



Understanding stakeholders' perception on developing seagrass-associated tourism: Evidence from marine protected areas of Bintan Island, Indonesia

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ABSTRACT

Seagrass ecosystems provide vital services but face increasing threats from human activities. Marine protected areas (MPAs) aim to mitigate these threats, but inadequate funding and management hinder effective conservation. Seagrass-associated tourism presents an opportunity to fund conservation efforts, enhance MPA implementation, and improve local livelihoods. This study explores stakeholder perceptions of seagrass benefits, tourism feasibility, and threats on Bintan Island, Indonesia, using quantitative (349 household surveys) and qualitative (focus group discussion with 15 participants) methods. Our findings show strong stakeholder support for seagrass-associated tourism, but challenges such as ongoing anthropogenic threats and governance shifts in MPA management remain to be addressed. For successful seagrass-based tourism and better conservation, ongoing engagement with local communities and stakeholders is crucial. This approach not only secures conservation funding but also fosters local ownership and stewardship. The study emphasizes understanding stakeholder perceptions to develop a sustainable tourism sector and ensure more effective, inclusive management strategies.

1. Introduction

Seagrass ecosystems play a crucial role in achieving blue economy objectives and UN-SDGs through their valuable ecosystem services. Often referred to as blue natural capital, seagrass meadows are essential for sustaining lives of humans and marine organisms (Unsworth et al., 2022). These highly valuable marine flowering plants form extensive meadows in shallow waters on every continent except Antarctica (Short et al., 2007).

There is a growing recognition of seagrass management as a nature-based solution (NbS; Seddon et al., 2021) to achieve the UNFCCC Paris Agreement's goal of limiting the global temperature rise to 1.5 °C (Dencer-Brown et al., 2022) since seagrass meadows can capture and store significant amounts of carbon in their sediment over the long term (Fourqurean et al., 2012; Serrano et al., 2019). Additionally, seagrass ecosystems provide multiple ecosystem co-benefits to society and biodiversity, including coastal protection (James et al., 2019; Risandi et al., 2023), nursery and foraging habitat for many valuable marine

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species (Unsworth et al., 2014), protection from bacterial pathogens (Lamb et al., 2017), provisions for food and livelihoods (Quevedo et al., 2022), social ecological services (Cullen-Unsworth et al., 2014), and tourism services (McKenzie et al., 2021; Quevedo and Kohsaka, 2024).

Despite the vital services they provide, seagrass ecosystems often receive less attention than other coastal ecosystems like mangrove and coral reefs, which are popular tourism destinations. The lack of public awareness about seagrass ecosystems and their benefits (Rifai et al., 2022; Unsworth et al., 2019) has contributed to a global decline in seagrass coverage (Dunic et al., 2021; Waycott et al., 2009). To reverse this trend, comprehensive conservation and restoration efforts are urgently needed (Rifai et al., 2023).

Indonesia, in particular, hosts some of the most extensive seagrass areas globally. Approximately 293,550 ha have been mapped with high confidence (McKenzie et al., 2020), though the total area is estimated to be around 3,000,000 ha (Kuriandewa et al., 2003). With 14 seagrass species present in Indonesia (Kurniawan et al., 2020), there is a significant potential for developing a tourism industry centered on seagrass beds (Lukman et al., 2023). However, similar to global trends, the Seagrass Ecological Quality Index surveys in Indonesia indicate that seagrass ecosystems are in moderate condition (Hernawan et al., 2021) and potentially declining (Unsworth et al., 2018).

Bintan Island is a popular tourist destination in Indonesia, attracting both foreign and domestic visitors due to its picturesque sandy beaches and exclusive resorts (Khotimah et al., 2022). Its proximity to Singapore and Malaysia is suspected to contribute to the influx of international tourists (Karim et al., 2017). The number of tourists visiting Bintan Island is projected to increase in the coming years (Oktaviana et al., 2021). While tourism supports local economic development, there are concerns about its environmental impacts, particularly on coastal and marine resources (Hakim et al., 2023). Thus, sustainable tourism development strategies that balance economic growth and environmental integrity are being explored on Bintan Island (Hakim et al., 2023; Oktaviana et al., 2021).

In 2007, the government of Bintan Island Regency established the first 2600 ha of seagrass conservation area in Indonesia to protect the ecosystem from human pressures (Kuriandewa, 2010). From 2007 to 2014, the management activities of this seagrass conservation area were carried out by the regency government of Bintan Island, however from 2014 to now, the management activities are conducted by the provincial government of Riau Island as the consequence of the enactment of Act No. 23/2014. Regardless of management, like other marine conservation initiatives (e.g., Bennett and Dearden, 2014; Smallhorn-West et al., 2023), the establishment of seagrass conservation area in Bintan Island has had some negative consequences. For example, it has placed local communities in a vulnerable position due to displacement and restricted access to seagrass areas. Consequently, the management status of the seagrass conservation area on Bintan Island has been less effective (Habibah et al., 2023). This is further evidenced by the decline in seagrass cover from 60 to 80 % in 2007 (Kuriandewa, 2010) to 42–71 % in 2022 (Hati et al., 2022; Jemi et al., 2022). This might be partly due to lack of available funding dedicated to seagrass ecosystems and limited involvement from local communities due to their lack of awareness of the importance of seagrass ecosystems (Rifai et al., 2022).

Implementation of a community-based seagrass-associated tourism industry offers an opportunity to address the issues of funding and community's involvement (Lukman et al., 2023). This concept has the potential to enhance local community involvement in conserving seagrass meadows within Marine Protected Areas (MPAs) through revenue-sharing from entrance fees (Brown et al., 2023), which can be used to both manage seagrass meadows and improve livelihoods. McClanahan et al. (2006) provide evidence that marine management initiatives, such as MPAs, are more successful when they also aim to improve local livelihoods, rather than focusing solely on biodiversity conservation.

To establish community-based seagrass-associated tourism, it is crucial to understand the perceptions and support from local

communities and key stakeholders, such as governmental institutions, non-governmental organizations (NGOs), and business owners. This involves assessing their views on ecosystem services, threats and tourism concepts. Engaging a wide-range of stakeholders from the early stages of development is important to ensure the success of any tourism activities conducted in seagrass ecosystems such as diving, snorkeling, and fishing. For example, local communities living near seagrass ecosystems can guide tourists in minimizing possible negative impacts on seagrass tourism activities, as they possess traditional ecological knowledge and experience of the area (Afouxenidi, 2022). Local and national government institutions can provide regulations and laws to support the implementation of sustainable seagrass-associated tourism and prevent actions that could potentially harm seagrass biodiversity (Hardy and Pearson, 2018). NGOs can act as bridging institutions, building relationships between different communities, governments, and stakeholders at various governance levels. They can enhance local communities' knowledge and capacity through active participation, integrate traditional knowledge with modern conservation theory, and improve access to information and resources (Berdej and Armitage, 2016; Berkes, 2009). Finally, business owners can implement best practices to ensure that tourism activities are both enjoyable and safe, thereby attracting more tourists to visit seagrass ecosystems.

We used Bintan Island as a case study to gather perceptions from relevant stakeholders regarding the potential implementation of a seagrass-associated tourism concept linked to an MPA. Through surveys and focus group discussion (FGD), this study specifically aims to: 1) understand local communities' perceptions of seagrasses and the ecosystem services they provide; 2) identify locally perceived threats to seagrass ecosystems; and 3) analyze the ideas, challenges, and suggestions from all related stakeholders regarding the implementation of a seagrass-associated tourism concept. This paper addresses one of the five recommendations by Lukman et al. (2023) by exploring local communities' perceptions to develop sustainable seagrass-associated tourism on Bintan Island. The study seeks to identify potential conflicts between the local community and tourists and assess whether seagrass-associated tourism can be effectively implemented from the local perspective. Additionally, it aims to gather opinions and recommendations from key stakeholders to guide the development of sustainable seagrass tourism on the island.

2. Materials and methods

2.1. Site description

Bintan Island, located in the western part of Indonesia within the Riau Islands Province, is home to extensive seagrass meadows, particularly abundant in its eastern coastal region. The coastal waters of Bintan Island support a diverse range of seagrass species, including *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Cymodocea serrulata*, *Halophila ovalis*, *Halophila minor*, *Halophila spinulosa*, *Halodule uninervis*, *Halodule pinifolia*, *Syringodium isoetifolium*, and *Thalassodendron ciliatum* (Kawaroe et al., 2016; Nugraha et al., 2023). The study focused on four coastal villages adjacent to seagrass conservation areas in Bintan Island Regency, namely Pengudang, Berakit, Malang Rapat and Teluk Bakau (Fig. 1), where local community perception surveys were conducted.

2.2. Data collection

This study employed a mixed-method approach, combining quantitative and qualitative methods (Creswell and Clark, 2017), to gather diverse perceptions of seagrass ecosystems from stakeholders at local and national levels. The study captured perceptions regarding seagrass benefits, threats, associated tourism activities and the potential for developing seagrass tourism.

Quantitative household surveys were conducted utilizing semi-

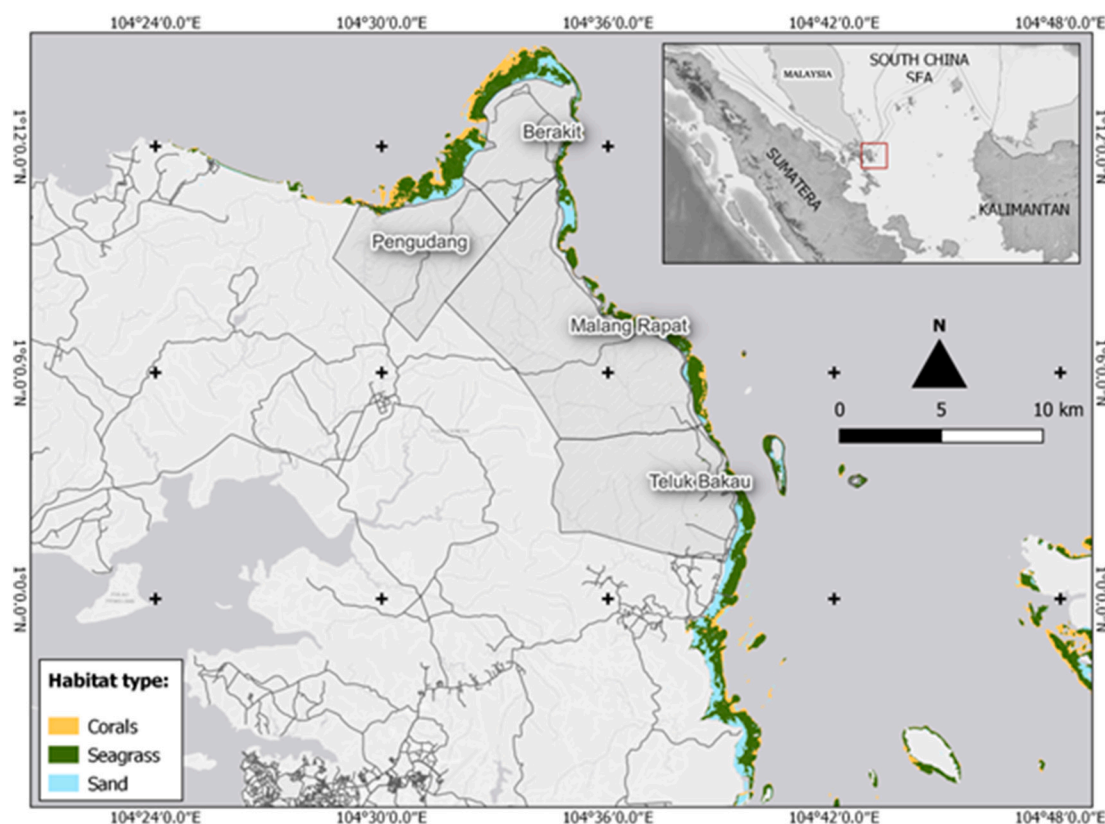


Fig. 1. Location map of households surveyed in Bintan Island adjacent to seagrass ecosystems.

structured questionnaires, which were pre-tested and comprised four sections (see Supplementary Material). The first section collected socio-demographic information (e.g., education, occupation) of the respondents. The second section assessed respondents' knowledge of seagrasses and their benefits (e.g., as source of food, habitat for various organisms, recreation site). Respondents indicate their knowledge of seagrasses with simple “yes” or “no” answers. Awareness levels of seagrass ecosystem services were measured using a 5-point Likert scale ranging from 1 (“not aware”) to 5 (“extremely aware”). The third section explored respondents' perceptions of the concept of seagrass-associated tourism, including their agreement with the concept, and, if they agree, they were prompted to list potential tourism activities, notable species in the ecosystems, and ideas for enhancing the appeal of seagrass ecosystem tourism locations. Finally, the fourth section asked respondents to rank various threats to seagrasses (e.g., coastal development, oil spill, plastic waste pollution) from 1 (“least damaging”) to 10 (“most damaging”).

To ensure a high response rate, participants were randomly selected, targeting one in every five households where feasible (Heerwegh and Loosveldt, 2008; Quevedo et al., 2020). According to the 2022 report from Indonesia Statistics, the population in the four study locations was 34,587 (BPS Kabupaten Bintan, 2023). Based on this data, the target sample size was calculated using Cochran's formula, with a 95 % confidence interval and a 5 % sampling error (Bartlett et al., 2001). To meet the target sample size, household surveys were strategically conducted in two periods, considering authors' availability and financial constraints. The first survey was carried out from December 5 to 12, 2022 ($n = 194$), and the second from December 19 to 22, 2023 ($n = 155$). These household surveys were conducted by 3 researchers with the help of 5 local enumerators that have been trained before.

Additionally, a focus group discussion (FGD) was held with key informants and decision makers, including representatives from regency, provincial, and national governments, university sector, business

owners, and NGOs ($n = 15$; see Table 1). All participants were purposefully chosen and formally invited to attend the FGD; targeting stakeholders directly and indirectly involved with coastal tourism management in Bintan Island. FGD was chosen for its effectiveness in gathering qualitative insights and opinions from multiple actors (Nyumba et al., 2018).

All participants were gathered into one group and coordinated by one moderator. The FGD started with the explanation of seagrass-associated tourism concept and the dissemination of the results of the household surveys. The participants were invited to contribute their perceptions around (1) knowledge on the condition of seagrass ecosystem in Bintan Island, (2) opinion on seagrass tourism development in Bintan Island, (3) perceived challenges to develop seagrass tourism in Bintan Island, and (4) suggested solutions to realize the development of seagrass tourism in Bintan Island. This FGD session lasted 3 h and was conducted at Mercure Hotel in Central Jakarta, Indonesia, on October 5, 2023.

2.3. Data analysis

Descriptive statistics were used to characterize the local communities, assess their awareness of seagrass ecosystem services, and

Table 1

List of key informants at regency, provincial, and national levels that participated in the focus group discussion (FGD).

Category	Number of agencies
Regency/local authorities	3 agencies; participants 1–3
Provincial authorities	1 agency; participant 4
National authorities	7 agencies; participants 5–11
Non-governmental organizations	2 agencies; participants 12–13
Business owners	1 agency; participant 14
Academics	1 agency; participant 15

evaluate their views on the tourism sector. Spearman's rank correlation coefficient (ρ) was applied to examine the relationship between socio-demographic factors (e.g., occupation and education) and the perceived benefits of seagrass, as well as perceptions of seagrass-associated tourism development.

For the data gathered from the FGD, a deductive thematic analysis was employed since the specific questions and themes have already been formulated (Braun and Clarke, 2006). This analysis aimed to identify and summarize the main points discussed by each stakeholder, highlighting four aspects raised in the FGD namely 1) knowledge on the condition of seagrass ecosystems, 2) opinion on the concept of seagrass-based tourism, 3) challenges identified to implement seagrass-based tourism, and 4) recommendations to develop seagrass-based tourism. The FGD recordings were transcribed and translated into English before data processing. The processing stage included eliminating similar phrases or words and rephrasing the answers to confirm clarity and cohesiveness of data interpretations. After data processing, the respondent's contributions towards the four aspects were manually analyzed and interpreted based on their respective themes. This qualitative analysis provided insights into differing perspectives and priorities among stakeholders regarding the development and management of seagrass tourism (adapted from Quevedo et al., 2024).

3. Results

3.1. Socio-demographic profile

A total of 349 respondents completed the socio-demographic profile questionnaire. The age range of the majority of respondents was between 31 and 50 years old (54 %), with 27 % being aged 41–50, and 27 % aged 31–40. There was smaller representation from respondents in the age groups; 51–60 (18 %) and 21–30 (17 %). The survey had 187 male respondents (54 %) and 162 female respondents (46 %). Most of the respondents had attained elementary or senior high education (42 % and 30 %, respectively), followed by junior high education (19 %). Moreover, there was a small number of respondents who did not have formal education (5 %), and a few who had achieved college education (4 %). Regarding occupation, most respondents were fishermen (39 %), followed by housewives (27 %), entrepreneurs (8 %), civil servants (7 %), and laborers (6 %). Among the respondents, some worked exclusively in the tourism sector (2 %), while a small proportion worked as private employees (2 %) and farmers (1 %). Interestingly, there were many respondents who were unemployed (8 %).

3.2. Awareness of seagrasses and their ecosystem services

The respondents' awareness of seagrasses and their benefits was relatively high, with 97 % respondents recognized what they are, and 87 % respondents perceived their benefits. Further questions on the seagrass ecosystem services (Fig. 2) revealed that the supporting

services (fish nurseries), provisioning services (food sources), and cultural services (recreation) were moderately perceived by most of the respondents, with a combination of very aware and extremely aware consisting of 56 %, 28 %, and 27 %, respectively. Conversely, awareness of seagrasses' benefits for carbon sequestration and alternative medicine was relatively low, with 74 % and 66 % of respondents, respectively, unaware of these services.

Correlation analysis highlights that awareness of seagrass ecosystem services varies significantly across different occupational groups (Table 2). Civil servants have significantly positive correlation with services of water purification ($\rho = 0.107$, $p < 0.05$), coastal protection ($\rho = 0.119$, $p < 0.05$), trapping sediment ($\rho = 0.152$, $p < 0.01$), and carbon sequestration ($\rho = 0.204$, $p < 0.001$). In addition, entrepreneurs have significantly positive correlation with services of water purification ($\rho = 0.132$, $p < 0.05$), coastal protection ($\rho = 0.136$, $p < 0.05$), and carbon sequestration ($\rho = 0.110$, $p < 0.05$). Another occupation with positive correlation is the tourism sector workers in regard to the services of provision ($\rho = 0.120$, $p < 0.05$), alternative medicine ($\rho = 0.143$, $p < 0.05$), water purification ($\rho = 0.121$, $p < 0.05$), coastal protection ($\rho = 0.115$, $p < 0.05$), trapping sediment ($\rho = 0.171$, $p < 0.05$), and carbon sequestration ($\rho = 0.243$, $p < 0.001$). Meanwhile, there are several occupations with negative correlation to the ecosystem services. For example, fishermen with negative correlation to the coastal protection ($\rho = -0.127$, $p < 0.05$) and carbon sequestration ($\rho = -0.110$, $p < 0.05$), as well as laborers for the services of water purification ($\rho = -0.128$, $p < 0.05$) and coastal protection ($\rho = -0.107$, $p < 0.05$). In addition, unemployed individuals had negative correlation with the trapping sediment ($\rho = -0.112$, $p < 0.05$).

Additional correlation analysis was undertaken for understanding the relationship between various seagrass ecosystem services with 1) education levels; 2) perception of seagrass-associated tourism and 3) perception of benefits from seagrass ecosystems (see Table 3). Educational levels significantly influence awareness of recreation services provided by seagrass ecosystems ($\rho = 0.132$, $p < 0.05$; Table 3), however no other significant correlations between education levels with other ecosystem services were evident (Table 3). The perception of seagrass-associated tourism development showed multiple significant positive and negative correlations such as the services of alternative medicine ($\rho = 0.113$, $p < 0.05$), recreation ($\rho = 0.223$, $p < 0.001$), water purification ($\rho = -0.121$, $p < 0.05$), trapping sediment ($\rho = -0.163$, $p < 0.001$), and carbon sequestration ($\rho = -0.124$, $p < 0.05$). In regard to the perception of perceived benefits from seagrass ecosystems, almost all eight services showed significant positive correlations which included the services of habitat ($\rho = 0.219$, $p < 0.001$), provision ($\rho = 0.325$, $p < 0.001$), alternative medicine ($\rho = 0.127$, $p < 0.05$), water purification ($\rho = 0.113$, $p < 0.05$), coastal protection ($\rho = 0.178$, $p < 0.001$), and recreation ($\rho = 0.157$, $p < 0.01$).

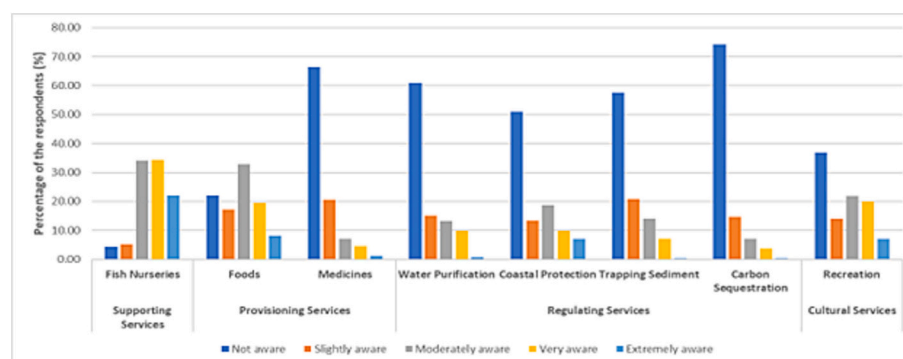


Fig. 2. Respondents' awareness level on seagrass ecosystem services utilizing a 5-point Likert scale from 1 ("not aware") to 5 ("extremely aware"), $n = 349$.

Table 2

Correlation analysis between occupation groups and awareness of seagrass ecosystem services. Numbers in bold represent significant correlations.

Variables	Perception of seagrass ecosystem services							
	Habitat	Provision	Alternative medicine	Water purification	Coastal protection	Trapping sediment	Carbon sequestration	Recreation
Civil servant (n = 24)	−0.015	0.041	0.089	0.107*	0.119*	0.152**	0.204***	0.002
Fisherman (n = 136)	−0.072	−0.014	0.081	−0.099	−0.127*	−0.085	−0.110*	−0.051
Private employee (n = 8)	0.071	0.088	−0.022	0.137*	0.003	0.082	0.002	0.049
Housewife (n = 93)	0.072	−0.022	−0.118*	−0.044	0.052	0.003	−0.025	0.008
Entrepreneur (n = 28)	0.088	−0.024	−0.028	0.132*	0.136*	0.054	0.110*	0.053
Tourism sector (n = 6)	−0.024	0.120*	0.143*	0.121*	0.115*	0.171*	0.243***	0.058
Laborer (n = 22)	−0.002	−0.029	−0.103	−0.128*	−0.107*	−0.067	−0.080	−0.025
Farmer (n = 5)	−0.091	−0.074	−0.040	0.030	−0.011	−0.009	−0.010	−0.006
Unemployed (n = 27)	−0.048	−0.002	0.045	−0.015	−0.059	−0.112*	−0.104	−0.006

*, **, *** indicate p-value of 0.05, 0.01, 0.001, respectively.

Table 3

Correlation analysis between education, perception of seagrass-associated tourism, perception of benefits from seagrass ecosystems and seagrass ecosystem services awareness. Numbers in bold represent significant correlations.

Variables	Perception of seagrass ecosystem services							
	Habitat	Provision	Alternative medicine	Water purification	Coastal protection	Trapping sediment	Carbon sequestration	Recreation
Education	−0.026	−0.001	0.003	0.042	−0.037	0.028	0.090	0.132*
Perception for seagrass-associated tourism development	0.066	0.094	0.113*	−0.121*	−0.010	−0.163**	−0.124**	0.223***
Perception of benefits from seagrass	0.219***	0.325***	0.127*	0.113*	0.178***	0.090	0.049	0.157**

*, **, *** indicate p-value of 0.05, 0.01, 0.001, respectively.

3.3. Community perception on seagrass-associated tourism

The respondents were asked about their agreement on utilizing the seagrass ecosystem as a tourism venture, and the result showed that the

vast majority (84 %) of the respondents agreed. Follow up questions to the respondents regarding activities that can be done in the seagrass ecosystem can be seen in Fig. 3a. Gleaning clams was the most recognized activity that respondents selected for establishing a seagrass-

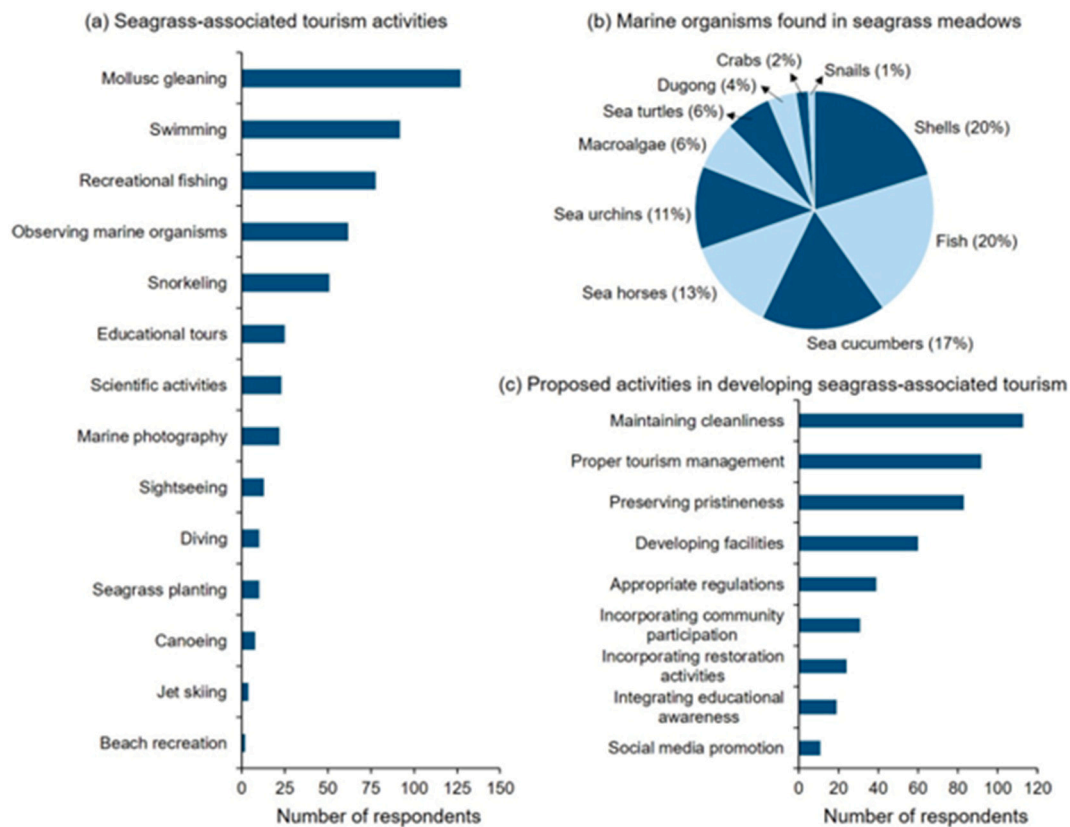


Fig. 3. Respondents' perceptions on (a) preferences towards seagrass-associated tourism activities, (b) marine organisms found in seagrass meadows, and (c) recommended activities in developing seagrass-associated tourism; n = 349.

associated tourism activity (36 %). This was followed by swimming (26 %), fishing (22 %), observing marine biota (18 %), and snorkeling (15 %).

In regard to the marine biota within the seagrass ecosystems, the locals perceived and listed several species that are commonly found in seagrass ecosystems (Fig. 3b). The top 3 most popular species identified by respondents included shells (20 %), fish (20 %), and sea cucumbers (17 %).

There were 9-themed recommendations with regards to respondents' perceptions on what they would consider making the seagrass ecosystem an appealing location for tourism (Fig. 3c). The top 3 recommendations included; maintaining cleanliness (32 %), proper tourism management (26 %), and preserving pristineness (24 %).

3.4. Community perception on threats faced by seagrass ecosystem

We provided 9 threats facing seagrass ecosystems on Bintan Island and respondents were asked to rate their perception of the level of threat with a rating scale from 1 (least damaging) to 10 (most damaging). The most perceived threats, as seen in Fig. 4, were anthropogenic threats such as boat waste, coastal development, and plastic waste.

3.5. Perceptions from FGD

3.5.1. Knowledge on the condition of seagrass ecosystems

Given the localized context, the participant from the local government (participant 2) provided input for what the current perceptions were on the condition of the seagrass ecosystems of Bintan Island. For example, it was noted that seagrass ecosystems in Bintan Island are largely known for being a habitat provider for dugong. In addition, much of the attention from the local government agencies was put specifically on the rehabilitation and conservation measures of the seagrass ecosystems in the region, although the funding allocated for these measures was very limited. According to the statement from participant 2:

"We are very grateful for the attention towards rehabilitation for the seagrass ecosystems in the (Bintan) region. The restoration and protection measures of seagrasses are needed to transform the systems into attractive and beautiful tourism objects."

- Participant 2

3.5.2. Opinion on the concept of seagrass-based tourism

Regarding the idea of seagrass tourism development for Bintan Island, the majority of FGD participants agreed with the concept. Participants perceived seagrass ecosystems as important ecological systems that provide multiple benefits via ecosystem services and its potential to support tourism activities. Participant 2 explained that:

"Currently, the tourists mainly come to enjoy the coastal areas such as the beach and coral reefs. But, I think in the future, there is a great opportunity for them to enjoy seagrass meadows to enjoy some fun activities such as dugong and turtles tours."

- Participant 2

That being said, seagrass as a tourism object is important to be considered from the perspective of creating an interesting event that is related to the seagrass ecosystem to attract tourists. According to the statement from participant 14:

"The main idea is trying to find a way to make seagrass valuable. If seagrass as itself is promoted for tourism, in my opinion, the success rate will be low. However, if we think of it as a domino effect, in regards that good seagrass (ecosystem quality) will influence the other ecosystems and marine habitats, then seagrass will be very important. From a tourism perspective, we should also consider the positive impact of a healthy seagrass ecosystem, for example influencing the appearance of dugong and other exotic species."

- Participant 14

However, the FGD participants considered that seagrass ecosystems should not be the main focus as a tourism venture, but rather consideration of other tourism activities. For example, the integration with water-based tourism activities, such as diving, and collaborating with entrepreneurs to create events related to seagrass and coral reef ecosystems could also be a potential avenue to attract more tourists. Conversely, the business owner (participant 14) suggested that promoting seagrass for tourism might not be effective, instead suggested raising the awareness of the importance of protecting seagrass ecosystems that will influence other ecosystems and marine habitats, ultimately supporting the overall tourism sectors in Bintan Island. Comments from the business owner (participant 14) regarding his perception to creating a seagrass-associated tourism industry in Bintan Island:

"I agree to promote seagrass ecosystems as tourism sites, however its effectiveness should be reconsidered again. Further analysis should be

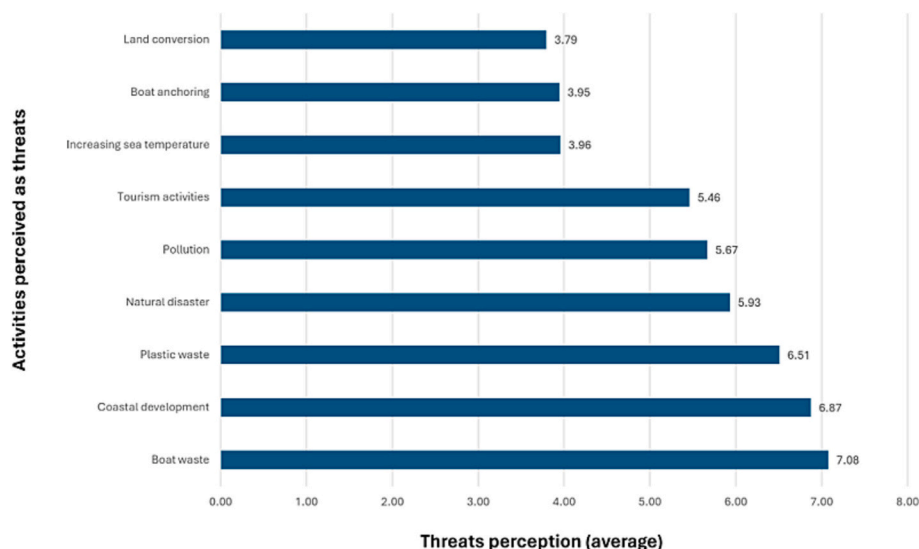


Fig. 4. Respondents' perception on the threats to the seagrass ecosystems in Bintan Island (n = 349).

done to see the market scale, because if the market (demand for seagrass tourism) is low, maybe another alternative (concept) can be proposed."

- Participant 14

3.5.3. Challenges identified to implement seagrass-based tourism

Several challenges were raised by the participants regarding the implementation of seagrass-associated tourism. The first challenge was the enactment of Act No. 23 in 2014. This Act has resulted in conflict of management of seagrass conservation area in Bintan Island. According to the statement from participant 4:

"It is very hard to manage seagrass ecosystems in Bintan Island since the regency government do not transfer the tools and facilities to the provincial government. These tools and facilities are crucially needed for conducting the monitoring, protection and restoration activities of the systems."

- Participant 4

The second challenge was the need for capacity building and introducing the concept to coastal communities so they could play an important role to support the seagrass-associated tourism implementation. The third challenge was an issue related to accessibility, amenities, and attraction aspects of the seagrass-associated tourism, given the current status of Bintan Island tourism being mostly land-based tourism. Furthermore, participant 2 emphasized that the transformation of seagrass ecosystems into attractive and beautiful tourist locations, should also consider ecosystem protection. Participant 13 also highlighted the challenges around the notion of authority of seagrass management for tourism, as well as regulation for the restricted activities, the law enforcement, and the monitoring programs to protect seagrasses. The last challenge to be considered was the safety aspect for the tourists when conducting seagrass-associated tourism activities, in particular, the potential threat of dangerous animals living near seagrass ecosystems. Participant 13 mentioned about the safety aspect as:

"Some considerations include the safety aspect in the implementation of seagrass tourism concept, for example with the potential threat of other species. The risk for every tourism activity should be considered because each (seagrass) site has different characteristics. In addition, we need to follow the main principle (i.e. ecotourism for seagrass). For example, in the case of Tomohon, there is the existence of 'blue octopus' as exotic species but it has its own risk, which is poisonous and dangerous. Therefore, identification and risk assessment measures are needed for each site, for example to see the regional characteristics, existing species, etc."

- Participant 13

3.5.4. Recommendations to develop seagrass-based tourism

In terms of recommendations, participant 14 proposed an educational tourism concept to promote seagrass-associated tourism. This concept has been conducted to promote overall tourism sectors in Bintan Island considering that many international tourists from Singapore visit Bintan Island. However, cost-benefit analysis should be conducted first to evaluate market feasibility of educational tourism in seagrass ecosystems. The statement from participant 14 was:

"Educational tourism for the youth is the main attraction for tourists from Singapore to visit Bintan, for example with a study tour program. Observing and learning seagrass and mangrove as part of tourism is still very limited, and perhaps can be promoted as part of educational tourism."

- Participant 14

Another participant (participant 10) stated that supporting facilities such as marine educational centers, can provide added values of learning about various marine ecosystems while also promoting awareness to the tourists. According to the statement from participant

10:

"Based on the experiences when managing the conservation area, there are demands of protection and utilization, for example in the tourism sector. Seagrass tourism should be replaced into 'dugong tourism', while also improving the communities' capacity, for example the tourists' guide to understand the benefits of seagrass. The additional value for tourism can also be added through research activities, for example by providing the insights of research to the visitors. Furthermore, existing infrastructure should also be considered, as well as site suitability, for example suitability for snorkeling activity. Existence of facilities such as education centers can provide comprehensive added values of learning various ecosystems and promoting awareness to the tourists before they go to the field for observation, as well as informing the restricted activities."

- Participant 10

4. Discussion

Indonesia will submit its third nationally determined contribution (NDC) document in 2025 to support global commitment to mitigate against, and adapt to climate change. In its third round of submissions, Indonesia has identified marine ecosystems, including seagrass ecosystems, as one of the primary components in the reduction of greenhouse gas emissions. Thus, it is critical to conserve and restore these globally important ecosystems (Rifai et al., 2023). Given that there is a lack of funding from the management authorities to conduct management activities of seagrass ecosystems in Indonesia's MPAs (Rifai et al., 2022), there should be an alternative source of funding through the implementation of seagrass-associated tourism concept. As a comparison, there was a specific national budget of US\$ 57.38 million for coral reef management measures called COREMAP (Coral Reef Rehabilitation and Management Program; World bank, 2024a) and a budget of US\$ 419.00 million for mangroves management programs called MCRP (Mangrove for Coastal Resilience Project; World bank, 2024b) in Indonesia, but there is no such budget for seagrass management activities. One strategy that could be implemented would be to introduce an environmental management charge (EMC) for foreign tourists visiting Bintan Island. For example, the Great Barrier Reef Marine Park Authority (GBRMPA) charges a daily EMC of US\$5.50 for all visitors to the reef which then supports the day-to-day management of the reef and contributes to enhancing the long-term resilience (Great Barrier Reef Marine Park Authority, 2024). In the context of Bintan Island where in 2019, 750,000 foreign tourists visited the island (Dinarto et al., 2020), and if we were to extrapolate from the GBRMPA rates, a potential US\$4,095,000 per annum could contribute to the management of the seagrass-associated tourism concept. Further discussions around how this charge is then divided across all stakeholders in an inclusive and equitable manner is required.

This study has allowed for a deep understanding of stakeholders' perceptions related to seagrass-associated tourism concept, and by fostering continuous dialogue and cooperation, this concept, with financial backing, can aim to deliver four main benefits to all stakeholders; from the local level, to the national level and including the management authorities. These four benefits are: 1) protecting the ecosystem from anthropogenic threats, 2) incorporating sustainable tourism practices, 3) enhancing community engagement and capacity building, and 4) providing sustainable funding for management measures (please see Fig. 5).

4.1. The support for implementing a seagrass-associated tourism industry

Seeking local communities' and relevant stakeholders' perspectives before implementing a tourism industry is essential for ensuring community support, cultural sensitivity, and economic fairness. Through understanding local perceptions towards a seagrass-associated tourism concept, it will help prevent potential conflicts between locals and

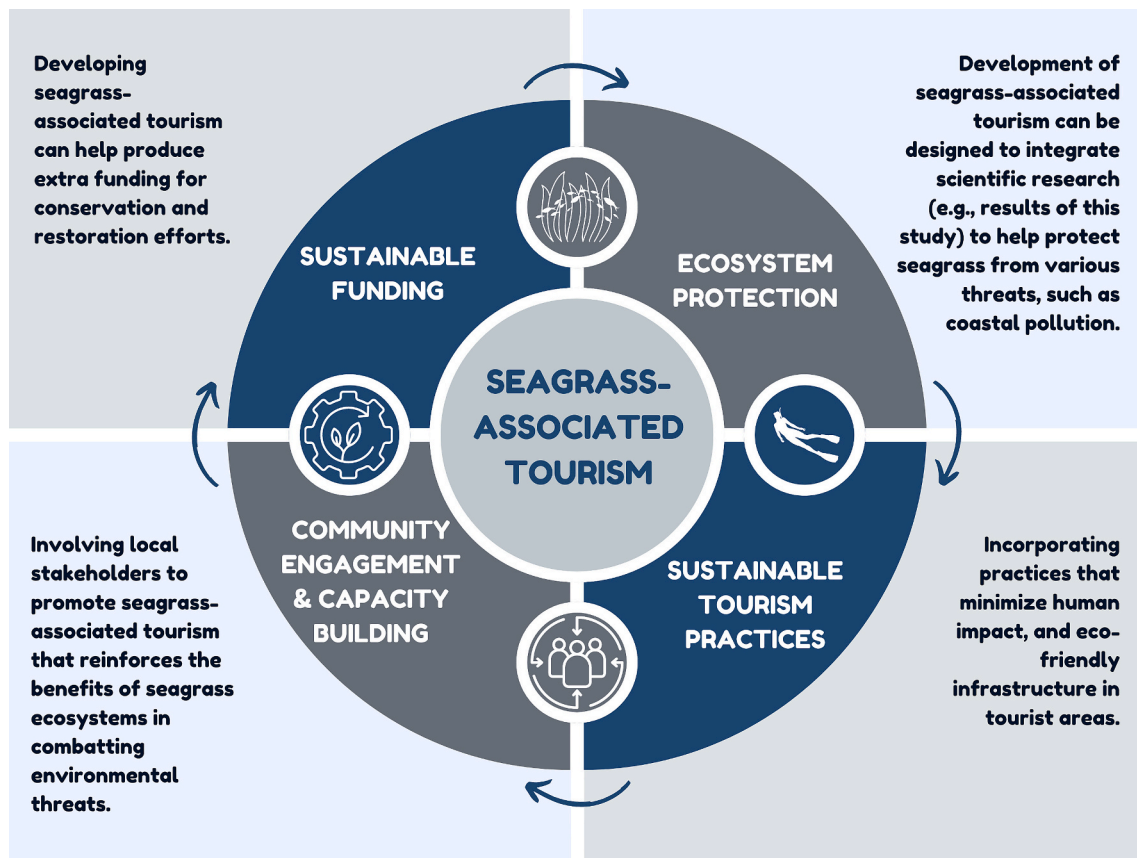


Fig. 5. Seagrass-associated tourism framework illustrating its role in ecosystem protection, sustainable tourism, community engagement, and generating funding for conservation through local stakeholder involvement and minimizing human impacts.

tourists (Herbst et al., 2020). In addition, as the ultimate goal of the implementation of seagrass-associated tourism is to improve the conservation and management of seagrass ecosystems in Bintan Island, the support from the locals is important given the success of conservation measures is often predicated on local support (Bennett and Dearden, 2014). We found that the majority of local communities in four villages of Bintan Island have perceived the benefits of the seagrass ecosystem, and showed support for developing seagrass-associated tourism. However, this study also identified that many of the respondents were not aware of specific seagrass ecosystem services, such as water purification, coastal protection, trapping sediment, and carbon sequestration. This result aligns with previous studies (e.g., Nakaoka et al., 2014; Rifai et al., 2023) showing that public awareness of seagrass beds in Asia is generally high for provisioning services, but low for most regulating services particularly regarding carbon sequestration.

Increasing awareness of a greater number of ecosystem services may encourage the design of better and more balanced habitat management (Richards et al., 2017). In the case of Bintan Island, we identified several occupation groups that had high awareness of multiple services provided by the seagrass ecosystems. These groups were civil servants, entrepreneurs, and the tourism sector. Lukman et al. (2021) highlighted the potential role from fisherman and government groups to raise the awareness of the seagrass ecosystem. We believe that in the case of Bintan Island, in addition to the civil servant group, the entrepreneur and tourism groups could also contribute in raising awareness of seagrass ecosystem services, as well as promoting the notion of seagrass-associated tourism concept.

Seagrass-associated tourism in Bintan Island has potential to thrive, and can be supported through promoting ocean literacy among local communities and visitors. Ocean literacy, defined as an understanding of the ocean's influence on people and people's influence on the ocean

(Cava et al., 2005), is now a key component of the UN's Decade of Ocean Science for Sustainable Development (2021–2030). This movement seeks to improve public understanding of the ocean's critical role in our lives, including its impact on climate, weather, food security and biodiversity (Intergovernmental Oceanographic Commission, 2021; Kelly et al., 2022; Worm et al., 2021). It promotes the idea that informed and engaged citizens are essential for the conservation and sustainable management of ocean resources. Implementing similar initiatives on Bintan Island, such as education programs around the ecological and economic benefits of seagrass meadows, will encourage sustainable tourism practices.

The FGD on seagrass-associated tourism development in Bintan Island revealed diverse insights and recommendations. On one side, the majority of the participants agreed that seagrasses could support the tourism sector with their multiple services. However, solely promoting seagrasses for tourism was not received well by some other participants, particularly by the business owner. Such concern from the business owner is understandable from the perspectives of tourism services, specifically related to the revenues that can be generated from seagrass-associated tourism as seagrass meadows are not often recognized for providing a place for people to spend their leisure time (McKenzie et al., 2021). One way to understand the contribution of seagrass to tourism is by analyzing tourist expenditure relating to seagrass-related experiences (Dewsbury et al., 2016). However, in Indonesia, studies on seagrass tourism are greatly lacking (Ahmad et al., 2019). Hence, highlighting the need to further understand tourists' perspectives on both the suitability of seagrass sites for tourism and activities that can be conducted within seagrass ecosystems (Lukman et al., 2023). Understanding tourists' preferences for site suitability and activities within seagrass ecosystems, as well as the potential revenues derived from these activities, can help formulate a sustainable seagrass-associated tourism concept.

4.2. Sustainable development for seagrass-associated tourism

Although this paper promotes the potential concept of seagrass-associated tourism as an alternative approach for conservation, there are several things that need to be considered to ensure that the concept can be implemented sustainably. The most important concern should be put on how to address the existing threats. Despite the seagrass ecosystems near the four study locations being designated as conservation areas since 2007, the results of this study revealed that local people still perceive many threats to these globally important ecosystems (Fig. 4). Most of these perceived threats came from human activities such as boat waste, coastal development, plastic waste, and pollution resulting in the decline in seagrass percentage cover. These threats need to be addressed by all stakeholders from local to global levels (Unsworth et al., 2018) if we are to establish seagrass-associated tourism in Bintan Island.

The attention on these highly productive ecosystems, however, is still less than their neighboring ecosystems such as mangroves and coral reefs (Rifai et al., 2022). For example, regular monitoring programs have been conducted in mangrove forests and coral reefs, but not with seagrass ecosystems. In addition, the transfer of MPA management authority from regency to provincial government under Act No. 23 in 2014, has resulted in some negative consequences to management measures of seagrass ecosystem in Bintan Island regency. These consequences include limited funds, limited monitoring programs, and limited number and personnel to act immediately in addressing the threats (Jompa et al., 2023). Authority-sharing models to enable co-management between regency and provincial governments that work under the new legal framework should be created to address the threats derived from local communities' activities. A particular concern should also be put on the oil-spill pollution since this type of pollution did not originate from local communities but from international companies' vessels. A strong law enforcement from national and international management authority (Unsworth et al., 2018; Sjafrie et al., 2018) should be carried out immediately to prevent the event of oil-spills that will have significant adverse impacts on the condition and spatial extent of seagrass ecosystems in Bintan Island.

Aside from the existing threats to seagrasses in Bintan Island, if the local government, communities, and tourism operators are planning to implement the seagrass-associated tourism, then there will be other potential threats from tourism activities that should also be considered. In the case of Bali, for example, the seagrass damage is mostly caused by tourism-related activities such as boat dragging and propeller scars (Watiniasih et al., 2021). Recreational activities can mechanically damage seagrass meadows resulting in fragmentation and decreased growth of meadows (Lukman et al., 2023). There are other potential threats to seagrass meadows in Indonesia that vary with respect to the region, although the threats from sedimentation and coastal development are relevant throughout the country (Unsworth et al., 2018). In that regard, the development of seagrass-associated tourism should ensure that the sustainability principles are upheld to prevent the accumulation of threats that already exist from anthropogenic activities.

5. Conclusion

This study investigated the perception of multiple stakeholders from local to national levels in terms of seagrass ecosystem services, threats to seagrass ecosystems, and the idea of seagrass-associated tourism development in Bintan Island. Overall, we have observed the appreciation of both seagrass ecosystem services and the potential role of seagrass in supporting the tourism sector. There is the concern related to the threats that can degrade the condition and spatial extent of seagrass ecosystems, as well as different directions on how the seagrass ecosystem can be integrated into the tourism sector.

Despite the potential of seagrass-associated tourism for environmental and economic aspects, our findings also highlighted the concern of mismanagement, in which seagrass ecosystems could not be solely

promoted as a tourism object but should be integrated with other tourism activities. We suggest that future studies should be conducted with regard to the feasibility of the seagrass-associated tourism implementation, in particular to the tourists' perception and their willingness-to-pay for supporting the conservation of coastal ecosystems, particularly seagrass ecosystems. Understanding the demand from the tourism sector can help to properly plan the implementation of seagrass-associated tourism. For example, from the perspective of the carrying capacity of the tourism destination, to ensure the environmental sustainability.

Considering the new target to increase the coverage of MPAs in Indonesia by 30 % in 2045 (MMAF, 2023) and the strong support from local communities and related stakeholders regarding the idea of seagrass-associated tourism development to fund the conservation and restoration measures of seagrass ecosystems in Bintan Island, it is expected that the management authorities of MPAs in Indonesia could increase the funding and support for better management of these significant global-scale value ecosystems within MPAs in Indonesia. Engaging local communities and stakeholders in the development of a new tourism sector not only helps secure funding for conservation efforts but also fosters a sense of ownership and stewardship among the local population. This collaborative approach can serve as a model for other regions worldwide, demonstrating how sustainable tourism can support the preservation of critical ecosystems while benefiting local economies and promoting ocean literacy.

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CRediT authorship contribution statement

Husen Rifai: Writing – review & editing, Writing – original draft, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Kevin Muhamad Lukman:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Jay Mar D. Quevedo:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Prue Francis:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization. **Nurul Dhewani M. Sjafrie:** Writing – review & editing, Methodology, Data curation. **Triyono:** Writing – review & editing, Methodology, Data curation. **Len Mckenzie:** Writing – review & editing. **Rahman Hidayat:** Writing – review & editing, Data curation, Conceptualization. **Aditya Hikmat Nugraha:** Writing – original draft, Data curation. **Tri Edi Kuriandewa:** Writing – review & editing, Data curation. **Siti Hajjar Suryawati:** Writing – review & editing, Data curation. **Bayu Prayudha:** Writing – review & editing, Visualization. **Suraji Suraji:** Writing – review & editing, Data curation. **Johan Risandi:** Writing – review & editing, Data curation. **Udhi Eko Hernawan:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Conceptualization.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.marpolbul.2024.117063>.

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