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Stock conditions and status of blue swimming crab (*Portunus pelagicus*) in Demak waters area, the northern coast of Central Java

Aisyah Nur Nabila[1], Am Azbas Taurusman[1,2,*], Budy Wiryawan[1,2], Mochammad Riyanto[1,2]

[1] *Marine Fisheries Technology Study Program, Faculty of Fisheries and Marine Sciences, IPB University, Bogor, Indonesia.*
[2] *Department of Utilization of Fisheries Resources, Faculty of Fisheries and Marine Sciences, IPB University Bogor, Indonesia.*

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ABSTRACT

Blue swimming crab (*Portunus pelagicus*) is the dominant catch in Betahwalang, Demak, and the most important export fish commodity, particularly to the USA. The high demand for this crab has triggered an excessive fishing effort, causing a decrease in the crab's natural stock. This study aims to investigate the biological condition of *P. pelagicus* on the northern coast of Central Java and assess the crab stock exploitation status in this study area. Carapace width, body weight, Gonad Maturity Stages (GMS), and sex of crab samples were collected from the fishers' and collectors' landing sites or meeting points. This study employs a simple random sampling technique with no replacement. This study revealed that the maximum carapace width of female crabs was 56-164 mm, and the estimated carapace width at first maturity (Lm) was 98.2 mm. The carapace width-body weight relationship between male and female crabs indicated positive and negative allometric growth patterns. During this assessment, the *P. pelagicus* stock showed an 'over-exploited' status, with an LB-SPR parameter of 19 percent and an exploitation rate (E) of 0.66. Management measures, such as minimum legal size, reduced effort, and open-close areas and seasons should be implemented to achieve sustainable use of the crab fishery.

Introduction

The Fisheries Management Area of Indonesia 712 (WPPNRI 712) is a blue swimming crab (BSC) fishery center in Indonesia, accounting for 40% of national production (MMAF, 2016). According to Moosa (1980), the BSC (*Portunus pelagicus*), locally known as 'rajungan', lives in sandy waters, muddy sands, and rocky islands. The BSC has a high selling price and constitutes the third-highest export fish commodity in Indonesia to the market of the USA, Singapore, Japan, Malaysia, and China (Agustina *et al.*, 2014). One of the crab fishery centers in FMA 712 is in Betahwalang Village, Demak, Central Java. The production of BSC in Demak Regency in 2019 was about 480,704. Kg (DKP Demak, 2021).

The high demand for crabs for the international and local markets has put pressure on BSC resources. Intensive fishing of crabs using various fishing gear types, even illegal mini bottom trawl (*arad*), and exploiting the small sizes (immature) have potentially threatened the sustainability of the crab resources. Thus, the natural stock of the BSC in the Java Sea (WPP/FMA 712) has decreased over the last ten years, even indicating an over-exploitation condition (e.g., Budiarto, 2015), a fully-exploited stock status characterized by an exploitation rate of 0.65 (MMAF, 2016). Particularly in the Demak fishing area, over-exploited stock status has been indicated based on the annual monitoring conducted by Ernawati *et al.* (2017) in January – December 2014 with a spawning potential ratio (SPR) of 15%.

To achieve sustainable management of the BSC fishery in Indonesia, the Ministry of Marine Affairs and Fisheries (MMAF), in 2016, established a fisheries management plan (FMP/RPP) for BSC

* Corresponding author.
Email address: azbas@apps.ipb.ac.id

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through the Decree of the Minister of Marine Affairs and Fisheries No. 70 of 2016. The MMAF has also regulated the minimum legal size for blue swimming crab, lobster, and mud crab in Indonesia through the Decree of the Minister of Marine Affairs and Fisheries No. 17 of 2021. The decree stipulates that the minimum size limit for the BSC is 100 mm carapace width (CW) and that the capture of berried females is prohibited.

In implementing the BSC fishery management plan, a harvest strategy has been formulated in FMA 712 (MMAF, 2020). Hopefully, the harvest strategy implementation would rebuild the BSC stock in the management area. The harvest strategy document puts SPR parameter as an indicator of stock status. The parameter has been widely used to evaluate regularly the BSC stock status (Prince *et al.*, 2014). Demak Regency has also been designated as one of the monitoring sites in FMA 712 for the BSC harvest strategy framework (MMAF, 2020).

This study was conducted to evaluate and update the status of the BSC fishery in the Java Sea (FMA 712), particularly in the monitoring site of Demak waters using Length based spawning potential ratio (LB–SPR). The study result is expected to contribute to the implemented FMP and harvest strategy of the BSC fishery in FMA 712.

Materials and Methods

Location and time of research

The field study took place in Betahwalang Village, Bonang, Demak Regency, Central Java, from 27 March to 12 April 2021 (Figure 1). The study team collected 100 to 200 crabs per day. According to Ernawati *et al.* (2017), the peak spawning season of the BSC in the study area occurs in March and October.

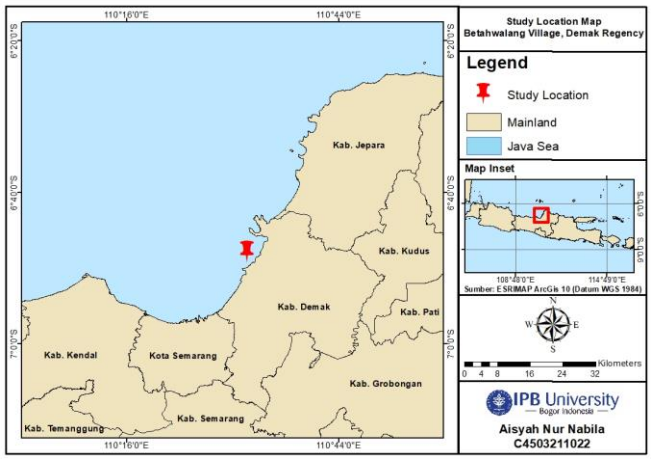

Figure 1. Study location of Demak waters.

Method of collecting data

The data were collected through observation, surveys, literature studies, and interviews. The respondents in this study included the head and members of the fishing group of KPPD (*Kelompok Pecinta Pesisir Demak* or Stakeholders group of the Demak Coastal Area), BSC collectors, and fishers who landed their catches on the traditional landing base or 'angkruk'. Interviews with respondents aimed to collect information on the crab fishery unit at the study location. Biological parameters of the BSC, i.e., carapace width (mm), weight (g), sex, and gonad maturity level of the BSC (*Portunus pelagicus*) samples, were directly measured in the landing base using a ruler, digital scale, and reference Costa and Negreiros (1998) in the criteria for GMS of crab. After that, the team used percentage for GMS of crab. The samples were taken from fishing boats using a simple random sampling technique. A sampling of crabs was carried out at every 'angkruk' per day, with 50 members or fishing boats and about 2-7 baskets of crab landing per angkruk. A number of samples were collected based on the number of BSC fishing vessels landed in the fishing base of 'Angkruk' during the study. A total of 1,558 individuals of the BSC samples were measured representing the fishing gear, i.e., mini trawl (local name 'arad') with 3-inch mesh, and BSC traps of 40x30x20 cm. There was no BSC catch of gillnet during the study.

Data analysis

The BSC fishery unit in this study area, i.e., fishers' characteristics, fishing gears, fishing time, boats, operating methods, fishing areas, and catches, were descriptively analyzed.

For biological data, the following analyses applied: body weight - carapace width relationship, growth parameters, carapace width - gonad maturity level (to estimate carapace width at first maturity), and estimation of spawning potential ratio (SPR). The information provided the basis for estimating biological characteristics and stock status of the BSC in the study area.

The relationship between body weight and carapace width of the crab samples was analyzed using equation (1), e.g., Effendie (1997),

$$W = a\,L^{b}$$

The relationship of constants (a and b) regression length and weight allows for comparing individuals within a population or between populations. For the value of b = 3 or b ≠ 3 with the hypothesis of:

H_0: b = 3, the relationship between carapace width and body weight is isometric

H_1: b ≠ 3, the relationship between carapace width and body weight is allometric.

The value of b≠3 indicates an allometric growth pattern, namely:
b>3 indicates a positive allometric growth pattern, namely, the growth of fish weight is relatively higher than its length growth.
b<3 indicates a negative allometric growth pattern, i.e., the growth in length of fish is relatively higher than the growth in weight.

Crab growth parameters were analyzed using ELEFAN program contained in the FISAT II software. The maximum carapace width, median value, and frequency data were input in this analysis. Then asymptotic carapace width (L∞), growth coefficient (K), the carapace width at first maturity of the gonad (Lm), natural mortality (M), fishing mortality rate (F), the total mortality rate (Z), and exploitation rate (E) were generated. The SPR and maturity-selectivity curve analysis used the R Studio software packages LB-SPR.

Reproductive output (EP) was estimated at each age t as Prince *et al.* (2014):

$$EP_t = (N_{t-1}e^{-M})f_t$$

The cumulative SPR was calculated for each age class t:

$$SPR_t = \frac{\sum_{t=0}^{t} EP_t}{\sum_{t=0}^{tmax} EP_t}$$

where:
SPRt = the proportion of potential lifetime reproductive output achieved at age t
EPt = reproductive output at age t
Nt = number of individuals at time y with N0 is 1000
M = natural mortality
f_t = fecundity at age t

If the ft value is not available, then the EPt value can be obtained by the following equation:

$$EP = Nt * Wt * mt$$

where:
Wt = mean weight of crab at age t
mt = the probability of being mature at age t

According to Prince *et al.* (2014), BSC stock status could be indicated by the SPR value of: < 20% suggesting 'over-exploited', 20 – 40% 'fully-exploited', and > 40% is 'under-exploited' stock status.

Results

The blue swimming crab fishery unit

The BSC fishery unit mainly comprises fishing gear, fishers, and boats. Based on fishing gear, there were 150 boats of traps (Figure 2), 450 boats of bottom mini trawls or 'arad' (Figure 3), and 150 boats of bottom gillnet that fishers used to catch the BSC in Betahwalang Village. In this village, there was a traditional fishing base for the BSC known as 'angkruk' and net cage to temporally release the berried female with the local name of 'branjang'.

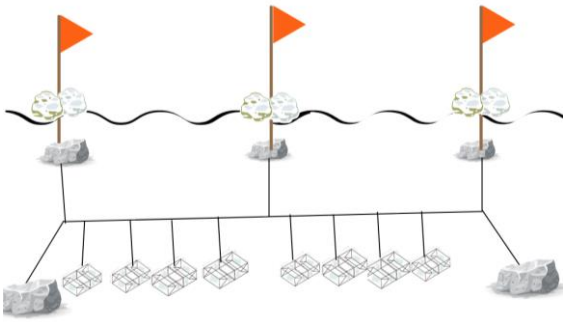

Figure 2. Construction of traps in one pair in Betahwalang Village.

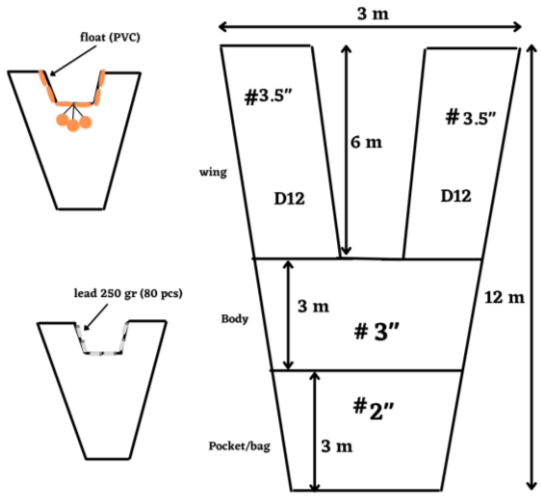

Figure 3. Construction of BSC 'arad' fishing gear in Betahwalang Village.

Fishers in Betahwalang Village mostly come from this village and work as BSC fishers. There were 903 fishers and 16 BSC collectors/middlemen (*pengepul*) in this village.

The crab fishing fleet in Betahwalang Village comprises small-scale fishers using boats under 10 GT. They use a 3-6 GT boat for fishing with traps, a 3 GT boat for using arad, and a 1 - 3 GT boat for bottom gillnet. Betahwalang Village also has 16 units of 'angkruk' and six units of 'branjang'. While the former is a traditional fishing base as a marketplace located near a river mouth where fishers sell their BSC catch to collectors, the latter is a fishing gear with a net at the bottom with a depth of about 3-5 m. This is an alternative for fishers who catch egg-laying crabs alive to return them to the sea and recatch them when the eggs have hatched. In the interview session, the fishers claimed they could catch the crabs throughout the year. In this study, samples of the BSC were taken to represent the gear and sex, as presented in Table 1.

Table 1. Number of BSC samples from different fishing gear in Betahwalang Village, Demak

No	Fishing gear	Male (inds.)	Female (inds.)	Total (inds.)
1	*Trap*	243	324	567
2	*Arad*	426	565	991

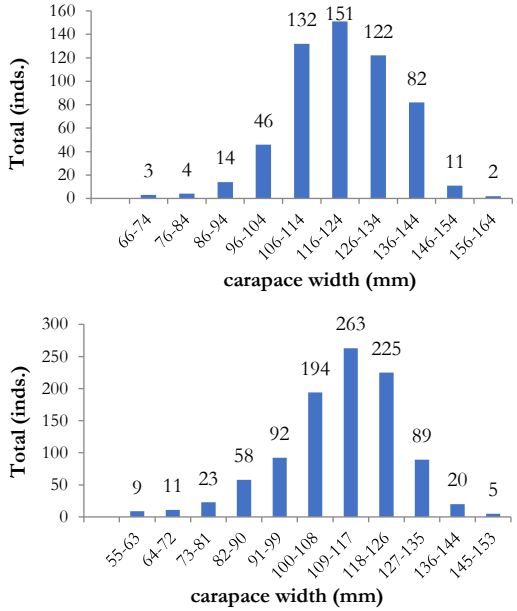

Figure 4. Frequency of distribution of carapace width from each fishing gear of a) trap b) 'arad'.

Carapace width – body weight relationship

Carapace width-body weight relationship indicates the BSC growth characteristics. Table 2 and Figure 5. below presents the carapace width-body weight relationship for the BSC samples in Betahwalang Village.

Table 2. Carapace width-body weight relationship for the BSC in Demak waters.

Sex	a	b	R^2	growth pattern
Male	0.00005	3.08476	0.90417	Positive allometric
Female	0.00032	2.67614	0.83777	Negative allometric
Combined sex (from traps)	0.00016	2.83441	0.83496	Negative allometric
Combined sex (from 'arad')	0.00015	2.83930	0.85807	Negative allometric

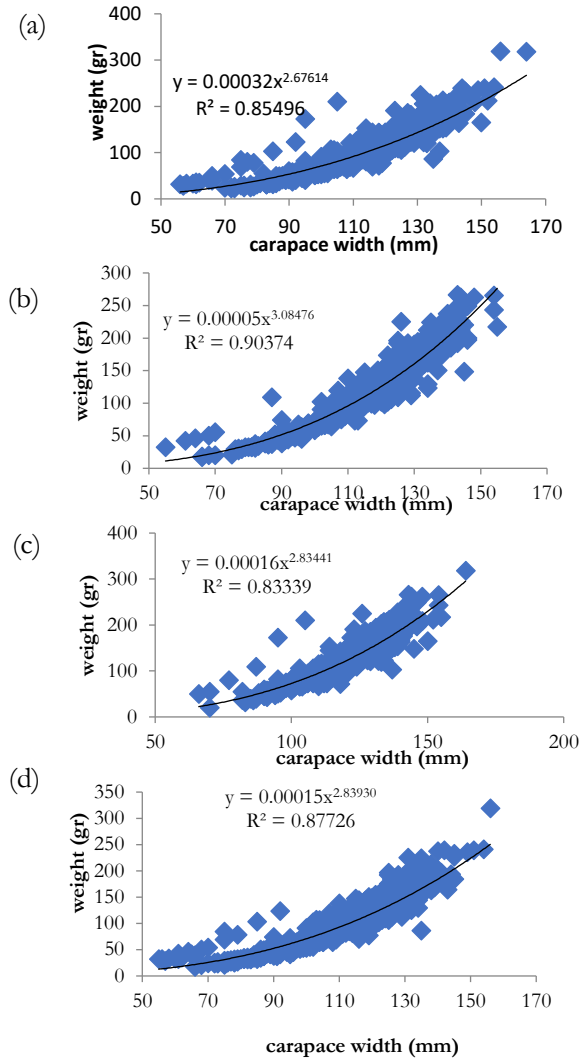

Figure 5. Correlation between carapace width and BSC body weight a) Female b) Male c) Trap d) *Arad*.

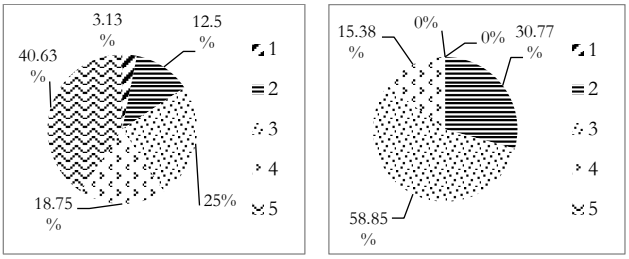

Figure 6. Composition (%) of gonad maturity stages of the female Blue Swimming Crab (left) and male (right) in Demak water.

Gonadal maturity stage (GMS)

A total of 32 females and 13 males of BSC samples were taken to estimate the gonad maturity stage, and the result is presented in Figure 6.

Growth parameters

Asymptotic length (L∞) and growth coefficient (K) of female BSC were determined using the ELEFAN program in FISAT II software, as presented in Table 3.

Table 3. Estimation of the BSC growth parameter in the study area from March to April 2021.

Parameters	Value
Lm (carapace *width at first Maturity*)	98.2 mm
L∞ *(Length Asymptotic)*	168.53 mm
Lmax (Maximum *Length)*	164 mm
K	0.71 /year
M	0.88 /year
to	-0.85 /year
Temperature	28 °C
SPR	19%
F	1.69 /year
F/M	3.91 /year
E	0.66
SL50	113.02 mm
SL 95	139.86 mm

Natural mortality rate and exploitation rate

The natural mortality rate (M) was analyzed using the Pauly empirical formula with a surface temperature of 28°C for female BSC. The calculation generated a value of M = 0.9. Figure 7 shows the natural mortality pattern using FISAT II, the value of M = 0.88, and the calculation using Rstudio resulted in M = 0.882. The calculation of the natural mortality analysis showed the same value using various methods. Figure 7 shows that the exploitation rate obtained for female crabs was 0.66 which indicates over- exploited because the value of E> 0.5.

Spawning potential ratio (SPR)

The SPR value was estimated using Rstudio software and obtained a value of 0.19 or 19% (over-exploited) as show in Figure 8. Below the limit references point (20%) shows the threshold for crab utilization status, but Figure 8. shows 19% or red. The estimated stock status of the blue swimming crab above the limit RP is shown in yellow, indicating a fully-exploited status. Meanwhile, green indicates the stock status above the target RP (40%), suggesting over-exploited.

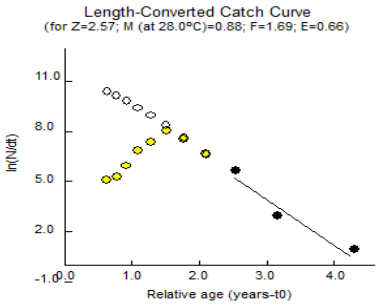

Figure 7. Linearized capture mortality curve based on blue swimming crab carapace width.

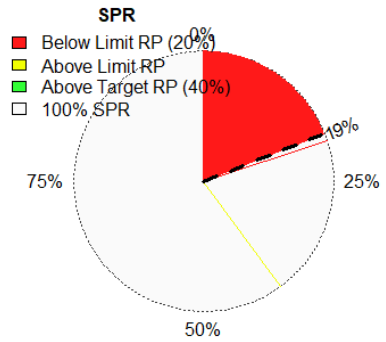

Figure 8. Spawning potential ratio (SPR) estimation using Rstudio software.

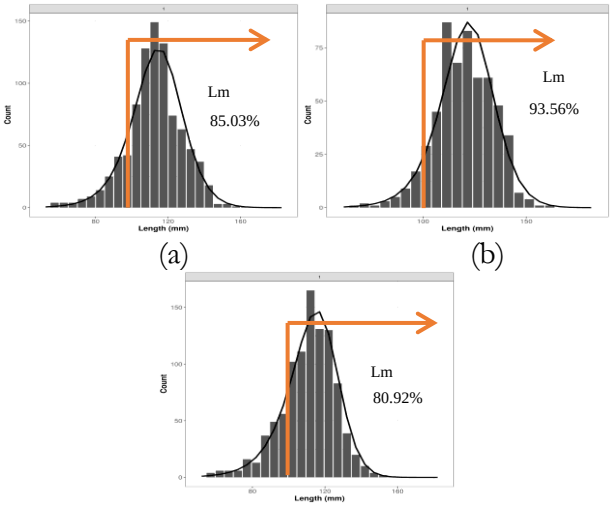

Figure 9. Distribution of carapace width of the blue swimming crab a) female (*Portunus pelagicus*) b) traps c) *arad.*

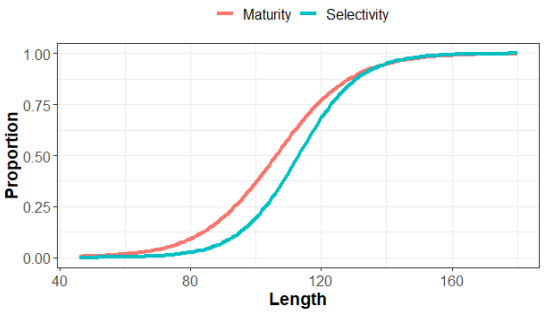

Figure 10. Blue swimming crab maturity-selectivity curve (*Portunus pelagicus*).

There were 889 samples of female crabs included in the analysis, with a 56 to 164 mm size distribution. The female crab maturity-selectivity curve in Figure 10 shows that the selectivity line is below the maturity line, indicating a low mortality rate of female BSC.

Discussion

Information on the number of BSC fishery unit in Demak Regency based on data from DKP Demak 2021. The trap used by fishers was a folding trap with

200 units in each pair, and each trip or boat could set up to 800 traps, or four pairs. Each pair of fishing gear was equipped with three flags to mark the traps in the fishing ground and used a *Global Positioning System* (GPS) to a location point. The trap fishing ground was about 20 km from the fishing base. The *arad* was operated for 1.5 hours sweeping time and four times setting and hauling in one day. Meanwhile, the fishing areas around Semarang could take up for 3 times setting. Arad nets are usually operated at a depth of 4 – 15 m. When towed, the immersion period of the arad was 1.5 hours with four times setting and hauling in one day.

During the field study (March to April) or the transition season showed a 'medium' catches volume. BSC fishing grounds were found in the waters of Demak, Semarang, Kendal, and Jepara. It also coincides with the study of Azkia *et al.* (2019).

Growth parameters

Carapace width-body weight relationship indicates the BSC growth characteristics (e.g., Effendi, 1997; Setiyowati, 2016). The crab's carapace width was analyzed to explain its growth, while the crab's body weight was a function of the carapace width (CW). The carapace width-body weight relationship indicated a negative allometric growth pattern, except for the male crab. The combined sex (from arad) showed a determination coefficient (R^2) of 0.85807, indicating the confidence level in this model was 85.8%. The coefficient of determination (R^2) showed a strong relationship between body weight and CW. In the Suryakomara (2013) study in East Lampung Waters, which was coincident with this study, the CW- body weight relationship showed positive allometric for male BSCs and negative allometric for females. Rusfayeni's (2017) study in Pati suggested that the relationship between males and females of BSC showed positive allometric growth patterns. Ernawati *et al.* (2015) study in Lampung waters showed that the males were isometric, while females and combined BSCs were negative allometric. Environmental factors, such as water temperature, dissolved oxygen, amount of food, age, and organism size, strongly affect crab growth (e.g., Ernawati *et al.*, 2015, Fatmawati, 2009).

During the larval stage, BSC has a planktonic phase, and plankton is the primary food. The larger the young crab's size or phase, the crab will return to the estuary and rule as an omnivorous feeder. This condition can be seen from the catch of crabs using arads in the fishing area near estuaries or shallow waters. The life cycle of the BSC can molt 20 times from the zoea phase to adulthood, and the carapace width reaches 18 cm (Nontji, 1986). The carapace width of male crabs increased faster than female ones (Soim,1994).

The analysis of the growth patterns showed asymptotic values ($L\infty$) = 168.53 mm and growth coefficient K = 0.71 per year in female BSCs. The K value indicated that the female BSC growth rate was relatively slow because K has a value of less than one (Panggabean *et al.,* 2018). The studies of Suryakoma (2019) and Kembaren *et al.* (2012) showed that a value of $L\infty$ = 183.22 mm and K = 0.64 per year and $L\infty$ = 154 mm and K = 1.08 per year in female crabs, respectively. These growth parameters of $L\infty$ and K were estimated based on different maximum CW of the samples.

The estimated carapace width at first maturity or length at first maturity (Lm) of the crabs in Demak Waters was 98.2 mm, and the results are presented in Table 3. The results of the length at first maturity (Lm) study show that it is smaller than the research by Ernawati *et al.* (2017) namely Lm = 104.89 mm.

Natural mortality and exploitation rate

The mortality rate was in Demak Waters shows M = 0.88 which is smaller than in case of the waters around Belitung M = 1.12 (Ernawati et al., 2015) and in East Lampung M = 1.05 (Suryakomara, 2013). The natural mortality (M) in a population is due to fishing activities, disease, predators or other availability of biota prey, and aging (Effendie, 1997). The fishing mortality rate (F) had a value of F = 1.69 per year, while the total mortality rate (Z) was Z = 2.57 per year. The greater the value of Z, the higher the mortality rate of the crab in that place. This information provided the basis for determining the exploitation rate (E) of crabs in Demak waters by comparing the values of F and Z. Then, the comparison results were obtained with a value of E = 0.66, meaning that 66% of crab mortality in Demak waters was due to fishing. This exploitation rate has exceeded the optimum due to the value of E>0.5. The decreasing number of individuals, species abundances, and diversity indicate the fishing effect on biota targets (Taurusman *et al.*, 2020). High mortality rates due to continuous fishing can give some individuals a low survival rate and prevent them from reaching maximum size (Binohlan and Froose, 2009).

Spawning potential ratio (SPR)

The Spawning potential ratio (SPR) is a relative reproductive index that can estimate exploited fishery stocks using relatively limited data (Prince *et al.*, 2014). The data needed to estimate the SPR parameter are carapace width, body weight, gonad maturity stage, and distribution frequency. To estimate the SPR parameter, there are some

considerations: (1) high capture selectivity, (2) growth that can be explained by the von Bertalanffy equation, and (3) the length composition parameters used are from males and females because both have the same chance of being caught so that a single growth curve can be used to describe the growth of both sexes, (4) a certain length of life can be normally distributed, the natural mortality rate is constant, the growth rate is constant in various cohorts in one stock unit (Prince *et al.*, 2020).

The advantage of the SPR parameter to evaluate the stock status is relatively simple data input or used for poor (limited) data fisheries. It uses long composition data from exploited stocks that are relatively inexpensive and easy to collect and is one of the most common forms of data available to fisheries researchers (Prince *et al.*, 2020). It is in contrast to CPUE estimation that needs fit time series data of catch and effort that in case of small-scale fisheries like BSC, the data are not well available. Sibagariang *et al.* (2011) explained that Catch per Unit Effort (CPUE) is used to determine the average annual yield of fishery production.

The maximum carapace width distribution data for female BSCs in the metadata of sealifebase.ca (Palomares and Pauly, 2021) is 200 mm in Tuticorin, India. The female BSC maturity-selectivity curve is in Figure 10. indicates that the selectivity line is below the maturity line. It shows that the mortality rate of female BSCs is low. Thus, most of the BSC catch was higher than Lm and complied with the MMAF Decree No. 17/2021.

The condition of the SPR value reached 19%, suggesting an over-exploited status. Therefore, in formulating policies, it is possible to prohibit the addition of fishing gear and crab fishing fleets for some time or about one year. It is estimated that this will reduce the impact of the increase in BSCs catching carried out in the Demak Waters.

The peak spawning season of the *P. pelagicus* in Demak waters occurs in March and October (Ernawati *et al.*, 2017). It can be used as scientific information to formulate the management measure for this fishing area's close fishing season in March and October. Fishers in Betahwalang Village consider releasing the egg-laying BSC caught alive into the habitat. They have developed a particular water area for freeing the eggs in a net cage, locally known as 'branjang'. After the crabs release the egg, fishers take them to sell.

To maintain the sustainability of crab resources, it is necessary to manage, monitor, and evaluate every policy the government will take. In addition, the government should adequately implement the regulations related to BSC fisheries management, for example, MMAF Decree No. 17 the year 2021, No. 18/2021 on the placement of fishing gear and supporting gear and the implementation of BSC fisheries management and the harvest strategy. This is because there are still many BSCs caught below the predetermined size in Demak waters.

Conclusion

The BSC fishery in Betahwalang Village, Demak, was a small-scale fishery with a boat size of 1–6 GT and one-day fishing activity. Based on fishing gear, mini bottom trawl (arad) with 3-inch mesh dominated the fishing fleet with 450 boats, followed by BSC traps of 30x20x40 cm with 150 vessels. The trap used by fishers could set up 800 units per boat. The growth parameters of the BSC during this study were $L\infty$ = 168.53 mm, K = 0.71 per year, M = 0.88 per year, E = 0.66, and Lm (minimum limit size of 98.2 mm carapace width (CW). The CW-body weight relationship indicates a negative allometric growth pattern, except for the male crabs. The BSC resource was an over-exploited stock status, indicated by an estimated SPR value of 19%, exploitation rate of 0.66 (E > 0.5), and fishing mortality higher than natural mortality (F/M = 3.91). Thus, the available regulations (MMAF Decree No. 17/2021) should be appropriately implemented to achieve the sustainable resources of the BSC fishery in the Java Sea, particularly in Demak waters.

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References

Agustina, E.R., A.K. Mudzakir, T. Yulianto. 2014. Analisis distribusi pemasaran rajungan (*Portunus pelagicus*) di Desa Betahwalang Kabupaten Demak. Journal of Fisheries Resources Utilization Management and Technology, 3(3): 190–199.

Almaida, S., D. Wijayanto, A. Ghofar. 2015. Analisis perbandingan pendapatan nelayan bubu Desa Betahwalang dengan pola waktu penangkapan berbeda. Journal Fisheries Resources Utilization Management and Technology, 4(3): 1-9.

Azkia, L.I., M.F.A. Sondita, E.S. Wiyono. 2019. Pola spasial dan temporal kegiatan penangkapan rajungan nelayan Betahwalang Kabupaten Demak. Jurnal Penelitian Perikanan Indonesia, 25(2): 67-77.

Binohlan, C., R. Froese. 2009. Empirical equations for estimating maximum length from length at first maturity. Journal of Applied Ichthyology. 1-3.

Budiarto, A. 2015. Pengelolaan perikanan rajungan dengan pendekatan ekosistem di Perairan Laut Jawa (WPPNRI 712). Essay. Faculty of Fisheries and Marine Science, IPB University, Bogor, 21 November.

Bunnel, D.B., T.J. Miller. 2005. An individual-based modeling approach to spawning-potential per-recruit models: an application to blue crab (*Callinectes sapidus*) in the Chesapeake Bay. Canadian Journal of Fisheries and Aquatic Science, 62: 2560-2570.

Brooks, E.N., J.E. Powers, E. Cortes. 2010. Analytical reference points for age-structured models: application to data-poor fisheries. ICES Journal of Marine Science, 67: 165-175.

[DKP] Dinas Kelautan dan Perikanan Kabupaten Demak. 2021. Kebijakan Pengelolaan Rajungan di Kabupaten Demak.

Effendie, M.I. 1997. Biologi Perikanan. Yogyakarta. Yayasan Pustaka Nusantara. 163 hlm.

Ernawati, T., D. Kembaren, K. Wagiyo. 2015. Penentuan status stok sumberdaya rajungan (*Portunus pelagicus* Linnaeus, 1758) dengan metode spawning potential ratio di perairan sekitar Belitung. Jurnal Penelitian Perikanan Indonesia, 21(2): 63-70.

Ernawati, T., B. Sumiono, H. Maddupa. 2017. Reproductive ecology, spawning potential, and breeding season of blue swimming crab (Portunidae: *Portunus pelagicus*) in Java Sea, Indonesia. Biodiversitas, 18(4): 1705-1713.

Fatmawati. 2009. Kelimpahan relatif dan struktur ukuran rajungan di daerah mangrove Kecamatan Tekolabua Kabupaten Pangkep, Essay. Faculty of Fisheries and Marine Science, Universitas Hasanudin, Makassar.

Kembaren, D.D., T. Ernawati, Suprapto. 2012. Biologi dan parameter populasi rajungan (*Portunus pelagicus)* di Perairan Bone dan sekitarnya. Jurnal Penelitian Perikanan Indonesia, 18(4): 273-281.

[KKP] Kementerian Kelautan dan Perikanan. 2020. Kelautan dan Perikanan Indonesia dalam Angka. KKP, Jakarta.

[KKP] Kementerian Kelautan dan Perikanan. 2016. Peraturan Menteri Kelautan dan Perikanan Nomor PER.70/MEN/2016 tentang Rencana Pengelolaan Perikanan Rajungan di Wilayah Pengelolaan Perikanan Negara Republik Indonesia. KKP, Jakarta.

[KKP] Kementerian Kelautan dan Perikanan. 2017. Peraturan Menteri Kelautan dan Perikanan Nomor PER.50/MEN/2017 tentang Estimasi Potensi, Jumlah Tangkapan yang Diperbolehkan, dan Tingkat Pemanfaatan Sumber Daya Ikan di Wilayah Pengelolaan Perikanan Negara Republik Indonesia. KKP, Jakarta.

[KKP] Kementerian Kelautan dan Perikanan. 2020. Ringkasan Eksekutif tentang Strategi Pemanfaatan Perikanan (*Harvest Strategy*) Rajungan di Wilayah Pengelolaan Perikanan Negara Republik Indonesia (WPPNRI 712). KKP, Jakarta

[KKP] Kementerian Kelautan dan Perikanan. 2021 Peraturan Menteri Kelautan dan Perikanan Nomor PER.17/MEN/2021 tentang Pengelolaan Lobster (*Panulirus* spp.), Kepiting (*Scylla* spp.), dan rajungan (*Portunus* spp.) di Wilayah Negara Republik Indonesia. KKP, Jakarta.

Nontji, A. 1986. Laut Nusantara. Djambatan, Jakarta.

Palomares, M.L.D., D. Pauly. 2021. SeaLifeBase.ca World Wide Web electronic publication. www.sealifebase.org, version (12/2021).

Panggabean, A.S., A.R.P. Pane, A. Hasanah. Population dynamics and utilization level of blue swimming crab (*Portunus pelagicus* Linnaeus, 1758) in Jakarta Bay Waters. Jurnal Penelitian Perikanan Indonesia, 24(1): 73-85.

Prince, J., A. Hordyk., S.R. Valencia, N. Loneragan, K. Sainsbury. 2014. Revisiting the concept of Beverton – Holt life history invariants with the aim of informing data-poor fisheries assessment. ICES Journal of Marine Science, 72 (1): 194-203.

Prince, J., S. Creech, H. Madduppa, A. Hordyk. 2020. Length-based assessment of spawning potential ratio in data-poor fisheries for blue swimming crab (*Portunus* spp.) in Sri Lanka and Indonesia: implications for sustainable management. Regional Studies in Marine Science, 36: 1-13.

Rusfayani, M. 2017. Dinamika populasi dan status stok rajungan (*Portunus pelagicus*) di Perairan Kabupaten Rembang, Jawa Tengah. Essay. Faculty of Fisheries and Marine Science, IPB University, Bogor, 28 November.

Setiyowati, D. 2016. Kajian stok rajungan (*Portunus pelagicus*) di Perairan Laut Jawa, Kabupaten Jepara. Jurnal Disportex, 7(1): 84–97.

Sibagariang, O.P., Fauziyah, F. Agustriani. 2011. Analisis potensi lestari sumberdaya perikanan tuna longline di Kabupaten Cilacap, Jawa Tengah. Maspari Journal, 3(2): 24-29.

Suryakomara, A. 2013. Keragaan reproduksi rajungan (*Portunus pelagicus*) di Perairan Lampung Timur. Essay. Faculty of Fisheries and Marine Sciences, IPB University, Bogor, 3 Desember.

Soim, A. 1994. Pembesaran Kepiting. Penebar Swadaya, Jakarta.

Taurusman, A.A., B. Wiryawan, Basweni, Isdahartati. 2020. Dampak penangkapan terhadap ekosistem: landasan pengelolaan perikanan berkelanjutan. Albacore, 4(1): 109-118.

Wulandari, S.Y., M. Yusuf, Muslim. Kajian konsentrasi dan sebaran parameter kualitas air di Perairan Pantai Genuk, Semarang, Buletin Oseanografi Marina, 3(1): 9-19.

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