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SUSTAINABILITY ASSESSMENT OF CORAL REEF ECOSYSTEM IN PANJANG ISLAND, JEPARA, CENTRAL JAVA

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ABSTRACT

Panjang Island, Jepara, is a conservation area in the northern part of Jepara Regency, Central Java, where the local community's economy relies on capture fisheries and tourism. However, human activities and environmental changes have degraded the coral reef ecosystem, threatening the island's sustainability and local livelihoods. This study aimed to assess the sustainability status of Panjang Island across various dimensions in response to these significant pressures. A descriptive quantitative method was employed. Observations of ecological variables, such as coral cover and recruitment, were conducted using the line-intercept transect method, while reef fish were surveyed using underwater visual census methods, and biodiversity indices were calculated manually. The social, economic, and institutional dimensions were assessed through interviews and focus group discussions. Although the ecological, institutional, and social dimensions are moderately sustainable, the main finding indicates that the economic dimension remains less sustainable. Enhancing community participation, governance, and capacity-building programmes is essential to support sustainable resource use and protect the island's ecosystem in the long term. These findings highlight the urgent need for synergistic and holistic management strategies that prioritize the improvement of local economic opportunities. Such an integrated approach is crucial for achieving balanced and genuinely sustainable coral reef management on Panjang Island.

Keywords:
Sustainability status
Panjang Island
RAPFISH

How to Cite

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INTRODUCTION

Indonesia, as an archipelagic nation, boasts substantial marine and coastal potential, encompassing a wealth of natural and cultural resources that are particularly valuable to its fisheries and tourism sectors (Nursahid et al., 2025). Nearly 65% of Indonesia's population resides in coastal and marine areas, and Java Island faces diverse pressures yet continues to yield significant fisheries resources (Andriyono, 2018). Jepara's coastal area in Central Java serves as a major center of economic activity in the marine, fisheries, and tourism sectors, but it faces severe sustainability impacts from detrimental human activities, such as intensive coastal development and the destruction of coastal protection structures (Latue et al., 2023; Hamid et al., 2021). In Jepara's coastal area, this damage is particularly evident in locations such as Panjang Island, where coral reefs have suffered significant ecosystem degradation (Rachmawati et al., 2018).

Panjang Island is a small island located in Ujung Batu Village, Jepara District, Jepara Regency, Central Java Province. Panjang Island has marine tourism and ecological potential supported by its coral reef habitat, which serves as a vital economic hub for the surrounding community through fishing and tourism activities (Nurhuda et al., 2023). Many of Jepara's coastal residents are highly dependent on marine resources for their economic and social livelihoods (Afifah et al., 2024). The quality of the coral reef ecosystem around Panjang Island is declining, with a 64.34% decrease in live coral cover at a rate of 0.17 hectares per year between 2001 and 2019, driven by population growth and expanding coastal utilization around the island (Suryono et al., 2022). Despite its ecological and economic benefits, the coral reef ecosystem has been severely damaged by human activities. Reef degradation, characterized by declining coral cover and reduced recovery capacity, threatens overall ecosystem health, sustainability, and the local community's economy, making effective management essential (Prasetia et al., 2020). Identifying and supporting community-led innovations that both utilize and protect coral reef resources, along with exploring new private financing mechanisms for coastal recovery that recognize critical inter-habitat connectivity, are crucial for long-term sustainability (Andrachuck et al., 2022). The effectiveness of conservation incentives depends on factors such as reward size, dependence on coral reefs for income, and community perceptions of reef value (Leonce, 2021).

The Panjang Island Conservation Area was formally established through zoning and designated uses under the Minister of Marine Affairs and Fisheries Decree Number 77 of 2022. The recent decline in coral health indicates a critical gap in understanding the overall sustainability status of the ecosystem. Although previous studies have assessed coral reef sustainability using ecological, social, economic, and institutional dimensions through RAPFISH

Table 1. List of respondents

Stakeholder	Respondent	Total (persons)
Institution	Department of Maritime Affairs and Fisheries of Central Java	1
	Eastern Regional Branch Office of Maritime Affairs	1
	Department of Maritime Affairs and Fisheries of Jepara Regency	1
	Department of Culture and Tourism of Jepara Regency	1
Organization/NGO	Seacrest Indonesia	3
	Yayasan Rekam Jejak Alam Nusantara	
	Yayasan Taka	
	Community Monitoring Group	2
Community	Panjang Island Tourism Manager	4
	Sapta Pesona Tourism Boat Group	6
	Fishermen	18
	Local Community	18
	Tourists	5
Total Respondents		60

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analysis (Nisak et al., 2024), effective management still requires stronger collaboration and stakeholder engagement to enhance community awareness of the value of coral reef ecosystems. Increasing pressure, causing physical degradation, demands more adaptive and site-specific management approaches for Panjang Island's ecological functions (Table 1). Therefore, this study aimed to assess and determine the sustainability status of Panjang Island's coral reefs through a comprehensive analysis incorporating ecological, social, economic, and institutional dimensions using RAPFISH analysis. The expected outcome is to provide critical, evidence-based information to support more effective and adaptive management strategies for this important marine area.

MATERIALS AND METHODS

This research was conducted from October 2024 to February 2025 in the Panjang Island Conservation Area, located in Ujungbatu Village, Jepara District, Jepara Regency, Central Java (fig, 1, table 2). The research location was determined using the purposive sampling method. This method was selected based on variations in coral reef cover conditions and differing levels of anthropogenic disturbance across zones, including the core zone, rehabilitation zone, and limited utilization zone. All zones encompassed reef flat and reef slope habitats, which are the most distinctive habitats of coral reef ecosystems.

Ecological data included coral cover measured using the Line-Intercept Transect (LIT) method, coral recruitment counted using a ruler with 1 mm precision, and reef fish surveyed using the Underwater Visual Census (UVC) method within a 50 m × 5 m belt transect, with an observation time of approximately one hour per site. Data collection was conducted by snorkeling and SCUBA diving along a 50 m transect line at depths of 1 – 4 m. Water parameters measured included temperature, recorded using a thermometer. All data were documented using an underwater camera. Data processing and analysis were performed using Microsoft Excel 2013, XLStat 2025, and RAPFISH software. Field documentation was facilitated using waterproof stationery, including Newtop waterproof paper, pencils, waterproof clipboards, and identification sheets.

Coral reefs were identified and analyzed based on cover composition, including hard corals, rubble, sand, and algae. Coral cover percentage was calculated using the formula proposed by English et al. (1997):

$$N_i = (Li/N) \times 100\%$$

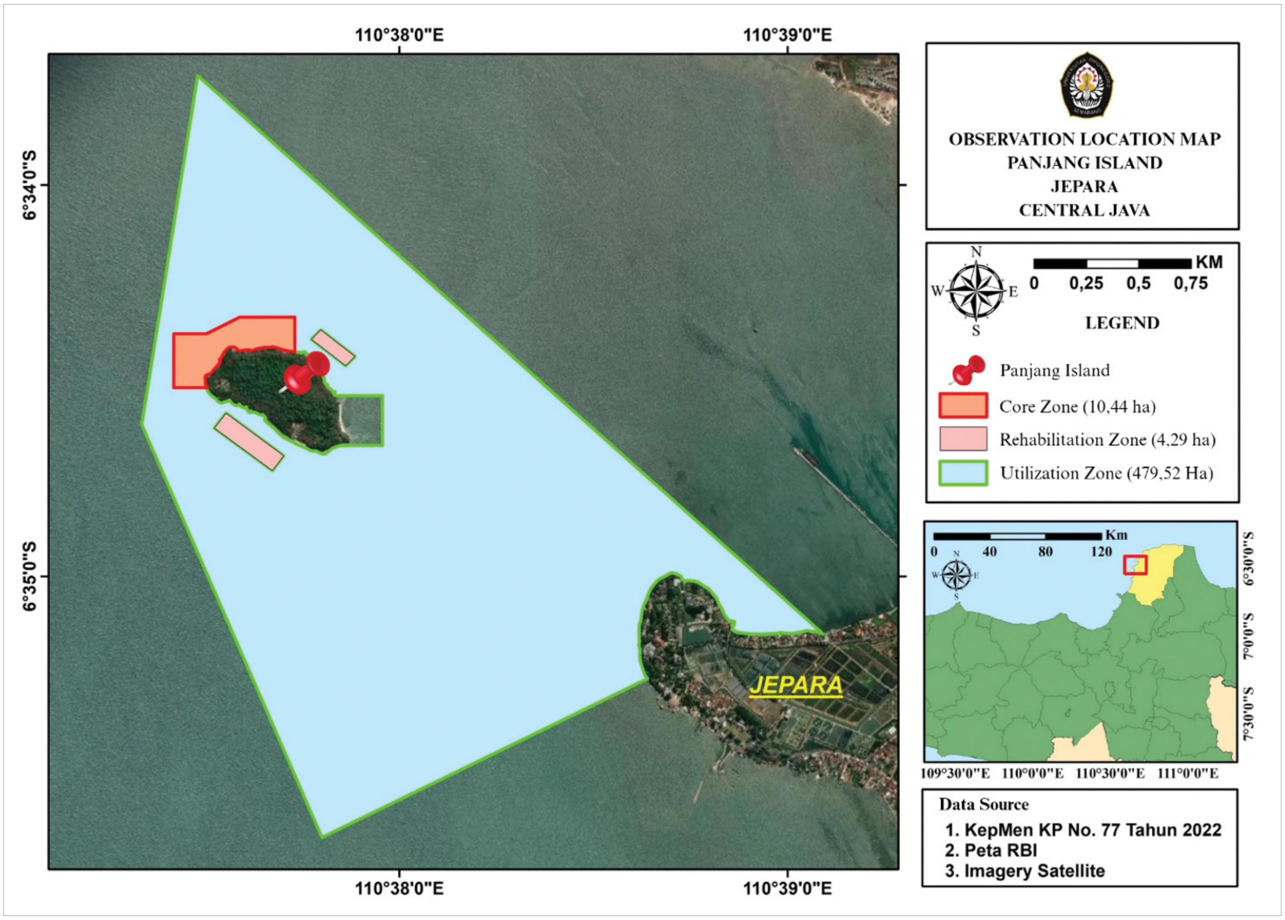

Fig 1. Research site and sampling locations

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Table 2. Study sites at the research location

Site	Depth (m)	Latitude (Y)	Longitude (X)	Orientation (Zone)	Coral cover (%)
1	1	06°34'24.6'' S	110°37'29.4'' E	Reef flat (core)	5.58
2	2	06°34'23.5'' S	110°37'28.4'' E	Reef slope (core)	36.60
3	1	06°34'26.82'' S	110°37'51.0'' E	Reef flat (rehabilitation)	9.30
4	3	06°34'26.3'' S	110°37'51.8'' E	Reef slope (rehabilitation)	18.96
5	1	06°34'42.4'' S	110°37'46.92'' E	Reef flat (limited utilization)	2.08
6	2	06°34'43.58'' S	110°37'46.8'' E	Reef slope (limited utilization)	5.76

where N_i is coral cover (%), L_i is the length of substrate type intercepted by the transect, and N is the total transect length. Coral cover categories were defined according to the Ministry of Environment Decree No. 4 of 2001 as follows: 0 – 24.9% (Poor), 25 – 49.9% (Moderate), 50 – 74.9% (Good), and 75 – 100% (Excellent). Coral recruitment data were collected *in situ* during coral cover surveys and included the total number of coral colonies with sizes ≤ 10 cm.

Reef fish data were collected using the standard UVC method, and species were identified using identification guides from the FishBase website. Fish length estimates were also recorded for biomass analysis. Reef fish biomass data were collected during diving by estimating the total length of fish in 5 cm size classes (e.g. 0 – 5 cm, 5 – 10 cm), with the midpoint of each length class used for calculations. Biomass calculations were performed for reef fish. Individual fish weight was estimated using the length–weight relationship, employing coefficients *a* (intercept) and *b* (slope). These coefficients were obtained from FishBase and derived from the standard length–weight relationship equation. The estimated weight (W) of individual fish was calculated using the following formula:

$$W = a \times L^b$$

where W is individual fish weight (g), L is estimated total length (cm), and a and b are species-specific coefficients obtained from FishBase (Froese & Pauly, 2014; Kulbicki et al., 2005).

Total reef fish biomass was calculated and converted to kilograms per hectare (kg/ha) using the following formula:

$$B = (W_{total} / A) \times 1000$$

where B is biomass (kg/ha), W_{total} is the total weight of fish per family (g/350 m²), A is the observation area in hectares (0.035 ha), and 1,000 is the conversion factor from grams to kilograms. Reef fish biomass categories were classified according to Giyanto et al. (2017) as low (< 970 kg/ha), moderate (970 – 1,940 kg/ha), and high (> 1,940 kg/ha).

Diversity refers to the composition of individuals within a community, while the evenness index describes the distribution of individuals among species. The diversity index provides information on population structure and the number of individuals per species (Makawaehe et al., 2021). Diversity was categorized as low (H’ ≤ 1), moderate (1 < H’ ≤ 3), and high (H’ > 3). Diversity indices for coral reefs and reef fish were calculated using the Shannon–Wiener index (Odum, 1971):

$$H' = -\Sigma[p_i \, Ln \, p_i] \text{ where } P_i = n_i / N$$

where p_i is the proportion of individuals belonging to species i (n_i / N), ni is the number of individuals of species i, and N is the total number of individuals across all species.

Ecological, social, economic, and institutional dimensions were assessed through interviews and focus group discussions. Data were scored using a Likert scale ranging from 1 to 3. Respondents were selected using a combination of purposive and snowball sampling techniques. The initial respondent, the Marine and Fisheries Department of Central Java, was purposively selected due to its authority and knowledge of Panjang Island. Subsequent respondents were identified through referrals until data saturation was achieved. Interview participants included representatives from non-governmental organizations (NGOs), community surveillance groups, local communities (e.g. fishers, tourism boat associations, traders) from five sub-districts near Panjang Island (Ujungbatu, Bulu, Kauman, Jobokuto, and Demaan), as well as tourists. The social dimension included social networks, community participation, and social conflict. The economic dimension focused on dependence on tourism, natural resources, and income. The institutional dimension comprised five attributes: legal status of conservation regulations, monitoring effectiveness, institutional conflict, human resource governance, and clarity of water boundary authority.

To ensure optimal and effective management of sustainable coral reef ecosystems, their sustainability status was determined using RAPFISH software. This multidimensional scaling (MDS) approach assesses sustainability based on sensitive qualitative and quantitative attributes across various dimensions, including social, economic, and institutional aspects. Attribute values, obtained through direct observation,

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interviews, and literature review, often require transformation. Sustainability status is categorized into four levels: poor (0–25), less sustainable (25.1–50), sufficiently sustainable (50.1–75), and good (75.1–100). Based on Fauzi (2019), RAPFISH analysis requires several conditions before use, including: (1) the analysis is multidimensional, covering economic, social, ecological, and institutional aspects; (2) it aims to determine the sustainability status of a system or economic activity; (3) it positions the unit of analysis within one dimension relative to other dimensions in a sustainability context; (4) it identifies variables or attributes that can serve as leverage points for sustainability improvement; (5) sustainability assessment is conducted through expert judgment based on existing data; and (6) there is an absence of complete hard data (Table 3).

Table 3. Categories of attribute scores

No	Attributes	Description	Index Value	Index Source
1.	Temperature (°C)	Temperature affects the metabolic rate and reproduction of corals	(1) < 11 °C and > 30 °C; (2) 11 - 28 °C; (3) 28 - 30 °C.	a
2.	HCC (%)	High resistance, high colony survival, high sustainability level	(1) ≤ 21%; (2) 22 - 84%; (3) ≥85%	b
3.	MC (%)	High macroalgae cover hinders coral reef recovery and disrupts coral growth	(1) > 30% (abundant); (2) 10 - 30% (moderate); (3) < 10% (low)	c
4.	S (%)	Inhibits coral settlement and growth; a low percentage indicates high sustainability	(1) 100 - 75%; (2) 74 - 50%; (3) 49 - 25%; (4) 24 - 0%	d
5.	RC (%)	Indicates disturbance; higher values reflect lower sustainability	(1) 100%- 75%; (2) 74% - 50%; (3) 49% - 25%; (4) 24% - 0%	e
6.	OT (%)	Indicates unhealthy coral reefs, low productivity, and low sustainability	(1) 100% - 75%; (2) 74% - 50%; (3) 49% - 25%; (4) 24% - 0%	d
7.	CR (colonies)	Higher recruitment indicates higher sustainability	(1) 0 colonies; (2) 1 - 5 colonies; (3) 6 - 15 colonies; (4) 16 - 25 colonies	d
8.	H'C	High diversity indicates high sustainability	(1) H' ≤ 1; (2) 1 < H' ≤ 3; (3) H' > 3	f
9.	H'F	High diversity indicates high sustainability	(1) H' ≤ 2; (2) 3 < H' ≤ 3; (3) H' > 3	f
10.	W (kg/ha)	The presence of fish indicates healthy coral reefs and high sustainability	(1) < 970 kg/ha; (2) 970 - 1940 kg/ha; (3) 1940 kg/ha	g
11.	Social Network	Assesses the organization of management mechanisms	(1) None; (2) Exists, not functioning; (3) Exists, functioning	h

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Continued. Table 3

No	Attributes	Description	Index Value	Index Source
12.	Community Participation	Assesses participation in coral reef management and training programs	(1) Not aware/not involved; (2) Not actively participating; (3) Actively participating	i
13.	Social Conflict	Higher conflict indicates lower sustainability	(1) Occurs frequently (>30%); (2) Occurs occasionally; (3) Never occurs	j
14.	Dependence on Tourism	Contribution of tourism to household income; higher dependence indicates lower sustainability	(1) Low (< 25%); (2) Moderate (26% - 50%); (3) High (> 50%)	k
15.	Dependence on Coastal and Marine Resources	Contribution of resources to household income; higher dependence indicates lower sustainability	(1) Low (< 25%); (2) Moderate (26% - 50%); (3) High (> 50%)	k
16.	Household Income	Compared with the minimum wage of Jepara Regency (IDR 2,610,224 in 2025)	(1) Below minimum wage; (2) Equivalent to minimum wage; (3) Above minimum wage	j
17.	Legality of Conservation Area Regulations	More effective regulations indicate higher sustainability	(1) None; (2) Exists, not functioning; (3) Exists, functioning	h
18.	Effectiveness of Monitoring and Supervision	Routine monitoring and surveillance indicate higher sustainability	(1) None; (2) Exists, less effective; (3) Exists, effectively functioning	h
19.	Institutional Conflict	Higher institutional conflict indicates lower sustainability	(1) Occurs frequently (> 30%); (2) Occurs occasionally; (3) Never occurs	j
20.	Optimization of Human Resource Governance	More optimal governance indicates higher sustainability	(1) None; (2) Exists, not optimally functioning; (3) Exists, optimally functioning	l
21.	Clarity and Authority of Marine Area Boundaries	Clear and well-defined authority over boundaries indicates higher sustainability	(1) None; (2) Exists, unclear; (3) Exists and clear	m

Notes: Index sources are:
a (Nurfiarini et al., 2016),
b (Verdadero et al., 2017),
c (Rahmawati et al., 2019),
d (Bachtiar et al., 2019),
e (Giyanto et al., 2023),
f (Makawaehe et al., 2021),
g (Giyanto et al., 2023),
h (Nisak et al., 2024),
i (Najmi et al., 2020),
j (Hidayah et al., 2020),
k (Nurrochmah and Falatehan, 2024),
l (Pitcher et al., 1999),
m (Mubarak et al., 2024).

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RESULTS

Panjang Island, a 21.1-hectare island in Jepara, Central Java, serves as a Coastal and Small Islands Conservation Area (KKP3K) and a vital economic hub for local communities through fishing and tourism (table 4). While its coral reef ecosystem plays a crucial role in maintaining marine ecological balance and supporting local livelihoods, the island is currently under significant pressure from human activities, leading to ecosystem degradation and reduced reef sustainability. These pressures are exacerbated by ongoing fishing activities, the establishment of fixed lift nets (*bagan tancap*) around the island, and intensive boat traffic and tourism. To address these challenges, adaptive management strategies are required, supported by RAPFISH analysis to assess the overall sustainability status of the coral reef ecosystem.

Table 4. Modal values of attribute scores

No.	Attribute	Attribute Score
	Ecological	
1.	Temperature	3 (28 - 30 °C)
2.	Hard Coral Cover (HCC)	1 (≤ 21%)
3.	Macroalgae Cover (MC)	3 (< 10%, low)
4.	Sand Cover (SC)	4 (0 - 24%)
5.	Rubble Cover (RC)	3 (25 - 49%)
6.	Other Cover (OTC)	3 (6 - 15 colonies)
7.	Coral Recruitment (CR)	4 (0 - 24%)
8.	Coral Diversity Index (HC)	2 (1 < H’ ≤ 3)
9.	Fish Diversity Index (HF)	2 (1 < H’ ≤ 3)
10.	Fish Biomass (W)	1 (< 970 kg/Ha)
	Social	
1.	Social Networking	3 (exists, active)
2.	Community Participation	1 (not participative)
3.	Social Conflict	3 (absent)
	Economical	
1.	Dependence on Tourism	1 (low, < 25%)
2.	Dependence on Coastal and Marine Resources	3 (high, > 50%)
3.	Household Income	1 (below minimum wage)
	Institutional	
1.	Legality of Conservation Area Regulations	3 (exists, implemented)
2.	Effectiveness of Monitoring and Supervision	2 (exists, not optimal)
3.	Institutional Conflict	3 (never occurred)
4.	Optimization of Human Resource Governance	2 (exists, not optimal)
5.	Clarity of Marine Area Zoning Authority	2 (exists, unclear)

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Table 5. Reef fish biomass data

Site	Fish Species	Total	Length (cm)	Biomass (kg/ha)	Total Biomass (kg/ha)
Reef Flat – Core Zone	*Abudefduf bengalensis*	6	5 - 10	8.872	16.213
	Acreichthys tomentosus	2	11 - 15	4.172	
	Aeoliscus strigatus	2	11 - 15	0.597	
	Chaetodon octofasciatus	2	1 - 10	0.494	
	Gerres filamentosus	1	5 - 10	0.280	
	Gerres oyena	2	5 - 10	0.541	
	Halichoeres nigrescens	1	5 - 10	0.226	
	Pomacentrus brachialis	2	5 - 10	1.032	
Reef Slope – Core Zone	*Abudefduf bengalensis*	6	5 - 15	10.75	72.1
	Abudefduf sexfasciatus	4	5 - 15	8.01	
	Aeoliscus strigatus	8	11 - 15	2.39	
	Cephalopholis miniata	1	1 - 10	11.50	
	Chaetodon octofasciatus	5	11 - 15	1.90	
	Halichoeres argus	1	11 - 15	0.83	
	Halichoeres nigrescens	6	5 - 15	3.70	
	Pomacentrus brachialis	6	5 - 15	2.06	
	Pomacentrus chrysurus	4	5 - 10	2.40	
	Scolopsis ciliata	1	16 - 20	5.05	
	Siganus javus	3	16 - 20	23.51	
Reef Flat – Rehabilitation Zone	*Abudefduf bengalensis*	2	11 - 15	4.83	11.87
	Aeoliscus strigatus	4	11 - 15	1.19	
	Dischistodus prosopotaenia	1	11 - 15	1.30	
	Halichoeres nigrescens	2	5 - 15	1.23	
	Ostorhinchus margaritophorus	3	1 - 10	0.21	
	Pomacentrus brachialis	6	5 - 15	3.10	
Reef Slope – Rehabilitation Zone	*Abudefduf bengalensis*	4	11 - 15	9.66	37.48
	Abudefduf vaigiensis	2	5 - 10	1.10	
	Aeoliscus strigatus	4	11 - 15	1.19	
	Amphiprion biaculeatus	2	1 - 15	2.57	
	Caesio cuning	4	5 - 10	18.53	
	Chaetodon octofasciatus	3	5 - 15	1.41	
	Halichoeres nigrescens	3	5 - 10	1.46	
	Pomacentrus brachialis	3		1.55	

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Continued. Table 5

Site	Fish Species	Total	Length (cm)	Biomass (kg/ha)	Total Biomass (kg/ha)
Reef Flat – Limited Utilization Zone	*Abudefduf bengalensis*	1	5 - 10	0.54	3.81
	Aeoliscus strigatus	12	5 - 15	1.73	
	Halichoeres bicolor	1	5 - 10	0.48	
	Pomacentrus brachialis	2	5 - 10	1.03	
	Pomacentrus tripunctatus	1	1 - 5	0.03	
Reef Slope – Limited Utilization Zone	*Aeoliscus strigatus*	6	11 - 15	1.79	9.97
	Abudefduf sexfasciatus	2	5 - 10	1.10	
	Chaetodon octofasciatus	1	1 - 5	0.02	
	Epinephelus merra	1	11 - 15	0.12	
	Gerres oyena	1	5 - 10	0.27	
	Pomacentrus brachialis	6	1 - 10	2.11	
	Pomacentrus tripunctatus	2	1 - 5	0.05	
	Halichoeres nigrescens	2	5 - 10	0.48	
	Siganus javus	1	16 - 20	4.01	

Coral reef fish biomass at Panjang Island showed a tendency toward higher values in zones with greater coral cover (Table 5). According to Ritonga et al. (2022), there is a positive correlation between live coral cover percentage and reef fish biomass. The data indicate the presence of fish families such as *Chaetodon* (corallivorous), Pomacentridae (major reef fish), and target fish groups such as the Caesionidae family. Furthermore, Suyatna et al. (2019) reported that Pomacentridae and Chaetodontidae are the most dominant families in coral reef ecosystems based on species richness, while Caesionidae is commercially important as a food fish.

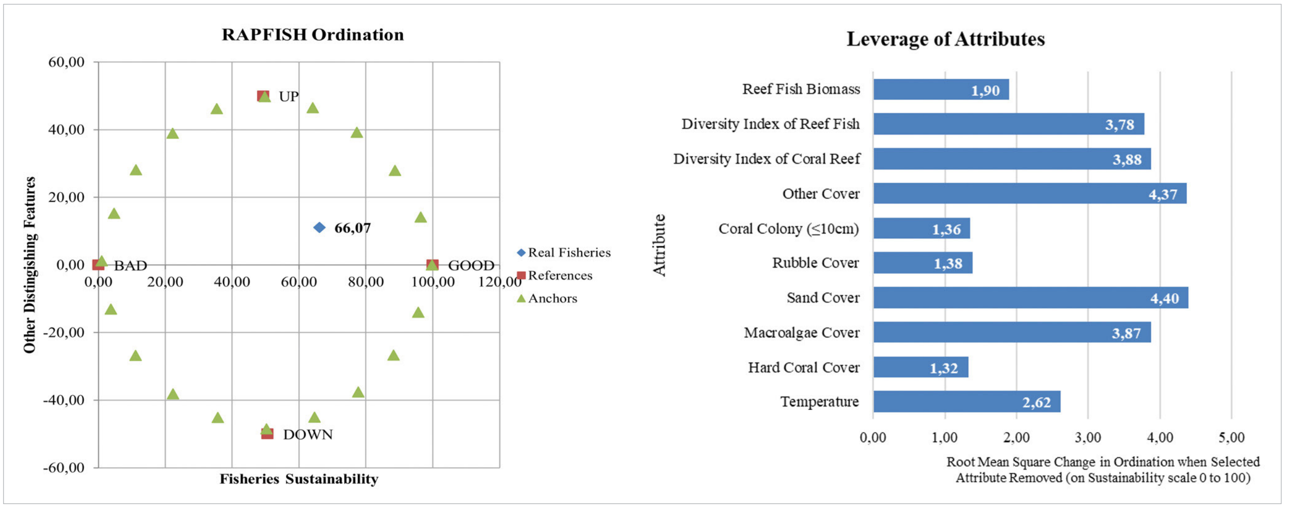

Fig 2. Index value and leverage value of the ecological dimension

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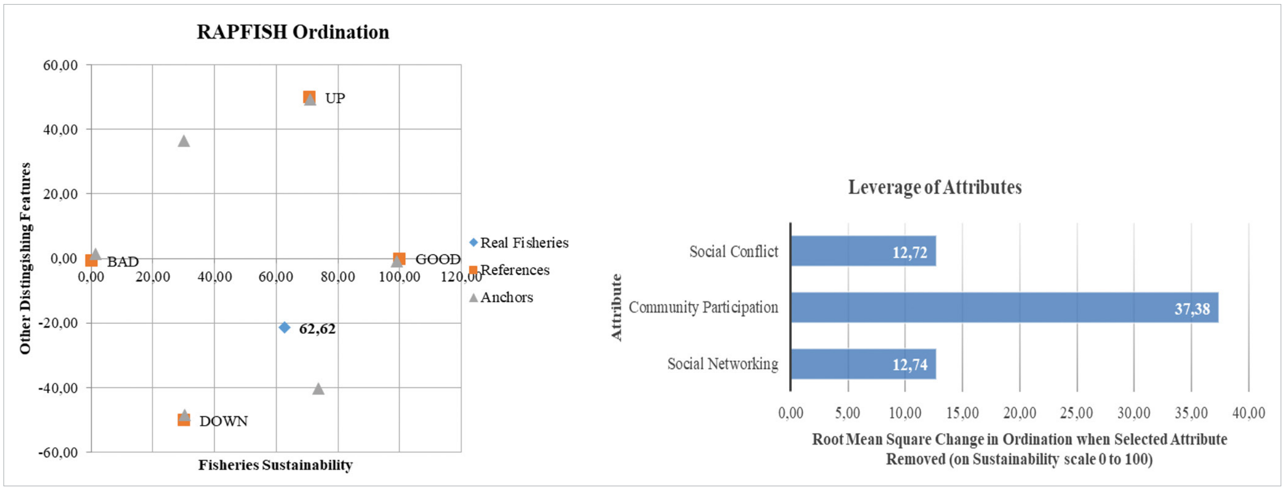

Fig 3. Index value and leverage value of the social dimension

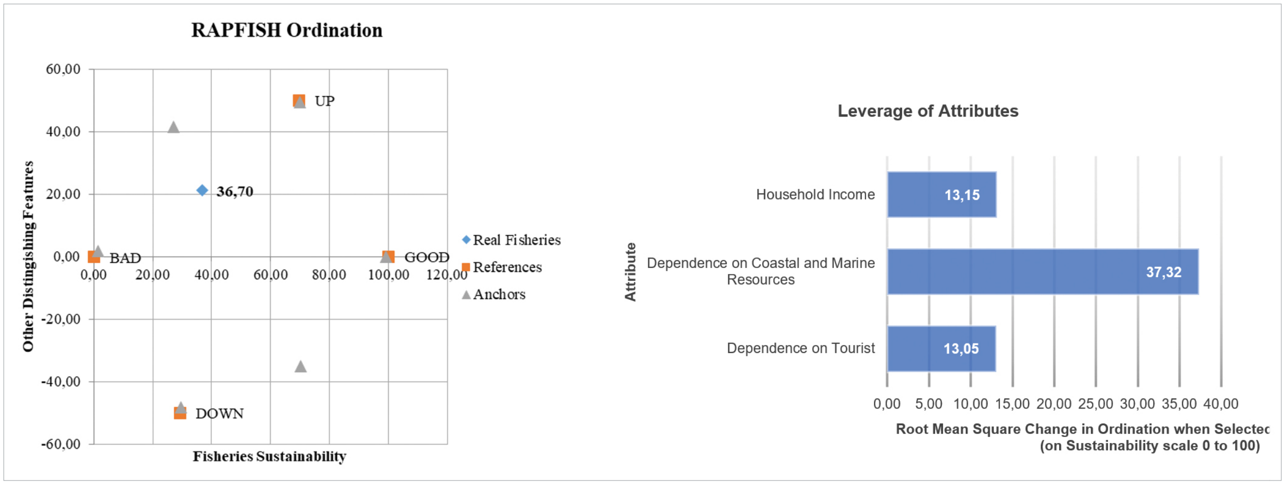

Fig 4. Index value and leverage value of the economic dimension

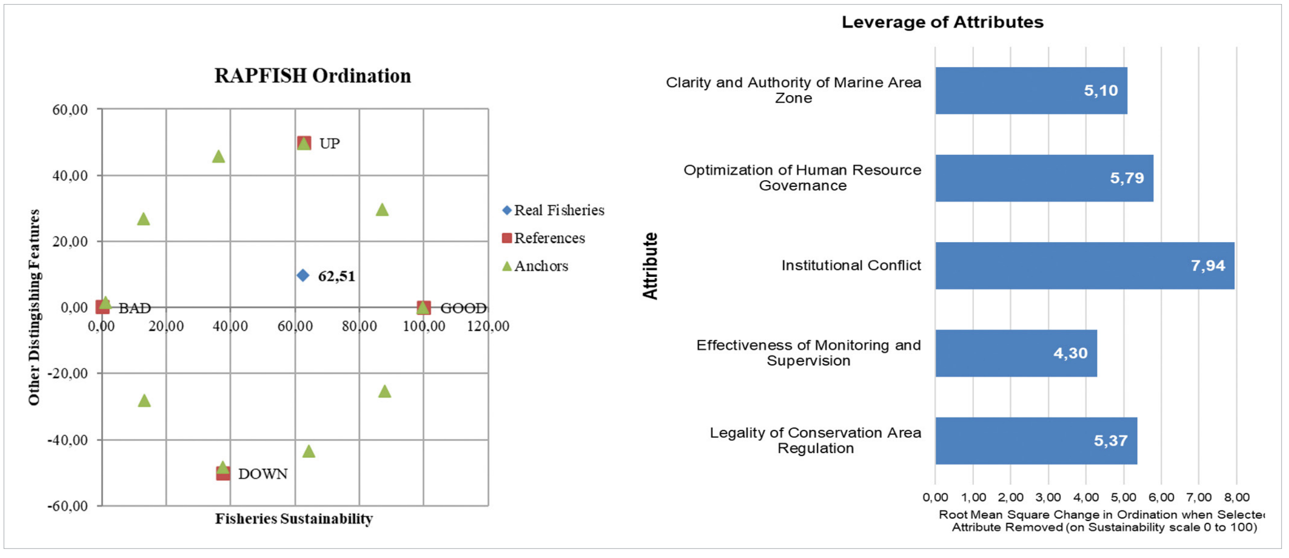

Fig 5. Index value and leverage value of the institutional dimension

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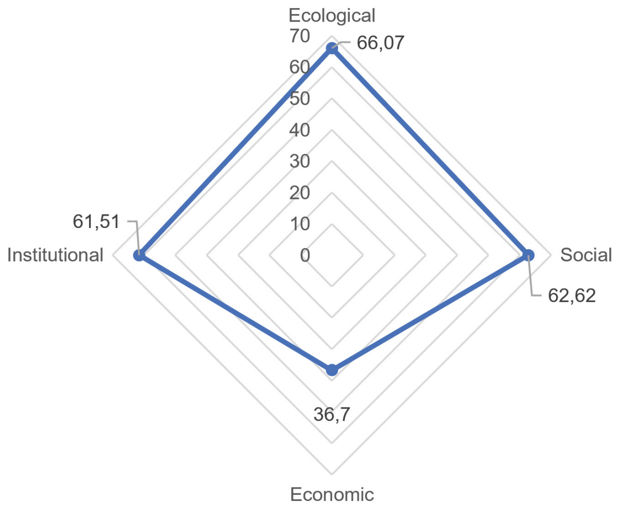

Fig 6. Coral reef ecosystem sustainability diagram of Panjang Island, Jepara

DISCUSSION

The sustainability status of the coral reef ecosystem on Panjang Island was categorized as poor to less sustainable. The ecological dimension was considered sufficiently sustainable, with sand cover identified as the most sensitive attribute. The sensitivity between suppressive and supportive indicators illustrates a complex interaction within the ecosystem. Sand cover inhibits coral growth and reduces ecosystem sustainability. Mu'thi et al. (2025) reported that sand causes ecosystem instability because it is easily transported by currents, making it difficult for coral larvae to attach.

The social dimension showed a sufficiently sustainable status, influenced by a predominantly unparticipative community. Meanwhile, the existence and functioning of social networks and the absence of social conflict acted as supportive indicators that required further attention. This condition requires balance by encouraging active participation in social networks and transforming minimal conflict into collaboration among stakeholders. According to Matulessy et al. (2024), collaboration among all stakeholders is an effective strategy to broaden participation and support long-term conservation sustainability, benefiting the ecosystem and surrounding communities.

The economic dimension supporting the sustainability status of coral reefs on Panjang Island showed a less sustainable condition. The attribute that most influenced sustainability was dependence on natural resources. Although the community largely consisted of traditional fishermen who predominantly used selective fishing gear, excessive dependence on these resources, when not balanced with conservation efforts, could reduce the sustainability of coral reef ecosystems. According to Siry et al. (2013), intensive resource utilization in coral reef ecosystems without adequate conservation of ecological functions can reduce biodiversity.

The institutional dimension on Panjang Island was categorized as sufficiently sustainable; however, institutional conflicts and human resource governance remained sensitive issues. The community had a limited understanding of conservation area boundaries and perceived supervision as inadequate. This situation was exacerbated by the inactivity of community monitoring groups (Pokmaswas) and funding constraints. Comprehensive socialization regarding boundary delineation, human resource capacity building, and financial support was required to enhance active community participation in adaptive conservation management. According to Maruapey et al. (2023), strategic interests in coastal areas require clear institutional arrangements and authority to effectively address coastal issues and achieve integrated coastal management and sustainable preservation. This condition highlights the need for alternative livelihoods to support local economies, considering that community income around Panjang Island tended to be below the regional minimum wage and highly dependent on natural resources. Intensive resource utilization poses a significant threat to ecosystem sustainability. Therefore, awareness among fishermen must be increased to encourage the adoption of alternative livelihoods and reduce dependence solely on capture fisheries (Zuhry et al., 2023).

Overall, the sustainability assessment of Panjang Island indicated moderate performance in the ecological, social, and institutional dimensions, but low performance in the economic dimension. This finding suggests the need to balance resource utilization with coral reef rehabilitation, strengthen social networks and monitoring systems, and enhance community engagement. Developing local economic alternatives and promoting sustainable livelihoods are essential for long-term island sustainability. In addition to improving coral reef management, maintaining a healthy local environment is crucial for achieving long-term, self-sustaining, and functional restoration success (Fattah et al., 2023).

CONCLUSION

The present study found that the coral reef ecosystem on Panjang Island experienced degradation and was currently in fair condition due to various pressures. These pressures were mainly driven by local human activities and reflected critical weaknesses in the ecosystem's sustainability status. Analysis of the ecological, social, and institutional dimensions indicated a sufficiently sustainable status. However, the economic dimension was classified as less sustainable. This condition was primarily due to the high dependence of the local community on the ecosystem and low-income levels. These findings highlight the urgent need for alternative livelihood options and synergistic, holistic management strategies that prioritize improving local economic opportunities. Such an integrated approach is essential to achieving balanced and truly sustainable coral reef management on Panjang Island.

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

DATA AVAILABILITY STATEMENT

The datasets generated and/or analysed during the current study are not publicly available but are available from the corresponding author on reasonable request.

PROCJENA ODRŽIVOSTI EKOSUSTAVA KORALJNOG GREBENA NA OTOKU PANJANG, JEPARA, SREDIŠNJA JAVA

SAŽETAK

Otok Panjang, Jepara zaštićeno je područje smješteno u sjevernom dijelu pokrajine Jepara u središnjoj Javi, gdje se gospodarstvo lokalne zajednice temelji na ulovu ribe i turizmu. Međutim, ljudske aktivnosti i promjene u okolišu degradirale su ekosustav koraljnih grebena, ugrožavajući održivost otoka i izvore prihoda lokalnog stanovništva. Cilj ove studije bio je procijeniti status održivosti otoka Panjang na temelju različitih dimenzija zbog značajnih pritisaka. Korištena je deskriptivna kvantitativna metoda. Opažanja ekoloških varijabli, kao što su pokrivenost koralja i regrutacija, provedena su metodom linijskih transekata (*line-intercept transect*), dok su ribe na grebenima istraživane metodama podvodnog vizualnog popisa (*underwater visual census*), a indeksi bioraznolikosti izračunati su ručno (*by hand*). Društvene, ekonomske i institucionalne dimenzije procijenjene su putem intervjua i fokus grupa. Iako su ekološke, institucionalne i društvene dimenzije umjereno održive, glavni nalaz ukazuje na to da gospodarska dimenzija ostaje manje održiva. Poboljšanje sudjelovanja u zajednici, upravljanja i programa jačanja kapaciteta ključno je za podršku održivom korištenju resursa i dugoročnu zaštitu ekosustava otoka. Ovi nalazi naglašavaju hitnu potrebu za sinergijskim i holističkim strategijama upravljanja koje daju prednost poboljšanju lokalnih gospodarskih mogućnosti. Takav integrirani pristup ključan je za postizanje uravnoteženog i istinski održivog upravljanja koraljnim grebenima na otoku Panjang.

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