



FIRST INSIGHTS INTO THE USE OF TRAPLINES IN THE PORTUGUESE PELAGIC LONGLINE FLEET IN THE INDIAN OCEAN

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Discussions: The intent of this paper is to inform the WPB and wider IOTC Scientific Committee that the Portuguese pelagic longline fleet operating in the Indian Ocean has started a pilot project to study in detail the new terminal gear modification known as “traplines” or “loop lines”, and to present the first quantitative data on its effects on catch composition, catch rates and size distributions of target and bycatch species.

Feedback: The authors of the paper request the WPB to review and provide comments on: 1) the data collection process; 2) the analytical approach used for the paired within-set comparison between terminal gears and; 3) on the priorities for continued data collection.

Recommendations: The paper seeks endorsement of the following recommendations: 1) that the ongoing Portuguese pilot project on the use of traplines in the Indian Ocean is continued and expanded; 2) that updates on this work are presented to future meetings of the IOTC WPB (or other IOTC WPs if relevant) as additional data become available; and 3) that other CPCs whose fleets use, or may begin to use, traplines be encouraged to collect and report comparable data on this terminal gear.

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Abstract

A new gear modification known as “traplines” has been expanding in pelagic longline fisheries at a global scale. Recently, IOTC has made requests on the need to study this new gear. To address this, the Portuguese Fisheries Administration (DGRM) and the Portuguese Institute for the Sea and Atmosphere (IPMA) started a pilot project, with this paper presenting the first preliminary analysis and results available for the Indian Ocean. The species composition is significantly different between the two terminal gears, as the main catch with hooks is blue shark followed by swordfish, while with traplines the catch is almost exclusively swordfish. The CPUEs are significantly different, with swordfish CPUEs higher in traplines, and the CPUE of sharks (blue shark and shortfin mako) much higher in hooks. The sizes are also different, with a tendency for both larger swordfish and blue shark to be captured in traplines compared to hooks. These results provide the first preliminary evidence from the Indian Ocean that this gear is considerably more selective, capturing almost exclusively swordfish, and having much lower catch rates of other species, including vulnerable species of pelagic sharks. This pilot project is ongoing, and updated results will be presented as additional data is collected.

Key-words

Bycatch, CPUEs, fishing gear characteristics, Indian Ocean, longline fisheries, species composition, trapline gear, swordfish.

1. Introduction

Recently, the IOTC Scientific Committee and IOTC Commission have taken note of the use of a gear modification known as “traplines” or “loop lines” in pelagic longline fisheries targeting swordfish. It is unclear when this practice started, but it looks like it has been in use years ago in the Pacific Ocean for targeting other species (Ochi et al., 2025), before being expanded and adapted to longline fisheries targeting swordfish. The loop lines consist of concentric monofilament loops attached to the branch line, replacing the conventional hook-and-bait terminal component (Báez and Domingo, 2026).

To date no analytical studies are known about this terminal gear modification in the Indian Ocean. For other oceans, and particularly for the Atlantic, some preliminary ICCAT documents have been presented, reporting higher catchability of swordfish (Garibaldi et al., 2024, Coelho et al., 2025), which has implications when producing indicators (e.g., standardized CPUEs) for use in stock assessments and MP runs within MSE processes. In addition, the preliminary notes presented also mentioned very few catches of bycatch species (Macías et al., 2025; Coelho et al., 2025), which has implications as a potential mitigation measure for interactions with vulnerable fauna (e.g., sea-turtles, seabirds, marine-mammals and some shark species).

In 2025, the IOTC Scientific Committee made a specific Recommendation for the IOTC Commission, encouraging ongoing trials with these gears (i.e., loop gears) to better understand their effect on target and bycatch species (IOTC, 2025). As such, it is currently of high priority for IOTC to address the issue of this new terminal gear modification, and there is a clear need to collect data and presenting results to IOTC through their Working Parties that are relevant to this issue, most notably the WPB and WPEB. For that purpose, the Portuguese Fisheries Administration (DGRM) together with the Portuguese Institute for the Sea and Atmosphere (IPMA) started a pilot project in 2025 to collect quantitative data from this gear.

The main objective of this paper is to provide the preliminary results of the data collected to date within this pilot project in the Indian Ocean, focusing the use of the trapline gear in the Portuguese pelagic longline fleet. The specific objectives of the project, and that are addressed in this document, are to:

- describe the specific configurations used for the “traplines” in the PRT LL fleet;
- collect and analyse data on captures (i.e. retained specimens) and catchability of the main target species (swordfish and blue shark) in “traplines” compared to the hooks regularly used by the fleet;
- collect and analyse data on the size distribution (i.e., size selectivity) of the main target species (swordfish) in “traplines” compared to the hooks used by the fleet;
- collect and analyse data on the bycatch of “traplines” compared to hooks, including interactions with vulnerable species.

It is noted that the project is ongoing, and that more data is currently being collected, compiled and analysed. Subsequent analysis will be provided to IOTC as more data is compiled and integrated into the analysis.

2. Material and methods

2.1. Data collection

The current paper provides a preliminary analysis using data that was collected and available until the 31 July 2026. The main areas covered in the project aim to be the Indian Ocean areas where the Portuguese pelagic longline fleet operates, which are mainly the southwest Indian Ocean region (**Figure 1**). The Portuguese pelagic longline fleets target mainly swordfish and blue shark, and captures other species as occasional bycatch, such as marlins, tunas, other bony fishes and other sharks. The fleet also interacts occasionally with some vulnerable species, including sea-turtles, seabirds and marine-mammals.

In terms of data collection, the project includes two types of data collection strategies:

- Detailed logbooks: Detailed logbooks developed specifically for this project that allow the collection of set-by-set data on effort, catches and individual size on the traplines and hooks.
- Fishery observers: Detailed data collected by onboard scientific observers allowing more detailed and independent collection of similar data. The data collected by onboard observers has a few additional items, such as individual hooking/entanglement location, data on at-haulback status (dead/alive upon capture), and specific details of the traplines gear characteristics.

To the date of this preliminary analysis, a total of 232 fishing sets were recorded, with 136 fishing sets from logbooks and 96 sets covered by onboard fishery observers, from a total of 3 fishing trips from 2 vessels. The trips ranged from 35 to 101 fishing sets. All the 232 sets monitored used simultaneously hooks and traplines. The overall effort corresponded to 233,675 hooks and 103,116 traplines monitored.

In those fishing sets, a total of N=10,357 specimens from 34 different species or taxa were captured and recorded, with the majority (N=9,911, 95.7%) having been measured.

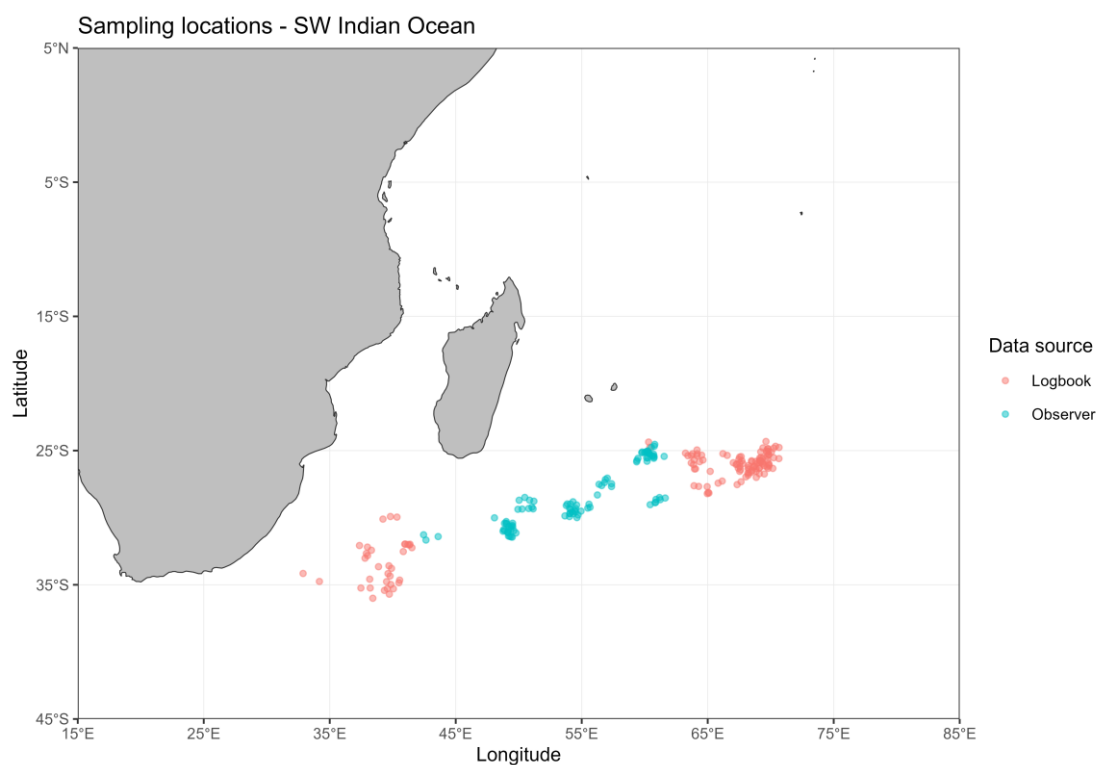


Figure 1. Map of the locations of the sets covered by logbooks and fishery observers for this study in the southwest Indian Ocean. Points are jittered by 0.5*0.5 degrees to minimize overlaps of the points.

2.2. Analysis

Species composition was analysed in terms of relative catches by each terminal gear. Additionally, and to compare the two different data sources (logbooks and observer data), the relative catch composition recorded with each data collection method is also presented.

Because terminal traplines and hooks were deployed simultaneously on the same fishing sets, all comparisons between terminal gears were made as paired within-set comparisons. Under this design, vessel, fishing area, season, time of day, depth and overall gear configuration are controlled by design (within set deployments of both terminal gears).

The species composition was compared statistically between hooks and traplines using multivariate analysis based on species catch (count) data. Individual catches were grouped by set, gear, and species, and a Bray-Curtis dissimilarity matrix was computed from the square-root-transformed abundance matrix. A Permutational Multivariate Analysis of Variance (PERMANOVA) was then computed using 9,999 permutations. The explanatory variable was gear type (i.e., hooks or traplines), and the test evaluated whether the differences observed in species composition between terminal gear types were greater than expected by random chance. A SIMPER analysis was used to identify the species contributing most to the dissimilarity between terminal gears. Finally, and to visualize the multivariate pattern distribution, a Principal Coordinates Analysis (PCoA) was performed on the Bray-Curtis dissimilarity matrix.

The catch-per-unit-effort (CPUE) was calculated on a set-by-set basis for both hooks and traplines separately, specifically calculated as N specimens captured per 1,000 hooks and N specimens captured per 1,000 traplines, for each fishing set. Hooks and traplines are recorded as two independent effort counts per set. All CPUE calculations included zero catches to ensure comparability between gears, and the fishing set was used as the unit of replication.

The CPUEs were compared between terminal gears using a Wilcoxon signed-rank test applied to the within-set differences in CPUE (traplines minus hooks). This non-parametric test is robust to outliers and does not assume normality of the data (Wilcoxon, 1945) and makes use of the paired structure of the data. Additionally, bootstrap confidence intervals (5,000 resamples, sets resampled with replacement) for the mean within-set difference in CPUEs were calculated, to quantify the magnitude of the differences.

With regards to the size distribution, descriptive plots and non-parametric Wilcoxon tests were used to compare the size distribution of the main species captured in hooks and traplines, namely for swordfish and blue sharks. Only those two species were compared in the size distribution analysis, as only those two are captured in both gears in sufficient numbers and have their respective size measurements recorded (N measured in each terminal gear ≥ 20).

The analysis was carried out in R language for statistical computing version 4.5.1 (R Core Team, 2025). Packages used included “dplyr” (Wickham et al., 2023), “tidyverse” (Wickham et al., 2019), “zoo” (Zeileis and Grothendieck, 2005), “ggplot2” (Wickham, 2016), “coin” (Hothorn et al., 2006, 2008), “vegan” (Oksanen et al., 2025), “lubridate” (Grolemund and Wickham, 2011), “cowplot” (Wilke, 2024), and “sf” (Pebesma, 2018; Pebesma and Bivand, 2023).

3. Results

3.1. Description of the new trapline gear

The Portuguese pelagic longline fleet that operates in the Indian Ocean deploys almost exclusively shallow longline sets targeting swordfish and blue shark that operate at night. When using traplines, the fishing strategy seems to remain mostly the same, with the same main line length deployed in general. The main difference is that in some of the gangions the terminal hooks are substituted by traplines.

To date a full replacement of hooks by traplines has not yet been observed or recorded, but rather a substitution of some hooks with traplines. Therefore, all sets that were covered used both hooks and traplines in the same sets. This implies that less hooks are deployed compared to the regular operations in each of those sets, as the overall gear length deployed and total number of gangions used remain the same. Traplines represented between 24.3% and 50.0% of the total terminal gear deployed per set (median = 33.3%). This proportion was relatively stable within each trip, but differed between trips, including between trips of the same vessel, indicating that the allocation of traplines seems to be mostly decided at the trip level.

The traplines that are being used by the fleet vary in number of concentric loops, monofilament sizes and colours. Usually, artificial squid bait is the centre of the traplines. The photo in **Figure 2** provides an image of traplines currently used by the fleet.



Figure 2. Traplines used by the Portuguese pelagic longline fleet being prepared to be deployed in a pelagic longline.

3.2. Species composition

There is consistency in the species composition that is recorded with both observer and logbook data (**Figure 3**). As such, for the subsequent analysis in this paper the data was combined.

The species composition is very different between the two terminal gear types. When using hooks, the main catch is blue shark, followed by swordfish, with those 2 species composing the majority of the catches. There are then several additional species, both bony fishes and elasmobranchs that are more occasionally captured as bycatch. When using traplines, the catch composition changes substantially, with the majority of the catch composed by swordfish, and only a few additional species more occasionally captured as bycatch, including some elasmobranchs and bony fishes (**Figure 4**).

The fleet occasionally interacts and captures vulnerable species such as sea-turtles, sea-birds and marine-mammals. To date there have been 8 records of interactions with sea-turtles, specifically 7 with hooks (6 loggerheads and one leatherback) and a single interaction of traplines with one loggerhead. In the present pilot study and considering the data collected to date, there have been no captures of sea-birds or marine-mammals with either hooks or traplines.

When comparing statistically the overall species composition by gear type, the differences are significant (PERMANOVA: Bray–Curtis dissimilarity $R^2 = 0.577$; F stat. = 632.0; p-value < 0.001), suggesting that there is a strong and significant terminal gear-specific selectivity that affects the catch composition. Those differences are well noted in the plots showing the results from the Principal Coordinates Analysis (**Figure 5**).

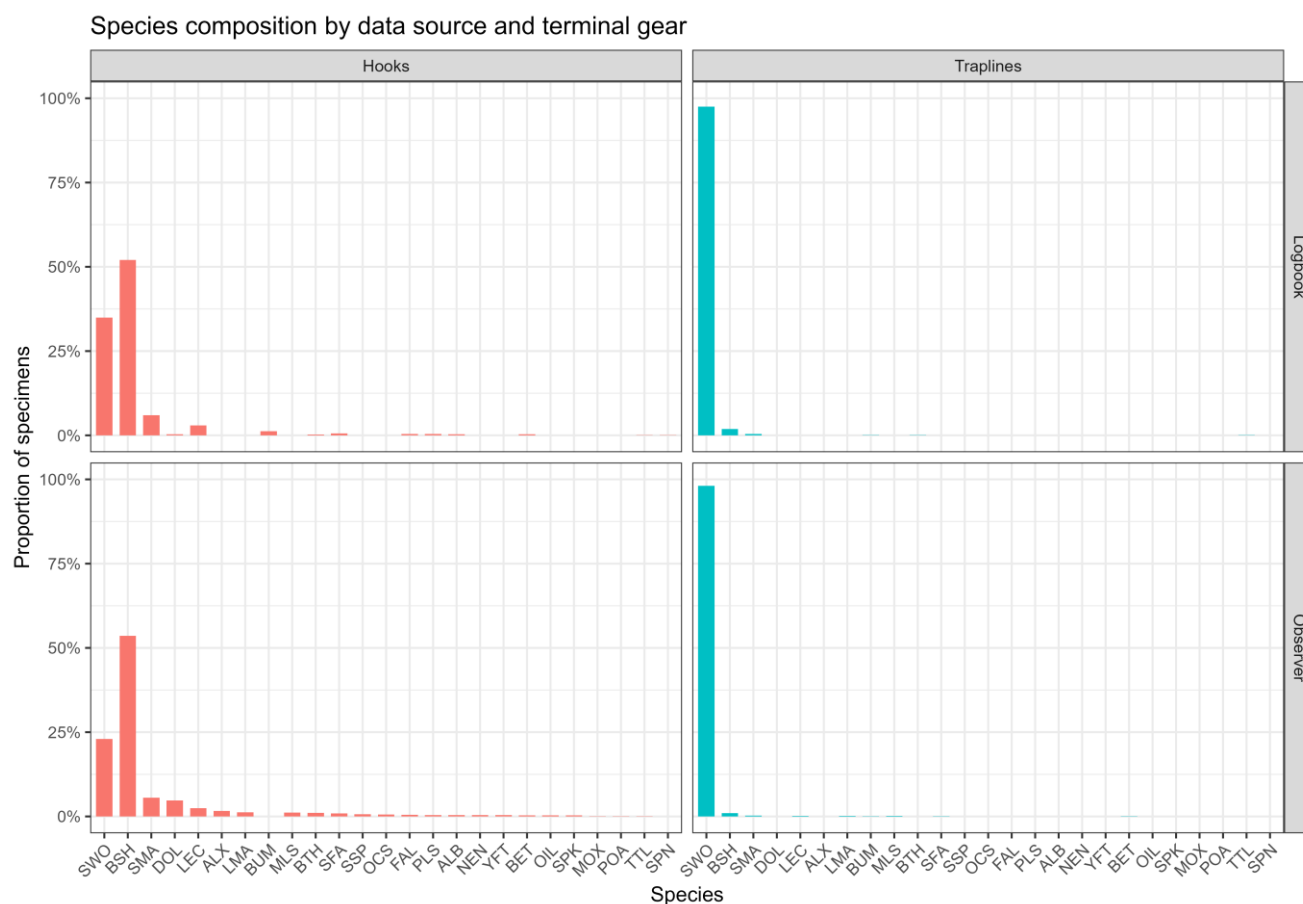


Figure 3. Species composition (percentage of specimens captured) in each gear type (hooks/traplines) and by data source type (logbooks/observers) for the Portuguese pelagic longline fleet operating in the Indian Ocean. Only the main 25 species recorded in the study to date are represented in this plot.

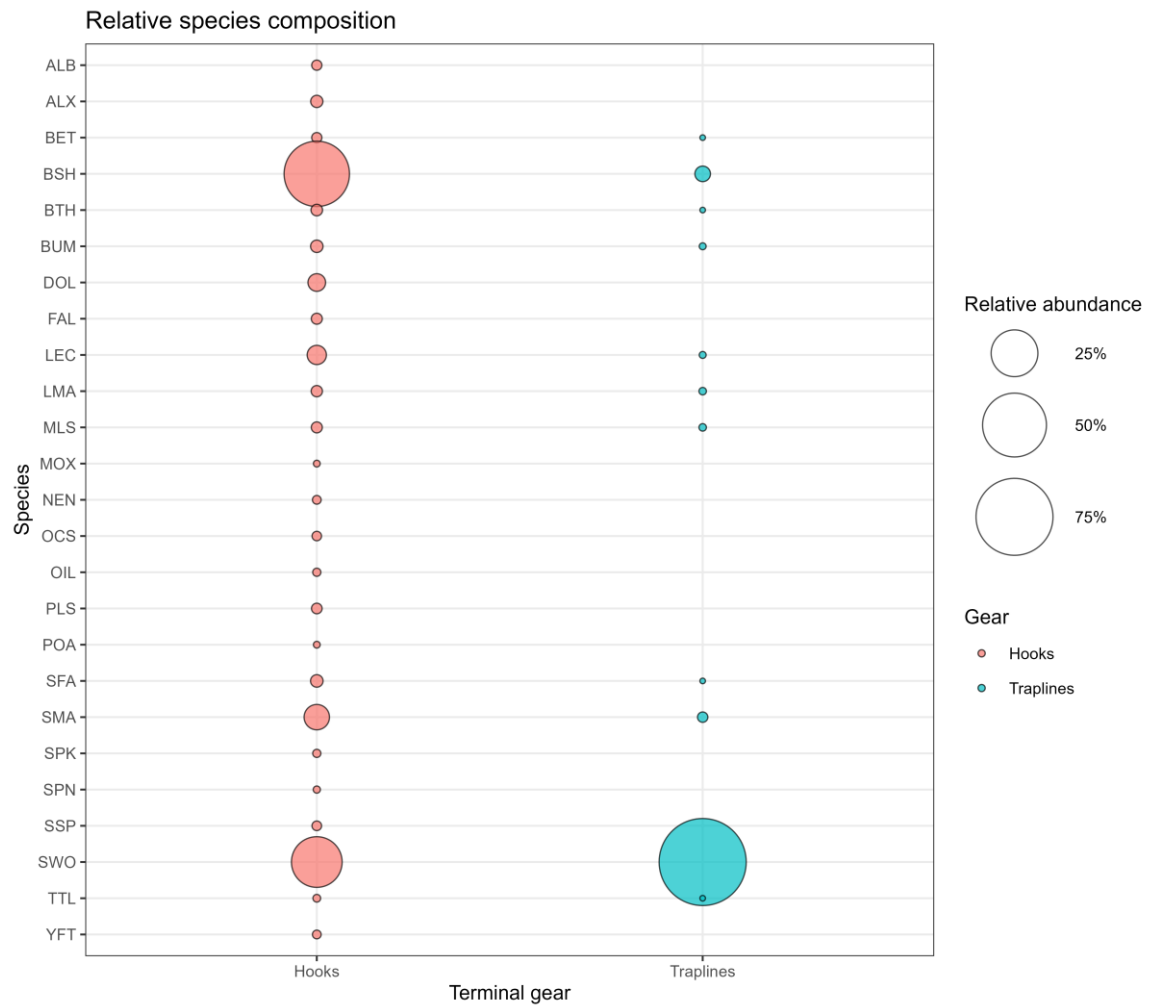


Figure 4. Overall species composition (proportion of specimens captured) in each gear type (hooks/traplines) for the Portuguese pelagic longline fleet operating in the Indian Ocean. The size of the bubbles are proportional to the catch of each species in each gear. Only the main 25 species recorded in the study to date are represented in this plot.

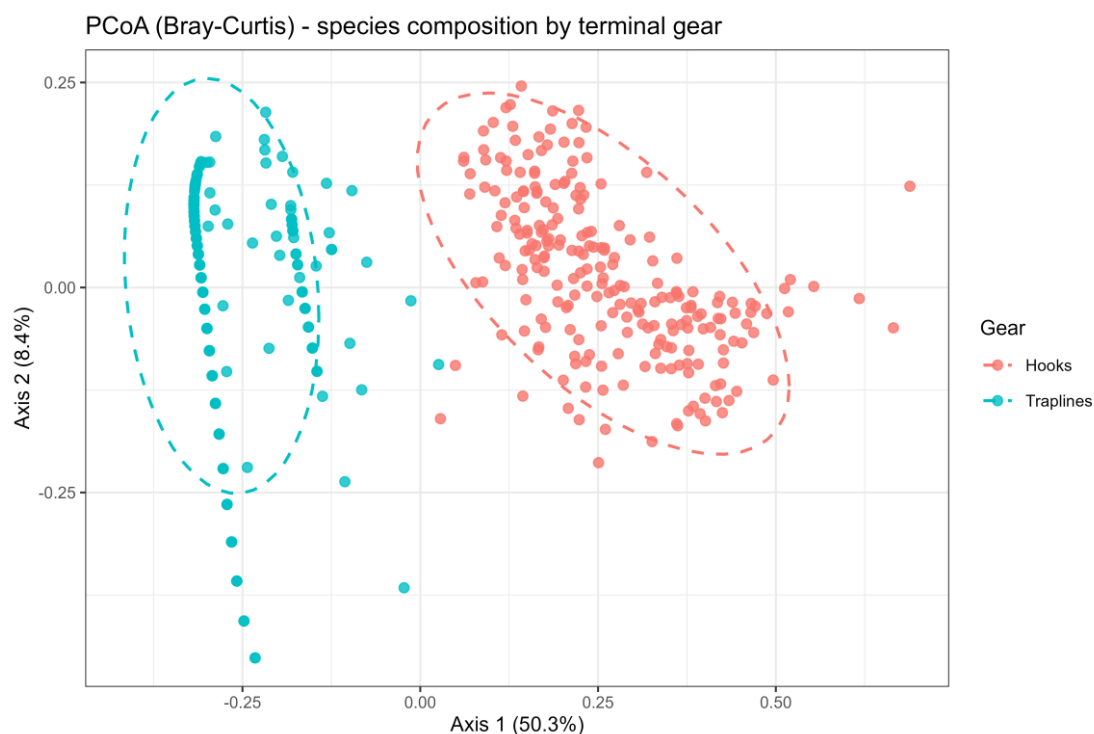


Figure 5. Principal Coordinates Analysis (PCoA) plot showing the differences in species composition when using each of the terminal gears for the Portuguese pelagic longline fleet operating in the Indian Ocean. Each point represents a fishing set $\times$ gear combination, with the representation of the group-specific ellipses (95% CI levels).

3.3. CPUEs

The records and distribution of the CPUE for all species and for each terminal gear type are represented in **Figure 6**. The specific details of the 3 main species captured, namely the two target species (SWO and BSH) and the main bycatch species (SMA) are presented in **Figure 7**.

It is noted that the CPUEs tended to be much higher for SWO when using traplines, and much higher for BSH and SMA when using hooks. For those species there are statistically significant differences on all cases (Wilcoxon signed-rank tests: $p\text{-value} < 0.001$ on all cases).

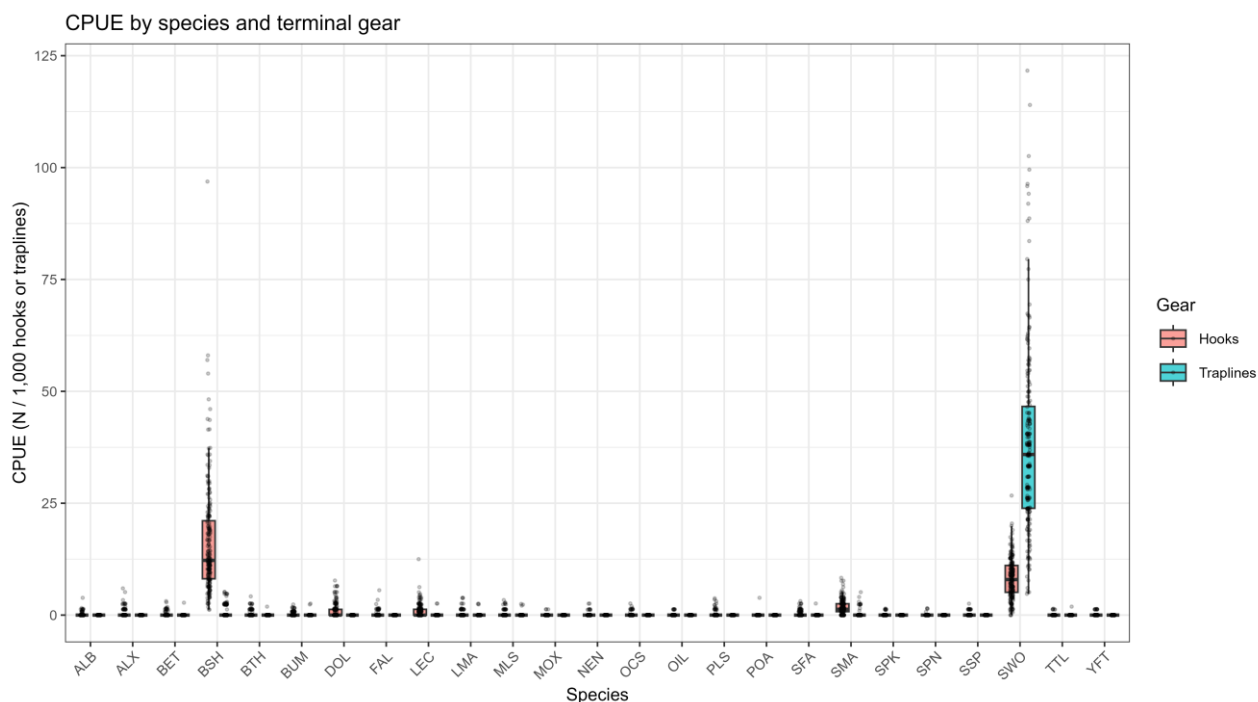


Figure 6. Boxplots (median, inter-quartile distribution and individual point distribution) of catch-per-unit-of-effort (CPUEs, N/1000 hooks or traplines) for the species captured and recorded in the study for each terminal gear type. Only the main 25 species recorded in the study to date are represented in this plot.

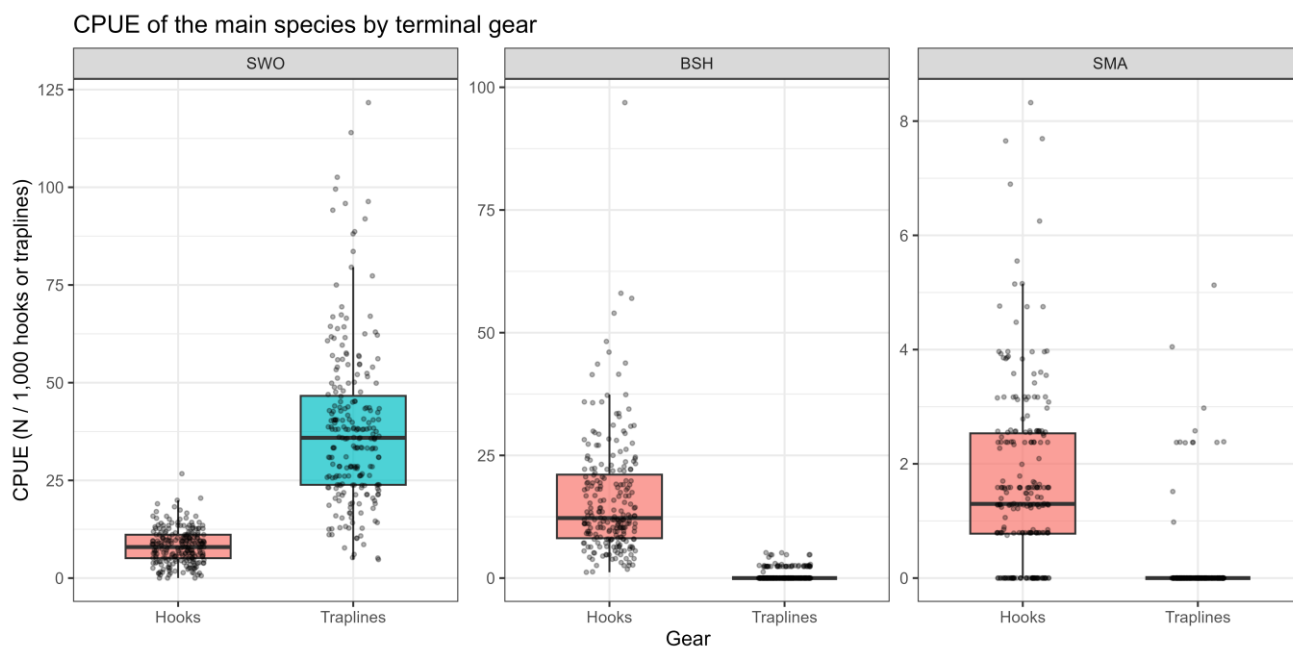


Figure 7. Boxplots (median, inter-quartile distribution and individual point distribution) of catch-per-unit-of-effort (CPUEs, N/1000 hooks or traplines) for the 3 main species captured and recorded in the study (swordfish, blue shark and shortfin mako), for each terminal gear type.

3.4. Size distribution

The size distribution of the main species (SWO and BSH) have some differences when comparing the size of the catch in hooks and traplines (**Figure 8**), with the specimens captured in traplines tending to be larger than the specimens captured with hooks. Those size differences are statistically significant for both species (Wilcoxon test: $p\text{-value} < 0.001$ on both species).

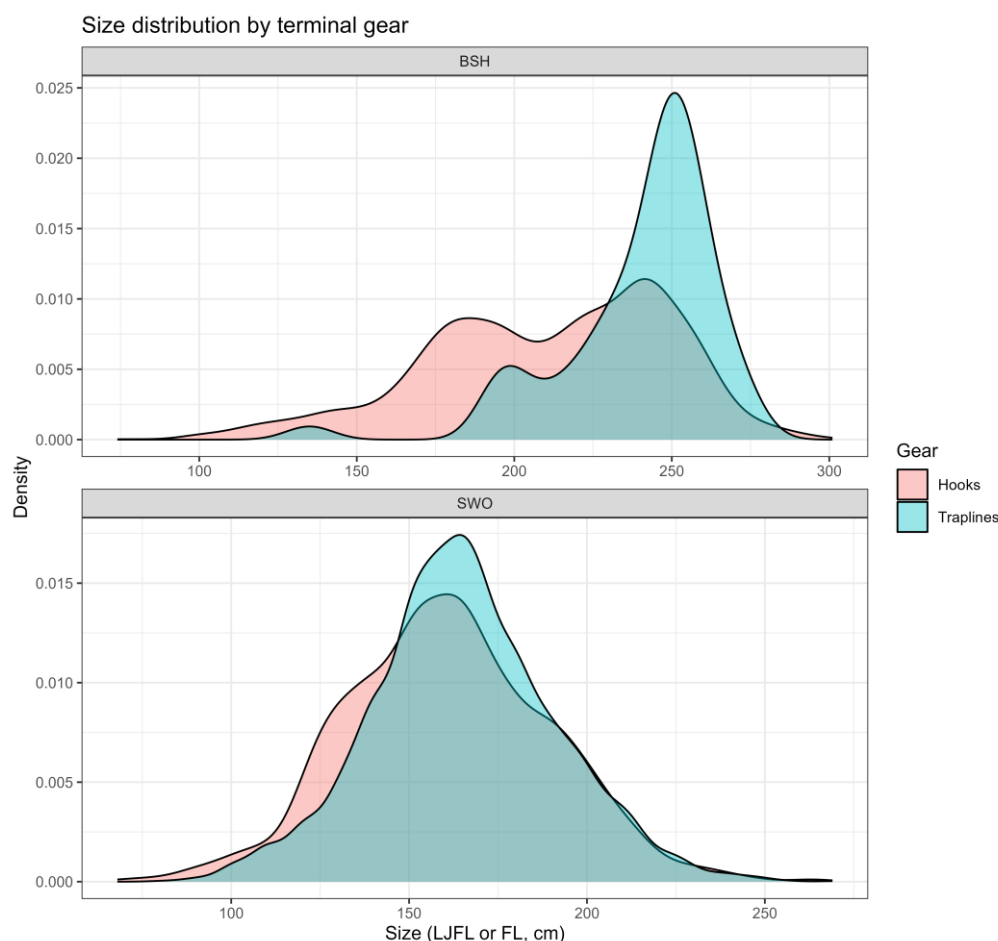


Figure 8. Size distribution for the main species (SWO, BSH) captured with each of the two terminal gears.

4. Discussion

This pilot project represents the first data collection and preliminary analysis of the new trapline gear in the Portuguese pelagic longline fleet operating in the Indian Ocean. Some previous preliminary studies have focused on this terminal gear for the Atlantic Ocean (Coelho et al., 2025) and the Mediterranean Sea (Garibaldi et al., 2024; Macías et al., 2025), and a description of its earlier use in the Pacific Ocean has also been provided (Ochi et al., 2025). To the best of our knowledge, our study is the first one that provides a quantitative analysis for the Indian Ocean.

A relevant aspect of the present study is that traplines and terminal hooks were deployed simultaneously on all the fishing sets monitored, meaning the comparisons between terminal gears are paired within each fishing set. In terms of the main results, it is noteworthy that the catch composition of the traplines is substantially different from that of the hooks, being composed almost exclusively of swordfish with some occasional bycatch of other species. This has been previously reported by other works for the Mediterranean Sea (Macías et al., 2025) and for the Atlantic Ocean (Coelho et al., 2025). In the present study, the same pattern was recorded consistently in both data sources (logbooks and onboard observers), which reinforces the results despite the still limited number of trips covered.

In terms of vulnerable species, a total of eight interactions with marine turtles were recorded, of which seven occurred on hooks and one on traplines. No interactions with seabirds or marine mammals were recorded in either terminal gear. While the number of interactions with traplines is clearly lower than with hooks, it should be noted that this differs from what has been reported for the Atlantic Ocean and the Mediterranean Sea, where no interactions of traplines with vulnerable species had been recorded to date (Macías et al., 2025; Coelho et al., 2025). This record indicates that captures of marine turtles on traplines, while apparently rare, are possible. It should also be noted that the current coverage and areas of the pilot project are still limited, and as more data is compiled this situation might change.

Size differences for the main species were also found, with larger swordfish and blue shark captured in traplines compared to hooks. For the Mediterranean Sea, Macías et al. (2025) also reported differences in swordfish sizes between terminal gears. In our case, the size differences are statistically significant but seem not to be as strong as what has been reported for the Mediterranean Sea. It is possible that the sizes of the individuals caught in traplines are related to the dimensions of the loops, even though the capture mechanism in traplines is not yet entirely understood.

The information provided in this work is important, and while still preliminary, it represents the first quantitative analysis of the new trapline terminal gear in the Indian Ocean. It is recommended that the project is continued, so that more data (logbooks and observer) can continue to be collected and provide more robust analysis. Additionally, once this initial fishery-dependent data collection phase is more advanced, it would be important to use such observational data to calculate the effort needed (e.g., power analysis) to conduct full experimental trials at sea for an experimental comparison of this new trapline gear with the traditional hooks used in pelagic longline fisheries.

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