The utilization level of banana shrimp (*Penaeus merguiensis*) in Kebumen waters

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Abstract. Groups of people living along the coastal area of Kebumen Regency work as fishermen, with banana shrimp (*Penaeus merguiensis*) as one of their major catches. This field research analyzed the level of utilization of banana shrimp on the coast of Kebumen Regency from October to December 2024. In this research, the biological characteristics of banana shrimp that affect the growth and length infinity (L∞) of the shrimp were examined. Furthermore, the mortality and exploitation level of banana shrimp on the coast of Kebumen were also analyzed. The findings indicate that the initial size of banana shrimp at first capture was 6.8 cm carapace length (CL), with the length infinity of 12.08 cm CL. Meanwhile, the highest recruitment of banana shrimp occurred in May. The exploitation level of 0.19 indicates that the utilization of banana shrimp in the area is within the under-exploited category.
Key Words: exploitation level, Kebumen coast, L∞, Lc 50%, *Penaeus merguiensis*.

Introduction. Kebumen Regency is located on the southern coast of Java Island, with coordinates between 109°33' to 109°50' East longitude and between 7°27' to 7°50' South latitude with long coastal area where many fishermen reside. Kebumen Regency has 8 fish auction places in that function as fish trading centers. In 2020, the number of fishermen in the area reached 3,179 people, with the majority using outboard motorboats. Other fishing gears were also utilized by the fishermen, including gill nets, line fishing, and trammel nets. The marine fisheries production in Kebumen Regency reached 1,560 tons in 2020, with the main catches including: largehead hairtail fish (*Trichiurus* sp.), white pomfret (*Pampus argenteus*), Asian seabass (*Lates calcarifer*), blue crab (*Portunus pelagicus*), banana shrimp (*Penaeus merguiensis*), lobster (*Panulirus* sp.), giant catfish (*Arius* sp.), pinjalo (*Pinjalo pinjalo*), little tuna (*Euthynnus affinis*, *Auxis rochei*, *A. thazard*), and mackerel scad (*Decapterus* sp.) (DKP Kebumen 2020; BPS-Statistics of Kebumen Regency 2024).

Banana shrimp ('*udang jerbung*' for local name or *Penaeus merguiensis*) can be found in the waters of the Indo-West Pacific from Kenya and the Persian Gulf to Hong Kong and Australia, including in Indonesia. This type of shrimp is caught using trammel nets. Banana shrimp has high economic value (Fischer & Bianchi 1984; Marini et al 2017). Unfortunately, anthropogenic activities can cause the stock of banana shrimp resources to decline, while human activities in coastal areas also cause environmental degradation (Makwinja et al 2021; Gernez et al 2023; Soeprobowati et al 2024). Therefore, it is necessary to calculate the availability of banana shrimp resources (including on the coast of Kebumen) in relation to issues regarding the sustainability of banana shrimp resources and the socio-economic interests of fishermen. This research was performed to analyze the level of utilization of banana shrimp on the coast of Kebumen Regency. The results of this research provide fruitful insights to the management of banana shrimp resources. Environmental sustainability and the welfare of fishermen need to be synergized as the community welfare is a factor that affects the success of resource conservation through active participation of local communities (Johannesen 2007; Rakotonarivo et al 2017; Wijayanto et al 2022).

Material and Method

Location and time of research. This research was conducted in Kebumen Regency (Figure 1). Researchers conducted surveys and interviews by visiting fishermen and fish traders in Kebumen Regency and measured the carapace length (CL) of banana shrimp from October to December 2024.

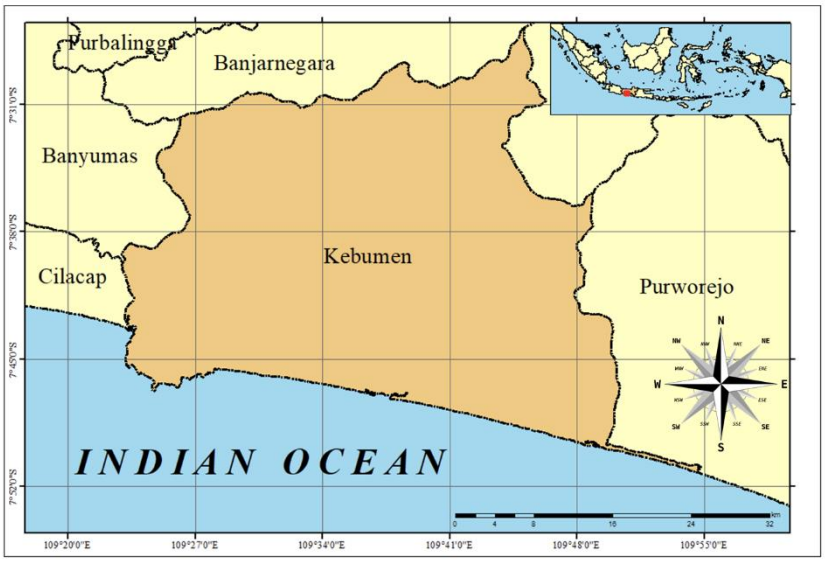

Figure 1. Kebumen Regency.

Research materials. The object of the research was banana shrimp caught by Kebumen fishermen. Trammel net is main tool used by Kebumen fishermen to catch banana shrimp on outboard motorboats within one day fishing. The CL of banana shrimp was calculated from 10% (347 ind) of banana shrimp population caught and purchased by traders from fishermen (King 1995; Sparre & Venema 1998).

Analysis method. The data were analyzed using Microsoft Excel and FiSAT II tools. The growth function was based on the von Bertalanffy equation (Sparre & Venema 1998). The $L\infty$ and K values were estimated using the ELEFAN (Electronic Length Frequency Analysis) I method, while the t_0 values were estimated using the formula of Gulland (1983). Total mortality (Z) was estimated using FiSAT II, and natural mortality (M) was calculated using the empirical formula proposed by Pauly (1980). Several formulas utilized in this research were derived from the works of Gayanilo et al (2005), Dutta (2023), Samad et al (2023), and Bhakta et al (2024):

$$Lt = L\infty\ (1\text{-}e^{-k(t-t0)})$$
$$Log(-t_0) = -0.3922 - 0.2752\ Log\ L\infty - 1.038\ Log\ K$$
$$Log\ (M) = -0.0066 - 0.279\ Log\ L\infty + 0.6543\ Log\ K + 0.4634\ Log\ T$$
$$F = Z - M$$
$$E = F/Z$$
$$E_{MSY} = 0.5$$
$$F_{MSY} = 0.5\ Z$$
$$C_{MSY} = \frac{F_{MSY}}{F}.C$$

where: Lt is the carapace length (CL) measurement at age "t" (cm); $L\infty$ is the infinite carapace length of the shrimp (cm); K is the growth coefficient; notation t is the age of the shrimp (years); t_0 is the estimated age of the shrimp when the CL of the shrimp is 0 cm (years); T is the average water temperature (°C), assumed to be 30°C; F is mortality index due to fishing; Z is total mortality index; M is natural mortality index; E is the exploitation rate; E_{MSY} is the exploitation level at maximum sustainable yield (MSY); F_{MSY} is the index

of fishing mortality at MSY; C_{MSY} is the banana shrimp production at MSY (tons); C is the existing banana shrimp production (tons).

Results. The habitat of banana shrimp is in tropical waters at the bottom of brackish and sea waters with a depth of between 10-55 m (Holthuis 1980; Cheung et al 2013). The CL of banana shrimp measured in this research ranged between 3.8 to 11.1 cm as presented in Table 1.

Table 1

Size composition of shrimp caught in Kebumen waters

Interval carapace length (cm)	*Median*	*Frequency*	*Percentage (%)*	*Cumulative percentage (%)*
3.0-3.9	3.5	1	0.3	0.3
4.0-4.9	4.5	2	0.6	0.9
5.0-5.9	5.5	27	7.8	8.6
6.0-6.9	6.5	94	27.1	35.7
7.0-7.9	7.5	158	45.5	81.3
8.0-8.9	8.5	53	15.3	96.5
9.0-9.9	9.5	10	2.9	99.4
10.0-10.9	10.5	1	0.3	99.7
11.0-11.0	11.5	1	0.3	100.0

Freshly-caught banana shrimp by fishermen in Kebumen are sold to fish traders through an auction process at the fish auction center in the form of fresh shrimp. The practice of catching banana shrimp along the Kebumen coast follows a one-day fishing pattern. The most frequently observed size class is within the 7.0-7.9 cm interval, comprising 158 individuals and accounting for 45.5% of the total catch. CL frequency serves as a crucial parameter for determining the growth characteristics of shrimp species (Sparre & Venema 1998). To estimate the first size at capture (Lc 50%), measurements are conducted by plotting the cumulative frequency percentage of the shrimp catch against their respective CLs (Figure 2).

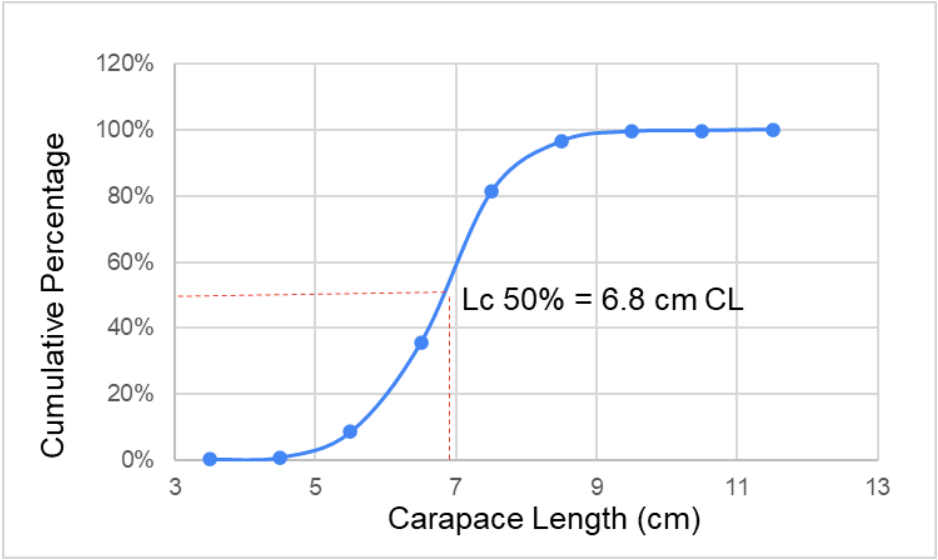

Figure 2. Lc 50% analysis.

The results of the research showed that the frequency distribution parameters of the CL and size first caught (Lc50%) were 6.8 cm CL or 68 mm CL. Lc50% is a selectivity factor of fishing gear. Lc50% can be compared with Lm. Lm is the shrimp length (CL) when the gonads first mature (Garcia & Le Reste 1981; King 1995; Dutta 2023). Several studies have shown that there is a Lm diversity of banana shrimp in various different regions in

Indonesia, namely in the range of 7.15 mm CL (in Segara Anakan) to 42.95 mm CL (North Coast of Central Java) (Nikolsky 1963; Tirtadanu & Ernawati 2016; Suman et al 2023). Lc50% value higher than Lm indicates that the method in catching shrimp is environmentally friendly. The results of the estimated values of L∞, K, mortality, and exploitation level can be seen in Table 2.

Table 2

Estimation of L∞, K, mortality and exploitation rate

Parameter	*Value*
L∞	12.08 cm CL
K	1.4
Total mortality (Z)	3.64
Fishing mortality (F)	0.68
Natural mortality (M)	2.96
Exploitation rate (E)	0.19 (under-exploited)
Assumption of fishing mortality	89 tons*
Estimated MSY production	238 tons
Estimated economic value of MSY	IDR 23.8 billion**

Notes: * using production data 2020; ** price of banana shrimp from fishermen is assumed at IDR 100,000 per kg.

The results of this research indicate that the estimated value of Z was 3.64 per year and the E was 0.19, indicating that banana shrimp catching method on the coast of Kebumen is still in the underexploited category (Sparre & Venema 1998; Dutta 2023; Samad et al 2023; Bhakta et al 2024). The estimated recruitment pattern is presented in Figure 3. May is the peak recruitment with a percentage of 26.48%. Recruitment patterns need to be considered in fisheries management related to the fishing season.

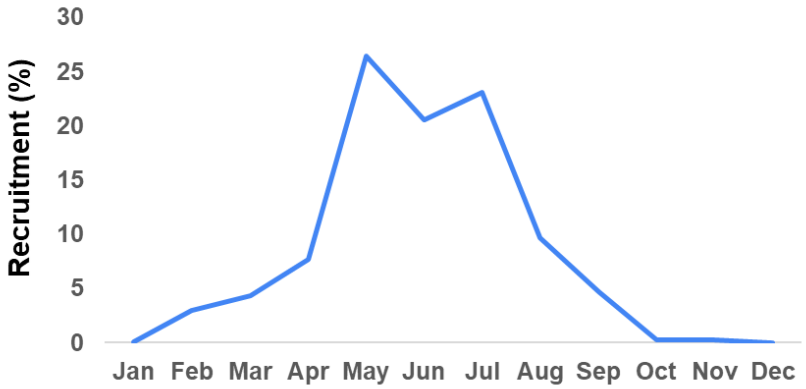

Figure 3. Estimated recruitment time.

Discussion. Shrimp, including banana shrimp, are among Indonesia's leading capture fisheries commodities, with a total production of 250,981 tons in 2022. Other key marine fisheries commodities include little tuna (*E. affinis*, *A. rochei*, *A. thazard*), skipjack (*Katsuwonus pelamis*), and tuna (*Thunnus* sp.) (KKP 2024). Kebumen waters, part of the Indian Ocean, fall under Fisheries Management Area (FMA) 573, which has a potential penaeid shrimp production of 4,257 tons, including banana shrimp. Indonesia hosts 11 economically valuable penaeid shrimp species across two genera, *Penaeus* and *Metapenaeus*. However, penaeid shrimp resources in FMA 573 have been classified as overexploited (Silaen & Mulya 2018; Decree of MMAF No. 19 of 2022). In contrast, this research indicates that banana shrimp in the coastal waters of Kebumen remain underexploited.

Banana shrimp are widely distributed across Indonesian waters, including estuaries, mangroves, coastal areas, lagoons, bays, and open seas. The shrimps typically inhabit waters with muddy or mixed sandy-mud bottoms, rich in organic matter and spend part of

their lifecycle in brackish waters (Holthuis 1980; Garcia & Le Reste 1981; Cheung et al 2013; Silaen & Mulya 2018). Their primary diet consists of mollusks, supplemented by microalgae (Lantang et al 2024). Shrimp density is influenced by environmental factors such as pH, temperature, and biological oxygen demand (BOD). The research by Salim et al (2022) in the Bengara Estuary, Bulungan Regency, found that female shrimp outnumbered males by a ratio of 2:1. Additionally, banana shrimp exhibit a negative allometric growth pattern, with weight increasing faster than length.

This research determined the Lc50% of banana shrimp to be 6.8 cm CL. Ideally, the Lc50% is higher than the length at maturity (Lm), ensuring that captured shrimp have already spawned, thus supporting population regeneration. Previous research shows significant variability in Lm for banana shrimp across Indonesia, ranging from 7.15 mm CL in Segara Anakan to 42.95 mm CL along the northern coast of Central Java. Factors influencing Lm include water depth, food availability, temperature, and light (Nikolsky 1963; Tirtadanu & Ernawati 2016; Suman et al 2023).

This research reveals that banana shrimp recruitment in Kebumen waters occurs from January to November, with a peak in May. Based on the von Bertalanffy growth equation, shrimp measuring 7.5 cm CL is 7 months old, suggesting peak spawning occurs in October. Further research on spawning times and locations is essential to inform shrimp spawning protection policies, ensuring the regeneration process remains undisturbed. The underexploited status of banana shrimp in Kebumen waters, as identified in this research, indicates potential for increased utilization. However, shrimp fishing practices must be regulated, particularly regarding minimum catch sizes and the protection of mature shrimp, to ensure resource sustainability. Additionally, maintaining the health of coastal ecosystems is critical, as destructive anthropogenic activities have been shown to deplete marine biological resources, including shrimp (Makwinja et al 2021; Umam et al 2021; Gernez et al 2023; Soeprobowati et al 2024).

In developing and implementing capture fisheries policies, the active involvement of local communities, especially fishermen and shrimp traders, is crucial. Beyond technical and legal considerations, socio-cultural factors must also be addressed to avoid social conflict. The Kebumen community places significant value on spiritual and cultural traditions. Engaging local leaders and incorporating local wisdom alongside formal policies can optimize fisheries management. Conservation efforts are more likely to succeed when supported by the active participation of local communities (Johannesen 2007; Rakotonarivo et al 2017; Suliyati et al 2017; Kennedy et al 2020; Wijayanto et al 2022; Setiyanto et al 2024).

Conclusions. The research found that the size at first capture (Lc50%) for banana shrimp was 6.8 cm CL, with an L∞ of 12.08 cm CL. The highest recruitment occurred in May. The utilization rate of 0.19 indicates that banana shrimp in the coastal waters of Kebumen remain underexploited, suggesting potential for sustainable increases in utilization. Production can be increased to around the MSY. Banana shrimp fishing should use selective fishing gear. The minimum size of banana shrimp that can be caught should be regulated. Mature gonad shrimp broodstock should be protected.

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Conflict of interest. The authors declare that there is no conflict of interest.

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