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"We Don't Need to Worry Because We Will Find Food Tomorrow": Local Knowledge and Drivers of Mangroves as a Food System through a Gendered Lens in West Kalimantan, Indonesia

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Abstract: Indonesia is home to the greatest area of mangroves globally, which provide an essential source of livelihoods and food for millions of people. Despite this, there is a gap in the empirical evidence on the role mangroves play as a food system and the diversity of species they provide. This study aimed to examine mangroves as a gendered food system through the knowledge of community mangrove resource users in West Kalimantan. The research applied a case study approach, using gendered focus group discussions and a participatory seasonal food mapping method in two villages. The research identified participants' extensive local knowledge of 276 species across 12 food groups sourced seasonally from mangroves primarily for food and as a source of income. Barriers to utilizing mangroves for women were influenced by socio-cultural norms, including but not limited to gender roles and access to fishing infrastructure, while men alone faced political and institutional challenges to mangrove utilisation. This study found that mangroves are an important local food system in West Kalimantan, Indonesia, and argues for greater consideration of the contribution mangroves make to local food and nutrition security. This study contributes to a growing global discourse of gendered food systems and inclusion of local knowledges in natural resource management.

Keywords: mangroves; local food systems; wild foods; aquatic foods; local knowledge; gender

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1. Introduction

Aquatic and forest ecosystems provide valuable resources that support food and nutrition security (FNS) and provide a source of income for billions of people across the globe [1,2]. As coastal forests that bridge terrestrial and aquatic environments, mangroves provide a variety of ecosystem services to dependent communities [3,4]. Mangroves cover an estimated 136,000 km^2 of tropical and subtropical shorelines globally [5]. Over a third of the world's mangroves are found in Southeast Asia with Indonesia's mangroves spanning 30,000 km^2 of coastline, making up 21% of the globe's mangroves [6,7]. They are recognised for their direct and indirect roles in mitigating climate change, their ability to sequester and store carbon, protect coastal communities by reducing storm surge flood levels, and providing productive habitats for various species; such as supporting diverse fisheries and a source of aquatic foods (AQFs), non-timber forest products (NTFPs), reptiles, birds, and more [8,9]. AQFs found in mangroves include finfish, shellfish, invertebrates, aquatic plants, and any other foods sourced from aquatic environments [10]. AQFs are incredibly nutrient-rich and diverse and provide essential micro- and macronutrients including vitamin A,

zinc, calcium, iron, and fatty acids [11]. Coastal communities across Indonesia are highly dependent on AQF found in mangroves and associated ecosystems such as adjoining coral reefs and seagrass meadows for food security and health, as they provide foods essential to support local dietary needs [12]. These foods are of particular importance in countries such as Indonesia, where rates of micronutrient deficiencies remain high and a public health concern [13].

Ickowitz et al. (2023) found that mangroves play an important role in contributing to levels of fish consumption among communities living nearby, and therefore FNS across Indonesia [14]. Mangroves can be considered as a socio-ecological systems involving environmental and human interactions [15]. Whilst acknowledging the variety of economic, social, and environmental services and provisions afforded by mangrove systems, this paper focuses on the role of mangroves as a food system, a specific framing that has been overlooked in the literature thus far. In particular, the diversity of foods sourced from mangroves and the drivers and barriers to utilisation which are not well understood. Addressing this knowledge gap on the role of mangroves as a food system is also increasingly important as mangrove deforestation is occurring at an alarming rate, with a global decline of 3.4% in mangrove coverage between 1996 and 2020 [15].

The Higher Level Panel of Experts (HLPE) on Food Security and Nutrition developed a food system framework in 2017, which was updated in 2020 [16] and focuses on the three main conceptualised elements of food systems: environments, supply chains, and the consumer. Food systems include all elements of a value chain, combining the natural environment, infrastructure, food environments, and people [16,17]. There are six food system drivers in the HLPE framework comprising biophysical and environmental; technology, innovation and infrastructure; economic and market drivers; political and institutional; and socio-cultural and demographic [16]. Biophysical and environmental drivers include how the climate and environment shape food systems. Technology, innovation, and infrastructure drivers include data-driven solutions and innovation, infrastructure that supports post-harvest strategies and new breeding technologies. Economic and market drivers include livelihoods and income. Political and institutional drivers including leadership and political structures are pivotal to creating sustainable and equitable food systems. Socio-cultural drivers include traditions, women's empowerment, social norms and demographic drivers related to age, migration and urbanisation [16,18]. Consumers also shape food systems as their behaviour and decisions influence the end of the value chain, including what food to purchase, how to prepare and consume it, who eats it, and in what order, which all impact people's diet and nutrition and health outcomes [16]. Food systems need to be inclusive for optimal nutrition and health outcomes for populations; therefore, food systems should be inclusive of the people to whom the decision ultimately benefits, otherwise they can have a negative impact on supply chains, the communities that access them, and their local food systems [16].

Appeals for food systems transformation to improve public health, nutrition, and sustainable environmental outcomes are gaining momentum and becoming more urgent, given the impacts of climate change and the fact that, in 2022, up to 783 million people globally did not have sufficient food to meet their daily needs [19–21]. The 2030 Sustainable Development Goals outline several targets to reduce food insecurity and malnutrition. However, countries have made very little progress in achieving these goals by the set date [22]. The need to transform our food systems in light of this demonstrates the need for context-specific research and policies that consider the role of the community and local knowledge to create more equitable and sustainable local food systems [23]. The interactions between producers or harvesters, consumers, and the management of the environment are more direct within local food systems, resulting in shorter value chains between production systems and home consumers [24]. A localised approach to food systems research and interventions can promote the inclusion of local voices and interests, especially those living in remote areas who are often the most in need of improved food systems and nutrition outcomes [25].

The role of local knowledge has often been overlooked in food systems research; however, recent attention has been paid to the importance of Indigenous Peoples' food systems and knowledge, to include the voices and local, ecological, or customary knowledge of custodians of traditional food systems [26]. This includes communities who have lived intergenerationally in one location and may have developed and used local knowledge gained through experiences and interactions with natural resources and who also have a deep understanding of their food environment and local ecosystems [27]. To date, local, traditional, and/or Indigenous knowledge, referred to broadly as local knowledge in this paper, have been marginalised in the current food systems paradigm, contributing to inequitable and unsustainable food systems practices, and therefore should be included in food systems transformation approaches [26]. Most importantly, gendered knowledge has also been overlooked and women are often ignored or marginalised within food systems and their value chains [28].

Globally, women represent around 39% of the fisheries, agriculture, and forestry workforce, engaging in different livelihoods along the value chain; however, they are often unrecognised for their contributions and occupy low-return jobs [2,29]. Gender norms are shaped by political and socio-cultural norms, which partly account for why women have been unrecognised, along with definitions of fishing and fishers that may exclude the activities conducted by women [30]. This is a significant issue for female fishers in Indonesia, as they are not recognised as 'fishermen' legally [31]. Women often face similar challenges in food systems more broadly, including being ignored, limited to specific roles, obtaining lower income, and being unable to own land or equipment [32]. Gender is also considered a substantial driver of diets as household roles are often dictated by socio-cultural norms related to gender, with the majority of household labour and responsibility related to food procurement and prepayment falling to the women [23]. As such, societal and political norms influence every aspect of a food system, especially considering that women are extremely influential on the household level and in providing food and care for children [23]. Further, there is increasing recognition that women are among the most food insecure and yet make major contributions to food security on the local and global level [33]. Key knowledge gaps persist and there is a need to move past gender-blind data to thorough gender analysis which tackles the underlying structures and drivers of gender relations and inequities in global and local food systems [34]. It has been suggested that dismantling the gendered dynamics of food system utilisation is necessary to address inequalities that people face, which in turn, would create more resilient food systems [35]. Therefore, applying a gender lens to food systems research at the local and global levels is essential to address the cycle of invisibility which currently results in non-inclusive policies and projects [32,33].

This paper reports on a study that examined mangroves as a food system through a gendered perspective, using a case study approach to provide a unique perspective into the local knowledge, drivers, and barriers of mangrove utilisation in Indonesia. We addressed three research questions through a mixed-method case study in a high mangrove cover region in two villages in Kubu Raya District, West Kalimantan. The questions addressed are as follows: (1) What is the seasonal availability of foods sourced from mangroves, according to women and men engaged in mangrove-based livelihoods? (2) What are the uses of mangrove species and from which habitats do women and men source them? And, (3) what are the drivers, barriers, and local knowledge of mangrove utilisation as a food system and how do these differ for women and men? We use livelihood activity as a descriptor for someone accessing mangroves and their resources for subsistence, income or other livelihood outcomes (e.g., cultural) [36]. The results present a gendered description of the seasonal availability of different species, food groups and use, followed by a gendered analysis of perceptions and experiences related to the role and utilisation of mangroves as a food system.

2. Materials and Methods

2.1. Approach and Positionality

The research team was composed of multidisciplinary international team members with expertise in mangroves, nutrition, livelihoods, natural resource management, and gender. The lead researcher and author is a British Hong Konger based at an Australian Institution. The field-based co-researcher and second author is a Kalimantan-born Javanese woman based at the largest public university in Pontianak, West Kalimantan, local partners to the research, who led a local field team drawn from partner organisations from West Kalimantan. The field team included a second facilitator, from a rural coastal community in West Kalimantan and a recent graduate from a university in Pontianak. We collaborated with the Indonesian NGO Blue Forests (Yayasan Hutan Biru) which specialises in developing mangrove-related projects and has had an existing presence in and understanding of the study sites since 2014. The three other research team members and co-authors were part of the Australian institution research team who provided research coordination, design, analysis, and write-up oversight.

Given the different backgrounds of team members, and that Indonesia is a low- to middle-income country with a complex colonial history [37], we recognise the privilege and power dynamics within our research team, between the team and the community and within the community themselves. We therefore worked to prioritise reflexivity into each step of our research to ensure that the community were at the centre of it. Research approaches grounded in decolonising methods aim to counter dominant worldviews by legitimising the perspectives of local actors and experiential knowledge, examining power imbalances, and decentralise the aims and role of Western researchers, to understand the agendas and realities of the communities or people participating in the research [38–40]. The first and second authors work in health- and food-related fields, which both have histories steeped in Eurocentric ideals and racism and therefore seek to dismantle the complex power dynamics present in our disciplines [41]. As a collaborative team, we worked to prioritise experiential or tacit knowledge and underwent training to challenge our unconscious biases and used reflexivity as a tool to promote transparency throughout the research process [42]. We used these methods and our collaborative approach to decentralise the Western research approach, and although this study is part of a larger project of the first author, the design, data collection, and analysis were conducted to ensure the first and second authors had equal power. Further, as part of our collaborative approach, we followed cultural protocols on the provincial and village level and visited the field sites before conducting focus group discussions to seek permission from each community and engage in discussions regarding the project.

2.2. Study Location

This study was conducted in Kecamatan (district) Batu Ampar, Kabupaten (regency) Kubu Raya in West Kalimantan (Figure 1). An estimated 161,967 hectares of mangroves and 49,255 hectares are located in Kecamatan Batu Ampar [43,44]. The mangroves in Kecamatan Batu Ampar are relatively intact due to a lack of conversion to aquaculture. Mangrove cover change analysis from Kubu Raya between 1996 and 2016 shows 100,592 hectares of remaining mangroves in this coastal forest landscape which experienced 2252 hectares of loss (2%) over the two decades [45].

Among the fifteen villages in Kecamatan Batu Ampar, two villages, Batu Ampar and Medan Mas (Figure 1), were selected for this study due to their proximity to the surrounding mangroves and the high numbers of people utilising these mangroves for food, such as fishers, gleaners, and those that harvest NTFPs. This decision was made in partnership with Blue Forests, the partner organisation that had knowledge of the livelihood activities in both villages. Medan Mas consists of 2 sub-villages with an estimated 339 households, mostly engaged in coconut farming, whilst Batu Ampar village consists of 8 sub-villages with 2841 households, mostly engaged in charcoal production and fisheries [46,47].

Figure 1. Map of Indonesia (**bottom right**), map of Kalimantan (**top right**), and map of Batu Ampar and Medan Mas villages located in Kubu Raya Regency.

2.3. Focus Group Discussions

Eight gendered-specific focus group discussions (FGDs), (four men and four women groups) were held in four sub-villages in Batu Ampar: Sungai Limau, Gunung Keruing, Teluk Air, and Medan Deli, in Medan Mas, between the 22 and 28 October 2022. Seed sample female and male participants were identified in each sub-village through Blue Forests who assisted in setting up meetings with each person to start the sampling process. Each seed participant was asked to refer people from their community who matched their gender and met the inclusion criteria. Eligibility criteria were that a person had over fifteen years of experience working as (a) a fisher; (b) a gleaner; and/or (c) a harvester of non-timber products within the surrounding mangroves. These categories were created with the community. Fishers were defined as people using boats or specialist fishing gear such as rods, nets, or trawling equipment. Gleaners were defined as people that focused on harvesting aquatic food, primarily shellfish, from the mangroves using knives or hands, and harvesters were defined as people targeting non-timber forest products such as leaves and honey. When quoting participants, they will be referred to by their primary livelihood activity, as self-identified during the recruitment stage; however, it is noted that some participants engage in multiple activities. Participants (n = 30) were identified through exponential discriminative snowball sampling to participate in FGDs (Table 1). This process continued until the eight focus groups had a minimum of three members. Two FGDs had two participants, as some members withdrew at the last minute for personal reasons including illness. The total sample was gender balanced even after the last-minute withdrawals; however, the FGD sizes were not equal across all sub-villages. In Medan Mas, the FGDs conducted combined fishers and gleaners from two sub-villages: Medan Deli and Sungai Masjid due to recent livelihood shifts towards coconut farming.

Table 1. Number of FGDs participants per sub-village, with gender and mangrove livelihood.

Village	Sub-Village	Focus Group	Number of Participants	Occupations
Medan Mas	Medan Deli	Female	4	4 gleaners
		Male	4	4 fishers
Batu Ampar	Sungai Limau	Female	5	1 gleaner, 4 fishers
		Male	2	2 fishers
Batu Ampar	Gunung Keruing	Female	2	1 fisher, 1 tea maker
		Male	3	3 fishers
Batu Ampar	Teluk Air	Female	4	1 fisher, 3 gleaners
		Male	6	6 fishers

The FGDs had two purposes; the first was to use a participatory seasonal food mapping (SFM) method created by Bioversity International [48] conducted to document the seasonal availability of all foods sourced from different habitats within the surrounding mangroves according to women and men. The second was to identify and discuss motivating factors, drivers or barriers experienced by participants when utilising mangrove food systems.

Two facilitators conducted the FGDs in the two villages. Communities speak both Indonesian and Malay; therefore, FGDs were conducted in both languages interchangeably. The facilitators are fluent in both languages. Each FGDs began with the main facilitator introducing the project, the research team, the ethical consent process, and the goal of the FGDs. Each participant was asked to sign informed consent forms. We collected these data through recording devices and used a conversational approach allowing the participants to lead the discussion. Each FGDs took between two to three hours to complete depending on the number of species listed by the participants and the discussions that arose.

2.4. Seasonal Food Mapping Method

FGDs began with the participants being introduced to the SFM method, in four main stages: (1) identify local seasons which were then matched to the Gregorian calendar; (2) free listing species and food sourced from mangrove systems, their uses and habitat sourced from; (3) verifying species identification; and (4) applying an availability score for each species by month. After the free listing exercise was completed, the facilitator listed all the species and checked with the group that there were no duplicates or multiple names for one species. Once these stages were complete the group was asked to score the availability of each species for each month of the year. Each species was scored from zero to three to capture seasonal variability; 0—no availability, 1—low availability, 2—moderate availability, and 3—high availability. Group consensus on month-to-month availability had to be reached before the facilitator noted the score. Each step of the SFM method was used an elicitation technique to further discuss the participants' utilisation of mangroves. Each topic covered during the quantitative SFM process, such as what species were available, source habitat, use and seasonal availability was used to prompt additional discussion on barriers, motivations, and drivers for the qualitative portion of this analysis. The facilitator supported the participants to lead the discussion organically but asked additional questions if required.

During FGDs all species were listed in local names, either in Indonesian or Malay and after the completion of the FGDs, the scientific names of all mangrove species listed were identified by a group of people drawn from partners at Blue Forest staff, Provincial office of The Ministry of Marine Affairs and Fisheries, and a marine biologist from Oso University in Pontianak, Indonesia.

2.5. Method of Analysis

2.5.1. Seasonal Food Calendar

Each seasonal map, species list, and associated rating developed during the FGDs (Figure 2) was entered into Microsoft Excel (version 16.83) to create eight datasets. Within the dataset, each species was assigned a location according to the sub-village and a gender marker such as F for female or M for male to indicate which FGD provided the information. English and scientific names were added for each species. The calendars created by the FGD participants were then combined to create one dataset per gender. Participants from different sub-villages reside within close proximity to each other and therefore often mentioned and scored the same species. To merge the eight datasets for each gender, the data for each species had to be combined into a single availability score for that species. If the participants from different groups assigned different scores to the same species, the mean score was calculated, and duplicates were removed. Further, some participants also used different local names for the one species. Once these had been identified, and if availability scored differed, they were merged using the same technique described above. The species were then organised into one of the following twelve food groups: jellyfish, crustaceans, molluscs, sharks and rays, finfish, mammals, insects and worms, reptiles, birds, plants, fruit, and honey (produced by stingless and honeybee species). This study is concerned with mangroves as a food system with different food groups, types of habitats accessed, and uses for harvested species as characterised by the participants. For example, the grouping of foods was made by the research participants, the different mangrove habitats areas were identified by the participants and the uses of each species, such as for sale or household consumption, were identified by the participants. The participants placed each species into one food group with the final listings checked and validated prior to data analysis. The species and groupings may not necessarily fit their taxonomic categories. Monthly availability scores for each of these food groups were created using the following formula:

$$Total\ potential\ availability\ score = total\ number\ of\ species\ per\ group \times 3 \quad (1)$$

$$Group\ monthly\ availability\ percentage\ (\%) = \frac{monthly\ group\ availabity\ score}{total\ potential\ availability\ score} \times 100 \quad (2)$$

A total potential availability score was created by multiplying the total number of species for each food group by three, which is the highest seasonality score participants could assign to each species they listed during the SFM exercise (Formula (1)). The scores for each species for each month were then combined to give the availability for each food group by the month and converted into percentages of the total potential availability score (Formula (2)). Seasonal calendars were created in Microsoft Excel showing monthly percentages by food group for each gender (Figure 2).

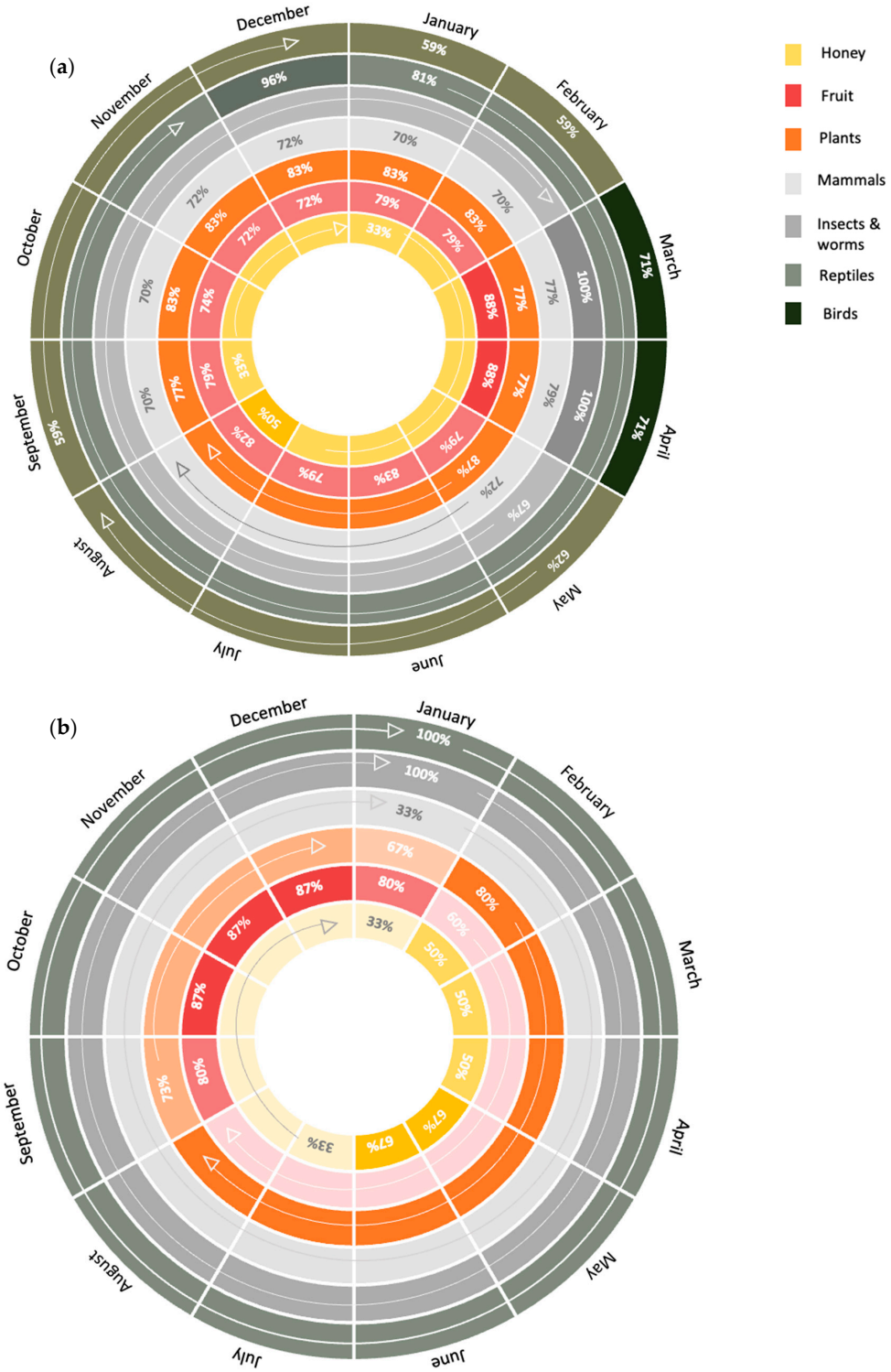

Figure 2. Percentage (%) of total potential seasonal availability for terrestrial food groups by month and gender (methods outlined in Section 2.5.1). (**a**) Shows seasonal percentage scores as recorded by female participants. (**b**) Shows seasonal percentage scores as recorded by male participants. Individual rings and colours represent food groups. Food groups are assigned the same colour for women and men to compare availability. Changes in colour on individual rings indicate an increase in the availability of the food group.

2.5.2. Thematic Analysis

FGD information for the second section of the results was transcribed verbatim into Microsoft Word and was then translated into English. The organisation, familiarisation, and coding of the transcribed data were conducted in NVivo 14. Thematic analysis was carried out using a hybrid approach integrating inductive coding and deductive analysis [49–51]. Inductive line-by-line coding was used to generate initial codes by identifying repeated words or topics related to motivations, drivers, barriers, and consumer preferences. These codes were reviewed, refined, and categorised into groups. After initial trends were noted from the codes, they were grouped according to the driver categories in the HLPE food systems framework (2020) [16] (Table 2). We used food systems drivers and consumer behaviour elements of the HLPE food systems framework within the context of the broader food environment to show how mangroves are viewed as a local food system. Not all codes fit into a category within the global framework as mangroves are utilised on the local level; therefore, additional themes that emerged from the codes included local ecological knowledge, non-food uses and personal barrier themes (Table 2). Some codes could also be coded in multiple themes. Examples of codes and quotes for each theme are provided in Supplementary Information.

Table 2. Themes and codes about the knowledge, drivers, and barriers of utilising mangroves as a local food system generated from the thematic analysis. Themes with (FR) next to them were created from the HLPE food systems framework (2020).

Themes	Codes
Local ecological knowledge	Species habitat and behaviour, harvesting method, species classification
Non-food uses of mangroves	Traditional medicine, beauty, timber
Environmental drivers (FR)	Changes in catch, changes to landscapes, environmental protection, seasons and weather, changes in climate
Economic drivers (FR)	Economic motivations (income-based motivation, economic demand)
Political and institutional drivers (FR)	Conflict, sourcing species protected by law/illegal trade
Socio-cultural drivers (FR)	Women's empowerment, autonomy, enjoyment, food and culture, pride, and social capital
Demographic drivers (FR)	Loss of knowledge (caused by urbanisation), modernisation
Personal barriers	Gender norms, ability, fear, risks, local customary beliefs
Consumer behaviour (FR)	Dietary preferences, flavour, dietary risk and fear, food processing

3. Results

3.1. Species Identification and Seasonal Availability

Seasons played a strong role in the availability and ability of the participants to source food. All groups described three local seasons based on the direction of the wind. The North (*Utara*) season takes place between February and April and is the start of the dry season. Between May and September is the South (*Selatan*) season, which is described as the peak dry season, with rain starting towards the end of this season. The West (*Barat*) season takes place from October to January and is classified as the rainy season, where the winds and waves are strong. The time of year when food groups were found to have the greatest availability mostly falls in the North and South seasons when the climate is dryer and there is less rain and intense winds (Figures 2 and 3).

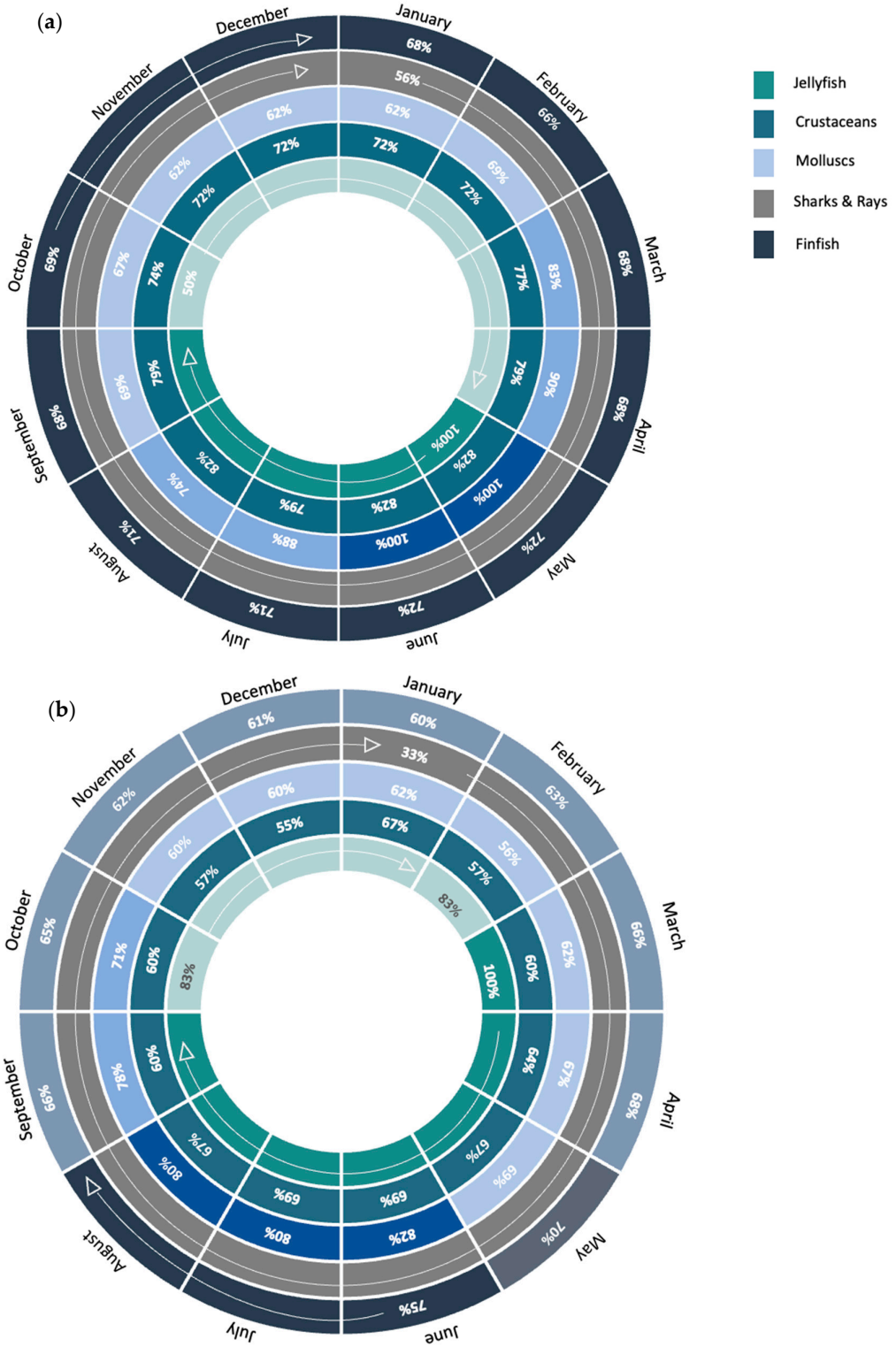

Figure 3. Percentage (%) of total potential seasonal availability for aquatic food groups by month and gender (methods outlined in Section 2.5.1). (**a**) Shows seasonal percentage scores as recorded by female participants. (**b**) Shows seasonal percentage scores as recorded by male participants. Individual rings and colours represent food groups. Food groups are assigned the same colour for women and men to compare availability. Changes in colour on individual rings indicate an increase in the availability of the food group.

During the FGD SFM exercise, participants identified a total of 267 species, 204 by women and 116 by men, with women listing 88 more species than men across 12 food

groups (Table 3). Of the 12 food groups, 5 are considered aquatic foods including jellyfish, molluscs, crustaceans, sharks and rays, and finfish. Figure 2 shows the seasonal availability of food groups by gender across annual periods. Differences in availability by gender occurred in all food groups. In cases where women and men agreed on the peak season for a species, there were still minor differences (Figures 2 and 3). This can be seen in the case of jellyfish, where men scored them to be most available between March and September, whilst the peak season for women began in May. The greatest number of species listed by women and men was finfish and although the seasons differed slightly, finfish were considered to be available throughout the year (Table 3 and Figure 3). Birds were only mentioned by women and were most available in March and April, which mirrored the time of year that fruit was most available (Table 3 and Figure 2).

Table 3. Number of species listed for each food group by women and men in the seasonal food mapping exercise.

Food Group	Female	Male
Honey	2	2
Fruit	8	5
Plant	10	5
Mammals	18	1
Insects and worms	2	1
Reptiles	9	2
Birds	35	0
Jellyfish	4	2
Crustaceans	13	14
Molluscs	14	15
Sharks and rays	9	2
Finfish	80	67
Total	204	116

3.2. Source Habitat and Uses

An important part of the mangrove food systems is the extensive local knowledge held by participants in identifying species, which species to harvest for food income, and other medicinal uses. Participants often distinguished fish species by size, colour, and defining features. If a fish was the same species but a female had a smaller body size it would be given a separate local name. The participants were also able to describe up to 10 different habitats where they sourced species from the mangrove bed (the forest floor) to the river/estuary (Table 4). Women listed 10 habitats where they harvested or caught species including (1) ponds, (2) Nypah forests, (3) mudflats, (4) mangrove trunk, (5) mangrove treetops, (6) mangrove forests, (7) the mangrove bed (substrate) (the mangrove forest floor), (8) mangrove roots, (9) the fringes of the mangrove, and (10) the river/estuary. Comparatively, men only source food from five habitats including (1) river/estuary, (2) Nypah forest, (3) mangrove roots, (4) mangrove bed, and (5) the mangrove fringes (Table 4). Mangroves were categorised by their proximity to the river, with each part of the forest separated into different habitats or areas for sourcing species. For example, when women listed the mangrove forests as the source, this was defined as the area of the forests closest to land, whilst the roots, trunk, and treetops could be on the same tree but serve as separate niche habitats for various species such as shrimp, snails, and birds, respectively.

Table 4. Number of species sourced by habitat and gender.

	Female	Male
Mangrove Bed	9	17
Mangrove Roots	6	6
Mangrove Trunk	6	0
Mangrove Treetops	33	0
Mangrove Forest	28	0
Nypah Forest	11	13
Mudflat	19	0
Ponds	2	0
Mangrove fringes	58	67
River/estuary	59	68

A total of 97 and 135 species were sourced for home consumption and 88 and 116 were for direct sale by men and women, respectively (Table 5). Women also sourced species for other uses such as traditional medicine, tea, and beauty products. Whilst men also mentioned sourcing species for medicine, a greater proportion of species were specifically sourced to sell and consume as foods. Women listed birds, a range of mammals, and aquatic foods when describing mangroves as a food system whereas men mainly focused on listing species (mostly targeting fish) they sourced for sale. A wide variety of plant and animal species as well as their habitats such as nests were sourced from mangroves for medicinal purposes. Species were sourced to relieve asthma symptoms, cure worm diseases, reduce fevers, and dry the umbilical cord after birth. A full list of species, their groups, source habitat, and uses are provided as Supplementary Information.

Table 5. Number of species sourced by use and gender.

	Female	Male
Food	135	97
Sale	116	88
Fish/Crab Bait	5	6
Medicine	6	4
Tea	3	1
Beauty Product	3	0

3.3. Drivers and Barriers of Mangroves as a Local Food System

This section presents results from FGDs thematic analysis on women and men's motivations, drivers, barriers, and consumer behaviour associated with the mangroves harvested for food, sale and other non-food uses. Demographic drivers were not a major theme, did not affect current mangrove utilisation, and were not discussed in detail by participants.

3.3.1. Environmental Drivers

"Poison" from industries located upstream was considered by the four male focused groups to be influencing fish catch and reducing the availability of certain species and "*lessen their sources now*" (Male, Fisher). These groups discussed how newer industries on the islands, as well as causing a shift towards trawling, are changing the landscape, "*Fishers now have a difficult life*" (Male, Fisher). The land use changes in some areas caused concern among men utilising these areas "*because mangroves are pivotal to our livelihoods*" (Male, Fisher).

Weather influenced how participants utilised mangroves as a food system, and this was discussed extensively in every group. However, only three focus groups referenced climate change and shifts in normal patterns over recent years, expressing that the weather is getting "*worse*" and "*unpredictable*". Weather increased the difficulty of their livelihood activities and often inhibited people from going fishing. For up to six months of the year,

the wind and rain are considered to worsen in all sub-villages, and participants often felt the challenges increased during this time. They felt food was freely available, but the seasons and weather impacted whether they could access them.

> "*Almost all the foods* (*from the mangroves*) *are always available here, but whether we can access them depends on nature*"
>
> Male, Fisher.

3.3.2. Political and Institutional Drivers

References to politics, organisations, institutions, and conflicts were discussed by male participants only. Conflict arose due to organisations operating on the islands that resulted in negative impacts for local communities, due to environmental changes, conflict over land tenure and rights, and physical conflict between locals and the government and organisations and their workers. The most pressing concerns and conflicts were due to converting mangroves to ponds and the increase in palm plantations in the landscape which created negative consequences for the community. In one group, men felt that the ponds blocked their access to the mangroves and impacted their livelihoods. The community felt ignored by local politicians, which increased tensions and resulted in physical altercations with those who owned the ponds. In the east of the island, men expressed struggles with large organisations that operate palm plantations and the use of pesticides and chemicals impacting their fishing environment. The men in three separate groups discussed the feeling of voicelessness and inferiority when being from rural areas compared to those working in the government.

> "*They* (*government and industry*) *are smart people, we are not, so we are the ones. The poor ones*"
>
> Male, Fisher.

3.3.3. Economic Drivers

Sourcing food from mangroves was highly influenced by economic drivers, mainly the demand for a specific species and an increase in selling price. Seven of the eight groups discussed market prices and demand, the different grades of finfish and the exact price of popular species. One male group discussed that "*fishers have insecure income*" (Male, Fisher), whilst a female group discussed that gleaning provided them with income when they had nothing else, "*When we have nothing at home, we just go looking for clams and we can collect 10 canting* (*local measurement*)" Female, Gleaner. Half of the groups discussed consuming the catch that they could not sell.

3.3.4. Socio-Cultural Drivers

Pride, joy, and autonomy served as explanations or reasons as to why the participants chose to work in the mangroves. Two male groups discussed how they feel "*freedom*" in what they do and the joys of learning from their work and not having a boss like other community members. Some discussed their pride in their mangroves and the well-being benefits they derive from their work:

> "*Because we have a rich ecosystem even though we are still poor. Because we always have an easy mindset. Don't worry we can find food tomorrow. We have that mindset*"
>
> Male, Fisher.

The groups also expressed "*love*" for their jobs, especially the women who felt that they had many "*experiences*" in life, as they had the skills to both "*cook and also go fishing*" (Female, Gleaner). Socialising in the mangrove or whilst harvesting food was mentioned in male and female groups. The act of getting together and consuming food or talking was discussed as a highlight of their work. All four women's groups expressed the importance of being together in the mangroves and how food is a part of that.

"*Many of us go* (*gleaning*) *together. . ., even if we only have rice for lunch, it tastes better because we eat it together*"

Female, Gleaner.

3.3.5. Consumer Behaviour

Consumer behaviour reflects the behaviour of the participants around the selection of foods that are sourced from mangroves. In all eight FGDs, flavour (e.g., "*sweet*", "*delicious*", "*yummy*", and "*tasty*") was emphasised as important in targeting certain species and enjoying the food they sourced from mangroves. Some species were harvested "*just for consumption*" because they "*prefer to consume it*". Flavour heavily influenced whether the participants would consume or sell their catch. Cooking methods, preparation, and what dishes would best accompany individual species were discussed in every group.

"*That fish is really delicious if you cook asam pedas* (*sour and spicy soup*)"

Female, Tea Maker.

Participants disliked certain foods due to their "*sour*", "*tart*" and "*bitter*" flavours. Texture also influenced whether a food would be sold or consumed at home. Certain species were not consumed by individuals as it caused them to "*feel disgusted*". Squid, jellyfish, and eels were all considered to be disgusting, often due to association with other species, "*looks like a snake*".

"*I don't like it, it feels disgusting, I don't like, especially its tentacle*"

Female, Fisher.

3.3.6. Personal Barriers

Personal barriers relate to the factors at such as physically being able to access certain environments and habitats seasonally, and dangers associated with accessing species, social norms impacting access and livelihood activities, relate to the individual's ability to utilise mangrove food systems. Local beliefs that have been discussed and passed down through the generations, combined with the physical risk and fear that the community faces when interacting with venomous or dangerous species were consistently referenced by all groups as barriers they faced when harvesting food. Jellyfish were perceived as the largest threat, with major concerns over the pain and symptoms that would be caused if stung whilst sourcing food. Participants believed that stings from jellyfish caused people to "vomit leaves" from various mangrove species, and the community used this knowledge as a reference for severe poisoning. One group also shared the origin story and history of the jellyfish in the area:

"*Based on our local folklore, people believe that jellyfish came from the placenta of the sea ghost. So, if you know their origin, then you know the cure for their sting*"

Female, Fisher.

Strong weather was also discussed by everyone as a point of fear when accessing mangroves and a risk to their safety. Thunder and heavy winds were specifically referred to as weather risks during certain times of the year. The act of working in the mangroves to harvest food was considered by many as physically challenging. Activities such as harvesting clams, which are mostly conducted by women in the community, were considered hard and challenging by both genders. There were references to ageing and the struggle for older women to continue gleaning for clams due to the physical difficulty of the job. Further, the women in one group discussed the challenges of travelling to work through newly established crab and shrimp ponds that disrupted their route, making it more physically burdensome for them. Female participants discussed feeling empowered stating that they had skill and experience.

> "*We are women with many experiences. . . usually the male fishers fish in areas that aren't as complex as the ones we visit*"
>
> Female, Fisher.

However, in opposition to this, women also discussed having to ask permission to work in the mangroves from their husbands,

> "*I usually persuade my husband to allow me to go fishing*"
>
> Female, Fisher.

4. Discussion

This study of mangroves as a gendered local food system provides critical evidence that mangroves are vital to livelihoods in Kubu Raya, providing an essential major source of local foods and income and other uses. A key finding from this study is how access, use, perceptions, and knowledge differ by gender which shapes the mangrove food systems. Our findings show that women had a depth of knowledge on what can be sourced from mangroves, whilst also travelling and fishing in more diverse habitats within mangroves to source food than men. Women spent more time in different areas of mangroves and used different modes of transport than men. This difference may indicate women have a deeper understanding of mangroves, compared to men who mostly focus their harvesting on fish species. Women specifically discussed working in groups and knowledge being shared by their elders and mothers, a topic that was not discussed in male groups.

The knowledge held by local communities, primarily living in rural areas, continues to be marginalised in food systems and nutrition interventions and research [52]. This is specifically relevant in the wake of the 2021 Food System Summit which was widely contested due to the tensions that arose from Indigenous and local voices that continue to be ignored within research and policy-making processes [53]. Some studies have concluded that communities have a lack of knowledge about mangrove species or ecosystem services [54–56]. Many communities have knowledge around mangroves that are shaped by their needs, such as income, food, and cultural values, which may not align with external knowledge around their role as ecological systems [57]. Narratives from such studies can be damaging and underestimate the role of local knowledge. Our findings show participants had a depth of knowledge that was adequate to meet their daily needs, including listing 267 species, when and where they were available and their uses.

This extensive knowledge has been mirrored in other studies, including one conducted in Kenya with 48 female and male resource users who could identify 24 separate goods across 5 defined groups which included food, fuel, construction materials, household items, and other goods [58]. The participants in Kenya listed categories of goods that contained seven groups that were identified by the participants including fish, shrimps, honey, molluscs, birds and eggs, tea, and vinegar [58]. The influence of gender on knowledge about forests was noted in Gachuiri et al. (2022) [59] study, where the female participants perceived themselves to have a lack of knowledge about food sourced from trees. Conversely, many of the women in our study felt proud of their knowledge and roles in gleaning, fishing, and/or harvesting food from the mangroves and their role in preparing food for their households, identifying 204 species, considerably more than the male participants. These findings are of interest as globally the voices of female food systems actors often go ignored, yet they play vital roles in procurement, processing, selling and consuming food system products [60]. Further, our findings show that women's knowledge in food systems research is essential given that they access and utilise food systems differently, often due to a lack of fisheries assets.

The physical environment experienced by participants in the study shapes their everyday lives, influencing when, and where they source food from mangroves. The environmental drivers demonstrate that, despite food being available, participants' capacity to fish is negatively impacted by weather patterns, mainly to avoid issues on the water caused by waves, wind, rain, and lightning [61]. This is a daily reality for the participants

in Kubu who utilise their local knowledge of weather, currents, and tides to secure their safety whilst working in the mangroves. Studies have documented concerns about how increasingly variable weather events are impacting fishing communities across the globe, both in terms of their well-being and safety but also reducing their income, working hours, and destroying fishing-related infrastructure [62–64]. This is significant considering that participants also shared concerns relating to a changing climate, reduced catch, and shifting institutional landscapes (Section 3.3.1).

Although women and men discussed the environment and the climate, the findings from the political and institutional driver revealed gendered differences. For example, only male participants discussed concerns about how waste and by-products from the industry upstream were impacting their fish catch. Further, the burden and threat of physical violence that emerged between industry, government, and fishers demonstrated that men also face gendered risks in relation to a changing industrial landscape that is threatening their safety and livelihoods. The complex power dynamics influenced by land use changes have been noted in other studies, with a review noting that communities often feel powerless and unable to exercise any rights when coming up against government actors and industry [65,66]. The female participants did not mention any conflict related to issues around mangrove access and land use or tenure. It is possible that the lack of engagement in this issue by women could be the result of exclusion from conversations around land tenure or institutional access, which may stem from social norms and structures. So, although these issues were not raised by the female participants in this study, the interaction between gender, food access, and tenure issues are worthy of future research. Instead, women focused more on the physical burden of the job and the challenges they faced as women wanting to pursue livelihood activities in the mangroves. A study examining the masculinity of land use changes for palm oil within West Kalimantan and other areas in Indonesia argues that women are often less involved in the conflicts than men despite being negatively impacted by way of losing access to land within their communities [67]. Similarly, the female participants of this study referenced having to travel far because of newly established ponds but did not mention conflict at any point during the FGDs.

The topic of income as shown in the economic driver results was consistently discussed throughout the FGDs and mangrove-based livelihoods are central to the community. Both women and men were driven to make income-based decisions when selecting species to harvest and had extensive knowledge on the price of individual species. As such, women are as much economic players in the local fisheries value chain as men, with both consuming and selling their catch.

Gendered differences in the perception of mangrove food systems, the number of species, and where they were sourced from were influenced by socio-cultural drivers including religion, gender, culture, and public policy. The socio-cultural factors that influenced mangrove food systems were nuanced in relation to gender, particularly from the perspective of the female participants. Although they listed more species across the four discussion groups, one group of women expressed that men in their area had more knowledge of species than they did. This duality was present in other areas related to gender, as women both felt empowered in their knowledge and abilities but also felt disadvantaged due to their gender norms. Age and exhaustion were mentioned across the female discussion groups, they had to endure harder physical journeys than men, possibly due to socio-cultural norms around the ownership of motorised boats [31]. Gachuiri et al. (2022) [59] found that men and women identified different challenges associated with socio-cultural norms around the ownership of assets and the definition of jobs that excluded women. Further, a study conducted by Anugrah et al. (2022) [68] in Indonesia, found that women were not considered primary users of forests. Similarly, women are not recognised legally as fishers within Indonesia, leading to a societal marginalisation of women working or utilising forest and aquatic food systems [69]. This may contribute to the duality of empowerment dynamics within this study as female participants as they have extensive knowledge that would not be recognised on a societal level.

These societal norms also influenced other barriers participants faced when utilising mangrove food systems. Although the restrictions for women were mentioned, the most prominent barrier was the risk of collecting/harvesting certain species. Women had accumulated knowledge on the risk posed by venomous species, such as jellyfish, which has led to practices in how to manage their stings. The knowledge built through experience in the mangroves is essential for communities to safely access, utilise, and manage mangroves and therefore, mitigating loss and highlighting traditional knowledge should be a priority [70].

Consumers have a vital role in shaping their local food systems, especially if they are the people harvesting or catching wild foods for subsistence or income purposes. Consumer behaviour is influenced by personal preferences determined by taste, convenience, culture and other factors and therefore all food systems drivers including environmental, political and institutional, economic, socio-cultural, beliefs, and preferences influence consumer behaviour [71]. However, on a larger scale, consumer behaviour is also shaped by the local environment, including the food environment [23]. Demand for specific species based on their taste was of great importance to the participants, and certain species were prioritised for these reasons. The theme of enjoying certain foods sourced from mangroves due to their flavour, taste and what they could be cooked with, demonstrated that mangrove food systems also contribute to the joy participants gained from their diets. Someone's preference for a food can be influenced by the smell and whether it is salty, sweet, sour, or bitter [72]. In this study, certain foods were not consumed during the wet season because of the personal safety risk fishers would have to take to when sourcing them, thus demonstrating that seasonality dictates when foods are consumed. Further, without access to fishing equipment, women were generally restricted to sourcing species closer to shore. The concern for reduced fish catch caused by industrial waste or climate change may negatively impact whether fishers can source the species they prefer to consume. The barriers and drivers that shape mangrove food systems are interwoven and the extensive knowledge of fishers, gleaners, and those who harvest NTFPs has been shaped by multi-generational experience. What is clear from the results is that regardless of barriers, challenges and the shifting environment, the community is dependent on mangroves for livelihoods through their socio-ecological relationship with the system.

This study contributes to the literature by providing a case study on mangroves as a local food system, the species available, and how the community perceive, access, and utilises these in West Kalimantan, Indonesia. This study collected data on the seasonal availability of species sourced from mangroves, which are subject to change over time, is context-specific, and the species and food groups are likely different in other mangrove-dependent populations. The data for this study were collected in October 2022 covering an annual period and therefore an element of recall bias is expected. Further, the sample was small, limited to 30 people, and therefore all results may not be applicable to the entire location. This study has provided an initial exploration of drivers and barriers of the mangrove food system. Further research in different mangrove-dependent communities in the Global South could deepen our understanding of mangrove food systems in different landscapes and expand the application of the food systems framework [73]. There is great potential to build on this research to develop more comprehensive understanding into how mangrove food systems contribute to household food security, dietary diversity, and nutrient intake, as well as how the gendered dimensions of these indicators should be addressed in mangrove management and conservation policies.

5. Conclusions

To the best of our knowledge, this study is the first to take an in-depth look at mangroves as gendered food systems in Indonesia using decolonising methodologies to facilitate the inclusion of local people's knowledge in a meaningful way. This approach has integrated consideration of gendered mangrove-based livelihood and food systems within the broader socio-ecological system. The findings demonstrate that mangroves are a vital food system, especially for women, who are not legally recognised as fishers in Indonesia.

Mangroves are often characterised as a blue carbon system and, as such, are valued for their role in mitigating climate change and supporting fisheries, e.g., by providing important nursery habitats. However, this study advocates for the need to understand mangroves as a food system, considering the local-scale and gendered dynamics embedded within the system. A greater inclusion of women, and their livelihood dependencies, needs to be considered in mangrove management and conservation, to promote gender equity and sustainable livelihoods. The approach taken in this paper supports the view that integrating and facilitating the inclusion of local people's values, experiences, and perceptions of mangrove food systems are a crucial part of sustainable outcomes, especially in the face of a dynamic policy and environmental contexts.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16083229/s1, Dataset: Seasonal availability of mangrove species by food group and gender, Table S1: Thematic analysis codebook.

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