Eduvest – Journal of Universal Studies
Volume 5 Number 5, May 2025
p- ISSN 2775-3735- e-ISSN 2775-3727

ANALYSIS OF SUBSTRATE CHARACTERISTICS OF SEAGRASS HABITAT IN DORERI BAY MANOKWARI DISTRICT

Feldy F Korwa*, Gandi Y.S Purba, Tresia S. Tururaja, Roni Bawole, Margaretha M. Yohana Wakum
Universitas Papua, Papua Barat, Indonesia
Email: feldyfebriankorwa@gmail.com

ABSTRACT

This study investigates the characteristics of substrates in seagrass habitats within Doreri Bay, Manokwari District, and their relationship with seagrass species composition. The research aims to assess the type, density, and percentage of seagrass cover, alongside the substrate characteristics in the region. Data were collected between March and May 2020 using the line transect method, while water quality data were gathered in situ. The study found seven seagrass species in Doreri Bay, with densities ranging from 1058 ind/m² to 1457 ind/m² and a cover percentage between 17% and 30%. Substrate types included calcareous, gravel, sands, and silt, each influencing the distribution of seagrass species. Principal Component Analysis (PCA) revealed correlations between specific seagrass species and substrate types: Cymodocea rotundata and Halodule pinifolia correlated with silt, while Thalassia hemprichii was associated with fine sand substrates. The results indicate that substrate characteristics play a significant role in seagrass distribution and biodiversity in Doreri Bay. The study's findings have important implications for the region's management and conservation of seagrass ecosystems, suggesting that targeted efforts to protect specific substrate types can support seagrass health.

KEYWORDS *Substrate, Seagrass, Correlation of Substrate and Seagrass, Doreri Bay*

Article Info:
Submitted: 03-01-2025 | Final Revised: 10-05-2025 | Accepted: 17-05-2025 | Published: 21-05-2025

INTRODUCTION

Sediment is an accumulation process caused by the deposition of materials and other particles formed through chemical processes in the sea (Gross, 1990; Rifardi, 2008). The sediment load that enters the marine environment through the water media is then deposited, so that with the continuous process, there will be deposition (sedimentation). The size and type of sediment varies greatly from gravel, sand, silt, and clay (Lisdawati et al., 2018). The source of sediment in a

How to cite: Korwa, F. F., Purba, G. Y. S., Tururaja, T. S., Bawole, R., & Wakum, M. M. Y. (2025). Analysis of Substrate Characteristics of Seagrass Habitat in Doreri Bay Manokwari District. Journal Eduvest. *5*(5): 5132-5149.
E-ISSN: 2775-3727
Published by: https://greenpublisher.id/

marine body of water determines the type of sediment, based on its origin, sediment is divided into 4 types, namely: 1) lithogenous sediments, 2) biogenous sediments, 3) hydrogenous sediments, and 4) cosmogenous sediments (Wibisono & S, 2011).

The substrate in the water affects the presence of coastal vegetation such as seagrass beds. Differences in substrate type composition can cause differences in seagrass species composition and affect seagrass fertility and growth (Malasari et al., 2016). The fine substrate has more organic matter than the coarse substrate. The high content of organic matter in the substrate greatly supports the growth process of seagrasses (Tomascik et al., 1977; Afiati et al., 2014).

Seagrass is important in marine biota's life as a habitat for various marine organisms and plays a role in the food chain. Seagrass ecosystems also play a role in coastal areas, preventing coastal abrasion and slowing currents and waves. Substrate characteristics affect the structure and cover of seagrasses, so that each type of seagrass has a different habitat depending on the main substrate requirements for the development of seagrass vegetation in its environment (Wajdiah, 2017).

One of the areas overgrown with seagrasses is the waters of Doreri Bay. According to Lefaan et al. (2013), there are 8 types of seagrasses identified in Doreri Bay Waters, namely: Enhalus acoroides, Halophila ovalis, Thalassia hemprichii, Cymodocea rotundata, Cymodocea serrulata, Halodule pinifolia, Halodule uninervis and Syringodium isoetifolium, with mixed vegetation type. The presence of seagrass species is influenced by water quality parameters such as temperature, salinity, DO, pH, turbidity, and substrate type. The structure of seagrass communities in Doreri Bay waters has been studied, including seagrass density, seagrass biomass, dominance, and percentage of seagrass closure, by Lefaan et al. (2013). However, research related to the relationship of substrate type to seagrass habitat is still largely unknown/conducted. Based on this, conducting research and analyzing seagrass habitat substrate characteristics in Doreri Bay, Manokwari Regency, is necessary. Based on the description above, research was conducted on the Analysis of Substrate Characteristics of Seagrass Habitat In Doreri Bay, Manokwari District (Sombo et al., 2016).

Seagrass habitats, particularly in Doreri Bay, Manokwari, face ecological challenges due to various substrate types influencing the distribution and density of seagrass species (Sjafrie et al., 2018). Understanding the relationship between substrate characteristics and seagrass species is crucial for maintaining biodiversity and promoting sustainable marine ecosystem management. Previous studies have explored the role of substrate in supporting seagrass growth; however, there is limited research on how different substrate types specifically affect the types and distribution of seagrass in Doreri Bay (Sembel et al., 2019; Setyawan et al., 2012; Simon et al., 2013; Siregar et al., 2017). The lack of research on how substrate variations in this region influence seagrass coverage and species distribution hinders effective management practices for preserving marine biodiversity (Hasanuddin & R, 2013).

Seagrass ecosystems play a critical role in marine environments by providing habitat for numerous marine organisms, mitigating coastal erosion, and supporting the overall health of marine ecosystems. Despite their importance, many seagrass ecosystems are threatened by human activities, environmental changes, and poor management practices (Tampubolon & S, 2010). In Doreri Bay, the variety of substrates, including silt, sand, and gravel, affects the distribution and health of seagrass beds. This study examines the specific correlation between substrate characteristics and seagrass species in this region to support better management and conservation strategies for seagrass ecosystems (Tangke & U, 2010).

This research is highly urgent because it aims to enhance understanding of the relationship between substrate characteristics and seagrass distribution in Doreri Bay, Manokwari. Given the critical role of seagrass ecosystems in maintaining marine biodiversity and preventing coastal erosion, this study is important for formulating more effective conservation strategies (Putra et al., 2017). As the threats to marine ecosystems continue to increase due to human activities and climate change, the findings of this research will help guide policies and actions to protect seagrass habitats, especially in areas like Doreri Bay, which have significant ecological and economic value (Hartati et al., 2017).

Lefaan et al. (2013) identified eight species of seagrasses in the waters of Doreri Bay but did not explore the specific relationship between substrate types and seagrass distribution. Malasari et al. (2016) found that differences in substrate composition can affect seagrass species composition, but they did not focus on the local environmental factors, such as water depth or water quality, which play a significant role in determining the suitable substrate for seagrass growth. Afiati et al. (2014) emphasized the role of organic matter in the substrate in supporting seagrass growth, but the relationship between substrate types and seagrass distribution in the specific context of Doreri Bay remains underexplored (Korwa et al., 2013).

While much research has been done on the general relationship between substrates and seagrass, limited research focuses specifically on the correlation between substrate types and the distribution of seagrass species in Doreri Bay. This study fills this gap by analyzing substrate characteristics at three different research sites in Doreri Bay and examining how these substrates affect the types and distribution of seagrass species. The research also introduces a new approach by linking environmental factors with substrate types to understand better their influence on seagrass ecosystems in tropical coastal areas.

This study offers a novel approach using Principal Component Analysis (PCA) to analyze the relationship between substrate types and seagrass species in Doreri Bay. This method provides deeper insights into how different substrate types influence the distribution and density of seagrass species at specific sites, an area that has not been thoroughly explored in previous studies. The findings of this research will contribute new knowledge to the field of marine ecology, particularly in understanding the ecological interactions between substrate types and seagrass species in tropical coastal environments.

This research aims to analyze the substrate characteristics of seagrass habitats in Doreri Bay and the relationship between substrate types and the composition and density of seagrass species at three different locations. This study aims to provide a clear understanding of the environmental factors that influence seagrass distribution in Doreri Bay, which can be used for better management and conservation strategies (Kuo et al., 2010).

Academically, this research will contribute to a better understanding the relationship between substrate types and seagrass distribution, particularly in tropical regions like Doreri Bay. Practically, the results of this study can be used by local authorities to develop conservation policies and strategies to protect seagrass habitats. This research will also provide a foundation for improved resource management, focusing on the preservation of seagrass ecosystems, which are essential for marine biodiversity and the overall health of coastal areas (Kurniawan et al., 2011).

RESEARCH METHOD

The research method used in this study is qualitative research, which aims to explore and understand the phenomena in their natural context, focusing on the depth of the subject matter rather than generalization. This method is suitable for examining the relationship between substrate characteristics and seagrass species in Doreri Bay, as it allows the researcher to investigate the underlying factors influencing the distribution and density of seagrass. The research uses purposive sampling to select specific sites with distinct environmental conditions, ensuring the findings are relevant to the study's objectives. Data collection is done through direct observation and in-depth analysis of substrate types and seagrass species using line transects and sediment sampling. The qualitative approach is supported by inductive data analysis, allowing for a nuanced understanding of the interactions between substrates and seagrass species in this coastal ecosystem.

Time and Place

This research was conducted from March to May 2020, including the preparation stage, initial observation stage, field data collection, and data analysis. It was carried out in Doreri Bay, Manokwari Regency, with three (3) observation locations: BLK Beach, Tanjung Manggewa, and Lemon Island (Figure 1). Data analysis was conducted at the Aquatic Resources Laboratory of FPIK and the Laboratory of Mineral and Metallurgical Materials Processing, Faculty of Mining and Petroleum Engineering, University of Papua.

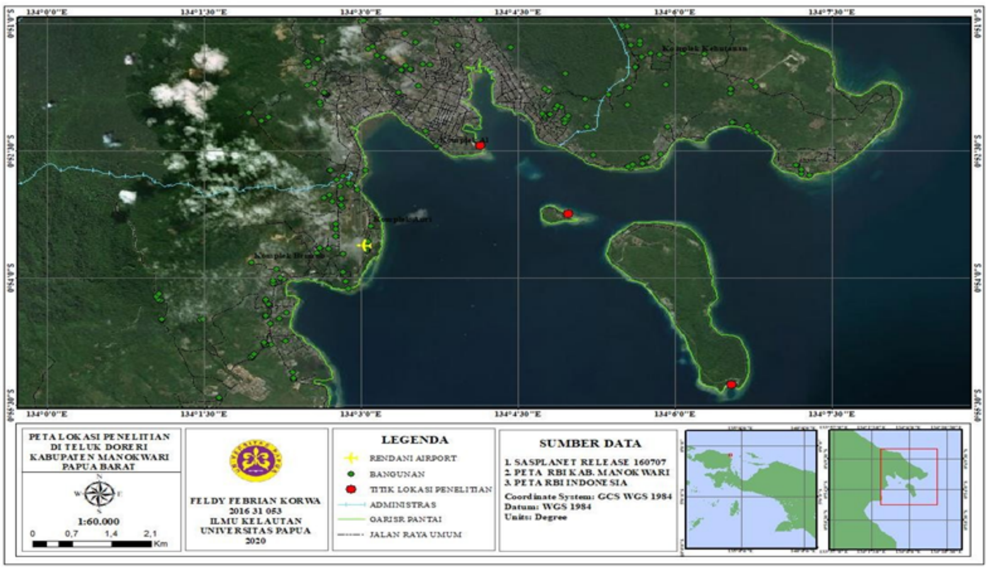


Figure 1. Map of the Research Location

Data Collection Method

Determination of Observation Location

The observation location was determined using the purposive sampling method, considering the difference in location. BLK Beach is at the center of residential activity, Lemon Island is in front of the city, a shipping activity route, and Tanjung Manggewa is far from residential areas, directly facing the Pacific Ocean. The location of different locations will affect the type of seagrass habitat substrate. The placement of transect and quadratic points uses the systematic random sampling (SRS) method, with the consideration that the sampling points for data collection can represent the overall seagrass habitat area of the research area (Tururaja et al., 2010).

Seagrass Data Retrieval

Seagrass data was taken using the line transect method with the following work stages:

1. Seagrass data were collected using the line transect method, with an average transect length for BLK Beach of 32 m, Tanjung Manggewa of 33.7 m, and Lemon Island of 34 m (Figure 2).
2. The square used is 50 cm x 50 cm, and the distance between it and the square is adjusted to the length of the transect (there are 10 squares in one transect line).

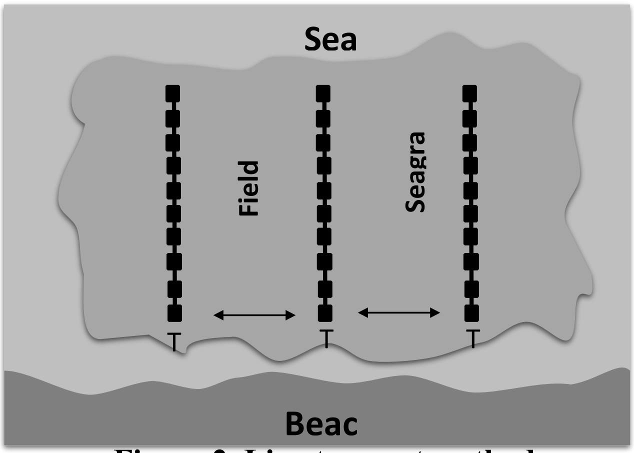


Figure 2. Line transect method

3. Identify the type of seagrass contained in the square using an identification book (Rahmawati et al., 2014).
4. Count and record the number of seagrass individuals from each type of seagrass in each square to determine the density of seagrass species.
5. Figure 3 and Table 1 show how the seagrass cover percentage was determined using a 50 x 50 cm square and assessed using the grid.

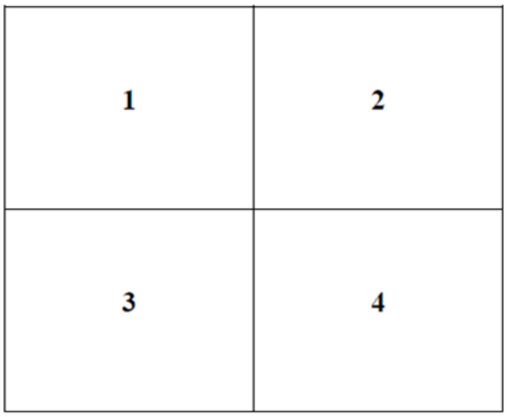


Figure 3. Example Plot 50 x 50 cm

Table 1. Closing Rating in Small Box 50 x 50 cm

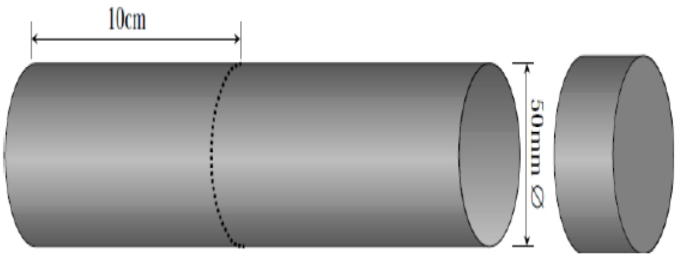
Category	Seagrass Cover Value
Full Cover	100
Cover $\frac{3}{4}$ small box	75
Cover $\frac{1}{2}$ small box	50
Cover $\frac{1}{4}$ small box	25
Blank	0

Source: Rahmawati et al., (2014)

Sediment Pickup

Sediment samples were taken by the line transect method using a sediment corer modification tool Latuconsina & H (2012); Hidayat et al. (2014); Yunitha et al. (2014), the stages of work are as follows:

1. The transect line is drawn vertically along 100 m perpendicular to the shoreline.
2. Sediment sampling was carried out using a modified sediment corer made of a PVC pipe with a diameter of 2 inches and a length of 30 cm (low tide) and 75 cm (high tide) (Figure 4) (Seagrass Watch in Tuwo, 2011).



Figur 4. Modified Sediment Corer Tool

3. Sediment sampling was carried out at 3 points of each transect line, namely at the end of the coast, the middle, and the end of the sea (sampling at these three points is to represent the seagrass habitat substrate. The consideration of sediment sampling is based on following the distribution of seagrass species that are distributed vertically towards the sea (Hazeri & G, 2014).
4. The sediment corer is inserted into the substrate at a perpendicular angle and pressed to a depth of 10 cm. The top of the sediment corer is covered with a rubber

or plastic aid and pulled out slowly. Sediments containing broken corals are taken using a small shovel.
5. The sediment samples that have been obtained are put into the sample plastic and labeled according to their transect and square.
6. The sediment samples are dried in an oven at 105 oC for ± 5 hours, after which they are cleaned of impurities. The sediment is weighed to obtain a gross weight.
7. The sediment is washed with clean (fresh) water to remove the salt content. The sediment is then filtered and dried again in the oven.
8. The dried sediment is weighed to obtain a net weight and analyzed in the laboratory for slate grain type and size.

Seawater Quality Data Collection

Water quality data is taken in situ at each observation station with three (3) repetitions by comparing the results of measuring water quality parameters with marine biota quality standards according to Kepmen-LH No.51 of 2004, the stages of work are as follows:
1. The temperature of seawater is measured using a thermometer.
2. Salinity is measured using a refractometer.
3. pH (acidity) is measured using a pH meter.
4. DO (dissolved oxygen) is measured using a DO meter.
5. Turbidity measurement is measured by taking seawater samples using a sample bottle, then measuring turbidity using a Turbidity meter.

Data Analysis

Seagrass Cover Percentage and Seagrass Density Analysis

The percentage of seagrass species cover is calculated by Equation 1 (Tuwo & A, 2011).

$$\mathbf{PJ} = \frac{\boldsymbol{\alpha}\mathbf{i}}{\mathbf{A}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where; PJ = Percentage of seagrass species to – i (%/m^2)
αi = Seagrass cover area of seagrass type to – i (%)
A = Total area covered by seagrass (m^2)

Type density of seagrass is calculated using Equation 2 **(**Tuwo, 2011).

$$\mathbf{Kji} = \frac{\mathbf{Ni}}{\mathbf{A}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where: Kji = Type density to – i (ind/m^2)
Ni = Total number of individuals of type to – i (ind)
A = Total sampling area (m^2)

The status of seagrass beds seen based on the percentage of seagrass cover refers to the Ministerial Decree No. 200 of 2004 which can be seen in (Table 2).

Table 2. Status of Seagrass Beds in Indonesia

Condition	**Cover (%)**
Rich/Healthy	> 60
Less Rich/Healthy	30 – 59,9
Poor	< 29.9

Source: Kepmen-LH No. 200 of 2004

Sediment Analysis

Sediment Handling in the Laboratory

Sediment analysis was carried out using the *Sieve shaker* method, which was further classified according to Wentworth's criteria to determine the type and size of sediment grains (Affandi & Heron, 2012). The stages of analysis work are as follows:

1. The sediment samples were drained and weighed initially (±300 g), then put in a Sieve shaker (tiered sieve) and sifted for ± 10 minutes.
2. The sediment is further sifted and weighed based on the size of the diameter of the cascading sieve eye (mm).
3. The sediment was weighed, and then the percentage (%) of the sediment weight was calculated using *the sieve shaker* method using Equation 3 (Purnawan et al., 2012).

$$\%\mathbf{berat} = \frac{\mathbf{Berat\ fraksi\ sedimen\ ke - i}}{\mathbf{Berat\ total\ sampel}} \times \mathbf{100\%} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Then classifying sediments according to their grain size using *the Wentworth* scale can be seen in (Table 3).

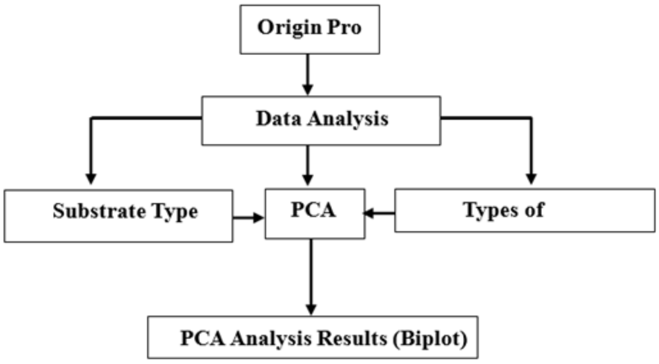
Table 3. the Wentworth Scale

	Terminology	Diameter (mm)
Gravel	Bolder (*Boulder*)	> 256
	Cobble	64 - 256
	Pebble	4 - 64
	Gravel (*Granule*)	2 - 4
Sand	*Very coarse sand*	1 - 2
	Coarse Sand	0,5 - 1
	Medium Sand	0,25 - 0,5
	Fine Sand	0,125 - 0,25
	Very Fine Sand	0,0625 - 0,125
Mud	*Silt*	0,0039 - 0,0625
	Clay	< 0,0039

(Source: Hutabarat and Evans, 1985 *in* Wajdiah, 2017)

Relationship between Substrate Type and Seagrass Type

An overview of the relationship between substrate type and seagrass type uses Principal Component Analysis (PCA), with the help of Origin Pro software. Major component analysis (PCA) is used to extract the most important information from a data group, reduce the data designated as important information, and simplify the data set description (Abdi & Williams, 2010). The results of the PCA analysis will show the correlation between the type of substrate and the type of seagrass. The work steps can be seen in Figure 5 below.



Figur 5. PCA Analysis Results (Bipolot)

The results of the PCA analysis characterize the observed variables and inform how one variable affects or is influenced by other variables. Positively correlated variables form a narrower angle, while negatively correlated variables form a wider angle (Rizkifar et al., 2019).

RESULT AND DISCUSSION

Location Overview

Manokwari is a regency and the capital of West Papua Province, Indonesia. Geographically, Manokwari Regency is located at the coordinates 0o55'05.71‘ LS and 134o01'49.64’ East. Manokwari Regency has an area of 3,168.28 km2 with a population of 173,020 people (BPS Manokwari Regency, 2019). Manokwari Regency is administratively bordered by (Permendagri No. 66 of 2011):

- North bordering the Pacific Ocean
- East is bordered by Lemon Island and Mansinam Island
- The Arfak Mountains Regency borders the South
- West bordering Tambrauw Regency

Doreri Bay is included in the coastal area of Manokwari Regency, where most of the population earns a living as fishermen and planters. Doreri Bay has marine biological resources such as seagrass beds in several locations, including BLK Beach, Lemon Island, and Tanjung Manggewa. BLK Beach is located at coordinates 0°52'26.72‘ N and 134°04'07.44’ East. Lemon Island is situated at 0°53'15.80‘ N and 134°04'52.66’ East. Cape Manggewa, located east of Mansinam Island, is located at coordinates 0°53'34.07’ LS and 134°05'38.45 ‘East. The conditions of these three locations are different, which can affect their resources. BLK Beach is located in the centre of Manokwari City, one of the recreational areas and shipping lanes. Lemon Island is in front of Manokwari City, a shipping lane. Tanjung Manggewa is far from the centre of Manokwari City and directly opposite the Pacific Ocean.

Water Quality

Water quality determines the life of marine organisms in a body of water. Environmental factors, such as temperature, salinity, pH, DO, turbidity, and tides, affect the distribution, growth, and reproduction of organisms. Table 4 shows the results of measurements of water quality parameters carried out in situ at the three locations in the Doreri Bay Waters of Manokwari Regency.

Table 4. Average Water Quality

Station	Temperature	Salinity	pH	DO	Turbidity
BLK	28,20	34,00	6,53	5,35	2,15
TM	29,93	35,67	7,46	6,55	0,38
PL	30,13	34,33	7,49	5,89	0,28
Average	29,42	34,67	7,16	5,93	0,94
Std. Deviation	1,06	0,88	0,54	0,60	1,05

(Data source: Primary data, 2020)
Decription: BLK Beach (Job Training Center)
TM (Cape Manggewa, PL (Lemon Island)

The optimal temperature for seagrasses to perform photosynthesis ranges from 25-35 oC (Imam & P, 2014). Table 7 above informs that the results of temperature measurements at the three locations ranged from 28.20 to 30.13 oC. The temperature range is still within normal conditions that can support the life of marine organisms in these waters. The optimal temperature for seagrass survival refers to Kepmen LH No. 51 of 2004 for seagrass survival, which is 28-30 oC. This condition is in accordance with Lee et al. (2007) and Yunitha et al. (2014), who state that in tropical and sub-tropical areas, the optimal growth of seagrass ranges from 23- 32 °C. (Ira et al., 2012).

Salinity is the concentration of all salt solutions obtained in seawater. It significantly affects the osmotic pressure in seawater and is also a factor that is quite important for the life of seagrass plants (Yunitha et al., 2014). Based on the results of salinity measurements at the three locations, the values ranged from 34.00 to 35.67%o. The optimal salinity for seagrass survival refers to the Decree of the Minister of Environment No. 51 of 2004. The optimal salinity for seagrasses is 34.00- 35.67%o. (Irawan et al., 2016).

Seagrass survival is 33-34%. The sea's salinity distribution is influenced by several factors, namely water circulation patterns, evaporation, rainfall, and river water flow (Nontji, 1984 in Sembel et al., 2019).

The degree of acidity (pH) of a body of water is influenced by several factors, such as the process of photosynthesis and the presence of various types of cations and anions in these waters that can affect the life of marine biota (Susana, 2009, in Imam, 2014). Based on the level of acidity measured at the three research locations has a value ranging from 6.53 to 7.49. The low pH at location I (BLK Beach) can be caused by anthropogenic activities from land, as there are river mouths, fish markets, and docks. This is the same as Sembel & Manan (2018) stated: the high and low pH of waters can be influenced by the amount of land organic matter carried by river flow. The optimal pH for seagrass survival refers to the quality standard of Kepmen LH No. 51 of 2004, the pH of seawater for seagrasses is 7-8.5, so the pH conditions in locations II (Tanjung Manggewa) and III (Lemon Island) are still supportive for seagrass life, while in location I (BLK Beach) it is relatively acidic which can affect seagrass growth.

Dissolved oxygen (DO) is one of the most important forms of dissolved gas in aquatic life systems (Utami, 2012, in Imam, 2014). Oxygen in the water comes from air diffusion and photosynthesis by organisms, such as phytoplankton and aquatic plants in the euphotic zone (Kopalit & H, 2011). Based on the measurements (DO) results conducted at the three locations, with values ranging from 5.35 to 6.55 mg/l. The high value of oxygen content at location II (Tanjung Manggewa) can be caused by the location being far from residential areas and directly facing the Pacific Ocean, so that the waters are not polluted, and allow for stirring, mixing by wind and currents (Jesajas et al., 2016). Stirring and mixing by wind and currents cause a sufficient supply of dissolved oxygen in the water column (Kamal & G, 2015). The optimal DO for seagrass survival refers to the quality standard of Kepmen LH No. 51 of 2004, DO for marine biota life > 5, so the DO conditions at the three locations are still within the quality standard to support seagrass growth.

Suspended solids in the water column affect the turbidity level of a body of water. Turbidity is a water condition that describes the optical properties of water. Turbidity can affect fish respiration, the photosynthesis process, and the primary productivity contained in the water. Based on the measurement results at the three locations, the turbidity value ranged from 0.28 to 2.15 NTU. Referring to the quality standard of Kepmen LH No. 51 of 2004, turbidity for marine life < 5 NTU, most of the turbidity is below the limit that can still support the life of aquatic organisms.

Tides are a phenomenon of periodic rise and fall of sea level caused by the gravitational influence of celestial bodies. The force of attraction of the Earth, Moon, and Sun causes the tidal generating force (Triatmodjo & B, 2012). The driving force of tides can be described as the result of a combination of several tidal harmonic components, which can be grouped into three parts: semi-diurnal, diurnal, and long-period (quarterly).

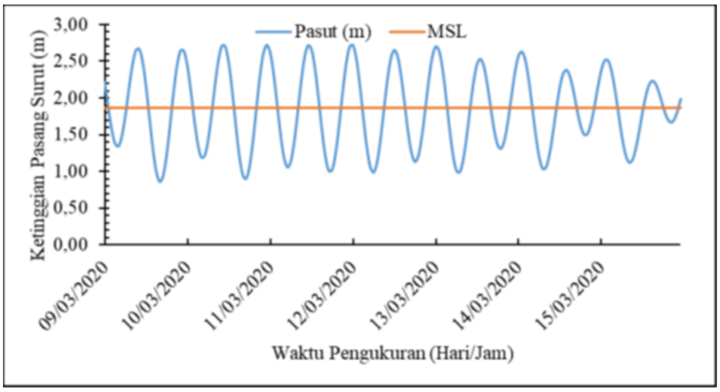


Figure 6. Tides in Doreri Bay (09-15 March 2020)
(Data source: Geospatial Information Agency, 2020)

The type of tide in Doreri Bay, based on Figure 6 above, is a mixed tide prevailing semidiurnal type, which in one day there are two tides and two low tides, but the height and period are different, which is a characteristic of tides that generally occur in Eastern Indonesian waters. Tidal data obtained, the average sea level (MSL) of Doreri Bay waters is 1.86 metres. MSL is the average between the highest and lowest water levels, where the highest tide was 2.72 metres on 10/03/2020 at 23:00 and the lowest tide was 0.86 metres on 09/03/2020 at 16:00.

BLK Beach

Substrate Type Characteristics

The results of data analysis, by classifying the characteristics of substrate types using the Wenworth scale criteria, obtained seven (7) substrate types at BLK Beach: Rocks, Gravel, Very Coarse Sand, Coarse Sand, Medium Sand, Fine Pair, and Silt, which can be seen in Figure 7 below.

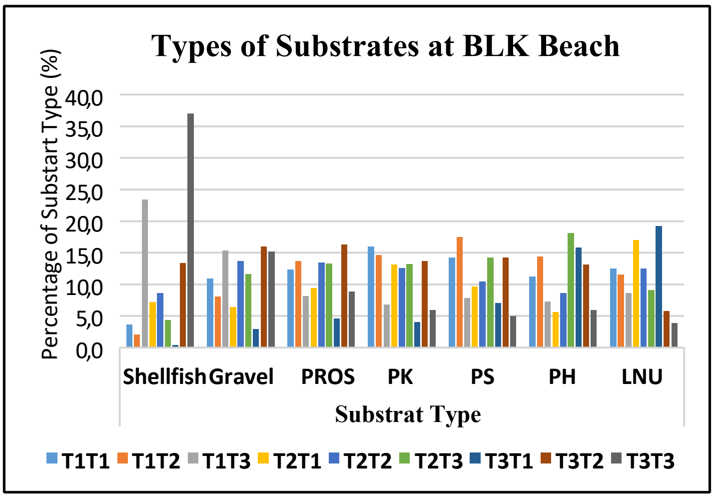


Figure 7. Percentage of Substrate Types at BLK Beach

(Source: Primary Data, 2020) (Caption: Very Coarse Sand (PSK), Coarse Sand (PK), Medium Sand) (PS), Fine Pair (PH), and Silt (LNU)

The overall percentage of substrate type at this location shows that the highest percentage of substrate type is dominated by silt substrate type, 35.5%, with substrate grain size ranging from 0.090-<0.075 mm. The lowest substrate type was very coarse sand at 4.8% with a substrate grain size of 1.18-1.70 mm. The semi-enclosed location within Sawaibu Bay influences the high percentage of silt substrate type in this location. There is also a river at this location, which can affect the substrate type. The silt substrate type that dominates at this location is spread across the three observation transects, where the highest distribution is in the second transect (T2T1-T2T3), which is still found at the third point, which is increasingly towards the sea.

According to Nugroho et al. (2014), the more towards the inside of the bay, the finer the substrate grain size. Oceanographic factors such as currents and waves also affect substrate grain size. Fine-sized substrate (mud/silt) indicates that the currents and waves in the area are relatively calm or weak. This is in line with the research of Purnawan et al. (2016), the type of silt substrate dominates in the research area in the semi-enclosed Balohan Bay, and is more protected from the influence of energy from waters outside the bay. Rifardi (2012) states that the type of substrate in a body of water can also be influenced by the location of the river in the body of water (Rawung et al., 2018)The further away from the mouth of the river, the more sedimentation is dominated by fine-sized substrates (clay and silt).

Seagrass Density and Percentage Cover

Six seagrass species were found in location I (BLK Beach): Thalassia hemprichii (Th), Cymodocea rotundata (Cr), Halodule pinifolia (Hp), H. uninervis (Hu), Halophila ovalis (Ho), and Syringodium isoetifolium (Si). Density values vary between seagrass species, as shown in Figure 8.

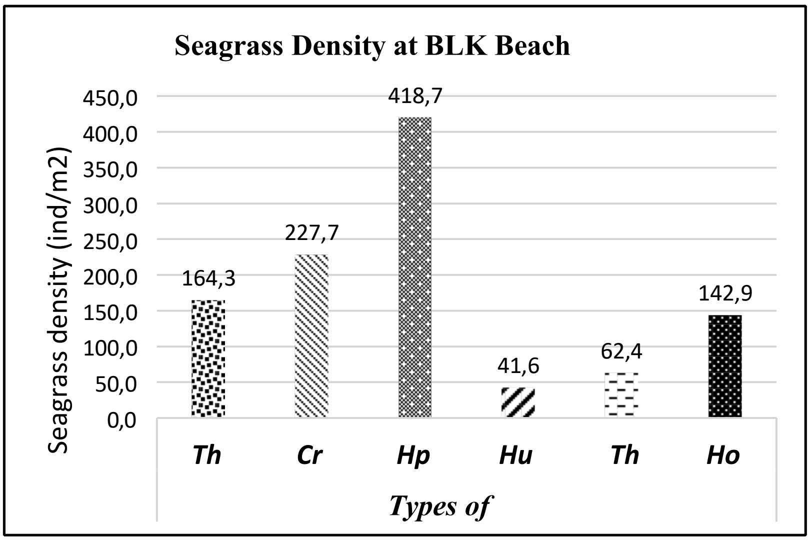


Figure 8. Seagrass Density on BLK Beach
(Source: Primary Data, 2020)
(Caption: (Thalassia hemprichii (Th), Cymodocea rotundata (Cr) Halodule pinifolia (Hp), H. uninervis (Hu), Halophila ovalis (Ho) and Syringodium isoetifolium (Si))

Figure 8 shows that the density of seagrass species obtained in location I (BLK Beach) ranged from 41.6 ind/m2 to 418.7 ind/m2. The seagrass species H. pinifolia has the highest density, while the seagrass species Halodule uninervis has the lowest density. The high density of H. pinifolia seagrass species in this location is because this seagrass species has the highest density. High adaptation to environmental conditions. The water quality measurements showed that the pH parameter was below the quality standard (6.53), and the turbidity level was higher than at other locations, but it was still tolerable for seagrass growth at this location.

Sakey et al. (2015) stated that H. pinifolia is a highly adaptable pioneer species. This species can grow and develop well in disturbed water environments. Seagrass H. uninervis with the lowest density value of 41.6 ind/m2 is caused by the location conditions that are more exposed at low tide, where this seagrass species grows in areas that at the lowest tide are still submerged in water. This is in accordance with Nurzahraeni (2014) that the seagrass species H. uninervis will be difficult to grow and develop in conditions where the bottom of the water is exposed to sunlight.

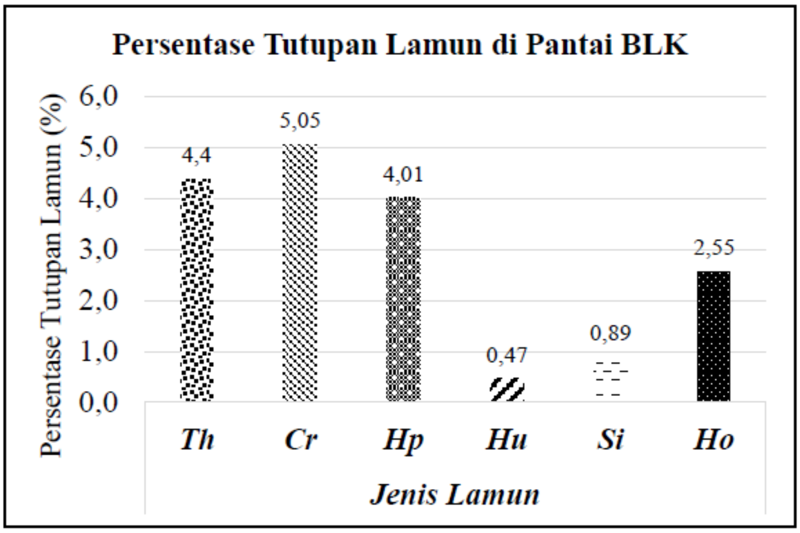


Figure 9. Percentage of Seagrass Planting at BLK Beach

(Source: Primary Data, 2020)

(Caption: (Thalassia hemprichii (Th), Cymodocea rotundata (Cr) Halodule pinifolia (Hp), H. uninervis (Hu), Halophila ovalis (Ho) and Syringodium isoetifolium (Si))

The percentage cover from Figure 9 above shows that the percentage cover in location I (BLK Beach) ranged from 0.47%-5.05%. The seagrass species C. rotundata has a high percentage cover value, although it has a lower density value than H. pinifolia seagrass. This is due to the morphological shape of this seagrass species, which is larger than that of other seagrass species. Simon et al. (2013) stated that the percentage of seagrass cover is higher than that of H. pinifolia seagrass. The percentage cover value is closely related to the morphological size of a seagrass species; the larger the morphological size, the higher the percentage cover value. While the lowest percentage cover and density value is seagrass H. uninervis, this species has a small morphological shape. Overall, the percentage of seagrass cover in location I (BLK Beach) is 17.37%, which is included in the poor condition/category according to Kepmen-LH No. 200 Year 2004, which ranges between (<29.9%).

Relationship between Substrate Type and Seagrass at BLK Beach

The results of principal component analysis (PCA) conducted to see the relationship/correlation between substrate type and seagrass at location I (BLK Beach), from Table 5, show that 2 factors were formed, namely PC1 and PC2. The factors formed are based on eigenvalues > 1, where PC1 has an eigenvalue of 5.1572 and PC2 has an eigenvalue of 3.7938. Factor (PC1) can present 39.67%, while factor 2 (PC2) can present 29.18%. The two factors can represent 68.85% of the total component variation. This means that out of 100% total variation in components, only 68.85% of PC1 and PC2 can be explained based on the variability of the components forming the PC1 and PC2 factors. The relationship between substrate type and seagrass at BLK Beach can be seen in Figure 10.

Table 5. Results of PCA Analysis Interpretation

No	Component	Factor	Eigenvalue	%Variation	%Cumulative
1	Shellfish	PC 1	5,1572	39,67 %	39,67 %
	Gravel				
	T. hemprichii				
	H . Uninervis				
	S. isoetifolium				
	H . Ovalis				
2	PROST	PC 2	3,7938	29,18 %	68,85 %
	Coarse Sand				
	Fine Sand				
	Coastal				
	C . rotundata				
	H . Pinifolia				

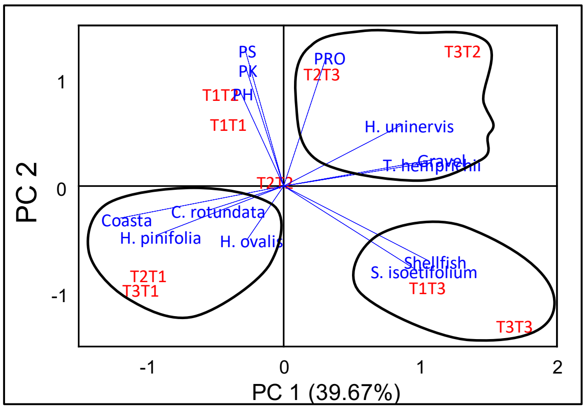


Figure 10. Relationship between Substrate Type and Seagrass on BLK Beach
(Source: Primary Data, 2020)

The results of the PCA analysis in Figure 10 above show that there are three groups of correlated components. The first group is the variables T. hemprichii and H. uninervis seagrasses, which are correlated with the substrate types of very coarse sand and gravel; these seagrasses and substrate types are distributed in transect two. Very coarse sand (PSK) and gravel, these seagrass and substrate types are distributed at the two-three-point transect (T2T3) and the three-point transect (T3T2). The second group, the variable S. isoetifolium seagrasses, correlated with the dominant gravel substrate type distributed in transects one and three point three (T1T3 and T3T3). The third group was variable seagrasses C. rotundata, H. pinifolia, and H. ovalis correlated with the silt substrate type, which was dominantly distributed in transects two and three point one (T2T1 and T3T1). Substrate type variables of coarse sand (PK), medium sand (PS), and fine sand (PH) were dominantly distributed in transects two and three point one. Fine sand (PH) is dominantly distributed in transect one points one and two (T1T1 and T3T1). (T1T1 and T1T2) and transect two point one (T2T1) did not show any correlation with seagrass species (Majidek, 2017).

Correlation with seagrass type variables. The relationship/correlation established between substrate type and seagrass species informs that the presence of seagrass species informs us that the substrate type of the site influences the presence of seagrass species at this site. By the substrate type of the site. Silt substrate type has the highest percentage compared to other substrate types. The highest seagrass density was H. pinifolia seagrass. PCA analysis showed a correlation between H. pinifolia seagrass and silt substrate type. This may indicate that the high seagrass density of H. pinifolia at the location, the silt substrate type, influenced me (BLK Beach). Silt substrate type. H. pinifolia seagrass is a pioneer species with high adaptability to environmental factors, so that it can be dominant in a water body (Eki et al., 2013).

CONCLUSION

Based on the research results in the three research locations, it can be concluded that there are seven (7) types of substrate characteristics in the three research locations. The types of seagrasses found in the three research locations were seven (7) types of seagrass. Seagrass H. pinifolia has the highest density at BLK Beach and Tanjung Manggewa, while Lemon Island has seagrass C. rotundata. The highest percentage of cover on BLK Beach and Lemon Island is seagrass C. rotundata, while the location of Tanjung Manggewa is seagrass H. pinifolia. Seagrass C. rotundata and H. pinifolia correlate with silt substrates, and seagrass T. Hemprichii correlates with the kerekal–fine sand substrate at all three study sites. Seagrass H. ovalis correlates with BLK Beach and Lemon Island silt substrates, while Tanjung Manggewa correlates with pebbles. Sealic H. uninervis correlates with very coarse crust-sand substrates on BLK Beach and Tanjung Manggewa, while Lemon Island correlates with fine sand.
Advice Based on the research that has been carried out, further research is needed on the influence of oceanographic factors (waves, currents, bathymetry, tides) on the characteristic distribution of substrates in the Gulf of Doreri.

REFERENCES

Hartati, R, Widianingsih, W, Santoso, A, Endrawati, H, Zainuri, M, Riniatsih, I, Saputra, L, W., Mahendrajaya, & T, R. (2017). Variation in the composition and density of seagrass species in Ujung Piring, Jepara Regency waters. *Journal of Tropical Oceans*, *20*(2), 96–105–196–105.

Hasanuddin, & R. (2013). The Relationship Between Density and Morphometrics of Seagrass Enhalus acoroides with Substrates and Nutrients on Sarappo Island, Lompo Regency, Pangkep. *Thesis. Marine Science Study Program. Hasanuddin University*, 50.

Hazeri, & G. (2014). A feasibility study of Laguna Beach, Merpas Village, Nasal District, Kaur Regency as a tourism and conservation development area. *Thesis. Faculty of Agriculture. University of Bengkulu*.

Hidayat, M, Ruswahyuni, Widyorini, & N. (2014). Analysis of Sedimentation Rate in Seagrass Beds with Different Density Levels on Panjang Island, Jepara. *Journal of Marine Management of Aquatic Resources*.

Imam, & P, P. (2014). Seagrass Density Study on the Density of Gonggong Snails (Strombus Canarium) in the Waters of Penyengat Island, Riau Islands. *Thesis. Faculty of Marine Sciences and Fisheries. Maritin Raja Ali Haji University*, 13.

Ira, O, D., & Juliatyi. (2012). Seagrass Density and Closure in the Wave Embankment Area in the Waters of Terebino Village, Central Sulawesi Province. *Aquascience*, *1*(2), 89–96–89–96.

Irawan, A, Nganro, & R, N. (2016). Seagrass distribution in Ambon Dalam Bay. *Journal of Tropical Marine Science and Technology*, *8*(1), 99–114–199–114.

Jesajas, D, Raunsay, K, E., Aisoi, E, L., Dimara, & L. (2016). Analysis of Seagrass Species in the Waters of Yendidori Village, Biak Numfor Regency. *Novae Guinea Journal of Biology*, *8*(2), 114–118–114–118.

Kamal, & G, R. (2015). Analysis of the Kekede Snail Community (Conus spp) in the waters of Laluin Kayoa, North Maluku. *Thesis. IPB Graduate School, Bogor*.

Kopalit, & H. (2011). Seagrass community structure in the waters of Manokwari, West Papua. *Journal of Fisheries and Marine Affairs*, *7*(1), 9–18–19–18.

Korwa, S, J. I., Opa, T, E., Djamaludin, & R. (2013). Characteristics of Litoral Sediments on Sindulang Satu Beach. *Journal of Tropical Coasts and Seas*, *1*(1), 48–54–48–54.

Kuo, J, Hartog, & D. (2010). Seagrass Morphology, Anatomy and Ultrastructure. *Seagrass: Biology, Ecology and Conservation. Springer, Dordrecht*, 51–67–51–67.

Kurniawan, R, Habibie, N, M., & Suranto. (2011). Monthly Variation of Sea Waves in Indonesia. *Journal of Meteorology and Geophysics*, *12*(3), 211–232–211–232.

Latuconsina, & H. (2012). Spatial Distribution of Seagrass Vegetation Based on Differences in Physical Characteristics of Sediments in the Waters of Ambon Dalam Bay. *Journal of Bimafika*, *4*(4), 405–412–405–412.

Lefaan, T, P., Setiadi, D, Djokosetiyanto, & D. (2013). Seagrass Community Structure in Manokwari Coastal Waters. *Maspari Journal*, *5*(2), 69–81–69–81.

Lisdawati, Ahmad, W, S., Siwi, & O, L. (2018). Study of Seagrass Biomass (Enhalus Acoroides L.) and (Halodule Pinifolia) Based on Seawater Depth on the Beach of Tanjung Tiram Village, Southeast Sulawesi. *Biowallacea*, *5*(2), 861–870–861–870.

Majidek. (2017). Effect of Substrate on Seagrass Density and Morphometrics (Thalassia hemprichii) and Nutrient Content of Substrate in Mangrove Bay, Bintan Regency. *Thesis. Raja Ali Haji Maritime University*, 28.

Putra, S, P., Nugroho, & H, S. (2017). Distribution of seabed surface sediments in the waters of Sumba, East Nusa Tenggara. *Journal of Oceanology and Limnology in Indonesia*, *2*(3), 49–63–49–63.

Rahmawati, S, Irawan, A, Supriyadi, H, I., Azkab, & H, M. (2014). Guide Seagrass Monitoring. Edition 01. *Coremap – CTI & Center Oceanographic Research – LIPI*.

Rawung, S, Tilaar, F, F., Rondonuwu, & B, A. (2018). Seagrass Inventory in the Waters of the Marine Field Station, Faculty of Fisheries and Marine Sciences Unsrat, East Likupang District, North Minahasa Regency. *Platax Scientific Journal*, *6*(2), 38–45–38–45.

Rifardi. (2012). Modern Marine Sediment Ecology Revised Edition. *UNRI Press*, 167.

Sembel, L, Manangkalangi, E, Mardiyadi, Z, Manumpil, & W, A. (2019). Water Quality in Doreri Bay, Manokwari Regency. *Journal of Enggano*, *4*(1), 52–64–52–64.

Setyawan, F, Harahap, A, S., Andriani, Y, Hutahaean, & A, A. (2012). Seagrass Bed Change Detection Using Remote Sensing Technology and Its Relationship with Carbon Storage Ability in Banten Bay Waters. *Journal of Fisheries and Marine Sciences*, *3*(3), 275–286–275–286.

Simon, P, I., Rifai, & H. (2013). Seagrass community structure in the waters of Mantehage Island, North Sulawesi. *Platax Scientific Journal*, *1*(4), 177–186–177–186.

Siregar, N, S., Sari, P, L., Purba, P, N., Pranowo, S, W., Syamsuddin, & L, M. (2017). The exchange of water masses in the Java Sea against the periodicity of monsoon and Arlindo in 2015. *J. Depik*, *6*(1), 44–59–44–59. https://doi.org/10.13170/depik.6.1.5523

Sjafrie, M, N. D., Hernawan, E, U., Prayudha, B, Supriyadi, H, I., Iswari, Y, M., Rahmat, Anggraini, K, Rahmawati, S, & Suyarso. (2018). Status of Indonesian Seagrass Beds 2018. *Coremap – CTI & Oceanographic Research Center – LIPI*.

Sombo, T, I., Wiryanto, & Sunarto. (2016). Characteristics and Structure of Seagrass Communities in the Intertidal Area, Litianak Beach and Oeseli Beach, Rote Ndao Regency, East Nusa Tenggara. *Journal of Ecoscience*, *9*(2), 33–44–33–44.

Tampubolon, & S. (2010). Sediment in Muara Aek Tolang Pandan North Sumatra. *Thesis. Marine Science. UNRI Pekanbaru*, 115.

Tangke, & U. (2010). Seagrass Ecosystem (Benefits, Functions and Rehabilitation). *Scientific Journal of Agribusiness and Fisheries*, *3*(1), 9–29–9–29.

Triatmodjo, & B. (2012). Planning of beach buildings. *Publisher Beta Offset*.

Tururaja, T, Mogea, & R. (2010). Coliform Bacteria in the Waters of Doreri Bay, Manokwari Marine Pollution Aspects and Species Identification. *Journal of Marine Science*, *15*(1), 47–52–47–52.

Tuwo, & A. (2011). Coastal and Marine Ecotourism Management. *Brilliant International*.

Wajdiah. (2017). *Seagrass Type and Density in the Relationship with Substrate Conditions in the Waters of Sarappo Lompo Island, Pangkep Regency*. *1*(31), 18–20–18–20.

Wibisono, & S, M. (2011). Introduction to Marine Science. *Universitas Indonesia Press*.

Yunitha, A, Wardianto, Y, Yulianda, & F. (2014). Substrate Diameter and Seagrass Types on the Bahoi Coast of North Minahasa: A Correlation Analysis. *Indonesian Journal of Agricultural Sciences (JIPI)*, *19*(3), 130–135–130–135.