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*; BET), skipjack tuna (*Katsuwonus pelamis*; SKJ), and yellowfin tuna (*Thunnus albacares*; YFT), have steadily increased over the last decades to exceed 5 million metric tonnes (t) in 2019 and more than 4.7 million t during 2020-2021 (FAO 2021). The contribution of the Indian Ocean to the global catch of tropical tuna also increased steadily following the development of the large-scale purse seine fishery from the early 1980s, reaching a maximum of about 28% of the worldwide total in the mid-2000s. Levels remained stable at about 20% of total catches in recent years, recording approximately 1.2 million t in 2021 (**Fig. 1**).

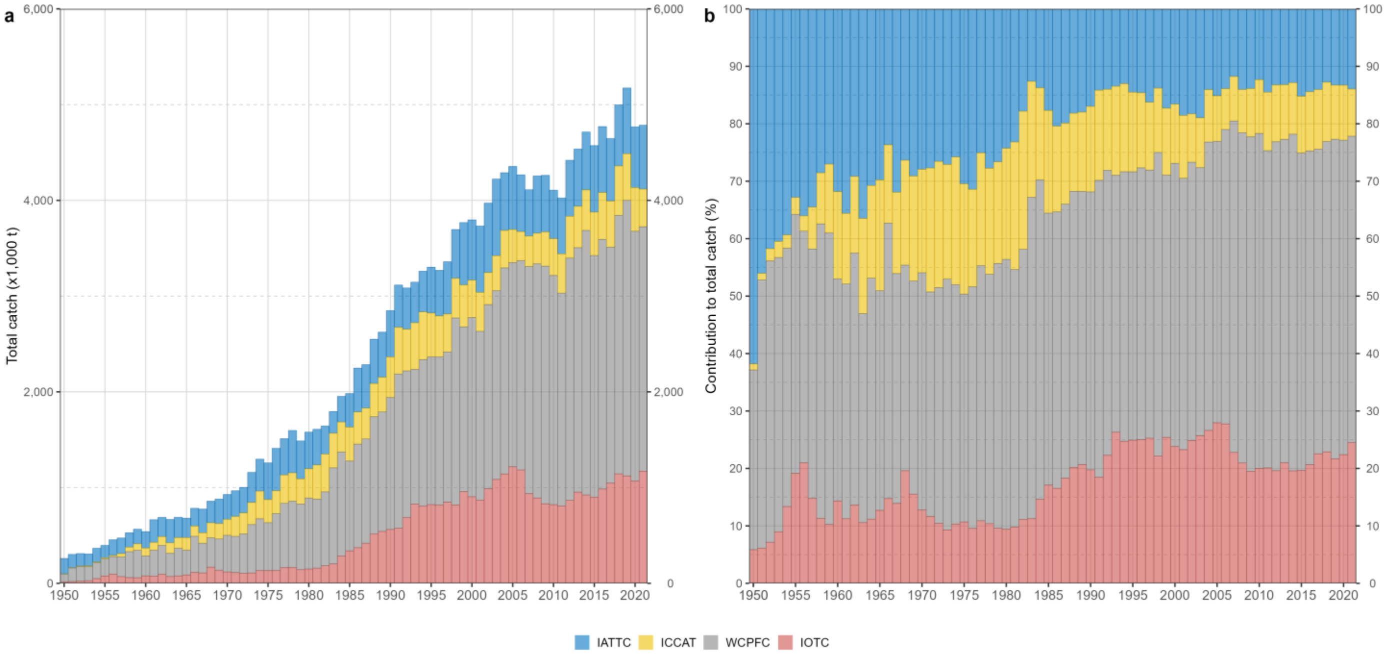

Figure 1: Annual time series of cumulative retained catches (metric tonnes; t) of tropical tuna by tuna Regional Fisheries Management Organisation for the period 1950-2021. IATTC = Inter-American Tropical Tuna Commission; ICCAT = International Commission for the conservation of Atlantic Tunas; IOTC = Indian Ocean Tuna Commission; WCPFC = Western and Central Pacific Fisheries Commission. Source: Global Tuna Atlas

The overarching objective of this summary is to provide participants at the data preparatory meeting for the 25th Session of the IOTC Working Party on Tropical Tunas (WPTT25(DP)) with a review of the status of the information available on Indian Ocean tropical tunas and their associated fisheries. The document provides an overview of the data sets available in the IOTC Secretariat databases as of May 2023, 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 to report data to the Secretariat is recommended as they facilitate data curation and management.

IOTC data requirements vary according to the size of the fishing vessels and their area of operation. Following IOTC Resolution 19/04, the IOTC maintains a record of vessels authorised to fish for tuna and tuna-like species in the IOTC area of competence (Authorized Fishing Vessels; AFVs) which includes all fishing vessels with a length overall of 24 m and over, and those under 24 m if they operate in waters outside the Exclusive Economic Zone (EEZ) of the flag state. For convenience purpose, we define the type of fishery as *industrial* when the fisheries are composed of AFVs while *coastal* fisheries, on the opposite, refer to any fishery composed of vessels of length below 24 m exclusively operating in areas under national jurisdiction of their flag state. This in line with IOTC Resolution 15/02 whereby coastal (or artisanal) fisheries are defined as all fisheries other than longline and surface fisheries undertaken by AFVs.

Retained catch data

Retained catches correspond to the total retained catches by species (in live weight) per year, Indian Ocean major area, fleet, and fishing gear (IOTC Res. 15/02) and shall be reported through IOTC form 1RC. In addition, and in order to support the monitoring of catch limits for the industrial fisheries of CPCs objecting to IOTC Resolution 21/01, IOTC Res. 19/01 requests these CPCs to submit from 2019 their catches of yellowfin tuna explicitly disaggregated by vessel length and area of operation (IOTC Form 1RC-YFT).

Changes in the IOTC consolidated data sets of retained 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 by 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. 22/04) 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. Time series of price cover the period from January 2000 to December 2021 and include (i) Thai import prices for whole round frozen skipjack and yellowfin tunas (USD/t; cost and freight), (ii) Japanese import prices for fresh and frozen bigeye and yellowfin tunas caught with longline (YEN/kg; cost, insurance and freight) and (iii) US import prices for fresh (chilled) bigeye and yellowfin tunas from Oceania caught with longline (USD/kg; free on board). 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.

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 price collated by FFA is based on the arithmetic average of the Brent, Dubai, and West Texas crude oil prices and provides a global index of the value of fuel for fishing vessels. Time series of import price for tropical tunas and fuel price are given in Appendix I.

Regional Observer Scheme

Resolution 22/04 *"On a Regional Observer Scheme"* 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 comprehensive description of the status, coverage, and data collected as part of the ROS is provided in IOTC (2022). 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 stores observer data reported by several fleets during different time periods, covering a total of 29,745 sets from 1,700 trips recorded between 2005 and 2021 from 7 fleets: EU,France, Japan, Sri Lanka for longline fisheries and EU,Spain, EU,France, Republic of Korea, Mauritius, Seychelles for purse seine fisheries. In addition, observer trip reports have been submitted to the Secretariat by some CPCs (e.g., Taiwan,China) but data were not provided according to the ROS standards, de facto preventing their inclusion 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**). The relationships are assumed to be dependent on fishing gear . For bigeye and yellowfin tuna, an average conversion factor of 1.13 borrowed from ICCAT is used to convert gilled-and-gutted weights into round weights without any information on the source of the data used to compute it.

Table 1: Summary of IOTC reference length-weight power relationships available for Indian Ocean tropical tunas. FL = fork length (cm); RD = round weight (kg); GG = gilled-and-gutted weight (kg). GN = gillnet; BB = baitboat; PS = purse seine; LL = longline; OT = Other gears; ALL = all gears

Code	Species	Equation	a	b	MinFL	MaxFL	Gears	Reference
BET	Bigeye tuna	RD = a*FL^b	2.2170e-05	3.012110	29.5	174	GN,BB,PS	Chassot et al. 2016
BET	Bigeye tuna	GG = a*FL^b	1.5921e-05	3.041541	70.0	187	LL,OT	Geehan and Pierre 2013
YFT	Yellowfin tuna	RD = a*FL^b	2.5490e-05	2.966700	29.0	166	GN,BB,PS	Chassot et al. 2016
YFT	Yellowfin tuna	GG = a*FL^b	9.4007e-06	3.126844	72.0	177	LL,OT	Geehan and Pierre 2013
SKJ	Skipjack tuna	RD = a*FL^b	4.9700e-06	3.392920	30.0	73	ALL	Chassot et al. 2016

Methods

The release in the public-domain of the IOTC curated data sets for tropical tunas, as per the confidentiality rules set in IOTC Res. 12/02, 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 data set and may require the submission of revised data from CPCs if the original one are found to be incomplete.

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

a. When retained 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* of multiple species or gears. In short, the process derives the proportion of catches for each IOTC species and / or gears using a combination of data from strata where these are reported separately and reverting on proxy gears and fleets and on a spatial-temporal substitution scheme when required.

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*		✓	✓
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	LL	LLCO	PS	PSS	RR	SPOR	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 retained catches using all available information, including expert knowledge, 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 catches 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. Raised data comprise estimated catches both in weight and number and stratified by year, month, fleet, gear, school type (when available) and 5°x5° grid, covering the entire time series for which retained catches are available. The average weight of each species can be computed directly from the raised weights and numbers for each stratum, with the accuracy of the results being directly proportional to the availability and quality of the original geo-referenced catch and size-frequency data.

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 measurements are provided with size bins exceeding the maximum width considered meaningful for the species (IOTC 2020a).

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 2020a). 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 2020b).

Data quality

A scoring system has been implemented to assess the quality of the retained 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 retained catches such as under-reporting and misreporting.

Table 4: Key to IOTC quality scoring system

<table>
<tr><th>Data set</th><th>Criterion</th><th>By species</th><th>By gear</th></tr>
<tr><td rowspan="3">Nominal catch</td><td>Fully available</td><td>0</td><td>0</td></tr>
<tr><td>Partially available</td><td>2</td><td>2</td></tr>
<tr><td>Fully estimated</td><td>4</td><td>4</td></tr>
<tr><td rowspan="4">Catch and effort</td><td>Available according to standards</td><td>0</td><td>0</td></tr>
<tr><td>Not available according to standards</td><td>2</td><td>2</td></tr>
<tr><td>Low coverage (<30% logbooks)</td><td colspan="2">2</td></tr>
<tr><td>Not available</td><td colspan="2">8</td></tr>
<tr><td rowspan="4">Size frequency</td><td>Available according to standards</td><td>0</td><td>0</td></tr>
<tr><td>Not available according to standards</td><td>2</td><td>2</td></tr>
<tr><td>Low coverage (<1 fish per tonne caught)</td><td colspan="2">2</td></tr>
<tr><td>Not available</td><td colspan="2">8</td></tr>
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Results

Retained catches

Historical trends (1950-2021)

Total retained 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 over 1.9 million t in 2021. Tropical tunas have always dominated the total IOTC catch between 1950 and 2021, although their relative contribution has varied over time in relation to different factors such as the expansion of fisheries targeting other species, the development of the purse seine fishery starting from the 1980s, and the threats of piracy in the late 2000s to mid-2010s.

In 2021, the total catches of tropical tuna in the Indian Ocean have been estimated at 1.17 million t (**Fig. 2.a**), corresponding to 61.4% of catches of all IOTC species combined (**Fig. 2.b**).

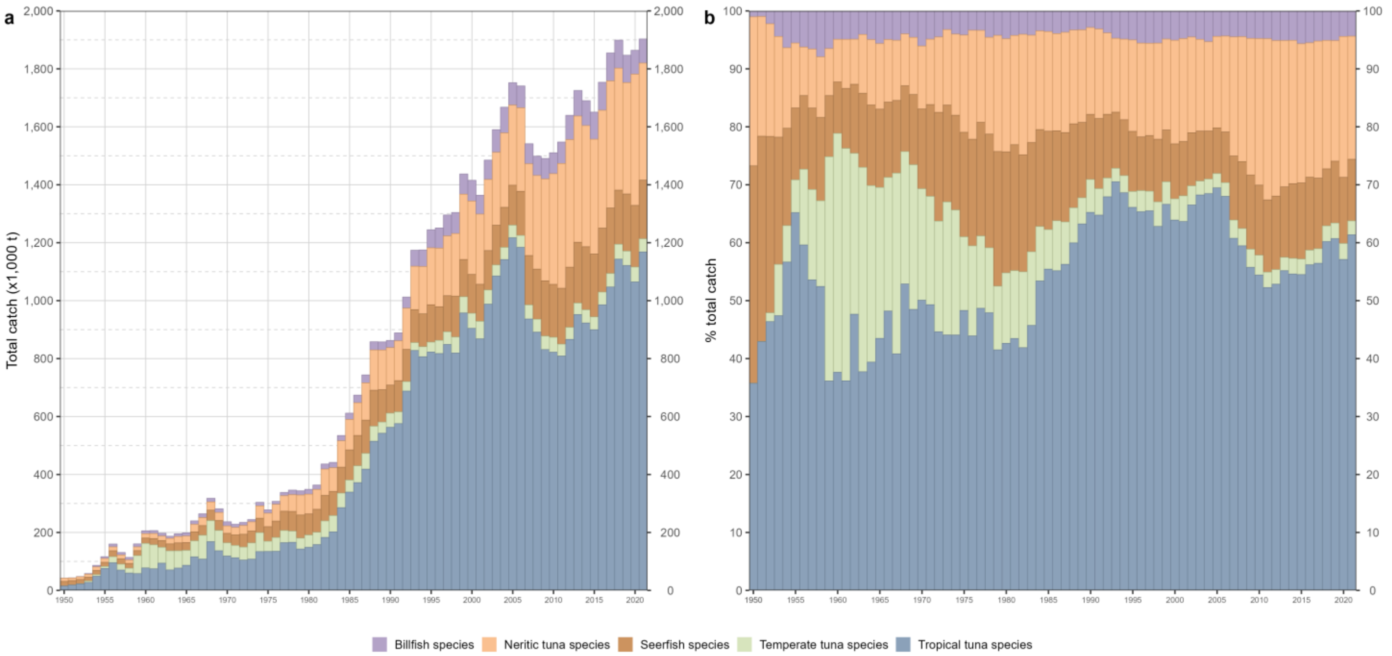

Figure 2: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of all IOTC tuna and tuna-like species by species category for the period 1950-2021

Catches of tropical tunas in the Indian Ocean show a sharp increase from the early to mid-1980s, following the arrival of purse seiners from the Atlantic Ocean and the quick development of the industrial purse seine fishery. Eventually, purse seine catches showed a constant increase until the mid-2000s, when annual total catches from all fisheries of the three tropical tuna species combined exceeded 1.22 million t (**Fig. 3.a**).

While yellowfin tuna dominated tropical tuna catches prior to the 1970s, its contribution decreased from over 60% in the mid-1950s to around 40% of the total catches in the early 1980s, a value that has remained fairly stable over the last four decades (**Fig. 3.b**). Annual catches of yellowfin tuna increased from around 28,000 t during the 1950s to around 433,000 t in recent years.

The contribution of skipjack tuna to total tropical tuna catches shows an almost continuous increase over time, from less than 30% of the totals in the mid-1950s to over 50% in recent years (**Fig. 3.b**). In absolute terms, annual catches of skipjack tuna increased from around 15,000 t during the 1950s to around 585,000 t in recent years.

Bigeye tuna has generally been the species that contributed the least to total tropical tuna catches (**Fig. 3.b**). In fact, its contribution shows a steady decline from 30% in the late 1970s to 10% in recent years. Annual catches of bigeye tuna increased from an average of around 7,000 t in the 1950s to an average around 91,000 t between 2017 and 2021 , with peak in catches well exceeding 110,000 t since 1994 and during the 2000s and in 2012 - 2013 (see IOTC-2023-WPTT25-07b - BET data for additional information).

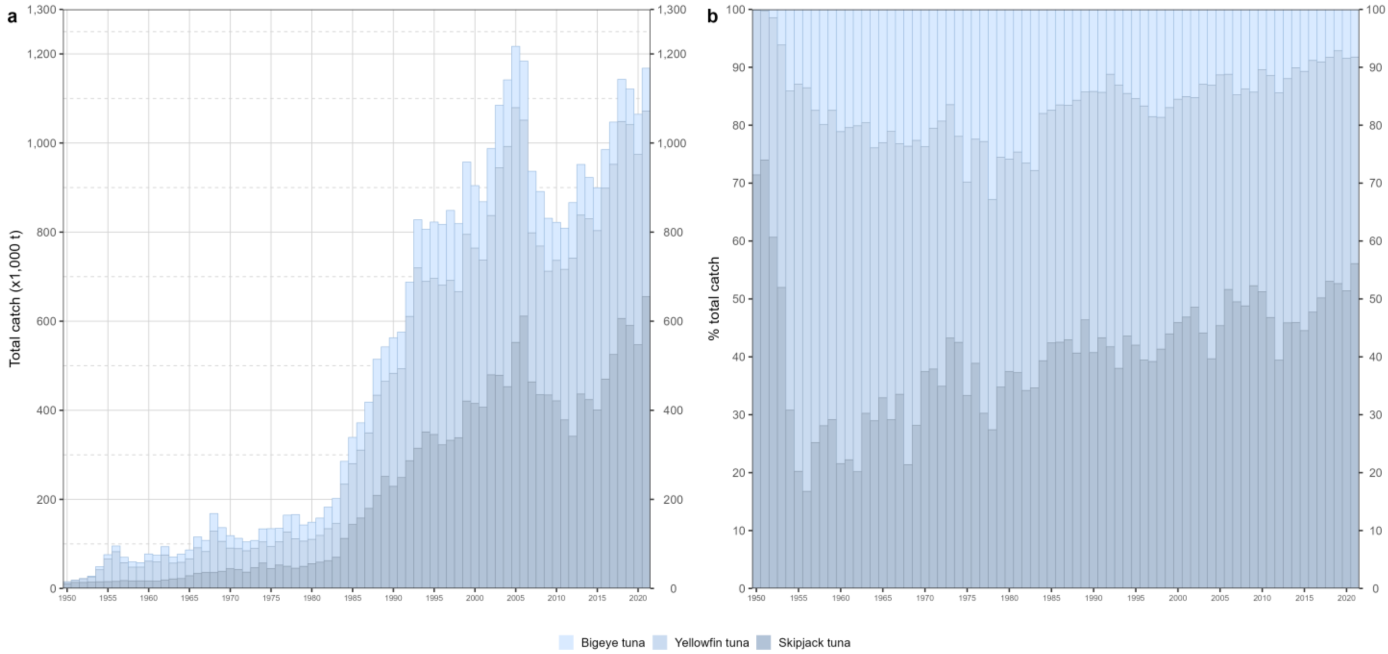

Figure 3: Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of Indian Ocean tropical tuna by species for the period 1950-2021

The majority of tropical tuna has been caught by industrial fisheries from the mid-1980s throughout the 1990s and 2000s, contributing to about 64% of the total catch over that period (**Fig. 4**). In the same years, total catches of tropical tuna taken by Indian Ocean artisanal fisheries increased steadily to annual values of around 447,000 t in recent years.

Following the major decline in catches by industrial fisheries in the late 2000s, catch levels of artisanal and industrial fisheries remained comparable at about 460,000 t per year between 2010 and 2015, when a new increase in industrial catches saw their contribution reaching 59% of the total tropical tuna catch, i.e., about 662,000 t as recorded in recent years (**Fig. 4**).

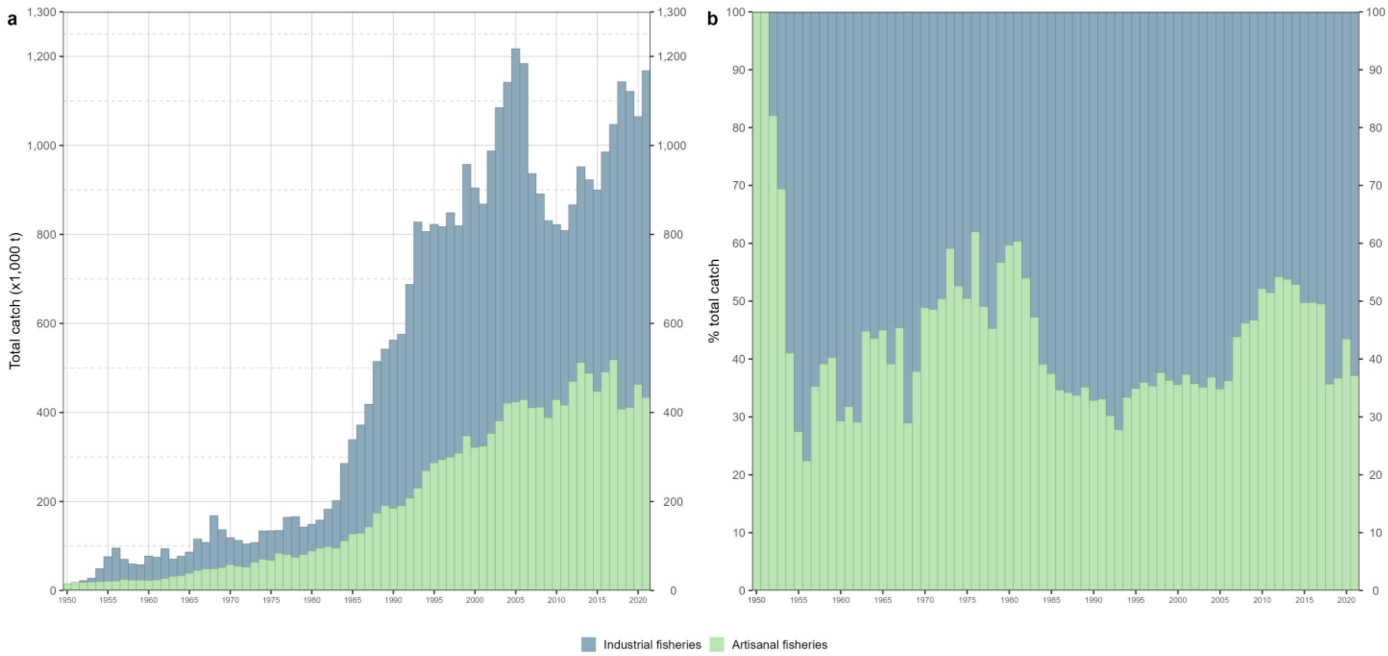

Figure 4: Annual time series of retained catches (metric tonnes; t) of Indian Ocean tropical tuna by fishery type for the period 1950-2021

Tropical tunas are harvested by a large diversity of fisheries and fishing gears, and except longline fisheries and purse seine fisheries catching free-swimming schools all other fisheries have shown a generally increasing trend in their total catches over the last decades (**Fig. 5.a**). The contribution of the different fisheries to the total tropical tuna catches has showed major changes over time in relation with the development, expansion, or decline experienced by the fisheries between 1950 and 2021 (**Fig. 5.b**).

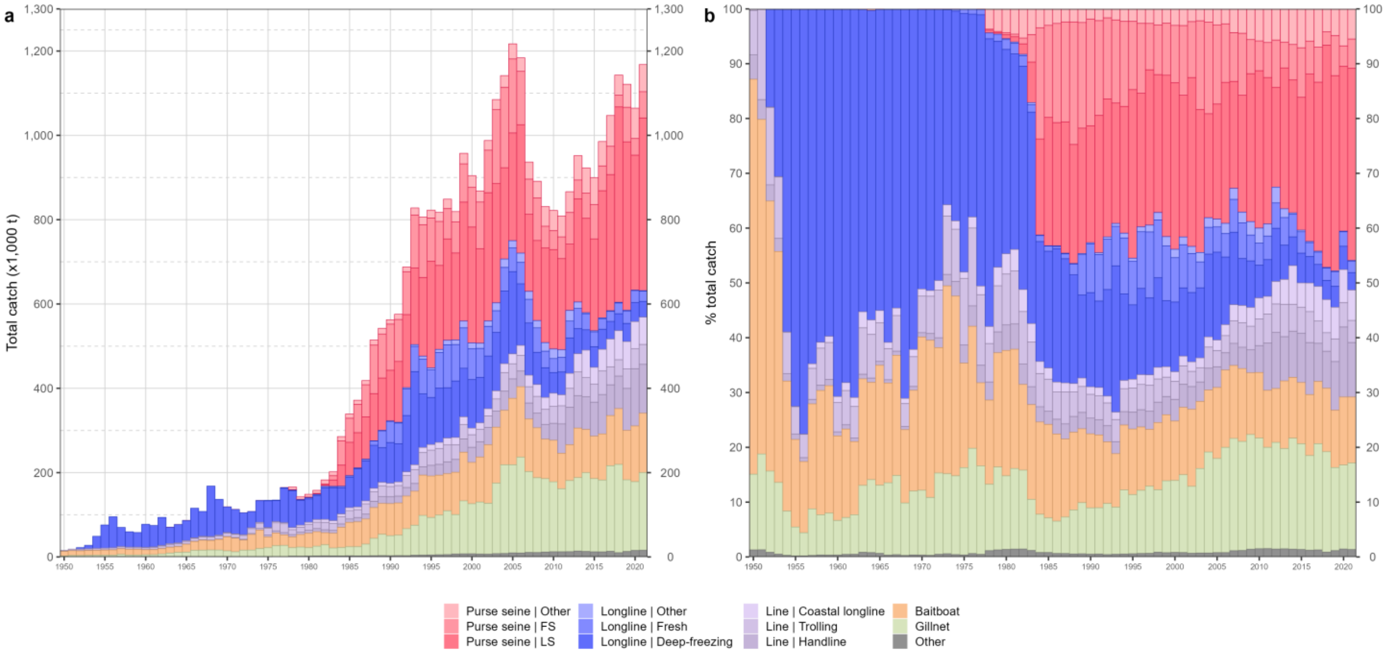

Figure 5: Annual time series of retained catches (metric tonnes; t) of Indian Ocean tropical tuna by fishery for the period 1950-2021

Main fishery features (2017-2021)

Purse seines, gillnets, and pole and line fisheries are those contributing the most to the total catches of tropical tuna in the Indian Ocean. In recent years, purse seine fishing on tuna schools associated with drifting floating objects has been the dominant fishery, representing about one third of the total tropical tuna catches estimated by the IOTC Secretariat for the years between 2017 and 2021 (**Table 5**). Over the same period, gillnets and pole and lines have contributed to 16.8% and 11.6% of the total catch, respectively. Catches from coastal line fisheries are also substantial in the Indian Ocean (18.9% for all line fisheries combined) while longline fisheries now represent only a small part of all tropical tuna catches (6.2% for all longline fisheries combined).

Table 5: Mean annual catches (metric tonnes; t) of Indian Ocean tropical tuna by fishery between 2017 and 2021. LS = schools associated with floating objects; FS = free-swimming schools

Fishery	Fishery code	Catch	Percentage
Purse seine | LS	PSLS	383,041	34.5
Gillnet	GN	185,963	16.8
Baitboat	BB	128,310	11.6
Line | Handline	LIH	100,251	9.0
Line | Coastal longline	LIC	65,860	5.9
Purse seine | Other	PSOT	62,464	5.6
Purse seine | FS	PSFS	55,755	5.0
Line | Trolling	LIT	44,410	4.0
Longline | Deep-freezing	LLD	41,485	3.7
Longline | Fresh	LLF	26,266	2.4
Other	OT	13,498	1.2
Longline | Other	LLO	1,478	0.1

Tropical tunas are currently caught at high levels by several fleets, with EU,Spain ranking first during the period 2017-2021 thanks to the high productivity of their large-scale purse seiners (**Fig. 6**). The other major fishing nations (according to their recent catch reports) are Indonesia, Maldives, and Seychelles, which are described by very different profiles in terms of fishery composition. These four countries together have contributed to 54.3% of the total tropical tuna catches in the Indian Ocean between 2017 and 2021.

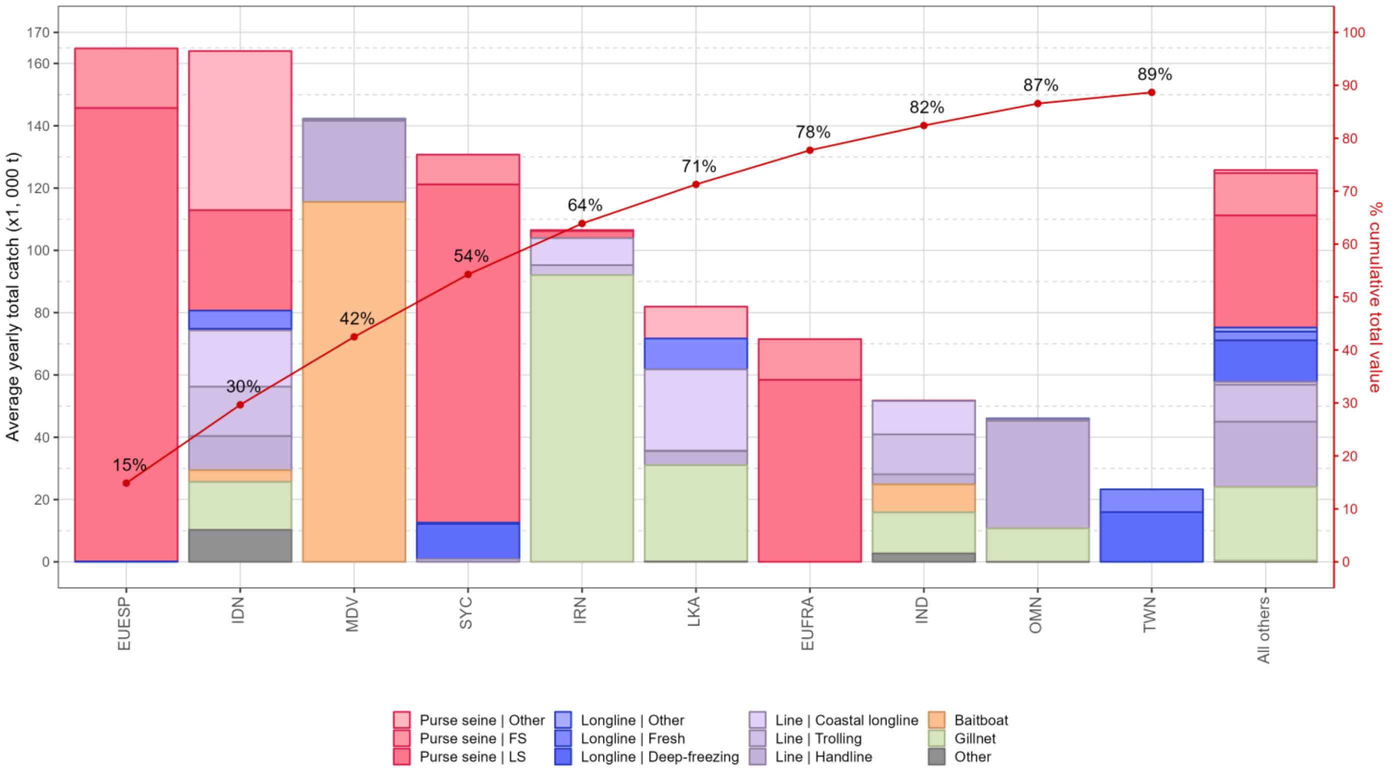

Figure 6: Mean annual catches (metric tonnes; t) of Indian Ocean tropical tuna by fleet and fishery between 2017 and 2021, with indication of cumulative catches by fleet. FS = free-swimming schools; LS = schools associated with floating objects

Fig. 7 and **Fig. 8** present the recent temporal trends in retained catch of tropical tuna by fishery group and fleet in the years between 2017 and 2021. Overall, catch levels vary significantly across fishery groups while the main fleets showing different inter-annual changes in catches within each fishery group.

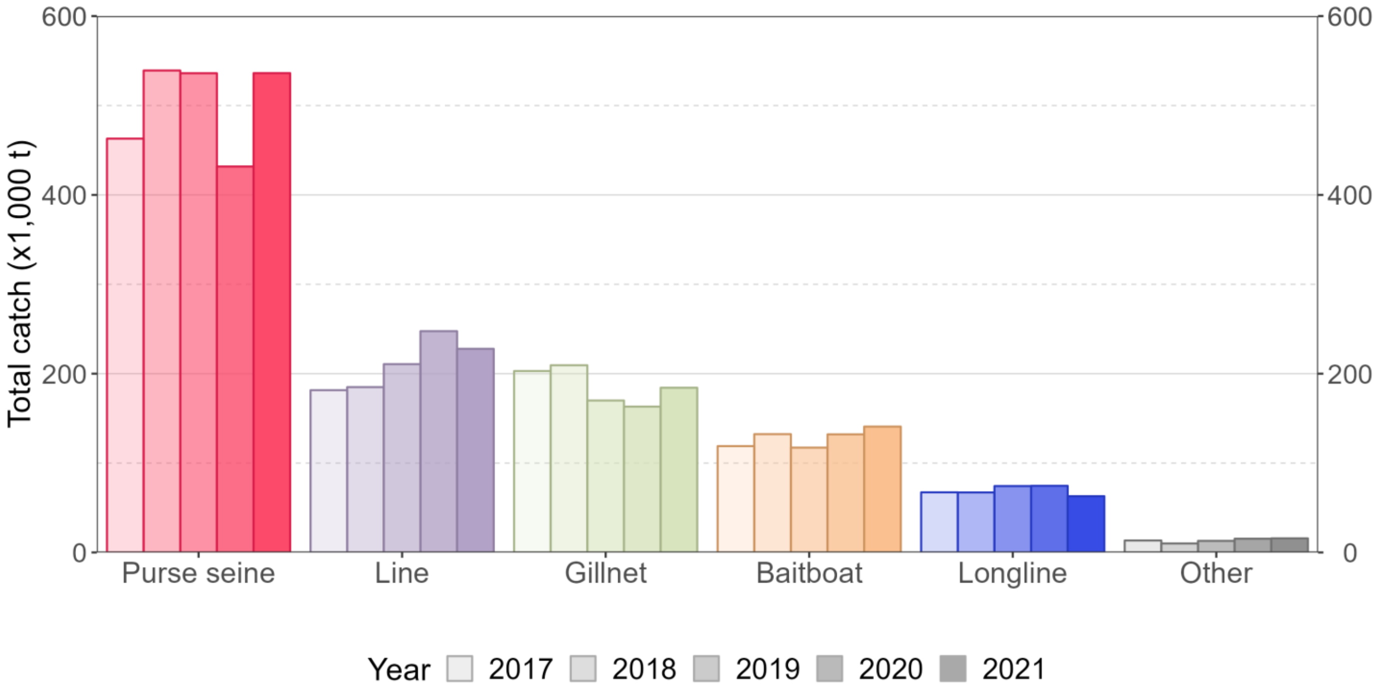

Figure 7: Annual catch (metric tonnes; t) trends of Indian Ocean tropical tuna by fishery group between 2017 and 2021

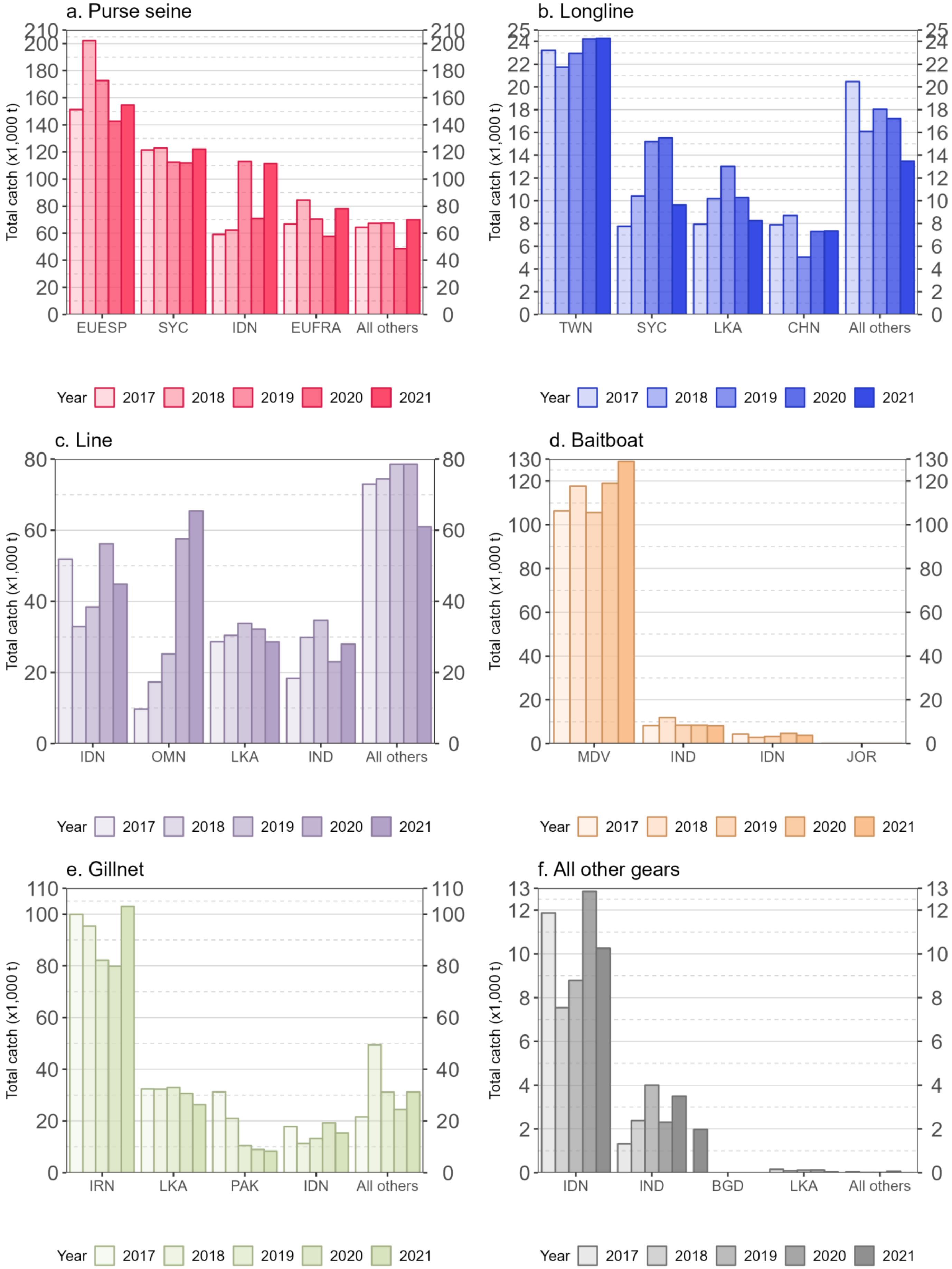

Figure 8: Annual catch (metric tonnes; t) trends of Indian Ocean tuna by main fishery group and fleet between 2017 and 2021

Reporting quality of retained catch data

The quality of the retained 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 artisanal fisheries, mostly because larger vessels are generally monitored with logbooks and recording systems at landing. 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 retained 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 2021, the percentage of tropical tuna catches fully or partially reported to the Secretariat was 87%.

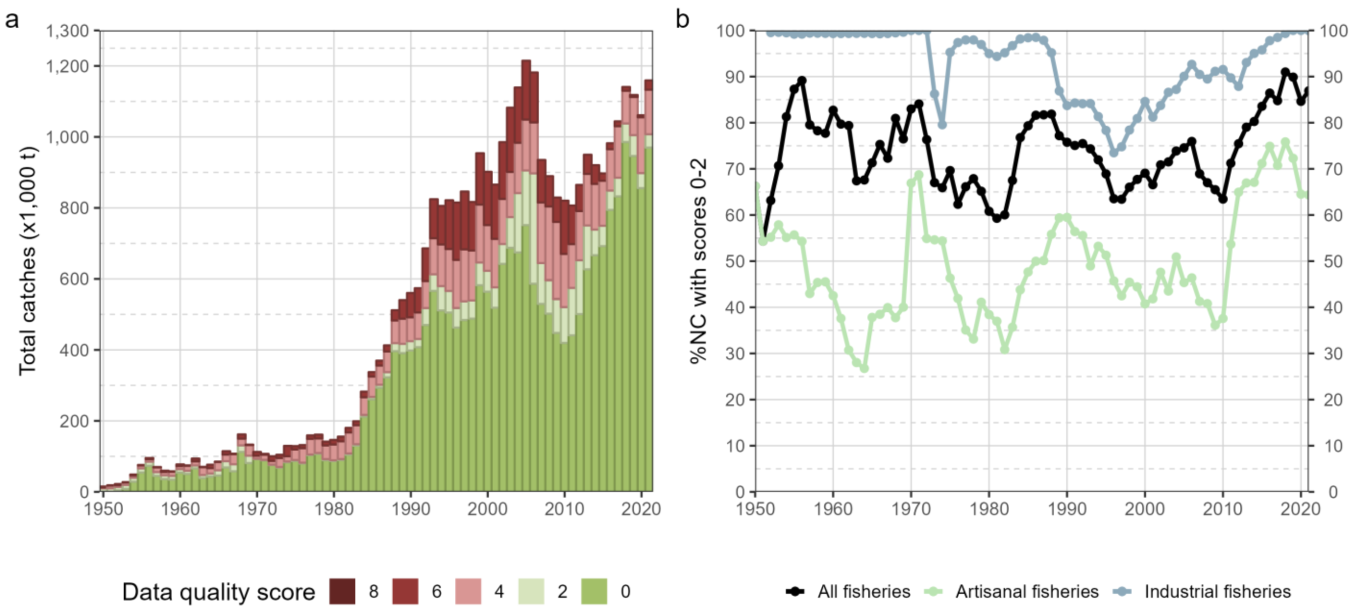

Figure 9: (a) Annual retained catches (metric tonnes; t) of Indian Ocean tropical tuna estimated by quality score and (b) percentage of retained catch fully or partially reported to the IOTC Secretariat for all fisheries and by type of fishery, in the period 1950-2021

Following the implementation of a catch limit on yellowfin tuna to rebuild the stock since 2017 (Res. 17/01), some issues have been raised about the possibility of misreporting and/or high-grading in some fisheries (IOTC 2019a, Medley et al. 2021). In particular, the 21st session of the WPTT highlighted how the relative composition of tropical tuna species reported for the year 2018 by the purse seine fleet from EU,Spain showed a higher proportion of bigeye tuna than in previous years (IOTC 2019b). The issue has not been tackled by the CPC concerned and also affects the spatial distribution of the catch for each tropical tuna species for that year.

In 2021, slightly higher-than-average values for the proportion of bigeye tuna were reported for the purse seine fisheries of EU,Spain, EU,France, and Seychelles. As very few samples were collected in 2020 at the unloading of large-scale purse seiners in Victoria due to the COVID pandemic, the composition of the purse seine catch for 2020 was mostly coming from fishers logbooks and not estimated from the standard processing procedure applied since the early 2000s (Pallarés & Hallier 1997).

Spatial distribution of reported efforts

Longline fisheries

By decade (1950-2009)

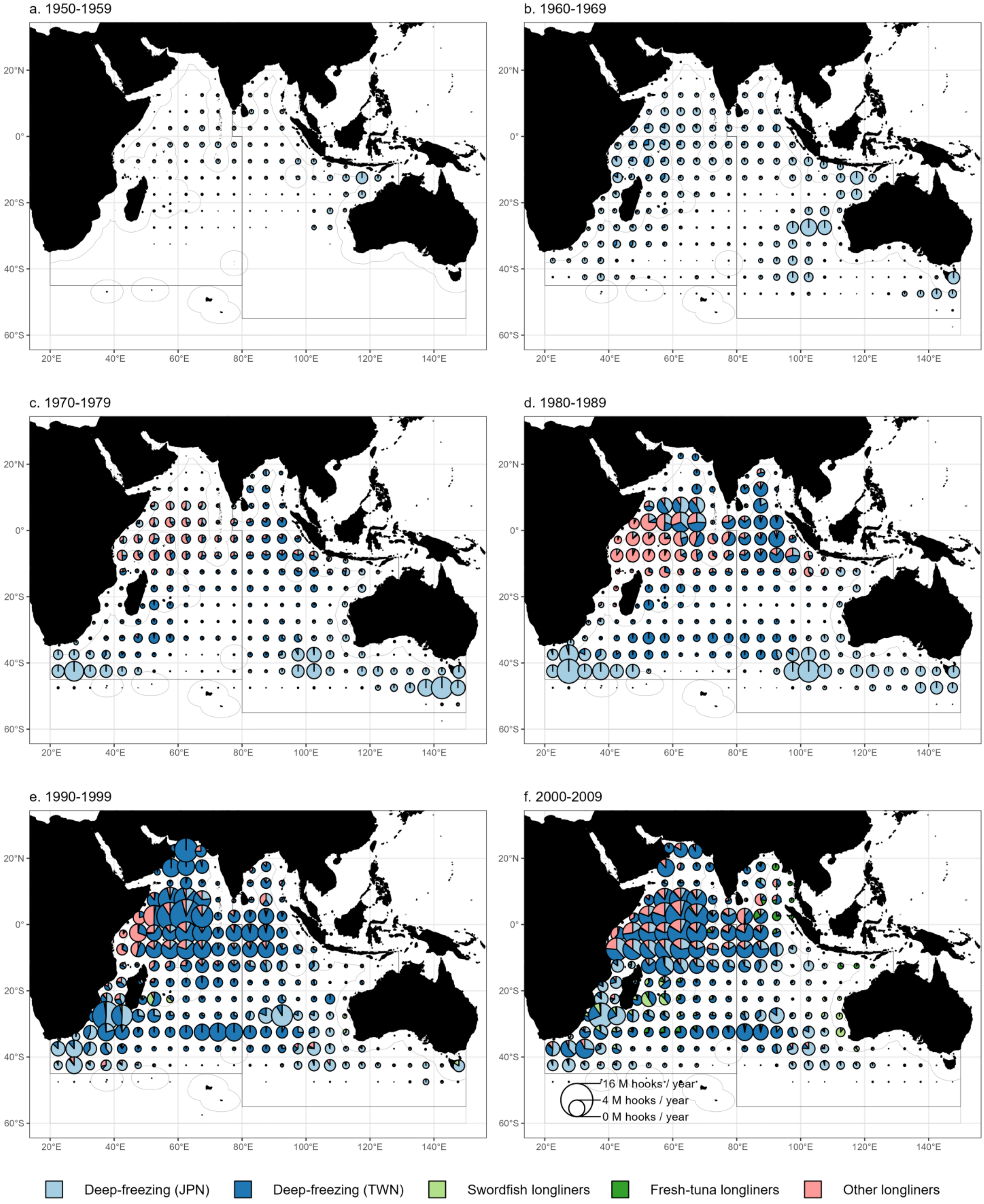

Figure 10: Mean annual effort (millions hooks deployed) exerted by industrial longline fleets by decade, 5°x5° grid, and fleet. Data source: time-area effort dataset for longline fisheries (Res. 15/02)

By last years (2017-2021) and decade (2010-2019)

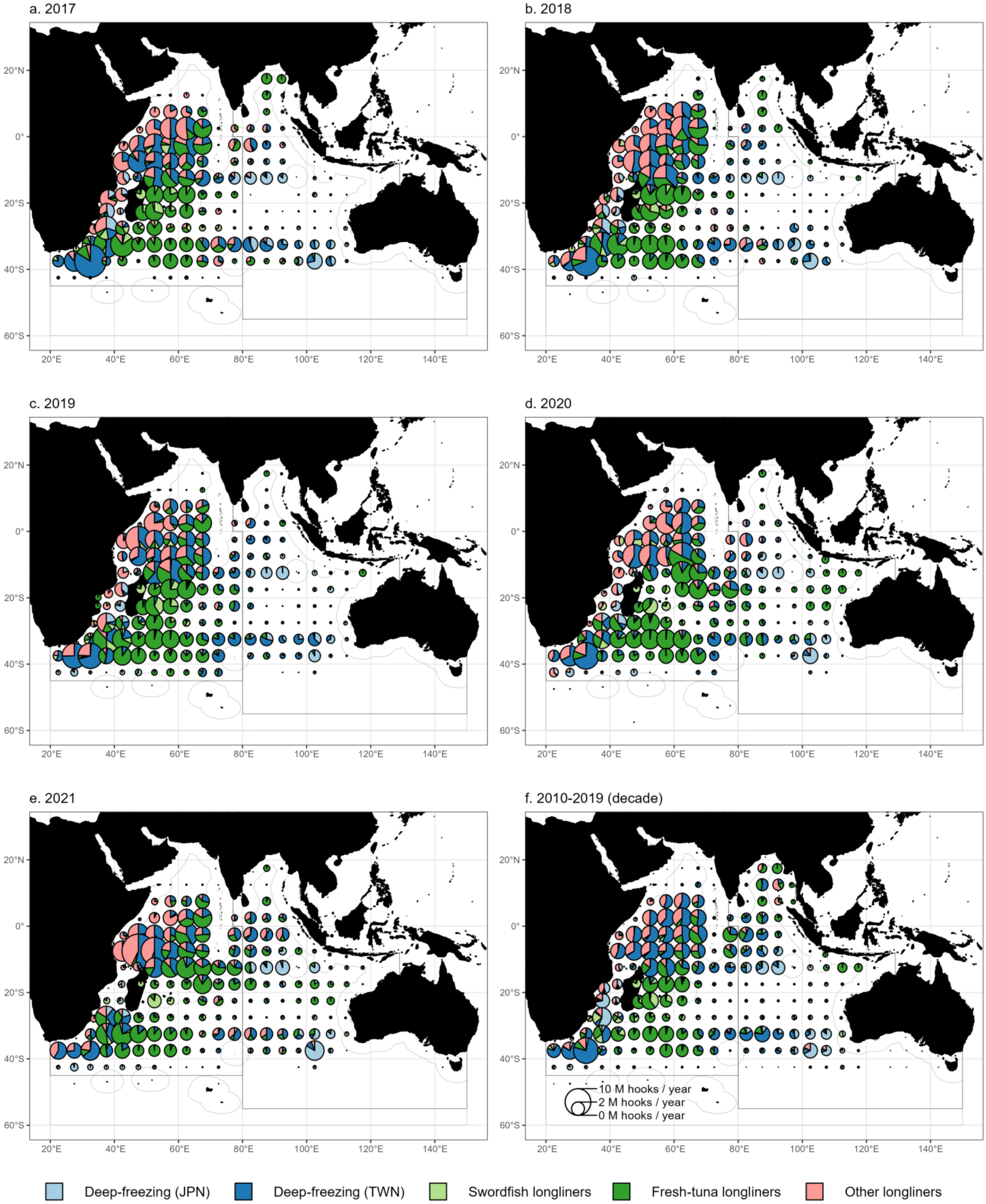

Figure 11: Mean annual effort (millions hooks) exerted by industrial longline fleets by year / last decade, 5°x5° grid. and fleet. Data source: time-area effort dataset for longline fisheries (Res. 15/02)

Purse seine fisheries

All, by decade (1980-2009)

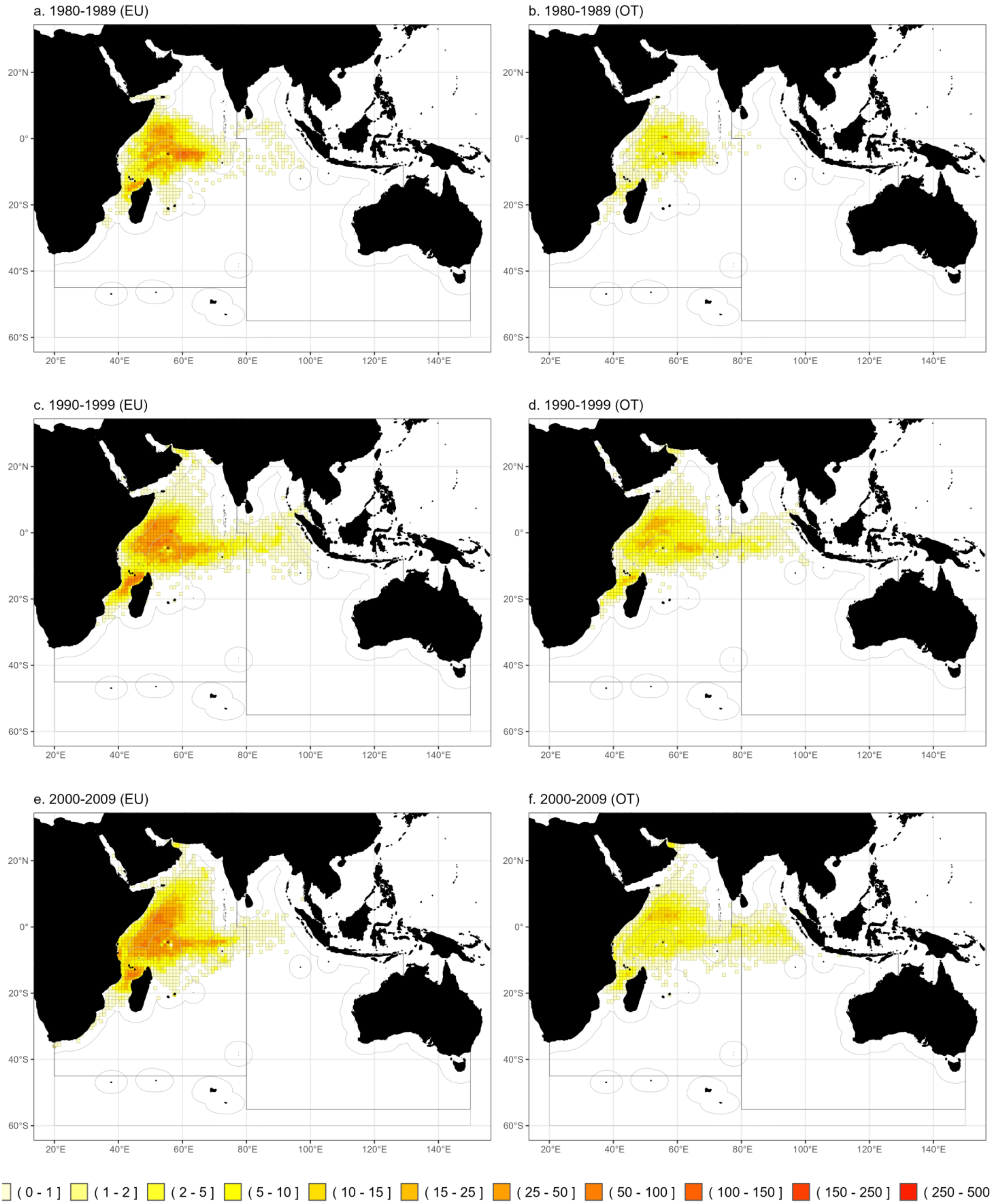

Figure 12: Mean annual effort (fishing days) exerted by the industrial purse seine fleets of the European Union and comparable fleets (EU) vs. all other flags (OT) by decade, 1°x1° grid, and fleet. Data source: time-area effort dataset for purse-seine fisheries (Res. 15/02)

European Union, by last years (2017-2021) and decade (2010-2019)

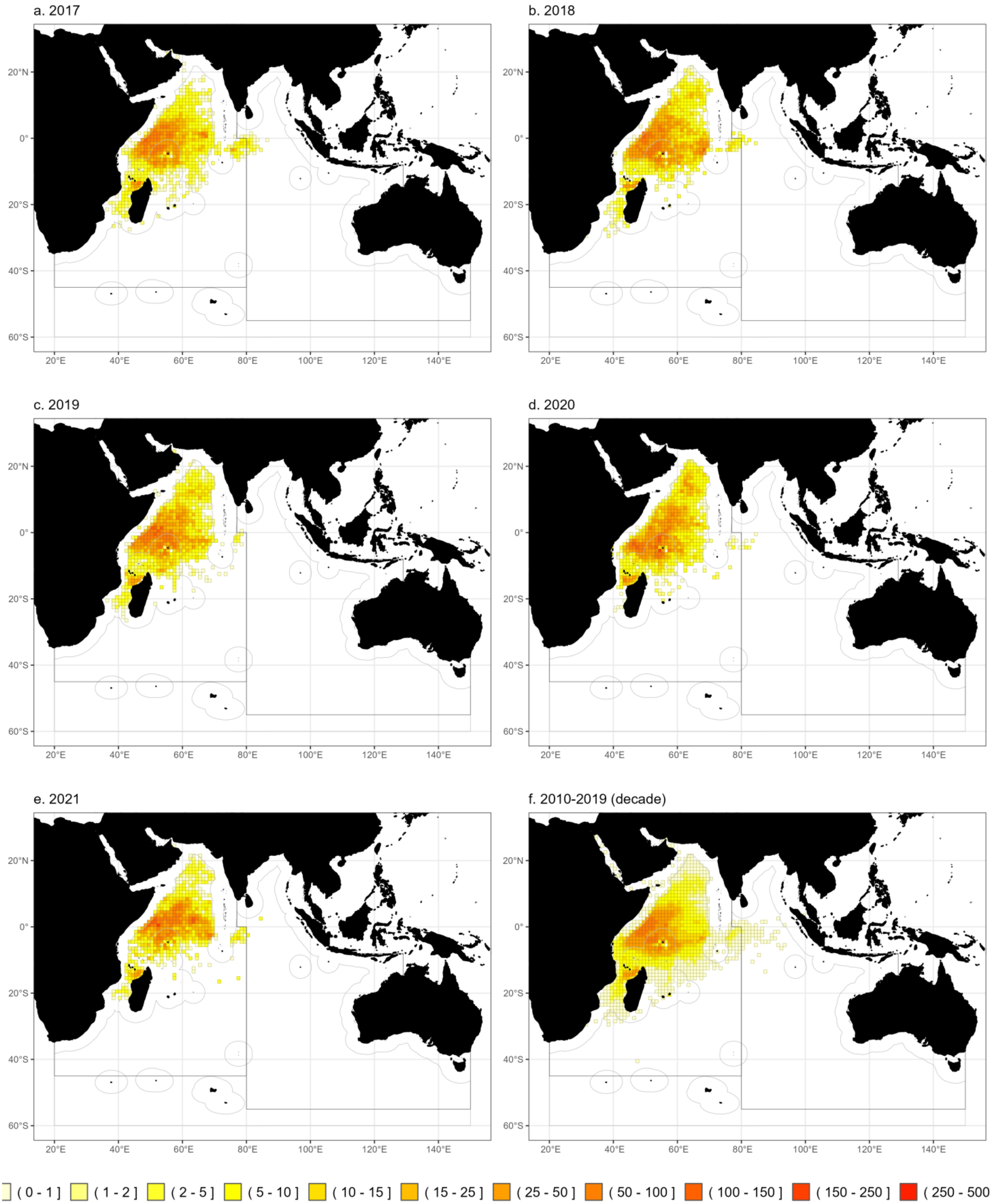

Figure 13: Mean annual effort (fishing days) exerted by the industrial purse seine fleets of the European Union and comparable fleets (EU) by year / decade and 1°x1° grid. Data source: time-area effort dataset for purse-seine fisheries (Res. 15/02)

All others, by last years (2017-2021) and decade (2010-2019)

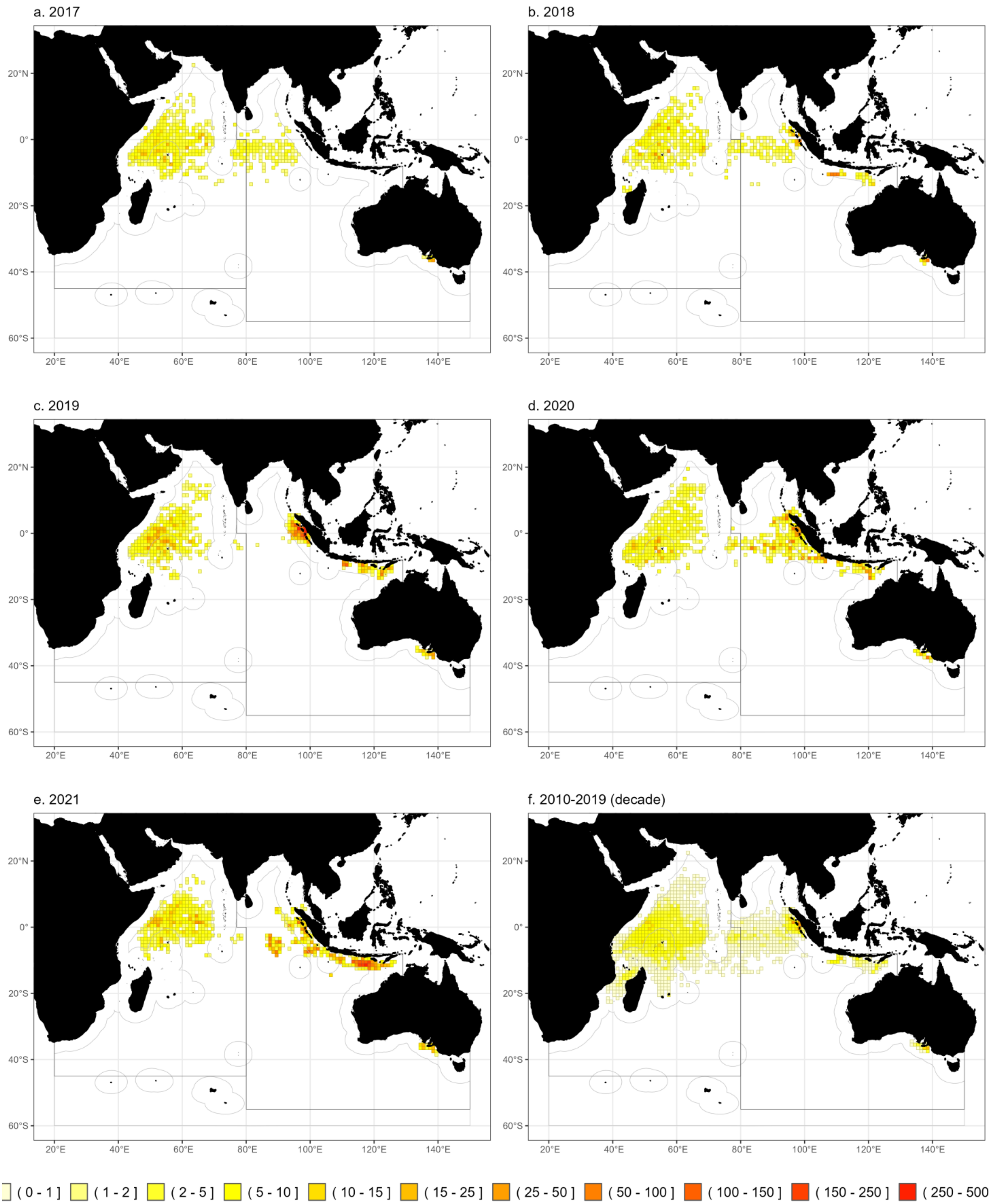

Figure 14: Mean annual effort (fishing days) exerted by purse seine fleets from other flags (OT) by year / decade and 1°x1° grid. Data source: time-area effort dataset for purse-seine fisheries (Res. 15/02)

Spatial distribution of reported catches

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

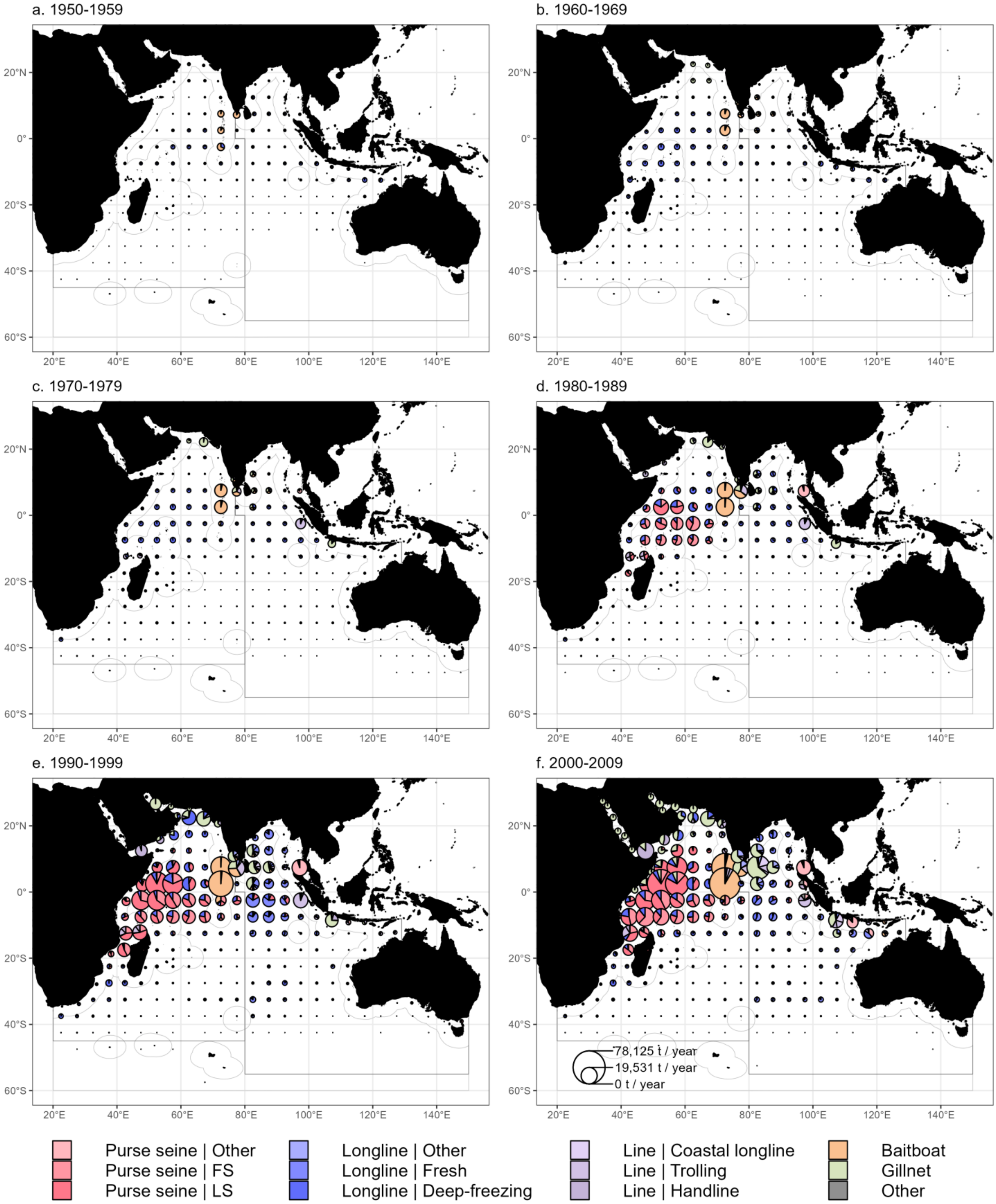

Figure 15: Estimated mean annual time-area catches (metric tonnes; t) of Indian Ocean tropical tuna by decade, 5°x5° grid, and fishery. Data source: tropical tuna raised time-area catches

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

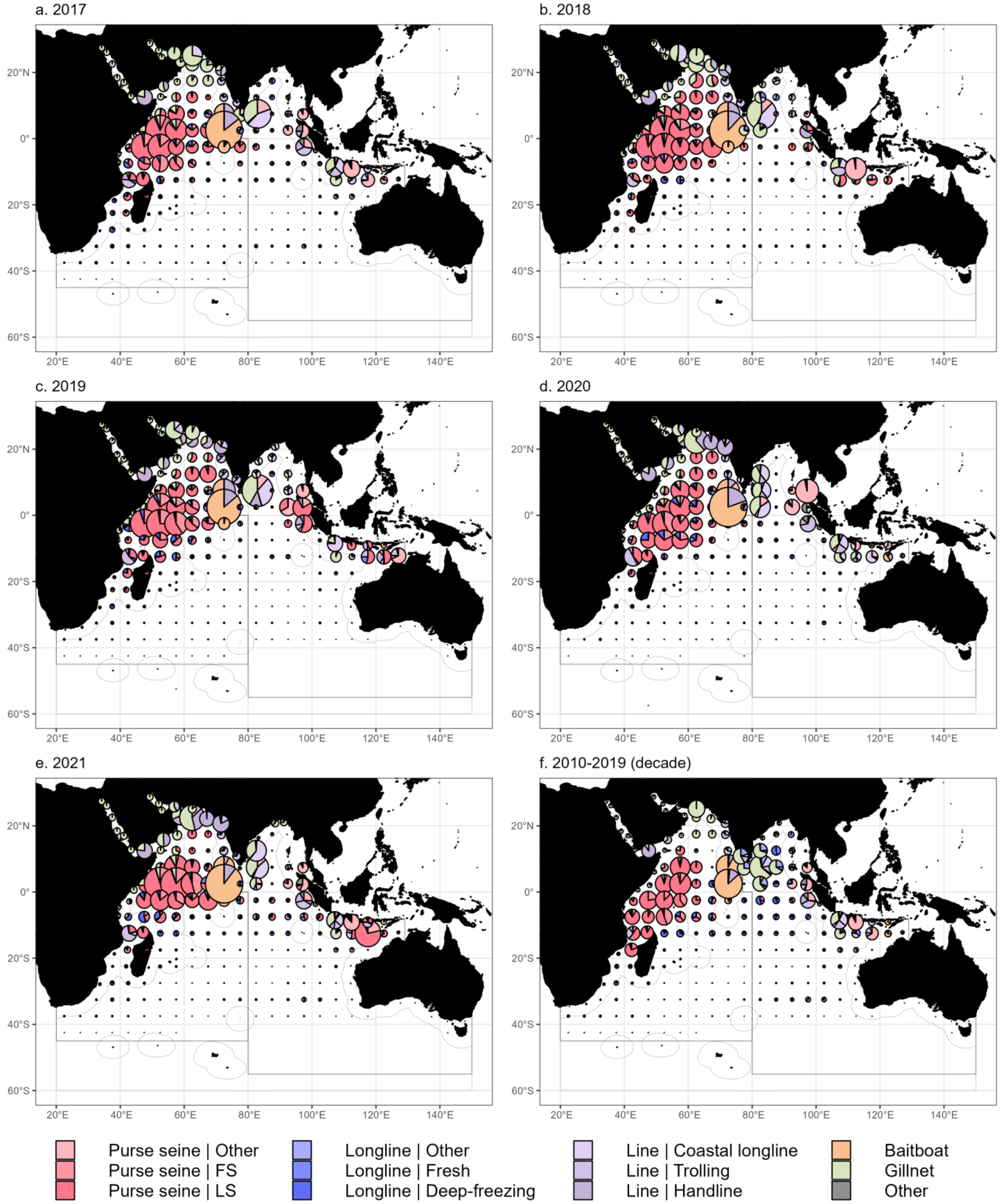

Figure 16: Estimated mean annual time-area catches (metric tonnes; t) of Indian Ocean tropical tuna by year / decade, 5°x5° grid, and fishery. Data source: Tropical tuna raised time-area catches

Reporting quality of catch and effort data

The quality of the geo-referenced catch and effort data for tropical tuna reported to the IOTC Secretariat shows large variability over the years (**Fig. 17**). Similar to retained 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.

Nevertheless, the same IOTC Resolution 15/01 (para. 11) calls for the progressive implementation, among developing coastal states, of proper data collection mechanisms for coastal fisheries, and therefore improvements in data collection and reporting quality from these fleets are expected in the future.

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 66% of the total retained catch of tropical tuna. In 2021, the percentage of retained catches for which good geo-referenced catch and effort data were available at the Secretariat was 83%.

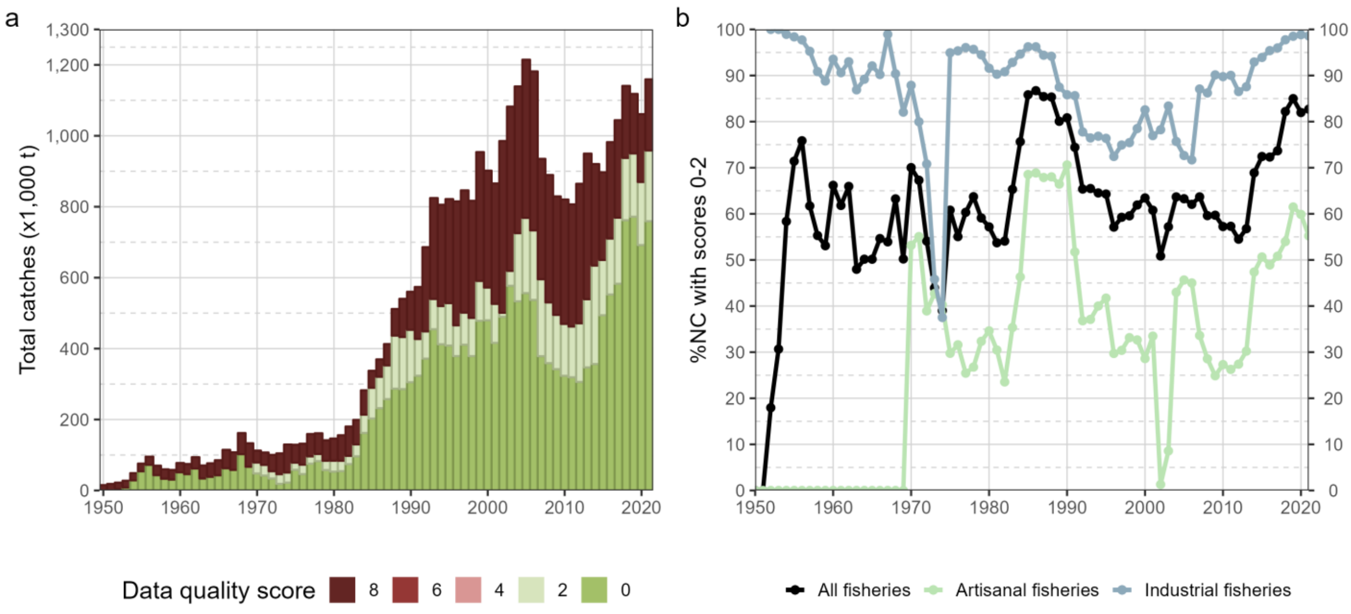

Figure 17: (a) Annual retained catches (metric tonnes; t) of Indian Ocean tropical tuna estimated by quality score and (b) percentage of geo-referenced catches reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 for all fisheries and by type of fishery, in the period 1950-2021

Size-frequency

Reporting quality of size-frequency data

The quality of tropical tuna geo-referenced size frequency data reported to the IOTC Secretariat is low overall, although showing improvements in the last decade (**Fig. 18**). Almost no size data are available prior to the 1980s and since then size data are unavailable for more than half of the retained catch estimated by the Secretariat. In 2021, the percentage of retained catch data for which good size data were available at the Secretariat was 71%.

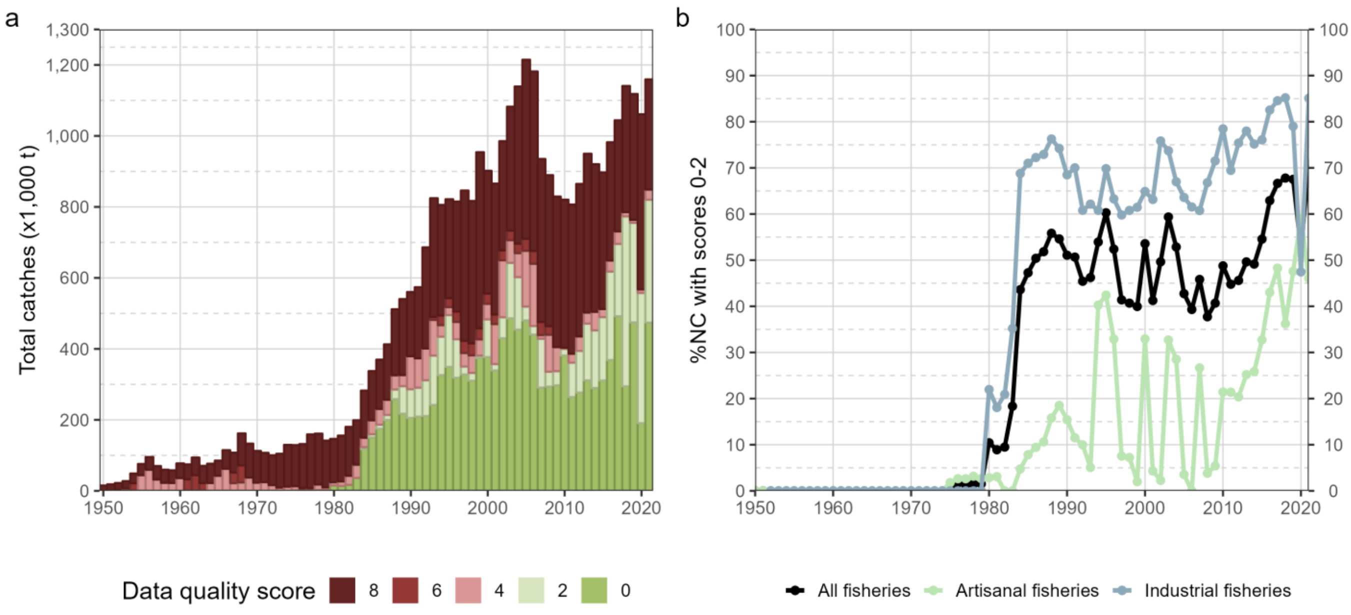

Figure 18: Annual retained catches (metric tonnes; t) of Indian Ocean tropical tuna estimated by quality score (barplot) and percentage of geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 (lines with dots) for all fisheries (a) and by type of fishery (b), in the period 1950–2021

Appendix I: Monthly time series of tropical tuna import prices and crude oil prices, 2000-2021

Frozen purse seine, Thai import prices (canning grade)

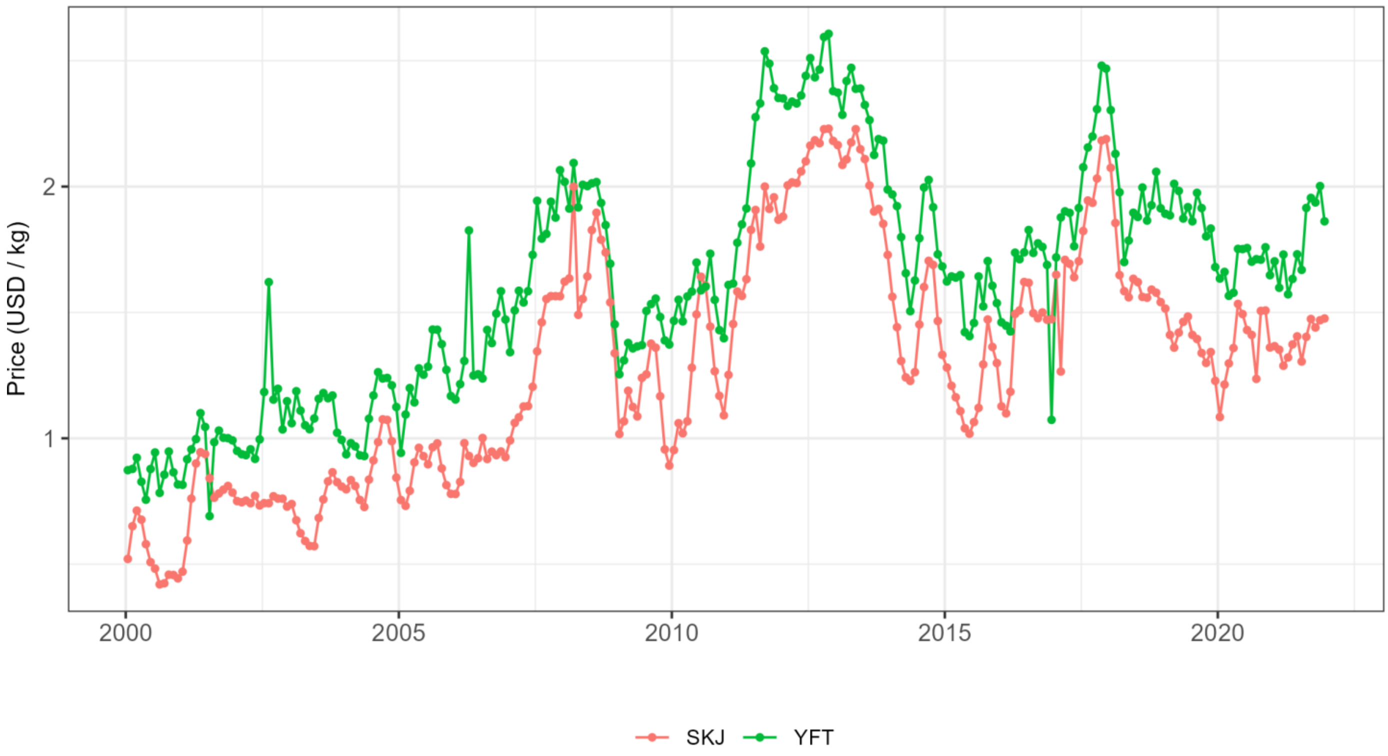

Figure 19: Monthly time series of import prices (USD/kg) in Thailand for canning-grade frozen skipjack and yellowfin tunas during the period 2000-2021. Data sourced from Thailand customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Frozen longline, Japanese import prices (sashimi grade)

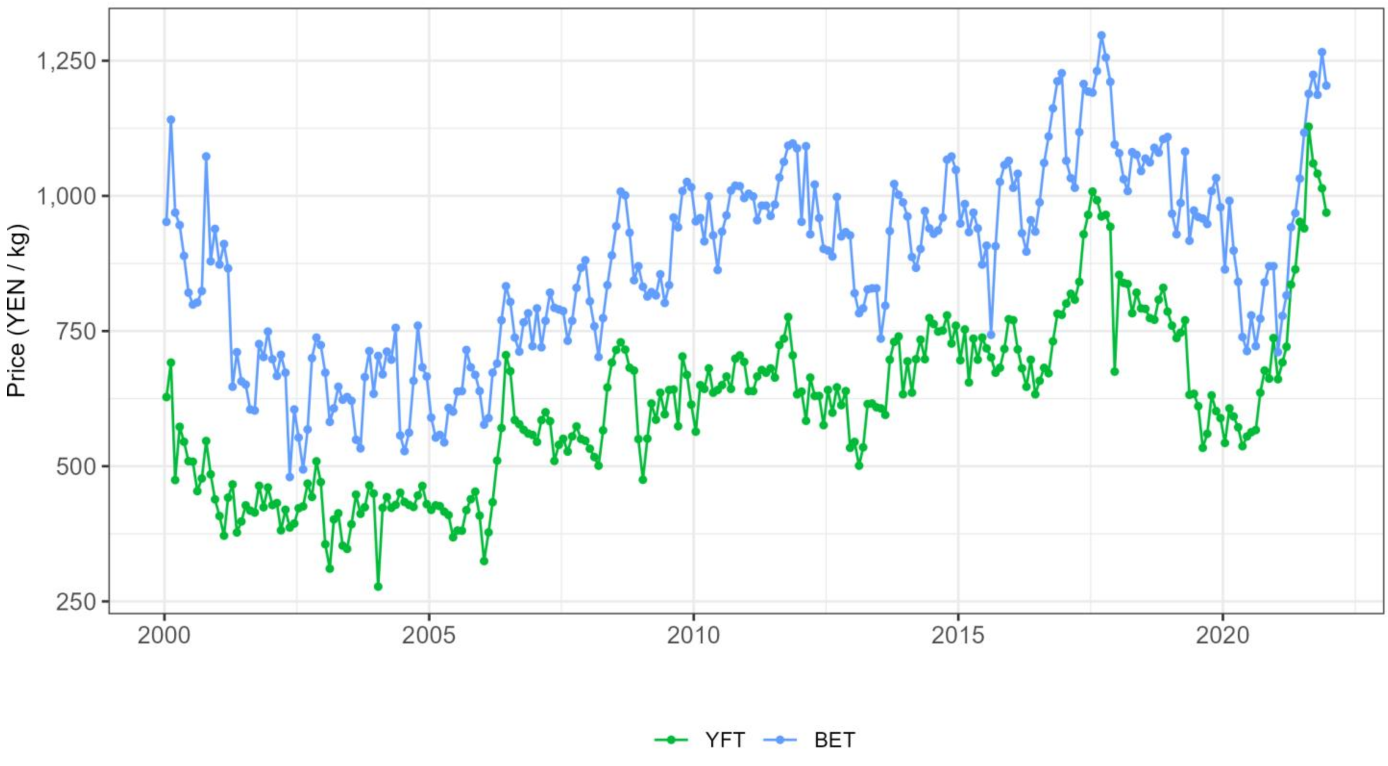

Figure 20: Monthly time series of import prices (YEN/kg) in Japan for sashimi-grade frozen during the period 2000-2021. Data sourced from Japanese customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Fresh longline, Japanese import prices (sashimi grade)

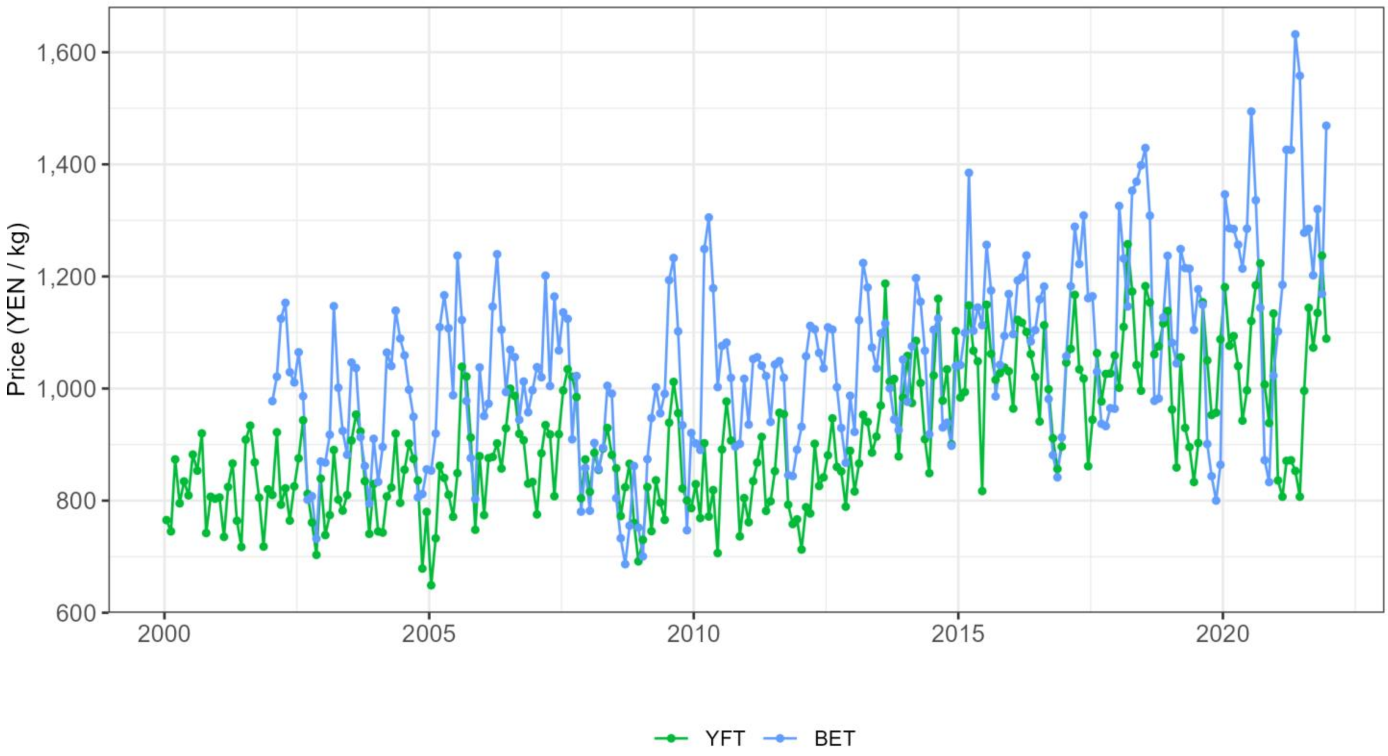

Figure 21: Monthly time series of import prices (USD/kg) in Thailand for canning-grade frozen during the period 2000-2021. Data sourced from Japanese customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Fresh longline, US import prices (sashimi grade)

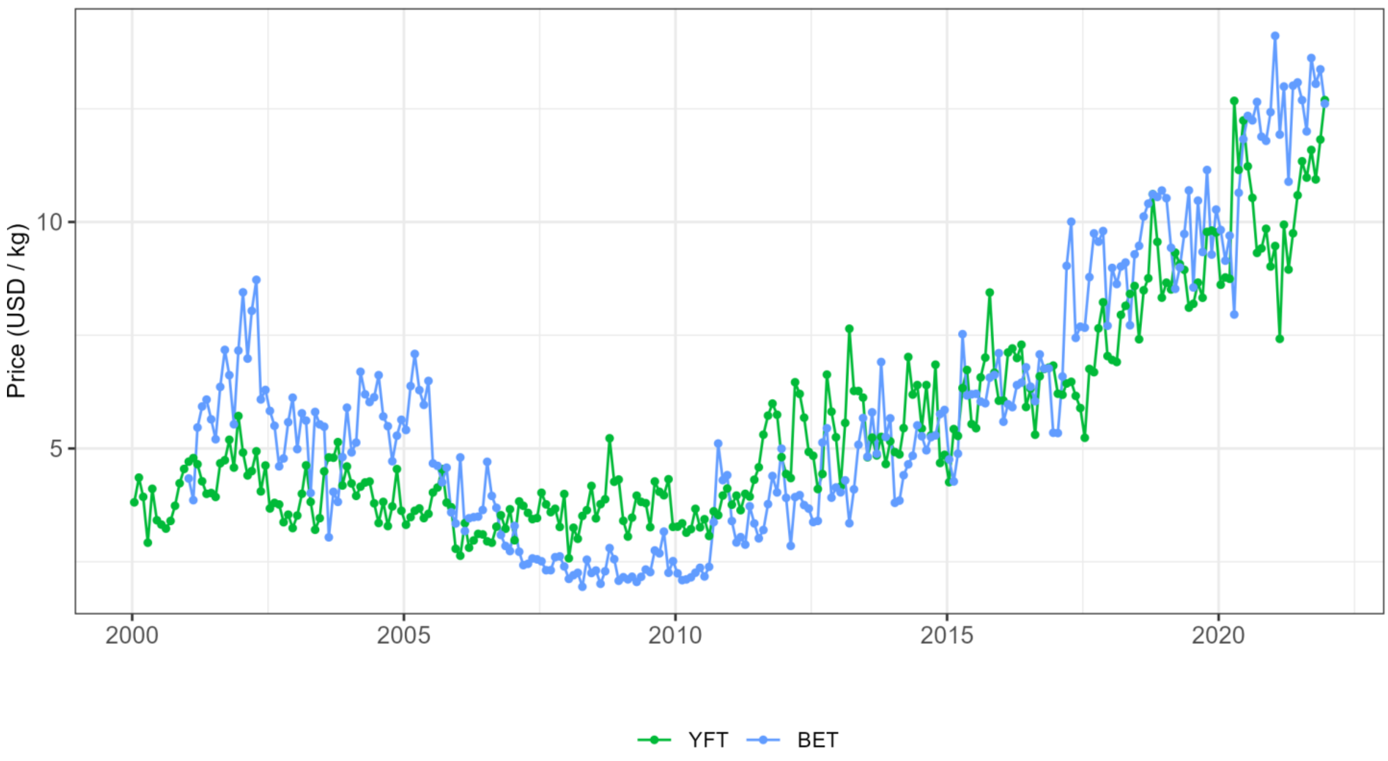

Figure 22: Monthly time series of import prices (USD/kg) in Thailand for canning-grade frozen during the period 2000-2021. Data sourced from USA customs, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Crude oil price

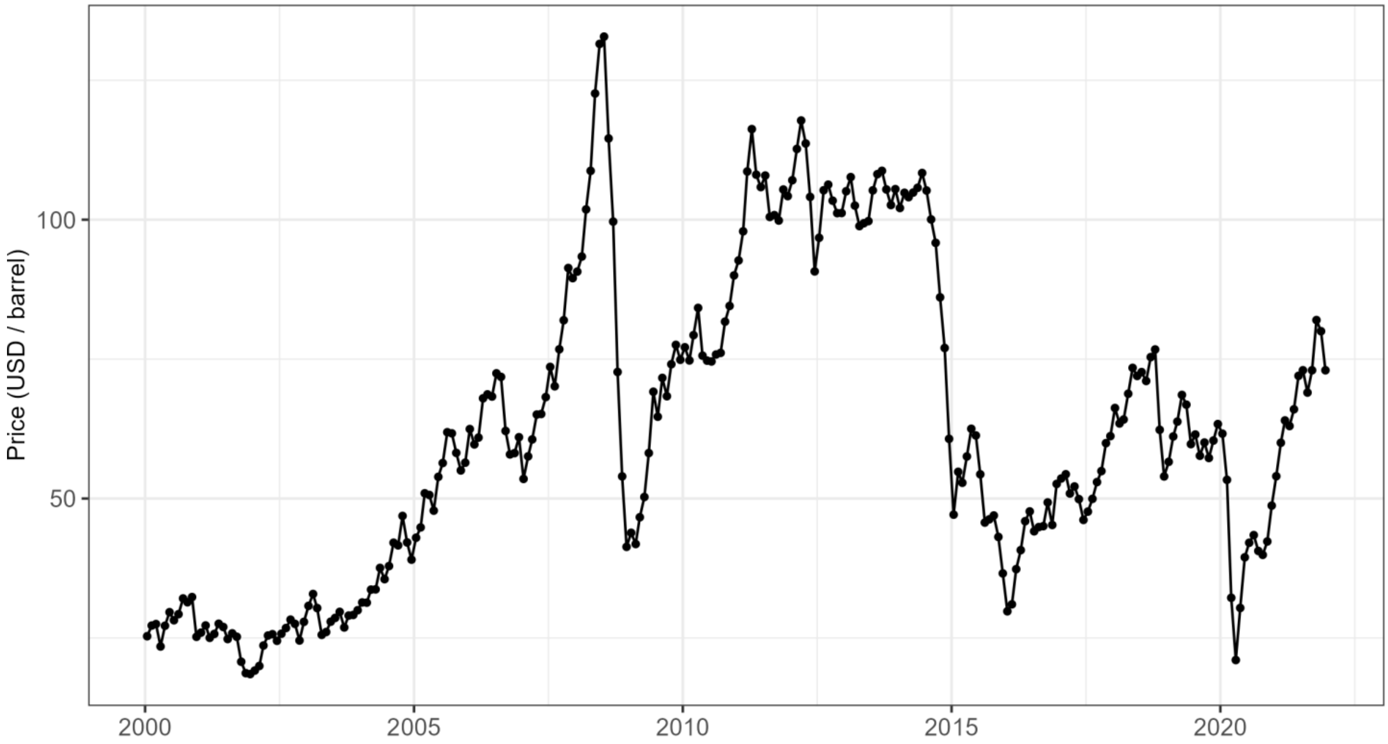

Figure 23: Monthly time series of crude oil spot price (USD/barrel) during the period 2000-2021. Data sourced from the spot prices of Brent, Dubai, and West Texas, compiled, and curated by the FFA Fisheries Development Division

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