Water Quality Analysis Around the Floating Net Cage Culture Activities in the Kampar River, Buluhcina Village, Kampar District

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Abstract. There are Wallago leeri and Mystus nemurus floating net cage culture activities in the Kampar River that use rotten chicken flesh as fish feed and thus the feed remains as well as the fish metabolism reduce the water quality. To understand the quality of the water, a study has been conducted in February – March 2017. There are three sampling sites, in the upstream or before the cage area (Station 1), in the cage area (Station 2) and in the downstream of the cage area (Station 3). Sampling was conducted once. Parameters measured were water temperature, current speed, light penetration, total N, nitrate, nitrite, total P, Orthophosphate, TSS, TDS, pH, DO, CO₂, BOD₅, and COD. Data were analyzed using a Pollution Index (PI) Method and it is shown that the the water in the Station 1 (1.35) and 3 (1.29) are lightly polluted, while that of the Station 2 (0.86) is categorized as good and suitable for culture activities. The overall condition of water of the Kampar River in the Buluhcina Village is lightly polluted (1.16).

Keywords: Wallago leeri. Mystus nemurus. Pollution Index. Fishes metabolism

1. Introduction
Buluhcina Village is one of the villages located in Siak Hulu District, Kampar Regency. The Kampar River water in the Buluhcina Village produces many consumption fish such as Mystus nemurus and Wallago leeri. Increasing the demand of the freshwater fish, especially M. nemurus and W. leeri, has led to increasing fishing efforts that are carried out by the people of the Buluhcina village and resulting in reduction of fish populations. Cage cultivation is a solution conducted by the people of the Buluhcina Village to continue to fulfill the demand for those fishes.

The Buluhcina villager was also use the river to do fish cage culture activities. In these recent years, several studies have been conducted to observe the quality of the Kampar River waters, for
example in 2013 [1] and 2015 [2]. However, but the observations of the suitability of the Kampar River waters for cage cultivation have not been studied. To understand the suitability of the Kampar River, especially in the Buluh Cina Village area, a study has been conducted.

This study aims to describe the quality of the waters of the Kampar River in Buluhcina Village based on the pollution index and its suitability for aquaculture activities.

2. Research Methods

This research was conducted in the Buluhcina Village, Siak Hulu District, Kampar Regency in February-March 2017. Analysis of physical and chemical parameters was carried out in situ in the field and ex situ in the Ecology and Aquatic Environment Management Laboratory of the Faculty of Fisheries and Marine, University of Riau.

This research is a quantitative study, using a survey methods. Morphometric measurements of the river (length, width, depth), temperature, and recording of coordinates are carried out using the Echo Sounder tool (Garmin brand GPSmap 585 series). The number and pattern of cage distribution was noted. Sampling was done at 10 am, during the sunny conditions. There were three sampling points: upstream or before the cage area (Station 1), cage area (Station 2) and downstream of the river or after the cage area (Station 3). Sampling was done once. The parameters observed were water temperature, current speed and light penetration, total N, nitrate, nitrite, total P, orthophosphate, TSS, TDS, pH, DO, free CO2, BOD5, and COD. All ex situ measurement samples were put into the cool box on the same day and then taken to the laboratory for analysis.

Data obtained were then analyzed using the PI (Pollution Index) method [3] based on Class II (two) water quality in the Republic of Indonesia Government Regulation No. 82 of 2001 [4]. The PI formula is:

\[ IP_j = \sqrt{\frac{(C_i/L_{ij})^2}{M^2} + \frac{(C_i/L_{ij})^2}{M^2}} } \]  \hspace{1cm} (1)

\( IP_j \) is a pollution index for allotments \( j \); \( C_i \) is the concentration of water quality parameters; \( i \) or the results of field measurements (mg/l); \( L_{ij} \) is the concentration of water quality parameters \( i \) listed in the standard water designation \( j \) (mg/l); \( M \) is the maximum; \( R \) is mean. There are 4 IP index classes with a score of 0 ≤ IP ≤1.0 which is fulfilling the quality standard (good); 1.0 < IP ≤5.0 slightly polluted; 5.0 < IP ≤10 fairly polluted, IP> 10.0 with the status of heavily polluted waters.

3. Results and Discussion

Condition of the study area. This research was carried out in the beginning of the rainy season in 2017. Physical-chemical measurements of the water were carried out when the Kampar River water discharge in the Buluhcina Village began to rise, about 1 m from the water conditions during the dry season. The increase in the water flow of river, especially in the Buluhcina area occurred due to water discharges from the Koto Panjang hydropower reservoir. The river area that was studied (in the Buluhcina Village) was around 1,400 m length. In this study area, there are fish cages, 105 cages that were distributed along 700 m in the right side of the river and 213 cages distributed along 1100 m in the left side of the river. Total number of the cages was 318. Data on river morphometrics, cage distribution area and coordinates of the sampling area are shown in Figure 1.
Quality Analysis of Kampar River Waters in Buluhcina Village for Aquaculture Activities. The measurement results and calculations of the parameters in the physical-chemical quality test of water are described in Table 1.

Table 1. Results of measurement and calculation of physical - chemical parameters of water.

| Element | Variable       | Station 1 | Station 2 | Station 3 | Average |
|---------|----------------|-----------|-----------|-----------|---------|
| Water   | Temperature (°C) | 28        | 28        | 28        | 28      |
| Physics | Flow Speed 1 (m/s) | 0.147     | 0.121     | 0.142     | 0.136   |
|         | Flow Speed 2 (m/s) | 0.277     | 0.192     | 0.250     | 0.230   |
|         | Light Penetration (cm) | 20        | 25        | 22        | 22      |
|         | TSS (mg/l)     | 74        | 21        | 49        | 48      |
|         | TDS (mg/l)     | 72        | 14        | 59        | 48      |
| Water   | pH             | 6.8       | 6.6       | 6.6       | 6.6     |
| Chemistry | N total (mg/l) | 0.114     | 0.074     | 0.127     | 0.105   |
|         | Nitrate (mg/l) | 0.095     | 0.054     | 0.116     | 0.088   |
|         | Nitrite (mg/l) | 0.086     | 0.065     | 0.086     | 0.079   |
|         | P total (mg/l) | 0.069     | 0.035     | 0.071     | 0.058   |
|         | Orthophosphate (mg/l) | 0.227 | 0.117     | 0.232     | 0.192   |
|         | DO (mg/l)      | 7.0       | 5.5       | 7.6       | 6.7     |
|         | CO₂ free (mg/l) | 13.4      | 17.7      | 13.9      | 15      |
|         | BOD₅ (mg/l)    | 2.2       | 10.8      | 9.6       | 7.5     |
|         | COD (mg/l)     | 6.4       | 25.6      | 12.8      | 14.9    |

Temperature. The temperature value in this study is within the range of quality standards and is suitable for aquaculture activities. The optimal water temperature for the growth of aquatic biota ranges from 28-32 °C [4]. The results of temperature measurements carried out in this study are in line
with previous studies [2] which are also in the area of Buluhcina Village precisely in Lake Oxbow Pinang Dalam whose source of water supply comes from the overflow of Kampar River in Buluhcina Village which is 28°C.

**Flow Speed.** In February, the entire observation station on the Kampar River in Buluhcina Village has a current speed that is included in the slow category (0.10-0.25 m/s), while in March this situation changed to a medium category at the Station 1 and 3 parts (0.25-0.50 m/s) with the middle part containing cages still in the slow category.

The cage areas are categorized as the river parts that with the lowest current velocity, and even in the area between cages tend to have no current. As the cages commonly used in the Buluhcina Village is massive, those structure may inhibit the water flow in the surface as well as in the certain depth. Narrow space between the cages was also hamper the water to flow. The existence of obstacles in the water may reduce the speed of water flow [5].

**Light Penetration.** The level of light penetration is closely related to the turbidity of the waters. Water flow is one of the factors that affect the turbidity due to the stirring process [5]. In the Kampar River, the difference of sunlight penetration is influenced by the speed of the current. As has been said in the previous discussion, Station 2 which is part of the river contained cages has the lowest current speed. This assumption is supported by the results of research [2] conducted in the Pinang Dalam Oxbow Lake, Buluhcina Village. Measurement of light penetration in this study [2] ranges from 27-28 cm or 2-8 cm higher than the value of light penetration in the river in general. This difference occurs due to the different forms of water condition in the both studies. The Pinang Dalam Oxbow Lake is a type of lake ecosystem that has lower current speed compared to rivers, and the area with low turbidity may occurs due to stirring of the water flow.

**The value of total suspended solid (TSS) and total dissolved solids (TDS).** The highest TSS and TDS values from was present in the Station 1, followed by Station 3 and the lowest was in the Station 2 that was used as cages area. Results of this study are not in line with research conducted in the Toba Lake in 2013 [6] which showed that the highest TSS value, 18.56 mg/l obtained in the cage area. The high TSS value may came from feed waste as well as feces originated from the dense cages in the study area.

TDS and TSS values are closely related to river current velocity. River currents will affect the presence of particles in the waters due to the stirring process [5]. TSS and TDS values in waters are not only influenced by current velocity but they also have an influence on river physical factors, namely light penetration. Penetration of sunlight to the surface and deeper parts does not take place effectively because it is blocked by suspended residues such as sand, mud, clay and living components (biotics) such as phytoplankton, zooplankton [7]. Thus it can be assumed that the higher TSS and TDS values at Stations 1 and 3 in this study are due to differences in current speed at the three observation stations where the current speeds at Stations 1 and 3 are greater than those of Station 2, causing the stirring process to occur greater at Stations 1 and 3 compared to Station 2 to cause higher TSS and TDS values at Stations 1 and 3 also become higher.

**Degree of acidity or pH.** The difference in pH values occurs due to differences in metabolic rate and respiration in water bodies. The pH value is inversely proportional to the level of metabolic activity and respiration. The more metabolic activity and respiration, the pH value will be increasingly decreased [8]. The highest pH level at Station 1 may be due to the absence of cage activity in this area. In Station 2, the existence of cage activity may increase the fish metabolism and respiration and causes a pH decrease.
Total N values, nitrates, and nitrite, total P and orthophosphate. The highest levels of the N and P elements in various forms are at Station 3 followed by Station 1, while the lowest grade values are at Station 2. Besides being influenced by activities occurring in the waters, N and P levels that are in a waters also influenced by inputs carried by the flow of water. This possibility will increase, especially when the current flowing in the river is in high speed and the strength of the current may stir the sediment in the river bed and causing the rise of N and P.

Based on these assumptions, it can be said that the high N and P values at Station 1 or upstream of the Kampar River in Buluhcina Village are derived from the overflow of N and P Koto Panjang hydropower reservoirs which are then added to the existing N and P waters before reaching the area of Buluhcina Village. This assumption is also supported by the results of this study which show that Station 3 has the highest levels of N and P elements compared to the other two stations. This shows that there were additional N and P inputs from the Village of Buluhcina. Station 2, which is a river body with cages, has the lowest levels of N and P elements and tends to be different compared to Stations 1 and 3 which are upstream and downstream of the river. This situation is due to the part that has a cage at the time of sampling has not been affected by the flow of water as seen from the results of the measurement of water flow velocity that is only 0.04 m/s.

These results are consistent with studies that have been conducted to look at the content of Nitrogen, Phosphorus and Organic Carbon in Sentani Lake - Papua in 2015 [9] which shows that the mean of the total N and P concentrations in the lake outlet area has a higher value than the a lake that has cages. This fact shows that the overflow water coming out of the lake has high total N and P levels which then flow into the river body.

DO and carbon dioxide levels. The lowest oxygen content was in the Station 2, which was the river body with cages, while those of the Station 1 and 3 was the same. This condition may be due to high level of oxygen demand in Station 2, as it is needed for respiration of the fish, as well as the need of oxygen for decomposition process of food and waste remains. Dissolved oxygen in the waters tend to decrease along with the high decomposition process of organic matter by decomposers (aquatic microbes) [10].

The free carbon dioxide level in the waters shows the that there was high respiration level in the waters [11]. The highest free carbon dioxide was in the Station 2, while those of Stations 1 and 3 have were lower. This condition may be due to the high respiration rate which causes high carbon dioxide production at Station 2. The value of free carbon dioxide is inversely proportional to dissolved oxygen value, the higher free carbon dioxide will be the lower dissolved oxygen level [11].

Biological oxygen demand (BOD5). The amount of BOD in the Station 2 is was resulted from the high level of oxygen used bacteria to do the decomposing process of feed remains. The BOD value is the amount of oxygen needed by bacteria to decompose almost all dissolved organic matter and some organic matter that is suspended in water [12]. The presence of the current may flow away feed and metabolism remains. The waste that were not decomposed in the Station 2 will be washed away and flow to Station 3 and as a consequence, the BOD value in this area is also moderately high. A study in the Toba Lake [9] shown similar results, where the highest BOD5 value was 1.7 mg/l in the dense cage areas and the lowest was in the area with no cage, which was 0.4 mg/l. The accumulation of organic pollutants in the waters will increase the decomposition process by decomposing.
organisms and the concentration of BOD5 was also increases [13]. Therefore, the difference in the BOD5 value in the research areas indicate that the waters where the cage activity produces waste causing an increase in the decomposition process and resulting in an increase of BOD5 concentration in the waters.

**Chemical Oxygen Demand (COD).** Results of this study shown that the COD value in the Kampar River, especially in the Buluhcina Village exceeds the quality standard threshold (> 25.0 mg/l) is Station 2 (25.6 mg/l). This result is in line with research conducted in the Cirata Reservoir in 2016 [14] which states that the COD concentrations in cage-dense areas have higher concentrations and are significantly different from non cage areas. The high value of COD in the cage area is due to the increase in the input of organic material from the feed remains and fish metabolism that causes increasing the decomposition process in the water bodies [15].

**Pollution Index.** Results of the calculation of Pollution Index in the Kampar River Waters in the Buluhcina Village Area shown that the water quality of the three observation stations are under the Class II water quality standards. However, there are parameters that have different values and affects the calculation of the PI (Pollution Index). The PI measurement results are listed in Table 2.

The PI values indicate that the overall condition of the Kampar River waters can be categorized as slightly polluted (PI 1.16). The highest level of pollution occurs in the Station 1 (PI 1.35) or in the upstream of the cage area. This condition occur because there are two parameters that exceed the threshold, they were TSS and nitrite. The high value of TSS at Station 1 is due to the stirring process that occurs due to the flow of water [5]. Nitrite values at the observation station that exceeded the quality standard (0.06 mg / l) were Stations 1 and 3 which were 0.08 mg / l. While Station 2 (IP 0.86) the nitrite value is at the threshold of the quality standard tolerance level of 0.06 mg / l. The high value of nitrates at Stations 1 and 3 is due to the influence of inputs carried by the water flow. Station 2 which is a cage area, the parameter that exceeds the standard quality limit is COD, but this COD value only slightly exceeds the threshold of 0.5 mg / l. With the other parameters that meet the quality standard as a whole, based on the PI value, this area is still in the category of meeting the quality standard (good) and suitable for aquaculture activities.

**Table 2.** Results of the analysis of the physical-chemical parameters of the waters of the Kampar River in Buluhcina Village and its Pollution Index values

| Parameters | sampel (mg/l) | Standards Class II (mg/l) | Exceed the conditions |
|------------|--------------|--------------------------|-----------------------|
|            | St 1 | St 2 | St 3 |                          |
| TSS        | 74   | 21   | 49   | 50 | Maximum |
| DO         | 7    | 5,5  | 7,6  | 4  | Minimum |
| COD        | 6,4  | 25,6 | 12,8 | 25 | Maximum out of range |
| pH         | 6,8  | 6,6  | 6,6  | 6,9 | out of range |
| Nitrite    | 0,08 | 0,06 | 0,08 | 0,06 | Maximum |
| Total P    | 0,0699 | 0,0359 | 0,0712 | 0,2 | Maximum |
| IP         | 1,35 | 0,86 | 1,29 | Information : = Parameters that exceed the quality standards |
4. Conclusions and Recommendations

**Conclusion.** In general, the condition of the waters of the Kampar River, especially in the Buluhcina Village is categorized as slightly polluted. The area that is suitable for cage cultivation activities is in the Station 2. The water conditions in the Stations 1 and 3 (in the upstream and downstream areas) are also slightly polluted, while the Station 2 or the cage area is not polluted.

**Suggestion.** As this research was conducted in the beginning of the rainy season, further research is needed related to the measurement of water discharge and the quality parameters during the dry season, when the rainfall intensity is low in order to obtain the discharge value and the value of the annual chemical physics parameters to get the information on the annual quality of the Kampar River.

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