Grouper: Jurnal Ilmiah Perikanan
Vol. 17 No. 2 (2026) pp. 590 - 595
pISSN: 2086-8480 | eISSN: 2716-2702
Journal Homepage: https://grouper.unisla.ac.id/index.php/grouper

Seagrass Abundance and Physico-Chemical Characteristics of Water in the Seagrass Ecosystem of South Waigeo District, Raja Ampat Regency

Murniati Tilik[1], Gunanti Mahasri[2*], Ayu Lana Nafisyah[2], Julianus Sangreat Rahawarin[1], Sukree Hajisamae[3], Nadirah Musa[4]

[1]Master's Program in Fisheries Science, Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya, Indonesia
[2]Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya, Indonesia
[3]Faculty of Science and Technology, Prince of Songkla University, Pattani 94000 Thailand
[4]School of Fisheries Science and Aquaculture, Universiti Malaysia Terengganu, Kuala Terengganu, Terengganu, 21030 Malaysia

*Corresponding Author: gunanti.m@fpk.unair.ac.id

Submitted: 29 August 2026 Revised: 27 September 2026 Accepted: 30 September 2026

Keywords:
Cymodocea Rotundata; Raja Ampat; Seagrass Abundance; Water Quality.

ABSTRACT

Seagrass meadows around Waisai, Raja Ampat, are exposed to port, tourism and settlement activities, yet recent data for South Waigeo District are limited. This study aimed to describe seagrass abundance and the physico-chemical characteristics of the surrounding water at three stations representing a port (Station 1), a resort (Station 2) and a settlement (Station 3). Seagrass shoots were counted in 50 × 50 cm quadrats placed every 10 m along three 50-m transects per station (54 quadrats), and water parameters were measured *in situ*. Five seagrass species and 4,401 shoots were recorded; the two dominant species, *Cymodocea rotundata* (60.2% of all shoots) and *Syringodium isoetifolium* (19.3%), are presented and discussed. Total abundance was highest at Station 2 (3,243 shoots), followed by Station 3 (658) and Station 1 (500), and differed among stations (Kruskal–Wallis, p = 0.024). *C. rotundata* occurred at all three stations, whereas *S. isoetifolium* was concentrated at Station 2 (767 of 848 shoots) and absent at Station 3. Temperature (28.5–30.0 °C) met the seagrass standard, whereas pH, salinity (25‰), transparency and, marginally, nitrate deviated from it. Seagrass abundance differed among sites in line with contrasting substrate, current and land use; repeated monitoring that includes seagrass cover is recommended.

INTRODUCTION

Seagrass meadows are shallow coastal ecosystems formed by marine flowering plants and provide a range of ecosystem services, including serving as nursery and feeding habitat for fish and invertebrates, stabilising sediments, and storing carbon (Fourqurean *et al*., 2012; Unsworth *et al*., 2019). The tropical Indo-Pacific region, including Indonesia, is one of the world's centres of seagrass species diversity (Short *et al*., 2007).

Nevertheless, seagrass extent continues to decline globally at an accelerating rate (Waycott *et al*., 2009). The main pressures come from coastal development, sediment and nutrient inputs, and vessel activity, which reduce light availability, one of the key determinants of seagrass growth (Duarte, 2002; Orth *et al*., 2006). Seagrass community responses to these pressures are not uniform. Changes in substrate, currents, and water quality can shift species composition and alter the dominance of one or several species (Hemminga & Duarte, 2000).

Raja Ampat Regency lies at the centre of the Coral Triangle and has seagrass meadows scattered around its small islands, together with coral reef and mangrove ecosystems. Seagrass studies in this region have been conducted at several locations. In the Waisai Islands, South Waigeo District, seven seagrass species were found, with *Cymodocea rotundata* having the

highest importance value at all stations (Ansal, 2017). In North Salawati District, eight seagrass species were recorded (Hoek *et al*., 2016), while in the Ayau Islands five species were recorded, with *Thalassia hemprichii* as the most common (Irawan *et al*., 2026).

However, information on seagrass community structure in South Waigeo District remains limited. Waisai is the regency capital, with port activity, marine tourism, and settlements along its coast, so the seagrass meadows around it potentially receive different pressures depending on land use. To the authors' knowledge, available studies generally report seagrass community structure separately from water environmental conditions, and have not simultaneously compared seagrass abundance and water conditions at sites with contrasting coastal uses.

This study combines measurements of seagrass abundance with water physico-chemical parameters at three stations representing port, resort, and settlement areas. The objectives were (1) to determine seagrass abundance and (2) to describe the physico-chemical characteristics of the water in the seagrass ecosystem of South Waigeo District, Raja Ampat Regency.

METHOD

Time and Study Site

The study was conducted from April to August 2026 in the waters of South Waigeo District, Raja Ampat Regency, Southwest Papua. Three stations were determined purposively based on differences in coastal land use: Station 1 near the port, Station 2 in a resort area, and Station 3 near a residential settlement.

Seagrass Data Collection

Seagrass data were collected using the quadrat transect method following *Seagrass-Watch* (McKenzie & Campbell, 2002) and the seagrass monitoring guide (Rahmawati *et al*., 2014). At each station, three 50-m line transects were laid perpendicular to the shoreline towards the sea. Quadrats of 50 × 50 cm were placed at 10-m intervals (0, 10, 20, 30, 40, and 50 m), giving 18 quadrats per station and 54 quadrats in total, with an observed area of 13.5 m^2. In each quadrat, seagrass species were identified using an identification key (Rahmawati *et al*., 2014) and the number of shoots of each species was counted. Field data entries that could not be reconciled with the per-quadrat counts (two entries) were excluded from the analysis. Entries coded hp and Hp in the field data represent the same species and were combined as *Halodule pinifolia*. All species were recorded, but only the two species with the most shoots are presented and discussed individually.

Measurement of Water Physico-Chemical Parameters

Water parameters were measured *in situ* at each station, including temperature, total dissolved solids (TDS), pH, salinity, transparency, nitrate, phosphate, current velocity, and substrate type. Water physico-chemical parameters were measured *in situ* using a refractometer (salinity), mercury and digital thermometers (temperature), a YSI Pro DO meter (dissolved oxygen), a portable digital pH meter (pH), a propeller current meter (current velocity), a 30 cm Secchi disk (transparency), and a portable echosounder (depth). Station coordinates were determined with a Garmin eTrex 30x GPS. Measurement results were compared with the seawater quality standard for marine biota (seagrass) according to Decree of the State Minister of Environment No. 51 of 2004.

Data Analysis

Shoot counts were tallied per species at each station, and the two species with the highest proportions of shoots were selected as dominant species to be presented and discussed. Abundance was expressed as the number of shoots per species, per quadrat, and per station, together with the proportion (%) of each species relative to the total number of shoots of all species. Differences in total abundance (all species) per quadrat among stations were tested with the Kruskal–Wallis test followed by a post hoc test with Bonferroni correction. Results

among stations and their relationship with water parameters were discussed descriptively, because water parameters were measured only once at each station.

RESULT AND DISCUSSION

Seagrass Abundance

Five seagrass species were recorded in the observation quadrats, with a total of 4,401 shoots. The two species with the most shoots, *Cymodocea rotundata* (60.2%) and *Syringodium isoetifolium* (19.3%), together made up 79.5% of all shoots and are therefore discussed further (Table 1).

Table 1. Abundance (number of shoots) of the two dominant seagrass species at three stations in South Waigeo District.

Species	St.1	St.2	St.3	Total shoots	Proportion (%)
Cymodocea rotundata	218	2,203	229	2,650	60.2
Syringodium isoetifolium	81	767	0	848	19.3
Two dominant species	299	2,970	229	3,498	79.5

Note: proportions are calculated relative to the total of 4,401 shoots of all recorded species (five species). Source: Primary data, processed.

C. rotundata was found at all three stations, with 218 shoots (Station 1), 2,203 shoots (Station 2), and 229 shoots (Station 3), indicating a broad tolerance to differences in substrate and water conditions at the study sites. In contrast, S. isoetifolium was found only at Station 1 (81 shoots) and Station 2 (767 shoots) and was not found in the quadrats at Station 3.
The absence of S. isoetifolium from the quadrats at Station 3 does not mean the species is absent from the surrounding waters, because the observations are influenced by transect position, depth, and sampling effort.

The abundance of the two dominant species was highest at Station 2 (2,970 shoots), far above Station 1 (299 shoots) and Station 3 (229 shoots) (Table 1; Figure 1). The dominance of Station 2 was also seen in the total abundance of all species (Table 2), at 3,243 shoots, compared with Station 3 (658 shoots) and Station 1 (500 shoots). Total abundance per quadrat differed among stations (Kruskal–Wallis, H = 7.42; df = 2; p = 0.024). The post hoc test with Bonferroni correction showed that the difference between Station 2 and Station 1 was close to significance (p = 0.058), whereas the other pairs did not differ significantly (p = 0.198 and 0.361). Thus, the difference was mainly driven by the high abundance at Station 2.

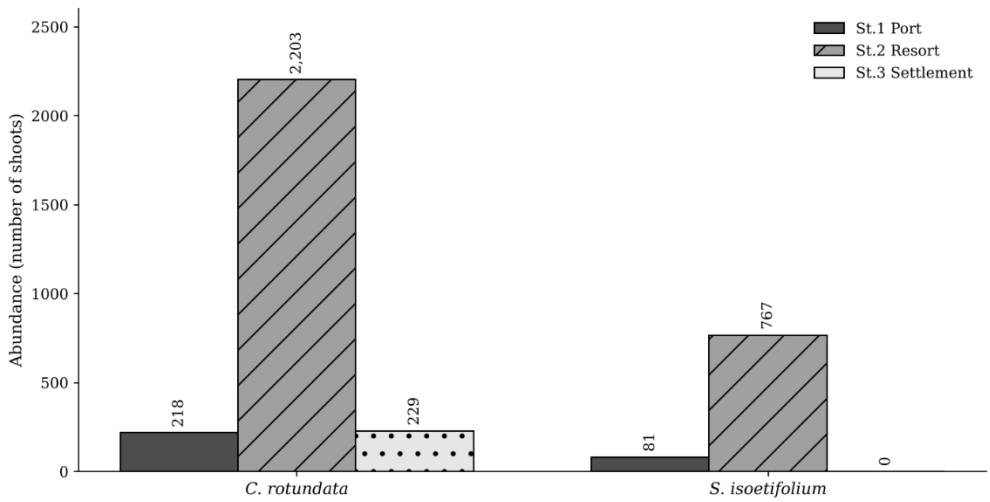


Figure 1. Abundance of the two dominant seagrass species (number of shoots) at three stations in South Waigeo District.
Source: Primary data, processed

Total abundance at Station 2 varied greatly among quadrats (mean 180.2 ± 167.1 shoots per quadrat; Table 2). Transect 2 alone contributed 2,138 of the 3,243 shoots (65.9%), with the richest quadrat holding 509 shoots, whereas several quadrats on Transect 3 were almost empty. This pattern indicates a patchy seagrass distribution, so the station mean should be interpreted together with its spread. The high abundance at Station 2 was formed mainly by *C. rotundata* (2,203 shoots) and *S. isoetifolium* (767 shoots), which together made up 91.6% of all shoots at *that* station. Both species have small growth forms and tend to form many shoots per unit area (Den Hartog, 1970; Hemminga & Duarte, 2000). Because abundance was calculated from shoot counts, it does not directly represent biomass or cover, so percent cover measurements are needed to assess the condition of the seagrass meadow.

Station 1 had the lowest total abundance (500 shoots) and a much lower abundance of the two dominant species than Station 2. Conditions at this station included a sandy mud substrate, a current of 0.9 m s^{-1}, and a pH of 9.6 (Table 3), and the station is close to port activity. However, Station 2 had the same current velocity and a much higher abundance, so current alone does not explain the difference. With three unreplicated stations, this study cannot separate the effects of substrate, vessel disturbance, and water quality on seagrass abundance at Station 1.

Based on shoot counts, *C. rotundata* was the most abundant species, with 2,650 shoots or 60.2% of all shoots, and 83.1% of them were at Station 2 (2,203 shoots). *S. isoetifolium* ranked second with 848 shoots (19.3%), and 90.4% of them were at Station 2 (767 shoots). The high abundance of *C. rotundata* is consistent with the findings of Ansal (2017) in Waisai, who found this species to have the highest importance value at all three of their stations. This comparison is qualitative because the metrics used and transect locations may differ. The concentration of both species at Station 2, which has a rocky sand substrate and a strong current (0.9 m s^{-1}), contrasts with Station 3, which has a muddy sand substrate and a weak current (0.2 m s^{-1}), where *C. rotundata* was recorded at only 229 shoots and *S. isoetifolium* was not found. This distribution suggests that substrate type and current may influence the abundance of both species, although this has not been tested statistically, and Station 1, which has the same current as Station 2, had a much lower abundance.

Table 2. Summary of total abundance of all seagrass species at three stations in South Waigeo District.

Parameter	St.1 Port	St.2 Resort	St.3 Settlement	Mean
Number of quadrats	18	18	18	54
Number of species (S)	5	5	4	5
Number of shoots	500	3,243	658	4,401
Mean ± SD (shoots per quadrat)	27.8 ± 32.9	180.2 ± 167.1	36.6 ± 20.8	81.5 ± 120.1

Source: Primary data, processed.

Physico-Chemical Characteristics of Water

Tabel 3. Parameter fisika-kimia perairan pada tiga stasiun di Distrik Waigeo Selatan.

Parameter	Unit	St.1 Port	St.2 Resort	St.3 Settlement	Standard[b]
Temperature	°C	30.0	29.3	28.5	28–30
TDS	ppm	29	29	26	–
pH	–	9.6	6.98	8.6	7–8.5
Salinity	‰	25	25	25	33–34
Transparency	m	0.9	1.0	1.0	>3
Nitrate	mg L^{-1}	0.01	0.01	0	0.008
Phosphate	mg L^{-1}	0.01	0.01	0	0.015
Current velocity	m s^{-1}	0.9	0.9	0.2	–
Substrate	–	Sandy mud	Rocky sand	Muddy sand	–

Decree of the State Minister of Environment No. 51 of 2004. Source: Primary data.

Water temperature ranged from 28.5 to 30.0 °C and was entirely within the seagrass standard (28–30 °C). The highest temperature was recorded at Station 1 (30.0 °C), exactly at the upper limit of the standard. Current velocity was high at Stations 1 and 2 (0.9 m s^{-1}) and low at Station 3 (0.2 m s^{-1}). Substrate varied from sandy mud (Station 1) and rocky sand (Station 2) to muddy sand (Station 3). The pH at Station 1 (9.6) was far above the standard range of 7–8.5. The pH at Station 3 (8.6) slightly exceeded the upper limit, while that at Station 2 (6.98) was just below the lower limit. A value of 9.6 is much higher than the pH of seawater, which is generally around 8, and needs to be verified against instrument calibration. In shallow vegetated waters, pH can rise during the day owing to carbon dioxide uptake by photosynthesis (Hemminga & Duarte, 2000), but a single measurement is not sufficient to confirm the cause.

Salinity was the same at all three stations (25‰) and below the 33–34‰ range set for seagrass. Such uniform values may reflect freshwater input or rainfall at the time of measurement, or limited instrument precision. Seagrasses are generally reported to tolerate a wide range of salinity (Dahuri, 2003), and *C. rotundata* was still found at all stations at this salinity. Transparency of 0.9–1.0 m was below the seagrass standard (>3 m). In shallow waters, transparency measurements can be limited by depth, so this value needs to be read together with depth data, which were not measured in this study. Nitrate at Stations 1 and 2 (0.01 mg L^{-1}) was slightly above the standard of 0.008 mg L^{-1}, whereas it was not detected at Station 3. Phosphate at all stations (≤ 0.01 mg L^{-1}) was below the standard of 0.015 mg L^{-1}. The nitrate comparison is limited by a measurement precision of only two decimal places, so the difference should be confirmed with a more sensitive method.

CONCLUSION

Five seagrass species with a total of 4,401 shoots were recorded at three stations in South Waigeo District, and the two dominant species, *Cymodocea rotundata* (60.2%) and *Syringodium isoetifolium* (19.3%), together made up 79.5% of all shoots. *C. rotundata* was found at all three stations and was most abundant at Station 2, whereas *S. isoetifolium* was concentrated at Station 2 and was not found at Station 3. Total abundance was highest at Station 2 (3,243 shoots), followed by Station 3 (658) and Station 1 (500), and differed among stations (Kruskal–Wallis, $p = 0.024$), mainly because of the high abundance at Station 2. Water temperature met the seagrass standard, whereas pH, salinity, transparency, and nitrate deviated from it. Regular monitoring, with added seagrass cover data and repeated water quality measurements, is needed to assess the condition of this seagrass meadow.

ACKNOWLEDGEMENT

The authors thank the supervisors for their guidance, the institutions for facility support, and all parties who helped with data collection in South Waigeo District, Raja Ampat Regency.

REFERENCES

Ansal, M. H. (2017). Struktur komunitas padang lamun di perairan Kepulauan Waisai Kabupaten Raja Ampat Papua Barat. *Jurnal Ilmu Alam dan Lingkungan*, *8*(1). https://journal.unhas.ac.id/index.php/jai2/article/view/3926

Dahuri, R. (2003). *Keanekaragaman hayati laut: Aset pembangunan berkelanjutan Indonesia*. PT Gramedia Pustaka Utama.

Den Hartog, C. (1970). *The sea-grasses of the world*. North-Holland Publishing Company.

Duarte, C. M. (2002). The future of seagrass meadows. *Environmental Conservation*, *29*(2), 192–206.

Fourqurean, J. W., Duarte, C. M., Kennedy, H., Marbà, N., Holmer, M., Mateo, M. A., Apostolaki, E. T., Kendrick, G. A., Krause-Jensen, D., McGlathery, K. J., & Serrano, O. (2012). Seagrass ecosystems as a globally significant carbon stock. *Nature Geoscience*, *5*(7), 505–509.

Hemminga, M. A., & Duarte, C. M. (2000). *Seagrass ecology*. Cambridge University Press.

Hoek, F., Razak, A., Hamid, H., Muhfizar, M., Suruwaky, A. M., Ulat, M. A., Mustasim, M., & Arfah, A. (2016). Struktur komunitas lamun di perairan Distrik Salawati Utara Kabupaten Raja Ampat. *Jurnal Airaha*, *5*(1).

Irawan, A., Hafizt, M., & Hernawan, U. E. (2026). Community structure and condition of seagrass meadows in Ayau Islands, Raja Ampat Regency. *Marine Research in Indonesia*, *45*(1). https://doi.org/10.14203/mri.v45i1.564

McKenzie, L. J., & Campbell, S. J. (2002). *Seagrass-Watch: Manual for community (citizen) monitoring of seagrass habitat – Western Pacific edition*. Queensland Fisheries Service, Northern Fisheries Centre.

Menteri Negara Lingkungan Hidup. (2004). *Keputusan Menteri Negara Lingkungan Hidup Nomor 51 Tahun 2004 tentang baku mutu air laut*. Kementerian Negara Lingkungan Hidup.

Orth, R. J., Carruthers, T. J. B., Dennison, W. C., Duarte, C. M., Fourqurean, J. W., Heck, K. L., Hughes, A. R., Kendrick, G. A., Kenworthy, W. J., Olyarnik, S., Short, F. T., Waycott, M., & Williams, S. L. (2006). A global crisis for seagrass ecosystems. *BioScience*, *56*(12), 987–996.

Rahmawati, S., Irawan, A., Supriyadi, I. H., & Azkab, M. H. (2014). *Panduan monitoring padang lamun*. COREMAP-CTI, Pusat Penelitian Oseanografi, Lembaga Ilmu Pengetahuan Indonesia.

Short, F., Carruthers, T., Dennison, W., & Waycott, M. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology*, *350*(1–2), 3–20.

Unsworth, R. K. F., Nordlund, L. M., & Cullen-Unsworth, L. C. (2019). Seagrass meadows support global fisheries production. *Conservation Letters*, *12*(1), e12566.

Waycott, M., Duarte, C. M., Carruthers, T. J. B., Orth, R. J., Dennison, W. C., Olyarnik, S., Calladine, A., Fourqurean, J. W., Heck, K. L., Hughes, A. R., Kendrick, G. A., Kenworthy, W. J., Short, F. T., & Williams, S. L. (2009). Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proceedings of the National Academy of Sciences*, *106*(30), 12377–12381.