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Analysis of Species Cover and Spatial Distribution of Seagrass Beds Based on Different Habitats in East Lombok Regency, West Nusa Tenggara

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Abstract. Seagrass beds are one of the coastal vegetation that is very important as an ecological service, the existence of different characteristics of aquatic habitats can affect the quality of waters, communities and zoning of seagrass grows. The research was carried out in the waters of Gili Maringkik and Poton Bako from September to December 2017. The water quality that differs significantly in both locations is the pH value and amount of dissolved solids, while the temperature, salinity, and dissolved oxygen are not significantly different. The composition of the types of seagrass in East Lombok found amounted to 10 species out of a total of 13 species of seagrass in Indonesia, including: *Cymodocea rotundata*, *Cymodocea serrulata, Enhalus acoroides*, *Halophila minor*, *Halodule pinifolia*, *Halodule uninervis*, *Halophila spinulosa*, *Syringodium isoetifolium*, *Thalassia hemprichii* and *Thalassodendron ciliatum*. The highest species density in both locations was *C. rotundata* (214.67±110.47 m^{-2} individuals in Poton Bako and 506.40±187.81 m^{-2} individuals in Gili Maringkik), while the highest species cover percentage was *T. hemprichii* (36.52±30.00 %), *C. rotundata* (33.47±26, 75%) and *E. acoroides* (31.07±16.24%). The distribution pattern of growth zoning of C*. rotundata* species has similarities in both locations, while *the types of T. hemprichii* and *E. acoroides* are different.

Keywords: Spatial distribution, density, water quality, seagrass meadows, type cover

INTRODUCTION

Seagrass meadows are coastal ecosystems that play a crucial ecological, economic, and social role in shallow tropical marine areas. These ecosystems serve as habitats, nursery grounds, and feeding areas for various marine organisms, including fish, invertebrates, and marine megafauna (Rahman et al., 2023). Furthermore, seagrass meadows play a role in stabilizing sediments, dampening wave energy, protecting coastlines from abrasion, and contributing to blue carbon storage (Johannessen, 2022; Twomey et al., 2022). The existence and condition of seagrass meadows are strongly influenced by the characteristics of their aquatic habitats, so environmental variations will shape differences in community structure and distribution patterns.

Various previous studies have shown that the structure and distribution of seagrass meadows are influenced by physical and chemical environmental factors in the water, such as depth, light intensity, turbidity, substrate type, salinity, and current and wave dynamics (Eisemann et al., 2021; Risandi et al., 2023). Studies in coastal areas of Indonesia have reported that waters with good light penetration and stable substrates tend to have higher seagrass cover than waters affected by land-based activities (Putra et al., 2024; Supriyadi et al., 2024). Furthermore, anthropogenic pressures such as land reclamation, destructive fishing, and coastal waste also contribute to the decline in seagrass quality and extent.

Although numerous studies have been conducted on seagrass meadows, most research focuses on species inventories and descriptive assessments of ecosystem condition. These approaches generally do not integrate in-depth spatial analysis to describe seagrass distribution patterns at different habitat scales (Cowley et al., 2025; O'Brien et al., 2022). Consequently, information on the relationship between habitat characteristics and seagrass spatial distribution remains incompletely described. This limitation has implications for the suboptimal use of scientific data as a basis for managing seagrass ecosystems based on local and spatial conditions.

One of the seagrass habitat locations is the coast of East Lombok Regency. Baseline data for seagrass research is still relatively limited, generally local in nature, and has not yet examined habitat variation comprehensively. This region has diverse coastal characteristics, ranging from main coastal waters, bay areas, to waters around small islands, each with varying levels of environmental pressure. However, information on differences in species cover and spatial distribution of seagrass meadows between these habitats is still limited. This limited data has led to a limited understanding of the actual condition of seagrass meadows, a vital component of the coastal ecosystem in East Lombok.

This research is novel through its integrated analytical approach, combining the study of seagrass community structure with spatial distribution analysis based on differences in aquatic habitats. This approach allows for the identification of relationships between seagrass species composition, density, and cover, and the characteristics of the habitats in which they grow. By integrating ecological and spatial data, this research is expected to provide a more comprehensive picture of seagrass distribution patterns and uncover the habitat factors that play a dominant role in shaping seagrass community structure in coastal areas.

This study also presents the latest empirical data on seagrass meadows in East Lombok Regency, which are rarely reported in the scientific literature. Spatial information on the distribution of seagrass species and cover in different habitats provides an important contribution to enriching the regional database of seagrass ecosystems in West Nusa Tenggara. These data are not only descriptive but also analytical, so they can serve as a reference for further research and support efforts to monitor changes in seagrass ecosystems due to environmental pressures and human activities.

Studies on the species cover and spatial distribution of seagrass meadows are highly urgent in supporting sustainable coastal ecosystem management. This information is crucial as a basis for assessing ecosystem condition, identifying areas vulnerable to degradation, and determining priority conservation zones. Furthermore, a spatial understanding of seagrass meadows can support integrated coastal space utilization planning, allowing development activities and marine resource utilization to be carried out without compromising the sustainability of the ecological function of seagrass meadows.

This study aims to analyze the species composition, density, percentage cover, and spatial distribution of seagrass meadows based on differences in aquatic habitats in East Lombok Regency, West Nusa Tenggara. Specifically, this research aims to identify variations in seagrass community structure across habitats and explain their spatial distribution patterns. The results are expected to provide a comprehensive scientific understanding as a basis for the management, conservation, and sustainable use of seagrass ecosystems.

RESEARCH METHODS

Research Time and Location

The research was conducted during the dry season of September-December 2017. The research was conducted in Poton Bako and Gili Maringkik, East Lombok Regency, West Nusa Tenggara with coordinates of 8°47'–8°49' South Latitude and 116°30'–116°32' East Longitude. The area of the observation plots used to determine the number of individual types and percentage of seagrass cover was 0.5 m x 0.5 m with the distance between plots 25 m and the distance between the paths being 100 m at both study sites. The observation lines in Poton Bako amount to six lines consisting of 36 plots on an area of 55.65 ha, while in Gili Maringkik there are five lines consisting of 25 plots on an area of 31.82 ha.

Identification of Lamun

The identification of seagrass species found in the observation plot was carried out based on morphological characteristics with reference to den Hartog (1970) and Azkab (1999).

Water Quality

Water quality data measurement was carried out on each observation plot in situ which included: temperature (digital thermometer), salinity (hand refractometer), pH (pH meter), Dissolved oxygen (DO meter), Total Dissolved Solids (TDS Meter).

Seagrass Closure

The percentage of seagrass cover in each plot was carried out based on *the Seagrass Watch* method (McKenzie *et al*. 2003).

Density of Sand

The calculation of the number of seagrass stands in Poton Bako and Gili Maringkik is carried out during the day and the sea water conditions recede to facilitate the calculation. The density value of seagrass types is calculated by the formula:

$$D = \frac{Ni}{A}$$

Description :
D = density of type (individual m^{-2})
Ni = total number of seagrass stands
A = total area of the sample tile (m^2)

Seagrass Distribution Pattern

The pattern of seagrass distribution in both locations was carried out by the method of exploring and depicting the spatial distribution of seagrass beds in Poton Bako and Gili Maringkik using *Terra Incognita software* and *ArcGIS 10.5* software.

RESULTS AND DISCUSSION

Water Quality of Padang Segar

Seagrass beds are coastal plants that can be influenced by aquatic environmental factors as one of the limiting factors and supporting their growth and development. Based on the measurement results, the temperature of the waters of the seagrass ecosystem in Poton Bako is between 29–33 °C with an average of 30.51±0.81 °C, while the water temperature of the seagrass ecosystem in Gili Maringkik is between 30–32 °C with an average of 30.72±0.83 °C.

The high average temperature of the waters on Gili Maringkik is suspected to be influenced by the absence of a river estuary, in addition to that throughout the year Gili Maringkik has very low rainfall. Based on the results of the variegated analysis, the water temperature in Poton Bako and Gili Maringkik was not significantly different ($p>0.05$) with $p = 0.122$, this is because water temperature measurements are always carried out during the dry season, namely: noon to evening when the sea water recedes and the distance of seagrass meadows in Poton Bako and Gili Maringkik is geographically close.

The results of the measurement of the salinity of seagrass waters in Poton Bako are between 29-34 psu with an average of 30.89±1.17 psu, while the salinity of the waters in Gili Maringkik is between 30-33 psu with an average of 31±0.84 psu. The salinity of the waters in Poton Bako and Gili Maringkik is still in accordance with the good salinity quality standard based on KepMenNeg LH No. 51 of 2004, which is 33-34 psu. Based on the results of the variety analysis, the salinity of the waters in Poton Bako and Gili Maringkik showed no significant difference ($p>0.05$) with *a value of p* = 0.223. The salinity of coastal waters always fluctuates due to the influence of water circulation, evaporation, rainfall and river water (Liu et al., 2022; Nybakken & Eidman, 1998; Pourfallah Koushali et al., 2021; Yang et al., 2023; Zheng et al., 2022).

The pH measurement results of seagrass waters in Poton Bako are between 8.2–8.5 with an average of 8.25±0.12, while the waters in Gili Maringkik are between 8.3–8.6 with an average of 8.42±0.10. Based on the results of the variety analysis, the pH of the waters in both locations showed significantly different results ($p<0.05$) with *a value of p* = 0.000. The real difference in water pH is suspected to be due to the seagrass ecosystem in Poton Bako being affected by two river flows, while the waters of seagrass meadows in Gili Maringkik are not affected by freshwater inputs from the mainland.

Based on the measurement results, the dissolved oxygen of the seagrass ecosystem in Poton Bako was between 4.4–6.8 mg/L with an average of 5.06±0.51 mg/L, while the dissolved oxygen of seagrass beds waters in Gili Maringkik was between 4.3–5.4 mg/L with an average of 5±0.22 mg/L. Based on the results of the variety, the dissolved oxygen of the waters in Poton Bako and Gili Maringkik showed no significant difference ($p>0$, 05) with a value of p = 0.408. Fluctuations in dissolved oxygen content can be caused by the factor of water currents that move relatively fast in coastal areas and the impact of water input from river mouths that contain a lot of organic matter. In addition, water pollution due to the entry of sewage into the sea can interfere with chemical and biological changes in the waters, this can interfere with the activity of marine biota in the metabolic process which can affect the dissolved oxygen content of the waters (Susana, 2009).

The total amount of dissolved solids in seagrass waters in Poton Bako is between 7556–9094 ppm with an average of 8605.97±364.04 ppm, while the waters in Gili Maringkik are between 8843–9204 ppm with an average of 8810.74±252.13 ppm. Based on the variety-based analysis, the total amount of dissolved solids in the waters in Poton Bako and Gili Maringkik showed significantly different results ($p<0.05$) with *a value of p* = 0.024. The real difference in the total amount of dissolved solids in the two locations can be due to the characteristics of the coastal waters in Poton Bako which are influenced by two rivers and mangrove forest vegetation can be a different factor from the seagrass ecosystem in Gili Maringkik with the characteristics of a small island without the presence of river flows and clear waters.

Composition of Seagrass Types

The total types of seagrass found in the waters of Poton Bako and Gili Maringkik amounted to 10 species out of a total of 13 types of seagrass found in Indonesia (Table 1). The difference in the composition of seagrass types in the two locations can be proven from the number of types found, namely six types of seagrass in Poton Bako and eight types in Gili Maringkik. In detail, there are two types of seagrass found in Poton Bako but not found in Gili Maringkik, namely: *T. ciliatum* and *H. uninervis,* while the types found in Gili Maringkik but not found in Poton Bako amount to four types, namely: *C. serrulata*, *H. pinifolia*, *H. spinulosa* and *S. isoetifolium*.

The difference in composition of this type is due to the characteristics of the waters in the two different locations. The first factor is that the coastal waters in Poton Bako are influenced by two river flows that have an impact on turbidity, while the characteristics of the waters in Gili Maringkik that are clear can support the penetration of light in the water column so that it is very useful in the seagrass photosynthesis process. The second factor is that the waste from the land in Gili Maringkik is relatively less when compared to the waters in Poton Bako which are more polluted, thus making the seagrass habitat in Gili Maringkik maintained.

Table 1. Composition of seagrass species in East Lombok Regency

Genus	Species	Poton Bako	Gili Maringkik
Cymodoceaceae	*Cymodocea rotundata*	+	+
	Cymodocea serrulata	-	+
	Halodule pinifolia	-	+
	Halodule uninerve	+	-
	Syringodium isoetifolium	-	+
	Thalassodendron ciliatum	+	-
Hydrocharitaceae	*Enhalus acoroides*	+	+
	Halophila minor	+	+
	Halophila ovalis	-	-
	Halophila decipiens	-	-
	Halophila spinulosa	-	+
	Halophila sulawesii	-	-
	Thalassia hemprichii	+	+

The composition of *T. ciliatum* and *H. spinulosa* species has a very low distribution in Indonesian waters. Based on Kiswara & Hutomo, (1985) that the distribution of *H. spinulosa* was recorded in only four locations in Indonesia, namely: Bintan Island, Riau Islands, Anyer Java Sea, North Baluran Sea and Irian Sea, while *T. ciliatum* is a species with low distribution in eastern Indonesian waters (Zulkifli et al., 2021) . The results of this finding can be new information on the distribution of *T. ciliatum* and *H. spinulosa* species in the waters of East Lombok Regency.

Density of Seagrass Type

Type density is a structure and composition that can be used to estimate the primary productivity ability based on the number of individuals by considering the area of research. The highest density of types in both locations is C*. rotundata* among other types with a density value of 214.67±110.47 m^{-2} individuals in Poton Bako and 506.40±187.81 m^{-2} individuals in Gili Maringkik. The density of *C. rotundata* in Gili Maringkik is higher when compared to Poton Bako, but in general *C. rotundata* grows in coastal habitats with a large number of stands and is found in the characteristics of fine sand in both locations. This is in accordance with the report of Hartati et al., (2017) that in coastal areas leading to the sea, there are often single, high-associated types that can affect the value of type density.

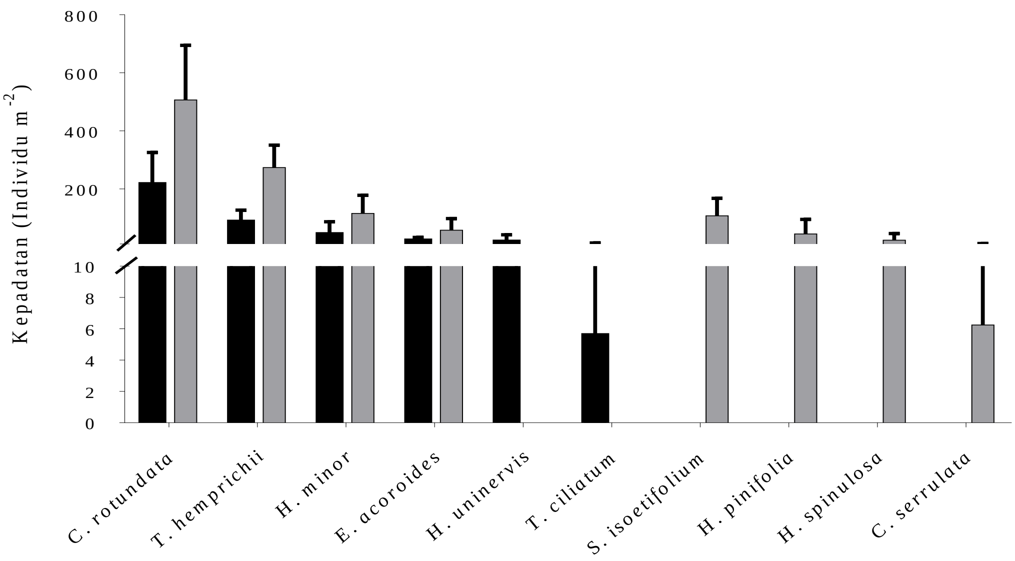

Figure 1. Density of seagrass species in East Lombok Regency

The second highest type density in Poton Bako and Gili Maringkik is *T. hemprichii* which is respectively 85.11±41.47 individuals m^{-2} and 73.28±77.15 individuals m^{-2} (Figure 1). The high density value of *T. hemprichii* can be caused by good adaptability in the Indonesian water environment, so that *T. hemprichii* is a determinant of the quality of Indonesian marine waters (Larkum et al., 1989).

The density of *E. acoroides* in Poton Bako is lower than in Gili Maringkik, but *E. acoroides* in Poton Bako has a higher distribution, one of the determining factors for the low density value of *E. acoroides* in Poton Bako because this species has a relatively larger morphology compared to Gili Maringkik, so it requires more space to grow, This is in accordance with the opinion of Kiswara & Hutomo, (1985) that the morphology of large seagrass generally has a lower density than the morphology of small seagrass. The lowest density in Poton Bako is *H. uninervis* and *T. ciliatum*, while in Gili Maringkik it is *H. pinifolia*, *H. spinulosa*, *C. serrulata*. In general, the low density values of these types in both locations are influenced by the limited distribution of species and the low adaptability to environmental factors.

Seagrass type closure

The percentage of seagrass cover has a positive correlation with the ability to control seagrass species in each observation plot. Based on the calculation results, the percentage of seagrass cover of five types of seagrass in Poton Bako is positively correlated with density, except for type *E. acoroides* had the fourth highest density (20.44±12.22 m^{-2} individuals) with the second-highest percentage of type cover (31.07±16.24%) among the six seagrass species (Figure 2). Average density and closure *E. acoroides* are not positively correlated because the distribution *of E. acoroides* is classified as the highest but has a low number of stands in each observation plot, this is because the large morphological size *of E. acoroides* can affect the level of control of the percentage of cover. This is in accordance with the report of Emmclan et al., (2022) that one individual *of E. acoroides* and *T. hemprichii* will have a higher closure value compared to one *H. minor* individual due to the much larger leaf morphological size of *E. acoroides*, whereas a smaller seagrass individual such as *H. minor* will have a smaller percentage of cover value.

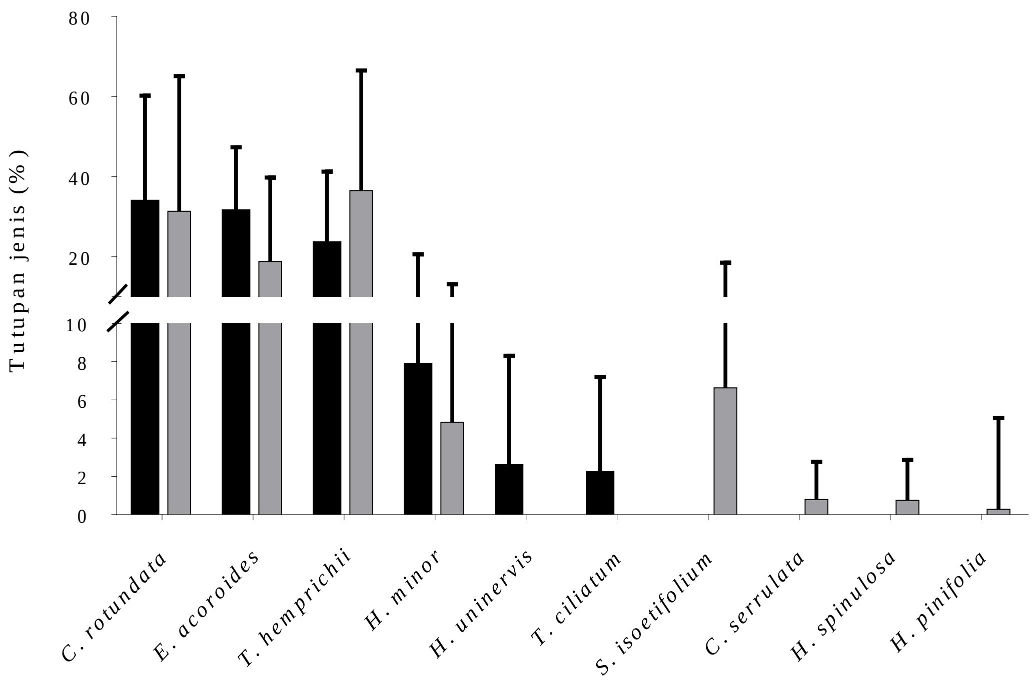

Figure 2. Closure of sewagegrass species in East Lombok Regency

Overall, the percentage of seagrass cover in the waters of Poton Bako and Gili Maringkik is based on the standard criteria for damage and guidelines for determining the status of seagrass beds Decree of the Minister of the Environment (KepMenNeg LH) No. 51 of 2004 that no species with rich (healthy) cover criteria were found, because overall the percentage of seagrass closure was less than 60%. There are several species with less rich (unhealthy) type criteria in both study locations because they are included in the category of species cover percentage between 30-59.9%, namely in the type *C. rotundata* (33.47±26.75%) in Poton Bako and *C. rotundata* (31.36±33.75%) in Gili Maringkik, followed by *E. acoroides* (31.07±16.24%) in Poton Bako and *T. hemprichii* (36.52±30.00 %) in Gili Maringkik, while other types of seagrass are included in the poor cover category with an average cover value of less than 29.9% in both locations.

Spatial Distribution of Padang Lamun

Seagrass beds in Poton Bako are generally dominated by *E. acoroides* and *C. rotundata species*. The spatial distribution of *C. rotundata* grows in coastal habitats adjacent to the distribution of *T. hemprichii* and *H. uninervis species,* while *E. acoroides* found in the waters of Poton Bako has the highest distribution and grows up to the tubir area, this is suspected because only *E. acoroides* which is able to adapt well to the depth and turbidity of the waters, this is in accordance with the report of La Nafie and Arifin (2003) that *E. acoroides* is a type of seagrass that can grow in coastal habitats affected by turbid river flows.

The distribution of *T. hemprichii* in Poton Bako grows close to *C. rotundata*, while in Gili Maringkik it is widely associated with *E*. *achoroids*. The difference in the association of *T. hemprichii* in Poton Bako and Gili Maringkik is due to the presence of factors that limit the depth and penetration of light. *E. acoroides* in Poton Bako is located in a tubir area with a depth of about 2–4 m and is always in a cloudy state, so T*. hemprichii* can only live in coastal areas that can well receive sunlight when the tide is low, unlike in Gili Maringkik even though it grows at a depth of 2–4 m but is supported by the quality of clear waters and good light penetration, makes *T. hemprichii* able to grow and associate widely with *E. acoroides*. Based on the report of Kiswara (1997) that the environmental factors required by *E. acoroides* and *T. hemprichii* have similarities and can grow on mud substrates, sandy mud, muddy sand, sand and corals, living in waters with good light penetration in the water column. The following is the spatial distribution of seagrass in Poton Bako in Figure 3 and in Gili Maringkik in Figure4.

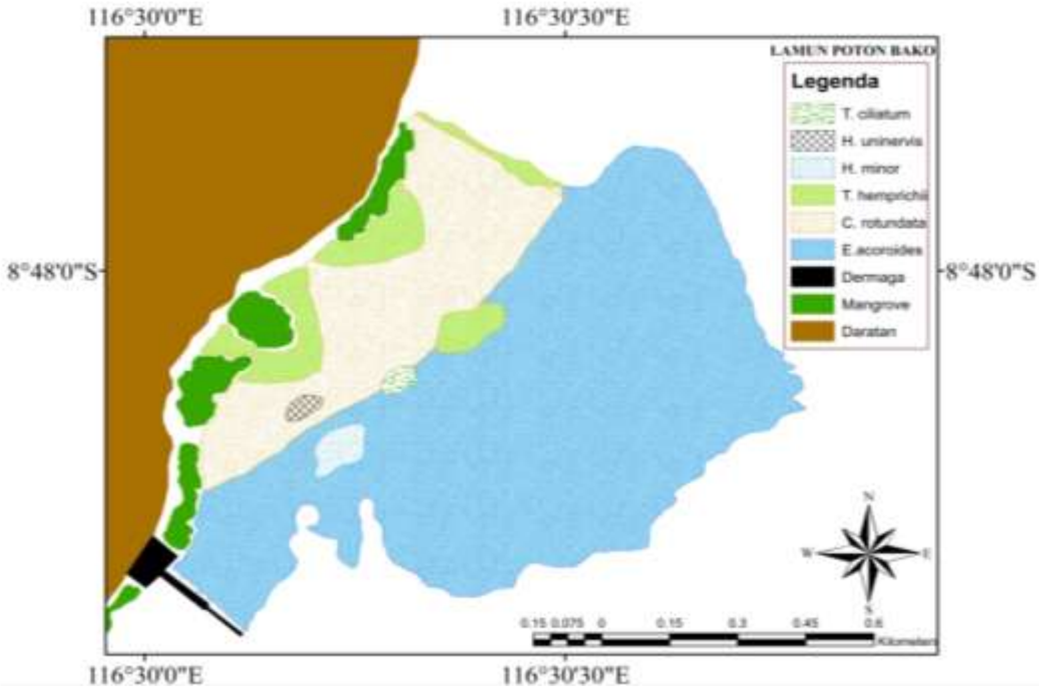

Figure 3. Spatial distribution of seagrass in Poton Bako, East Lombok Regency

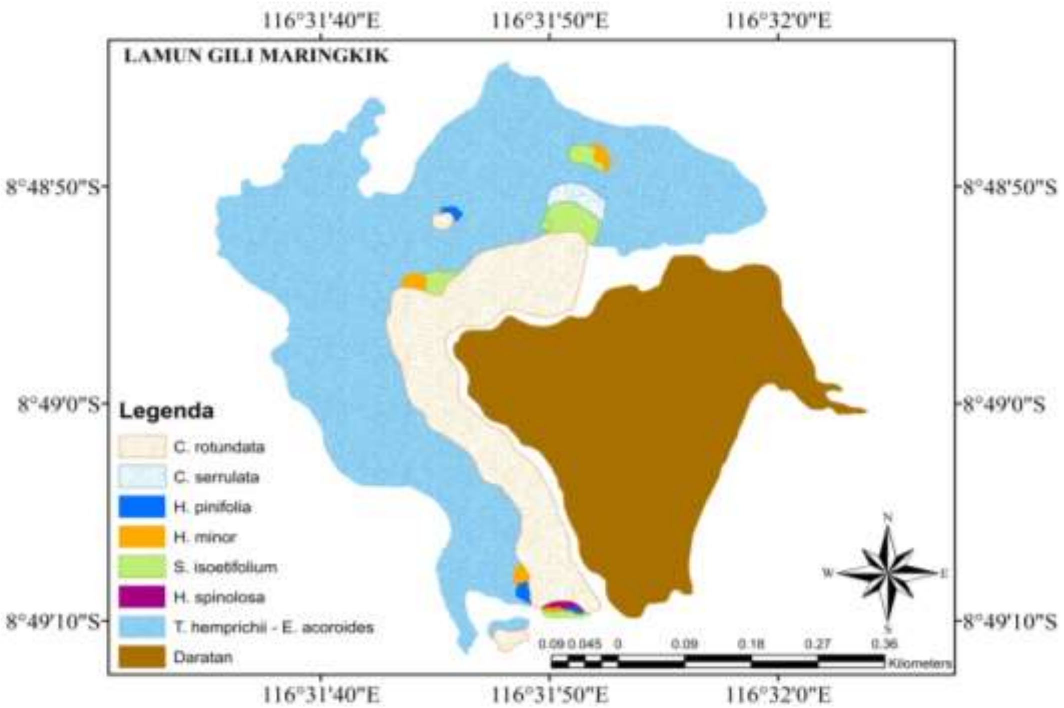

Figure 4. Spatial distribution of seagrass in Gili Maringkik, East Lombok Regency

CONCLUSION

This study shows that the water quality conditions in Poton Bako and Gili Maringkik generally still support the growth of seagrass beds, although there are significant differences in pH and total dissolved solids parameters influenced by the habitat characteristics of each location. The composition of seagrass at both locations consists of ten species, with higher diversity in Gili Maringkik (eight species) compared to Poton Bako (six species), which is related to the level of turbidity and light penetration. Cymodocea rotundata showed the highest density at both locations, while Enhalus acoroides had the widest spatial distribution despite its relatively low density. The percentage of seagrass cover in both locations was below 60%, indicating the condition of the seagrass beds is classified as unhealthy to damaged. The spatial distribution pattern of seagrass reflects adaptation to depth, turbidity, and light, so that habitat differences play an important role in shaping the structure and distribution of seagrass beds in East Lombok.

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