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SEAGRASS DISTRIBUTION BASED ON THEIR SEDIMENT CHARACTERISTICS IN PUNTONDO WATERS, TAKALAR DISTRICT, SOUTH SULAWESI, INDONESIA

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ABSTRACT

Seagrass distribution is influenced by many factors, including sediment characteristics. This study aims to determine the distribution of seagrass based on their sediment characteristics. Observations and sampling were carried out in the waters of the Puntondo Bay, Takalar Regency. This study observed the cover and density of seagrass species, water depth, water transparency, sediment's total organic matter and size of sediment grains. There were five species of seagrass found in the area, namely *Enhalus acoroides, Thalassia hemprichii, Cymodocea rotundata, Halophila ovalis and Syringodium isoetifolium* with sediment types of medium sand and coarse sand. Results of the regression analysis showed that the relationship between sediment particle size and seagrass density with the highest coeficient determination (R2=0,3346) was in seagrass *Cymodocea rotundata*, whereas the lowest was in *Syringodium isoetifolium*.

Keywords: Seagrass, Puntondo, aters, Sediment grain size, *Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Halophila ovalis*, *Syringodium isoetifolium*.

INTRODUCTION

Seagrass is a flowering plant (Angiospermae) and includes one-seeded plants (Monocotyledonae) having roots, rhizomes, leaves, flowers and fruit. Seagrasses can be found growing and thriving in shallow marine waters, high salinity estuarines, in areas that are always open at low tide, on sandy substrates, muddy sands, soft mud and corals in tropical areas (Juraij et al., 2014). Like other marine ecosystems, seagrass beds have important roles in the ecology of coastal areas. Some of these important roles are in providing habitat for various marine biota including being a feeding ground for green turtles, dugongs, fish, echinoderms and gastropods (Bortone, 2000), as well as wave absorbers and sediment traps (Fonseca and Fisher, 1986).

Sediment plays a role in determining the stability of seagrass life, as a growing medium for seagrass so that it is not carried away by currents and waves and as a source of nutrients (Lanuru and Ferayanti, 2011).

According to Yunitha (2014), seagrasses grow on various types of sediment characteristics, such as substrates with muddy, sandy to coral rubble sediment types. An initial survey was conducted in December 2019 in the waters of Puntondo Village and found that several types of substrates (such as sand, muddy sand and coral rubbles) were overgrown with several species of seagrass. Based on these conditions, a study on the distribution of seagrass based on sediment characteristics in the waters of Puntondo Village, Takalar Regency, was sonducted.

MATERIALS AND METHODS

This research was carried out in June-August 2020 in the waters of the Puntondo Bay of Puntondo Village, Takalar Regency (Figure 1). Observations of sediment type analysis and Total Organic Matter (TOM) took place at the Laboratory of Physical oceanography and Coastal Geomorphology, Department of Marine Science, Faculty of Marine and Fishery Sciences, Hasanuddin University, Makassar.

Seagrass cover

Seagrass cover data were collected using a quadrate (50 cm x 50 cm) which was divided into four grids with a size of each was 25 cm x 25 cm. The quadrat was thrown randomly according to the distribution of seagrass. Percentage of seagrass cover was estimated using the following standard percent cover (Rahmawati et al., 2014). Furthermore, the determination of the condition of seagrass beds by looking at the coverage value based on the Minister of Environment Decree No. 200 in 2004.

Seagrass Density

To observe the density of seagrass species, a 50 cm x 50 cm quadrat was used and seagrass density were measured for each species by counting the number of stands of each species in the quadrat (50 cm x 50 cm). The density of seagrass species was calculated using the formula as follows:

$$Species\ Density\ \left(\frac{Shoot}{m^2}\right) = \frac{Number\ of\ Shoot\ within\ plot}{Plot\ Area\ (m^2)}$$

Figure 1. Research location in the waters of Puntondo Village, Takalar Regency

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Sediment Sampling, depth measurement and Total Organic Matter (TOM)

Sediment sampling was carried out using a PVC pipe (2 inches diameter) on each seagrass observation transect. Sediment taken was then put in sample bags and taken to the Physical oceanography and coastal geomorphology Laboratory, Department of Marine Science, Faculty of Marine and Fisheries Sciences, Hasanuddin University. Depth was measured outside each transect using a scale bar that was put into the water until it reached the substrate. Water clarity was measured using a Secchi disk tied with a rope and then lowered slowly into the water until it was no longer visible on each quadrati of observation. Determination of Total Organic Matter (TOM) of dry sediment was carried out using the combustion method in the laboratory by weighing a porcelain dish, then weighing the weight of the dry sediment sample (±5 grams) then put into a porcelain dish and heated in a furnace (650℃; 2-3 hours). The sample was then removed from the furnace and cooled in a desiccator and the sampels were the re-weight (porcelain dish containing sediment samples) as the final weight. To calculate the Total Organic Matter (TOM) of sediment, the following formula was used:

$$\text{Initial Organic Matter Weight} = \text{Porcelain dish Weight} + \text{Sample Weight}$$

$$\text{Organic Matter Content} = \pm\ (\text{Initial Weight} - \text{Porcelain dish Weight}) - (\text{Final Weight} - \text{Porcelain dish Weight})$$

$$\%\ Organic\ Matter = \frac{Orgnic\ Matter\ Weight}{Sample\ Weight}\ X\ 100\ \%$$

Sediment Particle Analysis

Sediment analysis using dry sieving method was classified according to Wentworth to determine the grain size of the sediment. The dry sieving method was carried out by cleaning the sample from dirt and seagrass adhering to the sediment, then the sample was dried using an oven at a temperature of 150˚C. Sediment samples were weighed 100 grams as the initial weight, then sieved using a sieve net arranged sequentially with sizes of 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm, 0.063 mm and < 0.063 mm. Then the sediment sample was separated from the sieve and weighed. To calculate the % weight of sediment in the dry sieve method, the following formula was used:

$$\%\ Weight = \frac{End\ weight\ of\ sediment\ sieved}{Initial\ Weight} \times 100\ \%$$

Results then was used to classify sediments according to grain size using the Wentworth Scale (Hutabarat and Evans, 1985).

Data Analysis

To determine the relationship between sediment characteristics and the distribution of seagrass vegetation, it was analyzed descriptively using tables and figures, correlation analysis was used to determine the strength or weakness of the relationship between sediment characteristics and the distribution of seagrass.

RESULTS AND DISCUSSION

Environmental Parameter

The results of the average measurement of environmental parameters in the waters of Puntondo Village, Takalar Regency are presented in Table 1.

The average depth of water was the highest in I (1.14 m) while the lowest depth was in station III (0.99 m). The highest average water clarity occurred in station III (44%) while the lowest occurred at station II (37%).

Table 1. Results of measurement of water parameters

Station	Replication	Depth (m)	Clarity (%)	TOM in Sediment (%)
I	1	1.1	43	8.64
	2	1.1	46	9.32
	3	1.23	42	5.6
	Average	1.14	43.67	7.85
II	1	1.1	35	26.94
	2	1.18	39	27.62
	3	1.1	37	12.46
	Average	1.13	37	22.34
III	1	0.85	46	9.34
	2	1.18	41	8.6
	3	0.95	45	12.88
	Average	0.99	44	10.27

The results of the analysis of Total Sediment Organic Matter were different from each sampling station. The average value of the sediment total organic matter (TOM) was7.85%, 22.34% and 10.27% at station I, II and III, respectively.

Seagrass Cover

The results of measurements of seagrass cover obtained the highest value at station II (67%), while at stations I and III had the same results (42%) (Figure 2)

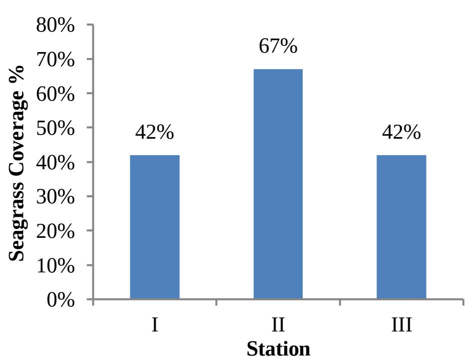

Figure 2. Average Percentage of Seagrass Cover in the Waters of Puntondo Village

Seagrass Density

The highest seagrass density was found at station II of 1308 ind/m² consisting of *Enhalus acoroides, Syringodium isoetifolium, Cymodocea rotundata* and *Thalassia hemprichii*. The lowest density was found at station I of 788 ind/m² consisting of *Enhalus acoroides, Syringodium isoetifolium, Cymodocea rotundata, Halophila ovalis* and *Thalassia hemprichii.* Meanwhile, the seagrass density at station III was 892 ind/m² consisting of *Enhalus acoroides*, *Cymodocea rotundata*, and *Thalassia hemprichii*.

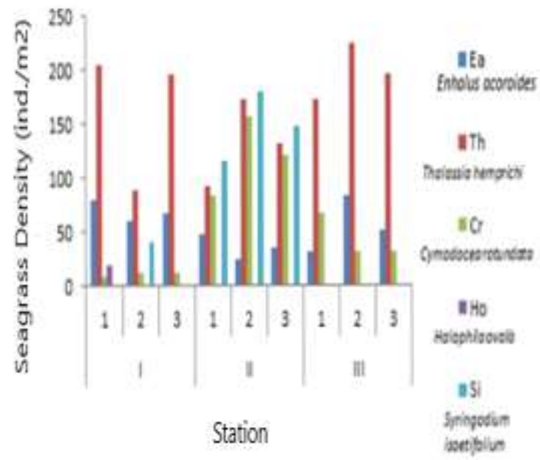

Figure 3. Average Density of Seagrass Per Species in the Waters of Puntondo Village

Sediment Characteristics

The percentage of cumulative mass weight of sediment based on the Wenworth scale was dominated by coarse sand (stations II and III), while at station I the percentage of sediment mass weight was dominated by medium sand. This was in line with the results of sediment analysis with the help of the Gradistat application which showed that the type of sediment was dominated by coarse sand (Table 2).

Table 2. Sediment particle size at each station

Stat.	Replication	Particle Size (mm)	Median (mm)	Sediment Type
I	I	0.25 - 0.5	0.323	Medium Sand
	II	0.25 - 0.5	0.257	Medium Sand
	III	0.25 - 0.5	0.34	Medium Sand
II	I	0.25 - 0.5	0.332	Medium Sand
	II	0.5-1	0.568	Coarse Sand
	III	0.5-1	0.551	Coarse Sand

III	I	0.5-1	0.552	Coarse Sand
	II	0.5-1	0.526	Coarse Sand
	III	0.5-1	0.558	Coarse Sand

Relationship of Sediment Characteristics to Seagrass Distribution

The correlation result of simple regression equation showed that the seagrass species *Enhalus acoroides* on the particle size of the sediment obtained an R^2 value (coefficient of determination) of 0.2519 (25.19%). Seagrass type *Syringodium isoetifolium* obtained R^2 value (coefficient of determination) of 0.0514 (5.14%). Seagrass species *Cymodocea rotundat*a on the particle size of sediment obtained the value of R^2 (coefficient of determination) of 0.3346 (33.46%). Seagrass species *Halophila ovalis* to the particle size of the sediment obtained a value of R^2 (coefficient of determination) of 0.1281 (12.81%). Seagrass species *Thalassia hemprichii* to the sediment particle size obtained the value of R^2 (coefficient of determination) of 0.1755 (17.55%). Of all the seagrass species found in Puntondo waters, it can be said that *Cymodocea rotundata* has the highest coefficient of determination (R2=33,46%) compared to other species.

Table 3. Relationship between sediment particle size and seagrass density

Seagrass Species	Regression Equation	R^2 Value
Enhalus acoroides	y = -20.66x + 22,643	$R^2 = 0.2519$
Syringodium isoetifolium	y = 32.578x - 1,06	$R^2 = 0.0514$
Cymodocea rotundata	y = 59.641x - 11,998	$R^2 = 0.3346$
Halophila ovalis	y = -4.6591x + 2,6299	$R^2 = 0.1281$
Thalassia hemprichii	y = 40.232x + 23,088	$R^2 = 0.1755$

Relationship of Total Organic Matter of Sediment to Seagrass Distribution

The correlation result of simple regression equation shows that the seagrass species, *Enhalus acoroides*, on the total organic matter of sediment obtained an R^2 value (coefficient of determination) of 0.3436 (34.36%). Seagrass *Syringodium isoetifolium* obtained R^2 value (coefficient of determination) of 0.6282 (62.82%). Seagrass species *Cymodocea rotundata* on Total Organic Sediment obtained an R^2 value (coefficient of determination) of 0.5623 (56.23%). Seagrass species *Halophila ovalis* to Organic Matter Total sediment obtained R^2 value (coefficient of determination) of 0.0503 (5.03%). Seagrass species *Thalassia hemprichii* on total organic matter sediment obtained R^2 value (coefficient of determination) of 0.1654 (16.54%).

Seagrass Cover and Density

Based on the category of seagrass conditions in the Decree of the State Minister of the Environment No. 200 of 2004, seagrass in Puntondo Village is divided into two categories, namely rich/healthy (station II) and less rich/less healthy (stations I and III).

Table 4. Relationship of Total Sediment Organic Matter with Seagrass Density

Seagrass Species	Regression Equation	R^2 Value
Enhalus acoroides	y = -1.5235x + 74.329	$R^2 = 0.3436$
Syringodium isoetifolium	y = 7.1917x – 43.23	$R^2 = 0.6282$
Cymodocea rotundata	y = 4.882x – 7.6303	$R^2 = 0.5623$
Halophila ovalis	y = -0.1843x + 4.7078	$R^2 = 0.0503$
Thalassia hemprichii	y = -2.4665x + 197.27	$R^2 = 0.1654$

The condition of the seagrass in the Rich Healthy category at station II is probably due to the relatively high TOM value in the sediment (22.34%) at that station due to the large number of BOT sources, one of which is human activity due to the proximity of the location to settlements.

There are five species of seagrass found in Puntondo Village, i.e., *Enhalus acoroides*, *Syringodium isoetifolium*, *Cymodocea rotundata*, *Halophila ovalis* and *Thalassia hemprichii*.

At station I, the highest density was *Thalassia hemprichii* with an average value of 488 ind/m², while the lowest density was *Halophila ovalis* with an average value of 20 ind/m². At station II found 4 species of seagrass, namely *Enhalus acoroides*, *Syringodium isoetifolium*, *Cymodocea rotundata* and *Thalassia hemprichii* with the highest density in *Syringodium isoetifolium*, namely 444 ind/m², while at station III there were 3 species of seagrass, namely *Enhalus acoroides*, *Cymodocea rotundata* and *Thalassia hemprichii* with the highest density of *Enhalus acoroides* was 592 ind/m² (Figure 3). *Halophila ovalis* has the lowest frequency of occurrence, it is suspected that the lack of adaptation level possessed by *Halophila ovalis* and the high environmental stress that occurs and this species of seagrass has a very narrow distribution and even small leaf morphology is not as common (Samson et al, 2020).

Kiswara (2010) in Suryanti et al., (2014) suggests that the density of seagrass shoots per area depends on the species. Seagrass species that have a large morphology such as *Enhalus acoroide*s have a low density compared to seagrass species that have a small morphology such as *Thalassia hemprichii* species with a high density.

Sediment Characteristics

The sediment texture in the waters of Puntonto Village is based on the results of measurements at all observation stations of coarse sand and medium sand type. The percentage of cumulative mass weight of sediment based on the Wenworth scale is dominated by coarse sand (0.5 - 1 mm) located at stations II and III, while at station I the percentage weight of sediment mass is dominated by medium sand (0.25 - 0.5 mm).

Relationship of Sediment Characteristics to Seagrass Distribution

The results of the correlation test between sediment particle size and seagrass density showed that the seagrass species *Enhalus acoroides* had an R^2 value (coefficient of determination) of 0.2519 (25.19%). This shows that sediment particles only affect 25.19% of the density of the seagrass species *Enhalus acoroides*, the low relationship between the density of *Enhalus acoroides* and the particle size of sediments is because *Enhalus acoroides* tends to live in muddy substrates. This is in line with Sangaji (1994) who stated that *Enhalus acoroides* dominantly lives in the bottom substrate is sandy and slightly mixed with silt and sometimes there is a bottom consisting of a mixture of dead coral debris. Then Bengen (2001) also stated that *Enhalus accoroides* is a seagrass that grows on muddy substrates from cloudy waters and can form a single species, or dominate the seagrass community.

Seagrass *Syringodium isoetifolium* obtained an R^2 value (coefficient of determination) of 0.0514 (5.14%) which means the species density is categorized as having a very weak relationship. This shows that sediment particles only affect 5.14% of the density of seagrass species. The correlation test of *Cymodocea rotundata* on sediment particle size obtained an R^2 value (coefficient of determination) of 0.3346 (33.46%) which means that the density of species is categorized as having a moderate relationship, indicating that sediment particles only affect 33.46% of the density of seagrass species. *Halophila ovalis* to the particle size of the sediment obtained an R^2 value (coefficient of determination) of 0.1281 (12.81%) which means that the density of species is categorized as having a weak relationship. This shows that the particle size of the sediment only has an effect of 12.81%. While the correlation test of *Thalassia hemprichii* on sediment particle size obtained an R^2 value (coefficient of determination) of 0.1755 (17.55%) which means that the density of species is categorized as having a weak relationship. This shows that the particle size of the sediment only affects 17.55%. The presence of a very variable and relatively low value of the determinant coefficient (R2) can indicate that apart from the grain size of the sediment, there are other factors that influence the density of seagrass species.

The particle size of the sediment that has a high influence on the density of seagrass species is *Cymodocea rotundata* seagrass. According to Arifin (2001), Seagrass *Cymodocea* spp. able to grow on a variety of substrates ranging from silty clay to coarse coral rubble, in a calm environment and sandy seagrass substrate this forms a broad and dense monospecific meadow.

The correlation result of simple regression equation shows that the type of seagrass *Enhalus acoroides* on total organic matter sediment obtained an R^2 value (coefficient of determination) of 0.3436 which means that the species density is categorized as having a moderate relationship, this shows that the sediment TOM only has an effect of 34.36% on the species density. seagrass. This agrees with Colton in Sabri and Hastono (2007) which states that if the correlation coefficient is between 0.26-0.50, it has a moderate relationship.

From the graph of the relationship between *Syringodium isoetifolium* seagrass and sediment TOM value, the R^2 value (coefficient of determination) of 0.6282 means that the species density is categorized as having a high relationship. This shows that the TOM of sediment has an effect of 62.82% on the density of seagrass species. The relationship between seagrass species *Cymodocea rotundata* and TOM sediment obtained an R^2 value (coefficient of determination) of 0.5623, which means that the species density is categorized as having a high relationship. This indicates that sediment TOM has an effect of 56.23% on the density of seagrass species *Cymodocea rotundata. Halophila ovalis* and *Thalassia hemprichii* have a low relationship to sedimentary TOM, where the relationship between seagrass *Halophila ovalis* and sediment TOM is obtained by the value of R^2 (coefficient of determination) of 0.0503 (5.03%). The relationship between seagrass species *Thalassia hemprichii* on total organic matter sediment obtained R^2 value (coefficient of determination) of 0.1654 (16.54%). The existence of a relatively variable value of the coefficient of determination indicates that the density of seagrass is not only influenced by the TOM of the sediment but there are other factors as well, for example by the characteristics of the seagrass species itself.

Environmental Parameter

Environmental factors can affect the spread and growth of seagrass species in waters. These factors can be in the form of clarity, depth, total organic matter of the sediment and the condition of the bottom sediment of the waters. Based on the results of the measurement of the depth of the waters at the study site, an average range of 1.09 m was obtained. this value is included in shallow waters, this is in accordance with what was stated by Nirmawati (2018) that the depth range of the waters where seagrass is found is classified as shallow if the depth is below 2 meters. the depth value can change periodically in the range of the highest and lowest low tide values, otherwise it will be of large value at the highest tide (Tubalawony, 2008). The level of clarity of the waters in general at all observation stations ranged from 37% - 44%. The low level of clarity does not match the results of the average measurement of sediment particles which are dominated by coarse sand, this is due to the high activity of fishermen catching fish at the research site, so that sediment particles are mixed in the waters. Clarity affects seagrass productivity because light penetration into the water is needed for photosynthesis for seagrass.

Measurement of sediment TOM at station I obtained an average value of 7.85%, at station II the average TOM value of sediment was 22.34%. This value is in line with the high density and percent seagrass cover values at station II. Meanwhile, at station III, the average TOM value of sediment was 10.27%. The high average value of sediment TOM at station II is because the location is close to residential areas, making it possible to supply organic matter into the waters from household waste. this is in accordance with what was stated by manik et al., (2017), that the high organic matter that enters the waters comes from increased activities on land such as household activities, filling oil for ponds, aquaculture and industry entering the waters.

CONCLUSION

In conclusion, 5 seagrass species (*Enhalus acoroides*, *Thalassia hemprichii*, *Cymodocea rotundata*, *Halophila ovalis* and *Syringodium isoetifolium*) were found in Puntondo waters with different distributions according to the characteristics of the sediment and the spcies of seagrass. Seagrass *Enhalus acoroides* had the widest distribution, compared to the seagrass *Halophila ovali*s which had the narrowest distribution. The relationship between sediment particles and seagrass density with the highest determinant value (R2=0.3346) was found in *Cymodocea rotundata*, while the lowest (R2=0.0514) was found in *Syringodium isoetifolium* seagrass.

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