

Population Dynamics of Yellow Prawn (*Metapenaeus monoceros*) Captured at Night in the Waters of Samboja Kuala, Kutai Kartanegara Regency

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ARTICLE INFO

Research Article

Article history:

Received June 18, 2023

Received in revised form July 17, 2023

Accepted August 1, 2023

DOI: <https://doi.org/10.30872/jipt.v2i2.628>

Keywords: population dynamics, samboja district, mortality, *Metapenaeus monoceros*



ABSTRACT

Samboja Kuala is one of the Kelurahan in Samboja District which is an area where most of the population works as fishermen. There are two types of fishery activities in the Samboja Kuala area, namely capture fisheries (fishermen) and aquaculture fisheries. One of the most common catches obtained by fishermen is shrimp. Yellow-spotted shrimp (*Metapenaeus monoceros*) is one of the catches of fishermen shrimp in Samboja Kuala Waters. This study aims to determine several parameters of population dynamics using the carapace length data frequency method. The research was conducted in Samboja Kuala waters, Kutai Kartanegara Regency, in November-December 2022. Based on the results of the study, the sex ratio between males and females was 0,38: 2,65. The length range in male and female sex is 48,34 mm – 78,85 mm and 48,80 mm – 90,78 mm. And the natural mortality (*M*) of males and females was 1,27 per year and 1,65 per year, the capture mortality (*F*) of males and females was 0,63 per year and 1,64 per year, the total mortality of males and females was 1,90 per year and 3,29 per year, and the exploitation rates of males and females were 0,33 and 0,50. New additions of males occurred in October by 16,27% and new additions of females occurred in October by 24,93%. And it is known that the yield per recruitment value is 0.04 grams / recruitment.

INTRODUCTION

Samboja Kuala is one of the sub-districts within the Samboja district, where the majority of the population is engaged in fishing. There are two types of fishing activities in the Samboja Kuala area: Capture Fisheries (fishermen) and Aquaculture. It is known that the fisheries in the Samboja area yield a variety of products, including fish, shrimp, squid, blue crab, lobster, and others. One of the most commonly caught products by fishermen is shrimp. Shrimp is recognized for its high nutritional value as a protein source and is considered an important commodity in the fisheries sector due to its high market value in the export commodity market (Pratiwi, 2008). The yellow-spot prawn (*Metapenaeus monoceros*) is one of the commonly caught shrimp species in the waters of Samboja Kuala.

Fishermen in the Samboja Kuala area use several types of fishing gear, including trawls, trammel nets, gill nets, purse seines, and cungkil nets for their fishing activities. It is known that the dominant catch for Samboja Kuala fishermen is shrimp. Most of the Samboja fishermen use trawl nets for shrimp fishing, as this type of gear has proven to be the most effective and economical for catching various types of fish and shrimp.

To ensure the sustainability of the yellow-spot prawn stock in the waters of Samboja Kuala, proper management is required. Effective management requires basic data, including aspects of population dynamics at various life stages and habitat, in order to maintain the population balance of shrimp in a given area. Hence, an analysis of population dynamics for the yellow-spot prawn in the waters of Samboja Kuala is needed.

METHODOLOGY

A. Research Location and Time

This study was conducted for 1 month from November to December 2022, located in Samboja Kuala Waters, Samboja District, Kutai Kartanegara Regency, East Kalimantan Province, Indonesia.

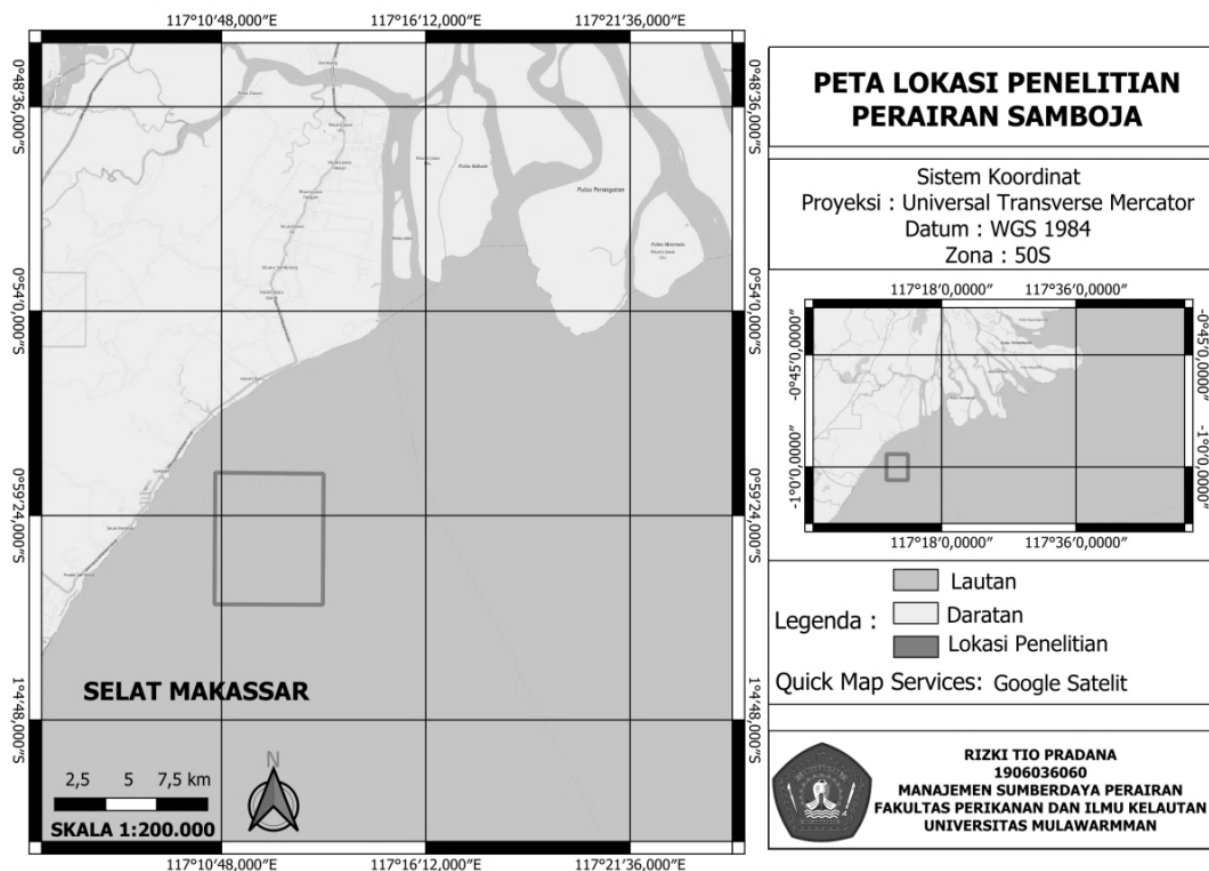


Figure 1. Research Location Map

B. Equipment and Materials

The tools used in this research include a digital caliper (as a length measuring tool), camera (for documenting activities during the research), writing materials (for recording research findings), scale (for weight measurement), measuring board (as a base and measurement tool), and identification book (as a reference for identifying yellow spot prawns).

C. Research Method

Sampling in this research was carried out by collecting samples from the catch of fishermen, namely prawns. Sample collection was done once a week to facilitate the researcher in measuring the samples and

preventing sample damage. After sample collection, the prawns were measured for weight, length, and gender. The measurement activities were conducted at the Conservation Laboratory of the Faculty of Fisheries and Marine Sciences, Mulawarman University.

D. Data Analysis

The collected data was then subjected to data analysis using the following methods:

1. Gender Ratio

The gender ratio of yellow spot prawns is obtained from the equation below:

$$X = M : F$$

Where:

X = Gender ratio

M = Number of male prawns (individuals)

F = Number of female prawns (individuals)

2. Estimation of Age

Age estimation is done using the Von Bertalanffy growth formula (Sparre et al., 1999), as follows:

$$Lt = L_{\infty} (1 - e^{-K(t-t_0)})$$

Where:

Lt = Prawn length at age t (mm)

L_{∞} = Asymptotic length of prawn (mm)

K = Growth coefficient

t₀ = Theoretical age of prawn when length is zero (months)

t = Age (months)

To determine t₀, the Pauly formula (1980) is used:

$$\text{Log} (-t_0) = -0.3922 - 0.2752 (\text{Log } L_{\infty}) - 1.038 (\text{Log } K)$$

Where:

L = Asymptotic length of prawn (mm)

K = Growth coefficient

t₀ = Theoretical age of prawn when length is zero (months)

3. Natural Mortality

Estimation of natural mortality is done 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 prawn (mm)

K = Growth coefficient

T = Average surface water temperature (°C)

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

$$Z = K \frac{L_{\infty} - \bar{L}}{L - L'}$$

Capture mortality is estimated using the equation:

$$Z = F + M$$

$$F = Z - M$$

Exploitation Rate (E) is obtained using the Beverton and Holt formula:

$$E = F / Z$$

Where:

Z = Total mortality rate (per month)

K = Growth coefficient

L_{∞} = Asymptotic length of prawn (mm)

L = Average length of captured prawns (mm)

L' = Lower limit of size class of captured prawns (mm)

F = Capture mortality rate

Z = Total mortality rate

4. Recruitment Pattern

Recruitment pattern is analyzed using the FiSAT II software, specifically the recruitment pattern sub-program. This aims to determine the recruitment pattern over a period of time from length frequencies to identify peak values per year. The software transforms data into (grouped frequencies) format, then the calculated values of L_{∞} and K are inputted to generate a recruitment pattern histogram.

5. Yield Per Recruitment

Y/R is calculated using the Beverton and Holt formula (1957):

$$\frac{Y}{R} = E - U \frac{M}{K} \left(1 - \frac{3U}{1+m} + \frac{3U^2}{1+2m} + \frac{U^2}{1+3m} \right)$$

Where,

$$U = 1 - \frac{L'}{L_{\infty}}$$

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

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

Explanation:

E = Exploitation rate

L' = Lower limit of size class of fully captured prawns (mm)

M = Natural mortality rate (per year)

K = Growth coefficient

RESULT AND DISCUSSION

A. Research Location

This study was conducted during the months of November-December 2022 in the waters of Kuala Samboja, Samboja Sub-district, Kutai Kartanegara Regency, East Kalimantan Province, Indonesia. This location serves as the primary landing site for fishermen's catches. The fishing gear used by the fishermen in Kuala Samboja includes Gillnets, Purse seines, Trammel nets, and Trawls. Fishing activities are carried out both during the day and at night.

B. Sex Ratio

The sex ratio values of male and female yellow spotted shrimp during the study period are presented in Table 1.

Table 1. Sex Ratio of Yellow Spotted Shrimp Based on Sex

Month	Total Individual		Ratio	
	Male	Female	Male	Female
November-December	137	363	0.38	2.65

Based on Table 1, it can be observed that the sex ratio of male and female yellow spotted shrimp is such that the number of females is greater than males, with a ratio of 0.38:2.65. According to Dwiponggo (1982), when there is a balanced number of males and females in the waters, the chances of fertilization of eggs by spermatozoa are higher. Darmono (1991) in Budianto (2012) states that normal waters have a male-female shrimp sex ratio of 1:1, but during spawning, the number of male shrimp decreases because male shrimp have a higher likelihood of dying earlier. This is a factor explaining why as time goes on, the number of female shrimp spawning tends to be higher than male shrimp in a given water body.

C. Age Estimation

Age estimation analysis was performed using the Length Frequency Analysis (ELEFAN-1) program, yielding growth parameter values for both males and females. Based on the data of total length frequency of male and female yellow spotted shrimp, the growth rate (K) of male yellow spotted shrimp is 0.88 and for females it is 1.40, while the asymptotic length (L_{∞}) for males and females is 80.16 and 93.24, respectively.

Table 2. Estimated Growth Parameter Values for Yellow Spotted Shrimp

Parameter	Jantan	Betina
L_{∞}	80,16	93,24
K	0,88	1,40
t0	0,13	0,08

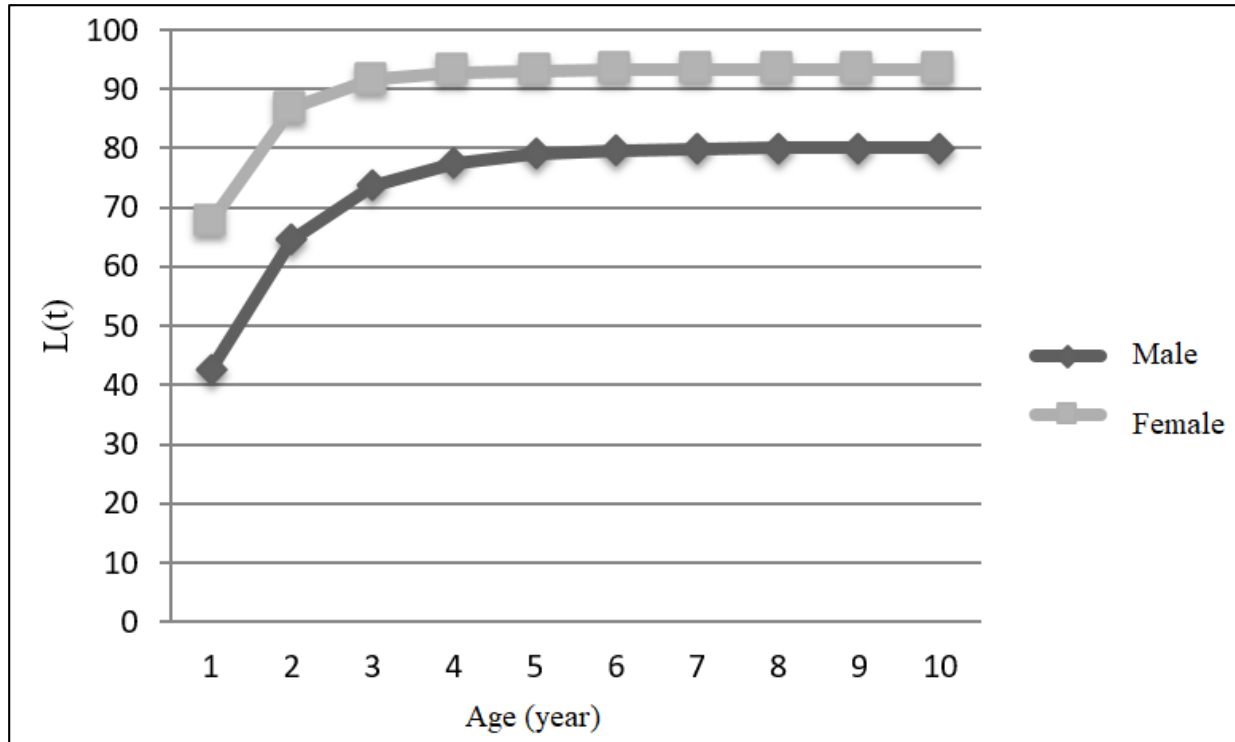


Figure 2. Age Estimation of Yellow Spotted Shrimp

Based on the growth curve in Figure 2, it shows that the growth of male and female yellow spotted shrimp differs, where the growth rate of female yellow spotted shrimp is faster compared to male yellow spotted shrimp. Rapid growth in the length of male and female yellow spotted shrimp occurs at a young age, while the growth of shrimp slows down as they age until their asymptotic length is reached, where there will be no further increase in length. Effendie (2002) states that age is an important tool in fisheries biology. Fluctuations in the number of each age group that makes up the population can provide a history of the mortality cycle of shrimp in each group. By knowing the age of the shrimp, as well as the composition and survival of their numbers, the success or failure of shrimp reproduction in a particular year can be determined.

D. Age Groups

Based on the measurement of the total length frequency of male and female yellow spotted shrimp during the study, it is presented in Figures 3 and 4.

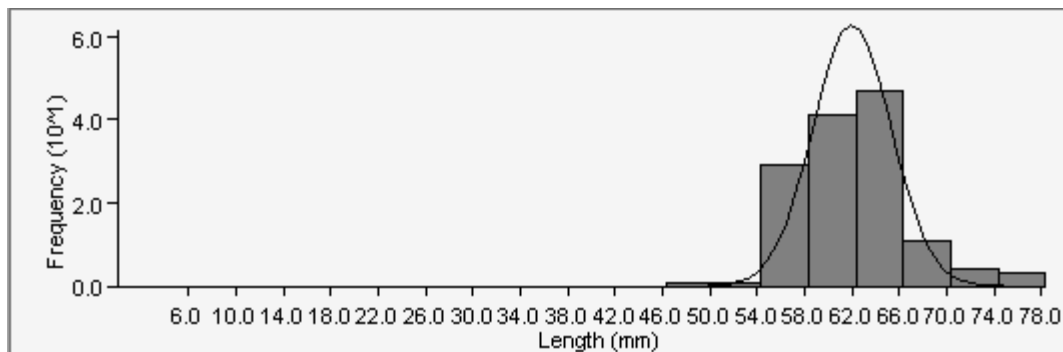


Figure 3. Frequency distribution of male yellow spotted shrimp

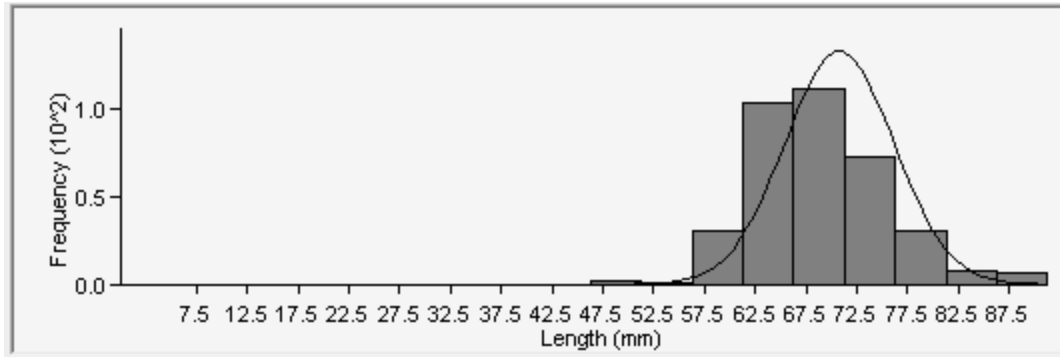


Figure 4. Frequency distribution of female yellow spotted shrimp

Based on the above figure, the mapping results show that there is a relatively consistent range between the frequency values and the class midpoints for age groups of male and female yellow spotted shrimp. The age group range for male yellow spotted shrimp is 48.34 mm – 78.85 mm, while for female yellow spotted shrimp, it is 48.80 mm – 90.78 mm.

E. Mortality

Based on the calculated parameter values of yellow spotted shrimp length, which were used as inputs for estimating catch results, the data were processed using the FiSAT II software program. The results can be seen in Table 2.

Table 2. Yellow Spot Shrimp Mortality

Parameter	Estimation Value	
	Male	Female
Natural Mortality (M)	1.27	1.65
Total Mortality (Z)	1.90	3.29
Catch Mortality (F)	0.63	1.64
Exploitation Rate (E)	0.33	0.50

Based on the above information, the maximum length and growth rate, water temperature is 29°C, which is considered a normal water temperature. The total mortality coefficient (Z) of male and female yellow-spotted shrimp is 1.90 per year and 3.29 per year, respectively. The natural mortality coefficient (M) of male and female yellow-spotted shrimp is 1.27 per year and 1.65 per year, respectively. The mortality coefficient due to fishing (F) for male and female yellow-spotted shrimp is 0.63 per year and 1.64 per year, respectively. The utilization rate of male and female yellow-spotted shrimp is 0.33 and 0.50, respectively.

F. New Growth Pattern (Recruitment)

The monthly percentage of new additions or new growth pattern of male and female yellow-spotted shrimp is presented in Figure 5 and 6, as well as in Table 3.

Table 3. Growth Pattern of Male and Female Yellow-Spotted Shrimp

Month	Male Proportion (%)	Female Proportion (%)
January	0.98	0.54
February	0.48	0.43

March	8.49	0.82
April	5.36	0.99
Mey	13.84	5.22
June	9.92	6.19
July	10.04	11.06
August	15.35	19.37
September	12.40	20.68
October	16.27	24.93
November	6.86	9.77

The growth pattern of male yellow-spotted shrimp in Samboja Kuala waters is based on the length frequency data obtained through the ELEFAN program. The analysis results reveal that new recruitment of male yellow-spotted shrimp occurred in October, accounting for 16.27%. Meanwhile, for female yellow-spotted shrimp, new recruitment occurred in October, accounting for 24.93%. Naamin (1984) stated that the addition of fishing effort up to a certain limit would lead to an increase in production, but if the fishing effort continues to increase, there will eventually be a decrease in production due to stock depletion.

G. Yield per Recruitment

The value of Yield per Recruitment (Y/R) is analyzed using the Beverton and Holt estimation method through the FiSAT II application. Based on the analysis results, the estimated Y/R value is 0.04 grams/recruitment, which is taken as the catch. This indicates that in each recruitment event, 0.04 grams are captured. The relationship between the exploitation rate and yield per recruitment can be seen in Figure 5.

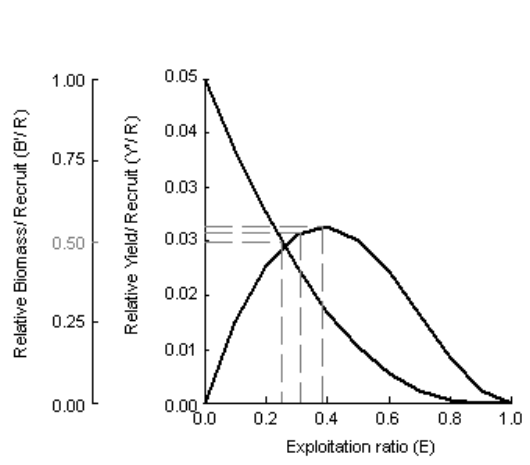


Figure 5. Relationship between Exploitation Rate and Yield per Recruitment

The exploitation rate of the yellow-spotted prawn in Samboja Kuala waters is 0.32, and the obtained Y/R is 0.04 grams. This indicates that the exploitation rate slightly exceeds the yield per recruitment capacity, which is 0.04 grams. The obtained E_{max} in the relationship between exploitation rate and yield per recruitment is 0.38.

CONCLUSION

1. The sex ratio of the yellow-spotted prawn (*Metapenaeus monoceros*) between males and females is 0.38:2.65.
2. The total mortality (Z), natural mortality (M), fishing mortality (F), and exploitation rate (E) of male and female yellow-spotted prawns are 1.90, 1.27, 0.63, 0.33 for males, and 3.29, 1.65, 1.64, 0.50 for females.
3. New recruits for male yellow-spotted prawns occurred in October at a rate of 16.27%, and for females, it occurred in October at a rate of 24.93%.
4. The estimated Y/R value obtained for yellow-spotted prawns is 0.04 grams/recruitment. When considering the relationship between exploitation rate and Y/R, the Emax value obtained is 0.38.

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