Macroalgae Community Structure at Semak Daun Island, Kepulauan Seribu, Indonesia

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ABSTRACT

Semak Daun Island was part of the Kepulauan Seribu which was a marine tourism destination such as snorkeling and diving site. The existence of these activities had been affecting the condition of the biota community that lives in these waters including macroalgae. The condition of macroalgae communities can be observed by abundance, diversity, uniformity, and dominance analysis that occur in these communities that are known as the community structure. The purpose of this study was to determine the structure of macroalgae communities (abundance, diversity, uniformity, and dominance) in Semak Daun Island. This research results was found 3 divisions, 10 orders, 13 families, 15 genera, and 20 species of macroalgae. The abundance of macroalgae ranges from 235 - 782 individuals/100m^2, classified as low abundance. Diversity ranges from 0.96 to 1.83, classified as low diversity. Uniformity ranges from 0.4 to 0.71, including the moderate uniformity and Dominance ranges from 0.22 to 0.57 belong to the low to moderate category, with the most dominant species being *Galaxaura rugosa*. Physics-chemical parameters of water in general are included in the normal range to support macroalgae life. Based on this, the condition of the macroalgae community structure on Semak Daun Island which is in a less favorable condition is likely due to the existence of snorkeling and diving activities by tourists.

Keywords: community structure, macroalgae, Semak Daun Island

ABSTRAK

Pulau Semak Daun merupakan salah satu gugus Kepulauan Seribu yang menjadi daerah tujuan wisata bahari seperti kegiatan snorkeling dan menyelam. Adanya kegiatan tersebut dapat mempengaruhi keberadaan struktur komunitas makroalga di perairan Pulau Semak Daun. Struktur komunitas merupakan kumpulan populasi yang berada didalam komunitas yang terkait dalam interaksi biotik dan berfungsi sebagai unit terpadu. Penelitian ini bertujuan untuk mengetahui struktur komunitas makroalga di Perairan Pulau Semak Daun yang meliputi kelimpahan, keanekaragaman, keseragaman dan dominansi. Hasil penelitian menunjukan bahwa terdapat 3 Divisi, 10 Ordo, 13 Famili, 15 Genus dan 20 spesies makroalga. Kelimpahan makroalga berkirsar antara 235 – 782 individu/100m^2 termasuk kedalam kategori rendah. Keanekaragaman berkisar antara 0.96 sampai 1.83 termasuk dalam kategori rendah. Keseragaman berkisar antara 0,4 sampai 0,71, termasuk kedalam kategori sedang dan nilai Dominansi berkisar antara 0,22 sampai 0,57 yaitu berkategori lemah hingga sedang dengan didominasi oleh jenis *Galaxaura rugosa*. Parameter fisika-kimia air secara umum termasuk kedalam kategori normal untuk mendukung kehidupan makroalga. Berdasarkan hal tersebut, kondisi struktur komunitas makroalga di Pulau Semak Daun berada dalam kondisi yang kurang baik kemungkinan disebabkan oleh adanya aktivitas snorkeling dan diving oleh wisatawan.

Kata Kunci: struktur komunitas, mikrolaga, Pulau Semak Daun

1. Introduction

The potential of natural resources at Semak Daun Island is natural beauty causes a diversity of aquatic biota. This causes Semak Daun Island, Seribu Islands D.K.I, Jakarta to become a marine tourism destination. The

number of tourists visiting Semak Daun Island, Thousand Islands is increasing every year. Snorkeling and diving activities are activities that are often done by tourists (Purnomo and Hariyadi, 2013). These tourist activities can cause damage to existing aquatic resources including macroalgae. Macroalgae as we known as seaweed is a plant that belongs to the Thallophyte division because it cannot be distinguished among its roots, stems, and leaves (Roem et al., 2017).

The development of tourism activities also triggers development in the island's coastal areas so that it can cause a decrease in the quality of water resources. The complexity of habitat quality degradation will affect the macroalgae community. Heo et al. (2011) state that the water pollution and disturbance of macroalgae habitats reduce species diversity of macroalgae. This condition can be determined by analyzing the structure of macroalgae communities (Miala et al., 2015)

Community structure is a collection of populations that are in the community, bound in biotic interactions and functions as an integrated unit (Sari et al., 2017). The large population of organisms in water can provide a picture of the complex community in these waters. The community structure and supporting factors of the aquatic environment exert a profound influence on the aquatic ecosystem (Sari et al., 2017). According to Rizal et al. (2017) that community structure can be studied from various aspects including abundance, diversity, uniformity and dominance. High species diversity shows that community stability is in prime condition (stable), or the water quality is clean. In contrast, low species diversity indicates that biota quality is unstable or polluted (Melsasail et al., 2018). Therefore, the purpose of this research is to analysis the abundance, diversity, uniformity and dominance of macroalgae as a one way to determine the condition of a macroalgae community in the waters of Semak Daun Island, Seribu Islands National Park, D.K.I, Jakarta.

2. Materials and Methods

2.1. Research Materials

The material of this research was used the macroalgae community found in Semak Daun shallow water and waters as objects of measurement of physical and chemical parameters.

2.2. Research Methods

The research method used is the survey method by calculated abundance and identified macroalgae species at Semak Daun Island and measured the physical and chemical parameters of the waters. Four sampling sides on Semak Daun Island was carried out where 3 stations determined on each side (Figure 1). At each station, 100 samples were taken used 1×1 m^2 squared transects. Water physics parameters as measured supported parameters are temperature, current speed, brightness, salinity, pH, and type of substrate.

2.3. Data Analysis

Data on the amount of each macroalgae species analyzed by Abundance, Diversity, Uniformity and Dominance based on the following formula (Odum, 1993) :
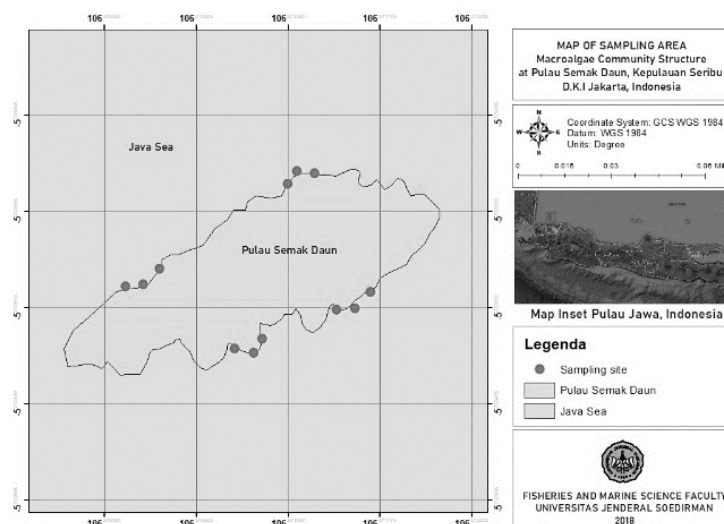

Figure 1. Map of sampling Area

Abundance:

$$Di = \frac{ni}{A}$$

Di = abundance species of-i (ind/ m²)
ni = Total amount of species of-i
A = total sampling area (m²)
Shannon–Wiener diversity Index:

$$H' = - \Sigma \, pi. \, Ln \, pi$$

Pi = ni/N
ni = Total amount of species of-i
N = Total number of individuals
Pielou's evenness Index:

$$E = \frac{H'}{H \, max}$$

H'= shanon wiener diversity
H max = max diversity = Ln S
S = total amount of species
Dominance Simpson Index:

$$D = \Sigma \, pi^2$$

3. Results and Discussion

Macroalgae abundance on the East side of the Semak Daun Island had the highest abundance (782 individuals / 100-m²), then the North side (499 individuals / 100-m²), the Southside (477 individuals / 100-m²), and the lowest on the Westside (235 individuals / 100-m²) (Table 1). Macroalgae abundance in Semak Daun waters ranged from 235-782 individuals / 100-m². If compared with the research by Kadi (2017) in Carita Pandeglang Gulf, Banten with ranged 13900-20700782 individuals / 100-m²,

the macroalgae abundance in Semak Daun Island were included in the category of low abundance.

Diversity (H') is highest on the Southside (1.83), then Northside (1.78), Eastside (1.06), and lowest on the Westside (0.96). Macroalgae diversity on the Semak Daun island ranged from 0.96 to 1.83. The diversity were included in the category of low to moderate diversity. This diversity is higher than the diversity of macroalgae in Pari Island, Seribu Islands D.K.I, Jakarta, namely 0.76-0.91 (Rusli, 2006). The result showed the Southside was highest diversity and the lowest are on the Westside (Table 2) it caused by differences of current and type substrate. Types of substrates on the Southside were dominated by sand and coral fragments, while on the Westside was dominated by muddy sand (Table 3). Stephani and Santosa (2014) stated the places that have stable coral and sand frahgments substrate will have a higher macroalgae compared to the places that have sand or mud substrate. Because macroalgae can survive from currents, waves, and tides (Johan et al., 2015). Besides that, the current on the Southside is higher than on the Westside (Table 3). Darmawati et al. (2016) stated, the stronger current will boost the diffusion of nutrients into the thallus, so that will accelerate the growth process. The low value of diversity on the Eastside is due to human activities such as boat docks and snorkeling.

Table 1. Abundance of macroalgae at the four-sampling site

Spesies	Abundance (indv/100-m²)			
	North	South	East	West
Avrainvillea erecta	-	-	-	1
Chaetomorpha crassa	-	-	-	2
Caulerpa racemosa	2	12	-	3
Caulerpa sertularioides	4	54	-	15
Halimeda macroloba	14	35	4	174
Halimeda opuntia	-	7	-	1
Acanthophora spicifera	2	19	67	2
Laurencia pedicularioides	1	1	-	-
Liagora ceranoides	-	-	-	-
Amphiroa fragilissima	72	-	3	1
Euchema striatum	2	-	-	-
Galaxaura rugosa	89	8	430	-
Gracillaria debilis	1	1	-	-
Laurencia majuscula	1	-	-	-
Laurencia nidifica	13	19	1	-
Dictyota dichotoma	151	141	6	4
Hydroclathrus clathratus	2	-	-	-
Padina minor	13	155	261	3
Sargassum cinctum	7	23	1	2
Sargassum cinereum	8	2	-	
Total	499	477	782	235

Table 2. Macroalga Community Structure parameters

Structure Community	North	South	West	East
Diversity (H')	1,78	1,83	0,96	1,06
Uniformity (E)	0,67	0,71	0,40	0,51
Dominance (D)	0,22	0,22	0,57	0,42

Table 3. Comparison of Physic- Chemical parameters were measured in Semak Daun Island

Parameters	North	South	East	West	Range	Standard
Temperature (°C)	26 (2)	26 (2)	27 (1)	26 (2)	26-27	26-28 (Lüning, 1990)
Current (m/s)	0.03 (3)	0.08 (1)	0.05 (2)	0.03 (3)	0.03-0.08	0-0,5 (Lüning, 1990)
Depth (cm)	58.72 (2)	62.06 (1)	56.39 (3)	50.06 (4)	50.06-62.06	50-500 (Palallo, 2013)
Light Penetration (%)	100	100	100	100	100	100 (Nybakken, 1992)
Substrate	Sand	Rubble sand	Coral sand	Muddy Sand	-	-
Salinity (ppt)	32 (1)	32 (1)	31 (2)	32 (1)	31-32	30-35 (Lüning, 1990)
pH (Unit pH)	7.89 (3)	8 (1)	7.94 (2)	7.94 (2)	7.89-8	7 – 8,5 (Ministry of Environment and Forestry, 2004)

These activities were disturbed of coastal environment have an impact to the macroalgae communities structure (Sormin et al., 2015) stated that species diversity tends to be low because an ecosystem were disturbed. According to Ayhuan et al. (2017) coastal community activities such as the frequency of shipping transportation also greatly affect the diversity of macroalgae species because ship propellers and their waste will had been reducing the quality of water that affected to reduced growth of macroalgae.

The uniformity of macroalgae on the Southside had the highest uniformity value (0.71), then the Northside (0.67), the Eastside (0.51) and the lowest uniformity on the Westside (0.40). Uniformity ranged from 0.40 to 0.71 constitutes uniformity in the medium category (unstable community) (Odum, 1993). The low value of uniformity on the Westside is followed by the low value of diversity. The smaller diversity and smaller uniformity of species in the community which mean the distribution of the number of individuals are different and there is a possibility of being dominated by certain types (Odum, 1993). The dominance of macroalgae ranges from 0.22 to 0.57, including the low to moderate category (Ayhuan et al., 2017). The highest dominance is on the Westside (0.574), then the Eastside (0.42), and the lowest on the Northside (0.22) and South (0.22). The differences of macroalgae dominancy were due to the low diversity and abundance of macroalgae obtained at each study site (Arfah and Papalia, 2015).

Based on the analysis of the community structure was showed that the condition of the macroalgae community in general is included in the less stable category. The most likely due to the snorkeling and diving activities were carried out by tourists, had caused damage to the macroalgae community. Supported by the results of chemical physics parameter analysis which in general the conditions wad supported for macroalgae life. Based on observations of the physic-chemical parameters of water in Semak Daun Island, it showed that the temperature range between 26-27 °C. The current velocity range from 0.03-0.08 m / s. The depth of the water's range from 50.06 to 62.06 cm. Brightness reaches 100 %. Types of sandy were substrate, sandy coral and coral fragments. Salinity range from 31-32 ppt and the degree of acidity (pH) range from 7.89-8. The side of Semak Daun which had the best condition was Southside, because the Southside had the high diversity and uniformity but low dominance with the highest current velocity and more diverse types of substrates. The worst condition of macroalgae communities was on the Westside where had low abundance, diversity and uniformity but high dominance.

4. Conclusions

Macroalgae conditions on Semak Daun Island based on the results of community structure analysis which had including abundance, diversity, uniformity and dominance was included in the category of unstable conditions. Indicated by conditions of abundance that was categorized as low, low categorized diversity, uniformity was classified as moderate (unstable) and dominance was classified as low to moderate. Therefore, it was concluded that the existence of tourist activities

in the form of snorkeling and diving had caused the condition of the macroalgae community on Semak Daun Island to be less stable. This were supported by the results of the analysis of the physical-chemical parameters of the waters which was classified as good quality for macroalgae life.

Acknowledgements

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