Interactions between tourism and small-scale fisheries in Zanzibar

An integrated social-ecological analysis

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Abstract

Small-scale fisheries (SSF) are vital for the livelihoods of millions worldwide, providing food security and employment. In Zanzibar, where coral reefs are critical ecological and economic resources, the rapid growth of tourism has placed new pressures on the marine ecosystem, SSF and local communities. The high demand from tourism for certain seafood, particularly pelagic species, larger reef fish, and invertebrates, has raised concerns about overfishing, selective harvesting and the sustainability of SSF. Despite extensive research on coral reef ecosystems and the economic importance of SSF, limited empirical studies explore how tourism shapes fish consumption, market dynamics and equitable access for marine protein for both tourists and locals in Zanzibar. This study addresses these gaps by exploring how tourism-driven demands impact fish consumption patterns, market distribution, and the livelihoods of small-scale fishers in Zanzibar. Semi-structured interviews with 182 participants, including fishers, fish traders and local and tourist restaurant operators were conducted. Findings reveal partly overlapping fish consumption patterns between locals and tourists, however there are key differences. Tourists mainly consume high-value species such as large tuna species and lobsters, which locals often cannot afford. As a result, locals rely on smaller, lower trophic level and less demanded species, such as rabbitfish, for protein. This pattern creates a "catch-all" market, where all fish, from pelagic to coral reef species and from juvenile to adult, are harvested to satisfy both local's and tourists' needs. In the long run, the high pressure on the marine ecosystem and the growing tourism demand for fish undermines the sustainability of SSF. It increases competition, drives up fish prices, exacerbates inequities in resource access and threatens local food security and income sustainability. To achieve a long-term sustainability of SSF and equitable access to marine resources, it is required to integrate local fishers into fisheries management and tourism planning. Furthermore, sustainable tourism should be promoted by educating tourists about the ecological and social consequences of their seafood choices and limiting tourism-driven exploitation of coastal areas. This research highlights the need to balance tourism growth with the capacity of SSF, striving for long-term social-ecological sustainability.

Keywords: small-scale fisheries, tourism, fish consumption, coral reefs, marine resources, sustainability, livelihoods

Popular science summary

Small-scale fisheries (SFF) are important for millions of people worldwide particularly in tropical countries. SSF are here carried out by fishers with limited money, using simple gear and vessels and catching fish for their own consumption or local markets. SSF provide food and jobs for local communities, especially in places like Zanzibar, where fishing and coral reefs play a big role in the economy. Also, the popularity to visit remote tropical places is growing, making tourism an important source of revenue for many countries. As for Zanzibar, tourism mostly occurs as coastal tourism which is associated with activities like snorkelling, diving, fishing and various water sports. As tourism grows it creates new challenges for both the marine environment and the people who depend on fishing. Particularly in terms of food consumption, tourists often want to eat special types of seafood, like lobsters, octopus and large fish such as tuna and snappers. With an increasing number of tourists every year in Zanzibar, the demand for seafood constantly increases. This has raised concerns about overfishing and whether the current way of fishing can continue without harming the environment and the people who depend on it.

While there has been a lot of research on coral reefs and fishing, it is less known how tourism affects what fish local people eat, how fish are sold in the market, and whether there is a fair distribution of it. This study aimed to answer these questions by looking at how tourism impacts small-scale fishing and fish consumption in Zanzibar. Here, 182 interviews with fishers, fish retailers, and restaurant owners who serve both to locals and tourist were conducted.

The results showed that the consumption of seafood by locals and tourists is overlapping, but there are clear differences. Tourists prefer expensive seafood like lobsters, tuna and larger reef fish, while locals tend to eat smaller, cheaper fish. Because tourists are willing to pay more, the prices for certain types of fish have gone up. This makes it harder for local people to afford their usual fish, so they often have to buy smaller and less popular types. This creates a market where fishers catch everything so they can meet the combined demand of locals and tourists. This puts a lot of pressure on the marine environment, making it difficult for fish populations to recover and threatening the long-term future of fishing. In the long run, tourism is making life harder for fishers. There will be increased competition between fishers, uneven distribution of fish, since better equipped fishers have better and more access to fish. Over time, this could harm the local food security.

To make sure fishing stays sustainable in Zanzibar, it is important to include local fishers in decisions regarding managing fish stocks and tourism. Tourists also need to learn about the impact of their seafood choices on the environment and local people. By working together, we can ensure that both tourism and fishing can thrive without harming the livelihoods of fishers or the health of the ocean.

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Abbreviations

Abbreviation	Description
CHICOP	Chumbe Island Coral Park
DFID	Department for International Development
IUCN	International Union for Conservation of Nature
MLF	Ministry of Livestock and Fisheries
MoBEF	Ministry of Blue Economy and Fisheries
NBS	National Bureau of Statistics
OCGS	Office of Chief Government Statistician
SIDS	Small Island Developing States
SLF	Sustainable Livelihoods Framework
SPC	Pacific Community
SSF	Small-scale fisheries
TZS	Tanzanian Shilling
UNCSD	United Nations Conference of Sustainable Development
UNWTO	UN World Tourism Organization
URT	United Republic of Tanzania
USD	US Dollar
WIOMSA	Western Indian Ocean Marine Science Association

1. Introduction

Small-scale fisheries

Small-scale fisheries (SSF) in many tropical countries are vital for food security, livelihoods, and cultural heritage, primarily depending on habitats of the tropical seascape such as coral reefs and seagrass beds (FAO, 2023) . Globally, SSF employ 90 percent of all fishers and contribute to at least 40 percent of the global catch (FAO, 2023; Virdin et al., 2023). SFF in developing countries, such as in the Western Indian Ocean region, are characterized by low-tech gear, including lines, nets, hooks and basket traps, and small non-motorized vessels, and they often operate in coastal communities (Jiddawi N & Khatib H, 2007). Local communities often depend heavily on marine resources for both food security and livelihood (Bene, 2006; FAO, 2023). However, this dependency on natural resources entails a vulnerability to environmental changes, overfishing, fluctuating market demands and socio-economic marginalization (Cinner et al., 2012; FAO, 2023; Islam & Chuenpagdee, 2022; Pauly & Zeller, 2016). While some small-scale fishers diversify their livelihoods through farming, tourism, or small trade, many are constrained to fishing due to limited alternative income sources, low capital and limited education (Allison & Ellis, 2001; Unicef Tanzania et al., 2018). This dependence, particularly in regions where fisheries are poorly managed or overfished, can lead to resource depletion and economic instability.

Coral reefs

Coral reefs are among the most diverse and important ecosystems in the world, accounting for 25 percent of marine life and serving as habitats, feeding, and spawning grounds for countless species (Brandl et al., 2019; Coker et al., 2014; Du et al., 2020; Graham & Nash, 2013; Knowlton & Jackson, 2013; Reaka-Kudla, 1997). They protect coastlines from storms and provide a vital source of food and income for coastal residents, particularly in developing countries (Cinner, 2014; Cruz-Trinidad et al., 2014; Wabnitz et al., 2018). Approximately six million people in different nations are employed in the coral reef fishing sector, which accounts for about a quarter of the total fish catches in developing countries (Cinner, 2014; Teh et al., 2013). Thriving coral reef ecosystems depend on key ecological processes, such as predation and herbivory by fish which maintain reef resilience (Graham & Nash, 2013). The loss of herbivorous fish can lead to macroalgal abundances outcompeting live corals and pushing reefs into an alternative algal-dominated state rather than one dominated by live coral (Adam et al., 2015; Bellwood et al., 2004; Komyakova et al., 2013). Similarly, the decline of predatory fish, such as triggerfish (*Balistapus undulatus*), is strongly associated with higher abundances of sea urchins feeding on algae and live coral, possibly changing the coral reefs from being dominated by corals to being populated by sea urchins

(Eakin, 1996; Lokrantz et al., 2009; T. R. McClanahan & Shafir, 1990; Norström et al., 2009). Unfortunately, coral reefs are under significant threats such as climate change, overfishing, eutrophication and pollution, with climate change posing the greatest stressor, including substantial impacts on fisheries (Guan et al., 2020; Hamad & Sawe, 2022; Muringai et al., 2021; Mustelin et al., 2010; Pendleton et al., 2016). While reef fisheries are traditionally linked to small-scale artisanal fishing, the growth of coastal communities and coastal tourism has increased fishing pressure on coral reef fish populations (Lachs & Oñate-Casado, 2020; Thyresson et al., 2013).

Tourism

Over the past decades, global tourism has grown steadily, with an expected annual growth rate of 4 percent (Adedoyin et al., 2021; Lenzen et al., 2018). As the world's largest and fastest-growing economic sector, tourism supported 330 million jobs in 2019, including indirect and direct employment (Al Saba et al., 2023; UNWTO, 2021). Travelling is not only easier and less expensive than it once was, but there is also a greater demand for exotic locations, with Sub-Saharan Africa being the second fastest-growing tourist destination (UNWTO, 2019). In particular, coastal areas play a crucial role in tourism, with 30 percent of global tourism activities occurring in these regions (Ghosh, 2012). For Small Island Developing States (SIDS), it is the primary source of foreign exchange (UNWTO, 2013). Coastal tourism includes a range of sea-related recreational activities that require a well-developed infrastructure to function effectively (Ghosh, 2012; Kabil et al., 2021). Tourism can have positive aspects in low-income countries, such as benefiting the country's economy, local communities, and environmental protection (Alam & Paramati, 2016; Kweka et al., 2003; Martial et al., 2023). Despite its benefits, tourism, particularly in low-income countries, also entails significant challenges, such as the dominance of foreign-owned businesses and tour operators, low-paying jobs for locals, high natural resource demand, infrastructure strain, and seasonality (Alam & Paramati, 2016; Brau et al., 2007; Farrukh et al., 2023; Mitchell, 2012). In many cases, over-reliance on tourism can slow the economic diversification and long-term growth (Brau et al., 2007; Martial et al., 2023). However, in 2012, the term "Blue Economy" first appeared at the United Nations Conference of Sustainable Development (UNCSD) to promote sustainable ocean resource management, which is closely linked with coastal tourism, offering an opportunity to make tourism, especially coastal tourism, more sustainable (Blue Economy Concept Paper, 2014). Unfortunately, the agenda's focus on economic growth raises concerns about rapid development and ocean exploitations, potentially overlooking social and ecological sustainability (Bennett et al., 2021; Cohen et al., 2019; Hicks & Childs, 2019). Hence, it is crucial to understand the

interactions between tourism, SSF, and local communities to ensure that tourism development is sustainable.

Zanzibar, Tanzania

In the archipelago of Zanzibar, Tanzania, the tropical seascape is of immense ecological and economic importance. Coral reefs around the islands of Unguja and Pemba cover roughly 218,596 km², making up for about 60 percent of Zanzibar's coral reef area along the shoreline (WIMOSA, 2023). These reefs support diverse marine life, with Tanzania's reefs being the most productive and diverse in East Africa, hosting around 500 species (Jiddawi & Öhman, 2002). However, Zanzibar's coral reefs are experiencing the same challenges as coral reefs globally, including pollution, eutrophication, climate change, and overfishing. Reports indicate that the coral cover was strongly impacted by massive bleaching in 1998, 2007, and 2016 driven by El-Niño events, and ongoing pollution and destructive fishing have significantly altered coral reefs (T. R. McClanahan et al., 2007; Obura D et al., 2002; Ussi et al., 2019). Artisanal fisheries dominate in Zanzibar, with 95 percent of the fisheries being small-scale and focusing largely on coral reef fish (Jiddawi & Öhman, 2002). SSF are crucial for food security and livelihoods, accounting for 90 percent of the total animal protein intake in Zanzibar (Le Gouvello et al., 2022; Lindström & de la Torre-Castro, 2017; WIMOSA, 2023). The annual per capita fish consumption in Zanzibar is 32.7 kg, significantly higher than the African average of 9.4 kg (OCGS, 2021). Despite higher fishing efficiency and higher fish catches due to increasingly advanced gear and vessels, there is still limited access to modern fishing equipment, which creates disparities in catch efficiency between low-income fishers using traditional methods and higher-income fishers equipped with advanced technology (WIMOSA, 2023). This pressure is compounded by inadequate legal regulations and poor enforcement of existing laws (Thyresson et al., 2013; Wallner-Hahn et al., 2016; Wallner-Hahn & de la Torre-Castro, 2018).

In Zanzibar, coastal tourism started in the 1980s and has grown significantly since, with arrivals rising from 42,141 in 1990 to 638,498 by 2023 (OCGS, 2024). The tourist numbers usually peak from June to October, during the warm and dry season, and again in January and February, when it is hot and dry (Zanzibar, 2024). Over the years, tourism has become the island's main revenue source, directly and indirectly employing 6.3 percent of the population (WIMOSA, 2023). With such a large number of tourists each year, the ratio of locals to tourists has shifted to approximately 3:1, putting significant pressure on natural resources and infrastructure (WIMOSA, 2023). Since its inception, tourism in Zanzibar has been poorly regulated, with a heavy emphasis on foreign investments and interests (Rotarou, 2014). This has contributed to environmental degradation and social changes, including three major challenges: (1) freshwater conflicts as each tourist needs 16 times more freshwater than a local resident (Gössling, 2001a; Nobel et al.,

2012); (2) the steady growth of hotels and restaurants has increased waste production, with 80 percent being illegally dumped, polluting neighbourhoods, groundwater, and the ocean (A Staehr, 2018; Ally et al., 2014; Lange, 2015); and (3) high demand for natural resources, particularly for local seafood, which accounts for 85 percent of restaurant products (Anderson, 2013; Jiddawi & Öhman, 2002; Wallner-Hahn & de la Torre-Castro, 2018; WIMOSA, 2023). Excessive tourism-driven demand for local fish and specific fish species might result in selective fishing, potentially leading to overfishing, further resulting in ecosystem disruptions and coral reef degradation (Casini et al., 2011; Garcia Rodrigues & Villasante, 2016; WIMOSA, 2023; Yadav et al., 2021).

1.1 Objective

Despite extensive research on the ecological and economic importance of coral reefs and SSF (FAO, 2023), there remains a gap in understanding how tourism affects small-scale fishing practices and market demand in regions such as Zanzibar, where both tourism and fishing are important for the local economy. While studies have examined overfishing and selective fishing pressure on coral reef ecosystems as well as tracing the value chain of coral reef fish in Zanzibar (Thyresson et al., 2013; Garcia Rodrigues & Villasante, 2016), there are limited empirical studies on how growing tourism affects the demand for different fish species, and specifically how it alters fish consumption patterns and impacts local fishing communities. Particularly, links between food provision of locally fished fish for locals and tourists remain underexplored. This thesis is an interdisciplinary social-ecological study addressing these gaps by examining the intersections of tourism, fish consumption, and SSF in Zanzibar. It contributes to a more comprehensive understanding of how tourism-driven demand influences local livelihoods and how it might affect the social-ecological sustainability of coral reefs and SSF. The three specific research questions to assess this are:

i.) Which fish species are consumed by local fishing communities vs. tourists, and why?

ii.) How does tourism influence the market demand and distribution of locally fished fish, and

iii.) Does tourism impact local SSF, and what are fishers' perceptions on this, and what possible benefits do they get from it?

This research seeks to provide insights through intersecting the topics tourism, market demand and SSF. I believe that the results of this study can provide stakeholders (including policymakers, conservationists, and the local fishing communities) with knowledge to develop strategies to reduce overfishing and especially selective fishing, striving for a long-term sustainable fishery. It is, however, important to address not only the ecological aspects but also social justice, such as ensuring the availability of marine protein to local communities.

1.2 Theoretical framework

This study draws on the Sustainable Livelihood Framework (SLF) to examine the social, economic, and ecological impacts of tourism on SSF in Zanzibar. Developed by Chambers & Conway (1992) and completed by DFID (1999), the SLF defines sustainable livelihoods as those that are able to withstand stress/shocks and bounce back or adapt to change without depleting natural resources. The SLF has been widely used in SSF research, providing a holistic approach to understanding how local fishing communities maintain their livelihoods in the face of external pressures (Allison & Ellis, 2001; Allison & Horemans, 2006; Bene, 2006). The framework considers five livelihood assets – human capital (health, education, skills), natural (owned land, fish stocks, public goods), financial (savings, credit, insurance), social (networks, trust, cooperations), and physical (infrastructure) (Allison & Horemans, 2006; DFID, 1999). In Zanzibar, SSF depend heavily on natural capital, such as coral reefs, for their fishing activities, making them vulnerable to environmental degradation, selective fishing pressure, and market fluctuations (Bene, 2006; Cinner et al., 2012). The SLF explores how fishers adapt to changes in their environment through livelihood diversification e.g., tourism or continued reliance on fishing (Allison & Ellis, 2001). By focusing on vulnerability and adaptive strategies, the SLF helps to highlight the challenges and opportunities that local fishers face, particularly regarding their ability to balance economic needs with the sustainability of marine resources (T. McClanahan et al., 2015). It helps to understand why certain fish species are targeted and how external influences such as tourism can alter the demand for seafood.

The SLF highlights the role of institutions and policies in shaping fishers' access to resources, markets, and decision-making processes. In Zanzibar, limited access to modern fishing equipment, combined with the dominance of foreign-owned tourism businesses, exacerbates the vulnerability of fishers, possibly reducing their ability to fully benefit from tourism and threatening the long-term sustainability of their livelihoods (Thyresson et al., 2013; Wallner-Hahn et al., 2016). Applying aspects of the SLF to this study allows us to explore how tourism influences SSF, whether it contributes to or undermines their livelihood sustainability.

2. Methods

2.1 Study area

Tanzania in East Africa has a long stretch of coastline along the Indian Ocean and includes the semi-autonomous Zanzibar archipelago, including Unguja and Pemba Island (Figure 1). Zanzibar, situated 40 km off the mainland, had a population of 1.89 million people in 2022, with 71 percent residing on Unguja Island, the more developed island (WIMOSA, 2023). The region is one of Africa's most densely populated areas, with 712 people per km^2, and its population grows at 3.7 percent annually (WIMOSA, 2023). As a Small Island Developing state (SIDS), Zanzibar relies heavily on its marine environment for socio-economic development such as tourism, fisheries, and seaweed farming (Hafidh H & Sharif M, 2022). Acknowledging the values of using marine resources sustainably, Zanzibar integrated the Blue Economy concept into its framework for socio-economic growth in 2020 (Hafidh H & Mkuya S.M, 2021; RGoZ, 2020). This approach highlighted significant challenges in resource use and management including illegal and unstainable fishing, low profit for seaweed farming, weak value chain connections, limited export ability, and infrastructural problems (RGoZ, 2020; WIMOSA, 2023).

This study was conducted at one of the islands of Zanzibar, Unguja Island (from this point onward referred to as Zanzibar). Unguja is the bigger, more infrastructural and economically developed island and it is where most tourism occurs. While fishing and agriculture are primary occupations, tourism employs locals mainly in unskilled jobs, with higher positions often filled by mainland or foreign workers due to limited education and training (Lange, 2015). For this reason, the shoreline of Zanzibar is extremely important to the local communities in order to make a living outside of tourism. Fisheries in the area are mainly artisanal and small-scale with approximately 34,000 fishers operating, primarily nearshore within six nautical miles (Fröcklin et al., 2013; N.S. Jiddawi & H. Khatib, 2007).

The island Unguja was chosen for this study due to its significant dependency on marine resource, particularly from seafood and the tremendous coastal tourism. The study focuses on specific sites in different parts of the island, including Unguja Ukuu, Kizimkazi, Paje, Uroa, Nungwi, Mkokotoni and Stone Town (Figure 1 B). These locations were selected for their vital fish markets, diverse landing sites and geographical representation across the island. A range of fishing practices are taking place in these sites, targeting species in the intertidal zone, such as corals and seagrass- associated ones, to pelagic species, providing a comprehensive understanding of the island's diverse fisheries. Notably, sites like Stone Town, Paje and Nungwi are major tourism hot spots emphasizing the intersection of fisheries and tourism.

2.2 Data collection

Data collection was conducted between February and April 2024, encompassing both social and ecological data.

2.2.1 Interview study

Social-ecological data were collected through semi-structured interviews designed to collect both qualitative and quantitative data. Semi-structured interviews offer the flexibility to allow for follow-up questions, cultural sensitivity and interpretation of the meaning of the phenomena described, making them ideal for exploring diverse and complex issues (Brinkmann, 2014).

The interviews were conducted with three distinct actor groups: local fishers, fish traders and executives from both local and tourist restaurants and hotels. A total of 182 interviews were conducted. With the help of a local interpreter, I was able to conduct the interviews with local fishers, fish traders and local "restaurants". The interpreter translated all my questions and interviewees' responses. Responses were documented, transcribed and later digitally coded for analysis.

Local fishers

A total of 98 interviews with local fishers were conducted across five different villages/landing sites on Zanzibar: Unguja Ukuu (n= 21), Kizimkazi (n= 18), Uroa (n= 18), Nungwi (n= 20) and Mkokotoni (n= 20) (Figure 1). The interviewed fishers were mainly men, and only three female fishers. Firstly, the research project was introduced to the local village chiefs (Sheha). Then, fishers were informed about the study with the assistance of the local translator and the local beach recorder, who is a local monitoring person, appointed by the local village committee. Interviews were conducted upon obtaining consent. The semi-structed interviews included questions on demographics, fishing practices (including catch details, fishing pressure, and fish availability), market sales, personal fish consumption and tourism (see Appendix 1 for details).

Fish traders

In total, 28 fish traders at the different fish markets were interviewed: Unguja Ukuu (n= 7), Kizimkazi (n= 5), Uroa (n= 3), Nungwi (n= 3) and Mkokotoni (n= 10) (Figure 1). The actor group "fish traders" include middlemen (Dalili), fish traders (Wachuuzi), and sales assistants (Karani). These interviews aimed to provide insights into the value chain and to describe the local market, covering topics such as market structure, sales, customers demographics, seafood species, and income (see Appendix 2 for details).

Restaurants and Hotels

Additionally, 53 interviews were conducted with restaurants and hotels: 37 with tourist restaurants/hotels (Stone Town: n= 17, Nungwi: n= 14, Paje: n= 6) and 16 with local "restaurants"/food stands, locally also called Mama ntilie (Stone Town: n= 6, Nungwi: n= 2, Mkokotoni: n= 3, Uroa: n= 1, Paje: n= 4) (Figure 1). Some interviews, particularly in tourist restaurants were held in English without an interpreter, as they often cater international visitors and maintain higher service standards. Interviews with local "restaurants", which usually operate at a more modest standard, required the assistance of an interpreter to overcome language barriers. The interview questions focused on menu offerings, popularity, supply and demand, and availability (see Appendix 3 for details).

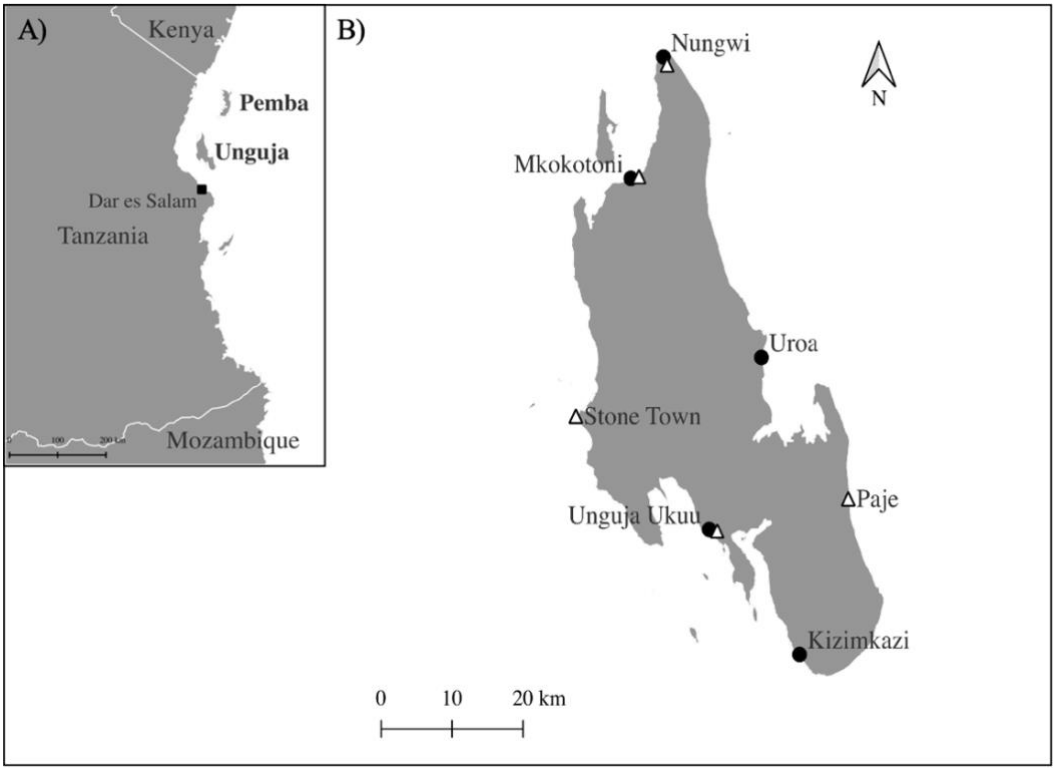

Figure 1. A) Location of Unguja Island (Zanzibar), B) Location of the different sites in Zanzibar where the interviews were conducted. The black dots indicate where interviews with fishers and trader were held, and the white triangle indicate where interviews with restaurants/hotels were held.

2.2.2 Ecological study

The ecological study focused on habitats of the tropical seascape, particularly coral reefs and seagrass beds, in highly fished areas. Cover of benthic habitat-forming organisms and substrates were estimated for each location. This additional observational study aimed to provide insights into the ecosystem, particularly the intertidal zone, to assess its condition. The intertidal zone is a vital fishing ground for SSF because it is accessible to all fishers, including those using low-tech gear.

Its condition plays a crucial role in supporting the food security of local communities. The study sites were aligned with the locations where interviews with local fishers were conducted (Table 1 & Figure 1).

Table 1. Ecological study locations around Zanzibar (Unguja Island).

Location	Geographical data	**Location**	Geographical data
Unguja Ukuu		**Uroa**	
Ukombe	S6° 20.0.26'E39° 14.519'	Shoreline	S6° 04.949'E39° 27.868'
Kwale	S6° 21.740'E39° 16.944'		S6° 05.628'E39° 26.315'
	S6° 18.471'E39° 17.999'		
Kizimkazi		**Nungwi & Mkokotoni**	
Shoreline	S6° 26.250' E39° 27.323'	Mnemba	S5° 46.838'E39° 23.485'
	S6° 26.027' E39° 27.111'	Tumbatu	S5° 46.550'E39° 12.934'
	S6° 25.809' E39° 26.907'		

In total, ten sites were surveyed, with GPS data points collected to mark the location of the sampling areas (Table 1). All sites were at depths ranging from 1.5 to 5 meters. The data was conducted using a 1 m x 1 m quadrat frame, which was randomly dropped from the surface and allowed to settle on the bottom. At each site, 10 to 15 quadrats were places, spaced at intervals of 5 to 10 meters. Once the quadrat had settled, I snorkelled down to photograph it. These pictures were later analysed to estimate the percent cover of bottom substrates, including seagrass, sand, soft corals, macroalgae, hard substrate, coral rubble and live hard coral. If seagrass was present in the quadrat, the seagrass species was identified, and the shoot height was measured. Additionally, coral growth type was assessed, and the three-dimensional complexity of hard corals was estimated. The complexity was categorized as follows: 0= no vertical relief, 1= low vertical relief (<10 cm), 2= some vertical relief (11-30 cm), 3= moderate vertical relief (31-60 cm), 4= high vertical relief (61-100 cm) and 5= very high vertical relief (>100 cm) (Polunin & Roberts, 1993; van Lier et al., 2018)

2.3 Data analysis

Local fish names were translated to common English names with the help of local fishers, a translator and literature (Bianchi, 1985; Froese & Pauly, 2024; Richmond, 2002) (Table 2). Traditional fish names in Swahili are generally not differentiated, in many cases, different taxonomic species within a genus or family are referred to by the same single Swahili fish name (Berlin, 1973). Regarding this issue, the fish taxa were grouped according to family level. Some exceptions were made where

the family level could not be assigned. All species of squid and cuttlefish are represented by suborder, Decapodiformes. All species of lobster, crabs, shrimps and prawns are categorized according to order, Decapoda. It was not possible to determine between different shark species and seashell species, so these two groups are represented as the groups ‘Shark’ and ‘Seashell’. In addition, fish families were categorized as either "coral reef-associated" or "non-coral reef", for the presentation of results, particularly in the graphs. A family is considered "coral reef-associated" if its members live in or feed on coral reefs.

In this study, the research questions were addressed using social-ecological data collection through semi-structured interviews. The ecological study played a minor role, serving only as an additional observation data, however, is included here to acknowledge its contribution to the data collection process.

2.3.1 Fish landings and consumption pattern

The analysing of fish landings was based on the interview results with fishers, focusing on general factors regarding their fishing activities. Data was categorized as described in Section 2.3, with the percentages calculated for both the number of fishers mentioning their catch and the total number of mentioned species to be caught. Additionally, the interviews with local fish traders were also analysed to provide an overview of the different fish markets. For the fish consumption pattern, interview data from fishers regarding their fish consumption, along with data from local and tourist restaurants about seafood species offered, were analysed. The results were presented as percentages, and a bar plot showing the proportions and distribution of fish families consumed by local fishing communities and tourists was created using R Studio.

2.3.2 Tourist’s impact on market demand and fish distribution

To examine this research question, interview results with fishers, specifically from the market section, were analysed. Data were processed following the methodology described in Section 2.3.

2.3.3 Impacts of tourism on local SSF

In this section, the interview results from fishers were used, focusing on fishing activity, fishing pressure, catch preference and overall thoughts of tourism. Fish species data were processed as described in Section 2.3. For qualitative data on fishers’ perceptions of tourism, similar responses were grouped and quantified to provide insights.

Table 2. Local Swahili fish name and their common English translation and scientific family/order name and habitat.

Functional group: Scientific family/ *(sub)*order* name	Local Swahili name	Common English name	Habitat
Piscivore			
Carangidae	Karambisi	Trevally	Coral reefs, pelagic
	Kole Kole	Jack	
Coryphaenidae	Panje	Dolphinfish	Pelagic
Decapodiformes*	Ngissi	Squid, Cuttlefish	Intertidal zone
Istiophoridae	Nduaro	Billfish, including	Pelagic
	Mbase	marlins and sailfish	
Lutjanidae	Janja	Red snapper	Intertidal zone, deeper
	Fuatundu		water
	Gombo		
	Chazanda		
	Numba		
	Mrongo	Grey snapper	
	Sare	Small-toothed jobfish	
Rachycentridae	Songoro	Cobia	Pelagic
Scombridae	Jodari	e.g.:	Pelagic
		Yellowfin tuna	
		Albacore	
		Bigeye tuna	
		Kawakawa	
	Sehewa	e.g.:	
		Longtail tuna	
		Skipjack tuna	
		Frigate tuna	
	Nguru	e.g.:	
		Wahoo	
		Narrow-barred	
		Spanish Mackerel	
		Kanadi kingfish	
	Kibua	Indian Mackerel	
Serranidae	Chewa	Grouper	Coral reefs
	Mjombo		
Sphyraenidae	Mzia	Barracuda	Pelagic,
	Msusa		Coral reefs
Xiphiidae	Sansuri	Swordfish	Pelagic
Invertivore			
Arridae	Fumi	Catfish	Intertidal zone

	Hongwe		
Dasyatidae	Taa	Ray	Intertidal zone
	Nyenga		
Haemulidae	Komba	Sweetlip rubberlip	Coral reefs
	Kui		
	Mchone		
	Mlea		
	Mwewe		
	Pamamba		
Lethrinidae	Changu	Emperor	Coral reefs, Seagrass beds
Muglidae	Mkizi	Mulletfish	Intertidal zone
Mullidae	Mkundaji	Goatfish	Coral reefs
Hebivore			
Acanthuridae	Kangaja	Surgoenfish	Coral reefs
	Puju	Unicornfish	
Labridae	Pono	Wrasse	Coral reefs,
		Parrotfish	Seagrass beds
Siganidae	Tasi	Rabbitfish	Coral reefs, Seagrass beds
Omnivore			
Dorosomatidae	Dagaa	Sardines	Pelagic
Engraulidae	Dagaa	Anchovies	Pelagic
Decapoda*	Kamba-koche	Lobster	Intertidal zone
	Kamba	Prawn	
	Kaa	Crab	
Gerreidae	Chaa	Common silver-biddy	Intertidal zone
Hemiramphidae	Morani	Half-beak	Intertidal zone,
	Mzuza		Pelagic
Carnivores			
Octopodidae	Pweza	Octopus	Coral reefs

2.4 Study limitations

Some limitations emerged during this study, particularly concerning communication during the field studies. Firstly, due to language barriers, there was a reliance on a translator to communicate with local fishers. While the translator facilitated the conversation, there was always a risk that important information may have been lost or misinterpreted in translation. This limited the depth of direct communication with fishers, potentially affecting the accuracy of the data. Additionally, the status of a European being the person doing interviews and cultural differences may have influenced how people responded to certain questions. In some cases, respondents may have provided responses they perceived to be of interest to the interviewer or withheld information out of concern about making an incorrect statement, particularly regarding sensitive topics such as tourism. Some even assumed an affiliation with the government, which likely influenced their willingness to speak openly. This concern even extended to interviews with restaurant and hotel owners, some of whom were cautious in their responses, possibly fearing repercussions. It was not always possible to speak directly with the manager or owner of the restaurant, which may have further limited the data collections process, particularly about the specific fish items purchased.

3. Results and Discussion

3.1 Ecological description of the intertidal zone of study sites

Observations (n= 42) across all study sites showed that the highest percent of the bottom substrate consisted of macroalgae, covering nearly 30 percent of the total studied area, followed by hard corals covering an average of 20 percent and exhibiting a low vertical relief (median complexity of 1, <10 cm). Seagrass made up 17.5 percent present, mainly of the species of Thalassodendron ciliatum (55 %; median shoot height 47.5 cm), Thalassia hemprichii (21 %; median shoot height n/a), Cymodocea rotundata (16 %; median shoot height 16 cm) and Syringodium isoetifolium (7 %; median shoot height 11 cm). Soft corals covered an average of 10 percent. This additional observational data provides context for the ecological structure of the intertidal zone and the understanding of the shallow Zanzibar seascape.

3.2 SSF demographics: median monthly working time, age, gear, substrate

Most interviewed fishers were men (except for three women), as women, due to cultural reasons, primarily harvest invertebrates and small fish in the intertidal zone (intertidal gleaning) rather than engaging in fishing from vessels (Fröcklin et al., 2014; Harper et al., 2013; Lindström & de la Torre-Castro, 2017; Nordlund et al., 2010). According to the interviews, the fishers spent a median number of 25 years in fishing (ranging from 1-60 years) and worked a median of 22 days per month (ranging from 1-31 days). Working days varied by site, with in Unguja Ukuu 16.5 days and the most in Uroa and Nungwi, which were almost 10 days longer. Twenty-nine percent of fishers had no other occupation besides fishing, while others engaged in agriculture (38 %), tourism (8 %), and fisheries-related activities like trading or processing (8 %) (n= 98). The most commonly used fishing gear were gill nets (4-16 inch) (46 %), followed by handlines (45 %), smaller-sized nets (0.1-4 inch) (32 %), spears (14 %), longlines (13 %), basket traps (11 %), fishing rods (6 %) and beach seines (3 %) (n= 98; multiple answers per fisher were accounted, as some fishers use different gear in different locations and during different season that they fish). The number of beach seines recorded is probably higher than stated, as it was difficult to determine the use of beach seines due to their illegal status. Forty-four percent of all fishers fished in the intertidal zone, and 35 percent preferred deeper waters but still within 12 nautical miles from the coast (n= 98). Twenty-one percent of the fishers used both intertidal and deeper water as their fishing grounds (n= 98). In the intertidal zone, the main fished substrates as

mentioned by the fishers, were mixed areas with coral reefs and seagrass beds (47 %), rocky reefs (40 %), seagrass beds and sand (both 39 %) and coral reefs (29 %) (n= 98; multiple answers per fishers were recorded as fishers use multiple substrates to fish on). Reasons for fishing in deeper waters were mainly gear dependent (26 %) and according to their fish target group (23 %) (n= 98, multiple answers allowed). Whereas the intertidal zone is used because of high fish abundance (52 %) as well as gear dependency (40 %) (n= 98, multiple answers allowed). The main boat types used at all sites were fibres (36 %) and dhows (bigger wooden boats) (33 %). Other boat types also mentioned were ngalawas (canoe with outriggers for support) (17 %), mtumbwi (dugout canoe) (6 %), and plastic canoe (2 %), while 5 percent did not use a boat at all (n= 98).

3.3 Fish landings

The interview results about usual catches showed that tuna-like fishes (Scombridae) were the most caught species, which were mentioned to be caught by more than every second fisher (63 %). The second most mentioned were emperors (Lethrinidae), at 49 percent (Figure 2 A). In Figure 3 the frequency of species mentioned was considered, showing that tuna-like species (Scombridae) were almost twice as often mentioned to be caught than the second most mentioned species of emperors (Lethrinidae). The Scombridae family is a pelagic group and includes commonly caught species such as kingfish (Nguru, 31 %), larger tuna (Jodari, 31 %), smaller tuna (Sehewa, 25 %), and mackerels (Kibua, 13 %) (n= 127). However, these species varied significantly between study sites, with lower representation in Unguja Ukuu and Uroa compared to Nungwi, Mkokotoni, and Kizimkazi. In Unguja Ukuu, higher trophic level pelagic species were not commonly mentioned as part of the usual catch. The spatial differences in catch composition can be attributed to two main factors: firstly, the use of mainly low-tech gear by fishers in these areas, and secondly, the geographical location of the fishing grounds. Unguja Ukuu, located in Menai Bay, features a tropical seascape of coral reefs, seagrass beds, rocky reefs, and mangroves (Punwong et al., 2013). This environment provides more accessible fishing opportunities for low-tech gears in the intertidal zone, whereas the pelagic zone further offshore is more challenging to reach and requires more advanced equipment. In contrast, Nungwi and Mkokotoni are situated near the Pemba Channel, which is known for its abundance of species such as mackerel (Scombridae), tuna (Scombridae), billfish (Istiophoridae), dolphinfish (Coryphaenidae) and sardines and anchovies (Dorosomatidae & Engraulidae) (Sekadende et al., 2020). The Pemba Channel, which separates Unguja Island and Pemba Island and reaches up to 800 m depth, serves as a critical conduit between the open ocean and coastal ecosystems (Sekadende et al., 2020). The daily sales across fish markets indicated what fish species were generally being landed. The market sales also reflected the spatial

differences. According to the middlemen working in local markets, in Unguja Ukuu, the average daily sales reached around 400.000 TZS (150 USD), while Uroa market sales averaged around one million TZS (357 USD). One factor explaining this could be that these markets primarily sell lower trophic fish, mainly from the intertidal zone and with larger pelagic fish being less common. In contrast, Nungwi and Mkokotoni reported much higher daily market sales, averaging 2.5 million TZS (940 USD) each. During high tourist season, sales in Nungwi have reached between 10 to 15 TZS (3760 – 5640 USD), while Kizimkazi had an average daily sale of 1.7 million TZS (640 USD), to about 6 million TZS (2250 USD) in high season. The higher sales in these markets suggest greater fish quantities, but more likely it reflects the sale of larger, higher-trophic level pelagic species, which tend to bring in higher prices. (All market sales at the different locations represent the sale average for the whole market, market size was not analysed here).

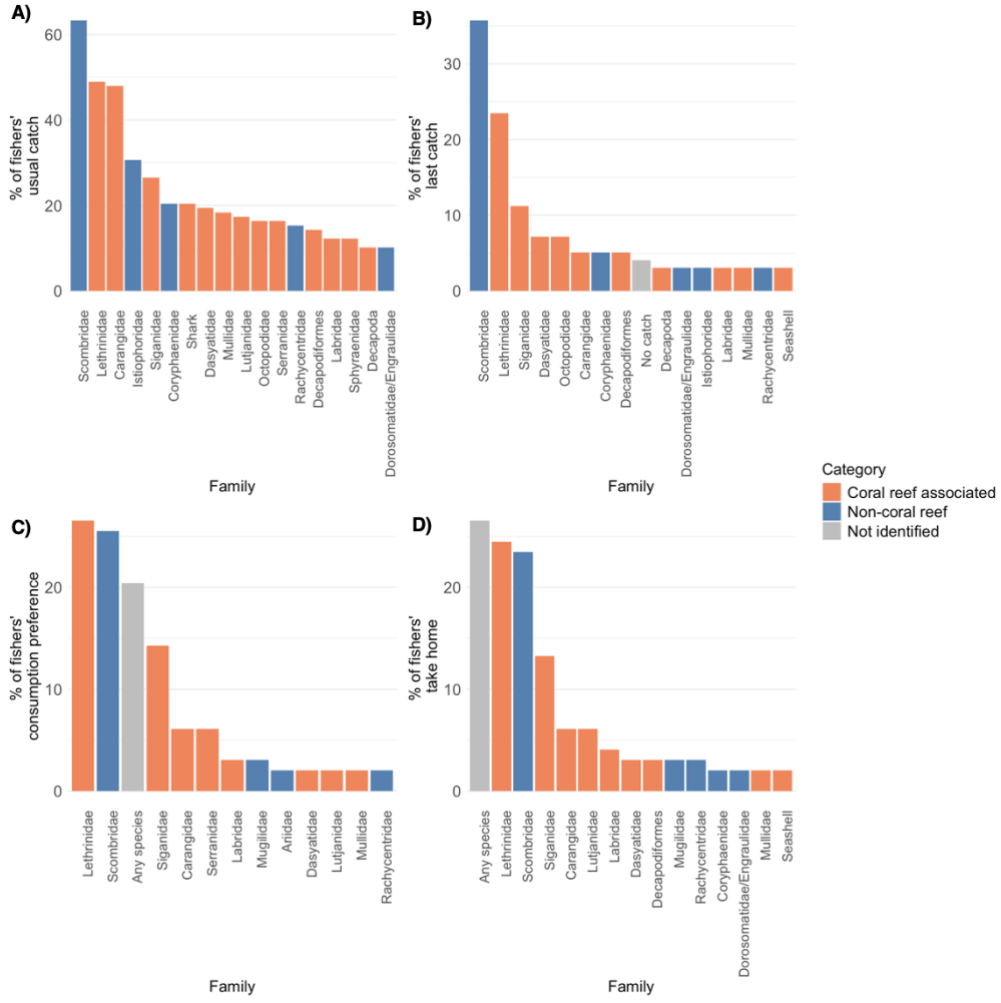

Figure 2. A) Percentages of the total fishers' usual catch, B) Percentages of the total fishers' last catch, C) Percentages of the total fishers' consumption preferences and D) Percentages of the total fishers' catch they take home. In all figures, all sites combined and divided into families. All plots show data in percent of fishers mentioning n= 98; multiple answers allowed. Only data are shown as follows: A) over ten percent, B) over three percent, C) and D) over two percent.

The Scombridae family was mentioned by the highest percentage of fishers, both in the usual catch (63 %) and in the last catch (36 %) (Figure 2 A-B, Figure 3). Tuna-like species (Scombridae) are pelagic, occupying deeper waters away from coral reefs. Their prevalence in catches might also relate to the high use of gill nets among the respondents (46% of total fishing gear used), which are well-suited for these deeper habitats. Gill nets are particularly more suitable for deeper waters, as coral reefs cannot destroy them and are generally more effective for catching pelagic and mobile fish species, as of the Scombridae family. Fishers target these species due to their larger size and higher trophic level, maximizing catch biomass and making fishing trips more efficient and profitable. They also hold considerable value, as they are popular in tourist restaurants.

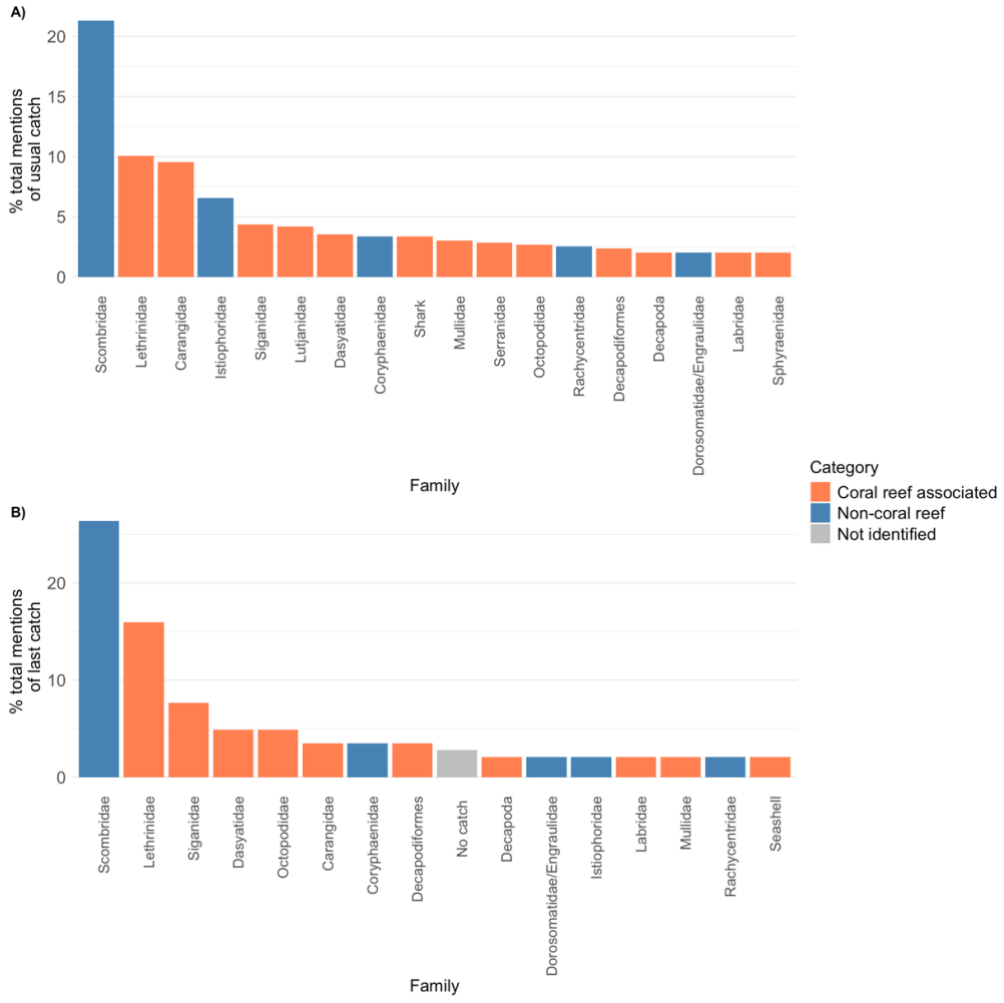

Figure 3. A) Fish families usually caught (in % of all the total number of mentioned species, n= 596), B) Fish families lastly caught (in % of all the total number of mentioned species, n= 144). All sites combined and divided into families in all figures. In all plot only data over two percent is shown.

Coral reef species such as emperors (Lethrinidae), rabbitfish (Siganidae), and jacks (Carangidae) also contributed significantly to both the usual and the recent catches

(Figure 2 A-B, Figure 3). Coral reef species are likely targeted due to their proximity to shore and availability in coral reefs and seagrass beds, making them more accessible to fishers with more traditional fishing gears like handlines, smaller-sized nets, spearing, and basket traps. Most fishers do not have access to higher technology gear and cannot afford to pay off bigger loans to buy better gear and vessels (MoBEF, 2022; Wallner-Hahn et al., 2016).

3.4 Fish species consumption by local fishing communities vs. tourists

Fish is a crucial part of fishers' diets, with 96 percent reporting that they eat fish daily (n= 98). When catches were low, or they could not catch anything, some fishers bought fish at the market or from other fishers for their own consumption. Regarding fish preferences, 27 percent of fishers indicated a preference for emperors (Lethrinidae) (Figure 2 C). This suggests that emperor species are highly valued for local diets, likely due to their taste and ease of preparation. Also, the tuna-like species (Scombridae) were mentioned to be consumed by 26 percent of all fishers, as well as for taken home by 23 percent (Figure 2 C-D). However, the species mentioned to be consumed were mainly smaller-sized individuals of kingfish, tuna and mackerels. In general, smaller-sized fish species were preferred in consumption preference and for take-home. Reasons for taking species home included mainly a “good taste” (43 %), “catch dependent” (30 %), “nutritious value” (5 %) and “bigger sized fish only for the market” (5 %) (n= 98, multiple answers allowed).

Coral-reef molluscs such, as Octopus (Octopodidae) and squid (Decapodiformes), represented a minor proportion of usual catch and last catch, with negligible representation in consumption preference and take-home catch of fishers (Figure 2, Figure 3). This might be due to their higher commercial value, as octopus and squid are often sold at higher prices, particularly to the tourism sector (Crona et al., 2010). The lower catch frequency for molluscs might also reflect the difficulty in harvesting these species compared to finfish. Harvesting molluscs like octopus and squid is more challenging due to their behaviour of hiding in crevices or burrowing into the seabed, requiring labour-intensive methods such as hand-collection or diving, and squids’ migratory nature often demands specialized gear and fishing at night (Arkhipkin et al., 2021; Oliver et al., 2015). However, overfishing, particularly octopus, may also be a reason for lower catch rates (Silas et al., 2022). The annual octopus catch in Tanzania and Zanzibar increased steadily from the late 1950s, peaking at 573 tonnes in 2003 before declining to 340 tonnes by 2017 (MLF, 2018; Sauer et al., 2021). According to the fisheries regulations, only octopuses above 500 g weight are allowed to be caught; however estimating size and weight underwater is challenging, making this guideline largely voluntary (MLF, 2009). Additionally, the size restriction does not correspond to increasing

fishing efforts, particularly after an octopus closing season (O'Neill et al., 2023; Silas et al., 2020, 2021).

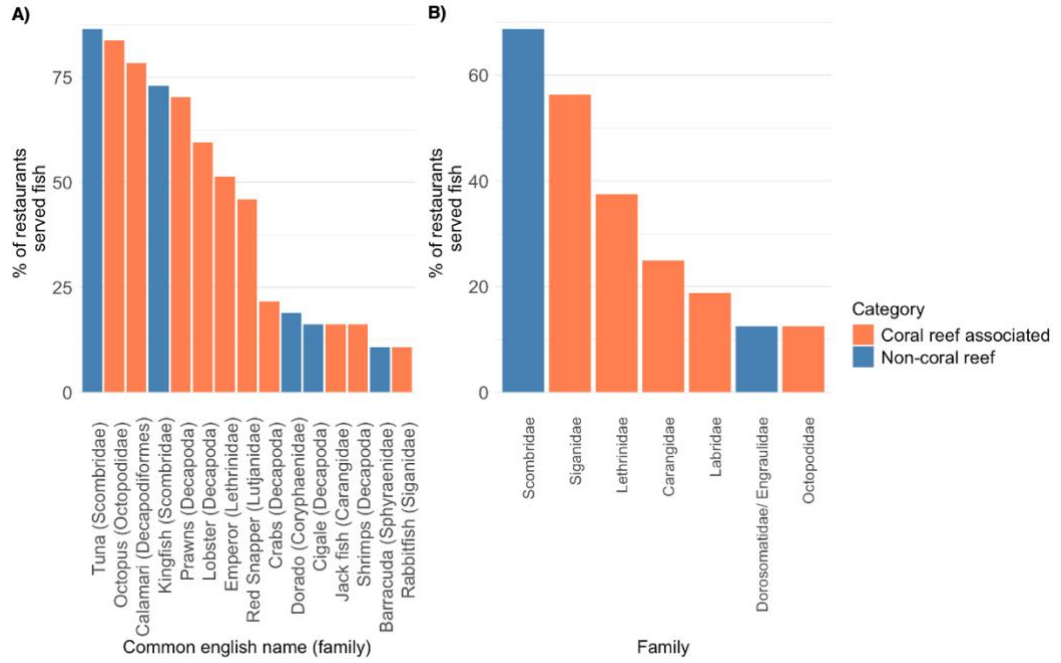

Figure 4. A) Percentage of the total restaurants' mentioned seafood to be offered in tourist restaurants seafood (in % of restaurants, n= 37), B) Percentage of the total restaurants' mentioned seafood to be offered in local "restaurants" (in % of restaurants, n= 16). Multiple answers allowed and all plots only show data over ten percent.

Figure 5. Fish and seafood display at a tourist restaurant in Nungwi. From the left: kanadi kingfish (Scomberomorus plurilineatus), dolphinfish (Coryphaena hippurus), snapper,emperor, squid, slipper lobster, prawns, rocky lobster, octopus. Photo by Lödel, M.

Regarding the fish and seafood species that were offered in restaurants or food stalls, the species most frequently served in tourist restaurants were tuna-like species (Scombridae) and invertebrate species like octopus (Octopodidae), squid

(Decapodiformes) and prawns and lobster (Decapoda) (Figure 4 A). The fish species listed on the different food menus were found to correspond closely with the species mentioned by the interviewees. However, it was observed that fish dishes on the restaurants' menus were often presented as "white fish fillet", "whole fish", or "catch of the day". Accordingly, it was more accurate to present to the species mentioned to be served by the interviewees and not which seafood was written down on the menu. The most popular species amongst tourists were found to be species like tuna (41 %) and kingfish (38 %) (Scombridae) as well as coral reef species such as emperors (16 %) (Lethrinidae) and Octopus (16 %) (Octopodidae) (n= 37, multiple answers allowed). The managers/ owners/ waiters interviewed mentioned that the popularity is based on good taste, less bones, well-known species worldwide and high availability. Other studies have also shown that hotels prefer specific species, especially larger pelagic fish, as well as shellfish like octopus, squid, crabs, and lobster (Crona et al., 2010; Gössling, 2003; Ndarathi et al., 2021; Pedersen, 2024; Sauer et al., 2021; Thyresson et al., 2013). Besides the popular local species, many tourist restaurants offered imported species like salmon from Norway or freshwater fish like Nile perch from the mainland of Tanzania.

The local "restaurants" investigated in this study were informal eateries operated by local women, often referred to as "Mama ntilie". These establishments are commonly situated in proximity to fish markets and offer a range of food items, often prepared and sold from improvised stalls equipped with basic seating, such as plastic chairs or wooden benches. The meals are usually rather simple, serving rice with fish or soup with a piece of fish. The species most often mentioned to be served are of the Scombridae family (Figure 4 B), including Indian mackerel (39 %), larger tuna species (33 %), and kingfish species (22 %) (n= 18, multiple answers allowed). The most popular fish among the guests within the Scombridae family was the Indian mackerel, also known as Kibua in local Swahili. This popularity may be the result that the fish is sold as a whole fish at a low price point of 1000 TZS (0,37 USD), compared to rice/soup with fish for 2500-5000 TZS (1,05-2,10 USD). The Indian mackerel is a species that is not sought after by tourists and is, hence, primarily consumed by locals. However, more valuable species, such as larger tuna species (yellowfin tuna) and kingfish, were also frequently served in local "restaurants". Local Mama ntilie have mentioned that it is better to use these species, as individual pieces remain whole in the soup when you cook it. Unlike the Maldives, where tuna fishing has a long history, in Zanzibar, these species have not traditionally been primary fish species to local diets (Yadav et al., 2021). Historically, SSF in Zanzibar targeted reef-associated species, such as emperors (Lethrinidae), snappers (Lutjanidae), groupers (Serranidae), and rabbitfish (Siganidae) which are abundant in the intertidal zone (Jiddawi & Öhman, 2002). However, in recent years, the consumption of tuna has increased, largely driven by the growth of artisanal and industrial fishing, improved fishing technology and

access to offshore fishing areas (Leroy et al., 2016; Lindström & de la Torre-Castro, 2017). The rise of tourism might also have influenced local markets, as there is a high demand for tuna by restaurants (O'Neill & Crona, 2017; Pedersen, 2024; Ratusinski, 2023; Thyresson et al., 2013). Despite the rise in pelagic species, reef-associated species, such as rabbitfish (Siganidae) and emperors (Lethrinidae) remain central to local diets due to their smaller size, affordability, and taste (Figure 4 B, Figure 6 B) (de la Torre-Castro & Rönnbäck, 2004; Jiddawi & Öhman, 2002). These preferences align closely with fishers' taken-home species (Figure 6). However, fishers also often take any available species, depending on the day's catch, resulting in broader species diversity (Figure 6).

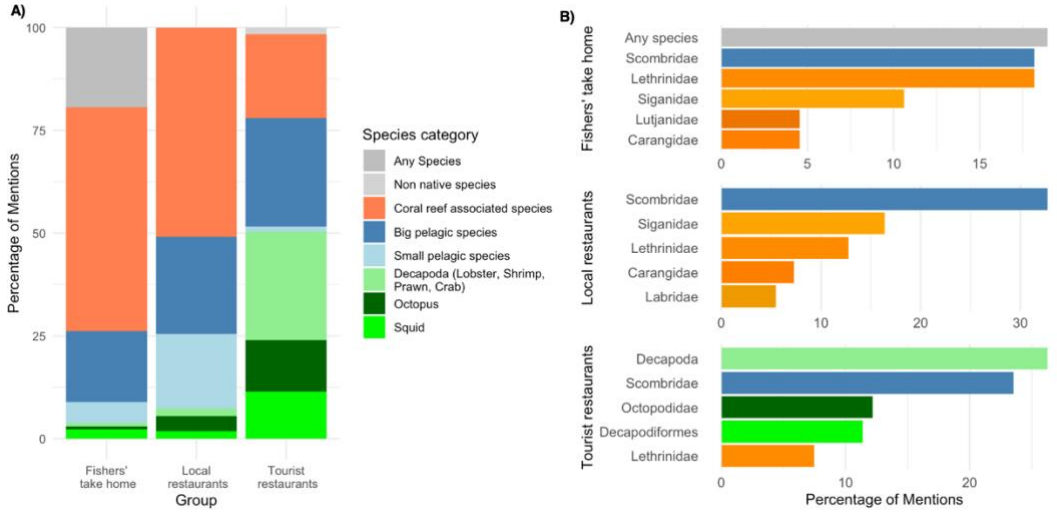

Figure 6. A) Seafood group proportions of the total number of mentioned species which fishers' take home (n= 134 mentions), are served in local "restaurants" (n= 55 mentions) and served in tourist restaurants (n= 254 mentions), B) Top five percent of the total number of mentioned species within each respondent groups (fishers' take home: n= 134, local "restaurants": n= 54, tourist restaurant: n= 261) (blue-coloured bars= pelagic species, orange-coloured bars= coral reef associated species, green-coloured bars= shellfish species).

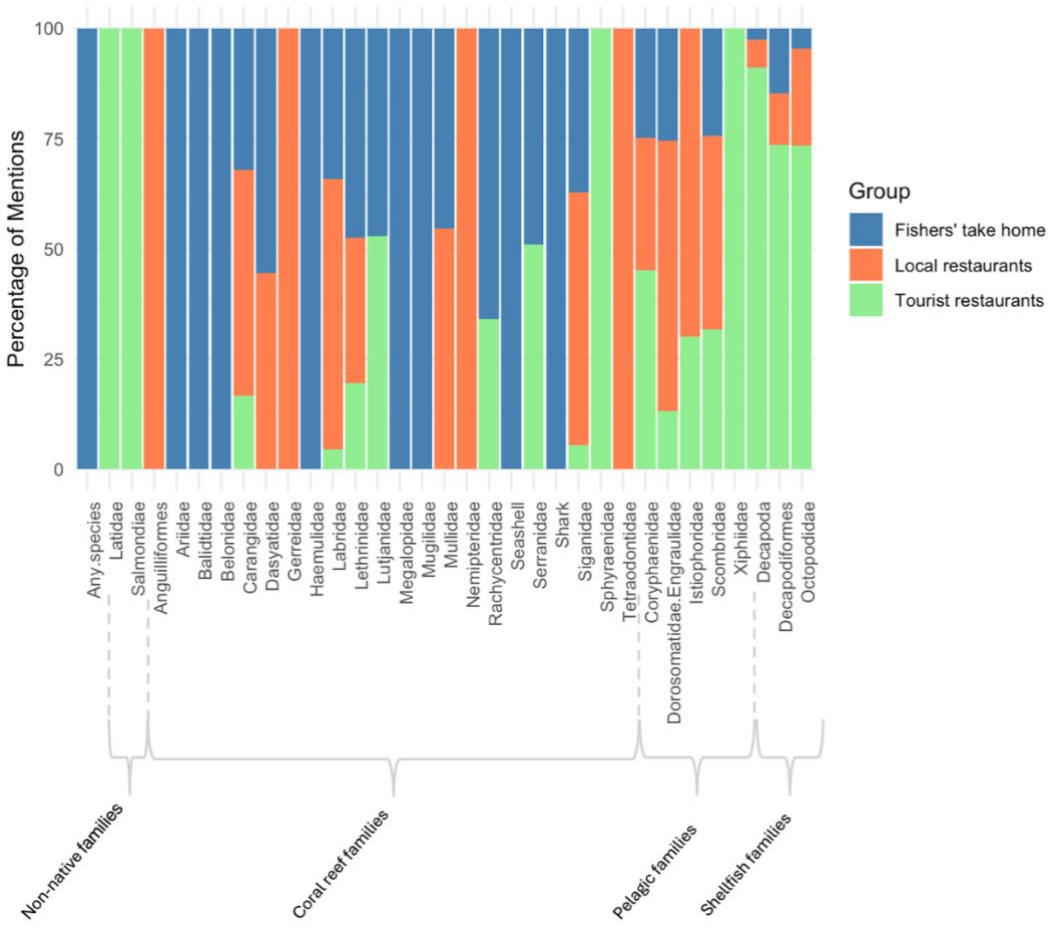

Figure 7. Contribution of each group to the total number of mentions for each family/ order (fishers' take home: n= 134, local restaurant: n=54, tourist restaurant: n= 261).

Interestingly, shared consumption patterns emerged among locals and tourists, particularly for tuna-like species (Scombridae), emperors (Lethrinidae), snappers (Lutjanidae), and jacks (Carangidae) (Figure 7). Still, some key differences were also present. A clear size-based distributions was evident, as bigger-sized, higher-priced fish are primarily purchased by tourist restaurants or wealthier people, while smaller-sized, more affordable fish are typically bought by the average local consumer (Thyresson et al., 2013). Additionally, tourist establishments predominantly feature high-value species, such as lobsters, octopus, and squid, while locals usually cannot afford these premium items (Figure 6, Figure 7). However, the increasing overlap in species preference might lead to competition between locals and the tourist sector. While the average locals' seafood consumption highly depends on the budget on hand, whereas tourist businesses are not as sensitive to fluctuating and higher prices (Gössling, 2003). As prices rise, locals may be forced to seek cheaper alternatives if they can no longer afford the fish they prefer. One fisher mentioned a notable shift in trade and consumption over the past 50 years. He explained that while species like moray eels were previously not consumed, today, nearly all types of marine life are sought after to meet the

growing demand, including moray eels. This trend highlights how resource competition and economic pressures are influencing and changing local diets and cultural preferences in coastal communities.

3.5 Tourism's influence on market demand and distribution of locally fished species

The Scombridae family was mentioned to be the top seller, delivering the highest value and economic benefit for fishers (Figure 8). This aligns closely with both the usual catch and the last catch (Figure 2 A-B, Figure 3), underscoring its market importance. Emperors (Lethrinidae) were mentioned to be the second most sold species by fishers and were also declared to be the most valuable and economically important coral reef fish for fishers (Figure 8). Beyond their essential role in local diets, emperors are also among the most valuable coral reef fish in the tourism sector, representing a significant income source for fishers (Figure 4). However, there is a distinct size distribution of the fish, whereby larger emperors are directed towards the tourism market, while smaller or even undersized juvenile fish are sold in the local market or even directly to local women at the beach (Figure 12) (Thyresson et al., 2013). The juvenile fish catch usually does not enter the auction at the local market. It can be assumed that the local people are aware that fish that are very small are not allowed to be caught (Fisheries Act, 2010 (No. 7 of 2010)) or simply that the value of these fish on the market is so low that they are only taken for home consumption. Emperors are highly abundant in coral reefs and seagrass beds, where they are targeted by a variety of fishing methods, including basket traps, which neither require high-tech gear nor specialized vessels. However, their reproduction is rather slow, taking up to eight to nine years to reach maturity, compared to rabbitfish, which mature within two years (SPC, 2017). Another study also confirmed that emperors are popular among both tourists and locals, making their management challenging (Thyresson et al., 2013). There is a demand across all life stages of this species, from juveniles to adults, which adds complexity to sustainable harvesting, as the demand may outpace the reproductive capacity of emperor populations, impacting long-term sustainability. Additionally, emperors spend different life stages in different habitats: juveniles are found in shallow seagrass and macroalga areas, and adults in deeper reef areas, which complicates effective management, as it requires consideration of multiple habitats at different life stages (Fulton et al., 2020; Unsworth et al., 2009).

Billfish (Istiophoridae) are also highly represented (31 %) in the total usual catch (Figure 2 A) and made up a relatively high percentage of those fish that were most sold, most valued and most economically important to fishers (Figure 8). However, they were rarely mentioned in the total last catch (Figure 2 B), which might indicate that their availability is becoming rarer, but they still are a preferred target. Due to their relatively high price, they are less attractive to tourist restaurants and

unaffordable for locals (Table 3). In contrast, rabbitfish (Siganidae) achieved high sales, but the profit appears to be relatively low (Figure 8 A-B, Table 3), suggesting a market primarily operating at local level. In general, the pricing of the different fish species is very dependent on factors like seasonality, size, and availability. Certain species are more abundant during specific monsoon seasons, such as during Kazkazi (November – March), more species of Indian mackerel, and during Kuzi (March – October), more species of kingfish.

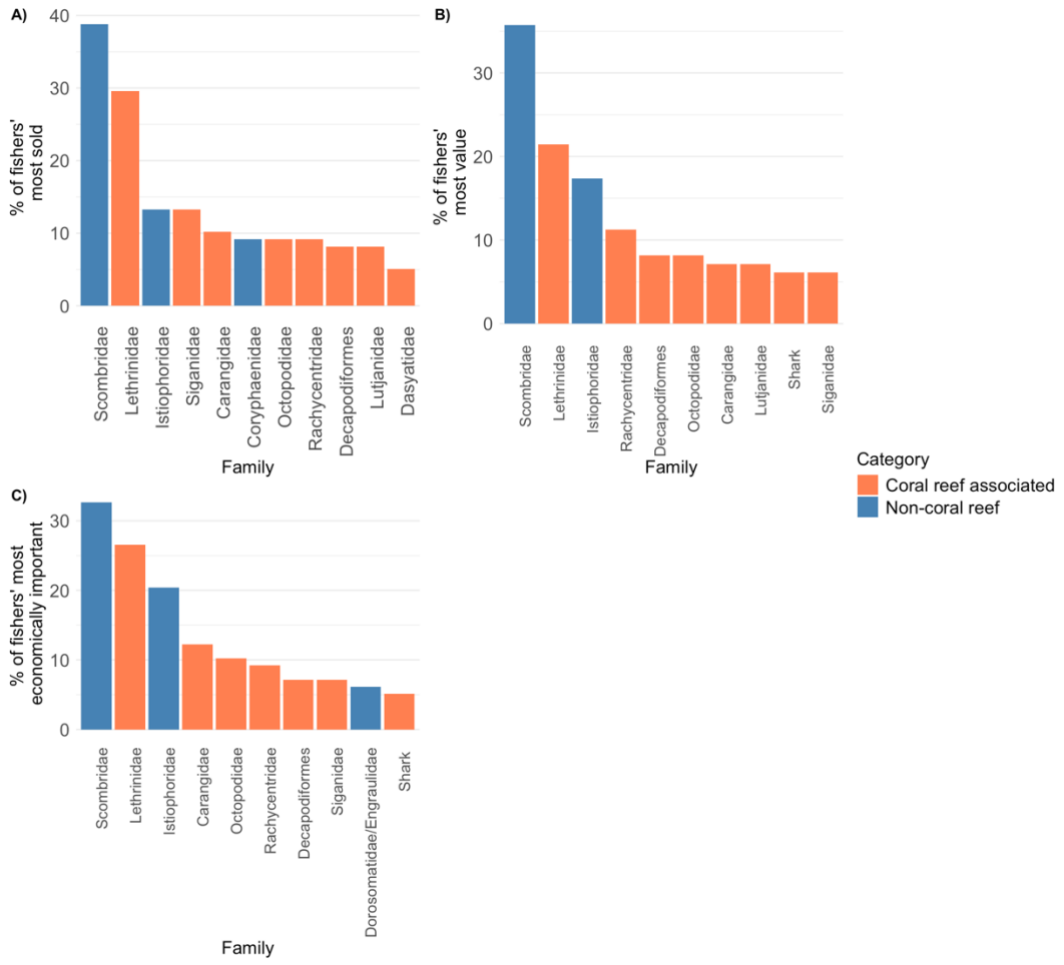

Figure 8. A) Percentages of the total fishers' most sold species, B) Percentages of the total fishers' most valuable species) and C) Percentage of the total fishers' most economically important species for themselves. In all figures, all sites were combined and divided into fish families. All plots show data in percent of fishers mentioning n= 98, multiple answers allowed. All plots only show data over five percent.

Table 3. Median prices that fishers receive for different fished families.

Family	**Price (Median)**		
Scombridae (Does not include species of mackerel)	90 USD (250,000 TZS) Big size fish	25 USD (67,500 TZS) Medium size fish	13 USD (35,000 TZS) Small size fish

Istiophoridae	367 USD (1 mil TZS) per fish
Rachycentridae	83 USD (225,000 TZS) per fish
Lethrinidae	32 USD (85,000 TZS) per group
Siganidae	13 USD (35,000 TZS) per group
Lutjanidae	20 USD (55,000 TZS) per group
Carangidae	30 USD (80,000 TZS) per group
Octopodidae	3 USD (8,500 TZS) per kg
Decapodiformes	3,80 USD (10,000 TZS) per kg

Most fish caught by SSF is primarily sold in local markets via daily auctions managed by so-called "Dalali" in Swahili (middleman), employed by the local villages. There are also self-employed middlemen and direct sales conducted by fishers, mainly at the beach. Most fish are sold to fish traders, who then continue selling the product to hotels, restaurants, local consumers, etc. Ninety-three percent of the fishers stated that the end consumers of their fish are locals, 83 percent of the end consumers are tourists, and only three percent was stated to be exported (n= 98, multiple answers allowed). It is important to note that fishers rarely sell directly to customers, they often determine whether the fish is destined for locals or tourists based on the buyers present at the auctions.

The high demand from the tourism sector drives market trends and indicates how much impact tourism has on SSF, including what is fished, how much is fished, and price fluctuations. The numbers of tourists in Zanzibar vary between low (March – May) and high season (June – October), which impacts the market demand and the price of fish. For instance, one fisher mentioned that during the tourist season the price of squid/cuttlefish is 10,000 TZS (3,70 USD)/ kg, and during off-season it drops to 7,000 TZS (2,60 USD)/ kg. Another fisher stated that he has no intention of consuming caught squid, given that the sale of the squid is his primary source of income. Consequently, economically valuable species like squid/ cuttlefish and octopus are now rarely consumed by locals today, despite their historical importance as an affordable protein source as they could be collected near shore during low water spring tides only using wooden sticks or spears (De la Torre-Castro, 2006; Jiddawi & Öhman, 2002; Raberinary & Benbow, 2012). Octopus

fisheries have traditionally been managed by women, as they typically fish by foot, mainly in the intertidal zone (Berrío-Martínez, 2022; O'Neill & Crona, 2017; Porter, et al., 2008; Westerman & Benbow, 2013). However, the increased demand for octopus and the associated higher income with it, has led to the involvement of male fishers, who are able to access deeper waters and use free diving techniques to catch larger octopus (Benbow et al., 2014; Guard, 2009; Rocliffe & Harris, 2016). Consequently, the increased presence of fishers in the same fishing grounds has led to increased fishing pressure, which has resulted in a decrease in size and number of octopus (Slade et al., 2019). According to one female fisher interviewed in this study, who only fishes by foot, it is increasingly challenging to find octopus, and the individuals have decreased in size. Furthermore, as a popular component of tourist restaurant menus, it has resulted in changes to how it is distributed between locals and tourists (O'Neill et al., 2023). Regarding the fishers' statement of high local consumption of SSF catch, is that not all fishers have the resources to fish the species that are in demand from tourists and/or to meet the high standards set by tourist restaurants and hotels, such as size and hygiene. After all, fish still seems to be the cheapest and most available source of protein for locals and is most likely not replaced by meat since it is more expensive (Gössling, 2003; IUCN, 2020; van der Elst et al., 2005; Walmsley et al., 2006; WIMOSA, 2023). However, given the complexity and the lack of transparency in the entire value chain, fishers are unlikely to know who the final consumer of their fish is, whether it is locally distributed or ends up on the tourist market.

Figure 9. Different catch observed at different fish markets, categorized by families/common English name: A) Unguja Ukuu: Lethrinidae, Lutjanidae, Scombridae, Octopodidae, B) Unguja Ukuu: Dasyatidae, Aetobatidae, Rhinidae, C) Uroa: Octopodidae, Labridae, Haemulidae, Mullidae, Fistulariidae, Siganidae, D) Unguja Ukuu: Lethrinidae, Serranidae, Labridae, Siganidae, E) Kizimkazi: Octopodidae, Scombridae and F) Nungwi: reef sharks* and Xiphiidae. For more species observed at fish markets, see appendix 4 (Table 4). Photo by Lödel, M.*

Almost all fishers (92 %) have confirmed that they have seen an increase in demand (n= 98) as the demand is higher than the catch. According to the fishers, population growth and increasing tourism are the main reasons for the increased need. Between 2012 to 2022, Zanzibar's population grew by nearly 45 percent, increasing by over 500,000 people from 1.3 million to 1.89 million (URT, 2022a). The rapid growth, driven by higher fertility rates, improved healthcare, and internal migrations for economic opportunities, particularly in the tourism industry, has significantly impacted the island's socio-economic and environmental systems (OCGS, 2021a; URT, 2022b). Combined with the raising influx of tourists, this population boom has placed significant pressure on Zanzibar's marine ecosystem and strained its limited infrastructure (Gössling, 2001a; Hugé et al., 2018; Lange, 2015; NBS, 2018). For example, one fish trader from Nungwi said: "I have to go to the mainland to buy fish from Tanga, Mafia Island, or Pemba Island since there is not enough fish on Zanzibar. Sometimes I get the freshwater fish 'Tilapia' from Dar es Salaam because there is not enough marine fish available, so I need to buy freshwater fish to meet the demands". In conclusion, the marine and social-ecological system of Zanzibar is experiencing considerable stress due to the increased demand for fish and seafood resulting from the rise in population and tourists. Particularly, the increased tourism demand leads to instable and higher fish prices on specific species.

3.6 Exploring if tourism is impacting local small-scale fishers and fishers' perception of and benefits from tourism

As tourism grows along Zanzibar's coast, its influence on local SSF becomes increasingly relevant. Fishers' livelihoods and perceptions offer crucial insights into ways tourism may be shaping fishing practices and local community dynamics. For instance, a majority of the fishers (85 %) reported high fishing pressure (n= 98), although they noted season variations. Nevertheless, many fishers associated this pressure primarily with the growing number of fishers in the area, driven by limited alternative employment opportunities, leaving coastal populations dependent on fishing for an income. A local fisher in Nungwi stated that approximately 90 percent of the male population in the area is engaged in fishing activities. Additionally, the fishers noted that the high numbers of fishers have led to increased competition, particularly between those with more advanced equipment, like high-tech gear and better vessels. In fact, fishing vessels have doubled from 4,129 in 2003 to 7,919 in 2020 (WIMOSA, 2023). The availability of improved equipment and vessels enables fishers to venture into deeper waters, and in general, to target more species that are in demand by the tourism industry. At the same time, fishers shared varying perceptions of fish availability in the ocean: 50 percent described it as low, 20

percent as medium, and 30 percent as high (n= 98), often influenced by seasonal changes and ocean conditions. Concerning the open question about perceived changes in their fishing activity, 78 percent of the fishers had experienced changes (n= 98), including reduced fish catches (46 %, n= 81), linked to an increase in the number of fishers, the use of illegal fishing gear and advanced vessels. Fishers also identified changes in price as key issues. They reported receiving a higher price for fish but noted a reduction in catch per individual. Another study corroborates the increased fishing efforts and intensified fishing activity in response to the high demand from the tourism industry (John et al., 2016).

Most fishers implied a catch preference for tuna-like species (Scombridae) and emperors (Lethrinidae) (Figure 10), which align with both local and tourist consumption patterns (Figure 4, Figure 6). Preferred tuna-like species included species of kingfish (Nguru, 36 %), and bigger tuna species like yellowfin tuna (Jodari, 28 %) and smaller tuna species like skipjack tuna (Sehewa, 24 %) (n= 59, multiple answers allowed). However, the other species mentioned to be a catch preference by fishers, like rabbitfish (Siganidae), stingrays (Dasyatidae), and sharks (Figure 10), seem to align more with a local consumption pattern (Figure 4, Figure 6, Figure 7). Sharks continue to be the preferred catch due to their contributions to fishers' and local communities' economic and nutritional security, with the meat consumed locally and the high-value fins often dried and exported (Barrowclift et al., 2017; Marshall & Barnett, 1997; Temple et al., 2024). As already mentioned, billfish (Istiophoridae) and octopus (Octopodidae) are highly valuable species for SSF (Table 3). In general, fishers cited market demand (40 %), gear compatibility (38 %), and ease of catching (15 %) as reasons for their species preferences (n= 98; multiple responses allowed).

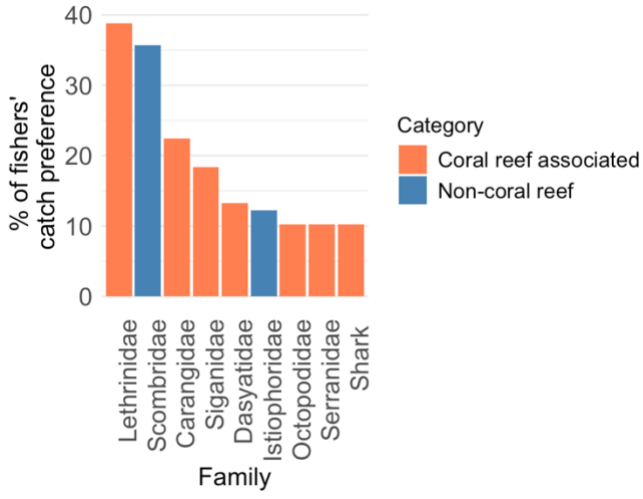

Figure 10. Percentages of the total fishers' catch preference (in % of fishers mentioning n= 98), all sites combined and divided into families, multiple answers allowed. Graph only shows data over ten percent.

As previously stated in section 3.4, Scombridae and Lethrinidae were the preferred families by both the local population and tourists. This overlap puts a high demand, and hence, high fishing pressure on these species, resulting in increased prices with an increased disadvantage to locals who have less spending capacity. A potential source of conflict may arise between the local communities and the hotels/restaurants. Some Mama ntilie of local "restaurants" mentioned that the fish

they offer depends on their budget constraints. They also highlighted a high level of competition with hotels, which at times results in the inability to afford fish due to the lack of profitability. In general, hotels prefer to purchase whole fish, such as adult tuna and kingfish species, whereas local Mama ntilie only purchase pieces of the fish or fish of lower market value, such as Indian Mackerel. For species of emperors, tourist restaurants seem to be more interested in bigger-sized individuals, whereas locals mainly tend to buy or consume smaller-sized fish (this study; Garcia Rodrigues & Villasante, 2016; Mitchell, 2012; Thyresson et al., 2013). Additionally, invertebrate species like prawns, lobster, shrimp, squid and octopus are highly sought after by tourists and rarely consumed by locals (Gössling, 2001; Gössling et al., 2004). It is evident from the results of this study that the tourism industry is greatly responsible for the elevated price of fish and the instability of the market prices. From the perspective of the SSF, there is an increase in profitability due to increased prices, but generally a perceived decline in catches (this study; John et al., 2016). Seventy-two percent of fishers (n= 89, multiple answers allowed) mentioned to be benefiting from higher prices of fish due to tourism (Figure 11). However, the price of fish is dependent on several factors, including the species, size, and level of freshness, as well as the demand from tourism restaurants. It is also the case that fishers who are not so well equipped and do not have the possibilities to fish species demanded by tourists also make important contributions to the local market and local fish consumption. These catches include mainly coral reef species such as rabbitfish (Siganidae), groupers (Serranidae), parrotfish, and wrasse (Labridae) and other species like rays (Dasyatidae) or even small pelagic fish such as sardines/anchovies (Dorosomatidae/ Engraulidae) and mackerels (Scombridae).

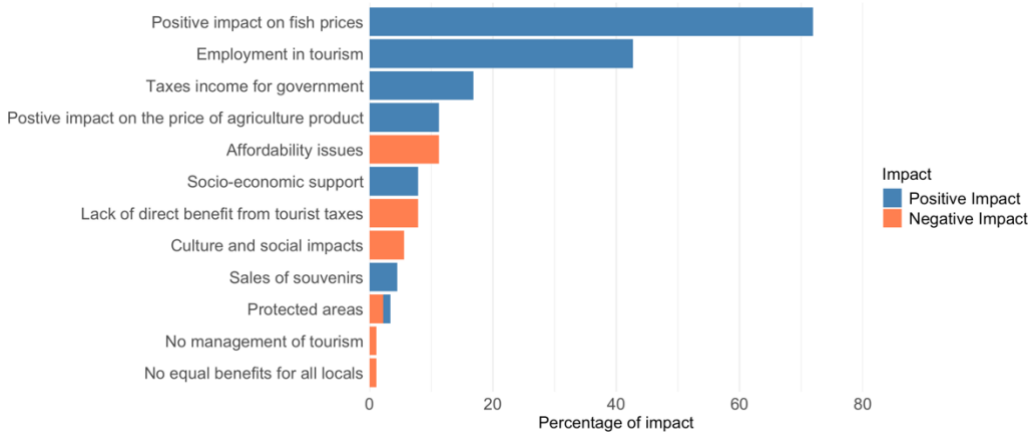

Figure 11. Perceived positive and negative impact of tourism (in % of fishers mentioning (n=89), multiple answers allowed).

However, the price for a fishing trip is getting more expensive, including fuel, gear, and vessels, particularly high-tech equipment, being sold at a high price. One pelagic fisher stated that the revenue generated from his catch cannot compensate

the high costs. Another fisher said that while the quantity of fish caught has decreased, the revenue generated has increased. However, this income is insufficient to meet his needs, particularly in comparison to the period when there were more fish that were sold for a lower price. In general, local communities seem to be the most negatively affected by the increased fish price. One female fisher reported that the general public is unable to afford fish in the market during high season. In a conversation with a former hotel manager who had lived in Zanzibar, it was mentioned that many local people cannot afford nutritious food. Instead, it is often cheaper for them to buy items like small loaves of white bread and soft drinks, such as Fanta, rather than healthier options like fresh fruits, rice, and fish. As a result, many locals can only purchase fish directly from fishers at the beach, which is less expensive but technically illegal, as regulations require all fish to be sold through the market (Crona et al., 2010). High-trophic level pelagic species, such as tuna-like species, billfish, and coral reef-associated species, such as emperors, snapper, and invertebrates such as lobsters, command higher prices primarily for the tourism market. Typically, fish size is the primary factor for determining the price, whether it is landed for locals or tourists (Garcia Rodrigues & Villasante, 2016; Thyresson et al., 2013). Meanwhile, local consumers often rely on lower trophic level fish, smaller-sized fish or unpopular species like juvenile/ subadult emperors or rabbitfish and rays as a source of marine protein (Figure 12). This highlights the growing challenge of ensuring food affordability and balanced diets for local communities.

Figure 12. Small juvenile fish species such as pink ear emperor (Lethrinus lentjan) on the left and the right, orange-spotted spinefoot (Siganus guttatus) in the middle. Location: landing site in Mkokotoni, Zanzibar. Photo by Lödel, M.

3.7 Reflecting on the Sustainable Livelihood Framework (SLF)

This study uses the approach of the Sustainable Livelihoods Framework (SLF), focusing on the elements of natural resources to assess whether tourism contributes to or undermines sustainable livelihoods for SSF in Zanzibar. The results of this study show that tourism has a significant impact on the dynamics of SSF in Zanzibar, particularly on seafood prices (Figure 11). Coupled with limited alternative and well-paid livelihoods, it promotes fishing as a profession, especially among young people (Ali et al., 2023; Cinner et al., 2012; Muumin Ali et al., 2023; Onyango & Yahya, 2022). The number of small-scale fishers in Zanzibar increased by 45 percent, from 34.751 in 2010 to 50.218 in 2020, exacerbating the competition and fishing pressure in an open-access fishery (Breuil & Grima, 2014; Jiddawi & Öhman, 2002; MoBEF, 2022). This might be why many fishers have reported reduced catches per individual, a trend that threatens the sustainability of their livelihoods. As one fisher mentioned that 30 years ago, he earned 500 TZS a day (0,20 USD) and was able to afford everything, now he gets up to 50.000 TZS a day (18,35 USD), yet it is not enough for all his needs as prices have risen.

Fishers in Zanzibar, like all fishers globally, are highly vulnerable to environmental changes due to their reliance on healthy marine ecosystems (Cinner et al., 2012; FAO, 2023; Lokrantz et al., 2009). Ecosystem degradation, declining fish stocks, and climate change pose severe risks to their livelihoods (Allison & Horemans, 2006; Muringai et al., 2021; Mustelin et al., 2010). For a sustainable livelihood, fishers need to withstand shock and adapt to change such as diversifying target species, geographic mobility, and livelihood diversification (Allison & Ellis, 2001; Muringai et al., 2021). However, adapting to environmental changes affecting the food web and therefore changing target species seems challenging due to tourism's specific demands for certain seafood. Additionally, due to the generally increasing fishing pressure, species across various habitats and levels of the food web, including low-value species, are already being targeted to meet the demands. Moreover, fishers depend highly on their gear, which can be more or less effective depending on the species. In most cases, they lack the resources to acquire new and better gear. Allison & Ellis (2001) highlighted the vulnerability of fishers, particularly as they lack alternative, stable income sources. While 38 percent of fishers in this study engage in agriculture as an additional livelihood, it is debatable whether this offers true security. Agriculture is also vulnerable to ecosystem changes and climate variability, including unpredictable rainfall, droughts, and soil degradation, which can reduce crop yields and income stability (Chemnitz & Hoeffler, 2011; Nhemachena et al., 2020). Furthermore, rising temperatures and shifting cultivating seasons due to climate change further undermine agriculture as a reliable alternative (Brottem & Brooks, 2018; Schraven & Rademacher-Schulz,

2016). This leaves fishers exposed to both marine and terrestrial ecological risks (Hamad & Sawe, 2022; Mustelin et al., 2010).

Tourism in Zanzibar was initially seen as the ideal opportunity to diversify local livelihoods, by creating accessible jobs for many and driving pro-poor growth (Rotarou, 2014; Wambura et al., 2022). In practice, however, only a limited number of locals in Zanzibar are actively employed in the tourism industry (Carboni, 2016). In this study, only eight percent of fishers reported having alternative work in the tourism sector, mostly in jobs like snorkelling or dolphin tour guides and kite surfing instructors. The limited engagement of locals in the tourism industry might be from the fact that the available jobs to locals are mainly lower-paid positions, such as cleaners, gardeners, and tour guides (Anderson, 2013; Lange, 2015; Omar & Rwela, 2023; Unicef Tanzania et al., 2018). Additionally, tourism is often associated with culture shifts, as younger locals sometimes adopt the lifestyle of tourists, discouraging participation in the industry (Figure 11) (Omar & Rwela, 2023). Overall, locals' involvement in tourism remains largely passive, with minimal involvement in the planning and decision-making processes (Omar & Rwela, 2023; Shechambo, 2019).

While tourism indirectly benefits fishers through higher fish prices and infrastructure like schools and hospitals, these gains alone do not ensure a sustainable livelihood (Allison & Ellis, 2001; Allison & Horemans, 2006). In fact, this study suggests that tourism may undermine SSF livelihoods in the long term. An increasing number of fishers and growing competition for marine places intensified pressure on fish stocks of numerous different species. The drivers are both the tourism's demand for specific high-valued species and Zanzibar's growing population. The high demand has increased fishing efforts targeting particularly species wanted by tourism, as they generate more income. Findings from this study, as well as by Thyresson et al. (2013), highlight that market demand caters to both tourists and locals, leading to a "catch-all" market where fish of all sizes and species from juvenile to adult are in demand. In the 12 years since Thyresson et al. (2013) published their research, tourism in Zanzibar has continuously been growing, further elevating fishing pressure across the ecosystem. Heavy fishing pressure depletes large long-lived fish, shifts to a system dominated by smaller, lower trophic level species, increases coral diseases, and reduces coral and fish larvae recruitment, leading to reef degradation (Sandin et al., 2008).

For instance, snappers (Lutjanidae) and groupers (Serranidae) are species that have always been featured on tourist menus (Jiddawi & Öhman, 2002; Thyresson et al., 2013), it was observed in this study that the catch rate by fishers and the numbers observed in the markets of these species were generally low. Although their status is largely unknown, particularly in small-scale fisheries, it can be an indicator, that these species might have already been overexploited in the past years (Amorim et al., 2019). In contrast, other coral reef species such as emperors

(Lethrinidae) were often mentioned as present in the last catch of fishers and were highly abundant at the observed landing sites. However, they might also face overexploitation in the future as they are such popular species both among tourists and locals. Given these patterns, CHICOP (2107), a not-for-profit organisation managing the only no-take zone in Zanzibar, recommends avoiding consumption of emperors (Lethrinidae), snappers (Lutjanidae), and groupers (Serranidae) to ease the pressure on these species. A decline in available fish particularly affects the food security and food culture of local communities, who traditionally rely on locally sourced fish as their daily protein. This need for marine protein and income of the local population stands in stark discrepancy to the luxury food preferences of tourists, who, in comparison, possess high levels of wealth. Further, even though this is not desirable, the tourism industry can compensate declining local fish stock with imports from other places or other more expensive high-value protein sources such as meat and tofu. While small-scale fishers have direct access to marine resources, increasing competition, exploitation, and rising costs make it challenging for fishers to maintain their livelihoods, and to afford their local fish. As for the future, particularly low-tech gear-equipped fishers with low capital will catch even less, and consequently earn even less, whereas high-tech gear fishers will receive even more, creating an uneven distribution. The lack of resilience-building strategies leaves fishers vulnerable to economic and ecological shocks. Developing sustainable and diversified livelihoods is crucial to improving long-term resilience for fishers and ensuring food security in Zanzibar's coastal communities.

3.8 Evaluation and reflection on the study methods

This study's methods, particularly semi-structured interviews, proved to be highly efficient in addressing the research questions. The approach enabled an exploration of fishing activities, market dynamics, and fish consumption patterns. However, there are some areas where the methodology could be refined to enhance future research outcomes.

The semi-structured interviews with fishers were a significant part of this study. They provided in-depth insights into fishing practices and market behaviours, while also uncovering valuable perspectives on the impacts of tourism on SSF. However, there were some challenges, particularly in obtaining detailed information about fish species and size categories. This process is very time-intensive, and the level of detail gathered could have been improved. In future studies, providing fishers with printed illustrations of various fish species and sizes to obtain specific species and to collect more accurate data about fish sizes. Another area for improvement is the investigation of market dynamics and the value chain of the catch. While the study touched on these topics, a more comprehensive analysis would require interviewing a greater number of fish traders and analyse market size. Additionally, future research should map the entire value chain, from the fishers to the final

consumers. This would provide a clearer picture of the flow of fish through the market, the roles of intermediates, and the factors influencing pricing and demand at each stage.

The interviews with restaurants provided useful insights but were somewhat limited in scope. Including a larger and more diverse sample of restaurants would provide a broader perspective. It is also crucial to only interview managers or people responsible for fish purchases in restaurants. This would offer a better understanding of where restaurants source their fish. Moreover, classifying restaurants by price range could reveal interesting patterns in seafood offered.

Despite these challenges, the study produced several surprising findings that underscored the importance of tourism in shaping fish consumption patterns and market demands. One unexpected result was the preference among local communities for larger pelagic species, such as yellowfin tuna and kingfish. This was contrary to the initial assumption that locals primarily consume smaller reef fish. However, it was not surprising to what extent, tourists demand high-value species, including invertebrates and large pelagic fish like big tuna.

Although, the data collected for this thesis was substantial, future research could benefit from incorporating more qualitative data. For example, conducting in-depth interviews and focus group interviews with fishers and local communities could provide a deeper understanding of their perceptions and, in general, changes over time. In conclusion, while the methods employed in this study were effective in addressing the research questions, reflecting on these challenges and highlights carries opportunities for improvement. Future research should aim to refine these methodologies to capture even more detailed and comprehensive data, thereby contributing to a deeper understanding of the social-ecological interactions between SSF and tourism.

4. Conclusion

The results of this study contribute to a better understanding of how tourism-driven demand for marine resources impacts SSF and local communities in Zanzibar, drawing on the natural capital domain of the SLF. The interdisciplinary social-ecological approach with semi-structured interviews with fishers, fish traders, and local and tourist restaurants allowed me to examine fish consumption patterns and market dynamics in a holistic way, highlighting the critical impacts of tourism on local fisheries and livelihoods. The main results of this study are summarized as follows:

1. Fish consumption among tourists and local communities is partly overlapping. Some key differences are, however, evident. Tourists favour certain high-value species like lobster, bigger tuna species and bigger-sized coral reef fish like emperors. Fishers and locals consume a broader range of fish species, with less specific preferences, as well as smaller-sized species, and their consumption is to a high degree dependent on the available local resources.

2. The specific fish and seafood preferred by tourism is influencing local fish markets by driving up prices for certain fish species and sizes, especially those in high demand. Thus, local people are not able to afford these species, generally leaving them to buy smaller and/ or species not preferred by tourists. This creates a "catch-all" market where fish of all sizes, from juveniles to adults, are harvested to meet the diverse demand of both locals and tourists. Consequently, this puts immense pressure on the whole marine ecosystem.

3. Tourism in Zanzibar, in its current form, undermines SSF and local communities' livelihoods in the long run. The high demand for seafood by the tourism industry, coupled with limited alternative livelihood options, promotes high competition among fishers. In this competitive environment, fishers with limited resources and low-tech equipment may struggle to secure adequate catches, while fishers with high-tech equipment can catch more and higher-valuable species like yellowfin tuna, leading to an uneven distribution of resources and money. Over time, the high fishing pressure from both local and tourist demand could lead to degraded marine ecosystems and -resources, with serious consequences for local livelihoods, such as through a lack of income and available animal protein, threatening local food security.

Figure 13. Recommendations to address the pressures from tourism-driven demand on marine resources and their impacts on SSF and local communities.

The study highlights the need for sustainable fishery practices that integrate SSF into decision-making processes, ensuring that tourism development does not undermine local livelihoods (summarised in Figure 13). Locally, these insights can advise policies to balance tourism with the needs of local communities and the conservation of natural resources. Globally, these results provide guidance for comparable coastal areas, showing how local communities and ecosystems may be impacted by the demand for fish and seafood driven by tourism.

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Appendix 1

Interview guide used for semi-structured interviews with SSF. (The questions focused on demographics, fishing practices (including catch details, fishing pressure, and fish availability), market sales, personal fish consumption and tourism). This study has Swedish ethnical approval, Dnr 2023-08067-01.

Interview guide - Small-scale fishers

I. Fishing

1. For how long have you been a fisher?
2. How many times per week/ per month to you go fishing?
3. Do you have a different occupation besides being a fisher? Different Livelihood? If yes, what is it?
4. When you fish what types of fishing gear do you use? What is your main gear?
5. Are you using a boat? If yes, which kind?
6. Which substrate do you usually fish on? (Corals, seagrasses, mangroves, sand, rocky bottom). Please explain importance. (Why do you prefer these substrates?)
7. What do you usually catch?
8. Which fish species do you usually target, is there a preference on what you would like to catch the most?
9. Why do you target these species?
10. Which fish species do you catch the most of?
11. Which fish species did you catch today/ the last time you went fishing?
12. Is the size of the fish (in general) important to you? And why?
13. What do you think about the fishing pressure? Rate: low, medium or high?
14. What do you think about the availability of fish in the sea? Rate: low, medium or high?

If time:

15. Has anything connected to your fishing activity changed since you started fishing, or not? If yes, how?

II. Market

16. What happens after you come back from a fishing trip? What do you do with your catch?
17. Do you sell your fish? If yes, to whom and where?

18. Do you go somewhere to sell your fish on the market, or do costumers or traders come to you?
19. Do you sell to one or several traders?
20. What happens to the fish you haven't sold to traders? (Sell locally, or do you take some home?)
21. What kind of relationship do you have to the trader?
22. Which species do you sell the most? (Which species are easy/hard to sell?)
23. Which species have the most value?
24. What do you usually get for this fish?
25. Which are the most economically important fish for you? Who buys that?
26. Do you know who is the end consumer/ who eats your fish? In general, all the fish you have fished.
27. Do you think the fish you fish is sold to hotels and/or tourists, or not?
28. Have you experienced any changes of demands or consumer preference? If so, are you fishing more now than you used to when you started fishing?

<u>If time:</u>

29. Do you take everything you have caught with you after a fishing trip? All species and sizes? If yes, why?

III. Personal fish consumption

30. Do you eat fish? If yes, how often do you eat fish (e.g. every day, once a week, once a month,…). If yes, do you have a preference in species and size (smaller/bigger) of the fish?
31. Do you take any species of fished fish yourself home for your own consumption? If yes, which species and why? Size related?
32. Has your own consumption changed over the year?

IV. Tourism

33. What do you think about tourism in general? Is it important to you?

<u>If time:</u>

34. Do you think tourist have a fish species preference? If yes, do you know which species?
35. Does tourism here affect you as a fisher in any way (explain)?
36. Does it affect the demand of fish? If yes, explain, any particular fish species?
37. What is your opinion on it?

Appendix 2

Interview guide used for interviews with local fish trader. (The questions focused on the value chain and a description of the local market, including market structure, sales, customers demographics, seafood species, and income.)

Interview guide - Fish traders

1. What is your occupation?
2. Are you a fisher yourself?
3. How does the market work here?
4. Do you **sell/ buy** fish every day?
5. How much fish do you **sell/ buy** approximately on an average day?
6. Do you know where the fish was fished? If yes, where?
7. How do you decide which fish to buy?
8. Which fish species do you usually buy?
    a. Why these species?
    b. Are any of these species coral reef associated?
    c. If yes, why?
9. Where do you sell your fish?
    a. Do the customers come to you, or do you go the customers?
10. Who do you sell your fish to?
    a. Locally or also to the mainland?
    b. Do you also sell to tourists?
    c. Which costumer group is more important?
11. Which species is there most demand for/are easiest to sell?
    a. Why?
    b. Who buys these species?
12. Which fish species are the most valuable ones you usually sell?
    a. Why?
    b. Who buys these species?
    c. How is the availability of the most valuable fish?
13. How do you decide the selling price?
14. What do you earn from selling fish? What are your benefits?

Appendix 3

Interview guide used for interviews with restaurants, including both more tourist establishments and local food stalls. (The questions focused on menu offerings, popularity, supply, demand, and availability.)

Interview guide - Restaurants

1. What is your position at the hotel/ restaurant?
2. Where are you from? Local/nonlocal?
3. Do you serve fish?
4. Which fish species do you usually serve?
5. Which are the most popular fish species (for guests) you buy/ serve?
    a. Why these species?
6. Do you buy "coral reef fish" (species which are associated to coral reefs)?
    a. If yes, which ones?
    b. Why?
7. Who decides which fish is bought/served?
8. What are the decisions based on?
9. Where do you buy the fish you serve?
    a. Do you know the person where you buy your fish from? Usual trader?
10. Do you know where the fish you buy is fished?
    a. Local/ nonlocal?
    b. Do you know who fished it?
11. Do your guests expect you to serve fish?
12. On a scale from 1 – 5 (1=not important, 5=very important), how important would you say is it for your hotel to be able to serve fish to your guests?
13. How would you describe the demand of tourism for fish? And on a scale from 1-5 (1=very low to 5=very high)?
14. How would you describe the availability of the fish species you prefer to buy? And on a scale from 1-5 (1=hardly ever available to 5=always available)?
15. Has the demand for fish from tourism changed over the last 5-10 years?
    a. If yes, how?
16. What do you think about the fishing pressure on the fish species you serve in your hotel?
17. Do you think tourism is a major contributor to fishing pressure on certain species here, or not?
    a. If yes, what do you think about that?

Appendix 4

Table 4. List of species observed at the different fish markets.

Location	Common English name	Local Swahili name	Family	Scientific name
Unguja Ukuu	Ember parrotfish	Pono	Labridae	*Scarus rubroviolaceus*
	Spot fin burrfish	Bunju	Diodontidae	*Chilomycterus reticulatus*
	Blue spotted mask ray	Taa	Dasyatidae	*Neotrygon indica*
	Octopus	Puesa	Octopodiae	na
	Leopard hind	Chewa	Serranidae	*Cephalopholis leopardus*
	Undulated moray	Mkunga	Muraenidae	*Gymnothorax undulatus*
	Blackspotted rubberlip	Mlea	Haemulidae	*Plectorhinchus gaterinus*
	Catfish	Hongwe	Arridae	na
	Jenkins whipray	Taa	Dasyatidae	*Pateobatis jenkinsii*
	Ornate spiny lobster	Kamba-koche	Palinuridae	*Panulirus ornatus*
	Ramose murex	Kome makucha	Muricidae	*Chicocreus ramosus*
	Cowtail stingray	Taa	Dasyatidae	*Pastinachus sephen*
	Common eagle ray	Pungu	Myliobatidae	*Myliobatis aquila*
	Spotted eagle ray	Pungu	Aetobatidae	*Aetobatus narinari*
	Leopard whipray	Taa	Dasyatidae	*Himantura tutul*
	White spotted wedge fish	Papa joza	Rhinidae	*Rhynchobatus djiddensis*
	Dusky spinefoot	Tasi	Siganidae	*Siganus luridus*
	Pink ear emperor	Changu-Njana	Lethrinidae	*Lethrinus letjan*
	Red Snapper	Fatundu	Lutjanidae	*Etelis carbunculus*
	Black-barred halfbeak	Mzuzu	Hemiramphidae	*Hemiramphus far*
	Coral hint	Chewa	Serranidae	*Cephalopholis miniata*
	Dory snapper	Changu	Lutjanidae	*Lutjanus fulviflamma*
	Laced moray	Mkunga	Muraenidae	*Gymnothorax favagineus*

	Cuttlefish	Ngisi	Sepiidae	*na*
	Kanadi Kingfish	Nguru Kanadi	Scombridae	*Scomberomorus plurilineatus*
	Triple wrasse	Pono	Labridae	*Cheilinus tribolatus*
	Black-spot emperor	Changu	Lethrinidae	*Lethrinus harak*
	Rosy goatfish	Mkundaji	Mullidae	*Parupeneus rubescens*
	Blue-barred parrotfish	Pono	Labridae	*Scarus ghobban*
	Striated surgeonfish	Punju	Acanthuridae	*Ctenochaetus striatus*
	Tomato jind	Chewa	Serranidae	*Cephalopholis sonnerati*
	Wahoo	Nguru maskat	Scombridae	*Acanthioybium solandri*
	Red mouth grouper	Chewa	Serranidae	*Aethaloperca rogaa*
	Yellow-edged moray	Mkunga	Muraenidae	*Gymnothorax flavimargiantus*
	Longnose unicorn fish	Punju	Acanthuridae	*Naso brevirostris*
	Brassy chub		Kyphosidae	*Kyphosis vaigiensis*
	Hound needlefish		Belonidae	*Tylosurus crocodilus*
	Moorish idol		Zanclidea	*Zanclus cornutus*
	Cigar wrasse		Labridae	*Cheilio inermis*
	Indian Mackerel	Kibua	Scombridae	*Rastrelliger kanagurta*
	One spot snapper		Lutjanidae	*Lutjanus monostigma*
	Blue sea chub	Tufi	Kyphosidae	*Kyphosus cinerascens*
	Batfish		Ephippidae	na
	Spangled emperor	Changu-Chaa	Lethrinidae	*Lethrinus nebulosus*
Uroa	Dusky spinefoot	Tasi	Siganidae	*Siganus luridus*
	Kanadi Kingfish	Nguru Kanadi	Scombridae	*Scomberomorus plurilineatus*
	Marbled parrotfish	Pono	Labridae	*Leptoscarus vaigiensis*
	Jack/ Sqad		Carangidae	na
	Oriental sweetlips	Mlea	Haemulidae	*Plectorhinchus vittatus*
	Triple wrasse	Pono	Labridae	*Cheilinus tribolatus*
	Rosy goatfish	Mkundaji	Mullidae	*Parupeneus rubescens*

	Blue spotted cornet fish	Dungidungi	Fistulariidae	*Fistularia commersonii*
	Squid	Ngisi	Decapodiformes	na
Nungwi	Swordfish	Sansuli	Xiphiidae	*Xiphias gladius*
	Common dolphinfish	Panje	Coryphaenidae	*Coryphaena hippurus*
	Longnose unicorn fish	Punju	Acanthuridae	*Naso brevirostris*
	Short nose unicorn fish	Punju	Acanthuridae	*Naso unicornis*
	Ember parrotfish	Pono	Labridae	*Scarus rubroviolaceus*
	Dusky spinefoot	Tasi	Siganidae	*Siganus luridus*
	Rosy goatfish	Mkundaji	Mullidae	*Parupeneus rubescens*
	Black-spot emperor		Lethrinidae	*Lethrinus harak*
	Skipjack tuna	Sehewa	Scombridae	*Katsuwonus pelamis*
	Indian mackerel	Kibua	Scombridae	*Rastrelliger kanagurta*
	Big eye snapper		Lutjanidae	*Lutjanus lutjanus*
	Bengal snapper		Lutjanidae	*Lutjanus bengalensis*
	Deep water red snapper		Lutjanidae	*Etelis carbunculus*
	Hound needlefish		Belonidae	*Tylosurus crocodilus*
	Lutke's halfbeak		Hemiramphidae	*Hemiramphus lutkei*
	Mangrove red snapper		Lutjanidae	*Lutjanus argentimaculatus*
	Big eye trevally		Carangidae	*Caranx sexfasciatus*
	Giant Trevally		Carangidae	*Caranx ignobilis*
	Golden Trevally		Carangidae	*Gnathanodon speciosus*
	Pink ear emperor	Changu Njana	Lethrinidae	*Lethrinus letjan*
	Rainbow runner		Carangidae	*Elagatis bininnulata*
	Anchovies	Dagaa	Engraulidae	na
	Sardines	Dagaa	Dorosomatidae	na
	Reef shark		Carcharhinidae	na
Mkokotoni	Eel catfish	Ngogo	Plotosidae	*Plotosus lineatus*
	Indian halibut		Psettodidae	*Psettodes erumei*
	Black-spot emperor	Changu	Lethrinidae	*Lethrinus harak*
	Marbled parrotfish	Pono	Labridae	*Leptoscarus vaigiensis*
	Dusky spinefoot	Tasi	Siganidae	*Siganus luridus*

African blue swimming crab		Portunidae	*Portunus segnis*
Blue-barred parrotfish	Pono	Labridae	*Scarus ghobban*
Brown spotted grouper	Chewa	Serranidae	*Epinephelus epistictus*
Deep water red snapper	Janja	Lutjanidae	*Etelis carbunculus*
Indian mackerel	Kibua	Scombridae	*Rastrelliger kanagurta*
Brown spotted spinefoot	Tasi	Siganidae	*Siganus stellatus*
Common eagle ray	Taa	Myliobatidae	*Myliobatis aquila*
Laced moray	Mkunga	Muraenidae	*Gymnothorax favagineus*
Common Octopus		Octopodiae	na
Black-barred halfbeak		Hemiramphidae	*Hemiramphus far*
Undulated moray	Mkunga	Muraenidae	*Gymnothorax undulatus*
Pink ear emperor	Changu-Njana	Lethrinidae	*Lethrinus letjan*
Ornate spiny lobster		Palinuridae	*Panulirus ornatus*
Painted lobster		Palinuridae	*Panulirus versicolor*
Long-legged lobster		Palinuridae	*Panulirus longipes*
Slipper lobster		Scyllaridae	*Thenus orientalis*
Common Octopus		Octopodiae	na
One spot snapper		Lutjanidae	*Lutjanus monostigma*
Leopard whipray		Dasyatidae	*Himantura tutul*
Jenkins whipray		Dasyatidae	*Pateobatis jenkinsii*
Hammerhead shark	Papa	Sphyrnidae	*Sphyrna mokarran*
Catfish	Hongwe	Arridae	na
Cuttlefish	Ngisi	Sepiidae	*Spepia latimanus or Sepia pharaonis*
Squid	Ngisi	Loliginidae	Loligo duvauceli
Yellowfin tuna	Jodari	Scombridae	*Thunnus albacares*

	Baraka's whipray	Taa	Dasyatidae	*Pateobatis ambigua*
	Orange spotted trevally		Carangidae	*Carangoides bajad*
	Kawakawa	Jodari	Scombridae	*Euthynnus affinis*
	Big eye tuna	Jodari	Scombridae	*Thunnus obesus*
	Needlefish		Belonidae	*na*
	Common silber-biddy	Chaa	Gerreidae	*Gerres oyena*
	Horseface unicorn fish		Acanthuridae	*Naso fageni*
	Blue spotted maskray	Taa	Dasyatidae	*Neotrygon indica*
	Albacore	Jodari	Scombridae	*Thunnus alalunga*
	Bowmouth quitarfish		Rhinidae	*Rhina ancylostoma*
	Four-bar porcupinefish	Bunju	Diodontidae	*Lophodiodon calori*
	Pufferfish	Bunju	Tetraodontidae	na
	Flapnose or Oman cownose ray		Rhinopteridae	*Rhinoptera javanica or Rhinoptera jayakari*
	Yellowtail emperor	Changu	Lethrinidae	*Lethrinus crocineus*
	Batfish		Ephippidae	
	Two spot red snapper	Kungu	Lutjanidae	*Lutjanus bohar*
	Orange spotted spinefoot	Tasi	Siganidae	*Siganus guttatus*
	Big eye snapper		Lutjanidae	*Lutjanus lutjanus*
	Coral hint	Chewa	Serranidae	*Cephalopholis miniata*
	Reef shark		Carcharhinidae	na
	Cobia		Rachycentridae	*Rachycentron canadum*
	Elongate surgeonfish		Acanthuridae	*Acanthurus mata*
Kizimkazi	Kanadi Kingfish	Nguru kanadi	Scombridae	Scomberomorus plurilineatus
	Narrow-barred Spanish mackerel	Nguru maskat	Scombridae	Scomberomorus commerson

	Dusky spinefoot	Tasi	Siganidae	Siganus luridus
	Cobia		Rachycentridae	Rachycentron canadum
	Octopus	Pwesa	Octopodiae	na
	Doublebar goatfish	Mkundaji	Mullidae	Parupeneus trifasciatus
	Emperor	Changu	Lethrinidae	Gymnocranius grandoculis
	Cuttlefish	Ngisi	Sepiidae	*Spepia latimanus or Sepia pharaonis*
	Cuttlefish	Ngisi	Sepiidae	na
	Emperor angelfish		Pomacanthidae	Pomacanthus imperator
	Devil fire fish		Scorpaenidae	Pterois miles
	Brown spotted spinefoot	Tasi	Siganidae	Siganus stellatus
	Daisy Parrotfish	Pono	Labridae	Chlorurus sordidus
	Blue-barred parrotfish	Pono	Labridae	Scarus ghobban
	Redaxil emperor	Changu	Lethrinidae	Lethrinus conchyliatus