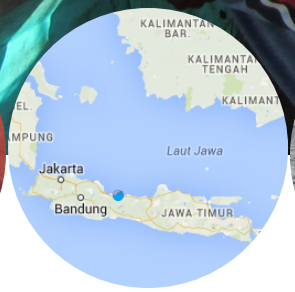


# REPORT 2014

## Stock Assessment, Fisheries and Environment Parameters for BSC (*Portunuspelagicus*) in the Java Sea

**Research Center for Fisheries Management and Conservation**
**and**
**Indonesian Blue Swimming Crab Association**

# RESEARCH REPORT

# Stock Assessment, Fisheries and Environment Parameters for BSC (*Portunus pelagicus*) in the Java Sea

Research collaboration
between

**Research Center for Fisheries Management and Conservation**
**and**
**Indonesian Blue Swimming Crab Association**

**Jakarta**

**2014**

## EXECUTIVE SUMMARY

Blue swimming crabs (*Portunus pelagicus,* BSC) in Indonesia is one of the marine crustacean species that have been exploited since decades, and it has grown rapidly in the last 10-15 years and in 2012 end up at the third of total foreign income after shrimp and tuna fisheries. The National capture fisheries statistics in 2011 showed that crabs contributed 44% (18,500 tons) of the total national production (42,000 tons).came from the Java Sea. Positive trends in crabs demand for exports has prompted an increase of the catch, which directed related to increase fishing activities. The resources is harvested early by bottom gillnet but lately dominated by collapsible traps. Recent study on stock status of BSC indicated that declining mean size and overfishing may occurred in some places such as in the northern of Java sea, and eastern of Sumatra. Therefore, initiating rational crab fishery management should be prepared in a sustainable manner. Updating stock status base on data assessment are required as a baseline to establish sustainable crab for fisheries management plan.

This report describe a reserach result of field base observation that carried out during 2014 through enumerator and onboard activities of the main BSC fishing base in the North coast of Java. Data and information on bio-exploitation and habitat observation were carried out in 2014 through several landing sites along the Coast of Java Sea. The width and weight frequencies, sex ratio and maturity stages were collected regularly supported with selected sampling through onboard small commercial fishing boat to describe to habitat and environment connectivity on their stock status. Analysis were determined by using a simple methods for tropical fish stock assessment and data poor fisheries approaches.

The results showed that there are slightly difference on length weight relationships, average size and growth rates, average length of first mature and spawning seasons among landing sites. Carapace width composition of BSC is classified into sizes by male and female. The analysed of sizes by males and females from some locations (Jakarta, Cirebon, Demak, Rembang, Sumenep and Sampit) showed that mean width males and females in Jakarta bay is the smallest. The Jakarta's crabs size is under size of ministry regulation that crabs allowed to catch is upper of 10 cm or 100 mm carapace width (Ministerial Decree No 1/ 2015). Crabs in the Jakarta bay mostly caught in area near of estuary. The growth rate (=K) of BSC in four locations have a fast growth. It's showed by (K) more than 1. The fast growth of BSC is indicating that BSC have a short lifespan. Carapace width frequency data by gears could be analysed to determine the mean carapace width at first capture (=$L_c$). The $L_c$ of BSC was variated in six locations landing site. The lowest $L_c$ of BSC (93.64mmCW) was obtained from bottom gillnet that landed the crabs in Jakarta bay and followed by dredge net in Cirebon waters (93.88mmCW). Meanwhile the highest $L_c$ (130.96 mmCW) was obtained from bottom gillnet in Sampit followed by collapsible traps in Demak waters (123.32 mmCW). The mean carapace width at first maturity (=$L_m$) can

be defined as the width at which 50% of all females are mature. The result of Lm in this research is variated.

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The lowest Lm (99.23 mmCW) of female crabs is landed in Cirebon and the highest (123.89 mmCW) is landed in Sampit.

Generally, the mean $L_m$ of BSC in north of Java sea that landed was 10.6 cm carapace width. From all locations in showed that always found the ovigerous crab in each months throughout the year. So, that spawning of BSC in Java Sea is happenned throughout the year. From four locations, showed the similarity of peak spawning season is occured in month of September, October and November.

The stock status of BSC by using length converted catch curve showed that exploitation rate (=E) of BSC in Cirebon and Sumenep is higher than 0.5. Result of analysis by Spawning Potential Ratio (SPR) methods showed from four locations (Cirebon, Demak, Rembang and Sumenep) were under 10%. Despite of that mean $L_m$ is equal to 10.6 cm. Its clarified the stock condition in those areas have been over exploited

The catch rates by mini bottom trawl in Cirebon and adjacent waters during July 2014 covered the depth less than 10m in the area of about 19 $km^2$ . The result that the lowest catch rate of about 50.45 kg/hr occured in the depth of 10m. While the highest catch rate was occurred at the depth of 6m was 319.44 kg/hr. The average of catch rates was 135.37 kg/hr. The average of density of BSC in Cirebon water was 81.11 $g/km^2$. Th catch composition showed that The most dominant catch was demersal fish of 29% and pelagic fish of 27% from total catch. Meanwhile, crabs as second dominant group (17.1%) followed by Holothuroids 7.7%, Cephalopods 5.2%, shrimps 4.4% and others 7.1%. The ratio of BSC to other organisms as by catch was 1: 5.8. The estimated density of BSC in Demak and adjacent waters based on swept area methods indicated that the density of crabs was 50 $kg/km^2$ with density of *Portunus pelagicus* were relatively small of 29.2 $kg/km^2$. The composition of crab were dominated by genera of *Carybdis , Episesarma* and *Podophthalmus*.

Oceanographic parameters observation in Cirebon waters showed that the water salinity ranged of 29.0–32.5 ppt, sea surface temperature between 27.9 - 29.0$^oC$, transparency ranged between 0-6m. Survey at Demak in the water depth between 4-20m showed the transparency ranged of 1-9m, sea surface temperature were ranged of 28.5 – 31.0 $^oC$, water salinity ranged of 28.0 -33‰, pH ranged between 6.2 – 7.4 with dissolve oxygen ranged between 5.0– 6.0 ppm. Generally, the substrate type were fine mud.

Implementing regulation on minimum legal size of BSC in Java Sea still indicated that the low level of spawning stock ratio (10%) occurred in the area, this was not enough to support the recovery of the stocks. A larger minimum size (suggested at 11 cm) should be considered to maintain the recovery ability of the stock. The last period of inter-monsoon II (September to November) as the predicted peak of spawning season could probably the best period of initiating close season in the area.

CONTENTS

# 1. INTRODUCTION

## 1.1. Backgorund

Blue Swimming Crab (*Portunus pelagicus,* locally called as rajungan), provide one of the economically important fishery commodity in Indonesia, after tuna and shrimps. According to Kailola *et al*. (1993) and Ng (1998), the geographical distribution of Blue Swimming Crabs (abbreviated as BSC) are mainly found in Indo-Pacific, the Indian Ocean to the west and east Pacific Ocean waters. Sumiono (1997) and Sumiono *et al*. (2011) mentioned the BSC distributed in Indonesia are widely distributed from east coast of Sumatra, northern coast of Java, south and east Kalimantan, south eastern Sulawesi and south west Papua.

A comparative information stated that production of BSC from Java sea in 1990 contributed about 20% of total product of BSC in Indonesia. Recent preliminary survey in 2014 in north coast of Java indicated that Jakarta Bay and Cirebon were one of the largest significant BSC producer in north of Java. Other significant contributors such as Brebes, Rembang (central Java) and Sumenep (east Java) were also play a role as important landing sites for BSC in Java Sea.

In most landing places, these BSC directly delivered to a collector or a special agent from a certain BSC processing company. Some companies processed the BSC into meat canning for export purposes. Antara News (2008) stated that among the various species of crabs in Indonesia, *Portunus pelagicus* had been the highest value in skin-less frozen crab meat in canned product. The estimate economic value blue swimming crab third ranked of national expert after shrimp and tuna product with BSC export volume in 2012 approximately at 28.212 tons with projected value of 329 million USD (Fauzi, 2013). This indicates that BSC is one of main export commodity, while tuna and shrimp already been recognized as two major export commodities since last decades.

According to (FAO, 2011 *in* Chu *et al*., 2012), the annual trend of crab production in Indonesia fluctuated during 1970-2008. A significant increased production occurred between the years 1970-2004, then decline in 2004-2005 and increased again in the next following years. In 2008, the estimate crab production reached 34,000 tons, which contributed 20 % of global production in the world and placed a second producer after China.

Global policy in seafood sourcing (including crabs) should be covering safety, security and sustainability principles of the resources. The policy recognized at the world market level, as requested by Wall Mart, Costco Wholesale, Sam's Club Whole Foods Market and others (Crawford, 2013).

In 2020 buyers at the world level is projected to take delivery of crab products that eco-label certified or fulfill standard principle of Marine Stewardship Council (MSC). Eco-label certification system is one alternative of fisheries management practices that environmentally friendly, where the labeling of the fishery products produced stating that the sourced of product originally harvested from environmentally friendly and responsible and best practice resources management.

Eco-label certification system is a voluntary market mechanism, in a responsible information form that covering fishing ground, catching methods, post-harvest handling to the final consumer. In relation with crab behavior in the nature, which spend most of its lifecycle on the bottom, there are several type of fishing gears could operated its habitat. The common fishing gear are bottom trawl (locally : “arad”), bottom gill net (locally: “kejer”) and collapsible trap (locally:”bubu”). These gears were listed In the national capture fisheries data which consisted of collapsible traps, bottom trawl, fixed gill nets, three-layer gill nets and fishing platforms (DJCF, 2012).

According to Nomura (1974), and Sumiono & Widodo (2006) the effectiveness of different catch rate among fishing gears are different based on the gear design, materials and the operation methods. Fishing activities carried out in a relatively short time on each trip by small-scale fishers. Gates *et al*. (1993)

mentioned that the harvested crabs should be boiled within less than 2.5 hours after being captured for maintaining the quality of the meat.

The National capture fisheries statistics in 2011 showed that crabs contributed 44% of the total national production (42,000 tons). came from the Java Sea (18,500 tons ). Positive trends in crabs demand for exports has prompted an increase of the catch, which directed related to increase fishing activities. Collapsible trap is the dominant gear that currently being used for crab in the Java Sea.

Recent study on stock status of blue swimming crabs indicated that declining mean size and overfishing may occurred in some places such as in the northern of Java sea, and eastern of Sumatra. Therefore, initiating rational crab fishery management should be prepared in a sustainable manner. Updating stock status base on limited data assessment are required as a baseline to establish sustainable crab fisheries management plan. This report describe a reserach result of field base observation that carried out during 2014 through enumerator and onboard activities in one of the main BSC fishing base in north coast of Java.

### 1.2. Objectives

The main objectives of the activities are:

1. To measure individual width and weight frequencies, maturity stages and sex ratio for estimation of population parameters and biological reference points
2. To identify of type of fishing gear and fishing methods
3. To identify the densities, distribution of BSC and by-catch
4. To identify characteristics of the habitat and aquatic environments

## 2. MATERIAL AND METHODS

### 2.1. Data sampling

Research on the stock assessment and fishery of Blue Swimming Crab (*Portunus pelagicus* ) in the Java Sea conducted from January to December

2014. Research activities involved scientists from Research Center for Fisheries Management and Conservation (P4KSI), member of Association on Indonesian Management of Blue Swimming Crab (APRI) and enumerators staff. Regular biological sampling (monthly) were established through local enumerators in selected landing sites around of Java sea, i.e. Jakarta, Cirebon, Demak, Rembang, Sumenep and Sampit (Figure 1).

### 2.2. Data Collection

Monthly biological data collection of BSC were obtained from each landing sites. The number of samples in each landing sites collection minimum of 100 individual crabs per week (400 individual crabs per monh). Biological variables measured include: carapace width (mm) , individual weight (gr) and sex ratio. The gonadal maturity stages were identified by following Sumpton *et al* (1994 ). Catch and effort-data were collected from collectors or middlemen, include: catch composition, catch per trip (kg), number of trips and fishing gear used.

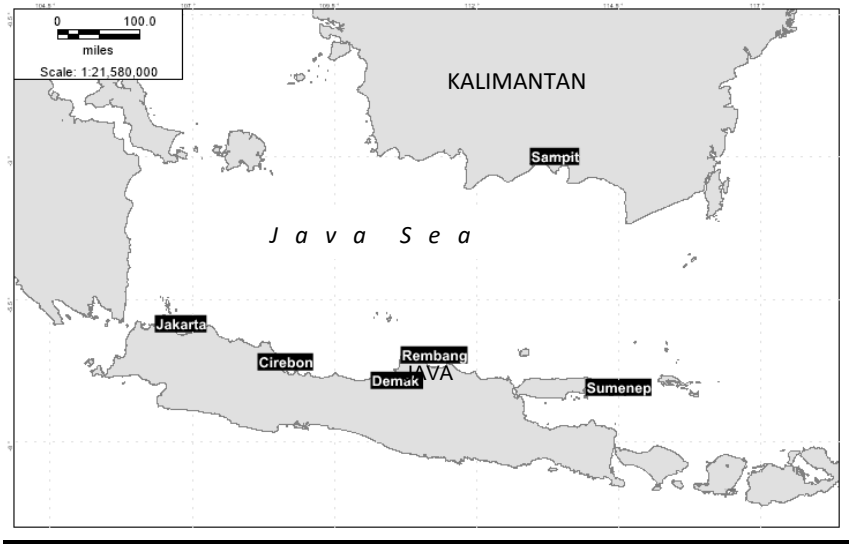



Figure 1. The location of BSC sampling site in the Java Sea

On-board observation in Cirebon and Demak and adjacent waters conducted by researchers from P4KSI by using mini bottom trawl, gillnet and collapsible trap. The purpose of mini bottom trawl used was associated with swept area method (Saeger *et al*., 1976) for calculating of stock densities. The data

collected include: catch composition, catch rates, operational aspects (geographical position, depth, time), substrat types and environmental parameters (water temperature, pH, salinity, water depth and transparency). The biological aspects of *Portunus pelagicus* were also measured.

### 2.3. Data Analysis

#### (1) Density and biomass

The calculation of stock density index analysed by using Saeger *et al*. (1976), as follows :

$$D = \frac{C/t}{a \times e}$$

$$a = \frac{v \times h \times E \times 1.852}{1000}$$

Where:

D = stock density (kg $km^{-2}$)

C/t = catch rate (kg per hour)

a = area coverage by trawl swept

e = escapement factor = 0.5 (Saeger *et al*., 1980 *vide* Sparre & Venema, 1999)

v = vessel speed (knot)

h = head rope opening (m)

E = head rope constanta = 0.5 (Pauly,1980 *in* Sparre & Venema, 1999)

1.852 = conversion mile to km.

Therefore to calculate the total biomass blue swimming crab in the waters are, as follows:

B = D x A

Where:

B = biomass (kg)

D = stock density (kg $km^{-2}$)

A = total area surveyed ($km^{-2}$)

## (2) Biological data analysis

Growth.

The growth parameters of BSC are determined by fitting the von Bertalaffy growth function $CW_t = CW_\infty * (1-e^{-k(t-to)})$ to the length frequency to the length frequency data using ELEFAN 1 incorporated in FiSAT II (Gayanilo *et al*., 2005) where $CW_t$ is the carapace width at the time t ; $CW_\infty$ is the asymptotic carapace width; k is growth coefficient; $t_o$ is the theory assumed carapace width at age 0.

Mortality

Natural mortality can be estimated using the empirical formula Pauly (Sparre & Venema, 1999) are as follows:

$$\text{Ln } M = -0.152 - 0.279 * \ln L_\infty + 0.6543 \ln K + 0.4634 \ln T$$

Where:

M = natural mortality
$L_\infty$ = asymptotic length
K = growth coefficient
T = average of water temperature ($^oC$).

Carapace width – weight relationship

Length – weight relationship of BSC is fitted using power regression for male and female BSC separately: $W = a*CWb$ for the carapace width with weight. Where CW is carapace width, a is anabonism and b is catabonism. The relationship of carapace width – individual weight of males and females is tested using t-test

Size at first maturity

Size at first maturity ($CW_{m50}$) of BSC is estimated by fitting a logistic curve to the relationship between proportion mature and size class $P = \frac{1}{1+e^{[-r(CW-CW_{m50})]}}$ (King, 1995) where P is the proportion mature and r is constant.

Size at first captured

Calculating the average size of crabs at first time captured ($L_{50}$) or Lc in the same gear as the trap trawl selectivity approach is to use the escape gap logistic function. The formula used is as follows

$$r(l) = \frac{\exp(a + bl)}{1 + \exp(a + bl)}$$

Where :

r(*l*) = opportunities crabs on certain size that retained

*l* = carapace width of crabs that captured

a & b = selectivity curve parameters (a<0 and b>0), so the carapace width at 50% retained, $L_{50}$ or Lc will be: $L_{50}$ = -a/b

**(3) Stock status and exploitation rate**

The exploitation rate (E) of BSC was calculated by the following equation of E = F/(F+M). A stock has over exploited if *E>0.5* or under exploited if *E<0.5*. It's assumed that optimal exploitation (*E opt*) is 0.5. Using of *E ~ 0.5* as the optimum value exploitation of the stock is assumed if natural mortality could be equal with fishing mortality (F=M) (Gulland, 1971).

**(4) Spawning Potential Ratio (SPR)**

The spawning potential ratio is an index of the relative rate of reproduction in an exploited stock. The basic concept of SPR is a proportion of the unfished reproductive potential left by fishing pressure. By explanation, unfished stock and individuals in an unfished stock have an SPR of 100% ($SPR_{100\%}$) and fishing mortality decreases $SPR_{100\%}$ from the unfished level to $SPR_{X\%}$ (Prince et al, 2014). SPR method is recommended for applying to stocks in poor data fisheries (Brooks *et al*., 2010).

## 3. RESULTS AND DISCUSSIONS

### 3.1 Population Parameters and Biological Reference Points

### (1) Width-weight relationship

The individual width-weight relationships in population characteristics is in general of great importance for estimating to calculate biomass, to estimate edible meat from crabs of various sizes and to convert width into weight (Sukumaran & Neelakantan, 1997). There is a good relationship between width and weight, as also compatibility of fitting the cubic formula, $W = aL^b$ to the data, where *b* is close to three in isometric growth and *a* is a constant determined empirically (King, 2007). The study has indicated that males are heavier than females as also showed by (b) exponent of males is bigger than females (Table 1). The values for exponent (b) in the present study other than 3 ($b<3$ or $b>3$) indicate allometric growth.

Table 1. Carapace width-weight relationship of *Portunus pelagicus* by landing sites

| Sex | Variabel | Length-weight relationship ($W = aL^b$) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Jakarta | Cirebon | Demak | Rembang | Sumenep | Sampit |
| Male | a | 7.00E-05 | 4.00E-05 | 8.00E-06 | 2.00E-05 | 3.10E-03 | 2.00E-05 |
| | b | 2.9953 | 3.1058 | 3.4489 | 3.2800 | 2.2200 | 3.3100 |
| | $R^2$ | 0.9217 | 0.8653 | 0.9630 | 0.9320 | 0.8303 | 0.8830 |
| Female | a | 1.20E-04 | 6.00E-05 | 1.80E-05 | 1.00E-05 | 3.23E-02 | 5.00E-05 |
| | b | 2.8803 | 3.0234 | 3.2695 | 3.394 | 1.7118 | 3.0722 |
| | $R^2$ | 0.8714 | 0.8668 | 0.935 | 0.947 | 0.8311 | 0.81 |
| ALL | a | 1.00E-04 | 4.00E-05 | 1.00E-05 | 2.00E-05 | 1.07E-02 | 2.00E-05 |
| | b | 2.9304 | 3.1019 | 3.3474 | 3.201 | 1.9532 | 3.2211 |
| | $R^2$ | 0.8955 | 0.8678 | 0.9443 | 0.928 | 0.8092 | 0.8512 |

### (2) Width Composition

Carapace width composition of BSC is classified into sizes by male and female. The analysed of sizes by male and female from some locations (Jakarta, Cirebon, Demak, Rembang, Sumenep and Sampit) showed that mean width

male and female in Jakarta is the smallest in all locations (Table 2). The Jakarta's crabs size is under size of ministry regulation that crabs allowed to catch is upper of 10 cm or 100 mm carapace width (Ministerial Decree No 1/ 2015). Crabs in the Jakarta bay mostly caught in area near of estuary. According to Nitiratsuwan *et al*. (2010), crabs with size under 10cm of carapace width occupied around sea grass meadows and river mouths. In this case especially in Jakarta, it need a regulation on setting fishing areas that noticed life cycle of crabs or in accordance with conservation principle.

**(3) Growth**

The growth parameters ($L\infty$, K and $t_o$) were determined by following the method of ELEFAN II. The carapace width in the monthly modal distribution in each locations were tabulated to determine the growth parameters. The growth analysis was done in four locations (Cirebon, Demak, Rembang and Sumenep). The data from jakarta and Sampit were can not to analysed of growth parameters. It's caused, the data from Jakarta and Sampit are not countinously per month.

Table 2. Width composition male and female of BSC by landing sites.

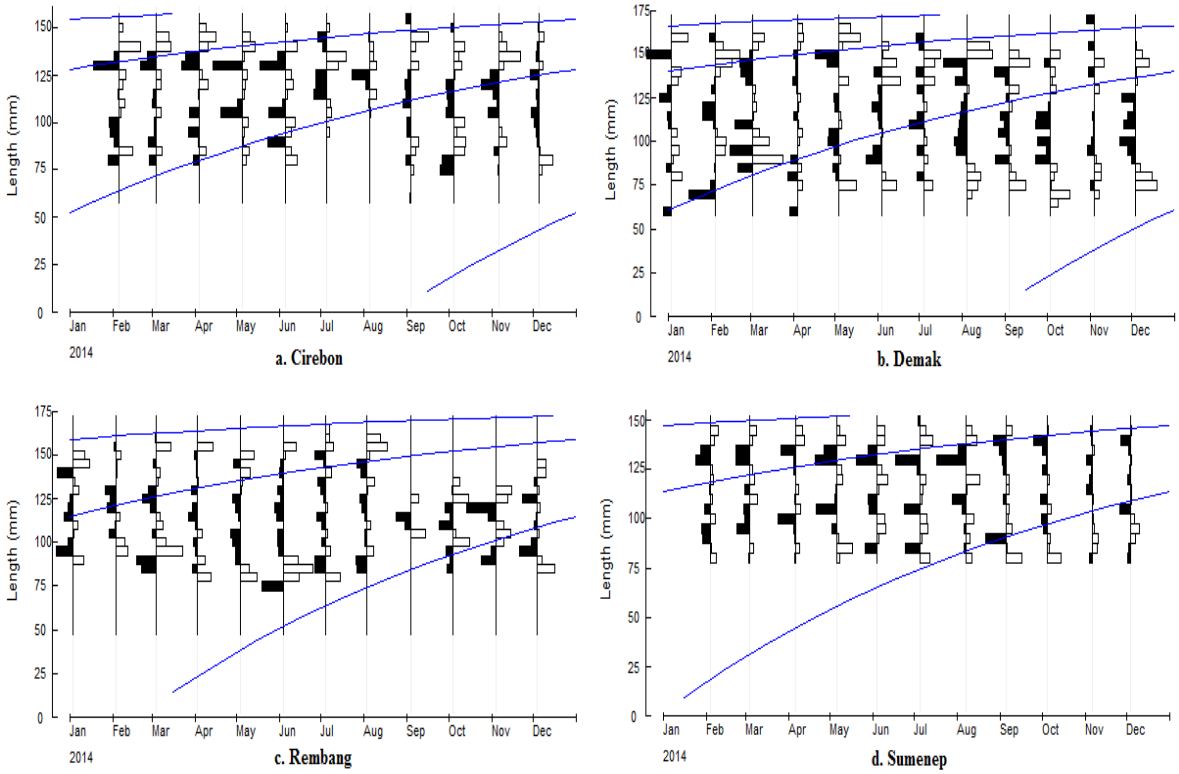
| Location | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | min | max | mean | min | max | mean |
| Jakarta | 73.4 | 152.0 | 95.3±10.73 | 69.1 | 122 | 94.5±11.43 |
| Cirebon | 71.1 | 151.3 | 111.60±11.64 | 60.0 | 152.6 | 108.08±14.66 |
| Demak | 58.8 | 168.4 | 110.35±18.06 | 40.4 | 166.1 | 112.56±18.21 |
| Rembang | 70.4 | 159.2 | 115.29±15.45 | 75.4 | 165.6 | 116.41±15.81 |
| Sumenep | 75.6 | 148.0 | 115.98±15.62 | 77.2 | 143.8 | 114.87±17.00 |
| Sampit | 87.0 | 165.0 | 134.63±14.73 | 90.0 | 183 | 131.96±14.32 |

The result of von Bertalanffy's growth parameters is showed in Table 3 and Figure 1. Parameters of growth in different locations indicated the variation results. It's showed that growth parameters are dynamic. This condition is influenced by the differences of enviroment oceanography and exploitation

rate. According to Beverton (1963) *in* Pauly (1980) that maximum carapace width ($L_{max}$) is generally achieved approximately 95% of asymptotic carapace width ($L_\infty$).

Table 3. The growth parameters of BSC by landing sites.

| Location | Growth parameters | | | |
|---|---|---|---|---|
| | $L_\infty$ (mm) | K (per year) | $t_o$ | $t_{max}$ (year) |
| Cirebon | 168.60 | 1.05 | -0.1040 | 2.86 |
| Demak | 179.35 | 1.11 | -0.1083 | 2.70 |
| Rembang | 178.80 | 1.18 | -0.1155 | 2.54 |
| Sumenep | 161.40 | 1.21 | -0.1219 | 2.48 |




Figures 1. Growth of BSC by monthly carapace width distribution in some landing sites

Based on the growth equation von Bertalanffy ($L_t = L_\infty\ (1\text{-}e^{[-K(t-to)]})$) can be made a relationship between carapace width and ages using age variation (t), where $L_t$ is the length at age *t*, $L\infty$ is the asymptotic width that species would reach if it lived indefinitely and K is growth coefficient which is a measure of the rate at

which maximum size is reached. The equation can determine the maximum age of BSC in each locations that are less than 3 years (Table 3). The growth curve of BSC is showed in Figure 2. The growth rate (K) of BSC in four locations have a fast growth. It's showed by (K) more than 1 (Sparre & Venema, 1999). The fast growth of BSC is indicating that BSC have a short lifespan.

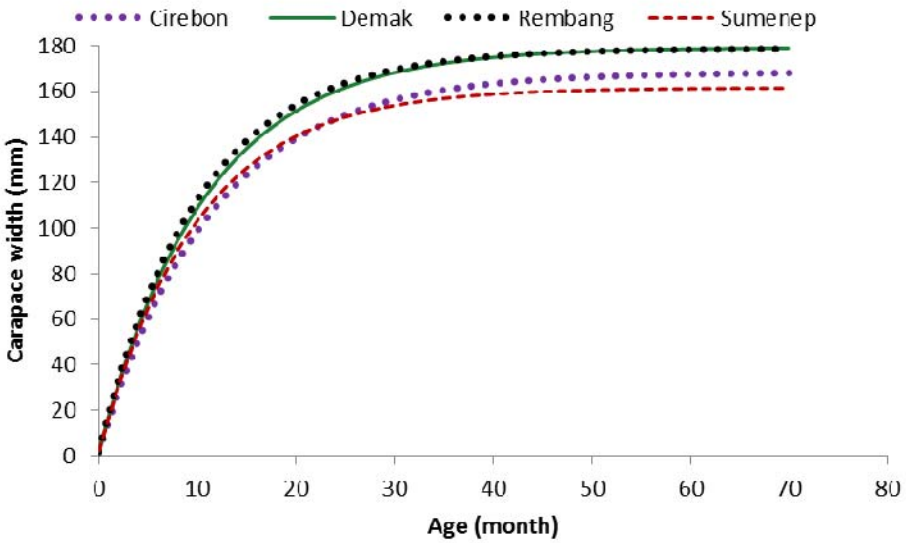



Figure 2. The Growth curve of BSC by landing sites

**(4) Width at first capture**

Carapace width frequency data by gears could be analysed to determine the mean carapace width at first capture ($L_c$). The $L_c$ is a chance of crabs has a 50% probability of being caught. Some gears are using to fishing BSC such as collapsible trap, bottom gillnet, mini bottom trawl and dredge net in some landing sites. The crabs are caught by collapsible trap is landed in Jakarta, Cirebon, Demak, Rembang and Sumenep. Bottom gillnet is using in Jakarta, Cirebon, Demak, Rembang and Sampit. The unenviromentally gears, such as mini bottom trawl and dredge net are using to catch the crab in Cirebon and Demak landing site. The $L_c$ of BSC was variated in six locations landing site. The lowest $L_c$ of BSC is obtained from bottom gillnet that landed the crabs in

Jakarta site and followed from dredge net Cirebon (Table 4). This is due to the fishing area of bottom gillnet (Jakarta) and dredge net (Cirebon) in both locations is around near-shore such as, estuary and mouth of river.

**(5) Carapace width at first maturity**

The mean carapace width at first maturity ($L_m$) can be defined as the width at which 50% of all females are mature. $L_m$ analysed is using to determine minimum legal size of crabs that must be caught. The result of Lm in this research is variated, but the lowet Lm of female crabs is landed in Cirebon and the highest is landed in Sampit. Generally the mean $L_m$ of BSC in Java sea that landed in some landing sites is 10.6 cm carapace width (Table 5).

Table 4. Mean carapace width at first capture of BSC by landing sites

| Location | Mean Length at first capture (Lc) in mm | | | |
|---|---|---|---|---|
| | Bubu lipat (*Collapsible trap*) | Jaring (Bottom *Gillnet*) | Arad (*Mini bottom trawl*) | Garuk (*Dredge Net*) |
| Jakarta | 100.21 | 93.64 | - | - |
| Cirebon | 109.01 | 107.22 | 108.52 | 99.38 |
| Demak | 123.32 | 101.34 | 105.43 | - |
| Rembang | 115.72 | 108.84 | - | - |
| Sumenep | 114.13 | - | - | - |
| Sampit | - | 130.96 | - | - |
| Mean | 112.5±8.6 | 108.4±13.9 | 107±2.2 | 99.38 |
| **Mean all** | | **109±10.2** | | |

Table 5. Mean carapace width at first maturity of BSC by landing sites

| Location | Mean length at first maturity (Lm/L50) |
|---|---|
| Jakarta | - |
| Cirebon | 99.23 |
| Demak | 104.89 |
| Rembang | 101.06 |
| Sumenep | 101.86 |
| Sampit | 123.89 |
| Mean | **106.2 ± 10.1** |

The result of $L_c$ and $L_m$ is identified that mean of $L_c$ is bigger than $L_m$. This showed that the mean crabs caught has carried out spawning. This conditon must be mantained to keep the suistainability BSC resources especially in Java Sea. In general, the mean crabs size caught in Java Sea is appropriate with

Ministry of Marine and Fishery regulation that contained in Ministerial Decree No. 1/2015 about minimum legal size of BSC, mangrove crabs and lobster.

**(6) Spawning season**

Plotting the percentage ovigerous female of BSC in some landing sites were observed throughout the year (Figure 3). Frequency distribution of ovigerous crab in Cirebon, Demak, Rembang and Sumenep is varied. Generally all locations in each months throughout the year are always found the ovigerous crab. So, we can said that spawning of BSC in Java Sea is happenned throughout the year. In tropical regions, *Portunus pelagicus* breeds throughout the year (Batoy *et al*., 1987). The peak of ovigerous percentage in each months can described of the peak spawning season. From four locations, the peak spawning season is occured at different months, such as Cirebon occurs in July to October; Demak occurs in March, August to November; Rembang occurs in September to November and Sumenep occured in May, June, September to November. However the similarity of peak spawning season in that locations is occured in month of September, October and November. It's almost the same in South Australia waters that the peak period for ovary maturation and spawning starts in October with peak proportion of ovigerous females occuring in November-December (Clarke & Ryan, 2004).

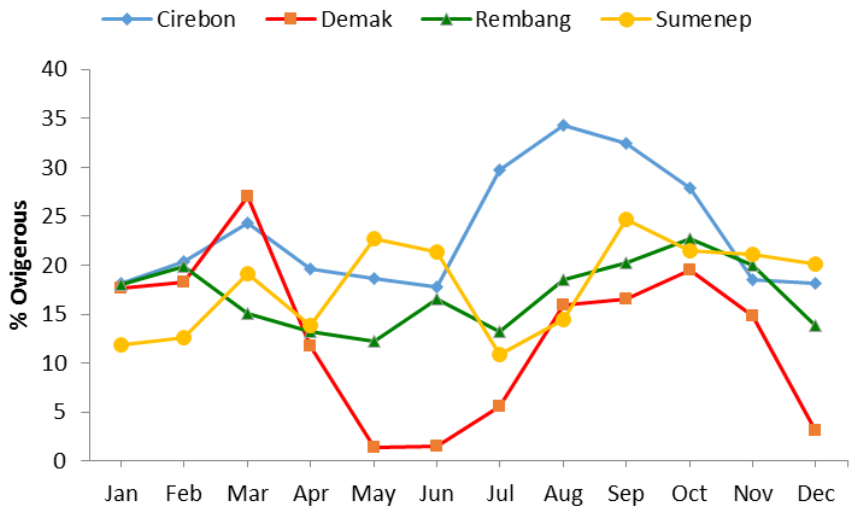



Figure 3. The precentage of ovigerous BSC by month, 2014

**(7) Stock Status**

In this research, the stock status of BSC is determined using by two methods including length and converted catch curve (LCCC) method and spawning potential ratio (SPR) method.

**Length and Converted Catch Curve (LCCC)**

LCCC method is analysed by using monthly carapace width frequency data. It's method can estimate the total instantaneous mortality coefficient (Z), natural mortality coefficient (M) and fishing instantaneous mortality coefficient (F). The result of mortality estimate in four location was varied (Table 6).

To obtained the exploitation rate (E) of BSC was calculated by the following the equation : E = F/(F+M). A stock has over exploited if *E>0.5* or under exploited if *E<0.5*. It's assumed that optimal exploitation (*E opt*) is 0.5. Using of *E ~ 0.5* as the optimum value exploitation of the stock is assumed if natural mortality could be equal with fishing mortality (F=M) (Gulland, 1971). The analysis result showed that exploitation rate (E) of BSC in Cirebon, Demak, Rembang dan Sumenep is higher than 0.5. So it can said the exploitation rate of BSC in all landing sites had been over exploited.

Table 6. Mortality coefficient and exploitation rate per year of BSC

| *Location* | *Mortality parameters & Exploitation Rate* | | | |
|---|---|---|---|---|
| | *Z (Total mortality)* | *M (Natural mortality)* | *F (Fishing mortality)* | *E (Exploitation Rate)* |
| Cirebon | 6.24 | 1.15 | 5.09 | 0.82 |
| Demak | 5.41 | 1.17 | 4.24 | 0.78 |
| Rembang | 5.49 | 1.23 | 4.26 | 0.78 |
| Sumenep | 4.65 | 1.26 | 3.36 | 0.72 |

**Spawning Potential Ratio (SPR)**

The spawning potential ratio is an index of the relative rate of reproduction in an exploited stock. The basic concept of SPR is a proportion of the unfished reproductive potential left by fishing pressure. By explanation, unfished stock and individuals in an unfished stock have an SPR of 100%

($SPR_{100\%}$) and fishing mortality decreases $SPR_{100\%}$ from the unfished level to $SPR_{X\%}$ (Prince *et al*., 2014). SPR method is recommended for applying to stocks in poor data fisheries (Brooks *et al*., 2010).

Result of analysis is showed in Figure 4. By plotting SPR and carapace width, it is obtained that SPR in each locations (Cirebon, Demak, Rembang and Sumenep) are under 10%. Despite of that mean Lm is equal to 10.6 cm. Its clarified the stock condition of BSC in Java sea have been over exploited.

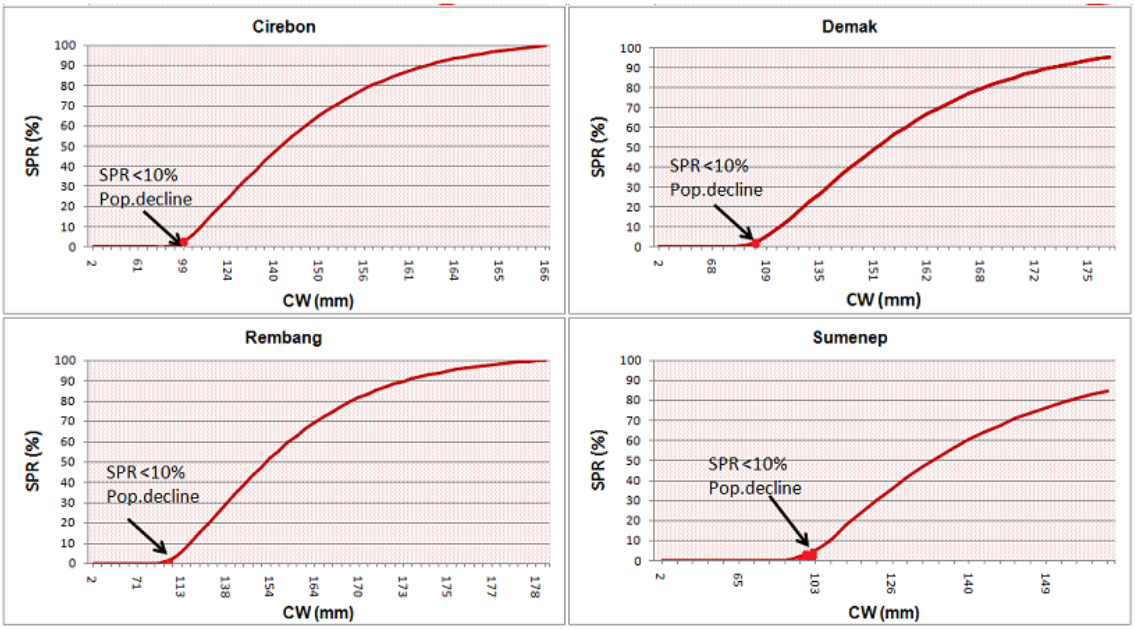



Figure 4. Observed relationship for BSC between SPR and carapace width

### 3.2. Fishing Gear and Fishing Methods

The type of gear for catching BSC in Java Sea commonly used in small-scale fishery are bottom gill nets, collapsible traps and mini bottom trawl other traditional gear such as dradge nets and bamboo stake trap nets. The most popular gear with BSC as a target species are bottom gillnet (local: *gillnet rajungan , jaring kejer*") and collapsible trap net (local: bubu). Meanwhile, BSC as a by catch in operating of mini bottom trawl (local: jaring arad). Collapsible trap has expanded rapidly in recent years along the north coast of Java. At present, most fishermen catch BSC by gillnet and traps with out-board fishing boat with 5 - 15 HP.

**(1) Bottom gillnet**

Gill nets are single-walled nets found in various mesh sizes. Fish (include crabs) of different body sizes get gilled or tangled into the netting when they try to pass through it. Trammel nets are included in this group. These are passive gear, but fish can also driven into gill nets. The most numerous of the bottom gillnet use of which is widespread to catch BSC. Usually, the netting material is monofilament with two of head ropes and ground ropes of polyethelene (PE). Most set gill nets are anchoraged or weighted to the bottom to catch demersal fish and BSC. In some locations, this gear increasingly are being displaced by trammel nets. Trammel nets consist of three layers of different mesh size. The two outside walls of netting have a mesh larger (4 inches) than the targetted fish or crab, and the interior netting has a smaller mesh size (usually 1.75 inches) The primary target species of this gear are shrimps and crabs as a a by-catch components.

Bottom gillnets are frequently operated in shallow waters with one piece of 60 to 80 m in length, and 5 m in depth, with mesh size of 3.5 inches. One unit of the gear consisted of 10 of piece of the nets. The unit 0f gillnet is shown in Figure 5. The fishing gears usually have one day–at sea for a fishing trip. Even two crews can manually deploy a gillnet or a trammel net from a small craft (< 5GT). Sinkers can be made of local materials such as cement or stones although manufactured equipment might be more efficient.

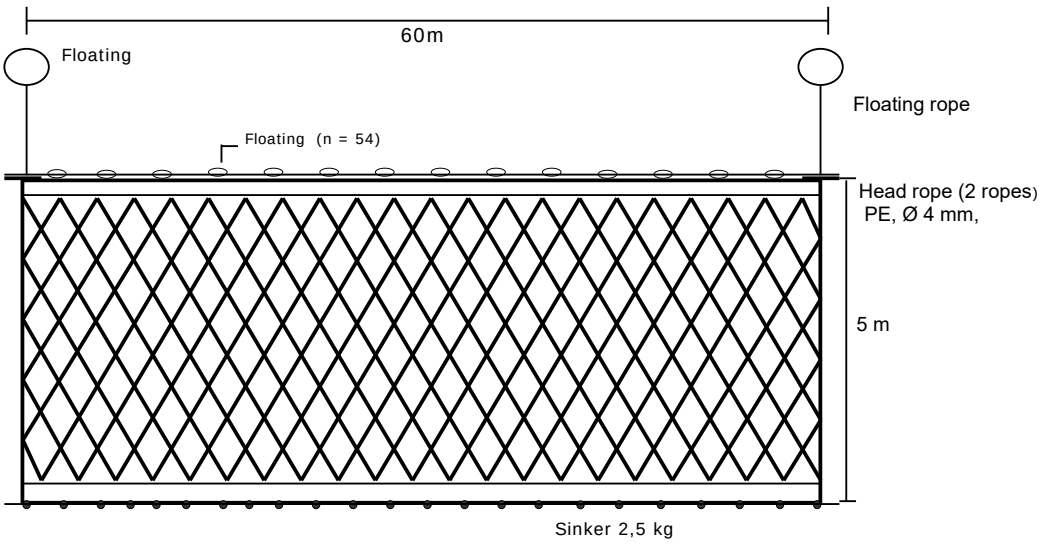



Figure 5. Construction of bottom gill net in Java Sea

**(2) Collapsible trap**

Traps are devices that fishes mor crabs enter in search of shelter or food. They are designed so that getting out is harder than getting in. Traditional techniques employing traps have developed with 2 funnels entries. An additional adventage of this fishing method is the high quality of the live catch. A box crab traps, made of wire mesh, are lined with boughs and are set out in long rows of 300-400 traps (Figures 6). The traps are checked every day or 7 days. It is fished in sandy bottoms in water depths between 20-50m and requires fish (usually oily fish) as a bait. The trap measures in sampling sites approximately 0.6m in length, 0.4m in width and 0,4mvin height and has 2 funnels openings (Figure 6).

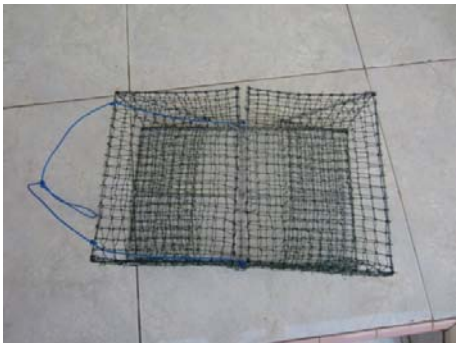


Figure 6. Collapsible trap for catching BSC in north of Java

**(3) Mini bottom trawl**

Mini bottom trawl is one of the fishing gear used for catching demersal and shrimps in Java Sea and crabs as a by-catch co4mponents. This active gear may be towed behind one boat. Two of otter board of 0.4 x 0.8m are require to open the net horizontally. The trawl net has a cod-end mesh size of 17-24m with 1,7m in length. The length of wing net is about 11m with mesh size of 24-45mm (Figure 7).

**(4) Dredge net**

Dredge net equipped with iron frames to keep the set bag open. The horizontal opening for these nets is provided by a beam made of iron or bamboo that can measure to 2m in length (Figure 8).

Such of gears operated to catch BSC in the water of Cirebon and Madura strait. Dredge net are used primarly to capture shell fish, demersal fish and BSC in the shallow water.

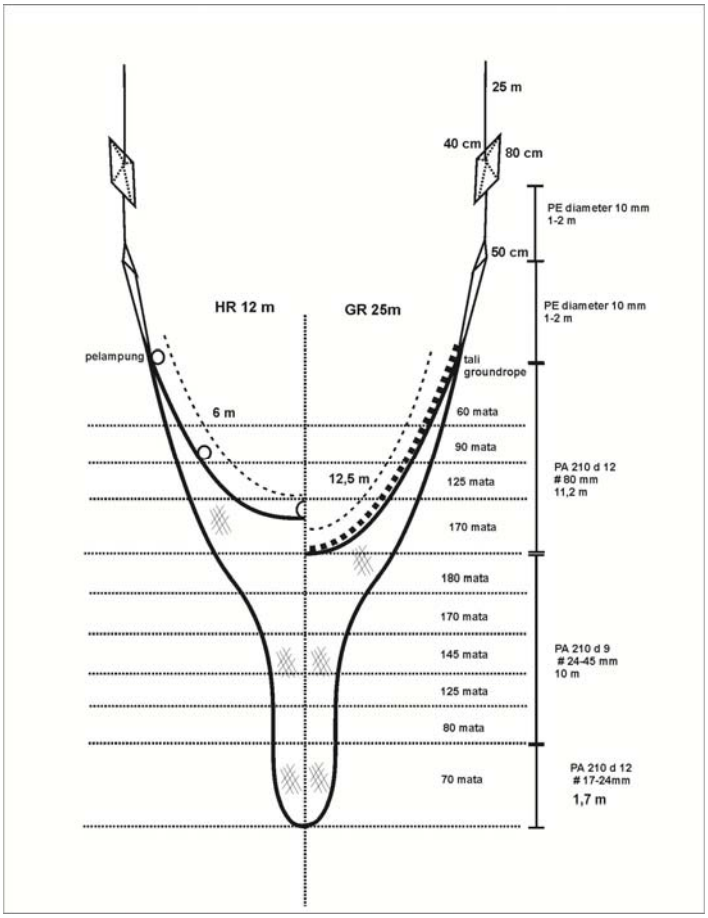



Figure 7, The construction of mini bottom trawl

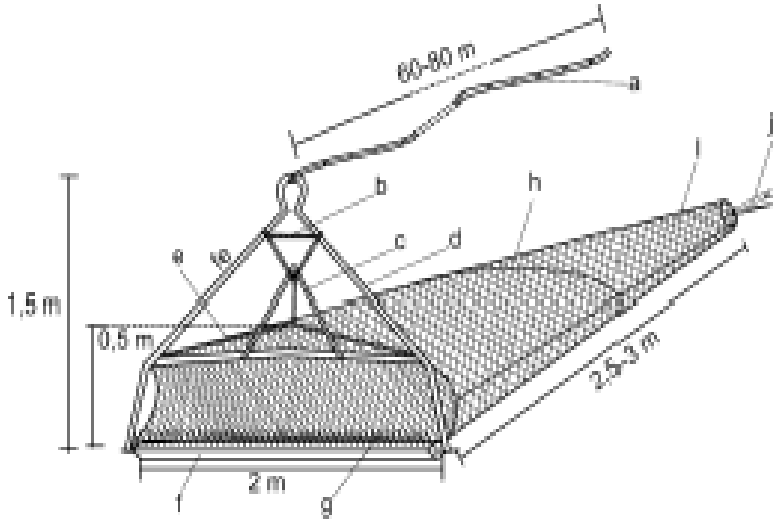



Figure 8, The construction of dredge net operated in Cirebon waters

### 3.3. Abundance and Stock Density

The independent survey uses a stratified random design to collect abundance and size-structure information from BSC populations. Strata are primarily defined by depth, shore type (overhanging or not), and bottom types. Fishing by mini bottom trawl was conducted in Cirebon and adjacent waters on July 2014 and Demak and adjacent waters on December 2014. The position of sampling stations were set up systematically along the latitude prior to each trawling station an oceanographic survey was carried out. In this station an equipment and water sampler were operated. The Niskin bottles sampler were used to collect samples of water for environment parameters analysis.

Following fishing operation, oceanographic measurement were carried out. Trawl net was towed in 1 hr duration at the vessel speed of about 3 knots. Fish catches were sorted and weighted. Sorting of fish and crabs were carried out whenever possible until species level, genus or family. The length and weight frequency measurements were done to some relatively dominant species

#### (1) Fishing in Cirebon waters

A total of 14 fishing, 8 oceanographic and larval stations has been completed in Cirebon waters. From total of 14 trawl stations, six stations should be considered unsuccessful haul. This was due to some technical problems occurred. The itinerary and daily activities of the vessel are shown in Table 7.

Table 7. Operational aspect of fishing in Cirebon and adjacent waters, July 2014

| | ST1 | ST2 | ST3 | ST4 | ST5 | ST6 | ST7 |
|---|---|---|---|---|---|---|---|
| Date | 15-Jul-14 | 15-Jul-14 | 15-Jul-14 | 15-Jul-14 | 15-Jul-14 | 16-Jul-14 | 16-Jul-14 |
| Start Position | | | | | | | |
| Longitude | 06°41'22"S | 06°42'54"S | 06°58'32"S | 06°38'24"S | 06°41'49"S | 06°47'45"S | 06°44'36"S |
| Latitude | 108°43'12"E | 108°39'23"E | 108°39'29"E | 108°42'50"E | 108°48'00"E | 108°48'00"E | 108°48'34"E |
| Depth (m) | 10 | 10 | 7 | 7 | 8 | 6 | 6 |
| Time (hr) | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 1 | 1 |
| Towing speed (knot) | 2.8 | 2.5 | 2.6 | | 2.5 | 2.3 | 2.1 |
| Total catch (kg) | 5.04 | 3.66 | 6.01 | 11.05 | 3.18 | 6.15 | 4.63 |
| Catch rate (kg/hr) | 10.08 | 7.31 | 12.02 | 22.10 | 6.36 | 6.15 | 4.63 |
| **CATCH COMPOSITION (Kg)** | | | | | | | |
| **Crabs** | **0.46** | **0.7** | **0.3** | **0.45** | **0.14** | **1.83** | **0.48** |
| **Demersal fish** | **0.996** | **0.92** | **0.67** | **2.6** | **1.68** | **0.42** | **1.79** |
| **Pelagis fish** | **3.2951** | **1.33** | **0.3** | **6.25** | **1.33** | **0.99** | **0.75** |
| **Gastropods** | **0** | **0** | **0** | **0** | **0** | 0.71 | **0.29** |
| **Molluscs** | | 0.495 | 0.62 | 0.25 | | 0.29 | 0.62 |
| **Shrimps** | **0.29** | **0.13** | **0** | **0.2** | **0.03** | **0.54** | **0.52** |
| **Others** | 0 | 0.08 | 4.12 | 1.3 | 0 | 1.37 | 0.18 |

Continued.

| | ST8 | ST9 | ST10 | ST11 | ST12 | ST13 | ST14 |
|---|---|---|---|---|---|---|---|
| Date | 41836 | 41836 | 41836 | 41836 | 41837 | 41837 | 41837 |
| Start Position | | | | | | | |
| Longitude | 06°43'08"S | 06°46'82"S | 06°46'28"S | 06°48'01"S | 06°40'08"S | 06°43'03"S | 06°44'54"S |
| Latitude | 108°45'04"E | 108°42'51"E | 108°43'24"E | 108°43'31"E | 108°46'82"E | 108°43'50"E | 108°47'02"E |
| Depth (m) | 8 | 8 | 10 | 4 | 8 | 8 | 8 |
| Time (hr) | 1 | 1 | 0.5 | 0.5 | 1 | 1 | 1 |
| Towing speed (knot) | 2.2 | 2.2 | 2.2 | 2 | 2.4 | 21.4 | |
| Total catch (kg) | 11.345 | 12.06 | 2.77 | 4.825 | 4.29 | 3.73 | 12.245 |
| Catch rate (kg/hr) | 11.345 | 12.06 | 5.54 | 9.65 | 4.29 | 3.73 | 12.245 |
| **CATCH COMPOSITION (Kg)** | | | | | | | |
| **Crabs** | 4.6 | 3 | 1.82 | 0.39 | 0.2 | 0.55 | 2.6 |
| **Demersal fish** | 4.28 | 4.13 | 0.56 | 2.755 | 2.41 | 1.11 | 3.36 |
| **Pelagis fish** | 0.57 | 0.57 | 0.08 | 0 | 1.44 | 0.95 | 6.1 |
| **Gastropods** | 0.13 | 0.06 | 0.05 | 0.51 | 0 | 0 | 0 |
| **Molluscs** | 0.72 | | | | | | |
| **Shrimps** | 0.61 | 1.1 | 0.18 | 0.36 | 0 | 0.56 | 0.125 |
| **Others** | 0.44 | 3.2 | 0.08 | 0.81 | 0.24 | 0.56 | 0.06 |

Fishing activities covered the depth range of 4m to 10m in the area of about 19 km$^2$. The daily sea weather conditions during this survey periods were mostly bright.Ffishing were carried out in the depth of 4-10m. The distribution of fishing were presented in Figure 9.

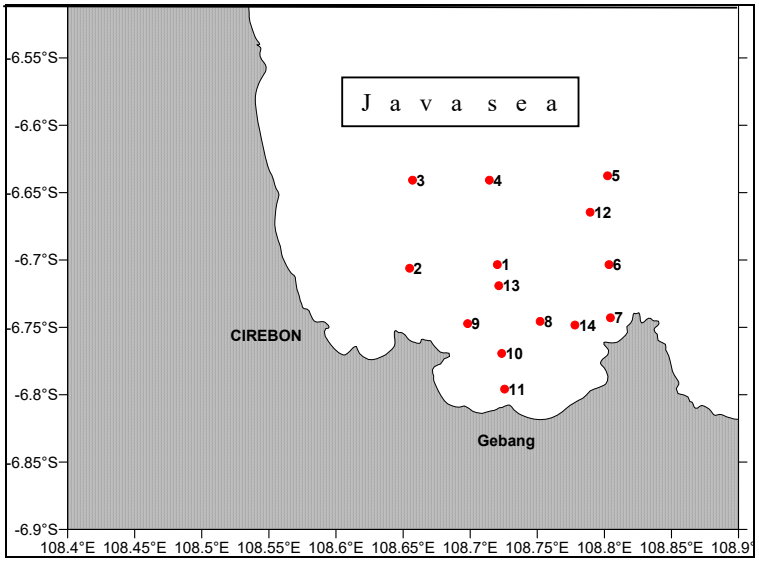



Figure 9. Distribution of trawl fishing in north coast Cirebon, July 2014

The estimated density of BSC in Cirebon and adjacent waters was calculated based on swept area methods, six sampling stations were conducted. Data indicated that there was no BSC at station 3, the estimate

average stock density of BSC was 81.11 kg/km$^2$. The estimate stock density of BSC by stations are presented in Table 8.

Table 8. Estimated catch rate and stock density of BSC in Cirebon and adjacent waters, July 2014.

| No | Latitude | Longitude | Towing (hours) | Catch (kg) | Catch rate (kg/hour) | Density (kg/km$^2$) |
|---|---|---|---|---|---|---|
| 1 | $6^0$46,305' | $108^0$44,305' | 0.75 | 100.47 | 133.96 | 100.47 |
| 2 | $6^0$46,724' | $108^0$45,090' | 0.83 | 42.04 | 50.45 | 42.04 |
| 3 | $6^0$45,649' | $108^0$44,303' | 0.83 | - | 0.00 | - |
| 4 | $6^0$45,657' | $108^0$44,111' | 0.92 | 104.23 | 113.71 | 104.23 |
| 5 | $6^0$46,584' | $108^0$43,342' | 0.47 | 90.85 | 194.68 | 90.85 |
| 6 | $6^0$47,167' | $108^0$43,558' | 0.47 | 149.07 | 319.44 | 149.07 |
| | | Total | 4.27 | 486.67 | 812.24 | 486.67 |
| | | Average | 0.71 | 81.11 | 135.37 | 81.11 |

Catch rate provide one of the index of abundance of crabs. From the Table 8 showed that the lowest catch rate of about 50.45 kg/hr was occurred at the station number 2. While the highest catch rate was occurred at the station number 6 was 319.44 kg/hr. The average of catch rates was 135,37 kg/hr. The average of density of BSC in Cirebon water was 81.11 g/km$^2$.

**Catch composition**

An approximately 486 kg of total catch of mini bottom trawl fishing during the cruise, Some of bony fish and elasmobranch, Cephalopod, shrimp, Holothuroids and crabs have been recorded. The most dominant catch was demersal fish and pelagic fish were 29% and 27% of total catch, respectifelly. Meanwhile, crabs as second dominant group (17,1%), followed by Holothuroid 7,7%, Cephalopods 5.2%, shrimps 4.4% and others 7.1%. From catch composition of mini bottom trawl operated in the water depth <10m resulted that ratio of BSC to other organisms as by catch was 1: 5.8.

The dominant catch of crabs was *Carybdis* spp. (90%), followed by *Portunus pelagicus* (2%) and *Portunus sanguinus* (5%).

Identifications of these species were carried out following Fisher & Whitehead (1974); Tarp & Kailola (1984); Carpenter & Volker (1998); Grey *et al*. (1983); Holthuis (1991).

During this survey, most of fish caught was dominated by demersal fish groups. Within this group the species of *Secutor ruconius, Leiognathus splendens* and *Gazza minuta* provide the most dominant. The second dominant fish group was pelagic fish, include *Anadontosoma chacunda*, *Stolephorus indicus* and *Alepes jedabba.* The shrimp groups were dominated by *Metapenaeus ensis* and *Trachypenaeus asper*. Other organism were *Pennatula aculeata* (Class Anthozoa), Sea star, Octopus and Jelly fish.

**(2) Fishing in Demak waters**

A total of 13 successful fishing station, 8 oceanographic and larval stations has been completed In Demak and adjacent waters. The itinerary and daily activities of the vessel are presented in Table 9. Fishing activities covered the depth range of 6m to 20m in the area of about 24 km$^2$. The distribution of fishing were presented in Figure 10.

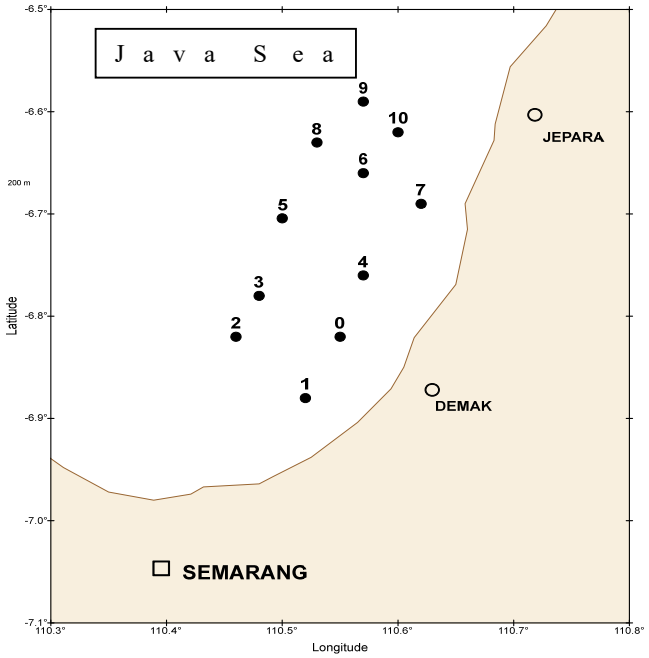



Figure 10. Distribution of trawl fishing in Demak waters, October 2014

Table 8. Operasional aspect of mini bottom trawl in Demak waters, October 2014

| PARAMETER | ST1 | ST2 | ST3 | ST4 | ST5 | ST6 | ST7 | ST8 | ST9 | ST10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | 08/10/2014 | 08/10/2014 | 08/10/2014 | | | 08/10/2014 | | 08/10/2014 | 09/10/2014 | 09/10/2014 |
| Position Latitude | 06°51'42"S | 06°50'58"S | 06°50'15"S | 06°47'30"S | 06°44'00"S | 06°47'23"S | 06°47'00"S | 06°48'16"S | 06°44'15"S | 06°43'28"S |
| Longitude | 110°29'42"E | 110°28'30"E | 110°28'48"E | 110°23'30"E | 110°25'10"E | 110°29'57"E | 110°29'30"E | 110°31'13"E | 110°32'10"E | 110°31'15"E |
| Depth (m) | 7 | 10 | 11 | | | 12 | | 5 | 4 | 14 |
| Time | 08:55-09:25 | 10:15-10:45 | 12:20-12:50 | | | 13:30-14:00 | | 07:00-07:30 | 07:10-07:40 | 08:30-09:00 |
| *Towing time* (hrs) | 0.5 | 0.5 | 0.5 | | | 0.5 | | 0.5 | 0.5 | 0.5 |
| Towing speed (knot) | 2.5 | 2.5 | 2.5 | | | 2.5 | | 2.5 | 2.5 | 2.5 |
| *Length of Head Rope* (m) | 5,4 | 5,4 | 5,4 | | | 5,4 | | 5,4 | 5,4 | 5,4 |
| Distance of swept area (Km) | 2.3 | 2.3 | 2.3 | | | 2.3 | | 2.3 | 2.3 | 2.3 |
| Luas Sapuan Area ($Km^2$) | 0.006 | 0.006 | 0.006 | | | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Catch rates (kg/hr) | 5,23 | 23,56 | 13,94 | | | 87,26 | | 4,92 | 15,16 | 4,62 |
| Total catch rates of crab (kg/hr) | 2,62 | 2,54 | 1,32 | | | 0,64 | | 1,8 | 2,04 | 0,4 |
| Total catch rates of BSC (kg/hr_ | 1,2 | 1,3 | 0,4 | | | 0,1 | | 0,6 | 1,46 | 0,36 |

| PARAMETER | ST11 | ST12 | ST13 | ST14 | ST15 | ST16 | ST17 | ST18 | ST19 | ST20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | 10/10/2014 | | | 10/10/2014 | 09/10/2014 | 09/10/2014 | | 10/10/2014 | 10/10/2014 | |
| Position Latitude | 06°42'15"S | 06°40'45"S | 06°37'30"S | 06°39'00"S | 06°39'45"S | 06°40'50"S | 06°38'45"S | 06°36'41"S | 06°35'45"S | 06°35'00"S |
| Longitude | 110°30'00"E | 110°28'00"E | 110°30'00"E | 110°33'30"E | 110°34'40"E | 110°35'45"E | 110°37'10"E | 110°34'42"E | 110°34'45"E | 110°31'30"E |
| Depth (m) | 20 | | | 14 | 10 | 6 | | 15 | 15 | |
| Time | 07:09-07:39 | | | 08:42-09:15 | 10:50-11:20 | 12:10-12:30 | | 11:45-12:15 | 10:28-10:58 | |
| *Towing time* (hr) | 0.5 | | | 0.5 | 0.5 | 0.3 | | 0.5 | 0.5 | |
| Towing speed (knot) | 2.5 | | | 2.5 | 2.5 | 2.5 | | 2.5 | 2.5 | |
| *Length of Head Rope* (m) | 5,4 | | | 5,4 | 5,4 | 5,4 | | 5,4 | 5,4 | |
| Swept area (Km) | 2.3 | | | 2.3 | 2.3 | 1.4 | | 2.3 | 2.3 | |
| Swept area ($Km^2$) | 0.006 | | | 0.006 | 0.006 | 0.002 | | 0.006 | 0.006 | |
| Total catch rates (kg/hr) | 4,3 | | | 5,64 | 7,14 | 2,26 | | 0,7 | 2,87 | |
| Total catch rate of Crabs (kg/hr) | 0,5 | | | 2,1 | 1 | 0,46 | | 0,1 | 0,53 | |
| Total catch rates of BSC (kg/hr) | 0,5 | | | 0,8 | 1 | 0,36 | | | 0,16 | |

The estimated density of BSC in Demak and adjacent waters was calculated based on swept area methods, 13 sampling stations were conducted as sucessful hauls. The estimate average stock density of BSC was 81.11 kg/$km^2$. The estimate catch rates of crab and BSC by stations are presented in Table 9. From this Table showed that the total catch rates of mini bottom trawl ranged of 0.7 to 87.26 kg/hr with average of 13.7 kg/hr. The catch rates of crabs were relatively small, ranged of 0.1 to 2.62 kg/hr with average of1.2 kg/hr.

Table 9. Catch rates of crabs and BSC caught by mini bottom trawl in Demak and adjacent waters, October 2014.

| STATION NO. | Total catch | Crab | BSC | Catch composition of Crab (kg/hr) | | | | |
|---|---|---|---|---|---|---|---|---|
| | (kg/hr | (kg/hr | (kg/hr) | *Episesarma sp* | *Charybdis affinis* | *Charybdis ferifiatus* | *Charybdis lucifera* | *Podophthalmus vigil* |
| 1 | 5.23 | 2.62 | 1.2 | 0.42 | 0.7 | tt | tt | 0.3 |
| 2 | 23.56 | 2.54 | 1.3 | tt | 0.44 | 0.3 | 0.3 | 0.2 |
| 3 | 13.94 | 1.32 | 0.4 | tt | 0.7 | tt | tt | 0.22 |
| 6 | 87.26 | 0.64 | 0.1 | tt | 0.04 | tt | tt | 0.5 |
| 8 | 4.92 | 1.8 | 0.6 | 0.2 | 0.7 | tt | tt | 0.3 |
| 9 | 15.16 | 2.04 | 1.46 | tt | 0.28 | tt | tt | 0.3 |
| 10 | 4.62 | 0.4 | 0.36 | tt | tt | tt | tt | 0.04 |
| 11 | 4.3 | 0.5 | 0.5 | tt | tt | tt | tt | tt |
| 14 | 5.64 | 2.1 | 0.8 | tt | 0.4 | 0.4 | tt | 0.5 |
| 15 | 7.14 | 1 | 1 | tt | tt | tt | tt | tt |
| 16 | 2.26 | 0.46 | 0.36 | tt | tt | 0.1 | tt | tt |
| 18 | 0.7 | 0.1 | tt | tt | 0.06 | tt | tt | 0.04 |
| 19 | 2.87 | 0.53 | 0.16 | tt | 0.21 | tt | tt | 0.16 |
| **TOTAL CATCH (kg)** | **177.6** | **16.05** | **8.24** | **0.62** | **3.53** | **0.8** | **0.3** | **2.56** |
| **Average** | **13.7** | **1.2** | **0.7** | **0.3** | **0.4** | **0.3** | **0.3** | **0.3** |

Catch rates of Portunus pelagicus ranged of 0.1 to 1.45kg/hr with average of 0.7 kg/hr). The distribution of BSC in Demak and adjacent waters are presented in Figure 11.

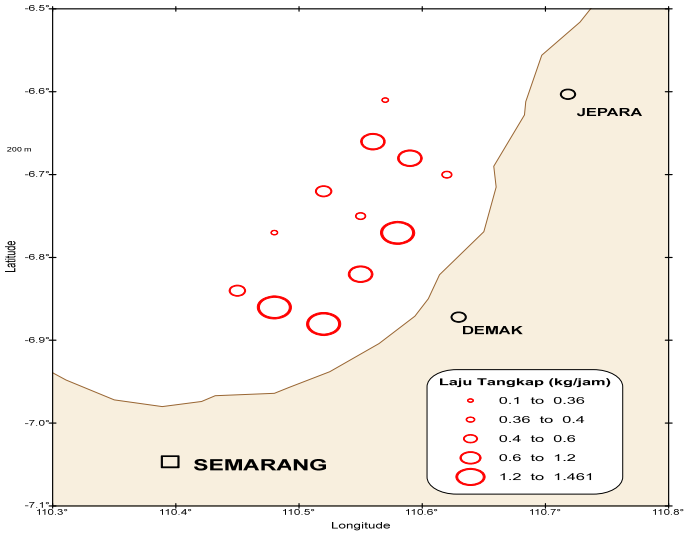



Figure 11. Distribution of catch rates of BSC by mini bottom trawl in Demak and adjacent waters, October 2014.

The estimated density of BSC in Demak and adjacent waters was calculated based on swept area methods, 13 sampling stations were conducted. The result indicated that the density of Crabs was 50 kg/km$^2$ with density of Portunus pelagicus relatively small was 29.2 kg/km2. The composition of Crab were dominated by genera of *Carybdis , Episesarma* and *Podophthalmus*.

### 3.4. Oceanographic Parameters

Observation in Cirebon waters predicted nursery ground indicated that the nursery ground has been determined based on the availability of juvenile caught by dradge net, with the depth of less than 10m. The results showed that salinity ranged at 29.0–32.5 ppt, surface temperature between 27.9 - 29.0$^o$C, transparency ranged between 0-6m (Table 10).

Table 10. Oceanography parameters in Cirebon and adjacent waters, July 2014

| Sta. | Depth (m) | Transparency (m) | Temperature ($^O$C) | | Salinity (‰) | | pH | | DO (ppm) | | Subtrate |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Surface | Bottom | Surface | Bottom | Surface | Bottom | Surface | Bottom | |
| 1 | - | - | - | - | - | - | - | - | - | - | - |
| 2 | 9 | 6 | 28.3 | 28.2 | 32 | 32 | 5.9 | 6 | 6.3 | 5.3 | Mud |
| 3 | 7 | 6 | 28.5 | 28.1 | 32 | 32 | 7 | 6.1 | 6.9 | 6.8 | Mud |
| 4 | 7 | 2 | 29 | 28.7 | 31 | 32.5 | 6.6 | 6.4 | 6.4 | 6.5 | Mud |
| 5 | 8 | 2 | 29.5 | 29 | 30 | 31 | 6 | 5.9 | 6.3 | 6.4 | Mud |
| 6 | 6 | 0 | 28.2 | 27.9 | 31 | 31 | 7 | 6.7 | 6.8 | 7.6 | Mud |
| 7 | 2 | 0.5 | 28 | 28 | 29 | 29 | 7 | 7 | 7.3 | 7.3 | Mud |
| 8 | - | - | | - | - | - | - | - | - | - | - |
| 9 | - | - | | - | - | - | - | - | - | - | - |
| 10 | 9 | 2.5 | 29.2 | 28.6 | 30 | 30 | 7.3 | 7.4 | 6.6 | 7.3 | Mud |
| 11 | - | | | | | | | | | | - |
| 12 | 8 | 3 | 28.3 | 28.2 | 31 | 32 | 5.5 | 6.6 | 8.6 | 8.7 | Mud |
| 13 | - | - | - | - | - | - | - | - | - | - | - |

Remarks; - : no data available

Survey at Demak in the water depth between 4-20m showed the oceanography parameters were as follows: transparency ranged of 1-9m, sea surface temperature were ranged of 28.5 – 31.0 $^o$C, water salinity ranged of 28.0 -33‰, pH ranged between 6.2 – 7.4 with dissolve oxygen ranged between 5.0– 6.0 ppm. The substrate type were fine mud (Table 11).

Table 10. Oceanography parameters in Demak and adjacent waters, October 2014

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8/10/2014 | 06$^0$51'42"S | 110$^0$29'00"E | 8:36 | 7 | 3.5 | 29.4 | ttd | 30 | ttd | 4.6 | ttd | 6.4 | ttd | 0.06 | 90 | Muddy |
| 8/10/2014 | 06$^0$50'58"S | 110$^0$28'30"E | 10:00 | 10 | 6.5 | 31 | 29.7 | 33 | 33 | 5.3 | 5.6 | 6.6 | 6.7 | 0.06 | 270 | Muddy |
| 8/10/2014 | 06$^0$50'15"S | 110$^0$28'48"E | 12:00 | 11 | 9 | 30.7 | 31.9 | 33 | 33 | 5 | 4 | 7 | 6.8 | 0.08 | 360 | Muddy |
| 8/10/2014 | 06$^0$47'27"S | 110$^0$29'43"E | 1:20 | 12 | 4 | 30.3 | 30 | 33 | 33 | 5 | 4.9 | 7 | 7.2 | 0.08 | 150 | Muddy |
| 8/10/2014 | 06$^0$48'30"S | 110$^0$31'30"E | 6:40 | 4 | 2 | 28.8 | ttd | 29 | ttd | 4.6 | ttd | 6.2 | ttd | 0.09 | 140 | Muddy |
| 9/10/2014 | 06$^0$44'20"S | 110$^0$32'15"E | 6:55 | 4 | 2 | 28.5 | ttd | 30 | ttd | 5.5 | ttd | 6.9 | ttd | 0.05 | 170 | Muddy |
| 9/10/2014 | 06$^0$43'28"S | 110$^0$31'15"E | 8:10 | 14 | 3 | 28.7 | 28.5 | 30 | 30 | 5.3 | 5.9 | 7 | 7.1 | 0.3 | 130 | Muddy |
| 10/10/2014 | 06$^0$42'15"S | 110$^0$30'00"E | 6:52 | 20 | 4 | 28.7 | 28.3 | 32 | 32 | 5.7 | 4.7 | 7.2 | 7.3 | 0.4 | 150 | Muddy |
| 10/11/2014 | 06$^0$39'00"S | 110$^0$33'30"E | 8:25 | 14 | 4 | 28.6 | 28.5 | 30 | 31 | 5.6 | 4.54 | 7.3 | 7.3 | 0.2 | 130 | Muddy |
| 9/10/2014 | 06$^0$39'45"S | 110$^0$34'40"E | 10:35 | 10 | 1 | 28.9 | 28.9 | 30 | 30 | 5.4 | 5.5 | 7.2 | 7.2 | 0.4 | 150 | Muddy |
| 9/10/2014 | 06$^0$40'50"S | 110$^0$35'45"E | 12:00 | 5.5 | 2 | 31 | ttd | 28 | ttd | 5.2 | ttd | 7.3 | ttd | 0.2 | 180 | Muddy |
| 10/11/2014 | 06$^0$38'15"S | 110$^0$36'50"E | 12:50 | 6 | 2.5 | 29.7 | ttd | 28 | ttd | 5.7 | ttd | 7.3 | ttd | 0.3 | 180 | Muddy |
| 10/11/2014 | 06$^0$36'41"S | 110$^0$34'42"E | 11:27 | 13 | 4 | 30.9 | 30.9 | 29 | 29 | 5 | 4.2 | 7.4 | 7.4 | 0.15 | 180 | Muddy |
| 10/11/2014 | 06$^0$39'00"S | 110$^0$33'30"E | 10:07 | 15 | 6 | 29.7 | 29.4 | 29 | 30 | 5.7 | 4.7 | 7.4 | 6.4 | 0.2 | 160 | Muddy |

### 3.4 Harvest Control Rules Suggestion

An optimal harvest control rules for any fishery resources bases on fishery management purposes. The purpose of fisheries management is making sure of the sustainability stock and providing benefits to the people and economy. The form of fisheries management of BSC in Java Sea can be done by using harvest control rules (HCR) that appropriate and rational.

**(1) Closed area**

Fishing activity of BSC in near-shore (estuary, river mouth, near-mangrove) is obtained crabs with small sizes. Its sizes are below 10 cm of carapace width. Many crabs were caught identifying as juveniles. That's why it need a regulation on setting fishing areas that noticed life cycle of crabs or in accordance with conservation principle. The suggestion of this case is not allow to fishing BSC in nursery ground area as preservation stock. However, for the current time data requirement on this research needs to be improved.

**(2) Minimum legal size**

The Ministry of Marine and Fishery has issued regulation about minimum legal size for mangrove crabs, lobster and BSC which contained in Ministry Regulation no 1/2015. One of regulation for BSC is not allowed to catch crabs with carapace width under size 10 cm. Exactly, by determined mean width carapace at first capture ($L_c$) is found out that mean crabs are approximately caugth in 10 cm sizes. However, based on SPR analysis result showed the SPR is under 10%, eventhough the mean Lm is 10.6 cm carapace width. It mean that BSC stock in Java sea had been endangered. To recovery the BSC stock in Java sea or increasing SPR on the level 10% as biological limit reference point is needed minimum sizes upper 11 cm. While, to reach SPR on the level 20% as biological sustainability is needed minimum sizes upper 12 cm carapace width.

**(3) Closed season**

Closed season recomendation in the fishery management is to conserve a brood stock in large number in a year. Plotting the ovigeraous or beried female againts month can define this information. The peak ovigerous percentage in Java sea is generaly occured at September, Oktober and November. This is assumed that after couples days the ovigerous females will be hatch their eggs. This is estimated that three months (September, Oktober and November) as the peak spawning season and that months is suggested as closed season for BSC in Java sea. While, to minimize bias data and information it still required to improve the data, such as monthly sampling BSC larvae.

**(4) Return on ovigerous crabs**

Ovigerous crabs is a female crabs that brood on the hundred thousand into millions of egg. If that crabs are caught, wisely it is returned on back into the sea. By restricting of catching ovigerous females, it will surely guard long-lasting the crabs. The restricted had been regulated by Ministerial regulation no.1/2015.

## CONCLUSIONS

- Length-weight relationship indicates that there are slightly difference between sex and areas. This indicated that the healthy habitat and environment index were also varied among landing sites. The estimated width length of first capture ($L_c$) were varied among landing sites, the role of environment and fisheries typology could probably contribute to different values of its length.

- The largest mean width length at first capture occurred in Demak which collapsible traps is the major fishing ground, the smallest found in Jakarta with gill net and dredge net in Cirebon. Among four types of fishing gear, collapsible traps is the largest average crab caught in this area.

- The width of first maturity ($L_m$) at around 99 to 123 mm, the largest size of Lm occurred in Sampit (south of Central Kalimantan) probably due to low exploitation level and healthier habitat of this sub region of Java Sea.

- The average density of blue swimming crabs in the north coast of central Java were at 81 kg/km$^2$ (Cirebon) and 50 kg/km$^2$ indicated that low abundance occurred in this area. The spawning potential ratio indicated that the exploitation stages were in an average of 10%. This suggested that fishing intensity of most of sub region of Java Sea were already in heavily exploitation stages.

- Implementing regulation on minimum legal size still indicated that the low level of spawning stock ratio (10%) occurred in the area, this was not enough to support the recovery of the stocks. A larger minimum size (suggested at 11 cm) should be considered to maintain the recovery ability of the stock.. The last period of inter-monsoon II (September to November) as the predicted peak of spawning season could probably the best period of initiating close season in the area.

## RECOMMENDATIONS

- Recognizing the average largest width size caught by collapsible traps, the need to improve fishing tactic and strategy to ensure the sustainability as well as to consider the most acceptable fishing gear targeting blue swimming crabs.

- Considering a vast geographic area of the coastal water of the Java Sea, and variation of bio-exploitation information, this result should be treated as a preliminary one. We believe that further frequent observation through fisheries improvement project involving enumerating system on size distribution data by private sectors could play a significant contribution on long-term sustainable fisheries development plan.

- Taking into account that implementing the harvest strategy should followed by a phased approach, a public campaign with plain language on the need of maintain the spawning stocks should be widely acknowledge to all related stakeholders.

## ACKNOWLEDGEMENT

The tim acknowledge the in-kind contribution of Reserach Institue for Marine Fisheries (RIMF), Jakarta, during onboard observation, supporting technical staff and laboratory analyses. We also thank to Cirebon and Demak Fisheries Offices for their administrative support and permission on field observation. The significant contribution of fishers experience during fishing would not have been possible without their kind support and help. We would like to extend my sincere thanks to all of them. We are very grateful to APRI for their support as well as to provide the necessary operating funds about the project. Special thanks also to Prof. Dr. Hari Eko Irianto for his support on implementing public private partnerships on strengthening the research base assessment to initiate crabs fisheries management plan in the Java Sea.

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