Seagrass distribution in the east coast of Bintan

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Abstract. There is a lot of seagrass species in Bintan. This study aimed to assess the seagrass distribution and density in the east coast of Bintan Island. The sampling was conducted from January to March 2017 in three observation stations which were Berakit, Malang Rapat, and Teluk Bakau. The observation and assessment of seagrass distribution and density was conducted using line transect method and 0.5 m x 0.5 m quadrats along the transect. In total, 9 species were found during this study namely Syringodium isoetifolium, Enhalus acoroides, Thalassia hemprichii, Cymodocea rotundata, Halophila uninervis, Halodule pinifolia, Halophila ovalis, Thalassodendron ciliatum, and Cymodocea serrulata. Highest seagrass composition is found in sampling point 3 and E. acoroides was found in all sampling point location. This could comparison study to the present status and be basic data for seagrass management in Bintan Island.

1. Introduction

Seagrass is one of the coastal ecosystems that become a key role in maintaining the stability of marine waters. It is also known as a very productive ecosystem and has an important role for the social, ecological, and economy sectors in coastal and marine environment. Seagrass supports fisheries production [1] traps and stabilize sediment, protects coastal from erosions and flood [2], absorbs and stores carbon dioxide (known as blue carbon) and marine biota utilizes seagrass as its habitat and nursery ground and the leaves for the food supply [3].

Bintan has a wide distribution of seagrass, which is more than 2500 ha that can be seen along the shallow coastal waters [4]. The coastal ecosystems include seagrass can’t be denied as an important part of the local community as they have economic benefits from fishing activities and marine tourism in seagrass meadows [5]. Trikora Seagrass Management Demosite stated there is 10 seagrass species in Bintan namely Thalassia hemprichii, Halophila uninervis, Enhalus acoroides, Cymodocea rotundata, Thalassodendron ciliatum, Halophila decipiens, Halophila ovalis, Halodule pinifolia, Syringodium isoetifolium, and Cymodocea serrulata.

Globally, seagrass is facing loss and degradation due to direct and indirects impact of anthropogenic activities and also threatened by natural causes such as climate change and ecological degradation [6]. Around 30-40% seagrass in Indonesia has been lost and the coverage and distribution has changed over the time [7], as well as Bintan due to some activities such as tourism, fisheries, illegal port, oil, reclamation, marine debris, pollution, and boating activities [8]. Based on the roles and conditions as described above, this study aimed to assess the distribution and density of the seagrass community in east coast of Bintan.
2. Materials and methods

2.1. Study site
This study was carried out in the east coast of Bintan from January to March 2017 (figure 1). There were 3 observation stations which were Berakit, Malang Rapat, and Teluk Bakau.

![Research Location](image)

**Figure 1.** Research location.

2.2. Seagrass sampling method
The seagrass data included composition, distribution, and density. The data collection was carried out using line transect that was drowned from the coastline up to 100 m towards the sea and placing quadrants 0.5 x 0.5 m² along the transect. The observations were conducted during the low tide.

2.3. Data analysis
Seagrass frequency is the percentage of occurrence of certain types of seagrass at the research location. The frequency was calculated by this equation:

\[
Fi (\%) = \frac{\sum ti}{T} \times 100\%
\]  

Where: \(Fi\) : Frequency of species-I, \(ti\) : Number of quadrant plots where species-i was found \(T\): Total number of quadrant plots

Density is number of seagrass shoot within a unit of area measured. The density was calculated using this equation [9]:

[9]
D (shoot/m²) = \frac{N}{A} \quad (2)

3. Results and discussion

The study location consisted of 3 stations with 8 sampling points which have different characteristics and activities (table 1).

Table 1. Area characteristics.

| Station    | Substrate                  | Activity          |
|------------|----------------------------|-------------------|
| **Berakit**|                            |                   |
| Sampling point 1 | Muddy sand | Without activity  |
| Sampling point 2 | Coral rubble and sand | Dock             |
| Sampling point 3 | Coral rubble and sand | Without activity  |
| **Malang Rapat** |                   |                   |
| Sampling point 4 | Coral rubble and sand | Tourism, Fishing |
| Sampling point 5 | Coral rubble and sand | Tourism           |
| Sampling point 6 | Coral rubble and sand | Without activity  |
| **Teluk Bakau** |                   |                   |
| Sampling point 7 | Muddy sand | Tourism           |
| Sampling point 8 | Muddy sand | Tourism, Fishing |

Seagrass in the east coast of Bintan grows from tidal areas to the edge in relatively clear waters. Based on the research location, seagrass coexists with coral reefs at sampling points 3 and 6. Meanwhile, at sampling point 1 seagrass coexists with mangroves, this area is also a seagrass protection area which is quite far from settlements. Another area that is used as a seagrass protection area is sampling point 5 which is located in Malang Rapat Village, unfortunately this area is no longer fully functioning as a seagrass protection area because it has been opened as a beach tourism spot by local community and until now there has been no further action from the government regarding the change in function.

Table 2. Water quality.

| Station                  | DO (mg/l) | pH   | Salinity (‰) | Temperature (°C) |
|--------------------------|-----------|------|--------------|------------------|
| **Berakit Village**      |           |      |              |                  |
| 1                        | 8.25      | 8.30 | 30           | 30.30            |
| 2                        | 8.00      | 8.33 | 30           | 28.77            |
| 3                        | 11.27     | 8.51 | 30           | 30.41            |
| **Malang Rapat Village** |           |      |              |                  |
| 4                        | 8.90      | 8.39 | 30           | 29.38            |
| 5                        | 8.18      | 8.28 | 30           | 28.67            |
| 6                        | 9.51      | 8.44 | 30           | 29.46            |
| **Teluk Bakau Village**  |           |      |              |                  |
| 7                        | 9.47      | 8.38 | 30           | 29.20            |
| 8                        | 7.51      | 8.23 | 30           | 27.95            |

In general, the physical and chemical conditions of the waters of the eastern coast of Bintan indicate that these waters are still in good condition and suit for seagrass habitat (table 2). There is no value that is less or more than the optimum value range. Optimum temperature for seagrass varied between 11.5 °C to 26 °C in temperate are and 23 °C to 32 °C in tropical area. The optimum salinity value for seagrass varied between 24 – 35 ‰. And The results for dissolved oxygen measurements in
all observation stations ranged between 4.7 - 5.9 mg/l which indicates that the DO value can support seagrass to grow. Based on the Decree of the Minister of Environment no. 51/2004 about sea water quality, the standard value for dissolved oxygen for seagrass is over than 5 mg/l.

The meadows type found in the eastern part of Bintan Coastal is the association and mixed types because consisted of three to nine types of seagrass that forming a large seagrass meadows. Seagrass beds in tropical country such as Indonesia are usually formed by several species. In contrast to temperate area, most of seagrass beds are dominated by one type of seagrass (single species). There are 9 seagrass species found during the study such as *Halophila ovalis*, *Halophila uninervis*, *Syringodium isoetifolium*, *Enhalus acoroides*, *Cymodocea serrulata*, *Thalassia hemprichii*, *Halodule pinifolia*, *Cymodocea rotundata*, and *Thalassodendron ciliatum* (table 3 dan figure 2).

**Table 3. Seagrass distribution.**

| Species                        | Sampling locations |
|--------------------------------|--------------------|
|                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| *Enhalus acoroides*            | + | + | + | + | + | + | + | + |
| *Thalassia hemprichii*         | + | + | + | - | + | + | + | + |
| *Cymodocea serrulata*          | - | + | + | + | + | + | + | - |
| *Cymodocea rotundata*          | + | + | + | - | + | + | + | + |
| *Halodule uninervis*           | - | + | + | - | + | - | - | - |
| *Halodule pinifolia*           | + | - | + | + | + | + | + | - |
| *Halophila ovalis*             | - | + | + | - | - | - | - | - |
| *Syringodium isoetifolium*     | - | + | + | - | + | + | + | - |
| *Thalassodendron ciliatum*     | - | + | + | - | + | + | + | - |

Note: + = present, - = not present

![Figure 2. Seagrass frequency.](image)

*Enhalus acoroides* was the most frequently encountered species because it was found in all research stations with various substrates, this condition is same with [10] research. *Enhalus acoroides*
can dominate and survive longer than other species because of its larger morphology and sturdier rhizome. Followed by *Thalassia hemprichii* and *Cymodocea rotundata* which were found in 7 sampling points. *Thalassia hemprichii* is widely distributed in tropical waters and often found in mixed species meadows along with *Enhalus acoroides*. *Halophila pinifolia* was found in 6 sampling points, *Thalassodendron ciliatum* in 5 sampling points, *Syringodium isoetifolium* in 4 sampling points, *Halodule uninervis* in 3 sampling points and *Halophila ovalis* in 2 sampling points. The distributions also described the frequency value of each species which was estimated based on its appearance on the transect during observation.

Seagrass density is influenced by the seawater quality where the better condition of the waters, the higher seagrass density. Based on the results, *Halophila pinifolia* was species with the highest density while *Halophila ovalis* was the species with the lowest density (figure 3). According to [11], the small species has the ability to live among the larger species as the way of defending itself from currents.

![Figure 3. Seagrass density.](image)

*Thalassia hemprichii, Enhalus acoroides, Halodule pinifolia, and Cymodocea rotundata* were found in sampling point 1, this location is the seagrass protection area of Berakit Village. *Thalassia hemprichii* has the highest density value with 54 shoot/m² and followed by *Enhalus acoroides* with 48 ind / m². The substrate type of this area is muddy sand and the seagrass grows side by side with mangroves. *Thalassia hemprichii* is the dominant species, presumably because it is able to live on all types of substrates, from coral fragments to soft substrates, even in muddy substrate. Research by [12] also found that Thalassia hemprichii can live on various substrate. *Enhalus acoroides* became the dominant species after *Thalassia hemprichii* because this species can live close to mangroves. In sampling point 2 (Semelur Dock), 7 types of seagrass were found such as *Thalassodendron ciliatum*
with 6 shoot/m², *Thalassia hemprichii* with 7 shoot/m², *Halodule pinifolia* with 11 shoot/m², *Cymodocea serrulata* with 23 shoot/m², *Halodule uninevris* with 25 shoot/m², *Cymodocea rotundata* with 45 shoot/m², with *Syringodium isoetifolium* 37 shoot/m² and *Enhalus acoroides* with 87 shoot/m². The substrate is sand with coral rubble.

Sampling point 3 is the area with highest seagrass composition, consisting of *Thalassodendron ciliatum* with 6 shoot/m², *Thalassia hemprichii* with 15 shoot/m², *Halophila ovalis* with 23 shoot/m², *Halodule pinifolia* with 31 shoot/m², *Cymodocea rotundata* with 32 shoot/m², *Cymodocea serrulata* with 38 shoot/m², *Enhalus acoroides* with 42 shoot/m², *Halodule uninervis* with 70 shoot/m², and *Syringodium isoetifolium* with 135 shoot/m². The highest total density of all types of seagrass is also found in this area with a value of 436 shoot/m². This is presumably because there is no activity in this area so the water quality is still very good and even though the seagrass coexists with coral reefs, the number of coral reefs does not dominate and is less than seagrass so competition for nutrients and places to grow is not high. In addition, it is suspected that the presence of corals protected the seagrass from strong currents and waves. The type of seagrass with the highest density at this station is *Syringodium isoetifolium* which has cylindrical leaves that allow it to grow densely and be more flexible when the current passes through it. *Syringodium isoetifolium* can usually be found in shallow areas with bare reef.

*Cymodocea serrulata, Cymodocea rotundata, Enhalus acoroides, and Halodule pinifolia* are found in sampling point 4 with consecutive densities of 2 shoot/m², 18 shoot/m², 46 shoot/m², and 195 shoot/m². *Halodule pinifolia* in this area is species with the highest density among all species and stations. Small types of seagrass such as *Halodule pinifolia* have a higher number of stands compared to other types because the size of the leaves and have the ability to live among the larger species. The stable substrate in the location is also the reason to support this species can grow well. Sampling point 5 is located in the seagrass protection area of Malang Rapat and 8 species were found which were *Halodule uninervis* with 11 shoot/m², *Cymodocea serrulata* with 22 shoot/m², *Thalassia hemprichii* with 31 shoot/m², *Cymodocea rotundata* with 31 shoot/m², *Syringodium isoetifolium* with 34 shoot/m², *Halodule pinifolia* with 44 shoot/m², *Thalassodendron ciliatum* with 45 shoot/m², and *Enhalus acoroides* with 66 shoot/m². In sampling point 6, 7 species seagrass were found, such as *Thalassia hemprichii* with 13 shoot/m², *Halodule pinifolia* with 16 shoot/m², *Cymodocea serrulata* with 20 shoot/m², *Cymodocea rotundata* with 21 shoot/m², *Thalassodendron ciliatum* with 28 shoot/m², *Syringodium isoetifolium* with 37 shoot/m², and *Enhalus acoroides* with 46 shoot/m². In sampling point 6, seagrass also lives with coral reef but the density and composition is lower than sampling point 3. This result is presumably due to the number and distribution of coral reefs in this location is higher than sampling point 3, so there is competition between coral reefs and seagrass to get nutrients and place to live. 7 species were found in sampling point 7 and 3 species were found in sampling point 8 namely *Cymodocea rotundata* with 54 shoot/m², *Thalassia hemprichii* with 70 shoot/m², and *Enhalus acoroides* with 95 shoot/m².

4. Conclusions
In total, 9 species were found during this research with largest seagrass composition was found in sampling point 3 and *Enhalus acoroides* was found in all sampling point location. This publication can be comparison data to the present status and be basic data for seagrass management in Bintan Island.

References
[1] Unsworth RFK 2018 Global challenges for seagrass scnservation *Ambio.* 48 pp 801-15
[2] Mellors J, Marsh H and Tim J B 2002 Testing the sediment-trapping paradigm of seagrass: do seagrasses influence nutrient status and sediment structure in tropical intertidal environments? *Bul. Of. Mar. Sci.* 71 pp 1215-26
[3] Jiang Z, Huang D, Fang Y and Zhao C 2020 Home for marine species: seagrass leaves as vital spawning ground and food source *Fro. Mar. Sci* 9 pp 1-9
[4] Damayanti AS 2011 *Pola Konektivitas Sistem Sosial-Ekologi Dalam Pengelolaan Ekosistem Lamun (Kajian Efektivitas Pengelolaan Kawasan Konservasi Padang Lamun di Desa Malang Rapat dan Desa Teluk Bakau, Kabupaten Bintan)* [The Connectivity Pattern of Social-Ecology System in Seagrass Ecosystem Management (Study About Management of Seagrass Conservation Area in Malang Rapat and Teluk Bakau, Bintan District)] (Jakarta: Universitas Indonesia)

[5] Dirhamsyah 2017 An economic evaluation of seagrass ecosystems in East Bintan, Riau Archipelago, Indonesia *J OLDI* 33 pp 257-70

[6] Orth R J 2006 A global crisis for seagrass ecosystems *Bioscience* 56 pp 987–96

[7] Setiawan F, Harahap SA, Andriani Y, and Hutahean AA 2012 Deteksi perubahan padang lamun menggunakan teknologi penginderaan jauh dan kaitannya dengan kemampuan menyimpan karbon di perairan [Detection of seagrass change by using remote sensing technology and the relation to carbon stock in waters] *JPK* 3 pp 275-86

[8] Karlina I, Kurniawan F and Idris F 2018 Pressures and status of seagrass ecosystem in the coastal areas Of North Bintan, Indonesia *SciFiMas* pp 47 pp 1-6

[9] Azkab M H 1999 Pedoman inventarisasi lamun [The guidelines of the seagrass inventory] *J. Ose.* 24 pp 1-16

[10] Soedarti T, Fadila AF, Hariyanto S, Safitri DP and Suwono 2019 Mapping seagrass beds diversity distribution in substrates on Sirondo Beach – Baluran National Park using GIS *Ecol. Environ. Conserv.* 25 pp 10-13

[11] Takaendengan K and Azkab MH 2010 Struktur komunitas lamun di Pulau Talise, Sulawesi Utara [Seagrass community structure in Talise Island, Sulawesi Utara] *J. OLDI* 36 pp 85-89

[12] Soedari T, Hariyanto S, Wedayanti A, Rahmawati D, Safitri P, Alificia I and Suwono 2017 Biodiversity of seagrass bed in Balanan Resort – Baluran National Park *AIP Conf. Proc.* 1888 020051