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Current Status and Species Diversity of Seagrass in Panjang Island, Banten

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Abstract

Damage to seagrass beds in Panjang Island, Banten, has increased every year. The most significant decline occurred at an interval of 2000-2005 with a decrease of about 22.9 ha. Seagrass damage continued to increase at the year between 1989-2002 as a result of natural stone mining and coastal reclamation activities to become industrial areas and ports. The objective of this study was to determine the characteristics of the species and current status of seagrass communities in Panjang Island waters, Banten. Analysis of seagrass data included identification of species, frequency, density, percent coverage, and important value index. Based on these results, it was found three species of seagrass on Panjang Island, Banten, including species of *Enhalus acoroides, Cymodocea serrulata,* and *Syrongodium isoetifolium.* The percentage of seagrass coverage at five different research stations, the highest percentage of seagrass coverage was at station IV with a percentage of coverage of 48.94% and the lowest coverage was obtained at station V of 10.28%. The calculation of the importance value index (INP) of seagrass in Panjang Island waters, Banten, showed that the highest INP value was found in the *Cymodocea serrulata* seagrass species which was 41.47 and the lowest was found in the *Syrongodium isoetifolium* seagrass species which was 16.81. *PCA analysis was also conducted to determine the relationship of seagrass density with chemical physics parameters. The results obtained showed the condition of seagrass ecosystems in Panjang Island waters, Banten, which was at a level of moderate to severe damage. The results of PCA analysis showed that water temperature, nitrate concentration, DO, and TSS greatly influenced the density of seagrass in these waters.*

Keywords: *seagrass, diversity, Panjang Island, water quality*

Introduction

Seagrass beds are one of the essential ecosystems in coastal areas, serving as producers in food webs in coastal areas, providing nutrients for aquatic biota, shelter, spawning grounds, and nurseries for various biota (Susetiono, 2004; Smith, 2012; Lefaan *et al*., 2013). As a primary producer, the contribution of seagrass beds is very dependent on the structure of the community. Differences in seagrass community structure can contribute differently to the productivity of these plant groups (Supriadi *et al*., 2006). Widespread of seagrass loss has occurred in various parts of the world as a result of the direct impacts of human activities including mechanical damage (dredging and anchoring), eutrophication, aquaculture, sedimentation, the effects of construction development and changes in food webs and the indirect effects of activities humans (Kiswara, 2009).

The condition of seagrass ecosystems in Indonesian waters itself has been damaged by around 30-40%, in some areas of Indonesia seagrass coverage and distribution has changed from time to time, one of them is in the waters of the Banten Bay. Damage and loss of seagrass beds in Banten Bay reached around 50 ha or around 35% of all seagrass beds in Banten Bay (Setiawan *et al*., 2012). It is estimated that about 60% of seagrass beds have been damaged and have an impact on the decrease in the value of cover and seagrass species density.

Over the past ten years, reduction in the area of seagrass on Panjang Island, Banten reached 63.9% from 1990. The most significant reduction occurred in the interval 2000-2005 with a decrease of about 22.9 ha. Damage to seagrass beds continued to increase at intervals between 1989-2002 as a result of natural stone mining activities, hill leveling, and coastal reclamation to become industrial areas and ports (Yunus, 2008). The increased activity resulted in high suspended solids contained in the waters, the measurement of TSS on the western region of Banten Bay and Panjang Island in 2000 was 38.7 $mg.L^{-1}$ (LIPI, 2001) whereas the TSS condition from the 2010 measurement data in the same area was 9 $mg.L^{-1}$ and 30 $mg.L^{-1}$.

Based on the condition of the problems that occur in the seagrass ecosystem of Panjang Island,

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this study aims to determine the characteristics of the species and current status of seagrass communities, on Panjang Island, Banten. The results of this study are expected to provide an overview of the seagrass community and as one of the information that can be used as a reference in the management of seagrass biological resources, especially in Panjang Island waters, Banten.

Materials and Methods

This research was conducted in Panjang Island waters, Banten, West Java, Indonesia. Data collection method used was a transect line that is perpendicular to the coastline by dividing the study site into five stations (Figure 1; Table 1). The plot/point was taken at each observation station

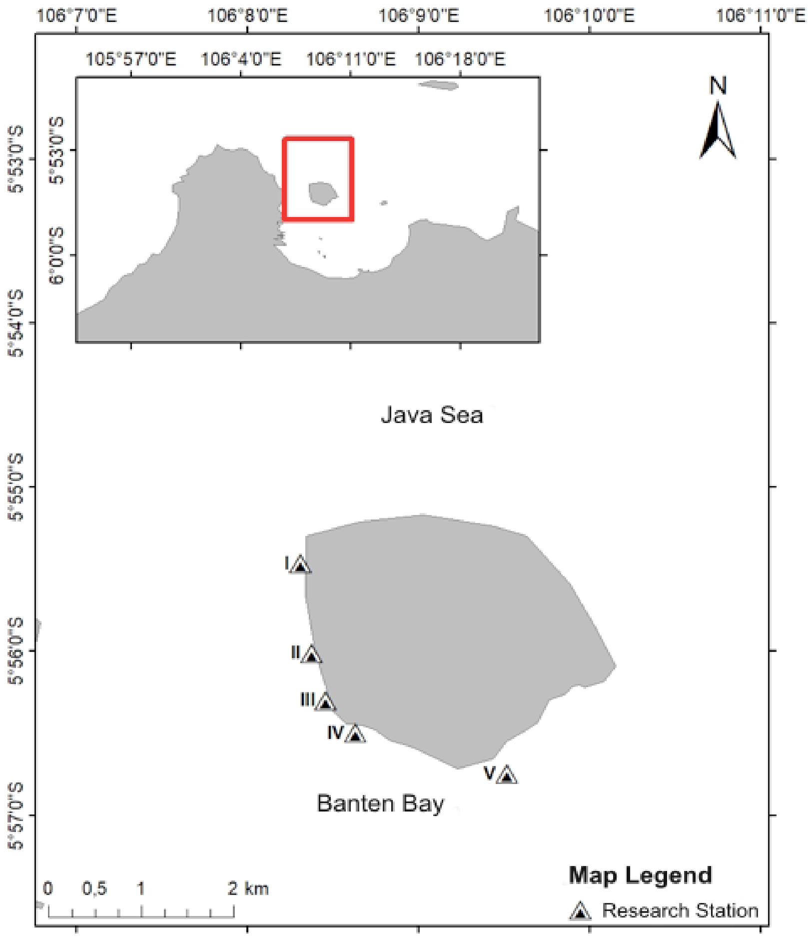


Figure 1. Research station on Panjang Island, Banten

Table 1. Description of the research station

Station	Coordinate	Description
I	S : 05º 55' 27.5 " E : 106º 08' 18.6"	- In the northwest of Panjang Island. - This location is quite representative because the characteristics of the area are much influenced by input from the mainland, especially from coastal reclamation activities, port activities, and seaweed farming activities.
II	S : 05º 56' 00.8 " E : 106º 08' 22.5"	- There are mangrove vegetation and transects used as seaweed cultivation.
III	S : 05º 56' 17.5 " E : 106º 08' 27.4"	- There is a water flow which is the result of waste from household waste, seaweed washing waste, ship waste, and at this station, there is also mangrove vegetation.
IV	S : 05º 55' 29.7 " E : 106º 08' 22.5"	- There is dense mangrove vegetation and no human activity at all.
V	S : 05º 56' 00.7 " E : 106º 09' 37.6"	- In this location, besides mangrove vegetation, there are also cultivation activities in the form of KJA (floating net cage) of grouper and *baronang* (Siganus) fishing.

from the coast to the edge of the coast. Station determination and transect placement are adapted from the Seagrass Net monitoring method (Short *et al.*, 2004), where locations have seagrass communities with a homogeneous or nearly equal percentage of closure, communities with relatively even seagrass closure, far from human disturbance or destructive sources such as port and location easily accessible.

Data were collected during three transects (development of research method from Hartati *et al.*, 2012), with a length of 50 m each and the distance between one transect, and the other was 50 m, so the area was 50 x 100 m^2. The quadratic frame was placed on the right side of the transect with the distance between one square and the other being 25 m, so the total square of each transect is 3. Transects starting point was placed at a distance of 5-10 m from the first time the seagrass was found from the direction of the beach (Sugianti, 2016).

Parameters were done in-situ such as temperature, brightness, salinity, pH, and the rest was done ex-situ, which was then analyzed in the laboratory. Data analysis of the seagrass included identification of species, frequency of seagrass species, calculating the density, percentage of seagrass coverage, and important value index (Leefan *et al.*, 2013; Adli *et al.,* 2016). From these results, it can be seen that the level of seagrass conditions at a particular location within a particular time was assessed based on the standard criteria for seagrass damage using a percentage of coverage area based on the Decree of the Minister of Environment No. 200/2004.

Frequency, density and percentage of seagrass species coverage is calculated using formula from English *et al., 1997.* To see the condition of seagrass from the value of the amount of coverage ranging from 0-100%, it can be categorized as follows: 0-25 = Rare; 26-50 = Medium; 51-75 = Dense; 76-100 = Very dense. The level of seagrass beds damage greatly determines the condition of its ecosystem (Poedjirahajoe *et al.*, 2013). To determine the level of damage, it requires standard criteria that apply in all regions in Indonesia. Seagrass status according to Minister of Environment Decree Number 200/2004 concerning standard criteria for damage and guidelines for determining seagrass status based on seagrass cover is divided into three criteria, namely rich/healthy with closure >60%, less rich/less healthy with closure of 30-59%, and poor <29,9%.

Important Value Index (INP)

The important value index (INP) is used to calculate and predict the role of each species of seagrass in their community (Brower *et al.*, 1998). The higher the INP value of a species relative to other species, the higher the role of species in the community. INP is calculated using the following formula:

$$INP = KR + FR + PR$$

Note: INP= Important value index; FR= Relative frequency; KR= Relative density; PR= Relative closure

Water quality analysis was carried out descriptively. The relationship of seagrass density with chemical-physical parameters were analyzed using Principal Component Analysis (PCA) by STATISTICA software.

Results and Discussion

Based on the results of the study, it was found three species of seagrass on Panjang Island, Banten, including species of *Enhalus acoroides, Cymodocea serrulata,* and *Syrongodium isoetifolium.* Seagrass species found in these waters were native to Indonesia (www.iucnredlist.org). Seagrass communities in Panjang Island waters were classified as mixed communities consisting of 1-5 species of seagrasses (Hartati *et al.*, 2012). The species found compared with studies in 2008-2010 showed that there had been a reduction and change in the number of seagrass species. Zulkarnain's study (2009) found 4 species of seagrasses, including *Enhalus acoroides, Cymodocea serrulata, Thalassis hemprichii,* and *Halophila spinullosa.* In contrast to seagrass found in 2010, where three seagrass species were found, including *Enhalus acoroides, Cymodocea serrulata,* and *Syrongodium isoetifolium.* Among the three seagrass species found in Pulau Panjang waters, Banten, the highest number of species (Fi) and relative frequency (FR) was *Cymodocea serrulata* with Fi of 0.77 and FR of 15.4. While the lowest was *Syrongodium isoetifolium* seagrass with Fi of 0.11 and FR of 2.2.

The frequency of seagrass species presence in all research locations (Table 2) showed that the species of *Cymodocea serrulata* had the highest value in Panjang Island waters, Banten. This showed that the species was found in almost all quadratic observations and was able to adapt to disturbed environmental conditions. The chance of finding a seagrass species usually depends on the type of substrate in the field because each seagrass species has a preference for different types of substrate. The disrupted condition of Panjang Island waters due to surrounding activities caused the existing seagrass species to be able to adapt to their environment. *Cymodocea serrulata* was a seagrass species that quickly recovered after disruption (Short and Waycott, 2010).

Seagrass density on Panjang Island, Banten, ranged from 80-856 ind.m^{-2}, where the highest density was found at station III and lowest at station V (Figure 2). Seagrass with the highest density was *Cymodocea serrulata.* The density of each species was different, *Enhalus acoroides* species ranged from 21.5-47 ind.m^{-2}, *Cymodocea serrulata* ranged from 56.75-101 ind.m^{-2}, while *Syrongodium isoetifolium* ranged from 69-75 ind.m^{-2}.

In addition to the high frequency of its presence, the density of *Cymodocea serrulata* seagrass species was also highest during the observation. Seagrass species with high density usually also have a high frequency of presence and coverage, generally the contribution of seagrass species (density and biomass) in a community tends to be dominated by one or several species only (Terrados *et al.,* 1997). This is thought to be related to the ability to adapt of a seagrass species to its environmental conditions.

For the percentage of seagrass coverage at five different research stations, the highest percentage of seagrass coverage was at station IV with a percentage of coverage of 48.94% and the lowest coverage was obtained at station V of 10.28% (Table 3). Seagrass coverage could describe the level of seagrass coverage by each species of seagrass or seagrass community. The percentage of seagrass coverage is not always linear with the high number of species or the high density of species because the observed coverage is the leaf blade while the species density seen is the number of stands (Minerva *et al*., 2014).

Based on the calculation of the importance value index (INP) of seagrass in Panjang Island waters, Banten, the results obtained were showed in Table 4, where the calculation results showed that in these waters, the highest INP value was found in the species of *Cymodocea serrulata* seagrass species which was 41.47 and the lowest was found in the *Syrongodium isoetifolium* seagrass species which was 16.81. The same seagrass species may have a different INP value although it is always present in all research locations. A high INP value is highly related to water conditions and substrate type.

Important value index (INP) shows the importance of a seagrass species and its role in the community, the diversity of INP values indicates the influence of the environment where the seagrass grows like nutrient concentration and substrate conditions. The dominant species has a large productivity where its existence will be an indicator that the community is in a suitable and supportive habitat (Rustam *et al*., 2015). *Cymodocea serrulata* species can grow on muddy sand substrate or sand of coral fragments in tidal areas. During observation, the condition of the substrate in Panjang Island waters was muddy sand (Sugianti, 2016). Based on the standard criteria for damage to seagrass of Decree of Minister of Environment Number 200 of 2004, seagrass ecosystems on Panjang Island were at a moderate level of damage.

Physical-chemical parameter conditions will directly or indirectly affect all life forms of aquatic organisms. Physical-chemical characteristics of a habitat will support a structure of the biota community that lives in it, including seagrass communities (Purba *et al*., 2015). During the observation, the value of physical parameters in the seagrass ecosystem of Panjang Island waters,

Table 2. Frequency of seagrass species presence in the research location of Panjang Island, Banten

No	Seagrass Species	Location				
		St. I	St. II	St. III	St. IV	St. V
1	*Enhalus acoroides*	0.68		0.54	0.57	0.58
2	*Cymodocea serrulata*	0.32	0.77	0.46	0.32	0.42
3	*Syrongodium isoetifolium*		0.23		0.11	
	Total	1.00	1.00	1.00	1.00	1.00

Table 3. Percentage of seagrass coverage (%) in research location of Panjang Island, Banten

No	Seagrass Species	Location				
		St. I	St. II	St. III	St. IV	St. V
1	*Enhalus acoroides*	9.58		5.22	17.71	5.36
2	*Cymodocea serrulata*	17.22	19.79	21.72	15.83	4.92
3	*Syrongodium isoetifolium*		15.42		5.83	
	Total	26.81	35.21	26.94	39.38	10.28

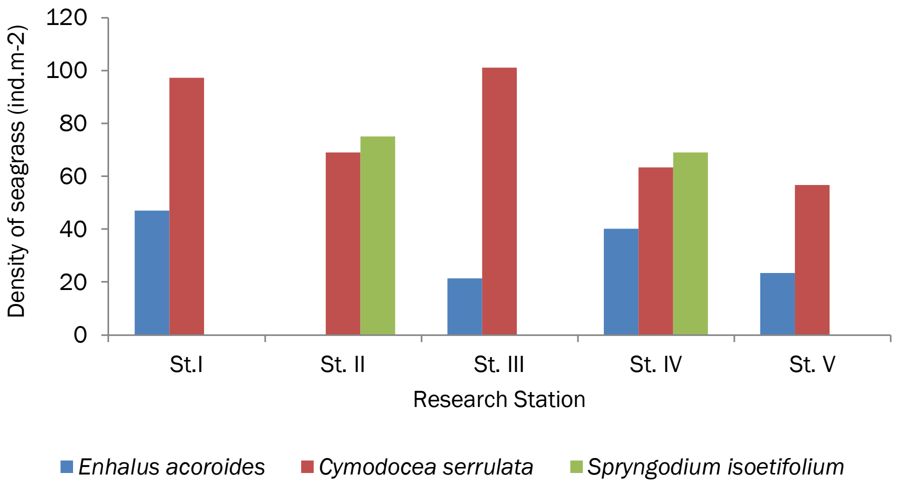


Figure 2. Density of seagrass species (ind.m^{-2}) on Panjang Island, Banten

Table 4. Importance value index (INP) of seagrass species in research location of Panjang Island, Banten

No	Seagrass Species	Location				
		St. I	St. II	St. III	St. IV	St. V
1	*Enhalus acoroides*	27.60		17.81	30.24	19.01
2	*Cymodocea serrulata*	33.48	41.47	40.09	27.36	16.81
3	*Syrongodium isoetifolium*		27.03		16.81	

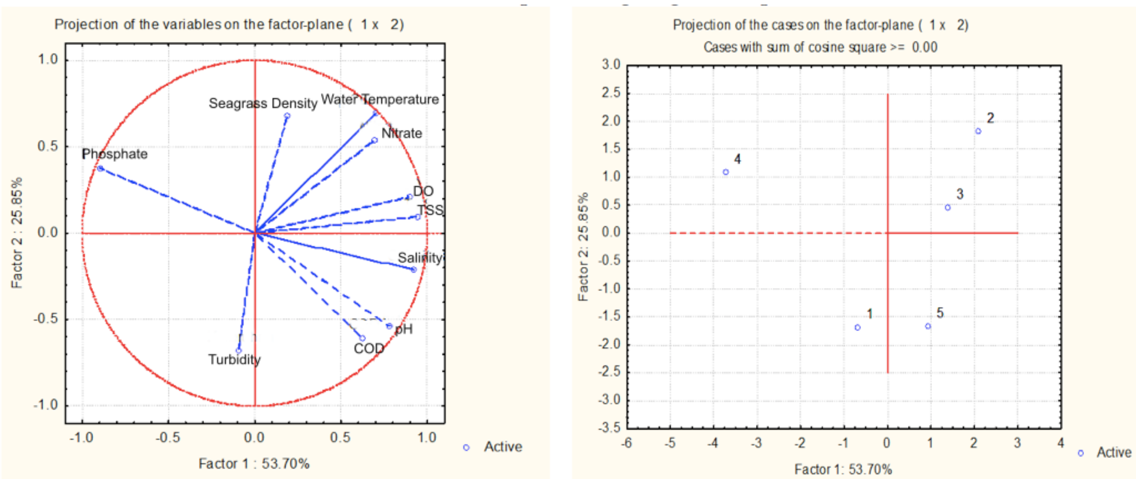
Table 5. Physical-chemical parameter values during the observation in the seagrass ecosystem on Panjang Island, Banten

Parameter	Quality Standard*	October 2015			April 2016		
		min	max	average	min	max	average
Turbidity	< 5 NTU	3.56	53.91	16.26	8.40	34.10	23.42
Water Temperature	28-30°C	29.22	30.34	29.63	29.22	29.80	29.55
Salinity	33-34‰	35.34	35.89	35.68	21.50	21.90	21.70
pH	7-8.5	7.93	8.31	8.19	8.29	9.17	8.62
TSS	20 mg.L^{-1}	19.85	45.74	33.68	72.50	111.00	87.20
DO	> 5 mg.L^{-1}	5.97	6.34	6.18	5.79	8.70	7.67
COD	25 mg.L^{-1}	90.03	117.83	104.18	123.00	176.00	140.80
Nitrate	0.008 mg.L^{-1}	0.13	0.53	0.26	0.50	1.11	0.67
Phosphate	0.015 mg.L^{-1}	0.00	0.13	0.07	0.03	0.67	0.27

* Sea water quality standard for marine biota based on the Decree of Minister of Environment No. 51/2004

Banten, such as turbidity ranged from 3.56-53.91 NTU, water temperature ranged from 29.22-30.34°C, salinity ranged from 21.50-35.89‰, pH ranged from 7.93-9.17, and TSS ranged from 19.85-111.00 mg.L^{-1}. Whereas for chemical parameters such as DO, it ranged from 5.97-8.70 mg.L^{-1}, COD ranged from 90.03-176.00 mg.L^{-1}, nitrate ranged from 0.13-1.11 mg.L^{-1}, and Phosphate ranged from 0.00-0.67 mg.L^{-1} (Table 5.). Some physical and chemical parameters had exceeded the seawater quality standard for marine biota, indicating that there had been a change in the condition of the aquatic environment due to input from surrounding activities.

Principal component analysis (PCA) showed that information related to the environment in Panjang Island waters seagrass ecosystem, Banten, was centered on 2 main axes (F1 and F2) with contributions of 53.70% and 25.85% (Figure 3a.). PCA analysis showed the grouping of stations based on differences in the values of physical and chemical parameters between stations. Figure 3b. showed that the density of seagrass in Panjang Island waters was strongly influenced by the parameters of water temperature, nitrate, DO, and TSS. Each observation station was characterized by specific physical-chemical parameters in the same quadrant. There were 3 main factors of PCA analysis



4a. 4b.

Figure 3. Relationship of several water quality parameters and seagrass density in Panjang Island waters, Banten

Table 6. Diversity of principal component analysis (PCA) data in research location of Panjang Island, Banten

Extraction : Analysis of Main Component				
Factor	Root Characteristics	Total of % Diversity	Cumulative Root Characteristics	% Cumulative
1	5.37	53.70	5.37	53.70
2	2.58	25.85	7.95	79.55
3	1.34	13.45	9.30	93.00
4	0.70	7.00	10.00	100.00

that were able to explain the diversity of data around 93.00% where factors 1, 2, and 3 described the diversity of data respectively of 53.70%, 79.55%, and 93.00% (Table 6.). The analysis showed that water temperature, nitrate concentration, DO, and TSS greatly affected the density of seagrass in Panjang Island waters, Banten.

High water temperature conditions affect metabolism, nutrient absorption and seagrass survival. The effect of temperature on seagrass in the waters is very high for the process of photosynthesis, respiration rate, growth and reproduction (Fahruddin *et al.*, 2017). Seagrass has the main function of providing nutrients to the biota in the surrounding waters. Growth, morphology, abundance and primary productivity of seagrass in a waters are generally determined by the availability of nutrients such as phosphate, nitrate, and ammonium (Minerva *et al.*, 2014). Nitrate itself is produced from the process of complete oxidation of nitrogen compounds in waters, in which if nitrate concentrations exceed 0.2 $mg.l^{-1}$, it can lead to water eutrophication, which can further stimulate the growth of algae and aquatic plants quickly (Effendi, 2003; Donald *et al.*, 2013). DO concentration during the observation was still greater than the quality standard criteria according to the Decree of Minister of Environment No. 51/ 2004, because if DO concentration was low in the waters, it could cause disruption to the biota respiration process. For TSS value during the observation was categorized high and exceeded the TSS quality standard for seagrass that was <20 $mg.l^{-1}$. The high value of TSS usually affects the high density that settle to the bottom of the water resulting in seagrass coverage, so that it would interfere with photosynthesis in the leaves (Zafren *et al.*, 2018).

Conclusion

Based on standard criteria for seagrass damage of the Decree of Minister of Environment No. 200/2004, seagrass ecosystems in Panjang Island, Banten were at a moderate level of damage. The analysis showed that water temperature, nitrate concentration, DO, and TSS greatly affected the density of seagrass in this area.

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