BLUE MARINE FOUNDATION

RESOURCE USE SURVEY REPORT: LAAMU ATOLL

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EXECUTIVE SUMMARY

In November 2018, Laamu Atoll Council declared their interest to protect five ecologically significant areas in the Atoll. Blue Marine Foundation (BLUE) and its locally affiliated NGO, Maldives Resilient Reefs (MRR) aim to support Laamu Atoll and Island Councils to achieve their vision of protecting these two areas: Fushi Kandu (Channel) and Hithadhoo Gaadhoo Kandu. Together with its partners, BLUE wants to create, and field test a model for marine conservation in the Maldives, in Laamu Atoll. The model will seek to combine effective management of small-scale fisheries with reef protection in a network of locally supported and managed Protected Areas (PAs).

It is crucial for the success of the protected areas that local stakeholders support its design and are involved in the process. Laamu Atoll is extremely biodiverse, and its natural resources support many industries and user groups. However, their activities are not well understood or quantified. By better understanding the activities of exploitative industries around Laamu Atoll it is hoped that effective marine conservation initiatives can be developed to ensure the ecosystems around the atoll, and the resources they provide, are not overexploited and to maintain their capacity to support the people who depend on them. To achieve this, BLUE carried out extensive surveys of the key resource user groups on Laamu Atoll that operate both within the proposed PAs, and in adjacent areas around Laamu Atoll.

This study represents the collection of one of the most comprehensive data sets on resources use around Laamu Atoll, considering a range of key user groups who exploit Laamu's natural resources. The dataset provides a good baseline to measure future change of resource use activities, practices, and perceptions in response to changes in the natural resources or to interventions. 240 responses to the fisheries resource use survey were gathered from across 11 inhabited islands on Laamu Atoll. Of these responses, 199 were male fishers and 41 were female fishers. 146 interviewees considered themselves to be commercial while 92 were non-commercial.

Results showed that the reef areas (<2.5km from land) of Laamu are extremely important in supporting several commercial fisheries including the reef fish, billfish, bait fish, sea cucumber and lobster fisheries. The largest commercial fishery, in terms of involvement (58% of respondents) and spatial footprint, is the reef fishery which operates to the North, East, South and West of Laamu, Spatial analyses showed that the areas around Isdhoo, Kalaidhoo, and Dhanbidhoo, areas around Maabaidhoo and Mundoo and areas around Hithadhoo are particularly critical areas for this fishery.

The main method of capture is handline and the top target species are: Two-spot red snapper, Humpback red snapper, Long nose emperor, Small tooth emperor and Bluefin trevally. Further away from the land the tuna fishery is another substantial fishery (35% respondents involved), with a spatial footprint that covers the southern and eastern outside areas of Laamu extended from 2.5 k m to up to 40 km away from the island. This fishery is dominated by the use of pole and line to catch a few tuna species : Skipjack (100% of tuna fishers target), Yellowfin (59% of tuna fishers target), Frigate (33% of tuna fishers target) and 'other' species (11% of tuna fishers target).

Typically, fishers rated the status of fisheries they were involved in as being very good, however, in each fishery tresponses ranged of responses from very good through to very bad. The exception again was tuna where most fishers rated this fishery to be in the worst shape possible.

Fisheries resource use activities were also assessed in respect to proposed PA's around Laamu. From these results we have shown that the newly proposed PAs, if introduced, would meet conflict with mainly commercial and non-commercial reef fishing and bill fish fishing activities. The proposed PA boundaries around Hithadhoo Gaadhoo and Fushi Kandu are identified as important areas for this. This is likely due to these two areas being identified as key channels between inner and outer areas of the atoll. Both areas are well known for their high biodiversity, their ecological significance as a breeding site for a wide range of species and therefore likely leads large aggregations of reef fish and bill fish. The bait fish fishery is also an intense fishery inside of the Vadinolhu Kandu area and is another fishery to consider if management was to be applied in this area.

In addition to fisheries resource uses, 11 local councils, 25 local reef fish export companies, 41 NGOs, two luxury resorts and one fish factory were surveyed on Laamu, between December 2020 and June 2021 to understand their resource use activities. Both Hithadhoo- Gaadhoo Kandu and Fushi Kandu channels are used by tourists from a nearby resorts for diving, snorkelling, dolphin watching and some fishing which, again, would need to be considered in the context of bringing in management in these areas.

This study provides the first baseline for marine resource use on Laamu Atoll and is important to monitor future change in resource use. The results from this study should be considered when management interventions are designed for the forthcoming Protected Areas and for any fisheries management measures at the local and national levels. The resource users who would be most impacted by future management interventions have been identified who should be actively engaged when designing management interventions and livelihoods diversification options.

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1.0 INTRODUCTION:

The Maldives' National Biodiversity Strategy and Action Plan (NBSAP) 2016–2025 update submitted to the Convention on Biological Diversity (MEE, 2015) states in its Strategy 5, Target 18 that at least 10% of coral reef areas, 20% of wetlands and mangroves, and at least one sandbank and one uninhabited island from each atoll would be under some form of protection and management by 2025. Further, the government of Maldives, in its Strategic Action Plan (President's Office, 2019), has committed to protecting at least one island, one reef and one wetland in each atoll by 2023. In 2019, Maldivian Government signed an MoU with the Blue Prosperity Coalition to embark on a marine spatial planning exercise with the aim of fully protecting 20% of the Maldivian ocean by 2025 (PO, 2019).

In November 2018, Laamu Atoll Council declared their interest to protect five ecologically significant areas in the Atoll.

Four of these areas are around the:

1. Hithadhoo-Gaadhoo Channel which was proposed as a Habitat/ Species Management Area (for its significance as a breeding site for marine species); and
2. Fushi Channel which was proposed as a Habitat/ Species Management Area (for its significance as a breeding site for marine species).

Blue Marine Foundation (BLUE) and its locally affiliated NGO, Maldives Resilient Reefs (MRR) aim to support Laamu Atoll and Island Councils to achieve their vision of protecting these two areas. BLUE is a charity that is dedicated to creating Marine Protected Areas (MPAs) and has both the expertise and resources to support the Laamu Atoll Council to protect these areas effectively. Together with its partners BLUE wants to create, and field test a model for marine conservation in the Maldives, in Laamu Atoll. The model will seek to combine effective management of small-scale fisheries with reef protection in a network of locally supported and managed MPAs.

Community involvement in the planning and development of MPAs is a key predictor of their success. It is crucial for the success of the MPAs that local stakeholders support its design and are involved in the process. Laamu Atoll is extremely biodiverse, and its natural resources support many industries and user groups. However, their activities are not well understood or quantified. Environmental protection is fundamental to the future of the Maldives. By better understanding the activities of exploitative industries around Laamu Atoll, it is hoped that effective marine conservation initiatives

can be developed to ensure the ecosystems around the atoll, and the resources they provide, are not overexploited, and can maintain their capacity to support the people who depend on them.

To achieve this, we carried out extensive surveys of the key resource user groups on Laamu Atoll that operate both within the proposed Protected Areas (PAs), and in adjacent areas around Laamu Atoll. Human activities inside and outside the boundaries of the PAs, both in the sea and in coastal areas, may directly affect decisions made in the design and management of a PA. Results from these surveys are analysed for each user group and their activities are defined and quantified. The activities of each group were then combined to give a better understanding of key areas around Laamu Atoll that support high levels of resource use, how these activities between groups interact with each other and the extent to which the marine areas inside proposed PAs support resource exploitation. The findings of the research are to be presented to relevant local and national stakeholders, as a tool to help with designing management interventions.

1.1 RESEARCH PROJECT AND OBJECTIVES

Resource users develop detailed knowledge of their resources, their environments, and their extraction method or practices (Neis et al. 1999). This information has long been used by some fisheries scientists as background knowledge (Smith 1994; Hutchings et al. 1997).

Resource users' knowledge is rarely collected in a systematic manner. In general, little of fishers' information has been used, relative to what is present or to what might be used in resource management (Berkes 1993). Personal interviews with fishers can elicit large amounts of information on both commercial and non-commercial species related to fish behaviour and fishing practices. Our objective was to conduct detailed surveys with a range of resource users known to exist on Laamu Atoll and elicit a baseline understanding of current exploitation. A secondary objective was to use this data to assess change over time by repeating these surveys in the future. Surveys examined all known extractive uses of living marine resources.

Between December 2020 and June 2021 BLUE and its partners conducted a series of semi--structured interviews. Questionnaires were developed for the different target groups and interviews were conducted with local island councils (n =11), fishermen (n=240), Non-Governmental Organisations (n = 41), local businesses (Fish factories (n = 1) and reef fish exporters (n = 25)) and tourism operators (n =2).

Results from these surveys are presented here. A key element of these surveys was understanding the spatial distribution of the different resource use on Laamu Atoll. Here, results have been mapped to show heavily used areas on Laamu Atoll and decipher which areas may be best suited for protection. This information will also help to identify which resource users may be impacted with the introduction of conservation measures so that mitigation measures can be considered to reduce impact on livelihoods and sustenance.

2.0 METHODOLOGY

2.1 STUDY AREA

Laamu Atoll (Figure 1) (also known as Haddhunmathi Atoll) is in the South-Central Province of the Maldives, at the southern end of the double chain of atolls that comprise the Maldives archipelago. It is mainly rimmed by barrier reefs, the broadest of which is topped by islands. There are many islands along its eastern and southern boundaries. Its reefs are generally of little breadth, with no signs of vilu (deep pools), except for its eastern fringes, covered with islands that are quite large by Maldives standards.

No protected areas have been established under the Environmental Protection and Preservation Act (4/93) on Laamu atoll. Hithadhoo-Gaadhoo Kandu and Fushi Kandu areas are ecologically significant areas which contain connected marine habitats; coral reefs, seagrass meadows and mangroves, and are biodiversity hotspots including manta ray cleaning sites, groupers spawning sites and turtle nesting sites.

Laamu Atoll residents live across 11 inhabited islands, and these include Laamu Gan, the largest island in the country at 8km long (NBS 2019). Gan is connected to its neighbours Kadhdhoo and Fonadhoo by causeways, creating the largest settled area in Maldives outside Male' and Addu Atoll. The capital island of the atoll is Laamu Fonadhoo.

Laamu Atoll has a recorded population of 18,281 people (9,364 males and 8,917 females) (NBS 2019). There are 11 inhabited islands, 61 uninhabited islands, three operational resort islands, 11 islands under resort development, six industrial islands specialized for fisheries, agriculture, and aquaculture purposes. The total number of islands on Laamu atoll is 75 (President's Office 2020).

The main economic activity of the atoll is fisheries and agriculture (NBS 2019). The tourism sector is still developing in the atoll, with only two operational resorts and 11 resorts leased for development. The atoll has significant ecosystems of mangroves, wetlands, coral reefs, and seagrass, and there are numerous archaeological sites.

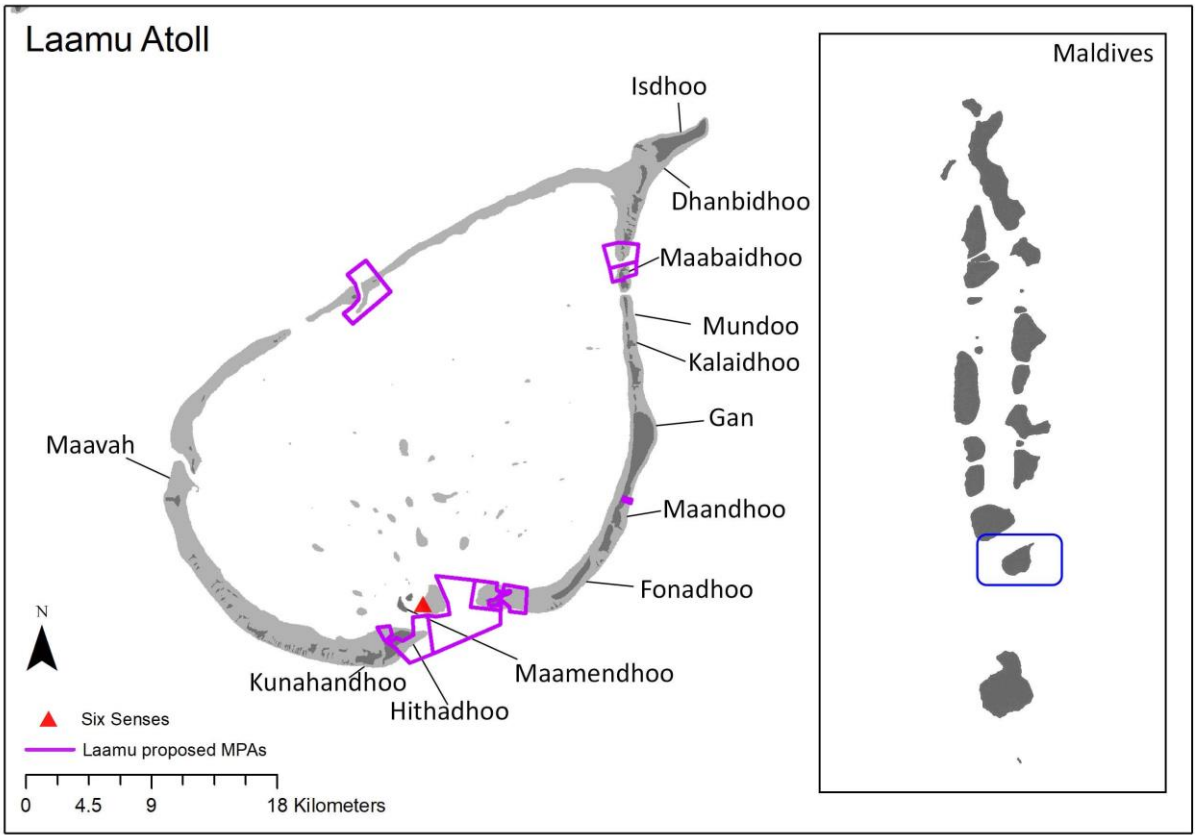


Figure 1. Study area and approximate geographic distribution of Laamu Atoll islands proposed PAs and Six Senses resort is displayed (red triangle).

The proposed Protected Areas (PAs) in Laamu Atoll around Fushi Kandu (Northeast) and Hithadhoo Gaadhoo Kandu (South), are mapped, plus additional PAs to the North and East (near Maandhoo). The surrounding islands where surveys were carried out as part of these project have been identified (Figure 1).

2.2 SURVEY DESIGN

Semi-structured interview questionnaires were developed and tested for the different target (resource) users. The following resource user groups were assessed:

- Fishers
- Island Councils
- Local fish factories
- Non-Governmental Organisations (NGOs)
- Reef fish exporters
- Tourism operators

Surveys contained both quantitative and qualitative question formats to: (1) define the activity; (2) understand the spatial activities (3) document the level of effort/exploitation and (4) define the demographics of each user group (for full questionnaires see Annexes 1-7).

Initial interviewees were identified using prior knowledge and understanding of resource users of each island from discussions with islands councils and following a 'snowball sampling' protocol, where interviewees were asked to assist researchers in identifying other local potential interviewees (Babbie 1989). In each island, for each fishery, the research team aimed to cover 30 per cent of reported fisher numbers/ vessels by the respective Island Councils. Interviews were conducted face to face except for local NGOs and local fish factory interviews on Laamu Gan.

Surveys were designed and carried out using Survey123 provided by ArcGIS. Survey123 is a mobile data collection application which integrates into the Esri ArcGIS platform. The surveys were conducted using tablets and mobile phones, with researchers present, and all data were stored online in a protected database which could only be accessed by authorised members of staff from BLUE and MRR, complying with the European Union General Data Protection Regulation (GDPR). A waiver was obtained by all interviewees prior to each survey being carried out to gain consent to this survey programme.

Answers were either quantitative, long text or spatial, depending on the question asked. Spatial questions included a mapping component with spatial data recorded on a map of Laamu Atoll and polygons were drawn by hand by the interviewee with assistance from the researcher using Survey123. These polygons corresponded with an activity the interviewee said they were involved in e.g., tuna fishing. Multiple polygons could be drawn for the same activity to indicate different areas these interviewees activities took place in. Users were also asked a range of other questions to describe typical seasonality, resources/species targeted, timing, place, methods used and earnings.

2.3 DATA ANALYSIS

Data were analysed using a combination of quantitative and qualitative analytical methods. Descriptive statistics were calculated when analysing demographics of interviewees for each resource user group. Quantitative data analysis was undertaken using Microsoft Excel. Where data can be presented in an aggregated format (e.g., engine power) averages are provided. Where a range of values were given (e.g., income) the mid-point was used for analysis. Interviewees were able to select more than one answer (e.g., fisheries involved in) and so frequency answers (%) in some instances equate to greater than 100%.

Qualitative data were extracted and analysed using NVivo (QSR International Pty Ltd. (2020) NVivo (released in March 2020), https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home) text analysis software which enables analysis of open-ended responses. The analysis involved coding responses into themes, the themes of which were based an initial review of interviewees answers.

Spatial analyses were carried out using ArcGIS 10.3.1 to identify areas of overlapping interest using spatial data composites. Assuming that overlapping polygons correspond to a higher density of activity, we computed the kernel density of resource use activity for all areas identified by interviewees. The Kernel density method generalizes incidents for the entire study area. It also gives a better indication regarding hot spot areas (Shahrabi and Pelot 2009).

Spatial analyses were undertaken at the Atoll level for resource use. Further analyses at the Laamu proposed PA level were also undertaken to provide finer scale resolution of resource use activities inside PA boundaries.

3.0 RESULTS

3.1 RESOURCE USE ACTIVITIES IN LAAMU ATOLL

3.1.1 FISHERIES

A total of 240 responses to the Fisheries resource use survey were gathered from across 11 inhabited islands on Laamu Atoll (Figure 2a). Of these responses 199 were male fishers and 41 were female fishers. Across all responses the average age was 74 years old (sd = ±6.9 years). Fishing experience

ranged from a maximum of 60 to a minimum of 1 years, with the average being 22 years (sd = ± 8.4 years). 146 interviewees considered themselves to be commercial while 92 were non-commercial. Most fishers interviewed were involved in the tuna and bait fishery with 97% of these fishing on a commercial basis. The reef fishery was the next most popular commercial fishery but had a much higher (74%) proportion of non-commercial fishers. The invertebrate fishery was the only non-commercial fishery on Laamu Atoll. A breakdown of commercial and non-commercial fishery involvement in the different recognised fisheries is provided below (Figure 2b).

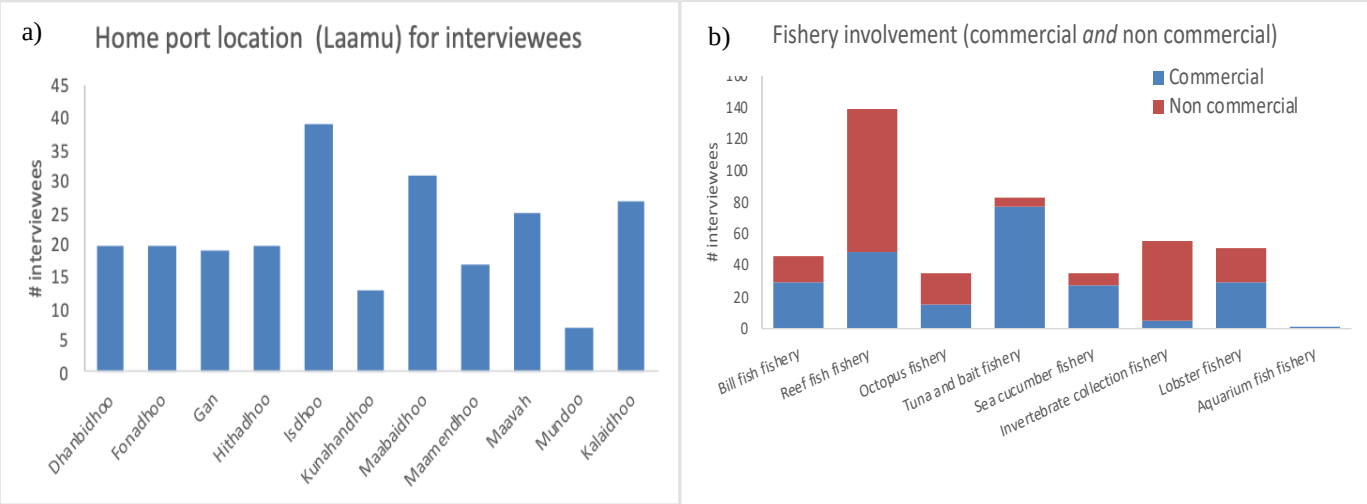


Figure 2. a) Interviewee home port locations, b) Breakdown of commercial and non-commercial involvement of interviewees, by fishery.

Fishers ranged from single working fishermen on vessels without an engine through to fishers that work with up to 18 other people with engine sizes over 300 horsepower (Figure 3a). Interviewees were asked about their income from the different fisheries they are involved in. They were also asked to rank these fisheries in order of importance for their income (1 = most important). If fishers were just involved in one fishery this was scored highest (1) (Figure 3b).

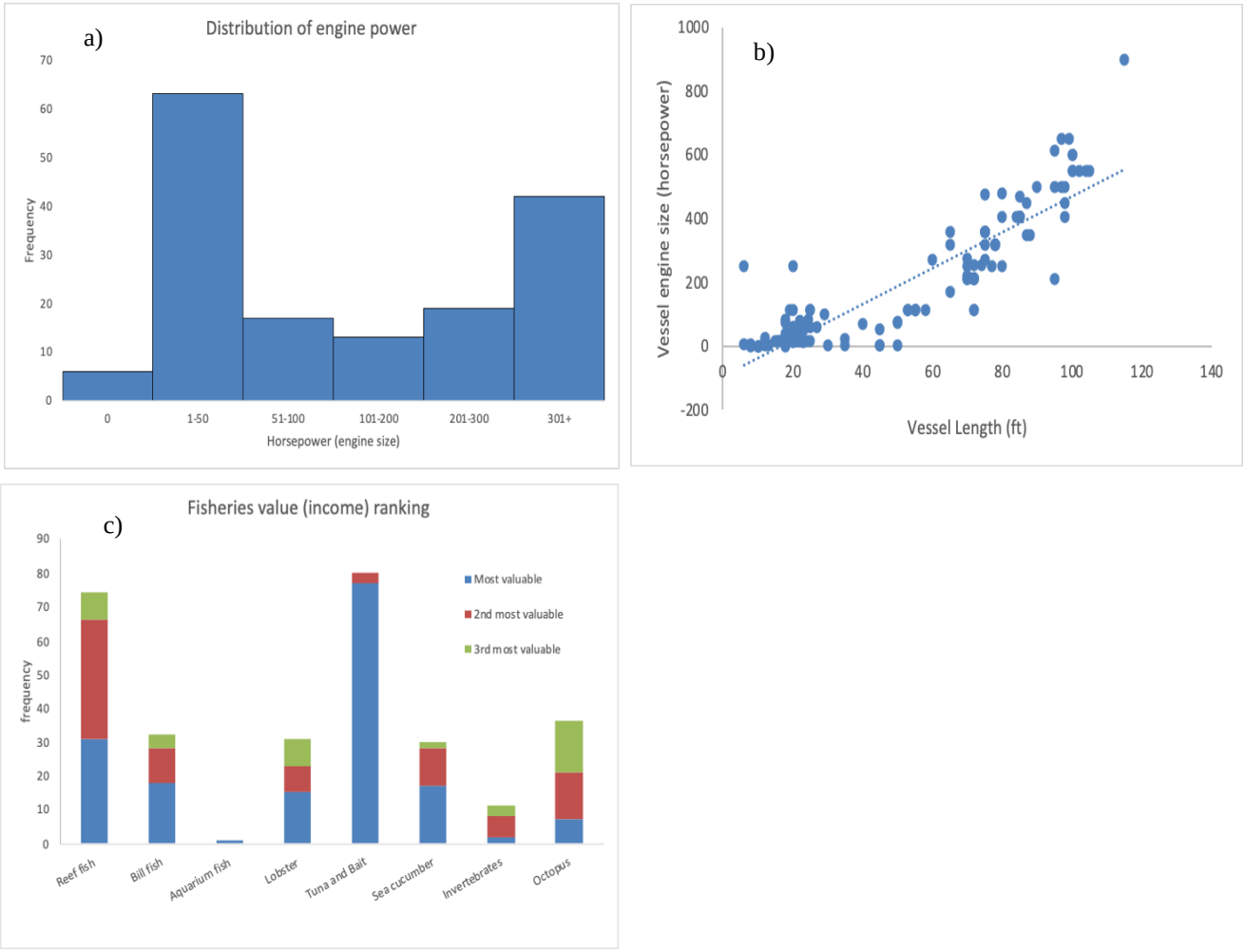


Figure 3. a) Horsepower frequency of all fishers, b) Vessel length, engine power relationship. Each point = 1 fisher and c) Interviewees ranking for economic importance (top 3) of fisheries they are involved in.

Kernel Density analysis of spatial activities of both commercial and non-commercial fishers for all fisheries show that density hotspots occur all around the atoll reefs with the densest area for commercial and non-commercial fisheries being around Isdhoo and Dhanbidhoo Islands. The northern reefs and reefs around Fonadhoo islands are also densely fished. There is also a concentration of activity around the Fushi Kandu proposed PA (Figure 4a & b). There is activity up to 40km from Laamu Atoll to the North, East and South of the atoll. in some instances which is largely driven by the tuna fishery (See section 3.1.1.1).

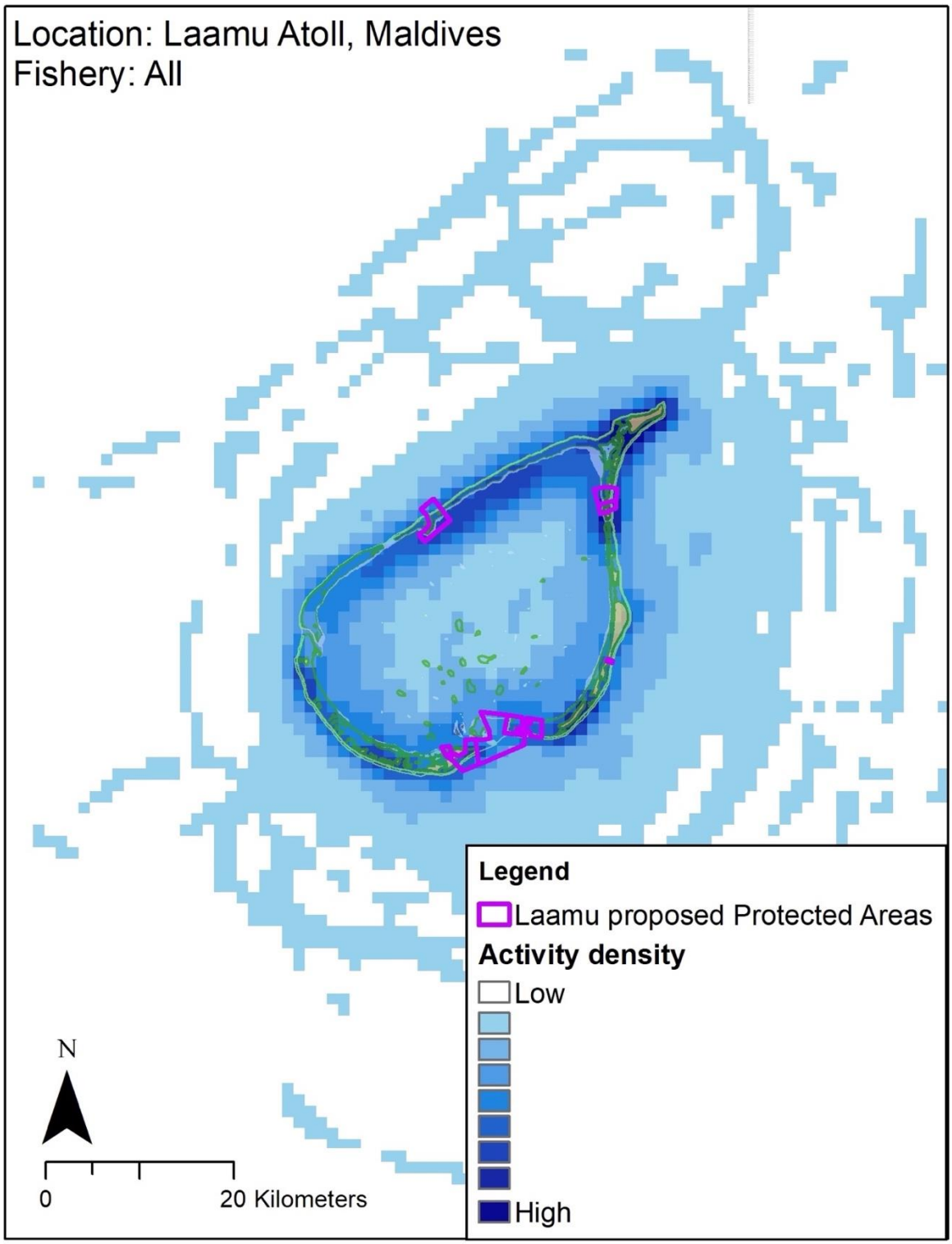


Figure 4. Kernel density analysis for all commercial and non-commercial fishing activities around Laamu Atoll. Darker colours indicate higher activity density. Proposed PAs on Laamu are overlaid

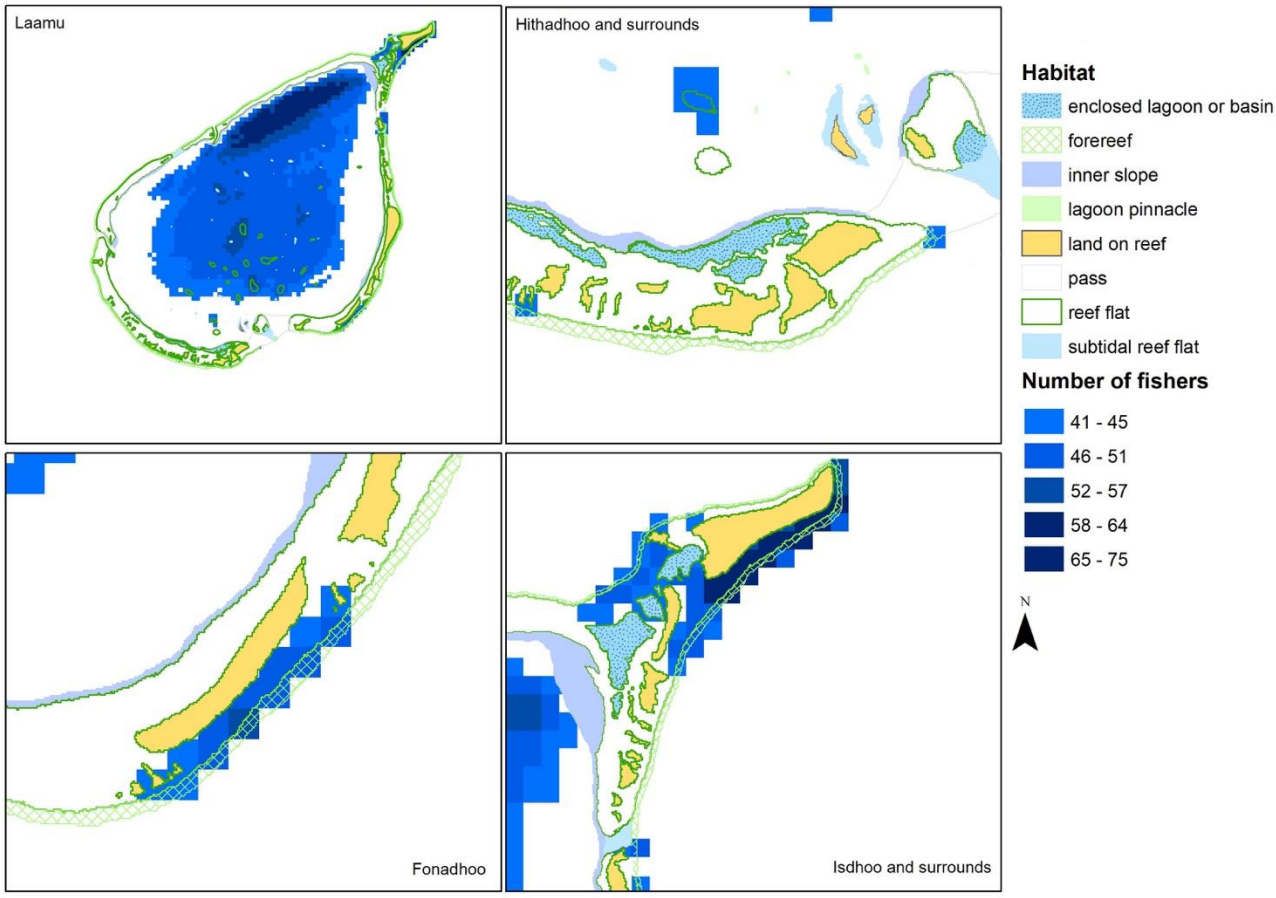


Figure *4b. Hotspots of all commercial and non-commercial fishing activities around Laamu Atoll. Darker colours indicate higher activity density of selection by fishers. A gridded overlay (grid cell = 0.25km²) was applied and overlapping polygons by each fisher were summed to identify highest fished areas.*

The top 20% of most selected fishing grounds (all fisheries) by respondents has been broken down in figure 4b. In some areas (darkest blue) 75 fishers (31% of all responses) selected the same areas (0.25km^2 grid cell) for fishing. These hotspots include the northern areas of Laamu, inside of the atoll, areas around the proposed Hithadhoo Kandu PA, areas around the east of Fonadhoo and around the Island of Isdhoo (Figure 4b)

A breakdown of the spatial activities, activity hotspots, fisher demographic, fisher practices, fishery perceptions and management recommendations for each individual fishery is provided below.

3.1.1.1 TUNA

83 fishers from 11 islands identified the Tuna fishery as a fishery they were involved in. A summary of responses is provided below.

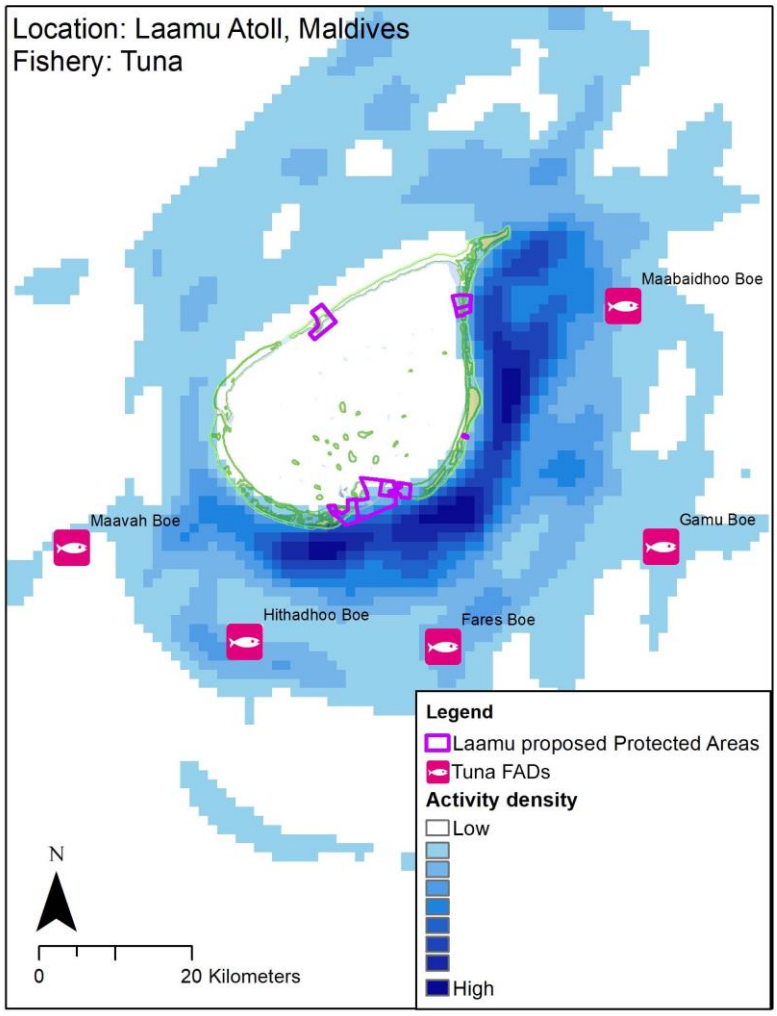


Figure 5: Tuna fishing activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local tuna fishers. Dark blue = highest density of activity (most fished area). Tuna FAD locations are also displayed.

Key fishing areas:
Outside Laamu Atoll;
South and South West areas within 5km of the atoll

Number of fishers:
34.6% of respondents involved in Tuna fishing. Most tuna fishers from Isdhoo, Maabaidhoo &Maamendhoo
Experience ranges from 1-50 years. Average = 22 years.

Target species:
Skipjack* (100%)
Yellowfin* (59%)
Frigate* (33%)
other (13%)

Gear types:
Pole and line (100%)
Handlines (11%)

Selling:
None of the fishers do any processing prior to selling, however, 74% of the fishers mentioned that they store fish in ice.
Markets:
88% sell to Maandhoo. Others identified selling to Kooddoo & Hithadhoo

Quotas followed?
None

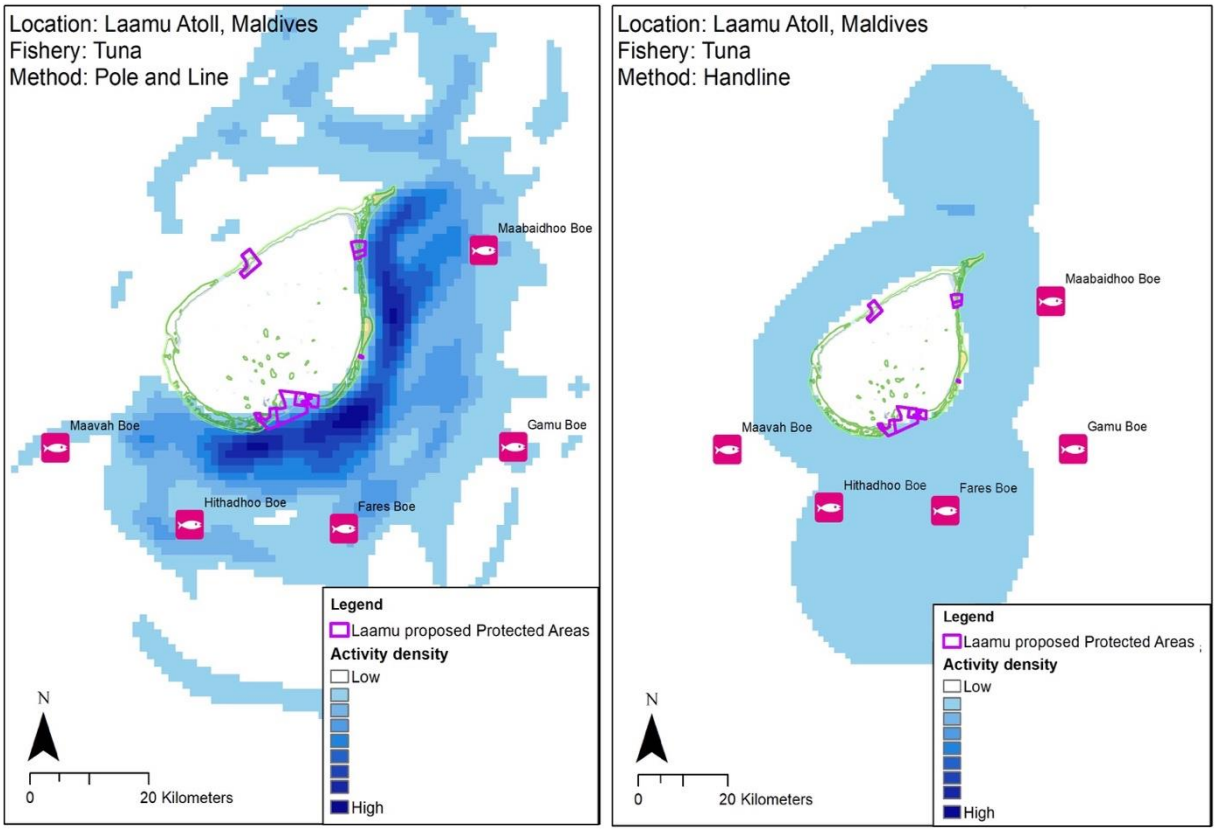


Figure 5b. Breakdown of tuna fishing activity around Laamu Atoll by fishing method. Left = Pole and line, Right = Handline. FAD locations are also displayed (fish symbol)

Fishing practices

Fishers indicated that the tuna fishery is an early morning fishery (4am-10am). The average tuna fishing trip has a duration of 6.25 days. 100% of respondents said that they use anchored Fish Aggregation Devices (FADs) when tuna fishing. Five main FADs were mapped, and fishers were asked how often they used each one (Figure 5b fish symbol). 84% of respondents said they used Hithadhoo Boe ranging to 96% indicating they used Fares Boe, with the other FADs being used by between 84% and 96% of fisers. All respondents said they catch their own live bait of the tuna fishery and a list of which species of bait fish are targeted is provided below:

Table 1a. Live bait species use reported by commercial Tuna fishers

Common Name	Scientific Name	Dhivehi Name	% of respondents
Cardinal fish	*Apogonidae*	Boadhi/ Fathaa	88
Anchovy	*Encrasicholina heteroloba*	Miyaren	82
Silver sprat	*Spratelloides gracilis*	Rehi	75
Fusilier	*Caesionidae*	Muguraan	74
Blue sprat	*Spratelloides delicatulus*	Hondeli	42
Chromis	*Chromis sp.*	Nilamehi	12
Other			5

Results show these bait fish are predominantly caught at night with the use of attracting lights. Nets are used and most baitfish being caught in waters inside the atoll. There is a small amount of SCUBA diving for baitfish in Laamu (2 respondents). Fishers that caught their own bait were asked an additional spatial question to identify where these bait fish were caught (Figure 5c).

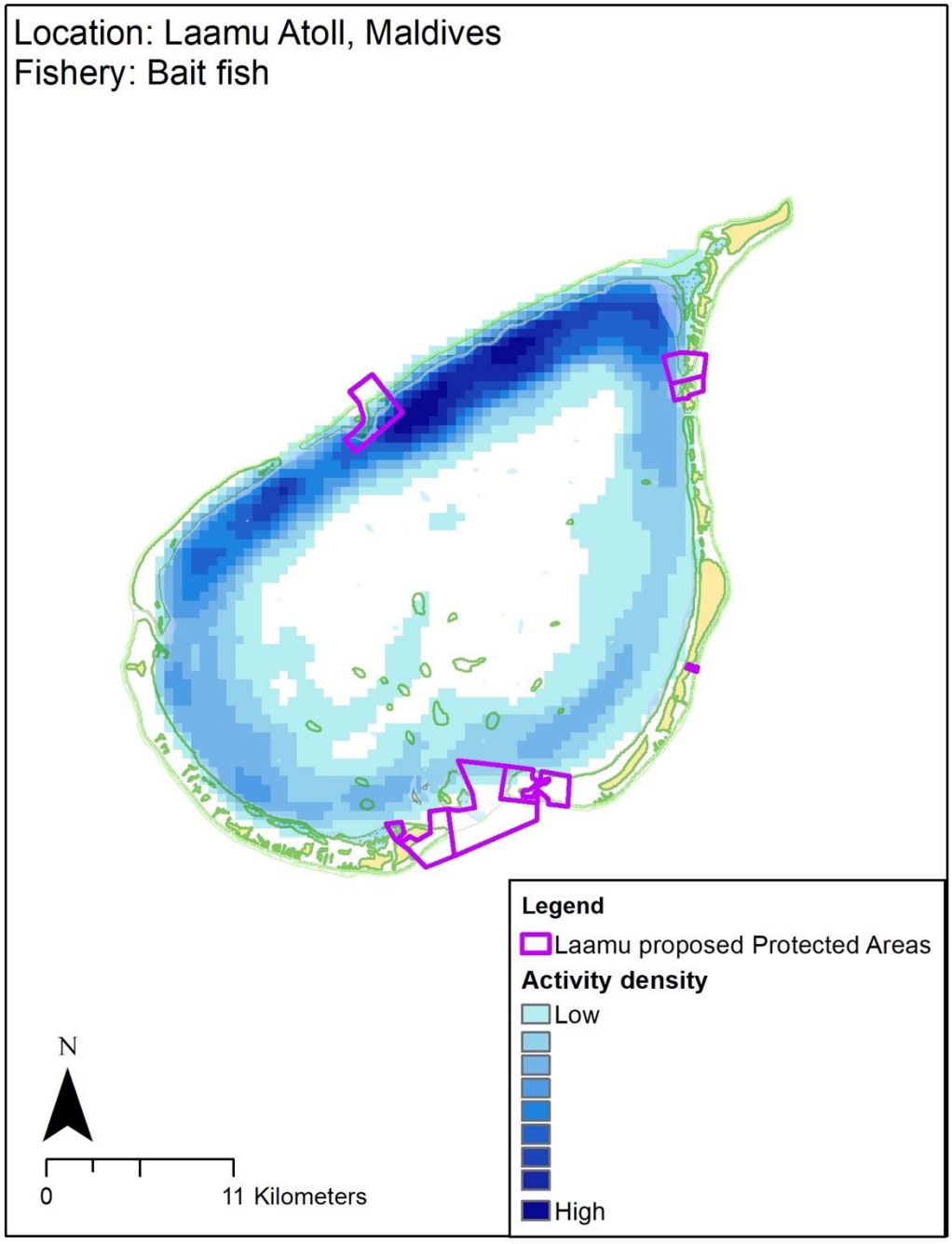


Figure 5c. Location of bait fish capture, identified by commercial tuna fishers

It is clear from spatial analysis that the northern edge of the atoll, inside of the atoll, known locally as Verehi Falhu, is an important area for bait fishing.

Fishers were asked to rate their perception of the status of the Tuna fishery, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 5.5, and the most selected rating for the tuna fishery was a 10 (Figure 5d).

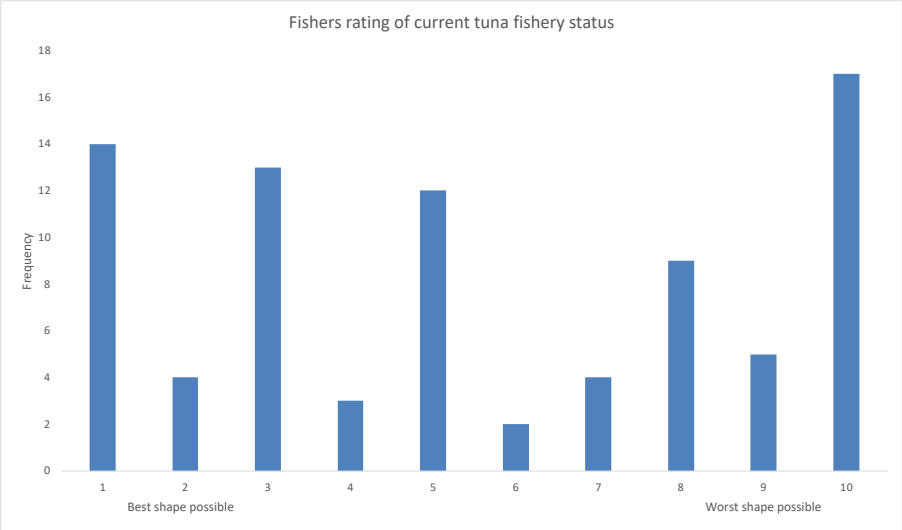


Figure 5d. Responses given by fishers regarding current tuna fishery status

Management thoughts/perceptions: Key themes

1. Improved pricing/value of fish (24 fishers, 31%).
2. The need of more ice plants and fish landing facilities (21 fishers, 27%).
3. Improved fisheries regulations for tuna and FADs (8 fishers, 10%).
4. Stop the fishing of bigeye/yellowfin tuna with lights as this prevents catch of other tuna species in the area for 4-5 days (7 fishers, 9%).
5. Fishing for live bait with lights decreases the number of fish available (5 fishers, 6%).
6. SCUBA as a collection method should be banned (2 fishers, 3%)

3.1.1.2 REEF FISH

129 fishers from 11 islands identified the reef fish fishery as a fishery they were involved in.

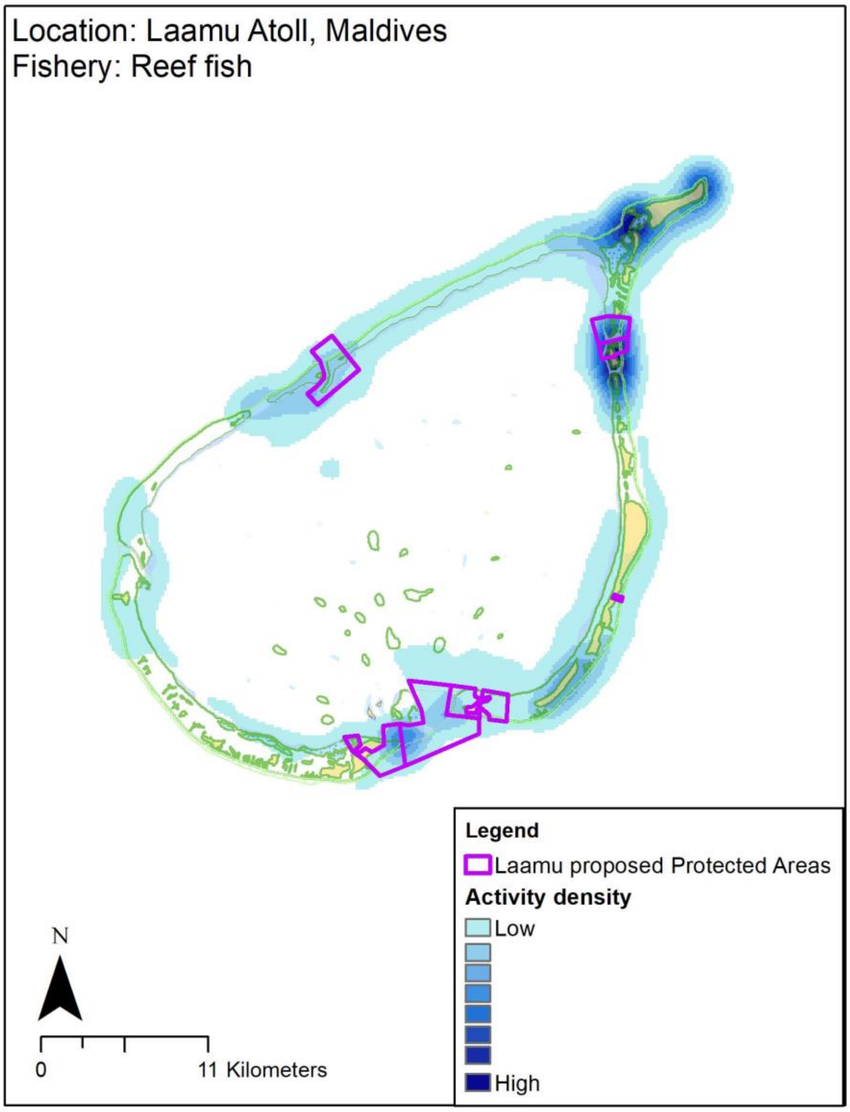


Figure 6: Reef fish fishing activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local reef fishers.
Dark blue = highest density of activity (most fished area (s)). Proposed Marine Protected Areas (MPAs) are also overlaid

Key fishing areas:
Nearshore reef areas of North Laamu. Hotspots = Fonagaadhoo, Maabaidhoo, Isdhoo

Number of fishers:
58% of respondents involved in Reef fish fishery. Most fishers from Kalaidhoo. Experience ranges from 2-60 years. Average = 23 years.

Target species:

Two-spot red snapper (79%) ރަތް މަސް
Humpback red snapper (76%) ދިނިމަސް
Long nose emperor (66%) ލައިބްންގިލާ
Smalltooth emperor (63%) ފް
Bluefin trevally (60%) ބޮންދިގިލާ

Gear types:

Handline (68%)
Trolling (9%)
Netting (7%)
Pole and Line (6%)
Jigging (6%)

Selling:

Processing: = all fishers clean their fish and store with ice

Quotas followed?

None

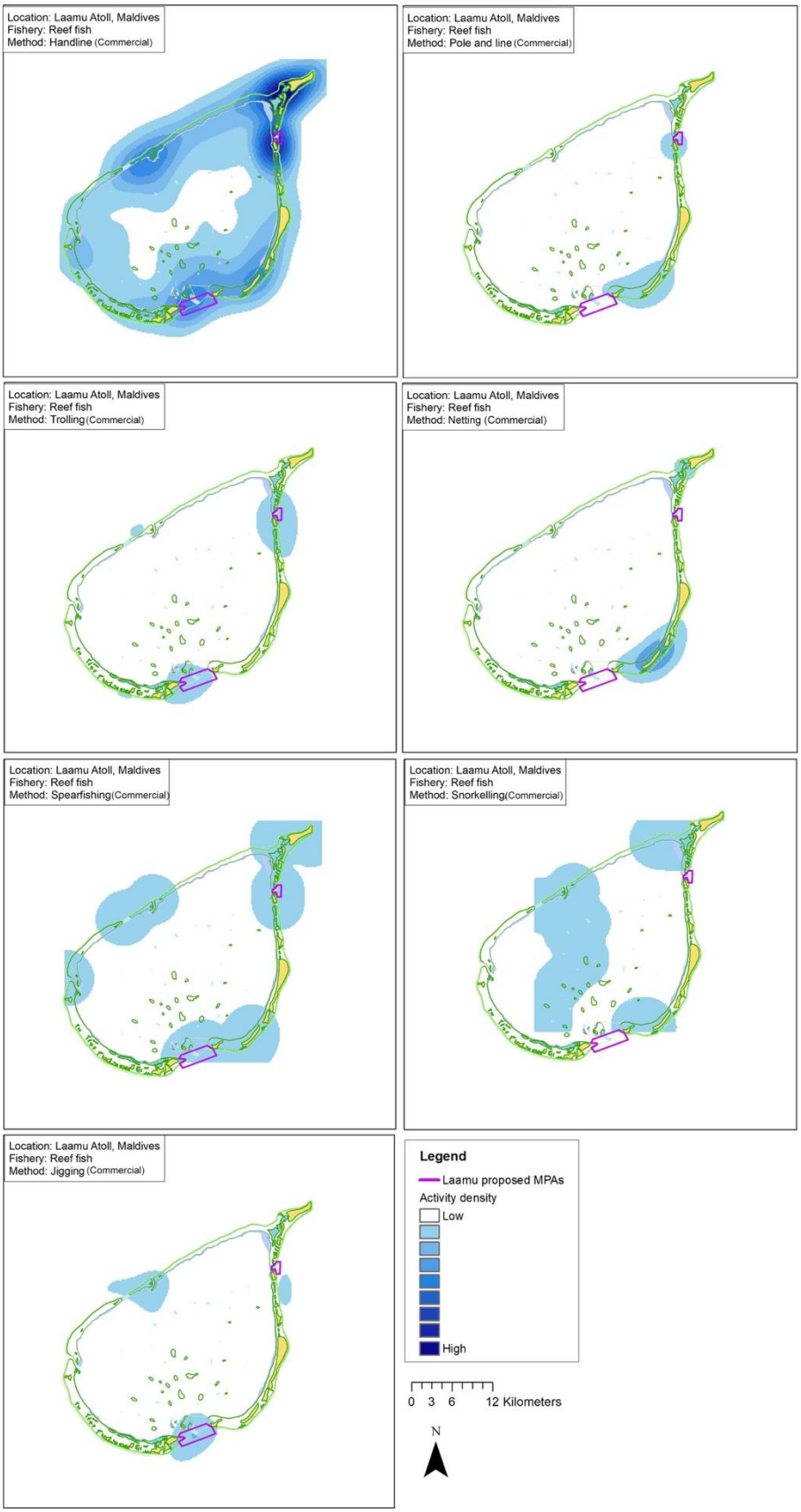


Figure 6b. Reef fish commercial fishing activity around Laamu Atoll broken down by gear type. See top left of each box for gear type.

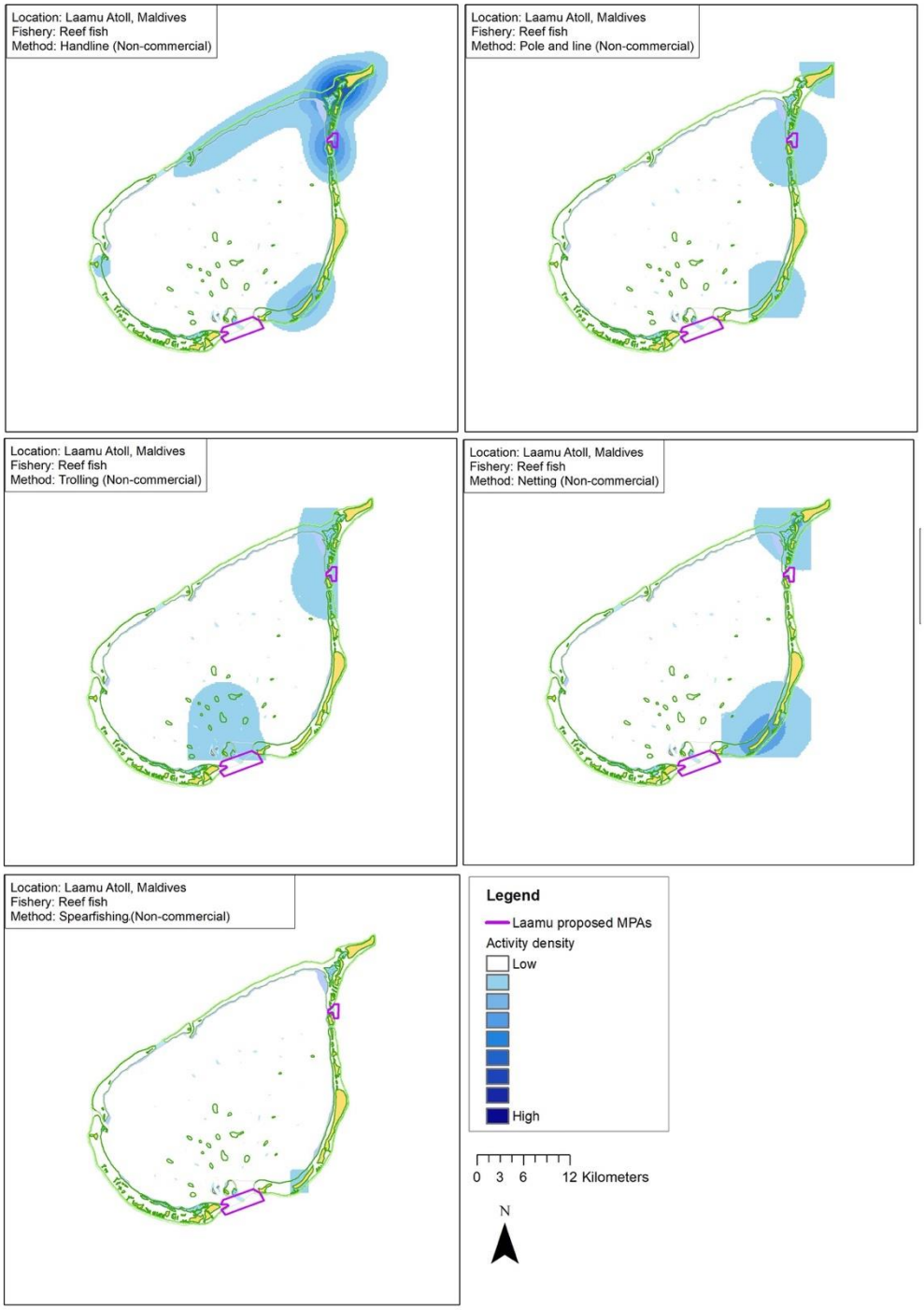


Figure 6c. Reef fish non-commercial fishing activity around Laamu Atoll broken down by gear type. See top left of each box for gear type.

Fishing practices

Fishers target reef fish mostly during days 10-15 of each lunar month (of those who gave a response to peak fishing period). The changes in tide were given as an explanation for this (21 fishers, ~ 20%).

New and full moon periods were noted to be best fishing times. A typical fishing trip would last 1 day or less and 84% said that the evening (5pm-10pm) was the best time to fish for reef fish.

There was a 50/50 split between reef fishers fishing for commercial and non-commercial purposes. Commercial fishers sell to a range of places but Six Senses Laamu resort and the Island of Gan and Fonadhoo made up 48% of all markets for reef fish. Male' was also indicated to be a key market (Figure 6d)

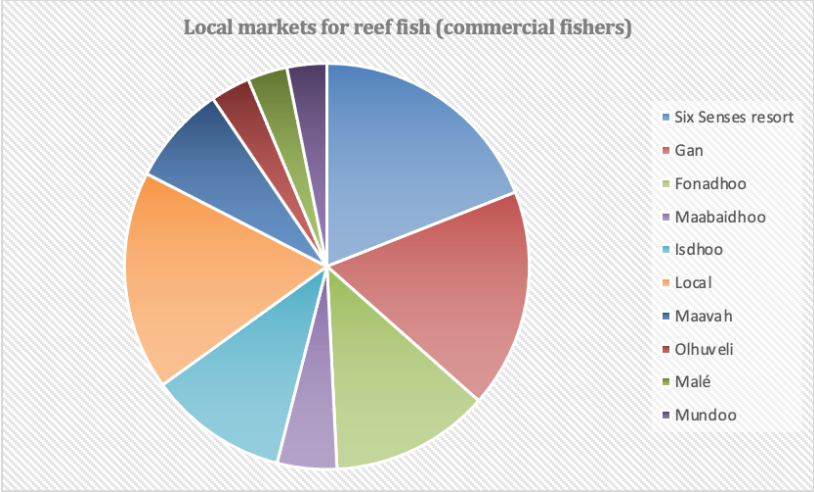


Figure 6d. Reef fish markets for commercial reef fish fishery

Fishers were asked to rate their perception of the status of the reef fish fishery, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 4.8, and the most selected rating for the reef fish fishery was a 1 (Figure 6e).

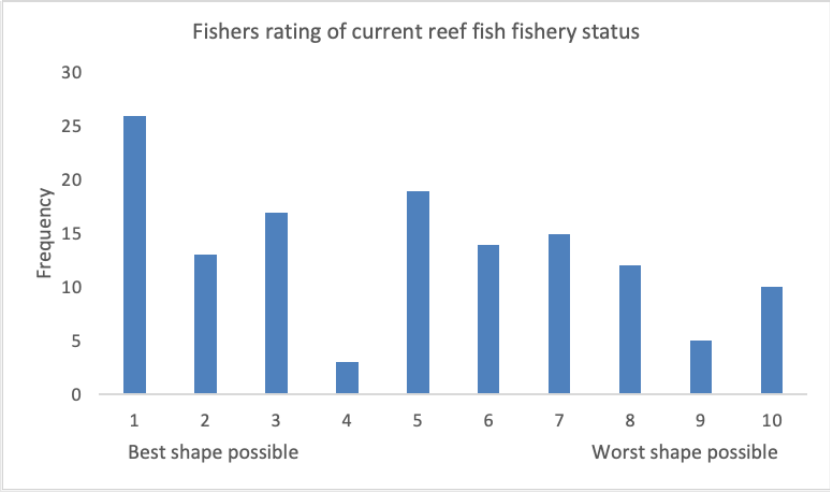


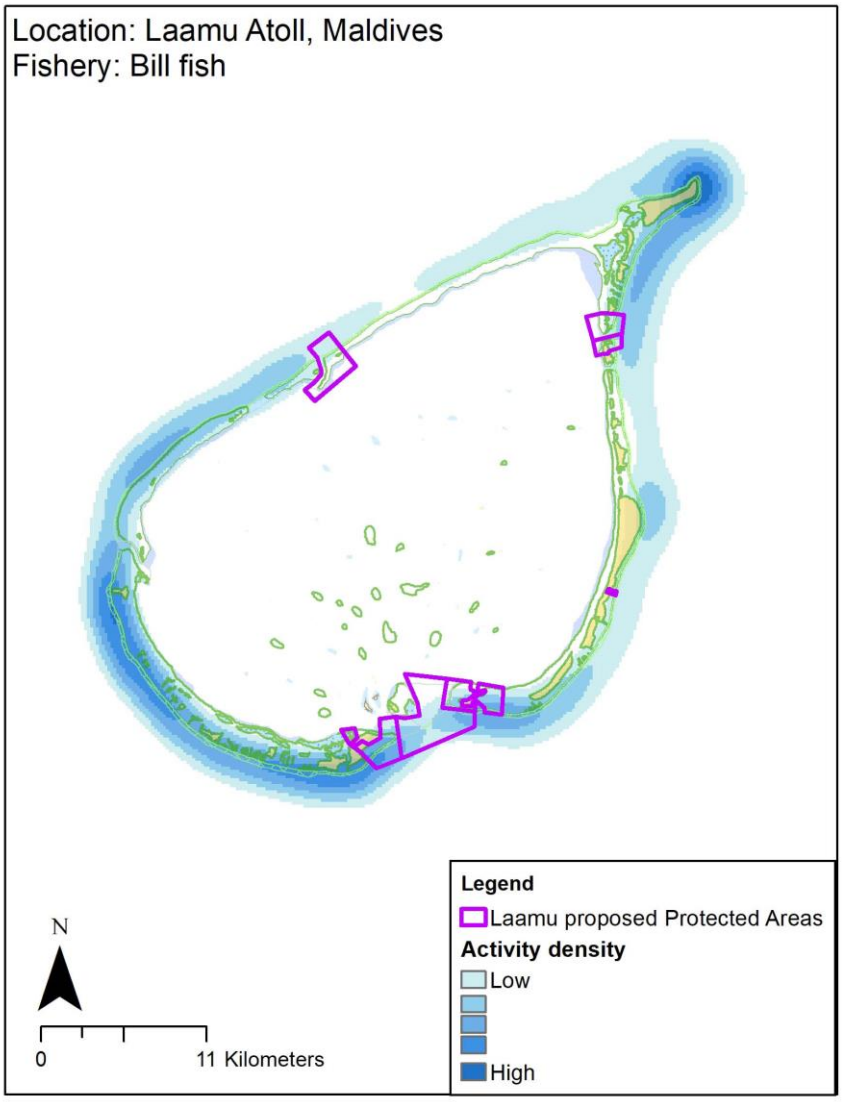
Figure 6e. Frequency of responses given by reef fish fishers for status of reef fish fishery

Management thoughts/perceptions: Key themes

1. Many fishers (75%) identified wanting access to better markets (90 fishers).
2. A large number of responses were themed around identifying and stopping net fishing and reducing waste and litter in order to protect the reefs and the fish populations they support (22 fishers, 19%).
3. Some fishers identified the need to protect immature reef fish from extraction and exploitation (10 fishers, 9%).

3.1.1.3 BILL FISH

46 fishers from 9 islands identified the bill fish fishery as a fishery they were involved in.



Key fishing areas:
Nearshore reef areas of NE and SW Laamu. Hotspots = Isdhoo, Hithadhoo/ Mendhoo/Kunahandhoo and Maavah

Number of fishers:
19% of respondents involved in Bill fish fishery. Most Bill fish fishers were from Isdhoo.Experience ranges from <1-52 years. Average = 14.5 years.

Target species:
Indo-pacific sailfish (100%)
Indo-pacific blue marlin (48%)
Black marlin (25%)
Swordfish (20%)
Common dolphinfish (17%)

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Gear types:
Trolling (99%)

Quotas followed?
None

Figure 7: Bill fish fishing activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local Bill fish fishers. Dark blue = highest density of activity (most fished area(s)). Proposed Marine Protected Areas (MPAs) are also overlaid

Fishing practices

Bill fish fishers strongly indicated (87%) that May to December was the main fishing season for Bill fish which coincides with the southwest monsoon. This climatic event brings with it a change in currents which most fishers highlighted as a reason for better fishing. A fishing trip lasts less than a day and 91% of fishers indicated the early morning (4am-10am) as the main fishing period, however, 42% also said they fished in the daytime too (11am – 5pm).

Commercial fishers sell bill fish to several different markets and islands. Maavah and Isdhoo were identified as key markets for bill fish (67% sold here). 'Locals' was also indicated to be a key market (Figure 7b).

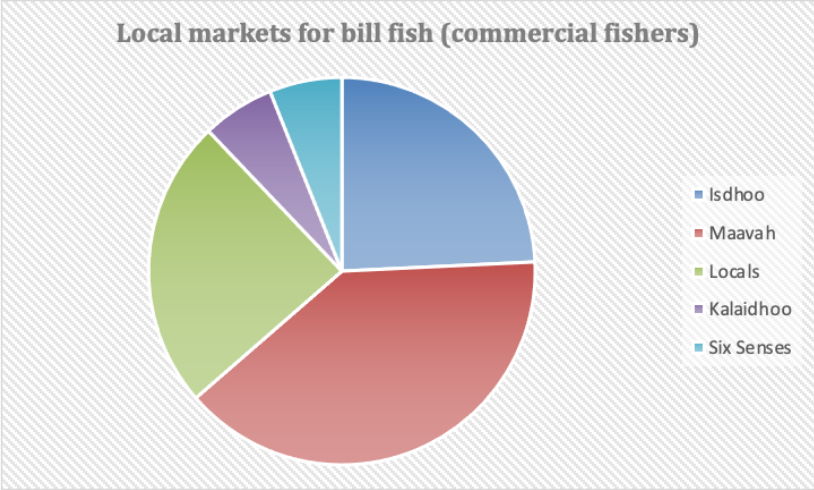


Figure7b. Markets identified for commercial bill fish fishers

Fishers were asked to rate their perception of the status of the bill fish fishery, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 3.84 and the most selected rating for the bill fish fishery was a 1 (Figure 7c).

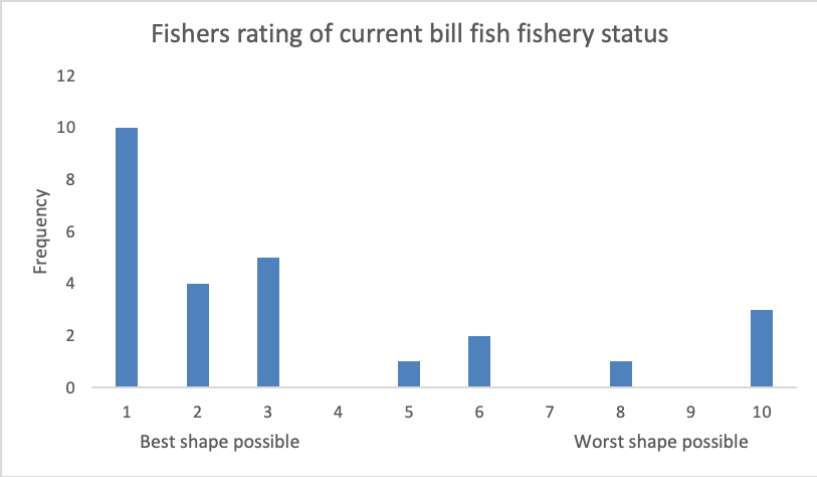


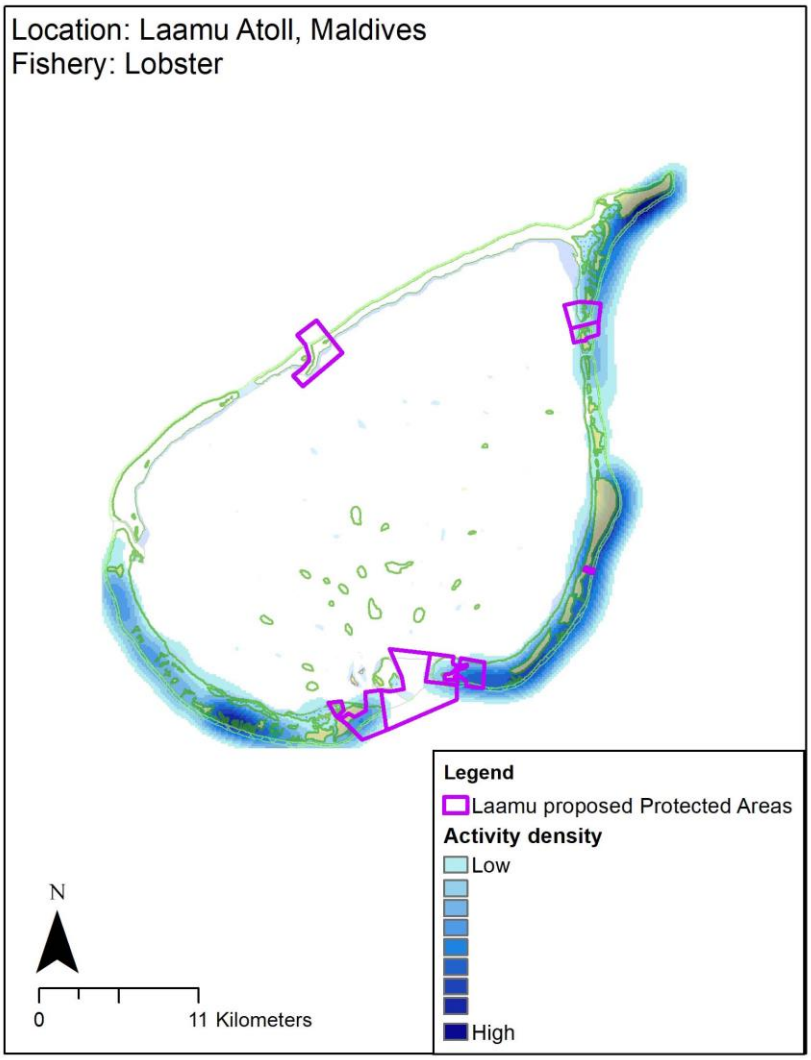
Figure 7c. Frequency of responses given by bill fish fishers regarding status of bill fish fishery

Management thoughts/perceptions: Key themes

1. The majority of bill fish fishers had no thoughts on the management of the bill fish fishery, but a few indicated that more markets for selling bill fish were required (8 fishers, 17%).

3.1.1.4 LOBSTER

51 fishers from 11 islands are involved in the atoll's lobster fishery.



Key fishing areas:
Nearshore reef areas of NE, E, SW Laamu. Hotspots = Isdhoo, Gan

Number of fishers:
20% of respondents involved in Lobster fishery.
Most lobster fishers are from Hithadhoo
Experience ranges from 1-45 years. Average= 14.7 years.

Target species*:
Panulirus versicolor (82%)
Parribacus antarcticus (75%)
Panulirus penicillatus (61%)
Panulirus japonicus (41%)

Gear types:
100% hand collection (Snorkelling, freediving, hand collection at low tide)

Selling:
Processing: = kept in water and packaged

Quotas followed?
None

Figure 8: Lobster fishing activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local lobster fishers. Dark blue = highest density of activity (most fished area (s)). Proposed Marine Protected Areas (MPAs) are also overlaid

Key target lobster species (Table 1b):

Table 1b. Lobster species targeted by commercial fishers

Fishing practices

Results show lobster fishers identified January to May as the main season, coinciding with the Northeast monsoon (most (~45%) during evening (5pm-10pm)). This season brings smaller waves on the outer reefs (locally known as futtaru) which makes hand collection much easier. Fishing trips last less than a day and lobster are sold to local buyers in Laamu Atoll.

Fishers were asked to rate their perception of the status of the lobster fishery, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 4.55 and the most selected rating for the lobster fishery was a 1 (Figure 8b).

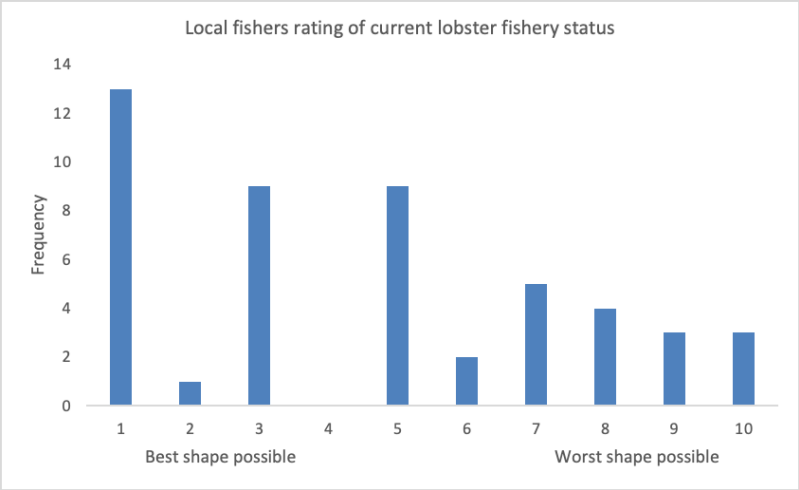


Figure 8b. Frequency of responses given by lobster fishers for status of lobster fishers

Management thoughts/perceptions: Key themes

1. Banning the collection of lobsters smaller than 6 inches (10 fishers, 25%).
2. Protecting burrows through limiting litter, discarded fishing gear and alternatives to walking on reefs (8 fishers, 20%).

3.1.1.5 SEA CUCUMBER

25 fishers from 8 islands identified the sea cucumber fishery as a fishery they were involved in.

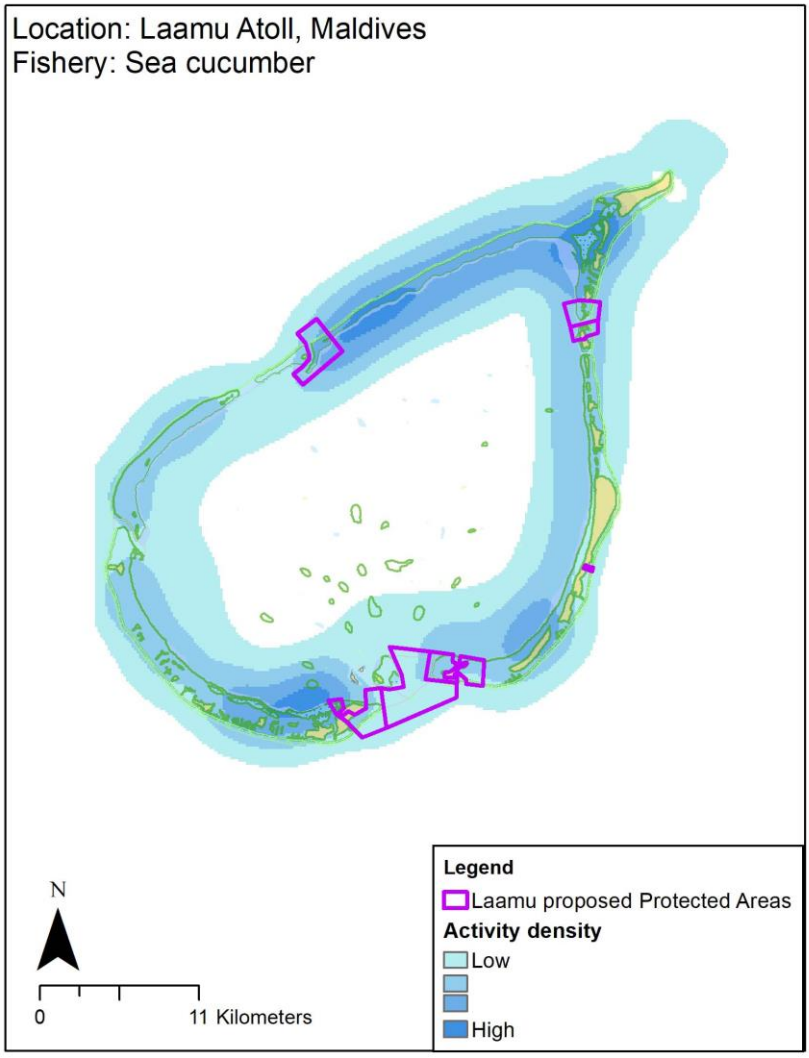


Figure 9: Sea cucumber fishing activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local sea cucumber fishers. Dark blue = highest density of activity (most fished area (s)). Proposed Marine Protected Areas (MPAs) are also overlaid

Key fishing areas:
Nearshore reef areas of NE, N, SW Laamu. Hotspots = Dhanbidhoo, Kundhandhoo

Number of fishers:
15% of respondents involved in Sea Cucumber fishery. Most sea cucumber fishers are from Maavah or Kalaidhoo. Experience ranges from <1-40 years. Average = 14 years.

Target species:
Wide ranging but 85% target *Actinophyga lecanora or white-bottomed sea cucumber.* See Figure 9b

Gear types:
100% hand collection (Hand collection, snorkel, SCUBA)

Selling:
Processing:
- Salt (43%)
- None (37%)
- Dehydrate (22%)

Around 50% sell to Male. Some to local buyers in Maavah, Kunahandhoo, Fonadhoo

Quotas followed?
None

Table 1c. Target sea cucumber species by commercial fishermen in order of frequency targeted

Common Name	Scientific Name	Dhivehi Name	Frequency selected
Stone fish	Actinophyga lecanora	Fili mushi/ Buhfulhi	86%
choke fish/ brown sand fish	Bohadschia marmorata	Hudhu Kiru	75%
Curry fish	Stichopus herrmanni	Curry	68%

prickly red fish	Thelenota ananas	Alanaasi	64%
Surf red fish	Actinophyga mauritiana	Raiy mushi	61%
Elephant trunk fish	Holothuria fuscopunctata	Elephant/ Vandhu keyo	57%
Green fish	Stichopus chloronotus	Kashi/ Feeru	50%
Lolly fish	Holothuria atra	Holhi	46%
Black fish	Actinophyga miliaris	Kalhu mushi	43%
Brown sand fish	Bohadschia vitiensis	Gaabulha	43%
White teat fish/ White teeth fish	Holothuria fuscogilva	Kandu Batu/ Mas batu/ Hudhu batu	38%
Leopard fish	Bohadschia argus	Summit kiru/ Lahjehi kiru	32%
Black teat fish	Holothuria nobilis	Falhu batu	29%
Brown fish	Actinophyga echinites	Brown fish	25%

Fishing practices

Fishers either fish or farm for sea cucumber. This was known *a priori* and so sea cucumber fishers were asked to identify their method. 80% of sea cucumber fishers interviewed said they fish for them. They identify the peak season to be January to May coinciding with the Northeast monsoon season. Fishers target a range of species (Figure 9b). The main fished species were *Actinophyga lecanora* (stone fish/white-bottomed sea cucumber, locally known as fili mushi/ buffulhi) and *Bohadschia marmorata* (chalk fish/ brown sandfish locally known as hudhu kiru). They are sold for the export trade to buyers from Malé, Maavah, middlemen and processors in the atoll. Local council survey results suggest there are sea cucumber processors on Maavah (n=2), Kunahandhoo (n=1) and Dhanbidhoo (n=1).

20% of interviewees said that they rear sea cucumber in cages. On average they stock farms with 5,000 sea cucumbers to start and then rear up to 4,000 more. Most farmers were not able to identify the species of sea cucumbers they buy to stock farms, but one farmer identified them as 'sandfish' (the alien species, *Holothuria scabra*). This species of sea cucumber was introduced to Isdhoo, Kalaidhoo and Dhanbidhoo islands in 2016-17 as part of the 'Mariculture Enterprise Development Project' of the Ministry of Fisheries, Marine Resources and Agriculture (MoMFA) funded by International Fund for Agricultural Development (IFAD). Cage locations were mapped in the same way as the other spatial fishing activities and when analysed the cages were seen to be located in the Northeast corner of Laamu only.

Wild capture fishers were asked to rate their perception of the status of the sea cucumber fishery, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 3.5 and the most selected rating for the sea cucumber fishery was a 1 (Figure 9b).

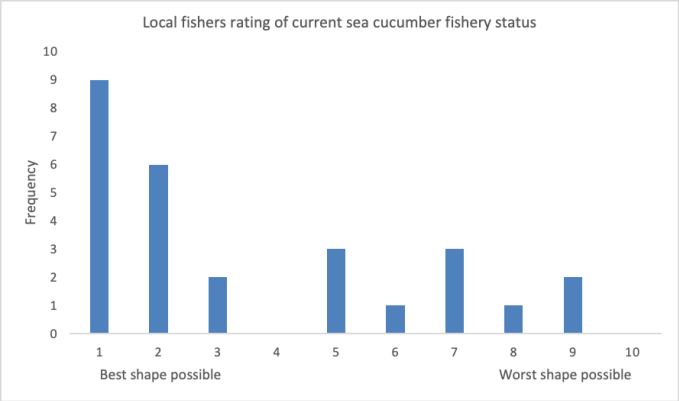


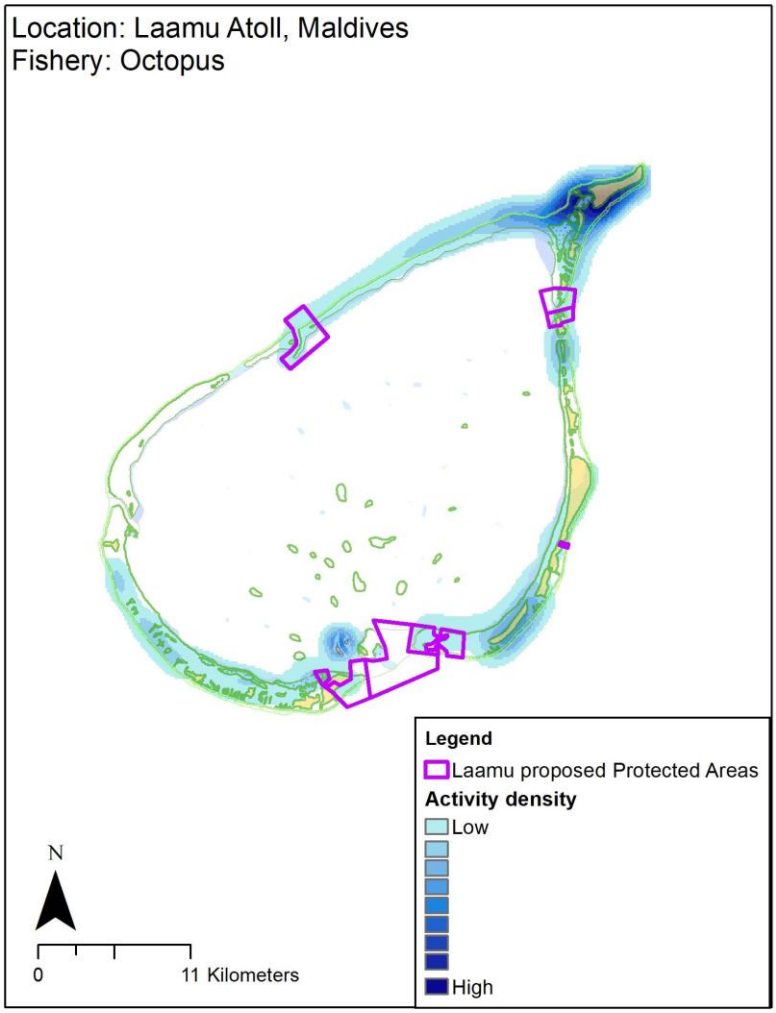
Figure 9b. Frequency of responses given by sea cucumber fishers and farmers for status of sea cucumber fishery

Management thoughts/perceptions: Key themes

1. Improved access to markets (7 fishers, 20%).
2. Protection of smaller species of sea cucumber by bringing in minimum size limits (7 fishers, 20%).
3. Banning fishing during spawning periods (lasts around 2-3 days) (6 fishers, 17%).
4. Protecting nurseries (identified between Fonadhoo and Gaadhoo, and Kalhaidhoo and Baresdhoo (5 fishers, 15%).
5. Enforcing restrictions to collect sea cucumber with SCUBA gear (4 fishers, 13%).

3.1.1.6 OCTOPUS

96 fishers from 11 islands identified the octopus collection as a fishery they were involved in.



Key fishing areas:
Mainly isolated to Dhanbidhoo, Isdhoo and Kalaidhoo. Some near Fonadhoo, Maamendhoo

Number of fishers:
40% of respondents involved in octopus collection

Experience ranges from 1-60 years. Average experience = 22.7 years.

Target species:
Common octopus

Gear types:
Stick 47%)
Spear (45%)
Chemicals/bleach (33%)

Selling:
Processing:
-None

Most don't sell. Some are sold to local people. Shops and restaurants, export to Male' if there is a request

Quotas followed?
None

Figure 10: Octopus fishery activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local octopus fishers. Dark blue = highest density of activity (most fished area (s)). Proposed Marine Protected Areas (MPAs) are also overlaid

Fishing practices

Octopus are collected throughout the year. Low tide is identified as a time to collect octopus, particularly during the daytime (11am – 5pm) and the evening (5pm -10pm).

Fishers were asked to rate their perception of the status of the octopus collection, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 5.12 and the most selected rating for the octopus collection was a 5 (Figure 10b).

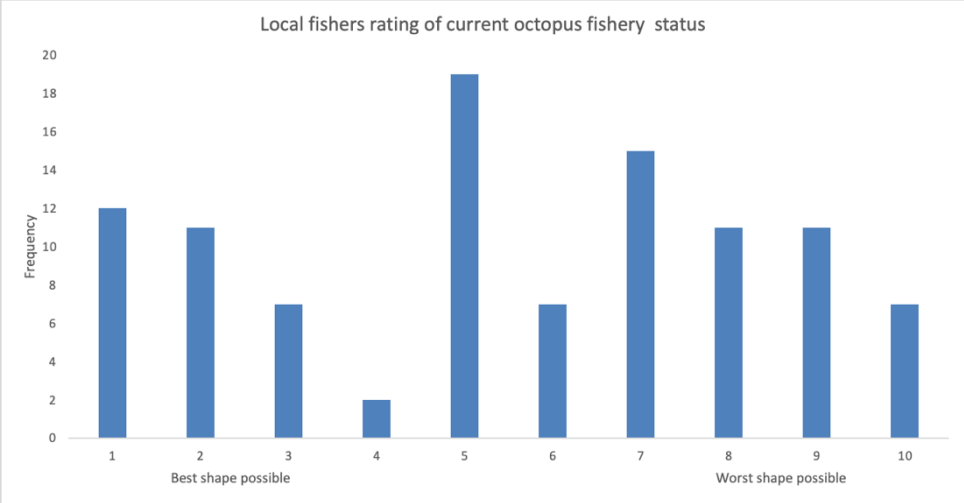


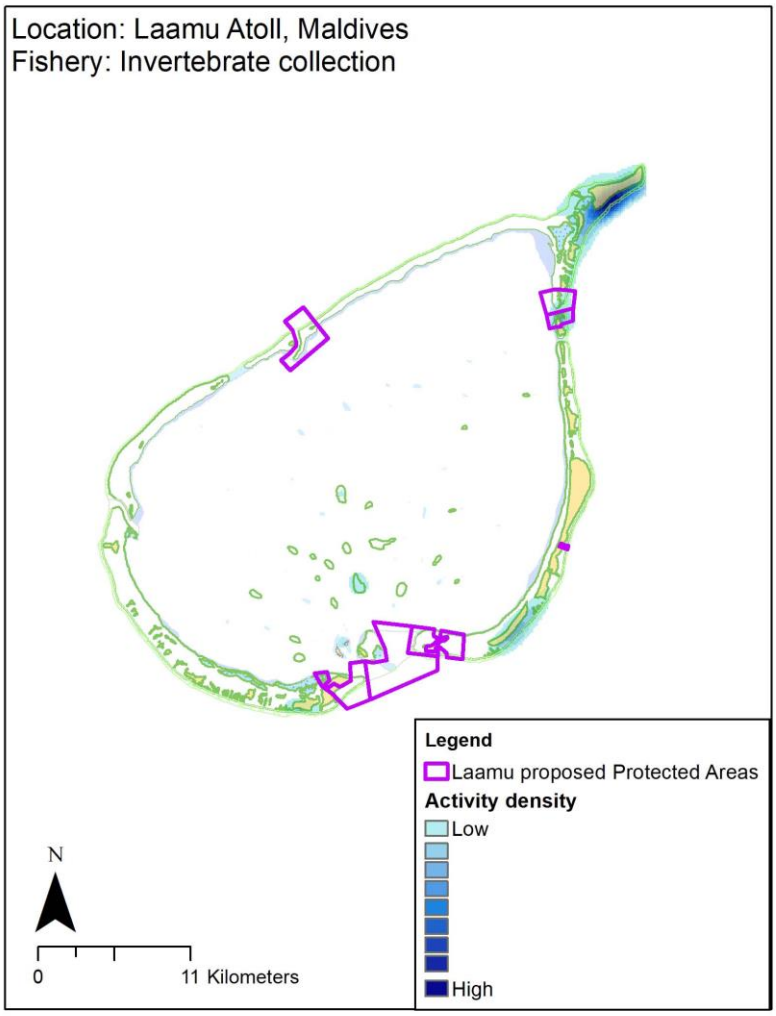
Figure 10b. Frequency of responses given by octopus fishers for status of the octopus fishery

Management thoughts/perceptions: Key themes

1. Banning the use of chemicals. Advised to use spears and alternative more sustainable methods to protect vital habitats from destruction (44 fishers, 59%).
2. Prohibiting the collection of small octopus (13 fishers, 18%).

3.1.1.7 INVERTEBRATE COLLECTION

55 fishers from 11 islands identified the invertebrate collection as a fishery they were involved in.



Key fishing areas:
Mainly isolated to Dhanbidhoo, Isdhoo, Kalaidhoo. Some near Fonadhoo

Number of fishers:
23% of respondents involved in Invertebrate collection. Most fishers were from Kalaidhoo. Only 31% sell commercially

Experience ranges from 1-50 years. Average experience = 20 years.

Target species:
See below

Gear types:
100% hand collection (shore collection, sometimes free diving)

Selling:
Processing:
-None

Commercially sold in Male

Quotas followed?
None

Figure 11: Invertebrate collection activity around Laamu Atoll. Activity is expressed as density calculated from spatial data inputted by local invertebrate collectors. Dark blue = highest density of activity (most fished area (s)). Proposed Marine Protected Areas (MPAs) are also overlaid

Invertebrate collectors target a range of invertebrate species. The most identified target species is the Silver-mouthed turban (*Turbo agyrostomas,* locally called 'Sandhara') (74% collectors) followed by the Chiagra spider conch (*Harpagp chiragra*, locally called 'Ha' ingili') (Table 1d).

Table 1d. Target invertebrate species by commercial fishers in order of frequency targeted

Common Name	Scientific Name	Dhivehi Name	Frequency selected
Silver-mouthed turban	*Turbo agyrostomas*	Sandhara	74%
Chiragra spider conch	*Harpago chiragra*	Ha'ingili	60%
Spider conch	*Lambis lambis*	Raakani	44%
To be determined	To be determined	Golaa	33%
To be determined	To be determined	Meybudi	29%
To be determined	To be determined	Kudhi anga	19%
Crabs	To be determined	"crab"	13%
To be determined	To be determined	Koku	5%
To be determined	*Trochus sp.*	Fooenburi	4%
To be determined	To be determined	Kashi boli	2%
To be determined	To be determined	Bodu ha'ingili	2%

Fishing practices

Collectors typically collect invertebrates in the evening (5pm – 10pm) and there is no main season for this. It is carried our although the year but usually at low tide particularly during new and full moons (32 fishers, 75%).

Invertebrate collectors were asked to rate their perception of the status of the invertebrate collection, 1 being in the best shape possible, 10 being in the worst shape possible. The average response was 5.5 and the most selected rating for the invertebrate collection was a 5 (Figure 11b).

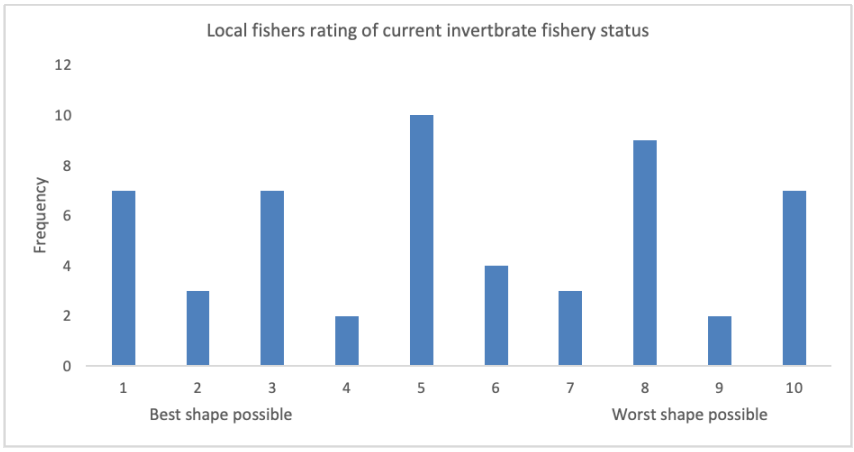


Figure 11b. Frequency of responses given by invertebrate collectors for status of the invertebrate collection fishery

Management thoughts/perceptions: Key themes

Most fishers did not specify specific management ideas or perceptions of the current invertebrate collection practices. A summary of those who did provide responses is below:

1. Prohibiting sand removal from the beach. This can lead to reef and seagrass habitat destruction due to sedimentation (8 fishers, 15%).
2. Reducing waste disposal in the sea and reef area (3 fishers, 6%).
3. Invertebrate collection periodic closures (a few months) (3 fishers, 6%).

3.1.1.8 AQUARIUM FISH

Only one fisher identified themselves as a fisher that targeted aquarium fish, which was for commercial purposes. As responses were limited to one, data were not interrogated. The main hotspot for this fishery is around Mundoo Kandu Channel.

3.1.1.9 MARINE PROTECTED AREAS

The Maldives government has recently highlighted five new areas that could become part of Laamu's protected area network. BLUE and its local partners aims to work closely with other local stakeholders to ensure everyone is involved and represented in decisions about the management of these sites. The following areas have been identified as potential Protect Area (PA) sites (Figure 12):

- Laamu Hithadhoo Kulhi
- Laamu Hithadhoo-Gaadhoo Kandu
- Laamu Gaadhoo
- Laamu Fushi Kandu
- Laamu Maabaidhoo Koaru
- Laamu Vadinolhu Kandu
- Laamu Gan Paree Fengan'du

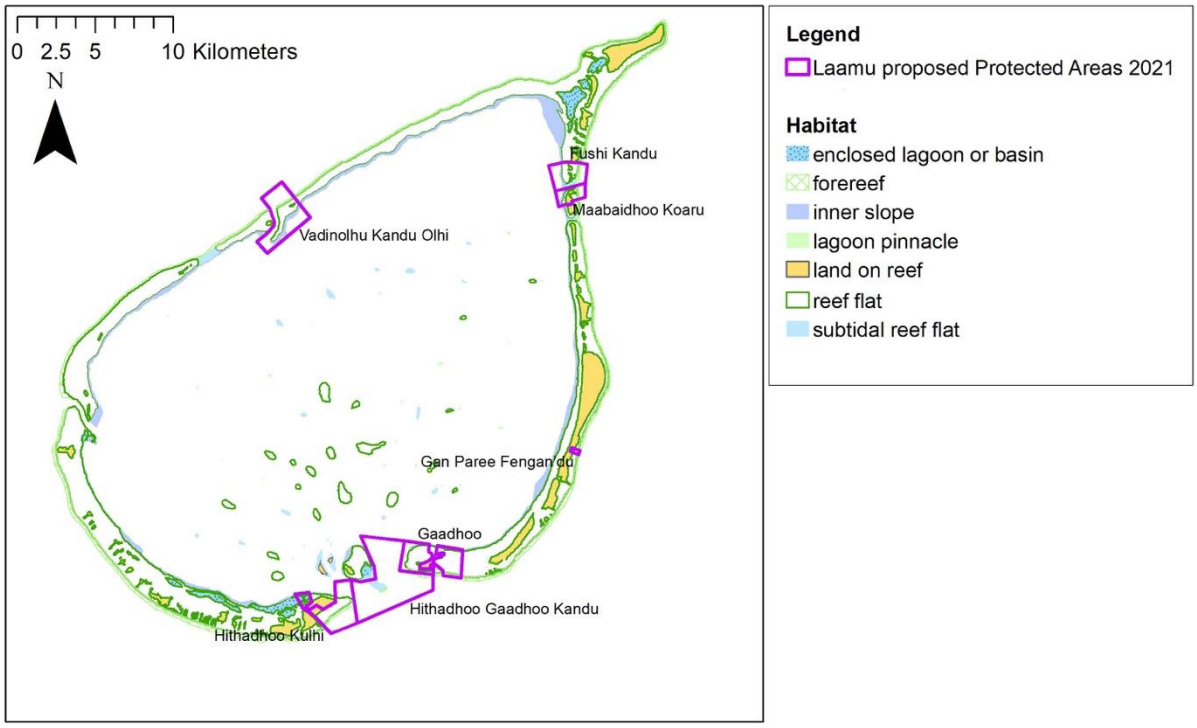


Figure 12. Map of five newly proposed Protected Areas around Laamu.

Below, the intensity of fishing activity within each fishery is mapped within each of the newly proposed PAs. The darker orange to red colours indicate a higher level of fishing activity (more intense fishing activity ⇌ total number of overlapping spatial polygons as drawn by interviewee). For the proposed PAs around Hithadhoo both reef fish fishing and bill fish fishing are important activities inside of the PA boundaries, in particular inside the Hithadhoo-Gaadhoo Kandu area for reef fishing and outer reef of Hithadhoo Kulhi for bill fish fishing (Figure 14a). Reef fishing is also a dominant fishery inside of the Fushi Kandu proposed MPA (Figure 14b). Bait fish fishing is the most intense activity inside of the Vadinolhu Kanduproposed PA, in North Laamu, with a small amount of reef fish fishing taking place there too (Figure 14c). There is a small amount of Lobster fishing around the outer reef of Gan Paree Fengan'du proposed PA (Figure 14d) Aquarium fishing activities did not overlap with any area so aren't mapped here.

Six Senses Laamu has a resort boundary which is managed by the resort inside of which all fishing is prohibited. This area acts as defacto Marine Protected Area. The boundary is mapped below (Figure 13).

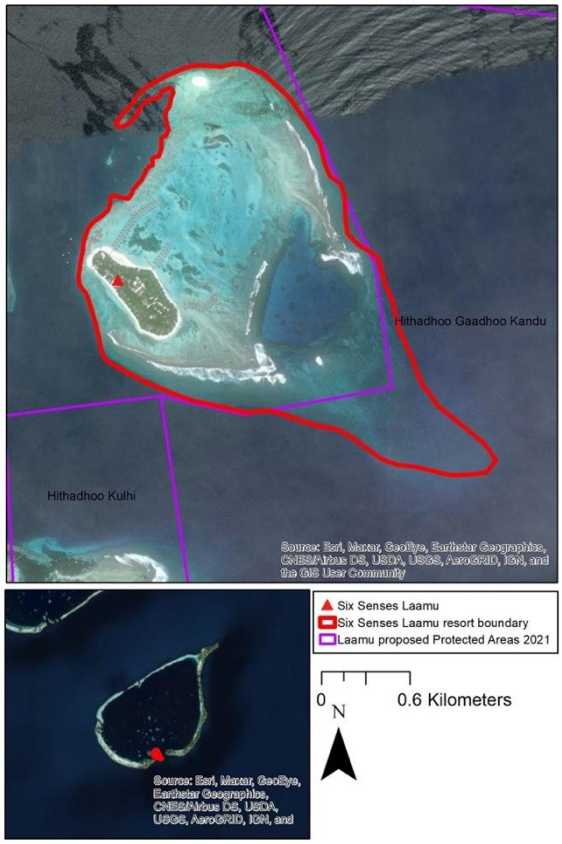


Figure 13. Six Senses Laamu resort boundary (red line) and resort location (red triangle) in Laamu Atoll. Newly proposed Protected Area boundaries are also mapped for reference.

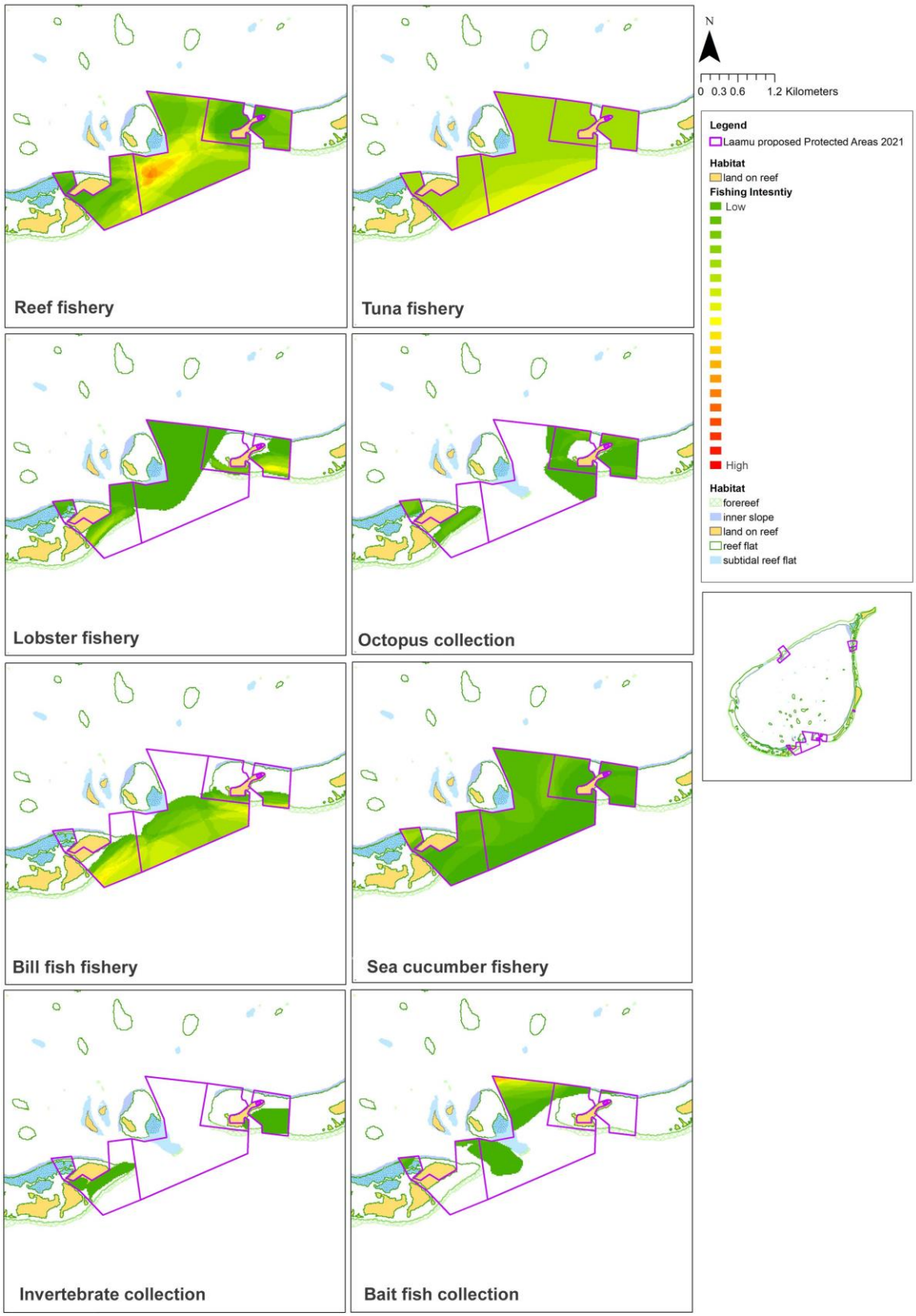


Figure 14a. Fishing intensity for each fishery inside the newly proposed Hithadhoo Kulhi + Hithadhoo-Gaadhoo Kandu + Gaadhoo Protected Areas. Green = low intensity, Red = high intensity

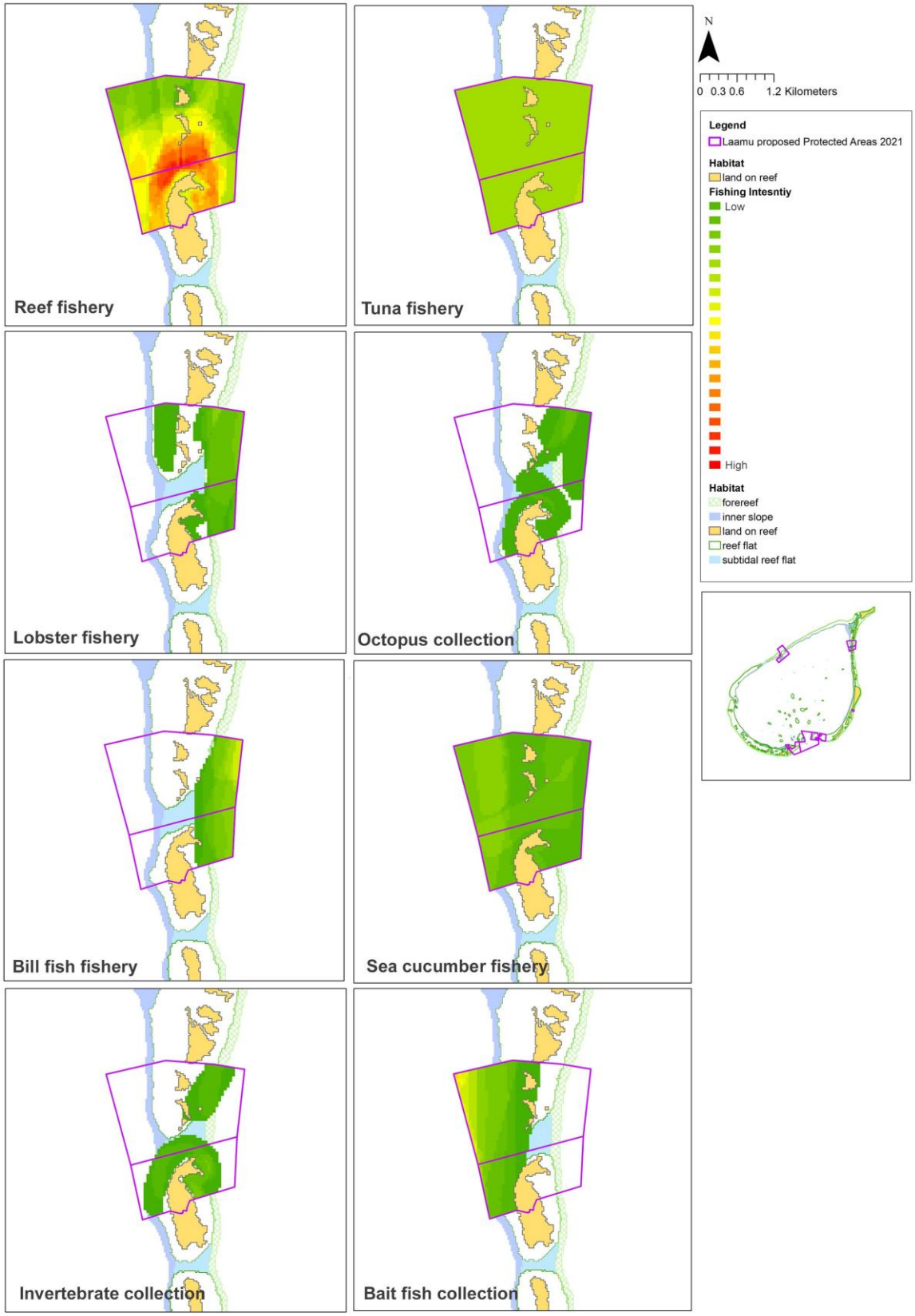


Figure 14b. Fishing intensity for each fishery inside the newly proposed Fushi Kandu and Maabaidhoo Koaru Marine Protected Areas. Green = low intensity, Red = high intensity

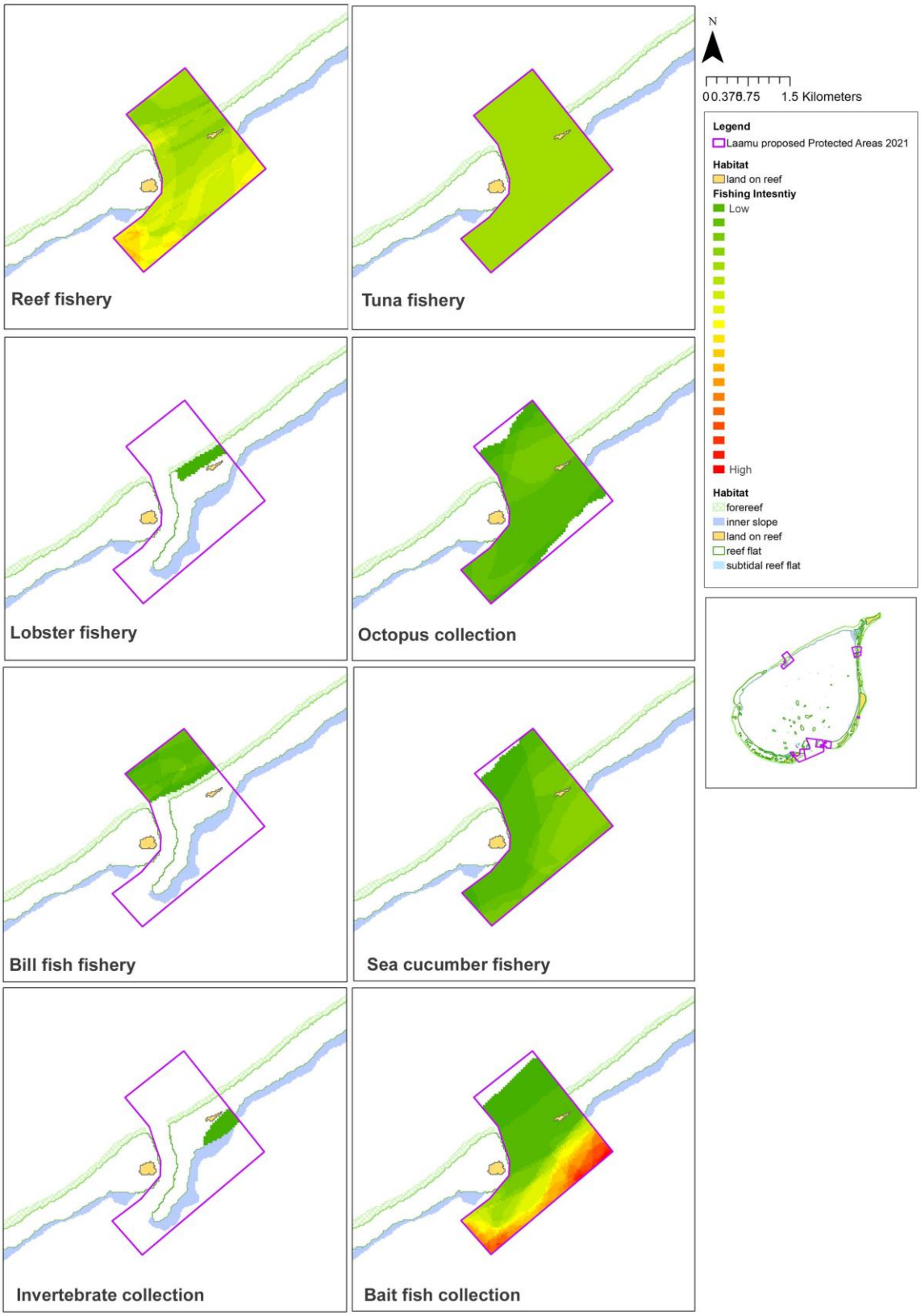


Figure 14c. Fishing intensity for each fishery inside the newly proposed Vadinolhu Kandu Olhi Protected Area. Green = low intensity, Red = high intensity

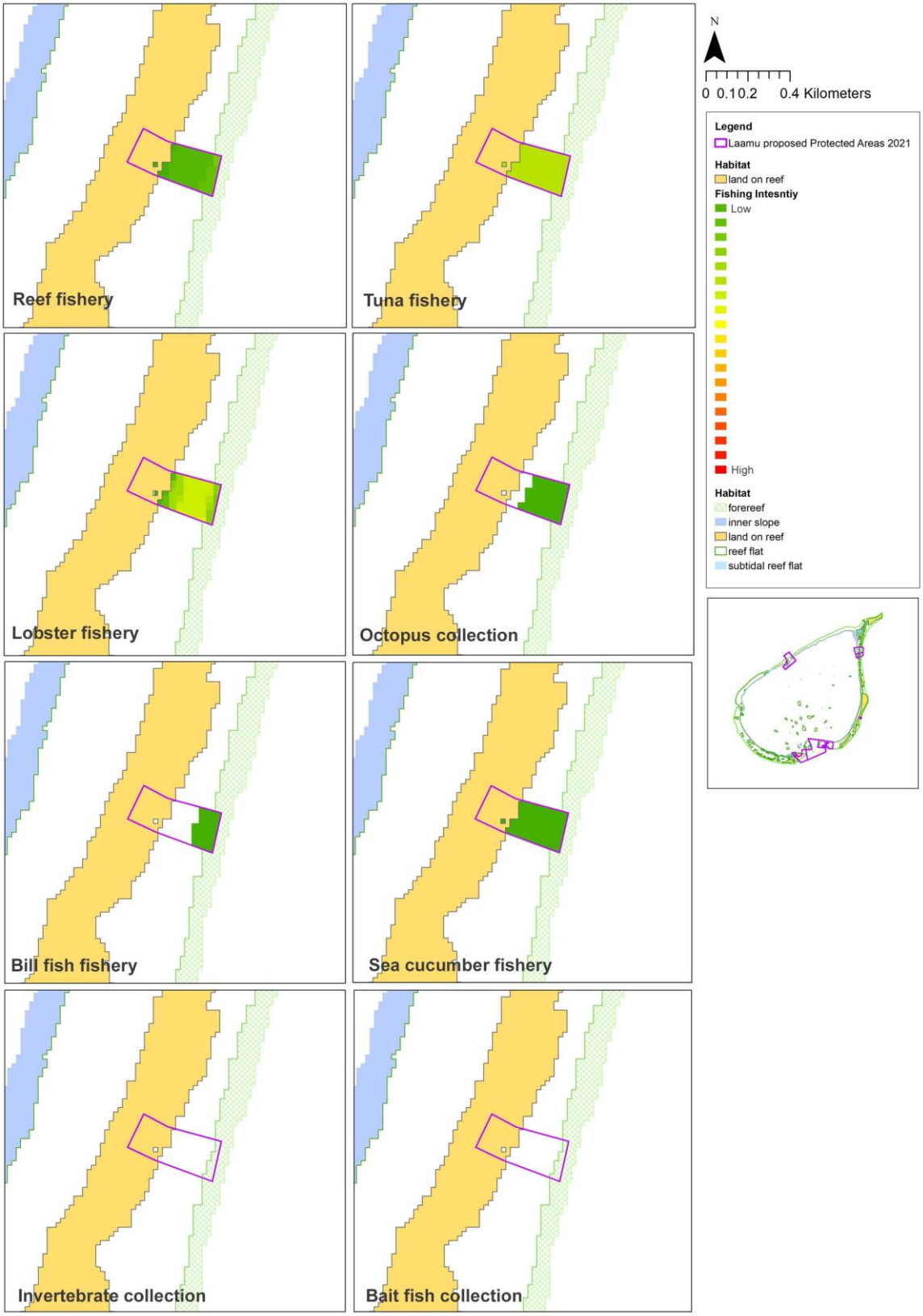


Figure 14d. Fishing intensity for each fishery inside the newly proposed Gan Paree Fengan'du Protected Area. Green = low intensity, Red = high intensity

3.1.1.10 SEASONALITY OF FISHING ACTIVITIES

Tuna and bait fishing, reef fishing and octopus and invertebrate collection are reported to be conducted throughout the year, without any seasonality. Fishers reported a seasonality for three types of fisheries, namely, bill fish and sea cucumber fisheries which are mainly conducted during the Southwest monsoon (May to December) and lobster fishery which is conducted during the Northeast monsoon (January to May). Tuna and bait fishery are mainly conducted during the morning hours (4am to 10am).

Both the reef fishery and the invertebrate collection are mainly conducted during the Full moon and the New moon periods. Reported primary fishing hours for both fisheries are the early evening hours between 5pm to 10pm.

Table 1e: Commonly reported fishing seasonality for the different types of fisheries conducted on Laamu Atoll

Fishery Type	Season	Lunar calendar	Time of day
Tuna and bait fish	All seasons	All days	4am – 10am
Reef	All seasons	Full moon and new moon periods	5pm – 10pm
Bill fish	Southwest monsoon (May to December)	All days	4am – 5pm
Lobster	Northeast monsoon (January to May)	All days	5pm – 10pm
Sea cucumber	Northeast monsoon (January to May)	All days	Not specified
Octopus	All seasons	All days	11am – 10pm
Invertebrate	All seasons	Full moon and new moon periods	5pm – 10pm

3.1.2 INCOME

Commercial fishers were asked to provide their average monthly income for each of the fisheries they were involved in. An average was taken for each fishery (Table 2). The most valuable fishery in terms of income (MVR) as reported by fishers is lobster, ~19,777 MVR a month, followed by bill fish ~ 14,625, tuna and bait ~12,323 and sea cucumber ~12,061 (Table 2).

Table 2. Average monthly income by fishery

Fishery	Average monthly income (MVR)
Reef fish	9,800
Bill fish	14,625
Lobster	19,777
Tuna and bait	13,323
Sea cucumber	12,061
Invertebrate	9,325
Octopus	9,550

3.1.3 LOCAL COUNCILS

Each administrative atoll in the Maldives is served by an Atoll Council (which will be located on the capital island of the respective atoll) and each inhabited island has its own island council. In the administrative landscape an 'island' refers to a specified inhabited area within an administrative atoll, which is governed over by an "island council". A survey, aimed at collecting data on resource use within islands of Laamu, was undertaken by researchers with a local council representative. Local councils were also asked about the resource use and exploitation that occurred within their jurisdiction. This was broken down into commercial fisheries and other types of resource exploitation. In addition to which activities were carried out, councils were also asked to identify the spatial extent of each of these activities. Furthermore, the activities of NGOs, fish exporters and fish factories were ascertained where appropriate. There results of these surveys are presented below.

Between December 2020 and June 2021 11 local councils were surveyed (Table 3). Each Council was asked if there was a Land Use Plan in place. Hithadhoo, Fonadhoo and Gan councils identified they had land use plans.

Table 3. Summary of local councils surveyed and land use plan availability

Island council	**Representative**	**Land use plan?**
Maavah Council	Council President	no
Maabaidhoo Council	Council president	no
Ishdhoo Council	Council president	no
Mundoo Council	Administrator	no
Kunahandhoo Council	Council President	no
Kalaidhoo Council	Council president	no
Dhanbidhoo Council	Director	no

Maamendhoo Council	President	no
Fonadhoo Council	Vice President	yes
Gan Council	Acting Secretary General	yes
Hithadhoo Council	Director	yes

All councils identified several commercial fisheries that took place by island residents within Laamu Atoll (average = 6.3 fisheries). All councils identified reef fishing was conducted from their islands. All councils but Maavah identified tuna/ bait fishing were conducted from their islands. Fishery involvement of each island community are summarised in the table below:

Table 4. Summary of fisheries involvement by island commecial fishing community. No. fishers estimated by council representative, '?' = 'don't know' or no answer given

Island council	Reef fish	Bill fish	Lobster	Tuna & bait	Sea cucumber	Invertebrate collection	Octopus
Maavah Council	✓ (24)	✓ (24)	✓ (12)	NA	✓ (20)	NA	✓ (?)
Maabaidhoo Council	✓ (67)	NA	NA	✓ (200)	✓ (4)	NA	NA
Isdhoo Council	✓ (150+)	✓ (42)	✓ (5)	✓ (52)	✓ (?)	✓ (?)	✓ (?)
Mundoo Council	✓ (6)	✓ (2)	✓ (1)	✓ (6)	NA	✓ (100)	✓ (?)
Kunahandhoo Council	✓ (10)	✓ (10)	✓ (15)	✓ (3)	✓ (15)	✓ (15)	NA
Kalaidhoo Council	✓ (75)	✓ (4)	✓ (15)	✓ (?)	✓ (35)	✓ (50)	✓ (?)
Dhanbidhoo Council	✓ (6)	✓ (6)	NA	✓ (50)	✓ (6)	NA	✓ (?)
Hithadhoo Council	✓ (4)	✓ (2)	✓ (40)	✓ (7)	✓ (1)	NA	✓ (?)
Maamendhoo Council	✓ (20)	NA	NA	✓ (7)	NA	✓ (?)	✓ (?)
Fonadhoo Council	✓ (125)	✓ (1)	✓ (3)	✓ (1)	✓ (3)	✓ (?)	✓ (?)
Gan Council	✓ (12)	✓ (1)	✓ (?)	✓ (300)	✓ (2 groups)	✓ (?)	✓ (?)

In addition, councils were asked about the number of vessels that were involved within each of the identified fisheries carried out. This was further broken down into broad vessel 'type' categories: Dinghies, large vessels and small vessels. Fonadhoo reported the highest number of vessels (53) but these were all smaller dinghies. Most tuna vessels were reported to operate from Gan (16 big and small) (Figure 15).

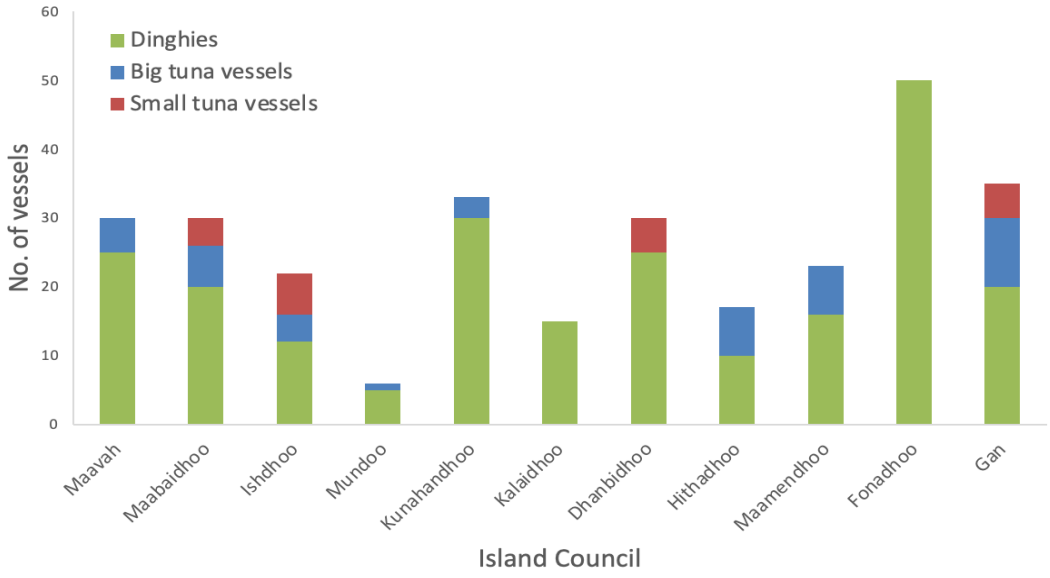


Figure 15. A breakdown of vessel number and type by island

A number of other resource use activities are known to take place within the island jurisdictions (e.g. sand collection). Councils were asked to identify which activities took place and they were given the chance to include others not considered. Coconut husk burying and Island picnic were identified to occur by all councils. Two councils identified an 'Other' activity, both of which identified this activity to 'collection of palm leaves for thatch weaving' (Maabaidhoo and Mundoo). Full results are presented below:

Table 5. Summary of identified resource uses other than fishing within each island's council's jurisdiction

Island council	Sand collection	Firewood collection	Coconut husk burying for rope making	Anchoring	Picnic	Watersports	Other
Maavah Council	NA	NA	✓	✓	✓	NA	NA
Maabaidhoo Council	✓	NA	✓	NA	✓	NA	✓ (collection of palm leaves)
Isdhoo Council	NA	✓	✓	✓	✓	✓	NA
Mundoo Council	✓	✓	✓	NA	✓	NA	✓ (collection of palm leaves)
Kunahandhoo Council	✓	✓	✓	✓	✓	NA	✓
Kalaidhoo Council	✓	✓	✓	NA	✓	NA	NA
Dhanbidhoo Council	✓	✓	✓	NA	✓	NA	NA
Hithadhoo Council	✓	NA	✓	✓	✓	NA	NA
Maamendhoo Council	✓	NA	✓	✓	✓	NA	NA
Fonadhoo Council	✓	✓	✓	NA	✓	✓	NA
Gan Council	✓	✓	✓	✓	✓	✓	NA

A summary of the spatial extent of these other exploitative/anthropogenic activities is provided below for each island. The island jurisdiction maps were obtained from Maldives Land and Survey Authority, Ministry of National Planning, and Infrastructure, for eight of the eleven inhabited islands on Laamu Atoll. For a comprehensive summary of exploitation, within each islands jurisdiction, results from the fisheries surveys (Section 3.1.1) have also been mapped to provide a more complete picture of resource use, and to help identify where two or more activities might overlap, around each island. Summary tables of results from additional surveys show the active NGOs, fish exporters and fish factories are present on each island.

3.1.3.1 MAAVAH

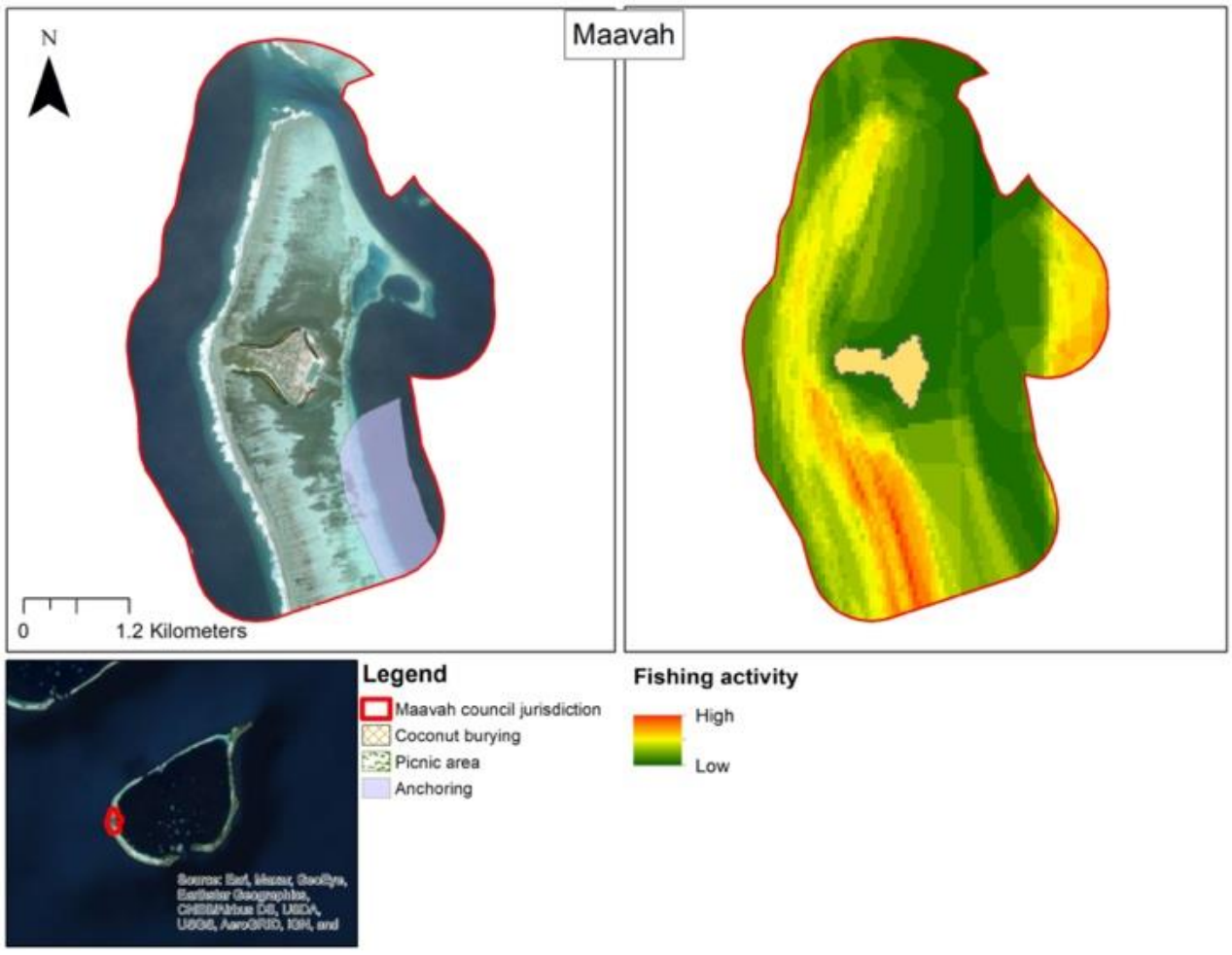


Figure 16. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Maavah's Island Council's jurisdiction.

Within Maavah's jurisdiction there is reported to be a relatively low level of exploitation. There is an anchoring area identified in the southeast, with small areas around the island for coconut husk burying for rope making. Most fishing activity occur in the southwest of the island (Figure 16).

Table 6. Active NGO's in Maavah

NGOs on island	Mission
Bina Jamiyya	Capacity building, Development projects
Maavashu Sports Club	Promote sports
HOPE	Promote social awareness
Games Associations of Maavah	Sports (athlete recruitment)

Table 7. Reef exporters based in Maavah

Type	Species (buy and export)	Supplier	Storage	Buyer/market	Management?
Individual	Reef fish, Tuna, Octopus	Local fishers	Tuna & Reef fish are frozen/chilled and boxed. Octopus are frozen.	Resorts on Laamu Atoll	Resort Requirements (not buying smaller fish less than 1 feet)
Individual	Groupers	Local fishing vessels of Maavah and other islands in the atoll	Cages are anchored in lagoon area close to Maavah	Buyers from Malé	Does not buy groupers that are 500g and below
Individual	Sea cucumber	Individuals from Maavah, sometimes from other islands	Curry fish, cooking and salting. Other species only salting	Buyers from Malé	Not buying smaller than 8 inches
Group	Sea Cucumber	Not buying (they fish on their own to export)	Salting	Buyers from Malé	Not specific (smaller sizes 8 inches)
Individual	Sea cucumber	Not buying (they fish on their own to export)	Stored in Styrofoam box (salted)	Malé company	Does not export banned species of sea cucumber

3.1.3.2 MAABAIDHOO

Within Maabaidhoo's jurisdiction there is some exploitation throughout the land area of the island. Collection of palm leaves for thatch weaving to the north and south, island picnic, and coconut husk burying for rope making in the island's lagoon. One reef exporter identified a large section of the island as a storage area for their fish. See table 8 for details. There is also a high level of fishing all around the island (Figure 17).

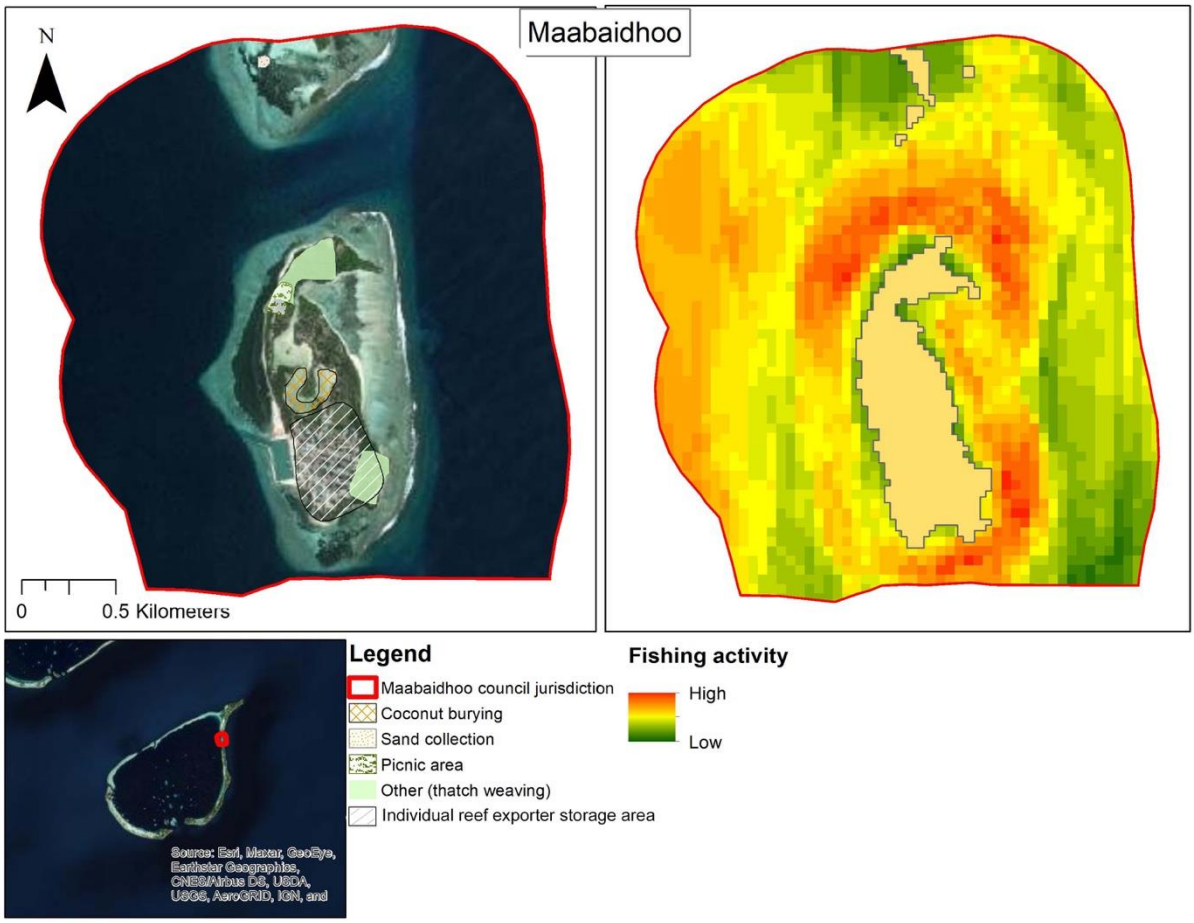


Figure 17. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Maabaidhoo's Island Council's jurisdiction.

Table 8. Active NGO's in Maabaidhoo

Active NGOs on island	Mission
Maabaidhoo All Youth Association	Promote togetherness of youth and population, social activities
Maabaidhoo Sports	Zuvaanun ge ekuverkan aalaa kurun
Maabaidhoo Issdharivarunge Jamiyyaa	Improve social togetherness improve the island and improve economic opportunities
Club Gusto	Social participation awareness, sports

Table 9. Reef exporters based in Maabaidhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/market	Management?
Individual (See map for storage area)	Redaxil emperor, Smalltooth emperor, Longnose emperor, Maldivian emperor, Orangefin emperor, Spotcheck emperor, Yellowlip emperor, Green jobfish, Humpback snapper, various groupers	Own catch	Ice	not specific	None
Individual	Skipjack tuna	Fishers that come with unsold fish to Maandhoo	Dried, smoked	Throughout Laamu atoll, sometimes to Kaafu atoll	None
Individual	Tuna	Mainly Maabaidhoo fishing boats	Rihaakuru, Dried ooked fish	Malé	None
Individual	Tuna	Fishers that come with unsold fish to Maandhoo		Buyers from Malé	None

3.1.3.3 ISDHOO

Isdhoo Council boundaries are yet to be finalised and so haven't been mapped here.

Table 10. Active NGO's in Isdhoo

Active NGOs on island	Mission
Amaaz Jamihyaa/Isdhoo	Youth development and empowerment
Isdhoo Youth Development	Youth development and empowerment
FOI Club	Sports and social development
Isdhoo Youth Empowerment	NA

Table 11. Reef exporters based in Isdhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/market	Management?
Individual	Tuna, Big eye tuna, Frigate tuna	Gaafu Alifu/Dhaalu Atoll, Dhanbidhoo and Maabaidhoo and Isdhoo boats. Also Vaavu atoll boats	Vacuumed, dry fish, rihaakuru bottles	Malé	None

3.1.3.4 MUNDOO

Within Mundoo's jurisdiction most of the land area of the island is used for different resource use activities. Collection of palm leaves for thatch weaving and coconut husk burying for rope making to the north, island picnic throughout and sand collection at the southern beach. The north of the island experiences some high fishing activity (Figure 18).

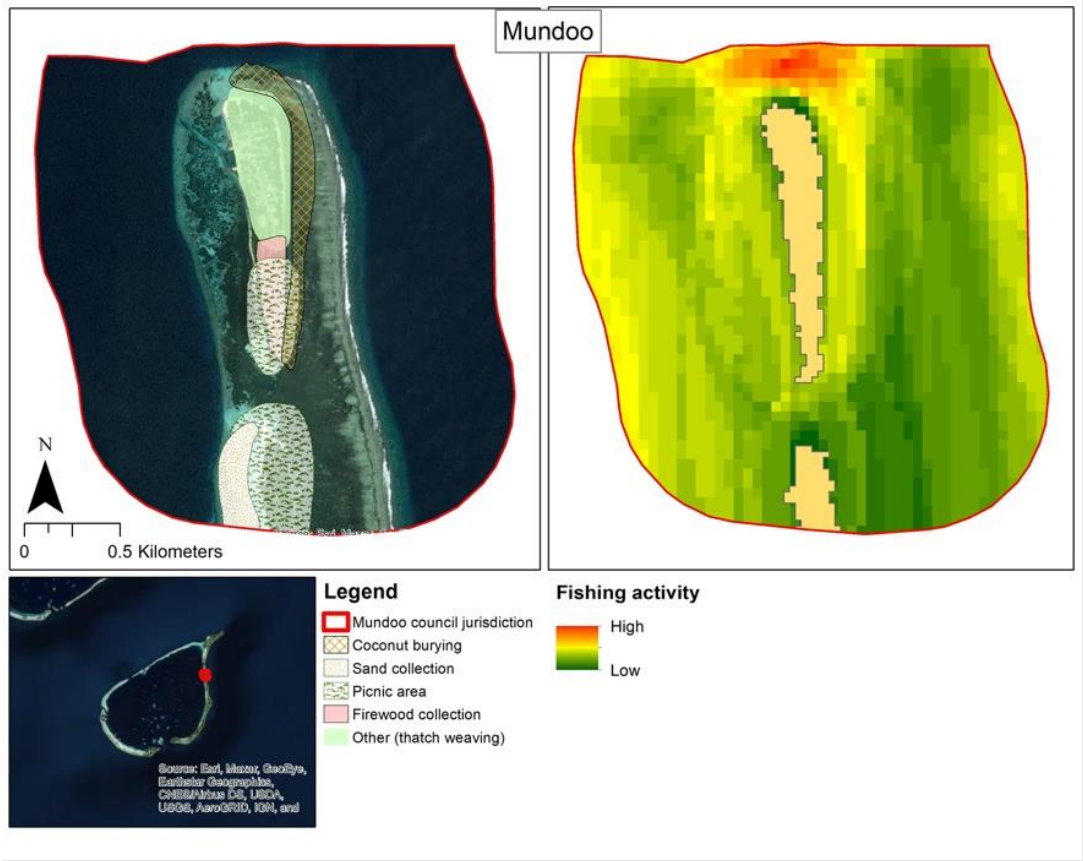


Figure 18. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Mundoo's Island Council's jurisdiction.

Table 12. Active NGO's in Mundhoo

Active NGOs on island	Mission
Mundoo Zumaanunge Jamiyya	Work on island's economic areas and social awareness plus educations development works

3.1.3.5 KUNAHANDHOO

Within Kunahandhoo's jurisdiction there are small land areas of firewood collection, sand collection and coconut husk burying for rope making. The north and the south of the island experiences high fishing activity, which in the south goes right up to the land boundary (Figure 19).

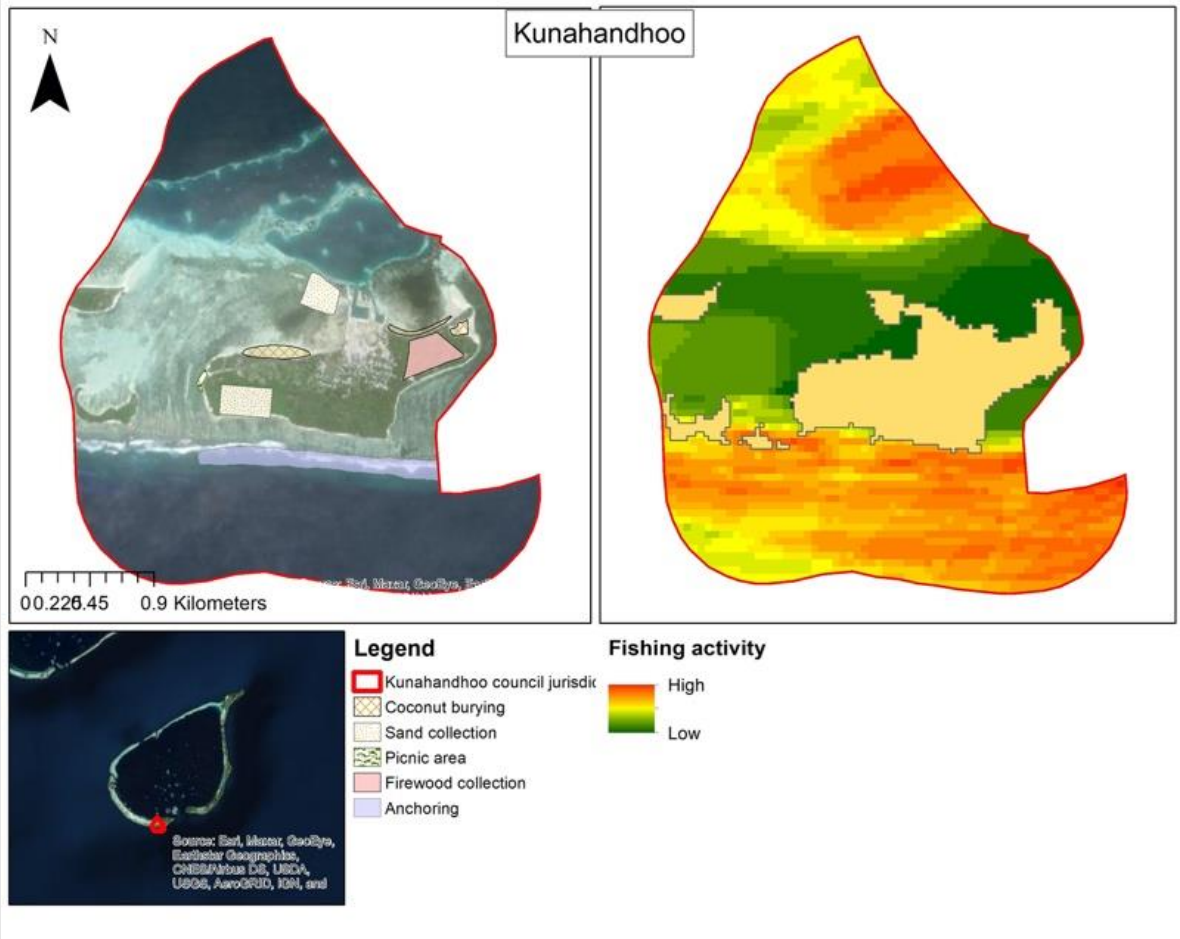


Figure 19. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Kunahandhoo's Island Council's jurisdiction.

Table 13. Active NGO's in Kunahandhoo

Active NGOs on island	Mission
Kundahandhoo Island Nomination Group -KING	Supporting the island development project, youth empowerment, protecting environment, sports and recreation
Soccer Academy	Sports opportunities for youth and youth empowerment/leadership

Table14. Reef exporters based in Kunahandhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/market	Management?
Individual	Tuna, Sea cucumber	Local individuals, Gan, Kunahandho , Maamendhoo and sometimes from as far as Haa Alifu Atoll	Cooking and drying, vaccuming, salted	Buyers from Male'	Maintain personal hygiene standards

3.1.3.6 KALAIDHOO

Kalaidhoo Council boundaries are yet to be finalised and so haven't been mapped here.

Table 15. Active NGO's in Kalaidhoo

Active NGOs on island	Mission
Kins/Kalaidhoo	Social development of Kalaidhoo

3.1.3.7 DHANBIDHOO

Within Dhanbidhoo's jurisdiction there are small land areas for island picnic and coconut husk burying for rope making but most of the island has no exploitation activities identified. The surround of the island experiences some high fishing activity, apart from in the channel between land masses (Figure 20).

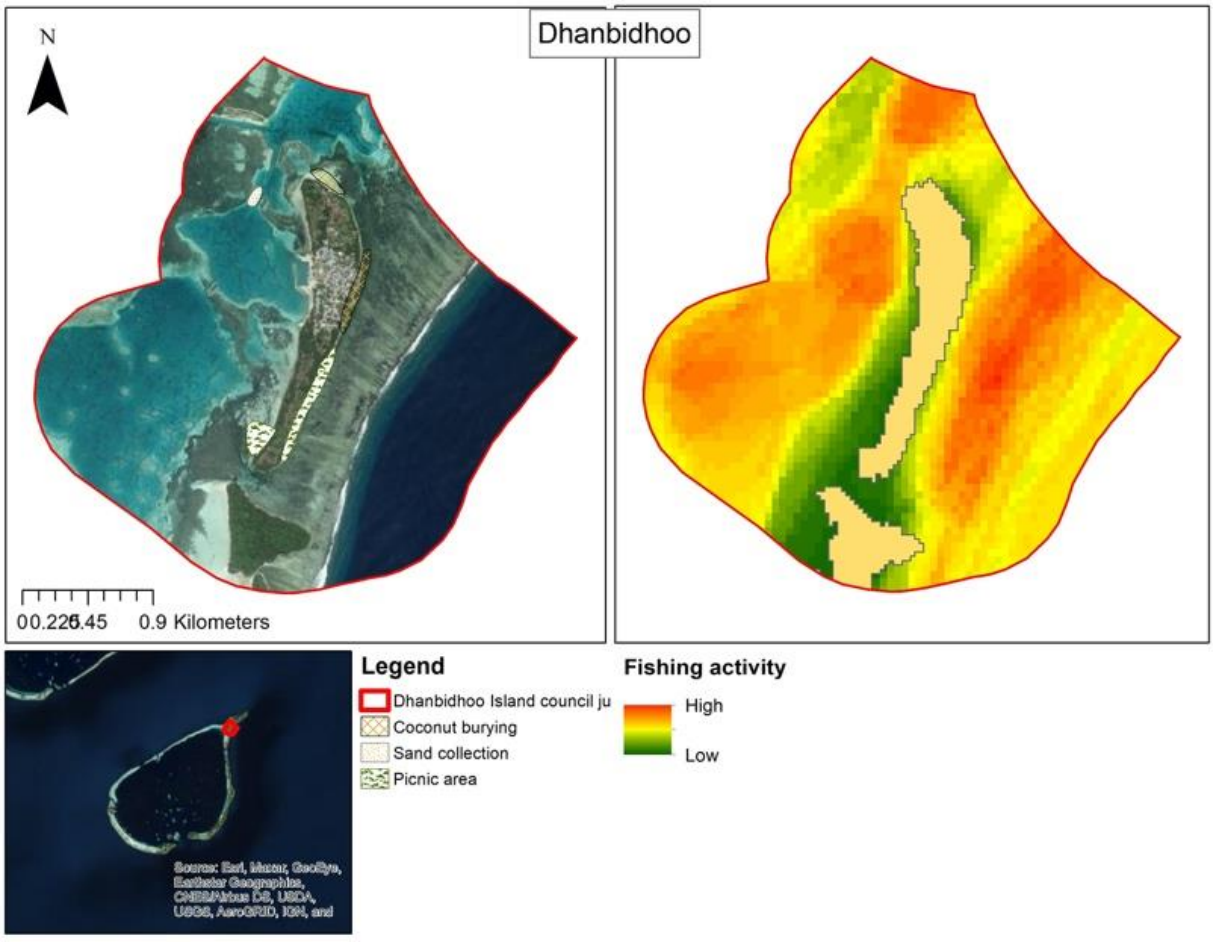


Figure 20. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Dhanbidhoo's Island Council's jurisdiction.

Table 16. Active NGO's in Dhanbidhoo

Active NGOs on island	Mission
Dhanbidhoo Youth Alliance	Island development, public awareness for youth and school children
Associations for Dhanbidhoo development	Work toward developing the island with the island council and bring in developmental projects

Table 17. Reef exporters based in Dhanbidhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/market	Management?
NA	Tuna	From Dhanbidhoo fishing boats	Fish is dried and packed in sacks. Fish paste (Rihaakuru) is stored in glass jars (big 280MVR and small 115MVR) (dried fish is sold for 30-35 MVR per Kg	Malé	Not particularly. Weighs and records the size and amount of fish before sending.
NA	Sea cucumber	From individuals of the island.	Plastic container	Malé	Handles carefully and in clean environment. Stores correctly so that it would last long
Individual	Smaller skipjack tuna	Tuna vessels from Laamu Atoll, but mostly Dhanbidhoo and Maabaidhoo	Small space in the kitchen	Isdhoo, Kalaidhoo, Dhanbidhoo. sometimes Malé	None

3.1.3.8 MAAMENDHOO

Within Maamendhoo's jurisdiction there are small sea areas for anchoring but most of the island's land area has no exploitation activity identified. The northern reef area is exposed to high fishing activity (Figure 21).

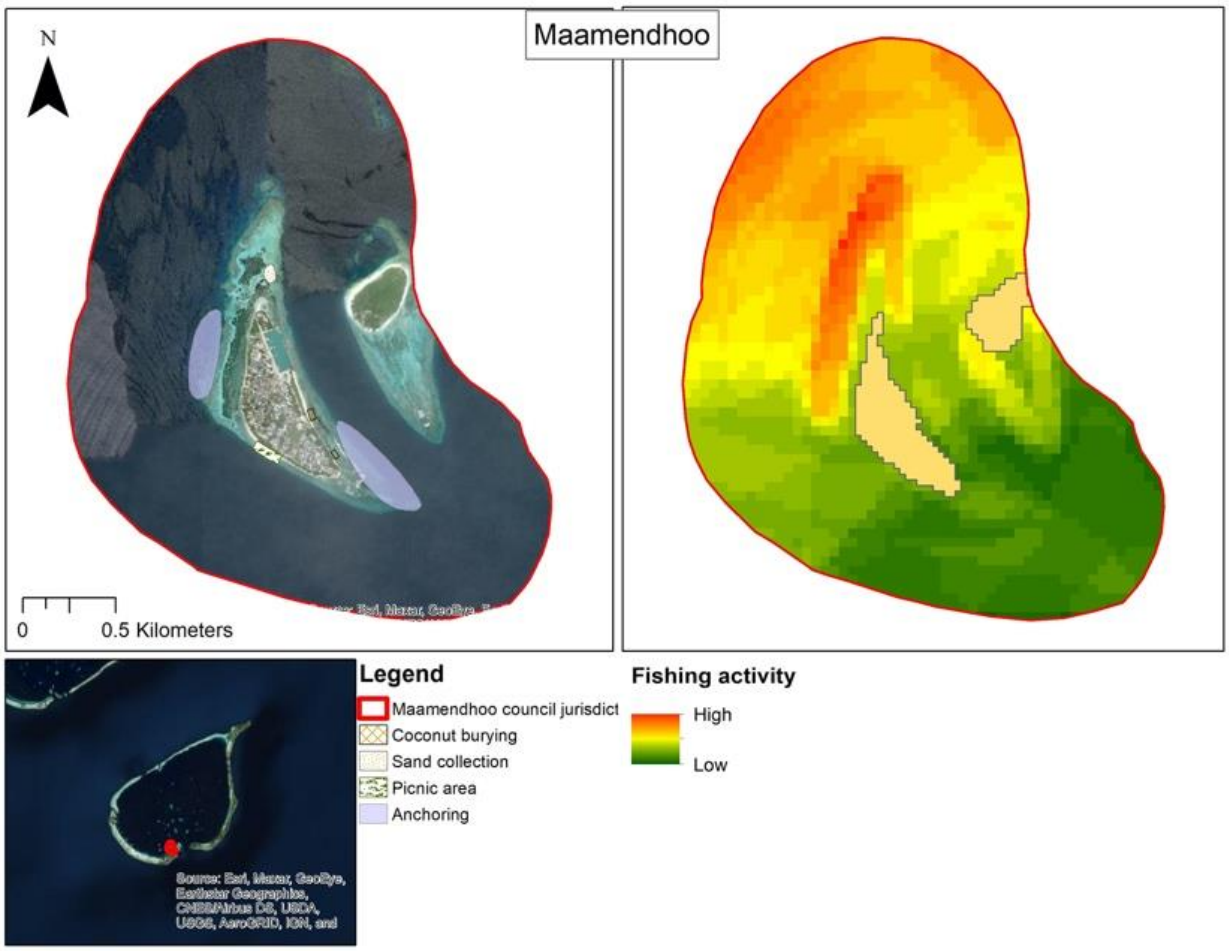


Figure 21. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Maamendhoo's Island Council's jurisdiction.

Table 18. Active NGO's in Maamendhoo

Active NGOs on island	Mission
Maamendhoo United	Welfare society
Maamendhoo masveringe gulhun	Social, economic and environmental empowerment

Table 19. Reef exporters based in Maamendhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/Market	Management?
Not Specified	Trevally, snappers, octopus and reef fish	Locals of Maamendhoo	Chilled in freezer	Laamu resort, Malé buyer	Not specified. but not selling octopus smaller than 1 foot, fishes smaller than 6 inches.
Individual	Green jobfish, Waahoo. emperor, One-spot red snapper, Humpback snapper.	Only buying tuna species on occasional orders	Not storing. Selling directly to Six Senses Laamu resort after catching the fish.	Laamu resort. Sold occasionally to Male' and a resort in Gaafu Dhaalu Atoll	Not specific

3.1.3.9 FONADHOO

Within Fonadhoo's jurisdiction there are coastal areas that are exploited for firewood, coconut husk burying for rope making, island picnic and a large area to the east for sand collection. The western edge of the island is heavily fished (Figure 22).

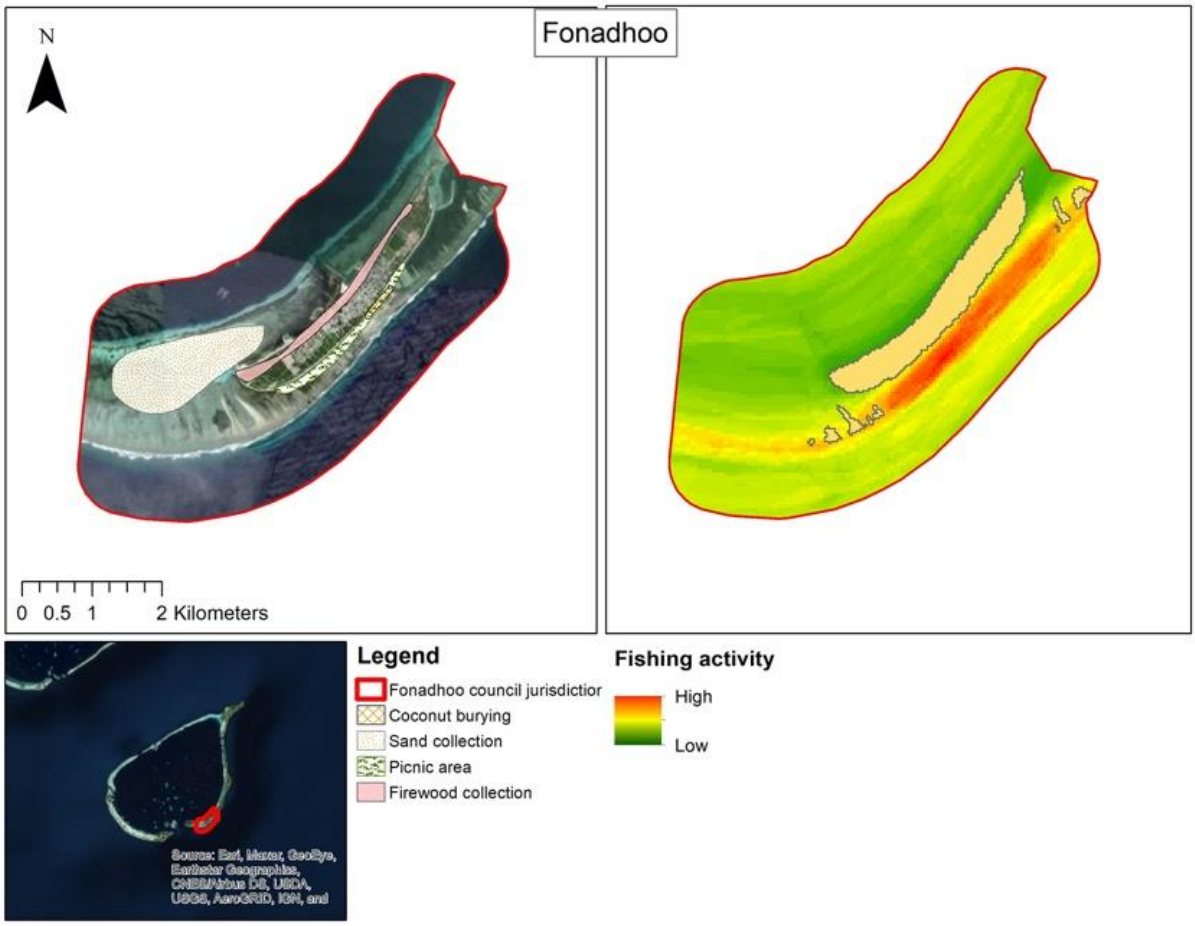


Figure 22. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Fonadhoo's Island Council's jurisdiction

Table 20. Active NGO's in Fonadhoo

Active NGOs on island	Mission
Fonadhoo Innovative Youth Society – Fonadhoo	To maintain peace and the bond between people of Kurigamu neighbourhood in Fonadhoo
Fonadhoo Zuvaanunge Rooh	Youth development
Women Enhancement/Fonadhoo	To empower women in the society and build more responsible youth in the community. Provide job opportunities for youths and give a helping hand to elderly.
Heylhi - Fonadhoo	Protect the environment

Laamu Youth Development (LYD)/ Fonadhoo	Youth development and economic and social awareness and development
Fonadhoo Youth Association	Social and sports development. Include children in sports activities
Laam Tour	Laamu atoll promotion
Fonadhoo Environment Sustainable Development	Carry out environmental sustainability-related activities. Includes all districts of Fonadhoo.
Fonadhoo Medhu Avah Sports Club	Community and sports development

Table 21. Reef exporters based in Fonadhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/Market	Management?
NA	Tunas: frigate, kawakawa, yellow fin and big eye	Maandhoo and Gan mostly	Dried fish, smoked fish and fish paste	Male’	

3.1.3.10 GAN

Gan Council jurisdiction boundaries are yet to be finalised and so haven't been mapped here.

There are no identified fish exporters currently active on the island of Gan.

Table 22. Active NGOs in Gan

Active NGOs on island	Mission
Islanders Association	To protect the environment and increase awareness on environmental issues
Hamad Incline Youth Association (HIYA Jamiyya)	Hamad School Alumni. Youth engagement
Real Island Society	Working on social and youth development issues
Society for Thundi Advancement and Recreation (STAR)	Engaging youth and building community.
Mukurimagu Zuvaanunge Jamiyya	Sports advancement
Gamu Zuvaanunge Jamiyya	Conducting social activities, youth related activities
Ithaa Community Development	Youth engagement and development
Laamu Advance Movement	Spreading awareness on social and religious matters

3.1.3.11 HITHADHOO

Within Hithadhoo's jurisdiction there is a coastal area that is used for anchoring to the east and small areas for other types of exploitation. Hithadhoo was the only island surveyed which had a conserved area identified in its Land Use Plan. The eastern edge of the island is heavily fished (Figure 23). There are no identified active NGOs on Hithadhoo.

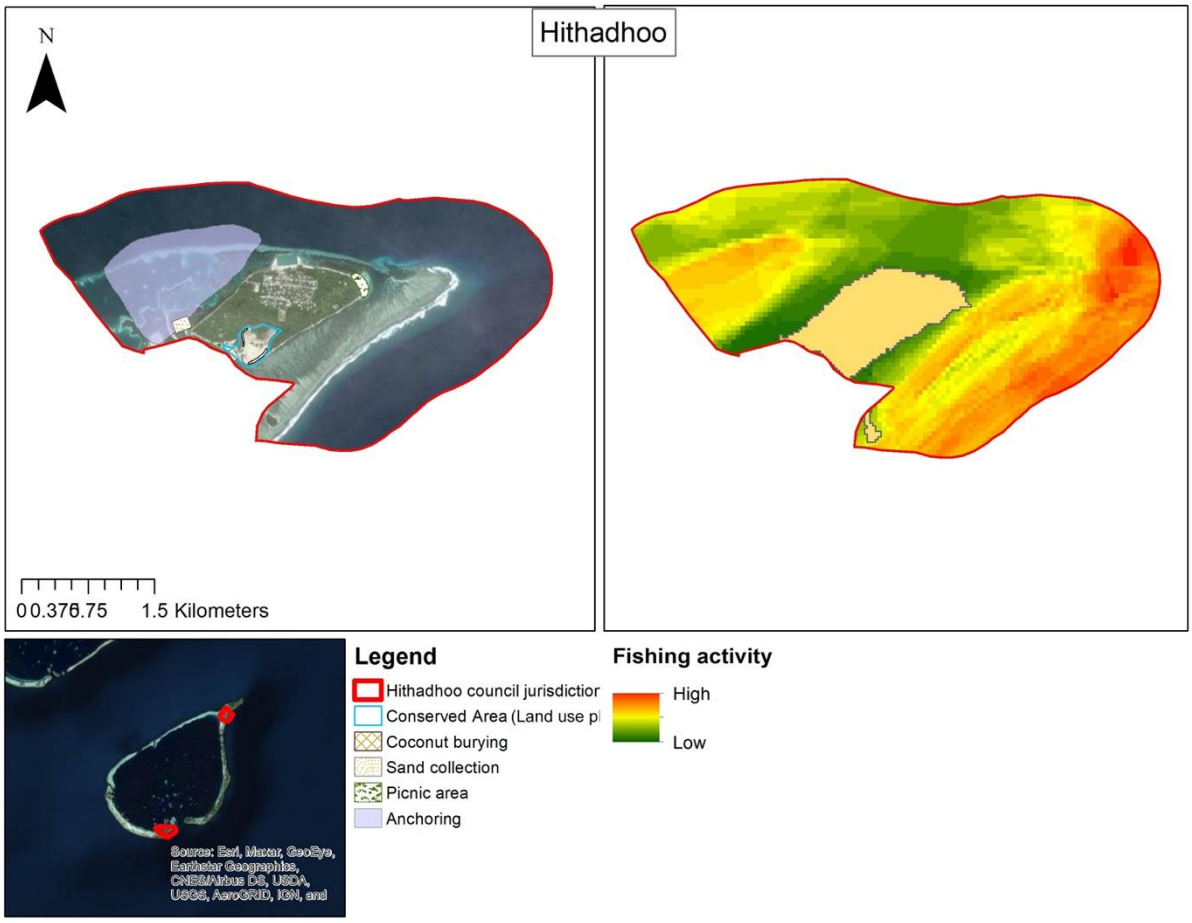


Figure 23. Spatial extent of resource uses other than fishing (left) and commercial fishing activity (right, darker colour = higher fishing intensity) within Hithadhoo's Island Council's jurisdiction

Table 23. Reef exporters based in Hithadhoo

Type	Species (buy and export)	Supplier	Storage	Buyer/Market	Management?
Individual	Tunas: Skipjack, Frigate and Kawakawa	From his own vessel	Dried and kept in a freezer until sent to Male' via boat.	Fonadhoo, Isdhoo, Hithadhoo	

3.1.4 MAANDHOO FISH FACTORY

There is only one fish processing factory in Laamu Atoll, which is in Maandhoo. This fish factory buys Skipjack (ކަޅުބިލަމަސް / ކަނޑުމަސް) and Yellowfin (ރީނދޫ ކަނޑުމަސް) tuna from all around the Maldives depending on fishing location and market. Laamu, Thaa, Dhaalu, Meemu were highlighted as the most common atolls where their sellers originate from. The factory acknowledged that if tuna fishing is better in other atolls, they send collection vessels to other atolls as well to supplement fish purchase. They are purchased from pole and line fishing vessels only. Maandhoo fish factory has registered fishing vessels under their Fairtrade programme which currently covers six islands in Laamu Atoll: Maamendhoo, Hithadhoo, Kunahahdoo, Maavah, Maabaidhoo and Gan.

Tuna is bought all year around but the low fishing season was identified as April/May to July, with a high season in December to March (for both Skipjack and Yellowfin). Market demand, supply and weather all contribute to how much fish is bought by the factory. The factory cans and smokes its fish. Canned and pouched products are sold to Europe, USA and Maldives. Smoked tuna and fish gonad and parts are sold within Maldives. When asked if the factory follows any management the factory identified it follows international market standards, it supports tracing at batch level, and follows the ISO 9001 system management, ISO 14000 environmental management system, BRC food standard, ISO 22000 FSM system, Maldives FDA Assessment and ethical audits.

3.1.5 TOURISM

Six Senses is a luxury resort in Laamu located near Hithadhoo in the south of the atoll. Reveries Diving Village (Guesthouse) is Laamu's first Boutique Hotel, located on Gan Island, at the northern end of the Thundi village. Both resorts were surveyed to understand associated tourism activities offered and undertaken by guests at each resort.

Both resorts offer several ocean-based activities to guests which include:

- Snorkeling (both tourism operators)
- Diving (both tourism operators)
- Fishing (both tourism operators)
    - Sunrise big game fishing with trolling (both tourism operators)
    - Sunrise big game fishing with jigging (Reveries Diving Village only)
    - Day time big game fishing with trolling (Reveries Diving Village only)
    - Day time big game fishing with jigging (Reveries Diving Village only)
    - Sunset reef fishing with handline (both tourism operators)
    - Big game fishing - casting and popping (Reveries Diving Village only)
- Dolphin watching (both tourism operators)
- Watersports (both tourism operators)
    - Jetski (both tourism operators)
    - Kayak (both tourism operators)
    - SUP (both tourism operators)
    - Waterskiing (Six Senses Laamu only)
    - Wind surfing (Six Senses Laamu only)
    - Kite surfing (Six Senses Laamu only)
    - Seabob (Six Senses Laamu only)
- Surfing (both tourism operators)
- Motorized hydrofoil (Six Senses Laamu only)

Snorkeling:

Snorkeling activities by Reveries Diving Village guests are carried out to the north of Gan in two small areas on the inner reef of the atoll (Figure 24). There is no crossover between snorkeling activities and the newly proposed Protected Areas. These areas are chosen for snorkeling because there are good coral reefs, good fish life and convenience. The southernmost area (nearest Gan) is the 'house reef'.

The house reef and the reef immediately north of this are visited multiple times weekly, with the other areas visited a few times a month. The average number of people on each snorkeling trip is 2. Reveries Diving Village were asked about the guidelines they follow and any rules or regulations they impose when guests go snorkeling and it was noted that guests are briefed not to step on corals when snorkeling on coral reefs.

Snorkeling activities by guests at Six Senses Laamu are concentrated around the reefs of Hithadhoo and Maamendhoo islands (Figure 24). These areas are chosen for their good coral reefs, good fish life, megafauna and convenience. There is also a large area for snorkeling on the inside lagoons and reefs of Maakalhuveli, again chosen for the same reasons above except for megafauna. Some snorkeling happens in the channels north of Maavah and Fushi Kandu inside the proposed Protected Area. Fushi Kandu is mainly chosen for the presence of Manta rays. On average 10 snorkelers from Six Senses participate in each trip but 20 can be accommodated. Most of these sites are visited once a month but the site to the immediate North of Six Senses is visited every day. All sites are visited both in the AM and PM. Six Senses Laamu noted they impose guidelines on snorkelers, and briefings are provided prior to every snorkeling trip.

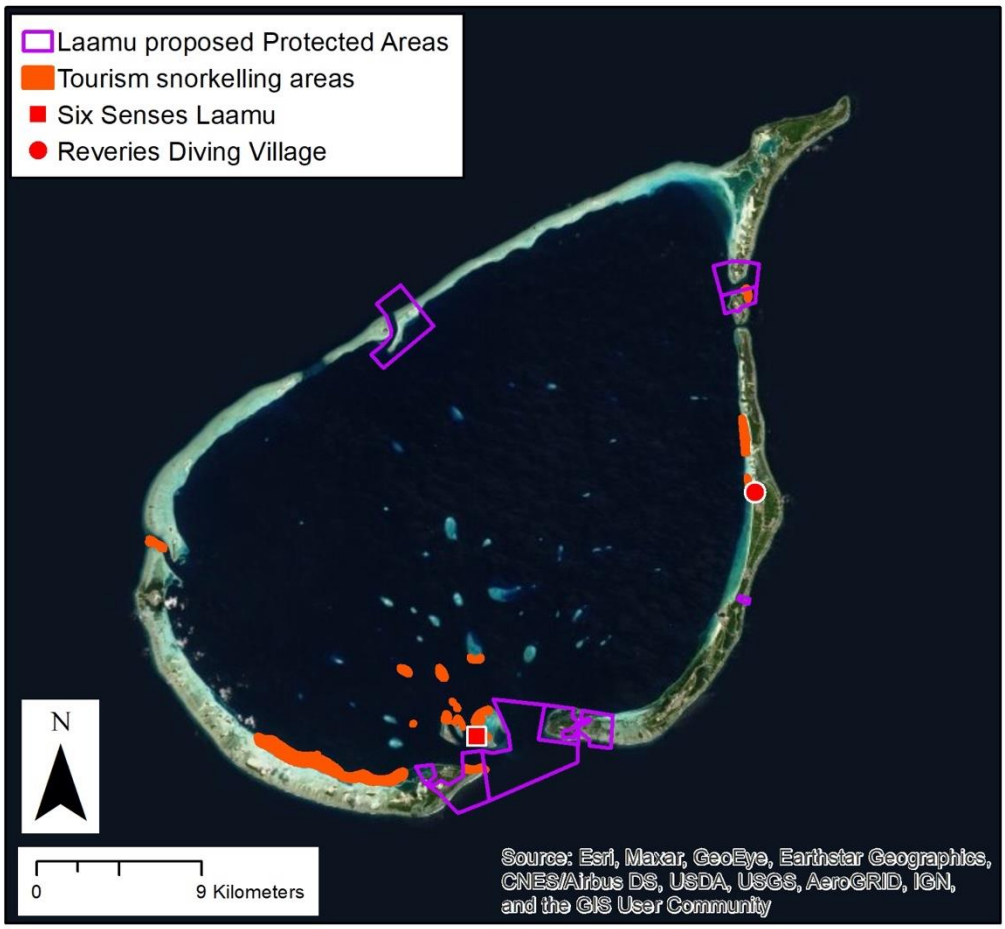


Figure 24. Spatial extent of snorkelling activity areas (red) used by guests of tourist sites in Laamu (Six Senses Laamu, Reveries Diving Village). Proposed Protected Areas are also shown.

Diving:

Diving activities by Reveries Diving Village guests are in the eastern and southern fringes of Laamu atoll. There are many areas identified for diving to the north of Gan on the inside reefs and the channels near Fushi Kandu, notably inside the Fushi Kandu newly proposed Marine Protected Area (Figure 25). There are a number of inner reefs which are used for diving and an area in the south in the Hithadhoo Gaadhoo Kandu proposed Marine Protected Area. These areas are chosen for diving mostly because there are good coral reefs. Other reasons for choosing these areas include megafauna sightings, convenience, good for novices/good for experienced divers. The southernmost area (nearest Gan) is the 'house reef' and this is popular for diving, visited multiple times a week while other areas area visited a few times a month. The average number of people on each diving trip is 2. Reveries Diving Village were asked about the guidelines they follow and any rules or regulations they impose when guests go diving and it was noted that the standard PADI protocols are followed.

Six Senses Laamu guests have diving sites distributed widely throughout Laamu Atoll. A number of sites fall within the Gaadhoo and Hithadhoo proposed Protected Areas as well as inside the Fushi Kandu and Vadinolhu Kandu proposed Protected Areas (Figure 25). The diving site that wraps around the eastern side of Hithadhoo is dived everyday and this falls within the Hithadhoo Kulhi and Hithadhoo Gaadhoo Kandu proposed Protected Areas. This site is dived in the AM and is chosen because it is a manta cleaning station. Six other sites including two more inside the Hithadhoo Kulhi proposed Protected Area, one in the channel north of Maavah, Reefs in the centre of the atoll and a site inside the Fushi Kandu proposed Protected Area are dived more than three times a week. These sites are chosen for their convenience, good coral reefs and for megafauna sightings (turtles & sharks). Notably, the diving sites inside the Vadinolhu Kandu proposed Protected Area are only dived once a month (Figure 26). As before Six Senses Laamu noted they impose guidelines on divers but these were not detailed in the survey. Three people on average go on each diving trip from Six Senses.

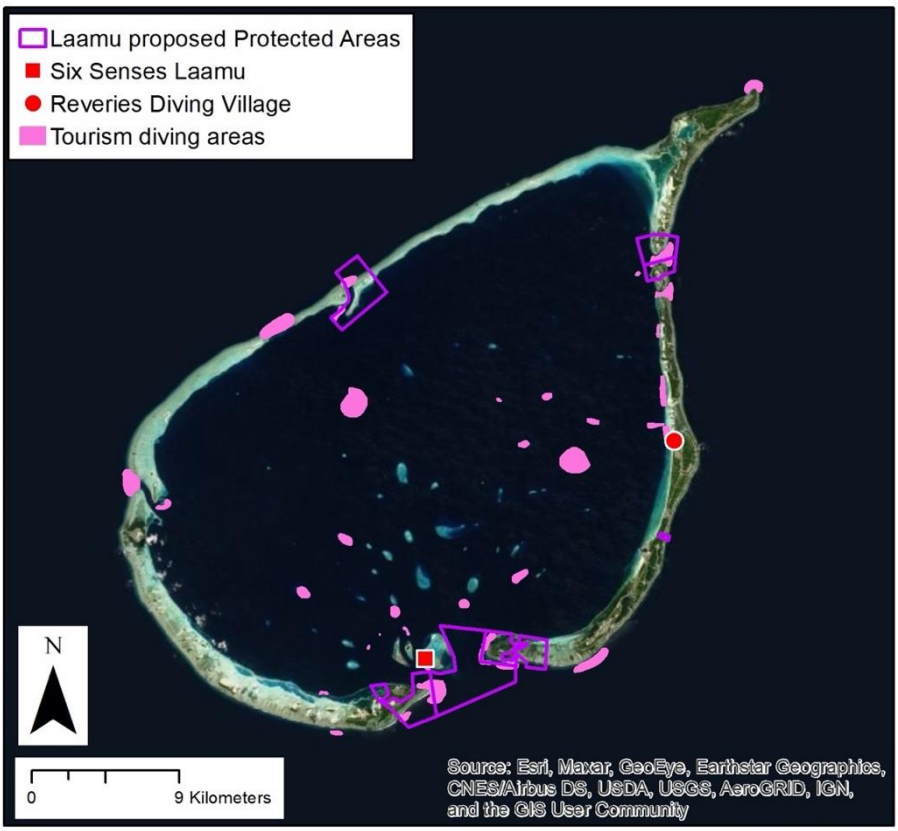


Figure 25. Spatial extent of diving activity areas (pink) used by guests of tourist sites in Laamu (Six Senses Laamu, Reveries Diving Village). Proposed Protected Areas are also shown.

Fishing:

For fishing activities by Reveries Diving Village guests there are many areas identified to the north of Gan on the inside reefs and the channels near Fushi Kandu, notably channels inside the Fushi Kandu

newly proposed Marine Protected Area. These northern areas are used for sunrise reef fishing with trolling, sunset reef fishing with handline. These areas are chosen for their good fishing, better weather conditions and for convenience (Solid green, Figure 27). The average number of people on each fishing trip is 3 and a total of 8-12 fish are estimated to be caught on each trip. There are no maximum limits in place but the trip duration ensures no more than 12 are caught on average.

The following species are targeted by Reveries guests during fishing trips (in order of frequency caught):

LOCAL NAME	COMMON NAME	SCIENTIFIC NAME
Ginimas	Humpback red snapper	Lutjanus gibbus
Reendhoo thun filolhu	Yellowlip emperor	Lethrinus xanthochilus
Raiy mas	Two-spot red snapper	Lutjanus bohar
Dhon olhu faana	Roving coral grouper	Plectropomus pessuliferus
Giulhu	Green jobfish	Aprion virescens
Haluvimas	Bigeye trevally	Caranx sexfasciatus
Kurumas	Wahoo	Acanthocybium solandri
Muda Handhi	Giant trevally	Caranx ignobilis

In addition, the general outer reef area around Laamu, is used for sunrise and daytime big game fishing with trolling and jigging, however, this wider area is only visited a couple of times each month. Outer reef areas around the atoll area chosen for their good fishing (hashed green, Figure 26). There is some overlap with the proposed Marine Protected Areas in the south for these fishing activities.

Reveries Diving Village were asked about the guidelines they follow and any rules or regulations they impose when guests go fishing and it was noted that while no guidelines are followed, they typically release small fish. Many guests also catch and release Giant Trevally.

Fishing activities by Six Senses Laamu tourists are concentrated on the central reefs inside the atoll and a large area outside of the atoll to the south, southeast corner (Figure 26). This larger area is visited every day and is chosen for convenience, good fishing, and suitable weather conditions, and it is fished in the morning. This area is used for sunrise reef fishing with handlines. Sites inside the atoll are visited much less (once or twice a month) and are visited in the PM only. These areas are used for sunset reef fishing with handlines. Fishers use one line and one hook only. Six Senses Laamu identified that Laamaseelu masveriyaa guidelines are followed when fishing. Typically, 6 fishers go on each fishing trip, but 8 can be accommodated. The following species are targeted by Six Senses guests during fishing trips (in order of frequency caught):

LOCAL NAME	COMMON NAME	SCIENTIFIC NAME
Giulhu	Green jobfish	*Aprion virescens*
Keyolhu rovvi	Smalltooth emperor	*Aphareus furca*
Haluvimas	Bigeye trevally	*Caranx sexfasciatus*
Bolike	Orange-fin emperor	*Lethrinus erythracanthus*
Reendhoothun filolhu	Yellowlip emperor	*Lethrinus xanthochilus*
Maaniya mas	Rainbow runner	*Elagatis bipinnulata*
Kurumas	Wahoo	*Acanthocybium solandri*
Voshimas	Dogtooth tuna	*Gymnosarda unicolor*
Latti	Kawakawa	*Kawakawa*
Muda Handhi	Giant trevally	*Caranx ignobilis*
Vabboa handhi	Coastal trevally	*Carangoides caeruleopinnatus*
Fashuvi rankara mas	Rusty jobfish	*Aphareus rutilans*
Kandu rasgefaanu	Black-saddled coral grouper	*Plectropomus laevis*
Olhu faana	Squaretail coral grouper	*Plectropomus areolatus*
Dhon olhu faana	Roving coral grouper	*Plectropomus pessuliferus*
Thijjehi faana	Areolate grouper	*Epinephelus areolatus*
Raiy mas	Two-spot red snapper	*Lutjanus bohar*
Ginimas	Humpback red snapper	*Lutjanus gibbus*
Dhonfalho mas	One-spot snapper	*Lutjanus monostigma*
Keyolhu rovvi	Small toothed jobfish	*Aphareus furca*
Kashithun filolhu	Long nose emperor	*Lethrinus olivaceus*
Farutholhi	Bigeye Barracuda	*Sphyraena forsteri*
Maatholhi	Great barracuda	*Sphyraena barracuda*

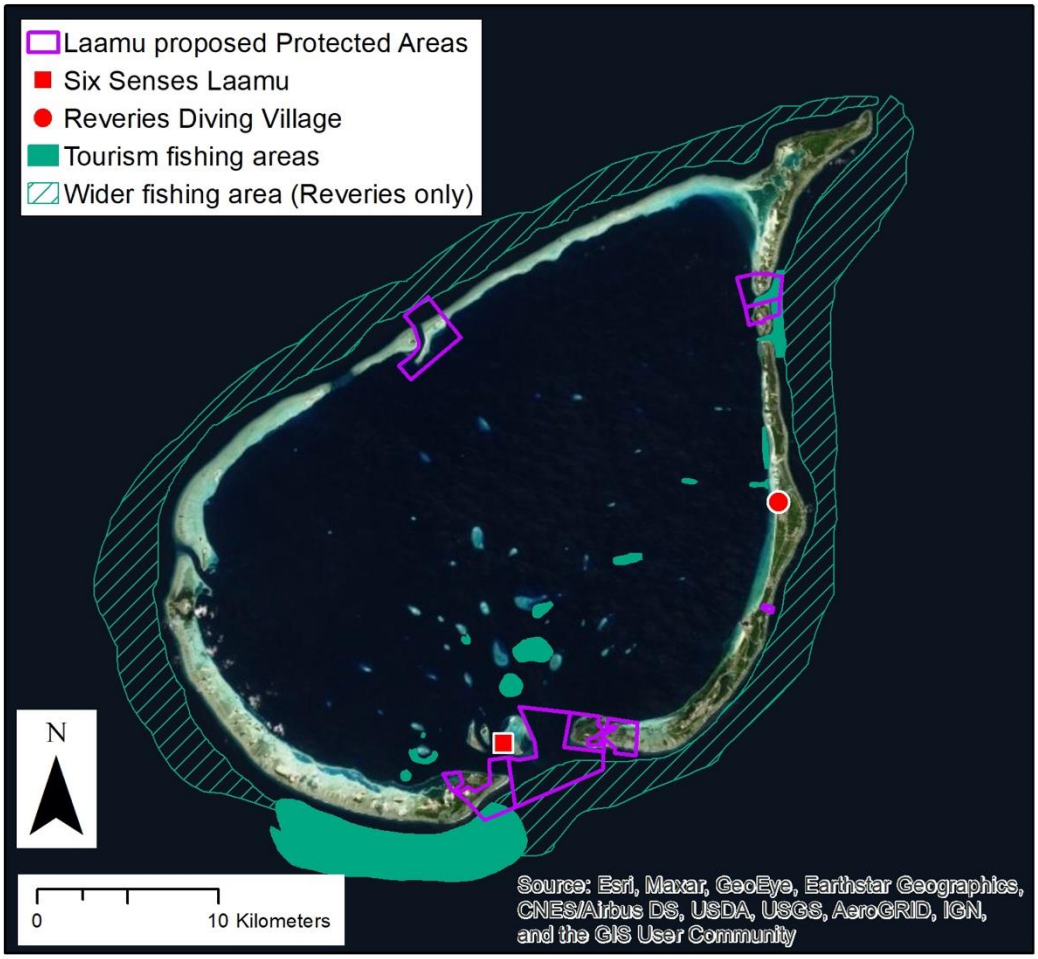


Figure 26. Spatial extent of all fishing activity areas (green (solid)) used by guests of tourist sites in Laamu (Six Senses Laamu, Reveries Diving Village). Reveries identified wider fishing area (hashed green) is mapped. Proposed Protected Areas are also shown.

Dolphin watching:

Dolphin watching activities by Reveries Diving Village guests are carried out around the channels near, and inside, the Fushi Kandu and Maabaidhoo Koaru newly proposed Protected Areas (Figure 27). These areas are chosen for dolphin watching because it is a nice route, has good sightings and for convenience. This area is visited multiple times each week. The average number of people on each dolphin watching trip is 2. Reveries reported a 100% sighting probability at Fushi Kandu/ Mundoo Kandu. No specific guidelines area imposed when dolphin watching.

Six Senses Laamu dolphin watching activities take place in one indiscriminate around to the north and south of Hithadhoo and all inside and outside the proposed Protected Areas (Figure 27). The area extends around 3 km north of Six Senses Laamu, 4 km south, 7 km to the west and 5.5 km to the East. This area is chosen for convenience and good sightings and is visited more than three times a week.

Six Senses Laamu responsible dolphin interaction guidelines are followed. 12 guests attend each trip on average but 22 can be accommodated. Bottlenose and spinner dolphins are seen and the chance of a sighting in 75%.

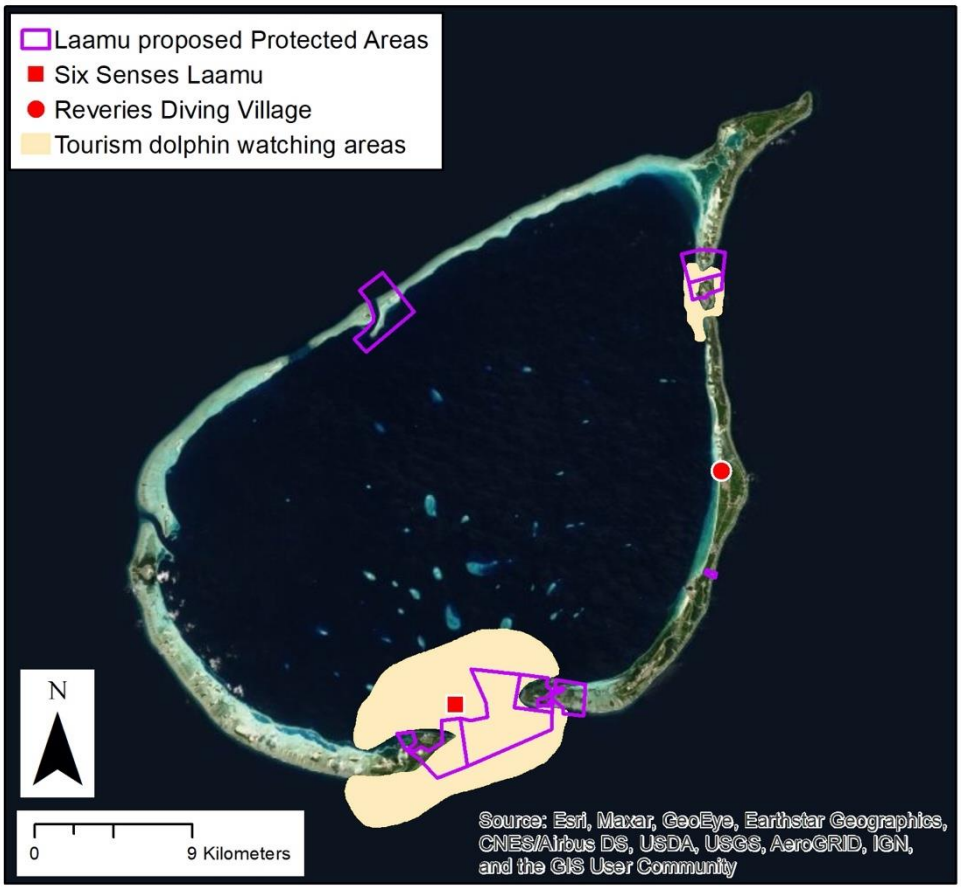


Figure 27. Spatial extent of dolphin watching activity areas (beige) used by guests of tourist sites in Laamu (Six Senses Laamu, Reveries Diving Village). Proposed Protected Areas are also shown.

Watersports:

Watersport activities by Reveries Diving Village are undertaken on the house reef to the north of Gan (Figure 28). Reveries Diving Village were asked about the guidelines they follow and any rules or regulations they impose when guests are undertaking watersports. For motorized water sports safety guidelines are explained and reveries have a specific zone marked for water sports activities. This area is used by their guests' multiple times a week.

Six Senses Laamu watersports take place in one area to the immediate north of Six Senses Laamu (Figure 28). The site is used for windsurfing, wakeboarding, jet blading, kayaking, SUP and seabob. It is visited everyday AM and PM. Motorized hydrofoil is also offered. No responsible guidelines were said to be followed.

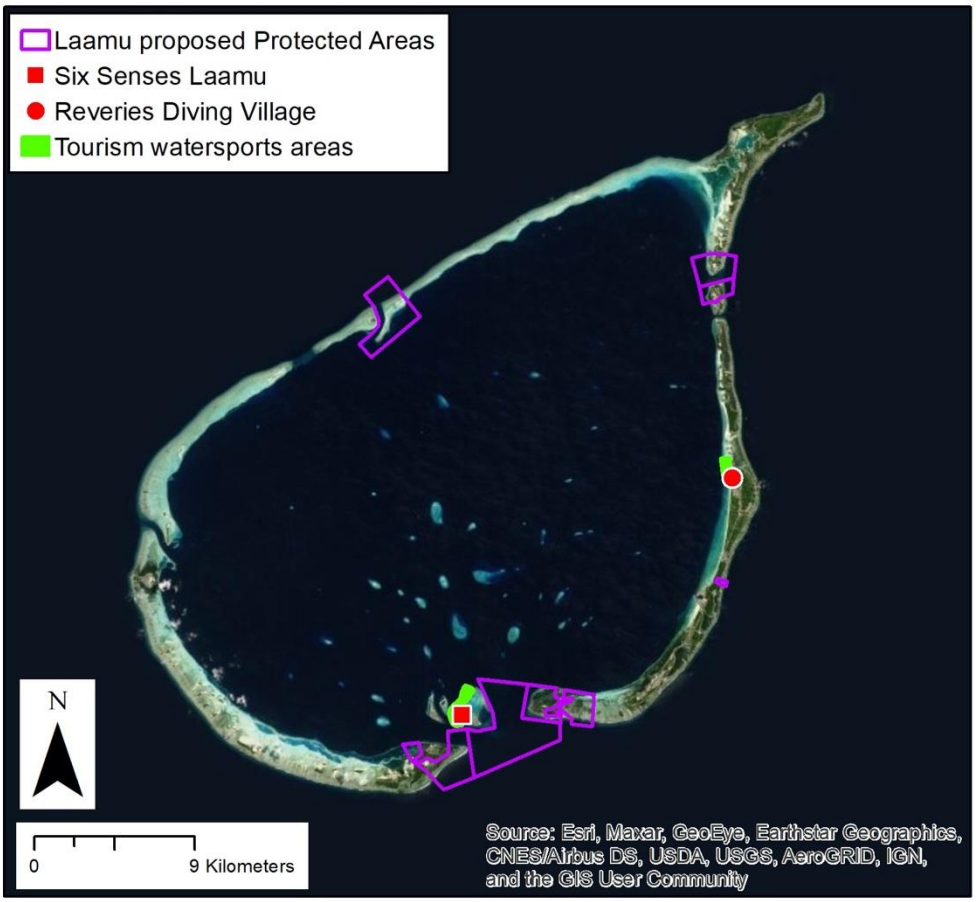


Figure 28. Spatial extent of watersport activity areas (light green) used by guests of tourist sites in Laamu (Six Senses Laamu, Reveries Diving Village). Proposed Protected Areas are also shown.

Surfing:

Surfing activities take place to the north near, and inside, the Fushi Kandu and Maabaidhoo Koaru newly proposed Marine Protected Areas, and to the south near, and inside, the Hithadhoo Kulhi proposed Marine Protected Area. No specific guidelines area imposed when surfing (Figure 29).

Surfing activities for Six Senses Laamu guests take place on the resort's house reef and inside the Hithadhoo proposed Protected Areas including the reef immediately east of Hithadhoo (Figure 29). These sites area visited multiple times each week. Some surfing is also undertaken inside the Fushi Kandu proposed Protected Area but this only happens 1-2 times a month. No specific guidelines area imposed when surfing for Six Senses Laamu tourists.

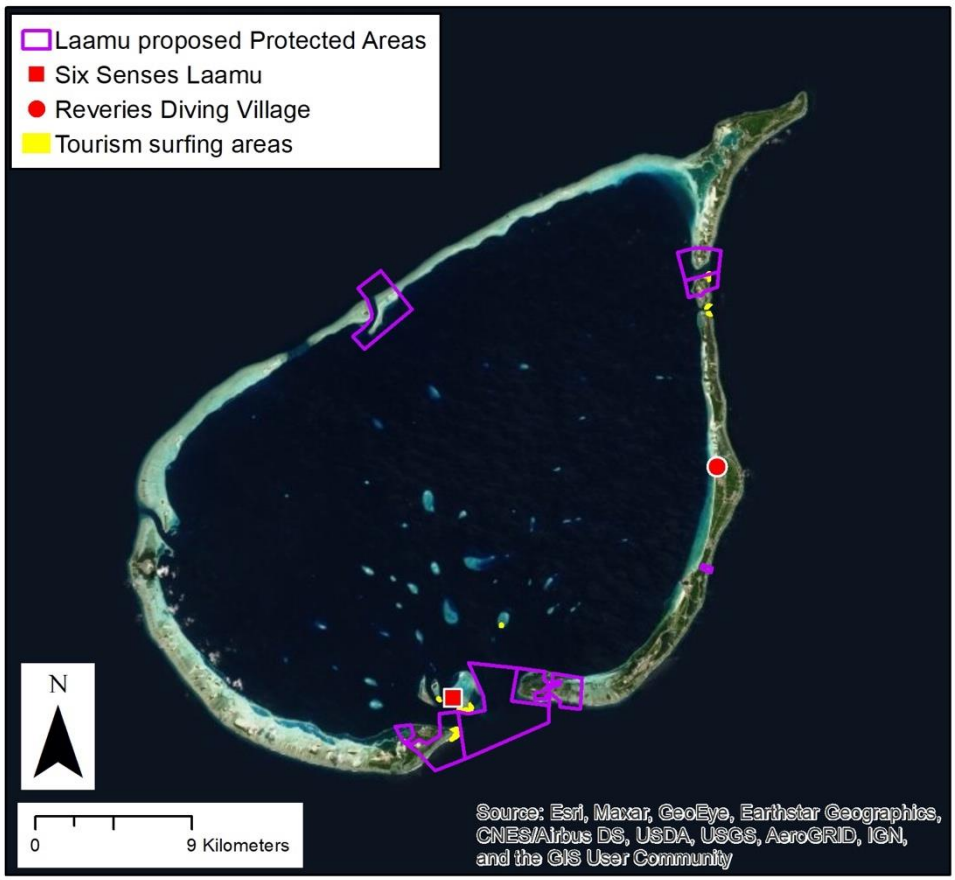


Figure 29. Spatial extent of surfing activity areas (yellow) used by guests of tourist sites in Laamu (Six Senses Laamu, Reveries Diving Village). Proposed Protected Areas are also shown.

Composite (all tourism activities):

All spatial activity data for tourism activity for both Six Senses Laamu and Reveries Diving Village guests has been combined here. We computed the kernel density of tourism resource use activity to give a better indication of hot spot areas, with proposed Protected Areas overlaid (Figure 30). This composite map shows hotspots for tourism activity largely around Hithadhoo and Six Senses Laamu (North, East and West). A large amount of activity appears to take place inside the Hithadhoo Gaadhoo Kandu and Gaahoo proposed Protected Areas. There is another hotspot outside of Protected Areas in the south which is around the reef to the west of Hithadhoo. The other hotspots are focused on small reefs inside of the atoll's boundaries. There is a medium level of activity inside the Fushi Kandu proposed Protected Area (Figure 30).

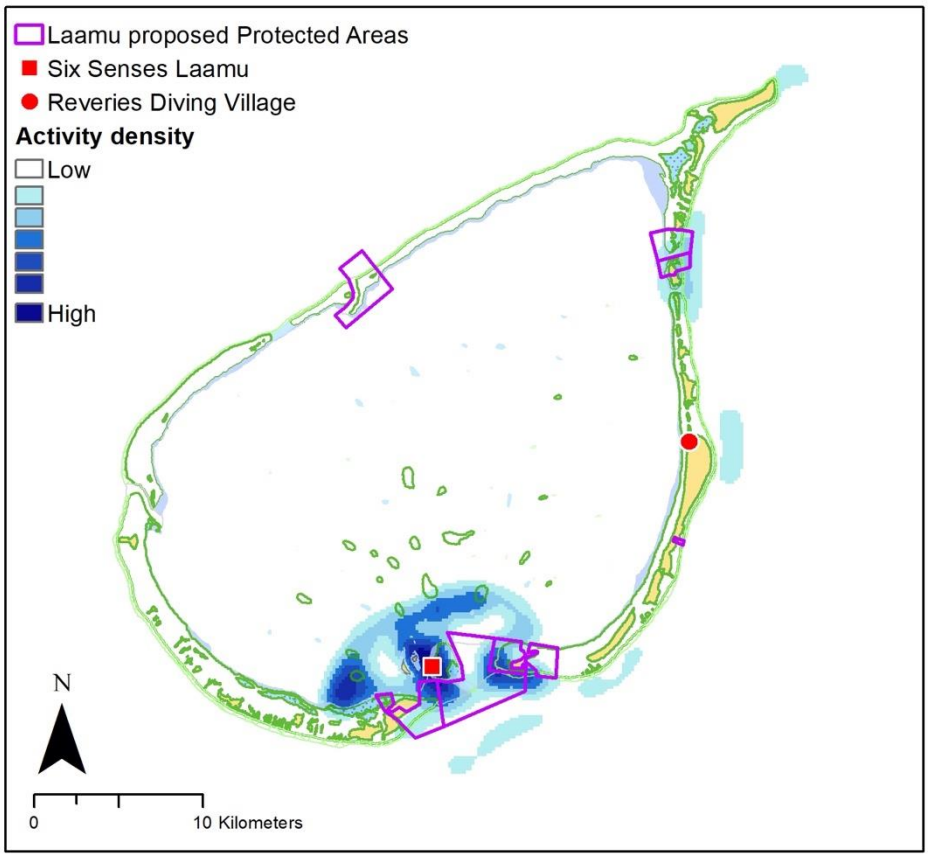


Figure 30. Tourism activities around Laamu Atoll, Activity is expressed as density calculated from spatial data from Tourism surveys with Six Senses Laamu and Reveries Diving Village resorts. Dark blue = highest density of activity (most used area (s)). Proposed Protected Areas are also overlaid.

4.0 DISCUSSION

This study represents the collection of one of the most comprehensive primary data sets on resources use around Laamu Atoll, considering a range of key user groups who exploit Laamu's natural resources. The dataset provides a good baseline to measure future change of resource use activities, practices, and perceptions in response to changes in the natural resources or to interventions. By extracting resource user expert, detailed local knowledge of their resources, their environments, and their extraction method or practices, outputs can be applied to decision future management interventions for Laamu's marine resources and placement of PAs. This is an example of a co-management approach to managing resources and it is hoped this approach will lead to more successful management and promote local stewardship.

Fisheries:

Fishing (commercial and non-commercial) is an important practice around Laamu Atoll which provides a source of employment, income, and food source for residents of the atoll. BLUE and its partners aim to develop a sustainable model for fishing by improving the management of reef resources within Laamu. Without healthy fish populations, the reefs will lose their resilience to future climatic events as well as their capacity to support the people and economies who depend on them. BLUE and its partners aim to support the Laamu Atoll Council to achieve its vision of protecting two PAs: Fushi Kandu (Channel) and Hithadhoo Gaadhoo Kandu (Channel). Central to this is understanding the fishing activities in and around these PAs and the wider Laamu Atoll. The demographic of the fishing interviewees, on average, was a 74-year-old male commercial fisher, with 22 years fishing experience, operating a boat with one-50 horsepower engine, mostly involved in the tuna and bait and reef fisheries. Tuna and reef fisheries are the most popular fisheries on Laamu in which most people are involved in and receive income from. Tuna fishers sell primarily to the Horizon Fish Factory on Maandhoo as this is the only fish processing factory in the atoll, while the reef fishery is driven by large markets at the Six Senses Laamu resort and local islands of Laamu Atoll, predominantly Gan and Fonadhoo but also to other islands. The fish factory processes and sells Skipjack and Yellow fin tuna to the Maldives and abroad.

It should be acknowledged that unlike the tuna fishery, the reef fishery has a large number of non-commercial involvement. Results showed that local fishers are mainly exploiting reef fish for personal use.

Results from the fisheries survey show clearly that the reef areas (<2.5km from land) of Laamu are extremely important in supporting several fisheries including the reef fish, bill fish, bait fish, sea cucumber and lobster fisheries. For example, the reef fishery operates to the North, East, South and West of Laamu, however, spatial analyses have shown that the areas around Isdhoo, Kalaidhoo and Dhanbidhoo, areas around Maabaidhoo and Mundoo and areas around Hithadhoo are particularly important areas for this fishery. These fisheries operate around most of Laamu Atoll's near reef areas close to the islands of Laamu. This is understandable when most fishers interviewed identified small dinghies and boats with low engine horsepower as their vessel, so are likely to be spatially restricted in areas they can fish. Inner areas (>2.5km from land) of the atoll do not appear to be very important areas for fisheries. The Isdhoo, Kalaidhoo and Dhanbidhoo area is also important in supporting the sea cucumber farms, invertebrate collection fishery and the octopus fishery. The lobster fishery mainly operates around the south and east of the Atoll with the islands Gan, Fonadhoo, and Isdhoo being most fished. The tuna fishery deviated from this pattern with areas further away from the atoll (up to 40 km in some instances) being important for this fishery, which is understandable considering tuna are pelagic, free roaming migratory fish with no home range but capable of travelling large distances (Druon et al. 2016). The commercial fishers who targeted bait for this fishery did, however, fish heavily inside the Northern areas of the atoll, known locally as Verehi Falhu. This area is therefore very important for supporting and maintaining one of the most valuable fisheries on Laamu. Tuna and bait fishing, reef fishing and octopus and invertebrate collection are reported to be conducted throughout the year, without any seasonality. Fishers reported a seasonality for three types of fisheries, namely, bill fish and sea cucumber fisheries which are mainly conducted during the Southwest monsoon (May to December) and lobster fishery which is conducted during the Northeast monsoon (January to May). Tuna and bait fishery are mainly conducted during the morning hours (4am to 10am).Both the reef fishery and the invertebrate collection are mainly conducted during the Full moon and the New moon periods. Reported primary fishing hours for both fisheries are the early evening hours between 5pm to 10pm.

Typically, fishers rated the status of fisheries they were involved in as being very good, however, for most fisheries there were a range of responses from very good through to very bad. The exception to this was the tuna fishery which most fishers rated to be in the worst shape possible. This is important to consider as this is a dominant fishery on Laamu. Almost all fishers who rated this fishery at 10 (worst shape) highlighted the need for better access to ice and better markets for tuna.

Several unsustainable practices were identified by fishers. These include use of powerful lights to catch Big-eye tuna and Yellowfin tuna which is becoming more prevalent in the atoll. This impacts the

fishery in the area for 4-5 days. Many fishers identified that the use of nets for reef fishing, SCUBA gear for sea cucumber fishery and chemicals for the octopus fishery. Most fishers in these fisheries identified mitigation of the forementioned activities would have positive effects on the associated fishery. Invertebrate collectors noted that the decline of seagrass meadows have affected invertebrate and fish stocks on some islands.

The sea cucumber *Actinophyga lecanora* lives in coral and coral rocks and reef ledges, between 0.5 and 7 m. It prefers hard substrates (i.e., coral reefs) that are sheltered. It is a predominantly nocturnal species. During the day, it seeks shelter under large stones and reef crevices. *Bohadschia marmorata* occurs in shallow water rarely deeper than 3 m. They inhabit seagrass beds in muddy-sand sediments, in sheltered or semi- sheltered sites. Predominantly burying in sediments during the day and forages on sediment surface nocturnally. In the western Indian Ocean and Africa *B. marmorata* prefers the back reef, seagrass beds on sandy bottoms between 0 and 20 m depth (Purcell et al. 2012). The importance of seagrass was highlighted by sea cucumber fishers noting that removal of sand from nearby beaches has increased sedimentation on seagrass meadows and impacted the abundance of sea cucumbers in key areas for sea cucumber fishing. As a result, many sea cucumber fishers suggest better protection (management recommendation) of seagrass would enhance their fishery.

The results allowed the key target fishery species for each fishery to be identified and this provides an important baseline to measures changes in fishing practices in the future. Knowing the target species allows a better assessment of the habitats that are important to support commercial and non-commercial fisheries. Data collected here will be combined with assessments of habitats around Laamu to further understand the link between habitats and fisheries.

The lobster fishery was reported to be the most valuable in terms of income per month, followed by bill fish and then tuna.

For the newly proposed Protected Areas, reef fishing and bill fish fishing are the dominant fisheries that operate within the Protected Area boundaries around Hithadhoo Gandhoo and Fushi Kandu. This is likely due to these two areas being identified as key channels between inner and outer areas of the atoll. Both areas area known to have high levels of biodiversity and are breeding sites for a wide range of species. It is therefore probable that large aggregations of reef fish and bill fish will be present in these areas. In addition, a high amount of bait fish fishery activity occurs inside of the Vadinolhu Kandu

Olhi proposed PA. Fishers that depend on these fisheries for income would need to be considered should the proposed PAs are designated.

Councils:

Resource use results from within council jurisdictions showed that coconut husk burying for rope making is a dominant activity that takes place on most islands. Many islands also host island picnics, support sand collection, collection of palm leaves for thatch weaving and firewood collection. Outside of the land area, some islands are exposed to anchoring. Most of these other types of resource use happen on land or very close to land and do not directly overlap with commercial fishing activities. As most of the commercial fishing activity takes place on the reefs of Laamu (see above) many of the islands around Laamu atoll, and their reefs, are therefore subject to high fishing intensity. We know from the prior analyses that this is largely driven by the reef fish, bait fish and bill fish fisheries which is to be expected as these fisheries are supported by reef ecosystems. Again, should PAs be designated in the reef areas they will encompass areas of high fishing activity (notably of the aforementioned big fisheries). The local councils will play an important role in the regulation and management of activity inside PAs, as well as in facilitating stakeholder engagement with the fishing communities affected.

Tourism:

In addition to Six Senses Laamu located on the southern channel entrance of the atoll, Reveries Diving Village is another tourism guest house, located on the island of Gan. They both offer several ocean-based activities to their guests, and each identified key areas in which these activities take place. The immediate surrounds of Hithadhoo, the inner reefs to the north of Hithadhoo and northeast of Gan, Fushi Kandu channel and the house reef of Hithadhoo and Gan are important areas for snorkelling, diving, dolphin watching and fishing. Some of these activities take place inside of the newly proposed Protected Area boundaries and this would need to be considered when considering management for these Protected Areas. The house reefs of Hithadhoo and Reveries Diving Village, the reef immediately north on the west side of Baresdhoo, are used multiple times a week by divers, snorkelers and for watersports. The Hithadhoo Gaadhoo areas and Fushi Kandu channel area, are also visited multiple times, weekly, for multiple tourist activities, the highest, most intensely used, is around Hithadhoo and inside the HithadhooGaadhoo Protected Area, and this should be considered when siting these Protected Areas and considering their knock effects or interaction with tourist activities. These are the intensely used areas as the other areas mapped are used less frequently (once or a couple of times per month). Activities are typically undertaken year-round with no peak season identified.

4.1 CONCLUSIONS

With the collection of this resource use data, the resource use activities of different user groups based on Laamu Atoll are now better understood. Activities have been quantified to better understand exploitation intensity and these activities, where required, have been mapped to understand the spatial footprint of this resource use, relating this to habitats and understanding the preseasons for why certainty activities happen where.

One of the main aims of this research was to better understand the spatial distribution of the different resource use on Laamu Atoll. Results have been interrogated to identify heavily used areas on Laamu Atoll. This information helps us to identify which resource users may be impacted with the introduction of conservation measures so that mitigation measures can be considered to reduce impact on livelihoods and sustenance. This is considered in the context of the proposed PAs suggested in 2021.

From these results we have shown that the newly proposed Protected Areas, if introduced, would meet conflict with mainly commercial and non-commercial reef fishing and bill fish fishing activities. The proposed PA boundaries around Hithadhoo Gaadhoo and Fushi Kandu are identified as important areas for this. This is likely due to these two areas being identified as key channels between inner and outer areas of the atoll. Both areas are well known for their high biodiversity, their ecological significance as a breeding site for a wide range of species and therefore likely leads large aggregations of reef fish and bill fish. The bait fish fishery is also an intense fishery inside of the Vadinolhu Kandu area and is another fishery to consider if management was to be applied in this area.

Both Hithadhoo Gaadhoo Kandu and Fushi Kandu area are also used by tourists from tourist establishments for diving, snorkelling, dolphin watching and some fishing which, again, would need to be considered in the context of bringing in management in these areas.

This study provides the first baseline for marine resource use on Laamu Atoll and is important to monitor future change in resource use. The results from this study should be considered when management interventions are designed for the forthcoming Protected Areas and for any fisheries management measures at the local and national levels. The resource users who would be most impacted by future management interventions have been identified who should be actively engaged when designing management interventions and livelihoods diversification options.

4.2 LIMITATIONS

- This study was undertaken with only a subsample of the resource users. We aimed to cover 30% of known fishers/ fishing vessels for each fishery but the extent of our surveys remains unknown as we do not have total figures for the number of people involved in each fishery.
- Surveys took place 9 months after the beginning of the COVID-19 pandemic so this could potentially impact responses and results.
- No invertebrate fishery information was collected from Laamu Gan island due to Covid restrictions.
- Island Councils may not have the up-to-date information on resource use due to their weak data systems

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6.0 ANNEXES

Annex 1: Survey123 fisheries resource use questionnaire:

Interviewer name

Interviewee name/ID?

Date and Time?

Gender

Age

Vessel name/number?

Home port?

Vessel Length (ft)

Vessel engine size (horsepower)

Do you own your vessel?

Do you own any other vessels?

If yes, provide details

Do you employ any other people on your vessel?

If yes, provide details

How many years have you been fishing generally?

Fishery details

Which fisheries are you involved in?

Please rank these fisheries in order of importance (i.e 1 = most important etc) for the following:

Your income (i.e 1 = most valuable)

Your time spent annually (i.e 1 = most time spent in this fishery)

Your enjoyment (i.e 1 = most enjoyable)

Rate your 'effort for return' value (i.e 1 = lowest effort for biggest return, 5 = highest effort for lowest return)

Do you fish or farm sea cucumber?

Do you fish for commercial purposes?

How many years have you been fishing commercially?

Please identify which of the chosen fisheries you fish for commercially

What is your average monthly income from each fishery? ($)

Where do you go reef fishing?

Please draw on the map (more than one allowed):

Where do you go Bill fishing fishing?

Please draw on the map (more than one allowed):

Where do you go Aquarium fish fishing?

Please draw on the map (more than one allowed):

Where do you go lobster fishing?

Please draw on the map (more than one allowed):

Where do you go cucumber fishing?

Please draw on the map (more than one allowed):

Where do you go to collect invertebrates?
Please draw on the map (more than one allowed):

Where do you go to fish for octopus?
Please draw on the map (more than one allowed):
When is peak season for the reef fish fishery? (month(s))
Is there a peak time within this season?
and if yes why?
When is peak season for the Bill fish fishery? (month(s))
Is there a peak time within this season?
and if yes why?
When is peak season for this Aquarium fish fishery? (month(s))
Is there a peak time within this season?
and if yes why?
When is peak season for this Lobster fishery? (month(s))
Is there a peak time within this season?
and if yes why?
When is peak season for this cucumber fishery? (month(s))
Is there a peak time within this season?
and if yes why?

When is peak season for this invertebrate collection fishery? (month(s))

Is there a peak time within this season?
and if yes why?
When is peak season for this octopus fishery? (month(s))
Is there a peak time within this season?
and if yes why?
Next:
How long have you been fishing for reef fish?
List all species of reef fish you target
How do you fish for reef fish?

Please add further details (number of hooks/pots/length of net)

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Where do you land your reef fish?

Do you do any proccessing before selling? If yes, what?

Where do you sell your reef fish?

Cages

Where are your cages located?

What habitat are your cages situated on?

Other- please specify

How many cages do you own?

How big is each cage roughly? (square metres)

Please provide and details on quotas you follow

How would you rate the status of the reef fish fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the reef fish fishery?

How long have you been fishing for Bill fish?

List all species you target when fishing for Bill fish

How do you fish for Bill fish?

Please add further details (number of hooks/pots/length of net)

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Where do you land your Bill fish?

Do you do any proccessing before selling? If yes, what?

Where do you sell your Bill fish?

Please provide and details on quotas you follow

How would you rate the status of the Bill fish fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the Bill fish fishery?

How long have you been fishing for Aquarium reef fish?

List all species of aquarium fish you target

How do you fish for Aquarium fish?

Please add further details (number of hooks/pots/length of net)

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Where do you land your Aquarium fish?

Do you do any proccessing before selling? If yes, what?

Where do you sell your Aquarium fish?

Please provide and details on quotas you follow

How would you rate the status of the Aquarium fish fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the Aquarium fish fishery?

How long have you been fishing for lobster?

List all species of lobster you target

How do you fish for the lobster?

Please add further details (number of hooks/pots/length of net)

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Where do you land your lobster?

Do you do any proccessing before selling? If yes, what?

Where do you sell your lobster fish?

Please provide and details on quotas you follow

How would you rate the status of the lobster fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the lobster fishery?

How long have you been fishing for sea cucumber?

List all species of sea cucumber you target

How do you fish for the sea cucumber?

Please add further details (number of hooks/pots/length of net)

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Please provide and details on quotas you follow

How would you rate the status of the sea cucumber fishery (1 = best shape possible; 10 = worst shape possible)

How would you rate the status of the sea cucumber farming (1 = best shape possible; 10 = worst shape possible)

What species of sea cucumber do you farm?

Cages

Where are your cages located?

What habitat are your cages situated on?

Other- please specify

How many cages do you own?

How big is each cage roughly? (square metres)

How many people work for you?

Do you buy or collect sea cucumbers for your farm?

Who do you buy them from?

Where do they come from?

Where do you collect them from? (map)

What season do you buy/collect them?

What is the reason for this?

How many do you buy/collect of each species?

How many sea cucumbers do you rear?

What kind of processing do you do?

Other- please specify

Where do you land your sea cucumbers?

Who do you sell your sea cucumbers to?

Do you record the sizes and or/numbers of the sea cucumbers you buy/collect?

Do you practice any management/regulation, if so what are the standards you follow?

Are there any management measures you think should be introduced in order to improve the sea cucumber fishery?

How long have you been fishing for Tuna?

List the species you target when tuna fishing?

Where do you go to fish for Tuna?

Please draw on the map (more than one allowed):

When is peak season for this Tuna fishery? (month(s))

Is there a peak time within this season?

and if yes why?

How do you fish for this Tuna?

Please add further details (number of hooks/poles etc)

List all bycatch species you get in this fishery

Where do you go to fish for baitfish?

Please draw on the map (more than one allowed):

Do you use FADs when fishing for tuna?

FAD location

Which of these FADs do you use?

Do you use lights to attract baitfish at night?

If yes, provide details

Do you fish using live bait?

What do you use for bait?

Do you source your own live bait?

Where do you catch your live bait?

Where do you get live bait from?

List the species you target when bait fishing?

How do you fish for baitfish?

When do you fish for baitfish in the Day or Night? Select all that apply

Why is this the best time of day?

How long (in days) is an average single tuna fishing trip (from leaving and returning to port)

Where do you land your tuna?

and why do you land here?

Do you do any proccessing before selling? If yes, what?

Where do you sell your tuna?

Please provide and details on quotas you follow

How would you rate the status of the Tuna fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the Tuna fishery?

How long have you been collecting invertebrates?

List all species of invertebrates you target

How do you collect invertebrates?

Please add further details (number of hooks/pots/length of net)

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Where do you land your invertebrates?

Do you do any processing before selling? If yes, what?

Where do you sell your invertebrates?

Please provide and details on quotas you follow

How would you rate the status of the invertebrate collection fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the invertebrate collection fishery?

How long have you been fishing for octopus?

List all species of octopus you target

How do you fish for octopus?

When do you fish in the Day or Night? Select all that apply

How long (in days) is an average single fishing trip (from leaving and returning to port)

Where do you land your octopus?

Do you do any processing before selling? If yes, what?

Where do you sell your octopus?

Please provide and details on quotas you follow

How would you rate the status of the octopus fishery (1 = best shape possible; 10 = worst shape possible)

Are there any management measures you think should be introduced in order to improve the octopus fishery?

Are you happy for us to keep your contact details on record? We may contact you again in the future for further interviews.

Additional notes about this survey