Makrozoobenthos Community as Bioindicator in River Belawan

Mayang Sari Yeanny*[1] and Ternala Alexander Barus[1]
[1] *Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Indonesia, , Jl. Bioteknologi No.1 Padang Bulan, Medan, North Sumatera, Indonesia 20155, Telephone 062-61-8211050, 062-61-*

Keywords: Makrozoobenthos, Bioindicator, Belawan River.

Abstract: Belawan River is very important for the residents of Medan and its surroundings. It serves as the main raw material for the local drinking water company, as well domestic, industrial, hotel and tourism. Many human activities had led to the declining condition of water in the river throughout the year. One way to approach the concept of bioindicator is by knowing Density, Relative Density, Frequency of Attendance, equitability, and diversity of the Makrozoobenthos itself. Results indicated that the Makrozoobenthos community were from 9 genera. Makrozoobenthos individual density was around 3,703 to 629,62 ind/m2. The diversity index was around 0 to 0,69, which is considered to have low to high pollution level. Equitability Index was approaching 0, with relatively high domination from Polymesoda erosa. The water quality that influences the diversity of Makrozoobenthos as bioindicator was light penetrationThe abstract should summarize the contents of the paper and should contain at least 70 and at most 200 words. It should be set in 9-point font size, justified and should have a hanging indent of 2-centimenter. There should be a space before of 12-point and after of 30-point.

1 INTRODUCTION

Belawan River is an important river for the people of Medan and its surroundings. Its flow passes through human residence, industries, PLTU, PDAM and aquaculture. With those activities around, waste water is often directly discharged into the water body, and thus can cause a negative impact to the aquatic environment. The utilization of the river itself as a waste water disposal site can cause changes in environmental factors that will be bad for the life of its biota. The quality change in water can greatly affect the life of the biota living in it.(Yeanny, 2018) Biota in Belawan River, such as makrozoobenthos, can be used as environmental bioindicator. By this nature, environmental changes can heavily affect the density and diversity of aquatic biota. This Density and diversity itself is highly dependent on their tolerance and sensitivity to environmental change. (Rudiyanti, 2009)

The aquatic organisms such as makrozoobenthos as a water bioindicator has several advantages, such as (1) providing relevant information of existing water quality conditions and can be done in an easy and relatively short time; (2) provide important information, not only on pollution caused by waste water in aquatic environment, but also to complete the special factor, that is, the change of organism's life structure as a result of the existence of various organisms in the water; (3) provides an overview of self purification in anaerobic or aerobic circumstances and may recognize toxic effects on the structure of the existing organisms; And (4) provide an overview of the state of water quality over a relatively long period of time, despite periodic changes. Thus, it is necessary to conduct a research entitled makrozoobenthos community as bioindicator in belawan river.

This study aims to see the makrozoobenthos community as a bioindicator of the quality of belawan river waters with various approaches, namely:

(a) to know the structure of the makrozoobenthos community includeing density, diversity, equitability and dominance of makrozoobenthos .

(b) to know the water pollution by using makrozoobenthos as bioindicator.

(c) the relationship between makrozoobenthos and water quality.

Yeanny, M. and Barus, T.
Makrozoobenthos Community as Bioindicator in River Belawan.
DOI: 10.5220/0010094810211026
In *Proceedings of the International Conference of Science, Technology, Engineering, Environmental and Ramification Researches (ICOSTEERR 2018) - Research in Industry 4.0*, pages 1021-1026
ISBN: 978-989-758-449-7

2 RESEARCH METHODS

2.1 Materials and Method

The Research was conducted in Maret – Oktober 2018. Five sample locations were picked based on the difference of community activities with 3 repetition, from upstream to estuary site of Belawan river

Station I	Salam Tani Village, Pancur Batu Sub-district, Deli Serdang District	No activity/ Upstream Control
Station II	Sunggal kanan Village , Sunggal Sub-district, Deli serdang District	Habitation, domestic
Station III	Kampung Lalang Village, Sunggal Sub-district, Deli Serdang District	Market, Hotel
Station IV	Kelambir Village, Hamparan Perak Sub-district, Deli Serdang District .	Soy industries, Paper industries
Station V	Sicanang Village, Medan Belawan Sub-district, Medan Belawan City .	Downstream (estuary)

2.2 Water Quality Sampling

From the measured water quality can be seen in the following table:

No	Water Quality	Instruments	Measurement Location
1.	Temperature	Termometer	Insitu
2.	Light Penetration	Secchi disk	Insitu
3.	Light Intensity	Luxmeter	Insitu
4.	Stream velocity (s/m)	Stopwatch	Insitu
5.	Depth (m)	Meter	Insitu
6.	pH	pHmeter	Insitu
7.	DO	Winkler method	Insitu
8.	BOD	Winkler incubation method	Laboratory

2.3 Benthic Sample Collection

Makrozoobenthos samples was taken from five (5) determined location based on the local community activities from upstream to downstream. Purposive random sampling method was used in order to collect the makrozoobenthos samples. Subsequently, sample collection was conducted using suber net on each sampling point. The collected makrozoobenthos samples are then put in a plastic bag and preserved using 4% formalin before putting label on the plastic bag. In the laboratory, samples were cleaned from formalin and soaked in clean water for about one day and night, and put in a bottle containing 70 % alcohol afterwards. Identification is then done afterwards using identification book Edmonson (1963), Pennak (1978), Streble and Krauter (1988).

2.4 Data Analysis

Data analysis for water quality such as temperature, light penetration and intensity, depth, pH, DO, BOD_5, makrozoobenthos are done using standard method APHA, (2005).

(1) Density (K)

$$K = \frac{a}{b} \quad (1)$$

K=density
a=thenumberofmakrozoobentos(individual)
b= area of plots

(2) Relative Density (KR) (2)

$$KR = \frac{ni}{\sum N} x100\%$$

ni = the number of individuals of a kind
ΣN = total of all individuals

(3) Frequency of Attendance (FK)

$$FK = \frac{\text{The number of plots is occupied by a type}}{\text{Total number of plots}} \times 100 \quad (3)$$

FK = 0-25. (Very rarely)
25-50. (Rarely)
50-75. (Many)
> 75. (Very much)

Table 1: Water Quality in Belawan River.

No.	Parameter	Station I	Station II	Station III	Station IV	Station V
1.	Temperature (^{o}C)	27	28	28	28	30
2.	Light Penetration (m)	3,31	6,11	4,26	4,35	5,35
3.	Light Intensity (Cd)	870	330	260	320	510
4.	Flow velocity (s/m)	2,7	5,9	1,7	1,6	3,6
5.	Depth (m)	0,9	1,1	1,2	1,1	1,4
6.	pH	4,0	3,0	4,0	4,0	7,6
7.	DO (mg/L)	5,3	4,4	3,8	3,8	5,2
8.	BOD_5 (mg/L)	2,2	2,3	1,3	2,6	4,0

(4) The Shannon-Wiener Diversity Index (H ')

$$H' = -\sum_{i=1}^{S} pi \ln pi \quad (4)$$

H '= Shannon-Wiener diversity index

2.5 Water Quality Relationship with Makrozoobenthos

Water quality such as temperature, penetration of light, light intensity, flow rate, Depth, pH, DO, BOD, COD were statistically tested and analyzed to observe its relationship with Makrozoobenthos using SPSS correlation analysis Ver. 22 in order to see the current pollution level of the river.

3 RESULTS AND DISCUSSION

3.1 Water Quality of Belawan River

The result of water quality of Belawan River can be seen on the table 1 below. Table 1 that the water temperature in the five stations ranges from 27-30 ^{0} C, with the highest temperature at station V which estuary with overall the temperature is relatively the same. Light penetration was ranged from 3,31 – 6,11 m with the highest light penetration on station II, which was caused by the open area of station II (less plants were grown), make the light easier to penetrate into water body. Light intensity was ranging from 320 – 870 Candela with the highest on station I. This is caused by the light ability to be absorbed was relatively high.

Flow velocity was ranged from 0,9 – 1,4 s/m with the highest on stasion V, the flow velocity is relatively the same. pH was ranging from 6.6 – 7.6 with the highest pH on station V (downstream). Dissolved oxygen (DO) was ranging from 3,8 – 5,3 mg / L with the highest on station I, which was caused by the environmental condition that supports photosynthesis which provides much oxygen in the water body. Biological Oxygen Demand (BOD5) was ranging from 1,3 – 4,0 mg/L with the highest BOD5 at station III which was a highly populated residential area that produced domestic waste in the form of organic materials in which the oxygen in the water was used by microorganisms to decompose the organic material.

Table 2: Density Value (K) (ind / m2), Relative Density (KR) (%) and Frequency of Attendance (FK) (%) Makrozoobenthos at Belawan River at Station I and II.

No.	Genera	Stasiun I			Stasiun II		
		K (ind/m^2)	KR (%)	FK (%)	K (ind/m^2)	KR (%)	FK (%)
1.	Paguroide	-	-	-	-	-	-
2.	Scylla sp	-	-	-	-	-	-
3.	Macrobrachium sp	-	-	-	3,703	2,22	33,33
4.	Hirudo	-	-	-	-	-	-
5.	Baetidae	25,92	25,92	66,67	-	-	-
6.	Polymesoda erosa	-	-	-	-	-	-
7.	Gerris remigis	70,37	70,37	100	159,25	95.55	100
8.	Fillopaludina javanica	-	-	-	-	-	-
9.	Melanoides sp	3,703	3,70	33,33	3,703	2,22	33,33
	Jumlah	99,993	100		166,656	100	

Table 3: Density Value (K) (ind / m2), Relative Density (Cr) (%) and Frequency of Attendance (Fk) (%) Makrozoobenthos at Belawan River at Station III, IV and V.

No.	Genera	Stasiun III			Stasiun IV			Stasiun V		
		K (ind/m^2)	KR (%)	FK (%)	K (ind/m^2)	KR (%)	FK (%)	K (ind/m^2)	KR (%)	FK (%)
1.	Paguroide	-	-	-	-	-	-	140,74	97,43	100
2.	Scylla sp	-	-	-	-	-	-	3,703	2,5	33,33
3.	Macrobrachium sp	-	-	-	-	-	-	-	-	-
4.	Hirudo	-	-	-	3,703	0,57	33,33	-	-	-
5.	Baetidae	-	-	-	-	-	-	-	-	-
6.	Polymesoda erosa	-	-	-	629,62	98,26	100	-	-	-
7.	Gerris remigis	-	-	-	-	-	-	-	-	-
8.	Fillopaludina javanica	18,51	100	66,67	-	-	-	-	-	-
9.	Melanoides sp	-	-	-	7,407	1,15	33,33	-	-	-
	Jumlah	18,51	100		640,73	100		144,443	100	

3.2 Density Value (K) (ind / m2), Relative Density (Cr) (%) and Frequency of Attendance (Fk) (%) Makrozoobenthos in Belawan River

Results of the Density Value (K) (ind / m2), Relative Density (Cr) (%) and Frequency of Attendance (Fk) (%) Makrozoobenthos in Belawan River are shown in Table 2 and 3.

Table 2 and 3 that *Polymesoda erosa* at station IV were found to have the highest density value, relative density and attendance frequency with 629,62 ind / m^2 (K), 98,26 (KR) and 100% (FK), while the lowest were found in genera *Melanoides Sp* at Station I, *Macrobrachium sp* dan *Melanoides Sp* (Station II) , *Hirudo* (Station IV), and *Scylla sp* (Station V) with density value of 3,703 ind/m^2

3.3 Value of Diversity (H') and Equitability (E) in Belawan River

The research conducted, the value of diversity (H') and equitability (E) in Belawan river were as follows:

Table 4: Diversity Values (H') and Equitability of makrozoobenthos (E) in Belawan river

St I	St II	St III	St IV	St V
0.69	0,18	0	0,07	0,09
0,63	0,16	0	0,06	0,13

Table 4 that the highest value of diversity (H') was found from station I, with 0,69 while the lowest was from station III with 0. The diversity of makrozoobenthos in the 5 stations was low. According to Kreb (1985), low diversity is when 0 < (H') <2,302, medium diversity is when 2,302 < (H') <6.907, and high diversity is when (H')> 6.907. The diversity value of stations 1 - 5 classified as heavily polluted. The water in the river is said to be heavily polluted if (H') <1, moderately polluted if (H') is between 1.0 to 1, 5, while lightly contaminated when (H')> 2.0. The equitability (E) value ranges from 0 to 0.63 with the highest equitability found at station I, with the lowest at station III. According to Kreb (1985) the uniformity value (E) ranges from 0 to 1, where value close to 0 means that equitability is low due to the dominant species like *Polymesoda erosa*. This means the number of individuals on the type is not equally and evenly distributed. (Krebs, 1985)

3.4 Correlation Analysis Value

Correlation value was obtained based on the measurement of the water quality parameters correlated with the value of diversity (Shannon-Wiener Diversity) as in Table 5 below:

Table 5: The Correlated Analysis Value obtained between water quality parameters and Makrozoobenthos diversity

No	Parameters	Diversity (H')
1.	Temperature (° C)	-0,588
2.	Light Penetration (cm)	+0,967
3.	Light Intensity (Cd)	-0,539
4.	Flow Rate (sec / m)	+0,202
5.	Depth	-0,753
6.	pH	-0,198
7.	DO (mg/L)	+0,677
8.	BOD_5 (mg/L)	-0,074

From Table 5 it can be seen that Light Penetration affects the diversity of makrozoobenthos as bioindicator. The obtained Light Penetration during the study ranged from 331 to 661 m, this value of was far from the needs of aquatic organisms and partly enough to support the needs of makrozoobenthos. Rudiyanti (2009) in which means that Light Penetration has a very strong relationship to the diversity of makrozoobenthos.

4 CONCLUSION

The research conducted on the makrozoobenthos community as bioindicator in river Belawan, it can be concluded that:

Makrozoobenthos obtained as many as 9 genera.The highest density of makrozoobenthos was in the genera of *Polymesoda erosa* with density value of 629,62 ind / m2 (K) at station V. The highest value of diversity (H') at station I is 0,69 and the lowest at station III is 0. The diversity of Makrozoobenthos in 5 stations was relatively low. The highest equitability (E) value was at station I is 0.69 and the lowest was at station III with 0. The overall equitability was low. The level of pollution based on the value of I-V station diversity was classified as lightly polluted. Makrozoobenthos dominating the observed area of study was *Polymesoda erosa*. The water quality that influences the diversity of makrozobentos as bioindicator was light penetration.

ACKNOWLEDGEMENTS

This research can be successfully conducted with the assistance and contribution from many parties. The author acknowledges the parties contributed in this research, particularly on the research program non PNBP USU 2018 which funded this research.

REFERENCES

[APHA] American Public Health Association (2005) Standard Methods For the Examination of Water and Wastewater. Amer. Publ. 17th Edition. New York Health Association.

Edmonson WT., 1963. Fresh Water Biology. Second Edition. Jhon Willey & Sons, inc., New York.pp. 274-285.

Krebs, Charles J., 1985. Ecology, the experimental analysis of distribution and abundance, 3rd edition. Harper & Row, New York.

Pennak RW., 1978 Fresh-water Invertebrates of the United States. 2nd Edition. New York: John Wiley & Sons.

Streble H, and Krauter, D., 1988. Das Leben im Wassertropfen: Mikroflora und Mikrofauna des

Sὐβwassers. Ein Bestimmungsbuch. Franckh-Kosmos Verlag GmbH, Stuttgart.

Rudiyanti S., 2009. Water Quality of Banger River Pekalongan Based on Biological Indicators. Journal of Saintek Fisheries. 4(2): 46-52.

Yeanny, M.S., 2018. Phytoplankton community as bioindicator of fertility in belawan river. IOP Conference Series: Earth and Environmental Science 130 (1), 012030