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Intensive catched parrotfish *Chlorurus bleekeri* (de Beaufort, 1940) in Wallace Line, Makassar Strait, Indonesia

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Intensive catched parrotfish *Chlorurus bleekeri* (de Beaufort, 1940) in Wallace Line, Makassar Strait, Indonesia

S A S Mansyur[1], M T Umar[1], Irmawati[1], I Yasir[2,3], A Yanti[3], P Y Rahmani[3], R Aprianto[3], A Tuwo[2, 3] and J Tresnati[1,3]

[1]Fisheries Department, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia.
[2]Marine Science Department, Faculty of Marine Science and Fisheries, Universitas Hasanuddin, Makassar, Indonesia.
[3]Multitrophic Research Group, Universitas Hasanuddin, Makassar, Indonesia.

Email: jtresnati@yahoo.com

Abstract. Bleeker's Parrotfish *Chlorurus bleekeri* (de Beufort, 1940) is a Scaridae lives in coral reef ecosystems in tropical and subtropical waters. Bleeker's Parrotfish is very abundant in the Indo-Pacific region. Bleeker's Parrotfish can be found from shallow water to a depth of 30 meters. Bleeker's Parrotfish is a herbivorous fish. Herbivorous reef fish are important in the coral reef ecosystem because ecologically they can control the coral competitor. Therefore, the exploitation of Bleeker's Parrotfish needs to be regulated keep sustainable use of Bleeker's Parrotfish. This study aims to analyze the growth, mortality, and exploitation rate of Bleeker's Parrotfish in the Wallace Line, Makassar Strait, Indonesia. Fish samples were obtained from the catch of fishermen landed at Fish Landing Port, Makassar City, South Sulawesi, Indonesia. Length frequency data is converted into group data using the Bhattacharya method. Growth parameters were estimated using the von Bertalanffy growth equation. The total mortality (Z) was estimated using the Beverton and Holt equations. The natural mortality rate (M) was estimated using the Pauly empirical formula. Fishing mortality rate (F) was estimated using the equation F= Z-M The exploitation rate (E) was estimated using the Beverton and Holt equations, $E = \frac{F}{Z}$ The growth rate was $\mathrm{Lt} = 40[1 - \exp^{-0.15\ (t+1.05)}]$. The total mortality rate was 2.56 $year^{-1}$, the natural mortality rate was 0.96 $year^{-1}$, the fishing mortality rate was 1.60 $year^{-1}$, and the exploitation rate was 0.63 $year^{-1}$. Exploitation rates greater than 0.50 indicate that the Bleeker's Parrotfish in the Wallace line was catched intensively.

1. Introduction

The Spermonde Islands are also known as Sangkarang Islands. These waters have great potential for fish resources, one of which is the Bleeker's Parrotfish *Chlorurus bleekeri*. Bleeker's Parrotfish is a species targeted for catching by artisanal fishers who live on the islands of the Spermonde Archipelago [1, 2].

Bleeker's Parrotfish has a wide distribution in Indo-Pacific waters, covering East India to Micronesia, Samoa, and Fiji and the Philippines to Australia, throughout East India except for the Andaman Sea [3]. Most (75%) parrotfish are scattered in the Indo-Pacific region (including Indonesia), and the rest are found in sub-tropical areas [4].

The male Bleeker's Parrotfish has a brighter color than the female. The female fish is dark brown with three to four pale stripes on the body and a yellowish tail. The male Bleeker's Parrotfish is greenish in color with pink scaly edges and a white rectangle on the cheeks and gill covers (operculum) bordered by a thick green line [5] (Figure 1).

Figure 1. Bleeker's Parrotfish *Chlorurus bleekeri* captured in the Wallace Line, Makassar Strait, Indonesia

Bleeker's Parrotfish is a Scaridae that lives in coral reef ecosystems in tropical and subtropical waters. Bleeker's Parrotfish can live in shallow water to a depth of 30 meters [3]. Bleeker's Parrotfish is an herbivorous fish. Ecologically, the role of herbivorous fish in coral reef ecosystems is vital because it can prevent algae blooms attached to the surface of dead corals, thus inhibiting coral recruitment [6]. Bleeker's Parrotfish has teeth shaped like a bird's beak so it can eat algae attached to dead coral. Therefore, the presence of Bleeker's Parrotfish can be a bioindicator of coral reef health [7].

Apart from having an ecological role, Bleeker's Parrotfish also has a significant economic role. Bleeker's Parrotfish is quite popular and is very selling well in the market. Bleeker's Parrotfish is an essential economic commodity exported fresh to Asian countries such as Hong Kong, Taiwan, and Singapore. Bleeker's Parrotfish has fine and soft meat fibers [8].

This increase in market demand led to an increase in the catch rate of Bleeker's Parrotfish in coral ecosystems, including the coral ecosystem in the Spermonde Islands. It is feared that the increase in the catch of Bleeker's Parrotfish could disrupt the ecological balance in the coral ecosystem. Therefore, it needs management efforts to ensure the preservation of coral reefs and Bleeker's Parrotfish resources. Without proper management, it is feared that it will cause the decline or extinction of Bleeker's Parrotfish. One of the parameters that need to be known in the management of Bleeker's Parrotfish resources is the rate of exploitation.

There has been no study regarding the exploitation rate of Bleeker's Parrotfish in the waters of the Spermonde Islands. This study analyzes the growth, mortality, and exploitation rate of Bleeker's Parrotfish in the Wallace Line, Makassar Strait, Indonesia. The study was expected to become a reference in the management of Bleeker's Parrotfish resources, especially in the waters of the Spermonde Islands.

2. Materials and Methods

Sampling was done at Fish Landing Port, Makassar City, South Sulawesi, Indonesia. Bleeker's Parrotfish sample was the catch of fishermen operating in the waters of the Spermonde Islands. Bleeker's Parrotfish samples were taken every mid-month. The total length of the Bleeker's Parrotfish sample was measured using a ruler to an accuracy of 1 mm. Measurement starts from the tip of the mouth at the forefront to the tip of the rear tail fin. The age group or cohort was determined using the Bhattacharya method by dividing the parrotfish by several long ranges (L), then looking for the theoretical frequency (fc) of the frequency of each cohort. Then look for the logarithm of the theoretical frequency (log fc) among the existing length classes, followed by finding the difference in logarithms ($\Delta Logfc$). Then plot the mean class value as the X-axis and the logarithmic difference of the cumulative frequency ($\Delta Logfc$) as the Y-axis. The number of lines formed indicates the number of cohorts. This cohort analysis was carried out with the help of the FAO-ICLARM Fish Stock Assessment Tools II (FISAT II) program [9].

Estimation of growth parameters based on the growth model of Von Bertalanffy [10] according to the equation:

$$Lt = L\infty [1 - exp^{-K(t-t0)}$$

where Lt was the length of the fish at age t (mm), L_∞ was the length of the fish asymptote (mm), K was the growth rate coefficient, the theoretical age of the fish when the length was equal to zero (years), the age was (years) at time t (years).

The values for L_∞ and K were estimated using the ELEFAN I package in the FISAT II program. Estimation of t_o was carried out using the empirical formula [11] according to the equation:

$$\log(-\mathrm{to}) = -0.3922 - 0.2752 (\log \mathrm{L}\infty) - 1.038 (\log \mathrm{K})$$

The total mortality (Z) was estimated by using the length converted catch curve method in the FISAT II program [11] according to the equation:

$$\mathrm{Ln} = \frac{\mathrm{C(L1 - L2)}}{\Delta \mathrm{t(L1 - L2)}} + \mathrm{C} - \mathrm{Z\,x\,t}\frac{\mathrm{(L1 - L2)}}{2}$$

The value of this equation was estimated using a simple linear regression equation, namely $\mathrm{y = b0 + b1\,x}$, whereas the ordinate, $X = t(L1 - L2)$ as the abscissa, dan $\mathrm{Z} = -\mathrm{b}$.

Natural mortality (M) was estimated using the Pauly empirical equation [11] according to the equation:

$$\log(\mathrm{M}) = -0.0066 - 0.279 \log \mathrm{L}\infty + 0.6543 \log \mathrm{K} + 0.4634 \log \mathrm{T}$$

where T was the average temperature flat in the waters of the Spermonde Islands (28.9 ^{o}C). Capture mortality (F) was estimated using the following equation:

$$\mathrm{F = Z - M}$$

The exploitation rate (E) was estimated using the Beverton and Holt equations [10] according to the equation :

$$\mathrm{E} = \frac{\mathrm{F}}{\mathrm{Z}}$$

3. Results

During the study, 302 specimens of Bleeker's Parrotfish were collected. From the results of the cohort analysis using 1 cm length class intervals, two cohorts were obtained (Figure 2 and Table 1).

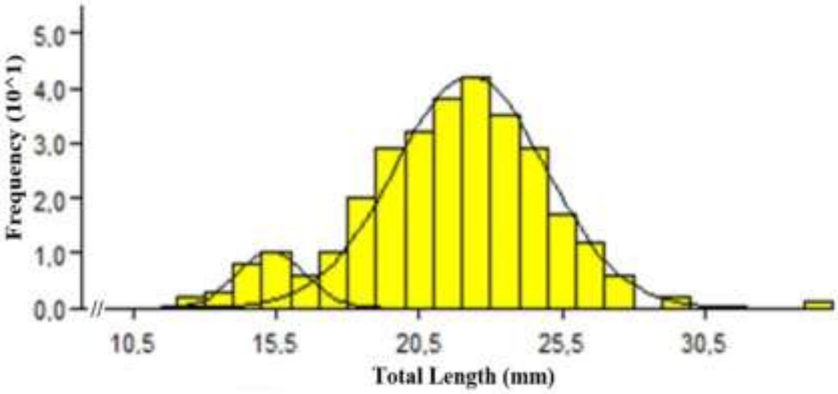

Figure 2. Distribution cohorts Bleeker's Parrotfish *Chlorurus bleekeri* in Wallace Line, Makassar Strait, Indonesia

Table 1. The average length of each cohort Bleeker's Parrotfish *Chlorurus bleekeri* in Wallace Line, Makassar Strait, Indonesia

Cohort	Average Length (cm)	Standard Deviation (cm)	Total Bleeker's Parrotfish (individual)	Separation Index
1	15.31	1.16	30	n. a
2	22.29	2.63	278	2.39

From the analysis of Bleeker's Parrotfish growth parameters, it was found that the value of $L\infty$ = 40 cm, the value of K = 0.15, and the value of to = -1.05. Based on the value of the growth parameter, the von Bertalanffy equation $Lt = 40\ (1 - e^{-0,15\ (t+1.05)})$ was obtained (Figure 3).

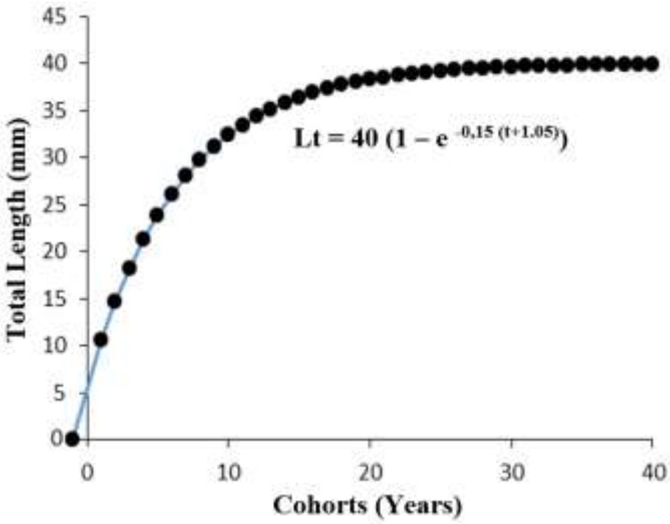

Figure 3. Bleeker's Parrotfish *Chlorurus bleekeri* growth curve in Wallace Line, Makassar Strait, Indonesia

From the analysis of the mortality and exploitation rate of Bleeker's Parrotfish, the total mortality value was 2.56 year^{-1}, natural mortality was 0.96 year^{-1}, fishing totality was 1.60 year^{-1}, and exploitation rate was 0.63 year^{-1}. This exploitation value indicates that there has been an intensive caught Bleeker's Parrotfish in Wallace Line, Makassar Strait, Indonesia.

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4. Discussion

Cohort is important to know because it can describe the success or failure of fish reproduction in a certain year [12]. Cohorts are also important because they can be used to calculate the growth or growth rate of fish [13]. In this study, two cohorts were found indicating that the Bleeker's Parrotfish caught came from two generations or recruitment. There is a possibility that the two cohorts have a difference in age of less than one year because based on the distribution of gonad maturity levels in parrotfish species [14-19] and wrasse [20-22] in the Spermonde Islands suggests the possibility of spawning many times a year, but this allegation still needs to be proven in more detail. The number of cohorts is the same as the number of cohorts for other parrot fish species, *Scarus rivulatus* caught in the waters of Kulisusu Bay, North Buton, Southeast Sulawesi, Indonesia [23]. The results of the analysis with two cohors are quite good because they have a separation index value that was greater than two. The separation index describes the quality of the separation of two adjacent cohorts, if the separation index was less than two, it was impossible to separate the cohorts because there will be overlapping of two cohorts [10].

Growth is the increase in length or weight over time. Estimation of growth rate is important in determining the productivity of reef fish caught in waters [24]. The L_∞ value of 40 cm means that theoretically Bleeker's Parrotfish in Wallace Line, Makassar Strait, Indonesia will not exceed 40 cm because $L\infty$ is related to the maximum length of fish that can be achieved [11] in a population. Theoretically, Bleeker's Parrotfish will take a long time to reach its asymptotic length. Bleeker's Parrotfish attains its asymptote length at the cohorts of 40 years; however, 80% of its asymptote length can be achieved in the first ten years of its life. This slow growth pattern also occurs in other parrotfish species, such as The bumphead parrotfish *Bolbometopon muricatum*, which reaches its maximum length at the age of 25 years [25].

The K value of 0.15 indicates that the growth rate of Bleeker's Parrotfish in Wallace Line, Makassar Strait, Indonesia was slow. A value of $K < 0.5$ per year means that the growth rate is slow, a value of $K > 0.5$ per year means that growth is classified as fast [26]. The environment influences parrotfish growth. Food availability dramatically affects the growth rate of parrotfish. Certain parrotfish species, *Scarus iserti*, show seasonal variations in growth which are thought to be due to variations in food availability [27]. On a laboratory scale, parrotfish growth is influenced by the content of amino acids [28], protein [28], protein [29], vitamin C [30], and probiotic supplementation [31].

Bleeker's Parrotfish t_o value was -1.05 year^{-1}. Value -1.05 was the theoretical age when Bleeker's Parrotfish measures 0 cm. The t_o value plays an important role in fisheries management because the t_o value was used to estimate the development of the final oocyte follicle to oviposition and during spawning [32]. Oviposition means expulsion of the egg from the oviduct to the external environment.

Theoretically, fish growth will continue, but at varying rates, usually higher at the beginning of the life cycle, then decreasing as it approaches asymptote size. Fish length increases with time, but the growth rate will decrease when the fish are old and will approach zero when the fish are very old [10].

The abundance of fish in a cohort at a certain time can be influenced by natural and exploitation factors, namely natural mortality and fishing mortality. Natural and exploitation factors can be described by the mortality coefficient. Fish stock mortality in the wild is defined as the rate of decline in the abundance of individual fish based on exponential time [10].

The average water temperature is the only environmental parameter in the Pauly empirical formula [11]. The average temperature in the waters of the Spermonde Islands is 28.9°C. This temperature is within the average temperature range of other waters in Indonesia, for example the Karimunjawa waters where the temperature is 28 to 31°C [33]. Other natural factors, such as biological factors, are reflected in the population growth parameters. Population growth parameters describe the stress suffered by a population in the form of disease, stress, spawning, hunger, and age in fish [10].

The fishing mortality which was greater than the natural mortality indicates that Bleeker's Parrotfish has a higher mortality due to exploitation. One of the causes of the high rate of exploitation of parrotfish was its high economic value. Parrotfish, including Bleeker's Parrotfish, are very popular with the public because they have a white flesh color and have soft and soft meat fibers [8]. Parrotfish is an important commodity which is exported fresh to Asian countries such as Hong Kong, Taiwan and Singapore.

Bleeker's Parrotfish exploitation rate is an index that describes the utilization rate of Bleeker's Parrotfish stock in a certain water. To maintain the sustainability of exploited fish resources, the rate of exploitation must not exceed the rate of optimum exploitation. The optimum exploitation rate is 0.5 [34]. The exploitation rate of 0.63 indicates that the fishing for Bleeker's Parrotfish has exceeded the sustainable use limit. Currently, there has been an intensive catched Bleeker's Parrotfish in Wallace Line, Makassar Strait, Indonesia. This condition needs serious attention from stakeholders so that this uncontrolled condition does not continue.

5. Conclusion

The study indicated two cohorts, Bleeker's Parrotfish in Wallace Line, Makassar Strait, Indonesia. These two cohorts indicate that there are two generations of parrots living together and experiencing fishing pressure at one time. Bleeker's Parrotfish catch mortality rate was more significant than natural mortality. The exploitation rate of 0.63 indicates that there has been an intensive caught Bleeker's Parrotfish in Wallace Line, Makassar Strait, Indonesia.

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