Diversity and cover percents of macroalgae species in intertidal zone of Pane

A F Dewinta*, Y T Halomoan, I E Susetya, E Yusni and A Fadhilah
Department of Aquatic Resources Management, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Indonesia.

E-mail: *astridfd@usu.ac.id

Abstract. Macroalgae or often referred to as seaweed is very abundant in Indonesian waters especially sea waters, including in Central Tapanuli. But it is unfortunate because not many people know about it, even though the seaweed has many benefits. This study aims to determine the amount of macroalgae cover and their diversity on one island in Central Tapanuli, namely Pane Island. This research was conducted from July to September 2019 in intertidal zone of Pane island with three observations, once a month. At the study site, three macroalgae classes were found consisting of six species, namely Sargassum crassifolium, Sargassum cristaefolium, Halimeda macroloba, Padina minor, Turbinaria decurrens and Hypnea pannosa. The highest macroalgae cover percent is occupied by Phaeophyta division and the lowest macroalgae cover percent is occupied by Rhodophyta division.

1. Introduction
Macroalgae is a algae with a large size, from a few centimeters (cm) to meters. Algae itself are organisms that enter the kingdom Protista similar to plants, with a body structure in the form of a thallus. Algae have chlorophyll pigments so they can photosynthesi. Algae mostly live in waters, both freshwater and marine waters [1]. Macroalgae is a macroscopic algae living in the intertidal zone. Based on the dominant pigment algae can be divided into 3 groups, there are Chlorophyta (green algae), Phaeophyta (brown algae), and Rhodophyta (red algae) [2].

Macroalgae is a low-level organism which is very abundant in Indonesia, which is a habitat for 88 species of algae from all the algae in the world [3]. Macroalgae have a good potential if they can be exploited, but in fact the use of macroalgae in Indonesia still rare.

The growth of macroalgae itself is greatly influenced by the physical-chemical parameters of water, substrate, and also season so that the study of macroalgae cover on Pane Island will provide information about the growth and potential of the macroalgae [4]. As for this study is to determine the species composition of the macroalgae in Pane Island and the relationship between environmental factors and the presence of macroalgae.

2. Material and methods

2.1. Study area
This research was conducted from July-September 2019 which included data collection and data processing research. The research location is carried out in Pane Island, Tapanuli Tengah Regency,
North Sumatra. Retrieval of data in location is conducted as many three times the observation. The method used in this study is the purposive sampling method. The map of the research location is presented in Figure 1.

Macroalgae identification is carried out using the line transect method [5]. The transect line that runs perpendicularly from the coastline to the sea is 100 m long. At the transect line, the transect points are set to put the transect squared (50cm × 50cm) and each transect point 10 m is measured from the 0 m point on the coastline to 100 m towards the sea. Retrieval of data at each station carried out as many as 3 times the observation at the station to determine the comparison in each observation. The macroalgae found in this research will be identified according to the book *The Living Marine Resources Of the Western Central Pacific*.

2.2. **Macroalgae cover in one squared**
The percentage of cover in one square is to add up the closing value of each small square in the square and divide it by the number of small squares of 4 [6]. The formula calculates the percentage of cover in a small square constituent square are as follows:

$$\text{Macroalgae cover (\%) = \frac{\text{Amount of macroalgae cover every square (4 square)}}{4}}$$  \hspace{1cm} (1)
Table 1. Percentage evaluation of macroalgae coverage in squares.

| Category       | Macroalgae cover value (%) |
|----------------|-----------------------------|
| Full           | 100                         |
| ⅓ small box    | 75                          |
| ½ small box    | 50                          |
| ⅔ small box    | 25                          |
| Blank          | 0                           |

2.3. Macroalgae cover per station
The method of calculating the average cover per station is to add up the cover of each square in all transects within one station and then divide the number of squares at that station [6]. Calculation of cover per station is the following formula:

Average macroalgae cover (%) = \( \frac{\text{total macroalgae cover throughout transects}}{\text{sum of squares of all transects}} \) (2)

2.4. Macroalgae cover per species at each one station
To calculate cover per species in one station is to sum the percentage value of cover of each type in the square of the entire transect and divide it by the number of squares at the station [6]. Calculations are made for each type contained at the station. Calculation of cover per species at one station is as follows:

The average value of macroalgae dominance (%) = \( \frac{\text{The sum of the closing values of each macroalgae type in all squares}}{\text{Sum of squares of all transects}} \) (3)

2.5. Macroalgae cover per location
To calculate the average macroalgae cover per location/island is to sum the average macroalgae cover per station then divided by the number of stations at that location/island [6]. Calculation of the average macroalgae cover per location using a Microsoft excel tool using the formula:

Average macroalgae cover throughout one location(%) = \( \frac{\text{Total number of station closures in one location / island}}{\text{Number of stations in the location / island}} \) (4)

Table 2. Cover categories.

| Cover Percentage (%) | Category  |
|----------------------|-----------|
| 0-25                 | Rare      |
| 26-50                | Medium    |
| 51-75                | Solid     |
| 76-100               | Very solid|

2.6. The measured water quality parameters
In this study, water quality parameters were measured including physical, chemical and biological parameters. The parameters measured and how to measure them are as follows:
Table 3. The measured water quality parameters.

| Parameter                  | Tools and materials used       | Measurement method |
|----------------------------|--------------------------------|--------------------|
| **Physics**                |                                |                    |
| Temperature (°C)           | pH meter                       | In situ            |
| Water flow                 | Guess ball                     | In situ            |
| Water depth                | Scaled stick                   | In situ            |
| Substrate                  | Laboratory test                | Ex situ            |
| **Chemical**               |                                |                    |
| Salinity (%/coe)           | Refraktometer                   | In situ            |
| pH                         | pH meter                       | In situ            |
| Dissolved oxygen (mg/l)    | Winkler method                 | Ex situ            |
| **Biology**                |                                |                    |
| Macroalgae cover (%)      |                                | Ex situ            |
| Dominance index (%)        |                                | Ex situ            |
| Composition type (%)       |                                | Ex situ            |
| **Macroalgae identification** | Identification book            | Ex situ            |
|                            | *(The Living Marine Resources of the Western Central Pacific)* | |

2.7. PCA analysis
PCA is included in the statistical field group whose purpose is to extract the characteristics of the data to be analyzed and transform it into a new space [7]. PCA (Principle Component Analysis) analysis in this study was conducted to determine the relationship between each parameter on macroalgae cover. The relationship can be known in the following way: If the results of the circle diagram of the physico-chemical parameter values of water and the cover value-line form an angle of < 90°, it can be concluded that these parameters are positively correlated (affect) to the macroalgae cover value. If the results of the circle diagram of the physico-chemical parameter values of water and the line of cover values form an angle of > 90°, it can be concluded that these parameters are negatively correlated (does not affect) the macroalgae cover value.

3. Results and discussion

3.1. Macroalgae type found
There are 6 species of macroalgae found in the intertidal waters of Pane island which consist of three divisions namely Chlorophyta (green algae), Phaeophyta (brown algae), and Rhodophyta (red algae). The species of macroalgae found in Pane Island intertidal waters are as follows:

Table 4. Species of macroalgae found.

| Division     | Species                           |
|--------------|-----------------------------------|
| Chlorophyta  | *Halimeda macroloba*              |
|              | *Sargassum crassifolium*          |
| Phaeophyta   | *Sargassum cristaefolium*         |
|              | *Padina minor*                    |
|              | *Turbinaria decurrens*            |
| Rhodophyta   | *Hypnea pannosa*                  |

3.2. Percentage of macroalgae coverage
Based on the results of research conducted in Pane Island intertidal waters in three months of observation, it was found that the average percentage of macroalgae cover in each month was 15.97%
in July, 12.49% in August, and 12.68% in month September. The results of the overall percentage of macroalgae cover per month in Pane Island intertidal waters can be seen in Figure 2.

The change in the percentage of macroalgae cover is strongly influenced by seasonal changes that occur from July to September because the change in season also affects the depth and brightness of the waters which greatly affects the growth of macroalgae [8].

3.3. Percentage of macroalgae cover per station

From the results of the study found that the average macroalgae cover at Station I was 29.54%, at Station II it was 9.09% and at Station III it was 2.52%. The results of the overall percentage of macroalgae cover per station in the intertidal waters of Pane Island can be seen in Figure 3.

The largest percentage of macroalgae cover is at the station I which is dominated by Sargassum sp. Macroalgae of Sargassum sp. found mostly in choppy waters, easy to get sunlight, and shallow tidal areas such as at station I [9]. The strong current at the station I also cause the spores of sargassum to spread more easily so that the cover of sargassum macroalgae is very abundant in July [8]. This makes macroalgae of Sargassum type very abundant at the station I, which automatically makes macroalgae at the station I very dominating.
3.4. Dominance index
From the results of data analysis, it can be concluded that the most dominant species of macroalgae in Pane Island Intertidal Waters is *Sargassum sp.* with the highest cover value of 9.02%. While the lowest species of macroalgae is *Hypnea pannosa* with the highest cover value of 1.01%. The results of the comparison data on the percentage of cover of each species can be seen in Figure 4.

![Figure 4. Average of macroalgae cover per species.](image)

3.5. Composition type
Based on the results of the study it was found that the composition of the most species of macroalgae is *Sargassum sp.* at station 1 that is equal to 21.39%. This shows that in this study macroalgae type *Sargassum sp.* is the most frequent macroalgae found in the Pane Island Intertidal Waters. The species composition of Macroalgae in the Pane Island Intertidal Waters can be seen in Figure 5.

![Figure 5. Species composition of macroalgae.](image)

From the results of the study, it was found that from a total of six species found macroalgae species of *Sargassum sp.* has the highest type of dominance. But the high level of dominance of *Sargassum sp.* this causes a low value of macroalgae diversity, especially at Station I [10]. The high dominance of macroalgae species *Sargassum sp.* is caused by the intertidal waters of Pane Island supporting the growth of *Sargassum sp.* because it has shallow waters and is easily entered by light. *Sargassum sp.* found mostly in choppy coral waters, easy to get sunlight, and shallow tidal areas [9]. *Sargassum sp.* is
a macroalgae capable of forming a distinctive environment, by associating with organisms another sea, so it can defend yourself and survive in sea waters [11].

3.6. Aquatic physics-chemical parameters
Based on observations from July-August, physic-chemical parameters in the intertidal waters of Pane Island are obtained as follows.

| Station | pH   | Temperature °C | Salinity (ppt) | DO (mg/l) | Water flow (m/s) | N total (mg/l) | Phosphate (mg/l) | C organic |
|---------|------|----------------|----------------|-----------|------------------|----------------|------------------|-----------|
| I       | 8.0  | 31.2           | 30             | 6.8       | 0.283            | 0.01           | 0.01             | 0.54      |
| II      | 8.3  | 33.3           | 30             | 6.33      | 0.004            | 0.07           | 0.01             | 3.64      |
| III     | 8.4  | 32.3           | 19             | 6.52      | 0.308            | 0.03           | 0.009            | 2.15      |

The parameters of pH, temperature, DO, total N, phosphate, and C organic at the three stations are still in accordance with quality standards and still support the growth of macroalgae well. However, there are some parameters of water quality that are not suitable so that it does not support the growth of macroalgae, which is salinity at station III and water flow at station II. Salinity at station III does not support the growth of macroalgae because it is brackish water with a low salinity value enough [12,13]. The low value of the current velocity at station II is caused by the current being held back by dead corals so that the spores on macroalgae at station II cannot spread properly [2].

3.7. PCA analysis
PCA analysis was carried out to determine the relationship between one parameter and the other parameters on macroalgae cover in Pane Island intertidal waters. According to the analysis results, parameters that are positively correlated to macroalgae cover are water depth, DO, phosphate, water flow, and salinity. While the parameters that are negatively correlated with the value of macroalgae cover are temperature, N total, C-organic, and pH. PCA analysis results can be seen in Figure 6.

According to the analysis results, the largest macroalgae cover was at station I with a depth of 102 cm which was dominated by Sargassum sp. This is because it is at this depth that the macroalgae, especially Sargassum sp, get optimal light and temperature that are good for their growth [14].
Figure 6. PCA analysis.

4. Conclusions
The conclusions obtained from the results of this study are as follows from the calculation of species composition, it was found that the most common macroalgae found at each station were Sargassum sp. at stations I and Padina minor on stations II and III. The most dominant type of macroalgae in Pane Island intertidal waters is Sargassum sp. while the least macroalgae are Hypnea pannosa.

References
[1] Arfah H and Patty S I 2014 Keanekaragaman dan biomassa makroalgae di perairan Teluk Kotania Seram Barat [Diversity and biomass of macroalgae in the waters of the bay of West Seram Kotania] Jurnal Ilmiah Platax 2 2 pp 63-73
[2] Wiga P, Shinta C, Dewi, Ihda Z R, Sari A H and Wajong A E 2015 Distribution and abundance of macroalgae in intertidal zone of Drini beach Gunung Kidul DIY Knowledge Life Sciences 2 pp 514-17
[3] Ira 2018 Struktur komunitas makro algai di perairan desa mata Sulawesi Tenggara [Structure of the macro algae community in the waters of mata village, southeast sulawesi] Jurnal Biologi Tropis 18 1 pp 45-56
[4] Dewinta A F, Susetya I E and Suriani M 2020 Nutritional profile of Sargassum sp. from Pane Island, Tapanuli Tengah as a component of functional food J. Phys. Conf. Ser 1542 012040 pp 1-8
[5] Ferawati E, Widyartini D S and Insan I 2014 Studi komunitas rumput laut pada berbagai substrat di perairan pantai Permisan Kabupaten Cilacap [Study of seaweed communities on various substrates in the waters of the Permisan beach, Cilacap regency] Scripita Biologica 1 1 pp 55-60
[6] Rahmawati S, Andri I, Indarto H S and Muhammad H A 2014 Panduan Monitoring Padang Lamun [Seagrass Field Monitoring Guide] (Bogor: PT. Sarana Komunikasi Utama)
[7] Wulanningrum R and Eri R 2012 Pengenalan rumput laut menggunakan euclidean distance berbasis ekstraksi fitur [Introduction of seaweed using euclidean distance based on feature extraction] Seminar Nasional Aplikasi Teknologi Informasi [National Conference on Information Technology Applications] 2012 (Yogyakarta, Indonesia) Accepted
[8] Kasim F M and Nur A I 2018 Studi kepadatan dan keanekaragaman makroalgae pada terumbu karang buatan dari sampah plastik di perairan Desa Tanjung Tiram Kecamatan Moramo Utara Kabupaten Konawe Selatan [Study of density and diversity of macroalgae on artificial coral reefs
from plastic waste in the waters of Tanjung Tiram village, North Moramo district, South Konawe regency] Jurnal Manajemen Sumberdaya Perairan 3 2 pp 93-103

[9] Food and Agriculture Organization (FAO) 1998 Species Identification Guide For Fishery Purposes Volume 1 The Living Marine Resources Of the Western Central Pacific (Rome: Food and Agriculture Organization of The United Nations)

[10] Fachrul M F 2007 Metode Sampling Bioekologi [Bioecological Sampling Method] (Jakarta: Penerbit Bumi Aksara)

[11] Marianingsih P, Amelia E and Suroto T 2013 Inventarisasi dan identifikasi makroalgae di perairan pulau Untung Jawa [Inventory and identification of macroalgae in the waters of Untung Jawa island] Prosiding Semirata FMIPA Universitas Lampung [Semirata Proceeding of FMIPA Universitas Lampung] pp 219-23

[12] Luning K 1990 Seaweed : Their Environment, Biogeography, and Ecophysiology (Canada: John Wileyand Sons Inc.)

[13] Harwinda F K, Satyantini W H and Masithah E D 2018 The effects of salinity and temperature shock on Kappaphycus alvarezii seaweed spores release IOP conf ser earth environ sci 137 012019 pp 1-7

[14] Irwandi, Salwiyah and Nurgayah W 2017 Struktur komunitas makroalgae pada substrat yang berbeda di perairan Desa Tanjung Tiram Kecamatan Moramo Utara Kabupaten Konawe Selatan Provinsi Sulawesi Tenggara [Community structure of macroalgae on different substrat in Tanjung Tiram waters, North Moramo, Southeast Sulawesi Province] Jurnal Manajemen Perairan 2 3 215-24

[15] Kadi A 2017 Interaksi komunitas makroalgae dengan lingkungan perairan teluk Carita Pandeglang [Interaction of the macroalgae community with the waters of Carita bay Pandeglang] Biosfera 34 1 pp 32-8

[16] Kementerian Lingkungan Hidup dan Kehutanan [Ministry of Environment and Forestry] 2004 Keputusan menteri negara lingkungan hidup nomor 51 2004 tentang baku mutu air laut menteri negara lingkungan hidup [Decree of the state minister for the environment number 51 2004 about regarding sea water quality standards, state minister for the environment] (Indonesia: Kementerian Lingkungan Hidup dan Kehutanan [Ministry of Environment and Forestry]) Available form: http://www.kelair.bppt.go.id

[17] Ayhuan H V, Zamani N P and Soedharma D 2017 Analisis Struktur Komunitas Makroalgae Ekonomis Penting di Perairan Intertidal Manokwari, Papua Barat [Structure analysis of macroalgae community at intertidal coastal area ini Manokwari, West Papua] Jurnal Teknologi Perikanan dan Kelautan 8 1 pp 2087-4871