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Stock Analysis of Kroyo Crab in Cirebon Waters, Gebang Mekar Village, Gebang District, Cirebon Regency

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Abstract: The development of crabs in Cirebon Regency is one of the important indicators in increasing fisheries production, the increase is based on the high market demand for crab commodities, especially kroyo crabs, causing an impact on the crab population. This research was carried out from February 2022 to March 2023 in 3 sub-districts, namely Suranenggala, Mundu and Gebang. This study aims to determine the stock of kroyo crabs which include carapace width and weight, growth, condition factors, mortality, and exploitation rate. The method used is direct observation of special fishermen catching kroyo crabs. The key crabs measured during the study amounted to 360 individuals with a carapace width range of male crabs of 27-44 mm and female crabs of 28-51 mm, with a frequency distribution of 8 class intervals from December 2022 to February 2023. Tools used to analyze stock conditions using the help of FISAT II and Microsoft Excel software. The first size results were caught in males (L50%=34,18mm) with more than half the asymptotic length (½L∞=23,75mm), while in females (L50%=41,08mm) greater than half the asymptotic length (½L∞=25,75mm). The carapace-weight width relationship of the male crab is W = 1,227L0,510 and the female crab W = 0,371L0,896. Conditions factors in male crabs (1,007) and females (1,008) have the same level of mon-decency. Growth equation of Von Bertalanffy male crab Lt=47,25[1- e(-0,79(t+0,179))] and female crabs Lt=51,45[1- e(-0,99(t+0,138))], So it can be stated that the growth of female crabs is faster than that of male crabs. In male crabs, the Total Mortality Rate (Z) was obtained at 2.99 per year, natural mortality (M) of 1.39 per year, and arrest mortality (F) of 1.60 per year. While in female crabs Z = 2.44 per year, M

= 1.57 per year, F = 1.60 per year. The exploitation rate (E) of male crabs was obtained at 0.54 per year and females at 0.35 which means that the capture of Charybdis anisodon waters is still a tendency of underfishing. The pattern of adding new male crabs in Cirebon waters has two peaks, namely in April and August, with female crabs in July. Based on the results of this study, it can be concluded that the stock condition in Cirebon waters is still in the category of suitable for fishing for fishermen.

Keywords: *Stock; Kroyo crab; growth; mortality; exploitation; Cirebon Regency*

INTRODUCTION

Crabs are crustaceans from members of arthropods. Crabs have an exoskeleton made of a cuticle layer which is a polysaccharide of chitin, proteins, fats, and minerals such as calcium carbonate. Most of the crab's body is protected by a carapace[1]. Crab is one of the important commodities in crustacean fisheries in Indonesia and is one of the mainstays in the fisheries trade besides fish, shrimp, lobster, and crab. Biologically, crabs have a long survival and can even be traded in living conditions in various regions and abroad. Crabs have a savory meat taste, contain many nutrients, and are highly marketable in living conditions[2].

The Cirebon Food Security and Fisheries Office recorded the length of the coast of Cirebon Regency is 77 km2, consisting of 8 districts crossed by the coast including Suranenggala District, Kapetakan District, Gunungjati District, Mundu District, Astanajapura District, Pangenan District, Gebang District and Losari District. The potential of fishery resources of Cirebon Regency is very broad ranging from fishing business activities, fish farming, fish processing and marketing, salt, and conservation can be found. The number of small fishermen was recorded at 17,965 people consisting of 16,241 full fishermen and 1,724 main part-time fishermen and the number of boats in Cirebon Regency was 6,794 units from 6,602 ships below 5 GT and 192 ships above 5 GT spread across 8 coastal districts (Kabupaten Cirebon dalam angka,2022) [3].

[1]Patricia Balaresque et al., "A Predominantly Neolithic Origin for European Paternal Lineages," *PLoS Biology* 8, no. 1 (2010): e1000285.

[2]Andina Ramadhani Putri Pane and Ali Suman, "Dinamika Populasi Dan Tingkat Pemanfaatan Kepiting Bakau (Sylla Serrata FORSKAL, 1775) Di Perairan Kepulauan Aru, Maluku," *BAWAL Widya Riset Perikanan Tangkap* 11, no. 3 (2019): 127–36.

[3] Yanfeng Wei et al., "The Impact of Oil Price Shocks on the US and Chinese Stock Markets: A Quantitative Structural Analysis," *Energy Reports* 10 (2023): 15–28.

Fisheries production in Cirebon Regency has increased after the Covid-19 pandemic was recorded in 2022 resulting in production of 71,636.33 tons an increase of 155 percent from 2019. The rate of fisheries production value also certainly increased with a value of Rp. 2,063,901,681,178.00 this was due to an increase in commodity prices driven by high market demand. Crab is one of the commodities with high production, this can be seen in 2022 producing 2,070.79 tons, or an increase of 133 percent when compared to production in the year of the Covid-19 pandemic of only 1,560.57 tons that can be produced. From the production data, crab commodities are among the highly relevant commodities in Cirebon Regency[4].

One type of crab that is often obtained by fishermen is the type of kroyo crab, kroyo crab is often obtained because it is a bycatch of main commodities such as crabs. Kroyo crab began to be in demand by the public because of the demand for crispy baby crab or seafood, so fishermen can sell it at a relatively good price. The increase in kroyo crab production has a positive influence on the income of small fishermen in Cirebon Regency, but it needs to be realized that the increase in demand for kroyo crab is always followed by pressure to intensify exploitation. If this continues, it is feared that sustainability could be disrupted and reduced stocks of kroyo crabs in Cirebon waters. Seeing the high potential of kroyo crabs, it is necessary to analyze the condition of kroyo crab stocks to determine the relationship between carapace width and weight, growth parameters, mortality rate, and exploitation rate as information material for the availability of kroyo crab resources in Cirebon waters [5].

Regional Geology

Classification and Morphology of Crabs

Crabs are a group of marine life that has very high diversity, such as in the Portunidae tribe often known as swimming crab "swimming crab". One of the clans of the very diverse Portunidae tribe is the genus Charybdis de Haan 1833. Charbydis is a small crab with a width ranging from 5 - 8 cm. Dark green and light purple on the upper surface, dark purple on the dorsal surface distal 4

[4]Ismatul Maulah, "Analysis of Customer Fisheries Business Development through Musyarakah Financing at Nusa Ummat Sejahtera KSPPS Losari Branch Office Cirebon Regency" (S1 Sharia Banking IAIN Syekh Nurjati Cirebon, 2022).

[5] Serhan Çiftçioğlu, Amin Sokhanvar, and Shawkat Hammoudeh, "Comparative Analysis of the Exchange Rates-Stock Returns Nexus in Commodity-Exporters and-Importers before and during the War in Ukraine," *Research in International Business and Finance*, 2023, 102152.

segments. The carapace has a light green to whitish color of the liver and epibranchial region. Charybdis has morphological characteristics on the forehead or "frontal" and the anterolateral edge of Charybdis is narrower than the widest part of the carapace. Charbydis has curved and sloping anterolateral edges and is equipped with 6 anterolateral teeth[6]. The morphological picture can be seen in (Figure 1).

Figure 1 Crab morphology

The easiest thing to identify this organism is the presence of spines on the posterior spine of the wrist bone on the fifth leg. The carapace of adult females usually measures 47-62 mm while adult males measure 74-83 mm wide. Smooth carapace; characterized by a faint protrusion of the transverse carapace, there are no frontal, cardiac, and mesobranchial protrusions; six frontal lobes, truncated median, in the lower plane, protruding outward laterally directed submedian, lateral obtuse triangular, separated from the submedian by a deep V-shaped groove; inner supraorbital lobe triangle, smooth ridge pad, blunt inner infraorbital lobe; Six *anterolateral* teeth, the first is obtuse triangular, the second is smaller than the third, the last is elongated and large, protruding sideways beyond the previous tooth.

Habitat and Behavior

Crabs are found under rocks and corals in the intertidal zone between 30-51 m deep. Crabs can compete with native crab species and cause change in a natural community. Crabs can also affect crab cultivation by replacing native species or reducing their numbers.

[6]William Poore et al., "Obesity and Its Impact on Kidney Stone Formation," *Reviews in Urology* 22, no. 1 (2020): 17.

According to[7], crab habitats usually consist of areas of mud or sand submerged in brackish water or calm sea water, such as lagoons, estuaries, and rivers close to the coast. The diet of crabs consists of different types of detritus, algae, and small *invertebrates* such as aquatic insects and worms. This food can be found on the bottom of the water or parts of the surface covered by aquatic plants. Crabs largely depend on their habitat, as a suitable habitat will provide shelter, a source of food, and a place to breed. Crabs tend to look for muddy, sandy places around brackish-waterlogged coastal areas to find food and protect themselves from predators. They also like the mangrove environment, because in the mangrove forest, various types of plants and marine animals are their food source.

Growth Pattern

According to Soetjiningsih, growth is a change in the size, number, size, or dimensions at the cell, organ, or individual level, which can be measured by weight (grams, kg), length (cm), bone age, and metabolic balance. Growth is a parameter that indicates the measure of length or weight in a certain period.

The growth of aquatic organisms including crabs is influenced by internal and external factors. Internal factors are heredity, sex, age, disease resistance, and ability to utilize feed. External factors are temperature, salinity, pH, and DO as well as the density and composition of proteins in the feed. According to Mustofa. Crab growth can be measured by several parameters, namely:

(a) Panjang Karapas (*Carapace Length/CL*)
The length of the crab carapace can be measured using a special bar. Carapace length is often used to measure the body size of kroyo crabs in growth and production studies.

(b) Berat Tubuh (*Body Weight/BW*)
The body weight of crabs can be measured using digital scales. The body weight of kroyo crabs is often one of the important parameters in measuring the production and yield potential of kroyo crabs.

(c) Volume Rekahan (*Crack Volume/CV*)
The crab's fracturing volume can be measured using a tool called a crack gauge. This parameter is often used in crab growth studies because it has a close relationship with the capacity of the crab's stomach chamber.

(d) Parameter Pertumbuhan (*Growth Parameter*)

[7]Cipta Afrilianti et al., "Deskripsi Dan Habitat Mycalesis Perseus Fabricius, 1775 (Rhopalocera: Nymphalidae) Spesies Kosmopolitan Di Gunung Tompotika, Sulawesi," *Natural Science: Journal of Science and Technology* 8, no. 2 (2019): 134–37.

Growth parameters are parameters that contain the basic growth values of crabs.

Mortality Rate and Exploitation Rate

Mortality is generally divided into two types, namely natural mortality (M) and capture mortality (F). Natural mortality is mortality caused by factors other than capture such as cannibalism, predation, stress at spawning time, and starvation of old age. Low natural mortality will be obtained in organisms that have a small rate of change coefficient value. Mortality due to fishing is the possibility of fish dying because, at any given time, all causative factors affect the population.

Based on research by Triyanto and Haryanti, the factors that affect crab mortality in the waters of Karimunjawa Jepara are crab size, season, and predation. The size of the crab has a significant influence on the mortality of the crab, where the larger the size of the crab, the lower the mortality. In addition, the season also has a significant influence on crab mortality with higher mortality occurring in the dry season compared to the rainy season. Predation is also a factor affecting crab mortality, where crabs that live in locations with more predators have higher mortality.

RESEARCH METHODS

Kroyo crab samples were collected from 3 (three) locations, namely Bungko Lor Village, Suranenggala District (6°54'64.83"S, 108°51'84.78"E), Citemu Village, Mundu District (6°76'5.54"S, 108°60'0.79"E), and Desa Gebang Mekar Kecamatan Gebang (6°81'46.33"S, 108°72'77.04"E) along the waters of Cirebon can be seen on (Gambar 1).

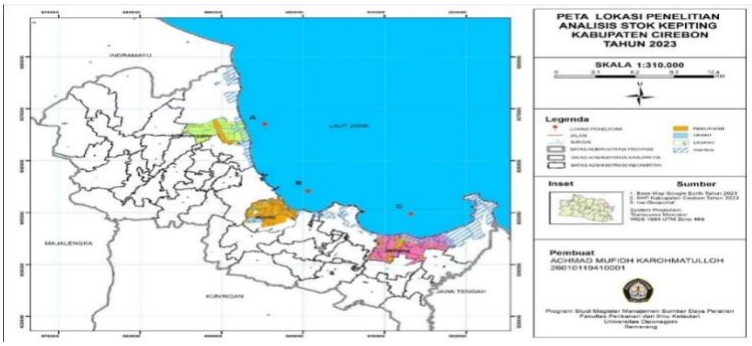

Figure 1. Sampling location

Sampling Techniques

Site surveys are carried out during the day to determine the place of sampling, the capture action is carried out at night when the low tide. The sampling technique starts with 1) Fish collection to be measured in length and weight is carried out at the place of mind, fish samples taken as many as 360 samples. The number of samples constitutes 2 – 5% of the total catch of fishermen landed;2) Measurement of the width of the crab carapaces carried out starting from the right and left ends of the carapace using a ruler that has a precision of 1 mm; 3) Measurement of the weight of Koryo crabs using digital scales with a weight of 0.5 grams; 4) From the results of measuring carapace width and weight of kroyo crabs then grouped according to their respective size groups according to predetermined class intervals.

The Relationship of Carapace Width and Crab Weight

According to [8]him, the analysis of the relationship of carapace width and weight is calculated using equations:

$W = a.CW^b$.....(1)

Where: W = body weight (gram); CW = lebar karpas (mm); a = constant atau intersep; dan b = exponent or tangential angle.

This equation can be solved through linear logarithmic transformations of the form log W = log a + b log CW. Thus this equation can be solved just like solving a regular linear equation. To determine whether or not there is a difference in the length and weight increase of male and female crabs in the same month, a covariance analysis is carried out according to Steel and Torrie's instructions (1980). The t-test of the b value against 3 aims to determine whether crab growth is classified as isometric or allometric. The hypothesis used in Ho: Nilai b = 3, then growth is isometric, and H1: Nilai b ≠ 3, then growth is allometric If b = 3, Then the growth is isometric, that is, the growth rate is wide, and the weight of the crab is the same. If it is not equal to 3, then the growth is allometric, i.e. allometric positive if b > 3 and allometric negative if b < 3.

Condition Factors

The calculation of the condition factor (*Ponderal Index*) is based on length and weight data, according can be formulated as follows:

Kn = W / W^ .....(2)

[8]F C Gayanilo, Per Sparre, and Daniel Pauly, *FAO-ICLARM Stock Assessment Tools: User's Manual* (Food and Agriculture Organization of the United Nations, 1996).

Where: Kn = Condition Factors; W = Actual average weight; and W^ = Average weight calculation (aL^b).
The value of the condition factor will be more important and more meaningful when compared between measures or between locations, because if you stick to only one FK value it does not mean much, or even does not exist[9]. The criteria for the condition factor value is if the Kn value is < 1 then the body condition is thin, if the Kn value = 1 then the ideal body condition, and if the Kn value is > 1 then the body condition is fat/plump.

Size First Caught

According to him[10], the average size of crabs caught is obtained by plotting the cumulative frequency with each length of fish, so that a standard logistic curve will be obtained, and the intersection point between the curve with 50% cumulative frequency is the length when 50% of crabs are caught. L50% analysis to determine the average size of crabs caught so that the basis for fisheries management that can be done can be done, especially related to the size of crabs that can be caught. Once the average size of the crab caught then L∞ (infinitive length), based on the maximum length of the crab in question. L∞ same as 1/0,95 X L∞, In general, it can be stated that if the average size is caught > from ½ L∞, Then it can be stated that the average size of crabs caught is quite large. Conversely, if it is smaller than L∞ Then the average size of crabs caught is too small, which can result in *growth overfishing*.

Growth Parameters

The calculation of growth patterns is carried out using the ELEFAN I (*ElectroLength Frequency Analysis*) method with the help *of the* FISAT II Software program developed in full by Gayanilo et al. (1996). CW∞ can be estimated using Pauly's (1984) formula as follows:

$CW\infty = CW_{max} / 0,95$.....(3)

Where: CW_{max} = The highest sample carapace width obtained by von Bertalanffy's growth pattern was thought to use ELEFAN-I on the *Response*

[9]Suradi Wijaya Saputra, Prijadi Soedarsono, and Gabriela Ari Sulistyawati, "Biological Aspects of Goatfish (Upeneus Spp) on Demak Waters," Journal of *Fisheries Science* 5, no. 1 (2009): 1–6.

[10]Saputra, Soedarsono, and Sulistyawati, "Biological Aspects of Goatfish (Upeneus spp) on Demak Waters."

Surface, namely by projecting several possible combinations of von Bertalanffy's growth parameters (CW∞ dan K) desirable. The main criteria for selecting the best combination of von Bertalanffy growth parameters is based on the ESP (Explained Sum of Peaks) ASP (*Available Sum of Peaks*) ratio criterion, which ranges from 0.0 to 1.0.[11] In the ELEFAN I program, the data used will produce troughs and peaks to guess the corresponding index (Rn) with the following formula::

$Rn = 10^{ESP/ASP}/10$.....(4)

Where: Rn=Conformity index; ASP=*Availbales Sum Peak*; andESP=*Explained Sum Peak*.

The formula of the growth pattern with the Von Bertalanffy model (Gulland, 1983) is:

$CW(t) = CW\infty (1-e^{-k(t-to)})$ .....(5)

To determine t_0 (the age of the crab at the time when the width of the carapace is equal to zero) according to [12] the empirical equation Pauly is used with the formula

$\log (-t_0) = 0{,}3922 - 0{,}2752 (\log CW\infty) - 1{,}038 (\log K)$ .....(6)

Where: CW(t)=Crab length at age t (years); CW∞=Long*asymptote*(cm) or *infinitive length;* K=Growth rate coefficient; t =Age of crab at a certain length; t_0=The lifespan of crabs at length 0; and e=Natural number.

Laju Mortalitas

Total mortality (Z) was analyzed with a catch curve approach with *the help of* FISAT II software, using the catch curve as an effect of the total mortality rate (Z). The functional relationship between Z and CW∞ is as follows:

$Z = K (CW\infty - CW) / (CW_c - CW)$ .....(7)

Where: CW=Average width of crab carapace; CW(c)=Lowest limit of carapace width interval; K=Coefficient of growth; and CW∞=Asymptote *carapace width or* infinitive *length.*

M (natural mortality) is calculated based on Pauly's (1984) empirical formula as follows:

[11]Daniel Pauly, *Fish Population Dynamics in Tropical Waters: A Manual for Use with Programmable Calculators*, vol. 8 (WorldFish, 1984).

[12]Saputra, Soedarsono, and Sulistyawati, "Biological Aspects of Goatfish (Upeneus spp) on Demak Waters."

Log M = -0,0066 – 0,279 Log CW∞ + 0,6453 Log K + 0,4634 Log T.....(8)
Where: M = Natural mortality; and T =Average temperature of Indonesian waters.
Capture mortality (F) can also be calculated by the following formula: Z = F + M F = Z - M.....(9)
Where: Z=Total mortality; F=Mortality from arrest; and M=Natural mortality.

Exploitation Rate

The value of the arrest rate is a comparison between the rate of death due to arrest (F) and the total death rate (Z).[13] The formula used is as follows: E = F/Z..... (10)
The hypothesis used is if: E > 0.5 then *overfishing;* E = 0.5 then MSY or optimal; and E < 0.5 then *underfishing*.

RESEARCH RESULT

Frequency Spread

The number of *Charybdis anisodone* samples obtained during the study from December 2022 to February 2023 was 360 samples, the data was obtained at 3 (three) research locations with compositions on male and female types. Measurement of frequency distribution values by collecting data and dividing it into classes (Figure 2).

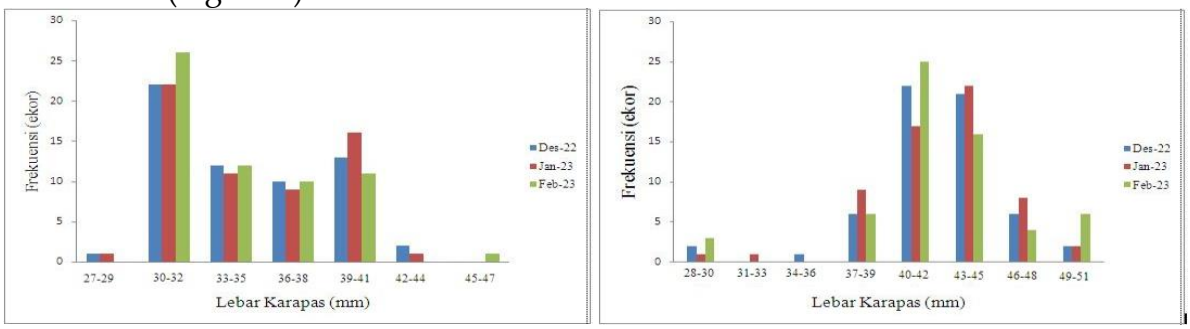

Figure 2. Graph of the results of the frequency distribution of male and female crabs in Cirebon waters from December 2022 to February 2023

The frequency distribution measurement in male size samples is divided into 7 class hoses with a lower limit ranging from 27 mm and an upper limit

[13]F C Gayanilo Jr, P Sparre, and D Pauly, "The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide," *FAO Computerized Information Series (Fisheries)* 8 (1996): 1–126.

ranging from 47 mm, where the dominance of the highest carapace width value at 30 -32 mm in December 2022 is 25%, in January is 25%, in February 2023 is 27%. Furthermore, the Female sample consists of 8 classes with a lower limit of 28 mm and an upper limit of 51 mm, where the highest value is on the carapace width class hoses of 40-42 mm and 43-42 mm, while the lowest values are on the carapace width class hoses of 31-33 and 34-36 mm.

The frequency distribution measurement in male size samples is divided into 7 class hoses with a lower limit ranging from 27 mm and an upper limit ranging from 47 mm, where the dominance of the highest carapace width value at 30 -32 mm in December 2022 is 25%, in January is 25%, in February 2023 is 27%. Furthermore, the Female sample consists of 8 classes with a lower limit of 28 mm and an upper limit of 51 mm, where the highest value is on the carapace width class hoses of 40-42 mm and 43-42 mm, while the lowest values are on the carapace width class hoses of 31-33 and 34-36 mm. From the frequency distribution data above, it is used to determine the analysis parameters. The parameter data of the relationship between width and weight are presented in (Table 1).

Table 1. Analysis Results The relationship between carapace width and weight

Parameter	**Male**	**Female**
N (Populasi)	180	180
an (*Intercept*)	1,277	0,371
B (*Slop*)	0,510	0,896
R^2 (Koefisien korelasi)	0,462	0,577

From the analysis obtained, it is known that the value of the coefficient (R2) in male samples of 0.46 shows that 46% of weight gain is caused by an increase in carapace width of 54%, then in female crabs it is known that the value of coefficient (R2) in female samples of 0.57 shows that 57% of weight gain is caused by carapace width increase which is 43% caused by other factors. The correlation value is known that the total carapace width of male and female crabs is directly proportional to the increase in crab weight. More details can be seen in (Figure3).

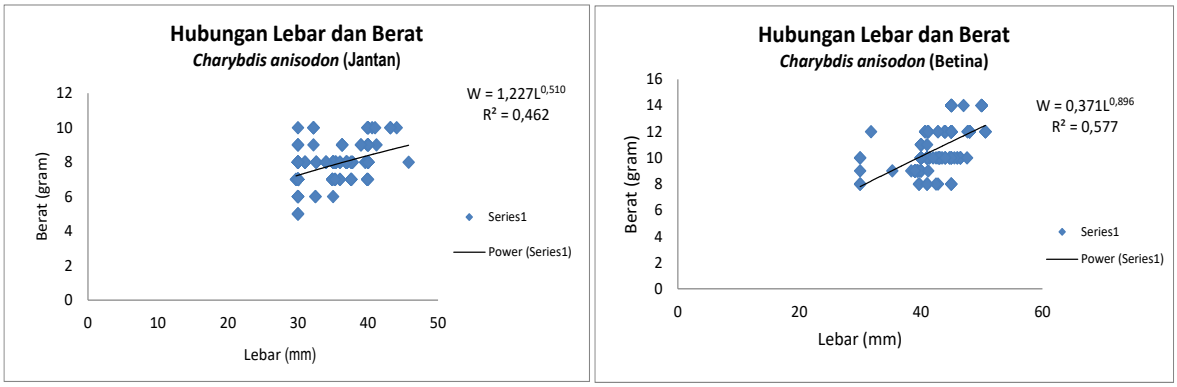

Figure 3. Draw the relationship between carapace width and weight

The value of the constant b (as an estimator of the degree of closeness of the relationship between the two parameters) shows that both male and female crabs have a slope value (b) less than 3, where crabs with a value of b less than 3 mean that the growth pattern is *negative allometric*, or it can be interpreted that the growth of carapace width of male and female crabs is faster than the growth in weight. The difference in crab growth patterns is caused by internal and external factors. These factors consist of the amount of food availability found in nature, aquatic environment, genetics, gonadal maturity level, and sex[14].

Condition Factors

The value of the condition factor obtained by each male and female crab in Cirebon waters varies. This value is used to see the shape of the body against the width of the carapace (plumpness). The results of the condition factor are presented in (Table 2).

Table 2. Condition Factor Parameters

Gender	Carapace Width Range (mm)	Average Carapace Width (mm)	Condition Factors
Male	27-47	34,76	1,007
Female	28-51	42,56	1,008

A condition factor value in crabs greater than 1.0 indicates that the crab is weighted and can be said to have better condition than crabs whose condition factor value is less than 1.0 in the same waters. The value of the condition factor obtained at 1.01 shows that the waters of Cirebon are quite good and of good

[14]John Alan Gulland, "Fish Stock Assessment: A Manual of Basic Methods," *(No Title)*, 1983.

quality and suitable for the growth of *Charybdis anisodon*. For more clear and detailed results the condition factors can be seen in (Figure 4).

Figure 4. Male and Female crab condition factor graph

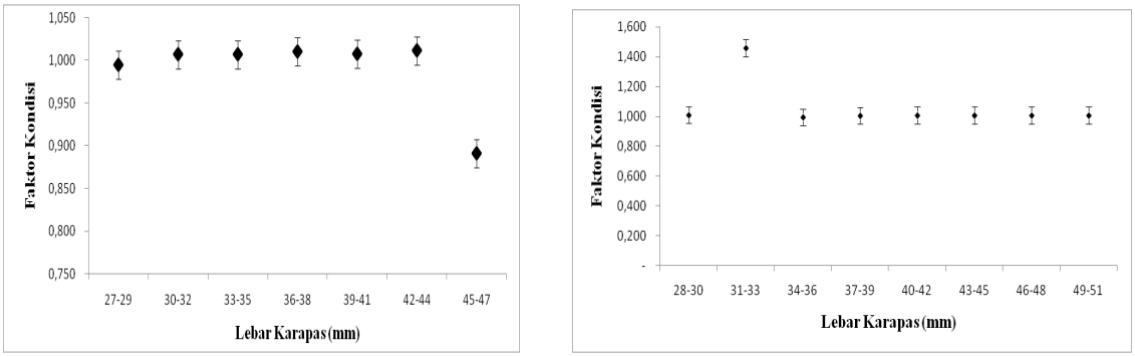

Figure 4. above illustrates the relationship between condition factors and crab size from the results of research in Cirebon waters, where there are known fluctuations and differences in each average size. Male crabs have the highest value in the carapace width range of 42-44 mm with a factor value of 1.011 and the lowest value in the carapace width range of 45-47 mm with a factor value of 0.89. Furthermore, female crabs obtained the highest value in the carapace width range of 31-33 mm with a factor value of 1.458 and the lowest value in the carapace width range of 37-39 mm with a condition factor value of 0.996. According to the variation in the value of the condition, the factor depends on the population density, the degree of maturity of the gonads, food, sex, and age of the fish. In this case, the value of crab factors in Cirebon waters is caused by environmental conditions, food availability, and the age of the samples used in the study.

Size First Caught ($Lc_{50\%}$)

Data collected during the study found that the carapace width range at the time of capture in male crabs had the lowest value of 29.7 mm (2.97 cm), and the highest value at 45.8 mm (4.58 cm) at the time of capture. Furthermore, females obtained the lowest value of 30 mm (3 cm) and the highest of 50.6 mm (5.06 cm). Referring to research Lasongko Bay, Central Buton, Southeast Sulawesi, the carapace width of male *Charybdis anticodon* ranged from 2.81 to 4.61 cm, and females at the time of capture ranged from 3.45 to 7.98 cm. The first time the size value is captured (Lc50%) is presented in (Figure 5).

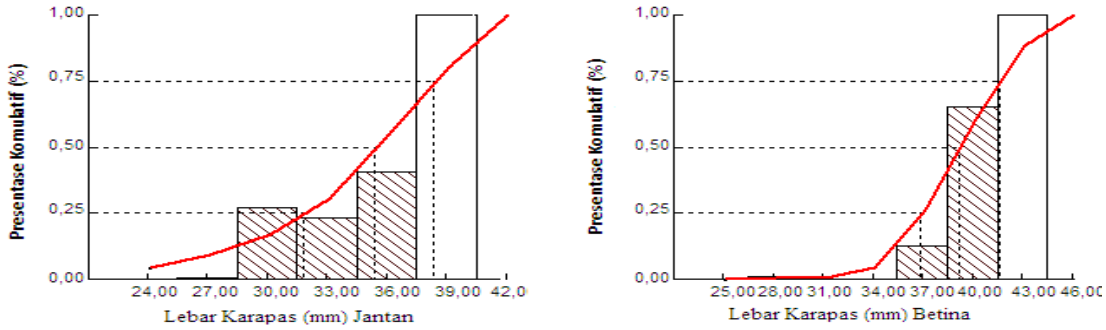

Figure 5. Size charts first caught

Infinity length in males (L∞) = 47.25 mm with a value of 1/2 L∞ = 23.75 and the size of first caught (Lc50%) of 34.18 mm. Furthermore, in the female sample, L∞ = 51.45 mm was obtained with a value of 1/2 L∞ = 25.72 mm, and Lc50% of 41.08. These results show the value of Lc50% > 1/2 L∞ which means the size of *Charybdis anisodone* is worth catching. It is assumed that *Charybdis anisodon* caught in Cirebon waters is still suitable to be caught and utilized by fishermen.

Growth Parameters

The results of calculating the estimation of growth parameters are presented in (Table 3)

Table 3. Growth Parameter Estimation Results

Parameter	Male	Female	Information
L∞	47,25	51,45	ELEFAN I in FiSAT II
K	0,79	0,99	ELEFAN I in FiSAT II
t_0	0,179	0,138	Pauly's formula (1984)
Lt	$47,25[1- e^{(-0,79(t+0,179))}]$	$51,45[1- e^{(-0,99(t+0,138))}]$	Von Bertalanffy's growth model

These values explain that if crabs in Cirebon waters continue to grow without death and are caught, the crabs can reach a length of 47.25 cm in males and 51.45 cm in females.

The increase in carapace width of male crabs was obtained by (K = 0.79) this value was interpreted as slower than in females (K = 0.99). According to Sparre, *et al.* (1999), crabs that have a growth rate or value of K coefficient ≤ 0.5 are categorized as crabs that are slow in growth, and crabs that have slow growth require a long time to reach their maximum length. More details can be seen in (Figure 6).

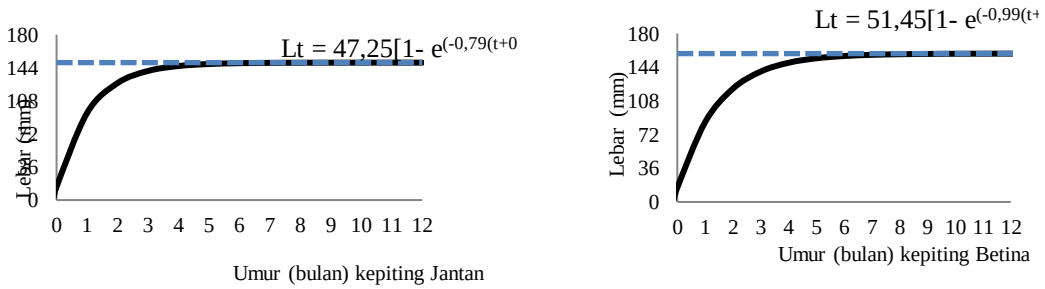

Figure 6. Growth curve between ages with crab carapace width

Based on (Figure 6) it is known that male and female crabs have a constant coefficient value which means that at first, the crab experiencing rapid growth, is 144 mm in size and 4 months old, but after that, there is no significant growth and stagnant growth.

Mortality Rate and Exploitation Rate

The results of calculating the mortality rate are presented in (Table 4)

Table 4. Mortality rate of male and female crabs

Parameter	Male	Female	Information
Z	2,99	2,44	Using curves based on length conversion in FISAT II
M	1,39	1,57	Using Pauly's formula (1984)
F	1,60	0,87	F=Z-M
E	0,54	0,35	E=F/Z

The value of suspected total mortality (Z) can be obtained using FiSAT II, the results were obtained in males at 2.99 per year and females at 2.44 per year. More details can be seen in (Figure).

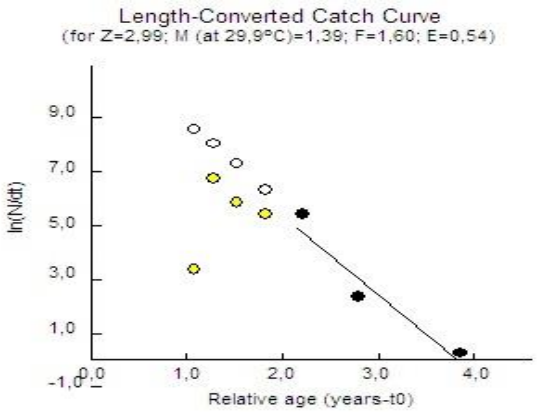

Figure 7. Mortality rate curve of male and female crabs

Furthermore, the estimation of the natural death rate (M) is obtained by Pauly's empirical formula (Spare, 1999) by entering the value L∞ = 47,25 mm, K= 0,79 per year, and T = 29.9oC with a natural mortality value **(M) of 1.39 per year for males.** As for females with values L∞ = 51,45 mm, K= 0,99 per year, and T = 29,9oC be obtained natural death value **(M) at 1.57 per year.**

The estimation of arrest mortality (F) is obtained from the calculation of F = Z-M, from this formula the capture mortality value (F) in males is 1.60 per year and in females is 0.87 per year. From these results, the natural mortality value (M) is higher than the capture mortality value (F), meaning that death in *Charybdis anisodone* in Cirebon waters is still dominated by natural and the capture is still categorized as minimal from the existing population.

The exploitation rate can be determined through a comparison of the death rate due to capture (F) and the total death rate (Z) or using the formula E = F / Z, assuming that if the value of E > 0.5 overfishing and E<0.5 *under fishing and E* = 0.5 MS. From the results of the research data, it was found that male Charybdis anticodon values of E = 0.54 per year and *females of E = 0.35* **per year**, **from these results it is known that the exploitation rate of** Charybdis**anisodone in Cirebon waters is still below 50% or it means that the fishing of** Charybdis anticodon *waters is still a tendency of* under fishing.

Recruitment Patterns

According to the explanation, recruitment is the addition of new members followed by a group which in fisheries is interpreted as the addition of new supplies that can be exploited followed by stocks that have long existed and are being exploited. Research on *Charybdis anisodone* in Cirebon waters was carried out for 3 months, to help analyze the use of Fisat II. The calculation results are presented in (Table 5)

Table 5. Male and Female crab recruitment percentage

Moon	Recruitment Percentage	
	Male	Female
January	1,67	6,02
February	1,57	7,08
March	3,14	7,86
April	6,54	**15,50**
May	9,77	13,97

Moon	Recruitment Percentage	
	Male	Female
June	17,16	9,44
July	**24,29**	13,98
August	21,01	15,48
September	13,02	5,16
October	1,19	4,46
November	0,65	1,06
December	0,00	0,00

From (Table 5) it can be seen that the presentation of male crab recruitment starts from May to July, with peak recruitment occurring in July **at 24.29%,** then female crabs experience 2 times the peak value, namely in April at 15.50% **and August at 15.48**%. The difference in the peak month of recruitment in females is due to the spawning cycle or seasonal patterns in Cirebon waters. For more details about the recruitment presentation, please see (Figure 8).

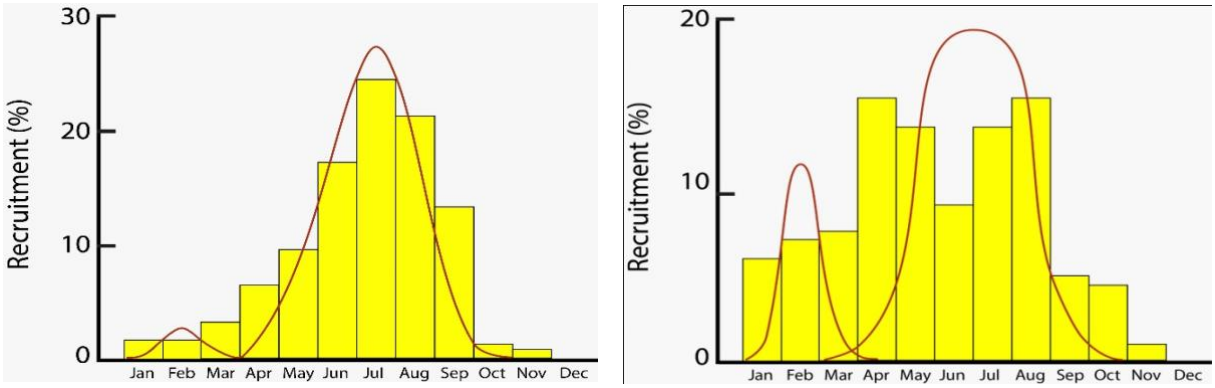

Figure 8. Charybdis anticodon*Recruitment Pattern*; (a) Male, (b) Female

The results showed that the recruitment of male crabs was less common than females. Peak recruitment estimation can be affected by maximum yield per recruit, catch mortality ratio, and spawning potential.

CONCLUSION

The key crabs measured during the study amounted to 360 individuals with a carapace width range of male crabs of 27-44 mm and female crabs of 28-51 mm,

with a frequency distribution of 8 class intervals from December 2022 to February 2023. Tools used to analyze stock conditions using the help of FISAT II and Microsoft Excel software. The first size results were caught in males (L50%=34,18mm) with more than half the asymptotic length (½L∞=23,75mm), while in females (L50%=41,08mm) greater than half the asymptotic length (½L∞=25,75mm). The carapace-weight width relationship of the male crab is W = 1,227L0,510 and the female crab W = 0,371L0,896. Conditions in male (1.007) and female (1.008) crabs have the same level of plumpness. Growth equation of Von Bertalanffy male crab Lt=47,25[1- e(-0,79(t+0,179))] and female crabs Lt=51,45[1- e(-0,99(t+0,138))], So it can be stated that the growth of female crabs is faster than that of male crabs. In male crabs, the Total Mortality Rate (Z) was obtained at 2.99 per year, natural mortality (M) of 1.39 per year, and arrest mortality (F) of 1.60 per year. While in female crabs Z = 2.44 per year, M = 1.57 per year, F = 1.60 per year. The exploitation rate (E) of male crabs was obtained at 0.54 per year and females at 0.35 which means that the capture of Charybdis anisodon waters is still a tendency of underfishing. The pattern of adding new male crabs in Cirebon waters has two peaks, namely in April and August, with female crabs in July. Based on the results of this study, it can be concluded that the stock condition in Cirebon waters is still in the category of suitable for fishing for fishermen.

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