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DISTRBUTION OF SEAGRASS SPESCIES BASED ON SUBSTRATE TYPE IN THE WATERS OF SAWAPUDO VILLAGE, KONAWE REGENCY

Distribusi Jenis Lamun Berdasarkan Tipe Substrat di Perairan Desa Sawapudo Kabupaten Konawe

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ABSTRACT

Seagrass meadows, which are extensive and distributed across various substrate types, play a crucial role in nutrient management and maintaining aquatic ecosystem stability. This study aims to determine the distribution of seagrass species, including seagrass density and seagrass cover percentage based on substrate types in the waters of Sawapudo Village. The purpose is to describe the condition of seagrass ecosystem distribution and provide initial information for coastal and marine resources. Seagrass sampling was conducted using quadrat transects at three stations determined by substrate type. The substrate types were sandy-muddy at Station I, muddy at Station II, and sandy at Station III. During the study period, the seagrass species found at the three stations were *Enhalus acoroides, Thallasia hemprichii, Cymodocea rotundata*, and *Halodule uninervis*. The average seagrass density at Station I was 216 shoots/m², at Station II was 293 shoots/m², and at Station III was 191 shoots/m². The seagrass cover percentage at Station I was 67.97%, at Station II was 72.45%, and at Station III was 53.44%. The seagrass distribution pattern at Station I had an Index of 1.64, at Station II an Index of 1.61, and at Station III an Index of 1.15. Differences in seagrass density are attributed to variations in substrate types. The seagrass cover percentage is influenced by the number of shoots, morphology, and substrate type. The seagrass species distribution pattern at the research location is clumped.

Key words: Coverage, Density, Distribution Pattern, Seagrass, Substrate Type

ABSTRAK

Padang lamun yang luas dan tersebar di berbagai tipe substrat berperan penting dalam pengelolaan nutrien dan menjaga kestabilan ekosistem perairan. Penelitian ini bertujuan untuk menganalisis distribusi jenis lamun, termasuk kerapatan dan persentase penutupannya, berdasarkan tipe substrat perairan Desa Sawapudo. Kegunaan menggambarkan kondisi distribusi ekosistem padang lamun dan data sebagai informasi awal bagi sumberdaya pesisir dan laut khususnya. Pengambilan sampel lamun dilakukan menggunakan metode transek kuadrat di tiga stasiun yang ditentukan berdasarkan tipe substrat. Stasiun I memiliki substrat pasir berlumpur, stasiun II berlumpur dan stasiun III pasir. Selama periode penelitian jenis lamun yang ditemukan pada 3 stasiun yaitu *Enhalus acoroides*, *Thallasia* *hemprichii, Cymodocea rotundata*, dan *Halodule uninervis*. Rata-rata kerapatan jenis lamun pada stasiun I yaitu 216 tegakan/m^2, stasiun II yaitu 293 tegakan/m^2 dan stasiun III yaitu 191. Sedangkan persentase penutupan jenis lamun pada stasiun I sebesar 67,97%, stasiun II mencapai 72,45% dan stasiun III sebesar 53,44%. Pola distribusi lamun pada stasiun I yaitu Indeks 1,64, stasiun II yaitu Indeks1,61 dan stasiun III yaitu Indeks 1,15. Perbedaan kerapatan jenis lamun disebabkan perbedaan tipe substrat. Persentase penutupan lamun dipengaruhi jumlah tegakan, morfologi dan tipe substrat. Pola penyebaran jenis lamun pada lokasi penelitian yaitu pola sebaran mengelompok.

Kata Kunci: Lamun, Kerapatan, Penutupan, Pola Distribusi, Tipe Substrat

INTRODUCTION

Seagrass is a flowering plant (Angiospermae) that lives and thrives in coastal ecosystems (Supriyadi *et al.,* 2018). This plant has many benefits for the biological and physical functions of the coastal environment (Supriyadi *et al.,* 2018). Seagrass beds act as nursery grounds, feeding grounds, and spawning grounds for various types of marine biota (Harjuna *et al*., 2020; Idris *et al.,* 2020; Moussa *et al.,* 2020; Jemi *et al.,* 2022).

According to Kuriandewa (2009), Indonesia has a seagrass bed area of around 30,000 km2. The vast seagrass beds allow many organisms to live in association with seagrass such as algae, molluscs, crustaceans, echinoderms, mammals, and fish. Seagrass beds are also inhabited by many fish, both permanent, temporary, or visiting to find food or protect themselves from predators. At least 12 types of seagrass have been reported in Indonesian waters (Sjafrie *et al.,* 2018).

The coastal area of Sawapudo Village is a water area of Southeast Sulawesi which has quite extensive seagrass beds and is spread across various types of substrates. According to Kiswara (1985), seagrass can be found on various substrate characteristics. The substrate functions as a place for seagrass to grow and plays a role in managing nutrients and maintaining the stability of seagrass in the waters. In addition, seagrass habitat is influenced by environmental quality such as temperature, salinity, pH, brightness, water depth and current.

The density of seagrass and the percentage of seagrass cover per unit area vary because they depend on the density of the seagrass species, where each seagrass species has a different type of leaf. In addition, it is also caused by different types of substrates. According to Kiswara (1997), one of the factors that affects seagrass density is the type of substrate. Therefore, research on the distribution of seagrass species based on substrate type in the waters of Sawapudo Village is very important to do because the distribution of seagrass based on substrate type can explain the types of seagrass that can grow and develop in several substrate conditions. In addition, it can help efforts to determine the condition of the seagrass ecosystem, because so far it is based on information data regarding the potential of coastal and marine resources, especially seagrass.

Based on the condition of the seagrass ecosystem in the waters of Sawapudo Village in several substrate conditions, a study is needed to determine the distribution of seagrass species including species density, percentage of cover and type of substrate found in the waters. The physical and chemical factors of the waters that are suspected of influencing the existence of the seagrass studied in this study are temperature, salinity, current speed, pH, depth, brightness, nitrate, phosphate, BOT and substrate type.

This study aims to analyze the distribution of seagrass species, including the density and percentage of seagrass cover, based on the type of substrate in the waters of Sawapudo Village. This study is expected to describe the distribution conditions of the seagrass ecosystem and is expected to be data as initial information for coastal and marine resources, especially the seagrass ecosystem in the waters of Sawapudo Village.

RESEARCH METHODS

Time and Place

This research was conducted in the waters of Sawapudo Village, Konawe Regency, Southeast Sulawesi (Figure 1). Water quality data analysis was conducted at the Laboratory of the Faculty of Marine Fisheries, Halu Oleo University.

Tools and Materials

The tools and materials used in this study include thermometers, refractometers, current kites, scaled stakes, Secchi disks, pH indicator paper, PVC pipes, plastic bags, graduated sieves, GPS, spectrophotometers, cameras, stationery, label paper, meter rolls, quadrat transects, identification books and coolboxes.

Determination of Research Stations

The determination of the location of the research station was carried out by considering that each selected station can represent the overall condition of the waters of Sawapudo Village based on the type of substrate that is overgrown with seagrass. The observation stations consist of three stations (Figure 1).

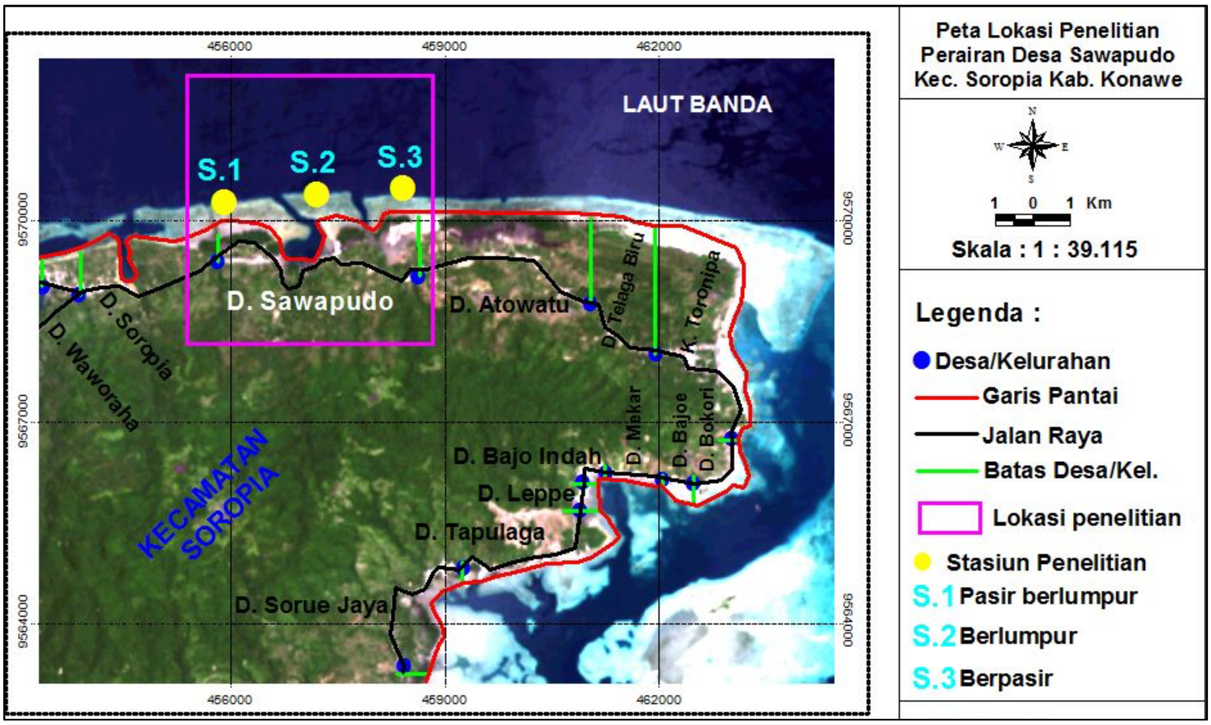

Figure 1. Map of research location

Research Parameters

Water quality parameters include: temperature, salinity, acidity (pH), depth, brightness, current velocity, nitrate and phosphate, total organic matter (BOT). Basic substrate parameters include texture. Seagrass parameters include: species density, percentage of cover and distribution of seagrass.

Sampling

Water Quality Parameters

Measurement and sampling of water parameters were carried out at high tide and measurements of total organic matter (TOC), nitrate, and phosphate were carried out in the laboratory.

Substrate Parameters

The substrate was collected at low tide using PVC pipes. After that, the samples were put into plastic bags that had been labeled according to the station and sub-station.

Seagrass Parameters

Seagrass data collection was carried out using a 1 m x 1 m quadrat transect. Observations were carried out at the lowest ebb, starting from the starting point where seagrass was found until no seagrass was found perpendicular to the coastline towards the sea, with the aim of seeing the types of seagrass that grow along the quadrat transect, to areas where no seagrass was found.

The seagrass parameters calculated include species density, percentage of cover and seagrass distribution patterns. In collecting seagrass data, environmental parameters were also measured. The following is a scheme of the research quadrat transect (Figure 2).

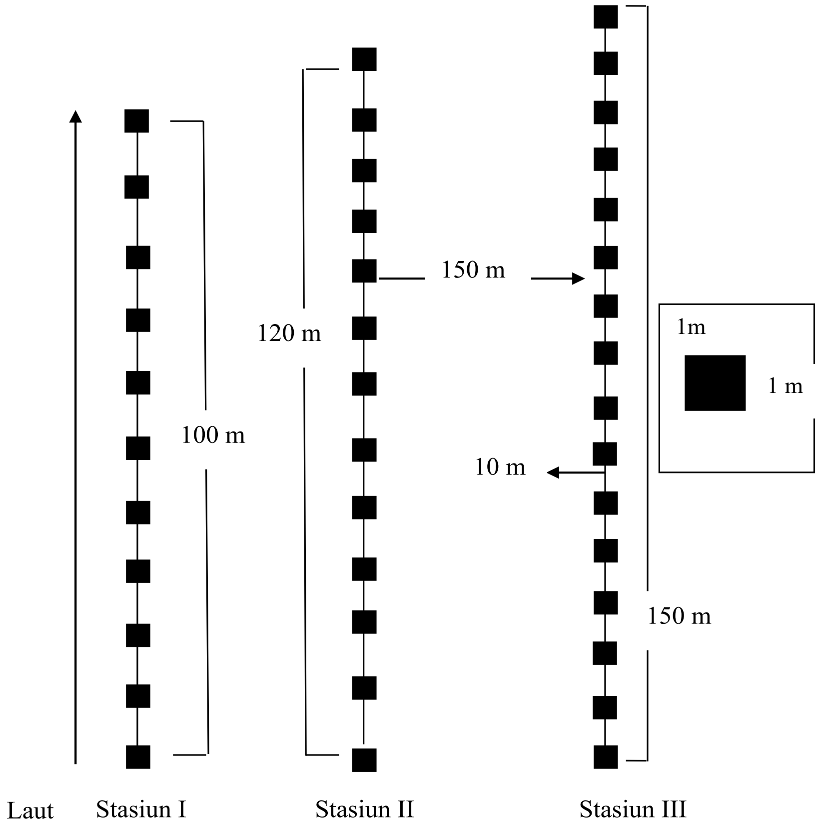

Figure 2. Transect scheme

Data Analysis

Seagrass Species Density

Density is usually calculated using the formula proposed by Soegianto (1994), namely:

$$Di = \frac{Ni}{A} \cdots\cdots\cdots\cdots\cdots\cdots (1)$$

Description:
Di = Seagrass density (stands/m^2)
Ni = Total number of stands of type I
A = Area of observation plot (m^2)

Percentage of Seagrass Cover

The percentage of seagrass cover was calculated using the formula proposed by (Setyobudiandi *et al.,* 2009).

$$C = \frac{\sum (Ci)}{N} \cdots\cdots\cdots\cdots (2)$$

Description:
C = Percentage of seagrass cover at each substation
Ci = Percentage of seagrass cover of i-th type at each transect plot
N = Number of transect plots at each substation

Seagrass Distribution

The distribution pattern of seagrass can be analyzed using the Morisita index according to the formula proposed by Brower et al., (1990).

$$Id = n\frac{\sum X^2 - N}{N(N-1)}\cdots\cdots\cdots(3)$$

Description:
d = Morsita dispersion index
n = Number of sampling plots
N = Total number of individuals in the plot
X2= Number of individuals in each plot

The distribution of seagrass follows the following criteria:
Id < 1: uniform
Id = 1: random
Id > 1: clustered

RESULT

Condition of Physical and Chemical Parameters of Waters

The results of the measurement of physical and chemical parameters of waters and substrates are presented in Table 1. The variables of temperature, salinity, pH, brightness of nitrate and phosphate are within the standard quality criteria.

Table 1. Physical and chemical parameters of waters and substrates

No	Parameter	Unit	Average	Average Standard
Water Physics-Chemistry				
1.	Temperature	^{0}C	28-30	28-30
2.	Salinity	ppt	33-34	33-34
3.	pH	-	7	7-8.5
4.	Distinction	m	3-5	>3
5.	Current velocity	m/s	0.039-0.056	-
6.	Total Organic Matter (TOM)	%	1.088-1.482	-
7.	Nitrate	mg/l	0.0133-0.0177	0.008
8.	Phosphate	mg/l	0,0016-0,0032	0.015
Substrat				
1.	Texture	Muddy Sand	Muddy	Sandy

* Minister of Environment Decree No. 200 of 2004

Density of Seagrass Species

The results of observations of the density of each type of seagrass found at each observation station are presented in Table 2.

Table 2. Density of seagrass species at each observation station in the waters of Sawapudo Village, Soropia District, Konawe Regency

No	Types of Seagrass	Density (standing/m^2)		
		I	II	III
1	*Enhalus acoroides*	462	619	230
2	*Thalassia hemprichii*	100	-	-
3	*Cymodocea rotundata*	86	124	86
4	*Halodule uninervis*	-	136	257
	Average	216	293	191

Percentage of Seagrass Coverage

The results of the analysis of the percentage of seagrass cover at each observation station are presented in Table 3.

Table 3. Percentage of seagrass cover at each observation station in the waters of Sawapudo Village, Soropia District, Konawe Regency

No	Types of Seagrass	% Seagrass Cover		
		Station I	Station II	Station III
1	*Enhalus acoroides*	98.00%	100%	87%
2	*Thalassia hemprichii*	50.05%	-	-
3	*Cymodocea rotundata*	55.87%	62.35%	30.48%
4	*Halodule uninervis*	-	55.00%	42,83
	Average	67,97%	72,45%	53,44%

Seagrass Distribution

The results of the distribution analysis at each observation station using the Morisita index can be seen in Table 4.

Table 4. Results of the analysis of seagrass distribution patterns

Station	Substrate Type	Id	Distribution Pattern
I	Silky sand	1,64	Clustered
II	Muddy	1,61	Clustered
III	Sandy	1,15	Clustered

DISCUSSION

Physical and Chemical Parameters of Water and Substrate

Temperature is one of the most influential environmental factors on the seagrass ecosystem and is also a limiting factor for the growth and distribution of seagrass. The results of water temperature measurements at the research location carried out during low tide showed slightly different values, ranging from 28-30°C. The temperature conditions at this research location are the optimal temperature that can support seagrass life to grow and develop. As stated by Pelafu *et al.,* (2022), the optimal temperature for seagrass growth ranges from 28-30°C.

Salinity is the level of salinity or salt content dissolved in water. Each seagrass species has a different tolerance to salinity, although most have a fairly wide tolerance range. Salinity is one of the most important limiting factors for seagrass growth. Changes in salinity occur due to fluctuations in the number of water molecules due to evaporation and rain. Salinity increases if the evaporation rate in an area is greater than rainfall. Conversely, salinity decreases in areas with higher rainfall than evaporation.

The measurement results at the research location showed a slightly varying salinity range, namely between 33-34 ppt. This is in accordance with the opinion of Hoek *et al.,* (2016) who stated that seagrass has a tolerance to salinity ranging from 10-40 ppt, with an optimum value for seagrass growth of 35 ppt. This means that in the salinity range at the research location, seagrass grows well because it is close to the optimum salinity value.

The pH value is influenced by several factors, including biological activities such as photosynthesis and respiration of organisms, as well as chemical processes in water such as the pH level itself and the presence of ions or mineral content. The optimum pH value to support seagrass life ranges from 7.5-8.5, with an average value of around 7.5. According to Sipayung *et al.,* (2023), the pH range that can support seagrass life is 6.5-10.3 with an average of 8.5, which results in a seagrass cover value of between 61.4-69.9%. Fahruddin *et al.,* (2023) reported that pH values between 7.3-7.5 with an average of 7.4 support the life of seagrass species with densities ranging from 473-800 individuals/m² and an average of 533 individuals/m². The pH range obtained at this research location is still in accordance with the water quality standards for aquatic biota based on the Minister of State for the Environment Decree No. 51/MNLH/2004, which states that the normal pH range of waters that can support the life of aquatic organisms is 6.50-8.50 (MNLH 2004).

The condition of ocean currents is influenced by several factors, including winds that cause surface currents and periodic currents caused by tides. Ocean currents can also threaten the existence of seagrass, especially if strong currents cause seagrass plants to be detached from the substrate at the bottom of the waters. The current speed at the research location ranged from 0.039 to 0.056 m/s, indicating that this current speed tends to be optimal to support seagrass growth. According to Dahuri *et al.,* (2004), current movement affects seagrass growth because it is related to the supply of nutrients and the supply of dissolved gases needed by seagrass. In addition, the influence of tides and the type of substrate can affect the zoning and growth of several types of seagrass.

The average results of water depth and brightness measurements during the study were not much different, both at high and low tide. At high tide, the depth ranged from 144-149 cm, while at low tide, the average depth ranged from 29-35 cm. The brightness of a body of water depends on the penetration of sunlight into the water. The observed water clarity in Sawapudo Village was 100%, which means that irradiation still occurs to a certain depth. Based on these data, it can be seen that the waters of Sawapudo Village are shallow and clear waters because light can enter to a certain depth. Similar conditions are also seen in the results of brightness measurements in seagrass beds in the waters of Pengujan District, Bintan, which reached 100% or to the bottom of the waters (Sari *et al.,* 2021). This is related to the seagrass habitat in shallow waters (Ariasari *et al.,* 2022).

Nitrate is the main form of nitrogen in waters and is the main nutrient for seagrass growth. While phosphate is orthophosphate in inorganic form that can be utilized by seagrass growth and development. Phosphate is a chemical parameter of waters that can be absorbed directly by seagrass. The nitrate content at the research location is on average around 0, 0.0133-0.0177 mg/l. The nitrate content in the waters of Sawapudo Village has a different nitrate content. According to Abidin and Rehena (2018), nitrate content in different levels is needed by each type of seagrass. Furthermore, Baron *et al.,* (2006) said that nitrate content exceeding 0.2 mg/l can result in eutrophication (enrichment) of waters.

Phosphate content at the research location ranges from 0.0016-0.0032 mg/l, this is the highest phosphate content and the lowest value, not much different when compared to the standard value of marine biota quality standards, which is 0.015 mg/l (Minister of Environment Decree No. 200 of 2004). Phosphate compounds in waters can come from natural sources such as soil erosion, animal waste, weathering of plants or from the sea itself.

Total organic matter (TOM) on the substrate is the accumulation of plant and animal remains, some of which have undergone weathering. Based on the results of observations, the TOM analysis at the research location is not much different, with an average range of 1.088-482%. Seagrass that lives rich in organic matter tends to be more easily separated from the substrate, compared to seagrass that lives on sandy substrates that are poor in organic matter. In addition, there are differences in morphology between seagrass that lives in areas that are rich and poor in organic matter. According to Ira (2011), seagrass that grows poor in organic matter has short and narrow leaves compared to those that live on substrates that are rich in organic matter.

The type of substrate at the research location (Table 1) shows differences in the type of substrate at the research location, namely muddy and sandy sand substrates. This is related to the location of the Badak Badak Island seagrass meadow at the mouth of the Tanjung Limau River and the characteristics of its basic substrate. Similar things were also found in the seagrass meadows of Sanur Beach, Bali Province, coarser grains, slightly finer and slightly fine mud (Junaidi, 2016). Seagrass can be found on various substrate characteristics. In Indonesia, seagrass beds can be grouped into six categories, namely mud, sandy mud, sand, muddy sand, coral rubble and coral rock. This grouping is based on the particle size of the substrate (Dahuri 2003). The substrate functions as a place for seagrass to grow and plays a role in regulating the availability of nutrients and maintaining the stability of seagrass in the waters. The substrate determines how far seagrass grows. Generally, seagrass grows on muddy substrates to coral fragments. The density of species and percentage of seagrass cover vary where each seagrass species has a different type of leaf, in addition to being caused by different types of substrates.

Composition of Seagrass Types

Seagrass beds in the waters of Sawapudo Village are overgrown with 4 species of seagrass consisting of 2 Families, namely the *Hydrocharitaceae* Family and the *Potamogetonaceae* Family, the *Hydrocharitaceae* Family consists of two species, namely *Enhalus acoroides*, and *Thalasia hemprichii*, while the *Potamogetonaceae* Family consists of the species *Cymodocea rotundata* and *Halodule uninervis*.

Based on the results of observations made at the three stations, it shows differences in the composition of species at each station. The existence of the 5 types is not evenly distributed and not all of them are found at each station. The existence of this difference in composition is caused by the types of seagrass found in the waters of Sawapudo Village growing scattered in separate groups with unclear boundaries and a certain amount and uneven distribution.

Seagrass Species Density

Seagrass species density is the number of individuals/stands of a type of seagrass in a certain area. The density of seagrass species will be higher if the environmental conditions of the waters where the seagrass grows are in good condition. The density of seagrass species is influenced by factors where the seagrass grows, namely depth, brightness, current speed, temperature, salinity, nutrients, total organic matter and substrate type.

Based on (Table 2), it can be seen that the density of seagrass species differs at each observation station. Where, the density of seagrass species at station II is greater when compared to stations I and III, namely the highest density of seagrass species found at station II is the muddy substrate type, namely 293 stands/m^2 (*E. acoroides, T. hemprichii, C. rotundata*), then followed by station I muddy sand substrate with an average density of 216 stands/m^2 (*E. acoroides, C. rotundata, H. uninervis*).

The high density at station II is due to the relatively calm waters and is likely closely related to habitat characteristics such as depth and type of substrate that are very supportive for growth and the nitrate phosphate content at station II is higher than at station III. According to Hartati *et al.,* (2017) stated that the density of seagrass species will be higher if the environmental conditions of the waters where seagrass grows are in good condition.

Station III is a sandy substrate that has the lowest density of seagrass species with an average density of 191 stands/m^2 (*E. acoroides, C. rotundata, H. uninervis*). This is because at station III the dominant substrate is sand so that it has a greater effect on the nutrient content accumulated in the substrate.

Percentage of Seagrass Coverage

The percentage of seagrass coverage describes how wide the seagrass covers a body of water and is usually expressed in percent. The percentage coverage value does not only depend on the density value of the seagrass species, but is also influenced by the morphological condition of the seagrass species.

The percentage coverage describes the level of cover/shading of space by seagrass. Based on the results of observations, the percentage coverage value at each research station (Table 3) varies, where the percentage of seagrass coverage at station I is a muddy sand substrate with an average value of 67.97%, and at station II the muddy substrate the average value of the percentage of seagrass coverage is 72.45%, the percentage of seagrass coverage at station III, has a sandy substrate, an average of 53.44%. The highest average value for the percentage of seagrass coverage is at station II, followed by station I. This difference occurs because the *Enhalus acoroides* seagrass stand has a higher level of coverage than the *Halodule uninervis* seagrass, which is caused by the larger size of the *Enhalus acoroides* leaves. According to Short and Coles (2003), small seagrass stands such as *Halodule uninervis* will have a smaller percentage cover value.

The difference in the percentage of seagrass cover at 3 stations can be influenced by the number of stands of seagrass species, morphology and substrate type. In addition, environmental factors such as current speed and human activities that cause damage to seagrass beds, namely the placement of boat anchors.

Seagrass Distribution

The distribution pattern is used to determine the distribution of seagrass species at a particular station. If the distribution index value is less than one (Id <1), then the distribution pattern formed is a uniform pattern, if the distribution index value is equal to one (Id = 1), then the distribution pattern is random, while if the distribution pattern index value is more than one (Id > 1), then the distribution pattern formed is clustered.

Based on the results of the analysis of seagrass distribution at each research station, it can be seen that the distribution pattern of seagrass in the waters of Sawapudo Village is a clustered distribution pattern with varying values. Where at station I with a muddy sand substrate, it is 1.64, then station II is muddy, it is 1.61, while at station III with a sandy substrate type, it is 1.15 (Table 4).

The distribution pattern is clustered at 3 stations because there are places that are in accordance with the growth needs of the species, for example substrate, pH, and other parameters as well as responses to weather. According to Blake *et al.,* (2014), seagrass grouping is the result of: 1) responding to weather changes, 2) responding to changes in local habitat and 3) as a result of reproductive processes, competition for space and nutrients.

CONCLUSION

The difference in density of seagrass species at the research location was caused by differences in different substrate types and preferences of seagrass species. In addition, the percentage of seagrass cover was influenced by the number of stands of seagrass species, morphology and substrate type. The distribution pattern of seagrass species based on substrate type at the research location was a clustered distribution pattern.

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REFERENCES

Ariasari, A., Sugara, A., Nabiu, N.L.M., Mahfudz, A.A. (2022). Karakteristik padang lamun perairan dangkal di Teluk Merpas, Pulau Enggano, Kabupaten Bengkulu Utara. *Jurnal Of Aceh Aquatic Sciences*, 6(2). https://doi.org/10.35308/jaas.v6i2.6480

Abidin, R., & Rehena, J, F. (2018). Hubungan kandungan nitrat terhadap pertumbuhan lamun *(Enhalus acoroides)* di pesisir pantai Negeri Suli Kecamatan Salahutu Kabupaten Maluku Tengah. *Biopendix*, 4(2), 128-132. https://doi.org/10.30598/biopendixvol4issue2page128-132

Brower, J. E., Zar, J. H., von Ende. C. N. (1990). *Field and Laboratory Methods for General Ecology.* Dubuque: Wm. C. Brown Publishers.

Baron, C., Middelburg, J. J., Duarte, C. M. (2006). Phytoplankton trapped within seagrass *(Posidonia oceanica)* sediments are a nitrogen source: An in situ isotipe labeling experiment. Limnology and Oceanography, 51(4), 16481653. https://doi.org/10.4319/lo.2006.51.4.1648

Dahuri, R. (2003). Keanekaragaman Hayati Laut: Aset Pembangunan Berkelanjutan Indonesia. Jakarta: Gramedia Pustaka Utama.

Dahuri, R. (2004). Pengelolaan Sumber Daya Wilayah Pesisir dan Lautan secara terpadu (Edisi Revisi). Jakarta: Pradnya Paramita.

Blake, R. E., Duffy, J. E., Richardson, J. P. (2014). Patterns of seagrass community response to local shoreline development. Estuaries and Coasts, 37(6), 1549-1561. https://doi.org/10.1007/s12237-014-9777-1

Fahruddin, M., Suriyadin, A., Murtawa, H., Abdurachman, M.H., Setyono, B. D. H., Saputra, A., Ilyas, A. P. (2023). Struktur komunitas lamun di perairan Ketapang, Lombok Barat. *Journal of Marine Research*, 12(1), 61-70. https://doi.org/10.14710/jmr.v12i1.34537

Hoek, F., Razak, A. D., Hamid, M., Suruwaky, A. M., Arfah, A. (2016). Struktur komunitas lamun di perairan Distrik Salawati Utara, Kabupaten Raja Ampat. *Airaha,* 5(1). www.airaha.org

Hartati, R., Widianingsih, W., Santoso, A., Endrawati, H., Zainuri, M., Riniatsih, I., Saputra, W.L. & Mahendrajaya, R.T. (2017). Variasi Komposisi dan Kerapatan Jenis Lamun di perairan Ujung Piring, Kabupaten Jepara. *Jurnal Kelautan Tropis*, 20(2), 96-105. https://doi.org/10.14710/jkt.v20i2.1702

Harjuna, R. A., Riniatsih, I., Suryono, C. A. (2020). Kondisi padang lamun di Pulau Panjang dan Pulau Lima, Banten. *Journal of Tropical Marine Science*, 3(2), 89-93. https://doi.org/10.33019/jour.trop.mar.sci.v3i2.1928

Idris, F., Ita, K., Sekar, M.C. H., Nugraha, A. H. (2020). Short Communication: Dugong's presence confirmation in Bintan Island based on local ecological knowledge. *AACL Bioflux*, 13(2), 2018-2023. http://www.bioflux.com.ro/aacl

Junaidi. (2016). Analisis diversitas padang lamun pada satu stasiun Pantai Sanur Kota Denpasar Provinsi Bali. *Journal Ilmiah Rinjani*: Media Informasi Ilmiah Universitas Gunung Rinjani, 3(1), 1–10. https://doi.org/10.53952/jir.v3i1.228

Jemi, J., Karlina, I., Nugraha, A. H. (2022). Struktur populasi ikan baronang pada ekosistem lamun di pesisir Pulau Bintan. *Journal of Marine Research*, 11(1), 9-18. https://doi.org/10.14710/jmr.v11i1.33029

Kiswara, W., & Hutomo, M. (1985). *Habitat dan sebaran geografik lamun.* Oseana, 10(1), 21-30. LIPI.

Kiswara, W. (1997). struktur komunitas padang lamun perairan indonesia. *In Inventarisasi dan Evaluasi Potensi Laut Pesisir II* (pp. XX-XX). Jakarta: Pusat Penelitian dan Pengembangan, LIPI.

Kuriandewa, T. E. (2009). Tinjaun tentang lamun di Indonesia. *Prosiding Lokakarya Nasional I Pengelolaan Ekosistem Lamun.* Sheraton Media, Jakarta: PKSPL. 2009.

Moussa, R. M., Bertucci, F., Jorissen, H., Gache, C., Waqalevu, V. P., Parravicini, V., Lecchini, D., Galzin, R. (2020). Importance of intertidal seagrass beds as nursery area for coral reef fish juveniles (Mayotte, Indian Ocean). *Regional Studies in Marine Science*, 33, 100965. https://doi.org/10.1016/j.rsma.2019.100965

Pelafu, R. E. P., Wagey, B. T., Paruntu, C. P., Tilaar, S.O., Windarto, A. B., dan Tilaar, F. F. (2022). Struktur komunitas padang lamun di Perairan Bulutui Kecamatan Likupang Barat, Kabupaten Minahasa Utara. *Jurnal Pesisir dan Laut Tropis*, 10(2), 1-13. https://doi.org/10.35800/jplt.10.2.2022.41120

Soegianto, A. (1994). *Ekologi Kuantitatif*. Surabaya: Usaha Nasional.

Short, F. T. Coles, E. (2003). Global *Seagrass Research Methods*. Netherlands: Elsevier Science.

Setyobudiandi, I., Yulianda, F., Kusmana, C., Hariyadi, S., Damar, A., Sembiring, A., Bahtiar. (2009). *Sampling dan Analisis Data Perikanan dan Kelautan: Terapan Metode Pengambilan Contoh di Wilayah Pesisir Laut.* Bogor: Fakultas Perikanan dan Ilmu Kelautan, IPB.

Sjafrie, N. D. M., Hermawan, U. E., Prayudha, B., Supriyadi, I. H., Iswari, M.Y., Rahmat, Anggraeni, K., Rahmawati, S., Suryasi. (2018). Status Padang Lamun Indonesia. Jakarta.

Sipayung, S. B., Sondak, C. F. A., Warouw, V., Rimper, J. R., Kemer, K., Mamuaja, J. M., Tilaar, F. F. (2023). Kondisi kesehatan padang lamun di Perairan Lantung Kecamatan Wori, Kabupaten Minahasa Utara. *Jurnal Pesisir dan Laut Tropis*, 11(1), 29–37. https://doi.org/10.35800/jplt.11.1.2023.53098