Seagrass species distribution, density and coverage at Panggang Island, Jakarta

Iswandi Wahab, Hawis Madduppa*, Mujizat Kawaroe*
Marine Science and Technology Dept. Bogor Agricultural University, Indonesia.

Email : hawis@ipb.ac.id/ mujizat@ipb.ac.id

Abstract. This study aimed to assess species distribution, density and coverage of seagrass in Panggang Island, within Kepulauan Seribu Marine National Park, northern Jakarta. Seagrass sampling was conducted between March to April 2016 at three observation stations in the West, East, and South of Panggang Island. A total of 6 seagrass species was recorded during sampling period, including Cymodocea rotundata, C. serulata, Halodule uninervis, Syringodium isoetifolium, Enhalus acoroides, and Thalassia hemprichii. All species were observed in the South station, while in the West and East station found only three species (C. rotundata, E. acoroides, and T. hemprichii). While, C. rotundata and T. hemprichii were observed at all station. The highest density was observed for C. rotundata (520 ind/m²) and for T. hemprichii (619 ind/m²) in the West station and South Station, respectively. The lowest density was observed in South Station for C. serulata (18 ind/m²), Halodule uninervis (20 ind/m²), and Syringodium isoetifolium (15 ind/m²). Seagrass coverage of Thalassia hemprichii was the highest (43.60%) and the lowest observed at Syringodium isoetifolium (0.40%). This could be basic information for the management of seagrass ecosystem in the Kepulauan Seribu Marine National Park.

1. Introduction
Seagrass ecosystems have a high biodiversity and act as a contributor of nutrients for productivity of coastal waters. Coastal water get a nutrient supply from two places, land and sea, to form an organic ecosystem of high productivity and very supportive of seagrass plants can live in coastal areas and develop optimally. Seagrass is a flowering plant found only in coastal area that is able to live submerged in water [8,9]. The existence of seagrass in the world are so vast but the highest biodiversity found in the Indo-Pacific region including Indonesia [27].

Indonesia has 12 species of seagrass from 69 species in the world. Distribution and diversity of abundant seagrass found throughout the coastal areas of Indonesia. Seagrass is very important for a number of threatened organisms, including dugongs, turtles and sea horses. This association has a complex interaction with seagrass. Groups of fauna which are in seagrass dominated by benthic organisms such as sea cucumbers, crabs (Arthropoda), sea urchins, starfish, clams, brittle stars (Echinodermata), snails (mollusks), shrimp and sponge [2]. This is consistent with [24], the presence of seagrass in a body of water can attract different types of marine organisms to feed, spawn and settled.

Distribution for all types of seagrass is the result of a combination of several seagrass, sexual reproduction and growth of colonial and influenced by the spread and environmental limitations [21]. Many seagrass populations are largely rely on asexual reproduction for the maintenance of the
population [16]. Seagrass produce a large number of sexual propagules with reproductive models varies and depend on the environmental conditions [6]. Seagrass is also the sexual reproduction that produce fruit and seeds (viviparous) [7]. A close relationship between the habitat and species of mussels obviously a lot happening in intertidal areas. All these systems exert a stabilizing effect on the environment, so that their physical and biological support is very important for other ecosystems [4].

Conditions seagrass ecosystems in some parts of Indonesia are under threat from human activities such as tourism, ports, aquaculture and sand mining. An estimated 58% of seagrass ecosystems in the world has decreased extents [27]. According to [24], the area of seagrass in Indonesia decreased by about 30-40%, and the greatest damage seagrass found in Java. Seagrass beds can be found in most of the waters of the island within the Thousand Islands Marine National Park, like Pramuka Island, Panggang island, Kelapa and Harapan Island. If islands change to tourist resorts and residential, so that damage seagrass easily occur on a large scale. However, this ecosystem might have experienced the impact from antrophogenic activities of Jakarta, as coral reefs and its associated organism [12].

According to [1], there are some major factors that affect changes in seagrass beds in the region, that are development activities, daily activities on the islands, reclamation and sand backfilling.

According to Kepulauan Seribu Marine National Park Authority (BTNKPpS), 12 different types of seagrass found in the waters of Indonesia, seven of which can be found in this marine park [1]. Changes that occur in seagrass can influence the presence of associated biota. The impact of human activities on seagrass influence on the distribution and condition of seagrass, both the density and the area of forest cover, particularly where seagrass close to the port, industry and coastal development [18, 19, 20]. The direct effect is dredging, reclamation beach, pier and aquaculture practices. Indirect impacts such as nutrient, suspended sediments, the removal of coastal vegetation and shoreline change resulted in reduced water clarity and the effect on the decline of seagrass.

Panggang Island that is the location of research is one of the islands located in the District of North Thousand Islands, with an area of approximately 9 hectares. Panggang Island geographically located on 5044'19,47" S and 106036'01,43"E. and have sloping beach topography with a carpet of seagrass are quite extensive. Panggang island known have a number of very dense human population, it can be seen from the reclamation of the island, in order intended for residential development. Under these conditions, the need for protection of seagrass and can be started with in-depth research on the distribution and diversity of seagrass. This study aimed to analyze the diversity of seagrass in the waters of Panggang Island. The diversity of sea grass distribution illustrated by the percentage of coverage and seagrass density.

2. Materials and Method

2.1. Research Location

This research was conducted in March and April 2016 in seagrass beds ecosystem in Pangang Island, Thousand Islands, Jakarta. There are three observation stations were set based on the level of complexity and the different vegetation density and closing with a view seagrass species constituent (Figure 1).

2.2. Seagrass Sampling

The process of data collection was done systematically by using line transect method by placing quadrant 1m x 1m [3], which begins with a site survey research to look at the condition of vegetation seagrass along the seagrass beds.
Specify the sampling point on the third observation station that is in the western, eastern and southern of Panggang Island predetermined accompanied by a decision point using GPS coordinates. In every observation location, west, east and south, three replicates of lines transect consists at each station with a 25 m distance between one another. In a transect line consists of five quadrants with each quadrant distance of 20 m. Seagrass found in the square was calculated of the stand and cover by type seagrass.

2.3. Water Quality

Water quality parameters measured such as temperature, salinity, pH, flow, dissolved oxygen (DO), tidal and substrate fractions (sand, silt, clay). Data measurement of temperature, salinity, pH, current speed was done directly in the location, while the measurement of the fraction of the sediment carried in Environmental Laboratory of Aquaculture, Faculty of Fisheries and Marine Science IPB. All parameters were measured as much as 3 repetitions at each station. Analysis of the results of the substrate is inserted into the triangular miller to determine the composition of granular substrate [23].

3. RESULTS AND DISCUSSION

3.1. Water Quality Condition

Water quality conditions of the study sites showed they are in the optimum range for growth of seagrass (Table 1).

The water temperature on the island ranges between 30-31°C. The value of this range is the optimum range in accordance with seagrass life. According [12] the temperature can affect photosynthesis for making nutrients depends on the water temperature. Events temperatures past the optimum value would mislead the seagrass is experiencing stress and eventually die [12].

Salinity waters in the study ranged from 31-32 ppt and is at the optimum value. According [17], the optimum salinity is at a value 31 ppt and 33 ppt. This is according to [15], changes in salinity may affect the spread of aquatic organisms and may indirectly alter the composition of organisms in a body of water.
Table 1. Water Quality Condition at research stations

| Parameter             | Station 1       | Station 2       | Station 3       | Quality Standards |
|-----------------------|-----------------|-----------------|-----------------|-------------------|
|                       | Average         | Average         | Average         |                   |
| Temperature (°C)      | 30.93±0.55      | 30.97±0.49      | 31.27±0.67      | ≤ 32              |
| Salinity (ppt)        | 31.17±0.06      | 31.5±0.17       | 31.43±0.12      | ≤ 34              |
| pH                    | 8.17±0.06       | 8.37±0.06       | 8.33±0.06       | ≤ 8.5             |
| DO (mg/l)             | 7.7±0.36        | 8.1±0.10        | 8.37±0.50       | > 5               |
| Flow(m/det)           | 0.43±0.02       | 0.47±0.01       | 0.62±0.02       |                   |
| Very coarse sand (%)  | 9.1±1.13        | 4.67±1.11       | 11.53±8.20      |                   |
| Coarse (%)            | 24.73±4.21      | 24.53±1.14      | 24.07±4.80      |                   |
| Medium (%)            | 48.37±6.23      | 57.03±2.11      | 46.3±17.34      |                   |
| Fine sand (%)         | 5.43±1.03       | 3.97±0.83       | 4.58±1.02       |                   |
| Very fine sand (%)    | 12.13±2.54      | 9.6±1.10        | 13.33±3.49      |                   |

**Note:** Quality Standard environment minister's decision No.51 of year 2004

3.2. Seagrass Density

The species of seagrass found in the waters of Panggang island bake consists of six types of seagrass that comes from the two tribes and the five clans. Cymodoceaceae tribe includes genera / species *Cymodocea rotundata, Cymodocea serulata, Halodule uninervis* and *Syringodium isoetifolium*. While tribal Hydrocharitaceae include; *Enhalus acoroides, Thalassia hemprichii*.

![Figure 2](image-url)

*Figure 2.* Density of seagrass species at each station in Panggang Island (CR = *Cymodocea rotundata*, HU = *Halodule uninervis*, EA = *Enhalus acoroides*, TH = *Thalassia hemprichii*, CS = *Cymodocea serulata*, SI = *Syringodium isoetifolium*).

Seagrass density value in the western part of the observation station types *Cymodocea rotundata* namely 520 ind /m², *Enhalus acoroides* 167 ind /m², and *Thalassia hemprichii* 30 ind /m². For observations in the eastern part of the station, the density of seagrass *Cymodocea rotundata* types namely 483 ind /m², *Enhalus acoroides* 36 ind /m² and *Thalassia hemprichii* namely 95 ind/m². While at the station southern part of seagrass types *Cymodocea rotundata* 218 ind/m², Type *Enhalus acoroides* 162 ind/m², and the type of *Thalassia hemprichii* 619 ind /m², type *Cymodocea serulata* namely 18 ind/m², Type *Halodule uninervis* of 20 ind/m² and *Syringodium isoetifolium* namely 15 ind/m² (Figure 2).
Seagrass density differences caused by several factors referred to topography, physical condition, activity of coastal communities around the seagrass beds and seagrass adaptation. Other factors that influence the distribution of seagrass is predation and associated biota [5]. Additionally Thalassia hempricii and Cymodocea rotundata has a wide coverage area because it can tolerate a wide range of water conditions [22] The highest density of seagrass species for the entire observation stations found in the southern part of the observation station (Figure 2). This is presumably because the substrate in observation southern part is sandy, many types of seagrass Thalassia hempricii and away from the influence of local settlement activities. [18], states that the seagrass stand density is influenced by several factors such as the type of seagrass, substrate conditions, seasons, tides, wave energy strength, the content of organic matter in the sediment and other environmental factors.

The highest density of seagrass species for the entire observation stations found in the southern part of the observation station (Figure 2). This is presumably because the substrate in observation southern part is sandy, many types of seagrass Thalassia hempricii and away from the influence of local settlement activities. [18], states that the seagrass stand density is influenced by several factors such as the type of seagrass, substrate conditions, seasons, tides, wave energy strength, the content of organic matter in the sediment and other environmental factors.

The existence of seagrass Cymodocea serulata, Halodule uninervis and Syringodium isoetifolium found very little and only in the south but the observation station density value is low, this is because all three of these species have the ability to adapt to different environmental conditions, and can not grow dominant. Seagrass adaptability to environmental conditions are very different from one species with other species [10]. In addition, the observations show that in general the seagrass species Cymodocea rotundata, Thalassia hempricii and Enhalus acoroides is the type commonly found in each observation station.

3.3. Seagrass Coverage
The highest value of seagrass in the western part of the station type Enhalus acoroides 15.87%. Seagrass type Cymodocea rotundata 14.87% and seagrass type Thalassia hempricii namely 3.00%. This is because the type of seagrass Enhalus acoroides have morphology great shape either stem, rhizome and leaves so dominant occupying more space than other type. Relating to the closure of seagrass habitat and morphological also the size of the species. One individual Enhalus acoroides will have higher closing value compared with one individual Halodule uninervis because its leaf size smaller than Enhalus acoroides [18].

For the coverage of seagrass in the eastern part of the observation stations are the type Cymodocea rotundata has a closing value namely 14.80%, followed by Thalassia hemprichii 9% and the type Enhalus acoroides namely 6%. The dominance of the seagrass Cymodocea rotundata due to a suitable substrate in the form of sand and rubble are peppered throughout these waters.

![Figure 3](https://example.com/figure3.png)

**Figure 3.** Coverage of seagrass species at each station (CR = Cymodocea rotundata HU = Halodule uninervis EA = Enhalus acoroides TH = Thalassia hemprichii CS = Cymodocea serulata SI = Syringodium isoetifolium)
While *Thalassia hempricii* was observed high coverage (34.60%) at south station, followed by *Enhalus acoroides* (21.00%), *Cymodocea rotundata* (6.27%), *Cymodocea serulata* (0.80%), *Halodule uninervis* (0.67%), and the lowest *Syringodium isoetifolium* 0.40%. Usually the species composition of seagrass consisting of 4-7 inclined *Cymodocea rotundata, Cymodocea serulata, Enhalus acoroides, Thalassia hemprichii, Halodule uninervis, Syringodium isoetifolium* [12]. Usually these seagrass dominated by *Enhalus acoroides* and *Thalassia hemprichii* [8, 9].

4. Conclusions
The highest number of seagrass species was observed in Panggang Island and they were distributed at all station with high percentage of coverage, with a dominant species *Thalassia hempricii*. This could be basic information for the management of seagrass ecosystem in the Kepulauan Seribu Marine National Park.

5. References

[1] BTNKPSS Thousand Islands National Park Office 2005 Inventory of seagrass in the Thousand Islands National Park. Jakarta
[2] De Wilde PAWJ, Kastoro WW, Berghuis EM, Aswandy, Al Hakim, Kok A. 1989 Strucutre and Energy demand of benthic soft-bottom communities in the java sea and around the islands if Madura and Bali Indonesia. Nether jour. Sea res. 23 449-461.
[3] English S, Wilkinson C, Baker V. Survey Manual for Tropical Marine Resources 1997 Australian Institute of Marine Science. Townsville.
[4] Gillander, B.M. 2006 Seagrasses. Fish, and fisheries. In: Larkum, A. W. D, Orth, R. J. Duarte, C.M. (Eds). Seagrass: Biology, Ecology and Conservation. Springer, The Netherlands 503-536.
[5] Heck KL., Valentine JF 2006 Plant-herbivore interactions in seagrass meadows. J Exp Mar Biol Ecol 330 420-436.
[6] Kuo, J. Coles. R.G. Lee Long, W, J. Mellors, J.E 1991 Fruits and seeds of Thalassia hmpemrchi (Hydrocharitaceae) from Queensland, Australia. Aquat Bot. 40 65-174.
[7] Kuo, J. Kirkman, H 1997 Floral and seedling morphology and anatomy of Thalassodendron pachyrhizum den Hartog (Cymodoceaceae) Aquant Bot 29, 1-7.
[8] Kawaroe M, Nugraha AH, Juraij. 2016 Seagrass Ecosystem. IPB Press, Bogor.
[9] Kawaroe M, Nugraha AH, Juraij, Tasabaramo I 2016 Seagrass biodiversity at three marine ecorion of Indonesia, Sunda Shelf, Sulawesi ea and Banda Sea. Indonesia. Bio Diversitas 585-591
[10] Keough, M. J., and G. P. Jenkins 1995 Seagrass meadows and their inhabitants in A. J. Underwood and G. Chapman, editors. Coastal marine ecology of temperate Australia. University of New South Wales Press, Sydney
[11] Minister of State for the Environment. Decree of the Minister of Environment On Sea Water Quality Standard for Marine Life. Jakarta: KEP No 51 / MENLH / I / 2004.8 April 2004.
[12] Marsh JA, Dennison WC, Alberte RS 1986 Effects of irradiance, temperature, and nutrients on growth dynamics of seagrasses: a review. J of Experiment Marine Biol and Ecol 101 257-267.
[13] Madduppa H., Subhan B, Suparyani E, Sirgear AM, Arafat D, Tarigan SA, Alimuddin, Khairudi D, Rahmawati F, Bramandito A 2013. Dynamics of fish diversity across an environmental gradient in the Seribu Islands reefs off Jakarta. Biodiversity, 14 (1):17-24 DOI: 10.13057/biodiv/d140103.
[14] Nienhuis PH, Coosen J, Kiswara W 1989 Community Structure and Biomass Distribution of Seagrass and Macrofauna in The Flores Sea, Indonesia. SeaResearch. 23:197-214.
[15] Odum EP. Dasar-dasar Ekologi Edisi Ketiga. Gadjah Mada University Press. Yogyakarta
[16] Rasheed, A.M. 1999 Recovery of experimentally created gaps within a tropical Zostera capricorni (Aschers). Seagrass meadow, Queensland, Australia. J. Exp. Mar. Biol. Ecol. 235 183-200.
[17] Rattanachot E, Prathep A 2011 Temporal variation in growth and reproduction of *Enhalus acoroides* (LF) Royle at Haad Chao Mai National Park, Trang Province, Thailand. *Botan Mar* 54 201-207.

[18] Short FT, Coles RG, (eds) 2003 *Global Seagrass Research Methods*. Amsterdam: Elsevier Science BV

[19] Short, F.T. Wyllie-Echeverria, S 1996 Natural and human-induced disturbances of seagrass. *Environ. Conserv.* 23 17-27

[20] Short FT & Coles RG 2001 Global Seagrass research methods. Elsevier Science BV. Amsterdam

[21] Spalding, M., Taylor, M., Ravilious, C., Short, F, Green, E. 2003 Global overview; The Distribution and status of seagrasses. In: Green, E.P. Short. F.T. (Eds), World Atlas of seagrasses. University of California Press, Berkeley

[22] Tomasick T, Mah AJ, Nontji A, Moosa MK 1997 *The Ecology of the Indonesia Seas, Part One Periplus Edition*, Singapore.

[23] USDA United States Department of Agricultural 2009 *Soil Survey Manual*. New York (US): Soils USDA Gov

[24] Vonk JA, Christianen MJA, Stapel J 2010 Abundance, edge effect, and seasonality of fauna in mixed-species seagrass meadows in South-West Sulawesi, Indonesia. *Mar.Biol.Res.* 6: 282-291.

[25] Vo ST, Pernetta JC, Paterson CJ 2013 Status and trends in coastal habitats of the south China sea. *Ocean Coast Manag* 85 153-163.

[26] Waycott M, Mahon KM, Mellors J, Calladine A, Kleine D 2004 *A Guide to Tropical Seagrass of The Indo-West Pacific*. Townsville-Queensland Australia; James Cook University

[27] Waycott M, Duarte CM, Carruthers TJB, Orth RJ, Dennison WC, Olyarnik S, Calladine A, Forgueiran JW, Heck KL Jr, Hughes AR, Kendrick GA, Kenworthy Wj, Short FT, Williams SL 2009 Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *Proc Natl Acad Sci USA* 106;12377-12381.