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Macrozoobenthos community structure as an indicator of water quality in the mangrove area of Bojong Salawe, Pangandaran, West Java, Indonesia

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ABSTRACT

Macrozoobenthos have a relatively fixed living habitat, limited movement, and live in and on the bottom of the waters. These properties make macrozoobenthos suitable for water use as a biological indicator. This research aimed to determine individual abundance, species diversity, and evenness of macrozoobenthos in the Mangrove area to determine the physical and chemical conditions based on diversity and the relationship between macrozoobenthos and environmental factors. This research was conducted in January 2022 in the Mangrove area of Bojong Salawe, Pangandaran, West Java. The data collection location is divided into four stations, with three plots at each station. The research results show that 35 species of 3 classes are spread over four stations. The abundance value of macrozoobenthos is at a value of 481.5 – 278 Ind/m^2. The diversity index value is at a value of 1.15 – 1.45. The uniformity index value is 0.45 – 0.59.

Keywords: Mangrove ecosystem, Makrozoobenthos, Water quality, Bojong Salawe

1. INTRODUCTION

Mangroves are tropical and subtropical forest plant communities that grow in estuary areas and coastal areas (Faiqoh *et al. al.* 2016). Mangroves have various benefits, both from social, economic, and ecological aspects (Poedjirahajoe *et al.* 2017). Bojong Salawe is a hamlet in Karangjaladri Village, Parigi District, Pangandaran Regency, West Java Province. Bojong

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Salawe has mangrove conservation. The area of mangrove conservation is around 30 hectares with a total of 12,000 trees (Forest Service Branch VII 2017). After the 2006 tsunami, the local government attempted to rehabilitate the mangroves. The river where mangroves grow is part of Cialit which flows from the west of the bridge and empties into Bojong Salawe beach and is a transportation route for fishermen (Noviatri *et al.* 2020). According to Nurani's research (2019) estuary Cijulang, which is located on the coast of Pangandaran Regency, has anthropogenic waste input originating from nata de coco factory waste, sugar factories, and coconut factories that enter from the Bojong Salawe River which passes through the mangrove area, as well as household waste. Originating from settlements that will affect the conditions of macrozoobenthos.

Macrozoobenthos are animals that inhabit the bottom of the waters and have a role as a biological indicator that reacts to changes in water quality (Noviyanti *et al.* 2019). Macrozoobenthos is an indicator of a water because this macrozoobenthos has a permanent habitat, so changes in the quality of the water where it lives will affect its composition and abundance (Asra 2013). Macrozoobenthosis an estimator of water quality, so its presence can determine whether there is pollution from domestic, industrial, agricultural, livestock, and fisheries waste (Novyanti *et al.* 2019). Macrozoobenthos in mangrove ecosystems also have a role as primary consumers and secondary consumers, which utilize plankton, algae, bacteria, and organic matter as food (Sabar 2016). Macrozoobenthos commonly found in mangrove areas are the class *Crustacea*, *Bivalvia*, and class *Gastropods* (Afkar *et al.* 2014).

Rehabilitation activities and human activities such as disposal of domestic waste around mangroves, will have an influence on changes in ecological conditions in the mangrove area, changes in these ecological conditions indirectly affect the diversity of macrozoobenthos (Ernawati *et al.* 2013). This study aims to look at the condition of the Bojong mangrove waters Salawe by analyzing the structure of macrozoobenthos.

2. METHODOLOGY

2. 1. Times and Place

This research was conducted at four stations around the mangrove area of Bojong Salawe, Pangandaran, West Java (Figure 1). Determination of research stations based on purposive sampling method based on human activities around the mangroves. This research was conducted in January 2022.

The differences in the activities of each station are as follows:

1. **Station 1:** located on the west side of the Bojong Salawe mangrove with coordinates 07º42'40.27” South Latitude, 108º30'01.93” East Longitude. At station 1, there are residential areas and close to ponds.
2. **Station 2:** located in the middle of the Bojong Salawe mangrove, precisely under the bridge on the main route to Bojong Salawe beach with coordinates 07º42'45.39” South Latitude, 108º29'55.21” East Longitude. At this station is an area that will become ecotourism.
3. **Station 3:** located in the east, adjacent to the estuary and is the boundary of mangrove vegetation in Bojong Salawe with coordinates 07º42'53.69” South Latitude, 108º29'56.93” East Longitude. At this station is a boat transportation route to the sea.

4. **Station 4:** located outside the mangrove conservation river flow, but there are still mangroves. This location has minimal human activity with coordinates 07º42'58.3" South Latitude, 108º30'00.4".

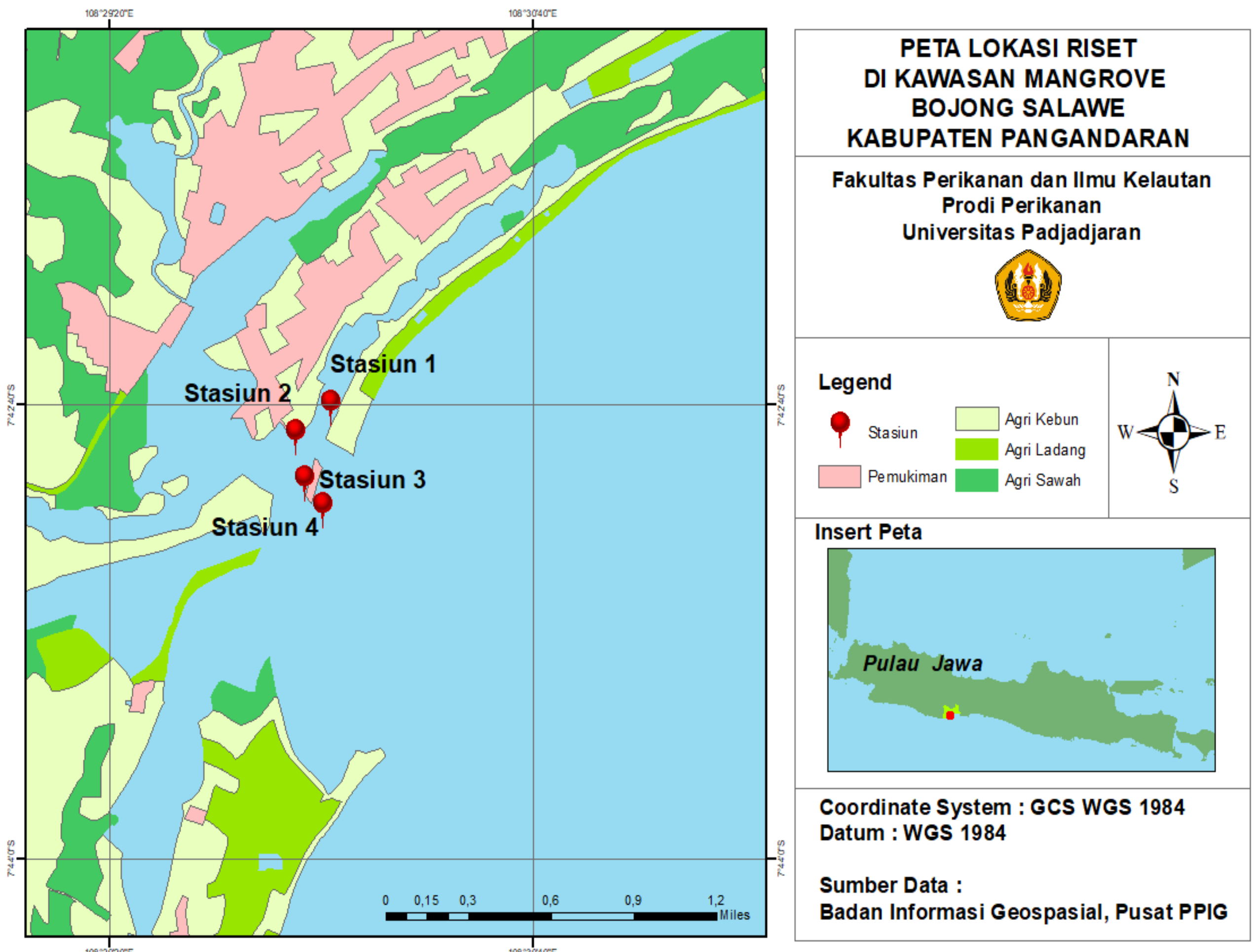

Figure 1. Research Locations

2. 2. Tools and Materials

The tools used are GPS (Global Positioning System), roll meter, booties, rope rap, shovel, stationery, label paper, camera, ziplock plastic, filter, DO meter, pH meter, refractometer, and thermometer. The materials used in this research were 70% alcohol, macrozoobenthos samples, water quality data, and substrate samples.

2. 3. Sampling and Measurement

Macrozoobenthos sampling was carried out four times in January 2022 in the intertidal zone. Substrate collection was carried out once in the first week. Each station has three transects 50 meters long, and there are three plots in each line transect with a distance of 25 meters. Plot size on line transect 1 m × 1 m.

Taking macrozoobenthos with the help of a shovel with a depth of 20 cm. Makrozoobenthos is put into ziplock plastic and then given 70% alcohol. Observations and measurements of water samples such as temperature, DO, pH, and salinity were carried out in situ. Observations of macrozoobenthos Fisheries Laboratory Integrated PSDKU Pangandaran and observations of substrates were carried out at the Laboratory of Soil Physics and Chemistry, Faculty of Agriculture University Padjadjaran

2. 4. Analysis Sample

Analysis of the samples carried out included abundance, diversity, uniformity and the relationship between physical-chemical parameters and macrozoobenthos. Water quality parameters are compared with quality standards according to Government Regulations concerning the Implementation of Environmental Protection and Management no. 22 years 2021 for the life of marine organisms.

1) Abundance

$$Y = \frac{a}{b}$$

Information:

Y = abundance of individuals (ind/m^2)
a = number of macrozoobenthos individuals
b = area number of quadrants x number of repetitions

2) Diversity Index

$$H = -\sum_{i-1,2,3}^{s} \quad Pi \; ln \;\; Pi$$

Description:

H' = Diversity index
Pi = ni / N
ni = Number of individuals of each i-type
N = Total number of individuals
ln = natural logarithm

3) Index Evenness

$$E = \frac{H'}{Hmax} = \frac{H'}{Ln\; S}$$

Information:

E = Uniformity index
H' = Diversity Index
Hmax = Ln S
S = Number of species

3. RESULT AND DISCUSSION

3. 1. Physical and Chemical Parameters in the Bojong Salawe Mangrove Ecosystem

Physical and chemical parameters become an indicator to determine an environmental condition that is used as a macrozoobenthos habitat. This research shows that there are variations in the physical and chemical parameters of the Bojong Salawe mangrove waters (Table 1).

Table 1. Physical-chemical Parameters of Mangrove Waters Bojong Salawe

No	Parameter	Unit	St 1	St 2	St 3	St 4	Quality Standard*
1	Temperature	ºC	29.5 ± 1	30± 1.4	30± 0.82	31± 1	28-32
2	pH	-	6.75± 1	7± 0.8	7±0.6	7±0.0	7-8.5
3	DO	mg/L	5.6 ±1.2	5.1±0.64	5.9±0.89	7.8±0.39	> 5
4	Salinity	‰	19.8±8.4	21.8±8.7	22.3±7.1	31±4.5	to 34
5	BOT	%	2.89	0.40	3.31	0.25	-
6	Substrates	-	loam	Sandy loam	Sandy loam	Sandy loam	-

* PP LH No. 22 of 2021 for the life of marine organisms

Temperature is one of the physical parameters which is an important factor in the metabolism of aquatic organisms. The temperature values in the Bojong Salawe mangrove waters at stations 1 to 4 range from 29.5 – 31 ºC, the lowest temperature at station 1 is 29.5 ºC and the highest temperature at station 4 is 31 ºC. Referring to PP LH No. 22 of 2021, good temperatures for biota including macrozoobenthos in mangrove waters range from 28 – 32 ºC, so the temperature in the mangrove waters of Bojong Salawe is suitable for macrozoobenthos life. The temperature difference from each station is caused by the time difference in data collection. Sampling time will affect the intensity of light entering the water. The temperature of water will be affected by brightness where brighter the water is, the more absorption of sunlight, and the temperature will increase. According to Schaduw (2018) water temperature is influenced by geographical location, cloud cover, time of measurement, and water depth. Extreme temperature changes will disrupt macrozoobenthos or cause death.

The degree of acidity (pH) is a limiting factor for organisms living in the waters (Taqwa *et al.* 2010). The pH values in the Bojong Salawe mangrove waters at stations 1, 2, 3, and 4 ranged from 6.75 to 7. Referring to PP LH No. 22 of 2021 The preferred pH for biota, including macrozoobenthos, in mangrove waters ranges from 7 – 8.5. According to Mathius *et al.* (2018) generally, gastropods require a water pH between 6.5 – 8.5 for survival and reproduction so that the pH at station 1 can still be tolerated by one of the macrozoobenthos, namely gastropods.

DO (*Dissolved Oxygen*) in waters affects the number and types of macrozoobenthos (Nurfajrin & Rosada 2018). Based on the results of DO measurements in the mangrove waters of Bojong Salawe, the DO values at stations 1 to 4 ranged from 5.6 to 7.8 mg/L. The DO value is in accordance with PP LH No. 22 in 2021, namely >5 mg/L, so it is good for macrozoobenthos life. A low DO value will threaten the life of macrozoobenthos, which is sensitive to a decrease in dissolved oxygen, and conversely, a high DO value will support the life of macrozoobenthos. According to Hanifah *et al.* (2020) if the DO value in water is high, the life level of macrozoobenthos will be better, and a low DO value will have a negative impact causing the death of macrozoobenthos species that are sensitive to decreased dissolved oxygen.

Salinity is one of the environmental factors that influence the development of several macrozoobenthos (Nurfajrin & Rosada 2018). Based on the salinity measurements carried out at the four stations, namely station 1 has a salinity value of 19.8 ‰, station 2 has a value of 21.8 ‰, station 3 has a value of 22.3 ‰ and station 4 has a value of 31 ‰. Salinity value according to PP LH No. 22 of 2021, namely up to 34 ‰. According to Mathius *et al.* (2018) factors that affect the difference are heat absorption, rainfall, river flow, tides, and current circulation patterns. Thus the factors affecting the difference in salinity at stations 1, 2, 3, and 4 are freshwater input from land and tides. Mudjiman (1989) explained that it is possible for gastropods to live and grow at a salinity of 15 – 45‰.

3. 2. Substrate Parameters

The substrate is a surface where an organism can live, and the substrate has a texture of sand, dust, and clay. The substrate taken at the research location was only one station which had a different type of substrate, namely clay, and the other three stations had the same type of substrate, namely sandy loam (Table 2). The difference in substrate at station 1 is caused by the research location being closer to land while 2, 3, and 4 are close to the ocean, especially station 4, which has a predominant sand texture. The majority of macrozoobenthos prefer to live in silt to sand substrates (Saputra *et al.* 2017).

Table 2. Substrate Type and C-Organic Bojong Salawe mangrove ecosystem

Station	Parameter analysis			Substrate Type	C-Organic
	Texture (%)				
	Sand	Dust	Clay		
Station 1	36	42	22	Clay	2, 89 %
Station 2	79	7	14	Sandy loam	0.40 %
Station 3	71	19	10	Sandy loam	3.31 %
Station 4	80	4	16	Sandy loam	0.25 %

Organic matter content at stations 1, 2, 3, and 4 has a value of 3.31% to 0.25% (Table 2). The station with the highest organic matter was station 3, with a value of 3.31%, while the lowest was at station 4, which was 0.25%. Several factors cause differences in the C-organic content of mangrove ecosystem waters, namely the composition of the substrate, which has been mixed with litter which is one of the main sources of organic matter, the age of mangrove planting affects the amount of litter (Rahman & Hadi 2021). The type of substrate also affects the C-organic value, texture of the sand substrate cannot store much C-organic because the pores in the sand are large and cannot bind carbon properly, so that sand has a very low organic matter content (Siringoringo *et al.* 2017).

3. 3. Community Structure of Macrozoobenthos

1) Abundance

The abundance of macrozoobenthos obtained during the research was 35 species consisting of 22 Gastropod classes, 11 Bivalvia classes, and 2 Malacostraca classes (Table 3).

Table 3. Macrozoobenthos Found During Research

No	Class	Species	St 1	St 2	St 3	St 4
1	Gastropods	*Faunus ater*	√	√	√	√
2	Gastropods	*Clithon oualaniensis*	√	√	√	√
3	Gastropods	*Cerithidea cingulata*	√	√	√	√
4	Gastropods	*Melanoides maculata*	√	√	-	√
5	Gastropods	*Neritodryas subsulcata*	-	√	-	-
6	Gastropods	*Nerita plicata*	-	√	-	-
7	Gastropods	*Bufonaria rana*	-	-	√	-
8	Gastropods	*Turbo marmoratus*	-	-	√	-
9	Gastropods	*Murex trapa*	-	-	√	-
10	Gastropods	*Chicoreus capucinus*	-	-	√	√
11	Gastropods	*Littoraria scabra*	-	√	-	-
12	Gastropods	*Nassarius crematus*	-	√	√	-
13	Gastropods	*Littoraria carinifera*	-	√	-	-
14	Gastropods	*Nassarius dorsatus*	-	-	√	-
15	Gastropods	*Engina mendicaria*	-	-	√	-
16	Gastropods	*Nassarius foveolatus*	-	-	-	√
17	Gastropods	*Rhinoclavis sinensis*	-	-	-	√

18	Gastropods	*Indothais gradata*	-	-	-	√
19	Gastropods	*Nassarius sufflatus*	√	√	-	-
20	Gastropods	*Babylonia spirata*	√	√	√	-
21	Gastropods	*Natica catena*	-	-	-	√
22	Gastropods	*Nerita albicilla*	-	-	-	√
23	Bivalvia	*Saccostrea echinata*	√	√	√	-
24	Bivalvia	*Glauconome virens*	-	-	√	-
25	Bivalvia	*Marcia opima*	-	-	√	-
26	Bivalvia	*Gari elongata*	-	-	-	√
27	Bivalvia	*Laternula truncate*	-	-	-	√
28	Bivalvia	*Scapharca pihula*	-	-	-	√
29	Bivalvia	*Anadara granosa*	-	-	√	√
30	Bivalvia	*Gafrarium tumidum*	-	√	-	√
31	Bivalvia	*Tucetona pectunculus*	-	-	-	√
32	Bivalvia	*Mactra mera*	-	-	-	√
33	Bivalvia	*Mactra luzonica*	-	-	-	√
34	Malacostraca	*Scylla olivacea*	-	-	√	-
35	Malacostraca	*Uca sp*	-	√	√	-
Total			**7**	**14**	**15**	**18**

The abundance of macrozoobenthos individuals is the number of individuals per unit area (Yasir *et al.* 2015). Based on the data collection, the abundance at station 1 was 482 ind/m^2, station 2 the abundance of macrozoobenthos was 332 ind/m^2, station 3 the abundance of macrozoobenthos was 350 ind/m^2, and at station 4, the abundance of macrozoobenthos was 278 ind /m^2.

The highest abundance of macrozoobenthos was at station 1 of 482 (ind/m^2), seven species were found one bivalve class 6 gastropod classes, and the abundance was dominated by *faunus ater* (270 ind/m^2) from the gastropod class. Gastropods have a fairly strong adaptation to environmental changes because they have a hard shell and a more mobile nature that allows them to survive compared to other classes (Alwi *et al.* 2020).

The lowest abundance was at station 4 of 278 (ind/m^2). This is due to the low density of mangroves with a sapling stage so that the organic matter is low (Aini *et al.* 2016). The water quality at station 4 is relatively good due to low anthropogenic activity, so the macrozoobenthos at station 4 is more diverse.

2) Diversity

The Shannon-Wiener macrozoobenthos diversity index values at each station ranged from 1.15 to 1.45 (Table 4). Based on the Shannon-Wiener diversity index criteria, stations 1 to 4 with a diversity index value of 1<H'<3 indicate moderate diversity, indicating the distribution of the number of individuals of each species and sufficient community stability and no significant ecosystem threats (Noviatri et al. 2020).

Table 4. Diversity index value

Station	Index Shannon-wiener H'	Category
Station 1	1.15	moderate diversity
Station 2	1.20	moderate diversity
Station 3	1.32	moderate diversity
Station 4	1.45	moderate diversity

3) Uniformity

The uniformity index shows the balance of the composition of individuals of each macrozoobenthos species found in one community (Table 5). The uniformity index value at each station ranges from 0.45 to 0.59. Based on the uniformity index criteria, the uniformity of macrozoobenthos populations at all stations is classified as moderate because the value of E 0.4 < E ≤ 0.6, indicates that the distribution of macrozoobenthos species at each station is fairly even. According to Alwi *et al.* (2020) if the uniformity value is close to 0, it means that the uniformity is stable because there are species that dominate, and if the uniformity value is close to 1, the uniformity is stable, which shows that no species dominates.

Table 5. Uniformity Index E

Station	Index Uniformity Index E (Krebs 1985)	Category
Stasion 1	0.59	medium
Station 2	0.45	uniformity index
Station 3	0.49	medium uniformity index
Station 4	0.50	medium uniformity index

4. CONCLUSIONS

Value abundance of macrozoobenthos 482 – 278 ind/m^2. The diversity index value is 1.15 – 1.45 in the moderate category. The uniformity index value is 0.45 – 0.59 in the moderate category. The water quality of the mangrove ecosystem based on the diversity index shows that the waters of Bojong Salawe are classified as moderately polluted but are still good enough for the biota of the Bojong Salawe mangrove waters.

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