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Introducing of a silvofishery pond on sapling and seedling density based in Lubuk Kertang Village, North Sumatera

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Abstract. The present study reports the introducing of mangrove management through community-based silvofishery pond according to the density of sapling and seedling stage in Lubuk Kertang village, Langkat, North Sumatra, Indonesia. The vegetation in the silvofishery pond consisted of *Rhizophora apiculata*, *R. mucronata*, and *Avicennia marina*. Silvofishery pond was introduced with an area total of 8,484 m², with an area of 0.4242 ha in each pond of dominated seedlings and saplings, respectively. In the predominated seedling density over sapling showing almost twice found that seedling density consisted of 297 individual/ha which domination of *R. apiculata* compared to sapling density of 144 individual/ha. Similarly, 726 individual/ha was recorded in the sapling stage, where *R. mucronata* dominated. Furthermore, the seedling density in the sapling domination ponds for the seedling level was 398 individual/ha. *R. mucronata* detected in ponds with sapling dominance and seedling domination generally located in the middle part of the pond. By contrast, *R. apiculata* dominated the seedling level either in the seedlings or saplings stage. Introducing silvofishery with seedling and sapling stages should use recommended species such *R. mucronata* and *R. apiculata* to sustain nutrient of fish and to generate high phytoplankton growth.

1. Introduction

Primary and secondary mangrove forests in North Sumatera, Indonesia comprised about 50,369.8 ha in 2015 and distributed mainly in the eastern and small part of the western coast of Sumatra Island [1]. Mangroves generally thrived in Asahan, Serdang Bedagai, Deli Serdang, Batubara, Tapanuli, Nias, Labuhan batu up to Langkat [1-2]. The noteworthy function of ecology/biology, economy, and physical of mangroves has been recognized, nonetheless; mangroves are presently the utmost endangered ecosystems attributable to direct and indirect degradation and deforestation [2-4].



Mangrove forests have complex functions from physical functions, biological functions, and potential economic functions (Figure 1). Biological functions of mangroves work for a spawning ground and growth after the larvae (nursery ground) of fishery commodities, food providers (feeding ground) for organisms that live around mangrove ecosystems, protect against biodiversity, and as carbon sinks and oxygen producers [5]. The physical function of mangrove forests, namely for breakwaters, coastal protection from abrasion, prevention of seawater intrusion into the land, organic waste processing, mud retaining, and trap pollutants. The economic mangrove functioned as fuelwood, pond or aquaculture, and ecotourism [6].

Lubuk Kertang village, Langkat, North Sumatra has a mangrove area and currently have been degraded due to land conversion to aquaculture and oil palm plantation [7]. One of the ways to maintain mangrove ecosystems by management through community-based silvofishery. Silvofishery is a form of mangrove conserving integrated with fishery cultivation for enhanced source of revenue of local societies adjacent mangrove forest [8]. The present study, therefore, aimed to introduce silvofishery pond on sapling and seedling density based in Lubuk Kertang Village, Langkat, North Sumatera, Indonesia.

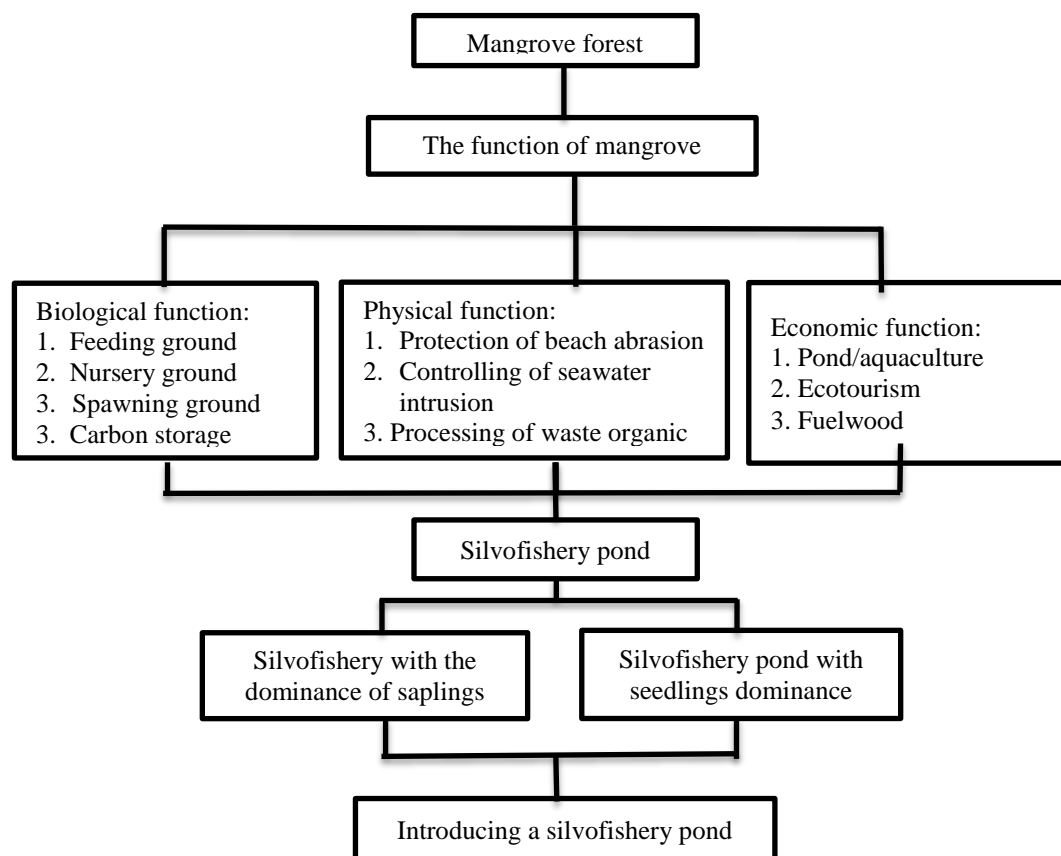


Figure 1. Characteristic of silvofishery in Lubuk Kertang including the function of mangroves.

2. Materials and method

2.1. Study area

The work was performed in Lubuk Kertang mangrove forest, North Sumatra, Indonesia. The Lubuk Kertang village is situated at 04° 07' 39.71" North latitudes, and at 98° 30' 97.87" East longitudes. Lubuk Kertang is administrated at Langkat Regency and district of Brandan Barat. The silvofishery is situated at 04° 03' 29.69" NL and 98° 15' 48.59" ET.

2.2. Data collection

Figure 1 shows the feature for introducing of silvofishery together with the function of mangrove forest relating to silvofishery and the consideration to develop silvofishery based on the density of mangrove stage (sapling and seedling) data collection as earlier described [8].

3. Results and discussion

Silvofishery pond in this study resulted of reforestation program and the re-vegetation in silvofishery ponds was planted in two stages, in 2014 replanting was carried out in the middle part of the pond while in part the embankment was planted in 2016. Therefore, there are differences in the level of existing mangrove vegetation: seedlings and saplings. Silvofishery pond was introduced with an area of 8,484 m², with an area of 0.4242 ha in each pond (Figure 2A and B). The silvofishery area was affected by tidal sea development; therefore, the mangroves were planted in the middle and around the pond as well. This action was to reinforce the beds soil structure as not to be crumpled by the tides. The mangrove planted in the silvofishery area is projected to return productiveness and bounce space to the fish or shrimp seeds that have been propagated by farmers and deactivate toxins that occur in the earlier fish or shrimp pond [8].

Preservation of aquacultures in the Lubuk Kertang village regarding to manage water for the practice is fully structured as depicted in Figure 2a. Figure 2 also shows that water approaching from the salty water entered the pond from side to side a sluice through for the launch of saline water and commonly drainage system water.

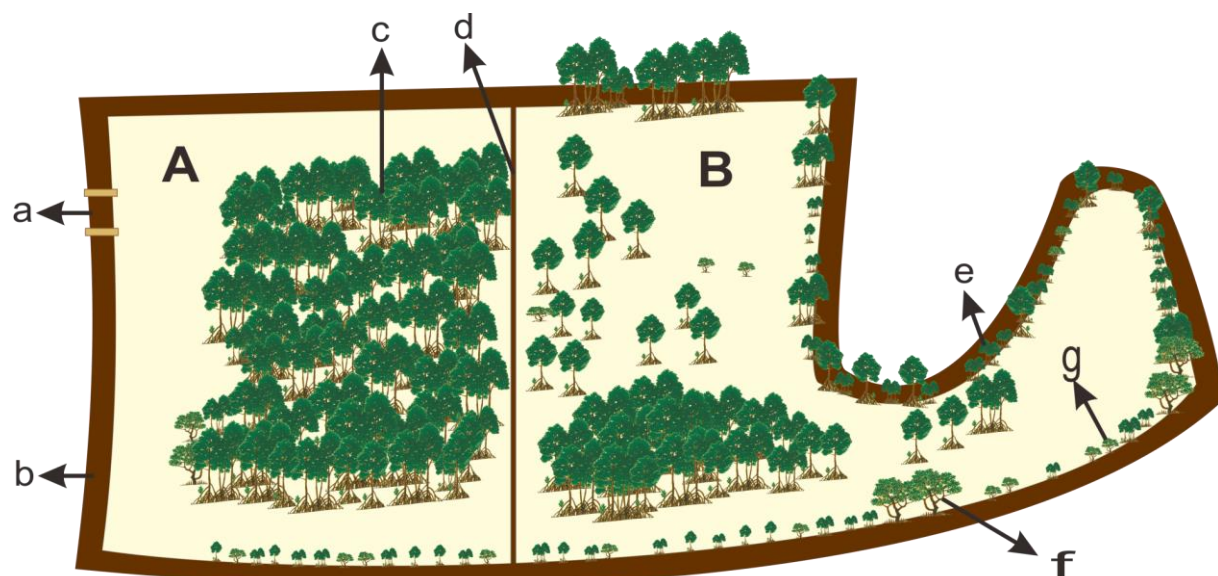


Figure 2. Silvofishery model in Lubuk Kertang village. A. Silvofishery with the dominance of saplings, B. Silvofishery with the dominance of seedlings. a. Pond sluice (silvofishery gate for brackish water), b. Beds, c. *Rhizophora* saplings, d. Limiting net, e. *Rhizophora* seedlings, f. *Avicennia* saplings, g. *Avicennia* seedlings.

The description of the composition of vegetation found in each pond depicted in Figure 3. Mangrove planted in the silvofishery scheme of Lubuk Kertang Village comprises of, *A. marina*, *R. apiculata*, and *R. mucronata*. These mangroves are planted on the center and brink of the ponds for the reason that they possess an essential function in generating high phytoplankton growth. The kind of

pond predominated by *R. mucronata* is more appropriate for plankton growth and was able to afford higher nutrient than other species of mangrove stands [9]. In this circumstance *Rhizophora* roots do not hinder the pond development. *R. mucronata* and *R. apiculata* leaves are being used for animal feeding such as cow and goat and offer gloominess for living creatures that are around the silvofishery pond [10-11].

A. marina was tree or shrub-shaped as depicted in Figure 3A, height can reach 12 meters, root of the breath like a pencil. Elliptical leaf shape with a single arrangement crosses and has a length of 5-11 cm. *A. marina* has a fruit with a width of 1.5-2.0 cm with a diameter of 1.5- 2.5 cm, the surface of the fruit is hairy and resembles a nut [11].

R. apiculata was tree-shaped with a height of up to 15 m, with root support (Figure 3B). Single leaf arrangement crosses; the ellipse narrows with sharp edges and has a length of 9-18 cm. The bottom surface of the leaves is yellowish green, has small black spots that spread throughout the lower surface of the leaf and has smaller leaf characteristics than all types of *Rhizophora*. The bark is dark grey and patterned like a mosaic. The cylindrical-shaped fruit has a diameter of 1.3-1.7 cm, 20-25 cm long with a relatively smooth speckled fruit surface with a green to brownish colour [11].



A



B



C

Figure 3. Mangrove species found in the silvofishery site. A. *A. marina*, B. *R. apiculata*, and C. *R. mucronata*.

R. mucronata on the other hand characterized by shaped trees with height can reach 25 m and have supporting roots (Figure 3C). The composition of a single leaf crosses; the ellipse narrows with a tapered tip (shaped like a tooth protrusion) and has a length of 15-20 cm. *R. mucronata* has the lower surface of the leaves is yellowish green, has small black spots that spread throughout the lower surface of the leaf, its size is larger than *R. stylosa*. The cylindrical-shaped fruit has a diameter of 2.0-2.3 cm and a length of 50-70 cm in green to yellowish green [11].

Table 1. Species and density of seedling and sapling dominance

Stage	Species	Seedling density (Individual/ha)	Sapling density (Individual/ha)
Seedling	<i>A. marina</i>	45	14
	<i>R. apiculata</i>	205	116
	<i>R. mucronata</i>	47	14
	Total	297	144
Sapling	<i>A. marina</i>	9	2
	<i>R. apiculata</i>	42	21
	<i>R. mucronata</i>	347	703
	Total	398	726

Table 1 illustrates the survey of the density of mangroves found in a silvofishery pond. In the predominated seedling density over sapling showing almost twice: seedling density consists of 297 individual/ha which domination of *R. apiculata* compared to sapling density of 144 individual/ha. Similarly, for sapling level, 726 individual/ha was recorded in the sapling stage, where *R. mucronata* dominated. Furthermore, the seedling density in the sapling domination ponds for the seedling level was 398 individual/ha. *R. mucronata* in ponds with sapling dominance and seedling domination are generally located in the middle part of the pond. By contrast, *R. apiculata* dominated the seedling level either in the seedlings or saplings stage (Table 1).

Mangroves usually were planted on the embankment are *Rhizophora* sp, *Sonneratia* sp, *Xylocarpus* sp, and for the middle/yard of the pond was primarily was *Rhizophora* sp. Our previous report showed [8, 12] the silvofishery system of mangroves species were *R. mucronata*, *R. apiculata*, and *R. stylosa*, which planted on the border of the pond due to having a significant function in increasing the growing of high phytoplankton.

The existence of *R. mucronata* which is generally located in the middle of the pond is perfect besides as a shelter from natural predators as well as one of the suppliers of natural food for fish growth both from the decomposition process of leaf, twig and fruit litters which causes the development of detritus [12]. It has been shown that *R. mucronata* is more suitable to be planted in the middle part of a pond because it can provide higher nutrition than other species [8].

4. Conclusions

Silvofishery pond integrated between mangrove management, and utilization of fishery is a promising alternative to maintain mangrove forest. Introducing silvofishery with seedling and sapling stages should use recommended species such *R. mucronata* and *R. apiculata* to sustain nutrient of fish and to generate high phytoplankton growth.

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