Jurnal Natur Indonesia
24(1), April 2025: 28-34

p-ISSN 1410-9379
e-ISSN 2503-0345

The Relationship between Seagrass Density and Macrozoobenthos Abundance in the Waters of Jago-Jago Village, Central Tapanuli Regency, North Sumatra

Hubungan Kepadatan Lamun dan Kelimpahan Makrozoobenthos di Perairan Desa Jago-Jago, Kabupaten Tapanuli Tengah, Sumatera Utara

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ABSTRACT

This survey was conducted in February - March 2023 in the waters of Jago-Jago Village, Central Tapanuli Regency. This study aimed to determine seagrass density and macrozoobenthos abundance, and to examine the relationship between seagrass density and macrozoobenthos abundance. This research was carried out according to a research method in which the sampling station was determined in a targeted area. Sampling was conducted at 3 research stations using 3 transects perpendicular to the shoreline at each station. Each transect line consists of 3 quadrat plots measuring 1 x 1 m^2. The seagrass species found was *Enhalus acoroides*. The research results showed the highest density at station I (29.44 stands/m^2), station II (25.33 stands/m^2), and the lowest density was in station III (19.22 stands/m^2). These data show that seagrass conditions at stations I and II are sparse, while station III has very sparse conditions. The result shows that the highest density is in station I, at 25.78 ind/m^2, and the lowest is in station III, at 6.78 ind/m^2. The results of the regression test show that the relationship between seagrass density and macrozoobenthos abundance is significant ($p = 0.012$) and positive ($r = 0.787$).

Keywords: Jago-jago Village, Seagrass, Macrozoobenthos, Sediment

ABSTRAK

Penelitian ini dilaksanakan pada bulan Februari - Maret 2023 di Perairan Desa Jago-Jago Kabupaten Tapanuli Tengah. Tujuan penelitian ini adalah untuk mengetahui tingkat kerapatan lamun, kelimpahan makrozoobentos, dan hubungan kerapatan lamun dengan kelimpahan makrozoobentos. Penelitian ini dilakukan dengan menggunakan metode penelitian dimana stasiun pengambilan sampel ditentukan secara purposive. Pengambilan sampel dilakukan pada 3 stasiun penelitian dengan menggunakan 3 transek tegak lurus terhadap garis pantai pada masing-masing stasiun. Masing-masing garis transek terdiri atas 3 petakan kuadran dengan ukuran 1 x 1 m^2. Jenis lamun yang ditemukan adalah *Enhalus acoroides*, dari hasil penelitian diperoleh data lamun dengan kerapatan tertinggi terletak pada stasiun I sebesar 29,44 tegakan/m^2, stasiun II sebesar 25,33 tegakan/m^2, dan kerapatan terendah terdapat pada stasiun III dengan nilai 19,22 tegakan/m^2. Dari data tersebut maka skala kondisi padang lamun stasiun I dan II memiliki skala kondisi kerapatan yang jarang sedangkan staiun III memiliki skala kondisi kerapatan yang sangat jarang. Data makrozoobentos yang diperoleh menunjukkan bahwa kelimpahan tertinggi terletak pada stasiun I dengan nilai sebesar 25,78 ind/m^2 dan untuk kelimpahan terendah terdapat pada stasiun III dengan nilai 6,78 ind/m^2. Dari hasil uji regresi dapat diketahui bahwa adanya hubungan antara kerapatan lamun dengan kelimpahan makrozoobentos memiliki nilai signifikansi sebesar 0,012 dan diproleh hasil positif dengan nilai r = 0,787.

Kata Kunci: Desa Jago-Jago, lamun, Makrozoobentos, Sedimen

INTRODUCTION

Seagrass is a plant that can survive completely in water. A large expanse of seagrass plants in the waters will form a seagrass meadow. The seagrass ecosystem plays an important role as a source of life for marine organisms. Seagrass beds help maintain coastal stability by extending their root systems to the bottom of the water column to capture and stabilize sediment, making seagrass areas important habitats for various marine biota.

Received: 15 February 2026
Accepted: 30 March 2026

Several types of marine biota may use seagrass roots as a place to live and survive against currents and waves.

Macrozoobenthos is a marine organism commonly found in seagrass ecosystems, both on the bottom substrate and at the bottom of the water column. The presence of macrozoobenthos in seagrass ecosystems may support the survival of these animals. The seagrass ecosystem is a macrozoobenthos habitat for growth and reproduction. Thus, the presence of macrozoobenthos in the seagrass ecosystem may indicate interactions between seagrass and marine organisms, with a relationship in which both depend on each other for growth and reproduction (Junaidi et al., 2017).

Jago-Jago Village is a village in Central Tapanuli Regency, North Sumatra Province. This area has extensive seagrass beds. Since seagrass is a habitat for marine biota, especially macrozoobenthos, the condition of the seagrass obviously affects the existence of macrozoobenthos. According to David (2011), the seagrass in the waters of Jago-Jago Village consists of three species: *Enhalus acoroides, Cymodocea rotundata,* and *C. serrulata.* However, the dominant type is *E. acoroides.*

MATERIALS AND METHODS

Time and place

This research was conducted from February to March of 2023 in the coastal waters of Jago-Jago Village in Central Tapanuli, North Sumatra. Data analysis was carried out at the Marine Biology Laboratory, Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau, and at the Fisheries Biology Laboratory of the College of Fisheries and Marine (STPK) Matauli, Pandan, Central Tapanuli, North Sumatra.

Methods

The method used in this research is direct observation and sampling at the research location. The samples collected included seagrass, sediment, and water-quality parameters, including substrate, temperature, pH, salinity, water transparency, depth, current velocity, and dissolved oxygen.

Procedures

Sampling stations are determined randomly and goal-oriented. The sample distribution criteria at each of the three-research station in Jago-Jago Village Waters, Central Tapanuli Regency, North Sumatra Province are as follows: Station I is an area with minimal human activity. Station II is in a tourist area and close to the mangrove ecosystem. Station III is located in an area with high human activity. The area of study is also used by fishing boats and various local communities to dispose of household waste.

Sampling was conducted at 3 research stations, with 3 transects perpendicular to the coastline at each station. Each transect line consists of 3 quadrant plots of 1 x 1 m^2. The distance of the sampling site from the coastline is 30 m towards the sea from the time the seagrass was first discovered. The sampling location determination is considered to represent the study location, with the station determination based on human activity.

Seagrass density

Seagrass density is the total number of individuals of a seagrass species per unit area, expressed in square meters (m^2). It is calculated using the Snedecor & Cochran formula (Agustina, 2016) as follows:

$$K=\frac{\sum Di}{\sum ni \times A}$$

Where: K: Individual density (stand/m^2); ΣDi: Number of stands (stands); Σni: Number of quadrants; A: Quadrant area (m^2). To determine the status of the seagrass beds in Jago-Jago Village Waters, a scale based on Gosari & Abdul (2012) was used, as shown in Table 1.

Table 1. Scale of seagrass conditions based on density

Dish	Thickness	Condition
5	>175	Very tight
4	125-175	Meeting
3	75-125	Reasonably close
2	25-75	Seldom
1	<25	Very rarely

Macrozoobenthos Abundance

The total abundance of individuals per unit area or per unit volume was then calculated using the formula:

$$Di=\frac{Ni}{A}$$

Where: Di: Macrozoobenthos abundance (ind/m²); Ni: Number of Macrozoobenthos (ind); A: Quadrant area (m^2). Abundance of macrozoobenthos per square meter (m^2) was obtained from the abundance conversion results in each sampling box (quadrant).

Sediment fractions and analysis of organic matter

The sediment type analysis in the laboratory follows the procedure described in Rifardi (2008): a sediment grain-size analysis of the sand and gravel fractions using the wet-sieve method, and of the silt fraction using the pipette method. Stages of analysis of the total organic matter (organic carbon) content using the LOI method, based on laboratory procedures of the University of Pittsburgh & Allen's determination (Sari et al., 2014), are as follows:

$$Li = \frac{W_0 - Wt}{W_0} x\ 100\%$$

Where: Li = Loss on inflammation; W0 = Initial weight (%); Wt = Final weight

RESULT AND DISCUSSION

Water quality parameters

The water quality parameters measured at the study site are temperature, pH, salinity, clarity, flow rate, dissolved oxygen, and depth. These water quality parameters were measured at each transect at each research station. The results of the water quality measurements at the study site are shown in Table 2.

Table 2. Water quality parameters in the waters of Jago-Jago Village

Parameter	Unit	Station		
		I	II	III
Temperature	°C	29.33	29.76	29.66
pH	-	7	7	7
Salinity	‰	34.33	30.33	29.66
Brightness	m	0.4	0.3	0.5
Flow rate	m/s	0.17	0.18	0.16
Dissolved oxygen	mg/L	5.1	5	5
Depth	cm	47.6	65.33	72.83

The temperature at each research station ranges from 29 to 30 °C. According to Supriharyono (2009), seagrass plants in tropical areas generally grow in water temperatures between 20 and 30 °C. The acidity, or pH, of the waters in Jago-Jago Village is 7. According to Decree No. 51 of 2004, the pH at the study site is classified as good and suitable for the survival of marine organisms. The results of salinity measurements at each station in the waters of Jago-Jago Village show a range between 29 and 34‰. According to Christon et al. (2012), the optimal salinity value for seagrass is 35‰. A low clarity level can reduce water productivity, whereas a high clarity level can increase it. The water clarity at the study site ranges from 0.3 to 0.5 m. The current velocity in the waters of Jago-Jago Village ranges from 0.16 to 0.18 m/s. According to Rosalina et al. (2018), areas with flow velocities of 0.1 to 1 m/s are classified as moderate flow velocities. Dissolved oxygen is also a consideration in seagrass growth. Results of dissolved oxygen measurements at the study site ranged from 5 to 5.1 mg/L. The results of this measurement are in agreement with the opinion of Effendi (2003), who stated that almost all aquatic organisms prefer dissolved oxygen conditions >5 mg/L. The water depth at the research site ranges from 40 to 70 cm, where the water is relatively shallow and still allows light to penetrate. The depth of a water body is one of the factors that influences the density of seagrass species.

Sediment Fraction

Substrate samples from each plot at the research location were then analyzed to determine the type of substrate used, using Shepard's Triangle. The types of sediment in the waters of Jago-Jago Village are sand and mud, as shown in Table 3.

the substrate conditions at the study site are generally mud and sand, which are supportive of seagrass growth. Seagrass can generally grow on soft substrates, such as muddy sand, allowing roots to penetrate more easily and supporting growth in its habitat. Tuwo (2011) said that seagrass can live on mud, sand, muddy sand, coral fragments, and rock substrates. Nevertheless, the most common and abundant seagrass is found on soft substrates (Dahuri et al., 2001).

Table 3. Percentage of substrate type fractions in Jago-Jago Village waters

Station	Example point	Sediment fraction (%)			Sediment type
		Grind	Sand	Mud	
I	1	7.13	74.32	18.55	Muddy sand
	2	4.4	76.36	19.24	Sand
	3	6.22	73.62	20.16	Muddy sand
II	1	8.89	59.17	31.94	Muddy sand
	2	5.8	62.08	32.13	Muddy sand
	3	4.8	46.5	48.7	Sandy mud
III	1	5.38	36.77	57.85	Sandy mud
	2	4.49	33.81	61.7	Sandy mud
	3	4.76	66.8	28.44	Muddy sand

Total Organic Matter

The organic material content of the sediment at each research station varies. Data from the analysis of sedimentary organic matter in the sediment, conducted in the Chemical Laboratory, are shown in Table 4.

Table 4. Percentage of total organic matter in sediment in Jago-Jago Village waters

Example Point	Station		
	I	II	III
I	5,99	9,86	8,05
II	7,08	9,15	7,67
III	8,40	8,50	6,69
Mean ± Standard Deviation	7,16 ± 1,20	9,17 ± 0,68	7,47 ± 0,70

Table 4 shows that the total organic matter data at the three stations have the highest percentage at station II (9.17%) and the lowest at station I (7.16%). Organic matter comes from animals and plants that rot, sink to the seabed, and mix with bottom sediment, while inorganic matter typically comes from the weathering of rocks. Based on the analysis of organic materials at the study site, station II has a higher organic material content than Stations I and III. The density of seagrass and the abundance of macrozoobenthos in the waters of Jago-Jago Village are not synchronous with the organic material content found. This is probably because the characteristics of the organic material sources vary from station to station.

Seagrass density

Research results show that the seagrass found in the waters of Jago-Jago Village is *E. acoroides*. *E. acoroides* is one of the most common seagrass species, widely distributed and very easy to recognize due to its large size compared to other seagrasses. Calculating seagrass stands across three stations yielded differing results. The results of seagrass density calculations conducted in the waters of Jago-Jago Village, Central Tapanuli Regency, North Sumatra, are shown in Table 5.

Table 5. Average density of seagrass in the waters of Jago-Jago Village

Station	Transect	Density (stand/m^2)
I	1	34.33
	2	33
	3	21
Mean ± Standard Deviation		29.44 ± 7.34
II	1	30
	2	21
	3	25
Mean ± Standard Deviation		25.33 ± 4.51
III	1	24
	2	18.33
	3	15.33
Mean ± Standard Deviation		19.22 ± 4.4

The analysis results showed that the highest seagrass density was at station I, namely 29.44 stands/m^2. Then there was station II with 25.33 stands/m^{2,} and finally, the lowest density was in station III with 19.22 stands/m^2 (Table 5). Differences in seagrass density among station are caused by several factors, including environmental parameters, human activities, and associated marine organisms (Junaidi et al., 2017).

Station I is an area with minimal human activity, so human hands rarely touch it, and it has good water conditions, such as salinity at 34.33‰, which is quite optimal for seagrass growth. This supports the higher level of seagrass density at Station I. Station II is 200 m from Station I and is close to the mangrove tourist attraction. Although located in a tourist area, this station also sees minimal human activity. This is because tourists who visit only see and enjoy the view from the beach. The water conditions at this station are relatively murky, which somewhat hinders photosynthesis. Station III has the lowest seagrass density compared to stations I and II, which is influenced by its characteristics in a residential area. This area has very high activity, such as a dump for household waste and a stop for small fishing boats. These factors make it difficult for seagrass at Station III to grow and develop compared to other stations at the study site.

Species of macrozoobenthos

The macrozoobenthos found at the research location was subsequently identified. For more details on the species of macrozoobenthos found in the waters of Jago-Jago Village, see Table 6.

Table 6. Species of macrozoobenthos in the waters of Jago-jago Village

Philum	Class	Family	Species	St. I	St. II	St. III
Moluska	Gastropodes	Cerithiidae	*Cerithium coralium*	+	+	+
		Olividae	*Olivia annulata*	+	+	-
		Neritidae	*Nerita polita*	+	+	-
		Bursidae	*Bufonaria rana*	+	+	-
		Nassariidae	*Nassarius dorsatus*	-	+	-
	Bivalves	Laternulidae	*Laternula truncata*	+	+	-
		Arcidae	*Anadara nodifera*	+	+	-
		Arcidae	*Scapharca inaequivalvis*	+	-	-
		Lucinidae	*Austriella corrugata*	+	+	-
		Arcidae	*Scapharca globosa*	+	+	+

Based on Table 6, field research revealed that two classes of macrozoobenthos dominate the waters of Jago-Jago Village: gastropods and bivalves from the mollusk phylum. The type of macrozoobenthos that is most often found belongs to the class of gastropods, because this macrozoobenthos directly uses seagrass as a habitat. This is in agreement with Hitalessy's (2015) statement that the gastropod class is an epifaunal macrozoobenthos that directly uses seagrass as shelter from strong currents and predators.

Macrozoobenthos Abundance

The macrozoobenthos abundance in the waters of Jago-Jago Village found in this study can be divided into 2 classes: bivalves and gastropods. Data on the abundance of macrozoobenthos are presented in Table 7.

Table 7. Data on the abundance of macrozoobenthos in the waters of Jago-jago Village

Station	Transect	Abundance (ind/m^2)
I	1	28
	2	27
	3	22.33
Mean ± Standard Deviation		25.78 ± 3.02
II	1	17.33
	2	14
	3	15
Mean ± Standard Deviation		15.44 ± 1.71
III	1	7.33
	2	6.67
	3	6.33
Mean ± Standard Deviation		6.78 ± 0.51

Each transect has values ranging from 6.63 to 28 ind/m^2. The highest density is at station I and the lowest density is at station III, with respective values of 25.78 ind/m^2 and 6.78 in/m^2. There are 10 species of macrozoobenthos found in the waters of Jago-jago Village. The most common species belong to the gastropod class. This is because the macrozoobenthos of the gastropod class has quite good adaptability to its environment. This was also mentioned by Alfitriatussulus (2003), where it is believed that the large number of macrozoobenthos species in the gastropod group is due to the wider distribution of gastropods and that their ability to adapt to their habitat is also high both in the sea and in surrounding fresh water and on soft and hard substrates. This is consistent with the water conditions in Jago-jago Village, which have moderate currents and muddy sandy substrates.

The highest macrozoobenthos density was at station I, namely 25.78 ind/m^2. This is believed to be caused by the high seagrass density and minimal human activity at the station. Station II, an area adjacent to tourist mangrove sites, has a macrozoobenthos abundance of 15.44 ind/m^2. Meanwhile, station III has the lowest macrozoobenthos abundance, with 6.78 ind/$m^{2.}$ This is believed to be due to Station III being located in an area with high human activity. In addition to fishing in the sea, they also look for shellfish for an additional income. Differences in the abundance of macrozoobenthos across studies may be due to differences in the characteristics of the study area, the organic matter content in the sediment, and the level of anthropogenic activity around the study area (Pramita et al., 2021).

Relationship between seagrass density and macrozoobenthos abundance

To determine the relationship between seagrass density and macrozoobenthos abundance in the waters of Jago-jago Village, a linear regression analysis was performed. The full regression relationship curve is shown in Figure 1.

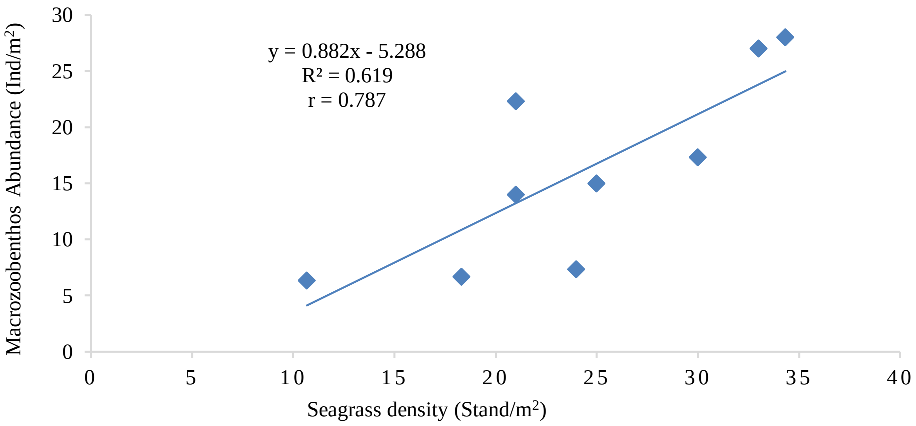

Figure 4. Relationship between seagrass density and macrozoobenthos abundance in waters of the village of Jago-Jago

The results of the simple linear regression test show that if the significance value is <0.05, it is rejected, meaning that there is a relationship between seagrass density and macrozoobenthos abundance in the waters of Jago- Jago Village. Looking at the value $R = 0.787$, this figure shows that the relationship between seagrass density and macrozoobenthos abundance is relatively strong. Meanwhile, the coefficient of determination (R2) is 0.619, indicating that seagrass density explains 61.9% of macrozoobenthos abundance, while other factors explain 39.1%. The study results show that the high density of macrozoobenthos is driven by the high density of seagrass at the study site, which is attributed to the size of seagrass roots, which can serve as habitat and shelter for macrozoobenthos, protecting them from the threat of other predators and from currents and sea waves. Sampling takes place at low tide, and environmental factors such as substrate properties, depth, and salinity often have a greater influence on the presence of certain macrozoobenthos in seagrass areas.

CONCLUSION

Based on research conducted in Jago-Jago Village Waters, it can be concluded that seagrass density at each station differs and shows an uneven distribution, with relatively low levels. The density of seagrass is influenced by environmental factors, with the highest densities in areas with minimal human activity (rarely affected by human activity). Meanwhile, the lowest seagrass density is found in areas of high human activity, such as ship berths and household waste disposal sites. The highest amount of macrozoobenthos is found in areas with high seagrass density, while the lowest amount of macrozoobenthos is also found in areas with low seagrass density. The density of seagrass in the waters of Jago-jago Village shows a strong relationship with the abundance of macrozoobenthos: the higher the seagrass density, the higher the macrozoobenthos abundance.

It is best to measure water quality at two times, namely high tide and low tide, to obtain more accurate data. There is a need for awareness to avoid activities that can damage seagrass and always maintain the sustainability of the seagrass ecosystem, which provides many benefits to the surrounding organisms.

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