The relationship of total macro marine debris abundance with total seagrass density in Tidung Kecil Island, DKI Jakarta

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Abstract. Marine debris is an object that is produced by human activities and is wasted around the coast or marine environment. The research aims to examine the composition, density, frequency, coverage of seagrass, and abundance of macro marine debris and to determine the relationship between total macro marine debris abundance and total seagrass density in Tidung Kecil Island. Observation of marine debris and seagrass samples was carried out using the seagrasswatch method. The relationship between marine debris abundance and seagrass density is knowing by linear regression and pearson correlation. The composition of seagrass in Tidung Kecil Island was found in four species Enhalus acoroides, Thalassia hemprichii, Cymodocea rotundata, and Halophila ovalis. The highest density of seagrass species was E. acoroides and the lowest was H. ovalis. The highest frequency of seagrass species was T. hemprichii and the lowest was H. ovalis. The highest type of seagrass cover was T. hemprichii and the lowest was H. ovalis. The highest abundance of macro marine debris is plastic and the lowest is metal. The relationship between the abundance of macro marine debris and the abundance of seagrass species is negative.

1. Introduction
The issue of marine debris is a serious topic of discussion in various countries. According to the National Ocean and Atmospheric Administration to marine debris is an object in the form of solids produced by human activities, in the form of processed products, or manufacturing which is wasted either intentionally or unintentionally around the coast and the marine environment and then floats or settles in the water [1]. This solid can be in the form of food wrapping waste, residual material from fishing activities, broken glass, and others. Marine debris has a big effect on various niches in the field of life, such as the environmental sector, marine debris can threaten biodiversity and ecosystems [2], in the economic sector it can reduce the quality of fishery products so that it can harm fishermen's income, in the tourism sector can spoil the scenery around the coast, and the health sector can damage the function of human organs [3].

The largest source of waste occurs in countries with a large population and fast economic growth, one of which is Indonesia [4]. Indonesia is the second-largest waste producer after China, where Indonesia is one of the most populous countries in the world with a population of around 263.99 million people [5]. About 60% of Indonesia's population lives and has activities in coastal areas such as industrial areas and big cities [6]. There are a lot of human activities on the coast causing a lot of waste to be washed
away or thrown into the water column, even being carried to small islands [7], one of which is Tidung Kecil Island. Tidung Kecil Island is a lowland island that is classified as a small island because it has an area of 14.45 ha or 0.145 km² and is even a very small island [8]. The island is formed by clastic deposits around the quaternary age, and the island is generally surrounded by coral reefs [9]. This island is an uninhabited island but has the potential for investment in ecotourism [10]. However, it is unfortunate that around the coast along the island, there is still a lot of rubbish that is not yet known where it comes from. Lots of rubbish with weights from light to heavy with different types are around the edge of the island where there is a seagrass ecosystem. Seagrass is the only flowering plant that belongs to the category of grasses that live on the coast and can live submerged in seawater [11]. The seagrass ecosystem itself provides services in maintaining sediment stability in order to remain calm, nutrient cycling, and fisheries such as nesting, foraging, and living. However, the services provided by seagrass do not have good reciprocity by human activities who always throw garbage in the sea so that the habitat of the seagrass continues to decrease [12]. In this case, it is necessary to study how marine debris affects the seagrass ecosystem on Tidung Kecil Island.

2. Methods

2.1 Study site

This research was conducted from December 2019 to May 2020. In the first phase, we determined stations, and the research location is set at 5 stations that had been representing the existence of the seagrass ecosystem and marine debris. The second phase on December 7th and 8th 2019 carried out observations, identification of samples, and fireplace data of seagrass and macro marine debris at each station on Tidung Kecil Island, DKI Jakarta. The third was carried out from January to May 2020, processing and analyzing data at the ITK FPIK IPB Dry Laboratory, Bogor. The following figure 1 is the location and research stations.

**Figure 1.** Tidung Kecil Island was an uninhabited island and conservation place.
2.2 Material
Sample observations were carried out directly or in situ with tools and materials including line and quadratic transects, GPS, underwater camera. Data processing using a laptop which contained ArcGis 10.7, Microsoft office excel 2016, and SPSS 26.0 software in The Dry Laboratory of Marine Science and Technology, FPIK IPB.

2.3 Method
Determination of research stations. The location of data collection or station points is determined based on the presence of seagrass and marine debris hotspots. There are 5 observation stations. Station 1 is representative of the northern part of the island, which is located close to the research accommodation. Station 2 is representative of the Northeast region of the island. Station 3 is representative of the southern area of the island which is close to the Tidung Kecil Island pier. Station 4 is a regional representative close to Tidung Besar Island and is in the southern part of Tidung Kecil Island. Station 5 is a regional representative close to Tidung Besar Island and is in the northern part of Tidung Kecil Island. Each station is determined by 3 substations. Each substation will be given a quadratic transect in which the transect direction is perpendicular to the coast to the edge. The distance between substations is adjusted to the area of each station. The distance between the substations is 50 meters but this is conditioned by the presence of seagrass and macro marine debris in the substation [13].

Seagrass sampling. Observation of seagrass data is carried out using the seagrass watch method by drawing transects perpendicularly from the coast to the edge. Seagrass observations are carried out around the line transect by throwing a quadratic transect next to the line transect in a zig-zag manner with a distance between quadratic transects of 10 meters as in figure 2. If the distance is less than or equal to 10 meters, the condition of the seagrass is still in a homogeneous state and can be observed to obtain the seagrass data. with further quadratic transects until another collection or type of seagrass is found. The throwing of the first quadratic transect is carried out when the first seagrass vegetation is found around the line transect which is very close to the coast then continues to the edge.

Macro marine debris sampling. Macro marine debris observations were carried out using the method of [14] by carrying out adaptations according to the seagrass collection method. It's just that the difference in the observation of marine debris data starts from the land that is not affected by sea tides, while seagrass starts in the first vegetation in the tidal area which is submerged by seawater.

Data Analysis Density of species is the number of individuals of the species in a certain area. The formula for determining specific density is referenced from [15]. According to [16] species frequency is the chance that a species is present or found in an observed plot. Coverage is the amount of seagrass...
that covers the substrate in each part of a plot. The formula used is referenced from the team of [13].
The relationship between total macro marine debris abundance and total seagrass density was seen using
simple linear regression statistical methods and Pearson correlation. According to [17], the regression
analysis model is a parametric and linear model that is quantitatively used in the analysis of the effect
of the independent variable (x) on the dependent variable (y). Pearson correlation is used to see how
strong the relationship is between the total abundance of macro marine debris and the total seagrass
density.

3. Results and discussion
3.1 Composition of seagrass species
Seagrass that grows in Tidung Kecil Island is from the Hydrocharitaceae and Cymodoceaceae families.
There are 3 species found from the family of Hydrocharitaceae, namely *Enhalus acoroides*, *Thalassia
hemprichii*, and *Halophila ovalis*. Only one species was found in the Cymodoceaceae family, namely
*Cymodocea rotundata*. While *E. acoroides* were almost found in every research location except at
Station 1, and *T. hemprichii* found in almost every research location except at Station 5. *E. acoroides*,
*T. hemprichii*, *Halophila ovalis*, and *C. rotundata* had been found in full at the research locations Station
2 and Station 4 because the stations are near human activities or the side of Tidung Besar Island where
the organic materials found there. While at Station 3, *C. rotundata* was not found there. The four types
of seagrass can live in areas where sand is still present in the substrate. Table 1 is the composition of
seagrass species in Tidung Kecil Island.

| Table 1. Composition of seagrass in each station. |
|---------------------------------|
| **Family**         | **Species**    | **Station 1** | **Station 2** | **Station 3** | **Station 4** | **Station 5** |
|                   |          | 1 | 2 | 3 | 4 | 5 |
| Hydrocharitaceae   | *Enhalus acoroides* |  - | V | V | V | V |
|                   | *Thalassia hemprichii* | V | V | V | V | - |
| Cymodoceaceae     | *Halophila ovalis* |  - | V | V | V | - |
|                   | *Cymodocea rotundata* | - | V | - | V | V |
| Total             |            | 1 | 4 | 3 | 4 | 2 |

3.2 Density of seagrass
Density of seagrass species is the number of stands of a certain type found in units of an area in a certain
area. The seagrass density on Tidung Kecil Island ranges from 3 - 119 individuals/m² shown in Figure
3. The stations with the highest total density are found at Station 2 with a total of 148 individuals/m² and
at Station 3 with a total of 147 individuals/m². The highest density of seagrass species in Tidung Kecil
Island is dominated by *E. acoroides* species with the lowest were 26 individuals/m² in Station 4 and the
highest were 119 individuals/m² in Station 3. The lowest density of seagrass species in Tidung Kecil
Island was *H. ovalis* with the lowest density were 3 individuals/m² in station 4 and the highest density
were 8 individual/m² in station 2. According to [11] density of seagrass species are influenced by many
factors such as brightness, depth, substrate type, and current. The low density of *H. ovalis* causes growth
of its near on a shallow coastline, causing stirring by waves and turbidity, so the light penetration to the
type of seagrass is *H. ovalis* low causing abundant growth in shallow coastal areas. The seagrass that
grows near the edge is exposed to the waves harder than the seagrass that is close to the shoreline so that
the tidal sediment covers the seagrass itself, making seagrass productivity not optimal. *E. acoroides* is a
seagrass plant that has a high growth rate compared to other seagrass species and they are flowering and
fruiting phase throughout the year. These *E. acoroides* are made to grow rapidly to dominate an area
and become territory compared to other seagrass species in Tidung Kecil Island. *E. acoroides* have fast growth so that it can spread widely and has a very high density in the area around the coast.

**Figure 3.** The density of seagrass species in Tidung Kecil Island.

Revealed that *T. hemprichii* is the most common species and can be said to interact with several seagrass species. For example, in a sand substrate with coral fragments of *T. hemprichii*, it will form seagrass beds with heterospecies conditions with *H. ovalis* and this seagrass can also grow well in fine sand substrates to muddy sand and coexist with *E. acoroides* and *H. ovalis*. Each seagrass will have interactions with other types of seagrass.

### 3. Frequency of seagrass

Frequency represents the probability of a species will be found on the transect plot or a species will be found on the sample. The plot or sample have found with rich seagrass species it means the value of the frequency of seagrass species were high, the seagrass can be said to have a good distribution in the station because the seagrass has grown in almost all substrate substrates. The highest total frequency of seagrass species was found in Station 2 and Station 3 in figure 4.

**Figure 4.** Frequency of seagrass species in Tidung Kecil Island.

These stations are the stations where the four species of seagrass are found compared to other stations. *T. hemprichii* is species that has the highest frequency in Tidung Kecil Island, although it was not found at station 5 and *H. ovalis* have the lowest species frequency in Tidung Kecil Island. *H. ovalis*
is a seagrass that grows far from the coast and nears the edge while *T. hemprichii* is found in almost every sampling point from the first point. *T. hemprichii* is a living seagrass and is dominant on hard substrates such as sand so that a sandy substrate such as Tidung Kecil Island is a suitable place for this type of seagrass life.

### 3.4 Coverage of seagrass
Coverage is the amount of seagrass covering the substrate. It can be seen from figure 4 that the seagrass cover is not so dominant, only that the highest type cover is at Station 2 and the lowest type cover is at Station 4. *T. hemprichii* has been the highest coverage in Tidung Kecil Island while the lowest is *H. ovalis*.

![Figure 5. Coverage of seagrass species in Tidung Kecil Island.](image)

The higher the cover of seagrass species as a result of the fairly shady growth of seagrass life. The shady seagrass will have a positive impact on the environment, such as stabilizing the water substrate. Seagrass with high coverage will make the water moves slower and become calmer thick. The root seagrass with high coverage will be sicking out the bottom of the substrate so that the substrate comes and settles will be trap in seagrass so the stirring process occurs in the water tend to be low and the water will be clearer. The penetration of sunlight will maximize into the water column and seagrass photosynthesis will increase the productivity of biomass.

### 3.5 Abundance of macro marine debris
The Abundance of macro types of marine debris is the amount of macro-sized marine debris found in a certain area. In this research, the unit used in the abundance of marine debris is the amount of marine debris per square meter. The following is the abundance of marine debris in each station classified by the material can be seen in figure 6.
The results show that the highest abundance of marine debris types based on material type is plastic while the lowest is metal. The Abundance of plastic items ranging from 0.1 to 0.42/m² while the metal ranges from 0 to 0.02 items/m² around the study site. That plastic waste is the most abundant waste scattered in the sea. The reason plastic is becoming dominant globally is that it is long-lasting (non-biodegradable), lightweight (easily floats), and has a very long carbon chain so that it is distributed by oceanographic parameters such as currents and waves. Various directions from rivers on the mainland to small islands. In contrast to metals, when exposed to seawater which is salt or strong electrolytes, it can become corrosive so that it is degraded or broken into smaller parts so that it is no longer included in the macro-sized marine debris category. Metals have a greater mass, making it very difficult to be carried away by oceanographic parameters such as currents and waves, and are more likely to sink to the bottom of the water.

3.6 The relationship of macro marine debris to density of seagrass

The relationship between the abundance of marine litter macro (ind/m²) with a total abundance of seagrass (ind/m²) at each station can be seen in figure 6. The coefficient of determination (R²) of linear regression results has a value of 0.8321 or 83.21%. It is assumed that the macro abundance of marine debris can strongly influence the total seagrass density of 83.21% and the rest is thought to be influenced by other factors. Another thing is also seen from the correlation coefficient (r) of the association of -0.912, which suggests that the correlation between the macro abundance of marine debris and the abundance of seagrass species is very strong and in the opposite direction (negative). It can be presumed that the increasing the total abundance of macro marine debris in the seagrass ecosystem, the total seagrass density in the seagrass ecosystem decreases as well as when the total abundance of marine debris decreases, the total seagrass density will increase.
Figure 7. The linear regression graph shows that the abundance of macro marine debris total has an opposite relationship with the density of seagrass total.

It is assumed that the increasing the total abundance of macro marine debris in the seagrass ecosystem, the total seagrass density in the seagrass ecosystem decreases, and when the total abundance of marine debris decreases, the total seagrass density will increase.

4. Conclusion
The composition of seagrass that were found in Tidung Kecil Island consisted of two families, namely the family Hydrocharitaceae with seagrass species of *E. acoroides*, *T. hemprichii*, and *H. ovalis* and family Cymodoceaceae, only one species was found, namely *C. rotundata*. The highest density of seagrass species was *E. acoroides* and the lowest was *H. ovalis*. The highest frequency of seagrass species was *T. hemprichii* and the lowest was *H. ovalis*. The highest type of seagrass cover was *T. hemprichii* and the lowest was *H. ovalis*. The highest abundance of macro marine debris was plastic and the lowest was metal. The relationship between the abundance of macro marine debris and the abundance of seagrass species is negative, indicating that the increasing the abundance of marine debris, the lower the seagrass density.

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