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Research Article

Study of Environmental Parameters on Lobster (*Panulirus* spp.) Enlargement with Fixed Cage at GWD, Banyuwangi

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Abstract

One of the marine commodities, Lobster (Panulirus spp.), has unabated demand in the global market, while, Lobster production remains static due to the difficulty of implementing its rearing activities. Relative rearing of lobster (Panulirus spp.) is usually performed using the floating net cage method with calm water conditions. In contrast, areas with extreme weather conditions tend to have difficulty applying this method. The potential of using the fixed cage method was assessed by rearing the Lobster at Pesona Bahari Banyuwangi Fish Cultivation Group. This research aimed to investigate the feasibility of the environmental conditions in the waters of GWD, Banyuwangi. The study was conducted for three months. Data such as temperature and light intensity through the help of a pendant were collected. Water quality parameters were recorded during this study, including salinity, pH, dissolved oxygen, and current velocity. Sampling was conducted four times to see the relationship between length and weight. The results showed that the GWD environmental parameters were very supportive for lobster rearing, with temperature values ranging from 27.2oC - 30.1oC, DO around 4.6 mg/l - 5.2 mg/l, salinity 28o/oo - 30o/oo, pH 7 - 8.2, the current speed is 0.468 m/s, and the light intensity is 0 lux - 3,616 lux. The growth pattern of all sampling results except sampling 2 (isometric) has a negative allometric result, with length and weight having a solid relationship. The fixed cage method is considered suitable for lobster rearing activities because the environmental parameters follow their natural habitat and the Fulton condition factor (K) value of more than 1. The greater the value of the Fulton condition factor (K), the healthier the condition lobster.

Keywords: lobster, environmental parameters, fixed cage

1. Introduction

Lobster is one of the marine commodities that are very hotly discussed lately because it has a high and essential selling value along with the increase in the mass of the lobster itself (Williams, 2007). Indonesia was the fourth-highest lobster-exporting country in the world in 2012 (WWF, 2015). Lobsters have five phases in their life, and the first begins with the production phase and the meeting between sperm and eggs, then enters the larval or phyllosoma phase, followed by a phase after larvae or post-larvae and is often called puerulus, after which it enters the juvenile or juvenile phase. , and the final stage is adulthood. It has five life stages starting from the egg sperm production process, then the larval, post-larvae, juvenile and adult (Phillips & George, 1980).

Sea lobster habitats can be found in sandy, rocky, and rocky waters, but the habitat considered the most strategic for lobster life is a hollow rock to be used as a hiding place. Lobsters include omnivorous animals with the types of food commonly sought after, such as algae, small molluscs, small fish, and small molluscs. Lobsters use their legs to walk on the seabed, find their prey, and use their antennae as chemoreceptors (WWF, 2015). Six species of lobster are found in Indonesia, including *Panulirus homarus*, *Panulirus ornatus*, *Panulirus longipes*, *Panulirus penicillatus*, *Panulirus polyphagus*, and *Panulirus versicolor*.

Water quality has a function that is strongly influenced by nature and human activities. Without human influence, water quality would be determined by weathering of minerals in the bedrock, evapotranspiration in the atmosphere and deposition of dust and salt by wind (Stark, Hanson, Goldstein, Fallon, & Fang, 2000). Water quality can be said to be good for its use if it meets several quality standards that have been set. Water quality standards, especially seawater, are divided into three uses by the Ministry of Environment as stated in Law No. 51 of 2004, with details of the first seawater quality standards used for port waters, the second for marine tourism, and the third for aquatic biota. Marine biota is living things that inhabit the oceans, both animals and corals. In this case, lobsters are included in it. According to Setyono (2006), seawater quality standards for lobster rearing include seawater temperature, light intensity, pH, salinity, dissolved oxygen, current velocity, and primary conditions of the waters or substrate.

In the use of lobster using cages, four types can be utilized according to the needs; these types include fixed cages, floating cages, submerged cages, and submersible cages in the cultivation or use of lobster at Grand Watu Dodol using a fixed cage system. The cage system consists of a net supported by a frame made of iron and a foundation to the seabed. The static cage system is used because of several possibilities. The location used for cultivation has strong currents. It is not possible to use a floating cage system. Using fixed cages for lobster cultivation is also considered applicable because it has a natural lobster habitat at a minimum depth of 3 meters and a market substrate or mud (Olivares, 2003). This study was conducted to determine the feasibility of a successful lobster enlargement system (*Panulirus* spp.) at Grand Watu Dodol, Banyuwangi, using the fixed cage method.

2. Materials and Methods

2.1 Materials

This research is classified into observational research. The study was conducted for three months, starting from November to February. The location of study was carried out at Grand Watu Dodol (GWD), Bangsring Village, Wongsorejo District, Banyuwangi Regency (8°05'14.2"S 114°25'01.3"E). The tools include pendants, analytical balances, DO meters, callipers, pH meters, current meters, and refractometers. The materials used during the study were young lobsters of at least 100 grams and sample bottles.

2.2 Method

The variables studied included water quality parameters, lobster survival rate (SR), and the relationship between lobster length and weight. Data sampling was conducted to determine the development of lobster weight and length. Sampling was carried out 4 times, where the first sampling was carried out when the young lobsters were to be stocked in cages, and the following sampling was every 30 days. The final sampling will be carried out during the harvesting process, and the lobster survival rate will be calculated by:

$$\mathbf{SR} = \frac{Nt}{No} \times 100\%$$

Note:
SR = Survival Rate
Nt = Final Sample Quantity
No = Initial Sample Quantity

The length-weight relationship was estimated using the equation: $W = aL^b$, with W = weight (g), L = carapace length (cm), a = Constanta, dan b = growth exponent. The b value obtained is used to determine the growth pattern—T-test for the b obtained at a 95% confidence interval. The influence of the environment on lobster growth was measured by the condition factor coefficient (K), relative weight (Wr), and standard weight (Ws). The condition factor is obtained from the calculation of the Fulton condition coefficient (K) based on Okgerman (2005) with the formula K=WL-3, with K is the condition factor, W is the weight (g), L is the length (mm) and -3 is the length coefficient to ensure that the value of K tends to be 1. The relative weight (Wr) is determined based on the Rypel and Richter (2008) equation as follow: Wr = (W/Ws) x 100, with W is the weight of the sample and Ws is the standard weight ($Ws = aL^b$).

The water quality used in this study includes temperature and light intensity which will be measured using a pendant device, where this tool will be set to measure data every 4 hours a day. The data will be accumulated and taken vulnerable from the results of measurements of temperature and light intensity in the cages. Salinity, pH, and DO are other abiotic factors whose data will be taken by taking water samples from the cage area using a sample bottle. Salinity measurement is operated using a refractometer. The pH value will be determined by measuring the water sample using a pH meter, and the DO value will be obtained using a DO meter. Current velocity data are obtained by measuring water speed for 1x24 hours using a current meter.

3. Results and Discussion

3.1. Results

Based on table 1, it can be seen that the results of temperature measurements during the study obtained values ranging from 27.2 OC to 30.1 OC. The results of the measurement of dissolved oxygen or DO in the waters around the lobster cages obtained a range of values between 4.6 mg/l to 5.2 mg/l.

Table 1. Environmental parameter measurement results

Parameter	Range of Value	Average Value
Temperature (°C)	27,2 - 30,1	28,7
DO (mg/l)	4,6 - 5,2	4,97
Salinity (°/₀₀)	28 – 30	29,6
pH	7 - 8,2	7,7
Current Speed (m/s)	0 - 0,634	0,178
Light Intensity (Lux)	0 - 3,616	198,6

The study also measured salinity around the cages, showing that the salinity of the waters around the cages has a value of 28°/°° to 30°/°°. The pH value or impact on the waters around the cages was also measured and was found to be between 7 and 8.2. The current speed of Grand Watu Dodol Beach, which is located right in the Bali Strait, has a value between 0 m/s to 0.634 m/s. The value of light intensity that can penetrate the waters into the cage is 0 Lux to 3,616 Lux.

The survival rate of lobsters obtained results of 85.4% for the Survival Rate when calculated by the incidence of mortality, mortality simultaneously within a few days after placing into the cage and 96.7% for the results if the number of mass mortality was neglected.

Table 2. Survival rate

Parameter	**Value (%)**
SR1 %	85,4
SR2 %	96,7

Table 3. The result of the relationship between length and weight

Parameter	**Sampling 0**	**Sampling 1**	**Sampling 2**	**Sampling 3**
W (gr)	132,83	205,6	174,6	194,4
Wr (gr)	100,02	100,6	100,5	100,6
Ws (gr)	132,8	204,9	186,1	192,5
K	5,5	5,9	6,03	6,07
b	1,8	3,04	2,9	2,8
R^2	0,95	0,94	0,91	0,9

Table 4. Range of values of the relationship between length and weight

Parameter	**Sampling 0**	**Sampling 1**	**Sampling 2**	**Sampling 3**
W (gr)	105-160	75-475	104-475	140-480
Wr (gr)	95,1-104,6	86,4-123,1	87,2-119,7	81,9-122,7
Ws (gr)	104,8-155,9	84,5-456,9	86,8-400,1	138,4-450,4
K	4,9-6,3	4,6-7,2	4,9-8	4,6-6,8

The results of the calculation of the relationship between length and weight, the value of W on the 0th sampling weights 132.83 gram. The W values for the 1,2, and 3rd sampling respectively, are 205.6 gram, 174.6 gram, and 194.4 gram. The results of the relative weight (Wr) in each sampling sequentially have values of 100.02 grams, 100.6 grams, 100.5 grams, and 100.6 grams. The standard weight values for each sampling are 132.8 grams, 204.9 grams, 186.1 grams, and 192.5 grams. The value of the condition factor or Fulton (K) at the 0th sampling obtained a value of 5.5, followed by the 1st sampling result with a value of 5.9, and then the 2nd and 3rd samplings were 6,03 and 6,07, respectively. The value of b, which shows the growth pattern in each sampling, has a value of 1.8, 3.04, 2.9, and 2.8. And the value of R2, which shows the relationship between the increase in length and weight in each sampling, has a value of 0.95, 0.94, 0.91, and 0.9.

3.2. Discussion

The temperature obtained during the study (Table 1.) can be considered optimal for lobster growth because lobsters require a temperature range to grow and develop between 23^{o}C-32^{o}C (Mahmudin & Muhammad, 2016). This statement is supported by Kordi & Tancung (2005) which state that the optimum temperature for lobster rearing is 24^{o}C-31^{o}C. Temperature can affect the metabolic system and the lobster's enzyme work system. This can happen because the temperature is related to the level of the lobster to take compounds O_2. The higher the temperature fluctuation, the higher the level of uptake of O^2 compounds by the lobster in response to changes in body temperature and metabolic processes. High-temperature fluctuations can also cause fluctuations in dissolved oxygen or DO, which causes the lobster to responsively neutralize its body to accelerate the oxidation process to minimize the entry of harmful substances such as hydrogen sulfide or ammonia. The high-temperature fluctuations can also reduce the lobster's immune response, which causes a decrease in appetite and lobster activity, and prefers to remain silent (Bardach, Rhyterr, & McLarvey, 1972).

The results of the DO measurement (Table 1.) during the study showed a range of values from 4.6 mg/l to 5.2 mg/l with an average DO of 4.97 mg/l. The DO value during the study was declared suitable to be used as a lobster habitat. Based on Cokrowati *et al.* (2012) research, the optimum DO value for lobster is 4.6 mg/l to 9.6 mg/l. According to Mahmudin & Muhammad (2016), the DO value for lobster enlargement should not be less than three because the fast growth of a lobster depends on its metabolic process, which is still related to the adequacy of the dissolved oxygen content. A low DO value will cause marine biota, in this case, to experience inhibition in the growth process and the worst possible to experience death; the cause is inseparable from the disruption of metabolic processes in the lobster body. Ministry of Environment in KEPMEN LH, number 51 years of 2004, stipulates seawater quality standards for biota to have a value of more than 5mg/l, where the DO value obtained during the study is still within the range specified by the Ministry of the Environment.

In this study, the range of salinity values (Table 1.) was between $28^{o}/_{oo}$ to $30^{o}/_{oo}$ with an average of $29,6^{o}/_{oo}$The salinity value of this study is still below the threshold outlined in the KEPMEN LH number of 51 years of 2004 which explains that the salinity value for marine biota has a minimum value of $30^{o}/_{oo.}$ According to Cokrowati *et al.* (2012), the ideal salinity for lobster growth is $32^{o}/_{oo}$ - $36^{o}/_{oo}$. In contrast to Tong et al. (2000) 's opinion, which explained that lobster growth's optimum salinity value was $25^{o}/_{oo}$ to $40^{o}/_{oo}$. The low salinity value of this study is inseparable from the high rainfall that occurs from November to January. The low salinity value is also influenced by the location of the lobster cages adjacent to the river mouth, which causes the mixing of fresh water from the estuary, which has a low salinity value, with brackish water, which tends towards high salinity values. This statement is reinforced by Nontji (2002), who said that several factors, such as high and low rainfall, evaporation, river flow, and water circulation, strongly influence salinity. Low salinity values can also be caused by the presence of winds that cause sea waves and cause a mixing process.

The pH value (Table 1.) in this study was obtained from 7 to 8.2 with an average of 7.7. According to Cokrowati *et al.* (2012), This value is still in the optimal range for lobster growth because the optimum pH value is 6.8 to 8.5. Ministry of Environment in KEPMEN LH number 51 years of 2004 revealed that the pH value for the quality standard of marine life is 7 to 8.5. The more acidic the pH value in the waters, it is feared that it will interfere with the lobster's metabolic process.

The results of current velocity measurements in the waters of Grand Watu Dodol can be seen in table 1, where the average current is 0.178 m/s with a current range from 0 m/s to 0.634 m/s. The current measurement is carried out in three phases; the first phase takes a value of 0.2 multiplied by the depth in this study, obtaining a depth of 8 meters. The second phase takes a value of 0.6 and the third takes a value of 0.8. The three phases represent current velocity conditions at the sea's surface, middle, and depth.

Table 5. Current Speed

Phase	Current Speed (m/s)		Source Direction
	Max	Average	
0,2 (Surface)	0,617	0,198	North Northeast
0,6 (Middle)	0,634	0,186	North Northeast
0,8 (Depth)	0,468	0,153	North

The maximum current velocity at the 0.2 phases or surface is 0.617 m/s (table 5). The average surface current velocity in Grand Watu Dodol is 0.198 m/s and mostly comes from the north, more precisely from the north-northeast. In phase 0.6 (table 5) or mid-current, the maximum current speed is 0.634 m/s with an average current velocity of 0.186 m/s originating from the north, more precisely, north-northeast. The maximum current velocity in the 0.8 phase (table 5) or the depth current is 0.468 m/s. The average current velocity at this value is 0.153 m/s, with the current direction mostly coming from the north. The current velocity in the waters of Grand Watu Dodol is considered optimum for lobster growth, as stated by Amri *et al.* (2010), that the optimal current velocity as a place for lobster growth is 0.2 m/s to 0.4 m/s. The current plays a vital role in the circulation process in the cage area. This circulation is essential for lobster life because it can affect the surrounding environment. Optimum circulation can provide the availability of oxygen supply for the lobster respiration process, besides that the circulation of ocean currents can also quickly break down food remnants in the cage so that no residue deposits occur and can cause harmful compounds to form from the remains feed like ammonia (Mujizat, 2020).

The light intensity (Table 1.) obtained around the cage has a value from 0 Lux to 3,616 Lux with an average of 198.6 Lux. Light intensity plays a significant role in the ability of lobsters to find food. The higher the intensity of light that can penetrate the waters, it is feared that it will interfere with the feeding process for lobsters. The reason is inseparable from the nature of lobsters as nocturnal animals that are more active foraging for food and active at night (Rombe, Wardianti, & Adrianto, 2018). Lobsters have a black eye colour structure, where this eye colour can absorb the slightest light. It is feared that the high intensity of light will damage the lobster's vision system so that it can cause the lobster to move passively. The passive movement of lobsters can cause the cannibalism process to increase because the lobster's condition is weak due to damage to its visual system. Lobsters have a black eye colour structure, where this eye colour can absorb the slightest light. It is feared that the high intensity of light will damage the lobster's vision system so that it can cause the lobster to move passively. The passive movement of lobsters can cause the cannibalism process to increase because the lobster's condition is weak due to damage to its visual system (Juliette, 2015).

The survival rate (Table 2.) in this study using the fixed cage method obtained a percentage of 85.4% when calculated by mass mortality events simultaneously during the early weeks of laying young lobsters or the juvenile phase. The high mortality rate in the early days of the stocking is indicated because of the unhealthy quality of the young lobsters. There are a few problems in the retrieval process while in the wild, but this needs further research to prove this statement. The percentage of lobster survival rate in the fixed cage method if the mass mortality incidence is ignored, the value is 96.7%. The value of the survival rate, whether calculated from the incidence of mass mortality or not, still has a reasonably high value. The value of the survival rate of lobster in this study when compared with research conducted by Junaidi & Hamzah (2014), where the study used the floating net cage method as a lobster rearing method carried out in Ekas Bay, West Nusa Tenggara.

The survival rate in this study was found to be 70%. Of course, this percentage is still far from the value obtained in research conducted at Grand Watu Dodol using the fixed cage method. Another study conducted by Mojjada *et al.* (2012) obtained a percentage of survival rate of 83.7%. The percentage results from the two studies that used the floating net cage method were still far from the results obtained in this study if the survival rate's percentage value was calculated from the mass mortality incident that occurred in the first week of stocking. It was concluded that the fixed cage method could be used as a lobster-rearing method that can be applied. However, further research is needed at the same place and time to see the actual data on the success rate of lobster rearing using the fixed cage method and floating net cages. The value of b (Table 3.) in the first sampling obtained a value of 1.8. The results of the b value in the first sampling said that the growth pattern in lobsters was negatively allometric, meaning that the increase in lobster length was faster than the growth in weight.

The first sampling in figure 1 is stated as the sampling of 0 because the data was obtained from young lobsters caught in nature which were collected and purchased for stocking in fixed cages in Grand Watu Dodol waters. The second sampling (sampling 1) obtained a b value of 3. From this value, it was stated that the lobster growth pattern after undergoing the enlargement process with the fixed cage method was isometric, or the increase in length equalled weight gain. The 3rd sampling (sampling 2) has a b value of 2.9 or is negative allometric, similar to the results of the 4th sampling (sampling 3), which has a value of 2.8.

The allometric values of b are negative at sampling 0.2, and 3 are considered reasonable to occur in lobsters according to research conducted by Suman *et al.* (1994) in Aceh and Pangandaran, then strengthened by Nuraini & Sumiono (2006) research in Pangandaran as well as Aisyah & Triharyuni (2010) in Yogyakarta and last confirmed by Hargiyatno *et al.* (2013) research conducted in Teluk Ekas, West Nusa Tenggara. According to Fauzi *et al.* (2013), the negative allometric growth pattern of the lobster is inseparable from the difference in the size of the lobster stocking and the type of feed given. The more nutrients contained in the feed, the higher the probability of having the same growth in length and weight. This statement is supported by the results of sampling 1, which is isometric. This result is inseparable from adding additional vitamins to the trash fish feed.

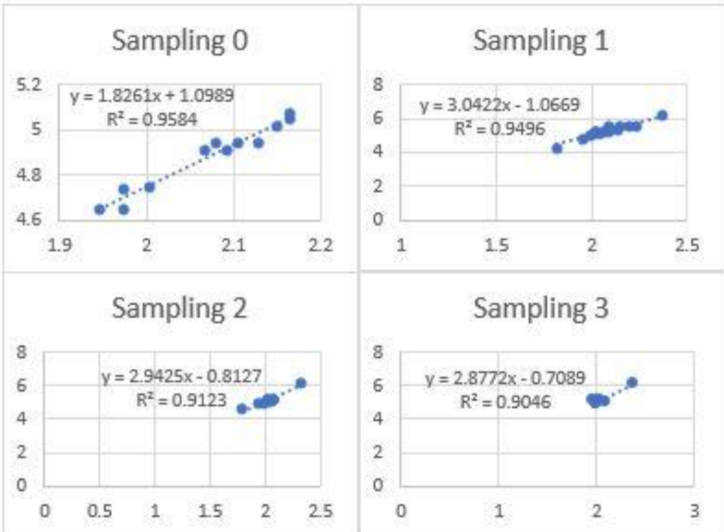

Figure 1. Graph of the relationship of length and weight

The determinant (R2) result in table 3 between the relationship between length and weight in each sampling has a value of 0.95 at the sampling of 0, the sampling of 1 is 0.94, and the sampling of 2 is 0.91, and the sampling of 3 is 0.9. The results for each sampling have a very strong relationship, meaning that the relationship between length and weight gain is very closely related (Rahman, Hedianto, & Wijaya, 2018). The results of the comparison between the original weight measurement (W) and the predicted weight (Ws) at the sampling of 0 stated that the average value of W was more significant than the average value of Ws, but the difference in values between the values of W and Ws was not too far at 0.03. The sampling of 0 was obtained from measuring young lobster data from natural catches right before stocking into fixed cages. The results from sampling 0 can be said that although the environment in the wild supports lobster growth, it is not able to increase the quality of lobster significantly, and the impact will certainly have an effect on the selling value of the lobster itself (Fauzi et al., 2013).

Problems found in the wild can be solved by developing lobster-rearing cultivation. It can be seen from the results of the sampling of 1 to the sampling of 3 that the original weight value is also obtained (W) greater than the predictive weight value (Ws), where the difference in the value of the two is quite far. These results indicate that apart from the surrounding environment in Grand Watu Dodol, it is very suitable for lobster rearing, which has been proven by measuring environmental parameters during the study. These results can also be said that lobster rearing activities can be a solution to increase the selling value of lobsters from the market because the weight value can increase significantly when compared to the weight value derived from natural catches, of course this cannot be separated from the availability of feed in the cages. While avoiding the danger of predators. This statement is supported by the results of the relative weights of sampling 1 to sampling 3, which have a value of more than 100 (Hargiyatno et al., 2013).

The results of measuring the value of the Fulton condition factor (K) in table 3 show that from sampling 0 to sampling 3, the value exceeds 1. The photon condition factor (K) value from sampling 0 to sampling 3 always increases. The greater the value of the Fulton condition factor (K), the healthier the condition of each lobster. The increase in the value of the Fulton condition factor (K) in each sampling also indicates that lobster-rearing aquaculture activities can improve the quality of individual lobsters, both in terms of health, productivity, and lobster physiological conditions (Rahman et al., 2018). The value of the Fulton condition factor (K) in this study, when compared with the value obtained by research by Hargiyatno *et al.* (2013) in Yogyakarta dan Pacitan, and research by Fauzi *et al.* (2013) where both studies used the floating net cage method. These results indicate that using the fixed cage method can improve the condition of each lobster to be better than the floating net cage method. This is inseparable from the condition of the environmental parameters in the fixed cage method, which is more in line with the ecological conditions of the lobster in its natural habitat. The result of the faulting condition factor value (K) at sampling 0 obtained from natural catchments in the Banyuwangi area also has a greater value than the Fulton condition factor value (K) obtained from catches in the Pangandaran, Gunung Kidul, and Pacitan areas. These results illustrate that the condition of young lobsters brought from Banyuwangi has a better physical condition than those caught by young lobsters from other sites. The high value of the Fulton condition factor (K) obtained by sampling 0 or the quality of young lobsters caught in Banyuwangi waters also indicates that the environmental parameters are still maintained and able to support the growth of young lobsters in their natural habitat.

4. Conclusion

The results of the measurement of environmental supporting parameters at GWD, Banyuwangi, were assessed according to the natural habitat of the lobster (Panulirus spp.) as evidenced by the data during the study. The relationship between length and weight obtained during the study has a solid relationship with the growth pattern, namely negative allometric and isometric. The fixed cage method can be a solution to improve the quality of crop yields with export quality because it has the same Fulton condition factor value as in nature.

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