Diversity of mangrove species associated with zonation in Lubuk Kertang Village and Pulau Sembilan, North Sumatra

M K Nawar¹, M Basyuni²* and C Hanum³

¹ Magister Program of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, North Sumatra 20155, Indonesia
² Center of Excellence for Mangrove, Universitas Sumatera Utara, Medan, North Sumatra 20155, Indonesia
³ Department of Agrotechnology, Faculty of Agriculture, Universitas Sumatera Utara, North Sumatra 20155, Indonesia

*Email: m.basyuni@usu.ac.id

Abstract. The Research about the diversity of mangrove species associated with zonation in Lubuk Kertang Village and Pulau Sembilan, Langkat Regency, North Sumatera was conducted in March – April 2021. This study aims to determine the diversity of mangrove species based on zoning observations in Lubuk Kertang Village and Pulau Sembilan. The research was conducted using the exploration method. The observation zone for the diversity of mangrove species is divided into three zones, namely zone 1 in brackish or almost fresh waters behind the actual green mangroves, zone 2 along the river, brackish to almost fresh, and zone 3 on the part facing the sea. The results of the study were fifteen mangrove species with two different mangrove groups, namely four true mangrove species (Lumnitzera racemosa, L. littorea, Nypa fruticans, and Scyphyphora hydrophyllacea) and eleven associated mangrove species (A. auriculiformis, Barringtonia asiatica, Casuarina equestifolia, Hibiscus tiliaceus, Melastoma candidum, Morinda citrifolia, Pandanus odoratatissima, Pongamia. Pinnata, Sesuvium portulcastrum, Stachytarpheta jamaicensis, and Terminalia catappa). Furthermore, the observations in zone 1 were dominated by mangrove association groups, namely A. auriculiformis, B. asiatica, C. equestifolia, H. tiliaceus, M. candidum, M. citrifolia, P. odoratatissima, P. pinnata, S. portulcastrum, S. jamaicensis, and T. catappa). In zone 2 and 3 are dominated by true mangrove groups. This shows that data on the diversity of mangrove species is very necessary to preserve mangrove species in Lubuk Kertang Village and Pulau Sembilan and the growing zone of mangrove species is natural zoning of mangrove forests.

1. Introduction
Mangroves are very important for life in coastal areas. Mangrove ecosystems also play a role in the global carbon cycle [1-3]. This vegetation plays a role in protecting coastal areas and maintaining associated biota to maintain biodiversity. In addition, mangroves are also important for humans including fisheries, tourism, agriculture, forestry, preventing line erosion, beaches, firewood, and building materials [4]. The physical role of mangroves is to protect against erosion, sedimentation, and tidal waves [5].
Mangroves are spread in several countries in the world with an area of 19.9 million hectares, where Indonesia is the largest mangrove forest in Asia and even in the world. In addition, Indonesia has the highest level of mangrove diversity in the world, with a total of 202 mangrove species, consisting of true and associated mangrove groups [6]. The high diversity of mangroves is used as a valuable asset and its sustainability is maintained.

The distribution pattern of mangrove vegetation forms a distinctive pattern, namely forming zoning parallel to the coastline. Mangrove vegetation has various variations at different locations [6]. In addition, the types of mangrove vegetation are not always the same for each area. This shows that many factors determine the zoning pattern of mangrove vegetation. The influence of different environmental factors on the formation of zoning, zoning conditions that are not optimal due to the influence of environmental conditions such as soil conditions, salinity, duration of inundation, tidal currents, and human activities [7].

One of the coastal areas that have many mangrove forest ecosystems is Lubuk Kertang Village and Pulau Sembilan which is part of Langkat Regency, North Sumatra. This area is very rich in potential coastal, marine, and fishery resources which include biological, non-biological, and environmental. Mangrove forest areas in Langkat Regency have been damaged and are dwindling due to illegal encroachment, conversion of mangrove forests into oil palm plantations, ponds, agriculture, housing, factories, and tourist attractions [8, 9]. Thus, the thing that is most worried about the damage to mangroves is the loss of mangrove species which causes a reduction in species diversity of the mangrove ecosystem. Based on the description above, research on the diversity of mangrove species is carried out so that data on mangrove species is very necessary to maintain the preservation of mangrove species in Lubuk Kertang Village and Sembilan Island, Langkat Regency.

2. Materials and Methods

2.1. Study Site

Lubuk Kertang is located at Langkat Regency, Berandan Barat district, bounded on the East by Malacca Strait, and South by Perlis district and Pangkalan Batu (4º 03’ LU and 98º 16’00. 19” BT). Pulau Sembilan is located at Langkat Regency, Pangkalan Susu district, and bounded on the East by Malacca Strait, South by Pangkalan Susu, West by Teluk Arun, and North by Pulau Kampai Strait (04º 08’ 39.13” N and 98º 13’ 55.38” E) (Figure 1). Knowing that the mangroves in this area have high diversity, the local community works as fishermen, catching fish, crabs, and prawns close together in the mangrove plants. The local community in this village can take advantage of the mangrove fruits as a potential source of food and medicine.

2.2. Data analysis

This research is a descriptive study using the exploration method. This method is intended to collect data on mangrove species from each observation zone. The observation zone consists of 3 zones, namely zone 1 in brackish or almost fresh waters behind the actual mangrove green belt, zone 2 along the river with brackish to almost freshwater, and zone 3 on the part facing the sea. Furthermore, as additional data, salinity, pH, dissolved oxygen, and temperature were measured in each observation zone to determine habitat differences from each zone. Data analysis using ANOVA and continued with Tukey's test, the value of P < 0.05 as a significant limit. All statistical comparisons were calculated using the SPSS version 21 program.
3. Result and Discussion

3.1. Mangrove species at the research site
The results found fifteen mangrove species with two different mangrove groups, namely four true mangrove species (Lumnitzera racemosa, L. littorea, Nypa fruticans, and Scyphyphora hydrophyllacea) and eleven associated mangrove species (A. auriculiformis, Barringtonia asiatica, Casuarina equestifolia, Hibiscus tiliaceus, Melastoma candidum, Morinda citrifolia, Pandanus odoratatissima, Pongamia. Pinnata, Sesuvium portulcastrum, Stachytarpha jamaicensis, and Terminalia catappa). Furthermore, the observations in zone 1 were dominated by association mangrove groups, namely A. auriculiformis, B. asiatica, C. equestifolia, H. tiliaceus, M. candidum, M. citrifolia, P. odoratatissima, P. pinnata, S. portulcastrum, S. jamaicensis, and T. catappa, in zone 2, namely L. littorea and L. racemosa and in zone 3, namely N. fruticans and S. hydrophyllacea, zones 2 and 3 are dominated by true mangrove groups (Table 1).

There are different types of mangroves found in Lubuk Kertang and Pulau Sembilan villages in each observation zone. The existence of these differences is highly dependent on environmental factors and the habitat of each mangrove zone. Tides that indirectly control the depth of the water table, salinity, pH, temperature, and dissolved oxygen are the physical and chemical qualities of mangrove habitat and sunlight that affect the growth of tillers of each type of mangrove. This result can be seen from Table 2 which shows the differences of each zone.
### Table 1. Diversity of mangrove species associated zonation in Lubuk Kertang Village and Pulau Sembilan

| Species                  | Mangrove Group | Zonation       | Study Site   |
|--------------------------|----------------|----------------|--------------|
| A. Auriculiformis        | Mayor +        | √              | Pulau Sembilan |
| B. Asiatica              | +              | √              | Lubuk Kertang   |
| C. equestifolia          | +              | √              | Pulau Sembilan   |
| H. tiliaceus              | +              | √              | Lubuk Kertang   |
| L. littorea               | +              | √              | Pulau Sembilan   |
| L. racemosa               | +              | √              | Pulau Sembilan   |
| M. candidum               | +              | √              | Pulau Sembilan   |
| M. citrifolia             | +              | √              | Lubuk Kertang   |
| N. fruticans             | +              | √              | Pulau Sembilan   |
| P. odoratatissima         | +              | √              | Pulau Sembilan   |
| P. pinnata               | +              | √              | Pulau Sembilan   |
| S. hydrophyllacea         | +              | √              | Pulau Sembilan   |
| S. portulacastrum        | +              | √              | Pulau Sembilan   |
| S. jamaicensis            | +              | √              | Pulau Sembilan   |
| T. catappa               | +              | √              | Lubuk Kertang   |

Note: Mangrove mayor and associated are indicated by (+), then the sign (√) indicates mangrove zonation.

### Table 2. Characteristics of mangrove physical and chemical habitat based on zonation

| Zona | Physical and chemical characteristic of mangrove forest habitat |
|------|----------------------------------------------------------------|
|      | Temperature (°C) | pH | Salinity (ppt) | Dissolved oxygen (ppt) |
| Zona 1 | 27.56±0.20<sup>a</sup> | 7.43±0.05<sup>a</sup> | 13.33±2.08<sup>b</sup> | 3.70±0.26<sup>a</sup> |
| Zona 2 | 28.08±0.25<sup>b</sup> | 7.80±0.10<sup>b</sup> | 25.66±0.76<sup>b</sup> | 5.43±0.20<sup>a</sup> |
| Zona 3 | 30.10±0.95<sup>a</sup> | 7.93±0.05<sup>a</sup> | 32.66±2.08<sup>a</sup> | 5.93±0.30<sup>a</sup> |

Data are expressed as mean ± SD (n=3). Means by the same superscript were not significantly different from each other (p < 0.05) with Tukey’s test.

The water temperature in zone 1 measured around 27.56 °C while in zone 2 it was 28.08 C, zone 3 was around 30.10 C. Furthermore, the highest pH was in zone 3 with a value of 7.93 and followed by zone 2 which was 7.8 and the lowest was in zone 3, which was 7.43. Then the salinity value measured using a refractometer showed that the highest value was in zone 3 (32.66 ppt), and the lowest was in zone 1 (13.33 ppt). Dissolved oxygen (DO) values in each zone ranged from 5.93 ppt (zone 3), then 5.43 ppt (zone 2) and 3.70 ppt (zone 1) (Table 2).

### 3.2. Discussion

In general, the true mangrove species found on Pulau Sembilan are the main constituents of the mangrove ecosystem (major mangrove) and associated mangroves (minor mangrove) found in Lubuk Kertang Village as additional components. Previous research [10] found 15 species of mangrove families in Lubuk Kertang, and 26 species of associated mangrove in Pulau Sembilan [11]. The results of this study found fewer species, namely 15 mangroves scattered in the research location. The types of mangroves found in the research location grow and develop from different zoning. According to [8-9] the mangrove forest area at the study site has been damaged and is getting thinner due to illegal encroachment, conversion of mangrove forests into oil palm plantations, ponds, agriculture, housing, factories, and tourist attractions.

The diversity of mangrove species in Lubuk Kertang Village and Pulau Sembilan from the research results is relatively low. According to [12,13] This diversity greatly affects the right chain found in the..
mangrove ecosystem. Furthermore [14,15] explained that this situation is a factor that greatly affects the ecological and economic value chain of coastal communities.

The relationship between zoning and mangrove groups found is different. In zonation 1, mangrove groups were found to be dominated by associated mangrove species, while in zones 2 and 3, true mangrove groups were found (Table 1). This shows that each zone has different characteristics and types of plants, where a plant found in zone one is not found in other zones. These differences in characteristics are due to differences in the physical and chemical qualities of the mangrove habitat, including temperature, pH, salinity, and dissolved oxygen (DO). According to [16] zoning is a condition where a collection of vegetation that is close together has the same nature or none at all even though it grows in the same environment where environmental changes can occur which can result in real changes between vegetation groups.

4. Conclusion
This study found 15 types of mangroves consisting of two groups, namely true and associated mangroves. This diversity of mangrove species is very necessary to maintain the preservation of mangrove species in Lubuk Kertang Village and Pulau Sembilan. Each zone has different characteristics and types of plants, where a plant found in zone one is not found in other zones.

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