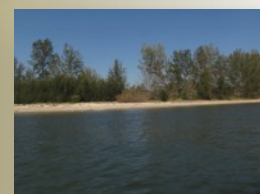
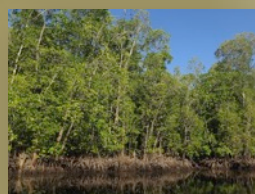
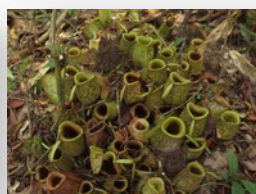
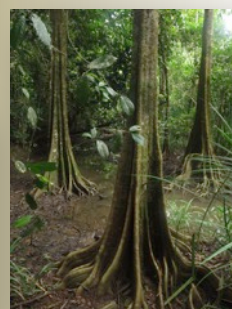
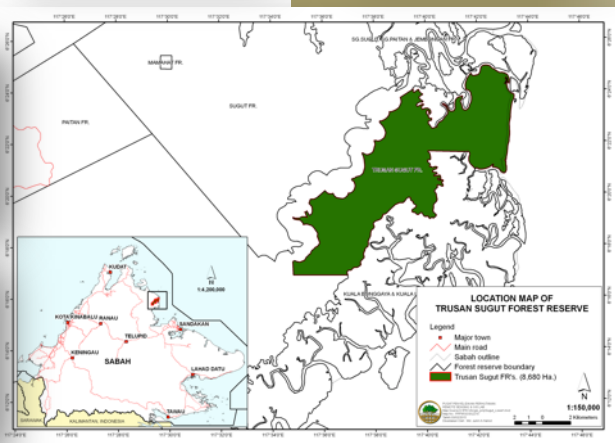
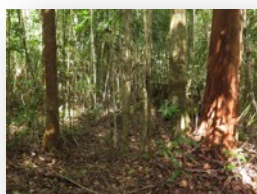
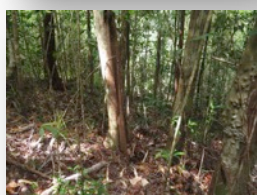
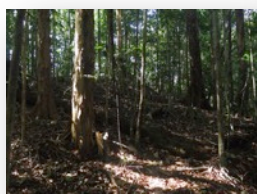
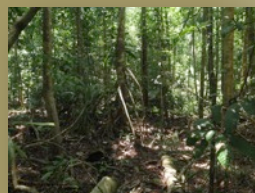


SABAH FORESTRY DEPARTMENT

2015

FOREST ASSESSMENT OF LOWER SUGUT FOREST RESERVE



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FOREST RESEARCH CENTRE

FEBRUARY 2015

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INTRODUCTION

Lower Sugut Forest Reserve (LSFR) is a Class I Protection Forest with a total area of 8,680 ha (Fig. 1). The Beluran District Forestry Office administers the reserve.

The Forestry Department through the Forest Research Centre has conducted forest quality assessment in Lower Sugut FR from the 22th till 27th September 2014. The objective of the survey is to determine vegetation quality in the various forest types. This information will provide forest ecosystems background for Lower Sugut Forest Management Unit.

STUDY SITE

Location and access

Lower Sugut FR is situated about 75 km northwest of Sandakan town (Fig. 1). It is geographically located between latitude 06° 16' 44.9"–06° 24' 32.3" N and longitude 117° 02' 19.6"–117° 21' 14.9" E. The reserve can be accessed through Sapi–Nangoh highway and traverse through IJM oil palm estate; and also through the sea by boat.

Soil

There are seven major soil association underlie Lower Sugut FR (Fig. 2). About 69% of the FMU is affected by high water table: 30% under tidal influenced and the soil is categorised as Weston association; 39% under freshwater influenced and categorised as Sapi (26%), Kinabatangan (12%) and Klias (15 ha) soil associations. The other soil associations that consider as dryland, such as Maliau and Tanjung Aru associations that underlie 19% and 11% of the reserve area, respectively, are categorised as intermediate fertility in plant nutrient aspect (Acres *et al.*, 1975). However, Tanjung Aru association can be slightly swampy during wet season.

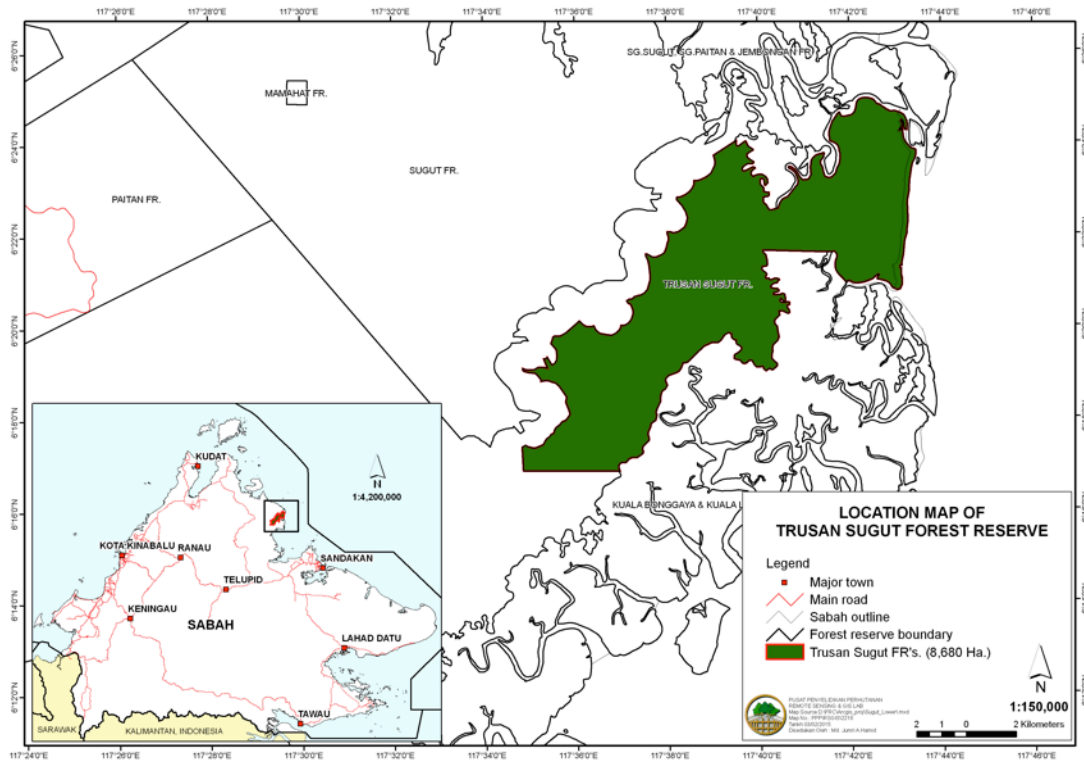


Fig. 1. Location map of Lower Sugut Forest Reserve in Sabah, Malaysia.

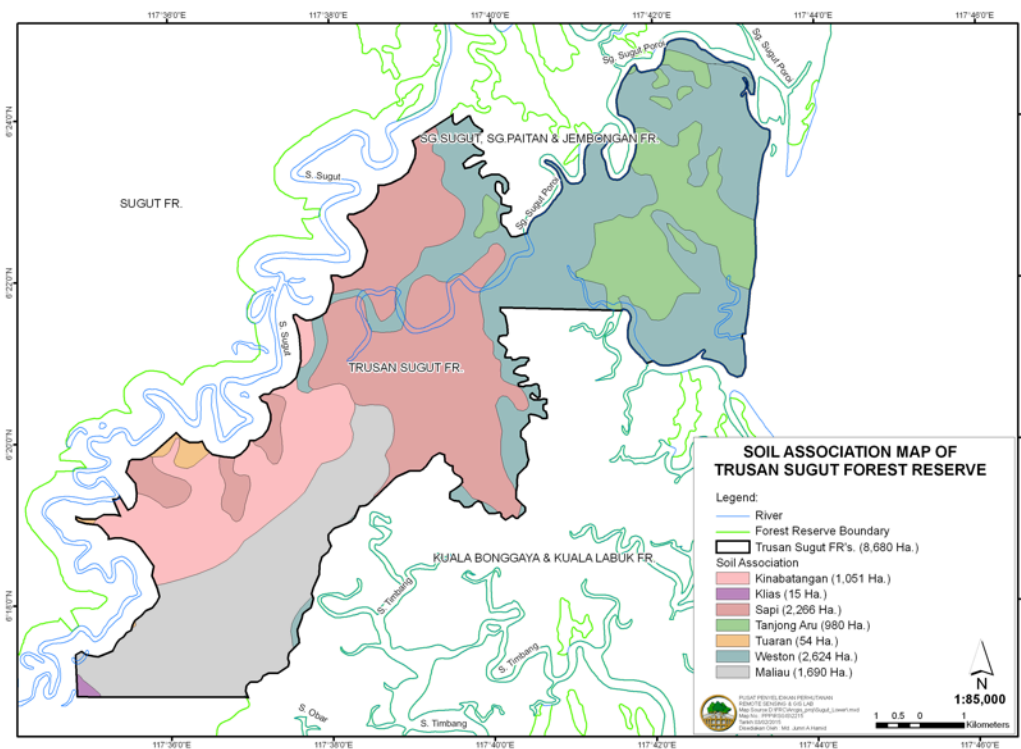


Fig. 2. Soil association map of Lower Sugut Forest Reserve in Sabah, Malaysia.

METHOD AND MATERIALS

Sampling and tree enumeration description

A total of ten (10) 0.13-ha permanent sample plots were established in a time span of 4 working days (Table 1). All trees ≥ 10 cm diameter at breast height (dbh) were enumerated and identified to species level. This fieldwork activity utilized several items, i.e., recording sheet, diameter and linear tapes, altimeter, compass, handheld Geographical Positioning System unit, maps and flags.

Plant identification

The common tree species were identified directly to species level in the field by means of their distinctive field characteristics. For those that could not be readily identified, voucher specimens were collected for subsequent determination at the Sandakan Herbarium (SAN). The voucher specimen collections were oven-dried 45–50° C for several days before determining their identities. All specimens were sorted according to morphospecies and identified to species level by cross-referencing with the existing specimens in the herbarium.

Data analysis

The importance value is the relative dominance of each species or family of trees enumerated in the plots that was calculated as the average of relative tree density and relative basal area as follow (Brower & Zar, 1977):

Relative tree density = $[\sum \text{tree density of species or family I} / \sum \text{tree density of all species or families}] \times 100$

Relative basal area = $[\sum \text{basal area of species or family I} / \sum \text{basal area of all species or families}] \times 100$

Relative dominance = $(\text{Relative tree density} + \text{Relative basal area})/2$

Results of the importance value of each family or species of trees enumerated in the plots are listed in Appendices II.

Table 1. Plot numbers and their corresponding geographical position points for the forest assessment and rapid plant diversity inventory in Lower Sugut Forest Reserve. (Notes: Lowland Mixed Dipterocarp Forest (LMDF); Lowland Mixed Dipterocarp & Kerangas Forest (LMDKF); & Lowland Kerangas Forest (LKF)).

Plot No	Soil Association	Vegetation Formation	Latitude	Longitude	Altitude(m)
1	Maliau	Disturbed LMDKF	6° 17' 21.9"	117° 36' 27.5"	91
2	Maliau	Disturbed LMDKF	6° 17' 06.5"	117° 36' 23.8"	82
3	Tanjung Aru	Disturbed LMDF	6° 21' 41.6"	117° 42' 10.1"	15
4	Tanjung Aru	Disturbed LMDF	6° 21' 56.8"	117° 42' 00.3"	13
5	Tanjung Aru	Disturbed LMDF	6° 21' 36.3"	117° 42' 20.9"	12
6	Maliau	Disturbed LMKF	6° 20' 00.8"	117° 38' 38.7"	65

7	Maliau	Disturbed LMKF	6° 20' 01.1"	117° 38' 44.8"	58
8	Kinabatangan	Disturbed FWSF	6° 18' 42.4"	117° 36' 56.9"	10
9	Kinabatangan	Disturbed FWSF	6° 18' 45.5"	117° 36' 54.8"	11
10	Maliau	Disturbed LKF	6° 17' 13.8"	117° 37' 04.2"	16

FOREST COMPOSITION

The whole LSFR is classified as extreme lowland with highest point not even reaching 200 m a.s.l. Originally, the forest formation of the reserve was mainly mangroves, freshwater swamp forest, mixed dipterocarp forest (Kapur Merah Forest), mixed dipterocarp and kerangas forest (Fig. 4). A strand of beach forest forms at the coastal area. All the forest, except the mangroves, were severely logged or exposed to human induced disturbance in the past. At present, various regenerative stages of mixed dipterocarp, kerangas, freshwater swamp, mangroves and secondary vegetations are the main vegetation classes in the reserve.

A total of 674 trees above 10 cm dbh were enumerated in all 10 plots. Of these total, 168 number of taxa and 96 number of genera derived from 44 known families were recorded. The Dipterocarpaceae is the most species-rich families and followed by the Myristicaceae (Figure 3). The common tree species representing the main, midstorey and understorey canopy layers according to their preferred vegetation types are listed in Table 3.

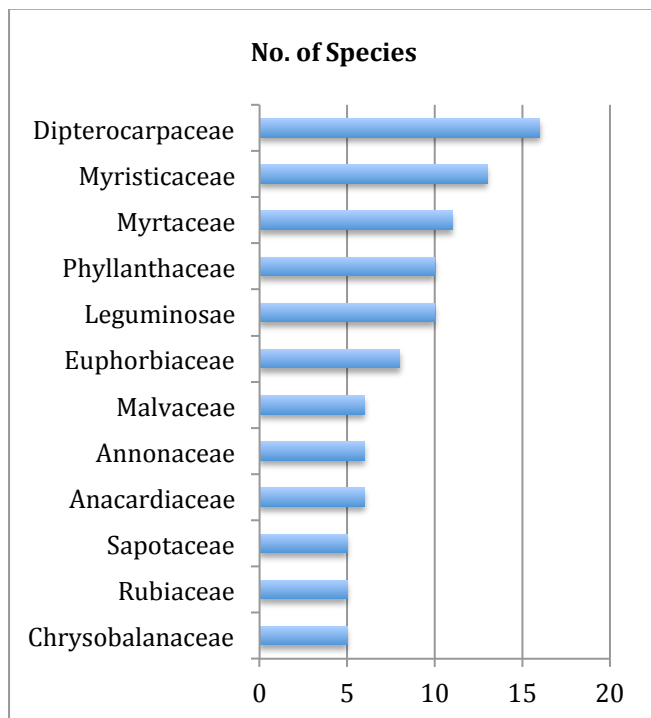


Figure 3. The 12 most species-rich families derived from pooled data of all the 10 plots for trees ≥ 10 cm dbh in Lower Sugut Forest Reserve, Sabah, Malaysia.

Table 2. Common tree species on various canopy layers in disturbed forest ecosystems in Lower Sugut Forest Reserves. (Notes: Main canopy layer (MC); middlestorey canopy layer (MS); and understorey canopy layer (US)).

Forest Formation/Family/Species	MC	MS	US
Lowland Kerangas Forest			
Annonaceae			
<i>Mezettia sp.</i>		✓	
<i>Xylopia ferruginea</i>		✓	✓
Myrtaceae			
<i>Syzygium biabas</i>			✓
<i>Syzygium incarnatum</i>			✓
<i>Syzygium sp.</i>			✓
<i>Tristaniopsis obovata</i>	✓	✓	✓
Sapotaceae			
<i>Palaquium pseudorostratum</i>			✓
<i>Palaquium sp.</i>			✓
Lowland Mixed Dipterocarp- Kapur Merah Forest			
Clusiaceae			
<i>Garcinia gaudichaudi</i>			✓
<i>Garcinia parvifolia</i>			✓
<i>Garcinia sp.</i>			✓
Dipterocarpaceae			
<i>Dryobalanops beccarii</i>	✓	✓	✓
<i>Vatica umbonata</i>			✓
Myrtaceae			
<i>Syzygium cf. acuminatissima</i>			✓
<i>Syzygium clavatum</i>			✓
<i>Syzygium confertum</i>			✓
<i>Syzygium sp.</i>		✓	✓
Peraceae			
<i>Chaetocarpus castanocarpus</i>		✓	
Rubiaceae			
<i>Gardenia elata</i>			✓
<i>Timonius luzonensis</i>			✓
Lowland Mixed Dipterocarp & Kerangas Forest			
Anacardiaceae			
<i>Gluta oba</i>	✓	✓	✓
<i>Mangifera griffithii</i>			✓
<i>Mangifera macrocarpa</i>			✓
<i>Mangifera swintonioides</i>			✓
Annonaceae			
<i>Mezettia sp.</i>		✓	
<i>Xylopia sp.</i>		✓	
Dipterocarpaceae			

<i>Anisoptera marginata</i>		✓	✓
<i>Cotylelobium melanoxydon</i>		✓	✓
<i>Dipterocarpus grandiflorus</i>			✓
<i>Dryobalanops beccarii</i>		✓	
<i>Hopea beccariana</i>		✓	
<i>Shorea atrinervosa</i>			✓
<i>Shorea kudatensis</i>	✓	✓	✓
<i>Shorea multiflora</i>	✓	✓	✓
<i>Shorea parvifolia</i>	✓	✓	✓
<i>Shorea rubra</i>		✓	
Myrtaceae			
<i>Rhodamnia cinerea</i>			✓
<i>Syzygium attenuata</i>		✓	✓
<i>Syzygium caudatilimbum</i>			✓
<i>Syzygium clavatum</i>			✓
<i>Syzygium confertum</i>			✓
<i>Syzygium sp.</i>		✓	✓
<i>Tristaniopsis obovata</i>		✓	✓
Lowland Seasonal Freshwater Swamp Forest			
Dipterocarpaceae			
<i>Dipterocarpus validus</i>		✓	✓
<i>Hopea nervosa</i>			✓
<i>Hopea sangal</i>	✓	✓	✓
<i>Parashorea malaanonan</i>			✓
<i>Shorea gibbosa</i>		✓	
<i>Vatica umbonata</i>	✓	✓	✓
Leguminosae			
<i>Cassia nodosa</i>	✓		
<i>Crudia reticulata</i>		✓	
<i>Crudia sp.</i>	✓		
<i>Neolamarckia cadamba</i>	✓		
<i>Sindora cf. coriacea</i>	✓		
<i>Sindora sp.</i>		✓	
Phyllanthaceae			
<i>Baccaurea lanceolata</i>			✓
<i>Baccaurea tetrandra</i>			✓
<i>Cleistanthus myrianthus</i>			✓
<i>Glochidion rubrum</i>			✓
Rubiaceae			
<i>Pleiocarpidia sandakanica</i>			✓

i. Mixed dipterocarp & kerangas forest

Originally, this lowland forest occupied about 1,773 ha or 19% of the total LSFR (Fig. 4). The dominant group of trees are the dipterocarps that represent up to 14–33 %

and 25–48 % of the total density and basal area of the forest, respectively. Other important tree families are Anacardiaceae and Myrtaceae (Plate 1).

The main canopy consists of mature trees with diameter of >50 cm and which can attain height about 40–50 m (Table 2). The main canopy is dominated by the typical upland species, namely *Shorea kudatensis*, *Shorea multiflora* and *Shorea parvifolia* from the tree family Dipterocarpaceae, and *Gluta oba* (Anacardiaceae). The middle storey forest structure consists of trees with a diameter range of 20–40 cm but rarely exceed 40 m in height. It is partly represented by the main canopy trees, as well as other medium-sized mature trees, such as, *Anisoptera marginata*, *Cotylelobium melanoxydon*, *Dryobalanops beccarii*, *Hopea beccariana*, *Shorea rubra* from the tree family Dipterocarpaceae; and *Syzygium attenuata*, *Syzygium* sp., *Tristaniopsis obovata* from the tree family Myrtaceae. The understorey of this forest is represented by most of the trees found in the main and mid-canopy layers, alongside understorey treelets with diameter of < 20 cm. Common trees in this understorey canopy are *Mangifera griffithii*, *Mangifera macrocarpa*, *Mangifera swintonioides* from the tree family Anacardiaceae; and *Rhodammia cinerea*, *Syzygium caudatilimbium*, *Syzygium clavatum*, *Syzygium confertum* from the tree family Myrtaceae (Table 3).

ii. Mixed dipterocarp forest: Kapur Merah Forest

The original coverage of lowland mixed dipterocarp forest (MDF) is estimated as 980 ha or 11% of the total LFR (Fig. 4). The Dipterocarp trees is the single most dominant family with at least 26–45 and 35–83 % of the total tree density and basal area represents the forest structure, respectively. The dipterocarps are also well represented in most of the canopy layer in the forest, i.e. the upper, middle storey and under storey canopies. The tree family Ixonanthaceae represents other important group of trees (Plate 2).

The main canopy of lowland MDF consists of mature trees with diameter of >50 cm and they can attain height to about 50–60 m (Table 2). The common trees found in this canopy layer are *Dryobalanops beccarii* (Dipterocarpaceae). The middle storey forest structure consists of trees with a diameter range of 20–50 cm but rarely exceed 40 m in height. It is partly represented by the main canopy trees, as well as other medium-sized mature trees, such as, *Chaetocarpus castanocarpus* (Peraceae) and *Syzygium* sp. (Myrtaceae). The understorey of this forest is represented by most of the trees found in the main and mid-canopy layers, alongside understorey treelets with diameter of <20 cm. Common trees in this understorey canopy are *Garcinia gaudichaudi*, *Garcinia parvifolia*, *Garcinia* sp. from the tree family Clusiaceae; *Syzygium* cf. *acuminatissima*, *Syzygium clavatum*, *Syzygium confertum* from the family Myrtaceae; *Gardenia elata*, *Timonius luzonensis* from the family Rubiaceae; and *Vatica umbonata* (Dipterocarpaceae).

Riparian forest that previously categorised as LMDF that usually establishes on soils of the Tuaran association could also occur in the reserve (Fig. 4). About 54 ha of this forest could have established on Tuaran soil association. However, due to remoteness of the area, the forest structure and composition is unattainable. It is expected that the riparian forests has been disturbed by shifting cultivators or latter by log extraction that may had lead to natural secondary successive vegetation with sporadic occurrence of climax species as relics, a typical important phenomenon that had happened elshewhere in Kinabatangan Floodplain.

iii. Seasonal freshwater swamp forest

Originally, the seasonal freshwater swamp forest (SFWSF) covered an estimated area of 1,051 ha or 12% of the total LSFR (Fig. 4). This forest is seasonally inundated and much of the composition is mixture of freshwater swamp and low lying mixed dipterocarp forest species. The forest structure is co-dominated by the Dipterocarpaceae and Leguminosae tree families. The former tree family represents about 8–20 % and 20–23 % of the total density and basal area of the forest, respectively. The trees from Leguminosae family represent about 10–13 % and 18–25 % of the total density and basal area of the forest, respectively. Other important tree families are Rubiaceae and Moraceae (Plate 3).

The main canopy consists of mature trees with diameter of >30 cm and which can attain height about 20–30 m (Table 2). The main canopy is dominated by the typical upland species, namely *Hopea sangal* and *Vatica umbonata* from the tree family Dipterocarpaceae; *Cassia nodosa*, *Crudia* sp. and *Sindora* cf. *coriacea* from the tree family Leguminosae; and *Neolamarckia cadamba* (Rubiaceae). The middle storey forest structure consists of trees with a diameter range of 20–30 cm but rarely exceed 20 m in height. It is partly represented by the main canopy trees, as well as other medium-sized mature trees, such as *Dipterocarpus validus* and *Shorea gibbosa* from the tree family Dipterocarpaceae; and *Crudia reticulata* and *Sindora* sp. from the tree family Leguminosae. The understorey of this forest is represented by most of the trees found in the main and mid-canopy layers, alongside understorey treelets with diameter of < 20 cm. Common trees in this understorey canopy are *Hopea nervosa* and *Parashorea malaanonan* from the tree family Dipterocarpaceae; *Baccaurea lanceolata*, *Baccaurea tetrandra*, *Cleistanthus myrianthus* and *Glochidion rubrum* from the family Phyllanthaceae; and *Pleiocarpidia sandakanica* (Rubiaceae).

The forest structure and composition of freshwater swamp forest (FWSF) is unattainable due to remoteness of the area and it was inundated with water throughout the survey. It is estimated that about 2,266 ha or 26% of the total LSFR are cover with this swamp forest.

iv. Lowland Kerangas Forest

This forest occurs sporadically within the matrix of lowland mixed dipterocarp forest that established over Maliau association. The structure of the forest is dominated by Myrtaceae trees that contributes to about 21 % and 27 % of the density and basal area of the forest, respectively. Other important associates in the forest are the Annonaceae and Sapotaceae (Plate 4).

The main canopy consists of mature trees with diameter of > 30 cm and which can attain height about 20–30 m (Table 2). The main canopy is dominated by the typical *kerangas* species, namely *Tristaniopsis obovata* (Myrtaceae). The middle storey forest structure consists of trees with a diameter range of 20–30 cm but rarely exceed 20 m in height. It is partly represented by the main canopy trees, as well as other medium-sized mature trees, such as *Mezzetia* sp. and *Xylopia ferruginea* from the tree family Annonaceae. The understorey of this forest is represented by most of the trees found in the main and mid-canopy layers, alongside understorey treelets with diameter of < 20 cm. Common trees in this understorey canopy are *Syzygium*

incarnatum and *Syzygium biabas* from the tree family Myrtaceae; and *Palaquium pseudorostratum* and *Palaquium* sp. from the family Sapotaceae.

v. Mangroves and beach forest

The mangroves are tidal influence areas and occupies about 2,624 ha or 30% of the total LSFR (Fig. 4). Based on observation, it is largely undisturbed and most of the mangrove zonations, such as seaward fringe, main mangrove, back mangrove and transitional forest are well represented (Plate 5 A–F).

At coastal area of the reserve, a strand of beach forest developed on raised sandy beach was observed. This forest is mainly dominated by *Aru* trees (*Casuarina equisetifolia*, Casuarinaceae) and associated with other coastal species, such as, *Heritiera littorale* (Malvaceae), *Barringtonia asiatica* (Lecythidaceae), *Calophyllum inophyllum* (Calophyllaceae), *Pongamia pinnata* (Leguminosae) and *Pouteria obovata* (Sapotaceae) (Plate 5 G & H).

ii. Secondary Vegetation

The natural landscape of this reserve has been degenerated into secondary vegetation with various successional stages. The scale, intensity and age of the past logging operations and encroachments have resulted in residual forests of varying levels of forest quality (Plates 6). Considerable forest area classified as LMDF and LMDKF are categorized as secondary growth vegetation that naturally very low quality in forest structure and diversity status. The recovery rate of such disturbed areas are largely compounded by the severity of soil degradation in relation to soil moisture and fertility. The rate will be slow in areas where the topsoil has been removed. Furthermore, the soils that had been compacted by the passage of heavy machineries that are often devoid of high vegetation structure and can be considered low in forest productivity.

The common secondary trees found in this heavily disturbed area are *Macaranga pearsonii*, *Macaranga gigantea*, *Macaranga tanarius*, *Macaranga hypoleuca* and *Macaranga beccariana* from the family Euphorbiaceae; *Neolamarckia cadamba* and *Neonauclea gigantea* from the family Rubiaceae; *Alstonia angustiloba* (Apocynaceae); *Trema orientalis* (Ulmaceae); *Alphitonia excelsa* (Rhamnaceae); *Homalium foetidum* (Flacourtiaceae); *Artocarpus elasticus* (Moraceae); *Vitex pinnata* (Verbenaceae); *Litsea garciea* (Lauraceae); and *Bruinsmia styracoides* (Styracaceae). Some of these trees established in patches or are sparsely distributed across the low shrub and sedge vegetation layer. A number of secondary treelets, namely, *Fagraea cuspidata* (Loganiaceae), *Ficus septica* (Moraceae), *Leea indica* (Leeaceae), *Melicope luna-ankenda* (Rutaceae), *Dillenia borneensis* (Dilleniaceae), *Callicarpa longifolia* (Verbenaceae), *Pternandra* sp. (Melastomataceae), *Homalanthus populneus* and *Glochidion* sp. from the family Euphorbiaceae, are categorized as common treelets that establish in the matrix of secondary vegetation. In much open areas, climbing bamboo (*Dinochloa scabrida*, Poacea), vines or woody climbers, such as, *Croton cordata* (Euphorbiaceae), *Merremia* sp. (Convulvulaceae), *Smilax borneensis* (Melastomataceae), and *Uncaria* sp. (Rubiaceae), scramble on the ground or smother other secondary plants. In relatively opened and nutrient poor site, the ground vegetation are occupied by lalang grass (mainly *Imperata cylindrica*), ferns

(mainly *Pteridium esculentum* and associated with *Dicranopteris linearis*) and shrubs (*Melastoma malabathricum*).

CONSERVATION SIGNIFICANCE

Retaining the whole FMU under the natural forest management activities is the best effort in maintaining the forest ecosystem function as forest corridor for plant dispersal and wildlife movement. With the application of rigorous forest silvicultural exercise and forest structural diversity restoration activities, it is envisaged that the forest ecosystem function for the physical and biological environment will maintain or perhaps become better over time.

Based on Sugau unpublished report (2015) that out of 584 plant taxa recorded in LSFR, 107 taxa are endemic to Borneo, including 10 taxa that are endemic to Sabah. Furthermore, under the IUCN Red List Categories and Criteria, the report also highlighted 7 plant species that are listed as Vulnerable (VU), 4 Endangered (EN) and 9 Critically Endangered (CR). There is one taxon, namely *Tetrastigma diepenhorstii* that fall under Schedule 1, part II, Totally Protected Plant Species under the Sabah Wildlife Conservation Enactment 1997 (SWD, 1997), including 7 taxa of orchids, 4 taxa of gingers and 5 species of pitcher plants that fall under Schedule 2, part II, Protected Plant Species.

Due to high presence of high conservation value flora in the reserve, it is important to protect and enhance the forest ecosystems in its natural setting. Long-term monitoring activities by using permanent sample plots are useful to determine long-term population trends of increase or decrease that can be related to human disturbance or short term term fluctuations caused by variations in weather or unpredictable natural catastrophic events. Therefore, based on Malaysian High Conservation Toolkit 2009, in relation to the flora diversity and a number outstanding conservation values, the assessment indicates that the whole area of originally occupied with LMDF, LMDKF, SFWSF and FSWF should be categorised as HCV 1.2 and HCV 1.3 that indicates habitats for endemics, threatened and endangered flora species.

All of LSFR area is estimated to be below 200 m a.s.l. of lowland forest. As mention earlier, the area originally covered with LMDF, LMDKF, SFWSF and FWSF of various regenerative qualities still contain rare, endangered, threatened and also endemic species that appropriate to be categorised as HCV 3. Long-term monitoring activities by using permanent sample plots are useful to determine changes in forest structure and composition.

POTENTIAL THREATS

Forest Fire

In Southeast Asian tropical rain forests, long drought events are associated with the atmospheric and oceanic anomaly known as the El Niño-Southern Oscillation (ENSO) phenomenon (Walsh, 1996). Frequent occurrences of these severe

drought events have increased the susceptibility of vegetation to wildfire. Over the period 1957–1998, Sabah experienced at least eight significant drought events, and those in 1983, 1986–87, 1992 and 1998 were identified as the most extreme (Walsh, 1996; Walsh & Newbery, 1999). During these climatic extremes, drought-induced fire burnt large areas of forest in Borneo (Beaman *et al.*, 1985; Leighton & Wirawan, 1986, Woods, 1989, Sabah Forestry Department Annual Reports). For example, the ENSO-associated drought induced-fires event in 1982–83 had damaged 5×10^6 ha in Borneo (Goldammer *et al.* 1996).

Most of the reserve is categorized as secondary growth vegetation. It is known that secondary vegetation or disturbed forest is more susceptible to fire in comparison to pristine forest (Woods, 1989). Therefore, fire is considered as a major threat to natural forest conservation and management, especially in areas surrounded by developed land for urban/rural or agricultural activities.

Forest Simplification

Forest simplification is the reduction of compositional and structural diversity from forest stands and landscapes. Most of the reserve area is dominated by secondary vegetation and planted forest with various degrees of degradation due to forest fire and encroachments. These areas are very much degraded with low diversity and productivity that the threat of forest simplification may be inevitable. The simplification of the forest could have a direct impact on the physical and terrestrial ecosystem throughout the forest landscape.

RECOMMENDATIONS

Protection of forest ecosystem

i. Monitoring extent of forest

Remote sensing and GIS have been used as a management tool to examine spatio-temporal processes such as old growth forest, disturbance, and species dynamics. This tool should be used to produce a stand-based mapping of vegetation type and structure as baseline for monitoring purposes in the management of this conservation area.

ii. Forest fire prevention programme

The goal of the programme is to create and use environmentally sound and economically efficient strategies that minimize the total cost to protect LS FR ecosystem's functionality from wildfire. The formulation of this programme should maintain multi-faceted activities, such as fire prevention, detection, control and suppression activities, in order to provide effective protection from fire to other forest values, such as water and watersheds, fisheries, wildlife, recreation, aesthetics, soil productivity and soil stability. The programme should encourage cooperation with public agencies with similar goals, and inform the general public of current

and potential forest fire danger in the effort to protect people, property, and natural resources from the risk of wildfire.

iii. Forest protection and enforcement

Forest protection and enforcement is a crucial component of the management to enforce the Forest Enactment 1969 and Forest Rule 1969 on the security and protection of the reserve. The following main objectives are required in this programme:

- a) formulate enforcement strategies and maintain patrolling activities
- b) enhance capacity of forestry personnel to remain competent in the enforcement activities.

Maintaining forest health and functionality

To monitor forest health and overall functionality of the existing disturbed lowland mixed dipterocarp forest area, establishment of long-term ecological research plot or permanent sample plots (PSPs) is a scientific approach in documenting detailed changes in forest structure and composition. The output of the plot could provide baseline distributions for high conservation value species and detailing habitats of a particular site. The long-term monitoring activities, such as assessment of the standing trees of these plots would provide invaluable information of changes in plant diversity and richness, growth, mortality, regeneration and dynamics of the sampled forest. This information on forest changes is an indicator of forest health and functionality. Therefore, the existing 10 PSP, and perhaps several more need to be established, are important to be included in the monitoring activities in the FMU.

Silvicultural treatment and restoration activities

Forest restoration has become an important management strategy in many conservation efforts. Restoration activities such as the planting of indigenous trees attempts to re-establish and enhance forest structure and diversity. This “silvicultural” practice has become a common approach in mitigating the negative impacts of forest degradation, in a bid to restore forest system function and productivity. In designing forest restoration activities, some measures should be considered and they are as follows (adopted from Lamb & Tomlinson, 1994):

- i. **Identify what limit recovery**—It is necessary to identify potential biotic and abiotic stressors that limit recovery.
- ii. **Using local species**—Local species have co-evolutionary animal linkages, a web of interaction not only between plant species, but also faunal species. Using exotic plants for restoration should be avoided as they may accidentally become widespread and invasive in nature.
- iii. **Conserving genetic variation**—Using localized tree species or neighbouring forest communities may reduce deleterious consequences on the genetic integrity of the local genotype (genetic erosion of a local gene-pool) and the genetic diversity of the local population.

- iv. **Expected vegetation structure**—The aim is diverse vegetation structure in any habitat restoration project.
- v. **Proper site preparation, planting and maintenance (silvicultural treatment and restoration measures)**—A precondition in formulating a restoration design strategy is an evaluation of the potential stressors of the site, both abiotic and biotic. The removal of this biotic stressor is an important start in preparing the site for planting. The planting design is a key aspect in creating a varied structured stand. Current practices require a greater variety of species (fruit trees, timber trees, mid-storey, upper-storey) to be planted consecutively, but selected based on their preferential light environment. The frequency and duration of many maintenance regimes is dependent on the growth of planted seedlings, to a point where the plant can competitively exclude or suppress weed species.
- vi. **Measures to evaluate success**—The restoration project success can be evaluated through silvicultural-approach monitoring programme of planted trees and natural flowering and fruiting in trees after planting.

Environmental awareness

Landuse activities by the large oil palm company and several local communities residing around the LSFR may give an impact to the integrity of the forest ecosystem, especially at the forest edge. There should be an effort to make these public aware of the importance and services of the ecosystem by designing environmental awareness programmes that address issues on ecosystem integrity and safeguarding the diversity, abundance and distribution of unique plant and wildlife species in this forest type. Furthermore, the threats of fire to the ecosystem in the reserve should be made aware to the local communities so that human could respect and live in harmony with nature.

CONCLUSION

Though Lower Sugut FR has moderate conservation significance, however, the units contain endangered lowland forest ecosystem that provide significant habitat for rare, threatened and endangered, and endemic flora and fauna in the region. A monitoring system to evaluate the integrity of the forest ecosystem is required and extensive restoration and silvicultural exercises are needed to enhance and protect the biodiversity of the area.

REFERENCES

- Acres, B.D., Bower, R.P., Burrough, P.A., Folland, C.J., Kalsi M.S., Thomas, P. & Wright, P.S. (1975). *The soil of Sabah*. Volume 1: Classification and description. Land Resource Study 20. Land Resource Division, Ministry of Overseas Development, Tolworth Tower, Surbiton, Surrey, England.
- Brower, J.E. & Zar, J.H. (1977). *Field and Laboratory Methods of General Ecology*. Wm. C. Brown Company Publishers, Dubuque, Iowa. 194 p.
- Goldammer, J.G., Seibert, B. & Schindele, W. (1996). Fire in dipterocarp forests. In: Schulte, A. & Schöne, D. (eds.). *Dipterocarp forest ecosystems: Towards sustainable management*. World Scientific Publication, Singapore-New Jersey-London-Hong Kong. Pp. 155–185.
- Leighton, M. & Wirawan, N. (1986). Catastrophic drought and fire in Borneo tropical rain forest associated with the 1982–1983 El Niño Southern Oscillation event. In: Prance, G.T. (ed.). *Tropical rain forests and the world atmosphere*. Westview Press, Boulder, CO. Pp. 75–102.
- Walsh, R.P.D. (1996). Drought frequency changes in Sabah and adjacent parts of northern Borneo since the late nineteenth century and possible implications for tropical rain forest dynamics. *Journal of Tropical Ecology* 12: 385–407.
- Walsh, R.P.D. & Newbery, D.M. (1999). The ecoclimatology of Danum, Sabah, in the context of the world's rainforest regions, with particular reference to dry periods and their impact. *Philosophical Transactions of the Royal Society of London Series B* 354: 1869–1883.
- Woods, P. (1989). Effect of logging, drought, and fire on structure and composition of tropical rain forest in Sabah, Malaysia. *Biotropica* 21: 290–298.

Appendix I Photo Gallery

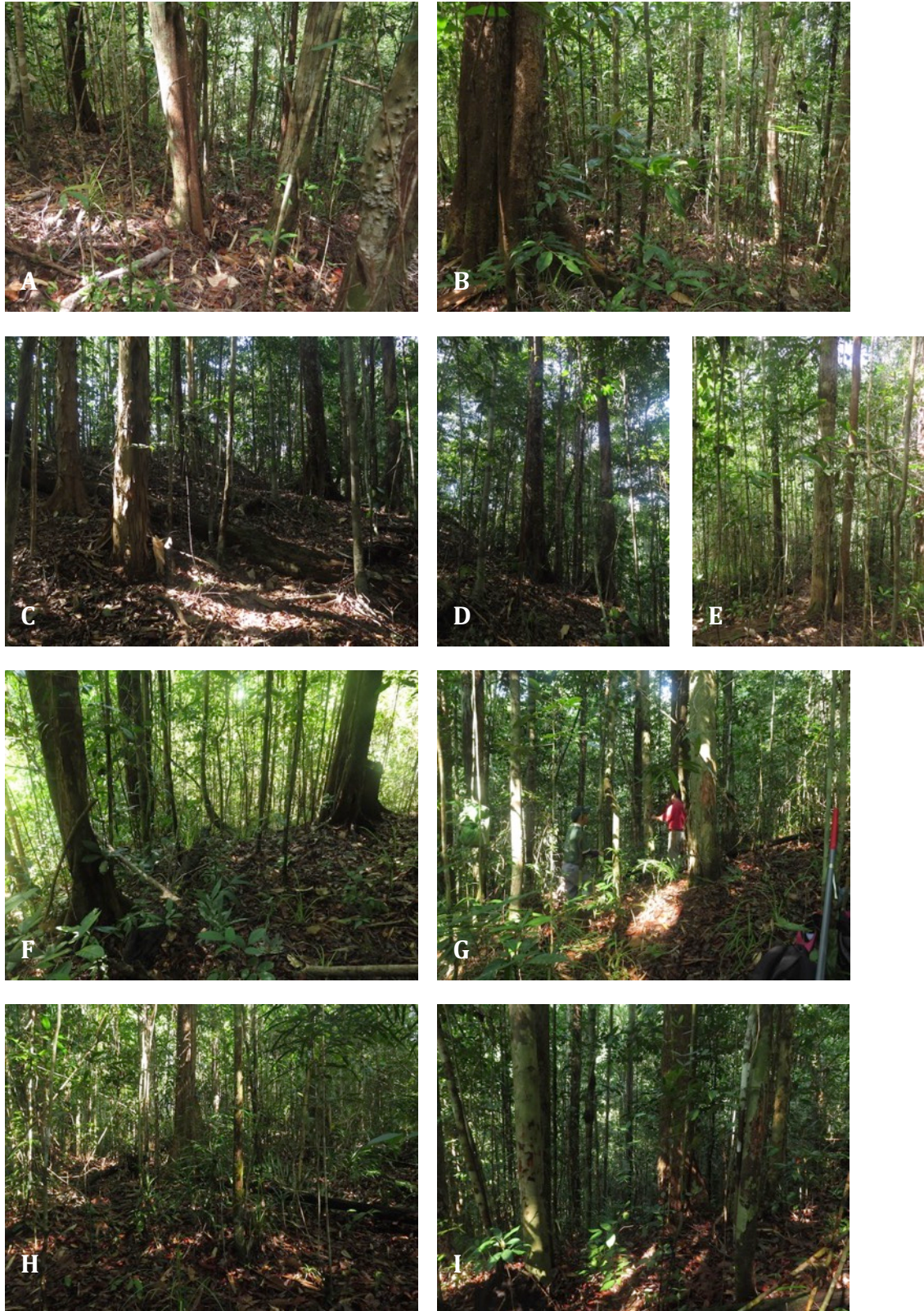


Plate 1. A–I The example of disturbed lowland mixed dipterocarp and kerangas forest stands, established on Maliau soil association in Lower Sugut FR.



Plate 2. The example of lowland mixed dipterocarp and kerangas forest stands that are predominantly represented by large *Dryobalanops beccarii* trees in Lower Sugut Forest Reserve: **A–E.** moderately disturbed forest patches; and **F & G.** early regenerating forest after slightly severe disturbance due to timber extraction in the past.

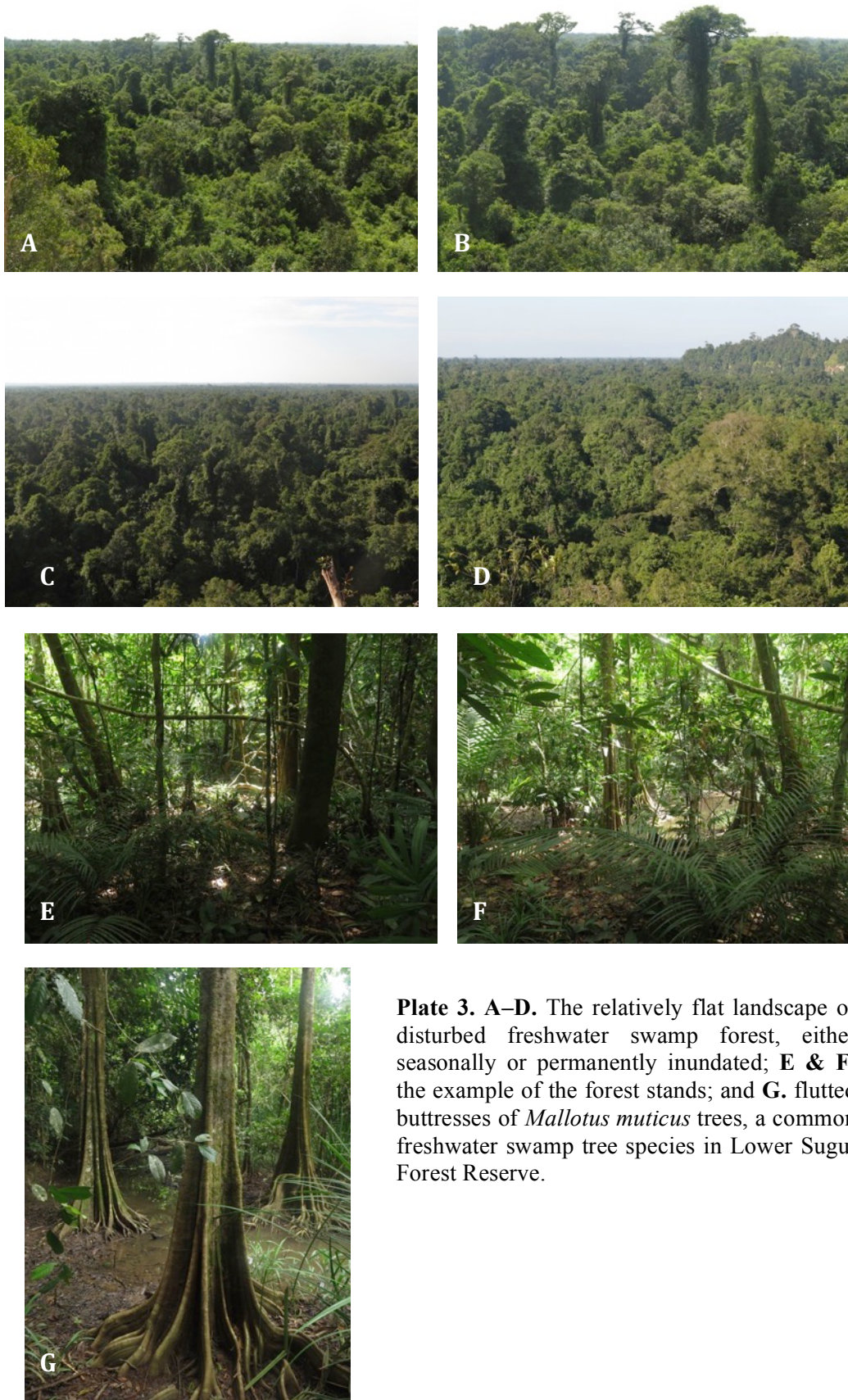


Plate 3. A–D. The relatively flat landscape of disturbed freshwater swamp forest, either seasonally or permanently inundated; E & F. the example of the forest stands; and G. fluted buttresses of *Mallotus muticus* trees, a common freshwater swamp tree species in Lower Sugut Forest Reserve.



Plate 4. A–E. The example of *Kerangas* forest, typically represented with smaller stature trees that thrives on nutrient poor site, that found sporadically within the Lowland Mixed Dipterocarp Forest on Maliau association; F. clusters of *Nepenthes ampularia* and G. a *Tristaniopsis obovata* tree (reddish peeling barks) important indicator of nutrient poor site; and H. gregarious regeneration of *Tristaniopsis obovata* pole-sized trees on disturbed *Kerangas* forest patch in Lower Sugut Forest Reserve.

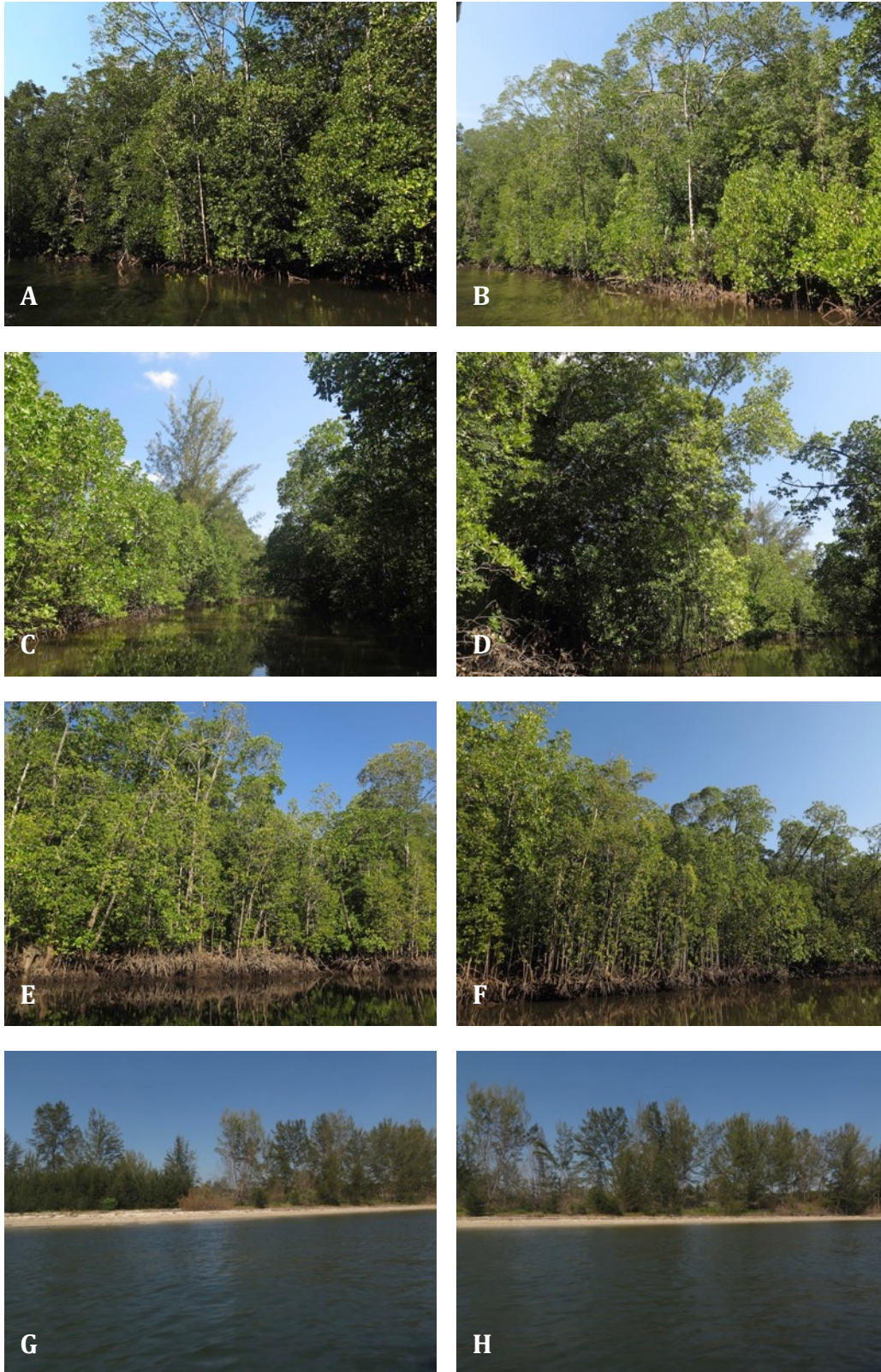


Plate 5. A-F. The example of mangroves that thrives on tidal influenced areas; and **G & H.** a strand of beach forest developed on sandy beach in Lower Sugut Forest Reserve.



Plate 6. Example of secondary vegetation after severe disturbance by logging activities in the past: **A.** an opened grassland develop on previously log stumping area, **B–D.** infestation of climbing bamboos on residual trees after logging; and **E.** evidence of fell stump.



Figure 7. A & B. An interesting sanstone cave that home to bats and swiflets; and peculiar unknown man-made artefact.



Figure 8. Illegal felling of *Kapur Merah* trees in the reserve.

Appendix Familial Composition

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Domin- ance	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
1	Dipterocarpaceae	159.2	7.2	24.7	27.1	25.9	71.7	47.8	39.8					
	Anacardiaceae	47.8	5.1	7.4	19.2	13.3	15.9		8.0	15.9	8.0			
	Myrtaceae	87.6	2.2	13.6	8.3	11.0	79.6		8.0					
	Ixonanthaceae	31.8	3.1	4.9	11.5	8.2		15.9	8.0	8.0				
	Ctenolophonaceae	15.9	3.3	2.5	12.2	7.3	8.0					8.0		
	Myristicaceae	39.8	0.8	6.2	3.1	4.6	31.8	8.0						
	Burseraceae	39.8	0.6	6.2	2.2	4.2	39.8							
	Clusiaceae	39.8	0.5	6.2	1.8	4.0	39.8							
	Peraceae	23.9	0.9	3.7	3.4	3.6	8.0	15.9						
	Oleaceae	31.8	0.4	4.9	1.5	3.2	31.8							
	Sapotaceae	23.9	0.6	3.7	2.2	2.9	15.9	8.0						
	Annonaceae	15.9	0.3	2.5	1.3	1.9	8.0	8.0						
	Polygalaceae	15.9	0.3	2.5	1.1	1.8	15.9							
	Euphorbiaceae	15.9	0.2	2.5	0.7	1.6	15.9							
	Elaeocarpaceae	8.0	0.3	1.2	1.3	1.3		8.0						
	Lauraceae	8.0	0.2	1.2	0.7	1.0	8.0							
	Celastraceae	8.0	0.2	1.2	0.7	1.0	8.0							
	Ulmaceae	8.0	0.2	1.2	0.7	1.0	8.0							
	Phyllanthaceae	8.0	0.1	1.2	0.5	0.9	8.0							
	Pentaphylacaceae	8.0	0.1	1.2	0.3	0.8	8.0							
Rubiaceae	8.0	0.1	1.2	0.3	0.7	8.0								
TOTAL		644.9	26.6	100.0	100.0	100.0	429.9	111.5	63.7	23.9	8.0		8.0	

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
2	Myrtaceae	183.1	4.5	26.7	18.1	22.4	151.3	23.9	8.0					
	Dipterocarpaceae	127.4	6.4	18.6	25.6	22.1	63.7	31.8	23.9	8.0				
	Anacardiaceae	31.8	5.6	4.7	22.6	13.6		8.0	8.0	8.0		8.0		
	Annonaceae	63.7	1.9	9.3	7.5	8.4	39.8	23.9						
	Clusiaceae	31.8	0.4	4.7	1.5	3.1	31.8							
	Stemonuraceae	23.9	0.4	3.5	1.5	2.5	23.9							
	Oleaceae	23.9	0.3	3.5	1.4	2.4	23.9							
	Melastomataceae	23.9	0.3	3.5	1.3	2.4	23.9							
	Peraceae	8.0	0.9	1.2	3.6	2.4			8.0					
	Calophyllaceae	23.9	0.3	3.5	1.2	2.4	23.9							
	Polygalaceae	23.9	0.3	3.5	1.2	2.4	23.9							
	Ixonanthaceae	8.0	0.8	1.2	3.2	2.2				8.0				
	Thymelaeaceae	8.0	0.8	1.2	3.1	2.1				8.0				
	Proteaceae	15.9	0.2	2.3	0.7	1.5	15.9							
	Ctenolophonaceae	8.0	0.3	1.2	1.3	1.2			8.0					
	Elaeocarpaceae	8.0	0.3	1.2	1.3	1.2			8.0					
	Myristicaceae	8.0	0.2	1.2	0.8	1.0	8.0							
	Celastraceae	8.0	0.2	1.2	0.7	0.9	8.0							
	Sapindaceae	8.0	0.2	1.2	0.7	0.9	8.0							
	Sapotaceae	8.0	0.1	1.2	0.6	0.9	8.0							
	Lauraceae	8.0	0.1	1.2	0.6	0.9	8.0							
Ulmaceae	8.0	0.1	1.2	0.5	0.8	8.0								
Fagaceae	8.0	0.1	1.2	0.3	0.8	8.0								
Symplocaceae	8.0	0.1	1.2	0.3	0.7	8.0								
Euphorbiaceae	8.0	0.1	1.2	0.3	0.7	8.0								
TOTAL		684.7	24.9	100.0	100.0	100.0	493.6	103.5	63.7	15.9			8.0	

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)							
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80
3	Dipterocarpaceae	199.0	42.8	44.6	82.7	63.7	119.4	39.8	8.0	8.0	8.0			15.9
	Myrtaceae	31.8	0.6	7.1	1.1	4.1	31.8							
	Lauraceae	23.9	1.5	5.4	2.8	4.1	15.9			8.0				
	Sapotaceae	15.9	1.6	3.6	3.0	3.3			15.9					
	Celastraceae	15.9	1.5	3.6	2.9	3.2	8.0			8.0				
	Moraceae	15.9	0.4	3.6	0.8	2.2	8.0	8.0						
	Burseraceae	15.9	0.4	3.6	0.7	2.2	8.0	8.0						
	Phyllanthaceae	15.9	0.4	3.6	0.7	2.1	15.9							
	Clusiaceae	15.9	0.2	3.6	0.4	2.0	15.9							
	Dilleniaceae	8.0	1.0	1.8	1.9	1.9				8.0				
	Peraceae	8.0	0.4	1.8	0.7	1.3		8.0						
	Rubiaceae	8.0	0.2	1.8	0.4	1.1	8.0							
	Elaeocarpaceae	8.0	0.2	1.8	0.3	1.0	8.0							
	Chrysobalanaceae	8.0	0.1	1.8	0.2	1.0	8.0							
	Ebenaceae	8.0	0.1	1.8	0.2	1.0	8.0							
	Centroplacaceae	8.0	0.1	1.8	0.2	1.0	8.0							
	Sapindaceae	8.0	0.1	1.8	0.2	1.0	8.0							
	Rhizophoraceae	8.0	0.1	1.8	0.2	1.0	8.0							
	Simaroubaceae	8.0	0.1	1.8	0.1	1.0	8.0							
	Euphorbiaceae	8.0	0.1	1.8	0.1	1.0	8.0							
Myristicaceae	8.0	0.1	1.8	0.1	1.0	8.0								
TOTAL		445.9	51.8	100.0	100.0	100.0	302.5	63.7	23.9	31.8	8.0			15.9

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)						
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9
4	Dipterocarpaceae	143.3	20.4	25.7	56.8	41.2	63.7	23.9	8.0	8.0	23.9	8.0	8.0
	Sapotaceae	47.8	4.0	8.6	11.2	9.9	15.9	8.0	8.0	8.0			
	Myrtaceae	55.7	2.3	10.0	6.5	8.3	15.9	31.8	8.0				
	Melastomataceae	47.8	1.1	8.6	3.1	5.8	39.8	8.0					
	Dilleniaceae	39.8	1.6	7.1	4.4	5.8	15.9	23.9					
	Peraceae	23.9	1.3	4.3	3.6	4.0		15.9	8.0				
	Clusiaceae	31.8	0.6	5.7	1.7	3.7	31.8						
	Anacardiaceae	23.9	1.1	4.3	2.9	3.6	8.0	8.0	8.0				
	Moraceae	23.9	0.6	4.3	1.6	2.9	15.9	8.0					
	Chrysobalanaceae	8.0	1.5	1.4	4.2	2.8				8.0			
	Centroplacaceae	15.9	0.4	2.9	1.0	1.9	8.0	8.0					
	Myristicaceae	15.9	0.3	2.9	0.8	1.8	15.9						
	Lecythidaceae	15.9	0.2	2.9	0.5	1.7	15.9						
	Pentaphyllacaceae	15.9	0.2	2.9	0.4	1.6	15.9						
	Calophyllaceae	15.9	0.1	2.9	0.4	1.6	15.9						
	Ctenolophonaceae	8.0	0.1	1.4	0.3	0.8	8.0						
	Sapindaceae	8.0	0.1	1.4	0.2	0.8	8.0						
	Simaroubaceae	8.0	0.1	1.4	0.2	0.8	8.0						
	Annonaceae	8.0	0.1	1.4	0.2	0.8	8.0						
TOTAL		557.3	35.9	100.0	100.0	100.0	310.5	135.4	39.8	23.9	31.8	8.0	8.0

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
5	Dipterocarpaceae	167.2	6.4	35.0	34.8	34.9	71.7	71.7	23.9					
	Ixonanthaceae	23.9	2.9	5.0	15.8	10.4		8.0	8.0		8.0			
	Peraceae	23.9	2.6	5.0	14.3	9.7			23.9					
	Myrtaceae	47.8	1.3	10.0	7.3	8.6	39.8		8.0					
	Rubiaceae	55.7	0.8	11.7	4.2	8.0	55.7							
	Anacardiaceae	31.8	0.8	6.7	4.3	5.5	23.9	8.0						
	Chrysobalanaceae	23.9	0.9	5.0	5.1	5.0	8.0	15.9						
	Euphorbiaceae	31.8	0.6	6.7	3.2	4.9	23.9	8.0						
	Elaeocarpaceae	15.9	0.9	3.3	4.8	4.0	8.0		8.0					
	Annonaceae	15.9	0.4	3.3	2.3	2.8	15.9							
	Calophyllaceae	8.0	0.2	1.7	1.3	1.5	8.0							
	Myristicaceae	8.0	0.2	1.7	0.8	1.2	8.0							
	Melastomataceae	8.0	0.1	1.7	0.6	1.2	8.0							
	Sapindaceae	8.0	0.1	1.7	0.6	1.1	8.0							
	Sapotaceae	8.0	0.1	1.7	0.6	1.1	8.0							
TOTAL		477.7	18.5	100.0	100.0	100.0	286.6	111.5	71.7		8.0			

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
6	Anacardiaceae	262.7	7.5	33.0	24.8	28.9	175.2	71.7	15.9					
	Dipterocarpaceae	111.5	7.4	14.0	24.6	19.3	31.8	39.8	31.8	8.0				
	Myrtaceae	87.6	3.1	11.0	10.4	10.7	39.8	31.8	15.9					
	Myristicaceae	47.8	1.6	6.0	5.3	5.7	31.8	15.9						
	Malvaceae	23.9	2.2	3.0	7.4	5.2		8.0	8.0	8.0				
	Peraceae	31.8	1.9	4.0	6.3	5.1	8.0	8.0	15.9					
	Euphorbiaceae	39.8	0.5	5.0	1.5	3.3	39.8							
	Phyllanthaceae	31.8	0.7	4.0	2.4	3.2	23.9	8.0						
	Ixonanthaceae	15.9	1.3	2.0	4.3	3.2	8.0				8.0			
	Annonaceae	23.9	1.0	3.0	3.3	3.1	15.9		8.0					
	Moraceae	8.0	1.3	1.0	4.4	2.7					8.0			
	Melastomataceae	23.9	0.4	3.0	1.2	2.1	23.9							
	Oleaceae	23.9	0.2	3.0	0.7	1.9	23.9							
	Calophyllaceae	15.9	0.2	2.0	0.8	1.4	15.9							
	Celastraceae	8.0	0.3	1.0	0.8	0.9		8.0						
	Burseraceae	8.0	0.2	1.0	0.5	0.8	8.0							
	Stemonuraceae	8.0	0.1	1.0	0.4	0.7	8.0							
	Ulmaceae	8.0	0.1	1.0	0.4	0.7	8.0							
	Leguminosae	8.0	0.1	1.0	0.3	0.6	8.0							
Rhizophoraceae	8.0	0.1	1.0	0.2	0.6	8.0								
TOTAL		796.2	30.1	100.0	100.0	100.0	477.7	191.1	95.5	31.8				

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)							
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80
7	Dipterocarpaceae	127.4	8.7	32.7	48.0	40.3	39.8	15.9	63.7	8.0				
	Anacardiaceae	47.8	3.4	12.2	19.1	15.7	31.8			8.0	8.0			
	Myrtaceae	47.8	1.2	12.2	6.6	9.4	39.8		8.0					
	Calophyllaceae	39.8	1.2	10.2	6.6	8.4	31.8	8.0						
	Burseraceae	15.9	0.6	4.1	3.3	3.7	8.0	8.0						
	Peraceae	15.9	0.3	4.1	1.8	2.9	15.9							
	Chrysobalanaceae	8.0	0.6	2.0	3.5	2.8			8.0					
	Polygalaceae	8.0	0.4	2.0	2.4	2.2		8.0						
	Annonaceae	8.0	0.3	2.0	1.7	1.9		8.0						
	Ctenolophonaceae	8.0	0.3	2.0	1.5	1.8		8.0						
	Malvaceae	8.0	0.3	2.0	1.5	1.8		8.0						
	Euphorbiaceae	8.0	0.2	2.0	1.0	1.5	8.0							
	Rhizophoraceae	8.0	0.1	2.0	0.7	1.4	8.0							
	Clusiaceae	8.0	0.1	2.0	0.5	1.3	8.0							
	Rubiaceae	8.0	0.1	2.0	0.4	1.2	8.0							
	Pentaphylacaceae	8.0	0.1	2.0	0.4	1.2	8.0							
	Melastomataceae	8.0	0.1	2.0	0.4	1.2	8.0							
Phyllanthaceae	8.0	0.1	2.0	0.4	1.2	8.0								
TOTAL		390.1	18.0	100.0	100.0	100.0	222.9	63.7	79.6	15.9	8.0			

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
8	Leguminosae	39.8	3.1	12.8	25.2	19.0	15.9	8.0	8.0	8.0				
	Dipterocarpaceae	23.9	2.4	7.7	20.1	13.9	8.0	8.0			8.0			
	Rubiaceae	55.7	0.9	17.9	7.4	12.7	55.7							
	Moraceae	8.0	2.0	2.6	16.1	9.3					8.0			
	Myrtaceae	31.8	0.8	10.3	6.2	8.2	23.9	8.0						
	Sapindaceae	31.8	0.4	10.3	3.6	6.9	31.8							
	Oleaceae	15.9	0.9	5.1	7.5	6.3	8.0		8.0					
	Phyllanthaceae	23.9	0.4	7.7	3.4	5.6	23.9							
	Sapotaceae	23.9	0.3	7.7	2.7	5.2	23.9							
	Symplocaceae	15.9	0.5	5.1	4.2	4.6	8.0	8.0						
	Euphorbiaceae	8.0	0.1	2.6	1.1	1.8	8.0							
	Anacardiaceae	8.0	0.1	2.6	0.8	1.7	8.0							
	Simaroubaceae	8.0	0.1	2.6	0.7	1.6	8.0							
	Burseraceae	8.0	0.1	2.6	0.7	1.6	8.0							
	Lauraceae	8.0	0.1	2.6	0.5	1.5	8.0							
TOTAL		310.5	12.2	100.0	100.0	100.0	238.9	31.8	15.9	8.0	15.9			

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)							
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80
9	Dipterocarpaceae	95.5	3.8	19.7	22.9	21.3	55.7	23.9	8.0	8.0				
	Leguminosae	47.8	3.1	9.8	18.3	14.0	15.9	15.9	15.9					
	Oleaceae	47.8	1.0	9.8	6.0	7.9	31.8	15.9						
	Euphorbiaceae	31.8	1.4	6.6	8.7	7.6	15.9	8.0	8.0					
	Myrtaceae	23.9	1.6	4.9	9.8	7.4	15.9			8.0				
	Dilleniaceae	23.9	1.2	4.9	7.1	6.0	8.0	8.0	8.0					
	Malvaceae	23.9	0.8	4.9	4.7	4.8	15.9	8.0						
	Myristicaceae	31.8	0.5	6.6	2.8	4.7	31.8							
	Lauraceae	23.9	0.5	4.9	3.2	4.1	15.9	8.0						
	Meliaceae	23.9	0.5	4.9	2.7	3.8	15.9	8.0						
	Phyllanthaceae	23.9	0.3	4.9	2.0	3.4	23.9							
	Putranjivaceae	8.0	0.5	1.6	3.0	2.3		8.0						
	Clusiaceae	15.9	0.2	3.3	1.2	2.2	15.9							
	Achariaceae	15.9	0.2	3.3	1.1	2.2	15.9							
	Ebenaceae	8.0	0.5	1.6	2.7	2.2		8.0						
	Anacardiaceae	8.0	0.2	1.6	0.9	1.3	8.0							
	Melastomataceae	8.0	0.1	1.6	0.8	1.2	8.0							
	Burseraceae	8.0	0.1	1.6	0.8	1.2	8.0							
	Celastraceae	8.0	0.1	1.6	0.7	1.2	8.0							
	Chrysobalanaceae	8.0	0.1	1.6	0.6	1.1	8.0							
TOTAL		485.7	16.7	100.0	100.0	100.0	318.5	111.5	39.8	15.9				

Plot	Family	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
10	Myrtaceae	119.4	5.1	20.8	29.3	25.1	47.8	47.8	23.9					
	Annonaceae	111.5	3.5	19.4	20.0	19.7	63.7	39.8	8.0					
	Sapotaceae	111.5	2.9	19.4	16.8	18.1	87.6	15.9	8.0					
	Dipterocarpaceae	47.8	1.6	8.3	9.4	8.8	31.8	8.0	8.0					
	Rubiaceae	31.8	0.5	5.6	2.9	4.2	31.8							
	Burseraceae	8.0	0.8	1.4	4.4	2.9			8.0					
	Ebenaceae	23.9	0.2	4.2	1.3	2.8	23.9							
	Leguminosae	8.0	0.7	1.4	4.0	2.7			8.0					
	Pentaphylacaceae	15.9	0.3	2.8	1.7	2.2	15.9							
	Tetrameristaceae	8.0	0.5	1.4	2.8	2.1		8.0						
	Clusiaceae	15.9	0.2	2.8	1.4	2.1	15.9							
	Lauraceae	8.0	0.2	1.4	1.2	1.3	8.0							
	Anacardiaceae	8.0	0.2	1.4	0.9	1.1	8.0							
	Oleaceae	8.0	0.1	1.4	0.8	1.1	8.0							
	Ixonanthaceae	8.0	0.1	1.4	0.7	1.0	8.0							
	Chrysobalanaceae	8.0	0.1	1.4	0.7	1.0	8.0							
	Hypericaceae	8.0	0.1	1.4	0.6	1.0	8.0							
	Symplocaceae	8.0	0.1	1.4	0.4	0.9	8.0							
	Elaeocarpaceae	8.0	0.1	1.4	0.4	0.9	8.0							
	Euphorbiaceae	8.0	0.1	1.4	0.4	0.9	8.0							
TOTAL		573.2	17.4	100.0	100.0	100.0	390.1	119.4	63.7					

Appendix III Species Composition

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Domin- ance	Diameter Class (cm)							
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80
1	<i>Cotylelobium melanoxyton</i>	71.7	3.7	11.1	14.0	12.5	31.8	15.9	23.9					
	<i>Gluta oba</i>	39.8	5.0	6.2	18.8	12.5	8.0		8.0	15.9	8.0			
	<i>Ixonanthes reticulata</i>	31.8	3.1	4.9	11.5	8.2		15.9	8.0	8.0				
	<i>Ctenolophon parvifolius</i>	15.9	3.3	2.5	12.2	7.3	8.0					8.0		
	<i>Syzygium attenuata</i>	39.8	0.8	6.2	3.0	4.6	39.8							
	<i>Dacryodes sp.</i>	39.8	0.6	6.2	2.2	4.2	39.8							
	<i>Garcinia gaudichaudi</i>	39.8	0.5	6.2	1.8	4.0	39.8							
	<i>Chaetocarpus castanocarpus</i>	23.9	0.9	3.7	3.4	3.6	8.0	15.9						
	<i>Palaquium rostratum</i>	23.9	0.6	3.7	2.2	2.9	15.9	8.0						
	<i>Madhuca cf. pallida</i>	23.9	0.5	3.7	1.9	2.8	15.9	8.0						
	<i>Anisoptera marginata</i>	15.9	0.8	2.5	2.9	2.7		15.9						
	<i>Syzygium sp.</i>	23.9	0.4	3.7	1.5	2.6	23.9							
	<i>Chionanthus laxiflorus</i>	23.9	0.2	3.7	0.9	2.3	23.9							
	<i>Tristaniopsis obovata</i>	8.0	0.9	1.2	3.4	2.3			8.0					
	<i>Hopea beccariana</i>	8.0	0.9	1.2	3.2	2.2			8.0					
	<i>Shorea parvifolia</i>	15.9	0.5	2.5	1.9	2.2	8.0	8.0						
	<i>Shorea kudatensis</i>	15.9	0.3	2.5	0.9	1.7	15.9							
	<i>Shorea multiflora</i>	8.0	0.6	1.2	2.1	1.7			8.0					
	<i>Mallotus griffithii</i>	15.9	0.2	2.5	0.7	1.6	15.9							
	<i>Shorea rubra</i>	8.0	0.4	1.2	1.4	1.3		8.0						
	<i>Elaeocarpus murudensis</i>	8.0	0.3	1.2	1.3	1.3		8.0						
	<i>Mezettia sp.</i>	8.0	0.3	1.2	1.0	1.1		8.0						
	<i>Xanthophyllum sp.</i>	8.0	0.2	1.2	0.8	1.0	8.0							
	<i>Litsea cylindrocarpa</i>	8.0	0.2	1.2	0.7	1.0	8.0							

<i>Myristica cf. villosa</i>	8.0	0.2	1.2	0.7	1.0	8.0					
<i>Lophopetalum beccarianum</i>	8.0	0.2	1.2	0.7	1.0	8.0					
<i>Gironniera subaequalis</i>	8.0	0.2	1.2	0.7	1.0	8.0					
<i>Baccaurea cf. sumatrana</i>	8.0	0.1	1.2	0.5	0.9	8.0					
<i>Chionanthus sp.</i>	8.0	0.1	1.2	0.5	0.9	8.0					
<i>Horsfieldia endertii</i>	8.0	0.1	1.2	0.5	0.9	8.0					
<i>Mangifera swintonioides</i>	8.0	0.1	1.2	0.4	0.8	8.0					
<i>Mezettia havilandii</i>	8.0	0.1	1.2	0.3	0.8	8.0					
<i>Dipterocarpus grandiflorus</i>	8.0	0.1	1.2	0.3	0.8	8.0					
<i>Ternstroemia aneura</i>	8.0	0.1	1.2	0.3	0.8	8.0					
<i>Canthium sp.</i>	8.0	0.1	1.2	0.3	0.7	8.0					
<i>Syzygium caudatilimbum</i>	8.0	0.1	1.2	0.3	0.7	8.0					
<i>Shorea atrinervosa</i>	8.0	0.1	1.2	0.3	0.7	8.0					
<i>Rhodamnia cinerea</i>	8.0	0.1	1.2	0.2	0.7	8.0					
<i>Xanthophyllum heterophyllum</i>	8.0	0.1	1.2	0.2	0.7	8.0					
TOTAL	644.9	26.6	100.0	100.0	100.0	429.9	111.5	63.7	23.9	8.0	8.0

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)							
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80
2	<i>Gluta oba</i>	31.8	5.6	4.7	22.6	13.6		8.0	8.0	8.0			8.0	
	<i>Syzygium attenuata</i>	55.7	2.2	8.1	8.9	8.5	31.8	15.9	8.0					
	<i>Cotylelobium melanoxyton</i>	71.7	1.6	10.5	6.4	8.4	63.7	8.0						
	<i>Dryobalanops beccarii</i>	31.8	2.0	4.7	8.0	6.3		23.9	8.0					
	<i>Mezettia sp.</i>	39.8	1.3	5.8	5.1	5.4	23.9	15.9						
	<i>Shorea parvifolia</i>	15.9	2.1	2.3	8.4	5.4				8.0	8.0			
	<i>Rhodamnia cinerea</i>	39.8	0.7	5.8	3.0	4.4	39.8							
	<i>Syzygium sp.</i>	31.8	0.8	4.7	3.2	3.9	23.9	8.0						
	<i>Garcinia gaudichaudi</i>	31.8	0.4	4.7	1.5	3.1	31.8							
	<i>Chionanthus sp.</i>	23.9	0.3	3.5	1.4	2.4	23.9							
	<i>Chaetocarpus castanocarpus</i>	8.0	0.9	1.2	3.6	2.4				8.0				
	<i>Xanthophyllum sp.</i>	23.9	0.3	3.5	1.2	2.4	23.9							
	<i>Ixonanthes reticulata</i>	8.0	0.8	1.2	3.2	2.2				8.0				
	<i>Gonystylus bancanus</i>	8.0	0.8	1.2	3.1	2.1				8.0				
	<i>Xylopiia sp.</i>	15.9	0.4	2.3	1.8	2.0	8.0	8.0						
	<i>Shorea kudatensis</i>	8.0	0.7	1.2	2.8	2.0				8.0				
	<i>Memecylon sp.</i>	15.9	0.3	2.3	1.0	1.7	15.9							
	<i>Calophyllum obliquinervium</i>	15.9	0.2	2.3	0.9	1.6	15.9							
	<i>Syzygium clavatum</i>	15.9	0.2	2.3	0.9	1.6	15.9							
	<i>Syzygium confertum</i>	15.9	0.2	2.3	0.9	1.6	15.9							
	<i>Stemonurus sp.</i>	15.9	0.2	2.3	0.6	1.5	15.9							
<i>Syzygium caudatilimbium</i>	15.9	0.2	2.3	0.6	1.5	15.9								
<i>Ctenolophon parvifolius</i>	8.0	0.3	1.2	1.3	1.2			8.0						
<i>Elaeocarpus murudensis</i>	8.0	0.3	1.2	1.3	1.2			8.0						
<i>Stemonurus malaccensis</i>	8.0	0.2	1.2	0.8	1.0	8.0								

<i>Myristica cf. villosa</i>	8.0	0.2	1.2	0.8	1.0	8.0				
<i>Lophopetalum beccarianum</i>	8.0	0.2	1.2	0.7	0.9	8.0				
<i>Guioa sp.</i>	8.0	0.2	1.2	0.7	0.9	8.0				
<i>Tristaniopsis obovata</i>	8.0	0.2	1.2	0.7	0.9	8.0				
<i>Xylopi mucronata</i>	8.0	0.2	1.2	0.6	0.9	8.0				
<i>Payena sp.</i>	8.0	0.1	1.2	0.6	0.9	8.0				
<i>Litsea cylindrocarpa</i>	8.0	0.1	1.2	0.6	0.9	8.0				
<i>Gironniera subaequalis</i>	8.0	0.1	1.2	0.5	0.8	8.0				
<i>Helicia petiolaris</i>	8.0	0.1	1.2	0.4	0.8	8.0				
<i>Castanopsis sp.</i>	8.0	0.1	1.2	0.3	0.8	8.0				
<i>Symplocos adenophylla</i>	8.0	0.1	1.2	0.3	0.7	8.0				
<i>Calophyllum sp.</i>	8.0	0.1	1.2	0.3	0.7	8.0				
<i>Mallotus griffithii</i>	8.0	0.1	1.2	0.3	0.7	8.0				
<i>Helicia sp.</i>	8.0	0.1	1.2	0.3	0.7	8.0				
<i>Memecylon oleifolium</i>	8.0	0.1	1.2	0.3	0.7	8.0				
TOTAL	684.7	24.9	100.0	100.0	100.0	493.6	103.5	63.7	15.9	8.0

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)								
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80	
3	<i>Dryobalanops beccarii</i>	183.1	42.6	41.1	82.3	61.7	103.5	39.8	8.0	8.0	8.0				15.9
	<i>Litsea cylindrocarpa</i>	23.9	1.5	5.4	2.8	4.1	15.9				8.0				
	<i>Palaquium rostratum</i>	15.9	1.6	3.6	3.0	3.3				15.9					
	<i>Kokoona cf. reflexa</i>	8.0	1.4	1.8	2.6	2.2					8.0				
	<i>Artocarpus kemando</i>	15.9	0.4	3.6	0.8	2.2	8.0	8.0							
	<i>Dacryodes sp.</i>	15.9	0.4	3.6	0.7	2.2	8.0	8.0							
	<i>Vatica umbonata</i>	15.9	0.2	3.6	0.4	2.0	15.9								
	<i>Syzygium sp.</i>	15.9	0.2	3.6	0.4	2.0	15.9								
	<i>Dillenia reticulata</i>	8.0	1.0	1.8	1.9	1.9					8.0				
	<i>Chaetocarpus castanocarpus</i>	8.0	0.4	1.8	0.7	1.3		8.0							
	<i>Baccaurea sumatrana</i>	8.0	0.2	1.8	0.5	1.1	8.0								
	<i>Timonius luzonensis</i>	8.0	0.2	1.8	0.4	1.1	8.0								
	<i>Syzygium confertum</i>	8.0	0.2	1.8	0.4	1.1	8.0								
	<i>Elaeocarpus clementis</i>	8.0	0.2	1.8	0.3	1.0	8.0								
	<i>Syzygium cf. acuminatissima</i>	8.0	0.2	1.8	0.3	1.0	8.0								
	<i>Baccaurea sp.</i>	8.0	0.1	1.8	0.3	1.0	8.0								
	<i>Garcinia sp.</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Kokoona sp.</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Diospyros elliptifolia</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Licania splenden</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Garcinia gaudichaudi</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Bhesa paniculata</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Guioa pleuropteris</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Carallia bracteata</i>	8.0	0.1	1.8	0.2	1.0	8.0								
	<i>Quassia indica</i>	8.0	0.1	1.8	0.1	1.0	8.0								
	<i>Pimeleodendron griffithianum</i>	8.0	0.1	1.8	0.1	1.0	8.0								
	<i>Knema conferta</i>	8.0	0.1	1.8	0.1	1.0	8.0								
	TOTAL	445.9	51.8	100.0	100.0	100.0	302.5	63.7	23.9	31.8	8.0				15.9

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)						
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9
4	<i>Dryobalanops beccarii</i>	135.4	20.2	24.3	56.2	40.3	55.7	23.9	8.0	8.0	23.9	8.0	8.0
	<i>Palaquium rostratum</i>	39.8	3.7	7.1	10.3	8.7	15.9		8.0	8.0	8.0		
	<i>Syzygium sp.</i>	55.7	2.3	10.0	6.5	8.3	15.9	31.8	8.0				
	<i>Pternandra coerulescens</i>	47.8	1.1	8.6	3.1	5.8	39.8	8.0					
	<i>Dillenia reticulata</i>	39.8	1.6	7.1	4.4	5.8	15.9	23.9					
	<i>Chaetocarpus castanocarpus</i>	23.9	1.3	4.3	3.6	4.0		15.9	8.0				
	<i>Buchannania arborescens</i>	23.9	1.1	4.3	2.9	3.6	8.0	8.0	8.0				
	<i>Artocarpus kemando</i>	23.9	0.6	4.3	1.6	2.9	15.9	8.0					
	<i>Parastemon parvifolius</i>	8.0	1.5	1.4	4.2	2.8				8.0			
	<i>Bhesa paniculata</i>	15.9	0.4	2.9	1.0	1.9	8.0	8.0					
	<i>Garcinia gaudichaudi</i>	15.9	0.3	2.9	0.9	1.9	15.9						
	<i>Barringtonia cf. sarcostachys</i>	15.9	0.2	2.9	0.5	1.7	15.9						
	<i>Ternstroemia aneura</i>	15.9	0.2	2.9	0.4	1.6	15.9						
	<i>Calophyllum obliquinervium</i>	15.9	0.1	2.9	0.4	1.6	15.9						
	<i>Palaquium sp.</i>	8.0	0.3	1.4	0.9	1.2		8.0					
	<i>Vatica umbonata</i>	8.0	0.2	1.4	0.6	1.0	8.0						
	<i>Garcinia sp.</i>	8.0	0.2	1.4	0.5	1.0	8.0						
	<i>Knema furfuracea</i>	8.0	0.2	1.4	0.4	0.9	8.0						
	<i>Knema conferta</i>	8.0	0.1	1.4	0.4	0.9	8.0						
	<i>Garcinia parvifolia</i>	8.0	0.1	1.4	0.4	0.9	8.0						
<i>Ctenolophon parvifolius</i>	8.0	0.1	1.4	0.3	0.8	8.0							
<i>Guioa sp.</i>	8.0	0.1	1.4	0.2	0.8	8.0							
<i>Quassia indica</i>	8.0	0.1	1.4	0.2	0.8	8.0							
<i>Xylopi mucronata</i>	8.0	0.1	1.4	0.2	0.8	8.0							
	TOTAL	557.3	35.9	100.0	100.0	100.0	310.5	135.4	39.8	23.9	31.8	8.0	8.0

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)								
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80	
5	<i>Dryobalanops beccarii</i>	151.3	6.2	31.7	33.7	32.7	55.7	71.7	23.9						
	<i>Ixonanthes reticulata</i>	23.9	2.9	5.0	15.8	10.4		8.0	8.0		8.0				
	<i>Chaetocarpus castanocarpus</i>	23.9	2.6	5.0	14.3	9.7			23.9						
	<i>Syzygium sp.</i>	39.8	1.2	8.3	6.5	7.4	31.8		8.0						
	<i>Timonius luzonensis</i>	47.8	0.6	10.0	3.4	6.7	47.8								
	<i>Buchannania arborescens</i>	31.8	0.8	6.7	4.3	5.5	23.9	8.0							
	<i>Elaeocarpus murudensis</i>	15.9	0.9	3.3	4.8	4.0	8.0		8.0						
	<i>Xylopia ferruginea</i>	15.9	0.4	3.3	2.3	2.8	15.9								
	<i>Paracroton penduculatus</i>	15.9	0.2	3.3	1.2	2.3	15.9								
	<i>Vatica umbonata</i>	15.9	0.2	3.3	1.1	2.2	15.9								
	<i>Atuna racemosa</i>	8.0	0.5	1.7	2.7	2.2		8.0							
	<i>Licania splenden</i>	8.0	0.3	1.7	1.6	1.6		8.0							
	<i>Pimeleodendron griffithianum</i>	8.0	0.3	1.7	1.5	1.6		8.0							
	<i>Calophyllum obliquinervium</i>	8.0	0.2	1.7	1.3	1.5	8.0								
	<i>Gardenia elata</i>	8.0	0.2	1.7	0.9	1.3	8.0								
	<i>Parastemon parvifolius</i>	8.0	0.2	1.7	0.8	1.2	8.0								
	<i>Horsfieldia laticostata</i>	8.0	0.2	1.7	0.8	1.2	8.0								
	<i>Syzygium clavatum</i>	8.0	0.1	1.7	0.8	1.2	8.0								
	<i>Memecylon sp.</i>	8.0	0.1	1.7	0.6	1.2	8.0								
	<i>Guioa sp.</i>	8.0	0.1	1.7	0.6	1.1	8.0								
<i>Palaquium sp.</i>	8.0	0.1	1.7	0.6	1.1	8.0									
<i>Paracroton pendulus</i>	8.0	0.1	1.7	0.5	1.1	8.0									
	TOTAL	477.7	18.5	100.0	100.0	100.0	286.6	111.5	71.7		8.0				

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)								
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80	
6	<i>Gluta oba</i>	262.7	7.5	33.0	24.8	28.9	175.2	71.7	15.9						
	<i>Cotylelobium melanoxyton</i>	47.8	3.3	6.0	10.9	8.5	15.9	8.0	23.9						
	<i>Syzygium sp.</i>	71.7	2.1	9.0	7.1	8.0	31.8	31.8	8.0						
	<i>Shorea multiflora</i>	31.8	2.2	4.0	7.2	5.6	15.9	8.0		8.0					
	<i>Chaetocarpus castanocarpus</i>	31.8	1.9	4.0	6.3	5.1	8.0	8.0	15.9						
	<i>Ixonanthes reticulata</i>	15.9	1.3	2.0	4.3	3.2	8.0			8.0					
	<i>Scaphium macropodium</i>	15.9	1.2	2.0	3.9	2.9		8.0	8.0						
	<i>Hopea beccariana</i>	15.9	1.0	2.0	3.5	2.7		8.0	8.0						
	<i>Paratocarpus sp.</i>	8.0	1.3	1.0	4.4	2.7				8.0					
	<i>Mezettia sp.</i>	15.9	0.9	2.0	3.0	2.5	8.0		8.0						
	<i>Heritiera simplicifolia</i>	8.0	1.0	1.0	3.5	2.2				8.0					
	<i>Memecylon sp.</i>	23.9	0.4	3.0	1.2	2.1	23.9								
	<i>Horsfieldia endertii</i>	15.9	0.6	2.0	2.1	2.0	8.0	8.0							
	<i>Neoscortechinia forbesii</i>	23.9	0.3	3.0	1.0	2.0	23.9								
	<i>Chionanthus sp.</i>	23.9	0.2	3.0	0.7	1.9	23.9								
	<i>Shorea parvifolia</i>	8.0	0.5	1.0	1.7	1.3		8.0							
	<i>Dryobalanops beccarii</i>	8.0	0.4	1.0	1.4	1.2		8.0							
	<i>Gymnacranthera sp.</i>	8.0	0.4	1.0	1.3	1.2		8.0							
	<i>Kokoona sp.</i>	8.0	0.3	1.0	0.8	0.9		8.0							
	<i>Horsfieldia crassifolia</i>	8.0	0.2	1.0	0.7	0.9	8.0								
<i>Rhodamnia cinerea</i>	8.0	0.2	1.0	0.7	0.8	8.0									
<i>Knema curtisii</i>	8.0	0.2	1.0	0.6	0.8	8.0									
<i>Cleistanthus gracilis</i>	8.0	0.2	1.0	0.6	0.8	8.0									
<i>Horsfieldia sp.</i>	8.0	0.2	1.0	0.5	0.8	8.0									
<i>Canarium sp.</i>	8.0	0.2	1.0	0.5	0.8	8.0									
<i>Gironniera subaequalis</i>	8.0	0.1	1.0	0.4	0.7	8.0									

<i>Stemonurus sp.</i>	8.0	0.1	1.0	0.4	0.7	8.0			
<i>Neoscortheclinia sp.</i>	8.0	0.1	1.0	0.3	0.7	8.0			
<i>Sindora cf. coriacea</i>	8.0	0.1	1.0	0.3	0.6	8.0			
<i>Popowia hirta</i>	8.0	0.1	1.0	0.2	0.6	8.0			
<i>Mallotus griffithii</i>	8.0	0.1	1.0	0.2	0.6	8.0			
<i>Carallia bracteata</i>	8.0	0.1	1.0	0.2	0.6	8.0			
<i>Tristaniopsis obovata</i>	8.0	0.8	1.0	2.7	1.8		8.0		
TOTAL	796.2	30.1	100.0	100.0	100.0	477.7	191.1	95.5	31.8

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominan ce	Diameter Class (cm)																					
							10.0- 19.9	20.0- 29.9	30.0- 39.9	40.0- 49.9	50.0- 59.9	60.0- 69.9	70.0- 79.9	>80														
7	<i>Shorea multiflora</i>	39.8	3.3	10.2	18.5	14.3	8.0																					
	<i>Gluta oba</i>	31.8	3.1	8.2	17.3	12.7	8.0																					
	<i>Shorea kudatensis</i>	23.9	2.8	6.1	15.5	10.8	23.9	8.0																				
	<i>Cotylelobium melanoxyton</i>	39.8	1.8	10.2	9.8	10.0	8.0																					
	<i>Calophyllum obliquinervium</i>	31.8	1.0	8.2	5.5	6.8	8.0																					
	<i>Syzygium sp.</i>	23.9	0.8	6.1	4.6	5.4	8.0																					
	<i>Rhodamnia cinerea</i>	23.9	0.4	6.1	2.0	4.1	15.9																					
	<i>Dacryodes sp.</i>	15.9	0.6	4.1	3.3	3.7	23.9	8.0	8.0																			
	<i>Chaetocarpus castanocarpus</i>	15.9	0.3	4.1	1.8	2.9		8.0	8.0																			
	<i>Parastemon urophyllus</i>	8.0	0.6	2.0	3.5	2.8		8.0	8.0																			
	<i>Xanthophyllum sp.</i>	8.0	0.4	2.0	2.4	2.2		8.0																				
	<i>Hopea beccariana</i>	8.0	0.4	2.0	2.2	2.1	15.9				8.0	8.0																
	<i>Mezettia sp.</i>	8.0	0.3	2.0	1.7	1.9			8.0																			
	<i>Ctenolophon parvifolius</i>	8.0	0.3	2.0	1.5	1.8			8.0																			
	<i>Heritiera sumatrana</i>	8.0	0.3	2.0	1.5	1.8		8.0																				
	<i>Shorea parvifolia</i>	8.0	0.2	2.0	1.2	1.6		8.0																				
	<i>Mangifera griffithii</i>	8.0	0.2	2.0	1.1	1.6		8.0																				
	<i>Calophyllum sp.</i>	8.0	0.2	2.0	1.1	1.5			8.0																			
	<i>Neoscortechinia sp.</i>	8.0	0.2	2.0	1.0	1.5		8.0																				
	<i>Anisoptera marginata</i>	8.0	0.2	2.0	0.9	1.5					8.0																	
	<i>Carallia bracteata</i>	8.0	0.1	2.0	0.7	1.4		23.9																				
	<i>Mangifera macrocarpa</i>	8.0	0.1	2.0	0.7	1.4					15.9	8.0																
	<i>Garcinia gaudichaudi</i>	8.0	0.1	2.0	0.5	1.3					39.8																	
<i>Canthium confertum</i>	8.0	0.1	2.0	0.4	1.2		8.0																					
<i>Ternstroemia aneura</i>	8.0	0.1	2.0	0.4	1.2		15.9			8.0																		
<i>Memecylon sp.</i>	8.0	0.1	2.0	0.4	1.2		8.0																					
<i>Baccaurea parviflora</i>	8.0	0.1	2.0	0.4	1.2				8.0																			
	TOTAL	390.1	18.0	100.0	100.0	100.0	222.9	63.7	79.6	15.9	8.0																	

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)							
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80
8	<i>Pleiocarpidia sandakanica</i>	55.7	0.9	17.9	7.4	12.7			8.0					
	<i>Ficus delosyce</i>	8.0	2.0	2.6	16.1	9.3	8.0		8.0					
	<i>Hopea sangal</i>	8.0	1.9	2.6	15.5	9.0	8.0							
	<i>Neolamarckia cadamba</i>	8.0	1.4	2.6	11.6	7.1		8.0						
	<i>Chionanthus pluriflorus</i>	15.9	0.9	5.1	7.5	6.3	8.0							
	<i>Nephelium ramboutan-ake</i>	23.9	0.4	7.7	2.9	5.3	8.0							
	<i>Palaquium hexandrum</i>	23.9	0.3	7.7	2.7	5.2	8.0							
	<i>Cassia nodosa</i>	8.0	0.9	2.6	7.2	4.9	8.0	8.0						
	<i>Dipterocarpus validus</i>	15.9	0.6	5.1	4.6	4.9	8.0							
	<i>Syzygium fastigiatum</i>	15.9	0.5	5.1	4.4	4.7					8.0			
	<i>Symplocos fasciculata</i>	15.9	0.5	5.1	4.2	4.6	15.9							
	<i>Glochidion rubrum</i>	15.9	0.3	5.1	2.3	3.7					8.0			
	<i>Syzygium sp.</i>	15.9	0.2	5.1	1.8	3.5	8.0							
	<i>Crudia reticulata</i>	8.0	0.5	2.6	4.0	3.3				8.0				
	<i>Nauclea subdita</i>	8.0	0.2	2.6	1.4	2.0	23.9							
	<i>Sapium discolor</i>	8.0	0.1	2.6	1.1	1.8	23.9							
	<i>Cleistanthus myrianthus</i>	8.0	0.1	2.6	1.1	1.8	8.0							
	<i>Peltophorum racemosum</i>	8.0	0.1	2.6	0.8	1.7	55.7							
	<i>Dracontomelon dao</i>	8.0	0.1	2.6	0.8	1.7	8.0							
	<i>Quassia indica</i>	8.0	0.1	2.6	0.7	1.6	8.0							
<i>Dacryodes rostrata</i>	8.0	0.1	2.6	0.7	1.6	8.0	8.0							
<i>Dimocarpus longan</i>	8.0	0.1	2.6	0.7	1.6	8.0	8.0							
<i>Cryptocarya acutiflora</i>	8.0	0.1	2.6	0.5	1.5	15.9								
TOTAL		310.5	12.2	100.0	100.0	100.0	238.9	31.8	15.9	8.0	15.9			

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)								
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80	
9	<i>Mallotus muticus</i>	31.8	1.4	6.6	8.7	7.6	15.9	8.0	8.0						
	<i>Syzygium sp.</i>	23.9	1.6	4.9	9.8	7.4	15.9			8.0					
	<i>Hopea sangal</i>	23.9	1.6	4.9	9.8	7.4	8.0	8.0		8.0					
	<i>Chionanthus pluriflorus</i>	39.8	0.9	8.2	5.6	6.9	23.9	15.9							
	<i>Vatica umbonata</i>	23.9	1.0	4.9	5.8	5.4	8.0	8.0	8.0						
	<i>Hopea nervosa</i>	31.8	0.6	6.6	3.7	5.1	31.8								
	<i>Dillenia excelsa</i>	15.9	1.1	3.3	6.5	4.9		8.0	8.0						
	<i>Sindora sp.</i>	15.9	1.0	3.3	6.3	4.8		15.9							
	<i>Crudia sp.</i>	8.0	0.9	1.6	5.1	3.4				8.0					
	<i>Sindora cf. coriacea</i>	8.0	0.8	1.6	4.6	3.1				8.0					
	<i>Aglaia sp.</i>	15.9	0.4	3.3	2.3	2.8	8.0	8.0							
	<i>Drypetes caesia</i>	8.0	0.5	1.6	3.0	2.3		8.0							
	<i>Baccaurea tetrandra</i>	15.9	0.2	3.3	1.3	2.3	15.9								
	<i>Diospyros sp.</i>	8.0	0.5	1.6	2.7	2.2		8.0							
	<i>Cryptocarya acutiflora</i>	15.9	0.2	3.3	1.0	2.1	15.9								
	<i>Shorea gibbosa</i>	8.0	0.4	1.6	2.6	2.1		8.0							
	<i>Dehaasia sp.</i>	8.0	0.4	1.6	2.2	1.9		8.0							
	<i>Pterygota horsfieldii</i>	8.0	0.3	1.6	2.0	1.8		8.0							
	<i>Dialium indum</i>	8.0	0.2	1.6	1.4	1.5	8.0								
	<i>Microcos triflora</i>	8.0	0.2	1.6	1.4	1.5	8.0								
	<i>Colona serratifolia</i>	8.0	0.2	1.6	1.3	1.5	8.0								
	<i>Parashorea malaanonan</i>	8.0	0.2	1.6	1.0	1.3	8.0								
	<i>Knema furfuracea</i>	8.0	0.2	1.6	1.0	1.3	8.0								
<i>Dracontomelon dao</i>	8.0	0.2	1.6	0.9	1.3	8.0									
<i>Knema sp.</i>	8.0	0.2	1.6	0.9	1.3	8.0									
<i>Peltophorum racemosum</i>	8.0	0.1	1.6	0.8	1.2	8.0									

<i>Pternandra rostrata</i>	8.0	0.1	1.6	0.8	1.2	8.0			
<i>Canarium odontophyllum</i>	8.0	0.1	1.6	0.8	1.2	8.0			
<i>Garcinia parvifolia</i>	8.0	0.1	1.6	0.7	1.2	8.0			
<i>Lophopetalum javanicum</i>	8.0	0.1	1.6	0.7	1.2	8.0			
<i>Baccaurea lanceolata</i>	8.0	0.1	1.6	0.6	1.1	8.0			
<i>Dillenia indica</i>	8.0	0.1	1.6	0.6	1.1	8.0			
<i>Maranthes corymbosa</i>	8.0	0.1	1.6	0.6	1.1	8.0			
<i>Hydnocarpus sp.</i>	8.0	0.1	1.6	0.6	1.1	8.0			
<i>Hydnocarpus borneensis</i>	8.0	0.1	1.6	0.5	1.1	8.0			
<i>Knema oblongata</i>	8.0	0.1	1.6	0.5	1.0	8.0			
<i>Garcinia sp.</i>	8.0	0.1	1.6	0.4	1.0	8.0			
<i>Chionanthus sp.</i>	8.0	0.1	1.6	0.4	1.0	8.0			
<i>Knema cinerea</i>	8.0	0.1	1.6	0.4	1.0	8.0			
<i>Dysoxylum arborescens</i>	8.0	0.1	1.6	0.4	1.0	8.0			
TOTAL	485.7	16.7	100.0	100.0	100.0	318.5	111.5	39.8	15.9

Plot	Species	Density / ha	Basal Area /ha	Rel. Density	Rel. Basal Area	Rel. Dominance	Diameter Class (cm)											
							10.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-69.9	70.0-79.9	>80				
10	<i>Tristaniopsis obovata</i>	79.6	4.4	13.9	25.5	19.7	31.8											
	<i>Palaquium sp.</i>	103.5	2.8	18.1	16.3	17.2	8.0											
	<i>Xylopiya ferruginea</i>	87.6	2.1	15.3	12.0	13.7	15.9	8.0										
	<i>Shorea parvifolia</i>	15.9	1.0	2.8	5.7	4.2	8.0											
	<i>Canthium sp.</i>	31.8	0.5	5.6	2.9	4.2				8.0								
	<i>Mezettia sp.</i>	15.9	0.8	2.8	4.7	3.7	23.9											
	<i>Cotylelobium melanoxyton</i>	23.9	0.5	4.2	3.1	3.7	8.0											
	<i>Dacryodes sp.</i>	8.0	0.8	1.4	4.4	2.9	8.0											
	<i>Diospyros evena</i>	23.9	0.2	4.2	1.3	2.8	8.0											
	<i>Koompassia malaccensis</i>	8.0	0.7	1.4	4.0	2.7	8.0											
	<i>Syzygium sp.</i>	15.9	0.4	2.8	2.4	2.6	8.0											
	<i>Mezettia havilandii</i>	8.0	0.6	1.4	3.3	2.4				8.0								
	<i>Ternstroemia aneura</i>	15.9	0.3	2.8	1.7	2.2	8.0											
	<i>Tetramerista glabra</i>	8.0	0.5	1.4	2.8	2.1				8.0								
	<i>Syzygium biabas</i>	15.9	0.2	2.8	1.0	1.9		15.9										
	INDET	8.0	0.2	1.4	1.2	1.3	8.0											
	<i>Mangifera macrocarpa</i>	8.0	0.2	1.4	0.9	1.1	79.6	15.9	8.0									
	<i>Garcinia sp.</i>	8.0	0.1	1.4	0.9	1.1	8.0											
	<i>Chionanthus laxiflorus</i>	8.0	0.1	1.4	0.8	1.1	8.0											
	<i>Ixonanthes reticulata</i>	8.0	0.1	1.4	0.7	1.0	8.0											
	<i>Parastemon urophyllus</i>	8.0	0.1	1.4	0.7	1.0	8.0			8.0								
<i>Cratoxylum aborescens</i>	8.0	0.1	1.4	0.6	1.0	8.0												
<i>Palaquium pseudorostratum</i>	8.0	0.1	1.4	0.6	1.0	15.9												
<i>Shorea kudatensis</i>	8.0	0.1	1.4	0.5	1.0	8.0												
<i>Garcinia bancana</i>	8.0	0.1	1.4	0.5	1.0	15.9												
<i>Syzygium incarnatum</i>	8.0	0.1	1.4	0.4	0.9	15.9												

<i>Symplocos sp.</i>	8.0	0.1	1.4	0.4	0.9	8.0		
<i>Elaeocarpus euneurus</i>	8.0	0.1	1.4	0.4	0.9	8.0	47.8	23.9
<i>Pimeleodendron griffithianum</i>	8.0	0.1	1.4	0.4	0.9	63.7	23.9	
TOTAL	573.2	17.4	100.0	100.0	100.0	390.1	119.4	63.7