Jurnal Ilmu Kelautan
SPERMONDE (2023) 9(1): 1-9

P-ISSN: 2460-0156
E-ISSN: 2614-5049

MACROZOOBENTHOS DIVERSITY AS A BIOINDICATOR OF WATER QUALITY AROUND THE CENTER POINT OF INDONESIA (CPI)

Fathin Nur Rahman[1], Rahmadi Tambaru[2*], Mahatma Lanuru[2], Yayu A Lanafie[2], Muh. Farid Samawi[2]

Submitted: February 7, 2022 Accepted: January 12, 2023

[1]Student at Department of Marine Science, Faculty of Marine Science and Fisheries, Universitas Hasanuddin
[2]Department of Marine Science, Faculty of Marine Science and Fisheries, Universitas Hasanuddin
Corresponding Author:
[*]Rahmadi Tambaru
Email: aditbr69@unhas.ac.id

ABSTRACT

Benthos are invertebrate animals that live at the bottom of the waters. One biota that can be used as a biological parameter in determining the quality of a waters is macrozoobenthos. The waters around the Center Point of Indonesia (CPI) are one of the waters that have received a lot of additional organic matter and other pollutant materials through the estuaries of the canals that flow into the waters of Losari Beach. The study was conducted by sampling macrozoobenthos at each station using Ejkman Grab at each station 3 times sampling then sieved using a benthos sieve measuring 1 mm. In addition, measurements of environmental factors were carried out at each station with 3 replications directly in the field and analyzed in the laboratory. The results of the macrozoobenthos sampling study obtained 4 macrozoobenthos classes found at the study site, namely the Gastropod Class (4 species), the Crustacea Class, the Ophiuroidea Class, and the Oligochaeta Class each 1 species. The highest diversity and abundance of macrozoobenthos was found at Station 6 which is suspected because this station has a sandy sediment texture and sediment DOM content and high concentrations of water solubility of oxygen which support the life of makzoobenthos. Macrozoobenthos diversity at the study site (waters around the Center Point of Indonesia) is low with a diversity index (H') value of 0.00 - 0.16. The high abundance of makzoobenthos at Station 5 and Station 6 is characterized by high current velocity, sediment DOM and high oxygen concentration.

Keywords: Macrozoobenthos, Reclamation, Diversity, Environmental Parameter

INTRODUCTION

Benthos are invertebrate animals that live at the bottom of the water, either on the surface or in the substrate. Benthos includes phytobenthos (vegetable organisms) and zoobenthos (animal organisms) (Nasution et al., 2017). Benthos live in intertidal areas with varying depths (Sinyo & Idris, 2013). One biota that can be used as a biological parameter in determining the quality of a waters is macrozoobenthos. Macrozoobenthos are invertebrates that can be seen with the naked eye and live on, in and around rocks at the bottom of the waters. Macrozoobenthos generally cannot move quickly, their size is large so it is easy to identify and their habitat in and on the bottom of the waters (Odum, 1996).

As in ecosystems in general, in marine waters there are ecological processes in which the interactions of several biotic and environmental (abiotic) components occur. One of these biotic components is macrozoobenthos or macrofauna. According to Agrista (2005), macrozoobenthos is more widely used as an environmental bioindicator because its diversity can more specifically represent the water quality of a place. The role of the benthic in waters includes its ability to recycle organic materials, assist the mineralization process, and various important positions in the food chain. Therefore, macrozoobenthic organisms are often used as indicator species for organic matter content and can provide a more precise picture than physical and chemical tests. The type of substrate determines the number and types of benthic animals in a waters. The type of substrate is very important in the development of benthic animal communities. Sand tends to make it easier to shift and move to another place. The substrate in the form of mud usually contains little oxygen and therefore the organisms that live in it must be able to adapt to these conditions (Lind, 1979).

One of the locations that has received a lot of additional organic matter and other pollutant materials is the waters around the Center Point of Indonesia (CPI) through the estuaries of the canals that flow into the waters of Losari Beach. These materials come from hospital, household, hotel and restaurant waste. Based on these factors, the quality of the waters is thought to have decreased drastically, especially since the accumulation of CPI caused water circulation to be increasingly disrupted around Losari Beach (Rahman, 2019) This study aims to determine the diversity of macrozoobenthos in the waters around the Center Point of Indonesia. This research is expected to be a reference source of information on macrozoobenthos diversity as a water quality bioindicator that can be used by stakeholders for environmental management in Makassar City. Based on this, research related to water quality was carried out to see macrozoobenthos diversity as a bioindicator

MATERIALS AND METHODS

The research was carried out from March to June 2021, sampling was carried out in the waters around the Center Point of Indonesia (CPI) Makassar City (Figure 1). Analysis of water samples was carried out at the Chemical Oceanographic Laboratory, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar. Macrozoobenthos analysis was carried out at the Marine Biology Laboratory, Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar.

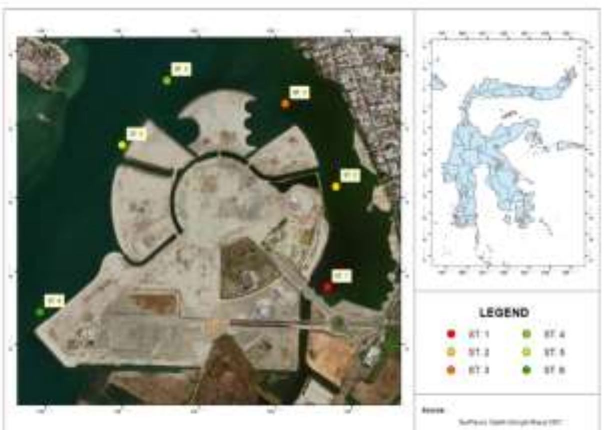

Figure 1. Sampling location

Station Determination

The are 6 stations where each of these stations is thought to have different water conditions and can represent the water conditions around the CPI (Rahman, 2019) (Table 1 & Figure 1)

Table 1. Characteristics of sampling locations

Station	Characteristics
1	Located on the inside of Losari Beach Waters. It is suspected that this station is influenced by land in the form of waste perkotaan dari bagian selatan-barat kota makassar
2	Located in the middle of Losari Beach. It is suspected that this station has poor water circulation and a high pollutant load because there are several canals for waste disposal from the city of Makassar
3	Located at the "mouth" of the waters between Losari Beach and CPI. It is suspected that this station has better water circulation than stations 1 and 2
4	Located in the waters between Makassar City and Lae-Lae Island. It is suspected that at this station the water circulation is good because there is a breakwater
5	Located in the waters between Lae-Lae Island and CPI. It is suspected that this station gets two influences between the reclamation area and the input of waste from the community
6	Located in the outer waters of the CPI. It is suspected that this station has better water circulation and the effect of reclamation is relatively small

Research Procedures

Macrozoobenthos sampling at each station was carried out using the Ejkman Grab (Figure 2). At each station, sampling was repeated 3 times and then sieved using a benthos sieve with a mesh size of 1 mm. The filtered macrozoobenthos samples were put into a sample bag then preserved in 70% alcohol and then taken to the laboratory to identify the species and count the amount. The results of the macrozoobenthos samples obtained were matched with the pictures and characteristics contained in the identification book (Fish and shellfish.)

Observation of environmental factors was carried out at each station with 3 repetitions. Environmental factors that will be observed in situ are temperature, salinity, pH, dissolved oxygen (DO), depth, direction and current velocity. Turbidity measurement, sediment texture analysis and sediment total organic matter (TOM) will be carried out in the laboratory.

Data Analysis

The statistical analysis used in this study was the abundance of macrozoobenthos species to see the number of individuals per unit area or per unit volume. Analysis of the macrozoobenthic community used ecological indices including diversity index, uniformity index and dominance index. Sediment texture analysis using Gradistat. Analysis of environmental parameters included parameters of temperature, salinity, pH, dissolved oxygen (DO), depth, direction and current velocity, turbidity, sediment texture and total organic matter of the sediment. Principal component analysis (Principal Component Analysis) is used to determine the identifying factors regarding environmental characteristics and the abundance of macrozoobenthos at each station.

RESULTS AND DISCUSSION

Species Composition and Macrozoobenthos Abundance

Based on the identification results, it was found that there were 4 macrozoobenthos classes from 6 observation station locations (Figure 2), consisting of 4 species of Gastropod Class, 1 species of Crustacean Class, 1 species of Ophiuroidea Class, and 1 species of Oligochaeta Class. The Gastropod class has a higher number of species than other classes. According to Islami and Mudjiono (2009) the high species composition of the gastropod class is thought to be related to habitat suitability and its distribution is controlled by several parameters, especially the characteristics of the bottom substrate. This affects the placement of larvae and the passing of the metamorphosis phase, thereby affecting the species composition of the gastropod class.

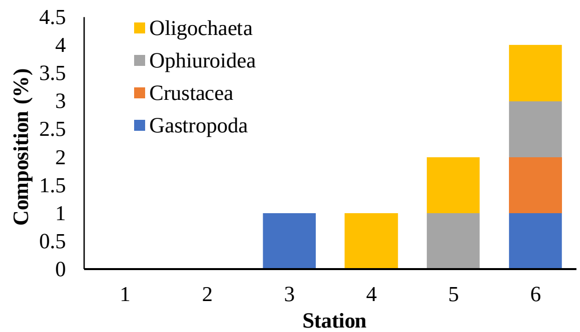

Figure 2. Macrozoobenthos species composition

The abundance of macrozoobenthos (Ind/m2) based on station (Figure 3) shows that Station 6 obtained the highest number of abundance. In detail it can be explained that the abundance of macrozoobenthos at each station was 0 Ind/m2 at Station 1 and Station 2, 11 Ind/m2 at Station 3 and Station 4, 34 individuals at Station 5, and 89 Ind/m2 at Station 6.

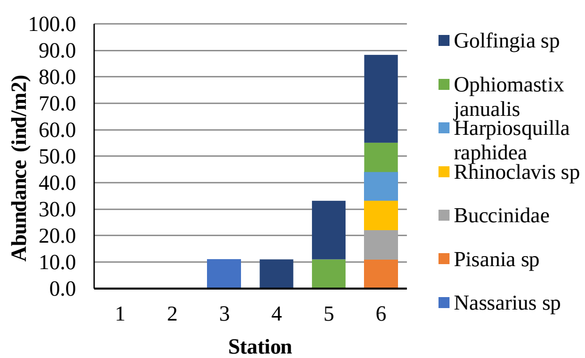

Figure 3. Diversity and species of Makrozoobenthos at each station

Macrozoobenthos abundance ranged from 0 – 88.2 indv/m2. The highest abundance was at station 6, namely 88.2 indv/m2. The worse the water quality tends to reduce the number of macrozoobenthos organisms that live in the area. The high abundance of macrozoobenthos at station 6 is thought to be due to compatibility with several environmental parameters including DOM values and high oxygen solubility. These two parameters are thought to provide support for macrozoobenthos life. If the oxygen solubility value of a water is high, the better the level of macrozoobenthos life found in a location. According to Efendi (2003) decreased levels of oxygen solubility can have a negative impact on macrozoobenthos, which can cause the death of certain species that are sensitive to decreased oxygen solubility. According to Setyobudiandi (1997), the oxygen solubility content affects a water, the higher the oxygen solubility level, the greater the number and types of macrozoobenthos. The absence of macrozoobenthos obtained at Station 1 and Station 2 is suspected to be a factor from other parameters not taken into account in this study, namely eH sediment and Ammonia. It is suspected that the eH value of the sediment can affect the oxygen content in the sediment (Bengen et al., 2004). High ammonia is thought to be toxic to waters if the concentration exceeds the threshold. This is confirmed by Alarest and Sartika (1987) in Widiadmoko (2013), if the concentration of ammonia in the waters is too high, then water pollution can be suspected.

Ecological Indexes

Ecological index values, namely Diversity Index (H'), Uniformity Index (E), and Dominance Index (C) at the six observation stations are presented in graphical form in (Figure 4). The highest Diversity Index and Uniformity Index were found at Station 6 with a Diversity Index value of 1.667 and a Uniformity Index of 0.857. At Station 3 and Station 4 the Diversity Index and Uniformity Index values were 0 where only 1 type of macrozoobenthos was found at the two stations. The highest Dominance Index was found at Station 3 and Station 4 with a Dominance Index value of 1. The Index value for Diversity, Uniformity, and Dominance at Station 1 and Station 2 was 0, where macrozoobenthos were not found at all. Based on the Diversity Index, it can be seen that the diversity index value (H') obtained at the six research stations ranged from 0.000 - 1.667, which means that the diversity value is still relatively low. This low diversity is suspected because the waters around the Center Point of Indonesia have been polluted so that the presence of macrozoobenthos is lacking. According to Odum (1993), low diversity (0<H'<2.302) indicates that the community is experiencing pressure and stress.

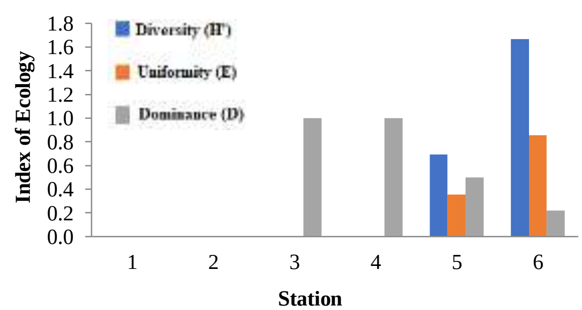

Figure 4. Macrozoobenthos Ecological Index

The highest diversity index (H') is at station 6 with a Diversity Index value of 1.667. Even though the value is the highest of the six stations, the value of 1.667 is still in the low diversity. According to Krebs (1985), the value of the diversity index (H') ranges from 0-2.302 indicating low diversity. The diversity index expresses the richness of species in a community and shows the balance in the distribution of individuals per species. This value will increase if the number of species is more and the proportion of species is more evenly distributed. According to Brower et al., (1990), a community is said to have high species diversity if there are many species with a relatively even number of individuals of each species.

According to Lee et al., (1975) in Fachrul (2012), the diversity index category based on the Shanon-Wiener equation is stated to be very high and unpolluted ranging from >3, high and lightly polluted ranging from 2-3, low and semi-polluted ranging from 1 – 2, very low and heavily polluted <1. According to Odum (1993), the Krebs uniformity index (E') ranges from 0-1. If the value is close to 0 it means low uniformity because other species dominate, and if it is close to 1 it means high uniformity indicates that no species dominates in that habitat. According to Indriyanto (2010), states that the index of diversity and uniformity is related. The higher the diversity index (H'), the lower the uniformity index because the diversity in the community, both genetically and species in a habitat, is different and not uniform.

The uniformity index value (E) at each station shown in Figure 5 ranges from 0.000 - 0.534. The highest uniformity index is found at Station 6. At this station the number of genera obtained is evenly distributed, almost no one dominates and the lowest is at Station 1, Station 2 and Station 3. The uniformity index (E) is used to determine the evenness of the proportions of each types of macrozoobenthos in an ecosystem, this is in accordance with the opinion of Krebs (1985), the smaller the value (E), the smaller the uniformity of a population and the distribution of individuals dominates the population. each type evenly or uniformly.

The Dominance Index ranges from 0.000 – 1 with an average of 0.453. This shows that the value is low, this statement is in accordance with the dominance index that is 0.00 <C <0.50 (low). The dominance index is used to determine the dominance of species in an area (Odum, 1993). Dominance index values at station 1, station 2, station 5 and station 6 are in the low category (0.00<C<0.50) while stations 3 and station 4 are in the high category (0.75<C<1). The lower the dominance index value indicates that there is no particular species that dominates, if the dominance index value is close to or equal to 1 there will be species dominance (Dimara et al., 2020).

Environmental Parameter

The results of measurements of environmental parameters including temperature, salinity, turbidity, water pH, current velocity, oxygen solubility, depth, sediment DOM, and sediment grain size which are used as supporting factors for macrozoobenthos survival at each observation station can be seen in (Table 2).

Table 2. Environmental Parameter Results

Parameter	Sta 1	Sta 2	Sta 3	Sta 4	Sta 5	Sta 6
Temperature (°C)	32	32	32	31	32	32
Salinity (ppt)	27.67	32.67	33.67	35.67	35.67	34
Current (m/s)	0.125	0.035	0.046	0.060	0.124	0.179
Acidity	7.53	7.71	7.79	7.75	7.75	7.74
Turbidity (NTU)	8.58	4.49	3.34	2.63	3.26	5.97
Total organic matter (%)	3.5	1.6	2.9	3.5	5.4	4.0
Dissolved oxygen (mg/l)	3.9	3.9	4.0	4.4	4.4	4.6
Depth (m)	1.80	2.50	4.20	10.60	3.45	5.90

Temperature is one of the most influential environmental factors on macrozoobenthos ecosystems. Temperature is also a limiting factor for the growth and distribution of macrozoobenthos. The temperature range obtained at 6 observation stations with an average of 31.83°C. Temperature can affect the activity and reproduction of organisms. The temperature range is suitable for macrozoobenthos life, which is around 20°C - 30°C. This temperature range can help support optimal living macrozoobenthos (Sugiarto et al., 2017). According to Hawkes (1978), the temperature for macrozoobenthos development is in the range of 28°C-31°C and the critical temperature for macrozoobenthos is around 35˚C-40˚C, because it can cause death.

Salinity values obtained at observation stations ranged from 27.67 ppt – 35.67 ppt. Salinity can affect the distribution of macrozoobenthos, as well as indirectly change the composition of organisms. Based on the research results, this salinity is still able to support macrozoobenthic life which can live in the salinity range of 15 ppt – 35 ppt (Siegers, 2013). Seawater has a very large buffering ability to prevent changes in pH. Changes in pH will provide an indication of disruption of the buffer system. This can cause changes and imbalances in CO^2 levels which can endanger marine biota. The average pH range obtained was 7.53 – 7.79. The highest pH value was obtained at station 4 with a value of 7.79 while the lowest pH value was obtained at station 1 with a value of 7.53. This shows that the pH level at each station has no significant difference. Based on Minister of Environment Decree No. 51 of 2004 concerning water quality standards for marine biota with an optimal pH value for the life of aquatic organisms, namely 7 - 8.5.

According to Ompi et al., (2019), sea water generally has a pH value above 7 which means it is alkaline, but under certain conditions the value can change to be lower than 7 so it is acidic, most aquatic biota are sensitive to changes in pH values. The decrease in carbon dioxide in the ecosystem can increase the pH of the waters, conversely, the process of respiration by all components of the ecosystem will increase the amount of carbon dioxide so that the pH of the waters will decrease. This was clarified by Patty & Akbar (2018) that the pH value in a waters can be influenced by various factors including rainfall and influences from the land as well as oxidation processes which result in a low pH value. This is in accordance with the data obtained, namely the lack of diversity of macrozoobenthos epifauna which is caused by the pH value of the water being too low so that the development and growth of macrozoobenthos epifauna is hampered. (Alimuddin, 2016).

Sediment is one of the constituent elements of water areas, has an important role for the life of megabenthos fauna to determine lifestyle, existence and types of organisms. Changes in the conditions and composition of the bottom substrate will trigger changes in the composition of the macrozoobenthos in it, so that macrozoobenthos is often used as an indicator in determining the condition of a waters (Satyawan & Atriningrum, 2019). The total organic matter content of sediments from the measurement results obtained values in the range between 1.6 – 5.4% as shown in Table 5. The highest sediment DOM content was obtained at station 5 with a value of 5.4% which is included in the criteria for organic matter content low while the lowest sediment DOM content was obtained at station 2 with a value of 1.6% included in the criteria for very low organic matter content.

The range of turbidity values obtained from each station is 2.63 – 8.53 NTU. The highest turbidity value was obtained at station 1 while the lowest turbidity value was obtained at station 4. Based on Minister of Environment Decree No. 51 of 2004 concerning water quality standards for marine biota with an ideal turbidity value of <5 NTU. Turbidity has almost the same effect on the abundance of macrozoobenthos. Based on Kepmen-LH 2004, the standard for turbidity for marine biota is less than 5 NTU. The turbidity value in the highest CPI waters is at Station 1, the high turbidity at Station 1 is suspected because a lot of waste from community activities enters the waters through the canals around Station 1, which results in high turbidity and inhibits the process of photosynthesis in the waters so that the chlorophyll content decreased as the primary productivity of the waters decreased. (Pratiwi, 2017). The brightness of the waters depends on the color and turbidity, if the turbidity is high or the brightness is low it can disrupt the osmoregulation system, for example breathing and the vision of aquatic organisms, and can inhibit the penetration of light into the water (Effendi, 2003).

The oxygen solubility levels obtained based on research results in the waters around the reclamation area of Losari Beach, Makassar City are lower at the inner stations (Station 1, Station 2 and Station 3) compared to the outer stations (Station 4, Station 5 and Station 6). The low levels of oxygen obtained are suspected to be due to the discharge of waste from the mainland through canal flow which can pollute the area around the coast. Furthermore, it is suspected that the decomposition process of these wastes requires a lot of oxygen to carry out the decomposition process, but this use of oxygen does not seem to be offset by the oxygen that is produced through the process of photosynthesis from phytoplankton because there are other factors that influence it (such as turbidity), this can explain the low level of oxygen solubility.

Furthermore, it can refer to Rahmawati's statement (2014), that the presence of contaminants such as materials or organic or inorganic waste originating from feces (animals and humans), industrial waste and household waste, the oxygen that is present will be used by these pollutants. Referring to the results of measuring the oxygen solubility levels obtained, it shows the level of pollutant in the waters, explained by Salmin (2005), that if in a water that has an oxygen solubility content of 0 – 5 mg/L, then the waters are categorized as having a moderate level of pollution. Depth range values obtained from each station are 1.80 – 10.60 m. According to Setiobudiandi (1997) water depth will affect the number of species, individuals and biomass of macrozoobenthic organisms, besides that it can also affect the pattern of distribution or spread of macrozoobenthos. Macrozoobenthos that live in shallow areas have larger habitat characteristics, so they tend to have a variety of species, because the penetration of sunlight reaches the bottom in shallow waters. The depth of a waters is one of the factors that limit the brightness of the waters. The depth of a body of water is related to the abundance of macrozoobenthos, where an increase in water depth is followed by a decrease in the abundance of macrozoobenthos, whereas the abundance of macrozoobenthos is higher in shallow waters (Sulistiyarto, 2008). However, Station 1 and Station 2 are stations that have the lowest depth, and there are no macrozoobenthos, which is suspected to be polluted in the waters around these stations.

Current speed is very important to know the process of moving and mixing in waters such as micronutrients and suspended matter. Based on the research results, the average range of current velocity obtained at each station is in the range of 0.035 m/s - 0.179 m/s (Table 1). The lowest current speed is at station 2, while the highest current speed is at station 6. According to Mason (1991) States that waters that have currents > 1 m/s are categorized as very fast-flowing waters, current speeds > 0.5 – 1 m /sec is categorized as a fast current, a current speed of 0.25 – 0.5 m/sec is categorized as a slow current and a current speed <0.1 m/sec is categorized as a very slow current.

Sediment Texture

The results of data analysis using the Gradistat presented in (Table 3) show that at each station it is dominated by medium sand sediment types with sediment grain sizes ranging from 0.2733 – 0.4587 mm, but at Station 2 (the middle part of Losari Beach waters) to be precise At sub-station 2.3, the sediment type was coarse sand with a grain size of 0.5456 mm. Based on the Goworth scale, the size of 0.25 mm - 0.5 mm is included in medium sand, and the size of 0.5 mm - 1 mm is included in coarse sand.

The sediment texture at stations 1 to 4 is silt sediment, while stations 5 and 6 are sand sediments. Different sediment textures at each station will result in different types of macrozoobenthos found at the six observation stations. At station 3 only found 1 type of gastropod, station 4 found annelids, station 5 found annelids and Ophiuroidea, and station 6 found Crustacea, Gastropods, Oligochaeta and Ophiuroidea. According to Gholizadeh et al. (2012), stated that the texture of mud sediments was found in many macrozoobenthos of the polychaeta class, while in the sand substrate there were many gastropods. Sedimentary textures in the form of sand have a lower organic matter content than sedimentary textures in the form of clay or silt. Because the grain size of the sediment is able to bind the organic matter content in the waters. As stated by Nybakken (1988), which states that the existence of different basic substrates causes differences in the fauna or community structure of macrozoobenthos.

Table 3. Sediment Characteristics Based on Gradistat Analysis

Station	Repetition	Sediment Grain Size	
		Median (mm)	Sediment Type
1	1.1	0.2997	Medium sand
	1.2	0.3982	Medium sand
	1.3	0.3090	Medium sand
2	2.1	0.4587	Medium sand
	2.2	0.4475	Medium sand
	2.3	0.5459	Coarse sand
3	3.1	0.3456	Medium sand
	3.2	0.3442	Medium sand
	3.3	0.3707	Medium sand
4	4.1	0.2918	Medium sand
	4.2	0.2970	Medium sand
	4.3	0.3712	Medium sand
5	5.1	0.2966	Medium sand
	5.2	0.2733	Medium sand
	5.3	0.2862	Medium sand
6	6.1	0.3827	Medium sand
	6.2	0.3506	Medium sand
	6.3	0.2840	Medium sand

Relationship between Environmental Characteristics and Macrozoobentos Abundance

The relationship between environmental characteristics and the abundance of macrozoobenthos based on Principal Component Analysis (PCA) is presented in (Figure 5). The relationship between environmental characteristics and abundance of macrozoobenthos was only able to be explained 78.91% by using 2 main axes, namely the F1 and F2 axes which were formed into 3 groups of station distribution in analyzing the relationship between environmental characteristics and macrozoobenthos abundance. Environmental factors such as temperature, turbidity, salinity, depth, pH, DOM Sediment Flow Rate and DO can affect the presence of macrozoobenthos. The relationship between aquatic environmental characteristics and the abundance of macrozoobenthos can be seen in Figure 8.

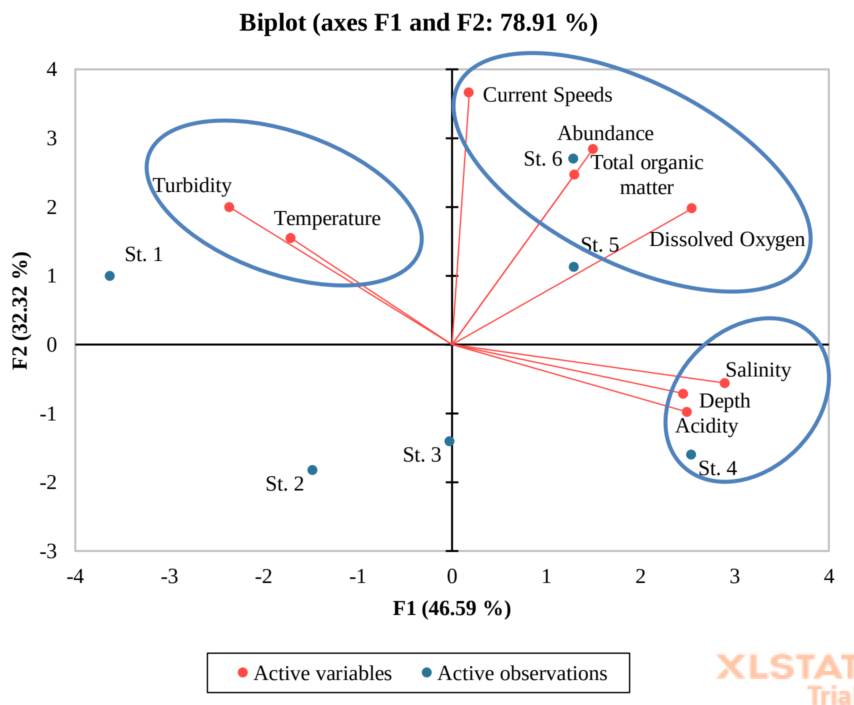

Figure 5. Relationship between Environmental Characteristics and Macrozoobenthos Abundance

Based on the results of the Main Component Analysis, Station 1 is characterized by the parameters of Turbidity and Temperature. At that station the temperature and turbidity values were high. The temperature value is at 32oC which exceeds the threshold. Lusianingsih (2011) states that the optimum temperature for macrozoobenthos life is in the range of 28°C – 31°C and is still within the tolerance limit for macrozoobenthos. The higher the temperature of a waters will result in a decrease in the diversity of species in a water (Bai'un, 2021). According to Rijaluddin (2016), high turbidity affects sunlight entering the water column which can inhibit primary production which affects water nutrients.

Station 4 is characterized by parameters of salinity, water depth and water pH. Salinity at this station is included in the high salinity category, according to Kinasih (2015) high salinity content will result in decreased levels of dissolved oxygen in the waters. According to Yuniar (2012) that the ideal salinity for the growth of macrozoobenthos biota is 26‰ – 37‰. According to Zahidin (2008), the depth of a water will affect the abundance and distribution of macrozoobenthos. The pH value of water plays an important role in the metabolism of macrozoobenthos. Previous research conducted by Bai'un (2021) explained that pH and macrozoobenthos have an inverse relationship where the higher the pH value in a waters, the greater the diversity of macrozoobenthos (low diversity) in a waters.

Stations 5 and 6 are characterized by parameters of current velocity, sediment total organic matter (DOM), oxygen solubility (DO) and abundance of macrozoobenthos. At this station, macrozoobenthos is more developed compared to other stations. At this station the current velocity obtained is included in the high category which allows movement and agitation in the waters such as micronutrients and suspended material so that macrozoobenthos get a high nutrient supply at both stations. According to Bai'un et.al (2021) high levels of oxygen solubility affect the high value of macrozoobenthos diversity and it is concluded that oxygen solubility can be a determining factor in a waters. According to Sanusi (2004) DO levels >5 mg/L are good DO levels for aquatic biota and the oxygen solubility value can be used as an indicator in describing the level of pollution that exists in an aquatic ecosystem. According to Nyabakken (1994), the solubility of oxygen is a chemical variable that has an important role as a limiting factor for the life of aquatic biota. Efendi (2003) added that the solubility of oxygen can come from the photosynthetic activity of aquatic plants and the diffusion of oxygen in the atmosphere. As long as DO is within the threshold, it will not affect the life of macrozoobenthos. The abundance of macrozoobenthos is influenced by the sediment present at the research station as obtained at both stations 5 and 6 which are the highest DOM values. According to Bai'un (2021) the high DOM value is due to the sediment in the form of medium-sized sand, which causes less organic matter to be contained and affects the food source of macrozoobenthos.

CONCLUSION

Macrozoobenthos diversity at the study site (waters around the Center Point of Indonesia) is low with a diversity index (H') value of 0.00 - 0.16. There were 4 macrozoobenthos classes found at the study site, namely the Gastropod Class (4 species), the Crustacea Class, the Ophiuroidea Class, and the Oligochaeta Class each with 1 species. The highest diversity and abundance of macrozoobenthos was found at Station 6 which is suspected because this station has a sandy sediment texture and sediment DOM content and high-water solubility oxygen concentrations which support the life of maczoobenthos at Station 6. Principal Component Analysis (PCA) results show that the abundance of macrozoobenthos is the highest. High levels at Station 5 and Station 6 are characterized by large current velocities, sediment DOM and high oxygen concentrations.

REFERENCES

Agrista, I. 2005. Makroinvertebrata sebagai Indikator Biologis Kualitas Air Sungai (Studi Di Sungai Brantas Kabupaten Malang). Malang: Universitas Muhammadiyah Malang.

Alimuddin, K. 2016. Keanekaragaman Makrozoobentos Epifauna Pada Perairan Pulau Lae-Lae, Makassar. Skripsi. Fakultas Sains Dan Teknologi. UIN Alauddin. Makassar.

Bai'un N. H., Indah, K., Yeni, M. & Sheila, Z,. 2021. Keanekaragaman Makrozoobentos Sebagai Indikator Kondisi Perairan Di Ekosistem Mangrove Pulau Pari, Kepulauan Seribu, Program Studi Ilmu Kelautan. Universitas Padjadjaran.

Bengen. D. G. 2004. Mengenal dan Memelihara Mangrove. Pusat Kajian Sumberdaya Pesisir dan Kelautan. IPB. Bogor.

Brower J, Jernold, Z, Von Ende, C. 1990. Filed and Laboratory Methode for General Ecology. Third Edition. USA:W. M. C. Brown Publisers.

Dimara, M. Baigo, H. John, H, K. Yunus, P. 2020. Analisis Ekologi dan Kelimpahan Ikan Karang Di Perairan Teluk Depapre. FMIPA Universitas Cenderawasih. Kota Jayapura.

Effendi, H. 2003. Telaah kualitas air bagi pengelola sumberdaya dan lingkungan perairan. Kanasius Press, Yogyakarta.

Fachrul, M. F. 2012. Metode Sampling Bioekologi. Jakarta: Bumi Aksara.

Gholizadeh M, Yahya, Talib A, Ahmad O. 2012. Effects of Enviromental Factors on Poluchaete Assemblage in Penang National Park, Malaysia. Word Academy of Science, Enggineering and Technology Journal 72:669-672.

Hawkes, H. A. 1978. River Zonation and Classification in River Ecology., ed. By. B. A. Whitton. Univ. California Press, 725 p.

Islami, M.M. 2012. Studi kepadatan dan keragaman moluska di pesisir pulau Nusalaut, Maluku. Oseanologi dan Limnologi di Indonesia, 38(3):293-305.

Indriyanto. 2010. Ekologi Hutan. Jakarta: Bumi Aksara.

Kementrian Lingkungan Hidup 2004. Keputusan Menteri Lingkungan Hidup Nomor 51 tentang Baku Mutu Air Laut.

Kinasih, P. W. Purnomo, Ruswahyuni. 2015. Analisis Hubungan Tekstur Sedimen Dengan Bahan Organik, Logam Berat (Pb dan Cd) Dan Makrozoobentos di Sungai Betahwalang, Demak. Fakultas Perikanan dan Ilmu Kelautan. Universitas Diponegoro. Indonesia.

Krebs, C. J. 1985. Experimental Analysis of Distribution of Abudance. Third Edition. New York: Haper & Row Publisher.

Lind, L. T. 1979. Hand Book of Common Method in Limnologis. Second Edition. The C.V. Mosby Company St. Louis, Toronto. London.

Lusianingsih, N. 2011. Keanekaragaman Makrozoobentos Di Sungai Bah Bolon Kabupaten Simamulung Sumatera Utara. Skripsi Biologi FMIPA Universitas Sumatera Utara. Medan.

Mason, C.F. 1991. Biology of Freshwater Pollution. Longman Group. Great Britain

Nasution, A. N, Wahyuningsih, H & Lesmana, I. 2017. Struktur Komunitas Makrozoobentos Di Zona Intertidal Desa Pintu Air Kabupaten Langkat Provinsi Sumatera Utara. Jurnal USU Vol. I, No. 1: 1-8.

Nybakken, J. W. 1994. Biologi Laut Suatu Pendekatan Ekologis. (E. H. Muhammad, Ed.). Jakarta: PT. Gramedia Pustaka.

Odum, E. P. 1996. Dasar-dasar Ekologi. Edisi Ketiga. Gajahmada University Press, Yogyakarta

Ompi M., Lumoindong. F, Undap. N, Papu. Adelfia, & Wagele. H. (2019). Monitoring Marine Heterobranchia in Lembeh Strait, North Sulawesi (Indonesia), In a Changing Enviroment. AACL Bioflux Vol 12, Issue 2.

Patty, S & N. Akbar. 2018. Kondisi Suhu, Salinitas, pH, dan Oksigen Terlarut di Perairan Terumbu Karang Ternate Tidore dan Sekitarnya, Loka Konservasi Biota Laut Bitung- LIPI, FPIK Universitas Khairun, Ternate. Jurnal Ilmu Kelautan Kepulauan Vol.1 (2).

Pratiwi, I. 2017. Karakteristik Parameter Fisika Kimia Pada Berbagai Aktivitas Antropogenik Hubungannya dengan Makrozoobentos di Perairan Pantai Kota Makassar. Fakultas Ilmu Kelautan dan Perikanan. Universitas Hasanuddin.

Rahman, N.A. 2019. Analisis keragaman fitoplankton di Perairan sekitar area reklamasi Pantai Losari Kota Makassar. Skripsi. Departemen Ilmu Kelautan. FakultasIlmu Kelautan dan Perikanan Universitas Hasanuddin. Makassar

Rahmawati. 2014. Analisis tingkat pencemaran bedasarkan indeks keragaman populasi Gastropoda di bagian tengah sungai Tambak Bayan Yogyakarta. jurnal penelitian Yogyakarta : UIN Sunan Kalijaga.

Salmin. 2005. Oksigen Terlarut (DO) dan Kebutuhan Oksigen Biologi (BOD) sebagai Salah Satu Indikator untuk Menentukan Kualitas Perairan. Oseana, 30: 21-26.

Sanusi, HS. 2004. Karakteristik Kimiawi dan Kesuburan Perairan Teluk Pelabuhan Ratu Pada Musim Barat dan Timur. Jurnal Ilmu-ilmu Perairan dan Perikanan Indonesia. Vol 11(2):93-100.

Satyawan, N. M. Dan Atriningrum, N. T. 2019. Kondisi Eksisting Fauna Megabenthos di Perairan Labuhan Pandan Lombok Timur Pasca Gempa Bumi Lombok 7.0 Skala Ritcher. Jurnal Biologi Tropis. 19(2): 172-179.

Setyobudiandi. I. 1997. Makrozoobenthos (Definisi, Pengambilan Contoh dan Penanganannya). Laporan Penelitian. Laboratorium Manajemen

Siegers, W.H. 2013. Kondisi Ekologi Makrobentos Pada Ekosistem Mangrove Dan Laut Desa Hanura, Kecamatan Padang Cermin, Provinsi Lampung. Tesis. Sekolah Pascasarjana. Institut Pertanian Bogor. Bogor.

Sinyo, Y & Idris, J. 2013. Studi Kepadatan Dan Keanekaragaman Jenis Organisme Bentos Pada Daerah Padang Lamun Di Perairan Pantai Kelurahan Kastela Kecamatan Pulau Ternate. Jurnal Bioedukasi Vol. 2, No. 1: 154-162.

Sugiarto, Ari, Verina, F.O, Aprilia, V. 2017. Identifikasi Jenis-Jenis Makrozoobentos Yang Terdapat di Sungai Gasing. Kecamatan Gasing. Kabupaten Banyuasin. Sumatera Selatan. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Sriwijaya. Palembang.

Sulistiyarto, B. 2008. Keterkaitan Antara Kelimpahan Makrozoobentos dengan Parameter Fisika Kimia Air di Danau Hanjalantung Palangka Raya Kalimantan Tengah. Fakultas Perikanan. Universitas Kristen Palangka Raya. Kalimantan Tengah.

Widiadmoko, W. 2013. Pemantauan Kualitas Air Secara Fisika dan Kimia di Perairan Teluk Hurun. Balai Besar Pengembangan Budidaya Laut (BBPBL) Lampung. Politeknik Negeri Lampung. Bandar Lampung.

Yuniar, A.S. 2012. Struktur Komunitas Makrozoobenthos di Perairan Morosari Kecamatan Sayung, Kabupaten Demak. Journal of Marine Research. Universitas Diponegoro, Semarang, 1(2):253-242.

Zahidin, M. 2008. Kajian Kualitas Air Di Muara Sungai Pekalongan Ditinjau dari Indeks Keanekaragaman Makrozoobentos dan Indeks Saprobitas Plankton. [Tesis]. Program Pascasarjana. Universitas Diponegoro. Semarang.