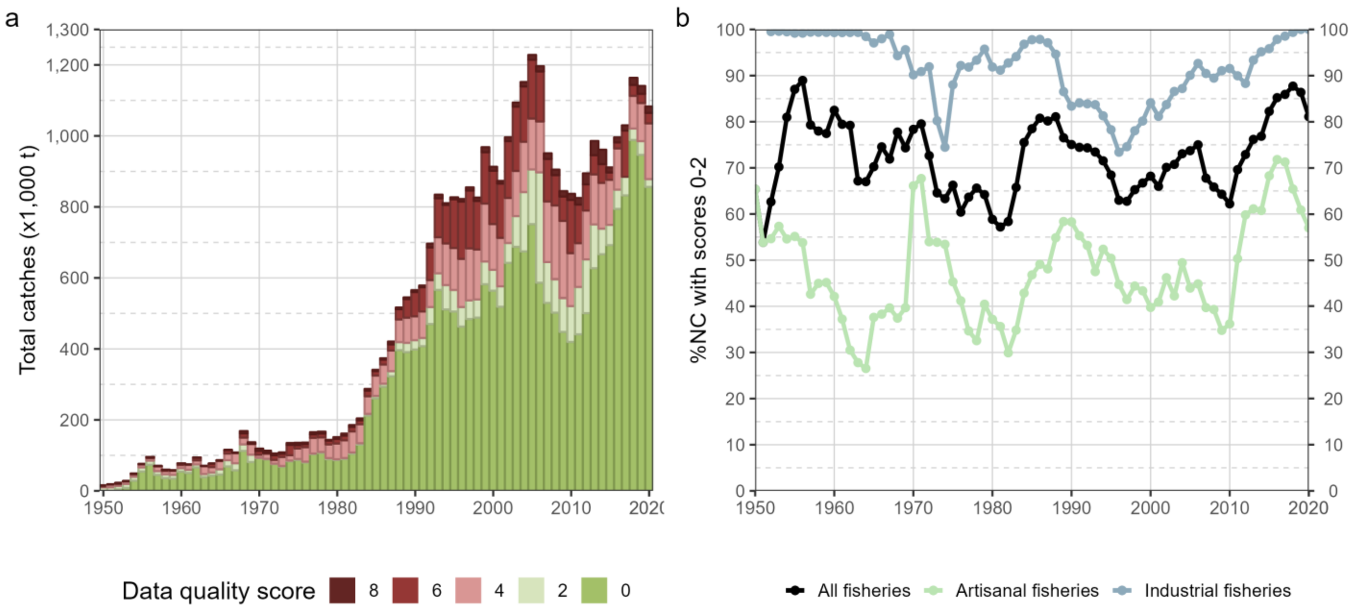

Figure 9: Annual nominal catches (t) of Indian Ocean tropical tuna estimated by quality score (barplot) and percentage of nominal catch fully/partially reported to the IOTC Secretariat (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950-2020

Spatial distribution of effort

Longline fisheries, by decade (1950-2009)

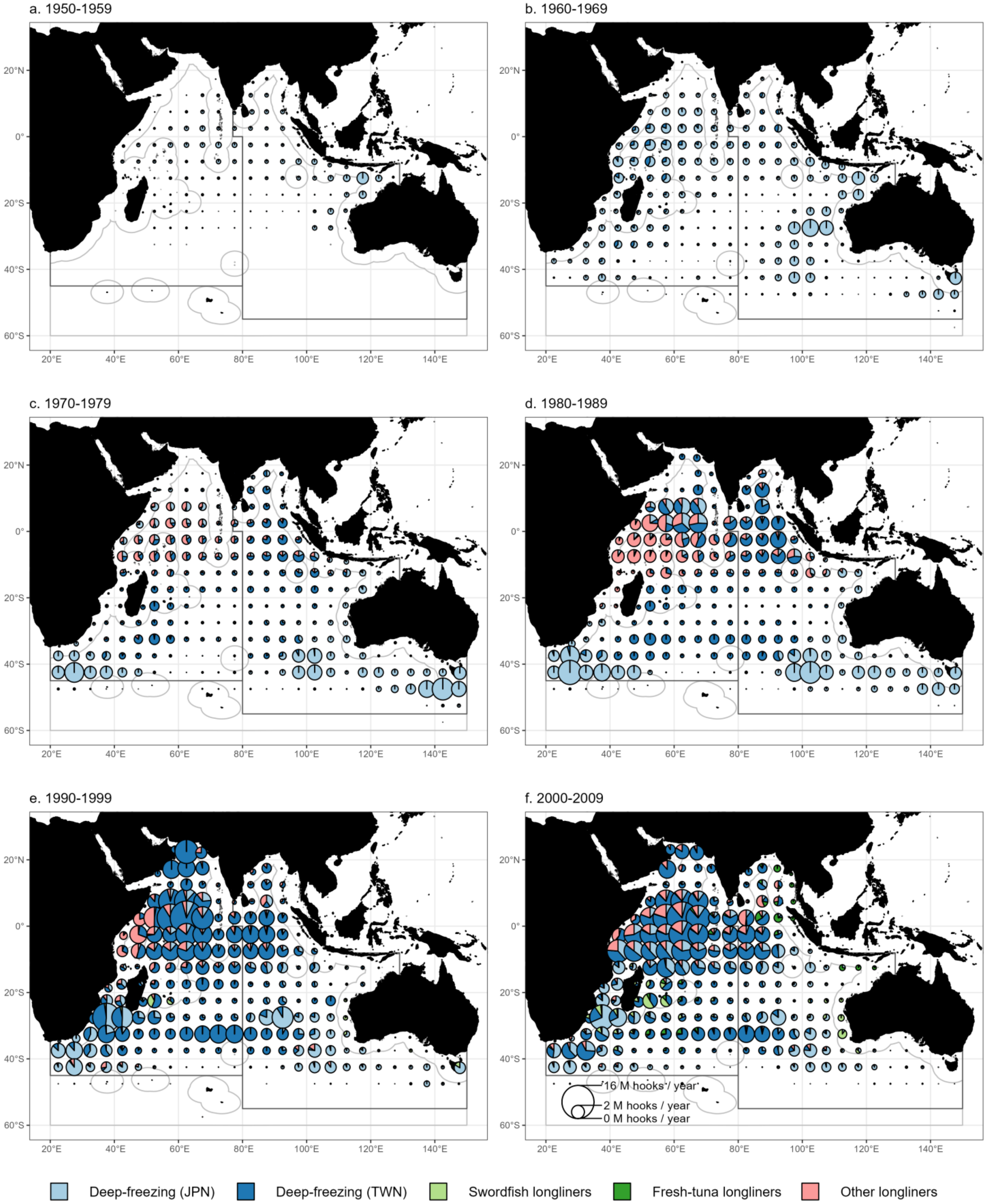

Figure 10: Mean annual effort (millions hooks deployed) exerted by industrial longline fleets by decade, 5x5 grid, and fleet. Data source: time-area effort dataset for longline fisheries (Res. 15/02)

Longline fisheries, by last years (2016-2020) and decade (2010-2019)

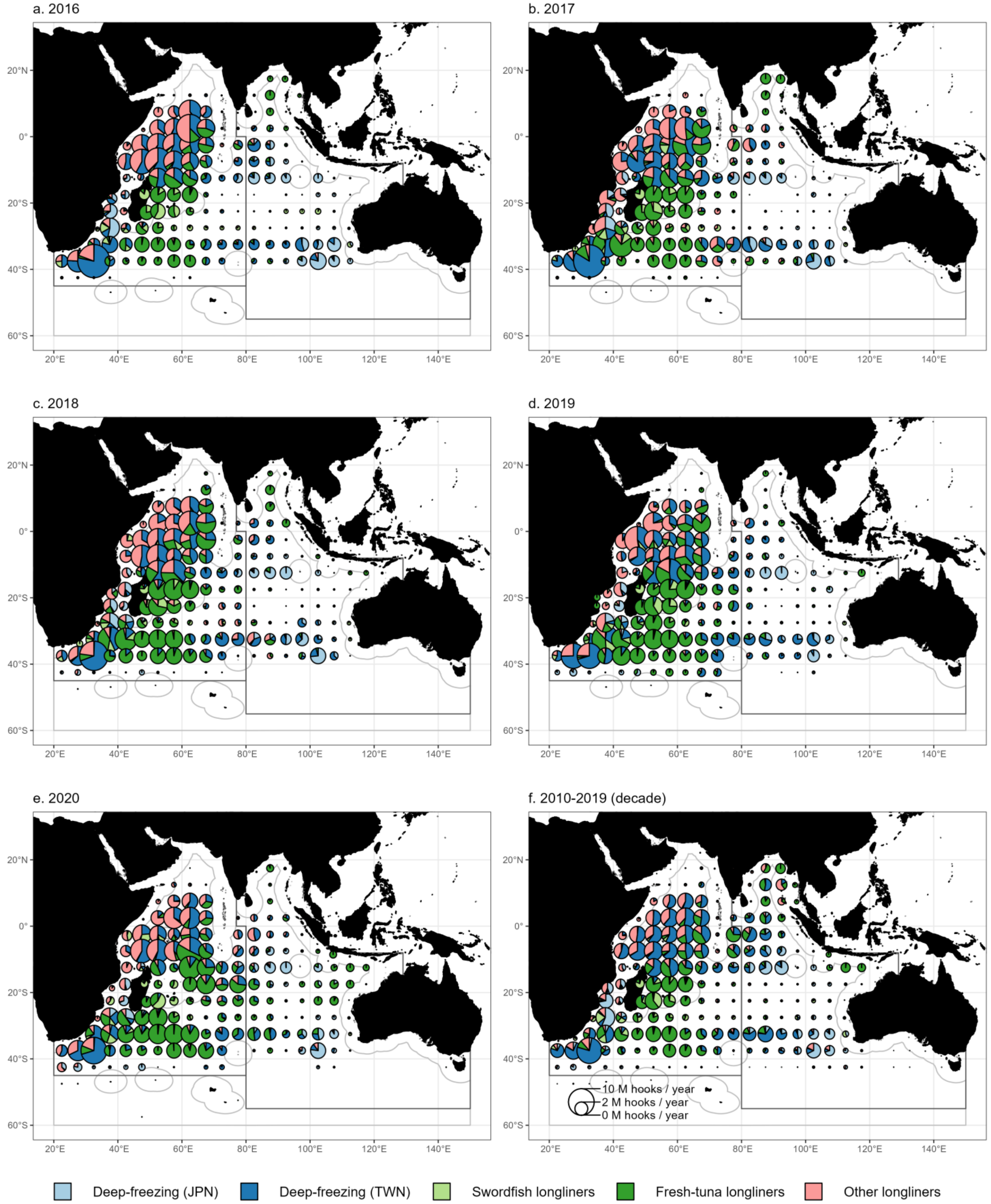

Figure 11: Mean annual effort (millions hooks) exerted by industrial longline fleets by year / last decade, 5x5 grid. and fleet. Data source: [time-area effort dataset for longline fisheries]() (Res. 15/02)

Purse seine fisheries, by decade (1980-2009)

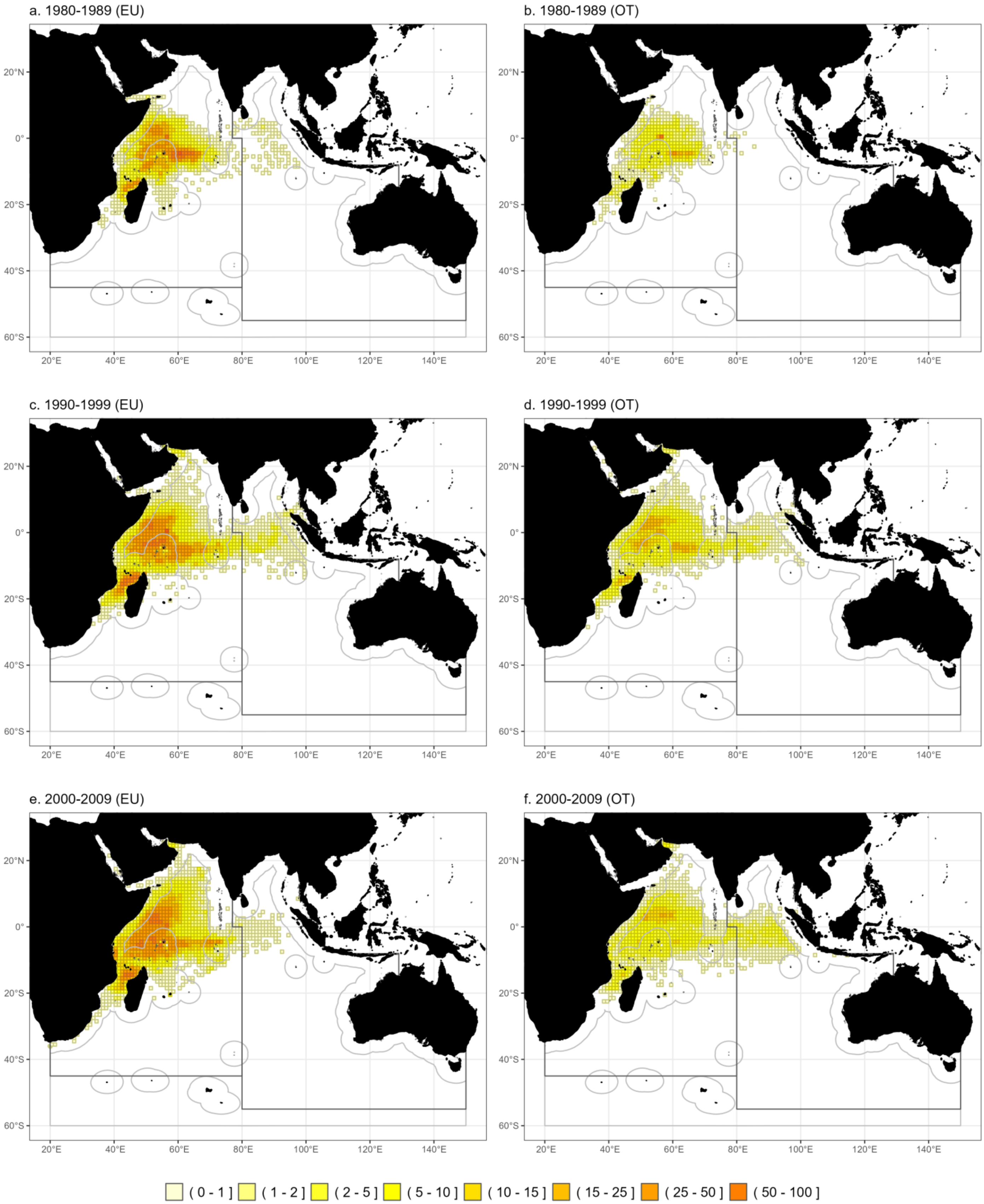

Figure 12: Mean annual effort (fishing days) exerted by the industrial purse seine fleets of the European Union and assimilated flags (EU) vs. all other flags (OT) by decade, 1x1 grid, and fleet. Data source: time-area effort dataset for purse-seine fisheries (Res. 15/02)

Purse seine fisheries (EU) by last years (2016-2020) and decade (2010-2019)

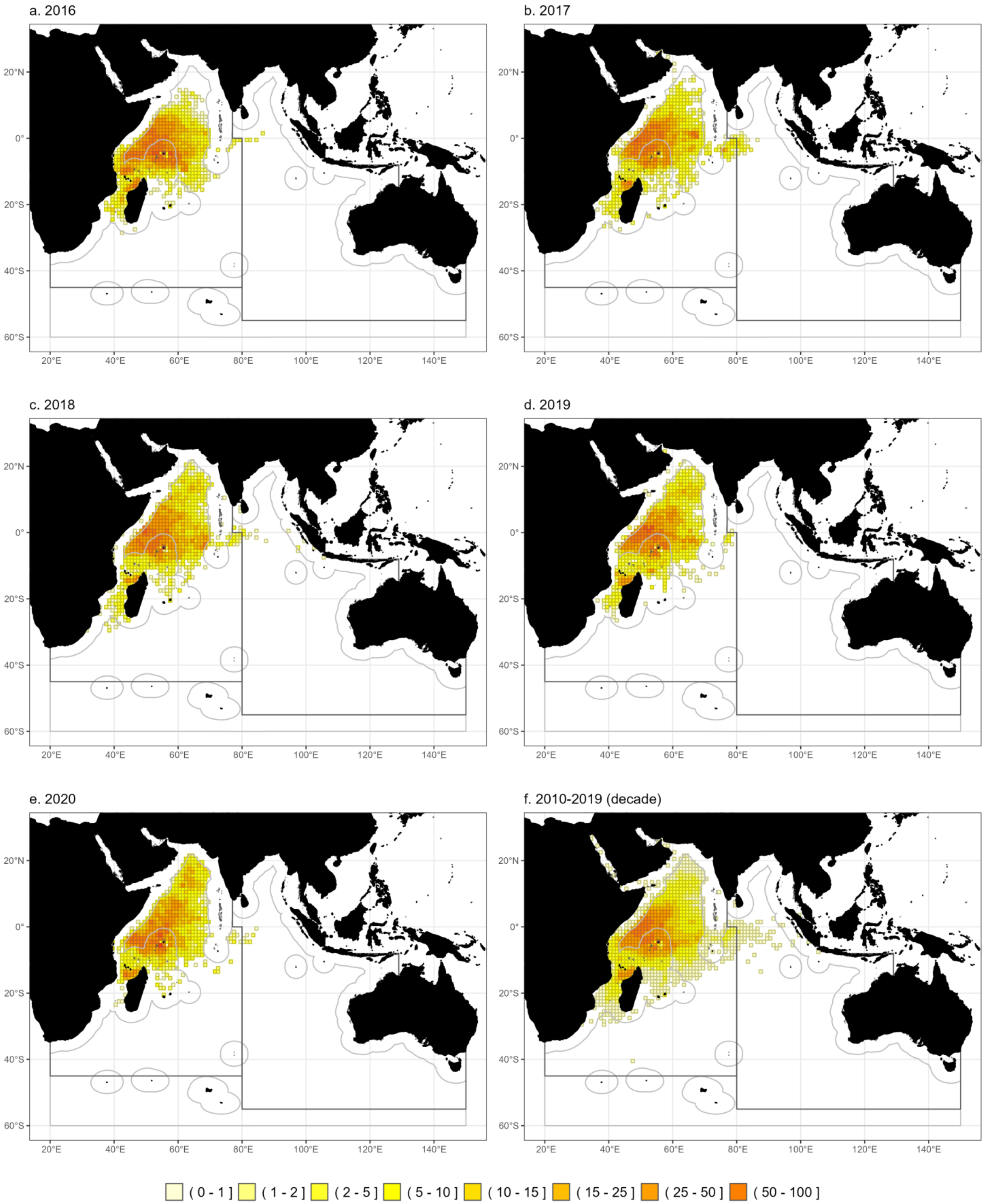

Figure 13: Mean annual effort (fishing days) exerted by the industrial purse seine fleets of the European Union and assimilated flags (EU) by year / decade and 1x1 grid. Data source: [time-area effort dataset for purse-seine fisheries] (Res. 15/02)

Purse seine fisheries (OT) by last years (2016-2020) and decade (2010-2019)

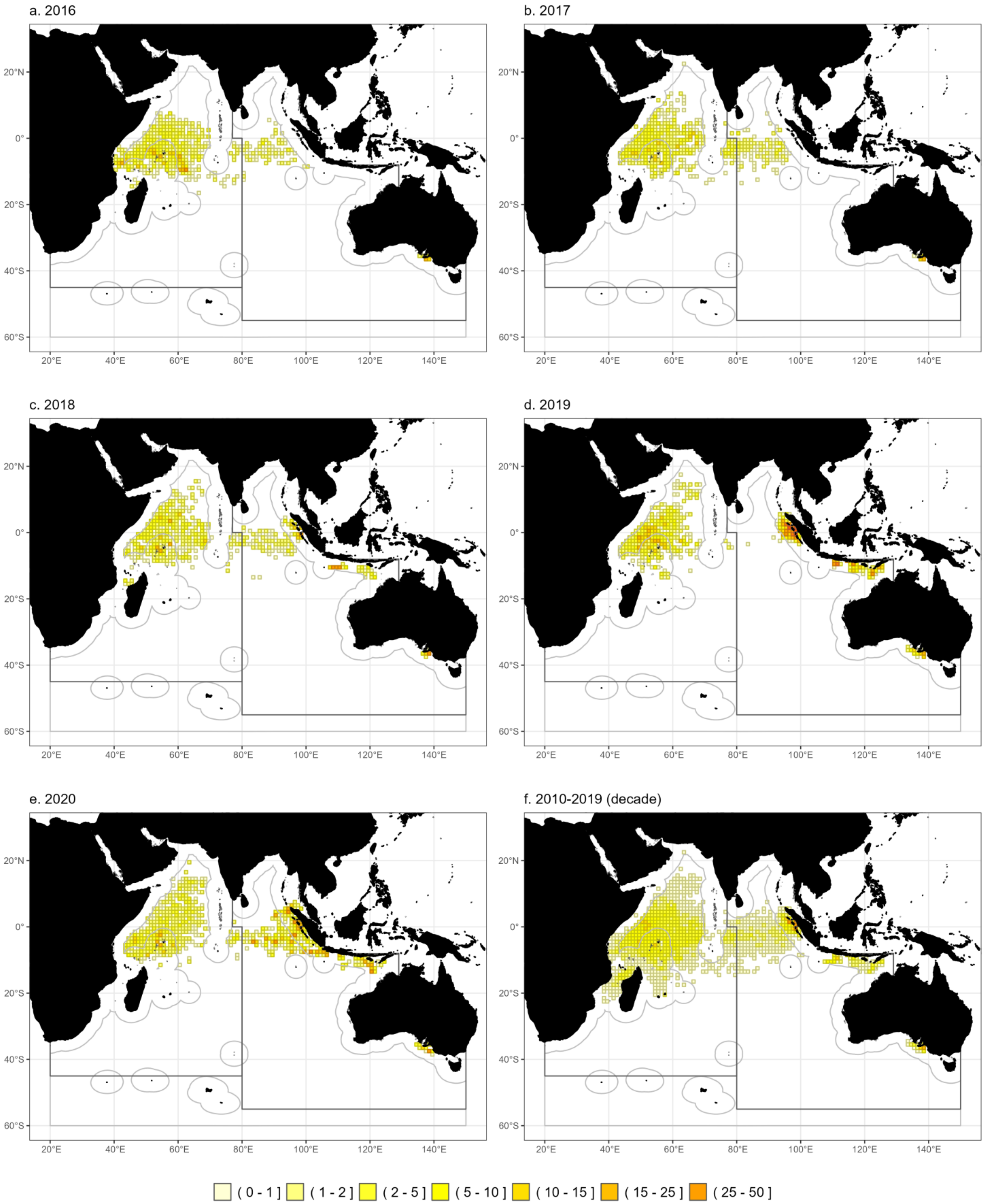

Figure 14: Mean annual effort (fishing days) exerted by the industrial purse seine fleets from other flags (OT) by year / decade and 1x1 grid. Data source: time-area effort dataset for purse-seine fisheries (Res. 15/02)

Spatial distribution of catch

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

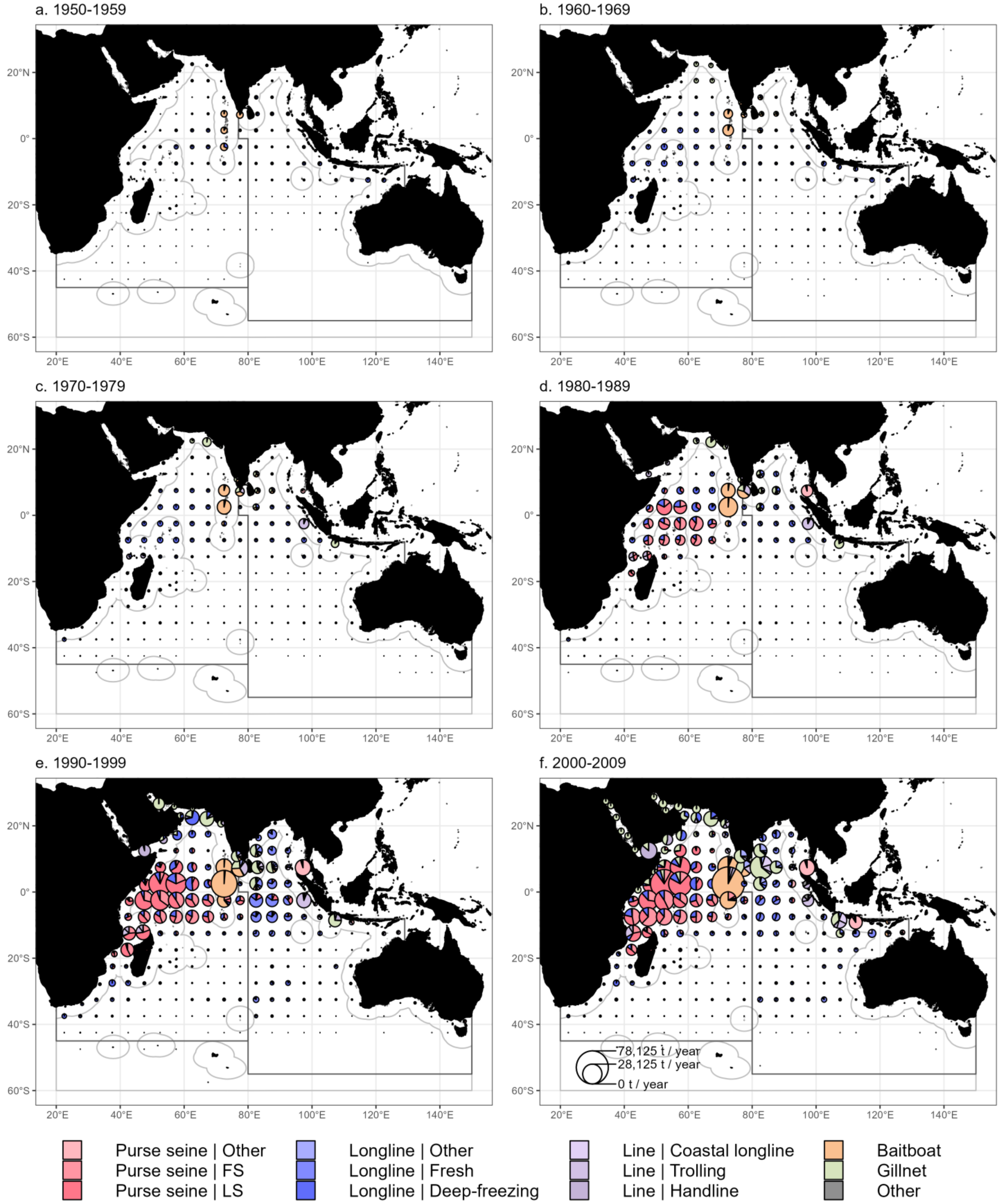

Figure 15: Estimated mean annual time-area catches (t) of Indian Ocean tropical tuna by decade, 5x5 grid, and fishery. Data source: tropical tuna raised time-area catches

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

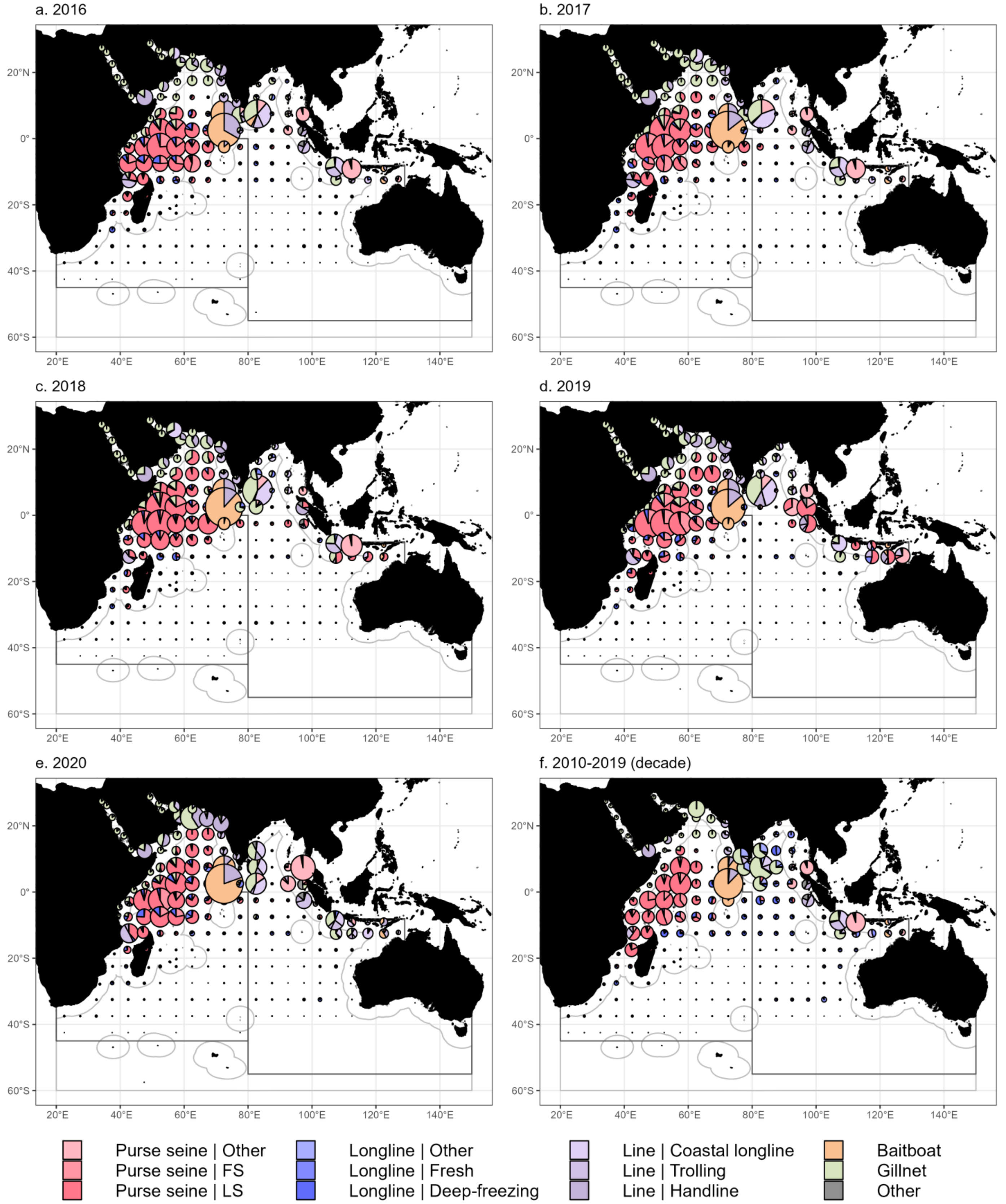

Figure 16: Estimated mean annual time-area catches (t) of Indian Ocean tropical tuna by year / decade, 5x5 grid, and fishery. Data source: Tropical tuna raised time-area catches

Reporting quality of catch and effort data

The quality of the geo-referenced catch and effort data reported for tropical tuna to the IOTC Secretariat shows major variability over the years (**Fig. 17**). Similarly to the nominal catch data, industrial fisheries show better reporting quality than artisanal fisheries, mostly due to the availability of logbook systems for the former as required by IOTC Resolution 15/01. Since the 1960s, geo-referenced catch and effort data considered to be of good quality (i.e., scores 0-2; **Table 4**) have represented a mean annual average of about 65% of the total nominal catch of tropical tuna. In 2020, the percentage of nominal catches for which good geo-referenced catch and effort data were available at the Secretariat was 80%.

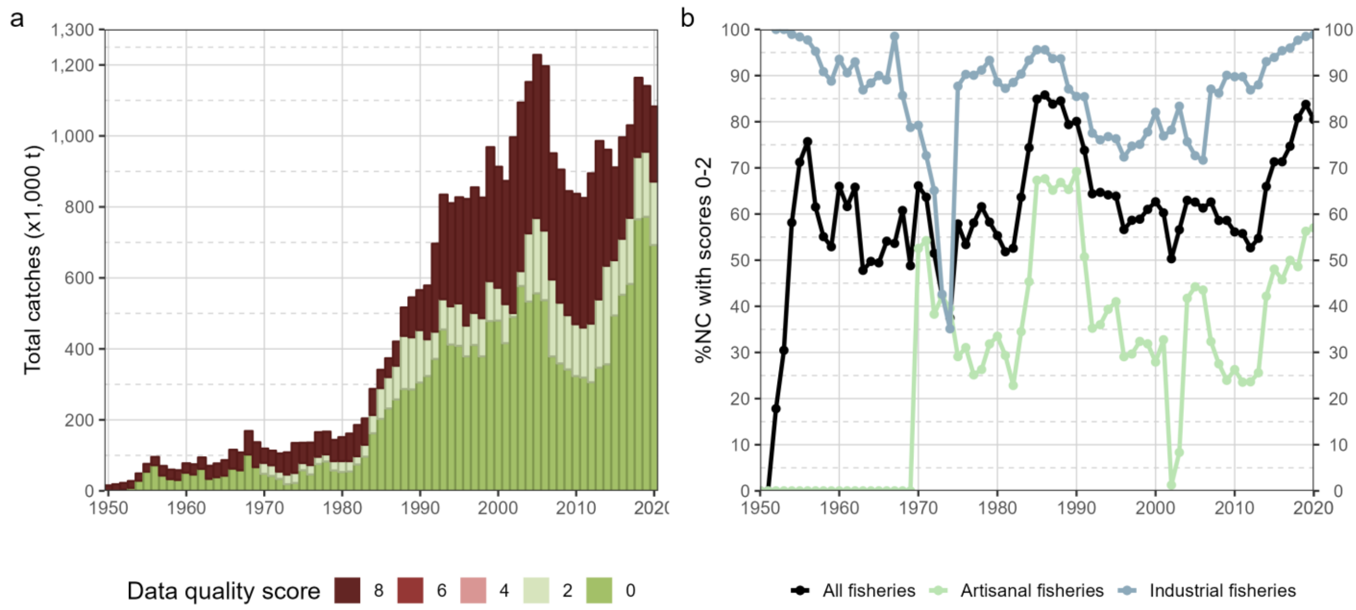

Figure 17: Annual nominal catches (t) of Indian Ocean tropical tuna estimated by quality score (barplot) and percentage of geo-referenced catches reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950-2020

Reporting quality of size-frequency data

The quality of the geo-referenced size frequency data reported for tropical tuna to the IOTC Secretariat is low but has shown an improvement over the last decade (**Fig. 18**). Almost no size data are available prior to the 1980s. Over the last four decades, size data have not been available for more than half of the nominal catch estimated by the Secretariat. In 2020, the percentage of nominal catch data for which good size data were available at the Secretariat was 50%.

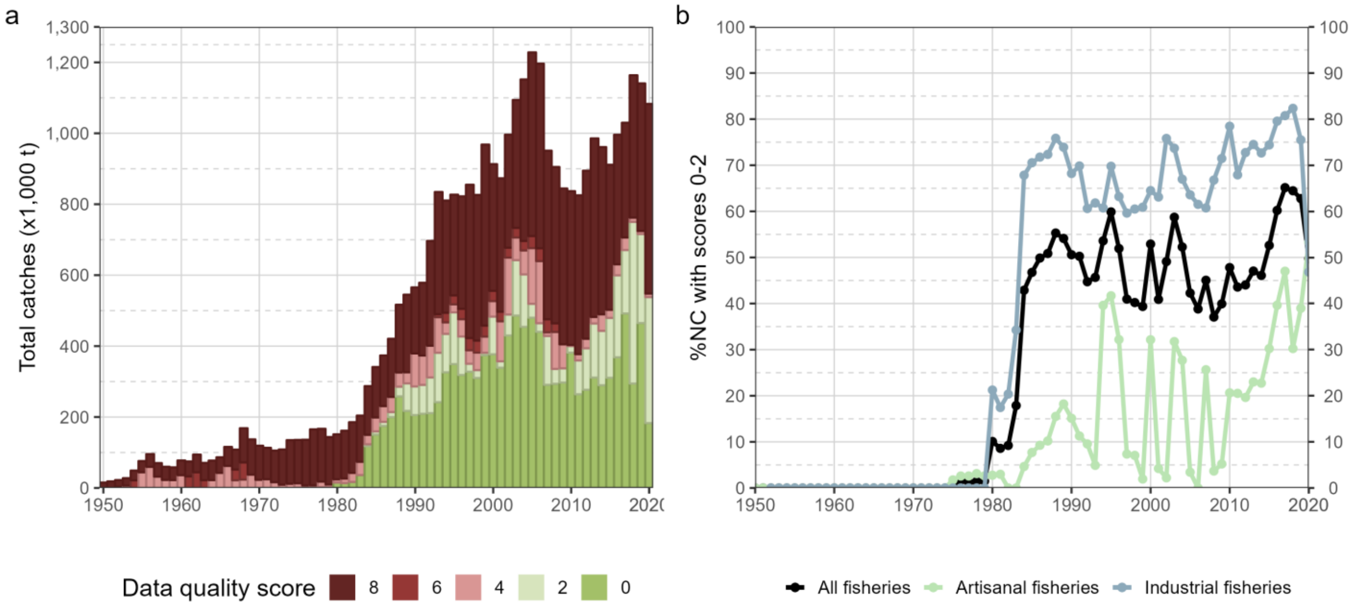

Figure 18: Annual nominal catches (t) of Indian Ocean tropical tuna estimated by quality score (barplot) and percentage of geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2020

Appendix I: Monthly time series of tropical tuna prices and fuel, 2000-2020

Frozen purse seine, import prices in Thailand (canning grade)

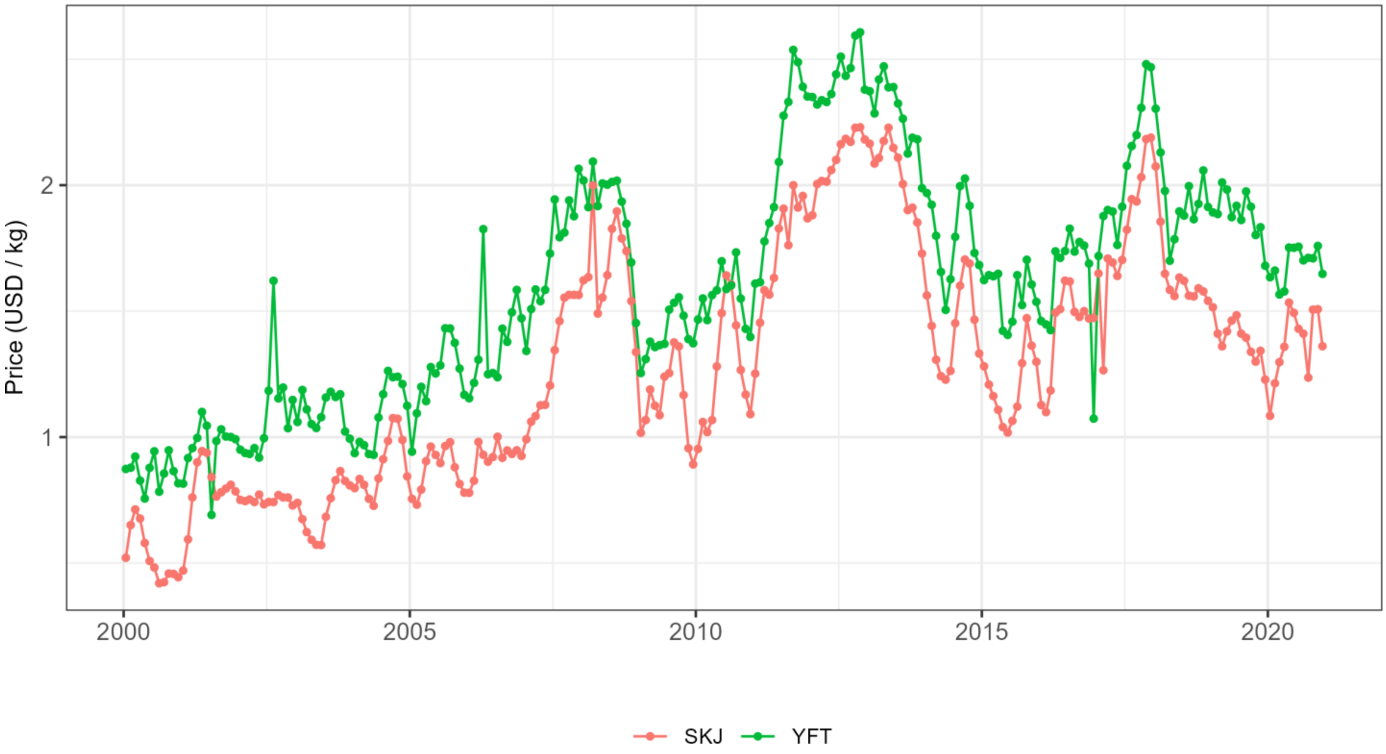

Figure 19: Monthly time series of import prices (USD/kg) in Thailand for canning-grade frozen skipjack and yellowfin tunas during the period 2000-2020. Data sourced from Thailand customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Frozen longline, import prices in Japan (sashimi grade)

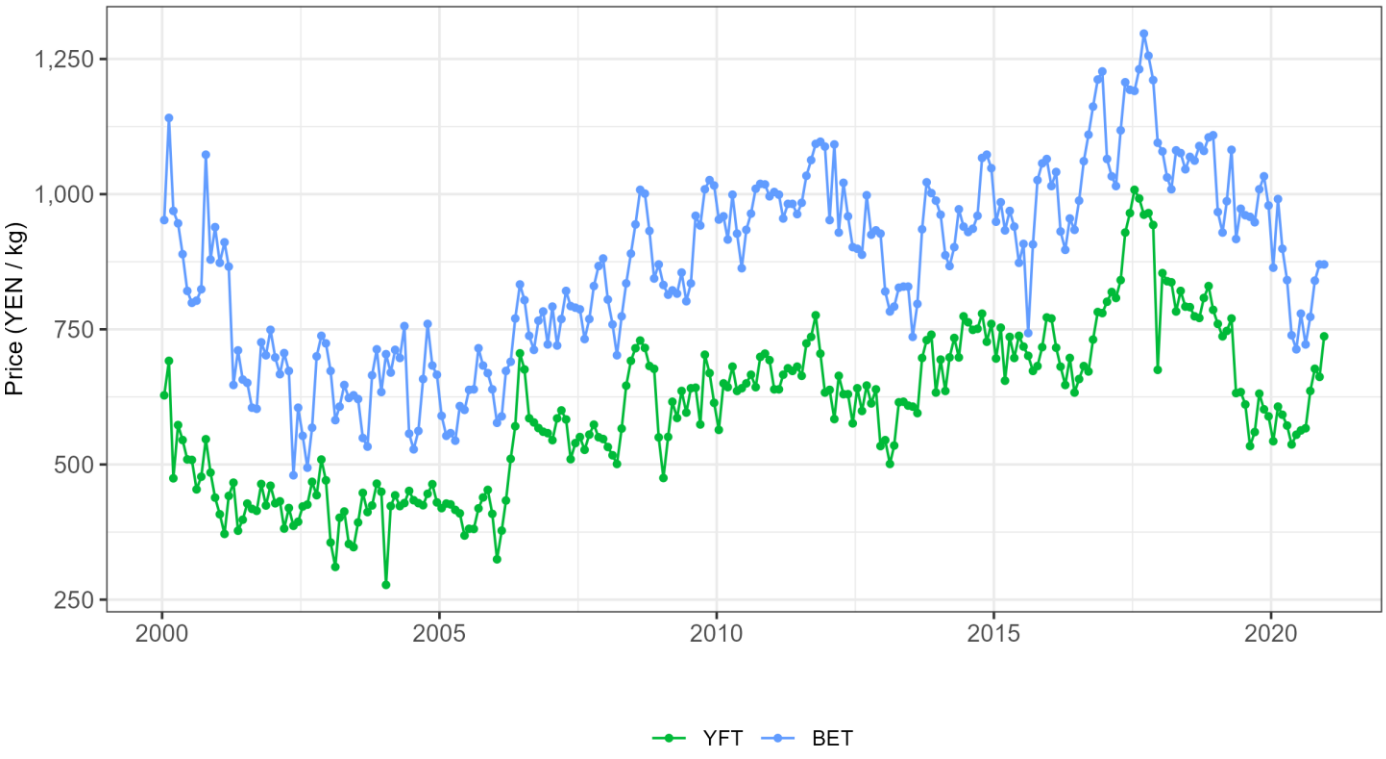

Figure 20: Monthly time series of import prices (YEN/kg) in Japan for sashimi-grade frozen during the period 2000-2020. Data sourced from Japanese customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Fresh longline, import prices in Japan (sashimi grade)

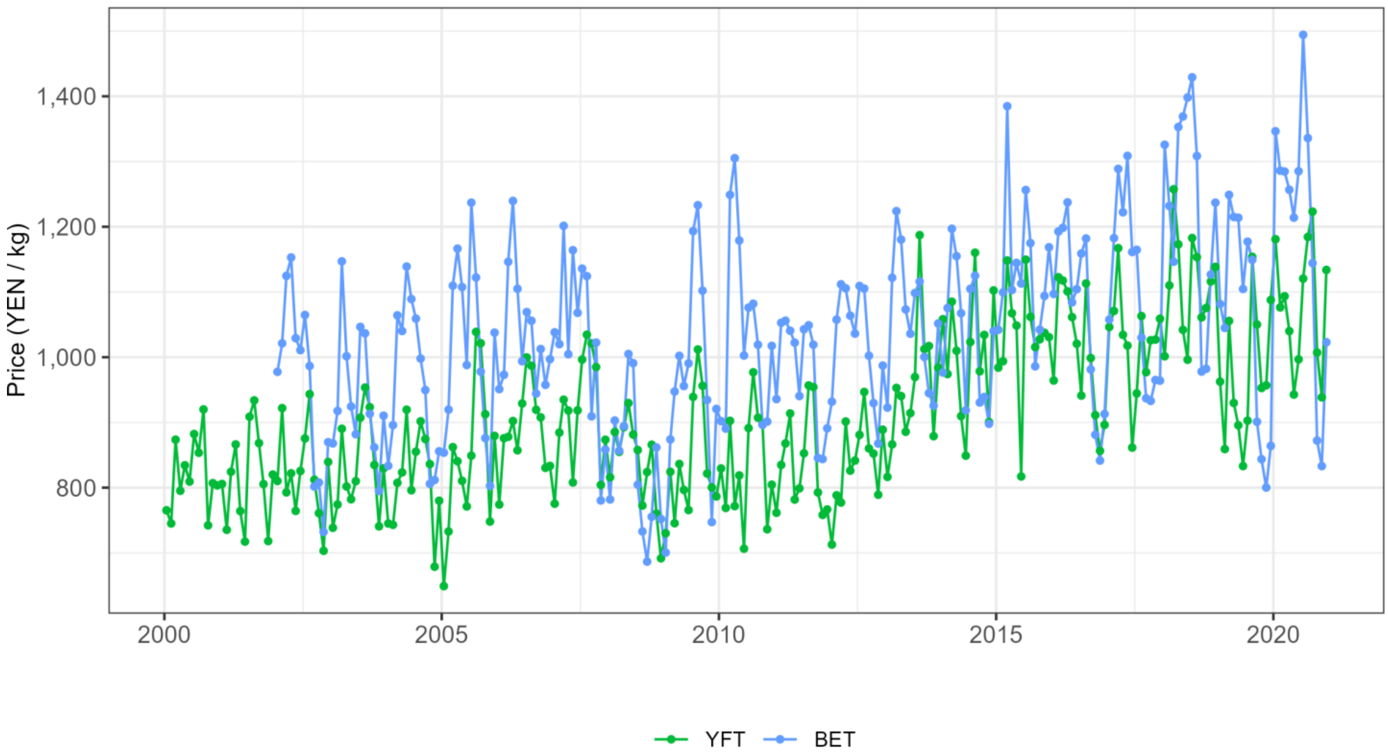

Figure 21: Monthly time series of import prices (USD/kg) in Thailand for canning-grade frozen during the period 2000-2020. Data sourced from Japanese customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Fresh longline, import prices in the USA (sashimi grade)

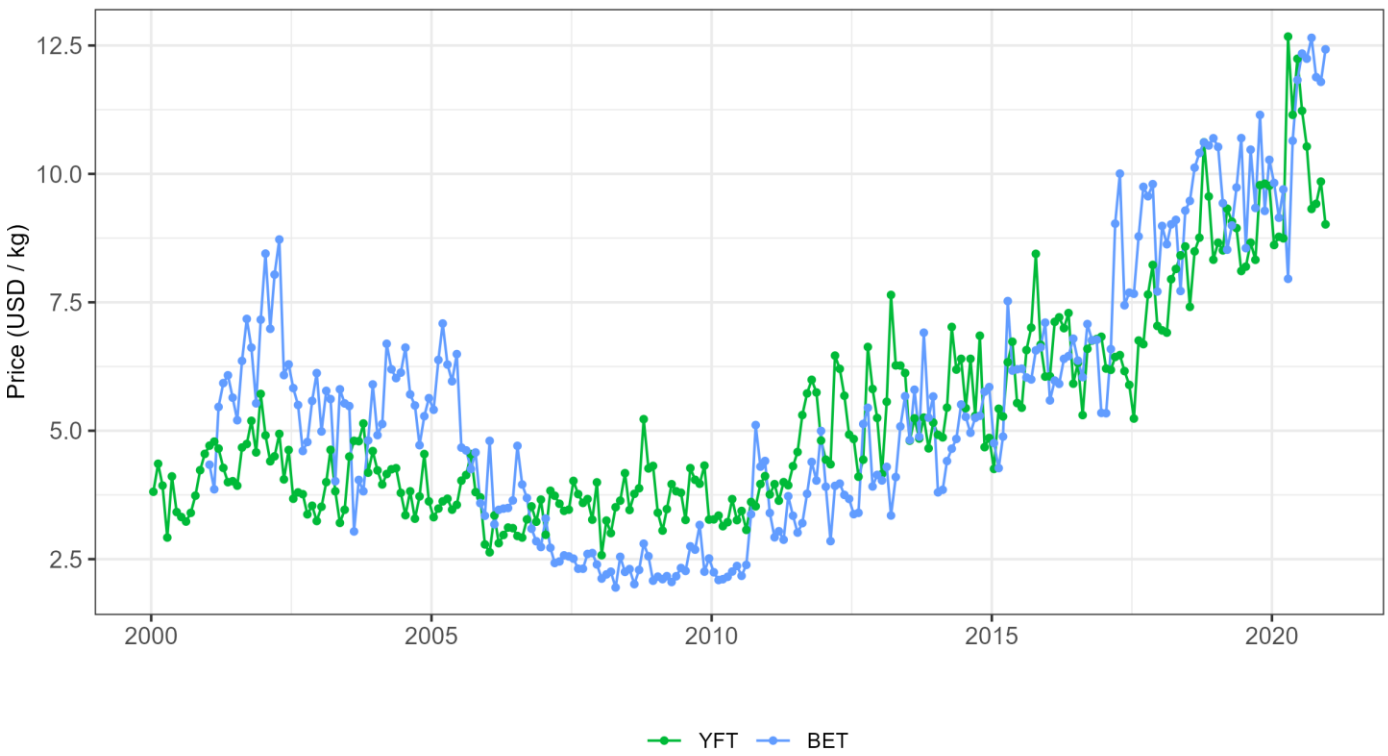

Figure 22: Monthly time series of import prices (USD/kg) in Thailand for canning-grade frozen during the period 2000-2020. Data sourced from USA customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Fuel price

Figure 23: Monthly time series of crude oil spot price (USD/barrel) during the period 2000-2020. Data sourced from the spot prices of Brent, Dubai, and West Texas, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020))

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