Case study of mangrove ecosystem services for tiger shrimp (*Penaeus monodon*) in the practical silvofishery

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Abstract. Mangroves are a particular form of brackish plants, estuaries, and deltas which distributed in tropical and sub-tropical areas. Mangrove has various functions including the ecological functions of mangrove forests such as nesting places, spawning, and enlargement of various types of fish, shrimp, crabs, birds, and other fauna. This study was aimed to determine the mangrove ecosystems service to produce tiger shrimp (*Penaeus monodon*) in silvofishery ponds that are consisting domination of trees and saplings. Survival of shrimp at trees domination was 0.21% with a total of 125 individual, yielded as much as 1.2 kg. Shrimp survival at saplings domination was 0.31% with a total of 186 individuals, yielded of 1.8 kg. To further increase production results in silvofishery ponds, it is necessary to regulate the techniques of preventing predatory animals that enter the pond when the floodgates are opened, namely by placing a smooth net and repairing the fort.

1. Introduction

The existence of mangrove forests provides many benefits for the community, especially in coastal areas in the form of goods obtained through increased catches fishery [1]. In addition, the mangrove area provides enormous environmental services, namely coastal protection from storms and erosion and direct income for the community through ecotourism activities [2].

The level of damage to the world's mangrove ecosystems, including Indonesia, is very fast and dramatic. Efforts to optimize utilization which is also an act of conserving mangrove forests can be made through a silvofishery [3]. Silvofishery is an integrated form of mangrove cultivation with brackish water ponds [4-5]. In addressing the transfer of the function of mangrove forests into fish ponds, introducing the use of mangroves silvofishery.

The effort was made to rehabilitate mangrove forests and also support the economy of the people who live nearby [6-7]. This activity makes this research relevant to conduct, namely to assess whether the use of silvofishery patterns is more profitable than the use of non-silvofishery patterns and to ensure the sustainable use by surrounding communities who depend on mangrove forests [3, 5].
The purpose of this study was to determine the mangrove ecosystem services on the production of tiger shrimp (Penaeus monodon) in silvofishery ponds.

2. Materials and method

2.1. Mangrove vegetation
Mangrove vegetation data collection is done by observing mangrove vegetation in the pond. The parameters observed were the type and density of the mangrove vegetation. Mangrove density is the number of mangrove individuals per observation area (hectares). Measurement of mangrove density was done by counting all mangrove vegetation contained in ponds as previously reported [5].

2.2. Water quality data
Water quality parameters measured at each water quality sampling location were temperature, salinity, brightness, pH. Water quality sampling is carried out three times, namely when the seeds are to be sown, at the time of two months of maintenance and at the time of harvesting. Data collection on temperature, salinity, brightness, pH and carried out in situ [1-2].

2.3. Production of tiger shrimp
Data on the production of shrimp individual done by direct observation in the study site ie, at the time of harvesting, then analyzed descriptively [5].

3. Results and discussion
Silvofishery ponds in this study are reforestation and revegetation planted in two stages, namely in 2014 planting in the middle of the pond while in the embankment planted in 2016 to differentiate in the level of mangrove vegetation with an area of 0.4242 ha on each pond as shown in Fig. 1. Fig. 1 depicted A as tree dominated, whereas B was sapling dominated.

![Figure 1. Silvofishery pond layout. A: dominated trees, B: predominated saplings](image-url)
Table 1. Water quality conditions in each observation Pond

| No. | Parameter | Unit | Domination | Quality Standards |
|-----|-----------|------|-------------|-------------------|
|     |           |      | Tree        | Sapling           |
| 1   | Temperature | °C   | 30 - 32     | 30.5 - 31.5       | 28-32             |
| 2   | Brightness  | Cm   | 46 - 53     | 39 - 51           | 20-40             |
| 3   | Salinity   | %    | 10 - 20     | 17 - 23           | 15-30             |
| 4   | pH         | -    | 4.5-1       | 4.1 - 5.7         | 7-8.5             |
| 5   | DO         | ppm  | 5.8-6.3     | 5.7-6.8           | 3-8               |

Table 1 showed that the temperature of the water when it is measured in the tree domination pond was 30-32 °C and in the pond dominance saplings was 30.5-31.5 °C. According to [8] the best water temperature for growth and life of tiger prawns ranges between 28-32°C. Water temperature is very influential on the chemical and biological processes of the waters. Based on this, the water temperature at the two ponds is suitable. Furthermore, the brightness of the waters when carried out measurements on the tree domination ponds were 46 -53 cm and on the ponds dominated by saplings that were 39 -51 cm (Table 1). The suspended positively correlated with turbidity [9]. The higher the value of the suspended solids, the turbidity value is also higher. However, the high dissolved solids are not always followed by high turbidity. For example, seawater has a high dissolved stable value, but that does not mean it has high turbidity. When the brightness has reached a depth of less than 35 cm, water change should be done immediately before the phytoplankton died, followed by a decline, oxygen dissolved drastically [3, 10].

When the water salinity measurements in ponds dominance tree namely 1 0-20 ppt and in ponds domination stake are 17-23 ppt, according to [11] ideal salinity for shrimp growth between 10 - 35 ppt, with daily fluctuations of no more than 5 ppt, based on this matter, the quality of each fishpond is classified as suitable for tiger shrimp farming activities. pH was measured when the water in the ponds dominance tree, namely 4- 5, 1, and in ponds domination stake of which is 4, 1 -5, 7. According to [12] suggested that in acidic waters, less productive can actually kill cultivated animals. At low pH, the dissolved oxygen content is reduced, resulting in decreased oxygen consumption, bag up, and taste respiratory make late will be reduced. [11] suggested that pH was measured by a pH meter carried out in the morning and evening. The ideal pH for shrimp growth is between 7.5 - 8.5, with daily pH fluctuations of 0.2 - 0.5. Based on this, the pH in each pond is not suitable for the growth of tiger shrimp because it is acidic. According to [13], one way to improve acidity is to do calcification. DO measurement moment waters in ponds dominated trees were 5.8 to 6.3 mg/l, and in ponds, domination saplings were 5.7 -6.8 ml. According to [14] suggested that optimal dissolved oxygen for shrimp ranged from 4.5 -7 ppm.

Table 2. Shrimp harvesting in each pond

| Shrimp Sivofishery | Weight/Size (g) |
|--------------------|-----------------|
| Tree domination    | 1.200           |
| Sapling domination | 1.800           |

Table 2 shown that after the harvesting process, the results obtained from the tree domination pond are 1.2 kg, and sapwood dominance is 1.8 kg. The level of fitting san live shrimp tend to be lower in the second pond, this is indicated shrimp are experiencing stress during a trip to the farm plus quality standards of water quality (pH) is low below the quality standard allowable shrimp stressed excess so that the activities and eating shrimp decreases so shrimp fries cause death. According to [15] at low pH, the dissolved oxygen content will decrease, so that oxygen consumption will decrease which
causes increased respiratory activity and appetite will decrease. The way to increase and maintain the pH value in the pond is by liming and regular water replacement. This is following the [16], one way to improve the degree of acidity is by liming. Subsequently occurring continuously for several weeks at the time of the shrimp still the possible cause of death due to rainfall that occurs continuously can reduce the temperature of the water in the ponds so that juveniles are vulnerable to changes in water quality are not able to adapt so many shrimp fries have died. According to data obtained from the Meteorology and Geophysics Agency in the sub-district Brandan Barat in 2018, there were rains with precipitation of rains showed highly in October was 314 mm/month, November was 145 mm/month, and December is 222 mm/month there. The average rainfall is divided into three categories, namely low (0-100 mm), medium (100-300 mm), and high (300-500 mm).

4. Conclusions
Production results in silvofishery ponds, it is necessary to regulate the techniques of preventing predatory animals that enter the pond when the floodgates are opened, namely by placing a smooth net and repairing the fort.

5. References
[1] Fitri A, Basyuni M, Wati R, Sulistiyono N, Slamet B, Harahap ZA., Balke T, Bunting P 2018 AACL Bioflux 11 1252-1264.
[2] Ambarita STP, Basyuni M, Sulistyonono N, Wati R, Fitri A, Slamet B, Balke T, Bunting P, Munir E 2018 J. Theor. Appl. Inf. Technol. 96(19) 6306-6317
[3] Basyuni M, Nasution KS, Bimantara Y, Hayati R, Slamet B, Sulistiyono, N 2019 IOP Conf. Ser.: Earth Environ. Sci. 305 012038.
[4] Ahmed, N, Thompson S, Glaser M 2018 Ambio, 47(4) 441-452.
[5] Basyuni M, Nasution KS, Slamet B, Sulistiyono N, Bimantara Y, Putri, LAP, Yusraini E, Lesmana I 2019 IOP Conf. Ser.: Earth Environ. Sci. 260 012115.
[6] Fahmi M, Fatimah E, Fitrayansyah A 2018 Int. J. Disast. Risk Re. 29 24-36.
[7] Kongkeaw C, Kittitornkool J, Vandergeest P, Kitiwatanawong K 2019 Ocean Coast. Manage. 178 104822.
[8] Mayor ABR, Paz D, Silk E, Devanadera MKP 2019 Philippine J. Fish., 26(1) 15-25.
[9] Zhao P, Xia X, Dong J, Xia N, Jiang X, Li Y, Zhu Y 2016 Sci. Total Environ. 568 57-65.
[10] Zhang H, Boegman L, Scavia D, Culver DA 2016 J. Great Lakes Re. 42(6) 1212-1227.
[11] Mudagandur SK, Gopalapillay G, Vijayan KK 2016 Abiotic and biotic stress in plants-Recent advances and future perspectives 101-120.
[12] Romano N, Kumar V 2018 Rev. Aquacult. 2018
[13] Ng WK, Koh CB, Teoh CY, Romano N 2015 Aquacult. 449 69-77.
[14] Peña - Rodríguez A, Magallón - Barajas FJ, Cruz - Suárez LE, Elizondo - González R, Moll B 2017 Aquacult. Res. 48(6), 2803-2811.
[15] Capaz JC, Tunnah L, MacCormack TJ, Lamarre SG, Sykes AV, Driedzic WR 2017. Frontiers Physiol. 8 344.
[16] Abd El-Halim AA, Omae H 2019 Soil Sci. Plant Nutr. 65 1-7.

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