



UNDERSTANDING TOURIST RESORT SEAFOOD SOURCING PRACTICES IN THE MALDIVES

NOVEMBER 2025



Suggested Citation

Maldives Resilient Reefs & Blue Marine Foundation (2025). Understanding tourist resort seafood sourcing practices in the Maldives.

Acknowledgments

Report authors were Jake Edmiston (Blue Marine Foundation), Aminath Shaha Hashim (Maldives Resilient Reefs) and Judith Brown (Blue Marine Foundation), with contributions from Afaaz Zahid (Maldives Resilient Reefs) and Fiona Llewellyn (Blue Marine Foundation). We would like to thank all the tourism operators who took part in the survey. Their responses have been highly valuable in better understanding the local seafood sourcing characteristics by resorts in the Maldives. We would also like to thank the Ministry of Fisheries and Ocean Resources and the Ministry of Tourism for collaborating on this project and Six Senses Laamu for funding this work. Specifically, we would like to thank staff members from the Ministry of Tourism for their assistance in contacting resorts to be part of this survey. We are also grateful to staff members from the Ministry of Fisheries and Ocean Resources for their comments and feedback on the report.

EXECUTIVE SUMMARY

Rapid tourism development over the past 50 years has resulted in an increased demand for coral reef fisheries resources in the Maldives.

The extent and impact of demand for local seafood at tourist resorts is not well understood, with limited data on resort local seafood sourcing characteristics and supply chains. This impedes the establishment of effective national fisheries management measures for the tourism sector, and when combined with increasing guesthouse demand and local consumption, leaves marine ecosystems vulnerable to overexploitation. This study utilised an online questionnaire of 30 tourist resorts to examine the local seafood sourcing characteristics of tourist resorts in the Maldives and identify future management directions for tourism-driven coral reef fisheries.

Seafood supply analysis revealed that respondents mainly sourced tuna, reef fish and billfish from within the Maldives but also extensively imported non-native seafood groups from overseas such as salmon, mussels and oysters. Tuna, reef fish, octopus, lobster, crab, salmon and scallops were the seafood groups sourced by all responding tourist resorts. Tuna was sourced exclusively locally, whereas reef fish, billfish, octopus, lobster, bream, cuttlefish and crab were sourced from a mix of local and international suppliers. Respondents identified independent fishers and Male'-based third-party suppliers as their primary suppliers. The most commonly sourced reef and oceanic fish groups included snapper, grouper and wahoo which were each sourced by over 80% of respondents. It is estimated that a resort averagely sources 340kg (± 28 kg) of reef fish, 180kg (± 26 kg) of lobster and

112kg (± 25 kg) of octopus per week during the high tourism season (December to April). This differs from 250kg (± 31 kg) of reef fish, 123kg (± 20 kg) of lobster, and 98kg (± 20 kg) of octopus sourced weekly during the low tourism season (May to November).

The majority of respondents indicated a desire to increase the sustainability of their local seafood sourcing practices. However, a lack of effective mechanisms through which tourist resorts can ensure the sustainability, consistency and quality of local seafood was evident. The development of frameworks to enable tourist resorts to sustainably source local seafood would facilitate data collection within resort seafood supply chains while better supporting local communities and livelihoods. Furthermore, an updated assessment of reef fishery carrying capacity would enable the ecological implications of local seafood demand by the tourism sector to be contextualised alongside other forms of fishery exploitation. It is recommended that this is coupled with further research into the extent and impacts of the billfish fishery and the emerging jigging fishery. Moreover, this study highlights the need for national octopus fishery management, with unregulated harvesting a potential threat to national octopus population health.

The Maldives tourism sector has the opportunity to utilise its position as a leading luxury travel destination to become the global gold standard of sustainable seafood sourcing. By embracing traceable seafood sourcing practices, tourism sector stakeholders and national policymakers have the opportunity to take action to protect Maldivian ocean biodiversity and reef fisheries productivity into the future.

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Acronyms and abbreviations

- Blue Marine = Blue Marine Foundation
- MFOR = Ministry of Fisheries and Ocean Resources
- MSY = Maximum Sustainable Yield
- MoT = Ministry of Tourism
- MRR = Maldives Resilient Reefs
- NGO = Non-Governmental Organisation



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INTRODUCTION

The Maldives is an archipelago of 26 atolls and nearly 1,192 low-lying islands spanning latitudes of 1°S and 8°N across the equator in the Indian Ocean^{1,2}.

Regarded to be on the frontline of the global climate crisis, 80% of Maldivian islands are less than one metre above sea-level, making the country highly vulnerable to the impacts of sea-level rise². The marine environment is central to Maldivian culture, economy and society^{3,4}. For centuries, the pole-and-line tuna industry was the largest economic sector in the Maldives and historically provided food and livelihood security to Maldivian communities^{5,6}. Tuna carries substantial socio-cultural value and comprises a large portion of protein-intake for Maldivians⁷. However, the economic dominance of tuna fisheries today has shifted, with growth in the tourism sector over the past 50 years exceeding tuna fishery development. The tourism sector now supports almost one-third of the Maldivian economy and a record 1.8 million tourists visited the Maldives in 2023⁸⁻¹⁰. Tourism growth has enabled the Maldivian economy to rapidly develop, with the United Nations progressing the Maldives to an upper middle income country status in 2011¹¹⁻¹³.

Tourism, and the revenue it has generated, has enabled country-wide investments in education and health care. Nonetheless, rapid tourism development has not occurred without significant environmental cost^{11,14}. The major draw for many visitors to the Maldives are the country's coral reefs, which provide the foundation of the Maldivian islands and support a plethora of marine fishes and invertebrates^{15,16}. However, land-use change to create tourist establishments can have negative implications for coral reefs if conducted in an unsustainable way. Removal of reef substrate and land reclamation of reef area can impede natural current movements and lead to coastal erosion and increased sedimentation on surrounding reef environments^{17,18}. Furthermore, untreated inputs of biological and chemical substances from urbanised coastlines can pollute nearshore waters and result in rapid declines in marine ecological health^{18,19}. Losses of ecosystem functioning due to pervasive anthropogenic impacts can lead to declines in ecosystem service provision and reduced socio-ecological resilience to climate change^{20,21}.

Overfishing is another pervasive threat facing Maldivian coral reef environments, with the rapid proliferation of tourism across the Maldives leading to an increasing commercial demand for local seafood. Many tourists visiting the

A large impediment to coral reef fisheries management in the Maldives is the lack of understanding around how tourist resorts source their local seafood.

Maldives enjoy observing marine life on diving and snorkelling trips, but also like consuming marine life as food fish^{1,22}. The development of coral reef fisheries management has historically lagged behind this ever-growing reef fisheries demand, with Maldives' first reef fishery management plan published in 2020^{4,5,23}. Many reef fishes have long lifespans and take a long time to mature, making them easily overexploited if fished beyond sustainable limits^{24,25}. It is important that coral reef fisheries management measures anticipate the innate vulnerability of coral reef fish stocks to ensure coral reef fisheries functioning and productivity.

A large impediment to coral reef fisheries management in the Maldives is the lack of understanding around how tourist resorts source their local seafood. Local seafood such as coral

reef fish and invertebrates are widely caught across the country for commercial, recreational and subsistence purposes¹. However, there is a paucity of data to inform management of coral reef fisheries in the country, with limited understanding of resort seafood supply and the extent of local seafood sourcing by tourism operators. Developing a better understanding of tourism operator supply and sectoral appetite to embracing sustainable sourcing practices will be necessary to inform the development of effective coral reef fisheries governance in the tourism sector. This study aims to reveal the local seafood sourcing characteristics of tourist resorts across the country. Furthermore, findings are used to derive management interventions which will enable tourist resorts and national policy makers to better understand and manage coral reef fishery resources.

METHODS

Survey design

The 'fish and seafood sourcing in the Maldives tourism industry survey' (*herein survey*) was designed by Maldivian non-governmental organisation (NGO) Maldives Resilient Reefs (MRR) and UK-based NGO Blue Marine Foundation in collaboration with the Ministry of Tourism (MoT) and Ministry of Fisheries and Ocean Resources (MFOR). The survey comprised 39 questions which spanned three sections covering: 1) tourism operation background; 2) current seafood sourcing practices; and 3) openness to sustainability. The survey used a branching structure, enabling participating operators (*herein respondents*) to move through the survey in response to the answers they were providing.

The entire questionnaire was designed to take respondents approximately 20 minutes to complete. The survey was targeted at senior management staff and purchasing departments, with assistance recommended from resident marine biologists or on-island sustainability professionals. In addition to the main survey questions, respondents were asked whether they would be interested in learning more about the *Laamaseelu Masveriyaa* programme. MRR and Blue Marine established the *Laamaseelu Masveriyaa* ('*exemplary fisher*') programme at Six Senses Laamu in 2020. By working alongside local fishers, the programme provides a framework to ensure tourism operators source local seafood in a sustainable way.

Data collection

Prior to the circulation of the survey, the MoT contacted all tourist resorts on their central database to invite resorts to take part in the survey. The MRR and Blue Marine team then shared the survey with all responding tourist resorts via email, in addition to operators which were independently contacted through telephone calls and email by the MRR and Blue Marine team. A total of 31 tourism operators completed the survey which included 30 resorts and 1 guesthouse. The survey was completed by tourism operators remotely using Microsoft Forms. The survey team were unable to corroborate survey responses with in-person visits to each respondent operator. Due to the remote survey design, MRR and Blue Marine conducted follow-up calls to verify survey responses if a question had been obviously mis-interpreted by a respondent.

A total of 31 tourism operators completed the survey which included 30 resorts and 1 guesthouse.

Data analysis and visualisation

An open access governmental database (*herein* national resort database) of Maldivian resorts was used to validate the survey dataset in the context of the broader resort sector²⁶. This enabled the survey team to contextualise geographic and resort demographic data in the respondent dataset and compare against the broader resort sector. Respondent answers to each survey question were aggregated and visualised. The geographical spread of the respondent resorts were compared to the national resort database by calculating the proportion of respondents represented from each atoll in the survey dataset.

An anomalous response of one resort was unable to be verified by the MRR and Blue Marine team and was omitted from group-specific supply analysis. Despite one guesthouse completing the survey, this response was not included in analysis due a lack of guesthouse sector replicability making an assessment of guesthouse sourcing characteristics unreasonable. This study considers the high tourism season to span between December and April, with the low tourism season to span the months of May to November. Geographical visuals were created in QGIS²⁷.



RESULTS

Location and type of respondent

The 30 respondents derived from nine atolls (Figure 1). Of all respondents, 47% were based on Kaafu Atoll (Figure 1). The geographical spread of respondents across the country was large, indicated through the participation of tourism operators based on more northerly Raa Atoll and southerly Gaafu Dhaalu Atoll and Gaafu Alif Atolls (Figure 1).

Overall, the survey respondents were geographically well aligned to the broader resort sector as outlined in the national resort database (Figure 2). A proportionally larger number of respondents derived from Kaafu, Baa, Alifu Dhaalu, Alifu Alifu, Laamu, Gaafu Dhaalu, Gaafu Alifu and Laamu atolls (Figure 2). Conversely, Raa and Lhaviyani atolls were less represented compared to the national resort database (Figure 2). Ten atolls saw no respondents take part in the survey despite the presence of resorts on the atoll (Figure 2). Eight of the 10 atolls with no survey participation comprised the

least resort saturated atolls in the country (Figure 2).

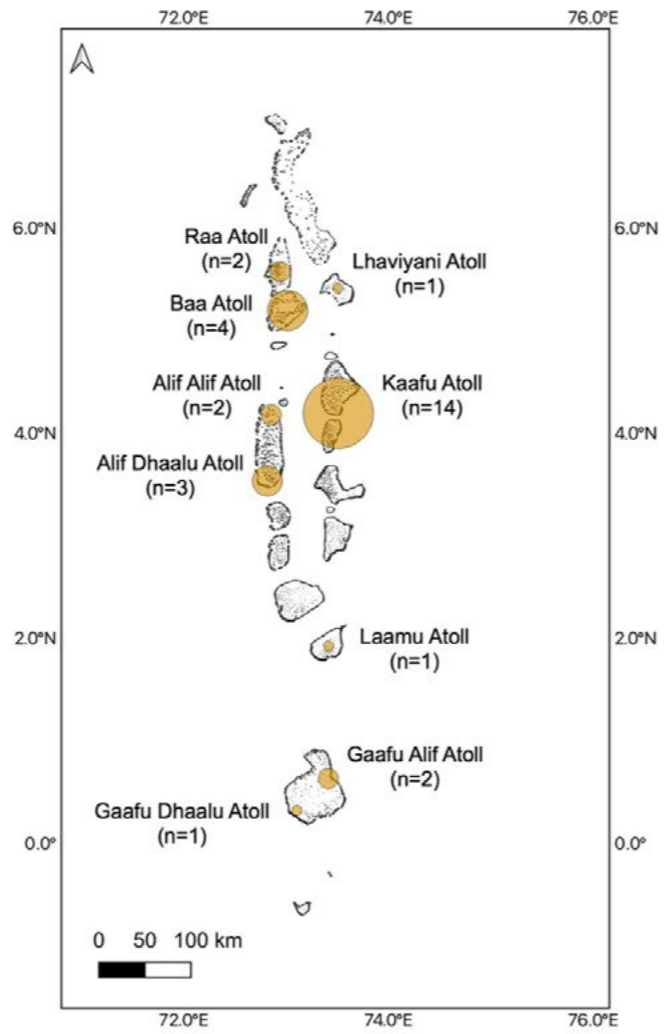


Figure 1. Number of survey respondents from each atoll. Orange bubble size indicates number of survey respondents (n).



Overall, 30 tourist resorts responded to the survey, representing approximately 17% of all operational resorts in Maldives.

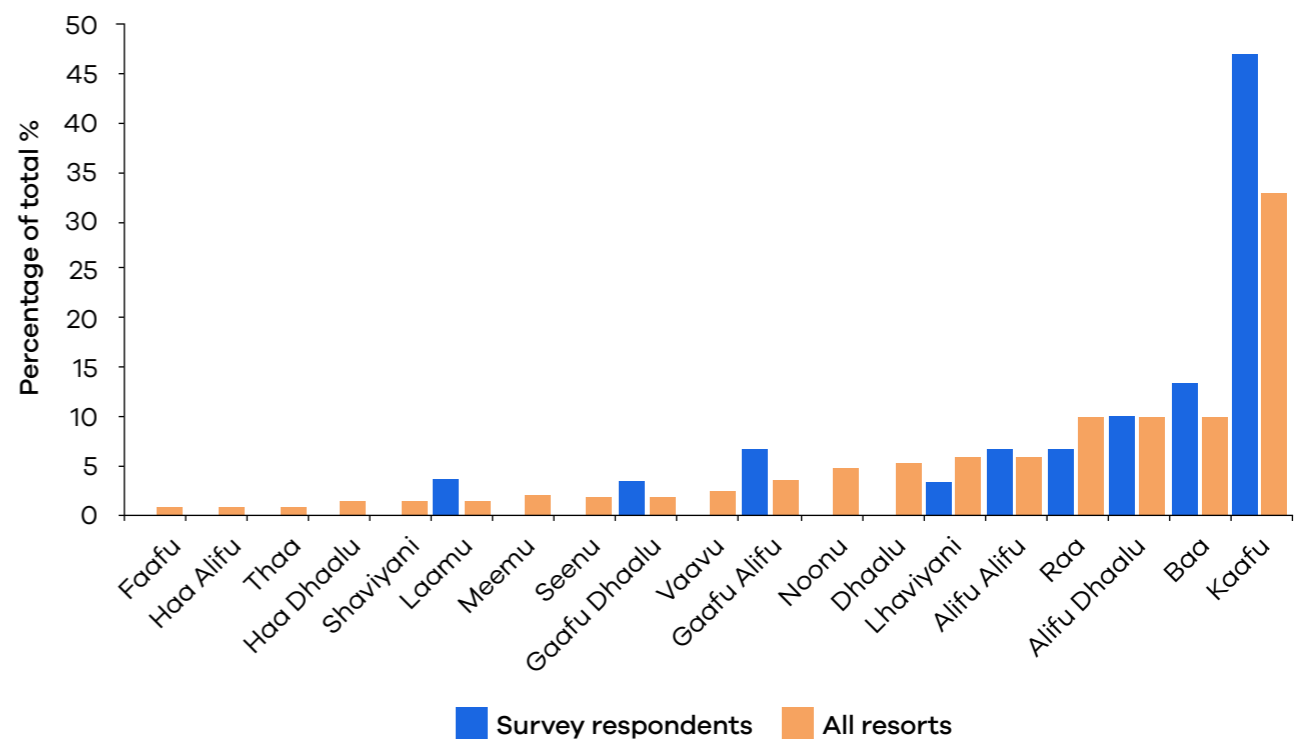


Figure 2. Proportion of resorts on each atoll across the survey respondents and national resort database.

Overall, 30 tourist resorts responded to the survey, representing approximately 17% of all operational resorts in Maldives. Of resort respondents, 21 identified as being 'high-end' and 9 identified as 'mid-range' (Figure 3). The number of years

that survey respondents had been operational varied (Figure 4). There was an equal spread of time since opening across respondent tourist resorts, with '0-5' years and '16-25' years the most commonly selected time interval (Figure 4).

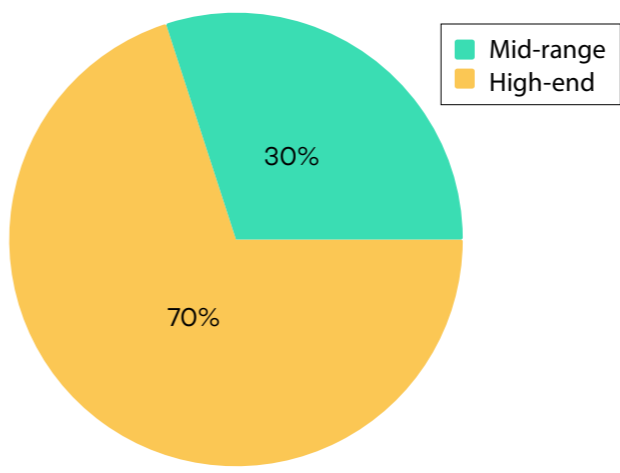


Figure 3. Type of tourist resorts.

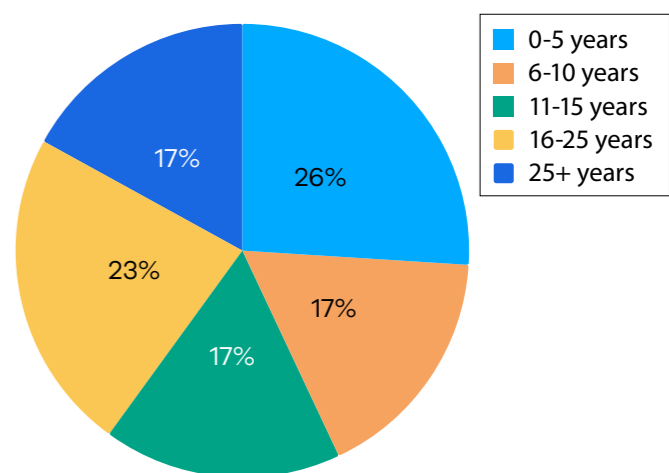


Figure 4. Length of time respondent resorts have been operational.

Sourcing methods across seafood groups

Respondents indicated that they source a large variety of seafood groups from both local and international suppliers (Figure 5). Tuna, reef fish, lobster, octopus, crab, salmon and scallops were sourced by 100% of respondents. Moreover, 90% or more of respondents sourced clams, mussels, prawns, oysters (Figure 5). Both billfish (45%) and bream (24%) were sourced by less than half of respondents (Figure 5). Cuttlefish and seaweed were sourced by 79% and 58% of survey respondents respectively (Figure 5). All respondents (100%) indicated that they sourced tuna from within the Maldives. Furthermore, 97% and 93% of respondents sourced reef fish and billfish from within the country.

The other seafood groups sourced locally were lobster, octopus, cuttlefish, crab and bream, yet all groups were also sourced from overseas. Lobster and octopus were sourced both locally and internationally by 38% and 31% of respondents, with 14% and 48% of respondents respectively sourcing these species exclusively from overseas. Bream, crab and cuttlefish were sourced exclusively from overseas by 72%, 69% and 61% of respondents. Overall, eleven seafood groups were predominately sourced from international suppliers, with clams, mussels, oysters, prawns, salmon, scallops and seaweed entirely sourced from international suppliers.

100%

Of respondents sourced tuna, reef fish, lobster, octopus, crab, salmon and scallop.

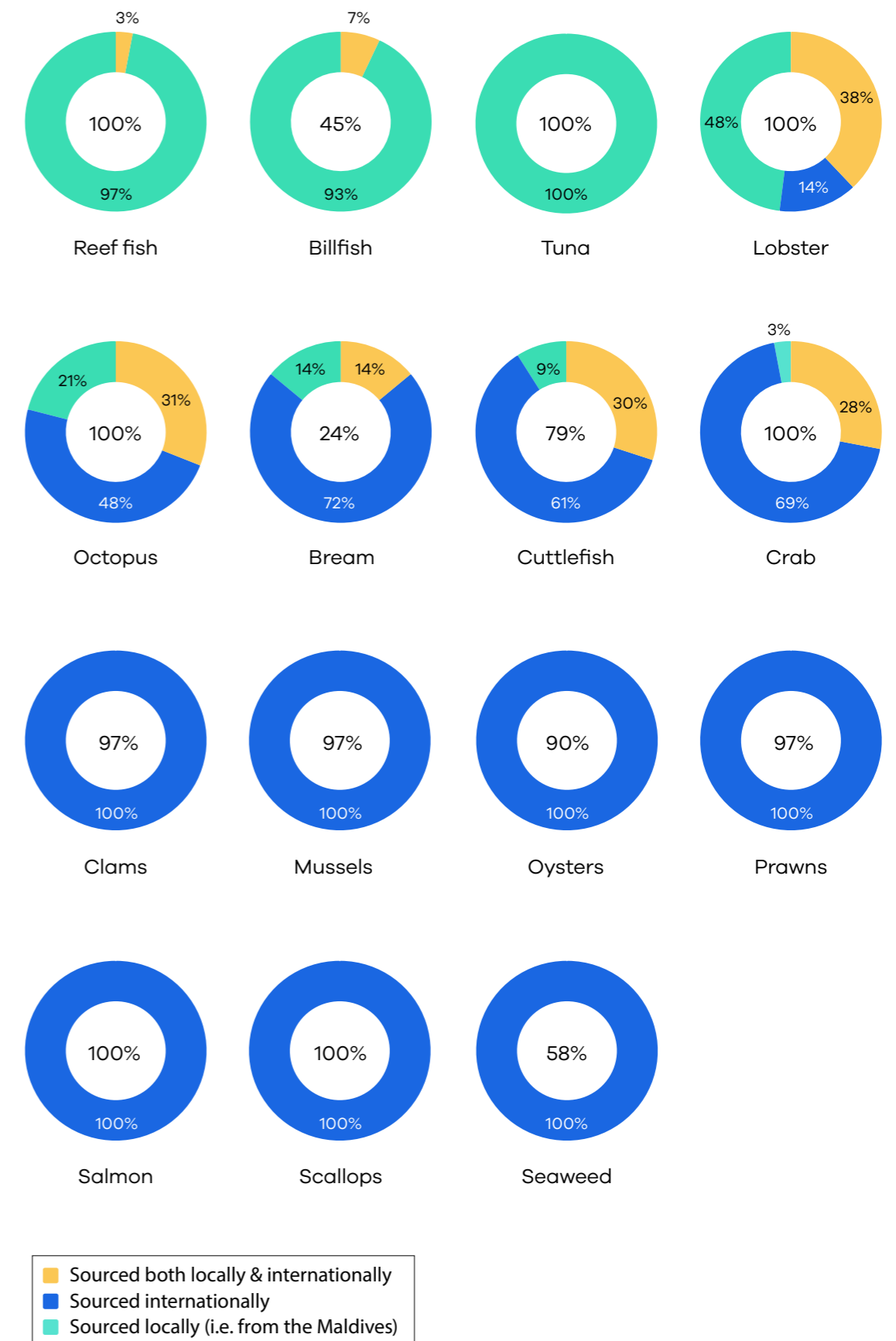


Figure 5. Seafood sourcing methods across seafood types. Percentage of respondents sourcing each seafood group indicated by central value.

Sourcing supply routes and issues

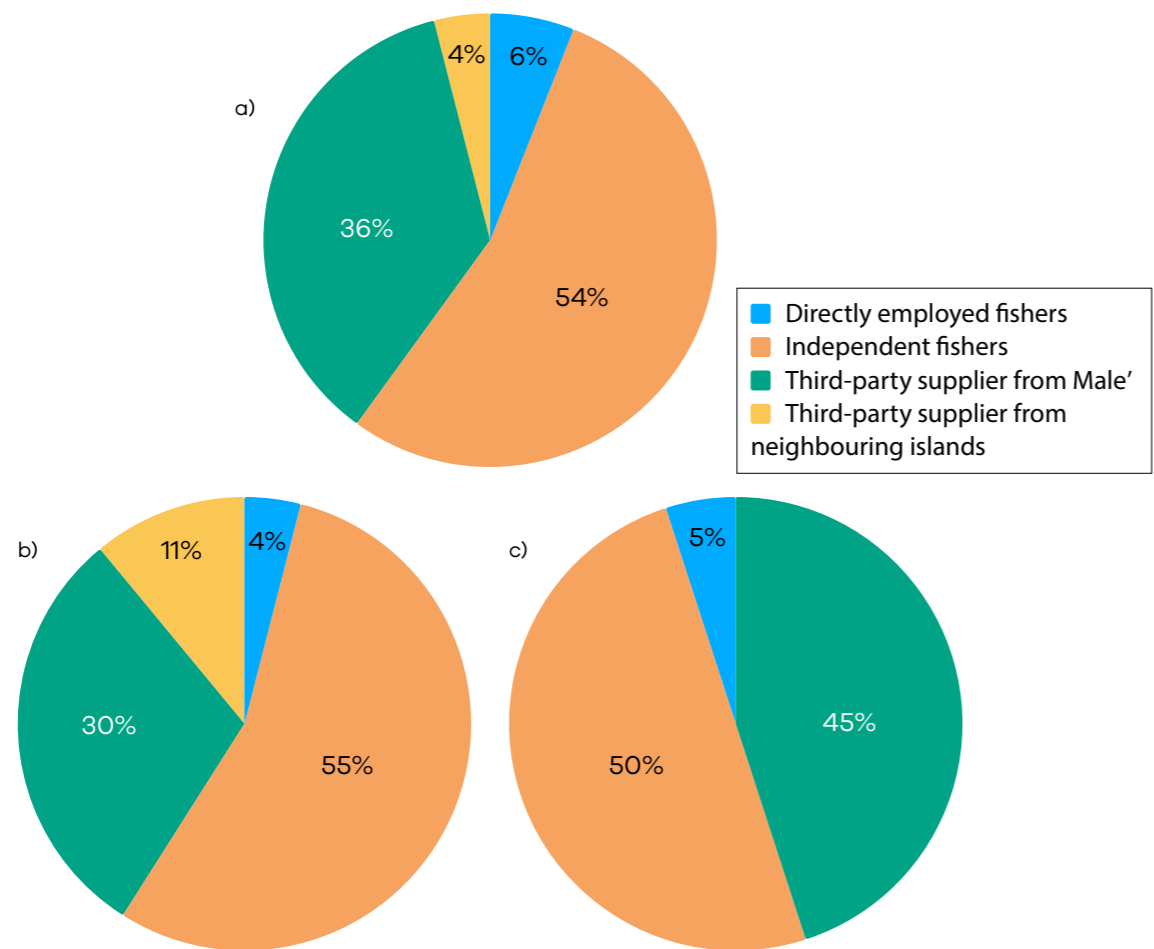
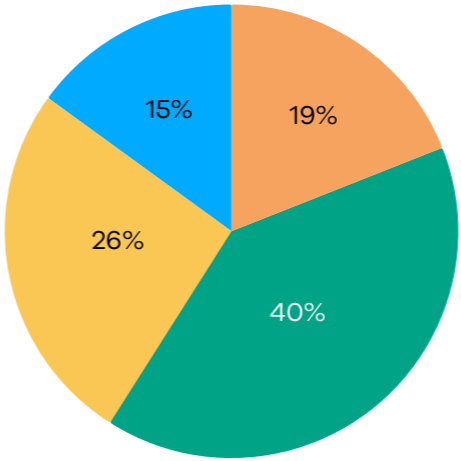


Figure 6. Local seafood sources for: a) all respondents; b) non-Male' based resorts only; c) Male' based resorts only.

Respondents indicated that the majority of local seafood is sourced using independent fishers from neighbouring islands (54%), with seafood also sourced through third-party suppliers from Male' (36%; Figure 6a). Similarly, non-Male' atoll based resorts sourced the majority of seafood from independent fishers from neighbouring islands (55%) and to a lesser extent, third-party suppliers from Male' (30%; Figure 6b). Non-Male'

based resorts also sourced from third-party suppliers from neighbouring islands (11%; Figure 6b). Both independent fishers from neighbouring islands (50%) and third-party suppliers from Male' (45%) dominated Male' atoll based resort sourcing (Figure 6c). Directly employed fishers comprised a substantially lesser portion of all survey responses across both Male' and non-Male' based resorts (Figure 6).



The majority of respondents indicated issues with their current local seafood sourcing processes with only 15% of respondents having no issues to report (Figure 7). The most common issue with local seafood sourcing was the inconsistent supply of the same type of seafood, followed by the insufficient supply of seafood to the resort (Figure 7). Issues around ensuring the sustainability of seafood were identified by 19% of respondents (Figure 7).

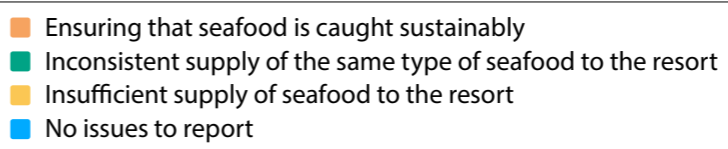


Figure 7. Issues identified by respondents with their local seafood sourcing practices.

Local seafood demand across tourism seasons

Respondents indicated that they sourced larger quantities of reef fish, octopus and lobster in high season, yet the differences between tourism seasons was variable across seafood groups (Table 1). The difference in demand between high and low tourism seasons was greater for reef fish and lobster compared to octopus (Table 1).

Respondents, on average, sourced 340kg (± 28 kg) of reef fish, 180kg (± 26 kg) of lobster and 112kg (± 25 kg) of octopus per week during the high tourism season (Table 1). During the low tourism season, respondents averagely sourced 250kg (± 31 kg) of reef fish, 123kg (± 20 kg) of lobster and 98kg (± 20 kg) of octopus (Table 1).

Table 1. Sample mean (X) and standard error of weekly seafood sourcing by respondents.

Season	Reef fish (kg)	Lobster (kg)	Octopus (kg)
High	340 \pm 28	180 \pm 26	112 \pm 25
Low	250 \pm 31	123 \pm 20	98 \pm 20

Detailed analysis by family – commonly sourced local reef and oceanic fish groups

The most common group of reef fish purchased by respondents were snappers (*Lutjanidae spp.*), followed closely by groupers (*Serranidae spp.*), jobfish (*Lutjanidae spp.*), and jacks and trevallies (*Carangidae spp.*; Figure 8). The reef fish groups which were least commonly sourced were dogtooth tuna (*Gymnosarda unicolor*) and ruby snapper (*Etelis carbunculus*), both of which were only reported to have been sourced by six survey respondents (Figure 8). Parrotfish (*Scaridae spp.*) were sourced by one survey respondent (Figure 8). Other groups of reef fish groups sourced

included barracudas (*Sphyraena spp.*), needlefish (*Belonidae spp.*), emperors (*Lethrinidae spp.*) and rainbow runner (*Elagatis bipinnulata*; Figure 8). The most frequently sourced oceanic fish group was wahoo (*Acanthocybium solandri*), followed by mahi mahi (*Coryphaena hippurus*), swordfish (*Xiphias gladius*) and indo-pacific sailfish (*Istiophorus platypterus*; Figure 9). Other groups of oceanic fish sourced included black marlin (*Istiompax indica*), striped marlin (*Kajikia audax*) and indo-pacific blue marlin (*Makaira nigricans*; Figure 9).



The most common group of reef fish purchased by respondents were snappers (*Serranidae spp.*)

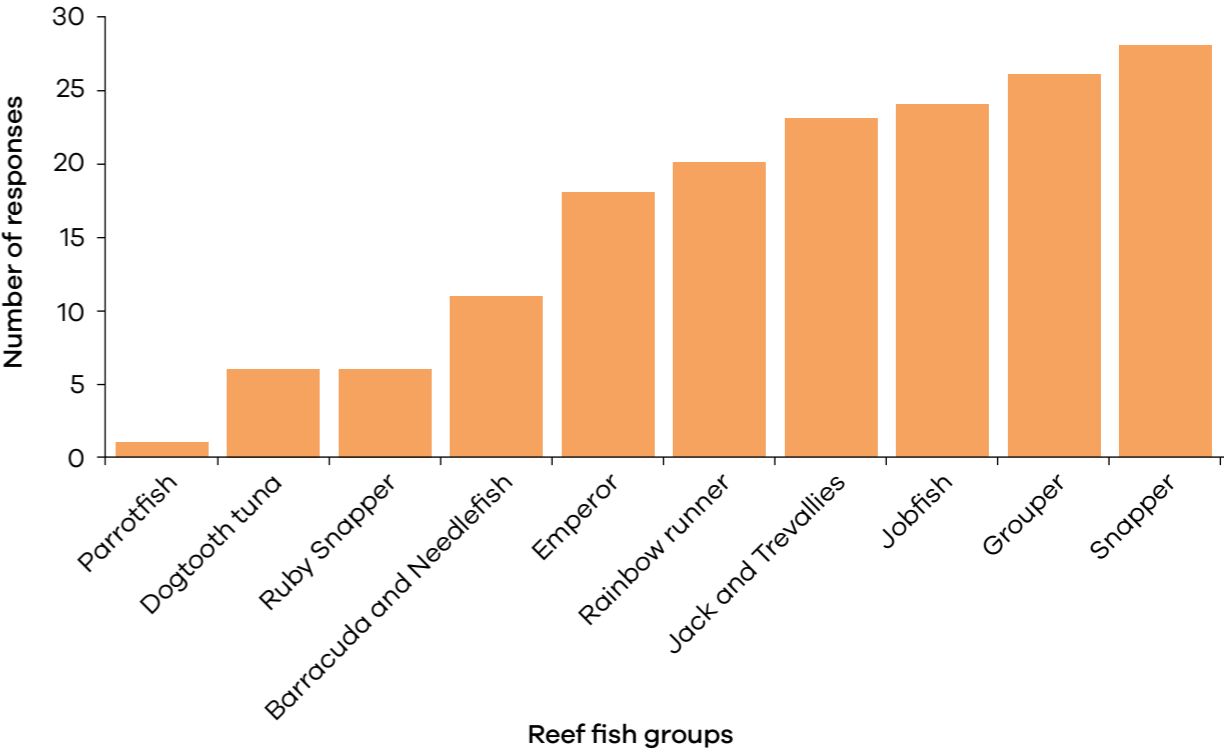


Figure 8. Local reef fish groups purchased by respondents.

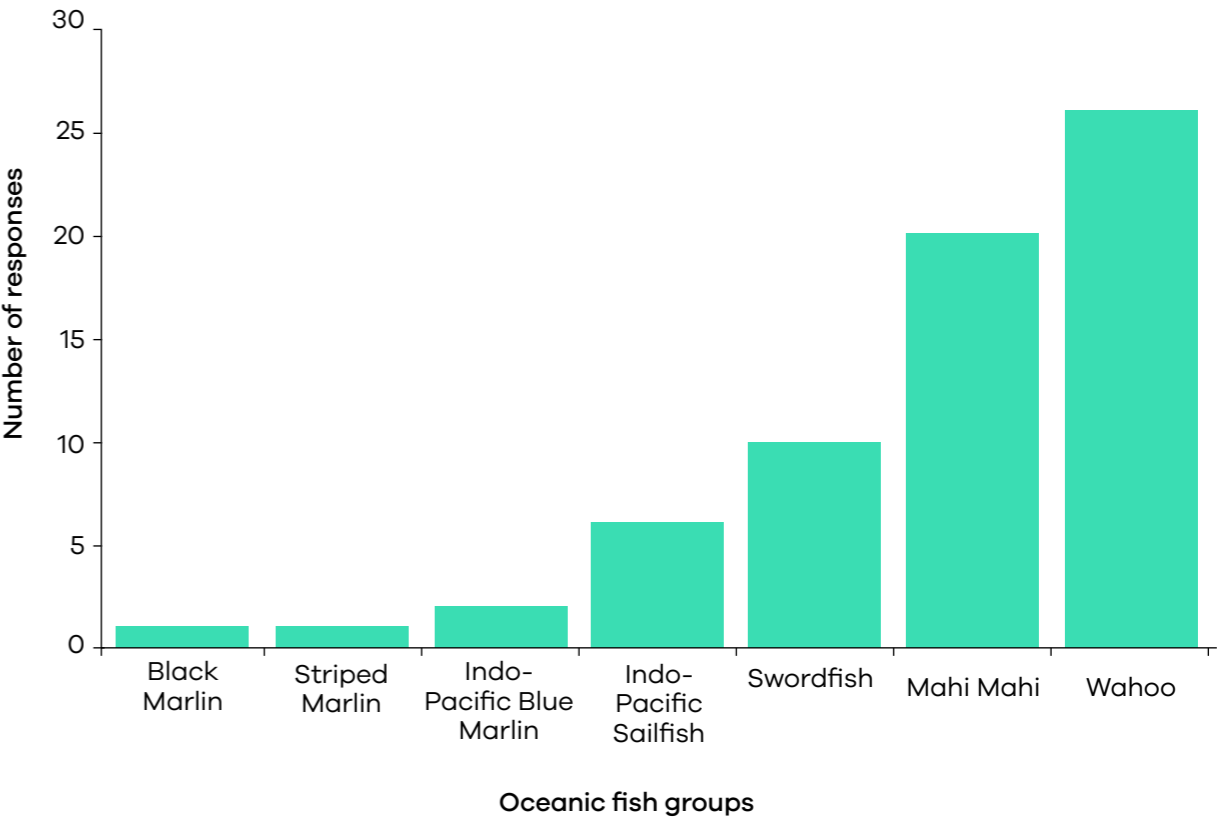


Figure 9. Local oceanic fish (non-tuna) groups purchased by respondents.



Existing local seafood supply chain standards

Over half of survey respondents indicated that they avoid sourcing vulnerable species (Figure 13). From these respondents, the majority specified that they avoid sourcing nationally protected species such as sharks, turtles and parrotfish (Annex 1). A small number of respondents also indicated that they avoid sourcing other locally caught species such as groupers, billfish and ruby snapper, and restrict lobster landings by size/ weight and egg-bearing status (Annex 1). Two respondents highlighted that they avoid sourcing non-local species such as orange roughy, sole, sturgeon, catfish, tilefish and blue crab (Annex 1). Respondents were evenly split in their response to whether they source live seafood. Of respondents who source live seafood, the majority indicated that they sourced live lobster, with one resort also sourcing live reef fish and another sourcing live mud crab (Annex 2).

Overall, 60% of respondents indicated that they recorded the species name of the local seafood they source (Figure 13). Similarly, the majority of respondents (67%) indicated that they impose

size limits on the local seafood they source (Figure 13). However, there was large variation in how size limits were implemented, with 10 respondents indicating that they impose weight thresholds rather than length thresholds (Annex 3). Lobster weight or size thresholds were mentioned by five respondents, with three other respondents indicating that size limits are set by culinary requirements rather than sustainability standards (Annex 3). Three respondents mentioned that they follow government guidance on size limits and one respondent indicated that they use visual estimates of size (Annex 3).

The majority of respondents (87%) indicated that they did not know where their local seafood was sourced (Figure 13). The 13% of respondents which indicated that they knew where their local seafood was sourced highlighted that they only knew the island of their suppliers (Figure 13; Annex 4). One resort indicated that they verify catch location through the Laamaseelu Masveriyaa sustainable fisheries programme (Annex 4). Respondents were mixed in their openness

The majority of respondents (87%) indicated that they did not know where their local seafood was sourced (Figure 13)

to sourcing cultured or farmed seafood. Accordingly, 63% of respondents indicated that they would be open to sourcing farmed seafood, 34% said they maybe would be open, and 3% said they would not be open to farmed or cultured seafood (Figure 13).

Respondents were mixed in their answer to whether they are able to determine when their local seafood was caught (Figure 13; Annex 5). Of the 16 (53%) respondents which indicated that they know the time of catch, four respondents indicated that they conduct temperature

and visual freshness checks (Annex 5). Three respondents indicated that they have set seafood sourcing protocols such as background checks and verification documentation to ensure freshness (Annex 5). Two respondents specified that they do not source frozen or thawed seafood to ensure freshness (Annex 5). Five respondents indicated that all local seafood is caught within a specific time frame prior to delivery but did not indicate how they verify this (Annex 5). One respondent indicated that they source seafood on an ad-hoc basis, with another indicating that they sometime source live reef fish (Annex 5).

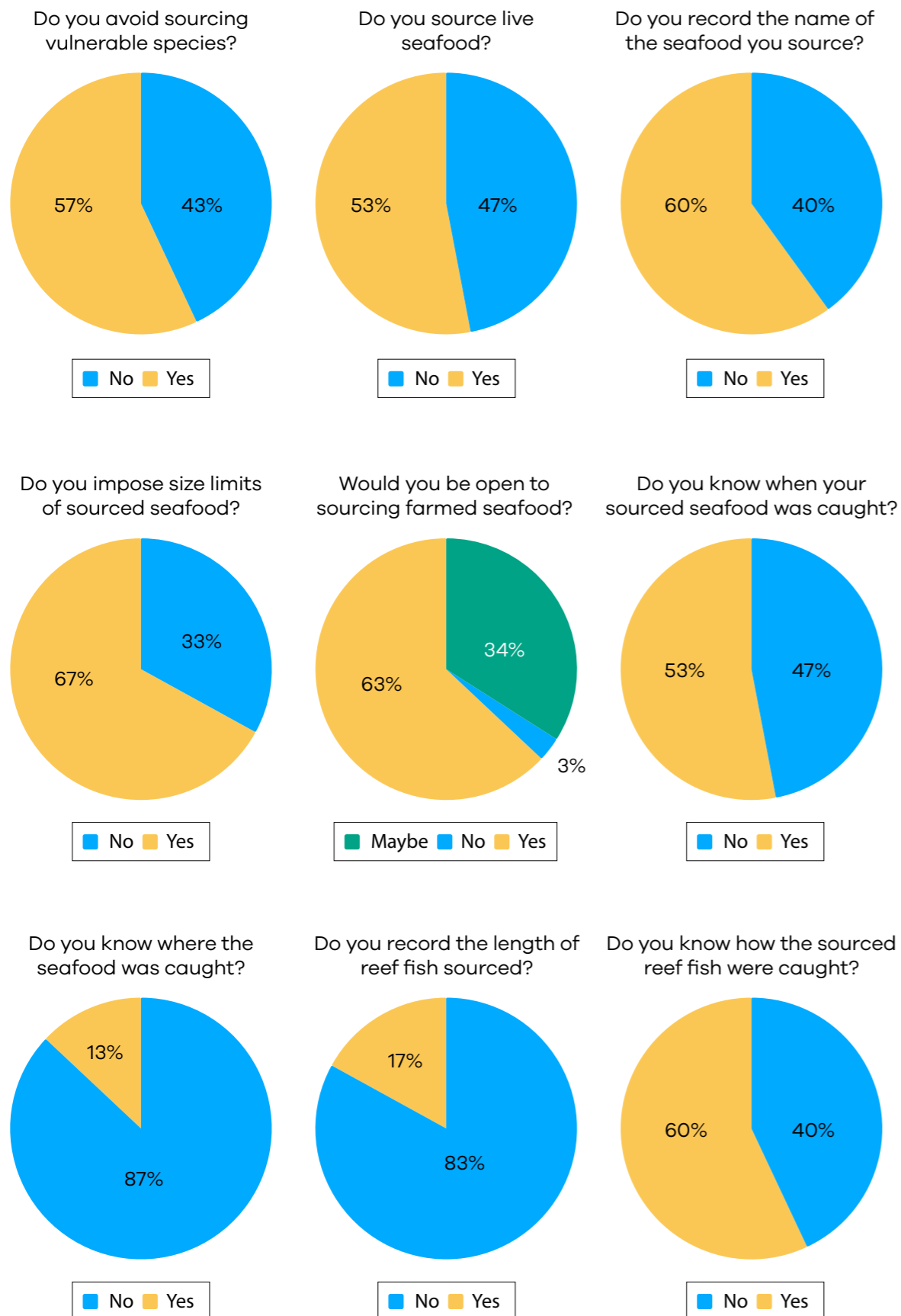


Figure 10. Respondent answers to the sustainability questions regarding locally sourced seafood indicated above each chart.

A majority of respondents (83%) do not record the length of the reef fish that they source (Figure 13). Furthermore, 60% of respondents indicated that they knew how their local seafood was caught (Figure 13). Of these respondents, handlines/droplines were the most frequently used fishing

method, with 58% respondents indicating that they source reef fish caught with this technique (Figure 14). The second most common fishing technique was jigging/popping followed by trolling and longlines (Figure 14).

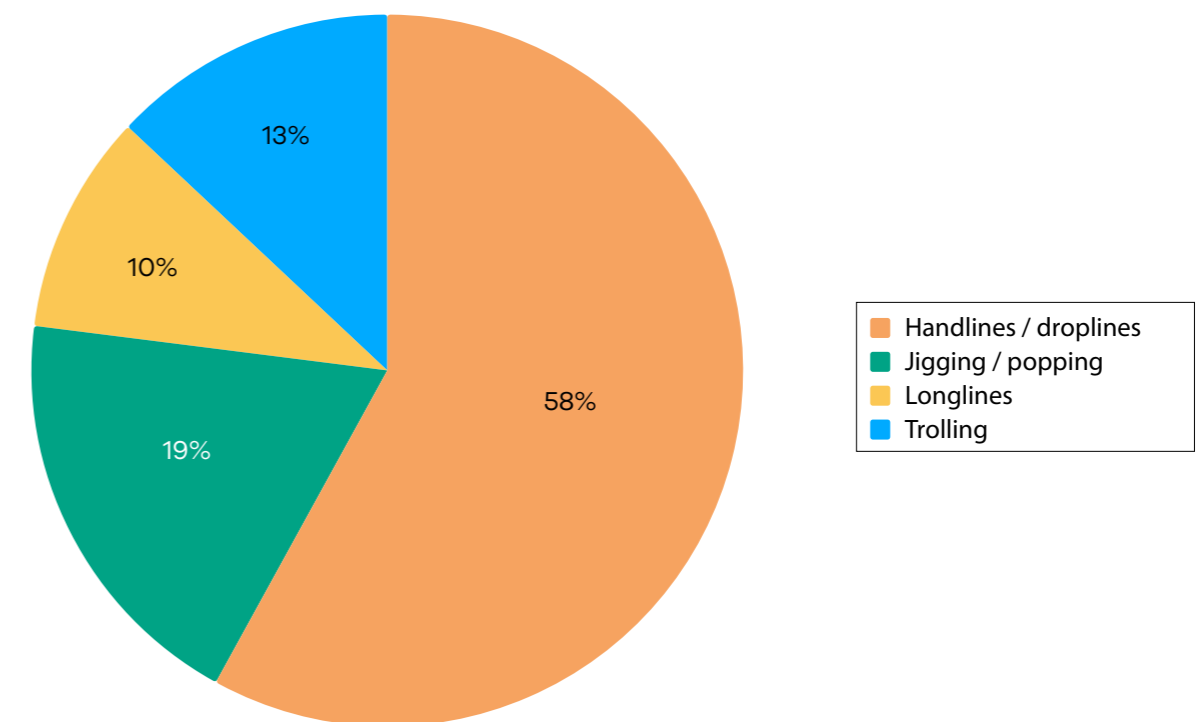


Figure 11. Fishing techniques used to source local reef fish.

Openness to sustainability

Every respondent indicated that they would be interested in improving the sustainability of their local seafood sourcing practices. When asked to rate their interest in learning more about sustainable seafood sourcing, with 1 being highly uninterested and 10 being

highly interested, respondents averaged 9.26 (± 0.31). Furthermore, 93% of respondents indicated that they would be interested in learning more about how the *Laamaseelu Masveriyaa* programme could benefit their business.

DISCUSSION

Respondent characteristics

Survey participation was strong among atolls which had a larger number of operational resorts compared to those that did not. There are 57 tourist resorts operating on Kaafu Atoll as reflected in the national resort database which is likely why most of the respondents (n=14) derived from this atoll.

Sourcing characteristics by seafood group

Imported seafood

Variability in seafood group specific sourcing from international and local sources is unsurprising as resorts offer guests a comprehensive range of non-Maldivian seafood choices. Guests visiting the Maldives expect to be able to eat global cuisine with the presence of 'luxury' seafood groups such as salmon expected when visiting high-end resorts. This explains why the majority of respondents extensively import non-native seafood groups from abroad.

Tuna

It is understandable that 100% of respondents sourced tuna from within the Maldives. Tuna and the associated pole-and-line fishing industry is a significant aspect of Maldivian culture and society, making tuna readily available locally. The freshness and availability of local tuna explains why 100% of respondents source tuna from within the Maldives. Pole-and-line fishing is regarded as sustainable by multiple international fisheries accreditation agencies (e.g. 'Marine Stewardship Council' and 'Fair Trade USA'), with tuna caught one at a time with minimal bycatch^{28,29}. Over the past 50 years, the Maldivian tuna industry has transitioned from small-scale non-motorised beginnings towards a highly commercialised sector.

This is evidenced by skipjack tuna catches increasing from approximately 28,000t in 1970 to over 129,200t in 2023³⁰. Pole-and-line tuna fishing has traditionally targeted skipjack tuna (*Katsuwonus pelamis*), yet over the past 20 years, a commercial yellowfin tuna (*Thunnus albacares*) fishery has also developed, with 30,776t of yellowfin tuna caught in 2023³⁰. Maldivian tuna is processed in bespoke processing facilities located at major landing sites. It is a possibility that resorts source their tuna from these facilities to meet demand from guests and on-island resort staff.



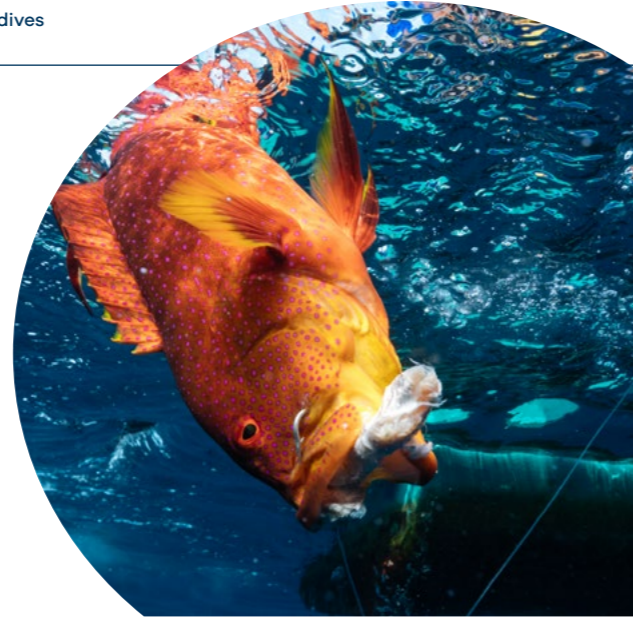
Reef and oceanic fish

Tourism establishments are the most significant domestic market for reef fish in the Maldives, so it makes sense that all respondents source reef fish, with the vast majority sourced from within the Maldives. The most frequently landed reef fish and oceanic fish were consistent with broader fisheries trends observed in the Maldives and through-out the Indo-Pacific region²². Snappers, jobfish, groupers, and jacks and trevallies are predatory coral reef fishes which are frequently caught using handlines across the Maldives. Similarly, wahoo, mahi mahi and rainbow runners are predatory oceanic fishes which are typically caught using trolling fishing methods but can also be caught around fish aggregation devices. Juvenile life-stage mahi mahi and rainbow runner are also known to aggregate alongside skipjack tuna schools and can be caught as tuna fishery bycatch³¹. A 2015 study estimated bycatch of the Maldivian pole-and-line fishery to be 552.6t which represented only 0.63% total annual tuna fishery catch³¹.

Of all bycatch recorded, 93% (513.9t) of bycatch comprised mahi-mahi and rainbow runner³¹. It is possible that third-party suppliers or other fishers could be operating at small scales to buy mahi mahi and rainbow runner from tuna boats and sell to directly resorts. However, any supply of bycatch to resorts is most likely to be highly localised and not a major component of national seafood supply.

A single respondent indicated that they source parrotfish, which have been nationally protected in the Maldives since 2020³². It is likely that the respondent in question was unaware of parrotfish protected status.

Parrotfish are herbivorous fish, making it unlikely that these species are caught using handlines or baited hooks. There



is a possibility that reef fishing methods such as netting and automated spearguns could be being utilised to catch these species, however this would require further investigation. Although not officially protected by law, ruby snapper are an understudied deep-sea fish which may be vulnerable to overexploitation^{33,34}. Five (17%) respondents indicating they source these species is of conservation concern.

Moreover, the large number of respondents sourcing groupers is a concern due to the conservation status of groupers throughout the Indo-Pacific region. Large live export demand has increased fishing pressure across Indo-Pacific over the past 30 years, with long-life spans, late maturation and mass spawning aggregation life history characteristics making grouper especially vulnerable to overexploitation²⁵. Of the 20 species targeted for the export trade in the Maldives, at least three species are considered vulnerable in the IUCN Red List of Threatened Species. Trends suggest that stocks of species targeted for export are decreasing, with 70 - 90% of exported groupers caught before they are able to reproduce³⁵. With the increase in fresh chilled exports, fishers and exporters are targeting a wider range of grouper species, which could have implications for the stock status of the broader grouper family in the Maldives. Large tourism industry demand for groupers could be exerting further pressure on exploited grouper stocks.



Lobster

The primary market for the Maldivian commercial lobster fishery is the resort sector, supported by 48% of respondents sourcing lobster locally³⁶. There are two species of lobster commercially caught in the Maldives: 1) the painted spiny lobster (*Panulirus versicolor*); and 2) the pronghorn spiny lobster (*Panulirus penicillatus*). Variability in whether tourism operators source lobster from local or international suppliers is most likely due to local availability. Variability in availability could be due to lobster fishery seasonality, meaning that lobster are most easily caught by fishers at certain times of the year - specifically between January and May³⁶. Resorts could turn to international lobster alternatives outside of the Maldives lobster season, explaining why 38% of respondents sourced lobster from both local and international suppliers.

Further to seasonal variability in lobster abundance, culinary hygiene requirements may also drive international imports of lobster by resorts. Lobster are nocturnal and generally caught during the night³⁷. A lack of cold storage facilities on local islands could inhibit supply of lobster to resorts, which typically only buy local seafood during the daylight hours. A study conducted by Blue Marine Foundation on Laamu Atoll found that lobsters in Laamu Atoll were caught through hand collection, which can be regarded as a highly selective and sustainable harvest method³⁸. Effective monitoring and reporting of local lobster supply to the tourism sector will be critical to ensure that management measures effectively conserve national stocks.



Variability in whether tourism operators source lobster from local or international suppliers is most likely due to local availability.



Octopus

There is little understanding of octopus fisheries across the Maldives, which is a concern in light of every respondent indicating they source octopus, with over half of respondents sourcing octopus from within the Maldives. In 2021, Blue Marine Foundation found that one third of local fishers on Laamu Atoll used chemicals to catch common octopus during the low tide³⁸. The extent of chemical usage during octopus fishing activities outside of Laamu Atoll is not well understood. The use of chemicals to flush octopuses out from their burrows carries understudied ecological impacts for other biota in the vicinity of the burrow. There is poor understanding of how chemical use impacts the re-habitation of octopus burrows. With 52% of respondents sourcing octopus locally, this study indicates that resorts could be a significant domestic market for octopus.

Billfish

Under half of respondents indicated that they sourced billfish, yet only two respondents indicated that they avoid sourcing billfish due to conservation concerns. Many species of billfish are thought to be over-exploited across the Indian Ocean, with Indo-Pacific blue marlin and striped marlin regarded to be subject to overfishing through-out the region³⁹. Billfish are thought to seasonally visit Maldivian waters through-out the year and are caught on an artisanal basis, yet the extent and size of the fishery is not well understood⁴⁰. A commonly used method of catching billfish, known locally as *Thai'kuraa vadhu*, involves using hookless lures made from ribbon which attach to the billfish's jagged bill once it strikes the lure. There is little understanding of the sustainability of this technique, nor the extent to which it is utilised to catch billfish across the country.

In addition to seasonality, differing culinary requirements across resorts could explain why billfish are less commonly sourced compared to other oceanic fish species. Billfish are large species, with Indo-Pacific sailfish having a common total length of 2.7 metres⁴¹. It is possible that the specialised post-processing required when sourcing billfish could deter some operators. Of the respondents who indicated that they source billfish, most highlighted swordfish and sailfish as the two species they source. Due to the remote survey design and varying billfish taxonomy capacity of respondents, limited conclusions can be drawn from species-level analysis of billfish sourcing by resorts.



In 2021, Blue Marine Foundation found that one third of local fishers on Laamu Atoll used chemicals to catch common octopus during the low tide³⁸

The role of third-party suppliers

It is unsurprising that many respondents indicated that they source seafood from independent fishers from local islands. Sourcing seafood directly from local fishers is likely preferable for tourism operators, compared to sourcing from non-local suppliers, as the seafood is fresher and cheaper due to reduced transport costs and localised market prices. A larger portion of Male' Atoll-based respondents indicated that they source local seafood from Male' Atoll-based third-party suppliers. This is logical due to the close proximity of these resorts to Male' Atoll suppliers. Accordingly, non-Male' Atoll based resorts are more dependent upon local fishers and third-party suppliers based on neighbouring islands.

The small-scale reef fishing sector in the Maldives is highly impacted by incremental weather, which can impact seafood supply to operators. Resorts working directly with independent local fishers could be more vulnerable to periods of seafood supply shortages. Natural fisheries productivity can temporally fluctuate on regional and local scales in accordance with both anthropogenic and natural drivers^{42,43}. Consequently, the availability and accessibility of fisheries resources typically do not correlate with tourism high and low seasons, causing a dichotomy between local seafood availability and resort market demand. This could explain why respondents highlighted issues with their seafood sourcing processes, with consistency of supply the two most highlighted concerns.

The use of third-party suppliers, or wholesalers, within the local seafood supply chain can act to buffer against misalignment of local seafood supply and demand between local fishers and tourism operators. Third-party suppliers operate

commercially to buy seafood from a number of different fishers at a lower price and then sell seafood in bulk to tourism operators at a higher price. Higher prices paid to third-party suppliers account for storage and transport costs, in addition to a premium for reliable and consistent seafood supply. It is likely that this study underestimates the prevalence of third-party suppliers within resort local seafood supply chains.

Sourcing seafood directly from local fishers is likely preferable for tourism operators

The presence of a third-party supplier can be beneficial to certain local fishers, who may not have the means, time, nor interest to travel to operators to sell their catch directly. This could include situations when resorts are not in close proximity to local islands, necessitating fishers to travel large distances to sell their catch. However, in other situations fishers might need to work with third-party suppliers out of necessity rather than choice. This would be true if a resort only works with an exclusive group of suppliers, reducing market accessibility for local fishers. In these situations, imbalanced power dynamics between local fishers and third-party suppliers could result in suppressed market accessibility for local fishers. Further research is required into resort supply chain community dynamics and how such dynamics vary across the country.



Understanding local seafood demand

Previous investigations into the maximum sustainable yield (MSY) of the Maldives reef fisheries sector have been sporadic. In 1992, Anderson and colleagues estimated that the MSY for the Maldivian reef fishery was 30,000 MT ($\pm 13,000$ MT)⁴⁴. In 2014, Sattar and colleagues reported the upper estimate of total annual catch of reef fish could be less than a couple of metric tonnes short of the MSY calculated in 1992²². The same study found that resorts sourced approximately 5,300 MT of reef fish in

2012²². The present study did not assess national local seafood demand because of the large variability in resort characteristics, such as size, bed capacity, sustainability ethos and guest demographics, across the country unable to be adequately reflected across respondent resorts. It is probable that demand for reef fish in the Maldives has increased since the estimations of Sattar and colleagues, with 68 new resorts and several hundred local guesthouses opening over the past 13 years.



Seafood sourcing sustainability

Supply chain traceability

Overall, traceability and transparency of local seafood supply chains within the Maldivian tourism sector was universally low. This is reflected in the vague responses operators provided in response to sustainability questions, with operators unable to robustly infer when, where or how local seafood was caught (Annex 3; Annex 4; Annex 5). For example, respondents were unable to verify where their local seafood had been caught and beyond visual assessments and basic freshness checks were unable pinpoint when their seafood was caught. Building traceability within resort local seafood supply chains is critical to ensure that local seafood has been sourced sustainably. This is important to ensure seafood is not caught from marine protected areas or using destructive fishing gears. Further to the conservation benefits, traceability ensures product quality and accountability across the supply chain.

Respondents indicated a high interest in sustainability and in learning about how the sustainability of their operations could be improved. Rather than a lack of interest from resorts, this study highlights how a lack frameworks to enable the collection of sustainability metrics

(such as catch location, gear used) within resort local seafood supply chains is the major inhibitor to sustainable sourcing. Enabling the collection of metadata around local seafood would enable resorts to ensure traceability from hook to plate. The development of national mechanisms for local seafood data reporting by resorts will need to be robust to the inclusion of both third-party supplier and direct fishers within supply chains. When dealing with third-party suppliers, these data can be easily lost when aggregating catches from multiple fishers.

Fishing methods used

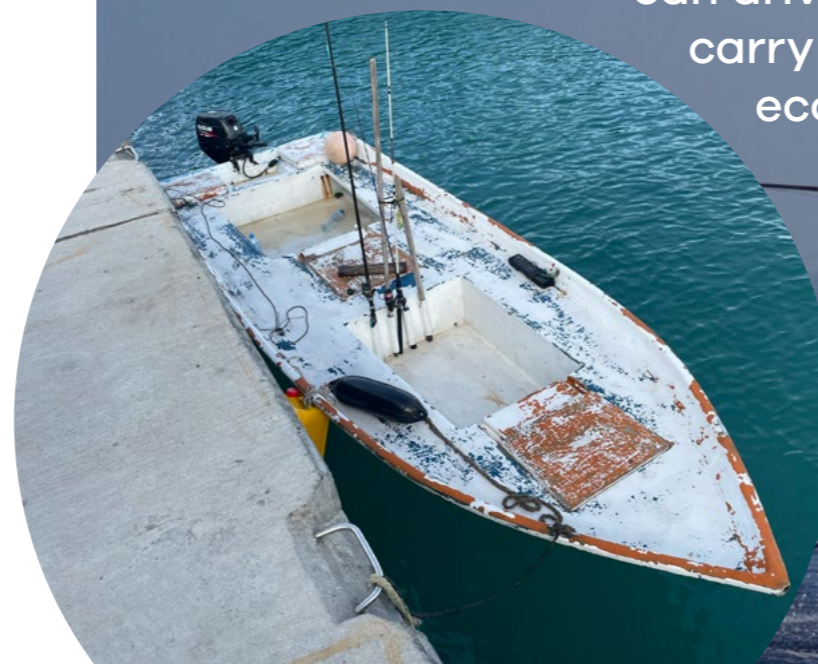
Coral reef fishing in the Maldives has been traditionally dominated by handline and trolling fishing, so it is unsurprising that handlines were the mostly commonly identified method of catching local reef fish. However, modern forms of fishing gears that are not well nationally understood are now growing in popularity across the country. This includes jigging and popping methods which are thought to have proliferated across the Maldives in recent years. This is supported by this study finding jigging and popping to be the second most commonly identified fishing method by respondents – mentioned more frequently than traditional trolling methods. Jigging is a deep fishing method using a lure, or 'jig', to catch deep-sea species.

Sourcing live and farmed seafood

Respondents were varied in their willingness to source live seafood and farmed seafood. The varied openness to sourcing farmed seafood by operators is most likely a result of respondents not knowing enough about the aquaculture industry – which is still at nascent stage in the Maldives. This is supported by 36% of respondents responding 'maybe' to sourcing farmed seafood. Sourcing live seafood can require operators to invest and maintain specialist aquaria equipment which is a financial and time commitment. However, sourcing live seafood enables operators to guarantee the freshness of their seafood produce by controlling when the animal is culled. The transportation of live crustaceans is easier than live fish, as the latter is required to be constantly submerged

in aeriated seawater. It is highly probable that respondents are already importing seafood groups which are commonly farmed such as prawns and salmon. Unsustainable aquaculture practices can drive overfishing, and carry significant socio-ecological impacts⁴⁵. However, if well managed and conducted in a sustainable way, aquaculture could play an important part of an equitable Maldivian blue economy and could provide an alternative livelihood for fishers.

Unsustainable aquaculture practices can drive overfishing, and carry significant socio-ecological impacts⁴⁵



DIRECTIONS FOR MANAGEMENT

Establish a traceable and equitable supply chain

Tourism operators indicated a desire to increase the sustainability of their local seafood sourcing practices, with some resorts indicating that they already attempt to understand where, when and how their local seafood was caught. However, a lack of effective mechanisms through which tourism operators can ensure sustainability, in addition to supply consistency and culinary standards of local seafood was evident. The development of frameworks through which tourism operators can facilitate sustainable local seafood sourcing would not only better equip operators to source local seafood sustainably but could better support local communities and coastal livelihoods.

Appetite from respondents for greater sustainability within resort local seafood supply chains is evidenced by respondents wanting to learn more about sustainability and the *Laamaseelu Masveriyaa* programme. The *Laamaseelu Masveriyaa* programme is operated through a code of conduct and stipulates that local fishers use sustainable fishing gear types and catch only resilient species of a mature size outside of protected and ecologically important ocean areas. In return, tourism operators provide local fishers with a stable and guaranteed market for sustainably caught local seafood and offer an incentivised price for their catch. Further to the ecological benefits to marine ecosystems, the *Laamaseelu Masveriyaa* programme empowers local fishers to work with tourism operators and increases the accessibility of the resort local seafood market.

Appetite from respondents for greater sustainability within resort local seafood supply chains is evidenced by respondents wanting to learn more about sustainability and the Laamaseelu Masveriyaa programme

The development of a traceable and transparent reef fishery framework, like the *Laamaseelu Masveriyaa* programme, would facilitate the achievement of all five objectives and strategies outlined in the Maldives Reef Fishery Management Plan²³. This includes the promotion of sustainable and precautionary fisheries management through reef fishery data documentation and monitoring. This study has built upon previous works examining the resort local seafood sector, yet could not reliably determine national resort local seafood demand. Understanding resort demand through the robust documentation of local seafood sourcing by resorts would enable determinations of resort-driven reef exploitation across the country and inform fisheries management.



Identify reef fishery baselines

Updated assessments of reef fisheries carrying capacity are required to understand the sustainability of existing reef fisheries exploitation across the country. Without having a current understanding of fisheries carrying capacity, it is impossible to devise coherent national fisheries management which ensure sustainable resource use. Establishing a baseline understanding of reef fishery health will enable the development of scientifically informed fisheries management. Assessments of both vertebrate and invertebrate stocks are urged to consider the impacts of climate change to ensure findings remain robust into an uncertain climatic future.



Understand the traditional billfish fishery

This study has evidenced how the Maldivian billfish fishery is transitioning away from its artisanal roots towards increased commercialisation driven by the tourism sector, with just under half of respondents sourcing locally caught billfish species. Building upon the progress of the Maldives Billfish Fishery Management Plan, it is recommended that further research explores the extent of the billfish fishery across the country. The lack of data surrounding billfish fishery impedes the development of scientifically informed fisheries management. The establishment of a resort local seafood sourcing framework (see section 5.1) could be one method to better enumerate national billfish catches.

It is particularly recommended that further research is conducted in the extent, impact and sustainability of the Thai'kuraa vadhu fishing technique, which is an understudied method of catching billfish across the Maldives. The Thai'kuraa vadhu fishing technique is hookless and selective for billfish species, yet it is unlikely that catch-and-release methods can be used for undersized individuals due to ribbon entanglement around the billfish's rostrum. Gaining an understanding of the sustainability of this fishing technique will be important to inform future iterations of the billfish fishery management plan.

Regulate the growing recreational jigging fishery

It is recommended that further research is conducted into the jigging fishery across the Maldives which is likely to be increasing exploitation on understudied deep-sea fish stocks. This study has highlighted how this technique is not only used recreationally but is now being used on a commercial scale to supply the tourism sector. Gaining an understanding of the geographic extent of the fishery, exploitation hotspots and commercially targeted species, will be critical to enable effective fishery management. Jigging is not currently outlined as a gear type in the reef fishery management plan. Further research into the fishery will enable jigging to be included within future iterations of the Maldives Reef Fishery Management Plan²³.

Develop an octopus fishery management plan

There is currently no octopus management plan published by the MFOR. This is a concern in light of this study, where every respondent indicated that they source octopus and over half of respondents indicated that these supplies are sourced within the Maldives. A lack of national scale understanding of the extent and impacts of the octopus fishery should make the establishment of an informed management plan a priority for policymakers. Quick maturation and highly fecund life history strategies enable octopus fisheries to be sustainable if effectively managed⁴⁶. Unmanaged exploitation of local octopus could be a threat to octopus population health across the country.



A lack of national scale understanding of the extent and impacts of the octopus fishery should make the establishment of an informed management plan a priority for policymakers



FINAL REMARKS

The Maldives tourism sector has the opportunity to utilise its position as a leading luxury travel destination to become the global gold standard of sustainable seafood sourcing. The ocean and life it supports has provided the backbone of rapid tourism growth in the Maldives over the past 50 years. By embracing equitable and traceable seafood sourcing practices, tourism sector stakeholders and national policymakers have the opportunity to take action to protect this socio-ecologically vital environment, and by doing so, ensure the longevity of the Maldivian tourism industry into the future.



THE OCEAN AND LIFE IT SUPPORTS
HAS PROVIDED THE BACKBONE OF
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MALDIVES OVER THE PAST 50 YEARS

50 YEARS

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ANNEXES

Annex 1. Number of mentions of each seafood groups avoided due to conservation status by respondents.

Response	Frequency
Parrotfish	5
Sharks	4
Any species protected by law	4
Rays	1
Grouper	1
Ruby Snapper	1
Rainbow Runner	1
Blue Marlin	1
Lobster	1
Lobster below 400gm	1
Lobster during breeding season	1
Turtle	1
Local clam	1
Surgeon fish	1
Unicorn fish	1
Sweet lips	1
Napoleon Wrasse	1
Orange Roughy	1
Sole fish	1
Sturgeon (wild caught)	1
Tilefish	1
Bluefin Tuna	1
Catfish	1
Swordfish	1
Sailfish	1
Marlin	1
Blue Crab	1
Whales	1

Annex 2. Number of mentions of seafood groups sourced live by respondents. Responses have been tidied for clarity.

Response	Frequency
Lobster	16
Reef fish	1
Mud crab	1

Annex 3. Responses to how operators impose their seafood sourcing size limits. Responses have been tidied for clarity.

	Response
1.	Follow Laamaseelu Masveriyaa sustainability standards
2.	Seafood weighs more than 1kg
3.	Between 600/1000g
4.	500gm or more
5.	According to menu requirements and legal sizes as deemed by international law
6.	Prefer 1kg to below 2.5kg due to culinary requirements
7.	2 to 3kg
8.	Lobster minimum of 500 grams
9.	Follow government law
10.	Legal size
11.	Minimum of 700 to 800 grams
12.	Size depends on species of fish
13.	Minimum of 2kg
14.	Lobster no smaller than 10"
15.	500-700g
16.	Over 18 inches
17.	Visual assessment
18.	Plate size
19.	400 grams - 500 grams
20.	Reef fish is 700grams minimum and lobster is 800grams to 1kg
21.	Lobsters should be larger than 6 inches

Annex 4. Responses to how operators verify where their seafood was caught. Responses have been tidied for clarity.

	Response
1.	Track fishers through the Laamaseelu Masveriyaa programme
2.	Our fisherman are from the atoll and surrounding islands (can be verified by documentation)
3.	We have local fisherman and local suppliers
4.	Seafood is caught by fishermen of a nearby local island

Annex 5. Responses to how operators verify when their seafood was caught. Responses have been tidied for clarity.

	Response
1.	Check freshness upon arrival at the resort
2.	Fishermen tell us the catch time but the kitchen team also checks skin and smell
3.	Mostly caught the same day
4.	Less than 24 hours before delivery
5.	Fishers catch fish in the morning and deliver in the afternoon
6.	Inform local fisher one day prior to delivery
7.	Team check the gills and freshness of the fish
8.	Fishers go out on our request and we check temperature when receiving
9.	Fishers catch fish 2-3 hours before delivery
10.	Fishers deliver seafood straight after fishing trip, sometimes fish is still alive
11.	Visual checks used when receiving (all seafood caught within 72 hours)
12.	Do not purchase frozen fish, usually caught same day
13.	Reef fish and tuna is caught Monday night and delivered on Tuesday
14.	Use full-time fishing boats that are assigned after background checks
15.	Fish is available on call
16.	Caught same day as delivery



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Published November 2025

