Indonesian Journal of Limnology
Vol. 05 No. 02, 2024 (77–90)
E-ISSN :2774-2571

Condition of the Progo River Upstream in Temanggung Regency based on Community Structure and Saprobic Index of Plankton

Alvin Afriliandri [a,b], Riche Hariyati [a, b*], Tri Retnaningsih Soeprobowati [a,b], Mirza Hanif Al Falah [b,c]

[a] Department of Biology, Diponegoro University, Jalan Prof. Soedarto, Semarang 50275
[b] Cluster for Paleolimnology, Diponegoro University, Jalan Imam Bardjo SH No 5, Semarang 50241
[c] School of Postgraduate Studies, Diponegoro University, Jalan Imam Bardjo SH No 5, Semarang 50241

* Corresponding author: riche.hariyati@gmail.com

Received 30 October 2024 Accepted 2 December 2024 Published 4 December 2024

DOI: 10.51264/inajl.v5i2.79

Abstract

Upstream of the Progo River in Temanggung Regency, it supports the daily lives of the surrounding community. As time goes by, human activities such as land conversion, deforestation, stone mining, agricultural activities and household waste slowly affect the condition of the waters in the Progo River, so it is necessary to monitor water quality. Plankton can indicate changes in water quality because it is responsive to changes in water quality. This research aims to assess the quality of the water environment using community structure and the saprobic index of plankton. Ten sampling stations were selected using the purposive random sampling method. Plankton were collected using a plankton net, water quality measurements were carried out using a Horiba water checker, and testing in the environmental engineering laboratory. As a result, 81 plankton species had an abundance per station of 805-3,981 ind/L. The diversity index (H') indicates a stable ecosystem, the Evenness Index (e) has a fairly even distribution, and the Dominance Index (D) is at all stations with no dominant species. According to PP No. 22 of 2021, the quality of the Progo River Upstream meets environmental quality standard criteria, except for DO and total N (class I). Based on the saprobic index and bioindicator species, it indicates that all stations belong to the β-Mesosaprobic. Several types of plankton that can be used as bioindicators of water quality include *Cladophora glomerata, Tabellaria* sp., and zooplankton, which are *Lecane* sp.

Keywords: Environment, Plankton, River, Saprobix index, Water quality.

1. Introduction

The condition of the river has been under pressure, along with the increasing number of human activities, which will disrupt the surrounding ecosystem (Agustira *et al.*, 2013). Anthropogenic activities in the upstream section, such as deforestation, riparian vegetation and conversion of agricultural land, plantations or residential areas, will have an impact on reducing water quality due to the receipt of input discharge loads originating from anthropogenic activities around the river (Pasisingi *et al.*, 2014).

One type of river watershed that has an important role and is feared to experience a decline in water quality is the Progo watershed (Suryatmaja *et al.*, 2015). The upstream Progo River Basin is located in the Temanggung region, with a length of around 38 km2 and a reasonably large area, namely around 576 km^2. Apart from that, several areas in the Upper Progo River have stone mining activities, which can reduce material deposits and result in erosion and river degradation (Ikhsan *et al.*, 2015). If this activity continues, it will cause problems from upstream to downstream and impact clean water sources (Antoro & Purnama, 2014).

The importance of clean water sources in Temanggung is proven by the increase in demand for clean water sources by 2,130 customers throughout 2022, bringing it to 48,997 customers (Central Bureau of Statistics Temanggung Regency, 2023). The use of water as a source of clean water in the upstream of the Progo River, Temanggung, is a vital need for the population; this is because the water in the upstream of the Progo River is used for the wider community, such as drinking, cooking, washing and industrial water. Apart from that, it is used for fisheries and irrigation needs. Even ecosystems are used to overcome fires, planting, reforestation and water reserves (Decree of the Minister of Public Works, 2010).

Problems in the Upstream of the Progo River are important, especially regarding clean water sources and increasingly rapid anthropogenic activities. One method for assessing the level of water quality is biological analysis, namely, aquatic bioindicator studies (Chandel *et al.*, 2024).

One of the aquatic living creatures that can be used as a bioindicator is plankton (Aprianti, 2015). Plankton are organisms that float in the water column and become biota that can be used as pioneers in aquatic productivity. In waters where waste loads have not been polluted, plankton composition will be balanced. If the waters are polluted, there will be changes in the structure of the plankton community in terms of species diversity, abundance and distribution of plankton (Kamboj *et al.*, 2022).

Water quality analysis studies using plankton have been carried out at the Cengklik Boyolali Reservoir (Roziaty *et al.*, 2018), Kartini Beach and Muara Wiso Jepara (Dewi *et al.*, 2023), and the Semarang West Canal Flood (Zulfiandi *et al.*, 2024). All three show that the Bacillariophyta division is found in the highest numbers and can help represent water conditions and hypothesize sources of pollution. Meanwhile, Fitriasa & Sudarsono (2022) analyzed the saprobic index in the Code River and discovered that it was in β– Mesosaprobic condition.

This research aims to determine the condition of the waters in the upper reaches of the Progo River, where previous studies have never been carried out, by interpreting the results of community structure and the saprobic plankton index. The results of this research help realize the implementation of Sustainable Development Goals (SDGs) 6 (clean water and sanitation) and 13 (climate action).

2. Methods

2.1. Study Area

The Progo River or Kali Progo is the name of a river whose water source and upstream are in Jumprit Village, which originates from Mount Sindoro (3,155 meters above sea level), while it empties into the Hindia Ocean (Indra *et al.*, 2013). The Progo River has a watershed that crosses Central Java Province and Yogyakarta Special Region province. The main Progo River is around 138 km long and has tributaries originating in several mountains (Ikhsan *et al.*, 2019). The Progo River Basin is divided into upstream watersheds and downstream watersheds; the upstream watershed includes Central Java province, with river water flowing from rain coming from several mountains such as Mount Sindoro (3,155 meters above sea level) (Sudibyakto, 1999). The upstream Progo River is a type of river in the Temanggung region and has a length of around 38 kilometres with a watershed or watershed area of more than 576 km^2.

2.2. Data Collection

Sampling was conducted in January 2023 and determined ten stations in the upstream area of the Progo River, Temanggung Regency, Central Java. Determination of stations using the purposive random sampling method. Sampling was carried out once with three repetitions. The selection of sampling locations is along the riverbank with the criteria of locations that are close to rocks, vegetation and sediment around the river, this allows plankton to be trapped around it. Thus reducing the effect of plankton movement caused by river currents.The selected locations are Umbul Jumprit (P1) which is a water source at the mouth of a cave and does not have a fast current, Candiroto Bridge (P2) is a river near an agricultural area and does not have a fast current, Jumo Dike (P3) is a river with a large dike and has a fairly fast current, Rowo Bridge (P4) is a river close to agriculture or plantations and has a fairly fast current, Kali Galeh (P5) is a river near densely populated settlements and has a fast current, the confluence of the Progo River and Galeh River (P6) is a river far from residential areas and has a fairly fast current, Grabah River (P7) is a river area close to residents' plantations and does not have a fast current, Kuas River (P8) is a river close to densely populated settlements and has a fairly fast current, Geneng Bridge (P9) is a river close to sand mining and has a fast current and Progo Kranggan Bridge (P10) is a river area close to residential areas and agriculture with a fast current (figure 1).

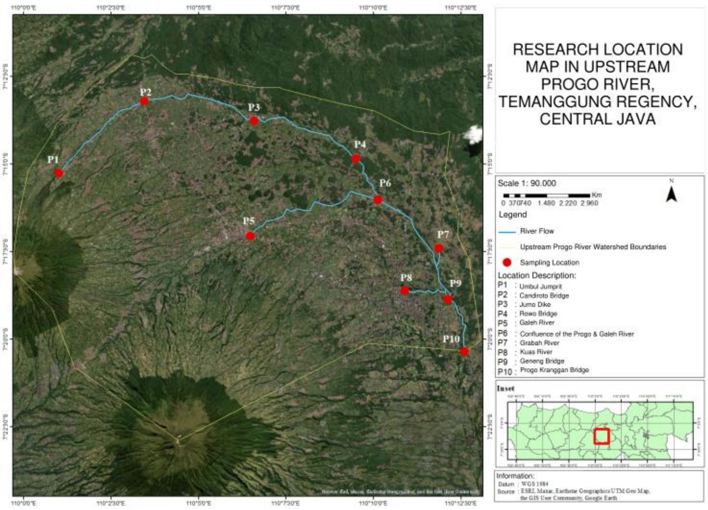

Figure 1. Research loaction map

Plankton were collected at all stations using a 25 micron (µm) plankton net, where 30L of water is taken. Then the plankton samples obtained were put into a sample bottle and dripped with 5-6 drops of Lugol to preserve the plankton samples (Witariningsih *et al.*, 2020; Rosada & Sunardi, 2021). Then, the sample bottle is given information according to where the sample was taken. Plankton samples were observed under a light microscope with a magnification of 1000x (the objective lens 100x and the ocular lens 10x) and identified using the identification book (Taylor *et al.*, 2007; Suthers & Rissik, 2009; Bellinger & David, 2010; Sahu *et al.*, 2013; Slotwinski *et al.*, 2014; Sulastri, 2018) and from AlgaeBase (Guiry & Guiry, 2023).

2.3. Surface Runoff Analysis

1) Plankton Abundance

Plankton abundance was calculated using the plankton abundance formula based on the American Public Health Association (2005) formula:

$$N = \frac{T}{L} \times \frac{p1}{p2} \times \frac{V1}{V2} \times \frac{1}{W} \quad \text{(Equation 1)}$$

N : Plankton abundance (ind/L)
Q : Number of boxes in SRC (1,000)
L : Number of squares in one field of view
P1 : Number of plankton observed
P2 : Number of observed SRC boxes
V1 : Volume of water in the sample bottle (250 ml/ 25 x 10^{-2} L)
V2 : Volume of water in the SRC box (1 mL/ 1 x 10^{-3} L)
W : Volume of filtered water (30 L)

2) Shannon-wiener Diversity Index (H’)

The diversity index is calculated using the Shannon-Wiener index according to (Odum, 1998) with a formula including:

$$H' = -\sum_{i=1}^{n} Pi \ln Pi \quad \text{(Equation 2)}$$

H' : Diversity index
Ni : Number of individuals of type i
N : Total number of individuals of all types
Based on this, the range of diversity index results according to (Odum, 1998) is divided into several groups:
0 < H' < 1.5 = Low diversity
< H' < 3.5 = Medium diversity
H' > 3.5 = High diversity

3) Evenness Index (e)
The evenness index is calculated using the formula (Odum, 1998):

$$e = \frac{H'}{Hmaks} \quad \text{(Equation 3)}$$

e : Evenness index
H' : Diversity index
H'max : Maximum Diversity Index
S : Number of types
Based on this, the range of equality index results according to (Odum, 1998) is divided into several groups, namely:
e > 0.6 = The level of evenness of taxa is even
0.4 < e < 0.6 = The level of evenness of taxa is quite even
e < 0.4 = The level of evenness of taxa is uneven

4) Dominance Index (D)
The dominance index is calculated using the formula from Simpson (1949):

$$D = \sum (Pi)^2 \quad \text{(Equation 4)}$$

D : Dominance index
Ni : Number of individuals of species I (ind/L)
N : Total number of plankton per sampling point (ind/L)
Based on this, the range of dominance index results according to (Odum, 1998) is divided into several groups, including:
0 < C < 0.5 = No dominance
0.5 < C < 1 = There is dominance

5) Saprobic Index
The saprobic index can be calculated using the following formula (Drescher & van der Mark, 1976):

$$X = \frac{(C + 3D - B - 3A)}{(A + B + C + D)} \quad \text{(Equation 5)}$$

X = Saprobic Index
A = Cyanophyta and Cilliata
B = Dinophyta and Euglena
C = Chlorophyta and Diatom
D = Chrysophyta/Peridinae/Conjugaceae

Table 1. The Relationship Between the Saprobic Index and the Level of Water Pollution (Dahuri, 1997)

Pollutants	Pollution Level	Saprobic Phase	Coefficient (X)
Many Organic Compounds	Very high	Polisaprobik	-3,0 until -2,0
		Poli/α - Mesosaprobik	-2,0 until -1,5
	Heavy enough	α-Meso/ Polisaprobik	-1,5 until -1,0
		α - Mesosaprobik	-1,0 until -0,5
Organic and Inorganic Compounds	Medium	α/β - Mesosaprobik	-0,5 until 0,0
		β/α - Mesosaprobik	0,0 until +0,5
	Slight	β - Mesosaprobik	+0,5 until +1,0
		β - Meso/oligosaprobik	+1,0 until +1,5
Few Organic and Inorganic Compounds	Very light	Oligo/β - Mesosaprobik	+1,5 until +2,0
		Oligo/saprobik	+2,0 until +3,0

All data will be calculated using Microsoft Excel and PAST 4.16c

3. Results and Discussion

3.1. Plankton Abundance

Based on the research results, 81 plankton species covered four divisions, consisting of 69 phytoplankton species and 12 zooplankton species. The composition of phytoplankton found in the research is divided into four divisions: Bacillariophyta, Chlorophyta, Chrysophyta and Cyanophyta, while zooplankton consists of several phyla such as Amoebozoa, Arthropoda, Ciliophora, Rhizopoda, Rotifera and Tardigrade (Figure 2).

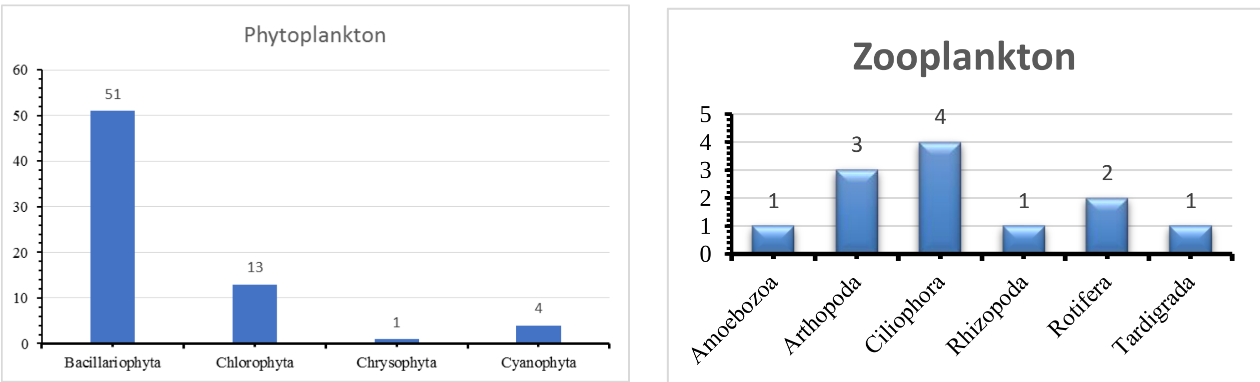

Figure 2. Composition of phytoplankton and zoopankton division

The largest phytoplankton community was found in the Bacillariophyta (74%), followed by Chlorophyta (19%), Cyanophyta (6%) and Chrysophyta (1%). According to research from Istadewi *et al.* (2016), Bacillariophyta can adapt well and quickly to light conditions or even low levels of food nutrition. Apart from that, Bacillariophyta is a type of plankton that reproduces faster than other types and can withstand environmental changes, so the community of Bacillariophyta is enormous.

Most zooplankton was found in the Ciliophora (34%), followed by the Arthropoda (25%), Rotifera (17%), then the Amoebozoa, Rhizopoda and Tardigrada groups, respectively (8%). Ciliphora can be abundant in waters such as rivers because the Ciliophora easily adapts to the environment and has a ciliary body structure for unrestricted movement. Sommer (1951) states that motility may significantly impact a cell's ability to react to environmental conditions and enhance its nutrient uptake. Ciliophora can be abundant in waters because it has a body structure in cilia allows it to move in the water, avoid predator attacks, and go to places with lots of food sources (Gao, 2016).

The calculation results show that the abundance of plankton ranges from 805 – 3,980 Ind/L, thus indicating it is in the low to medium category. According to Rikardo (2016), plankton abundance of less than 1,000 Ind/L is classified as low, 1000-40,000 Ind/L is classified as medium and more than 40,000 Ind/L is classified as high. The highest abundance of plankton was at station P5, with a total of 3,980 Ind/L. Meanwhile, the lowest plankton abundance was station P1, with a total of 805 Ind/L (figure 3). Jangkaru (2000) stated that the nutrients in that water cause the abundance of plankton in a body of water. Lander (1978) says that plankton abundance can be categorized into three categories such as low abundance or less than 2,000 Ind/L (Oligotrophic/Low fertility), medium abundance in the range of 2,000-15,000 Ind/L (Mesotrophic/Medium fertility) and abundant high ranges between 15,000 Ind/L (Eutrophic/High fertility).

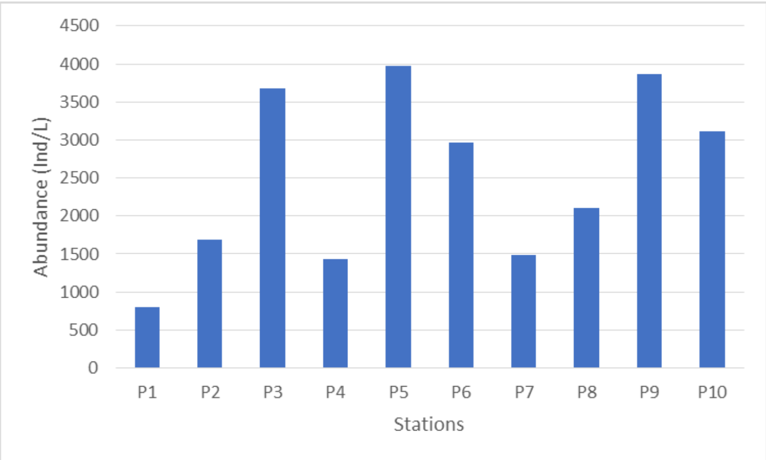

Figure 3. Plankton abundance (ind/L) from each station shows that P5 had the most abundance

The species with the most abundance is *Tabellaria flocculosa* Kutzing at station P7, with several individuals of 666 Ind/L. *Tabellaria flocculosa* lives in fresh waters and has a wide pH range. Spaulding *et al.* (2021) state that *Tabellaria flocculosa* can live with a wide range of acid-base levels and is usually found in various types of waters, including flowing waters. The presence of the *Tabellaria* may indicate that the waters are classified as lightly polluted. *Tabellaria* sp. is included in the Bacillariophyta, which plays a vital role in the primary productivity of waters. Anggoro (1988) says that *Tabellaria flocculosa* is an oligosaprobic level indicator organism.

One type of plankton often found at all stations is *Planktothrix* sp (Cyanophyta). This species is widely distributed and often lives in various habitats, such as freshwater (Gaysina *et al.*, 2019). Padisak (2009) found that the distribution of planktonic algae such as *Planktothrix* is wide.

Frustulia crassinerva (Kutzing) was found with a total of 633 Ind/L at station P5. The genus *Frustulia* is an organism with a wide habitat distribution system, including fresh water (Kociolek et al., 2015). *Frustulia* has habitat characteristics that tend to be acidic (Gell *et al.*, 1999). *Synedra fulgens* Graville is a type of plankton that is quite abundant at station P5, with the number of individuals being 566 Ind/L. This species is a species with a varied distribution.. In the opinion of Isti'anah *et al.* (2015), the genus *Synedra* can live in almost all aquatic environments, so it has high abundance.

3.2. Community Structure of Plankton

The Diversity Index (H') has varying values ranging from 2.27-3.28 (figure 4). This indicates that the diversity of all diversity stations is moderate to high. This is in accordance with Krebs (1985) that if the diversity index value H' >3 indicates the area has high diversity, if the value 1>H>3 indicates moderate diversity and if the value H<1, then it indicates low diversity. The station with the highest diversity value is P6, with an H value of 3.28. The H' value indicates that station P6 has stable conditions. This station has high diversity due to the accumulation of several plankton species from 2 rivers, so that diversity is more significant.

The evenness index value ranges from 0.44 to 0.79 (figure 4). This value states that the species are distributed relatively evenly and evenly. This was stated by Odum (1998) that an evenness value (e) of 0.4-0.6 indicates that the level of species evenness is relatively even, and an evenness value of 0.6 indicates that the species evenness is even and in a balanced condition (there is no competition). Great for getting food and for the environment). Meanwhile, if the evenness value is 0.4, it indicates that the evenness of the species is not even.

The dominance index is relatively low or indicates no dominant species. The dominance index ranges from 0.05-0.21; this means that the waters of the Upper Progo River can be said to be stable. The stability of the ecosystem can be caused by the penetration of light, which can still be captured by plankton so that it can grow well and no one dominates. According to Anggara *et al.* (2017), a low dominance index shows that each plankton can associate in a balanced way in a community; therefore, in the waters, no ecological factors are found for certain plankton. This means that no stations have differences in the number or types of plankton.

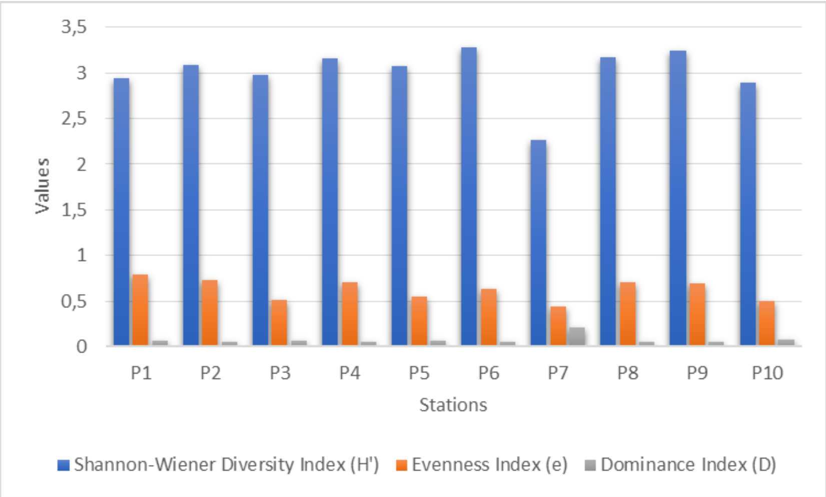

Figure 4. The community structure of plankton shows Progo River's upstream categorized as a good environment

3.3. Water Quality Based on Physical and Chemical Parameters

The study measured several water quality parameters, including temperature, pH, dissolved oxygen (DO), total phosphate, and total N. The results of calculating the average of these parameters at each station have varying values. All water quality parameters are compared with the quality standards of PP No. 22 of 2021 concerning the Implementation of Environmental Protection and Management.

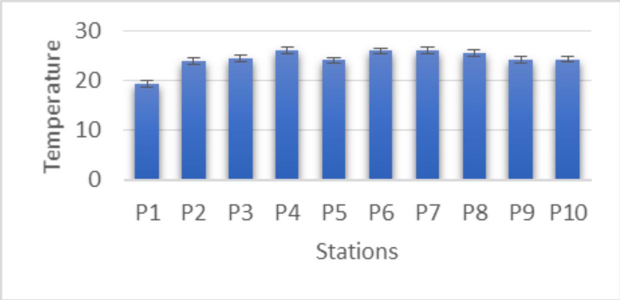

Figure 5. Temperature (°C) rate from each stations

The highest temperature measurement results were at station P4, 26.17 °C, while the lowest temperature was at station P1, 19.36 °C (figure 5). The station has the highest temperature because there are no shady trees around the station, and the intensity of sunlight during the day is relatively high. According to Chin (2006), the factor that influences temperature changes is shade, such as trees, while P1 is the station with the lowest temperature because this station has the highest altitude compared to all stations. Umbul Jumprit is a spring on the slopes of Mount Sindoro and is the source of the Progo River, located at an altitude of 2,000 meters above sea level and never dries up. All stations are quite optimal places for plankton to live. Effendi (2000) believes that a temperature of 20-30°C is optimal for the growth and development of plankton in waters.

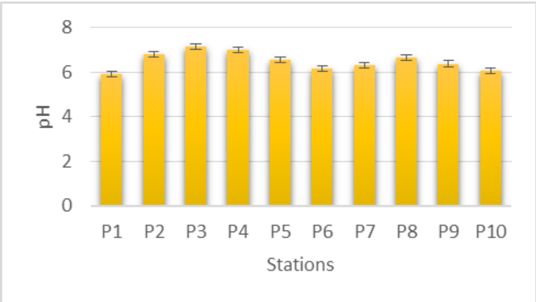

Figure 6. pH rate from each stations

Each station's acidity or pH level has a value ranging from 5.91-7.13 (figure 6). This is still a good measure for the growth and development of plankton to be able to live. Ananda *et al.* (2019) found that very acidic and alkaline pH levels can harm living plankton by disrupting the body's respiration and metabolism. All stations have a pH level below seven or are acidic except station P3. The acidic pH value is thought to be because organic and inorganic compounds enter the water, so the pH becomes acidic. Anderson *et al.* (2023) argue that the composition of organic materials can cause changes in the pH of water; this occurs because the decomposition of organic compounds will cause the pH of the water to decrease (acid).

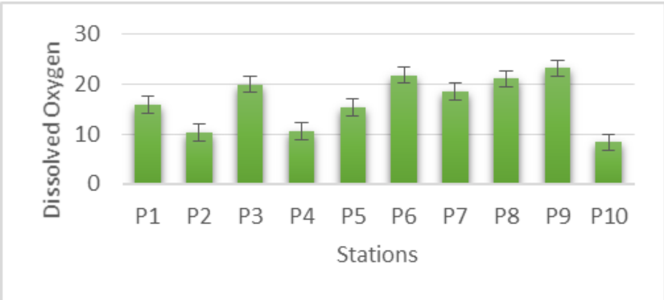

Figure 7. Dissolved oxygen rate from each stations

Dissolved Oxygen (DO) levels range between 8.29 and 23.09 mg/L (figure 7). This shows that oxygen in the waters supports plankton in growing and developing. According to PP no. 22 of 2021, the minimum DO limit for class I rivers is six mg/L, which indicates that all stations are suitable for living creatures. Adharini *et al.* (2021) argue that DO values of more than five mg/L are suitable for phytoplankton and zooplankton. The high DO at all stations is explained by the opinion of Radwan *et al.* (2003) that the high DO levels in upstream waters are because the area has flowing waters and strong currents, which provide opportunities for oxygen diffusion from air to water.

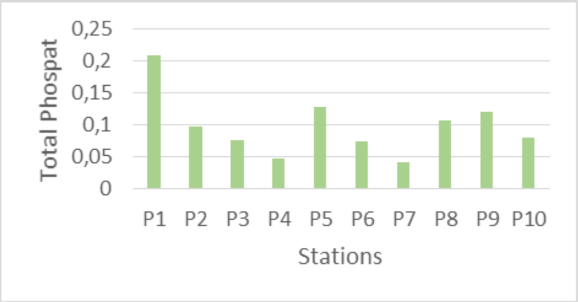

Figure 8. Total phospat rate from each stations

The phosphate parameter has a value range of 0.042-0.209 mg/L (figure 8). This value range is included in the class I quality standards of PP No. 22 of 2021. The station with the highest phosphate is P1 at 0.209 mg/L. This is thought to be because station P1 is close to a cave that produces phosphate minerals in the surrounding waters. According to the Ministry of Environment and Forestry of Indonesia (2016), areas with karst cave rocks will produce phosphate deposits in the surroundings. Apart from that, there is plant and animal waste and soil erosion. According to Moriber (1974), phosphate compounds come from natural sources such as soil erosion, weathering of animals and plants, the destruction of organic materials, phosphate minerals and the waste of living creatures.

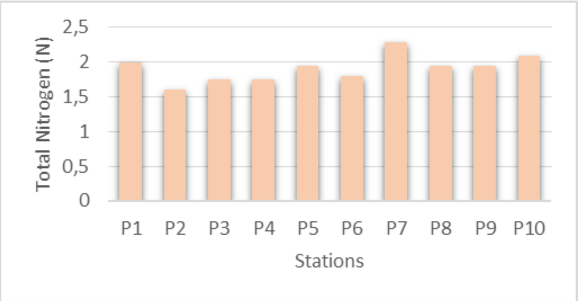

Figure 9. Total nitrogen rate from each stations

The total nitrogen concentration obtained ranged from 1,602 - 2,282 mg/L (figure 9); this does not meet the quality standards for PP No. 22 of 2021, where the quality standards are for class I. The station with the highest nitrogen content was station P7, with a value of 2,282 mg/L. This station has the highest levels due to community activities such as the use of agricultural fertilizer, washing activities, room waste.

3.4. Saprobic Index

Based on the results of the calculation of the saprobic coefficient, it can be seen that the saprobic value ranges between 0.50-0.84 (Table 2). The calculations according to the saprobic index show that the Upstream of the Progo River is lightly polluted. The highest saprobic index (0.84) was at station P5. This is because the station is near a densely populated residential area. In the opinion of Utomo (2013), the influence of residential proximity is most substantial on the level of the saprobic coefficient of a body of water. Apart from that, there is sedimentation activity and the influence of organic and inorganic compounds from residents' agriculture. All stations in this study have a saprobic phase, namely β-Mesosaprobic, with coefficient values ranging from 0.5 - 1.0. β-Mesosaprobic is a water condition with light levels of organic and inorganic pollution, produces nitrogen and has high DO. This is proven by the water quality results at all stations producing N-total (figure 8) and having DO levels (figure 6) that meet the quality standards of PP No. 22 of 2021.

Table 2. Saprobic Index in each stations from upstream of the Progo River

Stations	Saprobic Index	Pollution Level
P1	+0,54	Slight
P2	+0,61	Slight
P3	+0,58	Slight
P4	+0,56	Slight
P5	+0,84	Slight
P6	+0,55	Slight
P7	+0,70	Slight
P8	+0,81	Slight
P9	+0,59	Slight
P10	+0,50	Slight

3.5. Plankton as Bioindicator

The research results at each station have several species that can be used as bioindicators of water quality, such as *Cladophora glomerata*, *Tabellaria fenestrata*, *Tabellaria flocculosa*, *Pinnularia* sp., *Oscillatoria* sp., *Navicula* sp., *Nitzchia* sp., *Frustulia* sp., and *Synedra ulna* (Table 3). Anggoro (1998) found that the types of organisms that can be used for light pollution (β-mesosaprobic) are species such as the *Pinnularia* genus, *Tabellaria fenestrata*, and Chlorophyta species (*Cladophora glomerata*). Meanwhile, the type of organism that has a light pollution level or has not been contaminated is the *Tabellaria flocculosa*. Many of these species can be proven by several stations having a saprobic index, which is included in the β-mesosaprobic phase (Table 3).

Zhu *et al.* (2021) found that the genus *Oscillatoria* can be used to indicate the presence of aquatic nutrients. Dembowska *et al.* (2018) explained that diatom species could generally be used as waters containing nutrients in the waters and *Navicula* as indicators. Khushbu *et al.* (2022) argue that *Synedra ulna* and *Aulacoseira granulata* become abundant species if water nutrient levels are high. Another thing was clarified by Soeprobowati & Rahadian (2003), who explained that the *Synedra ulna* lives abundantly in industrial waters. Upstream of the Progo River, the industrial area includes tofu and plywood factories.

Zooplankton from the genus *Lecane*, namely *Lecane curvicornis* and *Lecane luna*, are bioindicators that live in waters with low to high nutrient levels (Table 3). In research in the Upstream of the Progo River, the discovery of the *Lecane* genus was thought to be due to water quality, total phosphate (figure 7) and total N (figure 8). It is clear from the opinion of Islam *et al.* (2022) that *Lecane luna* is an abundant species when nutrient conditions are maximum in Himalayan Lakes. Shah *et al.* (2018) also explained that *Lecane flexilis*, *Lecane* sp. and *Lecane luna* can live even in highly nutrient-rich waters. Plankton species as bioindicators in the Upstream of the Progo River, Temanggung Regency, can be seen in Table 3 as follows:

Table 3. Several species can be used to be bioindicator in Progo River Upstream

Species List	Information
Cladophora glomerata	Light pollution
Tabellaria fenestrata	Light pollution
Tabellaria flocculosa	Light pollution

Species List	Information
Pinnularia sp.	Light pollution
Oscillatoria sp.	Rendah-Tinggi Nutrisi
Navicula sp.	Low-High Nutrient
Frustulia sp.	Low-High Nutrient
Synedra ulna	Industrial Area
Lecane curvicornis	Low-High Nutrient
Lecane luna	Low-High Nutrient

4. Conclusion

Based on the research results, it can be concluded that in the Upstream of the Progo River, 81 species of plankton were found with an abundance ranging from 805 to 3,981 ind/L. The diversity index (H') in the medium to high category indicates a stable ecosystem, the Evenness Index (e) with a reasonably even to even distribution, and the Dominance Index (D) at all stations with no species dominating.

Water quality still supports plankton growth; according to PP No. 22 of 2021, the quality of the Progo River Upstream meets environmental quality standard criteria, except for total DO and N (class I). Based on the saprobic index between 0.50 and 0.84, it indicates that all stations belong to the β-Mesosaprobic category. This condition can be characterized by the emergence of *Cladophora glomerata*, *Tabellaria* sp., and zooplankton are *Lecane* sp.

5. Acknowledgement

There is no conflict of interest in this research. Thanks to Muhammad Isnaini, Ravena Eka, and Abdullah Zidan, who help this research.

6. References

Adharini, R.I., Namastra, P., & Toni, B.S. (2021). Kelimpahan dan Struktur Komunitas Plankton di Sungai Pasir dari Kabupaten Kulon Progo (Yogyakarta) hingga Purworejo (Jawa Tengah). *Limnotek*, 28(2). https://doi.org/10.14203/limnotek.v28i2.356.

Agustira, R., Kemala, S.L., & Jamila, J. (2013). Kajian Karakteristik Kimia Air, Fisika Air Dan Debit Sungai Pada Kawasan Das Padang Akibat Pembuangan Limbah Tapioka. *Jurnal Online Argoekoteknologi*. 1(3), 615-625. https://doi.org/10.32734/jaet.v1i3.2939.

American Public Health Association (APHA). (2005). *Standard methods for the examination of water and wastewater* (1st ed.). American Public Health Association.

Ananda, Y., Restu, I.W., & Rani, E. (2019). Status Trofik dan Struktur Komunitas Fitoplankton di Danau Beratan, Desa Candi Kuning, Kecamatan BatuRiti, Kabupaten Tabanan, Provinsi Bali. *Jurnal Metamorfosa*, 6(1), 58-66. https://doi.org/10.24843/metamorfosa.v06.i01.p10.

Anderson, L. E., DeMont, I., Dunnington, D. D., Bjorndahl, P., Redden, D. J., Brophy, M. J., & Gagnon, G. A. (2023). A review of long-term change in surface water natural organic matter concentration in the northern hemisphere and the implications for drinking water treatment. *Science of The Total Environment*, *858*, 159699. https://doi.org/10.1016/j.scitotenv.2022.159699.

Anggara, A.P., Kartijono, N.E., & Bodijantoro, P.M.H. (2017). Keanekaragaman Plankton di Kawasan Cagar Alam Tlogo Dringo, Dataran Tinggi Dieng, Jawa Tengah. *Jurnal MIPA*, 40(2), 74–79. https://doi.org/10.15294/ijmns.v40i2.12563.

Anggoro, S. (1988). *Analisa Tropic-Saprobik (Trosap) untuk Menilai Kelayakan Lokasi Budidaya Laut*, in: Workshop Budidaya Laut Perguruan Tinggi Se-Jawa Tengah. Universitas Diponegoro, Semarang. 66-90.

Antoro, M.D., and Purnama, L.S. (2014). Studi Perubahan Kualitas Air di Sungai Progo Bagian Hilir D.I Yogyakarta Tahun 2009-2013. *Jurnal Bumi Indonesia*, 3(4).

Aprianti, N.S., Sulardiono, B., & Nitisupardjo, M. (2015). Kajian tentang Fitoplankton yang Berpotensi Sebagai HABs (Harmful Algal Blooms) di Muara Sungai Plumbon, Semarang. *Diponegoro Journal of Maquares*, 4(3), 132-138. https://doi.org/10.14710/marj.v4i3.9330.

Bellinger, E.G, & David, C.S. (2010). *Freshwater Algae: Identification and Use as Bioindicators*. John Wiley and Sons, Ltd.

Central Bureau of Statistics Temanggung Regency. 2023. *Luas Penggunaan Lahan dan Alat-alat Mesin Pertanian Kabupaten Temanggung 2021*. Katalog BPS: 5104002.3323.

Chandel, P., Mahajan, D., Thakur, K., Kumar, R., Kumar, S., Brar, B., Sharma, D., & Sharma, A.K. (2024). A review on plankton as a bioindicator: A promising tool for monitoring water quality. *World Water Policy*, 10(1), 213-232. https://doi.org/10.1002/wwp2.12137.

Chin, D.A. (2006). *Water-Quality Engineering in Natural Systems*. New Jersey: John Wiley & Sons, Inc.

Dahuri, R. (1995). *Metode dan Pengukuran Kualitas Air Aspek Biologi*. Institut Pertanian Bogor.

Decree of the Minister of Public Works of Indonesia. (2010). *Pola Penggelolaan Sumber Daya Air Wilayah Sungai Progo-Opak-Serang*. Number 590.

Dembowska, E.A., Mieszczankin, T., & Napiorkowski, P. (2018). Changes of the phytoplankton community as symptoms of deterioration of water quality. *Environment Monitoring Assessment*, 190(95), 1-11. https://doi.org/10.1007/s10661-018-6465-1.

Dewi, A.N., Hadi, E., & Widianingsih. (2023). Kajian Distribusi Fitoplankton Kaitannya dengan Kesuburan Perairan Pantai Kartini dan Muara Wiso Jepara. *Journal of Marine Research*, 12(2), 275-282. https://doi.org/10.14710/jmr.v12i2.35240.

Drescher, T.G.N., & van der Mark, H. (1976). A simplified method for the assessment of quality of fresh and Slightly Brackish Water. *Hydrobiologia*, 48, 199-201. https://doi.org/10.1007/BF00028691.

Effendi, H. (2000). *Telaah kualitas air bagi pengelolaan sumberdava lingkungan perairan. Jurusan Sumberdava Perairan dan Kelautan*. IPB. Bogor

Fitriasa, M., & Sudarsono. (2022). Analisis Indeks Trofik-Saprobik Sebagai Indikator Kualitas Air di Aliran Sungai Code, Daerah Istimewa Yogyakarta (DIY). *Jurnal Edukasi Biologi*, 8(2), 131-146. https://doi.org/10.21831/kingdom.v8i2.18195.

Gao, F., Warren, A., Zhang, Q., Gong, J., Miao, M., Sun, P., Xu, D., Huang, J., & Yi, Z. (2016). The All-Data-Based Evolutionary Hypothesis of Ciliated Protists with a Revised Classification of the Phylum Ciliophora (Eukaryota, Alveolata). *Scientific Reports*. 6, 24874. https://doi.org/10.1038/srep24874.

Gaysina, L.A., Aniket, S., & Prashant, S. (2019). Cyanobacteria in Diverse Habitats. *Cyanobacteria*, 1-28. https://doi.org/10.1016/B978-0-12-814667-5.00001-5.

Gell, P.A., Sonneman, J.A., Reid, M.A., Illman, M.A., & Sincock, A.J. (1999). *An Illustrated Key to Common Diatom Genus from Southern Australia*. Cooperative Research Centre for Freshwater Ecology, Albury

Guiry, M.D., & Guiry, G.M. (2023). *AlgaeBase. World-wide electronic publication, National University of Ireland, Galway*. [accessed 2023 Feb 21]. https//www.algaebase.org.

Indra, B.B., Angghita, L.J., Wahyuni, S.E., & Kurniani, D. (2013). Perencanaan Bendung Progo Jumo, Sungai Progo Kabupaten Temanggung. *Jurnal Karya Teknik Sipil S1 Undip (JKTS)*, 1–10.

Ikhsan, J., Pratama, R.B., & Harsanto, P. (2015). Kajian Kegiatan Penambangan Pasir dan Dampaknya terhadap Dasar Sungai di Kali Progo Hilir Pasca Letusan Merapi tahun 2010. *Prosiding Konferensi Nasional Teknik Sipil*, 9, 291-296.

Ikhsan, J., & Krisna, B.A. (2019). Kajian Infrastruktur Dan Sempadan Sungai pada Wilayah Rawan Banjir Lahar di Sungai Progo Hilir. *Jurnal Teknik Sipil*, 15(2), 74–85. https://doi.org/10.24002/jts.v15i2.3715.

Islam, M., Azadi, M.A., Nasiruddin, M., & Islam, T. (2022). Checklist of Zooplankton of the Halda River, Chattogram, Bangladesh. *Journal of Bioresource Management*, 9(1), 110-122.

Istadewi, I., Jamhari, M., & Kundera, I.N. (2016). Kelimpahan Plankton di Danau Rano Kecamatan Balaesang Tanjung dan Pengembangannya Sebagai Media Pembelajaran. *Jurnal Sains dan Teknologi Tadaluko*, 5(3), 75- 84.

Isti'anah, D., Faizul, H., & Ainun, N. (2015). *Synedra* sp. Sebagai Mikroalga yang Ditemukan di Sungai Besuki Porong Sidoarjo, Jawa Timur. *Bioedukasi*, 8(1), 57-59. https://doi.org/10.20961/bioedukasi-uns.v8i1.3500.

Jangkaru, Z. (2000). *Pembesaran Ikan Air Tawar Di Berbagai Lingkungan Pemeliharaan Ikan*. Penerbit Swadava: Jakarta

Kamboj, V., Kamboj, N., Sharma, A., & Bisht, A. (2022). Phytoplankton communities as bio-indicators of water quality in a mining-affected area of the river Ganga, Haridwar, India. *Energy, Ecology and Environment*, 7(4), 425–438. https://doi.org/10.1007/s40974-022-00238-5.

Khusbu, R., Gulati, & Sushma. (2022). *Plankton: a Bio-Indicator of Healty for Aquatic Ecosystem*. In book: Research Trends in Fisheries and Aquatic Sciences.

Kociolek, J.P., Theriot, E.C., Williams, D.M., Julius, M., Stoermer, E.F., & Kingston, J.C. (2015). *Centric and Araphid Diatoms*, dalam JD Wehr, RG Sheath & JP Kociolek (Editor), Freshwater Algae of North America: Ecology and Classification, Second Edition, Academic Press, United States of America.

Krebs, C.J. (1985). *Experimental Analysis of Distribution and Abundance*. Third Edition. New York.

Lander. (1978). *Ecology: The Experimental Analysis of Distribution and Abudance*. Harper and row, New york.

Ministry of Environment and Forestry of Indonesia. (2016). *Potret dan Rencana Pengelolaan Ekosistem Karst Kalimantan*. Pusat Pengendalian Pembagunan Ekoregion Kalimantan.

Moriber G. (1974). *Environmental Science*. Allyn and Bacon. Inc. Boston. 549p.

Odum, E.P. (1998). *Dasar-dasar Ekologi*. Translated from Fundamental of Ecology by T. Samingan. Gadjah Mada University Press. Yogyakarta.

Padisak, J. (2009). *The Phycogeography of Freshwater Algae*. Encyclopedia of Inland Waters. Academic Press.

Pasisingi, N., & Niken, T.M. (2014). Water Quality of the Cileungsi River Upstream Based on Physical-Chemical Conditions. *Depik*, 3(1), 56-64.

Peraturan Pemerintah Republik Indonesia (PP). (2021). *Baku mutu sungai. Peraturan Pemerintah Republik Indonesia No. 22 Tahun 2021 Tentang Penyelenggaraan Perlindungan Pengelolaan Lingkungan Hidup*. Jakarta.

Radwan, M., Willems, P., El-Sadek, A., & Berlamont, J. (2003). Modelling of dissolved oxygen and biochemical oxygen demand in river water using a detailed and a simplified model. *International Journal of River Basin Management*, 1(2), 97-103. https://doi.org/10.1080/15715124.2003.9635196

Rikardo, I., Melani, W.R., & Apriadi, T. (2016). Keragaman fitoplankton sebagai indikator kualitas perairan Muara Sungai Jang Kota Tanjungpinang. *Skripsi*. Program Studi Manajemen Sumberdaya Perairan. FKIP. Universitas Maritim Raja Ali Haji, Kepulauan Riau.

Rosada, K.K., & Sunardi. (2021). *Metode Pengambilan dan Analisis Plankton*. Bandung: Unpad Press.

Roziaty, E., Daniek, H.A., & Nur, A.D.S. (2018). Keragaman Plankton di Wilayah Perairan Waduk Cengklik Boyolali Jawa Tengah. *Bioeksperimen: Jurnal Penelitian Biologi*, 4(1), 69-77. https://doi.org/10.23917/bioeksperimen.v4i1.5935.

Sahu, K.C., Baliarisingh, S.K., Srichandan, S., Anessh, A.L., & Kumar, T.S. (2013). *Monograph on Marine Plankton of East Coast of India-A Cruise Report*. Indian National Centre for Ocean Information Services, Hyderabad, 146 pp.

Shah, J., Akmad, Asyok, K.P., & Mustafa, S. 2018. Zooplankton as Bioindicator of Trophic Status of Two Wetlands in Kashmir Himalaya. *International Journal of Advance Research in Science and Engineering*, 7.

Simpson, E.H. 1949. Measurement of diversity. *Nature*, 163(4148), 688. https://doi.org/10.1038/163688a0.

Slotwinski, A., Frank, C., & Anthony, J.R. (2014). *Introductory Guide to Zooplankton Identification*. Brisbane: CSIRO.

Soeprobowati, T.R., & Rahardian, R. (2003). Diatom and Urbanization: A Case Study at Banger River Pekalongan. Paper presented in the *International Conference on Enviromental and Urban Management*. University of 1-3 August 2003. Soegyopranoto, Semarang.

Sommer, G. (1951). Die peritrichen ciliaten des Großen Plöner Sees. *Arch Hydrobiol*. 44, 349–440.

Spaulding, S. A., Potapova, M. G., Bishop, I. W., Lee, S. S., Gasperak, T. S., Jovanoska, E., … Edlund, M. B. (2021). Diatoms.org: supporting taxonomists, connecting communities. *Diatom Research*, 36(4), 291-304. https://doi.org/10.1080/0269249X.2021.2006790.

Sudibyatko, Suyono, & Dewi, G. (1999). Analisis Curah Hujan Untuk Antisipasi Kekeringan. In *Majalah Geografi Indonesia*, 23, 55–68.

Sulastri. (2018). *Fitoplankton Danau-danau di Pulau Jawa. Keanekaragaman dan Perannya Sebagai Bioindikator Perairan*. Jakarta: LIPI-Press.

Suryatmaja, H., Winardi, D.N., & Syafrudin S. 2015. Penentuan Status Mutu Air dengan Metode IKA-NSF Guna Pengendalian Lingkungan. *Jurnal Teknik Lingkungan*, 4(3), 1-6.

Suthers, I.M., & Rissik, D. (2009). *Plankton: A Guide to Their Ecology and Monitoring for Water Quality*. Collingwood: Commonwealth Scientific and Industrial Research Organisation (CSIRO) Publishing.

Taylor, J.C., Harding, W.R., & Archibald, C.G.M. (2007). *An Illustrated Guide to Some Common Diatom Species From South Africa.* Pretoria: Water Research Commission.

Utomo, Y., Priyono, B., & Ngabekti, S. (2013). Saprobitas Perairan Sungai Juwana Berdasarkan Bioindikator Plankton. *Unnes J. Life Sci*., 2(1), 28-35.

Witariningsih, N.P.M., Yulianto, S., & I Nyoman, G.P. (2020). Komposisi Jenis dan Fluktuasi Kelimpahan Plankton Secara Temporal di Perairan Selat Lombok. *Journal of Marine and Aquatic Sciences*. 6(1) 140-146.

Zhu, H., Liu, X.G., & Cheng, S.P. (2021). Phytoplankton community structure and water quality assessment in an ecological restoration area of Baiyangdian Lake, China. *International Journal of Environmental Science and Technology*, 18, 1529-1536. https://doi.org/10.1007/s13762-020-02907-6

Zulfiandi, Zainuri, M., & Ita, W. (2014). Kajian Distribusi Sebaran Fitoplankton dan Zooplankton di Perairan dan Estuaria Banjir Kanal Barat Kota Semarang Jawa Tengah. *Prosiding Seminar Nasional Kelautan IX*. Fakultas Teknik dan Ilmu Kelautan Universitas Hang Tuah Surabaya At: Surabaya, Indonesia Volume: IX.