Population dynamics of sailfin catfish (*pterygoplichthys sp.* Hancock, 1828) in sidenreng lake water, Sidenreng Rappang District, South Sulawesi

Suwarni, Moh Tauhid Umar and Sri Ramayani M
Aquatic Resources Management Study Program, FIKP, Hasanuddin University
Jl. Perintis Kemerdekaan Km.10 Tamalanrea, Makassar 90241

Email : suwarniliger17@gmail.com

Abstract. The aim of this research is to know some dynamic parameters of cat fishes population cohort, growth, mortality, exploitation rate, and Relative Yield per Recruitment Relative (*Y / R ’*) based on sex. The usefulness of this research is expected to be a basic data to provide an overview of age distribution, growth patterns, and mortality as well as the estimation of cat fishes rate of exploitation in Sidenreng Lake. In addition, the results of this study are expected to become information material for appropriate and sustainable management steps. The research was conducted for two months on March until April 2019 in Sidenreng Lake, Sidenreng Rappang Regency, South Sulawesi. Analysis of sample fish was carried out at the Laboratory of Fisheries Biology, Department of Fisheries, Faculty of Marine Sciences and Fisheries, Hasanuddin University, Makassar. Sampling of catfishes is obtained from all catches of one fisherman operating in Lake Sidenreng. The number of cat fish samples obtained during the study were 1056, consisting of 565 male cat fishes and 491 female cat fishes. The results of the analysis using a 2 cm length class interval obtained 16 classes. Cohort in the cat fishes in male fish and female fish there were 2 cohorts each. The growth rate coefficient for male fish and female fish was 0.69 per year and 0.46 per year fish reach the maximum length faster than female fish. The mortality value obtained in male and female cat fishes shows that the mortality value is more due to natural mortality than the capture mortality value.

1. Introduction
Sidenreng Lake is one of the potential lakes located in South Sulawesi, precisely in Sidenreng Rappang Regency. Lake Sidenreng is characterized as a lake which periodically fluctuates in water volume reaching 5 - 6 meters [1]. The fluctuations that occur in Lake Sidenreng have a major influence on the aquatic environment so that it can be used as a producer of fishery resources, tourism areas, agricultural areas and so on [2].

One type of fish found in the waters of Lake Sidenreng is the sailfin catfish. In Sidenreng Lake, sailfin catfish is known as bale tokke. However, for the local community sailfin catfish is not the main commodity in fishing. Even this fish is considered a pest that is troubling for fishermen. Hill & Lodge in 1999 stated that the sailfin catfish is an invasive species that is harmful because it is considered a predator or a competitor to native species [3]. While in other areas, this fish has many benefits, such as in Java, most people make sailfin catfish as raw material for making cilok (a type of meatball) and fish crackers [4] and Fish meat is also processed into grilled fish cake [5]. Sailfin catfish skin can be used as
an alternative source of gelatin [6]. In addition, this fish is also useful as a pond and aquarium cleaner and even this fish is also used as an indicator of the level of pollution in waters [7].

Based on the results of interviews with the local community, the population of sailfin catfish in Sidenreng Lake has been increasing in recent years. By looking at these conditions, to ensure the community's assumptions regarding the sailfin catfish population, a study of the status or presence of sailfin catfish in Lake Sidenreng is needed with the availability of data consisting of various aspects. One aspect that needs to be studied is the dynamics of the population. The aspect of population dynamics is used to determine the level of sailfin catfish population in Sidenreng Lake. Based on literature studies, data or research results regarding aspects of sailfin catfish population dynamics in Lake Sidenreng do not yet exist. Therefore, this research needs to be done to obtain this information.

2. Methods Research

2.1. Procedure
The cowstick fish sampling was obtained from all the catches of one fisherman operating in Sidenreng Lake. The fishing gear used by fishermen is gillnet (gill nets) with a mesh size of ½ inch (12.7 mm), nets (throwing nets) 1 inch (25.4 mm) mesh size, and jalabba (bubu), as well as using a boat. in the process of arrest. The sample fish were then landed in one of the fishermen's houses in Sidenreng Rappang Regency. The fish obtained is then put into a coolbox and bulk ice is added to keep it fresh, then the sample fish are taken to the Fisheries Biology Laboratory, Department of Fisheries, Faculty of Marine and Fisheries Sciences, Hasanuddin University for further analysis.

The sailfin catfish samples obtained were removed from the coolbox, then washed clean and placed on a preparation board and labeled as markers on the sample fish. After that, the total length of the fish was measured using a ruler with an accuracy of 0.1 cm. Measurement starts from the tip of the mouth at the forefront to the tip of the rear tail fin. The fish that had been measured were then dissected using scissors / scalpel and their gonads were observed to determine the sex and level of maturity of the fish gonads. To determine gender, it was carried out based on the morphological characteristics of the gonads and the gonad maturity level of sailfin catfish from Pratiwi [8].

2.2. Data analysis
The age group was determined using the Bhattacharya method. The procedure for determining the age group prior to making the frequency distribution of length, middle class, and frequency. Based on the distribution of the long frequency, we can get the number of age groups, average length of individuals, and number of individuals. Determining the age group of fish can be done by dividing it into long classes which are then searched for the difference between the highest and lowest scores of a class with the previous class. One age group was characterized by a histogram that peaked then decreased. Age groups were obtained by analyzing the total body length data of the fish which were then grouped into several classes. Estimation analysis of age groups was processed using the Bhattacharya method which was carried out with the assistance contained in the program FAO- ICLARM Fish Stock Assessment Tools II (FISAT II).

Growth parameters (K and L∞) were determined by the ELEFAN I method [9] based on the von Bertalanffy equation Sparre & Venema which was expressed by the formula [10]:

\[ L_t = L_\infty \left[ 1 - e^{-K(t - t_0)} \right] \]

Where: \( L_t \) = length of fish at age \( t \) (cm), \( L_\infty \) = length of fish asymptote (cm), \( K \) = coefficient of growth rate (per year), \( t_0 \) = theoretical age of fish when its length is equal to zero (year), and \( t \) = age of the fish (years).

To obtain the estimated value of the length of the fish asymptote (L∞) and the growth rate coefficient (K), the assistance is used in Response Surface Analysis in ELEFAN I in the FISAT II program. Estimation of theoretical age when the length of the fish is equal to zero \((t_0)\), it is estimated using the Pauly (1980) empirical formula as follows [11]:
log (-t0) = -0.3922 - 0.2752 (log L∞) - 1.038 (log K)
Where: L∞ = length of fish asymptote (cm), K = coefficient of growth rate (per year), and t0 = theoretical age of fish when fish length is equal to zero (years).

3. Results

3.1. Age group of sailfin catfish (Pterygoplichthys sp. Hancock, 1828)
The number of sailfin catfish samples obtained during the study was 1056, consisting of 565 male sailfin catfish and as many as 491 individuals sailfin catfish. Age group analysis used the Bhattacharya method contained in the software FISAT II.

The results of the analysis using 2 cm long class intervals obtained 16 classes. The age group of sailfin catfish obtained 2 age groups, namely male fish and obtained 2 age groups with a length of 20.97 cm and 30.29 cm and in female fish also obtained 2 age groups with a length of 26.61 cm and 37.25 cm. The age group of sailfin catfish that showed the most fish caught in male cow obtained an average length value of 20.97 cm as many as 383 fish and for female fish an average length value was obtained at 26.61 cm as many as 450 fish. This is thought to have occurred due to fishing pressure in the first age group due to the distribution of the largest length of sailfin catfish, ranging in size from 20.8 - 22.8 cm. The results of the analysis of the number, length range, and age group of male and female cow in Lake Sidenreng (Tables 1 and 2).

Table 1. Number, length range, and age group of cow (Pterygoplichthys sp. Male Hancock, 1828) in Sidenreng Lake.

| Group Age | Average Length - Mean± (cm) | Standard Deviation (SD) | Individuals (tail) | Separation Index (SI) |
|-----------|-----------------------------|-------------------------|--------------------|-----------------------|
| 1         | 20.97                       | 2.95                    | 383                | Na                    |
| 2         | 30.29                       | 4.33                    | 198                | 2.17                  |

Table 2. Number, length range, and age group of sailfin catfish (Pterygoplichthys sp. Hancock, 1828) females in Sidenreng Lake

| Group Age | Average Length - Average± (cm) | Standard Deviation (SD) | Individuals (tail) | Separation Index (SI) |
|-----------|-------------------------------|-------------------------|--------------------|-----------------------|
| 1         | 26.61                         | 3.86                    | 450                | na                    |
| 2         | 37.25                         | 2.45                    | 38                 | 2.28                  |

3.2. Fish Growth Sailfin Catfish (Pterygoplichthys sp. Hancock, 1828)
The results of the analysis of growth parameter estimates were carried out using the ELEFAN I method contained in the FISAT II program. The results of the analysis regarding the growth parameters of cowstick fish in male fish obtained L∞ with a value of 49.73 cm, a K value of 0.69 per year, and t0 with a value of -0.2033 per year and for female fish a value of Obtained.∞ was amounting to 48.94 cm, the K value of 0.46 per year, and the value t0 of -0.3111 per year (Table 3).

Table 3. Estimation of fish growth parameters cows(Pterygoplichthys sp. Hancock, 1828) based on the model of von Bartlam Fly in the waters of Sidenreng Lake.

| Parameter | Value |
|-----------|-------|
| L         | 49.73 | 48.94 |
| K (per year) | 0.69 | 0.46 |
| t0 (year) | 0.2033 | 0.3111 |
The results of the analysis of the estimated growth parameters that have been obtained are then entered into the growth equation (K and L∞), then entered into the von Bertalanffy equation for male sailfin catfish, namely \( Lt = 49.73 \left( 1 - e^{-0.69(t + 0.2033)} \right) \) and female fish \( Lt = 48.94 \left( 1 - e^{-0.46(t + 0.3111)} \right) \), then the growth curve of sailfin catfish in the waters of Lake Sidenreng can be seen in (Figure 1) by substituting various age levels into the \( t \) value.

3.3. Mortality And Exploitation Rate of Sailfin Catfish (Pterygoplichthys sp. Hancock, 1828)

Mortality and exploitation rate

The results of the analysis of mortality and exploitation rates of cow based on the estimation of the parameter value of the mortality rate, and the rate of exploitation of cow obtained in Periyar Lake Sidenreng using the Ricker and Efano method [10] obtained the mortality value in male fish, namely \( (Z) \) with a value of 2.4241, \( (M) \) with a value of 1.2426 per year, a value of \( (F) \) of 1, 1815 per year, and the value \( (E) \) of 0.4874 per year and for female fish the value \( (Z) \) is 1.9688, \( (M) \) is 1.2590 per year, the value \( (F) \) is 0.7098 per year, and value \( (E) \) of 0.3605 per year (Table 4).

| Parameter                          | Value of Male | Value of Female |
|------------------------------------|---------------|-----------------|
| Total Mortality Rate \( (Z) \)     | 24,241        | 19,688          |
| Total Mortality Rate \( (M) \)     | 12,426        | 12,590          |
| Mortality Rate of Total Catch \( (F) \) | 11,815        | 0,7098          |
| Exploitation                       | 0,4874        | 0,3605          |

3.4. Yield per Relative Recruitment \( (Y / R') \) Sailfin catfish (Pterygoplichthys sp. Hancock, 1828)

The results of the analysis regarding the Yield per Recruitment Relative Relative \( (Y / R') \) in male sailfin catfish obtained a value of 0.033409 per year and in female fish obtained a value of 0.013153 per year. The relationship between the rate of exploitation \( (E) \) and \( Y / R' \), at any change can affect \( Y / R' \) in the rate of exploitation \( (E) \) it, any increase in the rate of exploitation \( (E) \) will also be followed by an increase in \( Y / R' \). The Yield per Recruitment Relative \( (Y / R \ maximum') \) in male cow is \( (E) \) of 0.65 with a \( Y / R \ maximum' \) of 0.035462 per year and in female fish with a value of \( (E) \) of 0, 75 with a \( Y / R \ Maximum \) of 0.017948 per year. Yield per Recruitment Relative \( (Y / R') \) in male and female sailfin catfish is 0.033409 per year and 0.013153 per year, respectively, with \( E \) values of 0.4874 and 0.3605 (Figure 2).
Figure 2. Relationship curve Yield per Recruitment Relative ($Y/R'$) to the exploitation rate of sailfin catfish (*Pterygoplichthys* sp. Hancock, 1828) in the waters of Sidenreng Lake (a) male fish, (b) female fish.

4. Discussion

4.1. Age group of sailfin catfish (*Pterygoplichthys* sp. Hancock, 1828)

During this research, 1056 sailfin catfish were obtained with 565 male fish and 491 female fish. The catch obtained by male fish is more than female fish, this is presumably due to the influence of fish behavior. In accordance with the opinion of Hoover et al. in 2004 states that male sailfin catfish are more aggressive and more active so that these fish are more easily caught while female fish are less aggressive and often burrow at the bottom or on walls river or lake [12]. According to Effendie in 2002, the difference in catch in the proportion of sexes can be caused by external factors as well as internal factors [13]. Internal factors can be in the form of fish behavior, differences in mortality and growth rates, while external factors include food availability and population density. While the individual estimates (tails) contained in the *summary of results* appear to exceed the number of individuals or samples obtained due to *overlapping* in the age groups (first cohort and second), causing the number of individuals in the *summary of results* to not match the number. individual (sample) obtained.

Based on the results of the separation of size groups using the Bhattacharya method on the frequency distribution of individual length measurements in a normal distribution cohort, it shows that the population of caught sailfin catfish consists of 2 age groups. This shows that in these waters there are two generations of sailfin catfish, namely young and old fish, who live together at one time. This is the same as the results of the research of the cormorant fish (*Mystacoleucus obtusirostris* Valenciennes, 1842) which was carried out in the waters of the Opak River in Yogyakarta consisting of 2 age groups (cohort) [14].

Meanwhile, the separation index is an index separating two components of the population from different age groups. Based on the results of the separation of sailfin catfish size groups, the separation index value between size groups has a value of more than 2. This indicates that the separation of sailfin catfish size groups is acceptable in the Bhattacharya method. In accordance with the opinion [15–17] that the separation index which is quantity relevant to the study if the separation of two adjacent components is carried out, then if the separation index < 2 then the separation cannot be done because there is an overlap. The results of the study of sailfin catfish (*Pterygoplichthys* sp.) carried out in the waters of the Amazon River were obtained by as many as 1200 individuals during the study with an average length of 21.00 - 37.00 cm [18].
4.2. Growth of Sailfin Catfish (Pterygoplichthys sp. Hancock, 1828)

Based on the results of the analysis of the average size value obtained from the results of separating long frequency data into groups of long sizes, the growth parameters are obtained with the asymptote length value of male \((L_{\infty})\) amounting to 49.73 and for female fish with a value \((L_{\infty})\) of 48.94 where at that length the fish reached their maximum body length. The increase in fish length will decrease in line with the increasing age of the fish. This is supported by the statement put forward by Effendie (2002) in accordance with the concept of growth autocatalytic, that growth will run slowly, then it will run fast, then it will run slowly until it reaches a certain length, then the growth will run constantly [13]. The growth rate of each organism is highly dependent on the age of the organism itself. Young fish tend to grow faster than older fish. The growth of old fish will continue but slowly because the proportion of energy obtained from food used for plants is decreasing, while the proportion of energy for reproduction, maintaining body condition and replacing damaged cells increases with age [19].

The shape of the curve shows rapid growth in the initial phase, then decreases with age and stops growing when it reaches old age [20], food and trophic levels. The high growth is thought to be due to this fish having a wide range of food types (euryphagous), capable of preying on food from the types of animals and plants around it (Froese & Pauly 2014). Furthermore Effendie said that the size of the fish population in the waters is determined by, among other things, available food, recruitment, growth and mortality [13]. Meanwhile, the growth rate of each organism is strongly influenced by age and environmental conditions.

The results of the sailfin catfish (Pterygoplichthys pardalis) research carried out in the waters of the Amazon River obtained a growth rate coefficient \((K)\) of 0.41 per year with \((L_{\infty})\) of 41.3 cm [18]. The growth coefficient value obtained for females sailfin catfish was longer to reach its maximum length \((0.46\text{ per year})\) compared to male sailfin catfish which had a growth coefficient value of \((0.69\text{ per year})\). The difference in growth coefficients is thought to have occurred due to differences in fishing environment, abundance of food, and sex (gender). In accordance with the opinion [21] the growth rate coefficient \((K)\) will affect the maximum length of the fish and this is probably due to several factors that affect differences in fish growth including differences in habitat, eating habits, fish activity, season, temperature, availability.

4.3. Mortality and Exploitation Rate of Sailfin catfish (Pterygoplichthys sp. Hancock, 1828)

Based on the mortality value obtained in male and female sailfin catfish, it shows that the natural mortality value is higher than the fishing mortality value. One of the causes of the large value of natural mortality compared to fishing mortality is thought to be because the people around Sidenreng Lake still do not use sailfin catfish as the main catch which has commercial value. In addition, natural mortality or death of sailfin catfish can occur due to the influence of several factors including predation, disease, stress during spawning, food, and old age. High natural mortality is found in organisms that have a large growth rate coefficient value and vice versa. Low natural mortality is found in organisms that have small growth coefficient values [10]. The fishing mortality value for male fish is 1.1815 and for female fish is 0.7098, which is said to be a high value compared to the sailfin catfish fishing mortality value carried out by Saosa et al. in the waters of the Amazon River of 0.61 which is thought to have occurred because of the high fishing activity carried out in the waters of Lake Sidenreng, so many sailfin catfish caught in fishermen's nets (by catch) are also found and only thrown away (underutilized) so that it is suspected that the cause of fishing mortality is also high [18].

Meanwhile, the value of exploitation rate \((E)\), male and female fish obtained each has a value of exploitation rate \((E)\) which is still said to be below the optimum, which is below 0.5. A low \(E\) value indicates that the sailfin catfish in the waters of Lake Sidenreng are not experiencing fishing pressure (not being caught more). The cause of the low rate of exploitation of sailfin catfish in the waters of Lake Sidenreng is thought to be due to the lack of community demand for sailfin catfish (non-target) and these fish are only used as by-catch (fish that are not the target of catching but are also caught). This is in accordance with Guillard's (1983) statement that fish that have a maximum exploitation rate \((E) = 0.5\) and if they are greater than 0.5 then they are categorized as overfished [22].
The results of the research by Saosa et al. of sailfin catfish (*Pterygoplichthys pardalis*) carried out in the waters of the Amazon River obtained a total mortality (*Z*) of 1.84 per year, natural mortality (*M*) of 0.93 per year, fishing mortality (*F*) is 0.61 per year, and the exploitation rate is 0.38 [18]. The rate of exploitation with a value of 0.38 indicates that sailfin catfish fishing is below the optimum value, which means that there is no overfishing.

4.4. *Yield per Recruitment Relative (Y/R*) Sailfin catfish (*Pterygoplichthys sp. Hancock, 1828*)

Based on the *Yield per Recruitment Relative (Y/R*) value obtained, it shows that the population of male and female sailfin catfish in the waters of Lake Sidenreng is categorized as not being caught because the current rate of exploitation (*E*) is smaller than the current rate, optimum exploitation. In accordance with the opinion of Gulland (1983) that the maximum and sustainable exploitation rate of a fish stock is *F* = *M* or the rate of exploitation (*E*) = 0.5 [22]. This condition is supported by the mortality data obtained that sailfin catfish are not under fishing pressure due to natural mortality.

5. Conclusion

Based on the results of the study, it can be concluded that the age group of sailfin catfish in male and female fish each has 2 cohorts. This shows that these waters consist of two generations living together at one time. The growth rate coefficient obtained for male and female sailfin catfish is 0.69 per year and 0.46 per year, respectively, where the male fish reach the maximum length faster than the female fish. The mortality values obtained in male and female sailfin catfish indicate that the mortality value was caused more by natural mortality than by fishing mortality. The rate of exploitation showed that the sailfin catfish in Lake Sidenreng were not under fishing pressure (not being caught more). The *Yield per Recruitment Relative (Y/R*) value for male sailfin catfish was 0.033409 per year and for female fish it was obtained a value of 0.013153 per year which was below the optimum value.

Suggestion

Further research on aspects of population dynamics requires the availability of data on fish body height and it is better if the fishing is done per station and students go directly to the field to catch.

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