A RECENT OVERVIEW OF THE LARGE-SCALE PURSE SEINE FISHERY OPERATING IN THE INDIAN OCEAN WITH DRIFTING FISH AGGREGATING DEVICES

IOTC Secretariat

Abstract

We describe the capacity and composition of the large-scale purse seine fishery of the western Indian Ocean using drifting fish aggregating devices (DFADS) over the last two decades. In recent years, the fishery has been composed of 46 purse seiners of about 90 m length overall, representing a total fish hold volume of 97,000 m^3. Purse seiners have shown a steady increase in length and capacity since the early 2000s and were assisted in 2022 by 13 support vessels of about 40 m length overall which are essentially devoted to the management of DFADs and the satellite-tracked buoys used for locating them and estimating the size of tuna aggregations. An average of about 13,600 DFADs have been reported to have been annually deployed in the fishery during 2019-2022, suggesting that more than 20,000 deployments occur every year in absence of data for Seychelles, and Oman and Tanzania in 2022. This figure is corroborated by the daily buoy position data available at the Secretariat since 2020. Data on the types of FOBs deployed and encountered at sea indicate that there has been a major decrease in DFADs using fishing nets over the last two decades, with about 5.6% of all DFADs occurring in the Indian Ocean still including some nets in their materials. Information on FOB types also shows that many DFADs found at sea are not equipped with a buoy, calling for further studies to estimate the importance of the component of derelict DFADs that cannot be tracked remotely. Daily buoy positions show the high dynamics of activations-deactivations of buoys over the years and a marked seasonality linked to the oceanography of the Indian Ocean and the cessation of the fishing activities of some purse seiners before the end of each year due to the limits of catch implemented through IOTC Res. 21/01. The total number of buoys monitored in the fishery was around 11,000 in late June 2023. More than 8,300 fishing sets were made on FOBs in 2022, resulting in a total catch of 310,000 t, mostly composed of skipjack tuna.

Introduction

The overarching objective of this paper is to provide participants at the 5th Working Group on FADs (WGFAD05) with a recent overview of the information available on the large-scale purse seine fishery operating in the Indian Ocean with drifting Fish Aggregating Devices (DFADs). The following paper aims to (i) describe the composition and characteristics of the large-scale purse seiners and support vessels involved in the fishery, (ii) provide information on the activities related to DFADs and the buoys that are used to track them at sea, and (iii) give estimates of the catches of the large-scale purse seine fishery in 2022.

Materials & Methods

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

Fishery vessels and capacity

The IOTC has been monitoring the fishery vessels authorized to fish on the high seas of the IOTC area of competence through the Record of Authorized Vessels (RAV) established since 2003 (IOTC Res. 19/04). In addition, CPCs have to report to the Secretariat by the 15th of February every year the active vessels list (AVL), i.e., the fishery vessels recorded in the RAV that were active in the IOTC area of competence during the previous year (IOTC Res.

10/08). Information on vessel length overall (LOA; m), gross tonnage (GT), and fish hold volume (FHV; m^3) is reported to the Secretariat by the CPCs as part of these resolutions. FHV – i.e., the volume of well space in which tuna catch is stored onboard the purse seine vessels – can be used as an indicator of fishing capacity in absence of access to operational data and detailed vessel characteristics (Restrepo et al. 2020). Although data in the RAV and AVL go back to the late 1990s, both datasets may be incomplete and information on fishing gear, vessel type, as well as technical attributes may be missing or inconsistent over time. The number of active support vessels in the 2000s is uncertain but the quality of information progressively improved from 2004 with the implementation of logbooks (Delgado de Molina et al. 2004).

First, we compiled the list of active large-scale purse seiners using DFADs as well as the auxiliary vessels that supported their fishing activities during the period 2004-2022. This data set does not include purse seine vessels from I.R. Iran and Indonesia that might operate on the high seas but do not deploy DFADs or use satellite-tracked buoys. We also removed the Japanese purse seiner NIPPON MARU as this was exclusively used for research and training. Second, we reviewed and consolidated the technical attributes of each vessel available from the AVL and RAV with information collated from several national and international vessel registries, namely the Ob7 Turbobat, the Spanish Registro General de la Flota Pesquera, and the registries from ISSF, Baltic shipping, PNA, ICCAT, WCPFC, and IATTC. The year of construction of each purse seiner was also collected to compute the age of the vessels.

Total retained catch data

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 reported using IOTC form 1RC.

Catch and effort data

Catch and effort data refer to geo-referenced data aggregated by year, month, grid area, fleet, gear, fishing mode, and species (IOTC Res. 15/02). IOTC forms 3CE and 3AR have been designed for reporting geo-referenced catch and effort data for industrial and coastal fisheries, respectively, while form 3SU is intended to be used to report information on fishing effort exerted by support vessels assisting large-scale purse seiners.

Geo-referenced catches for the three principal market tropical tunas (bigeye tuna, skipjack tuna, and yellowfin tuna) were raised to the best scientific estimates of total retained catches using all available information, including expert knowledge, and by either leveraging data from proxy fleets or adopting substitution schemes when the spatio-temporal information was not available for a given stratum. Based on the assumptions made in the procedure, the raised catch data set includes information on fishing mode for most catches reported for large-scale purse seine fisheries. We focus here on the fleets using DFADs during the period 2004-2022 (see section Fishery vessels and capacity).

FOB-related data

IOTC form 3FA has been developed to report all data elements specific to activities on FADs (Appendix I), including deployments and sets made on FOBs in each time-area stratum, along with corresponding species-specific catches (IOTC Res. 15/02 and 19/02). The current IOTC classification for FOBs derives from para. 6c of IOTC Res. 15/02, which combines the nature of the FOB, the type of tracking system, and the presence of net webbing hanging underneath (Appendix II). It is considered to be less than adequate and potentially confusing, and is therefore in the process of being reviewed (Grande et al. 2018; IOTC 2022a). In addition, some categories of the current IOTC classification of FOB-related activities overlap, e.g., the code DH includes the retrieval of the DFAD which corresponds to the code DR (Appendix I). Furthermore, as the activities may concern both the raft and the buoy ("electronic equipment"), information on the type of FOB may be duplicated in the records.

Despite these limitations, the FOB-related data were first used to describe the extent of deployments during the period 2015-2022 and the composition of the FOBs deployed at sea during that period. Information on the presence of nets under the DFADs, which may pose a threat to Endangered, Threatened, and Protected (ETP) species through entangling and ghost mortality, was then derived from the type of FOB reported through encounters at sea. Information on retrievals from the sea was used to provide insight into the extent of reuse of the DFADs in the purse seine fishery. The annual numbers of fishing sets on FOBs for each fleet were compiled from the effort data provided through IOTC forms 3FA and 3CE. In absence of data, the numbers of sets in 2022 were repeated from 2021 for EU,Italy and Korea.

FOB-tracking data

IOTC CPCs with fishing vessels using drifting FOBs have the obligation to report daily information on all active FOBs monitored at sea with satellite-tracked buoys since January 1st 2020 (IOTC Res. 19/02). The information reported to the Secretariat shall follow the structure of reference codes embedded in IOTC form 3BU and contain the date of the month, the instrumented buoy ID, the assigned purse seiner, and one single daily position for each monitored buoy. The forms shall be compiled at monthly intervals and reported to the IOTC Secretariat with a time delay of at least 60, but no longer than 90 days from the end of the reference month.

Data coverage

This global data set covers the period from 01 January 2020 to 29 June 2023 and does not include any information for the six Kenyan-flagged purse seiners of around 50 m length overall which operated in the Indian Ocean between January 2020 and September 2021 despite some anecdotal evidence of the presence of electronic buoys on the vessels (**Appendix III**). Buoy data for one Korean purse seiner are being checked for the months of January-February 2023 and were not included in the present paper.

Shared buoys

As part of the fishing strategy of the purse seine companies, some buoys may be monitored by several vessels at the same time but information on buoys shared among purse seiners is not available for all fleets. Following the methodology defined by Maufroy and Goujon (2019) for dealing with multiple purse seiners monitoring the same buoys, each daily buoy position in the database was weighted by the number of purse seiners accessing the information.

Results & Discussion

Composition and characteristics of the fishery

Purse seine vessels

A total of 94 large-scale purse seiners using DFADs have been reported to have operated in the Indian Ocean during 2004-2022. Over that period, the annual number of operating vessels has varied from a maximum of 60 in 2006 to a minimum of 34 in 2011, at the peak of piracy threat (**Fig. 1**). The composition of the fishery has been dynamic over the last two decades, with several purse seiners joining the fishery from other oceans or newly built to replace the vessels that left or were decommissioned. Since 2004, 15 purse seiners have been constantly in operation in the Indian Ocean. In recent years, the number of purse seiners has remained stable at 46, with the fishery being mostly composed of EU and Seychelles purse seiners (**Fig. 1** and **Table A4**).

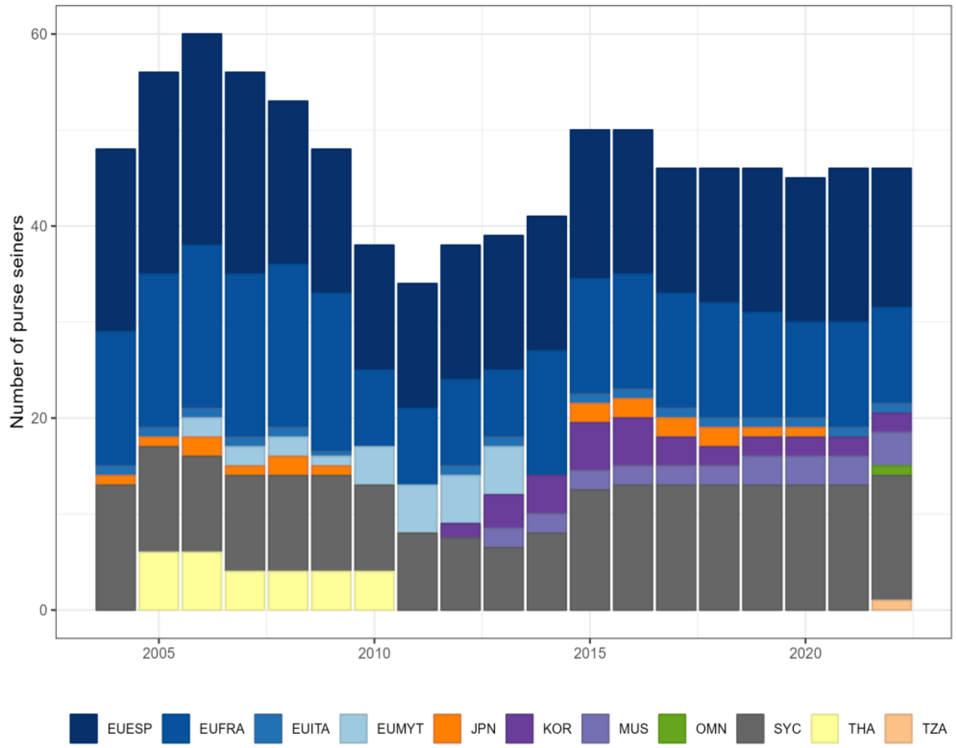

Fig. 1. Fleet composition of the Indian Ocean large-scale purse seine fishery. Number of large-scale purse seiners by fleet during the period 2004-2022. A weight of 0.5 was given to the vessels that changed flag during a given year

The composition of the fishery has changed over the last two decades and the mean length overall of the vessels has increased from 82 m in 2004 to 91 m in 2022 (**Fig. 2a**). As vessel length is highly correlated with GT and FHV (**Fig. A1**), the annual trends in the purse seiners' attributes are very similar, with a major increase observed between 2009 and 2011 that was mostly driven by the exit of the small purse seiners (<65 m) from the fishery (**Fig. 2b-c**). The mean GT has increased from 2,307 in 2004 to 2,844 in 2022 when the mean FHV increased from 1894 m^3 to 2,107 m^3 during the same period. In 2022, the total capacity of the fleet was about 96,900 m^3, in the same order of magnitude, but lower than the capacity of the Atlantic Ocean fleet estimated at about 106,000 m^3 in 2020 (Restrepo et al. 2020). The age structure of the fishery has also changed over time, with the mean annual age of the vessels increasing from about 14 years in 2004 to 15 years in 2013, before showing a sharp decline to 13 years in 2015 when 8 vessels built between 2014-2015 joined the fishery. Since then, the mean vessel age has increased and reached 18 years in 2022.

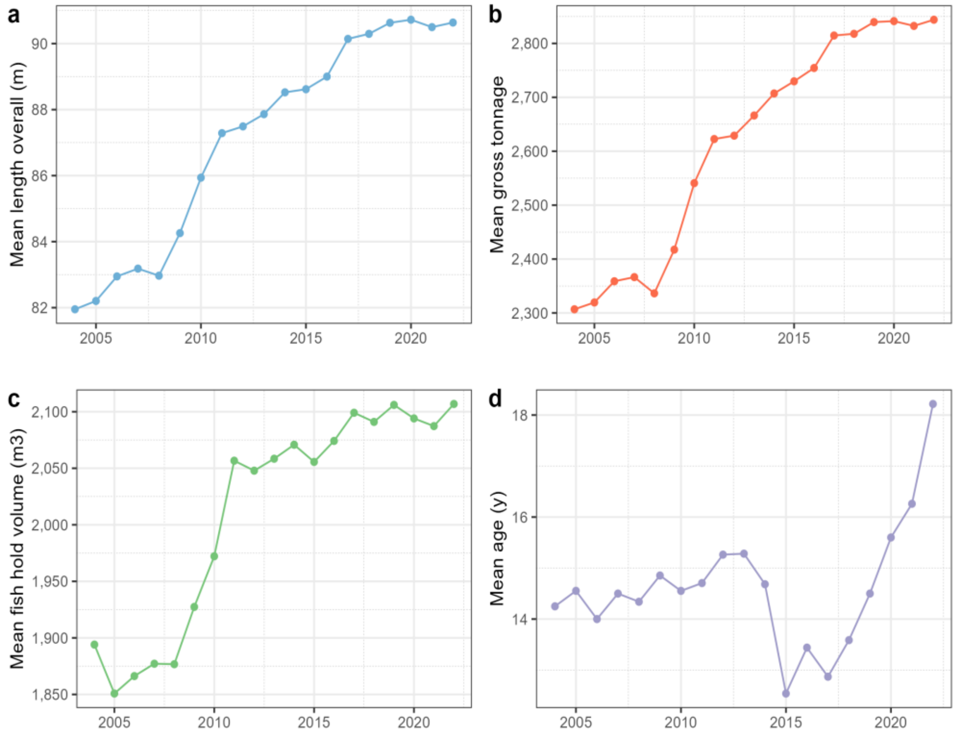

Fig. 2. Mean characteristics of the Indian Ocean large-scale purse seiners using DFADs. (a) Length overall (m); (b) Gross tonnage; (c) Fish hold volume (m³); (d) Vessel age (y)

Support vessels

During 2004-2022, a total of 33 distinct support vessels have assisted the large-scale purse seiners in their fishing activities, mostly for managing buoys and DFADs (Arrizabalaga et al. 2001; Ramos et al. 2010; Assan et al. 2015). Initially derived from the conversion of old, decommissioned vessels from other fisheries, support vessels were eventually specifically designed and built to assist the purse seiners from the late 1990s. The number of support vessels available from the AVL during 2004-2006 appears to be under-estimated as 13-15 vessels were in operation at that time (Ramos et al. 2010). The number of vessels in activity decreased during 2009-2011 due to the piracy threat and re-increased thereafter to reach a maximum of 22 in 2016 (**Fig. 3**). In that year, the combined fleet of EU,Spain and Seychelles was composed of 20 support vessels that assisted 28 purse seiners, i.e., a ratio of 8 to 10. Following the assessment of the stock of yellowfin tuna as overfished, IOTC Res. 16/01 (entered into force in January 2017) and subsequent resolutions (17/01, 18/01, 19/01, and 21/01) imposed limits on the number of support vessels, which resulted in their number to decline to 13 in 2022.

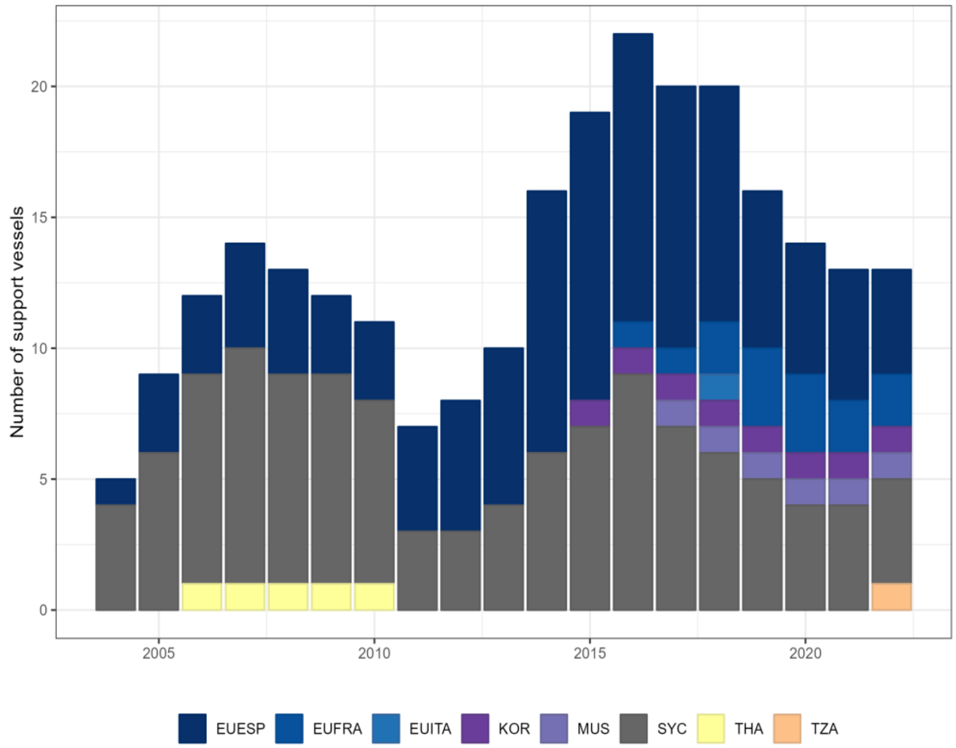

Fig. 3. Fleet composition of the Indian Ocean large-scale purse seine fishery. Number of support vessels by fleet during the period 2004-2022

Similarly to purse seiners, support vessels have increased in size over time. Their mean LOA and GT, which are highly correlated (**Fig. A2**), have shown increasing trends over the last decade, increasing from 36 m and 346 in 2013 to 40 and 422 in 2022 for LOA and GT, respectively (**Fig. 4a-b**). The mean age of the vessels has shown a decrease from 19 in 2010 to 12 in 2018 (**Fig. 4c**). In 2022, an average support vessel of the Indian Ocean large-scale purse seine fishery would be aged 16 years and characterized by a length overall of 40 m and a GT of 422.

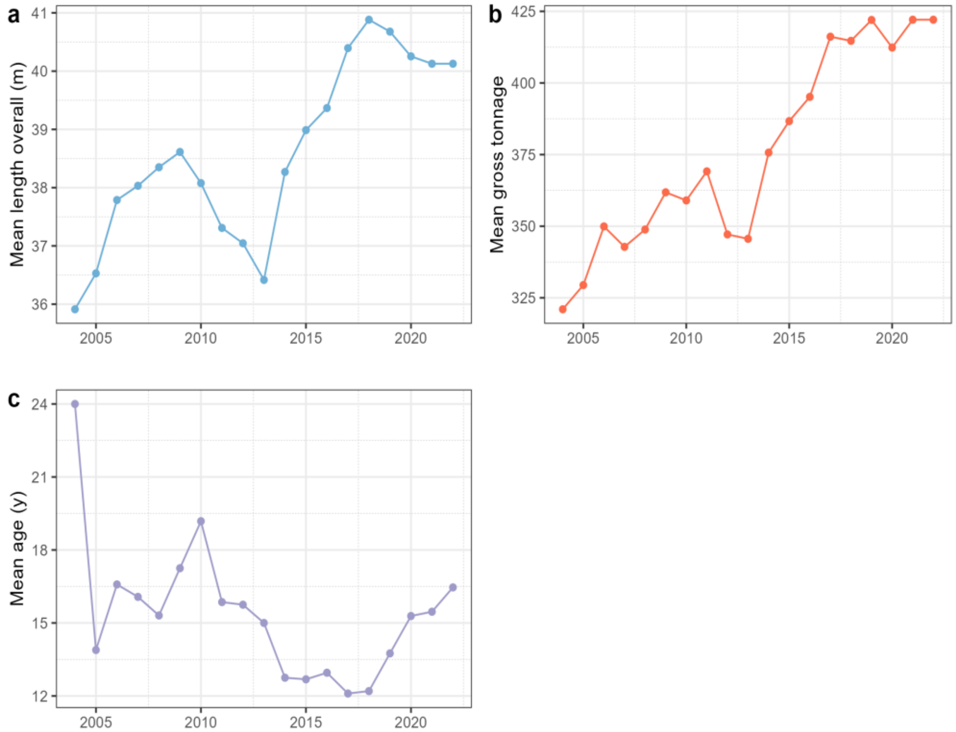

Fig. 4. Mean characteristics of the support vessels assisting Indian Ocean large-scale purse seiners using DFADs. (a) Length overall (m); (b) Gross tonnage; (c) Vessel age (y)

FOB-related activities

DFADs at sea monitored by purse seine fisheries include (i) new DFADs built on land or at sea and added into the Indian Ocean waters through deployments by purse seine and support vessels and (ii) DFADs encountered at sea and reused through buoy transfer or re-deployment. In addition, some information on the numbers of DFADs drifting at sea without any tracking system is available through data on the type of FOBs encountered at sea.

Deployments

Information on FOB deployments reported to the Secretariat through form 3FA has been shown to be incomplete and uncertain (IOTC 2022b). No FOB-related data, except for catches, have been reported for the Seychelles purse seine fishery composed of 13 vessels since 2013. Data are also lacking for EU,Italy (1 vessel) and the single purse seiners of Tanzania and Oman which started their operations in March and June 2022, respectively. Data available for the fleets of EU,Spain, EU,France, Japan, Korea, and Mauritius show a decrease from about 22,100 deployments during 2015-2016 to an average of about 13,600 deployments per year during 2019-2022 (**Fig. 5**).

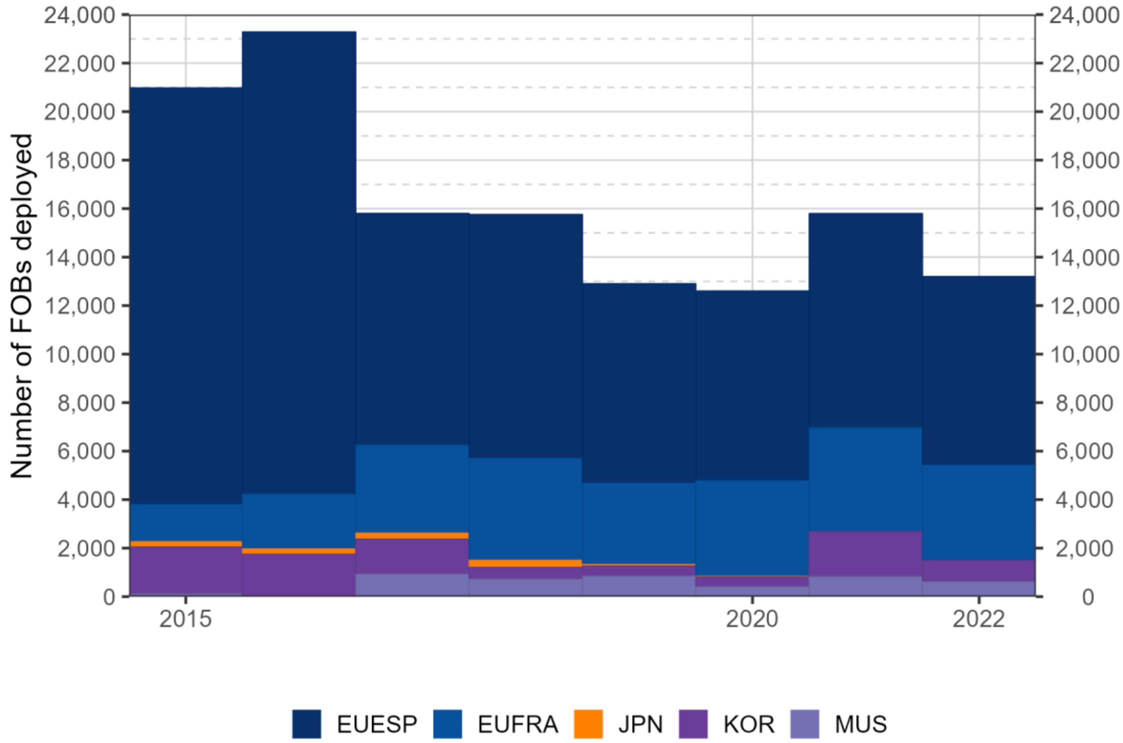

Fig. 5. Annual number of deployments of drifting floating objects (FOBs) by fleet as reported through IOTC form 3FA for the period 2015-2022

Information available on FOB types shows that the very large majority of FOBs deployed between 2015 and 2022 were DFADs equipped with tracking systems, and that the use of DFADs using nets has continuously decreased since 2015. In 2015, DFADs made of old, recycled fishing nets contributed to about 76% of all deployments but this percentage decreased to 5% in 2022 (**Fig. 6**). While no data on FOB types has been reported to the Secretariat for the Seychelles, Oman, and Tanzania, the pattern would be expected to be similar as all purse seiners from these fleets are operated by the same companies that operate the EU and Mauritian vessels.

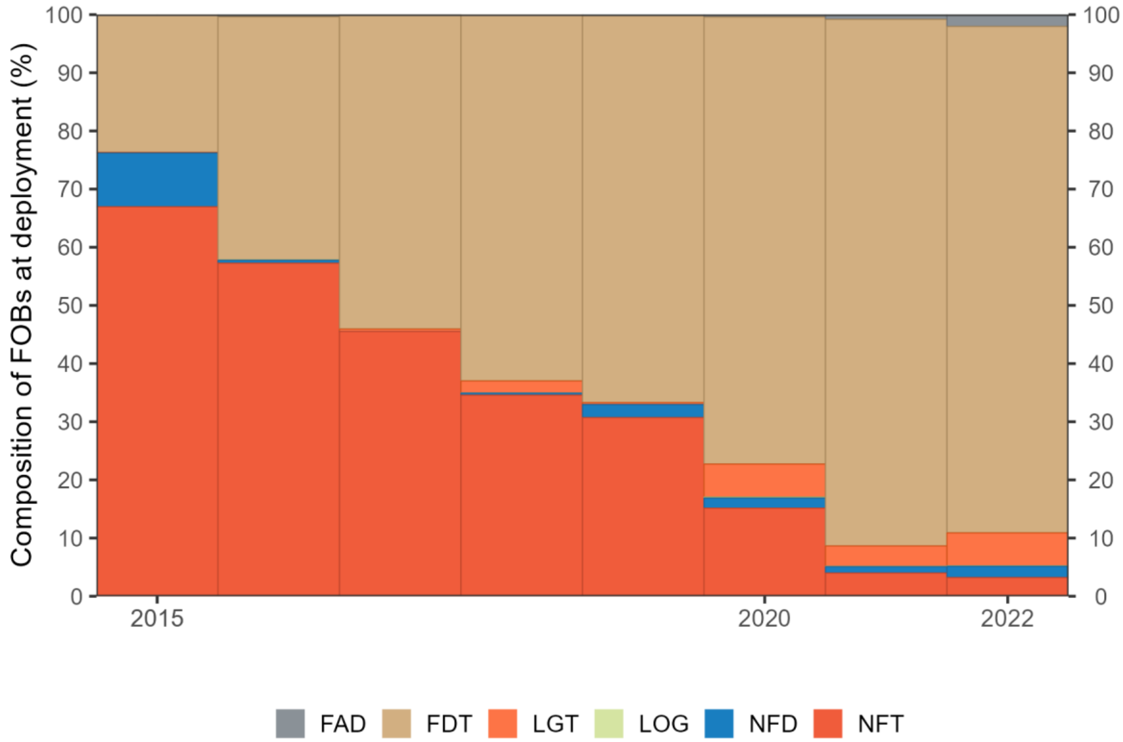

Fig. 6. Composition of the drifting objects (FOBs) deployed at sea for the period 2015-2022 as reported through IOTC form 3FA. See Appendix II for definitions of FOB types

FOB-related data reported for 2022 show the concentration of deployments in the western Indian Ocean, from the northern tip of Madagascar (Cap d'Ambre) at 12°S to the Arabian Sea, up to 21.5°N (**Fig. 7**). No deployment took place in the Mozambique Channel in 2022. While there is some seasonality in the extension of the deployment areas on the high seas of the Arabian Sea, the core area of deployment is quite stable over the year within and around the area under national jurisdiction (AUNJ) of Seychelles.

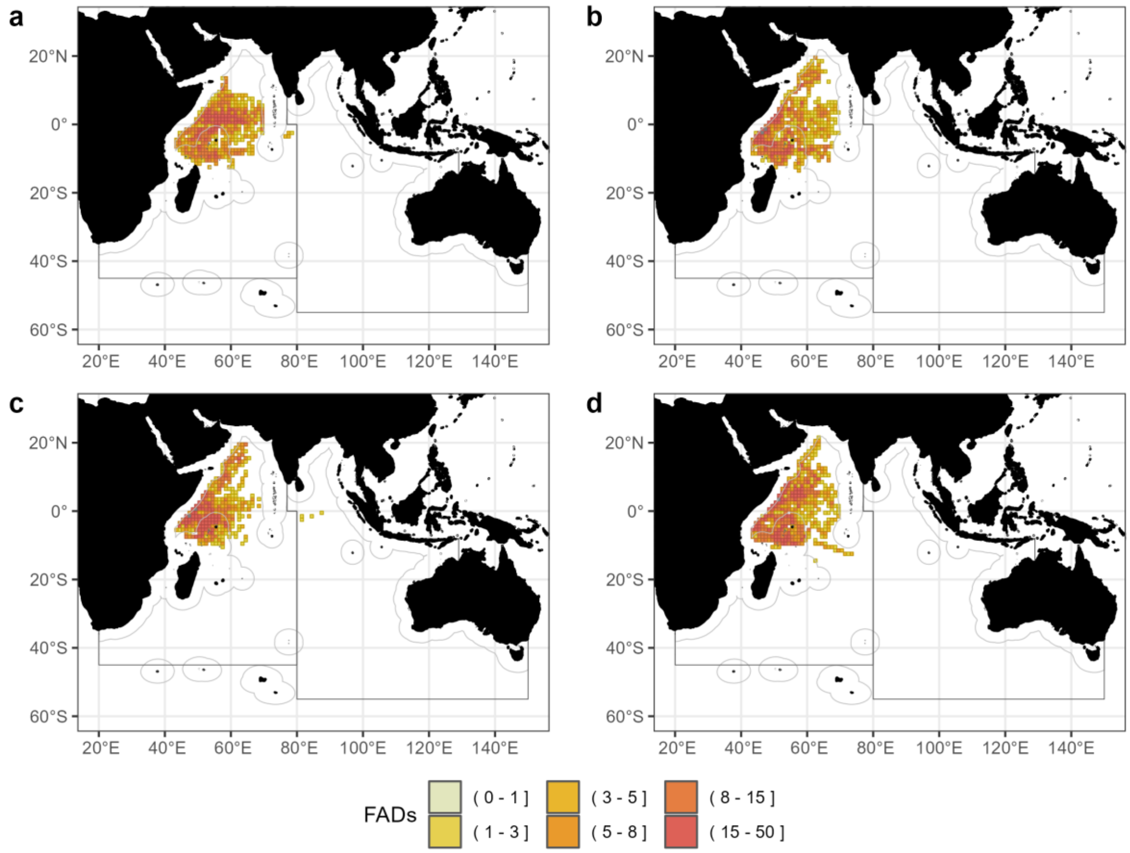

Fig. 7. Number of drifting floating objects (FOBs) deployed by quarter for all fleets and FOB types in 2022 as reported through IOTC form 3FA. (a) Jan-Mar; (b) Apr-Jun; (c) Jul-Sep; (d) Oct-Dec

DFAD materials

All DFADs encountered at sea by the fleets of EU,France and Korea between 2015 and 2022 were reported as "FDT", i.e., satellite-tracked DFADs without any nets used in their construction (**Appendix II**). This is highly unlikely as these fleets have been shown to frequently transfer buoys on "foreign" DFADs (Snouck-Hurgronje et al. 2018) which were mostly composed of netting materials in 2015-2016 (see section Deployments). Consequently, only data from the fleets of EU,Spain, Japan, and Mauritius were considered to assess the extent of use of fishing nets in the DFADs at sea.

The composition of the FOBs at sea shows a pattern consistent with the trend observed in deployments, i.e., a continuous decrease of the proportion of DFADs made of nets over recent years. In 2015, DFADs made of nets represented 62.7% and 74.8% of all FOBs and DFADs encountered at sea, respectively (**Fig. 8a**). In 2022, the percentages were 5.3% and 5.6% for all FOB and DFAD types, respectively. The proportion of DFADs made of nets observed in the FOBs retrieved from the water shows a similar decreasing trend between 2015 and 2022 (**Fig. 8b**). While about 70.4% of the retrieved DFADs were made of nets in 2015, this figure decreased to 5.7% in 2022 (**Fig. 8b**).

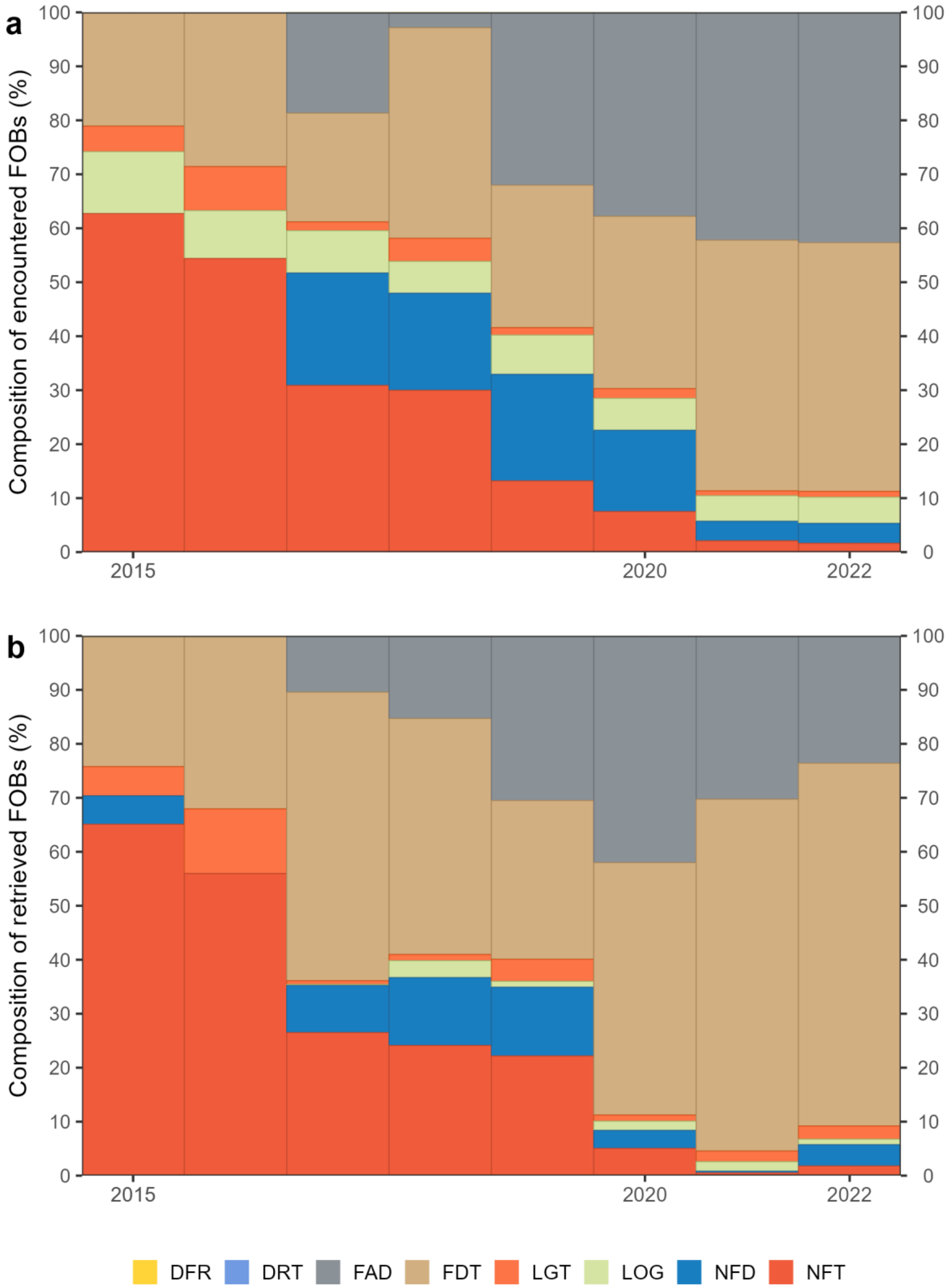

Fig. 8. Composition of the drifting objects (FOBs) (a) encountered at sea and (b) retrieved from the sea for the period 2015-2022 as reported through IOTC form 3FA. See Appendix II for definitions of FOB types

Ownership information, which indicates whether the encountered FOB is owned by the reporting CPC, has generally not been reported to the Secretariat. Future work could focus on FOB ownership to assess the composition of FOB types between fleets although specific fleet information is not available through the current version of IOTC Form 3FA. However, such data are collected throughout purse seine fisheries observer programs and could be included in the ROS data requirements. In addition, data on FOB types provide information on the relative numbers of unmonitored DFADs at sea, which is essential to estimate the total number of DFADs drifting in the Indian Ocean (Maufroy et al. 2017; Dupaix et al. 2021). In 2022, available data suggest that 49.3% and 28.5%

of all DFADs encountered at sea and retrieved from the sea, respectively, were not equipped with a satellite-tracked buoy (**Fig. 8**).

From a general point of view, improvements to the IOTC code lists and reporting 3FA forms are necessary to confirm the patterns and trends observed here and increase the general quality and usability of the FOB-related data required by IOTC Resolutions 15/02 and 19/02.

FOBs monitored at sea

Daily positions of the satellite-tracked buoys equipping FOBs provide information on the dynamics of the numbers of objects monitored in the purse seine fishery since their availability in January 2020. The total number of buoys showed large variability and strong seasonality between 01 January 2020 and 29 June 2023 (**Fig. 9**). Buoy numbers decreased throughout the year 2020 from a maximum of 12,016 on 06 February 2020 to less than 10,000 in early 2021. Buoy numbers then increased to an average of about 11,000 during the months of April-August 2021 before sharply decreasing to a minimum of 8,408 on 01 December 2021. From there, the buoys showed a general increasing trend until September 2022 although with some large variability, before showing a new decline in late 2022 to similar levels as observed in 2021. During the first semester of 2023, the total daily number of monitored buoys steadily increased to reach 11,055 buoys in late June 2023.

Fig. 9. Daily number of drifting floating objects (FOBs) monitored in the large-scale purse seine fishery of the Indian Ocean between 01 January 2020 and 29 June 2023. The blue solid line is a generalised additive model fitted to the data to visualise the temporal trend

Purse seine production on FOBs

FOB sets

The total number of sets on FOBs in the purse seine fishery using DFADs has remained relatively stable at around 9,400 between 2015 and 2022 (**Fig. 10**). In 2022, about two thirds of all FOB sets were made by purse seiners from Seychelles (n = 2,725) and EU,Spain (n = 2,697). Due to the inconsistencies encountered in the FOB-related data sets available through IOTC form 3FA (e.g., sets and catches associated with deployments or retrievals), some uncertainties are associated with the annual numbers of FOB sets although the global levels are considered good (IOTC 2022b).In addition, no information on sets has been reported by Oman and Tanzania for 2022. Recently, EU,Spain re-submitted geo-referenced effort expressed in numbers of sets for the period 2016-2021 and work is ongoing with the other concerned CPCs to reconcile 3FA and 3CE data.

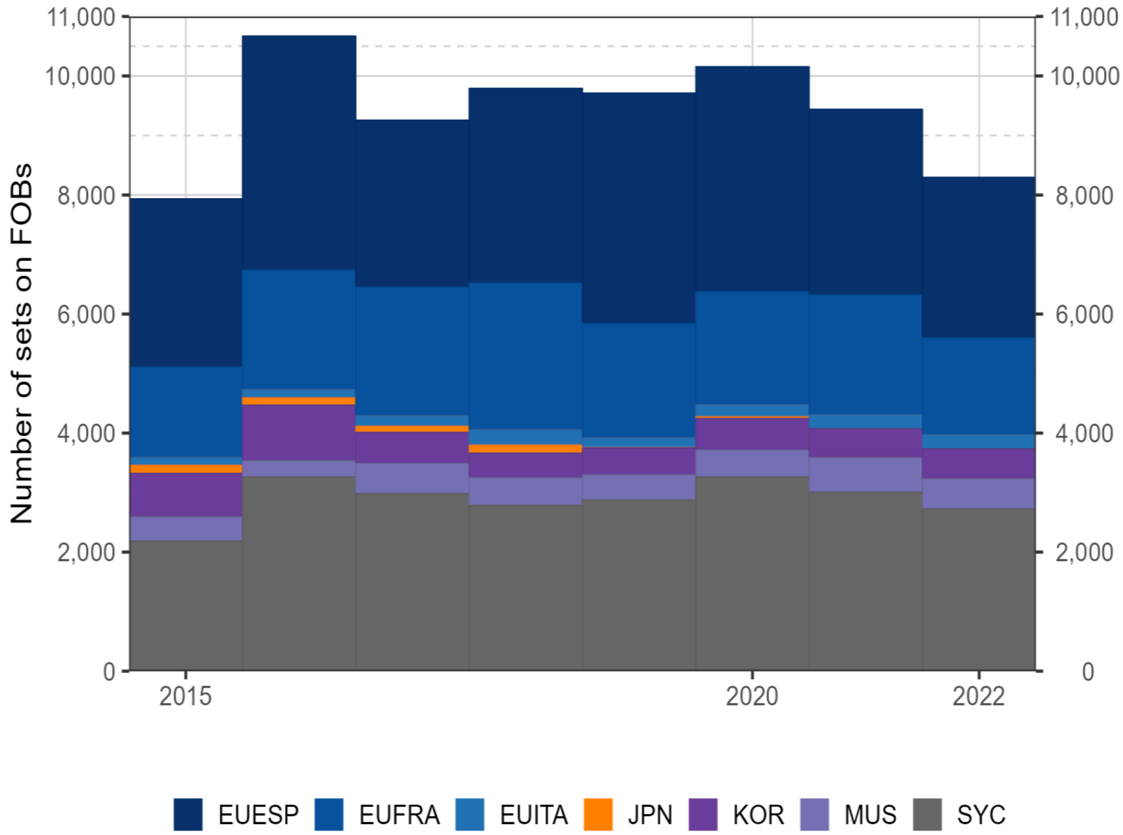

Fig. 10. Annual number of fishing sets on schools associated with drifting floating objects (FOBs) by fleet derived from IOTC forms 3CE and 3FA for the period 2015-2022

In 2022, FOB fishing grounds were mostly located in the western Indian Ocean and did not show any specific hotspot of DFAD fishing, although fewer sets were made in the north of the Mozambique Channel (i.e., Comoros archipelago) and on the high sea part of the Arabian Sea (**Fig. 11**).

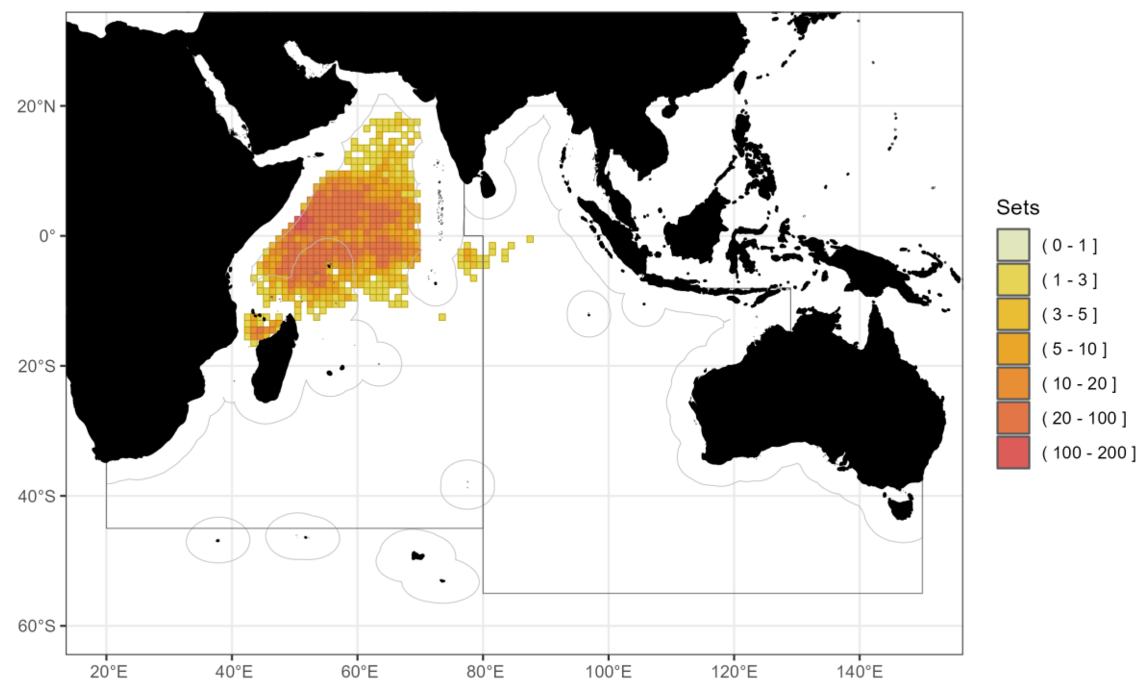

Fig. 11. Distribution of fishing sets on schools associated with drifting floating objects (FOBs) in 2022

FOB catch rates

The total catch per set (TCPS) on schools associated with FOBs shows a large variability, from a few hundred kg to more than 300 t per set. TCPS varies between years and fleets, with purse seiners from EU,Spain consistently showing the highest catch rates between 2015 and 2022 (**Fig. 12**). During that period, the median TCPS of Spanish purse seiners was 27.6 t when the median TCPS of French vessel was 20.4 t. Values of TCPS for the purse seine fleets of Mauritius and Seychelles were in between, but closer to the TCPS observed for EU,Spain. Differences in catch rates may be due to technical factors, including better ability in FOB selection and setting operations as well as larger purse seine nets used in the Spanish and Seychelles fleets which have the largest vessels. In addition, shared remuneration systems may differ between fleets, with French crews paid on the value of the catch and not for fish less than 1.5 kg as compared to the other fleets in the past (Guillotreau et al. 2011). This might result in less discarding of small fish onboard vessels where crew members receive a premium based on catch tonnage and could eventually affect the values of TCPS.

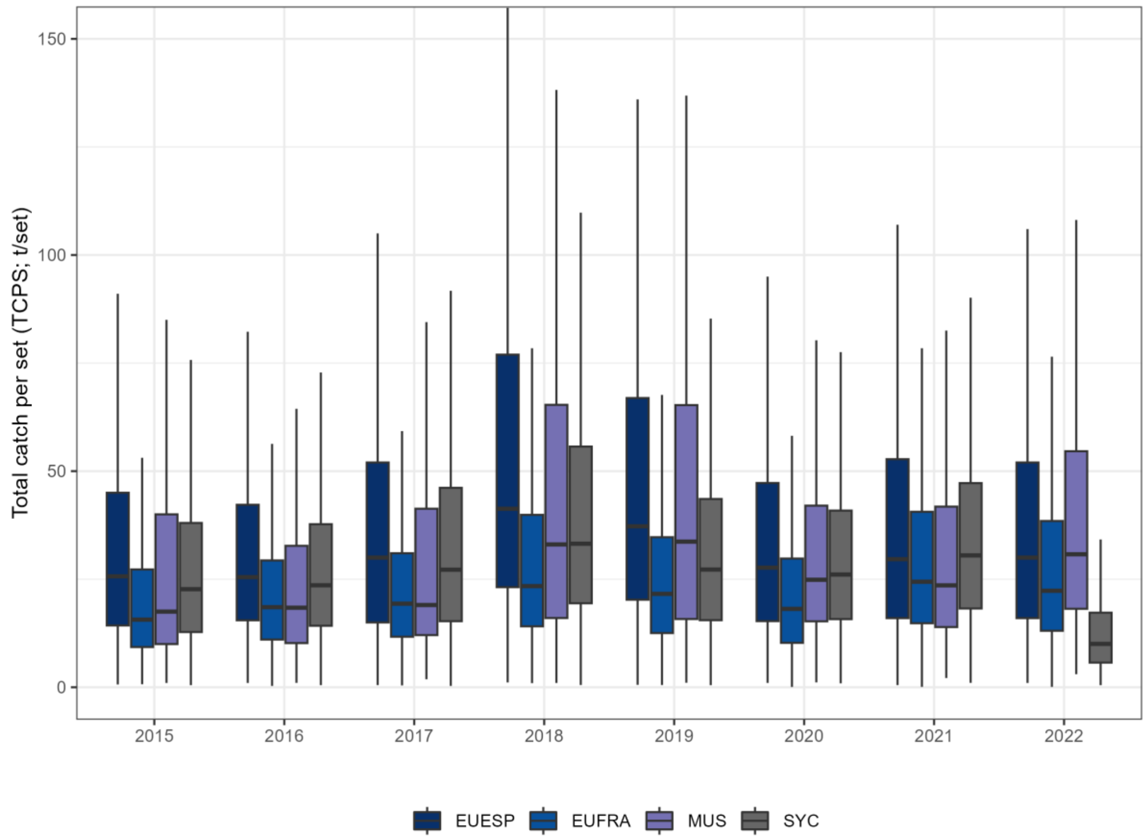

Fig. 12. Distribution of total catch per set (TCPS; t/set) on drifting floating objects (FOBs) by fleet for the period 2015-2022

The distribution of total catch per FOB set in 2022 does not show any clear spatial pattern except for the smaller than average values observed in the northern Mozambique Channel (**Fig. 13**).

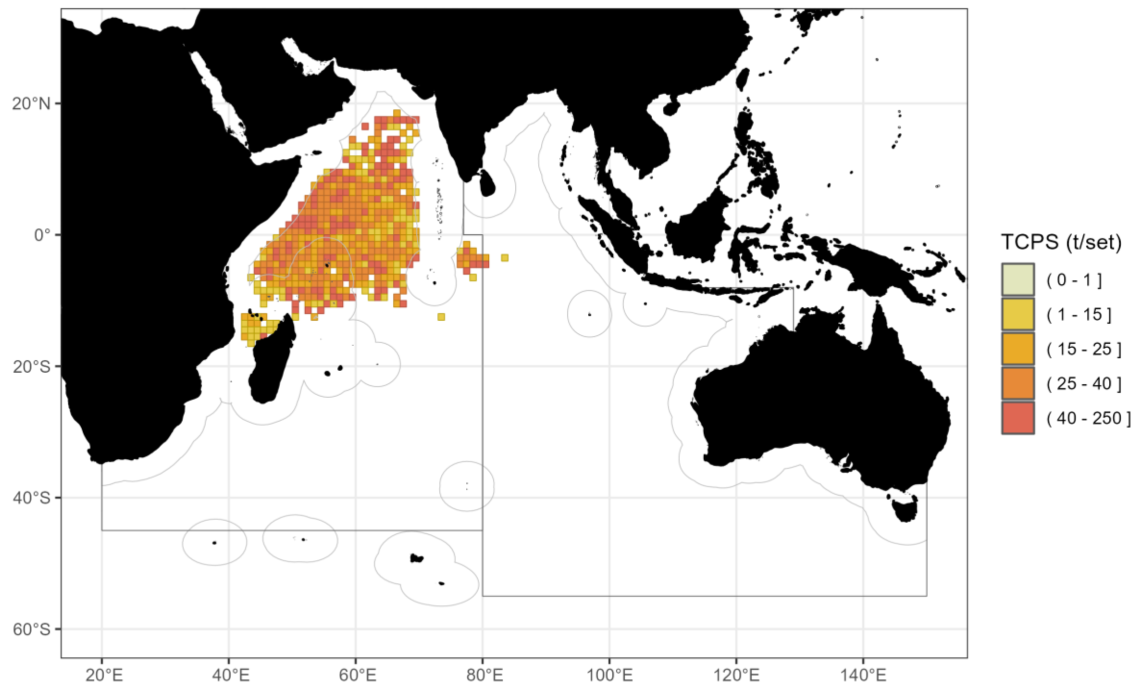

Fig. 13. Distribution of mean monthly values of total catch per set (TCPS; t/set) on schools associated with drifting floating objects (FOBs) for the fleets of EU,France, EU,Spain, Mauritius, and Seychelles in 2022

FOB catches

Excluding the exceptional year of 2018 which saw a peak at about 434,000 t, total catch levels on FOBs reported for the purse seine fishery using DFADs have remained quite stable at around 324,000 t per year between 2017 and 2022. In 2022, the total tropical tuna catch taken on FOBs was estimated to be 310,000 t corresponding to a 11.3% decrease relative to 2021 (**Fig. 14**). Skipjack tuna have always dominated the FOB catch, with a contribution to the total varying between 48.8% and 70.1% during 2004-2022. In 2022, more than 200,000 t of skipjack tuna were reported to have been caught in the Indian Ocean purse seine fishery using DFADs, while the retained catch of yellowfin and bigeye tunas reached 75,000 t and 32,000 t, respectively (**Fig. 14**). It is important to recall that while the methodology used to estimate the species composition of the purse seine catch was consistent across the main fleets until 2018 despite some limitations (Fonteneau et al. 2009; Duparc et al. 2018; Herrera and Báez 2018; Báez et al. 2020), the T3 processing method has not systematically been applied in recent years to the data of EU,Spain and Seychelles, raising concerns about the continuity of the time series for tropical tuna stock assessments (IOTC 2019).

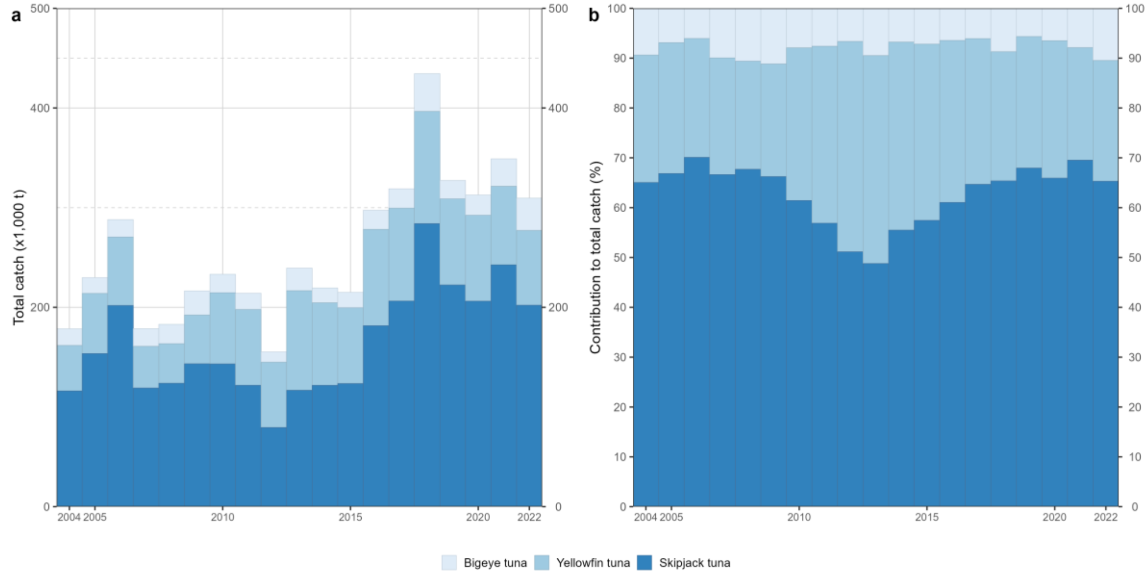

Fig. 14. Annual time series of cumulative retained absolute (a) and relative (b) catches (metric tonnes; t) of the three principal market tropical tunas (bigeye tuna, skipjack tuna, and yellowfin tuna) caught in schools associated with drifting floating objects (FOBs) in the Indian Ocean purse seine fishery using DFADs for the period 1985-2022

The mean weights in the FOB catch show some interannual variability and some apparent correlations between species during the period 2004-2022 (**Fig. 15 - Left panel**). After a period of decrease between 2004 and 2008, the weights of bigeye tuna do not show any clear pattern and an average value of 3.9 kg during 2009-2022. The mean weight showed a major increase from 3.8 kg in 2021 to 4.5 kg in 2022. The mean weight of yellowfin tuna in the catch shows more variability than observed for bigeye tuna. It varied between 4.1 kg and 6.2 kg over the period 2004-2022 (**Fig. 15 - Middle panel**). In 2022, the mean weight of yellowfin tuna had a high value of 5.9 kg. After a period of decrease between 2004 and 2008, the mean weight of skipjack tuna showed an almost constant increase until 2018 when it reached 3.4 kg (**Fig. 15 - Right panel**). Mean weights of skipjack tuna were low in 2019-2021 at around 2.7 kg, and sharply increased to 3.3 kg in 2022.

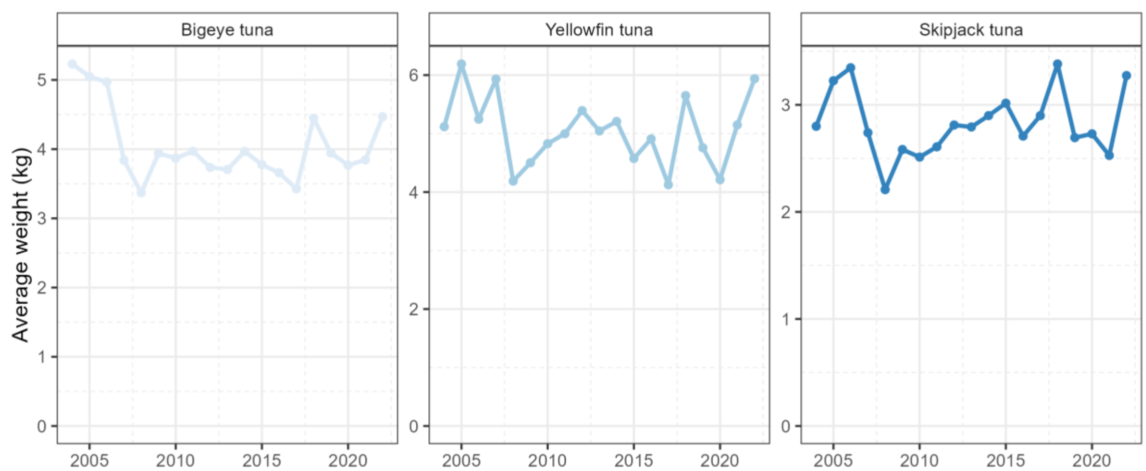

Fig. 15. Annual time series of mean annual weight (kg) of bigeye tuna, skipjack tuna, and yellowfin tu.na in the purse seine catch on schools associated with drifting floating objects (FOBs) in the Indian Ocean for the period 1984-2022

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Appendices

Appendix I: IOTC classification of activities related to drifting floating objects

Tab. A1: Classification of activities related to drifting floating objects in use at the IOTC Secretariat

CODE	ACTIVITY_TYPE
DD	Deployment of drifting FAD
DH	Retrieval/encounter and hauling of drifting FAD
DI	Retrieval/encounter, hauling, and intervention on electronic equipment of drifting FAD
DL	Loss of drifting FAD (tracking signal lost)
DR	Retrieval of drifting FAD

Appendix II: IOTC classification of types of drifting floating objects

Tab. A2: Classification of types of drifting floating objects in use at the IOTC Secretariat

CODE	FOB_TYPE
DFR	Other drifting objects NOT located using a tracking system (radio or satellite transmission) (e.g. dead animal, etc.)
DRT	Other drifting objects located using a tracking system (radio or satellite transmission) (e.g. dead animal, etc)
FAD	Drifting raft or FAD without a net NOT located using a tracking system (radio or satellite transmission)
FDT	Drifting raft or FAD without a net located using a tracking system (radio or satellite transmission)
LGT	Drifting log or debris located using a tracking system (radio or satellite transmission)
LOG	Drifting log or debris NOT located using a tracking system (radio or satellite transmission)
NFD	Drifting raft or FAD with a net NOT located using a tracking system (radio or satellite transmission)
NFT	Drifting raft or FAD with a net located using a tracking system (radio or satellite transmission)

Appendix III: Buoy data coverage

Tab. A3: Overview of the buoy position data set between 01 January 2020 and 29 June 2023 as available at the IOTC Secretariat. PS = Number of purse seiners. Note the same purse seiner may appear in different fleets in case of change of flag over the period considered. Buoys shared among the fleets of EU,France, EU,Italy, Mauritius, and Seychelles are repeated for each of them

YEAR	CPC	FLEET_CODE	PS	DAYS	POSITIONS	BUOYS
2020	EU	EUESP	15	366	1,459,581	14,242
2020	EU	EUFRA	11	366	3,086,904	8,546
2020	EU	EUITA	1	366	226,579	2,504
2020	JPN	JPN	2	88	4,353	109
2020	KOR	KOR	2	366	288,086	1,381
2020	MUS	MUS	3	366	515,353	2,788
2020	SYC	SYC	13	366	1,406,849	13,394
2021	EU	EUESP	16	365	1,343,232	13,956
2021	EU	EUFRA	10	365	3,088,548	9,000
2021	EU	EUITA	1	365	285,636	3,494
2021	KOR	KOR	2	273	219,619	1,348
2021	MUS	MUS	3	365	975,284	3,933
2021	SYC	SYC	13	365	1,491,882	13,728
2022	EU	EUESP	15	365	1,265,491	12,871
2022	EU	EUFRA	10	365	2,880,152	8,934
2022	EU	EUITA	1	365	255,214	3,315
2022	KOR	KOR	2	365	188,334	1,503
2022	MUS	MUS	4	365	915,327	4,054
2022	OMN	OMN	1	171	31,621	441
2022	SYC	SYC	13	365	1,110,494	11,841
2022	TZA	TZA	1	283	58,436	745
2023	EU	EUESP	13	181	570,479	7,760
2023	EU	EUFRA	10	181	1,491,955	6,127
2023	EU	EUITA	1	181	132,185	2,214
2023	KOR	KOR	2	181	77,556	1,042
2023	MUS	MUS	4	181	398,713	2,753

YEAR	CPC	FLEET_CODE	PS	DAYS	POSITIONS	BUOYS
2023	OMN	OMN	1	181	39,294	540
2023	SYC	SYC	13	181	548,240	7,786
2023	TZA	TZA	1	181	39,783	650

Appendix VI. Composition of the large-scale purse seine fishery, 2022

Tab. A4: Number of active vessels in the large-scale purse seine fishery of the Indian Ocean in 2022. A weight of 0.5 was given to the vessels that changed flag during a given year

VESSEL_TYPE	FLEET_CODE	FLEET	N
Purse seiner	EUESP	EU (Spain)	14.5
	EUFRA	EU (France)	10.0
	EUITA	EU (Italy)	1.0
	KOR	Republic of Korea	2.0
	MUS	Mauritius	3.5
	OMN	Sultanate of Oman	1.0
	SYC	Seychelles	13.0
	TZA	United republic of Tanzania	1.0
Support vessel	EUESP	EU (Spain)	4.0
	EUFRA	EU (France)	2.0
	KOR	Republic of Korea	1.0
	MUS	Mauritius	1.0
	SYC	Seychelles	4.0
	TZA	United republic of Tanzania	1.0

Appendix V. Relationships between vessel technical attributes

Purse seine vessels

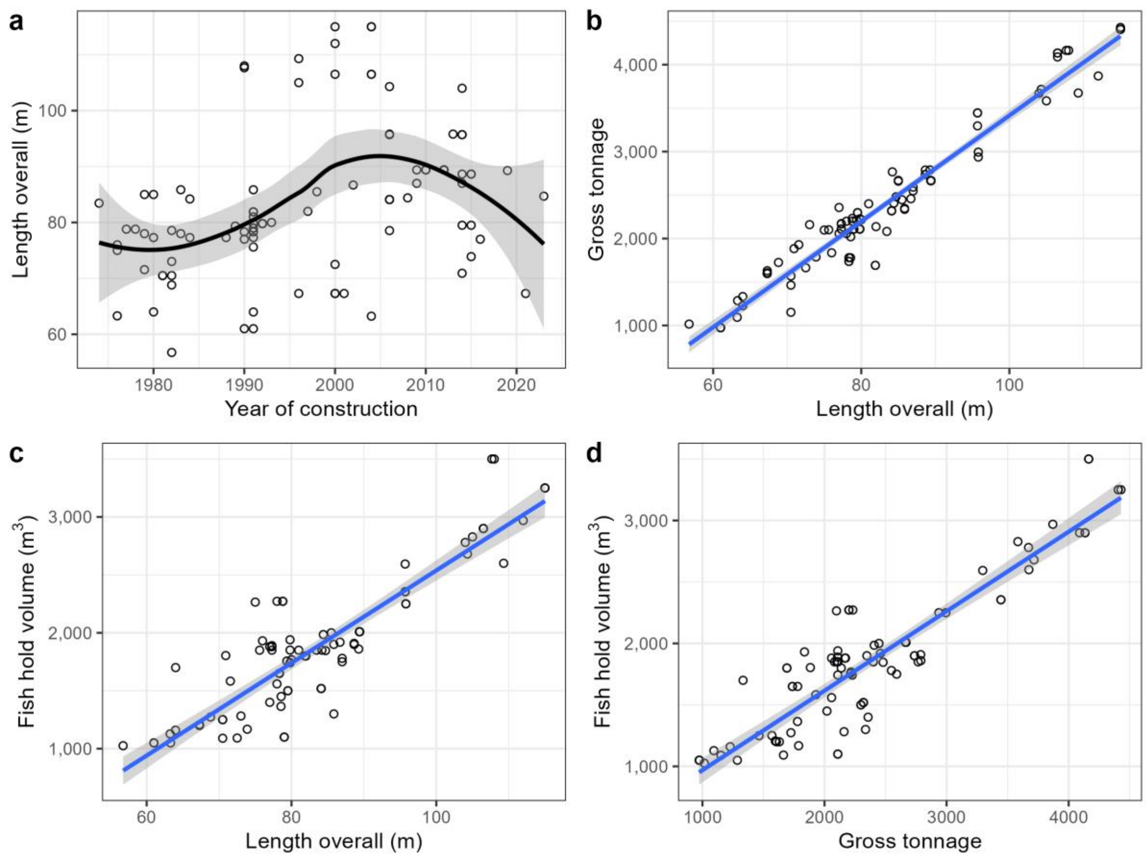

Fig. A1: Relationships between the technical attributes of the large-scale purse seiners using DFADs and having operated in the IOTC area of competence between 2004 and 2022. (a) Length overall (m) as a function of year of construction; (b) Gross tonnage as a function of length overall (m); (c) Fish hold volume (m3) as a function of length overall (m); Fish hold volume (m3) as a function of gross tonnage

Support vessels

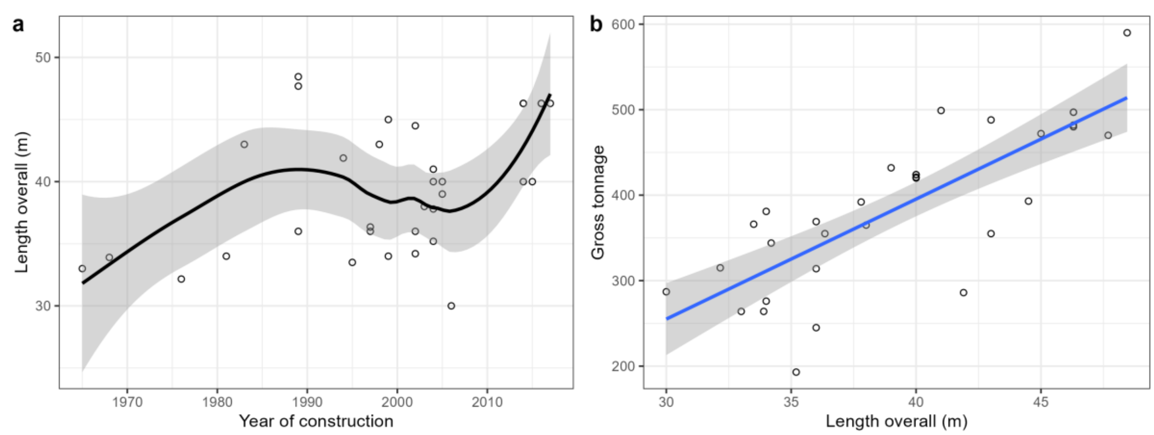

Fig. A2: Relationships between the technical attributes of the support vessels having operated in the IOTC area of competence between 2004 and 2022. (a) Length overall (m) as a function of year of construction; (b) Gross tonnage as a function of length overall (m)