



[ASSESSING SEABIRD INTERACTIONS IN THE SRI LANKAN TUNA LONGLINE FISHERY: AN INTEGRATED ANALYSIS OF FISHERS' PERCEPTIONS, OBSERVER DATA, AND LOGBOOK RECORDS.]

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

This study presents the integrated assessment of seabird interactions with the Sri Lankan tuna longline fishery, with fisher's perception evaluated using a pre-structured questionnaire, observer program data (2020-2025) and fisheries logbook records (2020-2025).

Discussions (for information and open discussion):

Open Discussion

Feedback (to collect input and suggestions)

[Feedback for further improvement of the study is welcome]

Conclusion (to record a concluded position or summary)

This is a continuous study and based on the available information sea bird entanglements were not recorded.

Recommendation (to ask the meeting to endorse a recommendation)

[Further improvement of the monitoring, awareness and research is suggested.]

Decisions (to request formal approval of actions)

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

Abstract

Assessing Seabird Interactions in the Sri Lankan Tuna Longline Fishery: An Integrated Analysis of Fishers' Perceptions, Observer Data, and Logbook Records.

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Although Seabird interactions in tuna longline fisheries are a global conservation concern, information on Seabird interactions with tuna longline fisheries operating in the Northern Indian Ocean remains limited. This study presents the integrated assessment of seabird interactions with the Sri Lankan tuna longline fishery, with fisher's perception evaluated using a pre-structured questionnaire, observer program data (2020-2025) and fisheries logbook records (2020-2025). The target group assessed via the questionnaire survey was skippers engaged in the tuna longline fishery within the Sri Lankan EEZ and high seas. According to the logbook data, longline fishing operations were concentrated in three distinct regions: The Western- central Indian Ocean, the Southern Indian Ocean, and the Bay of Bengal. 57,399 sets from 19,259 fishing trips were analyzed. Longline sets deployed during the scientific observer programme were representative of the fishing areas selected for the analysis. No seabird entangling was recorded in the logbook for the 2020-2025 period, while observer data documented vessel-associated behavior of Seabirds but no confirmed hooking or entanglements. Petrels and Terns were the species commonly observed around fishing vessels, particularly under rough sea conditions, and frequently feeding on discarded fish offal. Sixty-three percent of respondents indicated that seabirds caused no disruptions to fishing operations and therefore did not consider seabird-related observations as requiring reporting. However, respondents demonstrated limited knowledge on the importance of recording seabird interactions (74.2% of respondents) and seabird identification at least up to major groups (81% of respondents). The study highlighted the importance of strengthening fisher awareness, species identification, monitoring and reporting systems to support evidence-based implementation of IOTC seabird conservation and bycatch mitigation measures.

Keywords: Seabird interactions, tuna longline fishery, northern Indian Ocean, Sri Lanka.

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1. Introduction

Incidental entanglement is a major source of mortality of pelagic seabirds, particularly whose foraging habitats are overlap with the commercial tuna longline fishing grounds (Anderson et al., 2011). The frequency of such incidents varies with the species composition and their foraging behavior, geographic locations, seasonal patterns, fishing practices, gear configurations and bait accessibility (Brothers et al., 1999; Gilman et al., 2016; Zhou et al., 2021). Albatrosses and large petrels are particularly susceptible because many species' foraging movements overlap with the fishing grounds and attract to fishing vessels to take bait from hooks during line setting or hooking (Gilman et al., 2007; Anderson et al., 2011; Pott & Wiedenfeld, 2017). Tracking studies and fisheries data indicate core breeding distributions of these seabirds are concentrated mainly south of 30°S, although non-breeding and juvenile birds may forage northward to approximately 20°S. This overlap increases the risk of interactions and mortality with longlines and decline the populations of Albatross and Petrels (Weimerskirch et al., 1997; Nel et al., 2003; Barbraud et al., 2008; Delord & Weimerskirch, 2011). Observer data of the Taiwanese longline fleet demonstrated a clear change in interaction rate with latitude and the bycatch was estimated at approximately 0.0158 birds per 1,000 hooks in the southern Indian Ocean compared with only 0.0002 birds per 1,000 hooks in tropical waters, with an estimated 311–715 seabirds captured annually during 2004–2008 (Huang & Liu, 2010). Japanese observer data also highlighted the seabird interactions predominantly in the southwestern and southeastern Indian Ocean, with Grey-headed Albatross (*Thalassarche chrysostoma*) most frequently recorded, followed by Black-browed, Indian Yellow-nosed, Shy and Wandering Albatrosses and White-chinned Petrel (*Procellaria aequinoctialis*) (Inoue et al., 2011).

Apart from the Southern Indian ocean, limited knowledge on Seabird interactions with pelagic longline fisheries in the Northern Indian Ocean. Tropical offshore waters support



a different seabird assemblage, including terns, boobies, frigate birds, shearwaters and petrels, whose vessel-associated and foraging behaviours differ from those of the Albatross (Mondreti et al. 2020). Mondreti et al. (2020) surveyed 4,722 km during 39 vessel-survey days and recorded 2,697 seabirds representing 17 species in the Bay of Bengal. The assemblage was dominated by Sooty Terns (*Onychoprion fuscatus*; 85%) and Wedge-tailed Shearwaters (*Ardenna pacifica*; 12%), while petrels, storm-petrels, boobies, tropicbirds, skuas and other terns occurred at much lower frequencies. However, that study primarily characterized seabird distribution and fishery overlap rather than direct longline capture rates. But, highlighted the seasonal variation in seabird occurrence and spatial overlap between pelagic seabirds and commercial longline fishing effort in the Bay of Bengal. In the northern Arabian Sea, a Flesh-footed Shearwater (*Ardenna carneipes*) was reported entangled in Pakistan's tuna drift-gillnet fishery and subsequently released alive (Moazzam & Nawaz, 2014). Direct evidence of seabird interaction with pelagic longline gear in the tropical northern Indian Ocean was recently reported from Lakshadweep, India, where at least two frigate birds were captured during offshore tuna longlining at approximately 10.6°N; one was released immediately, while an injured adult female Great Frigatebird (*Fregata minor*) was released after recovered (Aju et al., 2025). In the central Indian Ocean, observer monitoring of the Maldivian pole-and-line tuna fishery recorded only three seabird captures during 106 fishing days (Miller et al., 2017).

In Sri Lanka, information on seabird interactions with pelagic fisheries is limited. The fishery-based assessment conducted by Maldeniya et al. (2014) through port sampling and onboard observations from research cruises and commercial fishing vessels during 2013–2014 indicated no direct interactions with fishing gears. Nevertheless, quantitative information on seabird occurrence, vessel-associated behaviour and direct interactions with Sri Lankan tuna longliners operating on high-seas fishing grounds remains scarce, and no comprehensive assessment has subsequently integrated fisher observations with observer and commercial logbook information.

2. Methodology



2.1. Questionnaire Survey

An integrated approach combining fisher questionnaires, onboard observer data and commercial fishery logbooks was used to assess seabird interactions with the Sri Lankan tuna longline fishery during 2020–2025. The questionnaire survey targeted 300 skippers engaged in tuna longline fishing within the Sri Lankan Exclusive Economic Zone (EEZ) and high-seas fishing grounds. A pre-structured questionnaire was used to obtain information on fishing experience, principal fishing area, approximate mainline length, hook type and operational practices, together with skippers' observations of seabird occurrence and behaviour during fishing operations. Seabird-related questions addressed the major groups encountered around vessels, association with discarded fish and offal, influence of monsoonal and rough-sea conditions, spatial patterns of occurrence, direct hooking or entanglement, and observations of seabird interactions with fishing operations. The questionnaire further evaluated knowledge of seabird identification and interaction reporting and willingness to adopt seabird-friendly fishing practices. Responses of "unsure" were retained as an informative category where appropriate. Self-reported mainline length and related gear characteristics were considered approximate and were used primarily to characterize fishing operations rather than as precise measures of fishing effort. Vessel-associated behaviour, including seabird attendance and feeding on discarded fish or offal, was distinguished from direct gear interactions such as hooking or entanglement.

2.2. Logbook Records (2020-2025)

Logbook data were used to characterize the spatial and temporal distribution of fishing effort in the Sri Lankan tuna longline fishery. Individual fishing sets were used as the unit of analysis, with fishing effort expressed as the number of hooks deployed per set. Geographic coordinates were standardized to decimal degrees (WGS 84; EPSG:4326), and unreliable coordinates were excluded. The cleaned dataset comprised 57,399 sets from 19,259 fishing trips, representing 59,236,930 hooks. Fishing effort was summarized by the number of sets and trips, total hooks, and mean, standard deviation,



and median hooks per set. Spatial effort was mapped using fishing-set locations and hook numbers. Latitudinal effort distribution was summarized across five zones: north of 10°N, 0–10°N, 0–10°S, 10–20°S, and south of 20°S. Monthly fishing effort was summarized using the number of sets, trips, total hooks, and mean hooks per set.

2.3.Observer Records

Observer information was obtained from two complementary sources. Set-level electronic observer records were available for a subset of monitored longline trips and were used to quantify observed fishing effort, including the number of sets and hooks deployed. Annual DFAR observer-coverage summaries were additionally examined to characterize the broader temporal and spatial extent of observer deployment. Observer records were examined for reported seabird hooking, entanglement, or other direct fishing interactions. For digitized observer records, individual fishing sets were identified using the combination of vessel identifier, set date and set number. Fishing effort was expressed as the total number of hooks monitored across identifiable sets.

2.4.Statistical Analysis

Questionnaire responses were summarized using frequencies and percentages to describe each variable and for conditional questions, percentages were calculated using the number of applicable respondents. Variables with no variations, including entanglements and bird species identification, were summarized descriptively. Logbook and digitized observer data were summarized using the number of fishing sets, trips and hooks, with mean, standard deviation and median hooks per set calculated where appropriate. Spatial patterns of fishing effort and observer coverage were evaluated descriptively using fishing locations and mapped distributions. Monthly and latitudinal patterns in logbook fishing effort were summarized using the number and proportion of sets and hooks. Questionnaire, logbook and observer data sets were analysed separately. All the data sets were processed and analysed using R 4.4.1.

3. Results



A total of 300 fishers were interviewed across four major fishing harbours. Most respondents were from Negombo (62.3%), followed by Trincomalee (18.0%), Mirissa (16.7%), and Dondra (3.0%). The respondents were predominantly experienced fishers, with 79.3% reporting more than 10 years of fishing experience. High-seas fishing was reported by 59.7% of respondents, while 22.7% operated within the Sri Lankan EEZ and 17.7% operated in both areas. Longlines of 20–40 km was most common (50.0%), followed by >40 km (29.0%) and <20 km (21.0%). Circle hooks and J-hooks were used by 44.7% and 41.3% of respondents, respectively, while 14.0% reported using both hook types. Night-time setting was reported by 70.7% of respondents, whereas 29.3% reported no mitigation measures (Table 1).

Table 1: Summary of data on fishers and fishing operations obtained from the questionnaire survey

Characteristic	Category	n	%
Fishing harbour	Negombo	187	62.3
	Trincomalee	54	18.0
	Mirissa	50	16.7
	Dondra	9	3.0
Fishing experience	>10 years	238	79.3
	6–10 years	39	13.0
	1–5 years	23	7.7
Fishing area	High seas	179	59.7
	Sri Lankan EEZ	68	22.7
	Both EEZ and high seas	53	17.7
Longline length	<20 km	63	21.0
	20–40 km	150	50.0
	>40 km	87	29.0
Hook type	Circle hook	134	44.7



[IOTC-2026-WPEB22-11]

	J-hook	124	41.3
	Both	42	14.0
Night-time setting	Reported	212	70.7
	Not reported	88	29.3
Percentages were calculated using the total number of respondents (n = 300).			

212 respondents (70.7%) indicating that they had observed seabirds, while 88 (29.3%) reported no observations. Reported bird groups included boobies, terns, frigatebirds, and petrels/shearwaters, although 16.3% of respondents could not identify the birds they observed. Given respondents' generally limited seabird-identification capacity, bird-group observations were treated descriptively rather than used for species-specific analyses. 85.3% identified the EEZ as the area with greater seabird occurrence/interactions, compared with 14.7% identifying the high seas. This pattern was consistent irrespective of the respondents' own fishing area: 86.8% of those operating in both areas, 83.8% of EEZ fishers, and 85.5% of high-seas fishers identified the EEZ as the area of greater seabird occurrence or interaction. A strong monsoon influence on seabird occurrence or activity was reported by 43.0% of respondents, while 31.3% were uncertain and 25.7% reported no effect. Similarly, 45.7% increased seabird occurrence during rough-weather conditions, whereas 30.3% were uncertain and 24.0% reported no such effect. These responses represent fishers' observations of seabird presence or activity rather than confirmed gear interactions. 212 respondents who observed seabirds, 56.6% reported seeing birds feeding on discarded fish or offal, while 24.1% did not observe this behaviour and 19.3% were uncertain. Despite frequent observations of seabirds around fishing vessels and reported offal-feeding behaviour, none of the 300 respondents reported direct seabird hooking or entanglement. All respondents also indicated that line length or hook type did not influence seabird interactions. Seabird identification capacity was considered adequate among 16.0% of respondents, while 84.0% indicated a need for further identification training. Awareness of seabird-interaction reporting procedures showed a similar knowledge gap, with 21.3% demonstrating adequate awareness and 78.7% requiring further awareness or training.

63.7% expressed willingness to adopt seabird mitigation measures, while 22.3% were uncertain and 14.0% were unwilling (Fig. 1).

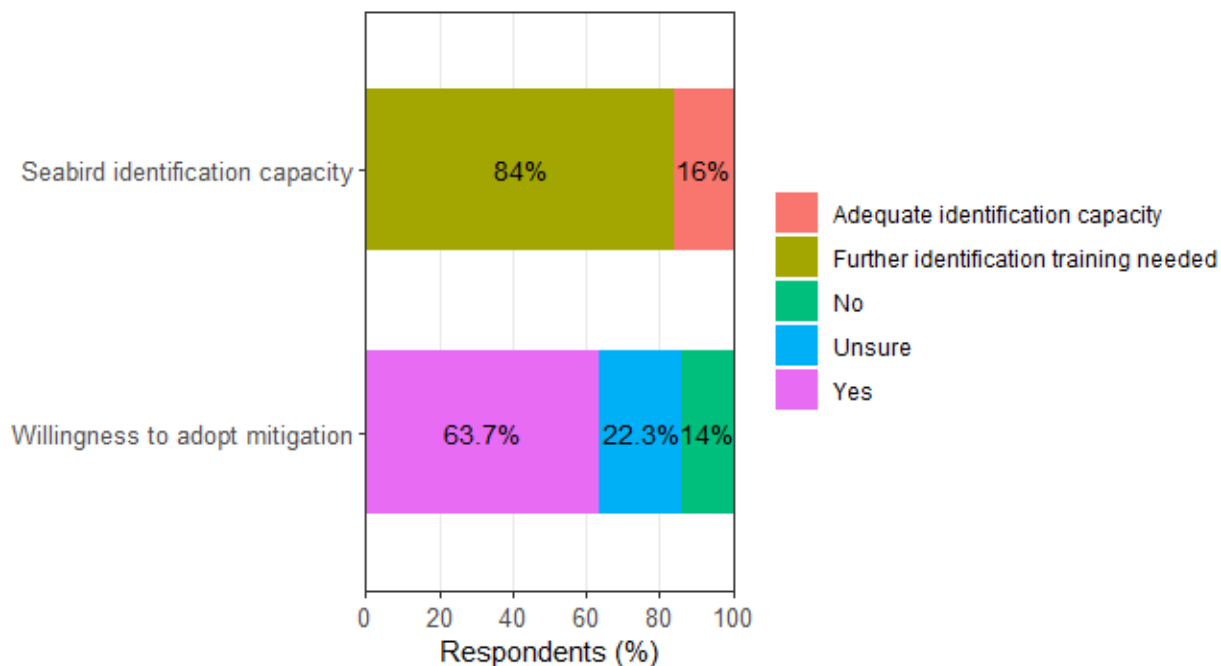


Figure 1: Identification capacity and the willingness to adopt seabird by-catch mitigation measures among the longline-operated fishers in Sri Lanka

Following quality control of fishing effort and positional records, 57,399 longline sets from 19,259 fishing trips were retained for analysis, representing a total fishing effort of 59,236,930 hooks. Mean effort was $1,032 \pm 482$ hooks set⁻¹, with a median of 1,000 hooks set⁻¹. No seabird hooking, entanglement, or other direct interactions were recorded in the analysed logbook records.

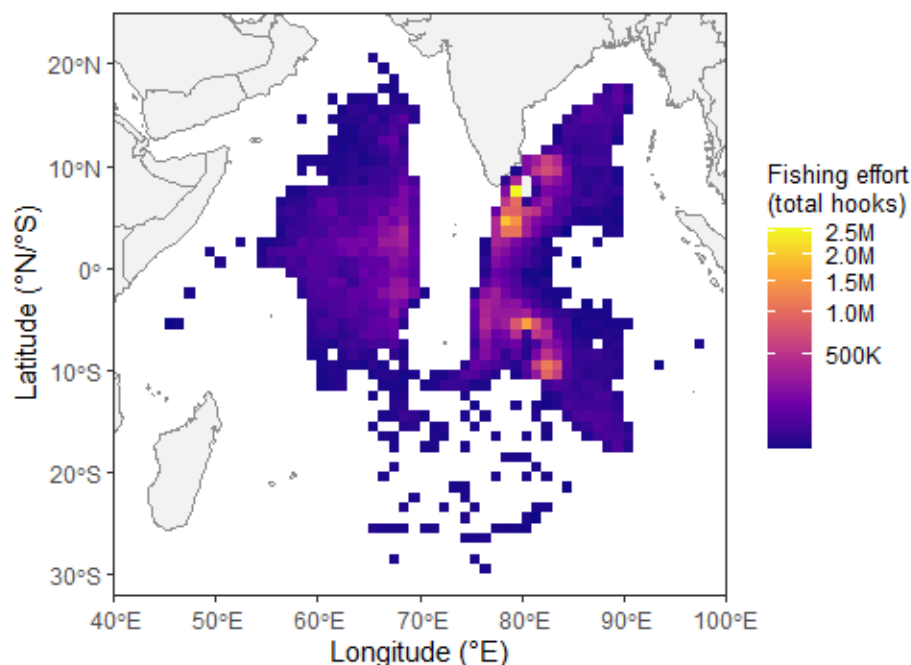


Figure 2: Spatial distribution of longline fishing effort

Fishing effort was widely distributed across the Indian Ocean but was strongly concentrated at tropical latitudes (Fig. 2). Half of all sets occurred between 0–10°N (28,708 sets; 50.0%), accounting for 51.6% of total hook effort, while a further 22,474 sets (39.2%) occurred between 0–10°S, representing 37.3% of hook effort. Collectively, 89.2% of sets and 88.9% of hook effort occurred within 10° of the Equator. Effort declined markedly towards southern latitudes: 5.3% of sets and 5.36% of hook effort occurred between 10–20°S, whereas only 41 sets (0.07%) and 0.10% of hook effort occurred south of 20°S.

Table 2: Distribution of fishing effort by latitudinal zone

latitude_zone	sets	trips	total_hooks	% sets	%_hooks
North of 10°N	3134	1312	3372800	5.46	5.69
0–10°N	28708	8777	30537366	50.01	51.55
0–10°S	22474	9131	22092120	39.15	37.29
10–20°S	3042	1650	3174714	5.3	5.36
South of 20°S	41	33	59930	0.07	0.1

The monthly distribution of recorded fishing effort was highest during February (7,931 sets; 8.48 million hooks) and March (7,195 sets; 7.80 million hooks). Effort declined towards the middle of the year, reaching its lowest hook effort in August (3,194 sets; 2.79 million hooks), before increasing during September–October. Mean effort per set ranged from 874 hooks set⁻¹ in August to 1,178 hooks set⁻¹ in December.

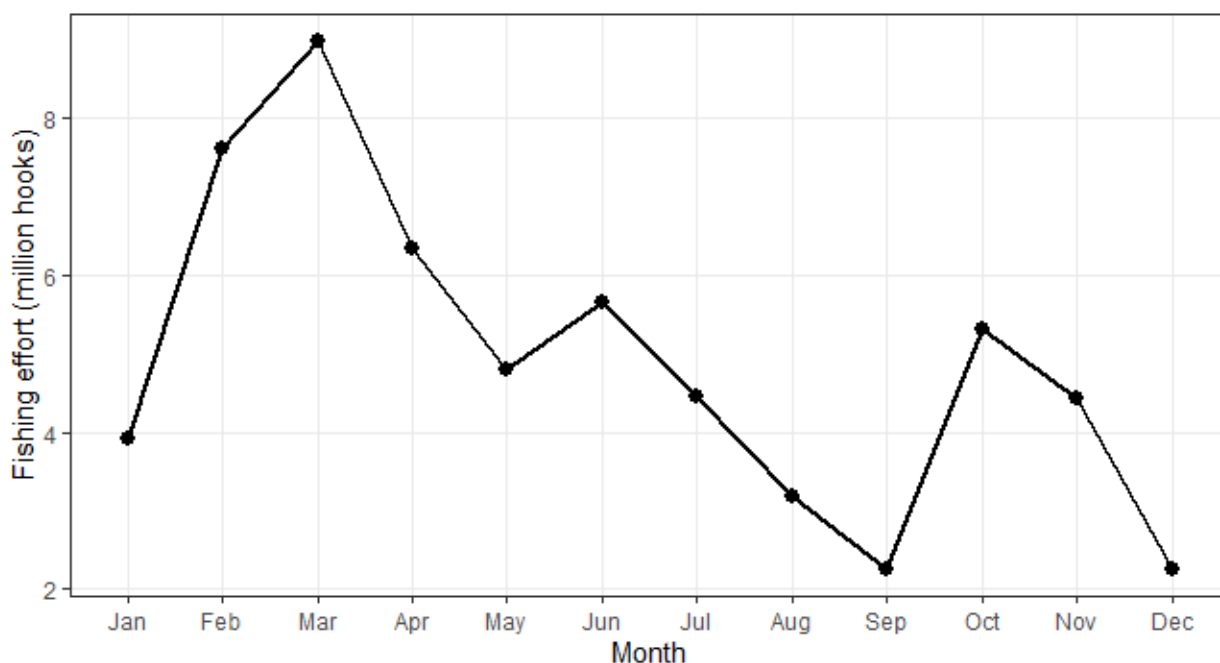


Figure 3: Monthly variation of the longline fishing effort during 2020-2025

The observer records used in this study consisted 318 identifiable longline sets, representing 580,569 monitored hooks. Mean fishing effort was $1,826 \pm 273$ hooks set⁻¹, with a median of 1,680 hooks set⁻¹ and a range of 1,080–2,205 hooks set⁻¹. No seabird hooking or entanglement events were recorded. According to the observer coverage reports, 2 out of 9 fishing operations in 2022 were covered by observers (22%), 1 of 10 in 2023 (10%), 1 of 7 in 2024 (14%), and 1 of 14 in 2025 (7.14%). Spatial distributions presented in the annual observer records showed that monitoring was conducted across offshore Indian Ocean fishing areas. Comparison with the logbook effort distribution

indicated that observer-monitored locations occurred within the principal fishing grounds represented by the logbook data (Fig. 4).

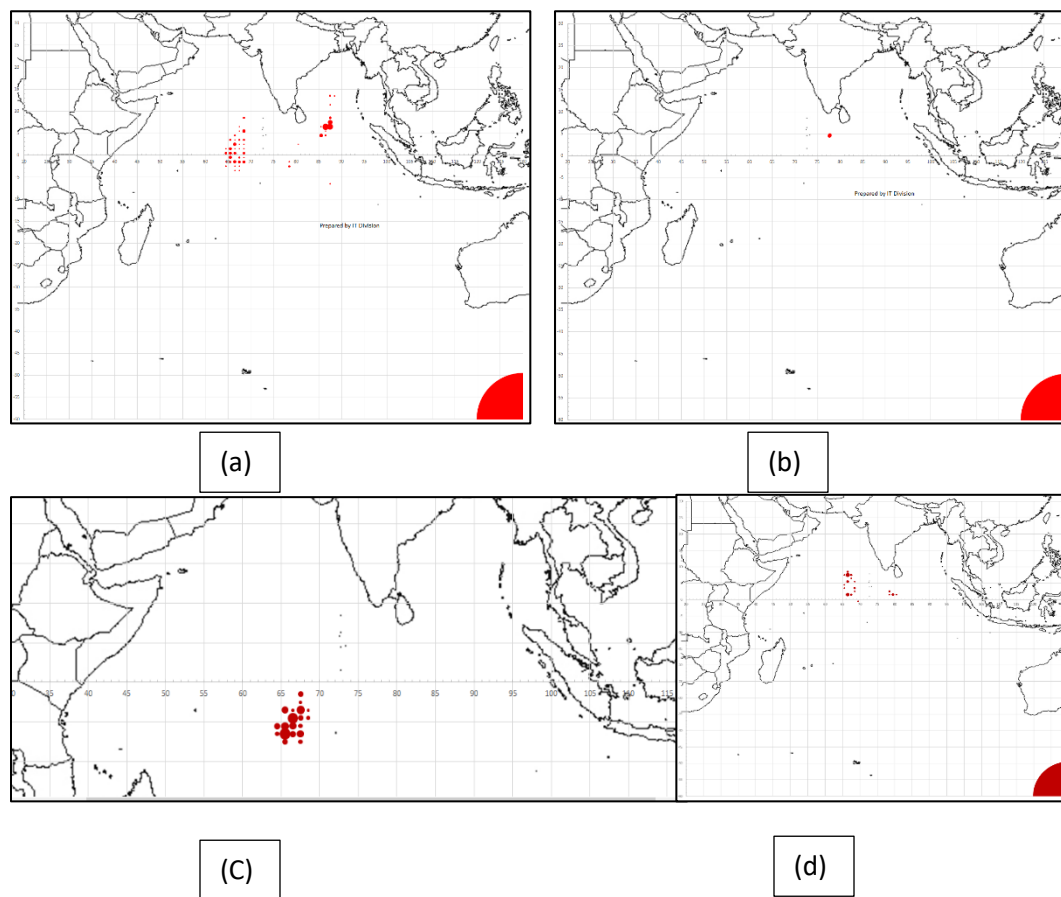


Figure 4: Spatial distribution of observer-monitored fishing operations in the Sri Lankan tuna longline fishery during (a) 2022, (b) 2023, (c) 2024 and (d) 2025

4. Discussion

According to the findings of the three independent data sources, no direct documented entanglement or hooking incident during the 2020-2025 period. However, seabirds were observed around fishing vessels, with 70.7% of surveyed fishers reporting seabird presence and more than half of those respondents observing birds feeding on discarded fish or offal



occasionally. These findings indicate that seabird–fishery overlap and vessel-associated behaviour occur even where direct capture is rarely or not routinely detected. Based on the study, 89% of both longline sets and hook effort occurred within 10° of the Equator, whereas only 5.3% of sets occurred between 10–20°S and 0.07% south of 20°S. This means major tropical fishing grounds are not overlapped with the higher latitudes of the Indian Ocean where Albatross and Petrels interactions were more frequent. Moreover, the occurrence of Seabirds, including terns, boobies, frigatebirds and petrels/shearwaters within the EEZ of Sri Lanka indicates the potential risk of interactions and provides insights into their spatial and temporal distribution. According to the observer data, fishing effort during the period considered highlighted the spatial overlap between commercial fishing grounds and the limited observer coverage across years. Moreover, zero observed captures should be interpreted as no interactions detected within the available monitoring effort, rather than confirmation that seabird bycatch does not occur in the fishery. The results indicated the relatively frequent seabird observations and limited capacity for their identification and reporting. This suggests that strengthening identification, recording and reporting capacity may be particularly important for improving future monitoring. Further, observation of seabirds feeding on discarded fish or offal also an important observation to pay attention because vessel-associated feeding provides a pathway through which birds may approach fishing operations even in the absence of observed capture.

Mechanisms to improve the awareness, monitoring and reporting of seabird interactions should be implemented. Observer coverage should be progressively increased and targeted to provide adequate representation of major fishing grounds, seasons and areas where seabirds are frequently encountered. Simple identification guides and focused training for fishers and observers would improve reporting quality. Particular attention should be given to areas and periods of greater seabird occurrence identified through future monitoring, allowing mitigation measures to be adapted as stronger evidence becomes available.

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