

Small pelagic marine fisheries for food sovereignty? The case of the *dagaa* fishery at three coastal sites in Tanzania

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Abstract

To implement effective ocean governance, development of policies and management strategies needs to incorporate input from communities that will be impacted by the decisions. People engaging in small-scale fisheries and aquaculture mobilize themselves in anticipation of various challenges, for example, food sovereignty. Food sovereignty is the right for people to access healthy and culturally appropriate food that is produced through ecologically sound and sustainable methods. Little attention has been paid to documenting and understanding the struggles and efforts of small-scale fishers to ensure their own food sovereignty. In the Western Indian Ocean region, and Tanzania in particular, there has been a limited number of initiatives among coastal fishers that seek to transform food systems. To better understand these initiatives, this study was designed to examine collective actions undertaken in pursuit of food sovereignty among small pelagic fishers at three landing sites on the coast of Tanzania. Collection of primary data involved a survey of 206 individuals, 25 key informant interviews, 3 focus group discussions and participant observation. Secondary data was also collected from official fisheries records and published materials to supplement the primary data. The study revealed limited current capacity of the small pelagic fisheries to satisfy local demand of fish for food security and sovereignty purposes due to increased fish trade supplying markets beyond the study sites. The prospects of satisfying an increasing fish demand from existing production systems are limited. Small pelagic fisheries need to be linked to the global food system through appropriate mechanisms to allow them to contribute meaningfully to food security and sovereignty.

Keywords: small-pelagic fishery, dagaa, food sovereignty, governance, interviews, marine resource

Introduction

Fishing and fisheries associated activities are important on many fronts (Herrón *et al.*, 2019): providing fish for food and nutrition security (Villasante *et al.*, 2022), income (March and Failler, 2022), employment (Okafor-Yarwood *et al.*, 2022) and sustaining livelihoods (FAO, 2020). Recently, there has been an effort to integrate fisheries into ocean governance strategies and blue economy growth without compromising the health status and sustainability of the ecosystems supporting them (Ayilu *et al.*, 2022; Cohen *et al.*, 2019). Fisheries are diverse, including for example large and small pelagics, inshore, reef, estuarine and riverine fisheries, and management needs to be adapted for the specific fishery and people involved in it.

Small pelagic fisheries constitute a large share of fish landings and drive production in the marine sector (March and Failler, 2022; McClatchie *et al.*, 2018; Sekadende *et al.*, 2020; Stephenson and Smedbol, 2019). The small pelagic fishery is one of the most challenging marine sectors to manage because of the widespread fishing effort and open access into the fishery, and the fact that a large proportion of coastal communities are dependent on this fishery for food, employment and income (Cushing *et al.*, 2019). However, a lack of appropriate storage and processing facilities causes post-harvest losses, creating a problem for the overall supply and access of fish for food, especially for poor households (Akande and Diei-Ouadi, 2010).

The marine fisheries sector in the Western Indian Ocean (WIO) region plays a significant role in the development of coastal economies (Obura *et al.*, 2017). Although precise data is still lacking, best estimates indicate that more than 25 million people in the WIO region could be directly or indirectly dependent on artisanal fisheries for their livelihoods (Taylor *et al.*, 2019). In 1997, the Food and Agriculture Organization (FAO) declared that the WIO had great fisheries potential, but since then the total landings appear to have leveled off, despite an increase in fishing effort (Groeneveld, 2016). This decline has been attributed to several factors, including increasing competition for dwindling stocks, excessive and destructive fishing methods (Jury *et al.*, 2010; Silas *et al.*, 2020). In particular, excessive and destructive fishing methods result in habitat destruction and high levels of by-catch and discards, which has led to a decline of marine resources and biodiversity in the region (UNEP-Nairobi Convention and WIOMSA, 2015). This situation has put the livelihoods and food security of more than 25 million people living in the coastal areas of the region at risk (Jebri *et al.*, 2020). Marine fisheries in most WIO countries are composed of artisanal and small-scale fisheries (Palmer *et al.*, 2021), predominately in inshore waters. Habitats such as coral reef, mangrove creeks, seagrass beds, and sand banks are where most fishing efforts are concentrated (Jiddawi and Öhman, 2002; Robertson *et al.*, 2018). Fishers also fish further offshore in search of small and large pelagics, as well as tuna and tuna-like species. Small pelagic fish commonly captured in WIO countries include species of sardine, anchovy and mackerel (Sekadende *et al.*, 2020). Other diverse species are caught depending on where fishing takes place and oceanographic characteristics (Jacobs *et al.*, 2021; Kizenga *et al.*, 2021).

Attempts to regulate fishing in the WIO region through the implementation of marine protected areas and gear restrictions, are beset with challenges (Mwaipopo *et al.*, 2010; Vousden and Stapley, 2013). These challenges include a lack of sufficient scientific data and expertise, which are complicated by economic and socio-political realities (Ochiewo, 2015). Fisheries statistics such as catch, the number of fishing vessels and fishers are limited in most WIO countries (Kadagi *et al.*, 2021). Tanzania and other countries make use of fisheries frame surveys that provide fisheries statistics but these are not conducted regularly due to financial constraints. The regional State of the Coast Report for the WIO (UNEP-Nairobi Convention and WIOMSA, 2015)

states that nearly all the countries in the region cannot adequately assess their marine resources and lack the financial capacity and technical expertise to manage them effectively. The lack of reliable data, analytical capacity and advice presents a barrier to decision making. Knowledge of the stock status, trends, potential productivity of a stock, and socio-economic implications of the fishery, is vital to the design of responsible fisheries management interventions and sound policy making yet many of the fisheries stocks have not been assessed (Obura *et al.*, 2017).

National fisheries institutes in some WIO countries have been mandated to collect routine fisheries data but this data is frequently underutilized or of poor quality. Records are sometimes misplaced, or the data is inaccurately captured, with no means of validating its authenticity due to the lack of an efficient digital data transmission system (Robertson *et al.*, 2018; Robertson and Midway, 2019). Thus, even though data exists, it will often remain unused. The analysis of the data may also be based on inappropriate metrics and methods, which hinder the formulation of relevant policies for the sector.

Available information suggests that small pelagic fish make up the largest proportion of fish caught in the WIO and contribute to the largest proportion of employment in the WIO's fisheries sector (Sekadende *et al.*, 2020). Estimates indicate that nearly one-third of marine fish catch in Tanzania are comprised of small pelagic fish (Breuil and Bodiguel, 2015; MLF, 2020). However, some scholars argue that the landings have been largely underestimated and that most stocks lack scientific assessment.

In the WIO region, small pelagic fish are predominately caught using locally made fishing vessels and different gear types and offer diverse benefits to local communities (Kizenga *et al.*, 2021; Sekadende *et al.*, 2020). For example, in Tanzania, this fishery plays a significant role in food security and nutrition and creates over 8,000 employment opportunities for people directly engaged in small pelagic fishing and ancillary activities (MLF, 2020). The vast majority of landings are dedicated for human consumption (MLF, 2019). A few fish processing facilities have been established along the Tanzanian coastline. There are no reliable records on the proportion of landings that go towards supporting the fishmeal and fish oil industries. There is a trade network where small pelagic fishes are exported through both formal and informal

channels to neighbouring countries such as the Democratic Republic of Congo (DRC), Zambia and Kenya (Ibengwe *et al.*, 2022).

The size of the catch from small pelagic fisheries is also reported to have increased in recent years (MLF, 2020). For example, in Zanzibar, catch of small pelagic fish has increased to 13,000 tonnes, according to the 2020 statistics (Ministry of Blue Economy and Fisheries, 2021). In mainland Tanzania, fish landings for small pelagics totaled 7,690 tonnes in 2011 and 8,053

management strategy to guide the management and sustainable use of the small pelagics through the established Collaborative Fisheries Management Areas in the Rufiji/Mafia/Kilwa (RUMAKI) seascape. An ocean governance framework that promotes sustainable fisheries management and incorporates the needs of local stakeholders, is essential to maintain fisheries and their roles in food security and sovereignty.

Coastal fisheries in Tanzania have been managed through the licensing of fishers and vessels, marine

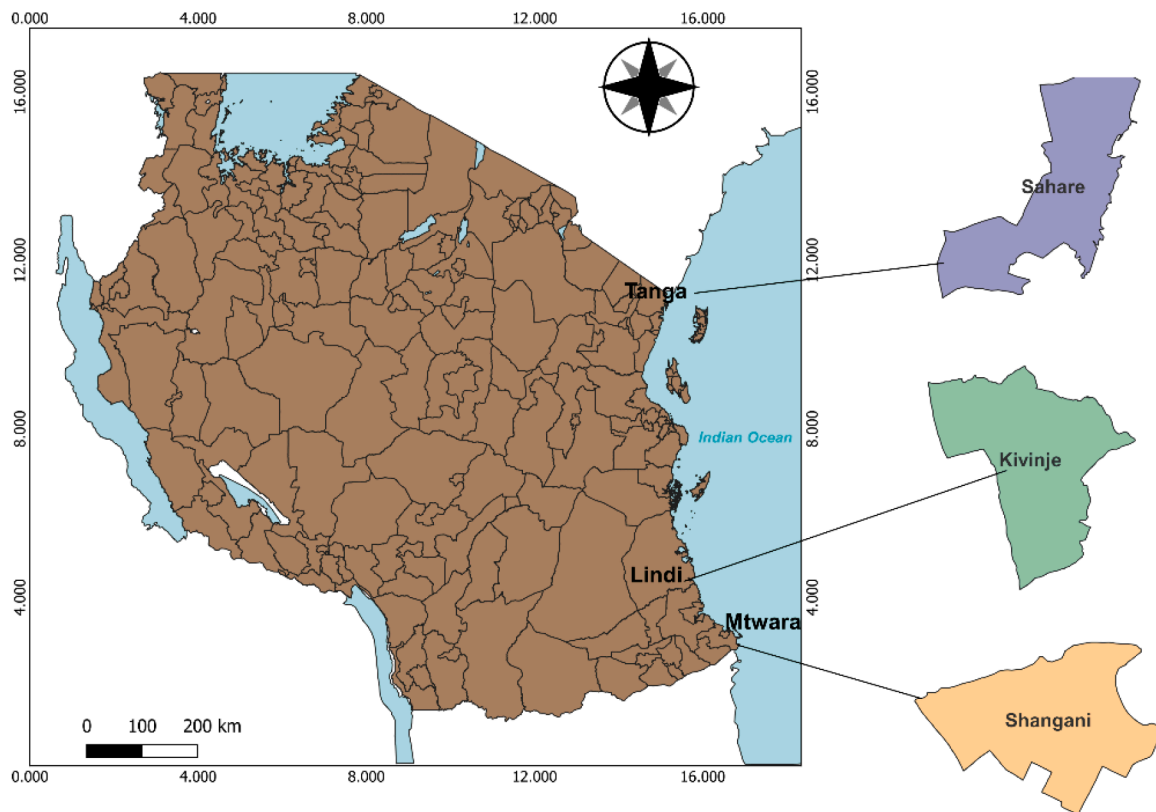


Figure 1. Three landing sites where small-scale fishing takes place, located in three coastal districts in Tanzania: Shangani (Mtwara district in Mtwara region), Kivinje (Kilwa district in Lindi region) and Sahare (Tanga district in Tanga region).

tonnes in 2020 (MLF, 2020). Despite its large contribution to annual landings and being an important source of food, the current economic performance of small pelagic fisheries is believed to be far lower than could be possible given the available resources in Tanzania. There are records of initiatives that have recently taken place to safeguard fisheries from further decline (Andriese *et al.*, 2022). One of these initiatives includes prioritizing the development of a management plan for small marine pelagic fisheries. The outcome of this includes a recent initiative by WWF Tanzania Marine Programme to develop a local area

fishery management plan, and input and output controls. Inadequate information of fishery resources and associated value chains hampers understanding of the role of small pelagic fisheries in improving food and nutrition security, as well as promoting food sovereignty. The aim of this study was therefore to investigate how small pelagic fisheries, particularly for sardine (i.e., *dagaa* in local Franca), add to the overall food status and sovereignty. Achieving a better understanding of the ways through which small pelagics contribute to food sovereignty in small-scale fisheries is essential in enhancing science-based advice to

fisheries management (Arthur *et al.*, 2022). It would also provide information for policy makers to plan and put policies in place to prevent future degradation of marine resources.

Materials and methods

Study area

The study focused on three landing sites located in three coastal districts in Tanzania: Shangani (Mtwara region); Kivinje (Lindi region); and Sahare (Tanga region), as indicated in Figure 1. The sites serve small-scale fishers (resident and migrant), who target small pelagic fishes and link with fish trade networks including traders and processors from both domestic and international markets (MLF, 2020, 2019). Infrastructure for fish processing at these sites is often inadequate, and the sites have few sanitary facilities for fishers and visitors. Fish play a significant role in the diet of people living in the study sites—fish consumption in and around these sites is relatively greater than in many regions of Tanzania (MLF, 2020). However, fish and fishery product consumption in mainland Tanzania is below the world and sub-Saharan Africa average (Ochiewo, 2015).

Data collection

A survey was administered to 206 individuals (Table 1) between July and December 2019 to obtain information to better understanding the role that small pelagic fisheries play in promoting food security and sovereignty. Respondents for the survey were randomly selected individuals involved in fishery-related activities in the study sites. With the help of a fisheries official, researchers engaged with a Beach Management Unit (BMU) at each of the study sites to identify a list of individuals engaged in various fisheries-related activities at that landing site. Every third individual was selected from a list prepared by the BMU office at each site. The research did not apply convenience sampling to select respondents as this can result in visiting individuals more than once, reducing efficiency. The survey involved face-to-face interviews in the sampled study sites. The survey was achieved mainly by visiting respondents at the locations they had selected, usually at landing sites (as the majority spent much time of the day there), or at a BMU office. This was important to ensure privacy and comfort for respondents. Some individuals, particularly in Kivinje-Kilwa, were interviewed at their homes.

The survey was designed to collect perceived knowledge of respondents on small pelagic fisheries.

It consisted of Likert scale, numerical and open-ended questions. Prior to the start of the field work, the survey was pre-tested with 10 individuals at Kunduchi fish landing site located in the Kinondoni district. Pre-testing allowed researchers to make the appropriate adjustments to the survey and clarify questions where necessary, before conducting interviews with the target population. The survey was conducted in Kiswahili language with five trained researchers. The average time spent for a survey interview was between 35 and 50 minutes. In addition to the survey, a research team noted down their observations in order to assess fisheries related activities as they took place. Observations included, but were not limited to, the processing of fish caught, women carrying fish from boats to auction site using large plastic containers, fish mongers purchasing fish directly at the auction, repair of fishing gears, and small-scale businesses on the shore. Observations concentrated on fish prices, marketing and sales of fish, processing, transport and governance issues (e.g., payment of levies and other fees). The purpose of noting down these observations was to enable researchers to better identify and understand interactions involved in the supply chain of small pelagic fish from the boat to consumers. Observations also supported researchers in developing further lines of questioning during interviews and informal interactions with the fisher communities.

The study included interviews with key informants. The 25 key informants were drawn from local leaders, fishers (resident and migrant), fish traders and processors, porters, business, BMUs, conservation practitioners, district fisheries officials, and fisheries and marine resource-based NGOs working in the study areas. Key informants were chosen from communities based on their experience in fishing activities. Special consideration was given to informants who had lived in their areas long enough to remember changes and developments that have occurred in the fishery sector. A snowball sampling technique was applied to select key informants. The number of participants grew by referral until the desired sample size was reached. Key informant interviews were designed to allow participants to share their personal experiences and opinions regarding small pelagic fisheries and to note how they perceive small pelagic fisheries are changing. Key informant interviews were important in gathering information on stakeholders' understanding on the journey of small pelagic fishes from boat to consumers, key actors in the supply

chain of these fishes, management and institutional issues related to small pelagic fisheries, and the role small pelagic fisheries play in the contribution of food consumed by the local households. The use of follow-up questions made it easy for the informants to relate their experiences of small-pelagic fisheries to the overall fisheries activities. Researchers also interviewed stakeholders to ascertain the current status of small pelagic fisheries including utilization, processing, trade, marketing, management and food value. Key informants were interviewed where they preferred, including their homes or private settings in landing sites, and in some cases, at local offices such as BMU offices. Interviews lasted between 40 and 60 minutes. All informants gave oral consent prior to the interviews. As in the questionnaire survey, Kiswahili language was used during key informant interviews. As the majority of key informants were not comfortable for the interviews to be recorded, notes were taken instead.

One focus group discussion including 6 to 10 participants was organized in each of the three study sites. The aim of the discussion was to compliment and verify information from the surveys and key informant interviews. Participants were drawn from stakeholders engaged in small pelagic fisheries. Priority was given to women participants to ensure coverage of their concerns and knowledge. The focus group discussion lasted between 50 and 70 minutes.

Data analysis

As described by Braun and Clarke (2006), the study made use of thematic analysis to identify patterns of meaning in line with the research objectives. Quotations from key informants and focus group discussions were labelled but participants were given pseudonyms. Confidentiality was one of the requirements for ethics clearance. All completed surveys were entered into MS Excel and then converted to SPSS for data analysis.

Results

Socio-demographic characteristics of survey respondents

Table 1 provides socio-demographic characteristics of the survey respondents. Of the 206 respondents, the majority were male (80 %) and 20 % were female. All respondents participated in diverse livelihood activities including fishing, trade, farming and other sea-based activities such as processing and transporting of fish.

Consumption of small pelagic fishes

A variety of names were used for small pelagic fish species in the responses during the survey. Most of the names were local/vernacular such as *dagaa mchele*, *dagaa papa*, *dagaa lumbuga*, *dagaa vibua*, and *dagaa*. Key informants, especially fisheries officials, as well as scientists knowledgeable of the fisheries commonly found in the study sites were consulted to clarify ambiguity

Table 1. Main socio-demographic characteristic of survey respondents.

Characteristics	Variable	Landing sites			Overall (%/n=206)
		Shangani (%/n=65)	Kivinje (%/n=93)	Sahare (%/n=48)	
Gender	Female	9	19	13	41
	Male	56	74	35	165
Age group (years)	18-30	15	17	17	49
	31-50	29	49	25	103
	>50	21	27	6	54
Education	No schooling	5	9	4	18
	Primary	46	64	37	147
	Secondary	12	19	3	34
	College/Vocational	2	1	4	7
Main occupation	Fisher	17	32	21	70
	Farmer	1	11	8	20
	Fish trader	19	25	12	56
	Fish processor	18	9	3	30
	Porter	7	9	3	19
	Waged job	2	5	1	8
	Other	2	1	0	3

around species names. Naming of the types of fish was not straightforward and was affected by location and socio-cultural background. Consensus was reached by a large proportion of respondents (68 %) that sardines (Clupeidae) (referred collectively as *dagaa*) was the most landed and consumed small pelagic fish in the study sites, followed by anchovy (Engraulidae), mackerel (Scombridae) and other species (Fig. 2). One key informant emphasized that *dagaa* are commonly classified into two groups; *dagaa mchele* and *dagaa lumbuga* as summarized below:

[...] it is possible to hear different names for dagaa. Essentially, these all would mean the same product. Both types of dagaa can be boiled and salted or sun-dried. People will tell you the famous dagaa is dagaa nyama, but I tell you this is the same as dagaa mchele. In other areas especially hinterland like Newala they call it dagaa lumbuga. Different names, but still implying the same product (KII5_140819)

Dagaa was said to be the most consumed fish because of its availability and lower prices compared with other fish species. When asked to identify consumption of these fishes across different income groups (low, middle and high), more than 70 % of survey respondents said that small pelagic fish species are more frequently consumed by low-income households compared to large pelagic species such as tuna and king fish. Larger fish, in their opinion, cost more than low-income households can afford. Many focus group discussion participants claimed that the fact *dagaa* is seen as a convenient fish food for low-income households is

indisputable. This assertion was also supported during the focus group held at Shangani in Mtwara:

The thing here is not preference. You see, everywhere here is dagaa, this is what is commonly landed and the catch is often bigger than for other fishes. Many people here lack steady sources of income, and we classify ourselves as poor. Our option is on dagaa, at least we can afford. We cannot go for changu or tuna [big fishes]. Those are for a few people who are well off and the vast majority is taken by traders who carry it to rich people in Dar es Salaam, although those people don't know where this fish has originated from (FGD 1_081219)

Approximately 45 % of key informants said that over 70 % of small fish landed is consumed locally, both within their areas and outside their areas. The remainder is transported by traders to neighboring countries, particularly the Democratic Republic of Congo (DRC). Survey respondents older than 50 years suggested that fishing activities have changed over time, as has fish eating habits and preferences. Their opinion was that small fishes such as *dagaa* were seen as inferior fish species and only few people would prefer for them. This too was captured in a focus group discussion where a 65 years old man, identified as a seasonal fisher/fish trader, said that before the early 1980s, fish resources were abundant and often people preferred large fish to small fish:

Local fish has been the most frequently consumed protein, and not beans! Things have changed, you can't imagine. During that time [1980s], nobody would choose dagaa

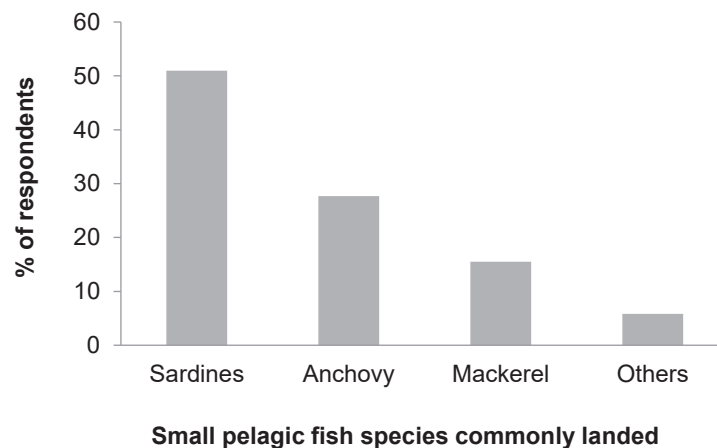


Figure 2. Proportion of small pelagic fish commonly landed across all three study sites, including sardine (Clupeidae) (referred to collectively as *dagaa*) as the most commonly landed and consumed small pelagic fish, followed by anchovy (Engraulidae) and mackerel (Scombridae).

Table 2 Selected questions to gauge responses on issues related to production of small pelagic fisheries

Question	Most likely (%, n)	Likely (%, n)	Neither likely nor unlikely (%, n)	Unlikely (%, n)	Most unlikely (%, n)
Current consumption of small pelagic fish might increase if fisheries resources management are improved	7.28% (15)	44.66% (92)	35.92% (74)	11.17% (23)	0.97% (2)
Financial and technical support to groups of small pelagic fisheries would improve their production efficiency	48.54% (100)	27.18% (56)	4.85% (10)	12.62% (26)	6.80% (14)
Fisheries governance initiatives will succeed to safeguard the interest of small pelagic fisheries	3.40% (7)	14.56% (30)	27.67% (57)	44.17% (91)	10.20% (21)

as this was seen as a sign of being poor. But now, dagaa is like gold, many people here can't even afford it. It has now turned to be an attractive commodity. Frequency of consuming fresh fish has declined; you now see in our market over there we even sell sardine from Lake Victoria (FGD2_171219)

I know one industry; I forget the name but is located in Mbezi beach area. I heard that they buy sardines from lake to produce fishmeal. I have never heard or seen any trader here buying sardines with the intention of selling to such industries. It could be, but I have no proof (FGD3_281219)

Both the Kilwa Kivinje, Shangani and Sahare interviews and participant observation indicated a lack of activities and initiatives by both government and non-governmental groups to promote small pelagic fisheries through facilitation such as extension services to fishers, training on processing and marketing, as well as creating an enabling environment for access to fishing gears and vessels. According to informants, it is not easy to identify the origin of these small pelagic fishes given that some could be brought from fishing grounds located in northern Mozambique and sold at local landing sites. This was also noted by one key informant in Kivinje:

It is clear that there is fish deficit. Fishers are poor, cannot access loans to purchase big fishing nets and motorized boat. They [government] see us dependent on dagaa, but no help has been channeled to improve dagaa fishery. [...] you may think that they feel dagaa is not a preferred fish, but this is our food and also, we make money to cover our needs from it (KII18_140819)

Over 80 % of survey respondents mentioned that small pelagic fish landed are destined for human consumption. A few respondents (8 %) were aware of the use of small fishes for producing fishmeal. When asked if they knew or have heard about a fishmeal and fish oil industry along the coast, the answer was no. During focus group discussions in Sahare, in Tanga, some participants were aware of fish feed producing industries located in Dar es Salaam but there was uncertainty.

When asked about price of small pelagics relative to other fish species, the majority of respondents (54 %) indicated that most often fish like *dagaa* would be cheaper than finfish such as king fish, emperor, tuna, barracuda and other large fish. This too was noted by one key informant who explained that it is common to see women buying *dagaa* and selling them elsewhere in small piles for approximately Tsh 1,000–2,000 (US\$ 0.4–0.8 as of 2021 exchange rate). There is often a profit margin, as reported during focus group discussions, when these women sell processed *dagaa*.

Interestingly, key informants said that when large fishes are available at lower prices, people prefer them. Many respondents (Table 2) were pessimistic with regard to whether actions would be put in place to ensure better performance of small pelagic fisheries for both food security and sovereignty.

Demand for small pelagic fish as food

The survey indicated that fish is a major component of the human diet in the study sites. Although district level official records on fisheries do not include figures that indicate existing demand and supply of fish, or their species, for human consumption, information from interviews and observation suggests that demand outstrips production. The majority of survey respondents (78 %) said that fish for consumption, within their area, is locally sourced but once landed it is traded as part of broader trade and distribution systems. Interestingly, 60 % of survey respondents agreed that fish may not be obtained when needed.

Key informants indicated that fish are bought with cash from fishers or from markets and that *madalali* (middlemen) buy directly from fishers and are able to pack fish in ice boxes and transport them for greater profit to distant markets, including Ferry (Kigamboni) fish market in Dar es Salaam. This decreases the fish available to locals. The lack of infrastructure such as refrigerators, was repeatedly mentioned during focus group discussions and interviews as a limiting factor to purchasing fish in bulk. Discussions revealed that processing methods such as salting, boiling, drying or frying are not commonly preferred by consumers:

“People want fresh fish. Those further from the sea are the ones that will run to buy dried or fried fish, but for us here we are very much interested with freshy fishes. [...] Seasonality has also its own role, suppose you dry dagaa during bumper season, who are you expecting will buy them? Only fresh will suit customers” (FGD3_281219)

Fresh fish are preferred but participants of discussion groups agreed that dried and fried fish are also consumed. The majority of survey respondents said that the diversity of small fish species in their diet is low compared to the past 10–20 years (Fig. 3). Processed fisheries products, such as smoked small fish, were rare. In one discussion, it was learned that smoking these types of fish is uncommon given taste preferences and that smoking *dagaa* without spoilage can be difficult.

Less than 15 % of survey respondents agreed that fish landed in their areas meet the demand, while 70 % said that the supply is low, and that people have adapted and buy vegetables or meat products to substitute

fish. Nonetheless, it was clarified in the Shangani focus group discussion that the inflow of people from fish-eating cultures into coastal areas has caused an increase in fish demand. Nearly three-quarters of participants in this discussion group perceived a deficit in meeting fish demand and attributed this to decline in catch, influx of fish traders who transport fish to the hinterland markets, price and losses incurred when fish are landed prior to reaching consumers as noted in the following excerpts:

It is good if large fishing vessels are not licensing here to prevent them getting much which they don't sell in our markets. If they sell here, the price is high, we cannot afford. Yet problems are still there, fishers use traditional wooden boxes which are not effective in keeping fish afresh resulting into fish spoilage. People here process these fish in different styles they are known to them, it is not uniform because they have not been trained. What you see is a trader packing fish here and before they reach a market in Nachingwea they are already spoiled (FGD2_17919).

We don't smoke dagaa, only few households would do it. Smoking may reduce taste and, in some instances, cause spoilage. I also think it is because we have never smoked dagaa not because of their size, I guess it is our traditional. There could be a likelihood to start and see how is going to appear (FGD1_081219)

In the survey results, 50 % of respondents were of the opinion that current consumption of fish was low compared with the past 2–3 decades, and 67 % said that on average they consume fish (irrespective of type, but mostly small fishes) two times in a week. Clarification

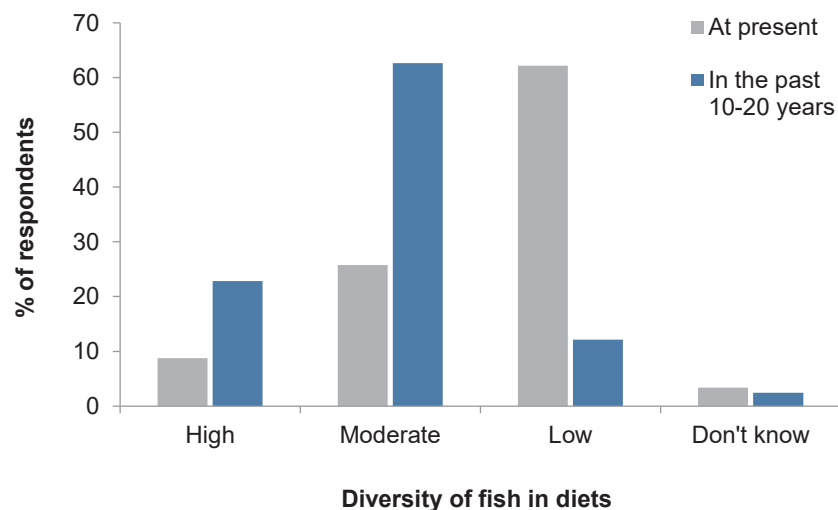


Figure 3. Responses to the question on how diversity of fish in human diets is perceived to differ from the present to what it was 10-20 years ago in the study sites.

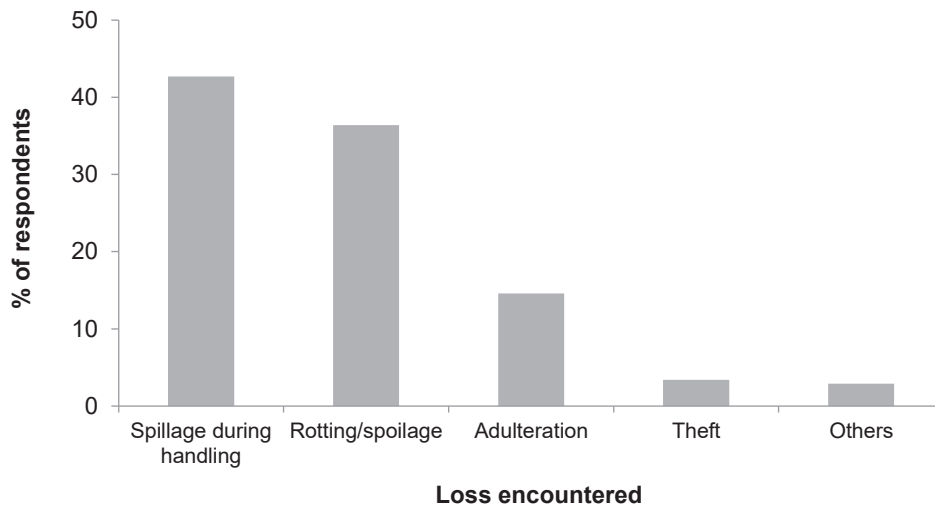


Figure 4. Response to the question on where losses of small pelagic fish occurs before reaching markets or households. Adulteration occurs when harmful chemicals are added to preserve fish.

from key informants revealed that the attitude of local residents towards fish consumption was positive and they have a good understanding on the importance of fish food for their nutritional requirements and health.

Level of fishing effort for small pelagic fishes

A review of secondary sources, including annual government fisheries reports, showed that the current levels of fishing in many coastal areas is unsustainable (MLF, 2020). However, the status of small pelagic species is not well understood (Anderson and Samoily, 2016; Mwaipopo and Mahongo, 2020). Despite contributing an important source of livelihoods and food security, few catch statistics clearly showed the levels of effort for small pelagics.

More than 90 % of survey respondents ranked fishing as the primary occupation of people in the study sites. Focus group discussions and interactions during field work revealed few opportunities for the residents to engage in other economic sectors. A discussion held at Sahare indicated that fishing effort is increasing and the current management approach (i.e., licensing and prohibiting gear and vessels) has not been able to curtail this increase. Sixty percent of respondents said that fishers go fishing on average two days per week. Most engage in the ring net or purse seine fishery which mainly target small pelagic fish. They work mainly as crew members because they cannot afford to buy their own fishing gear and vessels. Most of these fishers lack access to financial services and are not organized into groups that could be easily connected to donors and funding schemes. One key informant explained that a ring net fishing crew may attract up to 70 people, suggesting a high level of fishing effort in unrestricted

fishing grounds. The rapid increase in fishing effort does not, however, seem to be satisfying an increasing demand from existing production:

With these gears and vessels, where efficiency is low, we won't meet the growing demand of fish. Our crew members cannot find new fishing areas because the vessels they use are poor and sometimes are not propelled by engines. Going to new fishing areas is also a weird thing, because in our place here [Kivinje] there are many people from all over Tanzania. How then you leave here pretending you are going to fish where people have relocated because there is no fish available there (FGD3_281219)

Losses of small pelagic fish products

Across the three study sites survey respondents were interviewed to examine their understanding on fish product losses occurring from boat to consumers. In most instances, survey respondents and discussion participants explained that the small pelagic fishery experienced losses caused by spoilage during the season where the catch is high. The main causes were associated with limited or absence of processing capacity and methods that could adapt to significantly increased volume of catch. The other obvious loss mentioned during focus group discussions and interviews was attributed to discoloration, which according to 50 % of survey respondents happens when fishes are dried in the rainy season. Awareness of fish product losses and their associated economic and ecological impacts was high among survey respondents. Nearly 60 % of respondents agreed that they have experienced one type of post-harvest loss (Fig. 4) whereas 45 % were able to mention the causes of the losses.

A focus group discussion held in Kivinje revealed that the extended time taken from when the fish is caught to when it is transported from the landing site to markets is responsible for huge losses. Key informants suggest that these losses result in demand for fish outstripping supply:

It takes time as fishers would need to travel even up to 6 hours from where they have captured fish. They lack ice boxes or any materials that could preserve their catch. [...] you see those trucks parked over there! Waiting for fish to be auctioned, then they transport to different markets. This too affects the quality of fish and reduces availability of fish to consumers (FGD2_171219)

Despite losses along the fish value chain mentioned during interviews, some key informants pointed out that not all catches are wasted. They gave examples where fishers or fish traders mix deteriorating fish with better quality fish or sell at lower prices:

Nobody would be happy to incur losses. They mix up. Look, how will you know if the dagaa you are bargaining is all good, as it is being sold in a bucket. We are not happy with this, but there is nothing we can do except bearing the loss (KII24, 191019)

All but six key informants (n=25) reported that a large percentage of small pelagic fishes caught in the study sites are processed with methods that might compromising the quality of the fish. Sun drying, boiling and salting and deep frying were the most common processes observed in all study sites. Smoking was occasionally seen in Kivinje. Sun drying was ranked as the processing activity most often carried out (56 %), followed by boiling and salting (28 %) and deep frying (16 %). Approximately 65 % of survey respondents felt that losses are a barrier for them meeting their fish food demand and negatively impact their income. The research found few initiatives in place to transform these methods and support the transition to modern processing methods.

Discussion

The present study discovered an increasing number of people participating in small pelagic fisheries using rudimentary fishing gears and vessels in Tanzania. The catch is either consumed locally or transported to different markets, including across the border to DRC, Zambia and Kenya (Ibengwe *et al.*, 2022). Following the decline in fish resources, small pelagic fishes, especially *dagaa*, is now seen as an affordable fish for

the majority of poor households in coastal Tanzania and beyond. Yet, few initiatives have been developed to modernize the fisheries sector, and improve efficiency. The existing small pelagic fisheries in Tanzania do not seem to satisfy the demand and is influenced by lower prices and availability and a growing number of consumers and markets. This poses problems for food and nutrition security and hinders the prosperity of the sector to develop food sovereignty which goes beyond food security to include culture, knowledge systems and ecosystem dynamics.

Other regions of the world have increased their food sovereignty through improvement in their fisheries sector. These include movements to improve food supply chains to support household consumption of fish and sales of fish to earn income (Levkoe *et al.*, 2017). Emphasis has also been put on acknowledging the origin of fisheries products through certification (Bellchambers *et al.*, 2016; Nyiawung *et al.*, 2021).

Although efforts have already been undertaken to develop and implement management plans for some fisheries, including prawn, octopus as well as small and large pelagic fisheries, not all fisheries are adequately managed in Tanzania (Bradford and Katikiro, 2019; Gates *et al.*, 2021; MLFD, 2013; Silas *et al.*, 2022). In areas where fisheries management plans have been developed, the use of fishers to collect data and information relevant for monitoring and management plans has been valuable to support food sovereignty. Fishers, in such cases, are provided with important training and instruments, and act as stewards of their own resources despite having a limited voice in political decision-making. Despite their importance in recording the catch landed, inadequate support by both governmental and non-governmental actors for small pelagic fisheries in Tanzania has affected the capacity of the fishery to meet increasing human consumption and self-management.

The current situation in Tanzania does not indicate that this sub-sector will be able to supply fish in the quantity needed to meet demand. This may have negative repercussions on the small pelagic fish value chain, and affect a number of actors along the chain from fishers to consumers. In the recent past, *dagaa* are crossing borders, with consequences for decreasing fish availability for local household consumption and making it a competitive food commodity (Ibengwe *et al.*, 2022). In regions where government fisheries initiatives have succeeded, e.g., Asia Pacific,

to safeguard the interests of the small pelagic fisheries, their role in food security and sovereignty has grown (Ba *et al.*, 2017; Cook *et al.*, 2021; Tezzo *et al.*, 2021). In Tanzania, fisheries management interventions have been less successful, likely as a result of their pilot study nature and only covering limited areas along the Tanzanian coastline.

One approach that has been effective in addressing management in small pelagic fisheries is focused on marketing channels. In several regions of the world, this has been carried out to bolster existing management options, such as gear restrictions and closed seasons. In Bangladesh, for example, the ecosystem approach to fisheries management has led to signs of ecosystem recovery (Islam *et al.*, 2022). Similarly, in the Philippines, fish aggregative devices (FADs) have shown to increase average catch by about 5 kg (Palm *et al.*, 2021). However, FAD projects are not a long-term ecosystem approach to sustainable management given their shortcomings such as scarcity of required expertise, high cost of equipment, attraction of illegal fishers (Onyango *et al.*, 2021) as well as the lack of planning, monitoring and research needed to understand and fulfill their potential in nearshores (Bell *et al.*, 2015).

In this study, fishers prefer to sell their catch for financial gain, leaving the poor where fishing is taking place with limited access to fish or, when fish is available, unaffordable prices. Governance mechanisms could be put in place to support local communities, for instance prohibiting large sales to hinterland markets during low fishing seasons. These communities lack alternatives and eventually are forced to change their dietary needs, as seen in recent years where they opt for vegetables and beans instead of fish. This contributes to their food security but compromises the idea of small pelagic fish for food sovereignty. The economic value of small pelagic fishes in Tanzania is hidden by unrecorded 'export' of these fishes, to common markets in DRC and other countries. These fishes are transported 'illegally' to various areas, crossing borders without proper permits. The lack of data on this trade limits the actual recorded economic value of the fishery but indicates possibilities for expanding the incomes of fishers and traders of these species, which is one step toward food sovereignty.

It is important that any approach aimed at strengthening food sources, as with pelagic fisheries in this case, is set within the locally specific context, and that it recognizes the dynamic nature of food sources, as

any number of complex factors are likely to impede the success of the approach. In order to identify interventions that will help to achieve sustainable food systems, an understanding is first needed of the existing context in which people exist (Arthur *et al.*, 2022). We need to understand how poor coastal communities are responding to pressures on their food security and livelihoods, how they are engaging with the coastal environment and what drives their livelihood choices. This information is the foundation on which we can then work with communities to sustainably enhance ocean governance policies that improve their livelihood opportunities whilst not degrading the coastal environment.

Limited data on the production and consumption of small pelagic fishes was a main limitation of this study. The study has relied on recording the perspective of respondents in interviews and focus group discussions as well as the extrapolation of information from the limited reports and research available. Future studies need to focus on specific species of small pelagic fish and trace the value chain from production to consumption as a way to examine who will consume these fish in future. Furthermore, governance frameworks and policy recommendations for improving the role of fish in food security need to be streamlined in the current and potential fisheries management strategies. Barriers to the performance of the small pelagic fishery, including poor growth in the overall fisheries sector, should receive policy attention and prioritization in research.

Conclusions

It is evident that the existing production and marketing channels for marine small pelagic fishes in Tanzania are inadequate to promote food security and sovereignty. Urgent measures are required including integrating fisheries in the overall food production systems. Transformation in small scale fisheries is also important for creating a supportive environment for small scale fishers to be self-sufficient from the fish they catch. It became evident that the majority of people engaging in the small pelagic fish production chain lacked the skills to take the fishery forward on their own and that there was a need to support the process. There is a need to support small pelagic fisheries operations including processing, packaging, transportation, from skills development to business planning, and the development of markets. This requires long term commitment from both the public and private sector. Most of the fishing

units in the small pelagic fishery are generally small enterprises and these require an initial capital investment or startup cost. Many fishers do not have access to micro-credit services to finance these initial costs. For small pelagic fisheries in Tanzania to contribute to satisfying current demand of fish there is a need to support the development of skills to run these enterprises with relevant technical and financial management skills. There has been a lack of support to move the small pelagic fishery from a subsistence activity to a profitable economic opportunity for communities. Improving working conditions of fishers engaged in small pelagic fisheries as well as creating a favourable environment to support their activities would promote the role of this fishery in food sovereignty.

References

- Akande G, Diei-Ouadi Y (2010) Post-harvest losses in small-scale fisheries: Case studies in five sub-Saharan African countries. FAO Fisheries and Aquaculture Technical Paper. FAO, Rome. 72 pp [https://www.fao.org/3/i1798e/i1798e.pdf accessed on 18/05/2021]
- Anderson J, Samoilys M (2016) The small pelagic fisheries of Tanzania. In: Anderson J, Andrew T (eds) Case studies on climate change and African coastal fisheries: A vulnerability analysis and recommendations for adaptation options. FAO Fisheries and Aquaculture Circular 1113. pp 19-60
- Andriess E, Saguin K, Ablo AD, Kittitornkool J, Kongkaew C, Mang'ena J, Onyango P, Owusu V, Yang J (2022) Aligning bottom-up initiatives and top-down policies? A comparative analysis of overfishing and coastal governance in Ghana, Tanzania, the Philippines, and Thailand. *Journal of Rural Studies* 92: 404-414 [https://doi.org/10.1016/j.jrurstud.2022.03.032]
- Arthur RI, Skerritt DJ, Schuhbauer A, Ebrahim N, Friend RM, Sumaila UR (2022) Small-scale fisheries and local food systems: Transformations, threats and opportunities. *Fish and Fisheries* 23: 109-124 [https://doi.org/10.1111/faf.12602]
- Ayilu RK, Fabinyi M, Barclay K (2022) Small-scale fisheries in the blue economy: Review of scholarly papers and multilateral documents. *Ocean & Coastal Management* 216: 105982 [https://doi.org/10.1016/j.ocecoaman.2021.105982]
- Ba A, Schmidt J, Dème M, Lancker K, Chaboud C, Cury P, Thiao D, Diouf M, Brehmer P (2017) Profitability and economic drivers of small pelagic fisheries in West Africa: A twenty year perspective. *Marine Policy* 76: 152-158 [https://doi.org/10.1016/j.marpol.2016.11.008]
- Bell JD, Albert J, Andréfouët S, Andrew NL, Blanc M, Bright P, Brogan D, Campbell B, Govan H, Hampton J, Hanich Q, Harley S, Jorari A, Lincoln Smith M, Pontifex S, Sharp MK, Sokimi W, Webb A (2015) Optimising the use of nearshore fish aggregating devices for food security in the Pacific Islands. *Marine Policy* 56: 98-105 [https://doi.org/10.1016/j.marpol.2015.02.010]
- Bellchambers LM, Gaughan DJ, Wise BS, Jackson G, Fletcher WJ (2016) Adopting Marine Stewardship Council certification of Western Australian fisheries at a jurisdictional level: The benefits and challenges. *Fisheries Research* 183: 609-616 [https://doi.org/10.1016/j.fishres.2016.07.014]
- Bradford K, Katikiro RE (2019) Fighting the tides: A review of gender and fisheries in Tanzania. *Fisheries Research* 216: 79-88 [https://doi.org/10.1016/j.fishres.2019.04.003]
- Braun V, Clarke V (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology* 3 (2): 77-101 [https://doi.org/10.1191/1478088706qp063oa]
- Breuil C, Bodiguel C (2015) Report of the meeting on marine small pelagic fishery in the United Republic of Tanzania. SFFAO/2015/34, IOC-SmartFish Programme of the Indian Ocean Commission. FAO. Ebene, Mauritius. 90 pp
- Cohen PJ, Allison EH, Andrew NL, Cinner J, Evans LS, Fabinyi M, Garces LR, Hall SJ, Hicks CC, Hughes TP, Jentoft S, Mills D, Masu R, Mbaru EK, Ratner BD (2019) Securing a just space for small-scale fisheries in the blue economy. *Frontiers in Marine Science* 6:1-8
- Cook R, Acheampong E, Aggrey-Fynn J, Heath M (2021) A fleet based surplus production model that accounts for increases in fishing power with application to two West African pelagic stocks. *Fisheries Research* 243: 106048 [https://doi.org/10.1016/j.fishres.2021.106048]
- Cushing DH, Shipley ON, Siskey MR (2019) Pelagic fishes. In: Cochran JK, Bokuniewicz HJ, Yager PL (eds.) *Encyclopedia of ocean sciences (Third Edition)*. Academic Press, Oxford. pp 290-296 [https://doi.org/10.1016/B978-0-12-409548-9.10848-6]
- FAO (2020) State of the world fisheries and aquaculture 2019. Food & Agriculture Organization of the United Nations, Rome. 244 pp
- Gates AR, Durden JM, Richmond MD, Muhando CA, Khamis ZA, Jones DOB (2021) Ecological considerations for marine spatial management in deep-water Tanzania. *Ocean & Coastal Management* 210: 105703 [https://doi.org/10.1016/j.ocecoaman.2021.105703]

- Groeneveld J (2016) Capture fisheries. Chapter 21. In: Paula J (ed) *The regional state of the coast report: Western Indian Ocean*. UNEP Nairobi Convention and WIOMSA. pp 207-219
- Herrón P, Castellanos-Galindo GA, Stäbler M, Díaz JM, Wolff M (2019) Toward ecosystem-based assessment and management of small-scale and multi-gear fisheries: Insights from the tropical eastern Pacific. *Frontiers in Marine Science* 6: 1-17 [https://doi.org/10.3389/fmars.2019.00127]
- Ibengwe LJ, Onyango PO, Hepelwa AS, Chegere MJ (2022) Regional trade integration and its relation to income and inequalities among Tanzanian marine dagaa fishers, processors and traders. *Marine Policy* 137: 104975 [https://doi.org/10.1016/j.marpol.2022.104975]
- Islam MdM, Nahiduzzaman Md, Acosta R, Mome MA, Wahab MdA (2022) Status and potential of ecosystem approach to fisheries management (EAFM) in Bangladesh. *Ocean & Coastal Management* 219: 106068 [https://doi.org/10.1016/j.ocecoaman.2022.106068]
- Jacobs ZL, Yool A, Jebri F, Srokosz M, van Gennip S, Kelly SJ, Roberts M, Sauer W, Queirós AM, Osuka KE, Samoilys M, Becker AE, Popova E (2021) Key climate change stressors of marine ecosystems along the path of the East African coastal current. *Ocean & Coastal Management* 208: 105627 [https://doi.org/10.1016/j.ocecoaman.2021.105627]
- Jebri F, Jacobs ZL, Raitzos DE, Srokosz M, Painter SC, Kelly S, Roberts MJ, Scott L, Taylor SFW, Palmer M, Kizenga H, Shaghude Y, Wihsgott J, Popova E (2020) Interannual monsoon wind variability as a key driver of East African small pelagic fisheries. *Scientific Reports* 10: 13247 [https://doi.org/10.1038/s41598-020-70275-9]
- Jiddawi NS, Öhman MC (2002) Marine fisheries in Tanzania. *Ambio* 31 (7-8): 518-527
- Jury M, McClanahan T, Maina J (2010) West Indian Ocean variability and East African fish catch. *Marine Environmental Research* 70: 162-70
- Kadagi NI, Wambiji N, Fennessy ST, Allen MS, Ahrens RNM (2021) Challenges and opportunities for sustainable development and management of marine recreational and sport fisheries in the Western Indian Ocean. *Marine Policy* 124: 104351 [https://doi.org/10.1016/j.marpol.2020.104351]
- Kizenga HJ, Jebri F, Shaghude Y, Raitzos DE, Srokosz M, Jacobs ZL, Nencioli F, Shalli M, Kyewalyanga MS, Popova E (2021) Variability of mackerel fish catch and remotely-sensed biophysical controls in the eastern Pemba Channel. *Ocean & Coastal Management* 207: 105593 [https://doi.org/10.1016/j.ocecoaman.2021.105593]
- Levkoe CZ, Lowitt K, Nelson C (2017) "Fish as food": Exploring a food sovereignty approach to small-scale fisheries. *Marine Policy* 85: 65-70 [https://doi.org/10.1016/j.marpol.2017.08.018]
- March A, Failler P (2022) Small-scale fisheries development in Africa: Lessons learned and best practices for enhancing food security and livelihoods. *Marine Policy* 136: 104925 [https://doi.org/10.1016/j.marpol.2021.104925]
- McClatchie S, Vetter RD, Hendy IL (2018) Forage fish, small pelagic fisheries and recovering predators: managing expectations. *Animal Conservation* 21: 445-447 [https://doi.org/10.1111/acv.12421]
- Ministry of Blue Economy and Fisheries (2021). Draft report Zanzibar fisheries frame survey. Department of Fisheries and Aquaculture and Department of Marine Conservation, Zanzibar. 40 pp
- MLFD (2013) Management plan for the Tanzanian artisanal fishery for small and medium pelagic fish species. Fisheries Resource Development. Ministry of Livestock and Fisheries Development, United Republic of Tanzania. 20 pp
- MLF (2019) Annual fisheries report (January-December 2019). Ministry of Livestock and Fisheries Development, Dodoma, Tanzania. 63 pp
- MLF (2020) Annual fisheries report (January-December 2020). Ministry of Livestock and Fisheries Development, Dodoma, Tanzania. 59 pp
- Mwaipopo R, Lange G-M, Breton Y (2010) Understanding the human dimensions in the management of coastal and marine resources in the WIO region. *Ocean & Coastal Management* 53 (4): 147-149 [https://doi.org/10.1016/j.ocecoaman.2010.01.005]
- Mwaipopo R, Mahongo SB (2020) Adaptive capacity of small pelagic fishing communities in coastal Tanga (Tanzania) to changes in climate-related phenomena. *Western Indian Ocean Journal of Marine Science* 1: 127-144
- Nyiwawung RA, Raj A, Foley P (2021) Marine Stewardship Council sustainability certification in developing countries: Certifiability and beyond in Kerala, India and the Gambia, West Africa. *Marine Policy* 129: 104526 [https://doi.org/10.1016/j.marpol.2021.104526]
- Obura D, Burgener V, Owen S, Gonzales A (2017) Reviving the Western Indian Ocean economy: Actions for a sustainable future. WWF International, Gland, Switzerland. 64 pp
- Ochiewo J (2015) Social and economic impacts of capture fisheries and mariculture. *The regional state of the coast report: Western Indian Ocean*. UNEP, Nairobi, Kenya. pp 306-316

- Okafor-Yarwood I, Kadagi NI, Belhabib D, Allison EH (2022) Survival of the richest, not the fittest: How attempts to improve governance impact African small-scale marine fisheries. *Marine Policy* 135: 104847 [https://doi.org/10.1016/j.marpol.2021.104847]
- Onyango HO, Ochiewo JO, Karani NJ (2021) Socio-economic prospects and problems in under-exploited offshore marine fisheries: The case of Fish Aggregating Devices (FADs) in Kenya coastal fisheries. *Regional Studies in Marine Science* 44: 101706 [https://doi.org/10.1016/j.rsma.2021.101706]
- Palm KE, Campbell GA, Apriesnig JL (2021) Management of local fisheries: A case study of Laoang, Northern Samar, Philippines. *Marine Policy* 132: 104657 [https://doi.org/10.1016/j.marpol.2021.104657]
- Palmer MR, Shagude YW, Roberts MJ, Popova E, Wihsgott JU, Aswani S, Coupland J, Howe, JA, Bett BJ, Osuka KE, Abernethy C, Alexiou S, Painter SC, Kamau JN, Nyandwi N, Sekadende B (2021) Marine robots for coastal ocean research in the Western Indian Ocean. *Ocean & Coastal Management* 212: 105805 [https://doi.org/10.1016/j.ocecoaman.2021.105805]
- Robertson MD, Midway SR, West L, Tillya H, Rivera-Monroy VH (2018) Fishery characteristics in two districts of coastal Tanzania. *Ocean & Coastal Management* 163: 254-268 [https://doi.org/10.1016/j.ocecoaman.2018.06.015]
- Robertson MD, Midway SR (2019) Predicting coastal fishing community characteristics in Tanzania using local monitoring data. *Journal of Environmental Management* 246: 514-525 [https://doi.org/10.1016/j.jenvman.2019.05.082]
- Sekadende B, Scott L, Anderson J, Aswani S, Francis J, Jacobs Z, Jebri F, Jiddawi N, Kamukuru AT, Kelly S, Kizenga H, Kuguru B, Kyewalyanga M, Noyon M, Nyandwi N, Painter SC, Palmer M, Raitos DE, Roberts M, Sailley SF, Samoily M, Sauer WHH, Shayo S, Shaghude Y, Taylor SFW, Wihsgott J, Popova E, 2020. The small pelagic fishery of the Pemba Channel, Tanzania: What we know and what we need to know for management under climate change. *Ocean & Coastal Management* 197: 105322 [https://doi.org/10.1016/j.ocecoaman.2020.105322]
- Silas MO, Mgeleka SS, Polte P, Sköld M, Lindborg R, de la Torre-Castro M, Gullström M (2020) Adaptive capacity and coping strategies of small-scale coastal fisheries to declining fish catches: Insights from Tanzanian communities. *Environmental Science & Policy* 108: 67-76 [https://doi.org/10.1016/j.envsci.2020.03.012]
- Silas MO, Kishe MA, Mgeleka SS, Kuboja BN, Ngatunga BP, Matiku P (2022) The octopus fishing closures positively impact human wellbeing and management success; case of Tanzania. *Ocean & Coastal Management* 217: 106022 [https://doi.org/10.1016/j.ocecoaman.2021.106022]
- Stephenson RL, Smedbol RK (2019) Small pelagic species fisheries. In: Cochran JK, Bokuniewicz HJ, Yager PL (eds) *Encyclopedia of ocean sciences* (Third Edition). Academic Press, Oxford. pp 503-509 [https://doi.org/10.1016/B978-0-12-409548-9.11491-5]
- Taylor SFW, Roberts MJ, Milligan B, Ncwadi R (2019) Measurement and implications of marine food security in the Western Indian Ocean: an impending crisis? *Food Security* 11: 1395-1415 [https://doi.org/10.1007/s12571-019-00971-6]
- Tezzo X, Aung HM, Belton B, Oosterveer P, Bush SR (2021) Consumption practices in transition: Rural-urban migration and the food fish system in Myanmar. *Geoforum* 127: 33-45 [https://doi.org/10.1016/j.geoforum.2021.09.013]
- UNEP-Nairobi Convention and WIOMSA (2015) Regional state of the coast report: Western Indian Ocean. UNEP and WIOMSA, Nairobi, Kenya. 546 pp [https://wedocs.unep.org/20.500.11822/9668 accessed on 28/03/2021]
- Villasante S, Gianelli I, Castrejón M, Nahuelhual L, Ortega L, Sumaila UR, Defeo O (2022) Social-ecological shifts, traps and collapses in small-scale fisheries: Envisioning a way forward to transformative changes. *Marine Policy* 136: 104933 [https://doi.org/10.1016/j.marpol.2021.104933]
- Vousden D, Stapley J (2013) Evolving new governance approaches for the Agulhas and Somali Current Large Marine Ecosystems through dynamic management strategies and partnerships. *Environmental Development* 7: 32-45 [https://doi.org/10.1016/j.envdev.2013.04.010]

Appendix

Questionnaire used in the survey

1. Demographic characteristics
(name, gender, age, occupation, size of household, occupation)
2. Have you ever heard about small fishes?
(1=Yes; 2=No; 3=Don't know)
3. If the answer is yes, how informed are you about small pelagic fish and fisheries in your area?
(1=Very; 2=Somewhat; 3=Little)
4. Access to small fish in diets in the past 10-20
(1=Increased, 2=same, 3=decreased, 4=Don't know)
5. What has led to increased demand for small fish
(1=Population growth; 2=Urbanization; 3=globalized food trade; 4=Others, please mention)
6. Diversity of fish in your diet
(1=High; 2=Medium; 3=Low, 4=Don't know)
7. Preferences of small fish compared to large fish e.g., reef, large pelagics) in diets
(1=High; 2=Medium; 3=Low; 4=Don't know)
8. Source of small fish supply in your diets
(1=Domestically produced; 2=Imported; 3=Don't know)
9. Would you be willing to modify your diets following decline in availability of fishes you were used
(1=More willingly; 2=Willingly; 3=Neutral; 4=Unwillingly; 5=More)
10. Fish represent an important part of your diet
(1=Strongly agree; 2=Agree; 3=Neutral; 4=Disagree; 5=Strongly disagree)
11. On average, how often do you eat small fishes?
(1=Almost every day; 2=3 to 5 servings in a week; 3=1 to 2 servings in a week; 4=1 to 2 servings in a month; 5=Less than a serving (1) per month; 6=Never/I don't eat small fishes)
12. Where do you go often to buy small fisheries?
(1=Directly from fishers/landing site; 2=Fish traders/Local market; 3=Frozen fish market 4=Others (specify))
13. Among the seafood you buy, which one do you buy most frequently?
(1=Reef fish; 2=Small fish; 3=Large fish; 4=Other)
14. When you buy small fish, you prefer
(1=Fresh; 2=Dried; 3=Frozen; 4=Fried; 5=Canned)
15. What are the most important criteria when you buy seafood/fisheries products?
(1=Price; 2=Freshness; 3=Taste and texture of the seafood; 4=Eating familiarity; 5=Other)
16. How often do you try seafood that is new or unfamiliar to you?
(1=Frequently; 2=Sometimes; 3=Rarely; 4=Never)
17. Vessels that participate in small pelagic fishery
18. Main target species in small pelagic fishery
(1=Sardines; 2=Mackerel; 3=Anchovy; 4=Other)
19. Primary management measures for the small pelagic fishery are through:
(1=Licensing; 2=Closed seasons; 3=Closed fishery; 4=Gear and vessel restrictions; 5=Total allowable)

20. Who is eating pelagic fish now
(1=Low income; 2=Middle income; 3=High income; 4=All income groups, 5=Don't know)?
21. How important is fish in your diet
(1=Important; 2=Moderate; 3=Not important)
22. Who will be eating fish in the future
(1=Low income; 2=Middle income; 3=High income; 4=All income groups, 5=Don't know)?
23. Current consumption of pelagic fishes might increase if fisheries resource management are improved
(1=Most likely; 2=Likely; 3=Neither likely nor unlikely; 4=Unlikely; 5=Most unlikely)
24. To what degree do you think you would benefit from not fishing small fish?
(1=Not benefit; 2=Small; 3=Medium; 4=Big benefit; 5=Don't know)
25. Do you think that not fishing/consuming certain small fishes is a good way to maintain fish around here?
(1=Don't know; 2= Completely disagree; 3=Disagree somewhat)
26. Do you think that other fishers would agree to not fishing small fishes?
(1=Don't know; 2= Completely disagree; 3=Disagree somewhat; 4=Neutral; 5=Agree somewhat; 6=Completely agree)
27. Do you think fish products are good for your health?
(1=Yes; 2=No; 3=Don't know)
28. Fish distribution facilities
(1=Foot; 2=Motor cycle; 3=Bajaj; 4=Bicycle; 5=Mkokoteni; 6=Motor vehicle)
29. Estimated amount of catch landed per boat at present
(1=Big; 2=Low; 3=Moderate; 4=Don't know)
30. Estimated amount of catch landed per boat in the past 10-20 years
(1=Big; 2=Low; 3=Moderate; 4=Don't know)
31. Any mechanism to favour poor households in the management of SPF
(1=Strongly agree; 2=Agree; 3=Neither agree nor disagree; 4=Disagree; 5=Strongly disagree)
32. Fisheries government initiatives have succeeded to safeguard the interests of the SPF
(1=Yes; 2=No; 3=Don't know)