

Abundance of macrozoobenthos in seagrass beds in the waters of Tihi-Tihi Village, Bontang City, East Kalimantan

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ARTICLE INFO

Research Article

Article history:

Received June 3, 2025

Received in revised form June 20, 2026

Accepted July 17, 2026

DOI: <https://doi.org/10.30872/2fcg5e90>

Keywords: macrozoobenthos, seagrass beds, Tihi-Tihi Village, Bontang City



ABSTRACT

Macrozoobenthos are benthic organisms larger than 1.0 mm that live on or within the seabed by crawling, burrowing, attaching, or embedding themselves in the substrate. This study investigated macrozoobenthos abundance and community characteristics in seagrass beds in the waters of Tihi-Tihi Village, Bontang City, East Kalimantan, from November 2024 to January 2025. Sampling was conducted at four stations using 50 × 50 cm quadrats and purposive sampling along transects extending from the lowest tidal level toward the subtidal zone. The analysis included species composition, abundance, Shannon–Wiener diversity, evenness, Simpson dominance, seagrass density, and the relationship between seagrass density and macrozoobenthos abundance. Thirty macrozoobenthos species belonging to five classes (Asteroidea, Bivalvia, Echinoidea, Gastropoda, and Holothuroidea) were recorded. Four seagrass species were identified: *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila ovalis*, and *Cymodocea rotundata*. *Strombus urceus* was the most abundant species, with reported values of 228–280 individuals m^{-2} across the stations, whereas *Cypraea (Erronea) ovum palauensis* and *Angaria delphinus* had the lowest reported abundance, at 4 individuals m^{-2} each. Total macrozoobenthos abundance was highest at the southern station (892 individuals m^{-2}) and lowest at the northern station (648 individuals m^{-2}). The diversity index ranged from 2.132 to 2.231, indicating moderate diversity, while mean evenness was 0.646 and mean dominance was 0.176, indicating moderate evenness and low dominance. Seagrass density showed a very strong positive correlation with macrozoobenthos abundance ($r = 0.97$).

INTRODUCTION

Seagrass beds are important and highly productive shallow-water ecosystems that support ecological balance and provide habitat for a wide range of aquatic organisms (Haryati et al., 2021). They provide shelter or nursery grounds, feeding grounds, and spawning grounds for marine organisms, making them important habitats for the maintenance of coastal biodiversity (Wijaya et al., 2019 in Astutik et al., 2021).

Therefore, this study aimed to determine the composition and abundance of macrozoobenthos associated with seagrass beds in the waters of Tihi-Tihi Village, Bontang City, East Kalimantan, and to assess their diversity, evenness, and dominance. The study also evaluated seagrass density and examined the relationship between seagrass density and macrozoobenthos abundance. The results are expected to

provide baseline information for understanding the ecological condition of the seagrass ecosystem in Tihi-Tihi Village.

The waters of Tihi-Tihi Village, Bontang City, East Kalimantan, contain seagrass habitats that support diverse benthic organisms. However, the composition and abundance of macrozoobenthos can vary among locations because of differences in seagrass density, substrate characteristics, and water-quality conditions. Examining these differences is therefore important for understanding the ecological characteristics of the seagrass beds in this area.

The interaction between seagrass and macrozoobenthos is particularly important in seagrass ecosystems. Seagrass structure can provide shelter from currents and predators and can also contribute to food availability for benthic organisms. Consequently, the abundance and distribution of macrozoobenthos may reflect the condition of the surrounding habitat. Macrozoobenthos abundance is also associated with organic matter and environmental quality, so changes in their communities can provide useful information about ecosystem conditions (Ningsih et al., 2020).

Macrozoobenthos are organisms that live on or within the bottom substrate and may attach to, crawl over, or burrow into the sediment (Astutik et al., 2021). Because they remain closely associated with the seabed, their occurrence and abundance are influenced by both biotic and abiotic environmental conditions. Important environmental factors include temperature, water depth, current velocity, salinity, dissolved oxygen (DO), and pH (Devi et al., 2019).

METHODOLOGY

Study Period and Location

The study was conducted from November 2024 to January 2025 in the waters of Tihi-Tihi Village, Bontang City, East Kalimantan. Macrozoobenthos abundance was sampled at four stations using 50×50 cm quadrats. Data collection used purposive sampling following a purposive random sampling approach.

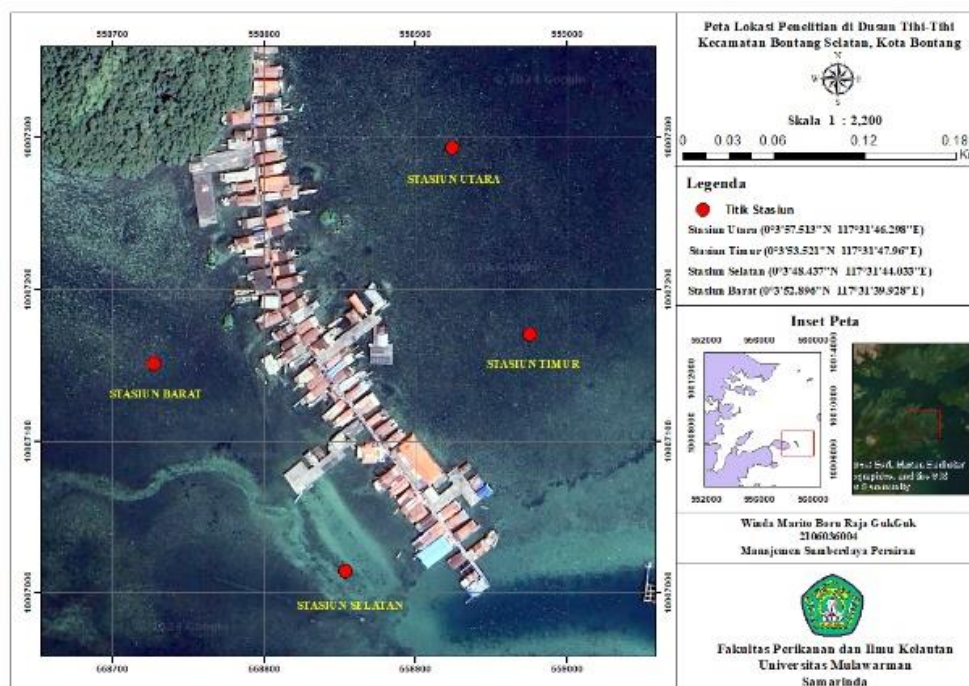


Figure 1. Study Location

Materials and Equipment

Table 1. Materials and Equipment Used

No.	Materials and Equipment	Purpose
1.	Ekman grab	For collecting macrozoobenthos samples
2.	DO meter	For measuring dissolved oxygen (DO)
3.	Water checker	For measuring standard water quality parameters
4.	Quadrant 50 cm x 50 cm	For defining the sampling area
5.	Vernier caliper	For measuring macrozoobenthos length and width
6.	GPS	For determining sampling coordinates
7.	Speedtech	For measuring water depth
8.	Shovel	For assisting sample collection
9.	2-L water container	For storing water samples
10.	Writing materials	For recording observations
11.	Sample bags	For storing samples
12.	Camera	For taking photographs
13.	Sediment core (PVC pipe)	For collecting substrate
14.	Macrozoobenthos	Study object
15.	Seagrass	Study object

Research Procedures

Macrozoobenthos Sampling

The purposive sampling method was used by establishing one transect line perpendicular to the shoreline, extending from the lowest tide level to the subtidal area. Three points and three replicates were established at 15-day intervals during low tide. Macrozoobenthos and seagrass samples were collected using 50 × 50 cm quadrats. Macrozoobenthos occurring on the substrate surface were collected directly.

Seagrass Observation

The seagrass observation method followed the guidelines of Ministerial Decree of the State Minister for the Environment No. 200 of 2004. A 50 cm × 50 cm quadrat was used as the sampling unit. The transect line was established from the lowest shoreline area toward the subtidal zone. Sampling was conducted by placing the quadrat frame perpendicular to the shoreline in the seaward direction at regular intervals. The number and species of seagrass within each quadrat were recorded.

Environmental Parameter Measurements

Water parameters were measured as supporting data to describe conditions at the study sites. In situ measurements included temperature, salinity, pH, DO, depth, turbidity, and current velocity. Nitrate and orthophosphate were analyzed ex situ at the Water Quality Laboratory, Faculty of Fisheries and Marine Sciences.

Sediment Sampling

Substrate samples were collected using a sediment core, placed in sample bags, and analyzed at the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University.

Community Structure Analysis

Macrozoobenthos abundance was calculated using the following equation (Cholid et al., 2023):

$$D_i = \frac{n_i}{A}$$

where:

D_i = Density of species i (individuals m^{-2})

n_i = Total number of individuals of species i

A = Sampled area (m^2)

Macrozoobenthos evenness was calculated using the Evenness Index equation of Odum (1998) cited in Yasir (2017):

$$E = H' / \ln S = H' / H'_{\max}$$

where:

E = Evenness index

H' = Diversity index

Hmax = Maximum diversity (ln S)

S = Total number of species recorded

The diversity index was calculated using the Shannon–Wiener equation according to Fachrul (2007) cited in Maula (2018):

$$H' = - \sum p_i \ln p_i$$

where:

H' = Diversity index

p_i = Proportion of individuals of species i (n_i/N)

n_i = Number of individuals of species i

N = Total number of individuals of all species

Dominance was calculated using Simpson's Dominance Index (Odum, 1998 cited in Yasir, 2017):

$$C = \sum (n_i/N)^2$$

where:

C = Dominance index

n_i = Number of individuals of species i

N = Total number of individuals of all species

Seagrass density was calculated using the following equation (Putra, 2014 cited in Sholihah, 2020):

$$K = \sum n_i / A$$

where:

K = Seagrass density (stands m^{-2})

$\sum n_i$ = Total number of seagrass individuals of species i

A = Sampled area (m^2)

The Pearson correlation equation was used to evaluate the relationship between seagrass density and macrozoobenthos abundance (Sugiyono, 2013 cited in Mustafa, 2023):

$$r_{xy} = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

where:

r = Correlation coefficient between variables x and y

x = Seagrass density

y = Macrozoobenthos abundance

n = Number of sampling plots

RESULT AND DISCUSSION

Environmental Parameters

The physical and chemical characteristics measured at the study sites are presented in Table 2.

Tabel 1. Water quality

Water quality	Unit	West	South	East	North	Mean	Quality Standard
Temperature	°C	28,9	28,2	28,1	29,9	28,8	28-30
Transparency	m	0,75	0,70	0,80	0,80	0,76	>3
Turbidity	NTU	1,62	1,38	2	1,47	1,62	5
Current velocity	m/s	0,108	0,112	0,106	0,09	0,104	-
Depth	m	0,75	0,70	0,80	0,80	0,76	
Salinity	ppt	31,5	31,9	30,5	29,8	30,9	33
pH	-	7,96	8,3	8,2	8,4	8,22	7-8,5
DO	mg/L	6,4	6,8	6,9	6,9	6,75	>5
Nitrate	mg/L	0,11	0,023	0,052	0,059	0,061	0,06
Phosphate	mg/L	0,004	0,003	0,004	0,006	0,0043	0,015

Based on the water-quality standards in Government Regulation of the Republic of Indonesia No. 22 of 2021, the mean water temperature was 28.8°C, which was considered optimal. Nontji (2005) cited in Isman (2016) reported that macrozoobenthos can tolerate temperatures of 25–36°C; therefore, temperature at all stations remained within the normal range.

Mean water transparency was 0.76 m. Higher transparency can support seagrass photosynthesis and consequently support surrounding organisms. Mean turbidity was 1.6175 NTU, indicating favorable conditions. High turbidity can interfere with seagrass and macrozoobenthos communities (Simanjuntak et al., 2018).

Mean current velocity was 0.104 m s⁻¹, categorized as slow. Mean water depth was 0.76 m. Water depth can affect the number of macrozoobenthos species and individuals and their distribution. Shallow water allows light to reach the bottom and can support photosynthesis in seagrass ecosystems (Simanjuntak et al., 2018).

Mean salinity was 30.925 ppt, indicating relatively stable conditions. Mean pH was 8.215, indicating suitable conditions. For benthic organisms, an environmental pH of 7–8.5 is considered suitable; pH below 7 may reduce benthic populations (Ningsih et al., 2020). Mean dissolved oxygen (DO) was 6.75 mg L⁻¹, indicating good oxygen conditions.

Mean nitrate was 0.061 mg L⁻¹, considered optimal, whereas mean orthophosphate was 0.00425 mg L⁻¹ and was considered low. Nitrate and phosphate are important for ecosystem growth and are used as indicators of water fertility because nutrient availability can influence seagrass growth (Rayyis et al., 2021). The substrate type at the study stations was sandy loam.

Seagrass Density

Based on the analysis of seagrass species density, *Thalassia hemprichii* exhibited the highest density among the seagrass species recorded at all four sampling stations, particularly at the western and southern stations in the waters of Tihi-Tihi Village. The total seagrass density was **1,452 stands m⁻²** at the northern station, **1,963 stands m⁻²** at the eastern station, **2,083 stands m⁻²** at the southern station, and **1,835 stands m⁻²** at the western station.

The relatively high density of *Thalassia hemprichii* was likely influenced by the substrate characteristics and water quality conditions at the study sites. According to Kiswara (2004), as cited in Sahertian et al. (2017), seagrasses growing on sandy substrates or sand mixed with fragments of dead coral generally have smaller and shorter leaves than those growing in turbid or muddy waters. Although sandy substrates and sand mixed with dead coral fragments generally contain lower nutrient concentrations than muddy substrates, these substrate conditions may still provide suitable conditions for the growth of *T. hemprichii*.

Table 3. Seagrass Density

Location	Density (stand/m ²)			
	<i>Enhalus acoroides</i>	<i>Thalassia hemprichii</i>	<i>Halophila ovalis</i>	<i>Cymodocea rotundata</i>
North	52	719	147	535
East	69	756	267	871
South	60	1023	365	635
West	107	1017	215	496

The variation in seagrass density among the four stations may therefore reflect differences in substrate composition and environmental conditions. The higher density observed at the southern and western stations suggests that these locations provide relatively favorable conditions for the establishment and growth of *T. hemprichii*.

Composition and Abundance of Macrozoobenthos

Table 4 details the spatial distribution and abundance of 3,104 macrozoobenthos individuals across 30 taxa sampled at four monitoring stations (North, East, South, and West). Population numbers vary across the study area, with the South station recording the highest cumulative abundance (892 individuals) and the East station following closely (820 individuals), whereas the North station exhibits the lowest abundance (648 individuals). These differences across stations point to potential variations in local ecological factors such as substrate composition, organic matter distribution, and hydrodynamic energy.

Table 4. Macrozoobenthos Abundance

No.	Class	Species	Station				Total
			North	East	South	West	
1	Bivalvia	<i>Anadara granosa</i>	28	48	28	32	136
2		<i>Codakia tigerina</i>	0	12	8	12	32
3		<i>Fragum unedo</i>	8	0	8	0	16
4		<i>Tapes literatus</i>	8	0	8	8	24
5		<i>Tegillarca granosa</i>	4	8	12	4	28
6		<i>Cymbiola innexa</i>	8	16	40	24	88
7		<i>Cypraea (Erronea) ovum palauensis</i>	0	4	0	0	4
8		<i>Cypraea tigris</i>	0	0	8	20	28
9		<i>Trochus maculatus</i>	40	92	128	64	324
10	Gastropoda	<i>Strombus urceus</i>	264	228	240	280	1012
11		<i>Pseudovertagus aluco</i>	32	220	204	92	548
12		<i>Terebralia sulcata</i>	4	12	0	0	16
13		<i>Rhinoclavis vertagus</i>	0	0	4	16	20
14		<i>Polinices tumidus</i>	20	8	0	28	56

15		<i>Natica vitellus</i>	12	0	8	4	24
16		<i>Nassaridus dorsatus</i>	4	20	20	4	48
17		<i>Bulla quoyii</i>	8	0	0	8	16
18		<i>Astrarium calcar</i>	8	0	0	0	8
19		<i>Angaria delphinus</i>	0	0	0	4	4
20		<i>Conus ferrugineus</i>	18	0	4	0	12
21		<i>Chicoreus capucinus</i>	0	4	4	0	8
22		<i>Hexaplex cichoreum</i>	4	16	4	12	36
23		<i>Telescopium telescopium</i>	12	4	0	0	16
24		<i>Tripneustes gratilla</i>	84	40	60	36	220
25	Echinoidea	<i>Diadema setosum</i>	0	36	0	0	36
26		<i>Anametalia regularis</i>	8	8	8	12	36
27		<i>Astropecten polyacanthus</i>	12	16	12	20	60
28	Asteroidea	<i>Ophionereis shayeri</i>	20	12	40	32	104
29		<i>Protoreaster nodosus</i>	52	16	8	8	60
30	Holothuroidea	<i>Holothuria scabra</i>	0	0	36	24	60
Total			648	820	892	744	3104

The benthic community is overwhelmingly dominated by gastropods, with a few prolific species accounting for the vast majority of total individuals. Specifically, *Strombus urceus* is the most abundant species by a wide margin with 1,012 individuals, followed by *Pseudovertagus aluco* (548 individuals) and *Trochus maculatus* (324 individuals). Other groups, including bivalves like *Anadara granosa* and echinoderms such as *Tripneustes gratilla*, display more moderate populations with distinct station-specific preferences, reflecting the diverse microhabitats present across the intertidal and benthic zones.

Relationship between Seagrass Density and Macrozoobenthos Abundance

The relationship between seagrass density and macrozoobenthos abundance was evaluated using seagrass density and macrozoobenthos abundance as the two variables in a Pearson correlation analysis. The resulting correlation coefficient was $r = 0.97$. The relationship is shown in the following figure.

Table 5. Correlation between Seagrass Density and Macrozoobenthos Abundance

	Seagrass Density (x)	Macrozoobenthos (y)
Kerapatan Lamun	1	
Macrozoobenthos	0,97	1

The analysis produced a positive correlation coefficient of $r = 0.97$, which falls within the 0.80–1.00 range and represents a very strong relationship. This indicates that higher seagrass density was associated with higher macrozoobenthos abundance. Dense seagrass can provide shelter from currents and predators and can also contribute to food availability for macrozoobenthos. Substrate characteristics may also influence both seagrass density and macrozoobenthos abundance (Roem et al., 2022).

CONCLUSION

Based on the study conducted in the waters of Tihi-Tihi Village, Bontang City, a total of 30 macrozoobenthos species spanning five classes were identified across the four sampling stations, with *Strombus urceus* emerging as the most abundant species. The community exhibited moderate diversity (Shannon-Wiener diversity index ranging from 2.132 to 2.231) alongside moderate evenness and low dominance. Furthermore, total macrozoobenthos abundance varied spatially across the area, peaking at the southern station with 892 individuals m^{-2} and reaching its lowest point at the northern station with 648 individuals m^{-2} .

Physical and chemical water parameters across all stations, including temperature, transparency, turbidity, current velocity, depth, salinity, pH, dissolved oxygen, nitrate, and phosphate—remained within optimal ranges to support aquatic life and seagrass growth. Concurrently, four seagrass species were recorded, with *Thalassia hemprichii* displaying the highest overall density across the stations, contributing to total seagrass densities ranging from 1,452 stands m^{-2} in the north to 2,083 stands m^{-2} in the south.

A very strong positive correlation ($r = 0.97$) was established between seagrass density and macrozoobenthos abundance. This statistical relationship underscores the ecological role of dense seagrass beds in providing crucial microhabitats, shelter from currents and predators, and enhanced food availability that directly support and govern the distribution of benthic communities in the area.

REFERENCES

- Astutik, M. D., Watiniasih, N. L., dan Kartika, I. W. D. (2021). Kerapatan Lamun (Seagrass) dan Kelimpahan Makrozoobenthos di Perairan Pantai Mengiat Nusa Dua, Bali. *Bumi Lestari Journal of Environment*, 21(2), 1-11.
- Budi, D. A., Suryono, C. A., & Ario, R. (2013). Studi Kelimpahan Gastropoda di Bagian Timur Perairan Semarang Periode Maret–April 2012. *Journal of Marine Research*, 2(4), 56-65.
- Cholid, I., Jailani., dan Taru, P. (2023). Studi Komunitas Makrozoobentos yang Terdapat Pada Padang Lamun di Perairan Dusun Malahing Kota Bontang Kalimantan Timur. *Jurnal Tropical Aquatic Sciences*, 2(2), 113-120.
- Devi, K. P. A., Dharma, I. G. S., dan Putra, I. N. G. (2019). Struktur Komunitas Makrozoobenthos (Infauna) pada Kondisi Padang Lamun yang Berbeda Di Kawasan Pantai Sanur, Bali. *Journal of Marine Research and Technology*, 2(2), 28.
- Haryati, R. N., dan Kurniawan, D. (2021). Kondisi Ekosistem Padang Lamun di Perairan Tanjung Pisau Kabupaten Bintan. *Pena Akuatika: Jurnal Ilmiah Perikanan dan Kelautan*, 20(1).
- Isman, M. (2016). Hubungan Makrozoobentos dengan Bahan Organik Total (BOT) pada Ekosistem Mangrove di Kelurahan Ampalas Kec. Mamuju Kab. Mamuju Sulawesi Barat (Skripsi). Universitas Hasanuddin Makasar, 61.
- Maula, L.H. 2018. Keanekaragaman Makrozoobentos Sebagai Bioindikator Kualitas Air Sungai Cokro Malang. [Skripsi]. Fakultas Sains dan Teknologi, Universitas Islam Negeri Maulana Malik Ibrahim. Malang.
- Mustafa, P. S. (2023). Tinjauan Literatur Analisis Uji R Berganda dan Uji Lanjut dalam Statistik Inferensial pada Penelitian Pendidikan Jasmani. *Jurnal Ilmiah Wahana Pendidikan*, 9(5), 571-593.
- Ningsih, S. W., Setyati, W. A., dan Taufiq-Spj, N. (2020). Tingkat kelimpahan makrozoobenthos di padang

- lamun Perairan Telaga dan Pulau Bengkoang, Karimunjawa. *Journal of marine Research*, 9(3), 223-229.
- Rayyis, A., Suryono, S., & Supriyanti, E. (2021). Pengaruh nitrat dan fosfat dalam sedimen terhadap kerapatan lamun di Jepara. *Journal of Marine Research*, 10(2), 259-266.
- Roem, M., Niar, A., & Rachmawani, D. (2022). Asosiasi Komunitas Makrozoobentos pada Padang Lamun di Perairan Pulau Panjang Kepulauan Derawan. *Journal of Aquatropica Asia*, 7(1), 1-11.
- Sahertian, D. E., & Wakano, D. (2017). Laju Pertumbuhan Daun *Enhalus acoroides* pada Substrat Berbeda di Perairan Pantai Desa Poka Pulau Ambon. *Biosel (Biology Science and Education): Jurnal Penelitian Science dan Pendidikan*, 6(1), 61-68.
- Simanjuntak, S. L., Muskananfolo, M. R., dan Taufani, W. T. (2018). Analisis tekstur sedimen dan bahan organik terhadap kelimpahan makrozoobenthos di Muara Sungai Jajar, Demak. *Management of Aquatic Resources Journal (Maquares)*, 7(4), 423-430.
- Yasir, A.A. 2017. Struktur Komunitas Makrozoobentos pada Lokasi dengan Aktivitas Berbeda di Perairan Sungai Tallo Kota Makassar. [Skripsi]. Fakultas Ilmu Kelautan dan Perikanan, Universitas Hasanuddin. Makassar.