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MACROZOOBENTHOS DIVERSITY IN THE FISHERIES MANGROVE ECOTOURISM AREA IN PULAU BANYAK VILLAGE LANGKAT DISTRICT

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ABSTRACT: Mangroves are important ecosystems located in tidal areas and become habitats for various types of biota, including macrozobenthos. Macrozobenthos is a group of animals that inhabit the bottom waters of mangrove ecosystems. This study aims to analyze the diversity of macrozobenthos species in the mangrove ecotourism area of Pulau Banyak village, Langkat Regency, North Sumatra. This research was conducted from October 2022 to October 2023 in the fisheries-based mangrove ecotourism area in Pulau Bayak village, Langkat Regency. The research location was divided into three research stations. Macrozobentos observations were made once a month. Sample collection is done by collecting directly by hand, the samples collected are on the sample map (plot) measuring 1 x 1 meter making as many as 10 pieces for every 100 m2. Data were analyzed using the Paleontological Statistic (PAST) Version 4.0 tool. Parameters studied include diversity index, evenness, species richness, and dominance. Based on the results of the analysis, it is known that the diversity index is in the medium category with a value of 2.4-2.5, while the evenness index is in the high category with a value of 0.91 - 0.92, then the species richness index is in a low category with a value of 2.20 - 2.22 and the dominance index shows that there are no certain species that dominate this ecosystem with an index value close to 0. Thus, it can be concluded that this fisheries-based mangrove ecotourism area is in good condition and can support the lives of organisations associated with mangrove ecosystems.
Keywords: macrozoobenthos, ecotourism, mangrove ecosystem, diversity, dominance.

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INTRODUCTION

Mangrove forests, found along coastlines and river mouths, are characterized by dense vegetation like *Rhizophora apiculata* and *Xylocarpus granatum*, providing essential habitats for macrozoobenthos and serving as feeding, nursery, and spawning grounds for various fauna (Kresnasari et al. 2022; Sari et al. 2022). Macrozoobenthos are organisms that inhabit the bottom of water bodies, including mangrove ecosystems, where they play crucial roles in nutrient cycling and ecosystem health (Destiana et al., 2022; Kresnasari et al., 2022; Saragih et al., 2024; Sari et al., 2022). These organisms, such as gastropods and bivalves, interact with

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their environment in complex ways, serving as bioindicators of habitat quality and responding to environmental changes (Destiana et al., 2022; Sari et al., 2022).

The abundance and diversity of macrozoobenthos in mangrove ecosystems are influenced by environmental factors like water quality, sedimentation, and food availability, making them valuable indicators of ecosystem health and functioning (Kresnasari et al., 2022; Saragih et al., 2024). Macrozoobenthos in mangrove forests play crucial ecological roles by contributing to the decomposition process of mangrove plant litter (Kresnasari et al., 2022), enhancing energy flow and nutrient cycling (Peng et al., 2023), and maintaining the health and functioning of the ecosystem (Checon et al., 2023). These organisms, which include a diverse array of species living in the muddy sediments and among mangrove roots, help stabilize the habitat by their presence and activities (Checon et al., 2023).

Factors influencing macrozoobenthos diversity in mangrove forests include mangrove density, stand age, habitat degradation, and management conditions. Research indicates a correlation between mangrove density and macrozoobenthos density, with a negative relationship observed (Tony et al., 2024). Stand age of mangroves also plays a role, as macrobenthos abundance increases with mangrove stand age, while diversity indices may show negative correlations (Wang et al. 2018). Habitat degradation poses a threat to macrozoobenthos diversity, with decreasing abundance and potential extinction risks in degraded ecosystems (Lismarita et al., 2022). Additionally, the community assemblage of macrozoobenthos is associated with mangrove management conditions, with significant differences observed between planted and natural mangroves, highlighting the importance of restoration efforts in maintaining diverse macrozoobenthic communities (Basyuni et al., 2022; Pan et al., 2021).

Macrozoobenthos in mangrove forests hold significant economic value through their role in supporting ecosystem services. Studies in various locations such as Brebes Regency, Central Java (Sinaga et al., 2019), North Sumatra (Basyuni et al., 2018), and Dumai waters (Sari et al., 2022) have highlighted the abundance and diversity of macrozoobenthos, including gastropods and bivalves. These organisms contribute to the ecological balance, indicating the health of the mangrove ecosystem. The relationship between macrozoobenthos abundance and mangrove density has been emphasized, showing a strong correlation (Nihan et al., 2022). Furthermore, the habitat characteristics that support macrozoobenthos life, such as salinity, temperature, and dissolved oxygen, have been identified as crucial factors (Basyuni et al., 2018). Overall, the economic value of macrozoobenthos in mangrove forests lies in their contribution to biodiversity, nutrient cycling, and supporting local fisheries, which highlights the importance of conserving these ecosystems to obtain sustainable economic benefits. the condition of the mangrove forest of Pulau Banyak village which is overgrown with various types of mangrove species makes this area rich in nutrients that can be utilised by various other organisms for their lives. Thus, it is necessary to conduct research that can provide information related to the diversity of macrozoobenthos species in this area so that it can be used as a basis for future development and protection of mangrove forests.

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METHOD

This study was conducted in a fisheries-based mangrove ecotourism area in Pulau Banyak village, Langkat Regency, North Sumatra Province (Figure 1). Markozoobenthos sampling was conducted in May-July 2023 where observations were made once a month. Markozoobenthos samples were collected using the quadrat method by making a 1 x 1-meter plot with 15 replicates (Figure 2). Samples that have been collected are then washed until clean and put into plastic for identification. Identification of macrozoobenthos species refers to (Abbott & Dance, 2000; Charpenter & Niem, 1998).

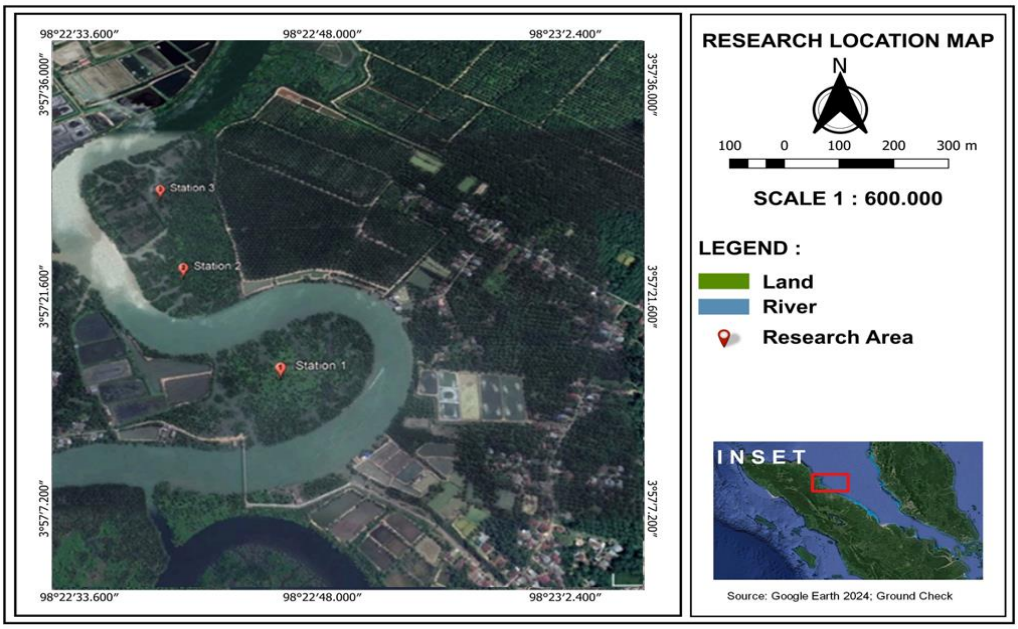

Figure 1. Map Research Location

Research data analysis was carried out using several analysis techniques as follows:

Diversity Index (H')

The calculation of the diversity index is based on the Shannon - Wienner index (Krebs, 1989).

$$H' = -\sum_{i=1}^{s} (pi \ln pi) \qquad (1)$$

Where:
H' = Shannon-Wiener diversity index
S = Number of species
Pi = Number of individuals of each type (i=1,2,3...)
With H' values:
0<H'<2,3,02 = low diversity
2,302<H'<6,907 = moderate diversity
H'>6,907 = high diversity

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Evennes Index (E)

The species evenness index refers to the Pielow evenness indices formula (Ludwigs & Reynolds, 1988) namely:

$$E=H' \ln S \quad (2)$$

Where:
E = (Evennes Index)
H' = (Diversity Index Shannon-Wienner)
S = (Total of species)
With E values:
$0.00 < E \leq 0.30$ = Low
$0.30 < E \leq 0.60$ = Moderate
$E > 0.60$ = High

Margalef Index (R_1)

The species richness index uses the Margalef formula (Magurran, 1988) namely:

$$R_1=\frac{(S-1)}{(\ln(N)} \quad (3)$$

Where:
R_1 = Margalef Index
S = Number of species
N = Total number of individuals observed
Ln = Natural logarithm
With criteria:
Dmg < 3.5 = then the species richness is low,
3.5 < Dmg < 5 = then species richness is medium and
Dmg > 5 = then high species richness

Dominance Index (C)

The dominance index is used to obtain information about the dominating species in a community. The formula is as follows (Odum & Barrett, 2005):

$$C=\sum_{i=1}^{s}\left(\frac{ni}{n}\right)^2 \quad (4)$$

Where :
C = Index of dominance
Ni = value of each species (number of i-th individual)
N = total value of all species (total number of individuals that have been found)

The dominance index value ranges from 0-1. An index of 1 indicates that dominance by one species is very high (only one species is at a station). An index of 0 means that none of the species found dominate.

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RESULT AND DISCUSSION

The results of the identification of macrozoobenthos species in the mangrove fisheries ecotourism area in Pulau Banyak village, Langkat district known there are 14 species consisting of 3 classes namely Bivalvia, gastropods, and malacostraca as presented in Table 1.

Table 1. Macrozoobenthos Species Caught at The Research Site

Class	Species	ST1	ST2	ST3	IUCN Status
Bivalva	*Pharella acutidens*	+	+	+	No data
	Galuconome virens	+	+	+	No data
	Geloina erosa	+	+	+	No data
	Geloina expansa	+	+	+	No data
Gastropoda	*Telescopium telescopium*	+	+	+	Least concern
	Telebralia sulcata	+	+	+	No data
	Neritina turrita	+	+	+	Least concern
	Neritina semonica	+	+	+	No data
	Faunus ater	+	+	+	Least concern
	Cassidula aurisfelis	+	+	+	Least concern
	Cassidula nucleus	+	+	+	No data
Malacostraca	*Scylla serrata*	+	+	+	No data
	Uca forcipata	+	+	+	No data
	Uca vocans	+	+	+	No data

*Note : ST = Sampling station; (+) = Found

Based on Shannon Wiener analysis, it is known that the value of H' ranges from 2.545 to 2.552 in the medium category as presented in Table 2.

Table 2. The Value of The Diversity Index (H') at Each Research Station

Sampling site	H’	Category
1	2.545	Moderate
2	2.552	Moderate
3	2.552	Moderate

The diversity index of macrozoobenthos in mangrove ecosystems varies across different locations and seasons, reflecting the dynamic nature of these habitats. Studies in various regions such as Bagan Asahan Village (Saragih et al., 2024), Lawas, Sarawak (Al-Asif et al., 2023), East Java (Retnaningdyah et al., 2023), Mempawah regency (Destiana et al., 2022), and Aceh Singkil (Octavina et al., 2018) have shown moderate to high diversity indices ranging from 1.49 to 4.37. The diversity of macrobentos in mangrove ecosystems is influenced by various environmental factors, including seasonal variations, habitat degradation, and ecological conditions. Research indicates that macrozoobenthos diversity is affected by the physical, chemical, and biological properties of water, with studies showing moderate diversity indices in different mangrove areas, suggesting stable yet vulnerable ecosystems (Destiana et al., 2022; Saragih et al., 2024). Seasonal changes significantly impact macro-benthos density and diversity, with higher abundance observed post-monsoon due to stable sediment conditions and increased

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food availability, while monsoon periods lead to erosion and higher turbidity, negatively affecting diversity (Khatun et al., 2023). Additionally, habitat degradation poses a threat to macrozoobenthos, potentially leading to decreased abundance and extinction risks (Lismarita et al., 2022).

The value of the evenness index is 0.91-0.92, the species richness index is 2.20-2.22, and the dominance index is 0.083-0.085 as presented in Table 3.

Table 3. Value of Evennes Index, Margalef Index, and Dominance index

Index	Research Station			Category
	1	2	3	
Evannes	0.91	0.91	0.92	high
Margalef	2.21	2.22	2.20	low
Dominance	0.085	0.083	0.083	no one dominates

The type richness index, evenness, and dominance of macrozoobenthos in mangrove ecosystems exhibit significant variability influenced by environmental conditions. In Bagan Asahan Village, macrozoobenthos diversity was classified as moderate (H' = 1.54-2.01), with a stable evenness index (E = 0.76-0.99) and low dominance (C = 0.14-0.31) (Saragih et al. 2024). In contrast, a study in a sub-tropical mangrove estuary revealed a higher density of macro-benthos post-monsoon, with significant seasonal variations in diversity indices, indicating that environmental factors like sediment stability and food availability play crucial roles (Khatun et al. 2023). Additionally, research in Totobo Village found a high diversity index (H' = 3.07) and low dominance (C = 0.01), suggesting a balanced ecosystem (Purnama et al. 2024). These findings highlight the complex interplay between ecological factors and macrozoobenthos community structure, emphasizing the need for ongoing monitoring to understand these dynamics better (Ramadhani et al., 2023; Sari et al., 2022).

The value of the type richness index, evenness, and dominance of macrozoobenthos in mangrove ecosystems is influenced by several interrelated factors. Environmental conditions, such as water quality, sediment characteristics, and food availability, play a crucial role. For instance, studies indicate that macrozoobenthos abundance is significantly affected by total suspended solids (TSS), which relate to food availability, and the overall quality of water and soil, which must meet marine life standards (Kresnasari et al., 2022). Additionally, seasonal variations impact macrozoobenthos diversity and abundance, with higher densities observed post-monsoon due to stable bottom conditions and increased food availability (Khatun et al., 2023). The community structure also varies between rehabilitated and non-rehabilitated mangrove areas, affecting species richness and abundance (Dewiyanti et al., 2021). Overall, these findings suggest that both abiotic factors and habitat management practices are critical in shaping macrozoobenthos community dynamics in mangrove ecosystems (Dewiyanti et al., 2021; Khatun et al., 2023; Saragih et al., 2024).

CONCLUSSION

Based on the research results, it can be concluded that the condition of the mangrove ecosystem in the fisheries-based mangrove ecotourism area is good and balanced, and can support the life of the association organisms in it.

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RECOMENDATION

Further research related to mangrove biota diversity needs to be carried out in other areas, in an effort to develop mangrove ecotourism areas in North Sumatra.

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