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GLEANERS, GLEANING ACTIVITIES, AND LIVELIHOODS IN PENINSULAR MALAYSIA

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Abstract

Seagrass-gleaning fisheries are vital small-scale fisheries that significantly contribute to coastal livelihoods. Despite their significance, these fisheries are often overlooked in coastal management planning. This study investigates the seagrass-gleaning fisheries of the Kampung Perigi Acheh community in the Sungai Johor estuary, focusing on the activities, products, and implications of this fishery for local livelihoods. Ethnographic methods, including participatory mapping and Focus Group Discussions (FGDs), were employed to identify six gleaning sites where fish, crabs, sea cucumbers, carpet anemones, seaweed, and shellfish are harvested. Gleaning methods encompass walking, swimming, and tool-based practices like the *sagang* and *kilah* techniques. While both men and women engage in gleaning, women play a vital role in sustenance, recreation, and cultural identity, strengthening community bonds and reflecting distinct gender roles. We recommend empowering communities in decision-making processes by enhancing the understanding of seagrass-gleaning fisheries, which is essential for safeguarding the sustainable livelihoods of coastal communities.

Keywords: *seagrass gleaning, small-scale fisheries, coastal livelihoods, women, Johor*

INTRODUCTION

Seagrass gleaning is a type of small-scale fishery (Stiepani et al., 2023) that involves the collection of invertebrates or other intertidal-associated species in seagrass meadows (Furkon et al., 2019). Meadows in the intertidal zone are vital fishing habitats due to their accessibility in shallow waters, where gleaning is easier (Unsworth & Cullen, 2010; Furkon et al., 2019). Seagrass gleaning is conducted by walking along the shoreline during low tide (Unsworth et al., 2019; Stiepani et al., 2023). Notably, gleaners submerge underwater, swim, or dive to collect seafood (Grantham et al., 2020; Bantayan, 2022; del Norte-Campos et al., 2023; Stiepani et al., 2023).

Gleaning is a significant livelihood activity for fishing communities in Southeast Asia (Furkon et al., 2020). It also contributes to food security by providing a direct food source amongst coastal communities and sustaining their need for daily protein (Unsworth et al., 2019). Gastropods are typically the most dominant species gleaned (Furkon et al., 2019). However, other target species also include algae, crabs, bivalves, crustaceans, and echinoderms (Stiepani et al., 2023). Furthermore, gleaning also provides income to communities. In Catanduanes, Philippines, gleaning supplies an average monthly income ranging from 1.86 to 76.26 USD (Aldea, 2023). Seagrass gleaning is practised by coastal communities in developing countries that have limited alternative sources of income (Food and Agriculture Organisation of the United Nations [FAO], 2019; Teh & Pauly, 2018; Lauritsen, 2019), such as farming, aquaculture, and selling groceries (Silas et al., 2020; Jones et al., 2022a).

Although men and women practice seagrass gleaning, women are more active in this small-scale fishery (Stiepani et al., 2023). In particular, gleaning is common for women in Eastern Africa and the tropical Indo-Pacific (Chitará-Nhandimo et al., 2022; Stiepani et al., 2023). In Malalison, Philippines, 85% of walking gleaners were women (Stiepani et al., 2023). In Eastern Indonesia, the largest group of gleaners consists of women, at 52% (Furkon et al., 2020). Coastal women's contributions to subsistence activities in seagrass meadows also include the collection of fruit from the tape seagrass (*Enhalus acoroides*) in South Sulawesi, Indonesia (Nessa et al., 2020). Multiple studies have displayed the role of women exclusively in invertebrate gleaning (Nordlund et al., 2010; Quiros et al., 2018; Furkon et al., 2019; Grantham et al., 2020; Stiepani et al., 2022; Stiepani et al., 2023). Nevertheless, women's position in coastal fisheries is still poorly acknowledged in fisheries management and policies (Grantham et al., 2020; Stiepani et al., 2022; Stiepani et al., 2023).

Despite the significance of seagrass gleaning to the livelihood of communities, intertidal gleaning sites have been notably excluded from fisheries

laws and regulations even with the existing documentation of gleaning in Southeast Asia, such as in Indonesia (Stiepani et al., 2023), Philippines (Aldea, 2023), and Timor-Leste (Grantham et al., 2020; Tilley et al., 2020). Gleaning was also recorded in Tanzania (Pike et al., 2024), Mozambique (Nordlund et al., 2018; Stiepani et al., 2022), and Ecuador (Trevĩno, 2022). Furthermore, gleaning activities in Peninsular Malaysia have not been substantially documented, although seagrass gleaning activities have been identified in Sabah (Choo, 2012) and Johor (Cob et al., 2008; Rahman & Yaakub, 2020). In the Sungai Johor estuary, fishery activities utilising gill or drift nets have been recorded, yet gleaning fisheries were notably absent from the study (Chong & Sasekumar, 2002).

The Department of Fisheries Malaysia (DOFM) manages and develops fisheries resources under the Fisheries Act 1985. This legislation was established under the principles outlined in the United Nations Convention on the Law of the Sea (UNCLOS) and the directives of the FAO of the United Nations (Wong & Yong, 2020). The DOFM plays a crucial role in fisheries management through zoning and licensing systems under the Fisheries Act 1985 (Wong & Yong, 2020). Concurrently, there is a growing consensus on adopting an Ecosystem-Based Fisheries Management (EBFM) approach in Johor. It complements existing measures and emphasises the protection of seagrass meadows that fall under state jurisdiction within three nautical miles of the low-water line (Hiew et al., 2012). However, specific legal protection for sensitive habitats like seagrass meadows remains insufficient, as these ecosystems are often undervalued in policy frameworks and economic assessments compared to other habitats like mangroves and forests (Rahman & Yaakub, 2020). In addition, these habitats' legal protection, including the Environmental Quality Act (1974) regulated by the Department of the Environment, has been applied in Johor to set clear environmental standards. Although the federal Environmental Quality Act requires an Environmental Impact Assessment (EIA) for eligible projects, enforcement issues often arise due to overlapping jurisdictions between federal and state authorities (Rahman, 2020). While federal agencies like the Department of Environment regulate pollution and land development, final decision-making on land use, agriculture, and other natural resources lies with the state. This leads to inconsistencies and gaps in implementation (Goh, 2016; Jamaluddin, 1996; Rahman, 2020). Moreover, the lack of enforcement and management policies for fisheries habitats can be traced to the case study of the Sungai Kim Kim pollution in 2019 (Ibrahim et al., 2021). Although industrial waste regulations exist, incidents like the illegal dumping in Sungai Kim Kim and ongoing pollution from multiple sources highlight the challenges in addressing cumulative pollution impacts in Johor's industrial areas (Kannan, 2018; Chan, 2019; Rahman, 2020). Despite the existence of regulations in waste

management policies, occurrences of waste dumping in various water bodies in Malaysia have persisted (Ibrahim et al., 2021), where the local community, including the fishermen, were affected.

The lack of local and regional management of intertidal-gleaning ecosystems in Malaysia endangers coastal communities that rely on seagrass meadows for livelihoods and food security (Sjafrie et al., 2021). Consequently, there is a dire need to document the gleaning resources, areas, and livelihoods of communities dependent on these fisheries to aid the management of gleaning fisheries resources. Note that the estuarine systems of Sungai Johor are the largest in southern Johor (Chong & Sasekumar, 2002), amplifying the need to document and protect these intertidal fisheries. To address the gaps in the documentation of seagrass gleaning and their contribution to community livelihoods, an exploratory case study was conducted in Kampung Perigi Acheh and Tanjung Kopok within the Sungai Johor estuary. The objectives are to explore seagrass-gleaning practices and their role in supporting livelihoods. The study aimed to answer the following research questions: (1) Where are the seagrass-gleaning habitats located within the Sungai Johor estuary? (2) What are the gleaning activities and methods employed? (3) How does gleaning contribute to the coastal community's livelihoods? and (4) Where do women glean in these areas? The findings will provide insights into the significance of seagrass-gleaning practices and their role in sustaining the livelihoods of coastal communities.

THEORETICAL FRAMEWORK

Seagrass Social-Ecological Systems (SES)

The Social-Ecological Systems (SES) approach, developed into a framework by Berkes and Folke (1998), offers a comprehensive lens to examine the dynamic interactions between social and ecological components of ecosystems (Jones, 2022; Stiepani, 2024). SES are inherently complex, with social and ecological processes occurring at multiple scales and timespans. This framework allows a deeper understanding of crucial social and ecological components, their interconnections, and the resulting feedback (Berkes et al., 1998; Colding & Barthel, 2019; Stiepani, 2024). Correspondingly, employing the SES framework can enhance the study of seagrass ecosystems, especially in terms of how they provide ecosystem goods and services to coastal communities (Wawo, 2017). This approach facilitates the analysis of the intricate relationships between human communities and seagrass meadows, integrating ecological and social science disciplines (Turner et al., 2003; Walker et al., 2004; Liu et al., 2007; Jones, 2022).

Ostrom's (2009) SES model characterises actors, resource units, and governance systems (Figure 1). While Ostrom's model does not explicitly address

gleaning practices, these components interact dynamically to influence the sustainability of such practices in coastal livelihoods, as applied in this analysis (McGinnis & Ostrom, 2014; Stiepani, 2024). Therefore, understanding these interconnections is crucial for effective seagrass resource management, as it helps bridge the ecological functions of seagrass ecosystems with the socio-cultural contexts in which they are embedded (Masterson et al., 2019; Boyle, 2023).

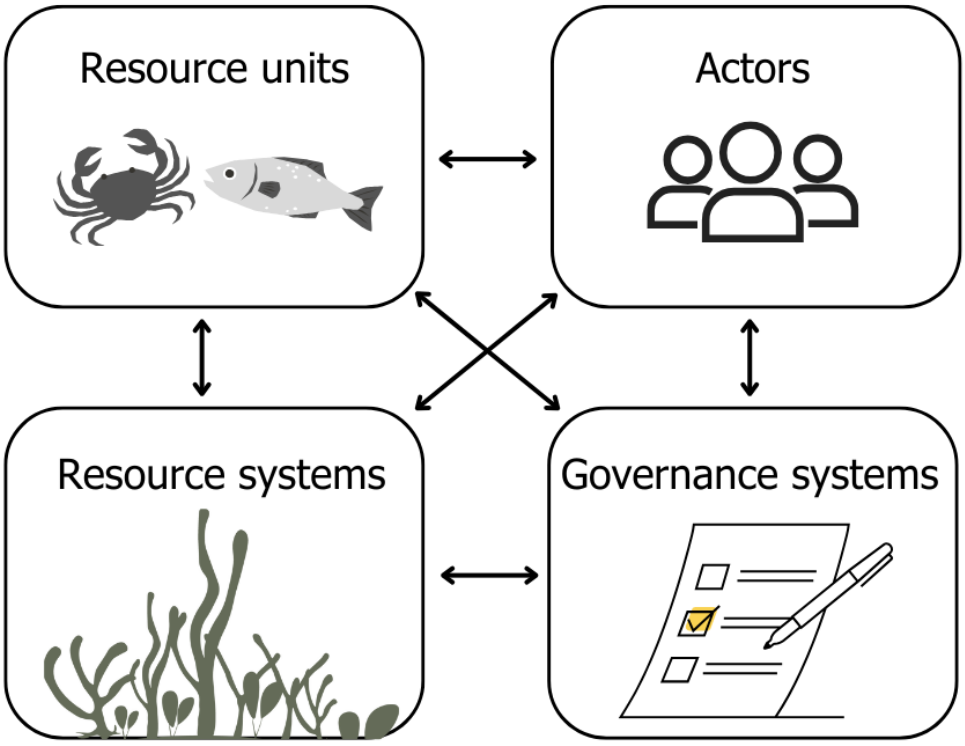

Figure 1: Social-ecological systems framework adapted from Stiepani (2024), illustrating four interacting components. (Source: Authors)

METHODOLOGY

Study sites

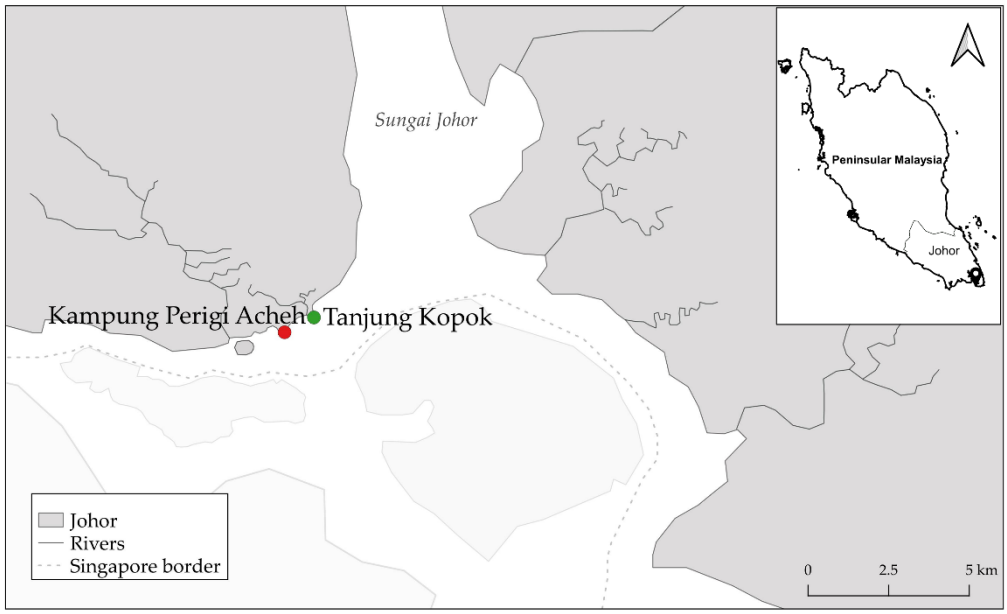

Figure 2: Map of the study area in the Sungai Johor estuary, featuring Kampung Perigi Acheh as the main case study site and the associated seagrass meadows, including Tanjung Kopok
(Source: Authors)

The study was conducted from August 2022 to December 2023 in Sungai Johor estuary, the largest estuary in southern Johor, with 10,635ha of mangrove reserves (Chong & Sasekumar, 2002). The total width of the estuary mouth is 5.8 km, while the total surface area of the water body, excluding the mangroves, is approximately 9000 ha. It focused on the Kampung Perigi Acheh village and the seagrass meadows found along the coastline, which were Tanjung Kopok seagrass meadow (1°26′05.3 "N 103°59′51.5" E) and Kampung Perigi Acheh seagrass meadow (1°26′14.0 "N 103°59′25.3" E) (Figure 2). Kampung Perigi Acheh is a coastal village located near the river mouth of Sungai Johor, inhabited by the Malay Muslim communities. This site was selected due to its accessibility to seagrass meadows (Tanjung Kopok, Kampung Perigi Acheh). According to the community members, most residents were born in the village, while others migrated from other states in Malaysia, such as Terengganu and Sabah. The community identifies the village as coastal since fishing activities are common among men and women.

The total population size of Kampung Perigi Acheh was approximately 670 individuals, where 45% of the total population were female, and 55% were male (A. Saat, personal communication, December 19, 2023). The main source of income was factory workers (40%), followed by full-time fishers (30%), self-employed (20%), and private sectors (10%). The average income for fishers was RM1200, while from factory workers, self-employed, and private sectors (working in factories, selling food, groceries) was RM2000 (A. Saat, personal communication, December 19, 2023). The main social activities in Kampung Perigi Acheh include Muslim-associated celebrations such as weekly *Yasin* recitals, the establishment of *Marhaban*, *Khatam Al-Quran* ceremony, and other social activities. This includes community sports day, community clean-ups, feasts, angling, and *rakit* (stilt house) fishing.

This study focused on the Kampung Perigi Acheh, villagers who were gleaners in the past or are still actively gleaning. Considering their extensive knowledge of seagrass gleaning, it targeted mainly the elders and fishers from Kampung Perigi Acheh. Participants in this study also included gleaners from Kota Masai, Kampung Tanjung Langsat, Kampung Pasir Putih, and Kampung Pasir Gogok, who were interviewed and observed in the Tanjung Kopok and Kampung Perigi Acheh seagrass meadows. The data was collected in the village, in local eateries, villagers' homes, open streets, beaches, and seagrass meadows (Tanjung Kopok and Kampung Perigi Acheh). During the high tide, the main author stayed in the village, but in the low tide, the main author walked to the seagrass meadows for data collection.

Data collection, processing, and analysis

Ethnographic data were collected from August 2022 to December 2023 in Kampung Perigi Acheh and Tanjung Kopok through the selective intermittent mode of ethnographic method (Jeffrey & Troman, 2004). The main author visited the site to observe and document community perspectives at specific times rather than always being present. A total of 60 visits were made to Kampung Perigi Acheh, each lasting six to seven hours daily. As for Tanjung Kopok, a similar number of visits were also made, but only during the low tide (two to three hours). Notably, during low-tide events, visits to the Tanjung Kopok and Kampung Perigi Acheh seagrass meadows to interact with gleaners. These interactions consisted of interviews and/or observations conducted only with consent from the participants and were halted if participants displayed signs of discomfort or reluctance to engage. These visits provided an understanding of the community's lifestyle and perception of seagrass gleaning. All participants listed in this study were given pseudonyms to protect their identities. A total of 23 participants were informally

interviewed, and 80 participants were observed. Seagrass species identification was also conducted in Tanjung Kopok to document the characteristics of the seagrass meadow.

Participatory mapping was conducted with the Kampung Perigi Acheh community in March 2023. The participants were selected based on their recognised expertise in seagrass gleaning. The group consisted of individuals aged between 40 and 60 years old, all familiar with the local seagrass meadows and had been gleaning regularly during low tide. Participant groups were divided into two categories: male-only group and mixed-gender group. These groups were formed to identify gender differences in resource use. The mapping activity was complemented with a Focus Group Discussion (FGD) to allow participants to discuss and elaborate on the significance of each seagrass-gleaning location. The session lasted for an hour.

The purpose and scope of the mapping exercise were first described to the participants, which was to identify seagrass areas, gleaning locations associated with gleaners' localities, gleaning areas, gleaning activities, gleaned catch, and women's spaces. A base map was used for the participants to draw the key locations mentioned above. The base map contained pre-defined features such as boundaries, villages, and rivers. However, participants were allowed to modify or suggest new categories (Stiepani et al., 2023).

Consequently, recorded interviews were transcribed from Malay, which was the language used in all the interactions. Subsequently, thematic analysis was conducted based on congruities and variations identified during the sorting process. Data were categorised and sorted using Microsoft Excel and Word according to the key theme of this paper: seagrass gleaning. At the same time, sub-themes were identified from this study's key themes: sustenance, recreation, and cultural factors associated with gleaning. As for the participatory maps, all maps drawn by the community were digitised in QGis 3.22.

Researcher positionality

Positionality plays a crucial role in shaping research design and outcomes (Holmes et al., 2020), as power dynamics in research introduce ethical challenges, particularly in cross-cultural contexts (Scheyvens & Leslie, 2000; Grantham et al., 2020). The main author, a master's student transitioning from marine biology to ethnography, acknowledges that their outsider identity may influence participant perceptions and the interpretation of the research context. Additionally, the co-authors, who were also not from fishing communities, added another layer of complexity and necessitated sensitivity in the approach. A reflexive approach involves ongoing self-reflection to recognise how personal background shapes

interactions and the knowledge generated (Cohen et al., 2011; May & Perry, 2017; Holmes, 2020). To build genuine relationships, the main author and research facilitators immersed themselves in the community's daily life to understand and appreciate its rich cultural values. These activities included sharing meals, attending religious ceremonies, participating in community sports and clean-ups, gleaning, gardening, and cooking. They also stayed with families during the day, relaxed with the ladies in the evenings, and joined picnics. Accordingly, these interactions helped to ensure that research questions and activities were grounded in local cultural values (Grantham et al., 2020).

RESULTS

Gleaners' profiles

Gleaning was established as one of the main fishery activities among the locals of Kampung Perigi Acheh. It is a practice passed down through generations, and those interviewed were unsure when or how it began. This was explained in one of the interviews with the gleaners, where the general response was that they have been gleaning since they were children:

> I have been gleaning since I was a child, and that was 42 years ago. My late father also gleaned, and my mother. (Interview with interlocutor Senah, 26 November 2022)

Men, women, and children practised gleaning, averaging five to six participants on weekdays and 15 to 20 on weekends and public holidays. However, it was not a full-time occupation in Kampung Perigi Acheh, where the main economic activities were fishing and tourism, with only 30% of the population being full-time fishers. Many industrial workers also fished and gleaned during their free time, and nine out of ten villagers gleaned for their daily meals during low tide:

> I come to this place (seagrass meadow) to find food for my children for almost every low-tide event. (Interview with interlocutor Ali, 25 November 2022)

In Kampung Perigi Acheh, both men and women engage in gleaning, with 45% of gleaners being men and 55% women, based on our observations in the seagrass meadows. In addition to Kampung Perigi Acheh, seagrass gleaners in the studied meadows also included communities from different villages and towns along the

coastline. This observation was made during ethnographic visits to the seagrass meadows and was emphasised by one of the Kampung Perigi Acheh gleaners, as described in the interview below:

> Some of the gleaners here were originally from Sabah, but they live in Kota Masai. They have known about this place (seagrass gleaning area) for a long time, and we see them here (seagrass meadows) every day of the week. (Interview with interlocutor Senah, 26 November 2022)

During the low tide, Kampung Perigi Acheh gleaners were not the only community utilising the seagrass meadows. There were gleaners from other communities in the Sungai Johor estuarine region, such as Kampung Pasir Putih, Kota Masai, Kampung Tanjung Langsat, and Kampung Pasir Gogok (Figure 3a). Unlike in Kampung Perigi Acheh, where the author conducted most of the data collection, demographic information of the other communities (Kampung Pasir Putih, Kota Masai, Kampung Tanjung Langsat, and Kampung Pasir Gogok) was absent as the author only engaged with them when they were on the seagrass meadow. In particular, Kota Masai was the only area slightly further from the coastline. Kota Masai was also more developed, with more residential, industrial, and commercial areas than the other villages. Note that the gleaners from Kota Masai were ethnically Bajau and migrated from Sabah to Kota Masai. This study referred to this group of gleaners from Kota Masai (both men and women) as the Bajau community. The Bajau community frequently visited Kampung Perigi Acheh and Tanjung Kopok. They have visited these seagrass meadows for gleaning activities since a decade ago:

> I have been gleaning here (Kampung Perigi Acheh seagrass meadow) for the past 11 years. More Bajau gleaners came here to glean since I started gleaning. They (Bajau gleaners) still come to glean now, especially during the *gonggong* season. (Interview with interlocutor Rakmah, 17 May 2023)

Seagrass gleaning locations in Sungai Johor estuary

Based on the participatory mapping, seagrass meadows utilised for gleaning in Sungai Johor estuary were Kampung Perigi Acheh, Tanjung Kopok, Pulau Nenas, Tanjung Surat, Kampung Pasir Gogok, and Tanjung Pengelih (Figure 3a). The seagrass-gleaning areas in the Sungai Johor estuary were mainly intertidal seagrass meadows. The seagrass species identified were *Halophila ovalis*, *Halophila spinulosa*, *Halodule uninervis*, *Thalassia hemprichii*, and *Enhalus acoroides*. These

seagrass species support various marine life, including shellfish and other invertebrates, which were commonly harvested by the community during gleaning. Regardless of the season, low tide was universally regarded as the optimal time of day for gleaning activities, as the flat and rocky shoreline was exposed during the low tide.

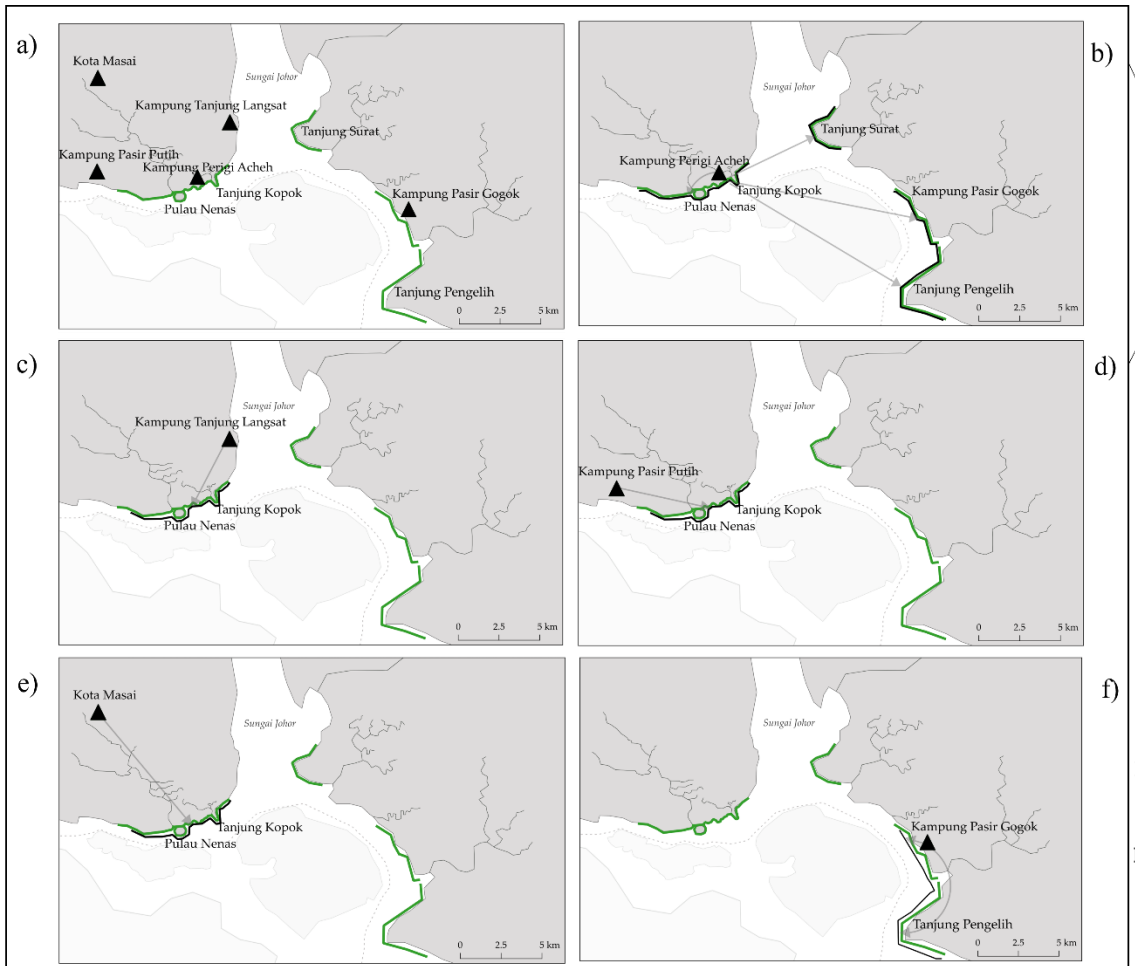

Figure 3: Map of a) seagrass, and gleaners' localities (main villages) in Sungai Johor estuary. Gleaning areas frequented by gleaners from these villages are shown in b) Kampung Perigi Acheh, c) Kampung Tanjung Langsat, d) Kampung Pasir Putih, e) Kota Masai, and f) Kampung Pasir Gogok. Gleaners' movement were indicated by grey arrows between gleaners' localities (main villages) and gleaning areas.
(Source: Participatory mapping, focus group discussion in Kampung Perigi Acheh, March 2023.)

The gleaners moved around to glean in different seagrass areas throughout the Sungai Johor estuary (Figures 3b, 3c, 3d, 3e, 3f). This was associated with accessibility and the motivation behind gleaning. Gleaners from Kampung Tanjung Langsat, Kampung Pasir Putih, and Kota Masai travel to Kampung Perigi Acheh, Pulau Nenas, and Tanjung Kopok seagrass meadows by motorcycle or car, then foot. This was attributed to the short travelling distance (less than 8 km) from their villages to the Kampung Perigi Acheh coastline. As for Kampung Perigi Acheh gleaners, the gleaning areas extended to the seagrass meadows on the opposite side of Sungai Johor, which included Tanjung Surat, Kampung Pasir Gogok, and Tanjung Pengelih. Some gleaners own boats, work as fishermen, or operate recreational fishing trips. This allowed them to travel further, increase their catch, and be more knowledgeable about where seagrass meadows and certain species are located due to their fishing experience:

> I often take my boat out to Gogok (Kampung Pasir Gogok) to look for more *boren laut* (carpet anemone). (Interview with interlocutor Ramli, 17 May 2023)

Gleaning activities and products

Gleaning activities in the Sungai Johor estuary were associated with collecting fish, crabs, sea cucumbers, carpet anemones, seaweed, and shellfish and included a local event called *Pesta Pantai* (Table 1). The location of the gleaning activities was identified by observations made in Kampung Perigi Acheh and Tanjung Kopok seagrass meadows, participatory mapping, and FGD.

Table 1. Gleaning activities in the seagrass meadows of Sungai Johor estuary

Activity	Location	Participants	Occurrence
Fish collection	Kampung Perigi Acheh, Tanjung Kopok, Tanjung Surat, Kampung Pasir Gogok, Tanjung Pengelih	Men, women, children	Done regularly during low tide.
Crab collection	Kampung Perigi Acheh, Tanjung Kopok	Men, women, children	Done regularly during low tide.

Sea cucumber collection	Kampung Perigi Acheh, Tanjung Kopok, Kampung Pasir Gogok, Tanjung Pengelih	Men, women	Done during low tide and is known to be seasonal. However, the specific timing of the collection season was not recorded during this study.
Carpet anemone collection	Kampung Perigi Acheh, Tanjung Kopok, Kampung Pasir Gogok, Tanjung Pengelih	Men, women	Done regularly during low tide.
Seaweed collection	Kampung Perigi Acheh, Tanjung Kopok	Men, women, children	Done regularly during low tide, especially during social gatherings.
Shellfish collection	Kampung Perigi Acheh, Tanjung Kopok, Tanjung Surat, Kampung Pasir Gogok, Tanjung Pengelih	Men, women, children	Done regularly during low tide, especially during social gatherings.
Pesta Pantai	Kampung Perigi Acheh, Tanjung Kopok	Men, women, children	Informal, spontaneous gathering during the lowest-low tides, where villagers come together to glean, though it occurs irregularly and is not formally planned.

The locals described *Pesta Pantai* as a festival-like gathering. It occurred during the lowest low tides of the year (0.1-0.2 m) when 30-40 gleaners gather in the seagrass meadow. While not a formal or annual festival, the term *Pesta Pantai* became a way for the community to brand this rare occasion. During the event, villagers invited friends and family to join them in the meadow to glean together. The villagers participated in collecting seafood, with *gonggong* (a type of marine snail) being a popular catch:

> During *Pesta Pantai*, we go out to the meadow together to *berkarang* (collecting *gonggong* and shellfish with a large group of people). There will be so many people in the meadow during the *Pesta Pantai*. (Interview with interlocutor Nizah, 23 March 2023)

Beyond the festival, gleaners regularly collected a wide range of seafood species during the 60 low-tide visits to Kampung Perigi Acheh and Tanjung Kopok seagrass meadow (Table 2). The most collected seafood species observed were *gonggong* (dog conch), followed by crabs, *boren laut* (carpet anemone), seaweed, and sea cucumbers (Figure 4).

Table 2: Gleaned products with common/local names, species names, and utilisation of gleaned products collected by gleaners of Sungai Johor estuary, which included Kampung Perigi Acheh (KPA) Kampung Tanjung Langsat (KTL), Kampung Pasir Putih (KPP), Kota Masai (KM), and Kampung Pasir Gogok (KPG). Information is based on reports from gleaners and observations made in Tanjung Kopok and Kampung Perigi Acheh seagrass meadows.

Gleaned products	Common/Local name	Species name	Use	Gleaners
Shellfish	Dog conch/*Gonggong*	*Laevistrombus sp.*	Sustenance, commercial	KPA, KPP, KM, KTL, KPG
	Noble Volute/*Kilah*	*Cymbiola nobilis*	Sustenance, commercial	KPA, KPP, KM, KTL, KPG
	Asian Brown Mussel/*Kupang*	*Perna veridis*	Sustenance, commercial	KPA, KPP, KM
	Asiatic Hard Clam/*Kepah*	*Meretrix meretrix*	Sustenance	KPA, KPP, KM, KTL
	Pen shell/*Siput beliung*	*Pinna sp.*	Sustenance	KPA, KM
	Tropical oyster/*Tiram*	*Crassostrea belcheri*	Sustenance	KPA, KM

Crabs	Horseshoe crab/*Belangkas*	*Tachypleus gigas*	Sustenance, commercial	KPA, KM
	Flower crab/*Ketam renjong*	*Portunus pelagicus*	Sustenance, commercial	KPA, KPP, KM, KTL, KPG
	Stone crab/*Ketam batu*	*Menippe rumphii*	Sustenance, commercial	KPA, KPP, KM, KTL, KPG
Sea cucumber	Garlic bread sea cucumber/*Timun laut*	*Holothuria scabra*	Sustenance, commercial	KM
	Smooth sea cucumber/*Timun laut*	*Acaudina sp.*	Sustenance	KM
Carpet anemone	Carpet anemone/*Buran*/*Boren laut*	*Stichodactyla sp.*	Sustenance, commercial	KPA, KM
Seaweed	Seaweed/*Gulaman*	*Gracilaria sp.*	Sustenance, commercial	KM
Fish	Filefish/*Ikan gosok*	*Pseudomonacanthus macrurus*	Sustenance, commercial	KPA, KM
	Black eeltail catfish/*Ikan sembilang*	*Plotosus canius*	Sustenance, commercial	KPA

Figure 4: Gleaned catch from Tanjung Kopok and Kampung Perigi Acheh seagrass meadow showing a) dog conch/*gonggong*, b) carpet anemone/*boren laut*, c) smooth sea cucumber/*timun laut*, d) noble volute/*kilah*, *e*) stone crab/*ketam batu* and f) seaweed/*gulaman.*
(Source: Fieldwork, 2022.)

Based on Table 2, only the Bajau community from Kota Masai were frequent gleaners of seaweed (*gulaman*) and sea cucumber (*timun laut*) as this seafood is a delicacy customary to their community. Unlike the Bajau gleaners, gleaners from Kampung Pasir Gogok, Kampung Perigi Acheh, Kampung Pasir Putih, and Kampung Tanjung Langsat did not collect seaweed (*gulaman*). Moreover, only a few of the gleaners collect sea cucumbers, provided there is a demand from local Chinese sea cucumber wholesalers. According to the Bajau gleaners of Kota Masai, seaweed (*gulaman*) can be eaten as a snack or incorporated into daily meals:

> The Malays here (in Kampung Perigi Acheh) do not collect *gulaman* (seaweed). They do not usually consume it. We (the Bajau) consume it as a snack. (Interview with interlocutor Rakmah, 17 May 2023)

Gonggong was observed to be the most desired species. Consequently, the local community of Kampung Perigi Acheh noticed the reduction in *gonggong*, attributing this decline to the high frequency of collection by various gleaners:

> There is less *gonggong* now because too many people have collected them. Especially those from Sabah (Bajau), who come to collect *gonggong* every day (Interview with interlocutor Senah, 26 November 2022)

Based on the participatory mapping, the availability of seagrass species, particularly *Setu* (*Enhalus acoroides)*, correlates with higher densities of gleaning catches such as *gonggong, boren laut,* and sea cucumber (Figure 5). *Gonggong* (*Laevistrombus sp.*) was usually found in most intertidal seagrass meadows in the Sungai Johor estuary. However, according to the gleaners, more *gonggong* can be found in seagrass meadows with *Setu (E. acoroides)* than in seagrass meadows without it. Both *Setu* and *gonggong* have declined over the years due to pollution and development:

> Back in the days when we had *Setu*, there were many fish and *gonggong.* Now that there are fewer *Setu*, there are fewer fish here (Tanjung Kopok). We do not know what chemicals were being thrown in there (rivers), and there were too many developments around… (Interview with interlocutor Long, 9 June 2023)

Some gleaners also collect Setu fruit for consumption. Many gleaners from Kampung Perigi Acheh explicitly travelled to Tanjung Surat, Kampung Pasir Gogok, and Tanjung Pengelih to glean in the seagrass meadows that were mainly *Setu* due to the availability of more *gonggong, boren laut,* and sea cucumbers:

> There are more *boren laut* in Pasir Gogok than here (Tanjung Kopok and Kampung Perigi Acheh seagrass meadow) because there are more *Setu* over there (Pasir Gogok). (Interview with interlocutor Ramli, 17 May 2023)

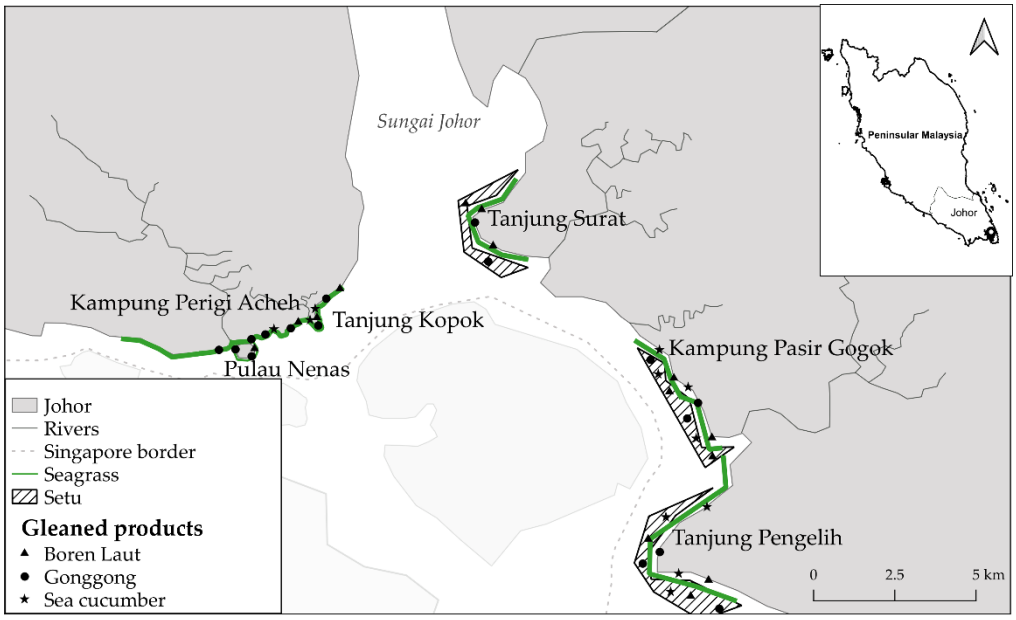

Figure 5: Map of gleaned products (*gonggong*, *boren laut*, sea cucumber) and *Setu* in Sungai Johor estuary.

(Source: Participatory mapping, focus group discussion in Kampung Perigi Acheh, March 2023.)

Gleaning methods

The gleaners utilise several unique methods to collect their harvest (Table 3). Most gleaners walk while gleaning; however, the Bajau gleaners demonstrate unique skills and methods.

Table 3. Gleaning methods and strategies based on observations in Kampung Perigi Acheh and Tanjung Kopok seagrass meadows

Method/Strategies	Description	Used by		Target Species	Tools Used
		Men	Women		

Walking fishery	Collecting invertebrates by walking along the shore during low tide.	/	/	*Gonggong*, Crabs, fish, shellfish, *Boren laut*, Seaweed	No tools
Kilah method	Using the shell of a *kilah* (marine snail) to lure out *gonggong* from the sediment.	/		*Gonggong*	*Kilah* shell
Boren laut scraping	Using modified tools (e.g., paint roller) to scrape and collect *boren laut*.	/**		*Boren Laut*	Scraping tool
Sea cucumber foot-thrusting	Gleaners tilt the front of their feet in the sediment to sense pressure and thrust sea cucumbers out using their feet.	/*	/*	Sea cucumbers	No tools
Sagang	Using sticks with hooks or baits to catch fish in shallow waters and intertidal areas.	/		Black eeltail Catfish	Sticks, hooks

Swimming fishery	Swimming in seagrass meadows to gather species by hand.	/*	/*	Sea cucumbers, Crabs, fish	No tools

*Method used by only the Bajau community
**Method used by all gleaners and Bajau community

The walking fishery was the prominent type of gleaning practised, as one did not need to use boats to move around the meadow. The distance between Kampung Perigi Acheh and Tanjung Kopok seagrass meadow was not too far (less than 3 km) from their homes, allowing them to access these sites easily without a boat. While walking, gleaners also utilise *sagang* to collect fish. In particular, *Sagang* is a gleaning method using sticks, hooks, and baits in shallow intertidal areas, mainly focused on acquiring black eeltail catfish (*Plotosus canius*). Some of the sticks used had no bait attached to them. Notably, *Sagang* is popular among male gleaners, who were usually observed gleaning alone. Gleaners utilise the *sagang* during the low tide to catch fish by deploying the *sagang* in the water first, and then they quickly yanked it out of the water once the fish was caught. The gleaner then collected the fish and deployed the *sagang* again. The gleaners stated that the black eeltail catfish preferred shallow and slightly turbid waters. Towards the edge of the seagrass meadow, the seagrass was inundated with water, sand, and some silt. These areas were most suitable for collecting black eeltail catfish using the *sagang*.

The *kilah* method was often used by gleaners, especially male gleaners, to collect *gonggong*. A *kilah* is a type of marine snail (*Cymbiola nobilis*) that is commonly found in the seagrass meadow. The *kilah* method uses the *gonggong*'s predator, the *kilah,* to lure the *gonggong,* the target species for most gleaners. The *kilah* can be reused many times to lure the *gonggong* to the surface. The origin of the *kilah* method is unknown; however, a few gleaners have adopted this practice, primarily fishers or individuals who collect *gonggong* for commercial use. Gleaners who collect *gonggong* for commercial purposes will most likely use the *kilah* method compared to gleaners who collect *gonggong* for sustenance or to pass the time. It was also observed that gleaners who utilised the *kilah* method collected more *gonggong* than those who did not. The *kilah* method was observed to be used when *gonggong* is abundant or scarce. The method was observed to be effective for many gleaners.

> We take the *kilah* and put some water in the *kilah* shell. The water was left in the *kilah* shell for a while. Then, we use the *kilah* water to spray the *gonggong* to lure it out. (FGD with interlocutor Awang, 23 March 2023)

The Bajau gleaners collected *boren laut* using specific tools. One of the common tools used was a paint roller that was modified into a scraping tool (Figure 6). The gleaners used any sharp tool (knife or a paint roller) and stuck it deep into the seagrass sediment to push the *boren laut* out instead of pulling it out with their hands. This ensured the *boren laut* was harvested in one piece without breaking its shape or structure.

Figure 6: Photos of a man gleaning for *boren laut* (carpet anemone) using a scraping tool in Tanjung Kopok.
(Source: Fieldwork, 2022.)

The Bajau gleaners utilised a special skill to identify the presence of sea cucumbers embedded in the sediment. They tilted the front of their foot slightly in the sediment until pressure was detected. Consequently, the gleaners used their feet to thrust the sea cucumber out from the sediment. This method maximised the efficiency of sea cucumber collection, as one only had two to three hours to glean before the tide rose. The Bajau also swam in the seagrass meadows during high tide and ventured into deeper areas during low tide to glean. Once at their chosen spot, they stood upright and used their hands to gather seaweed, crabs, fish, *gonggong,* and sea cucumbers. The method was called *raba,* which meant using one's hands or feet to sense the seafood prior to grabbing it. Unlike the Bajau

community, Kampung Perigi Acheh gleaners barely practised this method of gleaning as some of them cannot swim. Notably, most of the swimming gleaners observed were Bajau men and women from Kota Masai, known for their traditional heritage as seafaring people with exceptional swimming abilities. However, despite their swimming abilities, the Bajau community gleaned in pairs primarily for safety reasons:

> I swim in the meadow, but sometimes I piggyback my husband while he swims in the meadow should there be snakes in the water. (Interview with interlocutor Rakmah, 17 May 2023)

Gleaning and livelihood contributions

Coastal communities in the Sungai Johor estuary depend on gleaned products for sustenance and income, making them vital to their livelihoods. However, gleaning also contributes to recreational activities, cultural identity, and gender roles (Table 4).

Table 4. Aspect of livelihood contributions from seagrass gleaning in Sungai Johor estuary

Aspect of Livelihood	**Description**
Sustenance	Gleaned products (e.g., fish, shellfish) provide daily food for coastal communities.
Income Generation	Products like *gonggong* and sea cucumbers are sold to local markets for income.
Recreational Activities	Picnicking and group gleaning strengthen community bonds, especially among women.
Cultural Identity	Gleaning activities, especially *Pesta Pantai*, are integral to communal and cultural traditions.
Gender Roles	Women primarily glean for sustenance and recreation, while men often glean for commercial purposes.

In Kampung Perigi Acheh, the gleaned products provided food for families below the poverty line (<RM1000 household income). The significance of gleaning for sustenance was evident from community narratives:

> I came to the seagrass during low tide to look for food for my children. The food we have at home (rice) is not enough for them. If the seafood we collect is not enough for my kids, my wife and I would just eat rice and salt while the kids eat the seafood I collected today. (Interview with interlocutor Ali, 25 November 2022)

Gleaned products such as the dog conch (*Laevistrombus sp.)* and the noble volute (*Cymbiola nobilis*) were sold commercially while consumed locally. Gleaners from all villages frequently harvested *gonggong* and crabs, which were sought after both for home consumption and as income-generating resources. In Kampung Perigi Acheh, the dishes derived from gleaning fisheries were *gonggong rebus* (braised *gonggong*), *gonggong sambal* (*gonggong* cooked in spicy chilli sauce), *ketam rebus* (boiled crabs), and *boren kicap* (carpet anemone in soy sauce).

Both men and women engage in gleaning; however, recreational activities, cultural identities, and gender roles were more prominent among the Kampung Perigi Acheh and Bajau women. For these women, gleaning was a source of sustenance, income, and a way to reconnect with memories, participate in communal life, and preserve cultural traditions. Correspondingly, these livelihood contributions will be further explored in the women's gleaning spaces and contributions section.

Women's gleaning spaces and contributions

Participatory mapping revealed that both men and women from Kampung Perigi Acheh frequently access the seagrass meadows in Kampung Perigi Acheh, Tanjung Kopok, and occasionally Pulau Nenas for gleaning. While men also use these spaces, women prefer them due to their proximity to home. Unlike men, who may venture further using boats, women tend to glean in nearby areas, allowing them to engage in the activity more regularly:

> The meadow is close (to home), it is just right in front (of the beach), and there were many things (*gonggong*) to glean over there (seagrass meadow). (FGD with interlocutor Nizah, 19 June 2023)

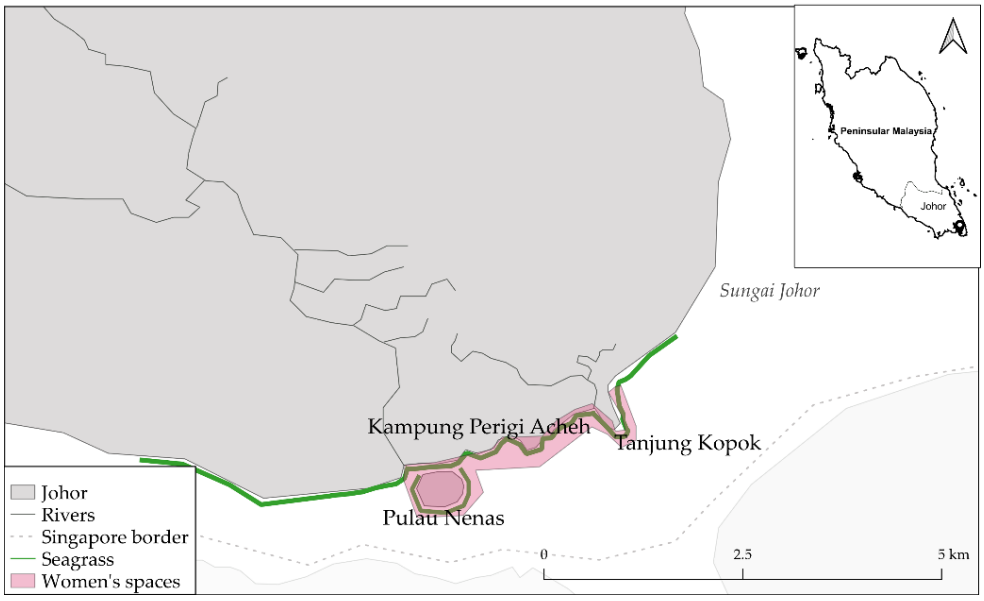

Figure 7: Map of women's spaces in Sungai Johor estuary. Source: participatory mapping activity, Focus Group Discussion in Kampung Perigi Acheh, March 2023

(Source: Participatory mapping, focus group discussion in Kampung Perigi Acheh, March 2023.)

Group gleaning and picnics were vital recreational and cultural aspects of women's interactions with seagrass meadows in Kampung Perigi Acheh and Bajau communities. In contrast to men, who often glean alone, women typically glean with friends or family. Group gleaning was conducted due to safety concerns, as the deep mud could be unsafe if women fell or drowned, making it crucial to have someone with them. In addition, picnics by the seagrass meadows were common for Kampung Perigi Acheh and Bajau women, who gathered to enjoy *gonggong* delicacies after cooking them at home. Kampung Perigi Acheh women had picnics on the seagrass meadows once or twice a week, while Bajau gleaners picnic almost daily, often collecting seaweed (*gulaman*) as part of their meals:

> We collect the seaweed and eat it here (points to the picnic mat) with mangoes or red onions …(Interview with interlocutor Rakmah, 19 June 2023)

Note that gleaning plays a significant role in shaping and maintaining the cultural identity of Kampung Perigi Acheh women. From a young age, they learned the

practice from their parents. This transmission of knowledge and tradition from parents to children further reinforces the cultural significance of gleaning:

> Coming here (to glean) makes me think of my childhood memories of when I was gleaning with my father... (Interview with interlocutor Senah, 26 November 2022)

In addition to revisiting memories of seagrass gleaning in the past, the women gleaners mentioned that gleaning activities were an inter-generational activity they shared as a community. According to one of the female gleaners, some of them gleaned simply since their parents had also gleaned in the past:

> My parents used to glean, and I used to follow them to the meadow. When I was a child, my father taught me how to glean. So, I come to glean now, and my uncles glean too… (Interview with interlocutor Senah, 26 November 2022)

Moreover, gleaning is not just an individual activity but a collective one, with women coming together as a community to share in the practice. As one gleaner noted:

> We love entertainment, and *we often do berkarang (gleaning for gonggong together)* with each other. The *gonggong* season takes place once a year, and we will all gather in the meadow for it. (Interview with interlocutor Melati, 23 March 2023).

DISCUSSION

Seagrass meadows as gleaning habitats

Our study identified six seagrass-gleaning sites in Sungai Johor. Carpet anemones, crabs, sea cucumbers, and gastropods were the main catches for gleaners across all seagrass sites. This was consistent with the ecological characteristics of seagrass meadows, which provide favourable habitats for suspension-feeding and burrowing organisms (Alsaffar et al., 2020). Moreover, bivalves and gastropods (shellfish) were also commonly harvested in these areas and constitute a significant portion of the gleaning catches in other coastal communities across Southeast Asia. This includes the Philippines (del Norte-Campos et al., 2005; Nieves et al., 2010) and Indonesia (Furkon et al., 2019). While these six locations provide valuable insights into gleaning areas within the estuary, it is crucial to note that the mapping was conducted exclusively with participants from

Kampung Perigi Acheh. Note that this limitation may overlook the practices of gleaners from nearby villages who also utilise the same seagrass meadows. Hence, future studies should engage a broader range of participants to better understand how different communities interact with these ecosystems.

Local ecological knowledge in gleaning practices

Based on the seagrass SES framework, our study identified the key "actors" involved in gleaning activities within the Sungai Johor estuary, which include women, men, and children. We also catalogued the "resource units," which comprised various gleaned products such as shellfish, fish, crabs, sea cucumbers, anemones, and seaweed. Although our study focused primarily on these elements, we did not delve deeply into the resource and governance systems, which are also integral components of the SES framework (Jones, 2022; Stiepani, 2024). Therefore, future research could further explore these areas to provide a more holistic understanding of the seagrass gleaning system. Nonetheless, the SES framework proved useful in highlighting how ecological changes influence social responses. This dynamic feedback between ecological conditions and social practices is crucial for understanding the sustainability of seagrass-gleaning fisheries (Berkes & Folke, 1998; Jones, 2022).

Due to the reduced population of gleaned products (*gonggong*), the gleaners employed Local Ecological Knowledge (LEK) to adapt to environmental and anthropological changes in the Sungai Johor estuary to acquire food sources. In particular, LEK is the knowledge acquired by local resource users due to their long-term interactions with the surrounding ecosystem (Beaudreau & Levin, 2014; Braga et al., 2018; Ullah et al., 2023). Our findings revealed that the Kampung Perigi Acheh community was resourceful. The villagers displayed knowledge of the significance of *Pokok setu* or *Enhalus acoroides*, a seagrass species linked to invertebrate abundance. This includes bivalves, gastropods, and polychaetes (Suvaluck et al., 2011; Caimbre et al., 2019). *Enhalus acoroides*' long blades create a canopy structure that provides refuge and nursery grounds for invertebrates and fish, increasing habitat complexity and species richness (Gullström et al., 2008; Hori et al., 2009; McCloskey & Unsworth, 2015; Ho et al., 2018). At the same time, seagrass-gleaning sites with more *E. acoroides* cover, such as Kampung Pasir Gogok and Tanjung Pengelih, were preferred habitats due to their abundance of invertebrates, including *gonggong, boren laut*, and sea cucumbers. This preference aligns with other case studies where gleaners select areas with dense seagrass cover to collect seafood (Nordlund et al., 2010; Furkon et al., 2019). Moreover, the community's reliance on these habitats for fishing likely shaped their generational knowledge of seagrass meadows' habitat function (Jones et al., 2022b).

The *kilah* method, where a predator species is used to lure *gonggong*, reflects the community's deep LEK and skill in harvesting practices. Although this technique is employed regardless of *gonggong* abundance, it demonstrates the community's understanding of their environment and species (Fontana et al., 2022). Additionally, Indigenous or Traditional Ecological Knowledge (IEK/TEK)—a core part of LEK—supports resilient practices, allowing communities to navigate ecological changes while maintaining key aspects of their traditional methods (Berkström et al., 2019).

Consequently, the local community of Kampung Perigi Acheh noticed a reduction in their harvest, especially *gonggong*, attributing this decline to the high frequency of collection by various gleaners (refer to section: ***gleaning activities and products***). While there is no direct evidence that the *kilah* method is specifically a response to the decline of *gonggong*, the overall decrease in the *gonggong* population is potentially linked to overharvesting (Cob et al., 2009). Note that excessive harvesting of invertebrates can negatively affect seagrass ecosystems (Furkon et al., 2019). The presence of various communities, such as those from Kampung Pasir Putih, Kota Masai, Kampung Tanjung Langsat, and Kampung Pasir Gogok, heightens the pressure on these resources. The access of gleaners from diverse backgrounds to the same seagrass meadows raises the risk of overharvesting. Consequently, this can harm the ecological health of these habitats by reducing invertebrate populations, seagrass biomass, and species composition (Nordlund & Gullström, 2013; Chitará-Nhandimo et al., 2022; Fanoro et al., 2023).

Expanding gleaning classifications

From our case study, we identified different methods and tools of gleaning, such as walking fishery, swimming fishery, and *sagang*. Walking and swimming fishery were similar to the gleaning types on the island of Malalison, Philippines (Stiepani et al., 2023). We discovered that Bajau gleaners in the Sungai Johor estuary used swimming fishery to maximise their seafood harvest, allowing them to access more invertebrates during low tide by swimming farther from the shoreline (Stiepani et al., 2023). Consequently, the resource is less exploited in these deeper areas, as not all gleaners possess the swimming skills necessary to reach these locations. Moreover, the Bajau gleaners prioritised sea cucumbers over other invertebrates in their catch, highlighting their preference for certain species (Choo, 2012).

Besides swimming or walking fishery, the use of tools and target species were also linked to the choice of gleaning type. Our findings revealed that men prefer gleaning with tools like the *sagang*. Objects such as sticks and bottles were easily found and washed out from the sea. These objects were frequently stuck

into the fishing nets; hence, the nets were impractical for use in the intertidal area. *Sagang* was a better alternative as no nets were used, saving cost and time and improving practicality. Furthermore, the use of *sagang* in the Kampung Perigi Acheh community revealed an interesting variation that expands our understanding of gleaning methods. Unlike more commonly documented methods such as walking, swimming, or diving (Stiepani et al., 2023), *sagang* employs specialised tools, highlighting the adaptive nature of gleaning in seagrass meadows. Moreover, the use of tools like *sagang* aligns with broader findings on seagrass fisheries, where diverse gear types such as traps, fyke nets, and hand tools are employed due to the shallow, soft-sediment characteristics of these environments (de la Torre-Castro et al., 2014; Jones et al., 2018a, 2018b; Unsworth et al., 2018; Exton et al., 2019; Jones & Unsworth, 2020; Jones, 2022). This adaptability in seagrass ecosystems differs from coral reef fisheries, as fewer gear types are typically used (Jones et al., 2018b). Thus, recognising *sagang* as a gleaning method in this context broadens the classification of gleaning techniques and highlights the unique ways communities interact with the diverse ecological functions of seagrass meadows.

Our study identified several co-occurring types of seagrass gleaning, revealing that the diversity of gleaning methods influences management and conservation decision-making by necessitating assessments of environmental impacts and species dynamics in various locations (Stiepani et al., 2023). Moreover, the knowledge gained from participatory mapping can lead to strategic planning for coastal zone management around the estuary. This incorporates tailored management measures specifically designed to address the unique aspects of each type of gleaning (Lim et al., 2021; de la Torre-Castro, 2019; Stiepani et al., 2023).

Implications of gleaning for livelihood

Sustenance and cultural identity

Gleaning is crucial in the Kampung Perigi Acheh community, serving as a vital source of sustenance and cultural identity. Coastal communities, particularly those from low-income households, heavily depend on intertidal gleaning for food security, particularly for marginalised groups who face limited alternative livelihood options (Stiepani et al., 2023). One interlocutor illustrated this reliance, sharing that when food is scarce, the seafood they collect is prioritised for their children, with parents resorting to rice and salt if needed (refer to section: ***gleaning and livelihood contributions***).

The connection between the community's customary dishes and their reliance on seagrass meadow resources was notable. For generations, the Kampung Perigi Acheh community had consumed seafood derived from

seagrass-gleaning fisheries. This can be reflected in the community's customary dishes derived from gleaning fisheries (refer to section: ***gleaning activities and products***). The availability of these seafood resources has shaped their culinary practices over time. However, the community also recalls traditional cooking methods that influence their preferences for certain species, such as *gonggong*. These dishes provide sustenance and contribute to the cultural identity of the community. This connection between culture and food sources is a crucial aspect of local heritage, showcasing the local community's capability to confront life's challenges, draw upon their local knowledge, and adjust to the surrounding environment and accessible natural resources (Fatimah et al., 2021).

While the dependence on seagrass meadows for food was clear, it also highlighted the vulnerability of these ecosystems (Orth et al., 2006; Hughes et al., 2009; Nordlund et al., 2013). Notably, overexploitation or degradation of these habitats could have severe consequences for the Kampung Perigi Acheh community. Thus, these findings emphasise the need for sustainable management and conservation efforts to protect these ecosystems for ecological reasons and the local population's well-being. However, rather than relying on exclusionary practices, inclusive approaches such as Other Effective Area-based Conservation Measures (OECMs) are essential to prioritise community engagement from the outset, integrating local knowledge and practices to develop preservation methods that benefit both the environment and the people who depend on it (Claudet et al., 2022). Thus, by recognising diverse governance systems and actors in biodiversity conservation, OECMs promote incentives that ensure social and ecological benefits. This includes empowering Indigenous peoples and local communities, thereby enhancing the effectiveness of conservation efforts (Food and Agriculture Organisation of the United Nations [FAO], 2022).

Recreation and social activities

Coastal areas like seagrass meadows are focal points of the interaction between humans and nature, influenced by recreational activities, tourism, and aesthetic appreciation (Virtanen et al., 2023). Seagrass gleaning was observed to be a routine or an event deeply rooted in the gleaners' s way of life. Gleaning was mentioned as a communal activity where social interactions also occur in Kampung Perigi Acheh, such as picnics after gleaning and *Pesta Pantai*. Studies indicate that seagrass meadows were common recreational areas among coastal communities in Southeast Asia (Lakshmi, 2021). Meanwhile, recreational areas were associated with the cultural services seagrass meadows provide. At the same time, cultural services are part of nature-society relationships that contribute to pleasure and contentedness (Elwell et al., 2020). Hence, the non-material benefits of seagrass

gleaning are essential to safeguard the mental well-being of communities (Grantham et al., 2020).

Gender narratives and livelihoods

The gender-based differences in gleaning were associated with the purpose of gleaning and with factors such as skills, local habitat knowledge, and economic status. These elements significantly affect the ability to engage in gleaning effectively, as those with greater knowledge of the habitat or better economic circumstances may have access to tools and resources (Bantayan, 2022). Furthermore, the intention behind gleaning—whether for commercial purposes, sustenance, or leisure—contributes to shaping these differences (Grantham et al., 2020).

In Kampung Perigi Acheh, women primarily glean for sustenance and recreation in nearby seagrass meadows, reflecting their reproductive roles and cultural norms restricting their movements. In contrast, men travel greater distances to maximise their catches, often serving as the primary breadwinners for their families (Boo, 2021). Additionally, women's gleaning activities are typically constrained by cultural restrictions and economic factors, such as limited access to alternative food sources or fishing tools (Rohe et al., 2018). According to Bantayan (2022), women generally employ simpler tools to gather invertebrates with less effort. Consequently, their gleaning practices prioritise family care over economic contributions, illustrating the complex interplay of cultural and economic factors influencing food security in the community.

Our findings highlighted the need to expand our perceptions and understanding of women's interactions with coastal environments. Traditionally, women's roles in Malay society have centred around household duties, while men were engaged in fishing activities at sea (Fortnam et al., 2019; Lim et al., 2021). These cultural norms contribute to the subsistence narrative, where Malay women are expected to focus on domestic responsibilities, including gathering food for the household (Boo, 2021). However, our findings suggested that women's motivations for gleaning extended beyond subsistence, challenging this narrative (refer to section: *women's gleaning spaces*). Note that our findings were similar to the case study of women gleaners in Timor-Leste, where recreation, social interactions, personal gain, and pleasure also motivated them to glean (Grantham et al., 2020). This further established the diversity in the role of gleaning in the livelihood of women. Hence, threats or management of the seagrass gleaning sites in Sungai Johor estuary could affect women's livelihood beyond material impacts (Grantham et al., 2020). On top of that, gendered perspectives, concerns, and inputs among gleaners were significant in addressing management initiatives for

seagrass-gleaning fisheries. Women's involvement in decision-making is necessary to address conservation and management initiatives that could negatively impact household nutrition (Williams, 2002; Bennett, 2005; Tilley et al., 2020). Therefore, empowering women by amplifying their role in conserving and managing women's fishing areas is crucial to protecting their gleaning areas for food security (Kleiber et al., 2018; Tilley et al., 2020).

CONCLUSION AND RECOMMENDATIONS

The protection of seagrass meadows is essential to safeguard the livelihoods of coastal communities. Tanjung Kopok, Kampung Perigi Acheh, Tanjung Surat, Kampung Pasir Gogok, and Tanjung Pengelih were seagrass areas utilised by the communities of Sungai Johor estuary for gleaning activities. These gleaning activities mainly include the collection of gastropods (*gonggong*), sea cucumbers, carpet anemones, crabs, and fish. Local authorities adopted specific gleaning methods for gonggong, carpet anemone (*boren laut*), and sea cucumbers to maximise the gleaning catch for commercial use and sustenance. However, the communities, especially women, practised gleaning activities for recreational and cultural values. In particular, women glean in seagrass areas closer to their homes. Due to the significance of seagrass gleaning in offering livelihood opportunities, the loss of seagrass meadows will put the communities that use the ecosystem at risk. For men and women engaging in gleaning, their landscape use generally reflects the gender roles ascribed to local Malay society in the study site. Men often glean by themselves, whereas women glean in groups by taking the family out for a meadow picnic. This multitude of environmental services needs to be highlighted to the various scales of governance: 1) from local or sub-district, 2) to district, and 3) from government agencies involved in planning local resource use and development. This ensures that the seagrass meadows' intangible and tangible services to local communities are recognised and protected in collaboration with the local communities. Moreover, this approach ensures that the environment benefits state revenue generation and supports local communities by improving their quality of life and involving them in decision-making processes. This way, the environment generates state revenue and reduces costs in the everyday lives of local people while engaging them in a participatory fashion.

It is crucial to ensure that local communities play a meaningful role in policymaking, managing, and monitoring their habitats. Thus, exploring OECMs can further strengthen these efforts, ensuring that local voices are heard and their knowledge is utilised to sustain their environment.

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List of interviews

Below are the key interviews cited in this paper, providing crucial insights into the study's focal points. Most of these interviews were unstructured, as the main author recorded most of these interviews while observing the gleaners on the seagrass meadow:

Interview 1: One-to-one unstructured interview, 26 November 2022 (12 minutes 16 seconds)

- Location: Kampung Perigi Acheh, Johor
- Number of interviewee (s): 1
- Interviewee cited in the paper:
    - Senah (role: Kampung Perigi Acheh female gleaner)

Interview 2: One-to-one unstructured interview, 17 May 2023 (19 minutes 12 seconds)

- Location: Tanjung Kopok, Johor
- Number of interviewee (s): 1
- Interviewee cited in the paper:
    - Rakmah (role: Bajau female gleaner)

Interview 3: One-to-one unstructured interview, 17 May 2023 (32 minutes 12 seconds)

- Location: Tanjung Kopok, Johor
- Number of interviewee (s): 1
- Interviewee cited in the paper:
    - Ali (role: Kampung Perigi Acheh male gleaner)

Interview 4: Group unstructured interview, 19 June 2023 (35 minutes 58 seconds)

- Location: Kampung Perigi Acheh, Johor
- Number of interviewee (s): 2
- Interviewee cited in the paper:
    - Nizah (role: Kampung Perigi Acheh male gleaner)

Interview 5: One-to-one unstructured interview, 17 May 2023 (13 minutes 15 seconds)

- Location: Kampung Perigi Acheh, Johor

- Number of interviewee(s): 1
- Interviewee cited in the paper:
    - Ramli (role: Kampung Perigi Acheh fisherman)

Interview 6: Group unstructured interview, 9 June 2023 (14 minutes 15 seconds)

- Location: Kampung Perigi Acheh, Johor
- Number of interviewee(s): 2
- Interviewee cited in the paper:
    - Long (role: Kampung Perigi Acheh fisherman)

Quotations from the FGDs held in Kampung Perigi Acheh were also included to support the findings:

FGD 2: Female and male group, 23 March 2023 (1 hour 27 minutes)

- Location: Kampung Perigi Acheh, Johor
- Number of participants(s): 4
- Participants cited in the paper:
    - Melati (role: Kampung Perigi Acheh female gleaner)
    - Awang (role: Kampung Perigi Acheh male gleaner)

In addition to the interviews referenced in this paper, other interviews contributed to the comprehension of the subject matter. Although not directly mentioned in the text, these interviews were instrumental in the study. Below is a table outlining these interviews.

No.	**Date**	**Location**	**Number of interviewees**	**Gender**	**Duration**
1	26 November 2022	Kampung Perigi Acheh, Johor	1	Male	49 minutes, 31 seconds
2	22 December 2022	Kampung Perigi Acheh, Johor	1	Male	22 minutes
3	25 December 2022	Kampung Perigi Acheh, Johor	1	Female	52 minutes
4	25 December 2022	Kampung Perigi Acheh, Johor	1	Male	49 minutes, 48 seconds
5	21 January 2023	Kampung Perigi Acheh, Johor	1	Male	1 hour, 31 minutes
6	21 January 2023	Kampung Perigi Acheh, Johor	1	Female	35 minutes, 38 seconds
7	23 January 2023	Kampung Perigi Acheh, Johor	1	Male	1 hour, 18 minutes
8	13 April 2023	Kampung Perigi Acheh, Johor	1	Female	17 minutes, 56 seconds

9	23 November 2023	Kampung Perigi Acheh, Johor	1	Male	20 minutes, 17 seconds

Information of personal communication (19 December 2023) is as below:
A. Saat, village headman of Kampung Perigi Acheh, was elected by the community with four years of service in this role.

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