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The gendered dimensions of small-scale fishing activities: A case study from coastal Kenya

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ABSTRACT

Although women contribute substantially to the small-scale fisheries sector globally, in many countries there is a severe lack of gender-disaggregated data on fishing activities. This gender data gap hampers a comprehensive understanding of small-scale fisheries dynamics with implications for fisheries management and food security. In this study, we investigate women's and men's engagement in small-scale fishing through a case study in coastal Kenya, a region characterized by a high dependence on fisheries for local livelihoods and nutritional needs. We applied a mixed method approach, combining participant observation, photography, semi-structured interviews on gender identities (n = 11) and gendered fishing practices (n = 28), an individual survey (n = 141), and pebble games (n = 35). Our results reveal a marked gendered division of labor across the seascape, with women mostly fishing in intertidal areas and men beyond the reef. Further, we find that women's fishing practices are characterized by less fishing gear, less catch, a lower functional diversity of catches, less fishing effort, and less income than those of men. However, women's catches contribute significantly to local diets, accounting for up to 50% of the fish and seafood consumed in fisherwomen-headed households. Despite women's fishing activities appearing less productive and profitable that those of men, they are important for achieving food security in Kenyan coastal communities. Results from this study contribute to broadening our understanding of the gendered dimensions of small-scale fishing and highlight relevant information for developing gender-inclusive management strategies. We conclude by providing key recommendations for fisheries research, management, and governance.

1. Introduction

Globally, small-scale fisheries are pivotal for local livelihoods, economy, and food security (FAO, Duke University, & WorldFish, 2023). Small-scale fisheries (SSF), also called artisanal fisheries, stand out for their lack of consensual definition within the scientific community (Smith and Basurto, 2019). They are broadly understood as multi-gear and multispecies fisheries with common technical and socio-cultural characteristics such as low-capital fishing methods, which differentiate them from industrial fisheries (FAO, 2022). Small-scale fisheries are the largest employer in the marine sector, representing 90% of the world's fishers and providing a key source of income for local communities (FAO, Duke University, & WorldFish, 2023). Further, SSF account for 40% of the global catch in capture fisheries and provide proteins and micronutrients for millions of people globally (Österblom et al., 2020). However, SSF often escape fisheries statistics owing to their diverse and

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informal nature, a certain disregard from governmental administrations, and methodological biases (Basurto et al., 2017). The lack of systematic and accessible data on SSF poses a challenge for the accurate quantification of their contribution to the sector to guide fisheries management (Smith and Basurto, 2019). This data gap is further exacerbated when it comes to considering the gendered nature of SSF.

Although women make up 40% of the SSF workforce (FAO, Duke University, & WorldFish, 2023), their engagement in fisheries has long been invisible, ignored, and unrecognized (Chambon et al., 2023; WSI, 2020). The commonly held image of SSF continues to be one of a male-dominated activity as epitomized by the term "fisherman" (Branch and Kleiber, 2015), thus overlooking women's participation in the production node and beyond (Smith and Basurto, 2019). Against this background, there has been a recent interest in fisheries policy development and research in adopting a gender lens to grasp a more complete picture of fisheries (FAO, 2016; Williams, 2008). At the institutional level, the FAO's Gender Handbook (2017), which completes the FAO's SSF Guidelines (2015), reiterates the importance of gender equality and equity in SSF. In academia, the growing study field of gender and fisheries aims to understand how gender - alongside other social categories such as age or ethnicity - influences the engagement of individuals of diverse gender identities in the SSF sector (Williams et al., 2002, 2008).

In this regard, researchers have striven to highlight the important contribution of women in fishing households from caring tasks such as cooking to raising children or managing finances (Raduan et al., 2010; Szymkowiak, 2020). While these support activities are not directly part of SSF, they are necessary for sustaining the whole SSF productive economy (Williams, 2019). Within the SSF value chain, women's participation has been primarily reported in the post-production stage, through fish processing and sales (Chavance and Morand, 2020; Lentisco and Lee, 2015). At the production level, studies have documented how fisherwomen also account for an important part of the fisher population, although their contribution to SSF landings varies regionally (FAO, 2022; Weeratunge et al., 2010). Research shows that women's fishing practices often differ from those of men, as they mostly consist of gleaning invertebrates in nearshore waters, while men usually fish offshore using boats (Grantham et al., 2020; Kleiber et al., 2015). It has been globally described in the literature how these differences in access and uses of fisheries resources maintain a gendered division of the seascape (Koralagama et al., 2017) - defined here as a spatially heterogeneous marine area, scientifically and strategically defined, and perceived as a mosaic of patches (Boström et al., 2011; Pittman, 2018). Despite these recent efforts to document the gendered nature of fishing activities, gender-disaggregated data on fishing, especially quantitative information, remains particularly scarce, which challenges the development of effective management strategies (Chambon et al., 2023; Kleiber et al., 2015).

In Kenya, SSF dominate the marine fisheries sector, accounting for 80% of the marine catch in volume (Kimani et al., 2018). Like in other tropical coastal countries, Kenyan SSF contribute substantially to local socio-economic and nutritional needs. While Kenyan SSF have been extensively studied from a social-ecological point of view (Cinner et al., 2012; Evans et al., 2011; Lau et al., 2021), little research has adopted a gendered approach and examined women's roles in the fisheries sector (Matsue et al., 2014). The limited number of studies on the topic have mostly focused on women's participation in pre- and post-production. For instance, previous research has highlighted the importance of female small-scale fishmongers for SSF management and governance in Kenya (Matsue et al., 2014). Overall, there is a major data gap regarding women's participation in small-scale fishing. Although the Kenyan authorities estimate that fisherwomen represent less than 2% of the total fisher's population (GoK, 2016), current gender biases in fisheries research methods (Kleiber et al., 2015) are reason to consider this number with caution. A handful of studies have started describing women's fishing practices in Kenya by examining their ecological knowledge (Alati et al., 2020), their engagement in specific fisheries such as the shelled mollusc fishery (Alati et al., 2023), and their vulnerability to external shocks such as Covid-19 (Lau et al., 2021), calling for further research on fisherwomen's activities and contributions to local livelihoods.

The data gap on fisherwomen in Kenya is problematic from an ecological, socio-economic, and governance standpoint. First, the lack of information about women's fishing practices may lead to underestimating their fishing efforts as well as the range of species and ecosystems they target, with direct implications for fisheries management (Kleiber et al., 2015). For instance, Kleiber et al. (2013) show how the limited definition of what a "fisher" is in SSF communities of the Central Philippines obscured the gleaning activities of women, leading to an underestimation of the total fishing effort and catch. This gender data gap also poses a challenge for a thorough understanding of Kenyan coastal social-ecological systems (SES) and the interconnections between fisherfolk and fisheries resources. Second, overlooking fisherwomen's activities may lead to an under-valuation of their socio-economic contribution to their communities and households, particularly in terms of food security. For example, the importance of women's contributions to subsistence fishing has been widely documented in other regions of the world (Harper et al., 2013; Hauzer et al., 2013; Thomas et al., 2021), but evidence in Kenya is scarce. This lack of information may mask the importance of fisherwomen's catches for local food security and household income. Finally, the lack of gender-disaggregated data in fishing has implications for fisheries governance since it may generate a gender-blind feedback loop which, in turn, excludes women from management and governance positions (FAO, Duke University, & WorldFish, 2023). As long as fisherwomen's practices remain undocumented, their needs and views may fail to be included in management and decision-making (Chambon et al., 2023; Mangubhai and Lawless, 2021).

While we recognize the multiple roles played by women within the SSF value chain and beyond, this study addresses the specific gender data gap on the SSF production node in Kenya. We do so by documenting and quantifying the respective contributions of fisherwomen and fishermen to the SSF sector with regard to local food security. More specifically, our research aims at.

(O1) Understanding how gender identities shape the access and uses of the seascape;
(O2) Documenting gendered fishing practices and their spatiotemporal fluctuations;
(O3) Comparing daily fishing catch, effort, and income of fisherwomen and fishermen;
(O4) Analyzing the composition of local meals and fisherwomen's contribution to diets.

Although we acknowledge the diversity of gender identities within fisherfolk (Kenny and Tapu-Qiliho, 2022), we apply here a binary view of gender (i.e., women; men) since this approach was culturally appropriate. Although this study did not address all aspects of gender that influence local power dynamics, we expect it to make a significant contribution to emerging research on gender and fisheries in Kenya.

2. Materials and methods

2.1. Study site

Our study site is located in coastal Kenya, which stretches along 640 km of coastline. More specifically, we conducted research in the Shimoni-Vanga seascape area, Kwale County, on the South coast of Kenya. The study site is characterized by the Inter-Tropical Convergence Zone, which experiences two reversal monsoon seasons – the Northeast monsoon (NEM) and Southeast monsoon (SEM), from November to March and from April to October respectively. Three main habitats occur in the coastal region, namely mangrove forests, seagrass beds, and coral

reefs (WWF, 2001) (Fig. 1). These ecosystems fall into different protection regimes, including one governmental marine protected area, the Kisite-Mpunguti Marine Park and Reserve (04°42′ S, 39°21′ E), and an array of Locally Managed Marine Areas (LMMA) (GoK, 2017). These LMMA are run by local communities with the support of the Kenyan government (Kawaka et al., 2017). The area, however, is expected to experience large disturbances with the ongoing construction of an industrial fishing port in the study area, which began in 2022. This project is anticipated to negatively impact local coastal ecosystems and SSF livelihoods (EECL, 2020).

As does the rest of the Kenyan coast, the Shimoni-Vanga area features great cultural diversity. While Swahili people are the dominant group, Mijikenda people are also common in the area. The total site population is estimated at 18,000 people (GoK, 2016). The main local livelihood activity is small-scale fishing, with people of different genders engaging in the SSF value chain (Gok, 2017). We conducted research on five villages which were selected for both their diversity and representativeness of the social-ecological characteristics of the site. All selected villages are constitutive of the Shimoni-Vanga Joint Co-Management, which is locally managed by beach management units.

2.2. Data collection

Before starting fieldwork, we received the ethics approval of the Ethics Committee of the Universitat Autònoma de Barcelona (CEEAH CA01) (Fig. 2). We gathered Free Prior and Informed Consent from each village and individual who engaged in the study. We also obtained the consent of local authorities from each community. We collected data over ten months, divided into two fieldwork periods from November 2021 to April 2022, and from July to November 2023. Our research was supported by the Kenya Marine and Fisheries Research Institute (KMFRI) that facilitated collaboration with local people and fishery committees in the studied villages. In the field, we worked with Kenyan collaborators who helped to conduct the study and translate the interviews and surveys from English to Swahili. To acknowledge the knowledge of our key informants we used the citation template by MacLeod (2021), adopting pseudonyms in order to respect their anonymity. Respondents' gender identities were derived from their self-identification, and we sought to ensure a gender-balance in our sampling. We combined both qualitative (i.e., participant observation, photography, semi-structured interviews) and quantitative methods (i.e., survey and pebble games) for data collection, as detailed below.

2.2.1. Qualitative methods

We conducted participant observation in the studied villages as a relevant research tool to collect qualitative information on gender roles and norms in SSF communities, women's and men's fishing practices, and their respective economic situations (Kawulich, 2005). We considered as fisher any person who harvested fisheries resources on an occasional, periodic, or daily basis. To complement participant observation, we also used photography. As a well-established method in anthropology, photography provides a powerful medium to bring complementary information to verbal expressions (Soukup, 2014). Here, we used photography to document people's relationships with fisheries and highlight gendered specificities and power asymmetries that may not be described by words. Specifically, the research team took pictures of fishing techniques used by fisherfolk, fishing gears, vessels and catches, coastal ecosystems, and scenes of interaction between women and men at home or in public spaces.

Further, we performed two series of semi-structured interviews (SSI) on i) gender identities and ii) gendered fishing practices. We provide the list of questions for the two SSI series in supplementary material A (List 1). To select participants for SSI, we used convenience quota sampling to reflect fishers' diversity in terms of gender and fishing technique (Rukmana, 2014). First, we selected 11 key informants to explore the emic approach of the understanding and identification of gender identities within the study site. During the interviews, we addressed questions related to gender identification, differences, and gaps, as expressed in the studied communities. Next, we ran another SSI series on gender-differentiated fishing practices and uses related to fisheries, partly based on the Protocol for the collection of cross-cultural comparative data on local indicators of climate change impacts on fisheries (hereafter: "LICCI Fisheries Protocol") by Miñarro et al. (2021). More specifically, we interviewed 28 respondents (14 women and 14 men) using convenience quota sampling and discussed their daily fishing routine, including their fishing schedule, fishing grounds, technique

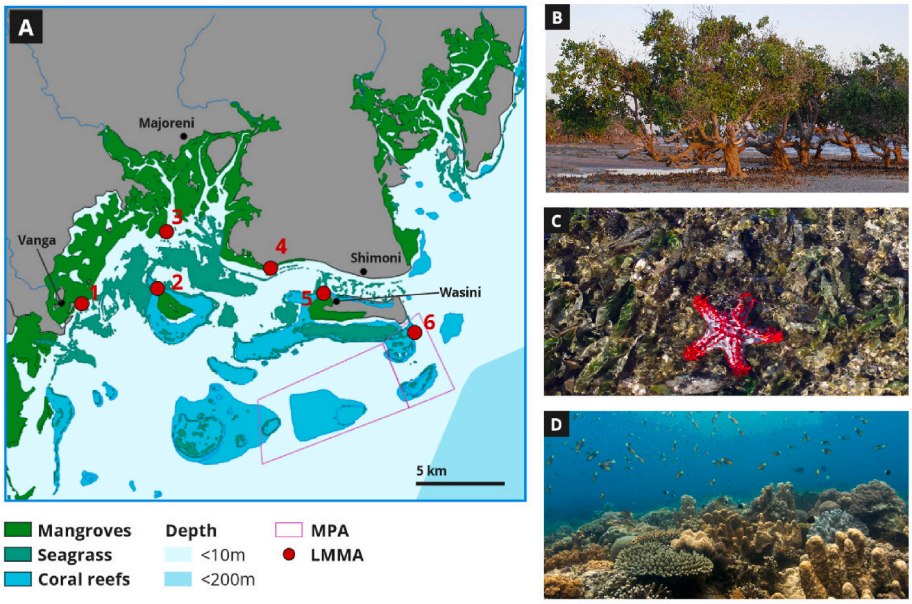

Fig. 1. (color). Location map of the study site. **(A)** Ecological features of the Shimoni-Vanga seascape (QGIS 3.28.0) - including mangroves, seagrass beds, and coral reefs - and marine protected areas such as the Kisite-Mpunguti Marine Park and Reserve (MPA) and six Locally Managed Marine Areas (LMMA): **1**-Vanga, **2**-Jimbo, **3**-Majoreni, **4**-Kibuyuni, **5**-Wasini and **6**-Mkwiro. Major marine habitats in the Shimoni-Vanga seascape comprise: **(B)** mangroves **(C)** seagrass beds, and **(D)** coral reefs. Pictures: © M. Chambon 2021 (B–C) and D. Knoester 2021 (D), from Reefolution Foundation Shimoni.

Fig. 2. (color). Flow chart picturing the methodological approach used in this study from ethical procedures to data collection over the two fieldwork periods (November 2021-November 2023). Main methods for data collection comprised: **1)** participant observation and photography; **2)** semi-structured interviews (SSI); **3)** individual survey; and **4)** pebble games.

(s) used, and target taxa.

2.2.2. Quantitative methods

We ran an individual face-to-face survey to gather gender-disaggregated information related to fishing temporalities, locomotion, gears and techniques, target taxa and fishing catch, effort, and income. We used convenience quota sampling to capture gender diversity among respondents at the site level. In total, we interviewed 141 fishers (62 women and 79 men). To build the survey, we used a list of fishing gears and target taxa derived from the SSI on gendered fishing practices. To determine the scientific names of the reported taxa, which were initially expressed in their local names, we used the marine fisheries identification guide developed for Kenya by the Food and Agriculture Organization of the United Nations (Anam and Mostarda, 2012). However, as this guide does not provide detailed information on invertebrate species, we used instead a booklet with pictures of invertebrate taxa and their scientific names to identify women's target taxa. We tested the survey with 10 respondents during a pilot stage. The final survey comprised three sections related to the interviewee's i) fishing gear(s), ii) target taxa, and iii) fishing locomotion, time, effort, and income. We provide the final version of the survey in supplementary material A (List.2).

Finally, we ran two pebble games using the "pebble distribution method" (Colfer et al., 1999; Lynam et al., 2007). We selected 35 households across the study site using convenience quota sampling and interviewed any available household member who was a fisher to allocate a given number of "pebbles" (i.e., marine shells) across different items. In total, we played the games with 22 female and 13 male households' members given that we found more women than men available at home. While we used households as unit of sampling, we acknowledge existing heterogeneity within households and recognize that intra-household strategic interactions and potential gender inequalities may affect fisheries resources allocation within households (Woolley, 2024). The first game involved items related to weekly fish and seafood portions in diets, while the second focused on the source of fish and seafood in local households. During the first game, we specifically asked participants to indicate the respective portions of fish, vegetables and staple foods based on carbohydrates (i.e., maize dish, chapatis or rice) which they eat weekly at home during both NEM and SEM seasons. Then, moving on to the second game, we asked the same participants to specify the eaten portions of fish and seafood at home that originate from men's catches, women's catches, purchased products or gifts from relatives and friends during both seasons. We used this method to document i) the average weekly fish and seafood composition in diets during NEM and SEM seasons and ii) fisherwomen's contribution to local subsistence (i.e., providing fish or seafood).

2.3. Data analysis

To understand how gender identities shape the access and uses of the seascape (O1), we used data from the SSIs, photos, and participant observation. We identified common themes from the SSI using content analysis (Mayring, 2000) and articulated them with a visual analysis of the coastal environment. We distinguished four main coastal habitats: seagrass beds and reef flats, fore-reef areas, rocky and sandy bottoms, and deeper waters. More specifically, based on participant observation, we drew a schematic representation of the gendered uses of the seascape across these four coastal habitats using a watercolor painting, which we linked to a narrative of the local gender identities (Fig. 3). Then, to investigate the influence of gender on fishing practices (O2), catch, effort and income (O3), we used survey data. Specifically, to calculate a fisher's catch per unit of time (CPUT) - as a quantitative metric widely used to describe fisheries globally (Appelman, 2015) - we used data on fishing time and catch. We divided the average daily catch (kg) by the daily fishing time (hour). Overall, we combined descriptive and statistical methods to analyze the influence of gender on a set of fishing variables related to fishing temporalities, gears and techniques, target taxa and fishing catch, effort, and income. First, we determined the average, minimum and maximum values of the numeric variables and counted frequencies of qualitative variables. Next, we applied the Welch Two Sample *t*-test (Kalpić et al., 2011) and the Chi-square test (Agresti, 2007) to explore statistical differences between fisherwomen and fishermen in numeric and categorical variables of interest. Further, to visually represent the gendered distribution of target taxa by coastal habitat, we generated a color-coded heatmap with R version 4.2.1 (2021) portraying the frequency of catch by gender and coastal habitat. To analyze the composition of local meals and fisherwomen's contribution to diets (O4), we used data from the pebble games and applied descriptive statistics. We used the household as a unit of analysis. Specifically, we compared mixed households where both men and women fished with fisherwomen-headed households where only women provided catch.

2.4. Research positionality statement

As researchers from a distinct socio-cultural, economic, and ontological background other than Kenyan coastal communities, we acknowledge that our methods might have only captured a partial and

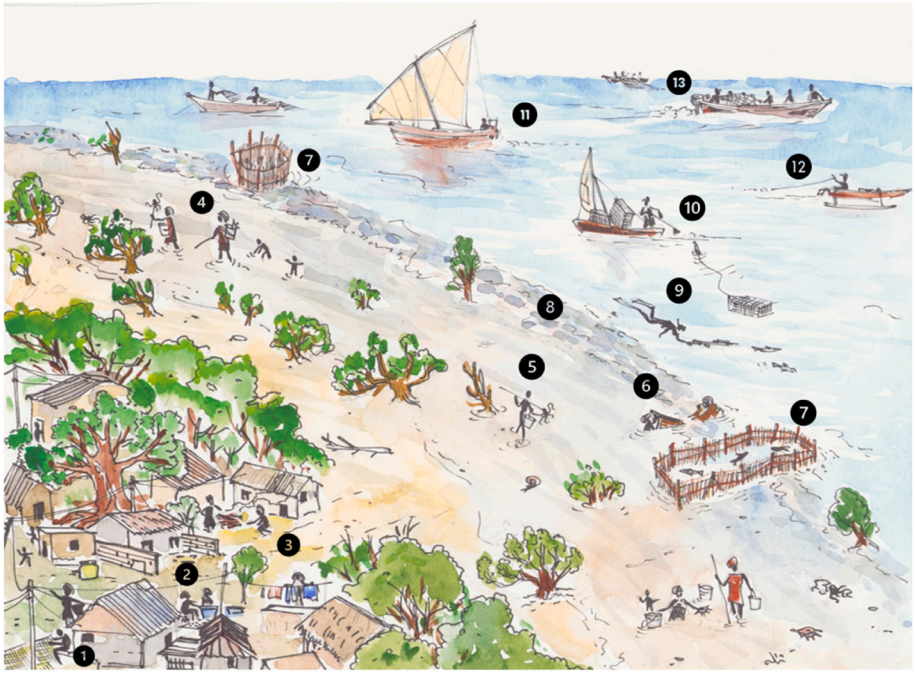

Fig. 3. (color). Gendered division of labor across the Shimoni-Vanga seascape. Daily fisheries and related activities are strongly gendered in the village and in the different coastal habitats: **Village - 1-** Man repairing his nets. **2-** Female fish processors boiling sardines ("*mama chemsha*" in Swahili). **3-** Woman doing house chores: making fire for cooking, drying clothes. **Seagrass beds and reef flats** - **4-** Group of women with children gleaning shells and fishing octopus along the shoreline. **5-** Man fishing octopus with a pointed stick. **6-** Young girls using a traditional cloth to catch small fish in the reef ("*kuranda*" technique). **7-** Fence trap. **8- Reef crest** marking the boundary between the reef flats and the fore-reef areas. **Fore-reef areas and rocky and sandy bottoms**: **9-** Man catching fish in the reef with a speargun. **10**- Basket trap fisherman. **11-** Swahili traditional dhow used for fishing and trading ("*Jahazi*"). **12-** Handline fisherman. **Deeper waters - 13-** Ringnet fishermen on their motorboat fishing in offshore waters. Drawing: © J. Dupont 2023.

situated understanding of the relationships between these communities and their coastal environment. Especially, the gendered dimension of such local interactions has been grasped through the prism of our own gender identities and cultural context. Thus, our results should be considered with caution, while encouraging the development of East African gender studies on the topic to foster gender analyses in SSF contexts.

3. Results

3.1. Gendered division of the seascape

Within the SSF communities from the Shimoni-Vanga seascape [hereafter "Shimoni-Vanga SSF communities"], gender norms play a key role in driving individuals' behaviors and aspirations, which in turn leads to a strong gender division of the seascape. Individuals growing up as men are socially expected to take on certain responsibilities such as providing resources to fulfil their family's needs (role of provider). To do so, men are usually encouraged to spend most of their time outside their home and engage in productive sectors to sustain their family. Individuals growing up as women are ascribed reproductive roles, such as taking care of their family and house chores (role of caregiver). As such, women are not expected to work in formal activities and spend most of their time at home to complete their domestic duties. While these norms are constantly shifting, notably towards a higher engagement of women in paid work, dominant views expressed within the studied communities contribute to maintaining a clear distinction between women's and men's realms.

This gendered division of labor influences the ways in which both genders interact with the coastal environment, and with fisheries particularly. It is socially accepted for fishermen to go out to sea and access areas beyond the reef. Conversely, fisherwomen are expected to fish in areas that are compatible with their domestic tasks. This implies fishing in direct vicinity of their house and with a flexible time schedule, sometimes accompanied by children. As a result, while men use the whole seascape to fish - from the coastline to areas beyond the reef -, women's fishing activities are usually restricted to the shoreline, which includes seagrass beds and reef flats. Coral reefs act as a clear barrier between fisherwomen's and fishermen's uses of the seascape (Fig. 3).

In addition to gender norms, social taboos, cultural norms and economic factors contribute to restrict women's fishing activities to nearshore waters. Participant observation and SSI on gendered fishing practices reveal that the presence of a woman on a fishing vessel represents a sign of bad luck for fishermen and is often perceived as dangerous for women's safety. Some women also expressed their fear of water as many of them did not know how to swim. Furthermore, women who were interested in acquiring a vessel to fish admitted that they felt limited by their low financial capital.

Gender differences in the access to the seascape are further reflected in the type of locomotion used by fishers to reach their fishing grounds. Results from the survey show that fishermen use predominantly traditional boats and motorboats (51% and 42% of surveyed fishermen, respectively), followed by foot fishing (1%). A few of them use a combination of both (6%). By contrast, all surveyed women are foot fishers.

3.2. Fishing practices

3.2.1. Fishing temporalities

Fishing activities are determined by the alternance of the two monsoon seasons, NEM and SEM. This alternance of seasons has strong implications for the gendered division of labor since it modulates fishers' access to certain target species and gendered fishing preferences. The NEM season corresponds to a period of high catch for most fishermen since the sea is quite calm, which allows them to navigate at sea and access various catches. Conversely, during the SEM season most fishermen are reluctant to go out to sea owing to unfavorable weather and sea

conditions (e.g., strong wind). Women's fishing activities follow the opposite trend. Women prefer the SEM season for fishing since cooler temperatures and lower sunlight favor the catch of invertebrates in intertidal areas. Besides the importance of seasonality, women's fishing activities also follow a semimonthly pattern. In particular, octopus (*Octopus cyanea* or *Octopus vulgaris)* is only hunted during periods of spring tides, locally called "*bamvua",* which happen twice a month. For this reason, most of the women focus their fishing effort on the *bamvua* and fish more opportunistically during the rest of the month. Results from the survey confirm field observations by indicating that women fish closer to their homes and for significantly less time and less often than men (Table 1). On average, fisherwomen go to sea for 3h30, nine days a month, whereas fishermen go to sea for 5h and fish 21 days a month.

Table 1
(no color). Comparison between fisherwomen and fishermen regarding fishing temporalities, gears and techniques, target taxa, fishing catch, effort, and income. Stars (*) indicate fishing variables for which we found statistically significant differences comparing fisherwomen's (n = 62) and fishermen's (n = 79) samples using a Welch Two Sample *t*-test (n = 141 fishers in total) on R software (2021).

Variable	Definition	Average value for fisherwomen	Average value for fishermen	P-value
Fishing temporalities				
Daily commuting time (hour)	Number of hours spent to access to fishing grounds	0.5	1.2	<0.001*
Daily fishing time (hour)	Number of fishing hours per day	3.5	5	<0.001*
Monthly fishing days (day)	Number of fishing days per month	9	21	<0.001*
Fishing gears and techniques				
Number of fishing gears (gear)	Number of fishing gears used by the respondent	2	4	<0.001*
Target taxa				
Number of commonly target taxa (taxa)	Number of taxa commonly targeted by the respondent	5	14	<0.001*
Fishing catch, effort, and income				
Average daily catch weight (kg)	Average daily amount of catch	3	46	0.021*
Catch per unit of time (CPUT) (kg/hour)	Amount of catch obtained by the respondent per hour	1	7	0.005*
Daily fishing income during the NEM season (Kenyan Shillings with equivalent in United States Dollar - USD)[a]	Respondent's fishing income per day during the NEM season	584 (5.3 USD)	3627 (33 USD)	<0.001*
Daily fishing income during the SEM season (Kenyan Shillings with equivalent in United States Dollar - USD)[a]	Respondent's fishing income per day during the SEM season	749 (6.8 USD)	2068 (18.8 USD)	<0.001*

[a] We converted the daily fishing income values expressed in the local currency (i.e., Kenyan Shillings) to United States Dollar using the exchange rate of 2021, which corresponds to our data collection period (https://www.exchangerates.org.uk/KES-USD-spot-exchange-rates-history-2021.html).

3.2.2. Fishing gears and techniques

Results from the survey indicate that fisherwomen use a significantly lower number of fishing gears than fishermen: 2 and 4 fishing gears, respectively, on average (Table 1). We also found gender differences in the distribution of fishing gear types (Fig. 4). We provide the total list of reported fishing gears used in our survey in supplementary material B (Table S1).

The most common fishing gears used by fishermen include handline (70% of fishermen), basket trap (49%), and longline (24%) (Fig. 5A; Table S2). While handline and basket traps are used to catch reef species such as emperor fish (Lethrinidae family) or snappers (Lutjanidae), longline is used farther at sea to catch pelagic species (e.g., Scombridae such as tuna or king fish). Hand gathering and speargun are the least reported fishing gears by fishermen (3% respectively). Fisherwomen, on the other hand, predominantly use hand gathering (90%), pointed stick (82%), or a combination of both (73%) (Fig. 5B). We found one case of a fisherwoman using basket traps (2%). In this specific case, the respondent combined basket trap fishing with seaweed farming activities. Women use hand gathering to collect various species of shells and sea cucumbers along the shore, a technique called gleaning ("*kuchukua*" in Swahili). As they are walking, women store the shells in a bucket on their backs and look for octopus at the same time. When they spot an octopus' den, they use a pointed stick to poke inside the den to check whether it is inhabited or not. If applicable, women stab the octopus, hang it on the stick and proceed to another location. In addition to the survey, field observations and interviews revealed another fishing technique used mostly by young girls and teenagers. This fishing technique, locally called "*kuranda*", consists of using traditional clothes to catch small fish in the intertidal parts of the reefs.

Participant observation and SSI on gendered fishing practices suggest a relation between fishing techniques and the building of gender identities. Women we interviewed defined themselves in relation to the action of gleaning ("*kuchukua*") but did not use the word "fisher" ("*mvuvi*"). By contrast, all men we interviewed self-defined as fishers, even if they were gleaning in addition to other fishing techniques. Gleaning activities tend to be perceived as the women's realm whereas the use of other fishing techniques characterizes what makes a fisher (man).

3.2.3. Target taxa

Results from the Welch Two-Sample *t*-test show that fisherwomen target a lower number of taxa than men: 5 and 14 taxa, respectively, on average (Table .1). We provide the complete list of reported target taxa used in our survey in supplementary material B (Table S3). In addition, we found that fishermen fish a wider diversity of taxa than fisherwomen (Table S4; S5). Fishermen predominantly target reef fish (95% of fishermen), followed by invertebrates (76%), pelagic fish (72%), elasmobranchs (65%) and crustaceans (27%). The four families the most targeted by fishermen are all reef fish families and include Lethrinidae (targeted by 86% of fishermen), Mullidae (84%), Siganidae (79%) and Scaridae (79%). By contrast, all fisherwomen fish invertebrates (100% of fisherwomen) and a few of them also target reef fish (10%), reflecting a lower functional diversity than men's catches. Fisherwomen's catches are mostly composed of octopus (*Octopus cyanea* and *Octopus vulgaris)* (targeted by 82% of fisherwomen), gold ring cowrie (*Monetaria annulus*) (79%), common spider conch (*Lambis lambis*) (71%), and lynx cowrie (*Lyncina lynx*) (57%). Furthermore, findings from the survey indicate that taxon distribution varies by the fisher's gender and coastal habitat (Fig. 6). Fisherwomen concentrate their efforts on seagrass beds and reef flats, while fishermen fish mostly in fore-reef area, rocky and sandy bottoms, and deeper waters.

3.2.4. Fishing catch, effort and income

We found that on average, women make significantly lower daily catches and CPUT than men (Table .1). Similarly, fisherwomen's average daily income derived from their fishing activities is significantly

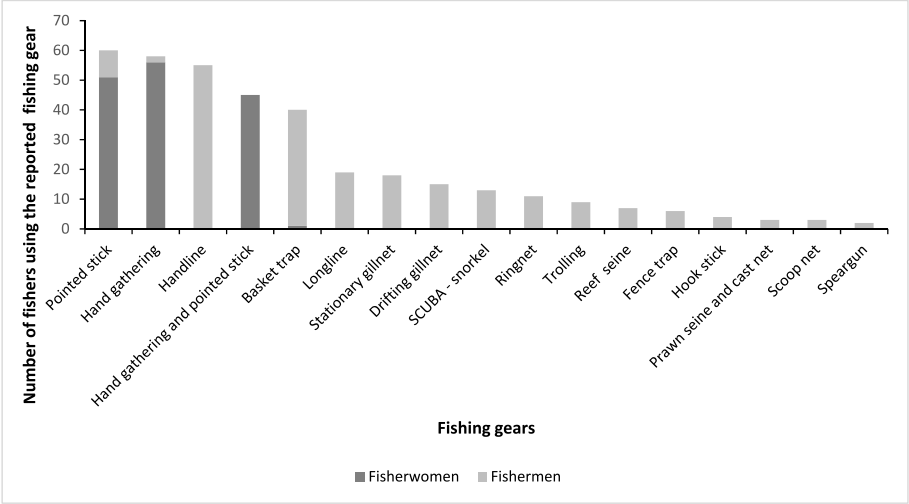

Fig. 4. (no color). Gendered distribution of fishing gears in the Shimoni-Vanga Seascape. Number of reported fishing gears by fisherwomen (n = 62 fisherwomen) and fishermen (n = 79 fishermen).

Fig. 5. (color). Gendered fishing techniques across the Shimoni-Vanga seascape. A. Men's fishing techniques: A1- Basket trap fisherman. Basket traps ("*malema*") are one of the most common and iconic traditional fishing gears used in nearshore shallow waters. Usually, fishers leave at dawn to access their fishing grounds in paddle canoes or outrigger sailboats. Once they reach the site, they identify where their basket traps are located by looking for plastic bottles or buoys. They take each of the traps, collect the catch, if any, refill the traps with bait like brittle stars or green algae and lower them down back into the water. The making of basket traps is a male-dominated artisanal know-how of weaving bamboo fibers and is passed on from one generation to the next. **A2-** Fence trap fisherman heading out at sea. This fisherman navigates by paddle canoe ("*mtumbwi*" in Swahili) through mangrove channels to reach his fence trap. This kind of traditional trap, made of mangrove stakes or palm leaves, is usually set perpendicularly to nearshore waters to catch fish during spring tides. Once the tide goes out, fish get stuck inside the trap. After one or two days, fishers come to collect the catch. **B. Women's fishing techniques: B1-** Female gleaners using hand gathering. Fisherwomen usually leave early in the morning to walk along the shore in small group of friends or relatives. They use their fishing time to share stories and news from the village and to learn from each other. Sometimes children come with them. After fishing, most the fisherwomen return home to prepare lunch and complete house chores. **B2-** Female octopus hunter using pointed stick. Women's fishing activities are heavily influenced by the lunar calendar. For instance, octopus is only hunted during the spring tide period, locally called "*bamvua*", which lasts eight days and occurs twice a month, before and after the new and full moon. During these periods, foot fishers can access the reef flats during low tides and look for octopus or shells. They usually poke octopus' dens with a pointed stick and stab any octopus found inside. This fishing technique requires fine skills to identify octopus in their natural habitats. Pictures: © S. Wachia 2021, 2023 (A1, A2) & M. Chambon 2021 (B1, B2).

lower than that of fishermen, although we notice a seasonal variation. While fisherwomen earn more during the SEM season, fishermen get higher benefits during the NEM season. Consequently, during the NEM season, women's average daily fishing income is 6 times lower than that of fishermen, but 2.8 times lower during the SEM season.

3.3. Fisherwomen's contribution to diets

Results from the pebble games indicate that respondents eat significantly more fish and seafood during the NEM than during the SEM season (p-value: 0.043), representing about a third (29,4%) and a fourth (23,7%) of diets for the two seasons respectively. Respondents supplement fish with vegetables (19,2% and 26,8% during NEM and SEM) and staple foods (51,4 % and 49,5% respectively). In addition, we found that about two-third of the catch eaten at home is provided by the man and the rest by the woman in mixed households (respectively 67% and 33% during the NEM season; 68% and 32 % during the SEM season) (Table S6). However, in fisherwomen-headed households, women's

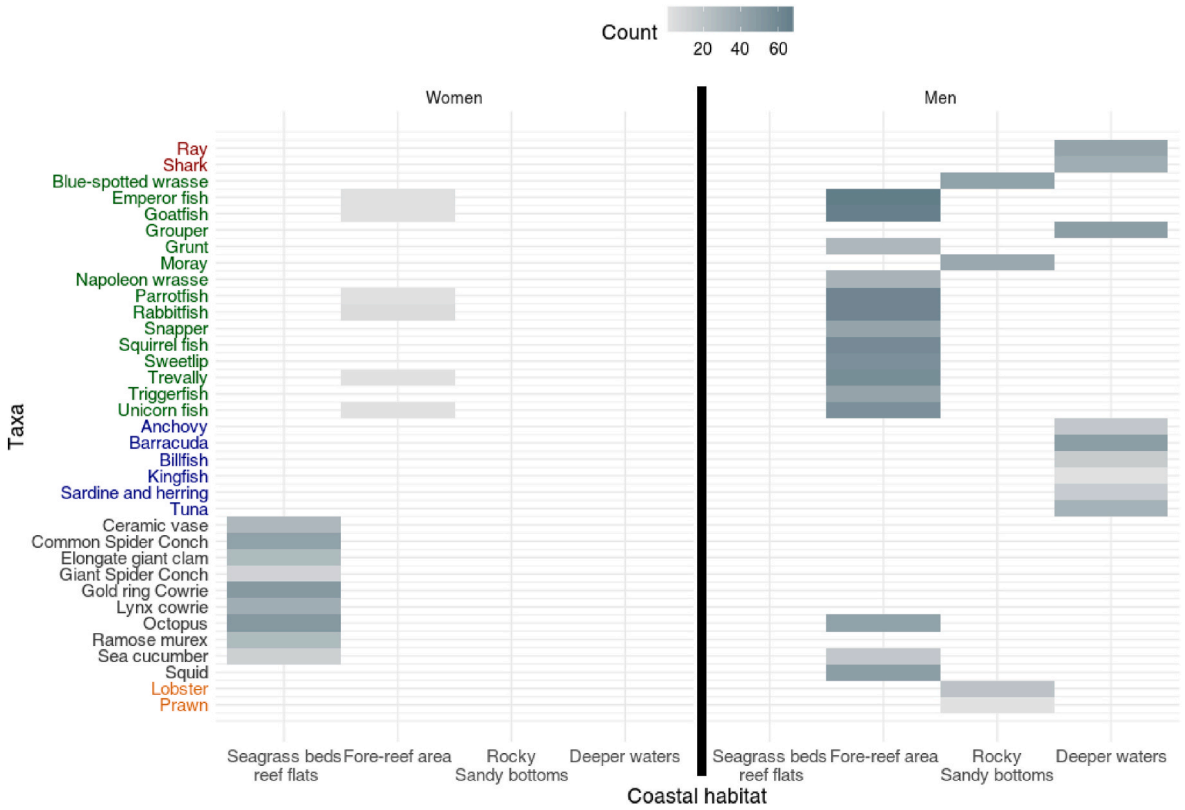

Fig. 6. (color). Gendered distribution of target taxa by coastal habitat. Heatmaps showing the number of fisherwomen (n = 62) and fishermen (n = 79) targeting the main taxa included in the survey by coastal habitat (i.e., seagrass beds and reef flats; fore-reef areas; rocky and sandy bottoms; deeper waters). Functional groups of the target taxa are indicated by different colors: red for elasmobranchs, green for reef fish, blue for pelagic fish, grey for invertebrates and orange for crustaceans.

catches contribute about half of the total amount of fish and seafood consumed at home (50% and 51% during the NEM and SEM seasons respectively) (Table S7). The other half corresponds to purchased and given fisheries products.

4. Discussion

This paper investigates women's and men's participation in small-scale fishing and the resulting nutritional implications through a case study in coastal Kenya. Our results reveal a pronounced gendered spatial and ecological division across the seascape. While women contribute to fishing, their practices are characterized by fewer fishing gears, less catch, a lower functional diversity of catches, less fishing effort, and less income than men. However, we find that women's contribution to diets is significant, representing one third of the catch eaten at home in mixed households, and up to 50% of the fisheries products consumed in fisherwomen-headed households. These findings suggest that, while fisherwomen's direct contribution to the SSF formal economy may be counted as lower than that of fishermen, their fishing activities provide key nutritional benefits for their households.

We are aware of three main limitations of our study. First, the use of Swahili as the main research language in this study may have erased certain nuances about the respondents' fishing experiences, since most of them were more comfortable expressing themselves in their local languages, which are different from Swahili. This difficulty raises the need to reflect on language pluralism in research and foster academic collaboration with local communities. Second, despite recognizing the value of applying an intersectional framework in fisheries research, we only focused on gender and did not include other related social variables such as age or ethnicity owing to time constraints in the field. We acknowledge that this limitation may restrict the scope of our analysis of local power dynamics and reinforces the need to consider intersectionality in gender and fisheries research (House et al., 2023). Finally, we are aware that our findings could be potentially misinterpreted by fishery and development actors and considered as evidence for a greater contribution of men than women to SSF in Kenya. To avoid any misuse of our data, we emphasize the need to consider the contributions of both genders through a holistic perspective, considering simultaneously economic, ecological and nutritional outcomes of women's and men's fishing activities. Using this interpretative lens, we hope that our study may add to the literature highlighting how gender considerations may support sustainable and equitable policies in SSF social-ecological systems (FAO et al., 2023).

4.1. The gendered division of labor in small-scale fishing activities

Although fishing is commonly considered a male domain (Lentisco and Lee, 2015), our findings in the Shimoni-Vanga seascape indicate that women also engage in fishing, in line with literature challenging the predominance of men in other sectors such as hunting (Reyes-García et al., 2020) or agriculture (FAO, 2021). In that sense, our findings contribute to the growing "women also fish" discourse that builds on case studies reporting the cultural diversity of women's fishing practices throughout the world (Harper et al., 2013; Williams, 2010). Furthermore, our study highlights major differences between fisherwomen's and fishermen's practices, thus adding to the existing literature that illuminates gender variations in the use of fisheries (FAO, Duke University, & WorldFish, 2023; Kleiber et al., 2015). In terms of effort and volume, fisherwomen appear to fish less than fishermen, in agreement with previous studies (Bradford and Katikiro, 2019). Moreover, fisherwomen are more spatially constrained in their fishing activities than fishermen. While women mostly concentrate their fishing effort on

intertidal areas, men use the whole seascape for fishing. This contrasting pattern was first reported by Chapman (1987) in Oceania and has been documented globally since then (Alati et al., 2023; Koralagama et al., 2017; Siar, 2003). Our findings also show that women and men tend to use distinct techniques and target different species. Our results align with previous studies showing that fisherwomen are primarily involved in gleaning (Alati et al., 2020). In addition, we found that, while women employ other fishing techniques to harvest fish, most of their catches consist of invertebrates. By contrast, men use more diverse fishing gears to catch essentially reef fish, which confirms the general statement that "*shells are for women, fish are for men*" (Siar, 2003, p.578) although some exceptions have been reported in the literature (Lentisco and Lee, 2015).

Overall, our findings suggest that the gendered division of labor in our study site stems directly from local socio-cultural norms and values, confirming evidence from the global gender and fisheries literature (de la Torre-Castro, 2019). In many societies, women are primarily ascribed reproductive roles, which implies that they must take care of their house and family (Lawless et al., 2019). This caring work is often perceived as not valuable in economic terms, and thus escapes assessment of the formal SSF sector (Williams, 2019). In turn, these gender norms and expectations limit women's time and mobility to engage in economic activities, for example restricting them to fish near their home. In addition, our study aligns with research in other fisheries settings by suggesting that socio-economic barriers such as limited access to capital or cultural taboos challenge women's access to fishing vessels, thus preventing them from fishing in deeper waters (Thomas et al., 2021). These complex and interlaced factors contribute to sustaining this gendered demarcation of fishing activities globally.

4.2. Small-scale fishing activities as a matrix of gender constructs

Beyond revealing local gender asymmetries, the observed gendered division of labor in SSF also contributes directly to the construction of gender roles. In other words, because of their gender-specific characteristics, women's and men's respective fishing practices become, in turn, constitutive elements of their gender identities. SSF thus plays a key role in setting gender boundaries by defining who is a woman and who is a man. This phenomenon has been discussed in the literature through the notion of occupational sex segregation (West and Zimmerman, 1987), which refers to the spatially differentiated occupations performed by women and men. Although gender construction processes encompass a wide range of social spheres, this notion is useful for understanding how fishing - as an occupation - may be pivotal in building and reinforcing gender identities in SSF communities. For instance, Yodanis (2000) applied this concept to understand why women from certain SSF communities in the United States did not perceive themselves as fishers, in contrast to men, even though some of them engaged in fish capture. The author argues that one of the main reasons was gender construction processes resulting from SSF activities. Since fishing was perceived as a male attribute, women tended to distance themselves from this activity: "*I found that gender in fishing villages is defined in relation to fishing. "Man" is defined as one who fishes and "woman" is defined in opposition to that which is a fisherman.*" (Yodanis, 2000, p.268). Similarly, Santos (2015) describes how fisherwomen's and fishermen's roles in Brazilian SSF, which are perceived as synergetic, do contribute to shape local gender identities, defining what a woman is in relation to men and vice versa.

Further, our results indicate that the construction of gender identities through SSF contributes to reinforcing gender inequalities. We found that fisherwomen had significantly less catch and earned less fishing income than fishermen. We suggest that this outcome is directly linked to fisherwomen's spatiotemporal and technical restrictions. Since women only fish along the coast, for a limited amount of time, and with a reduced number of fishing gears, it seems likely that their productivity will be lesser than that of fishermen. Our findings align with those of previous studies in SSF documenting how women's constraints in the SSF value chain result in a lower income than those of men (Bradford and Katikiro, 2019; Siar, 2003). For instance, investigating shelled mollusk fisheries in coastal Kenya, Alati et al. (2023) reported that a larger number of fisherwomen than fishermen earned a daily fishing income below the poverty line. The precarious situation of fisherwomen may be worsened in case of shocks such as climate-related disasters, which may increase gender gaps in local incomes (Brody et al., 2008). Taken together, our findings illustrate how a gender lens applied to SSF allows for a better understanding of the complex gender dynamics around the access to fisheries and shed light on gender economic disparities. In line with other feminist scholars (Davis and Nadel-Klein, 1992; De la Torre Castro et al., 2017), we support the need to bring a political dimension to the analysis of gender power relationships in fisheries settings (Alati et al., 2023; Mangubhai and Lawless, 2021).

4.3. The importance of fisherwomen's contribution to local subsistence

Despite their economic marginalization within the SSF sector, our results suggest that fisherwomen provide a substantial part of the fisheries products eaten at home, accounting for one third of the catch consumed in mixed households and 50% of fish and seafood eaten in fisherwomen-headed households. Fisheries resources are essential for coastal diets in many regions of the world, providing proteins and micronutrients that are critical for household food security and child growth (Hicks et al., 2019; Kawarazuka and Béné, 2011). Our findings suggest that fisherwomen's catches represent a critical complement to diets that are locally dominated by carbohydrates. Thus, our study adds to previous evidence shedding light on the significance of women's fishing activities for food security in SSF communities (Rabbitt et al., 2019; Thomas et al., 2021).

We also found that gleaning represents the women's main fishing technique, as reported elsewhere (Alati et al., 2020; Stiepani et al., 2023). Gleaning activities are recognized as being more predictable - and thus reliable - than other fishing techniques in providing food since they target invertebrates. These species are mostly sessile, thus easier to catch than mobile species like pelagics, whose distribution is highly variable in time and space (Chapman, 1987). Further, our results show that Shimoni-Vanga SSF communities consume more fish during the NEM than the SEM seasons. This may imply that, during the SEM period when men's catches are scarce, the contribution of fisherwomen to household diets through their gleaning activities is particularly important. While a general trend described in the literature and confirmed by our study is that women's fishing productivity tends to be lower than men's, fisherwomen's catches appear to be critical for SSF households since they provide their families with a stable amount of fish products (Rabbitt et al., 2019).

This essential role played by fisherwomen in providing fish and seafood to SSF households may become even more important in the future, especially considering climate change. Studies have highlighted the importance of women's fishing activities as a safety net during periods of instability and socio-environmental shocks (Agarwal, 2018). Given that SSF are identified as one of the food production systems most vulnerable to climate change impacts (FAO, Duke University, & WorldFish, 2023), SSF households may increasingly depend on women's subsistence fishing for meeting their nutritional needs over the coming years. A recent study by Virdin et al. (2023) shows that subsistence fishing activities represent a major lever to address poverty and malnutrition globally. However, a greater involvement of women in subsistence fishing may represent an additional burden on them, superimposing upon their traditional reproductive responsibilities (Williams et al., 2002).

5. Conclusions

Addressing the persisting gender data gap in fisheries, especially on fishing activities, will require deep transformations in fisheries research,

management, and governance. Our findings support three main recommendations to achieve gender inclusivity in the SSF sector. First, our study highlights the importance of integrating gender-disaggregated data in fisheries assessments to capture a comprehensive picture of coastal SES, thus providing a robust basis for developing appropriate and inclusive SSF management decisions. Specifically, we concur with other scholars to support the need to collect data on women's gleaning activities to improve baseline data on invertebrate stocks and mitigate potential negative environmental impacts (Alati et al., 2023; Stiepani et al., 2023). Second, our findings call for a better recognition of women's contribution to subsistence and artisanal fishing to optimize the nutritional outcome of certain fisheries, especially nearshore fisheries where fisherwomen predominate (Thomas et al., 2021). The potential of women's subsistence fishing for achieving food security is particularly important in East Africa where severe drought events have been increasingly reported over the past decades, posing severe threats on food security (Kimutai et al., 2023). Finally, insights from our work highlight the strong female presence in the fisher population in coastal Kenya, supporting the need to include women in SSF management and decision-making positions. A better participation of women in fisheries management has been documented for providing multiple benefits to SSF social-ecological systems (Chambon et al., 2023). Gender-inclusive management strategies are thus critical for ensuring that both men and women have equal access to SSF, and for building synergies between socio-economic, nutritional, and environmental considerations. We believe that driving change in the SSF sector in these recommended directions would directly contribute to achieving gender equitable and sustainable SSF, in line with the FAO's Gender Handbook of the SSF Guidelines (2017) and the Sustainable Development Goals 5 and 14.

CRediT authorship contribution statement

Mouna Chambon: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Patrizia Ziveri:** Writing – review & editing, Supervision, Conceptualization. **Santiago Alvarez Fernandez:** Writing – review & editing, Methodology, Formal analysis. **Adrien Chevallier:** Writing – review & editing, Methodology, Formal analysis. **Jean Dupont:** Writing – review & editing, Visualization. **Joey Ngunu Wandiga:** Writing – review & editing, Methodology. **Nina Wambiji:** Writing – review & editing, Supervision, Conceptualization. **Victoria Reyes-Garcia:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ocecoaman.2024.107293.

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