Plankton community structure and trophic status of Wadaslintang Reservoir, Indonesia

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Abstract. Eutrophication is a serious threat to water quality and the functioning of aquatic ecosystems. The species composition and structure of the plankton community show variations according to changes in the physico-chemical and biological nature of the water and its trophic status. The purpose of this study was to assess the trophic status of the Wadaslintang Reservoir based on the Trophic Status Index, using the Carlson method (CTSI), as a basis for future management. The indicators monitored are water transparency, total phosphorus, total nitrogen, chlorophyll-a, and plankton abundance. The results showed that the Wadaslintang Reservoir can be included in the eutrophic categories based on total nitrogen concentration, total phosphorus concentration and transparency value. Based on the concentration of chlorophyll-a and CTSI values, the reservoir can be included in the mesotrophic category. The dominant phytoplankton species are *Botryococcus braunii* (Chlorophyte) and *Achnantes lanceolata* (Bacillariophyte). Sustainable lake management needs to be developed to avoid the hyper-eutrophization of the water.
Key Words: Carlson's Trophic State Index, Chlorophyll-a, eutrophication, nutrient concentration.

Introduction. Eutrophication is one of the most serious problems for water quality. Some analyses show that 69.5% of the 277 lakes in China are eutrophic (Wen et al 2019). Eutrophication is a natural process that occurs in waters, characterized by the occurrence of nutrient enrichment, especially phosphorus and nitrogen (Watanabe et al 2015). By eutrophication, nutrients are slowly accumulated in the sediment into an internal load, which will be suspended again into the water column in certain environmental conditions (Shekha et al 2017). Eutrophication will lead to the excessive proliferation of planktonic algae due to an increase in the high total phosphate load. The phosphate load results from diffusion in the catchment area (Arab et al 2019).

Monitoring and assessing the water environment continuously is one of the mitigations efforts to reduce and prevent the impact of environmental damage due to eutrophication (Da Costa Lobato et al 2015). One approach to assess the water environment is to use the trophic status criteria (El-Serehy et al 2018). Trophic status is a biological characteristic of water that integrates various ecohydrological factors such as chlorophyll, total phosphorus, and nitrogen (Adamovic et al 2019). Ecohydrology is a field of science that examines the interaction of physical-chemical factors of water with biological factors in the concept of sustainable environmental management (Soeprobowati 2010). The trophic status of the lake reflects the anthropogenic effects of water quality and its ecological functions (Wang et al 2019). Trophic status is also used to determine the level of productivity of water based on a classification scale that uses water quality parameters such as the level of water clarity, light penetration, Chlorophyll-a (Chl-a) concentration and nutrient concentration, especially phosphorus (Marselina & Burhanudin 2017). Trophic status criteria can be known based on the Trophic Status Index (TSI), which is analyzed based on Chl-a concentrations (Patra et al 2017). One of TSI method is developed by Carlson (CTSI), and it was used in this research. CTSI is an important index for monitoring water quality status and eutrophication assessment. Therefore, it has been used to monitor the health of Lake Mansi Ganga in India (Sharma et al 2010), Grlište Reservoir in Eastern Serbia (Vidović et al 2015), Lake Duhok Dam in Iraq (Shekha et al 2017), and Lake Bitter on the Suez Canal (El-Serehy et al 2018), among others.

Most reservoir and lake ecosystems face environmental issues such as eutrophication, sedimentation, and water surface decline (Frumin & Gildeeva 2014). Wadaslintang Reservoir is a public water in Central Java Province, with a high economic value related to its role in the fields of tourism, fisheries, agriculture, energy, flood prevention and drinking water. However, Wadaslintang Reservoir has the potential to experience eutrophication. There have been changes in land use resulting in a decrease of the forest area by 20.8%, while settlements increased by 6.7%, rice fields increased by 2.5%, plantations increased by 32.5%, open land increased by 9.5%, and water bodies decreased by 7.9% (Rahayu et al 2019). This has an impact on increasing nutrient input in reservoir water (Piranti et al 2018). A previous study shows that the trophic status of Wadaslintang Reservoir based on light penetration, total phosphate, and total nitrogen is included in the mesotrophic category (Widyastuti et al 2009). The mesotrophic waters have led to eutrophic waters. Eutrophication will have an economic impact that must be considered, stemming from the loss of recreational opportunities for fishing and boating, social and aesthetic issues related to the smell and taste of drinking water, and loss of biodiversity (Wagner & Erickson 2017).

In addition to the Wadaslintang Reservoir, one of the reservoirs in Indonesia that have undergone eutrophication is the Saguling Reservoir. This reservoir has been classified as hypereutrophic, this condition being caused by high levels of contamination with organic matter that can cause phytoplanktonic blooms (Marselina & Burhanudin 2017). The trophic status of water is positively correlated with the primary productivity of phytoplankton. Therefore, the high and low primary productivity of phytoplankton is closely related to the carrying capacity of these waters of aquatic biota (Cutrim et al 2018). Phytoplankton has an important role in aquatic ecosystems (Watanabe et al 2015). Its presence in waters is described as Chl-a concentration (Patra et al 2017). Physical and chemical factors have a major role in influencing primary productivity in lakes (Chen et al 2018). Phytoplankton is also an indicator of the health of aquatic ecosystems (El-Serehy et al 2018). The amount of input pressure of organic matter from the catchment area and from the reservoir body that also functions as a floating net cage aquaculture area increases the potential of the reservoir to be eutrophic (Piranti et al 2018). The purpose of this study was to determine the composition of phytoplankton and assess the trophic status of the Wadaslintang Reservoir using the Carlson Trophic State Index (CTSI).

Material and Method. Wadaslintang Reservoir is located in Wonosobo Regency, Central Java, Indonesia. The GPS coordinates are 7°32’34.6"S – 7°36’38.8"S and 109°45‘8.6"E – 109°48'45.3"E. The reservoir has 14.6 km^2 with a water volume of 443 mil. m^3. The water sources are four major rivers, namely Cengis River, Tritis River, Lancar River, and Kumejing River and several smaller rivers. Some of the uses of the reservoir include aquaculture activities with floating net cages, fishing and geo-tourism, hydroelectric power, agricultural irrigation in Kebumen and Purworejo regencies. The sampling stations were established by following differences in environmental baseline and water body utilization. The ten sampling stations in the reservoir and their geographical position are presented in Table 1 and Figure 1. The study was conducted from May 2017 to the start of 2018.

Water samples for chemical analysis were collected from 10 stations using 1 L polyethylene containers and stored in an ice box with dry ice at 4°C (Vidović et al 2015). Transparency (SD) measurements were performed using a Secchi Disc (APHA 1998), while total nitrogen (TN), total phosphorous (TP), and Chl-a measurements were conducted using a spectrophotometer (APHA 1998). Water samples were analysed for TN, TP, and Chl-a concentrations at Wahana Laboratory.

Plankton samples were collected from ten research stations with a 55 μm mesh standard plankton net in the surface water layer (0.3-0.5 m below the water surface) (Makhlough et al 2017). The samples were stored in 100 mL containers and Lugol solution

(1%) was added. Plankton observations were carried out using an inverted microscope with a magnification of 100X and 400X. Plankton identification was carried out at the Aquatic Biology Laboratory, Faculty of Biology, Jenderal Soedirman University, Indonesia. The identification was carried out based on literature (Needham & Needham 1941; Shirota 1966; Presscott 1978).

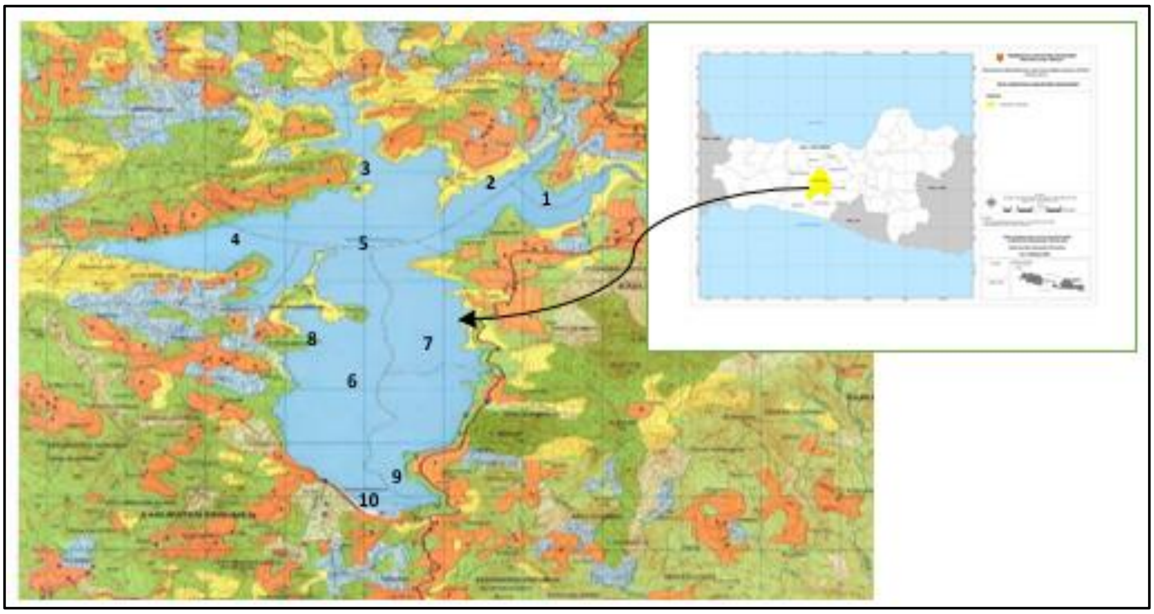

Figure 1. Sampling sites in the Wadaslintang Reservoir.

The results of plankton identification are systematically examined and grouped based on taxa. The abundance of individuals L^{-1} of each species at each station is calculated using a rating scale based on Atici & Alas (2012), with modifications, as follows: <100 - very few (+); 100-1000 - few (++); 1001-10000 - moderate (+++); 10001-100000 - abundant (++++); >100000 - very abundant (+++++).

Table 1

Geographical position and description of the research stations

Stations	*Geographical position*	*Sites description*
St-1	109°48′10.9″E 7°33′48.2″S	The entrance of Tritis River in the reservoir; the flow is swift; the water is murky; close to rice fields and gardens.
St-2	109°47′58.7″E 7°33′34.6″S	The entrance of Cengis River in the reservoir; flow tends to be slow; many macrophytes (*Eichornia crassipes*); close to rice fields.
St-3	109°47′11.6″E 7°33′35.7″S	The entrance of Lancar River in the reservoir; low water discharge; close to gardens and settlements.
St-4	109°46′32.7″E 7°34′6.8″S	The entrance of Kumejing River in the reservoir; the water flow is heavy, especially in the rainy season; the watershed is used as disposal of household industrial waste.
St-5	109°47′8.2″E 7°34′15.9″S	The mass of water in the reservoir formed by the previous four rivers.
St-6	109°47′6.7″E 7°35′46′3″S	The central part of the reservoir; close to floating net cage areas, intensively managed.
St-7	109°47′25.2″E 7°34′53.1″S	The central part of the reservoir; close to floating net cages managed traditionally.
St-8	109°46′48.8″E 7°34′59.1″S	Close to floating net cages no longer in use.
St-9	109°47′12.1″E 7°36′11.8″S	Section near the tourist area for fishing.
St-10	109°47′1″E 7°36′31.2″S	The reservoir outlet; close to the spillway; no or slow current.

The evaluation of eutrophication in the Wadaslintang Reservoir was carried out using Carlson's Trophic State Index (CTSI) according to the Carlson equation (1977), as presented below:

CTSI = [TSI (TP) + TSI (Chl-a) + TSI (SD)]/3

Where:

TSI (TP) = 14/42 Ln(TP) + 4/15 ($\mu g\ L^{-1}$)

TSI (Chl-a) = 9/81 Ln(Chl-a) + 30/6 ($\mu g\ L^{-1}$)

TSI (SD) = 60 – 14/41Ln (SD) (m)

The quantitative trophic status assessment of lake ecosystems is based on the CTSI value, with a scale of 0-100, as follows: 0-20 - hyper-oligotrophic category; 20-40 - oligotrophic category; 40-60 mesotrophic category; 60-80 eutrophic category; and 80-100 - hypereutrophic category (Xu et al 2008). The determination of trophic levels from Chl-a, TP, TN concentrations and transparency is based on the national and international criteria for classification of trophic status for a lake or reservoir (Table 2). The trophic status was determined based on the CTSI using logarithmic transformation.

Table 2

National and international criteria for the classification of trophic status for lakes or reservoirs

Trophic Status	*TP ($\mu g\ L^{-1}$)*	*TN ($\mu g\ L^{-1}$)*	*Chlorophyll-a ($\mu g\ L^{-1}$)*	*Transparency (m)*
OECD criteria (a)				
Oligotrophic	3–18 (8)	310–1600 (660)	0.3–4.5 (1.7)	5.4–28 (9.9)
Mesotrophic	11–98 (27)	360–1900 (750)	3–11 (4.7)	1.8–8.1 (4.2)
Eutrophic	16–390 (84)	390–6100 (1900)	2.7–78 (14)	0.8–7.0 (2.4)
Canadian criteria (b)				
Oligotrophic	4–10	–	<2.5	>3
Mesotrophic	10–20	–	2.5–8	1.5–3
Meso-Eutrophic	20–35	–	–	–
Eutrophic	35–100	–	8–25	0.7–1.5
Hipereutrophic	>100	–	>25	<0.7
Swedish criteria (b)				
Oligotrophic	<15	–	<3	>3.96
Mesotrophic	5–25	–	3–7	2.43–3.96
Eutrophic	25–100	–	7–40	0.91–2.43
Hipereutrophic	>100	–	>40	<0.91
Indonesian criteria (c)				
Oligotrophic	<10	≤650	<2	≥10
Mesotrophic	<30	≤751	<5	≥4
Eutrophic	<100	≤1900	<15	≥2.5
Hipereutrophic	>100	>1900	<200	<2.5

Note: TP - total phosphorous; TN - total nitrogen; a - Gibson et al (2000); b - El-Serehy et al (2018); c - Ministerial Regulation of the Environment of the Republic of Indonesia Number 28 of 2009; the mean is presented in brackets.

Results and Discussion. The determination of the trophic status of the reservoir is based on three components, namely biological, chemical and physical factors. Chl-a (microalgae pigment), as a biological factor, is an indicator of the presence of phytoplankton, TP (chemical factor), and SD (physical factor).

Chlorophyll-a. The concentration of Chl-a in water can be used as an indicator of the presence of phytoplankton. The concentration of Chl-a in the Wadaslintang Reservoir has a mean of 3.05 µg L^{-1}. Based on the provisions from the Regulation of the Minister of Environment of the Republic of Indonesia No. 28/2009, OECD (Gibson et al 2000), Swedish and Canadian criteria (El-Serehy et al 2018), the trophic status of the Wadaslintang Reservoir in May-August can be included in the mesotrophic category. In September-December it turned to oligotrophic, being caused by a decrease in Chl-a concentration (Figure 2). Chl-a concentration is positively correlated with trophic levels; the greater the chlorophyll concentration is in the water, the higher is the trophic level (Patra et al 2017). The decrease in Chl-a concentration is caused by a decrease in phytoplankton biomass. The rainy season starts in September, when the river flows with sediments, so it will tend to increase the turbidity concentration in the reservoir. Increased turbidity reduces light penetration and oxygen solubility. Chl-a concentrations tend to be high from May to August, because it is the dry season, with a high sunlight penetration. In the dry season, phytoplankton reproduces optimally, because of the availability of nutrients, and a high level of transparency. This is evidenced by the results of the analysis showing the correlation between Chl-a concentration and the level of transparency (Figure 3).

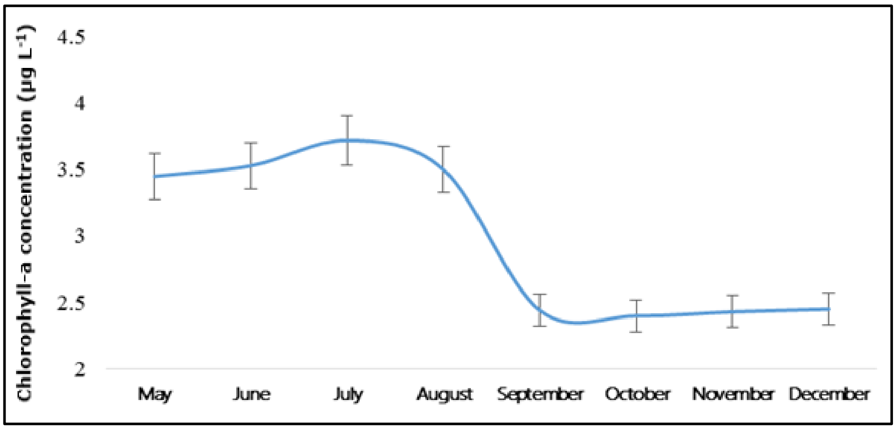

Figure 2. The average Chlorophyll-a concentration (µg L^{-1}) in Wadaslintang Reservoir.

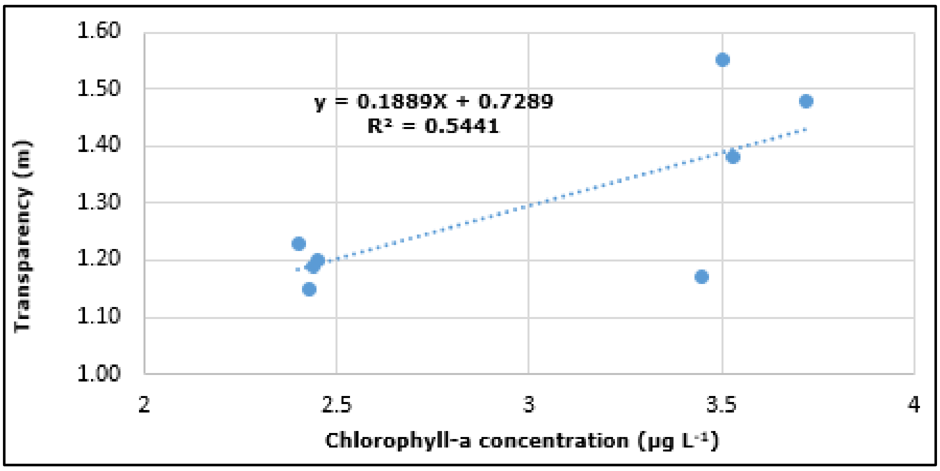

Figure 3 Correlation between Chlorophyll-a concentrations (µg L^{-1}) and transparency (m) in Wadaslintang Reservoir.

Total phosphorus. Nitrogen and phosphorus are nutritional components that stimulate phytoplankton growth (Bužančić et al 2016). The concentration of Chl-a is also influenced by these nutrients (Watanabe et al 2015). The average TP concentration during the study was 282 μg L^{-1}, and the concentration tended to increase in September-December (Figure 4). The highest concentration was found in St-6 due to the inclusion of organic waste originating from metabolic waste and fish feed from intensive aquaculture activities. According to Piranti et al (2018), the impact of floating net cage farming activities in the Wadaslintang Reservoir has caused the entry of phosphorus in the water, with 216.5 kg P ton^{-1} fish. The increasing TP concentration in September-December is due to the presence of organic material that enters through the sediment from the catchment area. According to Quevedo-Castro et al (2019), rainwater will bring along waste from settlements, agriculture, and livestock that are located along the watershed, so that it will enrich the organic material from the reservoir body.

The trophic status of Wadaslintang Reservoir based on TP concentration has been classified into the hypereutrophic category according to the Regulation of the Minister of Environment of the Republic of Indonesia Number 28 of 2009, as well as according to Canadian and Swedish criteria (El-Serehy et al 2018). Whereas based on OECD criteria (Gibson et al 2000), the Wadaslintang Reservoir is included in the eutrophic category.

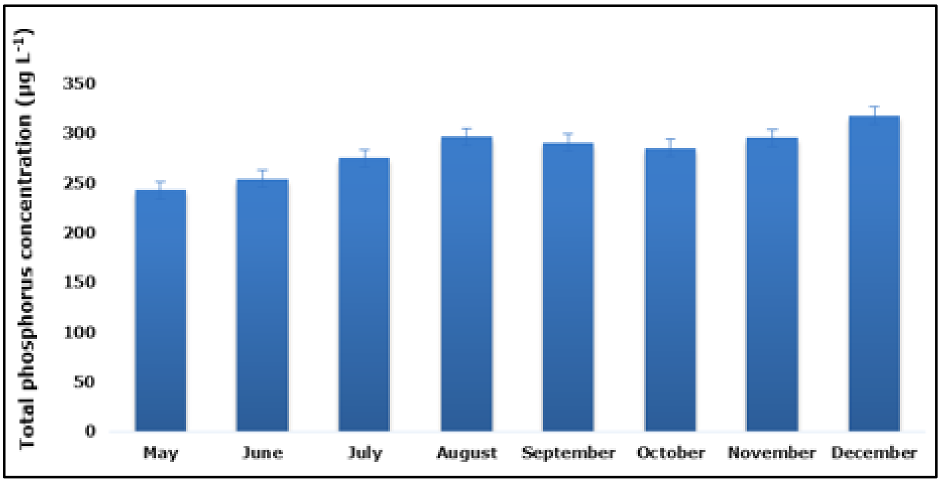

Figure 4. The average total phosphorus concentration (μg L^{-1}) in Wadaslintang Reservoir.

Total nitrogen. Nitrogen is a constituent component of proteins derived from ammonia (NH_3) and nitrates, needed by macro and microphytes for growth and multiplication (Liefer et al 2019). The average TN concentration during the study was 5739 μg L^{-1}. The highest concentration is in St-10 (outlet area), because the water flow brings all organic and inorganic components here (Figure 5). TN concentrations tend to increase from May to October, which coincides with the commencement of agricultural activities. When it rains, fertilizer and nutrients from the soil will be transported to the river and in the reservoir, increasing the concentration of TN in the reservoir. Similar conditions that show a relationship between high TN and TP concentrations associated with the rainy season were observed for the Yangtze River (Tong et al 2017), and those related to agricultural activities occur in the Presidio River, Mexico (Sarmiento-Sánchez 2017).

The trophic status of the Wadaslintang Reservoir based on the TN concentrations according to OECD criteria is eutrophic, while based on the Minister of Environment Regulation of the Republic of Indonesia Number 28 of 2009, is hypereutrophic. The main nutrients that play a role in increasing phytoplankton biomass are nitrogen and phosphorus. However, without the role of other parameters it cannot occur. Such parameters include increased DO, total suspended solids, and water transparency, among others.

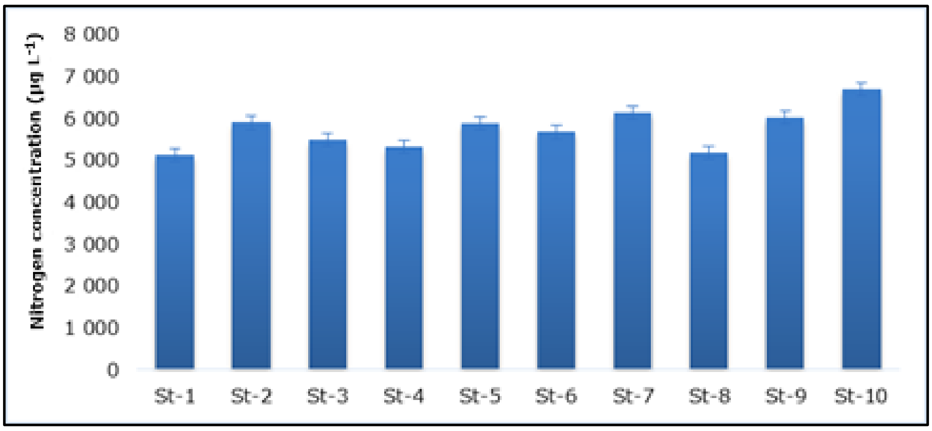

Figure 5. The average nitrogen concentration (µg L^{-1}) in Wadaslintang Reservoir.

Transparency. Waters can have high levels of transparency, or low levels of transparency because of sustainable phytoplankton production (Dembowska et al 2018). The measurement of the average transparency during the study was 1.3 m. The lowest transparency in the Wadaslintang Reservoir was found in November (Figure 6). August marks the end of the dry season, while November is already in the rainy season, and this causes a difference in the transparency value. The trophic status of the Wadaslintang Reservoir based on the level of transparency in accordance with the OECD criteria, Canadian and Swedish criteria is included in the eutrophic category. However, based on the provisions of the Regulation of the Minister of Environment of the Republic of Indonesia Number 28/2009, it is included in the hypereutrophic category, meaning that the Wadaslintang Reservoir is highly polluted.

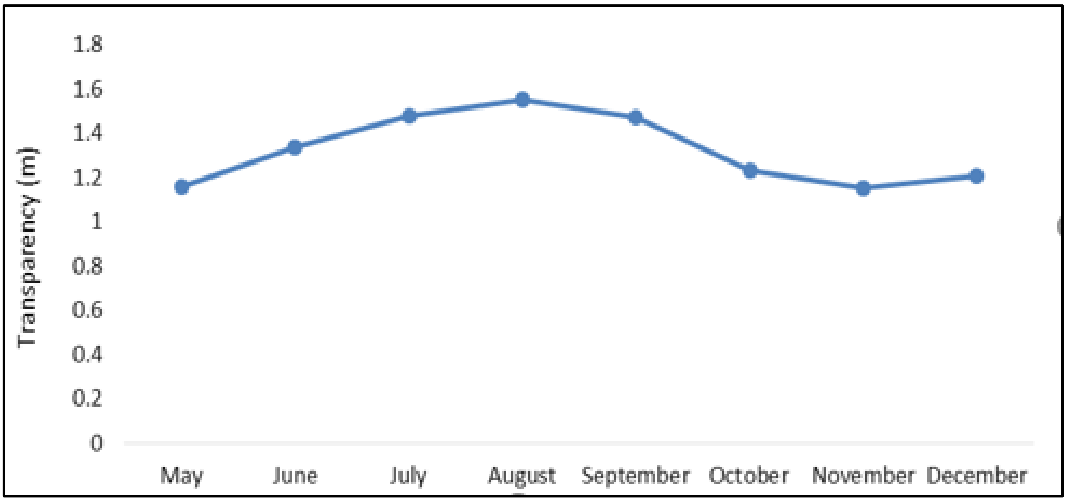

Figure 6. The average transparency (m) of water in Wadaslintang Reservoir.

CTSI. Organic components tend to accumulate in stagnant waters so that they will enrich nutrients that stimulate eutrophication. CTSI components are TP concentration, SD and Chl-a (Quevedo-Castro et al 2019). The CTSI value in the Wadaslintang Reservoir was between 52 and 54, with the highest values occurring in December, and the lowest in July. The range of CTSI values tends to increase from August to December (Figure 7). This is due to the increasing concentration of TN and TP from September to December, together with the ongoing rainy season.

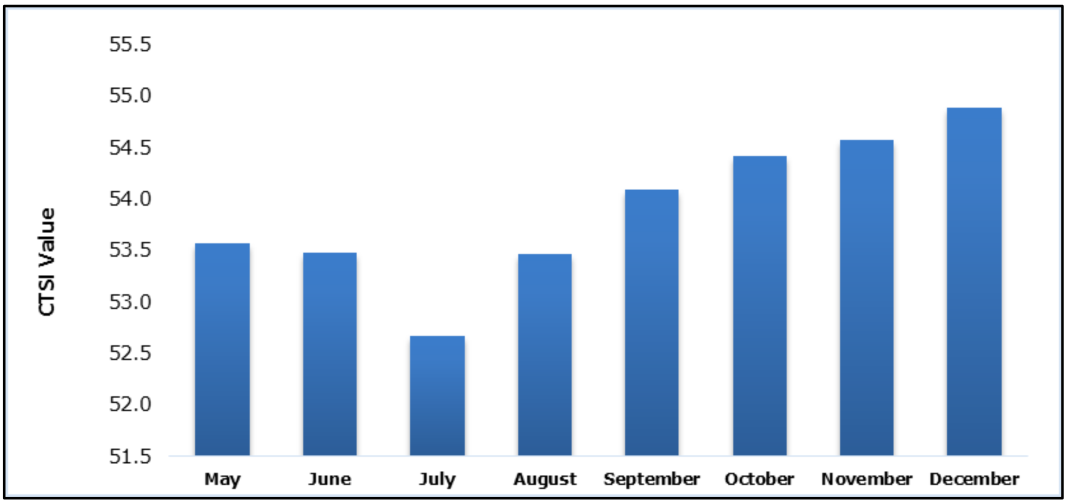

Figure 7. Temporal variation of the CTSI (Carlson's Trophic Status Index) values in Wadaslintang Reservoir.

The overall CTSI value is temporally and spatially included in the mesotrophic category. According to Wen et al (2016), if the TSI value ranges from 50 to 60, then the transparency value ranges from 2 to 1 m, with phosphorus concentrations ranging from 24 to 48 mg m^{-3}, and chlorophyll concentrations ranging from 7.4 to 48 mg m^{-3}. The spatial variation of the CTSI is presented in Figure 8.

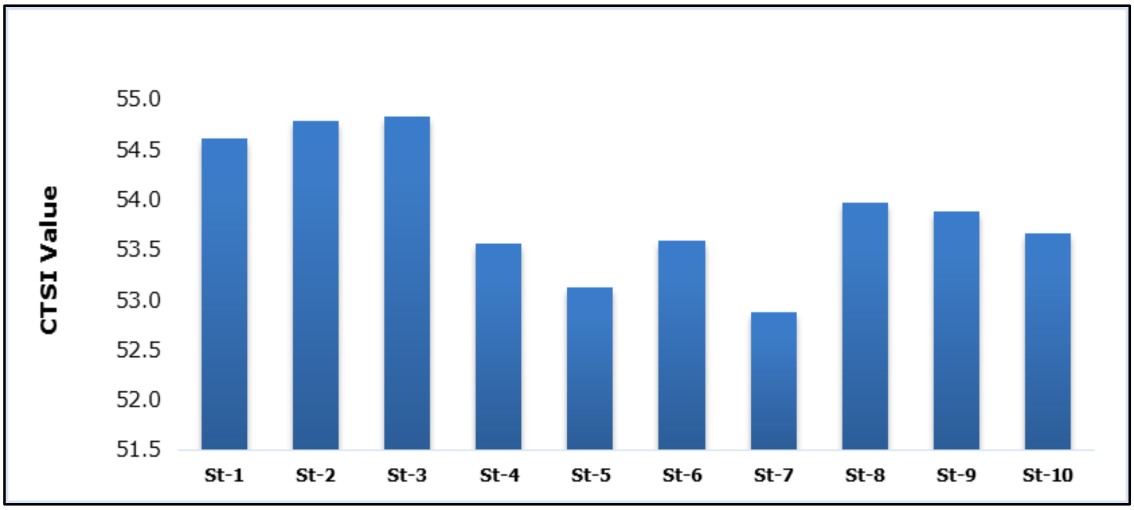

Figure 8. Spatial variation of the CTSI (Carlson's Trophic Status Index) values in Wadaslintang Reservoir.

Plankton composition in Wadaslintang Reservoir. The trophic status of the reservoir can be determined based on Chl-a concentration. It is both an indicator of the presence of plankton biomass and for nutrient concentration and transparency. There were identified 57 genera from 7 phyla consisting 20 species of Bacillariophyte, 3 species of Cyanophyte, 24 species originating from Chlorophyte, 2 species of Euglenophyte, 7 species of Pyrrophyte, 4 species Rotifers, and 5 species of Arthropods (Table 3).

The composition of plankton from Wadaslintang Reservoir is 84.86% Chlorophyte, 8.16% Bacillariophyte, 5.94% Pyrrophyte, 0.12% Cyanophyte, 0.75% Euglenophyte, 0.19% Rotifers, and 0.075% Arthropods.

Table 3

The abundance of individuals of each plankton species in the Wadaslintang Reservoir

	Phytoplankton	individual abundance		Phytoplankton (continuation)	individual abundance
	Bacilariophyte			Chlorophyte (continuation)	
1	*Achnantes lanceolata*	(+++++)	15	*Pediastrum tetras*	(++)
2	*Achnanthidium* sp.	(+++++)	16	*Protococcus viridis*	(++)
3	*Amphipleura* sp.	(+++)	17	*Sphaerocystis schroeteri*	(++)
4	*Coscinidiscus* sp.	(++)	18	*Staurastrum anatium*	(+++)
5	*Cyclotella* sp.	(++)	19	*Staurastrum dejectum*	(++++)
6	*Denticula tenuis*	(+++)	20	*Staurastrum elegantissima*	(++)
7	*Denticula thermalis*	(+++)	21	*Staurastrum manfeldtii*	(++++)
8	*Diatoma elongatum*	(++)	22	*Staurastrum tetracerum*	(+++)
9	*Eunotia serra*	(++)	23	*Scenedesmus bijuga*	(++)
10	*Mastogloia* sp.	(++)	24	*Tetraedron* sp	(+++)
11	*Melosira granulata*	(++++)		Euglenophyte	
12	*Navicula brachysirn*	(+++)	1	*Rodhomonas* sp.	(++)
13	*Navicula insuta*	(++++)	2	*Trachelomonas euchlora*	(++)
14	*Nitzschia actinotroides*	(++)		Pyrrophyte	
15	*Nitzschia acicularis*	(+++)	1	*Ceratium furca*	(+++)
16	*Pinnularia nobilis*	(++)	2	*Glenodinium* sp.	(+++)
17	*Rhopalodia gibba*	(++)	3	*Hypmnodinium* sp.	(+++)
18	*Synedra acus*	(++++)	4	*Peridinium epiniferum*	(++)
19	*Synedra ulna*	(++)	5	*Peridinium umbonatum*	(++++)
20	*Surirella robusta*	(++)	6	*Peridinium striolatum*	(+++++)
	Chlorophyte		7	*Peridinium willei*	(++)
1	*Ankistrodesmus* sp.	(++)		Zooplankton	
2	*Asterococcus* sp.	(+++)		Rotifers	
3	*Botryococcus braunii*	(+++++)	1	*Keratella cochlearis*	(++)
4	*Chlorella* sp.	(+++++)	2	*Keratella serrulata*	(++)
5	*Chlorococcum humicola*	(+++)	3	*Keratella valga*	(+++)
6	*Closteriopsis longissima*	(++++)	4	*Polyarthra* sp.	(+++)
7	*Closterium acutum*	(+++)		Arthropods	
8	*Closterium calosporum*	(++)	1	*Cyclops* sp.	(+++)
9	*Closterium indiosporum*	(+++)	2	*Cypris* sp.	(++)
10	*Cosmarium* sp.	(++)	3	*Daphnia* sp.	(++)
11	*Dispora* sp.	(++)	4	*Moina* sp.	(++)
12	*Eremosphaera* sp.	(++)	5	*Nauplius* sp.	(++)
13	*Golenkinia* sp.	(++)			
14	*Microspora* sp.	(+++)			

Note: <100 - very few (+); 100-1000 - few (++); 1001-10000 - moderate (+++); 10001-100000 - abundant (++++); >100000 - very abundant (+++++).

The dominant phytoplankton is Chlorophyte, composed of 24 species from 17 genera. Chlorophyte are usually found in freshwaters and are generally abundant in waters with sufficient light (Dembowska et al 2018). Chlorophytes are composed of highly adaptable species, with fast-breeding rates, and high tolerance to temperature fluctuations (Siagian & Simarmata 2018). Its members are found abundantly in almost all research stations. The dominant species is *Botryococcus braunii*, which was found in all stations with an average abundance of 3545714 individuals L^{-1} and the next is *Chlorella* sp., with an average abundance of 578937 individuals L^{-1}. *B. braunii* are aquatic organisms that are planktonic and cosmopolite (Çelekli et al 2007). The microalgae is also found in the Darwin Reservoir, Australia, and Lake Nozha, Egypt. This species has an allelopathic effect that affects the decline in aquatic biota diversity. The phytoplankton is also associated with the mass death of fish in Lake Liyu (Taiwan), Lake Paoay (Philippines) and Lake Nozha (Janse van Vuuren & Levanets 2019).

The Bacillariophyte identified in this study consist of 20 species from 16 genera. The dominant species is *Achnantes lanceolata*, with an abundance of 142513 individuals L^{-1}, and it was found in almost all research stations. Bacillariophyte (Diatoms) are used as a bioindicator of water quality assessment, eutrophication, and pollution of organic matter, because they have fast growth, high biodiversity and high sensitivity to physico-chemical water factors (Khudher & AL-Jasimee 2019; Soeprobowati et al 2020). Bacillariophyte had been used to reconstruct past environmental condition of Rawapening Lake, Java (Soeprobowati et al 2012) and the human impact on the water quality of Warna Lake (Soeprobowati et al 2017; 2018). Bacillariophyte are the main composers of phytoplankton structure in Rawapening Lake (Soeprobowati & Suedy 2014) and are a source of oxygen that can chemically change the environment of the surrounding waters (Letáková et al 2018). The most dominant member in Cyanophyte is *Microcystis* sp., with an abundance of 33265 individuals L^{-1}.

For zooplankton, the Rotifers are more abundant than Arthropods. The average individual abundance of each research station ranged from 258639 to 704607 individuals L^{-1}. The highest abundance was in St-5, while the lowest abundance was found in St-6 (Figure 9). The highest abundance occurred in July with 1868098 individuals L^{-1}, while the lowest abundance occurred in May, with 60324 individuals L^{-1} (Figure 10). *Peridinium* is the most common genus of Pyrrophyte. *P. striolatum* and *P. umbonatum* are the most abundant species, with a total of 176442 and 87021 individuals L^{-1}, respectively. *Keratella valga* is the dominant species of the zooplankton from the Rotifers, with a total abundance of 4817 individuals L^{-1}. *Cyclops* sp. is the most common member of the Arthropods, with a total abundance of 2128 individuals L^{-1}. Zooplankton abundance can be influenced by limnological variables such as SD, Chl-a, TP, or TN (Pomari et al 2018).

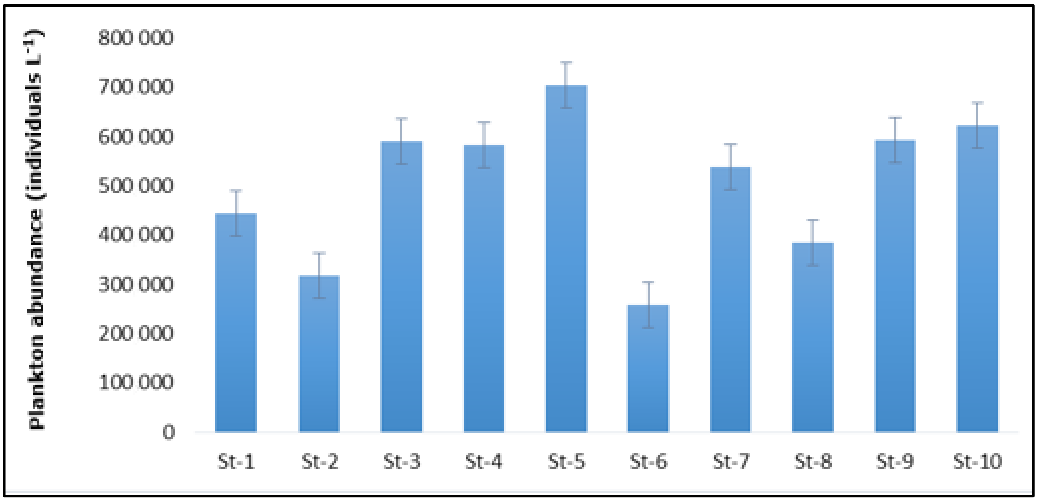

Figure 9. Plankton spatial abundance (individuals L^{-1}) in Wadaslintang Reservoir.

The abundance of phytoplankton in the dry season (May-August) is relatively higher than the abundance in the rainy season (September-December). Biomass changes will usually occur more quickly than changes in species composition when nutrient levels rise. In the rainy season, the intensity of sunlight is relatively lower than in the dry season. Although at that time the concentration of nutrients for phytoplankton growth was abundant, the process of photosynthesis could not take place optimally. Also in the rainy season, the level of sunlight penetration into the waters is lower, thereby reducing the level of oxygen solubility. This is one of the limiting factors in the survival of plankton, especially phytoplankton. The distribution of plankton in waters is influenced by season and water conditions (Kadim et al 2018).

Phytoplankton has the role of energy producer and it ensures oxygen production that helps other aquatic biota (Ali et al 2010). High phytoplankton biomass is also one of the basic indicators of eutrophication (Soria et al 2019). The results show that plankton abundance in Wadaslintang Reservoir ranges from 60384 to 1868098 individuals L^{-1}. According to Siagian & Simarmata (2018), waters with a plankton abundance higher than 15000 individuals L^{-1} are included in the eutrophic category. Plankton abundance in each research station varies due to the unequal distribution of aquatic organisms. Physico-chemical factors that influence abundance are differences in the concentration and solubility of nutrients in the waters, water flow, sunlight penetration, water currents and internal factors, such as the life cycle of phytoplankton. The life cycle of phytoplankton ranges from 15 to 20 days (Makhlough et al 2017). Phytoplankton is a bioindicator of organic matter pollution. It is related to the level of abundance of organisms that result in increased water fertility. The abundance of phytoplankton is influenced by the increase of nutrients in the waters. The main nutrients that play a role in increasing phytoplankton abundance are nitrogen and phosphate. These nutrient components generally come from residential, agricultural, livestock and fisheries waste (Makhlough et al 2017).

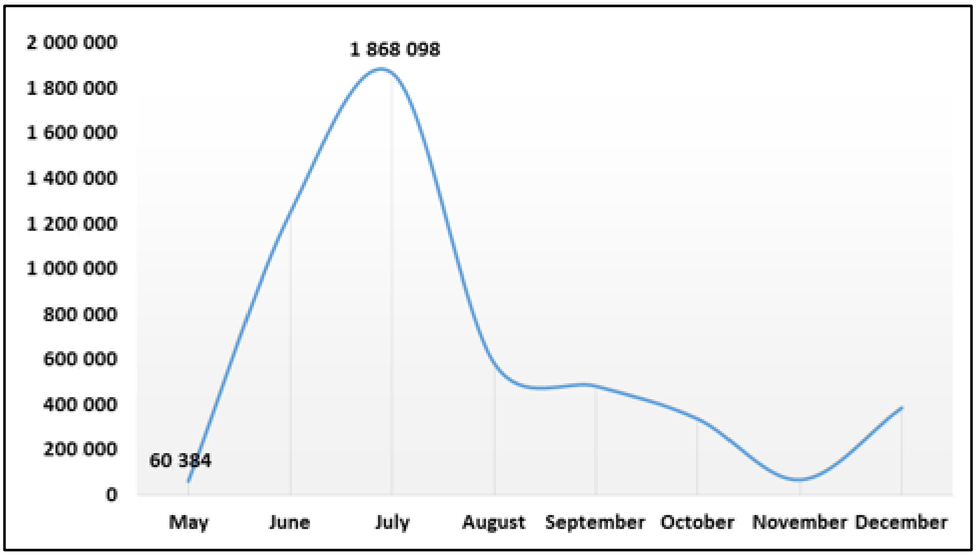

Figure 10. Plankton temporal abundance (individuals L^{-1}) in Wadaslintang Reservoir.

Conclusions. The results of this study indicate that the trophic status of the Wadaslintang Reservoir based on Chl-a concentration is mesotrophic, while based on TP and TN concentrations and SD is eutrophic. Based on the CTSI, Wadaslintang Reservoir is included in the mesotrophic category. TN and TP are the parameters that determine the CTSI value in the Wadaslintang Reservoir. The difference in time and sampling stations affects the trophic status value. The highest contamination occurred in September - December, in the reservoir overdraft area. This area receives nutrients from the catchment area of three major rivers (Cengis River, Tritis River, and Lancar River), which bring domestic, agricultural and livestock waste. In addition, aquaculture waste input increases the concentration of nutrients in the outlet area. However, the results did not show the effects of seasonal changes from May to December in the trophic level of the reservoir. The plankton from Wadaslintang Reservoir is composed of 84.86% Chlorophyte, 8.16% Bacillariophyte, 5.94% Pyrrophyte, 0.12% Cyanophyte, 0.75% Euglenophyte, 0.19% Rotifers, and 0.075% Arthropods. The dominant phytoplankton species are *Botryococcus braunii* (Chlorophyte) and *Achnantes lanceolata* (Bacillariophyte).

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