Population dynamics of blue swimming crab (*Portunus pelagicus*) using carapace width frequency in Jepara waters, Indonesia

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Abstract. Blue swimming crab (BSC), *Portunus pelagicus*, is locally referred to as *rajungan* in Indonesia and represents one of the most commercially valuable fishery products for local and international markets. The elevated market value of the BSC and the expanding demand for it from local and international markets has prompted an increase in fishing activities, which may exert considerable pressure on the stock and potentially lead to overexploitation. This study aims to assess the size distribution, width at first capture, carapace width-weight relationship, growth parameters, mortality and exploitation rate of BSC in Jepara waters. Sampling was conducted from October 2023 to January 2024 in Jepara waters. The sample consisted of 580 individuals caught by traps and bottom-set gill nets fishermen in Demaan village, Jepara. The results showed that in Jepara waters, BSC had carapace width ranging from 79 to 162 mm for males and from 75 to 166 mm for females. The catch was predominantly composed of adult BSC. The width at first capture (Lc) was 115.06 mm for males and 114.16 mm for females. The value of b was 2.7161 for males and 3.220 for females, indicating that BSC in Jepara waters exhibited an allometric growth pattern. Females had an asymptotic width ($CW\infty$) of 167.15 mm and a growth constant (K) of 1.03 $year^{-1}$, while males had $CW\infty$ = 164 mm and K = 1.25 $year^{-1}$. The mortality rate (Z) was 3.11 $year^{-1}$ for males (M = 1.31 $year^{-1}$, F = 1.80 $year^{-1}$) and 2.42 $year^{-1}$ for females (M = 1.15 $year^{-1}$, F = 1.27 $year^{-1}$). The exploitation rate (E) was 0.58 for males and 0.53 for females, both values exceeding the optimal level. This indicates that BSC in Jepara waters is being over-exploited. The findings supply helpful data on BSC management and conservation.

Key Words: blue swimming crab, exploitation rate, growth, mortality, width-weight relationship.

Introduction. *Portunus pelagicus* (Linnaeus, 1758), commonly known as the blue swimming crab (BSC) and locally referred to as *rajungan* in Indonesia, is one of the most commercially valuable fishery products due to its high nutritional content and appealing flavour (Rohyamani et al 2018). This species is widely distributed in the Indo-Pacific region, including both the Indian and Pacific Oceans (Oniam et al 2018; Hadijah Yusneri & Setia 2021). The BSC fishery has seen increased demand in the export market. In 2023, the export production and value of crab and BSC from Indonesia was 29,177 tonnes and USD 447,651, respectively (MMAF 2024).

Jepara Regency, located in Central Java, Indonesia, holds significant potential for BSC fisheries, with annual increases in production. In 2021, the production of BSC in Jepara Regency reached 30,833 kilogram with a production value of IDR 1,849,980,000. This was followed by a further increase in 2022, with production reaching 31,833 kilogram and a production value of IDR 1,909,963,448 (Jepara Regency Fisheries Statistics 2023). The majority of BSC production is derived from fishing activities. Various fishing gears, including crab pots, crab lift nets, gill nets, fish corrals, mini trawls, push nets, and seine nets, are used to capture BSC (Abrenica et al 2021). In Jepara, the predominant fishing gears employed by fishermen are traps and bottom-set gill nets. The elevated market value of BSC and the increasing demand for it from both domestic and international markets has resulted in intensified fishing activities, which may exert considerable pressure on the stock and potentially lead to overexploitation. Fishing pressure on the young specimens causes a decrease in the BSC population (Situmorang et al 2021).

The exploitation rate of BSC in the Java Sea has exhibited fluctuations in concert with advancements in fishing technology and management. In 2016, the exploitation rate was recorded at 1.05 (MMAF 2016). The following year, it was recorded at 0.65 (MMAF 2017). Subsequently, in 2022, the exploitation rate increased slightly to 0.7, indicating a potential for overfishing (MMAF 2022). The study conducted by Setyawan & Fitri (2019) discovered that in Tegal waters, the exploitation rate of BSC was 0.36, which suggests underfishing. Mustabiq et al (2023) reported a rate of 0.44 in Pati waters, indicating underfishing as well. However, Setiyowati & Sulistyawati (2019) observed a greater exploitation rate of 0.78 in Jepara waters, signaling overfishing in this area.

The sustainability of BSC stocks directly impacts the livelihoods of fishermen. The income of fishermen is influenced by various factors, including the production of BSC (Maulana et al 2020), which is contingent upon the health of the fishery stocks. To ensure the success of sustainable fisheries development, it is imperative to focus on BSC stock management, alongside improving the income and welfare of fishermen. Understanding population dynamics and fishery stock status is fundamental to the sustainable management of these resources (Cadima 2003). Such knowledge is crucial for formulating strategies and regulations that promote effective management. Several aspects that need to be considered in sustainable BSC management are related to the biological aspects. This study aims to assess the size distribution, width at first capture, carapace width-weight relationship, growth parameters, mortality and exploitation rate of BSC in Jepara waters, as a basis for the sustainable management and conservation strategies of BSC resources.

Material and Method

Sampling. The study was conducted from October 2023 to January 2024 in Demaan village, Jepara regency, Central Java, Indonesia. The research location is presented in Figure 1. BSC specimens were collected on a bi-weekly basis, with sampling occurring in the morning hours.

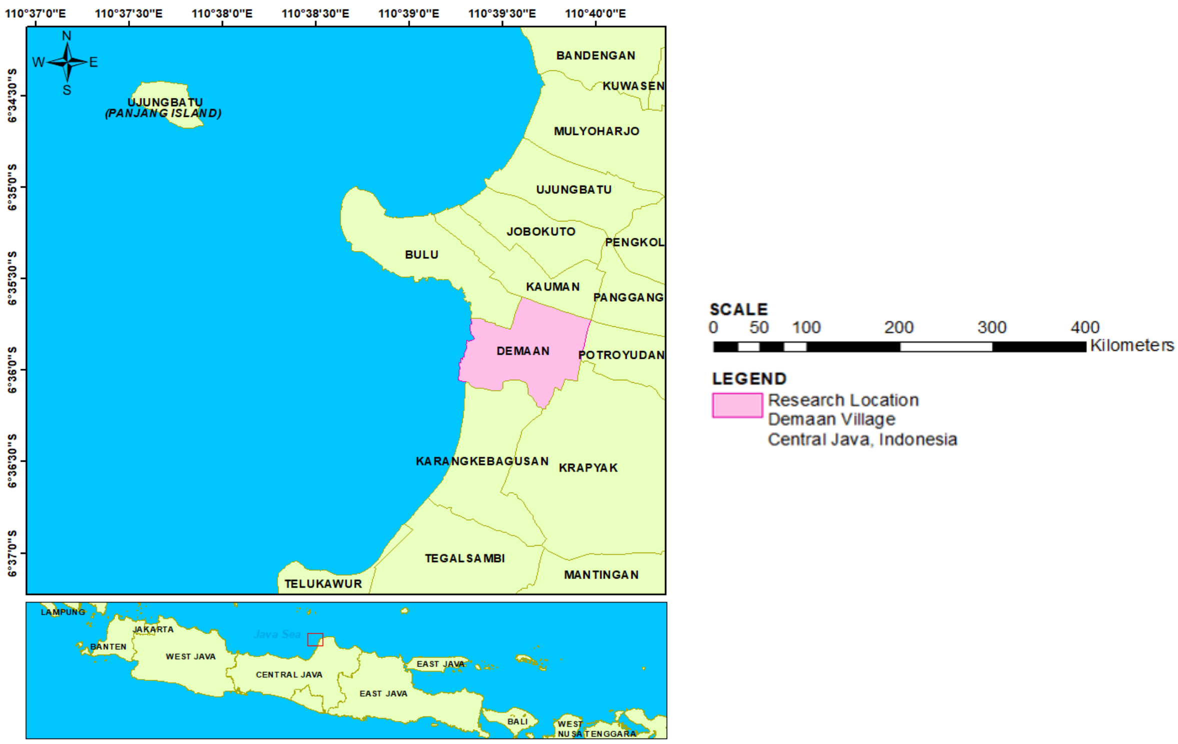


Figure 1. Research location.

A simple random sampling technique was employed to ensure that all BSC caught by fishermen in Demaan village had an equal probability of being selected. This approach is widely used for fisheries data collection (Cadima et al 2005; Hansen et al 2007; Pope et al 2010; Geethalakshmi 2018).

Data collection. Samples of BSC were collected from fishermen using traps and bottom-set gill nets. The primary data recorded included the sexes, the carapace width (which was measured using a 1 mm precision ruler), and the body weight (which was measured using a 1 g precision scale). The methodology for measuring the carapace width of BSC is illustrated in Figure 2.

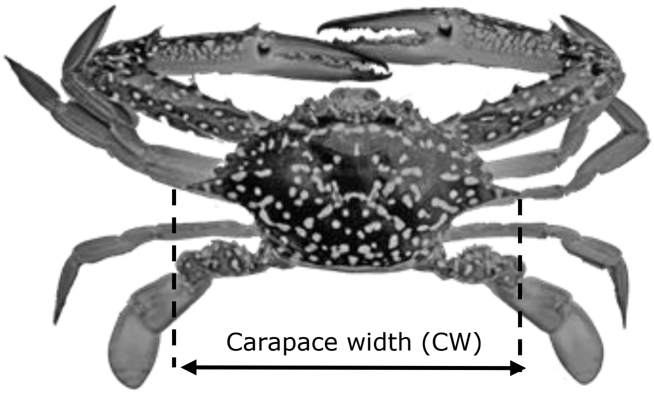


Figure 2. Measurement of carapace width of BSC.

Data analysis. Quantitative data analysis was conducted using the carapace width (CW) and body weight (BW) data of BSC. The data were analyzed separately for males and females using Microsoft Excel 2010 and FiSAT II version 1.2.2 (2005). The following section provides a detailed explanation of the data analysis.

Size structure was analyzed by calculating the class intervals, means, and frequencies of the BSC samples. The following formulas were applied:

$$R = Max - Min$$
$$K = 1 + (3.3 \log n)$$
$$p = R/K$$

where: R is the range of class; Maximum data; Minimum data; K is the number of class; n is the number of samples; p is the class interval.

Width at first capture (Lc) was analyzed using the logistic curve of the Spearman-Karber method. According to Sparre & Venema (1998), the equation is presented below:

$$SL = \frac{1}{1 + \exp(S1 - S2.L)}$$

$$Ln[(1/SL)-1] = S1 - (S2.L)$$

$$Lc = \frac{S1}{S2}$$

where: SL is the logistic curve; S1 and S2 are the logistic curve coefficients; L is the carapace width. S1 and S2 values are obtained using regression analysis with carapace width as X and Ln[(1/SL)-1] as Y.

Carapace width-weight relationship: $BW = a \times CW^b$ was applied, where BW is the body weight (g); CW is the carapace width (mm); a-intercept; b-slope (Ricker 1975; King 1995). The intercept (a) and the slope (b) are obtained using regression analysis with Ln CW as X and Ln BW as Y ($Y = a + b \times X$). According to Dutta & Debangshu (2014), b = 3 means that the growth pattern of width-weight is isometric, which means that the body weight gain of the BSC is directly proportional to the growth of the carapace width; if b > 3, it implies that the growth pattern of width-weight is positive allometric (A+), which means that the body weight of BSC gains faster than the growth of the carapace width: if b < 3, it indicates that the growth pattern of width-weight is negative allometric (A-), which means that body weight of BSC gains slower than the growth of the carapace width.

Growth parameters were estimated using the Von Bertalanffy growth model, as applied through the ELEFAN I method in FiSAT II software, based on carapace width data (Yeşilyurt et al 2022). According to Schnute & Richards (2002), the Von Bertalanffy growth model is as follows:

$$CW(t) = CW\infty(1 - e^{-k(t-t0)})$$

where: CW(t) is the carapace width at age t; CW∞ is the asymptotic carapace width; K is the growth coefficient; t-age; t0-age at a carapace width of BSC is null. According to Musick & Bonfil (2005), natural mortality can be determined using the Pauly equation below:

$$Log(-t0) = 0.3922 - 0.2752(Log\ CW\infty) - 1.038(Log\ K)$$

Mortality parameters were estimated using ELEFAN I in the FiSAT II program too. Based on Sparre & Venema (1998), the mortality parameters consist of total mortality (Z), natural mortality (M), and fishing mortality (F). Total mortality (Z) was estimated by using the Pauly method (length-converted catch curve) (Pauly 1990). Natural mortality can also be estimated using the ELEFAN I Pauly equation (Musick & Bonfil 2005): $Log\ M = -0.0066 - 0.279(Log\ CW\infty) + 0.6543(Log\ K) + 0.4634(Log\ T)$, where T is the average water temperature at research location. Once Z and M are known, the fishing mortality rate (F) can be estimated using the formula: $F = Z - M$.

Exploitation rate (E) can be determined using the formula: $E = F/Z$. The optimum exploitation rate is 0.5 (Gulland 1971; Pauly 1984). According to Pauly & Morgan (1987), $E > 0.5$ indicates overexploited, which means overfishing in these waters, and $E < 0.5$ indicates underexploited, which means underfishing in these waters.

Result and Discussion

Fishing gear. Fishermen in different regions may employ various fishing gears for capturing BSC. In Demaan village, Indonesia, the commonly used gears include traps and bottom-set gill nets. The traps, locally known as *bubu, wuwu*, or *jebak*, are rectangular structures made from iron (Fe) frames, while the nets, main line, and branch lines are typically made of polyethylene (PE). Bottom-set gill nets, referred to as *jaring pejer* or *jaring kejer*, are crafted from nylon or polyamide (PA) and come in varying mesh sizes. Both traps and bottom-set gill nets function as passive fishing gears and are sunk to the bottom of the water (He et al 2021).

In Demaan village, the average mesh size of traps was found to be 1.3 inches, while the average mesh size of bottom-set gill nets was 3.6 inches. The number of traps used varied, with > 500 units operated by 2-4 fishers, and < 500 units operated by individual fishers. Similarly, the bottom-set gill nets operated by groups of 2-4 fishers numbered > 50 pieces, while individual fishers used fewer than 50 pieces. Traps were baited with cowhide and *Leiognathus* sp., while bottom-set gill nets were operated without bait. Fishing vessels employed by BSC fishermen in Jepara were typically made of wood, with an average gross tonnage ranging from 1 to 13 GT.

Size structure. A total of 580 BSC samples were collected, consisting of 328 males and 252 females. The measured CW of male specimens ranged from 79 to 162 mm, while that of female specimens ranged from 75 to 166 mm. The size structure was analyzed using Microsoft Excel 2010. The size structure of BSC caught during the study (October 2023 - January 2024) is presented in Figure 3.

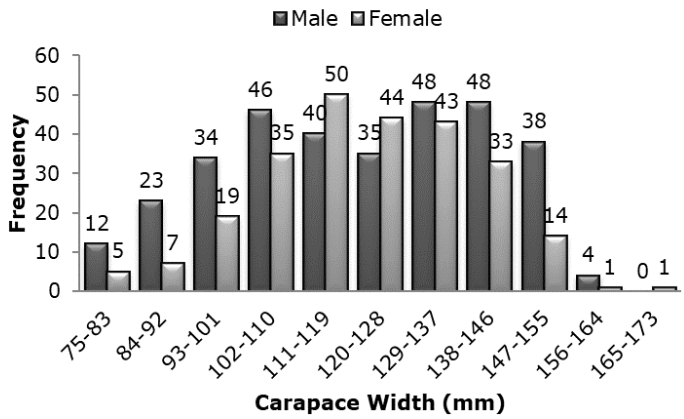


Figure 3. Histogram of the carapace width of BSC during the study.

The mean CW for both male and female specimens was 121 mm. A total of 309 male and female specimens measuring at least 120 mm in length were observed, while 271 crabs measuring less than 120 mm were also recorded. According to Budiaryani (2007), BSC is classified into three life cycle phases: juvenile (< 60 mm), young (60-120 mm) and adult (> 120 mm). This suggests that the BSC captured by fishermen in Demaan village are predominantly in the adult phase. Based on the MMAF Ministerial Decree No.7/2024, the size structure of the caught BSC complies with Indonesian fishing regulations, where a minimum carapace width of 100 mm and body weight of 60 g are required for capture, provided the BSC are not in a spawning condition. However, some spawning females were still caught during the study. Spawning females captured by fishermen in Demaan village, when in good physical condition, are typically subjected to a restocking system to allow the eggs to hatch. The purpose of restocking is to preserve the BSC population in Jepara waters for sustainability, ensuring that BSC abundance remains stable. Moreover, this system may help reduce fishermen's operational costs, as it eliminates the need to travel to distant fishing grounds, potentially improving their economic stability or even increasing their income (Suwandi & Prihatin 2020). According to Hidayat et al (2020), variations in size across different waters can be attributed to factors such as sex, life cycle, food availability, fishing grounds, water quality, fishing season, and fishing intensity. The different sizes of BSC in various waters may be due to differences in fishing gear, gear selectivity, fishing pressure, salinity, water temperature, and food availability. An overview of size structure across different waters is presented in Table 1.

Table 1

Size structure of BSC in different waters

Location	*Sexes*	*CW (mm)*	*BW (g)*	*Sources*
Persian Gulf coasts, Iran	Male	60-150	48-275.5	Hosseini et al (2012)
	Female	50-145	39.5-255.2	
Beibu Gulf, South China	Female	78.5-162	32.5-372	Liu et al (2014)
Rembang waters, Indonesia	Combined	72-167	40-303	Putra et al (2020)
Betahwalang waters, Indonesia	Combined	35-185	10-350	Maulana et al (2021)
Jepara waters, Indonesia	Combined	64-164	23-333	Iksanti et al (2022)
Labuhan Lalar waters, Indonesia	Combined	84-154	30-150	Novitasari et al (2023)
Bone Regency, Indonesia	Male	114.1-204.3	103.7-633.7	Nurmiati et al (2023)
	Female	119-227	113.7-863.7	
Pemalang waters, Indonesia	Combined	83-165	30.4-250.5	Hira et al (2024)
Jepara waters, Indonesia	Male	79-162	20-275	This study
	Female	75-166	19-289	

Note: CW = carapace width (mm), BW = body weight (g).

Width at first capture (Lc). The Lc was analyzed using Microsoft Excel 2010. The results of the Lc analysis of BSC in Jepara waters are presented in Figures 4 and 5.

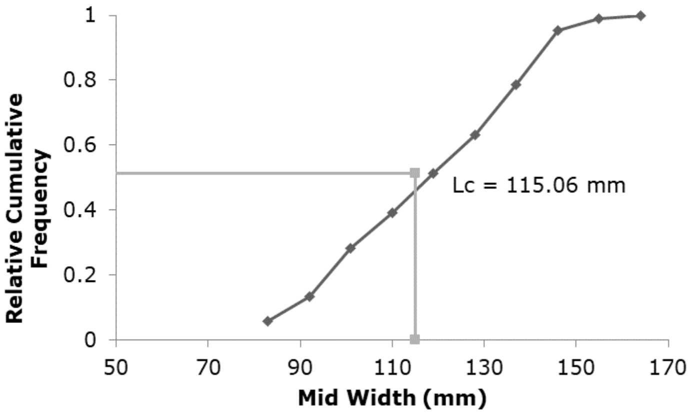


Figure 4. The width at first capture (Lc) of males BSC during the study.

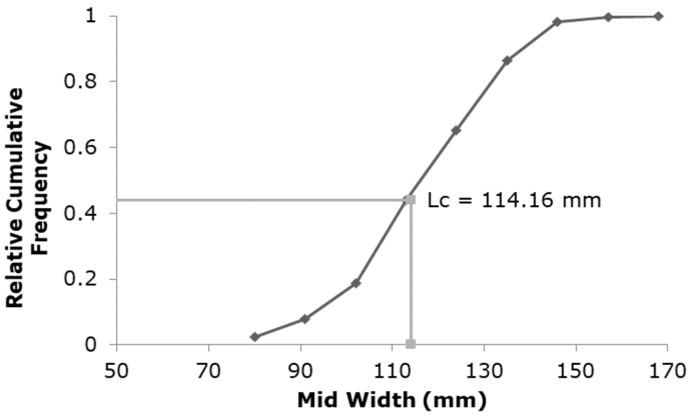


Figure 5. The width at first capture (Lc) of females BSC during the study.

The Lc of BSC using traps and bottom-set gill nets was determined to be 115.06 mm for males and 114.16 mm for females. The values of males and females are greater than that found by Setyawan & Fitri (2019) in Tegal waters, where the width at first capture was 98 mm. Similar results to this study were reported by Tirtadanu & Chodrijah (2019) in Kwandang waters and Suman et al (2018) in Kendari Bay waters, where the Lc was 121 mm for males and 116.65 mm for females. Haputhantri et al (2022) observed in the northern coastal waters of Sri Lanka that the Lc for males and females was 105.1 mm and 112.8 mm, respectively. Other studies, such as those by Abrenica et al (2021) in the Danajon Bank, Central Philippines, reported greater values for BSC first capture width, with Lc of 126.2 mm for males and 124.3 mm for females. Variations in Lc across different waters are likely due to differences in fishing gear selectivity, water temperature, and fishing season. The maximum CW for males was 164 mm, with the ½ CW at 85.26 mm, while for females, the maximum CW was 167.15 mm, and the ½ CW was 87.37 mm. Since the Lc for both sexes exceeds ½ CW, it indicates that the crabs were caught at an appropriate size. According to Saputra (2009), an ideal Lc should exceed ½ CW, suggesting that the exploitation has not surpassed sustainable limits and that reproduction is still maintained.

The Lc value can also be used to assess management criteria by comparing it with the Lm value (the width at first gonadal maturity). If Lc > Lm, it suggests proper management of fisheries resources. Conversely, if Lc < Lm, it indicates poor management, which leads to a decline in resource abundance due to excessive fishing effort (Saranga et al 2019). According to Maulana et al (2021), the Lm for female BSC caught by fishermen in Betahwalang, Demak, was 141.51 mm, meaning that in this study, Lc < Lm. In contrast, Munthe & Dimenta (2022) reported an Lm of 103.55 mm for female BSC in the mangrove ecosystem of Labuhanratu, meaning that Lc > Lm in this study. Sparre & Venema (1998) mentioned that the management of fishery resources is considered good if 90% of the captured resources have already reproduced or reached the minimum gonad maturity size (Lm), ensuring that the recruitment process of new resources continues and that the resource abundance in the waters remains stable.

Carapace width-weight relationship. The carapace width-weight relationship was analyzed using Microsoft Excel 2010. The results of the carapace width-weight relationship analysis of BSC in Jepara waters are presented in Figures 6 and 7.

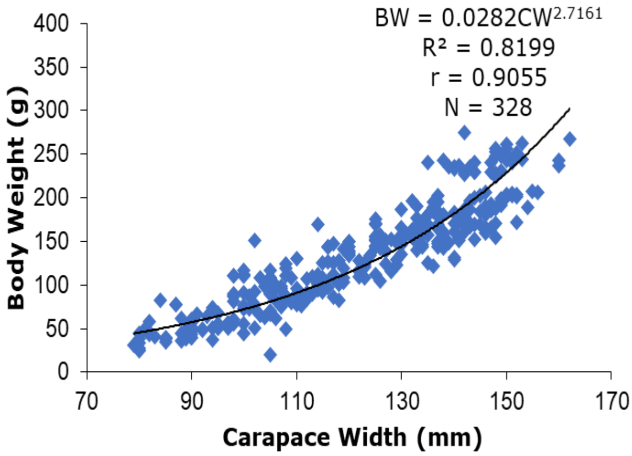


Figure 6. The carapace width-weight relationship of males BSC during the study.

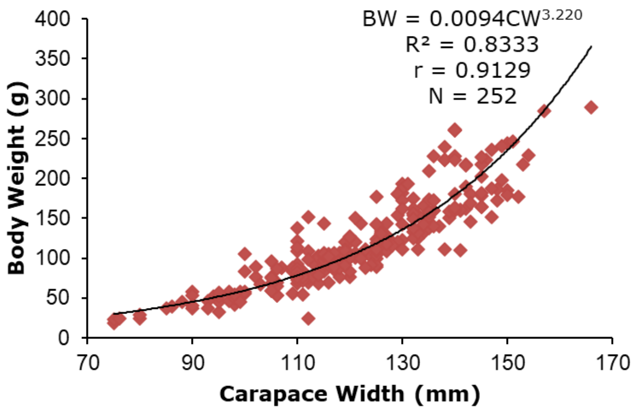


Figure 7. The carapace width-weight relationship of females BSC during the study.

Information on the CW and BW relationship is needed in fisheries management in order to determine the condition of the BSC in Jepara waters. Carapace width-weight relationship can also indicate the growth pattern. The carapace width-weight relationship of BSC in Jepara waters exhibited allometric growth patterns. Male BSC have an negative allometric (A-) growth pattern because of the b value was 2.7161, namely the increase in BW is slower than the increase in CW, while female BSC have an positive allometric (A+) growth pattern because of the b value was 3.220, namely the increase in BW is faster than the increase in CW.

Negative allometric growth patterns for male and female BSC were also reported in the coastal area of Trang Province, Thailand (Sawusdee & Songrak 2009), Jepara waters (Setiyowati & Sulistyowati 2019), Teluk Awur Jepara (Hidayah et al 2019), and other waters (Putra et al 2020; Qomariyah et al 2023). However, some studies have found positive allometric growth patterns, such as those in Betahwalang Demak (Maulana et al 2021), Bulu Jepara (Iksanti et al 2022), and Bardarwil Lagoon, Egypt (ElSaid et al

2022). In some cases, male BSC exhibited positive allometric growth, while females showed negative allometric growth (Suman et al 2018; Setyawan & Fitri 2019; Yanti et al 2023).

The growth pattern of BSC is also affected by factors such as sex, age, food availability, fishing season, water temperature, and salinity. According to Kangas (2000), these factors are crucial as they influence the growth and movement of BSC in the waters. The availability of natural food plays a significant role, as it serves as an energy source for their metabolic processes. Male BSC expend considerable energy on the growth of their carapace, while females use a significant amount of energy for reproductive processes (Abd-Allah et al 2022). Philips et al (2022) noted that male crabs generally have a larger carapace size compared to females, but females typically exhibit greater BW due to the presence of eggs under the abdomen. On the other hand, Mashar (2016) found that negative growth patterns can also be due to overfishing, competition and trophic potential.

Growth parameters. The growth parameters were estimated using the Von Bertalanffy model with FiSAT II software. The results of the growth parameters analysis of BSC in Jepara waters are presented in Figures 8 and 9.

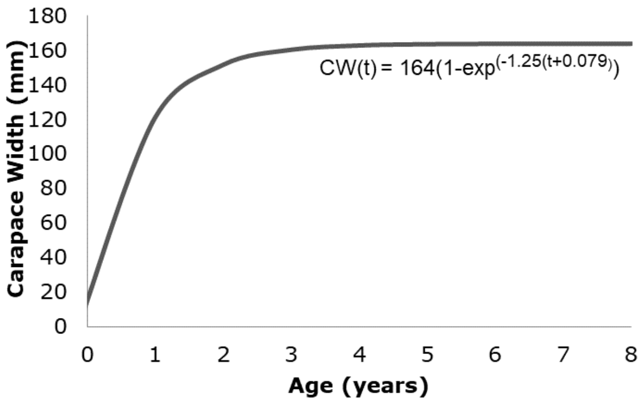


Figure 8. The von Bertalanffy growth curve of males BSC during the study.

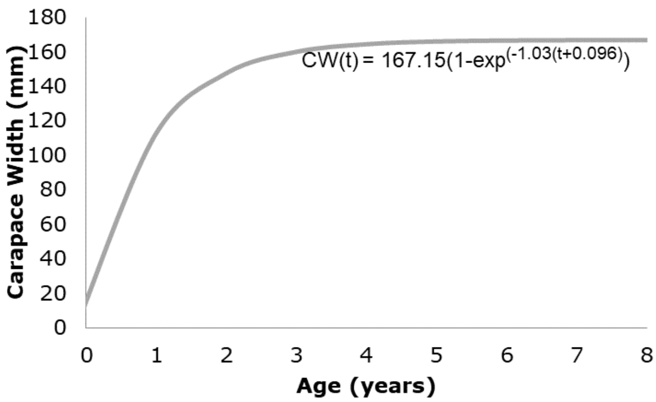


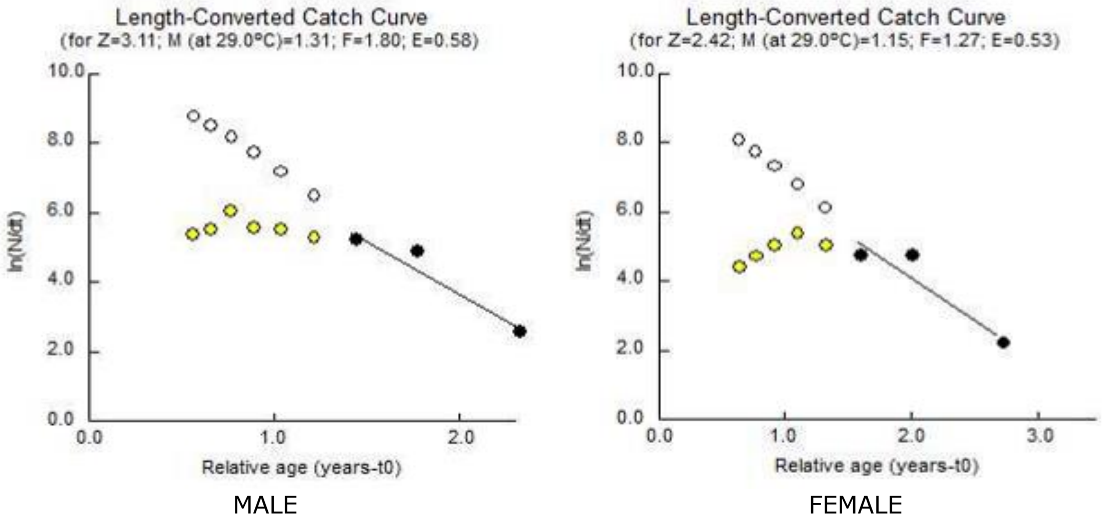
Figure 9. The von Bertalanffy growth curve of females BSC during the study.

The values obtained for males were CW_∞ = 164 mm, K = 1.25, and t_0 = -0.079, while for females, the corresponding values were CW_∞ = 167.15 mm, K = 1.03, and t_0 = -0.096. Based on these values, the Von Bertalanffy growth equations for males and females were as follows: for males, $CW(t) = 164(1 - \exp^{(-1.25(t+0.079))})$, and for females, $CW(t) = 167.15(1 - \exp^{(-1.03(t+0.096))})$. These equations describe the relationship between CW and age. The growth curves indicate that males reach their asymptotic CW in a maximum of 5 years, while females require up to 6 years. This suggests that the CW of males grows at a greater rate than females.

Several studies have reported less, greater or similar CW∞ and K values for both male and female BSC that were observed in this study. Research conducted by Setiyowati (2016) in Jepara waters found that BSC had a larger CW∞ of 169.8 mm, but with a less K of 0.65 and a t_0 value of -0.720 year^{-1}. A subsequent study by Setiyowati & Sulistyawati (2019) in the same water observed an increase in both CW∞ and K values, with CW∞ = 172.09 mm, K = 0.72, and t_0 = -0.140 year^{-1}. Jepara waters are part of the Java Sea. In a different study conducted in Pati waters, also within the Java Sea, Mustabiq et al (2023) found that the CW∞ and K values for BSC were less than those observed in Jepara, with males having CW∞ = 141.54 mm, K = 0.56, t_0 = -0.720 year^{-1}, and females having CW∞ = 141.61 mm, K = 0.54, t_0 = -0.710 year^{-1}. Sawusdee & Songrak (2009), in the coastal area of Trang Province, Thailand, reported males with CW∞ = 167 mm, K = 1.40, and t_0 = -0.041 year^{-1}, while females had CW∞ = 165 mm, K = 1.50, and t_0 = -0.041 year^{-1}. In Kendari Bay, Suman et al (2018) recorded a CW∞ of 182 mm and K = 0.91. Similarly, Abrenica et al (2021) found males in the stock enhancement sites of Danajon Bank, Central Philippines, with CW∞ = 216.5 mm and K = 1.30, while females had CW∞ = 214 mm and K = 1.28. Yanti et al (2023), in Pangkajane and Kepulauan Regency, South Sulawesi, reported males with CW∞ = 175.82 mm, K = 0.87, t_0 = -0.163 year^{-1}, and females with CW∞ = 179.40 mm, K = 1.20, t_0 = -0.310 year^{-1}. The growth parameters recorded in this study compared to that reported by other researchers at different locations can also be affected by the fishing grounds and the fishing gears.

The K reflects the rate at which BSC grows to reach its CW∞. A K value < 1 indicates slow growth, while K > 1 denotes fast growth. Based on the results of this study (Figures 8 and 9), the growth rate of male BSC in Jepara waters is relatively faster than that of females. The growth rate is closely linked to the species age, as K represents the time required to reach CW∞. This time is also influenced by the age and mortality of the species. A greater K value typically correlates with a high mortality rate; if a species has a slow growth rate but high mortality, it is at risk of extinction (Beverton & Holt 1959; Saputra 2009). The observed difference in the growth rates of male and female BSC may also be attributed to the differing energy demands for metabolism. Female BSC expends more energy on reproduction, while males allocate more energy to growth. As a result, males tend to be heavier than immature females. Additionally, female BW may decline during the gonadal maturation period, as noted by Abdel-Razek et al (2019).

Mortality and exploitation rate. The results of the mortality and exploitation rate analysis of BSC in Jepara waters are presented in Figure 10.



MALE FEMALE

Figure 10. The Mortality (Z, M, F) and Exploitation Rate (E) of BSC during the study.

The mortality parameters of BSC were calculated as follows: for males, total mortality (Z) was 3.11 year^{-1}, natural mortality (M) was 1.31 year^{-1} and fishing mortality (F) was 1.80

year^{-1}; for females, Z was 2.42 year^{-1}, M was 1.15 year^{-1} and F was 1.27 year^{-1}. The exploitation rates (E) were 0.58 for males and 0.53 for females (Figure 10). The average temperature in Jepara waters was 29^{o}C. The findings of this analysis indicate that the mortality of both male and female BSC is predominantly attributable to fishing activities. Continuous fishing with low-selectivity gears, which do not consider size-based capture restrictions, certainly threatens the abundance and long-term sustainability of BSC stocks in the waters. Mortality parameters can be used to estimate the exploitation rate, which refers to the utilization of fisheries resources. The E indicates the extent to which a fishery is being exploited. In this study, the values of E for both males and females exceeded the optimal level, indicating overexploited. According to Saputra & Taufani (2021), the exploitation rate is considered optimal when E = 0.5 (i.e., when fishing mortality equals natural mortality, F = M).

In Jepara waters, the E has fluctuated over the years. Setiyowati (2016) reported an E = 0.10 (Z = 1.66 year^{-1}, M = 1.50 year^{-1}, F = 0.16 year^{-1}), indicating underexploited or underfished. In contrast, Setiyowati & Sulistyawati (2019) found higher values (Z = 4.16 year^{-1}, M = 0.91 year^{-1}, F = 3.25 year^{-1}, E = 0.78 year^{-1}), indicating overexploited or overfished. Other studies in different waters have reported varying exploitation rates for BSC. In Tegal waters, Setyawan & Fitri (2019) calculated an lower exploitation rate of E = 0.36 (Z = 4.56 year^{-1}, M = 2.89 year^{-1}, F = 1.67 year^{-1}). Mustabiq et al (2023) found lower E in Pati waters, with E = 0.43 for males and E = 0.44 for females (Z = 1.42 year^{-1}, M = 0.81 year^{-1}, F = 0.61 year^{-1} for males, and Z = 1.41 year^{-1}, M = 0.79 year^{-1}, F = 0.62 year^{-1} for females). In contrast, Suman et al (2018) reported a higher E in Kendari Bay waters (E = 0.73, Z = 3.99 year^{-1}, M = 1.07 year^{-1}, F = 2.92 year^{-1}). Abrenica et al (2021) found similarly high E in Danajon Bank, Central Philippines, with E = 0.72 for males and E = 0.66 for females (Z = 8.43 year^{-1}, M = 2.32 year^{-1}, F = 6.11 year^{-1} for males; Z = 6.78 year^{-1}, M = 2.31 year^{-1}, F = 4.47 year^{-1} for females).

The results from this study, along with those from various waters, suggest that the mortality of fishery species is influenced by both M and F, with Z being the sum of the two. A higher F indicates that fishing activities are a significant factor in the depletion of species in the waters. The findings indicate that BSC in Jepara waters requires more focused management, as it has already surpassed the optimal level of exploitation. Effective science-based management is very important and urgent for BSC with high economic potential. One potential conservation strategy is the implementation of a restocking system, which has already been initiated by BSC fishermen in Demaan village. Another strategy to preserve BSC in Jepara waters is to reduce fishing efforts and decrease the number of fishing gears operating in areas that are already experiencing overfishing. Similarly, it is recommended that an open-close system for BSC fishing be considered with the objective of regulating fishing effort. The open-close system has been designed with the specific purpose of facilitating the hatching of eggs by female BSC, thereby ensuring the presence of new individuals in the water. It may be advisable to implement a limitation on fishing effort during the period of peak BSC spawning activity. Expert guidance is still required to ensure that the goals of conservation are fully achieved.

Conclusions. The results showed that in Jepara waters, BSC had carapace width ranged from 79 to 162 mm for males and from 75 to 166 mm for females. The catch is predominantly composed of adult BSC. The width at first capture (Lc) was 115.06 mm for males and 114.16 mm for females. The value of b was 2.7161 for males and 3.220 for females, indicating that the BSC in Jepara waters exhibited an allometric growth pattern. Females had an asymptotic width (CW_∞) of 167.15 mm and a growth constant (K) of 1.03 year^{-1}, while males had CW_∞ = 164 mm and K = 1.25 year^{-1}. The mortality rate (Z) was 3.11 year^{-1} for males (M = 1.31 year^{-1}, F = 1.80 year^{-1}) and 2.42 year^{-1} for females (M = 1.15 year^{-1}, F = 1.27 year^{-1}). The exploitation rate (E) was 0.58 for males and 0.53 for females, both values exceeding the optimal level. This indicates that the BSC in Jepara waters is being over-exploited. To ensure sustainable management, it is crucial to monitor the catches of BSC in Jepara waters with greater regularity.

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