

## DIVERSITY OF MANGROVES ECOSYSTEM IN SEMPORNA MANGROVE FOREST

Lo Man Wah<sup>1</sup>, Andy R. Mojiol<sup>1</sup> & Ejria Saleh<sup>2</sup>

<sup>1</sup>School of International Tropical Forestry  
Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia

<sup>2</sup>Borneo Marine Research Institute  
Universiti Malaysia Sabah, 88400 Kota Kinabalu, Sabah, Malaysia

**ABSTRACT.** *The aim of this study is to determine the diversity and density of mangrove tree species as well as to compare the diameter distribution of mangrove species in Semporna mangrove area. Two types of study area were compared the non-disturbed and disturbed mangrove areas in Semporna. The non-disturbed mangrove areas that were selected were distant from local settlements namely Sg. Sipit, Sum-sum, Tong Tabataba, Hampalan, Bantau-bantau and Sg. Gajah. While Kalumpang, Kg. Tanjung Kapur, Kg. Salimbangun, Kg. Parang Tengah, Pangkalangan, Labuan Senang and Proboscis monkey area were selected as disturbed mangrove areas due to their location close to settlements. A total of 30 rectangular plots were established randomly, each measuring 20 x 10 m. Each site consists of 3 separate plots and the minimum sampling area was 0.6 ha. From the findings, 26 species were identified at both disturbed and non-disturbed mangrove area. The mean diameter at breast height (DBH) at disturbed mangrove area ranges from 10-20 cm, as compared to 20-35 cm in non-disturbed mangrove area. Besides, the value of the mangrove species diversity in non-disturbed mangrove area is less diverse with Shannon-Weiner ( $H'$ ) = 0.711 as compared to disturbed mangrove area which has a higher value with  $H' = 1.725$ . The diameter distribution graph indicated both areas show an inverse J-curve shape which represents an even-aged tree stand structure. However, the graph showing disturbed mangrove area revealed more scattered and randomly distributed tree stands. This is due to local community activities in that area such as collection of wood and fire wood for personal use. The species *Rhizophora apiculata* is the most common species counted in most of the disturbed mangrove area with the highest Important Value Index (IVI) value of 173.6, as opposed to *Rhizophora mucronata* which is most dominant in nearly all of the non-disturbed mangrove area. The results show that the disturbed mangrove area has higher tree diversity and the tree stands are less dense as compared to non-disturbed mangrove area. It is recommended that more similar studies and longtime monitoring should be conducted in these areas in the future.*

**KEYWORD.** Density, diversity, diameter distribution, disturbed mangrove area, non-disturbed mangrove area, species composition

### INTRODUCTION

Mangroves consist of plant communities commonly found between the lowest and the highest tide level. These plants had evolved over time by developing special adaptive features allowing them to better survive in a harsh and stressful environment (Mastaller, 1997). Commonly, mangrove provides an important breeding ground and habitat especially for aquatic animals. They also act as a protective barrier for the human population along the coast from suffering from any massive casualties as a result of strong waves and storms such as tsunamis.

Mangrove forests in Sabah comprises of 341,000 ha of the total land. Approximately of 326,487 ha have been gazetted as Mangrove Forest Reserve class V, with Sabah having the most extensive coverage of mangrove in Malaysia. Therefore, the mangroves in Sabah represent an important resource to the state. However, some mangrove forest has been under threat at present accounting for 9.8% (33,311.33 ha) of the total area of mangrove forest in Sabah.

In Semporna, the mangrove forests cover an area of about 15,712 ha. There are approximately of 15 % of the mangrove forests in Semporna have been threaded by encroachment activity, such as conversion of mangrove forest for oil palm plantation, shrimp farming, and others that would lead the area to degrade (Sabah Forestry Department, 2007). In order to solve the problem, the forestry department has initiated the mangrove restoration program since April 2007. A total of 583.24 ha of the degraded mangrove forest have been replanted with the some mangrove and coastal plant species since 2006, such as Bangkita (*Rhizophora apiculata*), Bakau kurap (*Rhizophora mucronata*), Rhu pantai (*Casuarina equisetifolia*), Bintangor laut (*Callophyllum inophyllum*), and Tengar (*Ceriops tengar*). The effort of the restoration program was carried on until now and there are about 5.58 ha of the degraded mangrove forest has been replanted on year 2010 (Sabah Forestry Department, 2010).

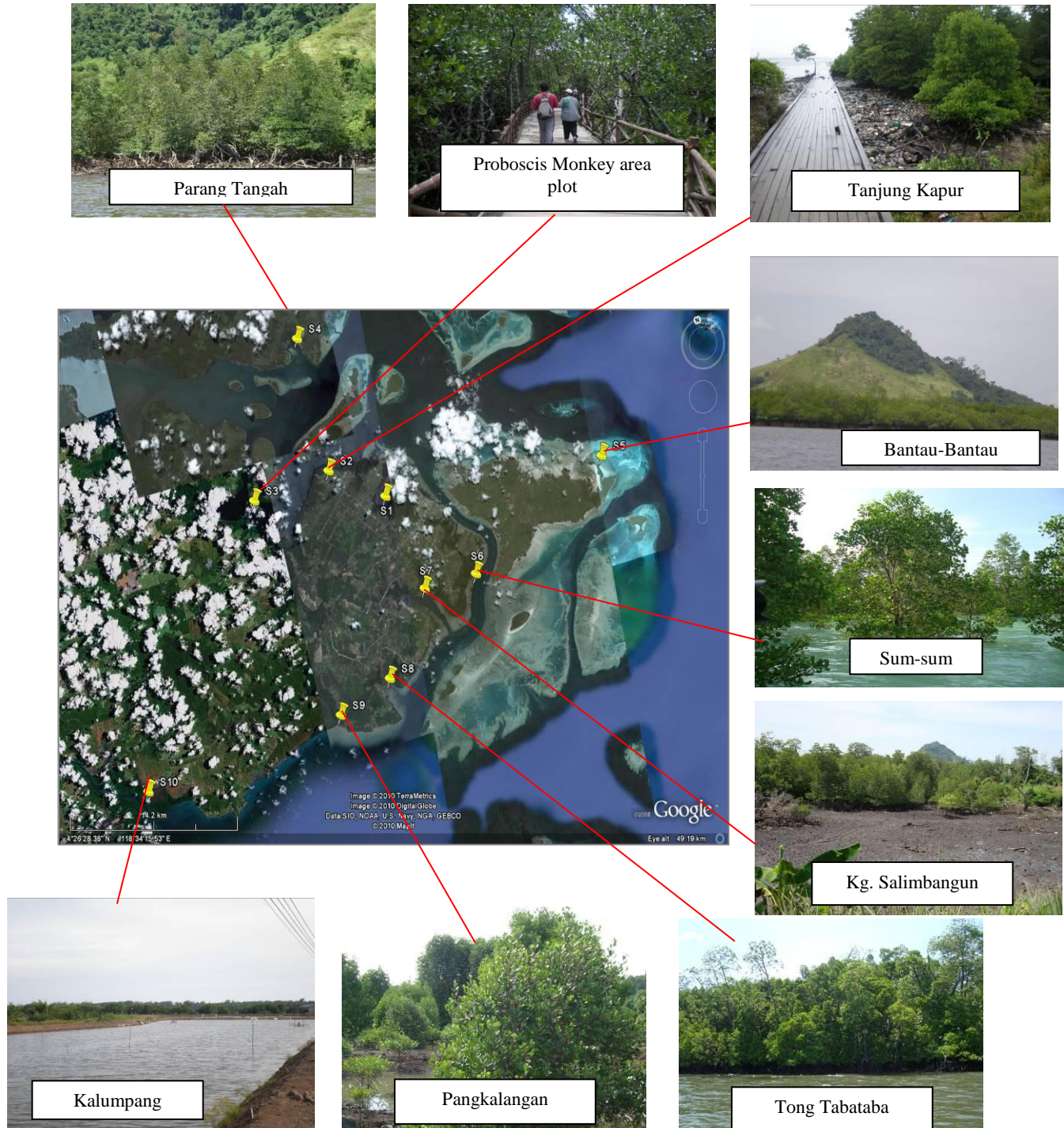
The aim of this study is to determine the diversity and density of mangrove trees by species in Semporna mangrove area as well to compare the diameter distribution of mangrove species at Semporna mangrove area in order to better understand its ecosystem health where steps and actions can be devised and implemented to maintain and improve its condition.

## MATERIAL AND METHOD

A random sampling method was applied in this study. Two study areas are made for comparison between the non-disturbed and disturbed mangrove area in Semporna mangrove area. The disturbed mangrove area is defined as an area that has been influenced by encroachment activity such as tree cutting, housing settlement or reclamation of land for agriculture as opposed to non-disturbed mangrove area with more regeneration of seedlings can be found within this health ecosystem.

13 study sites were selected randomly in this study. The non-disturbed mangrove areas that were selected in this study are namely Sg. Sipit, Sum-sum, Tong Tabataba, Hampalan, Bantau-bantau and Sg. Gajah. While Kalumpang, Kg. Tanjung Kapur, Kg. Salimbangun, Kg. Parang Tengah, Pangkalangan, Labuan Senang and 'Proboscis monkey' areas were selected as disturbed mangrove area due to its location close to settlement. A total of 30 plots were randomly set up at the sites, where three plots were made at each sites. Each sampling plot is in rectangular shape with size 20 x 10 m and the minimum sampling area in this study was 0.6 ha.

All trees found within the plot were determined and recorded. The data collected were the diameter at breast height (DBH), height of the tree, and the number of individual of mangrove species, and tree density. The diversity indices such as Shannon-Weiner index ( $H'$ ) and Simpson's index ( $D$ ) were used in order to calculate the diversity of mangrove species in each plot. The Important Value Index (IVI) was then calculated by adding relative density, relative dominance and relative frequency to determine the species composition of the mangrove forest. Due to bad weather (rain) during the study period only a few areas were be able to be pictured and located in GPS as shown below (Figure 1).



## RESULTS AND DISCUSSION

### Distribution of Mangrove Species

A total of 188 of mangrove tree were surveyed at non-disturbed mangrove area and 201 of mangrove trees at disturbed mangrove area with in total of 389 mangrove individual tree has been recorded. As many as 26 species were recorded at all study sites. Figure 2 and Table 1 in below showed the results of the mangrove species that have been found in both areas

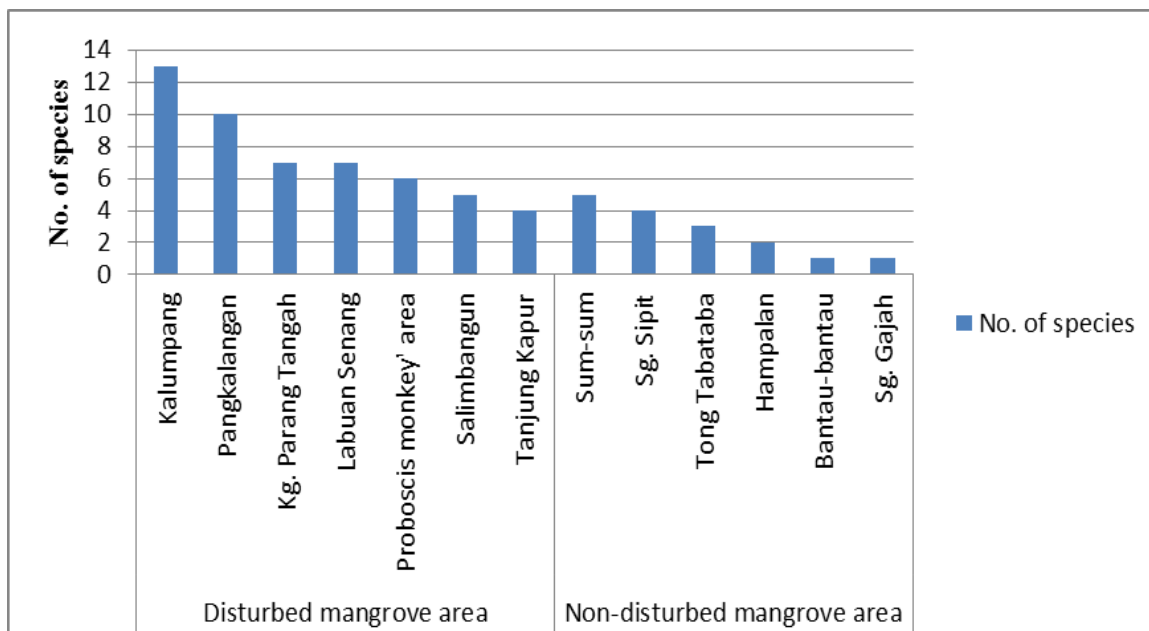


Figure 2. Histogram shows the difference in number of species according to study area.

### Mangrove Species Diversity Indices

The mean value of Shannon-Weiner index for non-disturbed mangrove area is 0.711, while disturbed mangrove area is 1.725. The value showed that disturbed mangrove forests are more diverse compared to non-disturbed mangrove area. The Shannon index which emphasizes the richness component of diversity, ranks disturbed mangrove area as the most diverse. However, these diversity indices varies due to the total number of species found in the study area and not represent to all area of Semporna mangrove area.

**Table 1. List of mangrove species recorded at all study sites.**

No.	Family	Species	Class	Malay name
1.	Anarcadiaceae	<i>Mangifera</i> sp.	MA	Mangga air
2.	Avicenniaceae	<i>Avicennia marina</i>	M	Api-api
3.	Arecaceae	<i>Nypa frustican</i>	MA	Nipah palm
4.	Casuarinaceae	<i>Cassuarina equisetifolia</i>	MA	Rhu pantai
5.	Combretaceae	<i>Lumnitzera littorea</i>	M	Teruntum merah
6.		<i>Lumnitzera racemosa</i>	M	Teruntum putih
7.	Euphorbiaceae	<i>Excoecaria agallocha</i>	MA	Buta Buta
8.		<i>Jatropha</i> sp.	MA	Jatropha
9.	Fabaceae	<i>Derris</i> sp.	MA	Pepanjat
10.		<i>Pongamia pinnata</i>	MA	Kekacang
11.	Lecythidaceae	<i>Barringtonia asiatica</i>	MA	Barringtonia
12.	Lythraceae	<i>Pemphis acidula</i>	MA	Sentidi
13.	Malvaceae	<i>Hibiscus tiliaceus</i>	MA	Bru-baru
14.	Meliaceae	<i>Xylocarpus granatum</i>	M	Nyirih
15.	Palmae	<i>Cocos</i> sp.	MA	Kelapa
16.	Pteridaceae	<i>Acrostichum aureum</i>	MA	Piai
17.	Rhizophoraceae	<i>Bruguiera cylindrical</i>	M	Beus
18.		<i>Bruguiera parviflora</i>	M	Lenggadai
19.		<i>Ceriop tagal</i>	M	Tengar
20.		<i>Rhizophora apiculata</i>	M	Bangkita
21.		<i>Rhizophora mucronata</i>	M	Bakau kurap
22.		<i>Rhizophora stylosa</i>	M	Bakau putih
23.	Rubiaceae	<i>Scyphiphora hydrophyllaceae</i>	M	Duduk rambat
24.		<i>Morinda cirtifolia</i>	MA	Bengkudu
25.	Sonneratiaceae	<i>Sonneratia saseolaris</i>	M	Berembang
26.	-	Unknown climbers	MA	Pemanjat

Note: M = True mangrove species ; MA = Mangrove associate species

**Table 2. Value of mangrove species diversity according to diversity indices.**

Study site	Disturbed mangrove area	Non-disturbed mangrove area
	Kalumpang Kg. Tanjung Kapur Kg. Salimbangun Kg. Parang Tengah Pangkalangan Labuan Senang Proboscis monkey area	Sg. Sipit Sum-sum Tong Tabataba Hampalan Bantau-bantau Sg. Gajah
<b>Shannon-Weiner index (H')</b>	1.725	0.711

### Mangrove Trees Density

The mean diameter at breast height (DBH) at disturbed mangrove areas ranges from 10-20 cm, while non-disturbed mangrove area was from 20-35 cm. Generally, Sg. Gajah has the highest tree density among the others, compared to Hampalan and Sg. Sipit which has the lowest tree density. Figure 3 shows the difference in tree density according to study sites.

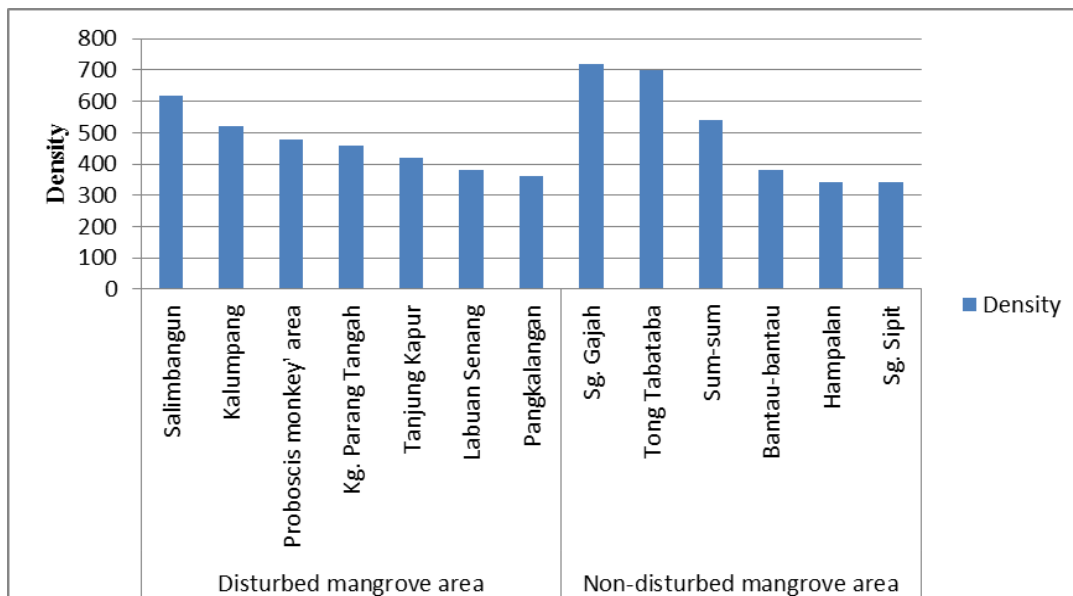


Figure 3. Histogram shows the difference in tree density according to study sites.

### Mangrove Species Composition

In most of disturbed mangrove areas, *Rhizophora apiculata* was the dominant species with the highest value of Important Value Index (IVI) = 173.6. The *Rhizophora apiculata* has ranked the first out of ten in sampling plot. The second highest IVI was that of *Rhizophora mucronata*, with a value of 55.8. The third was *Lumnitzera littorea* (15.6), and followed by *Ceriop tagal* (13.9), *Bruguiera parviflora* (11.6), *Rhizophora stylosa* (11.9), *Excoecaria agallocha* (8.9), *Hibiscus tiliaceus* (4.0), *Acrostichum aureum* (3.5), and *Nypa fruticans* (1.2) as showed in Table 3.

**Table 3. Mangrove species at disturbed mangrove area ranked by their Importance Value Index (IVI).**

Rank	Species	Relative dominance (m <sup>2</sup> /ha)	Relative abundance (n/ha)	Relative frequency	IVI
1	<i>Rhizophora apiculata</i>	89.6	70.0	14	173.6
2	<i>Rhizophora mucronata</i>	20.3	24.5	11	55.8
3	<i>Lumnitzera littorea</i>	3.5	2.1	10	15.6
4	<i>Ceriop tagal</i>	2.1	2.8	9	13.9
5	<i>Bruguiera parviflora</i>	1.5	1.1	9	11.6
6	<i>Rhizophora stylosa</i>	3.0	0.9	8	11.9
7	<i>Excoecaria agallocha</i>	4.5	0.4	4	8.9
8	<i>Hibiscus tiliaceus</i>	0.4	0.6	3	4.0
9	<i>Acrostichum aureum</i>	0.2	0.3	3	3.5
10	<i>Nypa fruticans</i>	0.01	0.2	1	1.2
<b>Total</b>					<b>300</b>

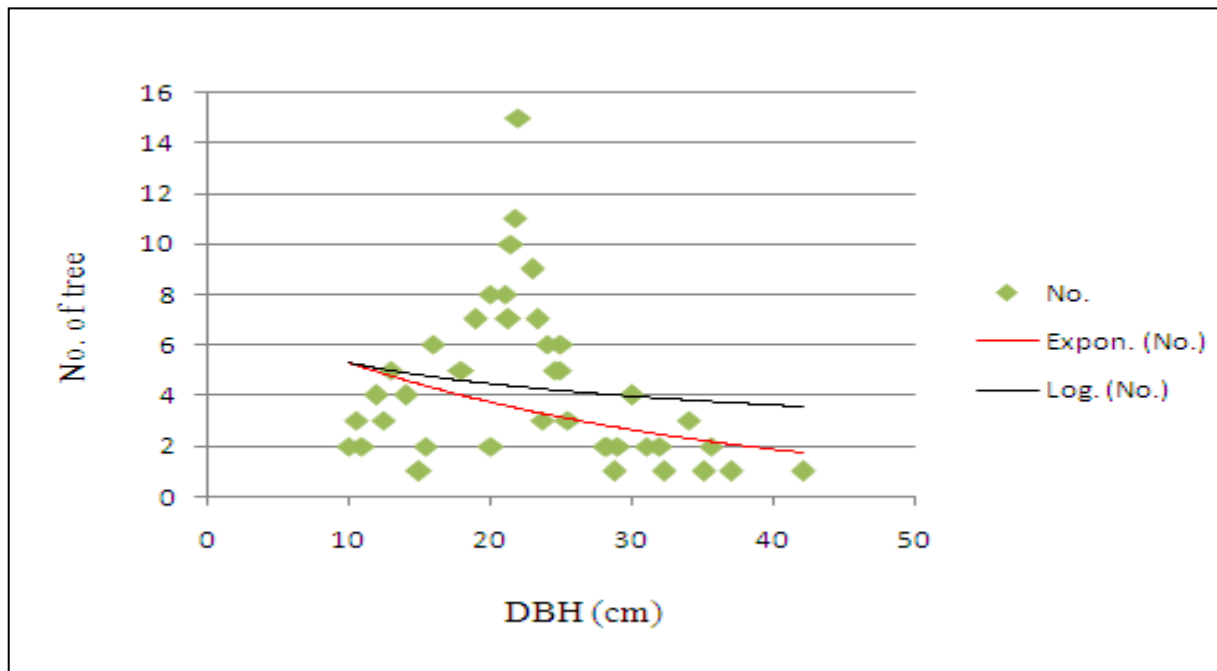
While in non-disturbed mangrove area, *Rhizophora mucronata* are the dominant species with the highest IVI value of 200. It was then followed by *Rhizophora apiculata* with IVI value of 81.0, and *Sonneratia caseolaris* with the IVI value of 19.0. This was shown in Table 4 below. It seems that all the study plots that had been made in both study areas are under the main vegetation zone or known as Bruguiera–*Rhizophora* zone and back mangrove zone due the occurrence of the *Acrosticum aureum*.

**Table 4. Tree species at non-disturbed mangrove area ranked by their Importance Value Index (IVI).**

Rank	Species	Relative dominance (m <sup>2</sup> /ha)	Relative abundance (n/ha)	Relative frequency	IVI
1	<i>Rhizophora mucronata</i>	70.8	80.2	49	200.0
2	<i>Rhizophora apiculata</i>	30.5	22.5	28	81.0
3	<i>Sonneratia caseolaris</i>	5.3	0.7	13	19.0
<b>Total</b>					<b>300</b>

### Diameter Distribution of Mangrove Species

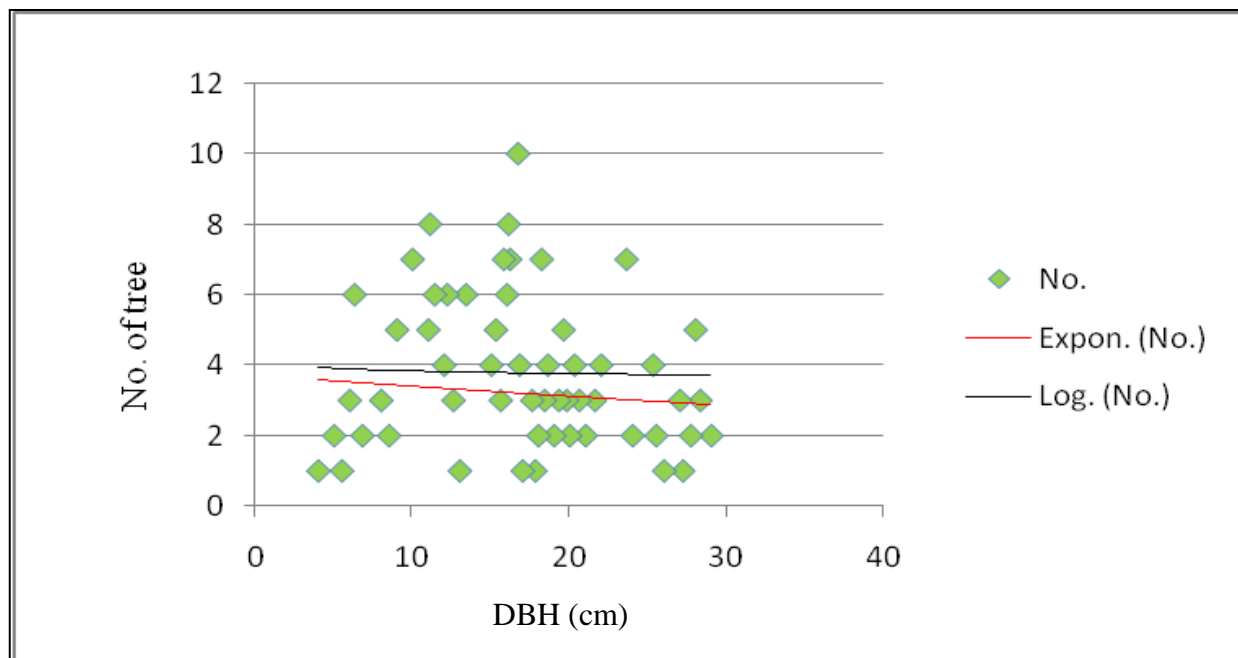
The diameter distribution of mangrove species at non-disturbed mangrove area as show in Figure 4 reveals negative exponential (black line) and logarithmic J-shape (red line). This graph showed the inverse-shaped diameter distribution curve which illustrated a normal structure in forest development. This explained that there are a lot of regeneration seedlings and young trees can be found in a normal mangrove forest area, and the competition for light and space are limited due to the dense canopy.



**Figure 4. The diameter distribution of mangrove species at non-disturbed mangrove forest.**

Meanwhile, Figure 5 below showed the diameter distribution of mangrove species at disturbed mangrove area where the chart also showed negative exponential (black line) and logarithmic J-shape. However, the distribution of number of individual tree per diameter was scattered and randomly distributed. This gives a clear view of the stand structure of this study site where proximity to settlement area could alter the structure of trees. Besides, it was observed that some local people used or cut trees for firewood and construction of their house.





**Figure 5. The diameter distribution of mangrove species at disturbed mangrove forest.**

Total of 26 species of mangrove species were identified at both disturbed and non-disturbed mangrove areas. Survey of the mangroves in all study sites revealed the existence of 188 of mangrove trees at non-disturbed mangrove area and 201 of mangrove trees at disturbed mangrove area. The mean diameter at breast height (DBH) at disturbed mangrove areas ranges from 15-20 cm, as compared to 23-35 cm at non-disturbed mangrove area.

Besides, the value of mangrove species diversity in non-disturbed mangrove area is less diverse with Shannon-Weiner ( $H'$ ) = 0.711 as compared to disturbed mangrove area which has a higher value with Shannon-Weiner ( $H'$ ) = 1.725. *Rhizophora apiculata* is the most important and dominant species with the highest Important Value Index (IVI) value of 173.6 in most of the disturbed mangrove area, as oppose to *Rhizophora mucronata* with IVI of 200 which is most dominant in nearly all of the non-disturbed mangrove area. While for diameter distribution, both disturbed and non-disturbed mangrove areas had shown the inverse J-shaped in diameter. However, the diameter distribution curve for disturbed mangrove area is more scattered and randomly distributed as compared to non-disturbed mangrove area. This was probably due to local community activities in that area such as collection of wood and fire wood for self consumption.

As a recommendation, by considering the importance of mangrove forests, the respective authority should enforce the regulation in order to protect and conserve the patches of mangrove forest in Semporna. In addition, it is suggested that more study should be conducted in this area in the future. Besides, long time monitoring is necessity in order to monitor the floristic structure in mangrove forest. The awareness programs need to be introduced to the local communities with the aim to set up the importance of mangrove forests and to protect it. The mangrove forests in Semporna would be an ideal site to support both conservation and land protection against other unexpected disastrous such as strong wave or Tsunami in the future.

## ACKNOWLEDGEMENTS

The authors would like to express their great appreciation to Semporna district Forestry Department for permission to conduct this study.

## REFERENCES

- Duke, N.C., Ball, M.C. & Ellison, J.C. 1998. *Factors Influencing Biodiversity & Distribution Gradient in Mangroves*. Blackwell Science Ltd.
- Hogarth, P.J. 2007. *The Biology of Mangroves & Seagrasses*. Oxford University Press Inc., New York.
- Magurran, A.E. 2004. *Measuring Biological Diversity*. Blackwell science Ltd, United Kingdom.
- Mastaller, M. 1997. *Mangroves: The Forgotten Forest Between Land & Sea*. Tropical Press Sdn. Bhd., Kuala Lumpur, Malaysia.
- Sabah Forestry Department. 2007. *Sabah's Mangrove Forests: Towards Conservation & Sustainable Use*. Sabah Forestry Department, Sabah.
- Sabah Forestry Department. 2010. *Restorasi Hutan Persisiran Pantai di Sabah: Seminar Pemuliharaan Pantai Negara*. Sabah Forestry Department, Sabah.