Diversity, Abundance, Uniform and Dominance of Plantones in the Batu Bumbun Reservat Kutai Kartanegara Regency

Sus Trimurti, Lariman

Biology, Faculty of Mathematics and Natural Sciences, Mulawarman University, Jl. Barong Tongkok No.4 Gunung Kelua, Samarinda, East Kalimantan

Abstract: **The research activity on the Diversity, Abundance, Uniformity, and Dominance of Plankton in the Batu Bumbun Reservat aims to determine the potential of plankton as natural food for fish in a waters that serves as a fishery reserve. Batu Bumbun Reservation is a freshwater reserve that is used as a fishery reserve, located in Muara Muntai District which borders on the bay (Ulak Banda), namely from Muara Tawar, Sungai Tawar and its surroundings to Lake Batu Bumbun, from Muara Sungai Muntai, Labak Beto to Tanjung Kemujan, Keluang river and its surroundings. The total area of the location is about 450 Ha. The methodology used is the survey method. Research activities are carried out from February to April 2021 for sampling and analysis in the laboratory. Water environment data includes data on physical, chemical and biological parameters. Physical parameters measured are: temperature, brightness, and depth. Chemical parameters to be taken are: pH, DO, and Alkalinity. The biological parameter to be taken is plankton. The results of the research on Plankton found in the Batu Bumbun reserve are 64 species which are divided into 10 classes consisting of 6 classes of phytoplankton, namely: Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenaceae, Myxophyceae and Xanthophyceae and 4 classes of zoo plankton, namely: Crustacea, Ciliata, Lobosa and Monogononta. The total value of plankton abundance obtained during the study at station 1 was 56,852 individuals/liter, station 2 was 38,552 individuals/liter and station 3 was 54,107 individuals/liter. The highest diversity index value (H') is found at station 1 of 3.4376 and the lowest diversity index value (H') is at station 2 of 2.8585. The range of diversity index (H') at 3 stations ranged from 2.8585 to 3.4376 which was classified as good and stable diversity. The highest uniformity index value (E) is at station 3 of 0.9152 and the lowest uniformity value (E) is at station 2 of 0.7916. The range of the uniformity index (E) at the 3 stations ranged from 0.7916 to 0.9152 so that at the 3 stations the distribution of individuals was fairly even at each station. The value of the dominance index (D') at the 3 stations ranged from 0.0399 to 0.1100 which indicated that the number of individuals for each species was almost the same and that there were no species that dominated other species or in other words the community structure was in a stable condition.This condition is very important considering Batu Bumbun is a fishery reserve that must provide fish as an economic source for the surrounding community and as a source of food for protected mammals, namely the Mahakam Pesut (Orcaellabrevirostris).**

Key words**: Diversity, Abundance, Uniformity, Dominance, Plankton, Reservat**

I. INTRODUCTION

In general terms, a fishery reserve or sanctuary is a protected part of the waters, so it is prohibited to carry out fishing activities and other activities that can damage the environment (Directorate of Bina SumberHayati, 1993). The broad definition of a reserve is a public water area that is protected in a limited manner with a function as a buffer for an aquatic ecosystem that is considered critical and its sustainability threatened or its habitat for fish resources (endemic species).

The fishery reserve will function as a water body where the fish community can carry out its life cycle, so that the water body can supply fish seeds and broodstock to the surrounding fishing grounds, can preserve the fish germplasm in it, can maintain the beauty and authenticity of the environment, and can maintain its authenticity and evolutionary process (Sarnita, 2000). Furthermore, it is hoped that fishery reserves can restore the carrying capacity of water bodies, so that fishery reserves can achieve benefits and balance the benefits of fishermen and the surrounding community (Anonymous, 1985). To achieve and ensure the sustainability of fish populations, fishery reserves should meet several criteria or requirements for habitat and water quality (physical, chemical, and biological properties). Reservat water quality parameters will support the productivity of the reservoir waters. Therefore, during the rainy and dry seasons, the water quality parameters must be good, so that it can support the life of fish in the reserve.

Batu Bumbun Reservation is located in Muara Muntai District which is bordered by the bay (Ulak Banda) namely from Muara Tawar, Sungai Tawar and its surroundings to Lake Batu Bumbun, from Muara Sungai Muntai, LabakBeto to TanjungKemujan, the Keluang river and its surroundings. The total area of the location is about 450 Ha.

The head of the Regional Environmental Impact Management Agency (Bapedalda) of KutaiKartanegara Regency reported that deforestation had damaged the lake's environment. "Thus, the nine lakes that were used as a reservation in KutaiKartanegara are lost because their boundaries, such as trees or grasses, are no longer there. He also stated that the existence of lakes around the Mahakam River is increasingly threatened with permits to open dozens of plantation projects.

"There are at least 26 oil palm plantation projects that have obtained permits for land clearing around Kota Bangun." In addition, the issuance of mining permits in the Gunung Bayan area, which is located upstream of the Mahakam River, is also increasingly threatening the existence the main lakes in the upper Mahakam River, including the reservoir lake (Sayekti, 2004).

The damage to the ecosystem of the fish reserve area has resulted in decreasing fishery potential. In the 1970s the average annual catch of fish from Semayang and Melintang Lakes reached 25,000 to 35,000 tons. In 1993, the average catch of fish from Semayang and Melintang Lakes was 5,139.7 tons/year, even in 2004 the average catch of fish was only 750 tons/year (BPDAS, 2010).

A watershed (DAS) is a complex megasystem built on physical systems, biological systems and human systems. Each system and its sub-systems interact with each other. In this process the role of each component and the relationship between components will determine the quality of the watershed ecosystem. Each of these components has a unique nature and its existence does not stand alone, but is related to other components to form a unified ecological system (ecosystem). Disturbances to one component of the ecosystem will be felt by other components with a chain impact nature. The balance of the ecosystem will be guaranteed if the condition of the reciprocal relationship between components goes well and optimally (Kartodihardjo 2008).

In addition, the watershed has a variety of living aquatic organisms that play an important role in maintaining the balance of the food chain, one of which is plankton (Barus, 2002). Plankton is a group of microscopic aquatic living organisms, usually moving slightly or against or following the current (Wibisono, 2005). Phytoplankton and zooplankton are natural food for fish. The food eaten by the larvae is certainly related to its availability in the waters (Effendie, 2002). Fish reserves will have high fishery productivity if the abundance of plankton in the waters of the reservation is also high.

II. METHODOLOGY

Location of Research on Batu Bumbun Reservation, Kutai Kartanegara Regency. Research activities are carried out from February to April 2021 for sampling and analysis in the laboratory. The sampling station was determined based on the characteristics of the Batu Bumbun reservation habitat type with 3 sampling stations assigned. Aquatic environmental data includes data on physical, chemical and biological parameters, samples were analyzed using the manual proposed by APHA (1981). Physical parameters measured are: temperature, brightness, and depth. Chemical parameters to be taken are: pH, DO, and Alkalinity. The biological parameter to be taken is plankton.

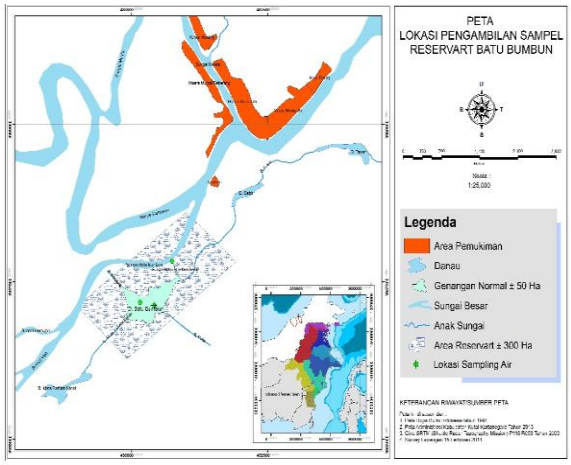

Figure 1: Map of Batubumbun Reservation Location in Kutai Kartanegara Regency, East Kalimantan

III. TOOLS AND MATERIALS

3.1. Tools include:

The tools needed are as follows: boat, life-jacket, water checker, secchi disc, transparent or bright bottle, stationery, GPS (Global Positioning System), digital camera, plankton net no. 25, bucket, sprayer, sample bottle, dropper, label paper, meter, microscope, cover-glass, object glass, plankton identification book, calculator, tissue paper.

3.2. Materials include:

The materials needed are as follows: plankton sample, 4% formalin, aquadest, river water.

Table 1 Methods of Measurement of Physical, Chemical, and Biological Parameters

No.	Parameter	Unit	Measurement Method	Description
A	PHYSICS			
1	Temperature	^{0}C	*Water Checker*	Insitu
2	Brightness	Cm	*Secchidisc*	Insitu
3	Depth	Cm	*Secchidisc*	Insitu
B	CHEMICAL			
1	pH		*Water Checker*	Insitu
2	DissolvedOxygen(DO)	Mg/L	*Water Checker*	Insitu
3	Salinity	‰ $^0/_{00}$	*Water Checker*	Insitu
C	BIOLOGy			
1	Plankton	Ind/L	Binocular Microscope	Laboratory

3.3. Data Analysis Techniques

3.31. Species Diversity Index (H')

Calculation of species diversity is carried out using the Shannon-Wiener (H') formulation (Barus, 2002), namely:

Information:

H' = Species Diversity Index

S = Many types

Pi = ni/N

ni = Number of Individuals of Type-i

N = Total number of individuals

Where:

H' < 1: Low diversity, low individual distribution of each speciesand low community stability (polluted water)

1≤ H'≤ 3: Moderate diversity, moderate individual distribution of each species and moderate community stability (moderate and sufficient water)

H' > 3: High diversity, high individual distribution of each species and high community stability (clean and stable water) (Sutjianto, 2003).

3.3.2 Abundance of Individual Plankton (N)

If all types of plankton have been known and the number of each species observed, then the data is calculated for the number of individuals of each type using the formula:

$$N = \frac{T}{L} \times \frac{P}{p} \times \frac{V}{v} \times \frac{1}{w}$$

Information:

N = Number of plankton cells (cells/liter)

T = Area of the cover box/cover glass ----20 x 20 mm = 400 mm2

L = Area of one field of view (mm2)---2.6067 mm2

P = Number of observed plankton cells

p = Number of boxes/ replicates observed---- 20 observations

V = Volume of plankton concentrate in sample bottle (ml)---- 20 ml

v = Volume of plankton concentrate in Cover glass----0.05 ml

w = Volume of filtered pond water with plankton net(liters)---- 50 liters(Sutjianto, 2003).

3.3.3. The uniformity index (Odum, 1993), is calculated by comparing the diversity index (H') with its maximum value (H'max):

E = H'

H'maks

Where:

H' max = Maximum diversity value (log2 S)

E = uniformity index

H' = Diversity index value

s = total number of species

With criteria:

E ~ 0 = There is species dominance

E ~ 1 = The number of individuals of each species is the same

From this comparison, a value that is between 0 and 1. The smaller the value of E indicates the smaller the uniformity of the species population. The greater the value of E, indicating the uniformity of the population, that is, if the number of individuals of each species can be said to be the same or not much different

3.3.4. Dominance Index (Simpson) (D')

According to Odum in Fachrul (2007), the Simpson index can be used to determine the dominance of certain species in the waters. The equation is as follows:

$$C = \sum_{i=1}^{s} \left(\frac{ni}{N}\right)^2$$

i=1

Information:

D = Simpson's Dominance Index

ni = Number of Individuals of the i-th type

N = Total number of individuals

S = Number of genera

Where:

Dominance Index between 0-1

D = 0, means that there is no species that dominates other species or the community structure is in a stable state.

D = 1, it means that there are species that dominate other species or the community structure is unstable, due to ecological pressure (stress).

IV. RESULTS AND DISCUSSION

To determine the condition of the waters, several parameters of water quality were measured, including the physical and chemical properties of the waters. Measurement results obtained from three different stations at the time of research and sampling of plankton.

4.1. Temperature (0C)

Based on the results of measurements that have been made during the study, the average temperature obtained (morning and afternoon) at 3 stations, the water temperature of the Batu Bumbun reservoir ranges from 24,490C - 29,180C. The temperature at station 1 in the morning ranges from 24.610C - 25.09 0C and for the day it ranges from 25.610C - 27.940C, at station 2 in the morning it ranges from 24,490C - 26,770C and during the day it ranges from 25,100C - 27.940C and at station 3 in the morning it ranges from 24,670C - 27,780C and during the day it ranges between 25,100C - 29,180C.

Judging from the temperature range obtained at each station, it shows that the general temperature range for waters and for the growth of aquatic biota is quite good. According to Isnensetyo&Kurniastuti (1995), the optimal temperature for phytoplankton growth ranges from 200C - 400C, while for zooplankton growth it ranges from 250C - 300C.

4.2. Brightness and Water Depth (cm)

Based on the results of measurements that have been carried out at each station (morning and afternoon), namely: station 1 brightness in the morning can range from 12 - 32 cm and depth ranges from 120 - 450 cm, station 2 brightness in the morning ranges from between 11 - 30 cm and the depth ranges from 150 - 500 cm and station 3 brightness in the morning ranges from 13 - 50 cm and the depth ranges from 60 - 165 cm. while for measurements made during the day, namely: station 1 brightness ranging from 13 - 30 cm and depth ranging from 120 - 435 cm, station 2 brightness ranging from 12 - 31 cm and depth ranging from 145 - 450 cm and station 3 brightness ranging from 15 - 50 cm and the depth ranges from 50 - 155 cm.

From the observations that have been made at each station, it is found that the highest level of brightness is found at station 3 with a brightness ranging from 13 - 50 cm and the lowest is at station 2 with a brightness ranging from 11 - 30 cm. Meanwhile, for the deepest level of Batu Bumbun reservoir water, it is found at station 2 ranging from 120 - 250 cm and the lowest is at station 3 ranging from 50 to 150 cm. The high level of brightness is thought to be caused by the absence of activity or the lack of organic waste material in the waters and also due to the entry of direct sunlight without any obstructions so that the light goes directly to the surface and penetrates into the river water body. According to Odum (1994), light penetration is often hindered by substances dissolved in water, limiting the photosynthetic zone where aquatic habitats are limited by depth. In addition, differences in brightness can occur when measurements are made, there are differences in weather conditions such as sunny, hot or cloudy weather.

4.3. Degree of Acidity (pH)

The degree of acidity (pH) is one of the most important parameters for monitoring water quality. Based on observations made at 3 stations in the morning and afternoon, the pH value of the Batu Bumbun reservoir water ranged from 4.85 - 6.15 and 6.13 - 6.74. Based on the results of observations that have been made at 3 stations, each station has a different pH, namely: at station 1 in the morning it ranges from 4.85 - 6.15 and for the afternoon it ranges from 6 - 7.42, at station 2 in the morning it ranges from 6.13 - 6.82 and in the afternoon it ranges between 6 - 6.74 and station 3 in the morning it ranges between 5.33 - 6.05 and in the afternoon it ranges between 6.33 - 7.12.

From the measurement results obtained, it can be concluded that the reservation conditions generally have varying degrees of acidity (pH). However, the overall condition of the waters is stable, although some are in acidic conditions. This is presumably due to environmental changes that occur in the waters as well as the increase in organic matter that releases CO2 which undergoes the decomposition process and the water conditions at the time of measurement are different. However, the water conditions of each station are still very supportive of aquatic biota to be able to breed

According to Kristanto's opinion in Siregar (2009), which states that the pH value of normal water is around neutral, namely 6-8, while the pH of polluted water, such as waste water, varies depending on the type of waste. Fresh water from the mountains usually has a higher pH. The longer the pH of the water will decrease towards an acidic condition. This happens because of the increase in organic materials that liberate CO2 if it undergoes a decay process.

4.4. Dissolved Oxygen (DO) (mg/l)

Based on the results of observations that have been made in two different conditions (morning and afternoon) during the study at each station, a different range of values was obtained between stations. The dissolved oxygen value of Batu Bumbun reservoir in the morning ranged from 3.15 mg/l - 6.15 mg/l, while during the day it ranged from 5.33 mg/l - 7.15 mg/l. At station 1 the dissolved oxygen value ranges from 4.15 mg/l - 8.15 mg/l, at station 2 the dissolved oxygen value ranges from 4.15 mg/l - 6.98 mg/l and for station 3 in the morning ranged from 3.15 mg/l - 5.97 mg/l and during the day ranged from 4.50 mg/l - 8.66 mg/l.

From the observations, it was found that the dissolved oxygen level in the morning tends to be lower than in the afternoon. It is suspected that in the morning conditions the organisms in the waters of the Batu Bumbun reservation, especially plankton, especially phytoplankton, are not optimal in carrying out the photosynthesis process to produce oxygen because in the morning the sun's position is not optimal so that sunlight is needed to help the process. photosynthesis reaches the waters so that the oxygen produced is still low. Meanwhile, during the day it tends to be higher, this is presumably because phytoplankton and aquatic plants can carry out photosynthesis optimally so as to produce more oxygen (O2).

According to Sastrawijaya in Siregar (2009), states that dissolved oxygen depends on: temperature, the presence of photosynthetic plants, the level of light penetration which depends on the depth and turbidity of the water, the loudness of the water flow, the amount of organic matter described in the water such as waste, dead algae or algae. industrial waste. Further explained according to Edi in Hasanah (2008), that to be able to just live a minimum of 1 mg/l dissolved oxygen is needed, but to be active and grow and develop a minimum dissolved oxygen level of around 3 mg/l is required. In addition, phytoplankton also helps increase dissolved oxygen levels in the surface layer during the day. This addition is caused by the release of oxygen as a result of photosynthesis (Hutabarat& Evans, (1984).

4.5. Salinity (0/00)

Based on the results obtained in the measurements during the study that of the three stations located in the Batu Bumbun reservation, it is still very good for the life of the aquatic biota contained in it because the results obtained all have a salinity value of 0. According to Barus (2002), that freshwater ecosystems are generally limnic nature such as rivers and lakes, the range of salinity values between 0 0/00 - 0.05 0/00.

In general, the results of the analysis of water quality in the Batu Bumbun reserve, ranging from temperature, brightness, dissolved oxygen, water pH and salinity, are in optimal conditions for the life of aquatic biota, especially plankton. This is very important because Batu Bumbun is a fishery reserve whose water quality must meet the requirements for the life of aquatic biota.

4.6. Plankton Abundance

From the results of sampling at the Batu Bumbun reservation that has been carried out in 2 (two) different conditions, namely in the morning and afternoon at 3 (three) observation stations, it can be seen that the type and abundance of plankton was found at station 1 in the morning and in the afternoon. 87 types of plankton, at station 2 in the morning and afternoon found a total of 75 types of plankton and at station 3 in the morning and afternoon found a total of 83 types of plankton. The types of plankton found during the study were 64 species that were included in 10 classes (Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenaceae, Myxophyceae, Xanthophyceae, Crustacea, Ciliata, Lobosa and Monogononta). Then the 10 classes are divided into 2 groups, namely 6 Phytoplankton classes (Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenaceae, Myxophyceae, Xanthophyceae) and 4 Zooplankton classes (Crustacea, Ciliata, Lobosa and Monogononta).

From the results of sample identification, it was found that each station had a varied abundance of plankton. At station 1, the total abundance of plankton was 56,852 individuals/liter, at station 2, the total abundance of plankton was 38,552 individuals/liter, and at station 3, the total abundance of plankton was 54,107 individuals/liter.

Overall it can be assumed that the condition of the Batu Bumbun reservoir waters at the three research stations is in good condition. This is because from all stations, the most dominant group is phytoplankton, especially the Bacillariophyceae group (25 genera). Of the 25 genera, the most numerous are the genus Melosira and the genus Diatoma. According to Lokman in Athirah (2012), freshwater diatoms are one of the largest species in the phytoplankton collection. In addition, diatoms are important primary producers in the food web in aquatic ecosystems. Diatoms are also used as indicators of water quality.

4.7. Diversity Index (H')

From the results of the calculation of the diversity index (H') that has been carried out at each observation station in the Batu Bumbun reservation, it can be seen in Table 4.1 below:

Table 4.1 Results of Calculation of the Diversity Index (H') Per Station

Condition	STASIUN		
	1	2	3
Morning	3.4132	3.3144	3.4362
Afternoon	3.4376	2.8585	3.3293

Based on the results obtained in Table 4.4, it is known that the results of the diversity index (H') at the 3 observation stations in the Batu Bumbun reservation ranged from 2.8585 to 3.4376. At station 1 it ranges from 3.4132 to 3.4376, at station 2 it ranges from 3.3144 - 2.8585 and at station 3 it ranges from 3.4362 to 3.3293. From the results obtained, the diversity is quite high, and the condition of the waters of the Batu Bumbun reservoir is good. This is reinforced by the opinion of Sutjianto (2003), that the value of H '> 3: High diversity, high individual distribution of each species and high community stability (clean and stable water).

According to Barus (2002), a community is said to have high species diversity if there are many species with a relatively even number of individuals of each species. In other words, if a community consists of only a few species with an unequal number of individuals, then the community has low diversity. According to Begon et al in Siregar (2009), the value of diversity based on the Shannon-Wiener index is associated with the level of pollution, namely H'<1 heavily polluted, if the value of 1<H'<3 is moderately polluted and if the value>H'3 is not polluted/clean.

4.8. Uniformity Index (E')

From the results of the calculation of the uniformity index (E) that has been carried out at each observation station in the Batu Bumbun reservation, it can be seen in Table 4.2 below:

Table 4.2 Results of Calculation of the Uniformity Index (E') per Station

Condition	STASIUN		
	1	2	3
Morning	0.9019	0.9111	0.9026
Afternoon	0.9139	0.7916	0.9152

From table 4.5, the results of the uniformity index at each research station range from 0.7916 - 0.9152 so from these results it can be assumed that the condition of plankton in the Batu Bumbun reservation at each research station is quite evenly distributed. According to Krebs in Siregar (2009), states that if the uniformity index is close to 0 then the uniformity of a population is smaller and the distribution of individuals of each genus is not the same, and there is a tendency for a genus to dominate in that population. On the

other hand, the closer the value to 1, the plankton population shows a uniform number of individuals.

4.9. Dominance Index (D')

From the results of the calculation of the dominance index (D') that has been carried out, the number at each observation station on the Batu Bumbun reservation can be seen in Table 4.3 below:

Table 4.3 Results of Calculation of the Dominance Index (D') Per Station

Condition	STASIUN		
	1	2	3
Morning	0.0432	0.0476	0.0412
Afternoon	0.0399	0.1100	0.0423

Based on Table 4.6, it is known that the results of the calculation of the dominance index (D') at 3 observation stations in the Batu Bumbun reservation range from 0.0399 - 0.1100. At station 1 the range is between 0.0432 - 0.0399, station 2 is ranging from 0.0476 - 0.1100 and station 3 is ranging from 0.0412 - 0.0423. From the dominance index value, it can be concluded that from the three stations In the Batu Bumbun reservation, Muara Muntai District, KutaiKartanegara Regency, East Kalimantan Province, none of them dominates. This is in accordance with the opinion expressed by Fachrul (2007), which states that the range of this dominance index indicates that the number of individuals of each species is almost the same or none dominates.

From the results of the plankton analysis, both in terms of abundance and diversity, the plankton in the Batu Bumbun reserve showed very good conditions, especially the highest species found from the Diatome genus, which is an indicator of good water quality. With this condition, the Batu Bumbun reservation will have a function as a good breeding ground for fish, so that it can improve the welfare of the surrounding community who work as fishermen.

The government, especially related agencies, needs to maintain good environmental conditions for the Batu Bumbun reservation because the community's economy is very dependent on this fishery reserve. The damage to the Batu Bumbun reserve is very influential on the surrounding community, moreover the Batu Bumbun reserve is also a breeding ground for fish which are the main source of food for protected animals, namely the Mahakam Pesut (Orcaellabrevirostri).

V. CONCLUSION

Based on the results of data analysis that has been carried out during research at the Batu Bumbun reservation, several conclusions can be drawn as follows:

In general, the results of the analysis of water quality in the Batu Bumbun reserve, ranging from temperature, brightness, dissolved oxygen, water pH and salinity, are in optimal conditions for the life of aquatic biota, especially plankton. This is very important because Batu Bumbun is a fishery reserve whose water quality must meet the requirements for the life of aquatic biota.

Plankton found in all research stations were 64 species which were divided into 10 classes consisting of 6 classes of phytoplankton, namely: Bacillariophyceae, Chlorophyceae, Cyanophyceae, Euglenaceae, Myxophyceae and Xanthophyceae and 4 classes of zoo plankton, namely: Crustacea, Ciliata, Lobosa and Monogononta. The total value of plankton abundance obtained during the study at station 1 was 56,852 individuals/liter, station 2 was 38,552 individuals/liter and station 3 was 54,107 individuals/liter. The highest abundance was at station 1 then station 3 and the lowest was at station 2. For the group the highest plankton genus was present in the Bacillariophyceae class.

The government, especially related agencies, needs to maintain good environmental conditions for the Batu Bumbun reservation because the community's economy is very dependent on this fishery reserve. The damage to the Batu Bumbun reserve is very influential on the surrounding community, moreover the Batu Bumbun reserve is also a breeding ground for fish which are the main source of food for protected animals, namely the Mahakam Pesut (Orcaellabrevirostris).

REFERENCES

[1] Ambarwati, D. (2014). Identification of Phytoplankton from Nadra Krenceng Reservoir Waters, Cilegon City, Banten. Journal of Fisheries and Marine Affairs. Vol.4 No. 4, 283-291.

[2] APHA. 2005. Standard Methods for The Examination of Water and Wastewater. APHA Inc., New York. 1134 p.

[3] Athirah, A. 2012. Study of the Diversity of Phytiplankton in the Melai Sea, TasikChini Pahang. http://www.ukm.my/ahmad/thesispelajar/fitomelai.htm Accessed November 2, 2012.

[4] Barus, T. (2004). Introduction to Limnology Study on Mainland Water Ecosystems. Medan: USU Press.

[5] Basmi, H. (2000). Plankton as an indicator of water quality. Bogor: Faculty of Fisheries and Marine Sciences, IPB.

[6] Bayurini, D. H. 2006. The Relationship Between Phytoplankton Primary Productivity and Fish Distribution in the Ecosystem of RawaPeningka Waters, Semarang Regency. Undergraduate Thesis of Mathematics and Natural Sciences Department of Biology, Semarang State University

[7] Boyd, Claude. E. 1979. Water Quality in Warmwater Fish Pond. First Printing. Auburn University Agriculture Experiment Station, Alabama. USA. 9 p.

[8] Boyd, C.E. 1990. Water quality in warmwater fishponds. Auburn University, Department of Fisheries and Aquaculture. First Edition, Alabama. USA 359p.

[9] Edmonsons, W.T. 1959. Fresh Water Biology, Second edition. Professor of Zoology. Seattle: University of Washington.

[10] Effendi, H. (2003). Study of Water Quality for Management of Aquatic Resources and Environment. Yogyakarta: PT. Canisius.

[11] Fachrul, F. (2007). Biotechnology Sampling Method. Jakarta: Earth Literacy.

[12] Fadhilatin, N. S. (2016). Diversity of Zooplankton in Pepe River Waters, Bengawan Solo River in Central Java. Surakarta: UMS Press.

[13] Fardiaz, S. 1992. Water and Air Pollution. Yogyakarta: Kanisius.

[14] Handayani, p. P. (2005). Zooplankton Community in Krenceng Reservoir Waters. Makara Sains, 75-80.

[15] Hutabarat, S. and S. M. Evans. 1984. Key to Zooplankton Identification. Jakarta: University of Indonesia (UI Press).
[16] Liinuga, D. (2008). Identification of Zooplankton in the waters of Bunaken Island, Manado. Journal of MIPA UNSRAT ONLINE 3,2, , 84-86.
[17] Lind, O. (1979). Handbook Of Common Methods in Limnology (2 edition). Kendal: Hunt Publishing Company Dubuque, Iowa.
[18] Mann, K.H & J.R.N. Lazier. 1981. Dynamics of marine ecosystem. Biological Physical Interactions in the Ocean. Blackwell Scientific Publications. Boston.345p.
[19] Nontji, A. (2008). Marine Plankton. Jakarta: LIPI Press.
[20] Sagala, P. E. (2012). Comparison of the Diversity Index and the Saprobic Plankton Index to Assess the Water Quality of Lake Toba, North Sumatra Province. Bandung: SEMNAS Limnology VI LIPI.
[21] Tebbut, T.H.Y. 1992. Principles of Water Quality Control. Fourth Edition. Pergamon Press, Oxford. 251 p.
[22] Tjakrawidjaya, A.H., Haryono and Wahyodewantoro, G. 2009. Diversity of freshwater fish in the Mahakam Watershed, East Kalimantan. LIPI Research and Engineering Intensive Program Travel Report. LIPI Biology Research Center. Unpublished
[23] Welch, P.S. 1952. Limnology. 2nd, Mc. Graw-Hill Book Company Inc., New York (XI): 538pp. Welcome. R. L. 1983. River Basin. Food and Agriculture Organization (FAO): Rome.
[24] Wilhelm, J.L. 1975. Biological indicators of pollution, in Whitton (ed), 1975. River Ecology, Blackwell scientific Publication, London: 375-402.
[25] Wilhelm, J.L. & T.C. Doris. 1968. Biological parameters for water quality criteria. Bioscience.Vol. 18:447-480.