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Plankton potential as bioindicator of trophic status of Lokop River Leuser Ecosystem

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ABSTRACT

Lokop is one of the villages in East Aceh which has a watershed in the Leuser Ecosystem. Human activities have the potential to disrupt the Trophic Status of Lokop River, such as the use of pesticides for agriculture, household waste and the use of potassium for fishing. It is necessary to research the quality of the waters in the Lokop River. The plankton community present in river waters can be an indicator of environmental pollution by analyzing the saprobic index. This study aims to determine the index of plankton diversity and water quality in the Leuser Ecosystem of the Lokop River through the saprobic index. The research was conducted at three stations. A sampling of plankton was taken in the form of a 10 cc filtrate and five replications were carried out for each study site. Water quality measurements include pH, TDS, Temperature, transparancy, depth, and current. 11 potential species can be used as pollution indicators in the Lokop River, namely *Cladophora* sp, *Diatoma elongatum*, *Fragilaria capucina*, *Oedogonium* sp., *Gonatozygon* sp, *Lyngbya* agardh, *Melosira* sp., *Merismopedia punctata*, *Microspora* sp, *Pinnularia* sp, *Synedra ulna*. The plankton diversity index is in the medium category. Based on the Saprobic Index, the level of pollution at the research site was not to lightly loaded of organic pollution and lowly loaded of organic pollution.

Introduction

Lokop is one of the villages in the Serbajadi sub-district, East Aceh with an area of 2,165, 66 KM^2 (Timur, 2020) which is one of the Leuser Ecosystem Areas. Lokop's natural conditions are surrounded by the Leuser Mountains with the Blangkejeren watershed as its upstream to the Tamiang River as its downstream. The bottom condition of the river waters consists of fine sandy soil with a little loam (Kaderudin, 2019). The bottom condition of these waters naturally has a high level of erosion. In addition, human activities also have the potential to disrupt the Leuser Sungai Lokop Ecosystem, such as the using of pesticides for agriculture, household waste, and the using of potassium to catch fish. River trophic status is one of the reasons for the presence of aquatic species such as fish. River trophic status can be seen from the abundance of phytoplankton in these waters. Rivers that have a high abundance of plankton are supported by good river water quality (Darmawan et al., 2018). Good aquatic has a good number of aquatic producers as well (Persada *et al*., 2019). In addition to abundance, phytoplankton can be used as a bioindicator by looking at the relative abundance, frequency, and relative frequency (Yeanny, 2018). The abundance of phytoplankton can affect the abundance of fish (Sulistiyarto, 2013). One of the fish found in the Lokop River is the Jurong Fish (*Tor* sp.) *Tor* sp. is a consumption fish that has high economic value, namely Rp. 150,000 – 170,000/kg (Maghfiriadi *et al*., 2019) *Tor* sp. is one of Indonesia's local freshwater fish whose existence is

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threatened with extinction (Desrita *et al.*, 2018). The IUCN in 2012 also stated that there are two types of Jurong fish in Indonesia that are threatened with extinction (Kottelat *et al.* 1993).

Based on the initial survey that has been carried out, there is also heavy equipment for excavating sand and stones. It is necessary to research the quality of the waters in the Lokop River. Water quality can be analyzed physically, chemically, and biologically. One of the water bioindicators is the presence of a community of aquatic organisms such as plankton, benthos and nekton (Pratiwi, 2019).

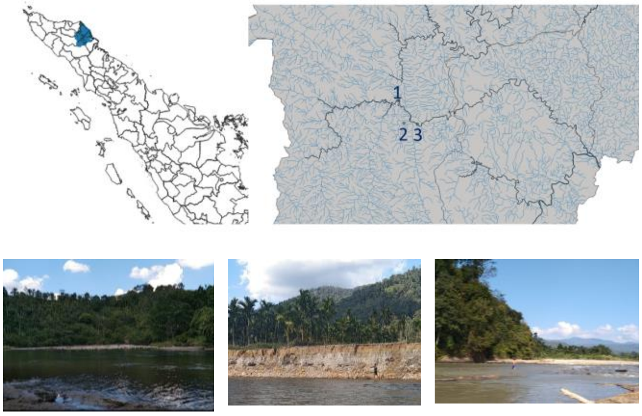
Plankton is small organisms that live in water and follow the movement of water. Plankton responds to environmental changes so that it can be used as a bioindicator of soil fertility, including river trophic status (Pratiwi, 2019). The plankton community will change due to changes in water conditions both naturally and due to human activities in the watershed. The changing environment due to the entry of certain substances or compounds causes the presence of plankton that can survive these conditions. Therefore, plankton can be used as a bioindicator of water quality, one of which is by using the aquatic saprobic index (Indrayani, *et al.,* 2014; Rasyid *et al.,* 2018)

The saprobic index is measured by the presence of plankton found such as Cyanophyta, Chlorophyta, Euglenophyta, and Chrysophyta. The saprobitc index can show the status of organic pollution in the waters (Indrayani, *et al.,* 2014; Ramadhan, *et al.,* 2016; Maresi, *et al.,* 2016). The presence of phytoplankton determines species at the trophic level above, such as fish and aquatic biota. Aquatic trophic status can be determined by the abundance of plankton in these waters. Therefore, it is necessary to research plankton in the Lokop River Leuser Ecosystem Area. This study aims to determine the types of potential plankton and the quality of the waters of the Lokop River Leuser Ecosystem. This research is hoped to be a guideline or reference in making policy on the development and management of Lokop River.

Materials and Methods

Location and time of research

The study was conducted in the Lokop River, East Aceh in August 2021 (Figure 1). The research was conducted at three stations, namely Upstream (4 25 49,958 N 97 30 34,555 E), Middle (4 24 04,376 N 97 31 00,133 E), and Downstream (4 24 00 N 97 32 04,164 E) (Table 1). Upstream is the highest station with a depth of more than 3 meters and have strong currents. Middle is the part that is close to residential areas with a depth of less than 1 meter. Downstream is a station that has sand mining activities. Each station sampled plankton and water quality measurements. A sampling of plankton was taken in the form of a 10 cc filtrate and five replications were carried out for each study site. Tools and materials for sampling water and plankton include 10 cc flakon bottles, 125µm plankton net, and lugol. The tools and materials used to observe and identify plankton were a microscope, Sedgwick Rafter Counting Cell (SRCC), aquades. The identification process is carried out at in the Basic Laboratory of Universitas Samudra. Water quality measurements include pH, TDS, Temperature, transparancy, depth, and current. Each environmental parameter was repeated three times for each research location.



Upstream Middle Downstream

Figure 1. Research station.

Table 1. Position of three locations on Lokop River.

Location	Position
upstream	4 25 49.958 N 97 30 34.555 E
middle	4 24 04.376 N 97 31 00.133 E
downstream	4 24 00 N 97 32 04.164 E

Data Analysis

Plankton samples that have been sampled will be analyzed for diversity index, evenness index and saprobic index. Diversity index analysis using the Shannon-Wiener diversity formula (Krebs, 2014):

$$H' = -\sum_{n=1}^{s} pi \ln pi \ , \ pi = \frac{ni}{N}$$

H'= diversity index; ni= total of individuals i, pi= relative abundance, N total number of individuals.

Analysis of the evenness index using the formula (Krebs, 2014):

$$E = \frac{H'}{H'maks}$$; H' maks = ln s; s= total of species

Saprobic index analysis using the formula (Dresscher *et al.,* 1976):

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$$X = \frac{C+3D-B-3A}{A+B+C+D}$$

X= Saprobic Coefficient; A= Total of organisms from the Cyanophyta/ polysaprobic group; B= Total of organisms from the Euglenophyta/ mesosaprobic group; C= Total of organisms from the group Cryshophyta/ -mesosaprobic; D = Total of organisms from the Chlorophyta/ oligosaprobic group.

Important Value Index (IVI) is calculated by adding up the relative density and relative frequency values Important Value Index (IVI) = Relative Density (DR) + Relative Frequency (FR);

$$DR = \frac{density\ of\ a\ species}{density\ of\ all\ species}\ x\ 100\%\ ;$$

$$Density\ (D) = \frac{number\ of\ individuals}{water\ volume}\ ;$$

$$FR = \frac{frequency\ of\ a\ species}{frequency\ of\ all\ species}\ x\ 100\%\ ;$$

$$Frequency\ (F) = \frac{number\ of\ water\ bottles\ found\ plankton}{total\ number\ of\ water\ bottles}$$

The results of water quality measurements are described and presented in the form of tables and figures.

Results

The results obtained 11 species of plankton in the form of phytoplankton with a different number of species for each location. Chlorophyceae was commonly found class with 9 species (Table 2, 3, and table 4). This was in line with Purbani's research that the largest class of Chlorophyceae is found in the waters of Simeulue Island, Aceh. The upstream location consisted of 10 species with a diversity index of 1.95 (Table 2). The species that had the highest (IVI) was *Fragilaria capucina* at 49.49%. The genus Fragilaria was a genus that can respond quickly to environmental changes such as increased phosphorus (Lestari, Sulardiono and Rahman, 2021) The middle location contains 7 species with a diversity index of 1.77 (Table 3). Downstream locations obtained 8 species with a diversity index of 1.59 (Table 4). *Synedra ulna* was a species that has the highest IVI, which was 81.41%. *Synedra ulna* is a species of the Bacillariophyta that highly tolerant of organic pollution (Haroon et al., 2020). The research location had a moderate category of diversity (1<H'<3). The evenness index for upstream, middle, and downstream locations were 0.81; 0.74; and 0.66. The evenness index which was close to 1 indicates that the distribution of the number of individuals of each species was the same. Species Eveness index at the study site was categorized as high (E>0.6). The saprobic index at the study site, included in Oligo and mesosaprobic. The upstream, middle, and downstream saprobic indexes were 2.56; 2.57; and 1.29 (Table 5).

Water quality measured included pH, TDS, water temperature, transparancy, depth, and current (Table 6). Each location was measured 3 times as a replication.

Table 2. Plankton upstream.

No	Species	Class	DR	FR	IVI	pi	ln pi	pi ln pi	H	E
1	*Cladophora*	*Chlorophyceae*	4.35	8.82	13.17	0.04	-3.14	-0.14		
2	*Diatoma elongatum*	Chlorophyceae	7.25	8.82	16.07	0.07	-2.62	-0.19		
3	*Fragilaria capucina*	Chlorophyceae	34.78	14.71	49.49	0.35	-1.06	-0.37		
4	*Gonatozygon sp*	Chlorophyceae	18.84	14.71	33.55	0.19	-1.67	-0.31		
5	*Lyngbya agardh*	Cyanophyceae	2.90	5.88	8.78	0.03	-3.54	-0.10	1.95	0.81
6	*Melosira sp.*	Chlorophyceae	2.90	5.88	8.78	0.03	-3.54	-0.10		
7	*Merismopedia punctata*	Cyanophyceae	5.80	8.82	14.62	0.06	-2.85	-0.17		
8	*Microspora sp*	Chlorophyceae	5.80	8.82	14.62	0.06	-2.85	-0.17		
9	*Pinnularia sp*	Chlorophyceae	4.35	8.82	13.17	0.04	-3.14	-0.14		
10	*Synedra ulna*	Chlorophyceae	13.04	14.71	27.75	0.13	-2.04	-0.27		
	Total		100	100	200	1	-26.44	-1.95		

Table 3. Plankton middle.

No	Species	Class	DR	FR	IVI	pi	ln pi	pi ln pi	H	E
1	*Diatoma elongatum*	Chlorophyceae	6.38	4.55	10.93	0.06	-2.75	-0.18		
2	*Fragilaria capucina*	Chlorophyceae	29.79	7.58	37.36	0.30	-1.21	-0.36	1.77	0.74
3	*Gonatozygon sp*	Chlorophyceae	25.53	37.88	63.41	0.26	-1.37	-0.35		

No	Species	Class	DR	FR	IVI	pi	ln pi	pi ln pi	H	E
4	*Lyngbya agardh*	Cyanophyceae	10.64	37.88	48.52	0.11	-2.24	-0.24		
5	*Microspora sp*	Chlorophyceae	8.51	3.03	11.54	0.09	-2.46	-0.21		
6	*Pinnularia sp*	Chlorophyceae	6.38	3.03	9.41	0.06	-2.75	-0.18		
7	*Synedra ulna*	Chlorophyceae	12.77	6.06	18.83	0.13	-2.06	-0.26		
	Total		100	100	200	1	-14.84	-1.77		

Table 4. Plankton downstream.

No	Species	Class	DR	FR	IVI	pi	ln pi	pi ln pi	H	E
1	*Cladophora*	Chlorophyceae	4.00	5.88	9.88	0.04	-3.22	-0.13	1.59	0.66
2	*Diatoma elongatum*	Chlorophyceae	8.00	11.76	19.76	0.08	-2.53	-0.20		
3	*Fragilaria capucina*	Chlorophyceae	8.00	11.76	19.76	0.08	-2.53	-0.20		
4	*Merismopedia punctata*	Cyanophyceae	12.00	17.65	29.65	0.12	-2.12	-0.25		
5	*Microspora sp*	Chlorophyceae	4.00	5.88	9.88	0.04	-3.22	-0.13		
6	*Oedogonium sp*	Chlorophyceae	8.00	11.76	19.76	0.08	-2.53	-0.20		
7	*Pinnularia sp*	Chlorophyceae	4.00	5.88	9.88	0.04	-3.22	-0.13		
8	*Synedra ulna*	Chlorophyceae	52.00	29.41	81.41	0.52	-0.65	-0.34		
	Total		100	100	200	1	-20.01	-1.59		

Table 5. Saprobic index.

Location	Level of Saprobic	Saprobic Indeks	Pullotion Level
Upstream	2.56	oligosaprobik	not to lightly loaded of organic pollution
Middle	2.57	oligosaprobik	not to lightly loaded of organic pollution
Downstream	1.29	Oligo/βmesos aprobik	lowly loaded of organic pollution

Table 6. Water quality.

Parameter	Location		
	upstream	middle	downstream
pH	8	7.8	7.6
TDS	0.23	0.27	0.25
Temperature (°C)	27.1	24.1	26.7
Transparancy (meter)	2.5	0.43	0.895
Current (meter/second)	2.53	1.405	1.61
Depth (meter)	3.5	0.87	1.18

Discussion

Based on the results of the study, *Fragilaria capucina* was a species found in three conditions with high relative density for each location. The relative density of *Fragilaria capucina* in the upstream, middle, and downstream areas, respectively, was 34.78%; 29.79%; and 8%. This is because *Fragilaria capucina* has a wide tolerance range for organic matter (Safitri, 2019). However, *Fragilaria capucina* is not the species that has the highest relative density downstream. *Synedra ulna* is a species that has the highest density downstream, which is 52%. This indicates that there has been pollution downstream. The high presence of species from the Cyanophyceae class indicates that there had been lowly loaded of organic pollution in these waters (Isti'anah *et al*,, 2015). This is also following the results of the saprobic index (Table 5) which shows that there has been lowly loaded of organic pollution downstream.

The diversity index of all locations was in the moderate category with 1 < H' ≤ 3 (Krebs, 2014). This shows that all locations have moderate community stability (Sirait *et al.*, 2018). However, the upstream location has the highest H' with a value of 1.95 (Table 2), while the H' index of the middle and downstream locations has decreased, namely 1.77 (Table 3) and 1.59 (Table 4). This could be because upstream has the highest depth and transparancy (Table 6) so that more plankton are present in the upstream. The upstream has the highest current, depth and transparancy. The high depth and transparancy indicate that there are more plankton habitats than other locations. this makes the plankton in water bodies more individuals and their species are dispersed due to the help of strong currents. Depth and transparancy play a role in vertical temperature stratification and light penetration. This is in line with the results of research (Saputri, 2015) which found surface plankton with the most currents in the upstream location of the Krueng Raba River.

The plankton evenness index shows the even distribution of plankton at each location. The evenness index at the research sites ranged from 0.66 to 0.81. The evenness index at the research site is high, namely E> 0.5 (Krebs,2014). This shows that the distribution at each location is evenly distributed, no species dominates. Even distribution of plankton species is assumed because the pH at each location has similarities, which is in the 7.6 to 8 (Table 6). The pH at the research site is a suitable pH for plankton, ranging from 6-8 (Anggraini *et al.*, 2016).

The transparancy of the research site ranges from 0.43 to 2.53 m. the upstream location has the highest brightness of 2.53. This is because the upstream area is an unspoiled location, there is a lack of human activity around the research location. According to (Rahman et al., 2016) the low transparancy value can be caused by the presence of domestic waste that blocks the sun from entering the water body. The transparancy level affects the dissolved material in the waters, including plankton, and will be dangerous if the transparancy is less than 25 cm (Syahrur *et al.,* 2021). In addition, brightness also plays a role in aquatic trophic status because sunlight entering water bodies is needed for photosynthesis. High transparancy is one of the requirements for good photosynthesis by phytoplankton (Dharawibawa *et al.*, 2008).

The water temperature ranged from 24.1 to 27.1 ºC. The lowest temperature was in the middle location, which was 24.1 ºC. However, the low temperature at the central location did not inhibit the photosynthesis process. This was evidenced by the plankton diversity index which was included in the medium category. The diversity index of the middle location was higher than that of the downstream location even though the downstream water temperature was 26.7 ºC. This result was in line with research (Widiyanti *et al.,* 2020) which found that light penetration in low water bodies did not inhibit the abundance of plankton.

Conclusion

11 potential species can be used as pollution indicators in the Lokop River, namely *Cladophora* sp, *Diatoma elongatum*, *Fragilaria capucina*, *Oedogonium* sp., *Gonatozygon* sp, *Lyngbya agardh*, *Melosira* sp., *Merismopedia punctata*, *Microspora* sp, *Pinnularia* sp, *Synedra ulna*. The plankton diversity index is in the medium category. Based on the Saprobic Index, the level of pollution of the research site was ightly loaded of organic pollution and lowly loaded of organic pollution.

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