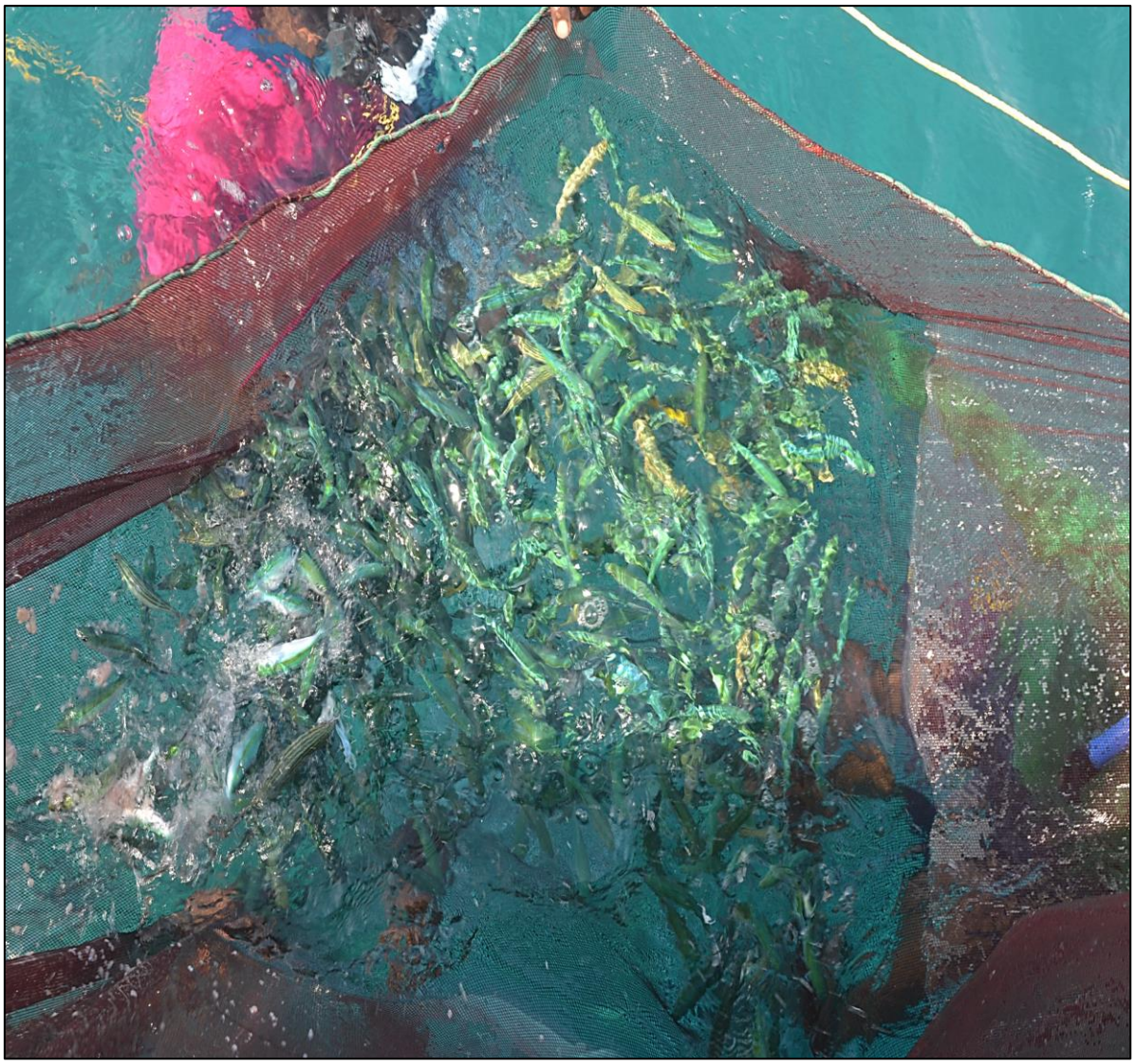
Livebait used in the handline tuna fishery of the Maldives



Maldives Marine Research Institute

Ministry of Fisheries, Marine Resources and Agriculture

This report is based on an analysis of the tuna logbook data for 2020 and 2021 reported by the Maldives handline tuna fishers. The report particularly focuses on livebait caught during the handline tuna fishing operations.

Compiled by: Ahmed Riyaz Jauharee

Ministry of Fisheries, Marine Resource and Agriculture

White Waves,

Moonlight Higun,

Henveiru,

Male', 20025,

Republic of Maldives

CONTENT

1. INTRODUCTION

Tuna fishery is the single most important fishery in the Maldives providing direct employment for nearly 17,500 people (MNBS, 2022) and thousands more through post-harvest, boat construction and maintenance activities. Five species of tuna are widely caught across the Maldives. Yellowfin tuna (*Thunnus albacares*) is the second most important species caught in the Maldivian tuna fishery. Yellowfin used to be fished mainly from skipjack targeted livebait pole-and-line method, although small amounts are also caught by troll gear. Adam and Jauharee (2009) provided a description of the handline large yellowfin fishery and some analysis of its data collected by fishermen-field officers.

Handline fishing is traditional and relatively a common method of fishing in the Maldives. Except on a single island in the south, Gn. Fuvamulaku, the method is not generally used for catching large yellowfin tuna (Anderson et al. 1993). But that was until about 1998 when the method was widely introduced for developing an export oriented large yellowfin fishery. Large yellowfin handline fishing is done on regular pole-and-line vessels without any modification except the use of handline gear.

Figure 1: Large yellowfin tuna fishers operating their handline gear from the back of the fishing gear.

The fishery continued to grow largely due to high demand by the exporters. Large yellowfin tuna (> 25 kg) are exported in various fresh forms to the lucrative markets of Europe and elsewhere. Total recorded yellowfin tuna catches (by both pole and line and handline) registered a record of approximately 50,000 t in 2014, but it declined to 24,530 t in 2021. About 53% (14,369 t) of the yellowfin tuna landed in the Maldives are caught by the handline tuna fishery (Ahusan et al. 2022).

Both pole and line and handline fishing for large yellowfin requires livebait. The livebait consists of small, often pelagic, schooling fish which are released alive into open oceanic waters to the tuna to the vessels. Once excited by the presence of the livebait, tuna can then be caught using baited hooks. Tuna harvests very much depend on, among other things, the availability of large quantities of livebait, which is sourced from the coral reefs within atoll basins. Unlike in many parts of the world where livebait is collected by separate vessels and then sold to tuna fishers, the livebait fishery in the Maldives is conducted at sea by both pole-and-line and handline vessels as part of the tuna fishing operation and takes place prior to almost every tuna fishing trip.

Livebait fishing

Livebait fishing takes place using a rectangular lift-net deployed from the sides of boat. Daytime livebait catching involved making use of snorkelers in the water who actively forced schools of fish on to the net or use chum to aggregate them on the net. This method is time consuming and requires many crew members. In recent year as fishing vessels have developed technologically, the livebait fishery has evolved from the very labour-intensive day-time fishing to a more efficient method using lights at night. Lights are used to aggregate the fish to the sea surface near the fishing vessel, which can then be collected with a large net.

Figure 2: Powerful lights are used to attract scads during night-time bait fishing operations.

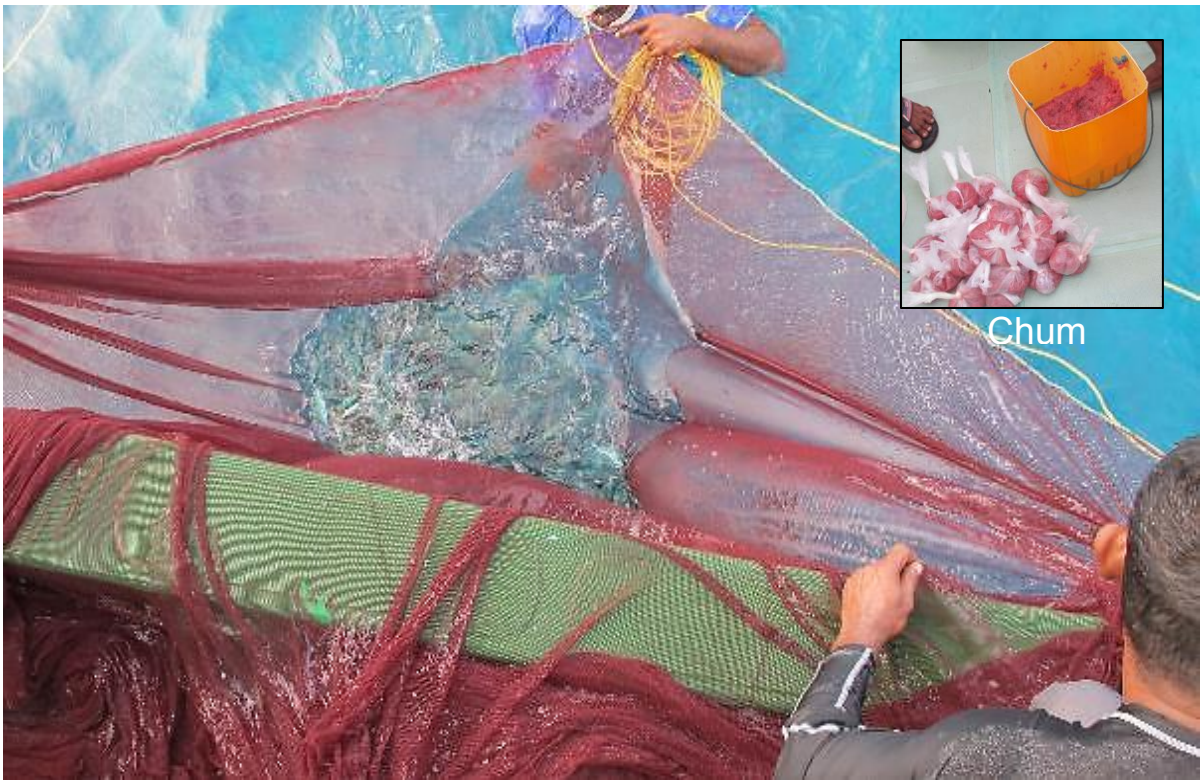


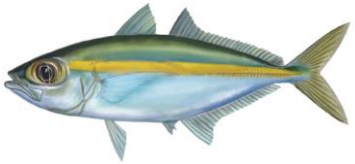
Figure 3: During the day-time bait fishing operations chum is used to attract bait fish on to the net.

Variation to the method of livebait fishing depending on the target species too. Livebait can be caught off the house reefs, around submerged reefs, inside atoll lagoons or inside shallow lagoons surrounding the islands. Livebait such as scads are also caught by using a small hook and pole and line gear. This technique is common while targeting large scads. The fish caught on the hook are flipped onto the vessels and into the bait tank to keep them alive.

Livebait species

Livebait used in the handline tuna fishery consists of pelagic and reef-associated species (Table 1) that are sourced from the relatively shallow waters of the atoll lagoon. Most of the targeted species for livebait have short generation times and a high population turnover. The availability of livebait species varies greatly between seasons and regions throughout the Maldives (Anderson and Saleem, 1994). In addition to the four main species (Table 1) Samoan silverside (*Hypoatherina temminckii*) locally known as thaavalhu and Indian mackerel (*Rastrelliger kanagurta*) are sometime used.

Table 1: Main livebait species exploited in the Maldivian handline tuna fishery

English Name	Family/Species	Local Name	Illustration
Bigeye scad	*Selar crumenophthalmus*	*Mushimas*	
Mackerel scad	*Decapterus macarellus*	*Rimmas*	
Fusiliers	Caesionidae	*Muguraan*	
Red-tooth trigger fish	*Odonus niger*	*Vaalan rondu*	

Livebait data collection

Despite data collection methods for the tuna fishery been well developed as early as 1960s (Anderson and Hafiz, 1988), there has been no data collection effort for the livebait fishery. In the past livebait fishing data was gathered opportunistically during field trips undertaken by Marine Research Centre (MRC). Such data collection activities to estimate annual livebait utilization in the pole-and-line fishery were conducted from 1978 to 1981; 1985 to 1987; 1993 to 1994 and in 2003 in the pole and line fishery.

Although handline tuna fishery started in the 1990s there was very little information on the quantity of livebait species caught until the logbooks were introduced in 2010. Only very few (11) observation trips were conducted onboard the handline vessels till now. During these observer trips information on bait fishing methods, targeted bait species and interactions with endangered, threatened, or protected species were recorded. An estimate of the quantity of

livebait caught was also recorded as number of scoops of livebait. The observer data on livebait have been analysed separately and attached as an Appendix to this document.

-	1	0	T	Registration no.		Vessel name
				Dep. port	Day/Month/Year	Dep. date

Day 2	Day 1	Trip information	
		Type of bait caught (code)	Bait fishery information
		Amount of bait caught (scoops)	
		Amount discarded (scoops)	
		Catch area (area code)	
		Time spent (hours)	
□□:□□ Afternoon/Before noon	□□:□□ Afternoon/Before noon	Start fishing time (departing time for FAD/schools)	Details of fishing operation
□□:□□ Afternoon/Before noon	□□:□□ Afternoon/Before noon	End fishing time (time after fishing last school)	
		Position at noon (area code)	
1 2 3 4	1 2 3 4	Type of school (circle the code)	

Figure 4: English translation of the section of logbook which records livebait fishery information. (*See appendix for full log sheet*).

The present logbook collects information on species of livebait caught during the fishing trip, the amount of the livebait caught as number of scoops of livebait collected, the discarded amount of livebait at the end of the fishing trip, region from where the livebait was caught, the date and the duration of the livebait fishing operation (Figure 4). Through logbook, fishers also report the interaction with endangered, threatened or protected species (see Appendix).

The objective of this study is to analyse the information on livebait fishing activities related to handline tuna fishery in the Maldives provided by the fishers through logbooks during 2020 and 2021. This study will specifically look at the composition of the livebait species utilized, the amount caught and the reported location of fishing grounds.

2. METHODOLOGY

In 2010 logbooks were introduced to collect information on tuna fishing activities in the Maldives. Since then, it was mandatory for tuna handline fishers to complete log sheets on fishing activities that they undertake. This was reinforced under the new Fishery Regulations[1]

In this study the 2020 and 2021 logbook data were analysed. The catch, fishing ground and the species caught for each year was studied. There were several species caught during the same bait fishing event and the total catch during that fishing event is recorded as the sum of all the species. In cases where the number of species recorded is more than one, the catch (recorded as the number of scoops), is equally divided among the total number of species. For example, in the table below – in row 4: five species were recorded, and the total catch is 845 scoops. Thus 845/5 = 169 scoops for each species.

BIGEYE SCAD	60997
BIGEYE SCAD,BLUE SPRAT	8
BIGEYE SCAD,CARDINAL FISHE (BOADHI),FUSILIERS	14
BIGEYE SCAD,CARDINAL FISHE (BOADHI),FUSILIERS,SILVER SPRAT,TRIGGER FISH	845
BIGEYE SCAD,CARDINAL FISHE (FATHAA),DAMSEL,FUSILIERS,MACKEREL SCAD,OTHERS,TRIGGER FISH	380
BIGEYE SCAD,CARDINAL FISHE (FATHAA),DAMSEL,FUSILIERS,MACKEREL SCAD,SILVER SPRAT,TRIGGER FISH	521
BIGEYE SCAD,CARDINAL FISHE (FATHAA),MACKEREL SCAD	1150
BIGEYE SCAD,DAMSEL,FUSILIERS	312
BIGEYE SCAD,DAMSEL,FUSILIERS,MACKEREL SCAD	80
BIGEYE SCAD,DAMSEL,FUSILIERS,MACKEREL SCAD,TRIGGER FISH	42

Figure 5: English translation of the section of logbook which records livebait fishery information.

Fishers also report the fishing ground location on a grid. The sum of the bait fish caught from each grid square is calculated by adding all the catch reported for that year within the square. It is then plotted and conditional formatting is used to highlight those areas (grids) where most of the bait fishing activities took place.

[1] https://www.gov.mv/en/guidance-and-regulations/the-fisheries-regulations-of-maldives

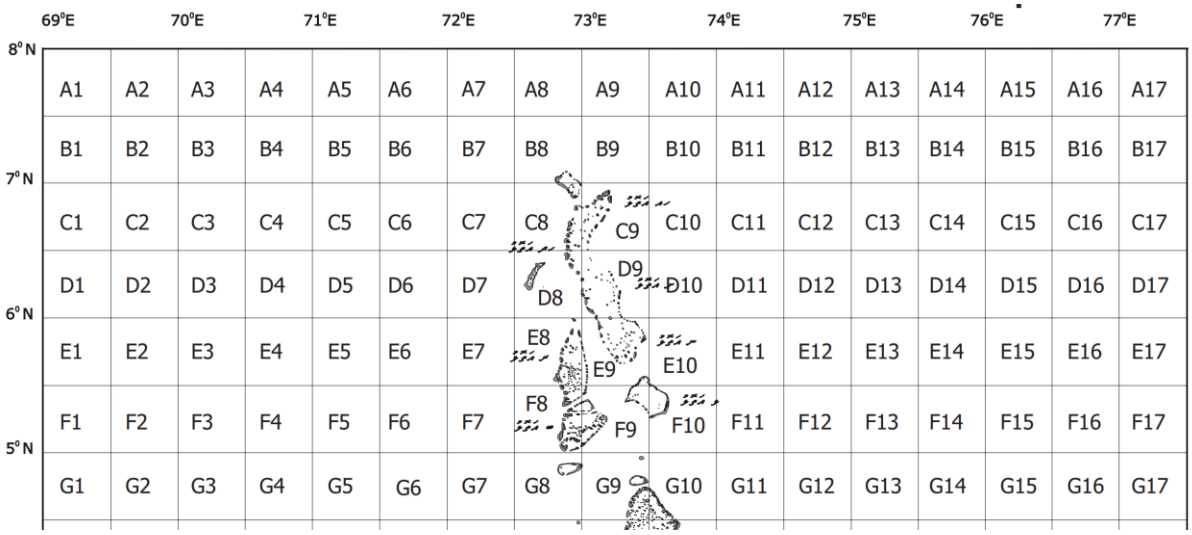


Figure 6: Section of the logbook grid chart that fishers use for reporting the location of the bait fishing grounds.

3. RESULTS

The number of logbook sheets received from tuna fishers have increased over the years from 2,652 log sheets in 2016 to 17,525 log sheets in 2021 (Table 2).

Table 2: Number of logbook sheets received from fishers.

Year	All fisheries Number of logbooks received	All tuna fisheries Number of logbooks received
2016	3,524	2,652
2017	3,300	2,333
2018	2,793	2,027
2019	17,133	16,563
2020	15,525	15,374
2021	17,731	17,525

In 2020, 15,374 completed tuna log sheets were received by the Ministry. In 2021 the number increased to 17,525 completed tuna log sheets. The total bait catches (all species) in the handline fishery in 2021 was at 415,224 scoops of bait caught during 5,381 bait fishing trips. In 2020 the total bait catches were 420,154 scoops of bait caught during 6,136 bait fishing trips. Ten species of bait are caught during the bait fishing operations for handline tuna fishing. But only 4 are widely utilized – bigeye scad, mackerel scad, trigger fish and fusiliers. In 2020, 72% and in 2021, 83% of the livebait used in the handline tuna fishery was scads.

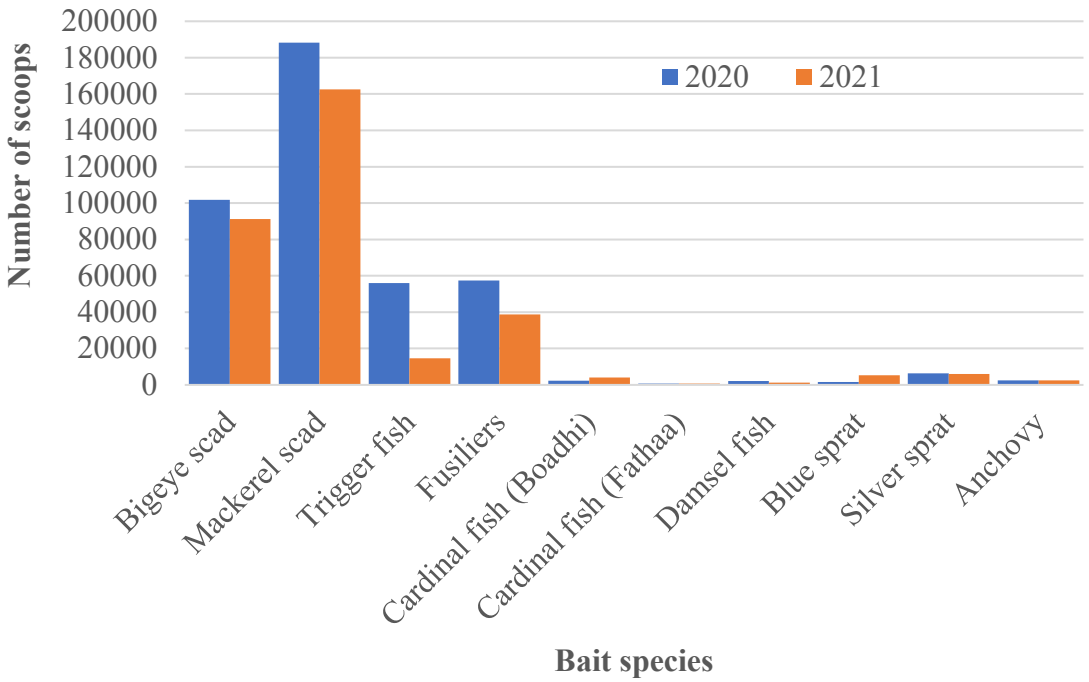


Figure 7: Amounts of different species of bait caught in 2020 and 2021.

The amount of livebait caught during the bait fishing trips varied from few scoops to a several hundred scoops. In 2020 and 2021 during 95% of the bait fishing trips less than 200 scoops of livebait were caught. Further analysis showed in the same two years 80% of the bait fishing trips recoded less than 100 scoops of livebait per trip. Only in 0.02% of the bait fishing trips more than 300 scoops of bait were caught in both years.

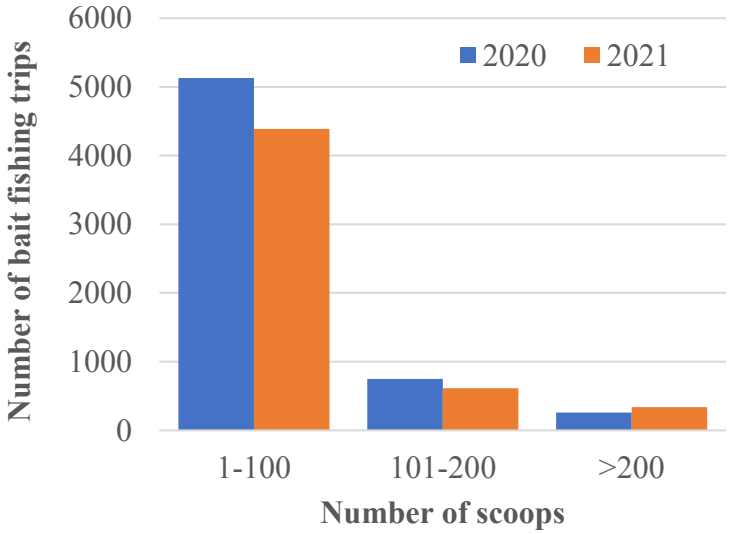


Figure 8: Number of scoops of livebait caught during the bait fishing trips in 2020 and 2021.

Of the 420,154 scoops of total catches reported in 2020 12% of the catches were reported from outside the atolls. In 2021 from 415,224 scoops of bait caught only 7% was reported outside the atolls (Figure 9).

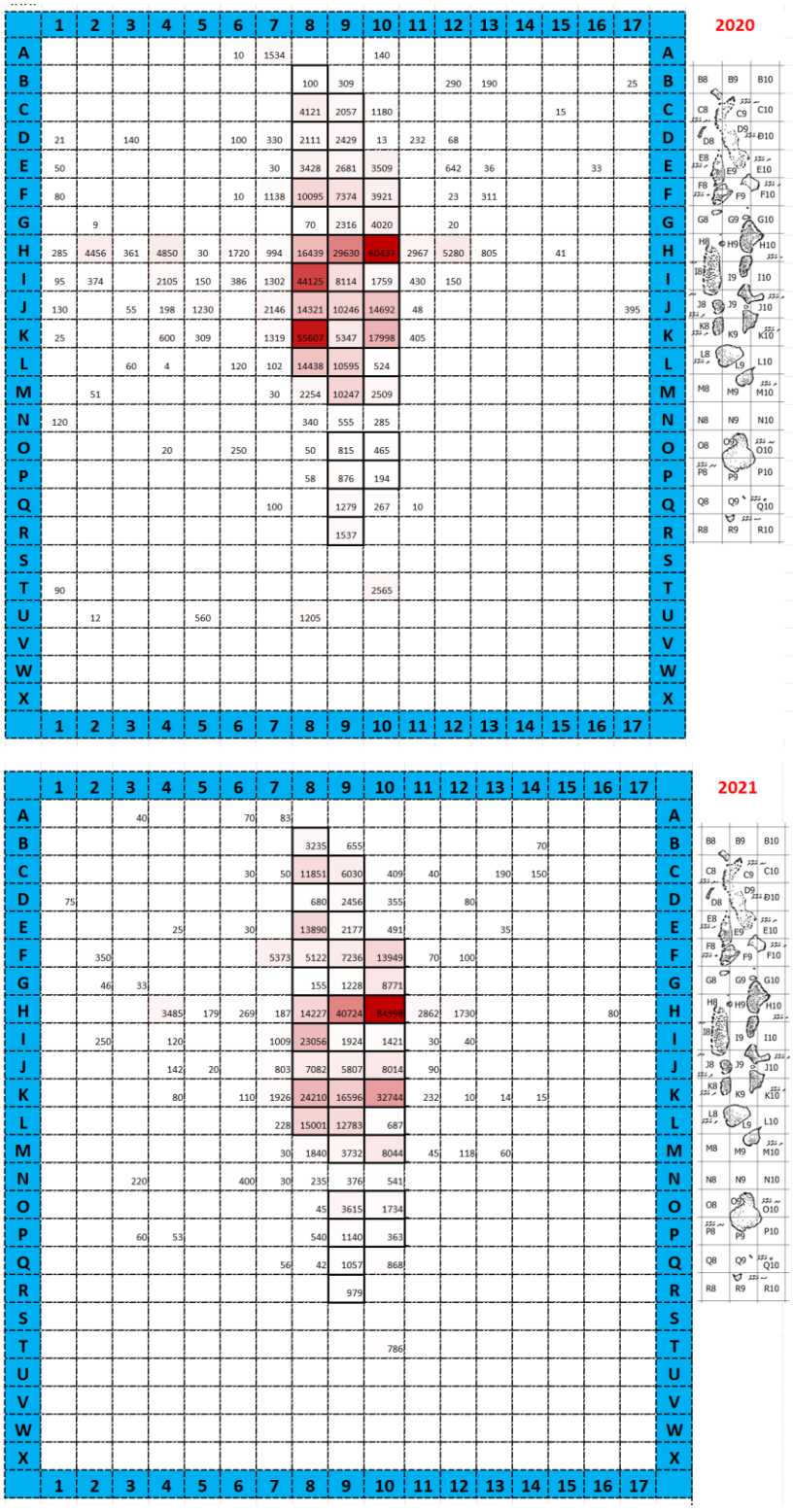


Figure 9: Number of fishing events reported for different locations (fishing grounds) for 2020 and 2021.

4. DISCUSSION

The number of logbooks received by the ministry improved from 2,027 log sheets in 2018 to 17,525 log sheets in 2021. This was mainly due to an initiative by the Ministry. In 2019 it was made mandatory for fishers to submit their log sheets to the commercial companies buying tuna, before they could land their catch. Now these companies collect the log sheets from the fishers and pass them to the Ministry. Hence since 2019 the number of log sheets received by the Ministry drastically increased.

The handline tuna fishery depends largely on four livebait species – bigeye scad, mackerel scad, trigger fish and fusiliers. The scads are extensively used both to attract large yellowfin tuna to the vessels and to put as livebait on hooks to catch tuna. The fusiliers are also used to attract tuna to the vessel and to put on hooks. But the trigger fish are mainly used on hooks while catching tuna. According to fishers, trigger fish is not chummed to attract tuna because once the tuna feeds on the trigger fish its belly gets filled quickly and since there is thick bones and thick skin on the trigger fish it takes a long time before the tuna starts feeding again. The trigger fish is good to put on the hook as unlike scads and fusiliers, trigger fish dives deeper taking the hook and the line to those fish swimming further down the water column.

Few handline tuna fishing vessels (0.08%) carry both pole and line and handline gear onboard. These few vessels tend to switch gear opportunistically depending on the schools they encounter. Hence they carry suitable livebait (smaller fish than handline bait) for pole and line depending on the availability of bait during some seasons. The logbook data shows that handline tuna fishers catch cardinal fish, damsel fish, sprat and anchovies which are suitable for pole and line fishing for tuna. In 2021, these species accounted for about 5% of the total livebait caught by the handline fishers. The total bait catches reported by the handline fishers (including all species) is 415,5224 scoops for 2021 and 420,154 scoops in 2020. Small size fusiliers are also used for pole and line fishing.

Of the four main bait species (bigeye scad, mackerel scad, trigger fish and fusiliers) mackerel scads are most widely caught – 188,274 scoops in 2020 and 162,508 scoops in 2021. Bigeye scads are the next popular species of bait caught – 10,1815 scoops in 2020 and 91,311 scoops in 2021. Both these species accounted for 72% in 2020 and 83% in 2021 of the handline bait caught. Both species can be kept for more than a week in the bait holds of the fishing vessels.

The total catches of the four main species of bait used in the handline fishery were 403,487 scoops in 2020 and 307,203 scoops in 2021. It is estimated that each bait scoop weighs

about 5 kg. Thus, the estimated total bait catches from the handline tuna fishery are 2,017 tons in 2020 and 1,536 tons in 2021. From this data it could be estimated that handline tuna fishers use about 500 kg of livebait for every trip. Since the large yellowfin tuna landings in 2021 was 24,530 ton, the estimated livebait to large yellowfin tuna ratio in the handline yellowfin tuna fishery is 1 kg of livebait to 16 kg of tuna.

All bait species used in the handline tuna fishery are widely available across the Maldives and are caught mainly from inside the atolls. Only very few fishers have occasionally stated encountering schools of scads outside the atolls in the open ocean. Most of the bait fishing activities takes place close to the capital near Male' where the commercial companies that purchase large yellowfin tuna are located. Fishing vessels conduct multiday trips, each trip lasting between 4 to 15 days.

Once the tuna are unloaded at the purchasing companies the fishers obtain their supplies and engage in bait fishing activities. Since bait are abundant in the atolls close to Male', fishers tend to fish from these atolls. Logbook data shows that bait fishing activities are concentrated to Kaafu and Alif atolls. Dhaalu atoll has a large handline fleet, and these vessels tend to fish for bait within Dhaalu and Meemu atolls as they commence their fishing trip from their home port after visiting their families.

The log sheets collect information on the bait fishing grounds. Fishers are required to report the location of the fishing grounds with reference to a grid provided to them in the logbook (Appendix 1). In 2020, 12% of the reported bait fishing ground locations were outside the atolls and in 2021 this number decreased to 7%. This misreporting of bait fishing grounds could be due to the lack of awareness among fishers about proper reporting of the location where bait fishing was conducted. There was no reporting of interactions with endangered threatened or protected (ETP) species during bait fishing activities but during few observer trips in the handline tuna fishery and more than 100 observer trips in the pole and line tuna fishery, some ETP species interactions were recorded (Miller, et.al; 2016)

5. RECOMMENDATIONS

Tuna logbooks provide information on the scale of the handline fishery including the livebait fishery associated with this fishery. With the help of the logbook data it is possible to estimate the identify main bait fishing grounds and the amount of extractions. There were some misreporting of information (both catch and location of catch) and this may be corrected through awareness programs conducted for the fishers.

Since the fishery began only very limited observer trips (11 trips – report included in the Appedix) were conducted. To better understand the fishery, it is important to conduct more observer trips and collect data on a finer scale on both bait fishing activities and the large yellowfin tuna fishing operations. From interactions with fishers, it was evident that postharvest mortality in the livebait fishery is an issue and efforts need to be made to reduce postharvest mortality. At present the Ministry is working with Japan International Cooperation Agency (JICA) to modify and improve circulation of seawater in the bait tanks to help reduce postharvest mortality. Two short videos documenting the issues in handling and storing livebait and possible solutions have been compiled by MMRI of MOFMRA with assistance from WWF and JICA. Information related to best practices in handling livebait needs to be widely spread among fishers.

Information on bait fishing grounds is now collected through logbook on a broader scale. Through interviews with fishers and observer trips detailed mapping of livebait fishing grounds needs to be carried out to better manage the livebait fishery. Similarly biological information of the species harvested, and their habitats needs to be studied. Climate change impacts, ecosystem interactions and impacts of habitat modification on these bait species needs to be better understood. Since fishers have not identified any interaction with ETP species during their bait fishing operations it may be important to study how these bait species contribute to ecosystem services. Such studies would help formulate a comprehensive livebait fishery management plan.

6. REFERENCES

Adam, M Shiham, and A Riyaz Jauharee.(2009). “Development of Large Yellowfin Tuna Fishery in the Maldives,” 14. Mombasa, Kenya 15-23 October 2009: IOTC (www.iotc.org), 2009.

Miller, Kelsey, Ibrahim. Nadheeh, Riyaz Jauharee, Charles Anderson, and M. Shiham Adam,. (2019). Bycatch in the Maldivian Pole-and-Line Tuna Fishery. PLoS ONE 12(5): e0177391. https://doi.org/10.1371/journal. pone.0177391.

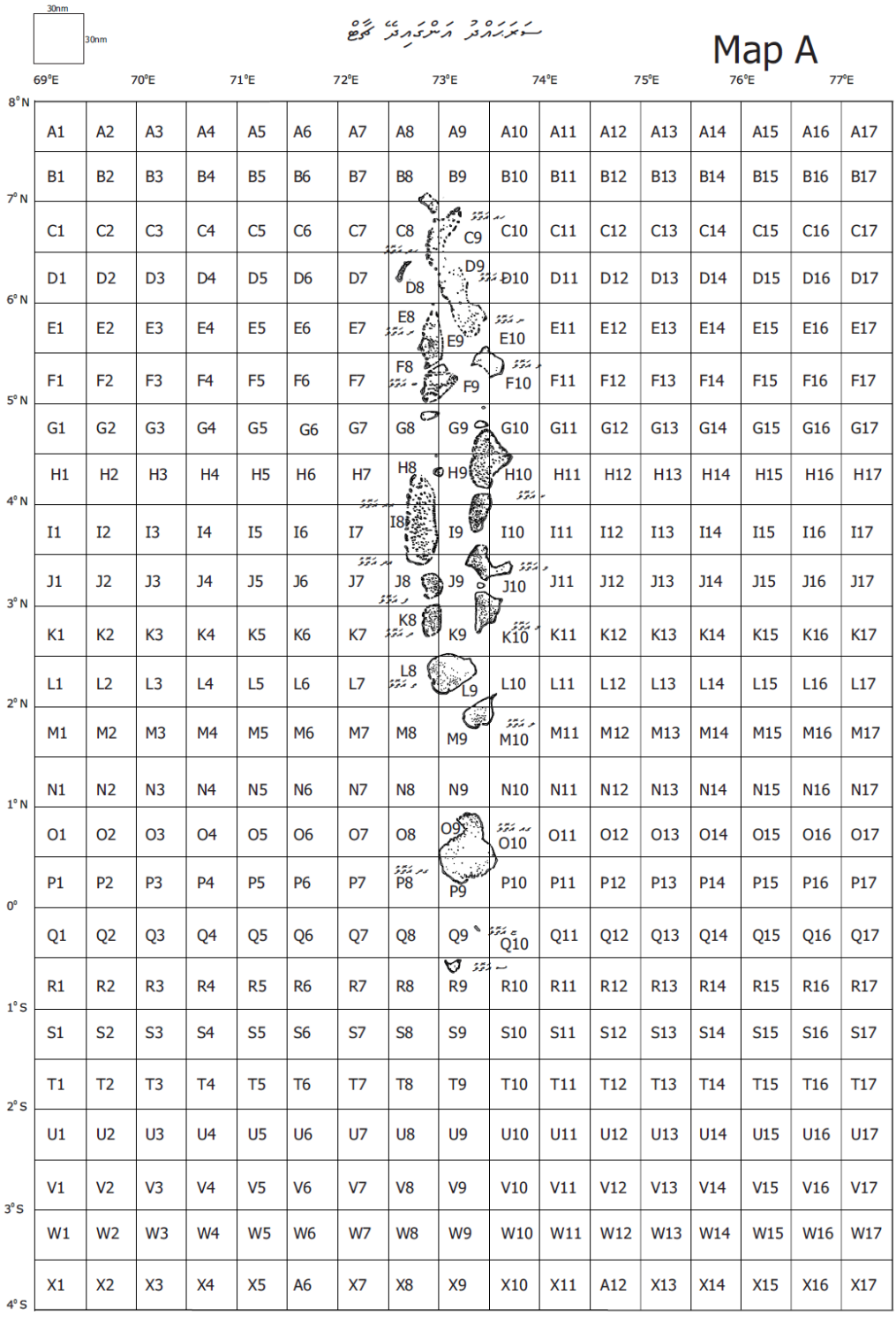
Miller KI, Jauharee AR, Nadheeh I, and Adam MS (2016). Interactions with Endangered, Threatened, and Protected (ETP) Species in the Maldivian Pole-and-line Tuna Fishery. IPNLF and MRC, July 2016. 28 pages

Robinson, Danielle, Steven P. Newman, Mark J. Whittingham, Richard M. Francksen, M. Shiham Adam, and Selina M. Stead. (2022). Fisher–Shark Interactions: A Loss of Support for the

Maldives Shark Sanctuary from Reef Fishers Whose Livelihoods Are Affected by Shark Depredation. Conservation Letters, August 19, 2022. https://doi.org/10.1111/conl.12912

7. APPENDIX

A – Grid for reporting location of livebait fishing grounds



B – Log sheet for reporting handline tuna fishing and livebait fishing activities.

FORM – A001

Tuna fishery information log sheet

	No. of crew	F	T	0	8	0	0	1	1	2	License no.	P	1	2	3	4	A	-	0	1	-	1	0	T	Registration no.		Vessel name
	Fuel consumed (barrels)										Arrival port	Day/Month/Year					Arrival date								Dep. port	Day/Month/Year	Dep. date

Day 9	Day 8	Day 7	Day 6	Day 5	Day 4	Day 3	Day 2	Day 1	Trip information	
									Type of bait caught (code)	Bait fishery information
									Amount of bait caught (scoops)	
									Amount discarded (scoops)	
									Catch area (area code)	
									Time spent (hours)	
Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Start fishing time (departing time for FAD/schools)	Details of fishing operation
Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	Afternoon/Before noon	End fishing time (time after fishing last school)	
									Position at noon (area code)	
1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	Type of school (circle the code)	
									Number of poles	Gear information
									Number of hand lines	
									Number of trolling lines	

Pole and line			Pole and line			Catch details		Handline/ Trolling			Pole and line			Catch details	
Discarded	Weight	Nos	Discarded	Weight	Nos			Discarded	Weight	Nos	Discarded	Weight	Nos		
	Kg			Kg		Black/Blue marlin	Bill fish species		Kg			Kg		Skipjacku	Tunas
	Kg			Kg		Sail fish			Kg			Kg		Small Yellowfin	
	Kg			Kg		Other marlines			Kg			Kg		Large Yellowfin	
Release details		Nos	Release details		Nos	Catch details			Kg			Kg		Bigeye	
1 2 3 4			1 2 3 4			Hammerhead sharks	Protected species		Kg			Kg		Kawakawa	
1 2 3 4			1 2 3 4			Thresher sharks			Kg			Kg		Frigate	
1 2 3 4			1 2 3 4			Mako sharks			Kg			Kg		Rainbow runner	Other species
1 2 3 4			1 2 3 4			Oceanic whitetip shark			Kg			Kg		Wahoo	
1 2 3 4			1 2 3 4			Others sharks			Kg			Kg		Dolphin fish	
1 2 3 4			1 2 3 4			Sea turtles			Kg			Kg		Dog tooth tuna	
1 2 3 4			1 2 3 4			Sea birds			Kg			Kg		Reef fish	

Code										
Bait type	Silver sprat ①	Anchovy ②	Fusiliers ③	Blue sprat ④	Cardinal fishes ⑤, ⑥	Damsel ⑦	Bigeye scad ⑧	Round scad ⑨	Trigger fish ⑩	Others ⑪
Type of school	FAD ①	Free swimming ②	dolphin associated ③	Logs ④						
Release details	Released with no injuries ①	Released with minor injuries ②	Released with major inuries ③	Dead ④						

Signature		Name	
		Phone:	

*Please use a new sheet for each fishing trip

APPENDIX:

Analysis of Observer Data – Livebait HL YFT Tuna[1]

Introduction

An observer program, supported and implemented by IPNLF in collaboration with the Maldives Marine Research Institute (MMRI, previously Marine Research Centre), was conducted from October 2014 and continued until 2022. The primary target at the beginning was pole-and-line fishery, but later focused on handline fishery as well. These scientific observations were conducted by trained observers taking part on regular fishing trips from key fishing islands. A good part of the data (its first 160 trips) exclusively on pole-and-line fishery has been published (Miller et. al, 2016, Miller et. al, 2017a, Miller et. al, 2017b). However, data from handline yellowfin fishery have not been analyzed.

Scientific observer data from handline yellowfin tuna has not been available in the past. Adam and Jauharee (2009) analyzed logbook data from handline yellowfin tuna fishery from AA Mahibadhoo for 2007-2009. They report bait use on 86 trips and shows the importance of trigger fish (*Odonus niger*) was in par with the scads (bigeye and round scads) at the time. Fusiliers (Fam: Caesionidae) were also commonly used. Adam and Jauharee, (2009) further notes that more than 90% of yellowfin tuna schools are first sighted with dolphins. Anderson et al., (1999) notes it is common to associate dolphins with yellowfin tuna in the Maldives.

This short report provides an analysis of observer data on handline fishing trips focusing on livebait and interaction of ETP species during livebait and handline fishing operations.

Data & Methods

A total of 11 handline yellowfin trips were observed during 2016 and later in 2021 and 2022. Of these 82% (8 trips) were observed in 2016, and remining three trips in 2021 and 2022. During these trips 39 livebait fishing events and exactly 39 fishing events were recorded[2]. The data include location, volume of catch and species composition and bycatch. ETP interaction were also noted during livebait fishing and handline fishing events and recorded as per IOTC Observer Data standards. These observer data on fishing events have been reported as part of IOTC compliance from the Maldives.

Following cleaning of data for any issues an exploratory analysis was carried out. Due to small number of observations no statistical analysis was carried out.

Results & Discussion

Handline yellowfin trips lasted less than a day to 16 days (mean 5 days). There were 6 trips that lasted less than a day. These short trips were from Sh. Feevaku, where fishing took place closer to the shore on oceanward side of the atoll reefs. This is a common practice in the north where they target small sized

---

[1] The report was compiled by Shiham Adam – IPNLF, Maldives; shiham.adam@ipnlf.org

[2] Number of livebait and handline fishing events being the same could be very rare. Handline fishing events are defined as fishing activities separated more than 10 mins.

fish not destined for export, but for sale to local communities or to the resorts. With those short trips removed, the mean number of days of handline trip was 11 days (range 8-16 days). In most cases handline yellowfin trips are known to last 10-15 day and target dolphin associated schools in offshore areas.

During these 11 trips a total of 39 livebait fishing events were observed (Table 1). Livebait fishing events are defined as catches taken from a single location. In this case, a fishing event can include more than one hauls 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 not uncommon to have to replenish livebait supply, in which case the vessel must steam to the atoll for livebait and back into ocean to continue fishing. In such cases livebait fishing events can occur more than one day during trip.

Livebait fishing takes place either during day or night. Day livebait fishing targets trigger fish (*Odonus niger*) and variety of fusiliers (Ceasionidae sp). Since these takes place on the coral reefs, minor variety of reef fish (Acanthurids; Pomacanthids, Labrids) may be caught as bycatch. These are however, released alive before transferring the haul to the bait well.

Table 1: Summary of handline livebait fishing events observed by month and by year. A total of 39 handline Livebait events were observed

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2016				12	3			4				
2021										8		
2022	8	3	1									

Scads – round and bigeye scads – *Decapterus macarellus* and *Selar crumenophthalmus* respectively, are caught in a different setting during night (Fig 2). They use lights to attract them. Once attracted they are netted and transferred to bait well. Unlike fusiliers and scads which are normally chummed live to attract and maintain feeding dolphin-associated schools, scads and trigger fish are baited on the hook live and released by the side of the vessel for catching the tuna.

Figure 1 shows the spatial distribution of livebait catch. For comparison catches in pole-and-line are also shown. Since all varieties of livebait (PL and HL) are taken in atoll lagoons or on reefs, it will be difficult to discern any spatial difference in catch locations between the two fisheries. Besides the data for HL are also too few to detect any differences.

Mean livebait catch per fishing event for handline fishery was 130 kg where are average livebait used per trip was estimated at 410 kg. These figures are higher than average for pole-and-line (343 kg per trip) because unlike pole-and-line hand line trips last around 11 days and bait fishing may take place more than once.

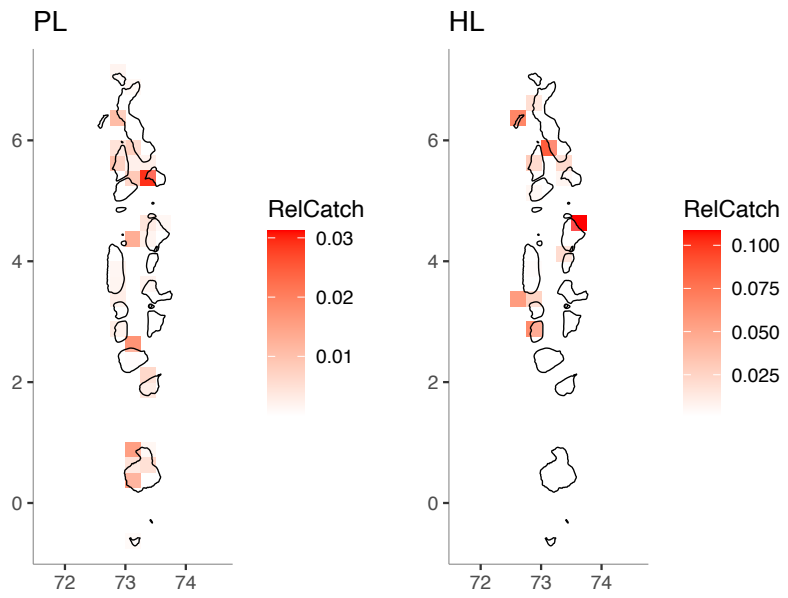


Figure 1: Distribution and intensity of livebait fishing in the Maldives, for both pole-and-line and handline fisheries.

Figure 2 shows average weight of bait type per fishing event. About 50% of catch was scads (bigeye or round – also known as mackerel scads). Adam and Jauharee (2009) notes that most common species in their observation of Mahibadhoo data were bigeye scads. Unfortunately, the data does not record the two species of scads separately. There is also 10% of OTHER species caught during nighttime. These can be mix of unidentified species with majority comprising, locally known as kashi mas, and Indian mackerel (*Rastrelliger kanagurta*). The latter is known to occur in north but only rarely.

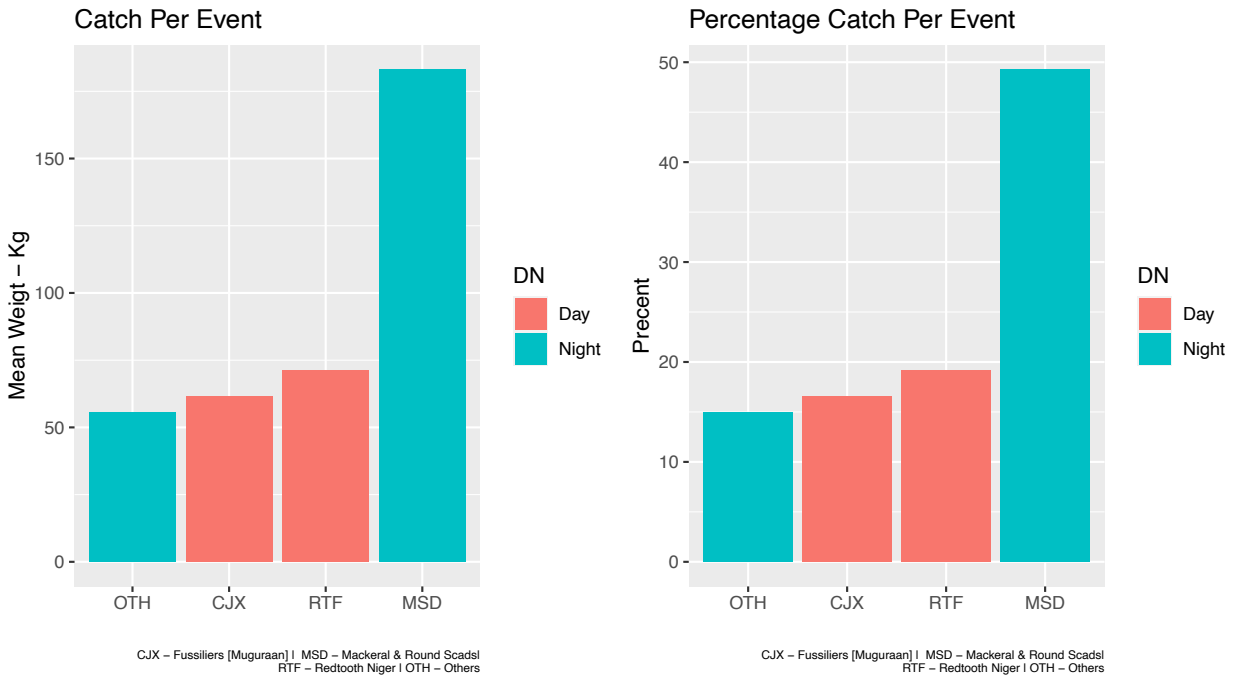


Figure 2: Mean weight of livebait taken per fishing event n handline fishery - 2016-2022

Interaction

Interaction with ETP species was not observed during livebait fishing. However, minor interaction with ETP species was observed during handline fishing events. And none of these interactions are thought to have induced mortality of the ETP species. Dolphins occasionally bite the scads and get caught on the hook. In all such cases the line is cut, and dolphins released – no dolphin was recorded been harmed.

Sharks occurred occasionally and on two incidents they were depredating the catch. Fishermen reported ~ 10% catch loss due to depredation in handline fishing (Robinson et al. 2022).

Table 2: Summary of Interaction with ETP species in Handline fishing operations. Fate Code A0 -Alive, swam away, A1 – alive in good condition, Interaction type 3 is Feeding on catch.

Event	Species	Fate	NumSp	IntType	Comments
HL	Dolphin	A0	1	NA	Alive and swam away
HL	Shark	A1	1	3	Alive in Good condition, Feeding on catch
HL	Dolphin	A0	2	NA	Alive and swam away
HL	Dolphin	A0	1	NA	Alive and swam away
HL	Dolphin	A0	1	NA	Alive and swam away
HL	Dolphin	A0	3	NA	Alive and swam away
HL	Shark	NA	NA	3	Feeding on catch

Reference:

Anderson, Robert Charles, A. Shaan, and A. Waheed. (1999) "Records of Cetacean 'strandings' from the Maldives." Journal of South Asian Natural History 4, no. 2: 187–202.

Adam, M Shiham, and A Riyaz Jauharee. (2009). "Development of Large Yellowfin Tuna Fishery in the Maldives," 14. Mombasa, Kenya 15-23 October 2009: IOTC (www.iotc.org), 2009.

Miller, Kelsey, Ibrahim. Nadheeh, Riyaz Jauharee, Charles Anderson, and M. Shiham Adam. (2019). Bycatch in the Maldivian Pole-and-Line Tuna Fishery. PLoS ONE 12(5): e0177391. https://doi.org/10.1371/journal. pone.0177391.

Miller KI, Adam MS, Baske A. (2017) Rates of Fuel Consumption in the Maldivian Pole-and-Line Tuna Fishery. International Pole & Line Foundation, London and Marine Research Centre, Maldives. 39 pages,

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

Robinson, Danielle, Steven P. Newman, Mark J. Whittingham, Richard M. Francksen, M. Shiham Adam, and Selina M. Stead. (2022). Fisher–Shark Interactions: A Loss of Support for the Maldives Shark Sanctuary from Reef Fishers Whose Livelihoods Are Affected by Shark Depredation. Conservation Letters, August 19, 2022. https://doi.org/10.1111/conl.12912.