

Status of utilization level of blue swimming crab (*Portunus pelagicus*) in Kebumen Waters

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Abstract. This study analyzed the utilization status of the blue swimming crab (BSC), (*Portunus pelagicus*) in Kebumen coastal waters. Field research was conducted from October to December 2024. Biological characteristics related to growth and infinity carapace width (CW_{∞}) were assessed, along with mortality and exploitation rates. Results showed a carapace width (CW) at 50% capture (CW_c 50%) of 11.95 cm and an infinity carapace width of 18.38 cm. Peak BSC recruitment occurred in May. An exploitation rate of 0.31 indicates that the BSC population in Kebumen coastal waters is currently underexploited.

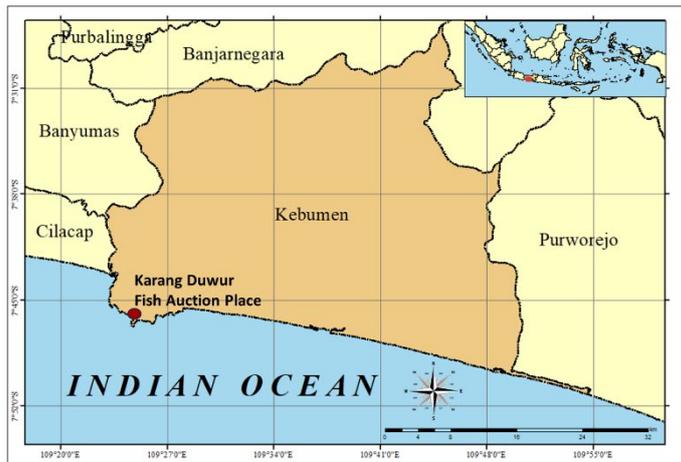
Keywords: CW_{∞} , CW_c 50%, exploitation rate, Kebumen Coastal, *Portunus pelagicus*

Introduction. Blue Swimming Crab or BSC (*Portunus pelagicus*) is one of major marine commodity in Indonesia, in addition to tuna, shrimp, and seaweed. A significant portion of Indonesia's BSC production is exported to the US with more than 40% of the crab market share. The crab export values, including BSC reached USD 411 million in 2018. In 2022, the Indonesia's crab export worthed USD 484 million (BPS-Statistics of Indonesia 2023; Setioko et al 2024).

Kebumen Regency that is locate in the Central Java Province is one of BSC producers in Indonesia. Residents living in the coastal areas Kebumen Regency work as fishermen. To catch the marine animal, including BSC, fishermen in Kebumen Regency use gill nets, line fishing, and trammel nets. Crabs tend to be caught with gill nets and pot trap ('*bintur*' in local name). BSC comprises a significant portion of the 1560 tons of marine fisheries production in Kebumen Regency (DKP Kebumen 2020; BPS-Statistics of Kebumen Regency 2024), its high market value making it a primary target for local fishermen. While crab fishing and other anthropogenic activities (including pollution and coastal ecosystem damage) can contribute to environmental degradation, continuous overexploitation is a key driver of declining fish and crab biomass (Gernez et al. 2023; Soeprobowati et al. 2024; Liu et al. 2024). Therefore, an analysis of BSC resource stocks is crucial for effective conservation efforts and to understand the socio-economic implications for fishermen. This study analyzes the level of BSC utilization on the Kebumen Coast.

Materials and Methods

Research Location and Time. Data for this study were collected from Kebumen Regency (Fig. 1), specifically at the Karang Duwur Fish Auction Place (FAP). The data collection process involved surveys and interviews with fishermen and crab traders, as well as direct measurement of BSC carapace width, conducted from October to December 2024.



a. Map of Kebumen Regency
Figure 1. Kebumen Regency and Blue Swimming Crab

Research Materials. The subjects of this study were BSC (*P. pelagicus*) captured by Kebumen fishermen using gill nets and pots trap during one-day fishing trips conducted with outboard motorboats. BSC carapace width measurements were collected using a random sampling method, targeting 10% of the landed catch (King 1995; Sparre & Venema 1998). A total of 416 BSC specimens were measured.

Analysis Method. The FiSAT II software package was employed for data analysis. Growth parameters were estimated using the von Bertalanffy growth function (Sparre & Venema 1998). Specifically, the ELEFAN I routine within FiSAT II was used to estimate infinity carapace width (CW_{∞}) and the growth coefficient (K). The t_0 parameter was calculated using Gulland's formula (1983). Total mortality (Z) was also estimated using FiSAT II, while natural mortality (M) was derived using Pauly's empirical formula (1980). The application of these methods was guided by established literature (Gayanilo et al. 2005; Ernawati et al. 2017; Samad et al. 2023; Dutta 2023; Bhakta et al. 2024):

$$CW_t = CW_{\infty} (1 - e^{-k(t-t_0)})$$

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

$$\text{Log } (M) = -0.0066 - 0.279 \text{ Log } CW_{\infty} + 0.6543 \text{ Log } K + 0.4634 \text{ Log } T$$

$$F = Z - M$$

$$E = F/Z$$

CW_t represents carapace width at age t (cm); CW_{∞} represents asymptotic or infinity carapace width (cm); K represents the growth coefficient; t represents age (years); t_0 represents the theoretical age at zero carapace width (years); T represents average water temperature ($^{\circ}\text{C}$), assumed to be 30°C ; F represents fishing mortality; Z represents total mortality; M represents natural mortality; and E represents the exploitation rate.

Results and Discussion

Results. The Blue Swimming Crab (BSC) is a tropical marine species inhabiting estuaries and near-shore marine waters (Western Australian Government Department of Fisheries 2011; Johnston et al. 2011; Ernawati et al. 2017). Table 1 presents the results of carapace width (CW) measurements obtained during this study. The observed range of CW in BSC caught by Kebumen fishermen was 8.7 cm to 17.5 cm.

Table 1.

Composition of Crab Size Caught in Kebumen Waters

Carapace Width Interval (cm)	Median	Frequency	Percentage	Cumulative Percentage
8.0-8.9	8.5	3	0.7%	0.7%
9.0-9.9	9.5	17	4.1%	4.8%
10.0-10.9	10.5	39	9.4%	14.2%
11.0-11.9	11.5	95	22.8%	37.0%
12.0-12.9	12.5	120	28.8%	65.9%
13.0-13.9	13.5	69	16.6%	82.5%
14.0-14.9	14.5	32	7.7%	90.1%
15.0-15.9	15.5	25	6.0%	96.2%
16.0-16.9	16.5	14	3.4%	99.5%
17.0-18.0	17.5	2	0.5%	100.0%

BSC caught by Kebumen fishermen are sold to traders as fresh product. The daily fishing practice on the Kebumen Coast generally maintains relatively good BSC quality. The modus of carapace width (CW) class interval was 12.0–12.9 cm, representing 120 individuals (28.8% of the sample). Carapace width frequency is a parameter used in determining BSC growth parameters (Sparre & Venema, 1998). The size at first capture (CWc50%) was estimated by plotting the cumulative frequency percentage of BSC against carapace width (Fig. 2).

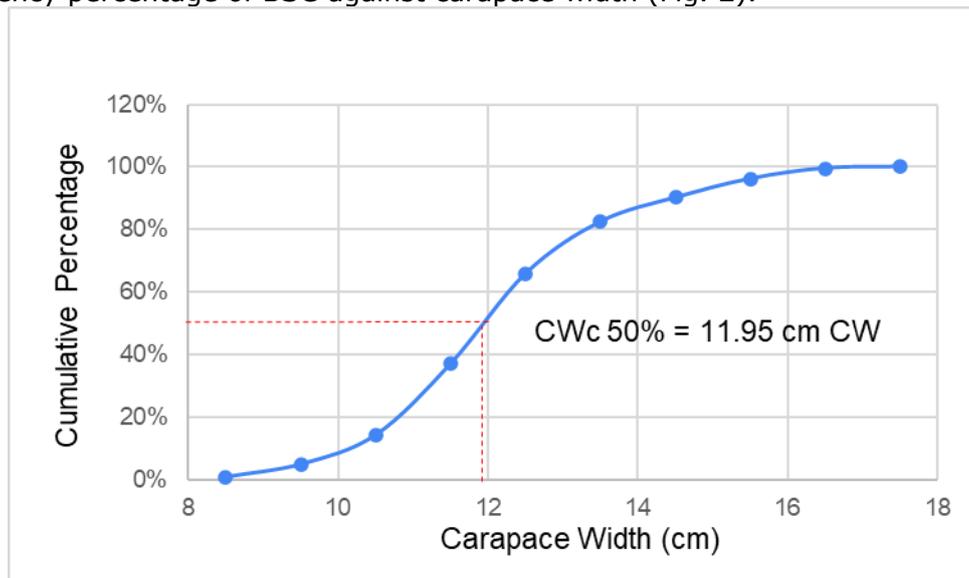


Figure 2. CWc 50% Analysis

The results indicated that the size at first capture (CWc50%) was 11.95 cm CW. This value is above the minimum legal carapace width of 10 cm established by the Minister of Marine Affairs and Fisheries Regulation Number 12 of 2020. This CWc50% value, being greater than the minimum legal size, suggests that the BSC fishing practice is likely sustainable (Ernawati et al. 2017; Bhakta et al. 2024).

Table 2. Estimation of CW_{∞} , K, Mortality and Exploitation Rate

Description	Value
CW_{∞}	18.38 cm CW
K	0.82

Total Mortality (Z)	2.69
Fishing Mortality (F)	0.83
Natural Mortality (M)	1.86
Exploitation Rate (E)	0.31 (under-exploited)
Assumption of Fishing Mortality	93 tons
Estimated maximum sustainable yield (MSY) production	150.7 tons
Estimated economic value of MSY production	IDR. 7.5 billion

Note:

* using 2020 production data

** using the assumption of BSC price at the fisherman level of IDR 50,000 per kg

This study estimated a total mortality (Z) of 2.69 per year and an exploitation rate (E) of 0.31. This exploitation rate suggests that BSC resources on the Kebumen Coast are currently underexploited (Sparre & Venema 1998; Samad et al. 2023; Dutta 2023; Bhakta et al. 2024). The estimated recruitment pattern (Fig. 3) indicates a peak recruitment in May, with a proportion of 19.64%. This recruitment pattern should be considered in fisheries management strategies, particularly regarding fishing seasons. The estimated asymptotic carapace width (CW_{∞}) for BSC in Kebumen coastal waters is 18.38 cm, exceeding the range of 16.14 cm (Sumenep, Madura Island) to 17.93 cm (Demak, Java Island) reported by Ernawati et al. (2017) for other locations in Indonesia.

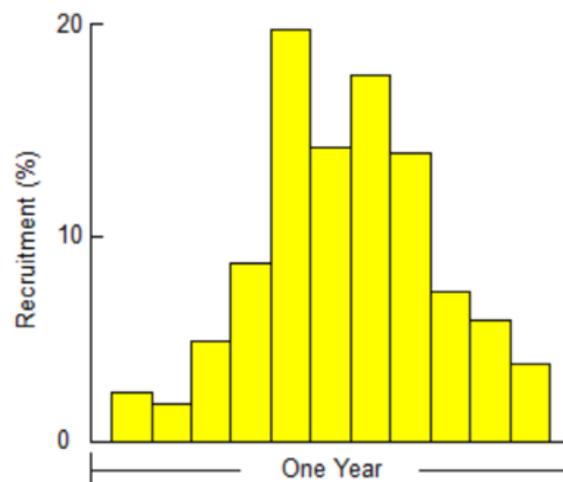


Figure 3. Estimated Recruitment Time

Discussion. Kebumen Regency is at the southern coast of Java Island on 109°33' to 109°50' East Longitude and 7°27' to 7°50' South Latitude. There are 8 FAP in Kebumen Regency that function as the trading centers. Karang Duwur FAP is the main FAP for BSC (DKP Kebumen 2020, BPS-Statistics of Kebumen Regency 2024). BSC is abundant in almost all Indonesian waters. BSC eat small fish, molluscs, worms, and small crustaceans, and they sometimes also eat algae and seagrass. The habitat of BSC is usually sandy, muddy, algal and seagrass habitats in estuaries, sheltered bays and offshore waters to 50 meter depth (Western Australian Government Department of Fisheries 2011, Ernawati et al 2017). BSC stocks positively correlates to chlorophyll-a. The stock biomass production is influenced by environmental factors that include primary productivity, temperature, and rainfall. Water temperature significantly affects species' physiology and production (Azra et al 2018, Marks et al 2021).

Natural mortality includes predation, disease, and old age. Fishing mortality occurs when crabs of a certain size become vulnerable to fishing gear (Bhakta et al., 2024). This study found that the carapace width at 50% maturity (CWc50%) for crabs on the Kebumen coast is 11.95 cm. Ideally, the CWc50% should exceed the carapace width at first maturity (CWm), ensuring that harvested crabs have had the opportunity to spawn and maintain population regeneration. Research by Ernawati et al. (2017) across Indonesia found CWm values ranging from 9.9 cm (Cirebon, Java) to 12.4 cm (Sampit, Kalimantan). These findings are relevant to the Indonesian Minister of Marine Affairs and Fisheries Regulation Number 12 of 2020, which sets a minimum catchable carapace width of 10 cm. Several factors influence CWm: depth, food availability, temperature, and light (Nikolsky 1963).

Identifying the key drivers of population dynamics and estimating recovery rates after stock declines are crucial for effective fisheries management. Water temperature is a major environmental factor that significantly influences species' physiological function and production. Crab movement (pre-molting walking) is positively correlated with acclimatization temperature (Azra et al. 2018; Marks et al. 2021). The FAO (2020) reports that one-third of global fish stocks are exploited at unsustainable levels. This study indicates that BSC (assuming this refers to a specific crab species; please define if possible) recruitment in Kebumen waters occurs from January to November, peaking in May. Applying the von Bertalanffy equation, the estimated carapace width of 8.7 cm is 18 months old. This suggests a peak spawning period in November. Further research on BSC spawning time and location is necessary to inform effective protection policies and ensure undisturbed regeneration of the BSC population.

Kebumen waters (part of the Indian Ocean) are within Fisheries Management Area (FMA) 573, with a BSC production potential of 3,750 tons, currently considered fully utilized. This aligns with the fully exploited status of BSC resources in FMA 573 as determined by KKP Decree Number 19 of 2022. Overexploitation can deplete fish and crab stocks, ultimately reducing catches and fishermen's profits (Dutta 2023; N'obrega et al. 2025). In Western Australia, BSC production declined significantly after 2000 due to low stock abundance, leading to a fishery closure. A three-year closure resulted in stock recovery, albeit slow (Johnston et al., 2011). However, this study indicates that BSC in Kebumen coastal waters are currently underexploited. This suggests potential for increased BSC utilization in the area. Nonetheless, managing BSC fishing practices in Kebumen is crucial, particularly regarding minimum catch size and protection of mature, spawning BSC, to ensure resource sustainability. Maintaining the coastal ecosystem is also essential, as destructive human activities can negatively impact marine biological resources, including BSC. Reduced fishing intensity can promote faster recovery of fish and crab biomass (Makwinja et al. 2021; Umam et al. 2021; Gernez et al. 2023; Soeprbowati et al. 2024; Liu et al. 2024).

Effective preservation of fish and crab resources requires active participation from the local community. Capture fisheries policies should involve local stakeholders, particularly fishermen, traders, and crab processors. Alternative BSC resource management strategies include determining the fishing quotas, minimum size limits, restrictions on destructive fishing gear, releasing egg-bearing females, and establishing marine protected areas (Johannesen 2007; Rakotonarivo et al. 2017; Suliyati et al. 2017; Kennedy et al. 2020; Zhang et al. 2021; Wijayanto et al. 2022). Modifying fishing gear, such as equipping pot traps with release holes or larger mesh sizes, can allow smaller BSC to escape. Release openings and optimizing gear soak time are often used to improve size selectivity and reduce bycatch (Leland et al. 2013; Zhang et al. 2021; Yu et al. 2024; Liu et al. 2024).

Conclusion. The study found that the carapace width at 50% capture (CWc50%) is 11.95 cm, while the theoretical maximum carapace width (CW ∞) is 18.38 cm. Peak

Blue Swimming Crab (BSC) recruitment occurs in May. A utilization rate of 0.31 indicates that BSC in Kebumen coastal waters is currently underexploited.

Acknowledgements. Gratitude is expressed to LPPM Universitas Diponegoro for facilitating the publication of this research.

Conflict of interest. The author declares that there is no conflict of interest.

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Received: xx xx 2025. Accepted: xx xx 2025. Published online: xx xx 2025.

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How to cite this article:

Wijayanto D., Kurohman F., Setyawan H. A., Dewi D. E., Wahyuningsih S. M., Wijayanti S. O., 2025 Status of utilization level of blue swimming crab (*Portunus pelagicus*) in Kebumen Waters. *AAFL Bioflux* xx(xx):xxxx-xxxx.