Water Quality Analysis Based on Plankton Community Structure in Kampar River, Riau Province

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Abstract. It is suspected that there has been pollution in the Kampar River as a result of land conversion. To determine the quality of Kampar River water, one of the parameters that can be used is a biological indicator, namely plankton. The research was conducted in July 2017 - July 2018 with the purposive sampling method at 3 observation stations. Plankton samples were analyzed using the Diversity Index (H’), Dominance (C), and Uniformity (E). From the results, it is known there are 13 types of plankton consisting of 2 classes: Bacillariophyceae (5 types) and Chlorophyceae (8 types). Abundance ranges from 7250-11500 cells/L with the genus Scenedesmus sp. has the greatest abundance. The diversity index value is included in the low to the medium category (1.9306-2.4574). The population dominance obtained from all stations is in a low category (<0.4). The population uniformity of the three stations shows a value that falls into the high category (>0.6), so it can be said that the uniformity of the plankton population in the Kampar River is high. From these results, it can be concluded that the Kampar River water body in this study belongs to the polluted category. This is also supported by the findings of the genus Synedra sp. at Station 2. This genus can live in a low DO condition and serve as an indicator of pollution. Although the abundance is low, the presence of this genus indicates that this area has experienced a decrease in water quality or pollution.

1. Introduction

A river is a natural and/or artificial water container in the form of a water drainage network and the water in it, starting from the upstream to the estuary [1]. The quality of river water is influenced by river conditions and water supply from small rivers which is also influenced by activities around the river [2]. The balance in the aquatic ecosystem is caused by human activities which result in water pollution [3]. Water quality that is not following water quality standards will interfere with the survival of organisms. Determination of the status of river water quality is carried out by comparing the water quality data with the quality standard according to its designation [4].

Kampar River is one of the large rivers flowing in Riau Province. Part of the Kampar River area is still functioning well as transportation infrastructure, a source of clean water, fish farming, and a source of electrical energy (PLTA) [5]. But the widespread conversion of land to oil palm plantations downstream of the Kampar River has caused flooding. The hydropower dam is unable to withstand the abundant water discharge due to land-use change resulting in flooding [6].

There are four major rivers in Riau, namely the Siak, Rokan, Indragiri, and Kampar rivers that have suffered damage due to company waste and oil spills, causing water quality to decline [7]. The Kampar River estuary is indicated to contain a lot of pollutants because there are many industrial activities along the river that dispose of waste into the river [8]. Cultivation activities in the Kampar River can affect water quality physically, chemically, and biologically which affect aquatic biota because they supply organic matter [9].

Various activities around the Kampar River have various impacts on river conditions. Therefore, it is necessary to measure the quality of water in the Kampar River to determine the status of the water quality from the three parameters, namely physics, chemistry, and biology to conserve the natural habitat in the river. The purpose of this study was to determine the physical, chemical, and biological water quality as well as the water quality status in the Kampar River, Riau Province.
2. Methodology
The research was conducted in July 2017 - July 2018, with the research object of the Kampar River. The research location is in the Pelalawan bridge area (Pelalawan sub-district) Riau Province at the coordinate point N: 00 ° 22'14.86 '' E: 101 ° 54'15.84 ". Sampling was carried out at three stations based on two seasons, namely the rainy season and the dry season. Water quality analysis was carried out at the Laboratory of Ecology and Water Environment Management, Faculty of Fisheries and Marine Science, Riau University.

2.1. Method
The method used in this research is purposive sampling. Biological parameters measured are plankton, plankton abundance can be calculated based on the method, namely

\[ N = Z \times Y \times X \times V \]

Information:
- \( N \) = total amount of plankton (cells / L)
- \( Z \) = Number of individuals found (cells)
- \( X \) = volume of filtered water (125 mL)
- \( Y \) = Volume of 1 dropper pipette (0.06 mL)
- \( V \) = volume of water filtered (100 L)

Furthermore, the plankton data that has been obtained were analyzed by the Diversity Index (H'), Dominance (C), and Uniformity (E). The species diversity index according to Shannon-Wiener is

\[ H' = \sum_{i=1}^{S} \frac{n_i}{N} \ln \left( \frac{n_i}{N} \right) \]

Information:
- \( H' \) = Species diversity index
- \( S \) = Many types
- \( N \) = total number of individuals
- \( n_i \) = number of individuals in each species

Indeks dominansi Simpon sebagai berikut[11] :

\[ C = \sum_{i=1}^{S} \frac{ni}{N} \]

Information:
- \( C \) = dominance index
- \( ni \) = abundance of the species
- \( N \) = total number of individuals of all species

Uniformity is the individual components of each species found in one community. The uniformity index formula is [12]:

\[ E = \left( \frac{1}{S} \right) \left( \sum_{i=1}^{S} \frac{n_i^2}{N^2} \right) \]

Information:
- \( E \) = uniformity index
\[ E = \frac{H'}{H_{\text{max}}} \]

Information:
- \( E \) = Uniformity index
- \( H' \) = Species diversity index value
- \( H_{\text{max}} = \log_2 S \)

3. Results and discussion
3.1. Plankton galore

Types of plankton found in the Kampar River during the study were 13 species consisting of 2 classes, namely: Bacillariophyceae (5 species) and Chlorophyceae (8 species) (Table 1).

**Table 1. Types of Plankton Found in the Kampar River during the Study**

| Class: Bacillariophyceae | Genus       | Species       |
|-------------------------|-------------|---------------|
| Centrales Cyclotellaceae | Cyclotella  | Cyclotella sp. |
| Pennales Diatomaceae    | Synedra     | Synedra sp.   |
|                         | Fragillaria  | Fragillaria sp. |
|                         | Navicula     | Navicula sp.   |
|                         | Nitzchia     | Nitzchia sp.   |

| Class: Chlorophyceae    | Genus         | Species         |
|-------------------------|---------------|-----------------|
| Chlorococcales Scenedesmaceae | Scenedesmus | Scenedesmus sp. |
|                         | Chodatellacea | Chodatella sp.  |
| Ulotrichaceae Desmidiaceae | Cosmarium    | Cosmarium sp.   |
|                         | Oocystaceae   | Ankistrodesmus  |
| Zyg nematales Desmidiaceae | Staurastrum  | Staurastrum sp. |
| Desmidiales Closteriaceae | Closterium   | Closterium sp.  |
| Sphaeropleales Hydrodictyaceae | Pediastrum | Pediastrum sp. |
|                         | Neochloridaceae | Plaktosphaeria | Plaktosphaeria sp. |

The abundance of plankton in the Kampar River ranges from 7250-11500 cells / L, the abundance of plankton in the Kampar River is more than that in the Sambas River, which is 150-201 cells / L [13], and in the Pepe Solo River is around 87-90 cells / L [14]. An adverse environment for plankton can lead to reduced plankton abundance [13]. The abundance of plankton can be seen in Table 2.

Genus *Scenedesmus* sp. has the most abundant and is the only genus found in three stations. *Scenedesmus* sp. that live in freshwater are cosmopolitan phytoplankton and act as producers in the waters [14]. Therefore, this genus is found at all stations on the Kampar River.

The genus with the least abundance is *Synedra* sp. which is only found at station 2. This genus can live in low DO conditions and is used as an indicator of pollution. Even though the abundance is low, the presence of this genus at station 2 indicates that station 2 has experienced a decrease in water quality or pollution.
Table 2. Plankton abundance found in the Kampar River during the study

| No. | Species          | Periphyton Abundance Mean (cells / cm²) | Total Abundance Each Species |
|-----|------------------|----------------------------------------|----------------------------|
|     |                  | St. I  | St. II | St. III |                      |
| 1   | Cyclotella sp.   | -      | 1000   | 1000    | 2000                 |
| 2   | Synedra sp.      | -      | 250    | -       | 250                  |
| 3   | Fragillaria sp.  | -      | 750    | -       | 750                  |
| 4   | Navicula sp.     | -      | 500    | 750     | 1250                 |
| 5   | Nitzschia sp.    | -      | 750    | -       | 750                  |

Bacillariophyceae

Chlorophyceae

Table 3. Diversity Index, Dominance and Uniformity of Plankton in the Kampar River

| Station | 1  | 2  | 3  |
|---------|----|----|----|
| H'      | 2.0821 | 2.4574 | 1.9306 |
| D       | 0.311  | 0.2533 | 0.3205 |
| E       | 0.8055 | 0.9507 | 0.8315 |

The dominance of the plankton population obtained from all stations is in a low category because the index value is <0.4. The low dominance index indicates that no plankton species dominate in the Kampar River. This is in line with the dominance of plankton in the Sambas River, namely 0.1138-0.153613 and in the Pepe River, namely 0.21-0.3214.

The uniformity of the plankton population from the three stations shows the values that fall into the high category. The obtained uniformity index value > 0.6, so it can be said that the plankton population uniformity in the Kampar River is high. The high value is inversely related to the diversity index. This shows that the more uniform the population of plankton species, the lower the diversity of species. The uniformity index in the Sambas River ranges from 1.8387-2.042613 and in the Pepe River is around 0.59-0.7114 which is in the high category.

4. Conclusion

Biological parameters of the Kampar River, there are 13 plankton genera with the highest total abundance at station 1 of 11500 cells / L. The genus that has the highest abundance at all stations is Scenedesmus sp. Based on the diversity value (H') of plankton including the Kampar River which is
classified as moderate, dominance (C) there is no dominant plankton genus and the uniformity value (E) of plankton is high.

Researchers suggest that efforts should be made to increase industrial waste management and other sources of pollution in the Kampar river. This is intended so that the potential of the Kampar River, especially in the field of fisheries, remains sustainable because various activities along the river do not interfere with the life of river organisms.

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