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

Sekar Ajeng Wulandari1*, Bintang Marhaeni1, and Maria Dyah Nur Meinita1,2

1 Fisheries and Marine Science Faculty, Jenderal Soedirman University, Purwokerto, Indonesia
2 Centre for Maritime Bioscience, Institute for Research and Community Services, Jenderal Soedirman University, Purwokerto, Indonesia

*Corresponding author: skrjng@gmail.com

Received 20 November 2019; Accepted 1 October 2020; Available online 31 December 2020

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/100m², 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 menunjukkan bahwa terdapat 3 Divisi, 10 Ordo, 13 Famili, 15 Genus dan 20 spesies makroalga. Kelimpahan makroalga berkisar antara 235 – 782 individu/100m² 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 http://dx.doi.org/10.20884/1.oa.2020.16.3.847
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 x 1 m² 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](image-url)
Abundance:

\[ Di = \frac{ni}{A} \]

\( Di \) = abundance species of \( i \) (ind/ m\(^2\))

\( ni \) = Total amount of species of \( i \)

\( A \) = total sampling area (m\(^2\))

Shannon–Wiener diversity Index:

\[ H' = - \Sigma pi \cdot \ln pi \]

\( Pi = \frac{ni}{N} \)

\( ni \) = Total amount of species of \( i \)

\( N \) = Total number of individuals

Pielou’s evenness Index:

\[ E = \frac{H'}{H_{\text{max}}} \]

\( H' \) = shanon wiener diversity

\( H_{\text{max}} \) = 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-m\(^2\)), then the North side (499 individuals / 100-m\(^2\)), the Southside (477 individuals / 100-m\(^2\)), and the lowest on the Westside (235 individuals / 100-m\(^2\)) (Table 1). Macroalgae abundance in Semak Daun waters ranged from 235-782 individuals / 100-m\(^2\). If compared with the research by Kadi (2017) in Carita Pandeglang Gulf, Banten with ranged 13900-20700782 individuals / 100-m\(^2\), 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 fragments 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

| Species                      | Abundance (indv/100-m\(^2\)) |
|------------------------------|-------------------------------|
|                             | 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 pediculareoides   | 1     | 1     | -    | -    |
| Liagora ceranoides          | -     | -     | -    | -    |
| Amphiroa fragilissima       | 72    | -     | 3    | 1    |
| Euchema striatum            | 2     | -     | -    | -    |
| Galaxaura rugosa            | 89    | 8     | 430  | -    |
| Gracillaria debilis         | 1     | 1     | -    | -    |
| Laurencia majuscula         | 13    | 19    | 1    | -    |
| Laurencia nidifica          | 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  |
These activities were disturbed of coastal environment have an impact to the macroalgae communities structure (Sorlin 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 has 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 Papalah, 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 was supported for macroalgae life. Based on observations of the physico-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 macroalgal community on Semak Daun Island to be less stable. This was supported by the results of the physical-chemical parameters of the waters which was classified as good quality for macroalgal life.

Acknowledgements

We would like to thanks our members of Team Algae Ekspedisi IV HIMAKEL for providing help with field work. This work was supported by Research and Technology of Himpunan Mahasiswa Ilmu Kelautan, Universitas Jenderal Soedirman.

References

Arfah, H., Papalia, S. 2015. Kepadatan dan Keragaman Jenis Rumput Laut di Perairan Pesisir Teluk Weda, Propinsi Maluku Utara. Ilmu dan Teknologi Kelautan Tropis 7(2): 745–756.

Ayyuan, H. V., Zamani, N. P., Soedharma, D. 2017. Analisis Struktur Komunitas Makroalga Ekonomis Penting di Perairan Intertidal Manokwari, Papua Barat. Teknologi Perikanan dan Kelautan 8(1): 19–38.

Darmawati, A., Niasotingih, R., Syamsuddin, R., Jompa, J. 2016. Analisis Kandungan Karotenoid Rumput Laut Caulerpa sp. yang di Budidayakan di Berbagai Jarak dan Kedalaman. Prosiding Seminar Nasional Hasil Penelitian Universitas Mahasarakmat 11: 196–201.

Heo, J. S., Park, S. K., Yoo, H. I., Song, J. N., Kim, B. Y., Choi, H. G. 2011. Macroalgal Community Structure on the Rocky Shores of Ongdo, Jusamdo, and Woejodo Islands of the Yellow Sea, Korea. Fisheries and Aquatic Sciences 14(4): 389–397.

Johan, O., Erliana, Radiarta, I. N. 2015. Hubungan Substrat Dasar Perairan dengan Kehadiran Rumput Laut Alam di Perairan Ujong Genteng, Sukabumi, Jawa Barat. Riset Akuakultur 10(4): 609–618.

Kadi, A. 2017. Interaksi Komunitas Makroalga dengan Lingkungan Perairan Teluk Carita Pandeglang Banten. Biosfera 34(1): 32-38

Melsasail, K., Awan, A., Papilaya, P.M., Rumahlatu, D. 2018. The Ecological Structure of Macroalgal Community on Various Zones in the Coastal Waters of Nusalaut Island, Central Maluku District, Indonesia. AACL Bioflux 11(4): 957–966.

Miala, I., Pratomo, A. Irawan, H. 2015. Hubungan antara Bulu Babi, Makroalga dan Karang di Perairan Daerah Pulau Pucung. Repository Umrah.

Odum, E. 1993. Fundamental of Ecology 3rd Edition. Edited by T. Saminger. Yogyakarta: Universitas Gadjah Mada Press.

Purnomo, T., Hariyadi, S., Yonvitner. 2013. Dampak Pemanfaatannya Bagi Masyarakat Sekitar (Studi Kasus Pulau Semak Daun Sebagai Daerah Penunjang Kegiatan Wisata Pulau Pramuka Kabupaten Administrasi Kepulauan Seribu. Depik 2(3): 172–183.

Rizal, M., Febriyanti, D., Sabila, H., Darmawati, W., Isfaeni, H. 2017. Struktur Komunitas Uca Spp. Di Kawasan Hutan Mangrove, Bedul Utara, Taman Nasional Alas Purwo, Jawa Timur. Parameter 29(1): 30–38.

Roem, M., Wiharyanto, D. Darmawati. 2017. The Association of Makroalga with Seagrass in Waters of Long Island. Borneo Saintek 1(1): 48–61.

Rusli. 2006. Tipologi Makroalga pada Ekosistem Terumbu Karang Di Tiga Pulau Kawasan Kepulauan Seribu D.K.I Jakarta. Institut Pertanian Bogor.

Sari, D. R., Rizki, J. W., Hadiyat, R. 2017. Struktur Komunitas Plankton Di Kawasan Wana Wisata Curug Semirang Kecamatan Ungaran Barat, Semarang. Biologi 6(2): 50–57.

Sormin, H., Gerung, G. S., Rembet, U. N. W. J. 2015. Community Structure of Seaweed Beds in Mantehage Island, North Sulawesi, Indonesia. Aquatic Science and Management 3(2): 32–37.

Stephani, W., Santosa, G. W. 2014. Distribusi Makroalga di Wilayah Intertidal Panti Krakal, Kabupaten Gunung Kidul, Yogyakarta. Marine Research 3(4): 633–641.