



Tropical Tuna Catch Composition and Spatio-Temporal Distribution in the Madagascar Fishing Zone, 2024–2025

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The purpose of the paper is to inform the WPTT about the tropical tuna catch composition and spatial-temporal distribution in the Madagascar fishing zone, 2024–2025

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Table des matières

1.	Introduction.....	3
2.	Methodology	3
2.1.	Study Area and Data Sources	3
2.2.	Analysis Methodology	5
2.2.1.	Distribution by Protocol, Fishing Gear, and Species	5
2.2.2.	Temporal Distribution of Catches	6
2.2.3.	Spatial Distribution of Fishing Operations	6
2.2.4.	Data Processing Tools	6
3.	Results	7
3.1.	Distribution of Tropical Tuna Catches in 2024	7
3.1.1.	Catch distribution by fishing protocol	7
3.1.2.	Catch distribution by fishing gear	8
3.1.3.	Catch Distribution by Species and Fishing Gear	8
3.2.	Monthly Distribution	10
3.2.1.	Monthly Distribution longline fleet Catches in 2024 and 2025	10
3.2.2.	Monthly Distribution of Purse Seine Catches in 2024 and 2025	11
3.3.	Spatial Distribution of LL and PS Catches in the Madagascar EEZ	13
4.	Discussion	14
5.	Conclusion	15

Liste des Figures :

Figure 1 :	Map of the Malagasy fishing zone	4
Figure 2 :	tropical tuna species.....	5
Figure 3 :	Catch distribution by fishing company group in the Madagascar EEZ.....	7
Figure 4 :	Catch Distribution by Fishing Gear	8
Figure 5 :	Distribution of Tropical Tuna Catches by Fishing Gear and Species, 2024–2025	9
Figure 6 :	Monthly Distribution of longline fleet Catches in 2024 and 2025.....	10
Figure 7 :	Monthly Distribution of Purse seiner fleet Catches in 2024 and 2025.....	12
Figure 8 :	Spatial distribution of the purse seine and longline fleets within the Madagascar EEZ.	14

Abstract

The Madagascar fishing zone is an important area for tropical tuna exploitation in the western Indian Ocean, where fishing activities are largely dominated by foreign fleets. Understanding catch composition and fishing patterns is essential for effective monitoring and sustainable resource management.

This study characterizes tropical tuna catches in the Madagascar fishing zone during 2024 and 2025, focusing on longline and purse seine fisheries. Data were obtained primarily from Electronic Reporting System (ERS) declarations and vessel entry and exit records. The analysis examined catch composition and the spatial and temporal distribution of the main tropical tuna species: yellowfin tuna (YFT), bigeye tuna (BET), and skipjack tuna (SKJ).

The results show marked differences between the two fisheries. Overall, SKJ dominated catches, accounting for 74.10% in 2024 and 69.16% in 2025, while YFT represented 12.84% and 23.95%, and BET 11.90% and 4.11%, respectively. Longline fishing showed a more diversified species composition and occurred throughout most of the year, with activity concentrated mainly along the eastern coast of Madagascar. Purse seine activity was strongly dominated by SKJ and was mainly concentrated in the northwestern part of the fishing zone, particularly during the first half of the year.

These findings improve the understanding of tropical tuna exploitation patterns in the Madagascar fishing zone and provide useful information for fisheries monitoring and sustainable management.

1. Introduction

Fisheries constitute one of the five key economic sectors of Madagascar. With approximately 5,600 km of coastline and an Exclusive Economic Zone (EEZ) estimated at 1,140,000 km², Madagascar has considerable fisheries potential. Its geographical position, at the interface between the tropical and subtropical zones of the Indian Ocean, also provides favorable conditions for the presence and exploitation of a wide diversity of fishery resources.

Among the various fisheries operating in Malagasy waters, including coastal and offshore fisheries, tuna fisheries play an important role. They are mainly conducted by foreign fishing vessels using two principal types of fishing gear: longline (LL) and purse seine (PS).

The waters under Malagasy jurisdiction constitute an important fishing area for the three main tropical tuna species, namely yellowfin tuna (YFT – *Thunnus albacares*), skipjack tuna (SKJ – *Katsuwonus pelamis*), and bigeye tuna (BET – *Thunnus obesus*). Other pelagic species are also caught, particularly in association with these target species.

This study focuses on the analysis of tropical tuna catches in the Madagascar EEZ during 2024 and 2025. It aims in particular to characterize the species composition of catches, their temporal distribution according to the type of fishery (LL and PS), and their spatial distribution within the EEZ. The analysis is primarily based on data from Electronic Reporting System (ERS) fishing logbooks and EEZ entry and exit declarations, complemented by Vessel Monitoring System (VMS) data for the spatial analysis.

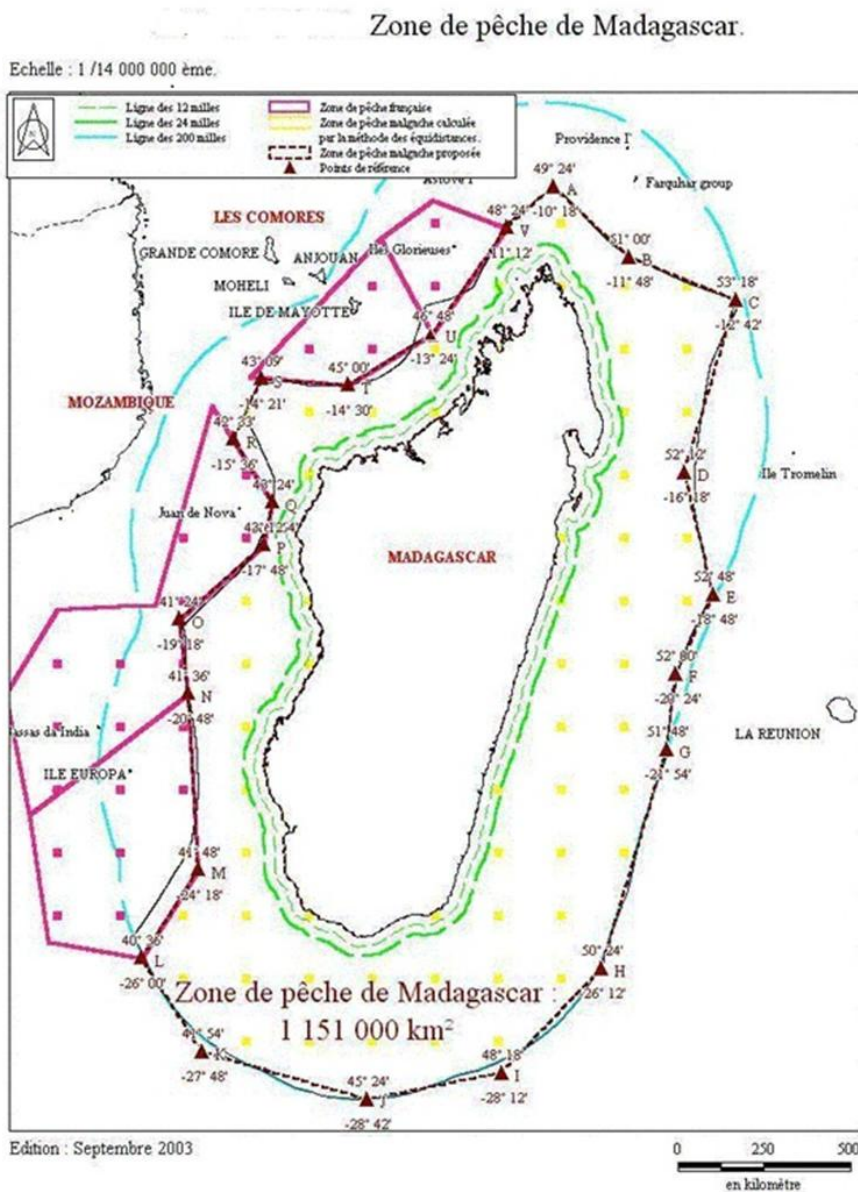
The study therefore highlights the main characteristics of tropical tuna catches, the differences between longline and purse seine fisheries, and the variations observed between 2024 and 2025. It provides additional information on the spatio-temporal dynamics of catches and the exploitation of tuna resources within the Malagasy EEZ, thereby contributing to the knowledge required for their monitoring, assessment, and sustainable management.

2. Methodology

2.1. Study Area and Data Sources

The study area is the Malagasy fishing zone in the western Indian Ocean. The analysis focuses on tuna fisheries operated by foreign vessels within this zone during 2024 and 2025.

Figure 1 : Map of the Malagasy fishing zone



Two main gear types were considered in this study: longline (LL) and purse seine (PS) fisheries. These methods differ in their strategies and target species, which may influence the composition and spatial distribution of tuna catches. The main tropical tuna species considered in the analysis were yellowfin tuna (*Thunnus albacares*, YFT), bigeye tuna (*Thunnus obesus*, BET), and skipjack tuna (*Katsuwonus pelamis*, SKJ).

Figure 2 : tropical tuna species

**Albacore***Thunnus albacares*

(Bonnaterre, 1788)

Taille max. :1,5m (Collette, B.B. and C.E. Nauen, 1983)

**Patudo***Thunnus obesus* (Lowe, 1839)

Taille max. :1,8m (Collette, B.B. and C.E. Nauen, 1983)

**Listao***Katsuwonus pelamis* (Linnaeus, 1758)

Taille max. :0,80m (Collette, B.B. and C.E. Nauen, 1983)

The data used in this study were mainly obtained from fisheries monitoring systems managed by the Centre de Surveillance des Pêches (CSP) of Madagascar. The first source was the Electronic Reporting System (ERS) database, which provides information on fishing activities, particularly catch and fishing effort. These data were used to examine catch composition by gear, species, and year.

The study also used vessel entry and exit data recorded by the CSP, together with on-board catch declarations submitted by fishing vessels. These records provide information on the presence and activity of foreign vessels within the Malagasy fishing zone and complement the ERS data.

The combination of these datasets allowed the analysis to characterize the catch composition and distribution of tropical tuna species by gear and year, and to compare the fishing patterns of longline and purse seine fleets operating in the Malagasy fishing zone.

2.2. Analysis Methodology

2.2.1. Distribution by Protocol, Fishing Gear, and Species

The distributions of catches by protocol, fishing gear, and tropical tuna species were expressed as percentages and calculated using the following formulas:

For the distribution by protocol :

Catch proportion by protocol (%) = (Catch weight by protocol / Total catch weight) × 100

For the distribution by fishing gear :

Catch proportion by fishing gear (%) = (Catch weight by fishing gear / Total catch weight) × 100

For the distribution by tropical tuna species :

Catch proportion by tropical tuna species (%) = (Catch weight of the species / Total tropical tuna catch weight) × 100

The results will be presented as pie charts to illustrate the relative contribution of each protocol, fishing gear, and tropical tuna species to the total catch.

2.2.2. Temporal Distribution of Catches

The temporal distribution of catches by purse seiners and longliners was analyzed for 2024 and 2025. The data were aggregated on a monthly basis using catch information from the ERS and vessel entry and exit declarations. Monthly catch weights were calculated by fishing gear, species, and year using the following formula:

$$CW_{g,m,s,y} = \sum_{i=1}^n CW_{i,g,m,s,y}$$

Where :

- $CW_{g,m,s,y}$ = total catch weight for fishing gear g, month m, species s and year y;
- $CW_{i,g,m,s,y}$ = catch weight reported by vessel/record i;
- g = fishing gear (PS or LL);
- m = month;
- s = tropical tuna species (YFT, SKJ or BET);
- y = year (2024 or 2025);
- n = total number of records considered.

2.2.3. Spatial Distribution of Fishing Operations

ERS data were used to analyze the spatial distribution of fishing operations within the fishing zone of Madagascar. The data were formatted and aggregated into 1° × 1° geographic grid cells, based on VMS positions recorded for fishing vessels.

For each grid cell, the number of VMS positions was aggregated to determine the occurrence of fishing operations by fishing gear. Due to data migration issues resulting from the change in the monitoring system, only VMS positions covering the period from July 2025 to June 2026 were extracted and processed for mapping.

This approach allowed the spatial distribution of tropical tuna fishing operations to be visualized and compared between the two main fishing gears: longline (LL) and purse seine (PS).

2.2.4. Data Processing Tools

All data processing, analysis, and presentation of results were performed using Microsoft Excel. Spatial data processing and map production were carried out using R software.

3. Results

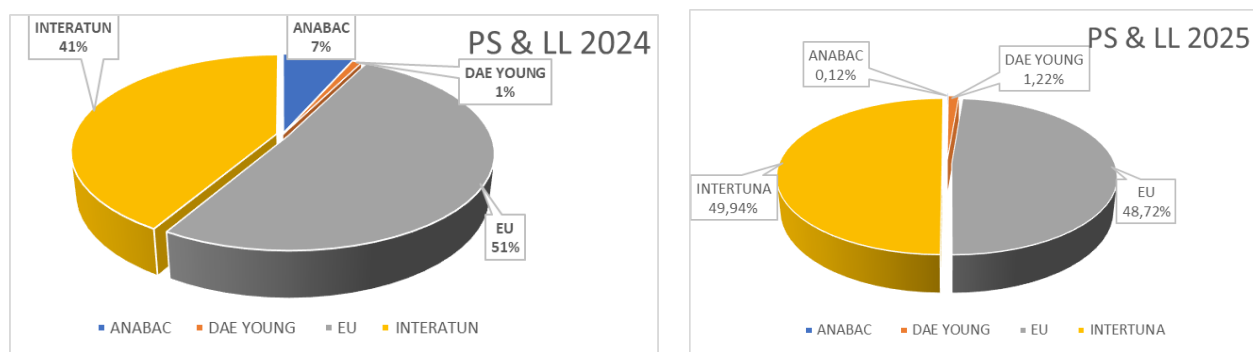
3.1. Distribution of Tropical Tuna Catches in 2024

Before examining the spatio-temporal distribution of tropical tuna catches, the catch distributions were first described according to fishing protocol, gear type, and tropical tuna species. This preliminary analysis provides a characterization of catch composition and highlights differences among fishing protocols, fishing gears, and target species. These results provide a descriptive basis for interpreting the spatial and temporal patterns observed in the distribution of tropical tuna catches.

3.1.1. Catch distribution by fishing protocol

The distribution of catches among the different fishing protocols or groups of fishing companies was examined to highlight the contribution of each protocol to the total tropical tuna catches. The analysis covers the two main types of fisheries considered in this study, namely purse seine (PS) and longline (LL) fisheries. Comparing catches among the different protocols makes it possible to identify the groups of fishing companies contributing most to the catches and to assess their relative importance according to the type of fishery. The results of this distribution are presented in the figure below..

Figure 3 : Catch distribution by fishing company group in the Madagascar EEZ



The distribution of catches by fishing protocol shows the predominance of the European Union (EU) and INTERTUNA in both years considered. In 2024, the EU accounted for 51.03% of catches, compared with 41.51% for INTERTUNA. Together, these two groups accounted for 92.54% of total catches, while ANABAC and DAE YOUNG represented 6.57% and 0.89%, respectively.

In 2025, the contribution of INTERTUNA increased to 49.94%, while that of the EU slightly decreased to 48.72%. Together, these two protocols accounted for 98.66% of catches. The contribution of ANABAC declined sharply, from 6.57% to 0.12%, whereas DAE YOUNG remained a minor contributor, with a slight increase from 0.89% to 1.22%.

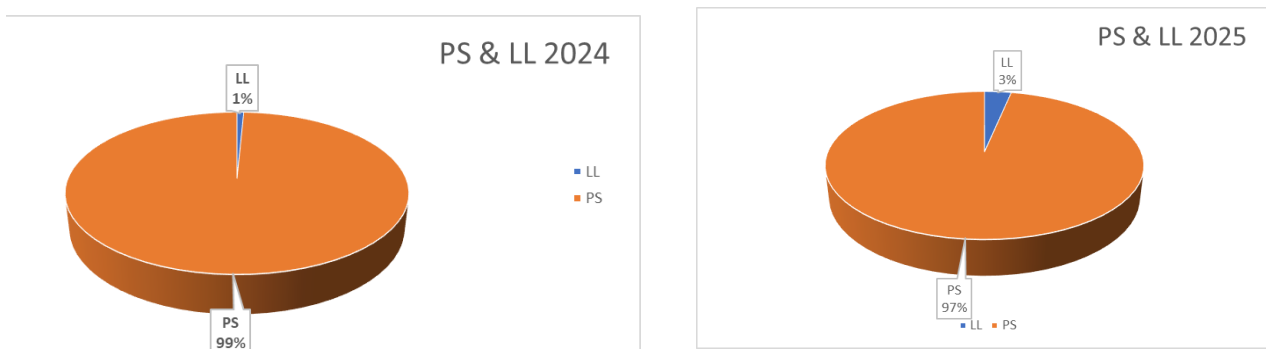
Overall, the comparison between 2024 and 2025 shows a shift in the relative contribution of the EU and INTERTUNA, with INTERTUNA becoming slightly predominant in 2025. The catch structure also became more concentrated around these two main fishing protocols.

3.1.2. Catch distribution by fishing gear

The distribution of catches by fishing gear is presented in Figure 2 below. This distribution allows for a comparison of the respective contributions of purse seine (PS) and longline (LL) fishing to tropical tuna catches recorded within the Madagascar EEZ.

The analysis highlights the relative contribution of each fishing gear and allows changes between 2024 and 2025 to be assessed. This comparison provides an overview of the structure of fishing activities and the respective contribution of the two main fishing gears to tropical tuna catches recorded within the Madagascar EEZ.

Figure 4 : Catch Distribution by Fishing Gear



The analysis of catch distribution by fishing gear highlights the strong predominance of purse seine fishing (PS) in both years considered. In 2024, purse seine fishing accounted for 99.24% of total catches, compared with only 0.76% for longline fishing (LL). In 2025, purse seine fishing remained overwhelmingly dominant, accounting for 96.76% of catches, while the share of longline fishing increased to 3.24%.

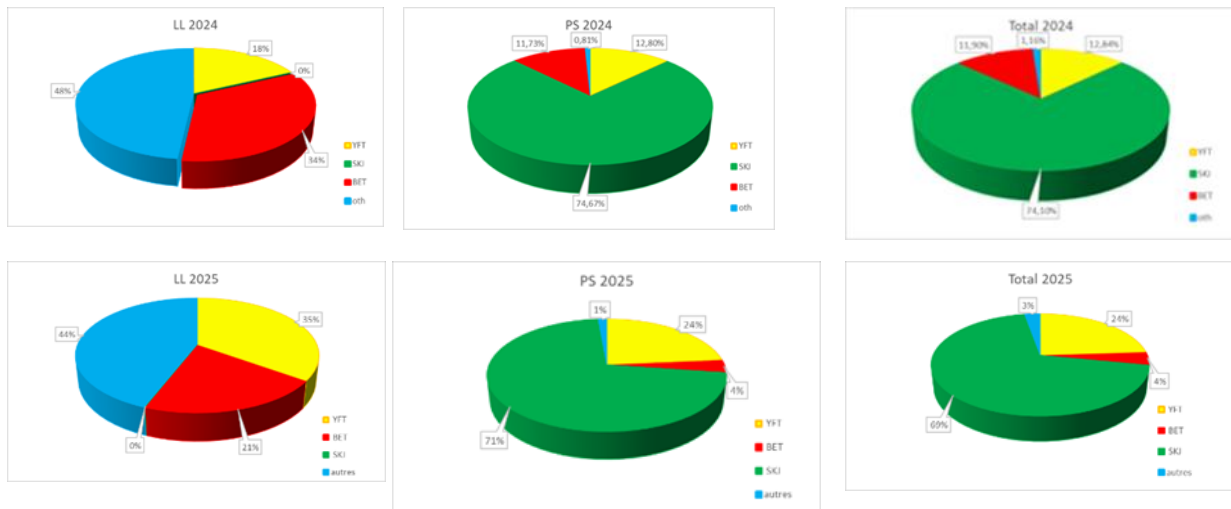
The comparison between the two years nevertheless shows a change in the relative contribution of the two fishing gears. The share of longline catches increased from 0.76% in 2024 to 3.24% in 2025, representing an increase of 2.48 percentage points. Conversely, the contribution of purse seine fishing decreased by 2.48 percentage points, from 99.24% to 96.76%.

Despite this change, the catch structure remained strongly dominated by purse seine fishing in 2025. The increase in the contribution of longline fishing may nevertheless indicate a relative diversification in the contribution of fishing gears to catches recorded within the Madagascar EEZ. This trend should be considered alongside the data on target species, fishing company groups, and the spatio-temporal distribution of fishing activities.

3.1.3. Catch Distribution by Species and Fishing Gear

The distribution of catches by species within the Exclusive Economic Zone (EEZ) of Madagascar is presented in Figure 5 below. This distribution provides an overview of the species composition of catches made by the two main fisheries considered, namely purse seine and longline fisheries.

Figure 5 : Distribution of Tropical Tuna Catches by Fishing Gear and Species, 2024–2025



In 2024, the total catch recorded for the species groups considered was approximately 39,950 T. The catch composition was largely dominated by skipjack tuna (SKJ), which accounted for 74.10% of the total catch. Yellowfin tuna (YFT) represented 12.84%, while bigeye tuna (BET) accounted for 11.90%. Other species contributed only 1.16% of the total catch. This distribution indicates a strong predominance of SKJ in the catches recorded in the Madagascar EEZ during 2024.

In terms of fishing gear, purse seine (PS) fishing accounted for 99.24% of the total catch, whereas longline (LL) fishing contributed only 0.76%. The predominance of purse seine catches was particularly evident for SKJ, for which virtually 100% of the recorded catch was associated with purse seine fishing. For YFT, purse seine catches represented 12.70% of the total catch, compared with only 0.14% from longline fishing. BET accounted for 11.64% from purse seine and 0.26% from longline, while other species contributed 0.80% and 0.36%, respectively.

In 2025, the total catch decreased to approximately 28,290 T, corresponding to a substantial reduction compared with 2024. The species composition also changed, although SKJ remained the dominant species. SKJ accounted for 69.16% of the total catch, followed by YFT with 23.95%, BET with 4.11%, and other species with 2.78%. Thus, compared with 2024, the relative contribution of YFT increased considerably, while those of SKJ and BET decreased.

Purse seine fishing continued to dominate catches in 2025, contributing 96.76% of the total, while longline fishing represented 3.24%. The increase in the relative contribution of longline catches compared with 2024 was mainly associated with YFT, BET and other species. However, purse seine fishing remained overwhelmingly dominant, particularly for SKJ, which accounted for 69.16% of the overall catch, with virtually no contribution from longline fishing.

Overall, the results show that catches in the Madagascar EEZ during 2024–2025 were strongly dominated by purse seine fishing, which accounted for more than 96% of total catches in both years. SKJ remained the main species caught, although its share declined from 74.10% in 2024 to 69.16% in 2025. In contrast, the contribution of YFT increased from 12.84% to 23.95%, indicating a notable change in the species composition of catches between the two years. BET showed a marked decrease, from 11.90% to 4.11%.

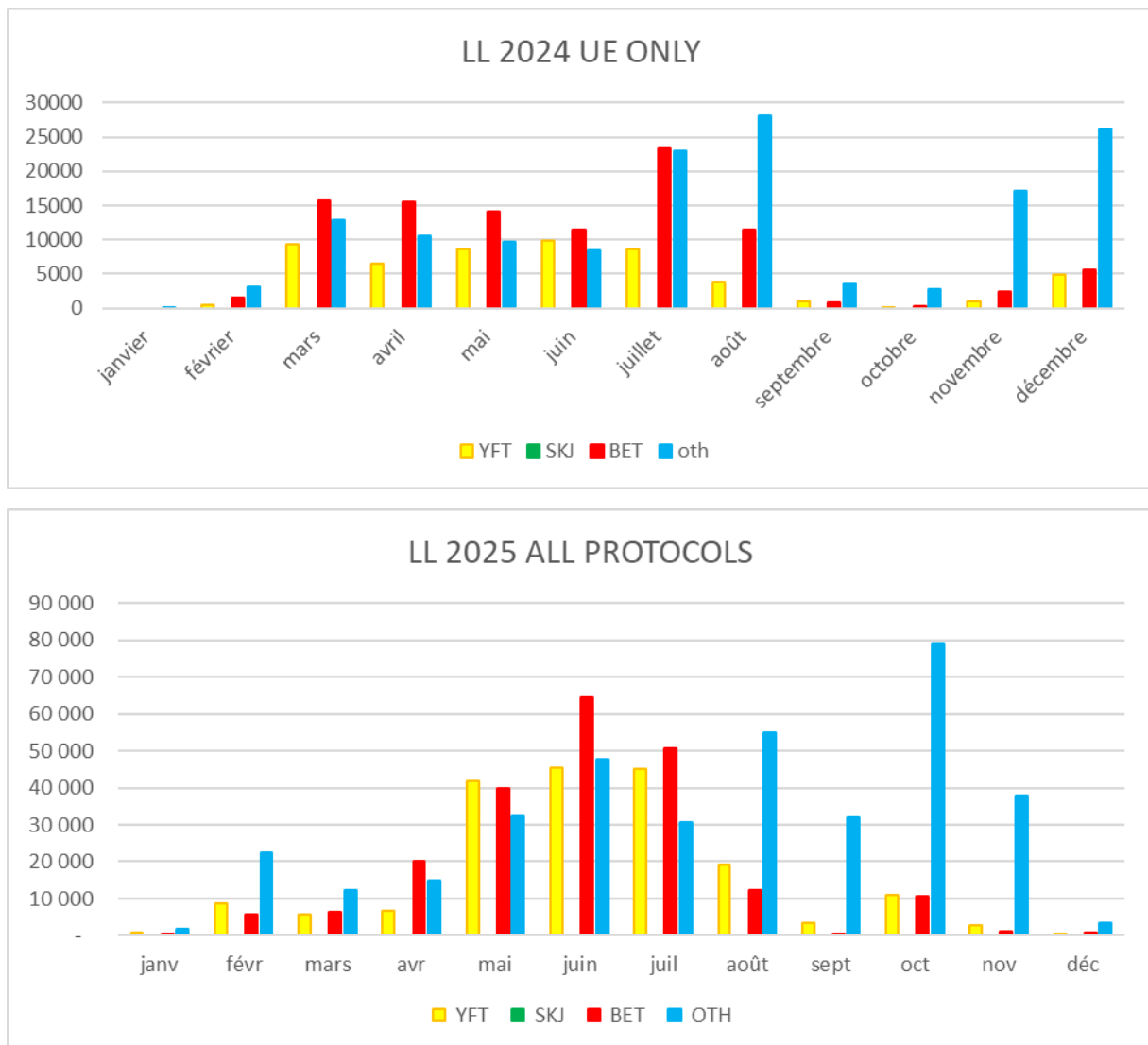
These variations suggest a change in the relative composition of tropical tuna catches between 2024 and 2025, while the overall dominance of purse seine fishing remained unchanged.

3.2. Monthly Distribution

3.2.1. Monthly Distribution longline fleet Catches in 2024 and 2025

Figure 6 illustrates the monthly distribution of tropical tuna catches by the longline fleet during 2024 and 2025. The analysis covers the main target species—bigeye tuna (BET), yellowfin tuna (YFT), and skipjack tuna (SKJ)—as well as other species (OTH)

Figure 6 : Monthly Distribution of longline fleet Catches in 2024 and 2025



The monthly distribution of catches from the longline fishery in 2025 shows substantial variability in species composition throughout the year. In both graphs, catches are mainly composed of YFT, BET and other species (OTH), while the contribution of SKJ is negligible.

For the EU protocol, OTH represents the largest component during several months, particularly in February, September, October and November. However, the contributions of BET and YFT become more prominent from May to August. BET shows a particularly high contribution in June and July, while YFT contributes significantly from May to August. Thus, the composition of EU catches varies considerably throughout the year, with the dominant species changing between months.

When all protocols are considered, the relative contribution of YFT and BET increases noticeably compared with the EU protocol alone, particularly between May and July. BET becomes particularly prominent in June and July, while YFT contributes substantially to catches in May and June. OTH remains an important component, with relatively high contributions in August, September and October.

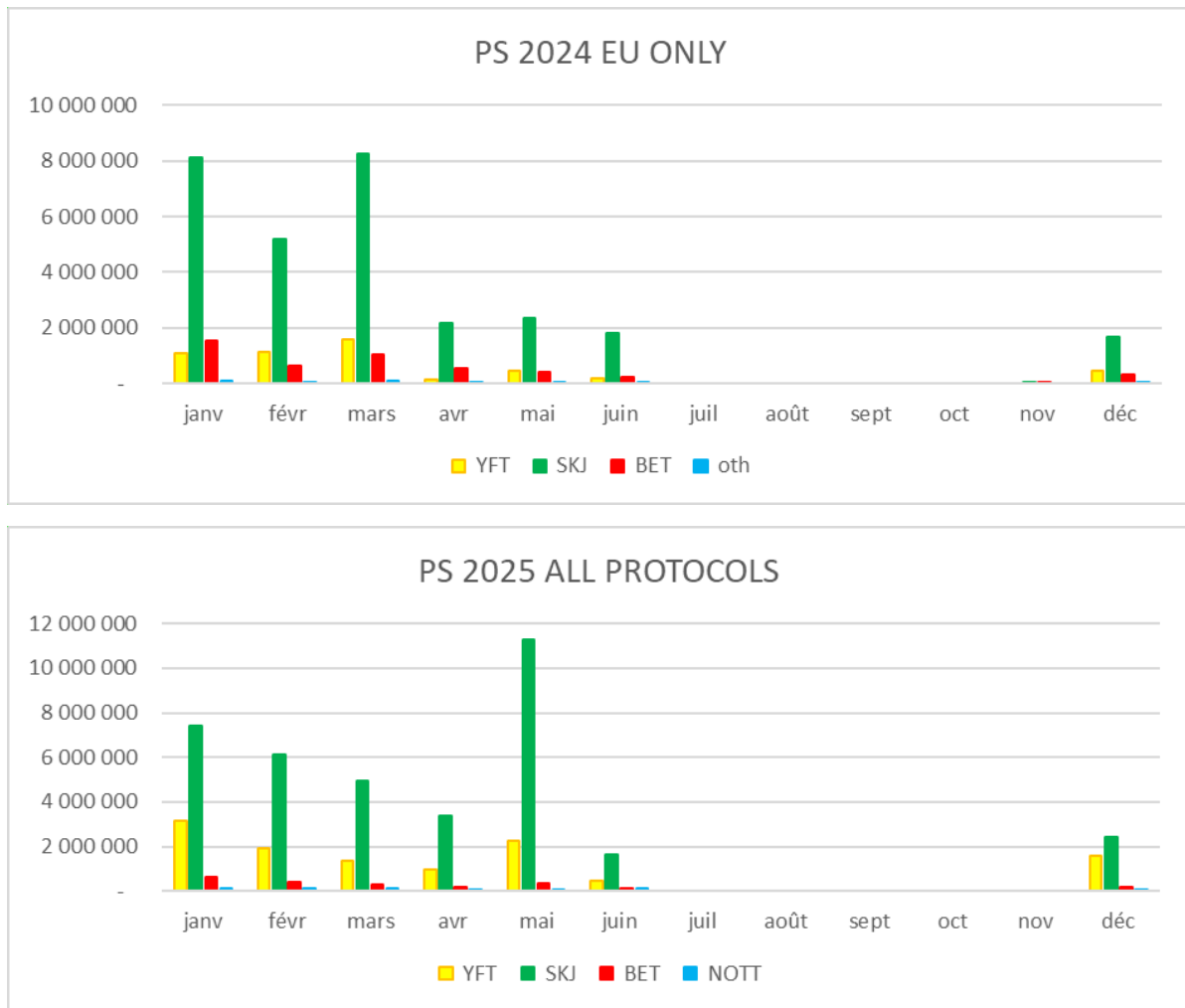
The comparison between the two graphs therefore indicates that including all protocols substantially modifies the relative composition of longline catches compared with the EU protocol alone. The contribution of YFT and BET is enhanced, while the relative contribution of OTH decreases during some months. This suggests that protocols other than the EU protocol make a significant contribution to the overall structure of longline catches.

Overall, the 2025 longline fishery shows a catch composition mainly characterized by YFT, BET and OTH, with a very limited contribution from SKJ. The species composition varies markedly throughout the year, with BET being particularly prominent around June–July, YFT contributing strongly during several months of the middle of the year, and OTH showing important contributions during several months, particularly toward the latter part of the year.

3.2.2. Monthly Distribution of Purse Seine Catches in 2024 and 2025

Figure 7 shows the monthly distribution of tropical tuna catches by the Purse seiner fleet in 2024 and 2025. The figure includes the main target species which are bigeye tuna (BET), yellowfin tuna (YFT), and skipjack tuna (SKJ) and other species.

Figure 7 : Monthly Distribution of Purse seiner fleet Catches in 2024 and 2025



Purse seine (PS) fishing shows strong seasonality, with activity mainly concentrated during the first half of the year. The absence of PS catches during the second half is consistent with the seasonal pattern of this fishery and does not represent a data gap.

PS catches were dominated by skipjack tuna (SKJ), followed by yellowfin tuna (YFT) and, to a lesser extent, bigeye tuna (BET). In 2024, catches were particularly high during the first quarter, with a maximum of 4,429 tonnes of SKJ in March. This figure corresponds only to catches from the EU fleet extracted from ERS data. YFT reached a maximum of 1,339 tonnes in March.

In 2025, considering catches from all protocols combined, the peak shifted to May, reaching approximately 11,000 tonnes, followed by a marked decline during the subsequent months.

The comparison between PS and longline (LL) fisheries highlights clear differences in both seasonality and species composition. PS activity is strongly concentrated during the first half of the year and is dominated by SKJ, whereas LL fishing is more evenly distributed throughout the year, with important contributions from YFT, BET, and other species.

Between 2024 and 2025, the main change was the substantial variation in PS catch volumes and the shift in the peak month, while the overall seasonal pattern remained evident. LL catches showed a relatively broader temporal distribution, particularly for YFT and BET.

Overall, seasonality appears to be a key factor structuring tuna catch distribution in the Madagascar fishing zone. The observed variations between years may reflect differences in fishing effort, fishing areas, and the spatio-temporal availability of the main target species.

3.3. Spatial Distribution of LL and PS Catches in the Madagascar EEZ

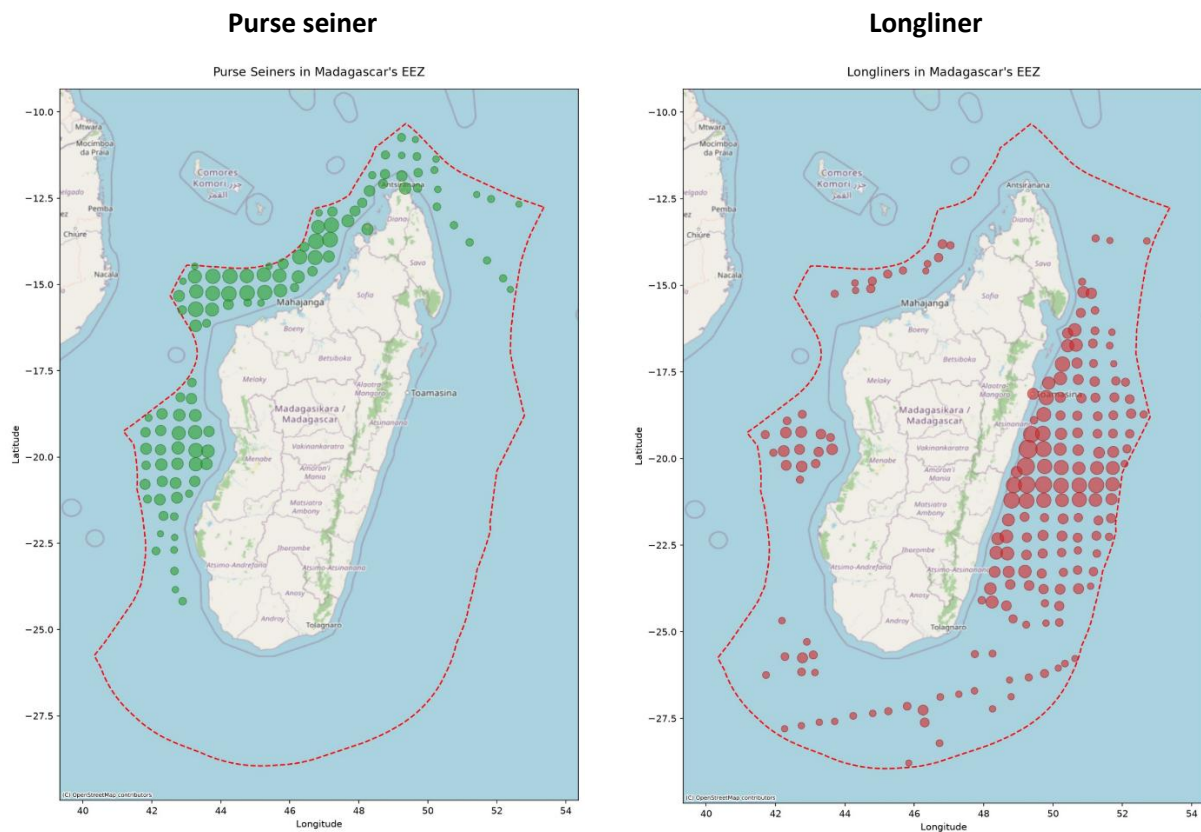
The spatial distribution of longline (LL) and purse seine (PS) fishing activities within the Madagascar EEZ was analyzed using vessel monitoring system (VMS) data.

Due to a data migration issue, the available data cover the period from July 2025 to June 2026. The results therefore do not cover the full 2025 calendar year but provide an overview of the spatial distribution of fishing activities by the two main fisheries during this period.

The following figures show the spatial distribution of fishing vessel positions within the Madagascar EEZ, aggregated into $1^{\circ} \times 1^{\circ}$ grid cells. The distribution is presented separately for longline (LL) and purse seine (PS) fisheries.

This approach identifies the main areas of fishing activity and highlights differences in the spatial distribution of the two fisheries. It also complements the temporal and species-composition analyses by linking the main fishing areas to the activities of the different fleets.

Figure 8 : Spatial distribution of the purse seine and longline fleets within the Madagascar EEZ.



The two maps show the spatial distribution of purse seiners (green) and longliners (red) within the Madagascar Exclusive Economic Zone (EEZ) from July 2025 to June 2026.

Purse seiners are mainly concentrated in the northern and western sectors of the EEZ, particularly offshore of Mahajanga, northern Madagascar, and along the western coast. Activity is limited in the southern and southeastern sectors.

Longliners show a wider spatial distribution, with the highest concentrations in the eastern and southeastern sectors, particularly between 48–52°E and 17–23°S. Their activity also extends farther south, reaching approximately 28°S, while remaining limited in the north.

Comparison and interpretation. The two fleets display distinct spatial patterns, with purse seiners predominantly using northern and western fishing grounds and longliners concentrating in the eastern and southeastern sectors. The relatively limited spatial overlap may reflect differences in fishing strategies, target species, and the spatial distribution of pelagic resources. Further analysis of fishing effort, catch composition, and environmental conditions would help explain these patterns.

4. Discussion

The results provide an overview of the composition, temporal distribution, and spatial patterns of tropical tuna catches within the Madagascar EEZ in 2024 and 2025. Overall, the results highlight clear differences

between purse seine (PS) and longline (LL) fisheries in terms of species composition, seasonality, and spatial distribution.

Purse seine catches were strongly dominated by skipjack tuna (SKJ), followed by yellowfin tuna (YFT), with bigeye tuna (BET) contributing to a lesser extent. PS activity also showed a marked seasonal pattern, with fishing activity mainly concentrated during the first half of the year. In contrast, longline catches showed a more diversified species composition, particularly involving YFT and BET, and were more evenly distributed throughout the year. These differences are consistent with the distinct fishing strategies and target species associated with the two fishing gears.

The spatial analysis further highlighted a clear separation between the two fleets. Purse seiners were mainly concentrated in the northern and western sectors of the EEZ, whereas longliners were more widely distributed, with higher concentrations in the eastern and southeastern sectors and a greater extension toward southern waters. The relatively limited spatial overlap between the two fleets suggests that they exploit different fishing grounds, potentially reflecting differences in target species, fishing strategies, and the spatial distribution of tuna resources.

Some differences were also observed between 2024 and 2025, particularly in the magnitude and timing of purse seine catches. These variations should, however, be interpreted with caution because the available data and reporting protocols were not fully consistent between the two years. In particular, some 2024 results were based on ERS data from the EU fleet, whereas 2025 analyses incorporated catches from multiple reporting protocols. Consequently, direct comparisons of catch volumes between years should be considered indicative rather than definitive.

The spatial analysis was also constrained by the data migration issue, which limited VMS data to the period from July 2025 to June 2026. Despite this limitation, the results provide a useful indication of the main fishing areas used by the two fleets within the Madagascar EEZ. Combining catch, effort, VMS, and environmental data in future analyses would allow a more comprehensive assessment of the factors influencing tuna distribution and fishing activity.

5. Conclusion

This study provides an overview of the temporal, spatial, and species composition of tropical tuna catches in the Madagascar EEZ during 2024 and 2025. The results show distinct characteristics between the two main fishing gears.

Purse seine fishing was mainly associated with SKJ and showed strong seasonal and spatial concentration, particularly in the northern and western sectors of the EEZ. Longline fishing had a more diversified catch composition, with important contributions from YFT and BET, and showed a broader spatial distribution, particularly in the eastern and southeastern sectors.

The results also indicate substantial variations in catch levels and distribution between years. However, differences in data sources, reporting protocols, and the available VMS period should be considered when interpreting interannual changes.

Overall, the study demonstrates the value of integrating catch and vessel monitoring data to characterize fishing activity within the Madagascar EEZ. Continued improvement in data quality, harmonization of reporting systems, and integration of catch, fishing effort, VMS, and environmental information would strengthen future assessments of tropical tuna fisheries and support more effective monitoring and management of these resources.