Primary Mangrove Forest Structure and Biodiversity

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Abstract: *An understanding of the mangrove forest structure is ecologically important, this information useful for the management and sustainable conservation. Aim of this study is to analyze the structure and biodiversity of natural mangrove communities in Sungai Sembilang and Sungai Bungin, Sembilang National Park (SNP). The survey was conducted in September-October 2013. The data was collected by using quadrat of line transect method. The results of the study have a highest density structure in location I was Nypa fruticans Sungai Sembilang and Sungai Bungin which was located on the third location of the same species on the tree level . Seedling density of Rhizophora mucronata highest in Sungai Sembilang at location III and Rhizophora apiculata Sungai Bungin at location I , and seedling of Bruguiera gymnorrhiza in location III Sungai Sembilang and Rhizophora apiculata in Sungai Bungin at location III . The composition of mangrove forests on both the location of the observation that 12 species of mangrove found. Similarity Index of the mangrove vegetation in Sungai Sembilang and Sungai Bungin on trees level, saplings and seedlings respectively 14.2%; 9.3%; and 12.5%.*

Keywords: *Biodiversity; Mangrove; Sembilang National Park; Forest; Important Value Index*

1. Introduction

Tropical mangrove ecosystems are highly productive and provide extensive ecosystems services (Ghost, 2011; Joshi and Ghose, 2014). Mangrove forests are extremely important coastal resources, which are vital to our socio-economic development. Mangrove forests as ecosystems are particularly vulnerable to environmental influences (Ghost, 2011). Mangroves are one of the most threatened ecosystems all over the world today due to direct and indirect degradation (Duke *et al*., 2007). Mangroves is ecologically important habitats that link the marine and terrestrial environments and provide habitat for both marine and terrestrial organisms, including several threatened species (Tomlinson, 1986; Goudkamp and June, 2006). Coastal development and mangrove deforestation have significantly reduce global mangrove area and created a need for restoration. In order to restore degraded mangrove systems, a complete understanding of the processes that lead to natural changes in mangrove area is necessary (FAO, 2007).

Mangrove vegetation structure varies depending on the location of the mangrove ecosystem, management and disturbance. Evaluation of changes in mangrove ecosystems are very important (Al-Tahir and Baban, 2005), and thus mangrove restoration encourages the return of such species, in some cases to levels equivalent to those in natural stands. Most of the studies on mangrove forest structure and regeneration have focused on natural stands (Bosire *et al*., 2008). Indonesia is largest mangrove area (31,890 km^2) of 6 large mangrove extent countries in Southeast Asia (ITTO, 2012). Mangrove ecosystems is the largest habitat in the Sembilang National Park, Banyuasin district, South Sumatra, Indonesia where the pond activity has been the main cause of mangrove degradation (Ulqodry *et al*., 2010; Suwignyo *et al*., 2012). An understanding of the mangrove forest structure is ecologically important, this information useful for the management and sustainable conservation (Analuddin *et al*., 2013).

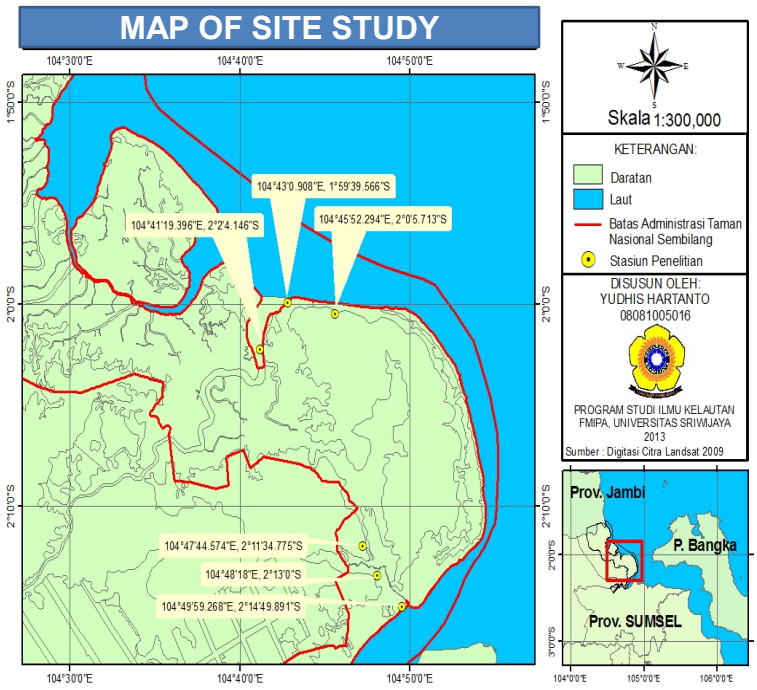
The aims of this study was to analyze the structure and composition of natural mangrove forests in the Sembilang National Park (SNP), South Sumatra; and mangrove biodiversity in primary forests SNP, South Sumatra. This study is expected to benefit as a comparison of restoration projects of degraded mangrove areas related to the condition of primary forest in SNP.

2. Materials and Method

This study was conducted in August 2013-September 2013 at SNP, South Sumatra (Figure 1 and Table 1). The site study of the transect activities in Sungai Bungin and Sungai Sembilang. Both are considered to represent the primary condition of mangrove forests of SNP. According to Ulqody *et al*. (2010), the condition of mangrove forests at both locations still natural or primary mangrove forest. Determining the line transect is based on differences in the characteristics of the mangrove vegetation.

Three locations starting from the river mouth until it was discovered that many areas covered by *Nypa fruticans*. Location I in Sungai Sembilang which describes the condition of a lot overgrown by *Nypa fruticans*. Location II overgrown by *Avicennia*

Figur 1. The map site study of mangrove vegetation in Sembilang National Park



and *Sonneratia*. Location III is dominated by *Rhizophoraceae*. Location I, II and III at Sungai Bungin is dominated by *Avicennia*, *Rhizophoraceae* and *Nypa fruticans* respectively.

Vegetation analysis using line transect method (Kusmana, 1997). Each location of the observations made transect lines perpendicular to the river and each transect line made 5 plots with a size of 10 x 10 m with a distance of 10 meters between the plot, in which is made a plot with a size of 5 x 5 m and 2 x 2 m. From the largest to the smallest to be a place for the collection of data for the trees, saplings and seedlings. The data collected is a mangrove species, diameter at breast height (DBH) (1.3 meters) and tree saplings. Ecological data collected include water temperature, pH and salinity at each location.

Field data regarding the mangrove species, number of tree stands and DBH of tree stands were analyzed to determine: Density (K), Basal Area (BA), Dominance (D), Relative Density (KR), Relative Frequency (FR), relative dominance (DR), and the Importance Value Index (IVI) (Bengen, 2002). Important value is the sum of the value of the Relative Density (KR), Relative Frequency (RF) and relative dominance (DR). The importance of mangrove species ranges from 0 to 300.

Table 1. Site study of mangroves vegetation

1	Sungai Sembilang	Location
	I	104°41'19.396" E; 2°2'4.146" S
	II	104°43'0.908" E; 1°59'39.566" S
	III	104°46'52.294" E; 2°0'5.713" S
2.	Sungai Bungin	Location
	I	104°47'44.574" E; 2°11'34.775" S
	II	104°48'18" E; 2°13'0" S
	III	104°49'59.268" E; 2°14'49.891" S

3. Results and Discussion

3.1 Mangrove Forests Structure and Composition

Mangrove species in Sungai Sembilang, the location I found 5 species: *Avicennia marina*, *Excoecaria agallocha*, *Hibiscus tiliaceus*, *Terminalia catappa* and *Nypa fruticans*. Location II found 4 species of mangrove: *Avicennia marina*, *Sonneratia alba*, *Rhizophora mucronata* and *Nypa fruticans*; and at the location III found 4 spcies of mangrove: *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Rhizophora apiculata* and *R. mucronata* (Table 2). *Nypa fruticans* most often found in the third location of the observations and indicate the number and highest density on the location of the first observations by the number of individuals 84 and a density of 1680 trees/ha.

Only the first observation location on the Sungai Sembilang were not found mangrove seedlings level. Based on IVI (Table 2), the highest value for the level of the tree in the location I, II and III respectively are: *Hibiscus tiliaceus* (IVI = 127.79); *R. mucronata* (IVI = 115.69); and *B. gymnorrhiza* (IVI = 166.43). The highest IVI in the location I, II and III to level sapling: *H. tiliaceus* (IVI = 300); *R. mucronata* (IVI = 157.14) and *R. mucronata* (IVI = 108.49). IVI teringgi mangrove seedlings on the location II and III respectively *R. mucronata* (IVI = 200) and *B. gymnorrhiza* (IVI = 80.21).

Number of mangrove species found in Sungai Bungin on the location I, II and III, respectively, are 4 species. Mangrove species at the location I: *Avicennia alba*, *A. marina*, *Kandelia candel* and *R. apiculata*. Mangrove species at the location II was B. *gymnorrhiza*, *Ceriops tagal*, *Nypa fruticans* and *R. apiculata*. Mangrove species at the location III was *A. marina*, *R. apiculata*, *R.*

Table 2. IVI of trees, saplings, seedlings of mangrove in the Sungai Sembilang

Level of mangroves	Mangrove spesies	DR (%)	FR (%)	RD (%)	IVI (%)
		Location I			
Tree	*Hibiscus tiliaceus*	79.31	42.86	5.62	127.79
	Excoecaria agallocha	6.90	28.57	32.91	68.38
	Ipomoea pres-caprae	3.45	14.29	36,85	54.58
	Avicennia marina	10.34	14.29	24.62	49.25
Sapling	*Hibiscus tiliaceus*	100	100	100	300
		Location II			
Tree	*Rhizophora mucronata*	48.28	50.00	17.41	115.69
	Sonneratia alba	37.93	33.33	24.88	96.14
	Avicennia alba	13.79	16.67	57.71	88.17
Sapling	*Rhizophora mucronata*	50	50	57.14	157.14
	Bruguiera gymnorrhiza	50	50	42.86	142.86
Seedling	*Rhizophora mucronata*	100	100		200
		Location III			
Tree	*Bruguiera gymnorrhiza*	34.78	35.71	95.94	166.43
	Ceriops tagal	41.30	35.71	0.28	77.30
	Rhizophora mucronata	23.91	28.57	3.78	56.27
Anakan	*Rhizophora mucronata*	55.74	33.33	19.42	108.49
	Ceriops tagal	39.34	41.67	22.74	103.75
	Bruguiera gymnorrhiza	3.28	16.67	44.57	64.52
	Rhizophora apiculata	1.64	8.33	13.27	23.25
Semai	*Bruguiera gymnorrhiza*	46.88	33.33		80.21
	Rhizophora mucronata	31.25	33.33		64.58
	Rhizophora apiculata	12.5	22.22		34.72
	Ceriops tagal	9.375	11.11		20.49

Table 3. IVI of trees, saplings, seedlings of mangrove in the Sungai Bungin

Level of mangroves	Mangrove species	DR (%)	FR (%)	RD (%)	IVI (%)
		Location I			
Tree	*Avicennia alba*	35.59	25.0	44.40	104.99
	Rhizophora apiculata	37.29	33.33	10.58	81.20
	Avicennia marina	11.86	16.67	41.31	69.84
	Kandelia candel	15.25	25.0	3.71	43.97
Sapling	*Rhizophora apiculata*	72.73	50.0	20.40	143.12
	Kandelia candel	9.09	25.0	45.63	79.72
	Avicennia alba	18.18	25.0	33.97	77.15
		Location II			
Tree	*Rhizophora apiculata*	81.48	66.67	53.35	201.50
	Bruguiera gymnorrhiza	14.81	16.67	44.68	76.17
	Ceriops tagal	3.70	16.67	1.97	22.34
Sapling	*Bruguiera gymnorrhiza*	100	100	100	300
Seedling	*Rhizophora apiculata*	100	100		200
		Location III			
Tree	*Rhizophora apiculata*	42.86	33.33	30.57	106.76
	Avicennia marina	28.57	33.33	38.23	100.14
	Rhizophora mucronata	28.57	33.33	31.20	93.11
Sapling	*Rhizophora apiculata*	66.67	50	62.09	178.75
	Rhizophora mucronata	33.33	50	37.91	121.25
Seedling	*Rhizophora apiculata*	100	100		200

mucronata and *Nypa fruticans* (Table 3).

We are not found mangrove seedlings in Sungai Bungin at location I (the area near the mouth of the river). IVI is the highest for tree level *A. alba* (IVI = 104.99); *R. apiculata* (IVI = 201.50) and *R. apiculata* (IVI = 106.79) in location I, II and III respectively. Mangrove seedling level the highest IVI is *R. apiculata* (IVI = 143.12); *B. gymnorrhiza* (IVI = 300) and *R. apiculata* (IVI = 178.75) respectively at location I, II and III. Mangrove seedlings with the highest IVI at location II and III, respectively *R. apiculata* (IVI = 200) and *R. apiculata* (IVI = 200) (Table 3).

3.2 Mangrogve biodiversity in Sungai Sembilang and Sungai Bungin

Similarity Index (Soerianegara & Indrawan, 2005) of the mangrove vegetation in Sungai Sembilang and Sungai Bungin on trees level, saplings and seedlings respectively 14.2%; 9.3%; and 12.5%. Water temperature in Sungai Sembilang at the location I, II and III respectively 27 ^{o}C, 24 ^{o}C and 22 ^{o}C. Salinity on the location of the location I, II and III respectively 24 ppt, 25 ppt and 22 ppt (Table 5). Parameter pH waters in the Sungai Bungin and the Sungai Sembilang showed the same pH value. Environment data of Sungai Bungin, water temperature at the location I, II and III respectively is 27 ^{o}C, 24 ^{o}C and 22 ^{o}C. Salinity on the location I, II and III respectively 24 ppt, 19 ppt and 9 ppt (Table 5).

Table 4. Biodiversity index of Shannon-Wiener (Odum, 1994)

No.	Category	Biodiversity index		
		I	II	III
		Sungai Sembilang		
1.	Tree	1.31	1.09	0.99
2.	Sapling	0	0.69	1.26
3.	Seedling	0	0	1.27
		Sungai Bungin		
1.	Tree	1.34	0.81	1.10
2.	Sapling	1.05	0	0.67
3.	Seedling	0	0	0

Table 5. Water quality in the site study

Locations	Temperature (°C)	Salinity (ppt)	Ph
Sungai Sembilang			
I	27	24	7.5
II	24	25	7.5
III	22	22	7.5
Sungai Bungin			
I	28	24	7.5
II	25	19	7.5
III	20	9	7.5

The recent study of the distribution of mangrove species in Sungai Calik, South Sumatra, i.e. Sonneratiaceae (Marisa and Sarno, 2015), *Sonneratia caseolaris*, *S. ovata* and *S. alba* were found, its own salinity zonation respectively 0-15 ppt, 6-15 ppt and 11-20 ppt.

Mangrove ecosystems especially in Sungai Bungin and Sungai Sembilang are healthy as a primary forests. Healthy mangrove forests are highly productive and dynamic and also have the peculiar ability to immobilize heavy metals (Vannucci, 2001); protection from tsunamis and responses to global climate change (Alongi, 2008).

4. Conclusion

The results of the study have a highest density structure in location I was *Nypa fruticans* Sungai Sembilang and Sungai Bungin which was located on the third location of the same species on the tree level . Seedling density of *Rhizophora mucronata* highest in Sungai Sembilang at location III and *Rhizophora apiculata* Sungai Bungin at location I , and seedling of *Bruguiera gymnorrhiza* in location III Sungai Sembilang and *Rhizophora apiculata* in Sungai Bungin at location III . The composition of mangrove forests on both the location of the observation that as many as 12 species of mangrove found. Similarity Index of the mangrove vegetation in Sungai Sembilang and Sungai Bungin on trees level, saplings and seedlings respectively 14.2%; 9.3%; and 12.5%. Environment parameters, i.e. temperature, salinity and pH werw compatible for mangrove growth.

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