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

Author: IOTC Secretariat

Introduction

The small-scale fisheries of neritic tunas and seerfish species, particularly those in the Scombrids family such as *Euthynnus*, *Auxis*, and *Scomberomous*, play a crucial role in the socio-economic of coastal states globally. SEAFDEC underscores their commercial importance, driven by favorable prices from processing companies, which in turn stimulate economic activities within coastal communities. Recent data from the FAO reveals an uptick in catches of these species, with Indonesia emerging as a prominent fishing nation in both the Indian Ocean and Pacific Ocean for neritic tuna species. However, despite their significance, only five neritic species of the Scombrids family are managed by the Indian Ocean Tuna Commission (IOTC), namely *Thunnus tonggol*, *Euthynnus affinis*, *Auxis rochei*, and *Auxis thazard*.

Global catch data of the neritic and seerfish species indicate steady increase, surpassing 2,109,000 t in 2022 (**Fig. 1a**). The Western and Central Pacific Ocean region, managed by the Western and Central Pacific Fisheries Commission (WCPFC), and the Indian Ocean region under the management of the Indian Ocean Tuna Commission (IOTC), are the primary contributors to neritic tuna catches, comprising approximately 60% and 32% respectively (**Fig. 1b**). These figures underscore the significant role these regions play in global fisheries management and highlight ongoing trends in capture volumes of these important species.

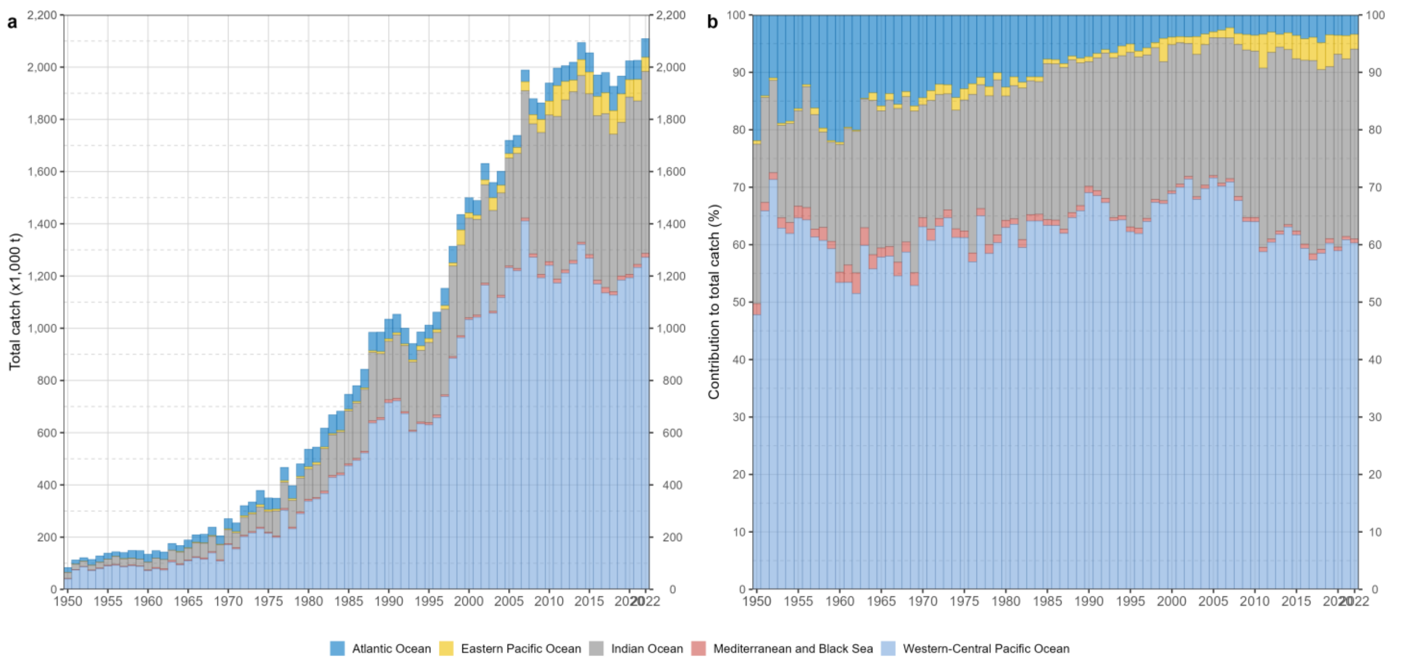

Figure 1: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of neritic tunas and seerfish by ocean basin for the period 1950-2021. Source: FAO global capture production database

The paper aims to present a comprehensive review of the status and information pertaining to the six neritic tuna and seerfish species managed by the Indian Ocean Tuna Commission (IOTC) in preparation for the 14th Session of the IOTC Working Party on Neritic Tunas (WPNT14). While IOTC management specifically covers six species, there are additional neritic pelagic species caught in the Indian Ocean, albeit at lower reported levels. The document discusses the historical context, noting that subsistence fisheries targeting these species have operated along the Indian Ocean coastlines for centuries (e.g., Yadav et al. 2020). It provides an overview of available fisheries statistics dating back to 1950 and outlines the methodologies used by the IOTC Secretariat to process and evaluate the quality of these datasets as of June 2024. Furthermore, the paper describes key trends and characteristics observed in Indian Ocean neritic tunas and seerfish fisheries over the past seventy years, offering a comprehensive perspective on the management and utilization of these valuable marine resources.

Materials

The analysis in the paper relies on data submitted annually to the IOTC Secretariat by Contracting Parties and Cooperating Non-Contracting Parties (CPCs) in accordance with IOTC Conservation and Management Measures (CMMs). These data sets undergo revisions throughout the year, reflecting ongoing improvements in reporting accuracy and completeness. To enhance transparency and compliance with reporting standards, the IOTC Secretariat has increased the visibility of IOTC Reporting guidelines and IOTC forms on the IOTC website. While adherence to the IOTC Reporting Guidelines is not mandatory, the use of IOTC forms is strongly recommended for submitting data to the Secretariat. These guidelines and forms facilitate effective data curation and management, ensuring that the information used for analysis is robust and reliable for assessing the status and trends of Indian Ocean neritic tunas and seerfish fisheries.

Retained catch data

The reporting of retained catches of species in the Indian Ocean, as mandated by IOTC Res. 15/02, requires that these catches be expressed in live weight equivalent and reported annually. This reporting encompasses several key aspects: the major fishing area within the Indian Ocean, the specific fleet involved, and the type of gear used. The preferred method for submission is through the use of IOTC form 1RC.

Changes in retained catches can occur due to several reasons:

1. **Updates**: Preliminary data for longline fisheries are initially submitted by June 30th each year, with updates received by December 30th of the same year.
2. **Revisions by CPCs**: Contracting Parties and Cooperating Non-Contracting Parties may revise historical data due to corrections of errors, inclusion of missing data, changes in data processing methodologies, etc.
3. **Estimation Process Changes**: The Secretariat may adjust catch estimations based on improved methods or assumptions, such as the selection of proxy fleets or updated morphometric relationships. These adjustments require endorsement by the IOTC Scientific Committee.

These measures ensure that the reported data on retained catches are accurate, comprehensive, and reflective of the ongoing efforts to manage and conserve Indian Ocean fisheries resources effectively.

Discard data

The IOTC adheres to the FAO's definition of discards, as detailed in previous reports (Alverson et al. 1994, Kelleher 2005). This definition encompasses all non-retained catch, whether individuals are released alive or discarded dead. According to IOTC Resolution 15/02, estimates of total annual discard levels in terms of live weight or number must be reported to the Secretariat. These reports should specify the Indian Ocean major area, species, and type of fishery involved.

To facilitate this reporting, the IOTC has developed IOTC Form 1DI specifically for reporting discards. The data submitted via Form 1DI should be extrapolated at the source to provide comprehensive estimates of total discard levels for the year. This extrapolation should encompass details such as the type of gear used, the fleet involved, the specific Indian Ocean major area, and the species discarded. Notably, these reports should also include data on discards of non-fish species like turtles, cetaceans, and seabirds, ensuring a comprehensive overview of the impacts of fishing activities on marine biodiversity within the Indian Ocean region.

Discard data reported to the IOTC Secretariat via IOTC Form 1DI are often insufficient, not comprehensive, and do not consistently meet essential reporting standards. As a result, the most reliable and detailed information regarding discards typically originates from the IOTC Regional Observer Scheme (ROS; IOTC Res. 22/04). This scheme focuses on collecting precise details, including the specific spatial and temporal locations of fishing activities and interactions, as well as the fate of observed individuals, encompassing both target and bycatch species in industrial fisheries.

In addition to gaps in reporting, studies in the literature suggest that advancements in gear technology have played a significant role in reducing incidental catch and discards in tuna fishing operations (Taiwo 2013). These technological improvements aim to minimize the unintended capture of non-target species, thereby potentially decreasing overall discard rates observed in fisheries managed by the IOTC.

Geo-referenced catch and effort data

Catch and effort data within the IOTC framework are detailed and stratified across various parameters, as specified by IOTC Res. 15/02. Typically sourced from logbooks, these data are aggregated and reported annually, delineated by year, month, grid area, fleet, gear type, school type, and species targeted.

Geo-referenced catch information is particularly emphasized, either in live-weight equivalent or fish numbers, and is reported to the IOTC Secretariat. To streamline this reporting process, the recommended IOTC form 3-CE has been designed. This form facilitates the submission of geo-referenced catch and effort data, capturing details such as the activities of support vessels that assist large-scale purse seiners.

Furthermore, specific information related to the use of drifting floating objects and anchored fish aggregating devices is reported separately. This data is submitted using IOTC forms 3DA and 3AA respectively. These forms ensure that comprehensive information on fishing activities, including associated vessels and gear technologies, is available for effective management and conservation efforts within the Indian Ocean region.

Size-frequency data

The size composition of catches is derived from data sets that include individual body lengths or weights collected both at sea and during the unloading of fishing vessels. To standardize reporting and ensure comprehensive data collection, the IOTC has developed the IOTC Form 4SF. This form includes all necessary fields for complete reporting of size-frequency data, stratified by fleet, year, gear type, school type, month, grid area, and species, as stipulated by IOTC Res. 15/02.

While the majority of size data reported via Form 4SF pertain to retained catches, Contracting Parties and Cooperating Non-Contracting Parties (CPCs) also have the option to use the same form to report size data for discarded individuals. This flexibility allows for a more thorough understanding of the size distribution across different species and fishing activities.

Additionally, onboard observer programs under the ROS play a crucial role in collecting supplementary size data, including measurements of individuals discarded at sea. This data is reported to the IOTC Secretariat, contributing to broader insights into fisheries dynamics and supporting management strategies aimed at sustainable resource utilization in the Indian Ocean.

Socio-economic data

The collection and reporting of socio-economic information from fisheries in the Indian Ocean under the IOTC framework face significant challenges and limitations. While the IOTC form 7PR focuses on collecting price data for all IOTC species, including neritic tunas and seerfish, reporting by Contracting Parties and Cooperating Non-Contracting Parties (CPCs) is voluntary. This voluntary reporting has resulted in sparse data availability at the Secretariat, with notable exceptions such as time series of monthly prices reported by Oman since 2015 and Malaysia since 2018. Additional information on the value of marine fishery landings has been collected by the Southeast Asian Fisheries Development Center (SEAFDEC) since the late 1970s, providing some insights into pricing dynamics ((Appendix I).

The limited socio-economic data is partly due to tuna species often being a minor target or a small proportion of national catches in many coastal fisheries. Moreover, countries with significant catches of tuna-like species may export them for canning in neighboring countries or to other markets such as the European Union, Saudi Arabia, and Sri Lanka. This export orientation can lead to less emphasis on local pricing and socio-economic impacts within the reporting framework.

To address these gaps, the IOTC will convene a socio-economic working party meeting in 2024 as per IOTC Res.23/10, aimed at defining clearer requirements for collecting and analyzing socio-economic data related to tuna fisheries in the region. This initiative underscores the importance of understanding the broader economic impacts of Conservation and Management Measures (CMMs) on CPCs.

In addition to price data, the Fisheries Development Division of the Pacific Islands Forum Fisheries Agency (FFA) has compiled monthly time series data on crude oil prices, a critical factor influencing operating costs in tuna fisheries (Ruaia et al. 2020). This data, covering the period 2000-2021 and based on the arithmetic average of Brent, Dubai, and West Texas crude oil prices, provides insights into cost dynamics within the industry (Appendix II).

Overall, while efforts to enhance socio-economic data collection and analysis are underway, challenges persist in capturing comprehensive information that fully reflects the economic dimensions of neritic tuna and seerfish fisheries in the Indian Ocean region.

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 under the ROS encompass various aspects crucial for fisheries management:

1. **Fishing Activities and Positions**: Detailed information on fishing operations and vessel locations.
2. **Catch Estimates and Composition**: Identification of catch composition, monitoring of discards, bycatch species, and size-frequency distribution.
3. **Gear Information**: Specifications such as gear type, mesh size, and any attachments used by the vessel.
4. **Logbook Cross-checking**: Verification of logbook entries, including species composition, quantities, live and processed weights, and fishing locations.

The ROS database includes morphometric data (lengths and weights) gathered at sea, which is essential for establishing morphometric relationships used in fisheries science. Despite challenges such as variability in coverage and data completeness across different fisheries and time periods, the ROS has accumulated information from 1,699 commercial fishing trips (949 from purse seine vessels and 750 from longline vessels of various types) between 2005 and 2022. This data primarily originates from fleets representing Japan, EU,France, and Sri Lanka for longline fisheries, and from fleets including EU,Spain, Japan, Korea, Mauritius, and Seychelles for purse seine fisheries. A comprehensive description of the status, coverage, and data collected as part of the ROS is provided in IOTC Secretariat (2022).

However, some fleets, such as Taiwan,China, historically submitted observer reports to the Secretariat but in formats not conducive to automated data extraction required by ROS standards, as instead required by the ROS standards (Athayde & IOTC 2018) – *de facto* preventing the entry of these data in the ROS regional database.. As a result, these data have not been fully integrated into the ROS regional database, highlighting ongoing challenges in data standardization and integration across all participating fleets. A full description of the ROS data requirements for each fishing gear is provided in IOTC Secretariat (2021).

Morphometric data

The length-weight relationships for Indian Ocean neritic tunas and seerfish species utilized by the IOTC are based on morphometric data collected through various fisheries monitoring programs over different periods and locations.

Specifically: (i) data from landing sites in Sri Lanka during the 1980s. More recent data from Iran and India have also contributed to updating these relationships (**Table 1**) and (ii)**Longtail Tuna**: the length-weight relationship for longtail tuna was established using extensive data collected from five sites 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). Information on length-weight relationships for kawakawa, frigate tuna, bullet tuna, and narrow-barred Spanish mackerel in the Indian Ocean remains limited from the Indo-Pacific Tuna Development and Management Programme (IPTP) (IPTP 1989). Furthermore, the length-weight parameters appear to be identical for frigate and bullet tunas. Data for Indo-Pacific king mackerel are primarily sourced from the Bay of Bengal Large Marine Ecosystem, with length-weight relationships available only for fish measured in total length (Dutta et al. 2012). Currently, the IOTC does not have length-length relationships available, although such relationships have been published for certain species like kawakawa, frigate tuna, and bullet tuna caught in Sri Lankan waters (Herath et al. 2019).

Overall, ongoing efforts are needed to expand the database of length-weight relationships and enhance the accuracy and comprehensiveness of morphometric data across all relevant species within the Indian Ocean region. These relationships are critical for effective fisheries management and stock assessment efforts conducted by the IOTC.

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

The data processing procedures at the IOTC Secretariat involve several systematic steps to ensure the quality and accuracy of reported datasets. Here's an overview of these procedures:

1. **Data Quality Review**: Initially, the Secretariat conducts a standard review of the quality and completeness of datasets submitted by Contracting Parties and Cooperating Non-Contracting Parties (CPCs). Historically, this review was solely performed by the Secretariat, but recent improvements have introduced validator tools for each dataset. These tools encourage CPCs to validate their data before submission, thereby minimizing errors and ensuring compliance with mandatory IOTC standards. Despite CPC validations, the Secretariat continues to validate datasets independently to ensure readiness for further processing.

2. **Processing Steps for Scientific Estimates**: Once validated, a series of processing steps are applied to derive scientific estimates of retained catches for the 16 species under IOTC management. Key processing rules include:

    a. **Data Imputation**: In cases where catches are not reported by a CPC for a specific year, data may be imputed using various sources such as partial catch and effort data, the FAO FishStat database, or data on imports from processing factories collaborating with organizations like the International Seafood Sustainability Foundation.

b. **Re-estimation**: For fisheries with known data quality issues, re-estimation of species and/or gear composition may occur. This process utilizes data from other years or areas, or employs proxy fleets assumed to have similar catch compositions, e.g., Moreno et al. (2012) and IOTC Secretariat (2018).

c. **Disaggregation**: If catches are reported in aggregate form, a disaggregation process breaks down these aggregates by species and gear (IOTC 2016). This involves using data from strata where species and gears are reported separately, and applying spatial-temporal substitution schemes when necessary.

These methodologies are evolving, with a gradual reduction in re-estimation practices due to improvements such as increased number of CPCs reporting of disaggregated data, availability of secondary data sources from national portals, and technical assistance provided to CPCs facing data challenges.

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 2022 (**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 2022 (**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 2022 best scientific estimates for 2022 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 Secretariat 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 Secretariat 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.

The IOTC Secretariat has implemented a scoring system to evaluate the reporting quality of retained catch, catch and effort, and size-frequency data submitted by Contracting Parties and Cooperating Non-Contracting Parties (CPCs) to the Secretariat. This scoring system is designed to assess the extent to which data submissions adhere to IOTC reporting standards (**Table** 4). Overall, the scoring system plays a crucial role in ensuring that the data used for scientific assessments and management decisions within the IOTC are reliable and consistent across member states.

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 for neritic tuna and seerfish species indicate a notable increase in catches over the past few decades. This trend stands in contrast to the observations for large pelagic species, where catch trends have shown variability or decline in some cases. In coastal waters, where these small tunas are predominantly caught, a diverse array of fishing gears are reported to be in operation.

Historical trends (1950-2022)

In the past two decades, the contribution of neritic tunas and seerfish species to the total catch has shown a significant increase, rising from 26% in the 1990s to 36% by 2010. This shift in the composition of catch can be attributed to two primary factors:

1. **Operational Changes in Fisheries**: Starting in the late 2010s, there was a notable transition in the operational activities of fisheries. Semi-industrial fishing activities, particularly those operating near Somali waters, reduced significantly. Vessels began focusing more on their national jurisdiction areas, potentially leading to a redistribution of fishing effort towards neritic tuna and seerfish species in coastal waters.

2. **Changes in Large Pelagic Fisheries**: Concurrently, industrial vessels from Distant Water Fishing Nations (DWFNs) that traditionally targeted large pelagic tuna species in the Western Indian Ocean also reduced their operations in the late 2010s. This reduction may have further facilitated an increase in relative catch of neritic tunas and seerfish species.

Fig. 2 illustrates this shift in catch trends by species groups from 1950 to 2022. It highlights a sharp decline in tropical tunas between 2009 and 2011, contrasting with the sustained increase observed in neritic tuna species over the same period.

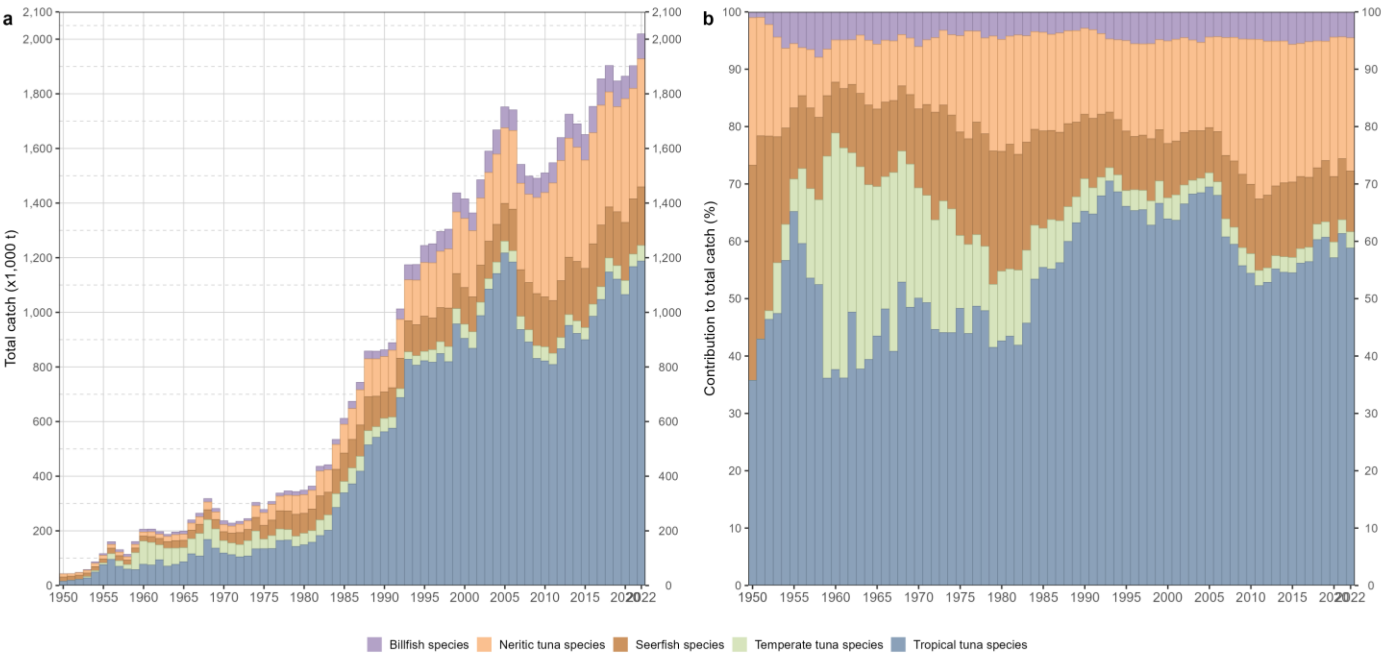

Figure 2: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of IOTC tuna and tuna-like species by species category for the period 1950-2022

Neritic tunas and seerfish species are primarily caught by coastal fisheries, with drifting gillnets playing a predominant role, accounting for over 57% of the catch. This method has remained the major fishery targeting neritic tunas and seerfish species since the 1950s, especially for mackerel species across all sizes of gillnet fisheries (Nguyen et al. 2023). In addition to drifting gillnets, other fishing gears are increasingly operating in coastal waters of the Indian Ocean (**Fig. 3**):

1. **Surrounding Nets**: This category includes purse seines and ring nets, which together contributed 14% of the catch between 2010 and 2022 (Fig. 4). These nets are effective in targeting schools of fish near the surface, including neritic tunas.

2. **Line Fisheries**: Line fisheries, including handlines and longlines operated in coastal areas, contributed 19% to the catch during the same period. These methods are selective and often target specific species, including neritic tunas and seerfish.

3. **Smaller Coastal Fisheries**: Techniques such as beach seines, Danish seines, and trawlers have also reported increased catches of neritic species in recent years. These methods vary in scale and specificity but contribute significantly to local fisheries.

In contrast, certain fishing methods have recorded lower catches of neritic tuna species, such as pole and line, and industrial longline fisheries

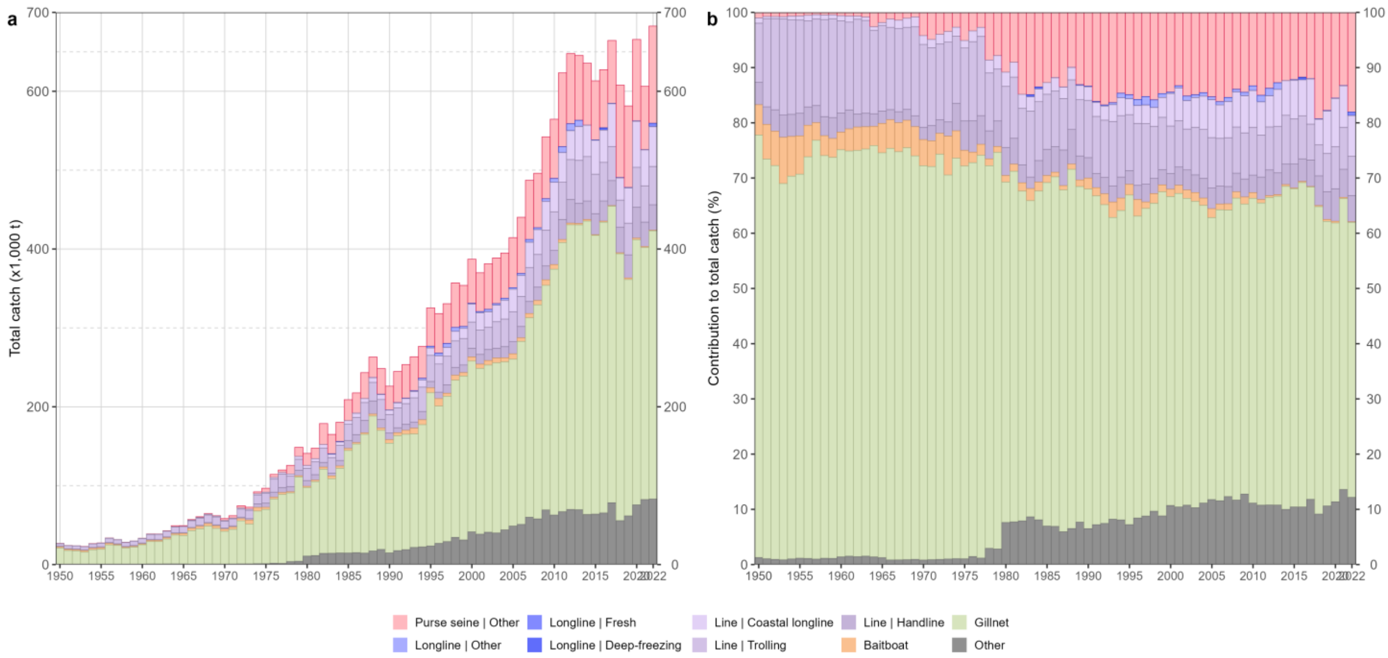

Figure 3: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of IOTC neritic tunas and seerfish by fishery for the period 1950-2022

Species wise, narrow-barred Spanish mackerel species is the main neritic species caught, about 5.6 million t caught between 1950 and 2022 see (**Fig. 4**), contributing 29% of total nertic species catch. Kawakawa and longtail tunas catches show increasing trend particularly in recent years, contributing, 24% and 21%, respectively.

Catch rates of the three species being assessed this year (Frigate and bullet tunas, and Indo-Pacific king mackerel) indicate various trends in the historical catch data:

- Catch trend indicated that Indo-Pacific king mackerel is declining overtime, although catches of narrow-barred Spanish mackerel increased substantially. Catches of Indo-Pacific king mackerel peaked at 52,000t in 2009, and remained at an average of 43,000t between 2018 and 2022.
- Frigate tuna catches on the contrary, related to the other two species, increased significantly in recent years, with highest catch at 141,000 in 2022.
- Although bullet tuna are caught by several fisheries, catches remain lower than other neritic species. Higest catch was in 2018 at 32,000t, as a result of substantial catch from large Indonesian purse seine fisheries. However, catches decline in recent years to reach 11,000t in 2021.

Species-wise, the narrow-barred Spanish mackerel is the predominant neritic species caught in the Indian Ocean, totaling approximately 5.6 million t 1950 and 2022 (**Fig. 4**). This species alone contributes 29% to the total catch of neritic species. Kawakawa and longtail tunas have also shown increasing trends in recent years, contributing, 24% and 21%, respectively.

The catch rates of species being assessed this year, namely Frigate and bullet tunas, and Indo-Pacific king mackerel, exhibit varied trends:

- **Indo-Pacific King Mackerel**: This species has shown a decline over time, despite substantial catches of narrow-barred Spanish mackerel. Peak catches reached 52,000t in 2009, although averaging at 43,000t between 2018 and 2022.
- **Frigate Tuna**: In contrast to Indo-Pacific king mackerel, catches of Frigate tuna have increased significantly in recent years, with the highest catch recorded at 141,000 in 2022.

- **Bullet Tuna**: While caught by various fisheries, catches of Bullet tuna have been lower compared to other neritic species. The highest catch was recorded in 2018 at 32,000t, primarily from large Indonesian purse seine fisheries. However, catches have declined in recent years, reaching 11,000t in 2021.

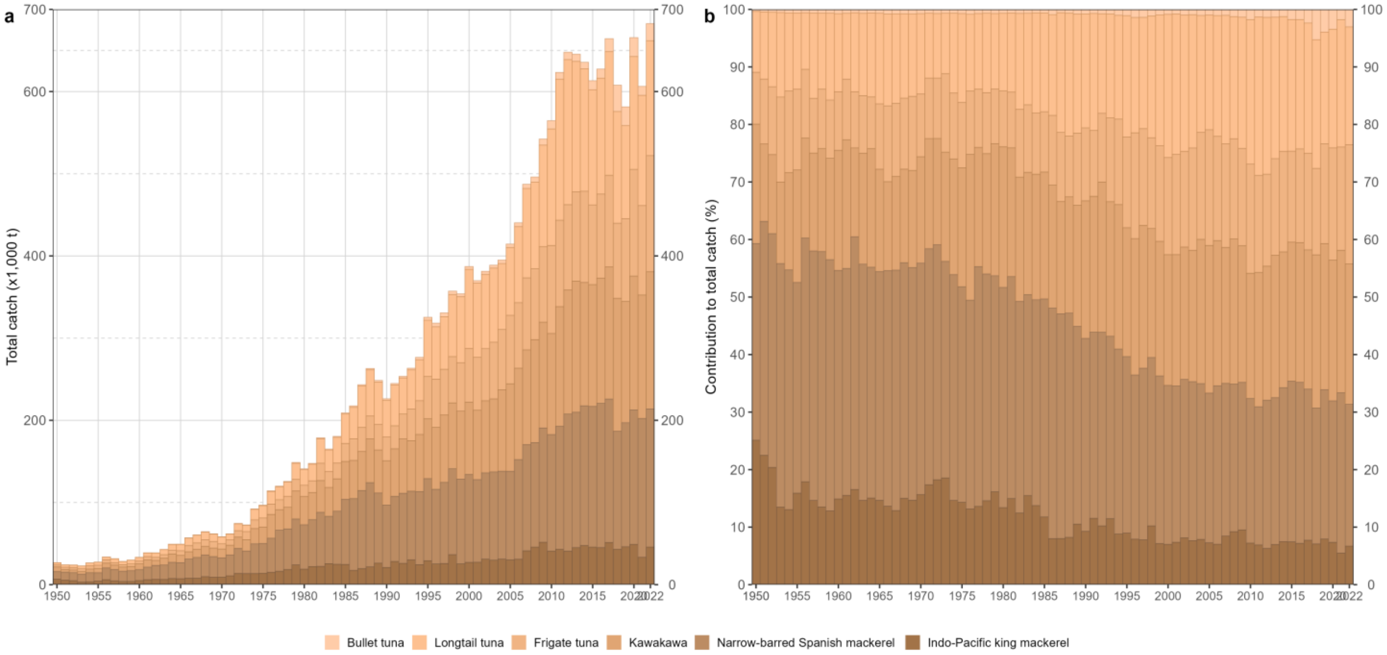

Figure 4: Annual time series of (a) cumulative retained catches (metric tonnes; t) and (b) contribution to the total retained catches (percentage; %) of IOTC neritic tunas and seerfish by species for the period 1950-2022

Overall, the catches of the neritic and seerfish species peaked at 683,000 t in 2022, following a decline in 2019 (**Fig. 5**). This recent increase is primarily attributed to higher catches from India (46%), Indonesia (22%) and Sri Lanka (92%) in 2022 compared to neritic catch data from 2021 (see Recent fishery features).

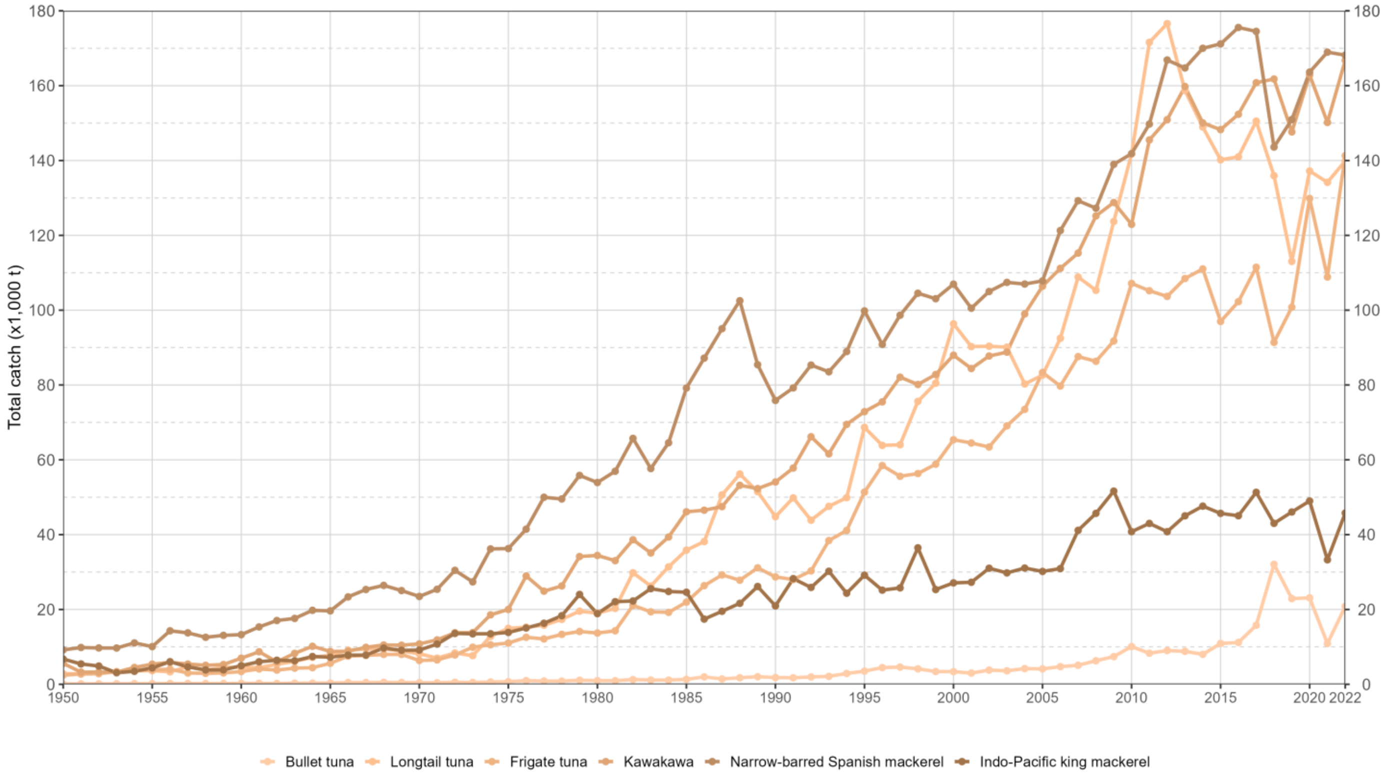

Figure 5: Annual time series of retained catches (metric tonnes; t) of IOTC neritic tunas and seerfish by species for the period 1950-2022

Recent fishery features (2018-2022)

In recent years (2018-2022) the pattern of catch for the neritic species in the Indian Ocean, shows relatively stable levels compared to historical trends. The mean annual retained catches of all IOTC neritic tuna and seerfish species averaged about 629,000 t per year, with gillnet, line (including handline, coastal longline and trolling), and purse seine fisheries contributing to 52%, 19.4%, and 16.8% 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 2018 and 2022 with indication of contribution of each fishery to the total

Fishery	Fishery code	Catch	Percentage
Gillnet	GN	326,733	52.0
Purse seine | Other	PSOT	105,506	16.8
Other	OT	71,627	11.4
Line | Coastal longline	LIC	45,402	7.2
Line | Trolling	LIT	43,931	7.0
Line | Handline	LIH	32,797	5.2
Baitboat	BB	1,500	0.2
Longline | Fresh	LLF	1,201	0.2
Longline | Deep-freezing	LLD	57	0.0

Between 2018 and 2022, the mean annual retained catches of the IOTC neritic tunas and seerfish were heavily influenced by a few Contracting Parties and Cooperating Non-Contracting Parties (CPCs), Specifically, approximately 71% 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**).

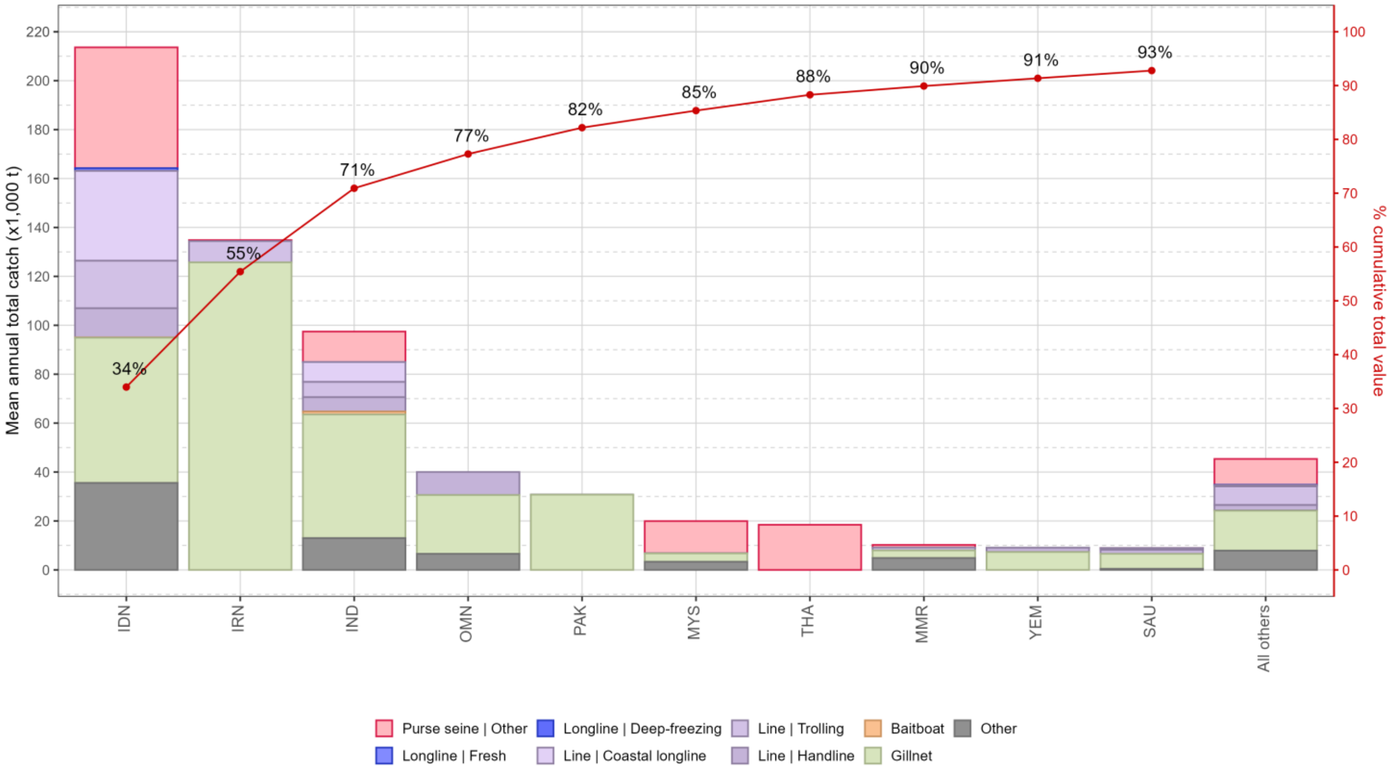

Figure 6: Mean annual retained catches (metric tonnes; t) of IOTC neritic tunas and seerfish by fleet and fishery between 2018 and 2022, with indication of cumulative contribution (percentage; %) of catches by fleet

In the last five years, the catch dynamics of neritic tuna and seerfish species across different fishing gears in the Indian Ocean have shown notable trends (**Fig. 7**) : (i) Total gillnet catches in the last five years fluctuated between 300,000t and 340,000t, with least catch recorded in 2019. (ii) Line fisheries show an increasing trend, with highest catch at 148,000t in 2020.(iii) Purse seine fisheries Purse seine fisheries experienced fluctuations, with catches dropping to their lowest point of 80,000t in 2021, but recovery significantly in 2022 at 123,000t. (iv) Baitboat and industrial longline fisheries recorded limited catches of neritic tuna and seerfish species. Neritic species are occasionally caught as bycatch in industrial longline fisheries, although these catches are typically underreported.(v) Besides the main fishing gears mentioned, there are other coastal fisheries operating in the region that also catch neritic and seerfish species. These fisheries, although less prominent in overall catch volumes, contribute to the broader exploitation of neritic resources in coastal waters.

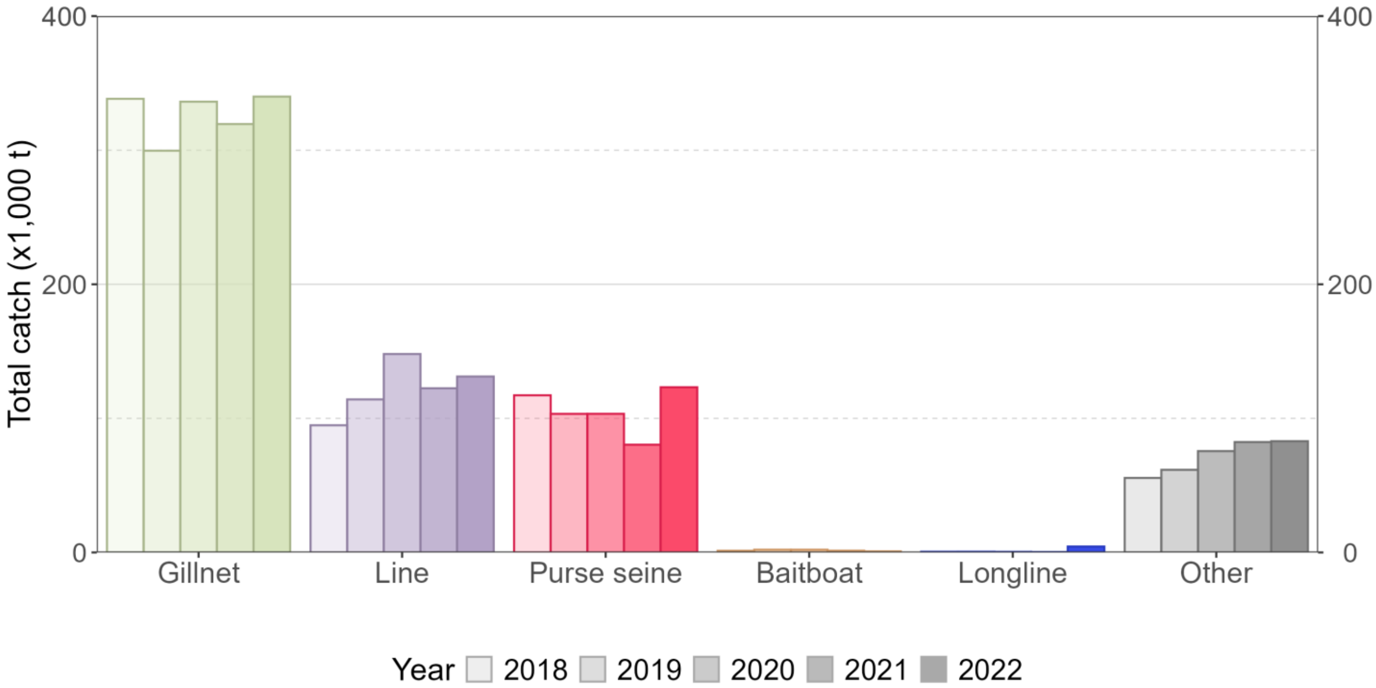

Figure 7: Annual trends in retained catch (metric tonnes; t) of IOTC neritic tunas and seerfish by fishery group between 2018 and 2022

The fluctuations in the gillnet catches are attributed to variations in several key neritic fisheries. I.R Iran, which contributed 38% of the total gillnet neritic catches, there was a decline of 13% in 2019, with catches remaining below 130,000 tonnes since 2020. sSimilar reductions were observed in the Arabian Sea, not only in Iran but also in Pakistan in recent years, due to factors such as fishing closures, reduced demand from the Iranian market (a major export destination for the species), and adverse environmental conditions (Moazzam 2021). Indian fisheries also initially experienced a decline in 2021 (39,000t), with a substantial increase recorded in 2022 (59,000t). Other gillnet fleets targeting neritic species showed an increase in recent years, particularly Oman, where catches doubled from (17,000t) in 2018 to (35,000t) in 2022 (**Fig. 8a**).

Line fisheries are primarily dominated by Indonesia, India, and Oman, although their catches are lower compared to gillnets, overall catches from these fleets have been increasing in recent years. Indonesia saw a marked increase in 2020 with catches rising to87,000t from 60,000t in 2019. Catches from India Oman and other fleet fluctuated in recent years. India line fishery catches varied between 16,000t in 2021 and 24,000 in 2019. Conversely, Omani's line catches fluactuated between r pn(rt(min_catch_y(NC_RP[FLEET_CODE == "OMN" & FISHERY_GROUP_CODE == "LI"])[,CATCH])) `t in 2018 and 14,000 in 2020. Catches from I. R Iran, and other fleets, showed an increasing trend (**Fig. 8b**).

The catch of neritic tunas and seerfish using purse seines in Indonesia has significantly declined in recent years, as reported to the Secretariat, dropping by nearly half from 63,000 t in 2017 to about 63,000 t in 2021. Catches were significantly higher in 2018 and 2022 compared to the years between 2019 and 2021 (**Fig. 8c**). Data reported from Indonesia indicate substantial catches from industrial purse seine fisheries but show variability, reflecting challenges in the reliability of data from coastal fisheries currently under review (DGCF & BRIN 2023). Similarly, catches of neritic species in purse seine fisheries in Thailand, Malaysia, and India also decreased between 2020 and 2022, albeit to a lesser extent. Thailand, which operates coastal purse seine fisheries, saw catches peak in 2020 at 30,000. However, average catches for other fleet hovered around 15,000t.

Catches from other fisheries such as longline, baitboat, and other small-scale fisheries collectively contribute a smaller share (12%) to neritic species catches, but they exhibit variability across fleets. Fleets engaged in other small-scale fisheries (e.g., beach seine, liftnet, trawl, etc.), notably Indonesia and India, have shown an overall increasing trend in recent years (**Fig. 8f**). Bangladesh, which has been enhancing its reporting quality, reported substantial catches of neritic species from trawl and set bagnet fisheries, averaging 14,000 t.

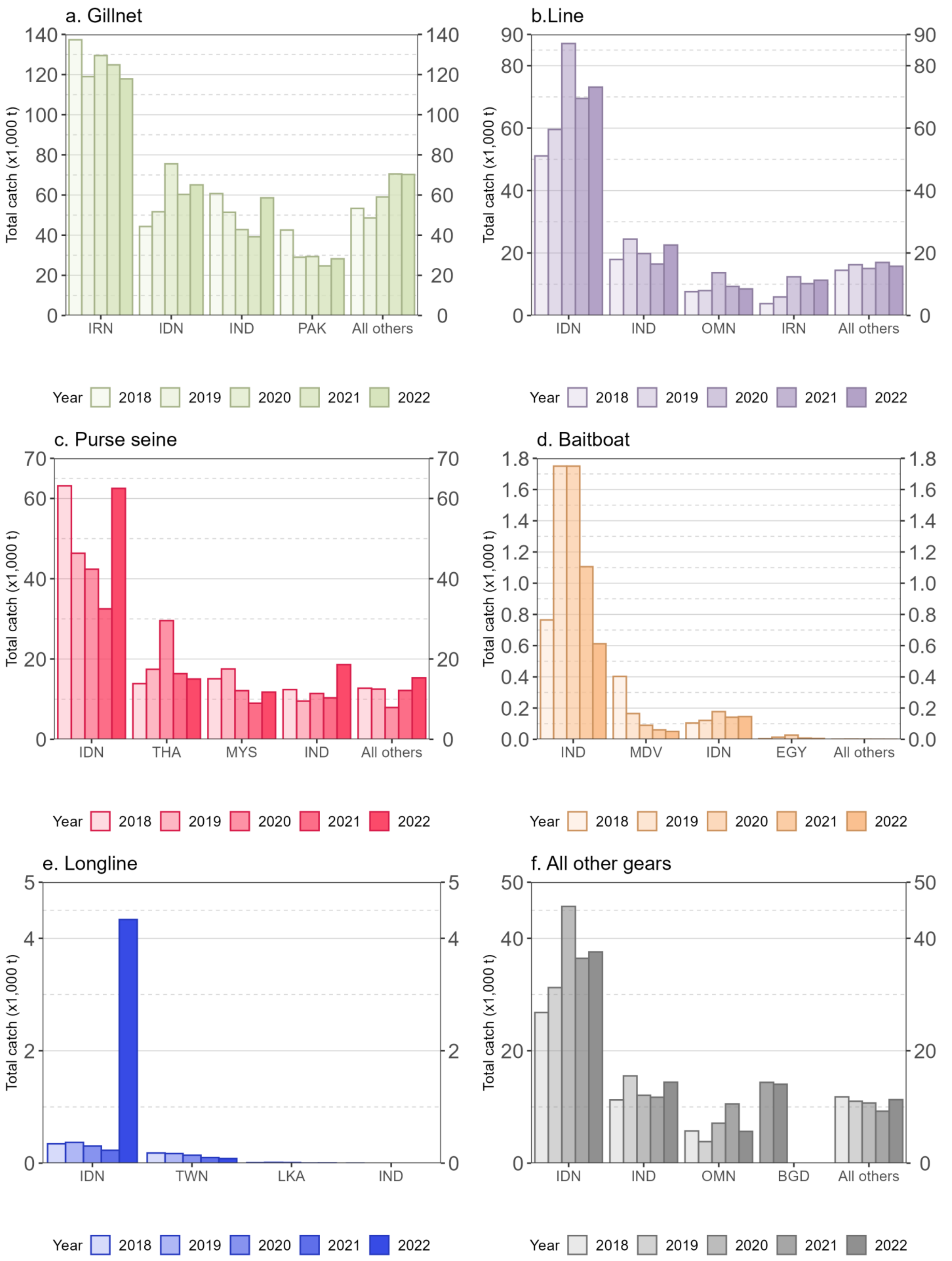

Figure 8: Annual trends in retained catch (metric tonnes; t) of IOTC neritic tunas and seerfish by fishery group and fleet between 2018 and 2022

Changes from previous Working Party

There have been recent updates in the time series of retained catches for neritic and seerfish species, following the release of datasets prepared for the 13th session of the Working Party on Neritic Tunas held in July 2023 which covered the period 1950-2021 (WPNT13). Changes primarily affected the years 2015 to 2021, with minimal adjustments related to historical revisions of catch data from industrial purse seine fisheries during this period (**Fig. 9**). Specifically, the revised data indicated an increase in neritic tuna catches in 2018, followed by a decrease in 2021 Appendix II.

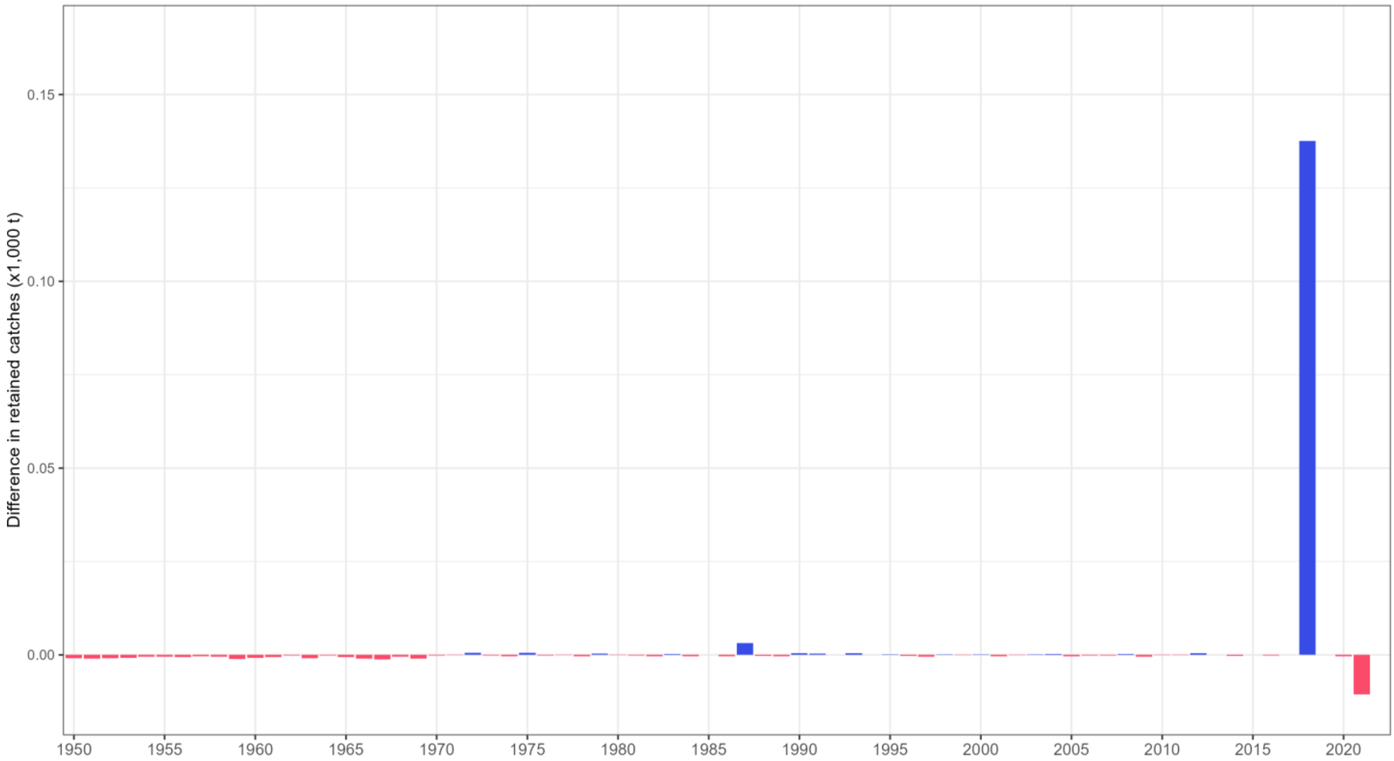

Figure 9: Differences in the annual retained catches (metric tonnes; t) of neritic tuna and seerfish available at this WPNT and its previous session

Uncertainties in retained catch data

Overall reporting quality scores

Uncertainty in the catch data available in the IOTC databases are becoming more concern to scientists using the data (Cappa et al. 2024). The Secretariat, with the supplementary funds from members is working closely with CPCs less able to meet the reporting requirements through several workshops; https://iotc.org/meetings/iotc-eastern-regional-workshop-enhancing-fisheries-data-reporting), aiming at enhancing the data reporting quality, and with the production of several tools to assist CPCs.

Uncertainty in catch data available in the IOTC databases is increasingly concerning to scientists (Cappa et al. 2024). The Secretariat, supported by supplementary funds from its members, is actively collaborating with CPCs that face challenges in meeting reporting requirements through workshops; https://iotc.org/meetings/iotc-eastern-regional-workshop-enhancing-fisheries-data-reporting), aimed at enhancing data quality reporting and tools are being developed to assist CPCs in this effort. Indian Ocean catches from national jurisdictions are on the rise, but this increase is accompanied by high uncertainty. Challenges include:

- Poor or non-existent data collection systems,
- Limited emphasis on recording catches of tuna and tuna-like species due to low catch rates,
- Aggregation and misidentification of tuna species,
- Simultaneous application of diverse fishing techniques that are difficult to monitor.

Data collection in national jurisdictions primarily relies on landing surveys, which have inherent limitations. Annual changes in the composition of retained catches, as indicated by quality scores, provide insights into data uncertainty at the IOTC Secretariat. Quality scores for the nominal catches of six IOTC neritic tunas and seerfish reflect: Non-reporting of data; estimation of species and gear composition when reporting aggregate figures; and persistent data quality issues in major countries such as Indonesia and India.

The percentage of nominal catches fully or partially reported to the Secretariat (quality score between 0 and 2) has varied between 37.2% and 72.2% of total catches over time, showing an encouraging increasing trend since the mid-1990s. However, the reporting quality has decreased since then and 62.4% of all retained catch was fully or partially reported to the Secretariat in 2022 (**Fig. 10**).

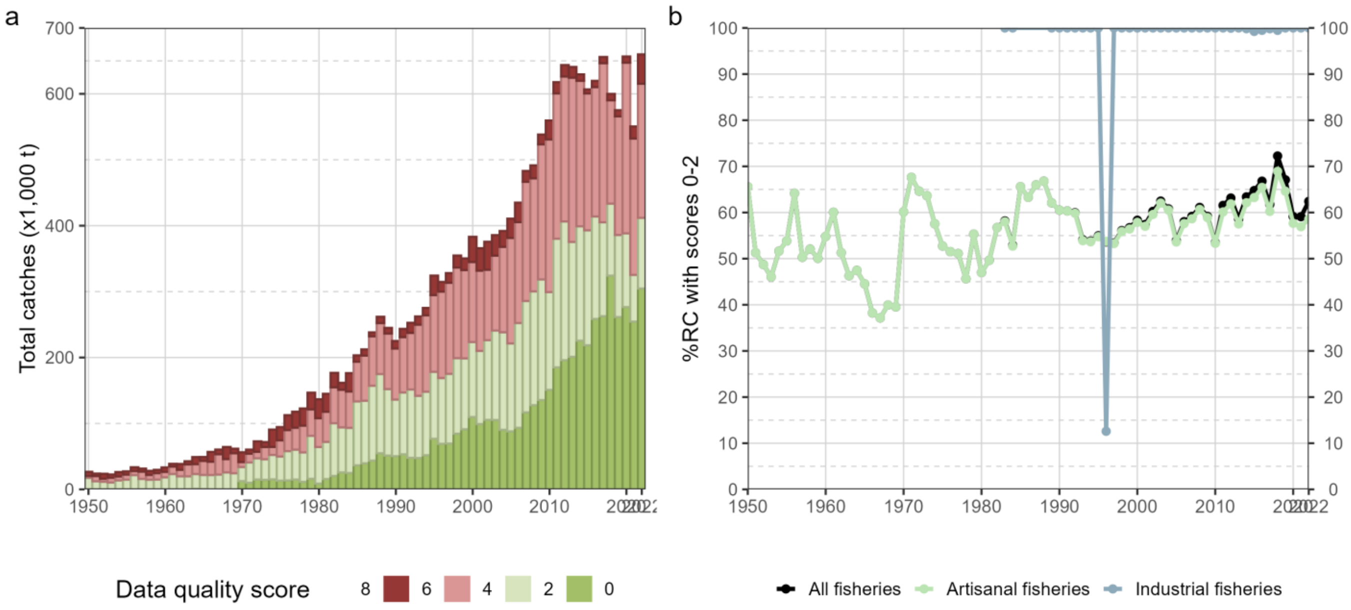

Figure 10: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches fully or partially reported to the IOTC Secretariat to all retained caches (percentage; %) of IOTC neritic tunas and seerfish for all fisheries and by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

In 2022, approximately 46.2% of the retained catch was estimated to have been fully reported to the Secretariat, with the remainder requiring partial or full estimation. Some of these catches were derived from alternative sources of catch data for CPCs and non-CPC coastal states that did not report directly to the Secretariat (Appendix III). Furthermore, a re-estimation process was undertaken for artisanal fisheries in Bangladesh, India, and Indonesia, along with adjustments for reporting catch data through species aggregates (Appendix III).

Discards

Due to incomplete reporting and varying data quality across coastal fisheries in the Indian Ocean, discarded catch data remains largely unknown to the IOTC Secretariat. Research (Heidrich et al. 2022) has indicated that discards of neritic and seerfish species do occur in several fisheries within the region, although specifics are not well documented. Discrepancies between reported data and estimates derived from sources like the Sea Around Us highlight the need for further analysis on the quality of reported data, species identification, and collaboration with institutions such as UBC for data validation. The Secretariat briefly reivewed and compared the data of Sea Around Us with information from IOTC database, which indicated various between the two data sets (**WPNTINF07?**).

The Covid-19 pandemic has further disrupted data collection efforts through the ROS, resulting in fewer onboard observers and delays in program implementation by some CPCs since 2020. Additionally, non-compliance with IOTC Res. 11/04 and the use of non-standard data formats by CPCs have restricted the inclusion of several data submissions into the ROS database, limiting the information available.

Data within the ROS regional database from 2005 to 2021 suggest that discarding of neritic species is minimal in longline fisheries but more common in purse seine fisheries, particularly for frigate tuna and kawakawa, and to a lesser extent for bullet tuna (**Fig. 11**). Notably, observations from industrial purse seine fisheries reveal widespread distributions of frigate tuna, kawakawa, and bullet tuna throughout the Western Indian Ocean, challenging previous assumptions that these species were strictly coastal.

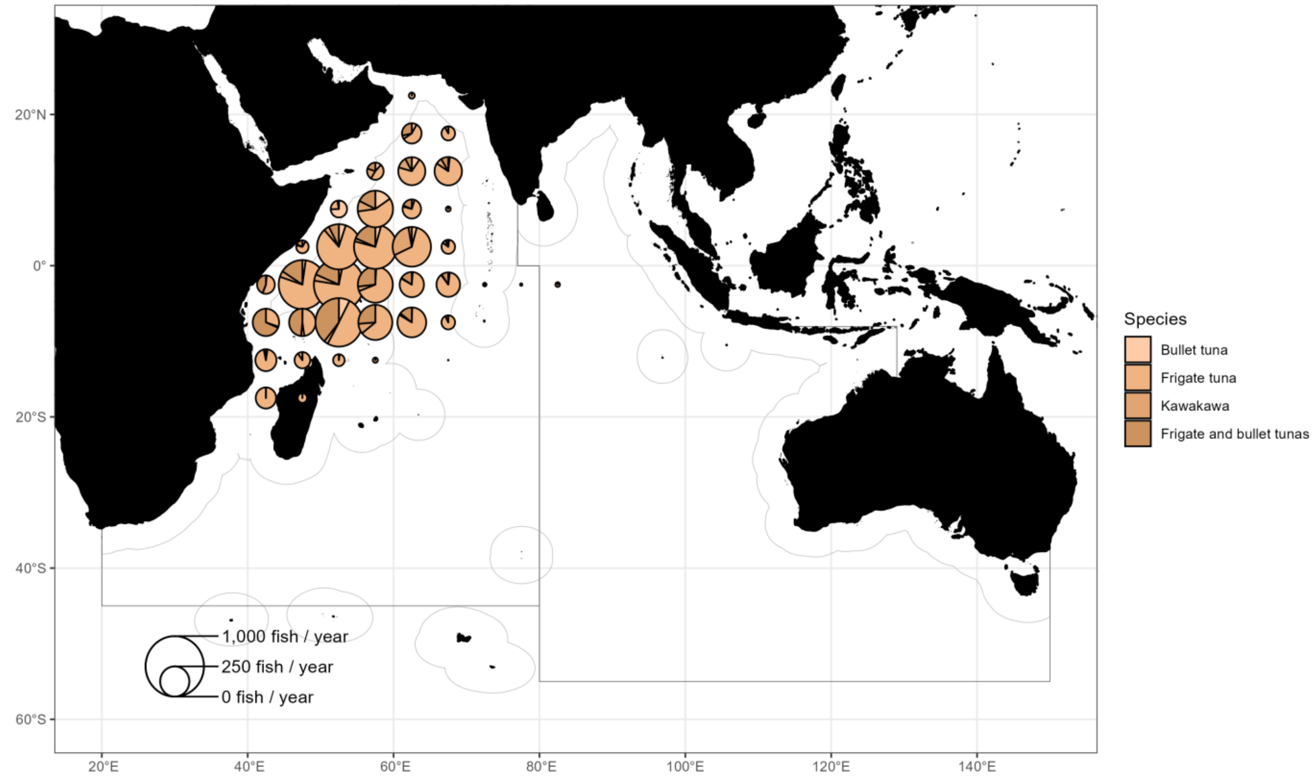

Figure 11: Distribution of interactions of neritic tunas with Western Indian Ocean purse seine fisheries as available in the ROS regional database. Light grey solid lines delineate areas beyond national jurisdiction

Currently, the ROS regional database does not include information on the release status (i.e., *alive* or *dead*) of neritic tunas discarded at sea by purse seine fisheries. This absence is primarily due to the data exchange format used by national institutes managing observer programs. However, it is widely believed that most tunas discarded at sea do not survive. This assumption stems from the conditions under which purse seine operations typically occur, where the handling and retrieval methods often result in high mortality rates for discarded fish.

It’s important to note that existing observer protocols within the ROS focus specifically on discards, omitting information on the fate of discarded tunas post-release. Furthermore, while discards are the primary focus, a portion of the bycatch of neritic tunas may be retained, particularly for international markets.

Size data collected at sea by scientific observers provide insights into the size ranges of different neritic tuna species caught with purse seines. Frigate and bullet tunas typically exhibit similar fork length ranges, spanning from 25 cm to 60 cm, with a median size around 38-40 cm. In contrast, kawakawas tend to be larger, with a median fork length of approximately 45.5 cm and occasionally reaching up to 70 cm (**Fig. 12**).

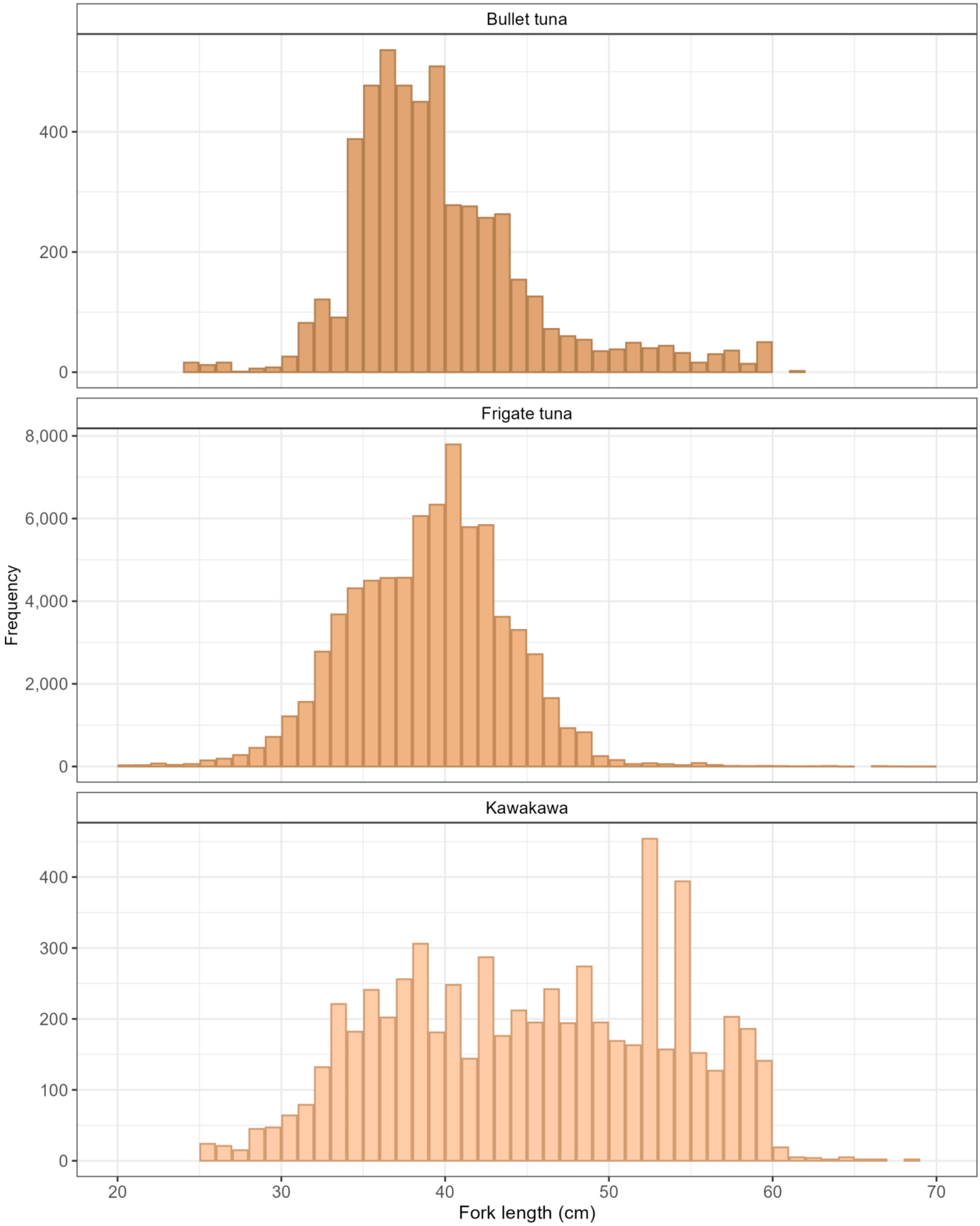

Figure 12: Size frequency distribution of neritic tunas caught in Western Indian Ocean purse seine fisheries as available in the ROS regional database

Spatial distribution of catch and effort

Geo-referenced catch and effort data for major fisheries targeting neritic species in the Indian Ocean are either completely unavailable or very limited in scope. This limitation extends to the time frames for which such data are accessible, further complicating efforts to analyze fishing activities comprehensively. One of the primary challenges is the inconsistency in recorded effort, as different units of effort (e.g., trips, days, etc.) have been used over time within the same fishery.

Indonesia and India, which together account for approximately half of the total catches of neritic species in the Indian Ocean in recent years, face significant gaps in their geo-referenced catch and effort data. Indonesia began reporting time-area catches for some artisanal and industrial fleets from 2018 onward, but the coverage remains notably low, typically less than 5% of fishing grounds. This limited coverage suggests that the reported data may not fully represent the extent of fishing activities across Indonesian waters.

In contrast, India has not reported any geo-referenced catch and effort data for its coastal fisheries since 1981, despite consistently reporting substantial annual catches, reaching about 97,000 t of fish in recent years. The absence of geo-referenced data poses challenges for accurately assessing the spatial distribution and intensity of fishing efforts in Indian coastal waters.

Furthermore, Pakistan has not submitted any geo-referenced data to the IOTC Secretariat since 1991, while Oman's last submission was in 2013. These omissions are noteworthy considering the significant contributions of these countries' fisheries to the total catches of neritic species in recent years.

These fisheries with crucial gaps in the geo-reference catch and effort data, contributed significant to the total catches of neritic species (**Fig. 6**).

By contrast, I.R. Iran has established a robust time series of catch and fishing effort data since 2007 through a dedicated port sampling program for their coastal and offshore gillnet fisheries. This initiative has significantly enhanced the availability of data, particularly following an IOTC Data Compliance mission conducted in late 2017. As a result, I.R. Iran has started reporting catch and effort data in compliance with Resolution 15/02, thereby improving the accuracy and consistency of time-area catches reported for Iranian gillnetters, which are among the primary fisheries targeting neritic tunas in the region.

In addition to reporting catch and effort data, efforts have been made to derive time series of Catch Per Unit Effort (CPUE) for key species such as longtail tuna, kawakawa, frigate tuna, and narrow-barred Spanish mackerel for the period 2008-2017 (Fu et al. 2019). This initiative provides valuable insights into the trends and dynamics of these fisheries, albeit with some challenges. Notably, the reported fishing effort for Iranian gillnetters is expressed in terms of fishing trips, reflecting the operational characteristics of a fleet comprising more than 1,200 vessels ranging from less than 15 m to over 30 m in length overall. The variability in trip durations introduces complexities in interpreting effort data, and efforts to derive days at sea from trip-level data collected by the Iranian Fisheries Organization may contain inherent biases (Fu et al. 2019).

Further collaboration with I.R. Iran is essential to leverage and refine the catch and effort data available from their gillnet fishery. Such collaboration will support the development of robust stock assessment models for neritic tunas and seerfish in the Indian Ocean, contributing to effective fisheries management and conservation efforts in the region.

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. 13a**). 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. 13b**). More effort data are available from the purse seine fisheries of Thailand and Sri Lanka but the time series remain short (**Fig. 13c-d**).

Very little information is available regarding the fishing effort exerted by Malaysian purse seiners, despite their annual average catch of 13,000 t of IOTC neritic species in recent years. Effort data are only accessible from 2019 onward and are confined to a single 5°x5° square grid (**Fig. 13a**). Similarly, the spatial distribution of effort for Indonesian purse seiners is limited to a few recent years and scattered across a few 1°x1° grids along the Indonesian coastlines, despite Indonesia's national purse seine fleet comprising over 150 vessels larger than 24 meters in length overall (**Fig. 13b**).

More extensive effort data are available from the purse seine fisheries of Thailand and Sri Lanka, although the time series remain relatively short (**Fig. 13c-d**).

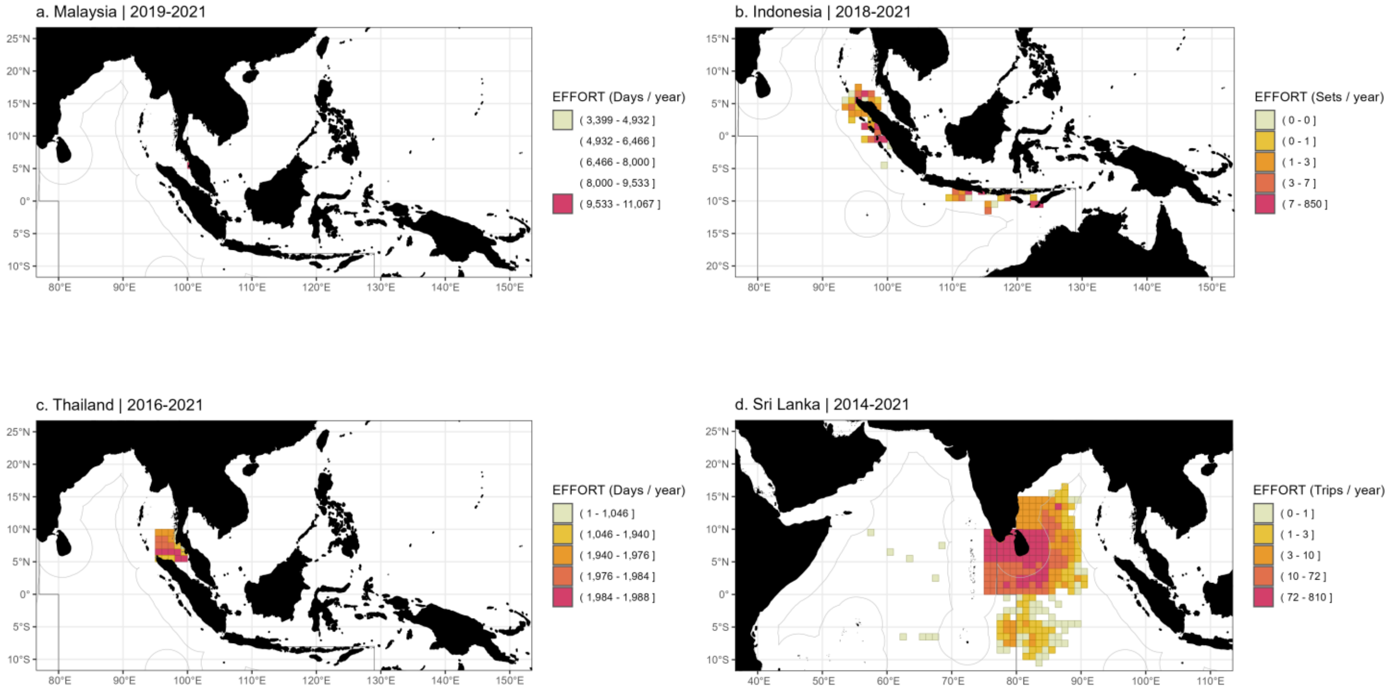

Figure 13: Distribution of fishing effort available at the IOTC Secretariat for purse seine fisheries catching IOTC neritic tunas and seerfish from (a) Malaysia (2019-2021), (b) Indonesia (2018-2021), (c) Thailand (2016-2021), and (d) Sri Lanka (2014-2021). Light grey solid lines delineate areas beyond 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. 13a-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. 13d**).

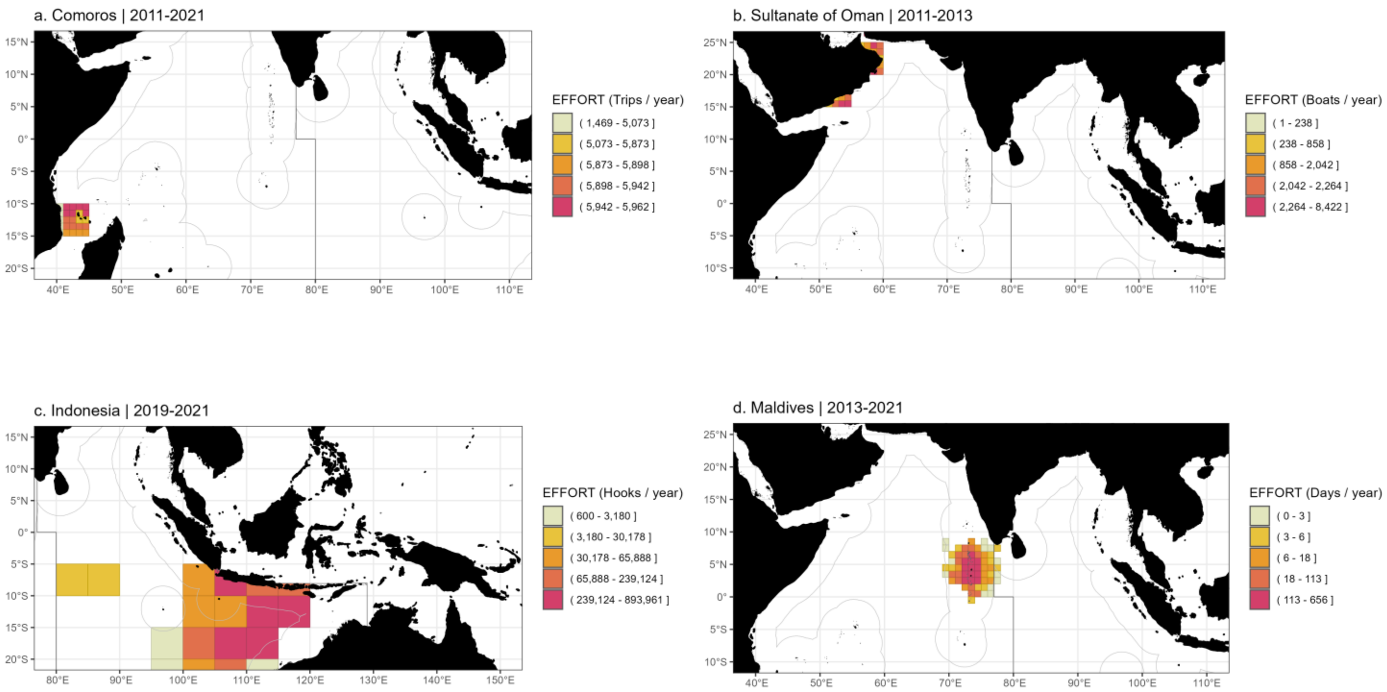

Figure 14: Distribution of fishing effort available at the IOTC Secretariat for line fisheries catching IOTC neritic tunas and seerfish from (a) Comoros (2011-2021), (b) Sultanate of Oman (2011-2013), (c) Indonesia (2019-2021), and (d) Maldives (2013-2021). Light grey solid lines delineate areas beyond 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. 15a**). The spatial distribution of the effort of the Sri Lankan gillnetters is also good in time and space (**Fig. 15b**). 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.

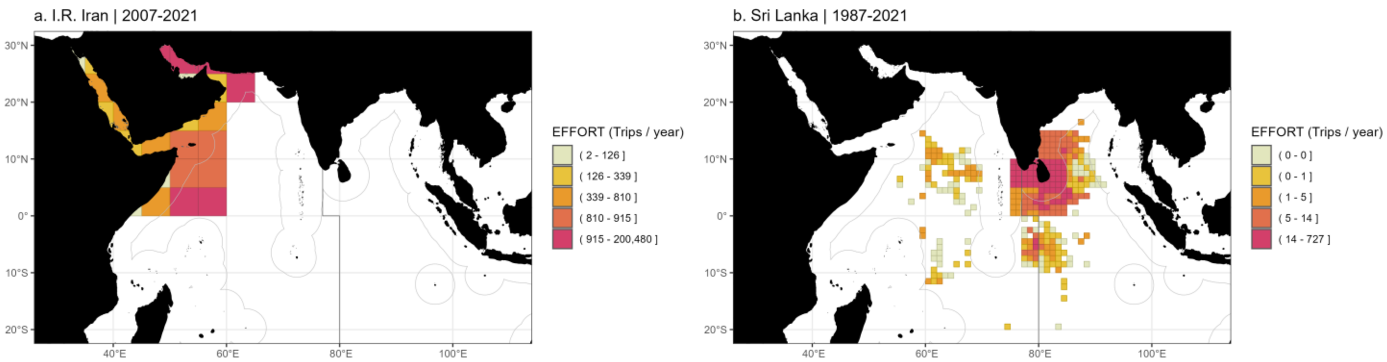

Figure 15: Distribution of fishing effort available at the IOTC Secretariat for gillnet fisheries catching IOTC neritic tunas and seerfish from (a) I.R. Iran (2007-2021) and (b) Sri Lanka (1987-2021). Light grey solid lines delineate areas beyond national jurisdiction

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. 16**).

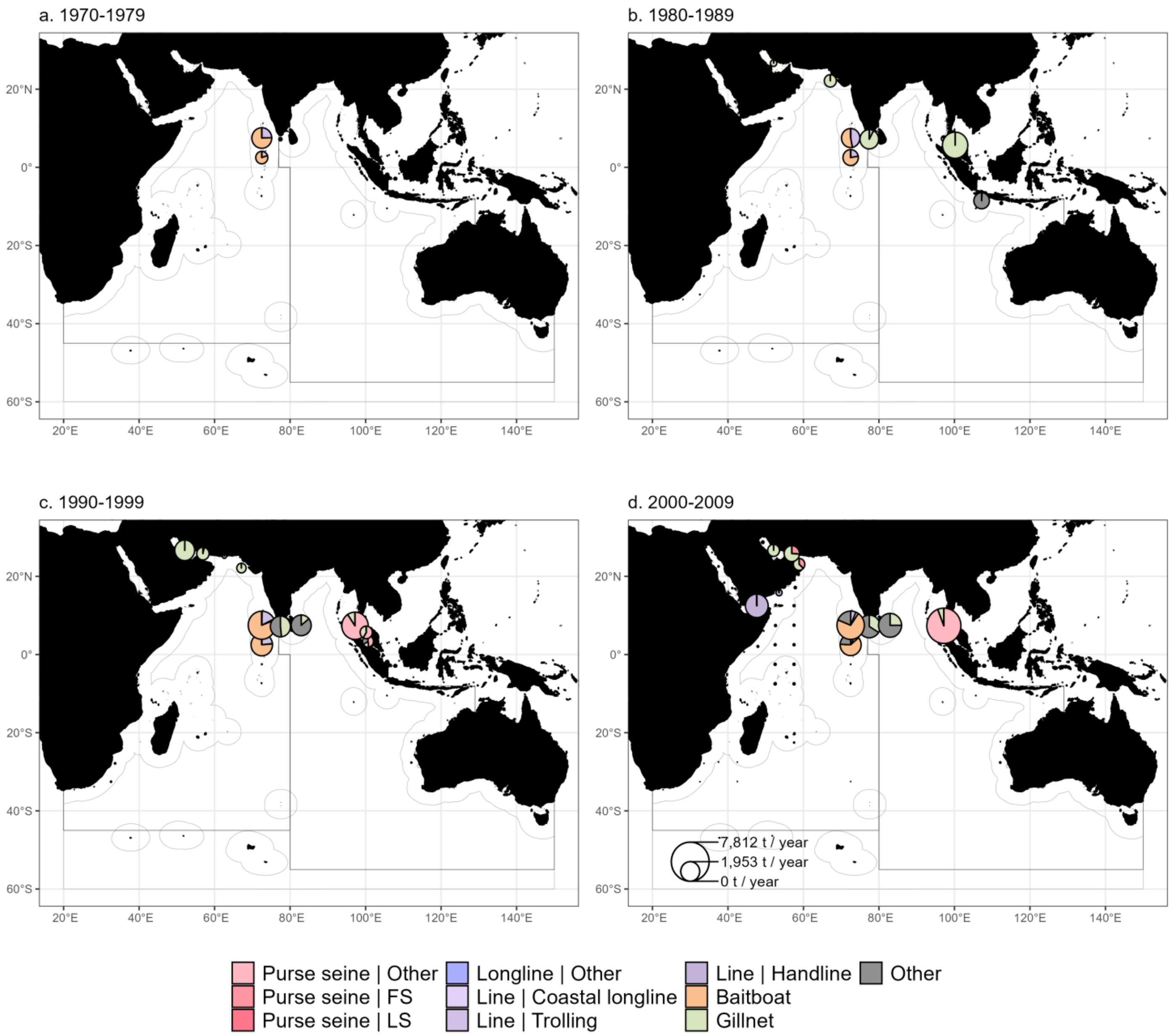

Figure 16: Mean annual time-area catches (metric tonnes; t) of IOTC neritic tuna and seerfish species by decade, 5x5 grid, and fishery as reported to the Secretariat. Light grey solid lines delineate areas beyond national jurisdiction

More information on the fishing grounds of IOTC neritic species has become available over the last decade (**Fig. 17**). 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.

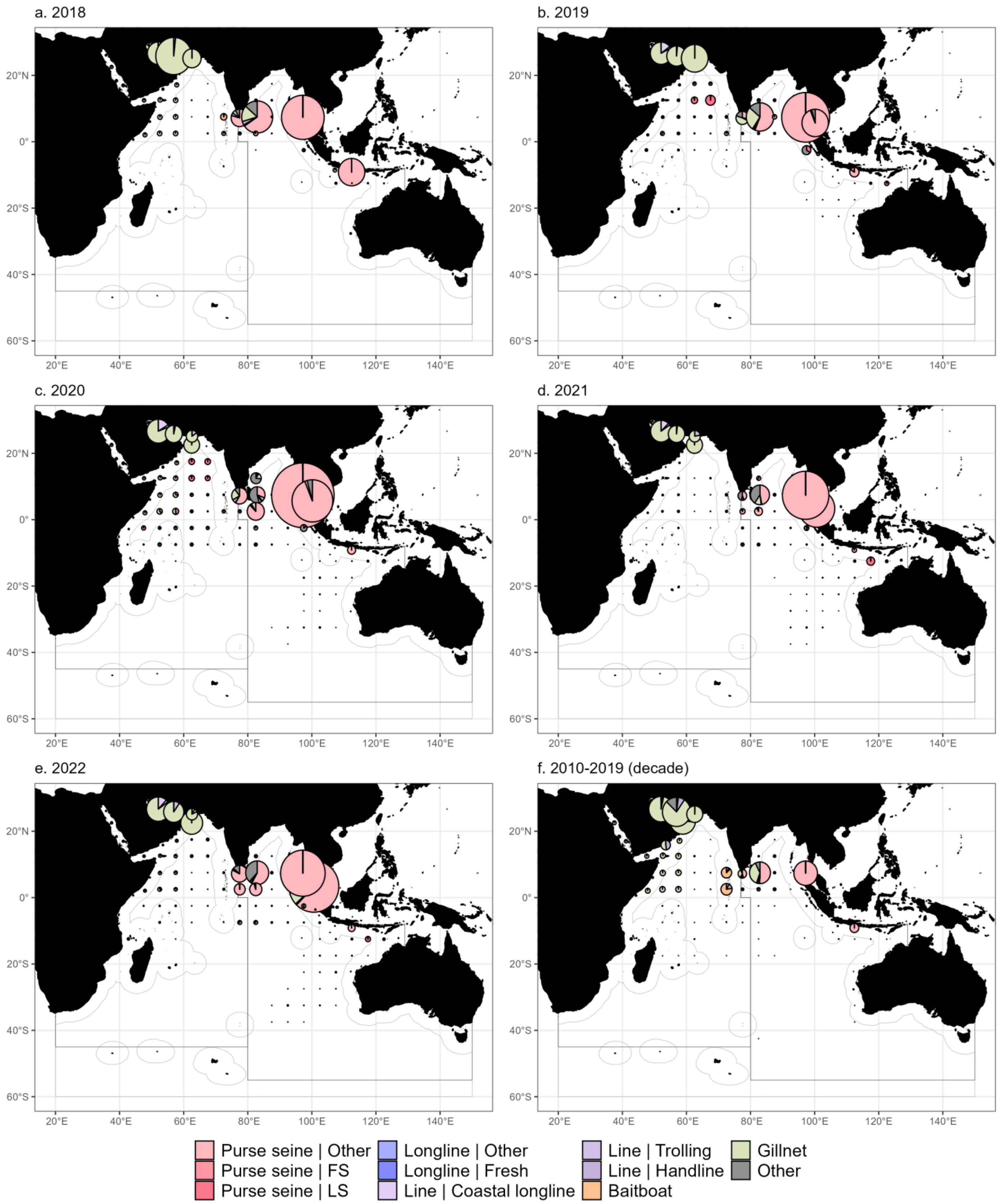

Figure 17: Mean annual time-area catches (metric tonnes; t) of IOTC neritic tuna and seerfish species by year for the period 2018-2022 and for the most recent decade, 5x5 grid, and fishery as reported to the Secretariat. Light grey solid lines delineate areas beyond national jurisdiction

Geo-referenced catch revision of Thailand

Improvements have been evident in Thailand's purse seine fisheries regarding geo-referenced catch data, particularly for neritic species. Historically, Thailand had reported aggregated catch data by species, which limited the detailed understanding of species-specific catches. Recently, Thailand undertook efforts to enhance their reporting by revising both retained and geo-referenced catch data, incorporating more detailed species-specific information. This revision included using sampling data collected over time and retrospectively adjusting catches dating back to 2006 (Noranarttragoon et al. 2023). Despite these advancements, the focus was primarily on purse seine fisheries, and other fisheries with historical catches of neritic species in Thailand were not included in this exercise.

Uncertainties in catch and effort data

Overall, the reporting quality of geo-referenced catch and effort data submitted to the Secretariat remains notably low, particularly for the main fisheries targeting neritic tunas and seerfish in the Indian Ocean (**Fig. 18a**). However, there has been an encouraging upward trend in data quality since the mid-2000s, driven by increased reporting from key fishing nations such as Iran, Thailand, and Sri Lanka. In 2022, the percentage of retained catches with sufficient geo-referenced catch and effort data (scores 0-2; **Table 4**) stood at 41.3% in 2022, down from 47.4% in 2021 (**Fig. 18b**).

The issues with catch and effort data have persisted over the years, with only updated historical data from Thailand and EU-Italy marginally improving the quality for the period 2006 to 2022. Significant uncertainties surround the catch and effort data of coastal fisheries, particularly:

- 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.

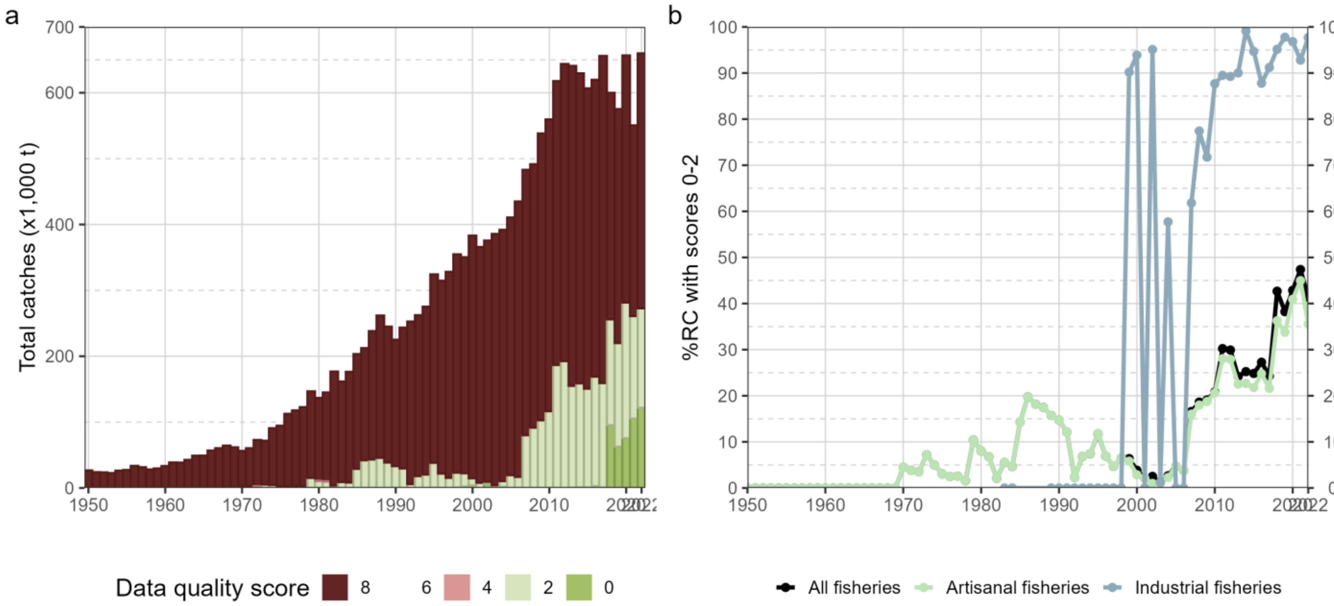

Figure 18: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches with corresponding geo-referenced catch and effort data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 to all retained caches (percentage; %) of IOTC neritic tunas and seerfish for all fisheries and by type of fishery, for the period 1950-2022

Size composition of the catch

Samples availability

Over the years, size samples of neritic species have been collected primarily by main neritic fleets such as I.R. Iran and Sri Lanka, with recent contributions from Indonesia and Thailand. Despite consistent data reporting from some fleets, meeting quality standards has proven challenging, even though samples are gathered from multiple fisheries.

The size samples available for neritic tunas and seerfish are predominantly from gillnet fisheries, comprising 75.7% of all size data in the IOTC database. Additionally, size samples are available from purse seine purse seine (1985-2022), baitboat (1983-2022), and trolling line (1983-2022) fisheries, albeit in smaller numbers compared to gillnet fisheries, while very few samples are available from all other fisheries (**Fig. 19**). Interestingly, size data have been available since the 1980s, primarily from projects conducted under the Indo-Pacific Tuna Programme (IPTP). Early samples were collected in Indonesia, Maldives, and Malaysia, and later in Sri Lanka, I.R. Iran, and Pakistan.

In recent years, coastal fisheries have collected very few samples. For example, Sri Lanka averaged sampling about 194,000 fish annually between 1985 and 1993, but less than 5,000 samples annually between 2018 and 2022. In contrast, I.R. Iran has increased the number of neritic fish sampled over the last decade, reaching around 130,000 in 2019, but decreasing recently to reach 103,000 fish in 2022 while the total catch levels have remained quite stable.

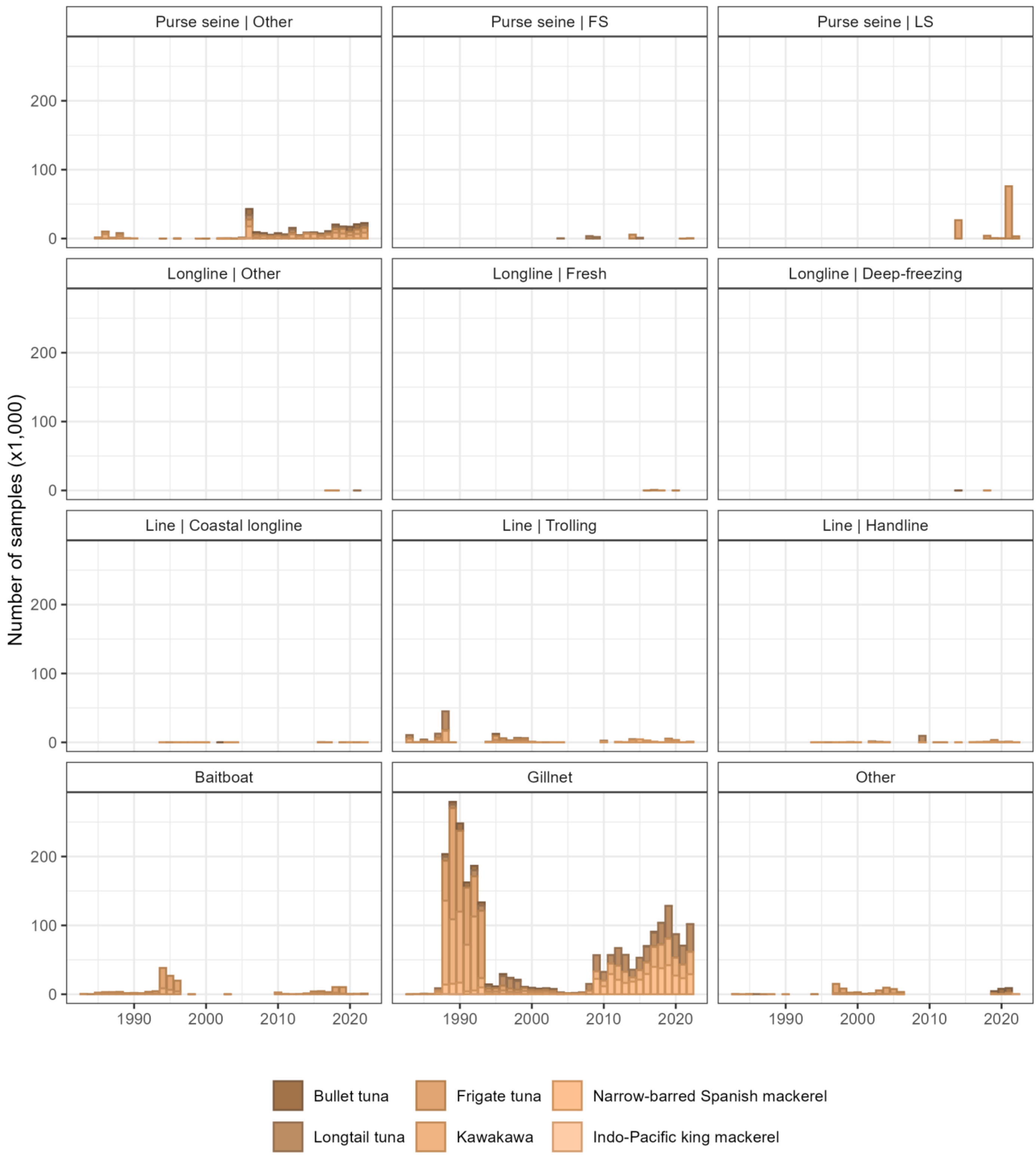

Figure 19: Annual number of standard size samples available at the IOTC Secretariat by fishery and neritic species. FS = free-swimming school; LS = school associated with floating object

The number of size samples by species is very unbalanced and not representative of the importance of each species in the retained catches (**Fig. 20**). About two thirds of all samples available are for kawakawa (32.96%) and frigate tuna (31.3%). Samples for narrow-barred Spanish mackerel only represent 14.75% 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 613 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 20: 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 interpreted with caution due to their lack of consideration for spatio-temporal changes in sampling (e.g., fishing grounds). Bias may arise from variability in sampling methodology and intensity over time and across CPCs. Nonetheless, the available data offer general insights into the size composition of the catch, revealing significant size variations across 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. 21**). 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 28.5 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 51.5 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 74.5 and 98.5 cm (**Fig. 21**). The very few samples available for Indo-Pacific king mackerel from coastal purse seine (n = 166) and gillnet (n = 393) fisheries indicate similar median values of fork length of 44.5 cm.

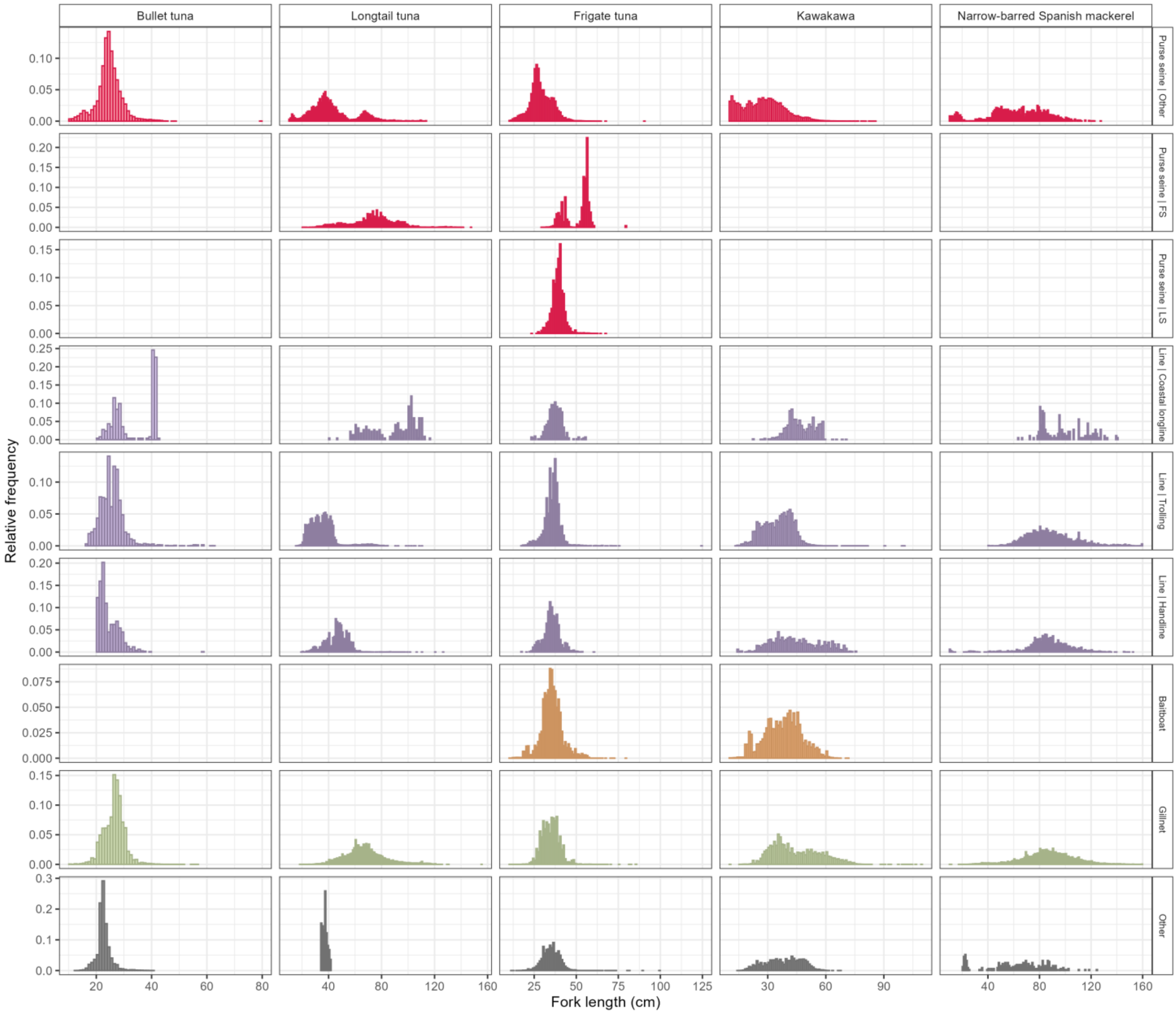

Figure 21: Relative fork length (cm) frequency distribution of IOTC neritic tuna and seerfish species (except for Indo-Pacific king mackerel) aggregated across all samples available at the IOTC Secretariat by fishery, excluding longline fisheries

By fleet, as indicated, majority of the samples are collected from Iranian fisheries, and increased in the sample coverage by Thailand (**Fig. 22**).

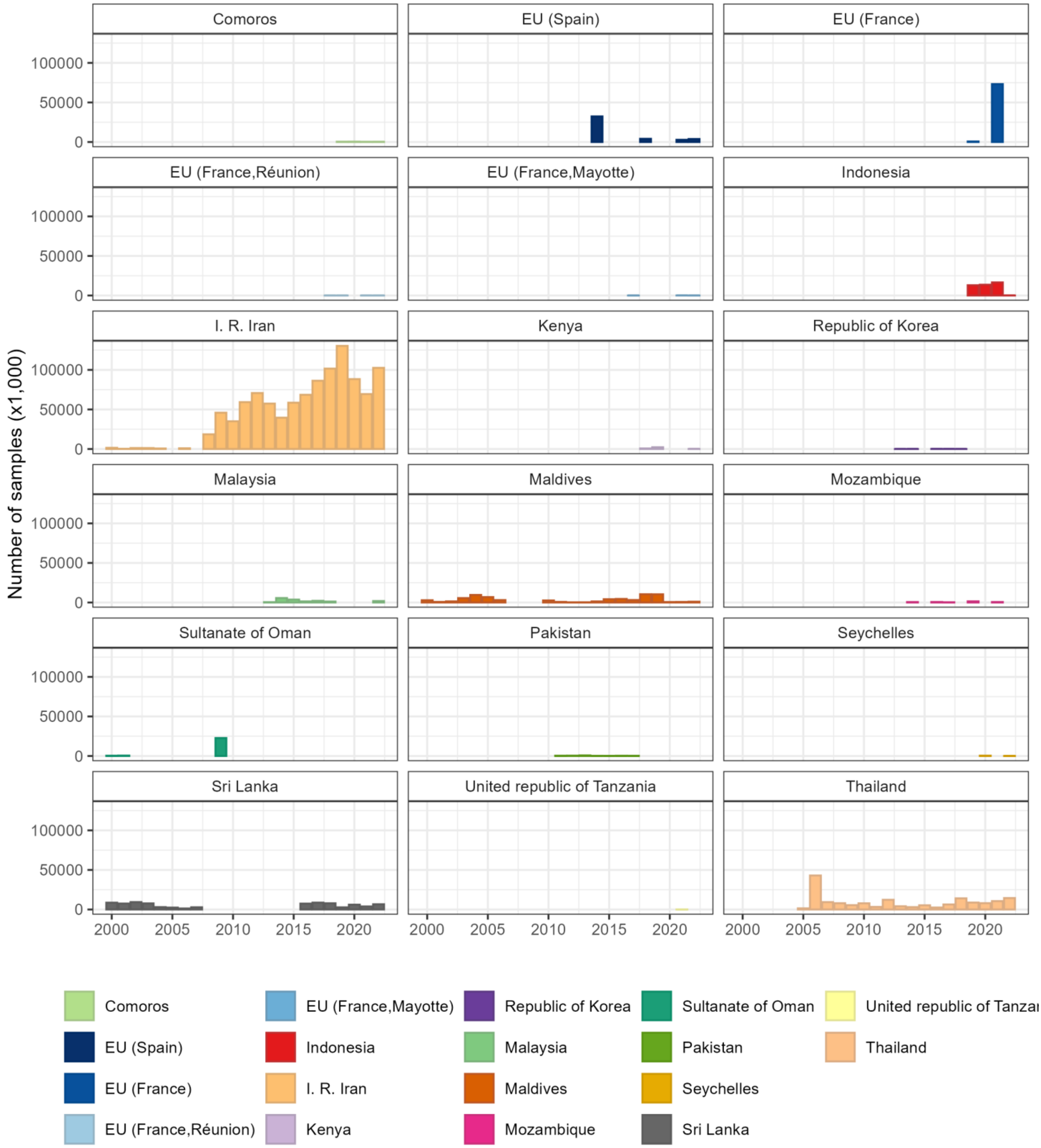

Figure 22: Relative fork length (cm) frequency distribution of IOTC neritic tuna and seerfish species (except for Indo-Pacific king mackerel) by fleet

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. 23a**).

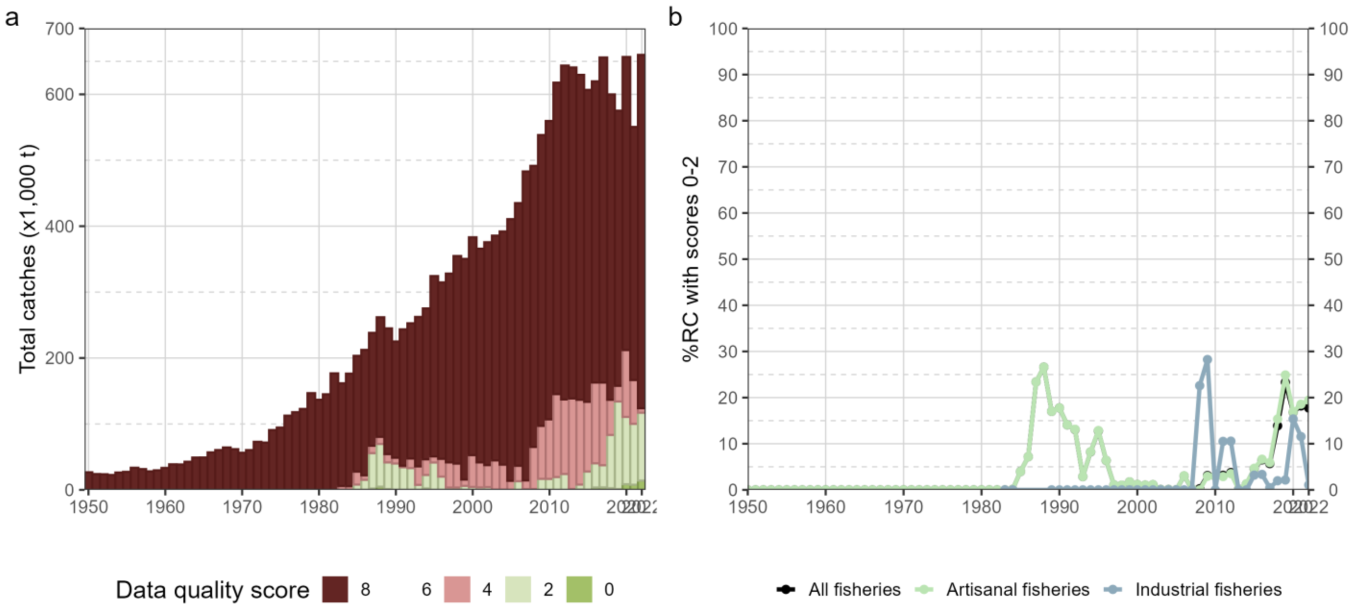

Figure 23: Annual time series of (a) cumulative retained catches (metric tonnes; t) estimated by quality score and (b) contribution of retained catches with corresponding geo-referenced size-frequency data reported to the IOTC Secretariat in agreement with the requirements of Res. 15/02 to all retained caches (percentage; %) of IOTC neritic tunas and seerfish for all fisheries and by type of fishery, for the period 1950-2022

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

The price of fish plays a crucial role in decision-making processes as it indicates species catchability and provides insights into the socio-economic conditions of coastal regions. Additionally, integrating market prices into models can help understand the driving forces behind exploitation (Auger et al. 2010). Despite being voluntarily requested from CPCs, the Secretariat does not routinely receive market price data. However, some CPCs, like Oman, directly extract and provide this data. Other sources of market prices include SEAFDEC, which publishes annual prices for neritic species.

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. 24**).

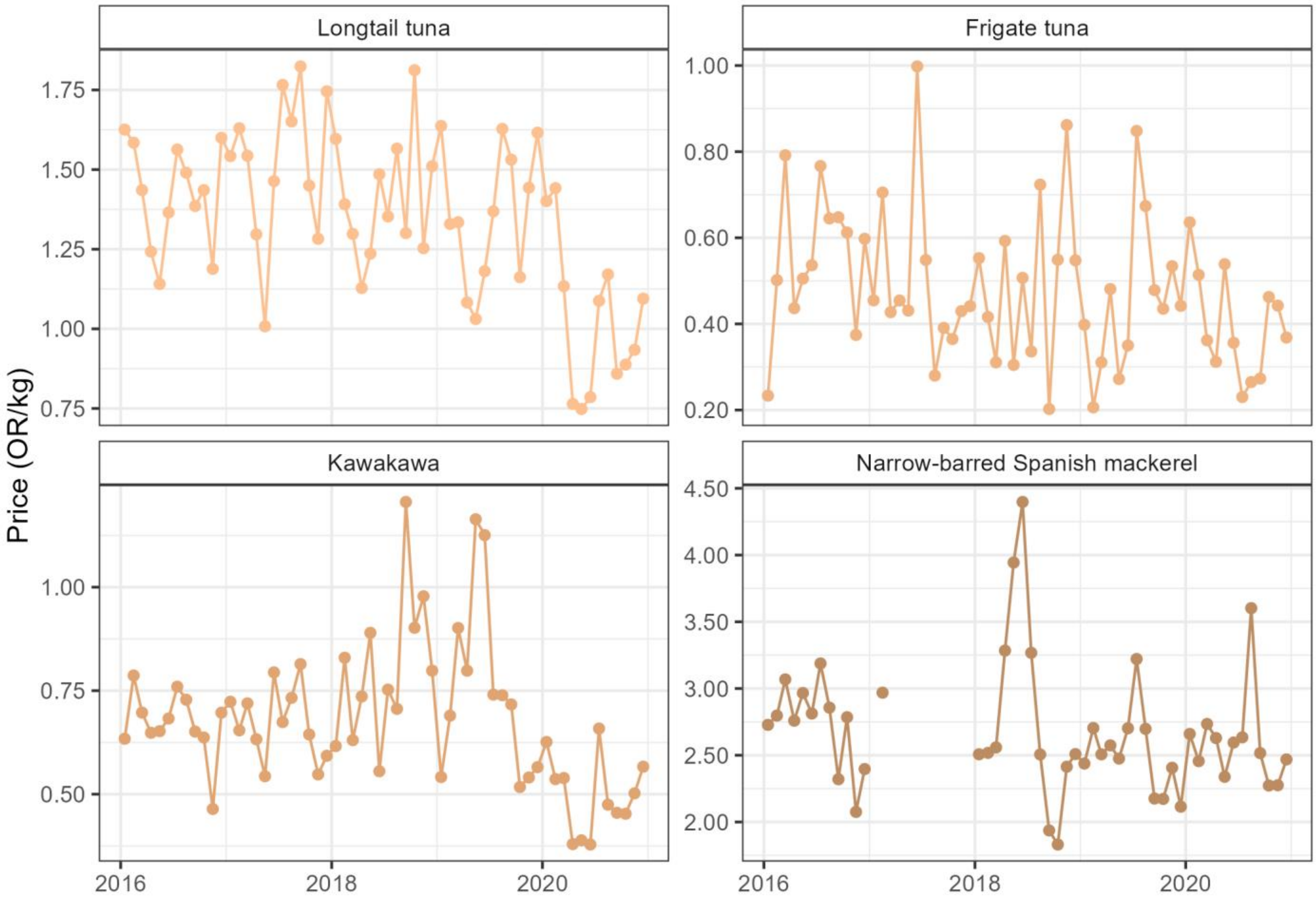

Figure 24: Monthly time series of price (Omani Rials; OR) for longtail tuna, frigate tuna, kawakawa, and narrow-barred Spanish mackerel in Oman between 2016 and 2020

SEAFDEC provides market prices for neritic and seerfish species in Thailand ((**Fig. 25**)) for multiple years, and in Indonesia (**Fig. 26**) for the year 2021 only. The trends observed in neritic market prices in Thailand indicate variations across years and seasonal fluctuations, suggesting that prices are influenced by market demand and supply dynamics.Conversely, market price data from Indonesia highlight the high value of king mackerel in the local market.

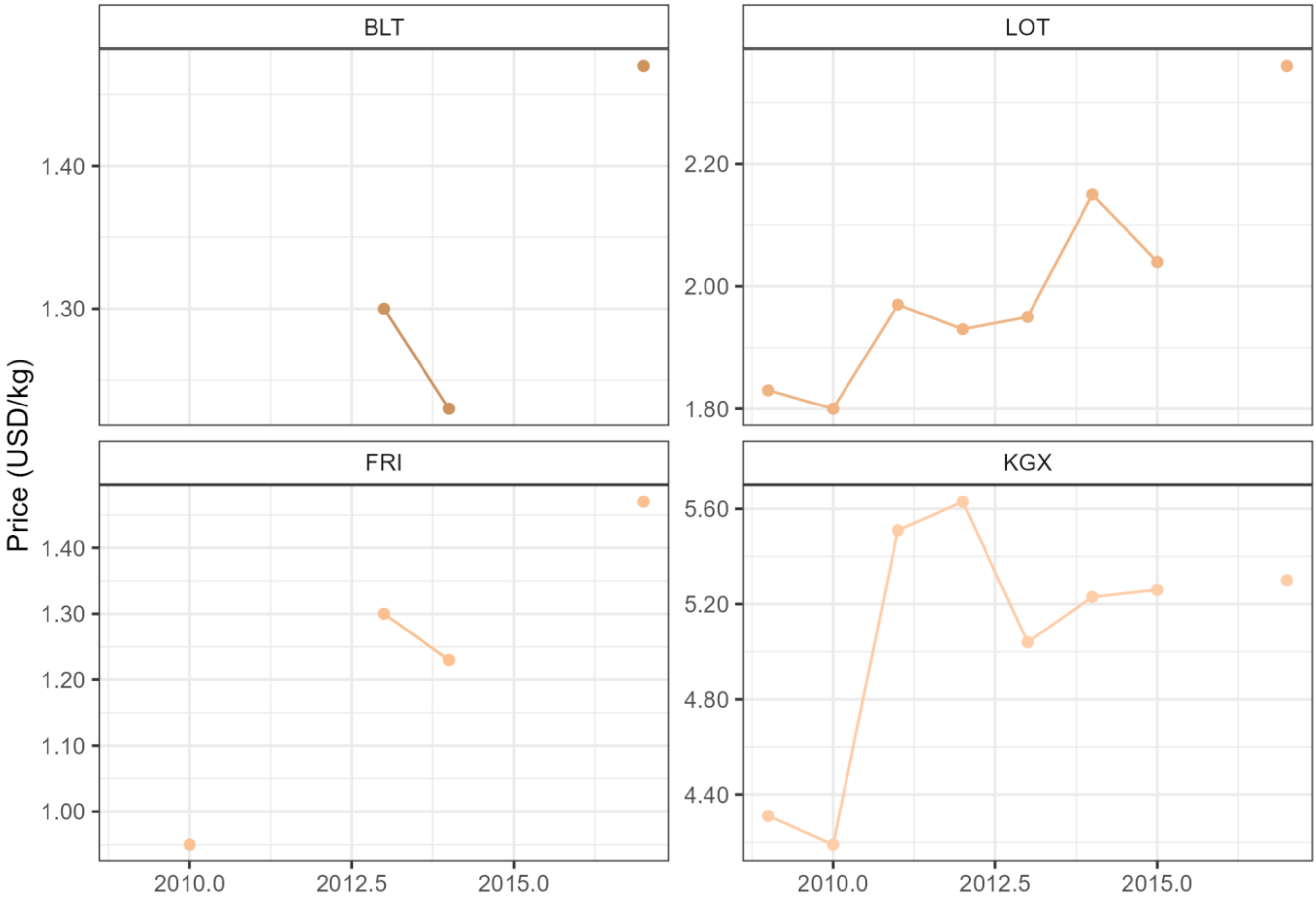

Figure 25: Monthly time series of price (Omani Rials; OR) for longtail tuna, frigate tuna, kawakawa, and narrow-barred Spanish mackerel in Oman between 2016 and 2020

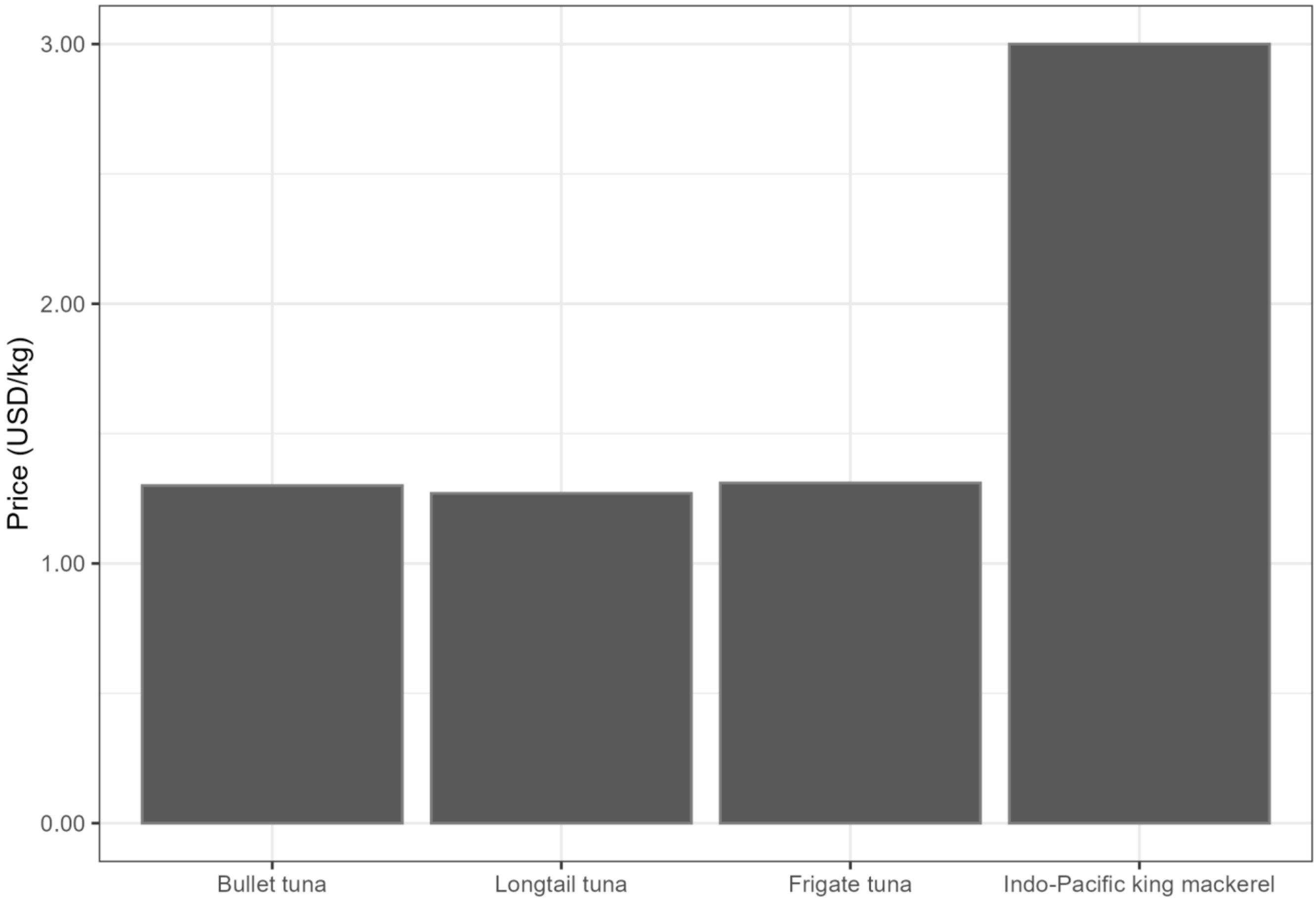

Figure 26: Monthly time series of price (Omani Rials; OR) for longtail tuna, frigate tuna, kawakawa, and narrow-barred Spanish mackerel in Oman between 2016 and 2020

Appendix II: Time series of fuel price

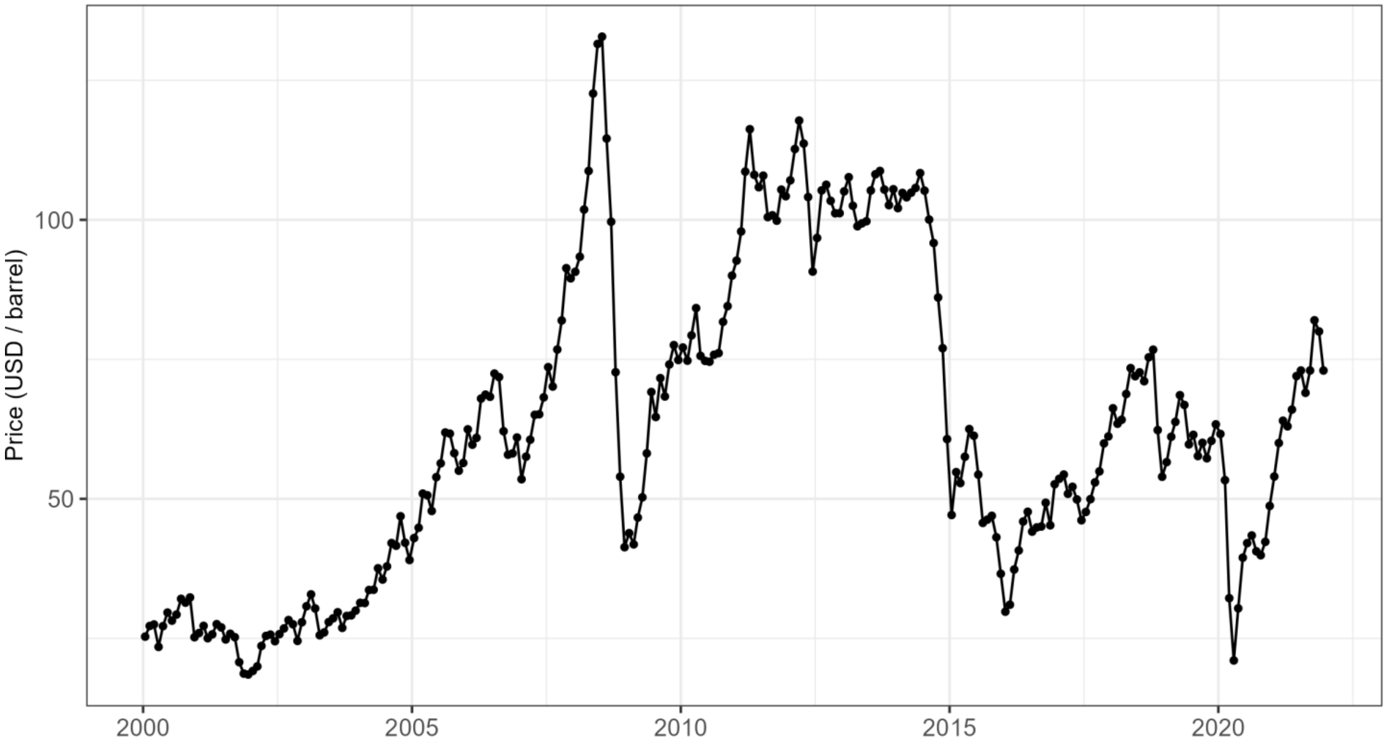

Figure 27: Monthly time series of crude oil spot price (USD/barrel) during the period 2000-2021. Data sourced from the spot prices of Brent, Dubai, and West Texas, compiled, and curated by the FFA Fisheries Development Division (Ruaia et al. 2020)

Appendix III: Best scientific estimates of nominal retained catches for 2022

Overall, nominal retained catches of neritic tunas and seerfish fully estimated in 2022 amounted to 48,209 t of fish for 14 distinct fleets, representing 7.1% 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 2022. In this case, catches were repeated from previous year (2021) except for Sudan who have not reported any information to IOTC since their accession in 1994 and 1996, respectively (**Table 6**). In fact, data for this country have been systematically extracted from the FAO global capture production database and further broken down by gear (**Table 6**).

Madagascar and Tanzania on annual basis reported data to the Secretariat. However, for the last two years Madagascar was not able to provide any data, following the termination of the World Bank project, which was aiming at assisting Madagascar to conduct sampling activities in various regions. Even though Madagascar was providing the sampling data to the Secretariat, the data fluctuated and diverse species and fisheries reported, attributed to the sampling strategy applied. Therefore, the Secretariat continue to repeat the catch data of Madagascar coastal fisheries.

Tanzania is progressing slowly following the sevaral technical assistance. There are progress in the data for 2022, however, the gaps remained for historical data. Data for 2022 indicate a large number of species are caught from diverse fisheries in Tanzania.

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 2022 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	IOTC	7,468.0
BHR	Bahrain	NM	IOTC	87.4
DJI	Djibouti	NM	IOTC	867.3
EGY	Egypt	NM	IOTC	790.0
ERI	Eritrea	MP	IOTC	467.1
JOR	Jordan	NM	IOTC	47.4
KWT	Kuwait	NM	IOTC	165.0
MDG	Madagascar	MP	IOTC	6,021.4
MMR	Myanmar	NM	IOTC	8,899.0
QAT	Qatar	NM	IOTC	3,183.9
SAU	Saudi Arabia	NM	IOTC	10,189.9
SDN	Sudan	MP	IOTC	150.0
SYC	Seychelles	MP	IOTC	805.4
YEM	Yemen	MP	IOTC	9,067.2
ALL	All fleets	-	-	48,209.1

Second, a re-estimation process was performed for the artisanal fisheries of Bangladesh, 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 2022, 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 2022.

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 2022, the total catches reported by India for the IOTC neritic tuna and seerfish species were about 115,000 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 2022, about 243,000 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 2021 for the preceeding statistical year (https://www.iotc.org/meetings/14th-working-party-neritic-tunas-wpnt14-meetingData/03-NC)

Year	Fleet	Fishery group	Area	Current (t)	Previous (t)	Difference (t)
2,021	EUITA	Purse seine	Western Indian Ocean	0	21	-21
	NEIPS	Purse seine	Western Indian Ocean	11	0	11
2,018		Purse seine	Western Indian Ocean	138	0	138