



# Effect of Mangrove Vegetation Density on Macrozoobenthos Abundance in the Mangrove Region of Pramuka Island

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## ABSTRAK

The purpose of this study was to describe the environmental conditions contained in mangrove vegetation, and establish the relationship between the density of mangrove vegetation and the abundance of macrozoobenthos in the mangrove ecosystem in Pramuka Island. The study was conducted in July-August 2019. The research location is divided into four stations based on mangrove density. Station 1 is mangrove with high density, station 2 mangrove with medium density, station 3 mangrove with low density, and station 4 without overgrown mangroves. The method in this study uses a survey method, by making direct observations to the research location. The results showed that in the mangrove ecosystem in Pramuka Island, only one species mangrove was found, namely *Rhizophora stylosa*. The highest mangrove density is 105 stands. The greatest abundance of macrozoobenthos is at station 1, which is 187 ind / m<sup>2</sup>. The highest abundance of macrozoobenthos species is the *Cerithium kobeltu*. The total species composition of species found at the study site were 20 species. The highest diversity index is found at station 2 with a value of 2,9. The highest uniformity index is found at station 2 with a value of 0,8. The relationship between the density of mangrove vegetation on macrozoobenthos abundance is 0,96 and has a very strong relationship.

*Keywords: macrozoobenthos, mangrove, Pramuka Island, Diversity, Density, and Evenness*

## 1. INTRODUCTION

Pramuka Island is a residential zone located within the Thousand Islands Marine National Park. Geographically, the location of Pramuka Island is 5 ° 38' 00 "-5 ° 45' 00" South Latitude and 106 ° 33' 00 "- 106 ° 40' 00" East BT (Thousand Islands National Park). One of the areas contained in the Thousand Islands National Park is the mangrove ecosystem.

Mangrove rehabilitation on Pramuka Island is based on environmental problems, especially coastal abrasion. Coastal rehabilitation began in Pramuka Island, namely in 2002-2004 as a result of the failure of planting since 1973. In 2002-2004 rehabilitation was still considered ineffective due to the influence of the west and east monsoon which caused the drift of newly planted mangroves. The type of mangrove found on Pramuka Island at this time is *Rhizophora stylosa* (Haryanto 2013).

Mangroves have an important role in the life cycle of fish, shrimp and mollusks. Mangrove areas provide protection and food for fish, shrimp, and mollusks in the form of organic materials that enter the food chain. Furthermore, mangroves are suppliers of organic material which is a food provider for organisms

that live around it. Mangrove litter production is beneficial for the fertility of coastal waters (Rangkuti 2017).

Macrozoobenthos have an important role in the nutrient cycle at the bottom of the water. Macrozoobenthos act as primary consumers and secondary consumers in mangrove ecosystems, namely by utilizing algae, plankton, bacteria, and organic matter as food (Sabar 2016). According to Ritonga (2017) in his research there is a relationship between mangrove density and macrozoobenthos abundance of 75.26% and correlation coefficient obtained by 0.867 which means that mangrove density and macrozoobenthos abundance have a very strong unidirectional relationship.

Based on the ecological conditions of mangroves found in the Pramuka Island area, research needs to be conducted to provide information and data regarding the relationships or interactions that occur between mangrove forests against macrozoobenthos on Pramuka Island. The relationship of macrozoobenthos to mangrove ecosystems will be seen based on the density of mangrove vegetation found on Pramuka Island

## **2. RESEARCH METHODS**

### **2.1 Research Time and Location**

This research will be conducted in April - May 2019. The research location is in the Mangrove area of Pramuka Island, Kepulauan Seribu National Park. Macrozoobenthos identification was carried out at the Laboratory of Water Resources (SDP), Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran.

### **2.2 Sampling**

#### **2.2.1 Mangrove**

Sampling for mangrove vegetation was carried out using the line transect plot method from the direction of water to land in intertidal areas. The length of the transect from the edge of the water towards the land depends on the thickness of the mangrove at each station. Mangrove density is measured using line transects in a position from the direction of the waters towards the land and consists of square plots of sample size 10 x 10 square meters for trees; 5 x 5 square meters for sapling; and 1 x 1 square meter for seedlings (Rangkuti 2017).

#### **2.2.2 Makrozoobenthos**

Collection of macrozoobenthos samples was carried out in conjunction with sampling of mangrove vegetation, with a sampling procedure based on Lasalu (2015) on a 10 x 10 meter observation plot, 5 observation plots of 1x1 meter were placed. Macrozoobenthos samples obtained from the screening results are classified, counted, and then collected. The sample is then preserved in 4% formalin solution, to be further identified.

### **2.3 Research Parameters**

#### **2.3.1 Mangrove Density**

Mangrove density is divided into three categories, namely seedling, sapling and tree with the following criteria (Bengen 2004 in Rangkuti 2017).

- a. seedling : height < 1 m
- b. sapling : diameter < 1 cm and height > 1 m
- c. tree : diameter > 4 cm

#### **2.3.2 Abundance of Macrozoobenthos**

According to Odum (1993) Abundance of macrozoobenthos by definition is as a sum of individuals of macrozoobenthos as a large union ( $m^2$ ):

$$K_i = \sum n_i / A$$

Explanation:

$K_i$  = Number of macrozoobenthos of type  $i$  (ind/ $m^2$ )  
 $n_i$  = Number of  $i$ -type individuals obtained  
 $A$  = Total of sampling area

### 2.3.3 Macrozoobenthos Diversity Index

According to Odum (1993) Macrozoobenthos diversity in estuarine waters was calculated using the formula proposed by Shannon-Winner (1949).

$$H' = - \sum \left( \left( \frac{n_i}{N} \right) \log_2 \left( \frac{n_i}{N} \right) \right)$$

Keterangan:

$H'$  = diversity index  
 $n_i$  = Total number of  $i$  individuals  
 $N$  = Total number of individuals

### 2.3.4 Macrozoobenthos Evenness Index

According to Odum (1993) the macrozoobenthos uniformity index can be known from the spread of individuals between different species used the Evenness Index formula:

$$E = H' / H' \text{ max}$$

Explanation:

$E$  = Evenness index  
 $H'$  = diversity index  
 $H' \text{ max}$  =  $\log_2 S$   
 $S$  = total of species

## 2.4 Data Analysis

Analysis of the data used in this study is the product moment correlation. Product moment analysis is used to find a relationship and prove the hypothesis of a relationship between two variables if the data to two variables are in the form of intervals or ratios, and the data sources of two or more variables are the same (Sugiyono 2014).

## 3. RESULTS

### 3.1 General Condition of Research Location

The general condition of the mangrove research location is near community settlements. The depths of the waters planted with mangroves are shallow waters with a maximum depth of 0.6 meters and are affected by tides. This research was conducted at four different station locations. Each station represents different mangrove density characteristics.

Station 1 with the characteristics of high mangrove density is at coordinates 05o 44 '43.5 "S - 106o 36' 56.0" E. Station 2 has the characteristics of medium mangrove density and is at the coordinates of 05o 44 '57.9 "S - 106o 36 '46.2 "E. Station 3, which is a mangrove that has a tenuous density. Station 3 is at the coordinates of 05o 44 '51" S - 106o 36 "53" E. Station 4 with characteristics without mangrove plants. The coordinates of the location of station 4, which is 05o 44 '46" S - 106o 36 "58" E.

All stations are directly affected by sea water without the influence of fresh water. This is because the location of Scout Island is one part of the Thousand Islands which surrounded is a sea area without any

influence from the river. There are only three types of mangrove stations that grow on Scout Island, which is *Rhizophora stylosa* type. The distinctive root shape and can penetrate sandy substrate causes mangroves of *R. stylosa* type to be more robust when there is the influence of waves and wind. According to Rangkuti (2017) *Rhizophora* sp. has a type of root support and root system is owned by mangroves that live on the beach.

### 3.2 Physical Parameters of Aquatic Chemistry

Physical and chemical parameters of the waters measured in this study include temperature, depth, current, acidity (pH), dissolved oxygen (DO), salinity and substrate (Table 1).

**Table 1. Water physics chemical parameters**

Parameter	Station			
	1	2	3	4
Temperature (°C)	25-31	27-31	27-31	27-32
Depth (cm)	0-40	10-35	4-30	20-60
Dissolved Oxygen (mg/l)	5.2-6.5	5.4-6.5	5.5-6.2	5.6-7.2
Salinity (ppt)	32-34	33-34	34-37	34-36
pH	6.5-8.63	6.5-7.52	6.5-8.06	6.6-8.69

Mangroves can flourish and are suitable in tropical conditions with a number above 20°C (Kennis 1990 in Haryanto 2013). The temperature value obtained at Pramuka Island is at the lowest rate of 25°C at station 1 and the highest at 32°C at station 4. The lowest temperature at station 1 can be caused by high mangrove closure so that sunlight intensity is obstructed by the closure of the mangrove. The highest temperature is at Station 4 because there is no mangrove cover in the area so the sun's intensity is not blocked. According to Poedjarahajoe (2016) conditions with a fairly dense canopy area can prevent sunlight from reaching the surface and the temperature of the waters below the canopy will tend to be lower. According to Cahyani (2001) temperature can affect the physiology of mangrove plants, and can also affect the activities of aquatic animals such as migration, predation, swimming speed, and speed of metabolism. Temperature conditions in the mangrove area on Pramuka Island have optimum figures for the life of mangroves and makrzoobenthos. According to Sukarno (1981) in Ekaningrum (2012) temperature can limit the geographical distribution of macrozoobenthos and the good temperature for macrozoobenthos growth ranges from 25 - 31 degrees Celsius.

The depth of the waters around the Pramuka Island mangrove area is not flooded by sea water at low tide. The location of the depth that is not flooded at low tide tends towards the land. The maximum depth of the mangrove area submerged in water is 0.6 meters. The value with the highest depth is in the area which tends to point towards the sea. According to Haryanto (2013) the difference in depth is caused by the presence of suspended solids carried to the mainland so that the accumulation of suspended solids causes silting. Tides are also a factor that causes changes in depth.

The pH value obtained in the Pramuka Island mangrove area shows the lowest number at the station which is overgrown by mangroves that is 6.5 and the largest pH value is at station 4 which is 8.69. The pH value at the station which is overgrown with mangroves shows a number that is still productive, while the station that is not overgrown with mangroves has a substrate in the form of coral fragments containing carbonate ions thereby increasing the pH value (Banarjea 1971 in Haryanto 2013).

The salinity range obtained in the Pramuka Island mangrove area ranges from 32-37 ppt. The lowest salinity is at station 1 of 32 ppt. This value shows that station one is still in accordance with seawater quality standards in accordance with Ministry of Environment Decree number 51 of 2004. Station 3 has the highest salinity value of 37 ppt. This figure shows a very high salinity value and is not very supportive for the survival of macrozoobenthos. This high salinity value can also be influenced by tides. When the tide is bigger the input of sea water will tend to increase the value of water salinity.

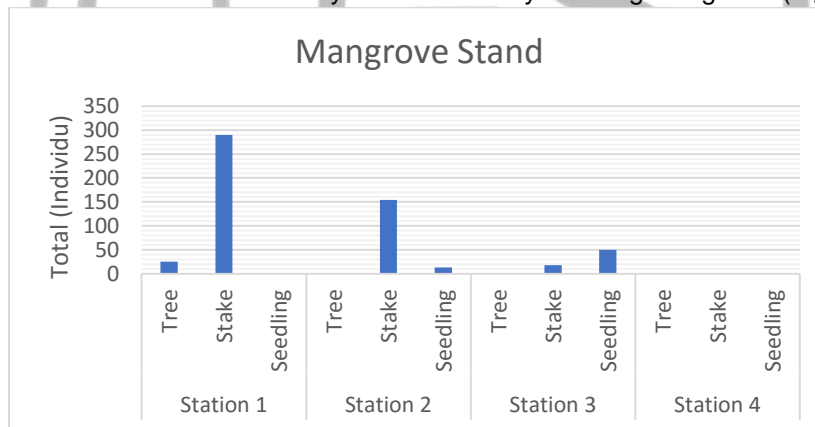
The DO content in the Pramuka Island mangrove area is between 5.2 -7.2 mg / l. The lowest DO value is at station 1, which is 5.2 mg / l. This can be caused by the use of dissolved oxygen for the oxidation process of organic and inorganic materials. According to Gemilang (2017) dissolved oxygen is also needed for the oxidation process of organic and inorganic materials. The largest DO value was obtained at station 4, which was 7.2 mg / l. The high DO value at station 4 can be caused because the location of this station is close to the seagrass planting area so that there is an influence of current that can carry dissolved oxygen to the place. This is in accordance with Hamuna (2018) high DO concentrations can also be caused because the research location is close to the seagrass ecosystem area.

The condition of the substrate on Pramuka Island is dominated by the type of sand. The four research stations have sand criteria. The highest sand content is at stations 3 and 4, which is 92%. Station 2 sand content is 91% and station 1 sand content is 90%. According to Setyawan (2010) in Haryanto (2013) mangrove planting on the northern part of Java Island shows that mangroves which are planted on sandy and steep beaches so that they cannot live (die) or live in bad conditions

The C-organic content at the study site is very low. The lowest C-organic content is at station 3 with a value of 0.27%. The highest C-organic content is at station 1 with a value of 0.91%. According to Hardjowigeno (1995) in (Nurfitriani (2019) C-organic content is said to be very high if > 30%, high 10-30%, moderate 4-10%, low 2-4%, and very low <2%. very low organic matter can be affected by coarse substrate so the ability to capture or retain organic content tends to be difficult.

### 3.3 Mangrove Vegetation Density

The research location in the Pramuka Island mangrove area is divided into four observation stations. Station 1 with 105 individual mangrove stands / are included in the high density mangrove category. Based on the category is still dominated by stakes. Station 2 of the medium density mangrove category has 56 stands / are. Station 2 is dominated by stake types. Station 3 of the low density mangrove category has 23 stands / are. Station 2 density is dominated by seedling categories (Figure 1).



**Figure 1. Mangrove Stand**

The mangrove category is divided into three, namely trees, saplings and seedlings (Bengen 2004). Research locations on the Pramuka Island mangrove category are dominated by saplings. Station 1 has 290 stakes, Station 2 has 154, and Station 3 has 18. There are only a few mangroves that can reach the tree category, namely Station 1 with 25 stands. The seedling categories at station 2 are 13 stands, and at station 3 there are 50 stands. At least mangroves that can reach the tree category can be caused by the high salinity found around the planting site. According to Rangkuti (2017) *R. stylosa* can grow at salinity up to 55 ppt, but this is not optimal and can make dwarf mangroves. The supporting root owned by *R. stylosa* is suitable for penetrating sandy substrates which will protect from wind and waves.

### 3.4 Abundance of Macrozoobenthos

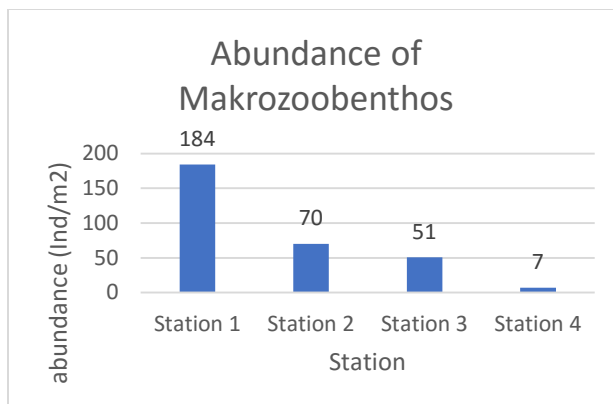
Abundance of macrozoobenthos is the number of individual macrozoobenthos per unit area in square meters. The highest abundance of macrozoobenthos is found in station 1 with 184 ind / m<sup>2</sup>, station 2 with an abundance of 70 ind / m<sup>2</sup>, station 3 with 51 ind / m<sup>2</sup>, and station 4 with 7 ind / m<sup>2</sup> (Table 2).

Table 2. Abundance of types of macrozoobenthos

No	Abundance of Type	Station				Total (ind/m <sup>2</sup> )
		1	2	3	4	
1	<i>Cerithium kobeltu</i>	102	19	12	7	133
2	<i>Indocerithium taeniatum</i>	15	1	0	0	16
3	<i>Rhinoclavis</i> sp	8	6	2	0	16
4	<i>Nodilittorina</i> sp	7	0	0	0	7
5	<i>Vasticardium subrogosum</i>	14	0	0	0	14
6	<i>Saccostrea</i> sp	11	20	26	0	57
7	<i>Antigona</i> sp	7	0	0	0	7
8	<i>Marcia (hemitapes) hiantina</i>	2	0	0	0	2
9	<i>Fimbria</i> sp	2	0	0	0	2
10	<i>Tellina</i> sp	1	0	1	0	2
11	<i>Scylla serrata</i>	15	5	0	0	21
12	<i>Rhinoclavis vertagus</i>	0	2	0	0	2
13	<i>Littorina</i> sp	0	5	7	0	13
14	<i>Conus</i> sp	0	1	0	0	1
15	<i>Cypraea</i> sp	0	0	0	0	0
16	<i>Strombus</i> sp	0	2	0	0	2
17	<i>Anadara</i> sp	0	7	2	0	9
18	<i>Dosinia</i> sp	0	2	0	0	2
19	<i>Tapes literatus</i>	0	0	1	0	1
20	<i>Donax</i> sp	0	0	0	0	0
<b>Total</b>		184	69	50	7	303

Station 1 with high mangrove density has the highest abundance value compared to the other three stations. This can occur because of the influence of the density of mangroves as one of the factors that affect the abundance of macrozoobenthos from each station. Mangrove litter production is different for each mangrove area. The difference in the amount of litter can be influenced by several factors, namely soil fertility, soil moisture, seasonality, stands, and density (Rangkuti 2017). The high density found at Station 1 affects the large abundance of macrozoobenthos because the higher the density value, the number of litter will also be more and macrozoobenthos as primary and secondary consumers can use the litter as food to be decomposed which can be reused by mangroves. The highest species abundance at Station 1 is *Cerithium kobeltu* with 102 ind / m<sup>2</sup>.

This can happen because *Cerithium kobeltu* is a typical mangrove gastropod which uses mangrove litter as its food. Other types found at this station, namely *Indocerithium taeniatum*, *Rhinoclavis* sp, *Nodilittorina* sp, *Vasticardium subrogosum*, *Saccostrea* sp, *Antigona* sp, *Marcia (hemitapes) hiantina*, *fimbria* sp, *tellina* sp, and *Scylla serrata*. The smallest abundance is *Fimbria* sp and *Tellina* sp with 1 ind / m<sup>2</sup>. *Tellina* sp is a Bivalvia whose habitat dominance is on a different clay substrate from the substrate found at the study site, which is in the form of sand. Station 4 has the smallest abundance, which is 7 ind / m<sup>2</sup>. This is because at Station 4 the mangrove is not overgrown so that macrozoobenthos can hardly utilize mangrove litter unless there is a current that can provide litter displacement (Figure 2).



**Figure 2. Abundance of macrozoobenthos at each station**

### 3.5 Macrozoobenthos Diversity Index

The Shannon-Wiener diversity index value shows that the difference is not too significant at the research location, especially in the area planted with mangroves. The highest diversity index is at station 2 with a value of 2.9 which means it has a moderate diversity index, station 1 with an index value of 2.4, station 3 with an index value of 2.0 and the lowest is station 4 with an index value of 0.4.

Stations planted with mangroves, i.e. stations 1, 2 and 3 have a moderate diversity index category. Differ on station 4 has a low diversity index value. Station 2 has the greatest diversity index value, meaning that this station is composed of more macrozoobenthos and the density of each type is the same or almost the same when compared to other stations. Location of station 2 is located close to the seagrass ecosystem, this can affect the DO value or dissolved oxygen which can later be utilized by macrozoobenthos for the metabolic processes of macrozoobenthos and also breeding.

### 3.6 Macrozoobenthos Evenness Index

The macrozoobenthos uniformity index criteria based on the Evenness Index are divided into three categories, namely high uniformity, medium uniformity, and low uniformity. The research location on Pramuka Island is divided into four stations. The station with the highest uniformity index value is station 2 with a value of 0.8, followed by station 1 with an index value of 0.68, station 3 with an index value of 0.67, and station 3 with an index value of 0.19.

Station 2 has the highest uniformity index value based on the Evenness Index category. This shows that station 2 has a uniform level of species uniformity and no species dominates. According to Wulansari (2012) the higher the value of uniformity, the smaller the level of dominance of a macrozoobenthos community. The high uniformity index value at station 2 can be expected because station 2 is adjacent to the seagrass ecosystem and directly facing the sea.

### 3.6 Relationship of Mangrove Density to Macrozoobenthos Abundance

The type of mangrove found on Pramuka Island is *Rhizophora stylosa*. This study divides mangroves into four stations. Station 1 with high density category is 105 stands / are, station 2 with medium density is 56 stands / are, station 3 with tenuous density is 23 stands / are, and station 4 is not overgrown with mangroves.

The highest abundance of macrozoobenthos is found in station 1 with 184 ind / m<sup>2</sup>, station 2 with 70 ind / m<sup>2</sup>, station 3 with 51 ind / m<sup>2</sup>, and station 4 with 7 ind / m<sup>2</sup>. The highest abundance of macrozoobenthos at each station came from station 1, the *Cerithium kobeltu* type with 102 ind / m<sup>2</sup>.

Correlation test produced in this study, which is 0.96. The correlation values obtained indicate a very strong correlation between the density of mangroves on the abundance of macrozoobenthos on Pramuka

Island. The value of determination obtained (R<sup>2</sup>) is 0.92. The determination value shows that 92% of mangrove density can affect the abundance of gastropods, and the other 8% is influenced by other factors.

#### 4. CONCLUSION

Conclusions obtained from this study, including, 1). the structure of the macrozoobenthos community in the Pramuka Island mangrove area has the highest diversity index value at station two, which is 2.9 and the lowest diversity index at station four, which is 0.4. The highest uniformity index is found at station 2, which is 0.80. The lowest uniformity index is at station four, which is 0.19. 2). Macrozoobenthos found on Pramuka Island include 2 phyla, 3 classes, 19 genera, and 20 species with a total of 14034 individuals. 3). The relationship between the density of mangroves on abundance of macrozoobenthos has a very strong relationship, with a correlation value of 0.96.

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