REVIEW OF THE STATISTICAL DATA AVAILABLE FOR INDIAN OCEAN NERITIC TUNA AND SEERFISH SPECIES UNDER IOTC MANAGEMENT

Author: IOTC Secretariat

Introduction

Neritic pelagic species of the *Thunnini* and *Scomberomorini* tribes sustain important commercial and subsistence fisheries in the coastal waters of many countries around the world. Information available from the Food and Agriculture Organization (FAO) of the United Nations indicates that annual catches of six neritic tunas (*Euthynnus* spp., *Auxis* spp. and *Thunnus tonggol*) and 12 seerfish species (*Scomberomorus* spp. and *Acanthocybium solandri*) exceeded two million metric tonnes (t) in recent years (**Fig. 1a**). Some of these species are not under the management of any regional fishery body and catch data available from the tuna Regional Fisheries Management Organisations (RFMOs) may therefore misrepresent their socio-economic importance. In recent years the Indian Ocean has contributed to about one third of the global catch of neritic tunas and seerfish (**Fig. 1b**).

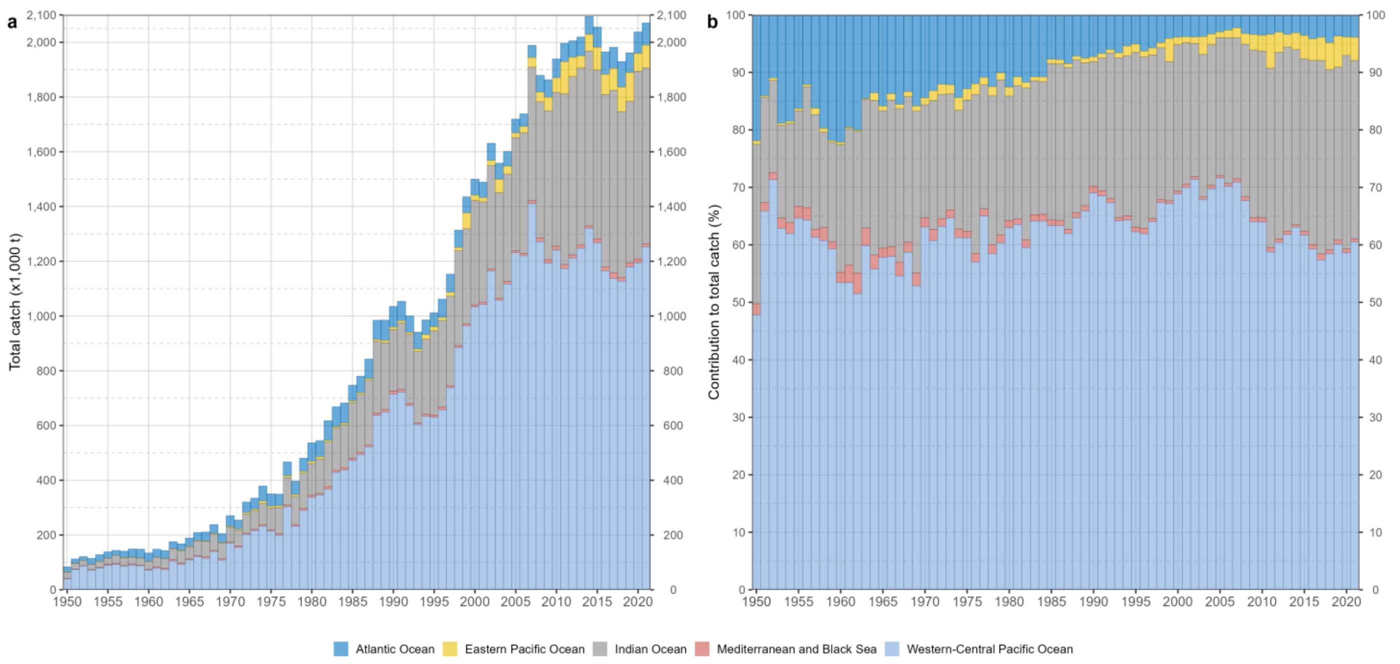

Figure 1: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of neritic tunas and seerfish by ocean basin for the period 1950-2021. Source: FAO global capture production database

Four species of neritic tunas – bullet tuna (*Auxis rochei*), frigate tuna (*Auxis thazard*), kawakawa (*Euthynnus affinis*) and longtail tuna (*Thunnus tonggol*) – and the two most abundant seerfish species – narrow-barred Spanish mackerel (*Scomberomorus commerson*) and Indo-Pacific king mackerel (*Scomberomorus guttatus*) – are under the management of the Indian Ocean Tuna Commission (IOTC). By contrast, streaked Spanish mackerel (*Scomberoromorus lineolatus*) and broad-barred king mackerel (*Scomberomorus semifasciatus*) occurring in the Indian Ocean are not managed by the IOTC but their catches reported to the FAO have been less than 100 t per year over the last two decades.

The overarching objective of this paper is to provide participants at the 13th Session of the IOTC Working Party on Neritic Tunas (WPNT13) with a review of the status of the information available on the six neritic tuna and seerfish species under IOTC mandate. IOTC fisheries statistics are available from 1950 but some subsistence fisheries catching them have been operating in coastal areas of the Indian Ocean for centuries (e.g., Yadav et al. 2020). The document provides an overview of the data sets available to the IOTC Secretariat as of April 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 neritic tunas and seerfish 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 data to the Secretariat as these facilitate data curation and management.

Nominal retained catch data

Nominal catches of retained species have to be expressed in live weight equivalent and reported per year, Indian Ocean major area, fleet, and gear (IOTC Res. 15/02) and preferably submitted using IOTC form 1RC. Changes in retained catches may occur as a result of: (i) updates, received by December 30th each year, of the preliminary data for longline fisheries submitted by June 30th of the same year, (ii) revisions of historical data by CPCs following corrections of errors, addition of missing data, changes in data processing, etc., and (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 area, fleet, gear, type of school, and species (IOTC Res. 15/02). Geo-referenced catches can be reported to the Secretariat in live-weight equivalent or in numbers of fish. The recommended 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 large-scale 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 key IOTC reporting standards. For these reasons, the most accurate information available on discards is considered to come from the IOTC Regional Observer Scheme (ROS; 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 can 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 stratified by fleet, year, gear, type of school, month, grid area, and species as required by IOTC Res. 15/02. While the great majority of size data reported through IOTC Form 4SF refer to 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

Little information is available on the socio-economic dimension of fisheries catching neritic tunas and seerfish in the Indian Ocean. The majority of the catches is sold locally, in raw or processed form (e.g., local canneries), or exported to markets in neighbouring countries. In addition, a small component of the catches of neritic tunas, in particular longtail tuna, is exported to the European Union (EU) or other markets in the region (e.g., Saudi Arabia, Sri Lanka).

The IOTC Form 7PR has been designed to voluntarily report prices of fish per type of product and market but little data have been received so far at the Secretariat with the notable exception of time series of monthly prices by species, fishing gear, and region reported by Oman since 2015 (Appendix I), and Malaysia since 2018. In addition, some information on the value of marine fishery landings has been collected by the Southeast Asian Fisheries Development Center (SEAFDEC) since the late 1970s. Annual price data (USD) for some neritic tunas and seerfish are available for Thailand between 2009 and 2017 but the information remains sparse and mostly indicative of the differences of value between species as the series are not complete.

The Fisheries Development Division of the Pacific Islands Forum Fisheries Agency (FFA) has been collating monthly time series of crude oil price, a major driver of operating costs in tuna fisheries (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 the derived time series of fuel price covering the period 2000-2021 is given in Appendix II.

Regional Observer Scheme

Resolution 22/04 *"On a Regional Observer Scheme"* (ROS) makes provision for the development and implementation of national observer programmes 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"*. As part of the ROS *"(…) each CPC shall ensure that all fishing vessels of 24 meters length overall and above and under 24 meters, if they operate outside the exclusive economic zone (EEZ) of the flag CPC and in the IOTC area of competence, comply with the minimum observer coverage of 5% as defined by the number of operations/sets"*. 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 (2021).

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 contains information for a total of 1,699 commercial fishing trips (949 from purse seine vessels and 750 from longline vessels of various types) made during the period 2005-2021 from seven fleets, namely: 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, although observer reports have been submitted to the Secretariat by other fleets (e.g., Taiwan,China), these were not provided in an electronic format suitable for automated data extraction of information at the operational level – as instead required by the ROS standards (Athayde & IOTC 2018) – *de facto* preventing the entry of these data in the ROS regional database.

Morphometric data

The current IOTC length-weight relationships of reference for Indian Ocean neritic tunas and seerfish were developed based on morphometric data collected through fisheries monitoring programs conducted in landing sites of Sri Lanka in the 1980s, and I.R. Iran and India in more recent years (**Table 1**). For longtail tuna, the relationship was based on more than 4,300 samples collected from five sites located along the north coast of the Persian Gulf and Oman Sea between 2006 and 2007, covering well the size range of the species between 40 and 120 cm fork length (Kaymaram et al. 2011). Very little information is available on the data collected throughout the Indo-Pacific Tuna Development and Management Programme (IPTP) and used for estimating the length-weight relationships of kawakawa, frigate tuna, bullet tuna, and narrow-barred Spanish mackerel (IPTP 1989). Furthermore, the length-weight parameters appear to be identical for frigate and bullet tunas. For Indo-Pacific king mackerel, all samples come from the Bay of Bengal Large Marine Ecosystem and the relationship is only available for fish measured in total length (Dutta et al. 2012). No length-length relationships are currently available to the IOTC, although such relationships have been published for kawakawa, frigate tuna, and bullet tuna caught in Sri Lankan waters (Herath et al. 2019).

Table 1: IOTC reference length-weight power relationships for Indian Ocean neritic tunas and seerfish. FL = fork length (cm); TL = total length (cm); RD = round weight (kg)

Code	Species	Length type	a	b	Min length	Max length	Reference
LOT	Longtail tuna	FL	2.0000e-05	2.83000	40	120	Kaymaram et al. (2011)
KAW	Kawakawa	FL	2.6000e-05	2.90000	20	65	IPTP (1989)
FRI	Frigate tuna	FL	1.7000e-05	3.00000	20	45	IPTP (1989)
BLT	Bullet tuna	FL	1.7000e-05	3.00000	10	40	IPTP (1989)
COM	Narrow-barred Spanish mackerel	FL	1.1760e-05	2.90020	20	200	IPTP (1989)
GUT	Indo-Pacific king mackerel	TL	1.0000e-05	2.89445	15	68	Dutta et al. (2012)

Methods

The release of the latest versions of the curated data sets for neritic tuna and seerfish species in the public-domain, 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 ones 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 catches are not reported by a CPC, catch data from the previous year may be repeated or 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 fleets, 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 retained catches by species and gear when they are reported as aggregates (IOTC 2016). In short, the process derives the proportion of catch for each IOTC species and/or gear using a combination of data from strata where these are reported separately, and reverting on proxy gears and fleets and a spatial-temporal substitution scheme when required.

A total of 7 aggregates that include IOTC neritic tuna and seerfish species have been reported as retained catches to the Secretariat by some CPCs for years between 1950 and 2021 (**Table 2**).

Table 2: List of species aggregates with their component species that have been used to report nominal retained catches of neritic tunas and seerfish to the IOTC Secretariat. BLT = bullet tuna; COM = narrow-barred Spanish mackerel; FRI = frigate tuna; GUT = Indo-Pacific king mackerel; KAW = kawakawa; LOT = longtail tuna

Aggr. code	Species aggregate	BLT	COM	FRI	GUT	KAW	LOT
AG06	Kawakawa, frigate and bullet tunas	✓		✓		✓	
AG10	Skipjack tuna and kawakawa					✓	
FRZ	Frigate and bullet tunas	✓		✓			
KGX	Seerfishes nei		✓		✓		
TUN	Tunas nei	✓		✓		✓	✓
TUS	True tunas nei						✓
TUX	Tuna-like fishes nei	✓	✓	✓	✓	✓	✓

A total of 6 gear aggregates have been used by some CPCs report retained catch data of IOTC neritic tuna and seerfish species to the Secretariat for years between 1950 and 2021 (**Table 3**).

Table 3: List of gear aggregates with their component gear codes that have been used to report retained catches of neritic tunas and seerfish to the IOTC Secretariat. BB = baitboat; GILL = gillnet; HAND = handline; LIFT = lift net; LL = deep-freezing longline; LLCO = coastal longline; PS = purse seine; RR = rod and reel; SPOR = gears used for sport fishing; TRAW = trawl; TROL = trolling line

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	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Details on the results of the estimation process used to derive the 2021 best scientific estimates for 2021 including the changes in time series of retained catches relative to the previous Working Party on Neritic Tunas are provided in Appendix III and Appendix IV, respectively.

Third, 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 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 2020). The standard length measurements considered at IOTC are eye-fork length (EFL; straight distance from the orbit of the eye to the fork of the tail) for black and blue marlins, and 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 2020). 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.

Data quality

A scoring system has been designed to assess the reporting quality of retained catch, catch and effort, and size-frequency data submitted to the Secretariat for all IOTC species. The determination of the score varies according to each 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 data such as issues in sampling and processing as well as under- or 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 tonne caught)	2	
	Not available	8	

Results

Retained catches & discards

The best scientific estimates of retained catches provide a decadal view on the history of the fisheries catching neritic tuna and seerfish species in the Indian Ocean. These species are caught with a large diversity of fishing gears all over the Indian Ocean although very few catches have been reported over time from the coastal waters of South Africa and Australia.

Historical trends (1950-2021)

The contribution of catches of neritic tunas and seerfish to total catches of IOTC species in the Indian Ocean has changed substantially over the last decades in relation with the development and expansion of coastal and industrial fisheries, e.g., following the arrival of industrial purse seine fleets to the Indian Ocean in the early-1980s which caused an increase in targeting of tropical tunas (**Fig. 2a**). In recent years, the six species of neritic tuna and seerfish under IOTC mandate represented about one third of the total catches of IOTC species (**Fig. 2b**).

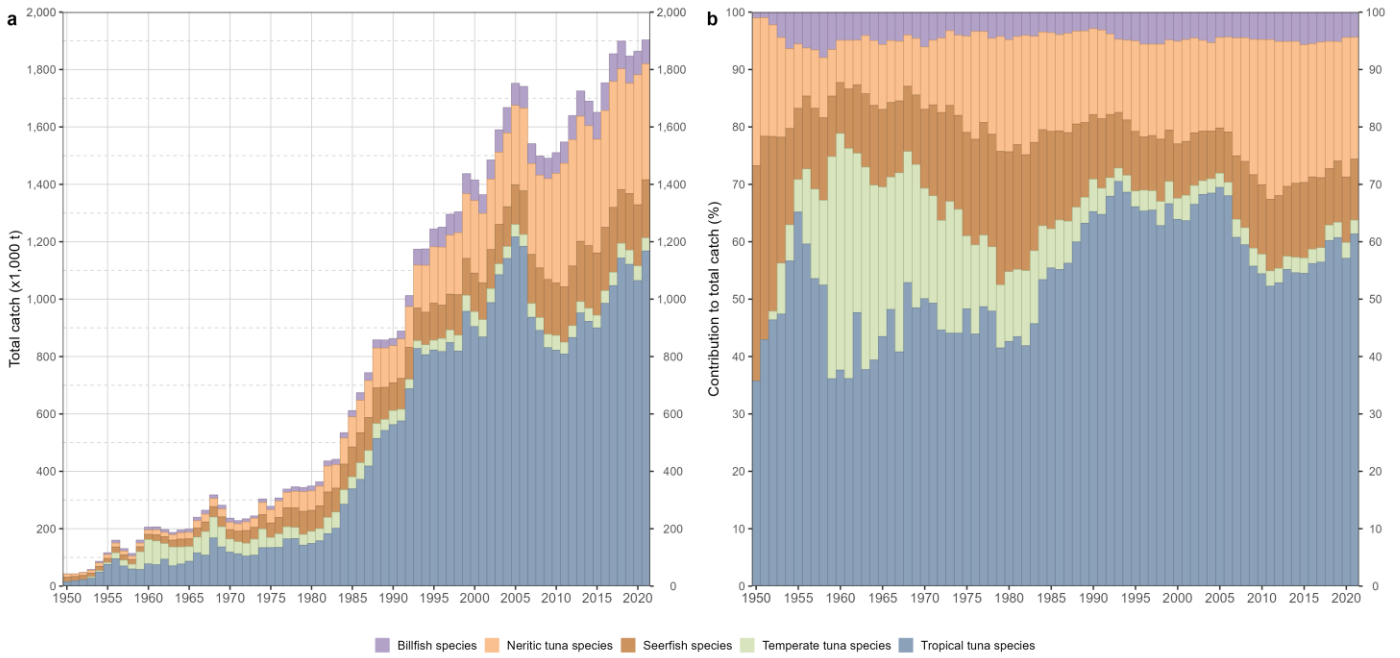

Figure 2: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of IOTC tuna and tuna-like species by species category for the period 1950-2021

The retained catches of the IOTC neritic tuna and seerfish species showed a major increase over the last seven decades, from less than 34,000 t reported in the 1950s to a maximum of about 666,000 t in 2020 (**Fig. 3**). Neritic tuna and seerfish species are mainly caught using drifting gillnets and surrounding nets (purse seines and ring nets) in coastal waters where they are also caught using troll lines, hand lines, small longlines and other gears (e.g., beach seines). Very few catches are reported for pole and line and high seas longline fisheries (**Fig. 3**).

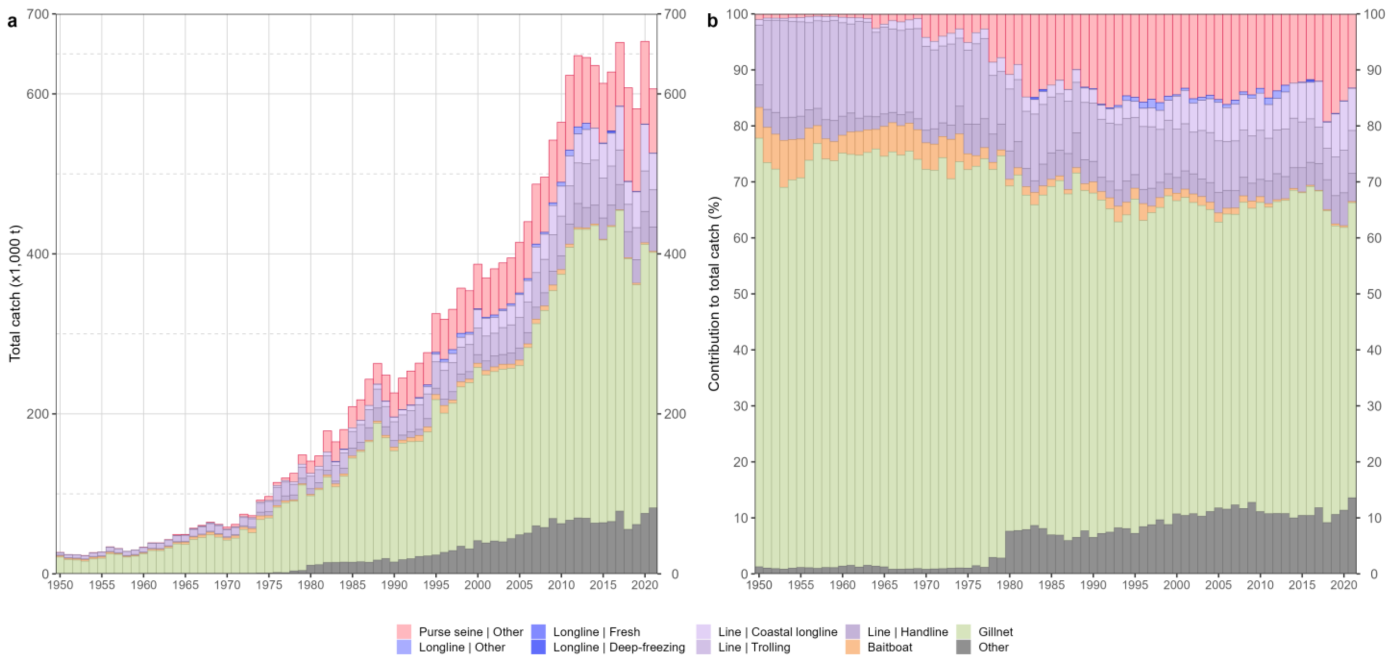

Figure 3: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of IOTC neritic tunas and seerfish by fishery for the period 1950-2021

About 18.5 million t of neritic tunas and seerfish have been reported to have been caught in the Indian Ocean since the 1950s, with narrow-barred Spanish mackerel being the main contributor with about 5.4 million t caught between 1950 and 2021 (**Fig. 4**). Kawakawa and longtail tuna contributed about equally, with cumulative catches of about 4.3 and 3.9 million t of fish taken during the period, respectively, while catches of frigate tuna and Indo-Pacific king mackerel were lower with about 2.9 and 1.6 million t, respectively. Bullet tuna represents the smallest component of the IOTC neritic species with a cumulative catch of about 0.3 million t between 1950 and 2021 (**Fig. 4**).

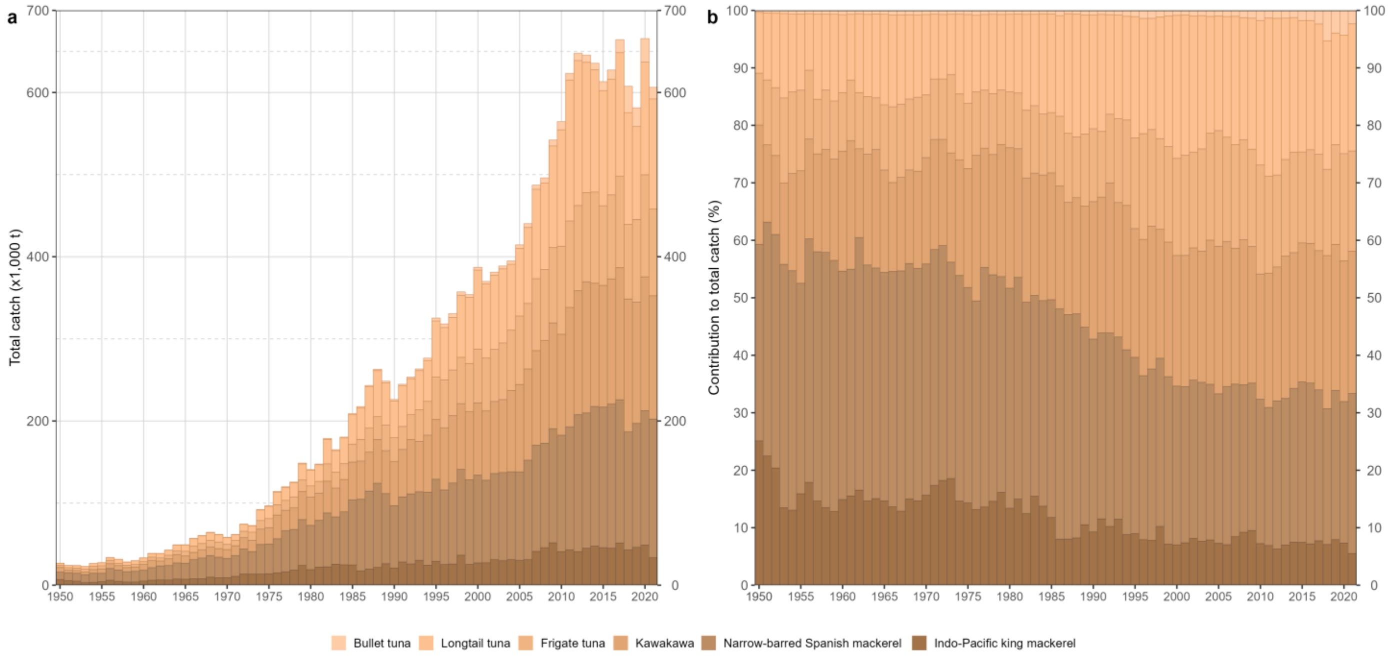

Figure 4: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of IOTC neritic tunas and seerfish by species for the period 1950-2021

Each of the six IOTC neritic tuna and seerfish species shows an increasing trend in nominal retained catches over time until recent years (**Fig. 5**). Following a period of steady increase for almost seven decades, the cumulative retained catch of all species reached a peak at 648,000 t in 2012, before declining down to 581,000 t in 2019. This decrease - which concerned longtail tuna, frigate tuna, and (to a lesser extent) narrow-barred Spanish mackerel - has been essentially driven by the reduction of the catches of gillnetters from I.R. Iran and Pakistan and small-scale purse seiners from Malaysia. In 2020, catches re-increased to 666,000 t but showed a marked decrease of around 10% to 606,000 t in 2021 (see Recent fishery features).

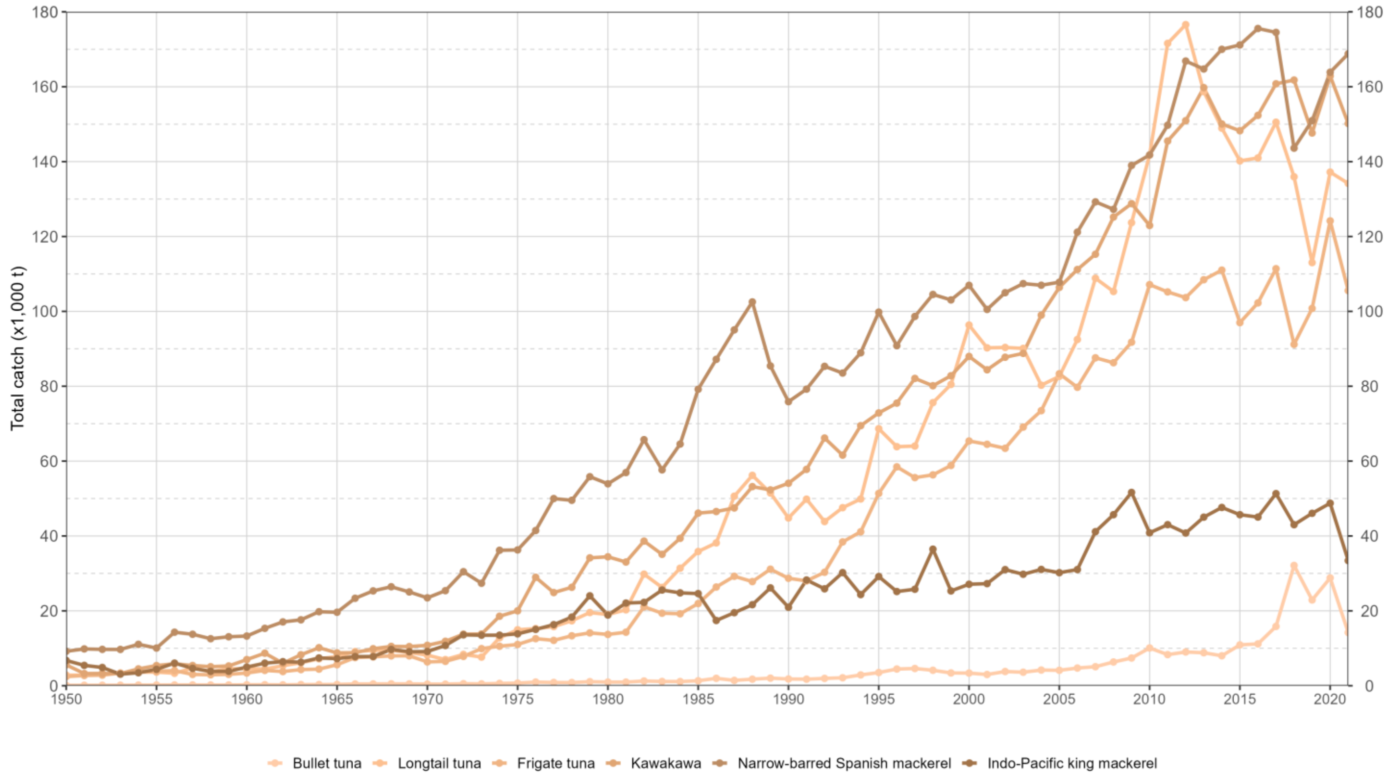

Figure 5: Annual time series of retained catches (metric tonnes; t) of IOTC neritic tunas and seerfish by species for the period 1950-2021

Recent fishery features (2017-2021)

In recent years (2017-2021), the mean annual retained catches of all IOTC neritic tuna and seerfish species stood at about 625,000 t per year, with gillnet, line (including handline, coastal longline and trolling), and purse seine fisheries contributing to 53.4%, 19.5%, and 15.5% of total annual catches, respectively (**Table 5**).

Table 5: Mean annual retained catches (metric tonnes; t) of IOTC neritic tunas and seerfish by fishery between 2017 and 2021 with indication of contribution of each fishery to the total

Fishery	Fishery code	Catch	Percentage
Gillnet	GN	333,915	53.4
Purse seine | Other	PSOT	96,814	15.5
Other	OT	70,703	11.3
Line | Coastal longline	LIC	46,200	7.4
Line | Trolling	LIT	42,883	6.9
Line | Handline	LIH	32,632	5.2
Baitboat	BB	1,484	0.2
Longline | Fresh	LLF	387	0.1
Longline | Deep-freezing	LLD	52	0.0
Longline | Other	LLO	0	0.0

Between 2017 and 2021, the mean annual retained catches of the IOTC neritic tunas and seerfish have been dominated by a few CPCs, to the point that about 70% of all catches was accounted for by three distinct fleets: Indonesia and India, which are characterized by a large diversity of coastal gears and fisheries, and I.R. Iran, where gillnet represents the large majority of the catches (**Fig. 6**).

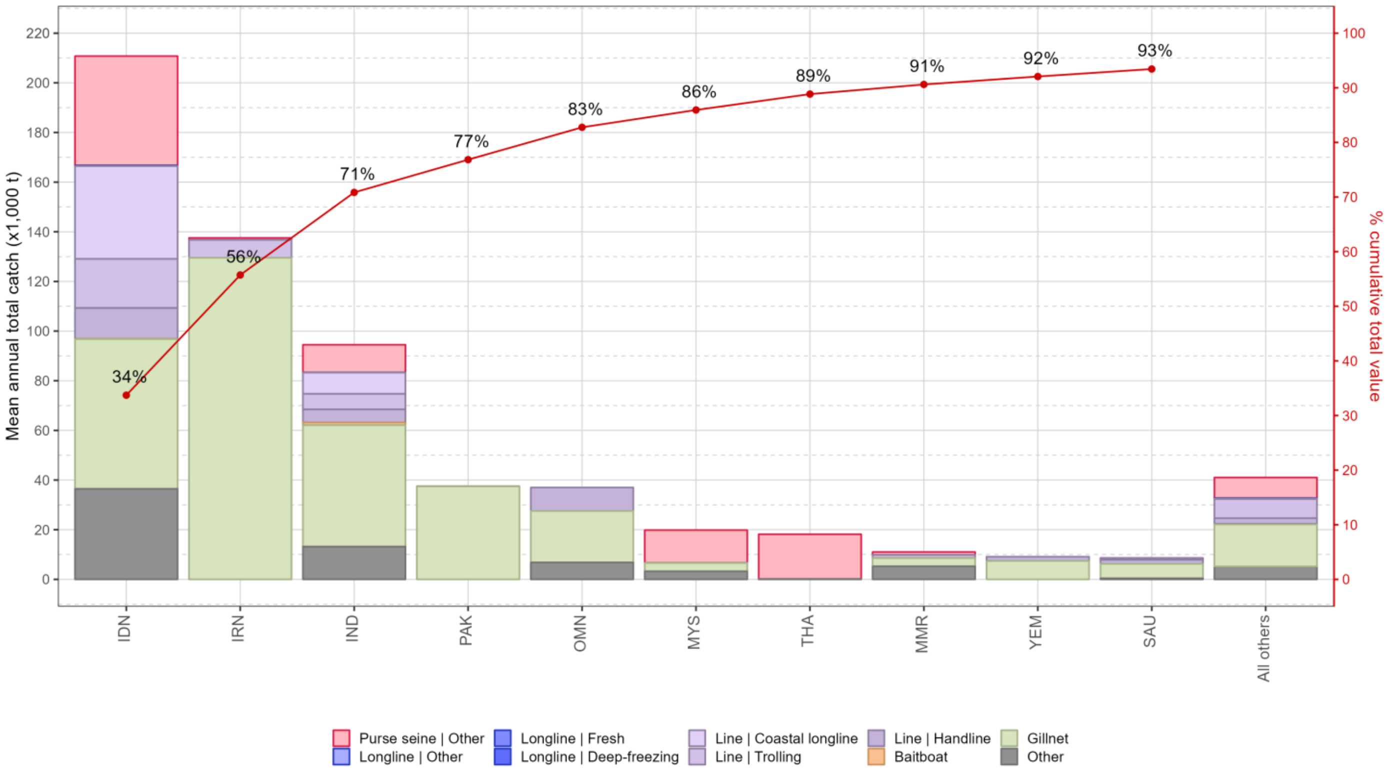

Figure 6: Mean annual retained catches (metric tonnes; t) of IOTC neritic tunas and seerfish by fleet and fishery between 2017 and 2021, with indication of cumulative contribution (percentage; %) of catches by fleet

Over that period the total gillnet catches showed an initial and substantial decline with some signs of recovery in the last two years, which brought the total catches of IOTC neritic and seerfish species from gillnet fisheries to 319,000 t in 2021 (**Fig. 7**). Catches from line fisheries increased in recent years to reach 122,000 t in 2021, while purse seine catches substantially decreased to reach the same level reported in 2017 of about 80,000 t in 2021 (**Fig. 7**).

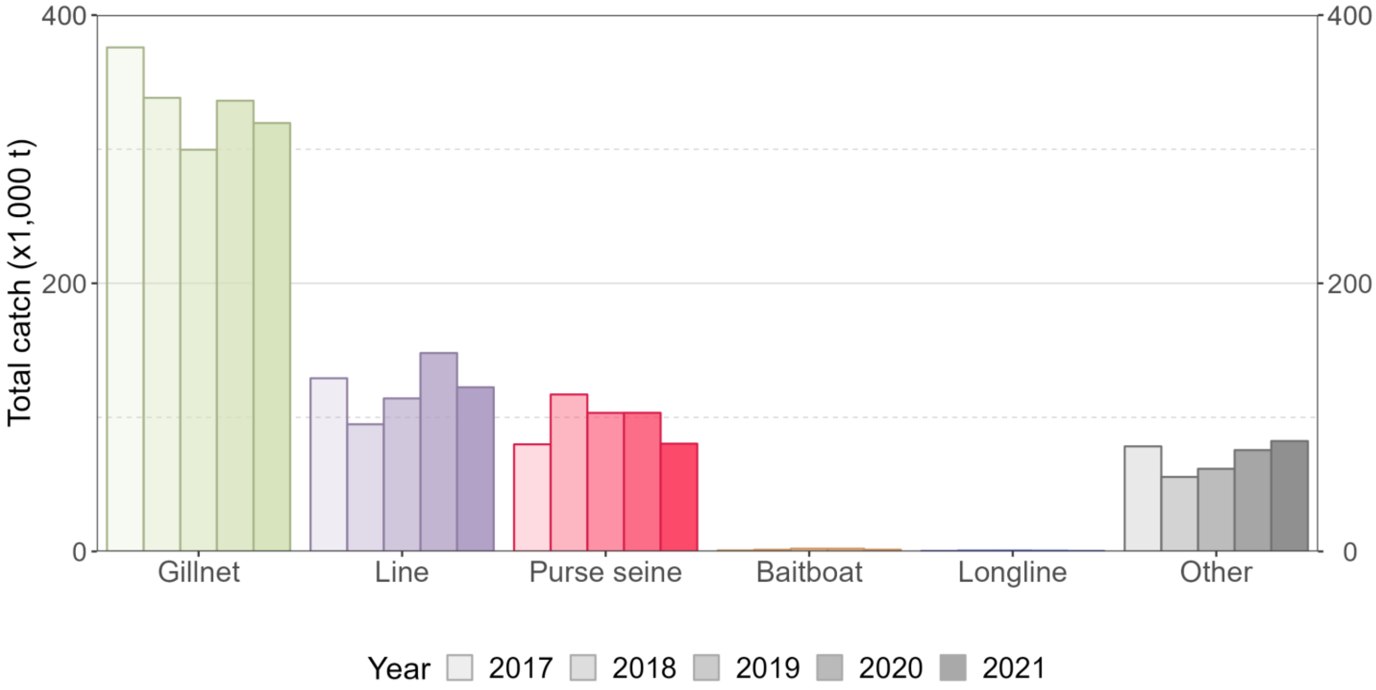

Figure 7: Annual trends in retained catch (metric tonnes; t) of IOTC neritic tunas and seerfish by fishery group between 2017 and 2021

The decline in gillnet catches has been particularly marked in Pakistan since 2017 due to a combination of factors, including fishing closures, reduced demand from the Iranian market (which was one of the main export markets for the species), and poor environmental conditions (Moazzam 2021). Catches of neritic and seerfish species from Iranian, Indian and Sri Lankan gillnet fisheries also showed a decreasing trend over the recent period while they increased for Indonesia and all other countries (**Fig. 8a**). In particular, catches from Omani gillnetters increased from 23,000 t in 2020 to 32,000 t in 2021.

Catches from line fisheries are mostly driven by Indonesia which showed a quite large variability over the recent time period, with catch levels varying from a minimum of 51,000 t in 2018 to a maximum of 87,000 t in 2020 (**Fig. 8b**). Between 2020 and 2021, line fisheries of Indonesia, India, Oman, and I.R. Iran all showed a decrease in catches of neritic species (**Fig. 8b**).

Neritic tunas and seerfish caught with purse seines in Indonesia showed a major decline over the recent time period, with the information reported to the Secretariat indicating an almost two-fold decrease from 63,000 t in 2017 to about 33,000 t in 2021 (**Fig. 8c**). Catches of neritic species also declined between 2020 and 2021 in the purse seine fisheries of Thailand, Malaysia, and India to a lesser extent (**Fig. 8c**).

Finally, a large amount of catches of neritic species (~70,000 t during the period 2017-2021) comes from fisheries using other gear types (e.g., beach seine, liftnet, etc.) that mostly occur in coastal areas of Indonesia, India, Oman, Myanmar, and Malaysia (**Fig. 8f**). In 2021, Bangladesh reported for the first time a large amount of tuna and tuna-like species caught as bycatch in liftnet and trawl fisheries, which resulted in an estimate of about 14,000 t of neritic tunas and seerfish for that year.

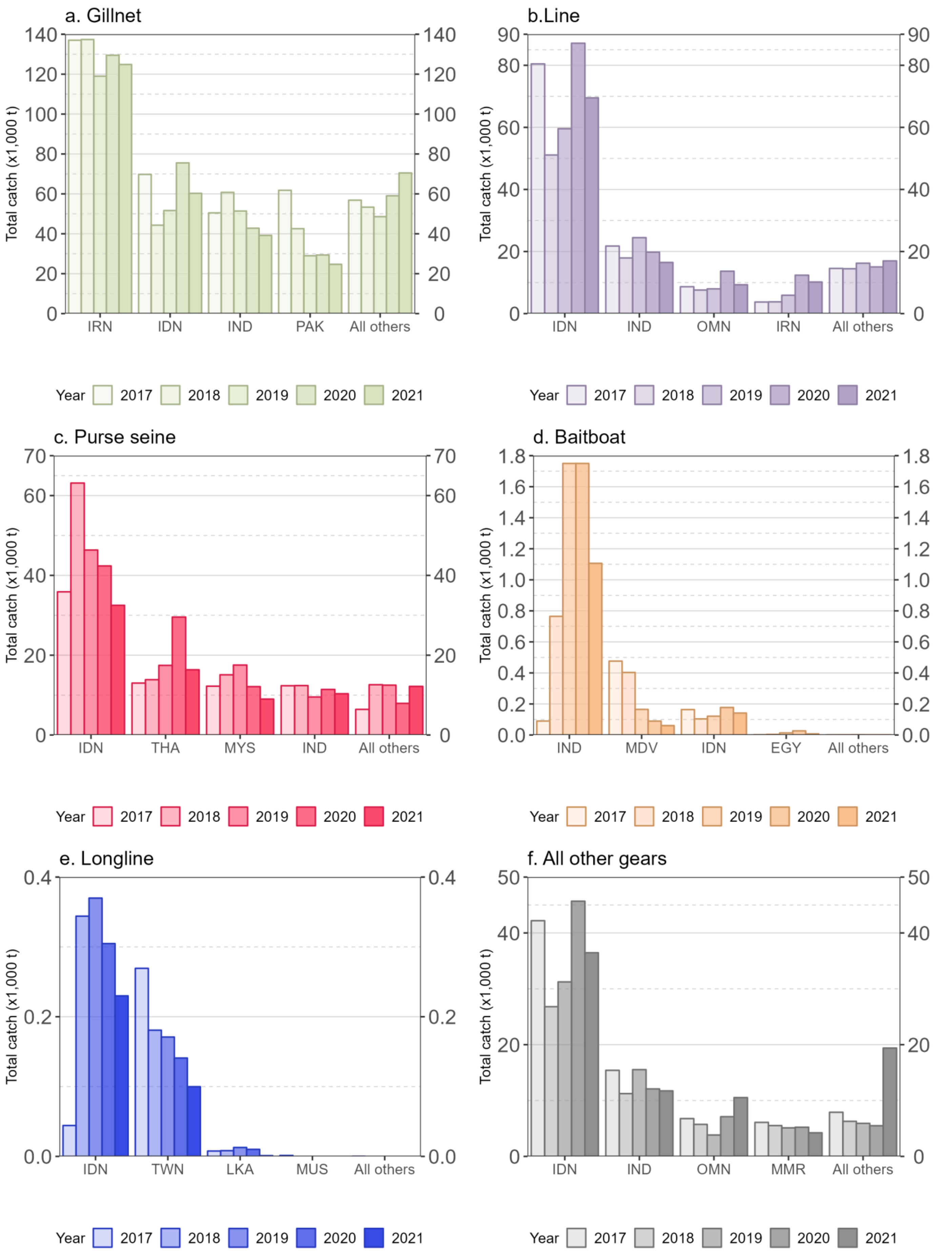

Figure 8: Annual trends in retained catch (metric tonnes; t) of IOTC neritic tunas and seerfish by fishery group and fleet between 2017 and 2021

Changes from previous Working Party

Some changes occurred in the time series of retained catches of neritic and seerfish species since the release of the data sets prepared for the 12th session of the Working Party on Neritic Tunas held in July 2022 which covered the period 1950-2020 (WPNT12). The changes concerned the period 2010-2020 and were due to (i) data revisions submitted to the Secretariat by some CPCs (I.R. Iran, Japan, Kenya, and Mozambique), (ii) a re-estimation of the catches by the Secretariat for Indonesia (2010-2013 and 2017) and Kenya (2020), and (iii) updates in the time series of the FAO global capture production database for some non-CPC coastal states (Myanmar, Qatar, and Saudi Arabia) (**Fig. 9**). The major change took place in 2017 and resulted in an increase in the total catch by about 45,000 t that followed updates reported by Indonesia for its coastal fisheries and how these were re-estimated by the Secretariat in agreement with the IOTC Scientific Committee. The detail of the changes by year, fleet, and main IOTC areas is given in Appendix II.

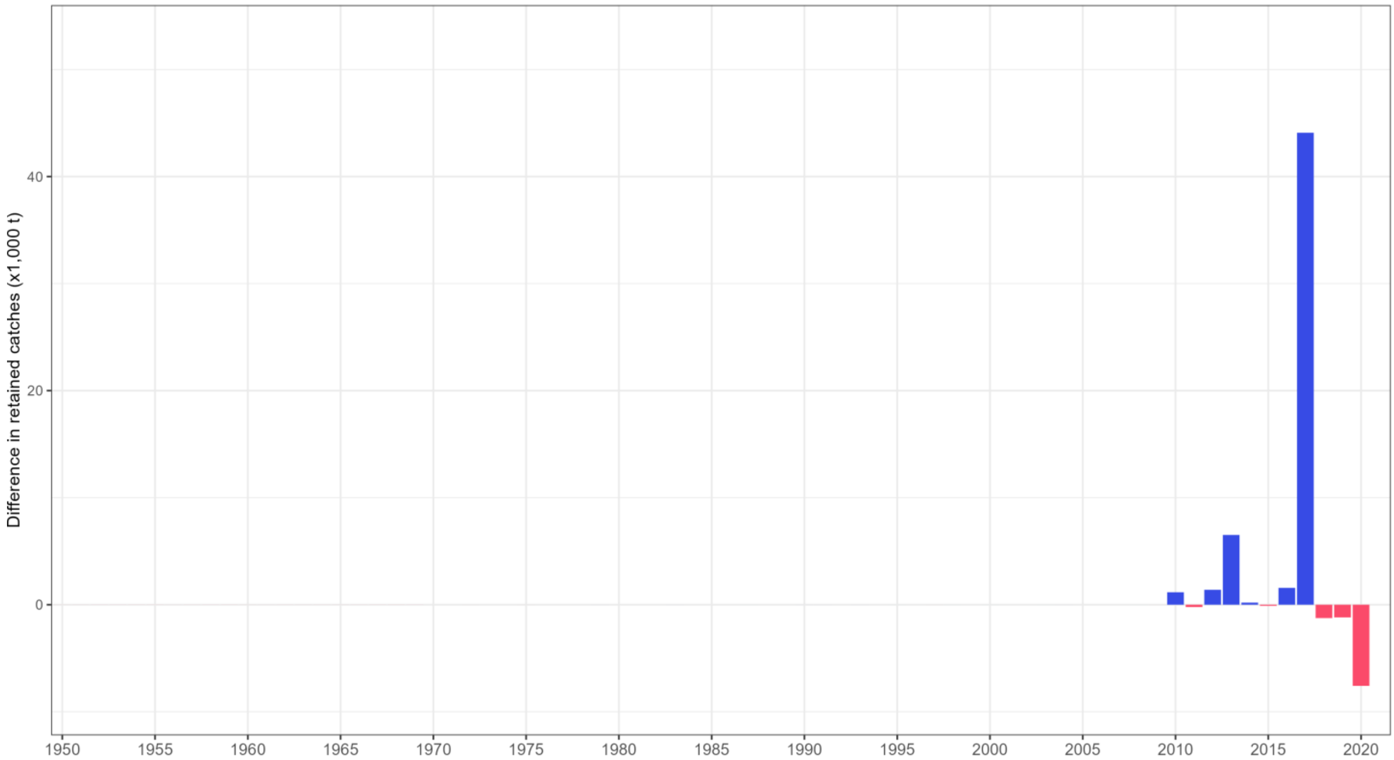

Figure 9: Differences in the annual retained catches (metric tonnes; t) of neritic tuna and seerfish available at this WPNT and its previous session

Uncertainties in retained catch data

Overall reporting quality scores

Overall, total estimated catches for neritic species in the Indian Ocean are considered to be highly uncertain. The majority of catches of neritic species in the Indian Ocean are caught within the areas under national jurisdiction of the coastal states, typically by small-scale or artisanal fisheries, which creates considerable challenges in terms of collecting reliable information from the diversity of vessels and fisheries operating in coastal waters. Difficulties in data collection are further compounded by species misidentification, particularly of juvenile tunas, that can lead to dramatic changes in reported catches by species between years.

In addition, a problem commonly encountered throughout the region is the reporting of distinct neritic species aggregated under a common label. Small or juvenile neritic tunas are often also treated commercially as the same species – particularly in the case of frigate and bullet tuna – and are often reported to the Secretariat as species aggregates or commercial categories, therefore requiring a disaggregation step to produce estimates at species level. Likewise, catches of narrow-barred Spanish mackerel and Indo-Pacific king mackerel may be combined and reported to the IOTC Secretariat as species aggregates of seerfish (e.g., Australia).

Annual changes in the composition of retained catches by quality score provide some insight into the level of uncertainty of the data available at the IOTC Secretariat. The quality scores of the nominal catches of the six IOTC neritic tunas and seerfish reflect the amount of catches that has to be estimated by the Secretariat to account for non-reporting of data, estimation of species and gear composition in the case of the reporting of aggregate gears and species, and outstanding issues in data quality for some major countries such as Indonesia and India. The percentage of nominal catches fully or partially reported to the Secretariat (i.e., with a quality score between 0 and 2) oscillated between 37.2% and 72.2% of the total catches over time, with an encouraging increasing trend since the mid-1990s until 2019. However, the reporting quality has decreased since then and 59.1% of all retained catch was fully or partially reported to the Secretariat in 2021 (**Fig. 10**).

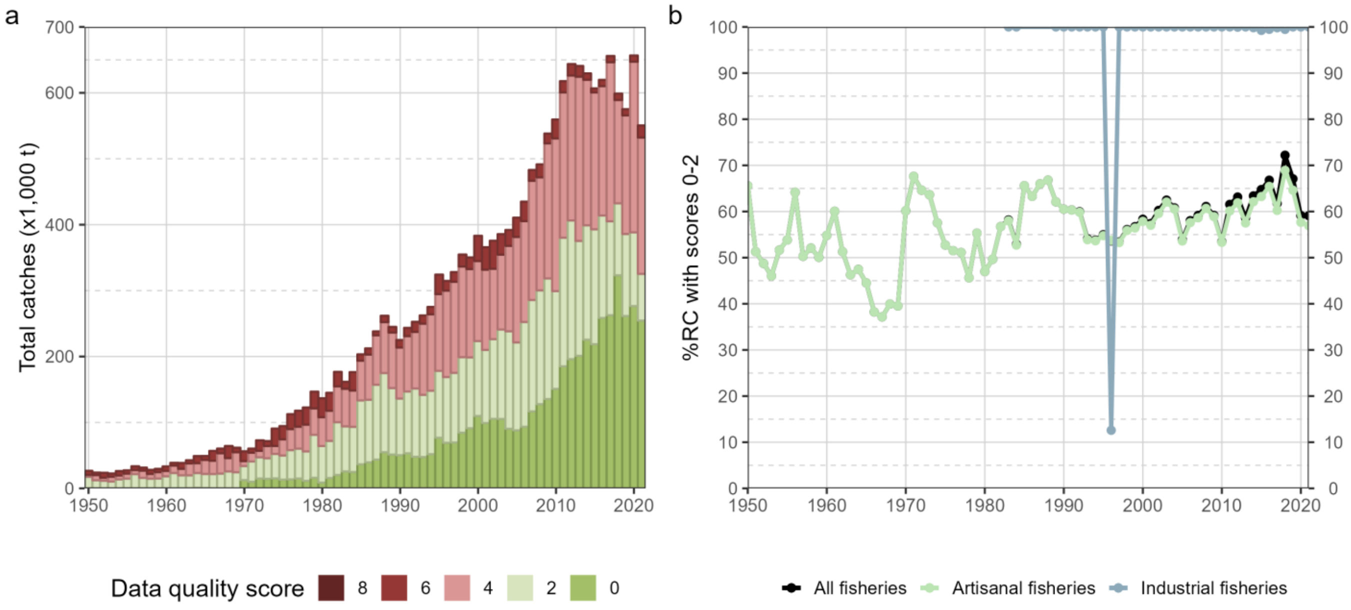

Figure 10: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches fully or partially reported to the IOTC Secretariat to all retained caches (percentage; %) of IOTC neritic tunas and seerfish for all fisheries and by type of fishery, for the period 1950-2021

In 2021, 46.2% of the retained catch was estimated to have been fully reported to the Secretariat while the rest had to be partially or fully estimated. Part of the catches was derived from alternative sources of catch data for the CPCs and non-CPC coastal states that did not report data to the Secretariat (Appendix III). In addition, a re-estimation process was performed for the artisanal fisheries of Bangladesh, India, and Indonesia as well as to account for the reporting of catch data through species aggregates (Appendix III).

The specific case of bullet tuna

Bullet tuna is the least abundant neritic tuna species with catches essentially dominated by Indian and Indonesian fisheries which represent about two thirds of of its total catch in the Indian Ocean in recent years. Data submitted to the Secretariat by Indonesia over the last decade show major interannual variability in catch levels as well as abrupt changes in the composition of catches by gear (**Fig. 11**).

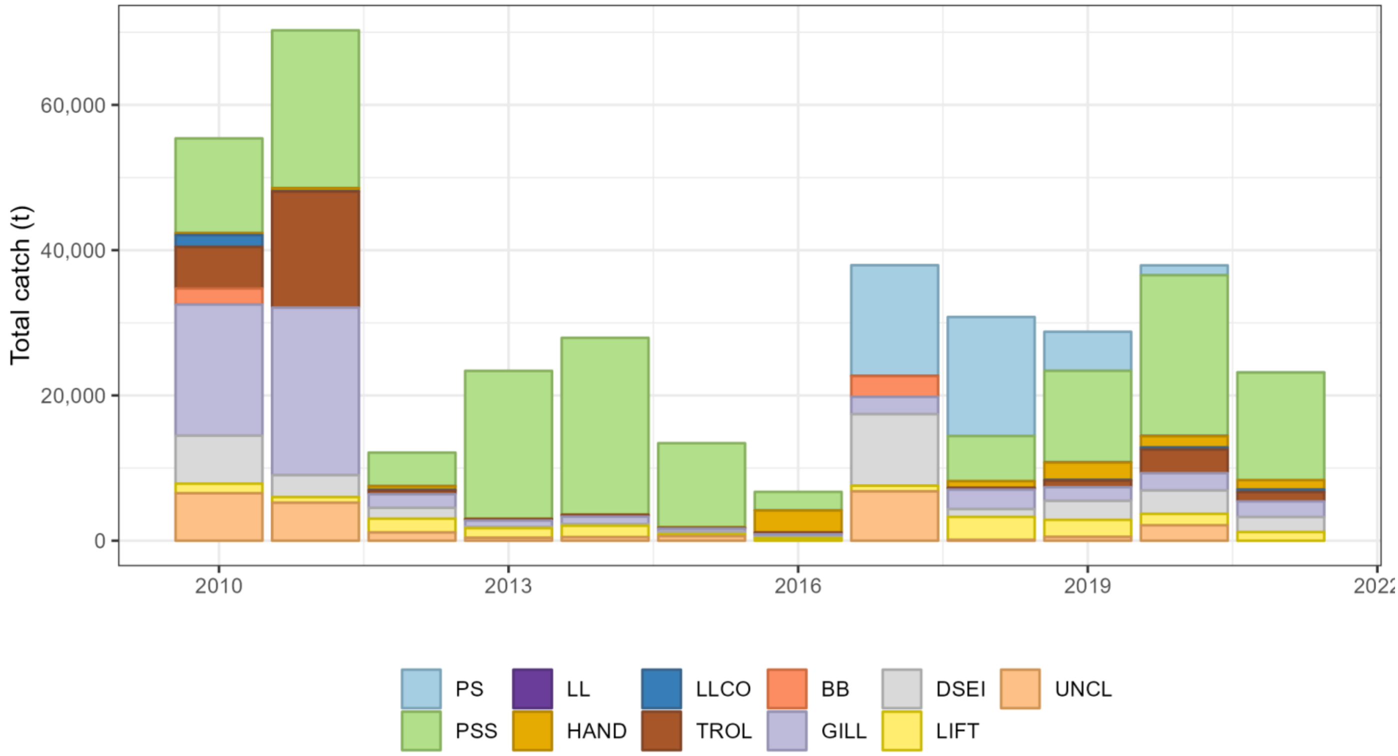

Figure 11: Annual time series of cumulative retained catches (metric tonnes; t) of bullet tuna by fishing gear as submitted to the IOTC Secretariat by Indonesia for the period 2010-2021. PS = industrial purse seines; PSS = coastal purse seines; LL = industrial longlines; HAND = handlines; LLCO = coastal longlines; TROL = trolling lines; BB = pole and lines; GILL = gillnets; DSEI = Danish seines; LIFT = lift nets; UNCL = Unclassified

The issues observed in data submissions stem from the complexity of Indonesian fisheries and are partly explained by long-standing problems with species identification and issues in the attribution of catches to the correct segment of the purse seine fleets (i.e., coastal vs. industrial - according to their IOTC definition in Resolution 15/02) reported to the Indonesian Ministry of Fisheries and Maritime Affairs (MFMA). To address these issues, the Secretariat is currently collaborating with Indonesia to review and improve the IOTC methodology developed in the early 2010s to estimate the catches of bullet tuna (and all other neritic species) taken in Indonesian coastal fisheries (Moreno et al. 2012, Indonesia 2022). In the meantime, the average composition of the catch by gear estimated by the Secretariat results in a major decrease of the catches of bullet tuna reported to the IOTC and the catch levels of the species are considered highly uncertain (**Fig. 12**).

Figure 12: Annual time series of retained catches (netric tonnes; t) by gear as reported to the IOTC Secretariat by Indonesia (IDN) and estimated by the IOTC Secretariat for the period 2018-2021

In addition, the composition of the catch of neritic tunas in the coastal purse seine fishery of Thailand has recently been reviewed and bullet tuna has been reported to occur in the catch since 2018 (**Fig. 13**). This has resulted in the catches of bullet tuna to increase from 0 t in 2017 to 2,960 t and 15,208 t in 2018 and 2020, respectively, during a period when the number of purse seiners has not showed much variation. The uncertainty in the Thailand purse seine catches of bullet tuna adds up to the uncertainties in the Indonesian catches to question the credibility of the time series of catches of bullet tuna currently available from the IOTC Secretariat.

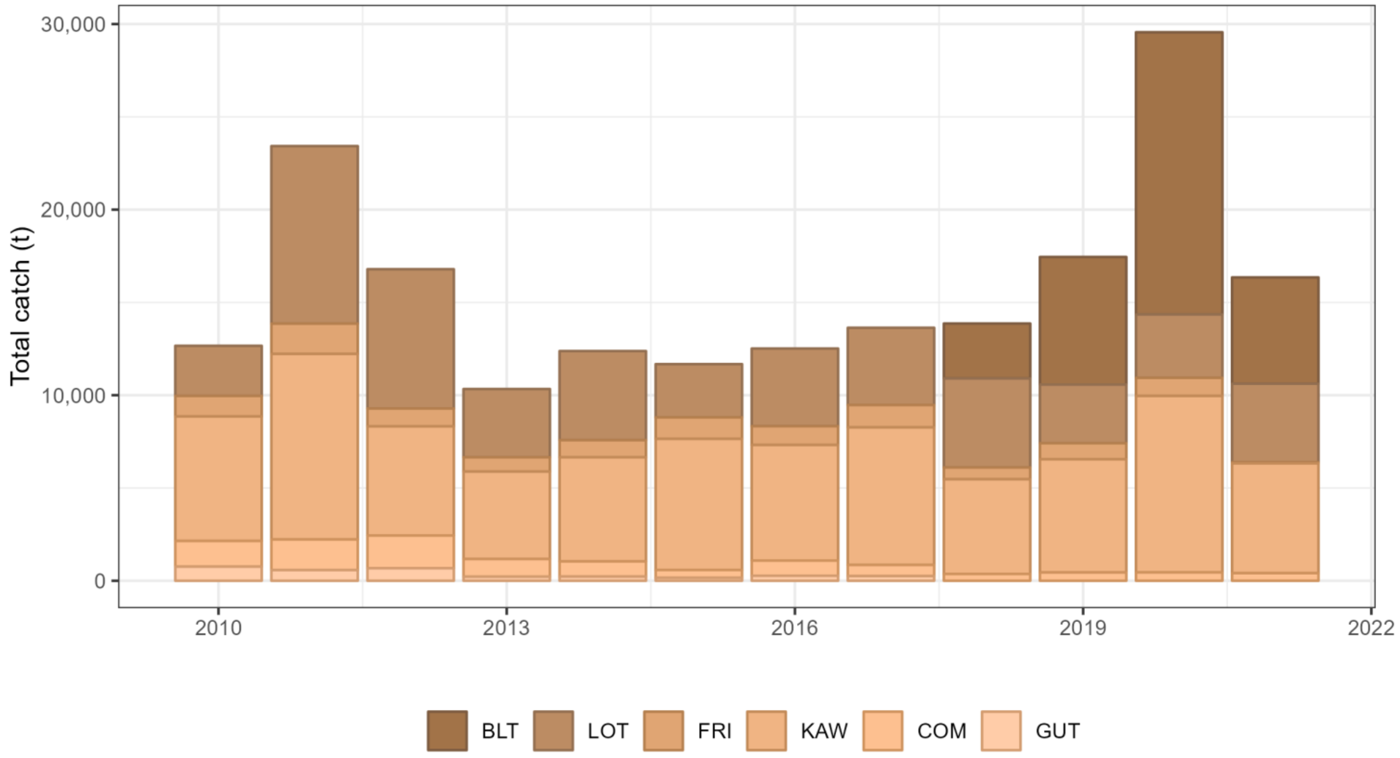

Figure 13: Annual time series of cumulative retained catches (metric tonnes; t) by gear as reported to the IOTC Secretariat by Thailand for the period 2018-2021

Discards

Overall, discarding is considered to be limited in coastal fisheries targeting neritic tunas and seerfish where there is a demand from canneries and local markets. By contrast, discarding has been found to occur in industrial fisheries that target tropical tunas and billfish but the bycatch volumes, which are seldom recorded in the logbooks nor monitored in ports, are considered to be small (Huang & Liu 2010, Amandè et al. 2012). In the case of Western Indian Ocean purse seine fisheries, the bycatch of neritic tunas has been shown to be essentially caught in association with drifting floating objects and estimated to be less than 2 t per 1,000 t of tropical tuna landed, amounting to a mean annual bycatch of about 600 t of fish during 2011-2017 (Ruiz et al. 2018).

Information collected through national fisheries observer programs and currently available in the ROS database is limited due to the non-compliance of several CPCs with IOTC Res. 11/04 and further accentuated by the various non-standard formats used for data collection and reporting by CPCs, which prevent the inclusion of several data submissions into the ROS database. Furthermore, due to the CoViD-19 pandemic, monitoring by observers was limited in 2020 and 2021, with some CPCs not running any scientific observer program in 2020.

Information available in the ROS regional database on interactions of IOTC fisheries with neritic tunas and seerfish during the period 2005-2021 indicates that discarding of neritic species is negligible in longline fisheries but common for frigate tuna and kawakawa in purse seine fisheries, and bullet tuna to a lesser extent (**Fig. 14**). Interestingly, observations of interactions of neritic tunas with the industrial purse seine fishery show the large extent of the distribution of frigate tuna, kawakawa, and bullet tuna across the whole Western Indian Ocean, notwithstanding the fact that these species were generally thought to be restricted to coastal areas.

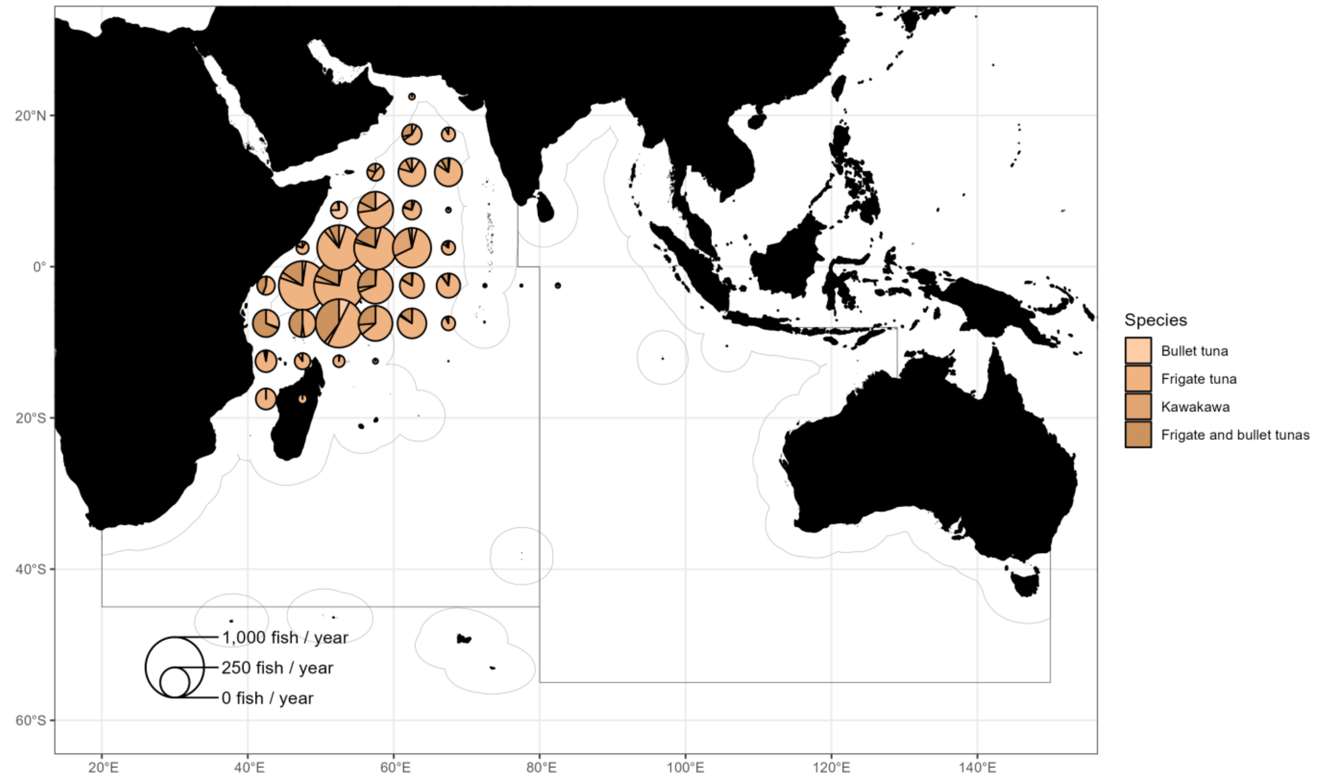

Figure 14: Distribution of interactions of neritic tunas with Western Indian Ocean purse seine fisheries as available in the ROS regional database. Light grey solid lines delineate areas beyond national jurisdiction

The release status (i.e., *alive* or *dead*) of neritic tunas discarded at sea by purse seine fisheries is currently not available in the ROS regional database due to the data exchange format used by the national institutes in charge of the observer programs, but most tunas discarded at sea are thought to be dead after release. Also, the current observer protocols only focus on discards while a component of the bycatch of neritic tunas may be retained for some international markets.

Size data collected at sea by scientific observers show that frigate and bullet tunas caught with purse seine have a similar fork length range (25-60 cm) with a median of about 38-40 cm. Kawakawas are generally larger, with a median size of 45.5 cm, and reaching up 70 cm in fork length (**Fig. 15**).

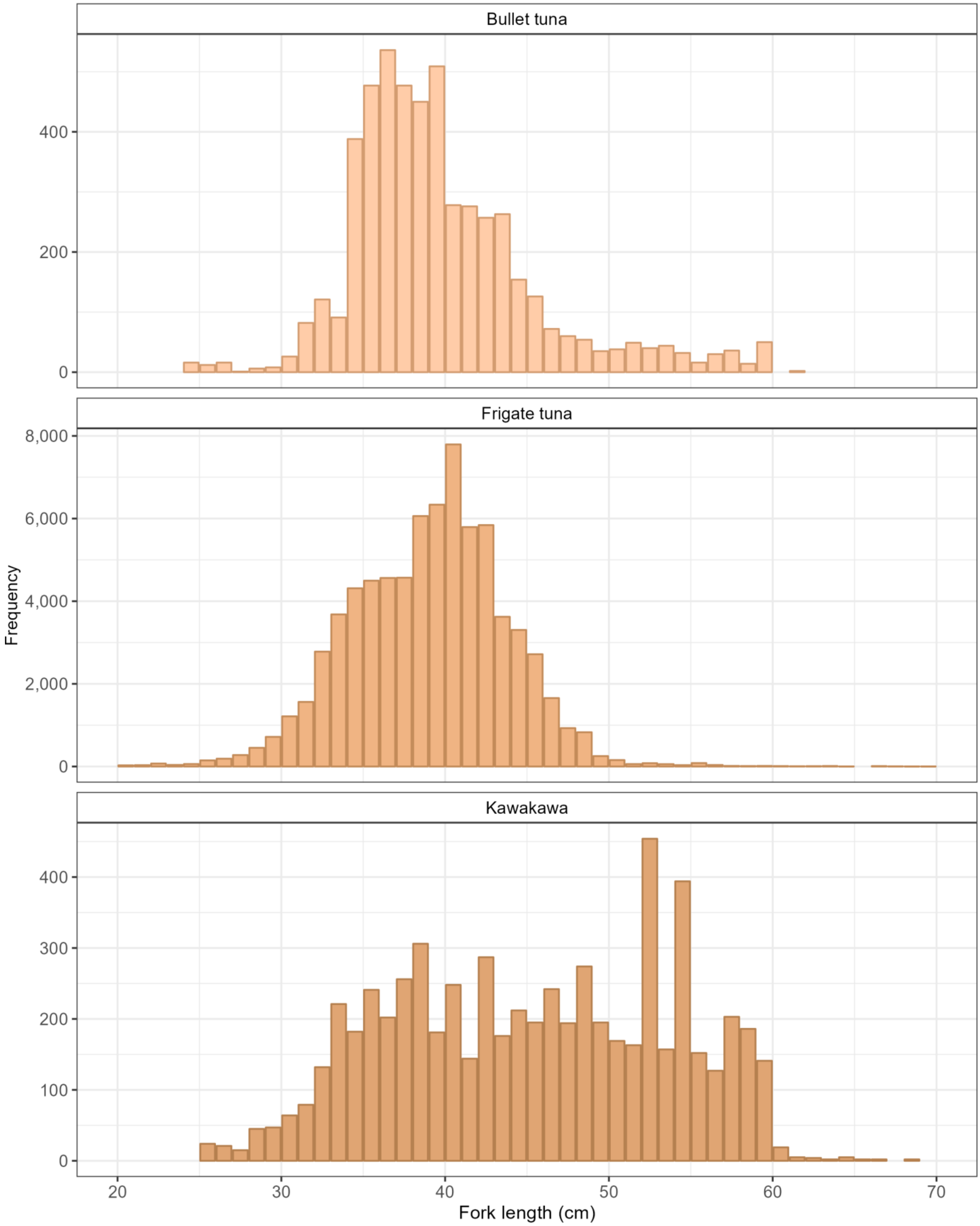

Figure 15: Size frequency distribution of neritic tunas caught in Western Indian Ocean purse seine fisheries as available in the ROS regional database

Spatial distribution of catch and effort

Geo-referenced catch and effort data are not available at all or only available for a very limited time frame for several major fisheries catching neritic species in the Indian Ocean. Furthermore, time series of effort are generally inconsistent as different units of effort (e.g., trips, days, etc.) may be used over time for the same fishery. In particular, even though Indonesia and India have accounted for around half of the total catches of neritic species in the Indian Ocean in recent years little information is available on the distribution of catch and effort for all their fisheries. Indonesia has started reporting time-area catches for some of its artisanal and industrial fleets since 2018 but the coverage appears to be very low (i.e., less than 5%) and not fully representative of the fishing grounds (see below). No geo-referenced catch and effort data have been reported for any of the coastal fisheries of India since 1981, although India reported an annual catch of about 95,000 t of fish caught in recent years. Furthermore, no geo-referenced data have been submitted to the Secretariat by Pakistan and Oman since 1991 and 2013, respectively, despite the significant contribution of the fisheries of these two CPCs to the total catches or neritic species in recent years (**Fig. 6**).

By contrast, I.R. Iran has collected a consistent time series of catch and fishing effort since 2007 through a port sampling program for their coastal and offshore gillnet fisheries. Following an IOTC Data Compliance mission conducted in late-2017, I.R. Iran has begun to report catch and effort data in accordance with the requirements of Resolution 15/02, which led to an improvement in the availability of time-area catches for Iranian gillnetters which represent one of the main fisheries for neritic tunas. In addition, a first attempt was made to derive time series of CPUE for longtail tuna, kawakawa, frigate tuna, and narrow-barred Spanish mackerel for the period 2008-2017 (Fu et al. 2019). The fishing effort reported for Iranian gillnetters is however expressed in fishing trips while the fleet is composed of more than 1,200 vessels in the size range from less than 15 m to more than 30 m length overall, which are therefore characterized by trips of significantly different lengths. Days at sea can be partly derived from trip-level data collected by the Iranian Fisheries Organization but they may include some bias (Fu et al. 2019). Further collaboration with I.R. Iran would be instrumental to further analyze the catch and effort data available from their gillnet fishery so as to support the development of stock assessment models for the neritic tunas and seerfish of the Indian Ocean.

Geo-referenced effort

Very little information is available on the fishing effort exerted by Malaysian purse seiners that caught a yearly average of 13,000 t of IOTC neritic species in recent years. The effort is only available since 2019 and limited to one 5°x5° square grid (**Fig. 16a**). Similarly, the spatial distribution of effort for Indonesian purse seiners is restricted to a few recent years and scattered in a limited number 1°x1° grids along the coasts of Indonesia, notwithstanding the fact that the national purse seine fleet is composed of more than 150 vessels larger than 24 m length overall (**Fig. 16b**). More effort data are available from the purse seine fisheries of Thailand and Sri Lanka but the time series remain short (**Fig. 16c-d**).

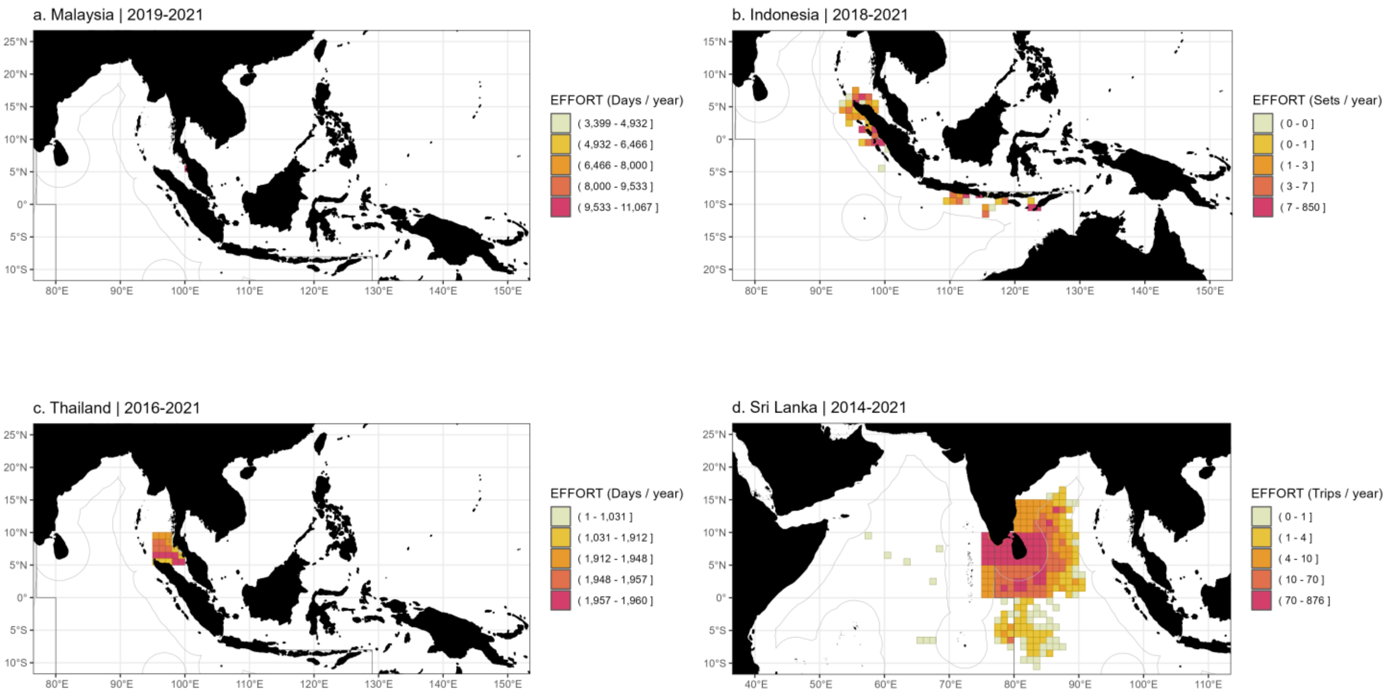

Figure 16: Distribution of fishing effort available at the IOTC Secretariat for purse seine fisheries catching IOTC neritic tunas and seerfish from (a) Malaysia (2019-2021), (b) Indonesia (2018-2021), (c) Thailand (2016-2021), and (d) Sri Lanka (2014-2021). Light grey solid lines delineate areas beyond national jurisdiction

Effort available from line fisheries is also restricted in time and space for Comoros and Oman, while effort from Indonesia is only available from 2019 onwards (**Fig. 16a-c**). Effort data from Maldives seem to be consistently reported since 2013, but the catches of neritic tunas and seerfish in Maldivian fisheries are almost negligible (**Fig. 16d**).

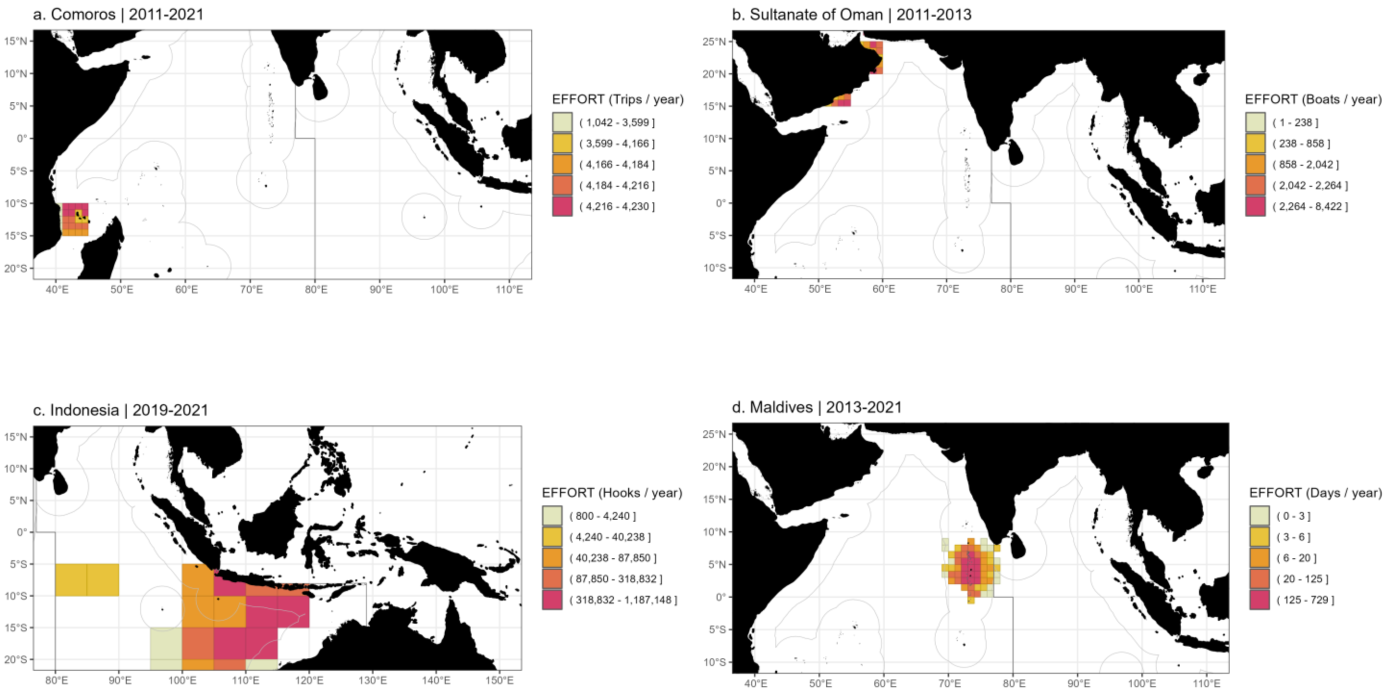

Figure 17: Distribution of fishing effort available at the IOTC Secretariat for line fisheries catching IOTC neritic tunas and seerfish from (a) Comoros (2011-2021), (b) Sultanate of Oman (2011-2013), (c) Indonesia (2019-2021), and (d) Maldives (2013-2021). Light grey solid lines delineate areas beyond national jurisdiction

Effort data for the gillnet fisheries of I.R. Iran and Sri Lanka are described by a better coverage than for purse seine and line fisheries. The effort from Iranian gillnetters is based on a large sample of vessels and appears to cover a large area of the northwestern Indian Ocean between 2007 and 2021 (**Fig. 18a**). The spatial distribution of the effort of the Sri Lankan gillnetters is also good in time and space (**Fig. 18b**). However, many Sri Lankan gillnetters used in the past a combination of gillnet and longline over a same fishing trip, with no accurate information collected of the composition of the catch by by the actual gear used, this preventing the use of nominal CPUE time series for deriving abundance indices for the species caught in this fishery.

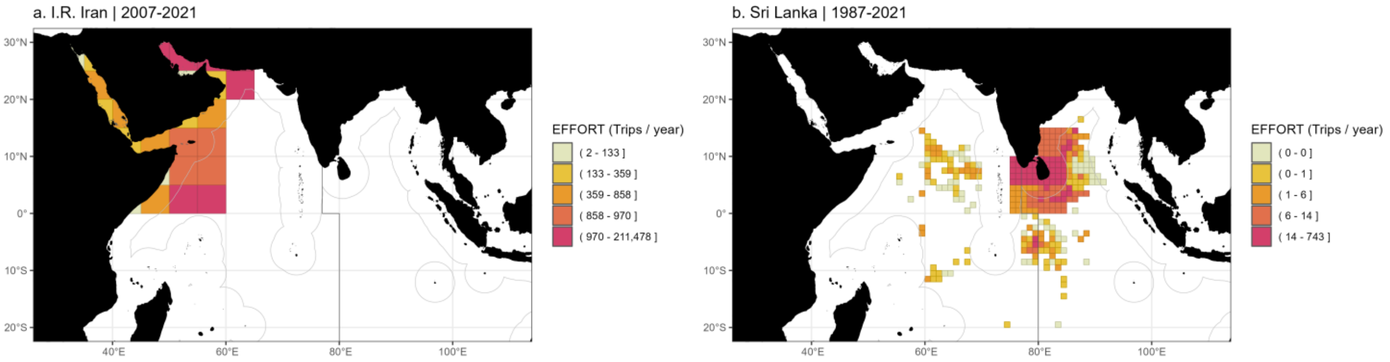

Figure 18: Distribution of fishing effort available at the IOTC Secretariat for gillnet fisheries catching IOTC neritic tunas and seerfish from (a) I.R. Iran (2007-2021) and (b) Sri Lanka (1987-2021). Light grey solid lines delineate areas beyond national jurisdiction

Geo-referenced catches

Decadal maps of mean annual catch by gear show the lack of spatial information available on the catches of the six IOTC neritic tuna and seerfish species over the decades 1970-2000 (**Fig. 19**).

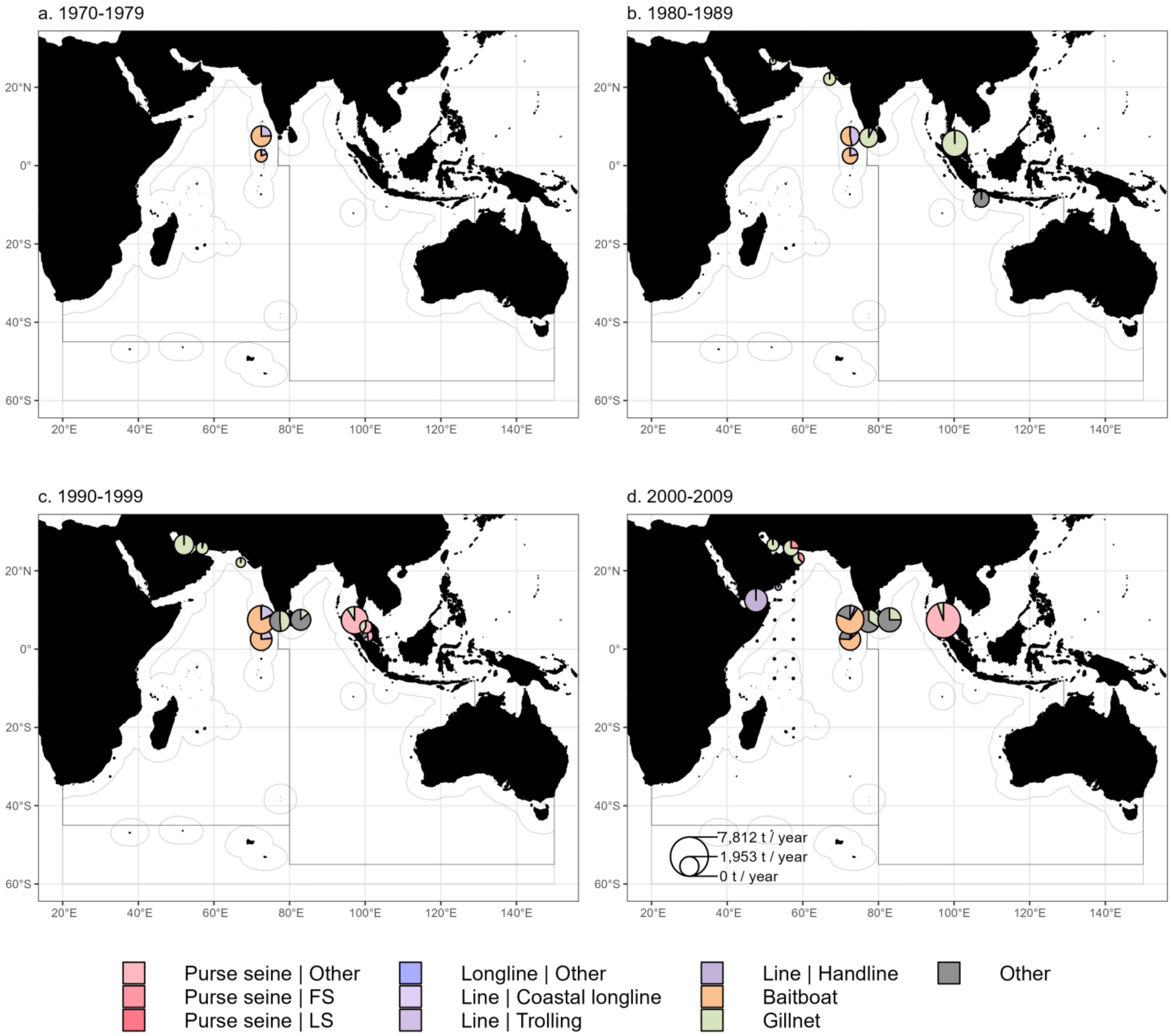

Figure 19: Mean annual time-area catches (metric tonnes; t) of IOTC neritic tuna and seerfish species by decade, 5x5 grid, and fishery as reported to the Secretariat. Light grey solid lines delineate areas beyond national jurisdiction

More information on the fishing grounds of IOTC neritic species has become available over the last decade (**Fig. 20**). However, the perception of the spatial extent of the fisheries in this period is biased by the limited geo-referenced data reported by some of the major neritic tunas fishing nations such as Indonesia, India, Pakistan, and Oman.

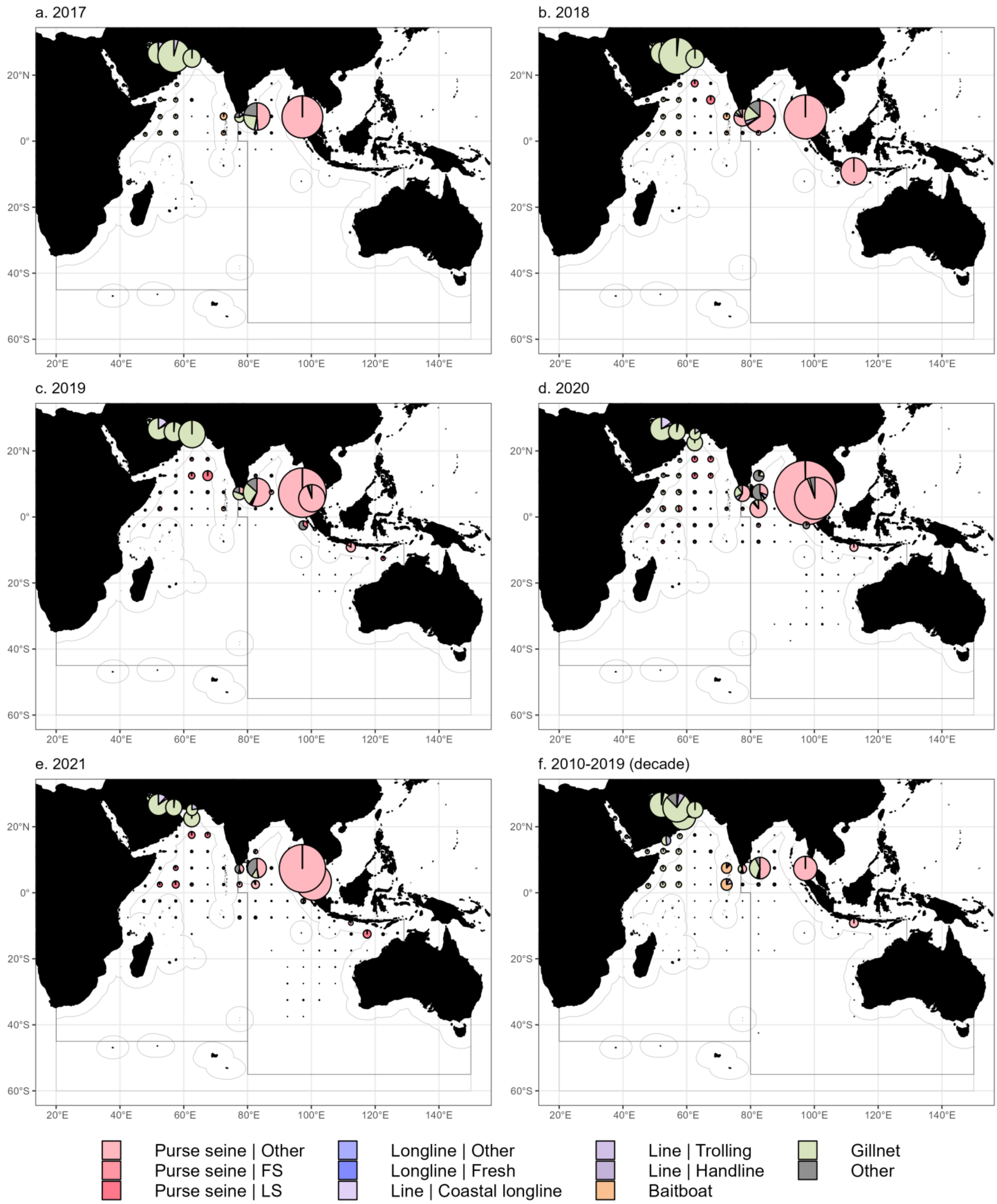

Figure 20: Mean annual time-area catches (metric tonnes; t) of IOTC neritic tuna and seerfish species by year for the period 2017-2021 and for the most recent decade, 5x5 grid, and fishery as reported to the Secretariat. Light grey solid lines delineate areas beyond national jurisdiction

Uncertainties in catch and effort data

Overall, the reporting quality of the geo-referenced catch and effort data submitted to the Secretariat is very low due to the lack of data for most of the main fisheries catching neritic tunas and seerfish in the Indian Ocean (**Fig. 21a**). Nevertheless, the quality of this data set has been showing an increasing trend since the mid-2000s in relation with the increasing reporting of data by some major fishing nations such as I.R. Iran, Thailand, and Sri Lanka. The percentage of retained catches for which adequate geo-referenced catch and effort data is available (scores 0-2; **Table 4**) reached 47.7% in 2021 (**Fig. 21b**).

Several issues are identified with the catch and effort data of coastal fisheries in particular:

- incomplete data reported to the Secretariat for hand lines and/or trolling lines (e.g., Oman, Madagascar);
- low sampling coverage (e.g., Indonesia);
- aggregate gears for coastal fisheries (e.g., Australia, EU,France);
- poor quality, where basic data requirements are not met (e.g., India);
- changes in effort unit over time (e.g., Thailand);
- use of trip as effort unit in fisheries described by a large range of sizes of vessels that may spend different periods at sea.

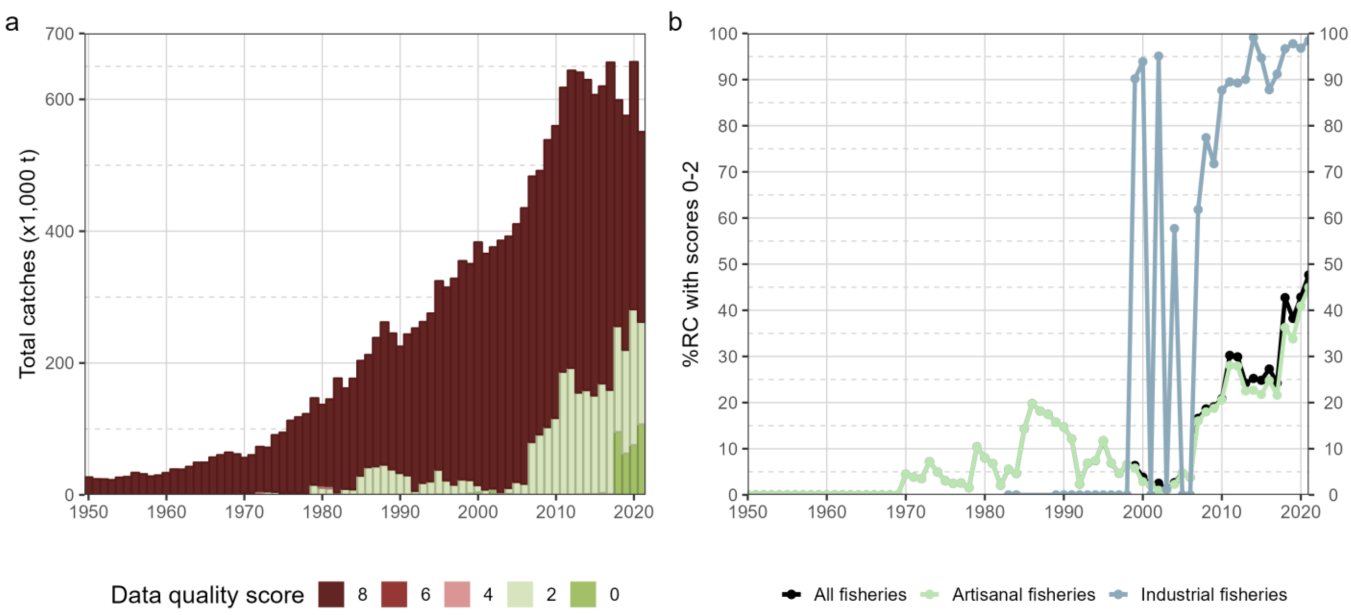

Figure 21: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches with corresponding geo-referenced catch and effort data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 to all retained caches (percentage; %) of IOTC neritic tunas and seerfish for all fisheries and by type of fishery, for the period 1950-2021

Size composition of the catch

Samples availability

The size samples available for neritic tunas and seerfish are largely dominated by gillnet fisheries which represent 75.5% of all size data available in the IOTC database. Some size samples are also available for purse seine (1985-2021), baitboat (1983-2021), and trolling line (1983-2021) fisheries, although in smaller numbers than for gillnet fisheries, while very few samples are available for all other fisheries (**Fig. 22**). It is interesting to note that some size data have been available from the 1980s, mostly from projects conducted under the Indo-Pacific Tuna Programme (IPTP), with some samples collected in Indonesia, Maldives, and Malaysia from the early 1980s and later on in Sri Lanka, I.R. Iran, and Pakistan.

Very few samples have been collected by coastal fisheries in recent years. For instance, Sri Lanka was annually sampling on average 194,000 fish between 1985 and 1993 when they have been measuring less than 6,000 samples annually between 2017 and 2021. On the contrary, I.R. Iran has been increasing the number of neritic fish sampled over the last decade, reaching around 129,000 in 2019, but decreasing recently to reach 69,000 fish in 2021 while the total catch levels have remained quite stable.

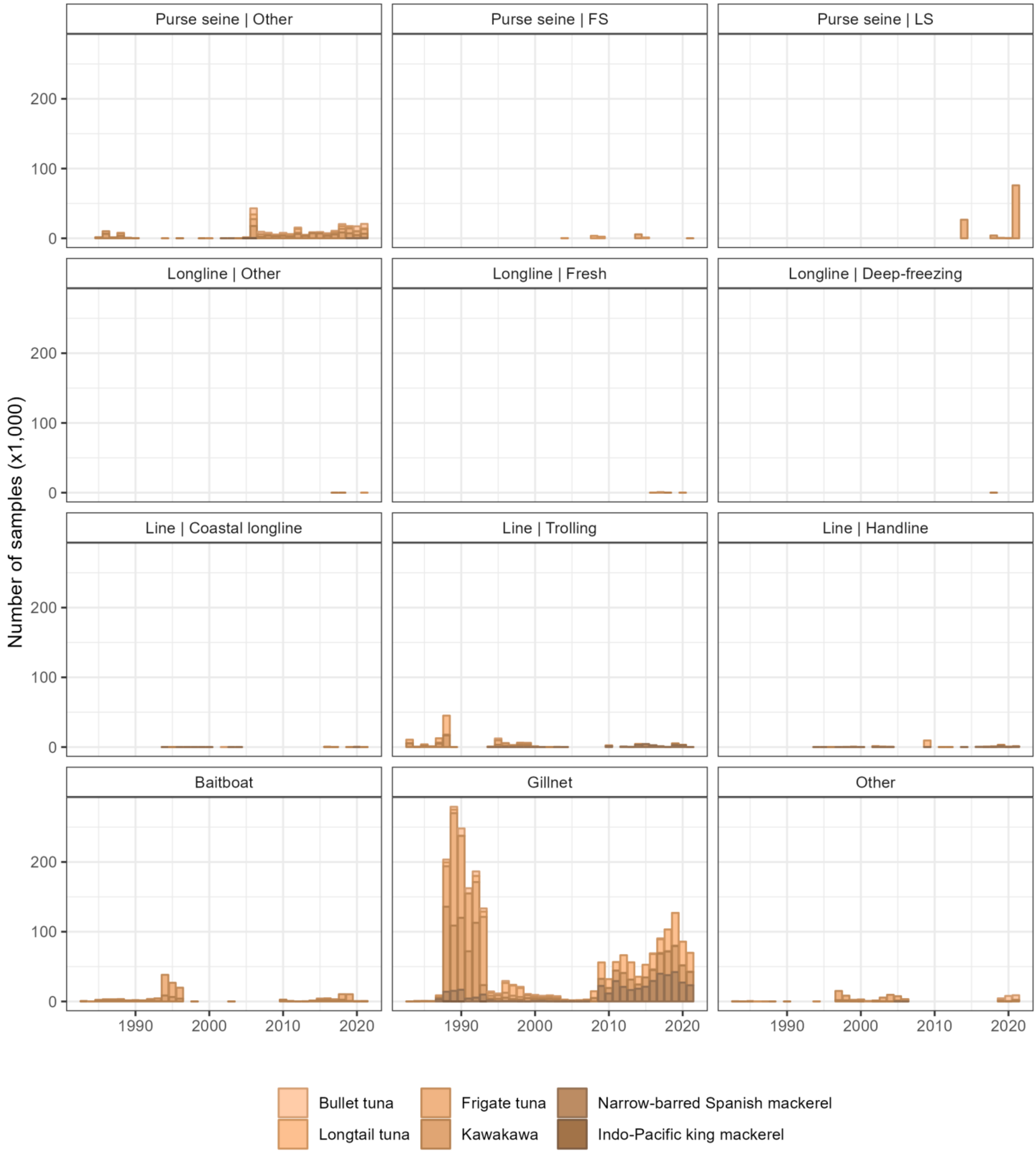

Figure 22: Annual number of standard size samples available at the IOTC Secretariat by fishery and neritic species. FS = free-swimming school; LS = school associated with floating object

The number of size samples by species is very unbalanced and not representative of the importance of each species in the retained catches (**Fig. 23**). About two thirds of all samples available are for kawakawa (32.82%) and frigate tuna (32.33%). Samples for narrow-barred Spanish mackerel only represent 14.43% of the samples even though this species has been the most abundant in the catch over the last four decades, i.e., representing almost 30% of all catches of neritic species between 1980 and 2020. Only 554 fish samples are available for Indo-Pacific kingfish when more than 1.4 million t of catch have been reported for this species since 1980.

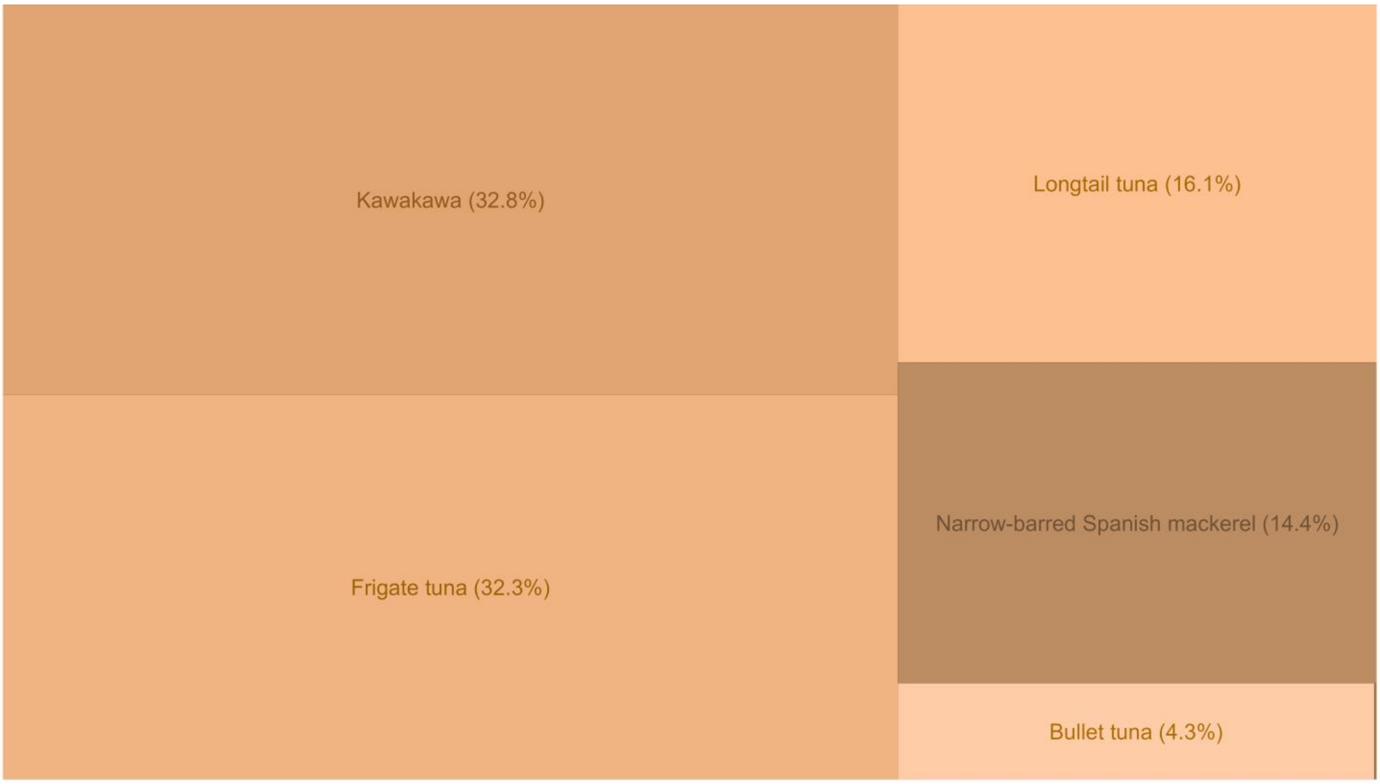

Figure 23: Percentage of size samples by species for all standard size data available at the IOTC Secretariat

Size distribution by species and fishery

The aggregated size frequency distributions should be considered with great caution as they do not account for spatio-temporal changes in sampling (e.g., fishing grounds) and may be biased due to the variability in sampling methodology and intensity over time and across CPCs. Overall, the available data provide some general information on the size composition of the catch, suggesting substantial differences in size between species and fisheries.

Bullet tuna, which has been mostly caught in purse seine fisheries in recent years, appears to be taken at the smallest size, with an overall median fork length of about 26 cm (**Fig. 24**). Information on size composition available from other fisheries catching bullet tuna indicates sizes in the interquartile range 22.5-28.5 cm fork length. Frigate tunas are slightly larger than bullet tuna when caught in coastal purse seine fisheries (median fork length of 27.5 cm) and appear to be taken at larger sizes in line fisheries (median fork length of 36.5 cm) and in high seas purse seine fisheries (median fork length of around 39.5 cm). Kawakawa are taken at larger sizes, with a fork length interquartile comprised between 32.5 and 50.5 cm. The largest kawakawa are taken in high seas and coastal longline fisheries with a respective median fork length of 56.5 and 46.5 cm, respectively. The smallest ones are caught in coastal purse seine fisheries (median fork length of 27.5 cm). Finally, narrow-barred Spanish mackerels are described by similar median sizes across fisheries, with the interquartile fork length range being comprised between 75.5 and 98.5 cm (**Fig. 24**). The very few samples available for Indo-Pacific king mackerel from coastal purse seine (n = 166) and gillnet (n = 388) fisheries indicate similar median values of fork length of 43.5 cm.

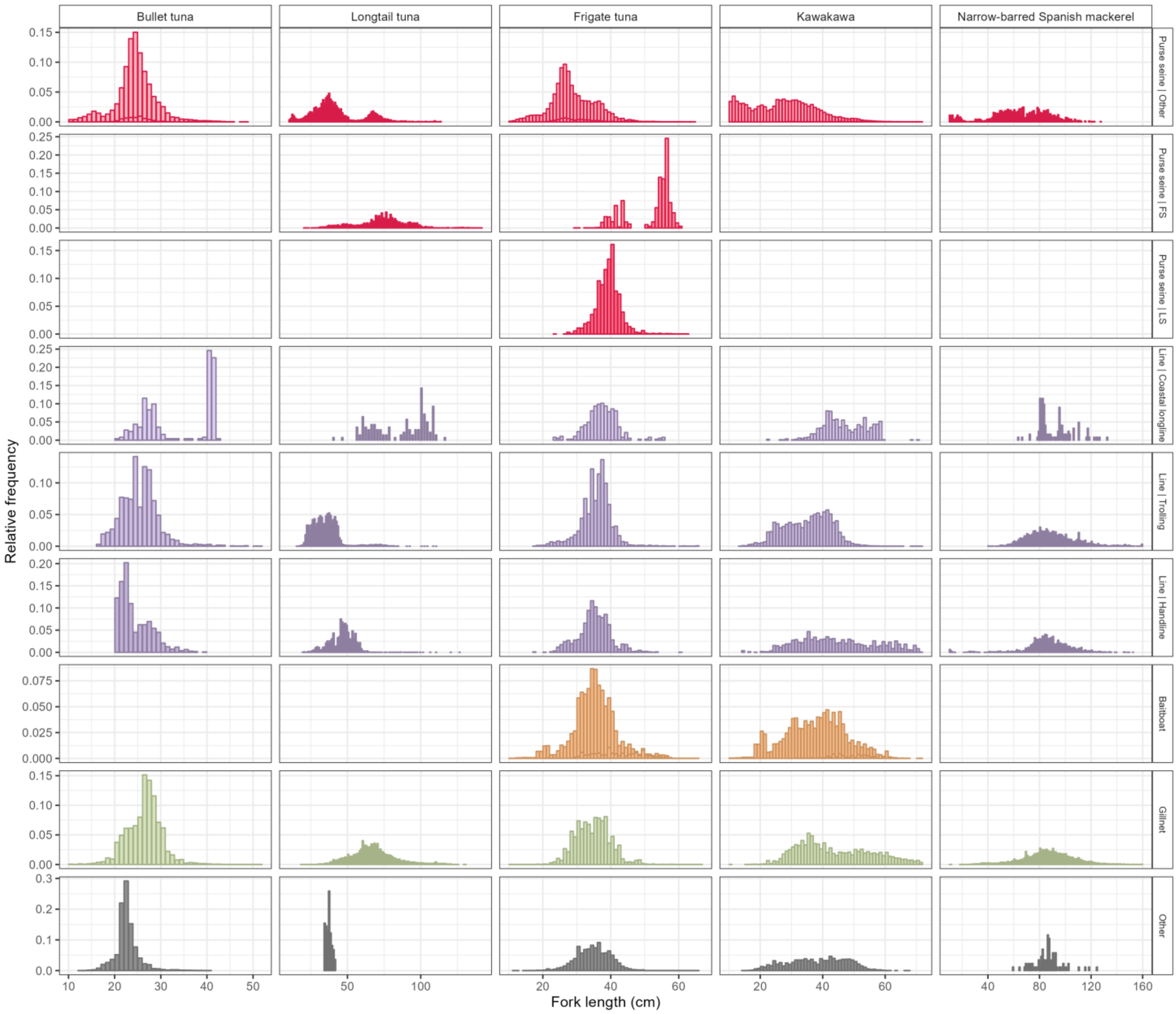

Figure 24: Relative fork length (cm) frequency distribution of IOTC neritic tuna and seerfish species (except for Indo-Pacific king mackerel) aggregated across all samples available at the IOTC Secretariat by fishery, excluding longline fisheries

Besides the regular data submission by the CPCs, the Secretariat also holds size frequency data collected at sea by scientific observers, which provide size information on neritic tunas taken in industrial purse seine fisheries (See section Discards).

Uncertainties in size-frequency data

The reporting quality of size-frequency data is the lowest among all IOTC species groups. The overall quality – as measured by the percentage of nominal catches with data of quality scores between 0-2 – of size data available for neritic tunas and seerfish is poor. Almost no size data are available prior to the 1980s and the fraction of data of acceptable quality has averaged around 6.5% over the last decade (**Fig. 25a**).

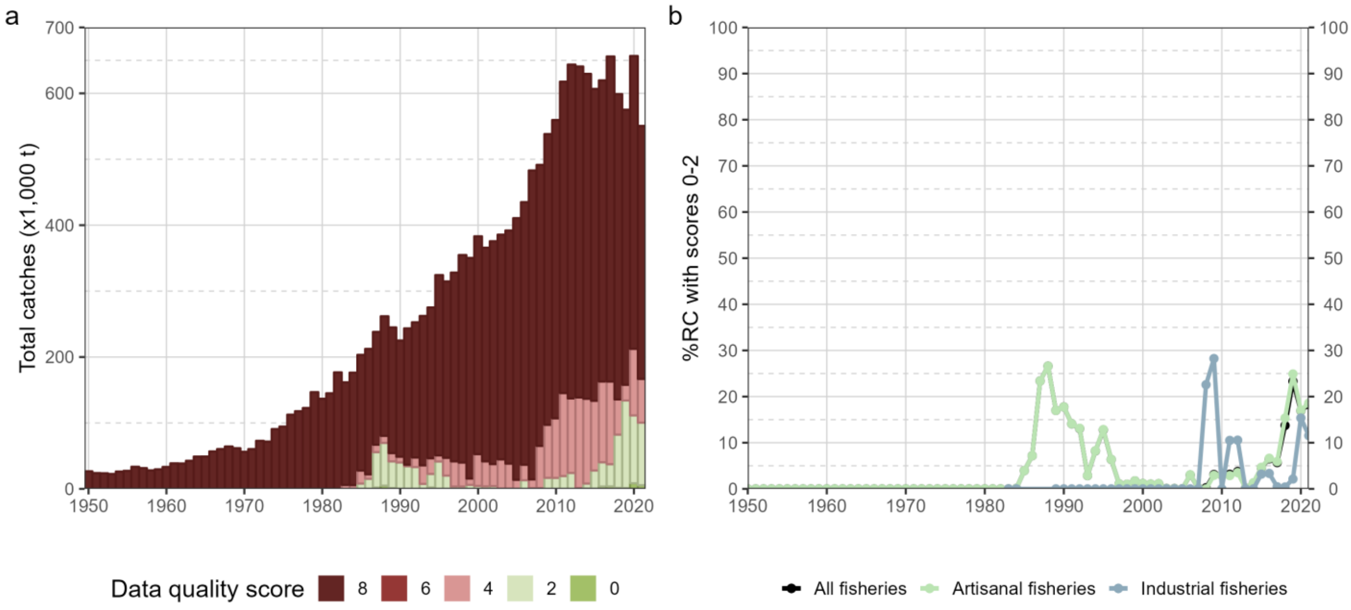

Figure 25: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches with corresponding geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 to all retained caches (percentage; %) of IOTC neritic tunas and seerfish for all fisheries and by type of fishery, for the period 1950-2021

Size frequency data are often not reported by the IOTC standards and as such cannot not be processed and included in the database. Recently the Secretariat has put more emphasis on complying with IOTC reporting requirements, such as including appropriate spatial information and using the recommended size bins for tuna and tuna-like species. In some instance however, data are included in the database but cannot be used due to poor quality. In particular, several size data sampled from neritic and seerfish species have been reported with large size bins and/or sizes exceeding the known maximum length of the species, e.g., size frequency data from Madagascar artisanal fisheries. Such data are filtered out in the IOTC processing generating the species-specific standard size data sets (see section Methods).

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Disclaimer

Appendix

Appendix I: Time series of price for neritic tunas and seerfish in Oman

Monthly market prices expressed in Omani Rials (OR) of longtail tuna, frigate tuna, kawakawa, and narrow-barred Spanish mackerel have been reported to the Secretariat by the Sultanate of Oman since late 2015 for each of its 11 governorates. No information is available on the source of price data which may have been collected from the sale value at landings in local markets and/or from prices of export to Omani neighboring countries.

Price information gives the value rank for each of the four species. Narrow-barred Spanish mackerel is the most expensive species with an average value of 3.20 OR (~8.25 USD) between 2016 and 2020. Longtail tuna comes second with a mean value of 1.55 OR (~4 USD) between 2016 and 2020 when kawakawa and frigate tuna are described by lower sale prices, i.e., 0.81 OR (~2.1 USD) and 0.62 OR (1.6 USD), respectively. Fish prices show some quite large variability between months without any particular trend for narrow-barred Spanish mackerel while the price for the three neritic tunas has shown a susbtantial decline in 2020 as compared to previous years (**Fig. 26**).

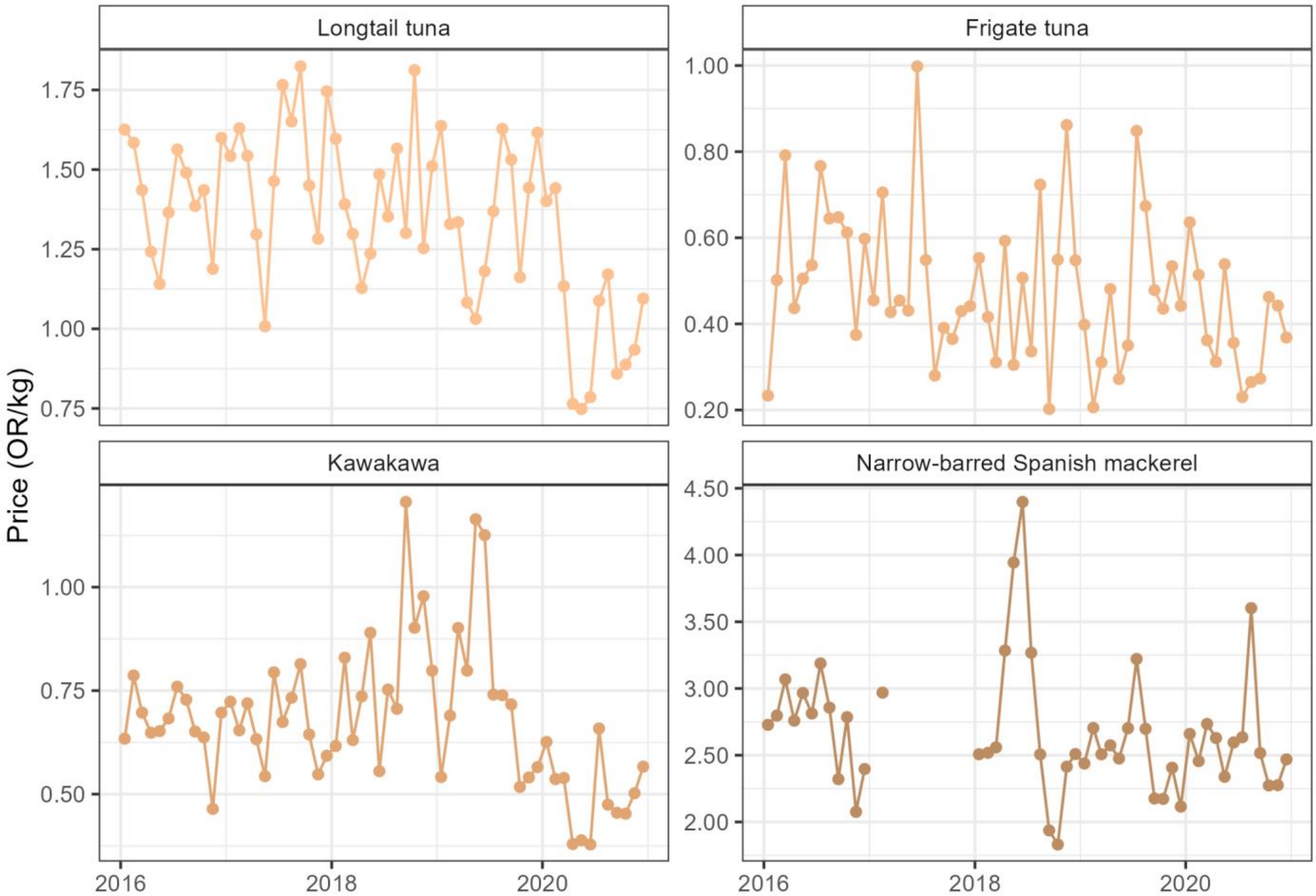

Figure 26: Monthly time series of price (Omani Rials; OR) for longtail tuna, frigate tuna, kawakawa, and narrow-barred Spanish mackerel in Oman between 2016 and 2020

Appendix II: Time series of fuel price

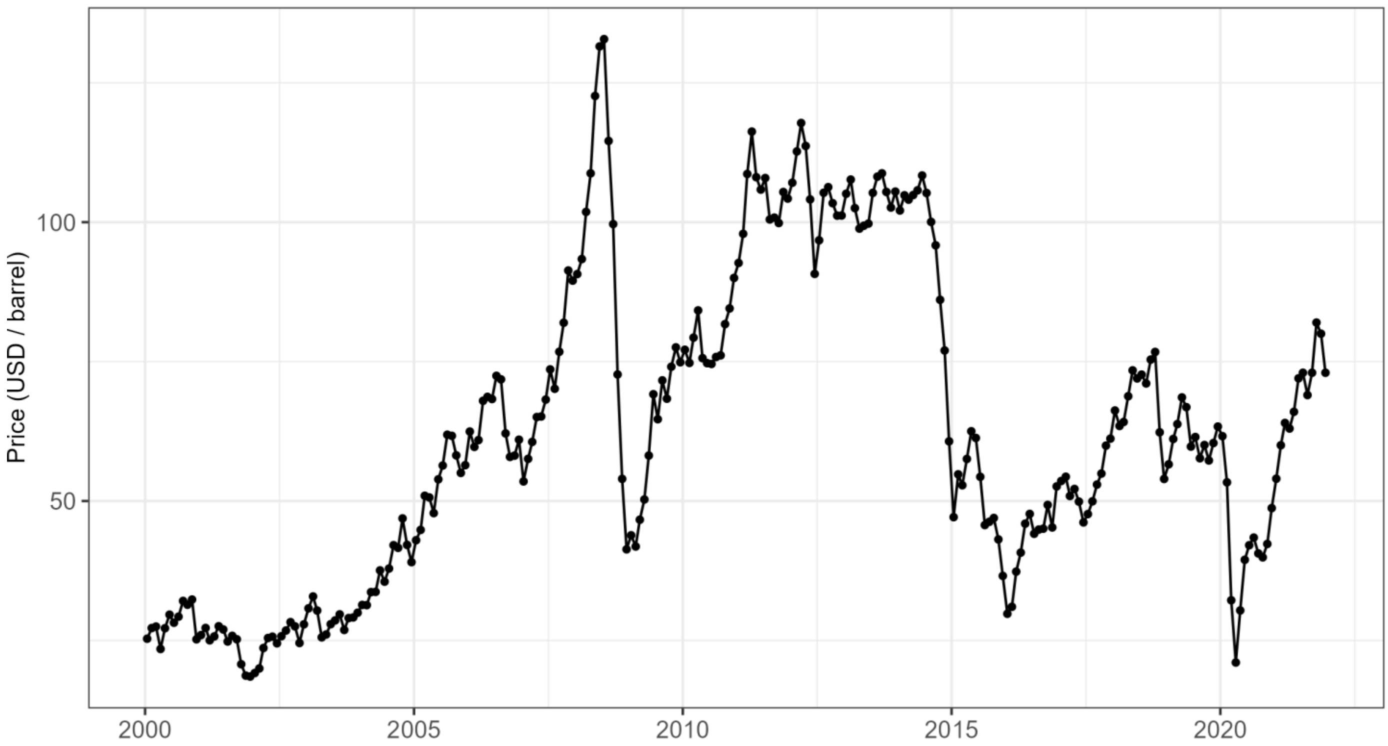

Figure 27: Monthly time series of crude oil spot price (USD/barrel) during the period 2000-2021. Data sourced from the spot prices of Brent, Dubai, and West Texas, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Appendix III: Best scientific estimates of nominal retained catches for 2021

Overall, nominal retained catches of neritic tunas and seerfish fully estimated in 2021 amounted to 51,266 t of fish for 15 distinct fleets, representing 8.5% of all catches of IOTC neritic species (**Table 6**).

First, retained catches were estimated for those CPCs that did not report any fishery statistics for 2021. In this case, catches were repeated from previous year (2020) except for Eritrea and Sudan who have not reported any information to IOTC since their accession in 1994 and 1996, respectively (**Table 6**). In fact, data for these two countries have been systematically extracted from the FAO global capture production database and further broken down by gear (**Table 6**).

Although Madagascar and Tanzania submitted catch data to the IOTC Secretariat for 2021, these showed high inconsistencies and were not deemed accurate for that reference year. For Tanzania, catch data as available from different sources (i.e., national reports and various data sets submitted to the Secretariat) showed large discrepancies in magnitude and composition, supporting the temporary repetition of catch levels from 2020 in lack of more accurate estimates. For Seychelles, information available for their coastal line fisheries was incomplete and catches from the previous year were also temporarily repeated.

For coastal states which are not members of the IOTC, catches were preferentially extracted from the FAO global capture production database and further broken down into distinct species and gears, when necessary, based on knowledge of the fisheries operating in each of the countries (**Table 6**).

Table 6: Estimates of nominal retained catches (metric tonnes; t) of IOTC neritic tuna and seerfish species for the year 2021 for non-members (NM) and members (MP) of the IOTC (see text for details)

Fleet code	Fleet	Status	Source	Catch
ARE	United Arab Emirates	NM	FAO	7,468.0
BHR	Bahrain	NM	FAO	87.6
DJI	Djibouti	NM	FAO	870.8
EGY	Egypt	NM	FAO	790.0
ERI	Eritrea	MP	FAO	467.1
KWT	Kuwait	NM	FAO	165.0
MDG	Madagascar	MP	IOTC	6,021.4
MMR	Myanmar	NM	FAO	8,899.0
QAT	Qatar	NM	FAO	3,183.9
SAU	Saudi Arabia	NM	FAO	10,189.9
SDN	Sudan	MP	FAO	150.0
SYC	Seychelles	MP	IOTC	543.8
TLS	Timor-Leste	NM	IOTC	0.1
TZA	Tanzania	MP	IOTC	3,361.9
YEM	Yemen	MP	IOTC	9,067.2
ALL	All fleets	-	-	51,265.8

Second, a re-estimation process was performed for the artisanal fisheries of Bangladesh, Malaysia, India, and Indonesia which are considered to be of low quality. In Bangladesh no fishery specifically targets tuna and tuna-like species and all IOTC species are reported through species aggregates (e.g., mackerel, tuna and tuna-like) which have changed in recent years. Previously, nominal retained catches reported as *mackerel* were assumed to be composed of narrow-barred Spanish mackerel (COM; 59%) and Indo-Pacific king mackerel (GUT; 41%) assumed to be exclusively caught with gillnets since 1986. Furthermore, historical catches of neritic tunas in Bangladesh fisheries have always been assumed negligible. In 2021, retained catches of all tuna and tuna-like species reported to the Secretariat were much increased and broken down by fishing gear, amounting to a total of 22,100 t. Considering the additional fishing gears reported by Bangladesh (e.g., set bag nets and coastal longlines), the disaggregation process resulted in a major increase of neritic tunas, with about 12,200 t reported for 2021. Also, while estimates of retained catches of seerfish were about 100 t during 2018-2020, they increased to 2,400 t in 2021.

Retained catches reported of neritic tunas reported by Malaysian coastal fisheries are considered accurate, but seerfish catches have only been reported for narrow-barred Spanish mackerel while both narrow-barred Spanish mackerel and Indo-Pacific king mackerel have been shown to occur in the landings. Except for handline that was only reported in 1962, the current data processing applies a fixed proportion over time (by gear) to each of the two species (COM-GUT): 82% and 18% for trolling line, 69% and 31% for gillnet, 89% and 11% for small purse seine, and 63% and 37% for trawling. In 2021, the nominal catches of narrow-barred Spanish mackerel and Indo-Pacific king mackerel were estimated to 4,762 t and 2,309 t, respectively.

For India and Indonesia, the current re-estimation process builds on a review requested by the IOTC Scientific Committee in the early 2010s, aiming at producing a temporary revision of the artisanal catches time series from these two countries, to be maintained until measurable improvements in data collection and reporting to the IOTC were detected (Moreno et al. 2012).

In the case of Indian coastal fisheries, the re-estimation process does conserve the total catches reported for each of the six IOTC neritic tuna and seerfish species, but modifies the gear composition of the catch by Indian Ocean major area for the following gears: beach seine (BS), gillnet (GILL), hook and line (HOOK), small purse seine (PSS), ring nets (RIN), trawl (TRAW), and troll line (TROL). In 2021, the total catches reported by India for the IOTC neritic tuna and seerfish species were about 79,000 t, with more than half of them taken in the gillnet fishery.

In the case of Indonesian coastal fisheries, a fixed proportion of total catch for each species and fishing gear is used to derive the catches of each of the IOTC neritic tuna and seerfish species based on samples of catch composition available for the period 2003-2011 (Moreno et al. 2012). In 2021, about 199,000 t of fish were estimated to be caught in Indonesian fisheries for these six species.

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

Table 7: Changes in best scientific estimates of annual retained catches (metric tonnes; t) of neritic tuna and seerfish species by year, fleet, fishery group, and main Indian Ocean area, limited to absolute values higher than 10 t. Data source: best scientific estimate of retained catches as estimated annually from 2012 to 2020 for the preceeding statistical year (https://www.iotc.org/meetings/13th-working-party-neritic-tunas-wpnt13-meetingData/03-NC)

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2020	ARE	Gillnet	Western Indian Ocean	6,407	7,374	-966
		Line	Western Indian Ocean	1,024	1,178	-155
	EGY	Gillnet	Western Indian Ocean	1,151	1,190	-39
		Line	Western Indian Ocean	140	100	40
	IRN	Gillnet	Western Indian Ocean	129,488	134,774	-5,286
		Line	Western Indian Ocean	12,375	6,190	6,185
	KEN	Gillnet	Western Indian Ocean	376	0	376
		Line	Western Indian Ocean	163	0	163
		Purse seine	Western Indian Ocean	71	0	71
	MMR	Gillnet	Eastern Indian Ocean	3,339	3,105	234
		Line	Eastern Indian Ocean	1,263	1,174	89
		Other	Eastern Indian Ocean	5,224	4,857	367
		Purse seine	Eastern Indian Ocean	1,169	1,087	82
	MOZ	Gillnet	Western Indian Ocean	111	1,557	-1,446
		Line	Western Indian Ocean	205	2,144	-1,939
		Other	Western Indian Ocean	64	1,150	-1,086
		Purse seine	Western Indian Ocean	45	5,184	-5,139
	SAU	Gillnet	Western Indian Ocean	6,082	4,763	1,319
		Line	Western Indian Ocean	2,208	2,490	-282
		Other	Western Indian Ocean	382	458	-76
		Purse seine	Western Indian Ocean	57	143	-86
	SDN	Gillnet	Western Indian Ocean	132	151	-19
2019	ARE	Gillnet	Western Indian Ocean	6,499	6,760	-260
		Line	Western Indian Ocean	1,039	1,080	-42
	IDN	Gillnet	Eastern Indian Ocean	51,649	51,687	-38
		Line	Eastern Indian Ocean	59,568	59,612	-44
		Other	Eastern Indian Ocean	31,241	31,264	-23

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
		Purse seine	Eastern Indian Ocean	46,356	46,376	-20
	IRN	Gillnet	Western Indian Ocean	118,986	121,406	-2,420
		Line	Western Indian Ocean	5,904	3,468	2,436
	MOZ	Line	Western Indian Ocean	2,242	2,144	98
	SAU	Gillnet	Western Indian Ocean	4,932	5,049	-117
		Line	Western Indian Ocean	1,997	2,624	-627
		Other	Western Indian Ocean	473	498	-25
		Purse seine	Western Indian Ocean	52	153	-102
2018	ARE	Gillnet	Western Indian Ocean	6,696	7,163	-467
		Line	Western Indian Ocean	1,070	1,145	-75
	IRN	Gillnet	Western Indian Ocean	137,377	137,901	-524
	SAU	Gillnet	Western Indian Ocean	5,646	5,143	502
		Line	Western Indian Ocean	2,171	2,674	-503
		Other	Western Indian Ocean	408	508	-100
		Purse seine	Western Indian Ocean	57	156	-99
2017	ARE	Gillnet	Western Indian Ocean	6,545	7,411	-866
		Line	Western Indian Ocean	1,046	1,185	-139
	IDN	Baitboat	Eastern Indian Ocean	164	131	33
		Gillnet	Eastern Indian Ocean	69,758	55,882	13,876
		Line	Eastern Indian Ocean	80,454	64,450	16,004
		Other	Eastern Indian Ocean	42,195	33,801	8,393
		Purse seine	Eastern Indian Ocean	35,878	28,742	7,137
	IRN	Gillnet	Western Indian Ocean	137,013	137,075	-62
		Line	Western Indian Ocean	3,723	3,796	-73
	SAU	Gillnet	Western Indian Ocean	5,609	5,027	582
		Line	Western Indian Ocean	2,161	2,720	-559
		Other	Western Indian Ocean	366	482	-116
		Purse seine	Western Indian Ocean	59	177	-118
2016	ARE	Gillnet	Western Indian Ocean	6,998	7,273	-275
		Line	Western Indian Ocean	1,118	1,162	-44

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
	DJI	Gillnet	Western Indian Ocean	459	475	-15
	IDN	Gillnet	Eastern Indian Ocean	55,933	55,882	51
		Line	Eastern Indian Ocean	64,509	64,450	59
		Other	Eastern Indian Ocean	33,832	33,801	31
		Purse seine	Eastern Indian Ocean	28,768	28,742	26
	IRN	Gillnet	Western Indian Ocean	126,698	126,772	-73
	KEN	Gillnet	Western Indian Ocean	660	338	321
		Line	Western Indian Ocean	286	72	215
		Purse seine	Western Indian Ocean	125	0	125
	QAT	Gillnet	Western Indian Ocean	2,212	2,026	186
	SAU	Gillnet	Western Indian Ocean	6,395	5,027	1,368
		Line	Western Indian Ocean	2,487	2,720	-233
		Other	Western Indian Ocean	408	482	-74
		Purse seine	Western Indian Ocean	72	177	-105
2015	ARE	Gillnet	Western Indian Ocean	7,243	7,411	-167
		Line	Western Indian Ocean	1,158	1,184	-27
	IDN	Gillnet	Eastern Indian Ocean	58,860	58,870	-11
		Line	Eastern Indian Ocean	67,884	67,897	-12
	IRN	Gillnet	Western Indian Ocean	123,395	123,468	-72
	MOZ	Gillnet	Western Indian Ocean	2,167	2,319	-152
		Line	Western Indian Ocean	1,913	1,725	188
	QAT	Gillnet	Western Indian Ocean	2,075	1,908	168
2014	ARE	Gillnet	Western Indian Ocean	7,596	7,321	275
		Line	Western Indian Ocean	1,214	1,170	44
	DJI	Gillnet	Western Indian Ocean	375	385	-11
	IDN	Gillnet	Eastern Indian Ocean	59,888	59,991	-103
		Line	Eastern Indian Ocean	69,070	69,189	-118
		Other	Eastern Indian Ocean	36,225	36,287	-62
		Purse seine	Eastern Indian Ocean	30,802	30,855	-53
	IRN	Gillnet	Western Indian Ocean	130,825	130,895	-70

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
		Purse seine	Western Indian Ocean	151	181	-30
	MMR	Gillnet	Eastern Indian Ocean	3,435	3,402	34
		Line	Eastern Indian Ocean	1,299	1,287	13
		Other	Eastern Indian Ocean	5,374	5,321	53
		Purse seine	Eastern Indian Ocean	1,202	1,191	12
	MOZ	Line	Western Indian Ocean	2,122	2,042	80
	QAT	Gillnet	Western Indian Ocean	2,058	1,924	134
2013	DJI	Gillnet	Western Indian Ocean	326	342	-15
	IDN	Gillnet	Eastern Indian Ocean	67,987	65,869	2,119
		Line	Eastern Indian Ocean	78,411	75,968	2,443
		Other	Eastern Indian Ocean	41,123	39,842	1,281
		Purse seine	Eastern Indian Ocean	34,968	33,878	1,090
	IRN	Gillnet	Western Indian Ocean	121,622	121,891	-269
		Purse seine	Western Indian Ocean	1,520	1,531	-11
	MMR	Gillnet	Eastern Indian Ocean	3,321	3,394	-73
		Line	Eastern Indian Ocean	1,256	1,284	-28
		Other	Eastern Indian Ocean	5,195	5,310	-114
		Purse seine	Eastern Indian Ocean	1,163	1,188	-26
	QAT	Gillnet	Western Indian Ocean	2,221	2,109	112
2012	IDN	Gillnet	Eastern Indian Ocean	58,194	57,711	483
		Line	Eastern Indian Ocean	67,117	66,559	558
		Other	Eastern Indian Ocean	35,200	34,908	292
		Purse seine	Eastern Indian Ocean	29,931	29,682	249
	IRN	Gillnet	Western Indian Ocean	125,228	125,509	-281
		Line	Western Indian Ocean	4,928	4,827	101
	MMR	Gillnet	Eastern Indian Ocean	3,477	3,523	-46
		Line	Eastern Indian Ocean	1,315	1,333	-17
		Other	Eastern Indian Ocean	5,439	5,511	-72
		Purse seine	Eastern Indian Ocean	1,217	1,233	-16
	QAT	Gillnet	Western Indian Ocean	2,366	2,215	151