Population dynamics of pink shrimp (*Metapenaeus affinis*) in Samboja Kuala Waters, Kutai Kartanegara Regency

Putri Handayani* | Muhammad Syahrir Ramang | Abdunnur Abdunnur

Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, Mulawarman University
Jl. Gunung Tabur No. 1. Kampus Gn. Kelua Samarinda 76123
**E-mail: putrisafitri867@gmail.com*

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ABSTRACT

Samboja Kuala has a very wide sea and has abundant natural resources, pink shrimp (*M. affinis*) is one of caught in Samboja Kuala waters. The pink shrimp catches operate at night, because the intensity of the jinga shrimp catch is high, the possibility of exploiting shrimp resources will be threatened. This research was conducted in November-December 2022. Shrimp sampling was carried out using mini trawls operated in Samboja waters. The purpose of this study was to study the sex ratio, growth rate, death rate, pattern of new additions, and yield per recruitment. The sex ratio of male and female pink shrimp was 1.00:1.40. The growth rate coefficient (K) for male and female pink shrimp is 1.10/year and 0.53/year and the estimated asimtotik length of male and female pink shrimp ($L\infty$) is 144.58, and 145.11. The male and female pink shrimp obtained an exploitation result of E>0.5, which means that the catch of pink shrimp is classified as overfishing. New additions to catches New additions to male pink shrimp occurred in May with a percentage of 34.69% and female pink shrimp in September 20.71%. Y/R values for male and female pink shrimp were 0.058/year and 0.23/year

INTRODUCTION

Samboja is a sub-district in the Kutai Kartanegara Regency of East Kalimantan province. The Samboja Kuala village has vast marine waters and abundant natural resources. One of the biological resources in the Samboja marine waters is capture fisheries. Capture fisheries in these waters have become one of the livelihoods of fishermen in the coastal area. Pink shrimp (*Metapenaeus affinis*) is one of the economically valuable catches because the waters of Samboja Kuala border the Makassar Strait, which can affect the fishery production value.

This shrimp can only be obtained by fishermen during the night and daytime because of its characteristics. The capture of pink shrimp (*M. affinis*) is done using mini trawl fishing gear. The shrimp population in a water body is dynamic, changing both in terms of increase and decrease. Therefore, it is necessary to conduct periodic and serious assessments related to the population dynamics of pink shrimp in the waters.

The pink shrimp resources in these waters are abundant, and fishing activities are carried out daily. Due to the high intensity of shrimp fishing in these waters, it is suspected that the utilization of pink shrimp resources will be threatened with sustainability and the continuity of resource utilization. According to

Suman (2010), this happens because shrimp resources are very vulnerable to fishing, given their characteristics of having narrow migration routes, low activity, and relatively small groups.

To maintain the shrimp stock in Samboja Kuala waters and due to the declining catch rates in these waters, shrimp resource management can be pursued through sustainable and conservation-based utilization. This research aims to assess the sex ratio, age group, growth rate, mortality and exploitation, recruitment patterns, and yield per recruitment of pink shrimp in the Samboja Kuala waters, Kutai Kartanegara.

METHODOLOGY

Location and Time of Research

This research was conducted from November to December 2022 in the waters of Samboja Kuala, Samboja Sub-district, Kutai Kartanegara Regency, by following the night-time shrimp fishing activities using mini trawls.

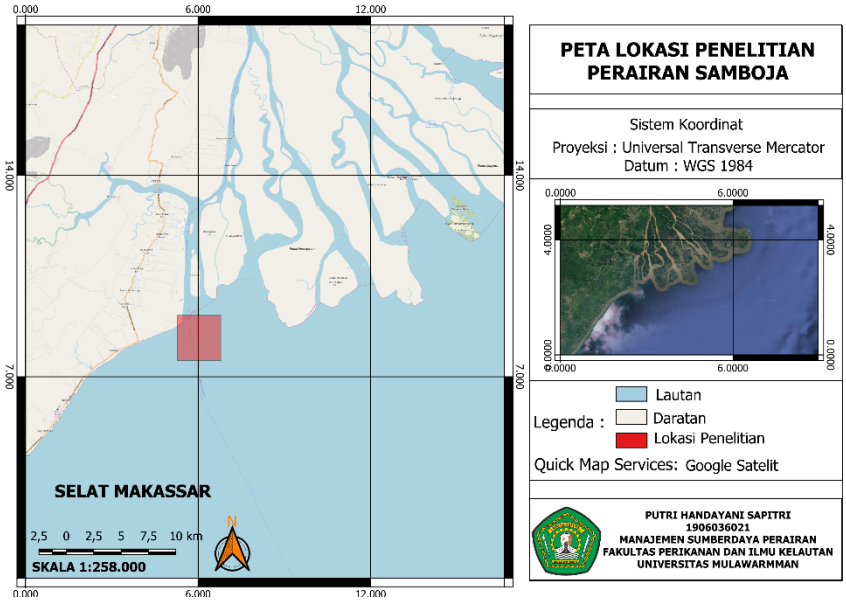

Figure 1. Study location map

Research Procedure

Sampling in this study was carried out by collecting samples from the fishermen's catch, specifically pink shrimp. Sampling was done once a week to facilitate the measurement process and prevent sample damage. The body length of the pink shrimp was then measured in the laboratory of the Faculty of Fisheries and Marine Sciences, Mulawarman University.

Data Analysis

Data obtained were analyzed using the following analytical methods:

1. Sex Ratio

Sex ratio of shrimp was calculated using the equation:

$X = M : F$

where:

- X = sex ratio
- M = number of male shrimp (individuals)
- F = number of female shrimp (individuals)

2. Age Estimation

Age estimation was performed using the Von Bertalanffy growth formula (Sparre et al., 1999):

$Lt = L\infty (1 – e^{-K(t-t0)})$

where:

- Lt = length of shrimp at age t (mm)
- L∞ = asymptotic length of shrimp (mm)
- K = growth coefficient
- t0 = theoretical age of shrimp when length equals zero (months)
- t = age (months)

The parameter t0 was determined using the Pauly formula (1980):

$\text{Log}(-t0) = -0.3922 – 0.2752 (\text{Log } L\infty) – 1.038 (\text{Log } K)$

3. Mortality

Natural mortality estimation was calculated using the empirical Pauly formula (1980):

$\text{Log } M = -0.0066 - 0.279 \text{ Log } L\infty + 0.543 \text{ Log } K + 0.4634 \text{ Log } T$

where:

- L∞ = asymptotic length of shrimp (mm)
- K = growth coefficient
- T = average surface water temperature (°C)

Total mortality was estimated using the equation proposed by Beverton and Holt (1956) in Sparre et al. (1992):

Fishing mortality was estimated using the equation:

$Z = F + M$

where:

- F = fishing mortality
- Z = total mortality

Exploitation rate (E) was obtained using the Beverton and Holt formula:

$E = F / Z$

4. Recruitment Pattern

Recruitment pattern data were analyzed using the FiSAT II software's recruitment pattern sub-program, aiming to determine the temporal construction of length frequency recruitment peaks per year. The data were transformed into lfq format (grouped frequencies) and input with previously calculated values of L∞ and K, resulting in recruitment pattern histograms.

This research was conducted from November to December 2022 in the waters of Kuala Samboja, Samboja District, Kutai Kartanegara Regency. This location was chosen as the initial area of fishermen's catches. Fishing gear used included Gillnets, Purse seines, Trammel nets, and Trawls, with fishing activities conducted both during daytime and nighttime.

RESULTS AND DISCUSSION

Sex Ratio

The sex ratio of pink shrimp analyzed during the research is presented in Table 1.

Table 1. The sex ratio of pink shrimp

Month	Number of Individual		Ratio	
November-December	Male	Female	Male	Female
	209	291	1,00	1,40

Based on Table 1, the sex ratio of male to female pink shrimp shows that the number of female shrimp is higher than male shrimp with a ratio of 1:1.40. According to research by Saputra et al. (2013), the sex ratio of pink shrimp in Cilacap waters, Central Java, is 1:1.02. In the study by Tirtadanu et al. (2017), the male-to-female shrimp ratio in Kotabaru waters, South Kalimantan, is 1:2.5. According to Darmano in Saputra et al. (2013), in unpolluted waters, the ratio of male to female shrimp is 1:1.

During the spawning period, the number of male and female shrimp differs significantly because male shrimp die earlier, leading to a decrease in the number of male shrimp. This factor contributes to the higher number of female shrimp compared to male shrimp. A higher number of female shrimp can be advantageous during the spawning season, as they can produce more eggs and have a higher chance of being fertilized by male shrimp sperm. This condition also indicates an imbalance in the catch of female and male shrimp. According to Tirtadanu et al. (2017), this imbalance indicates fishing pressure on shrimp resources. However, in the waters of Samboja Kuala, the fishing pressure has not yet disrupted population renewal, so the shrimp stock balance in these waters remains well-maintained.

Table 2. *Chi-Square* Test

Sex	N	Fo%	F%	(Fo-f)	$(Fo-f)^2$	$(Fo-f)^2/F$
Male	209	42	50	-8	64	1,28
Female	291	58	50	8	64	1,28
	500		100		X^2	2,56

Based on the chi-square test, the calculated X^2 value is 2.56, with a degree of freedom (df) of 1, and the table X^2 value is 3.841. Since the calculated X^2 value is less than the table X^2 value X^2 calculated < X^2 table), there is no significant difference, indicating that the male and female shrimp have a balanced condition. Although the number of female shrimp caught in this study is higher than the number

of male shrimp, the sex ratio comparison shows that the higher ratio of females to males indicates that the fishing pressure on pink shrimp resources in these waters has not yet disrupted population renewal. Consequently, the sustainability of the shrimp stock is well-maintained.

Age Group

The results of the age group analysis of male and female pink shrimp shown in Figures 2 indicates one peak in the histogram, signifying that there is one age group for both genders.

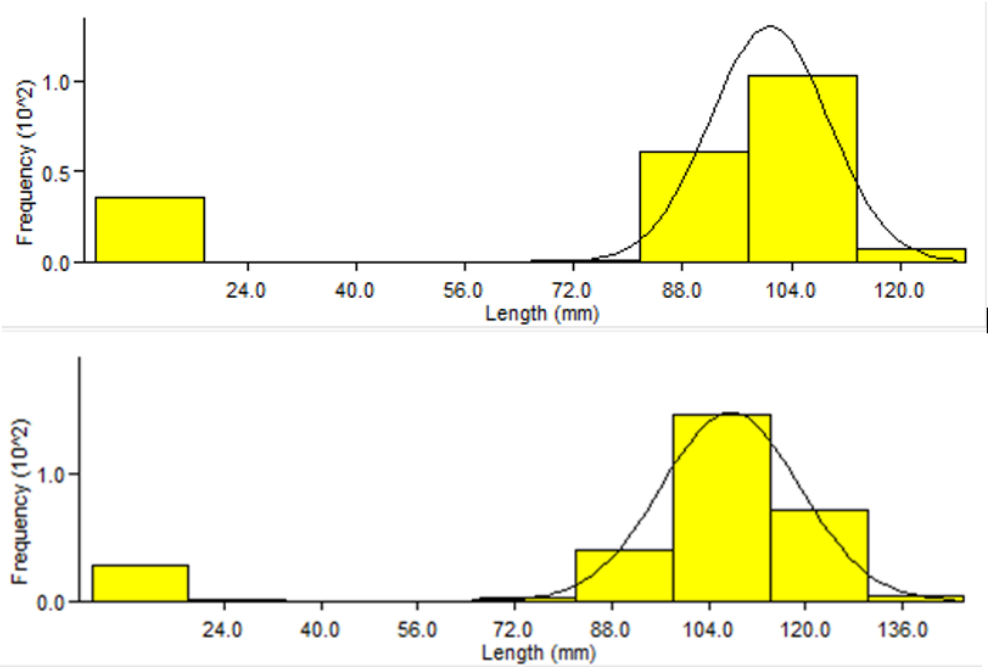

Figure 2. Age group of male (top) and female (bottom)

Based on Figures 2, the range of frequency and class midpoints shows that the age groups of male and female pink shrimp are not significantly different. The age group for male pink shrimp ranges from 24.00 mm to 120.00 mm, while the age group for female pink shrimp ranges from 24.00 mm to 136.0 mm. The mode, or the most frequently occurring length, for both male and female pink shrimp in their respective age groups, is 104.0 mm. Generally, the length frequency originates from the same age and tends to form a normal distribution.

Growth Rate

The analysis obtained the asymptotic length (L∞L_\inftyL∞), growth rate coefficient (KKK), and the theoretical age at zero length (t0t_0t0) for each gender of white shrimp (P. merguensis) presented in Table 3.

Table 3. Estimated Growth Parameters of Pink Shrimp

Parameter	Male	Female
L∞	144,58	145,11
K	1,10	0,53
t0	0,093	0,199

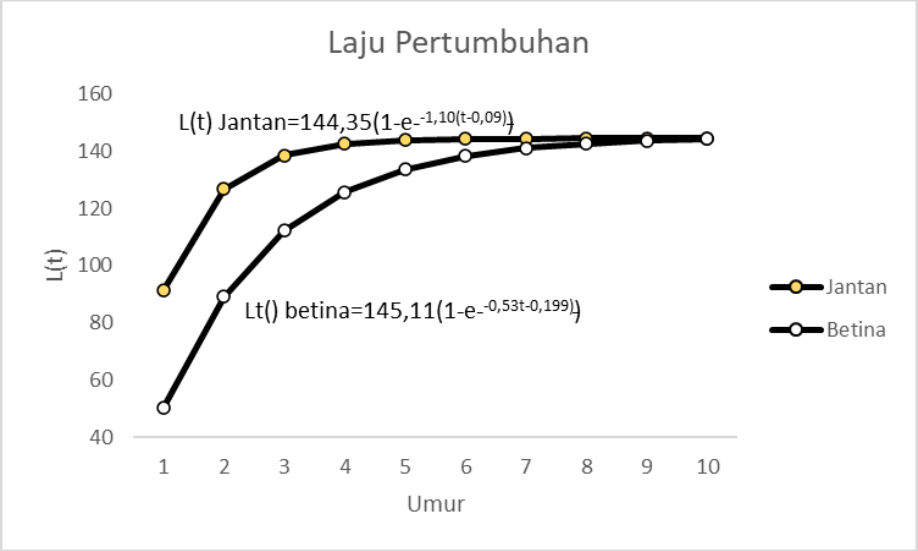

Figure 3. Graph of Estimating the age of Pink Shrimp

Based on Table 3 and Figure 3, the growth rate (KKK) of male and female pink shrimp is 1.10 and 0.53, respectively. These results indicate that the growth parameters of pink shrimp in Samboja Kuala have asymptotic growth parameters with a male value of 144.58/year and a female value of 145.11/year. The asymptotic length (L∞L_\inftyL∞) for males and females is 145.82 mm and 160.81 mm, respectively. In the study by Fatma et al. (2022), the growth rate coefficient in Egyptian waters for male pink shrimp was 0.68/year and for female pink shrimp was 1.33/year, which is not significantly different from the annual growth rate coefficient values of pink shrimp. The differences in the L∞L_\inftyL∞ and KKK values for pink shrimp are likely due to varying environmental conditions in different waters (Tsoumani et al., 2006, in Suman et al., 2022). These environmental conditions include water temperature, food availability, dissolved oxygen, and gonad maturity.

Mortality and Exploitation

Based on the growth parameters and growth rates at the average water temperature in Kalimantan, which is 27-29ºC (BMKG, 2021), the total mortality (Z), natural mortality (M), and fishing mortality (F) values are shown in Table 4.

Table 4. Mortality and Exploitation Values

Parameter	Estimated value	
	Male	Female
Natural mortality (M)	1,24	0,77
Total mortality (Z)	4,11	0,27
Catching mortality (F)	2,87	0,49
Mortality rate (E)	0,70	0,56

Based on Table 4, the total mortality coefficient (Z) in Kuala Samboja waters ranges significantly between 0.27-4.11 per year, while natural mortality (M) ranges from 0.77-1.24 per year, and fishing mortality (F) ranges from 0.49-2.87 per year for brown spot shrimp (*Metapenaeopsis barbata*). This indicates that fishing activities impact the mortality of male brown spot shrimp, while for females, fishing has not yet significantly impacted mortality, suggesting that female populations are still abundant in these waters. Male brown spot shrimp have been intensively exploited by fishermen in Kuala Samboja waters (Tirtadanu et al., 2017).

Total mortality rate is influenced by natural mortality (M) and fishing mortality (F). Fishing mortality (F) is higher than natural mortality (M) for male brown spot shrimp, while for females, fishing mortality (F) is lower than natural mortality (M). This indicates that the female population of brown spot shrimp is still abundant in these waters, whereas male populations have been heavily exploited.

Natural mortality is affected by environmental conditions such as predators, food availability, competition, stress levels, diseases, and changes in environmental quality (Sparre and Venema, 1992, cited in Tirtadanu and Chodrijah, 2020).

The exploitation rate (E) for male brown spot shrimp (Metapenaeopsis barbata) is 0.70 and for females it is 0.56 in Kuala Samboja waters. The exploitation rates for both males and females exceed the optimum exploitation rate of 0.5 (Gulland, 1983, cited in Tirtadanu et al., 2017), indicating overexploitation in male shrimp and suboptimal exploitation in females. Overexploitation is attributed to the use of non-selective fishing gear, leading to significant impacts on shrimp resources.

In previous research (Tirtadanu and Chodrijah, 2020), brown spot shrimp in Cilacap waters, Central Java, showed exploitation rates for both males and females below the optimal E value of 0.43-0.49, indicating that overfishing had not yet occurred in those waters.

New Growth Pattern

The analysis of length data for brown spot shrimp caught at night in Samboja waters reveals monthly percentages over a year, from January to December. The new recruitment pattern of male and female brown spot shrimp in Kuala Samboja waters, based on length frequency data obtained through the ELEFAN program, shows that new recruitment for male brown spot shrimp occurs in May, with an addition proportion of 34.69%. Meanwhile, new recruitment for female brown spot shrimp peaks in September at 20.71%. According to Naami (1984) cited in Nurdin and Kembaren (2015), rainfall levels are related to the peak spawning season of shrimp, which typically occurs at the beginning and end of the rainy season. Therefore, it is recommended to reduce or refrain from fishing efforts during these rainy months, as they coincide with the highest spawning period for brown spot shrimp. This approach aims to allow for normal regeneration processes in subsequent months or seasons.

Yield Per Recruitment

Yield per Recruitment (Y/R) was analyzed using the Beverton & Holt assumption. Based on the analysis, the estimated Y/R value is 0.058 for male brown spot shrimp and 0.23 for female brown spot shrimp, which are taken as catch results. This indicates that from each recruitment event, 0.058% and 0.23% are harvested as catch. The relationship between exploitation rate and yield per recruitment can be seen in Figure 4.

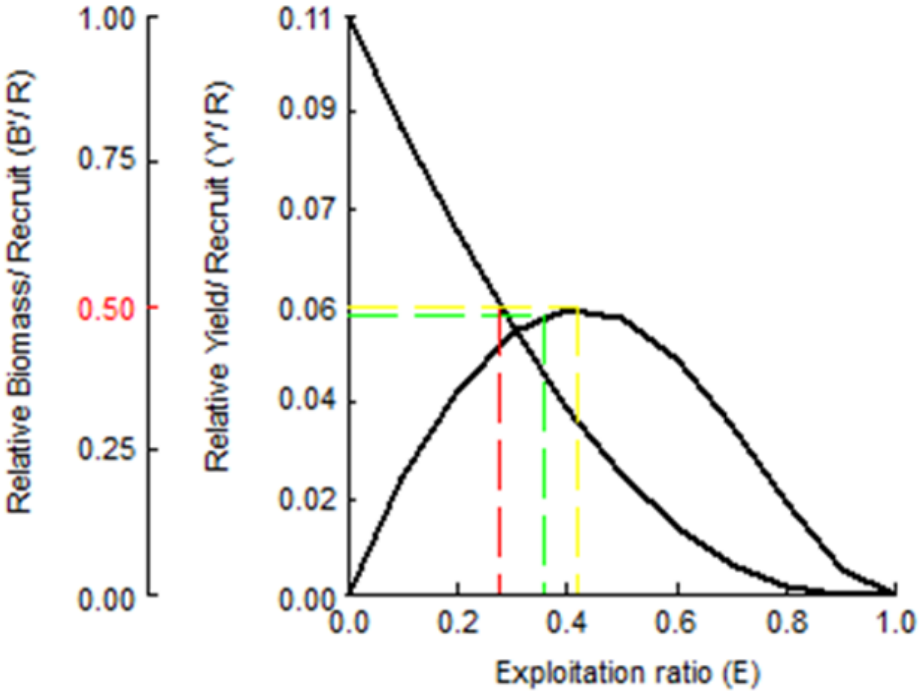

Figure 4. Graph of the Relationship between Exploitation Rate and Yield Per Recruitment

The exploitation rates of male and female pink shrimp in Samboja waters are 0.70 and 0.56, respectively, with a Y/R (yield per recruitment) value of 0.017. This indicates that the exploitation rates do not exceed the optimum value. The Emax obtained for the relationship between exploitation rate and yield per recruitment is 0.44 for male pink shrimp and 0.50 for female pink shrimp. To achieve optimum catch results, it is advisable to reduce fishing efforts by approximately 20% for male pink shrimp and 60% for female pink shrimp, in accordance with Pauly et al.'s statement (1984) that E opt = 0.5. This utilization will provide optimum results without jeopardizing the recovery capability of pink shrimp in these waters.

CONCLUSION

1. The sex ratio of captured pink shrimp is 1:1.40 for males and females, indicating a balanced condition based on a Chi-square test analysis of sex distribution.
2. The von Bertalanffy growth function (L(t)) for male pink shrimp has parameters (L∞) of 144.58 mm and (K) of 1.10 per year, while for female pink shrimp, the parameters are (L∞) 145.11 mm and (K) 0.53 per year.
3. Total mortality (Z) for male pink shrimp is 1.24, comprising natural mortality (M) of 4.11 and fishing mortality (F) of 2.87, whereas for female pink shrimp, total mortality (Z) is 0.77, with natural mortality (M) of 0.27 and fishing mortality (F) of 0.49.
4. The exploitation rates of male and female pink shrimp are 0.70 and 0.53, respectively, indicating E > 0.5, which suggests that the exploitation rates exceed the optimum level, indicating potential overfishing.
5. Recruitment of new individuals for male pink shrimp occurs in May with a percentage of 34.69%, while for female pink shrimp, it occurs in September with a percentage of 20.71%.

6. The estimated Y/R values are 0.058 per year for male pink shrimp and 0.23 per year for female pink shrimp. When relating the exploitation rate to Y/R, the Emax for male and female pink shrimp is 0.44 and 0.50, respectively.

REFERENCES

Badan Meteologi Klimatologi dan Geofisika. 2021. Buletin meteorologi (analisis cuaca dan iklam skala global dan regional dan lokal wilayah samarinda). Stasiun Meteorologi Temindung. Samarinda.

Beverton, R.J.H. & S.J. Holt. 1957. *On The Dynamics Of The Exploited Fish Population*. Academic Press. London.

Effendie, M. I. (2002). *Fishery Biology* (136 P.).Yayasan Pustaka Nusatama, Yogyakarta.

Fatma A. A. Razek, E. Ragheb, R.S. El-Deeb H. O Ahmed. 2022. *Growth pattern and stock assessment of jinga shrimp Metapenaeus affinis (H. Milne Edwards, 1837) (Decapoda, Penaeidae) from the southeastern Mediterranean of the Egyptian coasts. Journal of Aquatic Research*, 48(22): 83-90

Mollynda M., S.W. Saputra., A. Sabdaningsih., A. Solichin. Analisis Stok Udang Jerbung (*Penaeus merguiensis)* Yang Didaratkan Di Ppi Bandengan Kendal, Jawa Tengah. Jurnal Harpodon Borneo. 15 (1) ; 1-15

Nurdin, F. & D.D. Kembaren. 2015. Parameter populasi udang putih (*Penaeus merguiensis*) di Perairan Sampit dan sekitarnya, Kalimantan Tengah. Jurnal Bawal. 7(1): 03-109.

Pauly, D. 1983. *Some Simple Methods For The Assessment Of Tropical Fish Stocks*

Ricker, W.E. 1975 *On The Interpretation Of Biological Statistic Of Fish Population*. Bulletin. No.119. Ksh. Res. Bd. Canada. Ottawa.

Saputra, W.S., A. Solichin, W. Rizkiyana. 2013. Keragaman Jenis dan Beberapa Aspek Biologi Udang Metapenaeus Di Perairan Cilacap, Jawa Tengah. *Journal of Management of Aquatic* (2): 37-46.

Steel, R.G.D. & J.H.Torrie. 1980. Principles and Procedures of Statistic, Second Ed, Graw-Hall. Book Comp. New York

Sparre, P., S. C. Venema. 1992. *Introduction To Tropical Fishs To Ckassesment. Parti Manual.FAO* Fish. Tech. Pap. No.306/1.

Suman,,A., C. Umar. 2010. Dinamika Populasi Udang Putih (*Penaeus merguiensis De Man*) Di Perairan Kotabaru, Kalimantan Selatan. Jurnal Perikanan 16:29-33.

Tirtadanu, T., U. Chodrijah.2020 Laju Tangkap, Karakteristik Biologi Dan Status Pemanfaatan Udang Jerbung (*Penaeus merguiensis De Mann, 1988*) Dan Udang Dogol (*Metapenaeus affinis H. Milne Edwards*, 1837) Di Perairan Cilacap. Jurnal Penelitian Perikanan Indonesia 2: 47-58

Tirtadanu, T., S. Suprapto, A. Suman. 2017 Aspek Biologi Dan Parameter Populasi Udang Jinga (*Metapenaeus affinis H.Milne edwards*, 1837) di Perairan Kotabaru, Kalimantan Selatan. *Bawal* (9): 11- 20.