Mangrove vegetation supports milkfish production in silvofishery pond

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Abstract. The present study reports mangrove vegetation to support the milkfish (Chanos chanos) production in the silvofishery pond. This study aimed to determine the relationship between the densities of mangrove vegetation on C. chanos cultivation in a silvofishery pond and to determine the factors that influence milkfish production. 10,000 milkfish fries with a size of 3-4 cm were cultivated for six months in the silvofishery pond on sapling and seedling density based. The collection of milkfish production data was observed when harvesting was carried out. There are three mangrove vegetation inside the pond detected, including Rhizophora apiculata, R. mucronata, and Avicennia marina. Average water temperature measured in sapling dominance pond was 29-31.5 °C and seedling dominance pond 2 was 30-31.5 °C. The density of mangrove sapling domination was 870 individual, 265 fish average weight of 147.4 g/milkfish yielded 39.1 kg while on seedling dominance has a density of mangrove of 695 individuals, with the level of fish was 436, average fish weight 95 g/milkfish yielded 41.4 kg. This research provided consideration for decision makers in implementing sustainable mangrove management policies.

1. Introduction

Mangroves grow in the tropical and subtropical countries with an area of the world around 15.2 million ha, where the area of mangrove ecosystems in Indonesia is 3.5 million ha [1]. Mangrove ecosystems have been degraded mainly is caused by the conversion of mangrove land, illegal logging, pests and diseases, pollution and expansion of ponds practices resulting in deforestation in coastal ecosystems [2-3]. In North Sumatra, conversion of mangrove forest has been reported to be aquaculture, logging, reclamtion, and sedimentation due to high pressure on population [4-5].

Mangrove forests have a full role, including physical, biological/ecological, and potential economic [6-8]. The physical function of mangrove forests for breakwaters, coastal protectors from abrasion, prevention of seawater intrusion to land, processing of organic waste, mud retaining, and trap pollutants [6]. Biological roles as a spawning ground and nursery ground for fishery commodities, food providers for organisms living around mangrove ecosystems, protecting biodiversity, and as carbon sinks and oxygen producers [7-8].

The economic benefits of mangrove ecosystems are firewood for residents' needs, utilization of wild animals, and fishing. The gains in the mangrove ecosystem are as a source of fisheries, wood,
food, animal feed, medicinal ingredients, industrial raw materials, tourism, and education [9-10]. Land use around the mangrove ecosystem consists of fisheries or ponds, agriculture, as well as development areas and buildings [10-11].

The village of Lubuk Kertang, Langkat, North Sumatra, Indonesia is one of the communities that have a mangrove area on the east coast of the island of North Sumatra and presently have been degraded due to land conversion [11-12]. One way to sustain mangrove ecosystems was by utilizing silvofishery. Silvofishery models are a form of mangrove tree cultivation integrated with brackish water cultivation [8, 11]. This study, therefore, aimed to determine the relationship between the densities of mangrove vegetation on milkfish production (*Chanos chanos*) in silvofishery ponds and to determine the factors that influence the milkfish production.

2. Materials and Method

2.1. Study area

The work was done in Lubuk Kertang village, North Sumatra, Indonesia which is situated at 04° 07' 39.71" North latitudes, and at 98° 30' 97.87" East longitudes. Lubuk Kertang is governed at Langkat Regency and district of Brandan Barat. The silvofishery pond is sited at 04° 03'29.69" NL and 98°15'48.59" ET. The materials used in the study were 10,000 milkfish (*C. chanos*) dries measuring 3-4 cm in size, mangrove vegetation, and silvofishery ponds with an area of 8,484 m2.

2.2. Research procedure

Researching milkfish cultivation in silvofishery ponds following the process [8, 11]:

a. Pond processing. Processing on silvofishery ponds includes repairing dams, canals, and inlet gates. And then the elimination of pests is done by eradicating predators and competitors.

b. The spread of milkfish dries. The dries were stocked in maintenance, or enlargement pond are 3-4 cm size seeds. The range of seeds is done at low temperatures. This activity is intended to prevent seeds from being stressed. The milkfish seeds should have passed the acclimatization process for two weeks to reduce mortality during the enlargement/maintenance period.

c. Acclimatization. The acclimatization process was carried out because of differences in temperature and salinity conditions in pond water. Milkfish fries prepared as many as 10,000 tails size 3-4 cm.

d. Harvesting. There are two methods of collecting, namely at high tide (attack) and low tide [11]. The collection is done gradually adjusting when the estuary water begins to recede. Gradual harvesting is done at night by opening the main pond sluice (silvofishery gates) and laying nets at the maintenance ponds so that the water in the pond will come out slowly and the fish will be collected at one point on the sluice gate. Total harvesting is done using nets.

2.3. Water quality

Water quality parameters measured at each sampling location for water quality are temperature, salinity, brightness, and pH. A sampling of water quality is carried out four times, namely when the milkfish dries were stocked, during two months of cultivation, during four months of support, and at the time of harvesting. Data collection on temperature, salinity, brightness, and pH was done in situ as previously reported [8].

2.4. Milkfish production

Data collection of milkfish production is done by observing directly at the research location, namely when harvesting is done by calculating all the weight of the fish in each pond and calculating the average weight and percentage of fish survival as previously described [11].

3. Results and Discussion

3.1. Water quality parameter

Water quality obtained from observations is four times presented in Table 1 and Figure 1. Measurement for water temperature was made on sapling dominance ponds were 29-31.5 °C, and in
seedling, dominance ponds were 30-31.5 °C. The water temperature of the two ponds did not show a significant difference due to the growing place and mangrove which are still the types of seedlings and saplings so that the penetration of light can enter easily [5, 7]. It has been reported that the optimum water temperature for milkfish cultivation is 28-32 °C [8, 13]. Based on this observation, the water temperature in the two ponds is proper. Temperature observations were displayed in Table 1 and Figure 1.

| No. | Parameter | Unit | Sapling dominance | Seedling dominance | Standard |
|-----|-----------|------|-------------------|-------------------|----------|
| 1   | Temperature | °C   | 29-31.5           | 30.5-31.5         | 28-32    |
| 2   | Brightness   | Cm   | 47-53             | 40-52             | 20-40    |
| 3   | Salinity     | %    | 18-25             | 18-23             | 15-30    |
| 4   | pH          |      | 4-5.2             | 4.2-5.8           | 7-8.5    |
| 5   | DO          | Mg/l | 4-6.5             | 4.5-6.8           | 3-8      |

The brightness of the waters was measured in ponds dominated by saplings was 47-53 cm and in ponds dominated by seedlings was 40-52 cm (Table 1, Figure 1). The optimum water brightness for milkfish cultivation is 20-40 cm [13]. Based on this finding, the intensity of the waters in the sapling domination ponds is less optimum, and the seedling domination ponds are quite optimum for milkfish cultivation.

![Figure 1. Changes in temperature, pH, salinity and DO for four observations](image)

Salinity was measured in sapling domination ponds around 18-25%, and in seedling domination ponds were 18-23%. Salinity in each pond is considered suitable for milkfish cultivation because...
milkfish are classified as euryhaline organisms which are able to live in a wide range of salinity [11]. This result was in accordance with the previous finding that milkfish can live in current areas (ponds/rice fields), brackish water (ponds), and saltwater (sea) [14]. The optimum salinity for milkfish growth was 15-30 ppt.

The pH of the waters was measured on pond dominance 4-5.2, and the seedling dominance ponds were 4.2-5.8 as depicted in Table 1 and Figure 1. It has been suggested that less productive acidic waters it can kill aquaculture animals [15]. At low pH, the dissolved oxygen (DO) content will decrease. Consequently, oxygen consumption will decline, respiratory activity will increase, and appetite will decrease. The optimum water pH for milkfish pond cultivation was 7-8.5. Based on this observation, the pH of the waters in both ponds did not meet the quality standards for the advancement of milkfish ponds [15].

The optimum DO water for milkfish aquaculture is 3-8 mg/L. Based on this standard, DO waters in the optimum sapling domination ponds, and seedling domination ponds are optimum for the cultivation of milkfish ponds. The results of DO observations can be seen in Figure 1. DO waters were made on sapling dominance, 4-6.5 mg / L and in seedling dominance ponds of 4.5-6.8 mg/L. DO in both ponds is suitable for milkfish cultivation. The resu

3.2. Milkfish production

Data on fish harvesting in each pond was presented in Table 2. From Table 2, it is seen that after harvesting the results obtained at the ponds were sapling dominance, which was 39.1 kg and seedling dominance was 41.4 kg. The effects of harvesting from the level of fish life tend to be low in both ponds can be seen in Table 3. This result was indicated by fish experiencing stress during the trip to the farm plus the quality standard of water quality (pH) which is low below the quality standard which allows fish to experience excessive stress and activity fish appetite decreases so that milkfish fries experience excessive stress which causes death [15]. The decreasing value of water quality in ponds can trigger stress in fish and even cause mortality [11].

| Table 2. Fish harvesting in the silvofishery pond |
|-----------------------------------------------|
| Type of silvofishery pond | Weight/Size (g) |
| Sapling dominance | 39.100 |
| Seedling dominance | 41.400 |

Based on SNI (6148.3: 2013) concerning Milkfish Seed Production for pH quality in this study it was below the quality standard. It has been shown that at a low pH, the dissolved oxygen content will decrease so that oxygen consumption will decrease which causes increased respiratory activity and appetite will decrease [13]. To expand and maintain the pH value of ponds, namely by giving lime and replacing water regularly.

| Table 3. Data on the level of fish survival in each pond |
|---------------------------------------------------------|
| Silvofishery type | Amount | Percentage |
| Fish survival on sapling dominance | 265 | 4.92% |
| Fish survival on seedling dominance | 436 | 8.7% |

In addition, calcification can be done when the pH is less than 7 or is in an acidic state [15]. Rainfall that occurs continuously for several days when fish still fry is also a possible cause of death.
from shrimp fries because the rainfall that occurs consistently can reduce the water temperature in the ponds so that fries that are susceptible to changes in water quality are unable to adapt so that many fish tiller the dead. This circumstance is following data obtained from the Meteorology, Climatology and Geophysics Agency (BMKG) in the area of West Brandan sub-district at the end of November to the beginning of December 2017 with heavy rainfall and heavy rainfall for six consecutive days. The level of fish survival in each pond can be seen in Table 2.

There are differences from the average yield of fish where the sapling domination pond is larger than the seedling domination pond as shown in Table 4. This condition was possible by the composition of mangrove in sapling domination ponds higher than seedling domination ponds. It is indicated that in ponds with sapling domination higher composition of sapling than seedlings which means that the vegetation composition was higher the litter production will increase and decomposition will be higher which will eventually trigger the growth of phytoplankton as food from biota which can affect growth milkfish [16]. The biological function of mangroves is as a food provider for organisms around mangroves and places to carry out the life of the surrounding biota [17].

| Table 4. The yield of milkfish harvesting |
|-----------------------------------------|
| The average weight of fish              | Fish weight (g/fish) |
| Sapling dominance                      | 147.6                |
| Seedling dominance                     | 95                   |

The density of the fries stocked is also indicated as one of the causes of differences in the average weight of fish due to competition for feed and the space between fish and fish and competitors to be tight. This is consistent with the previous reports that density factors will affect the survival of the population [16]. Fish survival is influenced by internal and external factors [13-16]. Internal factors that influence are resistant to disease, feed, and age. External factors that affect are stock density, disease, and water quality. In addition, the presence of natural competitors such as tilapia, mullet, and birds that interfere with fish life is also possible to be one of the causes of differences in the weight of fish. There are several competitors for milkfish in utilizing space, food and oxygen including wild fish snails and mall shrimp.

4. Conclusions
This present research provided consideration for decision makers in implementing sustainable mangrove management policies. Fish survival is influenced by internal and external factors Factors that influence milkfish production in this study are pH, fish stock density and rainfall.

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