

## Primary Productivity Levels and About Phytoplankton in Tamblingan Lake, Buleleng District, Bali

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**Abstract.** The role of lake waters in supporting people's lives in a broad sense is largely determined by the level of lake productivity, one of which is primary productivity. The primary productivity of the lake can be seen from the abundance and diversity of phytoplankton which are the basic components in the food chain system in waters. The purpose of this study was to determine the level of primary productivity and abundance of phytoplankton. The bottle-dark-bottle-light method was used to determine the photosynthetic rate and respiration of phytoplankton. Gross photosynthesis (GP = dirty photosynthesis) is obtained by subtracting the dissolved oxygen content in the dark bottle from the dissolved oxygen content in the light bottle, after being subjected to lighting (incubation) for several hours. Result the highest abundance is at station II. The uniformity index shows that for station 3 it is the lowest category. The results of the calculation of the phytoplankton dominance index have a value that is inversely proportional to diversity. Based on the category, the index value for the three stations is categorized as low dominance. Water quality parameters measured include dissolved oxygen (DO), degree of acidity (pH), temperature, brightness, and turbidity. Based on all measurements and several aspects of conditions that occur in the waters of Lake Tamblingan, it is still classified as normal and good enough for the continuation of aquatic life. The determinant of the primary productivity among them were pH, temperature, turbidity, and brightness.

**Keywords:** abundance; phytoplankton; productivity; tamblingan lake

### I. INTRODUCTION

Tamblingan Lake is located on the northern slope of Mount Lesung, Munduk Village area, Banjar District, Buleleng Regency, Bali. This lake is one of three twin lakes formed from a large caldera. The role of lake waters in supporting community life in a broad sense is largely determined by the level of lake productivity, both primary, secondary and tertiary productivity. The primary productivity of the lake can be seen from the abundance and diversity of phytoplankton, which are the basic components in the food chain system in waters [1].

Aquatic productivity is the rate of anchoring or storing energy (sunlight) by autotrophic communities in an aquatic ecosystem. Productivity itself consists of primary productivity (producers) and secondary productivity (consumers: zooplankton, fish, benthos, etc.). Primary productivity of waters is an important factor in marine aquatic ecosystems, because it plays a role in the carbon cycle and food chain for heterotrophic organisms [2]. The

existence of phytoplankton in an area of water can provide information about the condition of the waters. Phytoplankton is a biological parameter, which can be used as an indicator to evaluate the quality and level of fertility of a waters [3].

Phytoplankton also functions as a bioindicator of water quality which has cosmopolitan properties, which can live in various types of waters or in other words, the distribution pattern is very wide, which means that the distribution of plankton varies from one place to another due to different water quality [4]. The ability of phytoplankton will decrease if there is damage to the surrounding environment, such as waste pollution and anthropogenic activities. Vice versa, the pros and cons of a waters can be seen through the level of primary productivity and the diversity of phytoplankton [5]. Based on the description above, this research was conducted to determine the condition of Tamblingan Lake as seen through the level of primary productivity and abundance of phytoplankton.

## II. RESEARCH METHOD

The method used in this research is quantitative descriptive method. The quantitative descriptive method begins by collecting data, analyzing the data, and interpreting it. Data collection Primary productivity measurements were carried out using the dark and light bottle oxygen method. The working principle of this method is to measure changes in oxygen content in dark and light bottles containing water samples that have been incubated in water exposed to sunlight. The incubation time for dark bottles and light bottles is 3-4 hours, to obtain the NPP, GPP and R values per hour, it is calculated based on the following formula [6]. The plankton sampling technique is carried out passively, not moving where the water sample is taken by drawing and pouring 100 liters of sample water into the Plankton Net. Samples were collected using a Plankton Net and a 20 ml bottle to place the plankton sample at the ends. The filtered sample in a container is then stored in a sample bottle and 1 ml of 4% formalin is added [5]. Water samples for phytoplankton were taken by a filtering method by taking them horizontally at the sea surface at a depth of 0.5 m [7].

### Data Analysis

#### a. Primary Productivity of Aquatic

The primary productivity value of waters is measured using the following formula:

$$NPP = \frac{(O_2BT - O_2BA) \times 1000 \times 0.375}{PQ(t)}$$

#### b. Abundance of Phytoplankton

Phytoplankton identification was done by taking a sample of 1 cc and placed in the Sedgwick-Rafter and observed under a microscope. The Sedgwick-Rafter observations are divided into 10 fields of view. The phytoplankton found are then counted and documented for further identification to the Genus level [5]. Kelimpahan Plankton dengan metode "Lackey Drop Microtransect Counting" [6] is as follows:

$$N = n \times \frac{A}{B} \times \frac{C}{D} \times \frac{1}{E}$$

#### c. Species Diversity Index ( $H'$ )

Diversity index is an index that shows the level of diversity of the types of organisms that exist in a community. The calculation of the diversity index using the Shannon index equation is as follows [8]:

$$H' = \sum_{n=1}^s pi \ln pi$$

#### d. Uniformity Index (E)

The species uniformity index is an index that shows the level of individual evenness of each species in a community [8]:

$$E = \frac{H'}{\ln S}$$

#### e. Dominance Index (C)

The dominance of phytoplankton can be determined by calculating the dominance index. The dominance index is calculated using the Simpson's "Evenness Shannon" formula [9] namely:

$$C = \sum \left( \frac{N_i}{N} \right)^2$$

## III. RESULTS AND DISCUSSION

### Primary Productivity of Aquatic

The productivity level ranges from 29.95 - 62.50 mg C/m<sup>3</sup>/hour. In the first observation on November 5, 2020, the highest water productivity value occurred at station II with a value of 55.99 mg C / m<sup>3</sup> / hour with the value of each station, namely station I with a value of 29.95 mg C/m<sup>3</sup>/hour, at station II with a value of 55.99 mg C/m<sup>3</sup>/hour, and at station III with a value of 36.46 mg C/m<sup>3</sup>/hour. In the second observation on November 19, 2020, the highest water productivity value occurred at station II with a value of 62.50 mg C/m<sup>3</sup>/hour with the value of each station, namely station I with a value of 36.46 mg C/m<sup>3</sup>/hour, at station II with a value of 62.50 mg C/m<sup>3</sup>/hour, and at station III with a value of 40.36 mg C/m<sup>3</sup>/hour. In the third observation on December 3, 2020, the highest water productivity value occurred at station II with a value of 48.18 mg C/m<sup>3</sup>/hour with the value of each station, namely station I with a value of 36.46 mg C/m<sup>3</sup>/hour, at station II with a value of 48.18 mg C/m<sup>3</sup>/hour, and at station III with a value of 41.67 mg C/m<sup>3</sup>/hour.

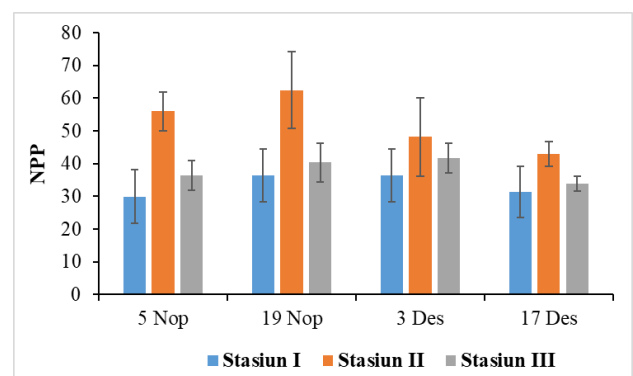


Figure 1. The primary productivity of aquatic

In the fourth observation on December 17, 2020, the highest water productivity value occurred at station II with

a value of 42.97 mg C / m<sup>3</sup> / hour with the value of each station, namely station I with a value of 31.25 mg C/m<sup>3</sup>/hour, at station II with a value of 42.97 mg C/m<sup>3</sup>/hour, and at station III with a value of 33.85 mg C/m<sup>3</sup>/hour. At all stations the value of the highest productivity level is located at station II and the lowest is at station I. The productivity level has decreased in the third observation or in December.

*Abundance phytoplankton*

The results of phytoplankton identification found in Tamblingan Lake, there are 11 genera from various classes (Table 1). The 11 genera include *Chrorella* sp., *Gyrosigma* sp., *Melosira* sp., *Navicula* sp., *Nitzschia* sp., *Oscillatoria* sp., *Pleurosigma* sp., *Rhizolenia* sp., *Skeletonema* sp., *Synedra* sp., *Tabellaria* sp. At station I 9 species were found, 10 species were found at station II, and 8 species were found at station III. Abundance calculation results from three stations, respectively, get 362.3 ind / m<sup>2</sup>, 479.3 ind/m<sup>2</sup>, and 388.5 ind/m<sup>2</sup>. The highest abundance was at station II and the lowest was at station I. At all stations the highest abundance was found in *Nitzschia* sp (Figure 2).



Figure 2. One of phytoplankton was found (*Nitzschia* sp)

*Phytoplankton Diversity index*

The results of the calculation of the phytoplankton diversity index found in the waters of Lake Tamblingan at station 1 were 1,954, at station 2 were 2,041, and at station 3 were 1,847. Based on the category value, the Shannon-Wienern index refers to all stations, namely the diversity in the medium category (Figure 3).

*Phytoplankton Uniformity Index*

The phytoplankton uniformity index found in Tamblingan Lake waters has the same pattern as the diversity index. The result of the calculation of the uniformity index at station 1 was 0.254, at station 2 it was 0.256, and at station 3 it was 0.238. Based on the category, the uniformity index value is aimed at station 1, namely the uniformity of the medium category, at station 2 it is in the medium category, and at station 3 it is in the low category (Figure 4).

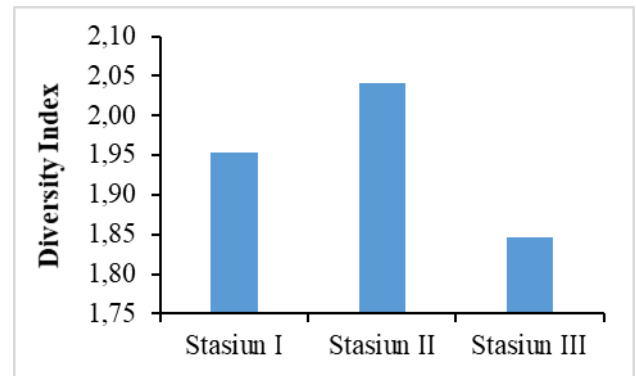


Figure 3. The graph of diversity index

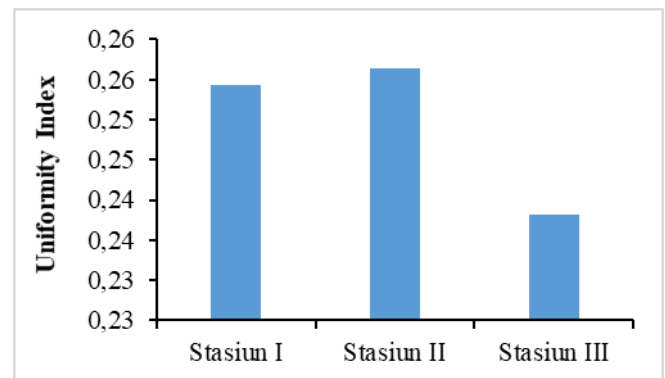


Figure 4. The graph of uniformity index

*Phytoplankton Dominance Index*

The results of the calculation of the phytoplankton dominance index found in the waters of Lake Tamblingan have a value that is inversely proportional to the diversity with the value at station 1 is 0.175, at station 2 is 0.155, and at station 3 is 0.187. Based on the Simpson index value category, it is aimed at all stations, namely the dominance is low category (Figure 5).

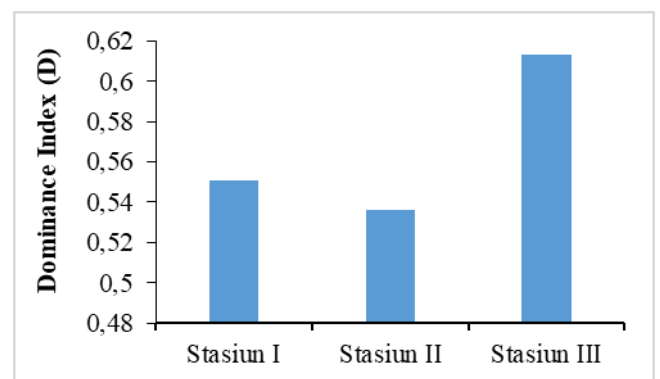


Figure 5. The graph of dominance index

*Water Quality Parameters*

The results of measuring the quality of water in Tamblingan Lake have varied values. Intake of water quality is carried out at three times, namely morning, afternoon and evening. The results of water quality at each station were slightly different, but for each station at different times did not experience large fluctuations.

Based on the results of observations and NPP calculations on Tamblingan Lake, there are differences between stations (Table II). This shows that there are differences in the activity of aquatic organisms such as the consumption of dissolved oxygen for respiration and the decomposition of organic matter by bacteria. NPP results are directly proportional to the abundance of phytoplankton at each station. The highest NPP value is at station II and followed by the highest NPP at station II. This shows that the existence of an abundance of phytoplankton greatly affects the productivity value of the waters in Tamblingan Lake. Phytoplankton as primary producers will produce dissolved oxygen through photosynthesis [9]. The higher the phytoplankton abundance, the more DO is produced, the higher the NPP.

Based on observations of phytoplankton found in Tamblingan Lake, there are 11 types. Most species found are *Nitzschia* sp. It is suspected that this type of plankton is very easy to breed compared to other types of plankton. *Nitzschia* is a phytoplankton that is able to adapt quickly when there is a change in water quality in aquatic ecosystems to keep reproducing properly [6]. The highest abundance of phytoplankton occurs at station II. It is suspected that at this station the intensity of the incoming light is very optimal so that the photosynthesis process by phytoplankton also runs optimally because at the time of sampling at this station the light intensity is quite good. Good light intensity will affect the productivity of the waters associated with the rate of photosynthesis by phytoplankton which is followed by a cultivation process that takes place in an aquatic ecosystem [10]. The abundance at station I and II has a lower value than at station II. It is suspected that this is influenced by the lack of light intensity that enters the photosynthetic process of phytoplankton. At stations I and II the conditions at the time of the sampling were quite dim because of the shady trees covering the waters of the Tamblingan lake.

Based on the phytoplankton diversity index found in the waters of Lake Tamblingan at station 1 is 1,954, at station 2 is 2,041, and at station 3 is 1,847. Based on the category value, the Shannon-Wiener index refers to all stations, namely the diversity in the medium category. The diversity value at all stations in the medium category is because the species found are quite heterogeneous, so that few species dominate at the station. If the diversity index value falls into the low category, it indicates that the waters are disturbed [11].

Based on the phytoplankton uniformity index in the waters of Lake Tamblingan, it has the same pattern as the diversity index. The result of the calculation of the uniformity index at station 1 was 0.254, at station 2 it was 0.256, and at station 3 it was 0.238. Based on the category, the uniformity index value refers to station 1, namely the

uniformity of the medium category, at station 2 it is in the medium category, and at station 3 it is in the low category. The highest uniformity was found at stations 1 and 2, because the species obtained were uniform and there were no dominant species. Whereas at station 3 the uniformity is low because there are species that dominate the area. The results of the calculation of the phytoplankton dominance index found in the waters of Lake Tamblingan have a value that is inversely proportional to the diversity with the value at station 1 is 0.175, at station 2 is 0.155, and at station 3 is 0.187. The absence of dominance in waters proves that the types of biota in these waters are very heterogeneous, so that no species controls an ecosystem [12]. Based on the results of temperature measurements in Lake Tamblingan, it is still classified as normal. Observations between stations at each point are still optimal for marine life.

In the measurement results of the degree of acidity (pH) of the Tamblingan Lake waters, all stations that have been studied have differences in the average pH value which are not much different. The pH range at the three stations is 5.5 - 6.7 where this range is still classified as normal for biota. The pH values across the stations are not much different. The lowest pH occurs at station 3. This condition is thought to be because at this station it has low water productivity which is thought to have a high respiration rate. The results of this respiration are generally in the form of ammonia and nitrite so that it greatly affects the pH of the waters.

The results of turbidity in the waters of Lake Tamblingan are still normal for aquatic biota. Turbidity levels at each station ranged from 3.64 - 12.92 NTU. The turbidity of the waters at the three observation stations is still within the range of quality standards for aquatic biota [13]. High turbidity is due to the large amount of organic material suspended from the land into the waters [14]. Based on the brightness values at all stations, it ranges from 27.79 - 53.83 cm. The ecological effect of decreasing brightness will result in decreased light penetration in the waters. It also has an impact on decreasing the quality of photosynthetic processes and primary productivity by aquatic plants, resulting in disruption of the food chain in a waters [15].

#### IV. CONCLUSION

Based on the above discussion, the conclusion in this study is that the primary productivity conditions in Tamblingan Lake have a value range of 29.95 - 52.50 for two months of observation. Meanwhile, the abundance of phytoplankton from each station is directly proportional to the primary productivity of each station. There were 11 types of phytoplankton found at the time of sampling with the highest abundance of *Nitzschia* sp. The determinant of

the primary productivity among them were pH, temperature, turbidity, and brightness.

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TABLE I  
 ABUDANNCE OF PHYTOPLANKTON

No	Genus	Station I	Station II	Station III
1	<i>Chrorella sp.</i>	-	58.5	68
2	<i>Gyrosigma sp.</i>	12	7.5	-
3	<i>Melosira sp.</i>	29	28	27
4	<i>Navicula sp.</i>	40.5	68	66.7
5	<i>Nitzschia sp.</i>	112.5	122.5	121.3
6	<i>Oscillatoria sp.</i>	72	94.5	52
7	<i>Pleurosigma sp.</i>	13.5	26	22
8	<i>Rhizolenia sp.</i>	-	14	13.5
9	<i>Skeletonema sp.</i>	23.3	35	18
10	<i>Synedra sp.</i>	28.5	-	-
11	<i>Tabellaria sp.</i>	31	25.3	-
Sub Total		362.3	479.3	388.5
Total		1230.1		

TABLE II  
WATER QUALITY PARAMETERS

Parameter	Station I			Station II			Station III			Quality Standards
	Morning	Noon	Evening	Morning	Noon	Evening	Morning	Noon	Evening	
Temperature (°C)	26.75	24.60	24.95	25.00	25.00	23.30	24.35	25.85	27.35	24-28
pH	6.41	6.50	6.19	6.69	6.56	6.53	5.52	5.61	6.71	5-9
Turbidity (NTU)	7.52	12.92	8.05	4.52	3.64	5.24	5.53	8.19	3.89	25
Brightness (Cd)	27.79	53.83	53.28	32.00	29.17	39.30	29.50	35.00	44.50	300-500