Density, coverage and biomass of seagrass ecosystem in the Lobam Island, Bintan Regency - Indonesia

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Abstract. Seagrass ecosystem is a sea plant that can store carbon in the form of biomass and in sediments known as blue carbon. This research conducted in around coastal waters of Lobam island, Seri Kuala Lobam sub-district, Bintan regency that has seagrass community type Thalassia hemprichii and Enhalus acoroides which has an important role as a carbon sink. This research aims to determine differences of density, coverage and differences in biomass based on a seagrass tissue at the Above ground (leaf Abg.) and Below ground (rhizome and root Blg.) of each station and the relationship between the density towards seagrass biomass. The research results show that the seagrass density in station 2 was higher than in station 1. While the difference in the seagrass biomass there is in the section of Abg. (leaf) and Blg. (rhizome and root) in station 1 and conversely there is no significant difference in station 2.

1. Introduction

The issue of global warming that has implications on the rate of climate change that occurs today is very worrying, where human activity is the largest contributor of carbon dioxide (CO₂) gases into the air. Human activities that can release CO₂ emissions are land burning, motor vehicle emissions, factory wastes and so on that lead to an increase in greenhouse gas concentrations (GHG). [1] explain this increase causes the radiation balance to change so that the earth's temperature increases. This thermal nature of radiation causes global warming of the atmosphere (global warming) [1,2]. Scientific evidence until now has also proven that there are marine ecosystems that act as carbon sinks.

One mitigation effort undertaken to reduce atmospheric CO₂ concentration is to nurture and develop the ability of forests and oceans to absorb and store carbon. Forest utilization in these mitigation efforts has been widely implemented, while the application of the role of the oceans has not been seen significantly [3,4]. Thus, oceans have a high enough ability to bind and store CO₂. Therefore, it is indispensable for marine ecosystem services in carbon sequestration.

The seagrass ecosystem is an important ecosystem to support the life of aquatic biota and is used as a nurturing, spawning, feeding and enlargement of larvae of aquatic organisms [5,6]. Seagrass ecosystems are important to protect because of their very important functions for the sustainability of fishery resources. The assessment of the seagrass condition becomes something that is needed as a control to see the condition of seagrass beds from time to time. [7] add the function of the seagrass is as a provider of shelter for marine biota living in it, as well as a nursery ground for several species of marine biota.
There are 4 seagrass families known throughout the world's waters, 2 of which are in Indonesia, i.e Hydrocharitaceae and Potamogetonaceae. In Indonesia, there are 12 types of seagrasses, from 12 species of seagrass growing in Indonesian waters [6,8] where 10 species can be found in the waters of Bintan Island, Riau Islands [9]. Seagrass ecosystem in Indonesia is often encountered in the inner intertidal and upper subtidal regions. Seen from the pattern of horizontal seagrass zoning, seagrass ecosystem is located between two important ecosystems i.e mangrove and coral reef ecosystems. Seagrass ecosystem is closely related and interacting, as well as the link and as a buffer of the sedimentation rate from mangrove ecosystem on the coast to coral reef ecosystem towards the sea [10,11].

The status of the seagrass condition determines the occurrence of the indication of seagrass damage due to the activity and influence around the coast. Changes in the conditions and status of seagrass beds can be analyzed using a community approach in the form of levels of coverage and density. From this approach, can be seen how far the damage to seagrasses occurred.

Lobam Island is one of the natural islands in Sri Kuala Lobam sub-district, Bintan Island which has seagrass ecosystems in the category of healthy to moderate [12]. The existence of seagrass which is broad enough in the waters of the island will certainly contribute to the climate balance through the seagrass function as a carbon sink (blue carbon). Based on these evolving issues and given the importance of the role of marine ecosystems in reducing GHG emissions, there is a need for a lot of research that can encourage the continued development of carbon in biomass calculations. This study aims to determine differences of density, coverage and differences in biomass in seagrass tissue in the Above ground (leaf) and Below ground (rhizoma and root) sections between stations and the relationship between density with seagrass biomass.

2. Research Methods

2.1. Research Location
This research was conducted in the waters of Lobam island, Sri Kuala Lobam sub-district, Bintan regency, Riau Islands province. Primary data collection in the field and analysis in the laboratory was carried out in November 2017. Geographically the location of the research is at coordinates 0°58'10.50" - 1°0'6.36" N and 104°13'9.11" - 104°15'52.42" E (Figure 1) is one of the conservation area plans based on the Decree of the Regent No. 261/VIII/2007 dated August 23, 2007 [13] and also the pre-eminent natural tourism area of Bintan regency and a pilot program on seagrass management in Indonesia, especially in the eastern part of the island of Sumatra.
The method used in this research is survey method, i.e., observation and sampling directly in the field. Determination of sampling points taken at 2 observation stations where station 1 is located in an area close to anthropogenic activities (catching fish) in the Lobam strait, while station 2 is located in the mangrove area which has little influence on anthropogenic activities.

2.2. Data and Samples
Sampling and observation of the condition of seagrass were carried out using the line transect method using a sized-square (50 × 50) cm² [6,14]. The number stand of seagrass beds type of *Thalassia hemprichii* and *Enhalus acoroides* in the square plot was calculated to determine its density (stand/m²) and the percentage value of seagrass coverage (%) was determined by observing the cover of seagrass leaf of *Thalassia hemprichii* and *Enhalus acoroides* (the other types were ignored) in each small box. The number of sampling points was 8 points scattered in 2 the observation stations.

Biomass sampling is done using a transect measuring (50 × 50) cm². Seagrass found on the transect is taken one rod (revoked) on the depth of root penetration. The sample is put into a sample bag after being cleaned of the substrate then put into ice box and taken to the laboratory, then cleaned (from sand, biota and epiphytes) and washed with fresh water to knock out epiphytes or biota attached to the seagrass. Each seagrass is separated between the Above ground (leaf Abg.) and Below ground (rhizoma and root Blg.). Then all the seagrass samples were dried by putting them in an oven at a fixed temperature of 60 °C for 72 hours, then weighed to find out the dry weight using analytical scales. After that, calculation of seagrass biomass (g BK/m²) was carried out using the formula according to [15,16,17].

2.3. Seagrass Biomass Analysis
The calculate of seagrass coverage as follows [18,19]:

\[
\text{Seagrass Coverage (\%)} = \frac{\text{Amount of seagrass coverage values (4 box)}}{4}
\]

The calculate seagrass density as follows [18]:

\[
\text{Density Ea (stand/m²), and density Th (stand/m²) } = \text{Amount (Ea* × 4) and (Th* × 4)}
\]

Information:
Ea = *Enhalus acoroides*
Th = *Thalassia hemprichii*
* = Amount of individuals in squares
4 = Conversion constants (50 × 50) to 1 m².

Biomass is an organic material produced through photosynthesis, good in a shape of a product or waste. Seagrass tissue biomass (g) can be calculated by a formula [15,17]:

\[
\text{Seagrass tissue biomass (g BK/m²) } = \frac{\text{Dry weight (g)}}{\text{Plot Size (m²)}}
\]

The data that obtained from research results were analyzed statistically and discussed descriptively with reference to the literature. Data processing is made with a software of Microsoft Excel and *Statistical Package for Social Science* (SPSS) version 16.0, as well as geographic information data assisted with a software of *Environment for Visualizing Images* (ENVI) version 5.1 and ArcGIS 10.4.
3. Results and Discussion

3.1. Density and Percentage of Seagrass Coverage

Based on the research results than obtained the seagrass density values on the 2 stations (Figure 2a), It can be seen that the value of seagrass density as a whole at station 2 (natural condition waters) with an average total value of 128.00 stands/m$^2$ is higher than the seagrass density value in station 1 (location of anthropogenic activities) with an average value of 115.00 stands/m$^2$. While the percentage of seagrass coverage in the research location is presented in Figure 2b, it is seen that the percentage of seagrass coverage in Station 2 is higher with an average value of 30.03% from in Station 1 with an average value of 27.21%.

Seagrass type of *Thalassia hemprichii* and *Enhalus acoroides* found in the waters of Lobam island are a type of seagrass that usually lives in shallow waters which are always exposed during low tide [20]. The relatively shallow waters of Lobam island with a high level of brightness strongly support high seagrass density and coverage. On each squared transect of each research station, there are different seagrass density of different *Thalassia hemprichii* and *Enhalus acoroides*. Differences of density and seagrass coverage in each station can illustrate that the spread is varied, this can be caused by differences in environmental conditions and treatment obtained in 2 station representing dense areas from anthropogenic activity (catching fish and coastal tourism) and lack of anthropogenic activity (natural environmental conditions).

The seagrass density of *Thalassia hemprichii* and *Enhalus acoroides* in station 2 was higher than seagrass density in station 1. The average seagrass density value at a distance of 0 m, 10 m, and 20 m at each station explained that the seagrass distribution varies according to the average value of density. In station 1, the average of seagrass density in each plot is different and fluctuating. On the contrary in station 2, increasingly getting towards the sea the value of seagrass density is getting higher.

The difficulty of seagrass developing in Station 1 allegedly due to the relatively shallow waters at low tides and the waters that are relatively much affected by anthropogenic activities that come from household and industrial waste, fishing vessels, ship disposal, and beach tourism [21]. On the contrary seagrass in station 2 is better than in station 1, this is because it grows in waters that are relatively deep despite being shallow and slightly affected by anthropogenic activities (Located in mangrove areas that are still natural). Based on research [21] the growth of seagrass is strongly influenced by tidal patterns, salinity, pH and water temperature, and anthropogenic activities in coastal areas such as fishing activities, berths of small vessels, harbour development and recreation or beach tourism, both directly and indirectly can also affect seagrass growth.

Figure 2. a) Density; and b) Percentage of Seagrass Coverage.
3.2. Seagrass Biomass

Biomass values of seagrass in the waters around Lobam island can be seen in Figure 3. Based on the graph in Figure 3 and the calculation of the total value of seagrass biomass in station 2 is higher with a value of 252.64 g BK/m² from in station 1 with a value of 150.17 g BK/m². The average value of seagrass biomass at the research location from 2 research Stations was 201.40 g BK/m².

The value of largest seagrass biomass is on the Blg (rhizoma and root) from 2 stations compared to the Abg (leaf) section. Seagrass biomass values of *Enhalus acoroides* is higher than *Thalassia hemprichii* in part of rhizoma and leaf, where is the length of the leaf blade of *Enhalus acoroides* can reach 75 cm and width 1.0-1.5 cm with rhizoma width is 1 cm [22].

![Figure 3](image)

**Figure 3.** a) Comparison of the average biomass on the tissue; and b) Comparison of the average biomass in Abg and Blg.

Seagrass biomass in station 2 was higher from station 1. This was because in station 2 seagrass type of *Enhalus acoroides* and *Thalassia hemprichii* was found to have a density value and the percentage of seagrass coverage was greater than station 1. This affects the value of seagrass biomass in every station, [23,24] explains that seagrass meadows that have a type of seagrass that has a larger size leaf and rhizoma and high density will cause a higher biomass. The high biomass of seagrass species of *Enhalus acoroides* and *Thalassia hemprichii* in station 2, reflects that the seagrass type this likes of the environmental conditions in station 2 where it does not get the influence of anthropogenic activity intensively from station 1.

Suspected leaf size that long makes the leaf more easily carried away by the flow so that it gives a burden in the rhizoma to defend itself. Where the seagrass in station 2 is located far from the shoreline and directly affected by the high seas, suspected of making the rhizoma and root at this station strong and large in order to survive from the currents and waves. While seagrass condition in station 2 was found with better conditions than seagrasses at station 1. Longer leaf and larger rhizoma make station 2 have relatively high biomass values compared to seagrasses in station 1 which have shorter (not intact) leaf or are more severed due to human activities and environmental factors, thus making the biomass content at station 1 relatively low both in leaf, root and in the rhizoma. If pay attention overall in each Stations, then it will be seen that the average density and biomass values will be directly proportional, i.e station 2 is the Station that has the highest density and biomass value. For more details, the appearance of the bases waters for the condition of the seagrass ecosystem in the observation station from the analysis of density, coverage and biomass can be seen based on lyzenga analysis using the Geography Information System (GIS) approach [25,26,27,28,29].
3.3. Relationship of Density with Biomass

In the results of the significance test (Tukey and Benferroni), showed that the biomass of each seagrass tissue had a significant that is a tissue of leaf and root tissue. On the test results of the group similarity, it was found that the biomass between root and leaf had a significant difference and there were no significant differences between root biomass and rhizoma and rhizoma biomass and leaf. Based on Figure 3 and T-test, it is known that in station 1, the amount of biomass of Blg is greater than that of Abg (p<0.05). In contrast to station 2, the average value of seagrass biomass in part of Abg and Blg did not differ significantly (p>0.05).

Based on the results of simple linear regression test in Figure 4 it is known that there is a seagrass density relationship with the seagrass biomass, indicated by the correlation coefficient (r) that is 0.413, which means that the relationship between density and the seagrass biomass is medium with the regression equation \( y = 96.95 + 0.761x \). The coefficient value of determination \( (R^2) = 0.171 \), which means 17.1% of the seagrass biomass variation can be explained by the seagrass density variables, while the remaining 82.9% is influenced by other factors outside the independent variable.

4. Conclusion

Seagrass density of Thalassia hemprichii and Enhalus acoroides in Lobam island beach was higher in station 2 than in station 1, while seagrass coverage was classified as poor and included in the medium category with the percentage of seagrass coverage also higher in station 2 than in station 1. The largest
biomass value is found in the section Blg (root and rhizoma) seagrass type of Thalassia hemprichii and Enhalus acoroides at both Stations. There is a significant difference in biomass the section of Abg and Blg in station 1, and conversely there is no significant difference in station 2. The relationship between the seagrass density and the seagrass biomass is medium, because the growth conditions of seagrass stand are not the same or the size of each seagrass stand is different. The high potential of the seagrass biomass illustrates the magnitude of the role of these ecosystems in tackling the adverse effects of global warming so that efforts need to be made to protect and undertake the conservation of the ecosystem.

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