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POPULATION PARAMETERS OF BLUE SWIMMING CRAB IN TANGKOLAK HAMLET, KARAWANG REGENCY

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Abstract (English)

Blue swimming crab is a high-value commodity due to its export market and is a superior product for Karawang Regency. High market demand has resulted in fishing activities for blue swimming crabs becoming more intensive from year to year, conducted without regard for the minimum size or the spawning season, thereby triggering overfishing. Given the lack of data and information, a study on blue swimming crab resources is needed to determine the population parameters of the crab (Portunus pelagicus) in Tangkolak Hamlet, Karawang Regency, by analyzing its growth rate, mortality, exploitation rate, and recruitment pattern. Data collection was carried out from January to May 2025, with a total sample of 500 crabs caught by fishermen using crab nets and folding traps. The measurement of the crab's biological parameters includes the measurement of the carapace width and weight of the crabs caught in the waters of Tangkolak Hamlet. The research was designed quantitatively and qualitatively using a descriptive method. The estimation of crab population parameters was analyzed using the FISAT (FAO-Iclarm Stock Assessment Tool) II program. The research findings indicated that the asymptotic carapace width (CW∞) for male and female crabs was 157 mm and 167 mm, respectively. The annual growth rate (K) for male crabs was 0.63/year and for female crabs was 0.4/year, demonstrating that the growth rate of male crabs is faster, as indicated by the higher K value. Regarding mortality, the total mortality (Z) was calculated at 4.18/year for males and 3.32/year for females. The natural mortality (M) was 0.84 for males and 0.62 for females. Crucially, the fishing mortality (F) rates were estimated at 3.34/year for males and 2.7/year for females, signifying that the fishing mortality rate exceeded the natural mortality rate for both sexes. The peak recruitment was estimated to occur in June for male crabs and in July.

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blue swimming crab, growth, mortality, exploitation, recruitment, hamlet tangkolak

INTRODUCTION

Coastal areas are viewed as unique transitional ecosystems, characterized by dynamic interactions between terrestrial and marine components. From a socio-economic perspective, these areas hold significant potential due to their rich natural resources. These resources encompass both biotic (such as fisheries and mangrove forests) and abiotic (such as land) aspects (Suriadarma, 2011).

Karawang Regency has significant potential for managing fisheries and marine resources, with a focus on capture fisheries, which offer high diversity and economic value. Its geographic location, supported by an 84.23-km northern coastline and 2,091.27 hectares of mangrove ecosystem, are key supporting factors for the development of the capture fisheries sector in the region (Gumilar & Nuryasin, 2022).

The potential resources contained in the waters of Karawang Regency have been exploited sustainably by fishermen, serving as a livelihood base and a provider of domestic consumption needs, as well as contributing to export activities. Among the catches with significant potential is the swimming crab. Swimming crab is a high-value commodity because it has an export market and is a superior product for Karawang Regency, processed into peeled swimming crab meat. Swimming crab has a high price, thus increasing the income of fishermen in the coastal areas of Karawang Regency (Istrianto et al., 2021). Swimming crab (Portunus pelagicus) is a commodity with an international market orientation, with export distribution covering various countries in the form of fresh and processed products (Panggabean et al., 2018). The United States is the main (dominant) destination market for Indonesian swimming crab exports, with a market share exceeding 80% of the total export volume. Meanwhile, Japan is identified as the second-largest export destination country for the same commodity (Saputra et al., 2022). Singapore is also one of the countries that exports crab in the form of canned meat (Kholishoh et al., 2019).

However, as the market value of blue swimming crabs increases, fishing activity tends to increase sharply from year to year (Mahendra et al., 2025). Data from the Indonesian Blue Swimming Crab Management Association (2024) shows that Indonesian blue swimming crab exports reached 7,448 tons in 2022, 10,104 tons in 2023, and 8,988 tons in 2024, with an export value of USD 448 million. Price increases provide a strong incentive for fishermen to increase fishing efforts, often without regard for minimum catch size or spawning season (Mahendra et al., 2025).

High market demand combined with favorable pricing structures has driven the intensive exploitation of blue swimming crab resources. This situation is exacerbated by the dependence on wild-caught production, which collectively poses a serious threat to the sustainability of blue swimming crab stocks (Kholishoh et al., 2019). Data from the Karawang Regency Fisheries Office indicates that marine capture fisheries production volume (in tons) fluctuates annually (Gumilar & Nuryasin, 2022). Furthermore, blue swimming crab fishing intensity has increased significantly in coastal areas of Indonesia (Mahendra et al., 2025).

Utilizing blue swimming crab resources presents significant challenges that require precise managerial intervention. Therefore, a measurable management strategy is necessary. A crucial component of this strategy is understanding the internal and external factors influencing blue swimming crab stocks, particularly the spatial dynamics of fishing areas and the variability of fishing season patterns (Ludirosari et al., 2025).

Given the increasing intensity of crab utilization, it is necessary to formulate management policies that focus on the resource's maximum sustainable yield. The goal is to prevent excessive population degradation and maintain its sustainability (Yanti et al., 2023). To support effective management, the availability of data and information on crab population parameters is crucial. This crucial information includes population size structure, the relationship between carapace width and weight, growth rate, mortality, exploitation rate, and current utilization status (Santoso et al., 2022).

Given the limited data and information available, an in-depth study of blue swimming crab resources is essential. This study aims to provide essential input for formulating blue swimming crab fisheries management policies. One of the most important types of information for such management is biological indicators, particularly blue swimming crab population parameters (growth, mortality, and recruitment). Therefore, this research is crucial. is a soft structure within the carapace. The blue swimming crab's eyes protrude from the front of the carapace and are located on relatively short stalks.

Thomson (1974) added that the blue swimming crab is capable of walking well on the seabed and in the muddy and damp intertidal areas. Morphologically, the blue swimming crab has five pairs of relatively flat legs, allowing for efficient movement in the water. The blue swimming crab's morphology can be seen in Figure 2.1.

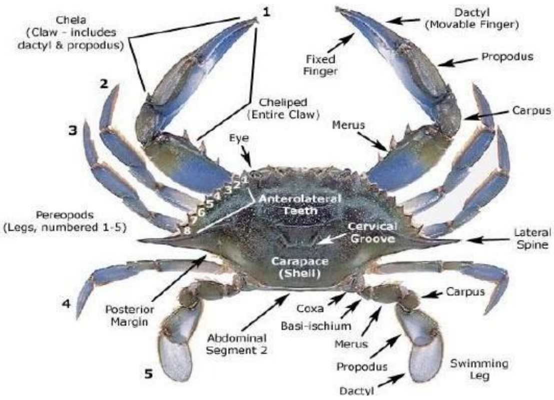

Figure 2.1 Morphology of Crab (Sartika, Alamsjah & Sugijanto, 2016)

The possibility of intensive fishing pressure. High fishing intensity and the influence of changing habitat conditions can influence the crab's life strategies. Changes in crab life strategies can be predicted through population dynamics parameters.

The study of crab population dynamics is a predictive study that can be used in fisheries management because it can evaluate the response of catches caused by fishing mortality and catch size. Population dynamics parameters include growth parameters, recruitment patterns, and mortality. Information on population dynamics parameters can be used to estimate crab stock status. Estimating crab stock status in data-poor conditions can also be done using the exploitation rate and spawning potential ratio approaches. A well-predicted stock status can be an alternative for sustainable fisheries management, thereby maintaining the sustainability and availability of crab stocks and fisheries activities. The flow of the conceptual framework can be seen in Figure 2.3.

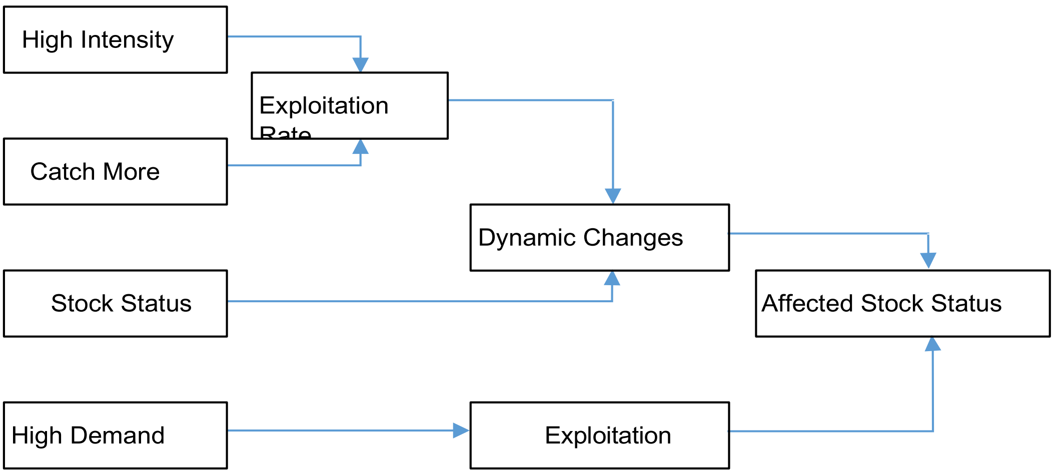

Figure 2. 3 Framework for Flow of Thought

RESEARCH METHODS

Intensive crab fishing without proper management can have negative impacts, including a decline in the population in its natural habitat. The long-term consequence is disruption to the sustainability of crab fishing activities themselves. Therefore, information on crab stock estimates is essential as a basis for sustainable crab resource management. This study was designed using a combined approach (quantitative and qualitative) with a descriptive framework. The descriptive method serves to describe the characteristics of a group, object, or phenomenon at the time of the study. The advantage of this method is its ability to provide relevant data regarding field conditions, so that the findings can be applied to solve problems and make future predictions. Descriptive research limits its analysis to the descriptive stage, namely by analyzing and presenting facts in a structured manner. The goal is to make the data easier to understand and draw conclusions. Overall, descriptive research aims to systematically and accurately describe the facts and characteristics of a specific population or field of study (Wirartha, 2006). This research was conducted from January to May 2025, with the study location being Tangkolak Hamlet, Sukakerta Village, Cilamaya Wetan District, Karawang Regency, West Java. Observations of biological and technical aspects were conducted.

A. Growth Rate

Crab growth parameters were obtained from the analysis of monthly frequency data of carapace width by tracking the mode shift in a time series according to the von Bertalanffy curve. The results of the analysis of crab growth parameters can be seen in Table 4.2.

Table 4.2 Growth parameters of swimming crab (Portunus pelagicus)

Species	Growth parameters		
	CW∞ (mm)	K (per year)	t_0(year)
Portunus pelagicus	157.85 (j)	0.63 (j)	-0.79
	167.50 (b)	0.4 (b)	-0.59

The results of the growth parameter analysis indicate differences between male and female blue swimming crabs. Male blue swimming crabs have an asymptotic carapace length (CW∞) of 157.85 mm with a growth rate (K) of 0.63 per year and a t_0 value of -0.79 years. Meanwhile, female blue swimming crabs reach a larger CW∞ size of 167.50 mm, but with a lower growth rate (K) of 0.40 per year, and a t_0 value of -0.59 years. These differences indicate that female blue swimming crabs have the potential to grow to a longer maximum size than males, although reaching this size is slower. Conversely, male blue swimming crabs tend to experience faster growth but stop at a smaller maximum size. This reflects the presence of sexual dimorphism, where females play an important role in increasing population biomass, while males excel in terms of accelerated growth. In line with the statement by Sara et al. (2017), that male blue swimming crabs grow faster than females.

The similarity of t_0 values in both sexes shows that the initial growth patterns are relatively similar. The von Bertalanffy growth curves of male and female crabs use The ELEFAN I program is presented in Figure 4.2.

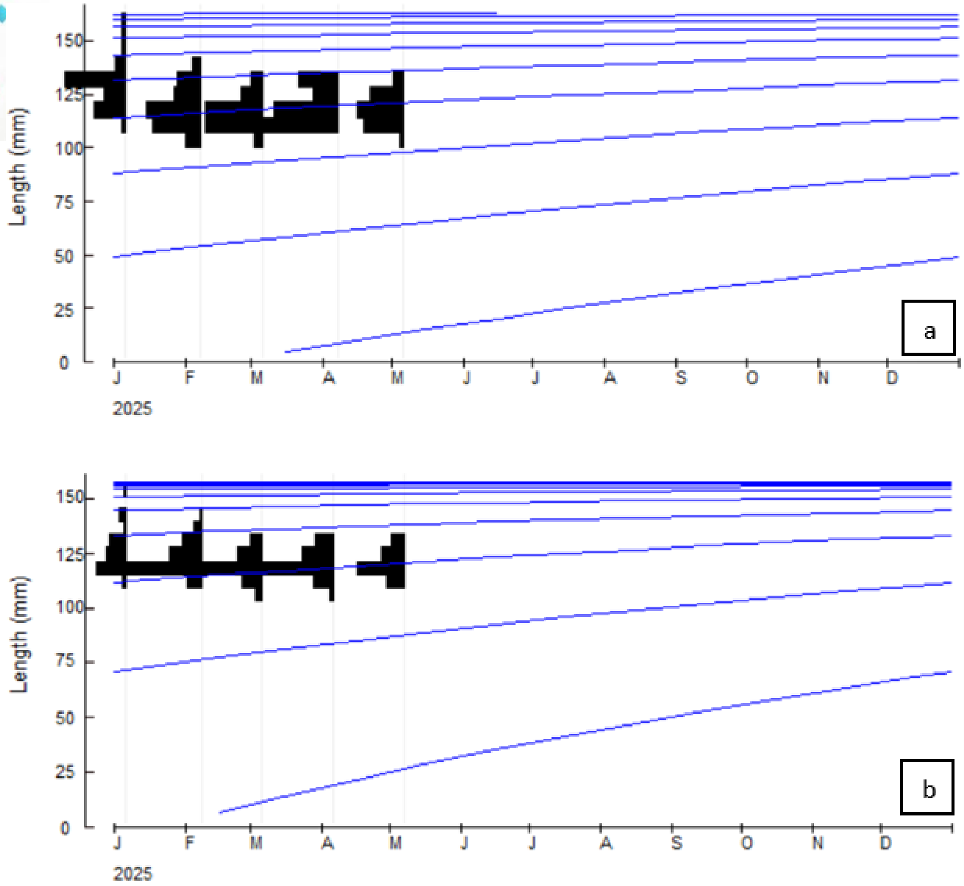

Figure 4.2 Growth curve of swimming crab (P. pelagicus) based on ELEFAN I (a. male; b. female)

The results of the growth curve analysis of the swimming crab (Portunus pelagicus) using the ELEFAN I method show differences in growth patterns between male individuals (Figure a) and female individuals (Figure b). In male swimming crabs, the asymptotic length (L∞) value is relatively larger than in females. The distribution of length data shows that the majority of male individuals caught are in the range of 100–125 mm carapace width, with a tendency to grow closer to the maximum size of around 150 mm. These results are in line with research conducted by Ernawati et al. (2015), which stated that male swimming crabs tend to have larger body sizes compared to female swimming crabs. Conversely, female swimming crabs have a lower L∞, which is around 140–145 mm. The distribution of female lengths is concentrated in the range of 110–130 mm, indicating that most of the captured females are already in the phase approaching gonadal maturity. This pattern illustrates a greater allocation of energy to the reproductive process compared to somatic growth. This finding is consistent with the statement of Potter et al. (1983), who stated that female crabs generally have a smaller maximum size because most of their metabolic energy is allocated to the reproductive process or egg production. Based on the growth equation obtained, the relationship between age and crab carapace length can be visualized as shown in Figure 4.3.

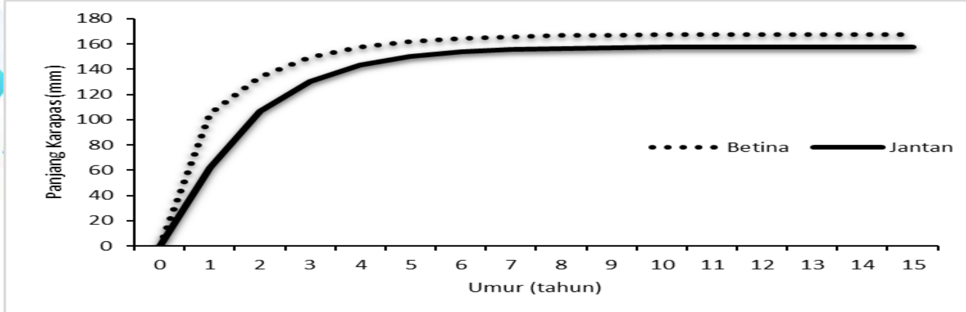

Figure 4.3 Prediction curve of growth of swimming crab (Portunus pelagicus)

Value of growth rate coefficient (K) and asymptotic carapace length (L∞) used to estimate the maximum age that can be reached by the population. Figure 4.4 shows that male and female crabs experience rapid growth at the age of 1–3 years, then their growth begins to slow down at the age of 4 years. According to Setiyawan & Fitri (2018), crabs aged less than two years generally focus most of their energy on the growth process, while at the age of more than two years, more of this energy is allocated to self-protection from threats and repair of damaged body cells. The maximum age that can be reached by crabs is between 11–12 years. In Table 4.3, it can be seen that the results of the study in Tangkolak Hamlet obtained a lower K value for crabs compared to other locations. The crab growth value tends to be above one, which reflects the rapid growth rate of crabs. The growth rate values of the research results for male and female crabs are less than one, this indicates that the crabs have slow growth (Sparre & Venema, 1999). The differences in growth parameter values obtained are thought to be caused by variations in sample size, sampling period, food availability, and environmental conditions (Ernawati et al., 2015).

Growth parameters play a significant role in crab stock analysis. Using the von Bertalanffy growth equation, the lifespan of crabs at a given length can be estimated, facilitating the planning of fisheries management strategies.

B. Mortality and Exploitation Rate

Based on the growth parameters inputted into the FISAT II program, analysis in the Mortality Estimation subprogram yielded crab mortality rates, including natural mortality (M), fishing mortality (F), and total mortality (Z). Mortality rate estimation was performed assuming an average temperature of 29°C. Mortality rate curves for male and female crabs (P. pelagicus) are shown in Figure 4.4.

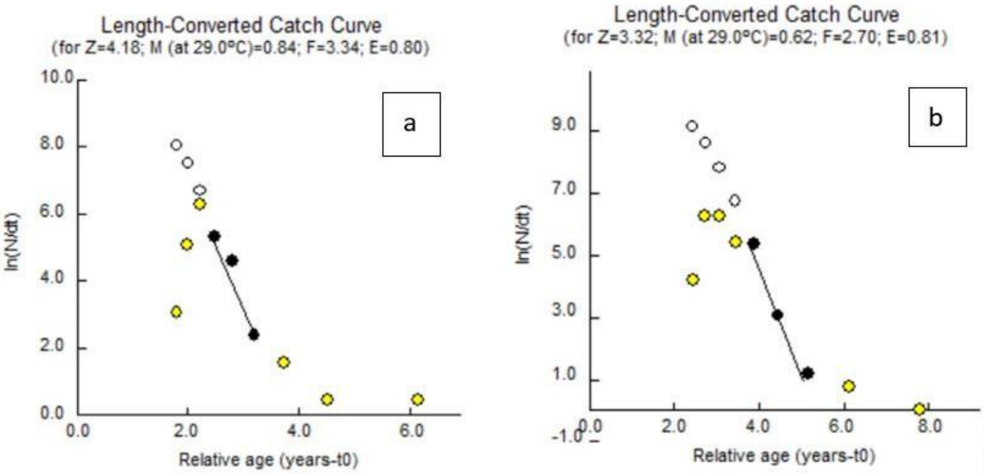

Figure 4.4 Mortality curve and exploitation rate of crabs (a. males; b. females)

Mortality rates (Z, M, and F) in male crabs were higher than in females (Table 4.4). The exploitation rate values for both male and female crabs were greater than 0.5, indicating that fishing mortality was higher than natural mortality. Fishing mortality refers to deaths resulting from the fishing activity itself. Differences in catch numbers are strongly influenced by the type of fishing gear, fishing frequency, and boat engine power, all of which interact with fish size, behavior, and habitat conditions (Setiyowati, 2016).

Table 4.4 Total mortality (Z), natural mortality (M), fishing mortality (F) and exploitation rate (E) of male and female crabs

Parameter	Male	Female
Total mortality (Z)	4.18	3.32
Natural mortality (M)	0.84	0.62
Fishing mortality (F)	3.34	2.7
Exploitation rate (E)	0.80	0.81

The results of this study, when compared with several other previous studies in Indonesia, show a relatively high mortality rate (Z, M, and F), with the highest mortality rate of 9.21 in Bone Waters, South Sulawesi (Kembaren et al., 2016). Several studies related to mortality rates and exploitation can be seen in Table 4.5.

Table 4.5 Several studies related to the mortality rate and exploitation of crabs

Location	Sex	E (year)	Z (year)	M (year)	F (year)	Reference
Bone Waters, South Sulawesi	Male	0.82	9.21	1.33	7.88	(Twinset al., 2016)
	Female	0.78	6.90	1.21	5.69	
Kotabaru, South Kalimantan	Male	0.68	4.17	1.35	2.82	(Tirtadanu& Suman, 2018)
	Female	0.77	5.11	1.17	3.94	
Aru Islands	Combined	0.76	4.94	1.20	3.74	(Twins & Surahman, 2018)
Jakarta Bay	Combined	0.75	4.87	1.24	3.63	(Wagiyo et et al., 2019)
Jepara, Central Java	Combined	0.78	4.16	0.91	3.25	(Setiyowati et al., 2019)
Bancaran, Bangkalan	Combined	0.45	0.89	0.49	0.40	(Kamelia et al., 2020)

Asahan, North Sumatra,	Male Femal e	0.56	5.70 1.42	2.50 1.16	3.20 0.26	(Lubis et al., 2022)
Pangkajene , South Sulawesi	Male Female	0.67 0.82	4.20 4.94	0.67 0.82	3.54 4.12	(Yanti et et al., 2023)
Tegal, Tawa Middle	Combined	0.31	3.03	2.09	0.94	(Pratiwi et et al., 2024)
Tangkolak	Male	0.80	4.18	0.84	3.34	Study
	Female	0.81	3.32	0.62	2.70	At the moment

The results of the comparison with several studies presented in Table 4.5 show a similar pattern, namely that mortality due to fishing has the greatest influence on increasing the rate of exploitation. Based on the analysis results, the exploitation rate (E) of male crabs was recorded at 0.80 and females at 0.81. According to Pauly (1983), a stock is considered to have reached its optimal utilization level if the optimal E value (E opt) is 0.5. The value of E ~ 0.5 is used as the optimal limit based on the assumption that a balanced utilization condition occurs when F = M. The exploitation rate of crabs in Tangkolak waters has exceeded this optimal value, which indicates that the crab resource has experienced overfishing conditions. Sparre & Venema (1999) added that the high mortality rate due to fishing may be caused by the absence of restrictions on operational fishing areas.

In addition, looking at the development of crab production data in Karawang Regency in 2021, there was a decline in crab catch production based on the Ministry of Maritime Affairs and Fisheries data portal in Figure 4.5.

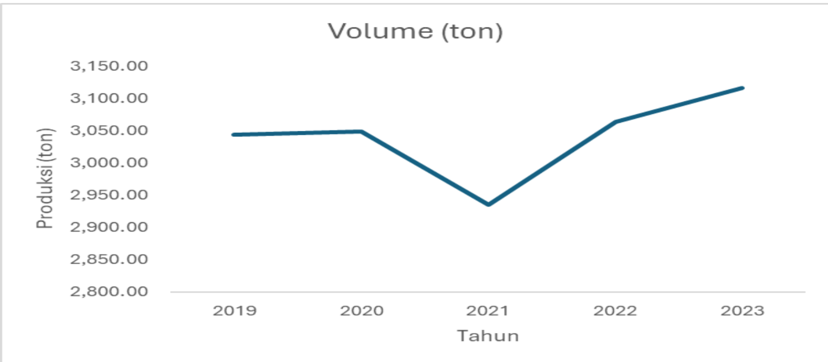

Figure 4.5 Production volume of crab catch in Karawang Regency from 2019 to 2023 (tons) (Source: KKP data portal, 2025)

The graph shows that crab production in Karawang Regency in 2019 and 2020 did not experience a significant increase in production, namely 3,044 tons/year and 3,048 tons/year, crab production in 2023 was 3,116 tons/year, and there was a decrease in crab capture production to 2,935 tons/year in 2021, but there was an increase in crab capture production of 3,064 tons/year in 2022 and 3,116 tons/year in 2023. From these data, it can be assumed that the volume of crab production in Karawang Regency has increased every year from 2019 to 2023, although in 2021 there was a decrease but there was another fluctuation in crab capture volume in 2022 and 2023.

The decline in crab production in 2021 could be caused by increased fishing activity, as evidenced by the increase in fishing fleets in 2021 based on KPP portal data, which can be seen in Figure 4.6.

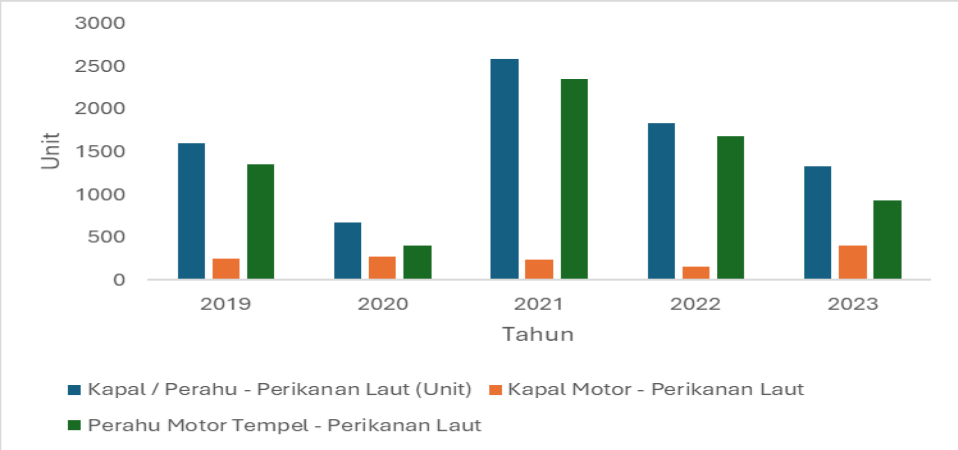

Figure 4.6 Number of fishing units in 2019-2023 in Karawang Regency (source: KKP data portal, 2025)

Figure 4.6 shows that in 2021, there were 7,189 fishing units, compared to 3,362 the previous year, and this figure declined again the following year. This phenomenon indicates that fish stocks are beginning to decline and that the number of fishing units has exceeded optimal fishing effort (overcapacity). This increase in effort is due to high market demand, as seen in Figure 4.7.

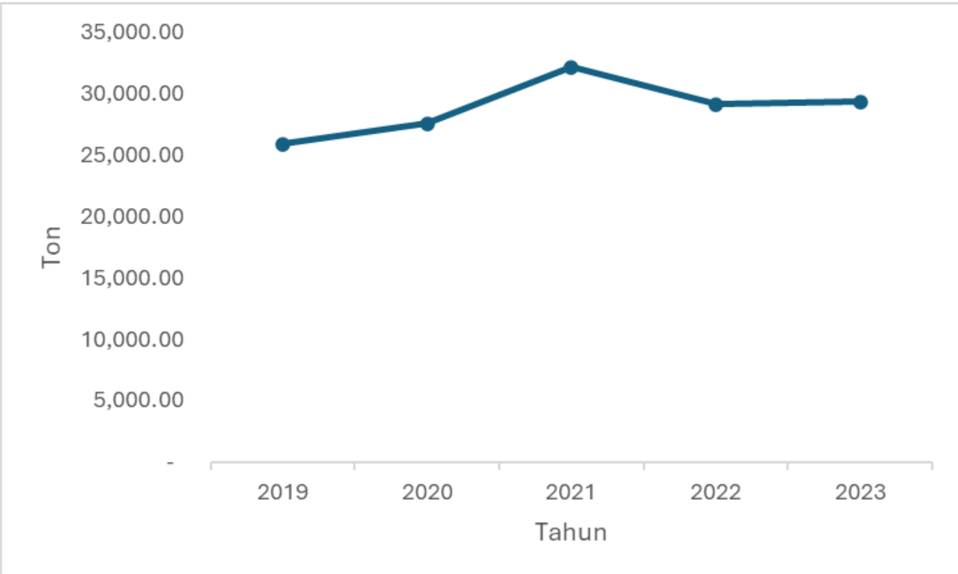

Figure 4.7 Indonesian crab and crab export data 2019-2023 (Source: KKP data portal, 2025)

The increase in market demand shown in Figure 4.7, as measured by the volume of crab exports, appears to be the primary driver of increased pressure on marine resources, although the end result is stagnation in local production. Export volume increased significantly from 25,942.91 tons in 2019 to a peak of 32,183.31 tons in 2021, triggering a response of drastic increases in fishing effort. This is evident from the surge in the fleet, with 2,584 ships and 2,350 outboard motorboats in 2021. Although fishing effort (including an increase in motorboats from 151 in 2022 to 308 in 2023) was maintained high to meet demand, crab production in Karawang actually stagnated at around 3,000 tons from 2019 to 2023. In fact, at the peak of fishing effort in 2021, local production actually experienced its lowest decline to 2,935 tons. This stagnation in catch results, amidst increasing fishing effort and intensity, is a strong indication that Catch Per Unit Effort (CPUE) has declined, reflecting that crab stocks are under exploitation pressure driven by high export demand.

One management strategy to reduce fishing mortality is to regulate the number of fishing gear and fleets used. According to Kembaren & Nurdin (2015), implementing a season-closing system during the peak spawning season is essential. Suherman (2017) added that fishing controls, accompanied by representative data, are expected to provide accurate and precise information.

C. Recruitment Pattern

The recruitment pattern was obtained using the FISAT II program in the Recruitment Pattern subprogram by entering the growth parameter values that had been analyzed previously, namely entering the values of L∞, K and t0. The results of the recruitment pattern analysis can be seen in Figure 4.8.

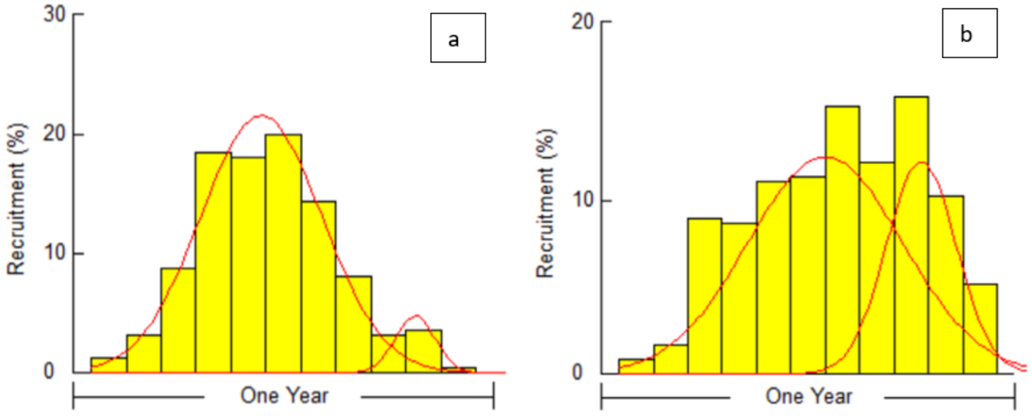

Figure 4.8 Recruitment pattern of crab (a. male; b. female)

Recruitment is the process of introducing new individuals into a fishing area. Based on Figure 4.6, the recruitment pattern of male and female blue crabs in Tangkolak Hamlet occurs throughout the year. The data obtained indicates that the peak recruitment of male blue crabs is estimated to occur in June. This is in line with research by Zairion et al. (2015) in the coastal waters of East Lampung, which stated that blue crab reproduction occurs seasonally and continuously throughout the year, with peak spawning and population growth occurring in April–June and October–November. Meanwhile, the peak recruitment of female blue crabs in Tangkolak Hamlet is estimated to occur in July and September. Ihsan et al. (2019) added that the zoea, megalopa, and juvenile crab phases occur between May and October, with the annual spawning peak in August. Small or young blue crabs generally inhabit shallow waters and migrate to deeper waters as they grow (Fazrul et al., 2020). In general, recruitment is a positive factor in a population because it contributes to an increase in the number of individuals, either through spawning or migration of new individuals.

CONCLUSION AND SUGGESTIONS

A. Conclusion

1. Male crabs grow faster than females, as indicated by higher K values. Fishing mortality rates are higher than natural mortality rates for both males and females. Peak recruitment is estimated for males in June, and for females in July and September.
2. Male and female crabs have reached a level of overexploitation, which is caused by

high fishing activity.

B. Suggestion

1. To reduce fishing pressure (F) and allow crab stocks to recover, fishing effort must be controlled. This includes strict restrictions on fleet size, regulating fishing seasons, particularly during peak recruitment and spawning periods (June to September), and implementing regulations that encourage gear selectivity.
2. Biological stock protection is mandatory to ensure that blue swimming crabs can grow to maturity and reproduce. Key measures include strictly enforcing minimum carapace size (ensuring blue swimming crabs reproduce at least once), prohibiting the capture of egg-laying female blue swimming crabs (particularly in July and September, as per Ministerial Regulation No. 7 of 2024), and adjusting net mesh sizes to allow juveniles to escape fishing gear.
3. Management effectiveness must be ensured through improved oversight and institutionalization. This means conducting regular stock research (at least every 3-5 years) to update catch quotas (TAC) and exploitation parameters (F,M,E), as well as involve and educate fishermen about the importance of maintaining exploitation levels (E) for the economic and ecological sustainability of fisheries.

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