Abundance and Ponderal Index of White Shrimp (*Penaeus merguiensis*) in Estuary Water

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Abstract. Research regarding the abundance and ponderal index of white shrimp (*Penaeus merguiensis*) in the estuary water of Karang Gading, Sumatera Utara has been conducted. Sampling of white shrimp used nylon webbing material. The white shrimps obtained were calculated for their number of individuals, carapace length and body weight, as well as their abundance, distribution, growth pattern and ponderal index. The study concluded that the white shrimps are very abundant in each stations. Distribution of white shrimp in the estuary waters belong to group distribution pattern. The growth pattern at station 1 and 2 is a positive allometric, while at station 3 is negative allometric, and the ponderal index of white shrimp in each station indicated that shrimps were in robust condition.

1. Introduction

The white shrimp (*Penaeus merguiensis*) was found in almost all Indonesian waters, ranging from estuarine of mangrove, coastal waters around mangrove such as estuaries, lagoons and bays, to open waters [1]. The white shrimp belongs to the family, Penaeidae and the order of Decapoda. The white shrimp or in trade, better known as banana shrimp, are found in almost all Indonesian waters, inhabiting estuary to marine water bodies [2].

Eleven species of penaeids with two commercially valuable species can be found in Indonesia water, they are from genera *Penaeus* and *Metapenaeus* [3]. Majority of people tend to consume certain species of penaeids with larger bodies, which are *Penaeus monodon* and *Penaeus merguiensis*, making them as export priority as well. In Indonesia, especially *Penaeus merguiensis*, the shrimp is also known as *jerbung* shrimp and in North Sumatra, is better known as *kelong* shrimp [4]. The white shrimp can be found in estuary water of Karang Gading in North Sumatera. Many fishermen harvest white shrimp in these waters. Currently, there is no current ecological data on white shrimp in these estuary waters. Our study then will present the current status of penaeids ecological aspects regarding the abundance and ponderal index in Karang Gading.
2. Materials and Methods
The location of sampling was conducted in the estuary waters of Karang Gading, North Sumatra (Figure 1). Analysis of white shrimp samples were conducted at Laboratory of Agronomy, Faculty of Agriculture, Universitas Sumatera Utara. Measurement of physico-chemical parameters of water including water temperature, water depth, water clarity, flow velocity, water pH, dissolved oxygen, salinity done were conducted in situ. The substrate fraction and BOD$_5$, were analyzed in the laboratory. Sampling of white shrimp was conducted by using nylon webbing material during high and low tides. Sampling points were located 10 m in each stations, to minimize ecosystem disturbance at the study site.

3. Results and Discussion
3.1 Physical Chemical Parameters
The result of physico-chemical parameters of water sampled in each stations are presented in Table 1.

Table 1. Physical Chemical Parameter Value at Each Station

| Station | Temp (°C) | Water Depth (m) | Water Clarity (cm) | Flow Velocity (m/s) | Salinity (%) | pH | DO (mg/L) | BOD$_5$ (mg/L) |
|---------|-----------|-----------------|-------------------|---------------------|--------------|----|-----------|----------------|
| 1       | 30.00     | 4.15            | 49.10             | 0.19                | 31.50        | 7.50| 4.51      | 0.62           |
| 2       | 29.90     | 1.75            | 30.70             | 0.10                | 30.00        | 6.70| 4.00      | 0.67           |
| 3       | 30.60     | 3.57            | 92.30             | 0.13                | 29.40        | 6.30| 3.91      | 0.84           |
The temperatures value in estuary water are in still tolerance level for the growth of white shrimp. This is in accordance with the previous report which stated that white shrimp can still live at a temperature of 10–36 °C [5]. High temperature in aquatic habitat may lead to an increase of metabolic rate and respiration which will lead to increased oxygen consumption. Another report stated the water temperature below 20 °C will inhibit the growth of white shrimp [6]. The depth at station 2 is the shallowest among other stations. This is explained by the characteristic of site used for local oil palm plantations area, carrying the use of heavy equipment for oil palm planting. The entry of plantation soil into the water column is thought to be one factor causing shallow of water bodies in this station. The clarity of water in each stations resulted in turbid waters and strongly supports the life cycle of white shrimp. The results also show a relatively quiet flow velocity, and considered to be an excellent condition for white shrimps [7]. When the flow velocity is weak, white shrimps do a lot of feeding activity for growth, whereas if the flow rate is strong enough, the white shrimp will immerse themselves to the base substrate.

The salinity value in each stations are also within tolerable limits to support white shrimps. [4] states that optimal shrimp growth is within the salinity range of 15–30 ‰ [4]. Higher salinity will affect to a decline of shrimp growth rate. Acidity value (pH) in each stations are within tolerable limits to support white shrimp life. Optimal pH for white shrimp growth 5.9–8.0. Low pH may lead to increased oxygen consumption, decreased body permeability and damage to shrimp gills. Dissolved oxygen value in each stations are also within optimum requirement in which white shrimp can still live in waters that have a minimum oxygen content of 3 mg/L [7]. Overall, the physico-chemical characteristics in study site are still considered in optimum condition for P.merguensis [8].

3.2 Abundance of White Shrimp

The results of the study showed that the abundance of white shrimps had values on each station, as shown in Figure 2.

![Figure 2. Abundance of white shrimps (ind/ m²) at each station](image)

The results showed that the highest value of white shrimp abundance was found at station 2 of 19.39 ind/ m² and the lowest in station 3 was 10.47 ind/ m². The high abundance of white shrimp at station 2 due to the condition of the watery environment in this station is quite supportive of white shrimp growth. Station 2 has a relatively quiet flow velocity (0.10 m. sec⁻¹) compared to other stations. This is due to the estuary topographic conditions at this station, where the station 2 is a straight estuary flow becoming the link between station 1 and station 3, causing relatively slow-moving currents as compared to the others. The relatively slow-moving waters are excellent for the life of white shrimp. This is in accordance with the statement that a fairly quiet flow is favored by white shrimp, especially in terms of feeding to support its growth [7].
Station 2 is also characterized by having low water clarity value (30.70 cm) as compared to the others. The relatively turbid waters strongly support white shrimp life. This is in accordance with the theory which stated that the relatively cloudy waters are one of the causes of the abundance of white shrimp populations in a waters, because it can cause a decrease in the range of vision distance from the predators in the waters, therefore expanding the enlargement area and improving the juvenile level of white shrimp [9].

3.3 Distribution of White Shrimp

Distribution of white shrimp in each station can be seen in Figure 3. The analysis resulted with the distribution value of 3, which describes the distribution of white shrimp in each station in the group. This can be seen from the number of white shrimp found in each station generally have almost the same size and always found in clump.

The pattern of group distribution is the most common pattern in natural populations because white shrimp tend to find suitable habitats for feeding to support their lives [5]. Coincide with results of abundance in station 2, it is known that station 2 may be considered as potential habitat with good carrying capacity for P. merguensis as reflected from its optimum physico-chemical characteristics.

3.4 The Growth Pattern

White Shrimp samples used in each station were 132 individuals with length of carapace in range between 3.20–12.30 cm and body weight in range between from 0.60 g–11.00 g from station 1, 137 individuals with length of carapace in range between 3.50–13.70 cm and body weight in range between from 0.60 g–15.80 g from station 1, and 74 individuals with length of carapace in range between 3.20–11.70 cm and body weight in range between from 0.60 g–9.00 g from station 3. The linear relationship between morphologies can be seen in Figure 4.

The result of analysis shows that station 1 has equation: Log W = 0.0102 + 2.7538 log L or in exponential form: W = 0.0102 L^2.7538 with coefficient of determination (R^2) = 0.949. Station 2 has the equation Log W = 0.0053 + 3.0924 log L or W = 0.0053 L^3.0924 with coefficient of determination (R^2) = 0.9697 and station 3 has log equation W = 0.0116 + 2.6816 log L or W = 0.0116 L^2.6816 with coefficient of determination value (R^2) = 0.9391. The value of B illustrates the pattern of white shrimp growth, whereas the closeness of the relationship between the length of the white shrimp carapace and its weight can be known through of determination coefficient, so that through the equation can be determined whether the individual of the white shrimp population in this region can be estimated body weight through size length of his carapace.
Figure 4. The growth pattern of white shrimp in each stations

The results showed that the growth of white shrimp at stations 1 and 3 was negative allometric with $b < 3$. At station 2, the value of $b$ obtained is greater than 3 or $b > 3$, so it can be said that the growth of white shrimp at station 2 is positive allometric. Based on the value of $b$, it can be seen that at station 1 and 3 the increase in white shrimp weight is slower than the increase in carapace length, whereas at station 3 the increase in carapace length is slower than weight gain. Other authors reported that if the value of $b = 3$, then growth is said to be isometric or increase in carapace length equal to weight gain, whereas if the value of $b$ is greater or less than 3, growth is said to be allometric or carapace length increased not equal to body weight [10]. The same opinion is expressed by [1] which states that the positive allometric growth when the value of $b > 3$, which illustrates that weight gain is faster than the increase in length, whereas the negative allometric growth when the value of $b < 3$, which illustrates that the increase in length is faster than the weight. The positive allometric growth at station 2, because this station is a natural mangrove area, so it has a high fertility.

Mangrove forest water characteristics are suitable for the growth of white shrimp, due to the density of mangrove trees 1300 ind.ha$^{-1}$, can produce waste 35,093.33 g.ha$^{-1}$day$^{-1}$, with detritus production 1,216.68 g.ha$^{-1}$day$^{-1}$. Density of mangrove tree 1,067 ind.ha$^{-1}$, can produce waste 32,941.33 g.ha$^{-1}$day$^{-1}$, with production of detritus 1129.09 g.ha$^{-1}$day$^{-1}$. Density of mangrove trees 800 ind.ha$^{-1}$, can produce 30,574.67 g.ha$^{-1}$day$^{-1}$ waste, with detritus production 1,119.94 g.ha$^{-1}$day$^{-1}$, density of mangrove tree 1,200 ind.ha$^{-1}$, can produce waste 34,749.33 g.ha$^{-1}$day$^{-1}$, with the production of 1,145.10 g.ha$^{-1}$day$^{-1}$ detritus and the density of mangrove trees 767 ind.ha$^{-1}$, can produce waste of 28,597.33 g.ha$^{-1}$day$^{-1}$, with the production of detritus 1,099.35 g.ha$^{-1}$day$^{-1}$. Some factors that cause positive or negative allometric growth include physiological and environmental conditions such as temperature, pH, salinity, geographical location and sampling technique [6].

The results show that white shrimp at station 1 and 2 are slightly larger or robust than station 3. The results may be caused by the salinity factor in which the value at station 3 is lower than station 1 and station 2 [12].
3.5 Ponderal index
The results of the analysis indicate that the white shrimp ponderal index at each station ranges from 1.0156 - 1.0282, as shown in Table 2.

| Ponderal Index | Station | 1    | 2    | 3    |
|----------------|---------|------|------|------|
|                |         | 1.0156 | 1.0198 | 1.0282 |

The ponderal index of white shrimp at each station greater than 1 or PI > 1. This indicates that the condition of white shrimp in estuary waters has good growth. This corresponds to [13] which states if the ponderal index value is 2-4, the shrimp body can be said to be lean, and if 1-3 then the shrimp body can be said to be fat. Based on the results obtained, it is assumed that at the time of doing research, is the beginning of spawning season of white shrimp, although many also get small white prawns.

4. Conclusions
1) The highest value of white shrimp abundance was found at station 2 of 19.39 ind/m² and the lowest in station 3 was 10.47 ind/m².
2) The distribution of white shrimp in each station is common with Distribution Index (DI) of 3
3) The growth of white shrimp at station 1 and 3 was negative allometric with b < 3, and station 2 the value of b obtained is greater than 3 or b> 3, so it can be said that the growth of white shrimp at station 2 is positive allometric.
4) Index of white shrimp foundation in each station is greater than 1 or PI> 1, which illustrates that the condition of white shrimp in estuary waters exhibit good growth.

References
[1] Bhadra S and Biradar RS 2000 Journal of the Indian Fisheries Association 27 65
[2] Mulya M B 2012 Kajian Bioekologi Udang Putih (Penaeus merguiensis de Man) di Ekosistem Mangrove Percut Sei Tuan Sumatera Utara (Bogor: Institut Pertanian Bogor)
[3] Nontji A 1993 Nusantara Sea (Jakarta: Penerbit Djambatan)
[4] Boyd CE and Fast AW 1992 Pond Monitoring and Management (Amsterdam: Elsevier Publish.)
[5] Peter JC and Kerr JD 2003 Journal of Experimental Marine Biology and Ecology 69 37
[6] Tung H, Lee SY, Keenan CP and Marsden G 2002 Journal of Thermal Biology 27 433
[7] Dall W, Hill BJ, Rothlisberg PC and Sharples DJ 1990 The Biology of the Penaedae (London: Academic Press)
[8] Boyd CE 2003 Journal of Applied Aquaculture 13 11
[9] Pramonowibowo, Hartoko A and Ghofar A 2007 Journal of Sea Sand 2 18
[10] Sparre P and Venema SC 1998 Introduction of Tropical Fish Stock Assessment (Rome: FAO Fisheries Technical Paper)
[11] Mulya MB and Jhon AH 2018 IOP Conf. Ser.: Earth Environ. Sci. 130 012033
[12] Mulfizar, Muchlisin ZA and Dewiyanti I 2012 Depik 11
[13] Silaen SN and Mulya MB 2018 IOP Conf. Ser.: Earth Environ. Sci. 130 012044