

# Composition and Diversity of Phytoplankton in Lake Lindu, Central Sulawesi

Sevi Sawestri<sup>+</sup>, Samuel and Ni Komang Suryati

Research Institute for Inland Fisheries, Ministry of Marine and Fisheries, Republic of Indonesia

**Abstract.** Lake Lindu is located in Lore Lindu National Park, Central Sulawesi, Indonesia. This lake kind of tectonic lake and still on natural condition. This study aims to determine the composition and diversity of phytoplankton in Lake Lindu. Observations were made in May, July and October 2012. Five stations representing the waters conditions of Lake Lindu were set up. Phytoplankton samples were collected by using a plankton net with 25  $\mu\text{m}$  mesh size. Supporting data, temperature, transparency, pH, nitrate ( $\text{NO}_3$ ), and phosphate ( $\text{PO}_4$ ) were measured on same location. Three phytoplankton classes were recorded consisting of 25 species of phytoplankton. The largest number of phytoplankton species was recorded in Chlorophyceae, with 12 species, while the lowest one recorded from Cyanophyceae classes, with 2 species. The abundance of phytoplankton varied from 200-2954 cells/L. The diversity/Shannon index ( $H'$ ) ranged between 0.50 and 2.24. The index of dominance ( $D$ ) ranged between 0.13 and 0.76.

**Keywords:** Composition, Diversity, Phytoplankton, Lake Lindu, Central Sulawesi.

## 1. Introduction

Indonesia has no less than 500 lakes with a total area of 5,000  $\text{km}^2$ , or approximately  $\pm 0.25\%$  land area. Lakes in Indonesia are rich with a diversity of functions and biodeversity. Lake Lindu is one of lakes in Indonesia. Lake Lindu is located in Lindu district, Sigi regency, Central Sulawesi province. This lake has an area pf over approximately 3488 ha. Lake Lindu has pristine condition because itu was in The Lore Lindu National Park. According to research Lukman, the water quality conditions of Lake Lindu well with the oxygen content was found to a depth of 25 m [1].

Phytoplankton play an important role as a provider of dissolved oxygen through the photosynthesis process and as the basis of the trophic level that determines the overall productivity lake [2]. Phytoplankton and zooplankton community structure characterized by biological indices such as number of individuals and species, diversity index ( $H'$ ) and dominance ( $C$ ) in waters of lake.

The changes of environment will affect phytoplankton. Community structure of phytoplankton in water can be used as a biological indicator in determining the changes in water conditions. This purposive of this study was to determine the composition and diversity of phytoplankton in Lake Lindu.

## 2. Materials and Methods

The present study was conducted on May, July and October 2012. Five stations i.e., inlet, middle of lake, outlet, Anca and small island were selected by purposive sampling criteria to represent the aquatic environment of Lake Lindu, Central Sulawesi-Indonesia.

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<sup>+</sup> Corresponding author. Phone. +62711 7537194, Fax. +62711 7537205  
E-mail address: sawestri@yahoo.co.id

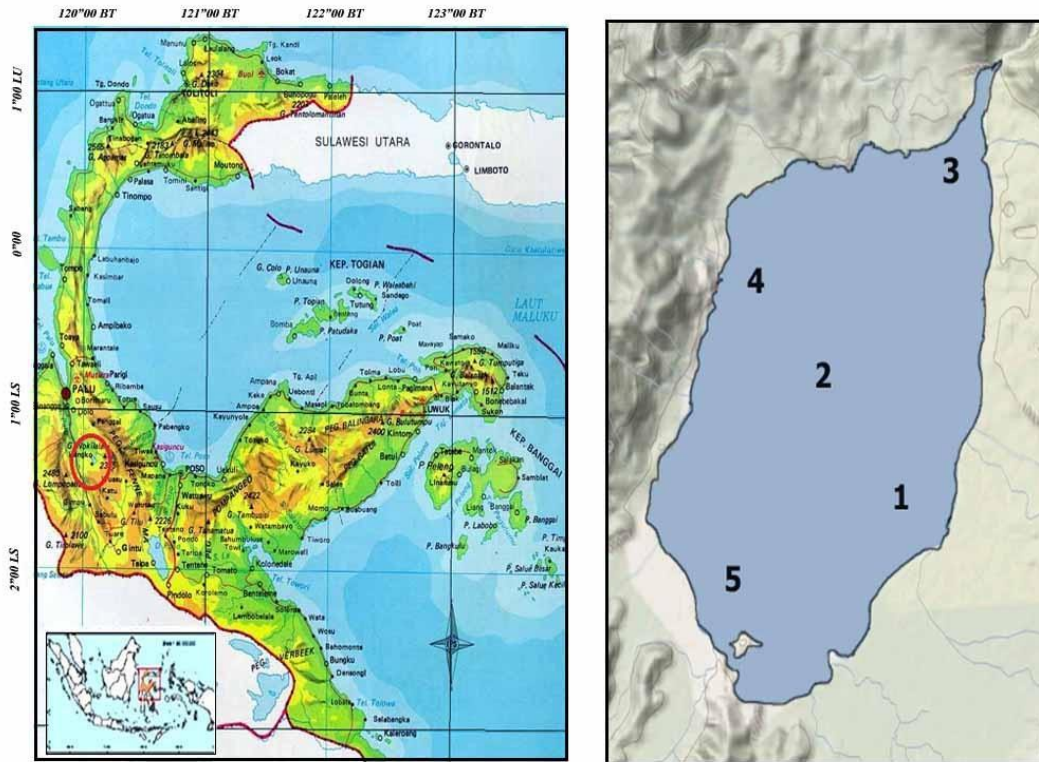


Fig. 1: Research stations in Lake Lindu (red circle): 1. Inlet; 2. Middle of lake; 3. Outlet; 4. Anca; 5. Small Island.

Phytoplankton samples were collected by using plankton net with mesh size of 25  $\mu\text{m}$ . Samples were preserved with lugol fixative and analyzed in the laboratory by using a compound microscope and Sedgewick Rafter object glass. Phytoplankton were identified to the lowest taxonomy (to species) [3] and analyzed for their abundance (A), Shannon diversity/index (H'), and dominance index (D) by using formula as follow.

1. Plankton abundance [4,5]

$$N = \frac{(ns \times va)}{vs \times vc}$$

- N : number of individual plankton per liter of water sample
- ns : number of individual plankton per liter in the Sedgewick Rafter
- va : the volume of water in the sample bottle
- vs : volume of water in the Sedgewick Rafter
- vc : volume of filtered water

2. Diversity/Shannon Index (H') [6]

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

- H' : Diversity/Shannon Index
- s : number of organisms
- pi :  $ni/N$
- ni : number of individu species i
- N : total number of individuals

3. Dominance Index (C) [6]

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

- ni = number of individu species i
- N = total number of individuals

Water quality parameters observed included water temperature, transparency, pH, nitrate (NO<sub>3</sub>), and phosphate (PO<sub>4</sub>).

### 3. Results and Discussion

The abundance of phytoplankton on May, July and October were ranged of 1104-2344; 584-2954 and 200-1486 cell/L respectively (Table 1). The highest abundance of phytoplankton occurred in May and the lowest in October. The differences of phytoplankton abundance between among the sampling time were suspected due to water level fluctuation during dry and wet seasons. The presence of phytoplankton was highly dependent on the condition of water environment in accordance with their life and can support life [7].

Table 1: Composition and abundance (cell/L) of phytoplankton in Lake Lindu

No	Species	Abundance (cell/L)														
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
		May					July					October				
	<b>Chlorophyceae</b>															
1	<i>Staurastrum</i> sp	0	8	0	0	0	0	0	0	0	0	0	0	0	0	
2	<i>Cosmarium</i> sp	16	4	20	4	44	0	4	52	92	24	0	60	4	4	
3	<i>Ulothrix</i> sp	0	144	0	0	0	80	0	0	0	0	72	238	134	44	
4	<i>Gloeocystis</i> sp	66	0	0	0	0	0	0	26	36	0	0	8	26	16	
5	<i>Oocystis</i> sp	16	0	24	0	8	0	0	0	16	0	0	16	8	0	
6	<i>Scenedesmus</i> sp	0	0	34	2	22	0	20	0	22	0	0	0	0	0	
7	<i>Coleastrum</i> sp	0	16	0	0	0	0	12	24	48	24	24	92	0	32	
8	<i>Senelastrum</i> sp	0	0	0	0	0	0	0	0	0	8	0	8	24	48	
9	<i>Dictyosphaerium</i> sp	0	0	0	0	0	0	352	912	576	384	0	24	96	24	
10	<i>Tetraedron</i> sp	0	0	0	0	0	2	4	8	16	8	2	4	0	2	
11	<i>Lyngbya</i> sp	318	0	538	828	0	82	210	336	324	72	0	76	72	122	
12	<i>Phormidium</i> sp	16	0	0	14	2	298	64	100	0	0	0	0	0	0	
	<b>Bacillariophyceae</b>															
1	<i>Cyclotella</i> sp	0	0	0	0	0	38	24	118	94	12	14	38	74	48	
2	<i>Coscinodiscus</i> sp	4	4	2	14	0	0	0	0	2	0	0	0	0	2	
3	<i>Cymbella</i> sp	0	0	0	0	0	2	2	2	0	0	2	0	6	0	
4	<i>Synedra</i> sp	0	0	0	0	0	4	0	0	2	0	4	0	0	0	
5	<i>Gomphonema</i> sp	0	0	0	0	0	0	0	0	0	0	0	0	6	0	
6	<i>Navicula</i> sp	2	0	4	12	14	2	6	0	0	0	12	2	4	0	
7	<i>Pinnularia</i> sp	10	2	0	4	2	14	2	0	0	0	6	0	14	2	
8	<i>Surirella</i> sp	0	0	0	2	0	4	0	0	0	0	8	0	2	2	
9	<i>Aulacoseira</i> sp	920	1152	338	1134	644	160	292	394	206	52	6	4	50	78	
10	<i>Fragilaria</i> sp	0	0	0	0	0	0	0	0	0	0	22	0	0	0	
11	<i>Nitzschia</i> sp	0	2	0	0	0	0	0	0	6	0	2	0	0	4	
	<b>Cyanophyceae</b>															
1	<i>Oscillatoria</i> sp	120	0	0	0	272	0	64	982	0	0	26	0	58	0	
2	<i>Chroococcus</i> sp	128	0	144	330	236	14	0	0	240	0	0	98	6	166	

Note: 1. Inlet; 2. Middle of lake; 3. Outlet; 4. Anca; 5. Small Island.

The highest abundance of phytoplankton occurred in May related to increasing in nutrient content resulted from incoming river water in Lake Lindu. Nutrients such as nitrates and phosphate can be directly utilized by phytoplankton organisms [8]. Phytoplankton requires nitrogen and phosphate elements for their growth [9]. Nitrate (NO<sub>3</sub>) is the main form of nitrogen in natural waters and is the main nutrient for plant growth and algae. Nitrate content in Lake Lindu ranged from 0.025 to 0.594 mg/L and phosphate content ranged from 0.030 to 0.230 mg/L.

Based on the abundance of phytoplankton in Lake Lindu showed a high abundance. It has different phenomenon with the abundance of phytoplankton in Lake Matano, Towuti and Mahalona at Sulawesi. The

abundance of phytoplankton in Lake Matano, Towuti and Mahalona were ranged of 283-790 ind/L, 252-470 ind/L dan 89-195 ind/L respectively [10]. The differences of phytoplankton abundance between among lake were suspected due to Lake Lindu has nutrient higher.

Lake Lindu consists of three phytoplankton classes, i.e. Chlorophyceae (12 species), Bacillariophyceae (11 species) and Cyanophyceae (2 species). Chlorophyceae and Bacillariophyceae were dominant algae in various types of waters. Sellers and Markland (1987) explained that Chlorophyceae, Cyanophyceae and Bacillariophyceae are dominant class of algae in freshwater [11].

Diversity/Shannon Index ( $H'$ ) and dominance index ( $C$ ) are an index used to determine the stability of a community of aquatic biota. Diversity index ( $H'$ ) of all observation stations were ranged from 0.50 to 2.24 (Table 2). Based on the average index of diversity, the waters of Lake Lindu was still considered low until moderate stable. That is meaning there was still a balance between the diversity of water quality conditions in accordance with phytoplankton. Dominance index ( $C$ ) of all observation stations ranged from 0.13 to 0.76. *Aulacoseira* sp from Bacillariophyceae was the dominant phytoplankton. Bacillariophyceae has a cosmopolitan characteristic, resistant to extreme conditions, adaptable and have a very high reproductive capacity [12].

Table 2: Diversity index ( $H'$ ) and dominance index ( $C$ )

Location	$H'$			$D$		
	May	July	Oct	May	July	Oct
St. 1	1.36	1.62	2.04	0.38	0.26	0.19
St. 2	0.50	1.69	1.94	0.76	0.24	0.19
St. 3	1.27	1.66	2.24	0.35	0.24	0.13
St. 4	1.12	1.91	2.03	0.38	0.20	0.16
St. 5	1.28	1.21	1.66	0.35	0.46	0.26

Water qualities of Lake Lindu were still in the range to support growth and life of aquatic organisms (Table 3).

Table 3: Water quality in Lake Lindu

Parameter	May	July	October
Temperature ( $^{\circ}C$ )	21-27	26.04-26.87	25-28
Transparancy (m)	0.9-2.3	1.6-2.3	1-2.3
$NO_3$ (mg/l)	0.025-0.128	0.120-0.163	0.222-0.594
$PO_4$ (mg/l)	0.037-0.074	0.019-0.030	0.067-0.230
pH	6.45-7.14	7.11-7.62	7-7.5

Aquatic organisms have a certain temperature range which favored for growth. The optimum temperature range for phytoplankton growth in the waters is 20-30 $^{\circ}C$  [8]. Water temperature in all stations Lake Lindu were in ranged of 21 to 28 $^{\circ}C$  and they were still within tolerance temperature for they life. The transparency in Lake Lindu ranged from 0.9 to 2.3 m. Water pH at all stations ranged from 6.45 to 7.62. Most of the aquatic organisms are sensitive in pH changes and they preferred 7 to 8.5 pH value [8].

#### 4. Conclusion

- Composition of phytoplankton that found in Lake Lindu consists of 3 classes of Chlorophyceae (12 species), Bacillariophyceae (11 species) and Cyanophyceae (2 species).
- The abundance of phytoplankton varied from 200-2954 cells/L. Diversity index ( $H'$ ) ranged from 0.50 to 2.24 indicated that the community of organisms in the water in low until moderate stable condition. Dominance index ( $C$ ) ranged from 0.13 to 0.76. Phytoplankton of *Aulacoseira* sp was dominant.
- Water qualities of Lake Lindu were still in the range to support growth and life of aquatic organisms.

## 5. Acknowledgements

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