Parameters Estimation of Population Dynamic Tilapia Fish (*Oreochromis Mossambicus*) in Limboto Lake, Gorontalo Province, Indonesia

Eka Purnama [1], Syafyudin Yusuf [2], Didiharyono Didiharyono [3]

[1]*IAIN Sultan Amai, Gorontalo, Indonesia*
[2] *Hasanuddin University, Makassar, Indonesia*
[3] *IBK Nitro, Makassar, Indonesia*

Abstract **– This article focuses on parameter estimation of the population dynamics of tilapia fish in Limboto Lake, Indonesia. The parameter estimation aims to determine the current condition of the population and its sustainability in the future. The research was conducted in 2022, 243 tilapia fish were analysed as a sample using a quantitative descriptive method. Based on the findings and analysis, it shows that there is an isometric relationship between the length and weight of the fish with a coefficient of determination of 96% and the current exploited rate is above the optimal exploited level. Therefore, this condition indicates that there is over-exploitation of the ability of the population, which can cause population loss in the future.**

Keywords **- parameters estimation, population dynamic, tilapia fish, Limboto Lake.**

1. Introduction

In the fishery sector there is one sector that can contribute to state revenue, improve the economic level of the community and develop regional potential [1].

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Corresponding author: Eka Purnama,
IAIN Sultan Amai, Gorontalo, Indonesia
Email: ekapurnama@iaingorontalo.ac.id

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Moreover, most of Indonesia's territory is territorial waters, so the fishery sector deserves attention and development in this country. Fisheries in Indonesia consist of marine fisheries and land fisheries [2]. Marine fisheries are fishery activities in the high sea waters, both around the coast to deep sea waters. Inland fisheries are carried out in fresh water and brackish water, for example in rivers, lakes, ponds, ponds, rice fields or dams [3]. Gorontalo Province is one of the areas with considerable fishery potential, both in marine and inland fisheries. In the field of inland fisheries, in Gorontalo there is a lake, namely Limboto Lake which spans an area of approximately 3000 hectares [4]. Limboto Lake is one of the assets of the Gorontalo area in the inland fisheries sector which is used as a source of livelihood, especially for farmers and fishermen who live around the lake [5].

The Department of Fisheries and Marine Sciences noted that the largest fish production by fishermen around Limboto Lake is Tilapia around 1,024 tons and tilapia fish around 313 tons. The tilapia fish population in Limboto Lake has been decreasing and one of the causes is over-exploitation [6].

Tilapia fish is one of the important fishery commodities and has economic value for residents around Limboto Lake [7]. Although there are fishery activities in the form of aquaculture, in general the fish cultivated by the community is Tilapia. Tilapia fish are obtained from fishing activities in the lake [6]. The existence of tilapia fishing activities continuously can cause a decline in the population of this fish species.

Information about tilapia fish is limited to its introduction to catches [7] and types of food [8]. Several studies have been conducted to determine the effect of heavy metal bioaccumulation on growth rates based on the distribution of fish length and weight [9]. Next, we can look at the effect of sanitation on fish growth [10].

To keep the population of tilapia fish high, it is necessary to preserve the existence and growth of fish [11]. This is related to the high potential of this fish for the welfare of the community, while information regarding the estimated parameters of growth, mortality, and exploitation rate of tilapia fish in the waters of Limboto Lake is not yet available [12]. Consequently, the information related to population dynamics estimation is needed so that it becomes a consideration in making policies that can ensure its sustainability.

The parameters needed consist of the relationship between length and weight, age group, growth parameters, mortality, and exploitation rate and yield per recruitment [13], [14]. This is useful as a basis for determining management policies and utilization of aquatic resources so that the sustainability of the tilapia fish population still exists, stable, and sustainable.

2. Method

This research was conducted in the area of Limboto Lake, West Pentadio Village, Telaga Biru District, Gorontalo Province, Indonesia in February-July, 2022. The map of the research location can be seen in Figure 1.

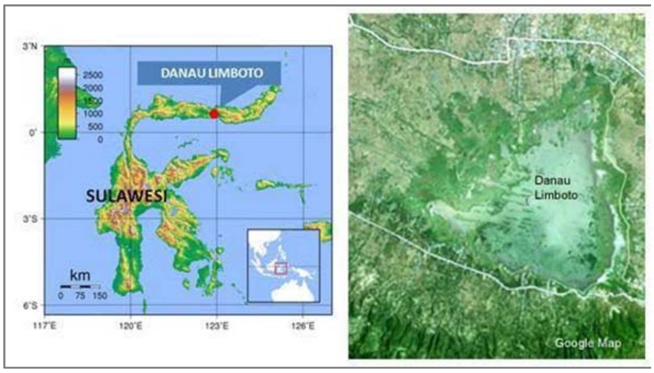

Figure 1 Map of Limboto lake

This research is quantitative descriptive research, which is a method that examines a particular population using numerical data. Furthermore, the data obtained were analyzed by certain methods, so as to describe the condition of the population.

The sampling technique used in this study is a simple random sampling method, which is a random sampling method. In this study, a sample of more than 243 tilapia fish was selected. Population dynamics parameters were calculated using primary data obtained by direct measurement of the tilapia fish samples. The tools used in this research are writing, ruler, scales, thermometer, and camera. Data analysis techniques are correlation of length and weight using the exponential regression model.

The age group of tilapia fish used the Bhattacharya method, the growth parameters used the Von Bertalanffy growth model, the natural mortality rate is calculated using Pauly's equation, the total mortality rate (Z) is calculated using the Beverton and Hold equation, and calculate yield per recruitment, the Beverton and Holt equations [15], [16], [17].

3. Result and Discussion

3.1. Correlation of Length and Weight

Correlation analysis of length and weight can provide an overview of the growth pattern of an organism. From these samples, the length of the standard fish length and weight were measured. From the measurement results, the body length of the caught tilapia fish was in the range of 6.1-23.5 cm and the weight of the fish was between 4.7-60.2 grams.

According to the correlation analysis of the length and weight of tilapia fish in Limboto Lake, the coefficient of determination value is obtained, showing that $R^2 = 0.966$. This means that there is a strong correlation between the length and weight of the fish. The growth model is known by using regression analysis, the growth pattern is exponential by following the equation $W = 0.146L^{0.983}$. The results of the t-test showed that the growth pattern of the fish was isometric. This indicates that there is abundant food in nature, so that the length and weight of tilapia fish increases exponentially, as shown in Figure 2.

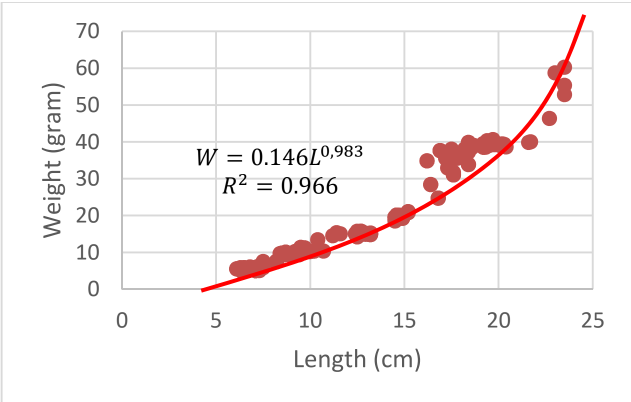

Figure 2 Graph of correlation between length and weight

3.2. The age group (Cohor)

The age group of tilapia fish was determined by the length of the fish. The length of the fish is divided into several interval classes and a mapping is carried out between the frequency and the mean value of the fish length class, as shown in Figure 3.

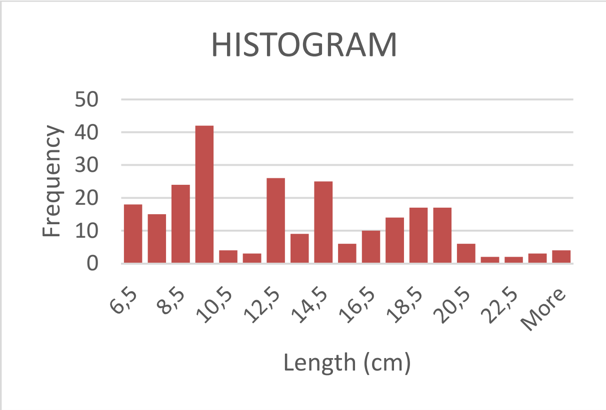

Figure 3 Histogram Graph of Fish Length Frequency Distribution

The results of the analysis using the Bhattacharya method obtained three age groups with an average length of each age group $L_1 = 8.109$ cm, $L_2 = 13.987$ cm and $L_3 = 18.044$ cm. The results of mapping the difference between the natural logarithm of the theoretical frequency to the mean value of the age group class can be seen in Figure 4.

Figure 4 Mapping of the Theoretical Natural Logarithm Difference to the Middle Value of Fish Age Group Class.

Illustrated in Figure 4, tilapia fishing is mainly done on small fish in the first age group. This can reduce the tilapia fish populations because the fish are taken before spawning.

3.3. Growth Parameters

Analysis of the growth of tilapia fish using the Ford and Walford method obtained asymptote length values of tilapia fish ($L\infty$) is 27.079 cm and coefficient of growth rate (K) is 0.371 per year. Value t_0 calculated using Pauly's equation obtained we get $t_0 = -0.979$. Furthermore, the growth of tilapia fish can be calculated using the Von Bertalanffy equation namely,

$$Lt = 27.079\left(1 - exp^{[-0.371(t+0.979]}\right)$$

Based on the equation (Lt), it can be estimated that the growth of tilapia fish every year reaches its asymptotes, as shown in Figure 5.

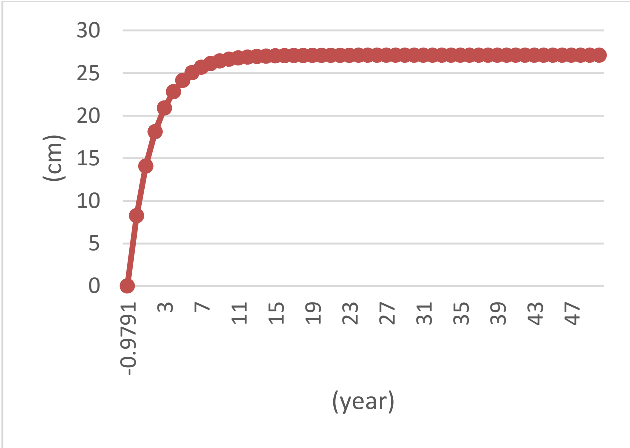

Figure 5 Graph of Tilapia Fish Growth

Figure 5 shows that the length growth of tilapia fish occurs rapidly at a young age and slows down with age, until it reaches its asymptote point.

3.4 Mortality

The estimated total mortality rate for tilapia fish was calculated using the Beverton and Hold equation where the asymptote length of fish (L∞) was 27.079 cm, and the coefficient of growth rate (K) was 0.371 per year so that the total mortality rate was obtained (Z) of 0.779 per year. Furthermore, by using Pauly's formula with an average water surface temperature (T) of 29.8 °C, the natural mortality rate (M) is 0.371 per year. The fishing mortality rate (F) is obtained by subtracting the total mortality rate and the natural mortality rate so that the fishing mortality rate is 0.408 per year. The exploitation rate (E) is calculated by dividing the fishing mortality rate by the total mortality rate and the result is an exploitation rate of 0.524 per year.

Table 1 Parameter Analysis of Fish Mortality Rate

Parameter Population	Estimation Value
Natural mortality rate (***M***)	0.371
Total mortality rate (***Z***)	0.779
Catch mortality rate (***F***)	0.408
Exploitation rate (***E***)	0.524

Table 1 shows that the rate of exploitation shows that about 52.4% of tilapia mortality occurs due to the fishing process. The mortality rate of this catch is greater than the natural mortality rate of tilapia caused by natural factors or natural predators.

3.5. Yield per Recruitment

The correlation curve between the exploitation rate and yield per recruitment is used to see whether the current exploitation rate is optimal, not optimal, or there is excessive exploitation compared to the population's ability to renew itself.

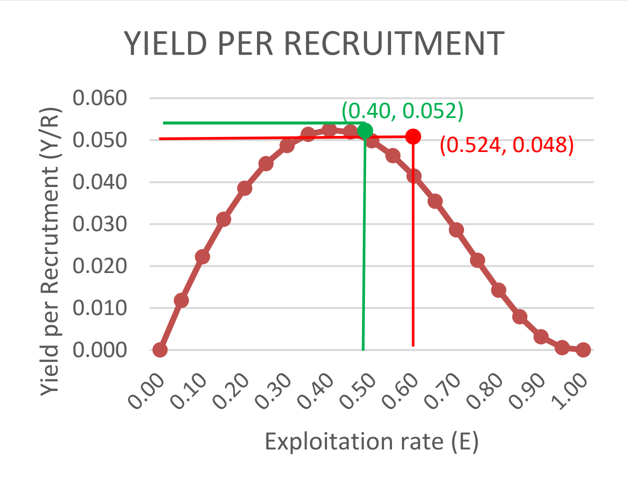

Figure 6 Graph of Correlation Between Exploitation Rate and Yield per Recruitment

Figure 6 shows that the current exploitation rate (E) is 0.524 using the Beverton and Holt equations, the yield per recruitment (Y/R) is 0.048. While the optimal exploitation rate (E_{opt}) is 0.40 with Y/R of 0.052. The graph above shows that there is over exploitation because it exceeds the optimum value. Therefore, it is necessary to reduce the current rate of exploitation, otherwise the tilapia fish population will decrease and even become extinct.

4. Conclusion

Based on the results of research conducted on population dynamics of tilapia fish in Limboto Lake, several conclusions were obtained, namely: (1) the relationship between length and weight of tilapia fish has a very strong correlation of R^2 = 0.966. The growth pattern of tilapia fish is isometric following the regression model $W = 0.146L^{0.983}$; (2) The population of tilapia fish consists of three age groups. The first age group with a standard length between 6-12 cm with an average length of L_1 = 12.386 cm. The second age group with a standard length of 12-18 cm with an average length of L_2 = 13.987 cm. And the third age group with a standard length between 18-24 cm with an average length of L_3 = 18.044. The greatest frequency of catching occurs in the first age group when the tilapia fish are still young. (3) The growth of tilapia fish experienced a relatively fast growth at a young age and then slowed down with age and could grow to a maximum length of $L\infty$ = 27.079 cm.

The growth rate of K = 0.37 is a bit slow because K < 0.5 per year. (4) The mortality rate and total mortality Z = 0.779 per year, natural mortality M = 0.371 per year and fishing mortality F = 0.408 per year. (5) The rate of exploitation with yield per recruitment of tilapia fish, indicates an overexploitation. The current exploitation rate is E = 0.524 with Y/R = 0.048 which is above the optimal exploitation rate E_{opt} = 0.40 with Y/R = 0.052.

Currently, the catch of tilapia fish exceeds the population's ability to renew itself, so the population is predicted to decline. This condition requires the attention of the local government to supervise and make regulations for tilapia fishing in Limboto Lake, Gorontalo, Indonesia. The fish caught should be at a size that has spawned to ensure the sustainability of the fish population.

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