Plankton Community Structure in PLTA Koto Panjang Reservoir, Kampar District, Riau Province

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Abstract. Koto Panjang Hydroelectric Power Plant is one of the reservoirs in Riau Province, many activities in Koto Panjang. Plankton is one of the organisms that is influenced by this condition. This study aims to determine the plankton community structure in Koto Panjang. The study was conducted on May 2019. Survey methods were used in this research. Samples were taken 3 times, once / weeks, in 3 different areas. One hundred liters of water was sieved into 125 ml using a plankton net number 25. The plankton was sampled was fixed using a Lugol solution and identified using a binocular microscope. There were 11 classes of plankton in Koto Panjang, 8 classes of phytoplankton and 3 classes for zooplankton. The value of plankton species diversity index (H’) is ranges from 4.86 to 5.35, dominant index (C) 0.03-0.05 and equitability index E 0.54-0.62. The plankton community structure in the Koto Panjang Reservoir is categorized as good.

Keywords: Diversity index, dominant index, equitability index, phytoplankton, zooplankton

1. Introduction
The Koto Panjang Hydroelectric Reservoir is one of the reservoirs in Riau Province. Activities around the Koto Panjang Hydroelectric Reservoir will provide input in the form of organic material into the waters, especially fish farming activities in the KJA. Economically, the presence of KJA will benefit the cultivators, but ecologically it will affect the quality of the waters. The fish culture system in the Koto Panjang Reservoir is carried out intensively, namely by providing continuous feed, so that not all the food given is eaten by fish in the cage, but some are wasted and spread around the waters.

There was 19.48% of the remaining feed from KJA Panjang Reservoir activities [1]. The presence of wasted food that is wasted and spread and the rest of metabolism that is wasted into the water will cause increased nutrients. Increased nutrients will cause increased water fertility. This situation can affect the community of plankton organisms that exist in the waters.

Plankton is a microscopic plant called phytoplankton. Phytoplankton is mostly autotrophic organisms and becomes primary producers of organic material in aquatic habitats. Another component of plankton is heterotrophic animals called zooplankton. So that phytoplankton is the baseline of food webs in the aquatic environment.

Plankton type and density conditions can be the basis for analyzing the abundance of resources and play an important role in influencing the primary productivity of waters. Diversity plays a vital...
role in natural wealth on this earth. Diversity maintains water and air quality and maintains soil fertility by decomposing and recycling waste products. In the field of fisheries, plankton plays an important role as a source of aquatic nutrition. There are various inputs from the results of human activities quickly or slowly that can affect the growth of plankton. Changes will occur in the composition of species and the amount of plankton in these waters. The quantity and quality of plankton in the water column always changes according to environmental conditions.

The fertility status of the Koto Panjang Hydroelectric Reservoir is included in the medium polluted category [2] and the status of water fertility based on the Nygard Index around the DAM Koto Panjang Hydroelectric Reservoir, including eutrophic waters [3]. Eutrophication occurs due to an increase in nutrients in the water. The increase in nutrients is thought to be closely related to the existence of floating net cages, and the use of fertilizers in oil palm plantations, which will have an impact on the growth of phytoplankton and zooplankton.

The structure of a plankton community is the arrangement of individuals of several types or species that are organized to form a community that can be learned by knowing one or two specific aspects about the community organization concerned such as species diversity indexes, stratification zones, and abundance. This study aims to determine the structure of the plankton community in the Koto Panjang Hydroelectric Reservoir in Kampar Regency. It’s given the important role of plankton in supporting the balance of the reservoir ecosystem.

2. Materials and Methods

This research was conducted on May 2019, the method used was a survey method, especially by observing and taking samples directly around the Koto Panjang hydropower reservoir in the dam site area. Data collected in the form of primary data and secondary data. Primary data consists of field data in the form of water quality data observed in the field or analyzed in the laboratory, while secondary data in the form of data obtained from the local government that is related to this study.

There were determinations of sampling locations by purposive sampling. To get data on plankton abundance and water quality around the Koto Panjang Hydroelectric Reservoir, the sampling location is divided into 3 points on the dam site area, so that it can represent the waters around the Koto Panjang Hydroelectric Reservoir. The criteria for each station are as follows:

The station I : It is an area around the Tanjung Alai Bridge which has 90-100 KJA plots. This station is in position 00'16'50.3 "LU - 100046 '37.8" East.

The station II : Is an area around Gadang Island, which has 200 - 300 KJA plots. This station is located at position 00 '16 '55.03584 "LU - 100049 '35.02596" East.

The station III : It is an area around a dam site with a relatively high density of KJA activities totaling around 800 - 950 KJA plots. This station is in position 00 '16 '51,1 "LU - 100051 '16,9" East.

Plankton sampling is done at 3 sampling points from the surface to a depth of 3 meters and is composited. Determination of the number of sampling points is very determining whether or not a representative sample.

Plankton abundance

Abundance is expressed as the amount of biomass per unit, or the unity of area/volume, or capture unity. Plankton density calculations were analyzed using formula.

\[ N = \frac{1}{A} \times \frac{B}{C} \times n \]

Information:

\( N \) = Plankton abundance (Individual / L)
\( A \) = Volume of filtered sample water (50 L)
\( B \) = Volume of filtered sample water (125 ml)
C = Volume of sample water in preparations (0.05 ml)
n = Number of plankton counted

### Community Structure

#### Diversity Index

Diversity index will make it easier to analyze information about the number of individuals and the number of species of an organism. The more species found in a sample, the greater the diversity. The diversity of phytoplankton and zooplankton species in waters is seen using the Shannon-Weiner formula in, namely:

\[
H' = -\sum \left( \frac{n_i}{N} \right) \log_2 \left( \frac{n_i}{N} \right)
\]

**Information:**
- \(H'\) = diversity index
- \(n_i\) = Number of individuals
- \(N\) = total number of individuals
- \(\log_2 = 3.321928\)

**With criteria:**
- \(H' > 3\): low, meaning low diversity with uneven distribution of individuals and low community stability.
- \(1 \leq H' > 3\): moderate, meaning moderate diversity with moderate individual distribution and medium community stability.
- \(H' < 1\): high, meaning high diversity with high individual distribution, high community stability.

#### Dominance Index

To see the presence or absence of planktonic organisms that dominate an aquatic ecosystem, seen using the Simpson formula, namely:

\[
C = \sum \left( \frac{n_i}{N} \right)^2
\]

**Information:**
- \(C\) = Domination Index
- \(n_i\) = Number of individuals
- \(N\) = Total number of individuals

If the value of dominance (C) is close to zero, it means that no type dominates, whereas if the value (C) is close to one, it means that there is a type that dominates.

#### Uniformity Index

Uniformity can be said as a balance that is the individual components of each species contained in a community. The type of index of fitness (E) is calculated using the Pilou formula, namely:

\[
E = \frac{H'}{H_{max}}
\]

**Information:**
- \(E\) = Uniformity Index
- \(H'\) = Diversity Index
- \(H_{max} = \log_2 S\)
If the value of E is close to 1 (> 0.5), it means that the uniformity of aquatic organisms in a balanced state means that there is no competition between place and food. If the value of E is <0.5 or close to 0, it means that the uniformity of aquatic organisms in an unbalanced condition means that there is competition between the place and food.

3. Results and Discussion

Waters quality around the cage Reservoir Koto Panjang

The Water Condition of the Koto Panjang Hydroelectric Reservoir is bordered by part of the land owned by the community that was managed from before the reservoir was built until the reservoir was completed and partly bordered by forest areas. After the construction of the reservoir is completed, the area of land managed by the community in the catchment area for agriculture and plantations continues to increase, while the reservoir waters are used for floating net cage fisheries (KJA) activities. The floating net cages in the Koto Hydroelectric Reservoir are mostly concentrated around the DAM [5]. The number of floating net cages (KJA) operating in the Koto Panjang PLTA Reservoir continues to increase each year. The number of KJA operating in 2006 was 513 plots, in 2009 the number of KJA became 900 plots in 2014 to 1,200 plots and in 2016 the number of KJA became 1,288 plots [3].

Physical and chemical parameters of water greatly affect existing aquatic biota, one of which is plankton. The measurement results for the physical and chemical parameters of the waters during the study can be seen in the table below.

| Parameter                  | Value of Value |
|----------------------------|----------------|
|                            | Unit          |
| 1. Temperature             | °C            |
| 2. Brightness              | cm            |
| 4. TSS                     | mg/L          |
|                            |               |
| A. Physics                 |               |
| B. Chemistry               |               |
| 1. Dissolved Oxygen        | mg/L          |
| 2. Carbon dioxide free     | mg/L          |
| 3. Nitrate                 | mg/L          |
| 4. Phosphate               | mg/L          |
| 5. Degree of Acidity (pH)  |               |

Source: Data primer (2019)

The temperature of the waters during the study ranged from 31 - 32 °C. The temperature range of these waters when associated with the survival of aquatic organisms, especially plankton is still at the optimum temperature for growth. This value is a normal value for the development of plankton in tropical waters that is 21-35 °C. whereas according to [4] the normal range for growth and development of plankton in freshwater waters, where the normal range is 20-30 °C. The reservoir water temperature is high for plankton life but is within the limits that can be tolerated by plankton organisms. Temperature is very influential for the existence of organisms; this is because the temperature is the main limiting factor, because aquatic organisms often have a narrow tolerance. Water temperature is influenced by the temperature of the surrounding air and the intensity of light entering the body of water. Value According to [6] several factors affect water temperature including
light intensity, heat exchange between the air and surrounding water and the number of canopies in the area.

Observations of all stations (Table 1) at point 1 show that brightness ranged from 152 - 293 cm, at point 2 ranged from 204 - 134 cm and at point 3 ranged from 146 - 185 cm. High and low brightness values in the Koto Panjang hydropower reservoir are influenced by the presence of particles that can interfere with the entry of sunlight into the water column, then the brightness value at each point of the study location is also influenced by weather conditions and time of observation. Brightness is very closely related to primary productivity because it is an important factor in the rate of photosynthesis where the brightness value is identified with depth as the process of photosynthesis progresses. Brightness can be influenced by factors such as watercolor, dissolved substances, and suspended particles.

The TSS value in the Koto Panjang hydropower reservoir area in general is good for the life of plankton because it is ranged from 7-10 mg/L, according to Government Regulation No. 82 of 2001 concerning Water Quality Management and Water Pollution Control states that for the Class II water quality criteria (fishery quality standard) the number of suspended solids permitted is 50 mg/L. When compared with Government Regulation No. 82 of 2001, the total content of suspended solids in the Koto Panjang Hydroelectric Reservoir can still be tolerated and is still below the quality standard threshold.

Based on Table 1, it is known that the dissolved oxygen content around the waters of the Koto Panjang hydropower reservoir ranges from 2.92 - 5.83 mg/L. Dissolved oxygen content is included in the good category because it does not exceed the specified quality standards. According to [7] states that dissolved oxygen levels of 5-6 mg/L are considered the most ideal for growing and developing aquatic organisms. The range of dissolved oxygen that can support aquatic organisms normally should not be less than 2 mg/L. In other words, these waters when viewed from the DO measurement results are included in good condition for the survival of aquatic organisms.

While the free carbon dioxide content during research in the waters is in good category for the life of aquatic organisms with a range of 7.90 mg/L - 9.98 mg/L carbon dioxide in waters should not exceed 12 mg/L and may not be less than 2 mg/L. According to Boyd (1982) free carbon dioxide levels of 10 mg/L can still be tolerated by origin aquatic organisms accompanied by sufficient oxygen levels. Most aquatic organisms can survive until free carbon dioxide levels reach 60 mg/L [4].

Nitrate and phosphate content around the floating net cage waters of the Koto Panjang hydropower reservoir are classified as good for aquatic biota life, for nitrates in all observation points are below 10 mg/L and phosphate is below 0.2 mg/L. Nitrate levels in the Koto Panjang hydropower reservoir are also the same in the condition of the Pandandure Reservoir whose nitrate content is below 10 mg/L based on research [8].

The results of measurements of the average acidity (pH) in the waters around the Koto Panjang hydropower reservoir during the study showed that the pH of the waters was relatively the same at all stations, namely 5 and 6 or was acidic. Government Regulation No. 82 of 2001 concerning the management of Water Quality and Water Pollution Control states that the pH value for class II waters (fishery quality standards) is 6-9. [9] states that pH is the optimum factor that influences the abundance of zooplankton in water. According to [10], a good optimum pH for plankton growth is in the range of 6.2-8.6.

**Plankton Community Structure**

The results of plankton identification show that the waters of the Koto Panjang hydropower reservoir are 11 classes of 8 types of phytoplankton, namely Chlorophyceae, Chyanophyceae, Zygematophyceae, Bacillariophyceae, Trebouxiophyceae, Synurophyceae, Dinophyceae, and Cryptophyceae. While zooplankton was consists of copepods, crustaceans, and Branciopods. Plankton abundance found in the surrounding waters of the Koto Panjang Hydroelectric Reservoir at each
station ranges from 69451 individual / L - 76650 individual /L. The highest abundance is recorded at the location of point 3 and the lowest is found at the location of point 1 Figure 1.

Figure 1. Plankton abundance during research

Figure 1 shown that the highest abundance is in the (station) 3 which is the center of the dam site. There are abundant nutrients from the rest of the feed and feces of fish for growth. This condition is very different in the waters of the Kedungumbo reservoir in Central Java-based on research by Hidayah et al., 2014, the abundance of phytoplankton in several locations in some KJA is lower than the Central location. The KJA is lower than in other places. This condition also occurs in several KJA locations on Lake Toba [11](Barus, 2008).

Plankton diversity index ($H'$) during the study at each research location point 4.86 - 5.35. The value of $H'$ indicates that the stability of the community in all these locations is high ($H'> 3$). Dominance index (D) (<0.5) which means that there is no dominance of certain types of plankton in the Koto Panjang hydropower reservoir. This is in line with the opinion of Weber (1973) in Siagian (2012), suggesting that the index of dominance is between 0-1. If the value is close to 0 (0.5) it means that there is a species that dominates the other species. Besides, it was also stated that if the diversity index decreases the index dominance will increase. Good waters are waters that can be a place for growth and development of various types of plankton. For 0.54 - 0.62 this shows that the value of E approaching 1 (> 0.5) means that the uniformity of aquatic organisms in a balanced state means there is no competition either for place or food.

4. Conclusion
The results of the measurement of physical and chemical parameters are still in good condition for the growth of aquatic organisms, especially plankton. This shows that the waters of the Koto Panjang hydropower reservoir are not polluted. And it’s with high stability index diversity. There is no dominance of certain types of plankton in the waters of the Koto Panjang hydropower reservoir around the cage and the uniformity of aquatic organisms in a balanced state.

5. Acknowledgment
This research is a UNRI DIPA research funded by LPPM Riau University, our research team would like to thank LPPM Riau University for providing financial assistance so that this activity can be carried out, and we also thank all parties who have participated in this research activity.
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