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Relationship of Water Parameters and Macrozoobenthos Community Structure in the Nature Tourism Park of Mangrove Angke Kapuk Dki Jakarta

Nur Hayati[1], Yuniarti MS[1] dan Subiyanto[1]

[1] Marine Science Study Program, Universitas Padjadjaran

Jl. Raya Bandung-Sumedang KM. 21 Jatinangor, Sumedang, Indonesia. No. Telp/Fax: (022) 842 88888

E-mail: nurnhy0815@gmail.com

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ABSTRACT

Macrozoobenthos is a sedentary benthic organism and has very slow movement. Therefore it will directly be affected if environmental changes exist. The purpose of this study was to determine the relationship of waters parameter with the community structure of macrozoobenthos at the Nature Tourism Park of Mangrove Angke Kapuk. Measurement of physical and chemical parameters, as well as a sampling of water, sediment, and macrozoobenthos, were carried out in situ. Nutrient concentrations and sediment characteristics were analyzed using spectrophotometric and granulometric methods, respectively. Macrozoobenthos were identified and then analyzed. Relationship of waters parameter with macrozoobenthos community structure analyzed by regression analysis. From the results of the study were identified seven species of macrozoobenthos belong to three classes (namely Bivalvia, Gastropods, and Polychaeta). The results for correlation between the macrozoobenthos abundance with pH, salinity, chlorophyll-a, and silt were very strong positive; with DO is strong positive; with ammonia and n-total were very low positive; with gravel, was very strong negative; with sand, was moderately negative; and with temperature, phosphate, nitrate, and nitrite negative were very low negative.

Keywords: The Nature Tourism Park of Mangrove Angke Kapuk, Macrozoobenthos, Water Quality

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1. INTRODUCTION

Mangroves are one of the main ecosystems that important to supporting life in marine and coastal areas. Mangroves are also known as fragile ecosystems or ecosystems that are vulnerable to damage if one of the factors that make up the ecosystem changes (Arief, 2003). On the north coast of Jakarta, there are several mangrove forest areas, one of which is The Nature Tourism Park of Mangrove Angke Kapuk. However, it cannot be denied that the mangrove ecosystem on the north coast of Jakarta is facing various pressures and threats due to environmental changes (Setiawan, 2015).

One of these pressures and threats because The Nature Tourism Park of Mangrove Angke Kapuk is located in the Jakarta Bay area, which is dense with various types of activities and has recently received special attention in terms of planning, policy, and management of coastal buildings (Water Front City) which are quite rapid (Fadhilah et al., 2018). In addition, Jakarta Bay is the last body of water to accommodate the results of anthropogenic activities in the Jakarta area. It is characterized by the presence of 13 rivers that empties into Jakarta Bay (Rositasari et al., 2017). The existence of rivers that empties into these waters causes changes in water quality and the entry of various nutrients and sedimentary materials from land to sea (Simbolon, 2016).

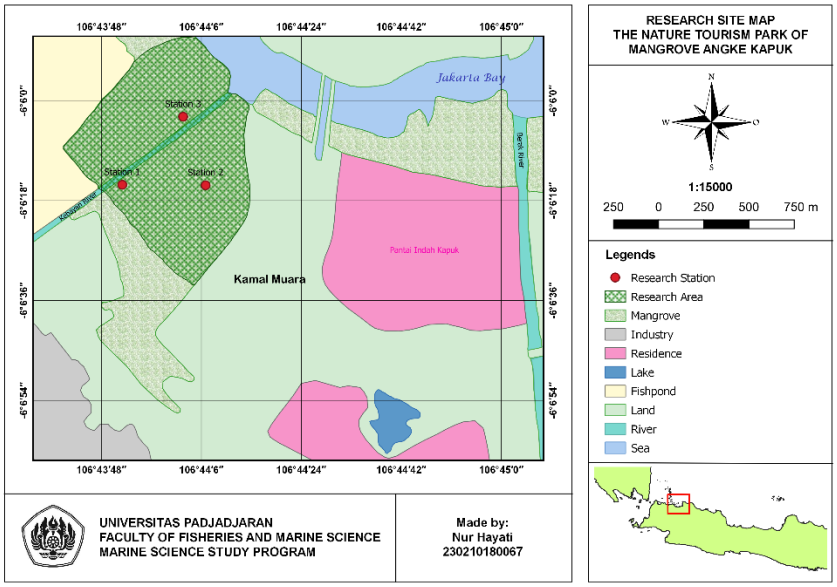
This also affects the water quality and the organisms that live in the mangrove ecosystem of the northern coast of Jakarta. Mangroves are very complex ecosystems with the life of organisms that live in sediments. One of the organisms that live in sediments is macrozoobenthos (Hutabarat & Evans, 1985). Macrozoobenthos is a sedentary benthic organism that has very limited movement, so it will be directly affected when there is a change in the environment. These environmental changes can change macrozoobenthos community structure (Rachman et al., 2017). The abundance of macrozoobenthos is relatively more on substrates containing organic matter, such as in sediment pores (Firmansyah et al., 2016). Pore water is a sedimentary layer filled with water or air (Yuniarti et al., 2018). In pore water, there can be changes in nutrients caused by organisms living in sediment, including macrozoobenthos of the infauna type (Payung, 2017).

The existence of macrozoobenthos is influenced by environmental limiting elements, including biotic and abiotic factors. Biotic components are one of the energy sources for macrozoobenthos. In addition to biotic components, there are also abiotic components, such as oceanographic physical and chemical parameters of waters including temperature, salinity, pH, Dissolved Oxygen (DO), substrate characteristics, and nutrient content (ammonia, phosphate, nitrate, nitrite, chlorophyll-a, and N-total) (Odum, 1994; Suhanda et al., 2019) Based on this background, data on water parameters and macrozoobenthos community structure in the Nature Tourism Park of Mangrove Angke Kapuk are needed. The purpose of this study was to obtain the relationship between physical and chemical parameters, nutrient composition, and sediment characteristics of the macrozoobenthos community structure, which can then be taken into consideration for assessing the condition, planning, and management of mangrove ecosystem areas in the short and long term.

2. METHODOLOGY

Time and Place

The study was carried out from February until May 2022 which included field sampling, processing sediment and water samples also data analysis. The determination of research stations was carried out by purposive sampling (consideration) at The Nature Tourism Park of Mangrove Angke Kapuk, which was divided into three stations. The selection of sampling stations is determined after considering the characteristics and factors of each station. The analytical method used in this research is descriptive analysis method.



Source: Personal Documentation

Figure 1. Research Site Map of The Nature Tourism Park of Mangrove Angke Kapuk.

Procedure

Data and sample collection were carried out from 09.00 until 14.30 WIB. Macrozoobenthos samples were taken using a shovel, with reference by Adelia et al. (2021). Macrozoobenthos trapped in the sieve were fixed with 90% alcohol. Sediment samples were taken using a piston core, and then the sediment was put into a ziplock. The pore water is taken with the piston core and then filtered using a Millipore filter. The water sample was put in a dark bottle and stored in an icebox to be brought to the laboratory.

Data collection of physical and chemical parameters of waters (temperature, salinity, pH, and dissolved oxygen) was carried out directly/in situ. Temperature measurements were taken using a chemical thermometer, salinity using a refractometer Atago 2483 Master-S28M, dissolved oxygen using a DO meter Lutron DO-5510 and pH using a PH meter Lutron PH. Meanwhile, other parameters (water samples, sediment, and macrozoobenthos) after being taken in the field are then analyzed in the laboratory.

In water samples, the ammonia concentration was tested using the reference from APHA-4500-NH3-F-2012, the phosphate concentration was tested using the reference from APHA-4500-P-D-2012, the nitrate concentration was tested using the reference from APHA 4500-NO3-B-2012, the concentration nitrite was tested using the reference of SNI 06-6889.9-2004, the concentration of chlorophyll-a was tested using the reference of SNI 06-2484-2002 and the total N concentration was tested using the reference of APHA 4500-Norg-B-2012. The sediment samples were analyzed by granulometric analysis using KUMMOD SEL software. The macrozoobenthos samples were identified using the book "Recent and Fossils Indonesia Shell" by the author Bunjamin Dharma, 2005.

In addition, the value of nutrient concentrations (ammonia, phosphate, nitrate, nitrite, and n-total) was calculated using Lambert-beer's law. The formula derived from Beer's Law is as follows:

$$A = a \cdot b \cdot c \text{ atau } A = \varepsilon \cdot b \cdot c$$

Where:

A = Absorbance

a = absorbance constant (if the concentration of the solution is measured in ppm)

c = concentration of the measured solution

ε = molar absorbance constant (if the concentration of the solution is measured in ppm)

b = thickness of the solution (the thickness of the cuvette is also taken into account, generally 1 cm)

The value of chlorophyll-a concentration was obtained by calculating the absorbance value using the Parsons et al. (1984) are as follows:

$$Klorofil\ (mg/l) = \frac{Ca\ X\ Va}{V\ X\ d}$$

Where:

Va = Volume of acetone (10 ml)

V = Volume of filtered water sample (ml)

d = Diameter of cuvette (1mm)

Ca = (11,6 x E_{665}) – (1,31 x E_{645}) – (0,14 x E_{630})

E = Absorbance at different wavelengths (corrected with a wavelength of 750 nm)

After that, data analysis was carried out. Macrozoobenthos sampling was carried out by calculating 4 parameters, namely:

- **Abundance Index**

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

Where:
D = Abundance of individual species (ind/m^2)
ni = Total number of macrozoobenthos filtered (ind)
A = Total transect area (m^2)

- **Diversity Index**

$$H' = -\sum pi \ln pi \text{ with } pi = \frac{ni}{N}$$

Where:
H' = Shannon Diversity Index
ni = Number of individual species i
N = Total number of individuals of all species
ln = Natural logarithm (2,302585 $\log_{10}$ = 0,693147 $\log_2$)

- **Uniformity Index**

$$E = \frac{H'}{Hmax} = \frac{H'}{ln\ S}$$

Where:
E = Uniformity Index
H' = Diversity value
$Hmax$ = Overall diversity value
S = Number of species in the sample

- **Dominance Index**

$$C = \sum (\frac{ni}{N})^2$$

Where:
C = Dominance Index
ni = Number of individuals of the species-i
N = Total individual of all species

To see the relationship between macrozoobenthos with physical and chemical oceanographic parameters, nutrient concentrations, and sediment characteristics, a simple linear regression analysis using Microsoft Excel was used. The dependent variable (bound) is given the notation Y, namely the abundance of macrozoobenthos. While the independent variables (unbound) are given the notation X, which is the water parameter, nutrient concentration, and sediment characteristics.

3. RESULT AND DISCUSSION

Water Quality

Based on the results of the data in Table 1, only the temperature parameters are still within the seawater quality standards according to PP No. 22 of 2021, while the parameters for salinity, pH, and DO are below the quality standard limits. The low salinity value is because the three research stations are located in the estuary area, belonging to the category of brackish water salinity, which ranges from 2 to 22 ppt (Bengen, 2000). For the pH parameter values, the conditions at the three stations have a pH value of < 7 which means it indicates that the waters are polluted. However, the range of pH values obtained from the measurement results can still be tolerated because it has a small difference from the minimum quality standard of 0.04-0.46. Macrozoobenthos were also found at each station, so these species have a strong tolerance for acidic pH.

The DO parameter value obtained is below the quality standard, but the range of DO value obtained can still be tolerated because it has a fairly small difference from the minimum quality standard, which is around 0.2 – 0.5 mg/L. This is also supported by the statement of Marpaung (2013) which states that the level of dissolved oxygen (DO) required by macrozoobenthos is 4.00 –6.00 mg/L.

Table 1. Water Physics and Chemical Parameter Value.

No	Parameter	Station 1	Station 2	Station 3	Seawater Quality Standard (PP No. 22 of 2021)
		09.00 WIB	10.40 WIB	12.30 WIB	
1	Temperature (°C)	28	29,33	28,67	28 - 32°C
2	Salinity (ppt)	15,33	17,5	22,67	33 – 34 ppt
3	pH	6,66	6,54	6,96	7 – 8,5
4	DO (mg/L)	4,73	4,5	4,83	> 5 mg/L

Nutrient Concentration

Based on the quality standard PP No. 22 of 2021, the concentration of ammonia and nitrate is below the quality standard. According to KepMen LH No. 51 of 2004, the concentration of nitrite is also below the quality standard or not polluted. Menurut Novonthy & Olem (1994) stated that in waters with a pH of less than 7 ammonia will be found more in the form of ammonium ions, while in waters with a pH of more than 7, toxic free ammonia will be found more. In all research stations, it is known that the pH is less than 7, so the concentration of ammonia contained is not toxic.

The low concentration of nitrite in all stations is caused by the slow nitrification process in the waters. The slowing of the nitrification process in the waters causes the nitrate concentration to be more and more stable. This is followed by the test results of higher nitrate levels than nitrite at each station.

The result of phosphate concentration is above the quality standard. The high levels of phosphate at the three stations were due to the influence of high rainfall intensity so more nutrients containing phosphate were carried on land through rivers and then into the waters at the research location. This is supported by the statement of Meirinawati dan Muchtar (2017) where the most dominant factor in influencing phosphate concentration is the difference in rainfall intensity in each season.

According to Khalil et al. (2016), if the phosphate value has exceeded the limit quality standard (> 0.1 mg/L), it is included in the category of hypertrophic waters. These conditions affect the decrease in the value of oxygen concentration in water bodies, and phosphate will be deposited back into the sediment pores through various processes, including sedimentation and adsorption (Carignan, 1982 in Purnamaningtyas, 2014). This is also followed by with the results of measurements of DO levels at the three research sites in the range of ±4 mg/L, which is relatively low and is below the threshold of quality standards according to PP No. 22 of 2021 (>5 mg/L).

The results of the measurement of chlorophyll-a concentration values ranged from 0.0013 to 0.0034 mg/L. In the category of PerMen LH No. 28 of 2009, stations 1 and 3 are included in the category of mesotrophic waters or water conditions with moderate nutrients and productivity. While at station 2 is classified as oligotrophic waters, which are waters with low productivity and nutrients. Also according to PerMen LH no. 28 of 2009, the n-total concentration obtained can be said to be in the category of oligotrophic waters because the amount is below 0.64 mg/L. The amount of total nitrogen that varies at each research location can be caused by differences in the levels of combined inorganic nitrogen (nitrate, nitrite, and ammonia) and organic nitrogen particles that are not dissolved in water in each water (Sharp, 1983).

Table 2. Nutrient Concentration in the Nature Tourism Park of Mangrove Angke Kapuk.

No	Nutrient (mg.L)	Station			Quality Standards	Source
		1	2	3		
1	Ammonia	0,1730	0,1050	0,1440	>0,3 mg/L	PP No. 22 of 2021
2	Phosphate	0,2417	0,3031	0,2753	>0,015 mg/L	PP No. 22 of 2021
3	Nitrate	0,0330	0,0580	0,0420	>0,06 mg/L	PP No. 22 of 2021
4	Nitrite	0,0080	0,0140	0,0100	>0,06 mg/L	KepMen LH No. 51 of 2004
5	Chlorophyll-a	0,0025	0,0013	0,0034	-	
6	N-Total	0,3260	0,2850	0,3110	-	

Sediment Characteristics

Based on the analysis of sediment texture classification from stations 1 to 3 in The Nature Tourism Park of Mangrove Angke Kapuk, the sediment fraction value (%) of gravel ranges from 3.54 to 4.94%, then the sand sediment fraction ranges from 87.73 to 95.42 % then followed by the silt fraction at 1.04 – 12.27%. The results of the sediment fraction value show that the percentage value of the sand fraction is greater than the value of the gravel and silt fraction, so it can be seen that the type of texture of the sediment in The Nature Tourism Park of Mangrove Angke Kapuk is dominated by sand. The difference in the characteristics of sediment types in the waters in each season is due to the size of the particles and skeletal remains determined by the physical properties of each sampling location (Muhaimin, 2013).

The type of sediment at station 1 which is close to fish ponds, and station 2 which is close to resorts and water tourism, is in the form of slightly gravel sand, while at station 3 which is closest to the sea, is silt sand. This is followed by the statement of Subardi dan Sidabutar (1994) in Triapriyasen et al. (2016) that only smooth sediment grains reach the sea so that the closer to the sea the smoother grains of sediment. The type of sediment structure can affect the concentration of nutrients contained in the substrate of an area. According to Ritniasih & Kushartono (2009), the smoother the texture of the substrate, the greater its ability to trap nutrients. This will affect the number of individuals and macrozoobenthos species found in the area.

Table 3. Sediment Characteristics at The Nature Tourism Park of Mangrove Angke Kapuk.

Station	Sediment Fraction (%)			Sediment Characteristics
	Gravel	Sand	Silt	
1	3,54	95,42	1,04	Sand with a little gravel
2	4,94	91,27	3,79	Sand with a little gravel
3	0	87,73	12,27	Silt sand

Community Structure of Macrozoobenthos

The results of observations on macrozoobenthos obtained 7 species with 3 different classes. In the waters of The Nature Tourism Park of Mangrove Angke Kapuk, the most habitat is the Bivalvia class, with a total of 26 individuals, followed by the Gastropod class with a total of 6 individuals, and Polychaeta with a total of 4 individuals. Can also be seen species *Tellina sp*. became the species with the highest total number of individual species, namely 17 individuals, with 14 individuals at station 3 and 3 individuals at station 1. While the lowest total number of individuals was at station 3 with the research location being *Strombus canarium*, which was 1 individual. From Table 4 it can also be seen that the abundance index ranges from 15 - 130 ind/m2; the diversity index ranged from 0.64 to 1.28 which was categorized as low to moderate; the uniformity index ranged from 0.86 - 0.93 which was categorized as high; and the dominance index ranged from 0.31 to 0.56 which was categorized as low to moderate.

Table 4. Community Structure Macrozoobenthos Found at the Research Site.

St	Organism	Abundance			Diversity	Uniformity	Dominance
		Bivalvia	Gastropoda	Polychaeta			
1	*Anadara* sp.	4	0	0	0,68290	0,49261	0,51020
	Telina sp.	12	0	0			
	Strombus canarium	0	4	0			
	Nassarius sp.	0	8	0			
Jumlah		**16**	**12**	**0**			
2	*Nassarius* sp.	0	4	0	0	0	1
	Melanoides sp.	0	8	0			
Jumlah		**0**	**12**	**0**			
3	*Anadara* sp.	12	0	0	0,42932	0,30969	0,73964
	Donax sp.	20	0	0			
	Telina sp.	56	0	0			
	Neries sp.	0	0	16			
Jumlah		**88**	**0**	**16**			

Correlation Between Water Parameters and Macrozoobenthos Community

The correlation between the abundance index and each measured water parameter shows a varied relationship. The regression results between the abundance index and temperature concentration r = 0.0251, the abundance and salinity concentration index r = 0.8066, the abundance and concentration index pH r = 0.9862, and the abundance and DO concentration index r = 0.6962. The value that has the most influence is pH, while the value that has the least influence is temperature. For parameters pH, salinity, and DO, are positively correlated, while temperature parameters are negatively correlated.

The correlation between abundance index and ammonia in pore water has a value of r = 0.0603, abundance index with nitrate concentration r = 0.0101, abundance index with nitrite concentration r = 0.0119, abundance index with phosphate concentration r = 0.0118, abundance index with n-total concentration r = 0.972, this correlation value shows the relationship between the abundance index and nutrient concentration with the most influencing nutrient concentration is chlorophyll-a. For the parameters of chlorophyll-a, ammonia, and n-total positively correlated, while the parameters of phosphate, nitrate, and nitrite were negatively correlated.

The correlation between abundance index and gravel substrate has a value of r = 0.9868, abundance index with silt substrate r = 0.8479, and abundance index with sand substrate r = 0.5524. Correlation on all substrates is positive, while the most influencing is gravel. According to Yunitawati et al. (2012), the main factor that greatly affects the structure of the macrozoobenthos community is the gravel substrate.

4. CONCLUSION

Based on the results of research that has been carried out at The Nature Tourism Park of Mangrove Angke Kapuk, several points that can be concluded, namely:

- All water parameters are correlated with the macrozoobenthos community structure. The oceanographic parameters that most influence is pH, the nutrient concentration that most influences is chlorophyll-a, and sediment characteristics that most influence is gravel substrate.
- Observations showed 7 species of macrozoobenthos with 3 different classes, where the majority were habitats from the Bivalvia class with a total of 26 individuals, followed by the Gastropod class with a total of 6 individuals, and Polychaeta with a total of 4 individuals.
- Sediment characteristics in the Angke Kapuk Mangrove TWA are dominated by the sand substrate fraction.

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