Growth parameters of *Channa striata* in Musi River, Bengkulu and South Sumatra Province

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Abstract. Due to the demand for striped snakeheads (*Channa striata*) as raw material for making exceptional Palembang foods such as corkscrews, fish cake "Pempek", and crackers, the rate of exploitation becoming high and triggering continuous fishing by the fishermen. Information connected to the stock of striped snakehead is not widely known. This research intends to examine the growth parameters of striped snakehead. The research was held in March, April, June to September 2018 in the Musi River, South Sumatra Province. Fish tackle, including different-sized gill nets and nets, was used to gather fish samples from fishermen. The information acquired includes the rate of exploitation, the rate of mortality from natural or fishing-related causes, and the rate of total mortality. The calculation results show the rate of total mortality (Z) = 0.95, the rate of natural mortality (M) = 0.67, death due to capture (F) = 0.28, and the rate of exploitation (E) = 0.29 every year.

Keywords: fisherman, fishing, natural causes, exploitation rates, total mortality rates

1 Introduction

The Musi River, which is included in the fishing area of The Territory of Inland Waters Fisheries Management of the Republic of Indonesia (WPPNRI PD 438), is a complex river system with a length of more than 750 km, consists of strong currents at the foothills of mountains, lowlands, and tidal (freshwater) and brackish water (estuarine) parts. The flow of the Musi River forms a network system that is interdependence between fisheries, land nearby, and water resources. The Musi River rises in the Bengkulu Province Bukit Barisan mountains and empties into Sungsang Village in the Banyuasin Regency of South Sumatra. Several places are crossed by the Musi River, including protected forests, agricultural areas, settlements, plantations, industrial zones, and mangrove forest regions. The Musi Watershed

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covers an area of 7,760,222.86 hectares and extends from 103°34'12" to 105°0'36" East Longitude to 02°58'12" to 04°59'24" South Latitude [1].

From the perspective of fisheries, a river basin serves an essential purpose, serving as a source of protein, a livelihood, and a way for the region to earn money through fishery fees and water auctions [2]. Based on data from the [3], per year the possibility of capture fisheries in inland waters reaches 125,250 tons (including in the Musi River) and 118,887.80 tons have been utilized. The utilization of fisheries is like a coin with two sides, on the one hand, it provides benefits but causes several issues, including habitat destruction and overfishing, which can impact decreasing fish production [4]. Fishing activity increases in inland waters during the dry season, resulting in overfishing that can deplete fish stocks the next year [5]. Because the usage of fishery resources is linked to population expansion, the ongoing increase in fishing operations and the use of fish tackle will result in an imbalance in fish populations. Using non-environmentally friendly fish tackle can lead to an imbalance in fish populations. The "Maximum Sustainable Yield" (MSY) catch value must be known to acquire maximum catches without depleting resources and to be used sustainably. Furthermore, [6] proposed that striped snakehead (*Channa striata*), Kissing gourami (*Helostoma temminckii*), Snakeskin gourami (*Trichopodus pectoralis*), and Climbing perch (*Anabas testudineus*) had all spent their lives in flooded swamp waters or “lebak lebung”.

Striped snakehead (*Channa striata*) makes special Palembang delicacies such as boiling cork, fish cake “Pempek”, and crackers. Many processed items employ striped snakehead as raw material. Hence, the natural population is expected to decline. Several studies on striped snakehead have been conducted, including reproductive aspects [7], stock conditions and population diversity [8], feeding habits [9], and growth and size of the first mature gonads [10] can provide information about the production of a type of fish [11].

The study of growth parameters, which are important in the dynamics of fish populations, has not been widely carried out. Therefore, it is essential to conduct studies on the state of the striped snakehead (*Channa striata*) population to assess its growth and rate of exploitation.

2 Methods

2.1 Location and Time

The study was conducted in the Musi River in March, April, June, and September 2018 (Figure 1). There were two stations upstream, two in the middle, and two in the downstream of Musi River. Fish sampling is done by fishermen using fish tackle in the form of nets with various mesh sizes. Using the methods of [12] and [13] samples will be identified to the species level and include calculations of the length and total weight of fish based on [14].

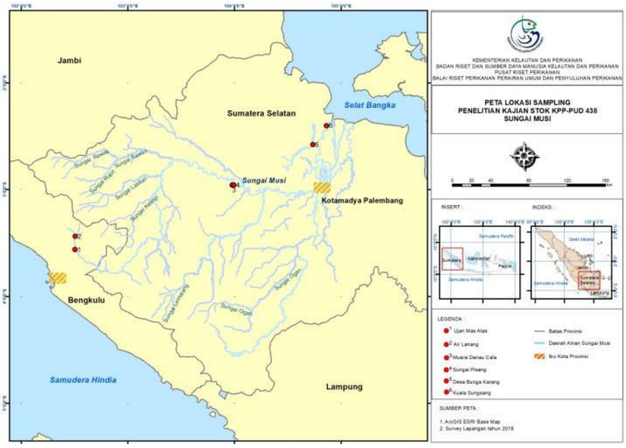

Fig 1. Map of research locations on the Musi River

2.2 Data Analysis

2.2.1 Growth parameters

The Bhattacharya approach was used to analyze age group structure by dividing a composite distribution into discrete normal distributions reflecting a cohort (age group) of fish [15]. Using the Ford-Walford plot analysis [16] developed from the Von Bertalanffy model, the value of the extended mode from the Bhattacharya technique is utilized to compute the length at asymptotes (L), growth coefficient (K), and theoretical age (t) as follows:

$$L_t = L_\infty(1 - e^{-k(t-to)}) \quad (1)$$

Another growth parameter, namely $t_\circ$, is found using the empirical equation [17]:

$$\text{Log}(-t_\circ) = -0{,}3922 - 0{,}2752 \log L\infty - 1{,}036 \log K \quad (2)$$

Description:

L_{t+1} = Fish length at age t (cm)
L_∞ = Length at asymptotes (cm)
t = Age of fish (years)
$t_\circ$ = Age of fish in certain length (years)
K = Growth Coefficient

2.2.2 Rate of Total Mortality (Z)

By utilizing the Beverton and Holt equation to linearize a catch curve based on length data, the rate of total mortality (Z) is determined [15]:

$$Z = K\frac{(L\infty - \underline{L})}{(\underline{L} - L\prime)} \quad (3)$$

Description:

Z = Total mortality
$\underline{L}$ = Average length (middle value)
L' = The lower limit of fish length in the fishing area

2.2.3 Rate of Natural Mortality (M)

The Pauly equation [18] is used to compute the rate of natural mortality (M), as shown below:

$$\log_{10} M = -0.0066 - 0.279 \log_{10} L_\infty + 0.6543 \log_{10} K + 0.4634 \log_{10} T \quad (4)$$

The variables M, L, K, and T in the Von Bertalanffy growth equation are the rate of natural mortality (per year), length at asymptotes (in cm), growth coefficient, and average water temperature (28.4°C).

2.2.4 Rate of Mortality due to Capture (F)

The mortality due to capture is calculated using the following equation since the rate of total mortality (Z) and rate of natural mortality (M) are known.

$$F = Z - M \quad (5)$$

2.2.5 Rate of Exploitation (E)

By comparing the fishing mortality due to capture (F) to the rate of total mortality (Z), the rate of exploitation (E) is calculated [15]:

$$E = \frac{F}{Z} \quad (6)$$

If:

$E > 0.5$: Overfishing or high exploitation
$E < 0.5$: Under fishing or low exploitation
$E = 0.5$: Optimal utilization

3 Results and Discussion

Growth parameter analysis of the Striped Snakehead can be $L\infty = 53.09$ cm; and K= 0.28 per year. A linearized capture curve based on length data was used to estimate the total mortality rate constant (Z) of striped snakehead (Figure 2). The amount is 0.95.

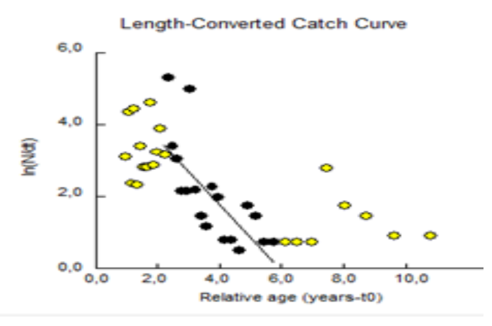

Fig 2. Length-Converted Catch Curve (Z)

Pauly's empirical formula [15] uses data on average water temperature (ºC), $L\infty$ (cm), and K (per year) to estimate the natural mortality rate (M). According to data from field sampling measurements, Musi River has an average temperature of 28.4 ºC, $L\infty = 53.09$ cm, and also a value of K = 0.28 per year which results in a natural mortality value (M) of 0.67. Results of the analysis of the natural mortality rate (M) using the Pauly empirical formula with the FISAT program.

The mortality rate due to capture (F) calculation yielded a value of 0.28 per year. As revealed by [22], the mortality rate due to capture (F) is death caused by fishing.

$Z = M + F$ where $Z = 0.95$ and $M = 0.67$
$F = Z - M = 0.95 - 0.67$
$F = 0.28$

The rate of exploitation of Snakehead in the Musi River is 0.29. Fish samples were gathered from fishermen, and the amount varied based on the catch each month (Figure 3). The analysis process for separating the age groups of Snakehead fish uses the ELEFAN I program.

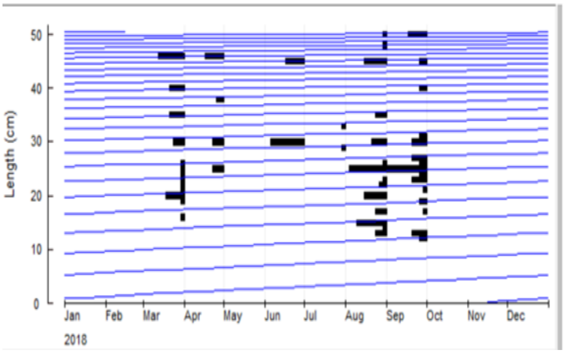

Fig 3. Graph of Striped Snakehead Frequency Data

Theoretically, if the fish's length is exactly zero (t_o) calculated using the Pauly equation [18], using the values $L\infty = 53.09$ cm and K = 0.28 per year, the following results are obtained:

$$\mathrm{Log}(-t_o) = -0.3922 - 0.2752 \log 53.09 - 1.038 \log 0.28$$
$$\mathrm{Log}(-t_o) = -0.29273$$
$$t_o = -0.53353$$

Then, obtained t_o with a value -0.53353 years. Therefore the Von Bertalanffy length growth formula is:

$$L_{(t)} = L\infty\,(1-e^{-K(t-t_o)})$$

$$L_{(t)} = 53{,}09\,(1-e^{-0{,}28(t+0{,}53353)})$$

The growth rate of striped snakehead is 0.28 per year (K). It has a low value of 0.3 (0.3) for the growth rate (K). The faster a fish theoretically reaches its asymptotic length and dies, the higher the K value. According to [19], a K value of higher than 0.3 per year falls into the high category. The length structure of commonly caught fish, the fish tackle employed, and the fishing location all influence differences in fish growth parameters for each kind [20]. Growth affects fish stocks in an area. Growth has a positive effect on stocks, but growth does not increase the number of stocks, but instead increases the biomass of a stock [21]. The striped snakeheads that are caught vary in total length. Differences in length structure can describe differences in growth that are influenced by heredity, age, sex, disease, parasites, and environmental factors [14].

The rate of Total Mortality is 0.95 per year, according to the curve in Figure 2. That value is smaller than 1. The value of total mortality rate indicates the value of the mortality index. The rate of fish mortality in that area increases with increasing value.

Natural mortality (M) is influenced by some parameters including maximum length factor ($L\infty$), growth rate, and surrounding circumstances, particularly water temperature, as stated by [17], which is mentioned by [15].

The results of calculating the mortality rate due to capture (F) obtained a value of 0.28 per year. As revealed by [22], the mortality rate due to capture (F) is death caused by fishing.

$Z = M + F$ where $Z = 0.95$ and $M = 0.67$
$F = Z - M = 0.95 - 0.67$
$F = 0.28$

The rate of exploitation will show how resources are being used. The rate of exploitation value can be calculated by comparing mortality due to capture (F) with total mortality rate (Z). Assuming that E values more than 0.5 (E>0.5) indicate overfishing, E value is lower than 0.5 (E<0.5) indicates underfishing, and E is equal to 0.5 (E=0.5) indicates MSY.

$$E = \frac{F}{Z}$$
$$E = \frac{0,28}{0,95}$$
$$E = 0.29$$

The level of exploitation influences the value of fishing mortality. Rate of exploitation (E) of striped snakehead computed from the ratio of mortality due to capture or fishing (F) to total mortality (Z) is 0.29, proving that 29% of snakehead fish deaths in the Musi River are the result of fishing. The rate of exploitation value of striped snakehead has not surpassed the optimal value. According to Gulland (1971), referred to by [18], that a resource should be used to its full potential at a rate of 0.50.

4 Conclusion

Growth parameters of Striped snakehead (*Channa striata*) with a low growth coefficient (K). Mortality due to capture (F) is lower than the natural mortality rate (M) and the rate of exploitation (E) is lower than the optimal rate of exploitation.

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