Blue shark (*Prionace glauca*) bycatch in tuna longline fishery in Sri Lanka

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Growing conservation concerns have arisen for sharks due to their high vulnerability to the tuna longline fishery. The Blue shark (*Prionace glauca*) is commonly identified as a bycatch species associated with the tuna longline fishery in Sri Lanka. However, there is a paucity of species-specific data on blue shark landings in Sri Lanka. Therefore, the present study aims to assess key fisheries aspects and reproductive features, including bycatch composition, Catch-per-Unit-Effort (CPUE), the effect of bait and hook type, length distribution, sex ratio, and spatial distribution of blue sharks based on data collected from port sampling, logbooks, and the observer programme from 2020 to 2023. A total of 218 male (102-310 cm TL) and 209 female (113–298 cm TL) blue sharks were studied. The results indicated that blue sharks (43%) were the second most dominant species, followed by Silky shark (33.1%) and Shortfin Mako shark (8.3%). The maximum nominal CPUE value was 0.16 in 2023, subject to variations related to fishing operations. J hooks contributed to the highest CPUE (1.8 indi/1000 hooks), while squid and "other" bait types were identified as the dominant baits, influencing blue sharks entangling in longlines. The length frequency distribution was normal. The sex ratio among the samples was approximately 1:1. Maturity stages were analyzed solely for male sharks based on clasper length and calcification. Clasper length of mature males was greater than 12 cm. The highest percentage of sexually mature male sharks was recorded in March and September-October each year.

Keywords: Blue sharks, bycatch, Sri Lanka, length distribution, Nominal CPUE

1. Introduction

The blue shark (Prionace glauca) belongs to the family Carcharhinidae, is a highly migratory species, spending most of their lifetime in high-sea areas and exhibiting a circumpolar distribution. Its distribution and migratory patterns depend on water temperature, food availability, and reproductive conditions (Nakano & Stevens,2008; Zhu & Richard, 2023), and are usually caught at the depths of 75-445m while larger individuals (>180cm FL) are more common in deeper waters (>300m). Although they are highly abundant, fast growing and the most fecund shark species compare to other pelagic sharks. their populations have declined due to frequent interactions with longlines targeting tuna, swordfish and purse seines, while increasing fishing pressure in various oceanic regions, due to their commercial value, particularly for shark fins (Mejuto, J. (1985), and leads to substantial by-catch an sometimes exceeding target catches in volumes (Sulaiman et al., 2018; Jordaan et al., 2020).

It has become a complicated situation to estimate the population's status as a result of inconsistent and a lack of species-specific data on blue sharks (Jordaan, 2018; Smale, 2008). Research has found that the Western Indian Ocean has a high impact due to the high levels of longline fishing activities. Therefore, effective management measures need to be implemented (Rochman et al., 2021). However, blue sharks are still classified as Near Threatened and exhibit a decreasing population trend. In the Indian Ocean context, the blue shark stock was estimated as not overfished and not subject to overfishing in 2021. Further, circle hooks have less at-vessel mortality compared to the J shape hooks (Godin et al., 2012) . The sustainability of blue shark populations in this area has raised concerns, requiring a closer look at their life history, distribution patterns, and the effects of fishing practices.

Sri Lanka is one of the dominant countries in the Northern Indian Ocean, engaging in a tuna fishery using multi-day longline vessels that target Yellowfin and Bigeye tuna year-round. According to the NPOA Shark 2018-2022, sharks make a significant contribution as non-directed catches of these multiday-longline vessels. The blue shark is the dominant shark species recorded between 2014 and 2017, accounting for 45.5% of longline shark landings (NPOA-2018-2022). Despite this, national-level statistics on species-specific information of blue shark interactions with tuna longline fleets, as well as data on size composition and spatio-temporal patterns, remain to be

addressed. This study has designed to address the species-specific fisheries and biological data on blue shark landings in major fishery harbours in Sri Lanka from 2020 to 2023

Methodology

This study used data collected from 2020 to 2023 during port sampling at major fishing harbours in Sri Lanka. Catch and effort data were obtained directly from the fishers, species, and morphometric measurements, including total length, fork length, gutted weight, sex and clasper length of male blue sharks were measured. Logbook data from the Department of Fisheries and Aquatic Resources, fishing locations from the Vessel Monitoring System (VMS), and shark landing data from the observer program were also included in the analysis.

Data Analysis

Species composition was estimated using the percentage of blue shark individuals compared to other sharks. Catch Per Unit Effort was estimated as the number of blue sharks per 1000 hooks per fishing trip. The number of individuals per set could not be calculated due to practical limitations. Length-frequency distribution was estimated by plotting the monthly average length for both male and female blue sharks separately. Verified fishing locations were plotted using QGIS.

Results

8 species of sharks were recorded during the study period as the bycatch of tuna longlines in Sri Lanka. (Table 1). Blue shark was the dominant species (43%) followed by the Silky shark (, Shortfin Mako shark (8%) and the Tiger shark (3.2%).

Table 1: List of shark species recorded during the survey and percentage composition of species

Scientific name	Common Name	Percentage composition (%)
Prionace glauca	Blue shark	43
Carcharhinus falciformis	Silky shark	33.2
Isurus paucus	Shortfin Mako shark	8.1
Isurus oxyrinchus	Longfin Mako shark	8
Sphyrna lewini	Scalloped Hammerhead shark	3.2
Galeocerdo cuvier	Tiger shark	3
Carcharhinus leucas	Bull shark	1.1
Sphyrna zygaena	Smooth Hammerhead shark	0.4

Catch Per Unit Effort (CPUE) of the Blue sharks showed lower values in 2020 and 2021. It indicates the variable abundance with higher and lower catches. Peak seasons can be observed after the August 2021 and the highest CPUE was recorded in July 2023.
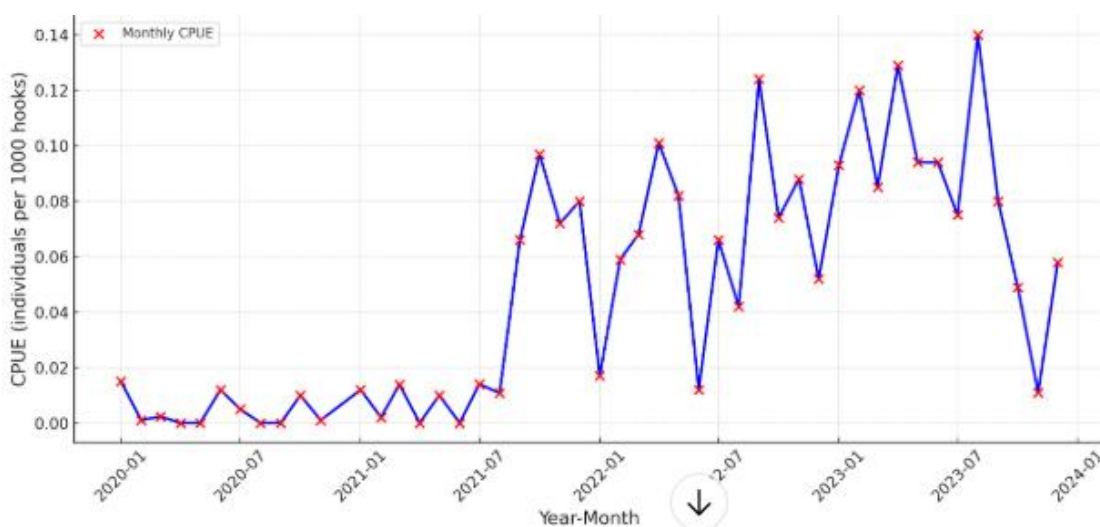

Figure 1: Monthly CPUE variation of Blue sharks landings in major fishery harbours

During the study period, a significant increment or decrease cannot be observed. Hence, blue shark landing can be identified as regular in the landings and vary throughout the year with some seasonal fluctuations.

During the survey period, 218 male blue sharks and 209 female blue sharks were landed and measured. The total length range for males was 102-310 cm, while for females it was 113-298 cm. The majority of male blue sharks had lengths between 160-220 cm, and for females, this range was between 150-210 cm. Compared to both males and females, a smaller number of individuals below 140cm were recorded. But, male blue sharks in >250cm length range was recorded higher compare to the female.
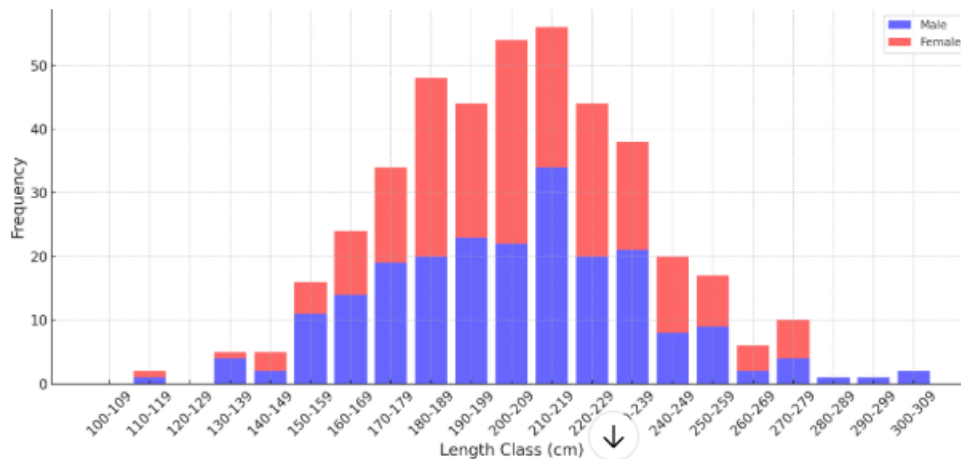

Figure 2: Length frequency distribution of both male and female Blue sharks recorded during the study period

During the years 2020 and 2021, fewer individuals were recorded, and there were zero catches in several months. Limitations to access to the fishery harbours and fishing activities during the COVID-19 situation could be one reason for this type of lower recordings. Length frequency distribution showed irregular and lower values compared to other years. A minimal number of male blue sharks were recorded and not significant in the graphs. In 2021, length frequencies were dominated by the juveniles and sub-adults, while a smaller number of larger individuals were present. But, in 2022, blue shark landings showed a consistent pattern throughout the year for both male and female blue sharks. In 2023, a significant seasonal pattern could be observed in March, September and October with peak seasons. During the peak seasons, both mature and immature blue sharks were recorded in different length classes.
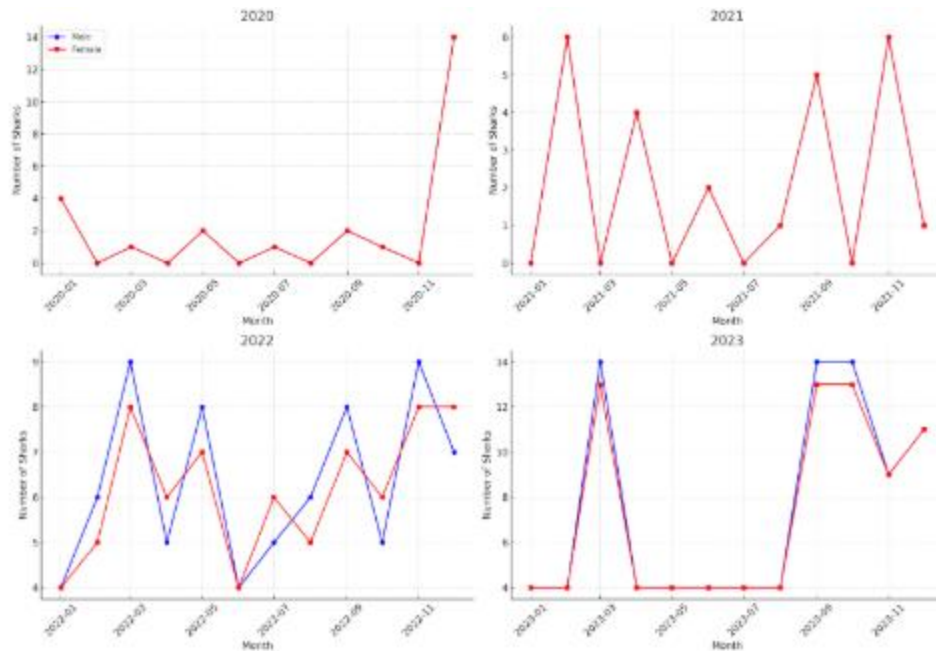
Figure 3: Length frequency distribution pattern in different years from 2020 to 2023.

Discussion

The low and variable CPUE values resulted during the study period (<0.0 individuals per 1000hooks), and this type of fluctuation can be identified as the incidental by-catch that can show fluctuations throughout the year. This type of insignificant long-term trend has been observed in previous studies in the Indian Ocean region, also where CPUE variability has been attributed to the fishing activities, target species and market values for the shark products in different seasons in different years. The reason for the peak seasons could be linked to the migratory patterns of blue sharks or their breeding cycles (Nakano & Stevens, 2008).

Length frequency analysis revealed a wide size range for the blue sharks, but a more limited size range for males (102-310 cm) compared to female sharks, and both sexes showed a modal length class of 160-200 cm, which dominated the sub-adult individuals. However, larger mature individuals were recorded in smaller numbers, and this size structure is typical for the longline fishery, where juveniles and sub-adults are highly vulnerable. Male blue sharks included small sizes and larger sizes, showing some degree of sexual segregation in habitat use (Verissimo et al.,2017).

The prevailing COVID-19 pandemic situation restricted access to the landing site and fishing operations in 2020 and 2021. That was a reason to record fewer landings, and after 2022, more consistent landings can be attributed to favourable environmental conditions and good market demand for shark products. Underreporting and variations in logbook accuracy can also influence the observed patterns in 2020 and 2021. Therefore, strengthening the logbook recording and observer program is important.

The dominance of sub-adults in catches highlights concerns about population sustainability, as the heavy exploitation of immature sharks decreases the population growth. Therefore, implementation of fishing regulations for the peak seasons of immature shark landings is crucial, but after analysing long-term data.

References

Clarke, S. C., Magnussen, J. E., Abercrombie, D. L., McAllister, M. K., & Shivji, M. S. (2006). Identification of shark species composition and proportion in the Hong Kong shark fin market based on molecular genetics and trade records. *Conservation Biology*, *20*(1), 201-211.

Dulvy, N. K., Baum, J. K., Clarke, S., Compagno, L. J., Cortés, E., Domingo, A., ... & Valenti, S. (2008). You can swim but you can't hide: the global status and conservation of oceanic pelagic sharks and rays. *Aquatic conservation: marine and freshwater ecosystems*, *18*(5), 459-482.

Jordaan, G. L., Santos, J., & Groeneveld, J. C. (2018). Effects of inconsistent reporting, regulation changes and market demand on abundance indices of sharks caught by pelagic longliners off southern Africa. *PeerJ*, *6*, e5726.

Nakano, H., & Stevens, J. D. (2008). The biology and ecology of the blue shark, *Prionace glauca*. In M. D. Camhi, E. K. Pikitch, & E. A. Babcock (Eds.), *Sharks of the open ocean: Biology, fisheries and conservation* (pp. 140–151). Oxford: Blackwell Publishing.

Smale, M. J. (2008). Pelagic shark fisheries in the Indian Ocean. *Sharks of the open ocean: biology, fisheries and conservation*, 247-259.

Sulaiman, P. S., Patria, M. P., & Sue, R. A. (2018). The shark by-catch of tuna longline fisheries in Southern Indian Ocean of Java, Indonesia. In *E3S Web of Conferences* (Vol. 74, p. 02004). EDP Sciences.

Zhu, J., Geng, Z., Zhu, J., & Richard, K. (2023). Reproductive biology and population dynamics of the blue shark (*Prionace glauca*) in the Indian Ocean. *Frontiers in Marine Science, 10*, 1123456.