Fattening of mangrove crab (*Scylla serrata*) in wooden pen and plastic container

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Abstract. Research to study fattening of mangrove crab (*Scylla serrata*) was conducted in the coastal waters of Wael Village, Western Seram Regency, Maluku Province Eastern Indonesia from September to October 2018. Two methods were used for fattening namely wooden pen and plastic container. Totally, there are 54 individuals of mangrove crab used in this study which consists of 30 individuals maintained in wooden pen and 24 individual kept in plastic container during five periods of research for two months. The results showed that at the end of the research, mangrove crabs kept in wooden pen had better growth than those maintained in plastic container. Even though they had same survival, the results of economic analysis showed that only mangrove crab in the wooden pen have a good price so that the investment gets a profit, while investing in mangrove crabs kept in plastic container becomes a loss.

1. Introduction

Mangrove crab (*Scylla* spp) is one of the most important economical fisheries resource in tropical and sub-tropical countries including Indonesia. This fishery has important contribution for small-scale fishers especially in developing countries [1, 2, 3, 4]. So far, most mangrove crab production come from capture fisheries and it depend on availability of the stock [5, 6, 7]. However, some research in Indonesia show that the production of mangrove crab tend to decrease such as North coast of Java [8], Subang West Java [9], Western Seram [10, 11, 12, 13] and in Evu, Southeast Maluku [14]. Due to high market demand, exploitation of mangrove crab increase remarkably. The main market for mangrove crab is East Asia countries such as China, Japan, Korea, Thailand, Taiwan, Hong Kong, and Singapore [10, 15, 16].

One of the main producer of mangrove crab in Eastern Indonesia is Western Seram, Maluku Province. Mangrove crab fisheries in the area has started in the early 1980’s [17] but mainly for local consumption. Fishers in the area are artisanal ones who caught mangrove crab using traditional fishing gear called *bubu* (bamboo trap) that is put in the mangrove forest [10, 11, 12, 13]. Mangrove crabs in Western Seram consist of three species namely *Scylla. serrata*, *S. olivacea* and *S. paramamosain* with *S. serrata* being the dominant species [13].

Currently, there is an increasing number of fishing gears (*bubu*) in Western Seram but it is not followed by the increasing of catch per unit effort [13]. Previous study showed that population of mangrove crab in Western Seram has decreased and the fishing ground has been expanded further away even to another island [10]. In addition, the size of mangrove crab captured also decrease [13]. The small size (< 400 g) crab is valued for only IDR 50,000 per kg (3 – 5 individuals) by traders operated in the area.

An effort for fattening small size mangrove crab has been done in Western Seram by using bamboo basket [18]. Even though mangrove crab kept in the basket had good growth but the bamboo...
basket used is easily broken, and thus it is not last long. Therefore, this study was conducted to fattening mangrove crab by using two different methods, firstly keep animal individually in plastic container and secondly mangrove crab are maintained in group in wooden pen which is placed in the mangrove forest. Plastic container and wooden pen are expected to be used longer than bamboo basket. Fattening mangrove crab is easy, so member of fishers' family, wife or their children can do it in their spare time.

2. Materials and Method

2.1. Field work
Research on fattening of mangrove crab (S. serrata) in wooden pen and plastic container was conducted at the coastal waters of Wael village, Kotania Bay (Teluk Kotania) Western Seram Regency, Maluku Province Eastern Indonesia (Figure 1) from September to October 2018.

![Figure 1. Map showing research site (red circle)](image)

2.2. Fattening procedure
Mangrove crabs (S. serrata) used in this study were bought from fishers who landed their catch in Wael village. Totally, there were 54 individuals of mangrove crab (S. serrata) bought from the fisher with the average weight about 225 g. Before the experiment, mangrove crabs (S. serrata) were maintained in wooden pen for two days to acclimate. As many as 30 individuals mangrove crab (S. serrata) were grouped and kept in wooden pen (5x5x1.5 m³), while 24 individuals were maintained separately in plastic container (0.5x0.5x0.3 m³). Mangrove crabs (S. serrata) were fed with mixed of chop trash fish and mollusc once a day in the afternoon about 5% of their weight.

Before maintained in their containers, carapace of mangrove crab (S. serrata) were measured by using vernier caliper to the nearest mm and weighted using digital balance to the nearest g. This procedure was repeated every two weeks during the research period.

2.3. Data analysis
Growth of mangrove crab was analyzed in term of weight increment, absolute growth rate and specific growth rate using following formula [19]:
Weight increment = \( W_{t+1} - W_t \)

\[
\text{Absolute growth rate} = \left[ \frac{(w_{t+1}) - (w_t)}{\Delta t} \right]
\]

\[
\text{Specific growth rate} = \left[ \frac{(\ln w_{t+1}) - (\ln w_t)}{\Delta t} \right] \times 100
\]

where:
- \( W_t \) = weight at time \( t \) (g)
- \( W_{t+1} \) = weight at time \( t+1 \) (g)
- \( \Delta t \) = time period (day)
- \( \ln \) = natural logarithm

Survival of mangrove crab during the research was analyzed based on [19]:

\[
SR = \frac{N_{t+1}}{N_t} \times 100\%
\]

where:
- \( N_t \) = number of individuals at time \( t \)
- \( N_{t+1} \) = number of individuals at time \( t+1 \)

Economic analysis of fattening mangrove crab was analyzed based on [20].

3. Result and Discussion

3.1. Size distribution

Total number of mangrove crab used in this study were 54 individuals that consist of 30 individuals kept in wooden pen and 24 individuals maintained in plastic container. Size distribution of mangrove crab is presented in Table 1.

| Period     | N  | Carapace width (cm) | Weight (g) |
|------------|----|---------------------|------------|
|            |    | Min     | Max     | Mean    | SD       | Min     | Max     | Mean    | SD       |
| Wooden pen | I  | 30       | 10.9    | 14.9    | 13.70   | 1.07    | 174     | 322     | 266.37   | 46.46    |
|            | II | 27       | 12.5    | 15.2    | 13.74   | 0.68    | 250     | 420     | 341.48   | 44.61    |
|            | III| 26       | 12.6    | 15.8    | 14.30   | 0.87    | 330     | 590     | 468.46   | 70.30    |
|            | IV | 24       | 13.8    | 16.4    | 15.11   | 0.76    | 410     | 700     | 548.33   | 77.16    |
|            | V  | 24       | 14.6    | 16.9    | 15.74   | 0.56    | 480     | 720     | 587.20   | 56.24    |
| Plastic container | I  | 24       | 8.9     | 14.0    | 12.01   | 1.15    | 130     | 280     | 189.71   | 39.59    |
|            | II | 23       | 9.2     | 14.9    | 12.25   | 0.20    | 140     | 290     | 196.17   | 7.48     |
|            | III| 19       | 10.0    | 15.2    | 12.80   | 0.22    | 144     | 300     | 211.89   | 9.53     |
|            | IV | 19       | 11.0    | 15.5    | 12.97   | 0.33    | 150     | 320     | 215.26   | 8.87     |
|            | V  | 18       | 11.9    | 15.6    | 13.45   | 0.34    | 155     | 337     | 234.33   | 14.73    |

The initial carapace width of mangrove crabs ranging from 10.9 – 14.9 cm (mean 13.7 cm) and 8.9 – 14.0 cm (mean 12.1 cm) with the weight ranging from 174 – 322 g (mean 266.37 g) and 130 – 280 g (mean 189.71 g) for those kept in wooden pen and in plastic container, respectively. At the end of the
study, average carapace width and weight with their standard deviation (SD) are 15.74 cm (SD=0.56 cm) and 587.20 g (SD=56.24 g) for mangrove crab maintained in wooden pen, while for those kept in plastic container their mean carapace width and weight are 12.97 cm (SD=0.33 cm) and 215.26 g (SD=8.87 g).

3.2. Growth

In this study, growth of mangrove crab kept in wooden pen and in plastic container was analyzed in term of weight increment, absolute growth rate and specific growth rate and its results is shown in Table 2.

| Period | Weight (g) | Growth rate |
|--------|------------|-------------|
|        | Mean | Increment | Absolute | Specific |
|        |      |           | (g/day)  | (%/day)  |
| Wooden pen |     |           |          |          |
| I      | 266.37| 75.11     | 5.37     | 1.77     |
| II     | 341.48| 126.98    | 9.07     | 2.66     |
| III    | 468.46| 79.87     | 5.71     | 1.12     |
| IV     | 548.33| 38.87     | 2.78     | 0.49     |
| V      | 587.20|           |          |          |
| Plastic container |     |           |          |          |
| I      | 189.71| 6.46      | 0.46     | 0.24     |
| II     | 196.17| 15.72     | 1.12     | 0.55     |
| III    | 211.89| 3.37      | 0.24     | 0.11     |
| IV     | 215.26| 19.07     | 1.36     | 0.61     |
| V      | 234.33|           |          |          |

Weight increment of mangrove crab kept in wooden pen is significantly larger than it maintained in plastic container (p<0.05). Weight increment during 5 period of study is 320.83 g (mean 80.21 g) and 44.62 g (mean 11.16 g) for mangrove crab kept in wooden pen and in plastic container, respectively. The highest increment occurred between periods II and III for mangrove crabs in wooden pen, while the lowest found in periods III and IV for mangrove crabs in plastic container. Absolute and specific growth rate show the same pattern as growth increment.

Previous study showed that growth increment of mangrove crab kept individually in plastic basket at Cemara Labat, Central Kalimantan (120 g) [21] and in bamboo basket in Western Seram, Maluku (320 g) [18] is larger than growth increment in this study (44.62g). This difference could be due to the shape and size of cage used as well as duration of the study. In addition, quality and quantity of food also affect growth of cultured animals. On the contrary, absolute and specific growth rate of mangrove crabs kept communally in wooden pen is higher than mangrove crab (S. serrata) maintained in bamboo pen in Bangladesh [22] and in South Sulawesi, Indonesia (S. olivacea) [23]. It seems that water quality and condition of mangrove forest in Western Seram, Maluku significantly affect faster growth of animals cultured.

3.3. Survival

Survival is the number of individuals alive to the next period or until the end of the study. The number of mangrove crab survive for each period of study is presented in Table 1 and its percentage is shown in Figure 2. There is no significant difference of survival for the animal kept in wooden pen and in plastic container (p>0.05). At the end of the study, only 80% and 75% of mangrove crab survive in the wooden pen and in the plastic container, respectively. Survival of mangrove crab kept communally in wooden pen in this study is higher than survival of mangrove S. olivacea maintained in silvofishery system in Pangkep, South Sulawesi Indonesia [22] but lower than survival of S. serrata kept in bottom
confinement in Konawe, South Sulawesi [24]. Furthermore, survival of mangrove crab kept individually in plastic container is also lower than *S. serrata* kept in bamboo basket in Western Seram [18].

![Image](141x513 to 447x679)

**Figure 2.** Survival of mangrove crab

### 3.4. Economic analysis

Economic analysis of fattening mangrove crab *S. Serrata* kept together in wooden pen and individually in plastic container is presented in Table 3.

Total investment is the sum of money spent to rent land and to buy material for cages as well as variable cost, which is used to buy mangrove crab, food and to pay wages. Fattening of mangrove crab taking place in the coastal waters of Wael village, so land can be used by community at no cost.

| Code | Item                        | Cost (IDR)          |
|------|-----------------------------|---------------------|
| A    | Investment (a + b)          | 2,008,000           |
|      | a. Land and materials      |                     |
|      | - Land                      | 0                   |
|      | - Wood/plastic container    | 1,000,000           |
|      | b. Variable cost            | 1,008,000           |
| B    | Fixed cost                  | 50,000              |
|      | - Depreciation              | 50,000              |
| C    | Variable cost               | 1,008,000           |
|      | - Crab                      | 408,000             |
|      | - Food                      | 300,000             |
|      | - Wages                     | 300,000             |
| D    | Total production cost (B + C)| 1,058,000           |
| E    | Revenue                     | 1,288,700           |
|      | - 100 - <500 g              | 0                   |
|      | - 500 - <700 g              | 1,127,700           |
|      | - 700 - < 1000 g            | 161,000             |
| F    | Profit (E-D)                | 230,700             |
| G    | Cash flows (B + F)          | 280,700             |

**Table 3.** Summary of economic analysis for fattening mangrove crab

Total production costs are IDR 1,058,000 and IDR 897,000 for fattening mangrove crab in wooden pen and plastic container, respectively. These costs consist of variable cost that depend on production and fixed cost for depreciation, which is not depending on production. Depreciation is
determined by the differences between current price and old price of the material used for cages and their economic life. Estimated economic life for wooden pen is 3 years while for plastic container is 5 years with their old and current price differences are IDR 150,000 and IDR 125,000, respectively.

Total production value or revenue depends on quantity of production and the price of product. The price of mangrove crab in Western Seram depends on its weight category and it is determined by collecting merchant in the area. The lowest price weight less than 400 g locally called *kaecang-kaecang* while the highest price categorized as super weight > 1000 g [10].

Total production value or revenue of mangrove crab kept communally in wooden pen and plastic container is shown in Table 4. As mention before, only 24 individuals of mangrove crab in wooden pen and 18 individuals in plastic container survive until the end of the study.

| Container          | Range     | n  | Production | Price/kg | Production value |
|--------------------|-----------|----|------------|----------|------------------|
| Wooden pen         | 100 - <400 | 0  | 0          | 50,000   | 0                |
|                    | 400 - <700 | 22 | 12.530     | 90,000   | 1,127,700        |
|                    | 700 - <1000| 2  | 1.400      | 115,000  | 161,000          |
|                    | Total     |    |            |          | 1,288,700        |
| Plastic container  | 100 - <400 | 18 | 4.938      | 50,000   | 246,000          |
|                    | Total     |    |            |          | 246,000          |

All mangrove crabs maintained in plastic container have weight < 400 g and they have low price with total revenue is IDR 246,000. On the contrary, mangrove crabs in wooden pen have weight ≥ 400 g in which 22 individuals weight 400 - < 700 g and 2 individuals weight 700 - < 1000g with total revenue is IDR 1,288,700. Based on revenue and total production cost, business on fattening mangrove crab in wooden pen get profit as much as IDR 230,700 while fattening mangrove crab in plastic container become a loss as much as IDR 651,000. Ratios between total production value or revenue and total production cost (R/C) are 1.22 for fattening mangrove crab in wooden pen and 0.22 for fattening mangrove crab in plastic container. Ratio of $R/C=1.22 > 1.00$ as well as positive cash flows indicated that business of fattening mangrove crab communally in wooden pen is feasible to be continued or developed [20].

Mangrove crab is the main and important marine resource for traditional fishers in Western Seram. However, some of mangrove crab caught consist of small size or *kaecang-kaecang* (weight <400 g) which is up to 20% of the total crabs caught [10]. Mostly crab of this size is consumed by fishers’ family or sold for local consumption at low price. Fattening of mangrove crab is one of the solution to increase the size and thus the price of this small size crab. In the long term, fattening mangrove crab is also possible to produce broodstock crab.

Procedure for fattening mangrove crab is simple and can be done by fisher or fisher family members in their spare time. However, it takes time to encourage fishers to do such job because their habits tend to sell instantly whatever their catch. In addition, fishers have some difficulty to get loan from bank for financial capital to run their new business in fattening mangrove crab. Empowering fishers in the area is necessary and urgently needed in order to improve their livelihood and to reduce poverty of coastal community.

4. Conclusion
Mangrove crabs maintained in wooden pen has better growth than those kept in plastic container. Fattening using these two methods has the same survival, however only crab kept in wooden pen is profitable so it is feasible to develop.
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