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DIFFERENCES IN SPECIES, COVERAGE AND DENSITY OF SEAGRASS IN THE INTERTIDAL AND SUBTIDAL AREAS AT LABAKKANG BEACH, PANGKAJENE ISLAND REGENCY

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ABSTRACT

Labakkang Beach, Pangkajene Islands Regency has the characteristics of gently sloping coastal waters covered with various mangrove and seagrass communities. In general, seagrass is more commonly found in intertidal than subtidal areas, this is due to the depth reason. However, based on first observations, seagrass in Labakkang coastal waters thrives in subtidal areas and is less fertile in intertidal areas. The purpose of this study was to decide the differences in species, cover, and density of seagrass in intertidal and subtidal areas in the waters of Labakkang Beach, Pangkajene Islands Regency. This research was conducted in July 2021 with the method used, namely purposive sampling. Measurements of environmental parameters at the sampling location were carried out directly (in situ) including temperature, salinity, tides, depth, and current velocity, while turbidity, Total Organic Matter (TOM) analysis, and grain size of sediment were carried out tegakanirectly (ex-situ). The results of the average measurements of temperature, salinity, current velocity, depth, turbidity and TOM respectively show the range of 300C - 310C; 33.3‰ – 35.0‰; 0.07 m/s - 0.18 m/s (at high tide); 0.31 m - 1.32 m; 11.06 NTU - 29.04 NTU and 2.49 % - 5.39 %. The results of sediment analysis using *Software Gradistat* are 2 types of sediment, namely medium sand & fine sand and 2 types of sediment texture, namely Slightly Gravelly Sand and Slightly Gravelly Muddy Sand. The average percentage of seagrass cover at the intertidal station was 23.33 % while at the subtidal station it was 61.11% and only 2 species of seagrass were found, namely *Enhalus acoroides* and *Halophila ovalis*. The average density of seagrass at the intertidal station is 48.88 ind/m^2 while at the subtidal station it is 86 ind/m^2. The results of the Independent T-test analysis showed that there were significant differences in the cover and density of seagrass in the intertidal zone and subtidal zone in the coastal waters of Labakkang.

Keywords: Seagrass, Intertidal zone, Subtidal zone, Labakkang Beach.

INTRODUCTION

Seagrass is flowering plant (Angiospermae) that has rhizomes, true leaves and roots that live submerged in the sea. The seagrass community is between the lowest limits of the tidal area and reaches a depth of 8-15 meters and 40 meters as far as sunlight can reach (Dahuri, 2003). Asirah et al (2019) explained that seagrass only exists in 2 zones, namely the intertidal and subtidal zones. In general, seagrass is found more often in intertidal areas than subtidal areas, this is due to the depth factor. However, based on initial observations, the seagrass ecosystem in Labakkang coastal waters, Pangkajene Islands Regency grows abundantly in subtidal areas and is less fertile in intertidal areas.

The intertidal zone is also known as the tidal area, namely the area that is flooded by water at high tide and exposed at low tide. This area represents a transitional area from ocean conditions to land conditions. The condition of tidal communities does not change much except that certain extreme conditions can change the composition and abundance of intertidal organisms. This area is the narrowest area but has a relatively higher diversity and abundance of organisms compared to other marine habitats (Yulianda et al. 2013). Meanwhile, subtidal areas are areas that are submerged in water or areas that are always submerged in water without experiencing tides, so the movement of organic material is very low (Rosmawati, 2011).

Labakkang Beach is characterized by sloping coastal waters with various mangrove and seagrass communities. The intertidal area of Labakkang Beach is located in an area that is most easily accessible to humans, making it vulnerable to community change. In some waters there is also intertidal biota which tends to experience a decline in diversity and population which can be influenced by natural and human factors. According to Tania (2014), increased community activity can also influence the community structure of biota associated with seagrass ecosystems. This can happen because many people often take aquatic biota or step on the bottom of the water, which disturbs the biota, especially the biota that lives at the bottom of the water.

Natural factors such as temperature, salinity, current speed, depth and tides also greatly influence seagrass growth. Therefore, this research was conducted to determine the differences in type, density and seagrass cover in intertidal and subtidal areas, as well as the oceanographic factors that influence these differences. Of course, this will provide information to determine whether or not the seagrass ecosystem is growing as a whole, both in the intertidal and subtidal areas in the waters of Labakkang Beach, Pangkajene and the Archipelago Regency.

MATERIALS AND METHODS

This research was carried out from January to June 2021. Field data was collection in the waters of Labakkang Beach, Pangkajene and Archipelago Regency, South Sulawesi Province (Figure 1).

Figure 1. Research Location Map

Meanwhile, texture and total organic matter (TOM) analysis of sediments was carried out at the Physical Oceanography and Coastal Geomorphology Laboratory at the Faculty of Marine and Fisheries Sciences, Hasanuddin University, Makassar, South Sulawesi.

Seagrass Data Collection

The method used in this research was quadratic transects using purposive sampling which was aimed at finding out the species of seagrass found, counting the number of stands and the percentage of seagrass cover. The placement of station locations is carried out selectively based on the results of initial observations. The research location is divided into 2 stations and each station is divided into 3 substations and each substation is divided into 3 points. Station 1 is an intertidal area, the distance is 200-300 m from the coastline (land) while station 2 is a subtidal area, the distance is 400-450 m from the coastline (land).

At each station a 100 m line transect is laid horizontally (parallel to the coast) using a roll meter. At each substation a plot measuring 10 m x 10 m is placed according to the selective representation of seagrass, with an interval distance of 20-30 meters between each plot. The plot functions as a boundary area for observing seagrass. In the plot (10 m x 10 m) a square plot (frame) 50 cm x 50 cm (with 25 grids) is placed and thrown three times randomly (randomly). Then, in the quadratic plot, observe the types of seagrass found and count the number of stands of each species and estimate the percentage of seagrass cover.

The seagrass specimen found were identified directly (in situ) according to the book "Status of Indonesian Seagrass Fields 2018 Ver. 02" (Sjafrie et al.. 2018). To observe the percent cover of seagrass, it is done visually, namely seeing directly what percentage of a species covers the sampling area based on Seagrass Percentage Cover according to McKenzie et al. (2003) in the Figure 3.

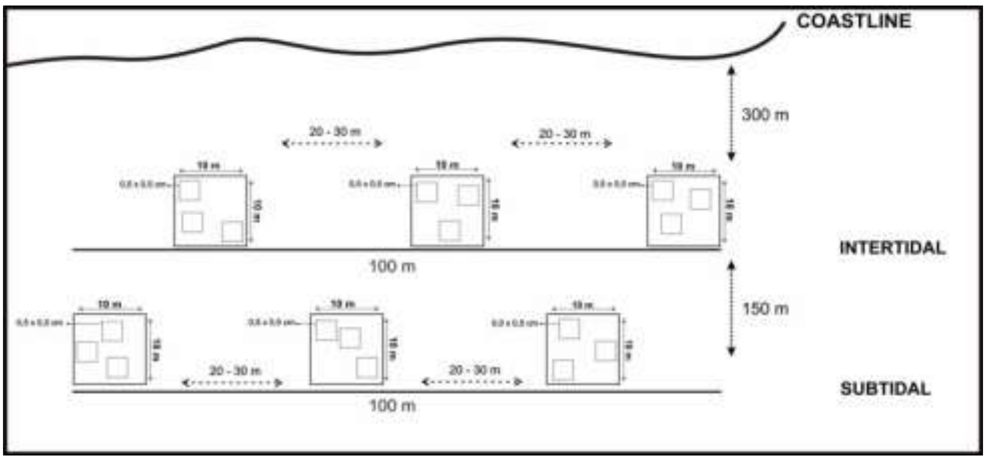

Figure 2. Schematic of transect placement at seagrass observation stations

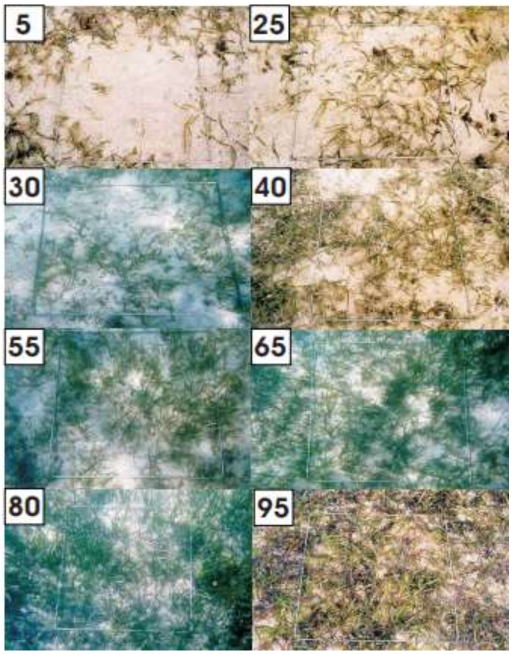

Figure 3. Seagrass Percentage Cover (McKenzie *el al.* 2003)

Measurement of the Environmental Parameter

Data collection on physico-chemical water parameters was carried out at the lowest tide at Labakkang Beach, except for current speed data collection during high and low tide conditions. Measurements of environmental parameters carried out directly (in situ) include depth, current speed, temperature, salinity and tides, while measurements of environmental parameters carried out indirectly (ex situ) include turbidity, grain size analysis and total organic matter (TOM).) sediment.

Percentage of Seagrass Coverage

Calculation of seagrass cover for each station is done by adding up the seagrass cover values for all 50 cm x 50 cm plots in one station and divide it by the number of plots at that station. The calculations using Microsoft Excel is shown in the following equation.

$$Seagrass\ Coverage\ (\%) = \frac{Number\ of\ seagrass\ coverage\ of\ all\ plots}{Number\ of\ plots\ at\ the\ station}$$

Based on the percent of seagrass cover, the condition of the seagrass ecosystem in a body of water can be categorized according to Minister of Environment Decree No. 200 of 2004 in the following table:

Table 1. Status of Seagrass meadows (Decree of the Minister of the Environment No. 200 in 2004).

Condition		Seagrass cover (%)
Good	Rich/Healthy	≥ 60
Damaged	Less Rich / Unhealthy	30 – 59,9
	Poor	≤ 29.9

Seagrass Density

Seagrass density measurements were carried out by counting the number of seagrass stands in a 50 cm x 50 cm plot. Calculation of seagrass density using the formula (Rahmawati et al. 2014).

$$Seagrass\ Density\ (shoots/m2) = Number\ of\ seagrass\ shoots^{*}\ x\ 4$$

Where:
* = Number of shoots within 50 x 50 cm^2 quadrate
4 = Constant for conversion of 50x50 cm^2 to 1 m^2

The results of calculating oceanographic parameters, species, density and seagrass cover will be discussed descriptively and presented in the form of tables and graphs. To determine the differences in seagrass cover and density at intertidal and subtidal stations in Labakkang coastal waters, a T test (Independent Samples T-test) analysis was applied using SPSS software.

RESULTS AND DISCUSSION

Environmental Parameter

Table 2. The average value of oceanographic parameters in six sub-stations of the study sites

Parameters	Intertidal Station (I)			Subtidal Station (II)		
	Substation 1	Substation 2	Substation 3	Substation 1	Substation 2	Substation 3
Temperature (^{0}C)	30.3	30.3	30.0	31.0	31.0	30.0
Salinity (ppt)	34.7	35.0	34.3	35.0	34.7	33.3
Current velocity (m/s)	0.08	0.07	0.07	0.13	0.10	0.18
Depth (m)	0.32	0.37	0.31	0.87	0.88	1.23
Turbidity (NTU)	17.22	29.04	20.35	14.18	23.68	11.06
Sediment DOM (%)	3.89	4.15	5.39	2.49	3.86	4.02

Temperature

The range of temperature values obtained from measurements at the research location at six intertidal and subtidal substations ranges from 30 ^oC – 31 ^oC, this value is still optimal or suitable for seagrass life. This means that the temperature in Labakkang coastal waters is suitable for seagrass growth.

The highest temperatures were found at substations 1 and 2 at the subtidal station. In this substation, seagrass species *Halophila ovalis* was found. This is in accordance with Rosmawati (2011) who states that seagrasses that live in waters that are often exposed to intensive heating so that the water temperature rises are more likely to be species with small leaves, for example *Halophila ovalis*.

A temperature range that is too high can also cause serious problems for seagrass life. Zurba (2018) explains that at a temperature of 38°C, it may cause seagrass to become stressed and at a temperature of 48°C it can cause death. Meanwhile, a temperature of 43°C will cause mass death of seagrass after two to three consecutive days, so this extreme temperature increase will affect the ecological function of seagrass in tropical areas.

Artika et al (2020) explained that *Enhalus acoroides* seeds are very tolerant to high exposure temperatures and are still within tolerance limits. Erftemeijer (1994) also found that the seagrass species *Enhalus acoroides* lives in the temperature range of 26.5 ^oC – 32.5 ^oC and in shallow water because it can tolerate temperatures up to 38 ^oC when the waters recede during the day.

Salinity

The salinity range found based on measurement results in the waters of the research location at six intertidal and subtidal substations is between 33.3‰ – 35.0‰. This value is still considered optimal for seagrass life. According to Ikhsan et al (2019), several species of seagrass may have different tolerances to water salinity. The salinity conditions at several different observation locations are what causes differences in the distribution of seagrass species that grow at the research locations. Although seagrass species have varying tolerances to salinity, mostly have a wide range of salinity, i.e., between 10‰ – 40‰. The optimum tolerance value for salinity in seawater is 35 $^o/_{oo}$ (Suhud et al. 2012).

Current

Based on surface water current velocity data measured at the research location, it was found that the current velocity at high tide was 0.07 m/s - 0.18 m/s. Overall, the current conditions in the coastal waters of Labakkang District are not optimal to support seagrass productivity because the current velocity value is far from the good standard for seagrass growth, i.e., 0.5 m/s.

The water conditions at the time of measurement were at high tide to low tide at 2 pm so that at the intertidal station the current speed value was smaller while the current speed value at the subtidal station was greater. This is possibly due to the intertidal station being close to the coastline (land). This is in accordance with Amri et al (2011) statement that the further the sampling position is from the coastline, the stronger the current tends to be. Erftemejer (1994) also explained that the value of current velocity on the water surface can vary greatly, this is due to tidal and wind fluctuations.

Turbidity

The range of seawater turbidity values at the research location at six intertidal and subtidal substations based on measurement results ranges from 11.06 NTU - 29.04 NTU. The turbidity level value is above the quality standard, namely < 5 NTU (Minister of Environment Decree No. 51 of 2004). The range of turbidity values at this location is classified as high with values above the specified average. The high turbidity in Labakkang coastal waters does not support seagrass life. This is the cause of the low diversity of seagrass species in this location because more adaptation is needed for the seagrass to receive light during the day. The highest turbidity value was found at intertidal substation 2 where this substation is close to the coastline. According to Amri et al (2011), high levels of turbidity are often found in locations close to the coastline, this is thought to be influenced by the location closer to the accumulation of rubbish from the surrounding areas.

According to Supriadi (2003), one of the environmental factors that influences the low growth rate of Enhahus acoroides is turbidity. This was confirmed by Ira et al (2013) who explained that high turbidity values indicate high levels of particles are floating in the water column. The particles will then stick to the seagrass leaves, so they can block sunlight which is used for photosynthesis. When the seagrass photosynthesis process is disrupted, it can result in seagrass growth being disrupted as well. According to Lanuru et al (2013), seagrass requires a light intensity of at least 20% of the light intensity on the surface to photosynthesize optimally.

Depth

The results of the average water depth at the research location measured at low tide to high tide at 6 consecutive intertidal & subtidal substations at the beginning of June 2021, namely the lowest depth at substation 3 (intertidal) 0.31 m and the highest depth at substation 3 (subtidal) 1.32m. The difference in depth at each substation in Labakkang coastal waters can be caused by differences in bottom topography of the waters in both intertidal and subtidal areas. Differences in the ability of seagrass to grow at different depths can also be caused by the light absorption of each individual seagrass.

The depth range at the research location, precisely at the seagrass sampling site, is classified as shallow water because it is still below a depth of 2 m. This depth range can still be penetrated by sunlight enabling optimum photosynthesis process. *Enhalus acoroides* is a species of seagrass commonly found in the waters of Labakkang Beach. According to Zurba (2018), *Enhalus acoroides* is a species of seagrass whose growth is highest in shallow locations with relatively high temperatures. The research results of Supriadi (2003) also stated that water depth plays a significant role in influencing the rate of recovery of *Enhalus acoroides* leaves. Low water depth can cause new leaves to emerge more quickly, especially after low tide which causes the bottom of the water to be exposed.

Sedimen DOM

The average values of sediment Dissolved Organic Matter (DOM) in the waters at 6 intertidal and subtidal substations at the beginning of June 2021 was 2.49% - 5.39%. In substation 3, the Intertidal area has the highest average value of total organic matter, i.e., 5.39%, however, according to Reynold (1971), who classifies the content of organic matter in sediment, this value is still relatively low, whereas in substation 1, the Subtidal area has an average value of the lowest average total organic matter was 2.49%, this value is classified as very low. The high DOM value of the sediment in intertidal substation 3 is thought to be because it is close to settlements. Manengkey (2010) explained that the organic material content in sediment is thought to come from rubbish or household waste which local residents throw away through rivers and some also directly into the sea.

Tides

Tides in the waters of Labakkang Beach, Pangkajene and Islands Regency were measured using tide signals for 39 hours (Doodson method). The pattern obtained in Figure 3 shows that at the highest tide the water level reaches 1.71 m at 5 am and the minimum sea water height at the lowest tide reaches 0.87 m at 8 pm, thus the water level height value The average sea level (Mean Sea Level) is 1.2 m. The tidal type in Labakkang Waters shows a single daily tidal type (Diurnal Tide).

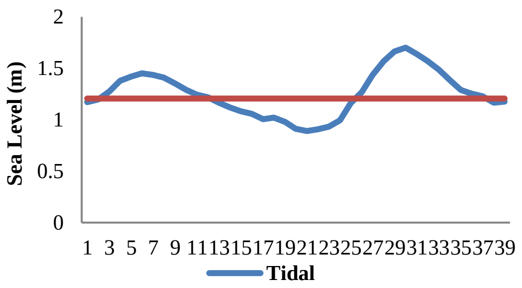

Figure 4. Tidal Patterns in the Waters of Labakkang District, Pangkajene Islands Regency (*Diurnal Tide*)

Based on the observations, the waters of Labakkang Beach have sloping bottom conditions with a wide intertidal zone (±300 meters). At the lowest tide, the intertidal zone is always open (not flooded) so it is more susceptible to drought. This causes several species of seagrass to be unable to survive. This is in accordance with Yulianda et al (2013) that some seagrasses show the effects of drought and heat, some seagrasses even die, but some are starting to grow again.

The *Enhalus acoroides* species of seagrass is able to survive the environmental conditions in the intertidal zone in Labakkang coastal waters even though the conditions are unhealthy and not evenly distributed. This is similar to the opinion of Supriadi (2003) that *Enhalus acoroides* is a species of seagrass that has thick leaves so it is more resistant to sunlight when it recedes and can grow more dominantly near the coast. Rosmawati (2011) also stated that *Enhalus acoroides* is able to adapt and live in the intertidal areas because it has narrow leaves (small leaf blade width) and an elongated shape.

Based on observations at the research location, tides are the most influential limiting factor, causing seagrass growth in the intertidal zone. Labakkang coastal waters are less good/healthy than the subtidal zone. Nugroho (2012) explained that one of the oceanographic factors that greatly influences the intertidal ecosystem is tides. This can cause the limiting factors in this area to become more extreme. The limiting factors in question are sunlight, dryness, and extreme temperatures. These factors are interrelated with ups and downs. Where if the sea water recedes, the intertidal zone will open and will cause the intertidal zone to be directly exposed to sunlight. This will have an impact on increasing temperatures. This increased temperature can cause evaporation and as a result the intertidal area will become dry (not flooded with water). This is confirmed by Lanuru (2011) who explains that the length of time seagrass beds is exposed to sunlight during low tide is a limiting factor because seagrass death in intertidal areas can be caused by desiccation or drought. This occurs at the lowest tide, where sunlight can burn seagrass leaves and the water temperature will increase significantly when exposed. High water temperatures will also increase sediment temperatures. Thus, many seagrasses die because they are unable to adapt to direct sunlight without being waterlogged.

Sediment Texture

The results of measuring the percentage of sediment types analyzed using Gradistat Software showed 2 types of sediment, namely medium sand and fine sand as well as 2 types of sediment texture, namely slightly gravelly sand and slightly gravelly muddy sand. Ikhsan et al (2019) states that sandy substrates can also support the life of seagrass species that like these conditions.

In substations 1 and 2, the *Halophila ovalis* species were found. According to Ikhsan et al (2019), this species usually occupies and is more dominantly found in moist (smooth) and muddy substrate areas. This is in accordance with the results of analysis from the Gradistat Software, namely at substations 1 and 2 subtidal where at these locations *Halophila ovalis* species was found dominated by fine sand.

Observation results at several substations show that the further towards the sea, the smoother the substrate. This also causes several species of seagrass such as *Halophila ovalis* to grow and develop well on sandy substrates with a little smooth substrate and which tend to live in areas that are submerged in water even at low tide (subtidal areas). Tuapattinaya (2012) also explained that differences in substrate characteristics in the two intertidal and subtidal zones are thought to cause differences in the diversity of seagrass that live in these waters, because differences in substrate will have an impact on differences in nutrient content.

In Labakkang coastal waters, around 300-400 m from the seagrass sampling location, a mangrove ecosystem was found. According to Rahman et al (2016), the factors that influence seagrass are sandy mud substrates because the location is not far from the mangrove ecosystem. The characteristics of sandy mud sediments have a big influence on the speed of seagrass leaf growth.

Seagrass Species, Coverage and Density

Seagrass Species

Table 3. The types of seagrass found in the Labakkang Beach, Pangkajene Islands

No.	Species of seagrass	Intertidal Station (I)			Subtidal Station (II)		
		Substation 1	Substation 2	Substation 3	Substation 1	Substation 2	Substation 3
1.	*Enhalus acoroides*	√	√	√	√	√	√
2.	*Halophila ovalis*	-	-	-	√	√	-

Note :
√ = Found in the Location
- = Not Found in the Location

Only 2 species of seagrass were found in the waters of Labakkang District, i.e., *Enhalus acoroides* and *Halophila ovalis*. The number of seagrass species in these waters is relatively low because there are only 2 species representing the 12 species of seagrass in Indonesia. This is different from the research results of Gosari and Haris (2012) who found 7 species of seagrass in the Spermonde Islands and also explained that the common and frequently found type of seagrass is *Enhalus acoroides*.

In the intertidal area of Labakkang coastal waters, only *Enhalus acoroides* seagrass was found, while in the subtidal area two speciess of seagrass were found, i.e., *Enhalus acoroides* and *Halophila ovalis*. The seagrass species *Halophila ovalis* is only found in substations 1 and 2 (subtidal), while the seagrass *Enhalus acoroides* is found in all substations. This is due to the conditions in the intertidal area of Labakkang coastal waters which are exposed when sea water recedes so that only *Enhalus acoroides* is able to adapt.

Hidayatullah et al (2018) states that the distribution of the *Enhalus acoroides* is also influenced by its morphological structure which has large and strong roots so that it can penetrate the substrate and make it easier for this species to absorb nutrients in the waters. This can support faster growth of *Enhalus acoroides* seagrass. Philips and Menez (1988) also explained that small seagrass species, such as

Halophila ovalis and the *Halodule* genus, usually occupy shallower waters but remain waterlogged. This is because the characteristics of its thin and flexible leaves make it easier for it to live in these environmental conditions.

Seagrass Density

The average density of seagrass in Labakkang waters is 48.44 ind/m2–133.78 ind/m^2. This average density value is relatively low when compared with the research results of Gosari and Haris (2012) which reported that the density of seagrass in the Spermonde Islands was 185 ind/m2 – 830 ind/m2.

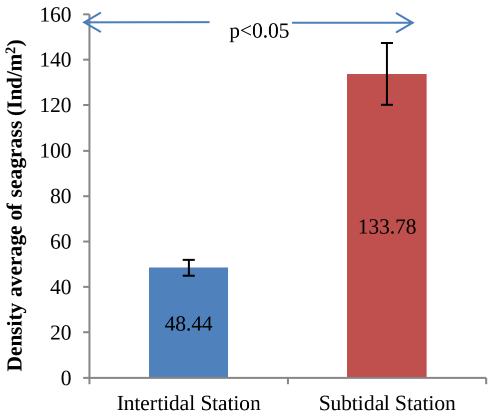

Figure 5. Seagrass density (Ind/m^2) based on stations in Labakkang Coastal Waters, Pangkajene Regency and Islands ($p<0.05$ indicates a significant difference between stations)

The results of the Independent T-test analysis show that there is a real difference, where the seagrass density between Intertidal and Subtidal stations has a significance value of 0.000. This value is still smaller than the alpha value ($p<0.05$), so the research hypothesis which states that "there are differences in seagrass density in the intertidal zone and subtidal zone" is accepted.

The measurement results showed that the density of *Enhalus acoroides* seagrass was much higher than that of *Halophila ovalis*. According to Ikhsan et a. (2019) *Enhalus acoroides* is a type of seagrass that has the ability to adapt to various substrates well so that it is spread quite evenly in subtidal areas. Lanuru (2011) has also transplanted *Enhalus acoroides* seagrass on Labakkang and Lae-Lae Island, the results show that *Enhalus acoroides* seagrass has a very high ability to survive. This is what influences the adaptability of *Enhalus acoroides* seagrass to be higher compared to *Halophila ovalis* seagrass.

Seagrass in Labakkang coastal waters that grows in areas far from the coastline has a higher density compared to seagrass that grows in waters close to the coastline. According to Ikhsan et al (2019), one of the main causes of differences in seagrass density in waters is the result of several oceanographic factors at each observation location because there are certain types of seagrass that have different adaptation patterns to oceanographic factors.

CONCLUSION

There are only two species of seagrass found in Labakkang coastal waters, i.e., *Enhalus acoroides* and *Halophila ovalis.* Seagrass cover in the intertidal area is classified as poor, while in the subtidal area it is classified as rich/healthy and is dominated by seagrass species *Enhalus acoroides*. The density of seagrass found in Labakkang coastal waters is generally lower than in several waters in the Spermonde Islands. The results of the Independent T-test analysis show that there are significant differences in seagrass cover and density in the intertidal zone and subtidal zone in Labakkang coastal waters. The average density and cover of seagrass in the intertidal zone is lower with the distribution of individuals tending to be uneven compared to the average density and cover of seagrass in the subtidal zone which is relatively higher and the distribution of individuals tends to be even.

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