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Assessment of Seasonal Waters Quality Based on Abundance, Diversity, and Domination of Phytoplankton in Bajulmati Reservoir

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Abstract. Water quality assessment can be carried out through physical, chemical, and biological analyses. Phytoplankton is a biological microorganism that is usually used as indicators to assess surface water quality, specifically primary productivity. Bajulmati Reservoir is located in Banyuwangi, East Java, which functions as irrigation for agricultural and fisheries land. The purpose of this study was to analyze the productivity of reservoir waters based on phytoplankton abundance. The method used is purposive sampling with four sampling point stations from the entire reservoir area. The phytoplankton found were nine genera, consisting of 5 genera from the Cyanophyceae class, and one genus from each class, namely the Chlorophyceae, Bacillariophyceae, Euglenophyceae, and Dinophyceae classes. The productivity of the Bajulmati reservoir is included in the eutrophic category, with an average abundance of phytoplankton of 15.215 ind.L^{-1}. Meanwhile, the diversity index shows that the distribution of stable individuals and communities is low, namely 0.87. Despite this, the Cyanophyceae class is dominating with the dominance index was 0.52.

1. Introduction

The reservoir is a body of stagnant water (tapering) created through a river dam, generally extending to follow the river bed [1]. Bajulmati Reservoir is one reservoir that functions as an irrigation reservoir. However, there is still no information regarding the condition of the waters, especially the assessment of fertility in the Bajulmati Reservoir. Water conditions can be carried out through physical, chemical, and biological analyses [2]. According to [3], phytoplankton is a biological parameter that can be used as an indicator to evaluate the quality and fertility of a water surface. Based on the [4] that phytoplankton was used as a bioindicator to determine the fertility status of water quality and water in the Sempor dam, Kebumen, Central Java. The results showed that the inlet area was a moderately eutrophic location because of its high nutritional content. Besides, [5] on the composition of phytoplankton during the rainy season on Mount Sukabumi, which shows that the Cyanophyceae class dominates during the rainy season. Moreover, [6] was also researched on the structure of phytoplankton communities during the rainy season in Lake Bromo Yogyakarta. This research shows that the ecosystem in Lake Bromo is unstable and varies so that there is dominance. The purpose of this study is to determine the fertility level of the reservoir Bajulmati based on abundance, diversity, and dominance of phytoplankton in the rainy season.

2. Material and methods

2.1. Study area

This research was conducted in March and April 2019 in Reservoir Bajulmati, Wongsorejo sub-district, Banyuwangi, East Java. The research location was divided into four stations where the determination point is purposive sampling was to determine the appropriate sample point representation of reservoir conditions based on ease of access roads and selection. The sampling coordinates marked with a global positioning system(GPS) sampling stations can be seen following (Figure 1).

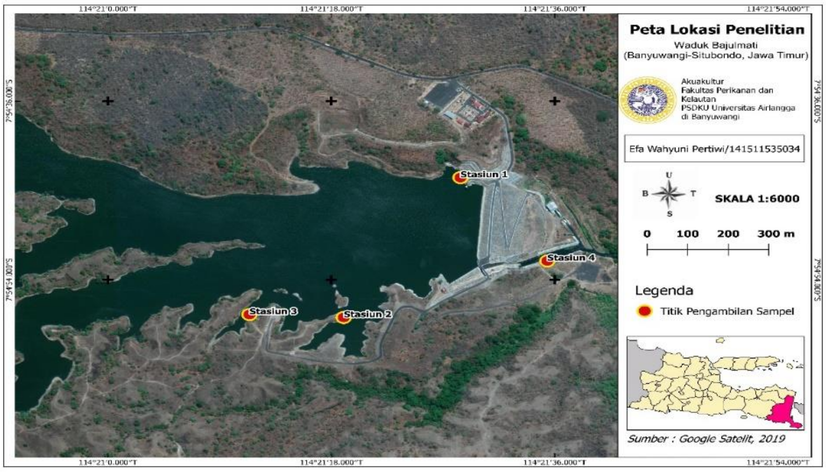

Figure 1. Study site and stations sampling

2.2. Collect data

Measurement of temperature, brightness, and dissolved oxygen was carried out directly (in situ). While nitrogen and phosphate measurements were carried out in the laboratory, by taking a water sample of 250 ml and stored in a cool box. On the other hand, phytoplankton sampling was done by filtering 100 liters of sample water using a 25µ size plankton net and stored in a dark 200 ml bottle given 5% Lugol. Furthermore, the observation of phytoplankton using a binocular microscope Nikon E 100 at a magnification of 100 - 400x. Phytoplankton identification used the book [7,8]. Meanwhile, abundance is calculated using the Sedgewick Rafter with calculations according to [9].

$$N = n \times \frac{Vr}{Vo} \times \frac{1}{Vs}$$

Where:

N = abundance of plankton (ind / m3)
n = number of individuals observed (ind)
Vr = volume of the filtered water sample (ml)
Vo = volume of water into deposited in Sedgewick Rafter (1 ml)
Vs = volume of filtered water sample (l)

2.3. Data analysis

Descriptive analysis was taken to describe the resulting quality of water measurement on each station sampling. Meanwhile, the phytoplankton data were analyzed by calculating the Important Value Index (IVI) to the determination of diversity index (H’), following calculation by Shannon-Wiener index [10]. Meanwhile, the phytoplankton dominance index (C) was calculated using the formula of Simpson's Index of Dominance.

$$H' = \sum Pi \ln Pi$$

Where:

H '= Diversity Index
Pi = ni/N, the number of individuals of each species/number of individuals of all types
Ln = natural logarithm

$$\boldsymbol{C} = \sum (\boldsymbol{ni}/\boldsymbol{N})^2$$

Where:

C = Dominance Index
ni = Total individual Every Type
N = Total Individual All Types

3. Result and discussion

3.1. Results

We found nine genera scattered in reservoir waters with the distribution of 5 genera from the Cyanophyceae class, and one genus each from the Chlorophyceae class, Bacillariophyceae, Euglenophyceae, and Dinophyceae. The average abundance of phytoplankton in the Bajulmati reservoir was 15,215 ind.L^{-1}. The highest quantity of phytoplankton at station 2 was 17,300 ind.L^{-1}, while the lowest abundance at station 4 was 14,220 ind.L^{-1}, presented in accordance in (Table 1). The highest phytoplankton diversity index was at station 2 of 0.95, while the lowest abundance was at Station 1 of 0.83. On the other hand, the diversity index at stations 3 and 4 has the same value, namely 0.85, which was presented in (Figure 2). Furthermore, the dominance index value (C) was the highest at station 4, with a value of 0.55, and the lowest dominance index is at station 2 with a value of 0.49. The dominance index for each study station was presented in (Figure 2). The results of measurements of physical and chemical parameters of water consist of temperature, brightness, DO, nitrogen, and phosphorus was presented in (Table 2).

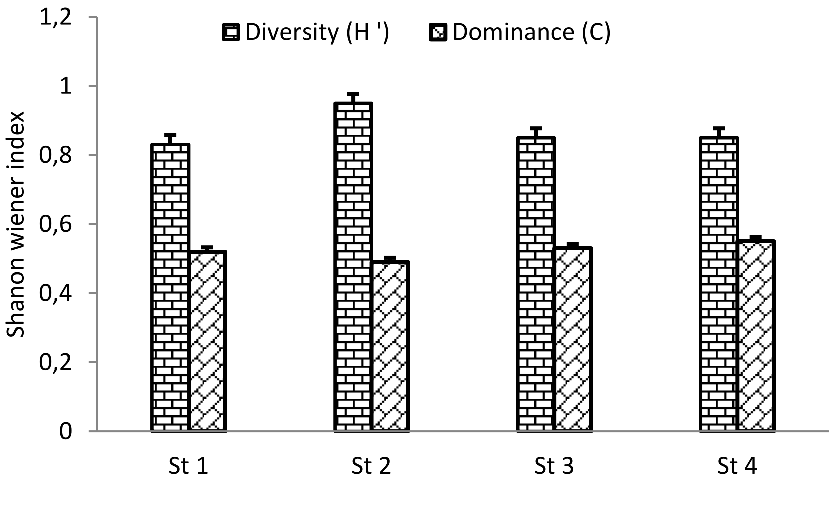

Figure 2. Dominance Index Value of each research station

Table 1. Phytoplankton Abundance each station

Station	Abundance (ind/ L)	Category (Landner, 1978)
St 1	14,660	oligotrophic
St 2	17,300	eutrophic

St 3	14,680	oligotrophic
St 4	14 220	oligotrophic

3.2. Discussion

The highest phytoplankton abundance was at station two, which was classified as eutrophic. The difference in phytoplankton abundance at each station was caused by differences in nutrient content. The abundance of phytoplankton is directly proportional to the nitrogen content. Nitrogen is a nutrient that acts as a limiting factor in photosynthesis and phytoplankton growth [11]. Nitrogen and nitrate are the macronutrients needed most by phytoplankton in photosynthesis besides carbon and oxygen. This causes differences in phytoplankton abundance [12]. The highest diversity index value is 0.95, and the lowest was 0.83. However, based on the value of the Shannon-Wiener index [10], the value of the diversity index is still in the low category where H '<1. This shows that these waters have low genus diversity and the number of individuals and community stability. This is under the results of research by [13] in Tapak Tugurejo Semarang with low diversity values of 0.73 - 1.95 and [14] in the Ciliwung river with a range of 0.39 - 1.02.

The low diversity index is thought to be due to increased water turbidity due to rainwater flow [15]. The increase in turbidity causes a decrease in sunlight penetration, which affects the photosynthesis process. In addition, each type of phytoplankton has a different response to nutrient ratios, especially nitrogen and phosphorus, in a water body [16]. Furthermore, the Cyanophyceae Class was found to dominate at each station with 0.55. This class was also found to dominate the waters of Telaga Bromo Yogyakarta during the rainy season. According to[17], the dominance of Cyanophyceae in waters was caused by the entry of natural organic matter. The phytoplankton community structure changes place and time. These changes will reflect the overall development, both diversity and productivity [18].

Table 2. Results of water quality in the Bajulmati reservoir

Parameters	Unit	Station				Standard	Reference
		1	2	3	4		
Temperature	^{o}C	30.33 ± 0.67	30.50 ± 0.65	29.63 ± 1.44	30.93 ± 1.44	20-30	Effendi (2003)
Brightness	cm	57.00 ± 4.68	69.67 ± 5.65	52.33 ± 3.21	77.67 ± 6.35	<200	Effendi (2003)
DO	$mg.L^{-1}$	7.40 ± 0.44	7.90 ± 0.85	7.40 ± 0.62	7.97 ± 1.01	> 6	Retnani (2001)
Nitrogen	$mg.L^{-1}$	2.39± 0.08	2.52± 0.19	2,48± 0.22	2.64± 0.16	> 20	(Novotny and Olem, 1994)
Phosphor	$mg.L^{-1}$	0.02± 0.01	0.01	0.01± 0.01	0.02± 0.01	0.02 to 5	PP 82 (2001)
N:P ratio	$mg.L^{-1}$	119.5	252	284	103.2	16: 1	Sanders (2004)

On the other hand, Spirulina is a species of the genus Cyanophyceae that dominates in these waters. According to [19], in water conditions with low N content, Cyanophyceae can bind N to free air so that this type of phytoplankton will grow faster than other classes. This is consistent with the N content in the waters of the Bajulmati Reservoir, which was included in the oligotrophic category (N <10).

4. Conclusion

Bajulmati Reservoir has a high abundance of phytoplankton, which is 15,215 $ind.L^{-1}$ (included in the eutrophic category) consisting of nine genera. Also, it has a stable distribution of individuals with a diversity index value of 0.87. Furthermore, Cyanophyceae is a class that dominates in these waters with a value of 0.52.

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