

## Seagrass Community in the Coastal Waters of Hitalawa Beach, Negeri Oma, Indonesia

*Komunitas Lamun di Perairan Pantai Hitalawa, Negeri Oma, Indonesia*

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**Abstract.** The limited data and information on seagrass ecosystems in Negeri Oma provided the basis for this study. The lack of previous studies offers an opportunity to examine the ecological potential of seagrass more comprehensively and to contribute to the conservation and sustainable management of coastal resources. This study aimed to analyze the species composition and description of seagrass, density and relative density, as well as frequency of occurrence and relative frequency of seagrass species in the coastal waters of Hitalawa Beach, Negeri Oma. The study employed a line transect–quadrat method, consisting of six transects with a total of 30 quadrats. Six seagrass species were recorded, namely *Cymodocea rotundata*, *Halodule pinifolia*, *Syringodium isoetifolium*, *Enhalus acoroides*, *Halophila ovalis*, and *Thalassia hemprichii*. The overall seagrass density reached 89.55 shoots/m<sup>2</sup>, placing the seagrass condition at Hitalawa Beach in scale category 3, namely moderately dense, with a density range of 75–125 shoots/m<sup>2</sup>. The highest frequency of occurrence was recorded for *T. hemprichii*, which was found in most of the observation plots. Water temperature and salinity across the six transects ranged from 31.2–32.5°C and 27.7–31‰, respectively. The findings indicate that the coastal waters of Hitalawa Beach support a relatively diverse seagrass community with moderately dense seagrass conditions. This study provides updated baseline information on the condition of seagrass beds in the area and may support future coastal resource conservation and management efforts.

**Keywords:** Negeri Oma, Hitalawa Beach, coastal waters, community, seagrass.

**Abstrak.** Keterbatasan data dan informasi mengenai ekosistem lamun di Negeri Oma menjadi salah satu alasan dilakukannya penelitian ini. Kekurangan kajian sebelumnya membuka peluang untuk menelaah potensi ekologi lamun secara lebih komprehensif serta memberikan kontribusi terhadap upaya konservasi dan pengelolaan sumber daya pesisir yang berkelanjutan. Penelitian ini bertujuan stu komposisi dan deskripsi jenis lamun, kerapatan dan kerapatan relatif, serta frekuensi kehadiran dan frekuensi kehadiran relatif spesies lamun di perairan Pantai Hitalawa, Negeri Oma. Hasil penelitian ini diharapkan dapat menjadi sumber informasi terbaru mengenai kondisi padang lamun di wilayah tersebut. Metode yang digunakan adalah transek linier kuadrat dimana dipasang sebanyak 6 transek dengan total 30 kuadran. Berdasarkan hasil penelitian, ditemukan enam jenis lamun, yaitu *Cymodocea rotundata*, *Halodule pinifolia*, *Syringodium isoetifolium*, *Enhalus acoroides*, *Halophila ovalis*, dan *Thalassia hemprichii*. Nilai kerapatan keseluruhan mencapai 89,55 tegakan/m<sup>2</sup>, yang menempatkan kondisi lamun di Pantai Hitalawa pada kategori skala 3 (75–125 tegakan/m<sup>2</sup>), yaitu kondisi agak rapat. Frekuensi kehadiran tertinggi dicatat pada *T. hemprichii*, yang ditemukan pada sebagian besar plot pengamatan. Suhu dan salinitas selama penelitian pada enam transek berkisar antara 31,2–32,5°C dan 27,7–31‰.

**Kata Kunci:** Negeri Oma, Pantai Hitalawa, perairan, komunitas, lamun.

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## INTRODUCTION

Seagrasses are submerged marine flowering plants (Angiosperms) that inhabit the water column and constitute one of the three major coastal ecosystems, alongside mangroves and coral reefs (Krisye et al., 2023). Morphologically, seagrasses consist of leaves, stems or rhizomes, and roots (Rahmawati et al., 2014). The distinctive characteristics of coastal waters enable seagrasses to develop either as multispecies assemblages (mixed vegetation) or as monospecific stands dominated by a single species (Hidayat et al., 2014; Pasanea et al., 2025). Ecologically, seagrass ecosystems play a critical role as nursery grounds, refugia, and feeding grounds for a wide range of fish and invertebrate species (Miftahuddin et al., 2020). These essential ecological functions underscore the importance of seagrasses in sustaining marine biodiversity and ecosystem productivity, highlighting the need for their conservation through sustainable management practices.

Numerous studies on seagrass species diversity and community structure have been conducted in several coastal areas of Ambon Island. Irawan and Nganro (2016) documented six seagrass species in the waters of Inner Ambon Bay, while Payung (2020) also reported six species in the coastal waters of Tulehu. Subsequently, Tuapattinaya et al. (2021) recorded spatial variation in species richness, with five species in Morela, seven species in Suli, and four species in Poka. Hetharia et al. (2022) further reported five seagrass species in the coastal waters of Waai and Liang. Collectively, these studies indicate that seagrass communities along the coast of Ambon Island exhibit considerable variation in species composition and community structure, largely influenced by local environmental conditions.

In contrast, coastal communities in Negeri Oma Village are currently experiencing increasing pressure on marine resources, as reflected in the declining quality and extent of coastal habitats. Sand and rock extraction for infrastructure development along the shoreline has accelerated coastal erosion and contributed to the degradation of marine environments (Uneputty et al., 2023). In addition, traditional harvesting practices, locally known as *bameti* and *balobe*, exert further pressure on coastal ecosystems. *Bameti* refers to the daytime collection of marine organisms during low tide by walking across the intertidal zone and manually gathering organisms such as mollusks, echinoderms, and other benthic fauna. *Balobe* is a nocturnal fishing practice that uses artificial light, such as lamps or torches, to attract and facilitate the capture of fish, squid, and other invertebrates. When conducted intensively and without appropriate management, both activities have the potential to damage coastal habitats, including coral reefs, seagrass meadows, and benthic substrates that support diverse marine organisms (Nanlohy & Timisela, 2017).

Despite the relatively high level of anthropogenic pressure, scientific information on seagrass communities in the coastal waters of Hitalawa Beach remains extremely limited. This lack of baseline data represents an important knowledge gap and underscores the need for a more comprehensive ecological assessment of seagrass ecosystems in the area. Therefore, this study aims to analyze the seagrass community in the waters of Hitalawa Beach, with particular emphasis on species composition, density, relative density, occurrence frequency, and relative occurrence frequency, as a scientific basis for supporting sustainable coastal management and conservation efforts.

## MATERIAL AND METHODS

### Research Time and Location

Based The research was conducted in February 2025. The research location is located in the coastal waters of Hitalawa, Oma State, Haruku Island District, Central Maluku Regency (Figure 1).

### Tools and Materials

The tools used in this study include 50x50 cm quadrant plots, seagrass samples, roll meters, *Global Positioning System* (GPS), ATK and data sheets, masks and snorkels, hand refractometers, thermometers, small shovels, rulers, stakes and seagrass

identification book *Guide To The Identification Seagrass In The Barrier Reef Region* (Lanyon, 1986).

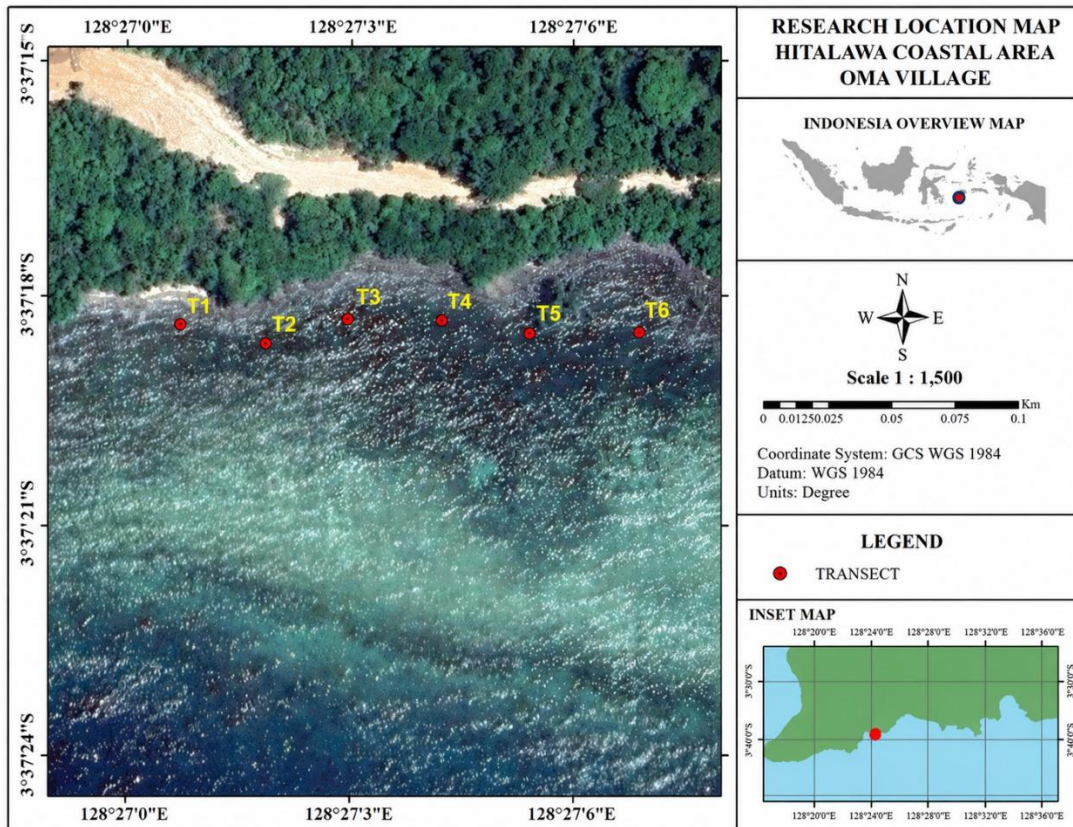


Figure 1. Map of the Study Site

### Data Collection Method

Seagrass data collection was carried out using the square linear transect method (Rahmawati et al., 2014), which was installed perpendicular to the coastline to the sea along 50 m, starting from the first point of seagrass discovery to the last area before seagrass was no longer found. The transect line is drawn vertically from the highest tide zone to the lowest low tide. The squares measuring 50 × 50 cm were then systematically placed along the transect with a distance between squares of 10 m and a distance between transects of 30 m (Figure 2). In addition, temperature and salinity measurements were carried out simultaneously with seagrass sampling at three observation points in each transect, namely in the first quadrant near the coastline, the middle of the transect, and in the lowest recede area.

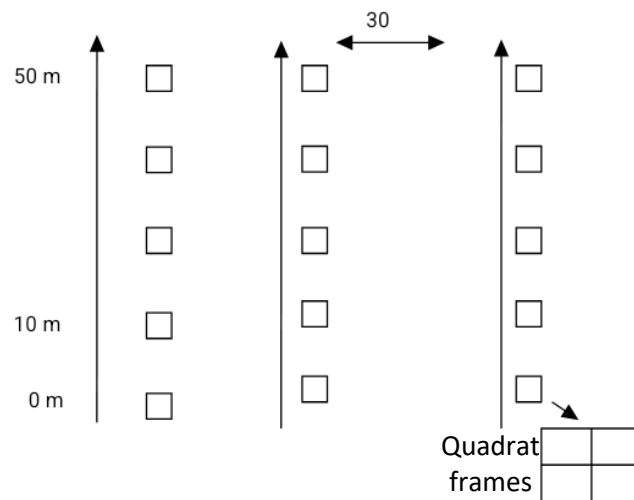


Figure 2. Seagrass Sampling Transect Layout

## Data Analysis Methods

Calculation of the density of the type of seagrass (Odum, 1998):

$$D_i = \frac{N_i}{A} \dots\dots\dots (1)$$

Description:

- $D_i$  : Species density (stands/m<sup>2</sup>)
- $N_i$  : Total number of species stands
- $A$  : Total observation quadrant

The data from the density calculation is known to determine the condition of seagrass beds based on the seagrass density scale as shown in [Table 1](#).

Table 1. Seagrass Condition Scale Based on Density Values

Scales	Density (stands/m <sup>2</sup> )	Seagrass Condition
5	> 175	Very Dense
4	126-175	Dense
3	76-125	Medium
2	26-75	Rare
1	1-25	Very rare

Source : Modified of [Gosari and Haris \(2012\)](#)

Calculation of relative density ([Odum, 1993](#)):

$$RD_i = \frac{D_i}{\sum D_i} \times 100 \dots\dots\dots (2)$$

Description:

- $RD_i$  : Relative density of species  $i$
- $D_i$  : Density of species  $i$
- $\sum D_i$  : Total density of all species

Calculation of the frequency of presence of the type ([Odum, 1993](#)):

$$F_i = \frac{P_i}{\sum P} \dots\dots\dots (3)$$

Description:

- $F_i$  : Frequency of presence of type
- $P_i$  : Number of sample tiles where species  $i$  is found
- $\sum P$  : Total number of observation quadrants

Calculation of relative attendance frequency ([Odum, 1993](#)):

$$Rf_i = \frac{F_i}{\sum F_i} \times 100 \dots\dots\dots (4)$$

Description :

- $Rf_i$  : Relative frequency of attendance
- $F_i$  : Frequency of presence of species  $i$
- $\sum F_i$  : Total frequency of presence of all species

## RESULTS AND DISCUSSION

### Seagrass Species

The seagrass species identified in the coastal waters of Hitalawa Beach ([Table 2](#)) are generally similar to those reported from other coastal areas in Maluku. Previous studies documented six seagrass species in the coastal waters of Ambon Bay (1), five species in Ori Village (2), six species in the coastal waters of Amahai (3), ten species on Lirang Island (4), and eight species in Suli (5).

Table 2. Distribution of Seagrass Species in Maluku Waters

Families	Species	Location						
		1	2	3	4	5	6	7*
<i>Cymodoceaceae</i>	<i>Cymodocea rotundata</i>	√	√	√	√	√	√	√
	<i>Cymodocea serrulata</i>	-	-	-	√	√	-	-
	<i>Halodule uninervis</i>	-	-	-	√	√	-	-
	<i>Halodule pinifolia</i>	√	√	√	√	√	√	√
	<i>Syringodium isoetifolium</i>	-	-	√	√	√	-	√
	<i>Thalassodendron ciliatum</i>	-	-	-	√	-	-	-
<i>Hydrocharitaceae</i>	<i>Enhalus acoroides</i>	√	√	√	√	√	-	√
	<i>Halophila ovalis</i>	√	√	√	√	√	√	√
	<i>Halophila minor</i>	√	-	-	√	-	-	-
	<i>Halophila major</i>	-	-	-	-	-	-	-
	<i>Halophila spinulosa</i>	-	-	-	-	-	-	-
	<i>Halophila decipiens</i>	-	-	-	-	-	-	-
	<i>Halophila beccarii</i>	-	-	-	-	-	-	-
	<i>Halophila sulawesii</i>	-	-	-	-	-	-	-
	<i>Thalassia hemprichii</i>	√	√	√	√	√	√	√
<i>Ruppia</i>	<i>Ruppia brevipedunculata</i>	-	-	-	-	-	-	-
	<i>Ruppia maritima</i>	-	-	-	-	-	-	-

Note : √ (Found), - (not found), \*(this study)

The results of this study revealed the presence of six seagrass species in the coastal waters of Hitalawa Beach, namely *Cymodocea rotundata*, *Halodule uninervis*, *Syringodium isoetifolium*, *Enhalus acoroides*, *Halophila ovalis*, and *Thalassia hemprichii*. In comparison, Rumakur (2017) reported only four species at the same site (Station 6), namely *Cymodocea rotundata*, *Halodule pinifolia*, *Halophila ovalis*, and *Thalassia hemprichii*. The present study, conducted in 2025, recorded two additional species that were not previously reported, namely *Syringodium isoetifolium* and *Enhalus acoroides*. A similar pattern of species dominance has been documented in other regions. In the coastal waters of Morotai Island, *Cymodocea rotundata* was identified as the dominant seagrass species, accounting for more than 94% of total seagrass cover relative to other species (Muhammad et al., 2021).

### Species Density

The results of this study indicate that the seagrass community structure in the coastal waters of Hitalawa Beach, Negeri Oma Village, exhibited substantial variation in density among transects, with different species dominating at each location. *Cymodocea rotundata* and *Thalassia hemprichii* were generally the most dominant species, particularly in Transects 1, 2, 3, 5, and 6 (Table 3). The high density of *C. rotundata* (reaching up to 53 shoots m<sup>-2</sup> in Transect 3) reflects the species' strong adaptability to dynamic coastal environments, especially sandy to muddy-sand substrates within the intertidal zone (Lefaan et al., 2023).

Compared with findings from other regions, the density of *C. rotundata* observed in this study can be considered relatively high. A study conducted in the coastal waters of Tuapejat reported an average density of 33.48 shoots m<sup>-2</sup> (Oktari et al., 2023), which is lower than the values recorded in several transects at Hitalawa Beach. This suggests that environmental conditions at the study site remain favorable for seagrass growth, particularly with respect to light availability, substrate suitability, and hydrodynamic stability. Furthermore, the variation in density among transects indicates the presence of habitat heterogeneity that influences the distribution and dominance of seagrass species.

The dominance of *T. hemprichii* in certain transects, particularly Transects 2 and 6, further demonstrates the species' broad tolerance to varying environmental conditions, including water movement and substrate characteristics. High abundances of *T. hemprichii* are often associated with relatively stable habitats, and the species is widely

regarded as a climax species in tropical seagrass ecosystems. In contrast, the relatively low density of *Enhalus acoroides* in several transects suggests that this species requires more specific environmental conditions, such as deeper and more stable substrates, resulting in a more restricted distribution.

Notably, all six seagrass species were recorded in Transect 5, indicating greater species diversity than in the other transects. This finding suggests that the habitat quality at this location is relatively favorable and capable of supporting the coexistence of multiple seagrass species. Mixed seagrass vegetation of this kind is generally associated with greater habitat complexity, which can enhance key ecological functions, including primary productivity, sediment stabilization, and the provision of habitat for diverse marine organisms. The observed variation in seagrass density and species composition is also likely influenced by anthropogenic activities in the coastal area of Negeri Oma Village. Sand extraction, along with traditional harvesting practices such as *bameti* and *balobe*, may disturb the benthic substrate and increase water turbidity. These disturbances can reduce light penetration required for seagrass photosynthesis, ultimately leading to declines in seagrass density and alterations in community structure.

Table 3. Species Density of Seagrasses in the Coastal Waters of Negeri Oma Village

Species	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6
<i>C. rotundata</i>	39.8	32.2	53.0	–	47.6	–
<i>H. pinifolia</i>	31.0	3.6	–	–	20.4	4.0
<i>E. acoroides</i>	2.8	–	1.4	–	4.2	–
<i>S. isoetifolium</i>	–	–	–	27.6	–	–
<i>H. ovalis</i>	–	–	–	5.4	4.2	–
<i>T. hemprichii</i>	–	34.8	–	–	11.0	45.4

Ecologically, differences in seagrass density among transects have important implications for the functioning of coastal ecosystems. Seagrass meadows with high shoot density generally possess greater capacity for blue carbon storage, sediment stabilization, and the provision of habitat for a wide variety of marine organisms (Oktari et al., 2023). Conversely, reductions in seagrass density may diminish these ecological functions, including decreases in carbon sequestration capacity and increased vulnerability to coastal erosion. Previous studies have also demonstrated a strong positive relationship between seagrass density, biomass, and carbon stocks, whereby increases in shoot density are accompanied by corresponding increases in biomass and carbon storage. Therefore, the findings of this study indicate that, although several locations still support relatively healthy seagrass conditions, ongoing anthropogenic pressures may threaten the long-term sustainability of seagrass ecosystems at Hitalawa Beach. Consequently, ecosystem-based management approaches that incorporate local environmental conditions are needed, including the regulation of activities that degrade coastal habitats and the enhancement of community awareness regarding the critical ecological role of seagrasses in supporting coastal ecosystem functions.

Based on the observations presented in Table 4, the seagrass community structure in the coastal waters of Hitalawa Beach exhibited a clear dominance pattern in terms of both species density and relative density. *Cymodocea rotundata* had the highest species density (38.56 shoots m<sup>-2</sup>) and the greatest relative density (42.99%), confirming that this species is the principal component of the seagrass community at the study site. This dominance reflects its high adaptive capacity to dynamic coastal environments, including tolerance to fluctuations in temperature and salinity, as well as its ability to thrive in shallow substrates exposed to high light intensity (Fortes et al., 2018).

The second most important species was *Thalassia hemprichii*, with a density of 24.30 shoots m<sup>-2</sup> and a relative density of 27.09%. These values indicate that *T. hemprichii* is the second major structural component of the seagrass community. As a climax species, *T. hemprichii* possesses a robust root and rhizome system that plays a

critical role in sediment stabilization and in increasing habitat complexity, thereby supporting a diverse assemblage of associated organisms (Hemminga & Duarte, 2000).

*Halodule uninervis* exhibited a density of 11.90 shoots m<sup>-2</sup> and a relative density of 13.27%, indicating that this species functions as a supporting component within the seagrass community. Its presence is generally associated with relatively favorable environmental conditions, particularly in shallow waters with adequate water circulation. *Syringodium isoetifolium* showed a density of 8.30 shoots m<sup>-2</sup> and a relative density of 9.25%, suggesting a moderate contribution to community structure. This species tends to occur in relatively clear and environmentally stable waters.

In contrast, *Enhalus acoroides* and *Halophila ovalis* had comparatively low density and relative density values, at 5.07 shoots m<sup>-2</sup> (5.65%) and 1.56 shoots m<sup>-2</sup> (1.74%), respectively. Their low relative abundance indicates that their contribution to the overall community structure is limited. *E. acoroides* generally requires more stable environmental conditions and is less tolerant of disturbance, whereas *H. ovalis* is considered a pioneer species with relatively low competitive ability in densely vegetated seagrass communities (Hemminga & Duarte, 2000).

Overall, the relative density pattern reinforces the species density results, demonstrating that the seagrass community at Hitalawa Beach is dominated by two principal species, *Cymodocea rotundata* and *Thalassia hemprichii*, which together account for more than 70% of the total relative density. This dominance suggests that the community structure is relatively simple but stable, characterized by species with broad environmental tolerance. When considered in relation to environmental conditions, particularly water temperature and salinity measured in the field, the dominance of certain species is likely a response to these factors. Species such as *C. rotundata* and *T. hemprichii* are known to exhibit greater tolerance to variations in temperature and salinity than many other seagrass species (Short et al., 2007). This helps explain their dominance at the study site. In contrast, species with narrower ecological tolerances, such as *E. acoroides* and *H. ovalis*, were recorded in relatively low abundance.

Compared with several other locations in Indonesia, this dominance pattern is broadly consistent, although absolute density values differ. The dominance of *C. rotundata* has also been reported in Prapat Agung and Menjangan Island, whereas *T. hemprichii* has been reported as the dominant species in Ternate and East Lombok (Purnomo et al., 2017; Larasati et al., 2022; Ihwani et al., 2023). Quantitatively, however, seagrass density values at Hitalawa Beach tend to be lower than those reported from some of these locations, which may indicate the presence of environmental stressors or suboptimal habitat conditions.

Ecologically, the dominance of a few key species has important implications for seagrass ecosystem functioning. The high contribution of *Cymodocea rotundata* and *Thalassia hemprichii* supports primary productivity, sediment stabilization, and blue carbon storage. However, the limited contribution of other species may reduce overall biodiversity and potentially decrease ecosystem resilience to environmental change. Maintaining a balanced seagrass community structure is therefore essential to sustaining the ecological functions and long-term stability of the coastal ecosystem at Hitalawa Beach.

Table 4. Species Density and Relative Density (%) of Seagrasses Based on the Total Number of Sampling Quadrats in Negeri Oma Village

Species	Species density (stands/m <sup>2</sup> )	Relatif density (%)
<i>C. rotundata</i>	38.56	42.99
<i>H. uninervis</i>	11.9	13.27
<i>S. isoetifolium</i>	8.3	9.25
<i>E. acoroides</i>	5.07	5.65
<i>H. ovalis</i>	1.56	1.74
<i>T. hemprichii</i>	24.3	27.09

## Frequency and Relative Frequency (%)

The occurrence frequency of seagrasses across the six transects in the coastal waters of Hitalawa Beach revealed distinct patterns of species distribution, reflecting the adaptive capacity of each species to local environmental conditions. In general, *Thalassia hemprichii* and *Cymodocea rotundata* exhibited relatively high and consistent occurrence frequencies across nearly all transects. *T. hemprichii* showed occurrence frequency values ranging from 0.10 to 0.16, while *C. rotundata* ranged from 0.06 to 0.16 (Table 5). These findings indicate that both species are widely distributed and capable of occupying a broad range of habitat conditions within the study area.

Table 5. Occurrence Frequency of Seagrass Species by Transect

Species	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6
<i>C. rotundata</i>	0.10	0.13	0.16	0.06	0.13	0.13
<i>H. pinifolia</i>	0.06	0.03	0.10	0.00	0.10	0.03
<i>S. isoetifolium</i>	0.00	0.00	0.03	0.10	0.06	0.06
<i>E. acoroides</i>	0.10	0.00	0.03	0.16	0.06	0.06
<i>H. ovalis</i>	0.00	0.00	0.00	0.10	0.03	0.00
<i>T. hemprichii</i>	0.13	0.16	0.16	0.10	0.10	0.16

The high occurrence frequencies of these two species were further supported by their dominant relative frequency values. *T. hemprichii* exhibited the highest relative frequency in several transects, including Transect 2 (50.00%) and Transect 6 (36.36%), whereas *C. rotundata* also made substantial contributions, particularly in Transect 2 (40.63%) and Transect 3 (33.33%) (Table 6). The dominance of relative frequency values indicates that these two species not only occurred at high densities but were also broadly distributed, emphasizing their central role in shaping the seagrass community structure at Hitalawa Beach.

*Halodule pinifolia* exhibited a fluctuating occurrence pattern, with values ranging from 0 to 0.10. Its relative frequency also varied considerably, reaching 20.83% in Transects 3 and 5, but the species was absent from Transect 4. This pattern suggests that the distribution of *H. pinifolia* is restricted to specific habitat conditions and that the species is less adaptable across the full range of environmental conditions represented by the transects. *Syringodium isoetifolium* displayed low to moderate occurrence frequencies (0–0.10), with the highest relative frequency recorded in Transect 4 (19.23%). This distribution pattern suggests that the species has particular habitat preferences, likely associated with relatively clear waters and favorable water circulation. Furthermore, *Enhalus acoroides* exhibited marked variation in occurrence frequency, with the highest value recorded in Transect 4 (0.16), while the species was absent from Transect 2. Its relative frequency was also relatively high in Transect 4 (30.77%), indicating that this species develops optimally only in locations with suitable environmental conditions, particularly in more stable waters.

In contrast, *Halophila ovalis* was the species with the lowest occurrence frequency, being recorded in only a few transects with a maximum value of 0.10. Its relative frequency was likewise low, reaching 19.23% in Transect 4 and 6.25% in Transect 5. These findings suggest that *H. ovalis* has a highly restricted distribution and likely thrives only under specific environmental conditions, while exhibiting lower competitive ability than the other seagrass species. Overall, the occurrence frequency and relative frequency values demonstrate that *Thalassia hemprichii* and *Cymodocea rotundata* were the most widely distributed and dominant species at the study site. This pattern is consistent with the previously reported results for species density and relative density, which also identified these two species as the principal components of the seagrass community. Their high occurrence frequencies indicate broad ecological tolerance to variations in environmental conditions, particularly temperature and salinity, which are key factors influencing seagrass distribution (Short et al., 2007).

Conversely, species with lower occurrence frequencies, such as *Halophila ovalis* and *Enhalus acoroides*, exhibited more restricted distributions, likely due to more specific

habitat requirements or greater sensitivity to environmental change. This pattern reflects the presence of habitat heterogeneity in the coastal waters of Hitalawa Beach, where not all species are equally capable of adapting across all transects. From an ecological perspective, high occurrence frequency reflects the stability and consistency of species distribution within the community, whereas relative frequency indicates the proportional contribution of each species to the overall community structure. Together, these parameters demonstrate that the seagrass community at Hitalawa Beach is dominated by species with broad ecological tolerance and extensive distribution, while still maintaining the presence of less abundant species that contribute to ecosystem diversity. This diversity is essential for sustaining key ecological functions of seagrass ecosystems, including habitat provision, sediment stabilization, and the enhancement of primary productivity in coastal environments.

Table 6. Relative Occurrence Frequency (%) of Seagrass Species by Transect

Species	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6
<i>C. rotundata</i>	25.64	40.63	33.33	11.54	27.08	29.55
<i>H. pinifolia</i>	15.38	9.38	20.83	0	20.83	6.82
<i>S. isoetifolium</i>	0	0	6.25	19.23	12.50	13.64
<i>E. acoroides</i>	25.64	0	6.25	30.77	12.50	13.64
<i>H. ovalis</i>	0	0	0	19.23	6.25	0
<i>T. hemprichii</i>	33.33	50.00	33.33	19.23	20.83	36.36

### CONCLUSION

Based on the results of this study, the seagrass community in the coastal waters of Hitalawa Beach, Oma Village, consisted of six species: *Cymodocea rotundata*, *Halodule pinifolia*, *Syringodium isoetifolium*, *Enhalus acoroides*, *Halophila ovalis*, and *Thalassia hemprichii*. The total seagrass density reached 89.55 shoots m<sup>-2</sup>, which falls within the moderate or moderately dense category (75–125 shoots m<sup>-2</sup>). Structurally, the seagrass community was dominated by *Cymodocea rotundata* and *Thalassia hemprichii*, which exhibited the highest values of species density and relative density. In addition, *T. hemprichii* showed the highest occurrence frequency, indicating a wide distribution and strong adaptive capacity to local environmental conditions. During the study period, water temperature and salinity ranged from 31.2 to 32.5°C and 27.7 to 31‰, respectively, which are still within suitable ranges for seagrass growth. Overall, the findings indicate that the seagrass ecosystem at Hitalawa Beach remains in relatively good condition. However, variations in community structure suggest the influence of environmental factors and potential anthropogenic pressures that should be considered in the development of sustainable coastal ecosystem management strategies.

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### AUTHOR CONTRIBUTIONS STATEMENT

The authors are grateful to the reviewers for their valuable comments and constructive suggestions, which substantially improved the quality of this manuscript. GS, as the first author, conducted field data collection and analyzed seagrass parameters at Hitalawa Beach. FR and KP contributed to the development and refinement of the discussion section. FFL contributed to language editing and assisted in the design of the research methodology. IVTS, as the corresponding author, supervised the study and was responsible for data analysis, interpretation, and final manuscript revision.

## CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest with any party regarding the publication of this article.

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