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Growth, Mortality and Exploitation Rate of Spiny Lobster (*Panulirus Homarus*) from Kebumen and Cilacap Coastal

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Abstract. The southern coast of Java, including Kebumen and Cilacap coastal, has important commodities that have high economic value which is lobster. However, this economic value become a trigger for uncontrolled exploitation, whether the number of catches and their size. Monitoring the status of lobster resources is difficult to do due to inadequate quality of catch data. Another method needs to be done using better validity data by making capture and direct recording data. The aims of this study is to determine the growth, mortality and exploitation rate of spiny lobsters (*Panulirus homarus*) on the beaches of Kebumen and Cilacap. Periodic sampling by measuring carapace length was carried out at these two beaches from November 2017 to March 2018. Longer studies were not possible because outside these months spiny lobsters were caught in very small quantities. The growth of spiny lobster (*Panulirus homarus*) is done with the Von Bertalanffy growth model in the form of $L_t = L_\infty (1 - \exp(-K(t - t_0)))$, calculating growth parameters K , L_∞ used Elefan 1 in the FISAT II software. t_0 , Mortality and exploitation rates are calculated using Pauly's (1984) empirical formula. The results showed that successive growth parameters were as follows: $K = 0.1300$; $L_\infty = 116.55$; $t_0 = -0.1806$; $Z = 0.2823$; $M = 0.2655$; $F = 0.0167$ and $E = 0.0595$. The low level of exploitation indicates that the resources of spiny lobsters on both beaches have not experienced overfishing. However, based on the results of sampling of spiny lobsters, as many as 910, only 8.5% had carapace length more than 80 mm

1. Introduction

Growth and mortality are two important parameters that control the population and sustainability of marine resources, beside information of immigration, emigration and recruitment. A population increases due to recruitment, growth and immigration. And it will be reduced due to mortality and emigration. In order to maintain the sustainability of resources, it is necessary to conduct a study to estimate the value of the parameters, especially for species that have high economic value and high fishing intensity. This situation occurs in the species of crayfish or lobster. Results of discussions with local fishermen state that Spiny Lobster (*Panulirus Homarus*) was the main catch in Kebumen and Cilacap coastal, while the other species are caught in small numbers or are difficult to find. Lobster production in Kebumen coastal over a period of five years from 2012 to 2016 fell to a quarter (from 24.17 tons to 6.18 tons) while fishing trips almost doubled in that period (from 52.86 trips to 115.94) [1]. Similar events also occur in Cilacap, indicating that although fishing efforts are increased but will not increase production, even vice versa. The most likely cause is the decline in lobster resources due to high fishing activities, also known as overfishing.

Estimates of sustainable catch, have been carried out by several researchers [2], [3], [4] using the Schaefer surplus production method. The method is difficult to applied [3] because some assumptions



of the production surplus model are not fulfilled or the results are less convincing [2] because in the period of research for 6 years from 1998 to 2003 only the 1998 and 2003 periods the catch exceeds the estimated maximum sustainable yield (MSY). Other years are still under MSY estimates. Another approach needs to be taken to estimate the populations by calculating the parameters of a population, such as growth and mortality models both natural and fishing and exploitation rate.

2. Research Method

Sampling of spiny lobster has been done in Kebumen and Cilacap Coastal as shown in Figure 1,

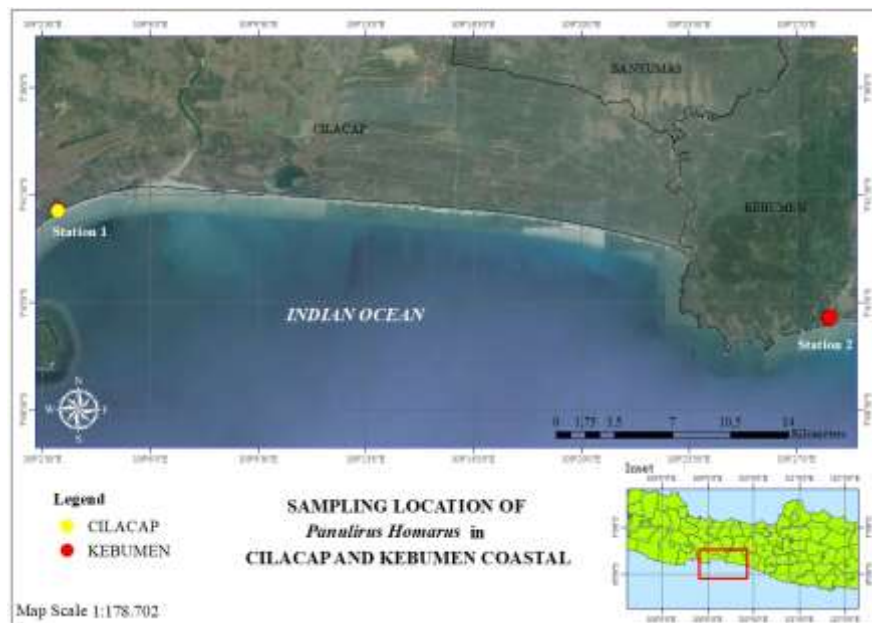


Figure 1. Sampling station of Spiny Lobster (*Panulirus Homarus*) in the Kebumen and Cilacap coastal.

Measurements of lobster carapace length were carried out for five months from November 2017 to March 2018. Carapace length measurements were carried out using a calipers run in mm. Spiny lobster sampling in Cilacap coastal uses surface gill net, while in coastal Kebumen using *krendet* (traditional fishing trap).

2.1. Growth Model

The growth models of spiny lobster base on the von Bertalanffy model [5], the mathematical model of von Bertalanffy equation is

$$L_t = L_{\infty} (1 - \exp(-K(t - t_0))) \quad (1)$$

Where :

- L_t = Length at time t (mm)
- L_{∞} = Asymptotic length (mm)
- K = Growth coefficient
- t_0 = Theoretical age at length equal to zero

The value of L_{∞} and K calculated using ELEFAN 1 in FISAT II Program launched by FAO. The value of t_0 was calculated using empirical equation of Pauly [6], as follows:

$$\text{Log } (-t_0) = 0,3922 - 0,2752(\log L_\infty) - 1,0380(\log K) \quad (2)$$

Then, all values that have been obtained for L_∞ , K , and t_0 are included in the Von Bertalanffy formula so that the equation and the growth graph are obtained. This is done to determine the growth of the length of the sand lobster during a certain age until it reaches its asymptotic length.

2.2. Total Mortality

The total mortality rate (Z) of the average size of the catch can be known if a large number of long frequency data is obtained from the stock with the existing fishing gear, so that the Z value can be estimated from the average length of lobster (\bar{L}) in each catch of the population Beverton and Holt [6] or can be formulated as follows:

$$Z = \frac{K(L_\infty - \bar{L})}{\bar{L} - L'} \quad (3)$$

Where:

Z = Rate of total mortality

L_∞ = Asymptotic length

K = Growth coefficient

\bar{L} = Average length of Lobster (mm)

L' = The smallest length lobster caught (mm)

2.3. Natural Mortality

The calculation of natural mortality value (M) is identified by the empirical formula of Pauly [6], but it is advisable also to take into account the habits of lobster are clustered natural mortality value multiplied by 0.8 so that species that gather the true value being 20% lower [5]. Following is the formula for calculating the value of natural mortality:

$$\ln M = -0,0152 - 0,279 \ln L_\infty + 0,6543 \ln K + 0,463 \ln T \quad (4)$$

$$M = 0,8 * \exp(\ln M)$$

Where:

M = Natural Mortality

L_∞ = Asymptotic length

K = Growth coefficient

T = Average surface temperature of water (°C)

2.4. Fishing Mortality

The total mortality (Z) is the sum of the value of natural mortality (M) and the value of fishing mortality (F), so that the value of F is obtained from the following calculation results:

$$F = Z - M \quad (5)$$

2.5. Exploitation Rate

Rate of exploitation (E) is ratio of fishing mortality (F) and total mortality (Z) [6] written as follows:

$$E = \frac{F}{F+M} \quad (6)$$

Where:

F= Fishing mortality

E= Exploitation rate

3. Results and Discussion

3.1. Length Frequency Data

The total number of sample of Spiny Lobster (*Panulirus homarus*) were 910. Carapace length was classified into 25 classes. The smallest Spiny Lobster (*Panulirus homarus*) was 18 mm and the biggest was 111 mm. Sampling duration was five months starting in November 2017 until March 2018 which is the season of spiny lobster at these two coastal areas. Before and after this duration only few spiny lobster available. Data were collected directly from the fisherman which sampling on 22nd every month.

Spiny Lobsters in Cilacap coastal were captured using surface gill net since this coastal has calm wave and Spiny Lobsters in Kebumen coastal was trap using *Krendet* tradisional fishing traps. Tabulated data as in Table 1 was then analyzed using Elefan I in Software Fisat II launched by FAO (Figure 2).

Table 1. Data Tabulation of Spiny Lobster (*Panulirus homarus*) from Kebumen and Cilacap Coastal.

Class	min	max	mean	2017		2018		
				Nov.	Dec.	Jan.	Feb	March
1	18	27	22.5	1	59	62	52	0
2	21.5	30.5	26	1	18	7	4	0
3	25	34	29.5	6	25	14	17	0
4	28.5	37.5	33	6	24	24	28	0
5	32	41	36.5	8	15	10	4	3
6	35.5	44.5	40	7	5	3	2	1
7	39	48	43.5	14	2	11	15	5
8	42.5	51.5	47	8	0	12	5	1
9	46	55	50.5	18	0	22	4	4
10	49.5	58.5	54	24	2	17	3	0
11	53	62	57.5	14	1	18	8	2
12	56.5	65.5	61	12	4	22	26	6
13	60	69	64.5	7	14	23	25	7
14	63.5	72.5	68	1	8	4	18	3
15	67	76	71.5	8	4	4	17	4
16	70.5	79.5	75	7	1	1	9	1
17	74	83	78.5	2	20	1	6	0
18	77.5	86.5	82	2	3	3	2	1
19	81	90	85.5	4	2	0	2	1
20	84.5	93.5	89	0	0	0	0	0
21	88	97	92.5	0	2	1	0	1
22	91.5	100.5	96	0	0	1	0	0
23	95	104	99.5	0	0	0	1	0
24	98.5	107.5	103	0	1	0	1	0
25	102	111	106.5	0	0	0	1	0

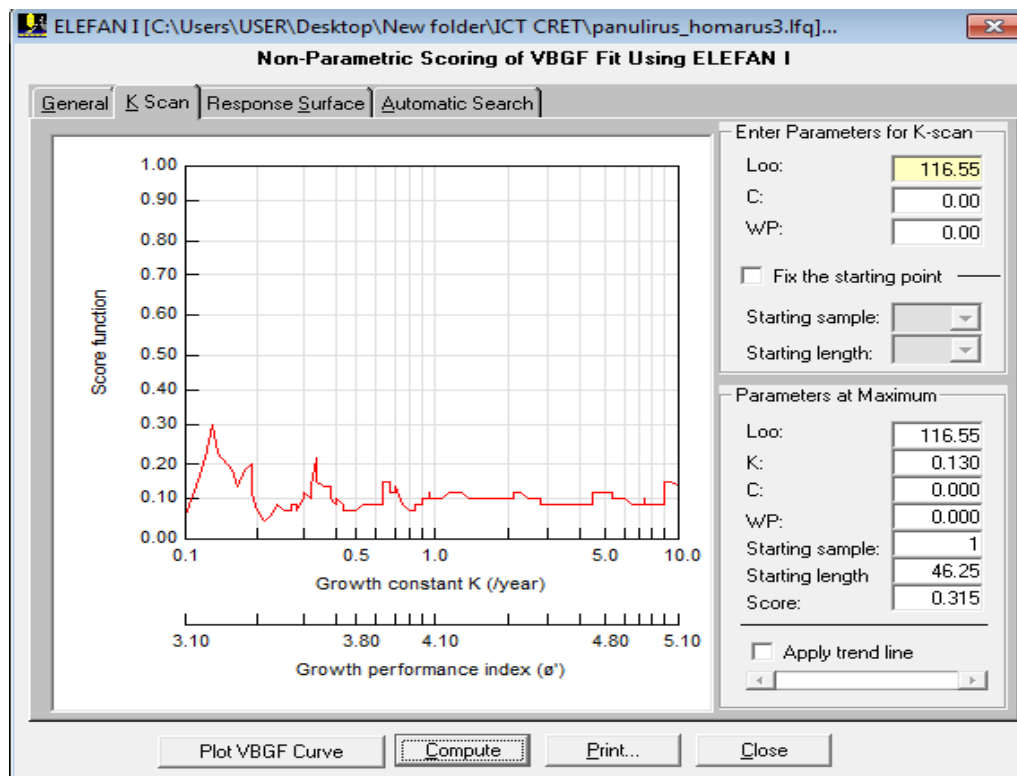


Figure 2. Output Result of K-Scan from Software FISAT II.

3.2. Growth model

The result of growth parameter analysis of spiny lobster is presented in Table 2.

Table 2. Parameters growth of Spiny Lobster (*Panulirus homarus*)

Parameter	Value
K	0.1300
L_{∞}	116.55
t_0	-0,1806

Based on the growth parameters of lobster above, the equation of von Bertalanffy was:

$$L_t = 116.55(1 - \exp(-0.1300(t + 0.1806))) \quad (7)$$

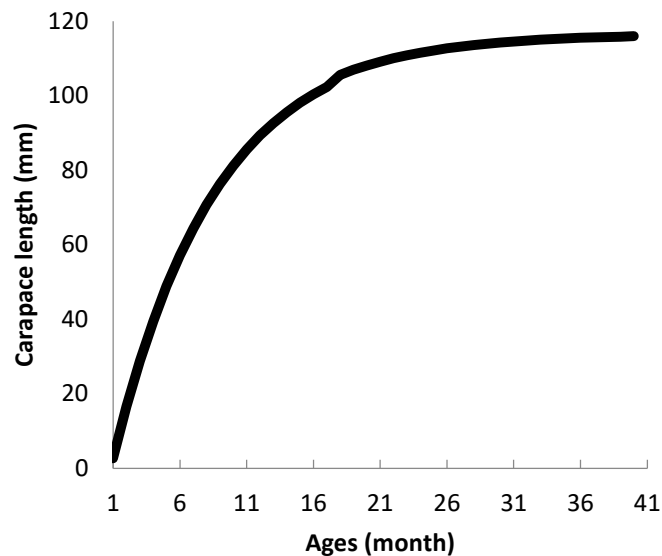


Figure 3. Von Brtalanffy Growth Function of Spiny Lobster (*P. Homarus*)

Figure 3. shows that spiny lobsters have a significant growth rate until reaching carapace length 100 mm, based on the equation model of von Bertalanffy obtained, to achieve this size spiny lobsters requires approximately 15 months.

Extracted from Table 1, shows that spiny lobsters in Kebumen and Cilacap coastal are kind of lobster that still small size (Figure 4), where lobsters that can be traded in Indonesia is a lobster with carapace length of 80 mm [7] (Permen-KP No. 56 - 2016) , whoever most lobster in both coastal areas has a carapace length less than 80 mm (91.5%) and only 8.5% has carapace length 80 mm or more. It means that lobsters with carapace length less than 80 cm are considered to be very cheap. While the size of carapace length 80 mm or more in international market reached 700,000 IDR/ 500 grs.

At least 3 months needed to raise spiny lobsters from carapace length 64.3 mm to 80 mm, the size are ready for sale in international market legally. Culture of lobster in both coastal areas is not yet well known.

Since 2006, spiny lobster caught by fishermen in the South Coast of Java (Kebumen, Yogyakarta and Wonogiri) have weighs less than 100 grams which are economically very low [8], [9],[10]. Fattening has been done in order to increase the weight of spiny lobsters to reach size above 100 grams or carapace length 46 mm from the seed weight 50 grams or carapace length 35.5 mm takes four months [8].

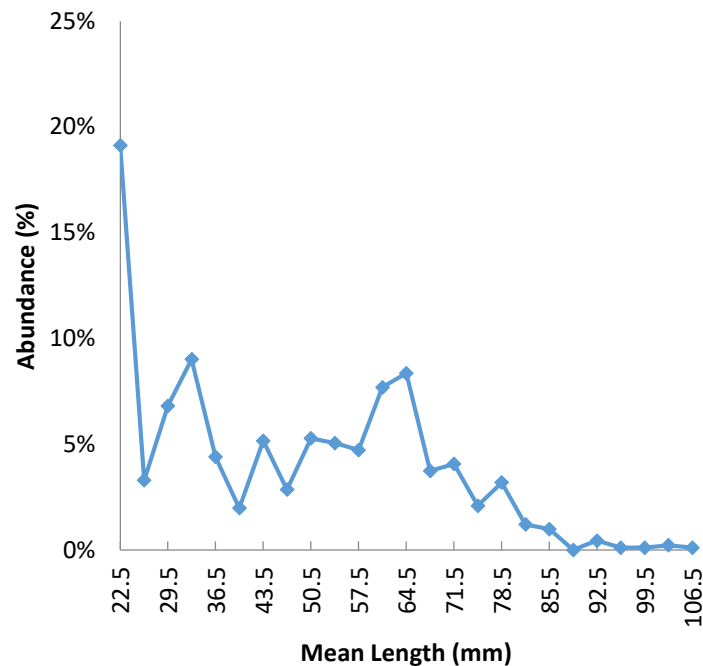


Figure 4. Size distribution of Spiny Lobsters (*P. Homarus*)

3.3. Mortality

Based on the research data it is known that the average length of sand lobster (*Panulirus Homarus*) (\bar{L}) is 49.0726 mm and the smallest length of sand lobster (*Panulirus Homarus*) (L') is 18 mm, so that the total mortality rate (Z) can be determined [11], i.e. 0.2827. Furthermore, from the calculation [6] obtained the value of natural mortality (M) 0.2655, capture mortality (F) 0.0167, and the rate of exploitation (E) was 0.0595.

Table 3. Mortality and Exploitation rates of Spiny Lobster (*P. homarus*) from Kebumen and Cilacap Coastal

Mortality	Value (per year)
Total (Z)	0.2823
Natural (M)	0.2655
Fishing (F)	0.0167
Exploitation (E)	0,0595

Fishing mortality from spiny lobster is much lower than natural mortality (Table 3). Natural mortality is caused by external factors such as predation, disease, food availability, physical chemical of waters. This natural mortality is also related to ecosystems, the same species in different waters may have different mortality rates depending on the density of predator and competitors.

Increasing the water temperature will lead to increase in the natural mortality of lobster [6]. The rate of exploitation can also explain the status of a lobster stock in the waters. If the rate of exploitation of lobster exceeds the optimum figure of 0.5, then it can be said that the stock of lobster in these waters has occurred overfishing. In addition, estimation of lobster stocks in the waters optimally exploited is when the value of capture mortality (F) equals natural mortality (M) [12]. The status of lobster resources in Kebumen and Cilacap coastal is based on the exploitation rate of

0.0595 far below the hazardous exploitation level of 0.5. However management needs to be done because the spiny lobster found on both beaches is still in a small size that still has a very rapid growth speed and almost has no economic value

4. Conclusion

Based on the results of the study, it is known that the growth rate of Spiny Lobsters (*P. homarus*) in Kebumen and Cilacap coastal, has a growth coefficient (K) of 0.1300, with asymptotic length (L_{∞}) 116.55, and the imaginary age of lobsters when the length is 0 cm (t_0) is -0.1806. Total mortality, Natural mortality and Fishing mortality were 0.2823, 0.2655 and 0.0167, respectively, while exploitation rate was 0.0595.

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