Shark Species Composition and Size Distribution of Indonesian Longline Fisheries Operating in the Indian Ocean

Tegoeh Noegroho, Irwan Jatmiko, Yoke Hanny R, Pratiwi Lestari, Lilis Sadiyah, Fayakun Satria, Tirtadanu, Putuh Suadela

Purpose, expectation and action intended (select one or more and include corresponding text)

Discussions (for information and open discussion):

[The paper is to inform meeting members that…, as set out in Section X]

Feedback (to collect input and suggestions)

[The paper is to request review and comments on…, as set out in Section X]

Conclusion (to record a concluded position or summary)

[The paper is to seek confirmation that…, as set out in Section X]

Recommendation (to ask the meeting to endorse a recommendation)

[The paper is to seek endorsement on…, as set out in Section X]

Decisions (to request formal approval of actions)

[The paper is to seek approval on…, as set out in Section X]

Abstract

Shark bycatch in tuna longline fisheries in the Indian Ocean is a major concern in sustainable fisheries governance. This study aims to identify species composition, analyze co-occurrence associations, and evaluate the length-frequency structure of dominant shark species caught by the Indonesian tuna longline fleet in the Indian Ocean. Data were collected through an onboard commercial vessel observer program from 2005 to 2021. Out of a total of 66,850 caught individuals, the shark group contributed 7.13% (4,763 individuals across 18 taxa). Shark composition was heavily dominated by the blue shark (*Prionace glauca*; 55.13%) and crocodile shark (*Pseudocarcharias kamoharai*; 29.12%), followed by the silky shark (*Carcharhinus falciformis*; 2.52%), shortfin mako (*Isurus oxyrinchus*; 2.29%), oceanic whitetip shark (*Carcharhinus longimanus*; 2.02%), and spinner shark (*Carcharhinus brevipinna*; 1.64%). Co-occurrence analysis and Spearman rank correlation revealed high epipelagic-mesopelagic habitat overlap between pelagic sharks and albacore (*Thunnus alalunga*), swordfish (*Xiphias gladius*), and wahoo (*Acanthocybium solandri*), whereas a negative correlation between southern bluefin tuna (*Thunnus maccoyii*) and silky sharks reflected thermal water segregation. The mean total length recorded was 156.9 cm (BSH), 80.0 cm (PSK), 122.6 cm (FAL), 115.8 cm (SMA), 140.1 cm (OCS), and 133.6 cm (CCB). Most size distributions exhibited non-normal patterns (bimodal/multimodal) due to gear selectivity and spatial/depth habitat segregation. Pelagic sharks in the Indian Ocean exhibit consistent size segregation: juveniles utilize coastal waters as nursery grounds for food and protection, while adults inhabit offshore waters, except for the shortfin mako which displays an inverted pattern.These findings are expected to support effective shark bycatch management and elasmobranch conservation in the IOTC area.

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Keywords: Species Composition, Size Distribution, Sharks, Tuna Longlines, Bycatch

Introduction

The tuna longline fishery is one of the primary capture fleets in the Indian Ocean exploiting critical pelagic resources such as tuna (IOTC–2025–SC27–NRXX). However, this fishing gear presents a ongoing issue where the captured fish do not consist entirely of the target catch (tuna), but also include bycatch. One of the primary components of longline bycatch is sharks. Sharks belong to the class elasmobranchii, characterized by long life cycles, slow growth, late sexual maturity, and low fecundity (Compagno, 1984; Last & Stevens, 1994; Castro et al., 1999). These biological traits render shark resources highly susceptible to rapid stock depletion under excessive fishing pressure (Daley et al., 2002). Deploying thousands of hooks makes this technique less selective, thereby generating a significant amount of bycatch (Gilman et al., 2008). High bycatch interactions not only cause resource waste, but also trigger severe disruptions to the structure and function of open-ocean food webs (Tolotti et al., 2015).

Bycatch in pelagic fisheries represents a fundamental challenge that threatens not only the sustainability of top predator populations but also broader marine ecosystem structures (Hall et al., 2000). At the regional Indian Ocean scale, pelagic longlining exhibits clear spatial patterns in declining catch rates and size variations of pelagic sharks (Ward et al., 2008). Globally, the exploitation of pelagic sharks by longline fleets requires a comprehensive evaluation of regulatory effectiveness and technical gear mitigation measures (Oliver et al., 2015), the detailed recommendations and improvement strategies of which are regularly reviewed by the IOTC Scientific Committee (IOTC, 2024).

Among various bycatch groups, pelagic sharks are the most heavily impacted and receive urgent attention from the international community (Coelho et al., 2018; IOTC, 2023). Sharks serve as top predators that play a vital ecological role in maintaining the population stability of other marine biota (Ferretti et al., 2010). The biological vulnerability of sharks characterized by slow growth rates, extended age-at-maturity, long gestation periods, and small litter sizes makes their populations exceptionally sensitive to fishing-induced mortality (Dulvy et al., 2014; Gallagher et al., 2012). Analyzing body size distribution and spatial variations of bycatch shark species provides fundamental information for understanding population structures and spatial habitat utilization patterns (Clarke et al., 2011; Queiroz et al., 2016). Spatial shifts along latitudinal and longitudinal gradients are closely linked to migratory strategies, size-based segregation by sex/age, and the availability of feeding or nursery grounds (Simpfendorfer et al., 2011).

The importance of this study stems from the need to supply valid scientific data to support evidence-based management. As a fishing nation operating in the Indian Ocean, Indonesia is obligated to fulfill its commitments under IOTC resolutions regarding bycatch monitoring and the protection of threatened elasmobranch species. Shark management in IOTC fisheries is reinforced by Resolution 25/08 (2025) – On the conservation of sharks caught in association with fisheries managed by IOTC, entering into force on January 1, 2026. This resolution supersedes and consolidates Resolutions 12/09, 13/05, 13/06, 17/05, and 18/02, which previously governed the conservation of thresher sharks, whale sharks, sharks in general, and blue sharks. Resolution 25/08 strengthens catch monitoring and reporting, bycatch management, prohibitions on shark finning, and safe release protocols as part of efforts to reduce fishery impacts on shark populations in the IOTC area of competence (IOTC, 2025).

A comprehensive understanding of species composition and size distribution of sharks in the Indian Ocean is essential not only for identifying critical habitats and minimizing stock vulnerability, but also serves as a strategic foundation for maintaining stable market access for national fishery exports and supporting global sustainable fisheries certification. This study aims to identify the species composition of catches, specifically the shark group, within the Indonesian tuna longline fleet operating in the Indian Ocean, as well as to analyze the length distribution patterns of dominant shark species across geographic spatial variations (latitude and longitude).

Materials and Methods

Data Collection

Data were collected from 2005 to 2021 by onboard observers stationed on Indonesian tuna longline vessels operating in the Indian Ocean, following protocols aligned with IOTC standards. Observers trained in taxonomic identification through morphological assessment logged detailed catch records for each fishing operation, identifying species across groups such as tunas, billfishes, sharks, bony fishes, rays, and mobulids. Identification was conducted to the species level whenever possible; otherwise, specimens were classified to the family level. The observer coverage primarily spanned fishing areas in the eastern Indian Ocean. Observers recorded the number of hooks set daily per longline set to standardize fishing effort and catch volume, and took length measurements of captured individuals.

Data Analysis

Catch composition was analyzed quantitatively using relative abundance percentages (catch composition analysis). The proportion of the shark group was calculated as the ratio of individual shark counts to the total accumulated catch recorded across the tuna longline fleet. To determine relationships between shark presence/abundance and both target and non-target catches, Catch Correlation Analysis was conducted using the Spearman rank correlation test. Additionally, Species Co-occurrence Analysis was applied to evaluate interspecific association levels within shared longline operations. Length distributions for the five dominant shark species were evaluated using Spatial Length-Frequency Distribution Analysis. Length measurements were grouped into class intervals, and relative percentages were calculated for each fishing location. Spatial distribution pattern differences between regions were evaluated using the Kolmogorov-Smirnov test (K-S Test), while the distribution of specific size classes was mapped to create size-class spatial abundance maps.

Result

Longline Catch and Shark Species Composition

Of the 66,850 total individuals captured by tuna longlines in the Indian Ocean during 2005–2021, the bony fishes group dominated the catches with 31,452 individuals (47.05%), followed by tunas at 22,075 individuals (33.02%). The Sharks group represented the fourth largest catch component with 4,763 individuals, accounting for 7.13% of the total catch. Meanwhile, billfishes contributed 3.92%, rays accounted for 8.87%, and mobulids comprised only 0.02% (Figure 1).

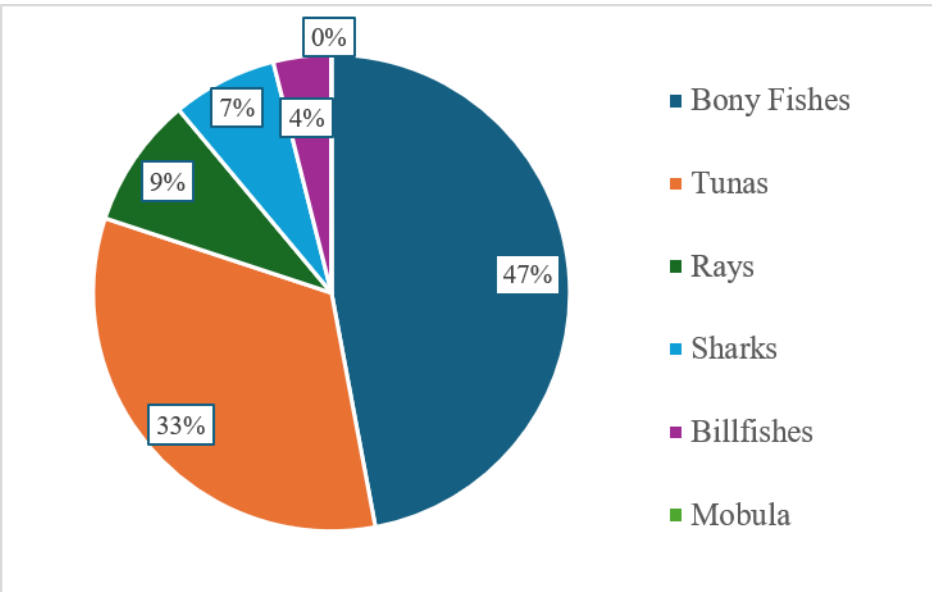

Figure 1. Percentage of fish groups caught by longline

According to observer data from 2005 to 2021, a total of 4,763 individual sharks across 18 taxa were recorded in longline catches (Table 1). Composition was heavily dominated by the blue shark (*Prionace glauca*/BSH) with 2,626 individuals (55.13%), followed by the crocodile shark (*Pseudocarcharias kamoharai*/PSK) with 1,387 individuals (29.12%). Together, these two species accounted for 84.25% of all landed sharks. The next dominant species were the silky shark (*Carcharhinus falciformis*/FAL) with 120 individuals (2.52%), shortfin mako (*Isurus oxyrinchus*/SMA) with 109 individuals (2.29%), oceanic whitetip shark (*Carcharhinus longimanus*/OCS) with 96 individuals (2.02%), and spinner shark (*Carcharhinus brevipinna*/CCB) with 78 individuals (1.64%). Thus, BSH and PSK represent the primary components of shark catches in this fishery.

Table 1. Shark species composition in longline catches and release condition

No	Species	FAO Code	Number	%	Release Condition Details*
1	*Prionace glauca*	BSH	2,626	55.13	A5: 757, A4: 8, A1: 5, A0: 4, A2: 3, A3: 1
2	*Pseudocarcharias kamoharai*	PSK	1,387	29.12	A5: 762, A2: 97, A4: 91, A1: 8, A3: 6
3	*Carcharhinus falciformis*	FAL	120	2.52	A5: 21, A4: 10, A3: 9, A2: 7, A1: 5
4	*Isurus oxyrinchus*	SMA	109	2.29	A5: 62, A4: 2, A1: 2, A3: 1
5	*Carcharhinus longimanus*	OCS	96	2.02	A5: 23, A1: 1, A2: 1
6	*Carcharhinus brevipinna*	CCB	78	1.64	A5: 13, A2: 2
7	*Scylliogaleus quecketti*	TSK	69	1.45	A5: 18, A3: 6, A4: 2
8	*Alopias superciliosus*	BTH	67	1.41	A5: 23, A4: 3, A3: 2, A1: 1
9	*Isistius brasiliensis*	ISB	48	1.01	A5: 41, A2: 3, A3: 1
10	*Lamnidae*	MSK	45	0.94	A5: 11, A2: 6
11	*Selachimorpha*	SKH	29	0.61	A4: 2, A5: 1, A2: 1
12	*Isurus paucus*	LMA	24	0.50	A5: 8, A3: 2
13	*Alopias pelagicus*	TSP	18	0.38	A5: 2
14	*Sphyrnidae*	SPY	14	0.29	A5: 3
15	*Galeocerdo cuvier*	TIG	11	0.23	A5: 5
16	*Carcharhinus limbatus*	CCL	9	0.19	A5: 2
17	*Sphyrna zygaena*	SPZ	8	0.17	A5: 4
18	*Carcharhinus plumbeus*	CCP	5	0.10	A4: 1
	Total		**4,763**	**100**	

* Release Condition Code: A0: Unknown / Unclassified release state, A1: Released alive – Good condition / Active, A2: Released alive – Injured / Weakened, A3: Released alive – Severely injured, A4: Released dead / Moribund, A5: Cut free / Escaped / Released with hook/line attached, Unrecorded: Release condition status not logged by observer.

The dominance of BSH and PSK is related to the characteristics of longline gear and its operational grounds. Tuna longlines utilize numerous hooks deployed throughout the water column in open ocean waters, creating a high probability of interacting with pelagic and oceanic sharks that exhibit wide home ranges and feed on pelagic teleosts. BSH is a widely distributed oceanic shark inhabiting open waters, whereas PSK is associated with high-seas and relatively deep waters. SMA and OCS are also pelagic predators that interact with longlines when attracted to bait or target species near the hooks. This composition demonstrates that longline operations in oceanic fishing grounds maintain substantial interaction with pelagic predator communities.

Release condition records indicate that a major portion of captured sharks were released. The A5 condition code was the most frequently logged category, particularly for BSH (757 individuals), PSK (762 individuals), SMA (62 individuals), OCS (23 individuals), FAL (21 individuals), and CCB (13 individuals). Aside from A5, conditions A4 and A1 were also recorded in moderate numbers across several species. This suggests that release practices form an integral part of shark bycatch handling on longliners. However, variations in individual condition upon release warrant attention, as physical state directly influences post-release survival rates. Shark bycatch management should maintain consistent release condition logging to support evaluations of post-capture mortality and release mitigation efficacy. Out of 4,763 recorded sharks, 2,049 individuals (43.02%) had documented release condition status. Category A5 represented the most dominant condition, totaling 1,756 individuals (36.87% of total catch), followed by A2 (120 individuals; 2.52%), A4 (119 individuals; 2.50%), A3 (28 individuals; 0.59%), A1 (22 individuals; 0.46%), and A0 (4 individuals; 0.08%). Meanwhile, 2,714 individuals (56.98%) lacked logged release condition information.

Species Co-occurrence and Catch Correlation

Based on the co-occurrence matrix (presence/absence) of species plot (Figure 2), interspecific co-occurrence analysis within individual fishing sets demonstrates clear habitat associations and spatial segregation patterns. The silky shark (FAL) and oceanic whitetip shark (OCS) pair recorded the highest positive co-occurrence value at 0.37, followed by FAL with shortfin mako (SMA) at 0.34, and albacore (ALB) with blue shark (BSH) at 0.34. These elevated values among pelagic sharks and between albacore tuna and BSH indicate significant operational overlap and shared environmental preferences across tropical and subtropical zones. Stable positive co-occurrence patterns were also observed in other pelagic shark pairs, such as BSH–OCS (0.29), SMA–OCS (0.28), and ALB–PSK (0.26). Conversely, the strongest negative co-occurrence was observed between southern bluefin tuna (SBF) and FAL (-0.17), signaling environmental separation or thermal water preference segregation, where SBF inhabits colder waters while FAL prefers warmer conditions. Other negative values, such as BET–OCS (-0.13) and ALB–BET (-0.03), indicate that interactions between these pairs tend to be mutually independent.

Overall, most pelagic species particularly sharks like FAL, OCS, BSH, and SMA exhibit statistically positive co-occurrence with one another and with Albacore tuna (ALB). This underscores a high potential for interaction and shark bycatch risk during pelagic tuna longline operations. On the other hand, the negative association between SBF and FAL confirms distinct geographical distribution and water mass preferences among these species.

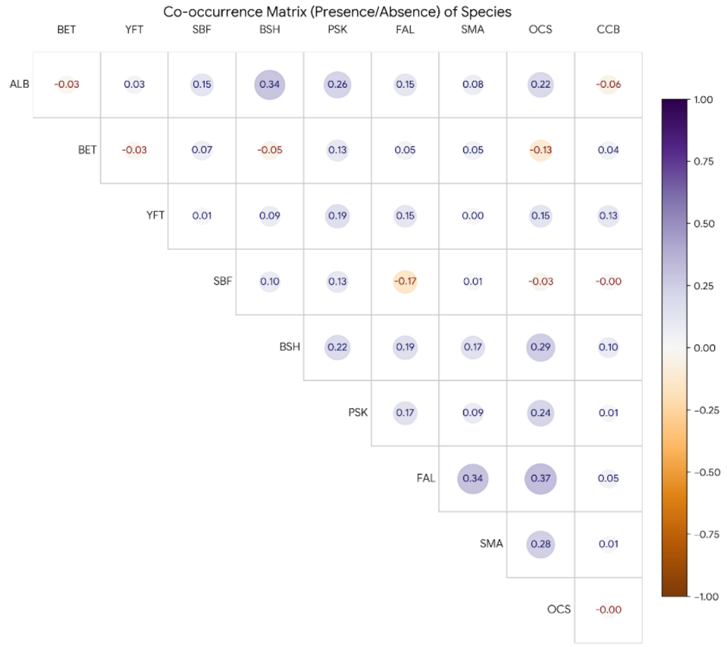

Figure 2. Co-occurrence matrix (presence/absence) of species

Based on the Spearman rank correlation matrix (Spearman Correlation of Species Catch Counts per Fishing Set) shown in Figure 3, the analysis of rank correlation coefficients (ρ) reveals quantitative variations in catch abundance relationships per fishing set. The highest positive correlations occurred in ALB–PSK ($\rho = 0.46$) and BSH–OCS ($\rho = 0.46$), followed by ALB–BSH ($\rho = 0.41$). These significant positive values indicate that higher Albacore (ALB) catch volumes are strongly associated with increased catches of pelagic sharks and rays, such as blue shark (BSH) and pelagic stingray (PSK). This phenomenon reflects shared habitat utilization across epipelagic and upper mesopelagic zones, as well as shared vulnerability to longline gear configurations.

Furthermore, positive co-associations recorded among tropical pelagic sharks, such as FAL–OCS ($\rho = 0.39$), BSH–SMA ($\rho = 0.34$), and FAL–SMA ($\rho = 0.33$), confirm the existence of a cohesive elasmobranch assemblage structure. In contrast, negative correlations were observed in SBF–FAL ($\rho = -0.21$) and ALB–CCB ($\rho = -0.12$). The negative correlation between Southern Bluefin Tuna (SBF) and Silky Shark (FAL) highlights oceanographic preference differences, where SBF inhabits lower-temperature water masses (subantarctic/subtropical), whereas FAL is a stenothermal species favoring warm tropical waters. Correlation values near zero in pairs like YFT–CCB ($\rho = 0.01$) and BET–SBF ($\rho = 0.02$) indicate independent abundance fluctuations during fishing operations.

This Spearman rank correlation matrix confirms that primary pelagic tuna catch abundance (particularly Albacore) shares a positive quantitative association with pelagic elasmobranch bycatch (BSH, PSK, and OCS). This verifies that co-extraction patterns in longline gear are heavily driven by shared vertical and horizontal habitat preferences, whereas negative correlations such as SBF–FAL reflect ecological niche partitioning regulated by oceanographic temperature gradients.

In the matrix shown in Figure 4, visualization and complete analysis of species co-occurrence and catch correlation between elasmobranch groups (BSH, PSK, FAL, SMA, OCS, CCB) and the most consistently positively correlated non-tuna dominant teleosts, namely swordfish (*Xiphias gladius* [SWO]) and wahoo (*Acanthocybium solandri* [WAH]), are presented. Excluding tuna species (ALB, BET, SBF, YFT, SKJ), the non-tuna dominant species exhibiting consistent positive associations across all elasmobranchs are swordfish (SWO) and wahoo (WAH).

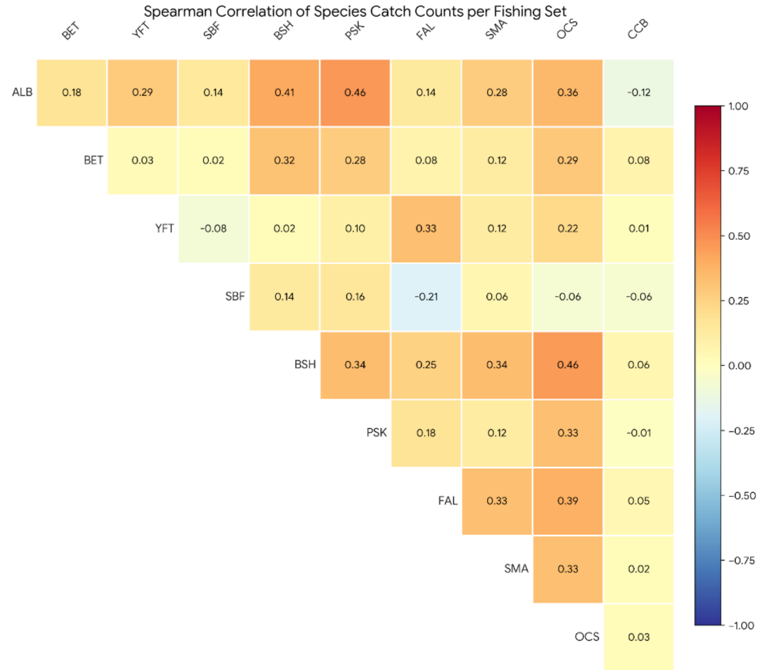

Figure 3. Spearman correlation of species catch counts per fishing set

Based on the co-occurrence matrix (presence/absence), SWO showed positive co-occurrence with all pelagic shark and ray groups, recording its highest associations with blue shark (*Prionace glauca* [BSH]) at 0.42 and pelagic stingray (*Pteroplatytrygon violacea* [PLS]) at 0.39, followed by oceanic whitetip shark (*Carcharhinus longimanus* [OCS]) at 0.22, silky shark (*Carcharhinus falciformis* [FAL]) at 0.15, spinner shark (*Carcharhinus brevipinna* [CCB]) at 0.13, and shortfin mako (*Isurus oxyrinchus* [SMA]) at 0.08. Consistent with these presence patterns, Spearman rank correlation analysis (ρ) of individual catch abundance showed that higher SWO catch counts correlated most strongly with PSK ($\rho = 0.50$), BSH ($\rho = 0.41$), and OCS ($\rho = 0.34$), alongside moderate to weak positive correlations with SMA ($\rho = 0.19$), FAL ($\rho = 0.13$), and CCB ($\rho = 0.03$).

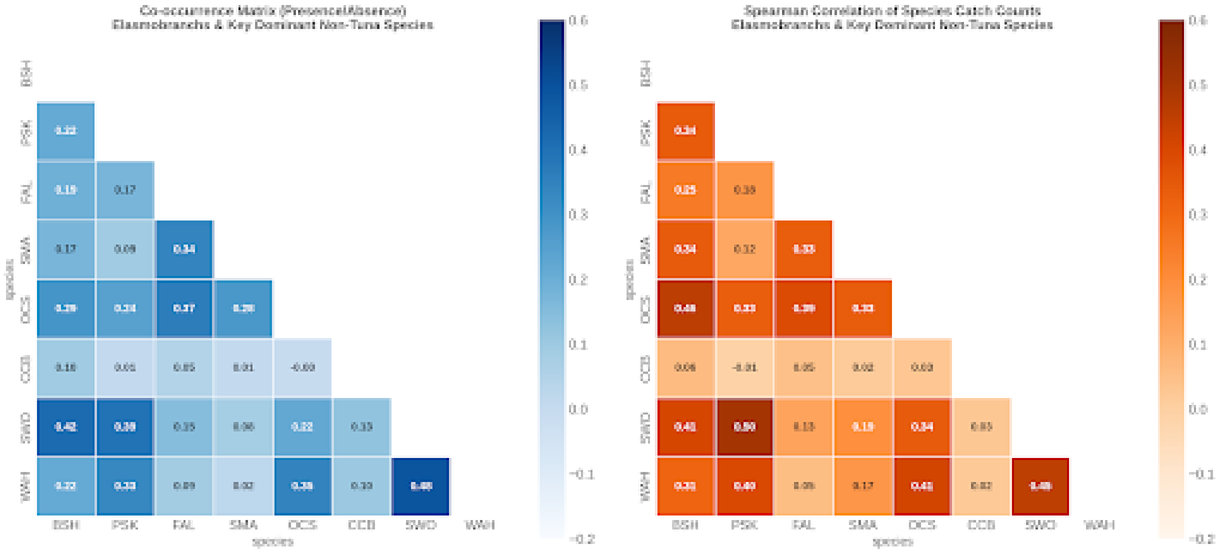

Figure 4. Species co-occurrence and catch correlations among sharks caught by longliners

In addition to SWO, wahoo (WAH) also demonstrated positive correlation trends across all elasmobranch groups, with abundance correlation peaking alongside OCS ($\rho = 0.41$) and PSK ($\rho = 0.40$). These persistent positive co-occurrence and abundance correlations indicate that fishing grounds rich in major pelagic teleost species function as high-interaction zones for shark and ray bycatch. Consequently, sustainable fishery management strategies must address these co-extraction risks in an integrated manner.

Length Frequencies

Length frequency analysis revealed that *Prionace glauca* (BSH) ranged from 26.0 to 312.0 cm in total length, with a mean of 156.9 cm and a modal interval at 170–180 cm. *Pseudocarcharias kamoharai* (PSK) exhibited a length range of 26.0–152.0 cm, averaging 80.0 cm with a modal interval of 80–85 cm. *Carcharhinus falciformis* (FAL) ranged from 31.0 to 231.0 cm, with a mean of 122.6 cm and a mode at 70–80 cm. Furthermore, *Isurus oxyrinchus* (SMA) spanned 28.0–398.0 cm, averaging 115.8 cm with a modal interval at 70–80 cm. *Carcharhinus longimanus* (OCS) ranged between 26.0 and 251.0 cm, with a mean of 140.1 cm and a mode at 140–160 cm, while *Carcharhinus brevipinna* (CCB) fell within 42.0–230.0 cm, with a mean of 133.6 cm and a modal interval of 130–140 cm (Figure 5).

The length distributions for most species did not conform to a normal distribution curve, exhibiting bimodal (*P. glauca*), right-skewed (*I. oxyrinchus*), or multimodal patterns (*C. falciformis*, *C. longimanus*, *C. brevipinna*). This outcome is attributed to a combination of limited sample sizes ($N < 120$ for species other than BSH and PSK) and pelagic longline gear selectivity, including the influence of hook size, bait type, and hook setting depth. Additionally, biological factors such as spatial and age-class habitat segregation (where juvenile and mature individuals occupy distinct water depths or geographic regions) prevent complete cohort structures from being captured uniformly on board, with the exception of *P. kamoharai*, which inhabits mesopelagic layers homogeneously and thus displays a near-normal distribution curve (Figure 5).

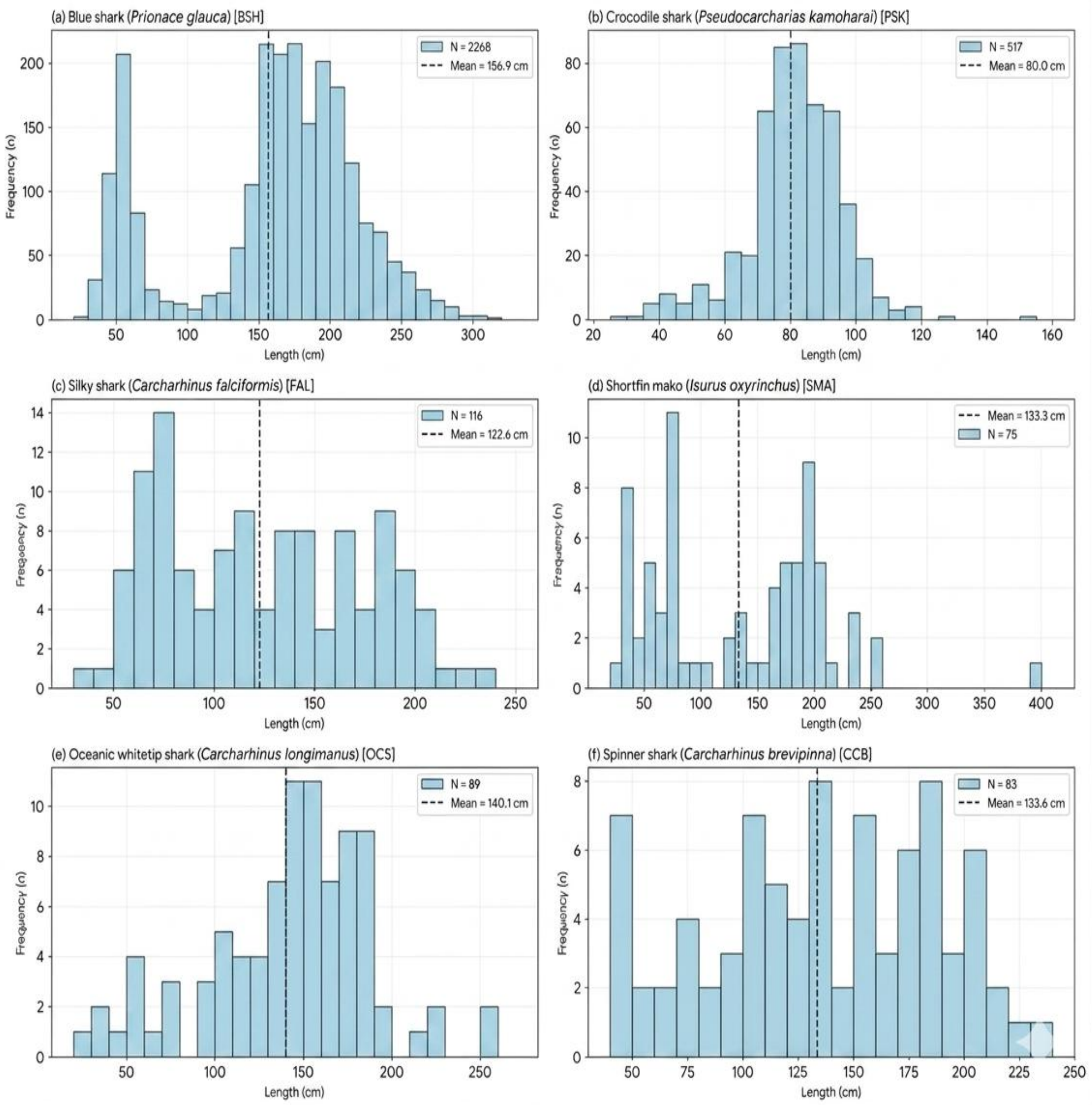

Figure 5. Length frequency distribution of sharks caught by longline

Size-Class Spatial Distribution Analysis

The results of spatial analysis of all pelagic shark species (BSH, FAL, OCS, PSK, SMA, and CCB) indicate the presence of consistent size segregation in the Indian Ocean. In general, small juvenile individuals are concentrated in the northern coastal waters (West of Sumatra and South of Java) as nursery grounds, while large adult individuals dominate the southern offshore waters (10°S–35°S). An exception is the shortfin mako (SMA), which exhibits the opposite pattern, with juveniles found in the cold southern waters and adults in the northern tropical zone (Figure 6). Small or juvenile sharks are abundant in coastal waters because these areas provide an abundant food supply suited to their mouth size, such as small pelagic fish and coastal squid. Additionally, the shallow coastal structure serves as natural protection from larger pelagic predators.

This habitat separation is driven by the interaction between food availability, size-based dietary shifts (ontogenetic shift in diet), and predator avoidance. Warm, primary-productivity-rich coastal waters provide an abundance of small prey (squid and small pelagic fish) that are safe for juveniles. The concentration of adult sharks in these zones is also driven by differences in water temperature preferences (such as the endothermic nature of SMA or the differentiation between cold and warm water masses) as well as the use of oceanic zones as migration routes and breeding grounds.

High shark abundance is also driven by oceanographic dynamics such as upwelling zones and nutrient-rich thermal fronts. High shark abundance is also driven by oceanographic dynamics, such as upwelling zones and nutrient-rich thermal fronts. However, there is a distinct time lag between the upwelling event and the peak of shark abundance, as it takes time for primary productivity to bloom, aggregate small pelagic fish, and ultimately attract top predators. The concentration of adult sharks at these specific locations is driven by an ontogenetic shift in diet toward high-energy prey such as tuna and billfish, and is supported by their strong swimming ability and tolerance for open-ocean water temperatures. This indicates that shark catches at specific locations result from a comprehensive interaction of habitat overlap, the abundance of primary prey, the species physiological adaptations, and the selectivity and attractiveness of longline bait.

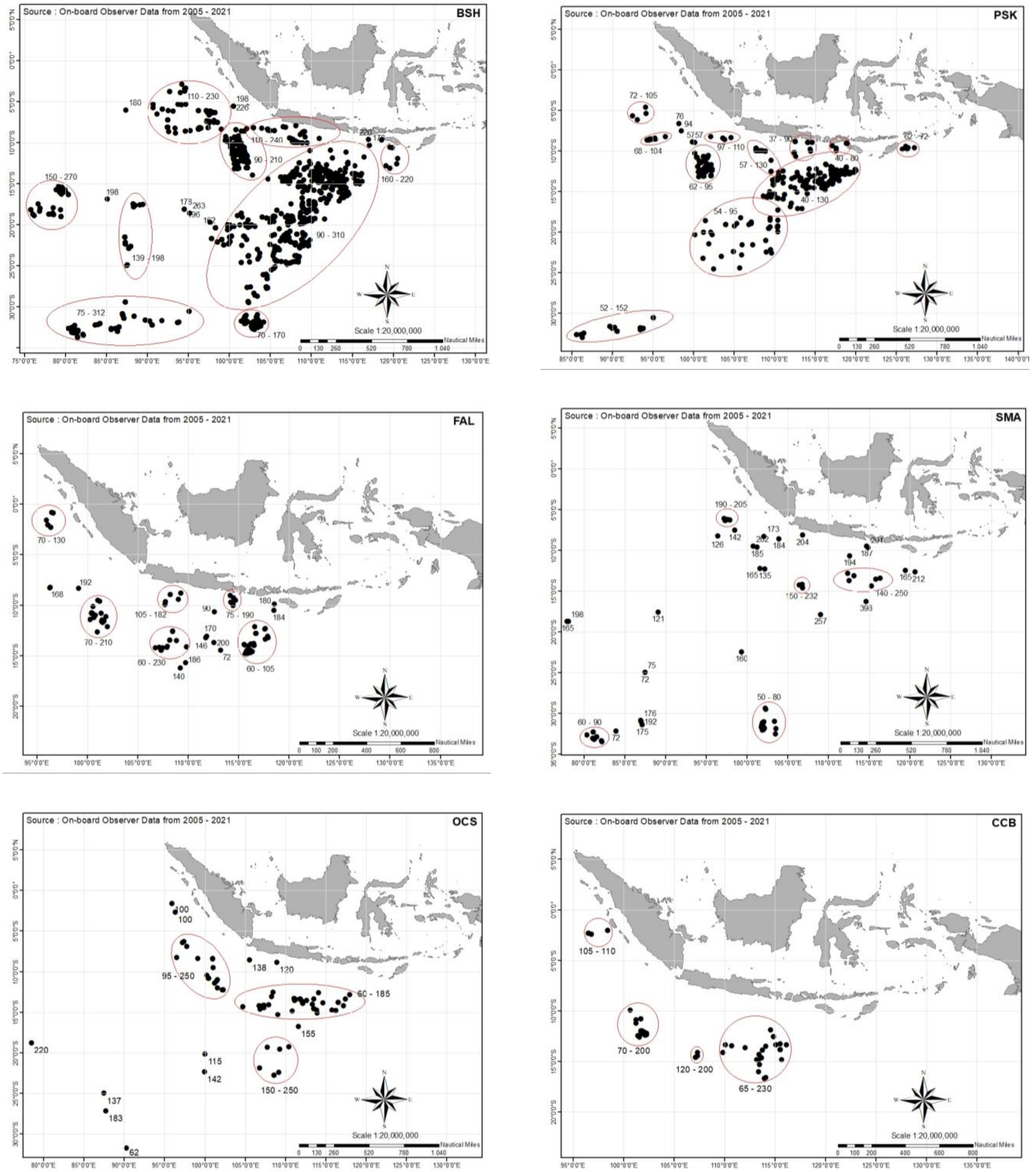

Figure 6. Spatial distribution map of dominant sharks by size class

Conclusion

The results of the study show that sharks accounted for 7.13% (4,763 individuals from 18 taxa) of the total catch by the Indonesian tuna longline fleet in the Indian Ocean (2005–2021), with *Prionace glauca* (55.13%) and *Pseudocarcharias kamoharai* (29.12%) being the most dominant species. Species interaction analysis confirmed strong interactions between pelagic sharks and *Thunnus alalunga, Xiphias gladius, Pteroplatytrygon violacea, and*

Acanthocybium solandri, as well as temperature-based habitat segregation between *Carcharhinus falciformis* and *Thunnus maccoyii*. The length frequency distributions of most species exhibited non-normal (bimodal/multimodal) patterns influenced by gear selectivity, spatial segregation, and limited sample size. Spatial size segregation was consistently identified, with juvenile individuals concentrated in northern coastal waters (West Sumatra and South Java) as nursery grounds, while adult individuals dominated the southern offshore region (10°S–35°S), except for *Isurus oxyrinchus*, which exhibited the opposite pattern. Overall, these findings provide scientific evidence that is expected to serve as the basis for developing strategies for shark bycatch management and elasmobranch conservation within the IOTC's area of jurisdiction.

Acknowledgment

This study is based on routine observer data collected aboard commercial tuna longline vessels operating in the Indian Ocean between 2005 and 2021, under the Research Institute for Tuna Fisheries program. The authors extend their sincere gratitude to all the onboard observers for their dedication in recording the longline catch data.

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Shark Species Composition and Size Distribution of Indonesian Longline Fisheries Operating in the Indian Ocean

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Purpose, expectation and action intended (select one or more and include corresponding text)

Discussions (for information and open discussion):

[The paper is to inform meeting members that…, as set out in Section X]

Feedback (to collect input and suggestions)

[The paper is to request review and comments on…, as set out in Section X]

Conclusion (to record a concluded position or summary)

[The paper is to seek confirmation that…, as set out in Section X]

Recommendation (to ask the meeting to endorse a recommendation)

[The paper is to seek endorsement on…, as set out in Section X]

Decisions (to request formal approval of actions)

[The paper is to seek approval on…, as set out in Section X]

Abstract

Shark bycatch in tuna longline fisheries in the Indian Ocean is a major concern in sustainable fisheries governance. This study aims to identify species composition, analyze co-occurrence associations, and evaluate the length-frequency structure of dominant shark species caught by the Indonesian tuna longline fleet in the Indian Ocean. Data were collected through an onboard commercial vessel observer program from 2005 to 2021. Out of a total of 66,850 caught individuals, the shark group contributed 7.13% (4,763 individuals across 18 taxa). Shark composition was heavily dominated by the blue shark (*Prionace glauca*; 55.13%) and crocodile shark (*Pseudocarcharias kamoharai*; 29.12%), followed by the silky shark (*Carcharhinus falciformis*; 2.52%), shortfin mako (*Isurus oxyrinchus*; 2.29%), oceanic whitetip shark (*Carcharhinus longimanus*; 2.02%), and spinner shark (*Carcharhinus brevipinna*; 1.64%). Co-occurrence analysis and Spearman rank correlation revealed high epipelagic-mesopelagic habitat overlap between pelagic sharks and albacore (*Thunnus alalunga*), swordfish (*Xiphias gladius*), and wahoo (*Acanthocybium solandri*), whereas a negative correlation between southern bluefin tuna (*Thunnus maccoyii*) and silky sharks reflected thermal water segregation. The mean total length recorded was 156.9 cm (BSH), 80.0 cm (PSK), 122.6 cm (FAL), 115.8 cm (SMA), 140.1 cm (OCS), and 133.6 cm (CCB). Most size distributions exhibited non-normal patterns (bimodal/multimodal) due to gear selectivity and spatial/depth habitat segregation. Pelagic sharks in the Indian Ocean exhibit consistent size segregation: juveniles utilize coastal waters as nursery grounds for food and protection, while adults inhabit offshore waters, except for the shortfin mako which displays an inverted pattern.These findings are expected to support effective shark bycatch management and elasmobranch conservation in the IOTC area.