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Community Structure of Seagrass Semak Daun Island and Kotok Kecil Island, Seribu Island, Jakarta

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Abstract

Seagrass is a shallow waters ecosystem. Research on the structure of the seagrass community has been conducted on Semak Daun Island and Kotok Kecil Island, Thousand Islands, Jakarta. Semak Daun Island includes the residential zone where is a lot of human activity, and Kotok Kecil Island is a part of the utilization zone. This study aimed to determine the structure of the seagrass community on Semak Daun Island and Kotok Kecil Island. Data were collected using the line transect and quadratic methods; one island is divided into 4 stations that are assigned into 3 transects with 25 m length from each station, and 50 meters straight line is drawn from each transect, and a plot 1 x 1 m is laid out every 10 meters. The results showed that the species composition on Semak Daun Island (4 species, 2 families) was higher than on Kotok Kecil Island (2 species, 2 families). The Similarity Index between the two islands was at the same level. The seagrass diversity index on Semak Daun Island was in the medium category, and the diversity of seagrass species on Kotok Kecil Island is low. Frequency, Density, Coverage, and Important Value Index on both islands were the same, *Thalassia hemprichii* had the highest yield compared to other species on both islands, whereas the smallest on Semak Daun Island was *Halophila ovalis* and the smallest on Kotok Kecil Island was *Halodule uninervis.*

Keywords: Community, Diversity, , Seagrass, Semak Daun Island, Kotok Kecil Island

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INTRODUCTION

Seagrass meadows are complex shallow-water ecosystems with high biological productivity. Therefore, seagrass meadows are a vital marine resource both ecologically and economically. The function of the seagrass community is as a primary producer, stabilizer of the bottom of the waters, recycler of nutrients, a source of food, a place of care and live. Seagrass is an essential food for dugong (*Dugong dugon*) and green turtles (Azkab, 2000; Jalaluddin *et al*., 2020)

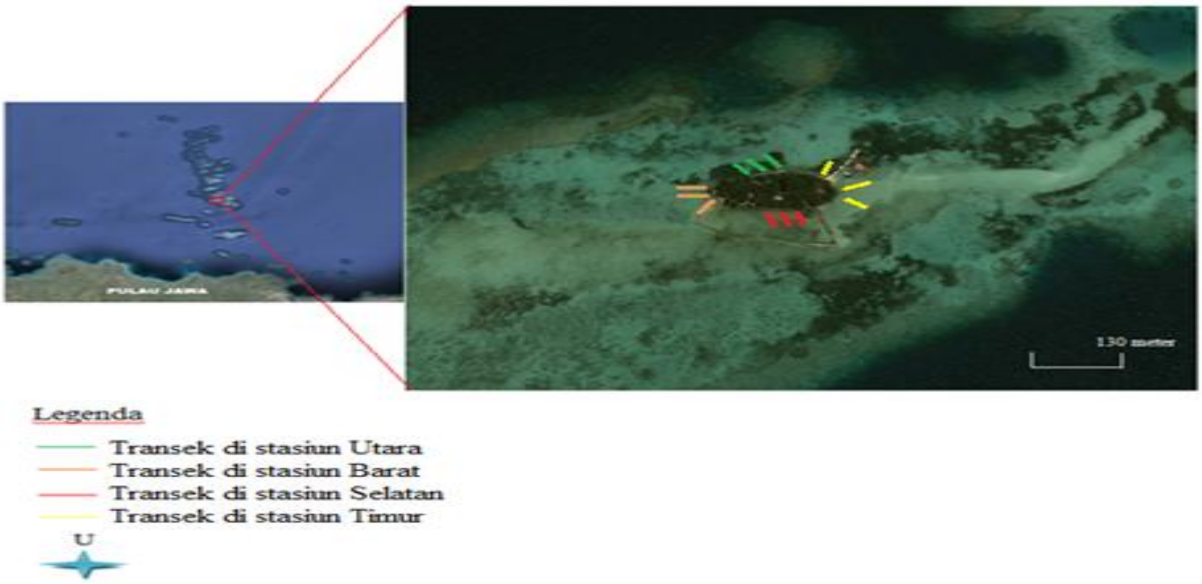
Around the world, 60 species of seagrass have been identified. Fifteen of them are found in Indonesia. In the Seribu Islands National Park area, there are 7 species, *Enhalus acoroides*, *Thalassia hemprichii, Cymodocea serrulata, Cymodocea rotundata, Halophila ovalis, Syringodium isoetifolium,* and *Halodule uninervis* distributed on the sub of the Seribu Islands (Haviarini CP *et al*., 2019; Jalaluddin et al., 2020). In Pallette waters, South Sulawesi, 3 species of seagrass were found, namely, *Thalassia hemprichii, Enhalus acoroides* and *Halophila sp*. and in Tangkulara waters found 5 species of seagrass consisting of *Cymodocea rotundata, Enhalus acoroides, Halophila sp., Halodule uninervis,* and *Thalassia hemprichii* (Jamil et al., 2020). In the Tonyaman Islands, 4 species of seagrass were found, namely *Enhalus acoroides, Thalassia hemprichii, Cymodocea rotundata* and *Cymodocea serrulata* (Parawansa et al., 2020). North Bali waters found six types of seagrass, namely *Enhalus acoroides, Thalassia hemprechii, Halophila ovalis, Cymodocea rotundata, Syringodium isoetifolium, Halodule uninervis* (Widagti *et al*., 2021)

Along with the increased activity in coastal areas, the ecological pressure on the seagrass ecosystem also increases. As a result, it impacts the destruction of the seagrass ecosystem; if it occurs continuously can cause the loss of seagrass species. This leads to decreasing its ecological role. Currently, in Indonesia, the condition of seagrass meadows is under pressure and threats that can cause the loss of these ecosystems. The causes are human activities, such as coastal area development, seaweed cultivation, land reclamation, deforestation, overfishing, and garbage (Cullen *et al*., 2016)

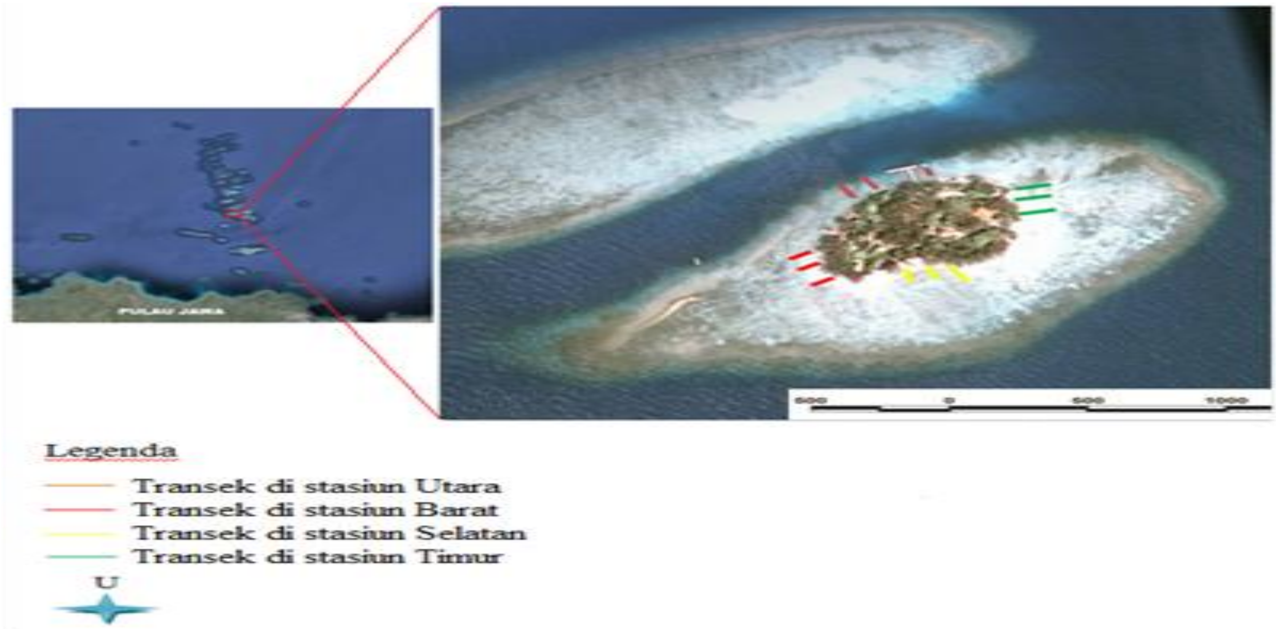
Semak Daun Island and Kotok Kecil Island are coastal areas included in the Seribu Islands National Park area. Kotok Kecil Island is part of the utilization zone, which is not purposed for commercial activities, so seagrasses around the site may have high diversity. Semak Daun Island is part of a residential zone used as a tourist area; this activity is one of the causes of damage to the seagrass meadow (BTNKpS, 2008). The Seribu Islands water is part of DKI Jakarta Province waters located outside of Jakarta Bay. These waters are oceanographically vulnerable to various pollution because it connects to Jakarta Bay, where 13 rivers flow through Jakarta with the density of population and industrial. As a coastal ecosystem, seagrass potentially reduces its population. The loss of seagrass meadows increases because of human activities in coastal areas that can reduce the function of the seagrass ecosystem. Given the significant role of the seagrass ecosystem for the life of marine biota and the consideration of many threats from human, industrial, and activities that decline the ecological part of the seagrass ecosystem, it is necessary to conduct environmental research on seagrasses because of the inadequacy studies of seagrass in these islands. This study aimed to determine the structure of seagrass communities on Semak Daun Island and Kotok Kecil Island. The results of this study can be used to manage and conserve seagrass in Seribu Island, especially Semak Daun and Kotok Kecil islands.

METHOD

This research was conducted in Seribu Island, DKI Jakarta Province, in March-May 2018 (Figure 1). Sampling was carried out on each island with four observation stations determined based on the cardinal directions: North, West, South, and East. This research took 2 locations, namely Semak Daun island and Kotok Kecil island.



A. Semak Daun Island



B. Kotok Kecil Island

Figure 1. Seagrass observation stations on Semak Daun Island (A) and Kotok Kecil Islan (B), Seribu Island, Jakarta

A line transect is drawn towards the sea (Tubir) at each station as far as 50 m; every 10 meters, a plot measuring 1 x 1 m is laid (Figure 2). When collecting seagrass data, water quality data were also collected, including temperature, current, brightness, pH, salinity, nitrate, and phosphate.

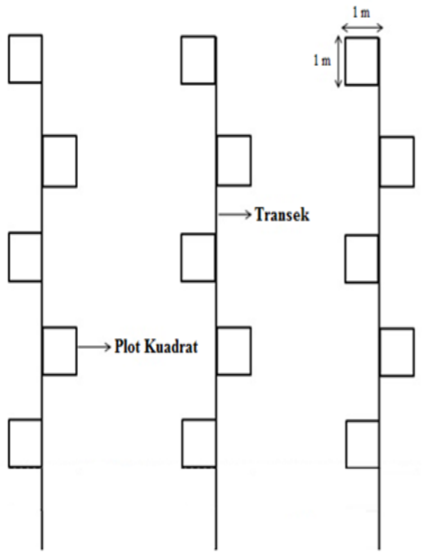


Figure 2. Seagrass Observation Plot

Data analysis

The quantitative method was used to assess the structure of the seagrass communities in the research location. To calculate the Similarity Index (IS) employed the Sorensen Index while the Diversity Index (H`) uses the Shannon-Wiener index. In addition, evaluating the diversity index community used the Hutchinson test and the density found by calculating the number of individual species in a measured area. Furthermore, measuring seagrass cover used the Saito and Atobe method (Azkab, 1999) (Kepmen Negara LH No. 200, 2004) and estimating the overall role of one species in a community done by calculating the value of the critical value index.

RESULT

A. Seagrass Composition

The identification results on Semak Daun Island found 4 types of seagrass, while on Kotok Kecil Island 2 types were found as shown in Table 1 below:

Tabel 1. Seagrass found on Semak Daun Island and Kotok Kecil Island

No.	Island	Family	Genus	Species
1	Semak Daun	*Hydrocharitaceae*	*Thalassia*	*Thalassia hemprichii*
			Halophila	*Halophila ovalis*
		Cymodoceaceae	*Cymodocea*	*Cymodocea rotundata*
			Halodule	*Halodule uninervis*
2	Kotok Kecil	*Hydrocharitaceae*	*Thalassia*	*Thalassia hemprichii*
		Cymodoceaceae	*Halodule*	*Halodule uninervis*

B. Similarity Index

The Similarity Index value obtained from Semak Daun and Kotok Kecil islands was 66.667%. According to Odum (1998), if the similarity index value is <50%, it is declared different, and if the IS value is > 50%, it states the same.

C. Diversity Index

The diversity index on Semak Daun Island was 1.249, while Kotok Kecil Island was 0.265. The diversity of seagrass on Semak Daun Island was in the medium category, while on Kotok Kecil Island was low.

D. Frequency of Seagrass Species, Relative Density of Seagrasses, Relative Coverage of Seagrasses, and Important Value Index

1. Frequency of Seagrass Type

The results of the species frequency on Semak Daun Island and Kotok Kecil Island can be seen in Figure 3:

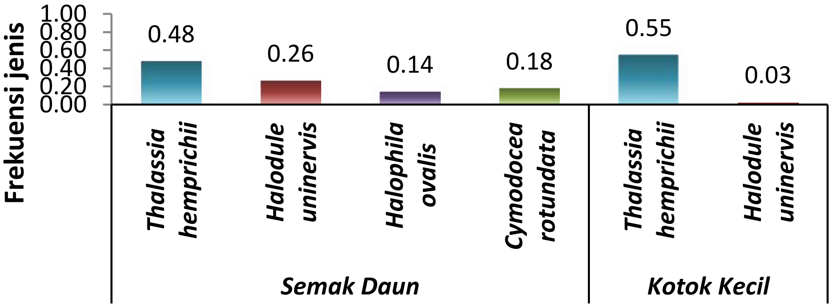


Figure 3. Frequency of seagrass species found on Semak Daun Island and Kotok Kecil Island

2. Seagrass Relative Density

The percentage density of Semak Daun Island and Kotok Kecil Island can be seen in Figure 4:

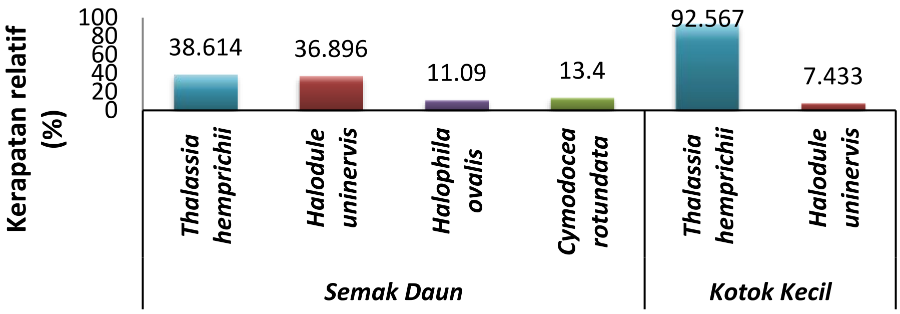


Figure 4. Relative density of seagrass found on Semak Daun Island and Kotok Kecil Island

Seagrass species with high individual density usually also have a high frequency of presence and closure. Several studies of seagrass in Indonesia have shown that *T. hemprichii* is a species that often dominates the waters.

3. Seagrass Relative Closure

The relative closure results on Kotok Kecil Island and Semak Daun Island can be seen in Figure 5:

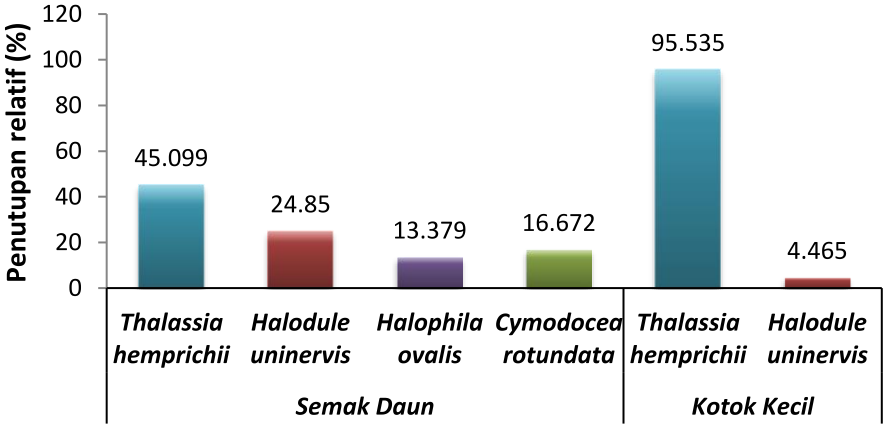


Figure 6. Relative cover of seagrass found on Semak Daun Island and Kotok Kecil Island

The coverage level is closely related to seagrass density and morphology. Generally high seagrass cover with large leaf morphology dominated in this study, namely *T. hemprichii*, which had the highest coverage rates from Semak Daun Island (45.099%) and Kotok Kecil Island (95.535%) while *H. ovalis* in Semak Daun Island had the lowest coverage percentage (13,379%) species has a small and thin leaf shape.

4. Important Value Index

The INP value is highly dependent on the relative density, relative cover, and relative frequency of each type of seagrass. Figure 7 shows that the important value index is on Semak Daun Island (128.8) and Kotok Kecil Island (283.6).

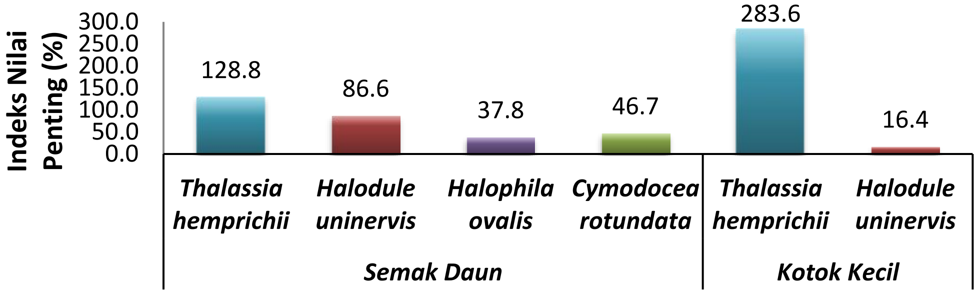


Figure 7. Important Value Index found on Semak Daun Island and Kotok Kecil Island

D. Chemical Physics Parameter

Water Physico-chemical parameters have a significant role in supporting the life of biota in marine waters, one of which depends on this parameter is seagrass life. The values of the water Physico-chemical parameters on Semak Daun Island and Kotok Kecil Island are shown in Table 3.

Tabel 2. The results of the measurement of the Physical and Chemical Parameters of the waters of Semak Daun Island and Kotok Kecil Island

Parameter	Unit	Island	
		Semak Daun	Kotok Kecil
Temperature	^{0}C	32,75	31,75
Current speed	m/s	0,083	0,134
Depth and Brightness	cm	73,083	64,417
pH	-	8,108	8,115
Salinity	PSU	33	33
DO	ppm	6,43	6,13
Nitrate	mg/l	0,029	0,029
Phosphate	mg/l	0,002	0,024
Substrate :			
Texture:			
a. Sand	%	93,945	98,12
b. Dust	%	6,055	1,88
c. Clay	%	0	0
d. Total N	%	0,035	0,035
e. Total P	%	0,01	0,01

DISCUSSION

There are fewer seagrass species on Kotok Kecil Island than on Semak Daun Island. One of the reasons is the difference in the substrate. The substrate on Kotok Kecil Island consists of coarse sand and coral rubble while Semak Daun Island consists of fine muddy sand. Following Supanwanid and Lewmanomont (2003) opinion, C. rotundata, H. uninervis, and H. ovalis prefer substrates with a fine sand texture like those found on Semak Daun Island. *T. hemprichii* is found on both islands because this species has thick and sturdy stolons allowed to grow on various substrates. *H. uninervis* can be found on Kotok Kecil Island, but only grows at the North station which has a suitable substrate, namely fine muddy sand. North Station has a more acceptable sand substrate (Sand: 96.85% and Dust: 3.15%) than other stations. (Larkum and Den Hartog, 1989; Green and Short (2003).

The Semak Daun island and Kotok Kecil similarity index are the same because of the similarity of species found, T. hemprichii and H. uninervis. Although the same species found were higher on Semak Daun Island, T. hemprichii and H. uninervis had a more equal distribution than the other species.

According to Odum (1989), the smaller the number of species and the number of individuals of each species or more individuals, then the species diversity of an ecosystem will decrease. The diversity index on Semak Daun Island is moderate because the number of species and individuals is higher than Kotok Kecil Island. Still, the number of individuals for each species is not evenly distributed because the number of *C. rotundata* and *H. ovalis* is not as much as *T. hemprichii* and *H. uninervis.*

The low diversity index on Kotok Kecil Island is due to the lower number of species and individuals compared to Semak Daun Island. In addition, the number of individuals of *T. hemprichii* was higher and dominated Kotok Kecil Island than *H. uninervis.*

Based on the Hutchinson test, the value of species diversity between Semak Daun Island and Kotok Kecil Island shows a non-significant difference (t hit 0.648 < t table 1.645) because the diversity index on Semak Daun Island that included as moderate only different one level with low category in Kotok Kecil Island.

Seagrass type *T. hemprichii* has the highest frequency value on both islands and is considered more evenly distributed than other seagrass species. Although T. hemprichii had the most elevated presence on both islands, *T. hemprichii* on Kotok Kecil Island was more significant than on Semak Daun Island. The high frequency of *T. hemprichii* in the two islands is due to the dominance of this species in the square plot compared to other species.

The high frequency of *T. hemprichii* in Kotok Kecil Island was due to the higher number of presences in the square plot than *H. uninervis*, which is supported by the opinion of Fauziyah (2004) in his research; *T. hemprichii* prefers places with high current velocity showed in the results of current velocity measurements on Kotok Kecil Island (0.134 m/s) was greater than Semak Daun Island (0.083 m/s). s). In addition, T. hemprichii is more dominant than other species because it has a thick and sturdy rhizome morphology that allows it to grow on substrates and varying current velocities (Larkum and Den Hartog, 1989).

The density of *T. hemprichii* was the highest on the two islands because *T. hemprichii* is generally found in coral reef flats such as on Kotok Kecil Island, and subtidal flats with sand and soft mud substrates such as on Semak Daun Island (Bronus, 1985; Phillips and Menez, 1998; Hartati et al., 2012).

The density of H. uninervis on Semak Daun Island was the second largest (36.896%), while on Kotok Kecil Island was the lowest (7.433) because the substrate on Semak Daun Island consists of fine sand and mud, while on Kotok Kecil Island is mostly substrate coral shards. This result is suitable with a finding of Supanwanid and Lewmanomont (2003) that H. uninervis prefers fine sandy and muddy substrates.

H. ovalis only found on Semak Daun Island had the lowest density due to the influence of depth (73.083 cm). Depth will affect the intensity of light entering the waters. In addition, too high an intensity of sunlight affects the physiological stress of seagrass. It influences a vascular system in H. Ovalis leaf, which disturbs its thin shape and disrupts the photosynthesis process.

It can be said that T. hemprichii has the most significant influence compared to other types of seagrass. This is supported by research from Unsworth et al. (2007); T. hemprichii is better to adapt to the surroundings and has a function for its ecosystem, such as on Semak Daun Island which may act as a sediment catcher from the mainland and on Kotok Kecil Island as a habitat for various biota.

Chemical Physics Parameters

1. Temperature

The temperature in the waters of Semak Daun Island and Kotok Kecil Island is not significantly different, in the range of 31 ^{o}C - 33 ^{o}C. This temperature is still included in the optimum temperature range for seagrass life, from 28 ^{o}C to 30 ^{o}C, the optimum temperature for seagrasses to conduct photosynthesis (Berwick, 1983; Bulthuis, 1987; Minister of Environment Decree No. 51, 2004). The temperature in the waters of Semak Daun Island and Kotok Kecil Island significantly affects the density and frequency of species because if the temperature is reduced even by 1 ^{o}C, it will cause to decrease the density and frequency of species as found in several transects at the research station.

2. Current Speed

The optimum current rate to support seagrass growth and distribution suppose to be in the range of 0.05-1.00 m/s is required (Koch, 2001). Water movement is essential to the seagrasses' growth, including the increasing nitrate absorption rate and the transport of carbon and nutrients from the water column to the leaf surface. If the current velocity is too weak, it can accumulate organic matter and cause one type of seagrass to become dominant over other less adaptable species. On the other hand, if the current velocity is too strong, it will result in excessive and unevenly distributed sediment transport that can cause low seagrass cover levels. For example, H. ovalis had the weakest species cover rate on Semak Daun Island because of its thin leaves. This species does not found on Kotok Kecil Island, which had a greater current velocity rate (0.134 m/s) than Semak Daun Island (0.083 m/s) (Roblee et al., 1991; Koch and Gust, 1999; Thomas and Cornelisen, 2003).

3. Depth and Brightness

The depth measurement recorded on Semak Daun Island was 73.083 cm, and Kotok Kecil Island was 64,417 cm. The bottom of the waters can still be seen; in other words, the brightness level is quite good. The depth affects the diversity of seagrass species. C. rotundata and H. ovalis species are not found on Kotok Kecil Island because Semak Daun Island is deeper than Kotok Kecil Island. Shallower waters can cause higher exposure to sunlight that causes physiological stress to seagrass. For example, thin leaves with smooth surfaces of C. rotundata and H. ovalis can experience a vascular system that interferes with their leaves (Terrados et al., 1997; Bach et al., 1998).

The brightness found on Semak Daun and Kotok Kecil islands includes the optimum brightness. According to the Minister of Environment Decree No. 51 (2004), the standard for brightness is more than 3 m. The depth and brightness are important to sunlight intake, which is a major component in photosynthesis (Berwick, 1983).

4. Degree of acidity (pH)

The pH obtained on Semak Daun Island and Kotok Kecil Island was 8,108 and 8,115, respectively; the pH value on the two islands showed no significant difference. According to the Minister of Environment Decree No. 51 (2004), the pH value is in the optimal pH range, i.e., 7 - 8.5. The degree of acidity (pH) can affect the species' composition. However, in this study, the pH was not very influential because the pH values on the two islands were not significantly different.

The pH value is significant as a water quality parameter because it will control the reaction rate of some ingredients in water and determine CO2 levels. Seagrasses can thrive at optimal pH because the compounds needed for photosynthesis by seagrass are in abundance (Nybakken, 1993).

5. Salinity

In this study, the salinity of the two islands was relatively the same (33 PSU). The salinity number is included in the optimal salinity range (±35 PSU), which can affect the rate of photosynthesis, seagrass growth, germination, and seagrass flower formation. Similar to pH, salinity numbers do not affect differences in community structure because the salinity values on the two islands are the same. (McRoy and McMillan, 1977; Lefaan, 2008).

6. Dissolved oxygen (DO)

The value of dissolved oxygen content from Semak Daun Island (6.43 ppm) and Kotok Kecil Island (6.13 ppm) is above the quality standard range for marine waters, which is > 5 ppm (State Ministerial Decree No. 51, 2004).

The lower dissolved oxygen levels found on Kotok Kecil Island could be due to the large number of biota activities, where all biota need oxygen for metabolism. On Semak Daun Island, the dissolved oxygen level is more significant because the biota other than seagrass found on Semak Daun Island is not as many as the biota on Kotok Kecil Island. This is in line with Lefaan (2008); dissolved oxygen levels is related to the usage of seagrass itself (for respiration and photosynthesis); respiration of aquatic biota, nitrifying bacteria in the nitrogen cycle process of seagrass, and decomposer organisms in breaking down waste and the bodies of dead biota.

7. Nitrates and Phosphates

The nitrate concentration in both islands is the same, 0.029 mg/l. This content has surpassed the quality standard for marine waters (0.008 mg/l) (Kepmen Negara LH No. 51, 2004). The phosphate concentration on Semak Daun Island (0.002 mg/l) is less than Kotok Kecil Island (0.024 mg/l). It can be concluded that the waters on Kotok Kecil Island are better than the waters on Semak Daun Island because the phosphate concentration has surpassed the quality standard for marine biota (0.015 mg/l). The higher phosphate concentration on Kotok Kecil Island may be due to more biota living in these waters than Semak Daun Island as one of the phosphate's sources is waste from animals and weathering from plants or the sea itself, and this content is not only seagrass needs but also other biotas. This is proportional to the diversity number because only certain species live in the waters of Kotok Kecil Island (*H. uninervis* and *T. hemprichii*) that can adapt to water conditions and compete in terms of nutrient absorption associated with biota found in the ecosystem. (Susan, 1996; Minister of Environment Decree No. 51, 2004).

8. Substrate

Based on the analysis of the substrate's particle size, it indicates that Semak Daun Island and Kotok Kecil Island are dominated by the sand sediment fraction (93.945% and 98.12%), and the rest is a dust fraction. The dust fraction in Semak Daun Island is higher than in Kotok Kecil Island, indicating a smoother substrate texture on Semak Daun Island. This may also be one of the causes of the more significant number of species on Semak Daun Island, where most of the species found prefer delicate sand substrates. The other two species found on Kotok Kecil Island, *T. hemprichii* have a thick and sturdy rhizome morphology that allows them to grow on a variety of substrates and *H. uninervis* likes delicate sand substrates found in the North Station (Larkum and Den Hartog, 1989; Green and Short, 2003).

9. Total Nitrogen and Phosphate

The results of the organic carbon analysis of sediments from the two islands ranged from 0.01% to 0.035%. Based on these results, both islands have the same organic carbon content. Total nitrogen and phosphate numbers may not significantly affect differences in community structure because the analysis results on the two islands are the same.

CONCLUSION

Conclusions created based on the results of the identification and analysis of the research: The number of seagrasses found was 4 species from 2 tribes which 4 species were found on Semak Daun Island, namely, *Thalassia hemprichii, Cymodocea rotundata, Halodule uninervis* and *Halophila ovalis* and 2 species in Kotok Kecil Island, namely *Thalassia hemprichii and Halophila ovalis.*

The similarity index of Semak Daun Island and Kotok Kecil Island was 66.667%. The seagrass diversity index on Semak Daun Island was in the medium category, and the diversity of seagrass species on Kotok Kecil Island was low. Hutchinson's test to compare Semak Daun Island and Kotok Kecil Island showed a non-significant difference in diversity.

Frequency, Density, Coverage, and Important Value Index on both islands had the same results, the highest on both islands was *Thalassia hemprichii* species which was equally distributed compared to other species, while the smallest on Semak Daun Island was *Halophila ovalis* and the smallest on Kotok Kecil Island was *Halodule uninervis*

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