The Tuna Livebait Fishery in North Ari Atoll

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EXECUTIVE SUMMARY

This North- Ari Livebait report is an initiative under the REGENERATE project implemented by IUCN to map the livebait fishery resources, its utilization, fishing grounds and fishing methods practiced by North-Ari fishers. Although livebait fishery is the most important fishery in the Maldives, proper mapping of livebait resources including fishing grounds has never been done till now. This is the first attempt to map livebait resources and its utilization in one atoll of the Maldives. The information used in this atlas is gathered mainly through fisher interviews and fisheries related statistics obtained from fishers. Both tuna and reef fishers in North-Ari atoll use livebait for fishing. The livebait is harvested around reefs across the atoll at night and during the day. The pole-and-line fishers targeting tuna use very small bait fish such as silver sprat (*Spratelloides gracilis*), blue sprat (*Spratelloides delicatulus*) anchovy (*Encrasicholina heteroloba*) and cardinal fishes (Apagonidae) while the handline fishers who catch large tuna (>80cm FL) use round scad (*Decapterus macarellus*), bigeye scad (*Selar crumenopthalamus*) and red-tooth trigger fish (*Odonus niger*) as bait. Reef fishers also harvest relatively large bait fish similar to those used by the handline tuna fishers.

The bait fish are caught using large rectangular lift nets (about 80 x 70 feet) operated from the fishing vessels. During the day bait is attracted on to the submerged net using chum. At night bait are aggregated under the boat with the help of powerful lights (2000W to 6000W). Net is then lowered into the water and spread beneath the aggregation. The bait net is pulled to the surface with the help of ropes attached to the sides of the net. North-Ari has rich livebait fishing grounds thus attracting several fishers from other parts of the country to harvest livebait from this atoll. On average fishers collect about 150kg of livebait for each fishing trip. When bait is abundant, large vessels may harvest more than 500kg of livebait. It is estimated that 10,000 Mt of livebait are harvested from the reefs across the Maldives every year.

Several fishers acknowledge sightings or interaction with endangered, threatened or protected species during livebait fishing operations. Organisms such as turtles, sharks and dolphins are sighted at the bait fishing grounds while sometimes rays and whale sharks do enter the bait nets as the fishers haul the net. Plankton feeders such as manta rays and whale sharks are attracted to the large volume of plankton aggregated under the lights used during night bait fishing.

Similar to any other open access fishery, if the livebait fishery is not managed properly, the livebait resources in the Maldives can be overharvested and could result in stock depletion. To properly manage this fishery it is important to successfully implement the existing data collection mechanisms; map catch trends at atoll level and use the data collected to produce annual reports that would help identify depletion of catch across the country. In addition discourage alternative use of livebait including the sale of baitfish species at the local markets; prevent introduction of any new bait fishing gear without approval by MoFA; effectively enforce the regulations on marine protected areas and if severe declining of livebait resources be evident more exclusion zones should be set up and size limits on baits and lights used for bait fishing should be in place.

CONTENTS

1. INTRODUCTION

Maldivians have been using livebait in the pole-and-line tuna fishery for more than 1000 years (Anderson, 2009). In the past livebait was caught during the daytime from within the coral reefs, but at the present most of the livebait are caught at night using powerful lights (Jauharee et. al., 2015). Each vessel carries several hundred kilos of livebait in their bait well during every tuna fishing trip. The livebait is chummed to attract tuna and excite a tuna school into a feeding frenzy. The chumming response draws the tuna closer to the vessel enabling the anglers to reach the school with their pole-and-line gear. Spray of water from the stern further simulates the biting response of the school. Barbless hooks with lines of equal length to the pole are used to hook and angle the fish on to the deck *(Figure 1)*.

The livebait used for catching tuna are caught within the atoll lagoon or close to the shallow reefs. The reefs provide shelter and plenty of food for the small fish that are used as bait. Several species of fish are used as livebait but only a few species are regularly used in large quantities as bait across the country (Anderson, 2009). The pole-and-line fishers who target small tuna (~30cm to 60cm FL) prefer to used small size bait fish such as silver sprat (*Spratelloides gracilis*), blue sprat (*Spratelloides delicatulus*) anchovy (*Encrasicholina heteroloba*) and cardinal fishes (*Apagonidae*) while the handline fishers targeting large tuna (>80cm FL) use larger sized bait fish such as round scad (*Decapterus macarellus*), bigeye scad (*Selar crumenopthalamus*) and red-tooth trigger fish (*Odonus niger*). Reef fishers also use relatively large bait fish.

"Each vessel carries several hundred kilos of livebait in their bait well during every tuna fishing trip. The livebait is chummed to attract tuna and excite a tuna school into a feeding frenzy."

It is not very clear when the livebait fishery began in the Maldives but since Maldivians have been catching tuna using pole-and-line gear for several hundred years (which requires livebait), it will be correct to assume that the livebait fishery is also as old as the pole-and-line tuna fishery in the Maldives (Anderson, 2009). Almost 90% of all tuna and reef fish landed are caught using livebait. Livebait is the most important fishery in the Maldives as both tuna and reef fisheries depend on livebait resources. Maintenance of healthy livebait stocks would be critical for the type of fisheries conducted in the Maldives.

The size of the livebait fishery has increased over the years (Jauharee et. al., 2015). Use of livebait by other fisheries other than pole-and-line tuna fishery has created additional demand on the resource; various forms of reef fishing and the yellowfin handline fishery require large quantities of livebait on a

Figure 1: Anglers positioned at the back of the vessel catch tuna using pole-and-line gear. Tuna are attracted to the vessel by chumming livebait.

regular basis. In addition some baitfish, particularly sprats and scads, are now routinely caught and landed on Malé fish market as a food fish increasing total livebait catch. In the mid-2000s total estimated bait catch was about 15,000 Mt per year (Anderson, 2009). The expansion of large yellowfin handline tuna fishery has reduced the pressure on the livebait used by the pole-and-line tuna fishery. In 2014, the estimated bait catch by the pole-and-line tuna fishery was around 10,000 Mt (Jauharee et. al., 2015).

Despite data collection methods for the tuna fishery being well developed as early as the 1960s, there is no regular and routine data collection for the livebait fishery. In 2010, logbooks were introduced to collect fishery data. This initiated formal data collection on the livebait fishery linked to the tuna fishery but it is still not very clear how much livebait is utilized by the reef fishers as they do not regularly submit their logbook data records.

From the observer data gathered by MRC in 2014, it was estimated that on average about 150 kg of livebait was used for every pole-and-line fishing trip (Jauharee et. al., 2015). The livebait catches of different bait species varied over the years and across various parts of the country. Catches also varied depending on the time of fishing operation – day or night. There was a much higher exploitation of livebait species (especially sprat) in the southern atolls than in other parts of the country (Jauharee et. al., 2015). Recent field observations by MRC staff showed that most fishers in the south now mainly target cardinal fish species by scuba diving.

According to fishers many factors affect the livebait bait catches in the Maldives. These include:

1. Variation in current pattern
2. Coral bleaching
3. Damage to coral reefs due to both natural and anthropogenic activities
4. Intensive livebait fishing around some reefs
5. Inappropriate fishing practices by some fishers

2. LIVEBAIT SPECIES

There are over 40 different species of small fish used as bait across the Maldives (Anderson, 2009) but only a few species are exploited regularly by fishers. Some of the qualities that fishers look for in a livebait species include its size, ease of catch and hardiness. The most important and extensively utilized bait species is the silver sprat. This pelagic species is small, abundant, and easy to catch and readily attracts tuna when chummed. Other frequently used species in the pole-and-line tuna fishery includes several species of cardinal fishes, fusiliers (muguraan), anchovy and blue sprat. There are several other species of small fish used as livebait in the handline fisheries targeting large yellowfin tuna and reef fish (*Table 1*).

"In the mid-2000s total estimated bait catch was about 15,000 Mt per year (Anderson, 2009). The expansion of large yellowfin handline tuna fishery has reduced the pressure on the livebait used by the pole-and-line tuna fishery. In 2014, the estimated bait catch by the pole-and-line tuna fishery was around 10,000 Mt"

Family/Species	English Name	Local Name	Utilised in
Spratelloides gracilis	Silver sprat	*Rehi*	PL
Spratelloides delicatulus	Blue sprat	*Hondeli*	PL
Apogonidae	Cardinalfishes	*Boadhi, fathaa*	PL
Encrasicholina heteroloba	Anchovy	*Miyaren*	PL
Caesionidae	Fusiliers	*Muguraan*	PL and HL
Chromis sp.	Chromis	*Nilamehi*	PL and HL
Selar crumenophthalmus	Bigeye scad	*Mushimas*	HL
Decapterus macarellus	Mackerel scad	*Rimmas*	HL
Odonus niger	Red-tooth trigger fish	*Vaalan rondu*	HL

Key: PL – Pole-and-line; HL – Handline

Table 1: Common livebait species exploited

Silver sprat (*Spratelloides gracilis*)

This fish has a slender body. The pectoral fin is short and is slightly shorter than eye and snout together. The body is covered with thin, comparatively large scales. The head is scale-less and the belly is without scutes. It is dark blue dorsally, silvery white ventrally. A very distinct silvery lateral band from operculum extends to the base of the caudal fin. This pelagic species usually inshore and occurs in large schools within the atolls. Silver sprat is found in most parts of the Maldives throughout the year and is considered the best bait for fishing skipjack tuna. Silver sprat is also very delicate and is very difficult to keep alive for even a day.

Figure 2. Illustration of a Silver Sprat

Blue sprat (*Spratelloides delicatulus*)

It is a close relative to silver sprat and they are similar. It has a slender, sub-cylindrical body with a pectoral fin shorter than snout and eye together. The dorsal fin is at mid body of fish. The pelvic fin is below the base of the dorsal fin while the anal fin is near the caudal fin and the belly is smooth. The body is covered with thin, delicate scales. This fish is dark blue dorsally while the sides are silvery. Unlike silver sprat this fish do not have the broad reflective stripes. This pelagic species is usually found inshore and occurs in large schools within the atolls. It is common during the southwest monsoon in shallow waters and is easy to catch. Similar to silver sprat, this species is also very delicate and difficult to keep for long periods in captivity.

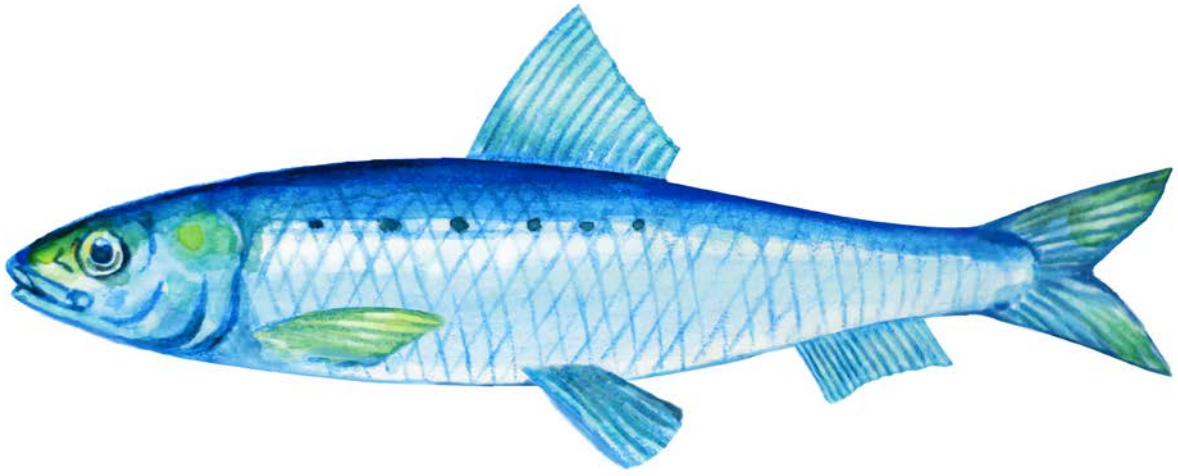

Figure 3. Illustration of a Blue Sprat

Cardinal fishes (*Apogonidae*)

These include several species of fishes of the family Apogonidae. Most of the species that are used as livebait belong to genera *Archamia*, *Apogon* and *Paramja*. The generally small red coloured fish found on the reefs are referred to as *boadhi* and the small pale coloured fish found in lagoons are referred to as *fathaa* by the local fishers. These fish take shelter among corals in deeper waters. Use of cardinalfish as bait has expanded with the introduction of scuba gear for harvesting livebait. Some cardinalfishes used as bait include headstripe cadinalfish (*himaboadhi*), blackstriped cardinalfish (*Fulhaaronguboadhi*), ghost cardinalfish (*loabodubureki*) and peppered cardinalfish (*thikijehiboadhi*). Cardinal fish abundance varies across the country and between seasons too. Cardinal fish can be kept for several days in the bait wells of the pole-and-line fishing vessel.

Figure 4. Illustration of a Cardinal fish

Anchovy (*Encrasicholina heteroloba*)

This small fish has a light transparent fleshy brown body and there are no dark lines like the silver sprat. It has a wide mouth and is found in inshore water near reefs, feeding on plankton. Anchovy is more abundant in the southern parts of the Maldives and during the northeast monsoon. It forms large schools and can be caught easily in large quantities. They are easily attracted to light used by fishers at night for bait fishing as lots of plankton gathers under the light. This fish also has a high mortality when in captivity and hence cannot be kept for long periods in the bait tank.

Figure 5. Illustration of an Anchovy

Bigeye scad (*Selar crumenophthalmus*)

This fish has an elongated and shallow body with a conspicuous large eye. It has a metallic blue to bluish green dorsal, white ventral and a distinct black opercular spot. This fish forms large schools in inshore waters near reefs. They feed on plankton, tiny fish and invertebrates. Bigeye scad is caught during the day and night using pole-and-line gear and nets. This fish is widely used as livebait by tuna handline and reef fishers. It is also a popular food fish and is regularly sold at Male' fish market.

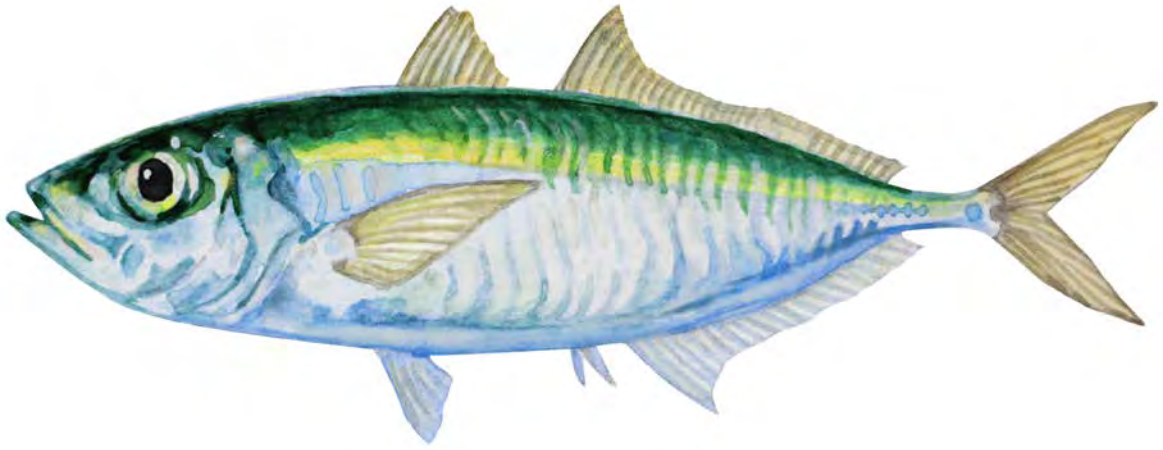

Figure 6. Illustration of a Bigeye scad

Red-tooth trigger fish (*Odonus niger*)

It has a red tooth and the body is deep blue or sometimes very dark brown or greenish in colour. This fish is common on the reef slope and feeds on zooplankton and sponges. They move in large groups and can be easily caught using the bait net. When disturbed they take refuge in crevices on the reef. This fish is used as bait by both the tuna and reef fish handline fishers.

Figure 7. Illustration of a Red-tooth trigger fish

Mackerel scad (*Decapterus macarellus*)

This fish has a very elongated rounded body. The dorsal fin is bluish green while the ventral fin is silvery. The caudal fin is yellowish green while the anal and pelvic fins are whitish. This pelagic species forms large schools inside the atolls feeding on planktonic invertebrates. This fish is widely used as livebait by tuna and reef handline fishers. It is also a popular food fish and is regularly sold at Male' fish market.

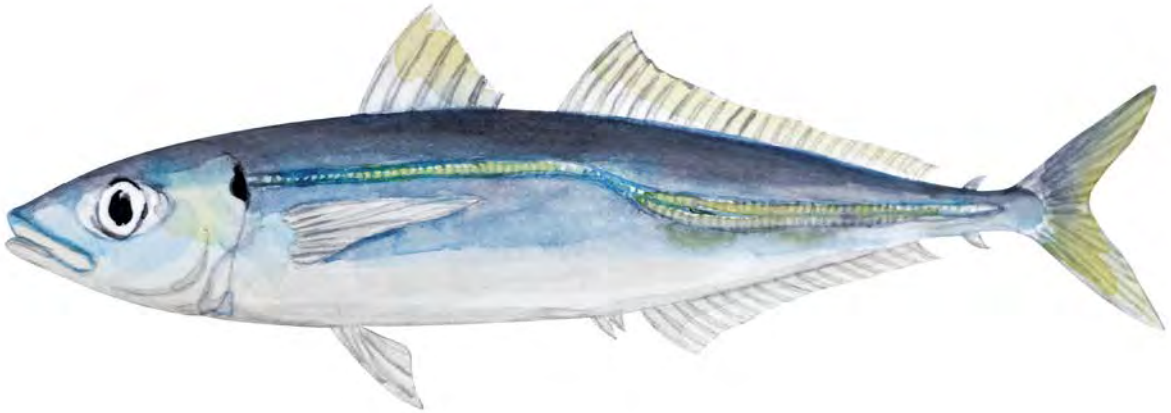

Figure 8. Illustration of a Mackerel

Fusilier (*Caesionidae*)

About six different species of fusiliers are used as bait. Some of these include yellowfin fusilier, gold-band fusilier, banana fusilier, slender fusilier, and dark-banded fusilier. The smaller – juvenile fusiliers are used in the pole-and-line fishery while the larger or adult fish are used in both the hand-line tuna fishery and reef fishery. This is considered as a good bait as it has a good survival rate in captivity. Pole-and-line fishers target this fish when there is a decline in abundance of sprats. Fusiliers are abundant in the northern atolls during northeast monsoon and in the southern atolls during southwest monsoon.

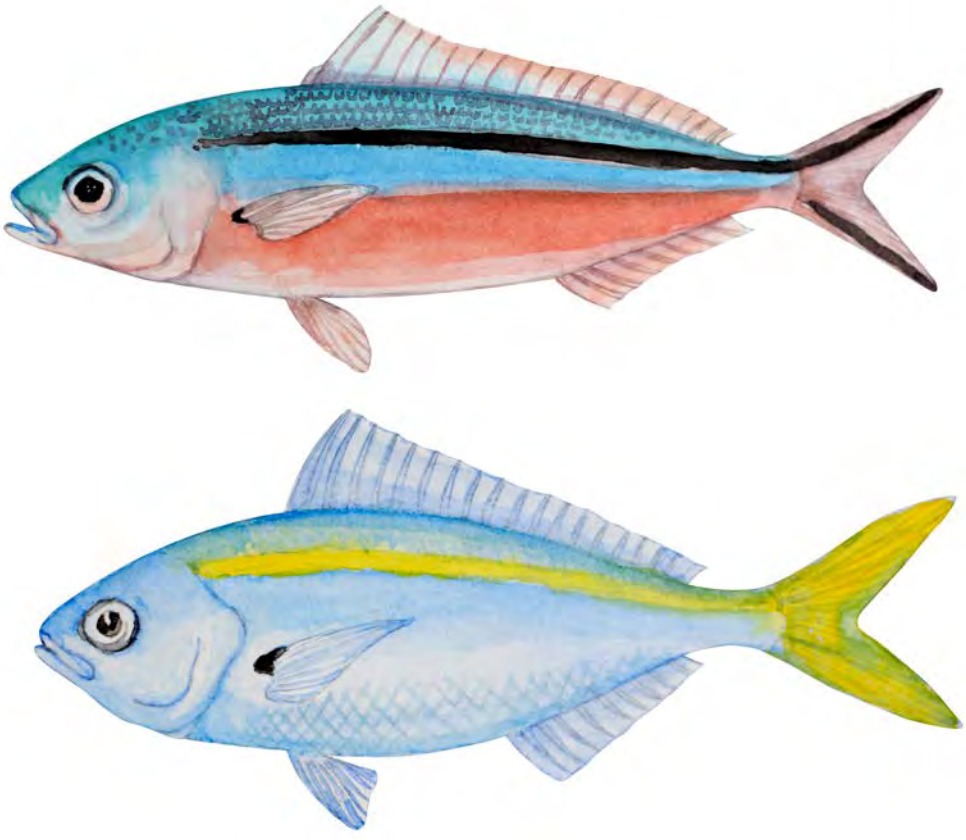

Figure 9. Illustration of a two species of Fusiliers

3. LIVEBAIT FISHING

The overall livebait fishing technique has not changed very much over the years. Fishers have always used a simple lift net for catching livebait. In the past (before the 1970s) the net was made from cotton. The net was small and was operated from the boat with the help of two poles attached to the two sides of the net. The cotton net also damaged easily. Only very small amounts of bait were caught using the cotton. Since the introduction of nylon nets (in early 1970s) the size of fishing net used has increased as nylon is also lighter, stronger and easier to handle than cotton nets. Today very large rectangular nets (90x80 feet) are used on many commercial tuna fishing vessels. When the bait is abundant on the reefs, fishers harvest between 500 to 1000 kg of livebait for their fishing trip.

Fishing gear

Livebait fishing gear includes a rectangular lift net made from nylon. In targeting pelagic species such as sprat, two long poles are used. In targeting benthic species long ropes and lead weights are used to sink the net to the bottom of the sea. The weights could vary from a few kilograms to 10kg, depending on the size of the net and strength of the current (*Figure 10*).

Fishing method

Fishing for livebait takes place both during day and night. There are two basic techniques used in this fishery for targeting pelagic and demersal species. Both pelagic and demersal species such as sprat aggregate on the outer side of the reef. During the day time fishers locate these schools with the help of masks. Swimmers get into the water and look for schools of sprat at the surface or for fusiliers and cardinal fish on the reef slope sheltering near corals.

Day time bait fishing

After locating the school of bait (if it is sprat), with the help of the two long poles attached to the sides of the net, fishers dip the net into the water and lift it, trapping the fish in it. Fishers repeat the process until they have collected enough bait for the tuna fishing trip.

While targeting bottom dwelling fish (cardinal fish and fusiliers) the net is lowered with the help of lead sinkers as close to the coral (where the fish take shelter) as possible. Fishers usually do not allow the net to make contact with the coral since any entangling of net with the coral could tear the net, damaging it. Once the net is lowered to the appropriate depth with the help of ropes, the fishers observe the movement of the bait using their masks from the surface of the water.

"The overall livebait fishing technique has not changed very much over the years. Fishers have always used a simple lift net for catching livebait."

Figure 10. Fishers operating a bait net.

Figure 11: At night several powerful lights are used to attract the bait.

"Sometimes a swimmer on the surface positioned towards the center of the net splashes to scare the small fish and to chase them deeper into the net."

Sometimes chum (fish fillets) is used to lure the bait onto the net. A swimmer dives close to the bottom of the net and spreads the chum over the net. When the bait swims on to the net, to feed on the chum, fishers start to pull the net up. They coordinate and simultaneously pull on the ropes attached to the net making sure that all sides of the net are raised together, thus preventing the bait from escaping.

The swimmers stay afloat with the help of floats as they pull on the net. Sometimes a swimmer on the surface positioned towards the center of the net splashes to scare the small fish and to chase them deeper into the net. If they are targeting bottom dwelling species such as cardinal fish and fusiliers, net is spread just above the coral at the bottom and chum is spread over the net to attract them.

Night time bait fishing

At night, while targeting pelagic bait species (sprat and anchovies), powerful lights are kept lit from one side of the boat for several hours to attract the baitfish. When the aggregation become large, the lift net is slowly lowered from the side of the boat and lifted up (with the help of the two poles) trapping the fish inside it.

At night the schools of fish are located with the help of fish finders. Most modern commercial tuna fishing vessels have fish finders on them for checking the depth of the water within the atoll and to locate bait schools. Once a suitable bait fishing ground is located the boat is anchored and the lights are kept on for several hours. The captain observes the bait school response to the light. When the bait has moved further away from the bottom, towards the light, several fishers enter the water and the net is lowered from the edge of the boat. Once the net touches the bottom, fishers in the water pull on the ropes attached to the far side and corners of the net, spreading the rectangular net on the sea floor beneath the aggregation of bait. Often the net is set in water depths exceeding 30m. All fishers (those in the water and on the boat) work simultaneously to pull the net towards the surface. It takes several minutes to pull the net to the surface (*Figure 11*).

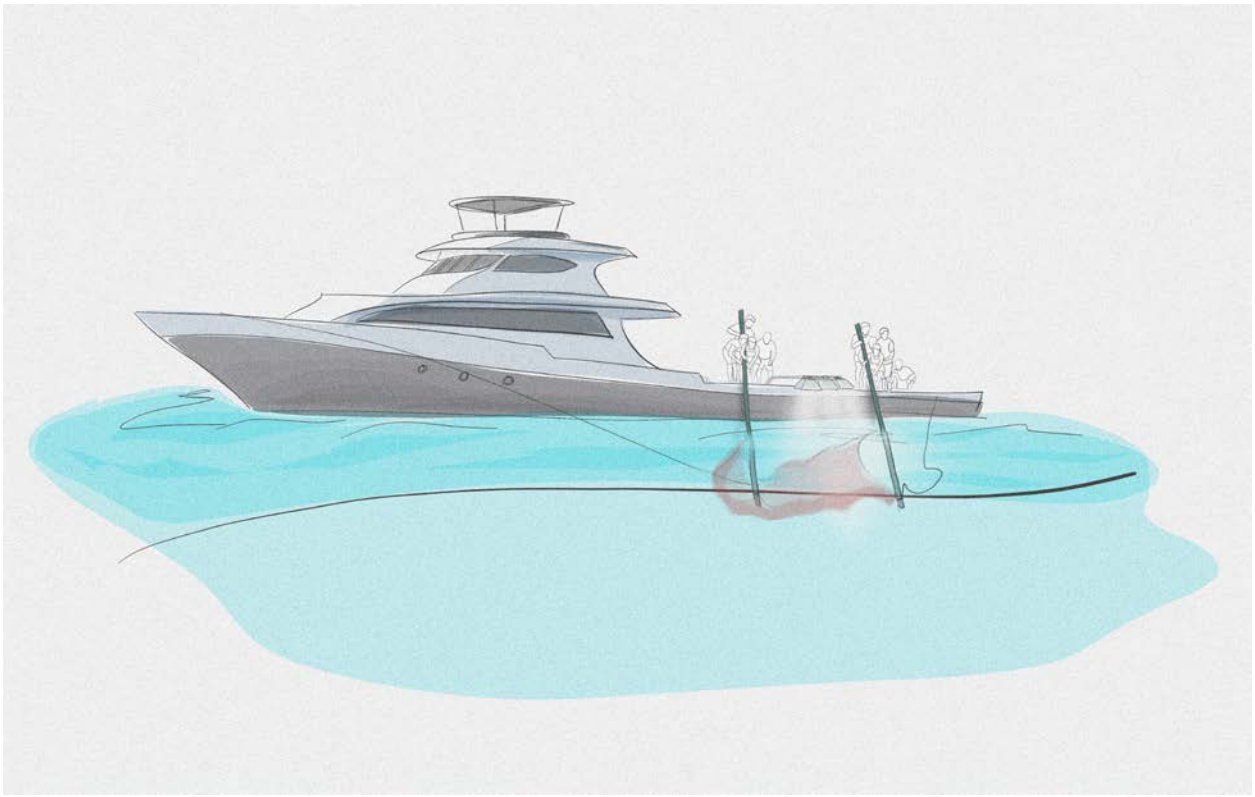

Figure 12 Lowering net into the water - dipping net for surface fishing + light shining

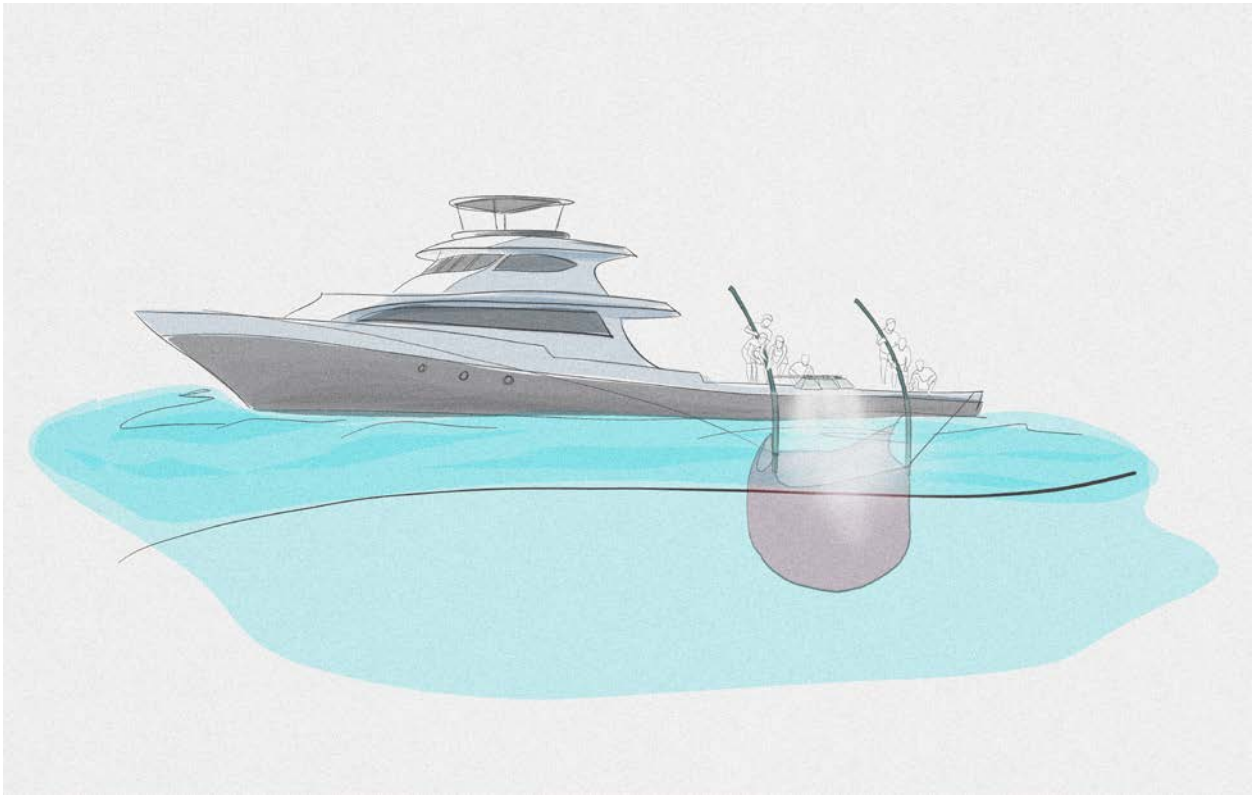

Figure 13 Net lifting - people putting pressure on poles/net gently risingfor surface fishing + light shiningfor surface fishing + light shining

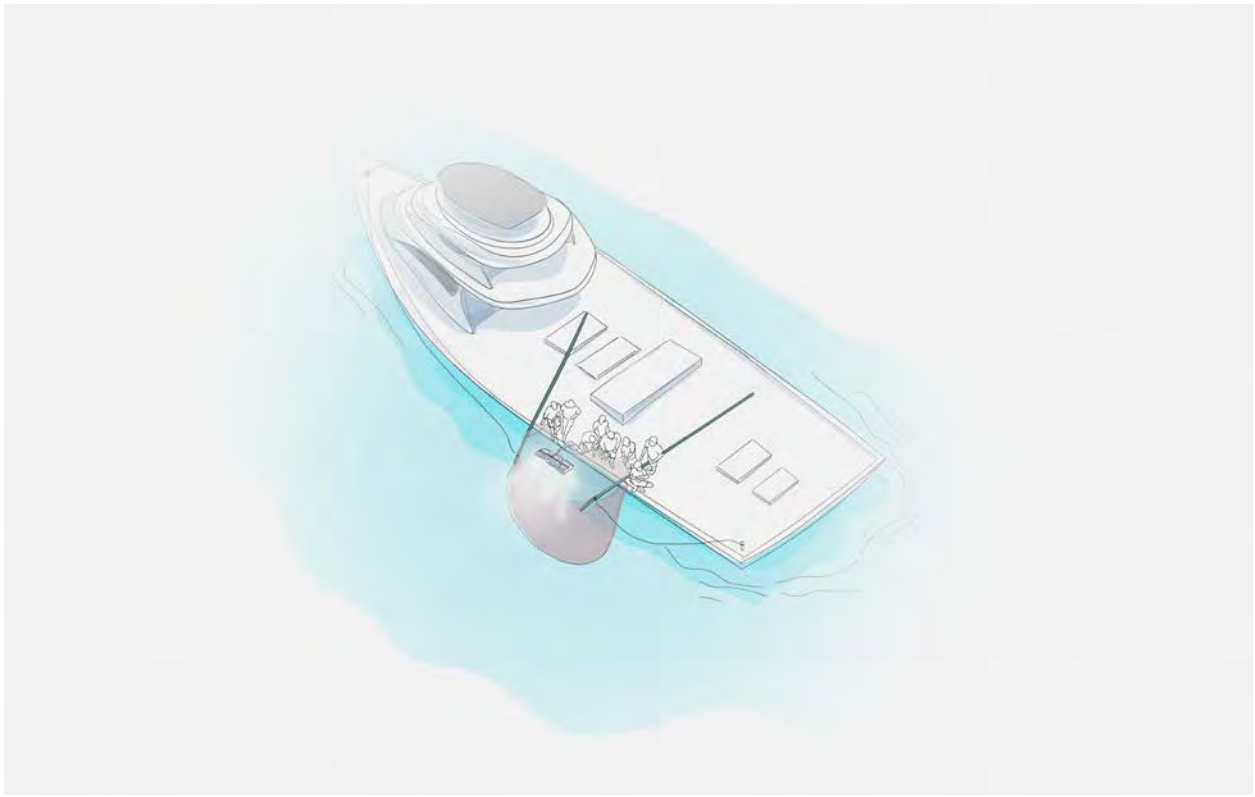

Figure 14 Net at the surface with poles on sides and people pulling on the net and poles

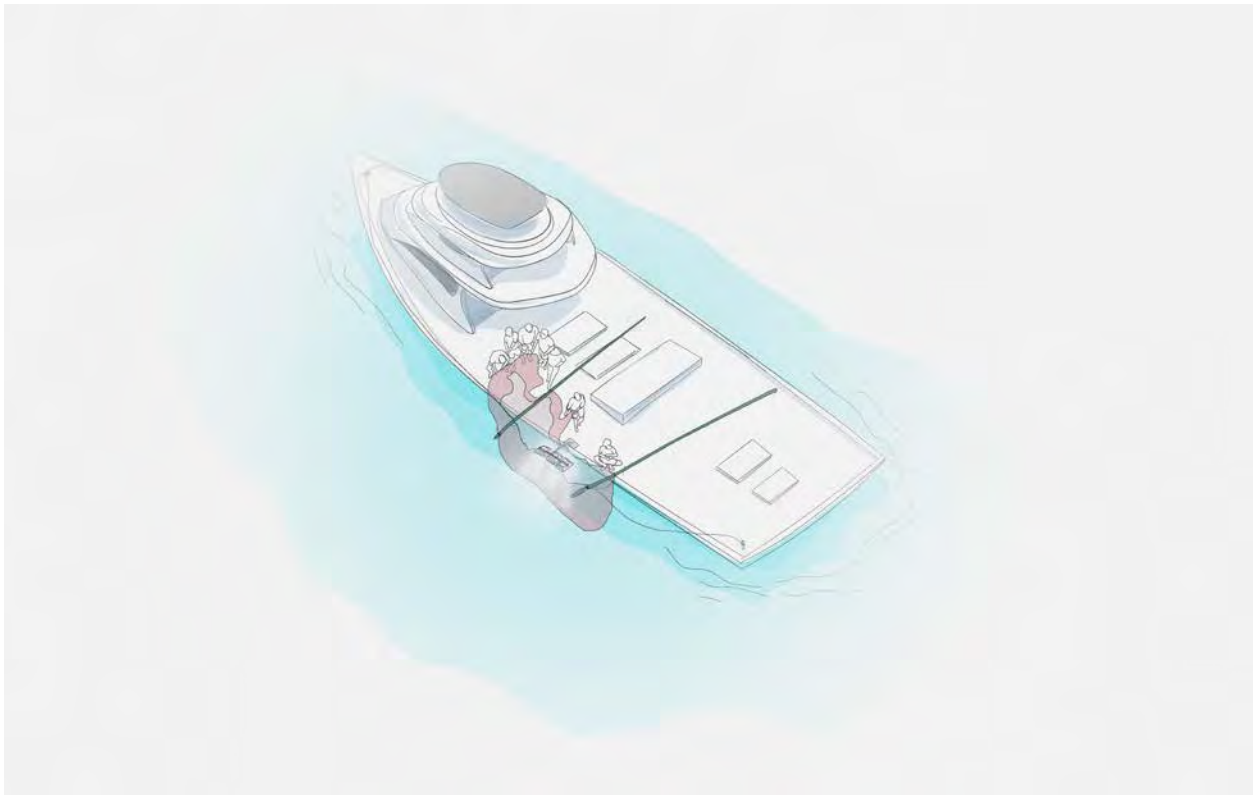

Figure 15 Net close to the boat-poles drawn in + net pulling in and lifted with content (outside view from boat)

Figure 16 Transferring bait from net to hold using net (on top deck-view of bait tank as well)

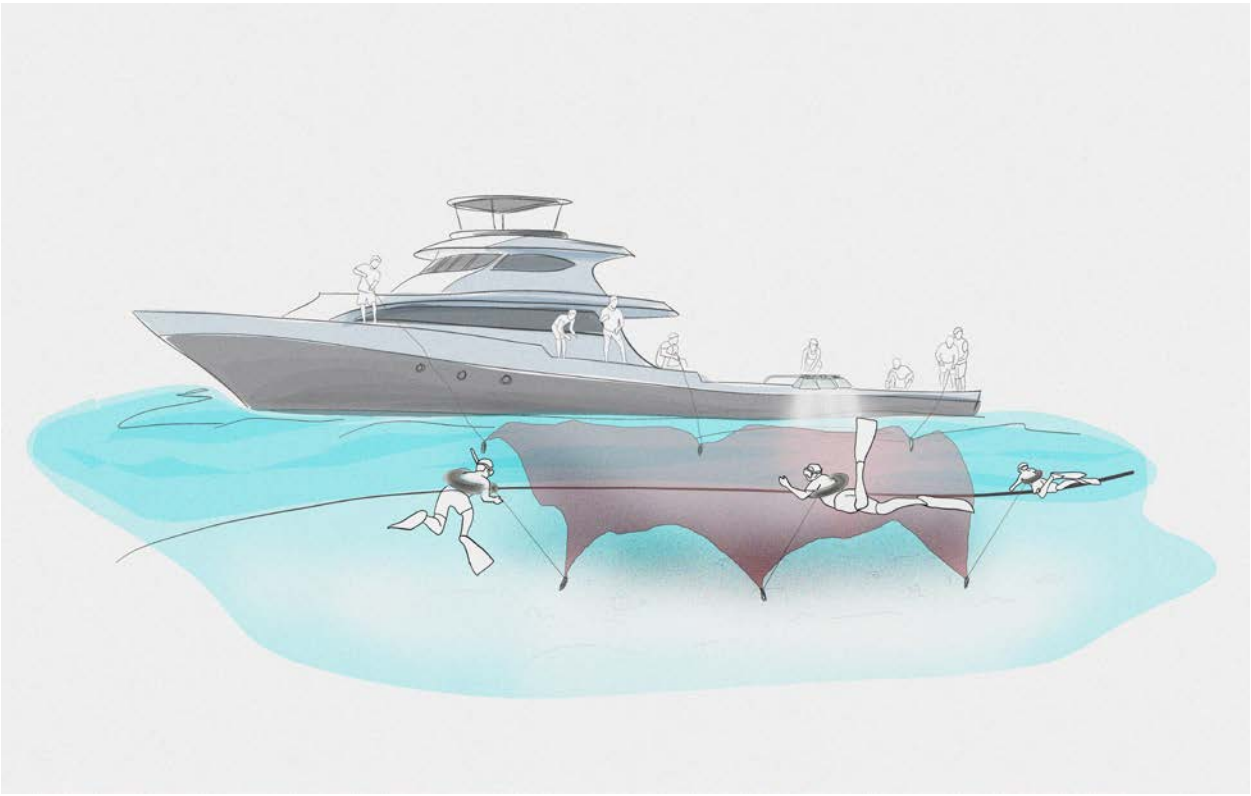

Figure 17 Lowering net into the water-net touching the bottom with weights + lights shining

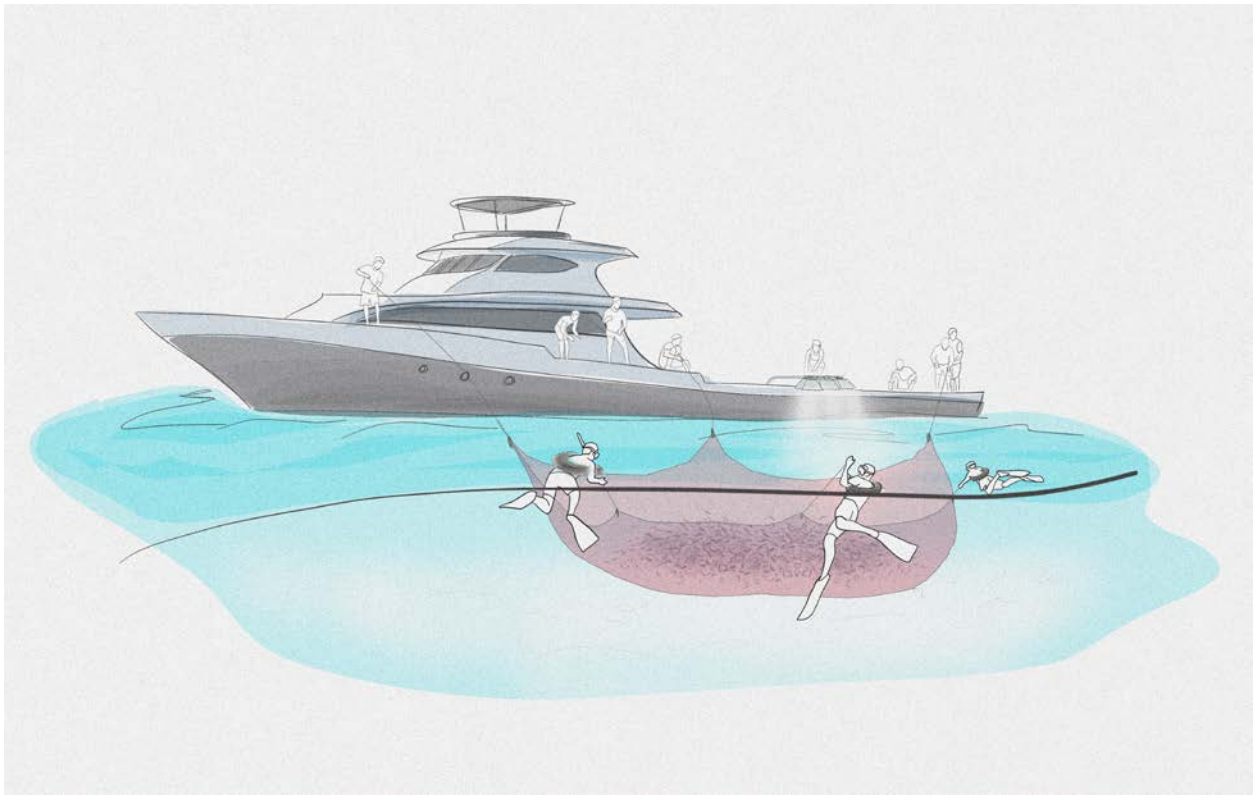

Figure 18: Net lifting-people pulling the net in the water and on boat/net gently rising

Figure 19 Net at the surface - people pulling the net trapping the fish

Figure 20 Transferring bait from net to hold using scoop - net opened by swimmers in water while scoops are used for transferring bait from net to bait hold

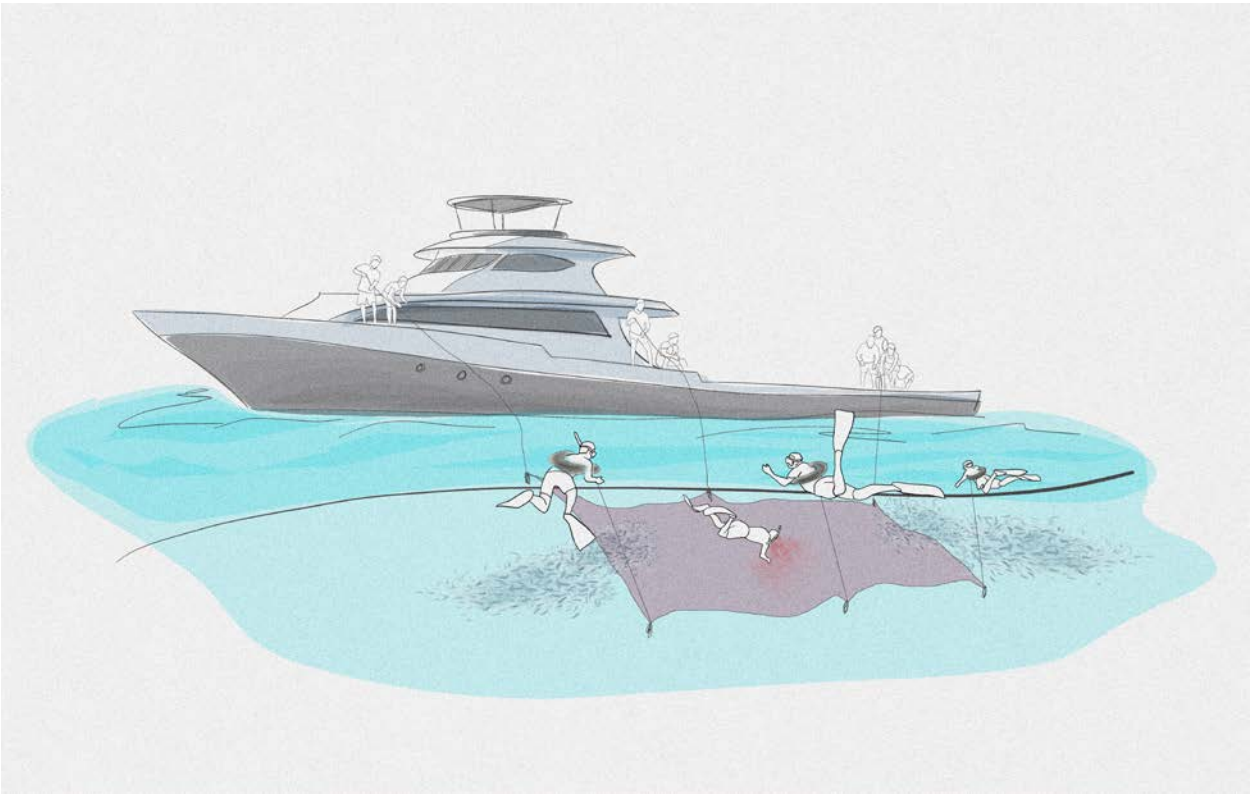

Figure 21 Swimmer diving down and placing chum on the net to attract bait fish

4. LIVEBAIT FISHERY IN NORTH ARI ATOLL

To understand the fisheries trends in North Ari atoll, project REGENERATE in collaboration with the government of the Maldives, administered a social survey with the fishers in North Ari atoll. The survey was carried out in 8 community islands of the Atoll reaching to a total of 71 fishers. These fishers varied from artisanal, commercial to recreational fishers.

The questionnaire administered during the survey had main two sections which is used to distinct the difference between reef fishers and tuna fishers. All the fishers were surveyed on the type of fishing activity carried out, area which is used for fishing and bait fishing, type of live bait used, frequency of live bait, duration of live bait fishing trips, interaction with the megafaunas and the perception towards managing the fisheries with conservation tools such as marine protected areas.

Fishers were asked to map the reefs within the atoll that are used for live bait fishing. These data can be implied in understanding the resilience factor of fishers in reef damaging scenarios such as mass bleaching events.

The maps were on a scale grid, and the fishers were asked to draw the exact areas on the given map. This is to improve the accuracy as most of the time fishers tend to vaguely describe the areas which they used for fishing. The maps were then digitized and processed by using Arc GIS software to identify the density of bait fishing areas within the atoll.

Livebait fishing grounds of North Ari atoll

In North Ari atoll, the most frequently visited reefs that are used as bait fishing grounds are located on the western rim of the atoll. Northern reefs of the atoll have the highest percentage of usage by the fishermen. Reefs such as "*Gangehi maavaru*" and "*Vihamaafaru*", which are in close proximity to Bodufolhudhoo and Mathiveri, are considered as the most heavily utilized reefs as 50% of the fishermen use these areas. Reefs such as "*Ranfaru*" and "*Maafaru*", which are in close proximity to Maalhos and Feridhoo, are also some of the most frequently

In contrast to the western reefs of the atoll, the eastern reefs are utilized less frequently by the fishermen. As most of the resorts of the atoll are located on the eastern side, fishers could be less tempted to engage with the reefs which are in close proximity to the resorts.

A decade ago the reefs which were utilized for bait fishing in North Ari were slightly different from the areas which are being used at present, though not by a huge margin. The most noticeable observation is that the majority of the community house reefs were commonly used as bait fishing grounds. It is known that a decade ago fishers were using smaller sizes of fishing vessel and hence did not travel as far as they are travelling at present.

Some of the fishers claimed that they used reefs from the eastern side of the atoll a decade ago; however, they do not use those reefs at present. The reason for this could be the development of resorts near these reefs (*Figure 22*).

"The most noticeable observation is that the majority of the community house reefs were commonly used as bait fishing grounds. It is known that a decade ago fishers were using smaller sizes of fishing vessel and hence did not travel as far as they are travelling at present."

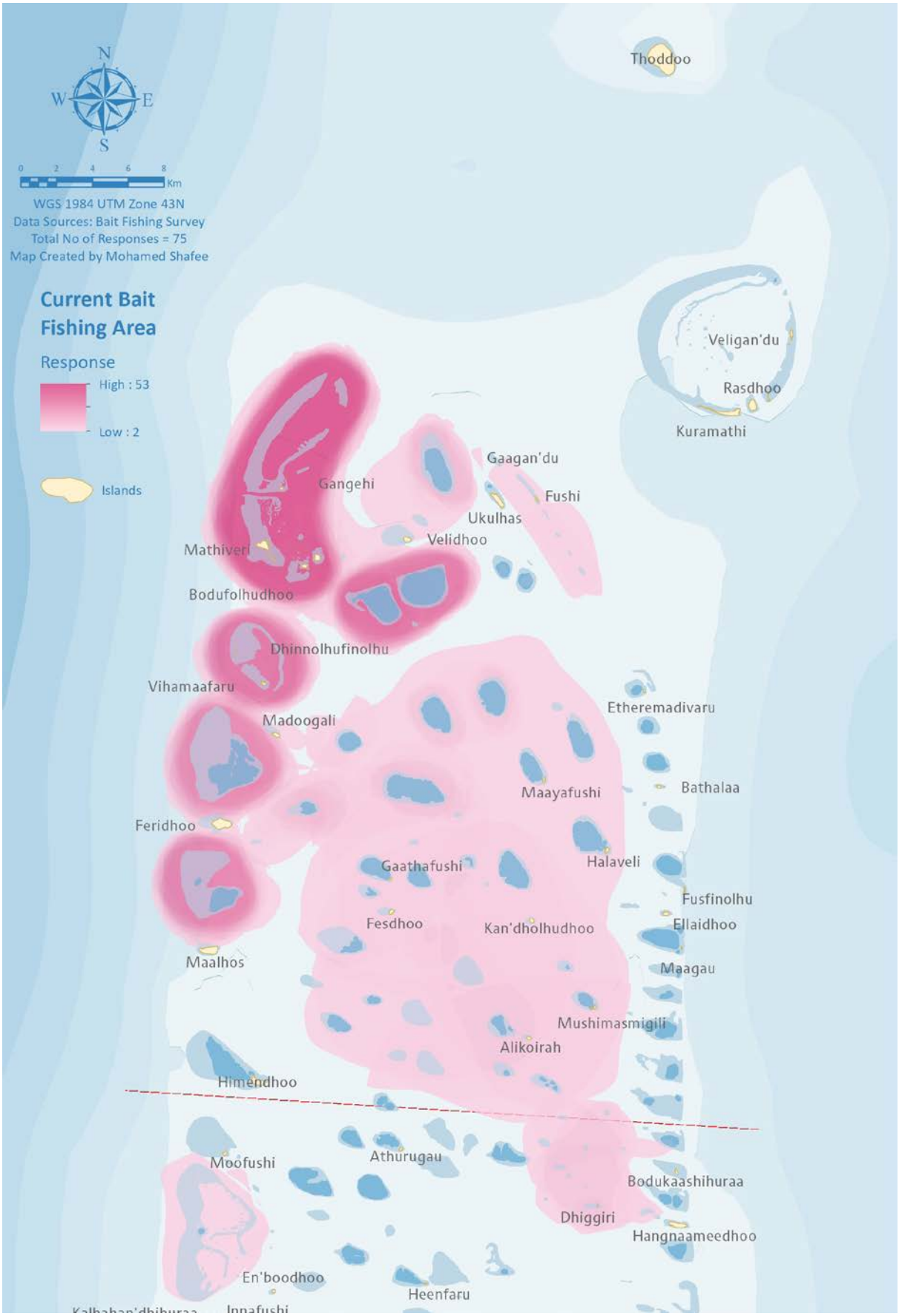

Figure 22 Map showing the usage intensity of current baitfishing grounds in North Ari atoll

Utilization of livebait in North Ari Atoll

In the past, the fishers operated small vessels (<15m) hence only few lines could be operated to catch fish. The bait wells on these vessels were small thus they could store only very small quantities of bait. With such limitation's fishers did not venture too far from shore. Since mechanization of the fishing vessels expanded to all parts of the Maldives in the early 1980s, the fishing vessels have become bigger and today most fishing vessel are more than 20m long (MoFA, 2013) (*Figure 23*).

In North Ari atoll, 19 large fishing vessels (that have a length of more than 20m) operated in the tuna fishery. Since these vessels have bigger bait wells they can also store large quantities of bait. In addition, modern technology have made fishers become more efficient in catching livebait and have also improved their ability to store large quantities of livebait in their vessels too (Anderson, 1994).

There were several shortcomings in the methods of estimation of livebait catches in the past. These included inadequate sampling activities. The most recent estimation was done in 2014 (Jauharee et al. 2015). In 2014, surveys were conducted by MRC to gather data on the livebait fishery. From this data the average livebait catch for a tuna fishing trip was estimated to be 148 kg. In 2014, the total number of tuna fishing trips conducted across the Maldives was 67,993 (MoFA statistics - 2015). Hence the estimated livebait catch for 2014 was about 10,000 tons. In the same year, the total tuna landing was 118,972 tons. Thus the ratio of tuna catch to livebait for 2014 is approximately 11.8 kg of tuna for every 1 kg of livebait (Jauharee et al. 2015).

"In North Ari atoll, fishers mention dolphins and turtles as the ETP species most commonly interacted with."

Interaction between livebait fishers and Endangered Threatened and Protected (ETP) species in North Ari Atoll

Endangered, Threatened and Protected (ETP) species are IUCN red listed megafaunas which are legally protected in Maldives, and which are threatened globally. These include Whale Sharks (Rhincodon typus), Dolphins, Turtles, Manta Rays and all other Sharks and Rays.

In North Ari atoll, fishers mention dolphins and turtles as the ETP species most commonly interacted with. At night, when using lights to catch livebait manta rays and dolphins are attracted to the planktons which are aggregate under the light. Turtles do not approach these aggregations of plankton. Turtles are sighted mainly during daytime bait fishing events. Dolphins, turtles and sharks were never reported being trapped inside the bait net but sometimes stingrays and manta rays do get caught in the net. Any such large organisms are released before

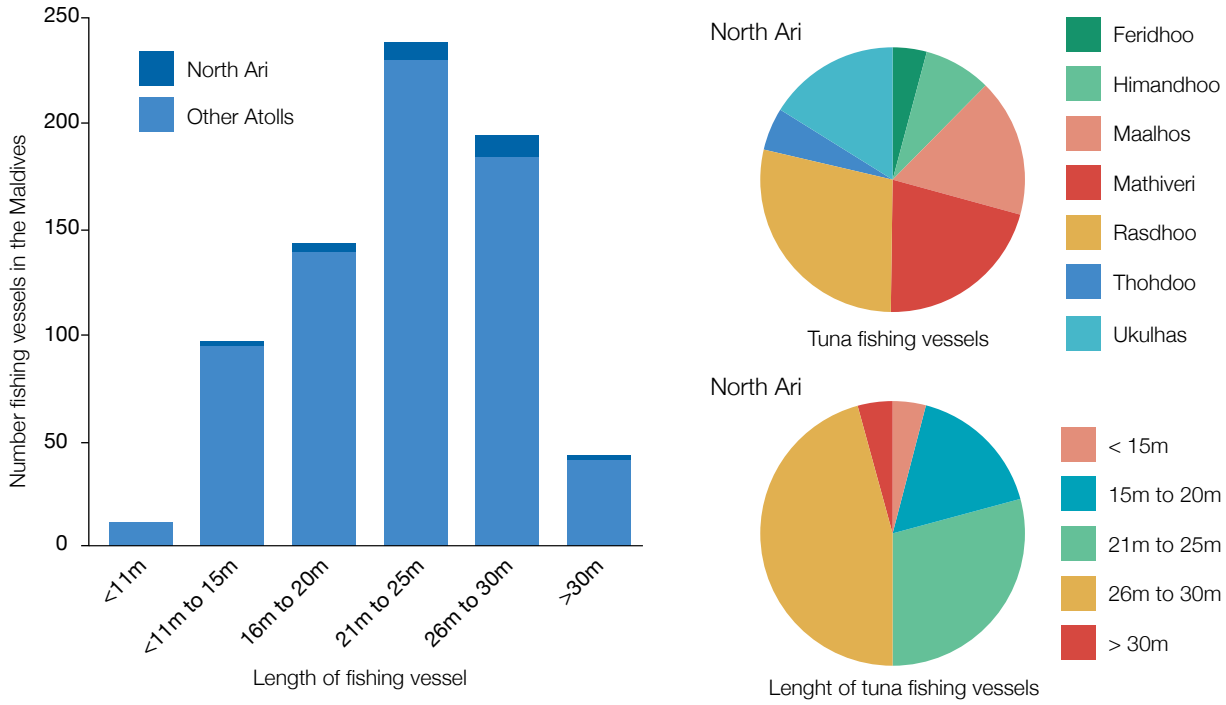

Figure 23 Most tuna fishing vessels which harvest large quantities of livebait operated in the Maldives including north-ari are more than 20m long (MoFA – 2013).

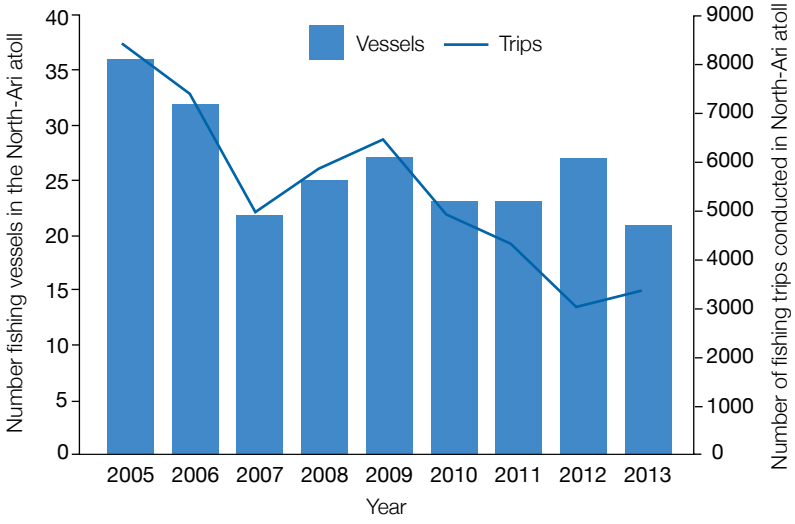

Figure 24 Both number of fishing vessels and fishing trips have declined over the years in North Ari (MoFA, 2005 to 2013)

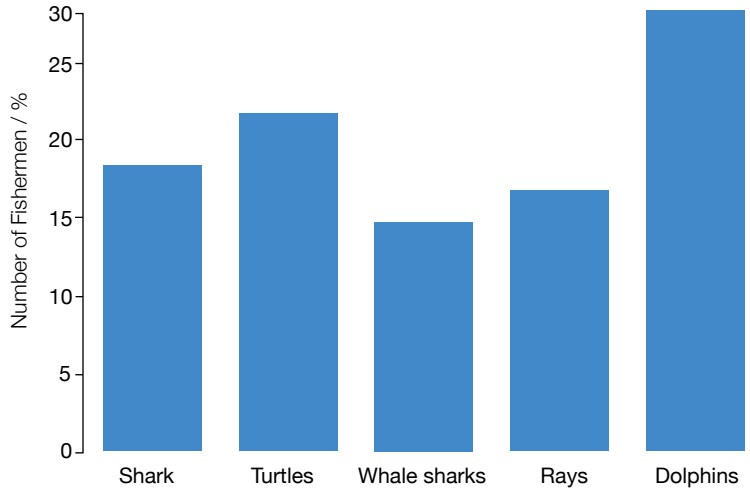

Figure 25 Several fishers acknowledge sighting and interaction with ETP species during bait fishing operations.

the net is completely surfaced as these organisms are of no use to the fishers and can easily destroy the bait net made from very fine nylon (*Figure 25*).

Fishers mention that they also interact with turtles, which are often seen entangled in ghost nets. As per the fishers, this is most common during the north-east monsoon. When such a scenario occurs, fishers sometimes remove the turtle from the ghost nets.

Interactions between fishers and the coral reef ecosystem

The coral reef ecosystem serves as a vital source of income for the fishermen as they are direct beneficiaries from the species living in the coral reefs. Fishers who do bait fishing daily interact with the coral reef ecosystem, as the majority of the bait species caught are closely associated with the coral reefs. A healthy coral reef with complex microhabitats and high rugosity is important for the production of reef fish and baitfish. If coral reefs degrade and lose their structural complexity because of coral mortality events, there can be negative impacts on reef fish and baitfish populations.

Fishers also anchor in the coral reef ecosystem, which is a negative interaction. Anchoring on the reefs does heavy damage on the coral reefs by destroying corals and breaking down reef habitat. Anchoring on the reef is a major source of conflict between bait fishers and tourism stakeholders such as resorts and SCUBA divers. Increase in night time bait fishing has reduced the number of boats anchoring on house reefs of islands. During night bait fishing boats are anchored further away from the reefs in deeper waters to avoid boats running aground due to changes in current or weather condition.

"Anchoring on the reefs does heavy damage on the coral reefs by destroying corals and breaking down reef habitat. Anchoring on the reef is a major source of conflict between bait fishers and tourism stakeholders such as resorts and SCUBA divers. Increase in night time bait fishing has reduced the number of boats anchoring on house reefs of islands."

5. RECOMMENDATION FOR SUSTAINABLE MANAGEMENT OF LIVEBAIT RESOURCES.

Maldives fishers have not experienced sustained shortages of fishery resources. Hence, some fishers have the belief that fisheries resources are unlimited, cannot be overexploited and does not need management interventions. Most fishers do not understand the need and benefits of fisheries resource management. When one species of livebait is short in supply fishers target other livebait species or travel to other areas where there is more bait. Livebait fishers from the southern atolls often complain about shortages in livebait resources. In the recent years some fishers from the southern atolls have travelled more than 700 miles (all the way from Addu to Lhaviyani atoll and back), for collecting the livebait. Fishers from North Ari-atoll also collect their livebait from nearby atolls. This is often due to seasonal variation in livebait stocks across the Maldives.

During some years an unusually high abundance of sprat is found near reefs across the Maldives. In 2016, several communities reported large quantities of sprat in their island lagoons/harbours. Many communities caught these sprats and distributed among community members for their local consumption. Several pole-and-line vessels caught sprat from the same harbour where the vessels were anchored and used it for catching tuna.

Some other issues associated with the bait fishery include high postharvest mortality due to poor handling of bait and poor circulation of seawater in the bait tanks. Fishers themselves have been raising questions on the impacts of using powerful lights, to attract bait at night, on the ecosystems. Observations during field work has shown that during some seasons very large quantities of plankton including fish larvae of many reef organisms gather under the light. There are no regulations limiting number and intensity of lights used. In addition several pole-and-line fishers now use scuba gear for livebait fishing.

With the open access to the livebait fishery resources across the Maldives managing this fishery resource can be challenging. In addition traditional beliefs among fishers also have a significant impact on resource management. For a very long time Maldivian fishers have targeted large resilient fishery resources such as bait and tuna that showed little response to heavy fishing in the past. This experience has made them believe that fishery resources are inexhaustible hence implementing management measures in this fishery will require a lot of effort. Fortunately several reefs are already designated as protected areas which would have a positive impact on the livebait stocks.

For any management measures to be successful it must be fully supported by those working in the fisheries. These measures must be finalised through extensive discussions among stakeholders. It should be efforts towards ensuring the continuous availability of livebait for pole-and-line fishers and creating awareness among fishers on the importance of managing livebait fishery resources. Emphasis should also be on reducing postharvest mortality, negative impacts on the ecosystems. Some of these management measures should be in place at all times while others can take effect when necessary and should be decided based on continuous monitoring of livebait fishery resources. Ongoing field by MRC staff and based on the data gathered through pole-and-line logbooks suggest that it will be most appropriate to manage bait stock at atoll level. For atoll level management measures to be successful monitoring needs to take place at atoll level to detect changes in catch rates.

Suggested management measures includes:

1. Properly implement the existing data collection mechanism to obtain information on catch trends at atoll level and use the data collected to produce annual reports
2. Discourage alternative use of livebait including the sale of baitfish species at the local markets
3. Any new gear for bait fishing should be approved by MOFA
4. Effectively enforce the regulations on marine protected areas
5. If severe declining of livebait resources be evident more exclusion zones should be set up and size limits on baits and lights used for bait fishing should be in place.

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