Estimation of Fish Production Potential with Benthos Biomass Approach in Sumani and Ombilin River of Singkarak Lake West Sumatra

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Abstract. The potential for fish production is very important as a necessary material for WPP PD in making policies. Estimation of fishery production potential is adjusted to aquatic ecosystem. The method used differs between running and stagnant water based on the shape of the water. Fishery resources in Indonesia, especially inland fisheries, still cannot be managed and utilized optimally and sustainably. The method used in estimating fishery stocks in the watershed is the Leger-Huet method. Research to estimate fish production potential using the benthic biomass approach using the Leger-Huet method was carried out in February, June, and October 2019 in the Sumani River and Ombilin River, Singkarak Lake. The research objective was to determine the estimated value of fish production potential through the benthic biomass approach in the Sumani River (Inlet) and Ombilin River (Outlet), Singkarak Lake. The calculation of benthic biomass and fish production potential was carried out at the Testing Laboratory of the Research Institute for Inland Fisheries and Extension in Palembang. This system is expected to be able to provide alternative solutions for decision-making and agencies to determine the potential for fish production in an area. The determination of the potential for fish production using the benthic biomass approach is highly dependent on the width of the river. The results showed that the types of benthos in the Sumani and Ombilin rivers were 5 classes and 17 families. The benthos found by the Ombilin River are more varied than those in the Sumani River, and the estimated fish production potential of the Ombilin River is greater than that of the Sumani River. The highest yield of benthic biomass was found in the Ombilin River (159.06 gr/m2) compared to the Sumani River (76.06 gr/m2). Meanwhile, the average potential fish production in the Batang Sumani River (573.8 (kg/ha) is higher than in the Ombilin River (244.74 kg/ha).

1. Introduction

Singkarak Lake is a lake that stretches across two districts in the province of West Sumatra, namely Solok district and Tanah Datar district. This lake has an area of 107.8 km² and is the second largest lake on the island of Sumatra. The lake inlet is at Batang (river) Paninggahan, Batang Kuok, Batang Lembang, Batang Imang Gadang and Batang Aripan. The lake outlets are Batang Ombilin (empties into Riau Province) and the Singkarak Lake hydropower plant [1]. Singkarak Lake is a type of tectonic lake [2] which is located in two districts, namely Solok Regency and Tanah Datar Regency [3].

Utilization of Singkarak Lake for various activities including capture fisheries, aquaculture, tourism, irrigation and hydroelectric power generation (PLTA). Based on research by Syandri et al., [4], the
number of fish species found in Singkarak Lake is 19 species and the most dominant population is bilih fish. At this time the population of bilih fish in Singkarak Lake is decreasing and the size that is caught is getting smaller, ranging from 6-7 cm compared to the size caught in 1996 ranging from 10-15 cm [5, 6, 7]. Research by Purnomo & Sunarno [8] found that the average total length of bilih fish in Singkarak Lake was 6.5 cm. In the lake live various types of fish and one type of fish that is endemic, namely the bilih fish (Mystacolencus padangensis Blkr). In addition to fisheries, Singkarak lake water is also used for a 175 MW Hydroelectric Power Plant (PLTA) which began operating since 1998 [1, 9, 10]. This paper focuses on the inlet and outlet of Singkarak Lake. Based on the research of Singkarak lake, there has been a decrease in the catch of fish, especially bilih fish in Solok district from 2013 of 81.78 tonnes, 2014 to 68.37 tonnes [11].

The reduced production from the catch and the smaller the size of the fish caught indicates that the fish population is starting to decline in Singkarak lake and is starting to become endangered. The threat of fisheries extinction is due to, among others, uncontrolled and excessive fishing using gill nets with relatively small mesh sizes of ¾ inch and 5/8 inch, as well as ½ inch mesh fishing gear which is operated by blocking fish that will spawn in watersheds. On the other hand, efforts to conserve fish populations through the local wisdom of the surrounding communities have not been carried out perfectly [6]. Based on these conditions, it is necessary to manage the bilih fish population in Singkarak lake. Data and information on the size distribution, reproductive aspects and spawning habitat of bilih fish in nature are needed in management efforts as well as policy materials by the community and local government in an effort to conserve fish in Singkarak lake. With this decrease, we will look at the causes of this decline by using other biota approaches. The approach used in the river basin is usually used with the benthic biomass approach. This is because benthos are organisms that are at the bottom of the waters and tend to settle down. It is hoped that by knowing the benthic biomass, it will approach the estimated value of fish potential in the rivers connected to the Singkarak Lake, especially the rivers which are the Inlet and Outlet of the Singkarak Lake.

Dynamic environment, biological analysis, especially benthic animal community structure analysis, can provide a clear picture of the condition of waters and fisheries. The factor that underlies the use of benthos as an indicator organism of water quality and the estimation of fisheries potential is due to the nature of the benthic which is relatively still or has low mobility so that it is heavily influenced by the environment [12]. The purpose of this paper is to predict or estimate the potential for fishery production in the Ombilin River and Batang Sumani River.

2. Materials and Methods

2.1. Location and Time of Research
The research was carried out in Singkarak lake, especially the connected rivers which are the Inlet and Outlet areas of Singkarak lake (Figure 1). When the research was conducted in February, June and October 2019.
Table 1. Name, coordinates and description of the observation station.

| Name of Station | Coordinate          | Description                                                                                                                                 |
|-----------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Sumani River    | S 00°42’05,3’’  E 100°35’24,8’’ | River with the name Sumani/ Lembang; the water flow has strong currents, on the banks of the river there are sparse settlements and agricultural land (rice fields and gardens), riparian vegetation in the form of kumpai (graminae) and muddy riverbeds. This River is the source of water from Singkarak Lake. |
| Ombilin River   | S 00°33’30,4’’  E 100°33’34,9’’ | River with the name Batang Ombilin; fast-flowing watercourses, rocky and sandy bottoms, residential areas, riparian vegetation in the form of coconut and banana plantations. This river is the outlet of Singkarak Lake. |

2.2. Data Analysis
The method used in the research to estimate the potential for fish production in rivers is the benthic biomass approach, namely the Leger huet method.

The amount of potential fish production is estimated using the formula from Leger-Huet's in Welcomme [13], namely:
The fertility coefficient \( k \) is as follows:

- Score 1-3, if poor natural food
- Score 4-6, if natural food is moderate / sufficient
- Score 7-10, if it is rich in natural foods.

The \( k \) coefficient value is the sum of the three coefficients \( k_1 + k_2 + k_3 \) .... (2)

Where:

\[ k_1 = \text{the average temperature} \]
\[ k_2 = \text{depending on the hardness and alkalinity of the waters and} \]
- Score 1 for soft / non-alkaline waters
- Score 2 for hard / alkaline waters

\[ k_3 = \text{composition of the dominant fish species with the following values:} \]
- Score 1 for fast current (rheophilic) fish
- Score of 1.5 for the combination of fast and slow current fish
- Score of 2.0 for dominant slow-current (limnophilic) fish

This method is then modified for wide and wide river waters by changing the coefficient 1 (k1) and biogenic capacity [13], where k1 is calculated based on the equation:

\[ k_1 = -0.6671 + 0.16671 \times \text{Temperature (°C)} \] ................................. (3)

The biogenic B capacity of the waters will be assessed using biomass from macrozoobenthos to replace the number of aquatic plants. According to Albrecht in Welcomme [13], the calculation of this biogenic capacity depends on macrozoobenthos biomass. If the macrozoobenthic biomass is less than 60 kg / ha, the biogenic capacity \( B \) is calculated by the formula:

\[ B = 0.00 + 0.05 \times \text{Bb} \] ................................. (4)

If the macrozoobenthos biomass is in the range of 60-700 kg / ha then the biogenic capacity is used the formula:

\[ B = 0.35158 + 0.45469 \log \text{Bb} \] ................................. (5)

Where:

\[ Bb \] is the measured macrozoobenthos biomass.

Two points of macrozoobenthos will be taken, namely 2 points on each side of the river from each station. The benthic samples were then combined (composited) then preserved with 10% formalin and analyzed in the laboratory for diversity and abundance analysis. The respective diversity and abundance index formulas are described below.

\[ KR = \frac{n_i \times 100%}{N} \] ................................. (6)

Where:

\[ KR = \text{Relative Abundance} \]
\[ n_i = \text{Number of individuals of the i-type} \]
\[ N = \text{total number of individuals}. \]
3. Results and Discussion

3.1. Composition of Macrozoobenthos

The composition of macrozoobenthos, seen from the family, was found to be 99% in the Thiaridae family, while 0.1–1% was found in the Tubificidae, Physidae, Bulimidae and Ampullaridae families. The Thiaridae family consists of the genus Melanoide tuberculate, Melanoide granifera, Melanoide sp, Melanoide costeralis, Thiara lineata, Thiara scabra, Thiara winteri, Clea Helena, Indoplanorbis sp, Pomacea sp, Digoniostoma truncatum, Bellmya sumatrensis and Brotia costulata (Fig 2). Whereas in the Ombilin river the highest composition was in the Thiaridae family 57%, the remaining 23% corbiculidae were from the physidae, bulimidae, viviparidae, Tubificidae, Unionida and Ampullaridae families (Fig 2). This is supported by the research of Septiani, et al., [14]; Apmayasari, et al., [15] stated that in their research Thiaridae had the largest family composition. Maula's research [16] also states that of the 10 families most found in the Malang Cokro river is Thiaridae. Muhammad's research [17] states that Thiaridae is one of the families found in macrozoobenthos observations in parks and river flows in the village of Karang Suko Malang. This is presumably because the waters in the category are still very good and good, this is supported by Bouchard's [18] research that the existence of the Thiaridae family indicates that water quality is still in a good category. In classification, the Thiaridae family is included in the Molusca class [19]. Isnaningsih [20] states that the typical physical characteristic of the Thiaridae family is that the threads taper regularly from anterior to posterior. Gregoric [21] mentions that Thiaridae is parthenogenetic in nature so that it supports an abundant population and high density in waters, especially fresh water.

Figure 2. Composition of the macrozoobenthos family in the Sumani river and the Ombilin river, Singkarak Lake in 2019.

3.2. Distribution of Macrozoobenthos

| Kelas      | Family    | Genus                |
|------------|-----------|----------------------|
| Annelida   | Tubificida| Branchiura sowerby   |
|            |           | Aulodrillus sp       |
|            |           | Limnoderllis sp      |
| Bivalvia   | Unionida  | Anodonta sp          |
|            | Corbiculida| Corbica sp          |
| Phylum          | Family             | Species                              |
|-----------------|--------------------|--------------------------------------|
| **Gastropoda**  |                    |                                      |
| Thiaridae       | Pomacea canaliculata |                                      |
|                | Melanoïdes tuberculata |                                    |
|                | Melanoïdes granifera |                                      |
|                | Melanoïdes sp       |                                      |
|                | Melanoïdes costeralis |                                    |
|                | Thiara lineata      |                                      |
|                | Thiara scabra       |                                      |
|                | Thiara winteri      |                                      |
|                | Clea helena         |                                      |
|                | Indoplanorbis sp    |                                      |
|                | Pomacea sp          |                                      |
|                | Digonoïstoma truncatum |                               |
|                | Bellamya sumatrensis |                                    |
|                | Brota costula       |                                      |
|                | Physidae            |                                      |
|                | Physa sp            |                                      |
|                | Bulimidae           |                                      |
|                | Digonoïstoma truncatum |                               |
|                | Viviparidae         |                                      |
|                | Viviparus sp        |                                      |
| **Hirudinea**   | Glossiphoniidae     |                                      |
|                | Helobdella sp       |                                      |
| **Insekta**     | Brachycentridae     |                                      |
|                | Oligoplectrum sp    |                                      |
| **Hydropsychidae** |                    |                                      |
| **Psephenidae** |                    |                                      |
| **Ampullaridae** |                    |                                      |
|                | Pila scutata        |                                      |
| **Chironomidae** |                    |                                      |
|                | Chironomus sp       |                                      |
|                | Criptochironomus sp |                                      |
|                | Micropsectra sp     |                                      |
|                | Tanypus sp          |                                      |
| **Cordulephyidae** |                    |                                      |
| **Limnephiila** |                    |                                      |
| **Perlidae**    |                    |                                      |

Based Table 2 and Fig 3 on the class distribution research, there are 5 classes of macrozoobenthos, namely Annelida, Bivalvia, Gastropoda, Hirudinea, and Insects, and there are 17 families and 29 genus of macrozoobenthos. The most common genus found in the Sumani river is Melanoïdes sp, while the Ombilin river is Corbicura sp. This is supported by research conducted at Lake Laut Tawar by Arita [22] which states that there are research stations with high Melanoïdes diversity, especially on rocky and sandy substrates, while Corbicula is found in stations with clean waters. Novi [23] states that changing the shell on Corbicura will give a sign that the environment is polluted and if the Corbicula is found that is still good and healthy it indicates that the environment is still good. Mardatila, et al., [24]: Iswanti, et al., [25] state that research in Upper and Lower lakes is dominated by Melanoïdes, this is because the substrate is rocky and sandy. Junaedi [26] states that Corbicula is an important biota in aquatic ecosystems, both as an important component in aquatic ecosystems, and as an indicator for monitoring water quality.
In Fig 4, the relationship between benthic biomass and fish production potential in the Lembang River is the highest in June while the lowest is in October. In the Figure, it is clear that the relationship between benthic biomass in the Lembang River is directly proportional to the production potential value, fish. On the Ombilin River the highest benthic biomass is October, while the lowest is February, while the highest production potential value is in June and the lowest is in February. According to Herlan et al., [1] the difference in the value of potential production is thought to be due to differences in different river widths, river width is a multiplying factor. in obtaining the production potential value. The value of benthic biomass will greatly affect the potential value of benthic biomass production. In obtaining the estimated value of the potential value of fish production, there are many ways to do it, in this case the estimation is obtained using benthic biomass because the location is in a river and uses biota which is a definite nature, namely benthos. Based on the research of Samuel & Ditya [27], the potential for fish products can be used by starting water quality, namely chlorophyll-a if the waters of the lake.

The estimated value of fish production potential in the Sumani River ranges from 284.94 kg / ha (February) -558.22 kg / ha (October), while the Ombilin river ranges from 143.43 kg / ha (February) -318.61 kg / ha (June). The estimated value of this estimate is different due to the difference in the size...
of the river width at the observation station which is a multiplying factor for potential fish production, where in three observations the width of the Sumani River always exceeds the width of the Ombilin River [1]. Thus there is sedimentation or land erosion which causes the land to widen or narrow, which greatly affects the estimated estimated value. Meanwhile, the value of biomass is highly dependent on its macrozoobenthic biota. The value of benthic biomass will be directly proportional to the estimated value of production potential in fish. This is because benthos are organisms that live in the bases of the environment which are used as a source of food for fish. Thus, if the benthic biomass value is large and the river is wide, it is assumed that the fish potential will increase in height. According to Noortiningsih, et al., [28]; Maula [29] that organisms including forms in the food chain are one of the food providers for small and large fish.

4. Conclusion
The results showed that the types of benthos in the Sumani and Ombilin rivers were 5 classes and 17 families. The benthos found by the Ombilin River are more varied than those in the Sumani River, and the estimated fish production potential of the Ombilin River is greater than that of the Sumani River. The highest yield of benthic biomass was found in the Ombilin River (159.06 gr / m2) compared to the Sumani River (76.06 gr / m2). Meanwhile, the average potential fish production in the Batang Sumani River (573.8 kg / ha) is higher than in the Ombilin River (244.74 kg / ha).

Acknowledgments
This paper is a contribution in research on “Estimation of Fish Stock and Potential Resources in Singkarak Lake and Connected Rivers” conducted during 2019 under Research Institute for Inland Fisheries and Extension. Author of the research team would like to thank a lot to the Head who have given confidence to do research, to colleagues of the office and also research assistants for invaluable help during the field survey and laboratory activity.

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