Dynamics Population Of Skipjack (Katsuwonus Pelamis) In Makassar Strait Water, South Sulawesi, Indonesia

Elsa Mallawa, Achmar Mallawa, Faisal Amir

Abstract: Skipjack (Katsuwonus pelamis) is an important commodity which is exploited by fisherman throughout the year using various types of fishing gear, so as expected the pressure on fish populations is very high and will disrupt the sustainability of population indicted bye the small size of fish caught. This study aims to determine some parameters of population dynamics of Skipjack such as age group, growth rate, fishing mortality, the rate of exploitation, and yield per recruits was conducted on September 2015 – February 2016 in the Makassar Strait Waters, South Sulawesi. The number of samples used was 3811fish with a total length range from 29.1 to 67 cm. The results showed that fish populations of Skipjack in the Makassar Strait Waters consists of three age groups where the average length of 1st, 2and, 3rd were 35.3507 cm, 44.7361 cm, and 54.2067 cm respectively and the infinity length, growth rate, and age where length of fish equal to zero were 108.1864 cm, 0.4489 per year and -0.5910 year respectively. The rate of total mortality (Z) was 0.97 per year, natural mortality (M) was 0.13 per year, fishing mortality was 0.83 per year and the rate of exploitation (E) was 0.86 per year and the yield per recruitment (Y/R) was 0.1270 g/recruitment.

Index Terms: Skipjack, Dynamics population, Makassar Strait Water

1 Introduction

Skipjack (Katsuwonus pelamis) is an important fishery commodity in Indonesian Fishery Management Area – 713 waters (Flores Sea, Bali Sea, Gulf Bone and Makassar Strait waters). In these fishing area skipjack is exploited by fishermen throughout the year by using various types of fishing gear such as pole and line, hand line, trolling line, purse seine and drift surface gill nets, and it is mentioned that the pressure on fish populations is very high and will disrupt the sustainability of this resources indicated by the small size of the fish caught and declining catch per unit effort. In the reason of sustainability of skipjack population the rational utilization must be practiced, therefore the data and information about biological population and population dynamic of skipjack are very important to know. A lot of study about biological population and population dynamic of skipjack have been done by several researcher such as Fadhillah (2011) [18], Baso (2012) [5], Mallawa et. al (2012) [14] in Bone Gulf waters, Samad (2002) [19], Fidyatul (2011) [7], Mallawa et al (2013) [15] at Flores Sea waters, and Djafar (1991), Hasmini (2003) Andriani (2012) [2], Agus (2012) [3] and Mallawa et al (2014) [16] at Makassar Strait waters.

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2 Methods

This study was conducted for 6 (six) months, namely from September 2015 - February 2016 in the Strait of Makassar, South Sulawesi. Data is collected on the area Pangkep, Barru, Pare-Pare, and Pinrang. Location of the study are presented in Figure 1.

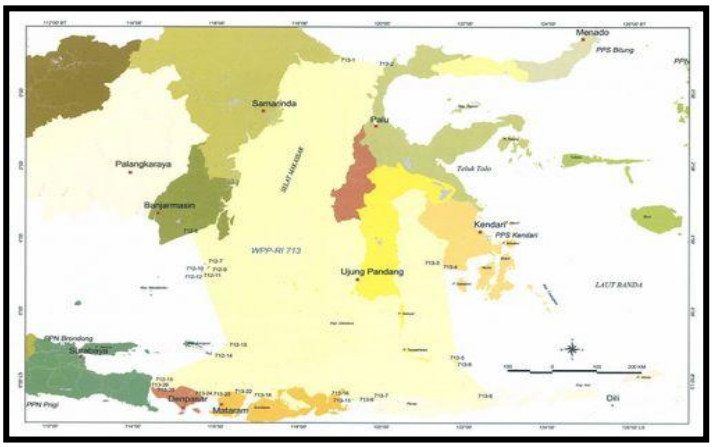

Figure 1. *Location of the study in Strait of Makassar Waters*

2.1 Collect of data

In this research Stratified Random Sampling have been used to collect data. The fish length sample was collected from the fishermen who used different kinds of fishing gear such as purse seine, hand line, trolling line, and drift surface gill net, and a lot of fishing base.

2.2 Analysis Data

1. Age Group

The number of age group (cohort) and the average length for each group age were estimated by difference logarithmic method of Battacharya (Sparre et al, 1999) [20].

2. Growth Rate

The rate of growth value was estimated using equation proposed by Von Bertalanffy (Sparre and Venema, 1999) [20]

as follows:

$$Lt = L\infty[1-e^{-K(t-to)}]$$

Where:
Lt = length of fish at time t (years),
L∞ = Infinity Length (cm),
K = growth rate coefficient (per year)

The value of infinity length and growth rate coefficient was calculated by Ford and Walford method, as follows

$$L(t+\Delta t) = a + b\,L(t)$$

where:

$$a = L\infty(1-b) \text{ and } b = \exp(-K\Delta t),$$
$$\text{then } K = -(1/\Delta t)\ln b \text{ and } L\infty = a/(1-b)$$

and t_0 was determined using formula of Pauly (1980) [17], as follows:

$$\text{Log}(-t_0) = -0.3922 - 0.2752(\text{Log } L\infty) - 1{,}038(\text{Log } K)$$

Where:
t_0 = theoretical age of the fish at the time of a length equal to zero (years)

3. Mortality

Natural Mortality
Natural mortality rate (M) was calculated using the Emphirical formula of Pauly (1980) [17] as follows:

$M = 0.8\text{Exp}(-0{,}152 - 0{,}279(\text{Ln } L\infty) + 0{,}6543(\text{Ln } K) + 0{,}4634(\text{Ln } T^0C))$
Where:
M = natural mortality rate (per year)
L∞ = Infinity Length (cm)
K = coefficient of growth rate (per year)
T = average temperature of the water (^{0}C)

Total Mortality
The rate of total mortality (Z) was calculated using the formula of Beverton and Holt (Sparre and Venema, 1999) [20].

$$Z = K\left[\frac{L\infty - L}{L - L'}\right]$$

Where:
Z = total mortality rate (per year)
L = The average length of fish caught (cm)
L '= Length of the smallest of fish are caught in full (cm)

Fishing Mortality
Mortality rate of fishing (F) estimated using the equation:

$$F = Z - M$$

Rate of exploitation

As for the rate of exploitation (E) estimated using the equation Beverton and Holt (Sparre and Venema, 1999) [20], as follows
$E =$

Yield Per Rekuitment
Yield Per Recruitment (Y / R), known from the equation Beverton and Holt (Sparre and Venema, 1999) [20], namely:

$$Y/_R = E.U^m\left[1 - \frac{3U}{1+m} + \frac{3U^2}{1+2m} + \frac{U^3}{1+3m}\right]$$

Where:

$$U = 1 - \frac{Lc}{L\infty}$$

$$m = \frac{1-E}{M/K}$$

Explanation:
E = rate of exploitation (per year)
Lc = length of the smallest fish that have been caught ≥ 50% (cm)
M = natural mortality rate (per year)
K = coefficient growth rate (per year)

3. Result and Discussion

3.1 Age Group

The number of fish was measured is 3811 fish where the smallest fish was 29.1 cm of length and the biggest fish was 67 cm of length. The plotted between the frequency of fish of classes of length and length of the middle length class produce histograms with three peaks as shown in figure 2. Figure 2 described that there are three age classes in yield capture of fishermen in Makassar Strait waters. Andriani (2012) [2]. Agus (2012) [3] and Mallawa et al (2014) [16] also found that skipjack captured by fishermen in Makassar Strait waters consist of three classes age. It is also shown that the distribution of length frequency not in normal distribution so the data must be normalized.

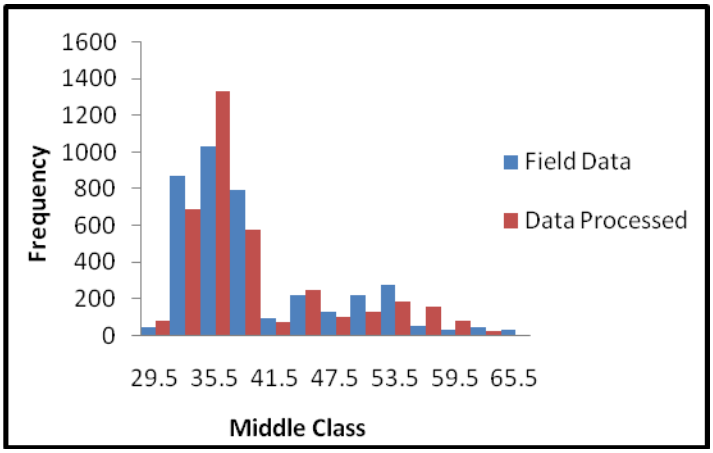

Figure 2. *Histogram of length frequency of the classes of length of the fish that has not been normalized and has been normalized*

Based on the histograms above (Figure 2) it is found that the number of length frequency of each length classes was not similar where the fishes 34 – 37 cm of length was dominantly, and the smallest one was the fishes 64-67 cm of length.

Hasmini (2003) reported that length range of fish captured by fishermen at North part of Makassar Strait waters was 14 – 74 cm and dominated by skipjack 55 – 62 cm of length. Andriani (2012) [2] described the skipjack captured by fishermen in Makassar Strait waters had length range and dominant length 14 – 82 cm and 29 – 32 cm respectively. Qarimah (2013) [21] reported that,length range and dominant length of skipjack captured by fishermen were 14 – 77 cm and 44 47 cm respectively, while Mallawa et al (2014) [16] reported that length range and dominant length of skipjack captured by fishermen in South part of Makassar Strait waters were 27 – 77.5 cm and 32.5 – 37.5 cm respectively. The average length of 1st,2nd, 3rd classes age were 35.3507 cm, 44.7361 and 54.2067 respectively as shown in Table 3 and Fig 3.

Table 3. *Length range and the average length of each age group of skipjack in the Makassar Strait waters.*

Long range (Cm)	Relative Age (Years)	Average length of individual (Cm)	Number of Fish
28 – 40	1	35.3507	2739
40 - 49	2	44.7361	463
49 - 67	3	54.2067	636

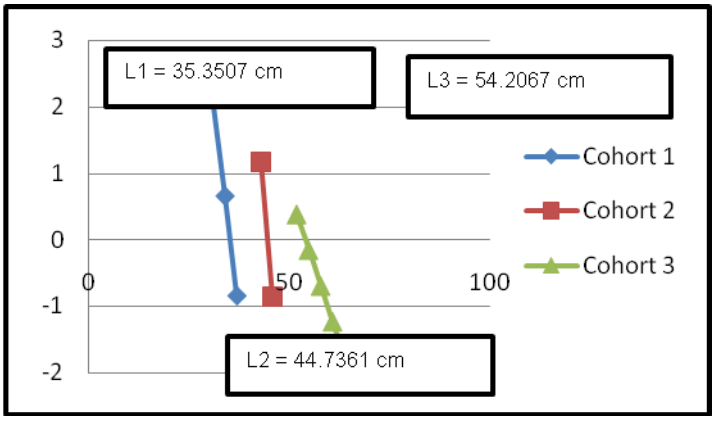

Figure 3. *Mapping the Middle Class Value (x) and Difference of Natural logarithm of length Frequency of Skipjack (Katsuwonus pelamis) in Makassar Strait waters*

Qorimah (2014) [20] explained that the average length of 1st,2nd,3rd age classes were 23.613 cm, 46.125 cm, and 64,041 cm respectively. Rezkika (2011) [18] described that in the Gulf of Bone waters average length of 1st,2nd,and 3rd age classes were 26.10 cm, 53.51 cm, and 74.94 cm respectively while Baso (2013) [5] showed that the average length of 1st,2nd,and 3rd age classes were 37 cm, 51 cm, and 61 cm respectively. And 64.13 cm in third year Fidyatul (2013) [7] described that the skipjack at Flores Sea waters had average length 30.72 cm in the first year, 51.23 cm in second year and, 63.13 cm in third year. Coan (2000) [6] reported that skipjack at East Pacific Ocean can reach 31 cm of average length in first year, 51 cm in second year and, 64 cm in third year Andrade and Kanis (2003) [4] explained that skipjack had 43 cm of length in the 1st year age and 64 cm of length in the 4th year age.

3.2 Growth Rate

The value of parameters of Von Bertalanffy growth equation was obtained by using Ford and Walford method and Pauly method. It Is found that the infinity length (L∞) was 108.1864 cm, growth rate coefficient (K) was 0.4489 yearly, and theoretical length of fish at zero ago (t_o) was -0.5910 year. Those values explained that the skipjack in Makassar Strait can reached about 108.19 cm of maximum length, and grows slowly (Figure 4). Qorimah (2013) [21] reported that infinity length, growth rate and to of skipjack at Strait of Makassar waters were 112.70 cm, 0.31 yearly, and -0.363 year respectively. Mallawa et al (2014) [16] described that the infinity length, growth rate and to of skipjack in South part of Makassar Strait waters were 82 - 107 cm, 0.34 - 0.45 yearly and -0.875 until -1.26 year depend on fishing season. Gartnert et al (2008) [8] explained that at East Atlantic Ocean the growth of skipjack varied according to fishing area and fishing season. Mallawa et al (2012 and 2013) [14,15] showed that the growth of skipjack in Bone Gulf waters and Flores Sea waters varie according to fishing area and fishing season.

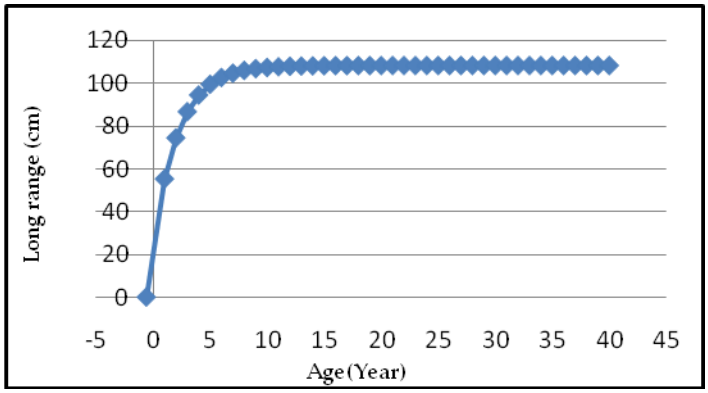

Figure 4. *Growth curve of Skipjack (Katsuwonus pelamis) in the Makassar Strait. Waters*

3.3 The Mortality

The result of calculation showed that the value of Total Mortality (Z), Natural Mortality (M) and Fishing Mortality (F) were 0.97, 0.13 and, 0.83 respectively while Qorimah (2013) [21] reported that the value of Total Mortality, Natural Mortality and Fishing Mortality were 0.647, 0.214 and, 0.434 respectively. Rezkika (2011) [18] reported that in the Bone Gulf waters the value of Total Mortality, Natural Mortality and Fishing Mortality were 0.61, 0.41 and 0.20 respectively. Fidyatul (2013) [7] showed that in the Flores Sea total mortality of skipjack was 1.8273, natural mortality was 0.5972 and fishing mortality was 1.2301. Mallawa et al (2014) [16] explained that the variability of mortality caused by oceanography condition such as sea surface temperature, availability of food, predation intensity and fishing intensity.

3.4 Rate of Exploitation

In this research the rate of exploitation was 0.8606. Mallawa et al (2012) [14] explained that the exploitation rate is categorized high if E > 0.5. The high value of exploitation rate also found by Qorimah (2013) [21] on skipjack population in Makassar Strait waters (E=0.670) and Fidyatul (2013) [7] on skipjack population in Flores Sea waters (E=0.6732) while Rezkika contrary found that the exploitation rate of skipjack in south part of Bone Gulf waters was not to high (E=0.33).

3.5 Yield per Recruitment

In this research the value of actual Y/R obtained was 0.1270, less than optimal value of Y/R 0.15 (See figure 5). Based on

the figure 5 that if we intent to keep the skipjack population in equilibrium condition (Y/R optimal), the rate of exploitation of skipjack population must be decreased. Qorimah (2013) [21] at the same fishing area found that actual Y/R and optimal Y/R were 0.3198 and 0.3299 respectively. Fidyatul (2013) [7] showed that in the Flores Sea waters the value of actual Y/R and optimal Y/R were 0.078 and 0.0975 respectively while Rezkika (2011) [18] found that actual Y/R and optimal Y/R of skipjack population in Bone Gulf waters were 0.35 and 0.33 respectively. The estimated value of Z, M, F and E in this study are presented in Table 4.

Table 4. *Value of Mortality and Rate of Exploitation of Skipjack (Katsuwonus pelamis) in the Makassar Strait waters.*

Population Parameter	Estimated Value (per year)
	Water of Makassar Strait, South Sulawesi, Indonesia Elsa (2016)
Total mortality (Z)	0.9652
Natural mortality (M)	0.1346
Fishing mortality (F)	0.8306
The rate of exploitation (E)	0,8606

Sources: *Primary data are processed*

Based on the Table 4 above that the role of natural mortality in total mortality is very small, otherwise the role of fishing mortality is very large.

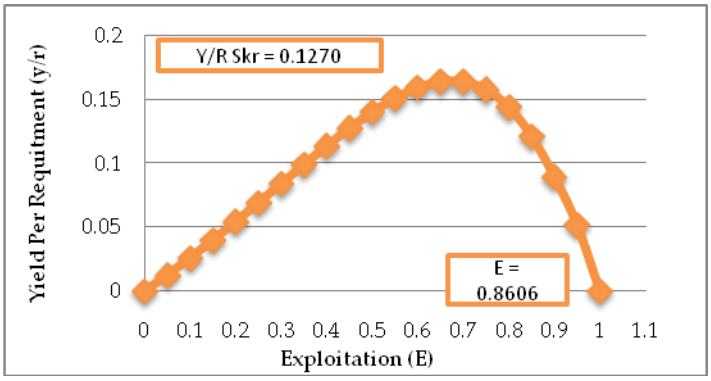

Figure 5. *Relationship Yield Curve per Recruitment (Y / R) Against Exploitation rate value (E) Skipjack in the Strait of Makassar, South Sulawesi, Indonesia.*

4 Conclusion

Based on the results of a study of some of the parameters of population dynamics of skipjack (Katsuwonus pelamis) in the Makassar Strait can be summarized as follows: The population of skipjack in Makassar Strait waters consist of three age classes, dominated by small fishes, grows slowly, and tend be decreasing. The values of population dynamic parameter were not to difference with the population of skipjack in certain fishing area,, and population dynamic of skipjack in Makassar Strait water affected mostly by fishing mortality. To maintain the population of skipjack in equilibrium condition the number (biomass) of fishes recruited must be increasing by decreasing of exploitation rate

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