
Review on the reporting and monitoring of interactions with Endangered, Threatened and Protected (ETP) species during tuna fishing in the Maldives – 2023

A Riyaz Jauharee¹, M Shiham Adam², Raufiyya Abdulla³, Ibrahim Nadheeh², Ibrahim Saneeh².
1-Maldives Marine Research Institute, 2-International Pole and Line Foundation Maldives, 3-MoFOR

Introduction

The Maldives islands located in the central Indian Ocean consists of 1192 coral islands distributed into 26 natural atolls. It stretches some 820km from 7 degrees north to 1 degree south with an estimated land area of about 300km² (MEE, 2015). About 90% of these 1192 islands have an area less than 0.5 km² contributes to rich marine and coastal biodiversity (MEE, 2015). The Maldives represents the 5th richest reef biodiversity with the 7th largest reef ecosystem of the world. More than 200 species of stony corals and 1200 species of fish are found in the Maldives (MEE, 2015). These rich ecosystems provide food, income and recreation opportunities for the Maldivians. The Maldives contains a large exclusive economic zone (EEZ) ~ nearly 900, 000 km² and the waters surrounding the Maldives are rich in large megafauna species. More than 20 species of marine mammals, 40 species of sharks, 5 species of marine turtles and rays are known to inhabit these waters (MEE, 2015).

The Maldives has always depended on its marine resources (Hemmings et al, 2014). Its oldest and main fishery has been the tuna fishery (Anderson and Hafiz, 1996). The catch in this fishery has expanded from a few thousand tons in the 1950s to more than 150 thousand tons by 2020 (Ahusan et al. 2022). Thus, this fishery is of national significance. Main species targeted by the tuna fishery are skipjack tuna (*Katsuwonus pelamis*), and yellowfin tuna (*Thunnus albacares*).

Maldives has never used large nets for fishing and all large nets are banned throughout the country (Adam et al. 2003). Hook and line are widely used across the Maldives (Anderson 1986; Rochepeau and Hafiz 1990; Adam et al. 2003; Adam 2004, 2007) for targeting several species of fish. The most common method of fishing continues to be pole-and-line and handline although trolling was popular before the mechanization began in the mid-1970s (Anderson, 1987). Pole-and-line fishery targets skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), frigate (*Auxis thazard*) and kawakawa (*Euthynnus affinis*) while the handline fishery targets yellowfin tuna.

The Maldives tuna fishers operate throughout the archipelago. Live bait, which is essential for both pole and line and handline operations, is caught within the atolls while tuna fishing activities are conducted outside the atolls (Jauharee et al. 2015). Logbook data indicates that most of the pole-and -line, and handline tuna fishing activities are conducted close to the atolls (within 100 miles) though some fishing activities can extend up to the edge of the EEZ (Ahusan et al. 2022).

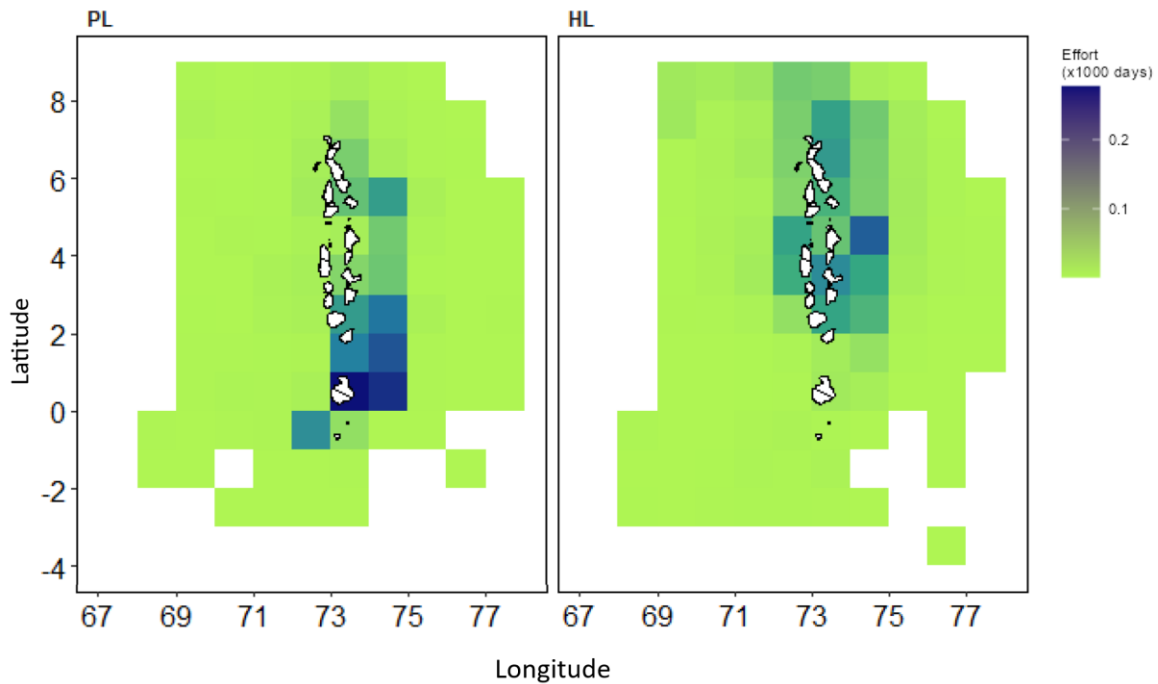


Figure 1: Locations of pole and line, and handline fishing effort across the Maldives. Average for the period 2017 to 2021 (Ahusan et al, 2022).

Interaction with ETP species

In the Maldives all marine megafauna species are protected. Particularly:

- All marine mammals (Cetaceans) – protected since 15 May 1993
- All shark and rays – protected since 1 March 2010
- All sea turtles – protected since 24 June 1995

Many of these creatures are considered as tourist attractions and are often sought by both snorkelers and divers to photograph. Thus, regulations are in place to minimize negative interactions from humans on these organisms. Fisheries interactions (especially tuna fishery) on such charismatic organisms in the Maldives were studied and the findings were published in 2016 (Miller et al. 2016).

In this study two categories of interactions were studied: interactions with ETP species with minor injuries but with high survival rate and interactions with serious injuries resulting in mortalities of the species. From this study (106 observer fishing trips) it was concluded that no sea turtles were affected by the tuna fishery or livebait fishery and there was no marine mammal's interaction with fishing gear.

The objective of this article is to review new data made available through logbooks, field observers and tuna fishers on interactions with ETP species while conducting/undertaking tuna fishing activities. ETP species considered in this report are turtles, whales, sharks, dolphins, and whale sharks.

Method

Information on ETP interactions can be gathered in several ways. These include logbooks data, observer data, and personal interviews of fishers. Since livebait fishing activities are considered as part of the tuna fishing operation (during pole-and-line and handline methods) such information through logbook data and observer data were considered in this article.

The terms “takes”, “interactions”, “bycatch” and “discards” are frequently considered in the literature, definitions are inconsistent and frequently ambiguous. In this article, we define interactions to include only observable interactions (those reasonably expected to be seen following accepted fishery observer protocols) and include both a) uninjured/minor injuries and b) serious injuries/mortalities following Warden and Murray (2011). These two categories of uninjured/minor injuries (with a high expectation of survival) and serious injuries/mortalities (low or no likelihood of survival) will be assessed separately.

Study site

As of November 2023, 529 registered tuna fishing vessels of different sizes (15 m to 35 m) operate in the Maldives. Although in the past (before the 1980s) the tuna fishing activities were very much restricted to the coastal waters, today tuna fishing vessels operate throughout the Maldives EEZ. Tuna fishing operation consists of two components conducted on the same vessel, typically during the same fishing trip: catching baitfish and catching tuna. Baitfish are typically caught inside the atolls during either the day or night. The baitfish are kept alive in a bait well in the boat and the boats head offshore to target tunas.

Fishing takes place throughout the archipelago. Maldivian tuna fishers operate throughout the archipelago. Fishers can either fish at one of the anchored fish aggregating devices (AFADs) in the country deployed and managed by the Ministry of Fisheries and Ocean Resources (MoFOR; Jauharee & Adam 2012), or search for a free swimming school of tuna. Additionally, they may encounter floating objects: drifting natural or manmade objects.

Observer data

Fishery observer data can provide reliable information on any interactions. Since 2014, the Maldives Marine Research Institute (previously the Marine Research Centre) has been working in collaboration with the International Pole and Line Foundation (IPNLF) to gather data on the tuna fishery – both pole and line, and handline fishery. Field observation trips were undertaken by trained fishery observers and represented the spatial and temporal extent of the fishery. Vessels were chosen opportunistically, but trips, vessels, and locations were chosen to best represent the fleet dynamics (size, geographic, seasonality). Fishing trips typically last from one day to 12 days depending on the type of fishing operation: pole and line or handline. This includes both bait fishing and tuna fishing activities. The stated goals of the observers were to provide independent fishery observation and representative data. The specific priorities were to document:

- livebait fishing activities including location of fishing grounds, species caught and the catch;
- interactions with ETP species during livebait fishing operations;
- the amount and proportion of non-targeted species, and their fate/condition at release;
- fishery interactions with endangered, threatened, and protected (ETP) species;
- catch composition and size, with site specific detail;
- fishing effort and fishing locations and
- observations of ETP species.

Trained observers worked on fishing vessels for the duration of a fishing trip, including both bait fishing and tuna fishing activities. Observers make qualitative notes describing the daily fishing and vessel activities. ETP species sightings are considered as observations if they are away from fishing activity and do not interact with fishing gear, targeted catch, or baitfish. Three main categories of ETP interactions were observed during this study.

1. Interactions where ETP species were sighted/present within the fishing area but no interactions as such occurred with fishing gear operations.
2. Interactions with ETP species with minor injuries but with high survival rate.
3. Interactions with serious injuries resulting in mortalities of the species.

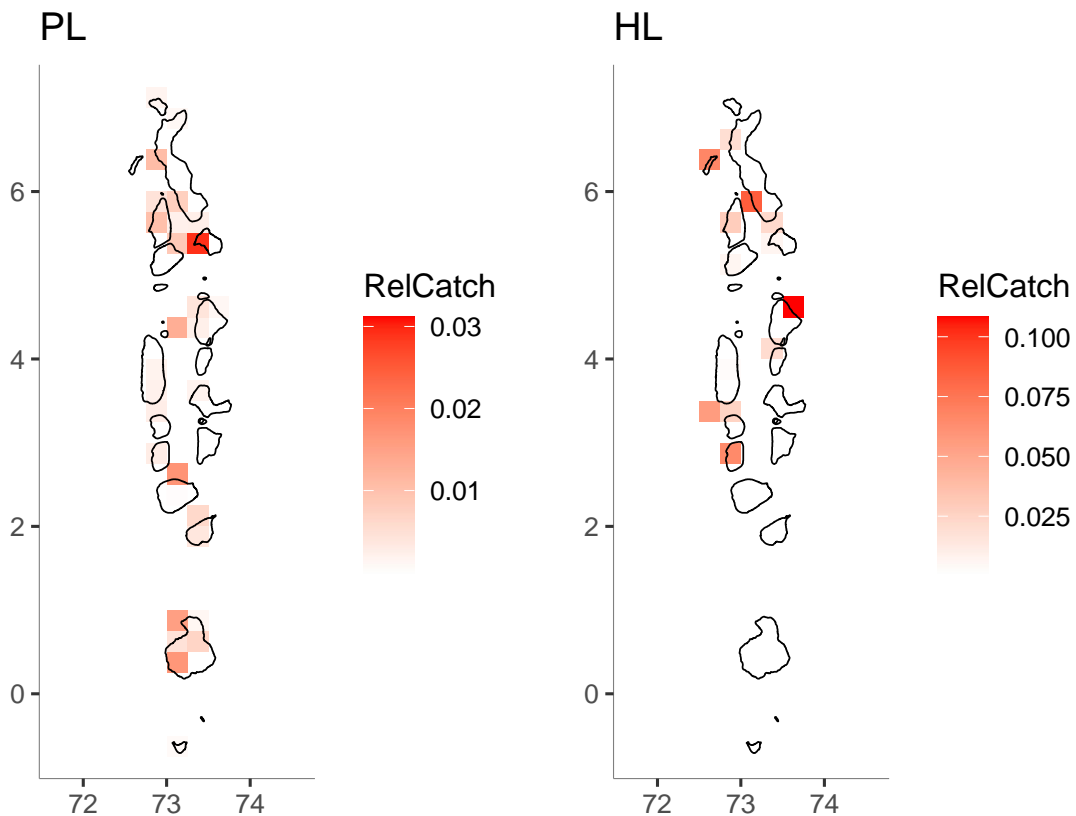


Figure 2: Distribution and intensity of livebait fishing during the observer trips, for both pole and line (PL) and handline (HL) fisheries.

Livebait fishing events are defined as catches taken from a single location. In this sense, a fishing event can include more than one haul of catch which are tallied under the same fishing event. It is possible to have more than one fishing event during the same day (for example from a different location). Also, it is common to replenish livebait supply on the same fishing trip and so livebait fishing events can occur more than one day during the entire duration of the fishing trip.

Over 120 pole and line tuna fishing events and 147 handline fishing events were observed. In addition, a total of 77 livebait fishing events (39 PL and 38 HL) associated with the tuna fishing operations were also observed. A tuna fishing event is considered as a continues

fishing activity without a 10 minutes break between two fishing activities. If there is a minimum of 10 minutes break between two fishing activities the second fishing event is considered as a new fishing event.

ETP species that interact with fishing gear, catch or bait are further assessed. First, the interaction type is described, as well as any mitigation techniques used by the fishermen to avoid, reduce, or end the interaction. Secondly, the condition of the animal is classified following IOTC and Maldivian observer protocols (IOTC 2010, Miller 2014):

- D: Dead;
- A0: Alive (swam away); conditions not determined;
- A1: Alive and in good health condition;
- A2: Alive; minor injuries / stressed high probability of survival;
- A3: Alive; life threatening injuries / severe stress unlikely to survive; and
- Unk: Condition not observed and unknown

As some ETP species that were observed interacting with fishing gear are known to be gregarious and typically encountered in groups, both the proportion of fishing trips with interactions and the rate of interaction (number of occurrences per trip) were considered.

Logbook data

In 2010 logbooks were introduced to collect information on livebait and tuna fishing activities. Since then, it is mandatory for tuna fishers to complete log sheets on all fishing activities that they undertake. This was reinforced under the new Fishery Regulations (MoFMRA, 2020). The logbooks also gathered information on interactions with ETP species during fishing activities. In this study logbook data from 2016 to 2021 were analysed.

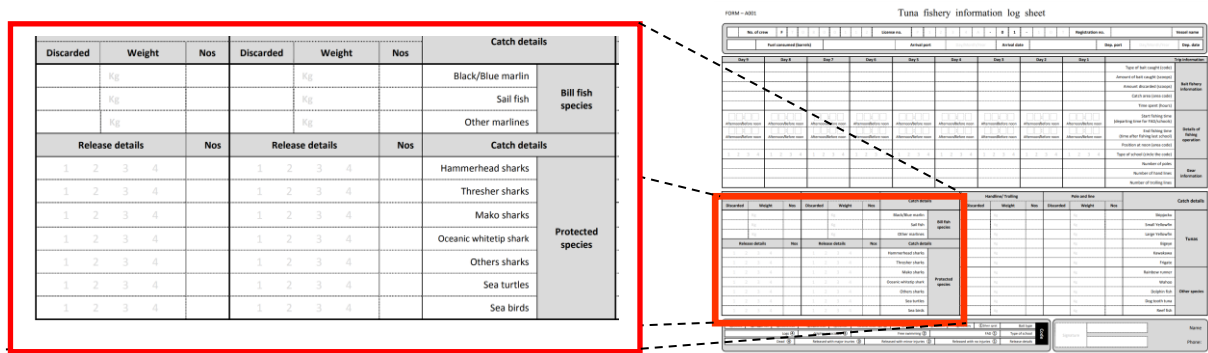


Figure 3: Section of the logbook where fishers report interactions with protected species

Results

Observer data

From 2016 to 2023 several observer trips were conducted on both pole and line, and handline tuna fishery by MMRI and IPNLF staff. Over the 7 years 39 pole and line bait fishing events and 38 handline bait fishing events were observed. Livebait fishing activities took place throughout the Maldives during the pole and line observation trips (Figure 2). Most of the livebait fishing events associated with the handline tuna fishery concentrated to the central and northern parts of the Maldives during the handline tuna fishery observation trips.

Table 1: Number of observed fishing events

Year	Bait fishing events		Tuna fishing events	
	Pole and line	Handline	Pole and line	Handline
2016	0	19	0	72
2017	8	0	26	0
2018	13	0	54	0
2019	0	0	0	0
2020	0	8	0	34
2021	0	11	0	41
2022	7	0	3	0
2023	11	0	37	0

Table 2: ETP species sighted in the fishing ground.

Year	Bait fishing events		Tuna fishing events	
	Pole and line ETP species	Handline ETP species	Pole and line ETP species	Handline ETP species
2016		Dolphins		Dolphins
2017	Dolphins and whale shark		Oceanic whitetip sharks	
2018	Dolphins and manta rays		Dolphins	
2019				
2020		Dolphins		Dolphins
2021				Dolphins
2022	Dolphins			
2023	Dolphins		Dolphins and Oceanic whitetip sharks	

During 267 tuna fishing events and 77 bait fishing events, no interactions with ETP species were observed during both livebait fishing and tuna fishing. But ETP species were sighted in and around the fishing ground on several occasions.

Logbook data

Information provided by fishers through logbooks for 2016 to 2021 were analysed to understand the reporting of interactions with ETP species during both livebait fishing and tuna fishing. Over the six years 56,474 logbook forms were received by the Ministry. Interactions with ETP species were reported in 2017, 2018 and 2020 and these reports were mainly about interactions with sharks.

Table 3: Number of logbook forms received from tuna fishers.

Year	2016	2017	2018	2019	2020	2021
Log forms received	2,652	2,333	2,027	16,563	15,374	17,525

Table 4: Logbook data on interactions with ETP species in the tuna fishery.

Year	Species	Amount	Action taken
2016	0	0	0
2017	Thresher shark	1	Released with no injuries
2017	Thresher shark	2	Released with minor injuries
2017	Hammerhead shark	2	Released with no injuries
2017	Hammerhead shark	1	Released with minor injuries
2018	Thresher shark	1	Released with no injuries
2018	Hammerhead shark	1	Released with no injuries
2018	Oceanic whitetip shark	1	Released with no injuries
2018	Other sharks	2	Released with minor injuries
2019	0	0	0
2020	Thresher shark	1	Released with no injuries
2020	Other sharks	1	Released with no injuries
2020	Other sharks	1	Dead
2021	0	0	0

Discussion

In the Maldives tuna fishery, there are three potential areas for interaction with ETP species.

ETP species may interact directly with:

- a) livebait fishing gear;
- b) pole and line or handline fishing gear (e.g., being caught as bycatch);
- c) species behaviour may be affected (e.g., feeding livebait to attract tuna to vessel).

Interactions with ETP species are observed from those on the deck of the fishing vessel. Thus, interactions between ETP species and the fishing gear that may occur below the surface of the water would not be seen nor reported.

Over the 8 years from 2016 to 2023 field observers who took part in the observer fishing trips were able to collect information from 341 fishing events (both livebait and tuna fishing). No interactions with the ETP species were observed either during the tuna fishing or livebait fishing operations that may endanger their survival. However, observers were able to record sightings of ETP species inside the fishing grounds not too far from the fishing gear. Several species such as manta rays, whale sharks, dolphins and other shark species were sighted during livebait fishing operations. Planktivore species such as manta rays and whale sharks occasionally feed on the plankton aggregated under the bright lights rigged from the side of the vessel to attract bait.

Over the six years 56,474 logbook forms were received by the Ministry. Very few interactions with ETP species were reported in 2017, 2018 and 2020. These reports were mainly of interactions with shark species – ocean whitetip sharks (*Carcharhinus longimanus*), thresher sharks (*Alopias*), hammerhead sharks (*Sphyrnidae*) and other species of sharks. In the past a shark fishery existed in the Maldives. Many fishers depended on this fishery of their livelihoods but since 2010, the Government of the Maldives decided to stop shark fishing in the Maldives EEZ and since then shark fishing has been banned in the Maldives. Hence fishers do not retain shark bycatches. Thus, the very few sharks that may be rarely caught are released often unharmed.

In the Maldives livebait fishery and tuna fishery interactions with ETP species and bycatch are minimal (Miller et al. 2017). Thus, no further management of ETP species is considered necessary currently. Based on the low levels of interaction observed, the authors conclude

that the Maldivian tuna fishery does not “pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species,”. But it is recommended that more observer trips are conducted every year and fishers are made aware of the importance of reporting such interactions through logbooks.

Acknowledgement

The authors thank the fishers who provided information on the fisheries activities and those who shared constructive feedback during the compilation of this article – Munshidha Ibrahim and Shafiya Naeem.

References

1. Adam SM (2004) Country review: Maldives. *In* De Young C (ed.), Review of the state of the world marine capture fisheries management: Indian Ocean. Fisheries Technical Paper 488. FAO, Rome.
2. Adam SM (2007) The Maldivian tuna fishery—An update. *In* Proceedings of the 9th Session of the Working Party on Tropical Tunas, Victoria, Seychelles. 23 p.
3. Adam SM and Anderson CR (1996) Skipjack tuna (*Katsuwonus pelamis*) in the Maldives. Proceedings of the Sixth Expert Consultation on Indian Ocean Tunas Colombo, Sri Lanka. 361-367 p.
4. Adam SM, Anderson CR and Hafiz A (2003) The Maldivian tuna fishery. Ministry of Fisheries, Agriculture and Marine Resources, Male, Republic of the Maldives. 202-220 p.
5. Ahusan, M, Shimal, M, Shifaz, A and Abdulla, R. (2022) Maldives National Report to the Scientific Committee of the Indian Ocean Tuna Commission. Ministry of Fisheries Marine Resources and Agriculture, Maldives.
6. Anderson CR (1986) Republic of the Maldives tuna catch and effort data 1970-1983.14, Indo-Pacific Tuna Development Programme, Colombo, Sri Lanka. 75 p.
7. Anderson CR and Hafiz A (1996) Status of tuna research and data collection in the Maldives., Marine Research Section, Ministry of Fisheries and Agriculture, Malé, Republic of the Maldives. 8 p.
8. FMA & FoFMA (2022) Basic Fisheries Statistics 2012. Fisheries Management Agency, Ministry of Fisheries and Agriculture, Male, Maldives.

9. Hemmings, M, Harper, S and Zeller, D (2014) Reconstruction of total marine catches for the Maldives: 1950-2010. pp. 107-120. *In: Zylich, K., Zeller, D., Ang, M. and Pauly, D. (eds.) Fisheries catch reconstructions: Islands, Part IV. Fisheries Centre Research Reports 22(2). Fisheries Centre, University of British Columbia [ISSN 1198-6727].*
10. Jauharee AR, Adam MS (2012) The evolving Maldivian tuna fishery and its increasing dependence on the anchored FADs. *In: IOTC (ed). Marine Research Centre, Ministry of Fisheries and Agriculture, Maldives.*
11. Jauharee AR, Neal K, Miller K (2015) Maldives Pole-and-line Tuna Fishery: Live Bait Fish Review. Centre for Marine and Coastal Studies Ltd (CMACS), Wirral, UK.
12. MEE, (2015). National Biodiversity Strategy and Action Plan 2016-2025, Maldives: Ministry of Environment and Energy.
13. Miller KI, Jauharee AR, Nadheeh I, and Adam MS (2016). Interactions with Endangered, Threatened, and Protected (ETP) Species in the Maldivian Pole-and-line Tuna Fishery. IPNLF and MRC, July 2016. 28 pages.
14. Miller KI, Nadheeh I, Jauharee AR, Anderson RC, Adam MS (2017) Bycatch in the Maldivian pole-and-line tuna fishery. *PLoS ONE 12(5): e0177391.*
<https://doi.org/10.1371/journal.pone.0177391>
15. Rochepeau S and Hafiz A (1990) Analysis of Maldivian tuna fisheries data 1970-1988. IPTP Report 22: 56.
16. Warden ML, Murray KT (2011) Reframing protected species interactions with commercial fishing gear: Moving toward estimating the unobservable. *Fish Res 110:387-390.*